

**BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL  
PRINCIPAL BENCH AT NEW DELHI  
ORIGINAL APPLICATION NO. 194 of 2020**

**IN THE MATTER OF**

Suresh Kumar Pandey & Anr.

...Applicant

Versus

Union of India & Ors.

...Respondents

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Place: New Delhi

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Suresh Kumar Pandey & Anr.

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**REPLY ON BEHALF OF RESPONDENT NO. 7 i.e. SASAN POWER LIMITED TO THE  
ORIGINAL APPLICATION.**

**I. CONSPECTUS**

1. The present Original Application (“**O.A**”) has been filed by Mr. Suresh Kumar Pandey i.e. the Applicant before the Hon’ble Tribunal (Central Zone) Bhopal, M.P, under Section 14, 15, 16 & 17 of the National Green Tribunal Act 2010 (“**Act**”).
2. By way of present O.A, the Applicant has primarily raised its grievances pertaining to the issue of breach of retention wall, within the plant boundary of the Sasan Ultra Mega Thermal Power Project (“**Sasan UMPP**”) operated by Sasan Power Limited (“**SPL/Answering Respondent**”) in Singrouli District, Madhya Pradesh, on 10.04.2020. Thereby, causing the loss of life of six persons and causing serious damage to the environment.
3. It is submitted that the breach of the retention wall on 10.04.2020, was majorly on account of human error as a machine operator while leveling soil on top of the retention wall, lost the balance of the machine and slipped down towards the outer slope of retention wall. In order to prevent slippage, the machine operator tried to anchor the bucket of the machine on the topsoil of the retention wall. However, due to its own weight, machine pulled down a chunk of soil from the retention wall, thus the acts of the operator damaged

the retention wall significantly which initiated the break of the said retention wall.

4. The present O.A was listed before the Hon'ble Tribunal on 31.07.2020, considering the concerns raised by the Applicant *qua* environmental damages, notice was issued and Respondents were directed to file their reply with the Hon'ble Tribunal.
5. The Answering Respondent i.e., SPL filed for summary dismissal of Original Application on 29.08.2020. The matter was listed before the Hon'ble Tribunal on 31.08.2020, whereby the Hon'ble Tribunal directed the registry to place the matter before the Hon'ble Chairperson for transferring this case (O.A. No. 47/2020) to the Principal Bench at New Delhi, for disposal with O.A. No. 164/2018.
6. Before advertng to the issues raised by the Applicant in the present O.A, it is submitted that the Hon'ble Tribunal *vide* its Order dated 29.06.2020 passed in O.A No. 31 of 2020 (CZ) titled as '*Hira Lal Bais vs Reliance Sasan Power Limited*' directed to constitute a Joint Committee comprising of representatives of Madhya Pradesh Pollution Control Board ("**MPPCB**"), District Collector Singrauli, representatives from CPCB and Ministry of Environment Forest & Climate Control ("**MOEF&CC**") and file an Action Taken Report. A true copy of Order dated 29.06.2020 is hereby annexed and marked as **ANNEXURE R/1**.
7. Thereafter, the Joint Committee filed its Action Taken Report and has made certain observations on the activities that were required to be undertaken by the Answering Respondent. In the said Action Taken Report, the Joint Committee recorded the following:-
  - (a) Reason for breach;
  - (b) Nature of Damage;
  - (c) Action taken by District Administration;
  - (d) Action taken by MPPCB;
  - (e) Action taken by Answering Respondent/ SPL;

- (f) Action taken by MoEF&CC;
- (g) Specific Observations of the Committee; and
- (h) Recommendations.

A true copy of the Action Taken Report of the Committee as per the Order dated 29.06.2020 is annexed hereto marked as **ANNEXURE R/2**.

8. Accordingly, the Answering Respondent has filed an Additional Affidavit dated 09.07.2021 in O.A No. 31 of 2020 for the limited purpose to place on record the current status of restoration and compensation work in the affected area. A true copy of the Additional Affidavit dated 09.07.2021 filed by the Answering Respondent is annexed herewith and marked as **ANNEXURE R/3**.
9. The present Reply is being filed to the subject O.A filed by the Applicant. At the outset, the Answering Respondent denies the averments set out in the subject O.A, which is contrary to or at variance with the statements/submissions made by Answering Respondent. Nothing stated in the said O.A shall be deemed to be admitted by Answering Respondent unless specifically admitted hereinafter. For ease of reference, an issue-wise Reply is prepared for the kind convenience of the Hon'ble Tribunal.

## **II. ISSUES FOR CONSIDERATION:-**

10. The Applicant *vide* the subject O.A under reply has sought the following reliefs from the Hon'ble Tribunal:-
- A. ***Constitution of an expert committee comprising of members from Ministry of Environment and Forests, CPCB, State Governments and institutes having experience in the field of environment for assessing short and long term impact vis - a - vis issues contended by the Applicant.***
- 10.1. In response to the above relief sought by the Applicant, it is humbly submitted that the Hon'ble Tribunal has constituted a committee in O.A No. 31/2020 (CZ) titled *Hira lal Bais v. Reliance Sasan Power Private Limited & Ors.* *vide* its order dated 29.06.2020, comprising of representatives of MPPCB, District collector Singrauli, representatives from CPCB and MOEF&CC. The committee

constituted has already submitted its report before the Hon'ble Tribunal in July 2020.

10.2. The Committee in its report made the following recommendations to be undertaken by the Answering Respondent:-

- (a) To check the strength of the bunds created around dykes/low-lying areas through expert agencies and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC periodically.
- (b) To expedite the ash cleaning work from the Goiwhai drain, to minimize the environmental contamination in the area.
- (c) To take appropriate steps to prevent fly ash from reaching Goiwhai drain and Rihand River.
- (d) The Corporate Social Responsibility ("CSR") cell of Answering Respondent in coordination with local administration shall set up grievance redressal camps in each affected village along the Goiwhai drain.
- (e) To obtain prior permission from MPPCB before any fly ash disposal in the low lying areas.
- (f) To expedite the studies undertaken by IIT – BHU, and CSIR – National Environmental Engineering Research Institute ("NEERI") to assess the actual impact of fly ash breach on the environment.

10.3. Thereafter, on 09.07.2021, the Answering Respondent filed an Affidavit before the Hon'ble Tribunal in O.A No. 31 of 2020 thereby placing on record all the steps undertaken by the Answering Respondent pursuant to the incident on 10.04.2020 in Singrauli District, Madhya Pradesh. In addition to the above, the Answering Respondent also placed on record the status of activities undertaken *vis -a -vis* the observations made by the Joint Committee in its report.

10.4. The Answering Respondent craves the liberty of the Hon'ble Tribunal to rely upon the contents of the Affidavit dated 09.07.2021 filed by the Answering

Respondent in O.A No. 31 of 2020 pending adjudication before the Hon'ble Tribunal and the contents of the same may be read as part and parcel of the present Reply.

10.5. Thus, the relief sought by the Applicant has already been considered and granted by the Hon'ble Tribunal in O.A No. 31 of 2020, therefore, the instant prayer ought to be dismissed.

**B. *Sasan UMPP may be directed to restore the watercourse of Gohwaiya river, and repair Giddha Khadi Bridge as well as desalination of Gohwaiya river and Rihand reservoir.***

10.6. In the context of the above issue, it is submitted that site restoration job, including cleaning of *Gabaiya* nalla, has been completed by the Answering Respondent. In this regard the following steps were undertaken by the Answering Respondent during the site restoration work:-

- (a) On a top priority, the cleaning of *Gabaiya* nalla was completed to restore its width and maintain its natural water flow profile. The cleaning of *Gabaiya* nalla has also ensured that there is no flow of any ash particle through it.
- (b) Subsequently, the ash spread into the agricultural fields were also cleaned and the fields were restored to a shape as per the choice of the farm owners, which has enabled them cultivate the immediate crop i.e. paddy.
- (c) All sites in the low-lying area (island 4) pursuant to the efforts of the Answering Respondent, was restored and the same was also informed to the regional offices of MPPCB, CPCB & MoEF&CC *vide* letters dated 16.09.2020 and 15.01.2021. It would not be out of place to mention herein that the Answering Respondent *vide* the said letters also provided to MPPCB, CPCB and MoEF&CC the site restoration pictures, showcasing substantial improvement in the affected area due to the efforts of Answering Respondent. A true copy of the letters dated

16.09.2020 & 15.01.2021 and site pictures are annexed herewith and marked as **ANNEXURE R/4 (COLLY.)**.

10.7. Considering the above, the Ash Restoration in the low-lying area (island 4) has been fully cleared and the Answering Respondent hereby undertakes not to use the said area for Ash Utilization in any mode in future, considering the risk involved due to increased water table in the area.

*C. Compensation to the tune of Rs 50 crores may be directed to be paid by SPL for restoration of the environment similar to the direction of Hon'ble NGT in LG Polymer gas leak case.*

10.8. In response to the above relief sought by the Applicant, it is humbly submitted that MPPCB on 13.04.2020, taking cognizance of the incident imposed a penalty to the tune of Rs 10 Crores upon the Answering Respondent towards interim Environmental Compensation for breakage of retention wall of low lying ash utilization area. A true copy of MPPCB letter dated 13.04.2020, is hereby annexed and marked as **ANNEXURE R/5**.

10.9. In compliance of to the above directions, on 26.05.2020, given the liquidity challenges and financial stress being faced by the Answering Respondent, an amount of Rs. 2,00,00,000 (Rupees Two Crores) was deposited in MPPCB (Member Secretary Environment Fund).

10.10. It is submitted that on 28.05.2020, the Answering Respondent addressed a letter to MPPCB, thereby apprising MPPCB of the following:-

- (a) The details of Rs. 2,00,00,000 (Rupees Two Crores) deposited with MPPCB in compliance of its directions.
- (b) Necessary relief and compensation paid to the affected families by the Answering Respondent.
- (c) Work being undertaken for the repair of retention wall of low lying ash utilization area and the safety precautions taken *qua* the same
- (d) Constant follow ups with IIT-BHU team for its Ash Dyke Stability study and NEERI to assess the environmental impact

(e) The Liquidity challenges faced by the Answering Respondent.

A true copy of the letter dated 28.05.2020 is annexed herewith and marked as **ANNEXURE R/6**.

10.11. In the interregnum, the Hon'ble Tribunal *vide* its order dated 14.07.2020, passed in O.A No. 164/2018 titled as *Ashwani Kumar Dubey v. Union of India & Ors.* directed NTPC Vidhyanchal, to deposit an amount of Rs. 10,00,00,000/- (Rupees Ten Crores) as recommended by the oversight Committee with SPCB towards interim Environmental Compensation. A true copy of the Order dated 14.07.2020 passed by the Hon'ble Tribunal in O.A No. 164 of 2020 is annexed herewith and marked as **ANNEXURE R/7**.

10.12. Considering the aforesaid directions of this Hon'ble Tribunal, on 24.08.2020, MPPCB issued a letter to the Answering Respondent and its holding company Reliance Power Limited ("**RPL**"), thereby directing to deposit the balance Rs. 8,00,00,000/- (*Rupees Eight Crores*) to MPPCB towards interim Environmental Compensation within 15 days. In the said letter, MPPCB also stated that NTPC Vidhyanchal Super Thermal Power Station ("**VSTPS**") also had a similar case of Ash Dyke breach and a penalty of Rs. 10,00,00,000/- (Rupees Ten Crores) was imposed upon NTPC for VSTPS. Therefore, there being a similarity in the case of the Answering Respondent and NTPC VSTPS, the Environmental Compensation was imposed upon the Answering Respondent. A true copy of the letter dated 24.08.2020 issued by MPPCB to the Answering Respondent and RPL is annexed herewith and marked as **ANNEXURE R/8**.

10.13. At this stage, the following is also relevant for the kind consideration of the Hon'ble Tribunal:-

(a) It is humbly submitted, aggrieved by the directions of this Hon'ble Tribunal, NTPC Ltd. preferred a statutory appeal, after depositing Rs. 1 Crore in the form of Bank Guarantee as against the direction to pay Rs 10 Crore, before the Hon'ble Supreme Court titled as *Vindhyachal*

*Super Thermal Power Station v. Ashwani Kumar Dubey & ors*, Civil Appeal No. 3087 of 2020.

- (b) The Hon'ble Supreme Court considering the restoration work undertaken by NTPC Ltd. *vide* its Order dated 14.09.2020, granted a stay on the balance unpaid amount of Rs. 9 Crores made by SPCB towards interim compensation. A true copy of the Order dated 14.09.2020 passed by the Hon'ble Supreme Court of India in Civil Appeal No. 3087 of 2020 is annexed herewith and marked as **ANNEXURE R/9**.

10.14. The Answering Respondent in response to the above letter wrote to MPMCB, on 09.09.2020 thereby apprising MPPCB of the following :-

- (a) The directions passed by the Hon'ble Tribunal *vide* order dated 14.07.2020, only NTPC for VSTPS was directed to deposit Rs 10,00,00,000/- (Rupees Ten Crore) towards interim Environment Compensation for breach of their Ash Dyke and not the Answering Respondent.
- (b) The case of the Answering Respondent is different from NTPC VSTPS, as in the case of NTPC VSTPS the incident was on account of breach of Ash Dyke. However, in the case of the Answering Respondent the incident happened due to breakage of retention wall of low lying ash utilization area located in the premises of the Sasan UMPP.
- (c) The Compensation *qua* NTPC VSTPS was based on the recommendation of the Oversight Committee, however, no such recommendations were made for the Answering Respondent.
- (d) As per the directions of MPPCB, NEERI has already been appointed for the evaluation and assessment of the Environmental Damage caused due to the incident on 10.04.2020.

(e) Details of Rs 15 Crores (Rupees Fifteen Crores) (approx.) incurred towards compensation and restoration works (till the date of the said letter) were provided, as under:-

- i. An amount of Rs 3.47 Crores towards loss of life, crop, cattle, livelihood, households, road construction, and medical support.
- ii. An amount of Rs 0.83 Crores towards the payment of sustenance allowance to dependents of the deceased.
- iii. An amount of Rs 10 Crores towards the restoration of work of Gabaiya nalla, agricultural fields and Island 4.

A true copy of the letter dated 09.09.2020 issued by Answering Respondent to MPPCB is annexed herewith and marked as **ANNEXURE R/10**.

10.15. However, disregarding & rejecting the request of the Answering Respondent made on 09.09.2020, MPPCB *vide* its letter dated 25.11.2020 requested to deposit balance interim environmental compensation of Rs 8 Crore immediately avoid any consequences. A true copy of the letter dated 25.11.2020 issued by MPPCB to Answering Respondent is annexed herewith and marked as **ANNEXURE R/11**.

10.16. It is submitted that Answering Respondent, in response to the MPPCB letter dated 25.11.2020, *vide* its letter dated 15.01.2021 once again requested MPPCB not to insist for payment of balance interim environmental compensation of Rs 8 Crore for the reasons mentioned therein. A true copy of the letter dated 15.01.2021 issued by Answering Respondent to MPPCB is annexed herewith and marked as **ANNEXURE R/12**.

10.17. However, MPPCB continued to insist for payment of balance interim environmental compensation of Rs 8 Cr. Hence, in order to sustain operation of Sasan UMPP, which is serving 47 Crore population in 7 States with its ultra-competitive tariff and most reliable supply of power and continue its contribution to nation-building, Answering Respondent, despite acute financial stress and liquidity challenges, has, with utmost difficulty, made

payment of Rs 8 Crore of balance Interim environmental compensation to MPPCB in MPPCB (Member Secretary Environment Fund) on 10.12.2021 and the payment details were informed to MPPCB by Answering Respondent vide letter dated 10.12.2021. A true copy of the letter dated 10.12.2021 issued by Answering Respondent to MPPCB is annexed herewith and marked as **ANNEXURE R/13.**

10.18. It is further humbly submitted that in addition to payment of interim environmental compensation of Rs 10 Crore, Answering Respondent has incurred Rs 16.92 Crore towards compensation and restoration works as under.

- I. An amount of Rs 3.47 Crores towards loss of life, crop, cattle, livelihood, households, road construction, and medical support.
- II. An amount of Rs 0.83 Crores towards the payment of sustenance allowance to dependents of the deceased.
- III. An amount of Rs 11.29 Crores towards the restoration of work of Gabaiya nalla, agricultural fields and Island 4.
- IV. An amount of Rs 1.33 Crore towards Restoration and Repairing of Embankment.

10.19. Therefore, in light of the above submissions the Hon'ble Tribunal would most graciously appreciate that the aforesaid actions were undertaken by the Answering Respondent despite suffering from liquidity issues and being a financially stressed asset the Answering Respondent has already incurred nearly Rs. 27,00,00,000 (Rupees Twenty Seven Crores) in the context of restoration, compensation works and payment of interim environmental compensation.

10.20. Further, Applicant's reliance on LG Polymer case to get a higher compensation is misplaced as factually the case of the Answering Respondent is different and distinguishable from the gas leak incident in Vishakhapatnam, the incident was an industrial disaster, which killed 12 people, nearly injured 1000 people,

and severely affected the environment in the region on account of gross human failure and a lack of basic safety norms.

10.21. While the incident on 10.04.2020, was majorly on account of human error as evident from the Joint Action Committee report. As detailed above, the breach of the retention wall was majorly on account of human error as a machine operator tried to anchor the bucket on the topsoil of the retention wall. However, due to its own weight, it pulled down a chunk of soil from the retention wall, thus the acts of the operator damaged the wall significantly which initiated the break of the retention wall leading to the said incident.

10.22. Thus on account of the foregoing reasons the contention raised by the Applicant is liable to be rejected.

***D. The dependent of 6 deceased persons be given adequate financial support, may be assessed by the expert groups.***

10.23. In response to the above relief sought by the Applicant, it is humbly submitted the following compensation is granted by the Answering Respondent to the family members of the deceased: -

- (a) Financial Compensation of Rs. 1.25 Crores is cumulatively paid to the dependent of family members of 6 deceased persons as per the district administration instructions and guidelines.
- (b) A lifelong monthly sustenance Rs 8,275/- per month is also extended to 6 Dependents of the deceased which cumulatively amounts to Rs 0.83 Crores approx.
- (c) Further, employment was provided to 3 members of the deceased persons.

10.24. In addition to the above, compensation to the tune of Rs. 80,00,000/- (Rupees Eighty lacs) (approx.) was provided to the affected villagers of Tehsil Singrauli and Tehsil Mada for cattle, motor, pump, well, poultry farm etc. Moreover, extensive efforts were made by the Answering Respondent to provide provisioning for food and drinking water to affected families and cattle in the

region. It is pertinent to mention herein that the Committee constituted by the Hon'ble Tribunal has duly recorded the efforts made by the Answering Respondent.

10.25. Without prejudice to the above, it is noteworthy to highlight that the Committee constituted by the Hon'ble Tribunal in its Action report made no recommendations *qua* for additional environmental compensation to be collected from Answering Respondent and emphasized on expeditious completion of site restoration work.

10.26. Thus in light of the above efforts made by the Answering Respondent, the prayer of the Applicant stands infructuous.

***E. Raising of the height of Harrahwa ash dyke may not be allowed by MPPCB and Sasan Power be directed to install a Hi-ranging sound siren system to alert the local population in order to avert such accidents.***

10.27. In light of the alleged incident, the Answering Respondent on 21.04.2020 issued a Letter of Intent ("**LoI**") to department of Civil Engineering IIT – BHU, Varanasi, to conduct a study on design and structural safety of the ash dyke situated near Harrahwa Village. A true copy of letter dated 21.04.2020 is hereby annexed and marked as **ANNEXURE R/14**.

10.28. The scope of work of the study awarded to IIT-BHU was *interalia* to assess the following:-

- (a) To assess the design and structural safety of the ash dyke situated near Harrahwa village.
- (b) To assess the ash dyke adequacy of engineering and constructional quality.
- (c) To ascertain measures to avert any incident of ash dyke breach.
- (d) To suggest emergency preparedness plan and environmental management plans to handle incidence of breach of Ash dyke.

10.29. Thereafter, in terms of the analysis done by IIT – BHU, on 09.08.2020, a study report *qua* stability analysis of Ash Dyke at Harrahwa village was prepared by

Professor Arun Prasad, Department of Geotechnical Engineering, IIT – BHU

wherein the following conclusions were made :-

- (a) The existing ash dyke was declared as structurally stable and safe for filling with Fly Ash.
- (b) Starter dyke can be raised by 7 meters by adopting downstream technique.
- (c) Instruments can be installed for monitoring the safety of Ash Dyke.
- (d) Ash Dyke can be raised to 20 meters, however, a detailed analysis needs to be carried out at the time of actual raising.
- (e) The area between Lagoons - 1 & 2 can be excavated to create additional Ash disposal capacity.

A true copy of the IIT BHU report is annexed herewith and marked as **ANNEXURE R/15**.

10.30. Accordingly, in terms of the aforesaid Report, the Answering Respondent diligently took the following additional measures in order to protect the Ash Pond bund from getting breached:-

- (a) Ash pond is lined using HDPE surrounding to the embankment and the bottom is lined for its impermeability with Bentonite.
- (b) A vast green belt as per the CPCB guidelines is being developed to curb the emission and also to provide an aesthetic look.
- (c) Onsite monitoring and emergency preparedness plan & standard operating procedures were revisited and being implemented. The copy of the said plan is annexed as **ANNEXURE R/16**.

F. ***By way of invoking the polluter pay principle, Sasan UMPP may be directed to construct better roads in the villages like Harrahwa, Siddhi Kala, Siddhi Khurd, Jhajhi Tola, etc.***

10.31. In response to the above prayers, it is humbly submitted that substantive efforts qua restoration and rehabilitation of the region, have been undertaken by the Answering Respondent as detailed out in the foregoing Paragraphs of

the present Reply and the contents of the same are not being repeated for the sake of brevity.

10.32. Moreover, in the context of the present issue, the following is noteworthy for the kind consideration of the Hon'ble Tribunal :-

- (a) The Answering Respondent has constructed approx 6 kms of roads in Harrahwa, Jhanjhitola villages and constructed approx 4 Kms roads in Sidhikhurd, Sidhikalan villages..
- (b) Moreover, various Fly Ash awareness campaigns and workshops have been organized by the Answering Respondents in nearby villages for making the public aware of Fly Ash usages and motivating them to come forward as an entrepreneur as part of its CSR program.
- (c) Lastly, the above initiatives are undertaken despite there being no recommendations made by Committee constituted by the Hon'ble Tribunal in its report *qua* construction of roads in the villages like Harrahwa, Siddhi Kala, Siddhi Khurd, Jhajhi Tola, etc.
- (d) Thus, all efforts made by the Answering Respondent are in the interest of people at large affected by the incident.

10.33. In addition to the above, it is pertinent to mention that Answering Respondent is supplying power at a competitive levelized tariff of Rs 1.196/kWh, the lowest among the coal-based power plants in the Country.

10.34. It is further pertinent to mention that the Answering Respondent is under major financial stress and is facing grave liquidity challenges and if the relief sought by Applicant is allowed, then the Answering Respondent would not be in a position to operate their power plant and would have to shut down its operations.

10.35. The aforesaid would further cause the Answering Respondent to default in its PPA and would lead to non-supply of power in various states and its consumers. Thus in the interest of justice, the relief sought by Applicant which can put an additional financial burden on the project should be dismissed,

much particularly when the Answering Respondent has contributed in a substantial manner to the affected people at Singrauli.

***G. By way of invoking the polluter pay principle, Reverse osmosis plant may be directed to be installed and filter the water supplied to the villagers.***

10.36. The Answering Respondent pursuant to the incident took immediate actions to restore the environmental damage and accordingly undertook the provisions for drinking water to families and the cattle in the region. The following steps were taken by the Answering Respondent:-

- (a) Provision of 570 drums of 100 liter capacity for cattle.
- (b) Installation of Hand-pump to families affected by the incident (8 nos).
- (c) Drinking water supply through the tanker.

10.37. Further, Answering Respondent has carried out digging of more than 50 nos of kaccha wells for irrigation purpose at villages Sidhikhurd, Harrahwa, Brandi Tola, Jhanjhi Tola area.

10.38. In addition to the above, the Answering Respondent has carried out the regular collection of water and sediment samples of Gabaiya drain and the nearby area to assess the impact on groundwater in the region. It is not out of place to mention herein that the pursuant to the incident, the Answering Respondent has also engaged NEERI for the assessment of the environmental damage and an analysis report is awaited. The Answering Responder undertakes to file the same before the Hon'ble Tribunal as and when the same is issued by NEERI to the Answering Respondent.

***H. Sasan UMPP may be directed to transport fly ash up to the site of brick manufacturers, road constructors etc. Further, Sasan UMPP and executive engineer of the electricity board may be directed to provide land, water, and electricity-free of cost to the interested entrepreneurs.***

10.39. Before delving into the present issue it is apposite to state that Answering Respondent, has a generation capacity of 3960 MW and supplies power to 14 power Distribution Companies that serve 47 Crore population across 7 states

at a levelized tariff of Rs 1.196/kWh which is the lowest among the coal-based power plants in the Country.

10.40. Further, the Coal for the Project is supplied from the captive coal blocks of Moher and Moher Amlohri Extension having an average ash content of less than 34%. The power plant consumes nearly 18-19 Millions of Tons of coal per year and produces about 5.5 Million Tons of fly ash per year.

10.41. It is further submitted that substantial efforts are being made by the Answering Respondent to achieve 100% Fly Ash utilization generated from the project and the same were shared by the Answering Respondent with MOEF&CC *vide* letter dated 28.08.2020. The contents of the same are detailed below:-

- (a) Fly ash has been made available free of cost.
- (b) No Objection Certificate (“**NoC**”) was obtained from MPPCB for filling of ash in low-lying area within plant premises.
- (c) The Answering Respondent is in discussion with cement manufacturers for the lifting of fly ash from Sasan UMPP on sharing of Transportation Cost and is exploring opportunities for providing Fly Ash for road construction projects.
- (d) Inside the plant, for all Controlled Low Strength Material (“**CLSM**”), 50% of the sand quantity is replaced with bottom ash and 30 to 40% of cement quantity is replaced with Fly Ash.
- (e) Fly Ash brick making unit of 9000/day capacity is installed within the premises. Annually over 20,000,00 bricks are utilized by the Answering Respondent in its various construction-related works.
- (f) Workshops were conducted for brick manufacturers/RMC producers for use of Fly Ash and its benefit.
- (g) Various Fly Ash awareness campaigns and workshops have been organized by the Answering Respondent in nearby villages for making

the public aware of Fly Ash usages and motivating them to come forward as an entrepreneur.

- (h) The Answering Respondent has undertaken to supply Fly Ash for road construction projects – Siddhi to Singrauli Road.
- (i) Various meetings have been organized with the cement industries to increase the Fly Ash lifting from the plant.
- (j) The plant layout including the Ash Dyke area is constructed with the approval of MoEF&CC and SPCB.
- (k) The unutilized Ash from the plant is conveyed in slurry form through a pipe to Ash Dyke. Further, the Ash deposited in Ash ponds is being utilized in permitted activities like embankment construction / strengthening, dyke raising, land area development, Fly Ash brick manufacturing, etc.
- (l) Central Institute of Mining and Fuel Research (CIMFR), Dhanbad is also engaged for the providing a technical feasibility of mixing of ash into the Overburden (OB) dumps of the Answering Respondent's Moher & Moher Amlohri Extension Coal Mine Project in compliance with MoEF&CC notification No. S.O 2804 (E) dated 03.11.2009 and MoEF&CC Office Memorandum (OM) dated 28.09.2019.

10.42. Without prejudice to the above, for effective utilization of Fly Ash, the Answering Respondent can only assist the organizations/ persons, etc. who can utilize the Fly Ash for various activities but cannot force other persons to carry out the required manufacturing or construction. In this regard, it is submitted, that on 13.07.2020, MoEF&CC issued a letter to Answering Respondent thereby requesting to provide a concrete Action Plan to achieve 100% Fly Ash utilization in compliance to the Fly Ash notification. A true copy of MoEF&CC letter dated 13.07.2020 is annexed herewith and marked as **ANNEXURE R/17**.

10.43. In response to the above letter, the Answering Respondent, on 28.08.2020, shared its concrete Action Plan with MoEF&CC to achieve 100% fly ash utilization for Sasan UMPP. Further, the Applicant has failed to appreciate that effective utilization is also contingent upon adequate assistance rendered by the Central/State Government. A true copy of the letter dated 28.08.2020 is hereby annexed and marked as **ANNEXURE R/18**.

10.44. Apart from above, the issue in relation 100% Fly Ash utilization as per MoEF&CC Notification dated 25.01.2016, is currently pending before the Hon'ble Supreme Court of India in Civil Appeal No. 3229 of 2020 titled as '*Association of Power Producers vs Shantanu Sharma & Ors*' and also before the Hon'ble Tribunal in O.A. No. 117/2014 titled as *Shantanu Sharma v. Union of India & Ors*. Therefore, the relief sought by the Applicant should be barred by the principle of multiplicity of litigation.

### **III. PARA WISE REPLY :-**

#### **A. FACTS IN BRIEF:-**

11. The contents of para 1 of the present O.A are denied for being false and misplaced. It is vehemently denied that MPPCB had directed all the TPPs in Singrauli and surrounding areas to get their Ash dykes inspected by a third party. Moreover, the Answering Respondent engaged the department of Civil Engineering IIT – BHU, Varanasi, to conduct a study on the design and structural safety of the Ash Dyke, and based on the analysis by IIT – BHU, a study report *qua* stability analysis of Ash Dyke was filed before the Hon'ble Tribunal in O.A No. 31/2020.

11.1. The contents of para 2-4 of the present O.A are denied for being false, misplaced. It is denied that the Fly Ash Dyke of Sasan UMPP collapsed on the unfortunate day of 10.04.2020 due to breach of the retention wall thereby leading to a flood of Ash slurry from the collapsed Dyke located in adjoining Harrahwa village. It is specifically denied that the Answering Respondent has constructed two or more artificial Ash ponds within the plant premises at

Village Siddhi Kala. Moreover the Applicant has failed to produce any documents to substantiate its averments and may be put to strict proof for the same. Further as stated in the preceding paragraphs, the breach of the retention wall was majorly on account of human error as a machine operator tried to anchor the bucket on the topsoil of the retention wall. However, due to its own weight, it pulled down a chunk of soil from the retention wall, thus the act of the operator damaged the wall significantly which initiated the break of the retention wall in low lying ash utilization area located within the power plant premises.

- 11.2. The contents of para 5 - 10 of the present O.A are denied for being false and misleading. In this regard, it is submitted that substantial steps have been taken by the Answering Respondent for restoration and rehabilitation of the region. It is further submitted that substantial efforts are being made by the Answering Respondent to achieve 100% utilization of Fly Ash generated from the project in light of MoEF&CC Notification dated 25.01.2016 and directions passed by the Hon'ble Tribunal in O.A. No. 117/2014 titled as *Shantanu Sharma v. Union of India & Ors.* The submissions pertaining to the same are sufficiently stated in the above paragraphs and are not being reiterated herein for the sake of brevity.

**B. GROUNDS:-**

- 11.3. The contents of para 1 of the grounds of the present O.A, pertains to the fundamental rights of the people to live in a pollution free environment and access to safe drinking water. It is denied that the Answering Respondent is not following the stipulations of the environmental clearances.. Sasan UMPP is the project of national importance and is serving 47 Crore population in 7 States with its ultra-competitive tariff and most reliable supply of power and is continuing its contribution to the nation-building..
- 11.4. The contents of para 2 - 4 of the grounds of the present O.A are ardently denied for being false and misleading. In this regard, it is submitted that the

breach in retention wall of low lying area is on account of human error and the Answering Respondent has already undertaken substantial efforts in restoration and rehabilitation of the region. Further, substantial efforts are being made by Answering Respondent to achieve utilization of Fly Ash generated from Sasan UMPP in light of MoEF&CC Notification dated 31.12.2021. The contents of the issue-wise response hereinabove maybe read as part and parcel of the instant Reply.

11.5. The contents of para 5 – 11 of the grounds of the present O.A are false, misleading, and vehemently denied. The contents of the issue-wise response hereinabove maybe read as part and parcel of the instant Reply.

11.6. Under the facts and circumstances of the present case, it is most respectfully prayed that the Hon'ble Tribunal may graciously be pleased to dismiss the present Application.

**FILED BY**



**SKV LAW OFFICES**

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[delhi.office@skvlawoffices.com](mailto:delhi.office@skvlawoffices.com)

Date: 20.01.2022

Place: New Delhi

## BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

## PRINCIPAL BENCH AT NEW DELHI

## ORIGINAL APPLICATION NO. 194 of 2020

## IN THE MATTER OF

Suresh Kumar Pandey &amp; Anr. ...Applicant

Versus

Union of India &amp; Ors. ...Respondents

AFFIDAVIT

I, Virendra Shukla, S/o. Late Sh. T.R. Shukla, aged about 47 years, having office at A-2, Sector 24, Noida, Uttar Pradesh, presently at New Delhi, do hereby solemnly affirm and state on oath as under:

1. That I am the authorized Representative Respondent No 7 i.e. Sasan Power Limited and I am competent to affirm this Affidavit on its behalf. I say that the facts stated herein are based on record of the Respondent, maintained in the ordinary course of business and believed to be true.
2. That I have read the accompanying Reply being submitted on behalf of Respondent No.7 and have understood the contents thereof and that the contents therein are true and correct to the best of my knowledge and belief.
3. That the Annexures filed along with the accompanying Reply are true copies of their respective originals.



4. I say that the averments of fact stated herein above are true to my knowledge and records, no part of it is false and nothing material has been concealed therefrom.

*Virender Singh*  
DEPONENT  


**VERIFICATION:**

I, the deponent abovenamed, do hereby verify and state that the contents of the foregoing affidavit are true and correct to the best of my knowledge and as derived from the official record maintained by the Appellant. No part of it is false and noting material has been concealed therefrom.

Verified at New Delhi on this the 20<sup>th</sup> day of January 2022

*Rajoo*  
6/28 92/2018  
I identify the Executant/Deponent  
Who has Signed in my presence

  
NOTARY PUBLIC  
GOVT. OF INDIA  
DULRISHI  
(Advocate)  
R.N.-17566/19  
B. No. 041204

ATTESTED  
*P*  
Notary Public, Delhi

20 JAN 2022

*Virender Singh*  
DEPONENT  


**ANNEXURE R-1**

Item No. 04(Through VC-Bhopal)

**BEFORE THE NATIONAL GREEN TRIBUNAL  
PRINCIPAL BENCH, NEW DELHI**

Original Application No.31/2020(CZ)

Hiralal Bais Applicant(s)  
Versus  
Reliance Sasan Power P. Ltd. & Ors. Respondent(s)

Date of hearing: 29.06.2020

**CORAM:**  
**HON'BLE MR. JUSTICE SHEO KUMAR SINGH, JUDICIAL MEMBER**  
**HON'BLE DR. NAGINA NANDA, EXPERT MEMBER**

For Applicant(s) Mr. Dharamvir Sharma, Advocate

**ORDER**

By way of filing this application, the applicant has raised the issue of the incident of collapsing of Fly ash pond constructed by Reliance Power's Ultra Mega Power Project's (UMPP) Singrouli (MP) on 10.04.2020 around 3 PM during COVID 19 pandemic, leading to flood of the toxic ash slurry located in adjoining Harrhava village, washed away six persons, including three kids, a woman and two men living in the adjoining villages. All the Respondents are severely and jointly responsible for the loss of human and animal's lives as well as severe damages to the nearby rivulets Goiwahai, vegetations, biodiversity, fertile agricultural lands, due to their negligence. A substantial issue of environment has been raised.

We deem it just and proper to call a report from a Joint Committee consisting of:-

1. Representative of MoEF & CC

  
**TRUE COPY**

2. Representative of CPCB
3. District Collector, Singrouli
4. Madhya Pradesh Pollution Control Board through its Regional Officer, Singrouli

The Committee is directed to visit the place and submit the action taken report within four weeks. The State PCB will be the nodal agency for coordination and logistic support.

The report in the matter be filed by the Committee by e-mail at [judicial-ngt@gov.in](mailto:judicial-ngt@gov.in) preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF.

A copy of the original application be provided to the Committee within a week.

List this matter on 27<sup>th</sup> August, 2020.

Justice Sheo Kumar Singh, JM

Dr. Nagin Nanda, EM

SN



**TRUE COPY**

**ANNEXURE R-2****Action Taken Report of the Committee****Submitted in Reference to****Hon'ble National Green Tribunal (NGT) Principal  
Bench, New Delhi order dated 29.06.2020****In the Matter of****Original Application No.31 of 2020 (CZ)****Hiralal Bais****Vs.****Reliance Sasan Power Ltd. & Ors.****Members of the Committee**

1. Rajiv Ranjan Meena, District Collector, Singrauli, MadhyaPradesh
2. Dr H V C Chary Guntupalli, Scientist-D, MoEF&CC, RO, Bhopal
3. Sunil Kumar Meena Scientist 'D', CPCB, Regional Directorate, Bhopal
4. S D Valmiki, Regional Officer, MPPCB, Regional Office, Singrauli

  
**TRUE COPY**

**Action Taken Report in compliance of Hon'ble NGT  
Principal Bench order dated 29<sup>th</sup> June 2020 in O.A. 31/2020  
(CZ) Hiralal Bais Vs. Reliance Sasan Power Ltd. & Ors.**

In compliance of the Hon'ble National Green Tribunal (NGT) Principal Bench (PB) order dated 29.06.2020 in the Original application (O.A.),31/2020 (CZ) Hiralal Bais Vs Reliance Sasan Power Ltd. & Ors., a joint committee comprising of following officers has undertaken the site visit during 14<sup>th</sup> and 15<sup>th</sup> July, 2020:

1. Rajiv Ranjan Meena, District Collector, Singrauli, MadhyaPradesh
2. Dr H V C Chary Guntupalli, Scientist-D, MoEF&CC, RO, Bhopal
3. Sunil Kumar Meena Scientist 'D', CPCB, Regional Directorate, Bhopal
4. S D Valmiki, Regional Officer, MPPCB, Regional Office, Singrauli

Following plant (Reliance Sasan Power Ltd) officials were present during the site visit & discussion:

1. Sh Anil Kumar Singh, Chief Executive Officer
2. Sh Sachin Mohapatra, Station Director
3. Sh Amitosh Verma, Assistant Vice President

Copy of the attendance sheets is enclosed as **Annexure-1**.

In compliance with the Tribunal order, the joint inspection committee carried out the site visit of breached fly ash pond during 14<sup>th</sup> & 15<sup>th</sup> July 2020 to verify the issues made by the applicant viz.

*“The applicant has raised the issue of the incident of collapsing of Fly ash pond constructed by Reliance Power's Ultra Mega Power Project's (UMPP) Singrouli (MP) on 10.04.2020 around 3 PM during COVID 19 pandemic, leading to flood of the toxic ash slurry located in adjoining*

*Harrhava village, washed away six persons, including three kids, a woman and two men living in the adjoining villages. All the Respondents are severely and jointly responsible for the loss of human and animal's lives as well as severe damages to the nearby rivulets Goiwahai, vegetations, biodiversity, fertile agricultural lands, due to their negligence. A substantial issue of environment has been raised."*

#### **1. The incidence & probable cause of its occurrence:**

Industry was disposing its fly ash in this Island 4 or C5 area (Geo-graphical location: 23.955383, 82.620307) since March 2019; the area of the low lying is 41.62 Hectares with average depth of 6.5mtrs. This provides effective volume of 27.06 Lakh M<sup>3</sup> to dispose the fly ash. Industry was discharging fly ash in High Concentration Slurry Disposal (HCSD) mode that has water to ash ratio 30:70. Based on the records, industry has disposed around 10 Lacs Ton fly ash slurry till the date of incidence i.e. 10.04.2020. Copy of the disposal records is enclosed as **Annexure-2**. To pump out the stagnated slurry water near retaining wall, pumping arrangement was provided by the industry.

As reported by plant official, the incidence of fly ash pond's retaining wall breach happened on 10<sup>th</sup> April 2020 at around 4.40PM in the low lying area called Island 4 or Compartment 5 (C5) inside the plant premise. One Poclain machine was on job of leveling soil on the top of the retaining wall; on moving back the machine, the machine lost its balance and slipped down towards the outer slope of the retaining wall. In order to prevent the slippage, the machine operator tried to anchor the bucket on the top soil of the retaining wall; However due to its own weight, it pulled down a big chunk of soil from the bund and further to stay up it kept on anchoring on

additional part of the bund. During the process, the operator damaged the wall significantly which initiated the break of the retaining wall. This resulted in huge quantum of fly ash with water gushed out through the breached wall in about 25mtrs width. Geo-graphical location of breach was 23.954105° Latitude, 82.623535° Longitude and 23.954335 ° Latitude, 82.623568 ° Longitude. On the day of site visit of the committee; continuous lean flow of water was observed in the low lying area; during discussion it was informed by industry representative that this flow of water is continuous from the day of incidence and it was also informed that a study was awarded to IIT-BHU to study the reason of breach in the embankment of ash disposal site. The report submitted by Prof Arun Prasad, Dept of Geotechnical Engineering, IIT BHU on 17.6.2020 after his site visit on 13.6.2020 reported the reason of embankment failure under point no. 12 as:

*“The failure of embankment was definitely initiated by slippage of Poclain. However the subsequent extent of damage of the bund was due to severe hydrostatic pressure on the upstream of the embankment. Through this damaged portion, dilute slurry started flowing leading to complete cutting of the retention wall. Accumulation of huge underground water had resulted into heavy flow of ash slurry causing serious consequences in the villages”.*

The copy of the IIT-BHU report is enclosed as **Annexure-3**. The reported hydrostatic pressure probably developed by the newly constructed check dam on a stream around May/June 2019 about 4mtrs lower elevation. Geo-graphical location of the check dam is 23.964515°Latitude, 82.611492° Longitude.

## 2. Nature of Damage

The breach of embankment/dyke caused severe damage to life of human & animal, property, agricultural fields, standing crops, motor pumps used in agriculture, water quality, macro-invertebrates etc. The flow of slurry was too forceful that it not only demolished the boundary wall as well as the adjacent private property but also flowed through the Goiwahai drain damaging the ash water recirculation pipeline of the industry and submerging the agricultural lands & summer season crops. The slurry travelled a path of about 6.5KMs in length; the average spread of slurry was 30mtrs wide with an average depth of 1mtr. Out of total 10 Lacs Ton ash deposits in Island 4 or C5 area, about 4 Lac Tons slurry breached out from about 11 Ha area with average 3mtrs depth which spread in nearby area, Goiwahai drain and on agricultural lands. The collected ash from C5 area and Goiwahai drain and agricultural land is dumped near Island 3 or Compartment C1 to C4 (Low lying area filled with fly ash), Ash dyke 1 & 2 for raising & bund strengthening. Based on the number of hyva, trucks, tractor, loader engaged and their trips, it was informed by industry representative that; Out of total 10 Lacs Ton ash; about 3.57 Lacs Ton fly ash excavated from C5 area and used in Island 3 bund strengthening, about 2.67 Lacs Ton ash collected from Goiwahai drain and agricultural land is used to strengthen the Ash dyke 1 & 2. Still around 2.15 Lacs Ton is lying in C5 area and about 1.5 to 2 Lacs Ton fly ash is deposited in drain. Document related to ash quantity removed is enclosed as **Annexure-4**. On the day of field visit, the committee observed deposits of dried fly ash in few agricultural fields viz (GPS location 23.969297, 82.634512; 23.969559, 82.635288 and 23.974791, 82.636981). The committee was of the opinion

that an appropriate direction needs to be issued to occupier to expedite the cleaning work so as to avoid further flow of ash towards Rihand reservoir. Accordingly, Regional Officer, MPPCB issued advisory in this regard to the occupier; copy of the direction issued is enclosed as **Annexure-5**.

Madhya Pradesh Pollution Control Board (MPPCB) Regional Office, Singrauli and Zonal Office Rewa carried out joint effluent sampling on 12<sup>th</sup> April 2020 from 5 locations; the details are as tabulated below:

S.No.	Location & Geo-graphical coordinates	pH	Total Solids (TS)	Total Dissolved Solids (TDS)	Total Suspended Solids (TSS)
1.	Goiwahi drain near Sasan Power Plant (23.977775, 82.638136)	6.5	13098	918	12916
2.	Rihand river before mixing of Goiwahi drain (23.985756, 82.655558)	7.5	266	85	181
3.	Rihand Reservoir, Near Sasan Pump House (24.038930, 82.673119)	7.5	330	104	226
4.	Rihand river after mixing of Goiwahi drain (24.007186, 82.653735)	7.5	606	724	476
5.	Goiwahi drain before mixing with Rihand River (23.991117, 82.651948)	7.5	1518	614	1368

All units are in mg/l except pH. Copy of the Analysis report is enclosed as **Annexure-6**.

The analysis report clearly status that the Total solids load in Goiwahi drain reduced from 13098 mg/l to 1518mg/l before mixing in Rihand River which reveals that in the travel path of about 6.5KMs majority of solids got deposited in Goiwahi drain only. Further after mixing the drain in Rihand River the total solids load increased from 266mg/l to 606mg/l. In this way, the breach incidence has significantly deteriorated the water quality in

Rihand river w.r.t. the Total solids. The resultant deposition of solids at the bottom of Goiwahai drain might have resulted in loss of benthic macro invertebrates.

### 3. Action Taken by District Administration

Following actions were initiated by District Administration, Singrauli immediately after the ash dyke breach:

- i. National Disaster Response Force (NDRF) team was engaged to carry out rescue, relief work. With the effort of NDRF team and district administration, the bodies of the 6 deceased were recovered from the ash spread area/drain.
- ii. Immediate relief was provided through M/s Sasan Ultra Thermal Power Plant to the families to the affected villagers in the form of food, water, shelter, fodder etc.
- iii. Initiated survey to assess the damage to agricultural fields, crop, livestock etc.
- iv. The injured persons were immediately shifted to the Nehru hospital, NCL Jayant, Singrauli for proper treatment.
- v. District Collector, Singrauli has ordered a magisterial enquiry on the breakage of this retaining wall vide order 452/RDM/2020 dated 11.4.2020. Police Department has also registered an F.I.R. under relevant section of I.P.C. against the industry.
- vi. Considering the damage to environment, life & property due to embankment breach and precautionary measure to adopt for the stability of another low-lying area, district magistrate had communication with Principal Secretary, Environment Department on 15.4.2020 vide letter no. 466/RDM/2020 for necessary direction to M/s Sasan Thermal Power

Plant. Copy of the letter is enclosed as **Annexure-7**. Energy Department, Govt of Madhya Pradesh vide letter No. F-3/16/2009/13 (Vol. XVIII) dated 4<sup>th</sup> May 2020 asked unit to take immediate action to get ash dykes repaired. Copy of the letter is enclosed as **Annexure-8**.

#### 4. Action Taken by Madhya Pradesh Pollution Control Board (MPPCB)

- i. Joint inspection of the breach site & sample collection was conducted jointly by MPPCB Zonal & Regional Office Rewa and Singrauli respectively on 12<sup>th</sup> April 2020. Looking into the grave danger to environment, life & property; directions under section 33 A of the Water (Prevention and Control of Pollution) Act, 1974 vide letter no. 23/MPPCB/MS/TS Singrauli/2020, Bhopal Dated 13/04/2020 were issued to repair, restore the breached area, remove the fly ash spread, assess environmental damage & deposit interim damage cost pending the assessment of actual damage & Copy of the direction is enclosed as **Annexure-9**.
- ii. Subsequently, MPPCB granted permission vide letter No. ENDT.43/MPPCB/MS/TS-Singrauli/2020 dated 28/04/2020 to industry to accommodate fly ash recovered from the ash breach area within the plant premises and adjoining affected area in to the identified total 9.825 Ha area of low lying area around the existing ash dyke 1 & 2 w.r.t. the units application vide Letter No. SPL/2020-21/11 dated 21/04/2020. Copy of the MPPCB letter is enclosed as **Annexure-10**.
- iii. Earlier, MPPCB vide its letter dated 13.2.2018 granted permission to M/s Sasan Thermal Power Plant to dispose the fly ash only in Compartment 1 (C1) of 6.09 Ha following the guideline prepared by Orissa Pollution

Control Board, Bhuvneshwar and C-FARM, New Delhi “Technology & methodology manual for reclamation of low lying area/abandoned queries/Literate mines etc. with pulverized fuel ash, July 2010. Copy of the same is enclosed as **Annexure-11**. MPPCB team during its visit to plant on 4.1.2019, observed non-compliance of the conditions like liner, partition, disposal in dry form & others stipulated in earlier permission issued on 13.2.2018 for disposing fly ash in low lying area. In this regard, MPPCB has issued a show cause notice to industry on 30.3.2019. Copy of the same is enclosed as **Annexure-12**. Industry replied the show cause notice vide letter SPL/EMG/2019-20/03 dated 22.4.2019 w.r.to the liner, soil permeability, ash transportation, high concentration slurry disposal etc. Copy of the same is enclosed as **Annexure-13**. It was informed by industry representative that as no further directions/Notice were issued from MPPCB after their reply to the show cause; unit has started disposing the ash in High Concentration Slurry Disposal (HCSD) in the areas C2 to C5, which was in accordance with their submission dated 22.04.2019. However, no prior permission was obtained from MPPCB for ash filling in compartments C 2 to C5, an embankment was made and ash in slurry form was filled above the ground level, which is in contravention to the permission granted by MPPCB on 13.2.2018 and was similar to creating an ash dyke and was opposed to the norms of ash filling in low lying areas. The industry kept filling the ash despite the consent renewals granted by MPPCB on 05.04.2019 and 08-03-2020 under the provisions of Water (P&CP) Act, 1974 and Air (P & CP) Act, 1981, in which it was clearly specified that for disposal of ash in low lying area/mine for void filling prior permission from the Board be obtained, and conditions stipulated therein shall be followed.. The consent renewal letters are

enclosed as **Annexure 14A** and **Annexure 14B**. MPPCB vide letter dated 26.5.2020 granted permission to Regional Officer, Singrauli to initiate legal action against the occupier under Water (Prevention & Control of Pollution) Act 1974 and Environment Protection Act, 1986. Copy of the same is enclosed as **Annexure-15**.

#### 5. Action Taken by M/s Sasan Ultra Thermal Power Plant, Singrauli

Action w.r.to the immediate repair of breached embankment, restoration, assessment of the environmental damage & dyke stability, compensation towards loss of life, property & others, removal of ash from compartment C5 etc. are as below:

- i. The restoration of ash spread area through earth moving and transporting equipment is under progress at multiple locations e.g., agricultural fields, nearby nalla with proper access. However, earlier unit faced constraints on large scale resource mobilization due to COVID 19 national lockdown. Out of total 10 Lacs Ton ash; about 3.57 Lacs Ton fly ash excavated from C5 area and used in Island 3 bund strengthening, about 2.67 Lacs Ton ash collected from Goiwahai drain and agricultural land is used to strengthen the Ash dyke 1 & 2. Still around 2.15 Lacs Ton is lying in C5 area and about 1.5 to 2 Lacs Ton fly ash is deposited in drain. Proper spreading and compaction of filled ash is carried out using dozer and compactors. Compaction testing at the ash filling site is carried out regularly conforming to the standards.
- ii. Repair work of damaged retention wall (at C5 area) up to a suitable height has been completed after provision made below the re-instated retention wall for safe passage of water flowing from the area to avoid

any water accumulation within this low lying area. About 3.57 Lacs Ton fly ash excavated from C5 area and used in Island 3 bund strengthening. Simultaneously, soil cover is being provided over the C5 low lying area.

- iii. M/s Sasan Power Ltd has issued letter of intent (LOI) & Work Order (WO) on 21.4.2020 & 2.6.2020 respectively to IIT-BHU for studying the ash dyke stability. Copy of the LOI & WO is enclosed as **Annexure-16**. Preliminary report submitted by IIT-BHU on 17.6.2020. The report states that *“The failure of embankment was definitely initiated by slippage of Poclain. However the subsequent extent of damage of the bund was due to severe hydrostatic pressure on the upstream of the embankment. Through this damaged portion, dilute slurry started flowing leading to complete cutting of the retention wall. Accumulation of huge underground water had resulted into heavy flow of ash slurry causing serious consequences in the villages”*.
- iv. A Letter of Intent (LOI) issued on 21.4.2020 to National Environmental Engineering Research Institute (NEERI), Nagpur for the assessment of the environmental damage. Work order (WO) was issued on 5<sup>th</sup> June 2020 in favor of NEERI. However, due to COVID19 & lockdown; NEERI has not carried out site visit till date. It was informed that regular follow-up is being made with NEERI to expedite the visit. Copy of the LOI & WO is enclosed as **Annexure-17**.

**v. Details of compensation, relief measures & others**

**a. Compensation to families lost their members**

M/s Sasan Power Ltd had compensated financially in **Rs. 125.3 Lakhs** to the dependant family members of **06** deceased persons as per the district

administration instructions & guidelines. Lifelong Monthly Sustenance Allowance was also extended to 6 Dependents of deceased ones @8275/month. Employment was provided to 03 members of the deceased persons. The details are as below:

- 1) Deceased person : **Dinesh Kumar Shah S/O Bisahulal Shah (Age 32 yrs)**  
Following compensation was paid to his dependents Mrs. Reena Shah (Wife), Smt Rudani (Mother), Sh Bisahulal Shahu (Father)
  - One Time Settlement amount- **Rs. 10.00 Lakh**
  - Employment in Company with monthly Salary **Rs. 15000/-** to Smt. Reena Shah W/O Late Shri Dinesh Kumar Shah.
  - Lifelong **Monthly Sustenance Allowance** to Mother Rudani W/O Bisahulal Sahu (67 yrs) & Father Sh. Bisahulal Shahu S/O Anantram Shahu (69 Yrs) @ **Rs. 8275/- (Each)** (Revised every six month as per GoMP Minimum wage guidelines) annual financial implication at today's rate= Rs. 8275x12X2 members=**Rs.198600/annum**
  - Cremation Support of **Rs. 30,000/-**
- 2) Deceased person : **Master Ankit S/O Late Dinesh Kumar Shah (Age 3 yrs)**  
Following compensation was paid to Mrs. Reena Shah (Mother)
  - One Time Settlement amount-**Rs. 10.00 Lakh**
- 3) Deceased person : **Choon Kumari Shah W/O Bhayyaram Shah (Age 28 yrs)**  
Following compensation was paid to dependent **Bhayyaram Shah (Husband)**

- One Time Settlement amount-**Rs. 10.00 Lakh**

4) Deceased person : **Seema D/O Bhayyaram Shah (Age 10 yrs)**

Following compensation was paid to Sh Bhayyaram Shah (Father)

- One Time Settlement amount-**Rs. 10.00 Lakh**

5) Deceased person : **Abhishek S/O Bhayyaram Shah (Age 8 yrs)**

Following compensation was paid to Sh Bhayyaram Shah (Father)

- One Time Settlement amount-**Rs. 10.00 Lakh**

Following compensation and relief was also given to Sh Bhayyaram Shah whose wife & 02 kids lost their life in this ill-fated incidence

- Cremation Support of **Rs. 50,000/-**
- Lifelong **Monthly Sustenance Allowance** to Mother Golari S/O Rambaran Shahu 48 Yrs & Father Rambaraan Shahu S/O Khulluram Shahu (52 Yrs) @ **Rs. 8275/- (Each)** (Revised every six month as per GoMP Minimum wage guidelines) annual financial implication on today's rate= Rs. 8275x12X2 members=**Rs.198600/annum**
- **Permanent Job** to Sh Bhayyaram Shah in Civil department of M/s Sasan Power Limited on the post of Technician.
- **Compensation of House** (Rs. 10.00 Lakh) , **Household items** (Rs. 10.00 Lakh), **property** (Rs. 8.00 Lakh)
- **Constructed House** of 5 room at Makrohar Road (Rs. 25 Lakhs Approx Valuation)

6) Deceased person : **Rajjad Ali S/O Jabbar Ali (Age 29 yrs)**

Following compensation were paid to dependent Mrs. Reshma Khatoon (Wife)

- One Time Settlement amount- **Rs.5.00 Lakh** to Smt. Reshma Khatoon w/o Late Shri Rajjad Ali.
- **Employment to 1 member** through outsourcing based on qualification
- One Time Settlement amount- **Rs.5.00 Lakh** to Shri Jabbar Ali F/o Late Shri Rajjad Ali
- Lifelong **Monthly Sustenance Allowance** to Mother Julekhaa Begum W/O Jabbar Ali (49 Yrs) & Father Jabbar Ali S/O Inshaa Mohammad (52 Yrs) @ Rs. 8275/- (EACH) (Revised every six month as per GoMP Minimum wage guidelines). Annual financial implication on today's rate= Rs. 8275x12X2 members= **Rs.198000/annum**
- Support for Cremation **Rs. 20000/-**
- Payment to be made to the nominees of worker under workmen compensation act (Amount deposited in Labour court) – **11.03 Lakhs**

Elaborated details of the compensation offered to families who lost their members are enclosed as Annexure-18.

**b. Compensation for Cattle, Motor, pump, well, poultry farm etc.**

Based on the survey of district administration, compensation was provided to affected villagers against their loss of livestock, motor, pump, water source, poultry farm etc. The details are as below:

- Affected villagers of 03 villages of Tehsil Singrauli as per SDM Singrauli Letter 165/SDO/RE-3/2020 dtd. 29.05.2020 – **INR 70.59 Lakhs**
- Affected villagers of 01 villages of Tehsil Mada as per SDM Mada Letter 541/SDO/RE-1/2020 dtd. 26.05.2020 - **INR 9.84 Lakhs**

Details of the compensation for Cattle, Motor, pump, well, poultry farm etc. are enclosed as **Annexure-19**.

**c. House Damage, Crop Compensation, House hold items**

About 566 sufferers of Sidhikala, Sidhikhurd, Harrahawa & Jhanjitola villages were recorded by the M/s Sasan Power Ltd. The details are as below:

Affected	Total Numbers	Details of affected persons, property etc.
Farmers	549	Siddhikala – 21 Sidhikhurd – 133 Harrahawa – 321 Jhanjitola - 74
House	14	House includes both Kaccha & pakka
Household items	03	-

**Details of the compensation are as below:**

- Support for Ration/Household damage to 11 families of Sidhi Khurd – **1.78 Lakhs**
- Compensation towards, house damage, crop, household materials (566 nos.) - **85.07 Lakhs**

Details of the compensation to House Damage, Crop Compensation, House hold items are enclosed as **Annexure-20**.

d. **Medical Support to Injured (Nehru Hospital)**

The insured persons were provided medical treatment to Nehru Hospital, Northern Coalfield (NCL), Jayant, Singrauli. Medical support of total Rs. 2.36 Lakhs was provided to Smt Reena Shah W/O Late Dinesh Shah and Golari Devi W/O Sh. Rambaran Shah.

Details of the Medical Support to Injured (Nehru Hospital) are enclosed as **Annexure-21**.

e. **Support for food to affected families**

M/s Sasan Power Ltd extended support for food, maintenance of electric & civil work to affected families. The following expenditure was incurred by the unit:

Support for fooding to affected families through our canteen – **1.5 Lakhs**

Support for civil, electrical maintenance and ration to main family – **1.5 Lakhs**

f. **Provision of drinking water to families and Cattle**

Unit has made drinking water supply provisions in the affected area. The details of work done and expenditure incurred are as below:

- Provision of 570 nos drums of 100 ltr capacity for cattle - 1.14 Lakhs
- Installation of Hand-pump to families affected by accidents (8 nos) - 6.4 Lakhs
- Drinking water supply through tanker - 0.45 Lakhs

Details of the Provision of drinking water to families and Cattle are enclosed as **Annexure-22**.

**vi. Interim compensation for the environmental damage**

MPPCB vide letter dated 13.4.2020 directed M/s Sasan Power Ltd to deposit an amount of Rs 10 Crore towards interim environmental compensation. M/s Sasan Power Ltd has deposited only Rs. 2 Crore to the account of MPPCB (Member Secretary Environment Protection Fund) on 26.5.2020. Details of the Interim compensation for the environmental damage are enclosed as **Annexure-23**.

**6. Action Taken by Ministry of Environment, forest & Climate Change (MoEF&CC)**

MoEF&CC, New Delhi issued a Show Cause notice vide office order no. J-13011/15/2006-IA-II (T) dated 21.05.2020 under Section 5 of Environment (Protection) Act, 1986. Project Proponent vide e-mail dated 04.06.2020 submitted a reply in response to the said show cause notice. Subsequently, MoEF&CC, New Delhi vide letter dated 13.07.2020 requested the project proponent to provide the concrete action taken and or being taken by the company to achieve 100% fly ash utilization. Simultaneously, MPPCB has been requested to furnish action taken by the Board as well as the remedial measures taken by M/s. Sasan Power Ltd. Copies of the same are enclosed as **Annexure-24**.

**7. Specific observations of the joint committee**

- i. Continuous flow of water contaminated with fly ash is seen flowing down the Hume pipe laid by the project proponent in the breach area, wherein the Project Proponent needs to take appropriate control measures to prevent the fly ash from reaching the Goiwahai drain and finally the Rihand river.

- ii. In spite of the efforts of the project proponent to remove fly ash from the Goiwahai drain, significant quantities of Fly ash between 1.5 to 2 Lacs Ton is seen spread on the banks of Goiwahai drain over a stretch of 6.5 km till its confluence with the Rihand River. Slower progress in fly ash removal due to constraints in resource mobilization due to covid-19 lockdown was noticed and the industry needs to expedite the fly ash recovery from the banks of Goiwahai drain.
- iii. In spite of the financial aid /compensation paid by the company to the affected people, the grievances of some of the affected people are still to be addressed by the company in co-ordination with local authorities.
- iv. The project proponent has engaged CSIR-NEERI to assess the cost of environmental restoration and IIT-BHU to assess the ash dyke stability study and others.

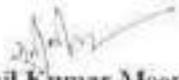
Google image of the site of the incidence and photographs taken during the field visit are enclosed as **Annexure- 25**.

## 8. Recommendations

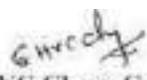
1. To check the strength of the bunds created around the dykes/low lying areas quarterly and one time especially before the on-set of the monsoon through expert agencies of repute and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC periodically.
2. To expedite the ash cleaning work from Goiwahai drain to ensure that the resultant environment contamination is minimized and resources should be channelized to complete the task within 1 month and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC on weekly basis.

3. To take appropriate control measures to prevent the fly ash from reaching the Goiwahai drain and finally the Rihand River.
4. In spite of the financial aid /compensation paid by the company to the affected people, the grievances of some of the affected people near Tola Badi village, Harrahawa are still to be addressed by the company in co-ordination with local authorities. The CSR cell of the company in co-ordination with the local administration shall set-up grievance redressal camps in each of the affected villages along the Goiwahai drain.
5. To obtain prior permission from MPPCB before any disposal of fly ash / bottom ash in the low lying areas and ensure disposal as per the CPCB guideline.
6. To expedite the studies to be undertaken by IIT-BHU to assess the impact of aquifers in the fly ash breach.
7. To expedite the environmental damage assessment studies with CSIR-NEERI so as to ensure the actual impact of fly ash breach on environment is assessed holistically.

  
(S D Valmiki)  
Regional Officer  
MPPCB, Singrauli

  
(Sunil Kumar Meena)  
Scientist-D  
CPCB, Regional Directorate Bhopal

  
(Rajeev Ranjan Meena)  
District Collector  
Singrauli

  
(Dr. HVC Chary Guntupalli)  
Scientist-D  
MoEF&CC, RO Bhopal

  
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**ANNEXURE R-3**

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL,  
 PRINCIPAL BENCH AT NEW DELHI  
 ORIGINAL APPLICATION NO. 148 OF 2020  
 IN  
 ORIGINAL APPLICATION NO.(CZ) 31 OF 2020

**IN THE MATTER OF.-**

Hiralal Bais

--Applicant

VERSUS

UNION OF INDIA &amp; ORS.

... Respondents

**AFFIDAVIT ON BEHALF OF SASAN POWER LIMITED / RESPONDENT NO. 1&2****Most Respectfully Sheweth.-**

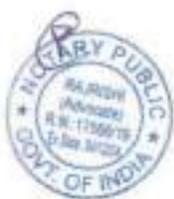
I, Virendra Shukla aged about 46 years, son of Late Sh T. R. Shukla, resident of J-1106, Amrapali Silicon City, Sector 76, Noida-201301, Authorised Representative of Sasan Power Ltd, being Respondent No1&2, having its office at A-2, Sector-24, Noida-201301, presently at New Delhi, do hereby solemnly affirm, declare and state on oath as under. -

1. That I am duly Authorised Representative of the Respondent No. 1 & 2 ("Answering Respondent"/"SPL") in the instant Original Application and as such I am well conversant with the facts and circumstances of the present case, based on my personal knowledge and as derived from the records maintained by the Answering Respondent in the ordinary course of business. As such, I am competent to swear and depose the present affidavit.
2. It is submitted that Answering Respondent herein is a subsidiary Company of Reliance Power Limited ("RPL") that has developed Sasan Ultra Mega Power Project ("Sasan UMPP") in the State of Madhya Pradesh ("M.P."), which is a flagship initiative of Government of India ("GoI") and is the largest integrated pit-head power project in India. The said Project has an installed power generation capacity of 3960 MW and an operating captive coal mine of 20 Million Tons Per Annum capacity. It supplies power to 14 power distribution


**TRUE COPY**

companies (Discoms) which serve 47 Crore population across 7 states at a levelized tariff of Rs. 1,196/kWh, lowest among the coal-based power plants in the country. It is pertinent to note that Coal for the Sasan UMPP is supplied from the captive coal blocks of Moher & Moher - Amlohri Extension having an average ash content of less than 34%.

3. That the Applicant has preferred the instant Original Application under Section 18(1) read with Section 14, 15 & 17 of the National Green Tribunal Act, 2010 ("NGT Act") before the Hon'ble National Green Tribunal, Central Zone, Bhopal (Madhya Pradesh) primarily, on account of alleged incident of breach of retention wall of the low lying area meant for ash utilization inside the boundary of the Sasan UMPP on 10.04.2020.
4. At the outset, it is humbly submitted that Madhya Pradesh Pollution Control Board ("MPPCB"), taking cognizance of the alleged incident, directed SPL to deposit an amount of INR 10 Crores towards interim environmental compensation *vide* its letter no. D. No. 23/MPPCB/MS/TS Singrauli/2020 dated 13.04.2020. In compliance to the said directions from MPPCB, on 26.05.2020, given the liquidity challenges and financial stress being faced by SPL, INR 2 Crores were deposited in MPPCB account (Member Secretary Environment Fund). That SPL *vide* its letter dated 28.05.2020 addressed to MPPCB, shared details of INR 2 Crores deposited with MPPCB in compliance of its directions. True Copy of letter dated 13.04.2020 & 28.05.2020 is hereby annexed and marked as ANNEXURE - R/1 (Colly).
5. It is further submitted MPPCB *vide* its letter dated 24.08.2020 directed SPL to deposit balance amount of INR 8 Crores to MPPCB in compliance of the Order dated 14.07.2020 passed by this Hon'ble Tribunal in O.A 164 of 2018 titled as Ashwani Kumar Dubey v. Union of India. In response to the aforesaid letter, SPL *vide* its letter dated 09.09.2020 addressed to MPPCB intimated that this Hon'ble Tribunal in its order dated 14.07.2020 directed NTPC, Vidhyanachal



to deposit INR 10 Crores towards interim compensation for breach of their ash dyke and further highlighted that the facts in SPL's case are different and clearly distinguishable from those in NTPC, Vindhyachal's case. In SPL's case retention wall at low lying area within the plant premises got damaged, ash dyke of SPL was totally safe and the same was confirmed by IIT-BHU through its report. SPL also drew reference to its letter dated 21.04.2020 wherein its precarious liquidity condition and stressed finances were highlighted and further added that despite facing severe liquidity crunch, SPL had deposited INR 2 Crores. Thus the principles as applied by this Hon'ble Tribunal in its order dated 14.07.2020 will not be applicable to SPL. In addition to the above payment of INR 2 Crores deposited with MPPCB as an interim environmental compensation, SPL has additionally incurred INR 15 Crores towards compensation and restoration works. Thus a total of ~INR 17 Crores has been incurred by SPL in the context of compensation and restoration works. True Copy of letters dated 24.08.2020 & 09.09.2020 are hereby annexed and marked as ANNEXURE R/2 (Colly)

6. It is submitted that the Hon'ble Tribunal (CZ), taking cognizance of the instant application, constituted a Joint Committee vide its order dated 29.06.2020, comprising of Representatives of the Ministry of Environment, Forest & Climate Change ("MoEF&CC"), Central Pollution Control Board ("CPCB"), District Collector, Singrauli and Regional Officer (Singrauli), MPPCB and thereby directed the said Joint Committee to visit the place and submit the report elaborating the actions taken. Further, the Hon'ble Tribunal (CZ) designated the respective State Pollution Control Board ("SPCB") as the Nodal Agency for the purpose of coordination and logistic support. Copy of NGT order dated 29.06.2020 is annexed herewith and marked as ANNEXURE R/3.



7. It is submitted that on 10.07.2020, MoEF&CC issued directions to the District Collector of Singrauli to inspect SPL site on 14<sup>th</sup> - 15<sup>th</sup> July 2020, with the Joint Committee constituted in compliance of the Order dated 29.06.2020 passed by this Hon'ble Tribunal. Copy of MoEF&CC directions dated 10.07.2020, is annexed herewith and marked as **ANNEXURE R/4**.
8. It is submitted further, that on 13.07.2020, MoEF&CC addressed a letter to SPL requesting it to provide a concrete Action Plan to achieve 100% fly ash utilization in compliance to the fly ash notification. Copy of MoEF&CC letter dated 13.07.2020 is annexed herewith and marked as **ANNEXURE R/5**.
9. In response to the above letter, SPL, on 28.08.2020, shared its concrete Action Plan with MoEF&CC to achieve 100% fly ash utilization for Sasan Ultra Mega Power Project. Copy of SPL action plan is annexed herewith and marked as **ANNEXURE R/6**.
10. That in July, 2020 the Joint Committee as per the Order dated 29.06.2020 carried out site visits of Sasan UMPP.
11. It is also submitted on 09.08.2020, a Study Report w.r.t. stability analysis of Ash Dyke, proposed Raisings, preparedness plan, Instrumentation and Monitoring was prepared by Prof. Arun Prasad, Department of Geotechnical Engineering, IIT - BHU at the instance of SPL. The report stipulated the following conclusions under point 9, which are extracted below for ease of reference.



*"Based on the analysis, and assessment discussed above, the following conclusions are made:*

- (a) *The existing ash dyke (lagoon 1 and 2 both) is structurally stable and safe for filling with ash.*
- (b) *The raising of starter dyke by 7.0 m can be done by adopting the downstream technique, which is structurally more stable as compared to upstream and centerline techniques*

- (c) *Instruments can be installed for monitoring the safety of the ash dyke.*
- (d) *Future raising of the ash dyke by 20 m is possible as suggested by the stability analysis. However, a detailed analysis needs to be carried out adopting the strength parameters of soil/ash obtained from tests carried out during the time of actual raising.*
- (e) *The area between Lagoons -1 and 2 towards the southern end of the ash pond can be excavated to create additional ash disposal capacity.\**

A copy of IIT BHU report is annexed herewith and marked as ANNEXURE R/7.

12. That the Report of the Joint Committee constituted as per the Order dated 29.06.2020 was filed before this Hon'ble Tribunal. In the said Action Taken Report the Joint Committee recorded the following:-
- (a) Reason for breach;
  - (b) Nature of Damage;
  - (c) Action taken by District Administration;
  - (d) Action taken by MPPCB;
  - (e) Action taken by Answering Respondent/ SPL;
  - (f) Action taken by MoEF&CC;
  - (g) Specific Observations of the Committee; and
  - (h) Recommendations.

A True Copy of the Action Taken Report of the Joint Committee as per the Order dated 29.06.2020 is annexed hereto and marked as ANNEXURE R/8.



13. It is humbly submitted that MPPCB in complete disregard of SPL's response dated 09.09.2020 made towards outstanding interim environmental compensation again requested SPL vide its letter dated 25.11.2020, to deposit outstanding interim environmental compensation of INR 8 Crores. SPL in addition to its response dated 09.09.2020, intimated MPPCB vide its letter dated 15.01.2021, that this Hon'ble Tribunal in the present O.A directed to constitute a committee comprising of District Collector (Singrauli), members

of CPCB, MoEF&CC & MPPCB. The recommendations submitted by the said committee do not include any further environmental compensation to be collected from SPL and emphasized on expeditious completion of site restoration work. SPL further added that despite facing severe liquidity challenges, which have further exacerbated due to unprecedented delays in bill payments in recent months by Madhya Pradesh Power Management Company Limited (MPPMCL), the Lead Procurer of Sasan UMPP, SPL has already paid an Interim Environmental Compensation of INR 2 Crores to MPPCB. In addition to above, SPL has incurred nearly INR 15 Crores towards compensation and restoration work. True copies of the letter dated 25.11.2020 & 15.01.2021 are hereby annexed and marked as ANNEXURE R/9 (Colly).

14. That the present OA was scheduled to be listed before the Hon'ble Tribunal on 27.08.2020, 02.12.2020 and 27.01.2021. However, the matter was adjourned as per the Cause List itself. Therefore, no Order directing the Answering Respondents to file a Reply has been passed by the Hon'ble Tribunal. However, the Answering Respondents are filing the present Affidavit with the limited purpose of placing on record the current status of activities undertaken by the Answering Respondents.

15. That as stated above, the Joint Committee in its Report has made certain observations on the activities required to be undertaken by the Answering Respondent. Therefore, the Answering Respondent is filing the present Additional Affidavit for the limited purpose to place on record the current status of such activities vis-a-vis the observations made by the Joint Committee in its Report.



(a) Still around 2.15 Lacs Ton is lying in C5 area and about 1.5 to 2 Lacs Ton fly ash is deposited in drain. (Para 2 @ Pg. 5 of the Report)

- i. It is submitted that SPL issued a letter no. SPL/2020-21/41 dated 31.10.2020 to MPPCB communicating status of ash removal and restoration of ash spread area.
- ii. The site restoration job is now completed and the status is as follows:

[All values in Lakh-Tonne]

SN	Details	Quantity of Ash Cleaned	Remaining Ash Quantity	Utilization areas
1	Agricultural and other fields	1.60	0.0	1. Approved Low lying areas around ash pond;
2	Gabaiya Nalla	2.25	0.0	2. Strengthening of dyke wall of ash pond.
	Total spilled over ash	3.85	0.0	

- iii. As regards, the remaining ash in the Island - 4 Area (~6.00 Lacs-Tonne), this low lying area has been fully cleared of remaining ash and additional soil cover has been provided in this area. Sasan UMPP is not going to use this area for any ash utilization in any mode considering the risk involved due to increased water table in the area. For safe passage of water from the four aquifers, because of high water table and rain, culvert has already been constructed.
- iv. Further, after ash restoration and associated field preparations, farmers have already grown paddy in their agricultural fields, most of them are presently under flowering stage and the condition of the crop yield is also very good.
- v. Copy of letter dated 31.10.2020 issued by SPL to MPPCB is annexed herewith and marked as **ANNEXURE R/10**. The Letter also attaches relevant photographs of restoration work in agriculture and other fields; Gabaiya Nalla and Island 4 area. Copy of site photographs are annexed herewith and marked as **ANNEXURE R/11**.



(b) To check the strength of the bunds created around the dykes/low lying areas quarterly and one time especially before the on-set of the monsoon through expert agencies of repute and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC periodically. (Para 8 (1) @ Pg 18 of the Report)

i. For the assessment of design and structural safety of the ash dyke of the Sasan UMPP, IIT BHU was engaged and the report is already submitted. As per the IIT- BHU Report "Existing Bund is structurally stable and safe for filling with ash". The said report is already submitted to MPPCB and is being placed before this Hon'ble Tribunal for its kind consideration as **Annexure R/7 of the present affidavit**.

ii. Further, the strength of the bund created around the ash dyke/ low lying area will be checked every year before the monsoon through the expert agency of repute and Action Taken Report will be submitted to Regional Offices of MPPCB, CPCB and MoEF&CC.

(c) To expedite the ash cleaning work from Gohwahai drain to ensure that the resultant environment contamination is minimized and resources should be channelized to complete the task within 1 month and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC on weekly basis. (Para 8 (2) @ Pg 18 of the Report)

i. It is submitted that the ash cleaning work from Gabaiya nalla is completed. Copy of SPL submissions dated 16.09.2020 and 15.01.2021 submitted to regional offices of MPPCB, CPCB & MoEF&CC are herewith annexed and marked as **ANNEXURE - R/12 (Colly)**.



ii. It is submitted that all the sites in the low lying area (island 4), post efforts of SPL, have been restored, same is evident from the site pictures annexed herewith as ANNEXURE – R/13.

(d) To take appropriate control measures to prevent the fly ash from reaching the Gaiwahai drain and finally the Rihand River. (Para 8 (3) @ Pg 19 of the Report

It is submitted that the site restoration job, including cleaning of Gabaiya nalla, is now completed. With regard to the precautions taken:

i. After cleaning, width of the Gabaiya nalla and hence the natural water flow profile is restored. With the increase in the width of the nalla, the velocity of the water flowing through the nalla is also reduced resulting into reduction in particle carrying capacity of the flowing water.

ii. Wherever there was no immediate approach for the dumpers to clean the ash, layer of soil cover was provided through poclaim and once the approach was established ash from the area was lifted immediately and shifted to designated low lying area around ash dyke.

(e) In spite of the financial aid /compensation paid by the company to the affected people, the grievances of some of the affected people near Tola Badi village, Harrahawa are still to be addressed by the company in co-ordination with local authorities. The CSR cell of the company in co-ordination with the local administration shall set-up grievance redressal camps in each of the affected villages along the Gaiwahai drain. (Para 8 (4) @ Pg 19 of the Report)



- i. It is submitted that SPL had received 17 complaints from *Bhadi Toia* villagers about non disbursement of their compensations. After checking their compensation status, SPL found that 10 complainants were already the part of Revenue Department original list and accordingly Crop compensation paid in their bank accounts as per the instructions by the District Administration. Further, as regards the remaining 7 complainants, they were not the land owner. However they claimed of having loss of their grown vegetables. SPL has paid Rs. 5000/- per person directly to them.
  - ii. Further, support has also been provided to affected villagers for levelling their agricultural fields and digging 21 wells for irrigation of the fields. Approx. 1 Km internal village roads connecting PMGSY *Harrahawa* have been strengthened benefitting *Bhadi Toia* villagers. Grievance redressal mechanism is already in place, wherein district admin officials (Tehsildar/SDM) along with Village Panchayat and CSR Cell of SPL address the complaints and grievances of affected people.
  - iii. Grievances of the villagers from *Jhanjhi Toia, Harrahawa, Siddhikhurd- Latbudwa Toia, Giddhakhadi Toia* are also settled by paying crop compensation.
  - iv. CSR team is also visiting the affected villages on daily basis and genuine grievances are being timely resolved.
- (f) **To obtain prior permission from MPPCB before any disposal of fly ash / bottom ash in the low lying areas and ensure disposal as per the CPCB guideline. (Para 8 (5) @ Pg 19 of the Report)**
- i. It is submitted that in the past, SPL has always obtained prior permission from MPPCB/relevant authorities and ensured its



compliance, for disposal of fly ash / bottom ash in any low lying areas. SPL will continue to do the same in future also.

- ii. It is further submitted that SPL had taken permission from MPPCB vide letter dated 13.02.2018. Visit of MPPCB officials to site took place on 04.01.2019 and 05.01.2019. Post visit of MPPCB officials a show cause notice was issued by MPPCB on 30.03.2019. SPL submitted a point-wise reply against that notice on 22.04.2019 and after SPL's point-wise submission no further action was taken by MPPCB. It is respectfully submitted that no response to SPL's point-wise reply of 22.04.2019 shows that the reply as submitted by SPL was accepted by the MPPCB.
- iii. Further, the said low lying area including the plant area was also visited by the Regional Officer, Singrauli on 30.03.2019, 01.04.2019, 15.02.2020 and 19.02.2020, during the course of renewal of Consent to Operate (CTO) of the plant and essentially based on his recommendation, CTO of the plant got renewed for FY 2019-20 and 2020-21. This clearly confirms that all the issues related to the low lying areas were closed before the renewal of CTO and nothing was pending to be done from SPL side. Further, SPL has also been reporting the quantum of ash utilization in different avenues, including low lying areas, through quarterly reports, annual returns, annual environmental statements, etc. to the MPPCB. Replies in this regard have already been submitted to MPPCB vide letters dated 21.04.2020, 10.06.2020 and 09.09.2020.



- (g) To expedite the studies to be undertaken by IIT-BHU to assess the impact of aquifers in the fly ash breach, (Para 8 (6) @ Pg 19 of the Report)

- i. It is submitted SPL has already engaged IIT- BHU to assess the impact of aquifers in Island #4 area. The work has been awarded to IIT -BHU ON 08.01.2021. The professors from IIT BHU have done pre contract award visit of the site on 28.11.2020 to assess the site condition and to have detailed discussions. It is humbly submitted SPL issued Work Order ("WO") dated 08.01.2021 to IIT - BHU for carrying out hydrological studies in and around of SPL. True copy of WO dated 08.01.2021 is hereby annexed and marked as ANNEXURE R/14 (Colly).



W.O. No.-33519884  
Hydrological Study (L)

- (h) **To expedite the environmental damage assessment studies with CSIR-NEERI so as to ensure the actual impact of fly ash breach on environment is assessed holistically. (Para 8 (7) @ Pg 19 of the Report)**

- i. NEERI has already been engaged for the said study vide WO dated \_05.06.2020. A team of NEERI Scientists, which could not immediately visit the site due to then prevailing lockdown conditions and subsequent travel restrictions, has visited the site from 22.12.2020 - 26.12.2020; carried out detailed site survey; and collected samples. NEERI's report is awaited. True copy of the WO issued to NEERI enclosed as ANNEXURE



NEERI Work  
Order.pdf

R/15.

16. In view of the aforementioned submissions raised at the instance of the Answering Respondents, it is submitted that SPL has complied with the directions issued by the joint Committee. The Answering Respondents crave leave to file a detailed affidavit as and when directed by the Hon'ble Tribunal and/or deemed necessary.

Counsel for the Respondent No. 1 & 2

*Virendra Shukla*  
Deponent  


**VERIFICATION**

I, Virendra Shukla the deponent above named, do hereby verify that the contents of paragraph No. 1 - 15 above are true and correct to the best of my knowledge and belief and that no part hereof is false and nothing material has been concealed therefrom.

090721

Verified at New Delhi on this \_\_\_\_ day of May, 2021.

*Virendra Shukla*  
Deponent  




**ATTESTED**

*R*  
Notary Public, Delhi

090721

*[Signature]*

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## ANNEXURE R-4 (COLLY.)

**Sasan Power Limited**

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Tiyara  
 Singrauli - 486 088  
 Madhya Pradesh, INDIA  
 www.reliancepower.co.in

SPL/ /2020-21/38

Date: 16.09.2020

To

**Er. Sunil Kumar Meena, Scientist - D**  
 Central Pollution Control Board,  
 Regional Directorate  
 Bhopal, (MP) - 462016

Ref: Your E-mail dated 21-August-2020

Respected Sir,

This has reference to your email mentioned under reference above wherein Sasan Power Limited (SPL) has been advised to submit the detailed Action Taken Report (ATR) against the advisory issued by the Committee constituted by Hon'ble NGT in OA 31/2020. In this regard SPL is pleased to submit the detailed ATR as under:

SN	Actions Recommended	SPL Submission
1	To check the strength of the bunds created around the dykes/low lying areas quarterly and one time especially before the on-set of the monsoon through expert agencies of repute and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC periodically.	<p>1. For assessment of the design and structural safety of the ash dyke of the Sasan UMPP, IIT-BHU was engaged and the report is already submitted. As per the IIT-BHU report "Existing bund is structurally stable and safe for filling with ash." The said report has already been submitted to MPPCB and the same is attached as <b>Annexure 1</b>.</p> <p>2. As suggested , the strength of the bunds created around the dykes/low lying areas will be checked every year before the monsoon through the expert agency of repute and Action Taken Reports will be submitted to regional offices of MPPCB, CPCB &amp; MoEF&amp;CC.</p>
2	To expedite the ash cleaning work from Gaiwahai drain to ensure that the resultant environment contamination is minimized and resources should be channelized to complete the task within 1 month and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC on weekly basis.	<p>1. We would like to submit that the ash cleaning work from Gabaiya nalla is now almost completed and its natural width and flow is restored which is helping in avoiding the possibility of carrying away of ash from the some of the ash patches left on the edges of the nalla where the ash cleaning is work is still in progress.</p>

Registered Office: Sasan Power Limited, H Block, 1<sup>st</sup> Floor, Dhirubhai Ambani Knowledge City, Navi Mumbai 400 710 INDIA

Page 1 of 4



**TRUE COPY**

## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Sidhi khund  
 Post Office: Tiyara  
 Singrauli – 486 386  
 Madhya Pradesh, INDIA  
 www.reliancepower.co.in

		<p>2. Till date, approx. 2.1 Lac Ton of ash from nalla has already been lifted. Cleaning of remaining ash (estimated at 20,000 Tonnes), deposited on the sides of the nalla in very few patches is already under progress. We are relentlessly pursuing the ash lifting from the side of the nalla and taking every possible measure that the ash from the sides of the nalla does not reach Rihand River.</p> <p>3. Further, around 1.5 Lac Ton (approx. 94%) ash from agricultural or other land areas has also been cleared. Lifting of remaining ash of approx. 0.1 Lac Ton from two locations is hampered because of the resistance from land owners owing to their internal family conflicts. We are discussing the same with the district administration for expeditious resolution of these issues to enable us clean these patches and hope to resolve the same by 30<sup>th</sup> Sep'20. We are very happy to mention that farmers have already grown paddy in their agricultural fields and the condition of crop growth is also very good.</p> <p>4. We have excavated and lifted 6.0 lac ton of leftover ash from island – 4 inside the plant boundary. The collected ash has been used in strengthening of retaining wall of island – 3 low-lying area and used around permanent ash pond in accordance with the MPPCB approval dated 28.04.2020.</p> <p>Restoration of leftover area of approx. 5-6% would be completed by 30.09.2020. (Site photographs are attached vide Annexure 2).</p>
3	<p>To take appropriate control measures to prevent the fly ash from reaching the Goiwahai drain and finally the Rihand River.</p>	<p>1. With achievement of natural water flow profile of Gabaiya Nalla after its cleaning, the effective water flow width increased resulting into reduction of velocity and hence reducing the particle carrying capacity of the flowing water.</p>

## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi Khurd  
 Post Office: Tiyara  
 Singrauli - 486 886  
 Madhya Pradesh, INDIA  
[www.reliancepower.co.in](http://www.reliancepower.co.in)

		<p>2. Wherever there was no immediate approach for the dumpers to clear the ash, layer of soil cover was provided through Poclain and once the approach was established, the ash from the area was lifted immediately and shifted to designated low lying area around ash dyke.</p>
4	<p>In spite of the financial aid /compensation paid by the company to the affected people, the grievances of some of the affected people near Tola Badi village, Harrahawa are still to be addressed by the company in co-ordination with local authorities. The CSR cell of the company in co-ordination with the local administration shall set-up grievance redressal camps in each of the affected villages along the Goiwahai drain.</p>	<p>1. We had received 17 complaints from Bhadi Tola villagers about non disbursement of their compensations. After checking their compensation status, we found that 10 complainants were already the part of Revenue Deptt original List and accordingly Crop compensation paid in their bank accounts as per the instructions by the District Administration. Further, to the remaining 7 complainants, they were not the land owner. However they claimed of having loss of their grown vegetables. SPL has paid Rs. 5000/-directly to them. Further, support has also been provided to affected villagers for leveling their agricultural fields and digging 21 wells for irrigation of the fields. Approx 1 Km internal village roads connecting PMGSY Harrahawa have been strengthened benefitting Bhadi Tola villagers. Grievance redressal mechanism is already in place, wherein district admin officials (Tehsildar/SDM) along with Village Panchayat and CSR Cell of the company address the complaints and grievances of affected people.</p> <p>2. Grievances of the villagers from Jhanjhi Tola, Harrahawa, Siddhikhurd- Latbudwa Tola, Giddhakhadi Tola are also settled by paying crop compensation.</p> <p>3. CSR team is also visiting the affected villages on daily basis and genuine grievances are being timely resolved.</p>

## Sasan Power Limited

CIN: L40102MH2006PLC190557

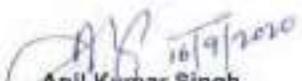
6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Tiyara  
 Singrauli - 495 895  
 Madhya Pradesh, INDIA  
 www.sasanpower.co.in

5	To obtain prior permission from MPPCB before any disposal of fly ash / bottom ash in the low lying areas and ensure disposal as per the CPCB guideline.	In the past, SPL has always obtained prior permission from MPPCB/relevant authorities and ensured its compliance, for disposal of fly ash / bottom ash in any low lying areas. SPL will continue to do the same in future also.
6	To expedite the studies to be undertaken by IIT-BHU to assess the impact of aquifers in the fly ash breach.	SPL has already initiated the process of engaging IIT-BHU to assess the impact of aquifers in Island #4 area. Formal work-order is expected to be placed by 30-Sept-20
7	To expedite the environmental damage assessment studies with CSIR-NEERI so as to ensure the actual impact of fly ash breach on environment is assessed holistically.	NEERI has already been engaged for the said study. NEERI has already informed that they will be commencing their damage assessment study very soon.
8	Water and sediment analysis of gabaiya drain on a quarterly basis	1. The first batch of water samples has already reached the laboratory on 20-Aug-2020 for analysis and its reports are expected to be received by 25-Sept-2020, which will be shared as soon as it is received. 2. Further, second and third batch of water samples were also dispatched on 25-Aug-2020 and 14-Sept-2020 for its analysis and the results of the same will be shared as soon as it is received.

Thanking You

Yours faithfully,

For Sasan Power Limited

  
 Anil Kumar Singh  
 (Chief Executive Officer)

Enclosures: 1. Annexure – 1 (IIT-BHU Dyke stability Report)  
 2. Annexure – 2 (Site Photographs)

CC: 1. Regional Officer, MPPCB, Singrauli  
 2. Dr. HVC Chari, MOEF&CC, Regional Office (W), Bhopal

  
 // TRUE COPY //

## ANNEXURE R-4 (COLLY.)

## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
Gram: Siddhi khurd  
Post Office: Tijara  
Singrauli – 486 886  
Madhya Pradesh, INDIA  
www.sasanpower.co.in

SPL/2020-21/43

Date: 15<sup>th</sup> January 2021

Er. Sunil Kumar Meena, Scientist - D  
Central Pollution Control Board,  
Regional Directorate  
Bhopal, (MP) – 462016

Ref: 1. Your E-mail dated 21-August-2020  
2. SPL letter vide no. SPL/2020-21/38 dated 16.09.2020

Respected Sir,

In continuation to our letter dated 16.09.2020, updated status of Action Taken Report (ATR) vis-a-vis the advisory issued by the Committee constituted by Hon'ble NGT in OA 31/2020 is as follows:

SN	Actions Recommended	SPL Submission
1	To check the strength of the bunds created around the dykes/low lying areas quarterly and one time especially before the on-set of the monsoon through expert agencies of repute and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC periodically.	1. IIT – BHU report already submitted to your good-self on 16.09.2020. 2. Vide our letter dated 16.09.2020, SPL has already confirmed that it shall carry out the said study annually before the monsoon through the expert agency of repute and submit 'Action Taken Report' to Regional Office of MPPCB, CPCB and MoEF&CC. 3. Therefore, no further update submission is envisaged in this regard.
2	To expedite the ash cleaning work from Goiwahai drain to ensure that the resultant environment contamination is minimized and resources should be channelized to complete the task within 1 month and to submit Action Taken Reports to regional offices of MPPCB, CPCB & MoEF&CC on weekly basis.	1. The site restoration job, including cleaning of Gabaiya nalla, is already completed and a letter in this regard is submitted to MPPCB on 31.10.2020 and to the office of your good-self on 28.12.2020. 2. Therefore, no further update submission is envisaged in this regard.
3	To take appropriate control measures to prevent the fly ash from reaching the Goiwahai drain and finally the	1. The site restoration job is already completed and a letter in this regard is submitted to MPPCB on 31.10.2020 and to the office of your

Registered Office: Sasan Power Limited, H Block, 1<sup>st</sup> Floor, Dhingrahal Ambani Knowledge City, Navi Mumbai 400 710 INDIA

Page 1 of 3



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## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Tiyora  
 Singrauli – 486 886  
 Madhya Pradesh, INDIA  
[www.reliancepower.co.in](http://www.reliancepower.co.in)

	Rihand River.	good-self on 28.12.2020. 2. <b>Therefore, no further update submission is envisaged in this regard.</b>
4	In spite of the financial aid /compensation paid by the company to the affected people, the grievances of some of the affected people near Tola Badi village, Harrahawa are still to be addressed by the company in co-ordination with local authorities. The CSR cell of the company in co-ordination with the local administration shall set-up grievance redressal camps in each of the affected villages along the Golwahai drain.	1. All the grievances, as recommended, are settled and update is submitted to your good-self vide letter dated 16.09.2020. 2. <b>Therefore, no further update submission is envisaged in this regard.</b>
5	To obtain prior permission from MPPCB before any disposal of fly ash / bottom ash in the low lying areas and ensure disposal as per the CPCB guideline.	A confirmation on the same is already provided vide letter dated 16.09.2020. <b>Therefore, no further update submission is envisaged in this regard.</b>
6	To expedite the studies to be undertaken by IIT-BHU to assess the impact of aquifers in the fly ash breach.	The work has been awarded to IIT-BHU on 8 <sup>th</sup> Jan, 2021. The Professors from IIT BHU have already visited the site on 28.11.2020 to assess the site condition and to have detailed discussions.
7	To expedite the environmental damage assessment studies with CSIR-NEERI so as to ensure the actual impact of fly ash breach on environment is assessed holistically.	NEERI has already been engaged for the said study. A team of NEERI Scientists has visited site from 22 <sup>nd</sup> to 26 <sup>th</sup> Dec-2020, carried out detailed site survey and collected samples. <b>The status of said study will be updated to your good-self on a regular basis.</b>
8	Water and sediment analysis of gabaiya drain on a quarterly basis	1. SPL has carried out regular collection of water and sediment sample of Gabaiya drain. 2. The reports of sample analysis, as received till date, are attached vide Annexure – 1. 3. As NEERI Team has now visited the site and

## Sasan Power Limited

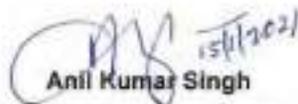
CIN: U40102MH2008PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Tiyara  
 Singrauli - 486 856  
 Madhya Pradesh, INDIA  
[www.reliantpower.co.in](http://www.reliantpower.co.in)

		collected the water, soil and sediment samples, the collection of sample by the SPL is now discontinued.
--	--	--

Thanking You,

Yours faithfully,  
 For Sasan Power Limited

  
**Anil Kumar Singh**  
 (Chief Executive Officer)

Enclosures: 1. Annexure - 1 (Water and Sediment analysis report)

CC: 1. Regional Officer, MPPCB, Singrauli  
 2. Dr. HVC Chari, MOEF&CC, Regional Office (W), Bhopal



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**ANNEXURE R-4 (COLLY.)**

Annexure - 2

**A. Ash Spread Areas and Restoration Work under Progress (Then)**



  
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**B. Present Site Condition**

1. Low Lying Area (Island – 4): Ash removed and covered with soil leaving a channel for the safe exit of ground / rain water.





**2. Island – 4 drain and Gabaiya nalla co influence up to AWRS Culvert:** All area (nalla and land) cleared and paddy cultivation going on. Some part of ash lifting pending because of internal family conflict of land owners.







**3. AWRS Culvert Area:** All area (nalla and land) cleared.



**4. Gabaiya nalla main culvert area:** All area (nalla and land) cleared.





**4. Gabaiya nalla main culvert downstream:** All area (main nalla area and land) cleared. Cleaning of ash deposited on the side of nalla in very few patches is in progress





5. Gabaiya nalla and Rihand River Confluence point: All area cleared.





A handwritten signature in blue ink, consisting of several loops and a long horizontal stroke.

**// TRUE COPY //**

## ANNEXURE R-5



## MADHYA PRADESH POLLUTION CONTROL BOARD

Paryawaran Parisar, E-5, Arera Colony, BHOPAL - 462 016

[0755] 2464428, 2466191 Fax: (0755) 2463742 e-mail: mppcb@rediffmail.com



✓ D. No. 23 / MPPCB/MS/TS Singrauli/ 2020

Bhopal, Dated: 13.4.2020

1. A.K Singh  
Chief Executive Officer,  
Sasan Power Ltd.  
Post- Tiyara,  
Distt: Singrauli (MP)- 486886

2. Sachin Mohapatra (Occupier)  
Senior Vice President & Station Director  
Sasan Power Ltd.  
Post- Tiyara,  
Distt: Singrauli (MP)- 486886

3. Dr. Amitosh Verma,  
Assistant Vice President- Environment  
Sasan Power Ltd.  
Post- Tiyara,  
Distt: Singrauli (MP)- 486886

gwp  
Back R  
13/4/2020

**Subject:** Directions under section 33 A of the Water (Prevention & Control of Pollution) Act, 1974

Whereas MP Pollution Control Board is a statutory body constituted under section 4 of the Water (Prevention & Control of Pollution) Act, 1974 and entrusted with powers to enforce the statute for the control of water pollution and maintain and restore the wholesomeness of water;

Whereas you are operating a Thermal Power Plant for the generation of the electricity @ 3960 MWh at village Siddhikhurd, Distt. Singrauli, Madhya Pradesh;

Whereas you were given permission by the Board as per the provisions of the Fly ash Notification, 1999 as amended up to date vide letter no. 1251/tech-CE-II dated 13-02-2018, for the filling and reclamation of the C1 compartment of the low lying area in the industry premises admeasuring 6.09 hectares with fly ash, by filling of ash in dry form and compacting it with rollers and covering with soil layers along with other conditions as incorporated in that permission;

Whereas industry started filling the low lying area with fly ash in the slurry form which was found to be a violation of the conditions of permission and therefore a show cause notice was given to the industry vide letter dated 30-3-19 indicating the violation being done by the industry along with suitable warning;

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Whereas despite the above show cause notice and subsequent legally binding conditions of consent issued to the industry from time to time, that the filling of low lying area inside the premises shall be under taken strictly in accordance with the consent / permission granted by MPPCB, the industry has willfully & knowingly failed to comply ;

Whereas it has been found in the recent inspection dated 12/04/2020 by the team of officers of the Board, that the industry has constructed bund wall above the general ground level and has been using the bund wall for the retention of the fly ash slurry being pumped in that area. It has also been observed that the industry has not restricted the disposal to fly ash slurry in an area of 6.09 hectares of the C1 compartment, but has started disposing it in a larger area, that too above the ground level. Thus in the garb of reclaiming of low lying area with fly ash, industry has started using the area as an ash bund/ dyke / pond for the disposal of fly ash slurry above the general ground level, which is strictly in contravention of the permission and consent conditions granted by the Board;

Whereas on 10-04-2020, due to the above violations done by industry and due to indiscriminate and uncontrolled discharge of the ash slurry against the conditions of the permission of low lying area filling and against the conditions of consent, the breakage of illegally constructed bund wall took place resulting in overflow of the fly ash slurry which has caused damage to the environment, agriculture, property, and lives of humans and cattle. A large quantity of fly ash flown is suspected to reach Govind Vallabh Pant reservoir thereby affecting the water quality, tank capacity and the life of aquatic flora and fauna is also at stake;

Therefore looking into grave danger to the environment, life and property that has been caused by the industry, under the powers vested with the Board under section 33A of the Water (prevention & Control of Pollution) Act, 1974 , you are hereby directed to comply with the following immediately:

- 1. That the industry shall take up the repair and restoration works immediately in a technically sound manner, preventing any further flow of ash and water from the low lying area in question,*
- 2. That the industry shall remove the fly ash spread, deposited & lying in the premises and adjoining area, outside the low lying area, in agriculture fields, villages and in and along the natural water bodies so that it does not reach Rihand reservoir and causes its siltation and pollution and dispose it in an environmentally safe manner,*
- 3. Depute an institute of national repute to assess the quantum of environmental damages caused due to the breakage and flow of fly ash outside the low lying area and industry premises in the adjoining area, agriculture fields, villages, and in and along the natural water bodies including Rihand reservoir,*

4. Deposit with MPPCB a sum of Rupees 10 Crore towards interim environmental compensation, pending the assessment of actual damages.

5. Submit a time bound action plan for remediation and restoration of the village, fields, rivers, nallahs, reservoir and other affected areas.

6. Depute an Institute of national repute to assess the design and structural safety of the ash dyke of the industry situated near village Horrhowa, including its adequacy of engineering and constructional quality, its safe ash handling and disposal capacity, along with measures if any to improve it to avert any incident of its breach, leakage, seepage, and Emergency Preparedness Requirements and Environmental Management Plan to avert and handle such incidences in future.

In case of failure to comply with the above directions within 15 days, in exercise of the powers conferred upon under section 33A of the Water (Prevention & Control of Pollution) Act, 1974, further directions shall be issued to you which could be as follows:

1. That the industry, shall be closed down hence forthwith and shall not restart the production till further orders,
2. That the concerned authorities shall disconnect the water supply, electricity supply and other facilities available to the industry with immediate effect.

You are hereby given an opportunity to comply with the urgent remediation measures as directed herein above within 15 days from the date of issue of this notice and file genuine submissions, if any. In case no compliance report or unsatisfactory compliance is received within the stipulated period, the proposed closure directions shall be confirmed without any further communication to the industry and action inter-alia under section 41 of the Water (Prevention & Control of Pollution) Act, 1974 shall be initiated against all the persons having control over the industry.

Please be informed that the Board keeps its rights and authority reserved for issuing any other directives as and when deemed necessary.

For & on Behalf of MP Pollution Control Board

*RS*  
13.11.2020  
(RS Kori)  
Member Secretary

✓ Endt. No. 24 / MPPCB/MS/TS Singrauli/ 2020

Bhopal, Dated: 13.11.2020

Copy to:

1. Principal Secretary, Environment Department, Government of MP for information. please
2. Collector Singrauli for information & necessary action please.
3. Regional officer MP Pollution Control Board, Singrauli for information & necessary action please. Kindly keep a close vigil on the situation and remedial actions being undertaken by the industry and report the same with recommendations from time to time.

  
13/11/2020  
(RS Kori)  
Member Secretary

  
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## ANNEXURE R-6

**Sasan Power Limited**

CIN: U40102MH2008PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Thara  
 Singrauli-485 886  
 Madhya Pradesh, INDIA  
[www.reliancepower.co.in](http://www.reliancepower.co.in)

SPL/ 2020-21/ 23

Date: 28.05.2020

**The Member Secretary**

Madhya Pradesh Pollution Control Board (MPPCB)  
 Paryavaran Parisar,  
 Bhopal,  
 Madhya Pradesh

**Subject:** Progress Report with respect to compliance of the various directions, permissions and notices issued by MPPCB's Head Office and Singrauli Regional Office to Sasan Power regarding restoration work post break in retention wall of the low lying ash utilization area inside plant premises dated 10<sup>th</sup> April 2020

**Ref:** Letter no. 1365/RO/MPPCB/2020 dated 21/05/2020 issued by Regional Office, MPPCB.

Respected Sir,

This has reference to the letter referred herein above and pursuant to the directions in the said letter; we are hereby submitting the progress report to your good office with a copy to Singrauli Regional office, as desired.

The brief update on the progress made on actions initiated in compliance with the MPPCB's directions in its letter no. D.No.23/MPPCB/MS/TS Singrauli/2020 dated 13<sup>th</sup> April 2020 and letter no. 43/MPPCB/MS/TS Singrauli/2020 dated 28<sup>th</sup> April 2020 is as under:

1. The repair work of the damaged retention wall of low-lying ash utilization area is under progress. All safety protections are being taken to safeguard under-repair retention wall.
2. Till date, we have already provided necessary relief and paid compensation of Rs. 201.98 Lakh to the families of the deceased and affected villagers for damaged houses, crop and household items in accordance with the instructions of the District Administration. Apart from the above, the sustenance allowance to the parents (six persons) of the deceased @ Rs. 47,700/- per month has been started from April 2020.
3. Further, the compensation towards the loss of cattle / poultry farms and other items such as pumps, generators, etc. is being estimated by the District Administration, which is expected to be around Rs. 90 Lakhs. Currently, support is also being provided to the villagers for cattle fodder, however the final compensation for the same is under estimation, which is expected to be in the range of Rs. 25 Lakhs.
4. The restoration of ash spread area is under progress at multiple locations and recovered ash is being transported and filled in an environment-friendly manner at site 'A' around ash pond, for which the permission has been granted by MPPCB. The entire work is expected to get completed by June, 2020 before the start of monsoon.
5. After awarding the Work Order, SPL is following up with National Environmental Engineering Research Institute (NEERI) for their expeditious site visit to assess the environmental impact.


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## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi khurd  
 Post Office: Tiyara  
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 Madhya Pradesh, INDIA  
[www.sasancepower.co.in](http://www.sasancepower.co.in)

6. Continuous follow up is being done with IIT – BHU to visit the site and kick start their ash dyke stability study.
7. We would further like to assure that all the activities will be completed as per the timelines submitted in our letter no. SPL/2020-21/19 dated 08.05.2020.
8. As conveyed earlier in our letter no. SPL/2020-21/03 dated 21<sup>st</sup> April 2020, Sasan Power, which supplies the cheapest thermal power in the country (Levelized tariff over 25-year PPA: Rs. 1.196 / kWh) at the highest reliability levels in the country (~96% PLF in FY'20), is indeed faced with a grave liquidity condition, which has been further aggravated by the sharp reduction in collections from Discoms in the wake of COVID-19 situation. Sasan Power is facing a real threat in sustaining its operations of power plant and captive coal mine. Sir, given that we have already paid compensation of more than Rs. 2.0 Crore as highlighted in para 2 above; given severe liquidity challenges and financial stress being faced by Sasan, we have deposited Rs. 2.0 Crore towards interim environmental compensation to the account of MPPCB Account No. 6310001200000043 (Member Secretary MPPCB Environment Protection Fund) of Punjab National Bank vide UTR no. SBINR52020052600141772 dated 26.05.2020. Final environmental compensation may please be addressed on submission of the final report by NEERI.

We express our deep sense of gratitude for your kind support and guidance for sustaining Sasan UMPP's operations that make transformational impact on the economy of the State of Madhya Pradesh, while contributing to the nation-building.

Thanking you

Yours faithfully,

For Sasan Power Limited

  
 Anil Kumar Singh  
 (Chief Executive Officer)

- CC: 1. Principal Secretary, Environment Department, GoMP, Bhopal  
 2. Chairman, MP Pollution Control Board, Bhopal  
 3. Director (Environment), MP Pollution Control Board, Bhopal  
 4. Regional Officer, MP Pollution Control Board, Singrauli  
 5. Collector Singrauli, District Singrauli

  
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**ANNEXURE R-7**

Item Nos. 03

Court No. 1

**BEFORE THE NATIONAL GREEN TRIBUNAL  
PRINCIPAL BENCH, NEW DELHI**

(By Video Conferencing)

Original Application No. 164/2018  
(Earlier O.A.No.276/2013)

(With report dated 28.02.2020)

Ashwani Kumar Dubey

Applicant(s)

Versus

Union of India &amp; Ors.

Respondent(s)

Date of hearing: 14.07.2020

**CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON  
HON'BLE MR. JUSTICE S. P. WANGDI, JUDICIAL MEMBER  
HON'BLE DR. SATYAWAN SINGH GARBYAL, EXPERT MEMBER  
HON'BLE DR. NAGIN NANDA, EXPERT MEMBER**

Applicant(s): Mr. Pankaj Sharma, Advocate

Respondent(s): Mr. K.M Nataraj, ASG with Mr. Sailesh Madiyal, Advocate  
for R-10  
Mr. Sanjay Jain, ASG with Mr. Nikhil Kandpal, Advocate  
for R-19  
Mr. Rajat Jariwal, Advocate for R-17  
Mr. Raj Kumar, Advocate for CPCB  
Mr. Daleep Dhyani, Advocate for UPPCB**ORDER**

1. The order is being passed in continuation of order dated 05.11.2019. The issue for consideration is remedial action against pollution and violation of environmental norms by Thermal Power Stations operating in Singrauli and Sonebhadra Districts of Madhya Pradesh and Uttar Pradesh respectively, resulting inter-alia in air pollution, water contamination and large scale of damage to public health. The areas figure in the list of polluted industrial clusters based


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on comprehensive environment pollution index, prepared by the CPCB as per available data of pollution

2. After considering the report of the joint Committee, constituted by the Tribunal, to the effect that damage to environment was being caused by the thermal power stations in Singrauli and Sonebhadra in M.P/U.P and that water bodies, including the Rihand Reservoir (main source of supply of drinking water in the area) were adversely affected, the Tribunal directed remedial action and also constituted an oversight committee (OC) headed by Justice, Rajesh Kumar, former Judge of the Allahabad High Court.

3. The Committee gave its reports about the status of compliance upon which the Tribunal passed further orders. The reports considered by this Tribunal include reports dated 14.12.2018 (I<sup>st</sup> report), 28.06.2019 (II<sup>nd</sup> report), 21.08.2019 & 23.08.2019 (III<sup>rd</sup> report) and 29.10.2019 (IV<sup>th</sup> Report). The IV<sup>th</sup> report pointed out **damage to the Rihand Reservoir on account of breach of fly ash dykes of Essar Power and NTPC on 07.08.2019 and 06.10.2019 respectively**. Slurry travelled upto the reservoir giving rise to emergent situation. The concerned plants were required to take suitable remedial measures by the Committee.

4. In the earlier orders, the Tribunal directed consideration of recommendations of the Committee and appropriate further action, adopting appropriate safeguards. The Tribunal also directed the CPCB to have an action plan prepared by the power plants for de-silting of the reservoir and improvement of the dykes. The issue of recovery of compensation was deferred to the extent that there was stay by the Hon'ble Supreme Court. The term of Committee headed by Justice

Rajesh Kumar was initially for six months but was extended till 31.12.2019. The NTPC and Essar power were directed to initiate steps for restoration of their respective ash dykes by 31.12.2019.

5. In pursuance of the above, we have considered the matter further in the light of following:-

- I) Report of Justice Rajesh Kumar dated 20.12.2019
- II) Report of the CPCB dated 28.02.2020
- III) Objections to the report by the Vindhyachal Super Thermal Power Station, R-10
- IV) Comments to the observations of the OC report dated 20.12.2019 by the UPVUN.

6. Report dated 20.12.2019 by the OC is based on the minutes of meeting held on 17.12.2019 which record the status report furnished by the concerned power plants. With regard to the NTPC, the Committee observed that on account of the breach of its ash dyke, the fly ash travelled up to the reservoir for which interim compensation of Rs. 10 Crore was liable to be deposited. NTPC was also required to take remedial measures. UPVUN was also found to be liable as follows:

***“ On the spot inspection, the Committee found that a large portion of Ash Dyke had been breached with the result huge quantity of fly ash had spread all over the land. It has travelled up to the Rihand reservoir. Prima facie, the interim environmental compensation demanded by the MPPCB at Rs. 10.00 Crore cannot be said to be excessive. The said amount ought to be deposited. We are of the view that the furnishing of bank guarantee of Rs. 1.00 Crore is not sufficient. MPPCB may issue the notice asking the Plant to deposit the entire Rs. 10.00 Crore. Bank guarantee cannot be said to be deposit, it can only be treated as the security.***

***The committee is of the view that to strengthen the ash dyke the plant should consider to develop RCC wall around the fly ash dyke. The structure should be of RCC having a layer of PVC,***

tiles to ensure the stability of the dyke. At present the dyke is being made out of the fly ash putting boulder pitching outside wall and brick lining inside the dyke. The storage of fly ash is very important aspect in the context of Environment. Improper storage of fly ash results in air pollution and water pollution affecting the Environment

In the last meeting we have asked the thermal power plants to explore the possibility of developing the fly ash mount as has been developed by NTPC Dadri. Neither any interest has been shown in this regard nor any step has been taken to develop the fly ash mount. In the face of status stated above, we direct NTPC-Vindhyachal to be very sincere and implement the directions given by the committee and by the Hon'ble NGT in a shorter time.

Committee directs the MPPCB to assess the Environment Compensation finally within one month. Plant is also directed to give the status report time to time, preferably within 15 days each time.

UPVUN, Anpara:

On the information being received from the various sector that there is a continuous flow of the water carrying fly ash from two sides towards Rihand Reservoir since last more than one year. On 15.12.2019 night at about 6:30 PM committee visited the spot and found that the information given is true. There is continuous flow of water coming from plant along with the fly ash filling in Rihand Reservoir. On a query being made that why this is happening, Shri Pradhul Gupta, Senior Engineer states that this flow is not continuous, it is mainly during the rainy season and this happened because of fulfilment of the ash dyke therefore the water is overflowing. It also carries catchment water. It is stated that they are raising the height of the dyke which may likely to take one year at least. He further submitted that they are also developing another compartment which may likely to take six months and they are also making effort to divert the nala which carries natural water to reduce the quantity of water.

We do not find explanation satisfactory. The fact is that the water carrying fly ash are continuously flowing towards the Rihand Reservoir, the volume of the flowing water is very high and it carries fly ash, it is continuous since last more than one year. Discharge of fly ash to the Rihand Reservoir pollutes the water of reservoir which is the only source of water of the area. We find that the information about the flow of huge water along with fly ash had not been conveyed to SPCB authorities and they have deliberately concealed the facts. It is mentioned here that these two areas are in a very interior and we have to reach these places after travelling about 18 KM kaccha road through forest. Act of pollution amounts to violation of various laws and polluter is liable to be punished. The committee is of the view that since the flow of water along with fly ash is continuous, and there is

**no possibility for its immediate stoppage. The only way to stop the flow is to close operation of the unit and their unit is liable to be closed until they make arrangements and ensure that no water with ashes may go to the Rihand Reservoir. The committee is also of the view that they are liable for the environment compensation as well as cost of desilting of the ashes from the reservoir on the principle of polluter pay. The UPPCB is directed to assess environmental compensation and take all stringent actions under the provision provided in the various Acts.”**

7. Report of the CPCB is on the issue of de-silting and restoration of Rihand Reservoir. It refers to pre-existing guidelines of CPCB on **ash disposal in mounds and backfilling of ash in abandoned mines**. With regard to the cost apportionment for de-silting/restoration of Rihand Reservoir, The CPCB has concluded as follows:

*“In absence of verified records in these respects, an assessment of contribution of each plant by this approach is difficult. Therefore, **the contribution of each power plant might also be revealed by the proposed study to assess sediment volume at various places in the reservoir.***

*To begin with, the total ash slurry volume generated by each plant on the periphery of Rihand reservoir can be considered as the basis of sharing of the cost of the study to assess sediment volume at various places in the reservoir. For this purpose, the information on annual power generation and coal consumption, average ash content, and annual ash generation as well as annual ash slurry generation based on ash to water ratio power plants and collated (Annexure-III). **Total ash quantity and ash slurry volume generated over the years by individual thermal power plants located on the periphery of Rihand reservoir on the basis of information collected is presented below:***

Table 1

Thermal Power Plant	Capacity (MW)	Total ash disposed in Ash Pond till 31.03.2019 (MMT)	Total ash slurry disposed in Ash Pond till 31.03.2019 (MMT)	Relative share in total Ash of plants (multiple of least)	Relative share in total Ash Slurry of plants (multiple of least)	Share in total Ash of plants (% of total)	Share in total Ash Slurry of plants (% of total)
Anpara TPS UPRVUNL	2630	81.313	569.225	31.7	66.3	22.9%	19.6%
Lanco Anpara	1200	10.870	46.395	4.2	5.4	3.0%	1.6%
Renusagar, Hindalco	820	2.564	8.584	1	1	0.7%	0.3%
Singrauli NTPC	2000	89.295	803.654	34.8	93.6	25.1%	27.6%
Vindhyachal	4760	104.937	953.855	40.9	111.1	29.6%	32.8%

<i>NTPC</i>							
<i>Rihand NTPC</i>	3000	66.136	529.008	25.8	61.6	18.6%	18.2%
<i>Total combined</i>	12610	355.115	2910.801	138.4	339	100%	100%

***It is submitted that*** U.P. Irrigation Department may be directed to coordinate the study to assess sediment volume at various places in the reservoir.

***It is further submitted that*** Anpara TPS and Lanco-Anpara power plants may be directed to stop ash pond overflow discharge into Rihand reservoir.”

8. According to the Vidhyachal Super Thermal Power Station, R-10, the observation of the oversight Committee are completely erroneous and unsubstantiated. Breach was plugged within 30 hours. PFL wall was repaired and it is also incorrect that fly ash transfer to the Reservoir and that the raising of the height was without expert opinion. It is further submitted that compensation of Rs. 10 Crores was not justified. Cash payment of Rs. 1 Crore has been made towards interim compensation. With regard to developing fly ash mound, it is stated that it is not necessary. Comments of the UPVUN are that necessary action has been taken which may be verified. There is zero discharge from the ash dyke. Reference has also been made to the inspection report by the joint Committee of the CPCB and the State PCB recommending as follows:

**“Recommendations**

1. *M/s NTPC Shaktinagar to repair the AWRS desloped pipeline within 07 days & to stop discharge of decant water of S1 & S2 dyke immediately by pumping in M/s NTPC Vindh Nagar AWRS 03 system immediately.*
2. ***M/s NTPC Vindh Nagar shall collect back the spread over ash from 53 Ha area with minimal fugitive emission & dispose it in operating dyke. Unit shall submit the time bound action plan in this regard.***
3. ***M/s NTPC Vindh Nagar to stop the probable mixing of slurry in Rihand reservoir & Surya drain near decanting pond with no further delay.***

4. *M/s NTPC Vindhya Nagar may be asked to deposit 01 Crore to CPCB or MPPCB towards an interim environmental compensation w.r.t Aryavart Foundation v. M/s Vapi Green Enviro Ltd & Ors. Hon'ble NGT O.A 95/2018 order dated 11.1.2019"*

9. We have duly considered the stand of the NTPC- Vidhyachal Super Thermal Power Station as well as the UPUVN. Mere self-serving denial in the face of report based on site visit by a Committee appointed by this Court headed by a former judge of the High Court has no legs to stand. Responsible organisations should refrain from adopting such attitude. We uphold the report of the OC. We also note that the Tribunal has been considering the issue of compliance of Notification dated 31.12.2018 issued by the MoEF&CC requiring 100% utilization of fly ash vide order dated 12.02.2020 in *Original Application No.117/2014, Shantanu Sharma v. Union of India & Ors.* In the said order, following directions were issued:-

*"32. Thus, our directions are as follows:-*

- a. The TPPs may take prompt steps for scientific disposal of fly ash in accordance with the statutory notification issued by the MoEF&CC under the provisions of EP Act requiring 100% utilization and disposal of fly ash.***
- b. For the non-compliant TPPs, environmental compensation needs to be determined w.e.f. the cut-off date of 31.12.2017 as stipulated in the Notification dated 27.01.2016.*
- c. CPCB may accordingly compute and levy Environmental Compensation in accordance with the formula referred to above w.r.t. individual TPPs in accordance with law and submit compliance report to this Tribunal before the next date.***
- d. CPCB Guidelines of May 2019 for Utilization/Disposal of Fly ash for Reclamation of Low Lying Areas and in Stowing/Back filling of Abandoned Mines/Quarries may be complied.***
- e. Task Force of Ministry of Power and Ministry of Coal may recommend list of abandoned mines/quarries for mine back filling purposes to the CPCB. CPCB may notify the same accordingly for use by the TPPs as per applicable guidelines and permission from State PCBs/PCCs.*

- f. A Committee comprising of CPCB and IIT Roorkee may assess the environmental damage with regard to the breach sites at Vidhyanchal TPP an Essar TPP in Singrauli area and submit its recommendation within three months. CPCB shall be at liberty to engage any other technical expert for this purpose.**
- g. The Committee comprising of Collector, CPCB and Member Secretary of MP State Pollution Control Board may assess the damage with regard to the breach sites at Vidhyanchal TPP and Essar TPP in Singrauli area to the crop and agricultural productivity and ensure effective restoration/remediation of affective sites within three months.
- h. CPCB may ensure implementation of action plans approved by it in accordance with timeline as provided in the statute.
- i. A joint Committee comprising of MoEF&CC, CPCB, IIT Roorkee and any other member considered necessary may submit quarterly progress report on recommendations of Expert Committee of Niti Aayog for enhanced utilization of fly ash in various sectors: mines, roads, cement, industries and bricks etc., along with its implementation status.
- j. The present order is subject to proceedings pending before the Hon'ble Supreme Court and where stay is operative, this order will not operate till stay continues and thereafter abide by orders of Hon'ble Supreme Court.

*Copy of this order may be conveyed to MoEF&CC, Ministry of Power, Ministry of Coal, CPCB, IIT Roorkee and MP State Pollution Control Board. CPCB may put the order on its website and communicate the same to all concerned TPPs."*

10. In view of the above, we direct:
- i. Fly ash disposal may be undertaken as per the directions in the order of this Tribunal dated 12.02.2020 referred to above.
  - ii. Fly ash disposal in mounds and backfilling of ash in abandoned mines may be undertaken as per the CPCB guidelines If necessary, Indian Bureau of Mines, Dhanbad may also be consulted so that latest technology is utilized and all necessary safeguards are adopted.

- iii. Report of the CPCB regarding Cost apportionment for de-silting/restoration of Rihand Reservoir is accepted and further steps, including further study be undertaken as recommended by the CPCB. The U.P Irrigation Department may coordinate such study.
  - iv. Anpara TPS and Lanco-Anpara power plants may stop ash pond overflow discharge into Rihand Reservoir to the extent the work remains unexecuted.
  - v. The NTPC, Vidhyachal may deposit amount of Rs. 10 Crores as recommended by the Oversight Committee with the State PCB towards interim compensation, deducting the amount already deposited. The plant may also develop RCC wall around the plant in the matter recommended.
  - vi. The liability for environmental compensation in respect of UPVUN, Anpara and NTPC Vidhyachal may be assessed by joint Committee of CPCB and the State PCB within two months. The nodal agency will be the State PCB for coordination and compliance.
  - vii. The transportation measures may be adopted as per suggestions of the Committee and directions of the Hon'ble Supreme Court.
11. Since the term of the Committee has expired, further oversight work may be undertaken by a joint Committee of the CPCB with respective State PCB and the District Magistrates. The State PCBs will be the nodal agency for the respective States.

12. The newly constituted OC may furnish its reports quarterly by e-mail at [judicial-ngt@gov.in](mailto:judicial-ngt@gov.in) preferably in the form of searchable PDF/OCR Support PDF and not in the form of Image PDF. First such report may be furnished giving status as on 31.10.2020 by 15.11.2020 with copies to concerned stake holders for their response if any by 30.11.2020.

A copy of this order be sent to the State PCBs, CPCB, concerned District Magistrates, Indian Bureau of Mines, Dhanbad by email for compliance.

List for further consideration on 02.12.2020.

Adarsh Kumar Goel, CP

S. P. Wangdi, JM

Dr. Satyawan Singh Garbyal, EM

Dr. Nagin Nanda, EM

July 14, 2020  
Original Application No. 164/2018  
(Earlier O.A.No.276/2013)  
AK



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## ANNEXURE R-8


**MADHYA PRADESH POLLUTION CONTROL BOARD**

Paryawaran Parisar, E-5, Arera Colony, BHOPAL - 462 016

 ☎ (0755) 2464428, 2466191 Fax: (0755) 2463742 e-mail: [mppcb@nsiffmail.com](mailto:mppcb@nsiffmail.com)

D. No. 1464 / MPPCB/CE IV/ 2020

Bhopal, Dated: 24-8-2020

To,

- |  |   |
|--|---|
| 1. Anil Ambani<br>Chairman, Reliance Power Ltd.<br>[Holding company of M/s<br>Sasan Power Ltd]<br>Reliance Centre, Ground Floor<br>19, Walchand Hirachand Marg,<br>Ballard Estate, Mumbai 400001 | 2. Satish Seth<br>Director, Reliance Power Ltd.<br>[Holding company of M/s Sasan Power Ltd]<br>Reliance Centre, Ground Floor<br>19, Walchand Hirachand Marg,<br>Ballard Estate, Mumbai 400001 |
| 3. A.K.Singh<br>Chief Executive Officer<br>M/s Sasan Power Ltd.<br>Post:- Tiyara<br>Distt: Singrauli (MP) - 486886   | 4. Sachin Mohapatra (Occupier),<br>Senior Vice President & Station Director,<br>M/s Sasan Power Ltd.,<br>Post Tiyara<br>Distt: Singrauli (MP)- 486886   |

**Subject:** Compliance of Directions u/s 33 of the Water Act, 1974 and order passed by Hon'ble NGT in OA 164 /2018 Ashwani Kumar Duboy vs. Union of India and ors. on 14-07-2020

**Reference:** 1. This Office letter no 23/ MPPCB/TS Singrauli/2020, Bhopal dated 13-04-2020  
 2. Environmental Compensation of Rs 2.0 Cr deposited by the industry on 26-05-2020

**1 A.** With reference to the above subject, vide order dated 13-04-2020 the industry was directed to deposit a sum of Rs 10 Cr. towards interim environmental compensation pending the actual assessment of the environmental damages caused due to the breach on 10-04-2020 of illegal ash dyke created by industry causing damage to the environment and taking lives of 6 citizens, cattle, agriculture and property. However the industry has deposited a sum of Rs 2.0 Cr. only on 26-05-2020.

Hon. NGT vide its order dated 14-07-2020 passed in OA 164/2018, has directed that :

*"Para 10 (v): The NTPC, V(n)dhyachal may deposit amount of Rs. 10 Crores as recommended by the Oversight Committee with the State PCB towards interim compensation, deducting the (a)mount already deposited. The plant may also develop RCC wall around the plant in the matter recommended."*

Although in the said order, name of M/s NTPC Vindhyachal has appeared, but the case of ash dyke breach of your industry M/s Sasan Power Ltd is similar to that of NTPC Vindhyachal, whose ash dyke also broke on 06-10-2019. MPPCB has asked for the interim compensation amount of Rs.10 Cr from M/s Sasan Power Ltd against which the industry has deposited only Rs 2 Cr, on 26-05-2020. Thus the principles as applied in the above order by Hon'ble NGT, also apply to M/s Sasan Power Ltd. Therefore in the similar facts & circumstances of ash dyke breach and deposition of interim environmental compensation, M/s Sasan Power Ltd is also liable to deposit the balance amount of Rs. 8.0 Cr (Rs. Eight Crores) to MPPCB.

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In light of the above judgment you are, hereby, directed again to deposit the balance amount of Rs. 8.0 Cr. in the designated account of the MPPCB within 15 days from the issue of this letter. Industry shall also submit a time bound programme for the development of RCC wall around the plant within 1 month's time, as ordered by MPPCB.

1 B. Hon'ble NGT has also directed in Para 10 that:

*"Para 10 (i) Fly ash disposal may be undertaken as per the directions in the order of this Tribunal dated 12.02.2020 referred to above.*

*(ii). Fly ash disposal in mounds and backfilling of ash in abandoned mines may be undertaken as per the CPCB guidelines. If necessary, Indian Bureau of Mines, Dhanbad may also be consulted so that latest technology is utilized and all necessary safeguards are adopted."*

In light of the above directions also you are, therefore, directed to comply with the directions for the disposal of fly ash as well and submit its action plan within 15 days to this office, to ensure compliance of the orders of Hon'ble NGT.

2. In reference to the industry's letter dated SPL/2020-21/16 dated 25-04-2020 pertaining to fly ash filling in low lying areas in slurry form, an opinion was sought from Central Pollution Control Board. The opinion received from CPCB vide its letter dated B-33014/07/2017-18/IPC-II/1200 dated 16-06-2020 is attached herewith as Enclosure 2, which is self explanatory. The industry shall have to abide by the CPCB letter and guidelines while undertaking filling of fly ash in low lying areas. The filling of fly ash in past in slurry formation in area C1-C5 was thus an illegal activity which resulted in fatal accident.

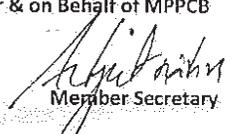
3. In reference to industry letter no SPL/2020-21/31 dated 8-7-2020, please be informed that so far no affidavit as required vide condition no 9 of this office letter dated 08-05-2020 has been submitted to this office. Similarly the industry has also failed to provide any progress report on the fly ash filling in low lying areas near the ash dyke as granted vide letter dated 28-04-2020. Regarding extension of time for completion of tasks directed for completion vide order dated 13-04-2020 and 30-05-2020 it is not permissible in the wake of the ongoing monsoon. Any delay will amount to washing off the deposited fly ash on agriculture fields / banks of nalla etc and industry will be liable to pay environmental damages compensation for the delay, so please be informed.

1. Please report compliance on the issues as mentioned at points 1A, 1 B & 3.

En:1. NGT Order Dated 14-07-2020

2. CPCB letter dated 16-06-2020

For & on Behalf of MPPCB

  
Member Secretary

Endt. No. / MPPCB/CE IV/ 2020  
Copy To:

Bhopal, Dated

1. Regional Officer MP Pollution Control Board, Singrauli for information and necessary action. The industry should be pursued to deposit a balance sum of Rs. 8.0 Cr of interim environmental compensation in the designated account of MPPCB at the earliest.

Member Secretary

  
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**ANNEXURE R-9**

ITEM NO.14 Court 3 (Video Conferencing) SECTION XVII

**S U P R E M E C O U R T O F I N D I A  
RECORD OF PROCEEDINGS**

Civil Appeal No(s). 3087/2020

VINDHYACHAL SUPER THERMAL POWER STATION Appellant(s)

**VERSUS**

ASHWANI KUMAR DUBEY &amp; ORS. Respondent(s)

(IA No.87393/2020-EXEMPTION FROM FILING C/C OF THE IMPUGNED JUDGMENT and IA No.87392/2020-STAY APPLICATION and IA No.87397/2020-EXEMPTION FROM FILING O.T. and IA No.87395/2020-PERMISSION TO FILE LENGTHY LIST OF DATES)

Date : 14-09-2020 This appeal was called on for hearing today.

CORAM :

HON'BLE MR. JUSTICE ROHINTON FALI NARIMAN  
HON'BLE MR. JUSTICE NAVIN SINHA  
HON'BLE MS. JUSTICE INDIRA BANERJEEFor Appellant(s) Mr. Tushar Mehta, S.G.  
Mr. Shailesh Madiyal, AoR  
Mr. Sudhanshu Prakash, Adv.  
Mr. Shailesh Madiyal, AOR

For Respondent(s)

UPON hearing the counsel the Court made the following  
O R D E R

Issue notice.

Having heard Shri Tushar Mehta, learned Solicitor General appearing for the appellant, we are of the view that the demand for a sum of Rs.9,00,00,000/- (Rupees Nine Crores) dated 06.08.2020 should be stayed for the present. However, insofar as construction of the dyke is concerned, we are not inclined to grant any stay.

(CHARANJEET KAUR)  
ASTT. REGISTRAR-cum-PS(R.S. NARAYANAN)  
COURT MASTER (NSH)

Signature Not Verified  
Digitally signed by  
Charanjeet Kaur,  
Date: 2020.09.14  
17:10:45 IST  
Reason:

  
**TRUE COPY**

## ANNEXURE R-10

**Sasan Power Limited**

CN: U40100MH2005PLC190257

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Sakhalikhand  
 Post Office: Thane  
 Singrauli - 480 001  
 Madhya Pradesh, India  
 www.sasanpower.co.in

No.: SPL /2020-21/36

09<sup>th</sup> September, 2020

**The Member Secretary**  
 Madhya Pradesh Pollution Control Board (MPPCB)  
 Paryavaran Parisar, Sector E-5, Arera Colony  
 Bhopal-462016  
 Madhya Pradesh

Ref: Letter from the office of your goodself vide no. 1464/MPPCB/CE IV/2020, dated 24.08.2020, received by post on 04.09.2020.

Respected Sir,

We are in receipt of your letter no. 1464/MPPCB/CEIV/2020 dated 24.08.2020, which is received by us through post on 04.09.2020. As you are kindly aware, Sasan Power Limited (SPL) has been sending the progress report on restoration works, payment of compensation and compliance of various directions of MPPCB, from time to time. The undersigned also apprised your goodself on the progress made in this regard during our meeting on 07.09.2020 and 08.09.2020. SPL's point-wise response / respectful submissions to the said letter are as follows:

- A. The Hon'ble NGT vide its order dated 14.07.2020 passed in OA 164/2018 has directed M/s NTPC, Vindhyachal to deposit Rs. 10 Cr towards Interim Compensation for the breach of their ash dyke. Ash dyke breach case of Sasan Power Limited is similar to that of NTPC Vindhyachal. Hence, the company is directed to deposit the balance Interim Environmental Compensation of Rs. 8.0 Crs after factoring Rs 2 Cr already paid

SPL's submission:

1. We would like to respectfully submit that in case of NTPC, Vindhyachal, there has been a breach of ash dyke. However, in case of Sasan Power Limited (SPL), the damage has happened in the retention wall of the low-lying area located within the plant premises. It is submitted that the ash dyke of SPL is totally safe and the same has been confirmed by the IIT-BHU through its report,


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which is already submitted to MPPCB vide SPL's letter dated 20.08.2020. In view of the above it is respectfully submitted that both the situations are not comparable.

2. Further, as per the said NGT order, the Environmental Compensation directed to be paid by NTPC, Vindhyachal power plant is based on the recommendations of the Oversight Committee. However, in case of SPL, no such recommendation has been given by any committee or any other legal authority. Hence, it is humbly submitted that the said NGT order is plant specific and it would not be appropriate to generalize the same.
3. As directed by MPPCB, we have already engaged National Environmental Engineering Research Institute (NEERI), Nagpur as communicated to you, vide letter dated 21.04.2020, for the assessment of environmental damage caused by the incident that happened in Sasan UMPP. The study report shall comprise of the environmental damage and restoration plan, which will be shared with MPPCB and at the same time the remediation & restoration plan shall be developed and implemented by SPL as a responsible corporate in a stipulated time frame as per the recommendation of the said study report.
4. Further, in our letter dated 21.04.2020, SPL had highlighted liquidity challenges and resultant financial stress due to factors beyond its control. Despite its financial stress, SPL has already paid an interim environmental compensation of Rs. 2 Crore to the MPPCB.
5. In addition to payment of Rs. 2 Crore as an interim environmental compensation, SPL has incurred & committed nearly Rs. 15 Crore towards compensation and restoration works, as brought out in the paragraphs below. **We therefore respectfully submit that Sasan has already incurred nearly Rs. 17 Crore in the context of compensation & restoration works.**
  - a. SPL has paid an amount of Rs. 3.47 Crore towards the compensation for loss of life, crop, cattle, livelihood, households, road construction and medical support as per the directives issued by the district administration. The details of the compensation paid are enclosed as Annexure -1.
  - b. An annuity of Rs. 0.83 Crore will also be incurred towards the payment of sustenance allowance to 6 no. of dependents @ Rs. 7950/- per month per person. The total amount of Rs. 47,700/- per month will be paid to the dependents of the deceased for their lifetime as per Government norms.

- c. It would also be pertinent to mention that as the part of site restoration work, which stands nearly completed, till date, SPL has incurred an amount of approximately Rs. 10 Crore towards the restoration work of Gabaiya nalla, agricultural fields and island 4 as under and has committed nearly Rs. 1 Crore towards completing remaining small portion of restoration work:
- i. Approx. 2.1 Lac Ton of ash from nalla has already been lifted. Cleaning of remaining ash, deposited on the sides of the nalla (approx. 0.2 Lac Ton) remaining in very few patches is already under progress.
  - ii. Further, around 1.5 Lac Ton (approx. 94%) ash from agricultural or other land areas has also been cleared. Lifting of remaining ash of approx. 0.1 Lac Ton from few of the agricultural fields is hampered because of the resistance from land owners owing to their internal family conflicts. We are discussing the same with the district administration for expeditious resolution of these issues to enable us to clean these patches expeditiously. We are very happy to mention that farmers have already grown paddy in their agricultural fields and the condition of the crop growth is also very good.
  - iii. We have excavated and lifted 6.0 Lac Ton of leftover ash from island - 4 inside the plant boundary. The collected ash has been used in strengthening of the retaining wall of island - 3 low-lying area, used around permanent ash pond in accordance with the MPPCB approval dated 28.04.2020.
  - iv. Restoration of leftover area of approx. 5-6% would be completed by 30.09.2020 and expected additional expenditure is approx. Rs. 1 Crore.
6. The photographs showing the status of site restoration work as mentioned in the previous para are attached in Annexure - 2
7. We are also in touch with a NABL (National Accreditation Board for Testing and Calibration Laboratories) accredited reputed agency named M/s. GreenC for independent assessment of site restoration work completion. Agency representative will be visiting the site very soon for an on-ground assessment. The report from the agency is expected by the end of the month.

8. It is further submitted that NEERI, Nagpur has already informed that they will be commencing their damage assessment study very soon. Based on the study report by NEERI, additional requirements, if any, will be addressed by SPL in the right earnestness.

9. Hence, in view of the above respectful submissions, we, most humbly, request your good office not to insist for the payment of the balance interim environmental compensation till the report from NEERI is submitted.

**B. Submit time bound action plan for the construction of RCC wall around the plant boundary**

**SPL's submission:**

1. With regard to the construction of RCC wall around our power plant, we would like to reiterate that the clause related to the construction of RCC wall around the plant by NGT is specific to NTPC, Vindhyachal only and hence may please not be generalized.
2. As far as directive issued by MPPCB for construction of RCC retaining wall in C5 compartment, SPL would like to place on record that this low lying area has been fully cleared of remaining ash and additional soil cover has been provided in this area.
3. Hence, Sasan UMPP is not going to use this area for any ash utilization in any mode considering the risk involved due to increased water table in the area.
4. We would like to further submit that for safe passage of water from the four aquifers because of high water table and rain, two culverts have already been constructed.
5. In view of above, you will kindly appreciate that there is no need of any RCC wall construction and any other kind of retention structure for C5 compartment.

**C. Action plan for compliance of the Hon'ble NGT order for the disposal of fly ash:**

**SPL's submission:**

1. It is submitted that most of the coal mines of M/s. NCL which are in vicinity of Sasan UMPP and also Moher & Moher-Amlohri Extension Opencast captive coal mine of SPL are in operation. As you may be kindly aware, the Gorbil mines of the NCL, which is the only abandoned mine in the vicinity, has already been allocated to NTPC for ash filling.

2. However, in order to have long-term sustainable plan to utilize the 100% ash from Sasan UMPP, SPL is exploring the possibility of taking fly ash to its operating Moher and Moher Amlohri Extension opencast captive coal mines, located at a distance of approx. 25 Kms, through pipeline in high concentration slurry mode for mixing with over burden for filling of de-coaled areas, which has now been permitted pursuant to MoEF&CC notification dated 21<sup>st</sup> May 2020. SPL intends to undertake the same in right earnestness after completing requisite studies and obtaining due approvals.
3. SPL has submitted the detailed action plan for achieving 100% utilization of fly ash to MoEF&CC on 28.08.2020 and the same is attached herewith as Annexure - 3.

**D. Filling of fly ash in past in slurry formation in area C1-C5 was illegal activity which resulted in fatal accident.**

**SPL's submission:**

1. As already submitted through our previous communications, facts in connection with the unfortunate incident of breach of retention wall of low-lying area are as follows:
  - i. SPL has carried out filling and reclamation of the low-lying area within the power plant premises in compliance with the stipulations under the permission granted to us by your esteemed office dated 13.02.2018.
  - ii. In this regard we would like to refer to our below mentioned submissions made through our earlier communication dated 22.04.2019 to your good office in response to your show cause notice dated 30.03.2019.
    - a. As per the guidelines mentioned in the permission issued by your esteemed office, the ash was to be transported by road with minimum moisture of 15% and at the time of compaction, a moisture content of 38~40% was to be maintained. However with 40% water content, the ash thoroughly becomes slurry of low concentration resulting into flowable liquid. So instead of taking fly ash with 15% moisture by road, which would have otherwise caused severe air pollution, and subsequently mixing water to bring it to a moisture level of 40% (which is not compactable), we introduced a scientific method of dumping high concentration slurry ash with 25~30% moisture, which after segregation of water forms a much better hydraulically compacted-base and this was a better methodology compared to the process mentioned under the permission.

- b. The high concentration slurry ash for filling in low-lying area could be achieved by slightly modifying the equipment available in the ash disposal system of the power plant.
  - c. The ash was not filled in a slurry form but in the form of a dense mixture of 70-75% ash and 30-25% moisture. This was done to prevent fugitive emission of dust during transportation by road. Indeed, no fugitive emission from low-lying area was observed even though the mixture used to get dried up within two days. This method was found to be highly effective in preventing dust emission.
  - d. Competent authorities from different departments of the government, including RO of MPPCB, Singrauli have been visiting Sasan UMPP from time to time and inspected the low-lying area used for ash filling. In the inspection report, while granting CTO for the FY 2019-20 and FY 2020-21, RO, Singrauli has clearly mentioned that the ash is discharged in this area in slurry mode and CTO was granted for both the Financial Years. SPL has also been reporting to MPPCB about the quantum of ash utilization by this method from time to time.
2. Therefore, in our respectful submission, the filling of ash in HCSD mode was already under the knowledge of MPPCB and hence it would not be appropriate to term it as 'illegal'.
  3. We had filled ash in C1 to C4 compartment in high concentration mode and they are in highly compacted dry state. The same had been inspected by the committee formed by Hon'ble NGT comprising the representatives from MPPCB, CPCB, MoEF&CC and the District Administration. Team members of Magisterial Enquiry Committee also visited the site and they made a specific mention of the high compaction property of the discharged ash in the form of HSCD.
  4. It is further respectfully submitted that the breach of retention wall of low-lying area was not because of the filling of ash in High Concentration Slurry Disposal (HCSD) mode. However, the same was due to the increase in water table in this low-lying area, because of construction of a water reservoir (check dam) for rainwater harvesting outside the power plant boundary, nearer to low-lying ash utilization area, by village panchayat before the onset of monsoon in 2019. After the construction of the water reservoir, there was substantial rise in water table in the surrounding area. After failure of retaining wall, it has been observed that

there is a continuous flow of underground water from four sources within the C5 compartment. This was not visible at the time of start of ash dumping in March, 2019. The underground water sources got charged after rise of water table in that area and the accumulation of underground water created huge hydrostatic pressure on the retention wall of the low-lying ash utilization area, making it weak at the bottom.

5. On the day of the unfortunate incident, the poclain which was working for raising the height of the retention wall met with an accident and while falling down along the outer slope of the retention wall, the operator damaged the retention wall with its bucket. This damage of the retention wall in combination with the hydrostatic pressure resulted into the unfortunate incident.
6. In order to ascertain the reason of damage of retention wall of ash utilization site, a work was awarded to IIT-BHU. As per the report submitted by IIT BHU on 17.6.2020 after its site visit on 13.6.2020, the reason of retention wall failure is as under:  
*"The failure of embankment was definitely initiated by slippage of Poclain. However the subsequent extent of damage of the bund was due to severe hydrostatic pressure on the upstream of the embankment. Through this damaged portion, dilute slurry started flowing leading to complete cutting of the retention wall. Accumulation of huge underground water had resulted into heavy flow of ash slurry causing serious consequences in the villages."*
7. In the final report, submitted by the Magisterial Committee set up by the District Collector for investigating the said incident, it has been clearly mentioned that accumulation of underground water opposite to the location of high concentration slurry discharge has resulted into the damage of retention wall created by SPL.
8. It is pertinent to mention that CPCB, vide e-mail dated 21.08.2020, acknowledged the increase in ground water level due to construction of pond outside the boundary of Sasan UMPP. Accordingly directed SPL to follow up with agencies who have created the said pond and further advised SPL to plan a solution to prevent ground water travel towards ash dump sites. A copy of the said email is attached as Annexure - 4.

9. Therefore, in our respectful submission, ash discharge in high concentration mode is not the reason for breach of retention wall of low-lying area. On the contrary, it is a better method of hydraulically compacting ash and a compaction value in excess of 100% in Procter scale can be achieved easily, which is not possible by standard mechanically compacted practices.

E. So far no affidavit submitted as required vide condition no. 9 of letter dated 08-05-2020

**SPL's submission:**

It is submitted that the copy of the said affidavit was already e-mailed to the office of your goodself and RO, MPPCB, Singrauli, vide our e-mail dated 29.06.2020. However, RO, MPPCB, Singrauli directed us to send the original of this affidavit directly to the Head Office, MPPCB, Bhopal and subsequently, the said affidavit was submitted to your good office by our staff at Bhopal on 07.08.2020. The copy of official receipt from the MPPCB, Bhopal on submission of the affidavit is attached herewith as Annexure - 5.

F. The industry has failed to provide any progress report on fly ash filling in low-lying areas near ash dyke as granted vide letter dated 28.04.2020:

**SPL's submission:**

It is submitted that we are regularly submitting the comprehensive progress report of the site ash restoration work and fly ash filling in low-lying areas near ash dyke (as permitted by MPPCB) to the Regional Office, MPPCB Singrauli and also to the office of your good-self, most recent being the report dated 15-August-2020. Regional and Zonal Officers of MPPCB have been visiting the site regularly and we understand that reports have been submitted by tem to the office of your good-self. Recently, the Committee framed by the Hon'ble NGT, which also included RO, MPPCB Singrauli, had visited the site and after having a complete and comprehensive site inspection, submitted the report to Hon'ble NGT. Further, as mentioned in the foregoing, the undersigned also apprised you of the progress on restoration works and filling of low-lying areas near ash dyke during our meeting on 07.09.2020 and 08.09.2020.

G. Regarding extension of time for completion of task directed for completion vide order dated 13.04.2020 and 30.05.2020:

SPL's submission:

As submitted under response no. 5 to the query A above, SPL has made relentless efforts in clearing 100% ash spread in nearby area and nalla before start of monsoon. However, till date SPL could clear ~ 95% ash and balance ~ 5% ash could not be cleared due to constraints in mobilization of contractors amidst lockdown conditions caused by COVID-19 and heavy monsoon at the onset itself, which made it difficult to access the relevant sites. As you will kindly appreciate these factors are beyond SPL's control. It is submitted that SPL is confident to clear the balance ash by 30.09.2020 and hence we request your good office to kindly reconsider our request and grant extension of time for completion of work till 30.09.2020.

We trust, SPL has clarified the issues raised in the letter under reference. We would like to once again reiterate our commitment to execution & completion of restoration works and ensuring plant operation in an environment friendly and sustainable manner.

Thanking You,

Yours faithfully  
For Sasan Power Limited

  
(Anil Kumar Singh)

Chief Executive Officer – Sasan Power Ltd.

Copy to: Regional office MP Pollution Control Board, Singrauli, Madhya Pradesh.

## Annexure - 1

## 1. Compensation to Families Lost Their Members

SMD	Name of Deceased	Age(Yrs.)	Dependent	Compensation	Amount (Rs. in Lakh)	Remarks
1	Dinesh Kumar Shah S/O Bhabulal Shah	32	Reena Shah (Wife)	One Time Settlement amount-Rs. 10.00 Lakh Employment in Company with monthly Salary Rs. 15000/- Lifelong Monthly Sustenance Allowance @ Rs. 8275/- (Revised every six months as per GoMP Minimum wage guidelines) to: 1. Mother Sudani W/O Bhabulal Sahu (67 yrs) 2. Father Sh. Bhabulal Shah S/O Anantram Shah (68 Yrs) Cremation Support of Rs. 30,000/-	10	10.3
2	Mitr Ankit S/O Late Dinesh Kumar Shah	3	Reena Shah (Mother)	One Time Settlement amount-Rs. 10.00 Lakh	10	10
3	Choon Kumari Shah W/O Bhayyaram Shah	28	Bhayyaram Shah (husband)	One Time Settlement amount-Rs. 10.00 Lakh	10	
4	Seema D/O Bhayyaram Shah	10	Bhayyaram Shah (Father)	One Time Settlement amount-Rs. 10.00 Lakh	10	
5	Abhishek S/O Bhayyaram Shah	8	Bhayyaram Shah (Father)	One Time Settlement amount-Rs. 10.00 Lakh Cremation Support of Rs. 30,000/-	10	58.5
			Bhayyaram Shah (Father)	Lifelong Monthly Sustenance Allowance @ Rs. 8275/- (Revised every six months as per GoMP Minimum wage guidelines) to:	0.5	

SlNo	Name of Deceased	Age(Yrs.)	Dependent	Compensation	Amount (Rs. in Lakh)	Remarks
6	Rajid Ali S/O Jabbar Ali	29		1. Mother Gobari S/O Rambaran Shahu 48 Yrs. 2. Father Rambaran Shahu S/O Khukuram Shahu (52 Yrs.)		
			Bhayanam Shah (Father)	Permanent Job to Bhayanam Shah		
			Bhayanam Shah (Father)	Compensation of House (Rs. 10.00 Lakh), Household Items (Rs. 10.00 Lakh), property (Rs. 8.00 Lakh)	28	
			Bhayanam Shah (Father)	Constructed House of 5 rooms at Malohar Road (Approx Valuation)	25	25
			Rehina Khazoo (Wife)	One Time Settlement amount- Rs.5.00 Lakh Employment to 1 member through outsourcing based on qualification	5	
				One Time Settlement amount- Rs.5.00 Lakh Lifelong Monthly Subsistence Allowance @ Rs. 8275/- (Revised every six month as per GokhP Minimum wage guidelines) to: 1. Mother Julekha Begum W/O Jabbar Ali (49 Yrs) 2. Father Jabbar Ali S/O Inshas Mohammad (52 Yrs) Support for Cremation Rs. 20000/-	5	21.23
	Jabbar Ali (Father)	Payment to be made to the nominees of worker under workmen compensation act (Amount deposited in Labour court)	0.2			
				Payment to be made to the nominees of worker under workmen compensation act (Amount deposited in Labour court)	11.09	
	Grand Total (Rs. in Lakh)-A.				125.08	125.03

**2. Compensation / Expenses to Affected Villagers as per Direction of District Administration**

SNO	Particulars	Amount (Rs. In Lakh)
<b>A</b>	<b>Crop Compensation</b>	
1	Compensation towards, house damage, crop, household materials to 3 villages of Tehsil Singraul-Ref SDM Letter no 448/RE-3/2020 dtd 21.04.20	79.40
2	Compensation towards, house damage, crop, household materials to 1 village of Tehsil Mecha-Ref SDM Letter no 180/RE-3/2020 dtd 21.04.20	05.67
	<b>Total-A</b>	<b>85.07</b>
<b>B</b>	<b>Cattle, well, motor pump etc Compensation</b>	
1	Compensation for Cattle, Motor, pump, well, poultry farm etc-3 villages of Tehsil Singraul as per the SDM Singraul Letter, 165/SDO/RE-3/2020 dtd. 29.05.2020	70.59
2	Compensation for Cattle, Motor, pump, well, poultry farm etc-1 village of Tehsil Mecha as per the SDM Mecha Letter 541/SDO/RE-1/2020 dtd. 26.05.2020	09.84
	<b>Total-B</b>	<b>80.43</b>
<b>C</b>	<b>Household items, crop etc directly paid by company as per recommendation of panchayat, district admin</b>	
1	Support for Ration/Household items damage to 10 families of Sathi Khurd	1.77
2	Crop compensation to Jhauchi Tola Beiga/Vidhikant families	1.35
	<b>Total-C</b>	<b>3.12</b>
<b>D</b>	<b>Medical treatment expenses</b>	
1	Medical Exp Reema Shah W/O Late Dinash Shah and Golan W/O Rambaharia Shih	2.36
	<b>Total-D</b>	<b>2.36</b>
<b>E</b>	<b>Fooding/ration and maintenance expenses</b>	

SNO	Particulars	Amount (Rs. in Lakh)
1.	Fooding to affected families through our canteen	1.5
2.	Civil and electrical maintenance and repair to main family	1.5
	<b>Total-E *</b>	<b>3.00</b>
F	water provision to cattle and families	
1.	Provision of drum 100 lit to cattle 570 nos drum	3.14
2.	Installation of hand-pump to families affected by accidents (8 nos x Rs.0.80 Lakh)	6.4
3.	Drinking water supply through tanker, test, utensil etc	0.45
	<b>Total-F</b>	<b>7.99</b>
G	Photography/videography expenses	
1.	Photography/Videography BB-1	1.84906
2.	Photography/Videography/Drone damage BB-2	2.76212
	<b>Total-G</b>	<b>4.61118</b>
H	construction of peripheral road and culvert	
1.	Construction of peripheral road and culvert damaged in the accident (approx valuation)	35
	<b>Total-H</b>	<b>35</b>
	<b>Grand Total (A+B+C+D+E+F+G+H)</b>	<b>348.01</b>

Annexure – 2

A. Ash Spread Areas and Restoration Work under Progress (Then)





**B. Dumping of restored ash in low lying area around ash Pond:**



### C. Present Site Condition

1. Low Lying Area (Island – 4): Ash removed and covered with soil leaving a channel for the safe exit of ground / rain water.





**2. Island – 4 drain and Gabaiya nalla co influence up to AWRS Culvert:** All area (nalla and land) cleared and paddy cultivation going on. Some part of ash lifting pending because of internal family conflict of land owners.







3. AWRS Culvert Area: All area (nalla and land) cleared.



4. Gabaiya nalla main culvert area: All area (nalla and land) cleared.





4. Gabaiya nalla main culvert downstream: All area (main nalla area and land) cleared. Cleaning of ash deposited on the side of nalla in very few patches is in progress





5. Gabaiya nalla and Rihand River Confluence point: All area cleared.





Annexure -3

**Sasan Power Limited**

CIN: U40102MH2006PLC192557

6 of 601 MW Sasan Ultra Mega Power Project  
 State: Madhya Pradesh  
 Post Office: Tikari  
 Singrauli - 485 205  
 Madhya Pradesh, INDIA  
 www.sasanpower.co.in

SPL/2020-21/03

Date: 28.08.2020

The Director-(A,)  
 Ministry of Environment, Forests and Climate Change  
 3<sup>rd</sup> Floor, Vayu Block  
 Indira Paryaveeran Bhawan, Jor Bagh Road,  
 New Delhi-110003

Ref: Your letter No. J-13011/15/2006-IA,8 (T) dated 13th July 2020

Kind Attn: Dr. S. Kerketta Director - (A,)

Sir,

This in reference to your letter mentioned under reference above vide which Sasan Power Limited (SPL) is requested to provide a concrete action taken or being taken by the company to achieve 100% fly ash utilization.

SPL is pleased to submit the attached Annexure which provides details of the concrete action taken or being taken by SPL to achieve 100% fly ash utilization for Sasan Ultra Mega Power Project.

We once again express our deep sense of gratitude for your kind support for continuation of operation of the power plant.

Thanking You

Yours faithfully,

For Sasan Power Limited

  
 Anil Kumar Singh  
 (CEO - SPL)

Encl.:

Annexure - Concrete action taken or being taken by SPL to achieve 100% fly ash utilization

CC:

1. The Chairman, Central Pollution Control Board
2. The Dy. Director General of Forests (C), MoEF&CC, Regional Office, Bhopal
3. The Chairman, MP Pollution Control Board, Bhopal

**CONCRETE ACTION TAKEN OR BEING TAKEN BY SASAN POWER LIMITED (SPL) FOR ITS 6 X 660 MW SASAN ULTRA MEGA POWER PROJECT (SUMPP)**

1. It is estimated that going forward, annual ash generation at SUMPP of SPL shall be approx. 51,50,000 Metric Tons (MT) of total ash out of which 80% (41,20,000 MT) shall be fly ash and balance 20% (10,30,000 MT) shall be bottom ash.
2. The above estimate is considering the annual coal consumption of 18.4 million Ton (MT) with ash content in coal as 28%.
3. The ash generation and its utilization for last 3 Financial Years (FY 2017-18 to FY 2019-20) was as under:

Financial Year	Fly Ash Generation (MT)	Fly Ash Utilization (MT)
2017-18	Fly Ash : 41,20,376 Bottom Ash : 10,30,097 Total Ash : 51,50,473	12,21,310
2018-19	Fly Ash : 40,22,186 Bottom Ash : 10,05,547 Total Ash : 50,27,733	14,91,694
2019-20	Fly Ash : 41,96,673 Bottom Ash : 10,48,918 Total Ash : 52,44,591	27,46,403

4. The details of fly ash utilization for FY 2019-20 are as under:

Sr. No.	Ash Utilization Avenue	Fly Ash Utilization (MT)
1	Cement	45,280
2	Fly-ash Bricks	1,294
3	Ready Mix Concrete	880
4	Low Laying Land Filling	26,98,119
5	Others (Cenosphere)	860
	<b>Total</b>	<b>27,46,403</b>

The data shows that filling of low lying area has been the major avenue of ash utilization for Sasan UMPP.

5. SPL has undertaken the following activities to achieve 100% Fly Ash utilization:

- a. Making fly ash available free of cost.
- b. Utilized fly ash in potential low lying area filling within the plant premises after obtaining permission from MP Pollution Control Board.
- c. Post in-principle approval of the transportation cost sharing proposal by Hon'ble Central Electricity Regulatory Commission (CERC) on 13-March-18, SPL initiated the process of entering into a long-term agreement with cement manufactures for lifting of fly ash from SUMPP on sharing of transporting cost basis.
- d. Inside the plant, for all CLSM (Controlled Low Strength Material), 50% of sand quantity is replaced with bottom ash and 30 -40% of cement quantity is replaced with Fly Ash.
- e. Fly Ash brick making unit of 9000/day capacity is installed within plant premises. Annually over 20 lakh bricks are utilized by SUMPP in its various construction related works.
- f. Workshops conducted for Brick Manufactures/ RMC producers for encouraging use of fly ash by highlighting its benefits.
- g. Various fly ash awareness campaigns and workshops have been organized at SPL and nearby villages for making public aware about fly ash usages and motivating them to come forward as an entrepreneur.
- h. SPL is continuously exploring opportunities for providing fly ash for road construction projects.
- i. Various meetings have been organized with the cement industries with an intention to increase the fly ash lifting from the plant.
- j. Regular meetings with the District Administration, MPPCB and GoMP officials conducted regarding constraints in the fly ash utilization from the power plant and also for seeking support for increasing the fly ash utilization.
- k. The ash deposited in ash ponds is being utilized in permitted activities like ash bund height raising of existing ash dykes, low lying area development, fly ash bricks / clay ash brick manufacturing and efforts being made for utilization in road embankment construction and mixing with mines OB etc.

i. SPL has also requested District Collector to allocate abandoned stone crusher void for filling with ash.

m. The ash utilization has increased from 1.77% in 2013-14 to 65.5% in FY 2019-20.

**6. Reason for non-utilization of 100% fly ash:**

Despite taking above mentioned efforts, SPL could not achieve 100% fly-ash utilization in FY 2019-20 for the following reasons:

- a. SUMPP is located at approx. 250 Kms from the nearest cement plant cluster. The fly ash demand of all the cement industries is getting fulfilled by the nearby power plants. Therefore, it is respectfully submitted that no cement plant prefers to lift fly ash from SUMPP because of high cost of transportation.
- b. SPL had issued NIT for supply of ash on the transportation cost sharing basis but the process could not conclude due to non-availability of sufficient bids / lack of interest from cement companies due to abundant availability of fly-ash in their vicinity, at a distance nearer to them.
- c. It is further submitted that the peak demand for fly ash by cement plants in the Singrauli region, where SUMPP is located, is around 9.1 Million-ton per year whereas the power plants in Singrauli region generate fly ash more than 25.5 Million-ton per year, i.e. 280% of the requirement. Therefore, there is an inherent mismatch between demand and supply of fly ash in the Singrauli region with ash generation far exceeding the demand.
- d. Total fly ash consumption is fixed for the cement industries irrespective of the location from where they are lifting the fly ash for making Pozzolana Portland Cement (PPC).
- e. It is humbly submitted that there is no substantial demand of fly ash in road construction works in the region. There is no substantial demand for fly ash in building construction works too.
- f. It is stated that around 20 ash brick plants are operating in the region to partially meet the requirement of ash bricks but due to existence of red brick kilns in the region, demand for ash bricks is not increasing.

- g. District Collector has also advised the District Mining Department to identify the abandoned coal crusher voids where the fly ash can be filled but the same has not materialized till date.
  - h. Meeting was held with NHAI, PWD & NCL officials for seeking support for using ash in road construction and filling of abandoned mines. During meetings, officials of NHAI and PWD assured of utilisation of ash in road construction projects but no support has come so far.
  - i. Due to these challenges, a large quantity of ash remains unutilized and is being disposed in the ash dyke.
7. Moreover, as may please be observed from the ash utilization details of SUMPP mentioned in preceding paragraphs, the major part of ash utilization was achieved through ash filling in low lying areas. However, the same has been hampered because of the breach of retention wall of low-lying ash utilization area, which occurred on 10th April 2020.
8. **Long term sustainable plan for achieving 100% fly ash utilization:**

Under the circumstances mentioned above and in order to have long-term sustainable plan, SPL is exploring the possibility of taking fly ash to its operating Moher and Moher Amlohri Extension opencast captive coal mines, located at a distance of approx. 25 Kms, through pipeline in high concentration slurry mode for mixing with over burden for filling of de-coaled areas, which has now been permitted pursuant to MoEF&CC notification dated 21<sup>st</sup> May 2020.

Accordingly, SPL has initiated the process for getting approval from the relevant authorities stated as under:

- a. Central Institute of Mining and Fuel Research (CIMFR), Dhanbad has been engaged to carry out the technical feasibility and slope stability study for the said option. The visit of CIMFR scientists is expected after relaxation in the COVID 19 travel restrictions. The report submission for CIMFR will take another 2 months after their site visit.

- b. Once this project gets cleared technically by the CIMFR, Dhanbad, Sasan UMPP will approach Madhya Pradesh Pollution Control Board (MPPCB) for obtaining permission and seek approvals from other statutory / regulatory authorities, as may be required.
- c. Post obtaining permission from MPPCB, the execution of the said work will be taken up which is expected to be completed in nearly 18 Months.
- d. In view of above, 100% utilization of fly ash from SPL can happen only after 2 years from now, after execution of the said proposal of mixing fly ash with over burden dumps in the operating captive coal mines of SUMPP.
- e. Meanwhile, ash is being utilized in the bund height raising work of the existing ash dyke which would utilize approx. 2.2 to 2.3 Million MT / lagoon.

9. Ash utilization plan from FY 2020-21 onwards

a. FY 2020-21 (Estimated):

SN	Description	Unit	Q1 (Actual)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	Ash Generation						
	Fly Ash	MT	1039777	1030000	1030000	1030000	4129777
	Bottom Ash		250044	257500	257500	257500	1032444
	Total Ash		1289721	1287500	1287500	1287500	5162221
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	390	500	500	500	1890
ii)	Ready Mix Concrete	MT	123	200	1000	1000	2323
iii)	Low Lying area filling/ Area Development	MT	89550	0.0	0.0	0.0	89550
iv)	Ash Dyke raising (Downstream)	MT	0.0	0.0	51600	458000	509600
v)	Cement	MT	20210	7200	20000	20000	67410
vi)	Sasan Coal Mine	MT	0.0	0.0	0.0	0.0	0.0
	Total Fly Ash Utilisation	MT	110273	7900	73100	478500	670773
C	Fly Ash Utilisation percentage #	%	11	1	7	47	18

# Dry Ash Utilization: Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

## b. FY 2021-22 (Estimated):

SN	Description	Unit	Q1 (Est.)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	Ash Generation						
	Fly Ash	MT	1030000	1030000	1030000	1030000	4120000
	Bottom Ash		257500	257500	257500	257500	1030000
	Total Ash		1287500	1287500	1287500	1287500	5150000
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	500	500	500	500	2000
ii)	Ready Mix Concrete	MT	1000	200	1000	1000	3200
iii)	Low Lying area filling/ Area Development	MT	0.0	0.0	0.0	0.0	0.0
iv)	Dyke raising	MT	508000	408000	508000	500000	1924000
v)	Cement	MT	20000	7200	20000	20000	67200
vi)	Sasan Coal Mine	MT	0.0	0.0	0.0	0.0	0.0
	Total Fly Ash Utilisation	MT	529500	415900	529500	521500	1996400
C	Fly Ash Utilisation percentage #	%	51	40	51	51	48

# Dry Ash Utilisation: Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

## c. FY 2022-23 (Estimated):

SN	Description	Unit	Q1 (Est.)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	Ash Generation						
	Fly Ash	MT	1030000	1030000	1030000	1030000	4120000
	Bottom Ash		257500	257500	257500	257500	1030000
	Total Ash		1287500	1287500	1287500	1287500	5150000
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	500	500	500	500	2000
ii)	Ready Mix Concrete	MT	1000	200	1000	1000	3200
iii)	Low Lying area filling/ Area Development	MT	0.0	0.0	0.0	0.0	0.0
iv)	Dyke raising	MT	508000	408000	558000	558000	2032000
v)	Cement	MT	20000	7200	20000	20000	67200
vi)	Sasan Coal Mine*	MT	0.0	0.0	458500	458500	917000
	Total Fly Ash Utilisation	MT	529500	415900	1036500	1038500	3021400
C	Fly Ash Utilisation percentage #	%	51	40	100	100	73

# Dry Ash Utilisation: Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

\* Subject to the technical feasibility clearance by the CMFR, Dharwad and NDC from MPPCB & DGMS

10. Therefore, FY 2022-23 onwards, entire unutilized fly ash of SUMPP is proposed to be sent to its captive coal mine for mixing with mine OB to achieve 100% fly ash utilization whereas the bottom ash will be sent to the ash pond in slurry mode from where it will be utilized as per the demand.

Annexure-4

Page 1 of 2

Fwd: माननीय राष्ट्रीय हरित अधिकरण में प्रेषित प्रकरण क्रमांक OA नं. 31/2020 (CZ), हीराताल बैस विरुद्ध रिलायंस सासन पावर लिमिटेड में दिनांक 29/06/2020 को पारित आदेश के अनुपालन में गठित संयुक्त समिति का निरीक्षण दिनांक 14 एवं 15 जुलाई आ. आ.।

AK Singh

to:

Amitosh Verma

31/08/2020 15:35

Hide Details

From: AK Singh/RPOWER/RelianceADA

To: Amitosh Verma/RPOWER/RelianceADA@INFOCOMM

History: This message has been replied to.

Sent from my iPhone

Begin forwarded message:

From: "Sunil Kumar Meena" <[hsunil2006@gmail.com](mailto:hsunil2006@gmail.com)>

Date: 21 August 2020 at 2:57:06 PM IST

To: [AK.Singh@relianceada.com](mailto:AK.Singh@relianceada.com)

Subject: Re: Fw: माननीय राष्ट्रीय हरित अधिकरण में प्रेषित प्रकरण क्रमांक OA नं. 31/2020 (CZ), हीराताल बैस विरुद्ध रिलायंस सासन पावर लिमिटेड में दिनांक 29/06/2020 को पारित आदेश के अनुपालन में गठित संयुक्त समिति का निरीक्षण दिनांक 14 एवं 15 जुलाई आ. आ.।

Sir,

This office have received the ATR against the advisory issued by the committee in OA 31/2020.

I request you to prepare detailed ATR and include the pre & Post photographs of the ash dump sites which were observed by the committee members. Also include the analysis reports of the laboratory engaged by your good self.

You are also requested to please follow up with agencies who have created the pond outside your boundary and plan a solution to prevent GW travel towards ash dump sites.

Regards

Er. Sunil Kumar Meena  
Scientist 'D'  
Central Pollution Control Board (CPCB)  
Regional Directorate - Bhopal (INDIA)  
Mobile No. 9617007250

On Sat, 15 Aug 2020 at 13:37, <[AK.Singh@relianceada.com](mailto:AK.Singh@relianceada.com)> wrote:

Respected Sir,

Please find attached Sasan Power Limited's reply in response to your letter dated 17.07.2020.

With Regards  
Anil Kumar Singh  
CEO-SPL





## ANNEXURE R-11



## मध्यप्रदेश प्रदूषण नियंत्रण बोर्ड

पर्यावरण एक्टिविज्म, ई-5, अवेरा कालोनी, भोपाल-462016  
 ☎: 8755-2466735 (O), फैक्स: 8755-2463742, टीवीएफ्म: 8755-2517606, 2466191  
 ई-मेल: : it\_mppcb@rediffmail.com, वे: www.mppcb.nic.in

क्रमांक 2285/राक/सी.ई-4/मुप्रनिबो/2020,

भोपाल, दिनांक 25-11-2020

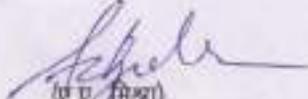
प्रति,

✓ श्री ए.के. सिंह,  
 मुख्य कार्यकारी-अधिकारी,  
 मेसर्स सासन पॉवर लिमिटेड,  
 पोस्ट-तियारा,  
 जिला-सिंगरौली (म.प्र.) -486886

विषय :- उद्योग की एश आईक टूटने के संबंध में बकाया पर्यावरणीय क्षतिपूर्ति राशि  
 रु. 08 करोड़ जमा करने बावत्।

संदर्भ :- 1. बोर्ड का पत्र क्रमांक 23/ MPPCB/MS/TS Singrauli /2020 दिनांक  
 13/04/2020  
 2. बोर्ड का पत्र क्र. 1464/MPPCB/CE-IV/2020 दिनांक 24/08/2020  
 3. उद्योग का पत्र क्रमांक SPL/2020-21/36 दिनांक 09/09/2020

उपरोक्त संदर्भित पत्रों का अवलोकन कर लेख है कि, उपरोक्त संदर्भित पत्र क्रमांक-1 के माध्यम से बोर्ड द्वारा उद्योग को एश आईक ब्रीच के संबंध में जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 33'क' के अन्तर्गत निर्देश जारी किये गये थे। तत्संबंध में माननीय एन.जी.टी. द्वारा प्रकरण क्रमांक O.A 164/2018 (अश्विनी कुमार दुबे विरुद्ध भारत सरकार व अन्य) में पासित आदेश दिनांक 14/07/2020 के परिप्रेक्ष्य में पुनः पर्यावरणीय क्षतिपूर्ति राशि रु. 08 करोड़ बोर्ड में जमा करने हेतु निर्देशित किया गया था, जिसका प्रतिउत्तर आपके संदर्भित पत्र क्रमांक-3 के माध्यम से दिया गया। उक्त प्रतिउत्तर बोर्ड द्वारा असंतोषजनक पाया गया है। ओ.ए. 31/2020 (हीरालाल वैस विरुद्ध रिजलॉयंस सासन पॉवर लिमिटेड व अन्य) में भी बोर्ड द्वारा इस संबंध में माननीय अधिकरण को अवगत कराया गया है। इस संबंध में पुनः निर्देशित किया जाता है कि, बकाया पर्यावरणीय क्षतिपूर्ति राशि रु. कुल 08 करोड़ शीघ्रातिशीघ्र बोर्ड में जमा करावे, अन्यथा जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 27 के अन्तर्गत सम्मति निरस्त करने की कार्यवाही की जायेगी जिसकी सम्पूर्ण जिम्मेदारी उद्योग प्रबंधन की होगी।

  
 (ए.ए. मिश्रा)  
 सदस्य सचिव

R O Singrauli

299

  
 TRUE COPY



## मध्यप्रदेश प्रदूषण नियंत्रण बोर्ड

पर्यावरण परिसर, ई-5, अरेरा कालोनी, भोपाल-462016  
 ☎: 8755-2466735 (O), फ़ैसल: 8755-2463742, पी.सी.एनए: 8755-2517600, 2466191  
 ई-मेल: [ic\\_mppcb@rediffmail.com](mailto:ic_mppcb@rediffmail.com), वेब: [www.mppcb.aic.in](http://www.mppcb.aic.in)

पु.कमांक / तक / सी.ई-4 / मुप्रनिबो / 2020.

भोपाल, दिनांक

प्रतिलिपि :-

क्षेत्रीय अधिकारी, क्षेत्रीय कार्यालय, म.प्र. प्रदूषण नियंत्रण बोर्ड, सिंगरीली की ओर  
 सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

(ए.ए. मिश्रा)  
 सदस्य सचिव

**TRUE COPY**

## ANNEXURE R-12

**Sasan Power Limited**

CIN: U40102MH2008PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhikhand  
 Post Office: Tiyara  
 Singrauli - 480 000  
 Madhya Pradesh, INDIA  
[www.reliancopower.co.in](http://www.reliancopower.co.in)

No.: SPL /2020-21/42

15<sup>th</sup> January, 2021**The Member Secretary**

Madhya Pradesh Pollution Control Board (MPPCB)  
 Paryavaran Parisar, Sector E-5, Arera Colony  
 Bhopal-462016  
 Madhya Pradesh

**Ref:** 1. SPL letter no. SPL/2020-21/36 dated 09.09.2020  
 2. Letter from the office of your good-self Reference no. 2285/Tech/CE-04/MPPCB/2020, dated 25.11.2020.

Respected Sir,

1. SPL is in receipt of your letter dated 25.11.2020 via e-mail, wherein SPL has been advised to deposit the remaining interim environmental compensation of Rs. 8.00 Crs.
2. Firstly, we would like to clarify that the area referred in your letter is not the ash dyke but is a low lying area located within the plant premises used for filling with fly ash as a part of our ash utilization plan.
3. As regards payment of environmental compensation of Rs 8 Cr , vide our letter dated 09.09.2020, we had respectfully submitted that:
  - a. The case of NTPC Ash Dyke Breach and Breakage of Retention wall of SPL's low lying area are two different situations and are not comparable.
  - b. The environmental compensation as directed by Hon'ble NGT to be paid by NTPC, Vindhyachal is based on the recommendation of the Oversight Committee and is totally plant specific, hence the generalization of the same would not be appropriate.
  - c. As directed by the MPPCB, we already have engaged National Environmental Engineering Research Institute (NEERI), Nagpur. The study report of NEERI shall comprise of the Environmental Damage and Restoration Plan and all the recommendations of the report will be implemented by the SPL.
  - d. Despite facing severe liquidity challenges, which have further exacerbated due to unprecedented delays in bill payments in recent months by Madhya Pradesh Power Management Company Limited (MPPMCL), the Lead Procurer of Sasan UMPP, SPL has already paid an Interim Environmental Compensation of Rs. 2.0 Crs to MPPCB.
  - e. In addition to above, SPL has incurred nearly Rs. 15 Crs towards compensation and restoration work.
4. In continuation to our aforementioned submissions, we would like to further submit that:
  - a. The referred Environmental Compensation imposed vide case no. OA 164/2018 (Ashwani Dubey V/s Govt of India and others) is only for NTPC, Vindhyachal and not for Sasan Power Limited and that too is based on the recommendations of the Oversight Committee. It would be pertinent to mention here that NTPC, Vindhyachal has only submitted a Bank Guarantee (BG) of Rs. 1.0 Crs to the MPPCB till date.
  - b. Any further recovery of environmental compensation from NTPC, Vindhyachal has already been stayed by the Hon'ble Supreme Court of India.
  - c. However, SPL has already deposited an environmental compensation of Rs. 2.0 Crs directly in the account of MPPCB, which is twice the amount of BG submitted by NTPC, Vindhyachal .
  - d. A committee was also constituted by Hon'ble NGT, Bhopal in OA 31/2020 (Hiralal Bais V/s Sasan power Ltd. and ors), which comprised of District Collector (Singrauli),



**TRUE COPY**

## Sasan Power Limited

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhikhand  
 Post Office: Tiyara  
 Singrauli – 486 888  
 Madhya Pradesh, INDIA  
[www.sasanpower.co.in](http://www.sasanpower.co.in)

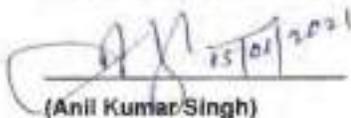
- members from CPCB, MoEF&CC and MPPCB. The recommendations submitted by the said Committee also do not include any further environmental compensation to be collected from SPL. The said Committee emphasized on the expeditious completion of site restoration work and expediting the environmental damage assessment study by NEERI.
- e. The site restoration work has already been completed and site verification has also been done by the Regional Officer, MPPCB on 12.10.2020. A detailed restoration work completion letter has already been submitted to MPPCB on 31.10.2020.
  - f. Additionally, Rs. 15.0 Crs has also been incurred towards the compensation and restoration work by SPL. Hence, till date approx. 17 Crs has already been spent by SPL towards the compensation and restoration work.
5. In view of above, we, most humbly and respectfully, request your good-self not to insist on payment of any further interim environmental compensation by SPL. SPL is committed to implement all the recommendations as per the final report by the NEERI, Nagpur. A team of NEERI Scientists has already visited the site from 22<sup>nd</sup> to 26<sup>th</sup> Dec-2020; collected all the relevant documents; carried out detailed site survey and collected the samples..

We express our deep sense of gratitude for your kind support and guidance for sustaining Sasan UMPP's operations, which make transformational impact on the economy of the State of Madhya Pradesh, while contributing to the nation-building.

Thanking You,

Yours faithfully

For Sasan Power Limited



(Anil Kumar Singh)

Chief Executive Officer – Sasan Power Ltd.

Copy to: Regional Office MP Pollution Control Board, Singrauli, Madhya Pradesh.



**//TRUE COPY //**

**Sasan Power Limited**

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
(An IMS Certified Power Project)  
Gram: Siddhi Khurd, Post Office: Tiwara  
Singrauli - 486 886, Madhya Pradesh, INDIA  
www.reliancepower.co.in

SPL/ /2021-22/28

Date: 10.12.2021

**The Member Secretary  
Madhya Pradesh Pollution Control Board  
Paryavaran Parisar, Arera Colony  
Bhopal, Madhya Pradesh**

**Subject:** Renewal of Consent to Operate (CTO) for 6 x 660 MW Sasan Ultra Mega Power Project developed by Sasan Power Limited (SPL) - Re. payment of balance Interim Environment Compensation of Rs 8 Crore.

**Reference:** 1) Our revised application for CTO renewal from 01.04.2021 to 31.03.2022.  
2) UNH-1289 dated 10<sup>th</sup> December 2021

Dear Sir,

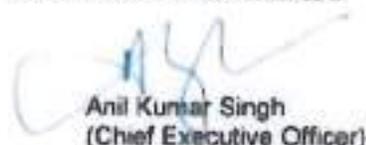
1. This has reference to the Interim Environment Compensation (IEC) of Rs 10 Crore directed to be deposited by SPL with MPPCB, vide its letter D. No. 23 / MPPCB / MS / TS Singrauli / 2020 dt.13.04.2020.
2. However, given severe liquidity challenges and financial stress faced by SPL, we expressed extreme difficulty in making the payment of IEC. Despite the said challenges, SPL deposited Rs 2.0 Crore towards the said IEC on 26.05.2020 to demonstrate its commitment and bonafide.
3. Further as we have highlighted in several communications addressed to MPPCB, SPL has promptly taken all remedial and restoration measures and paid requisite compensation as directed by District Administration and in the process spent an aggregate of Rs.17.30 Crore, including the IEC amount already paid.
4. In view of para 2 and 3, SPL has been repeatedly requesting MPPCB not to insist on payment of balance Rs. 8 Crore of IEC till final NEERI report becomes available.
5. However, citing that NEERI report is still awaited, MPPCB has requested SPL, vide its intimation under reference no. 2 above, to make a payment of balance IEC of Rs 8 Crore, else its CTO renewal application will be liable for rejection.
6. In order to sustain operation of Sasan UMPP, which is serving 47 Crore population in 7 States with its ultra-competitive and most reliable supply of power and continue its contribution to nation-building, we, despite acute financial stress and liquidity challenges, have, with utmost difficulty, made payment of Rs. 8 Crore of balance IEC. The payment details are as below:

10-Dec-2021	RTGS UTR NO: SBINR52021121056143500 MEMBER SECRETARY MPPCB ENVIRONMENT- PUNJAB NATIONAL BANK, Shahapura Branch, Bhopal	Rs 8,00,00,000.00
-------------	--	-------------------

7. **Request:** In view of the foregoing, we, most humbly, urge MPPCB:
  - a. To grant CTO renewal immediately.
  - b. To utilize entire amount of Rs. 10 Crore deposited as IEC, towards implementation of recommendations of final NEERI report.

Thanking You,

Yours faithfully  
For Sasan Power Limited

  
Anil Kumar Singh  
(Chief Executive Officer)

  
**TRUE COPY**

**ANNEXURE R-14****Sasan Power Limited**

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhikhurd  
 Post Office: Tijara  
 Singrauli – 486 886  
 Madhya Pradesh, INDIA  
[www.reliancepower.co.in](http://www.reliancepower.co.in)

**Letter of Intent**

Ref: SPL/ENV/01

Date: 21.04.2020

To,

Department of Civil Engineering  
 M/s Indian Institute of Technology (BHU)  
 Varanasi – 221005

Contact- **Dr. Arun Prasad (Mob No- 953 210 3389)**

Sub: LOI for Study on design and structural safety of the ash dyke situated near Harrahwa village at Sasan Power Ltd.

We are pleased to issue this LOI for conducting **study on design and structural safety of the ash dyke situated near Harrahwa village** at Sasan Power Ltd. against your offer reference mail dated **21.04.2020** as mentioned below BOQ.

S.No.	Service Code	MATERIAL DESCRIPTION	QTY	UOM	Rate	Total Value
1	6100000205	Study on design and structural safety of the ash dyke situated near Harrahwa village	1	LS	400000	400000
		Basic Value				400000
		GST (IGST)		18%		72000
		Total Value				472000

**Terms & Condition**

Order Value- Rs 472000/-

GST- IGST 18% included in total order value.

Scope of Work:

1. To assess the design and structural safety of the ash dyke situated near Harrahwa village.
2. To assess its adequacy of engineering and constructional quality, its safe ash handling and disposal capacity.
3. To ascertain measures, if any, to improve it to avert any incident of its breach, leakage, seepage.
4. Preparation of and Emergency Preparedness plan and Environmental Management Plan to avert and handle any incidence of its breach, leakage, seepage depending upon site condition.

Payment Terms- 100% payment advance against submission of PI.

Work Period – 12 Weeks for Study of design/drawings, analysis using software, assessment & Planning, report submission.

Our Work/Purchase Order along with detailed commercial and technical terms and conditions shall be sent to you in due course. You are, therefore, requested to please go ahead for further process.

Thanking You

For Sasan Power Limited



Procurement &amp; Contracts



**TRUE COPY**

2020

# Stability Analysis of Ash Dyke, Proposed Raisings, Emergency Preparedness Plan, and Instrumentation & Monitoring

## CLIENT

M/s Sasan Power Limited  
Sasan Ultra Mega Power Project  
Siddhikhurd, Tiwara  
Singrauli – 486886 (MP)



Arun Prasad  
Professor in Geotechnical Engineering  
Department of Civil Engineering  
Indian Institute of Technology (IIT) BHU  
Varanasi – 221005  
Email: aprasad.civ@iitbhu.ac.in

**TRUE COPY**

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**REPORT**  
**ON**  
**STABILITY ANALYSIS OF ASH DYKE, PROPOSED RAISINGS, EMERGENCY  
PREPAREDNESS PLAN, AND INSTRUMENTATION & MONITORING**

## **1. INTRODUCTION**

Sasan Ultra Mega Power Project (SUMPP) has constructed one ash pond with two lagoons (Lagoon-1, and Lagoon -2) for its 6 x 660 MW Power Plant at Sasan, Singrauli, MP. The plant runs on coal and the generated ash is collected in two forms; bottom ash and fly ash.

The bottom ash and a part of unused fly ash is mixed with water to form slurry and discharged into ash pond by means of pipe net work. After disposal of slurry in to the ash pond the ash settles down in the pond. The excesses water collects into the stilling pond by means of spill way structure which is located at North-West corner of ash pond area. From the stilling pond, a near clear water flows to the Ash Water Recirculation Pump House for recirculation, the system is called Ash Water Recirculation System (AWRS)

## **2. SCOPE OF WORK**

- (a) To assess the design and structural safety of the ash dyke (Lagoons-1 and 2) situated near Harrahwa village.
- (b) To assess existing and proposed ash storage facilities (main ash pond and its proposed raising) for their adequacy of engineering and constructional quality, their safe ash handling and disposal capacities.
- (c) To ascertain measures, if any, to improve existing and proposed ash storage facilities (main ash pond and its proposed raising) to avert any incident of breach, leakage, seepage etc.
  - (i) To suggest minimum safe section.
  - (ii) To study of seepage rates from the storage areas. The study should consider water table levels in different seasons and consider proper use of lining. Also consider the impact of nearby structures, such as check dams or rain water collection facilities in the ash pond vicinity. The study should also consider any potential erosion of embankments from exterior water source such as potential flooding of natural drainage features in the vicinity.
- (d) Preparation of an Emergency Preparedness Plan and Environmental Management Plan to avert and handle any incidence of its breach, leakage, seepage depending upon site condition. This plan should include a mechanism for warning the surrounding community of potential or imminent breaching or other hazardous conditions.

- (e) To assess the adequacy and suitability of the proposed area available between Lagoon-1 and Lagoon-2 for disposal Ash and capacity thereof. Evaluate the plans on building a bund in the area between both the dyke lagoons which is being planned to store Ash.
- (f) Review and evaluate the adequacy of the design to raise the height of the existing dykes.
- (g) Assess the integrity of the existing bund to contain the ash until the work to increase the height of the bund is completed. Evaluate the potential impact on the embankment of damage from equipment that may be used to remove previously deposited ash from the main pond and suggest safety measures, if any, to avert the avoid equipment induced failures.

### 3. STABILITY ANALYSIS OF ASH POND

The stability analysis of the existing ash pond and 1<sup>st</sup> raising is studied and the results are presented in article 3.1, and the results of stability analysis of the proposed raisings in future are presented in article 3.2.

#### 3.1 Stability Analysis of the Existing Ash Pond and with 1<sup>st</sup> Raising

The ash pond is developed in three compartments, two for ash disposal and one as stilling pond leading to the ash water recovery pump house system. The starter (initial) dyke all round the pond has been constructed with soil, mainly obtained from within the pond area.

A general view of the Ash Pond with two lagoons (Lagoons-1 and 2) and associated decantation wells is shown in Figure 1. The Lagoon-1 is almost filled-up with ash. Presently, the fly ash is discharged in to the partly filled Lagoon 1 in High Concentration Slurry Mode (HCSM) with Ash to Water ratio as 70:30 and bottom ash in to the Lagoon-2 in Lean Slurry Mode (LSM). It is also planned to raise the dyke of ash pond in phases, as and when required, starting with Lagoon-1.

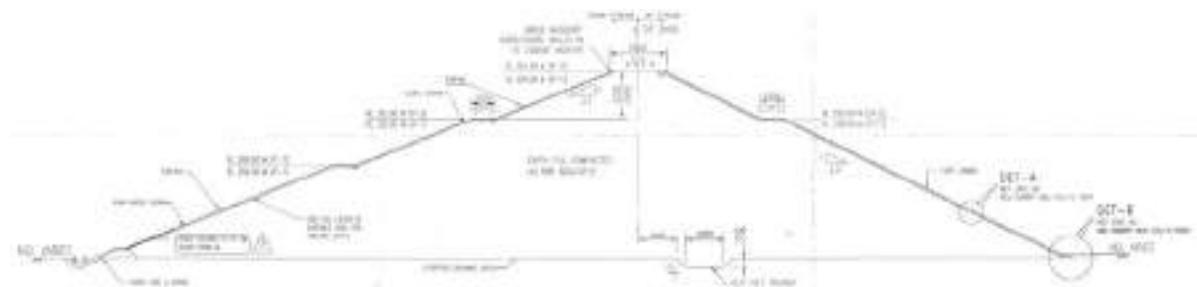


**Figure 1 A general view of Ash Pond with Lagoons -1 and 2**

(Source: Google Earth, Retrieved on: 06-08-2020)

The upstream and downstream slopes are constructed at slopes 1:2.5 (V:H). A cut-off trench is provided below the dyke area along the longitudinal profile of dyke in the natural ground. This is filled with impervious material and is compacted to 95% of maximum dry density (Light Compaction).

Also, 0.5 mm thick LDPE lining has been provided on the u/s side of the ash dykes and with is over-laid with Controlled Low Strength Material (CLSM) for the safeguard of the LDPE lining. Both the lagoons are provided with one decantation well each to remove water from the ash-water slurry. Further, the bottom of the ash pond is treated with bentonite to prevent any seepage of water. A cross-sectional view of the ash dyke of Lagoon-1 is shown in Figure 2. The ash dykes of Lagoons-1 and 2 are identical. Hence, only one typical cross-section has been considered for the stability analysis.

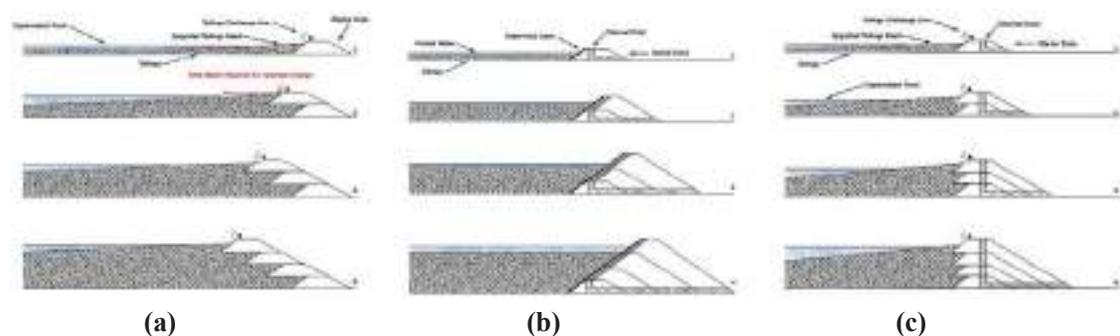


**Figure 2 A typical cross-section of dyke of Ash Pond** (Scale: 1:200)

The stability analysis of the dyke of Ash Pond has been carried out using Geo5, finite element software. This software solves slope stability problems assuming either circular or polygonal slips including an automatic search for the most critical surface (optimization). There are several approaches adopted starting from simplified methods (Bishop, Fellenius) to rigorous methods (Spencer, Morgenstern, Janbu, Sarma) that fulfill all boundary conditions. In the present study, the Spencer Method is used.

### 3.1.1 Ash Dyke Raising Methods

The raising of ash dyke is classified into three broad categories, upstream, downstream, and centerline construction methods as shown in Figure 3.



**Figure 3 Various construction methods of ash dyke raising, (a) upstream, (b) downstream, and (c) centerline** (Source: [www.tailings.info](http://www.tailings.info), © Jon Engels)

**(a) Upstream Construction Method**

This method is popularly used as the earth work required is the minimum. However, this method faces certain disadvantages:

- The entire weight of the new construction for raising the dyke is supported on deposited ash. Unless the ash deposition is done carefully, finer ash particles deposited along the embankment may result in significant lowering of the bearing capacity which may be hazardous for new dyke.
- With the increased height of the pond, there is considerable lowering of the plan area of the pond. Beyond certain stage, it becomes uneconomical to raise further height of the dyke.
- The drain provided on the upstream face needs to be suitably connected to the drain of the earlier segment. Improper design with regard to this can lead to the rising of the phreatic line and the stability of the slope may be endangered.
- Since the entire segment of the new construction is supported on fly ash, it is important to carry out bearing capacity estimation, so that bearing capacity failure can be avoided.

**(b) Downstream Construction Method**

This method is the most suitable for the construction of new embankments. In this method, the construction is carried out on the downstream side of the starter embankment, so that the crest of the dam is shifted progressively towards downstream and the starter dam forms the upstream toe of the final dam. This method has the following advantages:

- None of the embankment is built on previously deposited ash, the extensions being placed on the previously constructed earth dam, and hence the issue of lowered bearing capacity beneath the raisings does not come into picture.
- The placement and compaction control can be exercised as required over the entire fill operation.
- The embankment can be raised above its ultimate design height without any serious limitation and design modification, and
- In this case it is possible to raise the height of the pond even when the pond is in operation.

**(c) Centre Line Construction Method**

- The center line method is essentially a variation of the downstream method where the crest of the embankment is not shifted in the downward direction but raised vertically upward above the crest of the starter dam. In this method, after the pond gets filled up to the first stage, material is placed for raising height of the dyke on either side of centre line of the dyke such that the center line of the dyke remains at the same location. This requires part of the raw material to be placed on the mid part of the deposited ash on the downstream face of the existing dyke.
- The earth work required in this case is less compared to the construction while downstream method. However, as the material is required to be deposited on the settled fly ash, it is not possible to carry out the construction when the pond is in operation.

- This method can be adopted only if the total area of ash pond is divided into compartments. The center line method leads to many design, construction, environmental and operational problems and as such it is not generally used.

A stable embankment with relatively steep slope ranging from 2(H):1(V) to 2.5:1 is possible using the downstream method of raising the embankment. The phreatic line in such embankments is lower (higher phreatic line increases the tensile stresses in the embankment) and the possibility of liquefaction under seismic conditions is precluded since during all stages the embankment rests on the compacted material.

In view of the above, dykes raised by using downstream method are more structurally stable.

### 3.1.2 Various Cases Studied for Stability Analysis

The stability analyses have been carried out for a total of six cases:

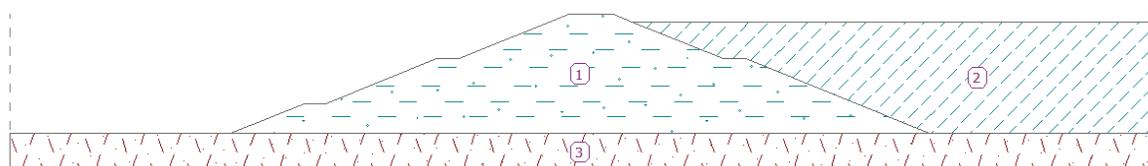
#### (a) Static Analysis

- Ash Dyke (Starter Dyke) with Ash Pond Full
- Raised Dyke (Empty) on d/s of Ash Pond & Ash Pond Empty (Excavated)
- Raised Dyke (Full) on d/s of Ash Pond & Ash Pond Full

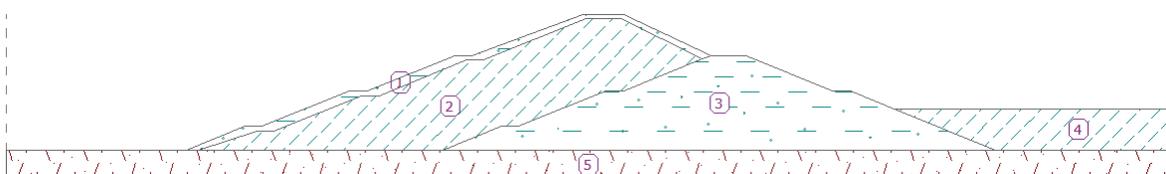
#### (b) Seismic Analysis

- Ash Dyke (Starter Dyke) with Ash Pond Full
- Raised Dyke (Empty) on d/s of Ash Pond & Ash Pond Empty (Excavated)
- Raised Dyke (Full) on d/s of Ash Pond & Ash Pond Full

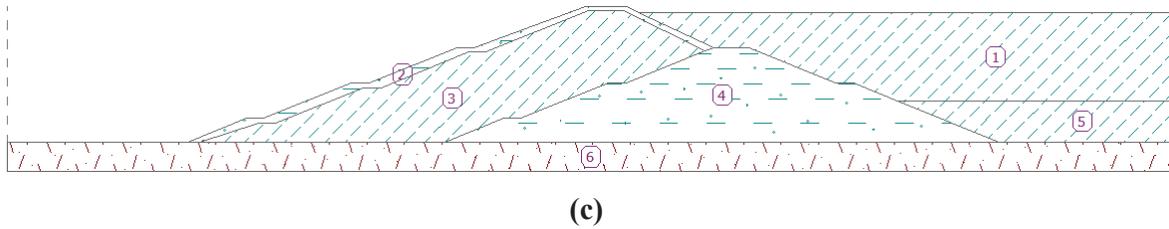
The above mentioned cases are also shown in Figure 4.



(a)



(b)



**Figure 4 Ash dyke cases for stability analysis, (a) Starter dyke full, (b) Ongoing raising using downstream technique (Empty), and (c) Capacity full after raising**

(Note: The numbers in the figures can be referred to in the stability analysis results in the appendix)

Here, the condition (i) represents that the Ash Pond is full. The condition (ii) represents a scenario in which ash from the ash pond is excavated for using the same for raising of ash dyke utilizing the downstream slope technique. Hence, just after raising, old ash pond is partial empty. Lastly, the condition (iii) simulates an ash pond full after raising. Freeboard is taken as 1.0 m. Further, it should be remembered that the upstream slope of the ash dyke is lined by 500 micron thick LDPE to prevent seepage of water from the ash pond to the downstream slope of the dyke. Finally, an inverted filter is provided at the toe of the downstream slope of the ash dyke.

The factor of safety to be satisfied in the stability analysis is considered as 1.0 for upstream slope just after construction (Empty) and under seismic condition. And, it is considered as 1.5 for downstream slope in static condition and 1.0 in seismic condition.

### 3.1.3 Results and Discussion

The results of the stability analysis have been presented in Table 1. A Google map of the ash dyke is shown earlier in Figure 1.

The factor of safety is satisfied for upstream and downstream slopes under both, static and seismic loading conditions.

Hence, the starter dyke (16m) and the proposed raising of the ash dyke (1<sup>st</sup> Raising) by 7.0 m are considered to be safe. However, it is also advised to monitor the ash dyke on a regular basis for any sign of distress in the embankment. The detailed results of analysis (Geo5) have been appended at the end of this report.

Further, the starter dyke has been constructed with upstream and downstream slopes at 1:2.5 (V:H). The 1<sup>st</sup> raising (ongoing) has the same upstream and downstream slope (1:2.5) as the starter dyke. Although a slope of 1:2, for both upstream and downstream slopes, during the 1<sup>st</sup> raising could have satisfied the safety and stability criterion.

**Table 1 Factor of Safety (Spencer Method)**

Description of Ash Pond Component	Details of Analysis/ Loading Condition	Ash Dyke: Empty/Full	Upstream Slope(u/s) / Downstream Slope (d/s)	Factor of Safety	
				Standard Slip Circle	Optimized Slip Circle
Existing Dyke (Starter Dyke)	Static	Full	d/s	2.59	2.60
	Seismic	Full	d/s	2.30	1.80
Raised Dyke (1 <sup>st</sup> Raising)	Static	Empty*	d/s	2.12	1.94
			u/s	2.42	1.81
		Full	d/s	2.16	1.94
	Seismic	Empty*	d/s	1.33	1.24
			u/s	1.97	1.22
		Full	d/s	1.29	1.18

\* Starter dyke is partly empty as ash from the pond is excavated for dyke raising.

### 3.2 Future Raisings (2<sup>nd</sup> Raising Onwards) of Ash Dyke

The newly created space after 1<sup>st</sup> raising will be exhausted with ash and one must go for raising of the ash dyke for an unhindered operation of the power plant. The future raisings have been suggested based on the soil profile, soil test results, ash shear strength parameters etc. and a detailed discussion and results of stability analysis are presented herein.

#### 3.2.1 Scope and Recommendations on Future Ash Dyke Raisings

A soil test was carried out for assessing the type of soil and soil profile by performing Standard Penetration Test (SPT), and few tests in the laboratory on undisturbed and disturbed soil samples collected from the boreholes. The RL of the NGL at various boreholes varied from 290.54 m to 306.58 m, implying that the ground is undulating varying up to ~15 m. At locations (RL: ~290 m), weathered rock is encountered at a very shallow depth of ~4-6 m. And, at locations (RL: ~306 m), weathered rock is encountered at a still shallow depth of ~2.7 m. Now, considering the soil profile, it can be assumed that the weathered rock continues up to several meters depth.

The soil is reported by the testing agency as of very good quality. Weathered rock layer was struck at very shallow depth. The subsoil is characterised by stiff to very stiff reddish brown/brownish grey silty clay/clayey silt followed by very dense, silty sand. After that weathered rock layer was struck and that continues up to the terminating depth of all the boreholes (Figure 5).

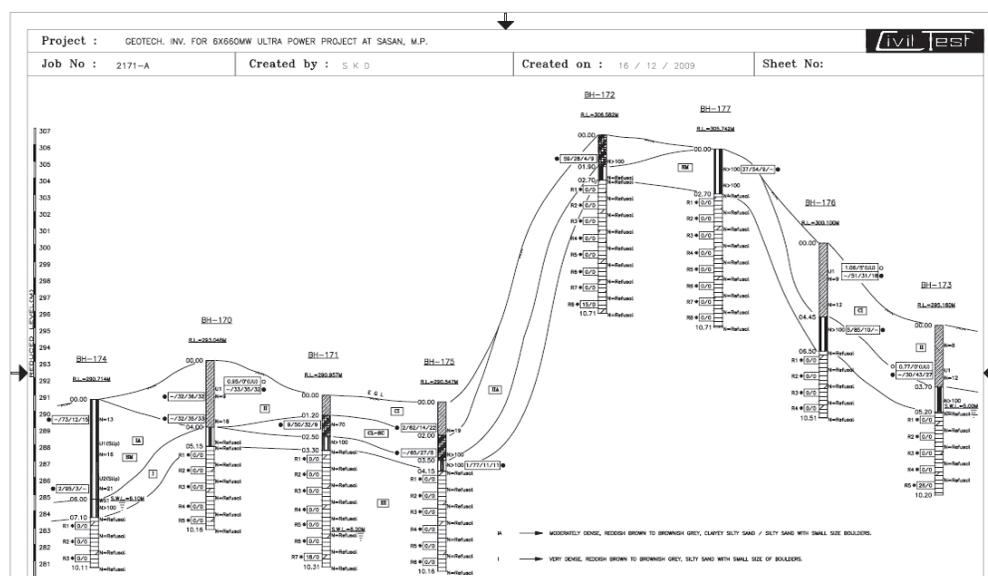


Figure 5 Soil profile at ash pond site

### 3.2.2 Proposed Ash Dyke Raisings (2<sup>nd</sup> Raising onwards)

The Net Allowable Bearing Pressure in the rock (at depth 3.5 m from EGL), is reported as 55 t/m<sup>2</sup>. SUMPP uses the technique of high concentration for ash slurry disposal in the ash pond. The *in situ* density of settled ash in the ash pond may be assumed to be 1.3 t/m<sup>3</sup>. This is based on the assumption that in the long run, 50% fly ash and 50% bottom ash will be deposited in the ash pond. The density of fly ash is ~1.4 t/m<sup>3</sup> and that of bottom ash is ~1.2 t/m<sup>3</sup>. Further, 1<sup>st</sup> dyke raising, as suggested by the design consultant, will be carried out with the ash excavated from the ash pond compacting it to a density of 1.2 t/m<sup>3</sup>. Similarly, future raisings can be carried out by utilizing the ash from the ash pond and compacting to the same density.

Now, with above assumptions, the maximum height of ash in the ash pond that can be safely deposited is:

$$55 \text{ (t/m}^2\text{)} / 1.3 \text{ (t/m}^3\text{)} = 42.3 \text{ m}$$

**Say, 42 m**

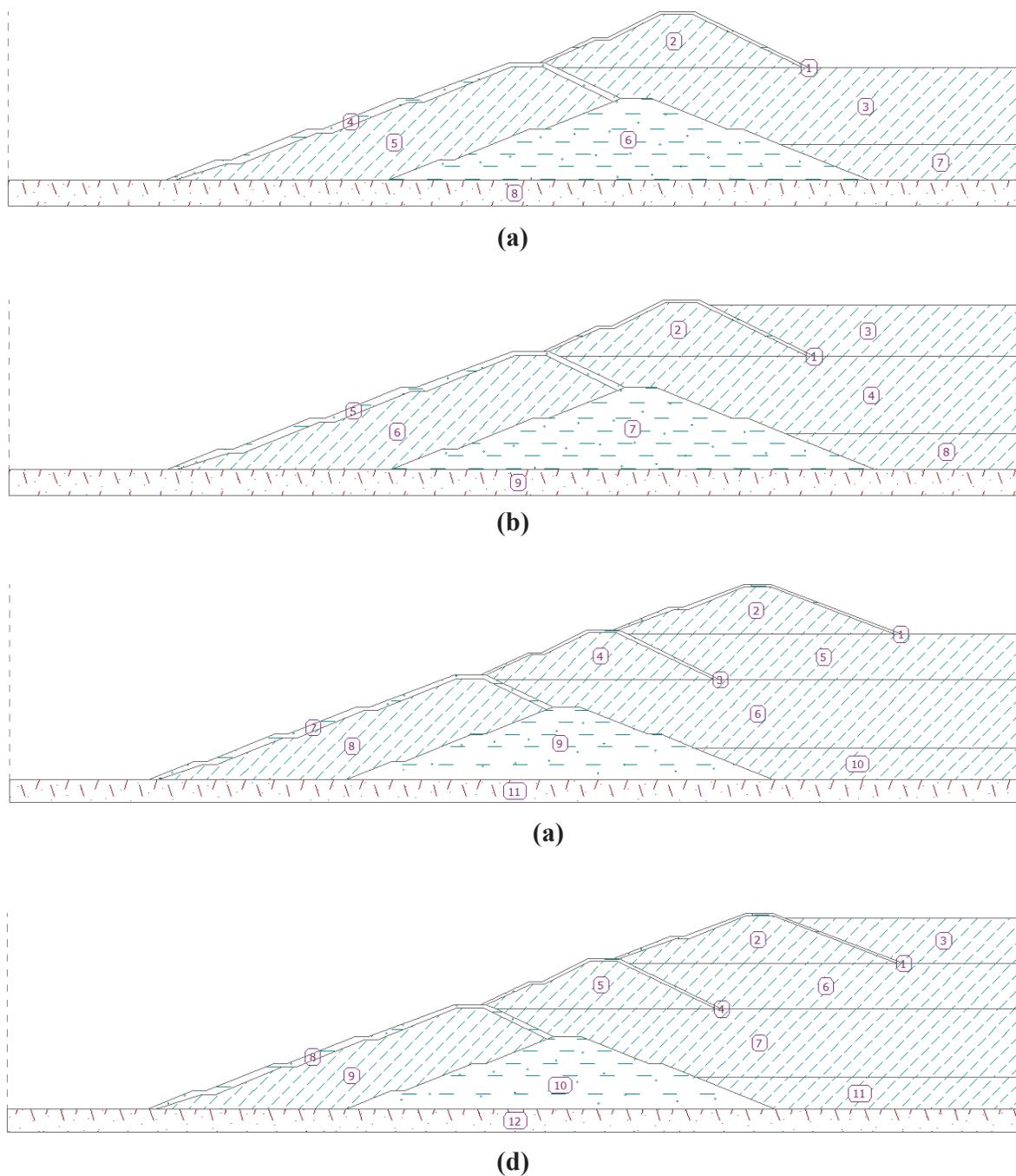
The starter dam (initial dyke) is 16 m high (RL 285 to 301 m), and the proposed 1<sup>st</sup> raising, using ash excavated from the ash pond, will add another height of 7 m (RL 301 to 308 m), including 1.0 m as freeboard. So, after 1<sup>st</sup> raising, the total height of the ash dyke will be 23 m.

**Hence, another raising (2<sup>nd</sup> raising) by 20 m (42m - 23m + 1 m freeboard) (RL 308 to 328 m) can be undertaken when the ash pond is filled up after the first raising is complete.**

Also, future raisings (2<sup>nd</sup> and 3<sup>rd</sup>) will be carried out using the upstream method, as the 1<sup>st</sup> raising is being carried out using downstream method and no space will be available for future raisings by the same construction method, i.e., downstream method.

The proposed future raising (20 m) is shown in Figure 6, and the results of the analysis are presented in Table 2. The various cases studied are similar to those discussed in article 3.1.2.

Further, the proposed future raising of 20 m can be discussed and planned at the time of actual raising depending upon the prevalent condition and the availability of fund.



**Figure 6 Suggested future raisings, (a) 2<sup>nd</sup> future raising (Empty), (b) 2<sup>nd</sup> future raising (Full), (c) 3<sup>rd</sup> future raising (Empty), and (d) 3<sup>rd</sup> future raising (Full)**  
 (Note: The numbers in the figures can be referred to in the stability analysis results in the appendix)

Table 2 Results of the stability analysis for future raisings (2<sup>nd</sup> & 3<sup>rd</sup>)

Description of Ash Pond Component	Details of Analysis/ Loading Condition	Ash Dyke: Empty/ Full	Upstream Slope(u/s) / Downstream Slope (d/s)	Factor of Safety	
				Standard Slip Circle	Optimized Slip Circle
2 <sup>nd</sup> Raised Dyke (10 m)	Static	Empty	d/s	1.76	1.57
			u/s	2.03	1.41
		Full	d/s	2.04	1.57
	Seismic	Empty	d/s	1.23	1.03
			u/s	1.05	0.95 <sup>a</sup>
		Full	d/s	1.14	1.03
3 <sup>rd</sup> Raised Dyke (10 m)	Static	Empty	d/s	1.95	1.42 <sup>b</sup>
			u/s	2.07	1.72
		Full	d/s	1.98	1.44 <sup>b</sup>
	Seismic	Empty	d/s	1.20	0.93 <sup>a</sup>
			u/s	1.29	1.09
		Full	d/s	1.18	0.93 <sup>a</sup>

Note: Factor of safety not satisfied

<sup>a</sup> Factor of Safety < 1.0

<sup>b</sup> Factor of Safety < 1.5

### 3.2.3 Results and Discussion

As discussed earlier, the 1<sup>st</sup> raising is being carried out by the downstream construction method. However, the future suggested raisings are to be carried out by the upstream construction method, as there will not be space available for raising to be carried out by the downstream method.

Now, the future 20 m ash dyke raisings may be planned in two phases of 10 m each, i.e., from RL 308 to 318 m in 2<sup>nd</sup> phase; and 318 to 328 m in 3<sup>rd</sup> phase (Final). For these two future raisings, a detailed stability analysis has been carried with a downstream and upstream slopes at 1:2 (V:H) for raising from RL 308 to 318 m, and at a slope of 1:2.5 (V:H) for the final raising from RL 318 to 328 m.

The desired factor of safety is  $\geq 1.5$  for the downstream slope under static loading. And,  $\geq 1.0$  for the upstream slope (just after raising; i.e., newly generated capacity unutilized) and downstream slope during a seismic loading.

In the final raising, a flatter slope is adopted as the stability criteria was not satisfied, but even with a flatter slope, few isolated conditions are not satisfied on stability criteria. It is also emphasized that the suggested future raisings from RL 308 to 328 m are based on presumptive soil and ash parameters which will definitely vary when the ash pond gets filled up and also the dyke settles/consolidates with passage of time.

Hence, it is recommended that prior to this suggested raisings, the ash in the pond and soil/ash in the dyke should be tested for their geotechnical parameters relevant to the stability analysis. With revised parameters of soil and ash, both raisings with upstream and downstream slopes of 1:2 (V:H) may satisfy the stability criteria.

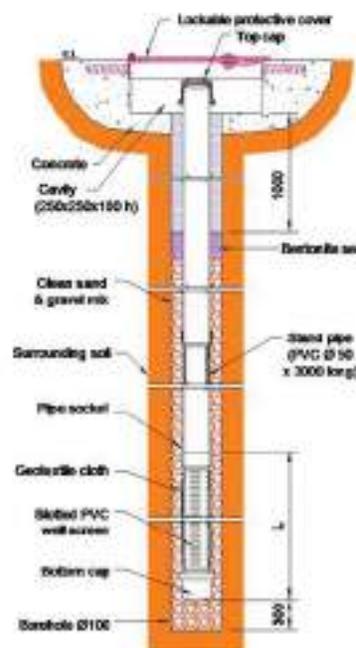
Further, in the event of stability criteria not being satisfied, there are many options available that can be adopted. For example, adopting a flatter slope, using geotextile or geocell, compaction of ash under the proposed dyke in the ash pond area, using a blend of ash and soil in the ash dyke etc.

#### **4. INSTRUMENTATION AND MONITORING OF ASH DYKE**

The instrumentation and monitoring of ash dyke utilizes different types of instruments to monitor early indicators of slope movement, settlement and potential failure modes of its failure. These instruments are installed around the impoundment facilities, at carefully chosen locations and usually in series, located in cross sections at the crest, mid-slope, and toe, of the dyke. The three different types of instruments being utilized are piezometers (Standpipe, Vibrating Wire), slope inclinometers, and Sondex settlement systems. A brief description is of all three types is presented below.

##### **4.1 Piezometer**

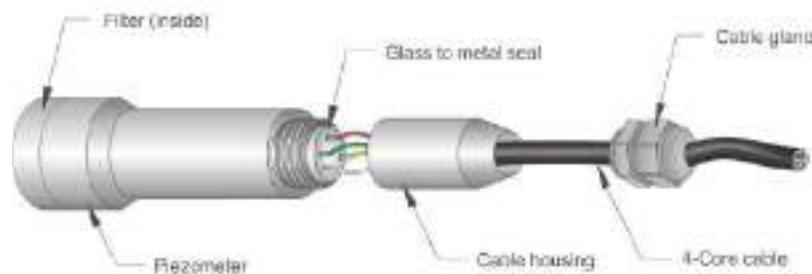
The most common instruments utilized for early detection of slope instability is a piezometer. The piezometers can be installed around the ash dykes. These are relatively easy to install, and do not require special hardware to collect readings. Piezometers measure the water level depths within the ash dyke and the associated pore pressures. High water levels in the slopes are indicators that sloughing, lateral movement, or slope failure may occur. They are typically installed in series, i.e., several piezometers are installed at the same cross-section of the embankment (Crest, Mid-slope, and Toe). A typical installation detail of a traditional non-automated standpipe piezometer that consists of a PVC filter tip joined to a PVC riser pipe is shown in Figure 7. Water flows from the surrounding soil, through the filter sand and into the slotted screen. The water level in the piezometer can be measured manually by measuring the distance from the top of the piezometer, down to the water level with a water level indicator.



**Figure 7 Open Standpipe Piezometer**

(courtesy: <https://www.encardio.com>)

Further, a vibrating wire piezometer can also be used that consists of a vibrating wire pressure transducer and signal cable. It converts water pressure to a frequency signal via a diaphragm, a steel vibrating wire, and electromagnetic plucking and pickup coils (Figure 8). Vibrating wire piezometers are more expensive and also more difficult to install than standpipe piezometers. However, they offer several advantages viz increased accuracy, readability, and reduced cost for automation.



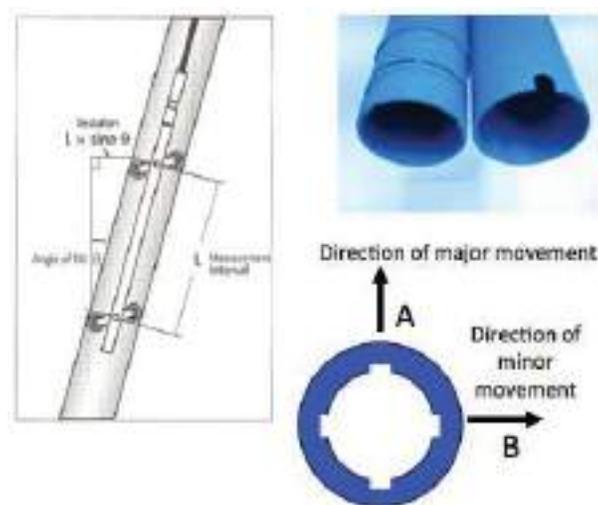
**Figure 8 Vibrating wire piezometer**

(Courtesy: <https://www.encardio.com>)

## 4.2 Slope Inclinometer

Slope inclinometer can be used for early indication of slope instability. They measure the lateral movement in the embankment, and establish whether movement is constant or accelerating. Slope inclinometer casing is installed in a borehole and typically

grouted in place or backfilled with a stiff material (Figure 9). Once it's installed, a baseline reading of the initial as dyke position can be recorded. All subsequent readings are compared to the initial reading and the amount and rate of lateral movement occurring within the embankment can be determined. Inclinometers require special measuring equipment and calibration factors to collect readings.



**Figure 9 Slope inclinometer**

(Courtesy: <http://www.geo-observations.com/>)

They are useful in measuring subsurface slope movement in ash dykes and can provide an early indication and depth of the potential failure surface. The cumulative changes from each reading are plotted over time to create displacement profile that is useful for determining the magnitude, depth, direction, and rate of movement in the dyke.

#### 4.3 Sondex Settlement System

Sondex settlement systems are used to monitor settlement and heave in the active waste (coal ash) stacking areas. The Sondex system consists of a probe, signal cable, and a cable reel with a built-in voltmeter, and a number of stainless steel sensing rings, as shown in Figure 10. Once installed, a baseline reading of the sensing ring depths is recorded, and then all subsequent readings collected thereafter measure the amount of settlement or heave that has occurred in that location.



**Figure 10 Sondex settlement system**

(Courtesy: <https://durhamgeo.com/>)

#### 4.4 Recommendation on Instrumentation

Although, all three instruments can be installed in and around the ash dyke for monitoring its safety and stability, my recommendation will be to install two instruments:

- (i) Open Standpipe Piezometer, and
- (ii) Slope Inclinometer

The recommendation is based on the ease of installation, ease of data collection, frequency of data collection, maintenance of the instrument, etc. These two instruments should be installed at strategic locations viz. near habitation, important civil structures etc.

#### 5. EMERGENCY PREPAREDNESS PLAN

The management is expected to take all necessary measures so that no untoward event/mishap occurs. However, in spite of adopting all safety measures, accident may happen due reasons beyond one's control. Hence, it is desirable that necessary measures should be in place to handle such situation with minimum loss to the property, environment, and above all human life.

Roles and Responsibilities of the Emergency Control Team during an Ash pond breach should be as follows:

1. In the event of an ash pond flooding emergency, the on-site emergency personnel team shall work under the direction of the Local/District crisis group.

### **5.1 Ash Handling Maintenance Head**

In the event of a potential ash pond failure the Ash Handling Head shall:

- Inform the Chief Incident Controller (CIC) to activate the Emergency Alarm, so that other internal On-Site Personnel are alerted to work; and also so that the Local/District crisis group may be activated.
- Maintain a log.
- Provide on-going surveillance and situation assessments to the Local/District crisis group as well as to the CIC.
- Consider establishing an Emergency Control Centre, in the area.
- Be prepared to dispatch a pathfinder to meet the emergency services at an agreed location and provide details of safe approach routes to the emergency services.

### **5.2 Role of Chief Incident Controller (CIC)**

Under intimation that there is potential off-site emergency or that off –site emergency is set to happen soon on account of ash pond flooding, the CIC shall do the following:

- Contact the Local Crisis Group and inform them about the Emergency.
- Initiate Emergency Alarm process.
- Continuously be in touch with the Local/State crisis group authorities, and provide them with information on the actual situation.
- Gather the internal resources for rescue and relief operations under the command of the Local/District crisis group.

### **5.3 OFF SITE RESPONSE**

The offsite response is detailed below:

This plan addresses the Off -Site, or downstream, consequences of flooding of the ash pond as a result of a potential or actual ash pond breach. The actions outlined to be based upon an assumption that there shall be sufficient time to enact a response.

Notwithstanding the above, ash pond failure may involve a complete collapse of a ash pond wall and a sudden release of water; or a “slow build” scenario.

### 5.3.1 Local Crisis Group

On receipt of information from the CIC, regarding the Off-Site emergency, the Local Crisis Group, shall do the following in the event of an offsite emergency such as ash pond flooding:

- Provide all possible kinds of assistance in the implementation of emergency plan for accident , by coordinating with other agencies such as the Police, Fire, Medical, Home Guards, etc
- Ensure integrate of the local emergency plan with the district off –site emergency plan, if necessary, based on the intensity of the accident.
- Deploy trained personnel involved in handling accident management.
- Educate the population, about the accident/emergency, about the remedies and existing preparedness in the area.
- Forward a report to the District Crisis Group, on the accident
- Respond to all public inquires on the subject.

### 5.3.2 District Crisis Group

On receipt of information from the Local Crisis Group, the District Crisis Group Shall do the following in the event of an offsite emergency such as ash pond flooding:

- Provide all kinds of assistance in the implementation of emergency plan in the event of an emergency, such as ash pond flooding.
- Continuously monitor the accident.
- Ensure continuous information flow from the district to the Centre and State Crisis Group regarding accident situation and mitigation efforts.

Forward a report of the accident within fifteen days to the State Crisis Group.

### 5.3.3 Fire and Rescue

On receipt of a Offsite Emergency message from the Local Crisis Group, the Fire Department shall do the following:

- Deploy of High Volume Pumping equipment.
- Provide advice during an emergency drawdown process.
- Assist in the evacuation process.
- Deploy Swift Water Rescue capability.
- Undertake Search and Rescue activity.
- Undertake damage control operations, which may include pumping-out floodwater from homes (where resources allow) and key installations, such as electricity substations.
- Assist in the controlled return of evacuees to their properties.
- Advise on the structural integrity and safety of affected buildings.

#### 5.3.4 Police

On notification of Off-site Emergency by the Local/District crisis group, the Police shall initiate the following measures:

- Provide overall strategic, tactical and operational co-ordination of the incident response provided by the emergency services, local authorities and other agencies.
- Ensure an appropriate coordinator is identified to provide tactical coordination with the Local/District Crisis group.
- Initiate the evacuation of the management areas in consultation with the CIC and in line with the incident scenario.
- Deploy officers where available and appropriate to the evacuation areas (within the management areas) in support of the evacuation, and work with other agencies to notify / identify vulnerable individuals (accessing available records) in the evacuation areas.
- Work with other agencies to notify / identify specific vulnerable establishments in the evacuation areas (accessing available records) to be evacuated and ensure that appropriate measures are in place.
- Make arrangements to mobilize other staff resources, to assist in the evacuation where appropriate and available.
- Support the Highways Agency where appropriate and make arrangements to establish the pre-identified road blocks.
- Identify properties to be evacuated and those not to be evacuated (if resources allow).
- Control and direct traffic to prevent bow waves from flooding properties and vehicles from breaking down in floodwaters, and provide assistance with closures where roads are impassable etc.
- Establish cordons (where practical, appropriate and safe to do so) and ensure that risk assessments are undertaken in conjunction with partner agencies e.g., Fire and Rescue Service, prior to access being granted to areas inside the cordon.
- Assist other agencies in providing specific assistance for people with additional needs such as the old, very young and disabled.
- Evacuate people from streets and buildings and direct them away from the incident scene towards pre-identified assembly / reception points for onward transport to rest centers.
- Maintain an incident log.

#### 5.3.5 Health and Ambulance Services

In the event of a potential or actual ash pond flooding incident, the local Hospitals may have additional responsibilities such as:

- Co-ordinate with the Local Crisis Group/Police/Fire in the rescue operation.
- Provide information to and liaising with Police and the Ambulance Service on the location of vulnerable people.
- Provide medical and other support to the affected people at Rest Centers/clinics.
- Provide a Command and Control point for medical resources near the incident scene;

- Where appropriate, provide patient transport facilities to evacuate vulnerable individuals from properties at risk to hospitals, Rest Centers or other accommodation.
- Maintain a log.

### **5.3.6 Roads / Highways**

The Road / State Highways/Transport department may have responsibilities:

- Provide a representative at the Local Crisis Group level to coordinate the rescue effort.
- Monitor traffic flows and clear debris from roads and road drainage systems.
- Identify and implement the closure of roads and diversion routes in conjunction with the Police
- Oversee repairs to road bridges and evaluating whether bridges affected by floods should remain open for use.

### **5.3.7 Other Agencies**

Other agencies such as local schools, nearby industries, home guards, local government, etc can also be involved in the relief and rescue operations on account of the ash pond flooding

### **5.3.8 Other support to be provided by SASAN in the event of an ash pond flooding**

A large number of ambulances would be necessary to transport casualties to the casualty response center and nearby hospitals. Details of ambulances in SASAN and other neighboring installations have been described in On-site Emergency plan. In case of need and off -site emergency purposes, all types of vehicles can be converted as ambulances at short notice. These vehicles would then be kept at the unit, the ECC and at other places as deemed necessary by the government.

### **5.3.9 Temporary Food and Accommodation**

SASAN shall provide temporary accommodation as and when required to provide relief to the affected population. These centers will be left under the control of the Local crisis group. These temporary shelters shall be equipped with all basic requirements of health, food, sanitation, etc.

### **5.3.10 First-aid and Hospital Services**

The first aid and hospital facilities in SASAN and surrounding organizations/industries shall be provided.

#### 5.4 Communication Network for Off-Site Emergency

An efficient communication system is a must to attend to any Offsite emergency situation, as this can go a long way in alerting the public, neighboring industries and also off-site emergency authorities and services.

The following systems are readily available at SASAN:

- Communication between ECC of SASAN to control rooms of nearby industrial units along with respondents of the area.
- Communication to ECC of nearby units, emergency services, meteorological stations, hospitals, etc.
- P&T telephone lines .

Furthermore this set-up can be used by the Local/district group, to assist in their off-site emergency measures. The designated Emergency Communication Officer of SASAN will ensure that all the modes of communication are functional round the clock. All communication operators shall maintain a log book for the messages received in/out and action plan. Effective warning system, in communication network would save lives, prevent injuries and reduce losses. Depending on the nature of hazards, and the areas affected, the following methods of warning may be used by the state government:

- Public Address System
- Mass Media
- Telephone to other organizations
- Door to Door visit by civil defense personnel
- Information to be provided at common gathering places such as canteens, shops, etc.

#### 5.5 Emergency Control Room

The Emergency control is the facility from where the Local/District crisis group will function in the event of an off -site emergency. The main purpose of this control room is indicated below:

- Act as the focal point of emergency management
- Keep records of all messages
- Inform operation officer on receipt of first information relating to Accident.
- Monitor implementation of mutual aid
- Serve as the focal point for meeting of the crisis Management Group.

The ECC shall be manned by CIC, the Local/District crisis group officials, and other key personnel of outside services called in for assistance. It is equipped with proper communication network and data processing network based on information to combat emergencies.

Regular community consultation programs should also be arranged with the local villagers and stakeholders to let them know the hazards related to the ash dyke breach.

## 6. ENVIRONMENTAL MANAGEMENT PLAN

In order to minimize the risk of failure, following preventive measures shall be adopted:

- More or less uniform ash filling within the lagoon;
- Completely utilize the available storage capacity;
- Maintain water cover throughout to avoid island formation within the lagoon leading to dust problem; and
- Multi-point discharge in the lagoon.

### 6.1 Prevention of Fugitive Emission

Dry fly ash is readily lifted up by wind due to less cohesive force in the fine solid particles. The fugitive dust emission could be either from ash pond from (a) operating lagoon, (b) non-operating lagoon and (c) abandoned ash pond.

The fugitive dust emission from the operative and non-operating lagoons can be controlled by maintaining the designed free board, uniform ash filling, judicious use of sprinklers and compaction of the exposed ash surface wherever feasible.

The fugitive dust emission from abandoned ash pond can be controlled by covering final ash surface with 300mm thick soil. This cover also assisted in the growth of vegetation over the abandoned ash pond which also controlled fugitive dust emission.

### 6.2 Prevention of Water Contamination

The disposal of ash in a pond can have effects on nearby surface waters if sufficient precautions are not taken. The liner system is already provided in the mother dyke. Upstream slopes of the dykes being raised should also be provided with CLSM to prevent any contamination to soil and ground water. To avoid the contamination of nearby fields, toe drain should be provided all around the periphery of outer dyke. Water escape structure for decantation, method of discharge and recirculation of decanted water will be provided as per requirement.

Piezometric monitoring wells around the ash pond will be provided to monitor the ground water level as well as water quality. Periodical surface water quality monitoring will be carried out in the nearby river and stream.

### 6.3 Monitoring of Ambient Air

Monitoring of Ambient air for PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub> through the existing monitoring station shall be continued through MoEF & CC approved and NABL accredited agency.

#### 6.4 Extra Precautions During Exigency

- During any exigency or unforeseen event, the immediate restoration of the affected area to be carried out to avoid a long term impact on different environmental components.
- The frequency of Environmental Monitoring work should be increased to during the emergency scenario.

### 7. DEVELOPMENT OF AREA BETWEEN TWO LAGOONS FOR ASH DISPOSAL

There is some available space between the two Lagoons-1 and 2 and it is desired to use that space for ash disposal. Figure 11 shows the area between Lagoons -1 and 2. The approximate coordinates of the area are N4250, E1975 to N4000, E1975 (on the western side) and N4200, E2725 to N3800, E2524 (on the eastern side). The top of the dyke is assumed to be at RL 301 m. Grading is to be done up to RL 292 m. With these values, the capacity generation for ash disposal will be 21,90,000 m<sup>3</sup> (approx.).

Further, the soil report and soil profile (see Borehole 172) at this area is suggestive of weathered rock with good bearing capacity and is very similar to other locations of the ash pond area. Hence, it is very much expected that the soil will behave in a similar manner to Ash Pond and disposal of ash in this area will not cause any problem.

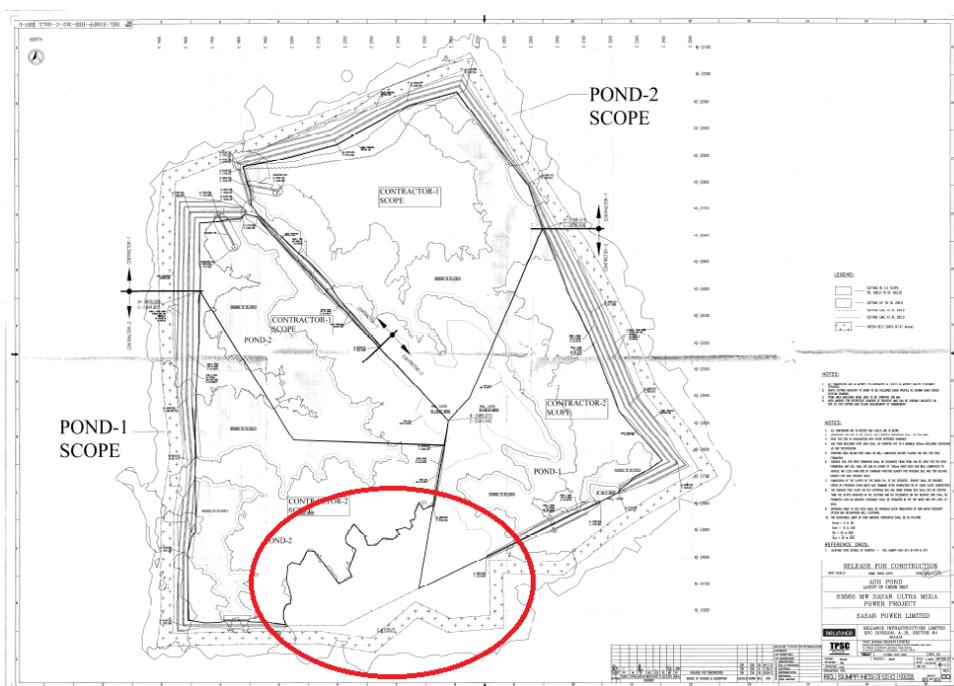


Figure 11 Available space (encircled in red) between Lagoons-1 and 2

However, a bund/dyke will be required to be left *in situ* during excavation that will act as a divide wall between Lagoons -1 and 2. The bund dividing the lagoons currently terminates at the coordinates N3806.881, E2524.020 and the top of the bund is at RL 304 m. The target slope of this bund (in excavation) can be 1:1.5 (H:V), and the top level can be formed at RL 301 m.

So, now, during excavation for developing a cavity for ash disposal, the soil (basically weathered rock) can be left in place from RL 301 m up to RL 285 m, and should be continued towards the coordinates N4200, E2400 (approx.) to terminate at the boundary of the ash pond area.

The site, being entirely in excavation, has enough bearing capacity (55 t/m<sup>2</sup>) to sustain the load of the disposed ash slurry, and also the load that will come due to future suggested raisings.

## 8. SAFETY MEASURES DURING DYKE RAISING

It is planned to raise the ash dyke by excavating the existing ash in the ash pond. This is an economical method as the ash from the pond is utilized, thus reducing the need for soil, that may sometimes be difficult to get nearby.

In the present situation, there are two lagoons in the ash pond, Lagoons -1 and 2, and a bund separates them. During the proposed raising of the dyke of Lagoon-1, the second lagoon (Lagoon-2) will remain in operation. Also, during the raising, the bund also needs to be raised to the same level as the dyke of ash pond being raised.

Now, during the raising operation, earth machinery (excavator, compactor etc) will be moving on the bund also. It is necessary to evaluate the safety and stability of the bund also.

However, the bund raising is also proposed to be carried out using the ash from the ash pond with the same upstream and downstream slopes (1V:2.5H) and similar soil cover is to be provided. Also, the raising of bund will be on the ash pond.

Now, the stability analysis of the ash dyke (future raisings) is carried out and reported in Section 3.2.2. So, a similar result is expected for the stability of the bund also, as the conditions are similar.

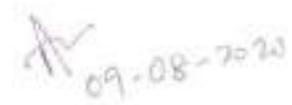
However, few precautions need to be adopted for both, bund and dyke raising as appended below:

- (a) The weight of the earth machinery (excavator, compactor etc) should be the minimum to achieve the desired work of excavation of ash, its transport, and compaction.
- (b) DCPT test (2 nos.) can be done near the site of bund to assess the strength of the deposited ash in the pond.
- (c) In the absence of the results of DCPT test, as far as possible, the bund raising activity should be avoided during monsoon season. If there is a time constraint, a few days should be allowed to pass after a rainfall, before resuming the activity. However, the raising of ash dyke on the downstream of starter dyke can go on unhindered during monsoon season also.

## 9. CONCLUSION

Based on the analysis, and assessment discussed above, the following conclusions are made:

- (a) The existing ash dyke (lagoon 1 and 2 both) is structurally stable and safe for filling with ash.
- (b) The raising of starter dyke by 7.0 m can be done by adopting the downstream technique, which is structurally more stable as compared to upstream and centerline techniques
- (c) Instruments can be installed for monitoring the safety of the ash dyke.
- (d) Future raising of the ash dyke by 20 m is possible as suggested by the stability analysis. However, a detailed analysis needs to be carried out adopting the strength parameters of soil/ash obtained from tests carried out during the time of actual raising.
- (e) The area between Lagoons -1 and 2 towards the southern end of the ash pond can be excavated to create additional ash disposal capacity.

A handwritten signature in blue ink, followed by the date '09-08-2020' written in blue ink.

**(Arun Prasad)**  
**Professor & Consultant**

**Place: IIT (BHU) Varanasi**

**Date: 9<sup>th</sup> August 2020**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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## Slope stability analysis

### Project

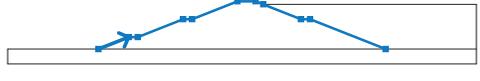
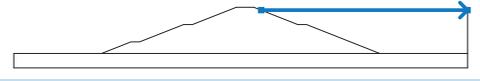
Task : Stability Analysis\_Starter Ash Dyke

Author : Arun Prasad

Date : 12-07-2020

Analysis type : in effective parameters

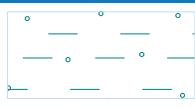
### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	46.00	16.00
		52.00	16.00	54.50	15.00	67.00	10.00
		70.00	10.00	95.00	0.00		
2		54.50	15.00	125.00	15.00		
3		-30.00	0.00	0.00	0.00	95.00	0.00
		125.00	0.00				

### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke Soil		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Rising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke Soil		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Rising)		14.00		

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke Soil

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Rising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

### Rigid bodies

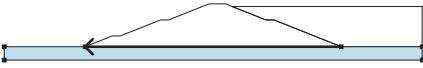
Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

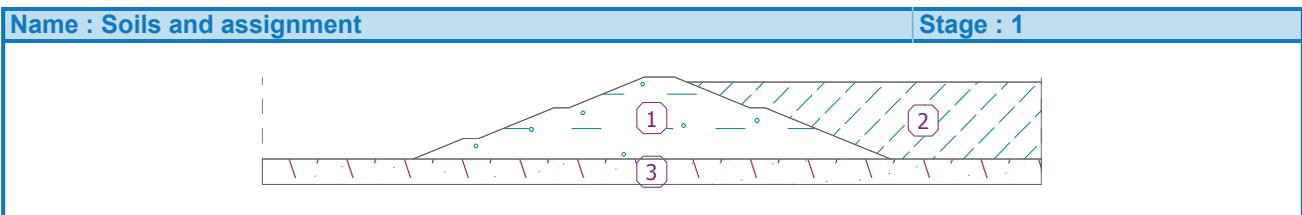
### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		95.00	0.00	70.00	10.00	Starter Dyke Soil 
		67.00	10.00	54.50	15.00	
		52.00	16.00	46.00	16.00	
		31.00	10.00	28.00	10.00	
		13.00	4.00	10.00	4.00	
		0.00	0.00			
2		125.00	0.00	125.00	15.00	Pond Ash 
		54.50	15.00	67.00	10.00	
		70.00	10.00	95.00	0.00	

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Stability Analysis\_Starter Ash Dyke

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
3		95.00	0.00	0.00	0.00	Foundation 
		-30.00	0.00	-30.00	-5.00	
		125.00	-5.00	125.00	0.00	



### Water

Water type : No water

### Tensile crack

Tensile crack not inputted.

### Earthquake

Earthquake not included.

### Analysis settings

Analysis settings : Standard  
Analysis type : Safety factor  
Safety factor : 1.50

## Results (Stage of construction 1)

### Analysis 1

#### Circular slip surface

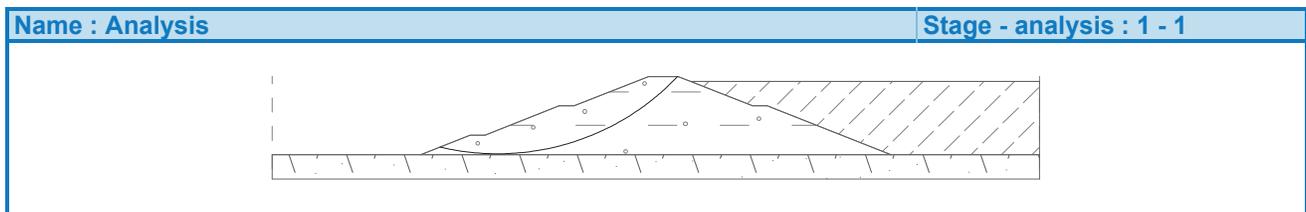
Slip surface parameters					
Center :	x =	15.50 [m]	Angles :	$\alpha_1 =$	-13.51 [°]
	z =	49.87 [m]		$\alpha_2 =$	47.03 [°]
Radius :	R =	49.69 [m]			

Analysis of the slip surface without optimization.

### Slope stability verification (Spencer)

Factor of safety = 2.86 > 1.50

**Slope stability SATISFACTORY**



### Analysis 2

#### Circular slip surface

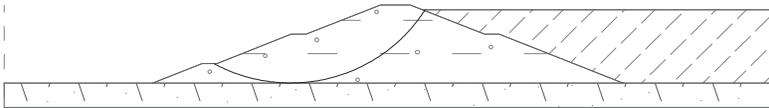
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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Slip surface parameters					
Center :	x =	27.86 [m]	Angles :	$\alpha_1 =$	-28.88 [°]
	z =	32.09 [m]		$\alpha_2 =$	57.81 [°]
Radius :	R =	32.08 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 2.59 > 1.50

**Slope stability SATISFACTORY**

Name : Analysis	Stage - analysis : 1 - 2
	

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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## Slope stability analysis

### Project

Task : Stability Analysis\_Starter Ash Dyke

Author : Arun Prasad

Date : 12-07-2020

Analysis type : in effective parameters

<b>Name : Project</b>	<b>Stage : 1</b>

### Interface

Number	Interface location	Coordinates of interface points [m]					
		z	x	z	x	z	x
1		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	46.00	16.00
		52.00	16.00	54.50	15.00	67.00	10.00
		70.00	10.00	95.00	0.00		
2		54.50	15.00	125.00	15.00		
3		-30.00	0.00	0.00	0.00	95.00	0.00
		125.00	0.00				

### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke Soil		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Rising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

1
<small>[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu]</small>

**school version**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke Soil		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Rising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke Soil

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Rising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

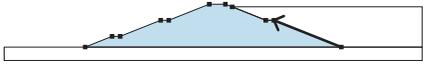
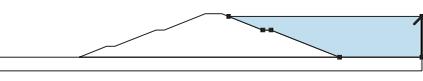
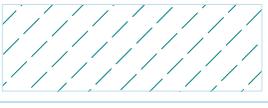
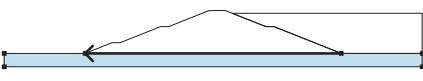
#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		95.00	0.00	70.00	10.00	Starter Dyke Soil 
		67.00	10.00	54.50	15.00	
		52.00	16.00	46.00	16.00	
		31.00	10.00	28.00	10.00	
		13.00	4.00	10.00	4.00	
		0.00	0.00			
2		125.00	0.00	125.00	15.00	Pond Ash 
		54.50	15.00	67.00	10.00	
		70.00	10.00	95.00	0.00	
3		95.00	0.00	0.00	0.00	Foundation 
		-30.00	0.00	-30.00	-5.00	
		125.00	-5.00	125.00	0.00	

**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Horizontal seismic coefficient :  $K_h = 0.16$

Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined

Analysis type : Safety factor

Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

**Circular slip surface**

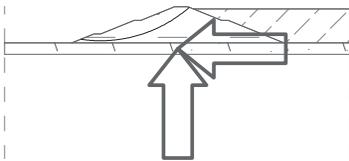
Slip surface parameters							
Center :	x =	12.93	[m]	Angles :	$\alpha_1 =$	-8.35	[°]
	z =	61.70	[m]		$\alpha_2 =$	40.81	[°]
Radius :	R =	60.70	[m]				
Analysis of the slip surface without optimization.							

**Slope stability verification (Spencer)**

Factor of safety = 2.30 > 1.00

**Slope stability SATISFACTORY**

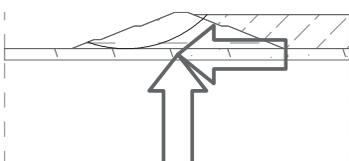
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke
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<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 1</b>
	

**Analysis 2**  
**Circular slip surface**

Slip surface parameters			
Center :	x =	24.31 [m]	Angles :
	z =	51.37 [m]	
Radius :	R =	51.38 [m]	$\alpha_2 =$ 44.93 [°]
The slip surface after optimization.			

**Slope stability verification (Spencer)**  
Factor of safety = 1.80 > 1.00  
**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 2</b>
	

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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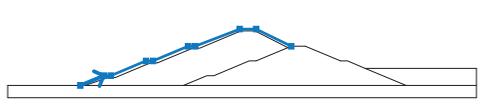
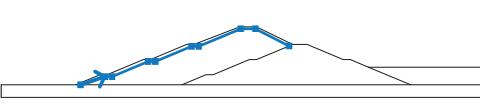
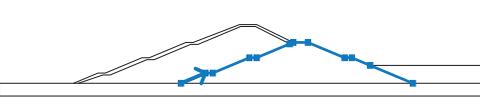
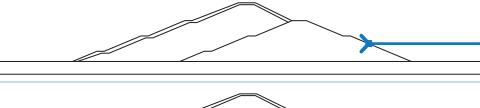
## Slope stability analysis

### Project

Task : Stability Analysis\_1st Raising  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	31.00	23.00
		46.00	16.00				
2		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
3		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
4		77.50	7.00	77.60	7.00	125.00	7.00
5		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

### Soil parameters - effective stress state

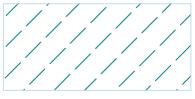
Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu]	1
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**school version**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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Number	Name	Pattern	γ <sub>sat</sub> [kN/m <sup>3</sup> ]	γ <sub>s</sub> [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

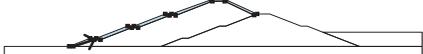
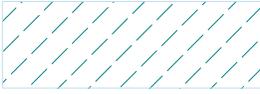
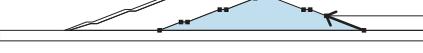
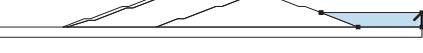
#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

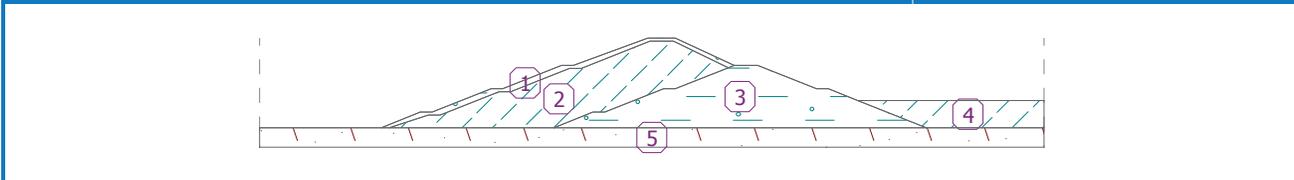
### Rigid bodies

Number	Name	Sample	γ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	31.00	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
		-16.00	10.00	-31.00	4.00	
-34.00	4.00	-44.00	0.00			
2		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
3		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
4		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
5		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	

Name : Soils and assignment Stage : 1



**Water**  
Water type : No water

**Tensile crack**  
Tensile crack not inputted.

**Earthquake**  
Earthquake not included.

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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### Analysis settings

Analysis settings : User-defined  
 Analysis type : Safety factor  
 Safety factor : 1.00

## Results (Stage of construction 1)

### Analysis 1

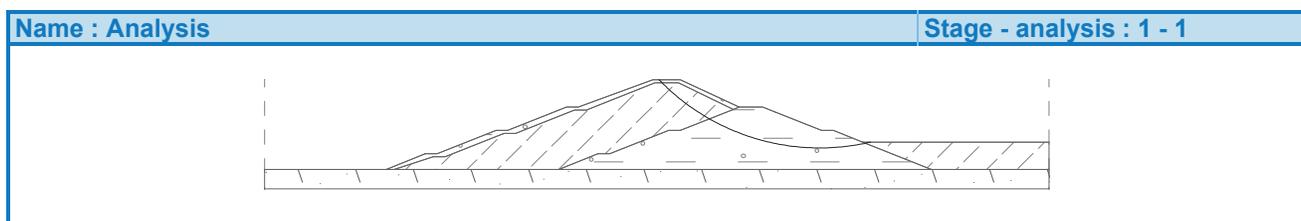
#### Circular slip surface

Slip surface parameters					
Center :	x =	66.56 [m]	Angles :	$\alpha_1 =$	-46.25 [°]
	z =	62.23 [m]		$\alpha_2 =$	13.21 [°]
Radius :	R =	56.73 [m]			
Analysis of the slip surface without optimization.					

#### Slope stability verification (Spencer)

Factor of safety = 2.42 > 1.00

**Slope stability SATISFACTORY**



### Analysis 2

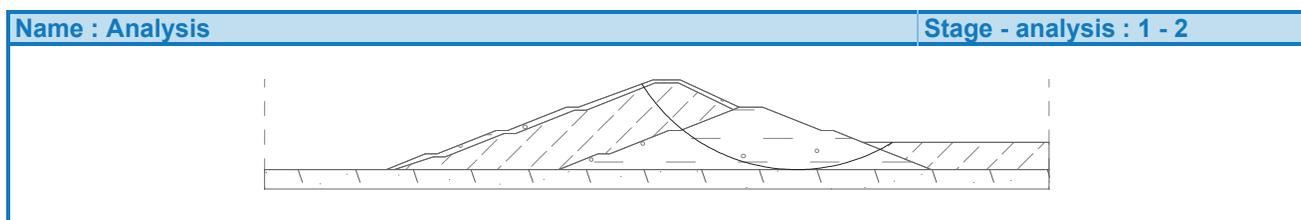
#### Circular slip surface

Slip surface parameters					
Center :	x =	60.63 [m]	Angles :	$\alpha_1 =$	-58.29 [°]
	z =	46.32 [m]		$\alpha_2 =$	31.94 [°]
Radius :	R =	46.34 [m]			
The slip surface after optimization.					

#### Slope stability verification (Spencer)

Factor of safety = 1.81 > 1.00

**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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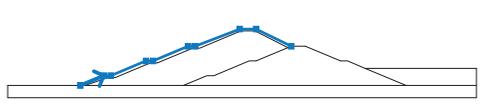
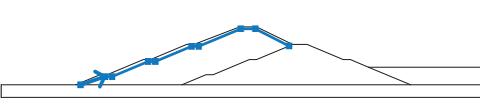
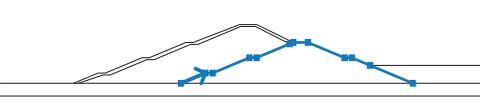
## Slope stability analysis

### Project

Task : Stability Analysis\_1st Raising  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

### Interface

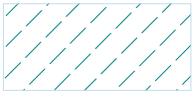
Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	31.00	23.00
		46.00	16.00				
2		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
3		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
4		77.50	7.00	77.60	7.00	125.00	7.00
5		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

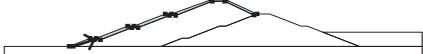
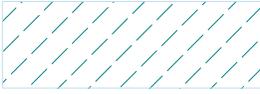
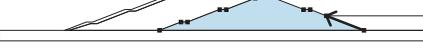
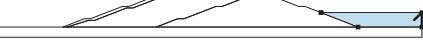
#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

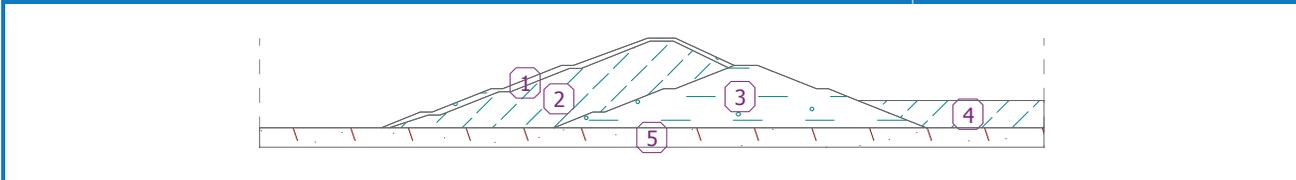
### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	31.00	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
		-16.00	10.00	-31.00	4.00	
		-34.00	4.00	-44.00	0.00	
2		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
3		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
4		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
5		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	

Name : Soils and assignment Stage : 1



**Water**  
Water type : No water

**Tensile crack**  
Tensile crack not inputted.

**Earthquake**  
Earthquake not included.

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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### Analysis settings

Analysis settings : Standard  
 Analysis type : Safety factor  
 Safety factor : 1.50

## Results (Stage of construction 1)

### Analysis 1

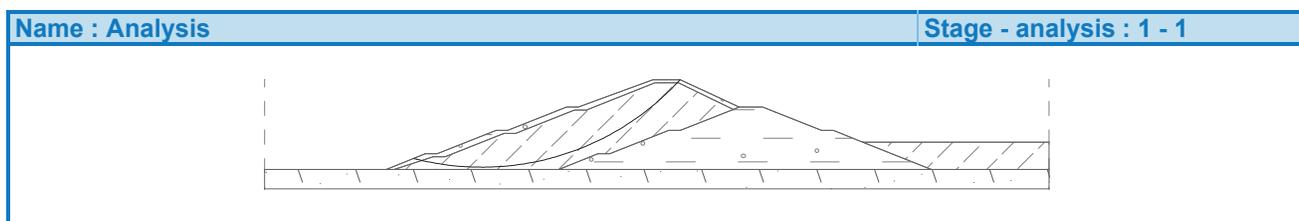
#### Circular slip surface

Slip surface parameters					
Center :	x =	-19.66 [m]	Angles :	$\alpha_1 =$	-14.73 [°]
	z =	68.76 [m]		$\alpha_2 =$	47.86 [°]
Radius :	R =	68.20 [m]			
Analysis of the slip surface without optimization.					

#### Slope stability verification (Spencer)

Factor of safety = 2.12 > 1.50

**Slope stability SATISFACTORY**



### Analysis 2

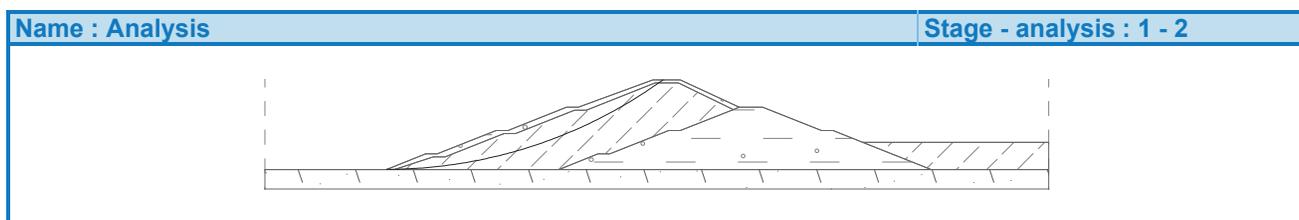
#### Circular slip surface

Slip surface parameters					
Center :	x =	-44.11 [m]	Angles :	$\alpha_1 =$	0.10 [°]
	z =	120.21 [m]		$\alpha_2 =$	36.01 [°]
Radius :	R =	120.16 [m]			
The slip surface after optimization.					

#### Slope stability verification (Spencer)

Factor of safety = 1.94 > 1.50

**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raised Ash Dyke
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## Slope stability analysis

### Project

Task : Stability Analysis\_1st Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	31.00	23.00
		46.00	16.00				
2		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
3		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
4		77.50	7.00	77.60	7.00	125.00	7.00
5		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

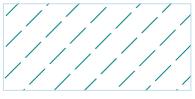
### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

1
[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu] <span style="float: right;">school version</span>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raised Ash Dyke
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Number	Name	Pattern	γ <sub>sat</sub> [kN/m <sup>3</sup> ]	γ <sub>s</sub> [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

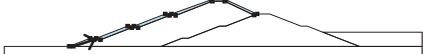
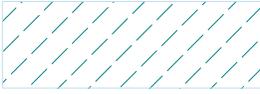
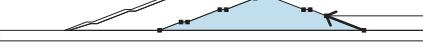
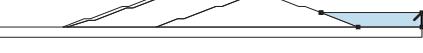
#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

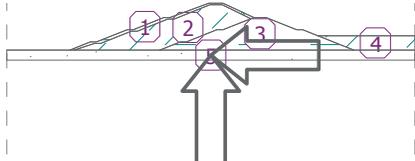
### Rigid bodies

Number	Name	Sample	γ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	31.00	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
		-16.00	10.00	-31.00	4.00	
-34.00	4.00	-44.00	0.00			
2		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
3		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
4		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
5		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	

Name : Soils and assignment Stage : 1



**Water**  
Water type : No water

**Tensile crack**  
Tensile crack not inputted.

**Earthquake**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raised Ash Dyke
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Horizontal seismic coefficient :  $K_h = 0.16$   
 Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined  
 Analysis type : Safety factor  
 Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

**Circular slip surface**

Slip surface parameters					
Center :	x =	63.27 [m]	Angles :	$\alpha_1 =$	-47.41 [°]
	z =	55.59 [m]		$\alpha_2 =$	12.40 [°]
Radius :	R =	48.16 [m]			

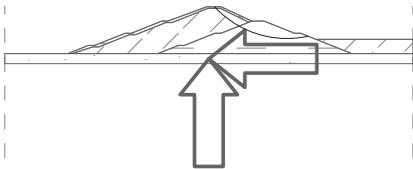
Analysis of the slip surface without optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.97 > 1.00

**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 1</b>
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**Analysis 2**

**Circular slip surface**

Slip surface parameters					
Center :	x =	58.08 [m]	Angles :	$\alpha_1 =$	-49.40 [°]
	z =	56.54 [m]		$\alpha_2 =$	28.81 [°]
Radius :	R =	56.54 [m]			

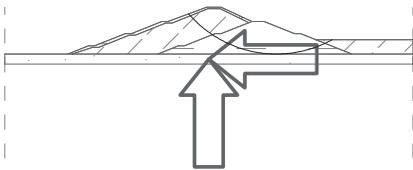
The slip surface after optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.22 > 1.00

**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 2</b>
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**Analysis 3**

**Circular slip surface**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raised Ash Dyke
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Slip surface parameters					
Center :	x =	-16.02 [m]	Angles :	$\alpha_1 =$	-18.40 [°]
	z =	60.64 [m]		$\alpha_2 =$	51.23 [°]
Radius :	R =	60.11 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**  
 Factor of safety = 1.33 > 1.00  
**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 3</b>

**Analysis 4**  
**Circular slip surface**

Slip surface parameters					
Center :	x =	-24.02 [m]	Angles :	$\alpha_1 =$	-4.85 [°]
	z =	85.39 [m]		$\alpha_2 =$	40.17 [°]
Radius :	R =	81.66 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**  
 Factor of safety = 1.24 > 1.00  
**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 4</b>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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## Slope stability analysis

### Project

Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	31.00	23.00
		33.14	22.00	46.00	16.00		
2		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
3		33.14	22.00	125.00	22.00		
4		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
5		77.50	7.00	77.60	7.00	125.00	7.00
6		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

### Soil parameters - effective stress state

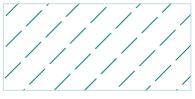
Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

1
<small>[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu]</small>

school version

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

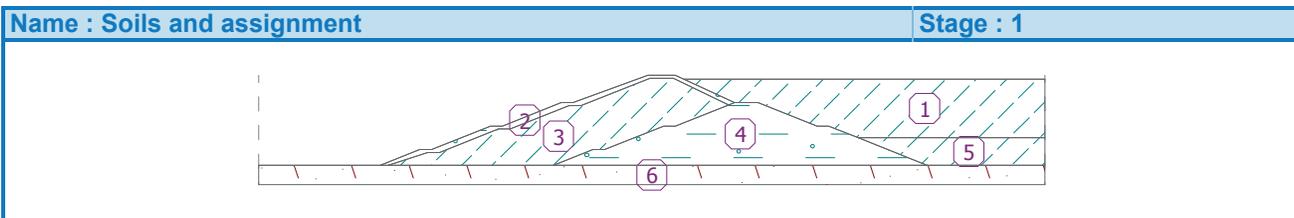
Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
2		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	24.00	23.00	
		5.00	16.00	2.00	16.00	
		-13.00	10.00	-16.00	10.00	
-31.00	4.00	-34.00	4.00			
-44.00	0.00					
3		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
4		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
5		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
6		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**  
Water type : No water

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Tensile crack**  
Tensile crack not inputted.

**Earthquake**  
Earthquake not included.

**Analysis settings**  
Analysis settings : Standard  
Analysis type : Safety factor  
Safety factor : 1.50

## Results (Stage of construction 1)

### Analysis 1 Circular slip surface

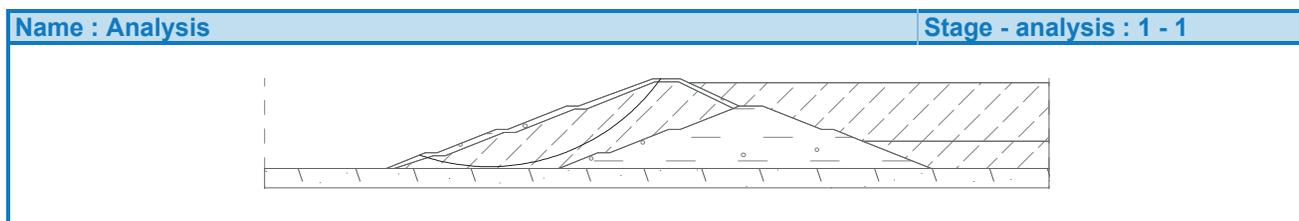
Slip surface parameters					
Center :	x =	-17.80 [m]	Angles :	$\alpha_1 =$	-19.16 [°]
	z =	54.21 [m]		$\alpha_2 =$	54.52 [°]
Radius :	R =	53.77 [m]			

Analysis of the slip surface without optimization.

### Slope stability verification (Spencer)

Factor of safety = 2.16 > 1.50

**Slope stability SATISFACTORY**



### Analysis 2 Circular slip surface

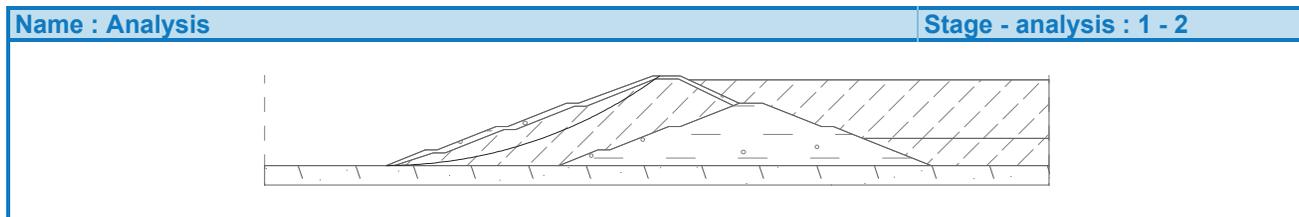
Slip surface parameters					
Center :	x =	-44.18 [m]	Angles :	$\alpha_1 =$	0.10 [°]
	z =	117.62 [m]		$\alpha_2 =$	36.44 [°]
Radius :	R =	117.61 [m]			

The slip surface after optimization.

### Slope stability verification (Spencer)

Factor of safety = 1.94 > 1.50

**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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## Slope stability analysis

### Project

Task : Stability Analysis\_1st Raising  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	31.00	23.00
		33.14	22.00	46.00	16.00		
2		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
3		33.14	22.00	125.00	22.00		
4		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
5		77.50	7.00	77.60	7.00	125.00	7.00
6		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

### Soil parameters - effective stress state

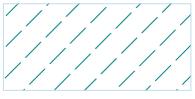
Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

1
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school version

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

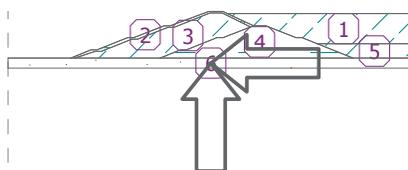
### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
2		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	24.00	23.00	
		5.00	16.00	2.00	16.00	
		-13.00	10.00	-16.00	10.00	
-31.00	4.00	-34.00	4.00			
-44.00	0.00					
3		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
4		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
5		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
6		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	

Name : Soils and assignment Stage : 1



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_1st Raising
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**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Horizontal seismic coefficient :  $K_h = 0.16$

Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined

Analysis type : Safety factor

Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

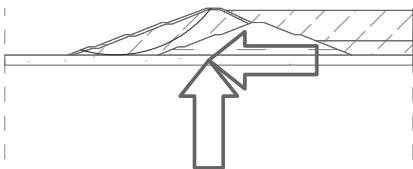
**Circular slip surface**

Slip surface parameters					
Center :	x =	-20.74 [m]	Angles :	$\alpha_1 =$	-16.53 [°]
	z =	59.43 [m]		$\alpha_2 =$	52.12 [°]
Radius :	R =	59.33 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 1.29 > 1.00

**Slope stability SATISFACTORY**

<b>Name : Analysis</b>	<b>Stage - analysis : 1 - 1</b>
	

**Analysis 2**

**Circular slip surface**

Slip surface parameters					
Center :	x =	-43.77 [m]	Angles :	$\alpha_1 =$	-0.08 [°]
	z =	127.39 [m]		$\alpha_2 =$	34.96 [°]
Radius :	R =	127.37 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 1.18 > 1.00

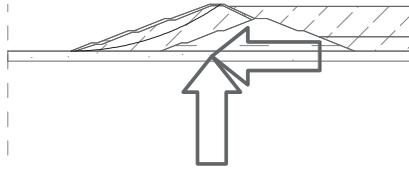
**Slope stability SATISFACTORY**

IIT (BHU) Varanasi  
Arun Prasad

Stability Analysis\_1st Raising

Name : Analysis

Stage - analysis : 1 - 2



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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### Slope stability analysis

#### Project

Task : Stability Analysis\_2nd Raising  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

#### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	83.20	22.00
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
4		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
5		33.14	22.00	82.00	22.00	83.20	22.00
		125.00	22.00				
6		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
7		77.50	7.00	77.60	7.00	125.00	7.00
8		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

#### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	$n$ [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$

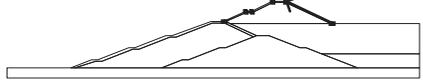
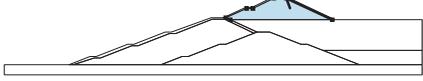
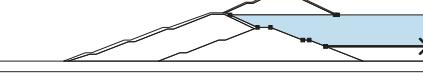
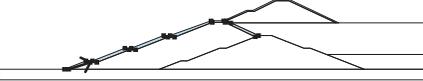
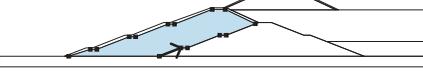
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

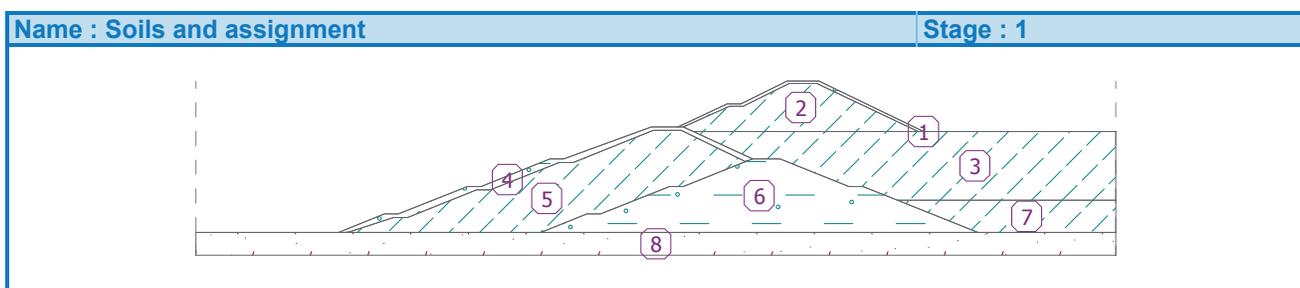
### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	60.50	33.00	Soil Cover (Dyke Raising) 
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
		60.00	32.50	82.00	22.00	
2		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
3		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
4		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			
5		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
		-42.00	0.00			

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
7		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
8		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Analysis settings**

Analysis settings : User-defined  
 Analysis type : Safety factor  
 Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

**Circular slip surface**

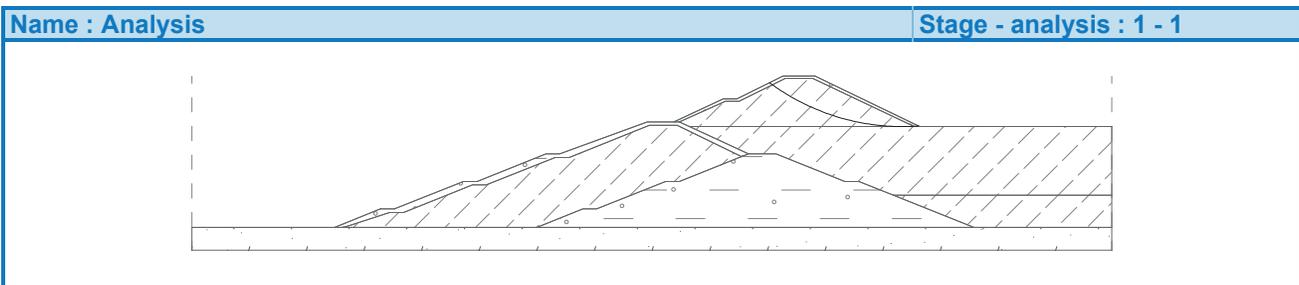
Slip surface parameters					
Center :	x =	79.52 [m]	Angles :	$\alpha_1 =$	-36.63 [°]
	z =	70.45 [m]		$\alpha_2 =$	4.12 [°]
Radius :	R =	48.48 [m]			

Analysis of the slip surface without optimization.

**Slope stability verification (Spencer)**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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Factor of safety = 2.03 > 1.00  
**Slope stability SATISFACTORY**

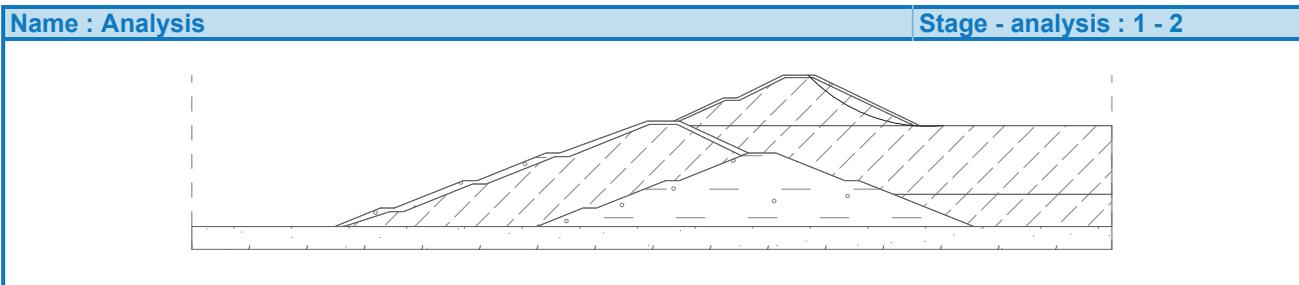


**Analysis 2**  
**Circular slip surface**

Slip surface parameters					
Center :	x =	85.04 [m]	Angles :	$\alpha_1 =$	-46.40 [°]
	z =	57.77 [m]		$\alpha_2 =$	5.23 [°]
Radius :	R =	35.92 [m]			

The slip surface after optimization.

**Slope stability verification (Spencer)**  
 Factor of safety = 1.41 > 1.00  
**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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### Slope stability analysis

#### Project

Task : Stability Analysis\_2nd Raising  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

#### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	83.20	22.00
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
4		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
5		33.14	22.00	82.00	22.00	83.20	22.00
		125.00	22.00				
6		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
7		77.50	7.00	77.60	7.00	125.00	7.00
8		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

#### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$

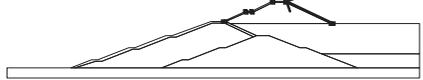
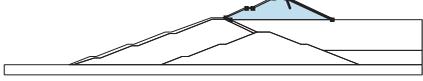
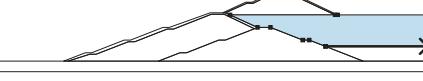
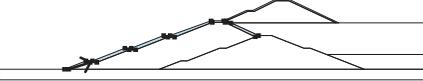
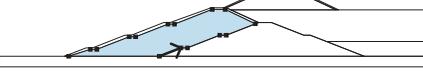
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

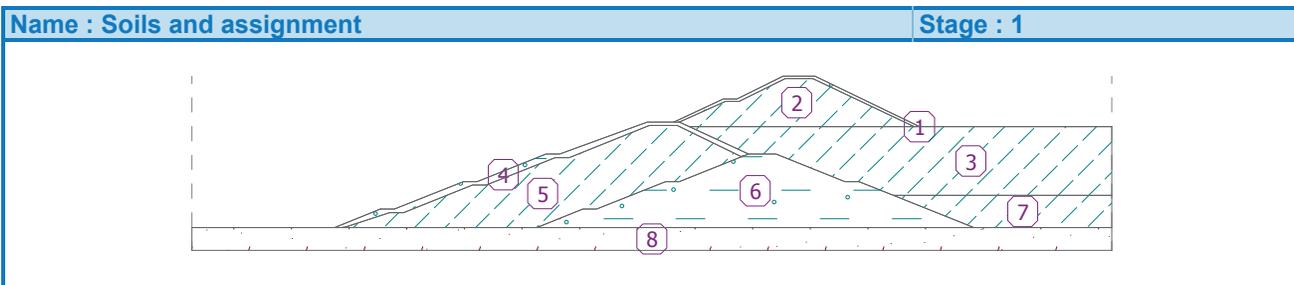
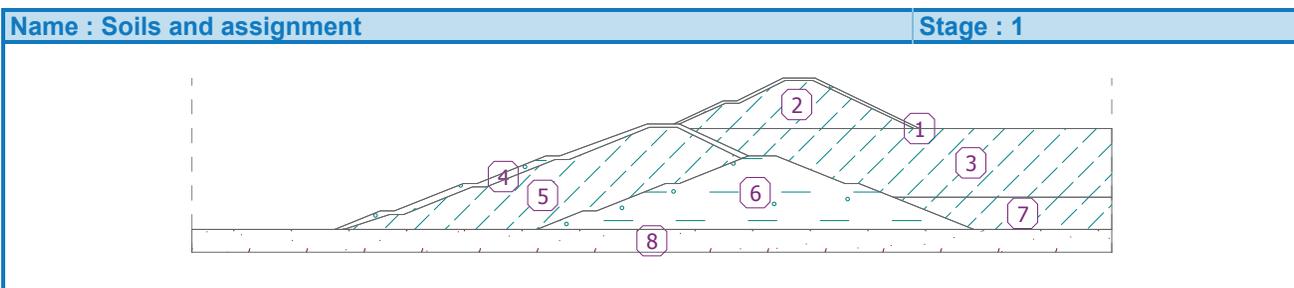
### Rigid bodies

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

### Assigning and surfaces

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	60.50	33.00	Soil Cover (Dyke Raising) 
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
		60.00	32.50	82.00	22.00	
2		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
3		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
4		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
		-16.00	10.00	-31.00	4.00	
-34.00	4.00	-44.00	0.00			
5		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
		-42.00	0.00			

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
7		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
8		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Analysis settings**

Analysis settings : Standard  
Analysis type : Safety factor  
Safety factor : 1.50

**Results (Stage of construction 1)**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_2nd Raising
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**Analysis 1**

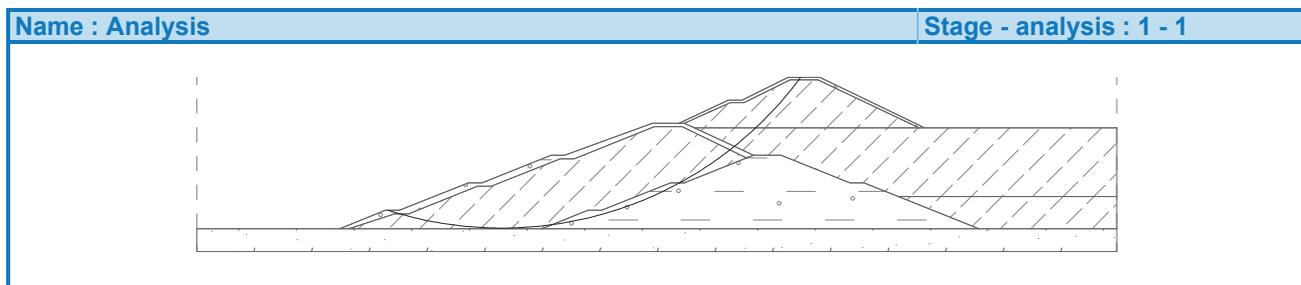
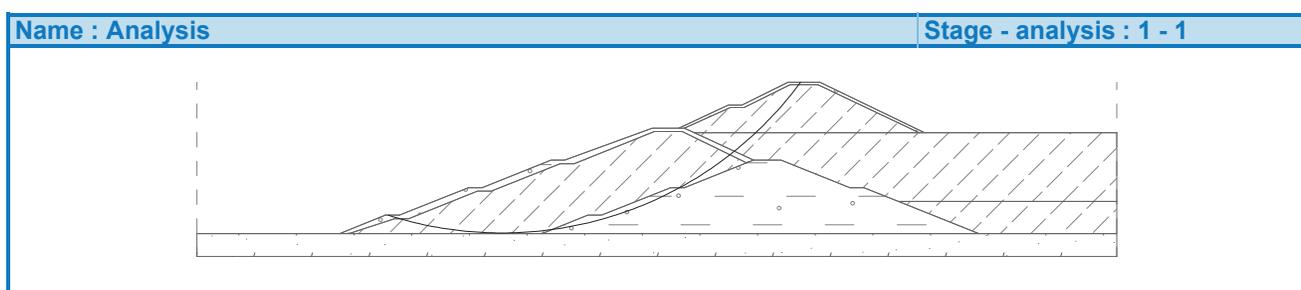
**Circular slip surface**

Slip surface parameters					
Center :	x =	-8.74 [m]	Angles :	$\alpha_1 =$	-17.84 [°]
	z =	80.79 [m]		$\alpha_2 =$	53.67 [°]
Radius :	R =	80.67 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 1.76 > 1.50

**Slope stability SATISFACTORY**



**Analysis 2**

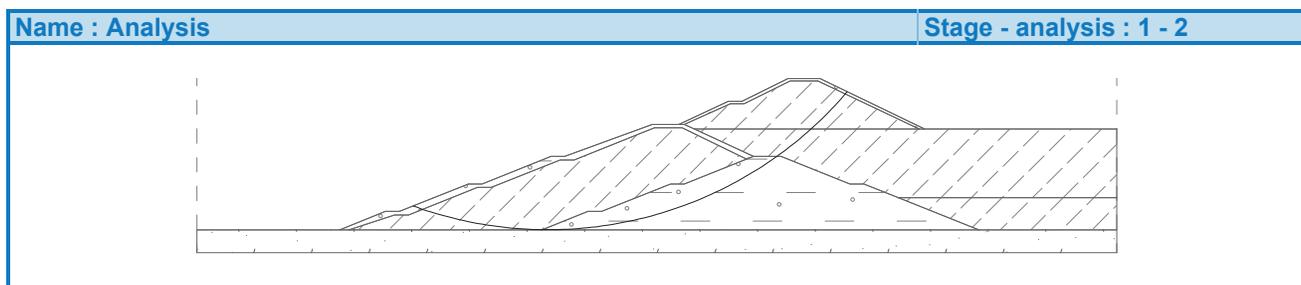
**Circular slip surface**

Slip surface parameters					
Center :	x =	1.32 [m]	Angles :	$\alpha_1 =$	-20.08 [°]
	z =	85.38 [m]		$\alpha_2 =$	49.67 [°]
Radius :	R =	85.37 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 1.57 > 1.50

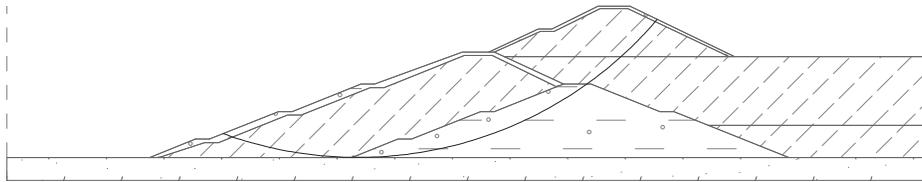
**Slope stability SATISFACTORY**



IIT (BHU) Varanasi  
Arun Prasad

Stability Analysis\_2nd Raising

Name : Analysis Stage - analysis : 1 - 2



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Slope stability analysis**

**Project**

Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	83.20	22.00
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
4		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
5		33.14	22.00	82.00	22.00	83.20	22.00
		125.00	22.00				
6		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
7		77.50	7.00	77.60	7.00	125.00	7.00
8		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

**Soil parameters - effective stress state**

Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	$n$ [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

#### Pond Ash

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

#### Soil Cover (Dyke Raising)

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$

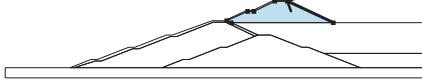
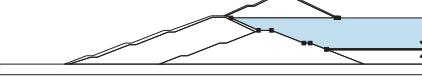
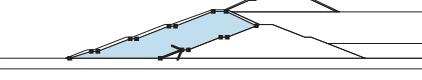
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

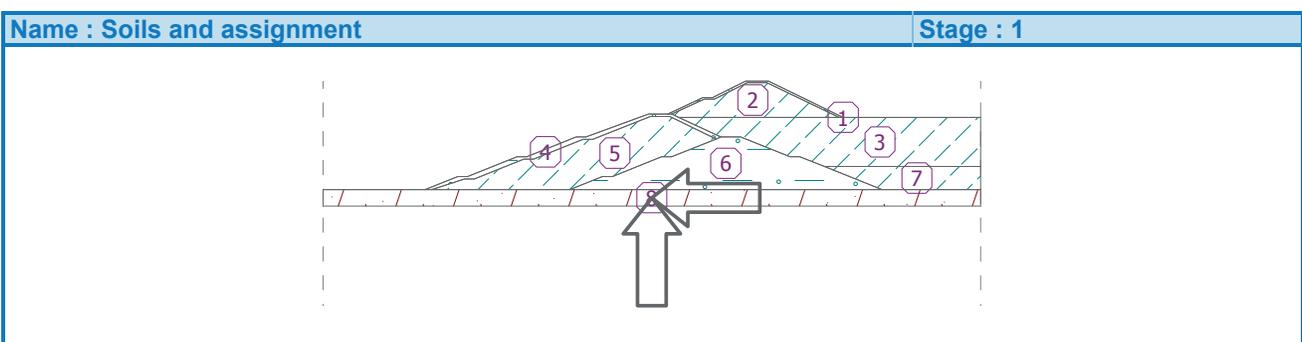
**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	60.50	33.00	Soil Cover (Dyke Raising) 
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
		60.00	32.50	82.00	22.00	
2		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
3		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
4		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
5		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					

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Arun Prasad

Stability Analysis\_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
7		125.00	0.00	125.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
8		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**  
Water type : No water

**Tensile crack**  
Tensile crack not inputted.

**Earthquake**  
Horizontal seismic coefficient :  $K_h = 0.16$   
Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**  
Analysis settings : User-defined  
Analysis type : Safety factor  
Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**  
**Circular slip surface**

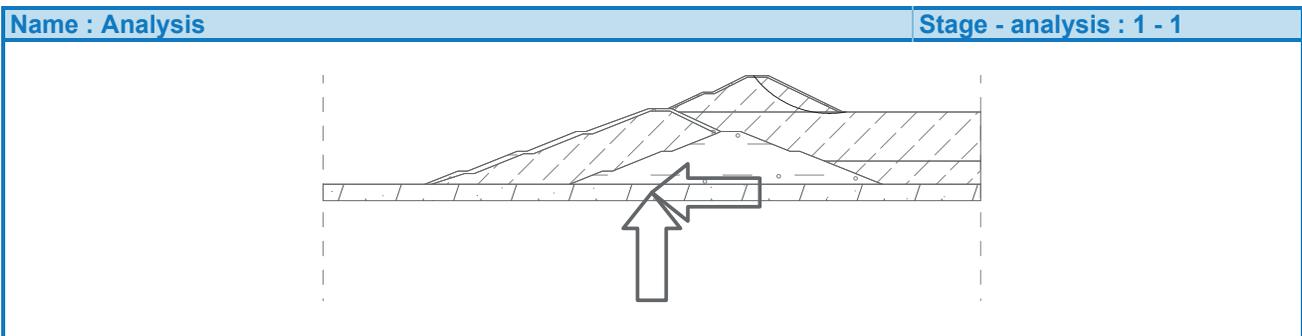
Slip surface parameters					
Center :	x =	78.95 [m]	Angles :	$\alpha_1 =$	-53.09 [°]
	z =	50.23 [m]		$\alpha_2 =$	10.27 [°]
Analysis of the slip surface without optimization.					

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Stability Analysis\_Raised Ash Dyke

Slip surface parameters			
Radius :	R =	28.69 [m]	
Analysis of the slip surface without optimization.			

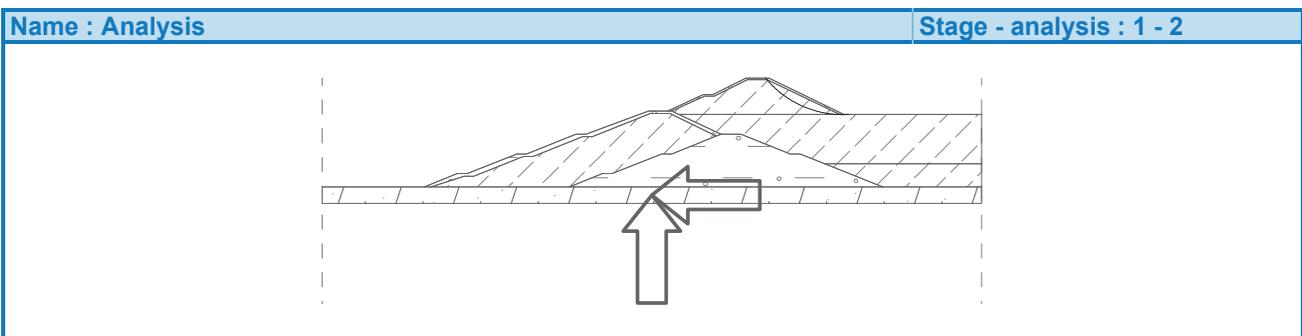
**Slope stability verification (Spencer)**  
Factor of safety = 1.05 > 1.00  
**Slope stability SATISFACTORY**



**Analysis 2**  
**Circular slip surface**

Slip surface parameters					
Center :	x =	82.86 [m]	Angles :	$\alpha_1 =$	-50.76 [°]
	z =	52.04 [m]		$\alpha_2 =$	3.61 [°]
Radius :	R =	30.10 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**  
Factor of safety = 0.95 < 1.00  
**Slope stability NOT SATISF.**



**Analysis 3**  
**Circular slip surface**

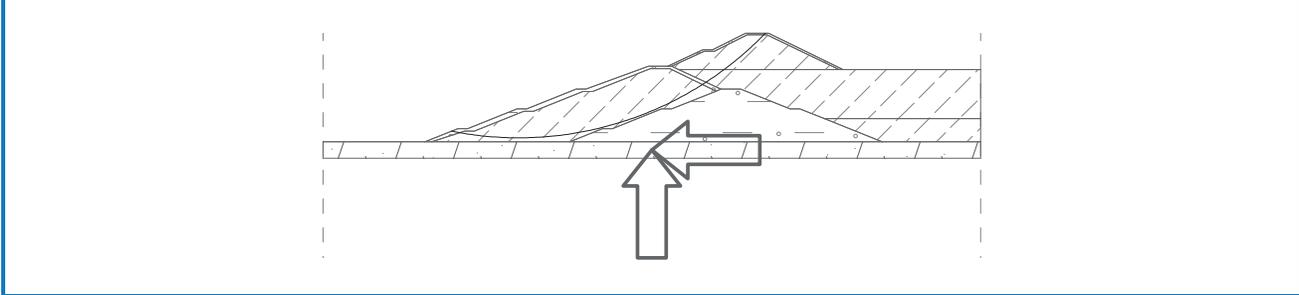
Slip surface parameters					
Center :	x =	-15.56 [m]	Angles :	$\alpha_1 =$	-11.28 [°]
	z =	105.66 [m]		$\alpha_2 =$	45.94 [°]
Radius :	R =	104.48 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**  
Factor of safety = 1.23 > 1.00  
**Slope stability SATISFACTORY**

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Arun Prasad

Stability Analysis\_Raised Ash Dyke

Name : Analysis Stage - analysis : 1 - 3



**Analysis 4**  
**Circular slip surface**

Slip surface parameters					
Center :	x =	2.69 [m]	Angles :	$\alpha_1 =$	-17.91 [°]
	z =	101.93 [m]		$\alpha_2 =$	42.97 [°]
Radius :	R =	101.93 [m]			

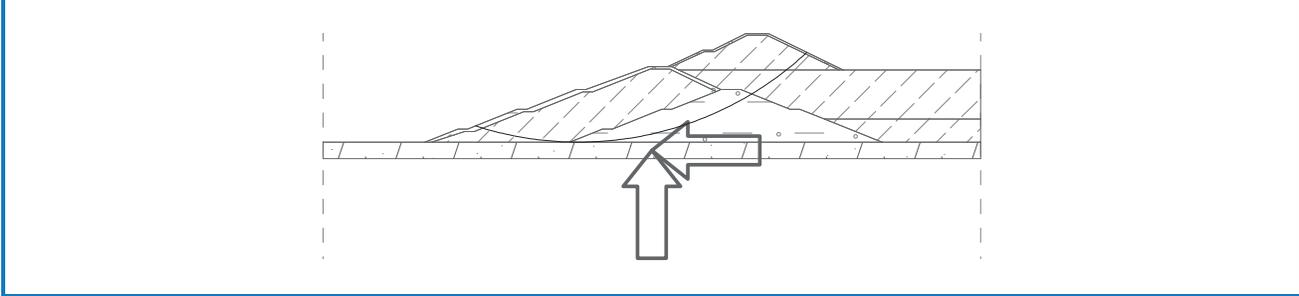
The slip surface after optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.03 > 1.00

**Slope stability SATISFACTORY**

Name : Analysis Stage - analysis : 1 - 4



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Slope stability analysis**

**Project**

Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	62.56	32.00
		83.20	22.00				
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		62.56	32.00	125.00	32.00		
4		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
5		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
6		33.14	22.00	82.00	22.00	83.20	22.00
		125.00	22.00				
7		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
8		77.50	7.00	77.60	7.00	125.00	7.00
9		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

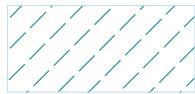
**Soil parameters - effective stress state**

1
[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu] <span style="float: right;">school version</span>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

**Soil parameters - uplift**

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

**Soil parameters**

**Starter Dyke**

Unit weight :  $\gamma = 18.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $C_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 20.00 \text{ kN/m}^3$

**Pond Ash**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $C_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $C_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

**Soil Cover (Dyke Raising)**

2
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[Geo 5 - Slope stability (school version) | version 5.8.13.0 | hardware key 6291 / 1 | Institute of Technology, BHU | Copyright (c) FINE Ltd. 2009 | [www.finesoftware.eu](http://www.finesoftware.eu)]

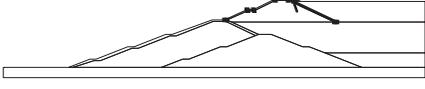
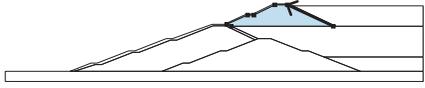
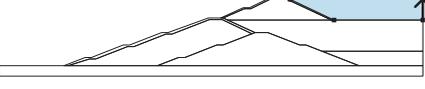
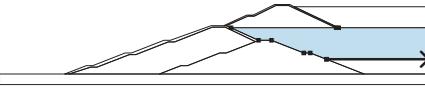
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

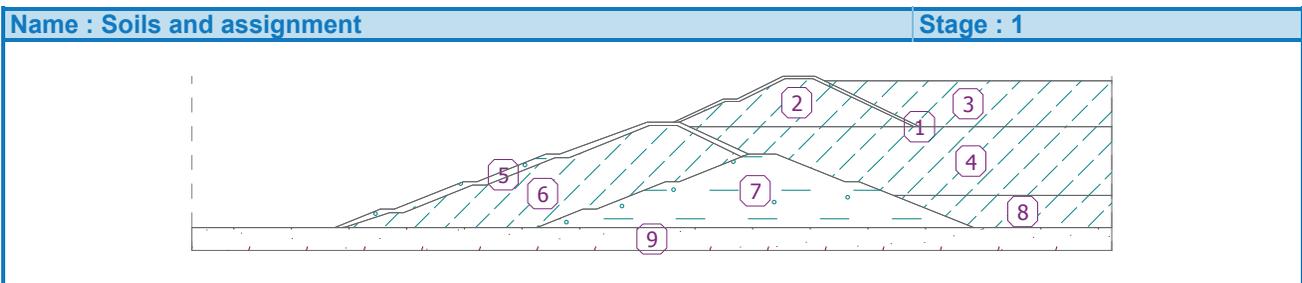
**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	62.56	32.00	Soil Cover (Dyke Raising) 
		60.50	33.00	53.50	33.00	
		43.50	28.00	40.50	28.00	
		29.80	23.00	31.00	23.00	
		41.00	27.50	44.00	27.50	
		54.00	32.50	60.00	32.50	
		82.00	22.00			
2		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
3		125.00	22.00	125.00	32.00	Pond Ash 
		62.56	32.00	83.20	22.00	
4		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
5		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
		-16.00	10.00	-31.00	4.00	
-34.00	4.00	-44.00	0.00			

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising)
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
7		95.00	0.00	77.50	7.00	Starter Dyke
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
8		125.00	0.00	125.00	7.00	Pond Ash
		77.60	7.00	77.50	7.00	
		95.00	0.00			
9		95.00	0.00	0.00	0.00	Foundation
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Analysis settings**

Analysis settings : Standard  
 Analysis type : Safety factor  
 Safety factor : 1.50

**Results (Stage of construction 1)**

**Analysis 1**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Circular slip surface**

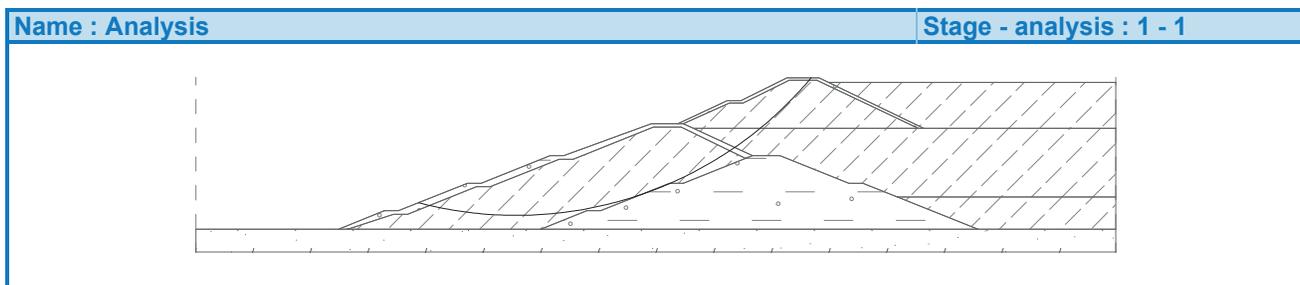
Slip surface parameters							
Center :	x =	-5.36	[m]	Angles :	$\alpha_1 =$	-14.74	[°]
	z =	86.55	[m]		$\alpha_2 =$	50.14	[°]
Radius :	R =	83.55	[m]				

Analysis of the slip surface without optimization.

**Slope stability verification (Spencer)**

Factor of safety = 2.04 > 1.50

**Slope stability SATISFACTORY**



**Analysis 2**

**Circular slip surface**

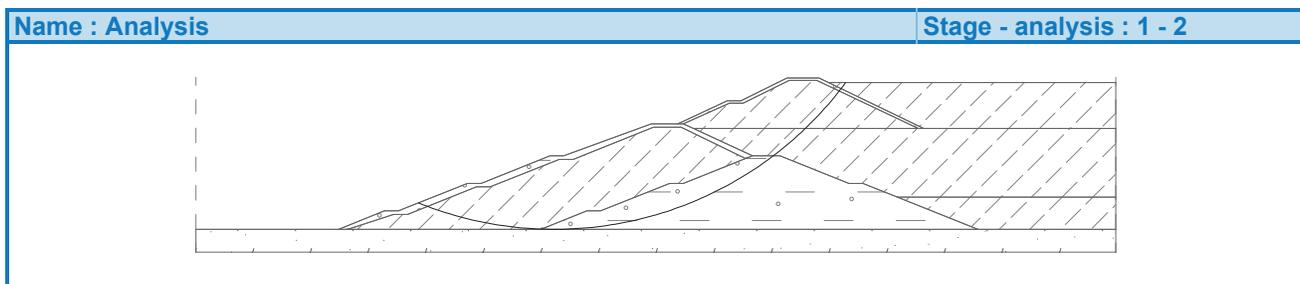
Slip surface parameters							
Center :	x =	2.93	[m]	Angles :	$\alpha_1 =$	-22.06	[°]
	z =	78.66	[m]		$\alpha_2 =$	53.62	[°]
Radius :	R =	78.68	[m]				

The slip surface after optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.57 > 1.50

**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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## Slope stability analysis

### Project

Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

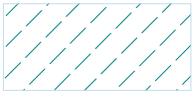
Analysis type : in effective parameters

### Interface

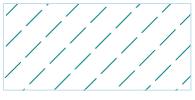
Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	62.56	32.00
		83.20	22.00				
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		62.56	32.00	125.00	32.00		
4		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
5		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
6		33.14	22.00	82.00	22.00	83.20	22.00
		125.00	22.00				
7		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
8		77.50	7.00	77.60	7.00	125.00	7.00
9		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	125.00	0.00

### Soil parameters - effective stress state

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

#### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

#### Soil parameters

##### Starter Dyke

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00$  °  
 Cohesion of soil :  $C_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

##### Pond Ash

Unit weight :  $\gamma = 12.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 30.00$  °  
 Cohesion of soil :  $C_{ef} = 0.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 14.00$  kN/m<sup>3</sup>

##### Ash Hearth (Dyke Raising)

Unit weight :  $\gamma = 12.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 30.00$  °  
 Cohesion of soil :  $C_{ef} = 0.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 14.00$  kN/m<sup>3</sup>

##### Soil Cover (Dyke Raising)

2

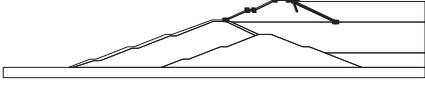
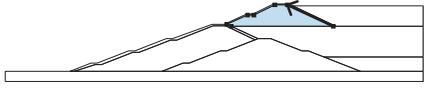
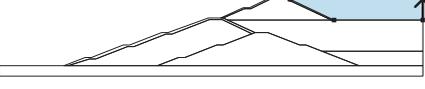
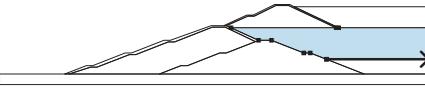
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

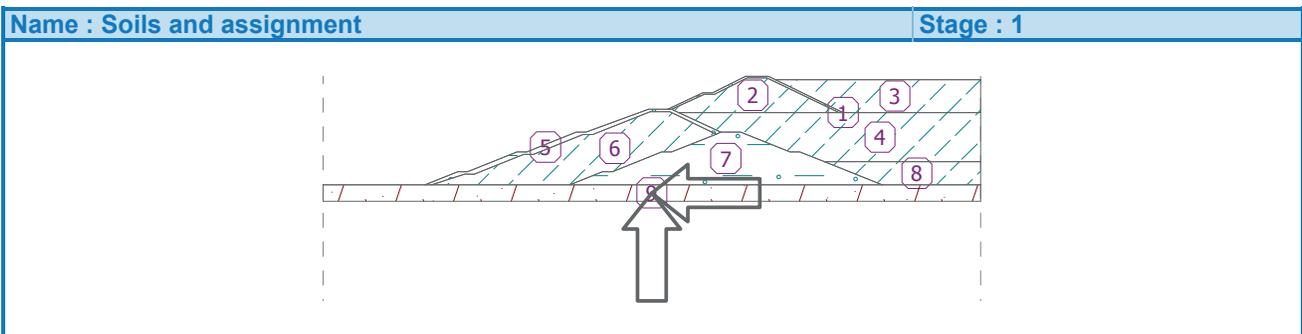
**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	62.56	32.00	Soil Cover (Dyke Raising) 
		60.50	33.00	53.50	33.00	
		43.50	28.00	40.50	28.00	
		29.80	23.00	31.00	23.00	
		41.00	27.50	44.00	27.50	
		54.00	32.50	60.00	32.50	
		82.00	22.00			
2		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
3		125.00	22.00	125.00	32.00	Pond Ash 
		62.56	32.00	83.20	22.00	
4		77.60	7.00	125.00	7.00	Pond Ash 
		125.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
77.50	7.00					
5		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising)
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
7		95.00	0.00	77.50	7.00	Starter Dyke
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
8		125.00	0.00	125.00	7.00	Pond Ash
		77.60	7.00	77.50	7.00	
		95.00	0.00			
9		95.00	0.00	0.00	0.00	Foundation
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		125.00	-5.00	125.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Horizontal seismic coefficient :  $K_h = 0.16$

Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined

Analysis type : Safety factor

Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

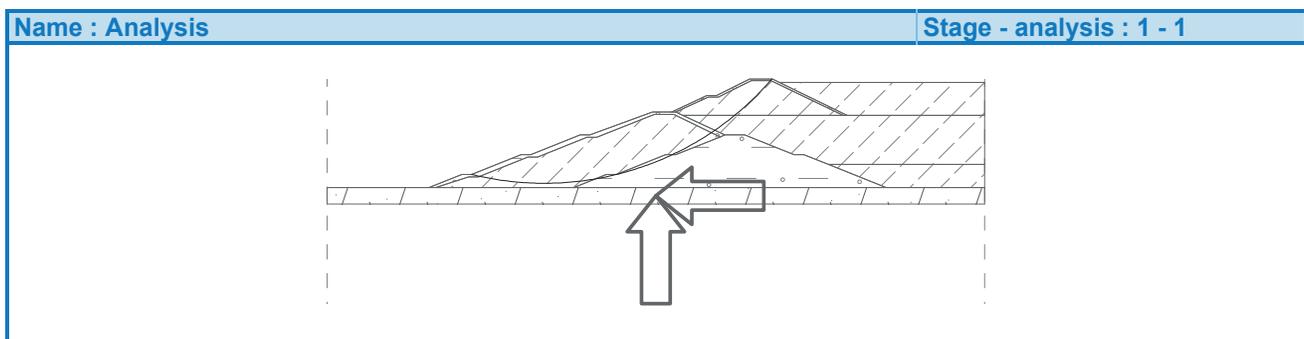
**Circular slip surface**

Slip surface parameters				
Center :	x =	-8.96 [m]	Angles :	$\alpha_1 =$ -14.01 [°]
	z =	92.75 [m]		$\alpha_2 =$ 49.22 [°]
Radius :	R =	91.47 [m]		
Analysis of the slip surface without optimization.				

**Slope stability verification (Spencer)**

Factor of safety = 1.14 > 1.00

**Slope stability SATISFACTORY**



**Analysis 2**

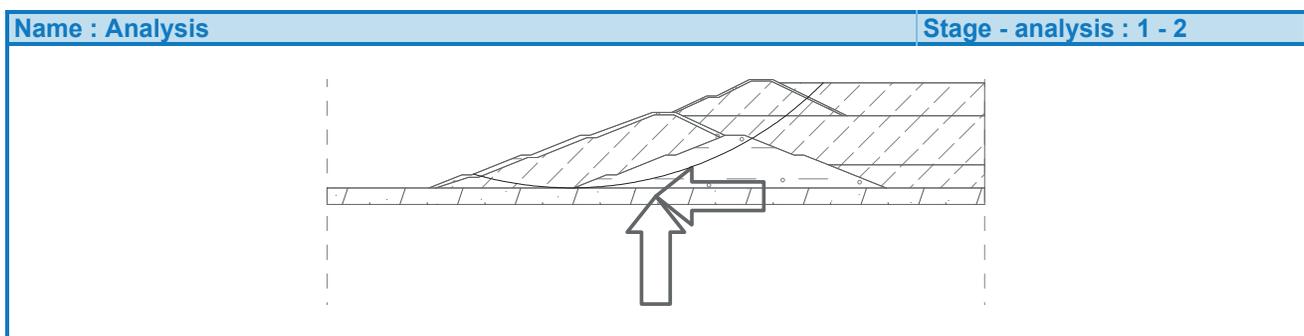
**Circular slip surface**

Slip surface parameters				
Center :	x =	-0.69 [m]	Angles :	$\alpha_1 =$ -16.05 [°]
	z =	107.73 [m]		$\alpha_2 =$ 45.33 [°]
Radius :	R =	107.72 [m]		
The slip surface after optimization.				

**Slope stability verification (Spencer)**

Factor of safety = 1.03 > 1.00

**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Slope stability analysis**

**Project**

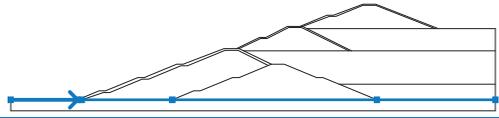
Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

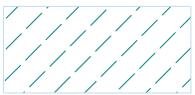
**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		59.30	33.00	71.80	38.00	74.80	38.00
		88.50	43.00	94.50	43.00	123.50	32.00
2		60.50	33.00	73.00	37.50	76.00	37.50
		88.50	42.50	94.50	42.50	122.00	32.00
3		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	59.30	33.00	60.50	33.00
		62.56	32.00	83.20	22.00		
4		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
5		62.56	32.00	122.00	32.00	123.50	32.00
		150.00	32.00				
6		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
7		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
8		33.14	22.00	82.00	22.00	83.20	22.00
		150.00	22.00				
9		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
10		77.50	7.00	77.60	7.00	150.00	7.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
11		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	150.00	0.00

### Soil parameters - effective stress state

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

### Soil parameters - uplift

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

### Soil parameters

#### Starter Dyke

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

#### Pond Ash

Unit weight :  $\gamma = 12.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 14.00$  kN/m<sup>3</sup>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

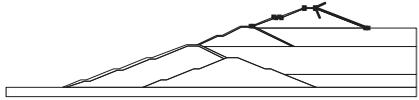
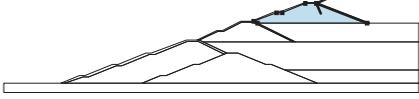
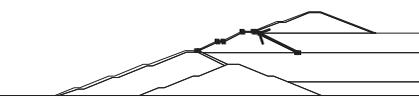
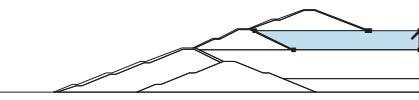
**Soil Cover (Dyke Raising)**

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

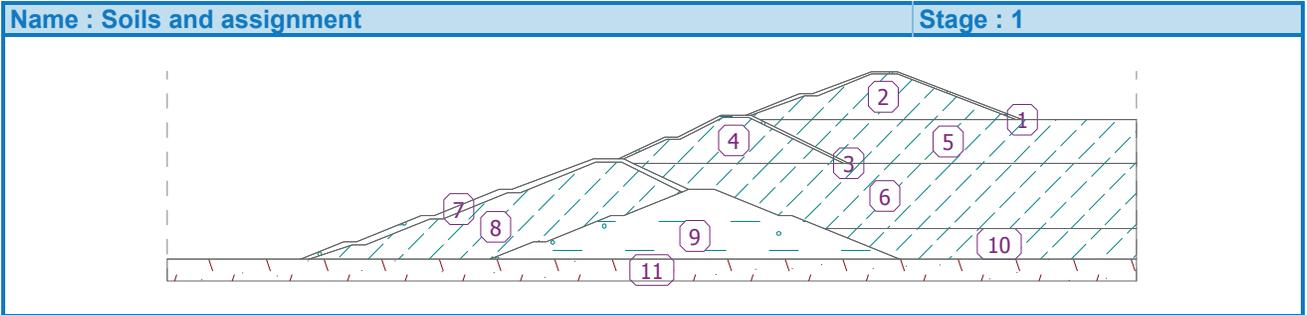
**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		123.50	32.00	94.50	43.00	Soil Cover (Dyke Raising) 
		88.50	43.00	74.80	38.00	
		71.80	38.00	59.30	33.00	
		60.50	33.00	73.00	37.50	
		76.00	37.50	88.50	42.50	
2		94.50	42.50	122.00	32.00	Ash Hearth (Dyke Raising) 
		122.00	32.00	94.50	42.50	
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
3		62.56	32.00			Soil Cover (Dyke Raising) 
		83.20	22.00	62.56	32.00	
		60.50	33.00	59.30	33.00	
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
4		44.00	27.50	54.00	32.50	Ash Hearth (Dyke Raising) 
		60.00	32.50	82.00	22.00	
		82.00	22.00	60.00	32.50	
		54.00	32.50	44.00	27.50	
5		41.00	27.50	31.00	23.00	Pond Ash 
		33.14	22.00			
		150.00	22.00	150.00	32.00	
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		77.60	7.00	150.00	7.00	Pond Ash 
		150.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
7		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			
8		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
9		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
10		150.00	0.00	150.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
11		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		150.00	-5.00	150.00	0.00	

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Arun Prasad

Stability Analysis\_Raised Ash Dyke



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Analysis settings**

Analysis settings : User-defined  
 Analysis type : Safety factor  
 Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

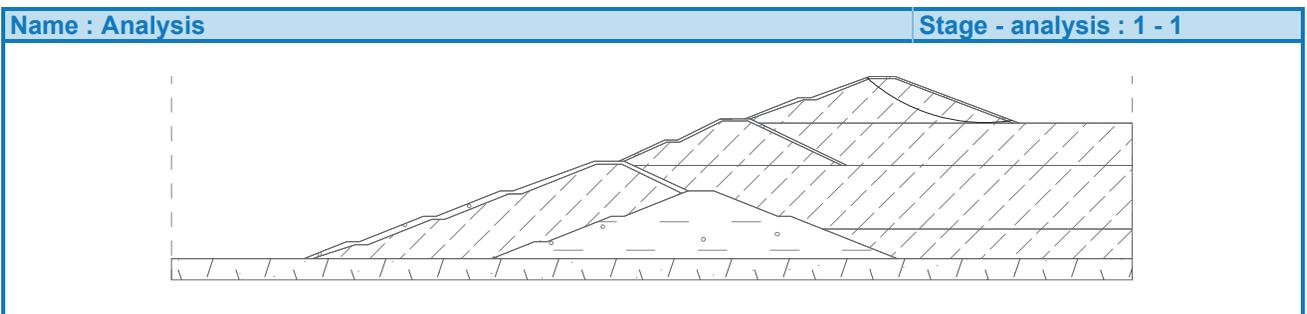
**Circular slip surface**

Slip surface parameters					
Center :	x =	115.45 [m]	Angles :	$\alpha_1 =$	-42.08 [°]
	z =	73.34 [m]		$\alpha_2 =$	8.90 [°]
Radius :	R =	41.20 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**

Factor of safety = 2.07 > 1.00

**Slope stability SATISFACTORY**



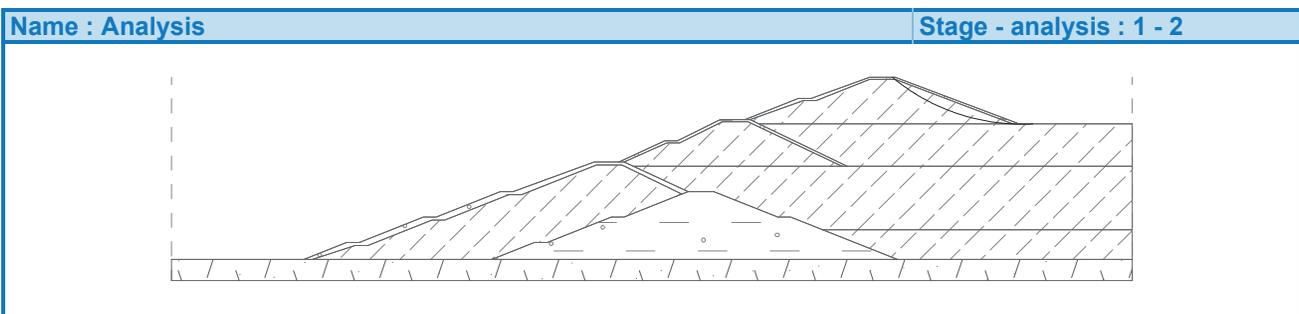
**Analysis 2**

**Circular slip surface**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Slip surface parameters					
Center :	x =	124.26 [m]	Angles :	$\alpha_1 =$	-39.95 [°]
	z =	79.35 [m]		$\alpha_2 =$	3.00 [°]
Radius :	R =	47.42 [m]			
The slip surface after optimization.					

**Slope stability verification (Spencer)**  
 Factor of safety = 1.72 > 1.00  
**Slope stability SATISFACTORY**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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### Slope stability analysis

#### Project

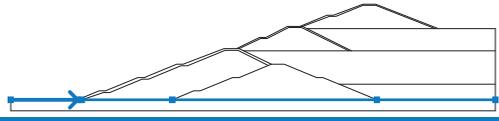
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 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

#### Interface

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		59.30	33.00	71.80	38.00	74.80	38.00
		88.50	43.00	94.50	43.00	123.50	32.00
2		60.50	33.00	73.00	37.50	76.00	37.50
		88.50	42.50	94.50	42.50	122.00	32.00
3		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	59.30	33.00	60.50	33.00
		62.56	32.00	83.20	22.00		
4		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
5		62.56	32.00	122.00	32.00	123.50	32.00
		150.00	32.00				
6		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
7		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
8		33.14	22.00	82.00	22.00	83.20	22.00
		150.00	22.00				
9		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
10		77.50	7.00	77.60	7.00	150.00	7.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
11		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	150.00	0.00

**Soil parameters - effective stress state**

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

**Soil parameters - uplift**

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

**Soil parameters**

**Starter Dyke**

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

**Pond Ash**

Unit weight :  $\gamma = 12.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 14.00$  kN/m<sup>3</sup>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

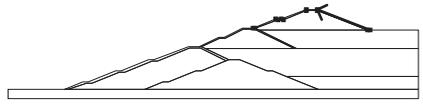
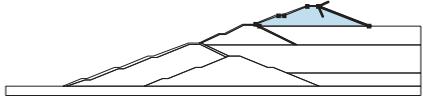
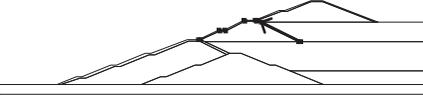
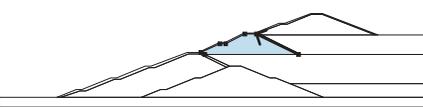
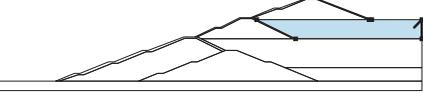
**Soil Cover (Dyke Raising)**

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

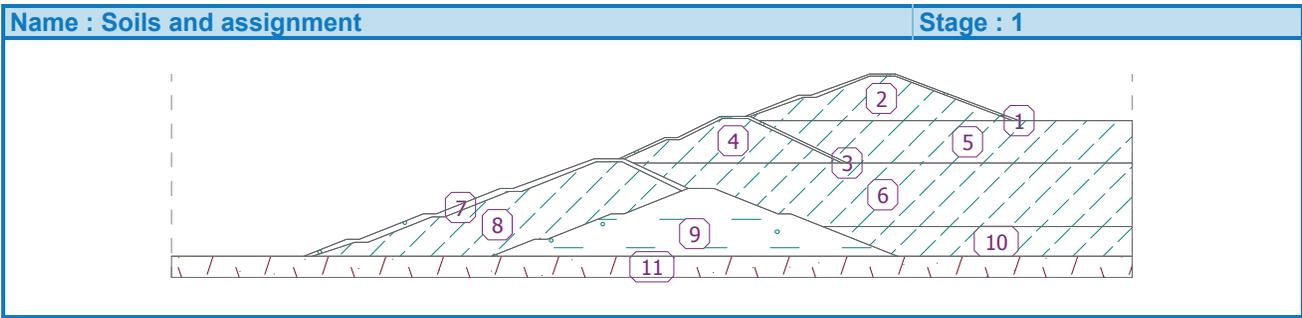
**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		123.50	32.00	94.50	43.00	Soil Cover (Dyke Raising) 
		88.50	43.00	74.80	38.00	
		71.80	38.00	59.30	33.00	
		60.50	33.00	73.00	37.50	
		76.00	37.50	88.50	42.50	
2		94.50	42.50	122.00	32.00	Ash Hearth (Dyke Raising) 
		122.00	32.00	94.50	42.50	
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
3		62.56	32.00			Soil Cover (Dyke Raising) 
		83.20	22.00	62.56	32.00	
		60.50	33.00	59.30	33.00	
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
4		44.00	27.50	54.00	32.50	Ash Hearth (Dyke Raising) 
		60.00	32.50	82.00	22.00	
		82.00	22.00	60.00	32.50	
		54.00	32.50	44.00	27.50	
5		41.00	27.50	31.00	23.00	Pond Ash 
		33.14	22.00			
		150.00	22.00	150.00	32.00	
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		77.60	7.00	150.00	7.00	Pond Ash 
		150.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
7		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			
8		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
9		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
10		150.00	0.00	150.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
11		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		150.00	-5.00	150.00	0.00	

IIT (BHU) Varanasi  
Arun Prasad

Stability Analysis\_Raised Ash Dyke



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Earthquake not included.

**Analysis settings**

Analysis settings : Standard  
 Analysis type : Safety factor  
 Safety factor : 1.50

**Results (Stage of construction 1)**

**Analysis 1**

**Circular slip surface**

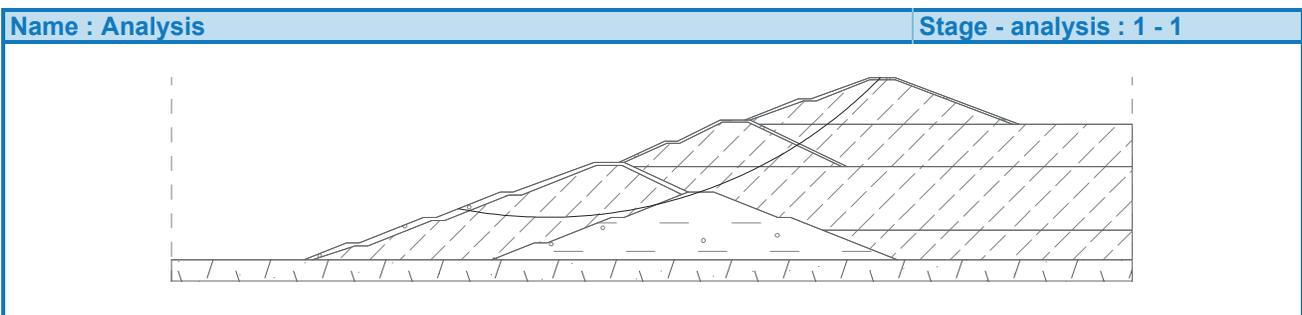
Slip surface parameters			
Center :	x =	13.17 [m]	Angles :
	z =	118.48 [m]	
Radius :	R =	108.44 [m]	$\alpha_1 = -11.14 [^\circ]$ $\alpha_2 = 45.89 [^\circ]$

Analysis of the slip surface without optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.95 > 1.50

**Slope stability SATISFACTORY**



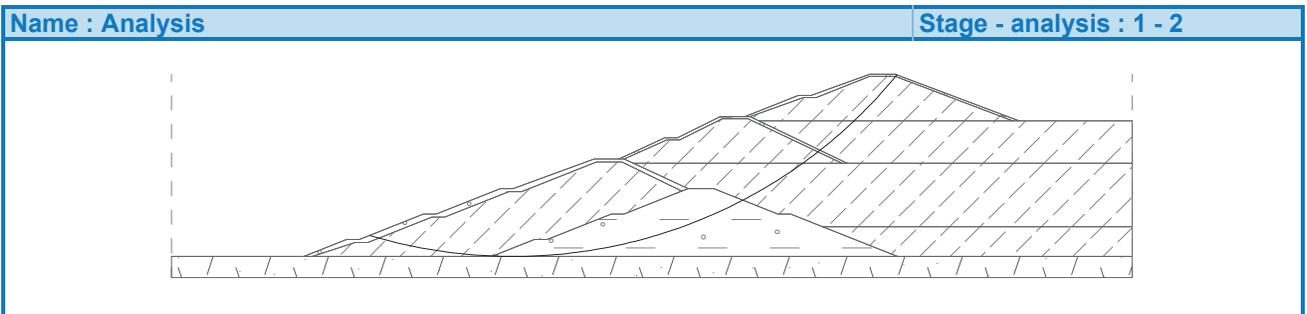
**Analysis 2**

**Circular slip surface**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Slip surface parameters							
Center :	x =	4.97	[m]	Angles :	$\alpha_1 =$	-16.86	[°]
	z =	115.67	[m]		$\alpha_2 =$	51.00	[°]
Radius :	R =	115.68	[m]				
The slip surface after optimization.							

**Slope stability verification (Spencer)**  
 Factor of safety = 1.42 < 1.50  
**Slope stability NOT SATISF.**



IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Slope stability analysis**

**Project**

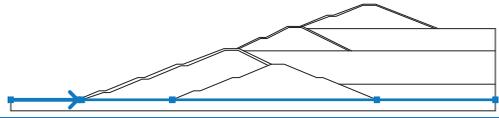
Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		59.30	33.00	71.80	38.00	74.80	38.00
		88.50	43.00	94.50	43.00	123.50	32.00
2		60.50	33.00	73.00	37.50	76.00	37.50
		88.50	42.50	94.50	42.50	122.00	32.00
3		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	59.30	33.00	60.50	33.00
		62.56	32.00	83.20	22.00		
4		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
5		62.56	32.00	122.00	32.00	123.50	32.00
		150.00	32.00				
6		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
7		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
8		33.14	22.00	82.00	22.00	83.20	22.00
		150.00	22.00				
9		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00
10		77.50	7.00	77.60	7.00	150.00	7.00

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
11		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	150.00	0.00

**Soil parameters - effective stress state**

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

**Soil parameters - uplift**

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

**Soil parameters**

**Starter Dyke**

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

**Pond Ash**

Unit weight :  $\gamma = 12.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 14.00$  kN/m<sup>3</sup>

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

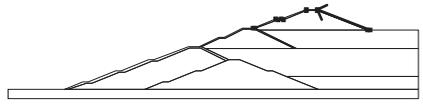
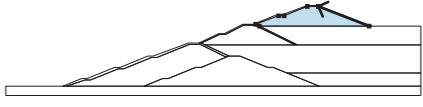
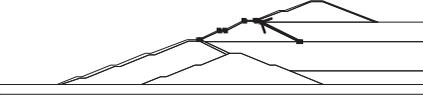
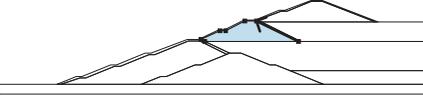
**Soil Cover (Dyke Raising)**

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

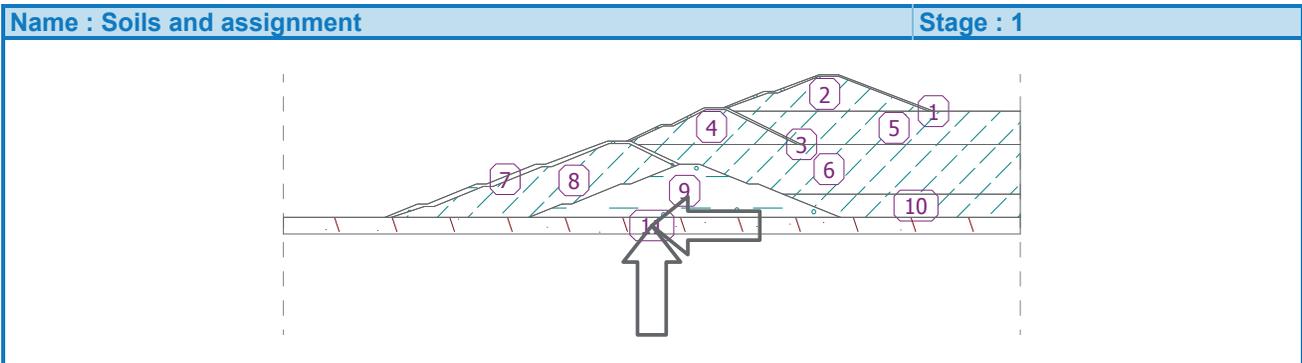
**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

**Assigning and surfaces**

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		123.50	32.00	94.50	43.00	Soil Cover (Dyke Raising) 
		88.50	43.00	74.80	38.00	
		71.80	38.00	59.30	33.00	
		60.50	33.00	73.00	37.50	
		76.00	37.50	88.50	42.50	
2		94.50	42.50	122.00	32.00	Ash Hearth (Dyke Raising) 
		122.00	32.00	94.50	42.50	
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
3		62.56	32.00			Soil Cover (Dyke Raising) 
		83.20	22.00	62.56	32.00	
		60.50	33.00	59.30	33.00	
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
4		60.00	32.50	82.00	22.00	Ash Hearth (Dyke Raising) 
		82.00	22.00	60.00	32.50	
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
5		33.14	22.00			Pond Ash 
		150.00	22.00	150.00	32.00	
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
6		77.60	7.00	150.00	7.00	Pond Ash 
		150.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
		77.50	7.00			
7		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			
8		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
9		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
10		150.00	0.00	150.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			
11		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		150.00	-5.00	150.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Horizontal seismic coefficient :  $K_h = 0.16$

Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined

Analysis type : Safety factor

Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

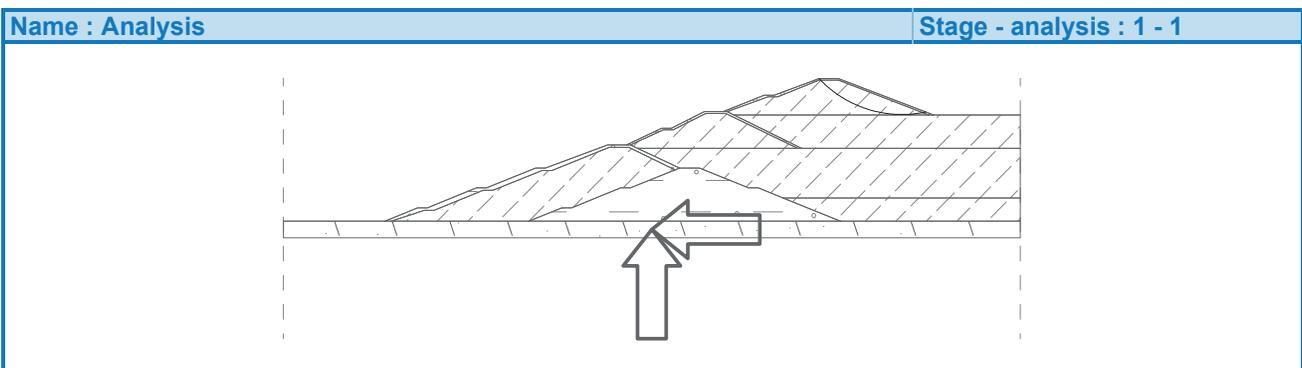
**Circular slip surface**

Slip surface parameters				
Center :	x =	113.86 [m]	Angles :	$\alpha_1 = -46.37 [^\circ]$
	z =	67.13 [m]		$\alpha_2 = 11.93 [^\circ]$
Radius :	R =	34.97 [m]		
Analysis of the slip surface without optimization.				

**Slope stability verification (Spencer)**

Factor of safety = 1.29 > 1.00

**Slope stability SATISFACTORY**



**Analysis 2**

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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**Circular slip surface**

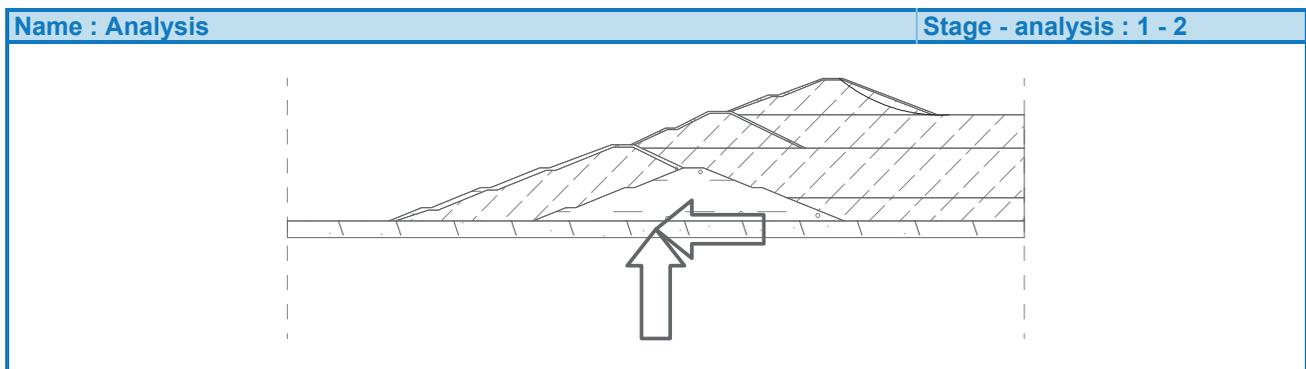
Slip surface parameters					
Center :	x =	124.39 [m]	Angles :	$\alpha_1 =$	-39.40 [°]
	z =	80.64 [m]		$\alpha_2 =$	3.14 [°]
Radius :	R =	48.71 [m]			

The slip surface after optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.09 > 1.00

**Slope stability SATISFACTORY**



**Analysis 3**

**Circular slip surface**

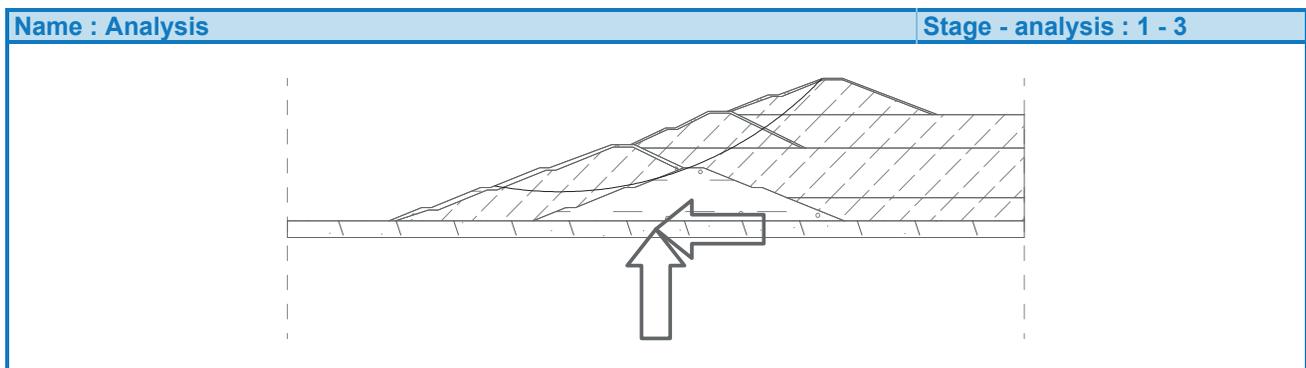
Slip surface parameters					
Center :	x =	8.11 [m]	Angles :	$\alpha_1 =$	-10.26 [°]
	z =	119.70 [m]		$\alpha_2 =$	46.16 [°]
Radius :	R =	110.93 [m]			

Analysis of the slip surface without optimization.

**Slope stability verification (Spencer)**

Factor of safety = 1.20 > 1.00

**Slope stability SATISFACTORY**



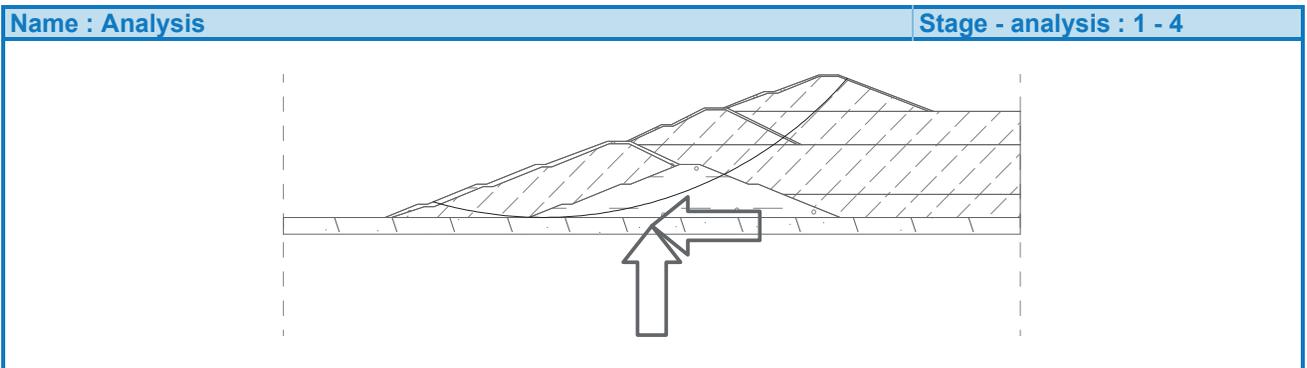
**Analysis 4**

**Circular slip surface**

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Slip surface parameters							
Center :	x =	4.36	[m]	Angles :	$\alpha_1 =$	-15.79	[°]
	z =	123.67	[m]		$\alpha_2 =$	48.65	[°]
Radius :	R =	123.65	[m]				
The slip surface after optimization.							

**Slope stability verification (Spencer)**  
 Factor of safety = 0.93 < 1.00  
**Slope stability NOT SATISF.**



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**Slope stability analysis**

**Project**

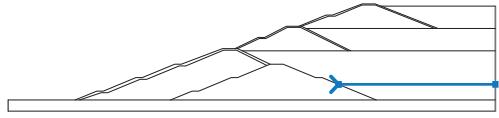
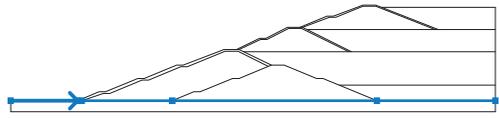
Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

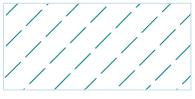
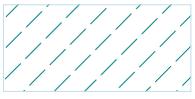
**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		59.30	33.00	71.80	38.00	74.80	38.00
		88.50	43.00	94.50	43.00	97.14	42.00
		123.50	32.00				
2		60.50	33.00	73.00	37.50	76.00	37.50
		88.50	42.50	94.50	42.50	95.81	42.00
		122.00	32.00				
3		97.14	42.00	150.00	42.00		
4		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	59.30	33.00	60.50	33.00
		62.56	32.00	83.20	22.00		
5		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
6		62.56	32.00	122.00	32.00	123.50	32.00
		150.00	32.00				
7		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
8		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
9		33.14	22.00	82.00	22.00	83.20	22.00
		150.00	22.00				
10		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00

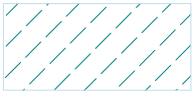
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
11		77.50	7.00	77.60	7.00	150.00	7.00
12		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	150.00	0.00

**Soil parameters - effective stress state**

Number	Name	Pattern	$\phi_{ef}$ [°]	$C_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

**Soil parameters - uplift**

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

**Soil parameters**

**Starter Dyke**

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $C_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

**Pond Ash**

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Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

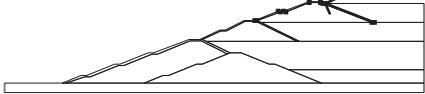
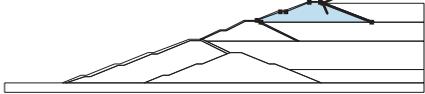
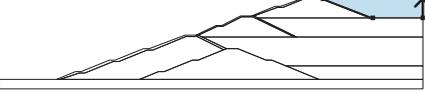
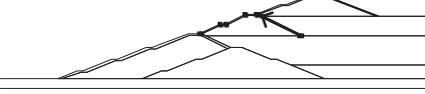
**Soil Cover (Dyke Raising)**

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

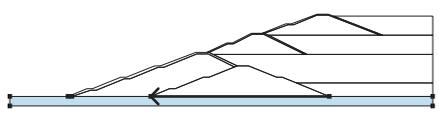
**Assigning and surfaces**

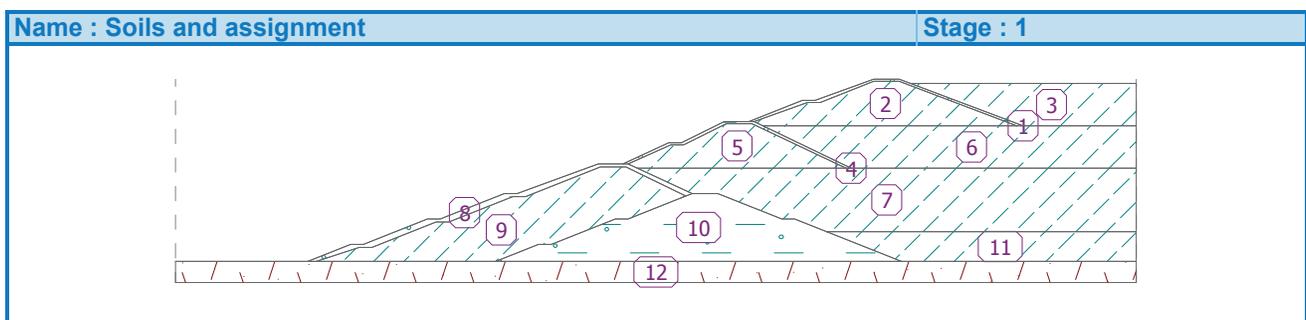
Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		123.50	32.00	97.14	42.00	Soil Cover (Dyke Raising) 
		94.50	43.00	88.50	43.00	
		74.80	38.00	71.80	38.00	
		59.30	33.00	60.50	33.00	
		73.00	37.50	76.00	37.50	
		88.50	42.50	94.50	42.50	
2		122.00	32.00	95.81	42.00	Ash Hearth (Dyke Raising) 
		94.50	42.50	88.50	42.50	
		76.00	37.50	73.00	37.50	
		60.50	33.00	62.56	32.00	
3		150.00	32.00	150.00	42.00	Pond Ash 
		97.14	42.00	123.50	32.00	
4		83.20	22.00	62.56	32.00	Soil Cover (Dyke Raising) 
		60.50	33.00	59.30	33.00	
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
		60.00	32.50	82.00	22.00	

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising) 
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
6		150.00	22.00	150.00	32.00	Pond Ash 
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	
7		77.60	7.00	150.00	7.00	Pond Ash 
		150.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
77.50	7.00					
8		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising) 
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
-16.00	10.00	-31.00	4.00			
-34.00	4.00	-44.00	0.00			
9		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising) 
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
-42.00	0.00					
10		95.00	0.00	77.50	7.00	Starter Dyke 
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
11		150.00	0.00	150.00	7.00	Pond Ash 
		77.60	7.00	77.50	7.00	
		95.00	0.00			

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Stability Analysis\_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
12		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		150.00	-5.00	150.00	0.00	



**Water**  
Water type : No water

**Tensile crack**  
Tensile crack not inputted.

**Earthquake**  
Earthquake not included.

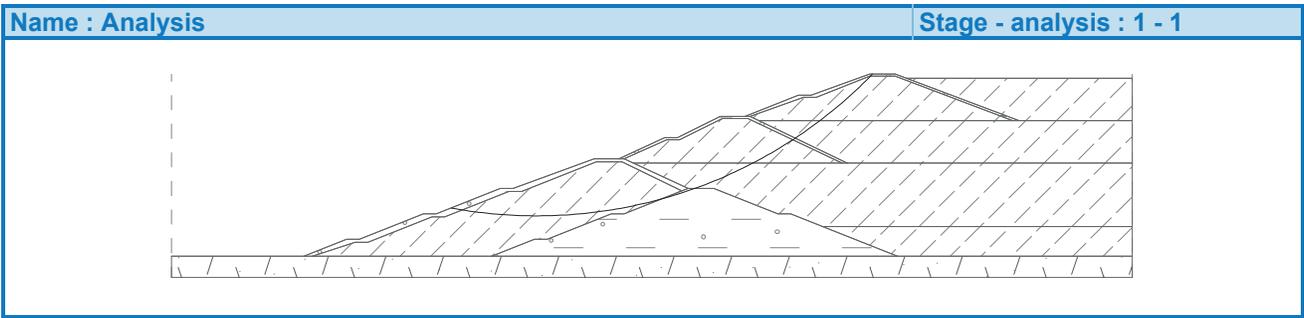
**Analysis settings**  
Analysis settings : Standard  
Analysis type : Safety factor  
Safety factor : 1.50

**Results (Stage of construction 1)**

**Analysis 1**  
**Circular slip surface**

Slip surface parameters					
Center :	x =	10.52 [m]	Angles :	$\alpha_1 =$	-10.59 [°]
	z =	118.66 [m]		$\alpha_2 =$	46.11 [°]
Radius :	R =	109.13 [m]			
Analysis of the slip surface without optimization.					

**Slope stability verification (Spencer)**  
Factor of safety = 1.98 > 1.50  
**Slope stability SATISFACTORY**

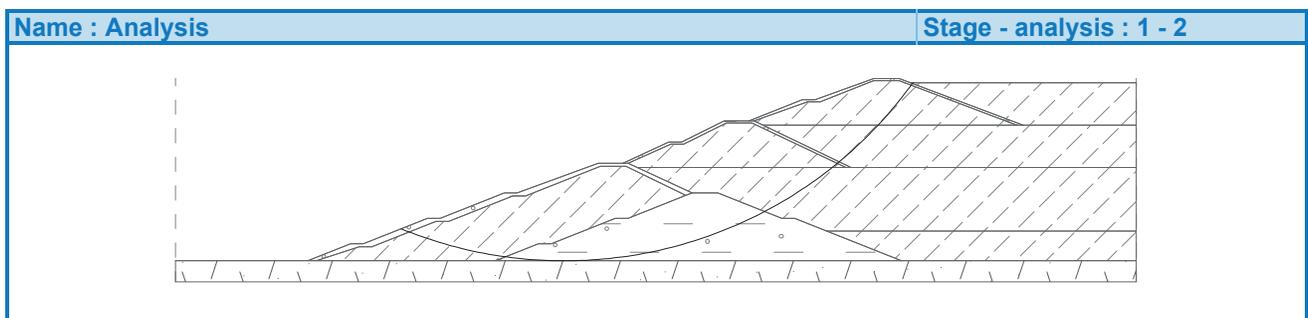


**Analysis 2**  
**Circular slip surface**

Slip surface parameters				
Center :	x =	16.04 [m]	Angles :	α <sub>1</sub> = -22.39 [°]
	z =	100.30 [m]		α <sub>2</sub> = 54.47 [°]
Radius :	R =	100.33 [m]		

The slip surface after optimization.

**Slope stability verification (Spencer)**  
Factor of safety = 1.44 < 1.50  
**Slope stability NOT SATISF.**



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**Slope stability analysis**

**Project**

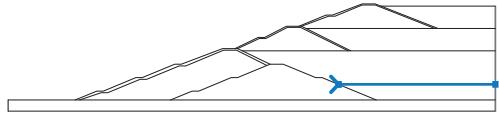
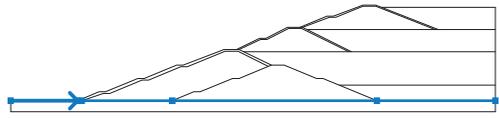
Task : Stability Analysis\_Raised Ash Dyke  
 User : Arun Prasad  
 Author : Arun Prasad  
 Date : 12-07-2020

Analysis type : in effective parameters

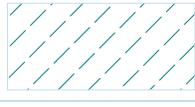
**Interface**

Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		59.30	33.00	71.80	38.00	74.80	38.00
		88.50	43.00	94.50	43.00	97.14	42.00
		123.50	32.00				
2		60.50	33.00	73.00	37.50	76.00	37.50
		88.50	42.50	94.50	42.50	95.81	42.00
		122.00	32.00				
3		97.14	42.00	150.00	42.00		
4		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	59.30	33.00	60.50	33.00
		62.56	32.00	83.20	22.00		
5		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
6		62.56	32.00	122.00	32.00	123.50	32.00
		150.00	32.00				
7		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	2.00	16.00
		5.00	16.00	24.00	23.00	29.80	23.00
		31.00	23.00	33.14	22.00	46.00	16.00
8		-42.00	0.00	-32.00	3.25	-29.00	3.25
		-14.00	9.25	-11.00	9.25	4.00	15.25
		7.00	15.25	24.50	22.25	30.50	22.25
		44.53	15.41				
9		33.14	22.00	82.00	22.00	83.20	22.00
		150.00	22.00				
10		0.00	0.00	10.00	4.00	13.00	4.00
		28.00	10.00	31.00	10.00	44.53	15.41
		46.00	16.00	52.00	16.00	67.00	10.00
		70.00	10.00	77.50	7.00	95.00	0.00

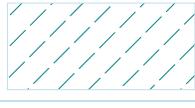
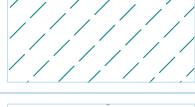
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke
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Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
11		77.50	7.00	77.60	7.00	150.00	7.00
12		-75.00	0.00	-44.00	0.00	-42.00	0.00
		0.00	0.00	95.00	0.00	150.00	0.00

**Soil parameters - effective stress state**

Number	Name	Pattern	$\phi_{ef}$ [°]	$c_{ef}$ [kPa]	$\gamma$ [kN/m <sup>3</sup> ]
1	Starter Dyke		5.00	64.00	18.00
2	Pond Ash		30.00	0.00	12.00
3	Ash Hearth (Dyke Raising)		30.00	0.00	12.00
4	Soil Cover (Dyke Raising)		5.00	64.00	19.06

**Soil parameters - uplift**

Number	Name	Pattern	$\gamma_{sat}$ [kN/m <sup>3</sup> ]	$\gamma_s$ [kN/m <sup>3</sup> ]	n [-]
1	Starter Dyke		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Raising)		14.00		
4	Soil Cover (Dyke Raising)		21.00		

**Soil parameters**

**Starter Dyke**

Unit weight :  $\gamma = 18.00$  kN/m<sup>3</sup>  
 Angle of internal friction :  $\phi_{ef} = 5.00$  °  
 Cohesion of soil :  $c_{ef} = 64.00$  kPa  
 Saturated unit weight :  $\gamma_{sat} = 20.00$  kN/m<sup>3</sup>

**Pond Ash**

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<small>[Geo 5 - Slope stability (school version)   version 5.8.13.0   hardware key 6291 / 1   Institute of Technology, BHU   Copyright (c) FINE Ltd. 2009   www.finesoftware.eu]</small>

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Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

**Ash Hearth (Dyke Raising)**

Unit weight :  $\gamma = 12.00 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 30.00^\circ$   
 Cohesion of soil :  $c_{ef} = 0.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 14.00 \text{ kN/m}^3$

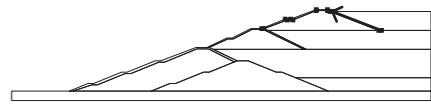
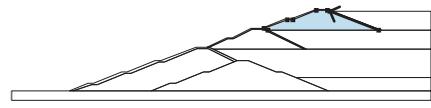
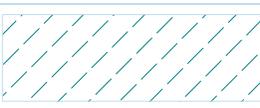
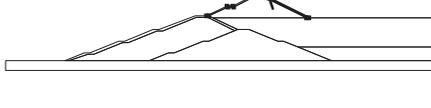
**Soil Cover (Dyke Raising)**

Unit weight :  $\gamma = 19.06 \text{ kN/m}^3$   
 Angle of internal friction :  $\varphi_{ef} = 5.00^\circ$   
 Cohesion of soil :  $c_{ef} = 64.00 \text{ kPa}$   
 Saturated unit weight :  $\gamma_{sat} = 21.00 \text{ kN/m}^3$

**Rigid bodies**

Number	Name	Sample	$\gamma$ [kN/m <sup>3</sup> ]
1	Foundation		26.00

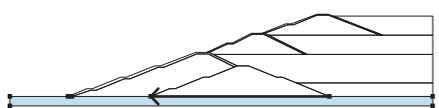
**Assigning and surfaces**

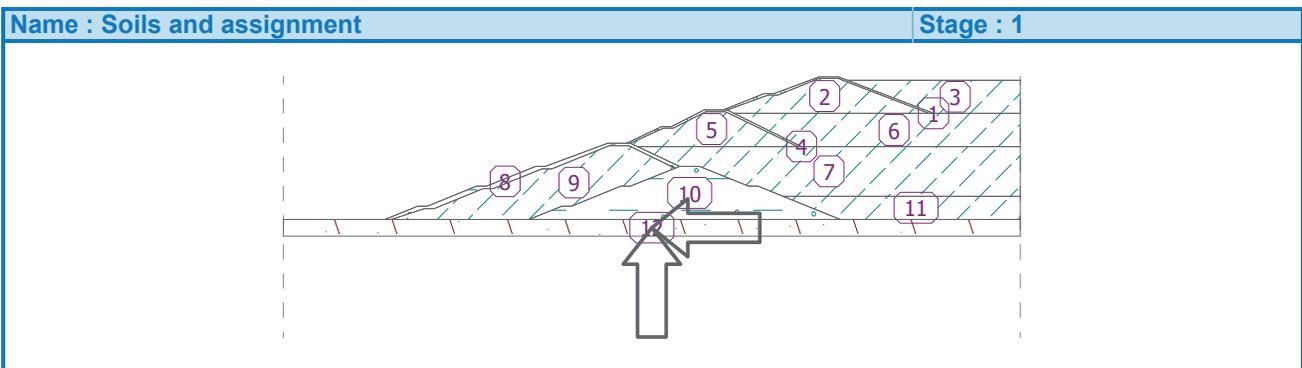
Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		123.50	32.00	97.14	42.00	Soil Cover (Dyke Raising) 
		94.50	43.00	88.50	43.00	
		74.80	38.00	71.80	38.00	
		59.30	33.00	60.50	33.00	
		73.00	37.50	76.00	37.50	
		88.50	42.50	94.50	42.50	
2		122.00	32.00	95.81	42.00	Ash Hearth (Dyke Raising) 
		94.50	42.50	88.50	42.50	
		76.00	37.50	73.00	37.50	
		60.50	33.00	62.56	32.00	
3		150.00	32.00	150.00	42.00	Pond Ash 
		97.14	42.00	123.50	32.00	
4		83.20	22.00	62.56	32.00	Soil Cover (Dyke Raising) 
		60.50	33.00	59.30	33.00	
		53.50	33.00	43.50	28.00	
		40.50	28.00	29.80	23.00	
		31.00	23.00	41.00	27.50	
		44.00	27.50	54.00	32.50	
		60.00	32.50	82.00	22.00	

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising)
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
6		150.00	22.00	150.00	32.00	Pond Ash
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	
7		77.60	7.00	150.00	7.00	Pond Ash
		150.00	22.00	83.20	22.00	
		82.00	22.00	33.14	22.00	
		46.00	16.00	52.00	16.00	
		67.00	10.00	70.00	10.00	
8		-42.00	0.00	-32.00	3.25	Soil Cover (Dyke Raising)
		-29.00	3.25	-14.00	9.25	
		-11.00	9.25	4.00	15.25	
		7.00	15.25	24.50	22.25	
		30.50	22.25	44.53	15.41	
		46.00	16.00	33.14	22.00	
		31.00	23.00	29.80	23.00	
		24.00	23.00	5.00	16.00	
		2.00	16.00	-13.00	10.00	
9		0.00	0.00	10.00	4.00	Ash Hearth (Dyke Raising)
		13.00	4.00	28.00	10.00	
		31.00	10.00	44.53	15.41	
		30.50	22.25	24.50	22.25	
		7.00	15.25	4.00	15.25	
		-11.00	9.25	-14.00	9.25	
		-29.00	3.25	-32.00	3.25	
10		95.00	0.00	77.50	7.00	Starter Dyke
		70.00	10.00	67.00	10.00	
		52.00	16.00	46.00	16.00	
		44.53	15.41	31.00	10.00	
		28.00	10.00	13.00	4.00	
		10.00	4.00	0.00	0.00	
11		150.00	0.00	150.00	7.00	Pond Ash
		77.60	7.00	77.50	7.00	
		95.00	0.00			

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Stability Analysis\_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
12		95.00	0.00	0.00	0.00	Foundation 
		-42.00	0.00	-44.00	0.00	
		-75.00	0.00	-75.00	-5.00	
		150.00	-5.00	150.00	0.00	



**Water**

Water type : No water

**Tensile crack**

Tensile crack not inputted.

**Earthquake**

Horizontal seismic coefficient :  $K_h = 0.16$

Vertical seismic coefficient :  $K_v = 0.16$

**Analysis settings**

Analysis settings : User-defined

Analysis type : Safety factor

Safety factor : 1.00

**Results (Stage of construction 1)**

**Analysis 1**

**Circular slip surface**

Slip surface parameters							
Center :	x =	13.67	[m]	Angles :	$\alpha_1 =$	-11.97	[°]
	z =	115.44	[m]		$\alpha_2 =$	46.82	[°]
Radius :	R =	105.86	[m]				
Analysis of the slip surface without optimization.							

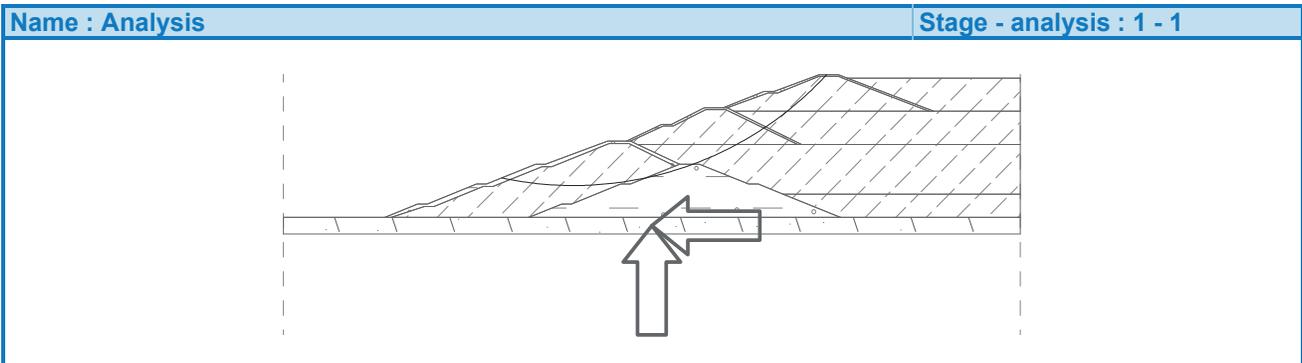
**Slope stability verification (Spencer)**

Factor of safety = 1.18 > 1.00

**Slope stability SATISFACTORY**

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Stability Analysis\_Raised Ash Dyke

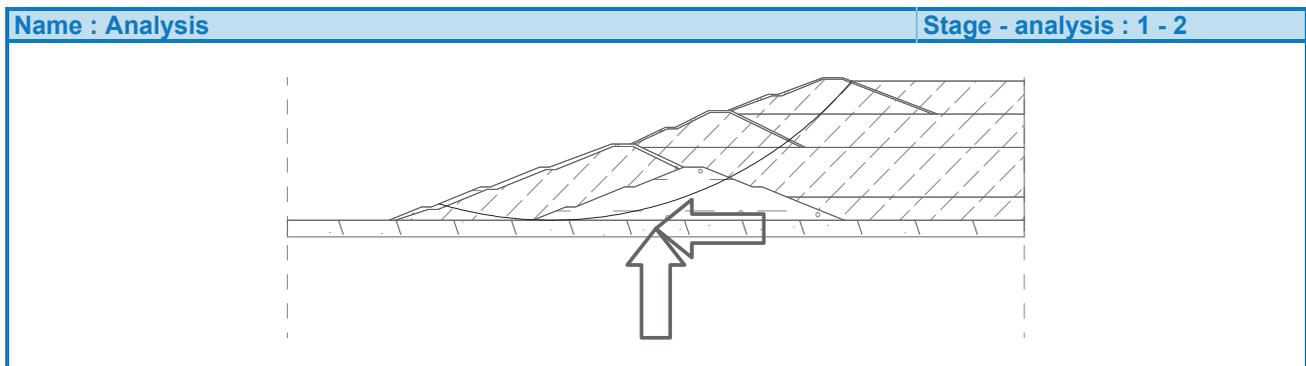


**Analysis 2**  
**Circular slip surface**

Slip surface parameters				
Center :	x =	5.55 [m]	Angles :	α <sub>1</sub> = -16.39 [°]
	z =	121.28 [m]		α <sub>2</sub> = 49.18 [°]
Radius :	R =	121.28 [m]		

The slip surface after optimization.

**Slope stability verification (Spencer)**  
Factor of safety = 0.93 < 1.00  
**Slope stability NOT SATISF.**

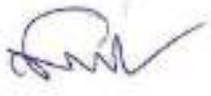
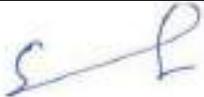


  
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## ANNEXURE R-16

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Revision status Record:				
Revision No.	Date	Page no.	Details of Changes	Reason for changes
01	14-09-2020	01	Name Change in Approval Sheet	Change in Responsibility

Document Approval sheet:			
Prepared by	Mr. Lal Prakash Singh	Signature	
Reviewed by	Mr. Jitendra Prasad	Signature	
	Mr. Srinivas Nadipelli	Signature	
Approved by	Mr. Sachin Mohapatra	Signature	


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**1. Introduction**

Sasan Power has limited ash disposal pond nearby outside plant for the disposal of bottom ash in slurry form. It is envisaged that the ash dyke may overflow or dyke may breach creating an emergency situation which is likely to affect the nearby population. To take care of any such eventualities Sasan Power has developed an off-site emergency response plan to contain and mitigate the consequences effectively.

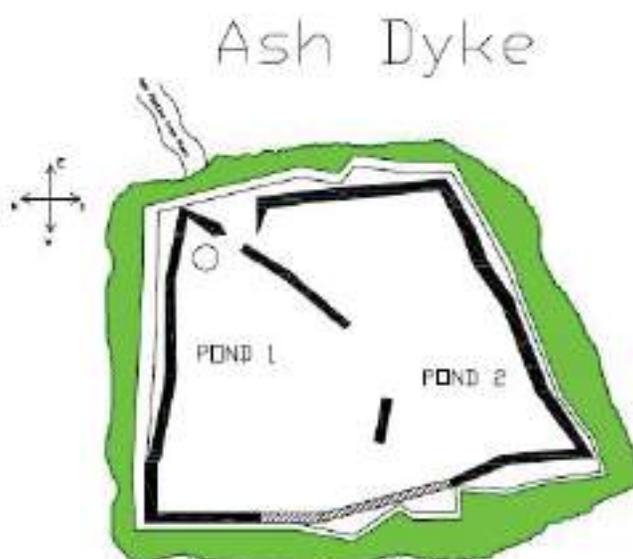
**2. Ash Pond detail:**

Volume of Ash Dyke : 15.32 million m<sup>3</sup> (For 1st 5 Years of Plant Life the Ash generated From 6 Units Considering 10% Utilization Every Year)

Area of Ash Dyke : 810 acres

Total Area for Disposal : 325 Hectares

Distance from main plant to ash dyke: 0.8 km



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### **3. Risk involved with Ash Pond Operation**

<b>S.No.</b>	<b>Activity</b>	<b>Risk</b>	<b>Effect</b>
1.	Bottom ash and fly ash disposal in slurry form	1. Overflow 2. Breaching of Dyke	<b>Affected Villages:</b> Hararwa, Jhaji and Sidhikhurd (Giddakhadi & Latbhudua) <b>Population affected:</b> 2000 (Approx.)

#### **3.1 Reasons of Breaching of Ash Dyke:**

The breach of the ash pond can be caused by any of the following reasons:

##### **3.1.1 Heavy rains**

This is a potential for causing flooding, as the amount of rainfall is not a controllable factor. This can trigger an off-site response, and management must prepare for this eventuality, any time.

##### **3.1.2 Seismic Activity**

The location of SASAN is in the seismic zone IV. Any disastrous seismic activity can uplift the ash pond causing immense flooding in the neighborhood. However the chance of seismic activity occurring in this zone so as to cause up swelling of the ash pond is extremely remote.

##### **3.1.3 Breaching due to overflow:**

The breaching may also occur due to rise of water level beyond the tolerable toe.

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#### **4 Roles and Responsibilities of the On-Site Emergency Team during an ash pond breach:**

The following are the responsibilities of the on-site emergency team in the event of an off-site emergency:

- The roles and responsibilities of the on-site emergency team shall continue to be the same in the event of an off-site emergency.
- In the event of an ash pond flooding emergency, the on-site emergency personnel team shall work under the direction of the Local/District crisis group.

##### **4.1 Ash Handling Maintenance Head**

In the event of a potential ash pond failure the Ash Handling Head shall:

- Inform the CIC to activate the Emergency Alarm, so that other internal On-Site Personnel are alerted to work; and also so that the Local/District crisis group may be activated.
- Maintain a log
- Provide on-going surveillance and situation assessments to the Local/District crisis group as well as to the CIC.
- Consider establishing an Emergency Control Centre, in the area.
- Be prepared to dispatch a pathfinder to meet the emergency services at an agreed location and provide details of safe approach routes to the emergency services.

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#### **4.2 Role of CIC**

Under intimation that there is potential off-site emergency or that off-site emergency is set to happen soon on account of ash pond flooding, the CIC would do the following:

- Contact the Local Crisis Group and inform them about the Emergency
- Initiate Emergency Alarm process
- Continuously be in touch with the Local/State crisis group authorities, and provide them with information on the actual situation
- Gather the internal resources for rescue and relief operations under the command of the Local/District crisis group.

#### **5. Roles and Responsibilities of the Off-Site Emergency Team during ash pond breach**

- This plan addresses the Off-Site, or downstream, consequences of flooding of the ash pond as a result of a potential or actual ash pond breach. The actions outlined are based upon an assumption that there would be sufficient time to enact a response.
- Notwithstanding the above, ash pond failure may involve a complete collapse of ash pond wall and a sudden release of water; or a “slow build” scenario.

#### **5.1 Local Crisis Group**

- On receipt of information from the CIC, regarding the Off-Site emergency, the Local Crisis Group, shall do the following in the event of an offsite emergency such as ash pond flooding:

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- Provide all possible kinds of assistance in the implementation of emergency plan for accident , by coordinating with other agencies such as the Police, Fire, Medical, Home Guards, etc
- Ensure integrate of the local emergency plan with the district off-site emergency plan, if necessary, based on the intensity of the accident.
- Deploy trained personnel involved in handling accident management.
- Educate the population, about the accident/emergency, about the remedies and existing preparedness in the area.
- Forward a report to the District Crisis Group, on the accident
- Respond to all public inquires on the subject.

### **5.2 District Crisis Group**

On receipt of information from the Local Crisis Group, the District Crisis Group Shall do the following in the event of an offsite emergency such as ash pond flooding:

- Provide all kinds of assistance in the implementation of emergency plan in the event of an emergency, such as ash pond flooding.
- Continuously monitor the accident
- Ensure continuous information flow from the district to the Centre and State Crisis Group regarding accident situation and mitigation efforts;
- Forward a report of the accident within fifteen days to the State Crisis Group.

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### **5.3 Fire and Rescue**

On receipt of Offsite Emergency message from the Local Crisis Group, the Fire Department shall do the following:

- Deploy of High Volume Pumping equipment.
- Provide advice during an emergency drawdown process.
- Assist in the evacuation process.
- Deploy Swift Water Rescue capability.
- Undertake Search and Rescue activity.
- Undertake damage control operations, which may include pumping-out floodwater from homes (where resources allow) and key installations, such as electricity substations.
- Assist in the controlled return of evacuees to their properties.
- Advise on the structural integrity and safety of affected buildings.

### **5.4 Police**

On notification of Off-site Emergency by the Local/District crisis group, the Police shall initiate the following measures:

- Provide overall strategic, tactical and operational co-ordination of the incident response provided by the emergency services, local authorities and other agencies.
- Ensure an appropriate coordinator is identified to provide tactical coordination with the Local/District Crisis group.
- Initiate the evacuation of the management areas in consultation with the CIC and in line with the incident scenario.

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- Deploy officers where available and appropriate to the evacuation areas (within the management areas) in support of the evacuation, and work with other agencies to notify / identify vulnerable individuals (accessing available records) in the evacuation areas.
- Work with other agencies to notify / identify specific vulnerable establishments in the evacuation areas (accessing available records) to be evacuated and ensure that appropriate measures are in place.
- Make arrangements to mobilize other staff resources, to assist in the evacuation where appropriate and available.
- Support the Highways Agency where appropriate and make arrangements to establish the pre-identified road blocks.
- Identify properties to be evacuated and those not to be evacuated (if resources allow).
- Control and direct traffic to prevent bow waves from flooding properties and vehicles from breaking down in floodwaters, and provide assistance with closures where roads are impassable etc..
- Establish cordons (where practical, appropriate and safe to do so) and ensure that risk assessments are undertaken in conjunction with partner agencies e.g. Fire and Rescue Service, prior to access being granted to areas inside the cordon.
- Assist other agencies in providing specific assistance for people with additional needs such as the old, very young and disabled.
- Evacuate people from streets and buildings and direct them away from the incident scene towards pre-identified assembly / reception points for onward transport to rest centers.
- Maintain an incident log;

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### **5.5 Health and Ambulance Services**

- In the event of a potential or actual ash pond flooding incident, the local Hospitals may have additional responsibilities such as:
- Co-ordinate with the Local Crisis Group/Police/Fire in the rescue operation.
- Provide information to and liaising with Police and the Ambulance Service on the location of vulnerable people.
- Provide medical and other support to the affected people at Rest Centers/clinics.
- Provide a Command and Control point for medical resources near the incident scene;
- Where appropriate, provide patient transport facilities to evacuate vulnerable individuals from properties at risk to hospitals, Rest Centers or other accommodation.
- Maintain a log.

### **5.6 Highways / Transport department**

The State Highways/Transport department may have responsibilities:

- Provide a representative at the Local Crisis Group level to coordinate the rescue effort.
- Monitor traffic flows and clear debris from roads and road drainage systems.
- Identify and implement the closure of roads and diversion routes in conjunction with the Police
- Oversee repairs to road bridges and evaluating whether bridges affected by floods should remain open for use.

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### **5.7 Other Agencies**

Other agencies such as local schools, nearby industries, home guards, local government, etc can also be involved in the relief and rescue operations on account of the ash pond flooding.

#### **Other support to be provided by SASAN in the event of an ash pond flooding**

A large number of ambulances would be necessary to transport casualties to the casualty response center and nearby hospitals. Details of ambulances in SASAN and other neighboring installations have been described in On-site Emergency plan. In case of need and off-site emergency purposes, all types of vehicles can be converted as ambulances at short notice. These vehicles would then be kept at the unit, the ECC and at other places as deemed necessary by the government.

#### **5.7.1 Temporary Food and Accommodation**

SASAN shall provide temporary accommodation as and when required to provide relief to the affected population. These centers will be left under the control of the Local crisis group. These temporary shelters shall be equipped with all basic requirements of health, food, sanitation, etc.

#### **5.7.2 First-aid and Hospital Services**

The first aid and hospital facilities in SASAN and surrounding organizations / industries have been described in Onsite Report.

### **6. Communication Network for Off-site Emergency:**

An efficient communication system is a must to attend to any Offsite emergency situation, as this can go a long way in alerting the public, neighboring industries and also off-site emergency authorities and services.

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The following systems are readily available at SASAN:

- Radio communication between ECC of SASAN to control rooms of nearby industrial units along with respondents of the area.
- Hotlines for communication to ECC of nearby units, emergency services, meteorological stations, hospitals, etc.
- P&T telephone lines.

Furthermore this set-up can be used by the Local/district group, to assist in their off-site emergency measures. The designated communication officer of SASAN will ensure that all the modes of communication are functional round the clock. All communication operators shall maintain a log book for the messages received in/out and action plan. Effective warning system, in communication network would save lives, prevent injuries and reduce losses. Depending on the nature of hazards, and the areas affected, the following methods of warning may be used by the state government:

- Public Address System
- Mass Media
- Telephone to other organizations
- Door to Door visit by civil defense personnel
- Information to be provided at common gathering places such as canteens, shops, etc.

#### **6.1 Emergency Control Room:**

The Emergency control is the facility from where the Local/District crisis group will function in the event of an off-site emergency. The main purpose of this control room is indicated below:

- Act as the focal point of emergency management

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- Keep records of all messages
- Inform operation officer on receipt of first information relating to accident
- Monitor implementation of mutual aid
- Serve as the focal point for meeting of the crisis Management Group

The ECC is manned by CIC, the Local/District crisis group officials, and other key personnel of outside services called in for assistance. It is equipped with proper communication network and data processing network based on information to combat emergencies.

#### **7. External Communication Dissemination**

In case of emergency arising out of fire, explosion, release of toxic gas etc. leading to Off-site emergency, following procedure shall be adopted.

- ECO - Emergency Communication Officer (Head –HR / Admin) in consultation with Chief Incident Controller (Station Director) arranges to give information to;
- Press / media
- Out-side public (through CSR Head) living in the vicinity who may be affected due to emergency situation,
- Corporate Centre and
- Statutory authorities e.g. District collector, Factory Director, Labor Inspector, Superintendent of Police and Nearest Police Station in-charge by fastest mode of communication may be Public address System, telephone, Fax, radio, etc.

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## **8. Composition of various committees for off-site emergency measures:**

### **8.1 Fire Control Committee**

The composition for this committee is suggested at Table No. 40. However the LCGs and DCG may amend and increase the number of members in this committee as per the requirement in due course of time.

#### **Composition of Fire Control Committee**

<b>Sr. No.</b>	<b>Name /Designation</b>	<b>Position</b>
1.	Sub Divisional Officer	Chairman
2.	Safety Officer- Fire Station, SASAN	Secretary
3.	Fire Officer- Fire Station, SASAN	Member

- Get information about the current status of the emergency situation from the CIC / WIC of the plant.
- On the basis of the information received from the CIC/WIC and only if safe to do so, take control of Fire Services for assisting in the emergency operations, inside the plant. Otherwise stay at safe point away from the vulnerable zones of the plant
- Divide fire personnel in to various teams and depute them to the points where the fire or any other emergency has occurred.
- In case of incidence of toxic chemical release, assist in/ or take the control of situation .Follow instruction of MSDS chart in this regard.
- The prime responsibility of this committee is to maintain the fire brigade strong enough to meet all requirements that may arise due to emergency situation in SASAN or nearby units.

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- The committee is also responsible for formulating a mutual aid scheme for firefighting aid with neighboring units
- The secretary of the committee will coordinate and inform the state of the emergency situation to chairman of the committee, local emergency control room, and other response committees.

### **8.2 Transport Arrangement committee**

The composition of this committee is suggested in the Table 41, below However the LCG/DCG may attend and increase the number of members in this committee as per requirement in due course of time.

#### **Composition of Transport Committee**

<b>Sr.No.</b>	<b>Name/Designation</b>	<b>Position</b>
1	Sub Divisional Officer(SDO)	Chairman
2	District Superintendent of Police (DSP)	Secretary
3	Officer in charge of Transportation	Member
4	Village Pradhan	Member
5	NGO	Member

- On hearing about the information, all members will rush to the LCG and report to the chairman of the committee.
- The committee is made responsible for the arrangement of the vehicles required for the evacuation of the people from the threatened areas; as required by the evacuation committee.

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- The committee will prepare a list of the addresses those can provide vehicles during the emergency. The list prepared by the committee should clearly detail about the number of vehicles available from each resource, type of vehicles to be provided and the details about the drivers of the vehicles.
- The committee will prepare database for emergency approach routes and the escape routes to be followed during the emergency so as to reach the hot spot in time.

### **8.3 Communication Committee**

The composition for this committee is suggested at Table No. 42. However the LCGs and DCG may amend and increase the number of members in this committee as per the requirement in due course of time.

#### **Composition of Communication Committee**

<b>Sr. No.</b>	<b>Name /Designation</b>	<b>Position</b>
1.	Sub Divisional Officer(SDO)	Chairman
2	District Information Officer	Secretary
3.	Wireless Officer (Police) or its representative*	Member
4.	Communication officer of SASAN	Member

This committee will keep the up-to-date information on -

- Type of safety equipments and their resources
- Plant Approach routes and associated Road Systems
- Area affected by the hazards

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- Areas to be evacuated
- Details (Name, Contact Number, Home Address, Nearest Relative, Department etc.) for all the key personnel involved in the various emergency teams.
- To maintain all the communication equipment required during the Emergency in the working conditions.
- To keep record of up to date contact number of the key personnel.
- Rush to the local emergency control room on hearing the emergency and report to the chairman of the committee,. Take control of communication system under the supervision of the chairman.
- If require, depute and post the personnel to pass the warning to the local person in the area likely to be affected.
- Interact, get and provide information to the various committees as per the requirement.
- Ensure the availability of telephone and/or wireless and /or also at shelter points or at assembly point.

#### **8.4 Health Services Committee**

This committee shall involve doctors from the private nursing homes and / hospitals, if necessary, and is constituted by the Local/district crisis group.

##### **8.4.1 Role and Responsibilities of Health and Welfare Committee**

- The very first role of this committee is to establish a standard outline for the necessary inputs of the Medical Services required during the emergency situation in SASAN.

	<b>SASAN POWER LIMITED</b>		
	Document No.	Issue No	Date
	SPL/SAFETY/SOP/002	R01	14-09-2020
<b>Title:</b>	<b>SOP - Offsite Emergency Plan for Ash Disposal Pond</b>		

- The committee will maintain the Ambulance and Quick Response System, so as to ensure that it reaches at the hot spot in time with all the required resources.
- The Quick Response System should address the following components:
  - Initial recognition and identification of the type of emergency
  - Activation of the Response plan based upon the notification of the type of accident received.
  - Initial survey of the accident site.
  - Establishment of the Medical Command Structure.
  - Establishment of the First aid camps at key location and away from the vulnerable zones.

### 8.5 Evacuation Team

The composition for evacuation team has been suggested in below table. However, the LCGs and DCG may amend and increase the number of members in this committee as per the requirement in due course of time.

#### **Composition of Evacuation Team**

Sr. No.	Name /Designation	Position
1.	Dy Collector	Chairman
2.	Superintendent of Police (DSP)	Secretary
3.	Station House Officers (SHO) Police	Member
4.	DG Civil Defense or his representatives	Member
5.	DG Home Guards or his representatives	Member

	<b>SASAN POWER LIMITED</b>		
	Document No.	Issue No	Date
	SPL/SAFETY/SOP/002	R01	14-09-2020
<b>Title:</b>	<b>SOP - Offsite Emergency Plan for Ash Disposal Pond</b>		

6.	Commissioner- Municipal or his representatives	Member
7.	Assistant Engineer- PWD	Member
8.	Assistant Engineer- MSETCL	Member
9.	Head (HR) of SASAN	Member
10.	One representative of Non Governmental Organizations (Nominated by Chairman)	Member

### **9. Format for Declaration of Emergency**

It is with deep regret, we announce that –

The Ash pond is in danger of being breached and flood waters are expected to affect areas \_\_\_\_\_of the plant.

We have tried our best to control the situation, but to no avail. We are therefore handing over the Emergency Measures to the Local Crisis Group, headed by \_\_\_\_\_.

Signed by \_\_\_\_\_ Date \_\_\_\_\_

### **10. Emergency Alarm**

Sirens have been provided at various locations fairly distributed in and around the plant. In the event of an Emergency, Fire Station Control Room will initiate the Emergency Alarm. The Emergency alarms are installed in the Fire Station Building, Central Control Room, and Service Building. Based on the type of Emergency, the Emergency Alarm will vary. These alarms are tested once every six months. The tabular column below lists the type of alarm that will be used based on the type of Emergency.

	<b>SASAN POWER LIMITED</b>		
	Document No.	Issue No	Date
	SPL/SAFETY/SOP/002	R01	14-09-2020
<b>Title:</b>	<b>SOP - Offsite Emergency Plan for Ash Disposal Pond</b>		

Type	Duration
EMERGENCY SIREN	20 SECONDS ON, 5 SECONDS OFF, 04 TIMES
ALL CLEAR SIGNAL	CONTINUOUS SIREN FOR 03 MINUTES ONLY ONCE

A high pitch warning siren audible up to 5 km range should be used for announcing the emergency and giving the all clear signals.

#### **11. Recovery**

The recovery measures that will be adopted by SASAN shall include the following:

SASAN shall establish a committee to identify the cause of the emergency, and take steps to prevent such happenings in future. The committee that will be identified to inquire into the incident shall use all possible resources at its disposal, with the help of Management support, to take steps to initiate corrective as well as preventive measures to prevent any such mishaps in future. Processes such as Fish-Bone diagram or Root Cause Analysis diagram would be adopted by the Management implement appropriate and corrective and preventive actions.

Post incident, the Management of SASAN, is committed to reviving the plant operations as soon as possible so that it can continue serving its stake holders, to their fullest satisfaction.

## ANNEXURE R-17



F.No. J-13011/15/2006-IA.II(T)  
Government of India  
Ministry of Environment, Forest and Climate Change

3<sup>rd</sup> Floor, Vayu Block,  
Indira Paryavaran Bhawan, Jor Bagh Road,  
Aliganj, New Delhi-110003

Dated: 13.07.2020

To,  
**The Head (Operations & Maintenance)**  
**M/s Sasan Power Ltd.**  
(Subsidiary of M/s Reliance Power Ltd.)  
Gram: Siddhikhurd,  
Post Office: Tiyara  
Singrauli-486 886, Madhya Pradesh.

**Sub: 3960 MW (6x660 MW) Sasan Ultra Mega Thermal Power Project, Singrauli District, Madhya Pradesh by M/s Sasan Power Ltd.- reg. breach of ash pond.**

Sir,

The undersigned is directed to refer the Ministry Show-cause Notice dated 21.5.2020 and your reply dated 3.6.2020 in regard to the breach of ash pond at 3960 MW Sasan Ultra Mega Thermal Power Plant of M/s Sasan Power Ltd.

2. It is requested to provide the concrete action taken or being taken by the company to achieve 100% flyash utilisation in compliance to the Flyash Notifications, EC conditions, the Orders passed by the Hon'ble NGT in the matter of Shantanu Sharma v. UoI with UoI v Sandplast and in light of the present incident.

This issues with the approval of the Competent Authority.

Yours faithfully,

(Dr. S. Kerketta)  
Director, IA.I

Copy to:-

1. **The Chairman, Central Pollution Control Board**, Parivesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi-110032.
2. **The Deputy Director General of Forests (C), Ministry of Environment Forests and Climate Change, Regional Office**, Bhopal.
3. **The Chairman, Madhya Pradesh Pollution Control Board**, Bhopal.
4. Guard file/Website of MoEF&CC.

Director, IA.I

**TRUE COPY**

## ANNEXURE R-18

**Sasan Power Limited**

CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project  
 Gram: Siddhi Khurd  
 Post Office: Tiyara  
 Singrauli - 486 886  
 Madhya Pradesh, INDIA  
[www.reliancepower.co.in](http://www.reliancepower.co.in)

SPL/2020-21/33

Date: 28.08.2020

The Director-IA.I  
 Ministry of Environment, Forests and Climate Change  
 3<sup>rd</sup> Floor, Vayu Block  
 Indira Paryavaran Bhawan, Jor Bagh Road,  
 New Delhi-110003

Ref: Your letter No. J-13011/15/2006-IA.II (T) dated 13th July 2020

Kind Attn: Dr. S. Kerketta Director - IA.I

Sir,

This has reference to your letter mentioned under reference above vide which Sasan Power Limited (SPL) is requested to provide a concrete action taken or being taken by the company to achieve 100% fly ash utilization.

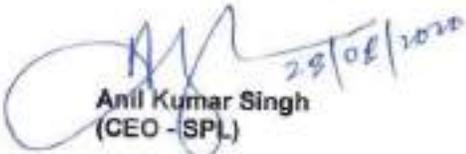
SPL is pleased to submit the attached Annexure which provides details of the concrete action taken or being taken by SPL to achieve 100% fly ash utilization for Sasan Ultra Mega Power Project

We once again express our deep sense of gratitude for your kind support for continuation of operation of the power plant.

Thanking You

Yours faithfully,

For Sasan Power Limited

  
 Anil Kumar Singh  
 (CEO -SPL)

Encl. :

Annexure - Concrete action taken or being taken by SPL to achieve 100% fly ash utilization

CC:

1. The Chairman, Central Pollution Control Board
2. The Dy. Director General of Forests (C), MoEF&CC, Regional Office, Bhopal
3. The Chairman, MP Pollution Control Board, Bhopal

  
**TRUE COPY**

**CONCRETE ACTION TAKEN OR BEING TAKEN BY SASAN POWER LIMITED (SPL) FOR ITS 6 X 660 MW SASAN ULTRA MEGA POWER PROJECT (SUMPP)**

1. It is estimated that going forward, annual ash generation at SUMPP of SPL shall be approx. 51,50,000 Metric Tons (MT) of total ash out of which 80% (41,20,000 MT) shall be fly ash and balance 20% (10,30,000 MT) shall be bottom ash.
2. The above estimate is considering the annual coal consumption of 18.4 million Ton (MT) with ash content in coal as 28%.
3. The ash generation and its utilization for last 3 Financial Years (FY 2017-18 to FY 2019-20) was as under:

Financial Year	Fly Ash Generation (MT)	Fly Ash Utilization (MT)
2017-18	Fly Ash : 41,20,376 Bottom Ash : 10,30,097 Total Ash : 51,50,473	12,21,310
2018-19	Fly Ash : 40,22,186 Bottom Ash : 10,05,547 Total Ash : 50,27,733	14,91,694
2019-20	Fly Ash : 41,95,673 Bottom Ash : 10,48,918 Total Ash : 52,44,591	27,46,403

4. The details of fly ash utilization for FY 2019-20 are as under:

Sr. No.	Ash Utilization Avenue	Fly Ash Utilization (MT)
1	Cement	45,280
2	Fly-ash Bricks	1,264
3	Ready Mix Concrete	880
4	Low Laying Land Filling	26,98,119
5	Others (Cenosphere)	860
	<b>Total</b>	<b>27,46,403</b>

The data shows that filling of low lying area has been the major avenue of ash utilization for Sasan UMPP.

**5. SPL has undertaken the following activities to achieve 100% Fly Ash utilization:**

- a. Making fly ash available free of cost.
- b. Utilized fly ash in potential low lying area filling within the plant premises after obtaining permission from MP Pollution Control Board.
- c. Post in-principle approval of the transportation cost sharing proposal by Hon'ble Central Electricity Regulatory Commission (CERC) on 13-March-18, SPL initiated the process of entering into a long-term agreement with cement manufactures for lifting of fly ash from SUMPP on sharing of transporting cost basis.
- d. Inside the plant, for all CLSM (Controlled Low Strength Material), 50% of sand quantity is replaced with bottom ash and 30 -40% of cement quantity is replaced with Fly Ash.
- e. Fly Ash brick making unit of 9000/day capacity is installed within plant premises. Annually over 20 lakh bricks are utilized by SUMPP in its various construction related works.
- f. Workshops conducted for Brick Manufactures/ RMC producers for encouraging use of fly ash by highlighting its benefits.
- g. Various fly ash awareness campaigns and workshops have been organized at SPL and nearby villages for making public aware about fly ash usages and motivating them to come forward as an entrepreneur.
- h. SPL is continuously exploring opportunities for providing fly ash for road construction projects.
- i. Various meetings have been organized with the cement industries with an intention to increase the fly ash lifting from the plant.
- j. Regular meetings with the District Administration, MPPCB and GoMP officials conducted regarding constraints in the fly ash utilization from the power plant and also for seeking support for increasing the fly ash utilization.
- k. The ash deposited in ash ponds is being utilized in permitted activities like ash bund height raising of existing ash dykes, low lying area development, fly ash bricks / clay ash brick manufacturing and efforts being made for utilization in road embankment construction and mixing with mines OB etc.

l. SPL has also requested District Collector to allocate abandoned stone crusher void for filling with ash.

m. The ash utilization has increased from 1.77% in 2013-14 to 65.5% in FY 2019-20.

**6. Reason for non-utilization of 100% fly ash:**

Despite taking above mentioned efforts, SPL could not achieve 100% fly-ash utilization in FY 2019-20 for the following reasons:

- a. SUMPP is located at approx. 250 Kms from the nearest cement plant cluster. The fly ash demand of all the cement industries is getting fulfilled by the nearby power plants. Therefore, it is respectfully submitted that no cement plant prefers to lift fly ash from SUMPP because of high cost of transportation.
- b. SPL had issued NIT for supply of ash on the transportation cost sharing basis but the process could not conclude due to non-availability of sufficient bids / lack of interest from cement companies due to abundant availability of fly-ash in their vicinity, at a distance nearer to them.
- c. It is further submitted that the peak demand for fly ash by cement plants in the Singrauli region, where SUMPP is located, is around 9.1 Million-ton per year whereas the power plants in Singrauli region generate fly ash more than 25.5 Million-ton per year, i.e. 280% of the requirement. Therefore, there is an inherent mismatch between demand and supply of fly ash in the Singrauli region with ash generation far exceeding the demand.
- d. Total fly ash consumption is fixed for the cement industries irrespective of the location from where they are lifting the fly ash for making Pozzolana Portland Cement (PPC).
- e. It is humbly submitted that there is no substantial demand of fly ash in road construction works in the region. There is no substantial demand for fly ash in building construction works too.
- f. It is stated that around 20 ash brick plants are operating in the region to partially meet the requirement of ash bricks but due to existence of red brick kilns in the region, demand for ash bricks is not increasing.

- g. District Collector has also advised the District Mining Department to identify the abandoned coal crusher voids where the fly ash can be filled but the same has not materialized till date.
- h. Meeting was held with NHAI, PWD & NCL officials for seeking support for using ash in road construction and filling of abandoned mines. During meetings, officials of NHAI and PWD assured of utilisation of ash in road construction projects but no support has come so far.
- i. Due to these challenges, a large quantity of ash remains unutilized and is being disposed in the ash dyke.

7. Moreover, as may please be observed from the ash utilization details of SUMPP mentioned in preceding paragraphs, the major part of ash utilization was achieved through ash filling in low lying areas. However, the same has been hampered because of the breach of retention wall of low-lying ash utilization area, which occurred on 10th April 2020.

**8. Long term sustainable plan for achieving 100% fly ash utilization:**

Under the circumstances mentioned above and in order to have long-term sustainable plan, SPL is exploring the possibility of taking fly ash to its operating Moher and Moher Amlohri Extension opencast captive coal mines, located at a distance of approx. 25 Kms, through pipeline in high concentration slurry mode for mixing with over burden for filling of de-coaled areas, which has now been permitted pursuant to MoEF&CC notification dated 21<sup>st</sup> May 2020.

Accordingly, SPL has initiated the process for getting approval from the relevant authorities stated as under:

- a. Central Institute of Mining and Fuel Research (CIMFR), Dhanbad has been engaged to carry out the technical feasibility and slope stability study for the said option. The visit of CIMFR scientists is expected after relaxation in the COVID 19 travel restrictions. The report submission for CIMFR will take another 2 months after their site visit.

- b. Once this project gets cleared technically by the CIMFR, Dhanbad, Sasan UMPP will approach Madhya Pradesh Pollution Control Board (MPPCB) for obtaining permission and seek approvals from other statutory / regulatory authorities, as may be required.
- c. Post obtaining permission from MPPCB, the execution of the said work will be taken up which is expected to be completed in nearly 18 Months.
- d. In view of above, 100% utilization of fly ash from SPL can happen only after 2 years from now, after execution of the said proposal of mixing fly ash with over burden dumps in the operating captive coal mines of SUMPP.
- e. Meanwhile, ash is being utilized in the bund height raising work of the existing ash dyke which would utilize approx. 2.2 to 2.3 Million MT / lagoon.

#### 9. Ash utilization plan from FY 2020-21 onwards

##### a. FY 2020-21 (Estimated):

SN	Description	Unit	Q1 (Actual)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	Ash Generation						
	Fly Ash	MT	1039777	1030000	1030000	1030000	4129777
	Bottom Ash		259944	257500	257500	257500	1032444
	Total Ash		1299721	1287500	1287500	1287500	5162221
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	390	500	500	500	1890
ii)	Ready Mix Concrete	MT	123	200	1000	1000	2323
iii)	Low Lying area filling/ Area Development	MT	89550	0.0	0.0	0.0	89550
iv)	Ash Dyke raising (Downstream)	MT	0.0	0.0	51600	458000	509600
v)	Cement	MT	20210	7200	20000	20000	67410
vi)	Sasan Coal Mine	MT	0.0	0.0	0.0	0.0	0.0
	<b>Total Fly Ash Utilisation</b>	<b>MT</b>	<b>110273</b>	<b>7900</b>	<b>73100</b>	<b>479500</b>	<b>670773</b>
C	Fly Ash Utilisation percentage #	%	11	1	7	47	16

# Dry Ash Utilization; Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

## b. FY 2021-22 (Estimated):

SN	Description	Unit	Q1 (Est.)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	<b>Ash Generation</b>						
	Fly Ash	MT	1030000	1030000	1030000	1030000	4120000
	Bottom Ash		257500	257500	257500	257500	1030000
	<b>Total Ash</b>		<b>1287500</b>	<b>1287500</b>	<b>1287500</b>	<b>1287500</b>	<b>5150000</b>
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	500	500	500	500	2000
ii)	Ready Mix Concrete	MT	1000	200	1000	1000	3200
iii)	Low Lying area filling/ Area Development	MT	0.0	0.0	0.0	0.0	0.0
iv)	Dyke raising	MT	508000	408000	508000	500000	1924000
v)	Cement	MT	20000	7200	20000	20000	67200
vi)	Sasan Coal Mine	MT	0.0	0.0	0.0	0.0	0.0
	<b>Total Fly Ash Utilisation</b>	<b>MT</b>	<b>529500</b>	<b>415900</b>	<b>529500</b>	<b>521500</b>	<b>1996400</b>
C	<b>Fly Ash Utilisation percentage #</b>	<b>%</b>	<b>51</b>	<b>40</b>	<b>51</b>	<b>51</b>	<b>48</b>

# Dry Ash Utilization; Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

## c. FY 2022-23 (Estimated):

SN	Description	Unit	Q1 (Est.)	Q2 (Est.)	Q3 (Est.)	Q4 (Est.)	Total (Est.)
A	<b>Ash Generation</b>						
	Fly Ash	MT	1030000	1030000	1030000	1030000	4120000
	Bottom Ash		257500	257500	257500	257500	1030000
	<b>Total Ash</b>		<b>1287500</b>	<b>1287500</b>	<b>1287500</b>	<b>1287500</b>	<b>5150000</b>
<b>B. Fly Ash Utilisation</b>							
i)	Brick Manufacturing	MT	500	500	500	500	2000
ii)	Ready Mix Concrete	MT	1000	200	1000	1000	3200
iii)	Low Lying area filling/ Area Development	MT	0.0	0.0	0.0	0.0	0.0
iv)	Dyke raising	MT	508000	408000	558000	558000	2032000
v)	Cement	MT	20000	7200	20000	20000	67200
vi)	Sasan Coal Mine*	MT	0.0	0.0	458500	458500	917000
	<b>Total Fly Ash Utilisation</b>	<b>MT</b>	<b>529500</b>	<b>415900</b>	<b>1038000</b>	<b>1038000</b>	<b>3021400</b>
C	<b>Fly Ash Utilisation percentage #</b>	<b>%</b>	<b>51</b>	<b>40</b>	<b>100</b>	<b>100</b>	<b>73</b>

# Dry Ash Utilization; Bottom ash disposed off in ash pond in slurry mode. Bottom ash will be utilized from the ash dyke as per the demand.

\* Subject to the technical feasibility clearance by the CIMFR, Dhanbad and NOC from MPPCB & DGMS

10. Therefore, FY 2022-23 onwards, entire unutilized fly ash of SUMPP is proposed to be sent to its captive coal mine for mixing with mine OB to achieve 100% fly ash utilization whereas the bottom ash will be sent to the ash pond in slurry mode from where it will be utilized as per the demand.

**Anshul Kumar**

---

**From:** Rishub Kapoor  
**Sent:** 20 January 2022 17:05  
**To:** Anshul Kumar; Sunil; Delhi Office  
**Subject:** FW: [Advance Service by way of email] O.A No. 194 of 2020 - Suresh Kumar Pandey v. UoI Reply on behalf of Sasan Power Limited

pfa

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**From:** Rishub Kapoor <rishub.kapoor@skvlawoffices.com>  
**Date:** Thursday, 20 January 2022 at 5:04 PM  
**To:** "ashish.kr.advocate@gmail.com" <ashish.kr.advocate@gmail.com>  
**Cc:** Shri Venkatesh <shri.venkatesh@skvlawoffices.com>, Bravo <bravo@skvlawoffices.com>  
**Subject:** [Advance Service by way of email] O.A No. 194 of 2020 - Suresh Kumar Pandey v. UoI Reply on behalf of Sasan Power Limited

Dear Sir,

Trust this email finds you well.

We represent the Sasan Power Limited i.e. Respondent No. 7, in the captioned matter.

Please find attached the reply to the Original Application, filed before the Hon'ble National Green Tribunal (New Delhi), for your reference and record purposes.

[https://skvlawoffice-my.sharepoint.com/:b:/g/personal/rishub\\_kapoor\\_skvlawoffices\\_com/ESssh4r8WQxFsc7TU7OgnxgBJ9X-G18gHINQGlyR1OpbsQ?e=KiKs2S](https://skvlawoffice-my.sharepoint.com/:b:/g/personal/rishub_kapoor_skvlawoffices_com/ESssh4r8WQxFsc7TU7OgnxgBJ9X-G18gHINQGlyR1OpbsQ?e=KiKs2S)

Kindly treat this email as a valid service of the Reply.

Best Regards



**Rishub Kapoor**  
**SKV Law Offices**

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