BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION No. **485/2023**

In the matter of:

DIWAN SINGH **APPLICANT**

VERSUS

STATE OF UTTARAKHAND **RESPONDENTS**

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Sharandeep

(Sharandeep Singh)

Scientist 'E'

Central Pollution Control Board

Date: 11.07.2024

Place: Delhi

Expert Joint Committee Report

on O.A. No. 485/2023

in the matter of Diwan Singh versus State of Uttarakhand

Hon'ble NGT order dated 16.05.2024

Hon'ble NGT vide its Order dated 16.05.2024 on Original Application No. 485/2023 in the matter of Diwan Singh versus State of Uttarakhand, instructed the following: -

> *"..... 09 We find substance in the above submissions that reply given by project proponent in respect of question of seismic zone on protection matter may be examined by Expert Committee constituted by this Tribunal vide order dated 30.01.2024.*
>
> *10. We, therefore, request said Committee to investigate reply which has been quoted above in this order and submit its comments/reports within one month.*

In compliance of the Hon'ble NGT order dated 30.01.2024, the following Expert Joint Committee (EJC) was constituted:

1. Dr. Sumer Chopra, Director & Head, Seismic Hazard Assessment and Microzonation Group, (nominated by Institute of Seismological Research)
2. Dr. K. Luirei, Scientist-F, (nominated by Wadia Institute of Himalayan Geology, Dehradun)
3. Sh. Kamal Kumar, Scientist-E, RD-Lucknow (nominated by CPCB)
4. Dr. K. Mondal, Scientist-D, Regional Office, Dehradun (nominated by MoEF&CC)
5. Shri Yashvir Singh, SDM, Gangolihat, Pithoragarh (nominated by DM, Pithoragarh)

In compliance to Hon'ble NGT OA no. 485/2023 vide its order dated 30.01.2024, Expert Joint Committee submitted report to Hon'ble NGT. In consideration of

committee's observation and report, the following paragraph exerted by Hon'ble NGT on order dated 16.05.2024:

".....06. While going through the above Report we found that with respect to seismic studies, there is observation by Expert Committee as under:

"A report on structural design calculation for tunnel intake prepared by M/s Tata Consulting Engineers Limited is also shared with the committee. The report was reviewed in detail. It was found that M/s Tata has wrongly considered the project in Zone IV as per seismic zoning map of India published by BIS. Actually, the project site is located in Zone V. considering the available documents, it seems the site specific seismic studies were not carried out for the project. The calculations are based on seismic zone factor only. The recommended horizontal seismic coefficient as per Zone V is 0.24 as per National Committee on Seismic Design Parameters (NCSDP) while M/s Tata has considered 0.11 factor for calculations."

"07. Respondent 5 has filed its reply dated 14.05.2024 to Hon'ble NGT and on the aspect of above observations made by Expert Committee, it has submitted its own Expert's Explanation as under:

"*A report on structural design calculation for tunnel intake prepared by M/s Tata Consulting Engineers Limited is also share with committee. The report was reviewed in detail. It was found that M/s Tata has wrongly taken the project in Zone IV as per seismic zoning map of India published by BIS. Actually, the project site is located in Zone V. Also, it seems that site specific seismic studies were not carried out for the project. The calculations are based on seismic zone factor only. The recommended horizontal seismic coefficient as per Zone V is 0.24 as per National Committee on Seismic Design Parameters (NCSDP) while M/s Tata has considered 0.11 for calculations.*

TCE's Reply

Khutani Small Hydro Electric Project is being developed as a low-head 'Run-of-th-River' type development involving a diversion barrage across the Saraju River in the Bageshwar district located in the Kumaon region of

Uttarakhand. The project lies in Zone V as per the Seismic Zoning Map of India incorporated in IS: 1893 (Part-1)-2016.

*The desing horizontal seismic coefficient (as) for project components are calculated according to Indian Standard IS 1893-1984 criteria for earthquake resistant design of structures and as given below as per seismic coefficient method given in clause 3.4.2.3. of IS 1893-1984 as=B*1* a0.*

*Therefore, design horizontal seismic coefficient (ah)=1*3*0.08=0.24 this is in line with the recommended value as per zone V as per National Committee on Seismic Design Parameters (NCSDP) considering highest value of importance factor. Therefore, vertical seismic coefficient for barrage, av=2/3 ah=0.16 similarly, for Tunnel Intake*

*Importance factor I=1 being categorized as other structure as per Table 4 therefore, design horizontal seismic coefficient for tunnel intake (ah)=1*1*0.08=0.08. However, in the structural design report for tunnel intake Doc. No. TCH.7784A-CV-CALC-3028-01 (R1), the Seismic Coefficient (ah) was calculated as 0.11 following the formula ah=z/2*1/R*Sa/g provided in IS: 1893 (Part-1)-2016.*

It is pertinent to mention IS: 1893 (Prt-1)-2016 deals primarily of building structure and the provision indicated in the above code for calculating design seismic coefficient is meant for buildings.

For hydropower structure, mainly dam/barrage/intake, horizontal seismic coefficients are generally calculated as per provision given in clause 3.4.2.3 of IS 1993-1984.

Therefore, the method for calculating design horizontal seismic coefficient following IS: 1893-(Part-1)-2016 and seismic zone were wrongly adopted in the structural design report for tunnel intake.

However, the value calculated in the report (0.11) is more than the actual value (0.08) calculated following IS 1893-1984 and thus, will not have any impact in the design aspect."

8. Mr. M. R. Shamshad, Learned Amicus Curie submitted, when in respect to Seismic Zone, as per Report of Expert Committee, there is error in respect to Seismic Zone, correctness of reply submitted by Expert of Proponent needs be examined by said Committee otherwise, it is an admitted fact that project lies in Seismic Zone-V and if calculation has been done by treating

Zone-IV, there is an apparent mistake on the part of experts of proponent and project require review on this aspect.

9. We find substance in the above submissions that reply given by project proponent in respect of question of seismic zone on protection matter may be examined by Expert Committee constituted by this Tribunal vide order dated 30.01.2024. "

As per the order of Hon'ble NGT court dated 16.05.2024, The Expert Committee discussed the order and the subject expert Dr. Sumer Chopra, Member of Expert Joint Committee has the following comments on the reply submitted by project proponent 5:

Facts on the reply submitted to NGT on seismic parameter IS 1893 is the Indian standard code of practice for "Criteria for Earthquake Resistant Design of Structures." The code has undergone several revisions to incorporate advancements in knowledge and technology related to earthquake engineering. The IS 1893-1984 is the fourth revision while the IS 1893-2016 is the sixth revision.

As per the IS code, the horizontal seismic coefficient (αh) for a structure can be computed by two methods,

(i) Seismic coefficient method / Equivalent static method and

(ii) Response spectrum method.

The seismic coefficient method is a simplified approach for seismic analysis, often used for regular and low-rise structures. It approximates the effects of an earthquake by applying equivalent static horizontal forces to the structure.

The response spectrum method is a more refined and accurate approach for seismic analysis, suitable for all types of structures, especially irregular and high-rise buildings. It uses the structure's dynamic characteristics to estimate the seismic response.

In IS 1893-1984, the expressions for αh in seismic coefficient method and response spectrum method are different. In IS 1893-2016, although the expression is same,

design acceleration coefficient for different soil types, normalized with peak ground acceleration (Sa/g) is different corresponding to natural period (T) of structure.

For example, as per IS 1893-1984, in seismic coefficient method the design value of horizontal seismic coefficient

$$\alpha_h = \beta * I * \alpha_0 \quad (1)$$

where I= a factor, called importance factor, depends upon the importance of the structure

β= a coefficient depending upon the soil-foundation system

α_0= basic horizontal seismic coefficient. This value is different for different seismic zones.

In response spectrum method,

$$\alpha_h = \beta * I * F_0 * Sa/g \quad (2)$$

where F_0 is the seismic zone factor and Sa/g is the average acceleration coefficient for appropriate natural period and damping of the structure.

As per IS 1893-2016, the horizontal seismic coefficient

$$\alpha_h = (Z/2) * (I/R) * (Sa/g) \quad (3)$$

where Z= seismic zone factor and R is the response reduction factor. Sa/g is taken from the following:

For use in equivalent static method

$$\frac{S_a}{g} = \begin{cases} \text{For rocky or hard soil sites} \begin{cases} 2.5 & 0 < T < 0.40 \text{ s} \\ \frac{1}{T} & 0.40 \text{ s} < T < 4.00 \text{ s} \\ 0.25 & T > 4.00 \text{ s} \end{cases} \\ \text{For medium stiff soil sites} \begin{cases} 2.5 & 0 < T < 0.55 \text{ s} \\ \frac{1.36}{T} & 0.55 \text{ s} < T < 4.00 \text{ s} \\ 0.34 & T > 4.00 \text{ s} \end{cases} \\ \text{For soft soil sites} \begin{cases} 2.5 & 0 < T < 0.67 \text{ s} \\ \frac{1.67}{T} & 0.67 \text{ s} < T < 4.00 \text{ s} \\ 0.42 & T > 4.00 \text{ s} \end{cases} \end{cases}$$

For use in response spectrum method

$$\frac{S_a}{g} = \begin{cases} \text{For rocky or hard soil sites} \begin{cases} 1+15T & T < 0.10 \text{ s} \\ 2.5 & 0.10 \text{ s} < T < 0.40 \text{ s} \\ \frac{1}{T} & 0.40 \text{ s} < T < 4.00 \text{ s} \\ 0.25 & T > 4.00 \text{ s} \end{cases} \\ \text{For medium stiff soil sites} \begin{cases} 1+15T & T < 0.10 \text{ s} \\ 2.5 & 0.10 \text{ s} < T < 0.55 \text{ s} \\ \frac{1.36}{T} & 0.55 \text{ s} < T < 4.00 \text{ s} \\ 0.34 & T > 4.00 \text{ s} \end{cases} \\ \text{For soft soil sites} \begin{cases} 1+15T & T < 0.10 \text{ s} \\ 2.5 & 0.10 \text{ s} < T < 0.67 \text{ s} \\ \frac{1.67}{T} & 0.67 \text{ s} < T < 4.00 \text{ s} \\ 0.42 & T > 4.00 \text{ s} \end{cases} \end{cases}$$

M/s Tata Consulting Engineers Limited in the structural design report for tunnel intake Doc. No. TCH.7784A-CV-CALC-3028-01 (R1), estimated the seismic coefficient (α_h) following the response spectrum method given in IS 1893-2016. While calculation, M/s Tata Consulting Engineers Limited considered the seismic zone factor Z of seismic zone IV, that is 0.24, I=1, R=1.5, Sa/g=1.358. Therefore α_h=(0.24/2)*(1/1.5)*1.358=0.11.

Now, M/s Tata Consulting Engineers (TCE) Limited mentioned that the α_h value calculated using equation (1) above i.e. $\alpha_h = \beta * I * \alpha_0$, that is using seismic coefficient method as per IS 1893-1984, is 0.08. They estimated the value by taking Importance factor I=1, β=1 and basic horizontal seismic coefficient for zone V (α_0)=0.08. They mentioned that α_h = 0.11, calculated in the report, is more than the α_h value calculated by use of seismic coefficient method of IS 1893-1984. Therefore, it will not have any impact in the design aspect.

It is observed that

1. The Khutani Small Hydro Electric Project site is in seismic zone-V and M/s Tata Consulting Engineers (TCE) Limited admitted this fact now. The zone factor Z in equation (3) is 0.36 for zone-V. Considering Sa/g=1.358 (corresponding to the natural period of the structure), I=1.0 and R=1.5 values as considered by M/s Tata Consulting Engineers Limited makes α_h = (0.36/2)*(1/1.5)*1.358 =0.16. So α_h=0.11 is not correct for sites in zone-V, rather 0.16 is the correct value.
2. M/s Tata Consulting Engineers Limited mentioned that IS 1893-2016 (Part 1) deals primarily of building structure and the provision indicated in the code for calculating design seismic coefficient is meant for buildings. For hydropower structure, mainly dam/barrage/intake, horizontal seismic coefficients are generally calculated as per provision given in clause 3.4.2.3 of IS 1993-1984. That makes the αh value 0.08 (equation 1), using the equivalent static method.

It is important to mention here that 'Recommendations for earthquake resistant design of structures' was first published in 1962, and revised in 1966, 1970, 1975 and 1984. Further, in 2002, the Committee decided to present the provisions for different types of structures in separate parts, to keep abreast with rapid developments and extensive research carried out in earthquake-resistant design of various structures. Thus, IS 1893 was split into five parts. The other parts in the series are:

Part 1: General provisions and buildings

Part 2: Liquid retaining tanks - Elevated and ground supported

Part 3: Bridges and retaining walls

Part 4: Industrial structures, including stack-like structures

Part 5: Dams and embankments (to be formulated)

However, it is mentioned in "Foreword" of IS 1893-2016 that this standard (Part 1) contains general provisions on earthquake hazard assessment applicable to all buildings and structures covered in Parts 2 to 5.

It is obvious that M/s Tata Consulting Engineers Limited is comparing α_h value estimated from older and recent IS codes and that too estimated by two different methods. Comparing the seismic horizontal coefficients calculated using IS 1893-1984 and IS 1893-2016 reveals significant differences due to updates and

improvements in the standards over the years. The following Table-1 presents an overview of the main differences in both the version of the codes.

Table 1: Comparison of factors used for calculation of α_h in IS 1893-1984 and IS 1893-2016

Factor	IS 1893-1984	IS 1893-2016
Seismic zone factor (Z)	The seismic zones were categorized into five zones (I to V) with corresponding zone factors. Zone V had the highest factor of 0.4.	Zones were updated, with Zone V having a factor of 0.36.
Importance factor (I)	The importance factor ranged from 1.0 to 3.0 depending on the type of building.	More detailed importance factors ranging from 1.0 to 1.5 or higher for critical structures.
Response reduction factor (R)	This factor was not explicitly detailed in the 1984 version as it is in the later versions.	More detailed and specific to different structural systems, ranging from 1.5 to 5.0 or more.
Average acceleration coefficient (Sa/g)	To be considered for appropriate natural period and damping of the structure	To be considered for rock/ stiff soil / soft soil sites based on appropriate natural period of the structure

Summary:

- The formula for α_h is similar in concept for both the versions of the IS codes, but uses updated factors and response spectra, leading to different results. Hence, the seismic horizontal coefficients calculated using IS 1893-1984 and IS

1893-2016 are not directly comparable due to significant updates in seismic zoning, importance factors, response reduction factors, and response spectra.

- The 2016 version provides a more accurate and detailed approach reflecting current knowledge and practices in earthquake engineering. Consequently, calculations using the 2016 code will generally result in different, and often higher, seismic forces, ensuring improved safety and performance of structures under seismic events.
- Justifying the estimations with older provisions is not correct and there should be consistency in estimations.
- In view of the above, the αh value will be 0.16, considering I=1.0, R=1.5, Sa/g= 1.358 and Z (for zone-V)=0.36.

The above Expert Joint Committee Report is being filed for the kind perusal and consideration of the Hon'ble Tribunal.

9/7/2024

(Dr. Sumer Chopra)
Director & Head
Sesmic Hazard Assessment and Microzonation Group,
Institute of Seismological Research

(Dr. K. Luirei)
Scientist-F
Wadia Institute of Himalayan Geology,
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(Kamal Kumar)
Scientist-E
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CPCB

(Dr. K. Mondal)
Scientist-D
Regional Office, Dehradun,
MoEF&CC

09/7/24

(Yashvir Singh)
SDM, Gangolihat
Pithoragarh

Item No.09 Court No.02

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

Original Application No.485/2023

Diwan Singh Applicant(s)

Versus

State of Uttarakhand Respondent(s)

Date of hearing: 16.05.2024

CORAM: HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE DR. AFROZ AHMAD, EXPERT MEMBER

Applicant(s): Mr. M. R. Shamshad – Amicus Curiae with Mr. Arijit Sarkar and Ms. Nabeela Zamil, Advocates.Applicant in Person (through VC).

Respondents: Ms. Anjali Rajput, Advocat for State of Uttrakhand.
M. Mukesh Verma, Advocate for UKPCB.
Mr. Alok Singh and Mr. Deepak Shukla, Advocates for Respondent No. 5 Project Proponent.

ORDER

1. This Original Application was registered on a letter petition raising complaint that a tunnel, length 1.5 km, is being constructed by M/s Khutani Power Project (hereinafter referred to as '**Project Proponent/PP**') in village Batgeri and Sirsauli, Tehsil Ganai Gangoli, Block Gangolihat, District Pithoragadh, State of Uttarakhand. On account of the aforesaid work undertaken by PP, cracks have appeared in houses of residents of locality which is likely to cause damage to lives and property anytime.

2. Taking note of said complaint, by order dated 04.08.2023, this Tribunal constituted a Joint Committee comprising representative of Ministry of Environment, Forest and Climate Change (hereinafter

referred to as **'MoEF&CC'**), Integrated Regional Office, Dehradun, Uttarakhand, and Uttarakhand Environment Protection and Pollution Control Board (UEPPCB) and District Magistrate, Pithoragarh, directing said Committee to submit a factual Report on the subject.

3. Pursuant thereto, Joint Committee submitted its Report by e-mail dated 18.11.2023. Report with respect to facts said that it could not be ascertained that cracks in some residential buildings in villages have occurred due to any activity of Project Proponent. However, Committee recommended that for finding out reasons of development of cracks, matter may be required to be examined by some subject expert institutes.

4. Consequently, by order dated 30.01.2024, Tribunal constituted another Expert Committee comprising (i) Director of Wadia Institute of Himalayan Geology, Dehradun, (ii) Director of Institute of Seismological Research, Gandhinagar, (iii) Central Pollution Control Board (iv) Regional Officer, Ministry of Environment, Forests and Climate Change, Dehradun and (v) Collector, Pithoragarh.

5. The said Committee has submitted its Report dated 19.04.2024, and its observations are as under:

> *"Based on the field visit, observations and available information, the Joint Committee submitted the following:*
> *Looking into all the aspects, past reports and on-site inspection, the causes of the development of cracks in the houses at both villages can be summarized as below:*
> *a) The houses are mostly constructed over colluvial deposit without concrete base slab as such the weight of the overburden (i.e. of the houses) must have distributed un-evenly that resulted in the development of cracks and bulging of the walls.*
> *b) The houses are constructed using small rock slabs without cementing materials, only the outer sides of the walls have been plastered either by cement and sand, or locally available materials (mixtures of mud and twigs and cow dungs). The roof slabs are constructed over the top of loosely placed small slabs*

along with that of the roof slab have resulted in redistribution of the overburden weight that led to the development of cracks and bulging of the walls in the houses.

c) Based on the field observations and information collected, it can be concluded that at present cracks observed in the houses of the villages Batgeri and Sirsauli's are due to local construction practices, materials used and local site conditions. These are not developed due to works carried out by M/s. Khutani Power Company Ltd. (no.5 at the project construction site).

d) A site specific seismic study may be carried out for the project by institute of repute. The design calculations of various structures shall be based on seismic coefficient arrived at from such study.

e) The boundary wall height needs to be enhanced to about 6.0 ft, toward River Saryu to avoid the spillage of debris from much dump site no.2.

f) Should submit the action plan to local concern authorities for stabilization of all muck dump site appropriately & concern authority required to review the same periodically and verify the compliance.

g) The debris excavated or any disposable material should not be discharged/disposed on the back of River Saryu or at any non-identified places. It must be disposed of as per conditions laid down in the Consent to Establish (CTE). The SPCH must periodically monitor and ensure strict compliance of the CTE issued."

6. While going through the above Report we found that with respect to seismic studies, there is observation by Expert Committee as under:

"A report on structural design calculation for tunnel intake prepared by M/s Tata Consulting Engineers Limited is also shared with the committee. The report was reviewed in detail. It was found that M/s Tata has wrongly considered the project in Zone IV as per seismic zoning map of India published by BIS. Actually, the project site is located in Zone V. considering the available documents, it seems the site specific seismic studies were not carried out for the project. The calculations are based on seismic zone factor only. The recommended horizontal seismic coefficient as per Zone V is 0.24 as per National Committee on Seismic Design Parameters (NCSDP) while M/s Tata has considered 0.11 factor for calculations."

7. Respondent 5 has filed its reply dated 14.05.2024 and on the aspect of above observations made by Expert Committee, it has submitted its own Expert's Explanation as under:

"A report on structural design calculation for tunnel intake prepared by M/s Tata Consulting Engineers Limited is also share with committee. The report was reviewed in detail. It was found that M/s Tata has wrongly taken the project in Zone IV as per seismic zoning map of India published by BIS. Actually, the project site is located in Zone V. Also, it seems that site specific seismic studies were not carried out for the project. The calculations are based on seismic zone factor only. The recommended horizontal seismic coefficient as per Zone V is 0.24 as per National Committee on Seismic Design Parameters (NCSDP) while M/s Tata has considered 0.11 for calculations.

TCE's Reply

Khutani Small Hydro Electric Project is being developed as a low-head 'Run-of-th-River' type development involving a diversion barrage across the Saraju River in the Bageshwar district located in the Kumaon region of Uttarakhand. The project lies in Zone V as per the Seismic Zoning Map of India incorporated in IS: 1893 (Part-1)-2016.

*The desing horizontal seismic coefficient (as) for project components are calculated according to Indian Standard IS 1893-1984 criteria for earthquake resistant design of structures and as given below as per seismic coefficient method given in clause 3.4.2.3. of IS 1893-1984 as=B*1* a0.*

*Therefore, design horizontal seismic coefficient (ah)=1*3*0.08=0.24 this is in line with the recommended value as per zone V as per National Committee on Seismic Design Parameters (NCSDP) considering highest value of importance factor. Therefore, vertical seismic coefficient for barrage, av=2/3 ah=0.16 similarly, for Tunnel Intake*

*Importance factor I=1 being categorized as other structure as per Table 4 therefore, design horizontal seismic coefficient for tunnel intake (ah)=1*1*0.08=0.08. However, in the structural design report for tunnel intake Doc. No. TCH.7784A-CV-CALC-3028-01 (R1), the Seismic Coefficient (ah) was calculated as 0.11 following the formula ah=z/2*1/R*Sa/g provided in IS: 1893 (Part-1)-2016.*

It is pertinent to mention IS: 1893 (Prt-1)-2016 deals primarily of building structure and the provision indicated in the above code for calculating design seismic coefficient is meant for buildings.

For hydropower structure, mainly dam/barrage/intake, horizontal seismic coefficients are generally calculated as per provision given in clause 3.4.2.3 of IS 1993-1984.

Therefore, the method for calculating design horizontal seismic coefficient following IS: 1893-(Part-1)-2016 and seismic zone were wrongly adopted in the structural design report for tunnel intake.

However, the value calculated in the report (0.11) is more than the actual value (0.08) calculated following IS 1893-1984 and thus, will not have any impact in the design aspect."

8. Mr. M. R. Shamshad, Learned Amicus Curie submitted, when in respect to Seismic Zone, as per Report of Expert Committee, there is error in respect to Seismic Zone, correctness of reply submitted by Expert of Proponent needs be examined by said Committee otherwise, it is an admitted fact that project lies in Seismic Zone-V and if calculation has been done by treating Zone-IV, there is an apparent mistake on the part of experts of proponent and project require review on this aspect.

9. We find substance in the above submissions that reply given by project proponent in respect of question of seismic zone on protection matter may be examined by Expert Committee constituted by this Tribunal vide order dated 30.01.2024.

10. We, therefore, request said Committee to look into reply which has been quoted above in this order and submit its comments/reports within one month.

11. List this matter for further consideration on 16.07.2024.

Sudhir Agarwal, JM

Dr. Afroz Ahmad, EM

May 16, 2024
Original Application No.485/2023
MK