BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH AT NEW DELHI

IN O.A. 298 OF 2023

IN THE MATTER OF:

Dr. Raja Singh

……..Applicant

Vs.

Union of India, Through the Secretary, Ministry of Environment, Forests and Climate Change and Ors.

…….Respondents

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Rejoinder by Dr Raja Singh response to the submission by respondent no. 4, the Fibre Cement Products Manufacturer's Association, praying for directions of the Hon'ble National Green Tribunal for phasing out asbestos roofing in schools under Air (Prevention and Control of Pollution) Act 1981 read along with Environmental Protection Act, 1986 and read along with precautionary principle as in Section 20 of the National Green Tribunal Act, 2010.

THE HUMBLE APPLICANT MOST RESPECTFULLY SHOWETH:

1. The humble applicant at the outset wants to most respectfully state that this matter is non adversarial in nature and is in larger public interest due to the health effect of use of asbestos cement roofing in schools.

2. The humble applicant also most respectfully states that this matter and this application is not about a blanket ban of asbestos in the country. It is about phasing out of asbestos cement roofing in schools as an issue of health of the children.

3. The humble applicant also wants to state that there is no sense of ill-will towards the manufacturing companies and their representative organisation, the Fibre Cement Products Manufacturer's Association, or FCPMA. The applicant appreciates that the companies produce employment and contribute to revenue for our great country and should continue in doing so.

4. But at the same time, the applicant wants to most respectfully state that the commercial interests cannot be at the cost of health and environment of the same country in which we all live and are nurtured. The humble applicant, would respectfully beg the Hon'ble Tribunal to direct the respondent no. 4 to show magnanimity and deal in this matter with a spirit of reform.

5. The humble applicant wants to respectfully assist this Hon'ble Tribunal and state that there are two broad types of exposures to asbestos which are namely:
    a. Occupational Exposure to the asbestos fibres: This can happen during mining of asbestos, transportation of asbestos, processing and manufacturing of asbestos products, dismantling of ships containing asbestos and installation of asbestos materials. This may also include para occupational exposure where the allied persons directly or indirectly to the above get exposed.

    b. Non occupational exposure to asbestos: This happens when a person is exposed to asbestos fibres when using a building, or utility service containing asbestos. This may also include the exposure when the building materials after use are demolished and not disposed of properly and is available in the vicinity of non-occupational users.

6. With respect to the above distinction made between occupational and non-occupational exposure, the humble occupant most respectfully wants to state that this instant application is associated only with the non-occupational exposure to asbestos. There is no attempt by the applicant to mix the two issues of occupational and non-occupational exposure to asbestos. The applicant also most respectfully urges the Hon'ble Tribunal to record this distinction made between occupational exposure and non-occupational exposure to asbestos.

7. The humble applicant also wants to state that the companies that FCPMA represents have by themselves made an attempt to switch to new alternatives instead of asbestos, which is for reasons that there is a realization that asbestos has harmful health effects for human beings. If asbestos would have been the only option, the companies may never have shifted to other alternatives which they have also started as a vertical in their production plans. Switching to responsible alternatives is a step that will actually make the businesses future ready which will actually save employment and not risking health of Indians, especially Indian children.

8. Apart from the above, the applicant wants to most respectfully point out that India is a signatory of the United Nations Convention on the Rights of the Child (signed in 1992), which not only ensures providing education to a child but also deals with taking care of the health of the child. In schools with asbestos roofing, the child are exposed to a carcinogen which may cause disease during the breadwinning period of the child's life.
The Full text of the Convention on the Rights of the Child are available here: https://www.unicef.org/media/52626/file

9. As a responsible nation and a growing economy, the interest of the child, studying in schools must be kept foremost along with the other issues highlighted in this document.

Before setting out the paragraph wise reply, the applicant most respectfully makes the following submissions for consideration of this Hon'ble Tribunal:

JURISDICTION UNDER SECTION 14 OF NATIONAL GREEN TRIBUNAL ACT, 2010

10. The submission by Respondent No. 4 that the OA 'is not maintainable as it does not relate to implementation of any law mentioned in the Schedule I to the National Green Tribunal Act 2010, and instead seeks relief which are purely in the realm of policy' is wrong, misconceived, denied on the basis of merits of the case. It totally disregards the Air (Prevention and Control of Pollution) Act, 1981 as well as the Environment Protection Act, 1986. It also, with grave audacity on the part of respondent No. 4, undermines the authority of this Hon'ble Tribunal which has been given *sui generis* characteristic, not only by its legislative intent but also by the various judgements of the Hon'ble Supreme Court of India.

11. On the issue of implementation of laws mentioned in Schedule 1 of the National Green Tribunal Act 2010, the applicant wants to bring to humbly and respectfully the notice of this Tribunal the question before the Tribunal. The issue is about release of asbestos fibres from weathered asbestos cement sheets which have been used in school buildings. It is stated that these fibres are released into the air of the school and the surroundings and become an *"air pollutant"* which has been defined in the Air (Prevention and Control of Pollution) Act, 1981 in Section 2 (a) as

'any solid, liquid or gaseous substance [(including noise)] present in the atmosphere in such concentrations as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.'

12. These fibres cause *"air pollution"* which means the ***'presence in the atmosphere of any air pollutant'*** under Section 2 (b) of the Air (Prevention and Control of Pollution) Act, 1981. In this regard, there may be two issues: One being the question of what is the 'such concentration' for asbestos in the air and the other being whether the inside of the school building is 'atmosphere'

13. In this regard, the Hon'ble National Green Tribunal has in ***Narendra Pratap Singh vs Central Pollution Control Board (OA 649/2022) dated 17th July 2023*** ruled that ***'There is no safe level of asbestos exposure'*** which automatically means that any number of fibres are an air pollutant. These same fibres when in soil will become a soil pollutant and when they reach the water become a water pollutant.

14. With respect to the issue of indoor pollutant the Hon'ble National Green Tribunal in ***Raja Singh v. Union of India & Ors. (OA 206/2022 judgment) dated 19 April 2022*** has ruled that ***'indoor air quality can be regulated in respect of public places'*** and that ***'there is no statutory bar to regulation of indoor air quality under the Air Act or the EP Act and the Rules.'*** This has also been defined by the Hon'ble Tribunal as an issue where a ***'substantial question of environment arises and is answered to the effect that there is need for regulation of indoor air quality at public places.'*** The same judgement in paragraph 10 also listed sources of indoor air pollutants as including:

1. building materials,
2. formaldehyde,
3. volatile organic compounds,
4. radon,
5. **asbestos,**
6. particulate matter,
7. gaseous pollutants and

8. biological pollutants.

It may be noted above that 'asbestos' in particular has been included in the judgement where sources of indoor air pollutants are listed. The order of the Hon'ble National Green Tribunal in ***Raja Singh v. Union of India & Ors. (OA 206/2022 judgment) dated 19 April 2022*** is attached as **Annexure A**

9. Thus, it may respectfully be shown that asbestos fibre pollution in the air caused by use of asbestos cement roofing is well within the scope and mandate of the Air (Prevention and Control) of Pollution Act, 1981 read along with Environmental Protection Act and their rules. The EPA Act specially gives powers to the Central Government to make rules. This makes the issue raised well within the Statues mentioned in Schedule 1 of the NGT Act, 2010.

10. Further, the asbestos fibres released can enter water as well as soil from weathering, renovation, or demolition of manufactured asbestos products as has been stated by the Ministry of Environment, Forests and Climate Change which states as follows about asbestos fibres: '..can enter the air, water, soil from the weathering, renovation, or demolition of manufactured asbestos products. ' This clearly indicates that not only can the Air Act be violated, but also the Water (Prevention and Control of Pollution Act, 1974.

11. On the issue of the use of the phrase 'realm of policy making' it may be respectfully submitted that NGT is not merely an adjudicatory body, but a regulatory body in essence.

12. In the book 'Environmental Law and Policy in India' by Armin Rosencranz and Shyam Divan, the authors note in chapter on NGT that:

'Tribunals are considered to be different from courts and other

judicial bodies. They are meant to play the role of the expert in an area where judicial remedy is being sought. It would, therefore, not be wrong to assume that this expert body 'adds' to the knowledge on the environmental impact produced in the regulatory process after the project has gone through all the basic regulatory filters. However, recent cases seem to indicate that the NGT is performing the role of simply because the MoEF and other state-level regulatory bodies set up under the EIA notification 2006 refuse to take their roles seriously. It is through this regulation that environmental impact of industrial and infrastructure projects is to be determined and they need to be either accorded approval or rejected. Illustrative of its regulatory role, the NGT responded to a petition filed by Rajiv Dutta highlighting the devastation caused by forest fires in Uttarakhand and Himachal Pradesh. Noticing that fires had destroyed large swathes of forest land, the Tribunal directed the MoEF to prepare and implement forest fire management plans for each state; to appoint anodal officer to monitor and coordinate an improved response to fires; and directed the establishment of a central Monitoring committee headed by the Secretary of the MoEF to strengthen implementation on the ground.'

13. This opinion has been resonated by the Hon'ble Supreme Court of India in Municipal Corporation of Greater Mumbai v. Ankita Sinha & Ors (CA No. 12122 of 2018) which states that:

> ***'24.5 The NGT is a Tribunal with sui generis characteristic, with the special and all-encompassing jurisdiction to protect the environment. Besides its adjudicatory role as an appellate authority, it is also conferred with the responsibility to discharge role of supervisory body and to decide substantial questions relating to the environment. The necessity of having***

a specialized body, with expertise to handle multi-dimensional environmental issues allows for an all - encompassing framework for environmental justice. The technical expertise that may be required to address evolving environmental concerns would definitely require a flexible institutional mechanism for its effective exercise. '

14. The judgement also quoted another judgment of the Apex Court : In 24.3 while quoting DG NHAI vs Aam Aadmi Lokmanch judgment by the Hon'ble Supreme Court, it was stated that the ***'Court repelled the argument for the restricted jurisdiction for the NGT, and fittingly observed that 'the powers conferred on the NGT are both reflexive and preventive and the role of the NGT was recognized as "an expert regulatory body" which can issue general directions also albeit within the statutory framework.'*** (emphasis supplied)

THE VARIOUS INDIAN GOVERNMENTAL ORGANISATIONS AND THEIR DEALING WITH ASBESTOS CEMENT SHEETS

15. The applicant wants to most humbly and respectfully bring to the notice of the Hon'ble Tribunal that the issue of stoppage of asbestos cement roofing or preventing the promotion of the same is not unprecedented in the world. But in India itself this action has been touched upon by the following:

    a. Western Railways, a part of Indian railways in 2013 based on the advice of the Railway Design Standard Organisation guideline No. WKS/WS/05/FS dated 16th January 2013 has phased out the use of asbestos roofing. This has also been reported in the Hindustan Times and Mumbai Mirror Articles. The letter from Western Railways and the guideline

No. WKS/WS/05/FS dated 16th January 2013 is attached as **Annexure B** and the articles in Hindustan Times and Mumbai mirror are attached as **Annexure C.**

b. CPWD, or Central Public Works Department, which is under the Ministry of Housing and Urban Affairs, and has responded in this current matter, and has stated on record that the latest DSR does not include asbestos materials. This fact is in the favour of the applicant as even though some CPWD buildings are using asbestos roofing, the policy by a central government agency directly under a Ministry has stated on record that asbestos is no more part of the DSR, which is document to be used in government constructions and is also the benchmark for all private construction in the country.

c. NDMA, or the National Disaster Management Authority working under Heatwave Action has come up with 'House Owner's Guide for Alternate Roof Cooling Solutions' has listed 16 roof technologies and have specifically excluded the roof containing asbestos fibre and have suggested a roof with alternate fibre. This is a guideline by a government agency that has suggested cheap and affordable methods for cool roofing in India. The 'House Owner's Guide for Alternate Roof' by NDMA is attached as **Annexure D.**

d. The Minister of External Affairs of India had informed the parliament that the Indian cultural centre in Washington DC was delayed due to asbestos problems in the building that was a brownfield project and asbestos was still in the building. This is indicative of the strong caution that asbestos containing materials cause to the Indian government when in the US jurisdiction, but the same asbestos containing

materials used in Indian buildings may be relooked at. The extract of statement of the Minister of External Affairs Shri S Jaishankar in Parliamentary Debates dated 9th February 2023 with Volume 259 No. 8 is attached as **Annexure E.**

e. In another case of a prison in Delhi, the renowned public figure and member of parliament, Late George Fernandes filed a case before the National Human Rights Commission on 11th August 1997 No. 693/30/97-98 for a Bhutanese National in Delhi Jail. The case was about use of asbestos containing roofing in the jail where the NHRC had directed the Delhi government to use roofing of some other material.

POSITION OF THE WORLD HEALTH ORGANISATION ON THE USE OF CHRYSOTILE ASBESTOS CEMENT ROOFING SHEET AND ITS EFFECT ON HEALTH

16. The World Health Organisation came out with a publication called 'Chrysotile Asbestos' in 2014. In this document it is stated as follows:

'Bearing in mind that there is no evidence for a threshold for the carcinogenic effect of asbestos, including chrysotile, and that increased cancer risks have been observed in populations exposed to very low levels, the most efficient way to eliminate asbestos-related diseases is to stop using all types of asbestos. Continued use of asbestos cement in the construction industry is a particular concern, because the workforce is large, it is difficult troll exposure, and ***in-place materials have the potential to deteriorate*** *and pose a risk to those carrying out alterations, maintenance, and* ***demolition****. In its various applications, asbestos can be replaced by some fibre materials and by other products that pose less or no risk to health.'* For the sake of schools, the use of asbestos cement sheets, learning from the above, may be phased out in India.

The publication titled 'Chrysotile Asbestos' by the World Health Organisation is attached as **Annexure F**

RECENT SCIENTIFIC EVIDENCE OF TOPICS RELATED TO THE RELEASE OF ASBESTOS FIBRES FROM ASBESTOS CEMENT SHEETS OVER TIME DUE TO WEATHERING, DETIORATION AND DECAY

17. The humble applicant, most respectfully prays to assist this Hon'ble Tribunal and states the following scientific studies:

    a. In the study titled 'Releasability of asbestos fibers from weathered roof cement' by Andrew F Oberta, Lee Poye and Steven P Compton from 2018, it has been stated that: ***'Chrysotile asbestos fibers were added to roofing products, including roof cement, for several decades. The fibers were described as "encapsulated" and therefore incapable of being released, an assertion that is disproved by the study therein.'***
    The study also went on to state that the disturbance also increases the chance of release and inhalation. The study is attached as **Annexure G.**

    b. In the study titled 'Surface of Asbestos-cement (AC) Roof Sheets and Assessment of the Risk of Asbestos Release by Jerry Dyczek it was stated follows:
    '…corrugated roof sheets were investigated on the older (40 years old) roof of a building in an industrialised area in Southwest Poland, were acid rain is rather frequent. Acid rain wears down the matrix and asbestos fibres ae exposed..' 'Fibres are clean, uncovered by calcium carbonated or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium carbonates or

calcium silicate hydrates and specifically not connected to the matrix. Here, calcium compounds reacted with acid to produce more soluble chemical compounds which were dissolved. As a result of this, on the sheet surface are found asbestos fibres, which can rather easily break away. Risk of asbestos dust release is high. '

The study is attached as **Annexure H.**

ON THE ISSUE OF USE OF ONLY CHRYSOTILE VARIETY IN ASBESTOS CEMENT ROOFS

18. It may also be stated that the existing schools and other buildings in the country which have asbestos cement roofing from more than 8 decades, as claimed by the respondent no. 4 may have used all varieties of asbestos apart from Chrysotile in the past. This means that the existing stock of buildings may have varieties of asbestos other than chrysotile as well.
The respondent number 4 may be put to strict proof that throughout the past time of sale and use of asbestos cement roofs in India, the only asbestos used has been chrysotile only.

ON KALYANESHWARI VS. UNION OF INDIA AND ORS. JUDGMENT BY THE HON'BLE SUPREME COURT OF INDIA

19. The applicant wants to humbly point out that the main issue in the ***Kalyaneshwari v. Union of India & Ors, 2011*** judgement has been the occupational exposure of asbestos during mining, manufacture, and processing of asbestos in India. Secondly, the current applicant does not seek complete ban on all uses of asbestos in any manner whatsoever as stated by the respondent. The applicant further reiterates that in the said judgment, the main issue of occupational exposure to asbestos is not the subject of this current application.

ON VISION STATEMENT OF THE MINISTRY OF ENVIRONEMNT, FORESTS AND CLIMATE CHANGE

20. The Ministry of Environment, Forests and Climate Change in its 'Vision Statement on Environment and Human Health' stated in para 4.3.1 that 'Alternatives to asbestos may be used to the extent possible and the use of asbestos may be phased out'. This may be most relevant to the phasing out of asbestos from roofs of schools in India. The document is available on the webste of the Ministry of Environment, Forests and Climate change here: https://moef.gov.in/wp-content/uploads/2017/08/visenvhealth.pdf

ON THE STUDY BY NATIONAL INSTITUTE OF OCCUPATIONAL HEALTH TITLED 'STUDY OF HEALTH HAZARDS/ENVIRONMENTAL HAZARDS RESULTING FROM USE OF CHRYSOTILE VARIETY OF ASBESTOS IN THE COUNTRY' ON CHRYSOTILE ASBESTOS AND ITS USE IN THE LITIGATION BEFORE THE NATIONAL HUMAN RIGHTS COMMISSION

21. The applicant wants to most humbly and respectfully assist this Hon'ble Tribunal and state that the NIOH study that has been quoted is valid for the occupational settings only where it was performed. Therefore the validity of this study is not for the current question of asbestos cement roofs in schools as that is a matter related to the non-occupational exposure to asbestos by use of asbestos containing material. Further, the applicant wants to most humbly and respectfully state that the study has another two issues which the applicant urges this Hon'ble Tribunal to record, which are as follows:
    c. The study was funded by the Asbestos Cement Manufacturers Association in part and this may raise some questions.

d. The NIOH in a reply to the applicant via the Right to Information Act 2005 has stated that 'No Information is held' about the validity of the study for non-occupational settings where there may be asbestos containing materials present. It may also be noted that the document containing the ethics approval for the study is 'not retrievable' by the NIOH. The above-mentioned reply duly signed by the NIOH is attached as **Annexure I.**

It may be kindly recorded that the scope of the study does not include the use of asbestos cement roofing in the non-occupational environment and may not be relevant nor be admissible in this current matter. The humble applicant begs the Hon'ble Tribunal for consideration of the same.

22. Moreover, the applicant most respectfully submits that the above report by NIOH was seemingly the only basis of the NHRC order that the respondent no.4 quotes. And, the applicant humbly reiterates that occupational exposure to asbestos was the scope of this report but it is not in the scope of the current application.

ON THE STUDY BY THE DIRECTORATE GENERAL FACTORY ADVICE SERVICE AND LABOUR INSTITUTES OR DGFASLI TITLED 'NATIONAL STUDY ON OCCUPATIONAL SAFETY, HEALTH AND WORKING ENVIRONMENT IN ASBESTOS-CEMENT PRODUCT INDUSTRIES' IN 2019

23. The applicant wants to most humbly and respectfully submit the following facts about this study by DGFASLI which is the most recent and most updated as far as the asbestos industries are concerned:

a. As the title and the contents suggest, this study is related to the Occupational environments related to industries where asbestos cement products are manufactured or processed. This mere fact

makes the citation of this study in this current matter as irrelevant as it does not address the non-occupational exposure to asbestos which this application talks raises.

b. The study also records that only chrysotile is being used by the asbestos cement products industries in India in para 10.5 of the study which states that

'It has been seen that asbestos cement product industries are importing and using chrysotile asbestos (white variety) only for the manufacture of asbestos cement sheets and pipes.'

c. Then, the study states the asbestos-related diseases/disorders, the effect of asbestos on lungs is shown as follows:

'In the early stage, asbestos fibres accumulate in those alveoli which open directly off the bronchioles. They penetrate the wall and produce a low grade inflammatory response followed by fibrosis. This causes lung thickening and some narrowing of the terminal airways which is picked up as a reduction of gas transfer and compliance on lung function testing. Fibres migrate away from these centrilobular foci into the interstitial between the alveoli and towards the pleura, causing extension of the low-grade inflammatory response and interstitial fibrosis.

The inflammation and interstitial fibrosis interferes with ventilation by making the lung rigid and lead to shrinkage of the affected area with honeycomb change. The change affects only the periphery of the lung and leaves the central part undamaged, but this normal lung is of little functional value as it is held immobile by the surrounding damage. Lavage of airways yield increased numbers of polymorphs and other inflammatory cells and also asbestos fibres and asbestos bodies.

Asbestos gives rise to no specific symptoms or signs apart from the inspiratory crepitations on auscultation. The patient will complain of very gradually increasing breathlessness.'

The major cause, the study quotes, of death in individuals with asbestosis is malignancy, i.e., primary lung cancer or mesothelioma.

d. The above makes it clear that Indian industries use chrysotile asbestos which causes the above medical condition.

e. The one point, even though not directly related to the current application, but to assist the Hon'ble Tribunal is the fact that the study may not have considered the latency of 20-40 years that asbestos diseases may cause and that the examinations of the retired workers may have missed, which contravenes the order of the Hon'ble Supreme Court in Consumer Forum case where it was specifically mentioned that records after 15 years may be taken. This point is not an allegation on the respondent no. 4 and is not applicable to this matter directly, but is a question raised about the study mentioned.

ON THE STUDY BY THE DIRECTORATE GENERAL FACTORY ADVICE SERVICE AND LABOUR INSTITUTES OR DGFASLI TITLED 'REPORT ON THE NATIONAL STUDY ON HEALTH STATUS OF WORKERS IN THE ASBESTOS INDUSTRY' IN 2004

24. At the outset it may be humbly stated in regards to this study that it deals with the occupational exposure to asbestos and hence it is not relevant in this current application. But, the study, may be quoted, under severability, as it highlights the four types of exposure to asbestos, which are as follows:

A. Industrial Processes
B. Para Occupational Exposure
C. Building Exposure
D. Environmental Exposure.

25. Apart from the acknowledgement of building exposure, it also, under the Environmental exposure states the source as ***'Drinking water, apart from contribution from asbestos cement pipes'***

26. In the same light, the asbestos fibres released from asbestos cement sheets on weathering may reach the drinking water and be a pertinent cause for water pollution under the Water (Prevention and Control of Pollution) Act, 1974.

27. Moreover, this water may evaporate and leave the non-soluble, non-biodegradable asbestos fibres behind and then immediately become a cause for soil pollution first and then air pollution as soon as there is a slightest of disturbance or breeze. The potential of asbestos in soil becoming air pollution is stated in a study titled 'Asbestos in commercial Indian talc.' One of the authors of this study was from Ministry of Environment, Forests and Climate Change, Government of India. This study stated that ***'Further, it has been shown that as little as 0.001% of asbestos in loose clay soil can produce around 0.1 fiber/cc of asbestos in air with respirable dust concentration around 5 mg/m3.'***

The study titled 'Asbestos in commercial Indian talc' as attached as **Annexure J**

ON BIS STANDARDS

28. The relevant standard to the use of asbestos roofing in school is IS: 11769 (Part-1)-1987 (Reaffirmed 2001) titled: 'Guidelines for safe use of products containing asbestos. Part-1 – Asbestos cement products (Incorporating Amendment No. 1). The standard has two issues:

1. It does not consider the weathering of the asbestos cement roofing and the release of fibres subsequent.
2. It talks about manual methods for cutting and drilling of asbestos cement roofing, but it is foolhardy to believe that people installing the same would not used power tools like drills and grinders while

installing the same and releasing asbestos fibres while weathering apart from the fibres released during the weathered use of the same.

The above mentioned IS:11769 (Part 1) 1987 titled 'Guidelines for safe use of products containing asbestos.' Part 1; Asbestos cement products is attached as **Annexure K**

ON THE ISSUE OF UTILISATION OF FLY ASH

29. The noble objective of use of fly ash which is waste from thermal power plants can still be utilized when the manufacturers produce cement sheets containing non asbestos fibres and this step is lauded as it solves the problem of fly ash.

ON PUBLICATION BY AUSTRALIAN QUEENSLAND GOVERNMENT

30. There is clear indication that in the document that 'over time, asbestos cement roofs will deteriorate. The cement slowly breaks down and asbestos fibres are washed down and blown away'.
31. This is the very big support of the fact that the cement slowly breaks down in asbestos cement roofing and is washed down and blown away. The term washed down means it will meet a water body and the term blown away means it will be suspended in the air. It may also reach the soil after evaporation of the water body or after settling down once suspended in the dust.
32. It has been made clear in ***Narendra Pratap Singh vs Central Pollution Control Board (OA 649/2022) dated 17th July 2023*** that ***'There is no safe level of asbestos exposure'*** which automatically means that any number of fibres are an air pollutant. These same fibres when in soil will become a soil pollutant and when they reach the water become a water pollutant. This has been further shown by other studies as the applicant shows.

PARA WISE REPLY:

33. The humble applicant submits that the contents of the reply by respondent no. 4 in total are incorrect, misconceived and are denied, save and expect anything specifically admitted.
34. Para 1,2 and 5 deal with the qualifications, work, fellowships, academic and personal credentials of the applicant. The applicant reiterates that these statements have been made under affidavit. The applicant submits that the copy of the PhD degree, other qualifications, work experience related certificates shall be made available for inspection by the respondent no. 4 in the court room **if directed by the Hon'ble Tribunal**. The convocation video in public domain of the PhD degree given to the applicant is here: https://www.youtube.com/live/0IVxlJZnJmU?si=P1sxquEIysdIjoPA The applicant can be seen at 1:15:24 onwards. As far as the publications are concerned, they are too available in the public domain with name and photo of the applicant, here: https://scholar.google.com/citations?user=ZLnS98sAAAAJ&hl=en

The public domain coverage or the applicant as a visiting faculty of the School of Planning and Architecture, New Delhi has been covered by the Hindu newspaper in article titled: NIT-C, SPA join hands for documentation of Iringannur Temple. The news is available here:https://www.thehindu.com/news/cities/kozhikode/nit-c-spa-join-hands-for-documentation-of-iringannur-temple/article67932656.ece
The work done by the applicant on tobacco and vector borne diseases at Tathatara foundation : https://www.tathatara.org/research

Some works by applicant and others from ISAC Centre for Built Environment Policy are here:https://isacfoundation.org/isacbuilt/
Further during the work done on the International Fellowship in Dornsife School of Public Health, the paper titled 'Analysis of mesothelioma cases and National Cancer Registry data to assess asbestos exposure in India'

published in the journal Public Health Action is available here: https://doi.org/10.5588/pha.24.0003

The applicant also contributes to the TB Mukt Bharat Abhiyan in India. The applicant in this case only represents the personal capacity and does not represent any of the above-mentioned bodies. The applicant reiterates that this application is in larger public interest and academic interest and there is no personal gain of the applicant in this matter. The applicant also states that Article 51A of the constitution of India which states that if shall be the duty of every citizen of India:

> ***(g) to protect and improve the natural environment including forests lakes, rivers and wildlife, and to have compassion for living creatures.***
>
> ***(h) to develop scientific temper, humanism and the spirit of inquiry and reform.***
>
> ***(j) to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement.***

35. Para 3: In this the applicant wants to humbly and most respectfully bring to the notice of the Hon'ble Tribunal that the applicant has cited these matter before NGT to show the bonafide of the applicant as a person who has sought directions from this Hon'ble Tribunal in matters of absolute public interest. Out of the three, the matter OA 206/2022 is directly related to this matter as it deals with indoor air being part of the Air (Prevention and Control of Pollution) Act, 1981 as has been gratefully directed by this Hon'ble Tribunal.

36. Para 4: The order of the Hon'ble High Court of Delhi in W.P. (C) 7810/2021 dealing with inclusion of dilution ventilation for prevention of COVID-19 spread, has been mentioned to show the intent of the applicant which is concerned with larger public interest. This petition was lauded by the Hon'ble Delhi High Cout. Also, it

shows the intent of the applicant who took his research from mere academic material to the level of policy change which is also true in this present case. This reiterates the position of the applicant as an academician who has most humbly and respectfully sought the indulgence of the various judicial forums in the past for matters related to public interest.

37. Para 6: In para 6, the applicant reiterates that the health and life longevity of young children across the country who are studying in schools have asbestos roofing is an important matter, as it may have effects on their health and at the pan India level the asbestos roofs should be phased out of schools. In the document quoted by the respondent no. 4 titled 'Asbestos in the Environment' by W.J Nicholson and F.L. Pundsack, which is a book chapter from conference proceeding and not a scientific paper in the true sense as stated by the respondent no. 4, it is to be noted that the effect of weathering has not been considered. Moreover, the study also highlights the 'demolition of structures which contain asbestos-bearing products' which 'can be a source of fibre in the air'

38. The study titled 'Biological Effects of mineral fibres' Volume 1 and its contents are denied for the want of knowledge. The respondent has not provided a copy of the full text (or at least the chapter/section) and may have copied out of context without looking the totality of the issue. In this context, the more reliable, credible and latest guideline by WHO as mentioned above titled 'Chrysotile Asbestos' may be considered as a more reliable factual source of information. On the paper titled 'Characterization and Properties of Asbestos-Cement Dust by A Deruyttere and J Helsen cited by respondent number , two things may kindly be noted:

a. The dust collected for this study was collected from occupational activities like machining, sawing and lathe. The study does not

consider the effect of weathering and the applicant wants to humbly and respectfully state that the current application deals with non-occupational exposure.

b. The study was performed in the 1980, and more latest studies including Tadas, Prasauskas, et al. "Comparative Characterization of Particle Emissions from Asbestos and Non-Asbestos Cement Roof Slates." Building and Environment, vol. 46, no. 11, Nov. 2011, pp. 2295–302. DOI.org (Crossref), https://doi.org/10.1016/j.buildenv.2011.05.010. States the release of asbestos fibres from the asbestos cement sheets. But due to non-applicability, as in this study too, the methods of obtaining the dust for testing is occupational in nature. This study rebuts the older study quoted by the respondent no. 4, but both are not relevant in the present matter as the non-occupational use of asbestos cement roofing and weathering is at the focus of this current application.

39. The applicant reiterates that on weathering, the release has been warned by studies and that the studies which are not studying weathered sheets do not consider the effect of weathering on the other products in the sheet like cement which may itself decay over time. And, as the respondents have stated that roofing of asbestos cement has been used for over 8 decades in India, this certainty is even more in India.

40. Para 7: In para 7, the applicant reiterates that over time, as stated before, the sheets weather and deteriorate and leads to release of fibres by weathering. The applicant has quoted the studies above and are repeated as follows:

    a. In the study titled 'Releasability of asbestos fibers from weathered roof cement' by Andrew F Oberta, Lee Poye and Steven P Compton from 2018, it has been stated that: 'Chrysotile asbestos fibers were added to roofing products,

including roof cement, for several decades. The fibers were described as "encapsulated" and therefore incapable of being released, an assertion that is disproved by the study therein.' The study also went on to state that the disturbance also increases the chance of release and inhalation.

b. In the study titled 'Surface of Asbestos-cement (AC) Roof Sheets and Assessment of the Risk of Asbestos Release by Jerry Dyczek it was stated follows:
'…corrugated roof sheets were investigated on the older (40 years old) roof of a building in an industrialised area in Southwest Poland, were acid rain is rather frequent. Acid rain wears down the matrix and asbestos fibres ae exposed..'
'Fibres are clean, uncovered by calcium carbonated or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium carbonates or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium compounds reacted with acid to produce more soluble chemical compounds which were dissolved. As a result of this, on the sheet surface are found asbestos fibres, which can rather easily break away. Risk of asbestos dust release is high.

41. The applicant also wants to state that since the asbestos fibre is only 7-9%, the overall efficiency by using other materials can be studied and optimised in order to do away with a carcinogen. The studies above clearly show that the asbestos fibres are released by weathering and even the cement gets weathered.
On the issue of dust pollution, the applicant re submits the study that was originally quoted, namely, 'The natural reduction of threat in selected systems of old buildings containing asbestos' which has given us a very important conclusion, as follows:
'Active behaviour in buildings with asbestos is a cause of above-

normal dust pollution. For this reason, children and young people should not use buildings with asbestos, regardless of their physical condition.

42. Para 8: The contents in reply by respondent no.4 for para 8 are denied by the applicant as the study mentioned by Dr David M Bernstein has the following flaws:

a. This matter related to the study by Dr David M Bernstein needs to be specially mentioned as this the study material in study itself has been corrected by the DGFASLI 2019 report as mentioned above, where industries have used chrysotile itself and the disease caused by asbestos in mentioned. Moreover, the disease mentioned, called mesothelioma, caused by asbestos exposure, is caused, as it is named in the mesothelium, i.e. the lining of the lung, and as it quoted by the DGFASLI study, where a change in the outer part makes the inside of the lung dysfunctional, as stated here: The change affects only the periphery of the lung and leaves the central part undamaged, but this normal lung is of little functional value as it is held immobile by the surrounding damage..
b. Moreover, the latest study from Russia, which still actively mines chrysotile asbestos fibres, the applicant points our not to the occupational focus on the study, but focus on the medical portion where the effect of chrysotile fibre is involved. The study states that **'we observed an increased risk of mesothelioma with high exposure to chrysotile fibers.'** The study is attached.
c. Moreover, it may be most respectfully pointed out, that in a case from New York, the court in the US observed that there may be some conflict of interest in studies by the stated expert and the court did not admit the same as such. The order of the court is attached.

The 2024 study on chrysotile from Russia is attached as **Annexure L**. The Court order from the US not admitting the study of Dr David M Bernstein is attached as **Annexure M.**

43. Para 9: The applicant humbly states the journal paper has been published in Nature Journal which is very reputed. This paper puts a very balanced approach to the problem and raises the issue for buildings with young people which have high disturbance and there may be issue of asbestos fibre release as well as high dust pollution as mentioned in the conclusions of the paper, which is quoted as follows:

'Active behaviour in buildings with asbestos is a cause of above-normal dust pollution. For this reason, children and young people should not use buildings with asbestos, regardless of their physical condition.'

ON THE STAND OF THE ENVIRONMENTAL PROTECTION AGENCY OF UNITED STATES WITH THE LATEST UPDATE

44. At the fore, it must be respectfully brough to the notice of the Hon'ble Tribunal that the most latest regulation by the US Environmental Protection agency dated 18th March 2024 under the Biden-Harris Administration under President Biden's Cancer Moonshot program to end cancer, the United States Environmental Protection Agency has finalised the ban on asbestos under the Toxic Substance Control Act. The information is available here: https://epa.gov/newsreleases/biden-harris-administration-finalizes-ban-ongoing-uses-asbestos-protect-people-cancer

45. Moreover the document from EPA mentioned by the respondent no. 4 does acknowledge the hazards of even encapsulated asbestos containing material and states that 'it should not be ignored' as the fibres can be released when not in good condition, like that of weathering. Further, the issue of asbestos in schools was so serious in the US that under the Asbestos-Containing materials in schools rule, the definition of asbestos containing material has been defined as ***'Asbestos-containing material (ACM) when referring to school***

buildings means any material or product which contains more than 1 percent asbestos'

The school rule is available here: https://www.govinfo.gov/content/pkg/CFR-2011-title40-vol31/pdf/CFR-2011-title40-vol31-part763-subpartE.pdf

46. Even in other countries like the UK, there is a great threat in school buildings as highlighted by the article titled: 'The hidden danger of asbestos in UK schools: 'I don't think they realise how much risk it poses to students': https://theconversation.com/the-hidden-danger-of-asbestos-in-uk-schools-i-dont-think-they-realise-how-much-risk-it-poses-to-students-203582

47. Para 10: The applicant reiterates the contents of para 10. The applicant humbly wants to show the following studies which show that on weathering, there is release of asbestos fibres from the asbestos cement sheets. These are as follows:
    a. In the study titled 'Releasability of asbestos fibers from weathered roof cement' by Andrew F Oberta, Lee Poye and Steven P Compton from 2018, it has been stated that: 'Chrysotile asbestos fibers were added to roofing products, including roof cement, for several decades. The fibers were described as "encapsulated" and therefore incapable of being released, an assertion that is disproved by the study therein.' The study also went on to state that the disturbance also increases the chance of release and inhalation.

    b. In the study titled 'Surface of Asbestos-cement (AC) Roof Sheets and Assessment of the Risk of Asbestos Release by Jerry Dyczek it was stated follows:

'…corrugated roof sheets were investigated on the older (40 years old) roof of a building in an industrialised area in Southwest Poland, were acid rain is rather frequent. Acid rain wears down the matrix and asbestos fibres ae exposed..' 'Fibres are clean, uncovered by calcium carbonated or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium carbonates or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium compounds reacted with acid to produce more soluble chemical compounds which were dissolved. As a result of this, on the sheet surface are found asbestos fibres, which can rather easily break away. Risk of asbestos dust release is high.

48. Para 11: With respect to the order passed by the Hon'ble Kerala State Rights Commission dated 31.01.2009, the applicant humbly and respectfully wants to submit the following:

a. The essence of the order of the issue of stopping usage of asbestos roofing in schools has been retained in subsequent Hon'ble Kerala High Court Judgement in WP (C) 3846 of 2021 and WP (C) 22457 of 2019 even though these were after the setting aside order in WP (C) 25100 of 2009 which the applicant has learnt about recently.

b. In the order by Hon'ble Kerela High Court in WP (C) 25100 of 2009 there are some points to note:

1) The Commission had relied upon the World Health Organisation report. World Health Organisation is a body responsible for guiding health in the world and India is a party to the World Health organisation since 1948. It may be humbly considered that the report of the World Health Organisation may kindly be considered by this Hon'ble Tribunal.

2) Further, since the matter was decided in 2009, there are many evidences today that show that asbestos cement roofing in schools is

a potential health hazard as is been shown by the applicant in this application.

3) One of the reasons for setting aside the order was the complainant had not appeared before the commission. Even before ethe le Kerla High Court, the order was passed ex-parte. There was no defence that was provided to possibly meet the ends of justice, or even represent the matter and principles of natural justice being at a possible stake. Without prejudice to the above, it is also submitted that the Hon'ble Kerala High Court in matters WPC 3846 of 2021 and WPC 22457 of 2019 has upheld the order passed by the Kerala government which was passed by on the basis of the order of the Hon'ble Kerala Human Rights Commission.

4) Additionally, the Hon'ble court acknowledged that '***the asbestos sheet referred by WHO may depend upon the environmental setting it is used.'*** This is the point that the humble applicant wants to most respectfully point out to the weathering and the release fibres due to it.

49. Para 12: In para 12, the humble applicant reiterates that the executive wing has also passed a governmental order and there has been an implementation of the stoppage of asbestos roofing for schools. The state of Kerala to this date enforces the executive order and that deals directly with stoppage of the asbestos roofing in schools. This order itself has been challenged before the Kerala High Court twice in in WP (C) 3846 of 2021 and WP (C) 22457 of 2019 but has not been stayed. It is to state that the Kerala government passed the order on the basis of the order of the Kerala Human Rights Commission, and that the Kerala government order, even though challenged twice before the Hon'ble Kerala High Court has not been stayed and is the law of the land in Kerala. In Kerala, a state in India, asbestos cement roofing is outlawed in school buildings till today.

The government order from Kerala is attached as a translated copy extract from the judgment as **Annexure N.**

50. Para 13: In para 13, the applicant reiterates that very recently on 32rd September 2019, the Hon'ble Kerala High Court in WPC 22457/2019 has passed an order as follows:

> ***The first respondent i.e. the State of Kerala, 'shall therefore file an affidavit as to why no action is taken for prohibiting such roof for buildings of schools in the state and why no action is taken to see that asbestos roof of classrooms in all the schools are replaced. The respondents shall also state why no action is taken to incorporate appropriate provisions providing for specifications for the roof of the classrooms. There shall be a direction to the respondents to see that the asbestos roof of the classrooms of all the schools are replaced in a time bound manner.'***

The judicial intent in this matter is clear and the dangers of asbestos are recognised and the state is directed in the form of a reminder to take action on the order of the government of Kerala.

51. Para 14: The humble applicant reiterates the mention to the judgement of the Calcutta High Court and respectfully states to assist the court and state all the facts that were considered by the Hon'ble Calcutta High Court before the judgment was passed. These facts are as follows:

a). World Health Organisation Fact Sheet which stated the risk of asbestos to human health which stated the following: ***'WHO recommendation on prevention of asbestos related diseases: Bearing in mind that there is no evidence for a threshold for the carcinogenic effect of asbestos, including chrysotile, and that increased risk have been observed in populations exposed to very low levels…….Continued use of asbestos cement in the cement industry is a particular concern, …. And in-place materials have the potential to deteriorate."***

d). The Asbestos convention, 1986 which provides (No. 162) that "where necessary to protect the health of workers and technically practicable, national laws or regulations shall provide for one or more of the following measures – a. replacement of asbestos or certain types of asbestos or products containing asbestos by other materials or products or the use of alternate technology. The convention is available here: https://normlex.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_INSTRUMENT_ID:312307

e). The control of asbestos regulations 2012 which states that the owner of premises has to protect anyone from using or working in the premises from the risks to health that exposure to asbestos causes. The regulation is available here: https://www.legislation.gov.uk/uksi/2012/632/contents/made

f). The National Human Rights Commission case where one Shri Rongthong Kuenley Dorji was detained in Delhi and the Director General (Investigation) DG (I) of the commission visited the same and prepared a report. On the basis of the report the commission ordered the following: ***"(i) Replace the asbestos sheets roofing with roofing made up of some other material that would not be harmful to inmates."***

[Case no. 693/30/97-98 before Hon'ble NHRC]

The reply by the respondent number 4 is denied and is misleading as follows:

a. On the issue that no study was conducted, it may be respectfully submitted that on the basis of known, scientific, peer reviewed knowledge, the action taken in prevention is in light with the Indian jurisprudence which is also the guiding principle of the National Green Tribunal, i.e. the precautionary principle. This has been held that the state has to "anticipate" and if there are irreversible damages by

asbestos (which have been agreed upon by both the judgments of the Hon'ble Supreme Court: Consumer Forum and Kalyaneshwari), the 'lack of scientific uncertainty should not be a reason for postponing measures to prevent environmental degradation'

b. On the issue of not considering the safety of asbestos cement sheets, the applicant denies the factual premise of the same. The lock in in the asbestos cement roofing is subject to the weathering and on weathering the effect has been stated by the Ministry of Environment Forests and Climate Change in the reply which stated that:

"7. That it is most humbly submitted that Asbestos in the building does not spontaneously release fibres, but can enter the air, water, and soil from the weathering, renovation, or demolition of manufactured asbestos products. People are likely to be exposed to asbestos through inhalation of airborne fibres."

c. On the third point about summary adjudication, it may be humbly stated that the prayer in the case was limited to the premises of the High Court and hence the court gave suitable orders which were implemented. It may be most humbly submitted that judgment stated that

'the asbestos-sheets, which have been used for roofing, would be replaced by any other materials which are non-carcinogenic'

This is a clear representation of the judicial intent in this case and this forms the very clear precedent for other cases, and summed up with the government notification in an Indian state, there is a direct application in this case which talks about the health effect of asbestos roofing to children in schools.

52. Para 15: The applicant reiterates the contents in para 15 as the contents are not from the applicant, but from the knowledge of World Health Organisation which is the apex health organisation, and of which Indian government is a party. The landing page mentioned does mention asbestos materials. Other guidelines of the World Health Organisation which lead from the website talk in detail about asbestos cement products, including the ones that are roofing materials and contain chrysotile fibres. This has been stated before and one such report is annexed as Annexure. The said process on encapsulation is subjected to weathering when there is loosening and deterioration and asbestos fibres hence released. The applicant denies that with respect to the matters related to Chrysotile in Rotterdam convention, something that may be problematic may be hazardous or may not be hazardous, and that is not directly related to the non-occupational use of asbestos roofing in schools. But in this case, the asbestos fibres, as shown in studies and as stated by the Ministry of Environment, Forests and Climate Change do lead to release and such release can cause health effects as stated before.

53. Para 16: The applicant reiterates that the manufacturers who are members of respondent number 4 have themselves very vehemently pushed other fibres and have large scale manufacturing of the same. This is so much so that one of the members has even promoted Non-Asbestos Sheet before the Research Designs and Standards Organisation (Ministry of Railways, Government of India) in 'Trials of various new technology/products presented by industries/firms during 8th Works standard committee meeting with the following positive points:

a. Does not fade or degrade.
b. Protects against UV
c. Provides thermal insulation.
d. Lightweight & easy to install.

e. Weather resistant

The above-mentioned document by Railway Design Standards Organisation highlighting the promotion of qualities of non-asbestos roofing sheets by manufacturers is attached as **Annexure O.**

Another company promoted the non-asbestos cement sheet with the following qualities, among many include 'Excellent load bearing strength. And 5times more durable than metal roofs.

Another brochure of non-asbestos roofing states the quality and mentions high durability, strength, impact resistance in the brochure.

The brochures by manufacturers mentioned above are attached as **Annexure P.**

54. In the context of the above the reply by the respondent no. 4 is denied. With respect to the two points mentioned the respectful submission by the applicant is as follows:

A. As stated above, the strength levels of the non-asbestos sheets have been promoted by manufacturers and are manufactured by the same organisations manufacturing the asbestos roofing. Shifting into non asbestos alternatives will enable the use of the same employees, factories, agents, distribution networks and all backward and forward linkages.

B. Chrysotile fibres as a type of asbestos is a class 1 carcinogen. When provided with alternatives, which the manufacturers have themselves developed and are widely sold by the manufacturers themselves at the large scale at which the asbestos roofing is made, the manufacturers may be able to achieve economies of large scales and consumers may eventually get safer products.

The applicant respectfully reiterates the contents of Para 16 of the Original OA.

55. Para 17: In para 17, the applicant humbly reiterates that the representation for phasing out of asbestos roofing in schools was made to the three ministries which are respondents no. 1,2 and 3 in this matter. The Hon'ble Tribunal had issued notice to these three ministries.

56. Para 18 and 19: The humble applicant in Para 18 and 19 had cited important provisions of the NGT Act as well as judgements of the Hon'ble Supreme Court of India. Section 20 of the National Green Tribunal Act 2010 where precautionary principle is one of the principles guiding the National Green Tribunal. The issue of the State anticipating, preventing and attacking the case of environmental degradation and precautionary principle even when there is scientific uncertainty should not be a reason for postponing measures to prevent environmental degradation. The applicant has in this rejoinder redisplayed the scientific evidence and governmental agency decisions. On the issue of the reopening of the issue, the applicant humbly states that this is an act of misleading. The applicant in the instant petition is praying for schools to not use asbestos sheets and phasing out of asbestos cement sheets in schools. There seems to be no repetition of the issue in this petition and the issues raised in the Kalyaneshwari judgment primarily dealt with occupational exposure to asbestos whereas this application deals with the non-occupational exposure of asbestos fibres by school children where asbestos cement roofing is present in schools.

57. Para 20 and 21: The applicant reiterates that the Hon'ble Tribunal is not merely an adjudicatory body, but as has been stated before in this rejoinder, NGT has been time and again reaffirmed by the legislative intent as well as by the Hon'ble Supreme Court of India to be a custodian of environmental matters and substantial questions of the environment. The attempt to mislead the Hon'ble Tribunal by respondent No. 4 by undermining the authority and power given to

the NGT by parliament and interpreted by the Hon'ble Apex Court is respectfully and humbly regretted and opposed by the applicant.

58. Para 22: The applicant in Para 22 had brought to notice of the Hon'ble Tribunal that in OA 206/2022, the Tribunal had noted that ***'there is no statutory bar to regulation of indoor air quality'*** and that ***'there was a need for regulation of indoor air quality at public places.'*** The same order included asbestos as an indoor air pollutant. The applicant most respectfully and humbly reiterates that airborne asbestos or dust particles in schools and the release of these into the air, soil and water involves a substantial question of the environment.

59. Para 23: The applicant reiterates the prayer where suitable directions may be given by the Hon'ble Tribunal which is not merely an adjudicatory body but a regulator and custodian of environmental health in India.

60. In Vellore Citizen's Welfare Forum v. Union of India, the Hon'ble Supreme Court of India held the "precautionary principle" is an essential feature of the principle of "sustainable development". It went on to explain the precautionary principle in the following terms:

11…(i) Environmental measures- by the State Government and the statutory authorities -must anticipate, prevent, and attack the causes of environmental degradation.
(ii) Where there are threats of serious and irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

61. In T.N. Godavarman Thirumulpad v. Union of India, (2022) 9 SCC 306, the Hon'ble Supreme Court of India ruled that:

'18. The principle of precaution involves the anticipation of environmental harm and taking measures to avoid it or choose the least environmentally harmful activity. It is based on scientific uncertainty. Environmental protection should not only aim at protecting health, property and economic interest but also protect the environment for its own sake. Precautionary duties must not only be triggered by the suspicious of concrete danger but also by justified concern or risk potential.

19. A situation may arise where there may be irreparable damage to the environment after an activity is allowed to go ahead and if it is stopped, there may be irreparable damage to economic interest. This court held that in case of a doubt, protection of the environment would have precedence over the economic interest, It was further held that the precautionary principle requires anticipatory action to be taken to prevent harm and that harm can be prevented even on a reasonable suspicion. Further, this Court emphasises in the said judgment that is not always necessary that there should be direct evidence of harm to the environment.'

62. That in the ***Kalyaneshwari v. Union of India & Ors, 2011***, the judgement has stated about the occupational exposure of asbestos during mining, manufacture, and processing of asbestos in India. Secondly, the current applicant does not seek complete ban on all uses of asbestos in any manner whatsoever as stated by the respondent. The applicant further reiterates that in the said judgment, the main issue of occupational exposure to asbestos is not the subject of this current application.

63. The issue is about release of asbestos fibres from weathered asbestos cement sheets which have been used in school buildings. It is stated that these fibres are released into the air of the school and the

surroundings and become an *"air pollutant"* which has been defined in the Air (Prevention and Control of Pollution) Act, 1981 in Section 2 (a) as

'any solid, liquid or gaseous substance [(including noise)] present in the atmosphere in such concentrations as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.'

64. These fibres cause *"air pollution"* which means the ***'presence in the atmosphere of any air pollutant'*** under Section 2 (b) of the Air (Prevention and Control of Pollution) Act, 1981. In this regard, there may be two issues: One being the question of what is the 'such concentration' for asbestos in the air and the other being whether the inside of the school building is 'atmosphere'

65. In this regard, the Hon'ble National Green Tribunal has in ***Narendra Pratap Singh vs Central Pollution Control Board (OA 649/2022) dated 17th July 2023*** ruled that ***'There is no safe level of asbestos exposure'*** which automatically means that any number of fibres are an air pollutant. These same fibres when in soil will become a soil pollutant and when they reach the water become a water pollutant.

66. With respect to the issue of indoor pollutant the Hon'ble National Green Tribunal in ***Raja Singh v. Union of India & Ors. (OA 206/2022 judgment) dated 19 April 2022*** has ruled that ***'indoor air quality can be regulated in respect of public places'*** and that ***'there is no statutory bar to regulation of indoor air quality under the Air Act or the EP Act and the Rules.'*** This has also been defined by the Hon'ble Tribunal as an issue where a ***'substantial question of environment arises and is answered to the effect that there is need for regulation of indoor air quality at public places.'*** The same

judgement in paragraph 10 also listed sources of indoor air pollutants as including:

a. building materials,
b. formaldehyde,
c. volatile organic compounds,
d. radon,
e. asbestos,
f. particulate matter,
g. gaseous pollutants and
h. biological pollutants.

It may be noted above that 'asbestos' in particular has been included in the judgement where sources of indoor air pollutants are listed. The order of the Hon'ble National Green Tribunal in ***Raja Singh v. Union of India & Ors. (OA 206/2022 judgment) dated 19 April 2022*** is attached as **Annexure A**

67. Thus, it may respectfully be shown that asbestos fibre pollution in the air caused by use of asbestos cement roofing is well within the scope and mandate of the Air (Prevention and Control) of Pollution Act, 1981 read along with Environmental Protection Act and their rules. The EPA Act specially gives powers to the Central Government to make rules. This makes the issue raised well within the Statues mentioned in Schedule 1 of the NGT Act, 2010.

68. Further, the asbestos fibres released can enter water as well as soil from weathering, renovation, or demolition of manufactured asbestos products as has been stated by the Ministry of Environment, Forests and Climate Change which states as follows about asbestos fibres: '..can enter the air, water, soil from the weathering, renovation, or demolition of manufactured asbestos products. '

This clearly indicates that not only can the Air Act be violated, but also the Water (Prevention and Control of Pollution Act, 1974.

69. On the issue of the use of the phrase 'realm of policy making' it may be respectfully submitted that NGT is not merely an adjudicatory body, but a regulatory body in essence.

70. In the book 'Environmental Law and Policy in India' by Armin Rosencranz and Shyam Divan, the authors note in chapter on NGT that:

'Tribunals are considered to be different from courts and other judicial bodies. They are meant to play the role of the expert in an area where judicial remedy is being sought. It would, therefore, not be wrong to assume that this expert body 'adds' to the knowledge on the environmental impact produced in the regulatory process after the project has gone through all the basic regulatory filters. However, recent cases seem to indicate that the NGT is performing the role of simply because the MoEF and other state-level regulatory bodies set up under the EIA notification 2006 refuse to take their roles seriously. It is through this regulation that environmental impact of industrial and infrastructure projects is to be determined and they need to be either accorded approval or rejected. Illustrative of its regulatory role, the NGT responded to a petition filed by Rajiv Dutta highlighting the devastation caused by forest fires in Uttarakhand and Himachal Pradesh. Noticing that fires had destroyed large swathes of forest land, the Tribunal directed the MoEF to prepare and implement forest fire management plans for each state; to appoint anodal officer to monitor and coordinate an improved response to fires; and directed the establishment of a central Monitoring committee headed by the

Secretary of the MoEF to strengthen implementation on the ground.'

71. This opinion has been resonated by the Hon'ble Supreme Court of India in Municipal Corporation of Greater Mumbai v. Ankita Sinha & Ors (CA No. 12122 of 2018) which states that:

> ***'24.5 The NGT is a Tribunal with sui generis characteristic, with the special and all-encompassing jurisdiction to protect the environment. Besides its adjudicatory role as an appellate authority, it is also conferred with the responsibility to discharge role of supervisory body and to decide substantial questions relating to the environment. The necessity of having a specialized body, with expertise to handle multi-dimensional environmental issues allows for an all - encompassing framework for environmental justice. The technical expertise that may be required to address evolving environmental concerns would definitely require a flexible institutional mechanism for its effective exercise. '***

72. The judgement also quoted another judgment of the Apex Court : In 24.3 while quoting DG NHAI vs Aam Aadmi Lokmanch judgment by the Hon'ble Supreme Court, it was stated that the ***'Court repelled the argument for the restricted jurisdiction for the NGT, and fittingly observed that 'the powers conferred on the NGT are both reflexive and preventive and the role of the NGT was recognized as "an expert regulatory body" which can issue general directions also albeit within the statutory framework.'*** (emphasis supplied)

PRAYER

In the light of the above, the humble applicant, in good faith and in larger public interest only, most respectfully prays before the Hon'ble National Green Tribunal:

1. **That suitable directions may be given as the Tribunal may deem fit.**

For the above, the humble applicant shall forever be grateful.

(Dr Raja Singh)
Date: 1st May 2024
Place: New Delhi

Annexure A

Item Nos. 11&12 (Pune Bench)

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Original Application 143/2016 (WZ)
(M.A. No. 377/2017)

Dileep Nevatia Applicant

Versus

Union of India, Secretary MoEF& CC & Anr. Respondent(s)

WITH

Original Application 206/2022

Raja Singh Applicant

Versus

Union of India & Ors. Respondent(s)

Date of hearing: 19.04.2022

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE MR. JUSTICE DINESH KUMAR SINGH, JUDICIAL MEMBER
HON'BLE PROF. A. SENTHIL VEL, EXPERT MEMBER
HON'BLE DR. VIJAY KULKARNI, EXPERT MEMBER
HON'BLE DR. AFROZ AHMAD, EXPERT MEMBER

Applicant: Mr. Dileep Nevatia, Applicant in Person in OA 143/2016
Mr. C P Mittal, Advocate for Applicant in OA 206/2022

Respondent(s): Mr. Siddhesh Paranjape, Advocate for Mr. Rahul Garg, Advocate for MoEF& CC (in OA 143/2016
Mr. Aniruddha S Kulkarni, Advocate for CPCB (in OA 143/2016)

ORDER

1. This order will deal with O.A. No. 143 of 2016 and O.A. No. 206 of 2022 as both the matters have common prayer for direction to evolve standards for Indoor Air Quality (IAQ).

2. In O.A. No. 143/2016, case set out by the applicant is Indoor Air Pollution (IAP) is as serious as Outdoor Air Pollution (OAP). IAP has potential of affecting public health. IAP causes large number of premature deaths due to pneumonia, chronic obstructive pulmonary disease (COPD), and lung cancer. Most affected groups are women and young children. Morbidities associated with IAP are respiratory illnesses, viz., acute respiratory tract infection and COPD, poor perinatal outcomes like low birth weight and still birth, cancer of nasopharynx, larynx, lung and leukemia. Sulphur dioxide and nitrogen dioxide cause wheezing and exacerbation of asthma. Nitrogen dioxide causes respiratory infections and deteriorates lung functions. Sulphur dioxide has an additional etiological role in exacerbation of COPD and cardiovascular disease. Risk of poor perinatal outcomes, viz., low birth weight and perinatal death increases from exposure to carbon monoxide. People disturbed by excessive levels of indoor noise have increased levels of stress hormones that raise their blood pressure and other risk factors, leading to disease and death. In terms of environmental burden on health, noise is second only to air pollution, according to the WHO. In spite of this factual position, no standards have been laid down for IAP by the MoEF&CC or the CPCB.

3. The application was first heard on 04.10.2016. The Tribunal issued notice to the Respondents – MoEF&CC and CPCB. Replies have been filed by the MoEF&CC and CPCB. Stand of the MoEF&CC is that indoor air quality norms have been developed by Bureau of Indian Standards (BIS) incorporated in National Building Code (2005) of India, applicable to the mega malls where large confined conditions exist. General household buildings do not have air handling system installed with them and as such are largely unregulated. Besides, noise Standards

for household tools, appliances, etc. have already been developed by BIS. MoEF&CC has notified the source specific standards for emission or discharge of environmental pollutants from certain categories of industries, operations or processes, besides the national ambient air quality standards. Guidelines may be proposed in respect of indoor air quality, instead of new standards as the control, monitoring, regulation and compliance of indoor air quality is not feasible at individual household level. Stand of the CPCB is identical. The applicant has referred to an earlier judgment of this Tribunal dated 30.08.2016 in O.A. No. 81 of 2015, Dileep B. Nivetia v. UOI & Ors., as follows:-

> **"***30. In the present application as noted above, the applicant is seeking directions to the Authorities to take measures* ***to notify sulphur standards for kerosene.*** *Needles s to say, that such measures are to be taken in accordance with law upon exercising the rule making power envisaged in the Environment (Protection) Act, 1986. Once such power is duly exercised, the issue arising out of other enactments like BIS Act become subservient to the cause of environment on account of overriding effect of Environment (Protection) Act. 1986 by virtue of Section 24 of the said Act which read as follows:-*
>
> > *"24…xxxxxxxxxx……xxxxxxxx*
> > *Pertinently, we are dealing with the environmental issue in the present case as per the provisions of the National Green Tribunal Act, 2010. Provisions of BIS Act can also not eclipse the provisions of National Green Tribunal Act, 2010 by virtue of Section 33 of the National Green Tribunal Act, 2010 which read as under.***"**

4. The matter was last considered on 05.07.2018 as follows:-

> **"***It is submitted by Mr. Rahul Garg, learned counsel on behalf of Respondent - MoEF, that* ***the matter relating to indoor air pollution is under consideration of the "Committee for Indoor Air Pollution Management" constituted by office order dated 02.04.2018 and had last met on 12.04.2018****. Learned counsel for the MoEF has referred to an affidavit of the MoEF filed on 02.07.2018 setting out the various aspects for the MoEF to supply a copy of the affidavit to the Applicant.*
>
> ***The matter pertaining to indoor pollution though on the face of it appears trivial, is quite serious that calls for urgent attention as it has serious consequences on the health of the people living indoor, more particularly, the infants, children***

and the aged persons. Concededly, there are various standards prescribed for indoor air pollution by the WHO, US and other advanced countries. We therefore, expect the Ministry to pursue with this matter vigorously to ensure that the standards prescribed are at the earliest.

*List the matter on 30th August, 2018 before which the MoEF shall file a report on the progress made in the matter by way of an affidavit.***"**

5. The matter has been taken up today after almost four years but no progress report has been filed by the MoEF&CC, as directed.

6. **In O.A. No. 206 of 2022**, case of the applicant is that large public buildings where people gather in large number need to maintain safe and healthy air quality by appropriate regulation under provisions of the Air Act, 1981, to safeguard against air borne infection. The applicant earlier filed a writ petition before the Delhi High Court being the W.P. (C) No. 7810/2021 which was disposed of vide order dated 05.07.2021 with a direction that the same be treated as representation to the authorities – MoEF&CC, Ministry of Housing, DPCC and Commission for Air Quality Management. The DPCC rejected the representation by stating that the Air Act, 1981 is not applicable to indoor pollution. Other authorities have not taken any decision. According to the applicant, the view taken by the DPCC is erroneous as air pollution in large public buildings needs regulation in the interest of public health. The applicant has relied upon articles annexed to the petition as Annexures D to G. It is submitted that it is permissible to lay down standards under the Environment (Protection) Act, 1986 (EP Act), Environment (Protection) Rules, 1986(EP Rules) as also the Air (Prevention and Control of Pollution) Act, 1981 (Air Act). The applicant has also referred to statement of objects and reasons of the Air Act, 1981 as follows:-

> **"***2. The presence in air, beyond certain limits, of various pollutants discharged through industrial emissions and from certain human activities connected with the traffic, heating,*

> *use of domestic fuel, refuse, incinerations, etc. has a detrimental effect on the health of the people as also the animal life, vegetation and property.***"**

7. We have heard learned counsel for the parties. During the hearing, apart from the pleadings referred to above, some further material has been relied upon to which reference will be made.

8. Question for consideration is whether a substantial question of environment arises under section 14 of the NGT Act and whether a case is made out for a direction under section 15(1) of the NGT Act.

9. We have duly considered the averments in the application, earlier order of the Tribunal dated 5.7.2018, stand of the respondents, relevant statutory provisions and the material produced during the hearing.

10. As per an article on the subject[1], toxic gases and particulate matter may be generated indoor which may adversely affect the employees working in such places and also general public visiting such places. The sources of indoor air pollutants can include building material, formaldehyde, volatile organic carbon, radon, asbestos, particulate matter, gaseous pollutants, biological pollutants. Conclusion in the article is as follows:-

> **"***In above review made, it is evident that the indoor air quality is poorly maintained in many Indian buildings because of various reasons. Poor ventilation, reduced per capita floor space, usage of solid fuels for cooking and household products releasing toxic gases and particulate matter are the more depending factors for indoor air pollution. Polluted ambient air is also responsible for indoor air pollution as there is high circulation of air between indoor and ambient air. Therefore, maintaining good ambient condition with natural trees, maximum reduction in usage of indoor polluting household products can help in reducing the indoor pollution to the maximum.***"**

[1] **Retraction: Review on indoor air quality in Indianbuildings** (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012037) - https://iopscience.iop.org/article/10.1088/1757-899X/1145/1/012156

11. In WHO Guidelines for indoor air quality[2], reference is made to sources of pollutants in indoor buildings including benzene, carbon monoxide, formaldehyde, naphthalene, nitrogen dioxide, polycyclic aromatic hydrocarbons, radon, trichloroethylene and tetrachloroethylene. Having regard to such pollutants, WHO has suggested guidelines as follows:-

" ***Table A. Summary of indoor air quality guidelines for selected pollutants***

Pollutant	***Critical outcome(s) for guideline definition***
Benzene	• *Acute myeloid leukemia (sufficient evidence on causality)* • *Genotoxicity*
Carbon monoxide	*Acute exposure-related reduction of exercise tolerance and increase in symptoms of ischaemic heart disease (e.g. ST-segment changes)*
Formaldehyde	*Sensory irritation*
Naphthalene	*Respiratory tract lesions leading to inflammation and malignancy in animal studies*
Nitrogen dioxide	*Respiratory symptoms, bronchoconstriction, increase bronchial reactivity, airway inflammation and decreases in immune defence, leading to increased susceptibility to respiratory infection*
Polycyclic aromatic hydrocarbons	*Lung cancer*
Radon	*Lung cancer* *Suggestive evidence of an association with other cancers, in particular leukemia and cancers of the extrathoracic airways.*
Trichloroethylene	*Carcinogenicity (liver, kidney, bile duct and non-Hodgkin's lymphoma), with the assumption of genotoxicity*
Tetrachloroethylene	*Effects in the kidney indicative of early renal disease and impaired performance.*

Guidelines	***Comments***
• *No safe level of exposure can be recommended.* • *Unit risk of leukemia per 1µg/m^3 air concentration is 6 x 10^{-6}*	

[2] **World Health Organization-Selected Pollutant** - https://www.euro.who.int/__data/assets/pdf_file/0009/128169/e94535.pdf

• *The concentration of airborne benzene associated with an excess lifetime risk of 1/10000, 1/100000 are 17, 17 and 0.17 µg/m^3, respectively.*	
• *15 minutes-100mg/m^3.* • *1 hour-35 mg/m^3.* • *8 hours-10 mg/m^3.* • *24 hour-7 mg/m^3.*	
0.1 mg/m^3-30 minutes average	*The guideline (valid for any 30-minute period) will also prevent effects on lung function as well as nasopharyngeal cancer and myeloid leukemia*
0.1 mg/m^3-annual average	*The long-term guideline is also assumed to prevent potential malignant effect in the airways*
• *200 µg/m^3-1 hour average* • *40 µg/m^3-annual average*	*No evidence of exposure threshold from epidemiological studies*
• *No threshold can be determined and all indoor exposures are considered relevant to health* • *Unit risk for lung cancer for PAH mixtures is estimated to be 8.7 x 10^{-5} per ng/m^3 of B[a]P* • *The corresponding concentrations for lifetime exposure to B[a]P producing excess lifetime cancer risks of 1/10000, 1/100000 are approximately 1.2, 0.12 and 0.012 ng/m^3, respectively.*	*B[a]P is taken as a marker of the PAH mixture*
• *The excess lifetime risk of death from radon-induced lung cancer (by the age of 75 years) is estimated to be 0.6 x 10^{-5} per Bq/m^3 for lifelong non-smokers and 15 x 10^{-5} per Bq/m^3 for current smokers (15-24 cigarettes per day); among ex-smokers, the risk is intermediate, depending on time since smoking cessation.* • *The randon concentrations associated with an excess lifetime risk of 1/100 and 1/1000 are 67 and 6.7 Bq/m^3 for current smokers and 1670 and 167 Bq/m^3 for lifelong non-smokers, respectively.*	*WHO guidelines provide a comprehensive approach to the management of health risk related to radon.*
• *Unit risk estimate of 4.3 x 10^{-7}*	

per µg/m³ • *The concentrations of airborne trichloroethylene associated with an excess lifetime cancer risk of 1:10000, 1:100000 are 230, 23 and 2.3 µg/m³, respectively.*	
0.25 mg/m³-annual average	*Carcinogenicity is not used as an endpoint as there are no indications that tetrachloroethylene is genotoxic and there is uncertainty about the epidemiological evidence and the relevance to humans of the animal carcinogenicity data*

"

12. Our attention has also been drawn to Council of Scientific & Industrial Research (CSIR), Guidelines on ventilation of residential and office buildings[3] and a documentary film on Indoor Air Quality Concerns and Action[4].

13. We may now refer to some of the statutory provisions. Noise Pollution (Regulation and Control) Rules, 2000 have been framed under section 6 read with Section 25 of the EP Act, 1986 read Rule 5 of the EP Rules, 1986. 'Public place' is defined as follows:-

> "*"public place" means any place to which the public have access, whether as of right or not, and includes auditorium, hotels, public waiting rooms, convention centres, public offices, shopping malls, cinema halls, educational institutions, libraries, open grounds and the like which are visited by general public; and.*"

14. Thus, on that pattern indoor air quality can be regulated in respect of public places, as defined with such changes in the definition as may be required. Regulation need not be for domestic building as rightly pointed out by the MoEF&CC. There is no statutory bar to regulation of

[3] **CSIR Guidelines on ventilation of Residential and office building** - https://www.niti.gov.in/sites/default/files/2022-01/VentilationGuidelines-and-VU-C-Disinfection-Technology-for-mitigation-ofSARS-CoV-2.pdf

[4] https://www.youtube.com/watch?v=kBie_sq7eRc

indoor air quality under the Air Act or the EP Act and the Rules. Need for such regulation is certainly shown by the studies referred to above. Thus, substantial question of environment arises and is answered to the effect that there is need for regulation of indoor air quality at public places. A case is made out for a direction to evolve an appropriate mechanism by the MoEF and CPCB in coordination with other concerned Ministries particularly the Ministry of Urban Affairs and Ministry of Health, with CPCB being nodal agency. Joint Committee may hold its first meeting within one month and after deliberations work out appropriate standards and protocols for indoor air quality for safeguarding public health at Public places under the EP Act, EP Rules or the Air Act within three months. It will be open to the applicants to make their respective representations before the Committee. Based on report of the Committee, MoEF/CPCB may issue appropriate orders under the relevant statutory provisions.

The applications are disposed of.

A copy of this order be forwarded to the MoEF&CC, CPCB, Ministry of Urban Affairs and Ministry of Health, GoI, by e-mail for compliance.

M.A. No. 377/2017 also stands disposed of.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

Dinesh Kumar Singh, JM

Prof. A. Senthil Vel, EM

Dr. Vijay Kulkarni, EM

Dr. Afroz Ahmad, EM

April 19, 2022
Original Application No. 143/2016 &
Original Application No. 206/2022
A

Annexure B

पश्चिम रेलवे
Western Railway

मंडल कार्यालय, पश्चिम रेलवे
इंजीनियरिंग विभाग, चामुंडा पुल के पास,
नरोडा रोड
अहमदाबाद- 382345

पत्र सं. WR-ADIOENGG/52/2024 (E-509170)

दिनांक: 16.04.2024

To,
Dr Raja Singh
E 205/206, GF, Amar Colony, Lajpat Nagar 4,
New Delhi, Pin:110024,

विषय : सूचना अधिकार अधिनियम -2005 के तहत जानकारी देने के बारे मे।
संदर्भ : आपका आवेदन पत्र प्राप्ति दिनांक: 12.04.2024

उपरोक्त विषय के सम्बंध मे अहमदाबाद मंडल के इंजीनियरिंग विभाग से संबन्धित सूचना निम्न है ।

क्रम संख्या	मांगी गयी सूचना	प्रदान की गयी सूचना
1.	Please provide a copy of the circular/ memorandum/ note/notification/ advisory/ guideline or any other record or document with any other name which states that railway is phasing out asbestos cement roofs in railway stations.	In this regard RDSO guidelines is already available on Indian Railway Website www.indianrailwy.gov.in vide letter No. WKS/WS/05/FS dtd. 16/01/2013
2.	Please provide information regarding the current quantity of asbestos cement roofing present in all the railway stations.	Presently asbestos sheet not used by Ahmedbad Division
3.	Please provide the information regarding the policy of railway on use of roofing material in railway stations including the sheds in platforms.	Remarks given as per Item No. 1

अन्य विभागों/मंडल के द्वारा आपको अलग से जानकारी उपलब्ध करायी जायेगी

यदि आप उपरोक्त सूचना से संतुष्ट नही है, तो आप 30 दिन के भीतरअपीलीय अधिकारी / अपर मंडल रेल प्रबंधक मंडल कार्यालय, पश्चिम रेलवे, जी सी एस हॉस्पिटल के नजदीक, नरोडा रोड ,अहमदाबाद (गुजरात) – 382345 को सूचना अधिकार अधिनियम -2005 की धारा 19(1) के अंतर्गत अपील कर सकते है ।

16/4/24

(मोहन लाल मीना)
सहा. मंडल इजी. (ट्रेक) अहमदाबाद
एंव जन सूचना अधिकारी – प.रे. अहमदाबाद

टेलीफैक्स 0522-2465736

ईमेल : edwksrdso@gmail.com

सत्यमेव जयते

Government of India - Ministry of Railways
Research Designs & Standards Organisation,
Manak Nagar, Lucknow-11

RB/L&A/002/2013

WKS/WS/05/FS

Dated 16.01.13

General Manager (C), N. F. Railway, Maligaon, Guwahati,

Principal Chief Engineer/ Chief Engineer (Coord.)

CR, ER, ECR, ECOR, NR, NCR, NER, NEFR,

NWR, SR, SCR, SER, SECR, SWR, WR & WCR, Metro Kolkatta

Chief Administrative Officer/ Chief Engineer Construction (Coord.),

CR, ER, ECR, ECOR, NR, NCR, NER, NWR,

SR, SCR, SER, SECR, SWR, WR & WCR

Sub: Guidelines on WSC Agenda item no. 004/01/05 "Standardization of specification of flooring, Roofing material for platform covering in Station Premises and Standardization of specification of workshop flooring".

Ref: (i) Railway Board letter no. 2004/LMB/01/04 dated 09.09.2009

(ii) RDSO letter no. WKS/WS/05/FS dated 22.09.09

(iii) Railway Board letter no. 2011/LMB/1/53 dated 20.09.2012

(iv) RDSO letter no. WKS/WS/05/FS dated 03.10.2012

As per above subject, guidelines have been prepared by RDSO which are based on the recommendations of the subcommittee and has been approved by Railway Board vide reference no. (i) and (iii). These guidelines is enclosed herewith for your information and necessary action please.

16/01/13

(Nand Kishore)
Executive Director/Works

DA: As above

Copy to:

(1) Director/IRICEN, Pune,
(2) Executive Director, L & A-III, Rly. Board
(3) Chief Engineer/General/Northern Railway
(4) Chief Engineer/Works/South Central Railway

} for kind information please.

For official use only

सत्यमेव जयते

GOVERNMENT OF INDIA
भारत सरकार
MINISTRY OF RAILWAYS
रेल मंत्रालय

Guidelines on WSC Agenda Item No. 004/01/05

Standardization of Specification of flooring, Roofing material for platform covering in Station Premises
&
Standardization of Specification of Workshop flooring

Works Directorate
कार्य निदेशालय

Research Designs and Standards Organisation, Lucknow – 226011
अनुसंधान अभिकल्प एवं मानक संगठन, मानक नगर, लखनऊ – 226011

RDSO
रेल अग्रदूत Transforming Railways
www.rdso.gov.in

Preface

During deliberation of 1st Works Standards Committee (WSC) it was felt that there exist a large variation in flooring and roofing standards (Specifications) in Railway, which is not good. Nothing has been laid down for flooring and roofing at different category of station and workshop. Hence, there is a need to lay down requirement of different kind of flooring and roofing at different category of stations and different locations. Different Railways are using different type of flooring in Workshops also.

On the recommendations of 1st Works Standards Committee , Railway Board had constituted a subcommittee of officers for **"Standardization of flooring, Roofing material for Platform covering in Station premises" &"Standardization of Workshop Flooring"**. Officers associated with this sub-committee for preparation of this guidelines are-

(i) CE/Works/Northern Railway.
(ii) CE/Works/South Central Railway and
(iii) ED/Works/RDSO.

This guideline is based on recommendations of subcommittee which is approved by Railway Board vide their letter no. 2004/LMB/01/04 dated 09.09.2009 and vide letter no. 2011/LMB/1/53 dated 20.09.2012.

10/01/13.

(Nand Kishore)
ED/Works/RDSO &Convener Member Secretary

Index

1.0 Introduction:

First Works Standards Committee meeting was held on 16th-17th June 2005 at IRICEN, Pune . **"Standardization of flooring of platform, concourse & FOB and platform cover sheds based on categories of station"** and **"Standardization of workshop flooring"** was introduced as non-agenda item during deliberation of 1st WSC by the CPDE/Eastern Railway, CE/G/N.F. Railway, Adv. L&A/Railway Board, CE/G/ W. Railway and Director /IRICEN.

During discussion it was observed that there is large variation in flooring, roofing standards in Railway and nothing has been laid down for different categories of stations. At Railway workshops type of flooring is also not specified. Hence, need to standardize the different kind of flooring, roofing at different category of stations and Workshop flooring was felt.

All members of WSC agreed to constitute a Sub- committee of three members which will study the data supplied from Railways in this regard and recommend its report to railway Board on this item.

In view of above a sub-committee was formed consisting of following members:

(i) CE/Works/Northern Railway,
(ii) CE/Works/South Central Railway and
(iii) ED/Works/RDSO.

2.0 BRIEF SUMMARY OF PROCEEDINGS IN WSC

2.1 The subcommittee had submitted its draft report in 2nd WSC on "Details of Flooring / Walling / Ceiling for Various Areas in Station Premises" & "Details of roofing materials for various areas in station building" which was discussed in detail and it was decided to be deferred to be discussed further in 3rd WSC. In 3rd WSC it was discussed in detail and recommendation were made to Railway Board for its approval. RDSO submitted guidelines on "Details of Flooring / Walling / Ceiling for Various Areas in Station Premises" & "Details of roofing materials for various areas in station building" to Railway Board vide letter no.WKS/WS/05/FS dated 03.09.2009 for approval. Railway Board has modified and approved only **"Details of Flooring / Walling / Ceiling for Various Areas in Station Premises"** vide letter no.2004/LMB/01/04 dated 09.09.2009 which was circulated to all Zonal Railway vide RDSO letter no. WKS/WS/05/FS dated 22.09.2009. (Annexure 1)

2.2 4th WSC discussed the "Details of roofing materials for various areas in station building" and "Workshop flooring" and after in corporating modifications as

Suggested in 4th WSC, RDSO finally submitted the "Details of roofing materials for various areas in station building" and "Workshop flooring" to Railway Board vide letter no. WKS/WS/05/FS dated 01.05.2012. "Details of roofing materials for various areas in station building" and "Workshop flooring" were approved by Railway Board vide their letter no. 2011/LMB/1/53 dated 20.09.2012 which was circulated to all Zonal railways vide RDSO letter no. WKS/WS/05/FS dated 03.10.2012. (Annexure 2)

2.3 Detail proceeding of all WSC is enclosed as Annexure 3 which can be referred to for detailed information.

3.0 "Details of Flooring / Walling / Ceiling for Various Areas in Station Premises", (Railway Board letter no. 2004/LMB/01/04 dated 09.09.2009) and "details of roofing materials for various areas in station building" and "workshop flooring" (RB letter no. 2011/LMB/1/53 dated 20.09.2012) has now been approved. The specification in tabular form as approved by Railway Board for Flooring / Walling / Ceiling for Various Areas in Station Premises is detailed below as item no 3.1, Roofing Materials for various areas in station building as item no 3.2 and Workshop Flooring as item no 3.3

3.1 Details of Flooring / Walling / Ceiling for Various Areas in Station Premises

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
1.	Platform (Covered Area)	1. ¶Polished Granite flooring. 2. Polished Kota stone or similar stone flooring with or without stone inlays 3. *Fiber reinforced vacuum dewatered concrete flooring.	1. ¶Polished Granite flooring. 2. Polished Kota stone or similar stone flooring with or without stone inlays 3. *Fiber reinforced vacuum dewatered concrete flooring.	1. ¶Polished Granite flooring. 2. Polished Kota stone or similar stone flooring with or without stone inlays 3. *Fiber reinforced vacuum dewatered concrete flooring.	1. ¶Polished Granite flooring. 2. *Fiber reinforced vacuum dewatered concrete flooring. 3. Polished Kota stone or similar stone flooring with or without stone inlays. 4. **Mastic flooring	1. *Fiber reinforced vacuum dewatered concrete flooring 2. ¶ Polished Kota stone or similar stone flooring with or without stone inlays 3. **Mastic flooring. 4. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Rough Dressed Stones Slab flooring. 2. Brick on edge. 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Interlocking pre-cast Cement Concrete Paver hydraulically pressed 2. Moorum surface flooring 3. Quarry dust flooring.
		Dado upto 1500mm height or upto sill level of window whichever is lower with polished granite of matching colour with flooring.						

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
2.	Platform (Uncovered Area)	1. Polished Kota stone or similar stone flooring with or without stone inlays 2. *Fiber reinforced vacuum dewatered concrete flooring.	1. Polished Kota stone or similar stone flooring with or without stone inlays 2. *Fiber reinforced vacuum dewatered concrete flooring.	1. Polished Kota stone or similar stone flooring with or without stone inlays 2. *Fiber reinforced vacuum dewatered concrete flooring.	1. Polished Kota stone or similar stone flooring with or without stone inlays 2. *Fiber reinforced vacuum dewatered concrete flooring.	1. *Fiber reinforced vacuum dewatered concrete flooring 2. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 3. Bituminous flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. Rough Dressed Stones Slab. 3. Brick on edge. 4. Moorum surface flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. Brick on Edge. 3. Moorum surface flooring.

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
3.	#No Trolley Zone on Edges of the Platforms	1. Precast concrete studded tiles manufactured by vibro compaction process and using jointless FRP Moulds 2. Heavy duty (high strength, high abrasion resistance) precast chequered tile 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Precast concrete studded tiles manufactured by vibro compaction process and using jointless FRP Moulds. 2. Heavy duty (high strength, high abrasion resistance) precast chequered tiles. 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Precast concrete studded tiles manufactured by vibro compaction process and using jointless FRP Moulds 2. Heavy duty (high strength, high abrasion resistance) precast chequered tiles. 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Precast concrete studded tiles manufactured by vibro compaction process and using jointless FRP Moulds 2. Heavy duty (high strength, high abrasion resistance) precast chequered tiles. 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. Precast concrete studded tiles manufactured by vibro compaction process and using jointless FRP Moulds 2. Heavy duty (high strength, high abrasion resistance) precast chequered tiles. 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. # CC Coping Slabs 2. Chequered CC Tiles 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds	1. #CC Coping Slabs 2. Chequered CC Tiles 3. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
4.	Concourse/ Booking Area	1. Polished Granite Flooring 2. Polished Kota stone or similar stone flooring with or without stone inlays	1. Polished Granite Flooring 2. Polished Kota stone or similar stone flooring with or without stone inlays	1. Polished Kota stone or similar stone flooring with or without stone inlays.	2. Polished Granite Flooring 2. Polished Kota stone or similar stone flooring with or without stone inlays	1. Polished Kota stone or similar stone flooring with or without stone inlays	1. Cement Concrete flooring	----------
		Dado upto 1500 mm height or upto window sill level whichever is lower with polished granite of matching colour with flooring.						
5.	Portico	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. *Fiber Reinforced Vacuum Dewatered Concrete Flooring 3. Mastic flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. *Fiber Reinforced Vacuum Dewatered Concrete Flooring 3. Mastic flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. *Fiber Reinforced Vacuum Dewatered Concrete Flooring. 3. Mastic flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. *Fiber Reinforced Vacuum Dewatered Concrete Flooring 3. Mastic flooring.	1. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 2. Bituminous flooring 3. *Vacuum Dewatered Concrete flooring	.....	----------

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
6.	Circulating Area	1. *Fibre Reinforced Vaccuum Dewatered concrete flooring 2. Mastic flooring.	1. *Fibre Reinforced Vacuum Dewatered Concrete Flooring. 2. Mastic flooring.	1. *Fibre Reinforced Vacuum Dewatered Concrete Flooring. 2. Mastic flooring.	1. *Fibre Reinforced Vacuum Dewatered Concrete Flooring. 2. Mastic flooring.	1. *Vacuum Dewatered Concrete Flooring. 2. Bituminous flooring	1. Bituminous flooring 2. Levelled surface with good quality soil/moorum .	1. Levelled surface with good quality soil/ moorum
7.	Parking Area	1. *Fibre Reinforced Vacuum Dewatered Concrete flooring. 2. Interlocking pre-cast Cement Concrete hydraulically pressed Paver Blocks using plastic moulds 3. Mastic flooring	1. *Fibre Reinforced Vacuum Dewatered Concrete flooring 2. Interlocking pre-cast Cement Concrete hydraulicall y pressed Paver Blocks using plastic moulds 3. Mastic flooring.	1. *Fibre Reinforced Vacuum Dewatered Concrete flooring 2. Interlocking pre-cast Cement Concrete hydraulicall y pressed Paver Blocks using plastic moulds 3. Mastic flooring.	1. *Fibre Reinforced Vacuum Dewatered Concrete flooring 2. Interlocking pre-cast Cement Concrete hydraulicall y pressed Paver Blocks using plastic moulds 3. Mastic flooring.	1. *Vacuum Dewatered Concrete flooring 2. Bituminous flooring.	1. Bituminous flooring. 2. Levelled surface with good quality soil/moorum	1. Levelled surface with good quality soil/ moorum

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
8.	Stairs	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	1. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	1. Heavy duty (high strength and high abrasion resistance) Chequered Tiles	
9.	FOB - Pathway	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles.	1. Flamed Granite Flooring. 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles.	1. Flamed Granite Flooring 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles.	1. Flamed Granite Flooring 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles.	1. RCC slabs 2. Heavy duty (high strength and high abrasion resistance) Chequered Tiles.	1. RCC slabs	------

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
10.	Waiting Hall	1. Polished Vitrified Tiles as per IS : 15622 2. Granite tiles flooring.	1. Polished Vitrified Tiles as per IS : 15622 2. Granite Tiles flooring. 3. Ceramic tiles as per IS:15622.	1. Polished vitrified tiles as per IS:15622. 2. Ceramic Tiles as per IS: 15622. 3. Polished Kota stone or similar stone flooring with or without stone inlays	1. Polished Vitrified Tiles as per IS : 15622 2. Ceramic Tiles as per IS:15622. 3. Polished Kota stone or similar stone flooring with or without stone inlays	1. Terrazo Tiles in white cement 2. Ceramic Tiles as per IS:15622. 3. Polished Kota stone or similar stone flooring with or without stone inlays	1. CC Floor 2. Rough Dressed Stones Slab. 3. Polished Kota stone or similar stone flooring with or without stone inlays	1. CC Floor 2. Rough Dressed Stone Slab 3. Polished Kota stone or similar stone flooring with or without stone inlays
11.	Refresh ment Room	1. Polished Vitrified Tiles as per IS : 15622 2. Granite tiles flooring.	1. Polished Vitrified Tiles as per IS : 15622 2. Granite tiles flooring.	1. Polished Vitrified Tiles as per IS : 15622 2. Granite tiles flooring.	1. Polished Vitrified Tiles as per IS : 15622 2. Granite tiles flooring.	1. Ceramic floor tiles as per IS:15622 2. Polished Kota stone or similar stone flooring with or without stone inlays	.....	....

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
12.	SS Office	1. Polished Vitrified Tiles as per IS : 15622	1. Polished Vitrified Tiles as per IS : 15622	1. Polished vitrified tiles as per IS:15622	1. Polished Vitrified Tiles as per IS : 15622	1. Ceramic Tiles as per IS:15622. 2. Polished Kota stone or similar stone flooring with or without stone inlays.	1. CC Floor	.....
13.	Waiting Room and Retiring Room	1. Polished Vitrified Tiles as per IS : 15622	1. Polished Vitrified Tiles as per IS : 15622	1 Polished Vitrified tile flooring 2. Ceramic floor Tiles as per IS:15622.	----------	1. Terrazo tiles flooring 2. Ceramic floor tiles as per IS:15622	-------	-------
14.	Cloak room	1. CC floor with hardened topping on concrete surface	1. CC floor with hardened topping on concrete surface	1. CC floor with hardened topping on concrete surface	1. CC floor with hardened topping on concrete surface	-------	-------	-------
		Fiber reinforced vacuum dewatered concrete shall be provided wherever feasible.						

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
15.	Parcel Area	1. *Fiber reinforced vacuum dewatered concrete flooring 2. CC floor with hardened topping on concrete surface 3. Mastic flooring	1. *Fiber reinforced vacuum dewatered concrete flooring 2. CC floor with hardened topping on concrete surface 3. Mastic flooring	1. *Fiber reinforced vacuum dewatered concrete flooring 2. CC floor with hardened topping on concrete surface 3. Mastic flooring	1. *Fiber reinforced vacuum dewatered concrete flooring 2. CC floor with hardened topping on concrete surface 3. Mastic flooring	1. *Fiber reinforced concrete flooring 2. CC floor with hardened topping on concrete surface 3. Mastic flooring		
16.	Toilet	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)	1. Anti-skid ceramic tiles in floor (Group B-II of IS-15622 and ceramic tiles on walls (Group B-III of IS-15622)
		Ceramic wall tiles upto 2100mm height of matching colour with flooring.						

S. No	Place	Type of flooring & Basis of station category						
		A1 Earning more than 50 crore	A Earning more than 6 and upto 50 crore	B Earning 3 to 6 crore	C Sub urban stations	D Earning between 1 & 3 crore	E Earning less than 1 crore	F Halt
17.	**Wall & Ceiling Finish**	Smooth finish with POP/ putty and painting with Emulsion in Concourse, Waiting hall, waiting rooms, Refreshment room, Retiring rooms & SS room. Oil bound distemper at other locations.	Smooth finish with POP/ putty and painting with Emulsion in Concourse, Waiting hall, waiting rooms, Refreshment room, Retiring rooms & SS room. Oil bound distemper at other locations.	Smooth finish with POP/ putty and painting with Emulsion in Concourse, Waiting hall, waiting rooms, Refreshment room, Retiring rooms & SS room. Oil bound distemper at other locations.	Smooth finish with POP/ putty and painting with Emulsion in Concourse, Waiting hall, waiting rooms, Refreshment room, Retiring rooms & SS room. Oil bound distemper at other locations.	Painting with oil bound distemper in Concourse, Waiting hall, Refreshment room, Retiring rooms & SS room and other locations.	Painting with oil bound distemper in Concourse, Waiting hall & SS room.	Oil bound distemper in Waiting hall.

¶ **Only on main platform.**

* **To be provided for all new work. For existing work, it can be provided wherever traffic diversion/protection of surface during setting period is possible.**

** **Mastic flooring is not to be used for home platform.**

The top surface of coping stone should be indented by XPM or some other method.

Note : i) In case existing flooring / finish are different from list above, there is no need of immediate replacement / change unless needed to be replaced on condition basis.

ii) Vacuum dewatered concrete without reinforced with fiber can also be provided wherever considered necessary with the approval of Sr DEN / Dy Chief Engineer.

iii) Exterior finishes shall be provided by Railways as per local conditions.

3.2 DETAILS OF ROOFING MATERIALS FOR VARIOUS AREAS IN STATION BUILDING

SL	Name of item	Category of Stations						
		A1	A	B	C	D	E	F
B.	Roofing Materials (Covered Shed) -							
1.	Passenger Platforms / FOB	1. * Polycarbonate sheet roofing. 2. # Precoated galvalume iron profile sheet roofing 3. $ Aluminium sheet roofing.	1. * Polycarbonate sheet roofing. 2. # Precoated galvalume iron profile sheet roofing 3. $ Aluminium sheet roofing.	1. # Precoated galvalume iron profile sheet roofing 2. β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871. 3. $ Aluminium sheet roofing.	1. # Precoated galvalume iron profile sheet roofing 2. β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871. 3. $ Aluminium sheet roofing.	1. β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871. 2. # Precoated galvalume iron profile sheet roofing 3. μ Bamboo corrugated sheet roofing as per IS: 15476.	1. β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871 2. μ Bamboo corrugated sheet roofing as per IS: 15476.	1. β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871 .
2.	Goods Platforms/ Shed	β Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS : 14871						

Note : In case existing material is different from list above, there is no need of immediate replacement unless existing material is needed to be replaced on condition basis.

* **Polycarbonate sheet roofing:**

a) Technical Details: As per Indian Railways Unified Standard Specifications- 2010 Vol. I Para 10.11.8, page 408

b) Polycarbonated roofing shall be provided for lighting/aesthetic purposes as per local requirement with the approval of Zonal Headquarters.

\# **Precoated galvalume iron profile sheet roofing:**

a) Item no. 109230 of USSOR-2010, Northern Railway

b) Technical Details: As per Indian Railways Unified Standard Specifications- 2010 Vol. I para 10.44 page-446

$ **Aluminium sheet roofing:**

a) Item no. 109140 of USSOR-2010, Northern Railway

b) Technical Details: As per Indian Railways Unified Standard Specifications- 2010 Vol. I para 10.43 page-445-446

β **Non-asbestos high impact polypropylene reinforced cement coloured sheets as per IS: 14871:**

a) Item no. 103010 of USSOR-2010, Northern Railway

b) Technical Details: As per Indian Railways Unified Standard Specifications- 2010 Vol. I, Para 10.5, Page 398 Non – Asbestos cement corrugated sheet shall be as per IS: 14871

µ **Bamboo corrugated sheet roofing as per IS: 15476:**

a) Item no. 109130 of USSOR-2010, Northern Railway

b) Technical Details: (As per Indian Railways Unified Standard Specifications- 2010 Vol. I, para 10.41 page-443-444)

3.3 Workshop Flooring

SL	Flooring Type	Type Of Use	Flooring Standards
(i)	**Hard surface for heavy loads**	**Movement of vehicles forklifts and cranes for loading/ unloading**	1. Consolidated & compacted subgrade with a cross slope of 1 in 60. 2. In case of poor subgrade soils i.e. black cotton, clay, silt, marshy land etc. 150mm thick layer of coarse material i.e. granular material like sand, quary dust etc. / moorum to be provided. 3. Overlay of 75mm thick Consolidated & compacted stone soling using 50 mm nominal graded stone aggregate. 4. Overlay of 75mm thick PCC layer of M10 Mix/1:3:6 nominal mix, well compacted, with 20mm nominal stone aggregate. 5. The top layer will consist of 150mm thick M-30 concrete with 20mm nominal size stone aggregate, vacuum de-watered (panel size not more than 3m for construction joint), smooth finish and mixing of polypropylene fibres in the top 35mm with 10mm nominal stone aggregate. **Proper cross slope should be provided to ensure that there is no stagnation of water on the surface.**
(ii)	**Hard surface for very heavy and impact loads**	**Dumping scrap etc. and in other shops where impact load comes**	1. Consolidated & compacted subgrade with a cross slope of 1 in 60. 2. In case of poor subgrade soils i.e. black

			cotton, clay, silt, marshy land etc. 150mm thick layer of coarse material i.e. granular material like sand, quary dust etc. / moorum to be provided. 3. Overlay of 150mm thick Consolidated & compacted stone soling using 50mm nominal graded stone aggregate. 4. Overlay of 75mm thick PCC layer of M10 Mix/1:3:6 nominal mix, well compacted, with 20mm nominal stone aggregate. 5. The top layer will consist of 150mm thick M-30 concrete with 20mm nominal size stone aggregate, vacuum de-watered (panel size not more than 3m for construction joint), smooth finish and use of Ironite/ Hardonate material in the top 15 mm with 6 mm nominal stone aggregate. Or Top layer to be laid with 40mm thick Mastic asphalt/Bituminous concrete with recommended preparatory laying arrangements. **Proper cross slope should be provided to ensure that there is no stagnation of water on the surface.**
(iii)	**Acid Proof floor and walls**	**Battery shop**	1. Consolidated & compacted subgrade with a cross slope of 1 in 60. 2. In case of poor subgrade soils i.e. black cotton, clay, silt, marshy land etc. 100mm thick layer of coarse material i.e. granular

			material like sand, quary dust etc. / moorum to be provided. 3. Overlay of 150mm thick Consolidated & compacted stone soling using 50 mm nominal graded stone aggregate. 4. Overlay of 75mm thick PCC layer of M10 Mix/1:3:6 nominal mix well compacted, with 20mm nominal stone aggregate. 5. The top layer will consist of 100mm thick M-20 concrete with 20mm nominal size stone aggregate, vacuum de-watered (panel size not more than 3m for construction joint), rough finish and Acid resistant tiles conforming to IS 4457 in floor and dado. **Proper cross slope should be provided to ensure that there is no stagnation of water on the surface.**
(iv)	**Epoxy coated floor finish for specific shops**	**Heavy duty Shops where floor gets dirty due to spill of oil/grease etc. and where cleaning arrangement is available.**	1. Consolidated & compacted subgrade with a cross slope of 1 in 60. 2. In case of poor subgrade soils, 100mm thick layer of coarse material/moorum to be provided. 3. Overlay of 150 mm thick Consolidated & compacted stone soling using 50 mm nominal graded stone aggregate. 4. Overlay of 75mm thick PCC layer of M10 Mix/1:3:6 nominal mix, well compacted, with 20mm stone aggregate. 5. The top layer will consist of 150mm thick M-30 concrete with 20mm nominal size stone

			aggregate, vacuum de-watered (panel size not more than 3m for construction joint), smooth finish and use of Ironite/ Hardonate material in the top 15mm with 6mm nominal stone aggregate over which epoxy coating be provided. **Proper cross slope should be provided to ensure that there is no stagnation of water on the surface.**
(v)	**Approach Road**	**Heavy duty road for movement of loaded trucks.**	1. Consolidated & compacted subgrade with a cross slope of 1 in 30 to be provided. 2. In case of poor subgrade soils, 100mm thick layer of coarse material/moorum to be provided. 3 (a) Overlaid by three layers of stone aggregate of various gradings with consolidation with roller of 8 to 10t capacity as under : i) Bottom layer - stone aggregate of size 90mm to 45mm including stone screening of 13.2mm – 230mm thick. ii) Middle layer – stone aggregate of size 63mm to 45mm including stone screening of 13.2mm – 100mm thick. iii) Upper layer – WBM layer with stone aggregate of size 53mm to 22.4mm including stone screening of 11.2mm – 75mm thick. 3 (b) Dense Bitumen Macadam (DBM) -75mm. 4. Top layer to be laid with 40mm thick Mastic asphalt/Bituminous concrete with

			recommended preparatory laying arrangements. 5. Edge protection by providing curb stones or by providing edges. 6. Proper drainage system should be designed and executed alongwith road construction.
(vi)	**Heavy duty floor for machinery involving vibrations in flooring like lathes etc. in workshop.**	**For locations where machines need to be installed.**	1. Consolidated & compacted sub-grade with a cross slope of 1 in 60. 2. In case of poor sub-grade soils, 100mm thick layer of coarse material/moorum to be provided. 3. Overlay of 150 mm thick Consolidated & compacted stone soling using 50 mm nominal graded stone aggregate. 4. Overlay of 75mm thick PCC layer of M10 Mix/1:3:6 nominal mix, well compacted, with 20mm nominal stone aggregate. 5. RCC Slab M30 grade 100mm thick for small machines with normal vibrations and for heavy and high frequency machine RCC slab should be got designed by vendor according to the static and dynamic load on the floor and size of pockets required for installation of machines. 6. A top layer of 55mm thick cement concrete flooring With "Hardcrete" concrete hardener topping may be provided.

4.0 Conclusion

An effort has been made to standardized the flooring details in passenger area which includes Platform area (both covered and uncovered), No trolley Zone area, Concourse and Booking area, Portico, Circulating Area, Parking area, Stairs, FOB pathway, waiting Hall, Refreshment rooms Office, Retiring room, Cloak room, Parcel area, Toilet, Wall and ceiling Finish and Roofing. The guidelines also include standardization of roofing material for area in station buildings like passenger platform/FOB and standardizations of flooring of various workshop areas.

Standardization will facilitate in quick decision making by Railway authorities besides it will help railways to limit non ending demands from passengers. Also it will give pan India passengers equal facilities. The standardization has given due consideration for the availability of local material like bamboo corrugated sheet etc thus environmental friendly products has been included besides it will use local material thus cost economy will be there.

Freezing of the specification will also help Expert group of USSOR to include the items in its list if any item is presently not available on it.

Acknowledgement

The Guidelines has been prepared by Shri Rajesh Agarwal, Director/Works under guidance of Shri Nand Kishore, Executive Director/Works with the assistance of Shri Ashutosh Kumar, Assistant Design Engineer/Works Shri Manish Kumar, SSE(D)/Works.

Annexure 1

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2004/LM8/01/04 New Delhi, dated 9.9.2009

Director General
RDSO
Manak Nagar
Lucknow.

Sub.: Specifications for some of passenger amenities items in stations developed by Southern Railway.

Ref.: ED/W/RDSO's letter No.WKS/WS/05/P'S dated 3.9.2009.

Specifications for passenger amenities items at stations submitted by RDSO in Railway Board office vide above referred letter has been considered. Specifications have been modified in Board's office and approved by Board (ME). Final approved specifications for the passenger amenities items at stations are enclosed as Annexure for issuing as a guideline to all zonal railways by RDSO.

DA: As above.

(J. S. Lakra)
Director / Land & Amenities
Railway Board

SN-55

Government of India - Ministry of Railways
Research Designs & Standards Organisation,
Manak Nagar, Lucknow-11

टेलीफैक्स/Tele-Fax :0522-2465736

सत्यमेव जयते

No. WKS/WS/05/FS

Dated 22.09.09

General Manager (C), N.F. Railway, Maligaon, Guwahati.
Principal Chief Engineer/ Chief Engineer (Coord.),
CR, ER, ECR, ECoR, NR, NCR, NER, NFR,
NWR, SR, SCR, SER, SECR, SWR, WR, WCR
Chief Administrative Officer/ Chief Engineer-Construction (Coord.),
CR, ER, ECR, ECoR, NR, NCR, NER, NWR, SR,
SCR, SER, SECR, SWR, WR, WCR

Sub: Standardization of flooring etc. in station premises.

Ref: (1) This office letter No. WKS/WS/05/FS dated 21.10.08.
(2) Railway Board's letter No. 2004/S.818/01/04 dated 09.09.09.

* * *

The specifications for passenger amenity items at stations - standardization of flooring and roofing at station have been prepared and submitted to Railway Board. Specifications have been approved by Board (ME) with some modifications. The approved specifications for the passenger amenity items – standardization of flooring is enclosed herewith.

The standards approved by the Board shall be followed for all new works/major renovation works. In case the existing floor/finish is different from the proposed one, there is no need of immediate replacement/change unless needed to be replaced on condition basis.

Encl: As above

22.9.09
(S. M. Maheshwari)
Executive Director/Works

Copy for kind information:-

1- ED (L&A), Railway Board
2- Director/ IRICEN/Pune
3- CE/Works, Northen Railway
4- CE/Works, South Central Railway

Annexure-2

SN. 139

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

No.2011/LMB/1/53. New Delhi, dated 20-09-2012.

Director General,
RDSO,
Manak Nagar,
Lucknow,

Sub:- Standardization of roofing material for platform covering and workshop flooring.

Ref:-RDSO's letter No.WKS/WS/05/PS dated 12.9.2012

The recommendations for Standardization of roofing material for platform covering and workshop flooring submitted by RDSO in Railway Board office vide above referred letter has been considered.

Recommendation have been approved by Board(ME) with modification that Bamboo corrugated roofing sheet to be used in the area where that material is easily available, at D&E category stations in place of A1, A, B & C category stations.

Final approved recommendations for Standardization of roofing material for platform covering and workshop flooring may be issued as guidelines by RDSO to all Zonal Railways & Production Units under intimation to this office.

(Ramesh Kumar)
Director, Land & Amenities
Railway Board

टेलीफैक्स :0522-2465736

ईमेल : edwksrdso@gmail.com

Government of India - Ministry of Railways
Research Designs & Standards Organisation,
Manak Nagar, Lucknow-11

WKS/WS/05/FS

Dated 03.10.12

Principal Chief Engineer/ Chief Engineer (Coord.)

CR, ER, ECR, ECOR, NR, NCR, NER, NEFR,
NWR, SR, SCR, SER, SECR, SWR, WR & WCR

Chief Engineer(Co-ord), Metro, Kolkatta

Sub: Standardization of roofing material for platform covering and workshop flooring.

Ref: Railway Board letter no. 2011/LMB/1/53 dated 20.09.2012

The specification for **workshop flooring** and passenger amenity items at stations-**standardization of roofing material for platform covering** have been prepared and submitted to Railway Board. Railway Board (ME) has approved the specifications. Specifications as approved by Board (ME) is enclosed herewith for your information and necessary action please.

DA: As above

(Nand Kishore)
Executive Director/Works

Copy to:

(1)	Director/IRICEN, Pune,	for kind information please.
(2)	Executive Director, L & A-III, Rly.Board	
(3)	Chief Engineer/General/Northern Railway	
(4)	Chief Engineer/Works/South Central Railway	
(4)	GM (Cons.)/NF Rly.	for kind information and necessary action please.
(5)	CAO/All Zonal Railways.	
(6)	Chief Engineer – CORE/Allahabad, CLW/Chittranjan, DLW/Varanasi, RCF/Kapurthala, ICF/Chennai, RWF/Bangluru, DMW/Patiala.	

Annexure-3

The progress of this item from 1st to 5th WSC is given below-

1. **1st WSC Meeting Recommendations:-**

   Committee recommends that Northern Railway and South Central Railway will compile data in this regard and will forward to RDSO. RDSO will prepare the compiled note and will present the same in the next meeting. Other Railways may also forward their suggestions to RDSO.

   Orders of Railway Board –

   Committee's recommendations accepted.

2. **2nd WSC Meeting Recommendations:-**

   Sub-committee constituted in 1st meeting of WSC comprising of **NR & SCR** had given their recommendations regarding materials to be used at different locations. Committee deliberated on each item. After discussing pros and cons of issues involved as proposed by sub-committee, it is felt by the committee to have more in-depth study on the subject. Hence, committee recommends to defer this item for discussion during next WSC meeting.

   Orders of Railway Board –

   This is an important topic related to works in Civil Engineering. Committee should finalize the same early. **RDSO should convene the meeting of sub-committee and make draft recommendations** which should be circulated to railways and Board for finalization in next meeting.

3. **3rd WSC Meeting Recommendations:-**

   (i) Good efforts have been made by Sub-committee in framing recommendation. However, some modifications are needed to be made in recommendations :
   - (a) Heavy duty floor terrajo tiles mentioned by ER, CR, ER & WR can be studied for inclusion, if found suitable by Sub-Committee.
   - (b) Detailed Specifications along with IS Specs, if any along with book references, whatsoever to be reflected regarding each item in notes.
   - (c) Paver block in 'E' Class stations in proposed recommendations shall be avoided and be replaced by concrete items.

(d) Fiber reinforcement, vacuum dewatered concrete used at SCR, seems quite good surface and can be recommended for use by Sub-committee in all categories of stations.

(e) Marble floor recommended shall be avoided being the soft material.

(f) On Gangways, use of ceramic tiles needs review. At 'A1', 'A' & "C Category stations, Flame Granite be recommended for steps of FOBs.

(g) Heavy duty Chequered tiles/ Concrete Blocks with projected studs can be a good surface for edges of platform.

(ii) At Dadar FOB, about ten years back, some tiled surface was provided which is still giving good service. CE/W/WR shall provide detailed specification of the same to RDSO for consideration of Sub-Committee.

(iii) All Zonal Railways shall send their suggestions/remarks on proposed recommendations, again circulated during meeting within next 10 days to RDSO for consideration of Sub-Committee.

(iv) Sub-Committee shall consider economy and life of material as well as least maintenance requirement criteria during framing recommendations. A great thought need to be put in for finalization of roofing.

(v) RDSO should revise recommendations, as discussed above.

Order of Railway Board-

(i) Standardization of flooring of platform, concourse & FOB has already been approved by Railway Board and instructions issued vide RDSO's letter no. WKS/ WS/05/FS, dated 22.9.09 to Zonal Railways for following the same as and when replacement is done.

(ii)–RDSO should take feedback from the Zonal Railways on Item-(i) above and make presentation during next meeting of WSC.

(iii) Recommendations submitted in regard to platform coverings should also be presented during next meeting of WSC.

(iv) Sub-Committee (ED/W/RDSO, CE/W/WR & CE/W/SCR) shall also propose the recommendations for flooring in workshops and goods shed areas and to be presented during next meeting of WSC.

4. **4th Meeting Recommendations:-**

(1) Standards approved for flooring & finishing at station premises are satisfactory and do not require any modifications for the time being.

(2) WSC endorsed the recommendations for roofing material for platform covering & workshop flooring with following modifications.

(a) Polycarbonate sheets proposed as roofing material shall be limited to approx 10% area for lighting/aesthetic purposes with approval of Zonal Headquarters.

(b) VDC in acid proof floor for workshop flooring be made 75 mm instead of 50 mm.

With the above modifications, sub-committee may submit their recommendations to Railway Board.

Railway Board's Order:

WSC's recommendations are accepted except that Polycarbonate roofing shall be provided as per local requirement and VDC flooring should be minimum 100 mm thick.

Sub-committee shall submit modified recommendations by March 2012.

5. **5th WSC Meeting Observation/Recommendations**

Committee Observations: -

Recommendations have been submitted to Railway Board and the same have been approved by them on 20.09.2012.

Committee Recommendations :-

Item is proposed to be closed.

Annexure C

Railways are phasing out asbestos, a suspected health hazard

Hindustan Times | By Manoj R Nair
Apr 23, 2018 12:28 PM IST

https://www.hindustantimes.com/mumbai-news/railways-are-phasing-out-asbestos-a-suspected-health-hazard/story-3laDnefgU8P1VgPXMYdTEP.html

In June 2009, this journalist had reported that the broken-down asbestos roof of a pedestrian bridge in a railway station in Mumbai was being replaced by metal sheets.

In June 2009, this journalist had reported that the broken-down asbestos roof of a pedestrian bridge in a railway station in Mumbai was being replaced by metal sheets.

The plan to replace asbestos at railway stations with metal, which was started a decade ago, is now a major project.(HT PHOTO)

The report from an obscure suburban station would have been insignificant but for the fact that asbestos sheet, which is manufactured from a naturally occurring fibrous mineral, has been an important construction material for India's railways. Most railway stations in India – there are nearly 8000 - have asbestos in their premises. The sheets are made by bonding asbestos

fibres with cement. The product is used as roofing and partition material for stations, workshops and worker's quarters. It is also used as insulation material in places with extreme weather.

But studies have shown that asbestos fibre can be dangerous. The American federal public health body, the Agency for Toxic Substances and Diseases Registry (ATSDR), says that the fibre, if inhaled for a long period of time, can cause asbestosis, or scarring of lungs. The material can also cause pleural diseases, where there is a change in the lining of the lungs. In some cases, inhalation of the fibre can cause cancer. ARSDR says that not everyone who comes in contact with the material develops health problems and that it is people with other preconditions who are more vulnerable.

The plan to replace asbestos at railway stations with metal, which was started a decade ago, is now a major project. Recently, the railways announced that all new railway stations will have metal sheet roofs. Asbestos roofs at older stations will be phased out. "Metal sheets look appealing as they are pre-painted. They do not break; they only bend on impact while asbestos has to be painted after it is installed, and it can break," a railway engineer had told this reporter.

Asbestos manufactures say that the alarm over asbestos is unwarranted, as only some products made from the material are dangerous to health. The Asbestos Cement Products Manufacturers Association (ACPMA) says that groups campaigning for the phasing out of asbestos are often supported by manufacturers of iron material who will benefit if mining and manufacturing of asbestos is banned. During the hearing of a writ petition asking for restrictions on manufacture and sale of asbestos product, the ACPMA had blamed ductile cast iron producers of supporting litigation aimed at asbestos makers.

"Actually, as far as we are concerned, health-wise there no problem in the manufacture, sale and distribution of what you call asbestos in India," said G Vivekanand, chairman, ACPMA.

An asbestos manufacturer told this reporter that asbestos as a raw material is harmful. "So, precautions have to be taken during manufacturing and packing. But in roofing sheets, asbestos fibre is bonded with cement and cannot escape into the air," said the representative of a firm.

According to Vivekanand, the concentration of asbestos fibre in Indian products is low – as little as eight percent. “It is certain types of fibres, used as insulation material, which are problematic. The fibre is a naturally occurring substance and our products are made scientifically and are safe,” said Vivekanand. “The railways may decide to use other materials for aesthetic purposes; it is their outlook, but asbestos sheets are longer lasting than metal, which will last only a few years.”

ACPMA says that the railway’s decision to reduce asbestos use does not affect them much. “Right now we are not in government construction. We are able to sell the material outside,” said Vivekanand.

But groups like Ban Asbestos Network of India (BANI), a group creating awareness about the possible hazards of asbestos, have been campaigning against the use of asbestos. The group said that health concerns about the material have prompted countries to ban the manufacture.

Disposal of the asbestos retrieved from railway will be a tough task as the material is used widely. Asbestos products that are breaking down can release the fibres in to the air. According to BANI, there is probably no public building in India that does not use the material. The railways have said that they will be using ‘scientific’ landfilling methods to dispose of the asbestos waste.

Printed from
Mumbai Mirror

Railways turns over a new roof

/ Jun 15, 2009, 04.18 AM IST

The pedestrian bridge at Vidyavihar station is getting a metal roof. The platforms (below) continue to have asbestos roofs

Indian Railways plans to stop using asbestos - a suspected carcinogenic banned in nearly 50 countries - on

station roofs and partitions. It is shifting to metal, which weighs less, is low maintenance and aesthetic.

After tobacco, asbestos is the most studied cause of lung cancer. Research has shown that exposure to asbestos fibres leads to a six-fold increase in carcinoma, or malignant cancer.

“Metal sheets look appealing as they are pre-painted. They do not break; they only bend on impact while asbestos has to be painted after it is installed, and it can break,” said Rajeev Tyagi, senior divisional engineer, Central Railways.

In Mumbai, metal roofs have replaced asbestos ones at many stations. The pedestrian bridge at Vidyavihar station on Central Railway is being fitted with painted metal roofs and partitions.

Railways will not get rid of the asbestos at one go because it will be too expensive and logistically impossible, as the material is used in nearly 7,000 railway stations across India.

“We will continue to use asbestos. Though commuters do not come in direct contact with asbestos, the material is known to be carcinogenic. To address such concerns, the manufacturing process has been improved to make the product safer. Nevertheless, we are shifting to metal or aluminium,” said Tyagi.

Asbestos manufacturers insist it is safe. “Asbestos as a raw material is harmful. So, precautions have to be taken during manufacturing and packing. But in roofing sheets, asbestos fibre is bonded with cement and cannot escape into the air,” said Jaywant Mehta of J K Overseas, a firm selling asbestos products.

But environmentalists are sceptical. Gopal Krishna, co-ordinator of Ban Asbestos Network of India (BANI), a group creating awareness about the possible hazards of asbestos, said, “Asbestos is not safe. Nobody disputes its carcinogenic properties even though manufacturers have been carrying on propaganda that, with safe and controlled use, it is harmless. It is not for nothing that 50 countries have banned its manufacture. [But] There is probably no public building in India that is asbestos-free.”

Doctors say that people exposed to asbestos fibres can develop asbestosis, a chronic inflammation of the lungs. “A person develops this condition after prolonged exposure of up to a few decades,” said Dr N T Avhad, head of department of respiratory diseases at the Lokmanya Tilak Municipal Hospital in Sion.

BANI estimates that 30 people die in India every day of asbestosis. In January, the Kerala State Human Rights Commission ruled that all schools in the state should be made asbestos-free.

Asbestos Poisoning

Asbestos poisoning can occur when harmful asbestos fibers are released into the air and inhaled or ingested. It can lead to cancer, mesothelioma, pulmonary hypertension, immunological effects other respiratory and digestive damage. The symptoms may not appear for 10 to 50 years after initial exposure. Asbestos exposure is particularly threatening for those employed in building and construction, automotive, railroad, shipyard, and factory.

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Annexure D

HEATWAVE ACTION

HOUSE OWNERS' GUIDE TO

ALTERNATE ROOF COOLING SOLUTIONS

National Disaster Management Authority

Heatwave Action: House Owners' Guide to Alternate Roof Cooling Solutions, April 2021

NDMA would like to thank SEEDS and the Global Network of CSOs (GNDR) for their support in design and development of this House Owner's Guide.

Published by:
National Disaster Management Authority (NDMA)
Ministry of Home Affairs Government of India
NDMA Bhawan A-1, Safdarjung Enclave
New Delhi - 110029

April, 2021

The House Owner's Guide has been adapted in part from
The Handbook on Achieving Thermal Comfort Within Built Environment, TARU, 2014

The authors would like to thank Shri Anup Kumar Srivastava, Senior Consultant, NDMA for his valuable contribution in reviewing this Guide.

Introduction

As average rise in temperatures are set to reach 1.5 degrees, the number of heatwave spells in the country are rising rapidly. During peak summer seasons, indoor temperature can rise up to 45 degrees. With heat island effect in urban areas, the impact is far more severe on people's health, family expenditure, and productivity.

This handbook aims to guide home owners with roof cooling solutions using techniques and material that is affordable and easy to use in existing homes. Due consideration has been made for prevailing building typologies and varying geo-climatic zones across India.

House owners can use this handbook to select solutions that are best suited to their location, affordability and ease of implementation. It is generally advised to implement under professional supervision. All safety precautions may be taken while carrying out such works. Those who may be planning to build a home in the future may refer to the last section for general tips on mitigating effect of heat gain through sensitive planning, orientation and design layout of their homes.

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Contents

IMPACT OF HEATWAVE

HEALTH

Extreme temperature events have profound - even fatal - impacts on human health. Rapid rise in heat gain due to exposure to hotter than average conditions compromise the body's ability to regulate temperature and can result in a surge of illnesses.

Physical

Dehydration & Heat Strokes

Cardiovascular & respiratory disorders

Children & elderly are at higher risk

During a heatwave, there is a significant increase in stress, anxiety, and depression that may trigger or exacerbate mental, behavioural, and cognitive disorders.

Mental

Lack of concentration & focus impacting performance

Rise in domestic abuse and violence

Increased alcohol and drug abuse

LIVING COST

Health and Medical

Health implications and disorders due to extreme temperatures may induce huge medical expenses. These further exacerbate the monthly budget of a household.

Unforeseen medical expenses

Healthy diet and supplements post illness

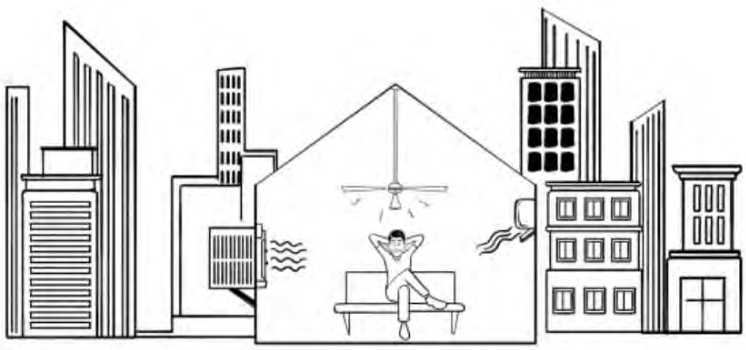
Leaves and workload may affect jobs

*On an average Indian family spends Rs 1000-2500 per month towards health expenses which increases during summers

Energy

"on an average, electricity bills increases by 15%-20% during heatwave for an urban household"

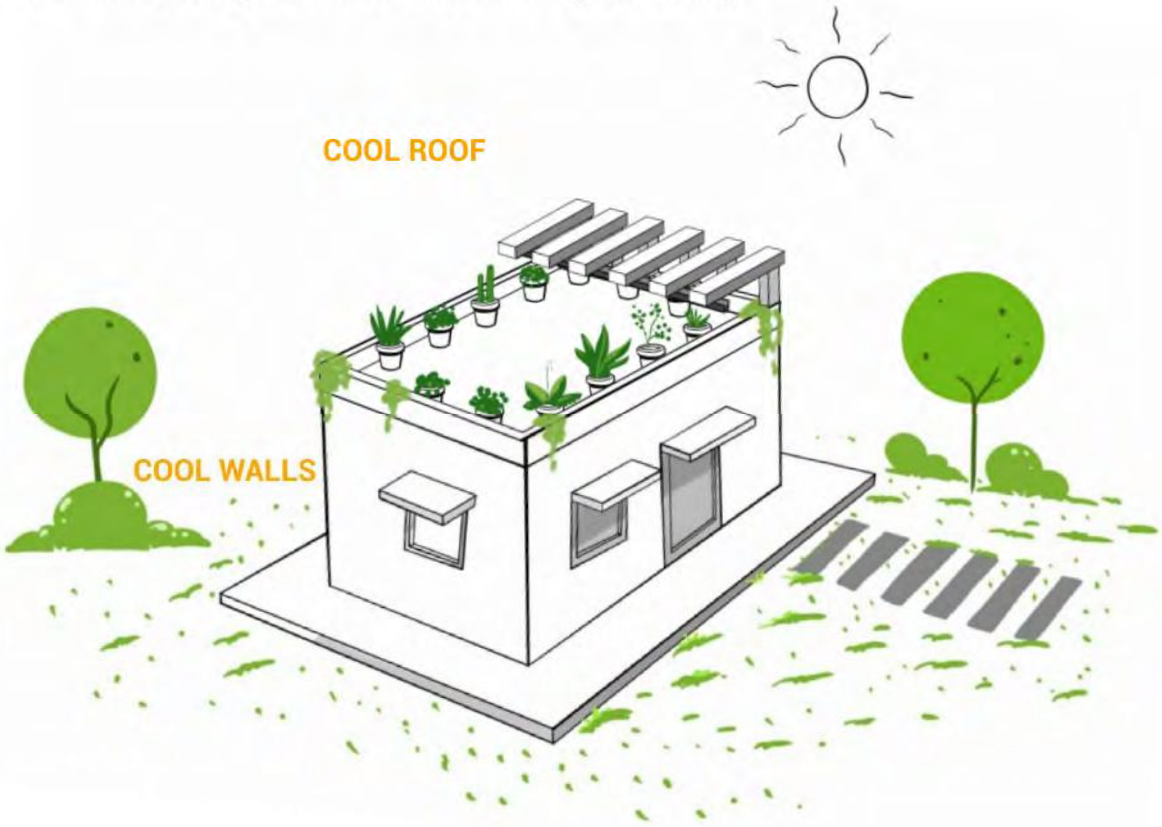
Temperature rise has led to an increase in need for space cooling. The power demand in urban areas during summers peak with "cooling load" due to the use of air conditioners, coolers and fans contributing to maximum consumption of electricity.



Extreme temperatures exacerbate the demand for mechanical cooling and air-conditioners, leading to increased electrical consumption impacting the average expenditure for a household.

Home Owner's Solutions for
RESILIENCE STRATEGIES AGAINST HEATWAVE

Building orientation and design can improve the impacts of heat waves, urban heat islands and local air pollution. Thermal comfort in buildings through low-energy consuming means complement each other in making comfortable living a reality.



COOLING SOLUTIONS FOR EXISTING HOMES

Cool Roof

- Bamboo/Thatch Screening
- Green Net Shading
- Roof Paint
- Gravel Roof
- Heat Insulation Tiles
- Hollow Concrete Tiles
- Broken China Mosaic
- Mud Phuska
- Lime Concrete
- Inverted Earthen Pots
- Extruded Polystyrene (XPS sheets)
- Modified Bitumen
- Cellulose Fibre
- Thermo Crete
- Mist Cooling System

Cool Walls

- Paints & Finishes

RESILIENCE STRATEGIES: Parameters

The guidelines develop a matrix of best sustainable & passive practices which improves living environment, increase comfort levels, and reduce economic & energy loads as per varying parameters. Geographic, Building Typology, a region's climate, and hazard context.

Locations

Geographic location plays an important role in defining the climate and related activities of the region.

HD Hot & Dry

WH Warm & Humid

CM Composite

TE Temperate

CL Cold

Skill & Expertise

Present day techniques have evolved to a large extent defining different sets of application modes based on time, cost & expertise.

Do It Yourself

Technical expert

Building Typology

Building typology further defines the appropriate practice to be adapted for cool roof and passive techniques.

Sloping Roof

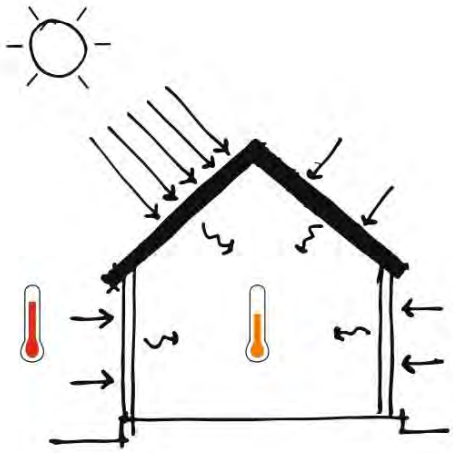
Flat Roof

Existing

New

Alternate Roof Cooling Solutions: The Working

Roof contributes up to 70% of the heat gain of a building during high temperatures. Solar radiation striking a surface is either reflected, absorbed, or transmitted.



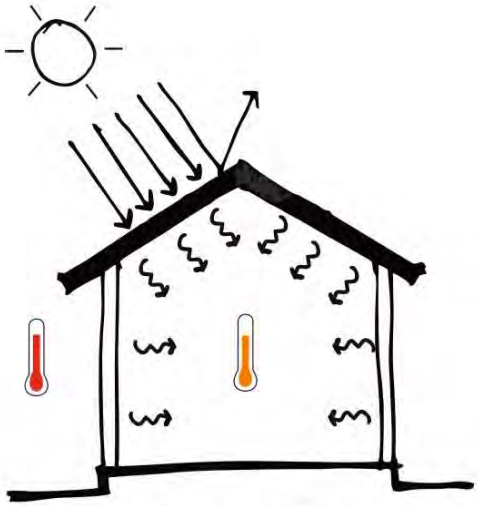
DAY

Heat is absorbed by the buildings in the daytime

NIGHT

Radiates it in night increasing the internal temperature

Cool Roofs through use of reflective materials and techniques, help in reducing heat absorption and improving overall thermal comfort of the building.



STANDARD ROOF

Reflection - **LOW**
Absorption - **HIGH**
Thermal Comfort - **LOW**

COOL ROOF

Reflection - **HIGH**
Absorption - **LOW**
Thermal Comfort - **HIGH**

ALTERNATE ROOF COOLING SOLUTIONS

Cool Roof

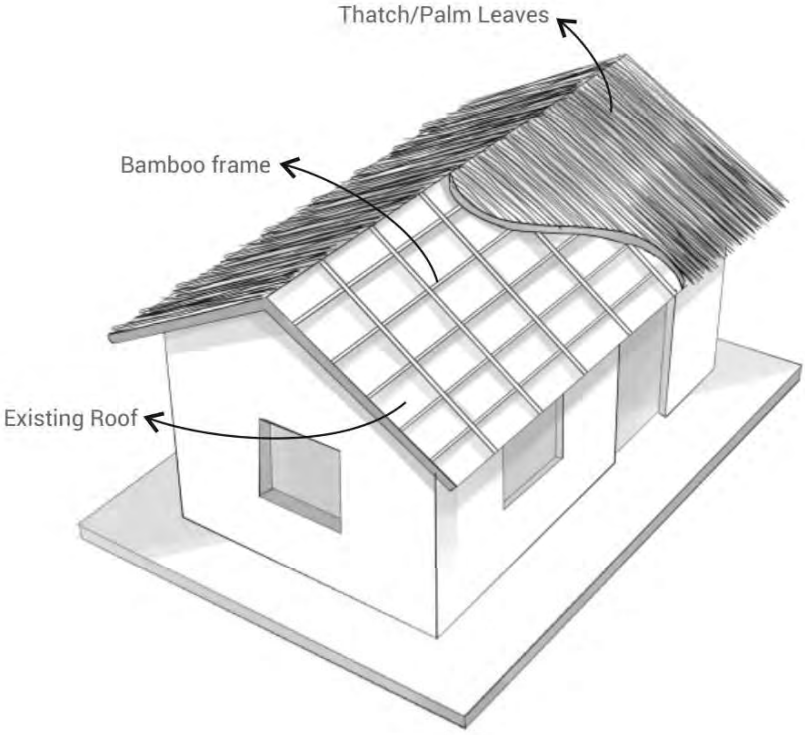
Bamboo, Thatch & Palm Leaves Roof Screen

Bamboo, Thatch & Palm leaves are locally available across India and can be installed as a secondary roof screen thereby reducing the heating effect.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET



- Materials are readily available
- High insulating capacity, maintains comfortable indoor temperature
- Light weight
- Comparatively expensive to hard materials
- Ridge is the weakest point of thatch roof
- Prone to fire risk

Medium to High

6 - 8 Months

< Rs 100/sqft

Clean the roof surface to remove dust and particles

Fix the bamboo frame on to the roof

Lay the thatch/leaves on the frame and tie with rope

Cool Roof

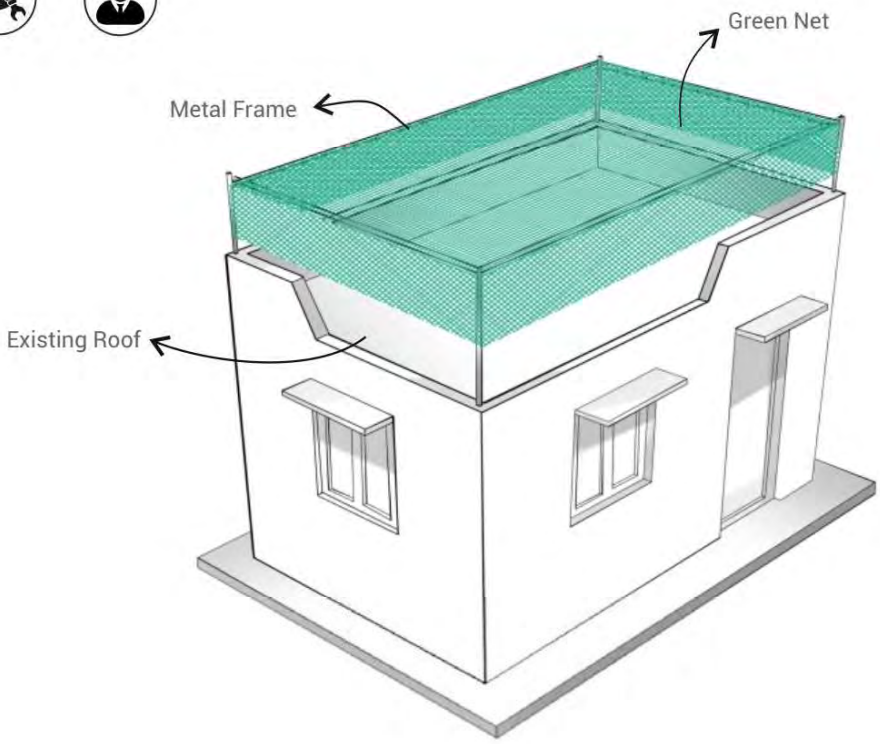
Green Net Shading

Green Net shading is the most basic strategy to achieve thermal comfort. Depending on its design and positioning, varied degree of thermal comfort can be achieved.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET



Highly durable to weather conditions

Light weight

Comparatively expensive to hard materials

Medium

2-3 Years

Rs 150-200/sqft

Clean the roof surface to remove dust and particles

Fix the metal frame on roof

Install the Green net on to the frame

Cool Roof

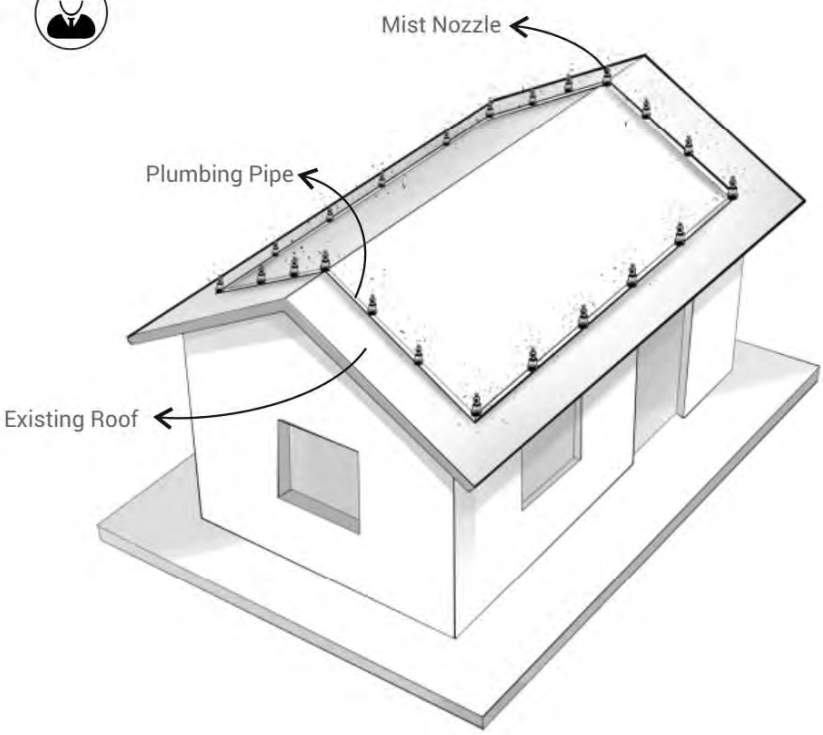
Roof Mist Cooling

Roof mist cooling system reduces the roof surface temperature by spraying an extremely small amount of water across the roof. Spraying allows to cool the roof as the water evaporating from the surface captures the heat.

CLIMATIC ZONE

BUILDING TYPOLOGY

SKILL SET



- Reduces the cost of insulation and water proofing
- Light weight
- Only effective in low relative humidity
- System is unfavorable for areas with water supply problems

Good

3-5 Years

Rs 100-150/sqft

Step 1

Install the mist cooling system on the roof

Step 2

Adjust the pressure of water to create mist environment

Step 3

Controlled quantity of water is sprayed to ensure evaporation quickly

Step 4

Avoid ponding of water on roof surface to prevent damage to roof

Cool Roof

Cool Roof Paint

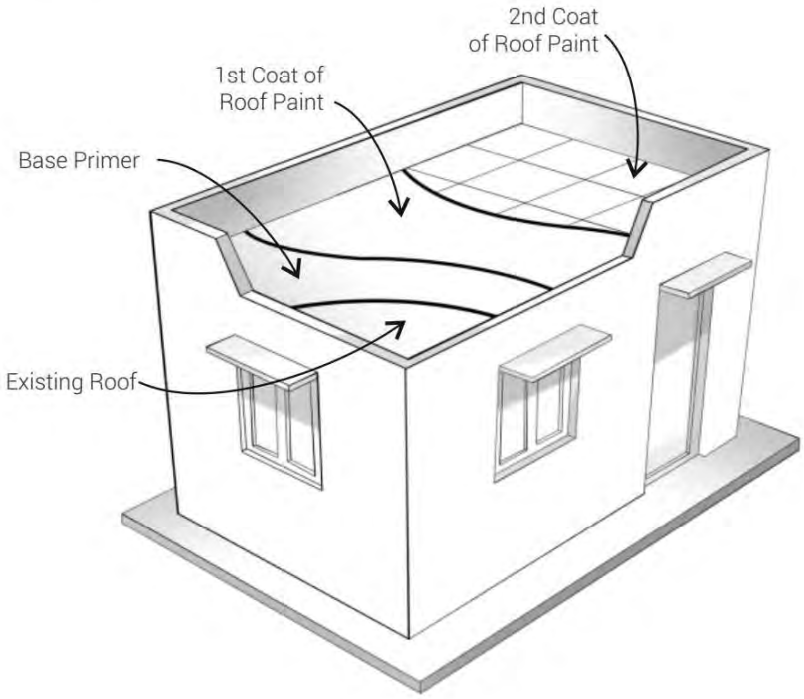
Cool roof coatings are applied to steep as well as low sloped roofs in good condition. Coatings can be field applied to both new roofs and existing roofs.

CLIMATIC ZONE — HD, WH, CM

BUILDING TYPOLOGY

SKILL SET

- Less costly as compared to other cool roof options
- Coating is easily applicable
- Coating acts as waterproof membrane
- Not damaged by freezing temperatures
- Can be damaged through human movement & objects
- Water based coating cannot be applied in winter and rainy season
- Susceptible to frost damage



Good

3-5 Years

< Rs 100/sqft

Step 1 — Clean the roof surface with water and remove dust

Step 2 — Add water to requirement with paint and stir thoroughly

Step 3 — Use brush or roller for application of paint

Step 4 — Apply first coat and allow it to dry for 3-4 hours

Step 5 — Apply second coat and allow it to dry for 48 hours

Cool Roof

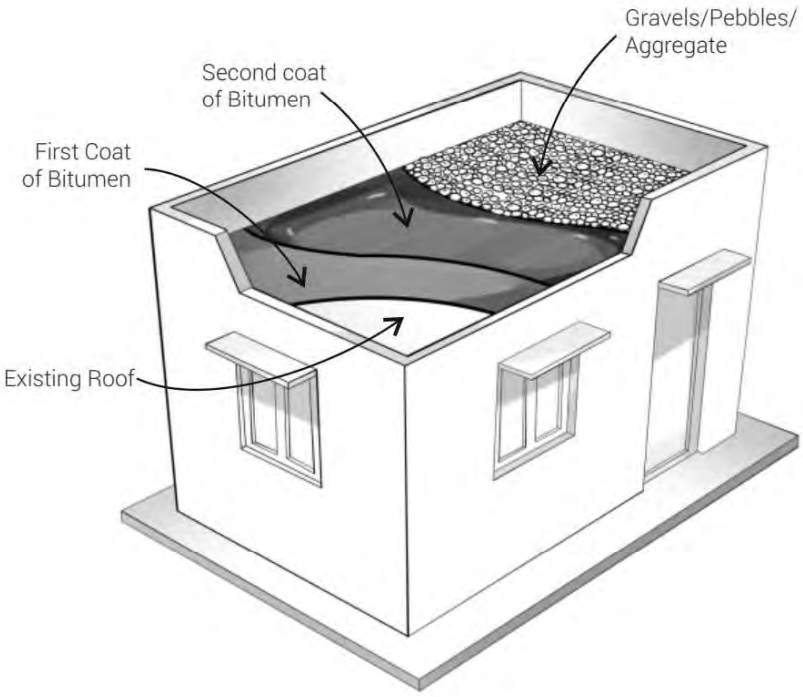
Gravel Roof

Tar and gravel roof is also termed as Built Up Roofing (BUR). It is easy to apply and repair and is inexpensive to install. Bitumen provide the water proofing agents and adhesive properties of the system.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET



Excellent water proofing protection

Ultraviolet protection

Higher installation cost

Hazardous during installation

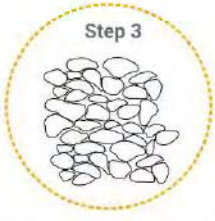
Medium to High

10 - 30 Years

Rs 150 - 200/sqft

Clean the roof surface with water and remove dust

Apply the asphalt or bitumen as base layer on roof surface



Apply marble chips or white gravel for more reflectivity

Cool Roof

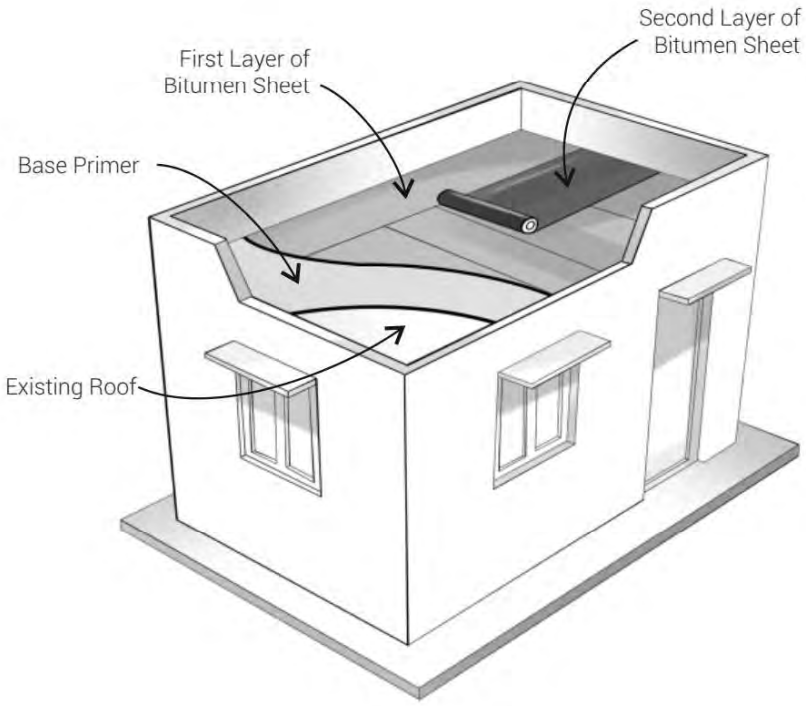
Modified Bitumen Membrane

Modified bitumen roof is one of the most common cool roof option for low sloped or flat roof. They come in pre-coated colors which increases the solar reflectance resulting in better cooling properties.

CLIMATIC ZONE

BUILDING TYPOLOGY
First coat of Bitumen

SKILL SET




Excellent water proofing protection


Ultraviolet protection

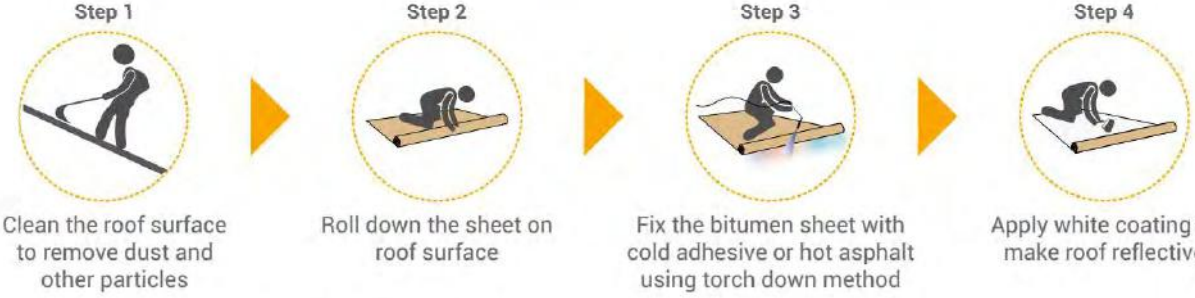

Higher installation cost


Hazardous during installation


Medium


10 - 30 Years


> Rs 200/sqft



Cool Roof

Thermoplastic Membrane

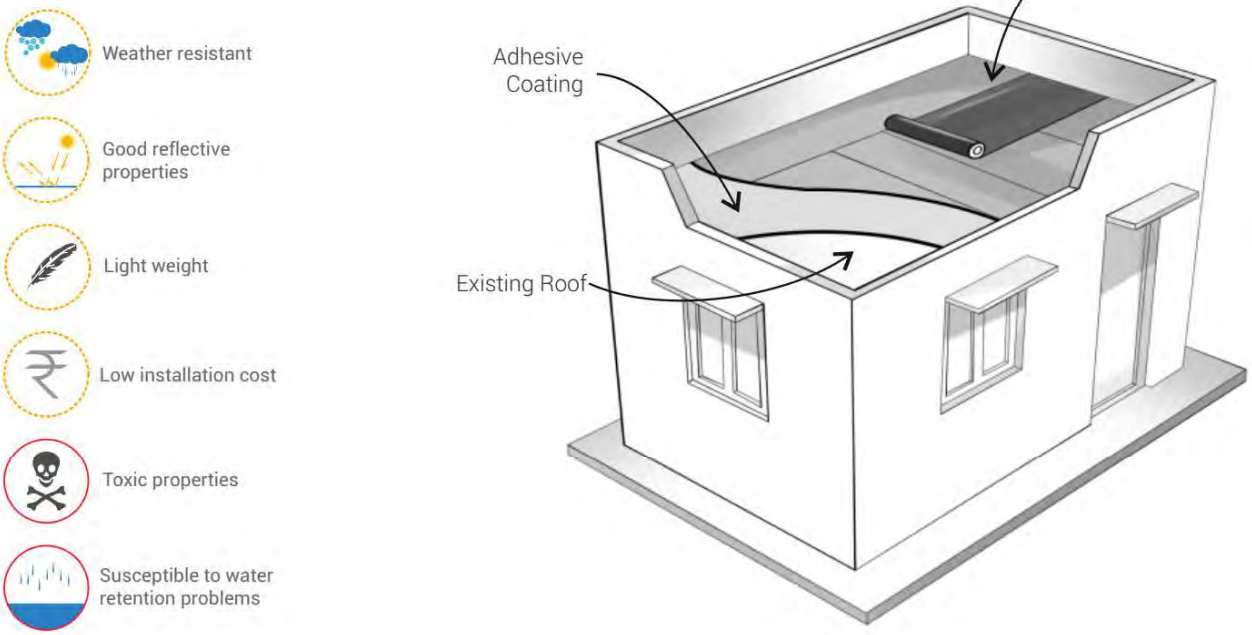
Thermoplastic membranes are made from plastic polymers.

The membranes do not require any coating as the product itself is integrated with cool roof properties. They are manufactured with self cleaning and mold resistant polymers to maintain solar reflectance.

CLIMATIC ZONE

BUILDING TYPOLOGY

SKILL SET



- Weather resistant
- Good reflective properties
- Light weight
- Low installation cost
- Toxic properties
- Susceptible to water retention problems

Good

20 - 30 Years

> Rs 200/sqft

Step 1

Clean the roof surface to remove dust and other particles

Step 2

Roll down the sheet on roof surface

Step 3

Fix thermoplastic membrane using adhesive & heat welding

Cool Roof

Heat Insulation Tiles

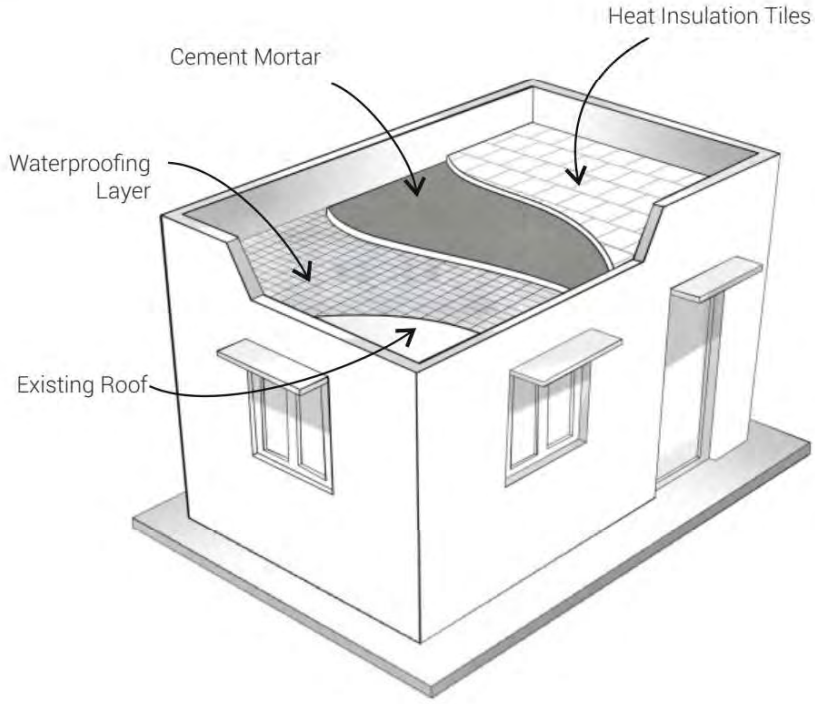
Tile is a resilient material and is able to withstand hail, wind and fire. Heat Insulation Tiles are made from PCM (Phase Change Material) Technology designed to control the flow of heat from roof and used as surface resistant.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET

- Recyclable
- Provide thermal insulation
- Low maintenance
- Highly durable to weather conditions
- Heavy, hence structural evaluation is necessary
- Ceramic tiles are fragile



Good

30 - 50 Years

Rs 150-200/sqft

Step 1 — Prepare and apply mortar with cement - sand ratio of 1:4 on roof

Step 2 — Spread cement slurry on mortar layer for bonding

Step 3 — Wet the rear side of tile with water and put them on mortar

Step 4 — Clean the tiles with wet sponge and allow it to dry for 48 hours

Step 5 — Fill the joints with pointing material (white cement+ pigment)

Cool Roof

Hollow Terracota/ Concrete Tiles

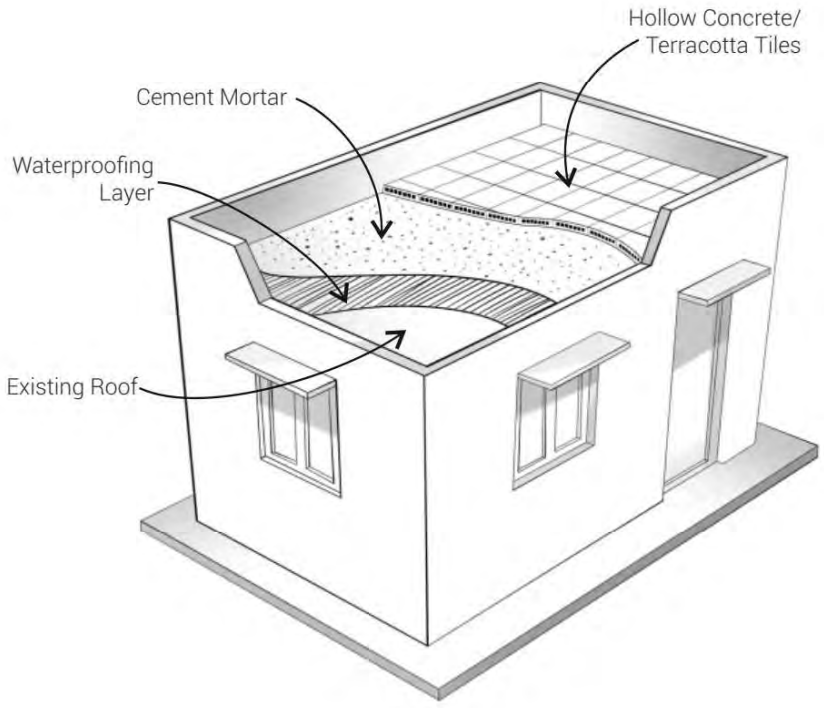
Hollow concrete/terracota tiles have high thermal insulation and sound insulation property which is very effective in limiting heat flow. The air inside the cavities provides the insulation to heat.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET

- Fire resistant
- Recyclable
- Energy efficient
- Low maintenance
- Highly durable to weather conditions
- Heavy, hence structural evaluation is necessary for concrete tiles
- Clay tiles are fragile



Good

30 - 50 Years

Rs 150 - 200/sqft

Step 1

Prepare and apply mortar with cement - sand ratio of 1:4 on roof

Step 2

Spread cement slurry on mortar layer for bonding

Step 3

Wet the rear side of tile with water and put them on mortar

Step 4

Clean the tiles with wet sponge and allow it to dry for 48 hours

Step 5

Fill the joints with pointing material (white cement+ pigment)

Cool Roof

Inverted Earthen Pots

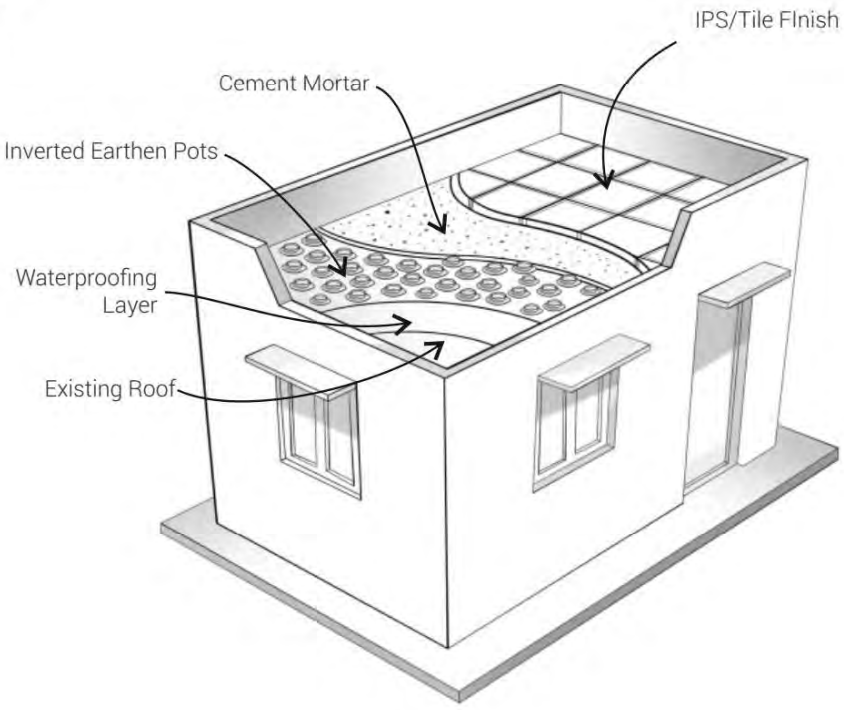
Using earthen pots to keep roofs cool has been traditionally practiced in hot and dry areas. Locally available earthen clay pots are affordable and exhibits high thermal insulation property.

CLIMATIC ZONE — HD CM

BUILDING TYPOLOGY

SKILL SET

- Provide thermal insulation
- Low maintenance
- Highly durable to weather conditions
- Heavy, hence structural evaluation is necessary



Good | 20 - 30 Years | Rs 150 - 200/sqft

Step 1

Spread cement slurry of roof surface for bonding

Step 2

Lay inverted earthen pots over wet slurry

Step 3

Prepare and lay cement concrete over the pots

Step 4

Finish the surface with IPS or Tiles

Cool Roof

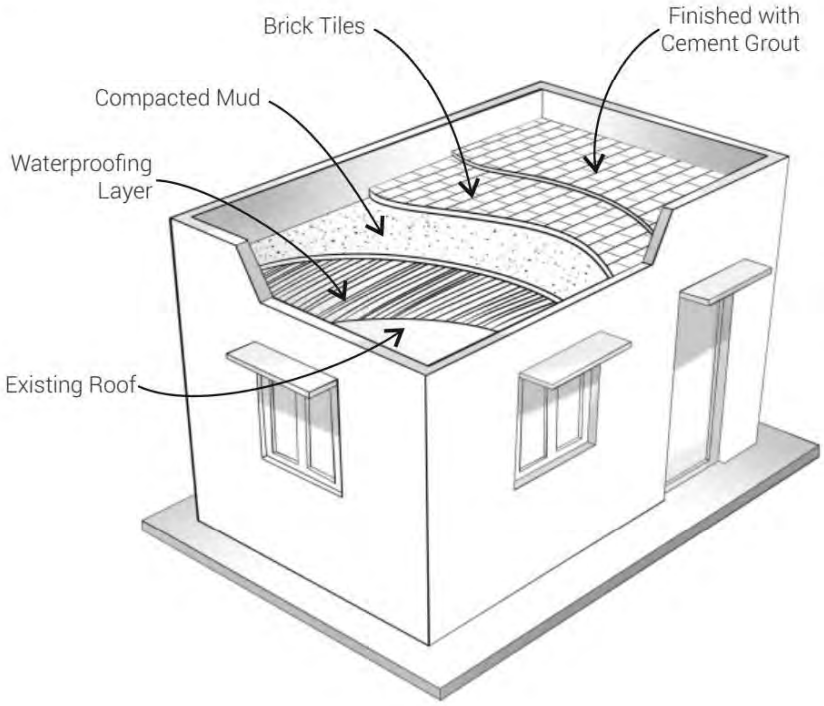
Mud Phuska

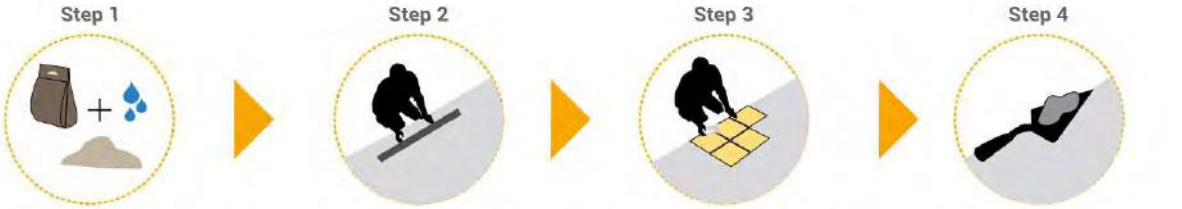
Mud-phuska is prepared from puddle clay mixed with "bhusa" (chopped straws) and cow dung. It is equally suitable to hot as well as arid regions and is commonly used over R.C.C roofing.

CLIMATIC ZONE

BUILDING TYPOLOGY

SKILL SET





Prepare mud phuska and lay it over the waterproofed roof slab

Manually level and compact the mud

Lay brick tiles over the compacted mud

Fill the gap in brick tiles with cement grout admixed with waterproofing grout

Cool Roof

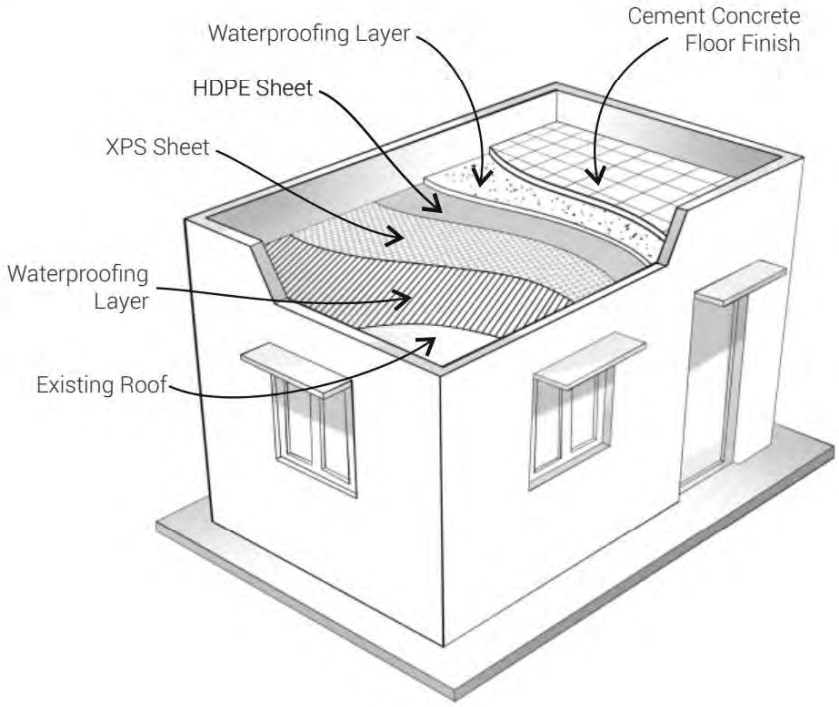
Extrude Polystyrene (XPS Sheets)

Polystyrene foam has a good resistance to flow of heat and sound and is a commonly used raw material for insulation boards in construction industry.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET



- Recyclable
- Provide thermal insulation
- Light weight
- Comparatively expensive to hard materials
- Cant put much load due to softer inner core

Medium

20 - 30 Years

< Rs 150-200/sqft

Step 1 — Lay cement mortar bedding layer for bonding

Step 2 — Lay XPS sheets over the bedding mortar

Step 3 — Place the vapour barrier plastic sheet over XPS sheets

Step 4 — Lay cement concrete over waterproofing layer

Step 5 — Finish the floor with IPS or tiles.

Cool Roof

Lime Concrete

Brick jelly-lime concrete has traditionally been used as a weathering layer over roofs. The principle is to install a layer of concrete made with lime-surkhi mortar with broken brick as coarse aggregate.

CLIMATIC ZONE — HD CM

BUILDING TYPOLOGY

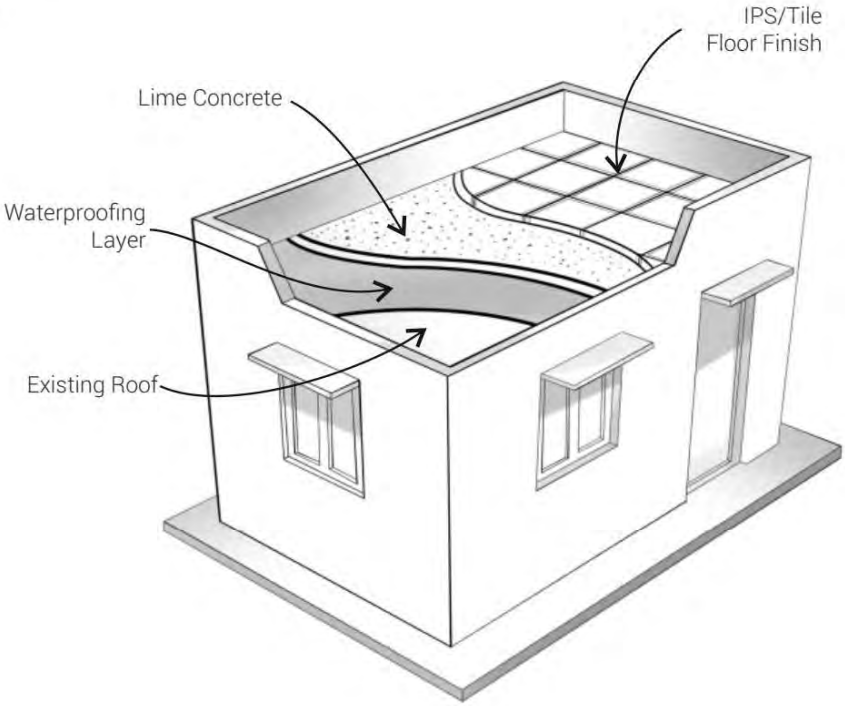
SKILL SET


Provide thermal insulation


Less expensive to install


Highly durable to weather conditions


Heavy, hence structural evaluation is necessary




Good


30-50 Years


Rs 150-200/sqft

Step 1 48 hrs


Prepare lime concrete by slaking lime and brick bats

Step 2


Lay lime concrete over the roof

Step 3 4-5 days


Cure the lime concrete for 4-5 days

Step 4


Spread a layer of cement mortar

Step 5


Finish the floor with tiles

Cool Roof

Broken China Mosaic

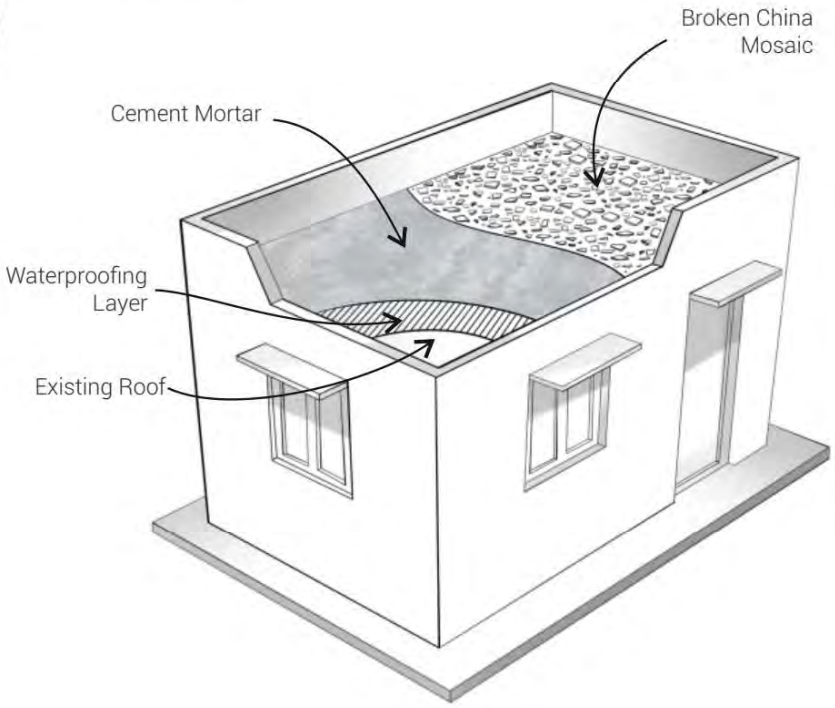
China mosaic terrace provides a reflective layer to the roof which reflects a considerable amount of solar radiation falling on the roof. The reflective layer is formed by broken and randomly sized pieces of light colored ceramic tiles, laid on a cement mortar bed, with joints between tiles sealed with white cement.

CLIMATIC ZONE

BUILDING TYPOLOGY

SKILL SET

- Weather resistant
- Provide thermal insulation
- Good reflective properties
- Less expensive to install
- Heavy, hence structural evaluation is necessary for concrete tiles
- Clay tiles are fragile



Medium

20 - 30 Years

< Rs 150-200/sqft

Step 1

Prepare and lay bedding mortar over waterproofing layer

Step 2

Lay broken ceramic tiles over cement slurry

Step 3

Fill and finish the gap with white cement slurry

Cool Roof

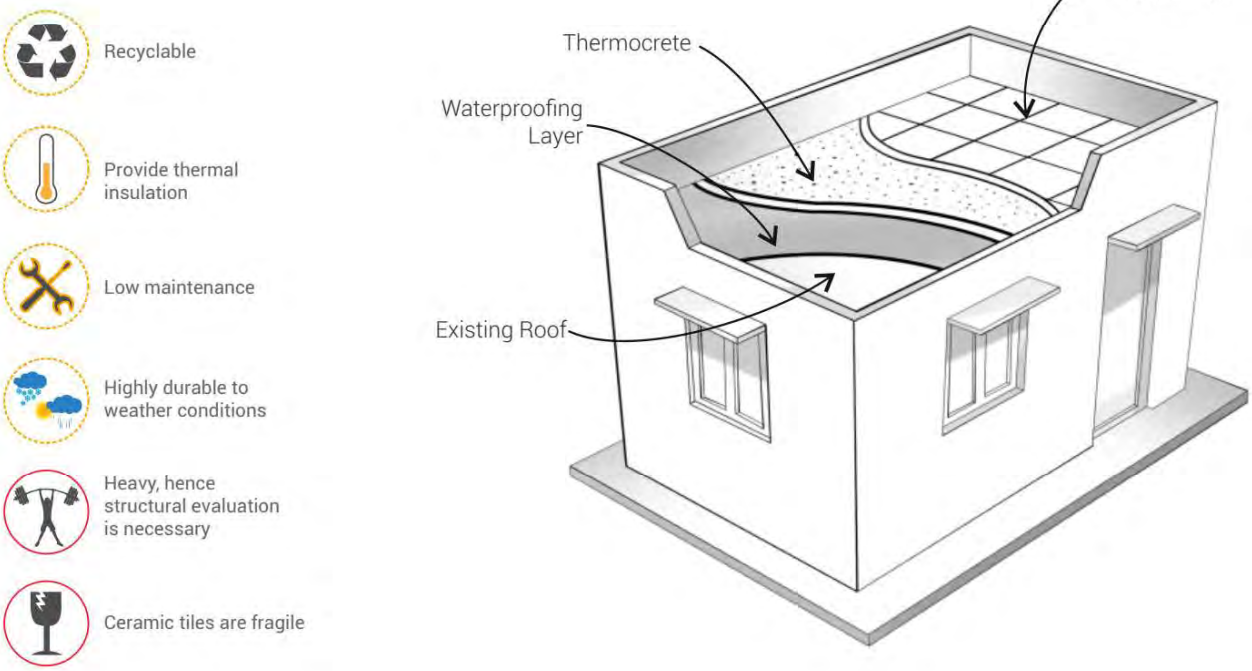
Thermocrete Insulation

Air cavities inside a material increases its ability to obstruct transfer of heat or cold through it. Cement concrete finish which is conventionally used in terraces can be improved for thermal performance by introducing a layer of thermocrete prepared and poured in-situ at site.

CLIMATIC ZONE — HD WH CM

BUILDING TYPOLOGY

SKILL SET



- Recyclable
- Provide thermal insulation
- Low maintenance
- Highly durable to weather conditions
- Heavy, hence structural evaluation is necessary
- Ceramic tiles are fragile

Good

30-50 Years

Rs 150-200/sqft

Step 1

Prepare and lay cement concrete mixed with thermocol balls.

Step 2

Lay 20 mm thick cement plaster over thermocrete.

Step 3

Finish the surface with IPS/Tiles

Cool Roof

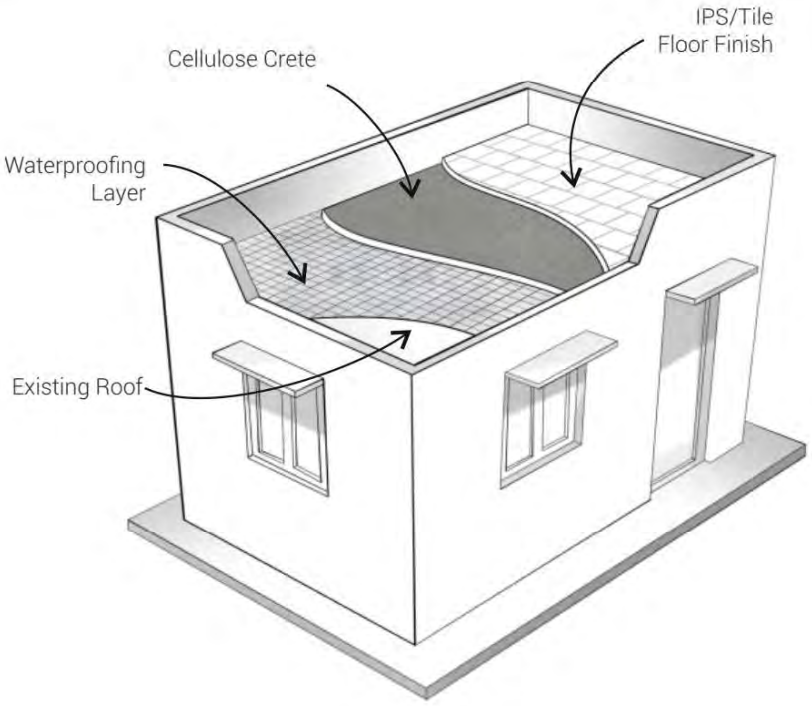
Cellulose Fibre

Cellulose is one of the most environment-friendly raw materials for insulation sourced from recycled paper and cardboards. the fibers get coated with cement sand mortar such that on drying, many air pockets are left inside, giving the dried material an insulating property.

CLIMATIC ZONE — HD CM

BUILDING TYPOLOGY

SKILL SET



- Provide thermal insulation
- Low maintenance
- Heavy, hence structural evaluation is necessary

Low to Medium

20-30 Years

Rs 150-200/sqft

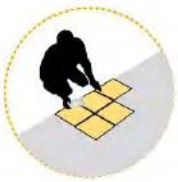
Step 1

Prepare and lay mortar mix with cellulose fibre and cement

Step 2

Lay 20 mm thick cement plaster over cellulose

Step 3

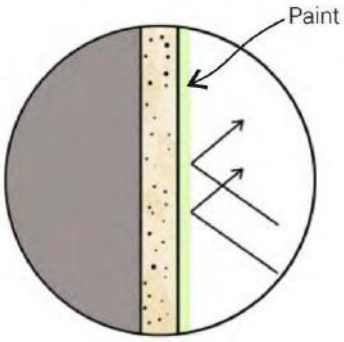


Finish the surface with IPS/Tiles

Cool Walls

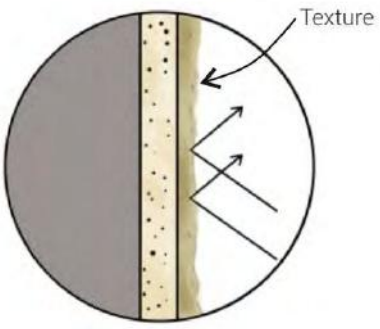
Paints and Finishes

Paint and wall finishes have an important role on solar absorption and thermal emittance of the façade. Wall color and texture can help to reduce temperatures by reducing solar heat gain.



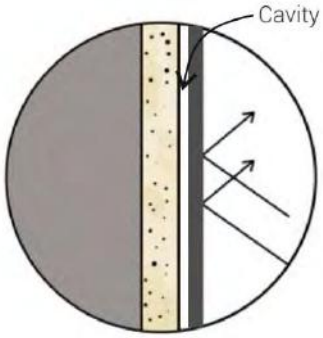
Color

Light colored exterior walls reflects the solar radiations thereby reducing the heat gain.



Texture

Textured surface treatment increases the surface area of the wall and reduces the heat gain.



Cladding

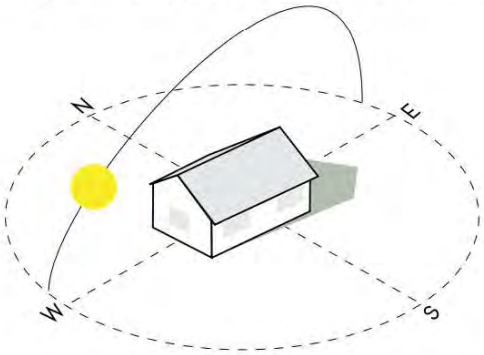
Curtain walls and dry-stone cladding reduces direct heat gain of the walls by creating a cavity between two surfaces.

COOLING SOLUTIONS FOR NEW HOMES

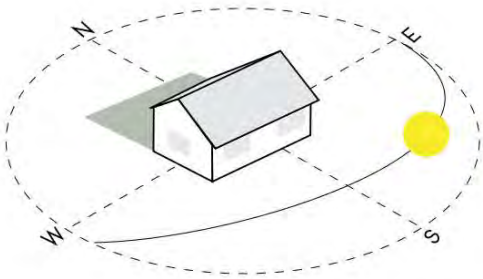
Planning & Orientation	Site Orientation
Fenestrations & Shading	Cross Ventilation Exterior shading devices
Landscaping	Terrace Garden Vertical Greens/Creepers

Planning & Orientation

Orientation of the building plays a crucial role with respect to solar exposure and wind direction. Orientation affects the heat gain through building envelope and thus the cooling demand of the building.



Sun Path: Summer

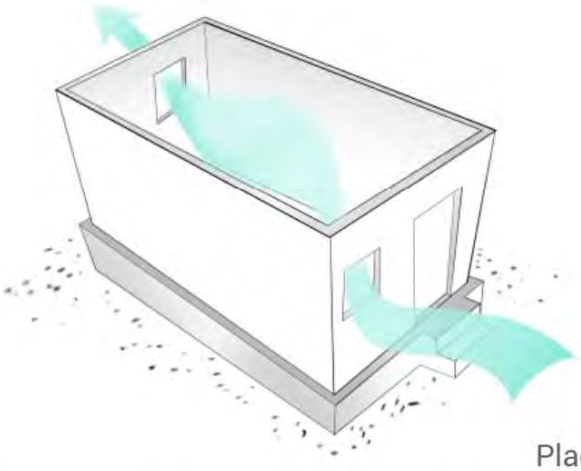


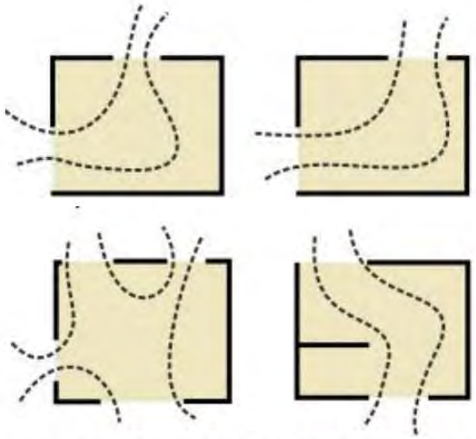
Sun Path: Winter

Fenestrations & Shading

Fenestrations

Properly oriented doors and windows when open provide natural cross ventilation. More cooling can be obtained if air is forced to take the longer path between inlet and outlet.





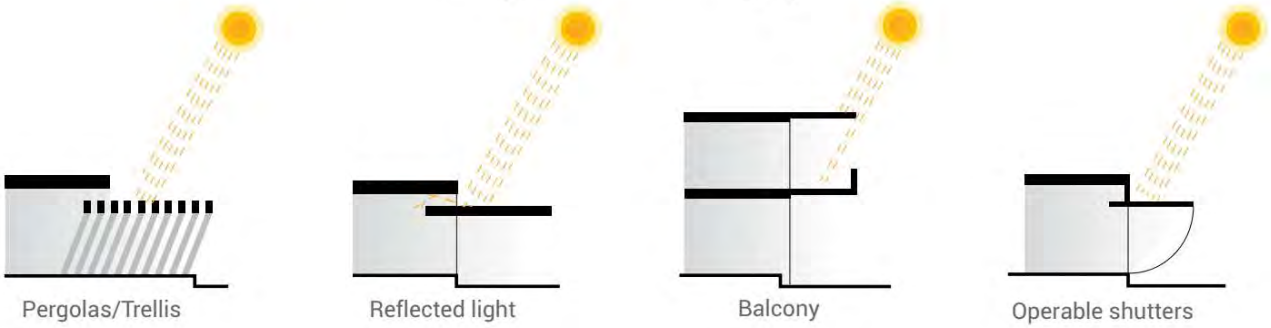
Placement of openings for effective cross-ventilation

Shading

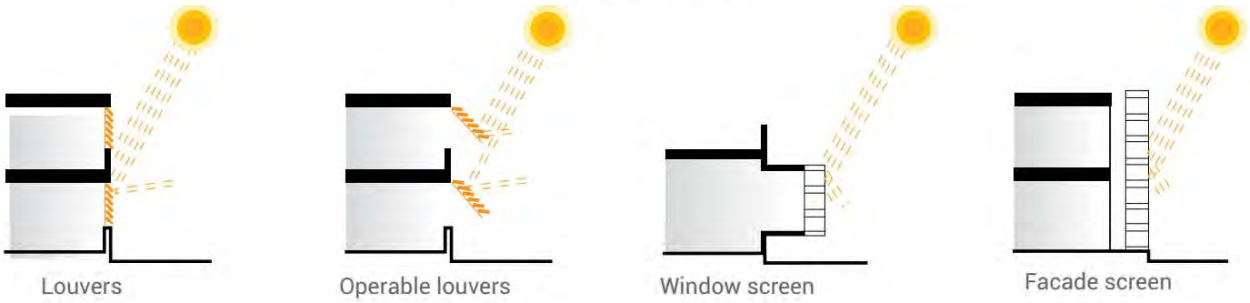
Shading devices are an effective means of cutting down on solar heat gain into the building and thereby reducing the external surface temperatures of the envelope which can easily reach up to 10% higher than ambient temperatures in hot climates.

Exterior shading devices can be provided in a variety of materials and designs, including sunshades, awnings, louvres, bamboo screens, '*jaali*'.

Different Types Of Over Hangings



Different Types Of Screens



Different Types Of Window Shadings

Awnings provide flexibility to span without need of extra support

Properly installed awnings can reduce heat gain by 65% from south and 77% from east

Adjustable louvers can control the sunlight entering into the building

Least cost solution for cutting heat gain into the building

Cool Walls

Walls share the maximum surface area of a building and plays an important role in heat gain of a building. During the day it absorbs the heat and radiates it inside the living space at night. This puts additional load on the cooling needs.

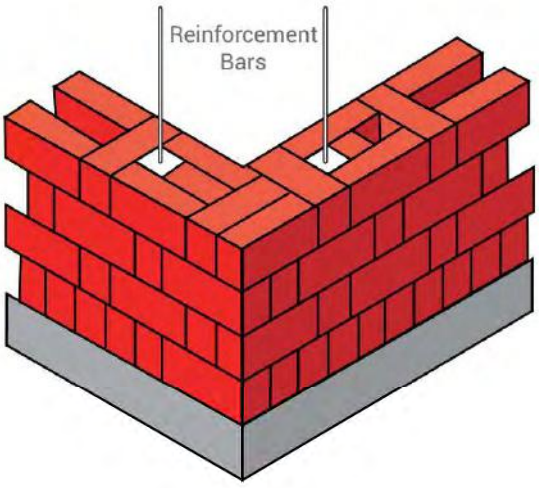
Several factors can be utilized to reduce energy consumption and improve thermal comfort. Design, techniques, material and finishes can together help in reducing the heat gain.

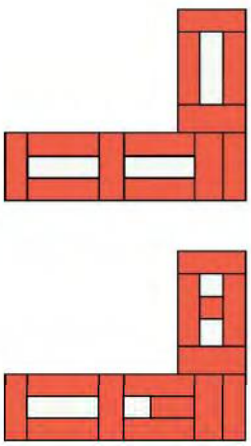
Hollow Walls

Creating cavities in walls by using different techniques and material have a noticeable impact on the heat gain of a building through walls.

Rat Trap Bond

Rat-trap bond is a masonry technique in which the bricks are laid in such a manner that a cavity is formed between two faces of the wall.

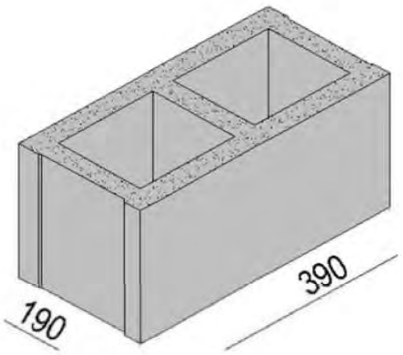


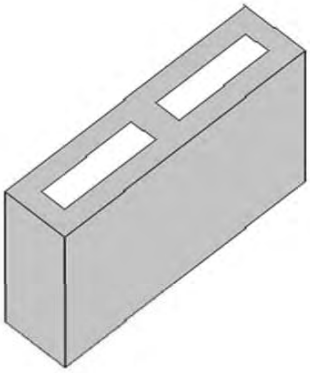


Cool Walls

Hollow Blocks

Hollow blocks are pre-casted concrete blocks designed with inbuilt cavity. They are bigger but lighter that brick masonry. Can also be customized as per requirement.

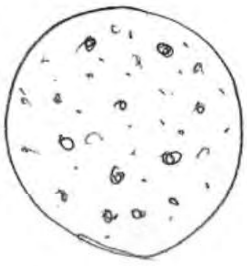




- Less time consuming
- Water Resistant
- Maintains room temperature and Sound proof
- Reduce the cost of materials in construction
- Not suitable for multi-stoyred/ load bearing structures

AAC Blocks

Autoclaved aerated concrete (AAC) is a lightweight, precast, foam concrete building material suitable for producing concrete masonry. Composed of quartz sand, calcined gypsum, lime, cement, water and aluminum powder.



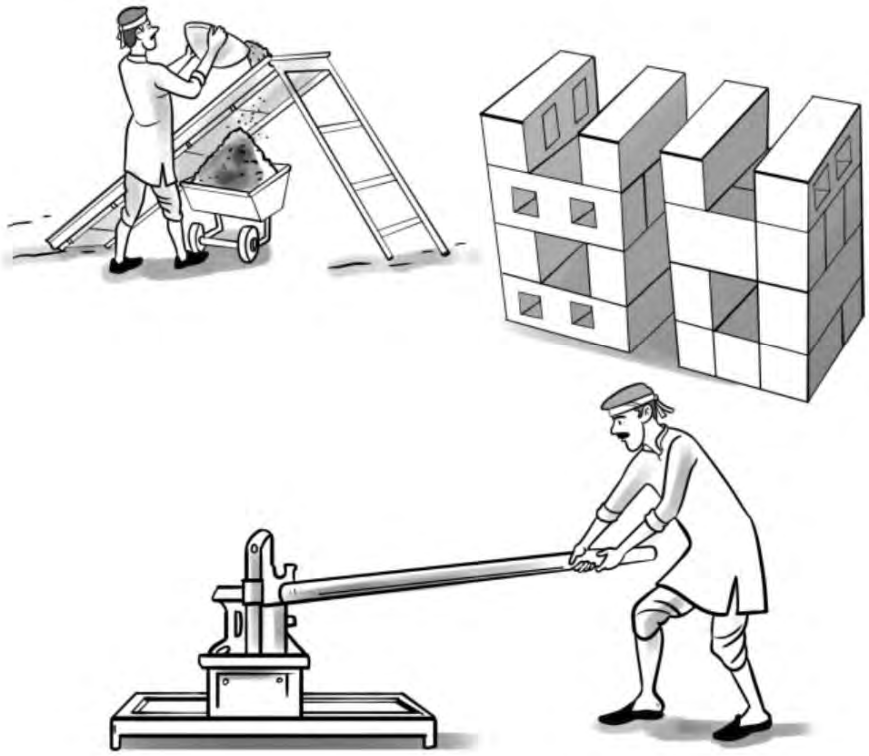
Air pockets makes it a better insulation material

- Less time consuming
- Water Resistant
- Maintains room temperature and Sound proof
- Reduce the cost of materials in construction
- Not suitable for multi-stoyred/ load bearing structures

Cool Walls

Compressed Stabilised Earth Blocks (CSEB)

Compressed Stabilised Earth Blocks (CSEB), commonly called, Pressed Earth Blocks, are construction material made using damp soil under high amount of pressure to form blocks. They are an eco-friendly alternate to conventional bricks.



Water Resistant

Maintains room temperature and Sound proof

Reduce the cost of materials in construction

Not suitable for multi-stoyred/ load bearing structures

Labor Intensive hence slightly expensive

Landscaping

Shading with trees (along with evaporation) can reduce the ambient temperature near outer walls by 2°C to 5°C. Landscaping helps shade south, east or west facing windows from summer heat gain.

Terrace Gardens

Terrace gardens reduce overall heat absorption of buildings and insulate the building against heat & cold. They provide shade by breaking the solar radiations, improves air quality and cools the surrounding air.

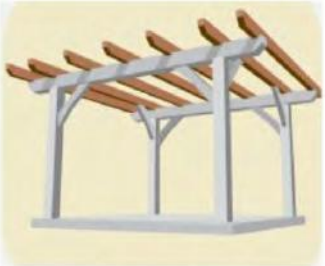
Vertical Green & Creepers

Vertical green has a multi-functional character. It provides shade, improves air quality, reduces building and internal temperatures by 2°C to 8°C.

Pergola & Trellis

Pergola not only defines a space but most important they provide shade there by reducing the direct impact of solar radiations resulting in heat gain and improving thermal comfort.

Vertical Green



Pergola

Trellis & Creepers

Maintenance

Buildings and material deteriorate with regular use and time. Timely maintenance not only increases the life of the material but also saves on to future costs.

Roof cooling techniques are surface based solutions which needs timely maintenance and extra care for its efficient and long-term functioning.

Clean the roof regularly with soft broom. Rainwater drains should be free of obstructions

Avoid keeping scrap & heavy items on roof

Do not drag on the surface

Timely repair the small damages

Benefits of Maintenance

Save unforeseen cost

Increases life of the building

Long-term thermal comfort

Annexure E

Vol. 259
No. 8

Thursday,
9th February, 2023
20 Magha, 1944 (Saka)

PARLIAMENTARY DEBATES

RAJYA SABHA

OFFICIAL REPORT (FLOOR VERSION)

(PART-II)

CONTENTS

DR. JITENDRA SINGH: Sir, the hon. Member's concern is well-taken but I would like to share with him that it is something which has been there right from the beginning. We have the Atomic Energy Regulatory Board, which is the overall umbrella, under the aegis of which the IREL also functions. Not only in this but also in other issues, which are required to be guarded or monitored, due exercise is done. In fact, I would rather solicit support or cooperation of the public representatives in this regard. At some of the places where we undertake a project, we see that undue apprehensions are created in the minds of the public. For example, we have a huge source of uranium in North Eastern State of Meghalaya but it got stuck. In Rawatbhata, we were about to put up a plant, but it has been stuck for the last two, three years. All the due caution is taken wherever this mining is done or even where the reactor is set up. These are only the apprehensions. Somebody says that there will be epidemic of cancers happening or something like that although we have provided studies to the contrary. We did a small in-house survey to see how many scientists working in Bhabha Atomic Research Centre died of cancer due to radiation. You will be surprised to know that there was none. There were two, three unnatural deaths and one or two deaths due to cancer which was not related to radiation. So, I think, it is the responsibility of all of us to allay these fears. In some of the countries, now the mining and reactors are being established even in the residential colonies or in their close vicinity.

MR. CHAIRMAN: Q.No.77.

Fees for OCI card scheme and its management

*77. SHRI MOHAMMED NADIMUL HAQUE: Will the Minister of EXTERNAL AFFAIRS be pleased to state:

(a) whether it is a fact that there has been misapplication of fees in the overseas citizenship of India (OCI) card scheme leading to a revenue loss of Rs.58.23 crores;
(b) if so, the details thereof and the reasons therefor;
(c) whether it is a fact that some financial irregularities have been reported in setting up of Indian Cultural Centres in Paris and Washington; and
(d) if so, the details thereof and the reasons therefor?

THE MINISTER OF EXTERNAL AFFAIRS (SHRI S. JAISHANKAR): (a) to (d) A statement is laid on the Table of the House.

Statement

(a) to (d) The Comptroller & Auditor General (CAG) of India is considered as an institution that is helpful in promoting good governance. Its findings are useful tools for all concerned, including the Ministry of External Affairs (MEA), to further improve its performance. On 20.12.2022, the CAG tabled Union Government (Civil) Compliance Audit Observation Report No. 24 of 2022 in Parliament. The Report contains audit findings arising from compliance audit of financial transactions under 54 grants relating to 28 Civil Ministries/Departments/ Constitutional Bodies of the Union Government under the general and social services sectors and central public enterprises.

The Report also has observations on fees for OCI card scheme and its management as well as setting up of Indian Cultural Centres in Paris and Washington. The property for Indian Cultural Centre at Paris was purchased in the year 2011 whereas in Washington, it was purchased in 2013. These properties have faced certain challenges in preparing them for their intended use after their purchase, including delay during Covid period.

As per existing guidelines on outstanding Audit paras, Action Taken Notes (ATN) on paragraphs mentioned in the CAG Report are to be furnished to the PAC through e-APMS Portal. The ATN in respect of OCI Fee and setting up of Indian Cultural Centre at Paris has been uploaded on 30.01.2023 and 08.02.2023, respectively.

SHRI MOHAMMED NADIMUL HAQUE: Sir, the Comptroller and Auditor General of India has pulled up the Ministry of External Affairs for revenue losses and improper financial management in a recently-released audit report. My question is: Does the Ministry have any planned compensation mechanism in order to recover the revenue losses of Rs. 58.23 crores occurred because of misapplication of fees in the OCI Card Scheme?

SHRI S. JAISHANKAR: Sir, I would like to inform the hon. Member, through you, that the Ministry of External Affairs extends a number of consular services like passports, visas, attestations, OCI, PIO, etc. Each of this is a charged service. Because these are rendered outside the country, there are rate of exchange issues which come up.

These are all services which came up at different points of time. So, instructions in each case were sent individually. Now, because whenever there is devaluation or revaluation, there is re-fixation of the rate of exchange. In 2017, instructions were sent regarding re-fixing of the rate of exchange. On the CAG paragraph, Sir, I want to say here my own experience of audit and of CAG. I believe they are a very essential part of good governance. They help us to look at imperfections in our process. So, CAG brought to our attention two sets of issues. One is related to the UK. In the case of the UK, there should have been, according to the CAG Report, a 23 per cent increase in the fees which was charged. But our Mission in the UK took the view at that point that this would have a very dampening effect on the tourism from the UK to India and, therefore, limited it to 10 per cent. So, they did it what they considered to be the right policy decision. In the particular case of 17 other Missions and Posts in Europe, they were under the assumption that the instructions were applied to visas and not to OCI. So, they did not make the necessary changes. When this matter came to our attention, before the matter was actually taken up by the CAG, we had issued instructions in 2020 to rectify the process. So, what we have tried to do is to put systemic checks because that is the nature of the CAG process. The CAG wants us to make corrections so that such a mistake does not happen again. So, we have instituted quarterly reporting which is monitored through the e-SamikSha process so that the rate of exchange on all services is monitored quarterly. Every month, the head of the consular wing is also required to report to the head of Mission or head of Post. And there is a mandatory revision every April so that whatever happens is not slipped up due to bureaucratic delay and there is a unified way of all services so that this kind of situation does not occur in future.

SHRI MOHAMMED NADIMUL HAQUE: Sir, there has been setting up of Indian Cultural Centers abroad. A Center was taken up in Washington DC at a cost of 5.75 million dollars in 2013, and in Paris, it was taken up in 2011, which is now encroached. In the answer, it has been given that these properties have faced certain challenges in preparing them for their intended use.

MR. CHAIRMAN: Your question, please.

SHRI MOHAMMED NADIMUL HAQUE: Sir, my question is: What is the plan of action and why has such a casual answer been given?

MR. CHAIRMAN: Hon. Member, the answer was very comprehensive. I am sure you will take note of it. And if there is an issue, you may discuss with the hon. Minister at mutual convenience.

SHRI MOHAMMED NADIMUL HAQUE: Sir, if I am allowed to ask, ...*(Interruptions)*...

MR. CHAIRMAN: No, please. ...*(Interruptions)*...

SHRI S. JAISHANKAR: Sir, in the case of the property in Washington, it was acquired in 2013, and in the case of the property in Paris, it was acquired in 2011. They were acquired for the purpose of cultural center. Typically, when properties are acquired, not built Greenfield, they need to be modified for use. That is the information which I was trying to convey to the hon. Member through my answer. There was a modification required to make it ready for use. Now in the case of Washington property, what happened was that after the acquisition of the property, a certain set of issues came up while the matter was being processed. There were waterproofing issues. There were asbestos concerns. There was conservation work which was recommended by the architect we were looking at. And in all of this, we also faced a problem that the General Financial Rules of the Government of India were at variance with the American practices. For example, our rules require us to take earnest money deposit, to seek a performance guarantee assurance bond, and to seek retention money. These are not American practices. So by the time we resolved this, we actually had two issues then which came up. One, the Americans made us an offer of additional land in Washington D.C. Then this raised the question whether we should go ahead with this project or whether we should be looking at the new land offer which we got in 2019. The second issue was COVID. Because of COVID, everything was at standstill for two and a half years. I would like to assure the Member that since we have a property, we are giving instructions for its usage by the Embassy, so that the Government asset is not rendered infructuous.

Now regarding the property in Paris, we had again some very peculiarly French problems. One was that the tendering practices in France are very different from us. They do not allow a general contractor who has overall supervision. They insisted that the tender had to be split up into 15 packages which were awarded to ten different companies. Unfortunately, Sir, one of the companies which was in charge of structures, partition, ceiling and facade went bankrupt. In our country, by our

procedures, we could have awarded that work to another contractor. In the French system, Sir, till the liquidation was done and the court of liquidation appointed another company to do that work, that company then raised the price and we had to follow the French practices. But I would like to assure the hon. Member that this project is 95 per cent done. There are challenges when we work abroad and we have to reconcile their practices with our rules. I think we have tried to do our best under the circumstances. I am sure when the CAG paragraph is examined, including by the PAC, these issues will be presented.

श्री राकेश सिन्हा : सभापति महोदय, मैं आपके माध्यम से माननीय मंत्री जी से यह जानना चाहता हूँ कि आदरणीय प्रधान मंत्री जी ने एक बहुत महत्वपूर्ण बात कही है, India is the oldest form of democracy. यद्यपि हम प्राइमरी लेवल किताब में पढ़ते थे, लेकिन पहली बार भारतीय राज्य ने इस नैरेटिव को एसर्टिव तरीके से रखा है, क्योंकि जब हम यूएस में देखते हैं, तो व्हाइट हाउस पर लिखा रहता है कि 'our founders looked at the oldest democracy, that is Greece.'

MR. CHAIRMAN: Your question.

SHRI RAKESH SINHA: This is unsettling the entire civilisational discourse. क्या माननीय मंत्री जी यह बताएँगे कि यह जो हमारा कल्चरल सेंटर है, वह विदेशों में डेमोक्रेसी के ऊपर डिस्कोर्स को महत्वपूर्ण विश्वविद्यालयों, जैसे हार्वर्ड, कैम्ब्रिज में शुरू करेगा?

SHRI S. JAISHANKAR: Sir, through you, I would like to inform the hon. Member that this matter has been discussed by us with the Indian Council for Cultural Relations. We have already initiated activities with various institutions abroad through our Cultural Centres to emphasise the message that India is the mother of democracy, that we have a pluralistic and consultative tradition which very few societies, if any at all can match, and this is very much a work in progress.

SHRI P. BHATTACHARYA: Sir, I would like to know this from the hon. Minister. You have said that in Paris and Washington, the Indian Cultural Centres are facing some sort of problems, etc. Besides Washington and Paris, in how many other countries do we have this type of cultural centres which are actively functioning and spreading Indian culture in other parts of the world?

SHRI S. JAISHANKAR: Sir, I do not have exact number readily with me but by memory, I would say that we have about 45 designated cultural centres. I would also like to inform the hon. Member that today every Embassy and every Consulate of

Annexure F

Chrysotile Asbestos

World Health Organization

Further information from WHO on chemicals of major public health concern, including asbestos, can be found at the following web address:

http://www.who.int/ipcs/assessment/public_health/chemicals_phc

Chrysotile Asbestos

World Health Organization

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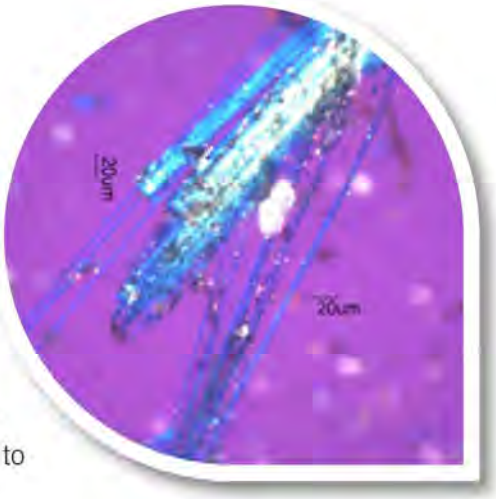
Foreword



Many countries have already taken action at a national level to prohibit the use of all forms of asbestos to limit exposure and so control, prevent and ultimately eliminate asbestos-related diseases, from which at least 107 000 people die each year globally. However, there are other countries that, for a range of reasons, have yet to act in the same manner. With that in mind, the prime intent of this publication is to assist Member States of the World Health Organization (WHO) in making informed decisions about management of the health risks attached to exposure to chrysotile asbestos.

The document is divided into three parts. The first part reproduces a WHO short information document for decision-makers on the elimination of asbestos-related diseases, updated in March 2014. The second part addresses questions commonly raised in policy discussions, specifically to assist decision-makers in coming to a view. The third part is a technical summary of the health effects of chrysotile, which brings together and summarizes for the first time the most recent authoritative WHO evaluations performed by its International Agency for Research on Cancer and its International Programme on Chemical Safety. The technical summary also reviews results from key studies published after those evaluations and then, briefly, the conclusions drawn from WHO assessments of alternatives.

I commend this publication to ministers, government officials and others who may wish or need to take decisions on, or provide advice related to, asbestos and in particular chrysotile asbestos and the health consequences of exposure.

Dr Maria Neira
Director, Department of Public Health, Environmental and Social Determinants of Health
World Health Organization, Geneva

World Health Organization

Elimination of asbestos-related diseases

Updated March 2014

Asbestos is one of the most important occupational carcinogens, causing about half of the deaths from occupational cancer *(1, 2)*. In 2003, the Thirteenth Session of the Joint International Labour Organization (ILO)/World Health Organization (WHO) Committee on Occupational Health recommended that special attention should be paid to the elimination of asbestos-related diseases *(3)*. World Health Assembly (WHA) Resolution 58.22 from 2005 on cancer prevention and control urged Member States to pay special attention to cancers for which avoidable exposure is a factor, particularly exposure to chemicals at the workplace and in the environment. In 2007, WHA Resolution 60.26 called for global campaigns to eliminate asbestos-related diseases, and in 2013, WHA Resolution 66.10 addressed prevention and control of noncommunicable diseases, including cancer.

Asbestos is one of the most important occupational carcinogens

The term "asbestos" designates a group of naturally occurring fibrous serpentine or amphibole minerals with current or historical commercial usefulness due to their extraordinary tensile strength, poor heat conduction and relative resistance to chemical attack. The principal varieties of asbestos are chrysotile, a serpentine material, and crocidolite, amosite, anthophyllite, tremolite and actinolite, which are amphiboles *(4)*.

Exposure to asbestos, including chrysotile, causes cancer of the lung, larynx and ovary, mesothelioma (a cancer of the pleural and peritoneal linings) and asbestosis (fibrosis of the lungs) *(5–7)*.

Exposure to asbestos and its impact on public health are substantial

Exposure to asbestos occurs through inhalation of fibres primarily from contaminated air in the working environment, as well as from ambient air in the vicinity of point sources or indoor air in housing and buildings containing friable asbestos materials. The highest levels of exposure occur during repackaging of asbestos containers, mixing with other raw materials and dry cutting of asbestos-containing products with abrasive tools. Exposure can also occur during installation and use of asbestos-containing products and maintenance of vehicles. Friable chrysotile- and/or amphibole-containing materials are still in place in many buildings and continue to give rise to exposure to both chrysotile and the amphiboles during maintenance, alteration, removal and demolition *(5)*. Exposure can also occur as a consequence of natural disasters causing damage to buildings.

Currently, about 125 million people in the world are exposed to asbestos at the workplace *(1)*. According to global estimates, at least 107 000 people die each year from

asbestos-related lung cancer, mesothelioma and asbestosis resulting from occupational exposures *(1, 2, 8)*. In addition, nearly 400 deaths have been attributed to non-occupational exposure to asbestos. The burden of asbestos-related diseases is still rising, even in countries that banned the use of asbestos in the early 1990s. Because of the long latency periods attached to the diseases in question, stopping the use of asbestos now will result in a decrease in the number of asbestos-related deaths only after a number of decades.

All types of asbestos cause cancer in humans

Asbestos (actinolite, amosite, anthophyllite, chrysotile, crocidolite and tremolite) has been classified by the International Agency for Research on Cancer as being carcinogenic to humans *(7)*. Exposure to chrysotile, amosite and anthophyllite and to mixtures containing crocidolite results in an increased risk of lung cancer *(7)*. Mesotheliomas have been observed after occupational exposure to crocidolite, amosite, tremolite and chrysotile, as well as among the general population living in the neighbourhood of asbestos factories and mines and in people living with asbestos workers *(7)*.

The incidence of asbestos-related diseases is related to fibre type, size and dose and to industrial processing of the asbestos *(6)*. No threshold has been identified for the carcinogenic risk of asbestos, including chrysotile *(5, 7)*. Cigarette smoking increases the risk of lung cancer from asbestos exposure *(5, 9)*.

At least 107 000 people die each year from asbestos-related lung cancer, mesothelioma and asbestosis resulting from occupational exposures

Chrysotile is still widely used

Asbestos has been used in thousands of products for a vast number of applications, such as roofing shingles, water supply lines, fire blankets and insulation materials, as well as clutches and brake linings, gaskets and pads for automobiles. As a result of increasing health concerns, the use of asbestos has declined in many countries. The use of crocidolite and products containing this fibre and spraying of all forms of asbestos are prohibited under the ILO Convention concerning Safety in the Use of Asbestos (No. 162) from 1986. However, chrysotile is still widely used, with approximately 90% being employed in asbestos cement building materials, the largest users of which are developing countries. Other remaining uses of chrysotile are in friction materials (7%), textiles and other applications *(10)*.

To date (end of 2013), more than 50 countries, including all member states of the European Union, have banned the use of all forms of asbestos, including chrysotile. Other countries have introduced less stringent restrictions. However, some countries have maintained or even increased their production or use of chrysotile in recent years *(11)*. Increased usage has been most prominent in the Asia-Pacific region. World production of asbestos in the period 2000–2012 was relatively stable, at approximately 2 million tonnes per annum *(12, 13)*.

WHO recommendations on prevention of asbestos-related diseases

Bearing in mind that there is no evidence for a threshold for the carcinogenic effect of asbestos, including chrysotile, and that increased cancer risks have been observed in populations exposed to very low levels *(5, 7)*, the most efficient way to eliminate asbestos-related diseases is to stop using all types of asbestos. Continued use of asbestos cement in the construction industry is a particular concern, because the workforce is large, it is difficult to control exposure, and in-place materials have the potential to deteriorate and pose a risk to those carrying out alterations, maintenance and demolition *(5)*. In its various applications, asbestos can be replaced by some fibre materials *(14)* and by other products that pose less or no risk to health.

Materials containing asbestos should be encapsulated, and, in general, it is not recommended to carry out work that is likely to disturb asbestos fibres. If necessary, such work should be carried out only under strict control measures to avoid exposure to asbestos, such as encapsulation, wet processes, local exhaust ventilation with filtration, and regular cleaning. It also requires the use of personal protective equipment – special respirators, safety goggles, protective gloves and clothing – and the provision of special facilities for their decontamination *(15)*.

WHO is committed to working with countries towards the elimination of asbestos-related diseases in the following strategic directions:

- by recognizing that the most efficient way to eliminate asbestos-related diseases is to stop the use of all types of asbestos;
- by providing information about solutions for replacing asbestos with safer substitutes and developing economic and technological mechanisms to stimulate its replacement;
- by taking measures to prevent exposure to asbestos in place and during asbestos removal (abatement);
- by improving early diagnosis, treatment and rehabilitation services for asbestos-related diseases and establishing registries of people with past and/or current exposure to asbestos.

WHO strongly recommends planning for and implementing these measures as part of a comprehensive national approach for the elimination of asbestos-related diseases. Such an approach should also include developing national profiles, awareness raising, capacity building, an institutional framework and a national plan of action for the elimination of asbestos-related diseases.

WHO will collaborate with ILO on implementation of the Resolution concerning asbestos, adopted by the Ninety-fifth Session of the International Labour Conference *(16)*, and will work with other intergovernmental organizations and civil society towards the elimination of asbestos-related diseases worldwide.

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Chrysotile in raw state

Commonly raised questions and answers

This section addresses questions commonly raised by policy-makers on the use of chrysotile.

Is it true that chrysotile is not really a form of asbestos?

No. Chrysotile is one of six forms of asbestos, the others being crocidolite, amosite, tremolite, actinolite and anthophyllite.

What is WHO's policy on asbestos?

WHO's policy on asbestos is unequivocal. Asbestos causes cancer of the lung, larynx and ovary, mesothelioma (a cancer of the pleural and peritoneal linings) and asbestosis (fibrosis of the lungs). Asbestos-related diseases can and should be prevented, and the most efficient way to prevent them is to stop the use of all forms of asbestos to prevent exposure. WHO's global campaigns to eliminate asbestos-related diseases aim to support countries in achieving that objective.

Why is WHO so concerned about asbestos?

There is clear scientific evidence that asbestos causes cancer and chronic respiratory diseases in humans. WHO is working to reduce the global burden of noncommunicable diseases, including cancer and chronic respiratory diseases, recognizing that primary prevention reduces health-care service costs and helps to ensure the sustainability of health expenditures. Worldwide, cancer is the second leading cause of death. In 2008, there were 7.6 million deaths from cancer, alongside 12.7 million new cases. Roughly 19% of all cancers are estimated to be attributable to the environment, including work settings.

Currently, about 125 million people in the world are exposed to asbestos at the workplace. According to WHO estimates, at least 107 000 people die each year from asbestos-related lung cancer, mesothelioma and asbestosis resulting from occupational exposures. Approximately half of all deaths from occupational cancer are estimated to be caused by asbestos.

With what authority does WHO speak on chrysotile and other forms of asbestos and their management?

WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends.

The World Health Assembly (WHA) is the supreme decision-making body for WHO; it meets annually and is composed of delegations from 194 Member States. The main function of WHA is to determine WHO policy.

WHO's policy on asbestos derives from three WHA resolutions: WHA 58.22 in 2005, WHA 60.26 in 2007 and WHA 66.10 in 2013. WHA 58.22 addresses cancers for which avoidable exposure to carcinogens is a factor in their causation, WHA 60.26 calls for global campaigns to eliminate asbestos-related diseases and WHA 66.10 deals with the prevention and control of noncommunicable diseases, including cancer.

How are people exposed to asbestos?

Exposure to asbestos occurs by inhalation and, to a lesser extent, ingestion during the mining and milling of asbestos and in the production and use of asbestos-containing products. This includes exposure from trimming and fitting of asbestos materials during building construction, maintenance and demolition. Asbestos is generally used or has been used as a fibrous mixture, bonded with other materials (e.g. cement, plastics and resins) or woven as a textile. The range of applications in which asbestos has been used is large and includes roofing, cement sheets for floors and walls, cement pipes (e.g. for supplying water), thermal and electrical insulation, including fire blankets and industrial fire curtains, gaskets and friction materials (e.g. vehicle brake shoes and brake pads and clutches). Today, exposure to asbestos fibres occurs particularly in circumstances where asbestos products have become degraded, such as during the course of building maintenance and demolition and the disposal of building waste, and also in the context of natural disasters.

There is clear scientific evidence that asbestos causes cancer and chronic respiratory diseases in humans

Why is it so important to tackle asbestos as a carcinogen when there are so many other carcinogens to be found in the environment?

Some cancers attributable to environmental factors are believed to have multiple carcinogenic determinants. Others, though, have as their causes single identifiable carcinogens, such as tobacco and asbestos, to which exposure is preventable. (Note: This is not the case for many of the other agents classified by the International Agency for Research on Cancer [IARC] as being in Group 1, carcinogenic to humans, and neither do many of them carry the same burden of disease.[1])

One of the reasons it is important that countries take action on asbestos as soon as possible is because of an unusually long latent period between exposure and the development of mesothelioma, often as long as 40 years. For this reason, the burden of asbestos-related diseases will continue to rise, for the moment, even in those countries that banned the use of asbestos many years ago.

All forms of asbestos cause cancer in humans (this includes chrysotile, the principal form of asbestos still in production and use), and no threshold has been identified for the carcinogenic risks. This is the conclusion of WHO and IARC in a series of authoritative international assessments conducted over a period of more than 15 years, the

[1] For details of IARC Group 1 carcinogens, see http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf.

most recent having been published by IARC in 2012. These conclusions reflect an international consensus of scientific experts convened by WHO to evaluate the health effects of asbestos.

In addition, it has been shown that co-exposure to tobacco smoke and asbestos fibres substantially increases the risk for lung cancer, and the effect is at least additive – that is, the heavier the smoking, the greater the risk.

Can we be certain that the scientific evaluations of asbestos by WHO and IARC are wholly independent of outside influence?

Yes. In every case, measures were taken to ensure that potential conflicts of interest were identified and addressed, that the assessments were extremely rigorous and independent of the views of governments, national institutions and special interest groups, and that they took account of opinions from all regions of the world and were subject to extensive international peer review.

What actions have been taken by countries at a national level?

Many countries have already legislated to prohibit the use of asbestos, with more than 50 WHO Member States now (end of 2013) having done so in order to protect and promote public health.[2] Typically, the decision was undertaken after cross-government consultation, to take account of sectoral interests but to avoid their over-predominance in the final decision. When considering taking legislative action against the use of asbestos, it has been necessary to take into account a range of costs and benefits, including the costs of providing health-care services and those associated with the loss of workforce productivity due to chronic ill-health, in addition to conventional economic and trade considerations.

What actions have been taken or are being proposed by countries at an international level?

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, which entered into force in 1992 and to which 181 countries are Parties, aims to protect human health and the environment against the adverse effects of hazardous wastes. Asbestos (dust and fibres) is listed as a category of controlled waste under the Convention. Parties to the Convention are required to prohibit or not permit the export of such waste to Parties that have prohibited its importation under the Convention.

[2] These include Algeria, Argentina, Australia, Bahrain, Brunei Darussalam, Chile, Egypt, the 28 member states of the European Union, Gabon, Honduras, Iceland, Israel, Japan, Jordan, Kuwait, Mozambique, Norway, Oman, Qatar, Republic of Korea, Saudi Arabia, Serbia, Seychelles, South Africa, Switzerland, Turkey and Uruguay. Asbestos is also banned in two states of Brazil, Rio de Janeiro and Rio Grande do Sul.

More recently, a majority of the 154 countries that are Parties to the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (which entered into force in 2004) have indicated a wish to see chrysotile listed under Annex 3 of the Convention. This would mean that chrysotile would become subject to a procedure whereby an informed decision of a country would be needed before consenting or not to future importation of the substance. However, to date, listing of chrysotile has been blocked by a small number of countries, predominantly but not exclusively by those with a continued interest in the trade in, and use of, chrysotile and chrysotile-containing products.

Is it true that chrysotile is less harmful than other types of asbestos and should not, therefore, be subject to the same control measures?

The scientific evidence is clear. The firm conclusion of the WHO and IARC assessments is that chrysotile causes cancer of the lung, larynx and ovary, mesothelioma and asbestosis, whether or not it is less potent than amphibole types of asbestos in doing so. Assertions about differing physicochemical properties, the question of whether or not historical epidemiological studies may have been dealing with chrysotile contaminated with amphibole types of asbestos, and the physical containment of chrysotile in modern high-density cement (at the time of manufacture) do not alter this finding.

The firm conclusion of the WHO and IARC assessments is that chrysotile causes cancer of the lung, larynx and ovary, mesothelioma and asbestosis

A major concern is that even where use is appropriately regulated, chrysotile-containing building products (e.g. roof tiling, water pipes) become damaged and release asbestos fibres into the environment during the course of building maintenance, demolition and disposal of building waste, and as a consequence of natural disasters. Such exposure may occur some time later than the original (controlled) installation. This risk can be wholly averted by ceasing to use such products. Information on substitute materials and products that can be used safely is available from national, regional and international organizations.

Could ongoing or future research into the toxicity of chrysotile change the current view of WHO and IARC regarding the occurrence of cancer?

Absolutely not. The firm view of WHO and IARC, based on repeated assessments of the scientific evidence, is that chrysotile causes cancer of the lung, larynx and ovary, mesothelioma and asbestosis, and that stopping the use of all forms of asbestos, including chrysotile, to prevent exposure should be recognized as the most effective way to eliminate asbestos-related diseases. Although the carcinogenic potential of chrysotile has been clearly identified, few studies have included women. There are also additional cancers suspected to be related to chrysotile, but for which existing studies are inadequate. There is therefore an ongoing need for further research to investigate the risks of chrysotile exposure for additional types of cancer, in particular for female-specific cancers.

What information is available on alternative products, especially as building materials, given assertions that modern fibre substitutes for chrysotile are either themselves toxic or of undetermined toxicity?

Many national governments, regional bodies and international organizations have identified alternatives and substitutes for the uses of asbestos, and human health evaluations of substitute materials have also been published. For example, a WHO/IARC workshop was convened in 2005, and there have been publications from the government of the United Kingdom, the European Commission and the WHO Regional Office for Europe. Evaluations of the human health hazard of chrysotile substitute materials have concentrated on alternative types of fibrous materials due to the potential risks associated with inhalation of fibres. However, it should also be noted that for some of its uses, chrysotile may be replaced by non-fibrous material – for example, unplasticized polyvinyl chloride (uPVC) and sheet metal.

Does an absence of reported cases of mesothelioma in a country indicate that there is no significant burden of disease resulting from asbestos and therefore no reason for action, given that mesothelioma is such a specific marker of asbestos exposure?

No. Detection of cases of mesothelioma and accurate measurement of their number require systematic surveillance systems at the national level, and these are frequently absent. It should also be borne in mind that the latent period between exposure to asbestos and the development of mesothelioma can be as long as 40 years or more, and such systems therefore need to be of long standing.

Asbestos is more likely to cause cancer of the lung than mesothelioma (estimated risk ratio 6:1), and the likelihood is greater in individuals who smoke tobacco. Cancer of the lung is much more common than mesothelioma and is multifactorial in origin. A history of prior exposure to asbestos (and this can include non-working environments, see below) many years previously may easily be overlooked. Current absence of evidence at a national level is not evidence of absence, and lessons learnt by other countries where large epidemics of mesothelioma are still occurring, even many years after widespread exposures have stopped, should be taken into account.

Is asbestos exposure only an occupational issue, with no or little risk to the population at large?

No. Many cases of mesothelioma have been described in wives and children of asbestos workers, as a result of domestic exposure (at least 376

cases), in white collar workers within the asbestos industry, and in individuals living in the vicinity of asbestos mines, as a result of air pollution; asbestosis has also been reported in the wives and children of asbestos workers. Cases of mesothelioma have been described in individuals exposed to naturally occurring asbestos or asbestos-like minerals in soil in regions in Turkey, Greece, Cyprus, Corsica, Sicily, New Caledonia, Yunnan province in China and California. Although the final group would not be protected by control measures on the production and use of asbestos, the other groups would be protected.

Other types of environmental exposure also occur. Reports from Australia and the United Kingdom have identified elevated concentrations of asbestos fibres in ambient air at busy traffic intersections from friction products in vehicles. Non-occupational exposures arise from home renovation and car maintenance activities. In addition to the occupational exposures of construction workers (because measures to control asbestos exposure are difficult to put in place for a large, fragmented workforce that may include many informal workers), there is also potential for non-occupational exposure to asbestos-containing building waste if the waste is not stored and disposed of correctly. This includes the potential for asbestos-containing building waste to be scavenged and reused in informal settlements.

The concern for policy-makers today is less in relation to occupational exposure within the mining and manufacture of asbestos products sectors and more in relation to the use of asbestos-containing materials within the construction industry. Concerns extend to occupational exposure during construction activities and inadvertent exposure of the wider population from degradation of building materials (e.g. broken corrugated asbestos roof tiles) and inappropriate disposal of building waste. The use of asbestos-containing building materials in the poorest communities, bringing families into close proximity to sources of exposure to chrysotile fibres, is of particular concern.

There is potential for non-occupational exposure to asbestos-containing building waste

Additional Information

Other WHO publications on asbestos

Title	Description	Website
Outline for the development of national programmes for elimination of asbestos-related diseases. International Labour Organization and World Health Organization; 2007	This document is intended to facilitate countries in establishing their national programmes for elimination of asbestos-related diseases. It also addresses countries' efforts to prevent asbestos-related diseases arising from exposure to the various forms of asbestos already in place and as a result of their use in the past. Available in English, French, Russian, Spanish, Arabic and Chinese.	http://www.who.int/occupational_health/publications/asbestosdoc/en/, accessed 11 March 2014
Asbestos – hazards and safe practices for clean up after earthquake. World Health Organization; 2008	This technical information note provides guidance on how to control the risks associated with asbestos during the clean-up and disposal of asbestos-containing waste from damaged and destroyed buildings following an earthquake or other natural disaster.	http://www.who.int/hac/crises/chn/asbestos/en/, accessed 11 March 2014

Published evaluations of substitute materials

Title	Description	Website
Review of substitutes for asbestos construction products by a WHO temporary advisor. In: National programmes for elimination of asbestos-related diseases: review and assessment. WHO Regional Office for Europe; 2012: Annex 4	A review of the availability and safety of asbestos substitute materials, prepared as a background document for a meeting on asbestos control in the WHO European Region by a WHO temporary advisor. Available in English and Russian.	http://www.euro.who.int/en/health-topics/environment-and-health/occupational-health/publications/2012/national-programmes-for-elimination-of-asbestos-related-diseases-review-and-assessment, accessed 11 March 2014
Opinion on chrysotile asbestos and candidate substitutes. Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE), European Commission; 1998	Evaluation of the risks to human health posed by three substitute fibres – cellulose fibres, polyvinyl alcohol fibres and *p*-aramid fibres – by an expert committee of the European Commission.	http://ec.europa.eu/health/scientific_committees/environmental_risks/opinions/sctee/sct_out17_en.htm, accessed 11 March 2014
Harrison et al. Comparative hazards of chrysotile asbestos and its substitutes: a European perspective. Environ Health Perspect. 1999;107:607–11	An evaluation of asbestos substitute materials prepared for the United Kingdom Health and Safety Commission (London, United Kingdom) and subsequently published in the scientific literature.	http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1566482/, accessed 11 March 2014

Technical summary of WHO evaluations of chrysotile

Introduction

This technical summary on the health effects of chrysotile summarizes the most recent authoritative World Health Organization (WHO) evaluations performed by its International Agency for Research on Cancer (IARC) and its International Programme on Chemical Safety (IPCS). Key studies published after these evaluations are also briefly reviewed. The purpose of this technical summary is to assist policy-makers in assessing the importance of undertakings to prevent the adverse health effects – cancer and lung fibrosis – associated with exposure to chrysotile.

WHO has conducted a number of evaluations of the health effects associated with exposure to chrysotile over the past 20 years *(1, 2)*. These evaluations have concluded that all forms of asbestos, including chrysotile, are carcinogenic to humans, causing mesothelioma and cancer of the lung, larynx and ovary. Chrysotile also causes non-malignant lung diseases, which result in deterioration of lung function (asbestosis). Many scientific studies linking domestic and environmental exposure to asbestos with adverse health effects have also been identified, alongside the large number of studies in occupational settings.

Most informative in the evaluation of the effects of chrysotile exposure in humans *(1)* have been the studies performed in chrysotile mines in Quebec, Canada (most recent cohort update) *(3)*, a chrysotile mine in Balangero, Italy *(4, 5)*, cohorts of textile workers in South Carolina *(6)* and North Carolina, United States of America (USA) *(7)*, and two cohorts of asbestos factory workers in China *(8, 9)*. More recently, studies on chrysotile miners *(10–12)* and chrysotile textile workers in China *(13–17)* and two meta-analyses *(18, 19)* have further consolidated the database. All types of asbestos cause asbestosis, mesothelioma and cancer of the lung, larynx and ovary *(1, 2)*. This text concentrates on cancer of the lung, mesothelioma and asbestosis, as these have been the principal areas of research until relatively recently.

"There is sufficient evidence in humans for the carcinogenicity of all forms of asbestos (chrysotile, crocidolite, amosite, tremolite, actinolite and anthophyllite). Asbestos causes mesothelioma and cancer of the lung, larynx and ovary." *(1)*

Chrysotile production, use and exposure

Production

Chrysotile has always been the main asbestos species mined; in the peak year of production (1979), chrysotile comprised more than 90% of all asbestos mined *(20)*. With the exception of small amounts (approximately 0.2 Mt annually, in 2007–2011) of amphibole asbestos mined in India, chrysotile is at present the only asbestos species mined. World production in 2012 was estimated to be 2 Mt, the main producers being the Russian Federation (1 Mt), China (0.44 Mt), Brazil (0.31 Mt) and Kazakhstan (0.24 Mt); production has stopped in Canada, which until 2011 was one of the main producers. Although world production has decreased considerably from its peak of 5.3 Mt in 1979, it has remained stable during the 2000s (2–2.2 Mt) *(21–23)*.

Use

Asbestos is used as a loose fibrous mixture, bonded with other materials (e.g. Portland cement, plastics and resins) or woven as a textile. The range of applications in which asbestos has been used includes roofing, thermal and electrical insulation, cement pipe and sheets, flooring, gaskets, friction materials (e.g. brake pads and shoes), coating and caulking compounds, plastics, textiles, paper, mastics, thread, fibre jointing and millboard *(1)*.

Organizations that track the usage of chrysotile globally report that all asbestos (including chrysotile) use had been prohibited in 32 countries by 2007, rising to approximately 50 countries by 2014 *(24)*. The form of prohibition in countries can vary (e.g. exemptions for limited, highly specialized engineering uses can be permitted),

which complicates the process of determining the status of a country at any given time. However, countries that have prohibited all widespread and large-scale uses of all types of asbestos (including chrysotile) include Algeria, Argentina, Australia, Bahrain, Brunei Darussalam, Chile, Egypt, the 28 member states of the European Union, Gabon, Honduras, Iceland, Israel, Japan, Jordan, Kuwait, Mozambique, Norway, Oman, Qatar, Republic of Korea, Saudi Arabia, Serbia, Seychelles, South Africa, Switzerland, Turkey and Uruguay. Asbestos is also banned in two states of Brazil, Rio de Janeiro and Rio Grande do Sul *(25)*.

Although asbestos has not been banned in the USA, consumption decreased from 668 000 t in 1970 to 359 000 t in 1980, 32 t in 1990, 1.1 t in 2000 and 1.0 t in 2010 *(22, 23)*. Consumption of asbestos (mainly chrysotile) was 143 000 t in the United Kingdom in 1976, decreasing to 10 000 t in 1995; as the use of asbestos is banned in the European Union, it is expected to be zero at present. France imported approximately 176 000 t of asbestos in 1976; imports stopped by 1996, when France banned asbestos use. In Germany, the use of asbestos amounted to approximately 175 000 t annually from 1965 to 1975 and came to an end in 1993. In Japan, asbestos consumption was approximately 320 000 t in 1988 and decreased steadily over the years to less than 5000 in 2005; asbestos use was banned in 2012 *(26)*. In Singapore, imports of raw asbestos (chrysotile only) decreased from 243 t in 1997 to 0 t in 2001 *(27)*. In the Philippines, the importation of raw asbestos was approximately 570 t in 1996 and 450 t in 2000 *(28)*. However, in some countries, such as Belarus, Bolivia (Plurinational State of), China, Ghana, India, Indonesia, Pakistan, Philippines, Sri Lanka and Viet Nam, the use of chrysotile increased between 2000 and 2010. In India, use increased from 145 000 t in 2000 to 462 000 t in 2010 *(21, 23)*; in Indonesia, the increase was from 45 045 t in 2001 to 121 548 t in 2011 *(29)*.

Non-occupational exposure

Non-occupational exposure, also loosely called environmental exposure, to asbestos may be due to domestic exposure (e.g. living in the same household with someone exposed to asbestos at work), air pollution from asbestos-related industries or the use of asbestos-containing friction materials, or naturally occurring asbestos minerals.

In studies of asbestos concentrations in outdoor air, chrysotile is the predominant fibre detected. Low levels of asbestos have been measured in outdoor air in rural locations (typical concentration, 10 fibres/m^3).[3] Typical concentrations are about 10-fold higher in urban locations and about 1000 times higher in close proximity to industrial sources of exposure. Elevated levels of chrysotile fibres have also been detected at busy traffic intersections, presumably from braking vehicles *(30)*. In indoor air (e.g. in homes, schools and other buildings), measured concentrations of asbestos are in the range of 30–6000 fibres/m^3 *(1)*.

[3] 1 fibre/m^3 = 1 × 10^{-6} fibres/mL; 1 fibre/mL = 1 × 10^6 fibres/m^3.

Elevated levels of chrysotile fibres have been detected at busy traffic intersections, presumably from braking vehicles

Occupational exposure

Exposure by inhalation and, to a lesser extent, ingestion occurs in the mining and milling of asbestos (or other minerals contaminated with asbestos), the manufacturing or use of products containing asbestos, and the construction, automotive and asbestos abatement industries (including the transport and disposal of asbestos-containing wastes) *(1)*. In estimates published in 1998, when most European Union countries had already banned the use of all asbestos, it was estimated that the proportion of the European Union workforce still exposed to asbestos (mainly chrysotile) in different economic subsectors (as defined by the United Nations) *(31)* was as follows: agriculture, 1.2%; mining, 10.2%; manufacturing, 0.59%; electrical, 1.7%; construction, 5.2%; trade, 0.3%; transport, 0.7%; finance, 0.016%; and services, 0.28% *(32, 33)*.

In 2004, it was estimated that 125 million people were exposed to asbestos (as stated above, mainly to chrysotile) at work *(34)*.

The National Institute for Occupational Safety and Health (NIOSH) in the USA estimated in 2002 that 44 000 miners and other mine workers may have been exposed to asbestos during the mining of asbestos and some mineral commodities in which asbestos may have been a potential contaminant. In 2008, the Occupational Safety and Health Administration (OSHA) in the USA estimated that 1.3 million employees in construction and general industry face significant asbestos exposure on the job *(1)*. In Europe, based on occupational exposure to known and suspected carcinogens collected during 1990–1993, the CAREX (CARcinogen EXposure) database estimates that a total of 1.2 million workers were exposed to asbestos in 41 industries in the (then 15) member states of the European Union. Over 96% of these workers were

employed in the following 15 industries: "construction", "personal and household services", "other mining", "agriculture", "wholesale and retail trade and restaurants and hotels", "food manufacturing", "land transport", "manufacture of industrial chemicals", "fishing", "electricity, gas and steam", "water transport", "manufacture of other chemical products", "manufacture of transport equipment", "sanitary and similar services" and "manufacture of machinery, except electrical" *(1)*. According to an unpublished report, in China, 120 000 workers of 31 asbestos mines come in direct contact with asbestos, and 1.2 million workers are involved in the production of chrysotile asbestos products *(35)*. Another unpublished report indicated that in 31 asbestos factories in China with 120 000 workers, all these workers could have come in contact with asbestos either directly or indirectly *(35)*. In India, approximately 100 000 workers in both organized and unorganized sectors were estimated to be exposed to asbestos directly, and 30 million construction workers were estimated to be subjected to asbestos dust on a daily basis *(36)*. The number of exposed workers in Brazil was estimated to be 300 000 *(25)*.

In Germany, there was a steady decline in asbestos exposure between 1950 and 1990; the 90th percentile of the fibre count was between 0.5 and 1 fibre/mL in textile, paper/seals, cement, brake pad and drilling/sawing activities in 1990 *(37)*.

In 2004, it was estimated that 125 million people were exposed to asbestos at work

In France, median asbestos concentrations were highest in the building (0.85 fibre/mL in 1986–1996 and 0.063 fibre/mL in 1997–2004), chemical industry (0.34 and 0.1 fibre/mL, respectively) and services (0.07 and 0.1 fibre/mL, respectively) sectors *(38)*.

In 1999, the median asbestos (almost exclusively chrysotile) fibre counts in the air, as measured by personal samplers, in a Chinese asbestos textile plant were 6.5, 12.6, 4.5, 2.8 and 0.1 fibre/mL in the raw material (opening), raw material (bagging), textile, rubber plate and asbestos cement sections of the plant; in 2002, the median asbestos fibre counts were 4.5, 8.6 and 1.5 fibres/mL in the raw material, textile and rubber plate parts of the plant *(15)*.

In 2006, the geometric mean asbestos fibre count in the air in the largest chrysotile mine in China was 29 fibres/mL, as estimated from gravimetric dust measurements. Available data indicated that up to 1995, dust concentrations had been 1.5–9 times higher *(11)*.

The geometric mean occupational exposures to asbestos fibres were 0.40, 1.70 and 6.70 fibres/mL in the construction, asbestos friction and asbestos textile industries in 1984 in the Republic of Korea; in 1996, the corresponding figures were 0.14, 0.55 and 1.87 fibres/mL *(39)*. Park and colleagues *(40)* analysed 2089 asbestos exposure data sets compiled from 1995 through 2006 from 84 occupational sites. Asbestos exposure levels decreased from 0.92 fibre/mL in 1996 to 0.06 fibre/mL in 1999, possibly in part because of enforcement of 1997 legislation banning the use of amosite and crocidolite. During the periods 2001–2003 and 2004–2006, mean asbestos exposure levels declined further to 0.05 and 0.03 fibre/mL, respectively. The mean concentration in the major primary asbestos production plants was 0.31 fibre/mL, and in the secondary asbestos industries (handlers and end uses of asbestos-containing

materials), 0.05 fibre/mL. In particular, a substantial reduction in asbestos exposure levels was evident among primary industries handling raw asbestos directly. In this industry, exposure dropped from 0.78 fibre/mL (period 1995–1997) to 0.02 fibre/mL (period 2003–2006).

In Thailand, breathing zone asbestos concentrations in 1987 in roof tile, cement pipe, vinyl floor tile, asphalt undercoat and acrylic paint plants and in brake and clutch shops were < 1.11, 0.12–2.13, < 0.18, < 0.06 and 0.01–58.46 fibres/mL, respectively. The brake and clutch shops were small-scale enterprises, in contrast to the others; they had high asbestos air concentrations also in 2000 (0.24–43.31 and 0.62–2.41 fibres/mL for the brake and clutch shops, respectively) *(41)*.

The occupational exposure limit for chrysotile has been lowered in the USA since the 1970s: from 12 fibres/mL in 1971 to 5 fibres/mL in 1972, 2 fibres/mL in 1976, 0.2 fibre/mL in 1986 and 0.1 fibre/mL in 1994 *(42)*. The occupational exposure limit for all asbestos species is also 0.1 fibre/mL in the Bolivarian Republic of Venezuela *(43)*, the European Union *(44)*, India *(36)*, Indonesia *(45)*, Malaysia *(46)*, Norway *(47)*, the Republic of Korea *(39)*, Singapore *(27)* and the provinces of Alberta and British Columbia in Canada *(48)*. Other occupational exposure limits for all asbestos fibres include 0.01 fibre/mL in the Netherlands *(49)*; 0.15 fibre/mL in Japan *(26)*; 0.2 fibre/mL in South Africa *(50)*; 0.8 fibre/mL in China *(11, 35)*; and 2 fibres/mL in Brazil *(48)* and the Philippines *(28)*. In Thailand, the labour law sets the limit for airborne asbestos at 5 fibres/mL *(41, 45)*. In Canada, the occupational exposure limit for chrysotile is 1 fibre/mL *(51)*.

Health effects

The key studies on the main health end-points associated with exposure to chrysotile have been summarized in Table 1 (see page 39).

Cancer of the lung

Studies in experimental animals

Bronchial carcinomas were observed in many experiments in rats after inhalation exposure to chrysotile fibres. There was no consistent increase in tumour incidence at other sites (except mesothelioma, see below) *(1)*.

Studies in humans

Occupational exposure

In the final report on male workers in chrysotile mines in Quebec, Canada *(3)*, there was an exposure-related increase in mortality from lung cancer, reaching a standardized mortality ratio (SMR) of 2.97 (95% confidence interval [CI]: 2.18–3.95) in the most heavily exposed group. There was little difference between workers in the Asbestos and Thetford Mines areas of Quebec; in the latter area, the chrysotile was (to a small extent) contaminated with tremolite.

An elevated mortality from lung cancer (SMR: 1.49; 95% CI: 1.17–1.87) was observed in a cohort of chrysotile friction product plant workers in Connecticut, USA. Some anthophyllite was used in some product lines during the last 20 years of the follow-up *(52)*.

The risk of lung cancer was greatly increased among asbestos textile workers, mainly exposed to chrysotile, who received compensation for work-induced asbestosis in Italy (SMR: 6.82; 95% CI: 3.12–12.95). There was no quantitative estimation of what the exposure to "mainly chrysotile" represented *(53)*.

Among workers with at least 1 year's work experience between 1946 and 1987 in a chrysotile mine in Balangero, northern Italy, the lung cancer SMR was 1.27 (95% CI: 0.93–1.70) during the follow-up to 2003 *(5)*. No fibrous amphiboles were found, but 0.2–0.5% of a fibrous silicate, balangeroite, was identified in the chrysotile mined *(54)*.

Among workers of eight chrysotile asbestos factories in China with at least 15 years of work experience and followed from 1972 to 1986, the mortality from lung cancer was elevated (relative risk [RR]: 5.3; 95% CI: 2.5–7.1). The lung cancer risk was especially high among heavy smokers (chrysotile-exposed non-smokers: RR: 3.8 [95% CI: 2.1–6.3]; chrysotile-exposed light smokers: RR: 11.3 [95% CI: 4.3–30.2]; chrysotile-exposed medium smokers: RR: 13.7 [95% CI: 6.9–24.6]; chrysotile-exposed heavy smokers: RR: 17.8 [95% CI: 9.2–31.3]) *(8)*.

In a study in an asbestos textile plant in South Carolina, USA, the exposure was almost exclusively to chrysotile (part of the time, approximately 0.03% of the total amount of fibre used was crocidolite, which was never carded, spun or twisted and was woven wet). The lung cancer SMR was 1.95, with a 95% CI of 1.68–2.24. Exposure–response modelling for lung cancer, using a linear relative risk model, produced a slope coefficient of 0.0198 fibre-years/mL[4] (standard error 0.004 96) when cumulative exposure was lagged 10 years *(6)*.

Elevated mortality from lung cancer has been observed in chrysotile mine workers, chrysotile friction product plant workers and textile mill workers exposed to chrysotile

In a cohort study in four asbestos textile mills in North Carolina, USA, workers with at least 1 day's work between 1950 and 1973 were followed for mortality to 2003. In one of the plants, a small amount of amosite was used between 1963 and 1976, whereas the others used exclusively chrysotile *(7)*. In subsequent analysis of fibres from North Carolina and South Carolina by transmission electron microscopy, 0.04% of the fibres were identified as amphiboles *(55)*. Lung cancer mortality was elevated in an exposure-related fashion and reached an SMR of 2.50 (95% CI: 1.60–3.72) in the high-exposure category. The risk of lung cancer increased with cumulative fibre exposure (rate ratio: 1.102 per 100 fibre-years/mL, 95% CI: 1.044–1.164, for total career exposure) *(7)*.

Non-occupational exposure

There are few studies on lung cancer in people with non-occupational exposure to asbestos and even fewer in which chrysotile specifically has been investigated.

In a cohort of 1964 wives (not working in the asbestos mills) of asbestos cement workers in Casale Monferrato, Italy, the risk of dying from lung cancer was slightly elevated (SMR: 1.50; 95% CI: 0.55–3.26). The asbestos used was mainly chrysotile, but included approximately 10% crocidolite *(56)*. A slightly elevated lung cancer risk was observed among spouses of workers in an amosite factory in New Jersey, USA (SMR for male spouses of workers with more than 20 years of exposure, 1.97 [95% CI: 1.12–3.44], and for female spouses of workers with more than 20 years of exposure, 1.70 [95% CI: 0.73–3.36]) *(57)*.

[4] Cumulative exposure is expressed in units of (fibres/mL) × years. These units are given hereafter as fibre-years/mL.

Meta-analyses

In an informal meta-analysis of 13 studies with dose–response information available in 1986, WHO estimated the risk of lung cancer and mesothelioma in asbestos-exposed smokers and non-smokers *(58)*. Most of these studies have since been updated, new studies have become available and formal meta-analyses of studies on lung cancer among chrysotile-exposed workers have been performed, with the main aim to investigate the carcinogenic potency of chrysotile, especially in comparison with that of amphibole asbestos species. Another objective of the meta-analyses has been the elucidation of possible differences in the carcinogenic potency of fibres of different dimensions (i.e. length and thickness).

Lash et al. *(59)* conducted a meta-analysis based on the findings from 22 published studies on 15 asbestos-exposed cohorts with quantitative information on asbestos exposure and lung cancer mortality. Substantial heterogeneity was found in the slopes for lung cancer between these studies. The heterogeneity was largely explained by industry category (mining and milling, cement and cement products, or manufacturing and textile products), considered to reflect the stages of asbestos fibre refinement, dose measurements, tobacco habits and standardization procedures. There was no evidence that differences in fibre type (predominantly chrysotile, chrysotile mixed with other, or other) would explain the heterogeneity of the slope – in other words, there was no difference in the potency to cause lung cancer between the different fibre types.

Hodgson & Darnton *(60)* performed a meta-analysis based on 17 cohort studies with information on the level of asbestos exposure. Marked heterogeneity was observed in the potency slope derived from different chrysotile-exposed cohorts; the risk estimated from the South Carolina, USA, asbestos textile plants (approximately 6% per fibre-year/mL) was similar to the average in the amosite-exposed cohorts (5% per fibre-year/mL), whereas that from the Quebec, Canada, mine studies was only 0.06% per fibre-year/mL, and the studies in asbestos cement and friction product plants were intermediate in risk. Hodgson & Darnton *(60)* decided to exclude the South Carolina study from the calculation, mainly because the risk derived for the cohorts with mixed exposure (chrysotile + amphibole) was approximately 10% of that with pure amphibole exposures, and concluded that the potency of chrysotile to cause lung cancer was 2–10% of that of the amphiboles. Their "best estimate" for excess lung cancer from exposure to pure chrysotile was 0.1% per fibre-year/mL. However, the IARC Working Group *(1)* noted that there is no justification for exclusion of the South Carolina cohort, because it is one of the highest-quality studies in terms of the exposure information used in the study. An alternative explanation of the large difference in the risk estimates from the mining studies and the asbestos textile studies (also observed in the meta-analysis of Lash et al. *(59)*) could be the differences in fibre dimensions: a larger percentage of long fibres was found in samples from the South Carolina cohort *(61)* compared with what was previously reported in samples from the Quebec mines and mills *(62)*. A further possible cause of the difference is the difference in the quality of the exposure data *(18)*.

Berman & Crump *(63, 64)* published a meta-analysis that included data from 15 asbestos cohort studies. Lung cancer risk potency factors, based on a linear exposure–cancer risk relationship, were derived for fibre type (chrysotile versus amphiboles) and fibre size (length and width).

As with the previous analyses, substantial variation was found in these studies, with results for lung cancer varying by 2 orders of magnitude. The slope factor for chrysotile was 0.000 29 (fibre-year/mL)$^{-1}$ for Quebec mining and 0.018 (fibre-year/mL)$^{-1}$ for the South Carolina textile workers. That for tremolite (vermiculite mines and milling operations in Libby, Montana, USA) was 0.0026 (fibre-year/mL)$^{-1}$, with an upper uncertainty level of 0.03 (fibre-year/mL)$^{-1}$, and that for amosite insulation, 0.024 (fibre-year/mL)$^{-1}$ *(64)*.

In a further analysis of the fibre dimensions, the hypothesis that long chrysotile fibres are equipotent to long amphibole fibres was rejected for thin fibres (width < 0.2 µm), but not for fibres of all widths or for thick fibres (width > 0.2 µm). When the South Carolina cohort was dropped in a sensitivity analysis, the potency in the remaining studies in the meta-analysis was significantly greater for amphiboles than for chrysotile ($P = 0.005$). Dropping the Quebec cohort resulted in there being no evidence of a significant difference in potency between the fibre types ($P = 0.51$) *(63)*.

It is not possible to draw firm conclusions concerning the relative potency of chrysotile and amphibole asbestos fibres

The IARC Working Group *(1)* noted that both the Hodgson & Darnton *(60)* and Berman & Crump *(63, 64)* analyses reveal a large degree of heterogeneity in the study findings for lung cancer and that findings are highly sensitive to the inclusion or exclusion of the studies from South Carolina or Quebec. The reasons for the heterogeneity are unknown; until they are explained, it is not possible to draw firm conclusions concerning the relative potency of chrysotile and amphibole asbestos fibres.

IARC conclusions on cancer of the lung

In respect of cancer of the lung, IARC concluded that there is *sufficient evidence* of carcinogenicity in humans for all types of asbestos, including chrysotile. This is the strongest IARC category for describing the strength of evidence *(1)*.

Key new studies

Hodgson & Darnton *(65)* updated their meta-analysis of the lung cancer and mesothelioma risks from exposure to different asbestos species following the publication of data for the North Carolina, USA, chrysotile textile workers and noted that their original "best estimate", 0.1% per fibre-year/mL, was practically identical to the estimate from the North Carolina cohort (RR: 1.102 per 100 fibre-years/mL).

In a cohort study in the largest chrysotile mine in Quinghai, China, all male workers (n = 1539) employed at the beginning of 1981 were followed until the end of 2006. Mortality from different causes was compared with the national rates. Using a method with a sensitivity of 0.001%, no amphiboles were detected in the ore. The fibre exposure (estimated from gravimetric dust measurements in 2006) was 2.9–63.8 fibres/mL. The SMR for lung cancer was 4.71 (95% CI: 3.57–6.21). The SMR for the non-smoking chrysotile-exposed workers (miners and millers) was 1.79 (95% CI: 0.49–6.51), and that for the non-smoking referents (rear services and administration), 1.05 (95% CI: 0.19–5.96). For the smoking miners/millers, the SMR was 5.45 (95% CI: 4.11–7.22), and for the smoking referents, 1.66 (95% CI: 0.71–3.88) *(11)*. Lung cancer mortality increased with increasing estimated fibre exposure, and the SMR was 1.10 (95% CI: 0.47–2.28), 4.41 (95% CI: 2.52–7.71), 10.88 (95% CI: 6.70–17.68) and 18.69 (95% CI: 12.10–28.87) in the groups with estimated cumulative exposures of < 20, 20–100, > 100–450 and > 450 fibre-years/mL, respectively *(12)*. In an overlapping study of all 1932 workers employed for at least half a year between 1981 and 1988 and followed until 2010, the lung cancer SMR among the group considered directly exposed was 2.50 (95% CI: 1.85–3.24) *(10)*.

In the largest chrysotile factory in China, situated in Chongqing, in a follow-up of 584 male workers for 37 years, the SMR for lung cancer was 4.08 (95% CI: 3.12–5.33) *(14, 15)*. The risk increased with estimated exposure and was seen in both non-smokers and smokers. In females ($n = 277$), with a total employment time of only 19 years, a statistically non-significant excess of lung cancer was observed (SMR: 1.23; 95% CI: 0.34–4.50). The chrysotile used in the factory was from a single source in China, and the content of tremolite was less than 0.001% *(66)*. An RR of 1.23 (95% CI: 1.10–1.38) per 100 fibre-years/mL was estimated by fitting a log-linear model with a 10-year exposure lag *(67)*.

In 2011, Lenters and co-workers *(18)* analysed the association of the quality of exposure assessment with the estimated lung cancer potency of asbestos exposure in a meta-analysis of 18 industrial cohorts and 1 population-based case–referent study. Stratification by exposure assessment characteristics revealed that studies with well documented exposure assessment, larger contrast in exposure, greater coverage of the exposure history by exposure measurement data and more complete job histories had higher potency slope values than did studies without these characteristics. Differences in potency for chrysotile compared with amphibole asbestos were less evident when the meta-analysis was restricted to studies with higher-quality exposure data *(18)*.

In order to better evaluate the carcinogenic potency of asbestos fibres at low exposure levels, van der Bij and collaborators *(19)* applied, in addition to linear dose–exposure models, a spline function to the lung cancer and exposure data from the studies with no fewer than two risk estimates at different exposure levels. The spline function has the advantage that responses at high exposures do not excessively determine the dose–response relationships at low exposure levels. They found that in exposure to chrysotile alone, the relative lung cancer risks at lifetime exposures to 4 and 40 fibre-years/mL were 1.006 and 1.064, respectively (natural spline function with correction for intercept). After stratification by fibre type, a non-significant 3- to 4-fold difference in RRs between chrysotile and amphibole fibres was found for exposures below

40 fibre-years/mL. The difference in potency between chrysotile and amphiboles thus was considerably smaller than in the earlier analyses *(60, 63)*. As in the other meta-analyses, risk estimates for chrysotile were very different for the South Carolina, USA, and Quebec, Canada, studies.

Kumagai and coworkers *(68)* assessed the relationship between lung cancer mortality and asbestos exposure in the vicinity of an asbestos factory, based on meteorological modelling of the town of Hashima, Japan, where an amosite–chrysotile plant operated in 1943–1991. Excluding individuals with occupational exposure to asbestos or silica, lung cancer risk was elevated among those with highest estimated environmental asbestos exposure (SMR: 3.5; 95% CI: 1.52–5.47).

Malignant mesothelioma has been linked to occupational, domestic and environmental exposure to asbestos

The standardized incidence ratio (SIR) for lung cancer during a 10-year period in 15 villages in Turkey with environmental asbestos exposure was 1.82 (95% CI: 1.42–2.22) in men and 1.80 (95% CI: 1.43–2.00) in women, in comparison with 12 villages with no asbestos exposure. The estimated lifetime asbestos exposure range was 0.19–4.61 fibre-years/mL; the fibre type was either tremolite or a mixture of tremolite + actinolite + chrysotile or anthophyllite + chrysotile. Lung cancer risk was elevated in both non-smokers (SIR: 6.87; 95% CI: 3.58–13.20) and smokers (SIR: 12.50; 95% CI: 7.54–20.74) *(69)*.

Mesothelioma

Studies in experimental animals

After intrapleural or intraperitoneal injection of chrysotile, mesothelioma induction was consistently observed in rats, when samples contained a sufficient number of fibres with a fibre length of greater than 5 µm. In several studies in rats, mesotheliomas were also observed after inhalation exposure to chrysotile *(1)*.

Studies in humans

Occupational exposure

An excess of mesothelioma has been reported in cohort studies of chrysotile-exposed miners and millers (38 cases out of a total of 6161 deaths) in Quebec, Canada *(3)*, and of asbestos textile workers (3 cases out of 1961 deaths) in South Carolina, USA, who were predominantly exposed to chrysotile asbestos imported from Quebec *(6)*. However, the fact that chrysotile mined in Quebec is contaminated with a small percentage (< 1%) of amphibole asbestos (tremolite) complicates the interpretation of these findings. McDonald et al. *(70)* found that in the Quebec mining areas, the mortality from mesothelioma was 3 times higher among workers from mines in Thetford Mines, a region with higher concentrations of tremolite, than among those from mines in Asbestos, with lower concentrations of tremolite. However, Begin et al. *(71)* noted that although tremolite levels may be 7.5 times higher in Thetford Mines than in Asbestos, the rate of mesothelioma in the asbestos mine/mill workforce of these two towns was similar. This does not support the notion that the tremolite content of the ores is the determinant of mesothelioma risk in Quebec chrysotile workers.

No cases of mesothelioma among the total of 803 deaths were observed in the Connecticut, USA, friction material plant workers exposed to chrysotile *(52)*.

There were two cases of malignant pleural tumours among asbestos textile workers who received compensation for work-induced asbestosis in Italy; this represents a greatly increased risk (SMR: 22.86; 95% CI: 2.78–82.57). There was a more pronounced increase in the risk of peritoneal tumours. The exposure was described as "mainly chrysotile", but no quantitative data on the exposure were provided *(53)*.

Among 126 cases of mesothelioma identified in six referral hospitals in South Africa, 23 cases had mined Cape crocidolite; 3 had mined amosite; and 3, crocidolite plus amosite. None had purely chrysotile exposure *(72)*. It should be noted that chrysotile mining began later, and production levels were lower than in the crocidolite and amosite mines of South Africa.

Cases of mesothelioma have been reported among asbestos miners in Zimbabwe *(73)*. Chrysotile from Zimbabwe has been reported to contain 3 orders of magnitude less tremolite than that from Thetford Mines, Quebec *(74)*.

Asbestos textile workers in North Carolina, USA, were primarily exposed to chrysotile imported from Quebec, Canada. Large excesses of both mesothelioma (SMR: 10.92; 95% CI: 2.98–27.96) and pleural cancer (SMR: 12.43; 95% CI: 3.39–31.83) were observed *(7)*.

Two cases of mesothelioma were observed in the 1990 study in the Balangero, Italy, chrysotile mine *(54)*. However, in a follow-up until 2003, four pleural and one abdominal mesothelioma were identified, giving SMRs of 4.67 (95% CI: 1.27–11.96) for pleural mesothelioma and 3.16 (95% CI: 1.02–7.36) for all mesothelioma *(5)*.

Non-occupational exposure

Since the first large case-series published by Wagner and co-workers *(75)* linking malignant mesothelioma to occupational, domestic and environmental exposure to asbestos, at least 376 cases of mesothelioma for which domestic exposure to asbestos has been considered the causative agent have been published in some 60 scientific papers *(76)*.

Three cases of mesothelioma were identified in 1980–2006 from the mesothelioma registry in Piedmont, northern Italy, among white collar workers of the Balangero chrysotile mine, three among employees of a subcontractor working as lorry drivers in the mine, four among persons living in the vicinity of the mine, one the wife of a mine worker and five cases who had had contact with the main tailings *(4)*. No fibrous amphiboles were found, but 0.2–0.5% of a fibrous silicate, balangeroite, was identified in the chrysotile mined in Balangero *(54)*.

In a cohort of 1780 wives (not working in the asbestos mills) of asbestos cement workers in Casale Monferrato, Italy, the risk of dying from malignant pleural tumours was elevated in 1965–2003 (SMR: 18.00; 95% CI: 11.14–27.52). The asbestos used was mainly chrysotile, but included approximately 10% crocidolite *(56, 77)*. The incidence of histologically verified pleural mesothelioma in 1999–2001 was also elevated in a roughly latency- and exposure duration–dependent way, reaching an SIR of 50.59 (95% CI: 13.78–129.53) in the group with a latency of at least 40 years and duration of exposure of at least 20 years.

In a population-based case–referent study in a local health area of Casale Monferrato, Italy, the association between non-occupational asbestos exposure and malignant mesothelioma was examined for 116 cases of mesothelioma diagnosed in 1987–1993 and 330 referents. The odds ratio (OR) for the cases to be a spouse of an asbestos worker was 4.5 (95% CI: 1.8–11.1); the OR for the cases to be a child of an asbestos worker was 7.4 (95% CI: 1.9–28.1). The risk was inversely related to the distance between the residence and the asbestos factory, reaching an OR of 27.7 (95% CI: 3.1–247.7) for those ever living less than 500 m from the factory. In 1984, the average asbestos concentrations in the air were reported to be 0.011 fibre/mL close to the plant and 0.001 fibre/mL in the residential area. In different studies, the proportion of amphiboles varied between 3% and 50% of total asbestos fibres *(78)*.

Of the 162 female cases of fatal mesothelioma in Canada and the USA in 1966–1972, three occurred in wives of workers in Quebec chrysotile mines *(79)*. In a case–referent study among wives of workers in Quebec chrysotile mines, the risk of living with a mine worker for less than 40 years was associated with a mesothelioma risk of 3.9 (95% CI: 0.4–35); the risk of living with a mine worker for more than 40 years was associated with a risk of 7.5 (95% CI: 0.8–72). All cases had lived with a worker from the mine in Thetford Mines, where the chrysotile ore was contaminated with tremolite *(80)*.

In several countries or regions in different parts of the world – Turkey, Greece, Cyprus, Corsica, Sicily, New Caledonia, Yunnan province, China, and California, USA – there are areas with a high incidence of mesothelioma, apparently caused by asbestos or erionite in soil *(1, 81)*.

In a case–referent study of 1133 mesothelioma cases and 890 referents in California, the risk of mesothelioma was observed to be inversely related to the distance of the residence from naturally occurring asbestos ultramafic rocks, which contain serpentinic asbestos. The mesothelioma risk decreased with an SMR of 0.937 (95% CI:

0.895–0.982) per 10 km of distance, adjusted for age and probability of occupational asbestos exposure *(82)*.

In a case–referent study of 68 cases of mesothelioma in New Caledonia, the prevalence of mesothelioma in different parts of the island was related to the serpentinite content of the soil, not to mining activity or the use of the traditional lime, "pö", to cover houses *(83)*.

Meta-analyses

From a meta-analysis of cohort studies with quantitative information on exposure, Hodgson & Darnton *(60)* estimated that the excess mesothelioma risk was 0.1% per fibre-year/mL for cohorts exposed to chrysotile.

The meta-analysis conducted by Berman & Crump *(64)* was based on the analysis of the slopes that were estimated assuming that the mortality rate from mesothelioma increases after exposure ceases approximately as the square of time since first exposure (lagged 10 years). The slope factor, indicating potency, was estimated to be 0.15×10^{-8} per year^2 × fibres/mL for the South Carolina, USA, plants and 0.018×10^{-8} per year^2 × fibres/mL for the Quebec, Canada, mines, representing exposure to chrysotile, whereas the estimate for the Patterson, New Jersey, USA, factory where the asbestos species used was amosite was 3.9×10^{-8} per year^2 × fibres/mL. In a further analysis in which fibre size was considered, the hypothesis that chrysotile and amphibole forms of asbestos are equipotent was strongly rejected ($P \leq 0.001$), and the hypothesis that the potency of chrysotile asbestos was zero was not rejected ($P \geq 0.29$).

The IARC Working Group *(1)* noted that there is a high degree of uncertainty concerning the accuracy of the relative potency estimates derived from the Hodgson & Darnton *(60)* and Berman & Crump *(64)* analyses because of the severe potential for exposure misclassification in these studies.

The study of textile workers in North Carolina, USA *(7)*, was not included in the meta-analyses. Based on the approach used by Hodgson & Darnton *(60)*, the authors of the North Carolina study *(7)* estimated that the percentage of deaths was 0.0098% per

fibre-year/mL for workers followed for at least 20 years. This estimate is considerably higher than the original estimate developed by Hodgson & Darnton *(60)* of 0.001% per fibre-year/mL for cohorts exposed to chrysotile.

Bourdes and coworkers *(84)* performed a meta-analysis of available studies on household and neighbourhood exposure to asbestos and mesothelioma risk and came up with estimated summary RRs of 8.1 (95% CI: 5.3–12) for household exposure and 7.0 (95% CI: 4.7–11) for neighbourhood exposure.

IARC conclusions on mesothelioma

In respect of mesothelioma, IARC concluded that there is *sufficient evidence* of carcinogenicity in humans for all types of asbestos, including chrysotile. This is the strongest IARC category for describing the strength of evidence *(1)*.

Key new studies

Hodgson & Darnton *(65)* updated their meta-analysis of the potency of different asbestos fibres to cause mesothelioma following the publication of the North Carolina, USA, study *(7)* and revised their potency estimate upward to 0.007% per fibre-year/mL.

Of a total of 259 deaths in the Chinese asbestos factory workers *(16)*, 2 were from mesothelioma, whereas no mesotheliomas were reported among the 428 total deaths in the Chinese chrysotile miner cohort *(11)*. The tremolite content of the chrysotile studied in these studies was less than 0.001%. In a brief report, it was stated that the mesothelioma incidence in the asbestos (almost exclusively chrysotile) production areas in China was 85/1 000 000, whereas it was 1/1 000 000 in the general population *(35)*. It is not clear what proportion of the excess risk observed is due to environmental exposure and what proportion is due to occupational exposure.

Exposure to asbestos was studied among 229 malignant mesothelioma patients identified from the Australian Mesothelioma Registry and diagnosed between 2010 and 2012. For 70, no occupational exposure was discovered; these included 37 who had performed a major renovation of their housing with asbestos-containing materials, 35 who had lived in a house during a renovation with asbestos-containing materials, 19 who had lived in a house built of fibro (asbestos cement sheet), 19 who had lived with someone working in an asbestos-exposed job, 12 who had performed brake/clutch work (non-professionally), 10 who had visited Wittenoom (the western Australian city

with a crocidolite mine) and 8 who lived in the vicinity of an asbestos mine or asbestos products factory (total does not add to 70 because a number of participants were counted in more than one category) *(85)*.

In a case–referent study in the United Kingdom, exposure to asbestos was studied by detailed interview of 622 mesothelioma patients and 1420 population referents. The OR for living with an exposed worker before the age of 30 years was 2.0 (95% CI: 1.3–3.2). No information was available on the fibre type *(86)*.

The prevalence of malignant pleural mesothelioma was elevated in the vicinity of a chrysotile asbestos plant in north Cairo, Egypt. The increased prevalence was limited to the immediate vicinity of the factory and people estimated to have had a cumulative exposure of 20 fibre-years/mL *(87)*. (This study was not included in the meta-analysis of Goswami and co-workers *(88)* described below.)

In a cohort study of inhabitants of 15 villages in Turkey with environmental asbestos exposure and 12 villages with no such exposure, there were 14 deaths from mesothelioma in men out of a total of 79 cancer deaths; for women, the number of mesothelioma deaths was 17 out of a total of 40 cancer deaths. The estimated lifetime asbestos exposure range was 0.19–4.61 fibre-years/mL; the fibre type was either tremolite or a mixture of tremolite + actinolite + chrysotile or anthophyllite + chrysotile *(69)*. (This study was not included in the meta-analysis of Goswami and co-workers *(88)* described below.)

Occupational exposure to chrysotile also causes non-malignant lung diseases

In a meta-analysis of 12 cohort and case–referent studies on mesothelioma after domestic exposure to asbestos, Goswami and coworkers *(88)* estimated a summary RR of 5.02 (95% CI: 2.48–10.13). In six studies, the fibre type was not specified; in one, it was chrysotile; and in four, it was chrysotile with other fibres.

Asbestosis

Of 8009 deaths among Quebec, Canada, miners and millers in 1972–1992, 108 were caused by pneumoconiosis *(3)*. In the South Carolina, USA, cohort, the SMR for pneumoconiosis and other pulmonary diseases was 4.81 (95% CI: 3.84–5.94), and that for asbestosis, 232.5 (95% CI: 162.8–321.9); there were 36 deaths from asbestosis and 86 from pneumoconiosis out of a total of 1961 deaths *(6)*. In the North Carolina, USA, chrysotile textile worker cohort, the SMR for pneumoconiosis was 3.48 (95% CI: 2.73–4.38) *(7)*.

The SMR for asbestosis in the Chinese chrysotile textile cohort was 100 (95% CI: 72.55–137.83) *(14)*. In the Balangero, Italy, mine cohort, there were 21 cases of asbestosis out of a total of 590 deaths *(5)*.

One should note, however, that the pneumoconioses have never been reliably recorded as a cause of death on death certificates. Additionally, mortality studies are generally not sufficient to detect clinically significant morbidity. Equally, in studies of morbidity, the etiological or diagnostic specificity of the usual methods of assessment (i.e. chest radiography, physiological testing and symptom questionnaire) is limited. Many

studies show that exposure to chrysotile induces decrement in lung function, radiological changes consistent with pneumoconiosis and pleural changes *(2)*.

A dose-related reduction in vital capacity ($P = 0.023$) and expiratory volume ($P < 0.001$) was observed with increasing cumulative exposure (i.e. > 8 fibre-years/mL) to chrysotile asbestos in miners and millers in Zimbabwe who were exposed for more than 10 years *(89)*.

Chest X-ray changes among textile and friction product workers in China were reported by Huang *(90)*. A cohort of 824 workers employed for at least 3 years in a chrysotile products factory from the start-up of the factory in 1958 until 1980, with follow-up through to September 1982, was studied. Overall, 277 workers were diagnosed with asbestosis during the follow-up period, corresponding to a period prevalence of 31%. Exposure–response analysis, based on gravimetric data converted to fibre counts, predicted a 1% prevalence of Grade I asbestosis at a cumulative exposure of 22 fibre-years/mL.

Asbestosis was also detected in 11.3% of wives of asbestos-exposed shipyard workers with a 20-year work history and in 7.6% of their sons. The asbestos type was not specified *(91)*. One or more radiological signs of asbestosis were observed in 35% of the household contacts of amosite asbestos insulation workers *(92)*. The prevalence of pleural calcifications was increased 10.2-fold (95% CI: 2.8–26.3) among blood relatives of workers in chrysotile asbestos factories and 17.0-fold (95% CI: 7.7–32.2) among people living in the vicinity of a factory using Russian and Canadian chrysotile asbestos *(93)*.

IPCS conclusions

In addition to lung cancer and mesothelioma, occupational exposure to chrysotile also causes non-malignant lung diseases that result in deterioration in lung function, in particular a form of lung fibrosis described by the term asbestosis *(2)*.

Global burden of disease

No studies are available specifically on the global burden of disease caused by chrysotile. However, more than 90% of all asbestos used historically and practically all asbestos used today is chrysotile; thus, the estimates made of the populations exposed to asbestos are largely directly valid for chrysotile.

Cancer of the lung

Based on the methods of Driscoll et al. *(33)*, the burden of disease estimate for lung cancer was updated by Prüss-Üstün and collaborators *(94)*. Using the combined relative risk (SMR 2.0) of lung cancer in 20 cohort studies published by 1994 *(95)* and the estimated proportion of the population actually exposed to asbestos in the different WHO regions, Prüss-Üstün and collaborators *(94)* estimated that in the year 2004, asbestos caused 41 000 lung cancer deaths and 370 000 disability-adjusted life years (DALYs).

In the year 2004, asbestos caused 41 000 lung cancer deaths

In an effort to estimate the global lung cancer burden from exposure to asbestos, McCormack and co-workers *(96)* studied the ratio of excess lung cancer deaths to excess mesothelioma deaths associated with exposure to different asbestos fibre types. This ratio was 6.1 (95% CI: 3.6–10.5) in the 16 available chrysotile-exposed cohorts. The authors were not able to derive an estimate for the total number of deaths or DALYs for asbestos-induced lung cancer. They concluded that in exposure to chrysotile, the observation of few mesothelioma deaths cannot be used to infer "no excess risk" of lung or other cancers.

Mesothelioma

Driscoll and co-workers *(33)* estimated the global burden of mesothelioma deaths and DALYs based on the notion that mesothelioma is nearly always caused by exposure to asbestos, using the proportion of workers in different economic sectors (agriculture, mining, manufacturing, electrical, construction, trade, transport, finance and services) who are exposed to asbestos in Europe, the population numbers in these subsectors, as developed in the CAREX database by the Finnish Institute of Occupational Health, and an average mesothelioma risk for different asbestos species from the study of Hodgson & Darnton *(60)*. The global burden estimates, updated for the year 2004 worldwide, were 59 000 deaths and 773 000 DALYs from malignant mesothelioma *(33, 97)*.

Asbestosis

Driscoll and co-workers *(98)* estimated the global burden of asbestosis deaths and DALYs based on the notion that asbestos is

the only cause of asbestosis, using the proportion of workers in different economic sectors (agriculture, mining, manufacturing, electrical, construction, trade, transport, finance and services) who are exposed to asbestos in Europe, the population numbers in these subsectors, as developed in the CAREX database by the Finnish Institute of Occupational Health, and published risks of developing asbestosis at different levels of exposure to chrysotile *(99)*. The global burden estimates for the year 2000 worldwide were 7000 deaths and 380 000 DALYs from asbestosis.

Chrysotile substitute fibres[5]

A WHO Workshop on Mechanisms of Fibre Carcinogenesis and Assessment of Chrysotile Asbestos Substitutes *(100)* was convened at IARC in Lyon, France, in response to a request from the Intergovernmental Negotiating Committee for the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (INC). The substitutes considered by the WHO workshop included the 12 chrysotile substitutes identified by the INC for priority assessment by WHO, 2 substances from a second list provided by the INC to be assessed if resources allow and 1 further substance for which data were submitted in response to WHO's public "call for data" for the workshop.

Methodological aspects

The workshop established a framework for hazard assessment based on epidemiological data, in vivo experimental animal data on carcinogenicity and potential to cause lung fibrosis, and mechanistic information, genotoxicity data and biopersistence data as determinants of dose at the target site and possible indicators of carcinogenic potential. Noting that substitutes may be used in a variety of applications with different exposure potential, either alone or in combination with other substances, the

[5] This section is largely taken from reference *100*.

workshop did not embark on risk assessment, but rather limited its work to assessing the hazard.

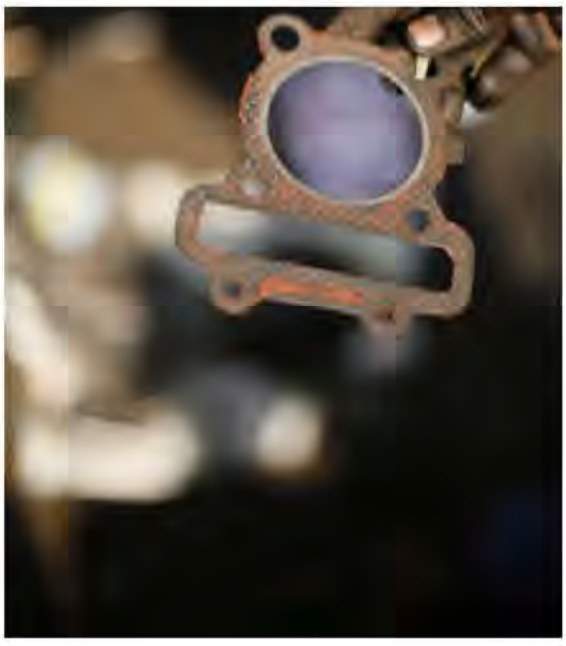
The workshop concluded that epidemiological studies on fibres have a clear advantage over toxicological studies, in that they involve studies of humans. They also have the advantage that they study the effects of exposure in the real world, where the effects of these exposures may be mitigated or enhanced by other factors. Despite these obvious advantages, the presence or absence of evidence of risk from epidemiological studies does not always override contrary findings from toxicological studies. The interpretation of either positive or non-positive epidemiological findings needs to be carefully considered in light of the strengths and weaknesses of the study design.

Carcinogenic response in experimental animals (lung cancer, mesothelioma) and fibrosis were considered to be the key effects; epithelial cell proliferation and inflammation were not regarded to be equally important indicators of human health hazard. From studies with asbestos, it is apparent that the sensitivity of the rat to fibre-induced lung tumours in inhalation studies is clearly lower than that of humans. This holds true when the effect is related to exposure concentrations and lung burdens. In comparison, testing of fibres by intraperitoneal injection represents a useful and sensitive assay, which also avoids the confounding effects of granular dusts.

The global burden estimates for the year 2000 worldwide were 7000 deaths and 380 000 DALYs from asbestosis

Fibres may act in principle on all steps in tumour development. However, of these interactions, the in vitro genotoxicity tests are mainly indicative of genotoxic effects involved in the first steps of tumour initiation. Effects related to biopersistence of fibres (e.g. continuous "frustrated phagocytosis") and secondary genotoxicity arising from reactive oxygen and nitrogen species and mitogen release by macrophages and inflammatory cells are not detected in routinely used genotoxicity tests. Therefore, negative results indicate a lack of primary genotoxicity, but do not exclude effects on later steps of carcinogenesis.

The chemical composition of the substitutes is a key factor influencing their structure and physicochemical properties, such as surface area, surface reactivity and solubility. Attention should be paid not only to the chemical composition of the fibres, including their major and trace elements, but also to contaminants or accompanying elements, including their speciation. Fibre-derived free radical generation favours DNA damage and mutations. Surface properties are a determining factor in the inflammatory response. In relation to fibre dimension and deposition, one can assume that there exists a continuous variation in the carcinogenic potency of respirable fibres, which increases with



length. Biopersistence of a fibre increases tissue burden and therefore may increase any toxicity the fibre might possess. For synthetic vitreous fibres, there is evidence in experimental animals that the potential for carcinogenicity increases with biopersistence. This has not been demonstrated, however, for other fibres. For all fibres, the fibres must be respirable to pose an appreciable hazard.

Respirability is mainly determined by diameter and density; thus, with a given fibre diameter, a higher specific density is associated with lower respirability (note that the specific density of most organic fibres is lower than the specific density of inorganic fibres).

Hazard assessment

The workshop decided to group substitutes roughly into hazard groupings of high, medium and low. However, for some substitutes, there was insufficient information to draw any conclusion on hazard; in these cases, the workshop categorized the hazard as indeterminate (a category that is not comparable to the other groupings). The hazard groups high, medium and low should be considered in relation to each other and do not have reference to formal criteria or definitions, as such. It is important to note that for each substitute, the fibre dimensions of commercially available products may vary, and the workshop did not assess this variation. The substitutes are listed below in alphabetical order.

***para*-Aramid** releases respirable fibres with dimensions similar to those of known carcinogenic fibres. *p*-Aramid fibres have induced pulmonary effects in animal inhalation studies. Biopersistence was noted. The workshop considered the human health hazard to be **medium**.

Most natural deposits contain **attapulgite** fibres that are less than 5 µm in length; at workplaces, the mean fibre length was less than 0.4 µm. The hazard from exposure to respirable attapulgite is likely to be **high for long fibres** and **low for short fibres**. This assessment is mainly based on findings in long-term inhalation experiments in

animals, in which tumours were seen with long fibres; no tumours were seen in studies with short fibres.

The nominal diameter of **carbon fibres** ranges from 5 to 15 µm. Workplace exposure in production and processing is mostly to non-respirable fibres. The workshop considered the hazard from inhalation exposure to these fibres to be **low**.

Most **cellulose fibres** are not respirable; for these, the hazard is **low**. For respirable fibres, the available data do not allow the evaluation of the hazard; the hazard is thus **indeterminate**.

The dimensions of **graphite whiskers** indicate high respirability, and they have a long half-time in the lungs. However, in the absence of any further useful information, the hazard from inhalation exposure was considered to be **indeterminate**.

Magnesium sulfate whiskers did not induce tumours in limited inhalation and intratracheal administration studies, were negative in limited short-term tests and are very quickly eliminated from the lung. It was discussed whether the hazard grouping should be **low** or **indeterminate**. On the basis of the data available, in the time available, consensus was not reached.

The fibres must be respirable to pose an appreciable hazard

For respirable **polyethylene**, **polyvinyl chloride** and **polyvinyl alcohol fibres**, the data were insufficient for hazard classification, and the working group thus considered the hazard **indeterminate**.

In facilities producing **polypropylene fibres**, exposure to respirable fibres occurs. After intratracheal administration, respirable polypropylene fibres were highly biopersistent; however, no fibrosis was reported in a subchronic animal study. However, the data are sparse, and the human health hazard potential was considered to be **indeterminate**.

The workshop considered that respirable **potassium octatitanate fibres** are likely to pose a **high** hazard to humans after inhalation exposure. At workplaces, there is exposure to respirable fibres. There was a high and partly dose-dependent incidence of mesothelioma after intraperitoneal injection in two species (high incidence indicating high potency). There is evidence of genotoxicity. Biopersistence was noted.

Wool-like **synthetic vitreous fibres** (including glass wool/fibrous glass, mineral wool, special-purpose vitreous silicates and refractory ceramic fibre) contain respirable fibres. For these fibres, the major determinants of hazard are biopersistence, fibre dimensions and physicochemical properties. It was noted that the available epidemiological data are not informative, due to mixed (vitreous fibre) exposures or other design limitations. Based on inhalation exposure studies, intraperitoneal injection studies and biopersistence studies, it was concluded that the carcinogenic hazard could vary from high to low, with **high** for the biopersistent fibres and **low** for the non-biopersistent fibres.

Natural **wollastonite** contains respirable fibres. In occupational settings, exposure is mainly to short fibres. In chronic studies, wollastonite did not induce tumours after intraperitoneal injection in animals; however, samples of wollastonite were active in different studies for genotoxicity. After considering this apparent discrepancy, it was concluded that the hazard was likely to be **low.**

In a limited study with intraperitoneal implantation, **xonotlite** did not induce tumours. After intratracheal injection in a chronic study, no inflammatory or fibrotic reaction of the lung was observed. The chemical composition of xonotlite is similar to that of wollastonite, but it is more rapidly eliminated from the lung. The workshop considered the human health hazard to be **low**.

Table 1. Key findings of the cohort studies on the adverse health effects of chrysotile asbestos

Industry and location	Exposure to chrysotile	Exposure to other fibres	Deaths from all causes	Lung cancer deaths SMR (95% CI)	Mesothelioma deaths SMR (95% CI)	Pneumoconiosis/ asbestosis deaths	References
Chrysotile mining/milling in Quebec, Canada	Average 600 fibre-years/mL	< 1% tremolite	8 009	657 1.37 (1.27–1.48)	38	108/ND	*3, 60*
Friction products factory in Connecticut, USA	Average 46 fibre-years/mL	Some anthophyllite in use during the last 20 years of follow-up	803	73 1.49 (1.17–1.87)	0	12/0	*52, 60*
Asbestos textile mill in Italy, women with compensated asbestosis	ND	"Mainly chrysotile"[a]	123	9 6.82 (3.12–12.95)	ND	ND/21	*53*
Asbestos textile mills in South Carolina, USA	99% < 200 fibre-years/mL, average 26–28 fibre-years/mL	0.04% amphiboles	1 961	198 1.95 (1.68–2.24)	3	85/36	*6, 55*
Asbestos textile mills in North Carolina, USA	Average (range) 17.1 (< 0.1–2 943.4) fibre-years/mL	0.04% amphiboles	2 583	277 1.96 (1.73–2.20)	4[b]	73/36	*7, 55, 60*
Chrysotile mine in Balangero, Italy	< 100 – ≥ 400 fibre-years/mL	No amphiboles, 0.2–0.5% balangeroite	590	45 1.27 (0.93–1.70)	4 4.67 (1.27–11.96)	ND/21	*5*
Chrysotile mine in Quinghai, China	Average in 2006, 2.9–63.8 fibres/mL	≤ 0.001% amphiboles	428	56 4.71 (3.57–6.21)	0[c]	ND	*11*
Eight chrysotile textile factories in China	ND	ND[d]	496	65 5.3 (2.5–7.1)	2	ND/29[e]	*8*
Asbestos manufacturing factory in China	Median 1, 8 and 23 fibres/mL in different departments	≤ 0.001% amphiboles	259	53 4.08 (3.12–5.33)	2	ND/39	*15*

ND: no data

[a] No further data on other possible asbestos fibre types.

[b] Mesothelioma data available only for 1999–2003 of the total follow-up period of 1953–2003.

[c] The authors note that mesothelioma may be underreported.

[d] The published paper has no information on the asbestos species, but most likely it is the Chinese chrysotile with < 0.001% amphiboles.

[e] The text of the paper states that there were 148 cases of asbestosis, not 29 as in the tables.

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PUBLIC HEALTH AND ENVIRONMENT

Asbestos – a group of minerals that includes chrysotile, crocidolite, amosite, anthophyllite, tremolite and actinolite – is one of the most important occupational carcinogens. At least 107 000 people die each year from asbestos-related diseases, including lung cancer. Even though the use of asbestos has declined in many countries, chrysotile is still widely used, particularly in developing countries.

This publication on chrysotile asbestos is divided into three parts. The first part reproduces a WHO short information document for decision-makers on the elimination of asbestos-related diseases. The second part addresses questions commonly raised in policy discussions, specifically to assist decision-makers. The third part is a technical summary of the health effects of chrysotile, which brings together and summarizes for the first time the most recent authoritative WHO evaluations performed by its International Agency for Research on Cancer and its International Programme on Chemical Safety. The technical summary also reviews results from key studies published after those evaluations and the conclusions drawn from WHO assessments of alternatives.

The publication will be of interest to all government officials who need to make informed decisions about management of the health risks associated with exposure to chrysotile asbestos.

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Releasability of asbestos fibers from weathered roof cement

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ABSTRACT

Chrysotile asbestos fibers were added to roofing products, including roof cement, for several decades. The fibers were described as "encapsulated" and therefore incapable of being released, an assertion that is disproved by the study reported herein. Three test panels of roof cement from the original container were exposed to ambient weathering in 2015 and 2016. Two panels were then sampled using the ASTM D5755 microvacuum method. Sampling revealed a light brown sub-layer under the dark brown surface layer, both of which crumbled and became friable during sampling. Analysis of the microvacuum samples with transmission electron microscopy showed that the material on the two panels contained 4,432,000 and 3,320,000 asbestos structures per cm^2 with nearly all of the structures consisting of fibers less than 5 µm long. Energy dispersive spectrometry determined that none of the fibers reported were coated with asphalt. The presence of free fibers were confirmed by direct examination of the surfaces of the panels and of dust released from handling the panels via scanning electron microscopy. This study confirmed the releasability of uncoated asbestos fibers from dried roof cement that was indicated in two previous studies published in 2007 and 2010. These results suggest that the finding of the 5th Circuit Court in 1997 that uncoated airborne asbestos fibers cannot be released from roof cement, and therefore do not present a potential exposure by inhalation, was erroneous in retrospect. The_exemption of roof cement from regulation under the Occupational Safety and Health Administration Construction Industry Standard for asbestos by the Court should not be relied on by employers of workers who remove weathered asbestos-containing roof cement, and precautions should be taken against exposure to airborne asbestos fibers during this work.

Keywords:
asbestos, roof cement, fiber release, fiber size, encapsulation, sampling, dermal transfer, TEM, SEM

INTRODUCTION

Description of Roof Cement Products and Their Use

Roof cement contains an asphalt binder, volatile solvent and non-fibrous additives. It was made with asbestos fibers by at least one manufacturer until 2004. [1] Asbestos fibers were added to roofing products for dimensional stability, strength, increased resistance to corrosion and rot, and fire retardant properties. [2] When the cement is removed by scraping several years or more after its application, airborne dust is generated.

This article describes the results of tests conducted to evaluate the releasability of asbestos fibers from weathered roof cement and characterize the population of fibers. It does not discuss airborne fiber concentrations resulting from such release, nor does it discuss the health effects of inhaling the fibers.

Occupational Exposure from Fiber Release

Occupational exposure to asbestos fibers in roofing products is regulated under the Occupational Safety and Health Administration Construction Industry Standard. [3]

The regulations were amended pursuant to a court decision that exempted roof cements, mastics and coatings, but not flashings. [4] This exemption was based on the argument that the fibers were "encapsulated" and could not be released. However, the argument may be valid for the wet product when it is applied as a paste from the can, but ignores the fact that it is eventually removed in a dry condition.

Fiber release from weathered roof cement has been reported.[5 – 6] but the material has not been previously tested to determine the availability of fibers for potential release during removal operations. This article reports on a long-duration ambient exposure test followed by sampling of the material to evaluate the releasability of fibers that could result in their inhalation when dried asbestos-containing roof cement is removed.

METHODS

Determination of Asbestos Content

A sample of Monsey Plastic Roof Cement (Monsey Products Co., Kimberton, PA), taken from the original quart-size container purchased in 1998, was submitted for gravimetric analysis to determine the asbestos content.[7] Gravimetric reduction was accomplished by weighing dry ceramic crucibles with a NIST traceable analytical balance with a resolution of 0.1 mg. A sample of the roof cement was placed in the pre-weighed crucible and reweighed to determine the initial mass of the sample. The crucible was placed in a muffle furnace set at 480 °C for at least six hours to burn off organic material. After the six hours, the crucible was removed from the furnace, allowed to return to a stable room temperature, and weighed again. Next, the residual material was acid washed to remove carbonates by adding hydrochloric acid and ultrasonicating. Finally, the remaining sample residue was deposited on a pre-weighed 0.2 µm polycarbonate filter, dried,

and weighed one last time. For this study, the filtered residue was examined using a JEOL JEM-1200EX Transmission Electron Microscope (Peabody, MA) fitted with an AMT digital camera and an AAT SUTW Light Element Detector and IXRF Model 550i Digital Pulse Processor (eumeX Instrumentebau, GmbH, Heidenrod, Germany). This method accurately determines the weight percent of asbestos and other components by first determining the weight loss of organics in ashing and then the weight loss of carbonates (and other acid-soluble components) in acid digestion.

Test Panel Preparation and Exposure to Weather

Three test panels were prepared in July, 2015, using non-asbestos resilient floor tile as the substrate. Each piece of tile was 7 in by 4 in (17.78 by 10.16 centimeters [cm]) and 1/8 in (0.32 cm) thick. The panels were covered with a 1/8 inch-thick layer of roof cement taken from the original container. A one-inch strip of tile was left uncoated at the top and bottom of each panel. The panels were mounted in a fixture with a clear acrylic rain shield and suspended vertically on a building, approximately seven feet (2.13 m) above ground level, facing south.

The panels were exposed for a total of nine months in 2015 and 2016 during times of peak seasonal temperatures at a location west of Austin, Texas. Weather conditions reported from the monitoring station nearest to this location are shown in Table 1. Higher average temperatures occurred in 2015 than in 2016, with 2016 experiencing periods of rain that were absent in 2015.[8]

The panels were initially suspended on July 19, 2015. (Figure 1) They were removed on October 18, 2015, for observation, which was inconclusive regarding the presence of asbestos fibers on the surface. It was decided to subject them to an additional six months of exposure during the time of peak seasonal temperatures in 2016. In the interim, they were stored indoors in a closed container at room temperature. The panels were re-suspended in the fixture in the same location on April 18, 2016, and inclined approximately 30 degrees from the horizontal to simulate the pitch of a roof. The panels were removed on October 18, 2016, and stored indoors in a closed container at room temperature.

Microvacuum Sampling of Test Panels

After visually observing fibers on the surface of the panels after their removal in October 2016, microvacuum sampling was performed to determine the surface loading of asbestos fibers on the panels. Because microvacuum sampling was not part of the original testing procedure in 2015, control panels unaffected by weathering were not prepared.

Two of the panels were sampled according to ASTM D5755. [9] The "microvacuum" sampling procedure consists of vacuuming the surface with a flexible plastic inlet tube attached to a 25-mm air-sampling cassette through which air was drawn at 2 L min^{-1}. On the first microvacuum sample, 25216-C-01 from the center panel, it was observed that the surface layer, which had weathered from black to dark brown, was crumbling

(becoming friable) and a light brown sub-layer was being exposed. A friable material is one that "can be crumbled, pulverized, or reduced to powder by hand pressure." [10] In this case, the hand pressure was applied with the inlet tube attached to the sampling cassette.

After completing the minimum two minutes of vacuuming over 100 cm² of the panel, the process was repeated for another two minutes more aggressively to remove more of the dark brown surface layer along with part of the light brown sub-layer from the same area. Figure 2 shows the center panel after completion of the microvacuum sampling. Note the horizontal and vertical scrape marks from the edges of the inlet tube.

A microvacuum sample was also taken from the left panel for 2 min 30 sec and submitted as 25216-L-01. Another sample of the same area was taken for two minutes and submitted as 25216-L-02. The same crumbling of the dark brown surface layer, exposing a light brown sub-layer, was observed as on sampling the center panel.

Analysis of Microvacuum Samples

The ASTM D5755 method generally involves suspending the collected dust in a 50/50 mixture of particle free water and reagent alcohol, agitating the suspension via ultrasonication, and filtering aliquots of the suspended dust onto membrane filters. Portions of each filter were prepared for examination via transmission electron microscopy (TEM). Details on the suspension, filtration, and grid preparation steps can be found in ASTM D5755.[9]

From the number of asbestos structures counted on the grid and the amount of sample material analyzed, the number of structures recovered from the sample surface was calculated. The result was reported as structures per cm² of sampled surface, which for the test panel samples was equivalent to fibers/cm².

Encapsulation Testing

Any contact with an asbestos-containing material that leads to the transfer of free asbestos fibers invariably shows that the asbestos is not entirely encapsulated. Contact with an asbestos-containing material can be performed directly with a touch of the finger (dermal contact) or with a mildly adhesive sampler (i.e., a Post-It™ note). [11 – 12] For purposes of this study, each tested panel was placed into a High Efficiency Particulate Absolute (HEPA) hood in case the manipulation caused a release of airborne fibers. The investigator's hands were washed immediately prior to testing. A clean fingertip was applied to an adhesive carbon tab on an aluminum disc. This carbon tab was examined as a quality control sample to ensure contamination was not an issue. The same finger was applied to the surface of the sample, then to a second adhesive carbon tab on an aluminum disc. This carbon tab was examined to determine if any fibers on the surface of the sample material were released via dermal contact. While this test is not a quantitative measure of how much fiber is released, it is important to ensure examination of both the negative control and the dermal transfer samples occur at similar magnifications and across regions of similar size.

Another method for investigating the presence of unencapsulated asbestos fibers on the surface involved direct microscopic examination of the sample. For this study, a direct examination was performed by cutting out a small section or "coupon" of the weathered roofing cement with an uncoated new razor blade and affixing the coupon, face up, to an adhesive carbon tab. Analyses of the negative control samples, dermal contact samples, and coupons of the weathered applied material were performed via scanning electron microscopy using a JEOL JSM-6490LV scanning electron microscope (SEM) (Peabody, MA) coupled with a Thermo Scientific Noran System 7 energy dispersive spectrometry (EDS) system (Waltham, MA). Each of the prepared samples were lightly coated with a thin layer of carbon to enhance electrical conductivity.

Results

Asbestos Content

The label on the can of Monsey Plastic Roof Cement has the number 25216 and lists the contents as Asphalt, Petroleum Distillate, Encapsulated Asbestos and Limestone. The cement in the can is considered a non-friable organically-bound material.[13] The sample was divided into three sub-samples designated 25216-M-01-1, -2 and -3 and the chrysotile asbestos content determined as 6.73%, 6.62% and 6.17%, respectively, of the original weight. This compares closely with the <8.5% asbestos -- not identified as to type of fiber -- reported for another Monsey Plastic Roof Cement No. 5610 on a Material Safety Data Sheet [14] and confirms the homogeneity of the original product.

This result also mirrored the asbestos content previously determined by one of the authors using the same methodology on four roofing products manufactured by the Henry Company as recently as 1996. Those products were found to contain between 5% and 15% chrysotile asbestos.

Analysis of Microvacuum Samples

Table 2 shows the results of analyzing the microvacuum samples from the left and center panels. The "Sampling time, minutes," "Asbestos structures counted" and "Loading, fibers/cm² "for the left panel are shown separately for samples 25216-L-01 and 25216-L-02 as well as for the combined results of the two samples (L01 + L02) based on a 100 cm² sampled area.

The D5755 TEM counting rules used for these analyses only include structures longer than 0.5 µm with aspect ratios (length:width) of 5:1 or greater. All of the fibers used to calculate the loading met this criterion. The loading results of 4,432,000 fibers/cm² for the left panel and 3,320,000 fibers/cm² for the center panel convert to 4,117,000,000 fibers/ft² and 3,084,000,000 fibers/ft², which expresses the number of fibers available for release in units more descriptive of the quantities of roofing material removed.

Microvacuum Sample Fiber Size Distributions

Fiber size distributions were determined from the laboratory bench sheets by sorting the structures according to aspect ratio, eliminating the 5.5% with aspect ratios less than 5:1. Next, the remaining fibers were sorted

according to length. The results are summarized in Figure 3 for the combined left panel samples and the center panel.

Figure 3 shows that 3.1% of the fibers collected from the left panel were longer than 5 µm and 4.0% of the fibers collected from the center panel were longer than 5 µm. The mean length of the fibers vacuumed from the left panel is 1.63 µm and the mean length of the fibers vacuumed from the left panel is 1.77 µm.

Encapsulation Testing

The left panel (subsequent to microvacuum testing) and the right panel (prior to any destructive sampling) were each examined for unencapsulated asbestos fibers by analyzing dermal contact samples and coupons from the weathered materials. Examination of the coupon samples show that encapsulated, partially encapsulated, and unencapsulated asbestos fiber bundles were present on the surfaces of the left and right panels. Examination of the dermal transfer samples from contact with the left and right panels suggest that unencapsulated asbestos fibers are present on the surfaces of the left and right panels. These fibers were free to be released by contact as well as more aggressive manipulation during removal (sanding, scraping, or grinding). Figures 4 and 5 show representative SEM micrographs of unencapsulated chrysotile asbestos fibers detected on the surface of the weathered right panel (which was not microvacuumed) as well as fibers transferred through dermal contact with that surface. The fibers shown in these figures were considerably longer than those detected in the microvacuum samples.

DISCUSSION

The effects of exposure to weather during nine months in 2015 and 2016 are illustrated by the microvacuum results, direct microscopic examination, and analyses of dermal transfer samples.

Microvacuum Sample Analysis

The ASTM method D5755 method is designed to remove and count asbestos fibers and other structures from the surface of a material. The microvacuum samples from the left and center panels not only recovered asbestos fibers on the dark brown surface layer but also those within this layer and in the light brown sub-layer underneath. This resulted in sampling the depth -- not just the surface -- of a layer of roof cement that is representative of the material scraped off during removal by a worker.

The sampling procedure, while aggressive enough to crumble the thin dark brown surface layer and render this layer and the light brown sub-layer friable, was not as aggressive as removal with a shovel, putty knife, or other tool by workers.

The test panels were exposed for nine months, whereas roofs are warrantied for up to twenty years. The degree to which the heat absorbed by the original black surface layer over a period of several years can degrade the surface layer and convert the underlying cement to a light brown sub-layer devoid of asphalt

binder would be at least as great as shown by these tests. The potential for releasing fibers during removal work would be correspondingly greater.

Figures 6 and 7 are images from TEM grids for two of the microvacuum samples. All of the fibers in these images are uncoated, except for those embedded in the asphalt particle in the lower left of Figure 7. All of the fibers reported in Table 2 and used to calculate loading were uncoated.

Fiber Size Distribution

Of the fibers that met the D5755 counting criteria of at least 5:1 aspect ratio, 96.6% were not greater than 5 µm long. They would not have been counted by Phase Contrast Microscopy (PCM) using the NIOSH 7400 method.[15] Those that are less than 0.25 µm wide are unlikely to have been resolved and counted. Nor would these short, thin fibers have been reported by the NIOSH 7402 TEM method [16] which counts PCM-equivalent (PCMe) asbestos fibers longer than 5 µm and wider than 0.25 µm with an aspect ratio of at least 3:1.

The distribution of fiber sizes is representative of those released during removal of roof cement for the following reason. The chrysotile fibers used in the manufacture of roofing products are "the finest grade 7 milled mineral" according to Meylan et al.[2] QAMA Grade 7 fibers are listed as "shorts and floats."[17] The product therefore contains very short fibers from compounding through application and removal, as well as through the microvacuum sampling performed for this study. It is likely that scraping with metal hand tools would be more disruptive than scraping with a flexible plastic inlet nozzle during microvacuuming.

The surfaces exposed from this destructive sampling as well as weathered surfaces not subjected to destructive sampling were tested for unencapsulated fibers by direct examination of the weathered bulk material and by examination of particles released through dermal contact.

CONCLUSIONS

"Encapsulation" of Asbestos Fibers

Although it was asserted in a Court decision that asbestos fibers in roof cement are encapsulated and, in turn, cannot be released into the air,[4] the findings presented by this study demonstrate that assertion, which was based on evidence presented to the Court in 1997, to be erroneous in retrospect. Energy dispersive spectroscopy (EDS) of the microvacuum samples was able to identify 295 fibers as chrysotile asbestos, which would not have been possible had the fibers been coated with asphalt.

Studies published by Mowat et al. [5] and Sheehan et al. [6] several years after the Court decision also present evidence that disagrees with the Court's assertion of safety. Mowat et al. [5] collected air samples during removal of synthesized and artificially weathered asbestos-containing roof cement and analyzed the filters by Phase Contrast Microscopy (PCM) and TEM. The NIOSH 7400 PCM method [15] does not distinguish between asbestos and non-asbestos fibers, whereas the NIOSH 7402 TEM method [16] identifies fibers from

the same filter -- not the same fibers -- by morphology and EDXA to determine chemical composition. The Mowat article reports 204 fibers in 28 out of 84 samples as chrysotile asbestos but fails to report the number of PCM fibers. The article does not state whether the fibers not reported as asbestos were rejected based on morphology or otherwise, or if they were coated with a substance, such as asphalt, that precluded their identification by EDXA. Nonetheless, chrysotile asbestos fibers were clearly present in the air samples and would not have been identified as such had they been "encapsulated."

Sheehan et al. published the results of a similar study [6] that subjected synthesized roof cement samples to ambient weathering and hand removal methods. The article reports finding asbestos fibers by TEM in a range of 10 to 64 fibers, but does not report the number of PCM fibers found. The study sheds no light on whether any fibers were reported as non-asbestos because they were not identifiable as asbestos by EDXA.

The study described in this article differs from the Mowat and Sheehan studies in the type of TEM analysis used. The NIOSH 7402 method used in the latter studies counts PCM-equivalent (PCMe) asbestos fibers longer than 5 µm and wider than 0.25 µm, whereas the TEM protocol in the ASTM D5755 method used for this study counts asbestos fibers greater than 0.5 µm long with no minimum width restriction. These fiber-counting rules are the same as those in the TEM analytical protocol in the AHERA rules for clearance samples for asbestos abatement projects in schools. [18] The AHERA approach is more logical to use for roof cement, a product known to contain primarily short asbestos fibers.

In summary, two previous studies demonstrated that uncoated asbestos fibers are released during removal of dried roof cement. This study confirms those results and explains the process that renders the material friable from the forces that crumble and pulverize it, reducing it to powder. While some fibers may remain "encapsulated" with the asphalt binder, the analytical procedures used confirmed the release of many more fibers that were not coated based on direct observation of the weathered surfaces, analysis of particles released upon contact with the weathered material, and characterization of fibers collected from the weathered surfaces during microvacuum sampling.

Significance for Worker Protection

This article makes no statements about the health effects of inhaling coated asbestos fibers, but the hazards from inhaling the uncoated fibers are beyond question. As recently as 2012, roofing products accounted for consumption of 300 tons of QAMA Grade 7 chrysotile asbestos fiber.[19] To the extent that roof cement accounts for part of the asbestos consumption in relatively recent production, removal of the weathered material remains a potential health hazard for workers. The 1997 Court decision, erroneous in retrospect, in part directed OSHA to delete roof cement from the materials regulated under 29 CFR 1926.1101(g)(8)(ii). [20] However, the studies by Sheehan and Mowat, as well as the study described in this article, confirm that the removal of dried roof cement constitutes disturbance as defined in 29 CFR 1926.1101(b) of the Construction

Industry Standard. Specifically, that "Disturbance means activities that disrupt the matrix of ACM or PACM, crumble or pulverize ACM or PACM, or generate visible debris from ACM or PACM."[3]

In April, 2009, the Assistant Surgeon General of the United States stated that "Activity that disturbs asbestos, causing these small fibers to float in air, increases the chances of inhalation and the contraction of asbestos-related diseases. Disturbance is what leads to exposure." [21]

Since disturbance of the roof cement during removal is unavoidable, the employer should not feel absolved from the responsibility to protect workers from asbestos exposure due to the deletion of this material from the OSHA regulation as a result of the Court decision.

The results of the weathering exposure tests conducted on panels coated with roof cement indicate that removal of dried roof cement as a friable material can generate the release of asbestos fibers and an inhalation hazard to workers.

RECOMMENDATIONS

It is recommended that precautions be taken against exposure to asbestos fibers when removing roof cement known or suspected to contain asbestos. Employers are advised to have bulk samples of the roof cement collected and analyzed by accredited asbestos inspectors and laboratories for the presence of asbestos prior to removal. If the material contains asbestos, precautions against exposure in the OSHA Construction Industry Standard should be followed. [3]

ACKNOWLEDGEMENTS

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Table 1. Weather conditions during exposure tests

	July – October 2015	April – October 2016
Number of days	92	184
Low temperature range	56°F (13 °C) – 82°F (28 °C)	51°F (11 °C) – 78°F (26 °C)
High temperature range	83°F (28 °C) – 105°F (41 °C)	72°F (22 °C) – 104°F (40 °C)
Average temperature range	70°F (21 °C) – 93°F (34 °C)	61°F (16 °C) – 89°F (32 °C)
Days with rainfall	0	38
Total rainfall	0	20.33 in (51.64 cm)

Table 2. Results of microvacuum sampling and analysis

	Left Panel			Center Panel
Sample 25216-	L-01	L-02	L-01 + L-02	C-01
Sampling time, minutes	2:30	2:00	4:30	4:00
Asbestos structures counted	97	98	195	100
Loading, fibers/cm²	2,570,000	1,862,000	4,432,000	3,320,000

Figure 1. Test panels as mounted during 2015.

Figure 2. Center panel after microvacuum sampling.

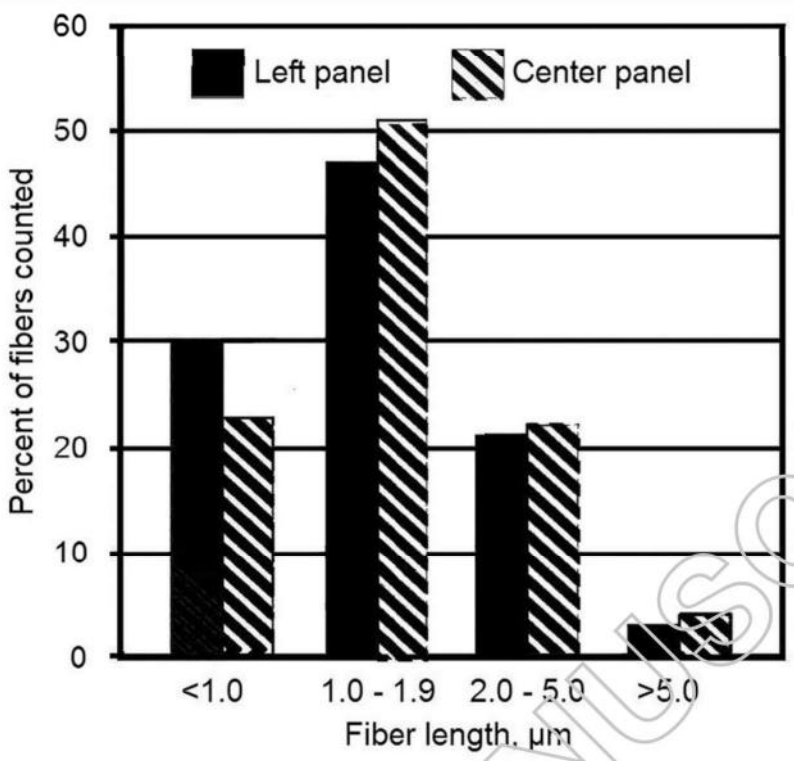

Figure 3. Fiber size distribution of microvacuum samples.

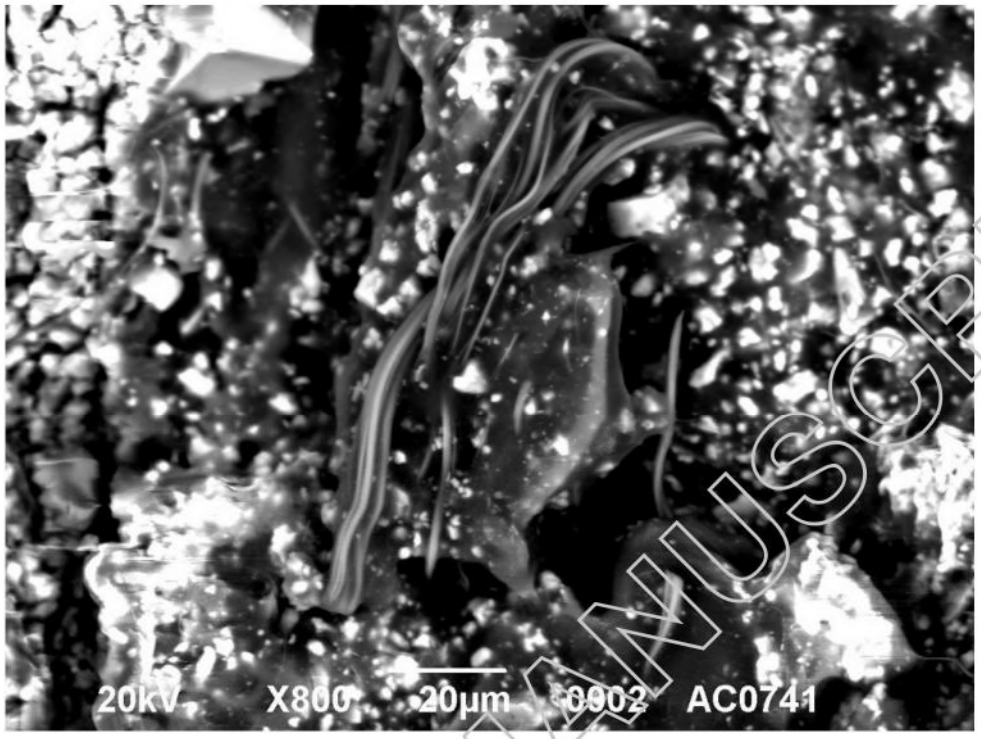

Figure 4. SEM micrograph of a chrysotile asbestos fiber bundle observed on the surface of the right test panel. (Photo courtesy MVA Scientific Consultants)

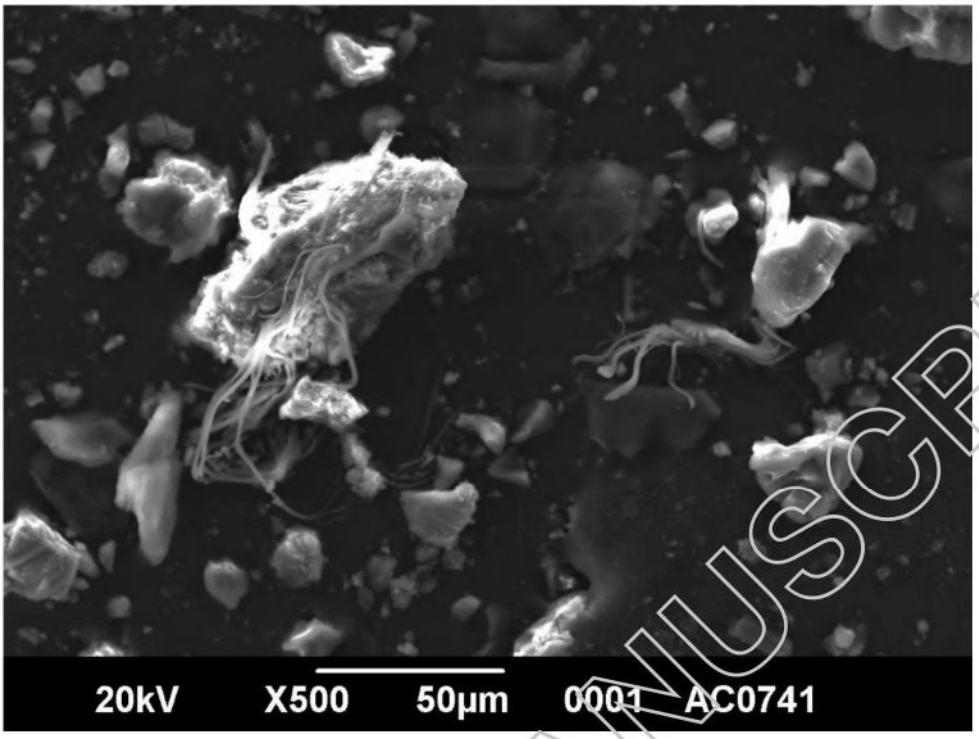

Figure 5. SEM micrograph of a chrysotile asbestos fiber bundle released after dermal contact with the surface of the right panel. (Photo courtesy MVA Scientific Consultants)

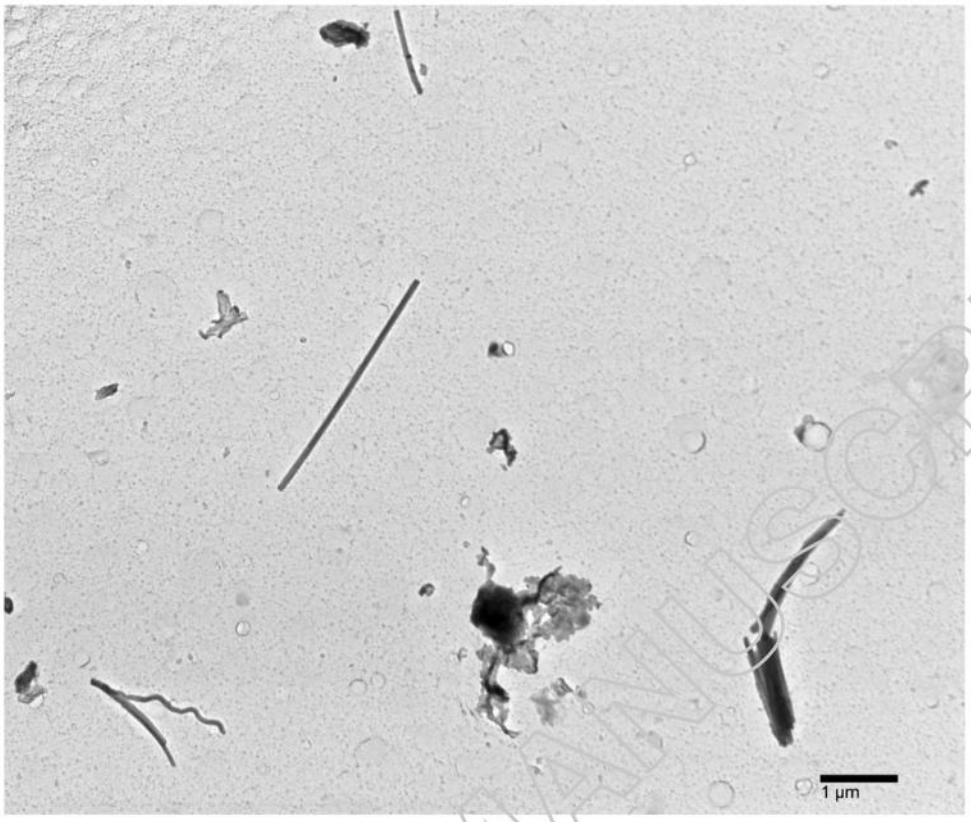

Figure 6. TEM image from microvacuum sample 25216 - C - 01. (Photo courtesy J3 Resources, Inc.)

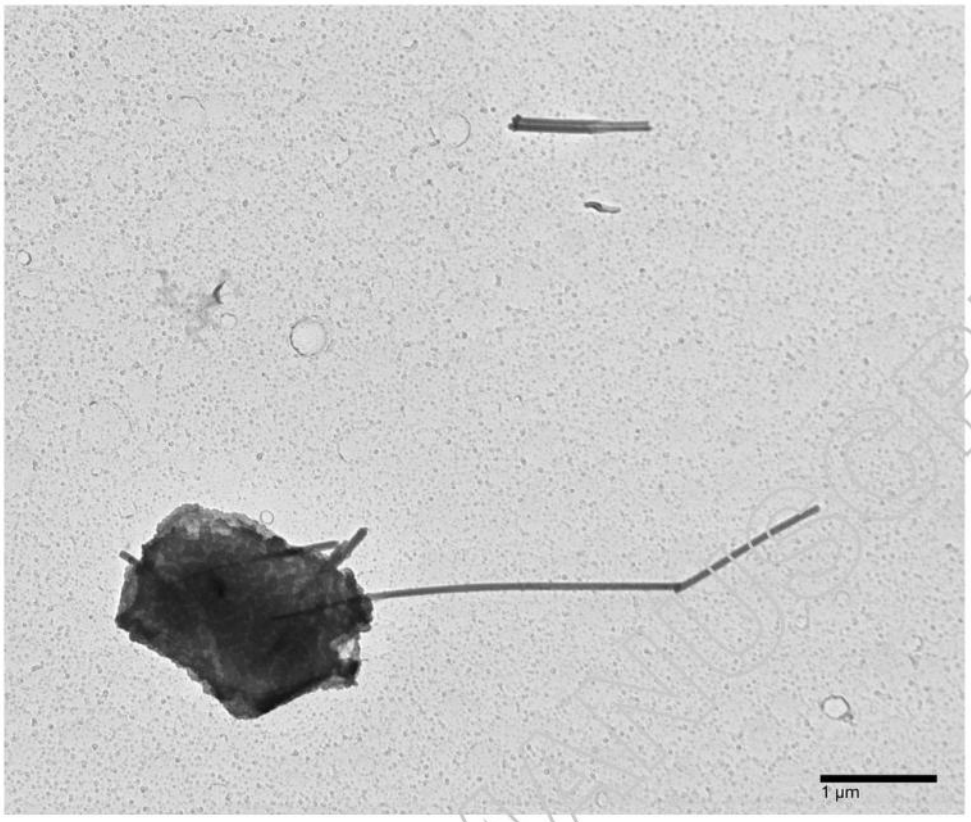

Figure 7. TEM image from microvacuum sample 25216 - L - 01. (Photo courtesy J3 Resources, Inc.)

WS-B-07 Jerzy Dyczek

Surface of Asbestos-cement (AC) Roof Sheets and Assessment of the Risk of Asbestos Release

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Abstract

A number of samples of asbestos-cement roof sheets were taken from roofs of buildings in a small village, different towns and industrial centres.

Sample surfaces were observed in a SEM. It was found that surface corrosion depends on air pollution and is faster on AC roof plates in industrial centres and smallest on samples of AC plates from roofs in some small towns. Observations suggest that AC plate breaking causes a serious risk of releasing asbestos fibres and that on new surfaces of a broken plate there are a number of asbestos fibres sticking out, partly damaged, and any mechanical effect may produce respirable fibres.

1. Introduction

In an assessment of the risk of asbestos fibre release from materials containing asbestos, especially from AC building materials, an important role is played by the assessment of the surface corrosion. Presence of cracks and other mechanical damage should also be taken into consideration as important factors.

AC was, and in some countries still is, frequently and on a relatively large scale used in the form of flat and corrugated roof and facade sheets. AC sheets in many countries were produced and used for about a hundred years. For example, in Poland there are 1,300,000,000 m^2 roofs covered by AC sheets, i.e., 15,000,000 tons. Additionally, in cooling towers and other cooling installations in industry we have over 100,000 tons of AC sheets.

Usually on roofs, in normal condition of roof exploitation, mechanical stress appears rather occasionally and is rather moderate. As long as the sheet surface corrosion is small enough, and asbestos fibres are not exposed, mechanically provoked asbestos release may be discounted. Risk of asbestos contamination is proportional to degree of surface corrosion and presence of cracks. Significant increase of risk of asbestos fibres release follows any attempt at a plate's replacement or other roof mending.

A number of measurements of asbestos fibre concentration in air executed in Poland confirm the above statements.

In these circumstances the corrosion process in AC sheets should be taken as the most important factor in estimating AC sheet durability, and observations of AC sheet surfaces may help us to understand and to assess the risk of environmental contamination by asbestos fibres.

The presence of so many AC sheets around us causes problems of AC durability and AC corrosion to be rather important.

AC products consist of 84 to 92 % of Portland cement and, respectively, 16 to 8% of asbestos. Asbestos is one of the most durable minerals. Its resistance to water, acids and other aggressive chemicals is very high. Asbestos is practically insoluble in water, like quartz or $BaSO_4$.

The matrix formed by cement (in sheets usually 90%) consists of compounds much more soluble in water than asbestos; especially more soluble in acids, even in weak acids, like the acid present in acid rain. The matrix in AC materials is identical to the cement paste in concrete, chemically and physically.

It is well known that acid rain accelerates concrete corrosion.

Mostly, AC products are formed from a water suspension of asbestos and cement by separating solids, cement grains and asbestos fibres from the water and simultaneously shaping. Freshly formed products are wet. So, all physical and chemical processes are very similar to fresh concrete. Cement reacts with water, and in consequence we observe the process of binding and hardening. Cement water reactions in so called green products and later on, in the following days and months, are identical to those in concrete.

Therefore the corrosion process of AC is practically identical to corrosion of concrete and is accelerated by acid rain.

It should be mentioned, that concrete is formed in rather big elements like plates, beams or pillars or even bigger like elements of civil engineering structures. The dimensions of concrete elements are measured in meters – often many meters. AC sheets are rather thin. AC sheet thicknesses usually range from 4mm to 8mm. Then, corrosion may not only expose fibres but also make sheets weaker and susceptible to cracking, that increases risk of environmental contamination by asbestos.

This paper presents observations, using a scanning electron microscope [SEM], of fragments of AC sheets collected from roofs, cooling towers and from ventilation installations.

2. AC corrosion

As it was earlier mentioned, AC sheets consist usually of 90% cement and 10% asbestos[1]. As a result of physical processes and chemical reactions of the cement a matrix is formed. Fibres of asbestos are matrix reinforcing. AC material is a composite reinforced by asbestos fibres.

[1] Usually 90%, in pressed flat sheets up to 91.5%. Corrugated sheets often contain more asbestos, up to ~12%.

In the matrix we may recognise physical processes like solvation, precipitation, crystal growth and recrystallization, and chemical processes – a number of different chemical reactions of cement with water. The matrix in AC products consists mostly of calcium hydroxide (10 – 12 %), calcium silicate hydrates (60 – 80%), calcium aluminate hydrates (3 – 10%), calcium aluminate sulphate hydrates (0 – 5%) and unreacted cement (10 – 25%).

Among these components, the solubility of calcium hydroxide in water is relatively high; even at 0 ºC it is 1.3 g CaO/l. The solubilities in pure water of the other products of cement water reactions are much lower. Thus, surfaces of AC products are eroded by rain, mostly because calcium hydroxide is slowly, but continuously washed out. The calcium hydroxide wash-out process slows down in time, because on the surface, part of the calcium hydroxide reacts with carbonate ions forming calcium carbonate $CaCO_3$

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O \qquad (1)$$

$CaCO_3$ is less soluble in water then $Ca(OH)_2$

Unfortunately in higher concentration of CO_2 $CaCO_3$ goes in to $Ca(HCO_3)_2$

$$CaCO_3 + CO_2 + H_2O = Ca(HCO_3)_2 \qquad (2)$$

$Ca(HCO_3)_2$ is more soluble than $CaCO_3$

Similarly to reaction (1) $CaCO_3$ is formed not only from calcium hydroxide, but also from calcium aluminate and calcium silicate hydrates. This process leads to a reduction of the matrix porosity and may retard reaction (2).

Increase of rain acidity (presence of ions of carbonates, sulphates or nitrates) increases the wash-out process for all matrix components.

Concluding, in the presence of acid rain there appears so called acid corrosion, well described in cement chemistry and concrete technology.

The mechanism of acid corrosion is complex. It is not only a simple washing out process depending on solubility. As the result of chemical reaction of acid (or acids), with calcium hydroxide, calcium aluminate and calcium silicate hydrates, new compounds are formed, much more soluble and accelerating corrosion.

Some new compounds like, e.g., $CaSO_4$ and $CaSO_3$ formed in reaction with sulphuric and sulphurous acids present in acid rain, are responsible for expansion. The product (sulphate) has larger volume than the substrates. It produces tension, and may accelerate corrosion.

3. SEM observations of AC product surface

Five different groups of AC products were selected:

a. unpainted flat roof sheets (pressed, low porosity AC),
b. unpainted corrugated roof sheets,
c. autoclaved facade sheets, unpainted but covered by inorganic coloured layer,
d. corrugated sheets from cooling tower,

e. Element of ventilation chimney collecting also exhaust gases from gas water heaters.

Additionally, the surfaces of fresh and old cracks were observed.

3.1. Unpainted flat roof sheets

Samples of unpainted flat sheets were taken in Southwest Poland, from the roof of a large, four-storied building in an industrial agglomeration at a busy street junction. This roof was covered by flat, pressed plates 40 × 40 × 0.6 cm of low porosity, lower than corrugated sheets. Plates were over 20 years old. Roof and plates were in good technical conditions.

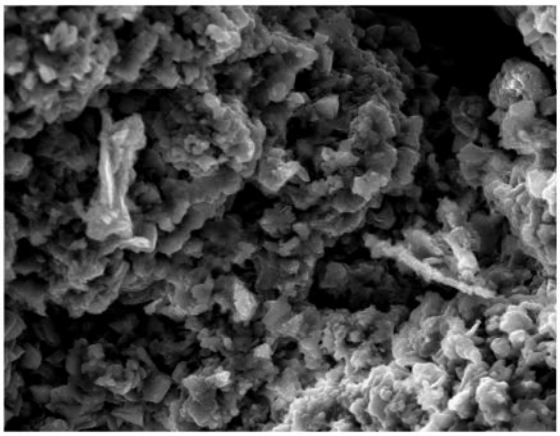

Photo1. Magnification 500×

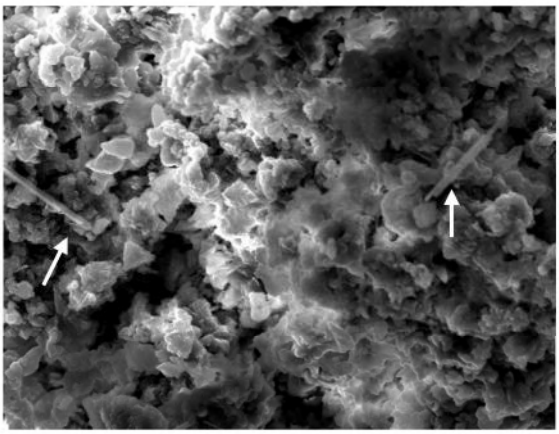

Photo 2. Magnification 1000×. Arrows are pointing out needle like gypsum crystals

SEM observation (Photo 1) shows very occasionally asbestos fibres, covered by calcium silicate hydrates, partly carbonised. Fibres are well connected with matrix. Risk of asbestos fibre liberation is rather small.

Photo 2 shows needle like secondary gypsum crystals. These result from reaction of calcium present in the matrix with sulphate anions present in acid rain. Nevertheless, on the surface appear a number of calcium carbonate crystals. Corrosion generally is rather slight. It is due to matrix low porosity and additional porosity reduction due to pores filling with carbonisation products.

3.2. Unpainted corrugated roof sheets

These samples were collected from the roof of an office block (two-stories) in a small town in south Poland. It is an agricultural area where the air is unpolluted and acid rain appears only occasionally. Only traffic pollution should be taken into consideration.

The roof and roof sheets were over 30 years old. Roof and plates were in good technical condition.

Asbestos fibres on the sheet surface are rarely visible in the SEM. All observed fibres are covered by cement reaction products and stick well to the sheet surface. Examples of

observed asbestos, as rather long fibres, are seen on Photo 4. Risk of asbestos dust release is estimated as medium high.

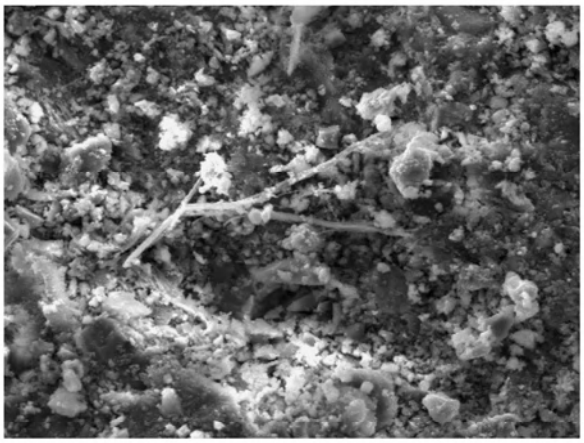

Photo 3. Magnification 300×

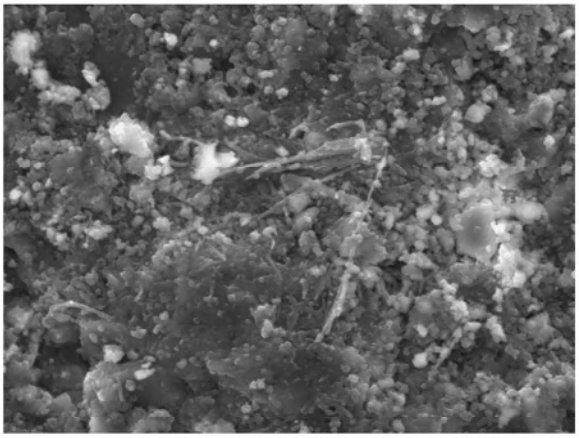

Photo 4. Magnification 500×

Other unpainted corrugated roof sheets were investigated on the older (40 years old) roof of a building in an industrialised area in Southwest Poland, where acid rain is rather frequent.

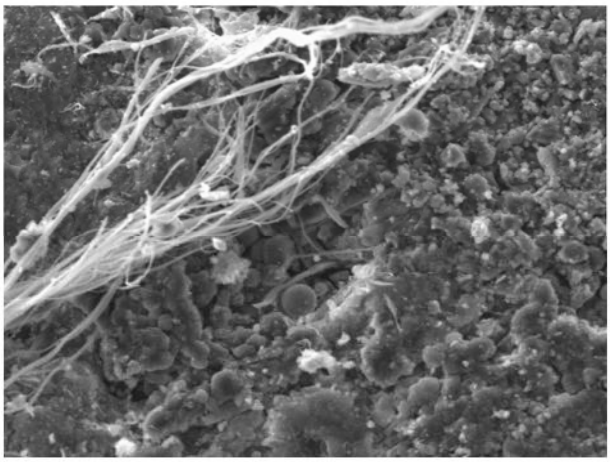

Photo 5. Magnification 300×

Acid rain wears down the matrix and asbestos fibres are exposed – Photo 5. Fibres are clean, uncovered by calcium carbonates or calcium silicate hydrates and specifically not connected to the matrix. Here, calcium compounds reacted with acid to produce more soluble chemical compounds which were dissolved. As a result of this, on the sheet surface are found asbestos fibres, which can rather easily break away. Risk of asbestos dust release is high.

3.3. Autoclaved facade sheets, unpainted but covered by inorganic coloured layer

Facades were occasionally finished in Poland with autoclaved sheets. These sheets were formed by dry technology, then coated with admixtures of powdered coloured quartz grains, pressed again and autoclaved (typical grain dimension 0 – 0.2 mm). Our observations suggest

that the layer rich in quartz grains and well connected with the A plate provides good protection from corrosion.

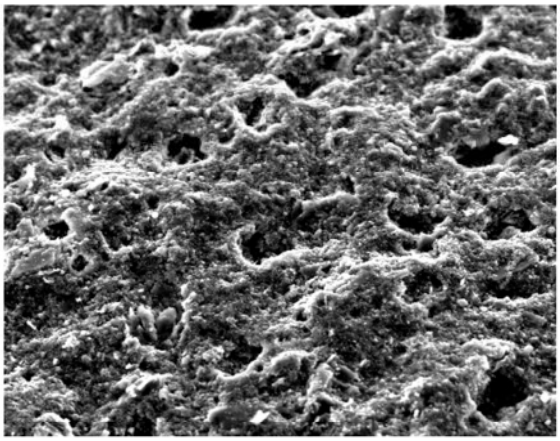

Photo 6. Magnification 100×

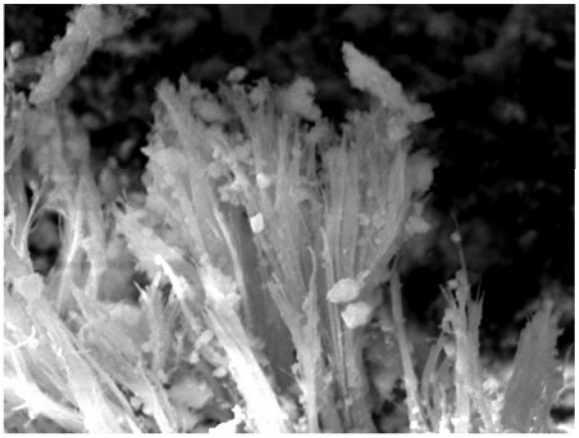

Photo 7. Magnification 1500×

Samples were taken from the facade of a multi-storey building in a medium polluted industrial area in central Poland, where acid rain is rather frequent. The building and the facade were over 28 years old.

Asbestos was not visible on the surface of any of the samples observed at lower magnification (photo 6.). Nevertheless, corrosion is significant. On the surface a number of craters are clearly visible.

At a higher magnification it is possible to have a look in these craters (holes). Inside these craters corrosion washed out the cement matrix and asbestos fibres are visible.

On the asbestos fibres, cement-water reaction products form small, differently shaped grains. These are mostly calcium silicate hydrates partly carbonised.

Further observation showed that corrosion may lead to scaling effects and the coloured layer may partly drop out. The drop out effect causes high risk of asbestos dust release.

3.4. Corrugated sheets from cooling tower

In traditional cooling towers an increase of the surface of heat exchange between water and air may be obtained by inserting into the tower a number of AC sheets. The sheets are continuously washed by water. The average temperature in cooling towers is over 20 $^{\circ}$C

The samples examined were from a cooling tower 15 years old, which means that for15 years they were washed with water. The sheets, in relatively good condition, had been exchanged for thinner PVC sheets to achieve an increased total surface area. (Neglecting other technical details, as a result, the final water temperature is lower, so cooling efficiency is improved.)

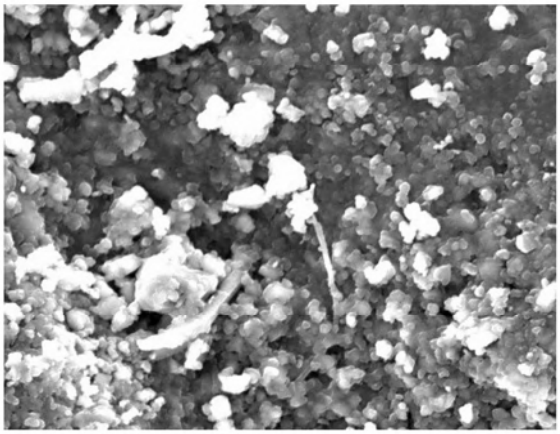

Photo 8. Magnification 500×

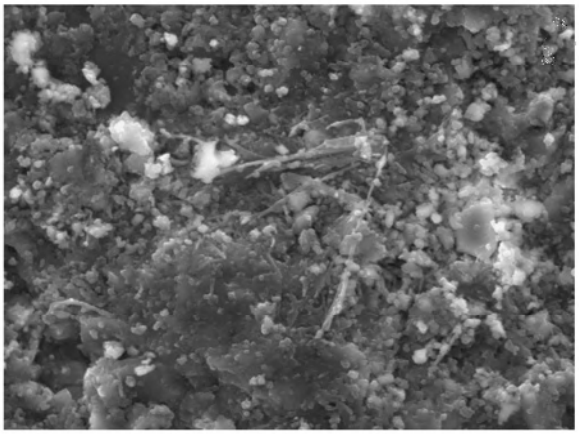

Photo 9. Magnification 500×

The presented SEM observations of these sheets – Photos 8 and 9 – occasionally show asbestos fibres: rather short and partly covered by cement-water reaction products.

As long as plates are wet, and are not submitted to any mechanical action like, e.g., stripping, risk of asbestos pollution is small. After drying the risk becomes serious.

3.5. Element of ventilation chimney collecting also exhaust gases from gas water heaters

The next photos, 10 and 11, present typical results of SEM observation of the inside surface of elements of a ventilation chimney. These chimneys also vented exhaust gases from gas water heaters. Exhaust gases were wet; temperature of these fumes only occasionally exceeded 100^0C.

The observed samples were taken from 23 years old AC elements of this ventilation system.

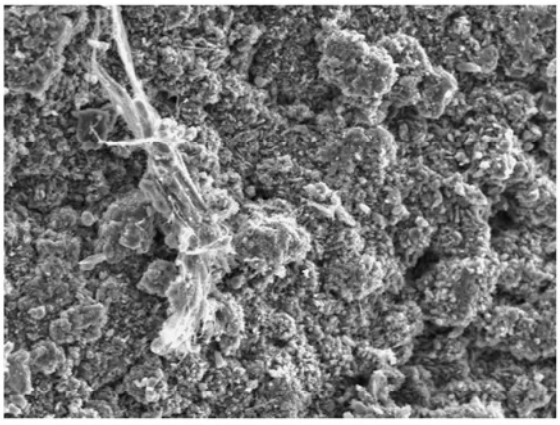

Photo 10. Magnification 300×

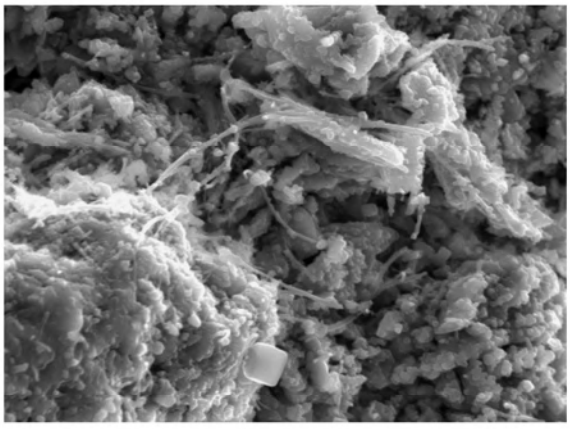

Photo 11. Magnification 1500×

Seemingly, the elements of the ventilation chimney looked well, but the inside surface was corroded and carbonised.

Observed exposed asbestos fibres are partly covered with aggregates of calcium carbonate small crystals (Photo 11) and are poorly connected to the sheet surface (Photo 10). Risk of asbestos dust release is significant.

3.6. The risk of asbestos dust release due to mechanical damage

For a number of reasons AC products may be mechanically broken down or cracked. Presence of cracks, split-off or broken AC sheets are particularly dangerous. See Photo 12.

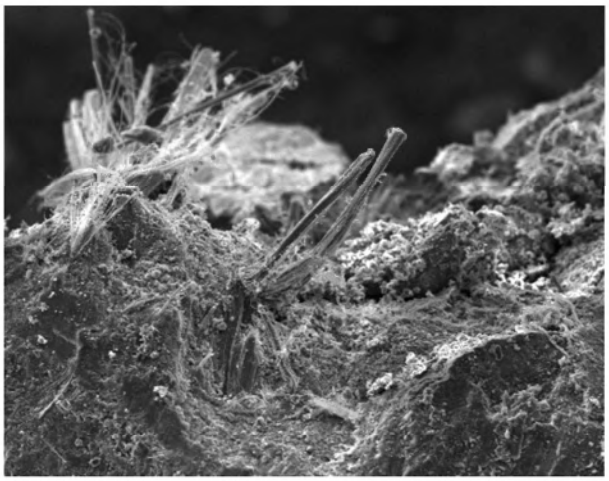

Photo 12. Magnification 200×

From the surface formed by breaking (more or less perpendicular to the sheet surface) a number of asbestos fibres are sticking out. This is due to the pull out effect. The pull out effect accompanies the cracking process in composites reinforced by short fibres. When, under bending or shear, stress cracks gradually open, some fibres are broken and some are pulled out. Fibres are pulled out because the mechanical strength of these fibres is higher than the strength of their attachment to the matrix.

Any mechanical influence on these protruding fibres may produce a large number of asbestos dust particles.

It should be emphasised, that the fibres in Photo 12 and in earlier photos, independently of magnification, differ in length and in dimensions. In fact, we observe not single asbestos crystals but fibres formed by hundreds and often thousands of asbestos long mono-crystals. Indeed, we observe bunches of a number of asbestos mono-crystals.

Forces keeping single fibres–mono-crystals together in the bunch are rather weak.

From one asbestos fibre, protruding as we see on Photo 12, we may get hundreds or thousands of respirable asbestos fibres; it is only a question of even feeble mechanical action or other tension. For example, movement caused by thermal expansion could be sufficient.

4. Conclusions

AC product service life differs according to environmental influences. In polluted regions, AC roof sheet corrosion is accelerated by acid rain. In the corrosion process the matrix binding asbestos fibres is washed out, leading to unveiling of the fibres (asbestos fibre exposure). Exposed asbestos fibres may cause asbestos dust release.

The risk of fibre liberation increases proportionally with corrosion. But independently of the degree of corrosion, any cracks in or other mechanical damage to AC sheets (and other AC products) lead to a high risk of asbestos dust release.

Annexure I

आई सी एम आर – राष्ट्रीय व्यावसायिक स्वास्थ्य संस्थान
स्वास्थ्य अनुसंधान विभाग, स्वास्थ्य और परिवार
कल्याण मंत्रालय, भारत सरकार

ICMR - National Institute of Occupational Health
Department of Health Research, Ministry of Health
and Family Welfare, Government of India

No. 1/RTI/2022-23/1549

Date: 14.12.2023
By speed post

Sh. Raja Singh
c/o Gurmit Singh,
E 205/206, GF, Amar Colony,
Lajpat Nagar 4, New Delhi,
Pin:110024

Sub: Your RTI application vide Reg. NIOHA/R/E/23/00013 dated 30/11/2023- reg.

Sir,
Please refer to your above mentioned application under RTI Act, 2005. The response to the questions are furnished below:

	Information Sought	Response
1	Provide the list of the funders of the above study.	Name of the funders. 1. M/o Chemicals & Fertilizers, Dept. of Chemicals & Petrochemicals, Govt. of India, New Delhi. 2. The Asbestos Cement Products Manufactures Association
2	Provide the list wise amount of fund in rupees received allocated by the various agencies including, but not limited to Ministry of Chemicals and Fertilizers, the Asbestos Cement Products Manufacturers Association, etc.	1. M/o Chemicals & Fertilizers, Dept. of Chemicals & Petrochemicals, Govt. of India, New Delhi : - Amount Received Rs.41.73 lakh 2. The Asbestos Cement Products Manufactures Association:- Rs.16 lakhs
3	Please provide a full copy of the file or files related to the study as titled above including all annexed documents, minutes of the meetings, file notations, internal memorandums and all other documents.	Scanned full copy of study report is sent on registered email (sent report attached as annexure 1).
4	Please provide the copy of the ethics approval provided to the study including the application form and the minutes of the meetings for the ethics approval of the above study.	The document is not retrievable.
5	Please provide the methodology chart, if any, apart from the methodology provided in brief in the study itself.	Please refer to attached study report as annexure 1.
6	Please provide the details of the principal investigators, investigators and other designations involved in the study.	Please refer to attached study report (annexure 1).
7	Please provide the utilization of funds documents related to the study.	Attached as Annexure 3

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कल्याण मंत्रालय, भारत सरकार

ICMR - National Institute of Occupational Health
Department of Health Research, Ministry of Health
and Family Welfare, Government of India

8	Please provide the validity of the study for non occupational environments where there may asbestos containing materials present.	No information is held.
9	Please provide the date of release of the above mentioned study.	Please refer to attached study report as annexure 1 .
10	Please provide whether there is any other update that has been made to the above mentioned study, or any addendum or annexure, or erratum that has been released after the first publication of the study.	A document in form of minutes pertaining to this study report which was conducted at 27th June 2014 is attached for your reference (annexure 2).

The Appellate Authority w.r.t this application is Dr. Ankit Sheth, Scientist 'E' ICMR-NIOH, Ahmedabad - 380 016.

Thanking you,

Yours faithfully,

(Dr. S D Mishra)
CPIO-Scientific
Scientist D

Annexures:

1. Full report of the Study – copy of email receipt attached
2. Minutes of Meeting -
3. Utilization Certificates - 03 Pages

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Annexure J

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BRIEF REPORT

WILEY AMERICAN JOURNAL OF INDUSTRIAL MEDICINE

Asbestos in commercial indian talc

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Abstract

Background: Easily available commercial Indian talc products widely used in Southeast Asia were examined for the presence of asbestos. Asbestos in talc products carry all risks of asbestos-related disease.

Methods: Using polarizing light microscopy, transmission electron microscopy (TEM), electron diffraction, and X-ray analysis, multiple over-the-counter Indian talc products were examined for the presence of asbestos.

Results: Results In an initial group of five Indian talc products, one was found to contain tremolite asbestos. The second group of eight products was tested and six of eight contained tremolite asbestos as well. No other regulated amphibole was found.

Conclusion: Large quantities of body talc products containing asbestos are used throughout Southeast Asia and are likely to pose a public health risk for asbestos-related diseases, especially for the cancers related to asbestos exposure. The country of origin in which the talc examined was sourced for production is unknown to the authors, and further investigation to measure associated public health risk is needed.

KEYWORDS

asbestos, cancer implications, consumer products, Indian talc, tremolite

1 | INTRODUCTION

As the international effort to eliminate asbestos-related diseases continues,[1] public health concerns surrounding the presence of asbestos in consumer talc products persists.[2-5] This is not a recent development.[6] Rohl, Langer, and Selikoff[7,8] raised the awareness of asbestos in talc and personal talc products over 25 years ago. Talc is composed of the elements magnesium, silicon, and oxygen, and is classified as a hydrous silicate mineral.[9] The asbestos-forming minerals serpentine and amphibole form under similar geologic conditions as talc, and are also hydrous silicate minerals containing magnesium, silicon, and oxygen. It is this close mineralogic relationship that is responsible for the common comineralization of talc and asbestos, not to be confused with a contaminant that was added after the mine.[10] Talc has been commercially used in personal hygiene and cosmetic products to aid in keeping skin dry and prevent rashes, as this mineral can be finely ground, provide absorbent anticaking properties, and promotes a soft, cool feel.[4,5,9]

Since the late 19th century, the intimate relationship between talc and asbestos formations has been observed by the geological and industrial communities.[7,8,10-13] The International Agency for Research on Cancer (IARC) recognizes this relationship and holds the position that any talc supply or products that contain asbestos should be treated as asbestos, accordingly a Group I carcinogen. In fact, the IARC Working Group decided to expand the name of the Group I carcinogen from "talc containing asbestiform fibers" to "talc containing asbestos or other asbestiform fibers," which "should be understood to mean any mineral, including talc," when it grows in the asbestiform habit.[5] It is, therefore, relevant to consider what the medical implications and public health consequences are for

populations which are exposed to these substances in domestic settings in addition to traditional workplace settings.

The medical implications of using talc products containing asbestos include the malignant and nonmalignant diseases associated with any asbestos exposure as well as those related to talc.[5] IARC has established a causal association between all forms of asbestos exposure and cancer of the larynx, lung, ovaries, peritoneal mesothelioma, and pleural mesothelioma.[5] Nonmalignant diseases associated with asbestos include asbestosis, asbestos warts, and pleural effusion, pleural plaques, and diffuse pleural fibrosis[5,14] Other reports of disease among those exposed to asbestos include renal, oropharyngeal, and gastrointestinal cancers.[14,15] Talc without asbestos can itself produce talcosis.[16,17]

A review of the literature that examines asbestiform materials not regulated as asbestos finds that either deposits with only true asbestos are being reported on with no admixed minerals. When there is evidence of asbestiform materials as part of the talc deposit there is usually also evidence of regulated asbestos fibers; therefore, it is difficult to state what role just nonasbestos asbestiform materials on their own may be playing in the health of those populations studied.[18]

The World Health Organization (WHO) reports that 125 million people are occupationally exposed to asbestos worldwide and that approximately half of all occupational cancer deaths are believed to be caused by asbestos.[1] The WHO further states that global asbestos exposure in the home is associated with several thousand deaths annually.[1] There are no population estimates of those exposed to asbestos contaminants in personal care products; therefore, substantial data to measure the past and future asbestos-induced burden of disease are not available. This lack of adequate data is significant when considering the traditional underreporting of diseases, such as mesothelioma.[19]

While Western countries, such as the United States, have the capability to engage in the surveillance of diseases, such as mesothelioma,[20] many developing nations throughout Southeast Asia exercise minimal to no mesothelioma surveillance.[21] In addition to the minimal surveillance of asbestos-related diseases in Southeast Asia, the majority of these countries continue to permit the commercial use of asbestos despite its health effects,[22,23] which is counter to the trends in global asbestos production and consumption.[23] The combination of these circumstances amplifies the challenge for public health.

Many of these nations, such as India and other Southeast Asian countries, face the risk of dermal heat disorders due to the hot and tropical climate.[24,25] One such disorder is miliaria, a widely recognized, heat-induced dermatitis that presents as a rash and has been documented since the time of Hippocrates.[26] In modern vernacular, the condition is commonly referred to as "prickly heat".[26] The risk of miliaria is significant for anyone exposed to a hot and humid climate. Those of lower socioeconomic status, who usually have more exposure to these conditions, are at elevated risk.[25] In India alone, the population exceeds 1.33 billion, representing a significant portion of the global population exposed to the risk of heat stress.[27]

To combat the risk of sweat-induced dermatitis, major manufacturers market talcum powders (cosmetic-grade talc) to the Indian and greater Southeast Asian populations.[16] These powders are advertised to cool against the effects of "prickly heat" and some claim to have bacteriostatic effects. These powders come in a variety of scents that would appeal to a wide range of consumers.

In light of the recent evidence of the asbestos contamination (or, more accurately asbestos comineralization) and subsequent personal injury litigation related to personal hygiene and cosmetic talc products sold in the West, the objective of this study was to determine if similar product contamination is observed in cosmetic talc sold in the East, as it is known that commercial talc deposits exist in India[2,3,10,28-30]

2 | METHODS

2.1 | Analytical procedures

Polarized Light Microscopy (PLM) and Transmission Electron Microscopy (TEM) analyses were conducted following the analytical procedures described in the U.S. Environmental Protection Agency "Test Method EPA/600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials". PLM analyses were conducted on a Leica DM750P petrographic microscope with cross-polarized filters, wave retardation, and dispersion staining techniques at magnifications up to 400×. TEM analyses were conducted on a JEOL 2000FX TEM equipped with energy-dispersive X-ray analysis (EDXA) and selected-area electron diffraction (SAED) at magnifications up to 50,000×, at an accelerating voltage of 100KeV. Since it has been repeatedly found that countable asbestos structures can occur in talc below the resolution of PLM7,[31] TEM analysis was conducted on all samples when definitive results were not obtained through PLM alone. Further, it has been shown that as little as 0.001% of asbestos in loose clay soil can produce around 0.1 fiber/cc of asbestos in the air with a respirable dust concentration of around 5 mg/m^3.[32]

Data from Libby, Montana, and other sites in the US provide evidence that soil/debris containing significantly less than 1% asbestos can release unacceptable air concentrations of all types of asbestos fibers (ie, serpentine chrysotile and amphibole tremolite).[33] The TEM analytical area of final preparations was therefore expanded to increase analytical sensitivity, i.e., the area of the final filter analyzed was increased to facilitate detection of lower asbestos fiber concentrations.

Quantification of countable asbestos structures per gram weight talc (str/g) was facilitated in TEM final analyses based on the asbestos counting criteria for structures containing fibers greater than 0.5 micrometers in length with at least a 5:1 aspect ratio, as described in the Asbestos Hazard Emergency Response Act (AHERA) and ASTM methods D6281, D5755, D5756, and D6480, as well as in ISO 10312 and 13794. These counting criteria are consistent with the procedure for the analysis of talc for asbestos as published by Millette.[34] Also consistent with Millette, analytical sensitivity varied based on total filter particle loading and area analyzed.[34-36]

2.2 | Preparations

The samples were prepared for PLM analysis by initial examination under a stereomicroscope at magnifications between 4 to 20×. Grain mounts were representative of the homogeneous powder constructed using appropriate refractive index liquid(s) for the determination of optical characteristics consistent with the asbestos-forming minerals. For electron microscopy analysis, a portion of the sample was weighed and suspended in an alcohol/ deionized water mix. Measured aliquots of the sample suspension were then filtered through a 0.2 µm mixed cellulose ester filter (MCE). The final MCE filter was dried, collapsed with acetone, and coated with carbon in a vacuum evaporator. The fibers and solids collected on the carbon-coated filter replicate were transferred onto copper grids for TEM analysis.

2.3 | Detection limits

All TEM scans in this analysis were at a minimum of 200 grid openings for samples where no fibers are identified. If there are abundant fibers, that number can decline significantly when a smaller number of grid openings demonstrate sufficient concentration calculation. The analytical sensitivity is therefore variable based on the overall loading of the filter, the number of grid openings, analyzed aliquot of the suspension, size of the individual grid openings, and weight of the original talc suspended. Of course, the actual size of fiber can vary greatly, so concentrations calculated as asbestos structures per gram are not directly comparable to a weight percent or parts per million value.

Detection limits in this study, therefore, varied from sample to sample, depending on the optimum suspension dilution required to achieve appropriate loading, as well as relative ease or difficulty in finding the asbestos fibers on the final filtrations. Generally, the lowest detection limits calculated were for those samples where no fibers were detected, in the 1×10^6 structures per gram range, which would equate to <0.0001% by weight, assuming average fibers of 5 µm x 0.25 µm, and the specific gravity of those fibers based on the mineral tremolite (the most common asbestos type determined in this study).

Each sample was prepared by suspending 20 to 80 mg of the talc product in 400 mL of water/alcohol mix, followed by filtering 1 to 5 mL of that suspension onto a 47 mm filter, which was then prepared for direct examination under TEM on copper grids. The analysis is an initial scan of the preparations, a minimum of two grids each containing 100 grid openings of variable size (usually approximately 0.01 mm^2) are scanned at 1200×, and individual fibrous structures evaluated at 25,000× (chemistry by EDS, crystal structure by diffraction, and fiber morphology, eg, length and width).

2.4 | Initial sample set

In February 2015, five samples of commonly available, over-the-counter brands of cosmetic talcum powders were purchased in India; some products were manufactured by multi-national corporations that originated in the United States. The mining source and location of talc used in these products are unknown. These purchases were made on the open market available to all Indian customers. The products were marketed for personal application as "beat the heat" fragranced talcum powders to be applied to the skin of the consumer. All samples were shipped to a testing laboratory for the purpose of evaluation. The product samples were labeled as 1) *"IA Talc,"* 2) *"IB Talc,"* 3) *"IC Talc,"* 4)*"ID Talc,"* and 5)*"IE Talc."*

Testing of these talc products was conducted to assess the presence of asbestos, and whether the asbestos present in these samples was aerosolizeable and quantifiable. When testing is conducted for asbestos and talc in the lab setting, the presence of fibrous talc and possible transitional structures are noted when observed. The samples were tested to include examination by SAED) and EDXA; a.k.a., EDS or EDX).

2.5 | Repeat testing of initial sample set

To confirm the first test results, these original five samples underwent a repeat analysis using the same test methods. The presence of asbestos, specifically, asbestiform tremolite, was confirmed in one of the products (*"ID Talc"*). As the presence of asbestos in this commonly available talc product was found to be substantial and repeatable, it was decided that further testing of other available personal hygiene talcs from India was warranted. The testing lab made online purchases of four additional varieties of talc products sold by the same manufacturer as the above product, as well as four varieties of another talcum brand (*"IA Talc"*) through an Indian-based retail outlet.

2.6 | Second sample set

This second set of samples were labeled as (1)*"ID.1 Talc,"* (2)*"ID.2 Talc,"* (3)*"ID.3 Talc,"* (4) *"ID.4 Talc,"* (5)*"IA.1 Talc,"* (6)*"IA.2 Talc,"* (7)*"IA.3 Talc,"* and (8)*"IA.4 Talc."* The samples were tested in the same manner as the initial sample set for the presence of asbestos in those products using the same analytical methods.

3 | RESULTS

3.1 | Initial sample set product: analyses, light microscopy

In the initial sample set, analysis of preparations revealed abundant mineral particulate, including platy and fibrous talc in all products tested (see Table 1). PLM analysis was able to determine that the products contained fibers with optical properties consistent with talc and some possible asbestiform amphiboles. Overall, the talc product was found to be fibrous by light microscopy. Preparations of the sample were, therefore, made for the determination of potential asbestos content by TEM.

TABLE 1 Initial sample set analytical summary

Product (initial sample set)	First qualitative assessment of tremolite asbestos Presence: *Yes or No*	Second qualitative assessment of tremolite asbestos Presence: *Yes or No*
IA Talc	*No*	*No*
IB Talc	*No*	*No*
IC Talc	*No*	*No*
ID Talc	*Yes*	*Yes*
IE Talc	*No*	*No*

TABLE 2 Second sample set analytical summary

Product (second sample set)	PLM findings of abundant mineral fibers including fibrous talc?	TEM quantitative identification of tremolite asbestos?
IA.1 Talc	*Yes*	*Yes*
IA.2 Talc	*Yes*	*Yes*
IA.3 Talc	*Yes*	*Yes*
IA.4 Talc	*Yes*	*Yes*
ID.1 Talc	*Yes*	*No*
ID.2 Talc	*Yes*	*No*
ID.3 Talc	*Yes*	*No*
ID.4 Talc	*Yes*	*Yes*

3.2 | Initial sample set: Asbestos analysis

Subsequent analysis of the initial set by TEM analysis confirmed the PLM findings of abundant mineral fibers including fibrous talc in all of the initial Indian talc products tested. Fibrous talc is noted when the mineral appears as fibrous or bundles both by light microscopy, such as PLM, and electron microscopy, such as TEM. The presence of asbestos, specifically asbestiform tremolite, was confirmed only in the *"ID Talc"* product (see Figure 1); the asbestiform structures were of a countable concentration above baseline background.[34] This is classified as substantial asbestos, that is, asbestos fibrous structures were found meeting the counting criteria of all airborne asbestos containing methods.[35,37-39]

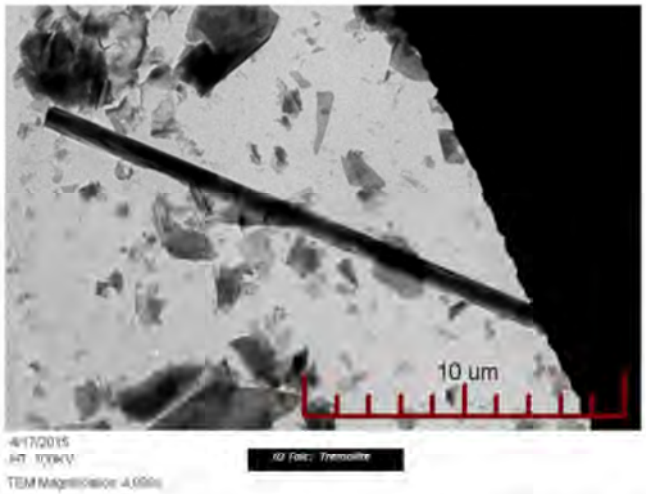

FIGURE 1 Tremolite asbestos fiber in "*ID Talc*," found in the first testing of this product. TEM magnification 4000×. Total fiber dimensions 61.5 μm long by 0.5 μm wide equates aspect ratio >120:1 This figure shows the part of the fiber extending into the grid opening. The majority of the fiber-structure length extends underneath the copper grid bar (to the right of the structure), extending into the adjacent grid opening. As can be seen from the micron marker, less than one-third of the entire length was captured in this image. This image demonstrates well the amphibole details alongside platy/sheets of talc. TEM, transmission electron microscopy [Color figure can be viewed at wileyonlinelibrary.com]

3.3 | Second sample set: PLM and TEM analyses for fibrous talc and asbestos

PLM findings of abundant mineral fibers including fibrous talc was evident in all of the second sample set of products. TEM analysis was able to qualitatively identify tremolite asbestos present in *"ID.4 Talc"* and the *"IA.1 Talc," "IA.2 Talc," "IA.3 Talc," and "IA.4 Talc"* products (see Table 2 and Figures 2-5). Asbestiform tremolite fiber str/g were also quantified for these same talc products. Concentrations of tremolite asbestos in the products were calculated for structures less than 5 μm and greater than 5 μm; the sum of the structure totals (less than 5 μm and greater than 5 μm) are reported as all structures (see Table 3). Among these,*"IA.3 Talc"* had the lowest total tremolite asbestos at a sum of 4.55 million str/g, with higher levels in*"IA.1 Talc"* (10.5 million structures per gram), *"IA.2 Talc"* (14.4 million str/g), *"IA.4 Talc"* (20.4 million str/g), and *"ID.4 Talc,"* which contained a sum of 59.9 million str/g of tremolite asbestos.

3.4 | Asbestiform talc structures detected in samples

Abundant fibrous structures of the mineral talc were identified in the cosmetic talcum powders tested. Two basic morphologies were common of the fibrous talc: more parallel fibers or "bundle of sticks" talc structures were observed, in addition to more lath-like "ribbons" of talc, often exhibiting kinks, beds, or folds. Although many of these structures would be countable as asbestos if they were the minerals regulated as such, the use of the term "asbestiform" when describing talc is controversial. As talc is a replacement mineral that does not crystallize from molten rock, it is often pseudomorphic after the protolith, that is, forms the shape of the mother rock from which it was derived.

Although it is common to observe the mineral anthophyllite in association with talc, that mineral was not observed in any of the samples in this study. Fibrous talc was observed in all of the samples analyzed for this study, occasionally in abundance, but talc fibers or fiber structures were not quantified, as there are no published methods or counting criteria for talc fibers or complex structures.

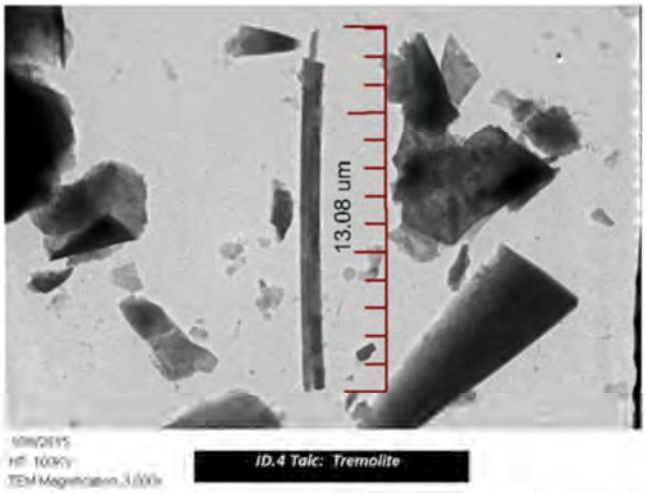

FIGURE 2 Tremolite asbestos fiber bundle in "*ID.4 Talc*," found in the second batch of testing this product.TEM magnification 3000×. Bundle dimensions are 13.1 μm long by 0.74 μm wide. Bundle thickness comprises numerous individual fibers within the structure; therefore, length to width aspect ratios should be based on constituents rather than whole bundle widths. As this structure comprises over a dozen individual fibers, it is inappropriate to calculate aspect ratio as 13.1/0.74 = 1:17.7, as known individual fibers greatly exceed that aspect. TEM, transmission electron microscopy [Color figure can be viewed at wileyonlinelibrary.com]

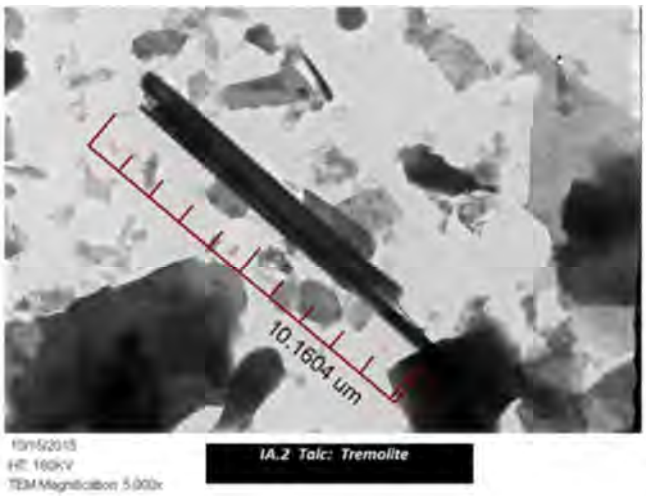

FIGURE 3 Tremolite asbestos fiber bundle in "*IA.2 Talc*," found in the first testing of this product. TEM magnification 5000×. Constituent fibers >10 μm in length, less than 0.1 μm in width demonstrate aspect ratios up to and exceeding 100:1. Note both platy and fibrous talc also observed.As a bundle is defined as three or more fibers (or 2, by the International Organization for Standardization (ISO)) parallel and not separated by more than the width of a fiber, a bundle contains constituent fibers by definition. The micron marker was placed on the image when at the scope. This provided the ability to resolve the other end through the crystal from which it protrudes (conservative analysis indicates aspect ratios exceeding 100:1) [Color figure can be viewed at wileyonlinelibrary.com]

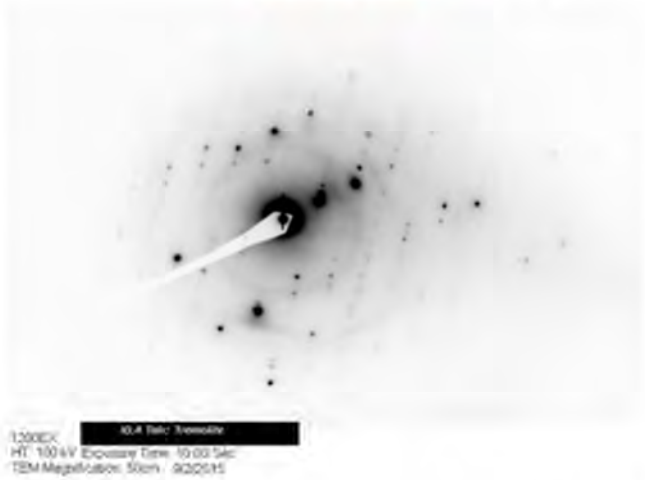

FIGURE 4 Selected-area electron diffraction (SAED) of tremolite structure found in the Indian talc product "*ID.4 Talc*." All asbestos structures used in the calculation of concentrations in this report were confirmed by morphology, chemistry (by energy-dispersive X-ray analysis: EDXA/EDS), and crystalline structure as demonstrated here by diffraction (SAED). Notice the 5.3 Å repeat of streaking lines consistent with the amphibole structure, and the arcing brighter bands demonstrating a nearby crystal zone axis

Analysis and quantifications were therefore limited to the six minerals regulated as asbestos, with established counting criteria.

4 | DISCUSSION

This product study of various talcum powders marketed to combat prickly heat, purchased from Indian retailers both over-the-counter and online, demonstrates the ease of general population access to such products and the potential for significant exposure to asbestos. The analytical results of this study confirm that asbestos exposure of the Indian and potentially greater Southeast Asian populations is not limited to traditional occupational settings. Products sampled in this study are sold in containers with 150 grams of product or more. For those products that tested positive for tremolite asbestos, the total product contamination for their containers ranges between a low of 600 million asbestos structures to high of 8 billion asbestos structures. These findings imply that the asbestos-related medical and public health implications to consider will need to extend to persons of both genders and all ages among this population group.

This study's confirmation of an underappreciated source of asbestos exposure, through personal care products, also highlights the risk that anyone within breathing range of these aerosolizeable, contaminated, talcum products incurs. With products of this nature being readily available and appealing to both genders, it is necessary to consider what the potential health risks and burdens of disease are for millions of exposed women of childbearing age and the children for whom they provide care. IARC has confirmed the causal association of asbestos with ovarian cancer and other cancers.[5] Shifts in perspective in epidemiologic surveillance are needed to

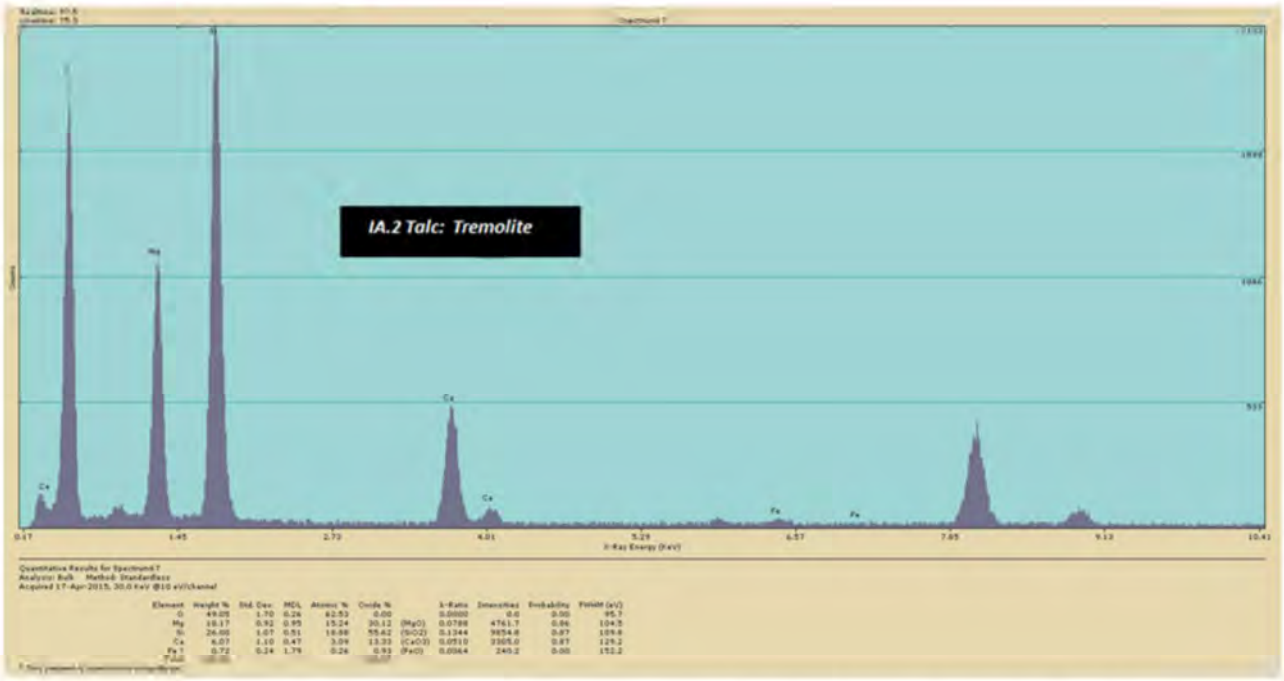

FIGURE 5 Energy-dispersive X-ray spectrum (EDX/EDS) showing chemistry of amphibole structure pictured in Figure 3 (tremolite bundle in "*IA.2 Talc*"). Relative ratios of magnesium (Mg), silica (Si), calcium (Ca), and iron (Fe) are consistent with the recognized chemical formula for the mineral tremolite: {Ca2}{Mg5.0-0.5Fe0.0-0.5}(Si8O22)(OH)2. Other peaks observed include oxygen (O) observable from the low-element detector used, and copper (Cu) resulting from the copper grid sample substrate [Color figure can be viewed at wileyonlinelibrary.com]

consider how to better collect, analyze, and disseminate data that apply to these consumer product exposures. It may also help us better understand a previously underappreciated source of exposure for those with asbestos-related cancers when no history of exposure can be elicited from those individuals.

A necessary measure to promote public health is to mandate quality control standards that guarantee all talc intentionally added as an ingredient to consumer products is tested before production and repeated testing is applied during production. Analyses conducted by the most rigorous and sensitive methods possible are required to assure the absence (ie, nondetectability) of asbestos in products. Further, records of where the talc was mined, and the specific records of testing must be maintained. End-users and manufacturers of those talc or talcum powder products should be held accountable for this information and make it available to consumers.

India's Consumer Protection Bill 2018 proposed legislation that would provide a measure of increased consumer protection; although, it remains under pending status in parliament.[40,41] If this or a similar bill eventually passes, India will be taking needed steps toward (a) establishing a central consumer protection authority, (b) subjecting manufacturers to imprisonment if they are found guilty of false or misleading advertising, (c) subjecting manufacturers to imprisonment if they are found guilty of the sale, storage, distribution, or importing of products that contain adulterants, and (d) introducing product liability action and class action concepts as avenues for consumer compensation.[40]

While the passage of this bill is a start toward protecting public health in general, until asbestos is also viewed as a hazard in India and banned, there will still be considerable risk to health.[5,21] The presence of amphibole asbestos (tremolite) among the products analyzed in this study confirms that asbestos exposure in India and potentially beyond is not limited to occupational origins. This heightened awareness of tremolite exposure in consumer products in India should also raise public health concern for the country that utilizes roughly 350,000 tons of chrysotile asbestos in approximately

TABLE 3 Tremolite asbestos structures count per gram (str/g) product

Product	Structures <5 μm	Structures ≥5 μm	All Structures
IA.1 Talc	6,280,000 str/g	4,190,000 str/g	10.5 million str/g
IA.2 Talc	7,210,000 str/g	7,210,000 str/g	14.4 million str/g
IA.3 Talc	3,030,000 str/g	1,520,000 str/g	4.55 million str/g
IA.4 Talc	15,300,000 str/g	5,090,000 str/g	20.4 million str/g
ID.4 Talc	20,000,000 str/g	39,900,000 str/g	59.9 million str/g

100 manufacturing plants—producing products such as cement piping, cement roofing, friction materials, textiles and insulation—with little regulatory oversight.[42] These 100 manufacturing plants employ nearly 300,000 employees.[42]

The products these asbestos using manufacturing plants produce are reaching millions within India alone.

The limitations of this study pertain to its design. The study was designed to demonstrate the potential for health risks and did not endeavor to identify health outcomes. It is not known to the authors where the manufacturers of these products marketed throughout India and Southeast Asia sourced their talc supply. The only fibers analyzed for this study were the six regulated fibers collectively called asbestos.

5 | CONCLUSION

Some global talc deposits are free of asbestos, while others are not.[5,7,8,10-13] Therefore, significant policy updates are necessary to promote product safety and accountability that protects the interest of consumers.[42] Without such measures, millions of people will be at heightened risk for asbestos exposure due to personal care talc products that contain millions of countable asbestos structures in every teaspoon full equivalent and diseases caused by such structures.

It is confirmed that these product samples are among those marketed and sold over-the-counter and online in India and other Southeast Asian countries. It is believed that this is the first report of such findings in India. It carries public health implications for Southeast Asia in general, and perhaps beyond. This study confirms that asbestos exposure in India and potentially elsewhere is possible through nonoccupational avenues previously overlooked.

AUTHOR CONTRIBUTIONS

TKJ conceived the idea for this work assisted with writing and participated in the final approval of the version to be published. EH assisted with writing, conducted bibliographic research, and participated in the final approval of the version to be published. SF assisted with writing, conducted analyses of materials, participated in the final approval of the version to be published, and was engaged in geologic, mineralogic, and laboratory work regarding asbestos, and has been retained by both plaintiffs and defendants in asbestos and talc-related matters. ALF participated in the design of the work, provided bibliographic references, assisted with writing, participated in the final approval of the version to be published, and has engaged in medical/legal work regarding asbestos, generally for plaintiffs.

ETHICS APPROVAL AND INFORMED CONSENT

No reviews and approvals needed, no human subjects.

DISCLOSURE (AUTHORS)

Dr. A.L. Frank regularly engages in medical/legal work regarding asbestos, generally for plaintiffs.

S. Fitzgerald, PG regularly engages in geologic, mineralogic, and laboratory work regarding asbestos, and has been retained by both plaintiffs and defendants in asbestos and talc-related matters.

DISCLOSURE BY AJIM EDITOR OF RECORD

None.

DISCLAIMER

None.

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Annexure K

AMENDMENT NO. 1 SEPTEMBER 2005 TO IS 11769 (PART 1) : 1987 GUIDELINES FOR SAFE USE OF PRODUCTS CONTAINING ASBESTOS

PART 1 ASBESTOS CEMENT PRODUCTS

(*Page* 4, *clause* **2.1**, *first line*) — Substitute 'objectives' *for* 'object'.

(*Page* 4, *clauses* **4.1.1** *and* **4.1.2**) — Interchange the respective matters under the clauses.

(*Page* 7, *clause* **6.3**) — Add the following Note at the end of the clause:

'NOTE — While using slow speed tools such as hand saw or drilling machines, the dust emission levels are observed to be much below 0.5 fibre/cc.'

(*Page* 16, *clause* **9.1**) — Substitute the following for existing clause:

'**9.1** Asbestos cement products shall bear a pictorial warning sign as given in IS 12081 (Part 2) : 1987 'Recommendations for pictorial warning signs and precautionary notices for asbestos and products containing asbestos : Part 2 Asbestos and its products' to caution the users that these products contain asbestos fibre and improper use of these materials may result in generation of asbestos dust, inhalation of which may cause serious damage to health.'

(*Page* 16, *clause* **10.1**, *first line*) — Substitute 'sheet' *for* 'sheat'.

(CED 53)

Reprography Unit, BIS, New Delhi, India

IS : 11769 (Part 1) -1987
(Reaffirmed 2006)
(Reaffirmed 2012)
(Reaffirmed 2017)
(Reaffirmed 2022)

Indian Standard

GUIDELINES FOR SAFE USE OF PRODUCTS CONTAINING ASBESTOS

PART 1 ASBESTOS CEMENT PRODUCTS

(First Reprint DECEMBER 1998)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 5 *July* 1987

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GUIDELINES FOR SAFE USE OF PRODUCTS CONTAINING ASBESTOS

PART 1 ASBESTOS CEMENT PRODUCTS

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(*Continued on page 2*)

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(*Continued on page* 17)

Indian Standard (Reaffirmed 2017)

GUIDELINES FOR SAFE USE OF PRODUCTS CONTAINING ASBESTOS

PART 1 ASBESTOS CEMENT PRODUCTS

0. FOREWORD

0.1 This Indian Standard (Part 1) was adopted by the Bureau of Indian Standards on 30 April 1987, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 In recent years there has been a growing awareness that exposure to asbestos dust can have harmful effects on the health of workers. In order to give guidance on how the risk of exposure to asbestos dust can be prevented, controlled or minimized, it was felt necessary to lay down some standards regarding safe use of different products containing asbestos, improving conditions in workplaces, preventive measures, protection and supervision of the health of workers, packaging and transport, disposal of asbestos waste, etc. This standard laying down guidelines for safe use of products containing asbestos has been prepared in three parts. This part of the standard lays down guidelines for safe use of asbestos cement products. Guidelines for safe use of friction materials containing asbestos and non-cement asbestos products other than friction materials are covered in Parts 2 and 3 respectively.

0.3 Asbestos cement products generally contain 10 to 15 percent asbestos fibres in a cement matrix that comprises the rest of the material and are termed as 'locked-in' asbestos products as these products have the asbestos fibres bound in cement. There is very little possibility of generation of airborne asbestos fibres during any reasonable handling, transport, storage and use of such products. However, during storing and installation, recommended work practices shall be followed to avoid harmful dust exposures.

0.4 In the formulation of this standard, due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from 'ILO Codes of practice: Safety in the use of asbestos', 1984 published by the International Labour Office, Geneva and ISO 7337 Asbestos reinforced cement products—Guidelines for on-site work practices, published by the International Organization for Standardization.

1. SCOPE

1.1 This standard lays down the guidelines for safe use of asbestos cement products.

2. OBJECT

2.1 The objects of this standard is to recommend procedures that shall be adopted to ensure that asbestos cement products are used safely and without harmful emission of asbestos dust.

3. APPLICATION

3.1 The provisions of this standard shall apply to any operation involving a risk of exposure to airborne asbestos dust arising during handling and installation of the following asbestos cement products:

a) Asbestos cement pressure pipes and joints,

b) Asbestos cement building and sanitary pipes and fittings,

c) Asbestos cement sheets and fittings for roofing and cladding, and

d) Asbestos cement flat sheets.

4. RECEIVING AND STORING OF ASBESTOS CEMENT PRODUCTS

4.1 During receiving and storing of products where asbestos is bound such as asbestos cement products, the recommendations given in **4.1.1** to **4.1.6** shall be followed to ensure minimum release of airborne dust, and thus minimum exposure of workers to such airborne asbestos dust.

4.1.1 When manual unloading is done, the pieces shall be lifted individually rather than sliding against abrasive surfaces that might release unnecessary fibres due to friction.

4.1.2 At the final stage of manufacturing or wherever asbestos cement products are being handled in large quantities, mechanical handling equipment shall be used, where practicable.

4.1.3 Individual boards, sheets or other products, when moved manually shall be placed with care on the stack or other resting site

4.1.4 Dropping and dragging of finished asbestos cement products shall be avoided.

4.1.5 All storage of asbestos cement products on site shall be made within a designated area which shall always be maintained clean.

4.1.6 Damaged and crushed pieces shall be suitably disposed of in accordance with the provisions laid down in IS : 11768-1986*.

*Recommendations for disposal of asbestos waste material.

5. WORK ON SITE

5.1 Asbestos cement products shall, where practicable, be delivered to the site ready for use and shall need no further processing which may generate dust.

5.2 Avoid creating dust and use hand tools or slow-running tools, which produce only coarse dust or chips, rather than high-speed machines or those which cut by abrading the material, thus generating inhalable dust.

5.3 When high speed tools are used, they shall be fitted with efficient dust extraction equipment designed for the purpose.

5.4 Abrasive or masonry discs shall not be used for cutting asbestos cement material.

5.5 For hand operations or short time and intermittent use of slow running tools in the open air, special precautions are not normally required.

5.6 When long continuous runs are carried out, dust extraction equipment shall be used with the machines, as in workshop conditions. Wet machining may be adopted, where practicable.

5.7 Sheets to be fixed in an overhead position shall be drilled, trimmed or rasped before they are in place. Where it is necessary to work on sheets in an overhead position and where dust is likely to reach the respiratory zone, a respirator shall be worn. However, such operations shall generally be avoided with proper planning.

5.8 Workplaces shall be kept clean as given in **8.1**.

6. WORKING PROCESSES AND RECOMMENDED TOOLS

6.1 Corrugated Sheets and Fittings — For sheets and fittings, the recommended tools for different working processes are given below:

Mitring	*Cross Cutting*	*Longitudinal Cutting*	*Cut Outs*	*Drilling*
Handsaw	Handsaw	Scriber	Handsaw	Hand-or-power operated drill
Scriber	Jig saw (*see* Note)	Jig saw (*see* Note)	Jig saw (*see* Note)	
Nibbler	Nibbler	Handsaw	Low speed circular saw	
Jig saw (*see* Note)	Low speed circular saw	Nibbler		
Hand-guided band saw		Low speed circular saw		
Low speed circular saw				

NOTE — Other machanically operated saws may be used with special precautions. Circular high speed saws are not recommended.

6.2 Flat Sheets — For flat sheets, the recommended tools for different working processes are given below:

a) General:

Cutting	*Drilling*	*Sanding*	*Cut Outs*
Handsaw	Hand-or-power operated drills	Power-driven sanders	Handsaw
Nibbler up to 10 mm (depending on design)		(This shall not be used unless provided with dust extraction equipment)	Jig saw
Low speed circular saw			Hand-or-power operated drills
			Low speed circular saw

b) For thickness up to 6 mm:

Scriber	Hand-or-power-operated drills	Power-driven sanders	Handsaw
Nibbler		(This shall not be used unless provided with dust extraction equipment)	Nibbler
Hammer shears			Jig saw
Low speed circular saw			Hand-or-power operated drills
			Low speed circular saw

6.3 Pipes — The recommended tools for different working processes of the pipes are given below:

a) For diameter up to 600 mm:

Cutting	*Turning*	*Drilling and Cut Outs*
Handsaw (small diameters)	Hand-operated lathe	Handsaw
Hand-operated lathe cutter	Power-operated lathe	Jig saw with carbide tipped blade

Cutting	*Turning*	*Drilling and Cut Outs*
Power-driven lathe cutter		Hand drill
Jig saw (plus guiding device for diameter 350 to 600 mm)		Power drill
Chain cutter		Hand operated hole cutter
Hand-guided band-saw		Power-driven hole cutter with milling head
Low speed circular saw		Power drill with hardmetal bit

b) For diameter above 600 mm:

Cutting	*Turning*	*Drilling and Cut Outs*
Hand-operated lathe cutter	Hand-operated lathe	Jig saw with carbide tipped blade
Power-driven lathe cutter	Power-operated lathe	Power drill
Chain cutter up to diameter 800		Hand-operated hole cutter
Hand guided bandsaw		Power-driven hole cutter with milling head
Low speed circular saw		Power drill with hardmetal bit

7. TOOLS SPECIFICATION

7.1 Power-Driven Saws Such as Jig Saws, Circular Saws, Band Saws, etc (*see* Fig. 1, 2 and 3)

7.1.1 When working asbestos reinforced cement products with power-driven equipment, such as saws, jig saws and band saws, the fineness of the dust produced depends primarily on the geometry of the saw blade as well as on the blade speed (number of strokes, number of revolutions, etc) of the machine.

7.1.2 With a machine operating at a high frequency together with a fine saw blade, an excessive amount of respirable fine dust is produced due to the grinding action and hence, such type of saw is not recommended.

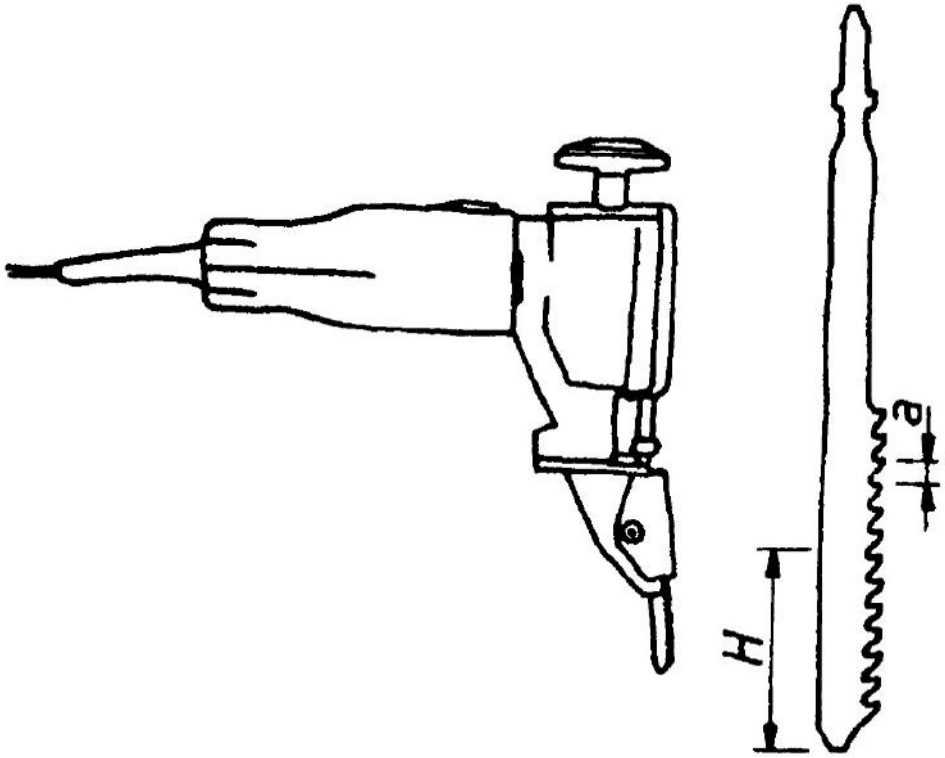

FIG. 1 JIG SAW

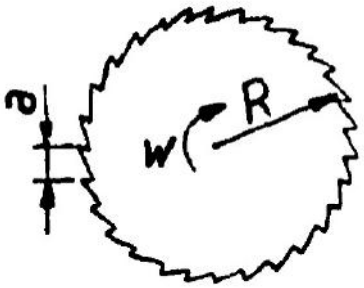

FIG. 2 SAW BLADE OF A CIRCULAR SAW

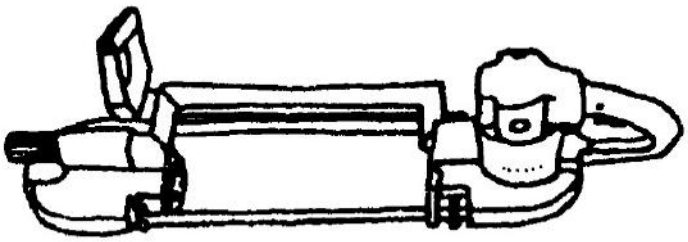

FIG. 3 HAND-GUIDED BAND SAW

7.1.3 With a coarse-toothed saw and a low frequency, a chip-cutting action takes place which produces mainly coarse dust. Under certain conditions such saw does not require any dust extraction equipment.

7.1.4 Low speed circular saws with milling action produce coarse chips and do not require dust extraction.

7.1.5 The type of machinery is assessed by the following formula:

$$d = \frac{va}{k}$$

where

d = calculated chip thickness im μm;

v = rate of feed in mm per minute;

a = tooth spacing in mm;

k = speed of the cutting teeth in mm per minute and is given by the following formula:

$k = Hf$, for reciprocating movement; and

$k = wR = 2\pi Rf$, for radial movement

H = length of stroke in mm;

f = frequency (number of strokes or revolutions) in revolutions per minute;

w = angular velocity in radians per minute; and

R = radius of circular saw blade in mm.

7.1.6 When working without dust extraction, the feed rate shall be so chosen that the required chip thickness is reached under normal operating conditions. For a given frequency of the machine and a given saw blade, the feed rate depends principally on the shearing force as well as the thickness and the properties of the material being cut.

7.1.7 A certain proportion of fine dust will be produced even when operating with a thick chip. For this reason, the required thickness of chip lies considerably above the dimensions of respirable dust particles.

7.1.8 The working process with a rotating saw blade is exactly the same as that of the working stroke of a machine with a reciprocating motion. However, on the return stroke, a grinding effect occurs which produces fine dust. The proportion of fine dust produced during the working stroke is, therefore, to be reduced to compensate for the fine dust produced during the return stroke in order to maintain a similar average dust concentration. Less fine dust is produced on the return stroke when using thick saw blades because of the reduced surface pressure.

7.1.9 The cooling air for a jig saw is often so directed that the fine dust falling from the saw blade is blown away. This sort of air flow is not permissible for working of asbestos reinforced cement products.

7.1.10 Fine dust produced, when a jig saw works with a grinding action, shall be removed by means of concentrated suction apparatus.

7.1.11 Some empirical criteria for working with or without dust extraction device when using saws with rotating and reciprocating blades are given below:

Chip Thickness	*Recommendations*
a) Saws with rotating blades:	
1) $d > 100$ µm	Extraction usually not required
2) $d < 50$ µm	Not recommended for field
3) $50 < d < 100$ µm	Extraction not required for occasional use but required for continuous use
b) Saws with reciprocating blades:	
1) $d > 200$ µm	Extraction usually not required
2) $d < 100$ µm	Not recommended for field
3) $100 < d < 200$ µm	Extraction not required for occasional use but required for continuous use

7.1.12 Circular saws, which work with a grinding action, shall be equipped with dust extraction comprising upper and lower suction. The lower extracter shall be adjustable and shall be so arranged that, in every case, the extractor touches the underside of the sheet. This is again not recommended for use in the field.

7.2 Power-Driven Nibblers — For power-driven nibblers, calculated chip thickness is assessed by the following formula:

$$d = \frac{v}{f}$$

7.2.1 *Tools with a Punching Action (see Fig. 4)*

7.2.1.1 These tools work in such a way that the piston of the aggregate moves up and through the sheet to be adjusted. One cut of approximately 10 mm width is effected per stroke.

7.2.1.2 The cut edge of the sheet becomes chamfered, the trace being wider on the underside of the sheet. This effect increases with the thickness of the sheet.

7.2.1.3 Extraction is not required if the calculated chip thickness satisfies the following conditions:

$$d > 500\ \mu m$$

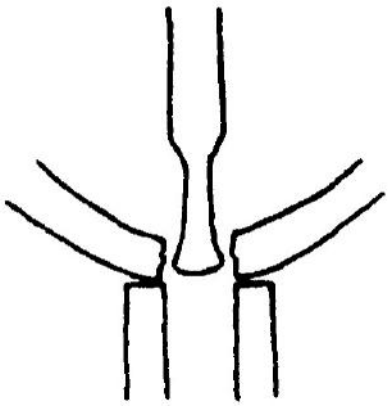

FIG. 4 TOOL WITH PUNCHING ACTION

7.2.2 *Tools with a Shearing Action* (*see Fig.* 5)

7.2.2.1 These tools work in such a way that the knife of the cutting aggregate moves up and down between two stationery jaws. The cutting edge of the sheet is perpendicular to the surfaces of the sheet.

7.2.2.2 Cutting from the back of the sheet effects absolutely sharp edges on the top side of the sheet (particularly autoclaved sheets).

7.2.2.3 The sheering action does not actually produce chips. The asbestos-cement material between the two stationary jaws becomes highly compressed and is peeled off continuously. This compression effects adequate stress of the blade. Working of asbestos-cement products with shearing tools is, therefore, limited to flat sheets up to approximately 8 mm.

7.2.2.4 In spite of the fact that chips are not really produced, a theoretical chip thickness may be calculated. Extraction is not required if the calculated chip thickness satisfies the following condition:

$$d > 200\ \mu m$$

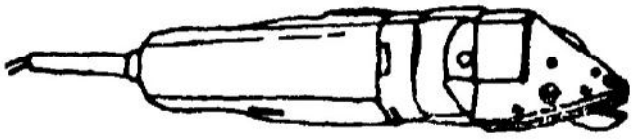

FIG. 5 TOOL WITH SHEARING ACTION

7.3 Tools for Working Pipes

7.3.1 *Lathe Cutter, Lathe and Hole Cutter* — These tools work by means of a rotating hardmetal chisel (or even two for a hole cutter) fixed on a turning frame.

7.3.1.1 *Lathe cutter* (*see Fig.* 6) — The lathe cutter, when completely assembled, may be pushed over the pipe or may be assembled around the pipe in the trench. The pipe is cut by a hardmetal chisel which rotates around the pipe. Closer adjustments of the chisel may be made by hand or with a screw nut. Lathe cutters are available with manual turning handles or optional power drive.

This operation produces coarse dust because of the low frequency. Dust extraction is unnecessary.

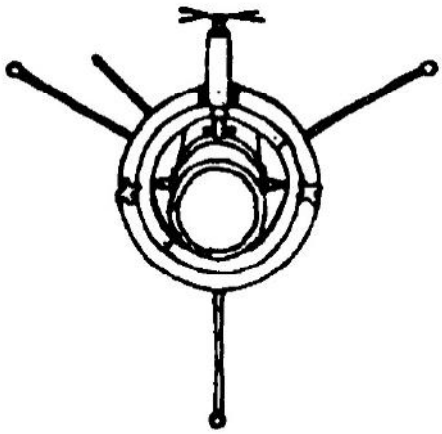

FIG. 6 LATHE CUTTER

7.3.1.2 *Lathe* (*see Fig.* 7) — The lathe used to end-trim and re-machine rough pipe-barrels to the necessary end profiles consists of an adjustable self-aligning arbor inserted into the pipe bore, a screw-fed turning frame, blades and manual turning handles or an optional power drive.

This operation produces coarse dust because of the low frequency. Dust extraction is not recommended.

7.3.1.3 *Hole cutter* (*see Fig.* 8) — The hole cutter consists of a turning frame, two chisels and manual turning handles or optional power drive. The turning frame is affixed in the pipe barrel.

This operation at a low frequency produces little dust. Dust extraction is unnecessary.

7.3.2 *Jig Saw* (*see Fig.* 9) — Large jig saws for cutting pipes up to 600 mm diameter consist of a driving engine of approximately 700 W or more and hardmetal toothed saw blade of a length up to 1 000 mm.

For stability reasons, this cutting unit needs a guiding and holding device to cut pipes with diameters exceeding 350 mm.

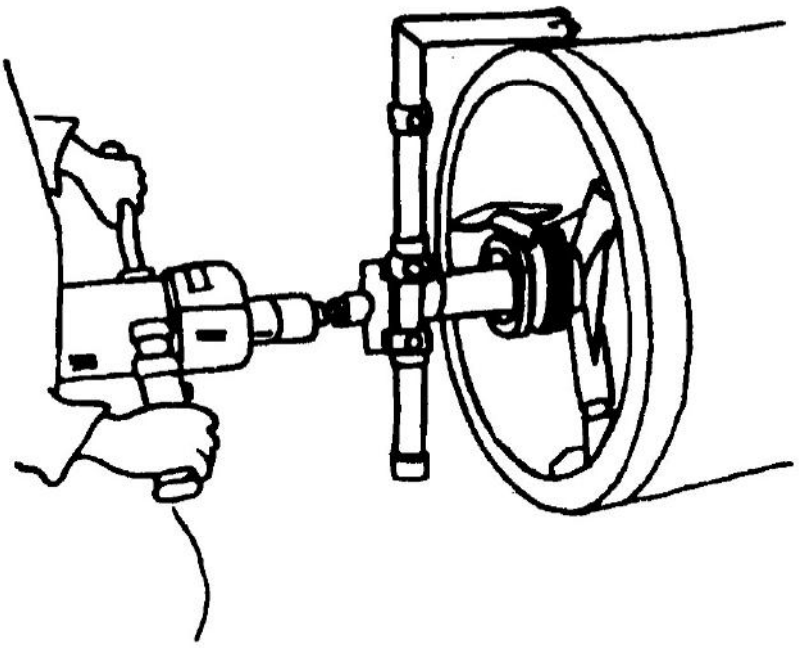

FIG. 7 LATHE

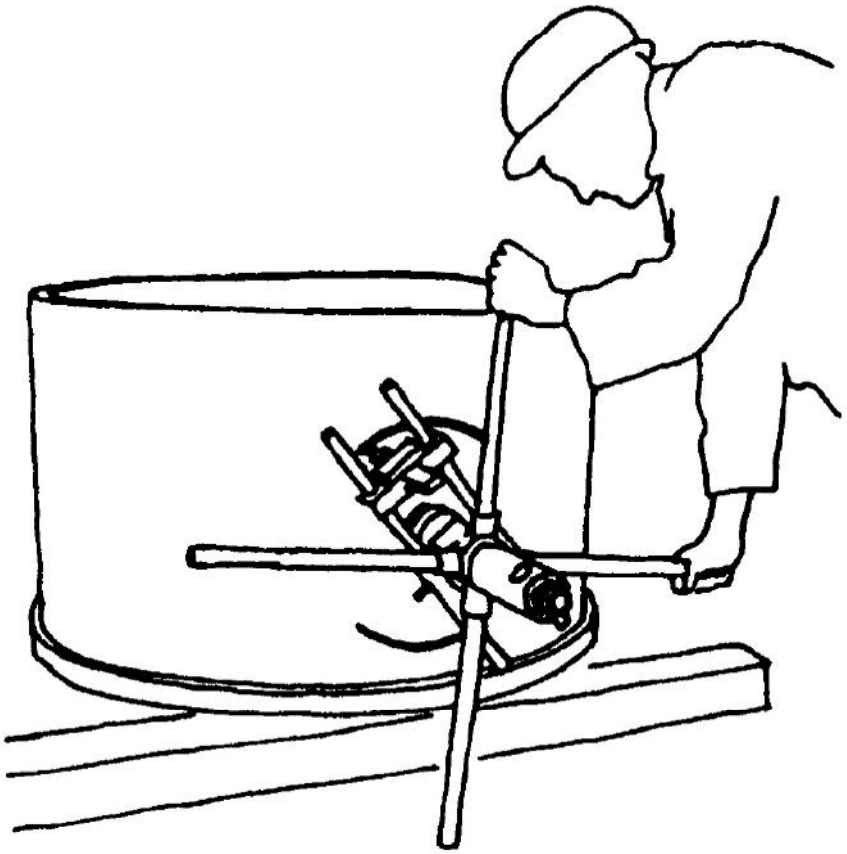

FIG. 8 HOLE CUTTER

Low frequency and wide tooth spacing produce coarse dust. Dust extraction is not necessary if the calculated chip thickness satisfies the following condition:

$$d > 200\ \mu m$$

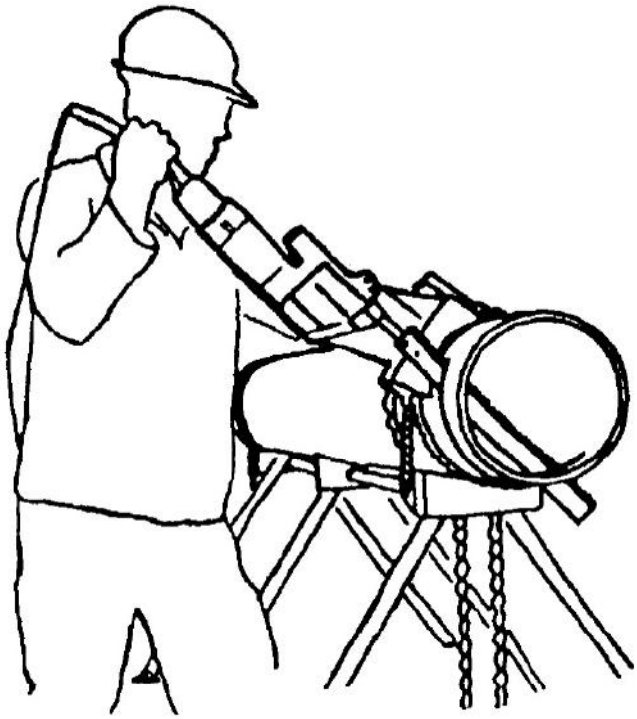

FIG. 9 LARGE JIG SAW

7.3.3 *Low Speed Circular Saw* (*see Fig.* 10) — The low speed circular saw is powered by a motor of approximately 330 W and has a speed of 250 revolutions per minute. The blade of typically 115 mm is tipped with hardmetal teeth. The low speed circular saw does not require dust extraction.

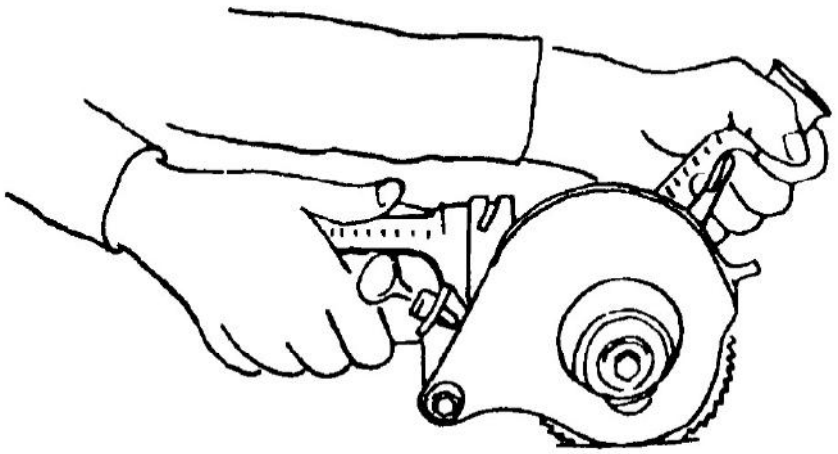

FIG. 10 LOW SPEED CIRCULAR SAW

7.3.4 *Chain Cutter* (*see Fig.* 11) — Chain cutters operate by means of cutting wheels, mounted in a chain wrapped around the pipe barrel. Hydraulic pressure, applied by means of a remote electric or manually operated pump, simultaneously squeezes the cutting wheels into the pipe-wall until the material shears along the squeezing line. Because of the shearing process, cutting with the chain is practically dust-free and no chip thickness is to be calculated.

The chain cutter is particularly recommended for autoclaved pipes. Its use for non-autoclaved pipes is not recommended due to the poor quality of the cut.

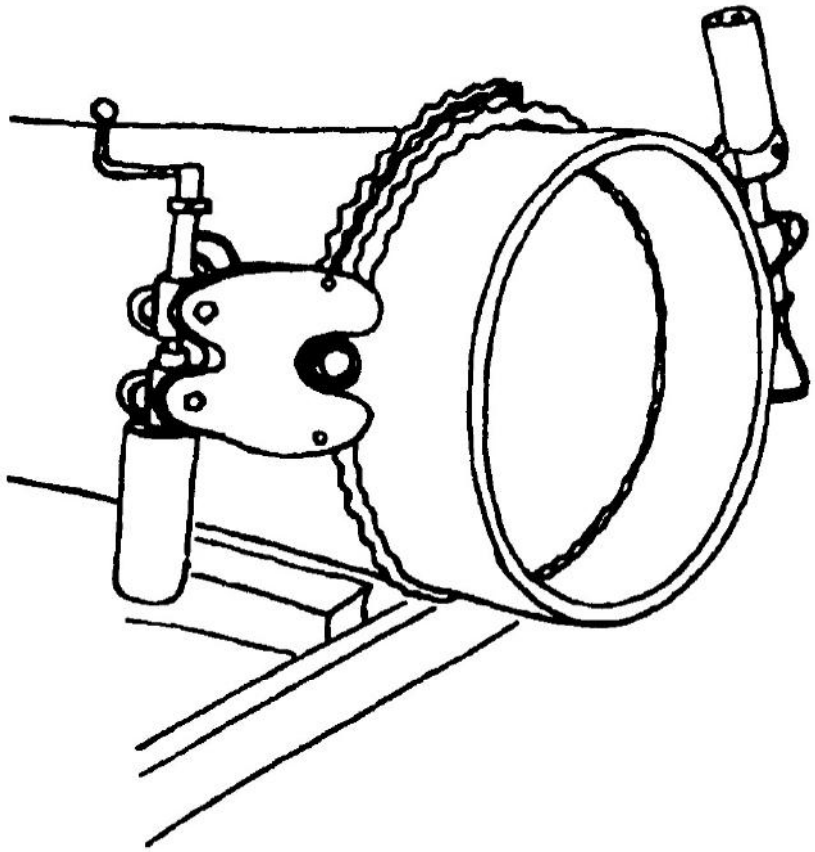

FIG. 11 CHAIN CUTTER

8. WASTE DISPOSAL

8.1 Waste material shall not be allowed to accumulate on the floor. All working areas should be kept clean by regular use of vacuum cleaner. Where vacuum cleaning is not practicable, the waste material shall be thoroughly wetted before removal. Cleaning shall be done in accordance with the provision laid down in IS : 11767-1986*.

8.2 Broken pieces and off-cuts of asbestos cement material shall be collected and disposed of in a manner which does not generate dust.

*Recommendations for cleaning of premises and plants using asbestos fibres.

8.3 Loose swarf and dust collected from fabrication processes shall be wetted, where practicable, and placed in sealed impermeable bags and disposed of in accordance with the procedure given in IS : 11768-1986*.

9. WARNING

9.1 Asbestos cement products shall bear a pictorial warning sign as given in 'Indian Standard Recommendations for pictorial warning signs and precautionary notices for asbestos and products containing asbestos: Part 2 Asbestos and its products' (*under preparation*) to caution the users that these products contain asbestos fibres and improper use of these materials may result in generation of asbestos dust, inhalation of which may cause serious damage to health.

10. SAFETY RULES SHEET

10.1 Safety rules sheat covering the following information are required to be published by the manufacturers and shall be referred to for safety in the use of asbestos cement products:

a) Product designation;

b) Name and address of the manufacturer of the product;

c) Health hazards that might arise from inhalation of asbestos dust;

d) Procedures for cleaning and safe disposal of asbestos, collected for waste and dust extraction system; and

e) Precautionary information regarding handling of the product.

*Recommendations for disposal of asbestos waste material.

(*Continued from page* 2)

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Article

Cancer mortality in chrysotile miners and millers, Russian Federation: main results (Asbest Chrysotile Cohort-Study)

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Abstract

Background: We investigated mortality in workers of the world's largest chrysotile mine and enrichment factories located in the town of Asbest, Russian Federation.

Methods: This historical cohort study included all workers employed for at least 1 year between 1975 and 2010 and follow-up until the end of 2015. Cumulative exposure to dust was estimated based on workers' complete occupational history linked to dust measurements systematically collected from the 1950s. Exposure to chrysotile fibers was estimated using dust-to-fiber conversion factors. Relative risks (RRs) and 95% confidence intervals (CIs) were estimated as mortality rate ratios in Poisson regression models.

Results: A total of 30 445 (32% women) workers accumulated 721 312 person-years at risk and 11 110 (36%) died. Of the workers, 54% had more than 30 years since their first exposure. We found an exposure-response between cumulative dust and lung cancer mortality in men. No clear association with dust exposure but a modest increase in the highest category of fiber exposure was seen for lung cancer in women. Mesothelioma mortality was increased (RR = 7.64, 95% CI = 1.18 to 49.5, to at least 80 fibers per cm^3 years and RR = 4.56, 95% CI = 0.94 to 22.1, to at least 150 mg/m^3 years [dust]), based on 13 deaths. For colorectal and stomach cancer, there were inconsistent associations. No associations were seen for laryngeal or ovarian cancer.

Conclusion: In this large-scale epidemiological study in the world's largest active asbestos mine, we confirmed an increased risk of mesothelioma with high fiber exposure and an increasing mortality for lung cancer in men with increasing dust exposure. Less clear-cut increased lung cancer mortality was seen in the women. Continued mortality follow-up is warranted.

The Asbest Chrysotile Cohort Study was set up as a historical cohort study of former and current workers exposed to chrysotile in the mine and enrichment factories of the Public Joint Stock Company (PJSC) Uralasbest in the town of Asbest, Sverdlovsk Region, Russian Federation. All commercially exploited forms of asbestos (amosite, anthophyllite, chrysotile, and crocidolite) and varieties that are not widely used in industry (eg, tremolite and actinolite) are known to cause cancer in humans, with sufficient evidence that asbestos causes cancers of the lung, larynx, and ovary as well as mesothelioma, and limited evidence for some other cancer types (1). Chrysotile has been the most used form of asbestos worldwide and is at present the only type that is commercially mined. The rationale and a detailed description of the cohort has been published elsewhere (2-4).

The study's main objective was to investigate cancer mortality in workers occupationally exposed to chrysotile, especially to obtain more precise quantification of the site-specific cancer risks, in a large workforce that has not been studied so systematically before. Here we present the main results on cancer mortality and, for a complete overview of results, the findings for the other noncancer disease groups.

Methods

Study setting

Asbest runs the world's largest open-pit chrysotile mine, which currently produces approximately 20% of the world's chrysotile and has been in operation for more than 120 years (2). The study was approved by the International Agency for Research on Cancer–World Health Organization (IARC-WHO) ethics committee (No. 12-22, September 2012). The ethics committee and an

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independent scientific advisory board monitored the progress of the study on a regular basis.

Cohort enrolment

The cohort includes all current and former employees with at least 1 cumulative year of employment between January 1, 1975, and December 31, 2010, of the following enterprises: the mine, all enrichment factories, transport and external rail transportation departments, the central laboratory, and the explosives unit. Consequently, the cohort included workers who were already employed in 1975 and workers who were newly hired in 1975 or afterward. In all, 35 837 workers were eligible and were entered into the cohort study database. Details of how this information was gathered from the company's archives, and of quality checks to ensure completeness and accuracy, are reported elsewhere (3); a flow diagram is shown in Figure 1. Characteristics of 5387 workers in the excluded group in nonproduction units are shown in Supplementary Table 1 (available online), including the justifications for exclusion.

Exposure assignment

Details on the development of the company-specific job-exposure matrix (5) after the analyses of time trends in concentrations of airborne dust at the site (6) and the calculation of conversion factors between dust exposure and fiber exposure (7) are published elsewhere. A summary is provided in the Supplementary Materials (Summary of the Exposure Assessment, available online). In brief, for each cohort member and each work period, the occupational history was linked with a company-specific job-exposure matrix constructed from more than 90 000 measurements of airborne dust across workplaces in the factories and the mine. Thus, for each individual, cumulative exposure to airborne dust particles (in mg/m^3-years) could be estimated for their entire occupational history at PJSC Uralasbest (ie, back to their first exposure, even if this was in the 1950s). Exposure to chrysotile fibers was estimated using dust-to-fiber conversion factors derived from 3 series of parallel measurements of dust and fiber concentrations. Notably, assessment of exposure to airborne dust is based on systematic detailed measurements over more than 4-5 decades, whereas fiber exposure is mainly modeled.

Follow-up and cause-of-death ascertainment

Several procedures were in place to follow up cohort members [see (3)]. The end date for follow-up was December 31, 2015. In brief, first we identified cohort members who were still alive using company records of current workers and using the PJSC Uralasbest Veterans Council's records for retired workers who still resided in Asbest. The major source for identifying deceased cohort members was the archive of the Civil Act Registration Office (ZAGS) of Sverdlovsk Region, which, in addition to the vital status, provided the date and cause of death of those who died in Sverdlovsk Region from the start of the follow-up, on January 1, 1976, until the end of 2015. Information from ZAGS was complemented by data from the Medical Information and Analytical Center of the Sverdlovsk Region Ministry of Health (8). The Federal Migration Service data were used to identify those who had migrated away from the region. Cohort members for whom the date of migration from the region was not recorded were censored at the last date when they were known to be alive and residing in Sverdlovsk Region (3). This includes cohort members who moved out of Sverdlovsk Region (4.1%) as well as cohort

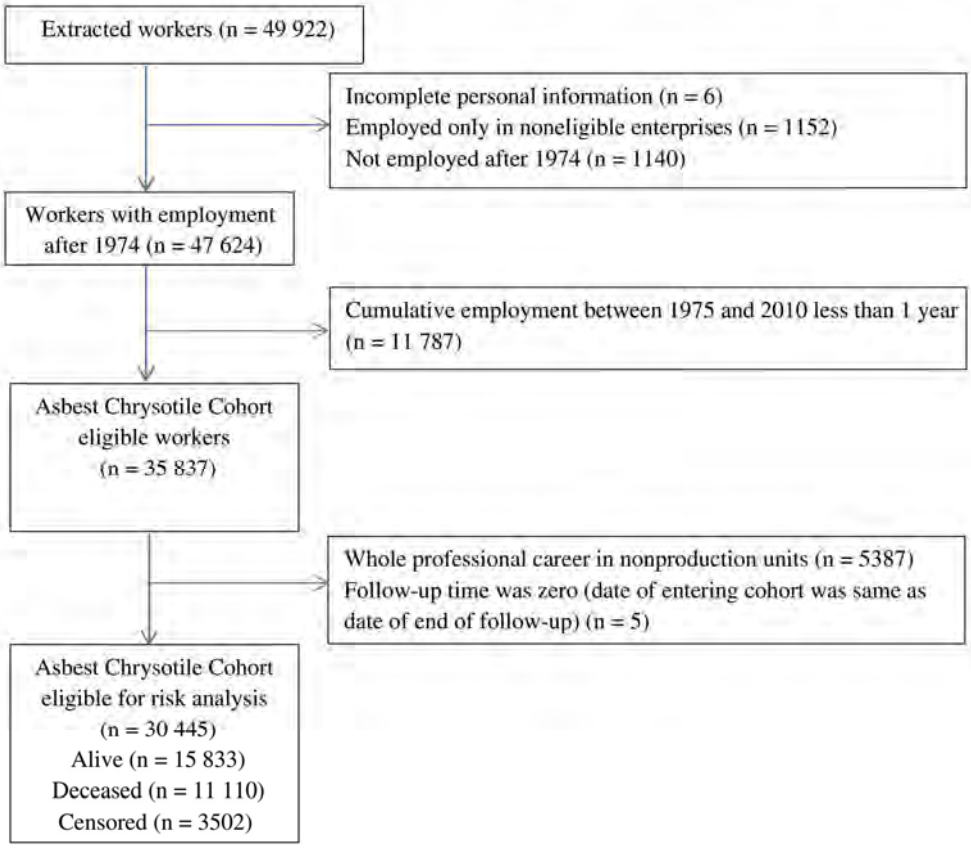

Figure 1. Flow diagram from workers extracted from company archives to those eligible for risk analysis.

members linked with the Federal Migration Service database, but the date of moving out from Sverdlovsk Region or the date recorded as being alive was not known or ambiguous (7.0%). Only 0.4% of cohort members were censored because they were not found in any source used for follow-up. Therefore, person-years at risk were counted from January 1, 1976, or the date of first employment at PJSC Uralasbest, whichever came last, to the date of death, the date last known to be alive and residing in Sverdlovsk Region, or December 31, 2015, whichever came first.

For each cohort member who died in Sverdlovsk Region, the cause of death was derived from the ZAGS electronic death certificates' database. ZAGS provided individuals' causes of death as original text information, and therefore we manually coded the underlying cause of death for deceased cohort members in accordance with the official coding instructions of the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) at IARC-WHO [details published in (8)], that is, death certificates of all 11 110 deaths between 1976 and 2015 were manually coded by IARC-WHO medical staff according to the international ICD-10 coding instructions, preventing underestimation of causes of death that did not have an individual code in earlier versions of the ICD or any Russian edition of ICD.

Statistical analyses

A data analysis plan was developed before linking exposure and outcome data (4). The association with endpoint-specific mortality was investigated using Poisson regression models with 4 exposure categories: workers in the first tertile (reference group) of the exposure distribution, those in the second tertile, and the third tertile of exposed workers split into the 66%-90% and at least 90% percentile (rounded, for integer category boundaries). This algorithm resulted in time-dependent exposure categories of more than 0 to less than 20, 20 to less than 65, 65 to less than 150, and at least 150 mg/m^3-years for cumulative dust and of more than 0 to less than 12, 12 to less than 40, 40 to less than 80, and at least 80 fibers/cm^3-years (f/cm^3-years) for cumulative chrysotile fibers. The same tertiles were used for male and female workers, who were analyzed separately in the Poisson analyses. Supplementary Figure 1 (available online) shows the distribution of cumulative exposure to dust and to fibers within their reference categories.

The main analyses used cumulative dust exposure as the exposure metric and applied a time-dependent 5-year lag of cumulative dust for each individual worker. A 5-year lag time was chosen for the main analysis to discount exposure close in time to the cancer death as not causative of the cancer. When the lag time is applied, there are workers who have no occupational exposure because the observation time at risk is shorter than the lag time (eg, for the 5-year lag, a worker who died less than 5 years after the first occupational exposure). This applied to only a few workers in the main analysis using the 5-year lag time. This group is shown in all tables, for completeness, but all workers in the reference group had at least some occupational exposure. The secondary analyses used modeled cumulative fiber exposure, also applying a 5-year lag.

In both analyses, adjustments were made for attained age, log (attained age), and time since last employment. The adjustment for time since last employment is proposed to be applied when healthy worker survivor effects are observed (or, like in our study, when the unhealthy workers have lower exposures because of shorter survival, as discussed below) (9). We therefore present the adjusted mortality rate ratios in the tables. For lung cancer, we also present the mortality rate ratios without adjustment for time since last employment in the legend of the respective table.

For mortality from mesothelioma, which had small numbers of deaths, male and female workers were combined. Because there were no mesothelioma deaths in the lowest cumulative exposure distribution tertile (used as reference category) for dust exposures and fiber exposures, we combined the 2 lower cumulative exposure distribution tertiles (0%-66%) to form the new reference category.

In sensitivity analyses, the effect of lag time was explored by applying longer lag times of 10 years and 20 years when the number of deaths for the respective outcome was sufficient. As this was a register-based study, no information from workers was available on any lifestyle factors, such as smoking and alcohol consumption.

Results

Table 1 shows employment-related characteristics of the workers eligible for the risk analysis, for male (68%) and female (32%) workers separately and combined. In total, the 30 445 workers accumulated 721 312 person-years at risk. Supplementary Table 2 (available online) shows the exposure distributions for airborne dust and fibers by number of workers and by person-years at risk for men, women, and combined. The correlation between cumulative exposures to dust and cumulative exposures to fibers was high, with a Pearson correlation coefficient of 0.88 for women and 0.70 for men. The mean duration of follow-up for vital status was 24 years, but because this was counted only from January 1, 1976, at the earliest, workers may have had a much longer time since first exposure because 36% of them had their first employment before 1970. In fact, 11% (8% men and 17% women) of workers had their first exposure 50 years or longer before the end of follow-up, 19% (17% men and 21% women) of workers had 40-49 years since their first exposure, and 24% (24% men and 24% women) of workers had 30-39 years since their first exposure. The mean time between first employment and the date of the last observation of the worker was 32 years.

Table 2 shows the site-specific mortality for cancer in male and female workers, for cumulative dust and fiber exposure. Increased lung cancer mortality rate ratios were seen in men, somewhat weaker with cumulative fibers. In women, no association was seen between dust exposure and lung cancer mortality, and with fiber exposure, only the mortality rate ratio in the highest exposure category was slightly elevated. No increases in mortality rate ratios were seen for laryngeal cancer or ovarian cancer. For stomach and colorectal cancer, rate ratios were increased in men but decreased or were close to 1.00 in women. When not adjusting for time since last employment, mortality rate ratios for lung cancer were somewhat lower in men (Table 2 footnote d). Table 2 also shows the results for mesothelioma mortality, based on 13 deaths from mesothelioma, for both sexes combined. Mortality rate ratios of the 2 highest exposure categories were elevated compared with the new reference categories. The association was slightly stronger for cumulative exposure to fibers compared with the corresponding relative risk for dust.

Table 3 shows the all-cause mortality and mortality from major disease groups for male and female workers, for cumulative exposure to dust and fibers. Given the indication of inverse associations with overall mortality seen especially in men, we also present the mortality from alcohol-related noncancer diseases, which showed a strong inverse association in both men

Table 1. Cohort characteristics, by sex and combined (Asbest Chrysotile Cohort Study)

Characteristic	Men	Women	All
Workers, No. (%)	20 662 (68)	9783 (32)	30 445 (100)
Year of birth			
Mean	1953	1950	1952
Min-max	1901-1992	1908-1991	1901-1992
Age at start of employment, mean (min-max), y	24 (12-68)	24 (13-73)	24 (12-73)
Age at start of employment, No. (%), y			
Younger than 20	8171 (40)	3825 (39)	11 996 (39)
20-29	9292 (45)	4162 (43)	13 454 (44)
30 years and older	3199 (15)	1796 (18)	4995 (16)
Age at last observation, mean (min-max), y	54 (18-97)	59 (16-97)	55 (16-97)
Duration of employment, mean (min-max), y	15 (1-59)	17 (1-56)	15 (1-59)
Duration of employment, No. (%), y			
<10	9573 (46)	3459 (35)	13 032 (43)
10-29	7811 (38)	4951 (51)	12 762 (42)
≥30	3278 (16)	1373 (14)	4651 (15)
Calendar year of first employment, No. (%)			
Before 1970	6827 (33)	4100 (42)	10 927 (36)
1970-1999	11 970 (58)	5158 (53)	17 128 (56)
2000 or later	1865 (9)	525 (5)	2390 (8)
Time from first employment until last observation, mean (max), y	30 (73)	35 (76)	32 (76)
Duration of follow-up, mean, y	22	27	24
Total person-years at risk, No. (%)	458 883 (64)	262 429 (36)	721 312 (100)
Vital status, No. (%)			
Alive	9972 (48)	5861 (60)	15 833 (52)
Deceased	8270 (40)	2840 (29)	11 110 (36)
Censored[a]	2420 (12)	1082 (11)	3502 (12)
Cumulative exposure, mean (max)[b]			
Dust, mg/m^3-years	61.2 (1641.5)	77.8 (1184.1)	66.5 (1641.5)
Fibers, f/cm^3-years	29.2 (392.1)	42.8 (399.7)	33.6 (399.7)

[a] Censored at date last known to be alive in Sverdlovsk Region; this includes cohort members who moved out of Sverdlovsk Region (n = 1244; 4.1%); cohort members linked with the Federal Migration Service database, but the date of moving out from Sverdlovsk Region or the date recorded as being alive was not known or ambiguous (n = 2136; 7.0%); and cohort members who could not be linked to any source used for follow-up (n = 122; 0.4%).
[b] Cumulative exposure lagged 5 years (f/cm^3-years = fibers/cm^3-years).

and women. Supplementary Table 3 (available online) shows the average age at death by different causes of death; the average age at death was lower in men for all disease groups, except for all cancers, for which it was equal in men and women.

Supplementary Table 4 (available online) shows results for all-cause mortality, all-cancer mortality, and mortality from cancer of the lung, larynx, ovary, stomach, and colon and rectum (combined) for lag times of 10 years and 20 years.

Discussion

In this first comprehensive cohort study of chrysotile miners and millers in the world's largest active chrysotile mine, we observed an increase in risk of dying from mesothelioma with high cumulative exposure to chrysotile. It should be noted that all mesothelioma deaths in the cohort occurred in workers with substantial cumulative exposure; no mesothelioma deaths were found in our reference categories of the lowest tertiles of dust and fibres. The lowest observed cumulative exposures were 12.5 f/cm^3-years for fibers and 24.2 mg/m^3-years for dust (in the same worker).

Mesothelioma is known to be caused by all forms of asbestos (1). This is also the case for chrysotile as mined in the Russian Federation, as seen in our study, showing a strong association with high cumulative exposure to fibers. We observed 13 deaths from mesothelioma in the cohort of more than 30 000 chrysotile miners and millers. It is well known that, in general, mesothelioma deaths occur in those aged older than 70 years. It is also known that occupationally related mesothelioma typically occurs 20-40 years after the first occupational exposure (10,11). Although the mean time between the first occupational exposure and the end of follow-up in men in our cohort was indeed 30 years, notably the average age at death, as typical for the Russian Federation during this time period, was less than 60 years, so it is the competing causes of premature death that to some extent explain the low observed number of mesothelioma deaths despite the long observation period. It is a notable observation that only 2 of the 13 mesothelioma deaths were observed in women, despite their higher average age at death compared with men and the slightly higher exposure levels in women compared with men.

We also observed an increasing risk of dying from lung cancer with increasing cumulative exposure to airborne dust in male workers and to a lesser extent with increasing cumulative exposure to fibers. In women, based on much smaller numbers of lung cancer deaths, there was no association with cumulative dust exposure, but there was a small elevation in risk in the highest category of cumulative exposure to fibers similar to that in men. When longer lag times were applied, similar results were found in men for the 10-year lag, but with the 20-year lag, the association was considerably weaker, especially for cumulative exposure to fibers. In contrast, in women, stronger associations were seen only with the 20-year lag time.

Lung cancer is known to be caused by all forms of asbestos (1,12), supported by our findings. Lung cancer in general is also caused by inhalation of other workplace air contaminants, and the risk increases with increasing cumulative exposure levels, such as for crystalline silica-containing dust (13), welding fumes (14), or diesel motor engine exhaust (15). All of those exposures have been present either in the Asbest mines, in the enrichment factories, or both, mainly in male workers, but no quantification of the

Table 2. Mortality rate ratios and 95% confidence intervals for categories of cumulative dust exposure and cumulative chrysotile fiber exposure, by deaths from different cancer sites,[a] by sex (except for mesothelioma), applying 5-year lag time, adjusted for age and time since last employment

Dust category, mg/m3-years	Men		Women		Fiber category, fibers/cm3-years	Men		Women	
	No. deaths	RR (95% CI)	No. deaths	RR (95% CI)		No. deaths	RR (95% CI)	No. deaths	RR (95% CI)
		Lung cancer[d]					Lung cancer[d]		
0[b]	3	0.94 (0.30 to 3.01)	0		0	3	0.82 (0.26 to 2.62)	0	
>0 to 20	89	1.00	7	1.00	>0 to 12	102	1.00	7	1.00
≥20 to 65	155	1.20 (0.92 to 1.57)	11	0.82 (0.32 to 2.12)	≥12 to 40	171	1.03 (0.80 to 1.32)	11	0.80 (0.31 to 2.07)
≥65 to 150	209	1.37 (1.04 to 1.80)	11	0.63 (0.24 to 1.63)	≥40 to 80	208	1.13 (0.87 to 1.46)	10	0.67 (0.26 to 1.77)
≥150	108	1.40 (1.03 to 1.90)	12	1.03 (0.40 to 2.62)	≥80	80	1.26 (0.92 to 1.72)	13	1.21 (0.48 to 3.04)
Total	564		41			564		41	
P_{trend}[c]		.02		1.00			.11		.64
		Laryngeal cancer[e]		Ovarian cancer			Laryngeal cancer[e]		Ovarian cancer
0	0		1	2.27 (0.26 to 20.12)	0	0		1	2.17 (0.25 to 19.12)
>0 to 20	9	1.00	8	1.00	>0 to 12	12	1.00	8	1.00
≥20 to 65	19	1.28 (0.57 to 2.87)	10	0.78 (0.30 to 2.03)	≥12 to 40	17	0.78 (0.37 to 1.65)	11	0.80 (0.32 to 2.03)
≥65 to 150	8	0.42 (0.15 to 1.14)	11	0.96 (0.36 to 2.54)	≥40 to 80	10	0.38 (0.16 to 0.92)	10	0.86 (0.33 to 2.28)
≥150	10	1.03 (0.39 to 2.68)	5	0.72 (0.22 to 2.35)	≥80	7	0.76 (0.29 to 2.01)	5	0.62 (0.20 to 2.00)
Total	46		35			46		35	
P_{trend}		.40		.70			.17		.48
		Stomach cancer					Stomach cancer		
0	2	1.23 (0.29 to 5.29)	3	3.10 (0.80 to 11.94)	0	2	1.13 (0.26 to 4.84)	3	2.76 (0.72 to 10.52)
>0 to 20	29	1.00	16	1.00	>0 to 12	32	1.00	18	1.00
≥20 to 65	49	1.21 (0.75 to 1.94)	23	0.87 (0.45 to 1.65)	≥12 to 40	55	1.09 (0.70 to 1.71)	21	0.66 (0.35 to 1.25)
≥65 to 150	72	1.55 (0.96 to 2.51)	15	0.54 (0.26 to 1.13)	≥40 to 80	77	1.43 (0.91 to 2.27)	17	0.58 (0.29 to 1.14)
≥150	35	1.49 (0.87 to 2.57)	14	0.78 (0.37 to 1.64)	≥80	21	1.16 (0.64 to 2.08)	12	0.57 (0.27 to 1.21)
Total	187		71			187		71	
P_{trend}		.08		.25			.24		.12
		Colorectal cancer					Colorectal cancer		
0	1	2.12 (0.27 to 16.55)	0		0	1	2.20 (0.28 to 17.16)	0	
>0 to 20	15	1.00	13	1.00	>0 to 12	15	1.00	14	1.00
≥20 to 65	44	1.74 (0.96 to 3.15)	24	1.08 (0.54 to 2.13)	≥12 to 40	47	1.70 (0.94 to 3.06)	26	1.03 (0.53 to 1.97)
≥65 to 150	44	1.20 (0.65 to 2.23)	21	0.80 (0.39 to 1.63)	≥40 to 80	46	1.25 (0.68 to 2.31)	19	0.75 (0.37 to 1.51)
≥150	30	1.52 (0.79 to 2.91)	19	1.05 (0.51 to 2.18)	≥80	25	1.96 (1.01 to 3.82)	18	0.97 (0.48 to 1.98)
Total	134		77			134		77	
P_{trend}		.66		.86			.22		.69
		Mesothelioma, men and women					Mesothelioma, men and women		
		No. deaths	RR (95% CI)				No. deaths	RR (95% CI)	
≥0 to 65		3	1.00		≥0 to 40		2	1.00	
≥65 to 150		5	2.54 (0.53 to 12.07)		≥40 to 80		7	6.27 (1.10 to 35.84)	
≥150		5	4.56 (0.94 to 22.14)		≥80		4	7.64 (1.18 to 49.46)	
Total		13					13		
P_{trend}			.03					.05	

[a] International Statistical Classification of Diseases and Related Health Problems codes for cancer sites are as follows: lung, C33-C34; larynx, C32; ovary, C56; stomach, C16; colon and rectum, C18-C21; mesothelioma, C45 and C38.4. CI = confidence interval; f/cm^3-years = fibers/cm^3-years; RR = relative risk.
[b] Because the 5-year lag time was applied, some workers had no occupational exposure to dust or fibers; as the counting of risk time started with first exposure, they are kept as a separate group and displayed only for the purpose of completeness (see Materials and Methods).
[c] Two-sided P_{trend} across the exposure categories (ie, dust categories >0 to 20, ≥20 to 65, ≥65 to 150, and ≥150).
[d] Without adjustment for time since last employment, the relative risk (95% CI) for lung cancer for the 3 categories of cumulative dust exposure compared with the reference category are as follows: RR = 1.07 (95% CI = 0.82 to 1.39), RR = 1.16 (95% CI = 0.90 to 1.50), and RR = 1.18 (95% CI = 0.88 to 1.58) (men) and RR = 0.83 (95% CI = 0.32 to 2.15), RR = 0.67 (95% CI = 0.26 to 1.75), and RR = 1.05 (95% CI = 0.41 to 2.69) (women); for the 3 categories of cumulative fiber exposure compared with the reference category, they are as follows: RR = 0.93 (95% CI = 0.73 to 1.19), RR = 0.99 (95% CI = 0.78 to 1.27), and RR = 1.13 (95% CI = 0.84 to 1.53) (men) and RR = 0.81 (95% CI = 0.31 to 2.08), RR = 0.70 (95% CI = 0.26 to 1.83), and RR = 1.20 (95% CI = 0.48 to 3.02) (women).
[e] Only 1 case of laryngeal cancer in women; therefore, analysis for women was not carried out.

exposures from these air contaminants was available for the present study. This confirms that exposure to chrysotile causes an occupation-related lung cancer burden in this setting, but co-exposures to other lung carcinogens may also have contributed, aligning with the available scientific evidence (12-15).

The different observations by sex could be a result of chance because of small numbers of lung cancer deaths in women but may also be due to the following reasons. Most importantly, whereas the prevalence of smoking was high in men (approximately two-thirds), it was very low (<5%) in women in the past although it gradually increased to almost one-third of female workers being smokers in more recent years, as assessed in our independent smoking survey among alive workers (16). Therefore, the dust-related increase in lung cancer deaths in men might be accelerated by a synergistic effect of simultaneous exposure to various types of dust particles and fibers and smoking. Although we were not able to study effect modification by smoking directly because of the lack of individual smoking histories, the marked differences between the sexes in their smoking behavior and the observation of an increase in lung cancer mortality in men at lower cumulative exposure levels than in women are suggestive of effect modification especially at lower exposure levels. More speculative, the physical demands of job groups may have resulted in a differential uptake of dust to the lungs by sex, although the median overall cumulative exposure was slightly higher in women.

We did not see any increase in laryngeal cancer deaths with increasing exposure to dust or fibers, irrespective of applied lag

Table 3. Mortality rate ratios and 95% confidence intervals for categories, and P_{trend} across categories of cumulative dust exposure and of cumulative chrysotile fiber exposure, by all causes of death and by selected disease groups, by sex, applying 5-year lag time, adjusted for age and time since last employment[a]

Dust category, mg/m3-years	Men		Women		Fiber category, f/cm3-years	Men		Women	
	No. deaths	RR (95% CI)	No. deaths	RR (95% CI)		No. deaths	RR (95% CI)	No. deaths	RR (95% CI)
	All deaths					All deaths			
0[b]	186	1.21 (1.03 to 1.42)	29	0.88 (0.58 to 1.33)	0	186	1.21 (1.03 to 1.42)	29	0.89 (0.59 to 1.34)
>0 to 20	2245	1.00	491	1.00	>0 to 12	2266	1.00	505	1.00
≥20 to 65	2318	0.93 (0.87 to 0.99)	835	1.06 (0.95 to 1.19)	≥12 to 40	2656	0.94 (0.89 to 1.00)	928	1.07 (0.96 to 1.20)
≥65 to 150	2278	0.88 (0.82 to 0.94)	858	0.98 (0.87 to 1.09)	≥40 to 80	2286	0.83 (0.78 to 0.89)	788	0.94 (0.84 to 1.06)
≥150	1243	0.94 (0.87 to 1.02)	627	1.02 (0.90 to 1.16)	≥80	876	0.94 (0.86 to 1.03)	590	0.97 (0.86 to 1.10)
Total	8270		2840			8270		2840	
P_{trend}[c]		.02		.76			.00		.14
	All cancers, main ICD group C					All cancers, main ICD group C			
0	11	1.02 (0.56 to 1.88)	7	1.41 (0.63 to 3.17)	0	11	0.97 (0.53 to 1.78)	7	1.40 (0.62 to 3.15)
>0 to 20	273	1.00	87	1.00	>0 to 12	293	1.00	87	1.00
≥20 to 65	424	1.05 (0.90 to 1.23)	173	1.21 (0.93 to 1.56)	≥12 to 40	475	0.99 (0.85 to 1.14)	175	1.15 (0.89 to 1.49)
≥65 to 150	541	1.10 (0.93 to 1.29)	149	0.98 (0.74 to 1.29)	≥40 to 80	540	0.98 (0.84 to 1.15)	151	1.06 (0.81 to 1.38)
≥150	277	1.09 (0.91 to 1.31)	119	1.18 (0.88 to 1.57)	≥80	207	1.10 (0.91 to 1.33)	115	1.12 (0.84 to 1.49)
Total	1526		535			1526		535	
P_{trend}		.31		.78			.46		.76
	Cardiovascular diseases, main ICD group I					Cardiovascular diseases, main ICD group I			
0	32	1.13 (0.79 to 1.62)	2	0.40 (0.10 to 1.65)	0	32	1.13 (0.78 to 1.62)	2	0.40 (0.10 to 1.65)
>0 to 20	754	1.00	225	1.00	>0 to 12	768	1.00	240	1.00
≥20 to 65	996	0.98 (0.89 to 1.08)	416	1.06 (0.90 to 1.24)	≥12 to 40	1151	1.00 (0.91 to 1.10)	480	1.09 (0.93 to 1.28)
≥65 to 150	1153	0.94 (0.85 to 1.04)	501	1.05 (0.89 to 1.23)	≥40 to 80	1184	0.91 (0.82 to 1.01)	442	0.98 (0.84 to 1.15)
≥150	666	1.03 (0.92 to 1.16)	367	1.08 (0.91 to 1.27)	≥80	466	1.04 (0.92 to 1.17)	347	1.04 (0.88 to 1.23)
Total	3601		1511			3601		1511	
P_{trend}		.92		.47			.60		.86
	Chronic, noninfectious, respiratory diseases[d]					Chronic, noninfectious, respiratory diseases			
0	0		0		0	0		0	
>0 to 20	18	1.00	7	1.00	>0 to 12	23	1.00	7	1.00
≥20 to 65	31	1.13 (0.63 to 2.05)	8	0.66 (0.24 to 1.85)	≥12 to 40	34	0.85 (0.50 to 1.46)	11	0.87 (0.34 to 2.25)
≥65 to 150	42	1.15 (0.63 to 2.11)	17	1.22 (0.49 to 3.02)	≥40 to 80	45	0.89 (0.52 to 1.54)	13	1.02 (0.40 to 2.60)
≥150	35	1.79 (0.96 to 3.33)	9	0.94 (0.34 to 2.60)	≥80	24	1.37 (0.75 to 2.52)	10	1.09 (0.41 to 2.92)
Total	126		41			126		41	
P_{trend}		.06		.68			.33		.73
	Infectious respiratory diseases[e]					Infectious respiratory diseases			
0	3	0.90 (0.27 to 2.94)	0		0	3	0.97 (0.30 to 3.19)	0	
>0 to 20	84	1.00	12	1.00	>0 to 12	79	1.00	10	1.00
≥20 to 65	65	0.73 (0.52 to 1.03)	4	0.22 (0.07 to 0.71)	≥12 to 40	79	0.86 (0.62 to 1.20)	9	0.57 (0.23 to 1.43)
≥65 to 150	30	0.39 (0.24 to 0.62)	6	0.34 (0.12 to 0.99)	≥40 to 80	28	0.38 (0.23 to 0.62)	3	0.21 (0.06 to 0.81)
≥150	17	0.45 (0.25 to 0.81)	3	0.24 (0.06 to 0.91)	≥80	10	0.40 (0.20 to 0.80)	3	0.29 (0.08 to 1.10)
Total	199		25			199		25	
P_{trend}		.00		.03			.00		.02
	External causes, main ICD groups S, T, V, W, X, and Y					External causes, main ICD groups S, T, V, W, X, and Y			
0	118	1.32 (1.06 to 1.64)	16	1.16 (0.61 to 2.19)	0	118	1.33 (1.07 to 1.66)	16	1.15 (0.61 to 2.17)
>0 to 20	728	1.00	68	1.00	>0 to 12	709	1.00	67	1.00
≥20 to 65	484	0.86 (0.76 to 0.98)	80	0.97 (0.69 to 1.36)	≥12 to 40	544	0.90 (0.80 to 1.02)	88	0.96 (0.69 to 1.34)
≥65 to 150	243	0.70 (0.59 to 0.83)	54	0.77 (0.52 to 1.15)	≥40 to 80	229	0.68 (0.57 to 0.81)	48	0.68 (0.46 to 1.01)
≥150	101	0.67 (0.53 to 0.85)	29	0.69 (0.43 to 1.11)	≥80	74	0.70 (0.54 to 0.90)	28	0.60 (0.38 to 0.97)
Total	1674		247			1674		247	
P_{trend}		.00		.07			.00		.01
	Alcohol-related noncancer diseases[f]					Alcohol-related noncancer diseases			
0	117	1.38 (1.12 to 1.72)	16	1.35 (0.74 to 2.47)	0	117	1.41 (1.14 to 1.74)	16	1.31 (0.71 to 2.40)
>0 to 20	845	1.00	92	1.00	>0 to 12	820	1.00	91	1.00
≥20 to 65	561	0.83 (0.74 to 0.93)	108	0.93 (0.70 to 1.25)	≥12 to 40	637	0.88 (0.79 to 0.99)	110	0.87 (0.65 to 1.16)
≥65 to 150	298	0.70 (0.60 to 0.82)	83	0.87 (0.62 to 1.20)	≥40 to 80	276	0.67 (0.57 to 0.79)	77	0.79 (0.57 to 1.10)
≥150	119	0.65 (0.52 to 0.80)	33	0.58 (0.38 to 0.89)	≥80	90	0.69 (0.54 to 0.87)	38	0.60 (0.40 to 0.89)
Total	1940		332			1940		332	
P_{trend}		.00		.01			.00		.01

[a] The diseases shown in the table have been selected because of the interest in the association between exposure and outcome, and some of them partly overlap, so the total of the number of deaths of the disease groups does not add up to the number of total deaths. CI = confidence interval; ICD = International Statistical Classification of Diseases and Related Health Problems; f/cm^3-years = fibers/cm^3-years; RR = relative risk.

[b] Because the 5-year lag time was applied, some workers had no occupational exposure to dust or fibers; as the counting of risk time started with first exposure, they are kept as a separate group and displayed only for the purpose of completeness (see Materials and Methods).

[c] Two-sided P_{trend} across the exposure categories (ie, dust categories >0 to 20, ≥20 to 65, ≥65 to 150, and ≥150).

[d] Chronic (noninfectious) respiratory diseases (ICD J30, J31, J33, J34.1-J34.8, J35, J37, J38, J39.2-J39.9, J40-J84, J90-J94, and J95-J99 excluding J98.7).

[e] Infectious respiratory diseases (ICD J00-J06, J09-J18, J20-J22, J32, J34.0, J36, J39.0-J39.1, J85-J86, and J98.7).

[f] Alcohol-related noncancer diseases (ICD E24.4, F10, G31.2, G62.1, I42.6, K29.2, K70, K85.2, K86.0, R78.0, S00-T35, and T51-T78).

time. For laryngeal cancer, the potency of different asbestos fiber types is not known; hence, our findings are not in contradiction to the available scientific evidence based on other asbestos-related studies (1,17). Lack of individual information on alcohol consumption is a limitation because this is a risk factor for laryngeal cancer, and the observed healthy worker survivor effect suggests an inverse association between alcohol consumption and cumulative exposure to dust and fibers. Consequently, negative confounding by alcohol consumption may have attenuated the possible association between cumulative exposure and laryngeal cancer mortality. We did not see an association of ovarian cancer deaths with increasing exposure to dust or fibers, and almost all observed mortality rate ratios were less than 1, irrespective of lag time. Our study is the first cohort study of chrysotile miners and enrichment factory workers to include a notable number of women. The associations seen in other studies have been in other industries, particularly textile, gas masks, or insulation material, with exposure also to amphiboles (1,18,19). Consequently, the different exposure circumstances, mix of different fiber types, and study settings may explain the differences in results for laryngeal and ovarian cancer.

For stomach cancer and colorectal cancer, there has been limited evidence in previous epidemiological studies (1). With regard to stomach cancer, our results were inconsistent, as we observed increased mortality in men, but all confidence intervals included 1.00. In women, all mortality rate ratios were decreased. For colorectal cancer, mortality rate ratios were increased for all exposure categories in men but not in women. Given that we had no information on the known nonoccupational risk factors for these 2 cancer sites (eg, dietary habits, alcohol consumption, *Helicobacter pylori* infections) and that results were not consistent across dust and fiber and sex combinations, these findings are difficult to interpret.

Overall mortality in the cohort was lower in male workers with higher cumulative dust exposure compared with the reference group, driven by inverse associations between exposure and deaths from alcohol-related noncancer diseases, deaths from infectious respiratory diseases, and deaths from external causes, but less so in female workers, with much lower numbers of deaths from alcohol-related noncancer diseases and deaths from external causes than in men. This effect was much stronger when not adjusting for time since last employment (data not shown), confirming the need for adjustment for the healthy worker survivor effect (9). Within our cohort, activities related to higher exposures require good health, so the workers selected for these jobs are healthy individuals, and this advantage of healthiness may have lasted throughout their working life, endorsed through the system of obligatory regular medical examinations enforced in the Russian legislation. All employees must undergo annual periodic medical examinations and, depending on the results of the severity of any health symptoms, either may be recommended to stop working in places with contact with dust or are officially withdrawn from work in such conditions. In addition, according to the pension law of the Russian legislation, the age at which retirement is allowed depends on whether the job is classified as hazardous; therefore, the duration of employment may be shorter in workers with higher exposure levels. Taking all this together, it is therefore possible that early symptoms of poorer health may lead to lower cumulative exposure (more discussion of the healthy worker survivor effect is provided in the Supplementary Materials, Considerations of the Healthy Worker Survivor Bias, available online). Notably, for the cancer sites of most interest (ie, mesothelioma and lung cancer), the healthy worker survivor effect is of less relevance as the first symptoms occur late in life and the time between symptom-based diagnosis and death is short because most patients die within 5 years. Indeed, as shown, adjustment for the healthy worker survivor effect had less effect on the results for lung cancer. Seven workers had died of asbestosis (ICD-10 J61; data not shown), a disease known to occur in chrysotile workers but rarely an immediate or underlying cause of death. Deaths from chronic respiratory disease were increased among workers in the highest 10% of cumulative exposure, but only in men and slightly stronger for dust than for fiber exposure.

Other cohort studies of miners and millers occupationally exposed to chrysotile were carried out in Canada (20,21), China (22,23), and Italy (24-27); notably, all studies included only male workers. In the Italian cohort study, mortality from lung cancer was analyzed by tertiles of cumulative exposure to chrysotile fibers, with mortality rate ratios of 2.1 (95% CI = 0.7 to 6.3; n = 17) for 27 to 345 f/ml-years and of 2.2 (95% CI = 0.6 to 8.0; n = 19) for at least 345 f/ml-years compared with the reference of less than 27 f/ml-years (n = 5). Results for occurrence of mesothelioma for the same cumulative exposure tertiles were 5.6 (95% CI = 0.5 to 57.6; n = 4) and 12.6 (95% CI = 0.9 to 171.0; n = 5) compared with the reference category (n = 1) (24). A more extended comparison with our findings is shown in the Supplementary Materials (Comparison with Other Cohort Studies, available online).

Strengths of our study are its large size, the large proportion of female workers to investigate sex-specific risks, access to the original text of all death certificates, the ability to estimate individuals' cumulative exposure by using dust measurements systematically carried out over 5-6 decades, and access to various authoritative sources, complementing each other, for vital status follow-up.

The main limitations are inherent in the design of a register-based historical cohort study. Endpoints were deaths, not incidence of disease. Every epidemiological study suffers from some exposure misclassification. However, this is one of the best informed studies in terms of person-years covered by dust measurements. Only few extrapolations were needed, with 76% of person-years of workers in the mine and 86% of person-years of workers in the enrichment factories entirely based on real measurements. Also, the duration component of the cumulative exposure is very precise and is not prone to measurement error. Parallel measurements of dust and chrysotile fibers were available for only a few years, and therefore estimated conversion factors may have uncertainties for earlier years (7). However, given that we assigned exposure to cohort members based on a company-specific job-exposure matrix, this would mostly lead to a Berkson-type error not resulting in biased mortality rate ratios but rather in lesser precision [ie, wider confidence intervals (28)] and lesser so to an attenuation of the association. Point estimates of mortality rate ratios based on cumulative fiber exposure were often slightly lower than those based on cumulative dust exposure, supporting this view; that mesothelioma and female lung cancer were exceptions showing slightly higher point estimates provides some evidence that the fiber exposure modeling and assignment via a job-exposure matrix worked well. Migrants from the region had to be censored at the date last known to be alive. With their low average age at death of approximately 60 years, many male workers died before the ages when cancer becomes more frequent, and the time passed since their last exposure may be short; however, this is a reality in this cohort and not a design limitation.

As already mentioned, because this was a register-based study, we had no information on other disease risk factors, so we cannot exclude confounding bias in some of the observed associations; depending on the combination of risk factor and disease, this can either inflate or attenuate associations. We collected group-level information on smoking, which appeared to have less potential for confounding bias for men as smoking prevalence did not differ much across dust exposure categories, but the possibility of some smoking-related confounding in women remains (16).

In conclusion, in the Asbest Chrysotile Cohort Study, we observed an increased risk of mesothelioma with high exposure to chrysotile fibers; men were more affected than women despite slightly higher cumulative exposure for women. We observed an increased mortality for lung cancer in men with increasing cumulative dust exposure. No increased risk of lung cancer with increasing dust exposure was seen in the female workers, but we observed a modest increase in the highest exposure category for fibers. Future research should aim at disentangling the effects of the exposure to different lung carcinogens in this cohort, especially looking at the risks related to dust and fibers in never smokers, as well as investigating additive and multiplicative interactions between smoking, fibers, and co-exposure to other occupational carcinogens. Less clear-cut evidence was observed for colorectal cancer and stomach cancer, but we observed suggestive increases that merit further attention. No increased mortality was seen for laryngeal cancer or ovarian cancer.

This is the first comprehensive study of the workforce of the worlds' largest active chrysotile mine. Even without extensive industrial use, chrysotile is in the environment and will remain there for many more decades. Therefore, our results are informative for public health at both the local and global scales.

Data availability

Raw data cannot be made publicly available according to the data confidentiality legislation of the Russian Federation.

Author contributions

Joachim Schüz, PhD (Conceptualization; Formal analysis; Investigation; Methodology; Project administration; Resources; Supervision; Writing—original draft; Writing—review & editing), Evgeny Kovalevskiy, PhD, MD (Conceptualization; Data curation; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Writing—original draft; Writing—review & editing), Ann Olsson, PhD (Data curation; Investigation; Methodology; Project administration; Supervision; Writing—original draft; Writing—review & editing), Monika Moissonnier, MSc (Data curation; Formal analysis; Methodology; Software; Validation; Visualization; Writing—review & editing), Evgenia Ostroumova, PhD, MD (Data curation; Investigation; Methodology; Supervision; Validation; Writing—review & editing), Gilles Ferro, Msc (Data curation; Formal analysis; Methodology; Software; Validation; Visualization; Writing—review & editing), Eleonora Feletto, PhD (Data curation; Formal analysis; Methodology; Visualization; Writing—review & editing), Sarah Schonfeld, PhD (Conceptualization; Data curation; Investigation; Methodology; Project administration; Writing—review & editing), Graham Byrnes, PhD (Formal analysis; Methodology; Writing—review & editing), Iraklii Tskhomariia (Data curation; Investigation; Project administration; Writing—review & editing), Kurt Straif, PhD, MPH, MD (Conceptualization; Methodology; Writing—review & editing), Tatiana Morozova, PhD (Investigation; Project administration; Resources; Validation; Writing—review & editing), Hans Kromhout, PhD (Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Supervision; Validation; Writing—original draft; Writing—review & editing), and Igor Bukhtiyarov, PhD, MD (Conceptualization; Funding acquisition; Investigation; Project administration; Resources; Supervision; Validation; Writing—original draft; Writing—review & editing).

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Conflicts of interest

Dr Kovalevskiy reported receiving, on behalf of his institute and personally through consulting firms, payments from companies to evaluate exposure to asbestos and risk of asbestos-related disease in those workplaces. All other authors have no competing interests to declare.

For full transparency, Dr Kovalevskiy reported participation as an occupational and environmental health expert as part of the delegation of the Russian Ministry of Health at multiple World Health Assembly meetings as well as at the Conference of the Parties to the Basel and Rotterdam Conventions. Dr Kovalevskiy reported attending meetings organized by the International Chrysotile Association and reported that all expenses for attendance were paid by his institute.

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The study is monitored by an independent scientific advisory board, which oversees the progress of the study. The scientific advisory board members are Professor Franco Merletti (chair), Professor Mads Melbye (until 2017), Professor Julian Peto, Professor Martin Röösli (from 2017), and Dr Antti Tossavainen. Scientific advisory board members provided their reviews of this manuscript, but the integration of their comments remained at the discretion of the authors. The authors like to express their gratitude to the scientific advisory board for many years of advice and their helpful comments on the manuscript.

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Annexure M

2013 N.Y. Slip Op. 04127 . 109 A.D.3d 7 . 966 N.Y.S.2d 420 .

In re NEW YORK CITY ASBESTOS LITIGATION. Weitz & Luxenberg P.C., Plaintiffs–Respondents, v. Georgia–Pacific LLC, Defendant–Appellant.

Supreme Court, Appellate Division, First Department, New York. (Jun 6, 2013)

DOCKET NO.

ATTORNEY(S)

Quinn Emanuel Urquhart & Sullivan, LLP, New York (Kathleen M. Sullivan of counsel), and Lynch Daskal Emery LLP, New York (Scott Emery of counsel), for appellant.Weitz & Luxenberg P.C., New York (Jerry Kristal and Alani Golanski of counsel), for respondents.

JUDGES

Richard T. Andrias

IMPORTANT PARAS

1. Attorney work product under CPLR 3101(c), which is subject to an absolute privilege, is limited to "documents prepared by counsel acting as such, and to materials uniquely the product of a lawyer's learning and professional skills, such as those reflecting an attorney's legal research, analysis, conclusions, legal theory or strategy" (Brooklyn Union Gas Co. v. American Home Assur. Co., 23 A.D.3d 190, 190–191, 803 N.Y.S.2d 532 [1st Dept. 2005]). Documents generated for litigation are generally classified as trial preparation materials (CPLR 3101[d][2]) unless they contain otherwise privileged communications, such as memoranda of private consultations between attorney and client (see People v. Kozlowski, 11 N.Y.3d 223, 244, 869 N.Y.S.2d 848, 898 N.E.2d 891 [2008]). Trial preparation materials are subject to a conditional privilege and may be disclosed "only upon a showing that the party seeking discovery has a substantial need of the materials in the preparation of the case and is unable without undue hardship to obtain the substantial equivalent of the materials by other means" (CPLR 3101[d][2]; Giordano v. New Rochelle Mun. Hous. Auth., 84 A.D.3d 729, 732, 922 N.Y.S.2d 518 [2d Dept. 2011]). This Court has also observed that "it is unfair for the opposing party in a litigated controversy to ... use this privilege both as a sword and a shield, to waive when it enures to her advantage, and wield when it does not" (Matter of Farrow v. Allen, 194 A.D.2d 40, 45, 608 N.Y.S.2d 1 [1st Dept. 1993] [internal quotation marks

omitted]).

2. A party seeking "to invoke the crime-fraud exception must demonstrate that there is a factual basis for a showing of probable cause to believe that a fraud or crime has been committed and that the communications in question were in furtherance of the fraud or crime" (United States v. Jacobs, 117 F.3d 82, 87 [2nd Cir.1997]; see also Ulico Cas. Co., 1 A.D.3d at 224, 767 N.Y.S.2d 228;Matter of Grand Jury Subpoena, 1 A.D.3d 172, 767 N.Y.S.2d 77 [1st Dept. 2003]). However, "[a] lesser evidentiary showing is needed to trigger in camera review than is required ultimately to overcome the privilege" (United States v. Zolin, 491 U.S. 554, 572, 109 S.Ct. 2619, 105 L.Ed.2d 469 [1989]).

3. This discovery dispute pertains to all of the Weitz & Luxenberg New York City Asbestos Litigation (NYCAL) cases in which Georgia– Pacific (GP) is a defendant. For the following reasons, we find that the motion court providently exercised its discretion when it denied GP's motions to vacate the Special Master's recommendations and directed an in camera review of certain internal communications identified in GP's privilege log and the production to plaintiffs of certain underlying data related to eight published research studies funded by GP concerning the health effects of its joint compound.

4. At Holm's deposition, plaintiffs requested that GP produce all documents relating to the studies. GP produced certain documents and a privilege log asserting that all communications with its consulting experts were protected by the attorney work product privilege and that its internal communications were protected by the attorney- client privilege. The Special Master directed an in camera review of all documents identified in GP's privilege log (Recommendation # 1), and production of all materials and raw data underlying the published studies (Recommendation # 2).

5. GP complied with Recommendation # 1 to the extent that it submitted for in camera review all communications to and from its consulting experts. On July 11, 2011, the Special Master found that the documents she reviewed were privileged and that no documents were discoverable other than those that GP had agreed to supply. The ruling was limited to GP's communications to and from its consulting experts that GP had produced, and did not otherwise modify or vacate the recommendations in respect of GP's claim of attorney-client privilege (internal communications) and the attorney work-product privilege regarding the underlying data, which remained in full force and effect.

JUDGMENT

RICHARD T. ANDRIAS

Quinn Emanuel Urquhart & Sullivan, LLP, New York (Kathleen M. Sullivan of counsel), and Lynch Daskal Emery LLP, New York (Scott Emery of counsel), for appellant. Weitz & Luxenberg P.C., New York (Jerry Kristal and Alani Golanski of counsel), for respondents.
RICHARD T. ANDRIAS, J.P., JOHN W. SWEENY, JR., HELEN E. FREEDMAN, PAUL G. FEINMAN, JUDITH J. GISCHE, JJ.

ANDRIAS, J.P.

This discovery dispute pertains to all of the Weitz & Luxenberg New York City *Asbestos* Litigation (NYCAL) cases in which Georgia– Pacific (GP) is a defendant. For the following reasons, we find that the motion court providently exercised its discretion when it denied GP's motions to vacate the Special Master's recommendations and directed an in camera review of certain internal communications identified in GP's privilege log and the production to plaintiffs of certain underlying data related to eight published research studies funded by GP concerning the health effects of its joint compound.

GP funded these studies in 2005 to aid in its defense of *asbestos* -related lawsuits. The studies were performed by experts from various organizations, who, among other things, recreated GP's historical joint compound product for the purpose of testing its biopersistence and pathogenicity. To facilitate the endeavor, GP entered into a special employment relationship with Stewart Holm, its Director of Toxicology and Chemical Management, to perform expert consulting services under the auspices of its in- house counsel, who also was significantly involved in the pre-publication review process.

At Holm's deposition, plaintiffs requested that GP produce all documents relating to the studies. GP produced certain documents and a privilege log asserting that all communications with its consulting experts were protected by the attorney work product privilege and that its internal communications were protected by the attorney- client privilege. The Special Master directed an in camera review of all documents identified in GP's privilege log (Recommendation # 1), and production of all materials and raw data underlying the published studies (Recommendation # 2).

The motion court denied GP's motion to vacate the Special Master's recommendations, as well its motion for leave to reargue the in camera prong of that decision to narrow its scope. GP appeals, arguing that plaintiffs failed to make the necessary showings to warrant in camera review of internal privileged communications or production of work product data and that ordering that review and production is an unwarranted intrusion into GP's privileged communications.

GP complied with Recommendation # 1 to the extent that it submitted for in camera review

all communications to and from its consulting experts. On July 11, 2011, the Special Master found that the documents she reviewed were privileged and that no documents were discoverable other than those that GP had agreed to supply. The ruling was limited to GP's communications to and from its consulting experts that GP had produced, and did not otherwise modify or vacate the recommendations in respect of GP's claim of attorney-client privilege (internal communications) and the attorney work- product privilege regarding the underlying data, which remained in full force and effect.

The motion court providently exercised its broad discretion in supervising disclosure when it confirmed Recommendation # 1 and granted in camera review of the documents to determine whether the crime-fraud exception to the attorney-client privilege applied (*see Those Certain Underwriters at Lloyds, London v. Occidental Gems, Inc.*, 11 N.Y.3d 843, 845,873 N.Y.S.2d 239,901 N.E.2d 732 [2008]).

The crime- fraud exception encompasses " 'a fraudulent scheme, an alleged breach of fiduciary duty or an accusation of some other wrongful conduct' " (*Art Capital Group LLC v. Rose*, 54 A.D.3d 276, 277,862 N.Y.S.2d 369 [1st Dept. 2008], quoting *Ulico Cas. Co. v. Wilson, Elser, Moskowitz, Edelman & Dicker*, 1 A.D.3d 223, 224,767 N.Y.S.2d 228 [1st Dept. 2003]). "[A]dvice in furtherance of a fraudulent or unlawful goal cannot be considered 'sound.' Rather advice in furtherance of such goals is socially perverse, and the client's communications seeking such advice are not worthy of protection" (*In re Grand Jury Subpoena Duces Tecum*, 731 F.2d 1032, 1038 [2d Cir.1984]).

A party seeking "to invoke the crime- fraud exception must demonstrate that there is a factual basis for a showing of probable cause to believe that a fraud or crime has been committed and that the communications in question were in furtherance of the fraud or crime" (*United States v. Jacobs*, 117 F.3d 82, 87 [2nd Cir.1997]; *see also Ulico Cas. Co.*, 1 A.D.3d at 224,767 N.Y.S.2d 228; *Matter of Grand Jury Subpoena*, 1 A.D.3d 172,767 N.Y.S.2d 77 [1st Dept. 2003]). However, "[a] lesser evidentiary showing is needed to trigger *in camera* review than is required ultimately to overcome the privilege" (*United States v. Zolin*, 491 U.S. 554, 572,109 S.Ct. 2619,105 L.Ed.2d 469 [1989]).

To permit in camera review of the documents to analyze whether the communications were used in furtherance of such wrongful activity, there need only be "a showing of a factual basis adequate to support a good faith belief by a reasonable person that in camera review of the materials may reveal evidence to establish the claim that the crime-fraud exception applies" (*id.* [internal quotation marks and citation omitted]). "Once that showing is made, the decision whether to engage in *in camera* review of the evidence rests in the sound discretion of the [ ] court" (*id.*).

Holm co- authorized nearly all of the studies, which were intended to cast doubt on the capability of chrysotile *asbestos* to cause cancer. On the two articles that he did not co-author, he and GP's counsel participated in lengthy "WebEx conferences" in which they discussed the manuscripts and suggested revisions. Despite this extensive participation, none of the articles disclosed that GP's in- house counsel had reviewed the manuscripts

before they were submitted for publication. Two articles falsely stated that "[GP] did not participate in the design of the study, analysis of the data, or preparation of the manuscript." For articles lead-authored by David M. *Bernstein* , Ph.D., and co-authored by Holm, the only disclosure was that the research was "sponsored" or "supported" by a grant from GP. The articles did not disclose that Holm was specially employed by GP for the *asbestos* litigation or that he reported to GP's in-house counsel. Furthermore, there were no grant proposals, and Dr. *Bernstein* was hired by GP on an hourly basis. Nor did the articles reveal that Dr. *Bernstein* has been disclosed as a GP expert witness in NYCAL since 2009, that he had testified as a defense expert for Union Carbide Corporation in *asbestos* litigation, or that he had been paid by, and spoken on behalf of, the Chrysotile Institute, the lobbying arm of the Quebec chrysotile mining industry. Although GP belatedly endeavored to address the inadequacies of certain of its disclosures, its corrections failed to acknowledge its in-house counsel's participation and did not make clear that Dr. Bernstein's testimony as an expert witness preceded the publication of the first GP reformulated joint compound article in 2008.

[5] The foregoing constitutes a sufficient factual basis for a finding that the relevant communications could have been in furtherance of a fraud, and the motion court properly confirmed the recommendation directing in camera review of the internal documents. As the court remarked, it is of concern that GP's in-house counsel would be so intimately involved in supposedly objective scientific studies, especially in light of GP's disclosures denying such participation (*see United States v. Philip Morris USA, Inc.*, 449 F.Supp.2d 1 [D.D.C. 2006] [applying the fraud-crime exception, in regard to defendants' litigation-related efforts to skew smoking and health research], *affd. in relevant part*566 F.3d 1095 [D.C. Cir. 2009], *cert. denied*—— U.S. ——, 130 S.Ct. 3501, **177 L.Ed.2d 1090** [2010]).

Plaintiffs' contention that this portion of the appeal is moot because GP complied with the order and produced the data pending review on appeal is without merit. While this Court may not be able to return the parties to the status quo ante since plaintiffs now have acquired the information in the underlying data, "a court can fashion *some* form of meaningful relief in circumstances such as these," including ordering the destruction or return of materials disclosed (*Church of Scientology of California v. United States*, 506 U.S. 9, 12–13, 113 S.Ct. 447,121 L.Ed.2d 313 [1992]).

The motion court providently exercised its discretion when it confirmed Recommendation # 2 and directed GP to produce all documents and materials underlying the published studies over which it has possession, custody, or control, including, but not limited to, microscopy images, the data generated in the chambers where the reformulated compounds were created, and numerical calculations, and to act in good faith to secure its consulting experts' compliance with the direction to produce.

Attorney work product under CPLR 3101(c), which is subject to an absolute privilege, is limited to "documents prepared by counsel acting as such, and to materials uniquely the product of a lawyer's learning and professional skills, such as those reflecting an attorney's

legal research, analysis, conclusions, legal theory or strategy" (*Brooklyn Union Gas Co. v. American Home Assur. Co.*, 23 A.D.3d 190, 190–191, 803 N.Y.S.2d 532 [1st Dept. 2005]). Documents generated for litigation are generally classified as trial preparation materials (CPLR 3101[d] [2]) unless they contain otherwise privileged communications, such as memoranda of private consultations between attorney and client (*see People v. Kozlowski*, 11 N.Y.3d 223, 244,869 N.Y.S.2d 848,898 N.E.2d 891 [2008]). Trial preparation materials are subject to a conditional privilege and may be disclosed "only upon a showing that the party seeking discovery has a substantial need of the materials in the preparation of the case and is unable without undue hardship to obtain the substantial equivalent of the materials by other means" (CPLR 3101[d] [2]; *Giordano v. New Rochelle Mun. Hous. Auth.*, 84 A.D.3d 729, 732,922 N.Y.S.2d 518 [2d Dept. 2011]). This Court has also observed that "it is unfair for the opposing party in a litigated controversy to ... use this privilege both as a sword and a shield, to waive when it enures to her advantage, and wield when it does not" (*Matter of Farrow v. Allen*, 194 A.D.2d 40, 45,608 N.Y.S.2d 1 [1st Dept. 1993] [internal quotation marks omitted]).

The results of the published studies commissioned by GP are relevant, and it cannot be seriously disputed that plaintiffs have a substantial need for the underlying data in the preparation of their cases. "Large corporations often invest strategically in research agendas whose objective is to develop a body of scientific knowledge favorable to a particular economic interest or useful for defending against particular claims of legal liability" (*In re Welding Fume Prods. Liability Litig.*, 534 F.Supp.2d 761, 769 n. 10 [N.D. Ohio 2008] [internal quotations omitted]). "The publication of [research] findings and conclusions invites use by persons whom the findings favor and invites reliance by the finders of fact. The public has an interest in resolving disputes on the basis of accurate information" (*In re American Tobacco Co.*, 880 F.2d 1520, 1529 [2d Cir.1989]). Here, GP commissioned the studies in anticipation of litigation and has admitted that "[a]t an appropriate time and after their publication is complete, GP plans to introduce the results of the studies in litigation."

In determining whether plaintiffs are unable without undue hardship to obtain the substantial equivalent of the materials by other means, due consideration must be given to the fact that discovery in NYCAL is governed by the September 20, 1996 Case Management Order (CMO), as amended May 26, 2011, which is designed to "allow the parties to obtain reasonably necessary documents and information without imposing undue burdens in order to permit the parties to evaluate the case, reach early settlements, and prepare unsettled cases for trial." The court has "full authority, under the controlling [CMO], to issue its discovery order pertaining to ongoing cases" (*Matter of New York City Asbestos Litig.*, 66 A.D.3d 600, 600,887 N.Y.S.2d 580 [1st Dept. 2009] [denying the defendant's claims that it be permitted to shield analogous materials via a protective order]).

Given the complexity of the studies, the motion court was rightfully wary of prejudicing plaintiffs by permitting the sudden introduction of the studies or experts on the eve of trial, or in the many other pending *asbestos* trials. As the court found, principles of fairness, as

well as the spirit of the CMO, require more complete disclosure, and GP should not be allowed to use its experts' conclusions as a sword by seeding the scientific literature with GP-funded studies, while at the same time using the privilege as a shield by withholding the underlying raw data that might be prone to scrutiny by the opposing party and that may affect the veracity of its experts' conclusions (*see John Doe Co. v. United States,* **350 F.3d 299, 302** [2d Cir.2003]; *see also Niagara Mohawk Power Corp. v. Stone & Webster Eng'g Corp.,* **125 F.R.D. 578, 587** [N.D.N.Y.1989]).

Plaintiffs will be prejudiced if they are prevented from discovering the data, protocols, process, conduct, discussion, and analyses underlying these studies. A significant expenditure of time and money would be required to duplicate the studies, if they could be exactly duplicated at all, whereas scrutiny of the underlying data may provide a permissible manner in which to attack the findings that would be consistent with the intent of the CMO to minimize the cost of and streamline discovery.

In this regard, we note that the court limited its ruling to the data, samples, and materials that relate to those studies whose results have been published or will be published. GP is not required at this juncture to produce to plaintiffs any internal communications that portray its attorneys' or consultants' notes, comments or opinions. Moreover, GP will be free to make whatever pretrial in limine application it deems appropriate.

Finally, no appeal lies from the order denying reargument (*Stratakis v. Ryjov,* 66 A.D.3d 411,885 N.Y.S.2d 597 [1st Dept. 2009]).

Accordingly, the order of the Supreme Court, New York County (Sherry Klein Heitler, J.), entered December 12, 2011, which confirmed recommendations of the Special Master directing an in camera review of all internal attorney-client and work-product documents identified on defendant GP's privilege log, and directing the production of all materials and raw data underlying several published studies funded by GP, should be affirmed, without costs. The appeal from the order, same court and Justice, entered June 14, 2012, which denied GP's motion for reargument, should be dismissed, without costs, as taken from a nonappealable order.

Order, Supreme Court, New York County (Sherry Klein Heitler, J.), entered December 12, 2011, affirmed, without costs. Appeal from order, same court and Justice, entered June 14, 2012, dismissed, without costs, as taken from a nonappealable order. **All concur.**

-------- Notes:

Administration Language - Mother Tongue
Government of Kerala
Summary

General Education Department-Interim Order of the Hon'ble High Court in W.P. (C) 22457/2019 - Order is issued prohibiting Asbestos Sheet Roofing and fixing time limit for removal of the same in Schools in the State under General Education Department.

General Education (M) Department

G.O.(MS)No.162/2019/GEDN Date 9/10/2019
Thiruvananthapuram

Ref: Interim Order dated 3/9/2019 of the Hon'ble High Court of Kerala in W.P. (C) 22457/2019.

ORDER

In the interim order cited above in W.P.(C).22457/2019 filed by the School Manager of Thrissur, Koorikuzhi AMUP School before the Hon'ble High Court it is directed to remove Asbestos sheet roofing from the class rooms in the Schools of the State in a time bound manner by fixing suitable materials.

Government has examined the matter in detail. On the basis of the Interim order of the Hon'ble High Court cited above, Order is passed prohibiting usage of asbestos sheet, which may cause health issues to the school children, for constructing the roof in all the schools in the State under General Education Department and issuing the following instructions.

1. In all the schools under General Education Department having Asbestos sheet roofing, the same have to be removed within two years from the date of this order by fixing other suitable roofings.

2. The Local Self Government Institutions have to take steps in this regard joining with managements for aided-unaided-approved Private Schools and with Education Department for Government Schools.

3. The Director of Public Instructions has to prepare a list of the Schools having asbestos sheet roofing in the State and to confirm removal of such sheets with suitable other roofings in a time bound manner and to make available monthly report in this regard to the Government.

4. The Director of Public Instructions and the Engineers of the Local Self Government Department have to confirm that no heat absorbing/flammable materials which are prohibited as per Chapter IV Rule 5 of Kerala Education Rules are used for substituting the roof or for constructing roof for the new school building.

The interim order of the Hon'ble High Court cited above is complied in the above manner.

(Under Order of Government)
P.S.Krishna Kumar,
Additional Secretary

10. Material on record further discloses that the 7th respondent/Secretary, Local Self Government Department issued Ext.P4 order to the Director of Panchayats, Director of Urban Affairs and Commissioner for Rural Development informing that issuance of Fitness Certificate for the schools and other educational institutions shall be made only after ensuring that the class rooms are constructed not using asbestos sheets, tin sheets and aluminium sheets.

11. Ext.P4 order reads as under:

File No.EPA4/302/2019-LSGD
Administration Language - Mother Tongue
Government of Kerala

No EPA4/302/19/LSGD

Local Self Goverment(EPA) Department,
17/10/2019
Thiruvananthapuram

Secretary

Director of Panchayats, Thiruvananthapuram
Director of Urban Affairs, Thiruvananthapuram
Commissioner for Rural Development, Thiruvananthapuram.

Sir,

Sub: Kerala State Commission for Protection of Child Rights-Prohibiting usage of asbestos sheet roofing to school buildings -regarding.

Annexure O 14/

भारत सरकार - रेल मंत्रालय
अनुसंधान अभिकल्प और मानक संगठन
लखनऊ - 226 011
EPBX (0522) 2451200
Fax (0522) 2458500

Government of India-Ministry of Railways
Research Designs & Standards Organisation
Lucknow - 226 011
DID (0522) 2450115
DID.(0522) 2465310

No. WKS/107/Trials

Date 15.06.17

CPDE/ CGE/ CE (Works) of
Zonal Railways
and Production Unit as per mailing list

Sub: Trials of Various New Technology/ Products presented by Industries/ Firms during 8th Works Standard Committee meeting.

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Various New Technology/Products presented by Industries/Firms during 8th WSC meeting held at IRICEN/Pune have been uploaded on RDSO website which can be seen as per path below:

http://www.rdso.indianrailways.gov.in ⟶ Directorate ⟶ Works ⟶ New Material From Industries.

SN	Technology/ Product	Qualities of Products (as claimed by Industries / Firms)	Industries / Firms
1.	Calcium Silicate Tiles for false ceiling & Wall Paneling.	• Lightweight tiles confirming to green building product. • Non – combustible, • 100% Relative Humidity resistant • TERMITE resistant.	Aerolite Ceiling Systems,A unit of Andhra Polymers Pvt. Ltd.,Plot No. 2, Phase-V, IDA, Jeedimetla, Hyderabad- 500055 Mobile: 09391217111
2.	Anti Skid Steel Block Flooring	• Suitable for heavy engineering, oily & greasy floorings, pedestrian and vehicular movements. • Provides good grip & firm bond to the concrete floor. • Permits easy & fast installation compared to concreting of floors. • Resists impacts due to Mechanical, Chemical & Thermal forces.	SURAJ TRADEWAYS Sarojini Sadan, Congress House, 406/408 Vithalbhai Patel Road, Mumbai 400 004 Tel: 022 23860514/ 022 23800514.
3.	Bamboo wood Products	• Eco – friendly products for flooring, wall skirting, wall cladding, door, window & furniture like sitting benches etc. • High resistance to moisture. • Biodegradable & fully recyclable. • Termite - resistant.	MUTHA INDUSTRIES PVT LTD Office: Room no.1, 2nd floor, Botawala Bldg. 11/13 Horniman Circle, Fort, Mumbai 400023, I Tel: 022-4033 4567/ 4585

4.	PVC doors & uPVC Windows	• 100% Moisture proof. • 100% Termite proof & borer free. • Flame retardant & self extinguishing. • Unbreakable & Shatter proof. • Chemical & Stain resistant. • Light weight & non – warping.	Rajshri Plastiwood, Plot No 100, Sector 2, PITHAMPUR- 454775 District, Dhar (M.P) Tel.: 07292-418801, 9302429108 Fax: 07292-418884
5.	Metal Roof Water Proofing paint	Used for waterproofing of metal roofs, external walls of old buildings, RCC roof, gutters, bituminous surface and asbestos roofs	Parex Group Construction Products Pvt. Ltd., New Udyog Mandir No. 2, Office No. 2, 2nd Floor, 7-C, Mogul Lane, Mahim (West), Mumbai- 400016 Tel: 022-24475051
6.	Cementitious Coating for Foot Over Bridge.	• Suitable for interior and exterior application such as FOB, stores, car parks, walkways etc. • Excellent adhesion to concrete • Excellent abrasion & impact resistance. • Good waterproofing properties.	
7.	Roofing Material (Non-Asbestos Sheet & Polycarbonate Sheet)	• Does not fade or degrade. • Protects against UV. • Provides Thermal insulation. • Lightweight & easy to install. • Weather resistant.	Everest Industries Limited D-206 sector-63, Noida Tel: +91 1204791800 Fax: +91 1204791802 Helpline : 09958037777 Web: www.everestind.com

You are requested to get some works executed with these materials and arrange to send feedback on performance to this office.

15.02.17

(राजीव कुमार गुप्ता)
निदेशक / कार्य / अ.अ.मा.स.

DA: Nil.

Copy for kind information: Principal Chief Engineer/ Chief Administrative Officer (Zonal Railways) as per mailing list

POLYCARBONATE & NON ASBESTOS ROOFING SHEETS

The products of manufacturers' mentioned in document is based on the details provided by firm and no testing or trial of the product has been carried out by this office. Products mentioned on webpage be used only as trial material on limited use considering prevalent guidelines, rules, cost & other factors including availability of similar type of materials in market by other manufactures. Railway vide letter no. WKS/107/Trials dated 15.06.17 has been advised to carry out trial and submit report to RDSO.

Lightweight corrugated polycarbonate roofing sheets are the ultimate in performance & durability in roof light with high light transmission. It helps to conserve energy while enhancing the quality of working environment. Superior physical properties such as UV protection and an advanced profile matching technology makes Rooflight ideal for in-plane rooflights and sidelights in corrugated metal roofs and Non Asbestos Cement roofings. It facilitates optimum solar transmission with clear panels allowing maximum light and diffusions filtering visible light and reducing heat loads. It saves electricity in return.

SPECIFICATIONS OF ROOFLIGHT POLYCARBONATE SHEET EPDM WASHER AND NON ASBESTOS SHEET.

ROOFLIGHT POLYCARBONATE SHEET (Item covers under Unified Standards Specification for Works & Material 2010 Clause no. 10.11.8)

Profiled Skylight polycarbonate sheets are manufactured through online extrusion process. The sheets thickness varies from 0.70 mm to 3 mm with co-extruded UV coating of 40 microns ensuring a 10 years weather resistant warranty with light transmission of not less than 85% . The sheets are having anti glare - white diffuser color with 100% light dispersion ratio. The sheets should confirms ASTM Standards D2240 for Hardness Shore A, D412 for Tensile Strength & Elongation Break, D624 for Tear Strength, D573 for heat resistance (Change in Hardness, Tensile Strength & Elongation), D395 for compression set and D1171 for ozone resistance. The Polycarbonate sheets should confirms fire test as per EN13501. Sheet should not show breakage due to loss of impact strength / weathering effect when tested as per ISO 6603/1-1985(E). Roof light extruded corrugation profile should match with main roof profile for a leak proof assembly. The sheet installation shall be carried out as per manufacturer's recommendation and as instructed by Engineer in charge.

NON-ASBESTOS SHEET ROOFING (As per IS 14871: 2000)

Providing and fixing non-asbestos high impact fibre reinforced cement 6 mm thick corrugated sheets (as per IS: 14871) roofing up to any pitch and fixing with polymer coated J or L hooks, bolts and nuts 8mm dia. G.I. plain and bitumen washers or with self drilling fastener and EDPM washers etc. complete excluding the cost of purlins, rafters and trusses including cutting to size and shape wherever required.

EPDM WASHER

This shall be used in roof sheeting for proper fixing and avoiding leakage. EPDM washer shall be consist of two components i.e. 25 MM dia Stainless steel cap SS 304 M8/16G and EPDM rubber washer.
EPDM stands for Ethylene Propylene Diane Monomer which is a type of synthetic elastomeric rubber.

Advantage of Everest Roof light Poly Carbonate Corrugated Sheets:

Parameters	**Everest Roof Light Extruded Poly carbonate Corrugated Sheets**	**Others (Cold Bended /Thermoformed Poly carbonate Corrugated Sheets (Made from Other Flat Sheets)**
Manufacturing	By Online process - from Resins to Profiled Sheet - manufactured on Extrusion Line	Normally Offline Manual Process - Made on Press Brake/ Thermoforming machine (from flat PC Sheets)
Raw Material	Manufactured from Virgin Grade Polycarbonate granules	Manufactured from PC Flat sheets with unknown machine - place - process
Dimensional Consistency/ Uniformity	Excellent Corrugated Sheets are extruded on a “continuous” process to ensure dimensional consistency – accuracy	Poor Individual sheet is corrugated - pressed making each sheet inconsistent in dimensions
Matching to Metal Profile	Excellent Special Extrusion tooling is made for each specific Roofing Profile, to ensure dimensional accuracy and perfect fit up	Poor Individual sheet is corrugated - pressed with inconsistent dimensions, making the fit up difficult and inconsistent
Leakage	Manufactured to match any profile thereby ensuring leak proof joints	Inconsistent dimensions of cold bended/ thermoformed PC Sheets results in gaps between fit up causing future leakages
UV Coating	Continuous online co-extruded UV Coating technology guarantees a very long life	UV coating gets damaged during the bending - thermoforming process, which reduces the life of sheets
Light Transmission (LT) & Yellowness Index	Advanced UV Coating technology minimises weathering effect = high LT % and very low Yellowness Index	Damaged UV Coating exposes the sheets to UV Rays and weathering effects = low LT% and high Yellowness Index
Warranty	5-year warranty with a normal product life of 20 years	Same as the “warranty”, available on the flat sheets

		used as raw material, which loses its properties post bending/ forming
Test Certificates/ Conforming Standards	Profiled sheets are tested at recognised labs and supplied with relevant load tables	Cold bended/ thermoformed sheets depend on Test Certificates of raw material i.e. flat sheet

Rates provided by M/s Everest Industries Limited & HIL Limited:

S. No.	Description of Item	Cost
1.	Non-asbestos sheet Size: Length 3 meter x width 1.050/1.097 meter x 6 mm thick corrugated sheets (as per IS: 14871)	Rs. 330-350/- Per Sqm Natural Grey Finish Rs. 400/- Per Sqm Weather-proof Acrylic Paint
2.	EVEREST ROOFLIGHT	Rs. 910/- Per Sqm 1 mm thickness Rs. 1365/- Per Sqm 1.5 mm thickness Rs. 1900/- Per Sqm 2 mm thickness
3.	EPDM WASHER Umbrella 25mm SS M8/16G	Rs. 6500/- Per 1000 nos.

Some of the known Manufacturers/ Suppliers:

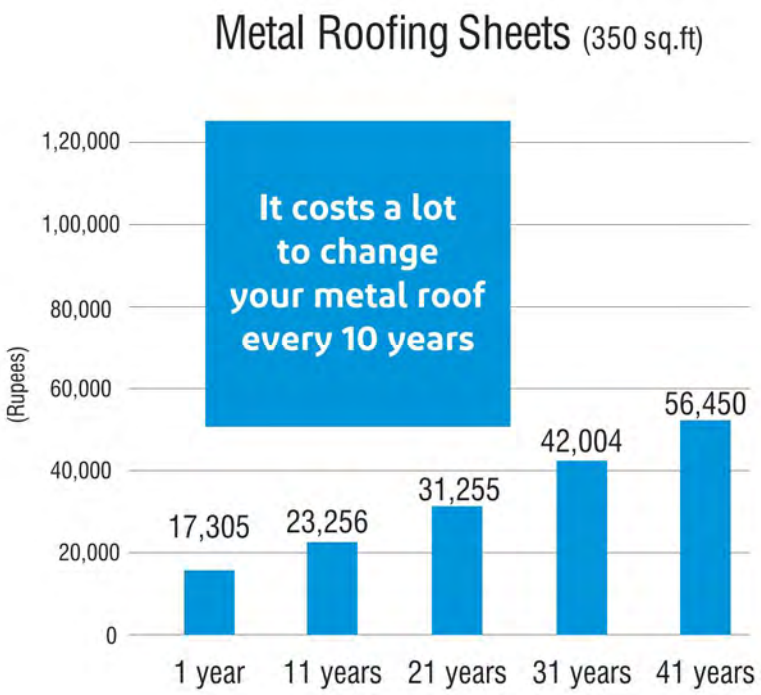
1. EVEREST INDUSTRIES LTD,
   "Everest Technopolis",
   D-206, Sector-63, Noida-201301
   Mb:- 9560136633
   landline :- 0120-4791896.
   rverma@everestind.com.

2. HIL Limited (CK Birla Group)
   7th Floor, SLN Terminus (Near Botanical Gardens)
   Gachibowli, Hyderabad-500032,
   Telangana, India, www.hil.in
   Tel: 040-30999000, Fax: 040-23702400
   Tollfree: 1800042542599
   Email: info@hil.in

Annexure P

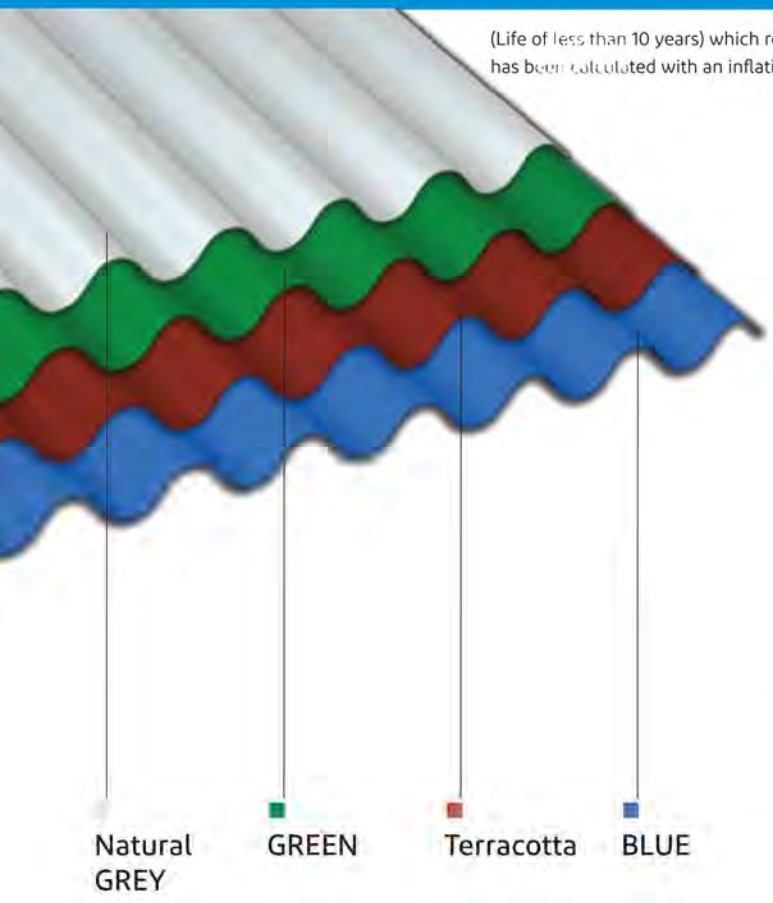
RAMCO GREENCOR
NEW AGE ROOFING

The roof over our home is GREENCOR



Original roof laying and total replacement cost over 40 years - 1,70,270 (for a 350 sq.ft. Structure)

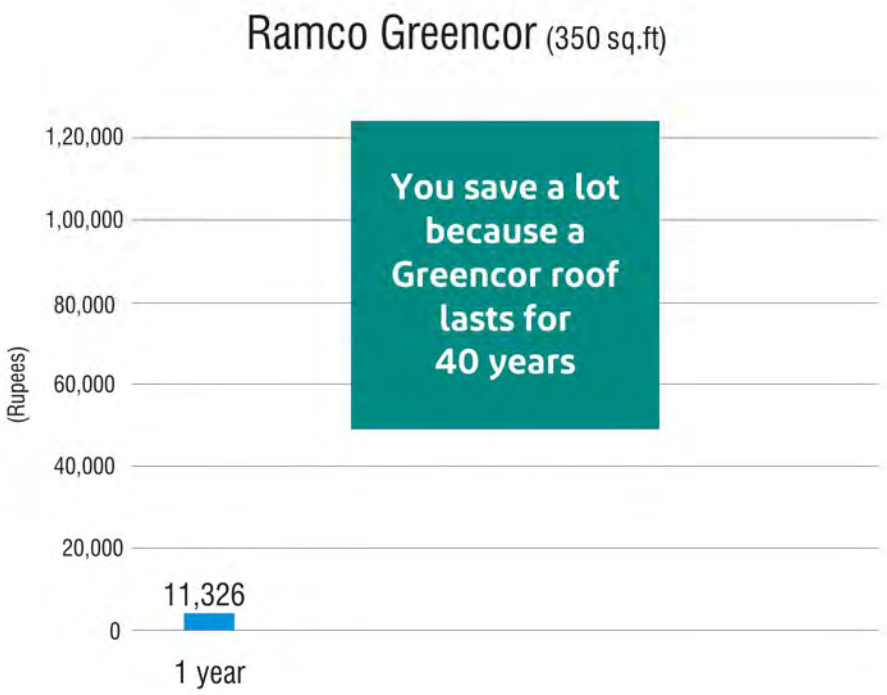
(Life of less than 10 years) which results in changing the roof every 10 years. The cost of changing the roof every year has been calculated with an inflation rate of 3% every year.



About RIL

Ramco Industries Limited, a well known and reputed manufacturer of fibre cement sheets since 1967, has a name that is synonymous with quality and durability. With a production capacity of 8,00,000 mt of fibre cement products being churned out from its 12 hi-tech factories across India and Sri Lanka, Ramco products are widely available through its extensive network of over 8000 dealers.

Ramco Industries Limited is a brand leader in its market space and is a part of the Ramco Group, a conglomerate with diversified business interests having an annual turn over of over US$ 1 billion.



Original roof laying cost over 40 years - Rs.11,326 (for a 350 sq.ft. structure)

The above cost has been worked on the durability of Ramco Greencor (Life of over 40 years) over Metal roofing sheets

The Stamp of Strength

Fully automated manufacturing process gives added strength to the fibre cement sheets.

Ensures 100% accuracy at every stage - mixing, forming, cutting, corrugating and stacking.

The Stamp of Durability

Made with high impact PVA/Polypropylene fibres with eight times the strength of steel.

Resists fire, rot, rust, vermin, brittle fractures and alkali attacks.

Strengthens with age.

The Stamp of Consistency

The automated process completely eliminates manual errors.

Sheet after sheet, the quality remains consistently good.

- Rust proof Corrosion resistant
- Extremely safe because fibre cement is an insulator and not a conductor like metal roof
- Calm and quiet environment
- Keeps Internal temperature 5°C coller than other roofs
- Excellent load bearing strength
- Better living environment because it has low thermal conductivity
- Zero maintenance
- Unaffected by lightning and live power wires
- 5 times more durable than metal roofs
- Excellent breathability and dimensional stability

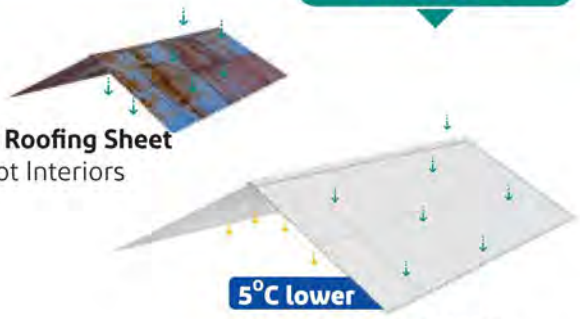
Houses | Schools | Marraige Halls | Factories | Poultry Farms | Stock Yards | Bus Stand | Railway Stations

When heat soars
stay Indoors
It's 5°C cooler than Metal Roofs

When thunder roars
go Indoors
You're 100% safe from Lightening Strikes.

Rain or Shine
Greencor is fine

Cool Inside



Metal Roofing Sheet
Hot Interiors

5°C lower

Ramco Greencor Sheet
Cool Interiors

Long Life

Metal Roofing Sheet
Prone to rusting

Ramco Greencor Sheet
Corrosion-free,
long life-atleast 40 years

Minimal Noise

Metal Roofing Sheet
Very noisy inside

Ramco Greencor Sheet
Quiet interior

Rust Proof

Metal Roofing Sheet
Rusts eats away into the
metal causing holes and leaks

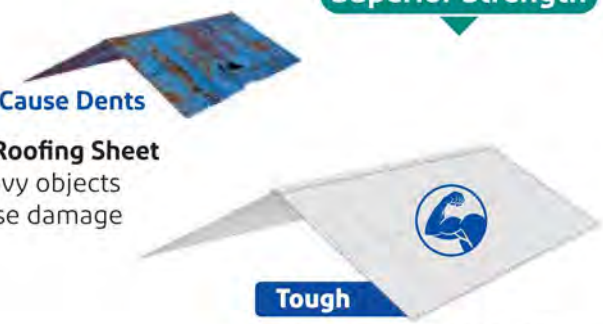
Ramco Greencor Sheet
Since it is mineral based it does not rust at all

Lightning Proof

Metal Roofing Sheet
Risk of electric shock

Ramco Greencor Sheet
is unaffected by lightning
and electricity hence ensures safety

Superior Strength



Metal Roofing Sheet
Heavy objects
cause damage

Ramco Greencor Sheet
Withstands static heavy objects

Fire Resistant

Metal Roofing Sheet

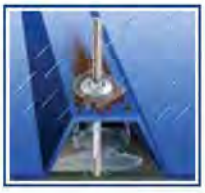
Ramco Greencor Sheet

Corrosion Resistant

Metal Roofing Sheet
Affected by chemicals

Ramco Greencor Sheet
Unaffected by chemicals

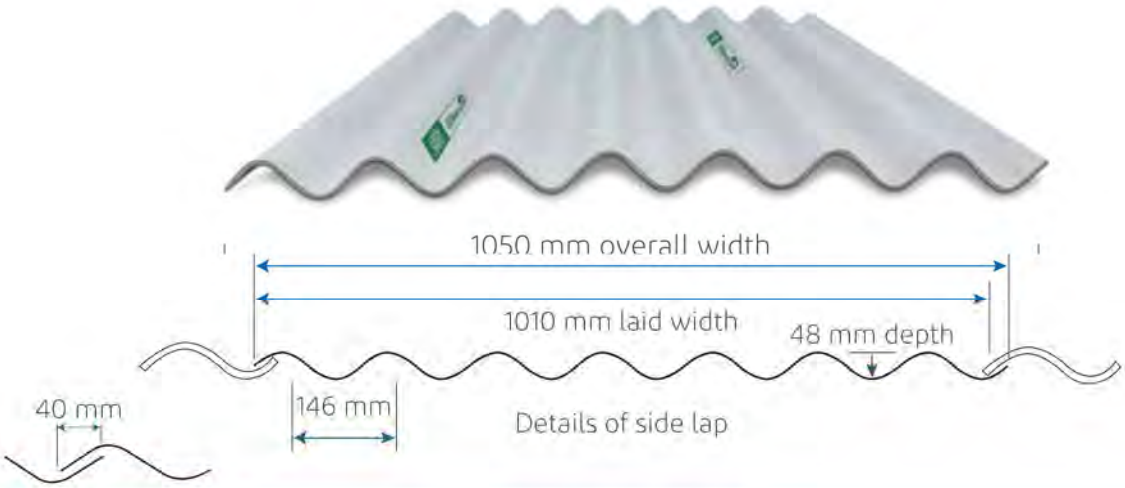
Leak Proof



Metal Roofing Sheet
bolt hole corrosion
causes leaks

Ramco Greencor Sheet
Leak proof since the
sheet does not corrode

Detail of side Lap Ramco Greencor Sheet



Dimensional Data	
Thickness (nominal)	6.00 mm
Overall width	1.05 m
Laid width	1.01 m
Cover efficiency (Allowing for side and end laps with 3 m sheet)	91%
Actual cover of 3 m sheet as laid	2.88 sq.m.
100 sq.m. laid area requires of sheeting (Allowing for loss by side end laps with 3 m sheets)	109.43 sq.m
100 sq.m. laid area requires of sheeting (Allowing for loss by side end laps with 1.5 m sheets)	115.51 sq.m
100 sq.m. laid area with other sizes between 1.5 m and 3 m sheets requires sheeting	Between 115.51 sq.m. & 109.43 sq.m.
Weight of 100 sq.m. as laid for 3 m	1.42 M. Tonnes
Standard lengths	1.5, 1.75, 2.0, 2.25, 2.5, 2.75 & 3.0 m
Purlin spacing	1.4 m (max)
Spacing of rails for side cladding	1.7 m (max)
Horizontal lap	150 mm
Colour available	Natural Grey / Blue / Green / Terracotta

RIL-GCR-III-Ver 2.0 - Apr 2023

RAMCO GREENCOR NEW AGE ROOFING

Ramco Industries Limited
Auras Corporate Centre,
98-A, Dr. Radhakrishnan Salai, Mylapore, Chennai - 600 004.
+91 44 4298 3109 / 91767 75882 info@ril.co.in
www.ramcogreencor.com

everest

HI-TECH

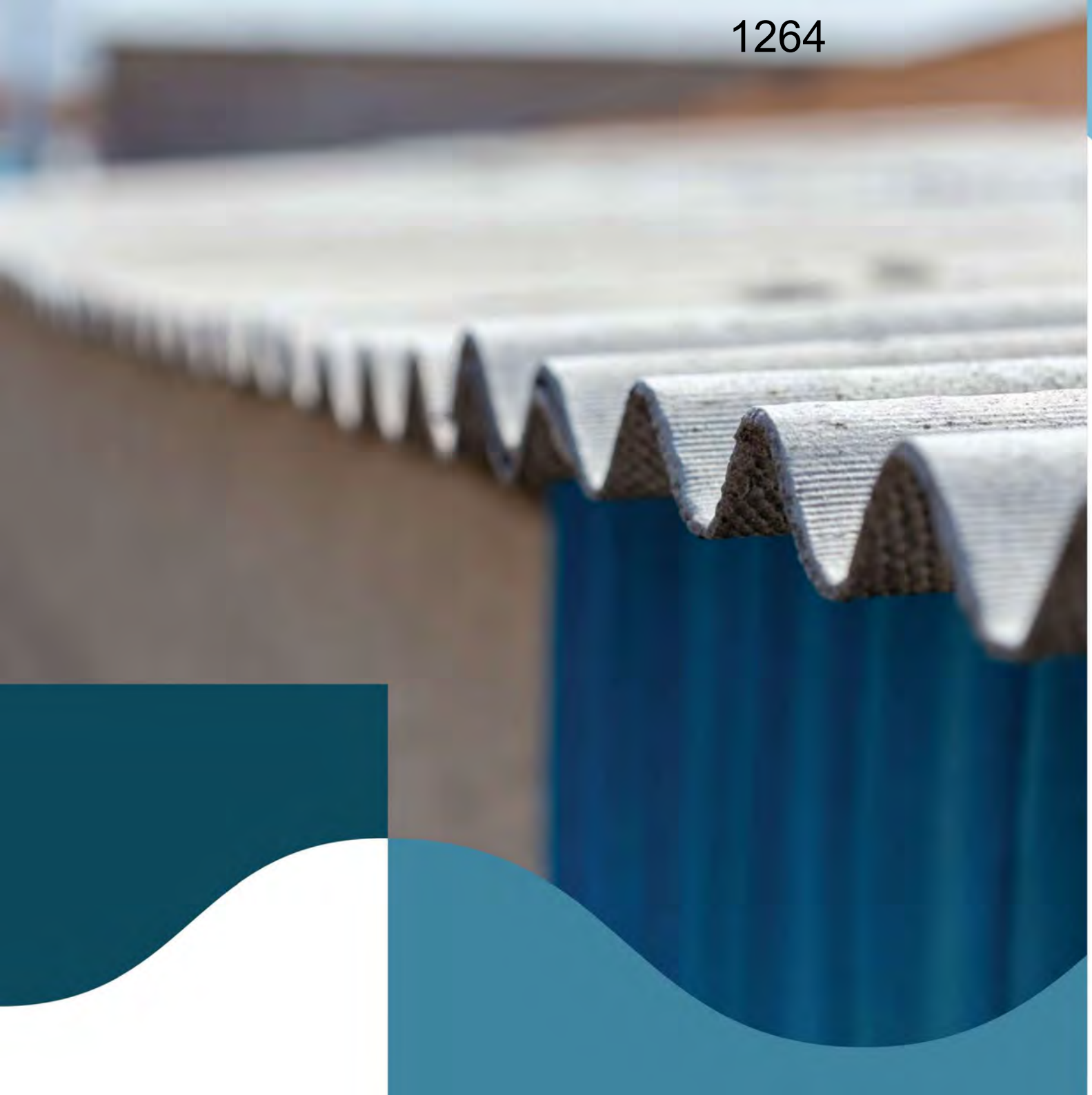
high performance roofs

Reimagining the way India builds with new-age solutions.

India needs a new generation of building technology to fuel its growth. Everest is ushering in a better future for construction, with new-age building solutions that are more efficient, sustainable, and better-performing. Our products are helping to construct hospitals, schools, homes, factories and offices, and have gained the support of India's leading architects, interior designers, and engineering firms. These modern construction materials enable them to deliver their vision with speed and efficiency, in a sustainable, eco-friendly manner, while opening up a world of aesthetic and design possibilities.

30+ applications offering complete building solutions

3,000+ pre-engineered steel buildings

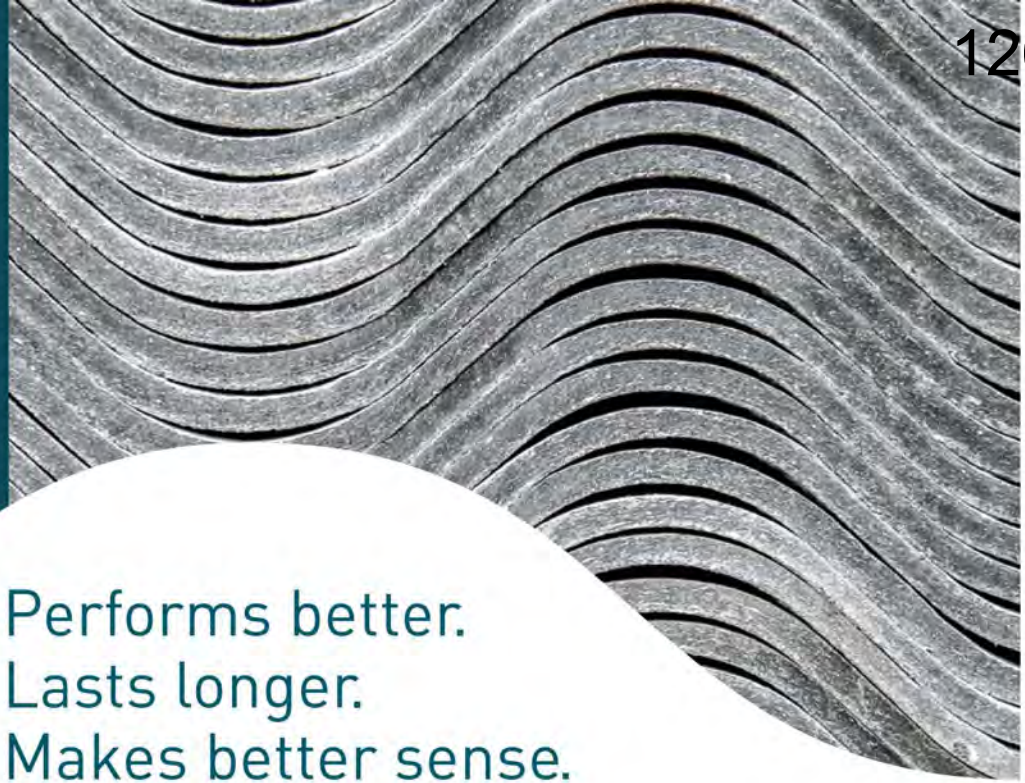


High performance roofs.

A new standard for Indian industry.

Today's industries demand solutions that deliver performance and sustainability advantages. Everest, the pioneer of innovations in roofing solutions, presents Everest Hi-Tech: a high performance, non-asbestos cement roofing that offers a range of performance advantages for demanding industries.

This non-corroding, condensation and fire resistant, heat and sound insulating roofing is reinforced with high-impact PVA fibres for extra durability. It is amongst the most sustainable roofing materials, making it the preferred choice for a new generation of companies across India.



Performs better.
Lasts longer.
Makes better sense.

Everest Hi-tech performs better than other roofing across multiple parameters, making it the smarter choice for a variety of industries and applications that want a longer lasting, more durable roof.

FIRE RESISTANT

Will not warp or melt even at high temperatures.

HIGH CHEMICAL RESISTANCE

Non-reactive, ideal for chemical and pharma industries.

WEATHER-PROOF

Better stability than metals in extreme weather conditions.

THERMAL INSULATION

Unlike metals that absorb and transmit heat, Everest Hi-tech insulates for cooler interiors.

NON-CORRODING

Unlike metal roofs, Everest Hi-tech does not corrode with water or chemicals.

ANTI-CONDENSATION

Ideal for industries and locations where moisture a deterrent.

MAINTENANCE-FREE

Does not require painting, rust removal, replacement panels.

Outperforms metal roofing. In every way.

Every business needs to make investments that pay off over the long-term. As a non-corroding, highly-durable roofing, Everest Hi-Tech displays better performance characteristics than metal roofing, lasts 3x longer and is maintenance-free##. It is an investment that outperforms metal roofing in every way, providing high performance and the best value for money.

PERFORMANCE CHARACTERISTICS

	Hi-Tech	Regular metal sheets
Sound insulation	Less noise pollution	Conducts sound, noisy with rain
Temperature insulation	Keeps interiors cooler	Makes interiors hotter
Lightning and power protection	Does not conduct lightning or electricity	Conducts electricity
Corrosion resistance	Resistant to corrosion	Metal roof corrodes over time
Vapor permeability	Prevents condensation because of breathability	Poor
Dimensional stability	Excellent dimensional stability	Can warp and dent
Lifespan	Longer lifespan	Shorter lifespan

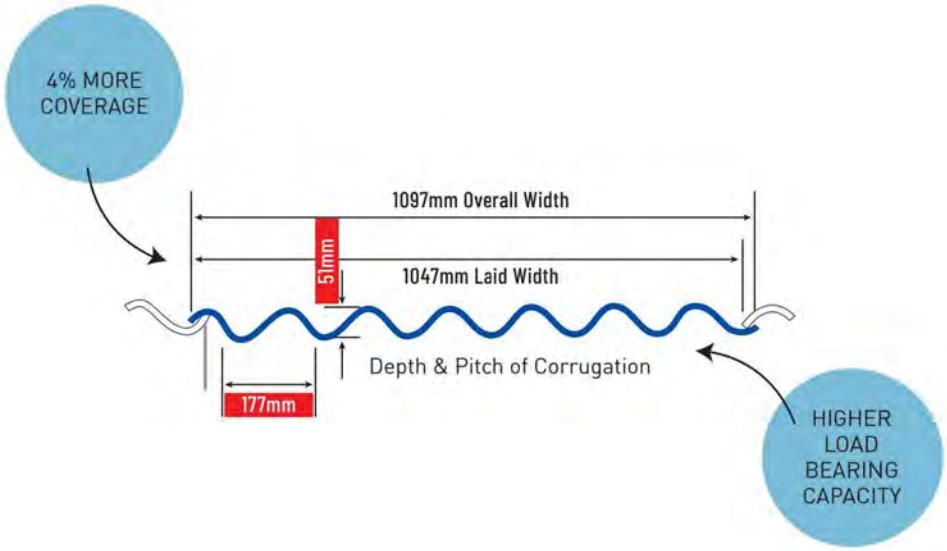
**with correct installation and under normal weather conditions

Advantage P7: the profile created to American specifications.

Everest Hi-Tech's unique P7 profile is made to the best-in-class American standards. The P7 profile makes Hi-Tech stronger, provides ease of water drainage and also makes it more cost effective.

ADVANTAGE OF P7 PROFILE

Parameter	P6 Profile	P7 Profile	Comments
Pitch of Corrugation (mm)	146	177	Higher the pitch, higher the breaking load
Depth of Corrugation (mm)	48	51	Higher depth allows better water flow
Laid Width of Sheet (mm)	1010	1047	More area coverage, which reduces the cost



Everest Hi-Tech. Proven across industries.

With its unique advantages and eco-friendly materials, Everest Hi-Tech roofing is best suited for warehouses, manufacturing and export-oriented units, and modern factory sheds across a wide variety of industries including:

- CHEMICALS
- FOUNDRIES
- PHARMACEUTICALS
- PETROLEUM
- FOOD AND BOTTLING
- GOVERNMENT PROJECTS
- PORTS
- AGRO INDUSTRIES
- ENGINEERING AND AUTOMOBILES
- PAINTS AND PIGMENTS
- TYRE INDUSTRIES

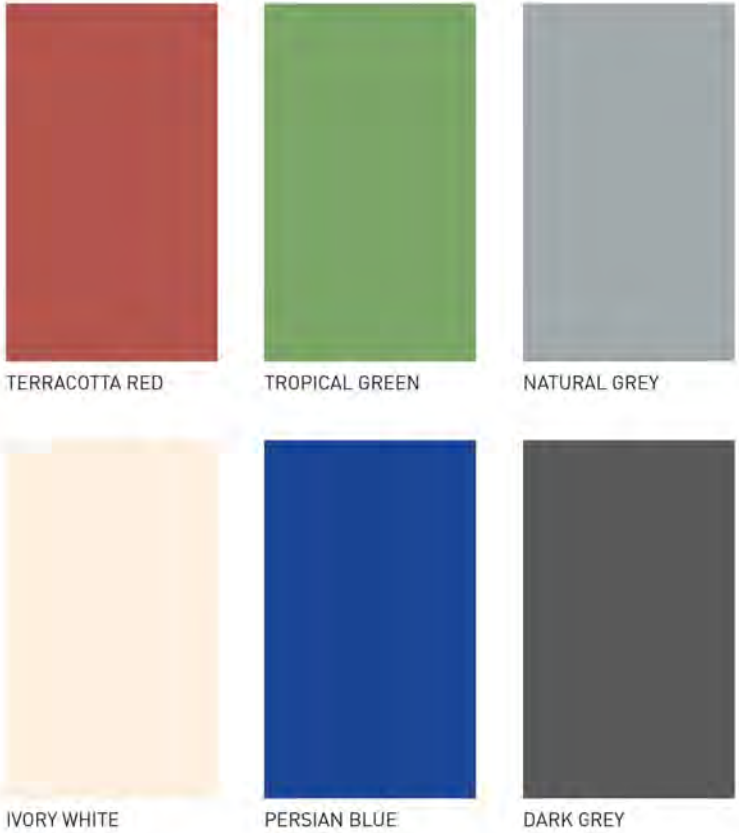
Everest Hi-Tech. Trusted by leading companies.

EVEREST HI-TECH SPECIFICATIONS

PRODUCT Fiber-cement roofing sheets reinforced with high-impact PVA fibres.

COATING Proprietary, high-quality, imported, water-based exterior acrylic coating. Provides resistance to UV rays, fungi and algae. Protects against many acids, alkalis, and solvents. Provides long-lasting aesthetic finish.

COLOURS Available in 6 colours



CERTIFICATION HIPP, IS 14871 and BIS certification

DIMENSIONAL AND TECHNICAL SPECIFICATIONS		
PARAMETERS	TOLERANCE	DIMENSIONS
Thickness	+/- 0.5 mm	6 mm
Overall Width	+10 mm; -5 mm	1097 mm
Laid Width (Half Corrugation Side lap)	Half (+10 mm; -5 mm)	1047 mm
Depth of Corrugation	+3 mm; -5 mm	51 mm
Pitch of Corrugation	—	177 mm
Weight per unit area	—	13.00 kg/running m.
Standard Length	+5 mm; -10 mm	1.0, 1.25, 1.5, 1.75, 2.0, 2.25, 2.5, 2.75, 3.0

INSTALLATION SPECIFICATIONS	
Side Lap	50 mm
End Lap (min)	150 mm
Actual Coverage of 3 m. Sheet as laid (side lap of 50 mm, end lap of 150 mm)	2.98 sq.m.
Purling spacing for side roofing	Max 1400 mm
Runner spacing for side cladding	Max 1700 mm
Max. free overhand of eaves	300 mm
Min. slope of roof	10 degrees

ADVANCED FEATURES	
Work of fracture - IMOR	8000 - 10000 J/M2
Impact resistance	10000 - 12000 J/M2
Breaking load	Min. 3300 - 3500 (N/M)
Density	1300 kg/m3

ROOFING ACCESSORIES

CLOSE FITTING ADJUSTABLE RIDGES: BS2

Available in pairs with socketed ends. Valley of each wing should be placed at the side lap of sheets for snug fitting ridges.

CORRUGATED APRON PIECE: BS3

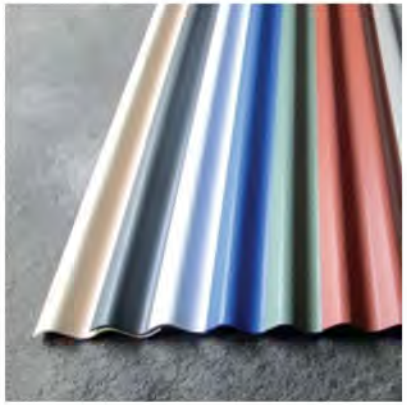
Used for covering the angle formed between the sloping roof with vertical cladding, glazing or walling.

CORRUGATED NORTH LIGHT CURVES: BS9

They are used at the apex of a North light roof. The curved portion protects the glazing from sun and rain.

CORRUGATED SERRATED ADJUSTABLE RIDGE: BS10

Available in pairs. Used for corrugated sheets. One of the corrugation tips is painted black to register with the valley of side lap of the sheet.



S-TYPE LOUVERS: BS13

Available in 3 m. & 1.75 m. lengths. Commonly used in Monitor and North Light roofs where ventilation is required by using rows of S-type louvers.

BARGE BOARD: TS6/6 & TS6/8

Used to finish the verges of the roof. They are also used to finish corners of Asbestos cement sheet walling.

EPDM washers

Ethylene Propylene Diene Monomer (EPDM) is a high class rubber which can exhibit outstanding performance even in high temperatures.

- EPDM exhibits outstanding resistance to heat, ozone, steam and weather. It is also an electrical insulator.
- EPDM washer provides excellent anchoring on roofing sheet. The unique shape of the washer allows it to grip on all sides, along the curve of roofing sheet.
- Compression pressure is generated by tightening the nut. This pressure is sustained by dense rubber. The tight grip prevents leakage; thereby providing a leakage-free roof.
- Stainless Steel (SS) ring of on the washer is resilient to corrosion, extreme weather conditions, and shocks.
- The high quality and resilience of both, the rubber and SS ring makes Everest EPDM washer the ideal choice for industrial, commercial and residential usage.

About Everest Roofing

With a rich legacy of dependability and trust as the pioneers of fiber cement roofing in India, Everest is a brand that stands for innovation, quality, strength, and longevity. Today, Everest is reimagining roofing in India with a wide range of solutions, that include coloured roofing and the high performance roofing. Our wide range of innovative products serve varied needs of customers across retail, commercial and industrial sectors, consistently delivering on trust and value.

7000+	1,00,000+	600+	1 Bn. sq.m.
Dealers	Villages	Cities	Roofing products installed across India

NOTES

NOTES

everest

EVEREST INDUSTRIES
LIMITED, INDIA.

everestind.com

Tower 14, 3rd Floor,
Solitare Corporate Park,
167, Guru Hargovindji Marg,
Andheri East, Mumbai - 400 093,
Maharashtra, India.

Customer care no.: 1800 4191 991

Affidavit

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH AT NEW DELHI

IN O.A. 298 OF 2023

IN THE MATTER OF:
Dr. Raja Singh

.....Applicant

Vs.

Union of India, Through the Secretary, Ministry of Environment, Forests and Climate Change and Ors.

.....Respondents

AFFIDAVIT

I, Dr. Raja Singh, S/o Sh. Gurmit Singh, aged 31 years, R/o E 205/206, GF, Amar Colony, Lajpat Nagar 4, New Delhi 110024, do hereby solemnly affirm and state as follows:

1. That I am the Applicant in the above captioned Rejoinder and as such fully conversant with the facts of the present case and hence competent to swear the present affidavit.
2. That I have gone through the contents of the accompanying application and has been drafted by me.
3. That I have understood the meaning thereof and the content of the accompanying rejoinder is true and correct to the best of my knowledge.

DEPONENT

Identify the Executant Deponent Who Has Signed In My Presence

01 MAY 2024

Verification

Verified at New Delhi on this 1st day of May 2024 that the contents of the above affidavit are true and correct to the best of my knowledge. No part of it is false and nothing material has been concealed therefrom to the best of my knowledge.

NOTARY AMIT ANAND Advocate L. No. 16627 Exp. on 27/01/2025 GOVT. OF INDIA

ATTESTED
NOTARY PUBLIC
DELHI (INDIA)
9716/1/5/2024
01 MAY 2024

DEPONENT

Service of Rejoinder in response to reply of of R. 4 in OA 298 of 2023

From Dr. Raja Singh <dr.rajasingh@proton.me>

To ankit@virmani.in, vaibhav.bhadana@virmani.in, hrithik@virmani.in, office@virmani.in

CC dheeraj.adv001@gmail.com, Gigicgeorge.adv42@yahoo.in, danubeconsulting@gmail.com, secy.sel@nic.in, mbalodhi.cpcb@nic.in, bhaskar.chhikara@gmail.com

Date Thursday, May 2nd, 2024 at 12:53 PM

BEFORE THE NATIONAL GREEN TRIBUNAL
Principal Bench at New Delhi

OA 298 of 2023
Dr Raja Singh vs Union of India & Ors

Most Respectfully,

Please find the rejoinder in response to the reply of Respondent No. 4 before the Hon'ble National Green Tribunal in OA 298 of 2023.

The rejoinder is here:
https://drive.google.com/file/d/1AjL9iuA6ILUH5ZAjZXNVoXGEEMrEHn7r/view?usp=drivesdk

Kindly confirm the receipt of the same.

Thanks and regards
Dr Raja Singh