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 & ORS. …. Respondents

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Place: New Delhi
Date: 17.05.2021

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AFFIDAVIT ON BEHALF OF SASAN POWER LIMITED / RESPONDENT NO. 1&2

Most Respectfully Showeth. –

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

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 14th – 15th 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 committed 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. Strengthening of dyke wall of ash pond.
2	Gabaiya Nalla	2.25	0.0	
	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) **<u>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.</u>** ***(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) **<u>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.</u>** ***(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 Goiwahai 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 Gabailya 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 poclain 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, *Harrahaw*a 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.** ***(Para 8 (4) @ Pg 19 of the Report)***

i. It is submitted that SPL had received 17 complaints from *Bhadi Tola* 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 Tola* 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 Tola, Harrahawa*, *Siddhikhurd- Latbudwa Tola, Giddhakhadi Tola* 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 acquifiers 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 (I.

(h) **<u>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.</u>** ***(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 R/15**.


NEERI Work
Order.pdf

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

Deponent

Sasan Power Limited

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.

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

Deponent

Sasan Power Limited

ANNEXURE R-1 (COLLY.)

ANNEXURE 9

संलग्नक – 10

MADHYA PRADESH POLLUTION CONTROL BOARD

Paryawaran Parisar, E-5, Arera Colony, BHOPAL - 462 016
(0755) 2464428, 2466191 Fax : (0755) 2463742 e-mail: st.mppcb@rediffmail.com

M.P. POLLUTION CONTROL BOARD Received No. 927 Dt. 15-4-20 SINGRAULI

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

Back 15/4/2020

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 villiage 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;

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 Harrhawa, 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

13.11.2020

(RS Kori)
Member Secretary

Endt. No. 24 / MPPCB/MS/TS Singrauli/ 2020 Bhopal, Dated: 13.4.2020

Copy to:

1. Principal Secretary, Environment Department, Government of MP for information. please

2. Collector Singruall 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.

13/4/2020

(RS Kori)
Member Secretary

// TRUE COPY //

ANNEXURE R-1 (COLLY.)

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

ANNEXURE 23

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 10th 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 13th April 2020 and letter no. 43/MPPCB/MS/TS Singrauli/2020 dated 28th 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.

Sasan Power Limited
CIN: U40102MH2006PLC190557

6 X 660 MW Sasan Ultra Mega Power Project
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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 21st April 2020, Sasan Power, which supplies the cheapest thermal power in the country (Levellized 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

28/05/2020

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

//TRUE COPY //

ANNEXURE-R/2(Colly)

MADHYA PRADESH POLLUTION CONTROL BOARD

Paryawaran Parisar, E-5, Arera Colony, BHOPAL - 462 016
☎ {0755} 2464428, 2466191 Fax : {0755} 2463742 e-mail: it.mppcb@rediffmail.com

D. No. 1464 / MPPCB/CE IV/ 2020 Bhopal, Dated: 24-8-2020

To,

1. Anil Ambani
Chairman, Reliance Power Ltd.
[Holding company of M/s Sasan Power Ltd]
Reliance Centre, Ground Floor
19, Walchand Hirachand Marg,
Ballard Estate, Mumbai 400001

2. Satish Seth
Director, Reliance Power Ltd.
[Holding company of M/s Sasan Power Ltd]
Reliance Centre, Ground Floor
19, Walchand Hirachand Marg,
Ballard Estate, Mumbai 400001

3. A.K.Singh
Chief Executive Officer
M/s Sasan Power Ltd.
Post:- Tiyara
Distt: Singrauli (MP) - 486886

4. Sachin Mohapatra (Occupier),
Senior Vice President & Station Director,
M/s Sasan Power Ltd.,
Post Tiyara
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 Dubey 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, Vi(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.

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 **Bhopal, Dated**

Copy To:

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

//TRUE COPY //

ANNEXURE R-2 (COLLY.)

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

No.: SPL /2020-21/36

09th 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 ask 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 Gorbi 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 21st 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 is 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

09/09/2020

(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

SNO	Name of Deceased	Age(Yrs.)	Dependent	Compensation	Amount (Rs. In Lakh)	Remarks
1	Dinesh Kumar Shah S/O Bisahulal Shah	32	Reena Shah (Wife)	One Time Settlement amount- Rs. 10.00 Lakh	10	10.3
				Employment in Company with monthly Salary Rs. 15000/-		
				Lifelong Monthly Sustenance Allowance @ Rs. 8275/- (Revised every six month as per GoMP Minimum wage guidelines) to: 1. Mother Rudani W/O Bisahulal Sahu (67 yrs) 2. Father Sh. Bisahulal Shahu S/O Anantram Shahu (69 Yrs)		
				Cremation Support of Rs. 30,000/-	0.3	
2	Mstr 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	58.5
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	10	
			Bhayyaram Shah (Father)	Cremation Support of Rs. 50,000/-	0.5	
			Bhayyaram Shah (Father)	Lifelong Monthly Sustenance Allowance @ Rs. 8275/- (Revised every six month as per GoMP Minimum wage guidelines) to:		

SNO	Name of Deceased	Age(Yrs.)	Dependent	Compensation	Amount (Rs. In Lakh)	Remarks
				1. Mother Golari S/O Rambaran Shahu 48 Yrs, 2. Father Rambaraan Shahu S/O Khulluram Shahu (52 Yrs)		
			Bhayyaram Shah (Father)	Permanent Job to Bhayyaram Shah		
			Bhayyaram Shah (Father)	Compensation of House (Rs. 10.00 Lakh), Household items (Rs. 10.00 Lakh), property (Rs. 8.00 Lakh)	28	
			Bhayyaram Shah (Father)	Constructed House of 5 room at Makrohar Road (Approx Valuation)	25	25
6	Rajjad Ali S/O Jabbar Ali	29	Reshma Khatoon (Wife)	One Time Settlement amount- Rs.5.00 Lakh Employment to 1 member through outsourcing based on qualification	5	21.23
				One Time Settlement amount- Rs.5.00 Lakh	5	
				Lifelong Monthly Sustenance Allowance @ Rs. 8275/- (Revised every six month as per GoMP Minimum wage guidelines) to: 1. Mother Julekhaa Begum W/O Jabbar Ali (49 Yrs) 2. Father Jabbar Ali S/O Inshaa Mohammad (52 Yrs)		
			Jabbar Ali (Father)	Support for Cremation Rs. 20000/-	0.2	
				Payment to be made to the nominees of worker under workmen compensation act (Amount deposited in Labour court)	11.03	
	Grand Total (Rs. In Lakh)-A				**125.03**	**125.03**

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

SNO	Particulars	Amount (Rs. In Lakh)
A	**Crop Compensation**	
1	Compensation towards, house damage, crop, household materials to 3 villages of Tehsil Singrauli-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 Mada-Ref SDM Letter no 160/RE-3/2020 dtd 21.04.20	05.67
	Total-A	**85.07**
B	**Cattle, well, motor pump etc Compensation**	
1	Compensation for Cattle, Motor, pump, well, poultry farm etc-3 villages of Tehsil Singrauli as per the SDM Singrauli 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 Mada as per the SDM Mada Letter 541/SDO/RE-1/2020 dtd. 26.05.2020	09.84
	Total-B	**80.43**
C	**Household items, crop etc directly paid by company as per recommendation of panchyat, district admin**	
1	Support for Ration/Household items damage to 10 families of Sidhi Khurd	1.77
2	Crop compensation to Jhanjhi Tola Baiga/Sidhikhurd families	1.35
	Total-C	**3.12**
D	**Medical treatment expenses**	
1	Medical Exp Reena Shah W/O Late Dinesh Shah and Golari W/O Rambarana Shah	2.36
	Total-D	**2.36**
E	**fooding/ration and maintenane expenses**	

SNO	Particulars	Amount (Rs. In Lakh)
1	Fooding to affected families through our canteen	1.5
2	Civil and electrical maintenance and ration to main family	1.5
	Total-E	**3.00**
F	**water provision to cattle and families**	
1	Provision of drum 100 ltr to cattle 570 nos drum	1.14
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, tent, utensil etc	0.45
	Total-F	**7.99**
G	**Photography/videography expenses**	
1	Photography/Videography Bill-1	1.84906
2	Photography/Videography/Drone damage Bill-2	2.76212
	Total-G	**4.61118**
H	**construction of peripheral road and culvert**	
1	Construction of peripheral road and culvert damaged in the accident (approx valuation)	35
	Total-H	**35**
	Grand Total (A+B+C+D+E+F+G+H)	**346.61**

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: 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

SPL/ /2020-21/33

Date: 28.08.2020

The Director-IA.I
Ministry of Environment, Forests and Climate Change
3rd 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**

28/08/2020

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

RELIANCE

Annexure - 3

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
	Total	**27,46,403**

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 21st 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. Fly Ash Utilisation							
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**	**479500**	**670773**
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	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. Fly Ash Utilisation							
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 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	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. Fly Ash Utilisation							
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	1038000	1038000	3021400
C	Fly Ash Utilisation percentage #	%	51	40	100	100	73

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.

Annexure- 4

Fwd: माननीय राष्ट्रीय हरित अधिकरण में प्रचलित प्रकरण क्रमांक OA न. 31/2020 (CZ), हीरालाल बैस विरूदamp;ध रिलायंस सासन पॉवर लिमिटेड में दamp;िनांक 29/06/2020 को पारित आदamp;ेश के अनुपालन में गठित संयुक्त समिति का निरिक्षण दamp;िनांक 14 एवं 15 जुलाई Ã.Ã..□
AK Singh
to:
Amitosh Verma
21/08/2020 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" <biosunil2006@gmail.com>
Date: 21 August 2020 at 2:57:06 PM IST
To: AK.Singh@relianceada.com
Subject: Re: Fw: माननीय राष्ट्रीय हरित अधिकरण में प्रचलित प्रकरण क्रमांक OA न. 31/2020 (CZ), हीरालाल बैस विरूद्ध रिलायंस सासन पॉवर लिमिटेड में दिनांक 29/06/2020 को पारित आदेश के अनुपालन में गठित संयुक्त समिति का निरिक्षण दिनांक 14 एवं 15 जुलाई Ã.Ã..□

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 sump 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> 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

Reliance Power is Proud to be felicitated for remarkable performance in the Power Sector at 'The Economic Times Power Focus Summit'

From: Regional office <rompcb.sgrl@gmail.com>
To: AK.Singh@relianceada.com, Amitosh.Verma@relianceada.com, sachin.mohapatra@relianceada.com, biosunil2006@gmail.com, hemant Sh <hsharma1091@gmail.com>, hksharma-pcb@mp.gov.in
Date: 18/07/2020 12:04
Subject: माननीय राष्ट्रीय हरित अधिकरण में प्रचलित प्रकरण क्रमांक OA न. 31/2020 (CZ), हीरालाल बैस विरूद्ध रिलायंस सासन पॉवर लिमिटेड में दिनांक 29/08/2020 को पा के अनुपालन में गठित संयुक्त समिति का निरिक्षण दिनांक 14 एवं 15 जुलाई 2020 ।

Respected Sir
Please find the Attachment.

माननीय राष्ट्रीय हरित अधिकरण में प्रचलित प्रकरण क्रमांक OA न. 31/2020 (CZ),
हीरालाल बैस विरूद्ध रिलायंस सासन पॉवर लिमिटेड में दिनांक 29/06/2020 को पारित आदेश के अनुपालन में गठित संयुक्त समिति का निरिक्षण दिनांक 14 एवं 15 जुलाई 2020 □

Regional Officer
MP PCB, Singrauli
Distt. Singrauli-486887

OIC

Annexure - 5

Sasan Power Limited

CIN: U40102MH2007PLC166537

Sasan Ultra Mega Power Project
Gram: Sasan Khurd
Post Office: Tiyara
Singrauli - 486 886
Madhya Pradesh, INDIA

www.reliancepower.co.in

SPL/ /2020-21/ 29

Date: 25.06.2020

To,

Regional Officer,
MP Pollution Control Board,
Singrauli, MP

Reference:

1. Permission Letter from the office of MS MPPCB Bhopal vide no: 833/MPPCB/MS/TS Singrauli / 2020 dated 08-May-2020.
2. Letter from the office of your good-self vide no. 1481/ RO/PCB/2020, dated 19-June-20 received by email dated 26-June-20.

Subject: Permission for disposal of fly ash in low lying area 6.05 Ha in the industry premises.

Respected Sir,

With reference your letter vide reference no 2 above, received by e-mail on 26-June-20, we would like to submit that

1. The disposal of fly ash in low lying area 6.05 Ha in the industry premises has not yet been started.
2. The affidavit as required as per the permission letter is attached as **Annexure – 1**.

Thanking You

Yours faithfully,
For Sasan Power Limited

25/06/2020

Ajay Kumar Singh
(Chief Executive Officer)

CC. 1. The Collector, Singrauli
2. Member Secretary, MPPCB, Bhopal
3. Director (Environment), MPPCB, Bhopal

ANNEXURE R-3

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

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 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 27th August, 2020.

Justice Sheo Kumar Singh, JM

Dr. Nagin Nanda, EM

SN

// TRUE COPY //

ANNEXURE R-4

सत्यमेव जयते

भारत सरकार
GOVERNMENT OF INDIA
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

SPEED POST
क्षेत्रीय कार्यालय, पश्चिम क्षेत्र,
Regional Office, Western Zone,
केन्द्रीय पर्यावरण भवन
Kendriya Paryavaran Bhavan"
लिन्क रोड नं0-3/Link Road No. 3
E-5, रविशंकर नगर /E-5, Ravi Shankar Nagar,
भोपाल (म0प्र0)/Bhopal-462016 (M.P.)
Telefax: 0755-2426611
फोन: 9990517580(M)
Email: rowz.bpl-mef@nic.in

FILE No. 21-5/2020 (ENV.)/560

DATE: 10/07/2020

To,

The District Collector
Collectorate Building, Majan Mod, Waidhan
Singrauli – 486886

SUBJECT: Site visit of the Joint Committee constituted in compliance of the Hon'ble NGT order dated 29.06.2020 in the matter of O.A. 31/2020, Hiralal Bais vs. Reliance Sasan Power P. Ltd. & Ors.

REFERNCE:
1. Hon'ble NGT Order dated 29.06.2020 (Enclosed)
2. MoEFCC, Regional Office, Bhopal's office order dated 09.07.2020 (Enclosed)

Sir,

I am directed to invite your kind attention to the above-cited references on the above-mentioned subject matter. In compliance of the said Hon'ble NGT Order, it is proposed to undertake the site visit 14th – 15th July 2020. You are requested to make it convenient to attend the same. Tentative program schedule is enclosed herewith as **Annexure A-1**.

Yours faithfully

GHVCCh

(Dr. H.V.C. Chary Guntupalli)
Scientist "D"

COPY TO:-

1	The Registrar, National Green Tribunal Central Zone Bench Bhopal	: For kind information please.
2	The Joint Secretary (CP Division), Ministry of Environment, Forest & Climate Change Indira Paryavaran Bhawan Aliganj Road New Delhi – 110 003	: For kind information please.
3	The Member Secretary Central Pollution Control Board Parivesh Bhawan East Arjun Nagar, Delhi – 110032	: For kind information please.
4	Shri Sunil Kumar Meena, Scientist 'D' Central Pollution Control Board Regional Directorate (Central) Parivesh Bhawan, Paryavaran Parisar	: With a request to join the said committee on the day of site visit

E-5, Arera Colony, Bhopal - 462016

5. The Member Secretary,
   Madhya Pradesh Pollution Control Board,
   Paryavaran Parisar, Sector E-5,
   Arera Colony, Bhopal- 462016 : For kind information please.

6. Regional Officer,
   M.P. Pollution Control Board,
   Sector-2, PlotNo.217, Navjeevan Vihar,
   Post:Vindhyanagar, Singrauli : With a request to join the said committee on the day of site visit and also to book accommodation and other logistics as required.

7. Shri Sachin Mohapatra
   Station Director,
   Sasan Power Limited,
   Village Siddhikhurd, Tehsil Waidhan,
   District: Singrauli, Madhya Pradesh : With a request to make a presentation on the collapse ash pond and other related aspects as well as to facilitate site visit.

Yours faithfully

(Dr. H.V.C. Chary Guntupalli)
Scientist "D"

ANNEXURE-1

Tentative program schedule

Date &Time	Details
14.07.2020.11:00 A.M.	Introductory meeting at the office of the District Collector, Singrauli.
14.07.2020, 12:30 P.M.	Presentation by the Project proponent at Sasan Thermal Power Plant, Singrauli.
14.07.2020, 2:00 P.M.	Working lunch.
14.07.2020, 2:30 P.M.	Site visit to the Ash pond.
14.07.2020, 4:00 P.M.	Concluding meeting and preparation of the report.

Note: The site visit and preparation & finalization of report may be extended to 15.07.2020, if required.

// TRUE COPY //

ANNEXURE R-5

F.No. J-13011/15/2006-IA.II(T)
Government of India
Ministry of Environment, Forest and Climate Change

3rd 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

ANNEXURE-R/6

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

SPL/ /2020-21/33

Date: 28.08.2020

The Director-IA.I
Ministry of Environment, Forests and Climate Change
3rd 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**

28/08/2020

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

Annexure

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
	Total	**27,46,403**

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 21st 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. Fly Ash Utilisation							
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**	**479500**	**670773**
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	**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. Fly Ash Utilisation							
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 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	**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. Fly Ash Utilisation							
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**	**1038000**	**1038000**	**3021400**
C	**Fly Ash Utilisation percentage #**	%	**51**	**40**	**100**	**100**	**73**

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.

ANNEXURE R-7

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, Tiyara
Singrauli – 486886 (MP)

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

CONTENTS

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 1st 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 1st 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.

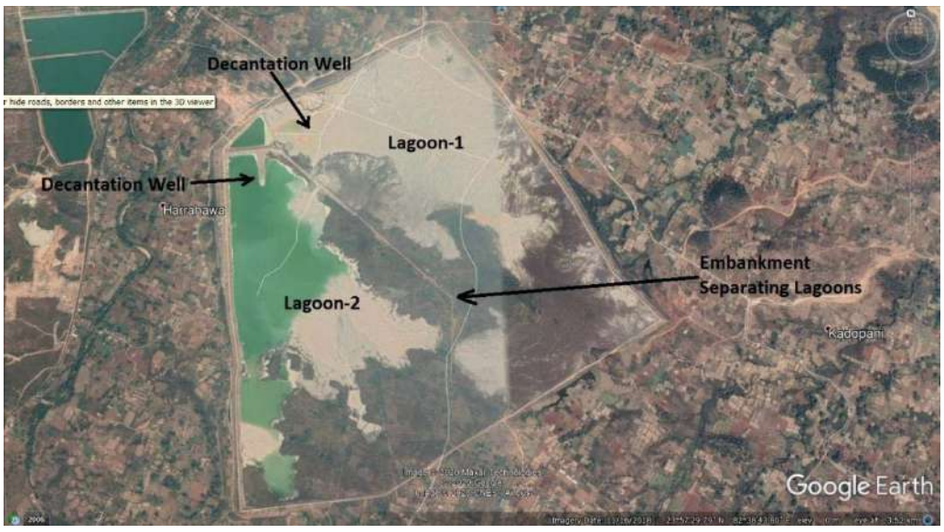


Figure 1 A general view of Ash Pond with Lagoons -1 and 2
(Source: Google Earth, Retrieved on: 06-08-2020)

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.

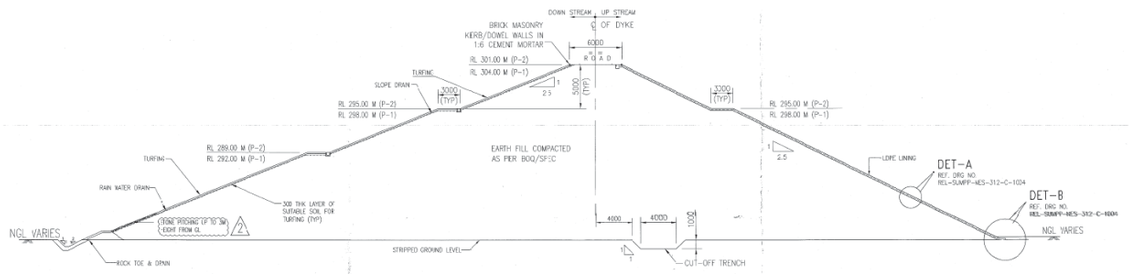
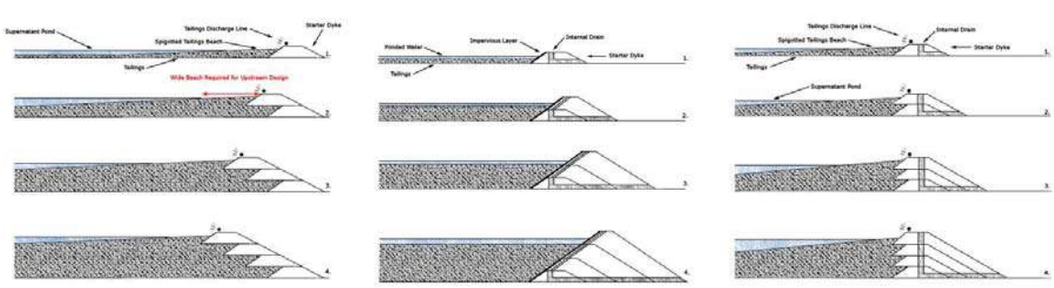


Figure 2 A typical cross-section of dyke of Ash Pond (Scale: 1:200)

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, Morgerstein, 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.



(a) **(b)** **(c)**

Figure 3 Various construction methods of ash dyke raising, (a) upstream, (b) downstream, and (c) centerline (Source: 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 baring 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:

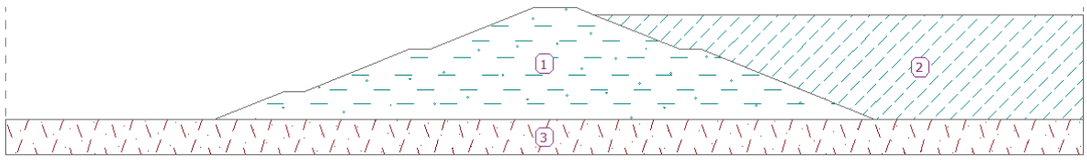
(a) Static Analysis

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

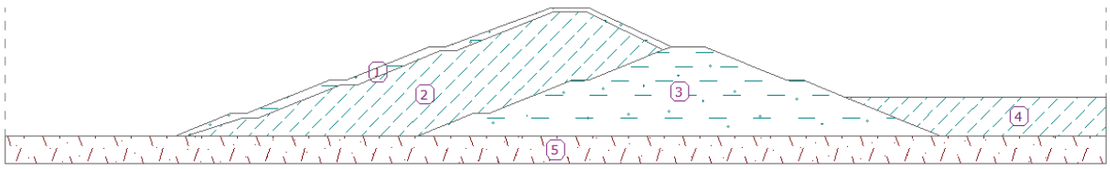
(b) Seismic Analysis

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

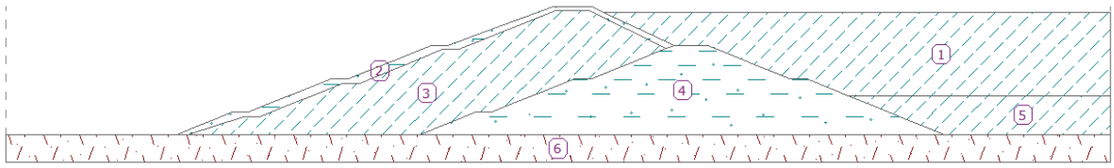
The above mentioned cases are also shown in Figure 4.



(a)



(b)



(c)

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 (1st 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 1st 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 1st 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 (1st 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 (2nd Raising Onwards) of Ash Dyke

The newly created space after 1st 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).

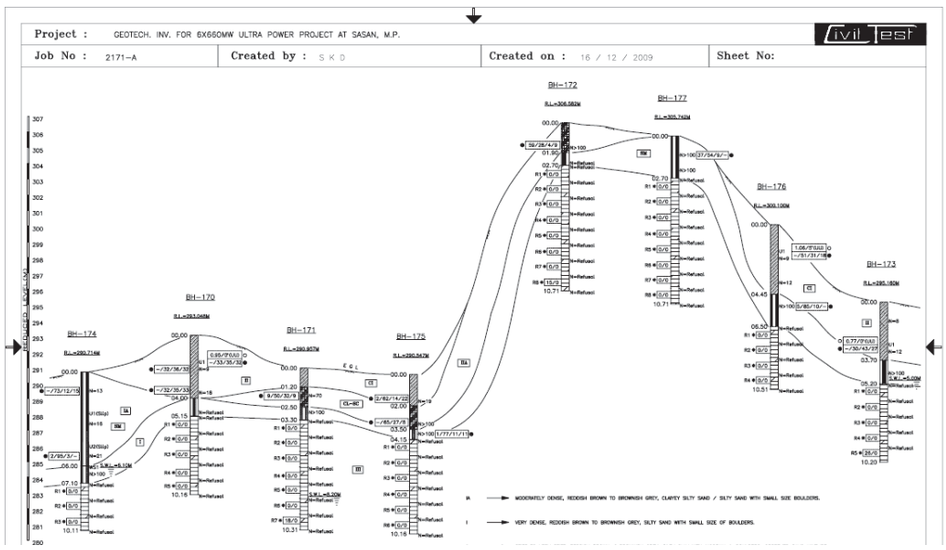


Figure 5 Soil profile at ash pond site

3.2.2 Proposed Ash Dyke Raisings (2nd Raising onwards)

The Net Allowable Bearing Pressure in the rock (at depth 3.5 m from EGL), is reported as 55 t/m^2. 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^3. 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^3 and that of bottom ash is ~1.2 t/m^3. Further, 1st 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^3. 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:

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

Say, 42 m

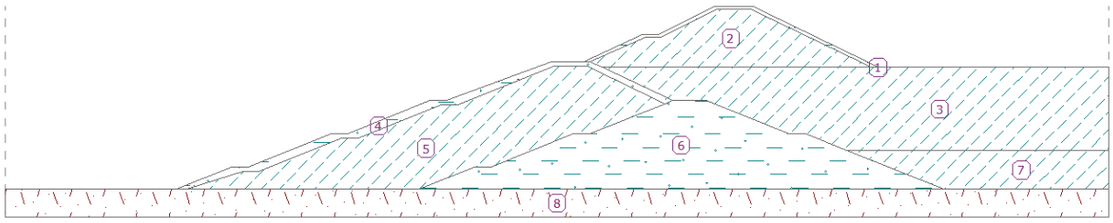
The starter dam (initial dyke) is 16 m high (RL 285 to 301 m), and the proposed 1st raising, using ash excavated from the ash pond, will add another height of 7 m (RL 301 to 308 m), including 1.0 m as freeboard. So, after 1st raising, the total height of the ash dyke will be 23 m.

Hence, another raising (2nd 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.

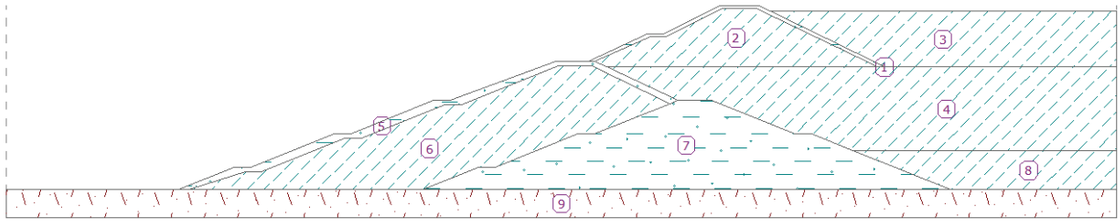
Also, future raisings (2nd and 3rd) will be carried out using the upstream method, as the 1st raising is being carried out using downstream method and no space will be available for future raisings by the same construction method, i.e., downstream method.

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.



(a)



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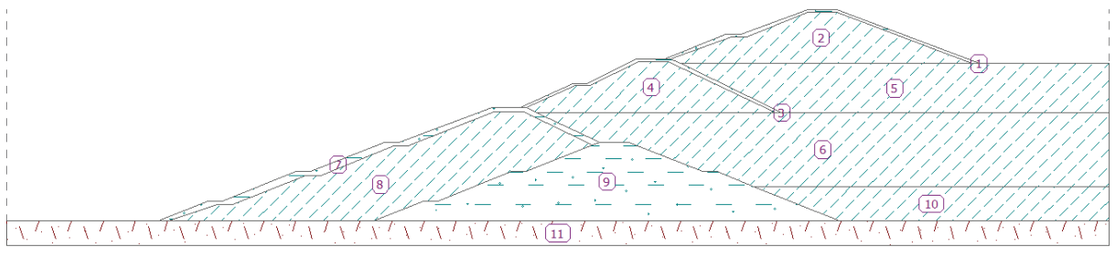
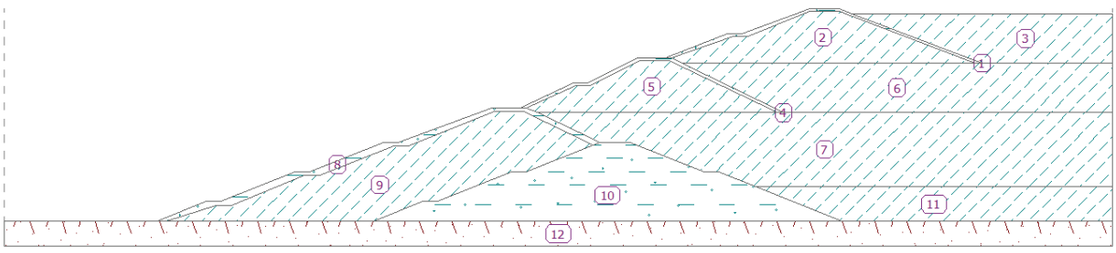


(a)



(d)

Figure 6 Suggested future raisings, (a) 2nd future raising (Empty), (b) 2nd future raising (Full), (c) 3rd future raising (Empty), and (d) 3rd 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 (2nd & 3rd)

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
2nd 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[a]
		Full	d/s	1.14	1.03
3rd Raised Dyke (10 m)	Static	Empty	d/s	1.95	1.42[b]
			u/s	2.07	1.72
		Full	d/s	1.98	1.44[b]
	Seismic	Empty	d/s	1.20	0.93[a]
			u/s	1.29	1.09
		Full	d/s	1.18	0.93[a]

Note: Factor of safety not satisfied

[a] Factor of Safety < 1.0

[b] Factor of Safety < 1.5

3.2.3 Results and Discussion

As discussed earlier, the 1st 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 2nd phase; and 318 to 328 m in 3rd 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 ≥ 1.5 for the downstream slope under static loading. And, ≥ 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.

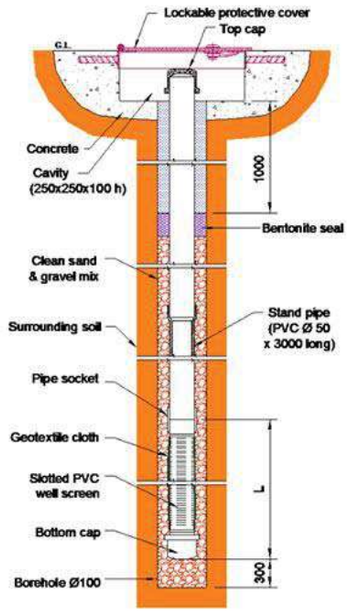


Figure 7 Open Standpipe Piezometer

(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.

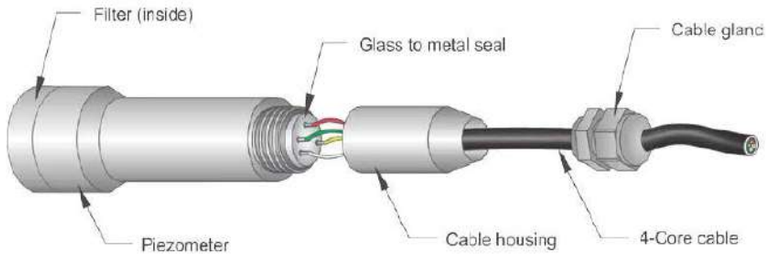


Figure 8 Vibrating wire piezometer

(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.

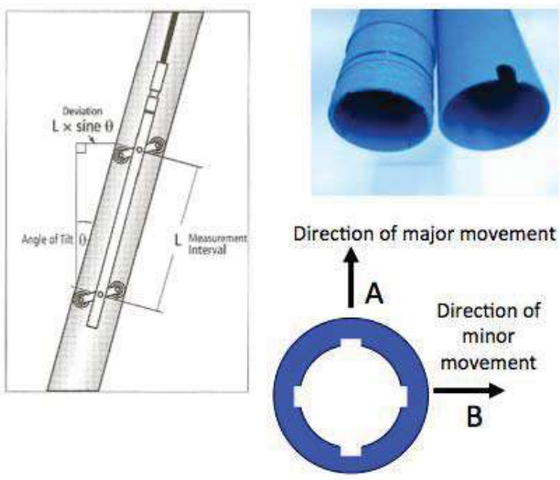


Figure 9 Slope inclinometer

(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 PM10, PM2.5, SO_2, NO_x 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^3 (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.

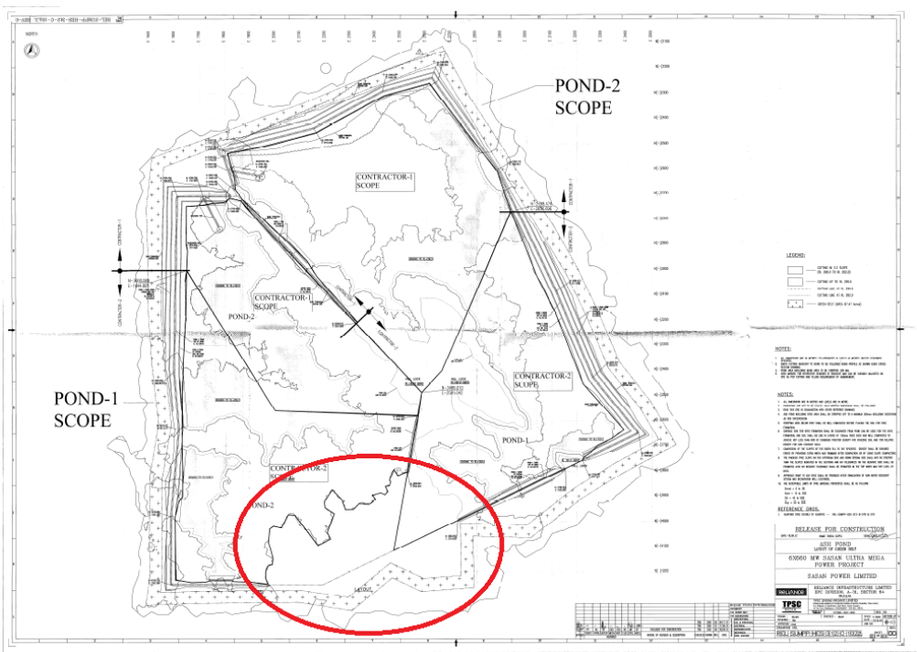


Figure 11 Available space (encircled in red) between Lagoons-1 and 2

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^2) 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.

09-08-2020

(Arun Prasad)
Professor & Consultant

Place: IIT (BHU) Varanasi
Date: 9th August 2020

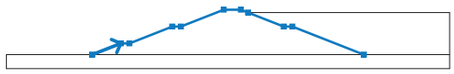
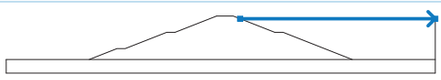
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Starter Dyke Soil		20.00		
2	Pond Ash		14.00		
3	Ash Hearth (Dyke Rising)		14.00		

Number	Name	Pattern	γ_{sat} [kN/m3]	γ_s [kN/m3]	n [–]
4	Soil Cover (Dyke Raising)		21.00		

Soil parameters

Starter Dyke Soil

Unit weight : γ = 18.00 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m3

Pond Ash

Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

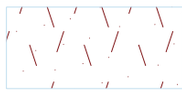
Ash Hearth (Dyke Rising)

Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

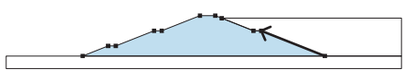
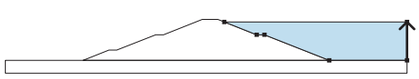
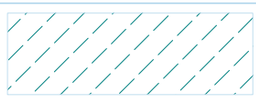
Soil Cover (Dyke Raising)

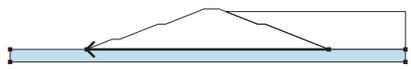
Unit weight : γ = 19.06 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

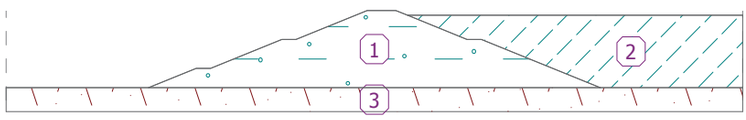
Number	Name	Sample	γ [kN/m3]
1	Foundation		26.00

Assigning and surfaces

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Name : Soils and assignment	Stage : 1



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

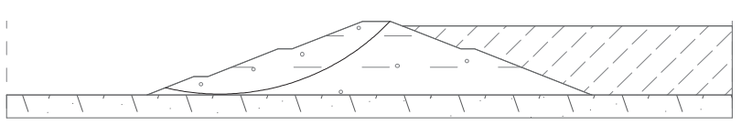
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	15.50	[m]	Angles :	α_1 =	-13.51	[°]
	z =	49.87	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



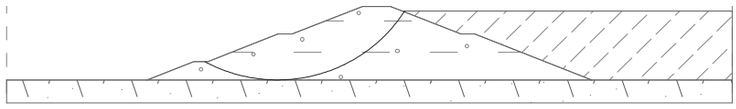
Analysis 2
Circular slip surface

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Starter Ash Dyke

Slip surface parameters							
Center :	x =	27.86	[m]	Angles :	α_1 =	-28.88	[°]
	z =	32.09	[m]		α_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



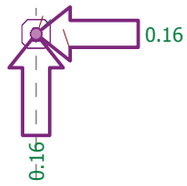
Slope stabilty analysis

Project

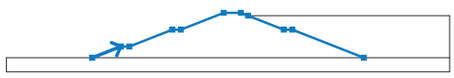
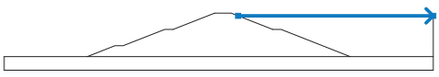
Task : Stability Analysis_Starter Ash Dyke
Author : Arun Prasad
Date : 12-07-2020

Analysis type : in effective parameters

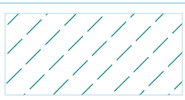
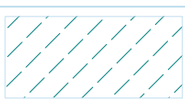
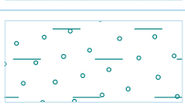
Name : Project	Stage : 1



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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_Starter Ash Dyke

Number	Name	Pattern	γ_{sat} [kN/m3]	γ_s [kN/m3]	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 : $\gamma = 18.00$ kN/m3
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa
Saturated unit weight : $\gamma_{sat} = 20.00$ kN/m3

Pond Ash

Unit weight : $\gamma = 12.00$ kN/m3
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m3

Ash Hearth (Dyke Rising)

Unit weight : $\gamma = 12.00$ kN/m3
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m3

Soil Cover (Dyke Raising)

Unit weight : $\gamma = 19.06$ kN/m3
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa
Saturated unit weight : $\gamma_{sat} = 21.00$ kN/m3

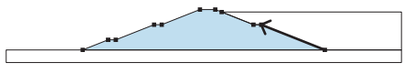
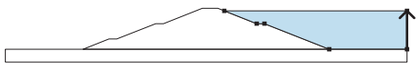
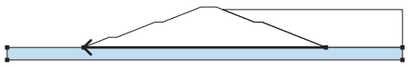
Rigid bodies

Number	Name	Sample	γ [kN/m3]
1	Foundation		26.00

Assigning and surfaces

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_Starter Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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)

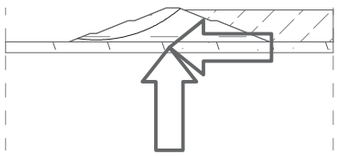
Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	12.93	[m]	Angles :	α_1 =	-8.35	[°]
	z =	61.70	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1

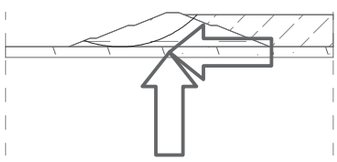


Analysis 2
Circular slip surface

Slip surface parameters							
Center :	x =	24.31	[m]	Angles :	α_1 =	-19.38	[°]
	z =	51.37	[m]		α_2 =	44.93	[°]
Radius :	R =	51.38	[m]				
The slip surface after optimization.							

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

Name : Analysis	Stage - analysis : 1 - 2



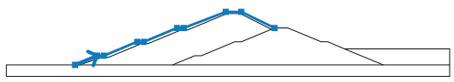
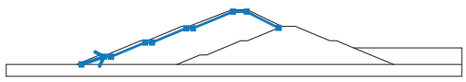
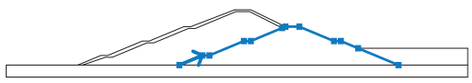
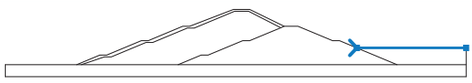
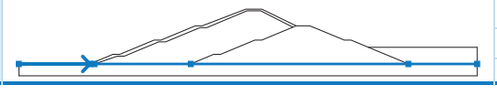
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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

Number	Name	Pattern	γ_{sat} [kN/m3]	γ_s [kN/m3]	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 :	γ =	18.00 kN/m3
Angle of internal friction :	φ_{ef} =	5.00 °
Cohesion of soil :	c_{ef} =	64.00 kPa
Saturated unit weight :	γ_{sat} =	20.00 kN/m3

Pond Ash

Unit weight :	γ =	12.00 kN/m3
Angle of internal friction :	φ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	14.00 kN/m3

Ash Hearth (Dyke Raising)

Unit weight :	γ =	12.00 kN/m3
Angle of internal friction :	φ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	14.00 kN/m3

Soil Cover (Dyke Raising)

Unit weight :	γ =	19.06 kN/m3
Angle of internal friction :	φ_{ef} =	5.00 °
Cohesion of soil :	c_{ef} =	64.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m3

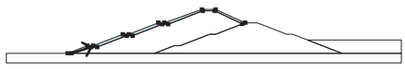
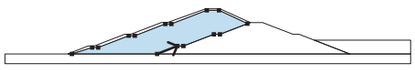
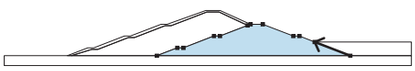
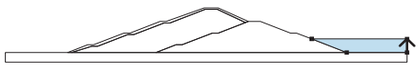
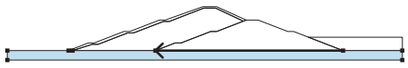
Rigid bodies

Number	Name	Sample	γ [kN/m3]
1	Foundation		26.00

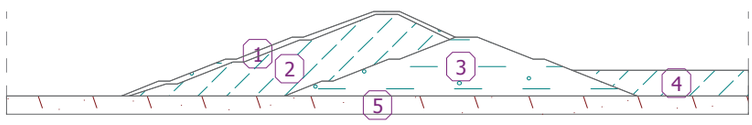
Assigning and surfaces

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_1st Raising

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	Stability Analysis_1st Raising
Arun Prasad	

Analysis settings

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

Results (Stage of construction 1)

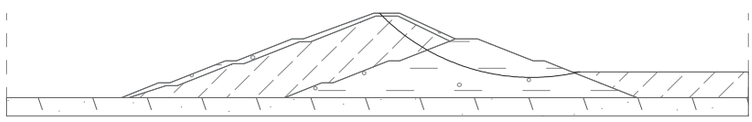
Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	66.56	[m]	Angles :	α_1 =	-46.25	[°]
	z =	62.23	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



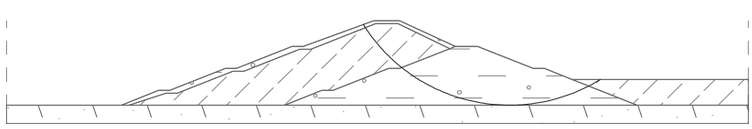
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	60.63	[m]	Angles :	α_1 =	-58.29	[°]
	z =	46.32	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



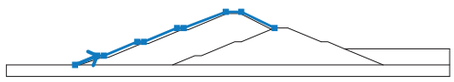
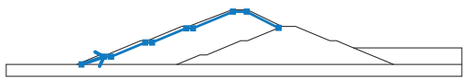
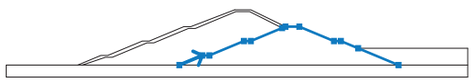
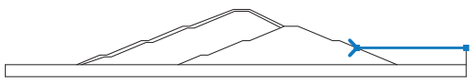
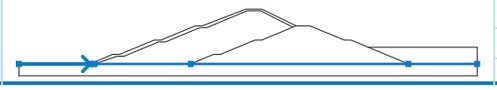
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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

Number	Name	Pattern	γ_{sat} [kN/m3]	γ_s [kN/m3]	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/m3
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa
Saturated unit weight : $\gamma_{sat} = 20.00$ kN/m3

Pond Ash

Unit weight : $\gamma = 12.00$ kN/m3
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m3

Ash Hearth (Dyke Raising)

Unit weight : $\gamma = 12.00$ kN/m3
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m3

Soil Cover (Dyke Raising)

Unit weight : $\gamma = 19.06$ kN/m3
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa
Saturated unit weight : $\gamma_{sat} = 21.00$ kN/m3

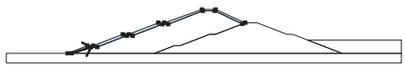
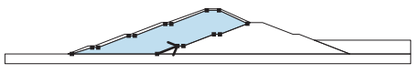
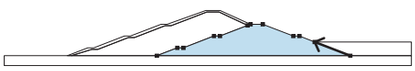
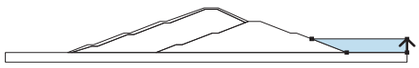
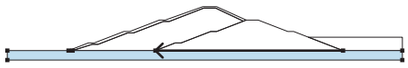
Rigid bodies

Number	Name	Sample	γ [kN/m3]
1	Foundation		26.00

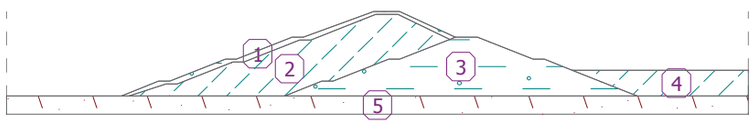
Assigning and surfaces

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_1st Raising

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	Stability Analysis_1st Raising
Arun Prasad	

Analysis settings

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

Results (Stage of construction 1)

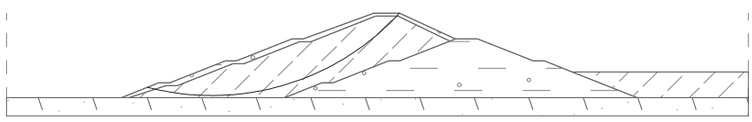
Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-19.66	[m]	Angles :	α_1 =	-14.73	[°]
	z =	68.76	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



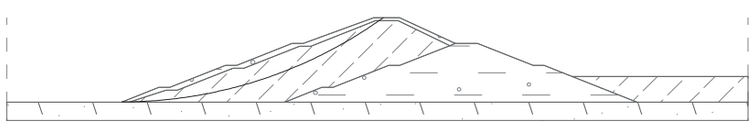
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	-44.11	[m]	Angles :	α_1 =	0.10	[°]
	z =	120.21	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



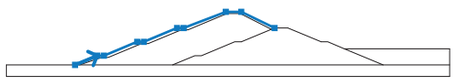
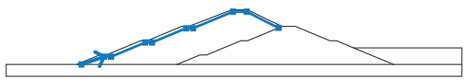
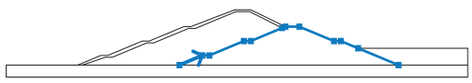
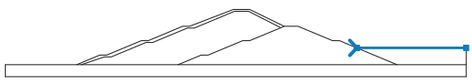
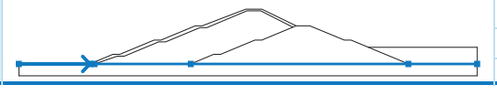
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

Unit weight : γ = 19.06 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

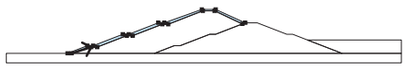
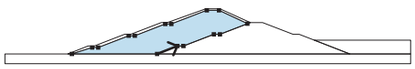
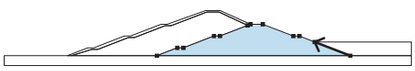
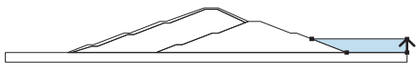
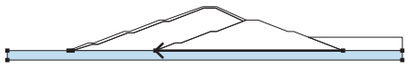
Rigid bodies

Number	Name	Sample	γ [kN/m^3]
1	Foundation		26.00

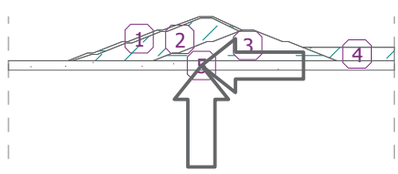
Assigning and surfaces

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_1st Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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

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

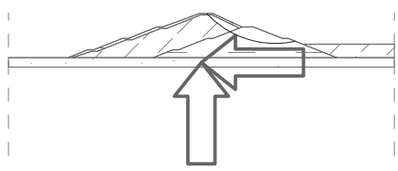
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	63.27	[m]	Angles :	α_1 =	-47.41	[°]
	z =	55.59	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1

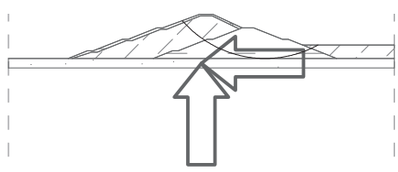


Analysis 2
Circular slip surface

Slip surface parameters							
Center :	x =	58.08	[m]	Angles :	α_1 =	-49.40	[°]
	z =	56.54	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2

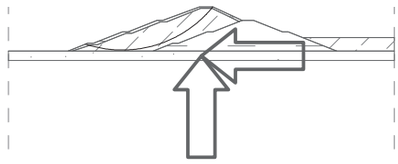


Analysis 3
Circular slip surface

Slip surface parameters							
Center :	x =	-16.02	[m]	Angles :	α_1 =	-18.40	[°]
	z =	60.64	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 3



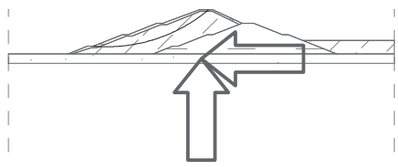
Analysis 4

Circular slip surface

Slip surface parameters							
Center :	x =	-24.02	[m]	Angles :	α_1 =	-4.85	[°]
	z =	85.39	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 4



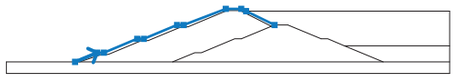
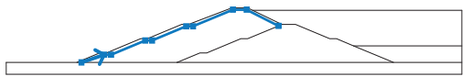
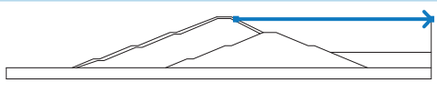
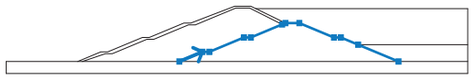
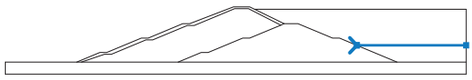
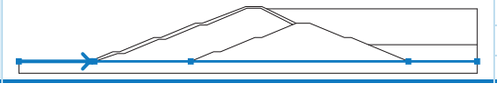
Slope stabilty analysis

Project

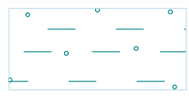
Task : Stability Analysis_Raised Ash Dyke
User : Arun Prasad
Author : Arun Prasad
Date : 12-07-2020

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

Unit weight : γ = 19.06 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

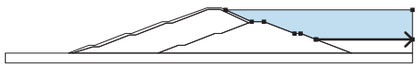
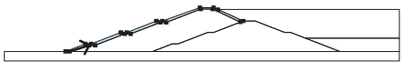
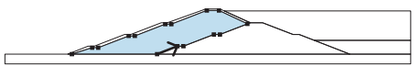
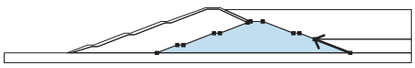
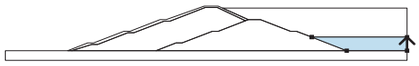
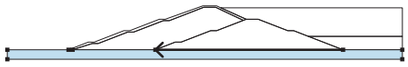
Rigid bodies

Number	Name	Sample	γ [kN/m^3]
1	Foundation		26.00

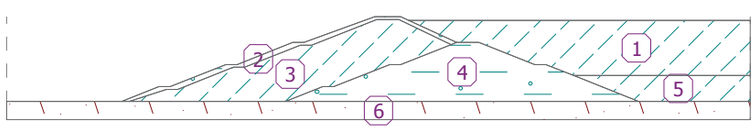
Assigning and surfaces

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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**



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

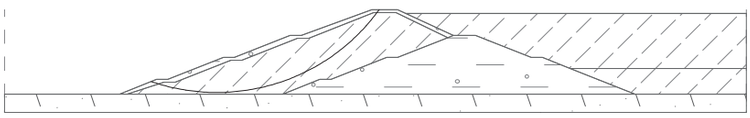
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	-17.80	[m]	Angles :	α_1 =	-19.16	[°]
	z =	54.21	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1

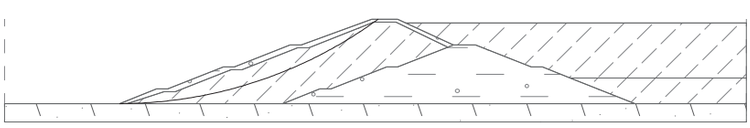


Analysis 2
Circular slip surface

Slip surface parameters							
Center :	x =	-44.18	[m]	Angles :	α_1 =	0.10	[°]
	z =	117.62	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



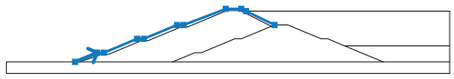
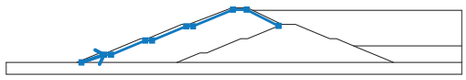
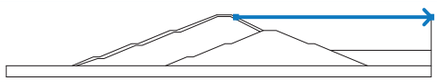
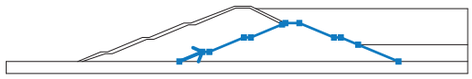
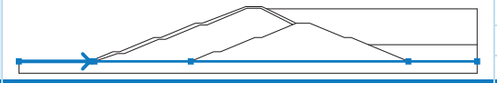
Slope stabilty analysis

Project

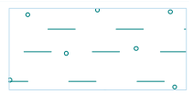
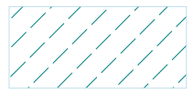
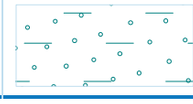
Task : Stability Analysis_1st Raising
User : Arun Prasad
Author : Arun Prasad
Date : 12-07-2020

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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

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Number	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

Unit weight : γ = 19.06 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m^3

Rigid bodies

Number	Name	Sample	γ [kN/m^3]
1	Foundation		26.00

Assigning and surfaces

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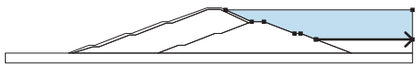
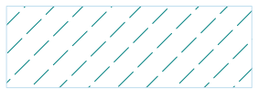
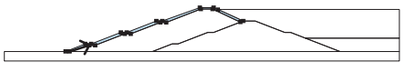
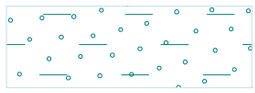
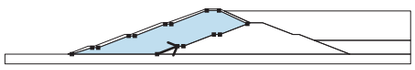
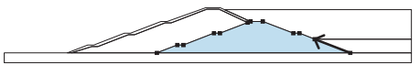
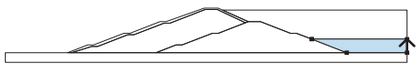
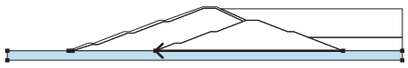
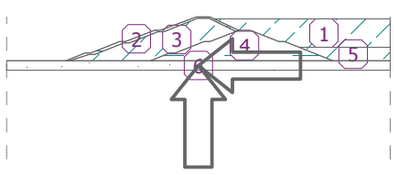
Stability Analysis_1st Raising

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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**



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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

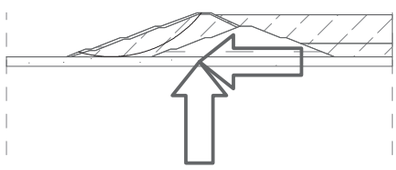
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	-20.74	[m]	Angles :	α_1 =	-16.53	[°]
	z =	59.43	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



Analysis 2
Circular slip surface

Slip surface parameters							
Center :	x =	-43.77	[m]	Angles :	α_1 =	-0.08	[°]
	z =	127.39	[m]		α_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

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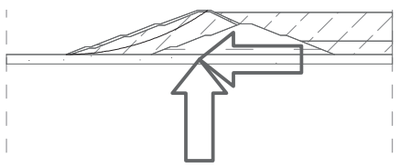
Name : Analysis	Stage - analysis : 1 - 2



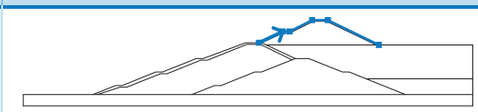
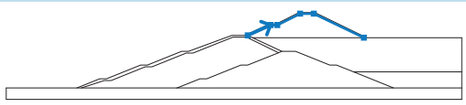
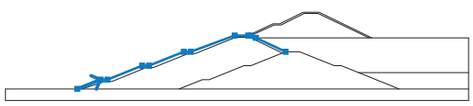
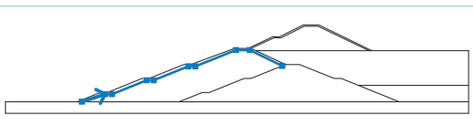
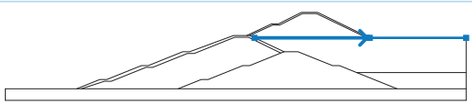
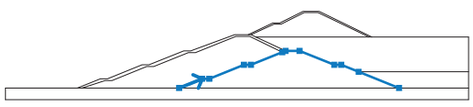
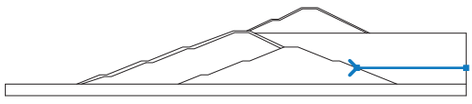
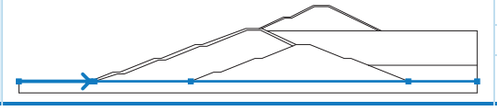
Slope stabilty analysis

Project

Task : Stability Analysis_2nd Raising
User : Arun Prasad
Author : Arun Prasad
Date : 12-07-2020

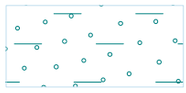
Analysis type : in effective parameters

Interface

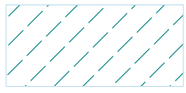
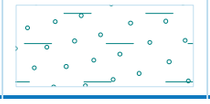
Number	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		29.80	23.00	40.50	28.00	43.50	28.00
		53.50	33.00	60.50	33.00	83.20	22.00
2		31.00	23.00	41.00	27.50	44.00	27.50
		54.00	32.50	60.00	32.50	82.00	22.00
3		-44.00	0.00	-34.00	4.00	-31.00	4.00
		-16.00	10.00	-13.00	10.00	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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Starter Dyke		5.00	64.00	18.00

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
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	γ_{sat} [kN/m³]	γ_s [kN/m³]	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 : γ = 18.00 kN/m³
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m³

Pond Ash

Unit weight : γ = 12.00 kN/m³
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m³

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m³
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m³

Soil Cover (Dyke Raising)

Unit weight : γ = 19.06 kN/m³
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa

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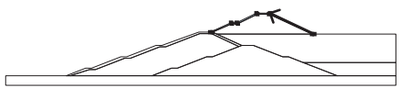
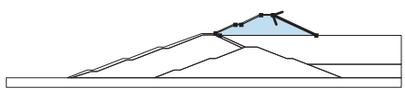
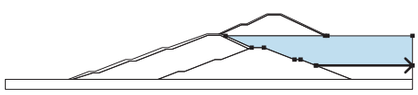
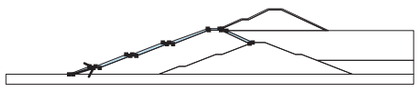
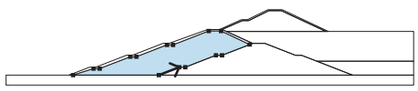
Stability Analysis_2nd Raising

Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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			

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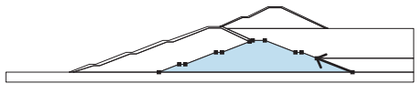
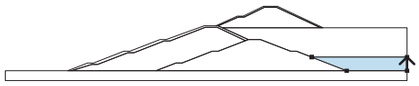
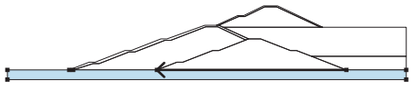
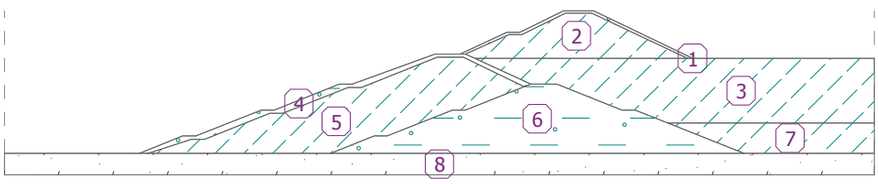
Stability Analysis_2nd Raising

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Name : Soils and assignment **Stage : 1**



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

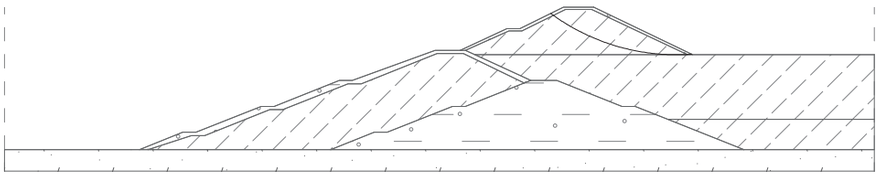
Slip surface parameters							
Center :	x =	79.52	[m]	Angles :	α_1 =	-36.63	[°]
	z =	70.45	[m]		α_2 =	4.12	[°]
Radius :	R =	48.48	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (Spencer)

IIT (BHU) Varanasi	Stability Analysis_2nd Raising
Arun Prasad	

Factor of safety = 2.03 > 1.00
Slope stability SATISFACTORY

Name : Analysis	Stage - analysis : 1 - 1



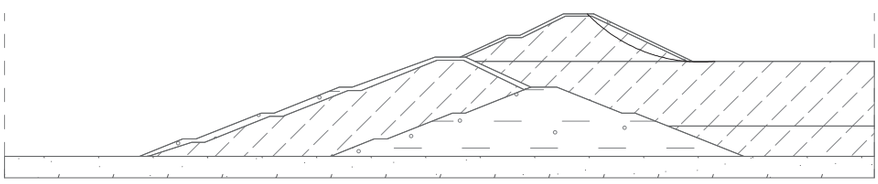
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	85.04	[m]	Angles :	α_1 =	-46.40	[°]
	z =	57.77	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



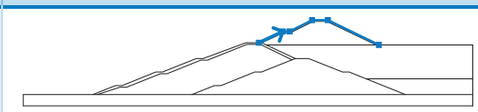
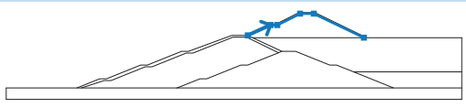
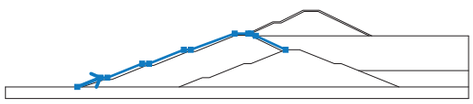
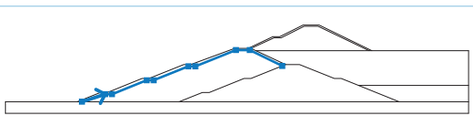
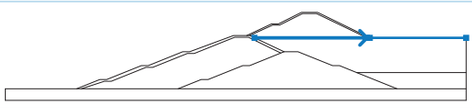
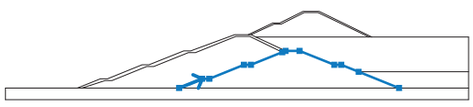
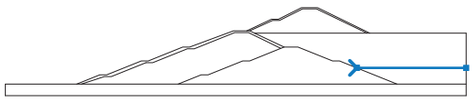
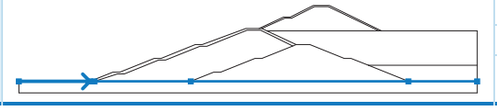
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Starter Dyke		5.00	64.00	18.00

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Stability Analysis_2nd Raising

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
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	γ_{sat} [kN/m³]	γ_s [kN/m³]	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/m³
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa
Saturated unit weight : $\gamma_{sat} = 20.00$ kN/m³

Pond Ash

Unit weight : $\gamma = 12.00$ kN/m³
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m³

Ash Hearth (Dyke Raising)

Unit weight : $\gamma = 12.00$ kN/m³
Angle of internal friction : $\varphi_{ef} = 30.00$ °
Cohesion of soil : $c_{ef} = 0.00$ kPa
Saturated unit weight : $\gamma_{sat} = 14.00$ kN/m³

Soil Cover (Dyke Raising)

Unit weight : $\gamma = 19.06$ kN/m³
Angle of internal friction : $\varphi_{ef} = 5.00$ °
Cohesion of soil : $c_{ef} = 64.00$ kPa

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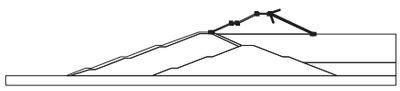
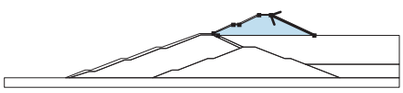
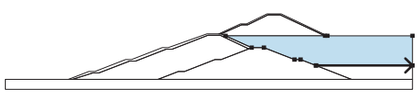
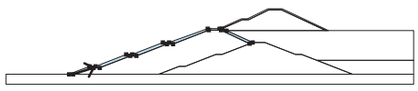
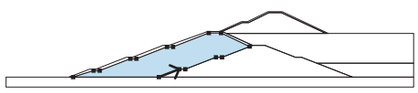
Stability Analysis_2nd Raising

Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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			

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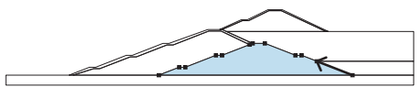
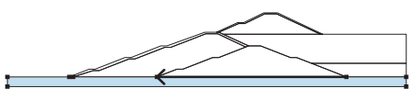
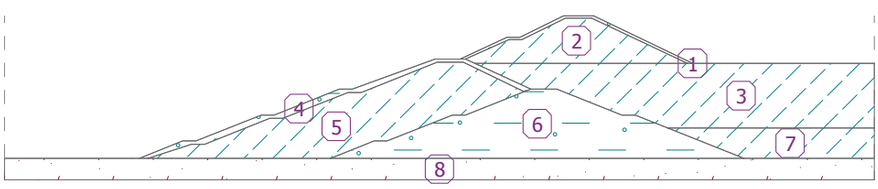
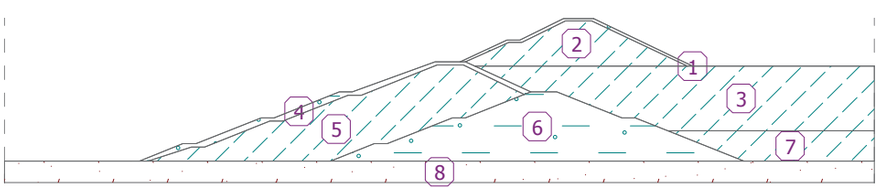
Stability Analysis_2nd Raising

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Name : Soils and assignment **Stage : 1**



Name : Soils and assignment **Stage : 1**



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

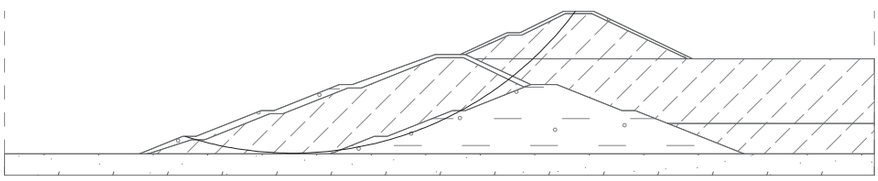
Analysis 1

Circular slip surface

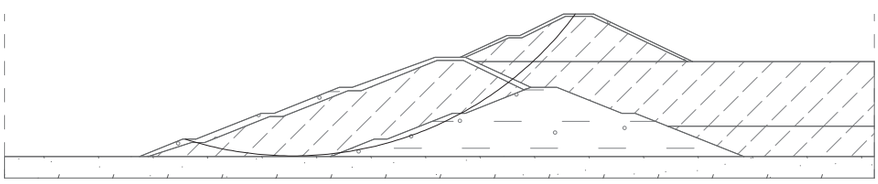
Slip surface parameters							
Center :	x =	-8.74	[m]	Angles :	α_1 =	-17.84	[°]
	z =	80.79	[m]		α_2 =	53.67	[°]
Radius :	R =	80.67	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (Spencer)
Factor of safety = 1.76 > 1.50
Slope stability SATISFACTORY

Name : Analysis	Stage - analysis : 1 - 1



Name : Analysis	Stage - analysis : 1 - 1



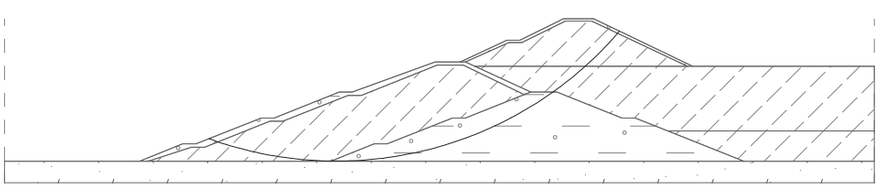
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	1.32	[m]	Angles :	α_1 =	-20.08	[°]
	z =	85.38	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



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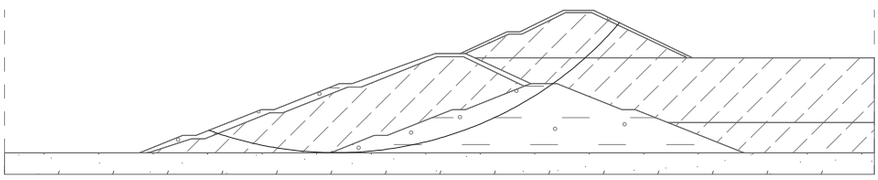
Name : Analysis	Stage - analysis : 1 - 2



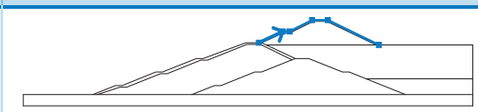
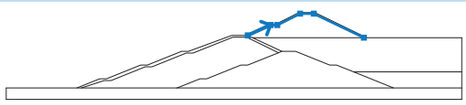
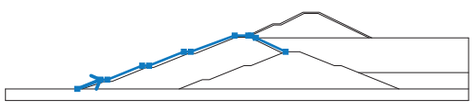
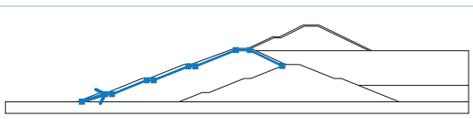
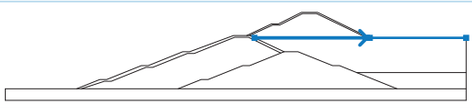
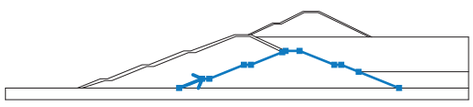
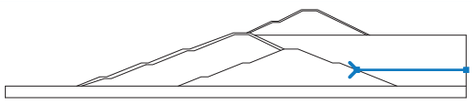
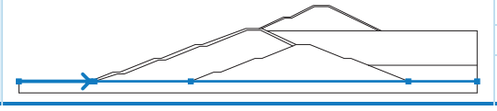
Slope stabilty analysis

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Starter Dyke		5.00	64.00	18.00

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

Unit weight : γ = 19.06 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa

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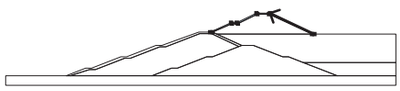
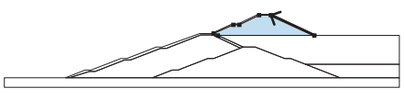
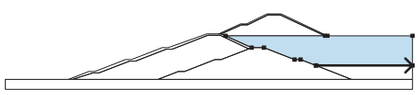
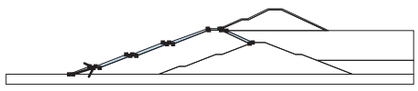
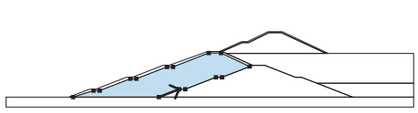
Stability Analysis_Raised Ash Dyke

Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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			

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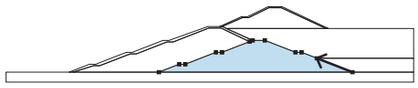
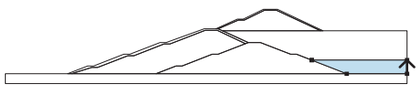
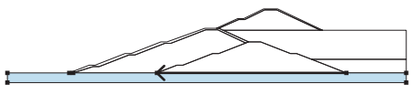
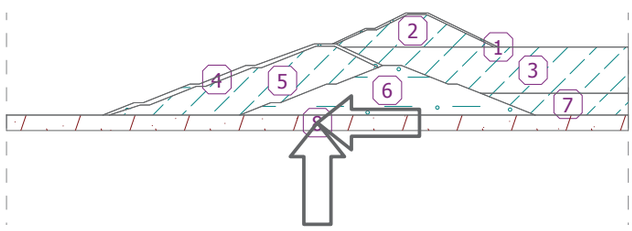
Stability Analysis_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Name : Soils and assignment | **Stage : 1**



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 :	α_1 =	-53.09	[°]
	z =	50.23	[m]		α_2 =	10.27	[°]
Analysis of the slip surface without optimization.							

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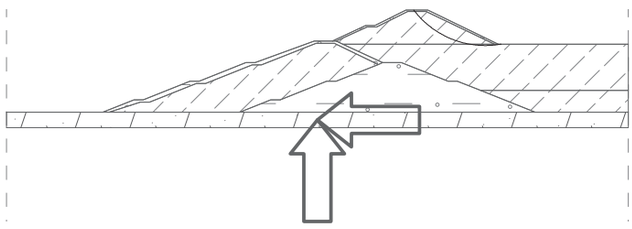
Slip surface parameters				
Radius :	R =	28.69	[m]	
Analysis of the slip surface without optimization.				

Slope stability verification (Spencer)
Factor of safety = 1.05 > 1.00
Slope stability SATISFACTORY

Name : Analysis	Stage - analysis : 1 - 1

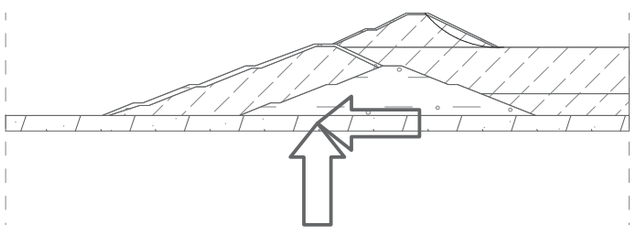


Analysis 2
Circular slip surface

Slip surface parameters							
Center :	x =	82.86	[m]	Angles :	α_1 =	-50.76	[°]
	z =	52.04	[m]		α_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.

Name : Analysis	Stage - analysis : 1 - 2



Analysis 3
Circular slip surface

Slip surface parameters							
Center :	x =	-15.56	[m]	Angles :	α_1 =	-11.28	[°]
	z =	105.66	[m]		α_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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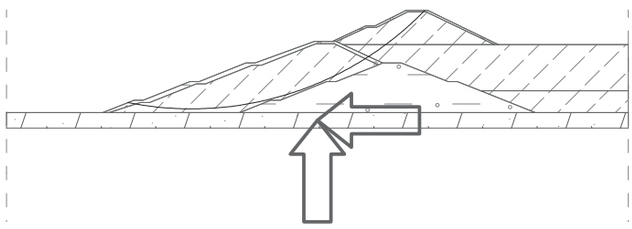
Stability Analysis_Raised Ash Dyke

Name : Analysis	Stage - analysis : 1 - 3



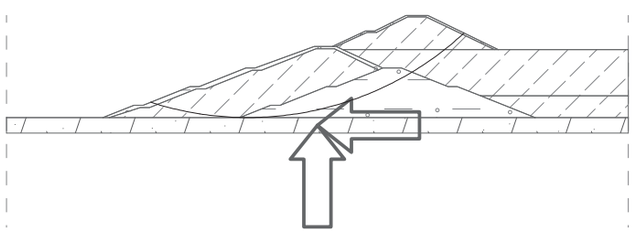
Analysis 4

Circular slip surface

Slip surface parameters							
Center :	x =	2.69	[m]	Angles :	α_1 =	-17.91	[°]
	z =	101.93	[m]		α_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



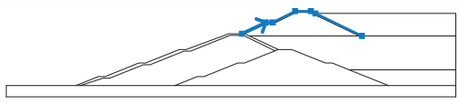
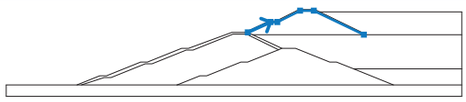
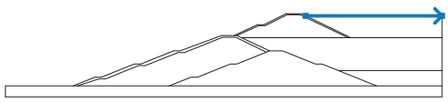
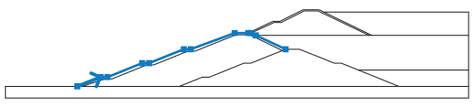
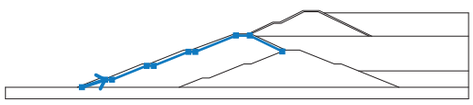
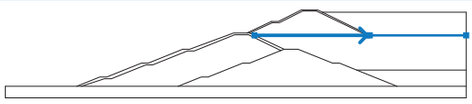
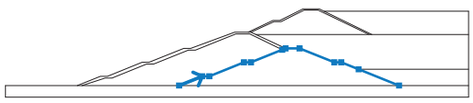
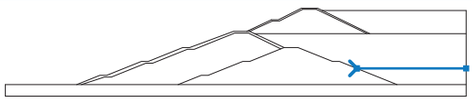
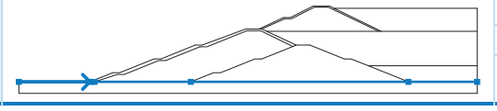
Slope stabilty analysis

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

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

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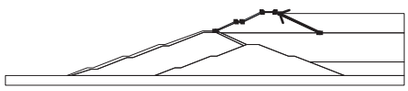
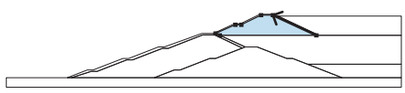
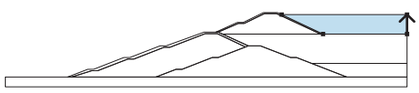
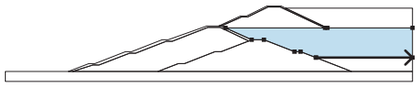
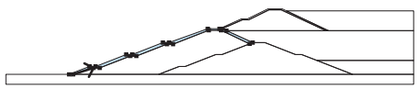
Stability Analysis_Raised Ash Dyke

Unit weight : γ = 19.06 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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	

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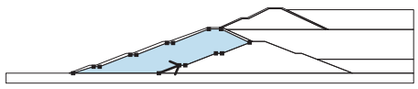
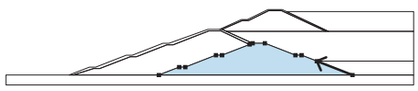
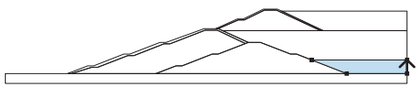
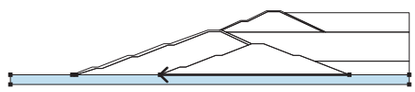
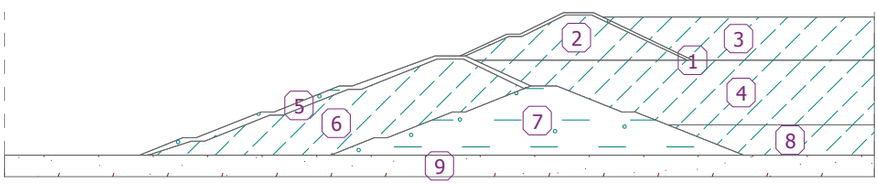
Arun Prasad

Stability Analysis_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	
		-42.00	0.00			
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	

Name : Soils and assignment | **Stage : 1**



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

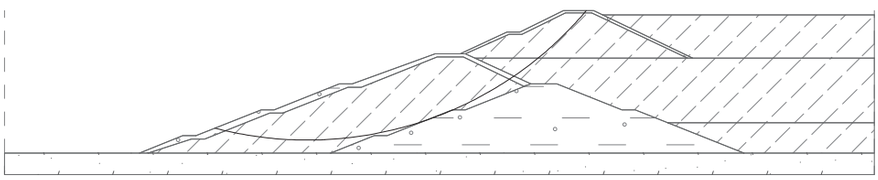
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke

Circular slip surface

Slip surface parameters							
Center :	x =	-5.36	[m]	Angles :	α_1 =	-14.74	[°]
	z =	86.55	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



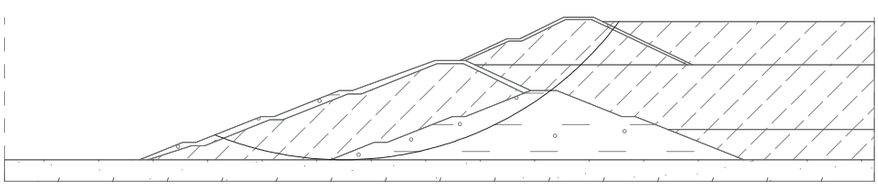
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	2.93	[m]	Angles :	α_1 =	-22.06	[°]
	z =	78.66	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



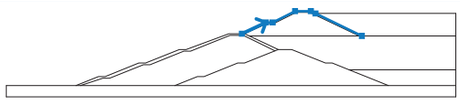
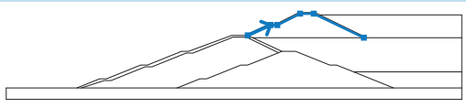
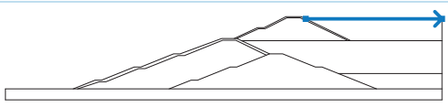
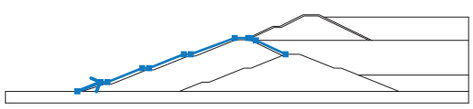
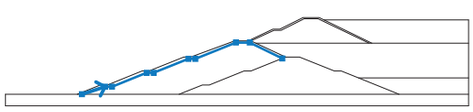
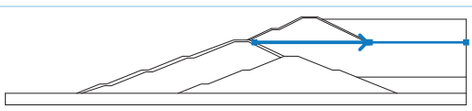
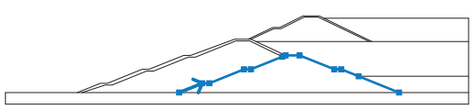
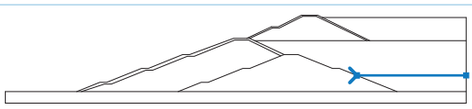
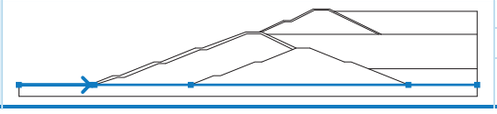
Slope stabilty analysis

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

Number	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Soil Cover (Dyke Raising)

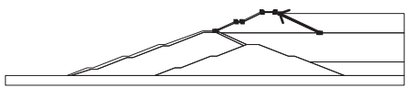
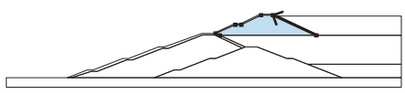
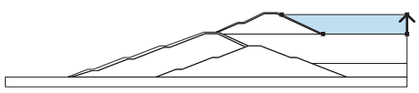
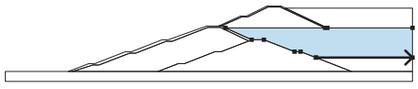
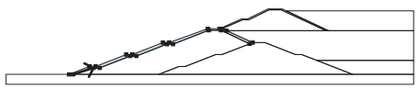
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke

Unit weight : γ = 19.06 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

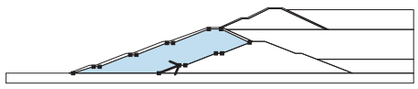
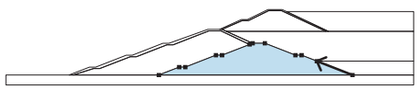
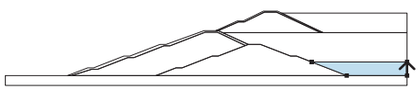
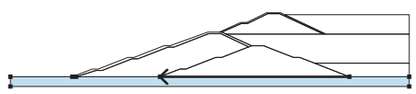
Number	Name	Sample	γ [kN/m3]
1	Foundation		26.00

Assigning and surfaces

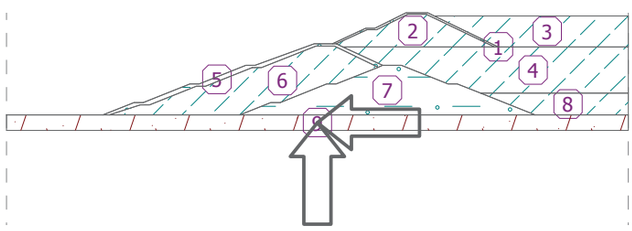
Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		83.20	22.00	62.56	32.00	Soil Cover (Dyke Raising)
		60.50	33.00	53.50	33.00	
		43.50	28.00	40.50	28.00	
		29.80	23.00	31.00	23.00	
		41.00	27.50	44.00	27.50	
		54.00	32.50	60.00	32.50	
		82.00	22.00			
2		82.00	22.00	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	

IIT (BHU) Varanasi
Arun Prasad

Stability Analysis_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	
		-42.00	0.00			
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	

Name : Soils and assignment | **Stage : 1**



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)

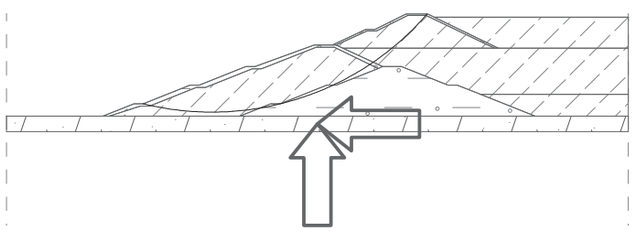
Analysis 1

Circular slip surface

Slip surface parameters							
Center :	x =	-8.96	[m]	Angles :	α_1 =	-14.01	[°]
	z =	92.75	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



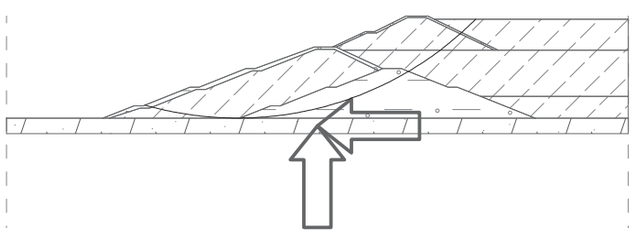
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	-0.69	[m]	Angles :	α_1 =	-16.05	[°]
	z =	107.73	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



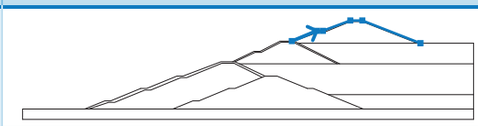
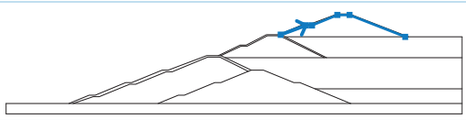
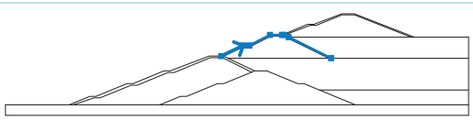
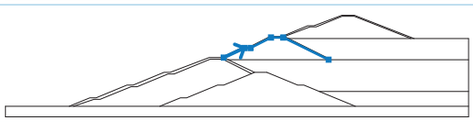
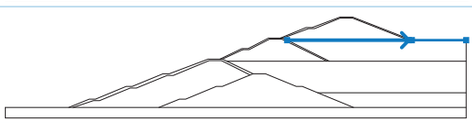
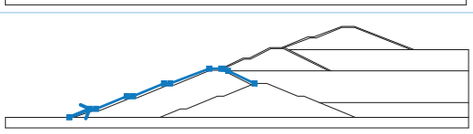
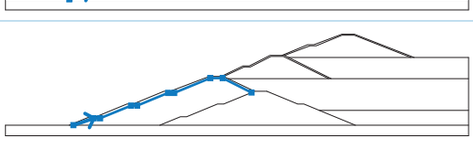
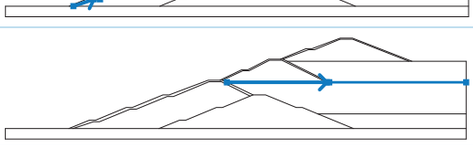
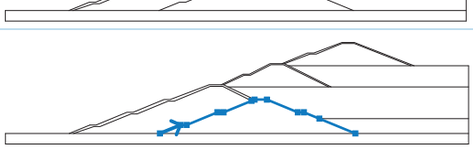
Slope stabilty analysis

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

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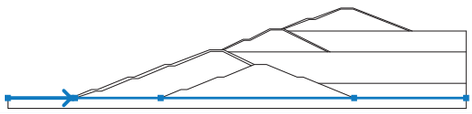
Stability Analysis_Raised Ash Dyke

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight :	γ =	12.00 kN/m^3
Angle of internal friction :	φ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	14.00 kN/m^3

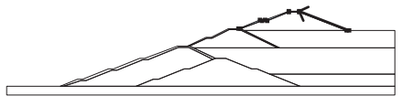
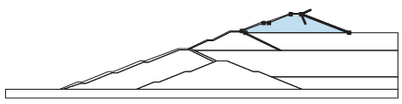
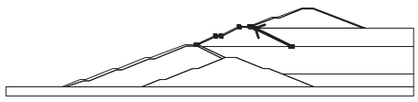
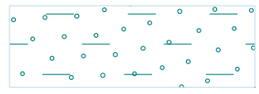
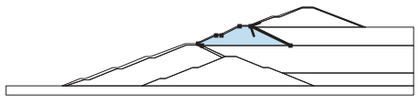
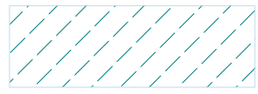
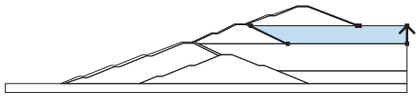
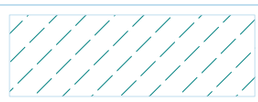
Soil Cover (Dyke Raising)

Unit weight :	γ =	19.06 kN/m^3
Angle of internal friction :	φ_{ef} =	5.00 °
Cohesion of soil :	c_{ef} =	64.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m^3

Rigid bodies

Number	Name	Sample	γ [kN/m^3]
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	
		94.50	42.50	122.00	32.00	
2		122.00	32.00	94.50	42.50	Ash Hearth (Dyke Raising)
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
		62.56	32.00			
3		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	
4		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			
5		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	

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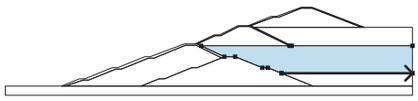
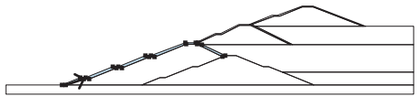
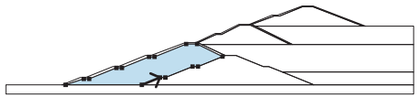
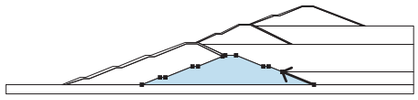
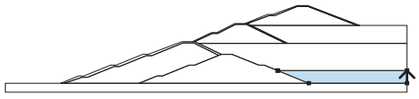
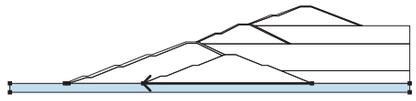
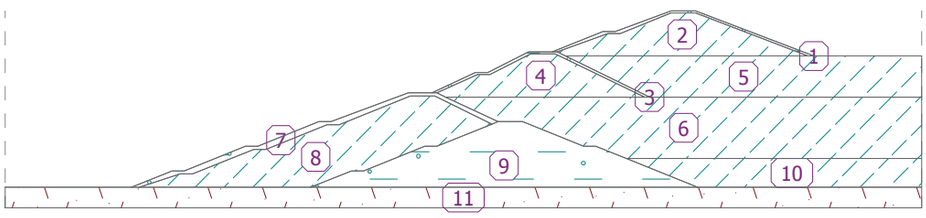
Stability Analysis_Raised Ash Dyke

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	

Name : Soils and assignment	Stage : 1



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

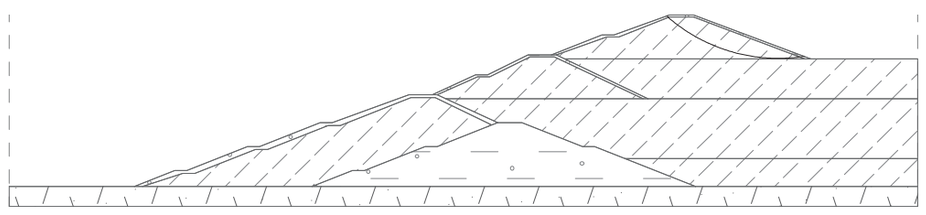
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	115.45	[m]	Angles :	α_1 =	-42.08	[°]
	z =	73.34	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



Analysis 2
Circular slip surface

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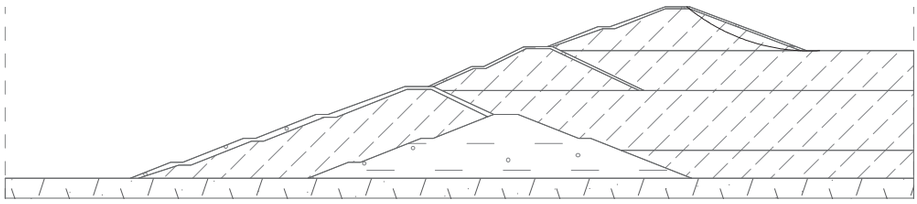
Slip surface parameters							
Center :	x =	124.26	[m]	Angles :	α_1 =	-39.95	[°]
	z =	79.35	[m]		α_2 =	3.00	[°]
Radius :	R =	47.42	[m]				
The slip surface after optimization.							

Slope stability verification (Spencer)
Factor of safety = 1.72 > 1.00
Slope stability SATISFACTORY

Name : Analysis	Stage - analysis : 1 - 2



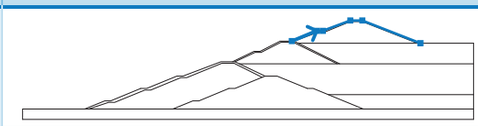
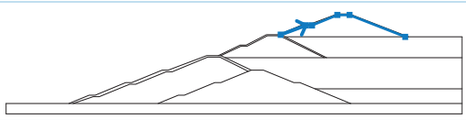
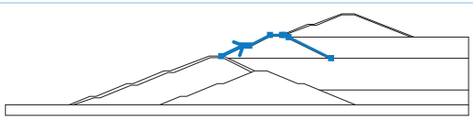
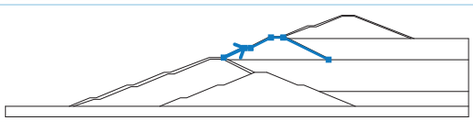
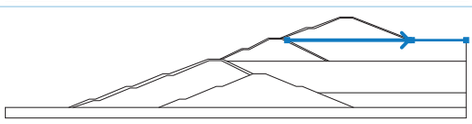
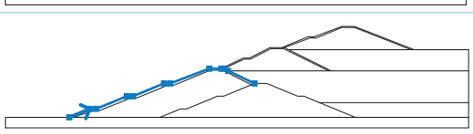
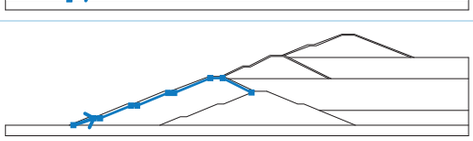
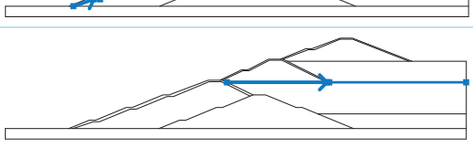
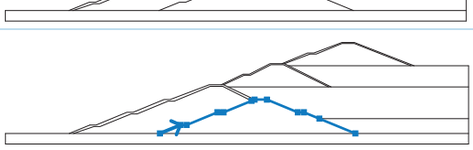
Slope stabilty analysis

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

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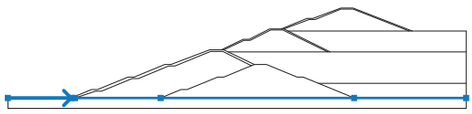
Stability Analysis_Raised Ash Dyke

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

Ash Hearth (Dyke Raising)

Unit weight :	γ =	12.00 kN/m^3
Angle of internal friction :	φ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	14.00 kN/m^3

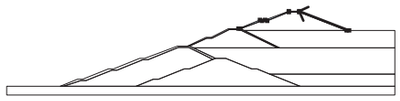
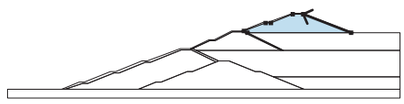
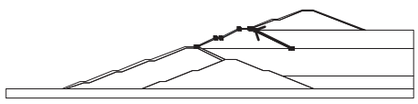
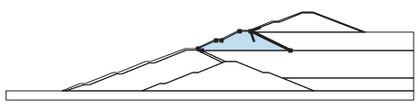
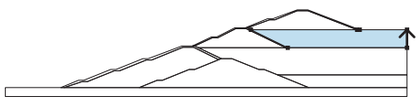
Soil Cover (Dyke Raising)

Unit weight :	γ =	19.06 kN/m^3
Angle of internal friction :	φ_{ef} =	5.00 °
Cohesion of soil :	c_{ef} =	64.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m^3

Rigid bodies

Number	Name	Sample	γ [kN/m^3]
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	
		94.50	42.50	122.00	32.00	
2		122.00	32.00	94.50	42.50	Ash Hearth (Dyke Raising)
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
		62.56	32.00			
3		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	
4		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			
5		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	

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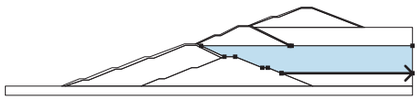
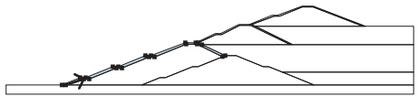
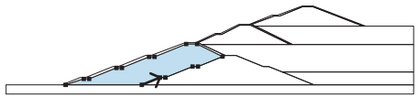
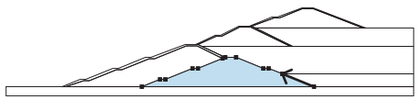
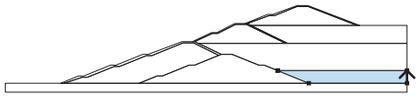
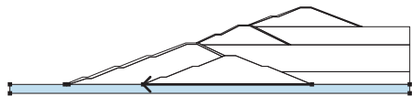
Stability Analysis_Raised Ash Dyke

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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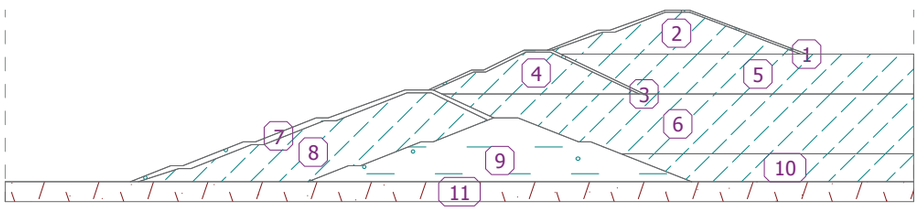
Stability Analysis_Raised Ash Dyke

Name : Soils and assignment	Stage : 1



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

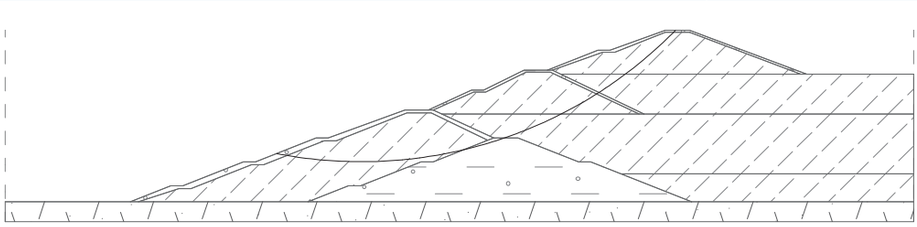
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	13.17	[m]	Angles :	α_1 =	-11.14	[°]
	z =	118.48	[m]		α_2 =	45.89	[°]
Radius :	R =	108.44	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (Spencer)
Factor of safety = 1.95 > 1.50
Slope stability SATISFACTORY

Name : Analysis	Stage - analysis : 1 - 1



Analysis 2
Circular slip surface

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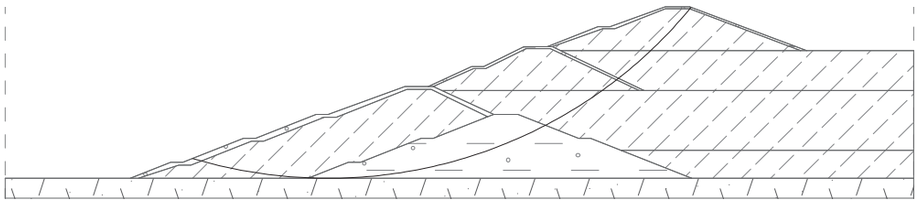
Slip surface parameters							
Center :	x =	4.97	[m]	Angles :	α_1 =	-16.86	[°]
	z =	115.67	[m]		α_2 =	51.00	[°]
Radius :	R =	115.68	[m]				
The slip surface after optimization.							

Slope stability verification (Spencer)
Factor of safety = 1.42 < 1.50
Slope stability NOT SATISF.

Name : Analysis	Stage - analysis : 1 - 2



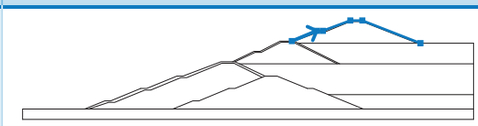
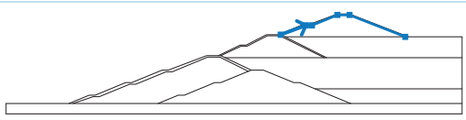
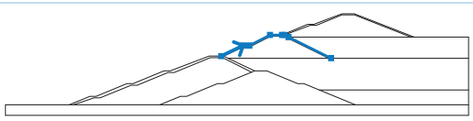
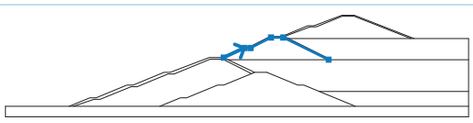
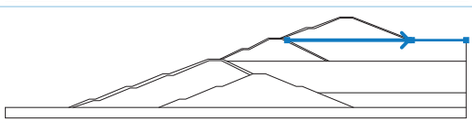
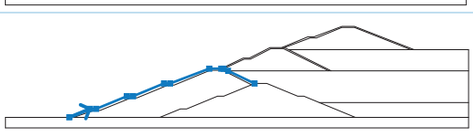
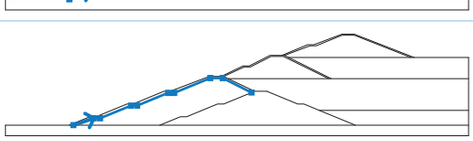
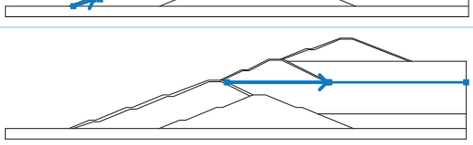
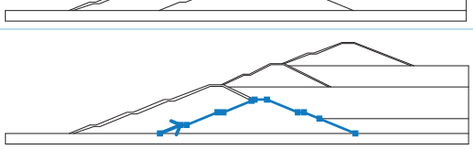
Slope stabilty analysis

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

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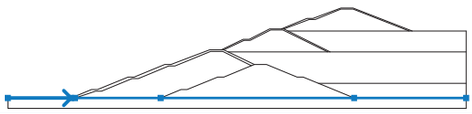
Stability Analysis_Raised Ash Dyke

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m^3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m^3

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Ash Hearth (Dyke Raising)

Unit weight :	γ =	12.00 kN/m^3
Angle of internal friction :	φ_{ef} =	30.00 °
Cohesion of soil :	c_{ef} =	0.00 kPa
Saturated unit weight :	γ_{sat} =	14.00 kN/m^3

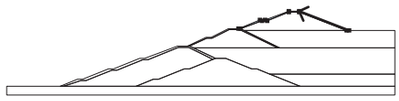
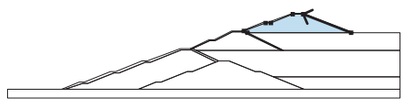
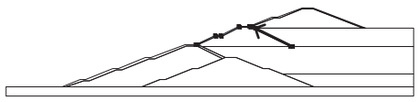
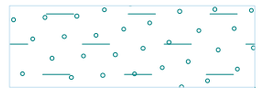
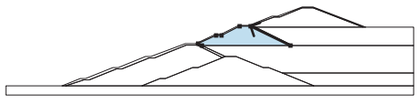
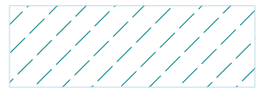
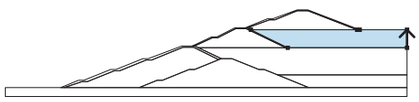
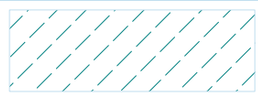
Soil Cover (Dyke Raising)

Unit weight :	γ =	19.06 kN/m^3
Angle of internal friction :	φ_{ef} =	5.00 °
Cohesion of soil :	c_{ef} =	64.00 kPa
Saturated unit weight :	γ_{sat} =	21.00 kN/m^3

Rigid bodies

Number	Name	Sample	γ [kN/m^3]
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	
		94.50	42.50	122.00	32.00	
2		122.00	32.00	94.50	42.50	Ash Hearth (Dyke Raising)
		88.50	42.50	76.00	37.50	
		73.00	37.50	60.50	33.00	
		62.56	32.00			
3		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	
4		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			
5		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	

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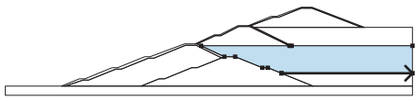
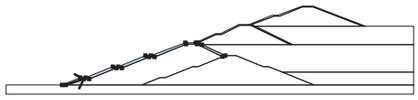
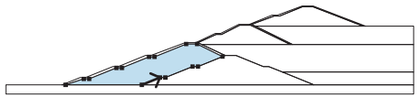
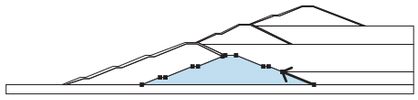
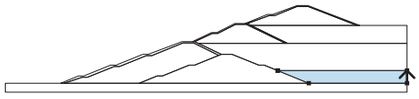
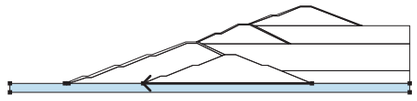
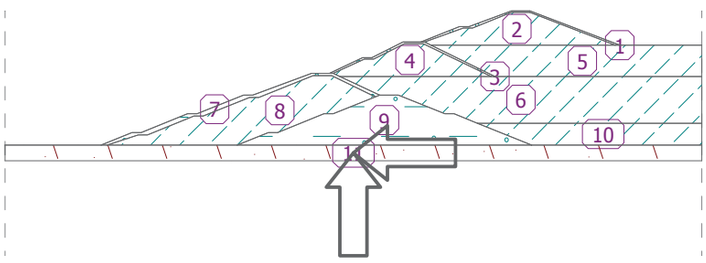
Stability Analysis_Raised Ash Dyke

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	

Name : Soils and assignment	Stage : 1



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

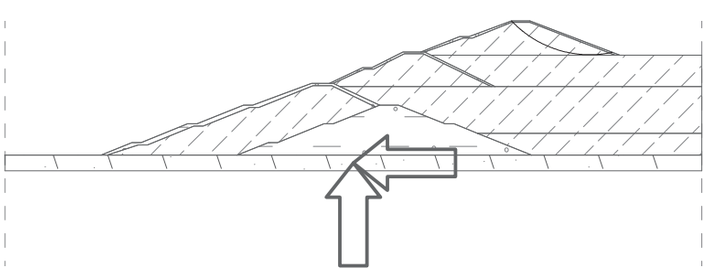
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	113.86	[m]	Angles :	α_1 =	-46.37	[°]
	z =	67.13	[m]		α_2 =	11.93	[°]
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

Name : Analysis	Stage - analysis : 1 - 1



Analysis 2

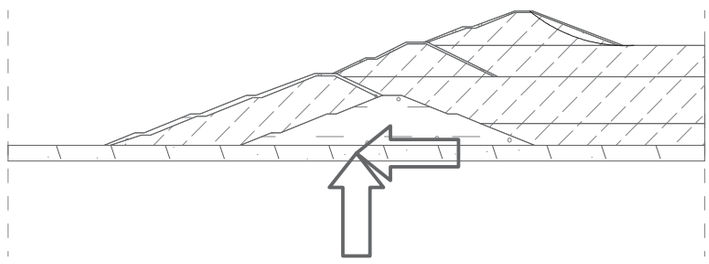
IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke

Circular slip surface

Slip surface parameters							
Center :	x =	124.39	[m]	Angles :	α_1 =	-39.40	[°]
	z =	80.64	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 2



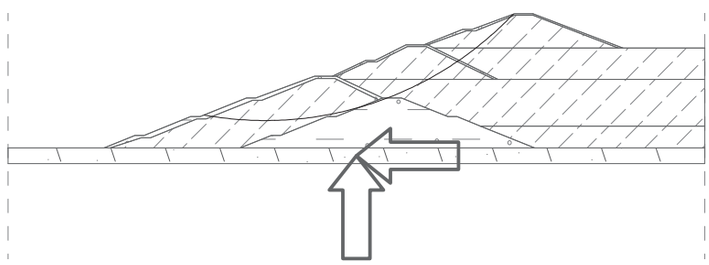
Analysis 3

Circular slip surface

Slip surface parameters							
Center :	x =	8.11	[m]	Angles :	α_1 =	-10.26	[°]
	z =	119.70	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 3



Analysis 4

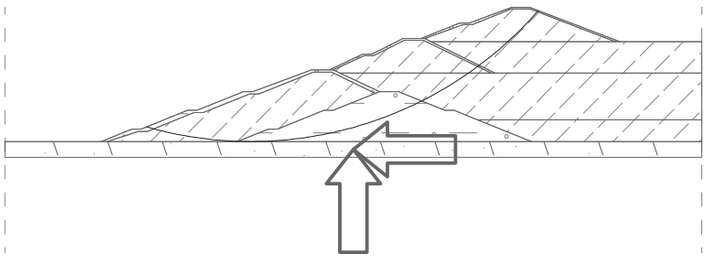
Circular slip surface

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke

Slip surface parameters							
Center :	x =	4.36	[m]	Angles :	α_1 =	-15.79	[°]
	z =	123.67	[m]		α_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.

Name : Analysis	Stage - analysis : 1 - 4



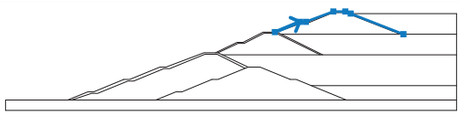
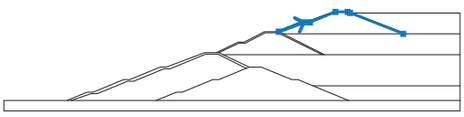
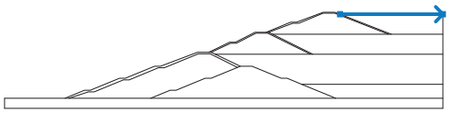
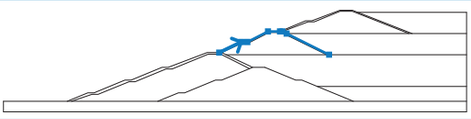
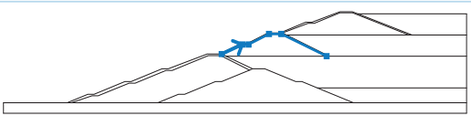
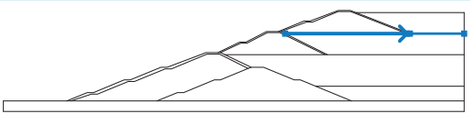
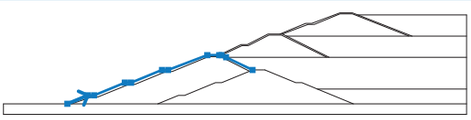
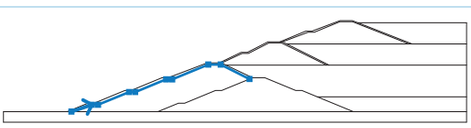
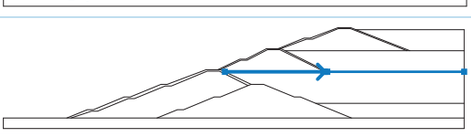
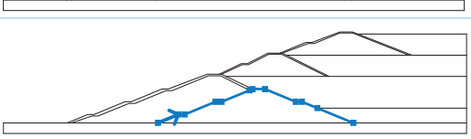
Slope stabilty analysis

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

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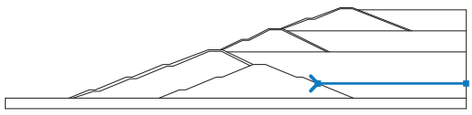
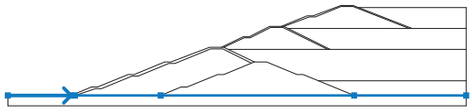
Stability Analysis_Raised Ash Dyke

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

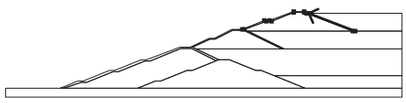
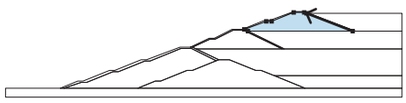
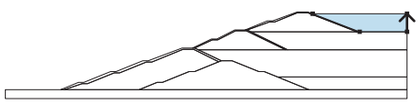
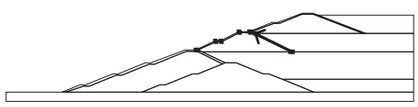
Ash Hearth (Dyke Raising)
Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

Soil Cover (Dyke Raising)
Unit weight : γ = 19.06 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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	
		95.81	42.00	122.00	32.00	
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	

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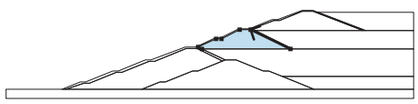
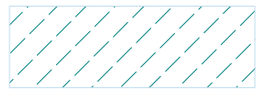
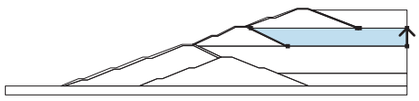
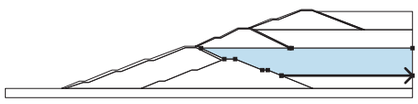
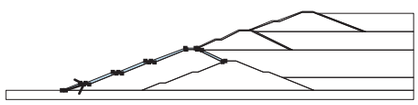
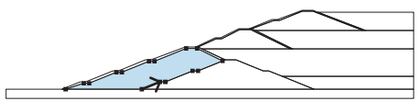
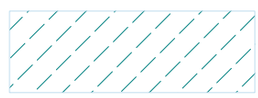
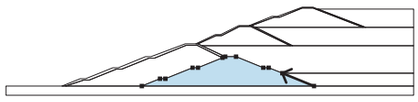
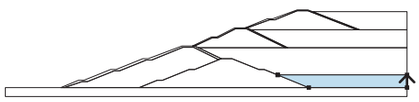
Stability Analysis_Raised Ash Dyke

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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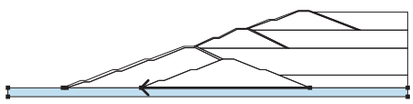
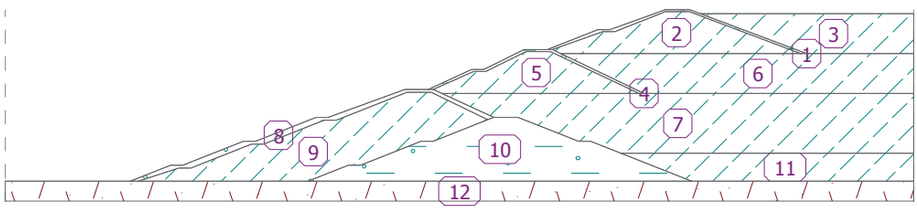
Stability Analysis_Raised Ash Dyke

Number	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
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	

Name : Soils and assignment **Stage : 1**



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

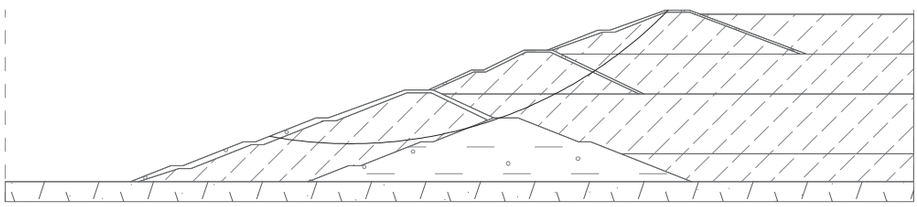
Results (Stage of construction 1)

Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	10.52	[m]	Angles :	α_1 =	-10.59	[°]
	z =	118.66	[m]		α_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

Name : Analysis	Stage - analysis : 1 - 1



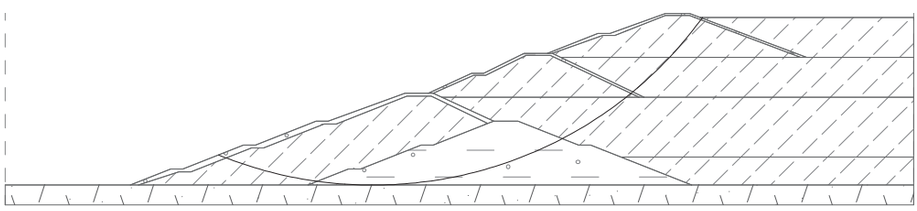
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	16.04	[m]	Angles :	α_1 =	-22.39	[°]
	z =	100.30	[m]		α_2 =	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.

Name : Analysis	Stage - analysis : 1 - 2



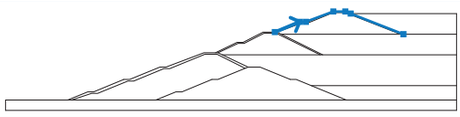
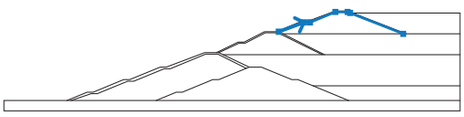
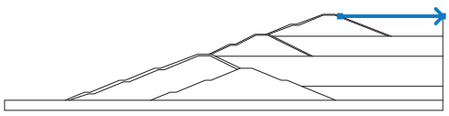
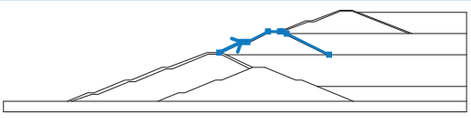
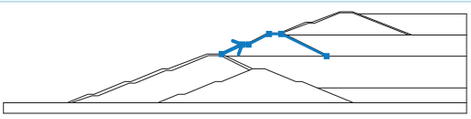
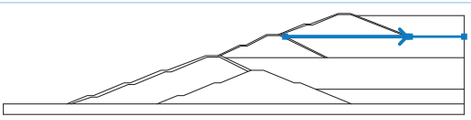
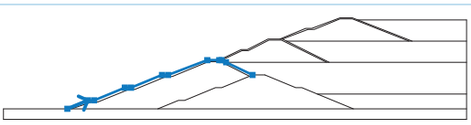
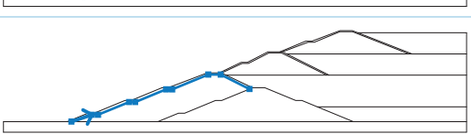
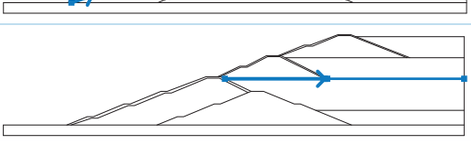
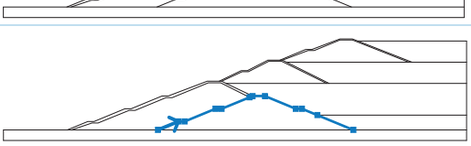
Slope stabilty analysis

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

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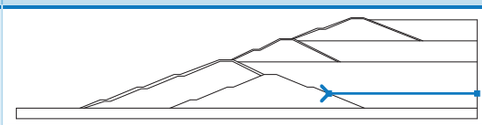
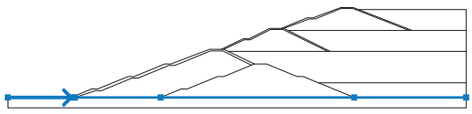
Stability Analysis_Raised Ash Dyke

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	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
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	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	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 : γ = 18.00 kN/m^3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 20.00 kN/m^3

Pond Ash

Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

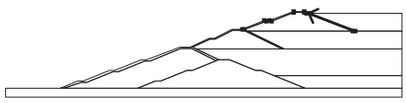
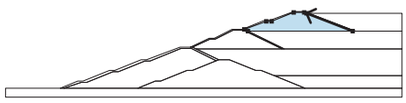
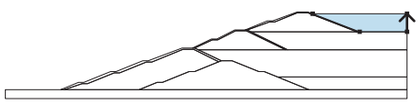
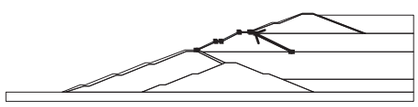
Ash Hearth (Dyke Raising)
Unit weight : γ = 12.00 kN/m3
Angle of internal friction : φ_{ef} = 30.00 °
Cohesion of soil : c_{ef} = 0.00 kPa
Saturated unit weight : γ_{sat} = 14.00 kN/m3

Soil Cover (Dyke Raising)
Unit weight : γ = 19.06 kN/m3
Angle of internal friction : φ_{ef} = 5.00 °
Cohesion of soil : c_{ef} = 64.00 kPa
Saturated unit weight : γ_{sat} = 21.00 kN/m3

Rigid bodies

Number	Name	Sample	γ [kN/m3]
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	
		95.81	42.00	122.00	32.00	
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	

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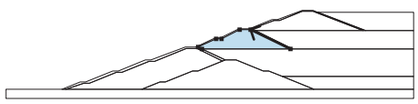
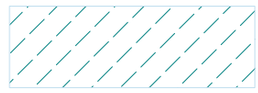
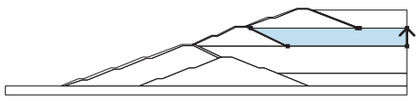
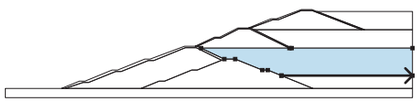
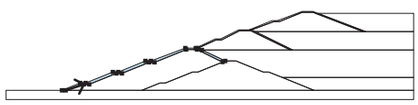
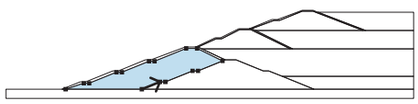
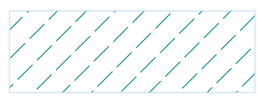
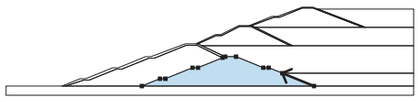
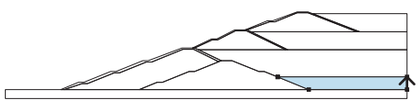
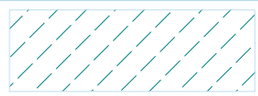
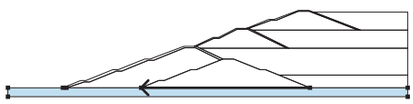
Stability Analysis_Raised Ash Dyke

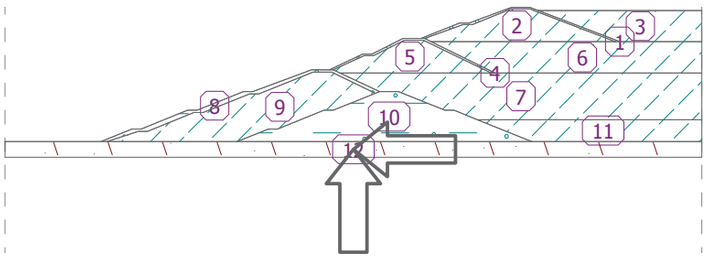
Number	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		82.00	22.00	60.00	32.50	Ash Hearth (Dyke Raising)
		54.00	32.50	44.00	27.50	
		41.00	27.50	31.00	23.00	
		33.14	22.00			
6		150.00	22.00	150.00	32.00	Pond Ash
		123.50	32.00	122.00	32.00	
		62.56	32.00	83.20	22.00	
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			

IIT (BHU) Varanasi
Arun Prasad

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	

Name : Soils and assignment | **Stage : 1**



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)

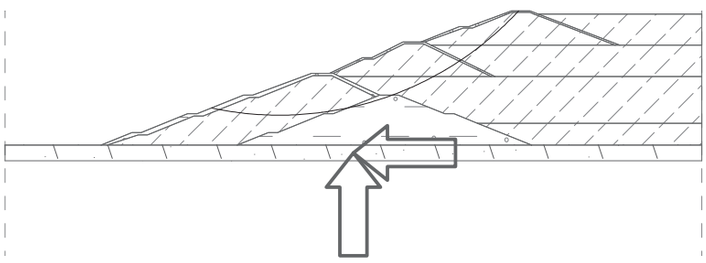
Analysis 1
Circular slip surface

Slip surface parameters							
Center :	x =	13.67	[m]	Angles :	α_1 =	-11.97	[°]
	z =	115.44	[m]		α_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

IIT (BHU) Varanasi Arun Prasad	Stability Analysis_Raised Ash Dyke

Name : Analysis	Stage - analysis : 1 - 1



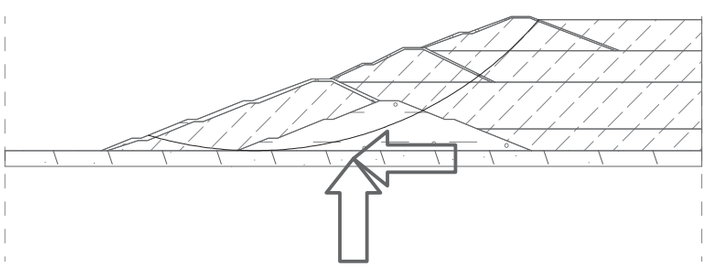
Analysis 2

Circular slip surface

Slip surface parameters							
Center :	x =	5.55	[m]	Angles :	α_1 =	-16.39	[°]
	z =	121.28	[m]		α_2 =	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.

Name : Analysis	Stage - analysis : 1 - 2



// TRUE COPY //

ANNEXURE-R/8

Annexure R-2/I

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

Action Taken Report in compliance of Hon'ble NGT Principal Bench order dated 29th 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 14th and 15th 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 14th & 15th 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^3 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 10th 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^{o} Latitude, 82.623535^{o} Longitude and 23.954335 ^{o} Latitude, 82.623568 ^{o} 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^{o}Latitude, 82.611492^{o} 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 12th 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.	Goiwahai drain near Sasan Power Plant (23.977775, 82.638136)	6.5	13098	918	12916
2.	Rihand river before mixing of Goiwahai 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 Goiwahai drain (24.007186, 82.653735)	7.5	606	724	476
5.	Goiwahai 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 Goiwahai 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 Goiwahai 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 4th 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 12th 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 about1.5 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 5th 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 dependent 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

(Rajeev Ranjan Meena)
District Collector
Singrauli

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

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

ANNEXURE 1

ATTENDANCE SHEET

Subject: Site visit of Joint Committee in compliance of Hon'ble NGT Order dated 29.06.2020 and subsequent NGT Central Zonal Bench's letter: D. No./F.S. /2020/130 dated 01.07.2020 in the matter of Hiralal Bais Vs. Reliance Sasan Power Pvt. Ltd. & Ors.

Venue: M/s Sasan Power Ltd.
Date: 14-15.7.2020
Time: 12 P.M

S.No.	Details	Name of the officer & Designation, Organization	Signature
1.	Representative of MoEF&CC and Member Convenor	Dr. H.V.C. Chary Guntupalli, Scientist-D, MoEFCC, Regional Office Bhopal	
2.	Representative of Central Pollution Control Board (CPCB)	Shri Sunil Kumar Meena Scientist 'D' 9617007250	
3.	District Collector, Singrauli,	Shri Rajeev Ranjan Meena, IAS	-Sd-
4.	Regional Officer, Madhya Pradesh Pollution Control Board, Singrauli,	Shri S. D. Valmiki	
5.	CEO - SPL Sasan Power Ltd	A.K. SINGH	
6.	Sasan Power Ltd representative	Dr. Amitesh Verma, Asst. V.P.	
7.	Station Director, SPL	Sachin Mohapatra	
8.			
9.			
10.			
11.			
12.			

// TRUE COPY //

ANNEXURE-R/9(Colly)

मध्यप्रदेश प्रदूषण नियंत्रण बोर्ड

पर्यावरण परिसर, ई-5, अरेरा कालोनी, भोपाल-462016

): 0755-2466735 (O), फैक्स: 0755- 2463742, पी.बी.एक्स: 0755-2517600, 2466191

ई-मेल: : it_mppcb@rediffmail.com , वेब: www.mppcb.nic.in

क्रमांक 2285 / तक / 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 डाईक टूटने के संबंध में बकाया पर्यावरणीय क्षतिपूर्ति राशि रू. 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 डाईक ब्रीच के संबंध में जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 33'क' के अन्तर्गत निर्देश जारी किये गये थे। तत्संबंध में मान्नीय एन.जी.टी. द्वारा प्रकरण क्रमांक O.A 164 / 2018 (अश्विनी कुमार दुबे विरूद्ध भारत सरकार व अन्य) में पारित आदेश दिनांक 14 / 07 / 2020 के परिप्रेक्ष्य में पुनः पर्यावरणीय क्षतिपूर्ति राशि रू. 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 बैस विरूद्ध रिलायंस 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 रू. कुल 08 करोड़ शीघ्रातिशीघ्र बोर्ड में जमा करावें, अन्यथा जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 की धारा 27 के अन्तर्गत सम्मति निरस्त करने की कार्यवाही की जावेगी जिसकी सम्पूर्ण जिम्मेदारी उद्योग प्रबंधन की होगी।

(ए.ए. मिश्रा)
सदस्य सचिव

मध्यप्रदेश प्रदूषण नियंत्रण बोर्ड

पर्यावरण परिसर, ई-5, अरेरा कालोनी, भोपाल-462016

): 0755-2466735 (O), फैक्स: 0755- 2463742, पी.बी.एक्स: 0755-2517600, 2466191

ई-मेल: : it_mppcb@rediffmail.com , वेब: www.mppcb.nic.in

पृ.क्रमांक /तक/सी.ई–4/मुप्रनिबो/2020, भोपाल, दिनांक

प्रतिलिपि :–

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

(ए.ए. मिश्रा)
सदस्य सचिव

Annexure R/9(Colly)

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

No.: SPL /2020-21/42

15th 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),

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www.reliancepower.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 22nd to 26th 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

15/01/2021

(Anil Kumar Singh)
Chief Executive Officer – Sasan Power Ltd.

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

//TRUE COPY //

ANNEXURE-R/10

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

No.: SPL /2020-21/41

31st October 2020

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

Ref: 1. Letter from the office of your good self vide no. 1464/MPPCB/CE IV/2020, dated 24.08.2020, received by post on 04.09.2020.
2. SPL reply no. SPL /2020-21/36 dated 09.09.2020

Respected Sir,

1. This has reference to our previous communications regarding the status of ash removal and restoration of ash spread area, pursuant to spread of ash due to breach of retention wall of low-lying area,
2. In this regard, we would like to further inform your good office that the pending restoration works which were hampered due to internal family conflicts of the land-owners and non-availability of fronts due to severe monsoon stand completed. The detailed status of the restoration work is as under:

Sr. No.	Particulars	Quantity of Ash Cleaned (Lac Ton)	Remaining Ash Quantity (Lac Ton)	Utilization areas
1	Agricultural and other fields	1.60	0.0	1. Approved Low lying areas around ash pond 2. Strengthening of dyke wall of ash pond
2	Gabaiya Nalla	2.25	0.0	
3	Island 4 area (remaining ash)	6.00	0.0	Strengthening of: 1. Retaining wall of island 3 low lying area 2. Dyke wall of ash pond
	Total	9.85	0.0	

3. Further, Island-4 low lying area has been fully cleared of remaining ash and additional soil cover has been provided in this area. It is further submitted that Sasan UMPP will not be using Island-4 for any ash utilization in any mode considering the risk involved due to

increased water table in the area. A Culvert has already been constructed for safe passage of water from the four aquifers because of high water table and rain.

4. Further, we are also very happy to mention that after ash restoration and associated field preparations, farmers have already grown paddy in their agricultural fields which is presently under maturity and harvesting stage and the condition of the crop growth is also very good. Photographs of the site restoration completion work are enclosed as **Annexure – 1**.
5. All the compensation payable to the affected parties has been disbursed as per directives of the District Administration.
6. After completion of the restoration work, Regional Officer of MP Pollution Control Board along with his team visited site on 12.10.2020 to review the status of entire restoration work.
7. Further, the report on "Stability Analysis of Ash Dyke" by IIT-BHU has already been submitted to the office of your good-self vide our letter dated 20.09.2020.
8. NEERI has already been engaged for the "Environmental Damage Assessment Study" and NEERI has informed telephonically that that they will be visiting site in the last week of November, 20 to carry out on ground verification.

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

31/10/2020

(Anil Kumar Singh)
Chief Executive Officer – Sasan Power Ltd.

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

// TRUE COPY //

ANNEXURE-R/11

Annexure – 1

SITE RESTORATION PHOTOGRAPHS

Affected Low Lying Area (Island 4)


Just Outside of affected low lying area (Island 4)


Island 3 Low lying area covering with Soil


Restored Agricultural and Other fields





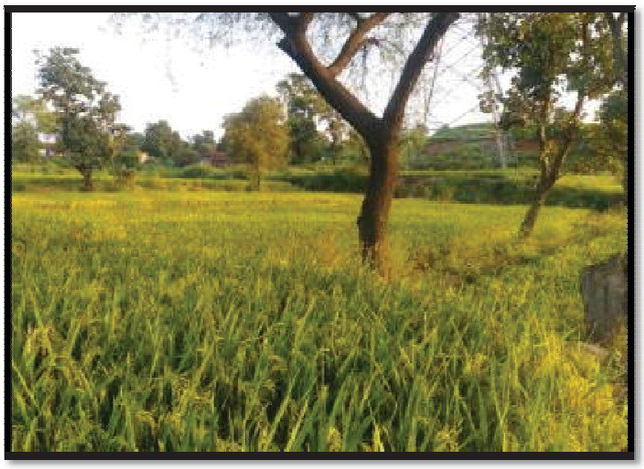
















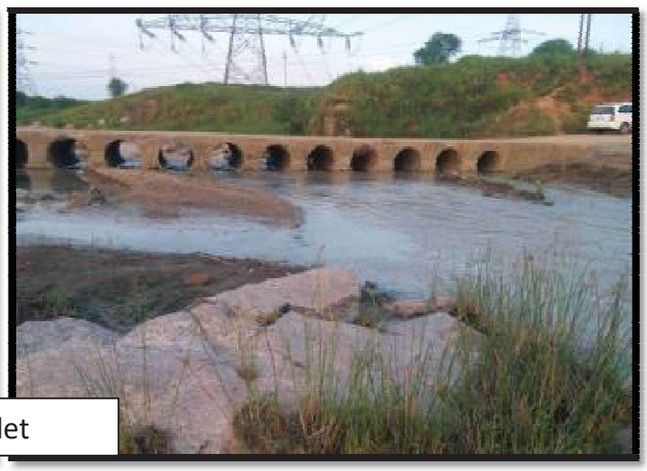
Gabaiya Nalla Upstream


Gabaiya Nalla Mid stream (Before AWRS Culvert)

Gabaiya Nalla Mid stream (AWRS Culvert)

Gabaiya Nalla Down stream (Before Harrahwa Culvert)

Gabaiya Nalla Downstream (At Harrahwa Culvert)



Outlet

Gabaiya Nalla Downstream (At Harrahwa Culvert)

Photos of Bhadi Tola Area

// TRUE COPY //

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

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.	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 **Annexure 1**. 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 & MoEF&CC.
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. 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.

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		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. 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 30th 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. 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. Restoration of leftover area of approx. 5-6% would be completed by 30.09.2020. (Site photographs are attached vide **Annexure 2**).
3	To take appropriate control measures to prevent the fly ash from reaching the Goiwahai drain and finally the Rihand River.	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.

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		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.
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.	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. 2. Grievances of the villagers from Jhanjhi Tola, Harrahawa, Siddhikhurd- Latbudwa Tola, Giddhakhadi Tola are also settled by paying crop compensation. 3. CSR team is also visiting the affected villages on daily basis and genuine grievances are being timely resolved.

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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

16/9/2020

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-P/12(Colly)

Sasan Power Limited
CIN: U40102MH2006PLC190557

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SPL/ /2020-21/43

Date: 15th 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

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	Rihand River.	good-self on 28.12.2020. 2. **Therefore, no further update submission is envisaged in this regard.**
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.	1. All the grievances, as recommended, are settled and update is submitted to your good-self vide letter dated 16.09.2020. 2. **Therefore, no further update submission is envisaged in this regard.**
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. **Therefore, no further update submission is envisaged in this regard.**
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 8th 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 22nd to 26th Dec-2020, carried out detailed site survey and collected samples. **The status of said study will be updated to your good-self on a regular basis.**
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

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		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

15/1/2021

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

// TRUE COPY //

ANNEXURE-R/13

Annexure - 2

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











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.


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ANNEXURE-R/14

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ANNEXURE 16

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, it's 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.

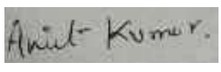
Payment Terms- 100% payment advance against submission of PI.

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 & Contracts

WORK CHANGE ORDER

W.O.Number SERO/SSP/33518809
Revision No : 0001 Dt. 02.06.2020
Page No: 1

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

No	Item Code	Material/Work Description	Quantity	UOM	Price Details	Unit Rate		Amount (INR)
1		Study on safety of ash dyke	1	PU				
					Value of Work		INR/PU	400,000.00
					GST Integrated			72,000.00

The item covers the following Work :

10	6070000294	STUDY OF DESIGN AND STRUCTURAL SAFETY	1	NOS - Numbers				
					Net value of item	400,000.00		400,000.00

STUDY ON DESIGN AND STRUCTURAL SAFETY OF THE ASH DYKE SITUATED NEAR HARRAHWA VILLAGE

Total Value of Work	**INR**	**400,000.00**
Total Expected Value		**N/A**
Total GST Integrated	**INR**	**72,000.00**

Revised Total Work Order Price:	**INR**	**472,000.00**
Original/Previous Total Work Order Price:	**INR**	**472,000.00**
Amendment to the Total Price as a result of this Revision	**INR**	**0.00**

Terms of payment :

100% Advance aganist Purchase Order / Proforma Invoice

Note(S): 1. OOO It is essential that the Contractor shall mention ItemNo. & Item code along with corresponding Material/Work Description and W.O.No. as mentioned above, in the Delivery challan (On-Shore Order), Measurement sheet and invoice for ease of material Inwarding, Certification of work and Bill Processing. Failure to do so may be the grounds for the rejections(s) or delay in release of payment(s).

2.

WORK ORDER

SASAN POWER LIMITED
Gram: Siddhikhurd, Post Office: Tiyara
Tehsil : Waidhan, Singrauli-486886, MADHYA PRADESH, INDIA
Telephone : 91 -9522320120
EMAIL: Anurag.Keshri@relianceada.com

Number : SSP / 33518809
Revision No : 0001
Date 02.06.2020

1.0 Documents
The documents listed below together constitute this Work Order. In case of any discrepancy/ conflict and / or differences in documents constituting the Work order, the order of precedence of the documents shall be as follows:
1. WO No. 33518809 dated 20.05.2020
2. GCC of SPL
3. Your consent letter Ref dated 01.05.220

2.0 SCOPE OF WORK, TIME SCHEDULE
2.1 Scope of work shall comprises as per BOQ and instruction from engineer incharge.
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, it#s 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.

Work Duration- 12 Weeks from the date of issue of NTP/ PO/ as confirmed by EIC.

WORK ORDER

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3.0 Price
The Rates mentioned in BOQ are inclusive of all taxes and duties. The rates shall remain firm and no variation shall be allowed on any account.

4.0 TERMS OF PAYMENT
100% payment advance against submission of PI.

5.0 TAXES AND DUTIES
Total Contract price is inclusive of all taxes and duties.

6.0 COORDINATION
Engineer-in-charge for above work shall be:
Mr Amitosh Verma
Sasan Power Limited,
SASAN, MP - 486886

Copies of correspondence on contractual matters shall also be addressed to

Purchase & Contract Division
SUMPP
Village # Sasan, Post-Tiyara
Waidhan
Distt.- Singrauli (MP) 486886

7.0 Liquidated Damages for delay in Completion - Not applicable.
8.0 Warrantee / Defect Liability Period - Not applicable.
9.0 Quantity variation: Not applicable.
10.0 INSURANCE

WORK ORDER

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Contractor has to take the required insurance cover for all his men.

11.0 Bank Guarantees- Not Applicable

11.0 STATUTORY OBLIGATION:

You shall be responsible and shall comply with the provision of all the statutory Acts applicable. You shall take all steps as may be necessary to comply with various Acts, Rules, including but not limited to The Child Labour (Prohibition & Regulation) Act, 1986, The Contract Labour (Regulation & Abolition) Act, 1970. The Employees Pension scheme , The Employees Provident Funds and miscellaneous provisions Act, 1952 ,The Employees state Insurance Act,1948 ,The Equal Remuneration Act, The Industrial Dispute Act,1947, The Maternity Benefit Act , 1961, The Minimum Wages Act, 1948, The payment of Bonus Act ,1965, The Payment of Gratuity Act,1972, The Payment of wages Act, 1936, The Shops & Establishment Act, The Workmen#s Compensation Act , 1923, The Employers Liability Act,1938, Building and Other Construction Workers Welfare Cess Act 1996, Indian Electricity Act, 2003 and Indian Electricity Rules, Environment (Protection) Act 1986 / Rules.

12.0 Special Terms & Condition

-Work has to be carried out as per instruction of and satisfaction of EIC

-The T&P and material require for above work will be arranged by you.

13.0 Invoicing Procedure (As per GST Guideline):

1- Vendor must submit HSN/SAC Codes for all the items to be supplied under the Contract. HSN/SAC Codes must be mandatorily

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mentioned in the Invoice.
2- Vendors should update the details in their invoice in our GST Vendor portal before dispatching the goods and also upload the invoice in our Vendor Portal. Vendor should send the invoice marked as #duplicate for the transporter# through the Transport and #Original for Recipient# through courier to the billed address.
3- Vendor portal Login link for invoice entry in our GST Vendor portal is http://gstportal.relianceada.com

Safety Norms :
(A) Safety Norms to be followed by the Service Provider/Contractor-
1)The contractor will have to obtain safety clearance certificate from Safety Department before start of work.
2) The contractor will have to submit the medical fitness certificate of his employees.
3) The contractor along with his employees will have to undergo safety training program in T&D center of Reliance Infra/SPL, Sasan.
4) Safety of workers employed by contractor is entirely contractor#s responsibility and in the event of any accident, major or minor the worker can be treated in hospital nearby plant if his responsibility is not available for adequate medical aid, and the cost of treatment will be recovered from bills.
5) As the area of work is highly sensitive with respect to safety hazards, the contractor must take proper work permit, shut down clearing and other instruction from Engineer-in-charge daily before starting the work. The contractor will have to follow all the safety precautions and rules in this regard.

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6) Contractor shall be responsible for complete safety of Men, machines and environment. There shall be no any act which held responsible for violation of safety norms.
Safety Items to be used:
a) Safety helmet
b) Safety boot
c) Hand Gloves
d) Safety belts
e) Hand gloves (leather)
f) Gum boot
g) Nose mask
h) Dust Mask
i) Safety Goggles etc.etc.
(B) The Service Provider / Contractor shall ensure adequate safe conditions and ensure safety precautions at the Establishment as required under applicable laws and shall be solely and entirely responsible for the complete safety of its manpower as well as other persons at the Establishment.
(C) The Service Provider shall take requisite precautions and use his best endeavors to prevent any riotous or unlawful behavior by, or amongst his manpower and /or others employed in the Establishment by him and for the preservation of peace and protection of the inhabitants and security of the property in the neighborhood of the Establishment. In the event of R INFRA/SPL requiring the maintenance of a special force, statutory or otherwise, at or in the vicinity of the site during the tenure of the Agreement in consequence of the riotous or unlawful behavior by, or amongst the Service Providers manpower, all expenses thereof and costs of all damages due to such riotous or unlawful behavior shall be borne by the Service Provider and if paid by R

WORK ORDER

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INFRA/SPL, shall be recoverable from the Service Provider from any money due or that may become due to the Service Provider by R Infra/SPL.
(D) The contractor should carry out the work as per Safety Instructions of our EIC/Safety Deptt.
Environment Norms:

1.1 Compliance with Environmental Law: Contractor shall comply with environmental laws of every nature ("Environmental Laws") with respect to the Premises. No hazardous material of any nature ("Hazardous Material") shall be brought on to, permitted to exist or remain at or upon, or stored, or disposed of from or used, at the Premises by Tenant or any of its employees, agents, independent contractors, licensees, subtenants or invitees in violation of any applicable laws, or in such manner as would result in any liability under any applicable laws Restricted uses of Ozone depleting substances at site as per guidelines of MoEF&CC / CPCB.
The contractor shall be responsible for fully complying with the prevailing policies and procedures of the organization, including the IMS system (Occupational Safety, Health & Environment Management System).

1.2 Definition of Hazardous Material. As used in this Lease, the term "Hazardous Material" shall mean any flammable items, explosives, radioactive materials, oil, hazardous or toxic substances, material or waste or related materials, including any substances defined as or included in the definition of "hazardous substance", "hazardous wastes", "hazardous materials" or "toxic substances" now or subsequently regulated under any applicable

WORK ORDER

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Federal, state or local laws or regulations, including without limitation petroleum-based products, paints, solvents, lead, cyanide, DDT, printing inks, acids, pesticides, ammonia compounds and other chemical products, asbestos, PCBs and similar compounds, and including any different products and materials which are subsequently found to have adverse effects on the environment or the health and safety of persons.

1.3 Dangerous and Harmful Environment: Contractor, shall as far as reasonably practicable, ensure that his workers are not exposed to dangerous fumes, asphyxiating atmospheres, and dangerous confined space atmospheres, by ensuring that they strictly follow the safe process prescribed for the work, and also by wearing any PPEs that may be prescribed.

1.4 Disposal of Hazardous waste: It shall be responsibility of the contractor to ensure that hazardous materials and waste generated in the course of work shall be properly disposed off and in such a manner so as not to cause injury or illness to workers or pollute the environment.

1.5 Maintenance of Clean Environment: This will be the sole responsibility of the contractor to follow the best waste management practices within the plant premises during the work and after completion of the work he will has to clean the work place and all the waste is required to be disposed on to their designated areas only.

1.6 Maintenance of Safe Environment: The contractor will be solely responsible for any increase in pollution load in the environment

WORK ORDER

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because of their activities with air, water or noise and this shall be treated as a punishable offence.
1.7 Pollution Prevention & Resource Reduction: Waste of all type and energy are to be reduced at site by adopting conservation, recycling & re-using of materials.
1.8 Implementation of Buy Back Policy: The contractor will be responsibility for implementing Buy Back policy for waste, applicable if any, like battery or insulation material.

"Note: OHS Condition of Contract is being provided along with this Work Order. You must comply all OHS condition"

SASAN POWER LIMITED
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Tehsil : Waidhan, Singrauli-486886, MADHYA PRADESH, INDIA
Telephone : 91 -9522320120
Email: Anurag.Keshri@relianceada.com
GST: 23AAKCS0723M1ZB, PAN: AAKCS0723M

WORK CHANGE ORDER

GST No. : 09AAAJI0396R1ZJ 2533962 **IIT-BHU** **DEPARTMENT OF MINING ENGINEERING** **BHU** **VARANASI** **VARANASI** **Pin Code: 221005 India**	**WORK ORDER No.:SERO/SSP/33518809** **Revision No.: 0001** **Date: 02.06.2020** **Plant:MP21** **Desc:Sasan Power-Madhya Pradesh**

Attention :
Tel.No. :
Fax.No. : 0542-2369434
E-Mail : bk_shrivastva@rediffmail.com

WORK CHANGE ORDER - DO NOT DUPLICATE

This WORK CHANGE ORDER is issued to incorporate the following change(s) to the above noted Work Order:

Amendment to the Total Price as a result of this Revision	**INR**	**0.00**
Original/Previous Total Work Order Price :	INR	472000.00
Revised Total Work Order Price :	INR	472000.00

Revised Value in Words : Rs. Four Lakh Seventy Two Thousand only

ALL OTHER REQUIREMENTS, TERMS AND CONDITIONS SHALL REMAIN SAME AS PER THE ORIGINAL WORK ORDER AND ANY PREVIOUS CHANGE ORDER REVISION(S).

It is important that Contractor signs and returns the Work Change Order Copy within three (3) days of receipt. No other form of Order acceptance will be accepted. Failure to return the copy does not diminish responsibilities as set forth here in but may result in a delay to any payments that may be due.

This document is electronically generated through SAP system of SASAN POWER LIMITED; and no signature is required to authenticate the same.

Sachin Mohapatra (Sr.Ex.V.P.)

BUYER : Authorised Signatory

Contractor's Acceptance :

Engineer Incharge :
Validity From :01.05.2020 TO 31.10.2020

// TRUE COPY //

ANNEXURE-R/15

WORK ORDER

W.O.Number **SERO/MSC/33518914** **Dt.05.06.2020**
Page No: 1

Environmental Damage Cost Assessment Study due to Spillage of Ash at Sasan Power Limited

No	Item Code	Material/Work Description	Quantity	UOM	Price Details	Unit Rate		Amount (INR)
1		Study of Environmental Damage assessment	1	PU				
					Value of Work		INR/PU	2,940,000.00
					GST CGST			264,600.00
					GST SGST/UGST			264,600.00

The item covers the following Work :

10 6070000293 STUDY ON ENV. DAMAGE & COST ASSESSMENT — 1 NOS - Numbers
Net value of item 2,940,000.00 — 2,940,000.00

STUDY OF ENVIRONMENTAL DAMAGE COST ASSESSMENT DUE TO SPILLAGE OF ASH AT SASAN POWER LIMITED

Total Value of Work	**INR**	**2,940,000.00**
Total Expected Value		**N/A**
Total GST CGST	**INR**	**264,600.00**
Total GST SGST/UGST	**INR**	**264,600.00**
Total Order Value:	**INR**	**3,469,200.00**

Note(S): 1. OOO It is essential that the Contractor shall mention ItemNo. & Item code along with corresponding Material/Work Description and W.O.No. as mentioned above, in the Delivery challan (On-Shore Order), Measurement sheet and invoice for ease of material Inwarding, Certification of work and Bill Processing. Failure to do so may be the grounds for the rejections(s) or delay in release of payment(s).
2.

WORK ORDER

SASAN POWER LIMITED
Reliance Centre, Corporate Procurement Group
Prabhat Colony, Santacruz East, Mumbai-400055,
MAHARASHTRA, INDIA
Telephone : 91-22 -4303 1000
Fax : 91-22 -4303 2663
EMAIL: cpg@relianceada.com

Number : MSC / 33518914
Date 05.06.2020

Ref: LOI dated 21st April, 2020

1.0 Introduction

Sasan Ultra Mega Power Plant or Sasan UMPP is one of the four Ultra Mega Power Projects planned by the Ministry of Power, Government of India. It is located in Sasan village of Singrauli, Madhya Pradesh. Sasan UMPP is among the world's largest integrated power generation and coal mine project with 3,960 MW power plant and 20 MT per year coal mining capacity. It is presently the 4th largest electricity generation power plant in India after 4760 MW NTPC Vindhyachal, 4620 MW Mundra Thermal Power and 4000 MW Mundra UMPP. The plant is operated by Sasan Power Limited, a subsidiary of Reliance Power Limited which was incorporated on 10 February 2006. As of March 2020, it provides electricity to 13 million customers across 7 states of India. Being a thermal power plant, lot of ash is produced which is stored in ash ponds. The ash pond of thermal power plant consists of ash in the form of High Concentration Slurry Disposal (HCSD). Coal ash typically contains heavy metals including arsenic, lead, mercury, cadmium, chromium and selenium, as well as aluminum, antimony, barium, beryllium, boron, chlorine, cobalt, manganese, molybdenum, nickel, thallium, vanadium, and zinc. Many of these elements are highly toxic to human and other life. Spillage of coal ash can also cause the pollution of waterways, drinking water, air and soil.
It has been reported that On 10th April 2020, at around 1700 hrs, the retention wall of ash utilization area inside the power plant boundary got damaged causing the ash to flow towards an adjacent Gabaíya nullah, where it got mixed with water and was flown over some distance and it covered the adjoining area. In this incident an earth-moving equipment (i.e. poclain) also drowned with the flowing ash and its operator is also missing. The equipment was in service during the day, working on the retention wall to fill soil for maintaining safe height above the level of ash, so as to prevent overflow of rain water in the event of accumulation. As understood from another operator, who was present at the location at that time, the machine was returning after finishing the work, when it got unbalanced and started slipping down the slope of the

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retention wall. The machine operator tried to stop it from sliding by anchoring the bucket into the soil. However, in that attempt, the boom damaged the retention wall as the machine kept on sliding down because of its heavyweight. In order to assess the damages due to this breach, Sasan Power Limited has asked CSIR-NEERI to submit a proposal. The details of the proposal are delineated in subsequent sections.

2.0 Scope of the Study

The main objective is to study the environmental damage cost incurred due spillage of coal ash and suggestion of remedial action plan.
The study is divided into three parts:
Part 1. Demarcation of the contaminated site and analysis of suitable samples for contamination
Part 2. Environmental damage cost assessment due to spillage of ash
Part 3. Remedial Action Plan for Sasan Power

3.0 Stages of the Study:

-Delineation of Study Area: Area of source of contamination shall be analyzed in detail in order to ascertain the number of samples required to understand the impact of ash contamination. Remote sensing tools and ArcGIS will be used to create digital elevation model and drainage map of the region to understand the possible flow of contaminants.
-Finalization of Parameters and Sampling: Radial boundaries shall be marked based on drainage patterns of the region to finalize the number of samples. Soil and water samples shall be collected based on requirement.
-Laboratory Assessment: The soil and water samples shall be analyzed along with virgin ash samples to understand the contamination. Heavy metals leaching would be analyzed in soil samples, if any. Physico-chemical parameters along with heavy metals shall be analyzed in the water samples. Baseline analysis shall also be done with multiple samples.

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-Multiple Sampling: The restoration process of spilled ash is ongoing on the site. Hence multiple sampling including and pre and post-remediation shall be done in order to understand the change in concentration of contamination
-Damage Assessment: Based on assessment of samples, available literature and methodologies for damage cost assessment shall be used to determine the monetary damages.
-Remediation: Based on assessments, remedial action plan shall be suggested for the contaminated area.

4.0 Valuation Methodology

1. Soil pollution: Spillage of ash on nearby land area of pond may cause deposition of layers of ash on soil. To evaluate the impact on the affected land, soil monitoring shall be carried out in and around the site of spillage. Heavy metal analysis, fertility loss may also be considered to estimate the monetary damage due to soil pollution. The damage cost due to contaminated soil shall be estimated using benefits transfer/avoided cost methodology.
2. Ground and surface water pollution:
Due to the occurrence of heavy rainfall after and at the time of incident, leachate generated from the ash slurry is directly subjected to the open land, which has a tendency to percolate and reach the nearby water bodies. The harmful metal concentrations in leachate can cause considerable impacts on human health and agriculture in addition to the aquatic life. Water quality testing of nearby ground and surface water sources shall be carried out to analyze the level of pollution. The concentration value, breaching the standards, shall be determined and resulting environmental damage shall be estimated using control cost methodology linking all the environmental values/indices. Where costs are quantified on the basis of the cost of one pollutant coupled with linked environmental values. Both environmental and health effects are covered by the study.
3. Miscellaneous impacts: If in the detailed site study other miscellaneous impacts such as vegetation, life loss etc. are identified, corresponding monetary value associated with the impact shall be quantified using market price method or shadow

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pricing method.

4.0 Total Study Duration:
10 (Ten) Months from the receipt of first installment.
-First Report on Initial Sampling: Three Months
-Final Report on Second Sampling: Seven Months
-Final report based on Comments: Ten Months

5.0 Contract Value
The contract value for the study shall be Rs. 29.4 Lacs + GST@18% = Rs. 34.69 Lacs (Including GST@18%)

6.0 Payment Terms:
1. 50% advance with the award of the project
2. 30% post submission of the draft project report
3. 20% on submission of the final report.

7.0 Support from Sasan Power Team
- Machinery for sampling and boring (if required) for example poclain, bore etc shall be provided by Sasan Power Limited
- To provide any past record of soil, fly ash and groundwater quality
- To provide groundwater table details
- To provide details of bore wells, open wells, dig wells, hand pumps for sampling in the defined study area
- To provide details about area which got contaminated.

Further, the following assistance to visiting CSIR-NEERI staff shall be provided
-Accommodation for NEERI staff during the visit
-Local transport facility
-A senior technical staff for data collection and coordination

****

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Telephone : 91-22 -4303 1000
Fax : 91-22 -4303 2663 Email: cpg@relianceada.com
GST: 23AAKCS0723M1ZB, PAN: AAKCS0723M

WORK ORDER

2515713 NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INSTITUTE ENVIRONMENT IMPACH & RISK "ASSESSMENT DIV., NEHRU MARG" NAGPUR NAGPUR MAHARASHTRA Pin Code: 400020 INDIA PHONE : FAX : 9107122249878/96 E-Mail : Attention :	WORK ORDER NO.: SERO/ MSC/ 33518914 DATE: 05.06.2020 Contractor's Quot. Ref : Date : Our Ref : Plant:MP21 Desc:Sasan Power-Madhya Pradesh

In accepting this WORK ORDER, CONTRACTOR agrees to furnish the GOODS/Do WORK specified in full accordance with all conditions set forth herein and / or attachments hereto. All drawings, designs, specifications and other data prepared by OWNER and related thereto are the property of the OWNER and must be returned to OWNER upon completion by CONTRACTOR of the obligations under this WORK ORDER. The information contained herein is not to be released or disclosed for any other use or purpose other than for the execution of this WORK ORDER.
It is important that CONTRACTOR signs and returns the Work Order copy within three (3) days of receipt.
No other form of Order acceptance will be accepted. Failure to return the Order acceptance does not diminish the responsibilities as set forth herein, but may result in delay to any payment(s) that may be due and may be the cause for termination of this WORK ORDER.

For all correspondence, Please quote Contract/Work Order No.
For detailed commercial terms & conditions, please refer line items terms/enclosures.

WO Period From DT: 05.06.2020 To DT:04.04.2021	Value of Work	INR	2,940,000.00
	Expected Value		N/A
	GST CGST	INR	264,600.00
	GST SGST/UGST	INR	264,600.00
	TOTAL ORDER VALUE: INR		**3,469,200.00**

Value in Words :(Rs. Thirty Four Lakh Sixty Nine Thousand Two Hundred only)
For other details, please refer line items.

Delivery Terms :
N/A
Engineer in Charge :

Payment Terms : See Page Inside

BUYER : Manish Saxena	This document is electronically generated through SAP system of SASAN POWER LIMITED; and no signature is required to authenticate the same. Jitendra Jaiswal (Sr.V.P.) Authorised Signatory	CONTRACTOR'S Acceptance **Signature Title Date**

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 & ORS. …. Respondents

APPLICATION ON BEHALF OF SASAN POWER LIMITED / RESPONDENT NO. 1 & 2 SEEKING EXEMPTION FROM FILING NOTARISED AFFIDAVIT UNDER SECTION 151 OF CIVIL PROCEDURE CODE, 1908.

MOST RESPECTFULLY SHOWETH:

1. That the Respondent No. 1 & 2 has filed the accompanied affidavit in the captioned Original Application No. 31 of 2020. The facts stated in the accompanying affidavit may be read as part and parcel of the instant application and the same are not being repeated herein.

2. That owing to COVID-19 pandemic situation and the consequent lock down directed by the government of Delhi, Respondent No. 1 & 2 are not in a position to get the affidavit attested by an oath commissioner or notary. Respondent No. 1 & 2 undertake to file an attested copy of the affidavit upon resumption of normal functioning as and when directed by this Hon'ble Tribunal.

3. That the instant application is made bona fide and in the interest of justice.

PRAYER

In light of afore-stated facts, circumstances and position of law, it is most respectfully prayed that this Hon'ble court may graciously and expeditiously pleased to:-

A. Allow the instant application and grant exemption from filing the attested affidavit;

B. Pass any other order and further orders or directions as this Hon'ble Tribunal may deem fit in the facts and circumstances of the present case.

AND FOR THIS ACT OF KINDNESS THE RESPONDENT NO. 1 & 2 SHALL EVER BE DUTY BOUND

RESPONDENT No. 1 & 2

Sasan Power Limited

THROUGH

SKV LAW OFFICES
Counsel for Petitioner
B-50 Defense Colony,
New Delhi -110024
Email- delhi.offices@skvlawoffices.com

Place : New Delhi
Date: 17.05.2021