

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

ORIGINAL APPLICATION No. 580 OF 2022

**IN THE MATTER OF:**

MUKESH SINGH

.....APPLICANT

VERSUS

TATE OF UTTAR PRADESH & ORS.

...RESPONDENTS

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Ramasankar  
Advocate  
Waidhan, Distt. Singrauli (M.P.)

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Northern Coalfields Ltd.  
Khadia Project

Through



**ASHUTOSH THAKUR, Adv**  
#321, C.K.Daphtary Block,  
New Lawyers Chamber,  
Supreme Court of India,  
New Delhi-110001  
Email-ashu2638@gmail.com  
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8700083787

**Filed on:22/02/2023**

**Place: New Delhi**

*Ramaswami*  
Advoc  
Waidhan, Dist. Sirgauli (M.P.)  
22/2/2023

BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH  
NEW DELHI

ORIGINAL APPLICATION No. 580 OF 2022

**IN THE MATTER OF:**

MUKESH SINGH

.....APPLICANT

VERSUS

STATE OF UTTAR PRADESH & ORS.

...RESPONDENTS

**RESPONSE ON BEHALF OF RESPONDENT NO.5/ NORTHERN  
COALFIELDS LTD, KHADIA PROJECT, DISTRICT-SONEBHADRA**

I, Rajiv Kumar, aged about 57 years, S/o Late Shivanath Jha , R/o Khadia Area, Post- Shaktinagar, Dist- Sonbhadra, Uttar Pradesh, Presently at do hereby solemnly affirm and declare as under: -

1. That I am working as the General Manager, Northern Coalfields Limited, Khadia Area, as such in my official capacity, I am well conversant with the facts and circumstances of the Present Case and also Competent to swear this Present Affidavit.
2. That this Hon'ble Tribunal vide its order dated 30.09.2022 passed in O.A No. 580/2022 considered it appropriate to have response of (1) State of Uttar Pradesh through Chief Secretary, Government of Uttar Pradesh, (2) CPCB, (3) State PCB, (4) District Magistrate, Sonbhadra and (5) Project Proponent-Northern Coalfields Ltd. who stand impleaded as respondents No. 1 to 5. The Registry is directed to prepare and attach memo of parties to the application and issue notices to respondents No. 1 to 5 accordingly.

Ramasri  
Advoc.  
Wardhan, Dist-Sonbhadra

This Hon'ble Tribunal further constituted a Joint Committee comprising of representatives of CPCB, State PCB and District Magistrate, Sonbhadra and direct the same to meet within four weeks, undertake visits to the site, look into the grievances of the applicant, associate the applicant and representatives of the project proponent, verify the factual position and submit its report within six weeks. A copy of the order dated 30.09.2022 passed by this Hon'ble Tribunal in O.A No. 580/2022 is annexed herewith and marked as **ANNEXURE R-1.**

3. That Planting of trees/biological reclamation at finalized overburden dump is a continuous activity at Khadia Project of NCL and is being carried out through U.P Forest Department, Renukoot Forest Division. In the FY 2021-2022, total 50,000 plants sapling have been planted on finalized OB dump by Khadia Project through Renukoot Forest Division. Out of which in East Dump 28,750 plants have been planted A copy of the Letter No. 11/Khadia Project/29(plantation) dated 20.09.2021 issued by the Regional Forest Officer, Kharia Project, Renukoot is annexed herewith and marked as **ANNEXURE R-2.**
4. That it is necessary to point out that Office of the Regional Forest Officer, Khadia Project vide its letter dated 27.09.2022 has informed that the target allotted by the N.C.L, Khadia Project for plantation of 82,500 plants for Year 2022-2023 has been successfully carried out by planting different varieties of plants. Out of which in East Dump 34,525 plants have been planted. A copy of the Letter No. 06/Renukoot/29(plantation) dated 27.09.2022 issued by the Regional Forest Officer, Kharia Project, Renukoot is annexed herewith and marked as **ANNEXURE R-3.**

Ram  
13/09  
Weldhan, D

27/09/2022

5. That at present production capacity of Khadia mines is 15.00 MTPA. The latest EC was granted by MoEF&CC vide letter No. J11015/255/2006-1A-11 (M) dated 27.07.2022. Stripping ratio 4.61 m<sup>3</sup>/T as per approved mine plan for 15 MTPA. A copy of the MoEF&CC letter No. J11015/255/2006-1A-11 (M) dated 27.07.2022 granting Environmental Clearance is annexed herewith and marked as **ANNEXURE R-4**.
6. That during open cast mining the overline soil and the fragmented rock is removed and is heaped to form the Over Burden dump which is to kept in a proper manner and as per the environmental norms. Over Burden (OB) dumping near the Nawatola village has already been stopped and plantation on OB is a continuing activity, retaining wall and drain has been constructed at the toe of the OB dump.
7. The dump stability report prepared in October 2019 by Central Mine Planning and Design Institute Limited (CMPDIL) and has been sent to UP Pollution Control Board vide letter no. NCL/KHD/GM/Min/Env/UPPCB /22-23/3751 dated 24.01.2023. A copy of the letter no. NCL/KHD/GM/Min/Env/UPPCB /22-23/3751 dated 24.01.2023 alongwith Dump Stability Report is annexed herewith and marked as **ANNEXURE R-5**.
8. That the Manual monitoring of ambient air at Nautola Village has been initiated on 26.01.2023 through Central Mine Planning Design Institute Ltd. (CMPDIL).
9. The third party study through the reputed organisation for evaluation of effectiveness of measures taken to control the air and water pollution from the east dump shall be submitted within one year. Proposal for engaging third party is already in process.

  
Date: 21/02/23  
Name: \_\_\_\_\_  
Designation: \_\_\_\_\_

10. That regular health check-up/survey on quarterly basis of the residents of the village Nautola will be done through Nehru Shatabdi Chikitsalaya (NSC), Jayant for which necessary steps has been initiated by the Northern Coalfields Ltd.
11. The representative air quality of Nautola Village is taken care of by monitoring being done through CAAQMS installed at nearby Khadia Colony. Apart from this, manual monitoring of air quality at Nautola Village can be done through Khadia Project at regular interval. It may further be noted that the pollution in the area can not be attributed to Khadia Project only, but from other sources also such as:
- i. Burning of primary fuel in the village and nearby locations.
  - ii. Emissions from Thermal Power Plants
  - iii. Vehicular pollution as the village is situated adjacent to Shaktinagar-Audi Road.
  - iv. Construction activities in the village and nearby areas.

A copy of the Commissioning Report of CAAQMS dated 16.05.2019 is annexed herewith and marked as **ANNEXURE R-6.**

12. That the Maximum Reduced level (R.L.) of the east dump is 487 m above mean sea level whereas the joint committee in its report has mistakenly considered total height of dump as 487 m.
13. That every year, before onset of the monsoon, measures are taken for control of surface run-off. From now onwards, the measures to be taken shall be submitted to UPPCB and their kind suggestion will be put into

2080/23  
with  
21/02/23

action. A copy of the Monsoon action plan for the FY 2022-2023 is annexed herewith and marked as ANNEXURE R-7.

14. That the Northern Coalfields Ltd is taking appropriate remedial action, in accordance with Statutory provisions for prevention, control and abatement of environmental pollution/degradation and for protection and improvement of environment.

15. That I say that the Annexure R-1 to R- 6 annexed along with the present Affidavit are true copy of its respective original.

16. I say that averments of facts stated herein above are true to my knowledge, no part of it is false and has been derived from the official records and nothing material has been concealed therein.

By Of Deponent  
Executant

Sw  
20/02/2023  
DEPONENT  
[Signature]

**VERIFICATION**

I, above named deponent mentioned above do hereby most solemnly affirm and verify that what is stated in the above affidavit is true to my knowledge and I believe the same to be true as per the official records of Northern Coalfield Ltd.

Verified at Singrauli on this \_\_\_\_ day of February, 2023.



Identified by

[Signature]  
Waldhan, Distt. Singrauli (M.P.)

Sw  
20/02/2023  
DEPONENT  
[Signature]

**BEFORE THE NATIONAL GREEN TRIBUNAL  
PRINCIPAL BENCH**

(By Video Conferencing)  
Original Application No. 580/2022

Mukesh Singh ...Applicant

Versus

State of Uttar Pradesh ...Respondent

Date of hearing: 30.09.2022

**CORAM: HON'BLE MR. JUSTICE ARUN KUMAR TYAGI, JUDICIAL MEMBER  
HON'BLE DR. AFROZ AHMAD, EXPERT MEMBER**

Applicant: None.

**Application is registered based on a Letter Petition received by  
Email.**

**ORDER**

1. The grievance in the present letter petition received by way of Email, which is registered and treated as original application, is regarding dumping of overburden by Khadia Project of Northern Coalfields limited at Nawatola village Khadia, Tehsil Dudhi, District Sonbhadra, Uttar Pradesh in violation of environmental norms which is causing severe air and water pollution and posing serious health hazards to the local residents.

2. The registry has submitted report that no matter pertaining to Khadiya Project of Northern Coal fields Ltd. at Nawatola village Khadia, Tehsil Dudhi, District Sonbhadra, Uttar Pradesh is pending

3. This Tribunal is empowered to suo moto take cognizance of the cases involving questions relating to environment arising out of the implementation of enactments specified in Schedule I of the National Green Tribunal Act, 2010 as held by Hon'ble Supreme Court in **Municipal Corporation of Greater Mumbai V/s. Ankita Sinha and others 2021 SSC Online SC 897**. This

Tribunal can also take cognizance of such cases on the basis of letter petitions in accordance with settled principles of law governing Public Interest Litigation.

4. *Prima facie*, the averments made in the application raise questions relating to environment arising out of the implementation of the enactments specified in Schedule I to the National Green Tribunal Act, 2010.

5. In view of the averments made in the application, we consider it appropriate to have response of (1) State of Uttar Pradesh through Chief Secretary, Government of Uttar Pradesh, (2) CPCB, (3) State PCB, (4) District Magistrate, Sonbhadra and (5) Project Proponent-Northern Coalfields Ltd. who stand impleaded as respondents No. 1 to 5. The Registry is directed to prepare and attach memo of parties to the application and issue notices to respondents No. 1 to 5 accordingly.

6. In view of the allegations made in the application, we also consider it appropriate that a Joint Committee be constituted to verify the factual position. Accordingly, we constitute a Joint Committee comprising of representatives of CPCB, State PCB and District Magistrate, Sonbhadra and direct the same to meet within four weeks, undertake visits to the site, look into the grievances of the applicant, associate the applicant and representatives of the project proponent, verify the factual position and submit its report within six weeks by e-mail at [judicial-ngt@gov.in](mailto:judicial-ngt@gov.in) preferably in the form of searchable PDF/OCR Supported PDF and not in the form of Image PDF. The State PCB will be the nodal agency for coordination and compliance.

7. In case the Joint Committee observes any violation of consent conditions/environmental norms, then it shall forward a copy of its report to:-

- (i) The concerned Project Proponent to enable it to comply with the recommendations in the report of the Joint Committee or file objections against the observations/recommendations contained in

the same and file its response before this Tribunal within one month from the date of receipt of a copy of the report of the Joint Committee by e-mail at [judicial-ngt@gov.in](mailto:judicial-ngt@gov.in) preferably in the form of searchable PDF/OCR Supported PDF and not in the form of Image PDF; and

(ii) The concerned Statutory Authorities including State PCB and District Magistrate, Sonbhadra to enable them to take appropriate remedial action, in accordance with Statutory provisions mandating them to take remedial action for prevention, control and abatement of environmental pollution/degradation and for protection and improvement of environment, by giving notice to/hearing the project proponent and following due process of law within one month from the date of receipt of a copy of the report of the Joint Committee by e-mail at [judicial-ngt@gov.in](mailto:judicial-ngt@gov.in) preferably in the form of searchable PDF/OCR Supported PDF and not in the form of Image PDF.

8. List for further consideration on 16.12.2022
9. A copy of this order, along with a copy of the application and documents attached with the same, be also forwarded to the CPCB, State PCB and District Magistrate, Sonbhadra by e-mail for compliance.

Arun Kumar Tyagi, JM

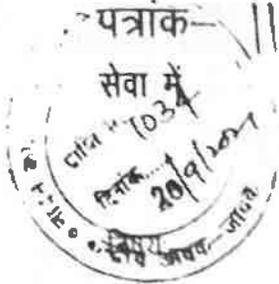
Dr. Afroz Ahmad, EM

September 30, 2022  
AG



कार्यालय क्षेत्रीय वन अधिकारी, खड़िया प्रोजेक्ट, रेनुकूट वन प्रभाग, रेनुकूट (सोनभद्र)  
दिनांक, सितम्बर १०, २०२१

पत्रांक- // / खड़िया प्रो०/२१



महा प्रबन्धक

एन०सी०एल० खड़िया परियोजना।

वृक्षारोपण वर्ष-२०२१-२२ (वर्षाकाल-२०२१) में पौध रोपण कार्य पूर्ण किये जाने के सम्बन्ध में।

महोदय,

उपरोक्त विषय के क्रम में अवगत कराना है कि एन०सी०एल० खड़िया परियोजना अन्तर्गत वृक्षारोपण वर्ष-२०२१-२२ (वर्षाकाल-२०२१) में पौध रोपण कार्य निम्नानुसार कराया गया है-

क्र०स०	वृक्षारोपण क्षेत्र का नाम	क्षेत्रफल (हेक्टेयर में)	लक्ष्य	कुल रोपित पौध	रोपित प्रजातियों का विवरण
1	ओ०बी० क्षेत्र वृक्षारोपण वर्ष-२०२१	२० हे०	५००००	५००००	क०त्री, नीम, प्रकेशिया, अरिकुलिसफार्मिस, बास, सुबबूल, बकायन, चिलचिल, बागनबलिया, जंगलजलेबी, आवला, केसियाग्लूका, अमरुद, पेल्टोफोरम, कनेल, बर, महुआ, शीशम, कंसिया, स्यामिया, बेल, अनार इत्यादि।

अतः महोदय की सेवा में सूचनार्थ एवं आवश्यक कार्यवाही हेतु रिपोर्ट प्रेषित है।

भवदीय

(धीरेन्द्र कुमार मिश्र)

प्रभारी क्षेत्रीय वन अधिकारी

खड़िया प्रोजेक्ट रेंज

रेनुकूट वन प्रभाग, रेनुकूट-सोनभद्र

So(M)  
Dy.Mgr(E&V)

कार्यालय क्षेत्रीय वन अधिकारी, खड़िया प्रोजेक्ट, रेनुकूट वन प्रभाग, (सोनभद्र)

पत्रांक- 06/रेनुकूट/29(वृक्षारोपण) दिनांक, रेनुकूट, सितम्बर, 27, 2022

सेवा में,

महाप्रबन्धक,

एन.सी.एल. खड़िया प्रोजेक्ट ।

विषय:-

वृक्षारोपण वर्ष-2022 (वर्षाकाल 2022) में रोपित किये गये पौधों का प्रजातिवार विवरण के सम्बन्ध में ।

महोदय,

उपरोक्त विषयक के क्रम में सादर अवगत कराना है कि एन.सी.एल. खड़िया प्रोजेक्ट द्वारा वृक्षारोपण वर्ष-2022-23 (वर्षाकाल 2022) में 82500 पौधों के रोपण हेतु लक्ष्य आवंटित किया गया था, उक्त आवंटित लक्ष्य के अनुरूप प्रजातिवार पौधों का रोपण निम्न विवरण के अनुसार किया गया है:-

वृक्षारोपण वर्ष-2022-23 (वर्षाकाल 2022) में रोपित पौधों का प्रजातिवार विवरण:-

क्र०सं०	प्रजाति	रोपित पौध संख्या
1	शीशम	7100
2	सीरिस	800
3	बागनबलिया	1400
4	चिलाबेल	4998
5	बेल	500
6	कनेल	900
7	सागान	90
8	पल्टोफाम	4500
9	कजी	7000
10	अकोसिया आर०फा०	8600
11	बास	9800
12	इमली	600
13	कोसियास्यामिया	4500
14	बकायन	6000
15	जगल जलबी	5500
16	कचनार	1600
17	गाल्डमोहर	900
18	अमलतास	700
19	सुबबूल	3600
20	अमरुद	100
21	जामुन	60
22	आवला	3500
23	अगस्त	1600
24	महुआ	70
25	कुमकुम	200
26	बैर	800
27	कोसियाग्लुका	2900
28	प्रासापिस	2398
29	ढाक	275
30	अन्य प्रजाति	1509
	याग-	82500

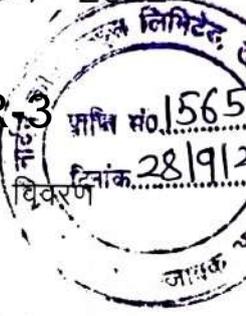
अतः महोदय की सेवा में सूचनार्थ एवं आवश्यक कार्यवाही हेतु रिपोर्ट प्रेषित है।

SO(M)  
Dy. Mgr (Env)

3/2/22

(धीरेन्द्र कुमार मिश्र)  
क्षेत्रीय वन अधिकारी,  
खड़िया प्रोजेक्ट रेंज,  
रेनुकूट वन प्रभाग, रेनुकूट

11  
Annexure R-3



ENVIRONMENTAL  
CLEARANCE

Government of India  
Ministry of Environment, Forest and Climate Change  
(Impact Assessment Division)

To,

The General Manager  
Northern Coalfields Ltd. (NCL)  
General Manager Khadia ,P.O. Shaktinagar, Distt.:Sonebhadra, Uttar  
Pradesh PIN 231222,,Sonebhadra,Uttar Pradesh-231222

**Subject:** Grant of Environmental Clearance (EC) to the proposed Project Activity  
under the provision of EIA Notification 2006-regarding

Sir/Madam,

This is in reference to your application for Environmental Clearance (EC)  
in respect of project submitted to the Ministry vide proposal number  
IA/UP/CMIN/271949/2022 dated 09 Jul 2022. The particulars of the environmental  
clearance granted to the project are as below.

- |   |                                |
|---|--------------------------------|
| 1. EC Identification No.                      | EC22A042UP184193               |
| 2. File No.                                   | J-11015/255/2006-IA-II(M)      |
| 3. Project Type                               | Expansion7                     |
| 4. Category                                   | A                              |
| 5. Project/Activity including<br>Schedule No. | 1(a) Mining of minerals        |
| 6. Name of Project                            | Khadia Opencast Project        |
| 7. Name of Company/Organization               | Northern Coalfields Ltd. (NCL) |
| 8. Location of Project                        | Uttar Pradesh                  |
| 9. TOR Date                                   | N/A                            |

The project details along with terms and conditions are appended herewith from page  
no 2 onwards.

Date: 27/07/2022

(e-signed)  
Lalit Bokolia  
Scientist F  
IA - (Coal Mining sector)

*Note: A valid environmental clearance shall be one that has EC identification  
number & E-Sign generated from PARIVESH.Please quote identification  
number in all future correspondence.*

*This is a computer generated cover page.*

**PARIVESH**  
(Pro-Active and Responsive Facilitation by Interactive,  
and Virtuous Environment Single-Window Hub)



F. No. J-11015/255/2006-IA-II(M).

Government of India

Ministry of Environment, Forest and Climate Change

(Impact Assessment Division)

\*\*\*\*\*

2<sup>nd</sup> Floor Vayu Wing,  
Indira Paryavaran Bhawan,  
Jorbagh Road, N Delhi – 3  
Email: lk.bokolia@nic.in Tel: 011-20819417

Dated: 27<sup>th</sup> July, 2022

To

The General Manager (Khadia Project),  
M/s Northern Coalfields Ltd,  
P.O. Shaktinagar, Distt: Sonbhadra,  
Uttar Pradesh PIN 231222  
Email: [gmenv@ncl.gov.in](mailto:gmenv@ncl.gov.in); [gmenv\\_ncl@coalindia.in](mailto:gmenv_ncl@coalindia.in), [cgm.khd@gmail.com](mailto:cgm.khd@gmail.com)

**Sub: Expansion of Khadia opencast coal mining project for increase in production capacity from 14 MTPA to 15 MTPA (increase of 10% w.r.t 10 MTPA) in land area of 1640 Ha by M/s Northern Coalfields Ltd, located in the village Khadia, Tehsil Dudhi, District Sonbhadra (UP) & village Dhudhichua, Tehsil Singrauli, District Singrauli (M.P.)- Environmental Clearance under OM vide no. F. No. IA3-22/10/2022-IA.III 07.05.2022- [Availing total 50% relaxation of OM dealing with exemption of public hearing under clause 7 (ii) of EIA notification].**

Sir,

This has reference to your online proposal No. IA/UP/CMIN/271949/2022 dated 11<sup>th</sup> July, 2022 submitted to this Ministry for grant of Environmental Clearance (EC) in terms of the provisions with MoEF & CC's Office Memorandum vide no. F. No. IA3-22/10/2022-IA.III (E 177258) dated 07.05.2022 and as per EIA Notification, 2006) of the Environment Impact Assessment (EIA) Notification, 2006 under the Environment (Protection) Act, 1986 for Expansion of Khadia opencast coal mining project for increase in production capacity from 14 MTPA to 15 MTPA (increase of 10% w.r.t 10 MTPA) in land area of 1640 Ha by M/s Northern Coalfields Ltd, located in the village Khadia, Tehsil Dudhi, District Sonbhadra (UP) & village Dhudhichua, Tehsil Singrauli, District Singrauli (M.P.).

2. The proposal was granted EC for production capacity of 10 MTPA in ML area of 1640 Ha dated 10.04.2007. Further EC was granted for expansion under Clause 7 (ii) of EIA notification, 2006 on 23.03.2016 as per the O. M. dated 30.05.2014 for total 40 % expansion i.e. 14 MTPA production capacity in ML area of 1640 Ha. Presently the proposal is considered by the Ministry in view of the exigency, as per the provisions of O.M. F. No. IA3-22/10/2022-IA.III dated 07.05.2022 and abeyance vide MoEF&CC's OM dated 28.01.2022 on OM no. 22-23/2018-IA.III(Pt.) dated 31.10.2019 on mechanism for consideration of proposal of critically/ severally polluted area and abeyance on above OM has been lifted vide OM dated 05.07.2022

3. Based on the submission of Project Proponent, Ministry hereby grants approval to Expansion of Khadia opencast coal mining project for increase in production capacity from

Page 1 of 3

14 MTPA to 15 MTPA (increase of 10% w.r.t 10 MTPA) in land area of 1640 Ha by Northern Coalfields Ltd, located in the village Khadia, Tehsil Dudhi, District Sonbhadra (UP) & village Dhudhichua, Tehsil Singrauli, District Singrauli (M.P.) under the provisions of OM vide no. F. No. IA3-22/10/2022-IA.III 07.05.2022, under the Environment Impact Assessment (EIA) Notification, 2006 and subsequent amendments/circulars thereto subject to the compliance of the following terms & conditions / specific conditions for environmental safeguards as stated below:-

- i. PP shall submit Certified Compliance Report of the EC vide No. F. No. J-11015/255/2006-IA-II(M) dated 23/03/2016 granted for total 40% expansion, along with EIA/EMP report, prepared based on standard ToRs for the additional capacity of 10% on PARIVESH portal within six months of enhancement of production beyond 40%.
- ii. In view of above (i), Ministry shall ascertain the adequacy of the proposed environmental safeguards and stipulate necessary conditions, if required, which shall be monitored as a part of the EC compliance monitoring.
- iii. PP shall obtain necessary prior consent for enhanced capacity from State Pollution Control Board under Air and Water Act.
- iv. Environmental quality parameters arising out of proposed expansion shall be within the prescribed norms and the same shall be maintained as per prescribed norms.
- v. Hon'ble Supreme Court in an Writ Petition(s) Civil No. 114/2014, Common Cause vs Union of India & Ors vide its judgement dated 8th January, 2020 has directed the Union of India to impose a condition in the mining lease and a similar condition in the environmental clearance and the mining plan to the effect that the mining lease holders shall, after ceasing mining operations, undertake re-grassing the mining area and any other area which may have been disturbed due to their mining activities and restore the land to a condition which is fit for growth of fodder, flora, fauna etc. Compliance of this condition after the mining activity is over at the cost of the mining lease holders/Project Proponent".
- vi. All other terms and conditions as prescribed in Ministry's letter dated 10.04.2007, and 23.03.2016 shall remain the same and need to be complied by PP.

Additional Specific conditions as the area falls under Severely Polluted Areas (SPAs)

- (i) Transportation of materials by rail/conveyor belt shall be implemented
- (ii) Encourage use of cleaner fuels for trucks, If the roads required to be widened upto nearest railway siding, the same be constructed to avoid traffic congestion.
- (iii) Increase green belt cover by 40% of the total land area beyond the permissible requirement of 33%, wherever feasible.
- (iv) Greenbelt outside the project premises such as avenue plantation, plantation in vacant areas, social forestry, etc. shall be implemented.
- (v) Assessment of carrying capacity of mine & road transportation shall be done as per the State Plan/instructions.
- (vi) Reuse/recycle of treated wastewater shall be implemented as feasible with latest technology. Zero liquid discharge concept may be adopted.
- (vii) PP to install Continuous monitoring station for ambient air quality and also continuous effluent quality in ETP shall be installed. Data so generated shall be linked with respective SPCB and CPCB websites.

- (viii) A detailed water harvesting plan may be prepared by the project proponent for water augmentation and submitted to Regional Office of MoEF&CC.
- (ix) The project proponent shall install STP for generated domestic wastewater and should meet for discharge standards.
- (x) More stringent norms for management of hazardous waste like oil container, ETP sludge etc shall be adopted. The waste generated should be preferably utilized in co-processing.
- (xi) Monitoring of compliance of EC conditions may be submitted with third party audit every year.
- (xii) Fund allocation for Corporate Environment Responsibility (CER) which is atleast 1.5 times as per OM of 1st May, 2018 may now be considered as 1.5 times of fund allocated on commitment made during public consultation process for incorporating in EIA-EMP for deliberation of EAC and item-wise details along with time bound action plan shall be prepared and submitted to the Ministry's Regional Office.

This issues with the approval of the competent Authority



(Lalit Bokolia)  
Director

**Copy to:**

1. The Secretary, Ministry of Coal, Shastri Bhawan, New Delhi
2. The Chief Conservator of Forests (Central), Ministry of Environment and Forests, Regional Office, B-1/272, Sector K, Aliganj, Lucknow
3. The APCCF, MOEF&CC, Regional Office(EZ), E-5 Arera Colony, Bhopal - 462 016
4. The Secretary, Environment Department, Government of U.P., Secretariat, Lucknow
5. The Secretary, Department of Environment & Forests, Government of Madhya Pradesh, Secretariat, Bhopal
6. The Member Secretary, Central Ground Water Authority, Jamnagar House, 18/11, Man Singh Road Area, New Delhi, Delhi 110001
7. The Member Secretary, Central Pollution Control Board, CBD-cum-Office Complex, East Arjun Nagar, Delhi -32
8. The Member Seretary, Uttar Pradesh State Pollution Control Board, Building No. TC-12V, Vibhuti Khand, Gomti Nagar, Lucknow (U.P.)
9. The Member Secretary, Madhya Pradesh State Pollution Control Board, Paryavaran Parisar, E-5, Arera Colony, Bhopal - 462 016
10. The District Collector, Sonbhadra, Government of Uttar Pradesh
11. The District Collector, Singrauli, Government of Madhya Pradesh
12. Monitoring File/Guard File/Record File
13. PARIVESH Portal



(Lalit Bokolia)

Signature Not Verified  
Digitally signed by Lalit Bokolia  
Scientist Page 3 of 3  
Date: 7/27/2022 3:35:34 PM

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16

Annexure R-5

नॉर्दर्न कोलफील्ड्स लिमिटेड  
खड़िया परियोजना  
(मिनिरात्र कंपनी)

(कोल इण्डिया लिमिटेड की अनुषंगी कंपनी)



**Northern Coalfields Limited**  
**Khadia Project**  
(A Miniratna Company)  
(A subsidiary of Coal India Limited)



Office of General Manager



CIN- U10102MP1985GOI003160

**An ISO: 9001, ISO: 14001 & OHSAS: 18001 Certified Company**

थाना-शक्तिनगर, जिला-सोनभद्र (उ०प्र०) पिन-231222/ Thana-Shaktinagar, Dist. Sonebhadra (U.P.) Pin- 231222

Phone: 05446- 232274, (FAX) 05446- 232274 Email: cgm.khd@gmail.com, website : www.nclcil.in

Ref: NCL/KHD/GM/Min/Env/UPPCB/22-23/3751

Date:-24/01/2023

To  
Chief Environment Officer,  
Circle-2,  
UP Pollution Control Board,  
Dr. Bhimrao Ambedkar Bhawan, T.C. 12 V,  
Vibhuti Khand, Gomati Nagar Lucknow, (U.P.) – 226010

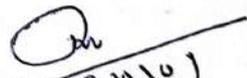
Sub: Submission of slope stability report as directed in OA no. 580/2022.  
Ref.:- Order issued by Hon'ble NGT on 16.12.2022

Dear Sir,

As per order dated 16.12.2022 of Hon'ble National Green Tribunal, New Delhi in the matter of OA no. 580/2022 (Mukesh Singh Vs State Of Uttar Pradesh & Ors), Joint Committee of UPPCB, CPCB and District Administration recommended that "The coal mine should submit the dump stability study report to UPPCB at the earliest".

In compliance of the above, please find enclosed herewith slope stability report prepared by Central Mine Planning and Design Institute Limited (CMPDIL), published in October'2019.

Yours faithfully,

  
General Manager,  
Khadia Area, NCL

Copy to:-

- (1) Regional Officer, UPPCB, Sonebhadra
- (2) GM (Env) – NCL, Singrauli.

# SCIENTIFIC STUDY

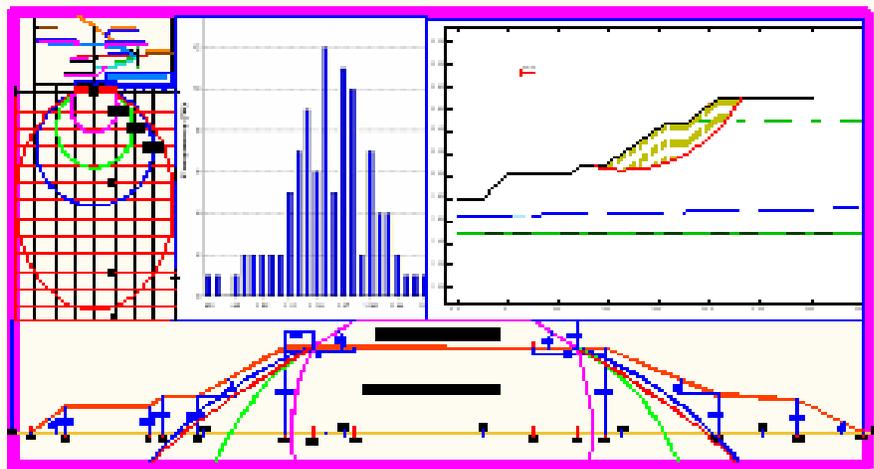
OF

## KHADIA OPENCAST PROJECT

(14.00 MTPA)

(UNDER REGULATION 106 OF CMR- 2017)

## NORTHERN COALFIELDS LIMITED



**OCTOBER- 2019**

**SLOPE STABILITY CELL**

**CENTRAL MINE PLANNING & DESIGN INSTITUTE LTD.**

**REGIONAL INSTITUTE - VI**

**P.O.: JAYANT**

**DIST.: SINGRAULI (M.P.), 486 890.**

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**CHAPTER - I**  
**INTRODUCTION**

**1.0 Type of job :**

Regulation 106 of CMR- 2017 stipulates that for every mechanized open cast working, its method of working, ultimate pit slope, dump slope and monitoring of slope stability has been planned, designed and worked as determined by a scientific study. In view of the above GM (CP), NCL had requested RI-VI for scientific study & remedial measures for safe operation of Khadia Open cast Project through their letter no. NCL/CP/CMPDI/348 dated 06.06.2018.

Accordingly above job has been taken up by Slope Study Cell at Environment department of CMPDI, RI-VI, Singrauli. The Job number assigned is 181906124.

Feasibility Study of Singrauli Coalfield was prepared by Soviet Experts in collaboration with CMPDI in 1974. Khadia OCP is one of the important and oldest mine in NCL in which coal production started in the year 1991-92. Considering the demand and linkage of coal at that time, capacity of mine was restricted to 4.0 Mty. Due to growing demand of coal, capacity of mine was increased to 10.0 Mty in 2011.

As per Project report combined dragline and shovel dumper system is being used here for mining purposes. Considering the mining and geological conditions the combined system of opencast mining with the use of dragline and shovel dumper combination has been proposed.

A detailed stability study with following objectives is done for the sections provided by the project authorities. This report is based on the data and sections provided by project authorities in August-2019.

**1.1 Scope of work:**

As per Reg no-106 of Coal Mines Regulation -2017 the scope of work is to include:

1. The method of working,
2. Ultimate pit slope,
3. Dump slope & Pit Slope stability, and
4. Monitoring of slope stability.

**1.1 Objective of the study:**

For compliance of the Reg.106 of CMR 2017, regarding the scientific study, slope stability analysis has been conducted and remedial measures have been indicated to prevent failure for safe dump/bench profile. This study done based on the data and sections provided by project authorities in August 2019 would also increase the confidence of workers and will also help in saving the loss of human life and properties.

**1.2 Detailed Project history:**

The Project Report for Khadia OCP Expansion (10 Mtpa) was first prepared in April, 2001. Additional reserves were included by expanding the project boundary further in the dip side. The PR was subsequently revised and updated on incremental basis in July, 2005 for a capital investment of `2091.60 crores (Departmental Option).



**Fig 1.1: Google Map of Khadia OCP**

The PR was discussed in PIB meeting held in November, 2005 which recommended to forward proposal to CCEA only after formal receipt of environmental/ forestry clearance.

The approval of PR for Khadia OCP Expansion (10 Mtpa) was held up due to non-clearance of Forest Land. Subsequently, CIL and NCL attained Nav Ratna and Mini Ratna Status respectively and the project approval have come within their purview.

The PR for Khadia OCP Expansion (10 Mtpa) has been re-casted with the following two options after clearance of Stage-II forest land (180 Ha- MP Side) and also taking into account the development made in the project.

Option-I: Total mining operation i.e. coal winning as well as OB removal is proposed to be done departmentally.

Option-II: Additional 2 Nos. of draglines (24m<sup>3</sup>/88mR) would be procured and deployed alongwith the existing two nos. of draglines (20m<sup>3</sup>/83mR) in the parting above Turra Seam.

The balance OBR capacity after taking into account the existing and the sanctioned equipment as per completion report (1998) would be generated through outsourcing.

Khadia OCP (10Mtpa) has been approved by CIL Board for an additional initial capital investment of `1131.28 crores for Option-II (Partial outsourcing of OB and Dragline departmental on 28.06.2011).

#### **1.4 MINING PLAN FOR ENHANCED COAL PRODUCTION (14 Mtpa)**

Khadia OCP (10Mtpa) is linked to Anpara TPS (1630MW) of UPRVUNL and Lanco Anpara TPS (1200MW). To meet the increased energy demand of coal in the country and further in order to cope up with the fluctuation of production of other mines of NCL, it is imperative that production from Khadia OCP is increased. The project has favourable geo-mining conditions for further enhancement of coal production. The increase in production would be achieved by enhancing the utilization of existing HEMM, increasing the no. of working days of project and by augmenting mine capacity through additional OB outsourcing as well as by arrangement of additional HEMM (for coal) from internal resources of NCL.

Considering the above facts, this Mining Plan for Khadia OCP has been prepared for enhanced coal production of 14 Mtpa.

#### **1.5. EC/EMP STATUS**

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEFCC) for a rated capacity of 14.00 Mtpa of coal production vide letter no. J-11015/255/2006-IA. II (M) dated 23.03.2016.

**CHAPTER – II**  
**PROJECT PROFILE**

**2.0 Location**

The Project is located in Moher basin of Singrauli Coalfields partly in Sonebhadra District of Uttar Pradesh and partly in Singrauli District of Madhya Pradesh. Project is covered under Topo sheet no. 63-L /12& 64-L/16 between latitude 24° 07' 26" to 24° 8' 47" North and longitudes 82° 41' 40" to 82° 44' 47" East.

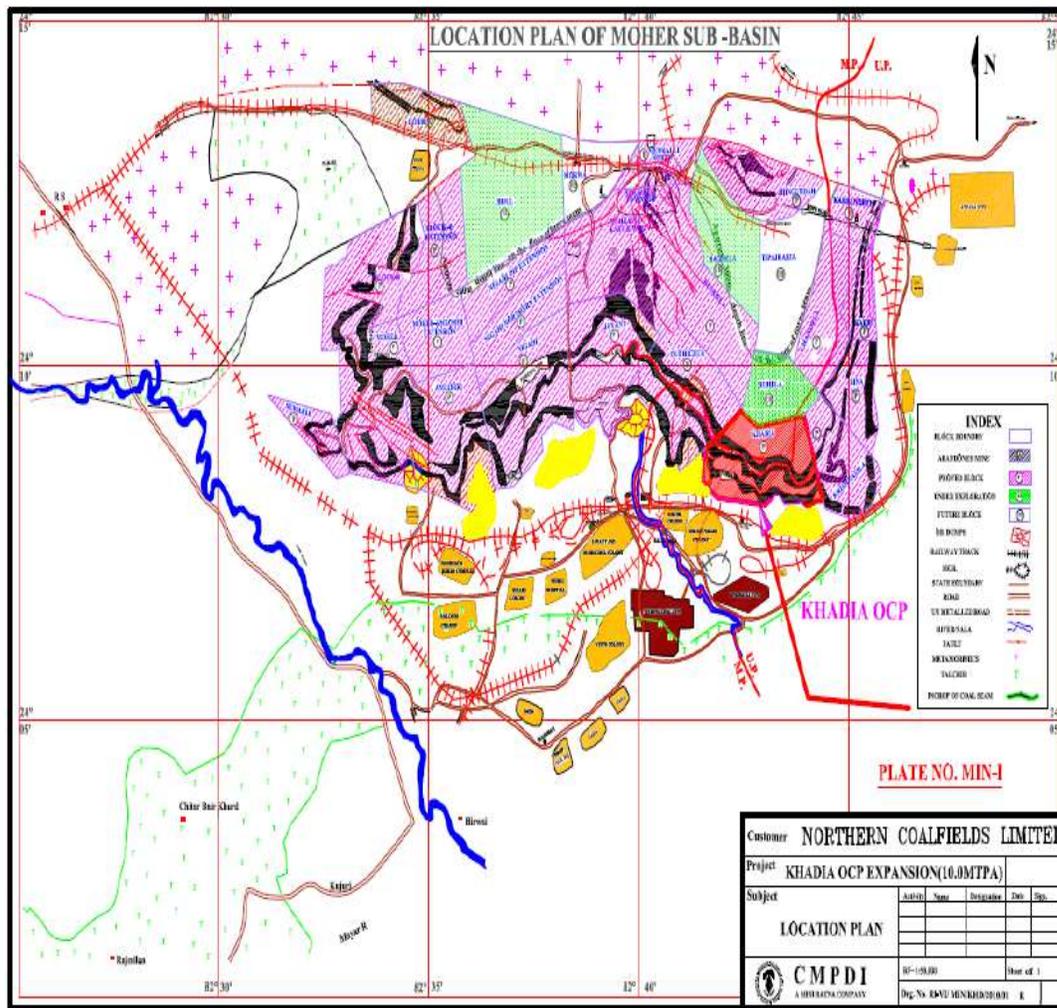


Fig-1 Showing Location Map of Khadia OCP.

## 2.1 Communication

Khadia OCP is well connected by all-weather roads. The nearest railway station Shaktinagar is at a distance of about 2 km. Another railway station 'Singrauli' on Katni-Chopan Branch Line of East -Central Railway is at a distance of about 12 km from the project. The nearest town Waidhan, the Singrauli district HQ (MP) is located about 12 km to the south, Renukut (UP) is 50 Km in the east and Varanasi (UP) is about 225 km in the north. Renukut-Waidhan all-weather road passes through the southern part of the block without blocking any coal reserves.

## 2.2 Topography and drainage

The Khadia block stands out as a plateau above the plains on its south. The plateau is pronounced by steep escarpment facing south rising from an elevation of 290 m at the base to 425 m at the top of the plateau. The area on the top of the plateau is gently undulating except one hill in the north-east corner have an altitude of 489 m. The general elevation of the plateau varies from 420-440 m.

The drainage is controlled by a few seasonal nallas with southerly flow. All these seasonal nallas meet the Balia Nalla in the south which is semi-perennial and join the GBP Sagar on the south.

## 2.3 Climate

The climate of the area is tropical with severe summer. The temperature in the summer (May-June) rises as high as 48°C and the average minimum summer temperature is 21°C. In winter (November-February), the minimum and maximum temperature varies from 4°C to 21°C.

The average annual rainfall is around 1000 mm of which 95% of the precipitation is during rainy season (July-September).

## 2.4 Geology

The geological sequence established in Khadia Block by detailed investigation by GSI, NCDC & CMPDI is as follows:

Five coal seams occur in Khadia Block viz. (i) Kota, (ii) Turra, (iii) Purewa Bottom, (iv) Purewa Top, and (v) Khadia seam in ascending order. Besides these, an inter-banded and impersistent coal band Turra 'A' seam has been observed in few boreholes below Turra Seam. The Turra, Purewa Bottom and Purewa Top Seams are fairly thick and are potential for exploitation. Other seams viz. Kota and Khadia have not been explored in detail because of its thinness, impersistent and inter-banded nature. The generalized sequence of Khadia Block is as follows:

Lithology	Thickness (m)
Soil & sub-soil	0 - 8.10
Sandstone & shale	Upto 74.65
Khadia Seam	0.25-1.25
Sandstone & shale	
Purewa Top Seam	7.00- 10.35
Sand stone & shale	30.34- 43.70
Purewa Bottom Seam	7.10 - 13.39
Sandstone & shale	52.40- 64.28
Turra Seam	18.41 - 22.93
Sandstone & shale	50.73-79.69
Kota seam	0.40- 2.13

### Geological Structure

**Dip and Strike:-**The strike is NW-SE in the west which swings to ENE-WSW in the eastern part of the area. The strike is E-W in the central part of the area. The dip generally varies from 2° to 3° (1 in 28 to 1 in 19) towards north.

**Faults/Joints:** - The areas devoid of any fault. However, two sets of prominent vertical joints (NE-SW and NW-SE) and one set less prominent (E-W) joints have been observed in the area.

**Sequence of Coal Seams:**

Coal seams/parting	Thickness		Depth of Occurrence from surface	
	From	To	From	To
Purewa Top	7.00m	10.35m	35.35m	76.20m
Parting	30.34m	43.70m		
Purewa Bottom	7.10m	13.39m	74.00m	139.50m
Parting	52.40m	64.28m		
Turra	18.41m	22.93m	13.40m	209.27m

**Quality of Coal Seams**

Coal Seam	Thick ness range	Proximate Analysis (on 60 % RH & 40 °C Basis)				GCV (KCal/ kg)	GCV (Grade )	UHV (KCal / kg)	UHV Grade
		M%	Ash%	VM%	FC%				
Purew a Top	7.00-10.35	5.9-8.0	23.7 - 39.1	-	-	3857 - 5177	G8- G12	2538- 4540	D-F
Purew a Bottom	7.10-13.39	6.6-8.5	18.5 - 37.1	25.0 - 28.8	31.3- 43.1	3920 - 5450	G7- G12	2870- 5174	C-F
Turra	18.41-22.93	5.5-7.9	20.5 - 33.9	23.6 - 27.5	38.1- 40.5 0	4540 - 4875	G9- G10	3366- 5008	C-E

**Quarry Parameters**

The quarry parameters of Khadia OCP Expansion are given below:

Sl. No.	Particulars	Unit	Eastern	Western
1	Maximum strike length of quarry along Turra seam floor	Km	1.70	2.40
2	Maximum strike length of quarry along surface	Km	1.95	2.70
3	Dip-rise width of the quarry on Turra Seam floor	Km	2.07	1.98
4	Dip-rise width of the quarry on surface	Km	2.45	2.35
5	Maximum depth of the quarry from surface	m	280	260

6	Final Stage Quarry Surface Area	Sq.Km	4.25	5.78
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### Geo-Mining Characteristics

The mining and geological characteristics of Khadia OCP Expansion are summarized below:

Sl. No.	Description	Unit	Value
1	Thickness of Coal Seams		
	a) Purewa Top	m	8-10
	b) Purewa Bottom	m	8-13
	c) Turra	m	19-22
2	Thickness of OB Partings		
	a) Top OB above Purewa Top	m	35-155
	b) Parting between Purewa Top & Purewa Bottom Seams	m	31-43
	c) Parting between Purewa Bottom & Turra Seams	m	53-62
3	Mine floor Gradient	Deg.	2-3°
4	Volume weight of Coal		
	a) Purewa Top Seam	t/m <sup>3</sup>	1.57
	b) Purewa Bottom Seam	t/m <sup>3</sup>	1.58
	c) Turra Seam	t/m <sup>3</sup>	1.55
5	Volume weight of OB	t/m <sup>3</sup>	2.35
6	Excavation category of Coal	Cat.	Cat-III : 100%
7	Excavation category of OB	Cat.	Cat-III : 90%
			Cat-IV : 10%
8	Balance Mineable reserve as on 31.3.2015		
	Mineable Coal Reserves	Mt	218.66
	Volume of Overburden	Mm <sup>3</sup>	948.83
	Average Stripping Ratio	m <sup>3</sup> /t	4.34

**Mining Technology:**

Considering the mining and geological conditions such as:

1. Flat gradient of 2 to 3 deg. of the coal seam;
2. Mining of multiple seams viz Turra (19-22m), Purewa Bottom (8 -13 m), and Purewa Top (8-10 m).
3. Parting of 53 to 62 m between Turra and Purewa Bottom seams;

Large scope of work, including 14.00 Mt of ROM coal and peak OBR of 70.14 Mm<sup>3</sup>per annum;

Khadia OCP is being worked by combined system of mining using shovel-dumper system and dragline both as per approved PR/EPR/Scheme or Mining plan.

## CHAPTER –III DATA PREPARATION

### 3.1 Introduction

OB dump and high wall are the essential parts of the Open Cast Mining system, particularly in the initial phase of mining operation. Due to non-availability of land and various restriction & constraints, high OB dumps are being created for maximization of the volume capacity and minimization of area. Intermittent mixing of low quality soil (for ex: BCS) with the dumping materials makes the slopes more unstable.

### 3.2 Factors governing the Slope Stability

Two main categories which causes slope failure are:-

- Natural and
- Manmade disturbances.

The seismic activities of the earth crust, seepage due to rain, tornado and geological disturbances comes under the naturally occurred disturbance. The blasting, excavation, HEMM induced vibrations are the manmade disturbance for slope stability. Following are the detailed factors that influence the slope stability.

#### 3.2.1 Geo physical parameters

##### (a) Shear strength parameters:-

This is the basic parameters and holds the key role to control the stability of the slope. All stability analysis involves knowledge of the shearing strength the soil but it is most difficult to comprehend it accurately. The shearing resistance of soil comprises basically of the following components:

- The frictional resistance between the individual soil particles at their contact points.
- The cohesion between the surfaces of the soil particles, i.e. the structural resistance to displacements of the soil because of the interlocking of the particles.

- The shear strength in cohesion-less results from inter-granular friction alone, while in other soils, it results both from internal friction as well as cohesion.
- The fundamental shear strength equation proposed by French engineer Coulomb is  $S=C + \bar{\sigma} \tan (\Phi)$ .

**(b) Bulk density of dump mass:**

Bulk density of dump mass is one of the important parameters in stability calculation. It determines the weight of waste rock / soil mass, and most important factor in determination of factor of safety of slope mass.

**(c) Strength of interface material**

Strength of interface materials is also hold the very important key factors to keep the slope stand safely. Generally interface materials become slurry due to the crust of coal, soil and accumulation of rain water. It badly affects cohesion of soil and frictional coefficient of the pedestal material dump. So arrangement should be made to prevent formation of slurry.

**(d) Grain size distribution of the dump material:**

It indicates composition of dump material comprising of clay, silt, sand, gravels and boulders and the particle size of dump mass varies from 0.075 mm to more than 1.0 m and the percentage composition of dump material. It influences the permeability, density, range of values of shear strength parameters and other characteristics of the soil materials.

**(e) Plastic Limits**

If there is existence of clay material within the dump, determination of Atterberg limits are necessary to assess the expansive properties of clay material. In case of expansive soil, shear strength properties drastically reduces due to swelling when coming in contact with water. Swelling index is also to be determined in case of expansive soil.

**(f) Co-efficient of permeability:**

This parameter is important for assessing the seepage properties of water. It is important to mention that except for the pure clayey dump, all waste rock dumps are permeable.

### 3.2.2 Hydro-geological parameters–

The effect of Hydro-geology in determining stability of dump is as follows:

- A. Shear strength parameters of dump materials gets affected due to water saturation during rainy season. Majority of the dump failure is reported during rainy season & thus the effect of water saturation due to rain water is to be considered.
- B. Upward thrust of water i.e. hydro-static force is created due to accumulated water at the base of dump. It is determined by the product of unit weight of water and volume of submerged overburden dump material falling within the failure mass. It also reduces the cohesion and friction between interface materials.
- C. Seepage of water exerts dragging force on the dump materials. It depends upon the unit weight of moving water, speed and resistant offered by soil particles. Seepage pressure acts on the base of slice below the phreatic line and in the direction of flow. It can be calculated by
  - Knowing the pore water pressure or
  - Drawing the phreatic line.

If pore water pressure can be measured then the seepage force can be calculated by

$$\text{Seepage pressure} = \Delta_h * \gamma_w$$

Where  $\Delta_h$  = Pore water pressure

If the pore water pressure is not known, phreatic line in the dump or highwall can be drawn as shown in following figure.

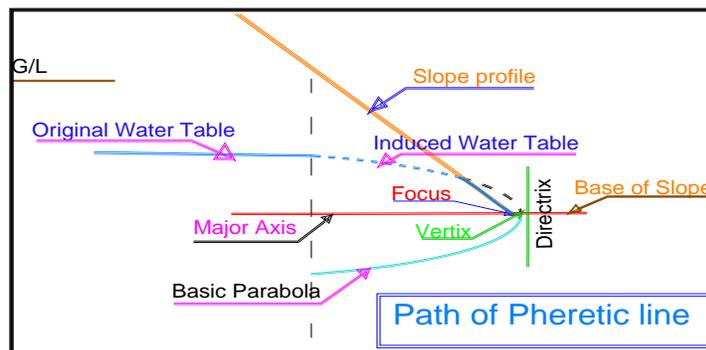


Fig – 3.2.2

If phreatic line is known it can be calculated by

$$\text{Seepage force} = i_p * \gamma_w$$

Where  $i_p$  = gradient of phreatic line.

**D. Erosion of slope surface due to flowing of water**

Flowing of rain water create large and deep cavity on slope surface and at damage the slope profile and geo-physical properties of the soil and may cause of slope failure.

**3.2.3 Geo-mining parameters**

**A. Mine floor inclination**

It is one of the major influencing parameters controlling stability of internal dump. As the internal dumps are formed above the mine floor, which is the place of natural occurrence of coal seam or layer, all the internal dumps are to be designed as per the gradient of coal seam which is not in the control of the mine operators.

Inclination of floor (dip) reduces the effective angle of repose as such shear strength of materials.

In case of external dump standing against a hill; it is also a major factor influencing stability of dump.

**B. Blasting affect**

Blasting has the adverse effect on the stability of dump. Seismicity of the area is to be considered as per Indian Seismic map. Both effects should be compared on the stability of slope most perilous value should be taken for analysis. In both the above cases, horizontal seismic co-efficient has to be measured and multiplied with dead load to determine horizontal force on the dump.

**C. Profile of the dump**

The profile of the dump, i.e height, and berm width and slope angle of individual bench are the crucial factors to determine the stability of slope. As the height of dump increases, the natural time period of dump mass increases as such amplitude of natural frequency. This increases the momentum of whole mass and become susceptible to the even smaller vibration.

#### D. Location of dump

Location of dump site also play vital role in the stability of the slope. Site of the dump must be on firm ground and away from the quarry edge to avoid differential settlement, high wall and base failure.

#### E. Surcharge

Since it is usually assumed that the surcharge is caused by the weight of objects found on the slope body, the vertical component of surcharge having the direction of weight is added to the weight of blocks (slices) and horizontal component give the outward thrust on the slope face. Following diagram show the affect of continuous and point load.

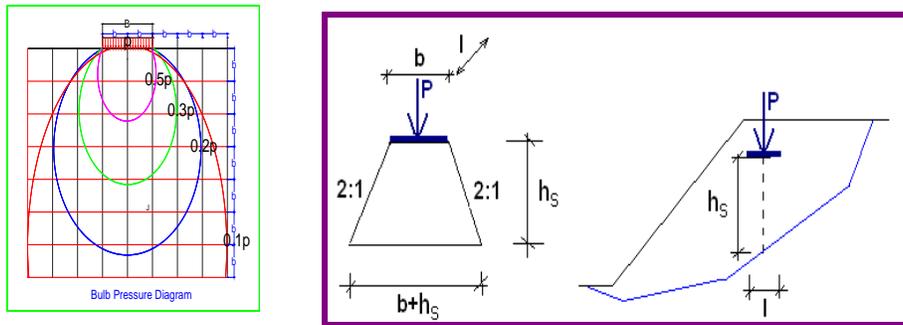


Fig – 3.2.3 E

This surcharge load also increases the earthquake effects and these load component is also multiplied by the factor of horizontal acceleration or vertical earthquake.

Uniform surcharge load spread to a depth as shown in the bulb pressure diagram above.

Concentrated Surcharge load spread to a depth along the slope 2:1 as displayed in figure above.

Scheme of spreading the concentrated load on the slip surface

The analysis then proceeds with the resultant of surface load  $p$  having the value:

$$p = \frac{P}{(b + h_s) l}$$

Hence no structures should be constructed near the edge of dump or high wall because it exerts the pressure on the slope wall. If necessary it should be located at

least 2B from the edge of dump or high wall where B is the width of the structures so as bulb pressures created due to surcharge does not cut the slope face.

### 3.2.4 Dynamic forces:

#### (A) Seismic forces

Earthquake experience by a structure depends on its own dynamic characteristics and ground motions such that random motion of ground, vibration intensity, magnitude of the earthquake; depth of focus, distance from the epicenter and the strata on which the structure stands.

Seismic forces are considered as per "Indian standard criteria for earth quake resistant design of structures (fifth revision) IS 1893:1984 (reprint 2002) in the following manner:-

Seismic force/coefficient  $\alpha_h$  is calculated as per the para 3.4.2.3 of the IS Code by following two methods and higher value will be taken for slope stability calculation.

#### a). Seismic Coefficient Method,

$$\alpha_h = \beta I \alpha_0$$

$\beta$  = Coefficient depending on soil foundation system

$I$  = Factor depending upon importance of structures

$\alpha_0$  = basic horizontal seismic coefficient

#### b) Response Spectrum method

$$\alpha_h = \beta I F_0 S_a/g$$

$F_0$  = Seismic zone factor for average acceleration spectra

$S_a/g$  = Average acceleration coefficient for appropriate natural period and

Damping of structure. Value taken from T-  $S_a/g$  graph

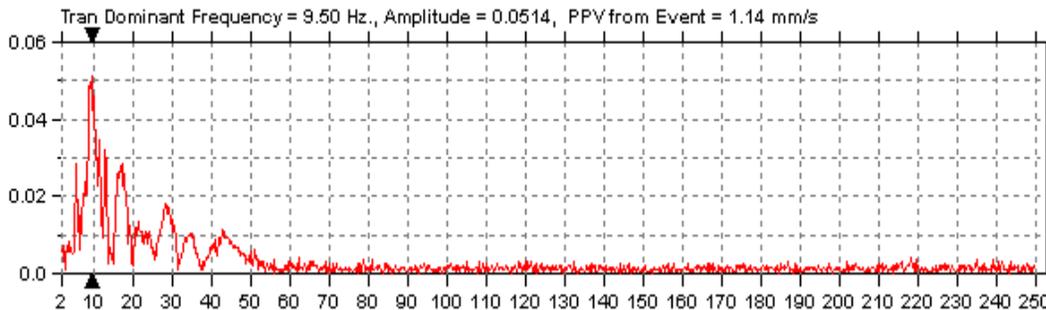
$T = 2.9 H_t (\rho/G)^{1/2}$ ,  $T$  = Natural period of vibration for earth fill structure.

$H_t$  = Height,  $P$  = Mass density,  $G$  = modulus of rigidity.

## (B) Blasting Effect

### (a) Peak particle Velocity

Explosive type, quantity, delay-timing, size and number of holes, distance between holes and rows, method and direction of blast initiation, geology and overburden are the most important factors which effect ground vibrations. The explosive types directly influence ground motion through detonation velocities of explosives and a square root of the charge weight. Microsecond-delayed blasts are used for reduction of PPV of ground vibrations which are connected with the maximum charge weight detonated per delay. Wave propagation might differ with direction if there is geological complexity. The effect of overburden manifests itself in attenuation of high-frequency components of ground motion.



Typical graph of blasting in Opencast mine.

### (b) Threshold Value of Ground Vibration

The study has been conducted keeping in view the norms set for the threshold value of PPV by DGMS. As per DGMS Circular No.7 dated 29.8.97, depending on the type of structures and the dominant excitation frequency, the peak particle velocity (PPV) on the ground adjacent to structures should not exceed the following given values.

Permissible peak particle velocity (PPV) at the foundation level of structures in mining area is in mm/sec:

TYPE OF STRUCTURES		DOMINANT EXCITATION FREQUENCY (Hz)		
		< 8 Hz	8-25 Hz	> 25 Hz
<b>(A)</b>	Building/structures not belonging to owner			
	(i) Domestic houses/structures (Kuchha, Brick in cement).	5	10	15
	(ii) Industrial building (RCC) framed structures.	10	20	25
	(iii) Object of historical importance and domestic structures.	2	5	10
<b>(B)</b>	Building belonging to owner with limited span of life			
	(i) Domestic houses/structures (Kuchha, Brick in cement)	10	15	25
	(ii) Industrial building (RCC) framed structures	15	25	50

In our case 75% to 80% times blast frequency comes in the range of 8-25 Hz.

Langefors et al. (1973), Edwards and Northwood (1960), USBM (1971) and several others have a common agreement that a PPV of less than 50 mm/s would have low probability of structural damage to residential buildings.

### **(C) Horizontal acceleration –**

Horizontal acceleration will be calculated by determining the Scaled Distance using the following Ambraseys and Hendron(1968) formula

$$SD = R/W^{1/3}$$

Where, SD = Scaled Distance

R = Distance of instrument from blast (m)

W = Maximum charge per delay (kg)

A best-fit curve has been drawn among the scaled distance and acceleration which satisfy the following equation with correlation coefficient of 0.84 –

$$F_g = 24.315(R/W^{1/3})^{-0.8711}, \quad \text{Where, } F_g = \text{Acceleration (g)}$$

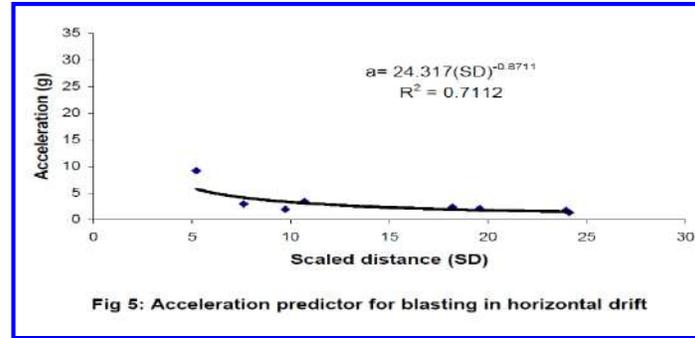


Fig – 3.2.4 C

### (D) Moving force

Moving force is type of live load that constitutes from the vehicular traffic including the HEMM. These moving loads affect the slope stability by creating the dynamic/static load besides the breaking and acceleration jerks. So moving of vehicle should be restricted near the dump or high wall otherwise a suitable factor is required during the analysis of slope stability.

### 3.3 Types of failure:

A slope may have various types of failures which depend upon the type of materials, profile of dump, reasons of failure, base of dump, etc. In our case, generally following types of failure occurs:

**A. Circular failure** – The circular failure, as observed in internal dump, occurs in following conditions-

- As the failure mode or surface finds the path of least resistance, circular failure generally occurs in high dump, soil having low shear strength and base of dump material stronger than dump materials.
- The internal dump is standing above on the mild mine floor.

**B. Circular-cum-planar Failure** –

- It occurs when the shear strength of interface material between dump and the mine floor is less than that of dump material ( after extraction of coal, a slushy layer of water and coal dust lying at the floor of the internal dump is termed as interface material).
- The dump is standing on steep mine floor.

**C. Base failure -**

It occurs when the weak strata lies beneath the toe of the dump.

**3.4 Calculation of Factor of Safety(FoS)**

The shear resistance of the sliding slope is assessed by an index called the factor of safety. The factor of safety gives relative static state of the studied slope about its mobilization. This also gives an indication of risk factor of failure at a glance. This is a ratio of the shear resistance to shear force developed at the sliding surface (mobilization force).

In many Literature and different agencies such as National Coal Board, UK, Appolonia Consulting Engineers, mine branch, Canada and GL Fiesenko, Russia, etc have envisaged that a factor of safety more than 1.10 is safe in the design of slope stability, if appropriate seismic acceleration is considered and more than 1.20 is safe if seismic acceleration is not considered.

**CHAPTER - IV****SLOPE STABILITY ANALYSIS & PROCEDURE****4.1 General**

The numerical method is widely used for slope stability analysis now-a-days. The term numerical analysis and numerical modeling are used here to describe analysis method for numerical solution for a problem. The numerical methods takes into account the physical constraints under which the OB dumps are generated and effect of both of dynamic acceleration & static force. The blasting effect comes under man made seismic activity and analysed accordingly to different type of blasting intensity. The effect of tension cracks and varied hydrological conditions towards the stability are also modeled.

The major benefits of numerical modeling are that both the stress and the displacement in a body subject to external load and imposed boundary conditions can be calculated. Today, large number of different suitable software's/tools based on numerical methods are available for the analyzing the slope stability for the dump/ waste rock piles and high wall.

**4.2 Software**

One of the leading soft wares for analyzing the stability of the slope is GALENA, which is used here for analyzing slope stability. It is very powerful and accurate slope stability software and incorporates Bishop Simplified, Spencer- Wright and Sharma method of analysis to determine the stability of slope The Bishop method is used to determine the stability of slope of circular failure surface, the Spencer-Wright method is applicable for circular and non-circular failure surface and Sharma method is used for problem where non vertical slices are required.

It analyses the multi-layer slopes with tension cracks, earthquake forces, water pressure and surcharge if any within or above the slope including the phreatic surfaces and piezo metric pressures.

### 4.3 Forces

#### Seepage Pressure

When analyzing the slope stability, the water influence is considered through the pore pressure acting within a soil which may reduce its shear strength.

In this study, analysis is being done for the OB dump which contains the heterogeneous materials, having the particle size varies from few microns to more than a meter large boulder. So permeability of these materials is very high, hence analysis has been done for drained condition. Analysis is also done in saturated condition of slope considering the rainwater percolation that may account for seepage/pore water pressure during rainy season.

For high wall, the material layers are intact and percolation of water is minimal when compared to OB dumps in rainy season. Therefore for high walls the analysis is done considering the phreatic surface at peak monsoon level with assumptions based on post and pre monsoon data collected from nearby dug wells and piezometers.

#### Tension Cracks

The program makes possible to account for the influence of tensile cracks that appear on terrain surface and are filled with water  $h$ . The only input parameter is the depth of tensile cracks. The effect of cracks is incorporated when calculating normal and shear forces in sections of a slip surface containing cracks with the shear strength parameters are set to zero ( $c = 0$ ,  $\varphi = 0$ ), and a horizontal force *is introduced*, if there is presence of water in a tensile crack.

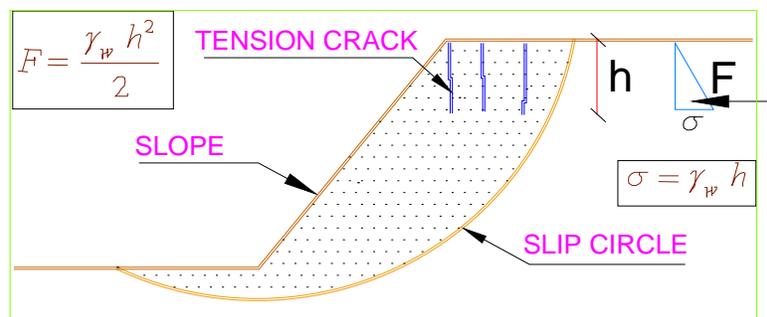


Fig-4.3 A

Generally dump is made on un-consolidation condition so there are always chance to develop cracks on upper portions of the dump due to shrinkage & expansion of the materials caused by the different climate conditions.

Here, it is supposed that all cracks will be filled up immediately so tension crack affect in not considered in calculation of slope stability.

### Ground Acceleration

The program allows for computing the earthquake/blasting effects with the help of factor of horizontal acceleration  $K_h$ . The coefficient of horizontal acceleration introduces into the analysis, an additional horizontal force acting in the center of gravity of a respective slice with the magnitude  $K_h * W_i$ , where  $W_i$  is the overall weight of slice including the gravity component of the slope surcharge.

Earthquake and blasting affect are almost similar type. Horizontal acceleration caused by blasting is directly depending upon the intensity of blasting and inversely to the distance of object. It produces the peak particle velocity and accordingly ground acceleration is calculated.

A zone III earthquake factor is be taken for the analysis of slope stability that can take care of the blasting effect on stability of soil.

### Earthquake

Expected Ground Acceleration for zone III due to earthquake has been calculated on the basis of IS Code and method described in chapter- III.

#### 1). Seismic Coefficient Method,

$$\alpha_h = \beta I \alpha_0$$

Here

$$\beta = 1.0, \quad I = 1.5, \quad \alpha_0 = 0.04$$

Hence,  $\alpha_h = 0.06$

#### 2) Response Spectrum method

$$\alpha_h = \beta I F_0 S_a/g$$

$$F_0 = 0.2$$

$S_a/g$  = Value taken from graph between natural period of vibration verses  
average acceleration coefficient

Natural period of vibration T for earth fills structure will be calculated as follow

$$T = 2.9 H_t (\rho/G)^{1/2}, \quad H_t = 80\text{m}$$

$$P = 18000\text{N/m}^3$$

$$G = 15 \text{ MPa} \times 1000$$

Hence,  $T = 0.239 \text{ sec.}$

$$\text{Now } ah = 1 \times 1.5 \times 0.2 \times 0.16 = 0.048$$

### **Blasting**

Horizontal acceleration will be calculated by determining the Scaled Distance using the following formula

$$SD = R/W^{1/3}$$

Where, SD = Scaled Distance

$$R = 100\text{m}, \quad W = 80 \text{ Kg}$$

$$\text{Hence } SD = 100/80^{1/3} = 23.24$$

$$F_g = 24.315(R/W^{1/3})^{-0.8711} = 1.535$$

Hence basic seismic coefficient of  $F_0 = 0.0156$

From above calculation it can be seen basic seismic coefficient of earthquake is more than seismic coefficient of blasting. So earthquake seismic coefficient will be taken in calculation for slope stability.

### **Surcharge**

The slope stability analysis takes into account even the surcharge caused by neighboring structures. The surcharge can be introduced either as a concentrated force or distributed load acting either on the ground surface or inside the soil body.

The vertical component of surcharge having the direction of weight is added to the weight of blocks (slices). It means that if the earthquake effects are included, this component is also multiplied by the factor of horizontal or vertical acceleration earthquake.

Lateral loads for quick draw down conditions have been checked.

It is assumed that there will be no moving surcharge either on the bench or top of surface.

**Shear Strength of materials**

Strength of soil/rock is mainly depend on shear strength of their materials and holds the key role to control the stability of the slope. Shear Strength depends on the type of formation/strata and their characteristics. Knowledge of formation of the strata their thickness, sequence, location, local topography, structures and hydrology is important. All stability analysis involves knowledge of the shearing strength the soil but it is most difficult to comprehend it accurately. The shearing resistance of soil comprises basically of the following components:

Shear strength of the soil consist Cohesion & Angle of repose that is most important parameters which govern the stability of soil. So, accurate value of these parameters is very necessary. Natural soil is heterogeneous materials and their characteristic varies with place, depth, time, season and hydrological conditions as well as the effect of nature and man-made construction. Hence few test of soil cannot represent the true picture of whole mass of dump. Even the test report of different laboratory of same sample shows the large variation in test results.

In above circumstances a judicious thinking and experience along with sensible thought, study of the previous soil report of the project as well as surrounding projects and back history of the area can help to choose the right combination of data.

**Geotechnical Interpretation**

Table shows the material properties used for simulation of dump slope of Khadia OCP. The data has been obtained based on laboratory investigations and available in literature. Following shear strength parameters have been used for analysis of OB Dump and High wall benches of Khadia OCP. The Soil samples are collected from various Location of Khadia OCP base on geologically differences soil sample of the OB Dump and High wall of the project.

The Soil sample have been tested from geotechnical Lab, Civil Engineering Department, MNNIT, Allahabad

Table

Sl. No.	Sample No	Material	Unit Weight N/m <sup>2</sup>	Cohesion N/m <sup>2</sup>	Angle of repose (Deg.)
1	KH -01	Light gray color poorly graded sand	26.2	36.7	30.58
2	KH -02	Brown clays sand	26.5	36.7	34.68
3	KH -03	Light gray color poorly graded sand	26.4	28.0	32.90
4	KH -04	Boulder Size Coal	15.8	120.0	23.25
5	KH -05	Gray rock of boulder size	22.6	163.0	33.40
6	KH -06	Black rock of boulder size	15.3	210.0	31.40
7	KH -07	Whitish gray rock	26.2	130.0	30.80
8	KH -08	Light brown intermediate compressible clay	27.3	46.1	33.81
9	KH -09	Radish silty sand with gravel	23		
10	KH -10	Brownish silty sand with gravel	-	33.7	30.11

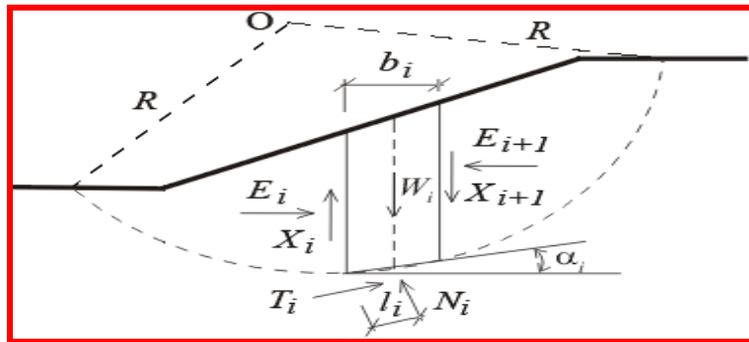
#### 4.4 Method of Analysis:

##### (a) Modified Bishop's method

The Modified (or Simplified) Bishop's method for slope analysis is an extension of the method of Slices or circular slip method. By making some simplifying assumptions, the problem becomes statically determinate. It assumes the effect of vertical component of the inter-slice force is zero and forces on sides of each slice are horizontal. It is more suitable for circular failure

All methods of limit equilibrium assume that the soil body above the slip surface is subdivided into slices (dividing planes between slices are always vertical).

Forces acting on individual slices are displayed in figure.



**Fig-4.4 A**  
**Static scheme of slice**

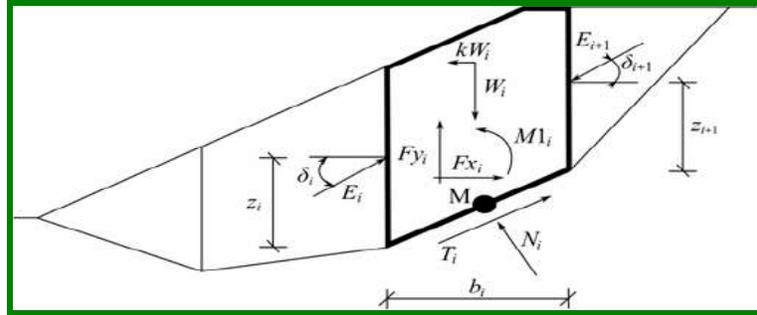
Here,  $X_i$  and  $E_i$  are the shear and normal forces acting between individual slices,  $T_i$  and  $N_i$  are the shear and normal forces on individual segments of the slip surface,  $W_i$  are weights of individual slices.

Individual methods of slices differ in their assumptions of satisfying the force equations of equilibrium and the moment equation of equilibrium with respect to the center O.

#### (b) Spencer Method

The Spencer method is a general method of slices developed on the basis of limit equilibrium. It requires satisfying equilibrium of forces and moments acting on individual slices. The slices are created by dividing the soil above the slip surface by planes, which in general may have different inclinations. Forces acting on individual slices are displayed in the following figure.

The Spencer method is a general method of slices developed on the basis of limit equilibrium. It is also known as rigorous method. This method is applicable to any shape of slip surface. It assumes that inclinations of side forces are the same for every slice so that satisfy all three conditions of equilibrium. So it is more accurate. Forces acting on individual slices are displayed in the following figure.



**Fig-4.4 B**  
**Static scheme – Spencer method**

The result then obtained are presented through preparation of a technical report that summarized the computer generated output observation and drawing which is based on the geo-technical investigations, Laboratory testing and stability evaluation.

### (C) Sharma Method

The **Sharma method** is used primarily in the area of seismic analysis of earth dams to assess the stability of soil slopes under seismic conditions and calculating the permanent displacements due to strong shaking. It is the standard method used for seismic analysis. Using appropriate assumptions the method can also be employed for static slope stability analysis.

It is called advanced and rigorous method because it can satisfy all the three conditions of equilibrium, horizontal, vertical forces and moments. It is called advanced because it can take account of non-circular and irregular slope geometry failure surfaces as well.

When used to analyse seismic slope stability it can provide the factor of safety against failure for a given earthquake load. Besides, it can provide the required earthquake load (force or acceleration) for which a given slope will fail, i.e. the factor of safety will be equal to 1.

Its accuracy has been verified by various researchers and it has been proved to high accuracy yield results.

### 4.5 Analysis

Analysis for the slope stability has been done with the help of Galena software. Galena works by creating a model that represent a slope or excavation. A model can be defined

as a data component necessary for an analysis to be undertaken. The basic data component is materials profile, physical properties of profile, slope surface, tentative failure surface and type of analysis method that include Bishop method, Spenser-Wright method and Sharma method.

The program allows for adopting one method at a time however all methods can be used in same analysis but one by one.

More than 80% slope failure is either circular or near circular in nature. Circular failure generally occurs in high slope with loose materials, low frictional strength and free from the geological disturbances. This condition matches with our OB dump material, so a chance of circular failure is quite high. Hence Bishop's simplified method has been used for the analysis of dump as well as high wall.

#### 4.6 Input

**Plans and Cross sections:** Plans, cross-sections and data used for analysis in this slope stability report have been used as submitted by Khadia Project office.

**Material Properties:** Material regions are defined by material profiles, and each material profile definition includes reference to an associated material. Material Properties are therefore defined for each referenced material, and for each material that is to be considered within the slope.

**Unit Weight:** The unit weight for the material as derived from the laboratory tests and literature is applied as one of the input parameter.

**PWP from Phreatic Surface:** The pore water pressure within the material is calculated directly from the assumed phreatic surfaces.

**Strength Model** Galena includes use of four material strength models out of those Mohr-Coulomb – strength criterion is considered in the analysis which allows strengths to be defined in terms of cohesion (c) and phi ( $\Phi$ ) for isotropic materials.

**Cohesion (c):** Cohesion is the force that holds together molecules or like particles within a soil. Is usually determined in the laboratory from the Direct Shear Test.

**Phi ( $\Phi$ ):** The angle of shearing resistance (in degrees within the range 0.0 to 89.9) for the material.

Six existing cross-sections (A-A', B-B', C-C' , D-D' , E-E' & F-F') from east and west section as provided by project authorities of Khadia OCP at different locations of OB dump and high wall face have been analyzed from slope stability point using strength parameters and GALENA software for different conditions considering the effect of water table, effect of earthquake in the mines.

#### 4.7 Output:

**Factor of safety (FoS)** can be defined as the ratio of resisting forces to driving forces:

A factor of safety of 1.5 means that the strength is 50% higher than the stress on the slope.

A slope at the angle of repose has a Factor of Safety of 1.0. Meaning that there is just enough strength to keep the slope stable. It is exactly on the verge of failure.

**Critical (minimum) Factor of Safety:** The Factor of Safety for the critical failure surface.

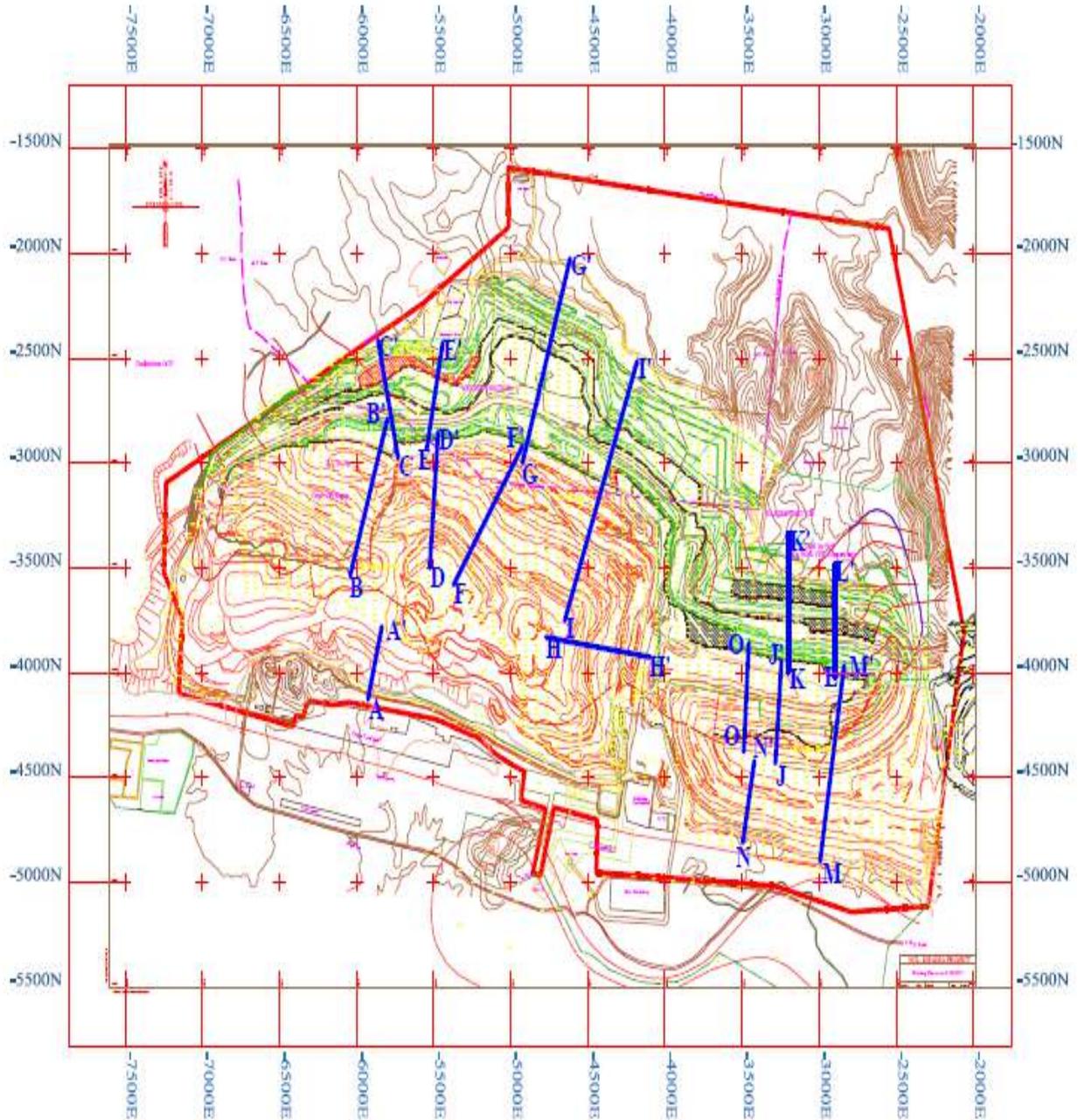
**Failure Surface Display:** This interactive option indicates the number of failure surfaces displayed on the analysis result image. It is possible to have up to 99 failure surfaces displayed - the available number (shown within the Failure Surface Display group) will be the lower of the number of successful trial analyses and 99, and will be in order of FoS result (1 having the lowest FoS).

- Surfaces with FoS  $\leq 1.0$  are red;
- Surfaces with FoS  $> 1.0$  and  $\leq 1.2$  are orange;
- Surfaces with FoS  $> 1.2$  and  $\leq 1.4$  are yellow;
- Surfaces with FoS  $> 1.4$  are light green.

The critical Factor of Safety surface is displayed as a thickened dark red line.

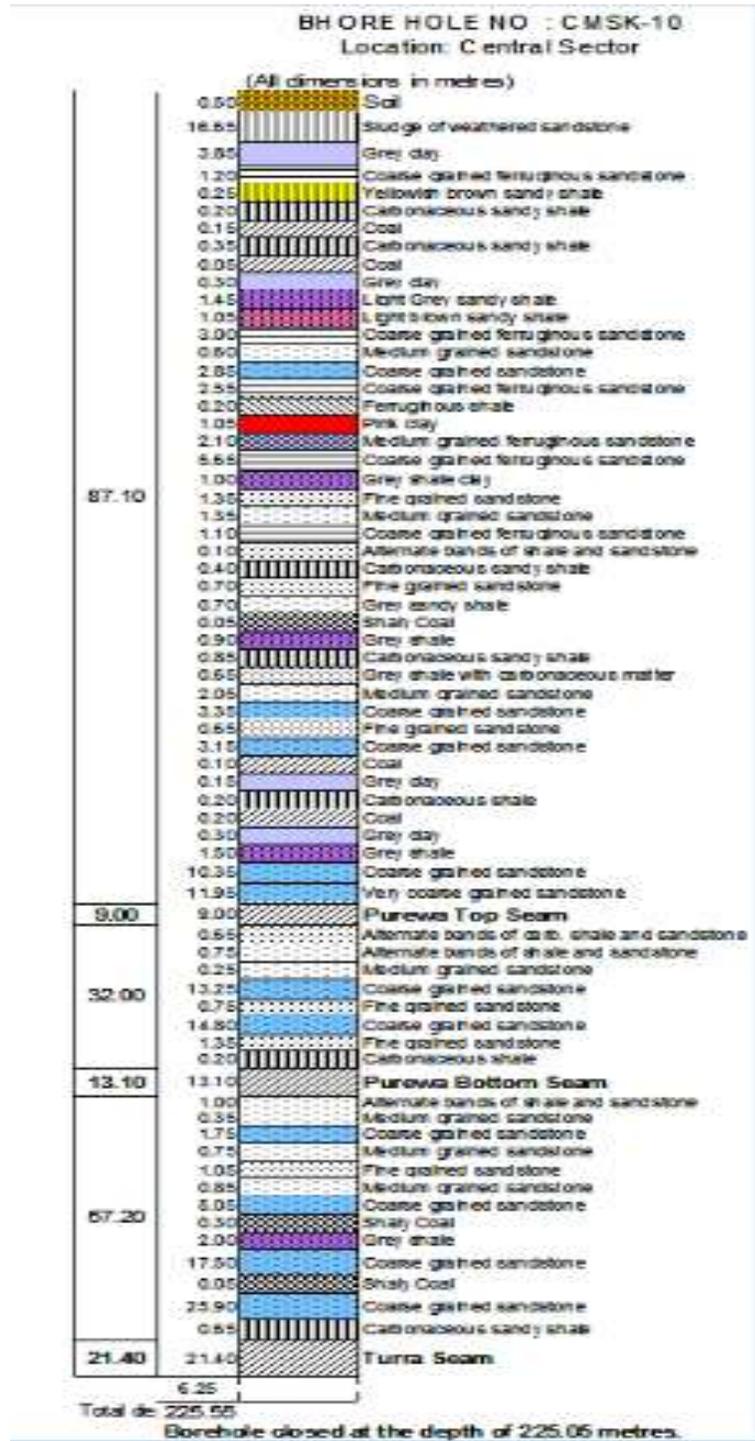
**CHAPTER-V****5.0 Scientific Study and Results Using Galena Software**

The Existing working plan of Khadia OCP as on August-2019 is shown below:



**FIGURE: 5.1: Existing working plan of Khadia-OCP as on August-2019 depicting cross section lines A-A',B-B',C-C',D-D',E-E, F-F',G-G'',H-H',I-I',J-J',K-K', L-L', M-M', N-N' and O-O'.**

**Lithological Plan Of Khadia OCP:**



### 5.1 Report of Soil Sample Testing:

The following are the test results of soil samples collected from difference places of Khadia OCP. The test were conducted at the Geo Technical Lab of Civil Engineering Department, MNNIT-Allahabad, Prayagraj.

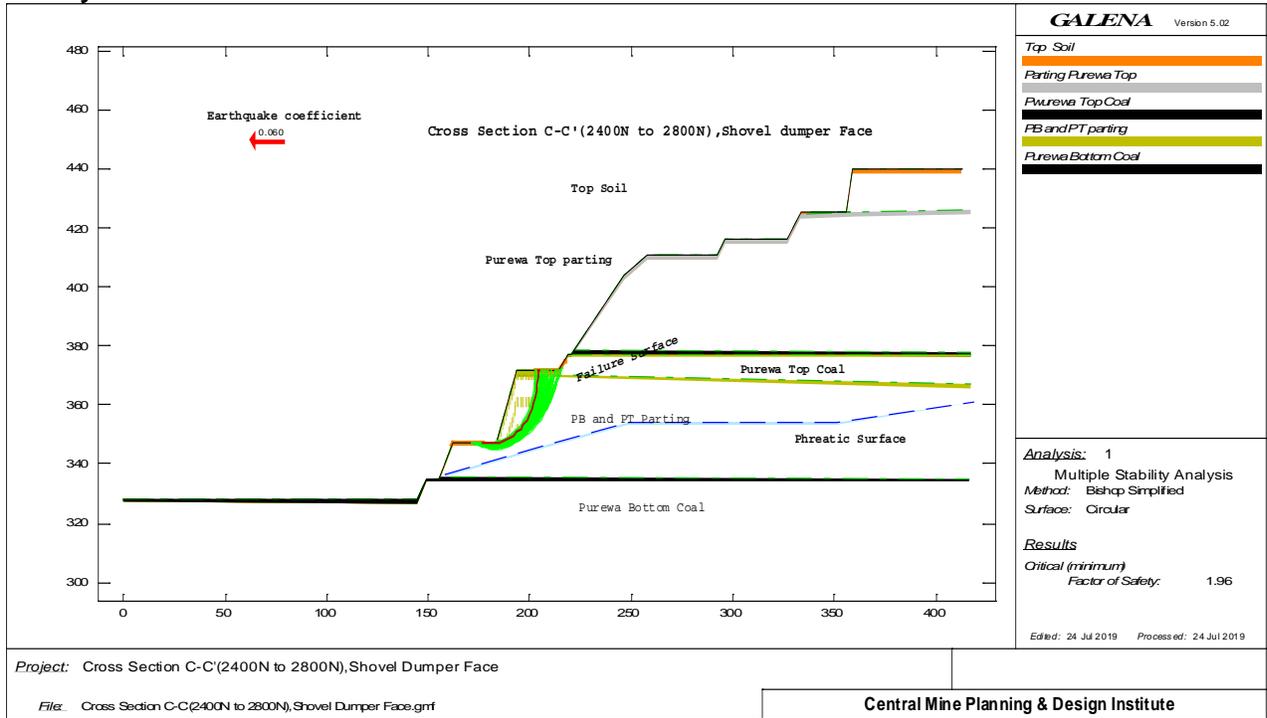
The Soil sample have been tested from geotechnical Lab, Civil Engineering Department, MNNIT, Allahabad.

Table-1

Sl. No.	Sample No	Material	Unit Weight N/m <sup>3</sup>	Cohesion N/m <sup>2</sup>	Angle of repose (Deg.)
1	KH -01	Light gray color poorly graded sand	26.2	36.7	30.58
2	KH -02	Brown clays sand	26.5	36.7	34.68
3	KH -03	Light gray color poorly graded sand	26.4	28.0	32.90
4	KH -04	Boulder Size Coal	15.8	120.0	23.25
5	KH -05	Gray rock of boulder size	22.6	163.0	33.40
6	KH -06	Black rock of boulder size	15.3	210.0	31.40
7	KH -07	Whitish gray rock	26.2	130.0	30.80
8	KH -08	Light brown intermediate compressible clay	27.3	46.1	33.81
9	KH -09	Radish silty sand with gravel	23.00	43.13	36.00
10	KH -10	Brownish silty sand with gravel	29.32	33.7	30.11

**5.2. Data analysis and Results of Shovel Dumper Face:**

(a) Cross Section C-C'(-2400N to -2800N),Shovel Dumper Face:  
Analysis-1:



**Result Of the Section:**

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

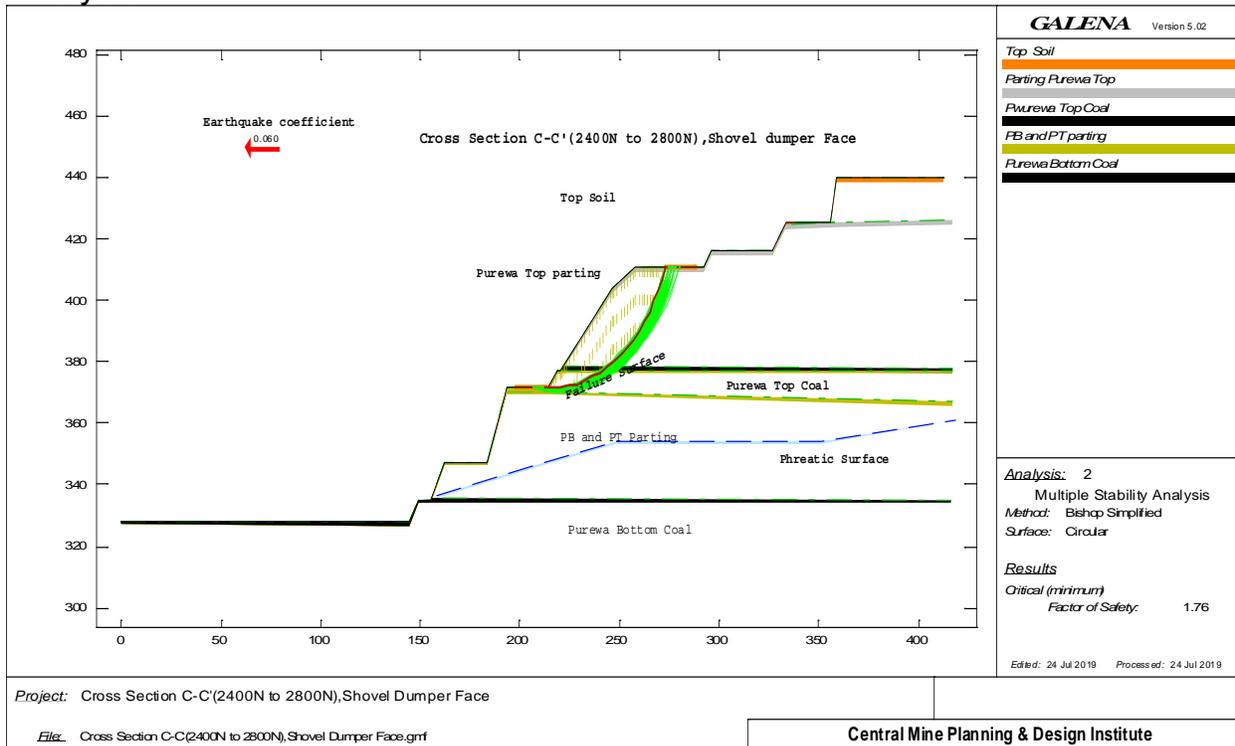
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	181.17	369.86	176.45	203.97	22.86	1.965
2	181.09	368.42	176.45	202.30	21.43	1.965
3	181.35	371.29	176.45	205.63	24.29	1.979
4	180.31	374.37	176.45	207.30	27.14	1.981
5	181.61	372.69	176.45	207.30	25.71	1.994
6	182.83	367.96	176.45	203.97	21.43	1.996
7	180.71	375.75	176.45	208.97	28.57	1.997
8	182.87	369.44	176.45	205.63	22.86	2.004
9	182.96	366.41	176.45	202.30	20.00	2.008
10	181.95	374.08	176.45	208.97	27.14	2.015

Analyses  
Factor of Safety for initial failure circle approximation: 2.19

720 Successful analyses from a total of 1501 trial surfaces  
781 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result  
More information on terminated/failed analyses is provided in the Session Log

Print Close

Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	215.31	433.59	212.75	273.00	62.14	1.764
2	216.26	432.11	212.75	273.00	60.71	1.768
3	215.08	436.46	212.75	274.67	65.00	1.771
4	217.23	430.62	212.75	273.00	59.29	1.772
5	216.00	434.99	212.75	274.67	63.57	1.773
6	218.21	429.10	212.75	273.00	57.86	1.778
7	214.33	434.99	211.08	273.00	63.57	1.778
8	216.94	433.50	212.75	274.67	62.14	1.779
9	213.41	436.46	211.08	273.00	65.00	1.779
10	215.27	433.50	211.08	273.00	62.14	1.782

Analyses

Factor of Safety for initial failure circle approximation: 2.01

1465 Successful analyses from a total of 1501 trial surfaces

36 Analyses were terminated due to unacceptable geometry

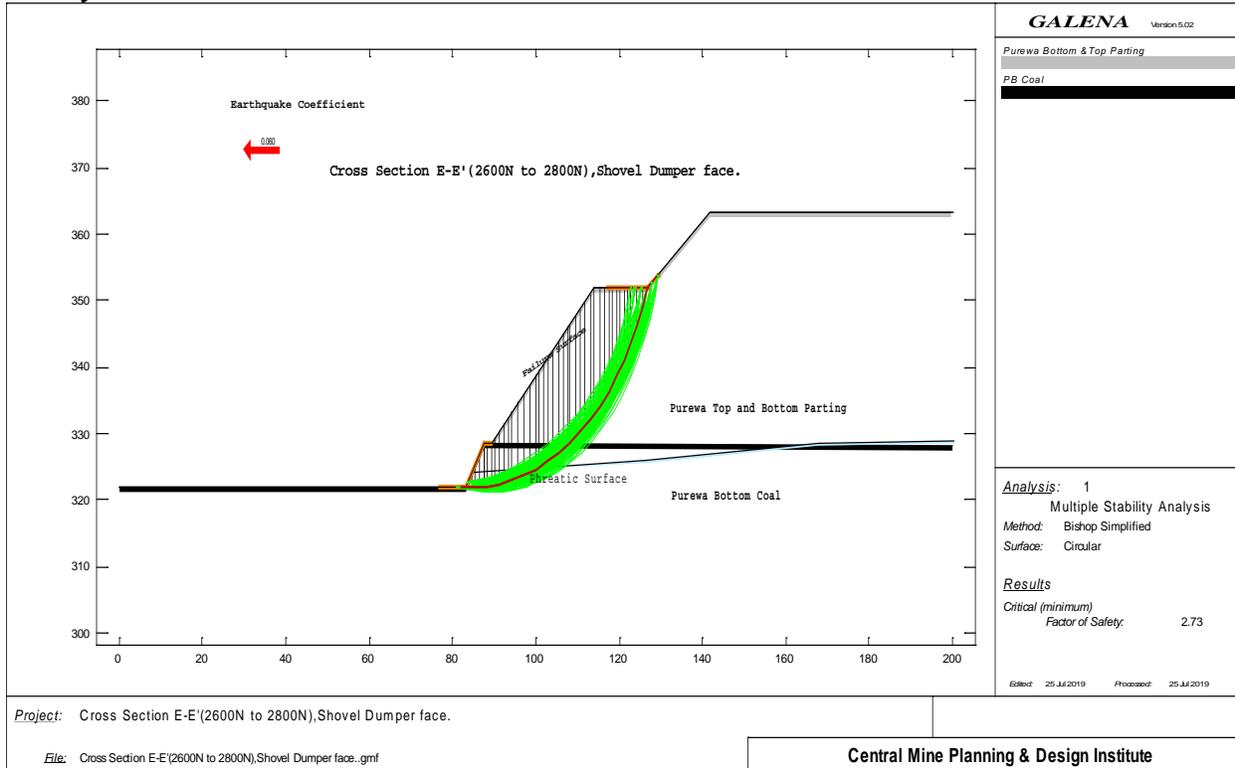
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print

Close

(b) Cross Section E-E'(-2600N to -2900N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	84.74	366.25	82.28	126.63	44.32	2.726
2	85.70	364.82	82.28	126.63	42.95	2.726
3	83.79	367.66	82.28	126.63	45.68	2.727
4	86.68	363.36	82.28	126.63	41.59	2.730
5	84.81	367.61	82.28	127.97	45.68	2.735
6	85.77	366.18	82.28	127.97	44.32	2.735
7	87.69	361.86	82.28	126.63	40.23	2.736
8	85.38	363.48	82.28	125.30	41.59	2.736
9	83.87	369.02	82.28	127.97	47.05	2.737
10	84.39	364.90	82.28	125.30	42.95	2.737

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

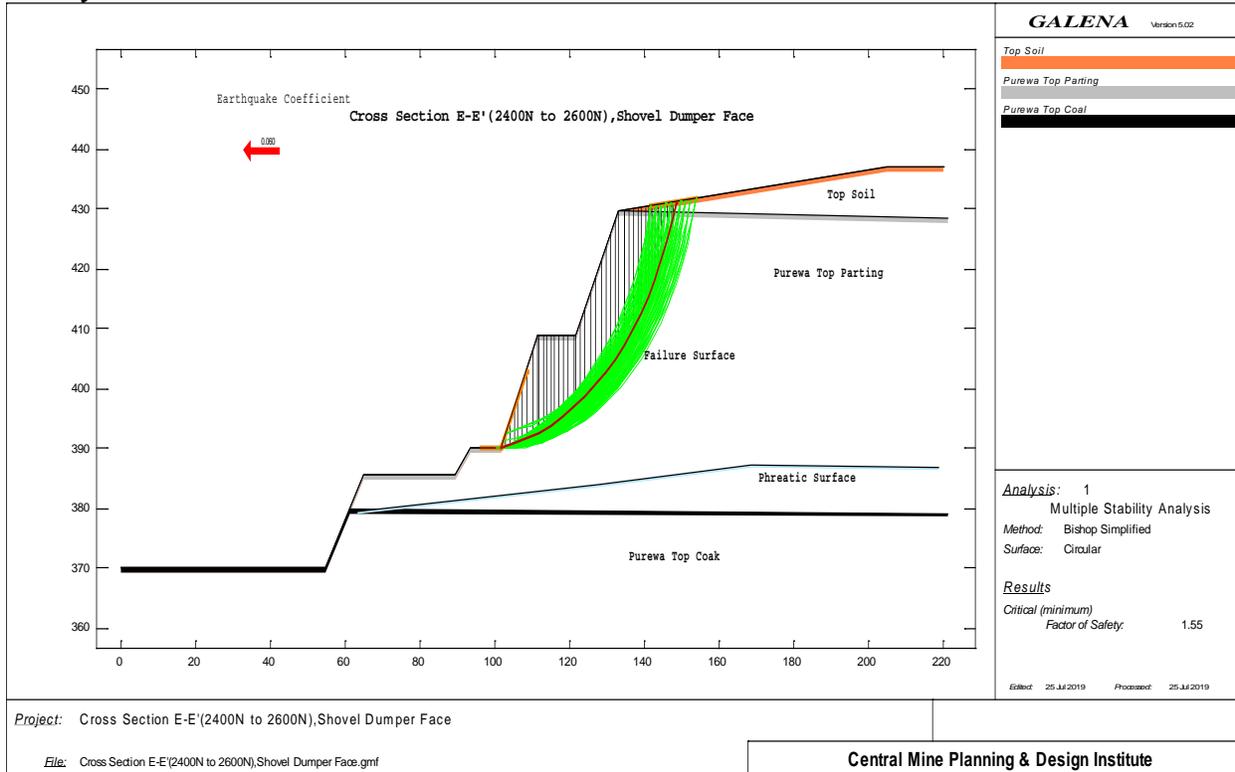
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print

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(c) Cross Section E-E'(-2400N to -2600N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

Multiple Analysis Result Summary - Analysis 1

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	93.27	447.01	101.88	148.52	57.50	1.551
2	94.62	447.20	101.88	149.85	57.50	1.552
3	94.34	445.79	101.88	148.52	56.14	1.554
4	91.91	446.79	101.88	147.18	57.50	1.555
5	92.99	445.59	101.88	147.18	56.14	1.556
6	95.69	445.95	101.88	149.85	56.14	1.557
7	95.96	447.35	101.88	151.18	57.50	1.557
8	95.43	444.55	101.88	148.52	54.77	1.558
9	94.09	444.37	101.88	147.18	54.77	1.559
10	96.76	444.69	101.88	149.85	54.77	1.562

Analyses

Factor of Safety for initial failure circle approximation: 1.61

893 Successful analyses from a total of 1201 trial surfaces

308 Analyses were terminated due to unacceptable geometry

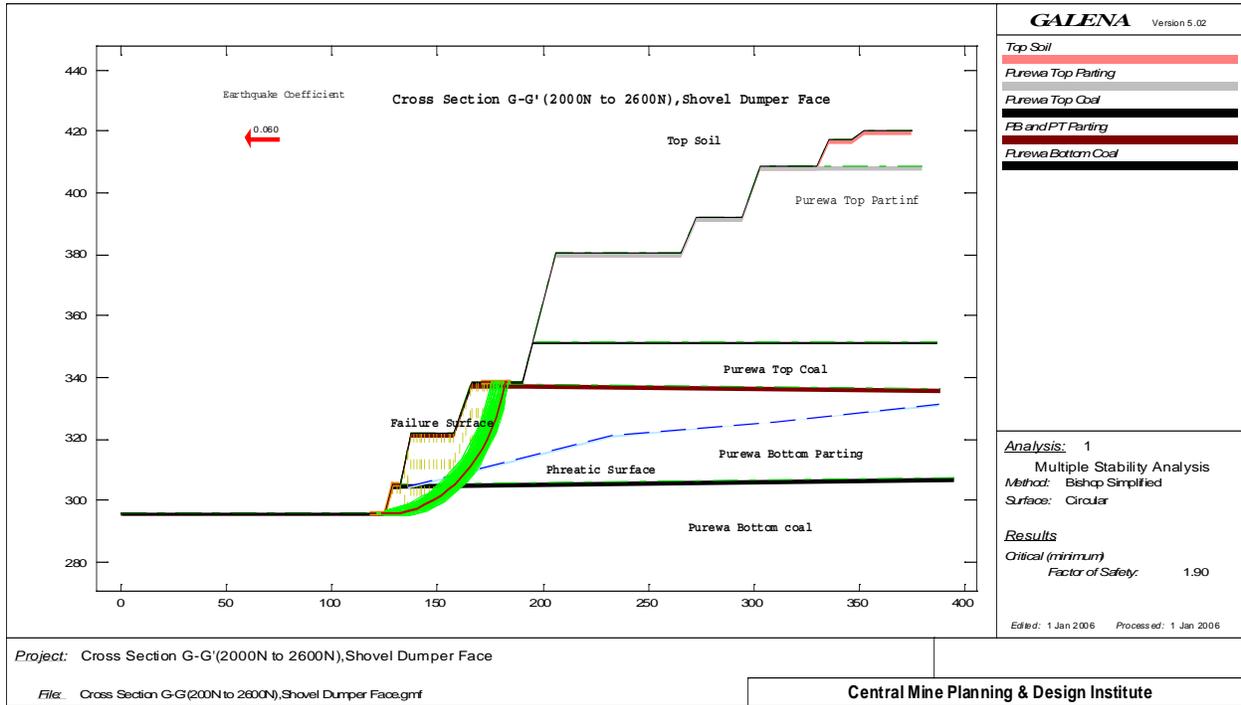
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(d) Cross Section G-G'(2000N to 2600N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

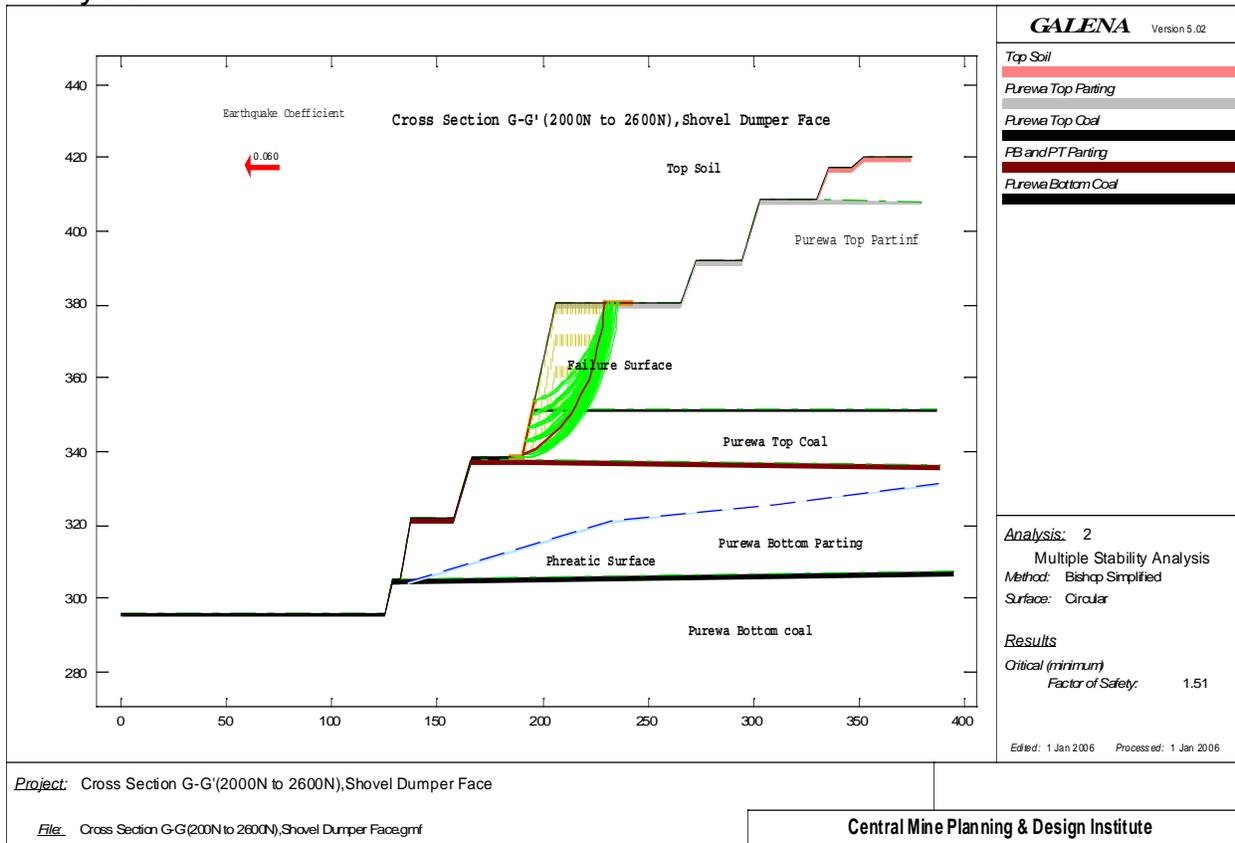
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	126.69	353.43	123.88	182.17	57.50	1.899
2	126.41	352.08	123.88	180.83	56.14	1.906
3	128.01	353.35	123.88	183.50	57.50	1.907
4	125.61	354.33	125.22	180.83	57.50	1.907
5	124.28	354.32	125.22	179.50	57.50	1.908
6	127.73	352.00	123.88	182.17	56.14	1.910
7	126.94	354.31	125.22	182.17	57.50	1.910
8	122.93	354.29	125.22	178.17	57.50	1.913
9	125.31	352.97	125.22	179.50	56.14	1.913
10	126.16	350.73	123.88	179.50	54.77	1.913

Analyses  
 Factor of Safety for initial failure circle approximation: 1.94

929 Successful analyses from a total of 1201 trial surfaces  
 272 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result  
 More information on terminated/failed analyses is provided in the Session Log

Print  
 Close

Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	182.06	386.12	190.72	229.20	47.50	1.512
2	183.30	384.95	190.72	229.20	46.14	1.528
3	182.61	389.53	192.05	229.20	47.50	1.540
4	183.42	386.35	190.72	230.53	47.50	1.542
5	184.56	383.76	190.72	229.20	44.77	1.547
6	183.77	388.37	192.05	229.20	46.14	1.556
7	184.65	385.15	190.72	230.53	46.14	1.561
8	185.85	382.55	190.72	229.20	43.41	1.570
9	183.99	389.79	192.05	230.53	47.50	1.574
10	184.96	387.19	192.05	229.20	44.77	1.574

Analyses

Factor of Safety for initial failure circle approximation: 1.88

1067 Successful analyses from a total of 1201 trial surfaces

134 Analyses were terminated due to unacceptable geometry

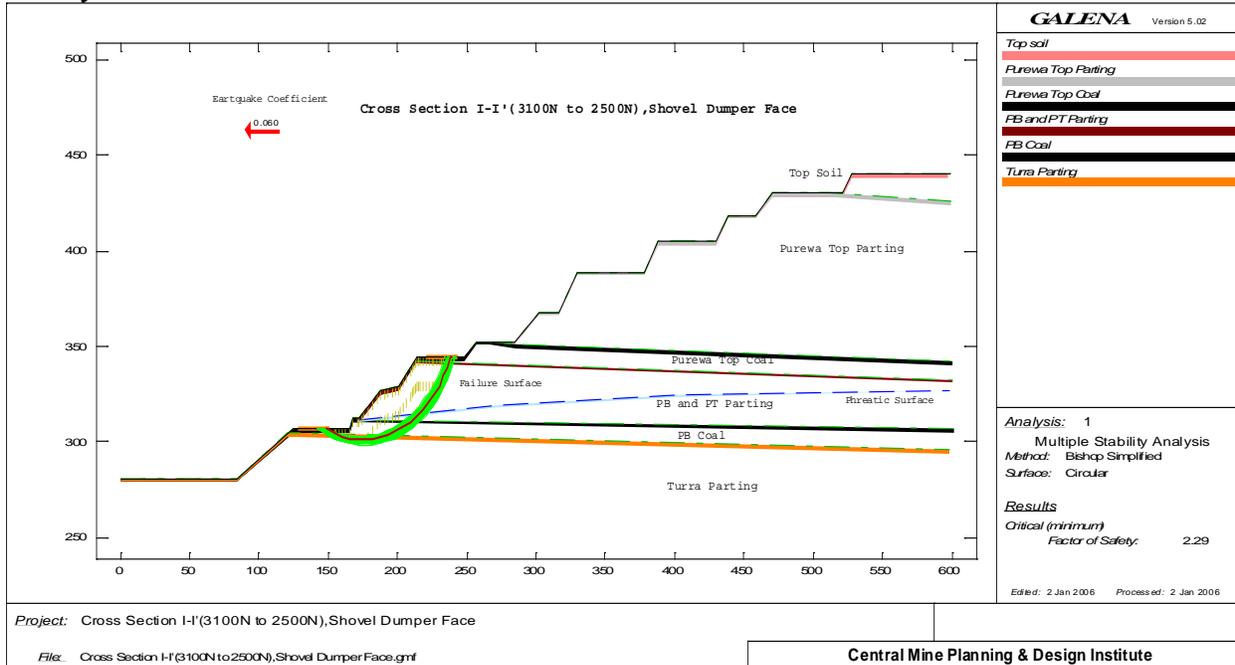
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(e) Cross Section I-I'(-2000N to -2600N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	175.34	368.90	148.65	238.24	67.50	2.292
2	176.57	368.36	148.65	239.67	67.50	2.292
3	175.84	370.12	148.65	239.67	68.82	2.295
4	174.62	370.63	148.65	238.24	68.82	2.297
5	174.12	369.41	148.65	236.81	67.50	2.297
6	177.06	369.58	148.65	241.10	68.82	2.297
7	175.14	368.36	147.22	238.24	67.50	2.298
8	177.78	367.79	148.65	241.10	67.50	2.298
9	176.35	367.79	147.22	239.67	67.50	2.298
10	176.35	371.33	148.65	241.10	70.13	2.299

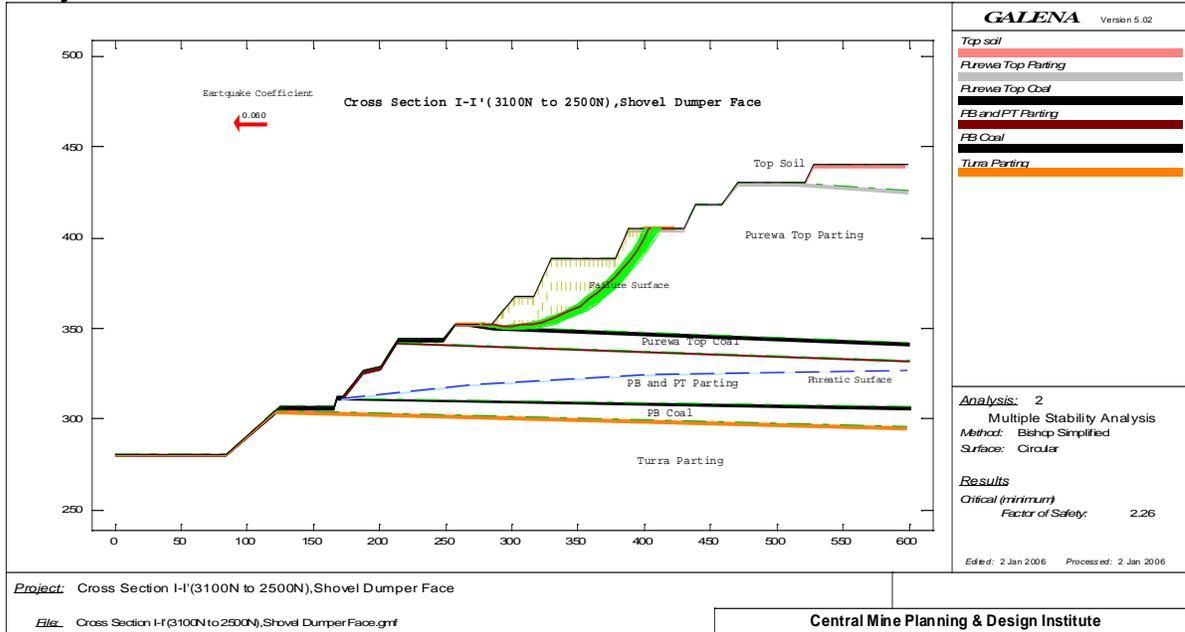
Analyses  
 Factor of Safety for initial failure circle approximation: 2.63

4072 Successful analyses from a total of 4501 trial surfaces  
 429 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	296.93	483.56	278.10	403.56	132.50	2.258
2	296.23	482.33	278.10	402.13	131.18	2.260
3	295.63	483.73	278.10	402.13	132.50	2.261
4	296.14	479.68	278.10	400.70	128.55	2.268
5	296.83	480.91	278.10	402.13	129.87	2.269
6	295.53	481.09	278.10	400.70	129.87	2.269
7	294.93	482.50	278.10	400.70	131.18	2.270
8	294.33	483.90	278.10	400.70	132.50	2.272
9	294.80	482.33	276.67	400.70	131.18	2.275
10	294.20	483.73	276.67	400.70	132.50	2.276

Analyses

Factor of Safety for initial failure circle approximation: 2.45

4501 Successful analyses from a total of 4501 trial surfaces

0 Analyses were terminated due to unacceptable geometry

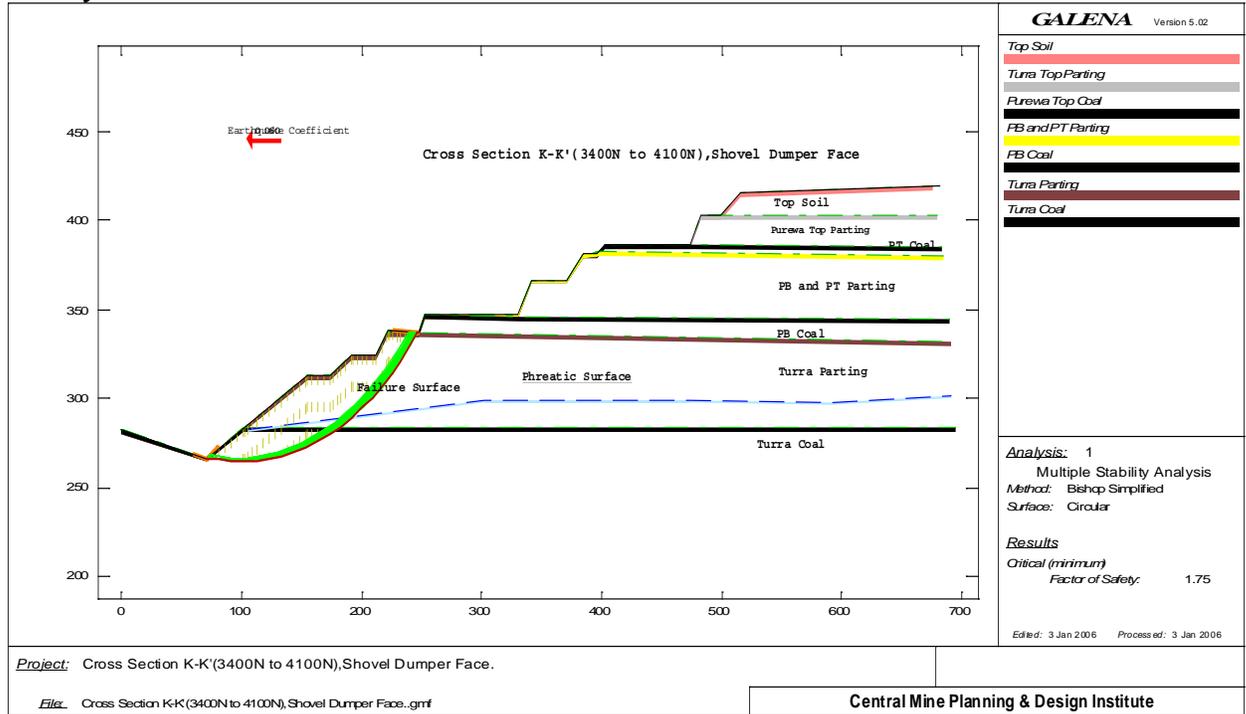
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(f) Cross Section K-K'(-3400N to -4100N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	98.55	451.98	70.30	246.60	187.50	1.748
2	97.98	453.40	70.30	246.60	188.82	1.753
3	97.21	452.18	70.30	245.17	187.50	1.758
4	97.42	454.81	70.30	246.60	190.13	1.758
5	96.86	456.22	70.30	246.60	191.45	1.763
6	96.64	453.59	70.30	245.17	188.82	1.764
7	96.30	457.62	70.30	246.60	192.76	1.769
8	96.08	455.00	70.30	245.17	190.13	1.769
9	95.87	452.37	70.30	243.74	187.50	1.769
10	99.19	452.81	71.73	246.60	187.50	1.772

**Analyses**

Factor of Safety for initial failure circle approximation: 1.89

2395 Successful analyses from a total of 4501 trial surfaces

2106 Analyses were terminated due to unacceptable geometry

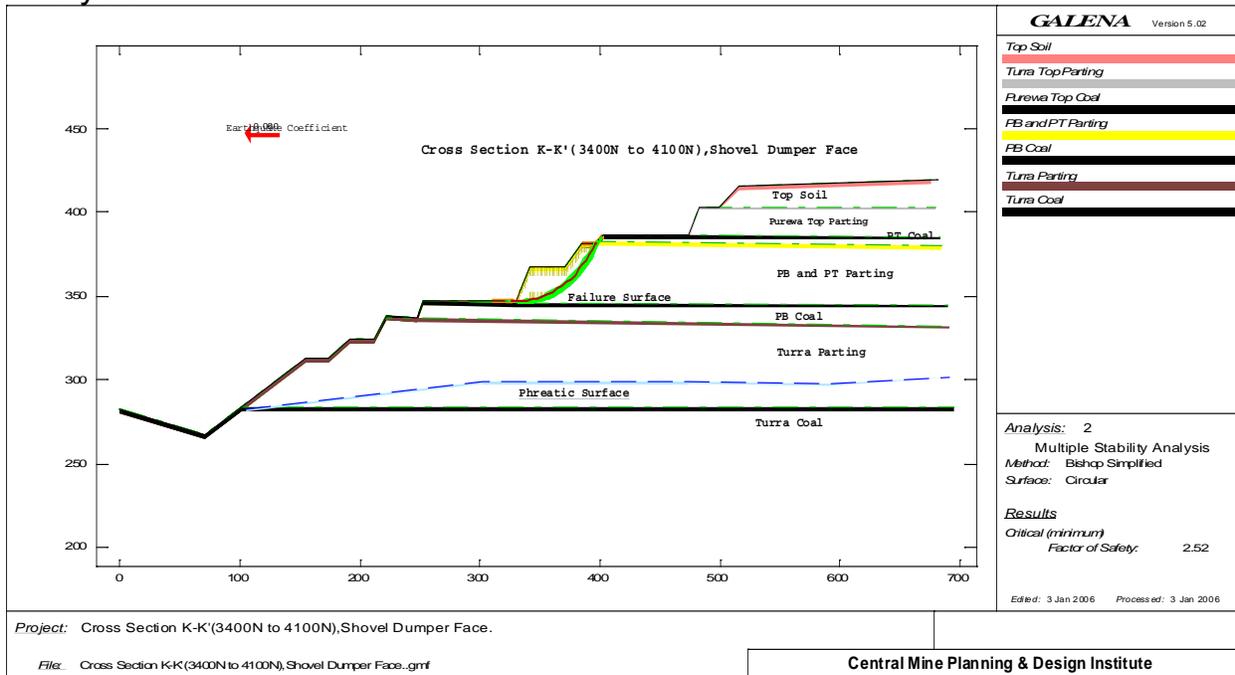
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result Of the Section:

Multiple Analysis Result Summary - Analysis 2

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	332.56	422.77	326.50	396.25	75.71	2.524
2	333.30	421.27	326.50	396.25	74.29	2.525
3	331.82	424.26	326.50	396.25	77.14	2.525
4	334.05	419.77	326.50	396.25	72.86	2.526
5	331.09	425.74	326.50	396.25	78.57	2.526
6	330.36	427.21	326.50	396.25	80.00	2.527
7	334.80	418.24	326.50	396.25	71.43	2.528
8	335.56	416.71	326.50	396.25	70.00	2.530
9	333.50	422.69	326.50	397.92	75.71	2.531
10	332.76	424.19	326.50	397.92	77.14	2.532

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

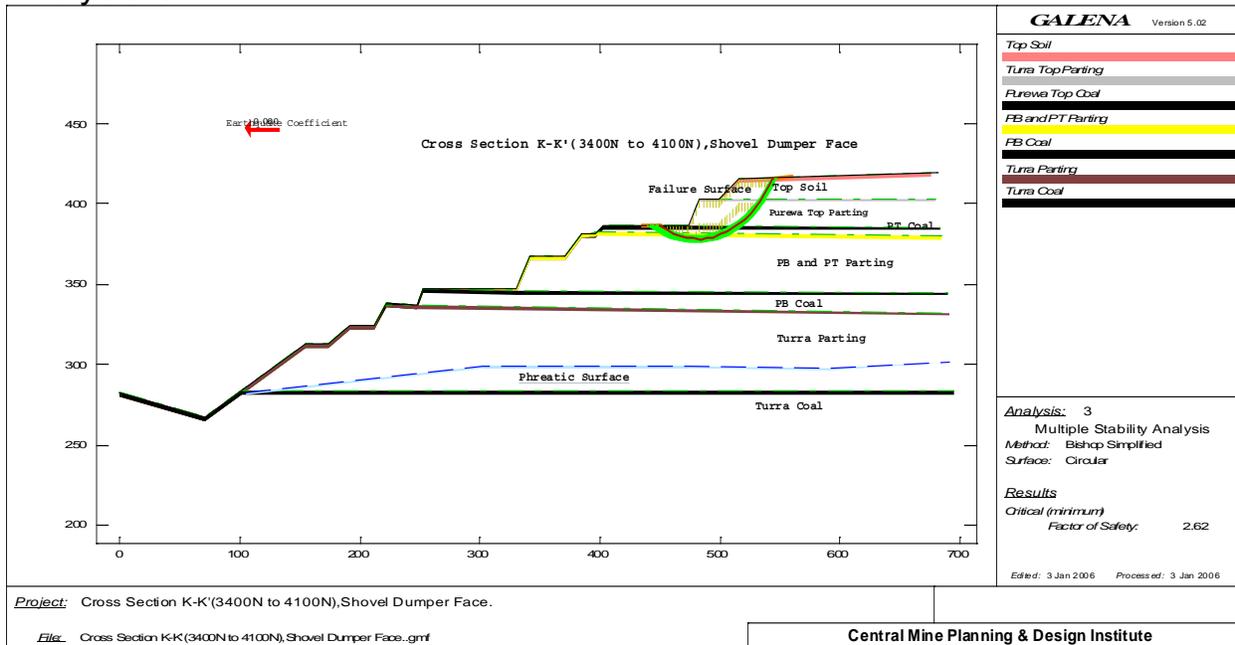
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-3:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	482.11	447.04	450.10	543.40	68.57	2.625
2	481.14	448.29	448.43	543.40	70.00	2.627
3	481.49	448.97	450.10	543.40	70.00	2.627
4	480.53	450.21	448.43	543.40	71.43	2.630
5	480.17	449.53	446.77	543.40	71.43	2.630
6	480.78	447.58	446.77	543.40	70.00	2.630
7	481.76	446.33	448.43	543.40	68.57	2.631
8	479.58	451.45	446.77	543.40	72.86	2.631
9	482.74	445.08	450.10	543.40	67.14	2.632
10	479.94	452.09	448.43	543.40	72.86	2.633

Analyses

Factor of Safety for initial failure circle approximation: 2.81

1479 Successful analyses from a total of 1501 trial surfaces

22 Analyses were terminated due to unacceptable geometry

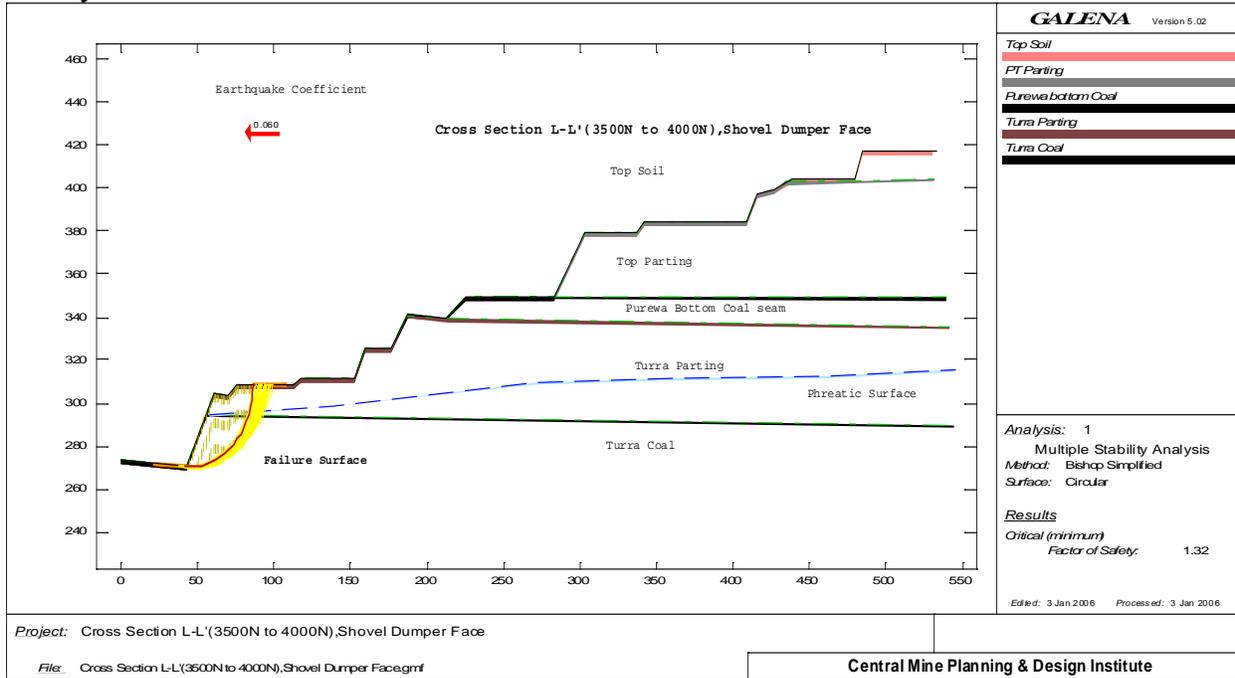
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(g) Cross Section L-L'(-3500N to -4000N),Shovel Dumper Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	46.46	310.44	42.00	86.55	40.13	1.323
2	46.66	311.74	42.00	87.98	41.45	1.329
3	47.74	308.94	42.00	86.55	38.82	1.333
4	46.88	313.04	42.00	89.41	42.76	1.334
5	47.88	310.25	42.00	87.98	40.13	1.339
6	45.23	311.84	40.57	86.55	41.45	1.340
7	47.14	314.33	42.00	90.84	44.08	1.341
8	45.46	313.13	40.57	87.98	42.76	1.342
9	48.07	311.55	42.00	89.41	41.45	1.345
10	46.46	310.35	40.57	86.55	40.13	1.346

Analyses

Factor of Safety for initial failure circle approximation: 1.48

3135 Successful analyses from a total of 4501 trial surfaces

1366 Analyses were terminated due to unacceptable geometry

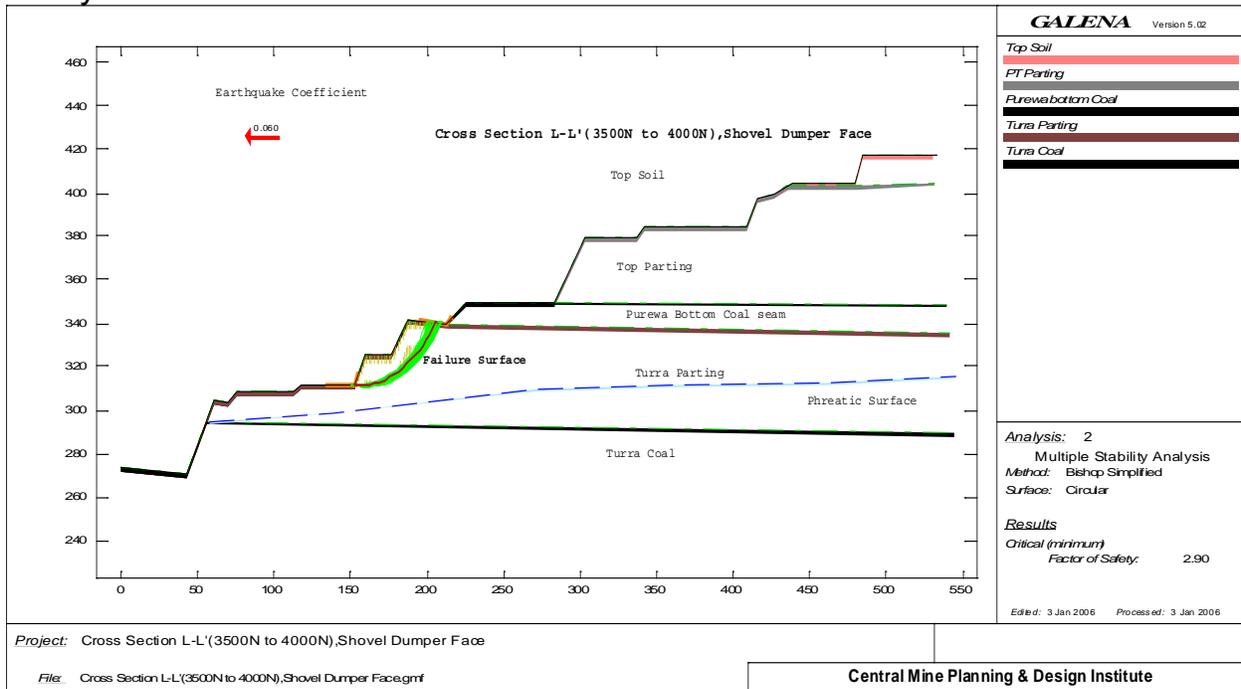
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	154.78	370.09	152.09	205.35	58.55	2.902
2	155.52	368.73	152.09	205.35	57.24	2.902
3	154.83	367.45	152.09	203.92	55.92	2.902
4	155.60	366.09	152.09	203.92	54.61	2.902
5	154.05	371.44	152.09	205.35	59.87	2.903
6	156.27	367.37	152.09	205.35	55.92	2.903
7	154.08	368.80	152.09	203.92	57.24	2.903
8	156.37	364.72	152.09	203.92	53.29	2.904
9	153.33	372.77	152.09	205.35	61.18	2.904
10	153.33	370.14	152.09	203.92	58.55	2.905

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

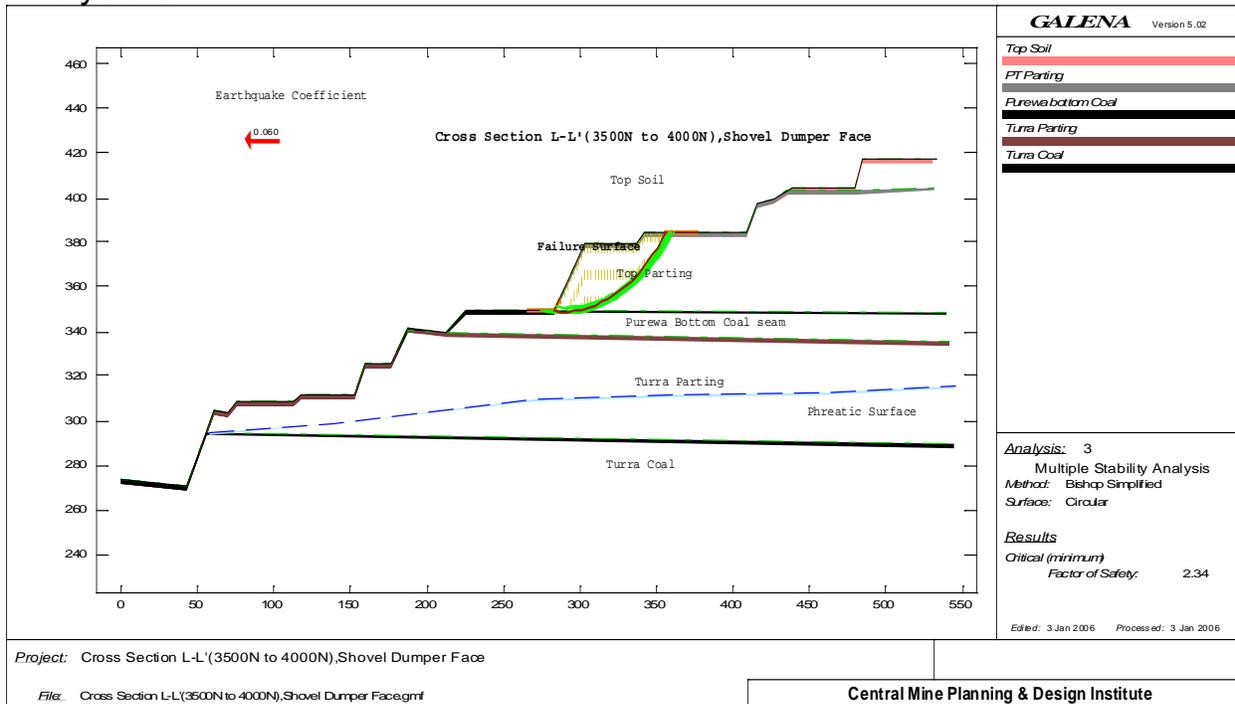
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-3:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	288.38	431.62	282.99	356.10	82.50	2.336
2	289.71	433.48	284.42	356.10	82.50	2.337
3	290.35	432.12	284.42	356.10	81.18	2.345
4	289.04	430.26	282.99	356.10	81.18	2.351
5	290.98	430.75	284.42	356.10	79.87	2.353
6	288.31	431.52	281.56	356.10	82.50	2.361
7	291.63	429.37	284.42	356.10	78.55	2.362
8	289.70	428.89	282.99	356.10	79.87	2.366
9	291.07	433.38	284.42	357.53	82.50	2.370
10	292.27	427.99	284.42	356.10	77.24	2.372

Analyses

Factor of Safety for initial failure circle approximation: 2.88

4500 Successful analyses from a total of 4501 trial surfaces

1 Analyses were terminated due to unacceptable geometry

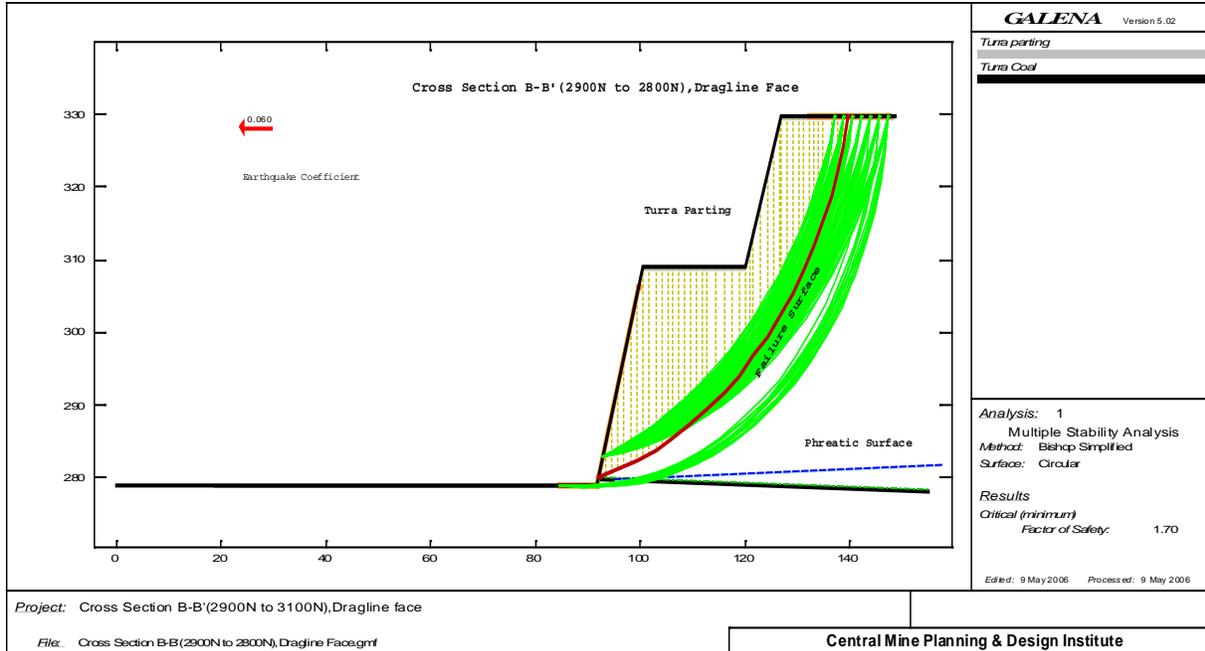
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

**5.3.Data analysis and Results of Dragline Face:**

(a) Cross Section B-B'(-2900N to -3100N), Dragline Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

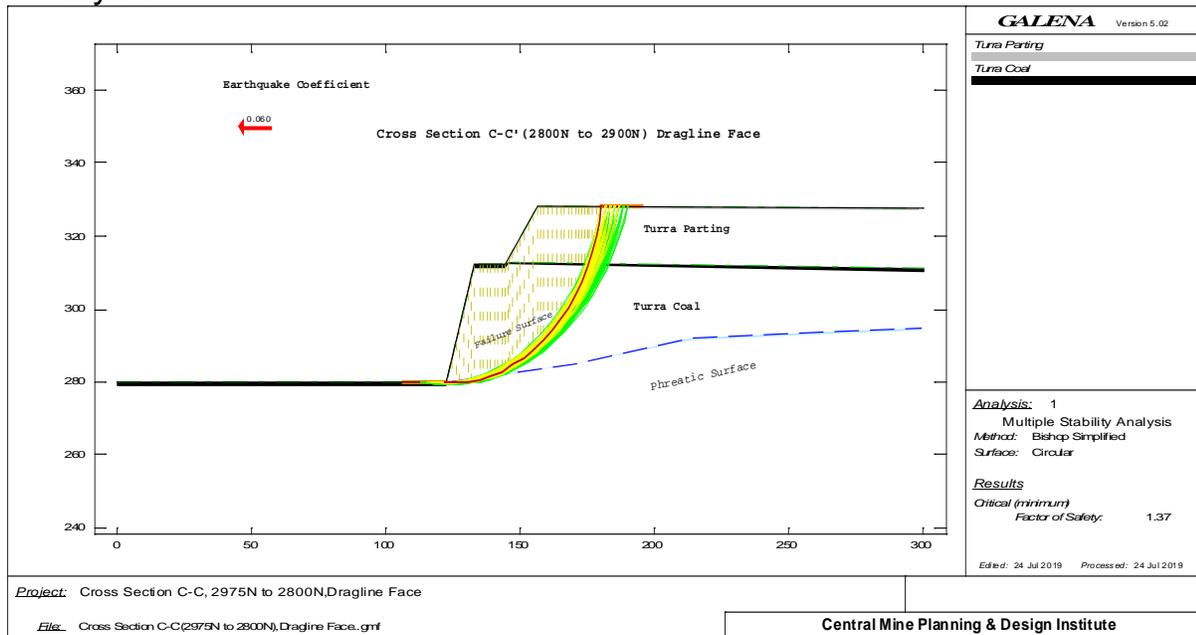
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	76.18	343.16	92.10	139.75	65.00	1.695
2	73.53	355.49	92.93	143.92	75.00	1.768
3	75.37	355.95	92.93	145.58	75.00	1.770
4	74.61	354.29	92.93	143.92	73.57	1.770
5	71.67	354.96	92.93	142.25	75.00	1.772
6	75.71	353.10	92.93	143.92	72.14	1.772
7	76.44	354.74	92.93	145.58	73.57	1.773
8	72.77	353.80	92.93	142.25	73.57	1.773
9	73.88	352.62	92.93	142.25	72.14	1.774
10	76.81	351.89	92.93	143.92	70.71	1.775

Analyses  
Factor of Safety for initial failure circle approximation: 1.70

506 Successful analyses from a total of 1501 trial surfaces  
995 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result  
More information on terminated/failed analyses is provided in the Session Log

Print Close

(b) Cross Section C-C'(-2975N to -2800N), Dragline Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

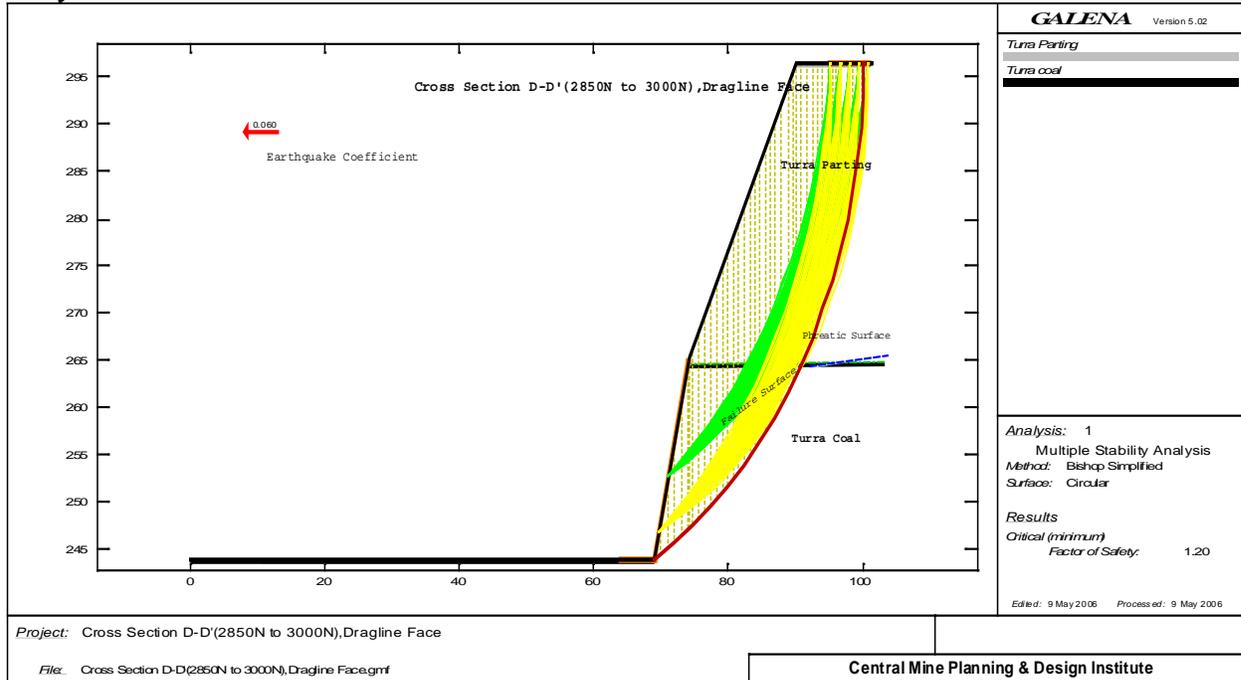
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	124.32	336.07	121.70	180.20	56.43	1.369
2	120.71	340.37	118.37	180.20	60.71	1.371
3	122.37	340.37	120.03	181.87	60.71	1.372
4	123.08	337.48	120.03	180.20	57.86	1.373
5	124.04	340.37	121.70	183.53	60.71	1.378
6	121.88	338.88	118.37	180.20	59.29	1.379
7	124.75	337.48	121.70	181.87	57.86	1.379
8	121.21	341.78	118.37	181.87	62.14	1.379
9	123.54	338.88	120.03	181.87	59.29	1.382
10	122.88	341.78	120.03	183.53	62.14	1.383

**Analyses**  
Factor of Safety for initial failure circle approximation: 1.45

1182 Successful analyses from a total of 1501 trial surfaces  
319 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result  
More information on terminated/failed analyses is provided in the Session Log

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Close

(c) Cross Section D-D'(-2975N to -2800N), Dragline Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	40.20	296.64	69.00	100.20	60.00	1.198
2	47.03	294.31	69.71	99.49	52.50	1.244
3	48.43	294.96	69.71	100.91	52.50	1.247
4	45.63	293.62	69.71	98.06	52.50	1.248
5	45.33	295.34	69.71	99.49	54.17	1.250
6	46.75	296.03	69.71	100.91	54.17	1.250
7	45.09	297.08	69.71	100.91	55.83	1.253
8	43.92	294.60	69.71	98.06	54.17	1.253
9	43.65	296.35	69.71	99.49	55.83	1.256
10	44.25	292.88	69.71	96.63	52.50	1.256

Analyses

Factor of Safety for initial failure circle approximation: 1.20

201 Successful analyses from a total of 641 trial surfaces

440 Analyses were terminated due to unacceptable geometry

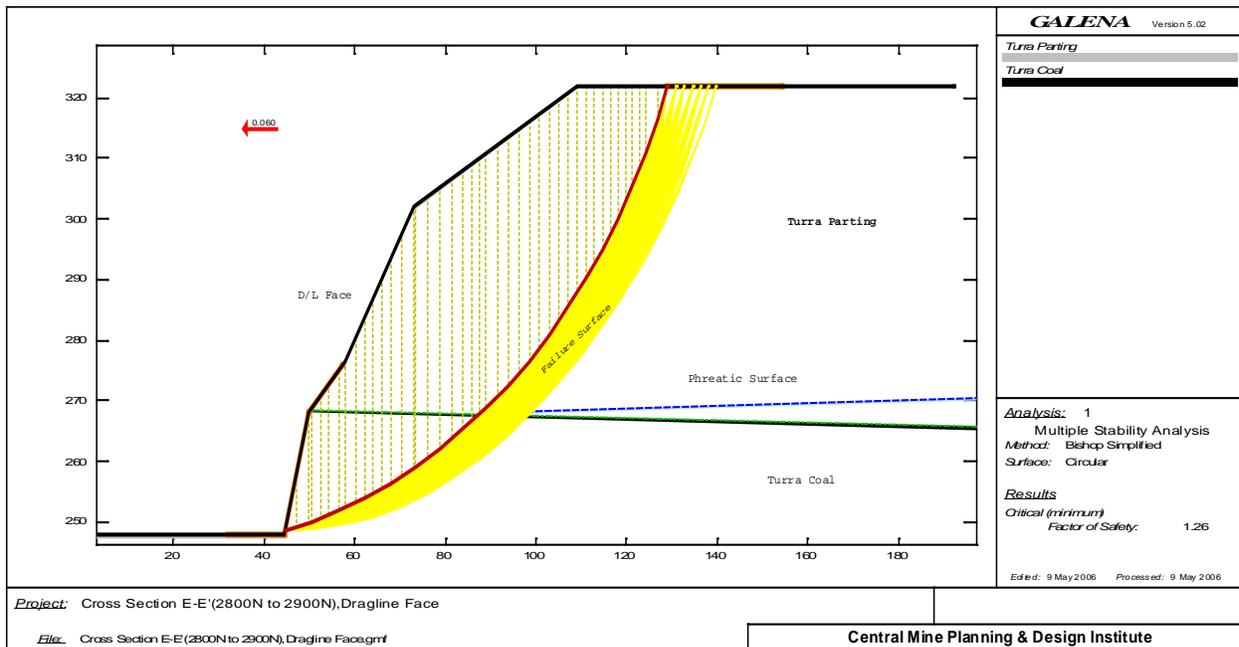
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(d) Cross Section E-E'(-2800N to -2900N), Dragline Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	19.07	363.23	44.65	129.10	117.50	1.257
2	20.16	361.97	44.65	129.10	116.04	1.258
3	21.26	360.72	44.65	129.10	114.58	1.260
4	22.35	359.45	44.65	129.10	113.12	1.261
5	23.46	358.18	44.65	129.10	111.67	1.262
6	24.57	356.91	44.65	129.10	110.21	1.264
7	25.68	355.63	44.65	129.10	108.75	1.266
8	21.01	363.64	44.65	130.89	117.50	1.267
9	22.09	362.37	44.65	130.89	116.04	1.269
10	26.80	354.34	44.65	129.10	107.29	1.269

Analyses

Factor of Safety for initial failure circle approximation: 1.39

4584 Successful analyses from a total of 5625 trial surfaces

1041 Analyses were terminated due to unacceptable geometry

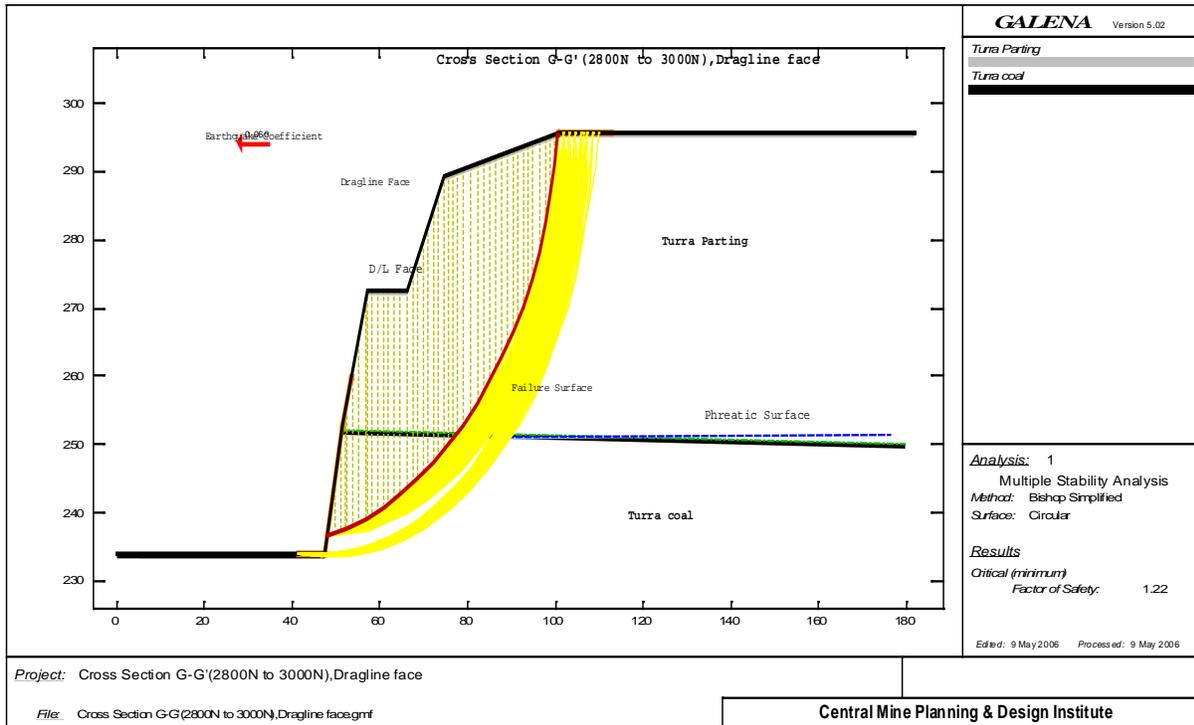
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(e) Cross Section G-G'(-2800N to -3000N), Dragline Face: Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

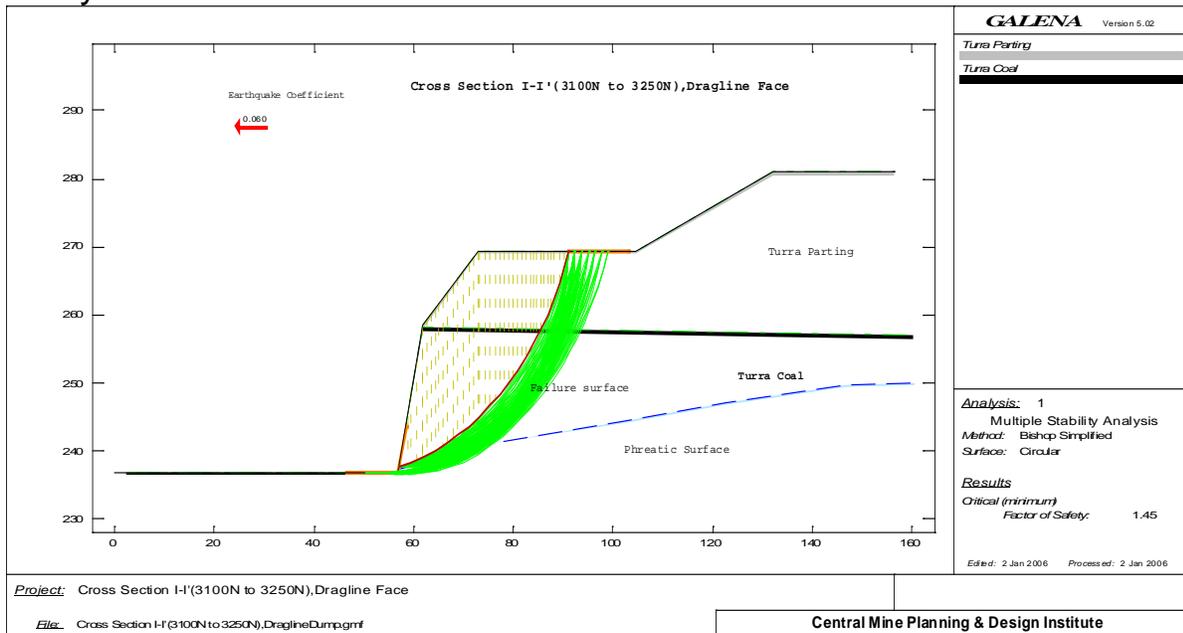
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	33.37	302.52	48.17	100.50	67.50	1.219
2	34.63	301.40	48.17	100.50	66.14	1.222
3	35.90	300.26	48.17	100.50	64.77	1.226
4	34.72	302.81	48.17	101.83	67.50	1.229
5	37.20	299.11	48.17	100.50	63.41	1.231
6	35.98	301.66	48.17	101.83	66.14	1.233
7	38.50	297.95	48.17	100.50	62.05	1.236
8	37.25	300.51	48.17	101.83	64.77	1.238
9	36.08	303.07	48.17	103.17	67.50	1.240
10	39.83	296.77	48.17	100.50	60.68	1.241

Analyses  
Factor of Safety for initial failure circle approximation: 1.27

890 Successful analyses from a total of 1201 trial surfaces  
311 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result  
More information on terminated/failed analyses is provided in the Session Log

Print Close

(f) Cross Section I-I'(-3100N to -3250N), Dragline Face:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	45.81	283.86	57.17	91.05	47.50	1.449
2	46.88	282.72	57.17	91.05	46.14	1.454
3	47.96	281.56	57.17	91.05	44.77	1.461
4	49.05	280.39	57.17	91.05	43.41	1.468
5	47.25	284.20	57.17	92.38	47.50	1.472
6	50.16	279.20	57.17	91.05	42.05	1.477
7	48.30	283.02	57.17	92.38	46.14	1.478
8	49.37	281.83	57.17	92.38	44.77	1.485
9	51.29	278.00	57.17	91.05	40.68	1.487
10	50.45	280.63	57.17	92.38	43.41	1.494

Analyses

Factor of Safety for initial failure circle approximation: 1.70

938 Successful analyses from a total of 1201 trial surfaces

263 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

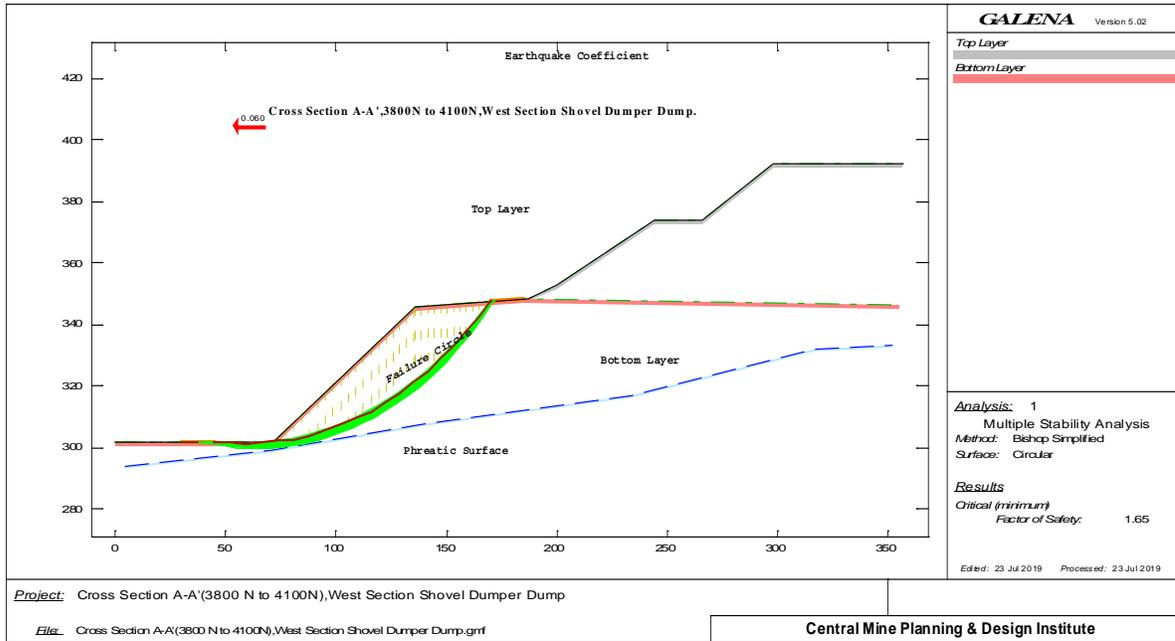
Print

Close

5.4) Data Analysis and results of the Shovel Dumper Dumps:

(a) Cross Section A-A'(-3800N to -4100N),Shovel Dumper Dump:

Analysiss-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	58.95	456.87	44.85	169.80	155.71	1.649
2	59.49	455.39	44.85	169.80	154.29	1.649
3	58.41	458.36	44.85	169.80	157.14	1.649
4	60.04	453.90	44.85	169.80	152.86	1.649
5	60.58	452.41	44.85	169.80	151.43	1.649
6	61.13	450.91	44.85	169.80	150.00	1.649
7	61.68	449.42	44.85	169.80	148.57	1.650
8	62.23	447.91	44.85	169.80	147.14	1.650
9	62.78	446.41	44.85	169.80	145.71	1.651
10	63.33	444.90	44.85	169.80	144.29	1.651

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

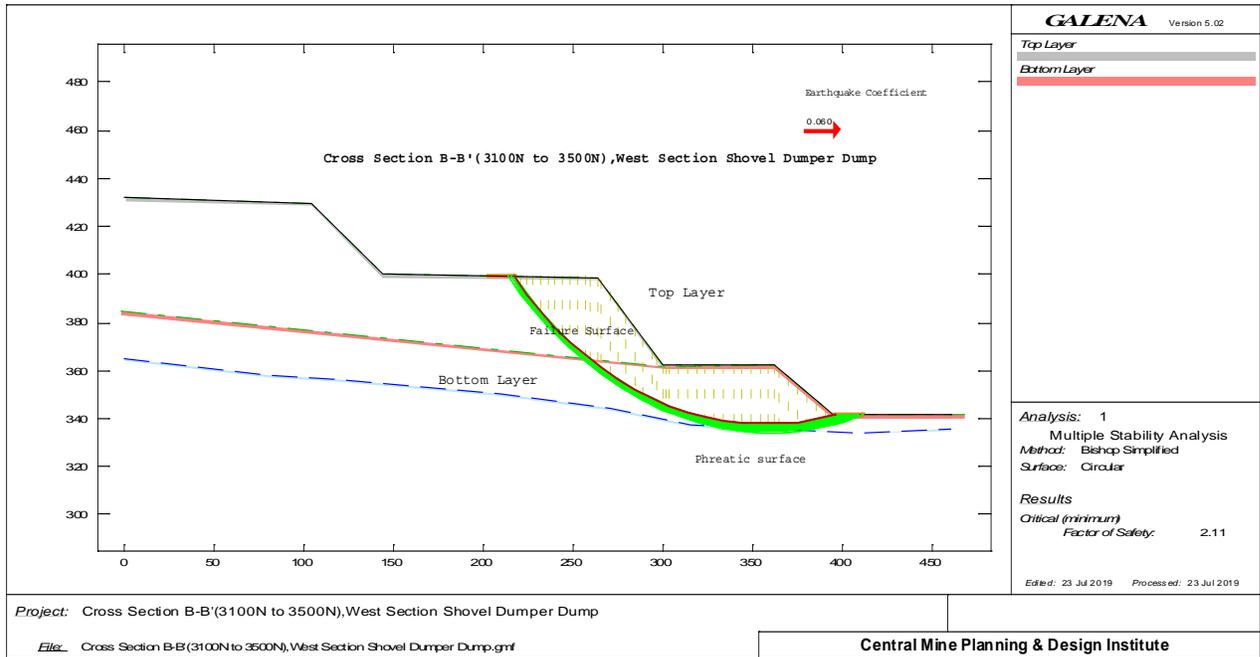
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Close

(b) Cross Section A-A' (-3100N to -3500N), Shovel Dumper Dump:  
 Analysiss-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	357.37	527.66	217.20	395.40	190.00	2.113
2	357.64	527.36	217.20	397.07	190.00	2.115
3	356.86	526.09	217.20	395.40	188.57	2.117
4	357.91	527.06	217.20	398.73	190.00	2.117
5	357.13	525.79	217.20	397.07	188.57	2.119
6	356.35	524.52	217.20	395.40	187.14	2.121
7	358.19	526.75	217.20	400.40	190.00	2.121
8	357.41	525.49	217.20	398.73	188.57	2.121
9	358.48	526.43	217.20	402.07	190.00	2.123
10	356.62	524.22	217.20	397.07	187.14	2.123

Analyses  
 Factor of Safety for initial failure circle approximation: 2.20

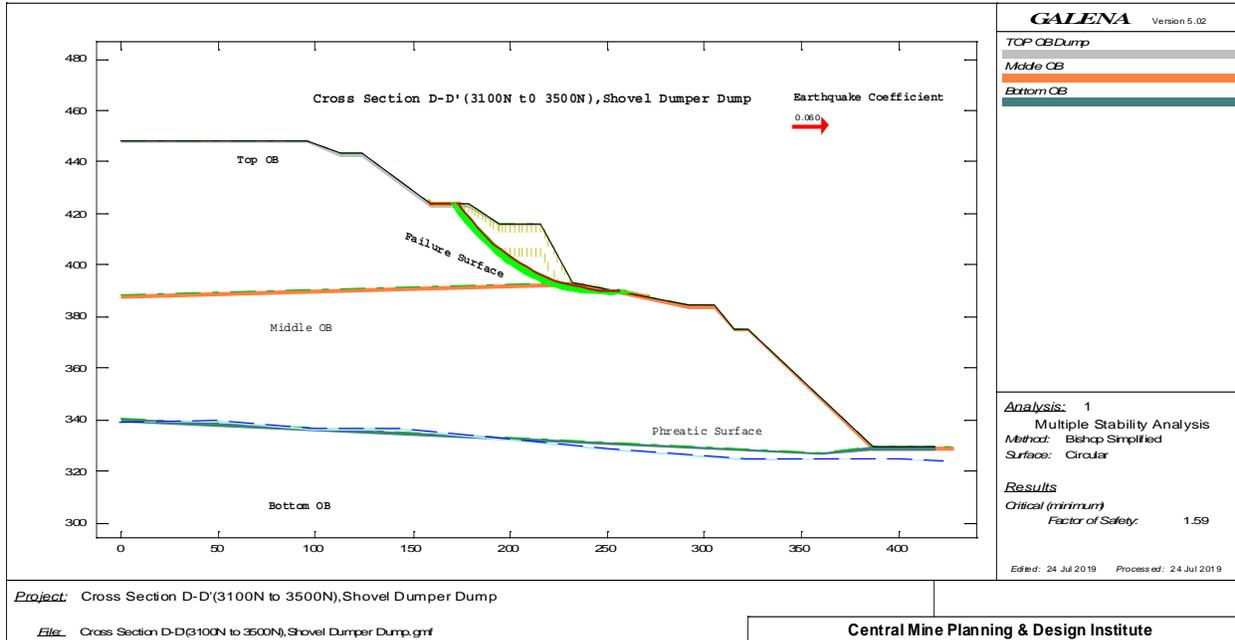
1501 Successful analyses from a total of 1501 trial surfaces  
 0 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

(C) Cross Section D-D' (-3100N to -3500N), Shovel Dumper Dump:

Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	252.43	500.25	173.15	255.55	110.00	1.590
2	251.84	498.80	173.15	255.55	108.57	1.590
3	250.65	495.90	173.15	255.55	105.71	1.592
4	251.25	497.35	173.15	255.55	107.14	1.592
5	250.05	494.44	173.15	255.55	104.29	1.592
6	249.46	492.97	173.15	255.55	102.86	1.593
7	248.85	491.50	173.15	255.55	101.43	1.595
8	248.25	490.03	173.15	255.55	100.00	1.597
9	247.65	488.55	173.15	255.55	98.57	1.599
10	252.72	499.95	173.15	257.22	110.00	1.600

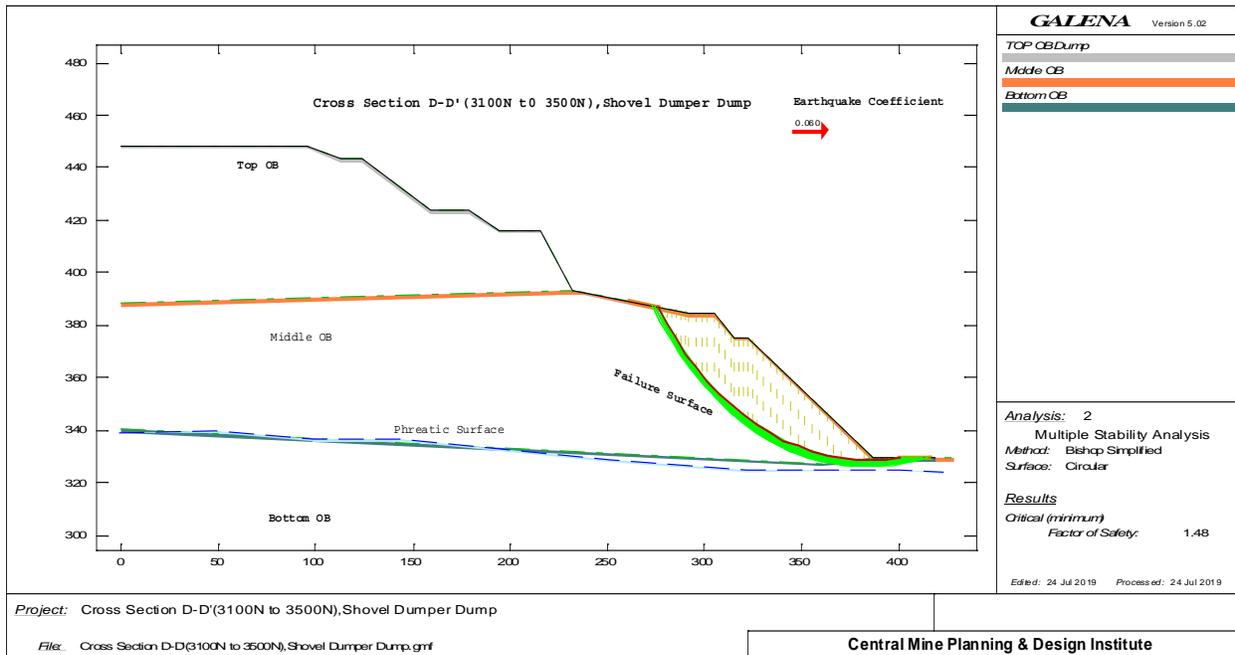
Analyses  
Factor of Safety for initial failure circle approximation: 1.76

1501 Successful analyses from a total of 1501 trial surfaces  
0 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

Analysiss-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	384.73	458.74	276.20	400.50	130.00	1.479
2	384.86	458.54	276.20	402.17	130.00	1.481
3	384.03	457.21	276.20	400.50	128.57	1.481
4	385.00	458.33	276.20	403.83	130.00	1.483
5	384.16	457.00	276.20	402.17	128.57	1.484
6	383.32	455.68	276.20	400.50	127.14	1.484
7	385.15	458.10	276.20	405.50	130.00	1.485
8	384.31	456.78	276.20	403.83	128.57	1.486
9	383.45	455.46	276.20	402.17	127.14	1.486
10	382.60	454.13	276.20	400.50	125.71	1.487

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

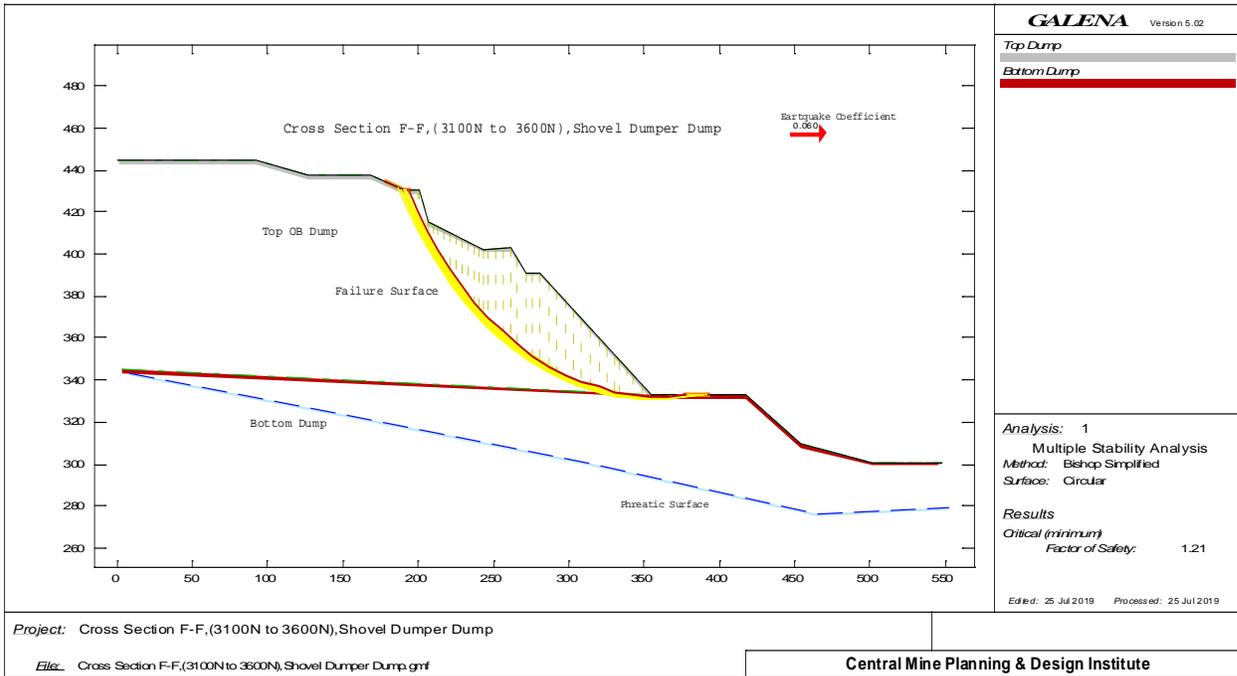
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Close

(d) Cross Section F-F'(-3100N to -3600N),Shovel Dumper Dump:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	360.04	522.30	193.80	377.45	190.00	1.215
2	360.12	522.15	193.80	379.12	190.00	1.217
3	359.24	520.79	193.80	377.45	188.57	1.218
4	358.46	522.15	192.13	377.45	190.00	1.219
5	360.22	521.98	193.80	380.78	190.00	1.220
6	359.33	520.63	193.80	379.12	188.57	1.220
7	358.44	519.27	193.80	377.45	187.14	1.221
8	358.55	521.98	192.13	379.12	190.00	1.222
9	357.66	520.63	192.13	377.45	188.57	1.222
10	360.31	521.81	193.80	382.45	190.00	1.223

Analyses

Factor of Safety for initial failure circle approximation: 1.29

1501 Successful analyses from a total of 1501 trial surfaces

0 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

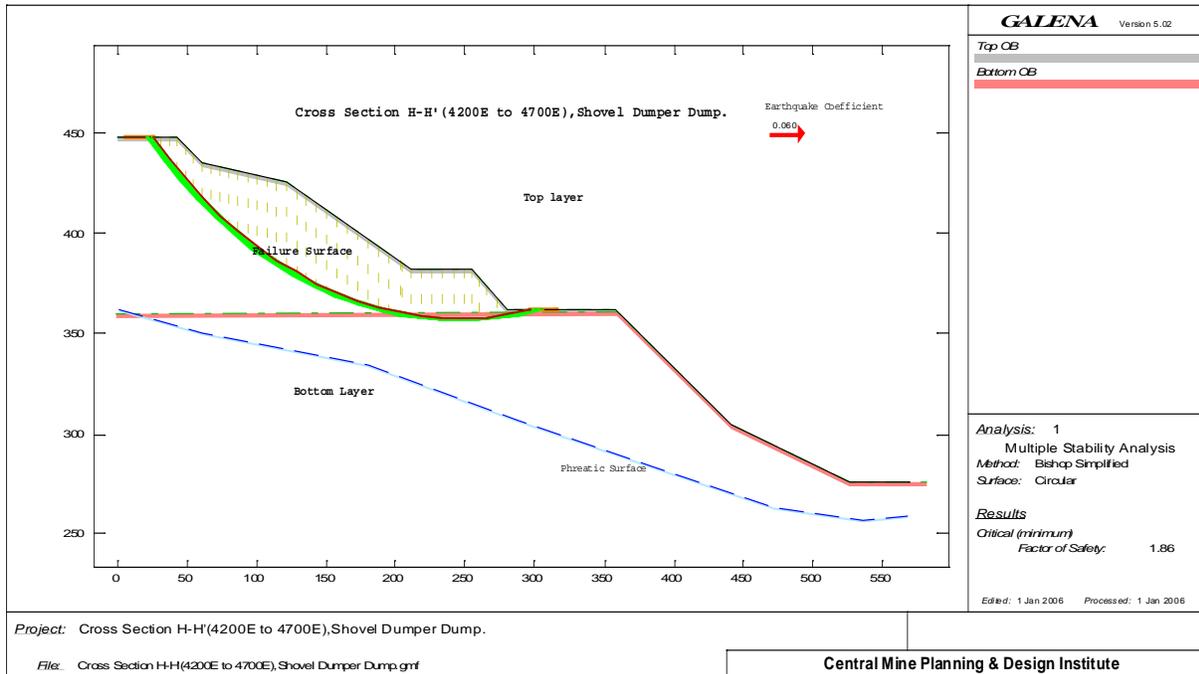
More information on terminated/failed analyses is provided in the Session Log

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(e) Cross Section H-H' (-4200E to -4700E), Shovel Dumper Dump:

Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	245.80	670.48	25.95	295.75	312.50	1.861
2	245.35	669.08	25.95	295.75	311.18	1.864
3	246.01	670.28	25.95	297.18	312.50	1.864
4	244.90	667.67	25.95	295.75	309.87	1.866
5	244.58	670.28	24.52	295.75	312.50	1.866
6	245.56	668.87	25.95	297.18	311.18	1.866
7	246.21	670.08	25.95	298.61	312.50	1.867
8	244.45	666.26	25.95	295.75	308.55	1.868
9	244.13	668.87	24.52	295.75	311.18	1.868
10	245.11	667.46	25.95	297.18	309.87	1.868

Analyses

Factor of Safety for initial failure circle approximation: 1.95

4501 Successful analyses from a total of 4501 trial surfaces

0 Analyses were terminated due to unacceptable geometry

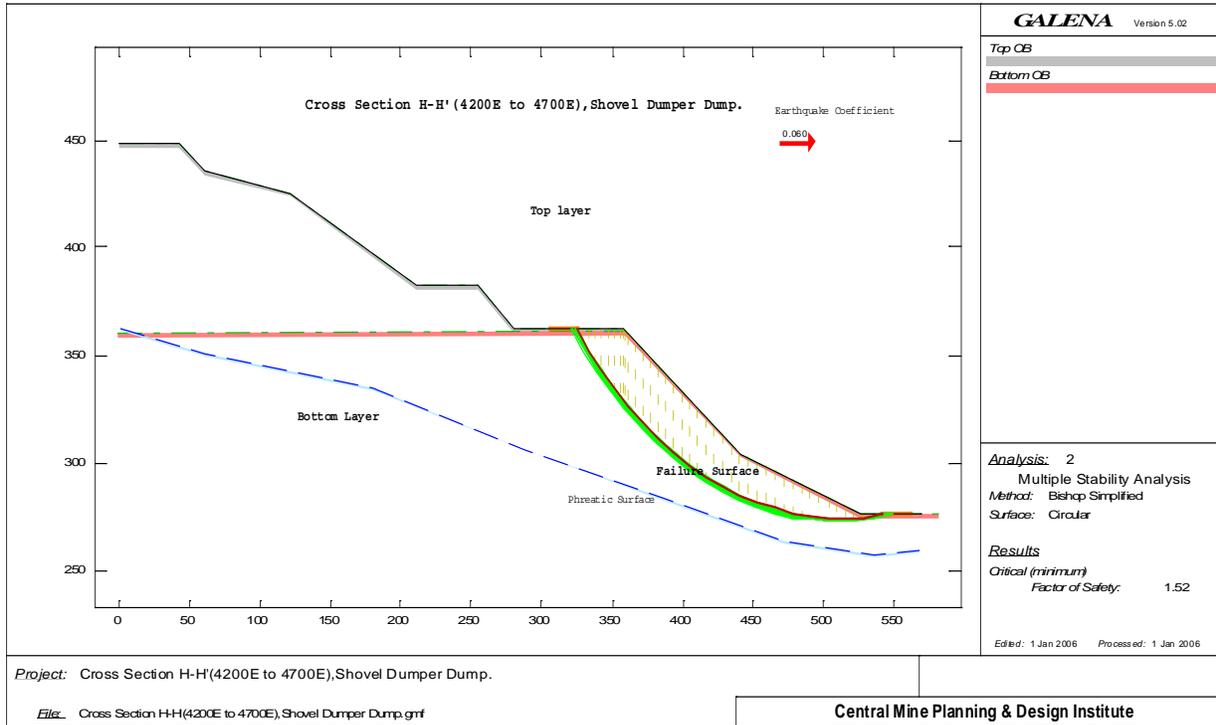
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	512.24	516.53	325.35	541.50	242.50	1.524
2	511.68	515.13	325.35	541.50	241.18	1.525
3	511.13	513.74	325.35	541.50	239.87	1.526
4	512.37	516.37	325.35	542.93	242.50	1.527
5	510.57	512.34	325.35	541.50	238.55	1.527
6	511.82	514.97	325.35	542.93	241.18	1.528
7	510.01	510.94	325.35	541.50	237.24	1.529
8	511.26	513.57	325.35	542.93	239.87	1.529
9	510.94	516.37	323.92	541.50	242.50	1.530
10	512.51	516.20	325.35	544.36	242.50	1.530

Analyses

Factor of Safety for initial failure circle approximation: 1.62

4501 Successful analyses from a total of 4501 trial surfaces

0 Analyses were terminated due to unacceptable geometry

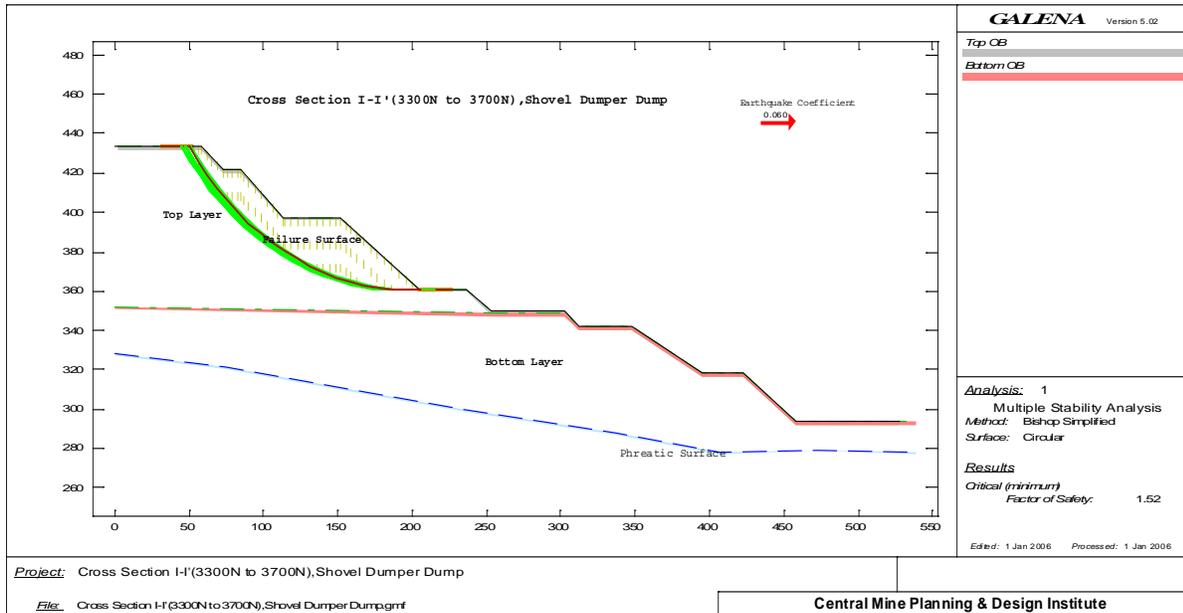
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(f) Cross Section I-I' (-3300N to -3700N), Shovel Dumper Dump:  
Analysis-1:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	195.51	543.45	49.92	205.00	182.50	1.524
2	194.13	543.38	48.49	205.00	182.50	1.524
3	196.88	543.52	51.35	205.00	182.50	1.525
4	195.56	543.38	49.92	206.43	182.50	1.525
5	194.20	543.29	48.49	206.43	182.50	1.525
6	192.77	543.29	47.06	205.00	182.50	1.526
7	194.88	542.10	49.92	205.00	181.18	1.526
8	196.93	543.45	51.35	206.43	182.50	1.526
9	193.51	542.02	48.49	205.00	181.18	1.526
10	196.25	542.17	51.35	205.00	181.18	1.526

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

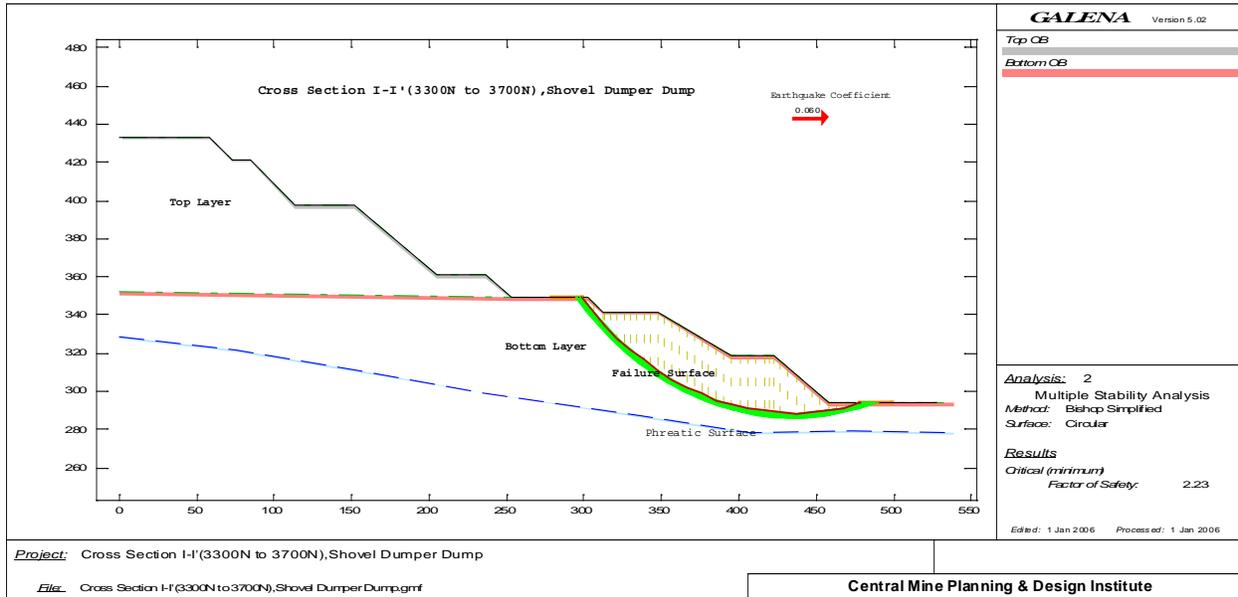
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result Of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	434.89	471.05	298.85	477.95	182.50	2.234
2	435.15	470.76	298.85	479.38	182.50	2.236
3	434.44	469.58	298.85	477.95	181.18	2.237
4	435.41	470.46	298.85	480.81	182.50	2.239
5	434.70	469.29	298.85	479.38	181.18	2.239
6	433.98	468.11	298.85	477.95	179.87	2.240
7	435.68	470.16	298.85	482.24	182.50	2.241
8	433.72	470.76	297.42	477.95	182.50	2.241
9	434.96	468.99	298.85	480.81	181.18	2.242
10	434.24	467.81	298.85	479.38	179.87	2.242

Analyses

Factor of Safety for initial failure circle approximation: 2.37

4501 Successful analyses from a total of 4501 trial surfaces

0 Analyses were terminated due to unacceptable geometry

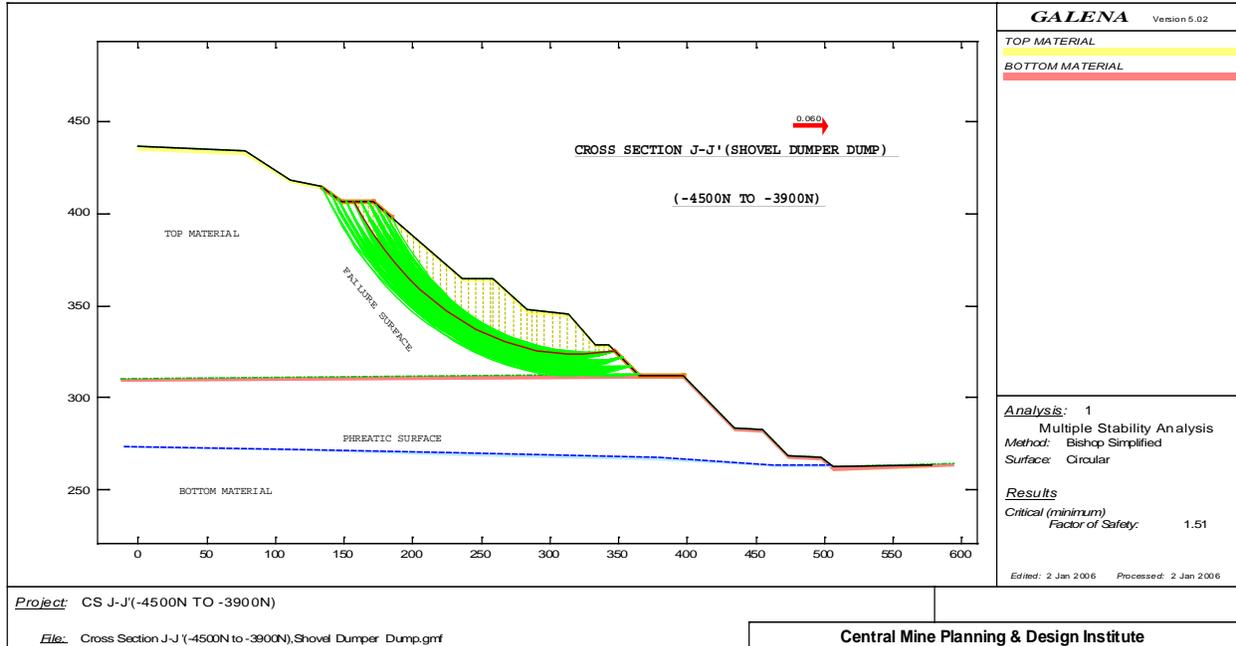
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Close

(g) Cross Section J-J' (-3900N to -4500N),Shovel Dumper Dump:  
Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

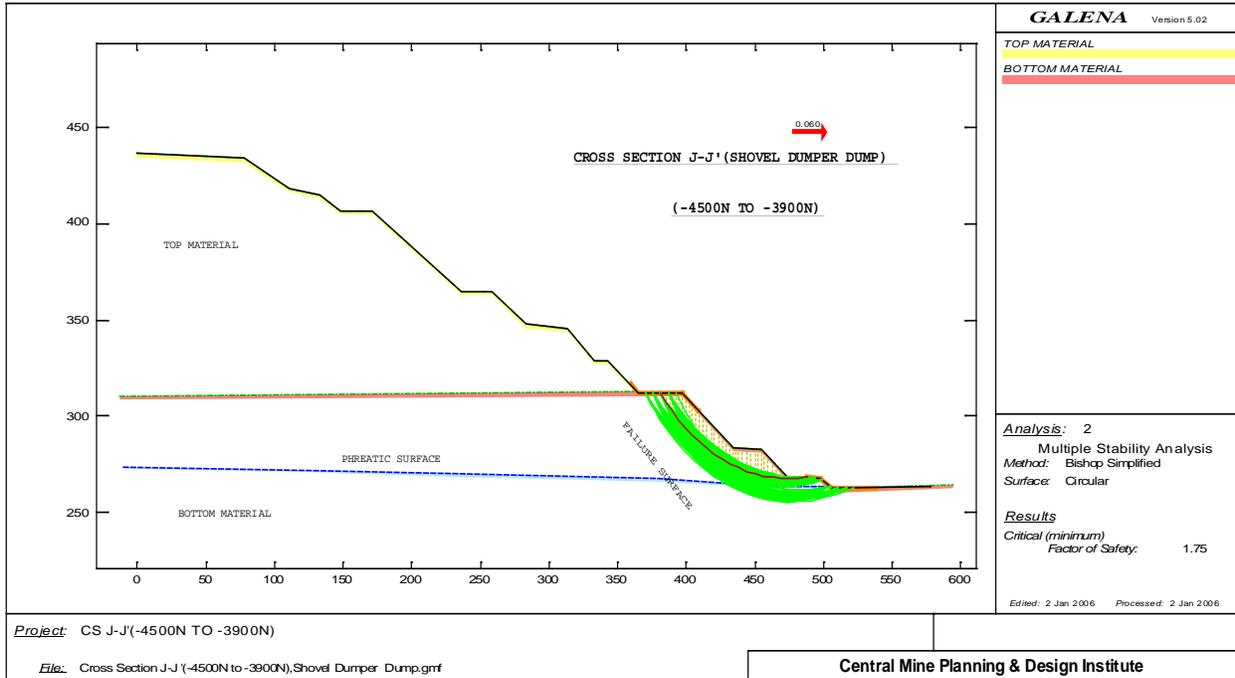
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	318.77	523.78	156.52	347.00	200.08	1.507
2	330.00	515.47	162.08	358.11	200.08	1.508
3	321.93	519.26	156.52	352.56	200.08	1.509
4	324.95	514.69	156.52	358.11	200.08	1.509
5	313.77	523.00	150.97	347.00	200.08	1.512
6	326.99	519.98	162.08	352.56	200.08	1.512
7	316.72	518.97	156.52	347.00	195.63	1.513
8	323.84	524.44	162.08	347.00	200.08	1.515
9	327.80	510.65	162.08	358.11	195.63	1.516
10	319.82	514.41	156.52	352.56	195.63	1.517

**Analyses**  
Factor of Safety for initial failure circle approximation: 1.71

1001 Successful analyses from a total of 1001 trial surfaces  
0 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result  
More information on terminated/failed analyses is provided in the Session Log

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Analysiss-2:



Result of the section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	474.83	389.01	381.27	487.65	121.18	1.745
2	476.73	393.67	381.27	487.65	125.62	1.745
3	478.61	398.28	381.27	487.65	130.07	1.747
4	472.90	384.31	381.27	487.65	116.72	1.747
5	470.96	379.55	381.27	487.65	112.28	1.751
6	473.47	397.82	375.72	487.65	130.07	1.758
7	468.98	374.72	381.27	487.65	107.83	1.758
8	471.64	393.12	375.72	487.65	125.62	1.761
9	469.80	388.37	375.72	487.65	121.18	1.765
10	473.99	375.47	386.83	487.65	107.83	1.765

Analyses

Factor of Safety for initial failure circle approximation 1.84

955 Successful analyses from a total of 1001 trial surfaces

46 Analyses were terminated due to unacceptable geometry

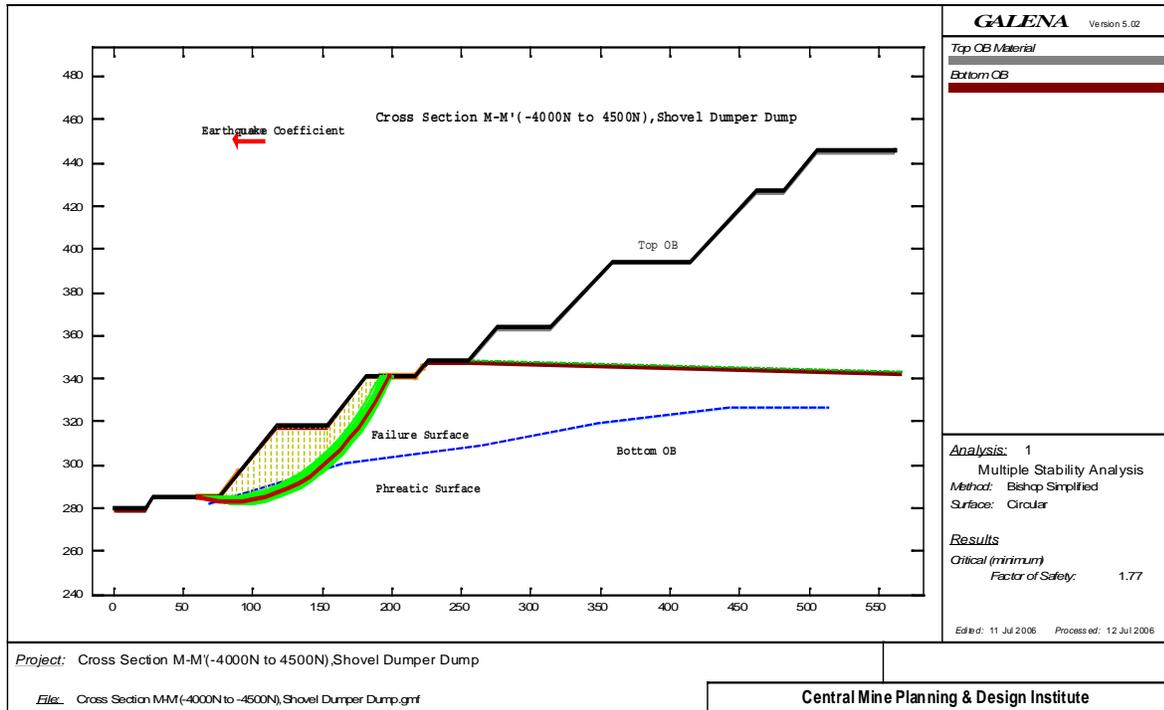
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print

Close

(h) Cross Section M-M' (-4000N to -4500N),Shovel Dumper Dump:  
Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	85.62	420.66	59.85	197.98	137.50	1.767
2	86.45	418.63	59.85	197.98	135.66	1.767
3	84.56	418.99	59.85	195.84	135.66	1.768
4	83.73	421.01	59.85	195.84	137.50	1.768
5	85.39	416.96	59.85	195.84	133.82	1.768
6	87.27	416.58	59.85	197.98	133.82	1.768
7	86.23	414.91	59.85	195.84	131.97	1.768
8	83.96	421.33	61.99	195.84	137.50	1.768
9	85.87	421.01	61.99	197.98	137.50	1.768
10	84.79	419.33	61.99	195.84	135.66	1.768

Analyses  
Factor of Safety for initial failure circle approximation: 1.85

4501 Successful analyses from a total of 4501 trial surfaces

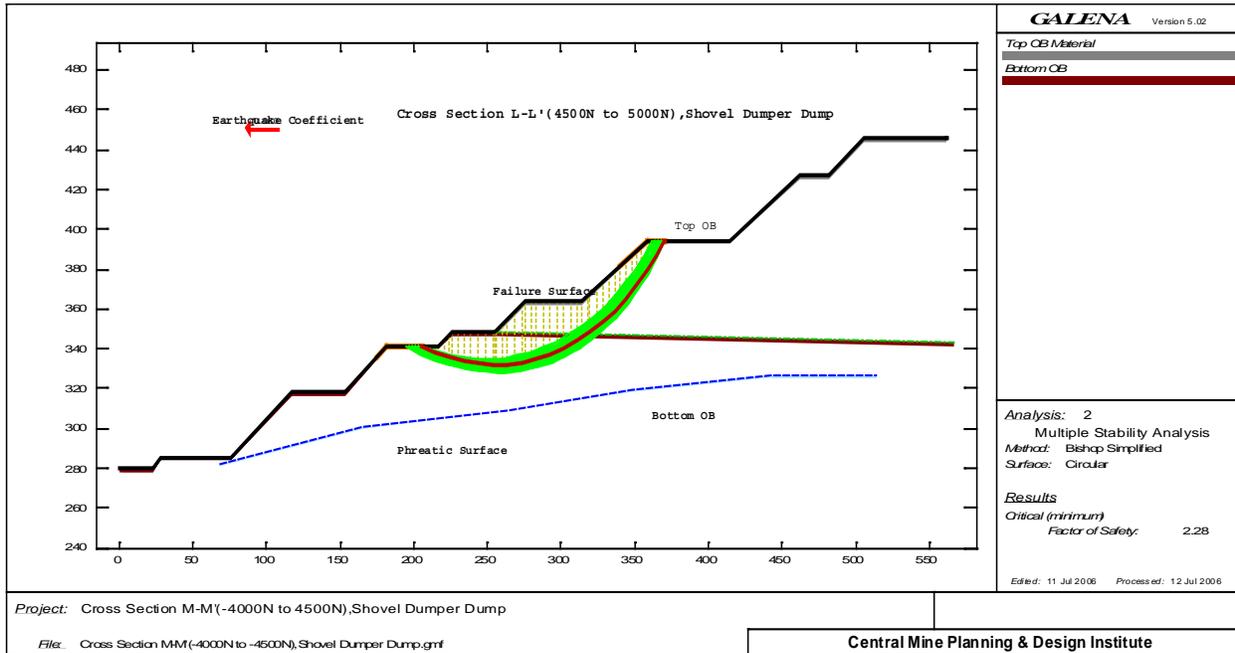
0 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

Analysis-2:



Result of the section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	255.05	469.70	205.60	370.30	137.50	2.284
2	255.79	467.43	205.60	370.30	135.66	2.296
3	253.34	470.35	205.60	368.16	137.50	2.296
4	254.62	469.03	203.46	370.30	137.50	2.302
5	254.07	468.10	205.60	368.16	135.66	2.307
6	256.53	465.15	205.60	370.30	133.82	2.310
7	252.91	469.70	203.46	368.16	137.50	2.314
8	255.35	466.74	203.46	370.30	135.66	2.314
9	251.61	470.97	205.60	366.01	137.50	2.317
10	254.82	465.84	205.60	368.16	133.82	2.319

Analyses  
Factor of Safety for initial failure circle approximation: 2.75

4501 Successful analyses from a total of 4501 trial surfaces

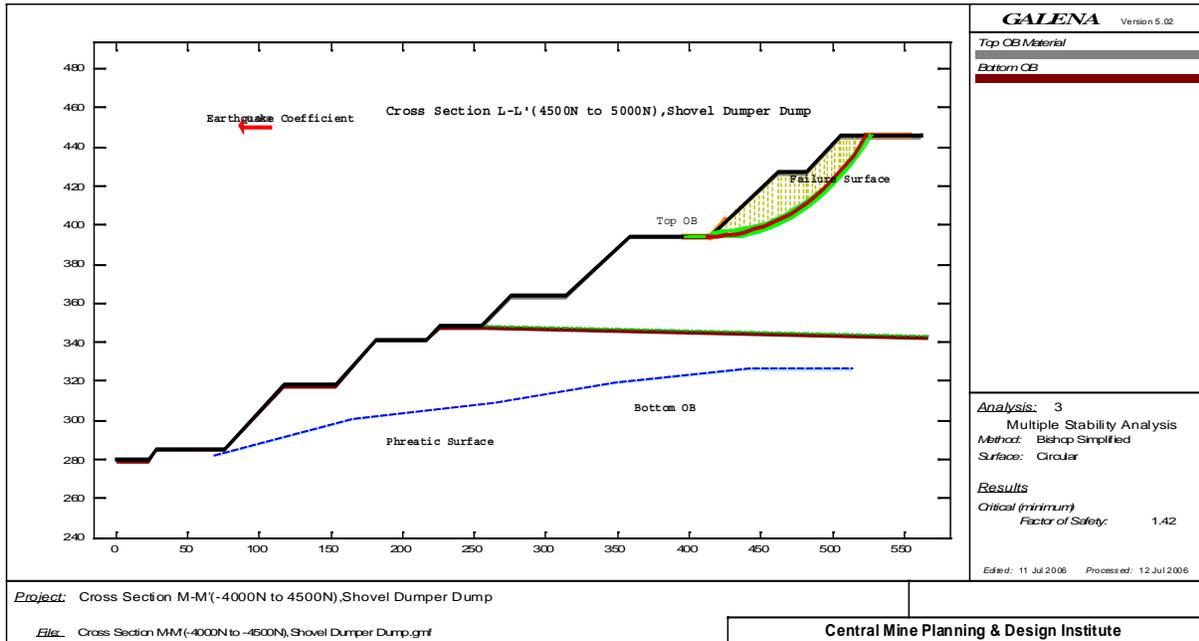
0 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

Analysis-3:



Result of the section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	416.50	532.14	412.49	523.35	137.50	1.420
2	416.88	532.61	414.64	523.35	137.50	1.421
3	417.36	530.27	412.49	523.35	135.66	1.423
4	417.75	530.75	414.64	523.35	135.66	1.424
5	416.44	532.07	410.35	523.35	137.50	1.424
6	418.22	528.39	412.49	523.35	133.82	1.425
7	417.29	530.18	410.35	523.35	135.66	1.426
8	418.61	528.89	414.64	523.35	133.82	1.426
9	416.35	531.96	408.21	523.35	137.50	1.428
10	419.09	526.51	412.49	523.35	131.97	1.428

Analyses  
Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

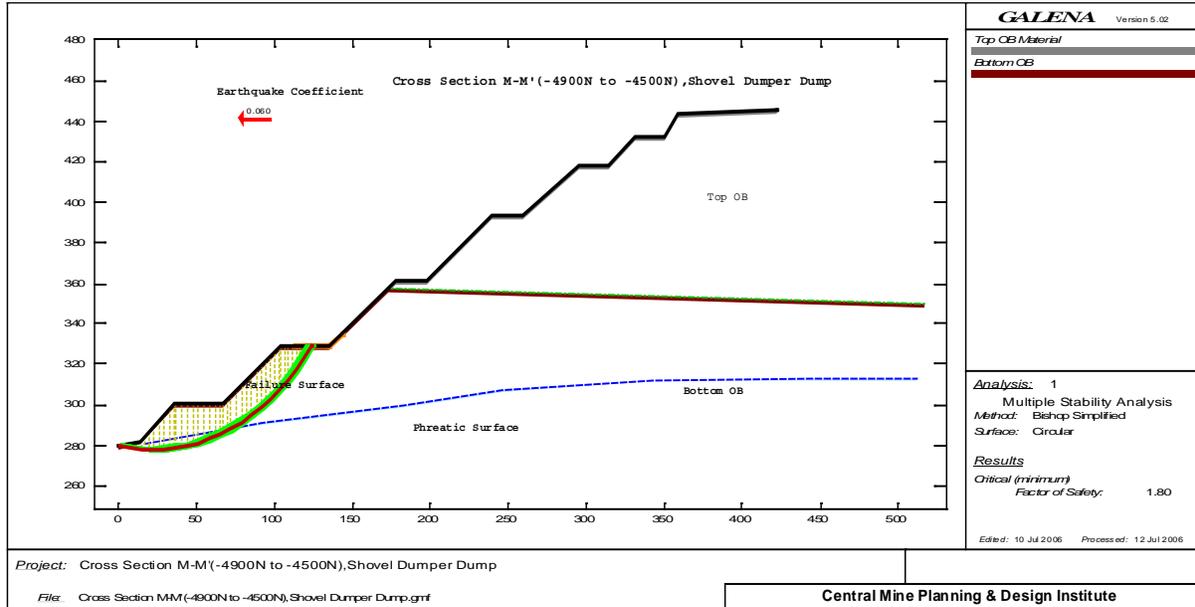
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print

Close

(I) Cross Section M-M' (-4900N to -4500N), Shovel Dumper Dump:  
Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	22.79	403.57	0.70	123.50	125.43	1.801
2	22.27	404.89	0.70	123.50	126.64	1.801
3	22.21	402.45	0.70	122.25	124.22	1.801
4	23.31	402.25	0.70	123.50	124.22	1.801
5	22.74	401.12	0.70	122.25	123.02	1.801
6	21.75	406.20	0.70	123.50	127.84	1.801
7	21.68	403.76	0.70	122.25	125.43	1.801
8	23.27	399.80	0.70	122.25	121.81	1.801
9	23.84	400.92	0.70	123.50	123.02	1.802
10	21.23	407.51	0.70	123.50	129.05	1.802

Analyses

Factor of Safety for initial failure circle approximation: 1.84

14251 Successful analyses from a total of 18751 trial surfaces

4500 Analyses were terminated due to unacceptable geometry

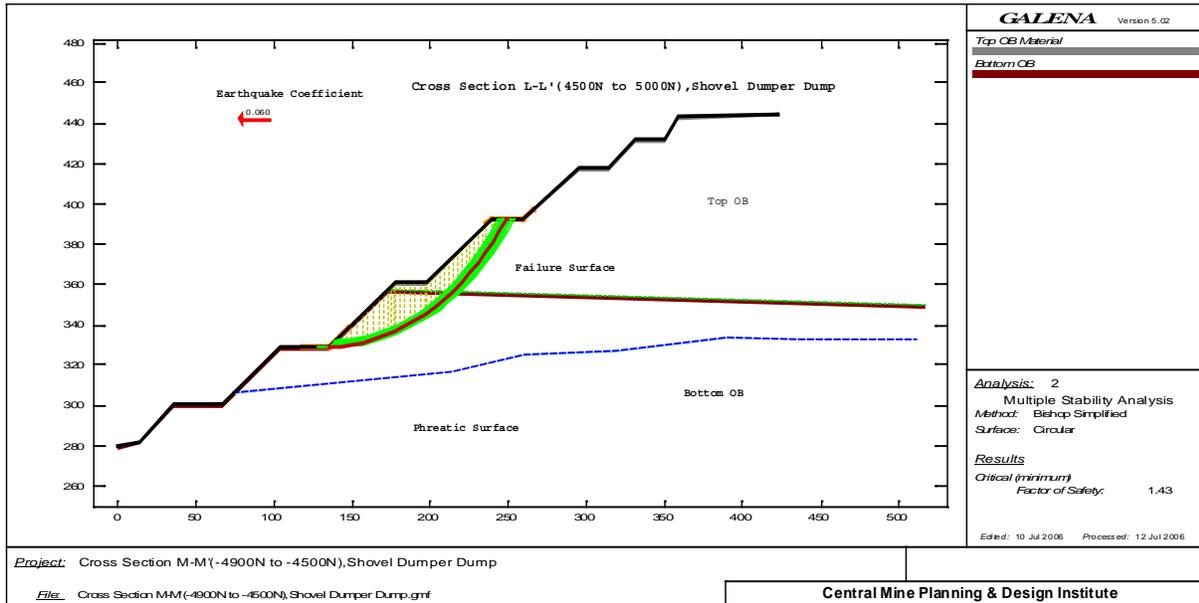
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Central Mine Planning & Design Institute

Result of the section:

Multiple Analysis Result Summary - Analysis 2

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	130.93	468.84	135.55	248.55	140.00	1.432
2	129.65	468.79	135.55	247.30	140.00	1.432
3	132.21	468.87	135.55	249.80	140.00	1.433
4	128.36	468.73	135.55	246.05	140.00	1.434
5	130.43	467.44	135.55	247.30	138.62	1.434
6	131.70	467.48	135.55	248.55	138.62	1.434
7	131.54	469.76	136.80	248.55	140.00	1.435
8	133.47	468.90	135.55	251.05	140.00	1.435
9	132.97	467.51	135.55	249.80	138.62	1.436
10	129.14	467.39	135.55	246.05	138.62	1.436

Analyses

Factor of Safety for initial failure circle approximation: 1.50

17262 Successful analyses from a total of 18751 trial surfaces

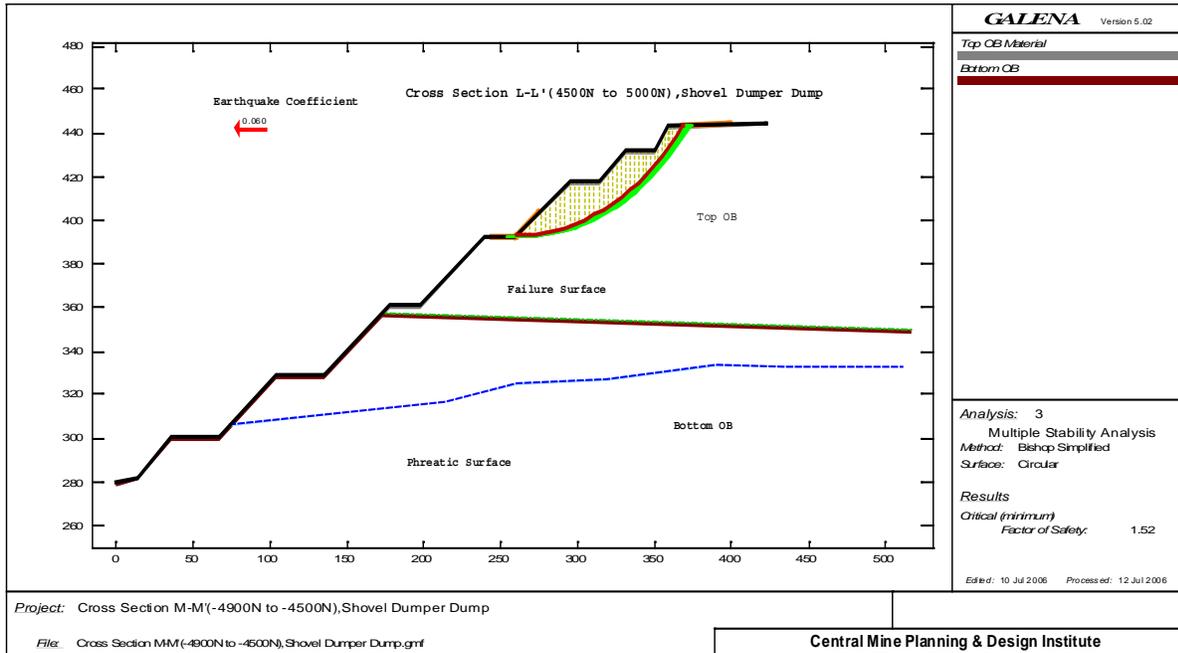
1489 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-3:



Result of the section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	260.42	533.04	259.60	368.30	140.00	1.516
2	261.64	533.03	259.60	369.55	140.00	1.516
3	261.07	531.65	259.60	368.30	138.62	1.517
4	262.28	531.64	259.60	369.55	138.62	1.518
5	262.85	533.00	259.60	370.80	140.00	1.518
6	262.15	531.47	258.35	369.55	138.62	1.518
7	262.71	532.83	258.35	370.80	140.00	1.518
8	261.72	530.27	259.60	368.30	137.24	1.518
9	262.93	530.24	259.60	369.55	137.24	1.519
10	261.48	532.83	257.10	369.55	140.00	1.519

Analyses

Factor of Safety for initial failure circle approximation: 1.64

18746 Successful analyses from a total of 18751 trial surfaces

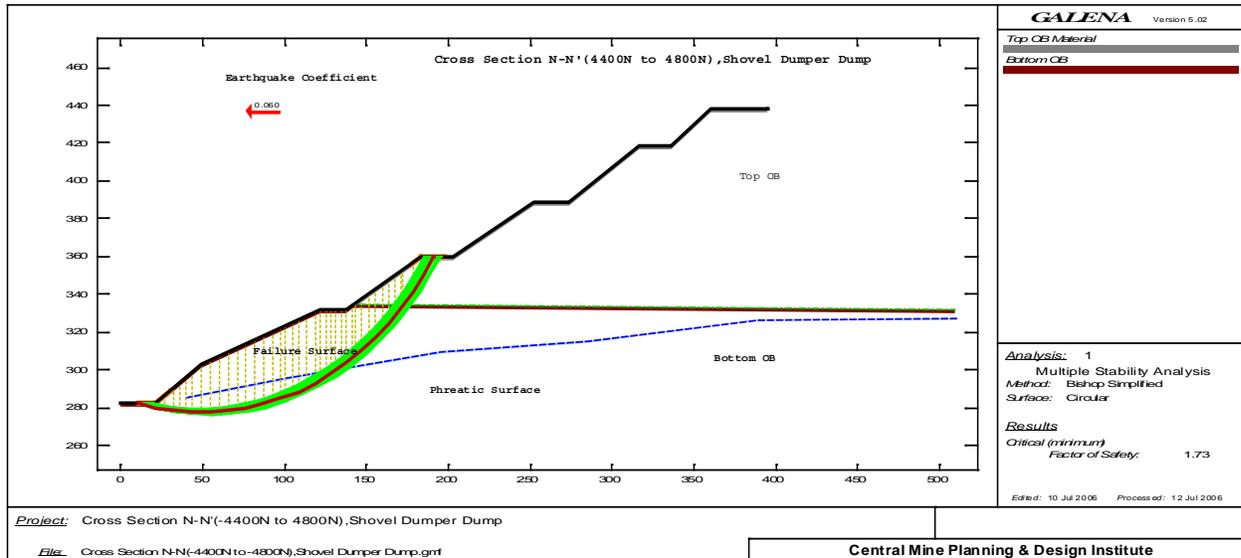
5 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(J)Cross Section N-N' (-4900N to -4500N), Shovel Dumper Dump:  
Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	49.07	439.82	10.35	190.56	162.50	1.729
2	47.81	440.12	10.35	189.13	162.50	1.729
3	49.24	440.12	11.78	190.56	162.50	1.730
4	47.98	440.42	11.78	189.13	162.50	1.730
5	48.14	440.70	13.21	189.13	162.50	1.730
6	50.32	439.51	10.35	191.99	162.50	1.730
7	46.55	440.42	10.35	187.70	162.50	1.731
8	46.71	440.70	11.78	187.70	162.50	1.731
9	50.50	439.82	11.78	191.99	162.50	1.731
10	49.41	440.42	13.21	190.56	162.50	1.731

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

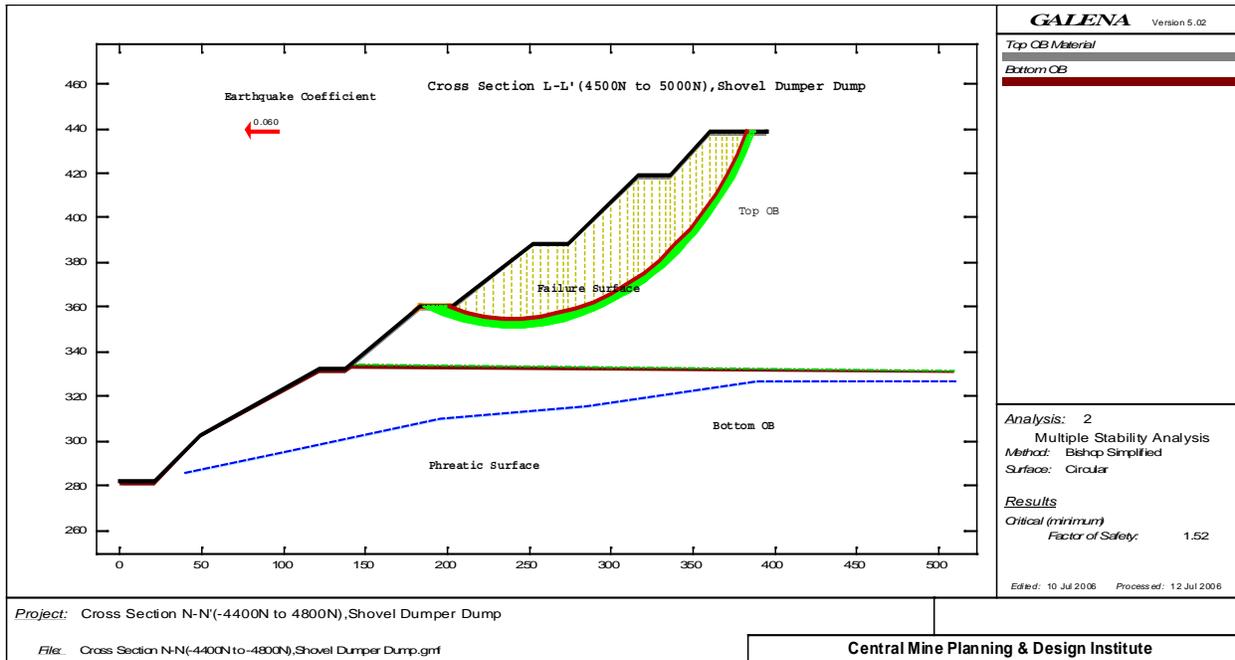
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Close

Analysis-2:



Result of the section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	241.19	517.25	200.60	383.05	162.50	1.521
2	241.00	516.92	199.17	383.05	162.50	1.523
3	240.82	516.59	197.74	383.05	162.50	1.525
4	241.84	515.72	200.60	383.05	161.18	1.527
5	240.63	516.24	196.31	383.05	162.50	1.527
6	241.66	515.38	199.17	383.05	161.18	1.528
7	240.43	515.89	194.89	383.05	162.50	1.530
8	242.43	516.92	200.60	384.48	162.50	1.530
9	241.47	515.04	197.74	383.05	161.18	1.530
10	242.50	514.18	200.60	383.05	159.87	1.532

Analyses

Factor of Safety for initial failure circle approximation: 1.69

2701 Successful analyses from a total of 4501 trial surfaces

1800 Analyses were terminated due to unacceptable geometry

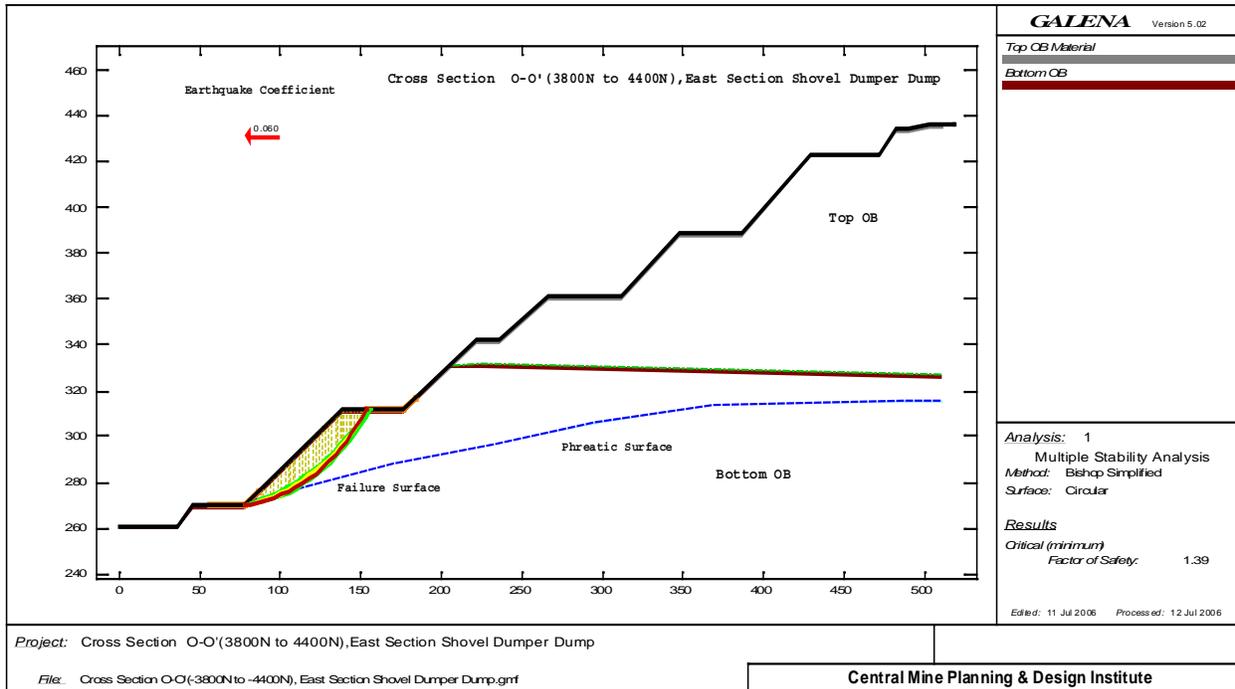
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(J)Cross Section O-O' (-3800N to -4000N), Shovel Dumper Dump:  
Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	69.00	375.80	77.30	153.80	106.12	1.395
2	69.63	374.63	77.30	153.80	104.91	1.395
3	68.36	376.95	77.30	153.80	107.33	1.395
4	70.27	373.47	77.30	153.80	103.71	1.395
5	67.72	378.11	77.30	153.80	108.53	1.395
6	70.91	372.30	77.30	153.80	102.50	1.395
7	67.09	379.27	77.30	153.80	109.74	1.395
8	66.46	380.42	77.30	153.80	110.95	1.395
9	65.83	381.57	77.30	153.80	112.16	1.395
10	65.20	382.71	77.30	153.80	113.36	1.395

Analyses

Factor of Safety for initial failure circle approximation: 1.56

14542 Successful analyses from a total of 18751 trial surfaces

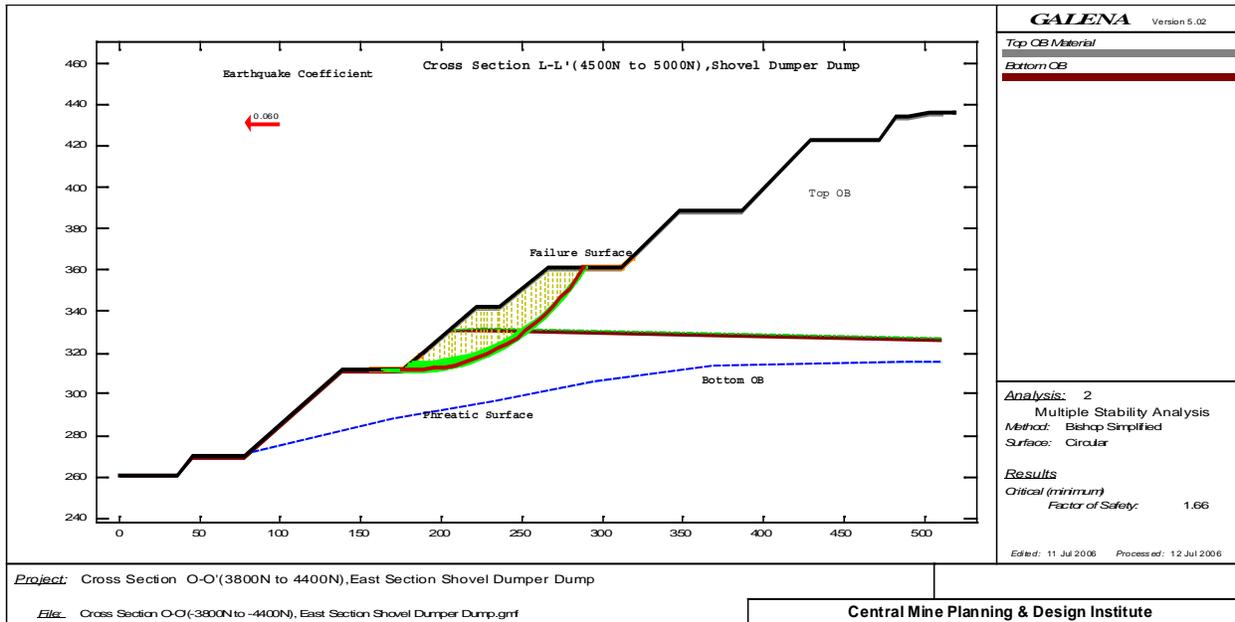
4209 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-2:



Result of the section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	183.01	449.29	175.40	288.50	137.50	1.663
2	183.25	449.58	176.65	288.50	137.50	1.664
3	182.95	449.22	174.15	288.50	137.50	1.666
4	183.54	448.05	175.40	288.50	136.29	1.666
5	183.79	448.34	176.65	288.50	136.29	1.667
6	182.88	449.14	172.90	288.50	137.50	1.668
7	183.48	447.97	174.15	288.50	136.29	1.669
8	183.98	450.44	177.90	288.50	137.50	1.669
9	182.80	449.05	171.65	288.50	137.50	1.670
10	184.08	446.81	175.40	288.50	135.09	1.670

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

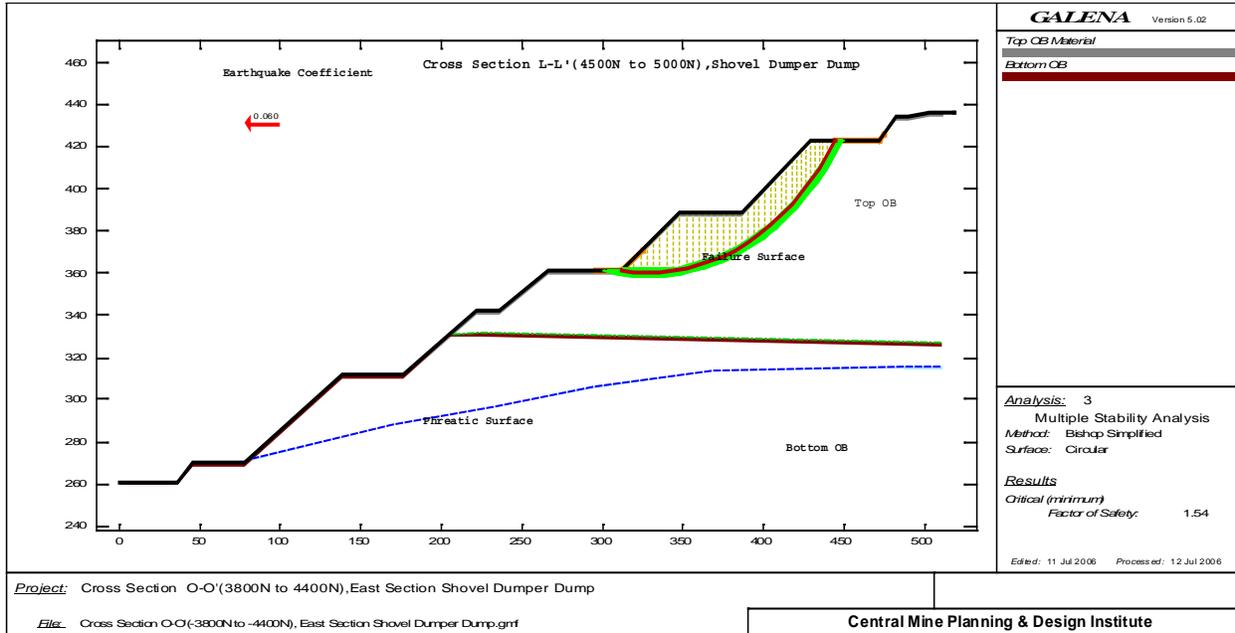
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Analysis-3:



Result of the section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	328.70	497.53	311.60	444.25	137.50	1.539
2	328.61	497.38	310.35	444.25	137.50	1.540
3	329.86	497.38	311.60	445.50	137.50	1.540
4	328.50	497.22	309.10	444.25	137.50	1.541
5	329.75	497.22	310.35	445.50	137.50	1.541
6	329.31	496.24	311.60	444.25	136.29	1.542
7	328.40	497.06	307.85	444.25	137.50	1.542
8	329.65	497.06	309.10	445.50	137.50	1.542
9	329.18	498.27	312.85	444.25	137.50	1.543
10	331.00	497.22	311.60	446.75	137.50	1.543

Analyses

Factor of Safety for initial failure circle approximation: 1.71

18751 Successful analyses from a total of 18751 trial surfaces

0 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

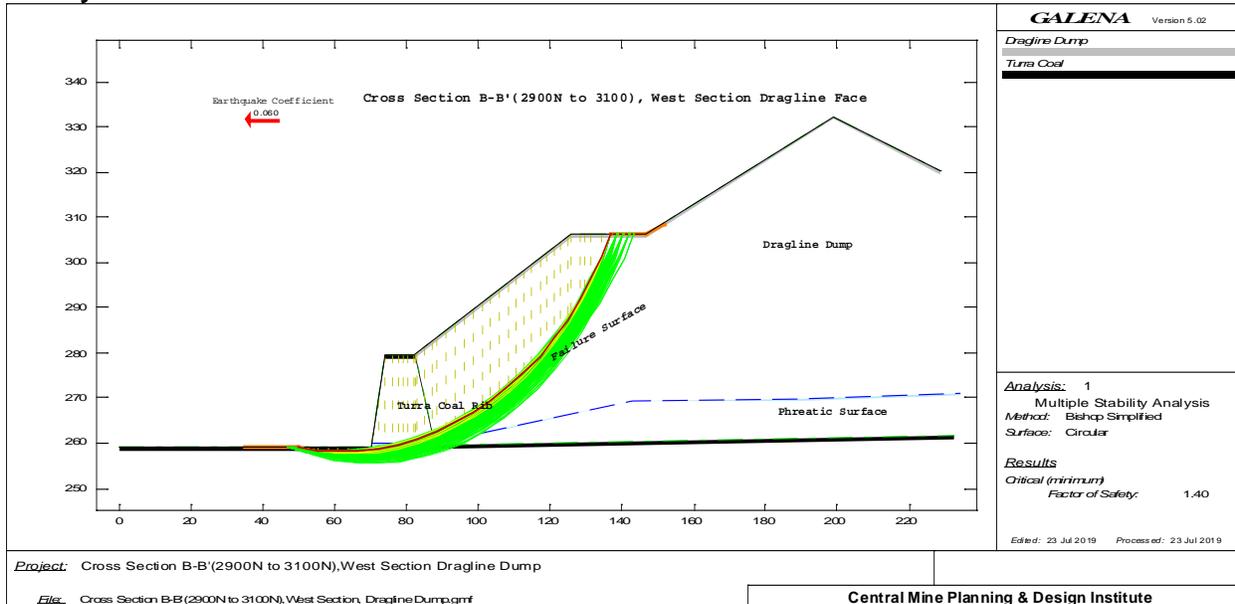
Print

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**5.5) Data Analysis and results of the Dragline Dumps:**

(a) Cross Section B-B'(2900N to 3100N), Dragline Dump:

Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	61.66	341.01	49.85	136.80	82.86	1.397
2	62.51	339.44	49.85	136.80	81.43	1.398
3	60.81	342.57	49.85	136.80	84.29	1.398
4	63.37	337.85	49.85	136.80	80.00	1.398
5	64.24	336.24	49.85	136.80	78.57	1.399
6	61.54	343.91	49.85	138.47	85.71	1.401
7	65.12	334.62	49.85	136.80	77.14	1.401
8	62.37	342.35	49.85	138.47	84.29	1.401
9	60.72	345.46	49.85	138.47	87.14	1.401
10	63.21	340.77	49.85	138.47	82.86	1.402

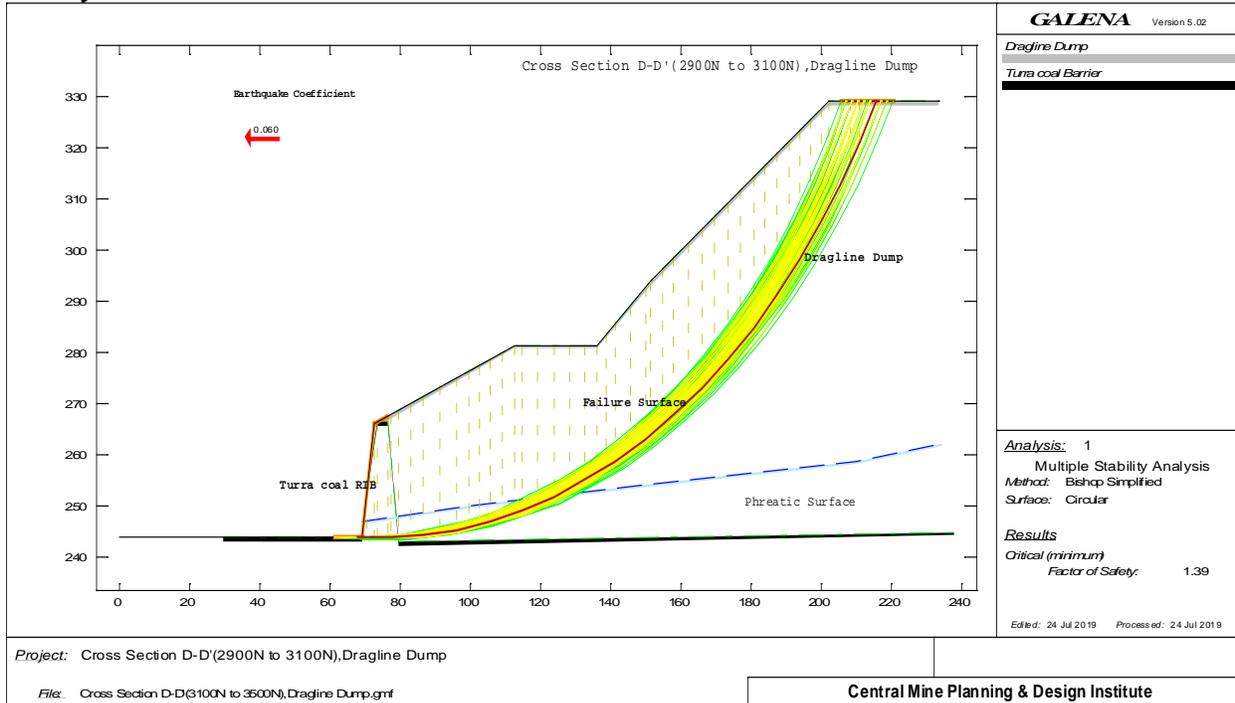
Analyses  
 Factor of Safety for initial failure circle approximation: 1.46

1488 Successful analyses from a total of 1501 trial surfaces  
 13 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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## (b) Cross Section D-D'(2900N to 3100N), Dragline Dump: Analysis-1:



## Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	73.90	403.89	67.92	215.45	160.00	1.388
2	72.23	403.89	66.25	213.78	160.00	1.388
3	73.59	401.68	67.92	213.78	157.78	1.388
4	73.28	399.46	67.92	212.12	155.56	1.389
5	71.92	401.68	66.25	212.12	157.78	1.389
6	70.57	403.89	64.58	212.12	160.00	1.390
7	72.99	397.25	67.92	210.45	153.33	1.392
8	71.62	399.46	66.25	210.45	155.56	1.392
9	70.25	401.68	64.58	210.45	157.78	1.392
10	73.86	403.82	66.25	215.45	160.00	1.392

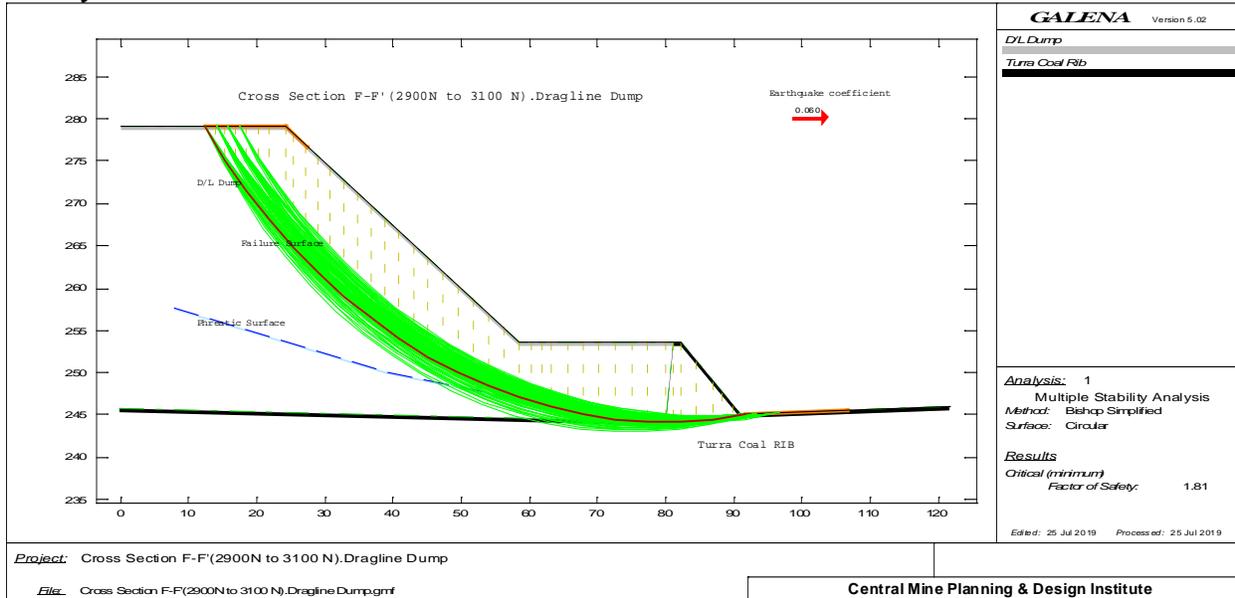
**Analyses**  
Factor of Safety for initial failure circle approximation: 1.40

943 Successful analyses from a total of 1001 trial surfaces  
58 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(c) Cross Section F-F'(2900N to 3100N), Dragline Dump: Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

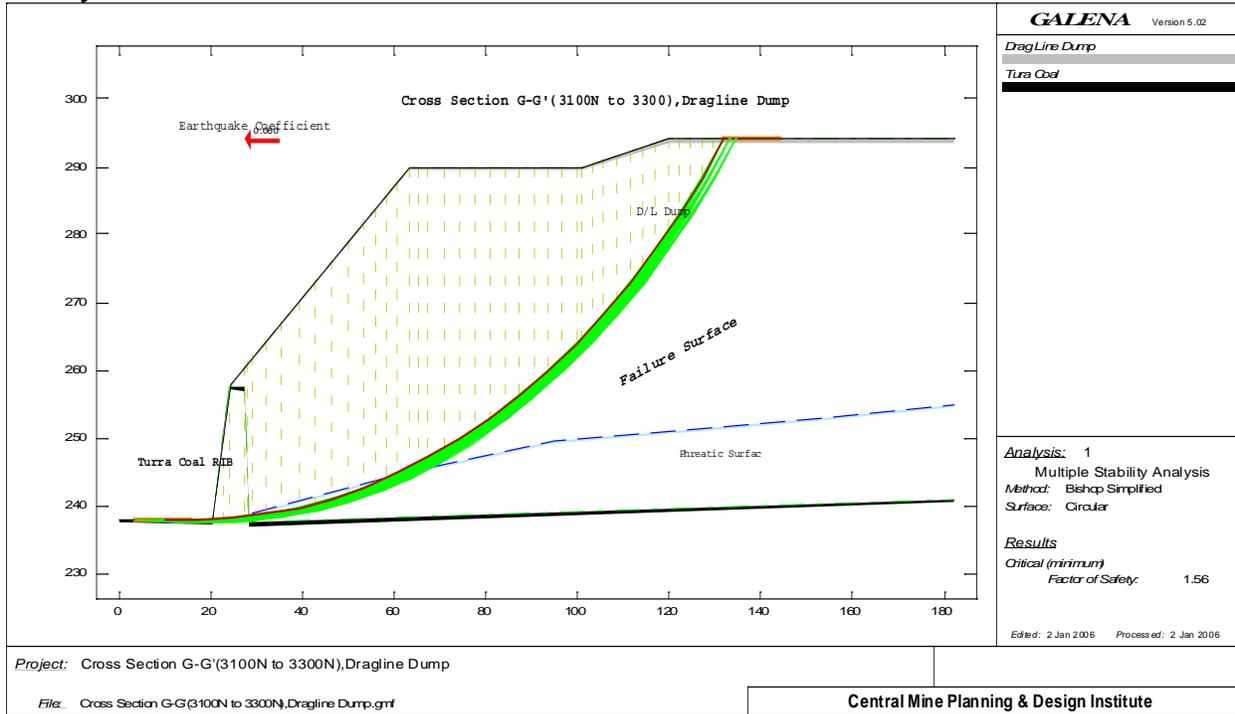
Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	79.95	327.06	12.45	91.60	82.86	1.809
2	80.60	328.59	12.45	91.60	84.29	1.811
3	81.26	330.11	12.45	91.60	85.71	1.813
4	81.91	331.62	12.45	91.60	87.14	1.815
5	82.56	333.13	12.45	91.60	88.57	1.816
6	83.20	334.63	12.45	91.60	90.00	1.817
7	80.13	324.20	14.12	91.60	80.00	1.823
8	80.80	325.73	14.12	91.60	81.43	1.826
9	81.47	327.26	14.12	91.60	82.86	1.828
10	82.14	328.78	14.12	91.60	84.29	1.830

Analyses  
 Factor of Safety for initial failure circle approximation: 2.14  
 1294 Successful analyses from a total of 1501 trial surfaces  
 207 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result  
 More information on terminated/failed analyses is provided in the Session Log

Print Close

## (d) Cross Section G-G'(3100N to 3300N), Dragline Dump: Analysis-1:



## Result of the Section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	16.01	385.38	9.97	131.80	147.50	1.555
2	16.73	384.08	12.63	131.80	146.14	1.557
3	16.69	384.04	11.30	131.80	146.14	1.558
4	16.65	383.98	9.97	131.80	146.14	1.559
5	17.38	382.69	12.63	131.80	144.77	1.561
6	17.34	382.65	11.30	131.80	144.77	1.562
7	15.97	385.32	8.63	131.80	147.50	1.563
8	18.06	381.35	13.97	131.80	143.41	1.564
9	18.03	381.31	12.63	131.80	143.41	1.565
10	17.29	382.59	9.97	131.80	144.77	1.566

Analyses

Factor of Safety for initial failure circle approximation: 1.68

1186 Successful analyses from a total of 1201 trial surfaces

15 Analyses were terminated due to unacceptable geometry

0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print

Close

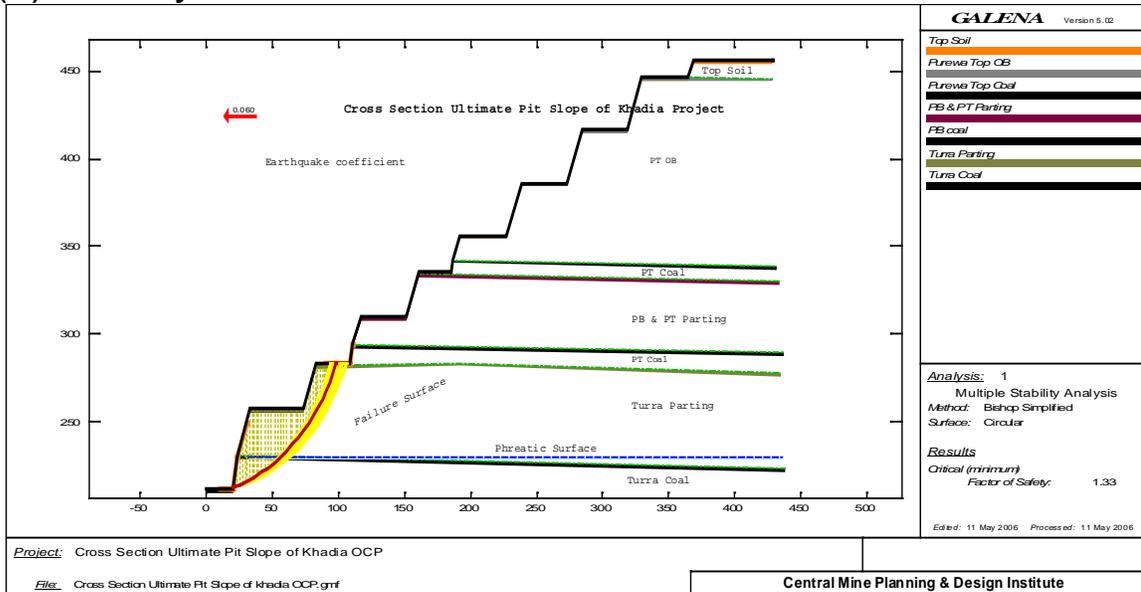
**(5.6) Table: The Summary of analysis results:**

SL No.	Cross Section & Location Khadia OCP	FoS (Min)
<b>A</b>	<b>Shovel Dumper Face (western,central and eastern Section):</b>	
a	CS C-C'(-2400N to -2800N),Shovel Dumper Face:	
	Analysis-1	1.96
	Analysis-2	1.76
b	CS E-E'(-2600N to -2900N),Shovel Dumper Face:	2.73
c	CS E-E'(-2400N to -2600N),Shovel Dumper Face:	1.55
d	CS G-G'(-2000N to -2600N),Shovel Dumper Face:	
	Analysis-1	1.90
	Analysis-2	1.51
e	CS I-I'(-2000N to -2600N),Shovel Dumper Face:	
	Analysis-1	2.30
	Analysis-2	2.26
f	CS K-K'(-3400N to -4100N),Shovel Dumper Face:	
	Analysis-1	1.75
	Analysis-2	2.52
	Analysis-3	2.62
g	CS L-L'(-3500N to -4000N),Shovel Dumper Face:	
	Analysis-1	1.32
	Analysis-2	2.90
	Analysis-3	2.34
<b>B</b>	<b>Dragline Face(western and central Section):</b>	
a	CS B-B'(-2900N to -3100N),Dragline Face:	1.70
b	CS C-C'(-2975N to -2800N),Dragline Face:	1.37
c	CS D-D'(-2975N to -2800N),Dragline Face:	1.20
d	CS E-E'(-2800N to -2900N),Dragline Face:	1.25
e	CS G-G'(-2800N to -3000N),Dragline Face:	1.22
f	CS I-I' (-3100N to -3250N),Dragline Face:	1.45
<b>C</b>	<b>Shovel Dumper Dump (western,central and Eastern Section):</b>	
a	CS A-A'(-3800N to -4100N),Shovel Dumper Dump:	1.65
b	CS A-A' (-3100N to -3500N), Shovel Dumper Dump:	2.11
c	CS D-D' (-3100N to -3500N),Shovel Dumper Dump:	
	Analysis-1	1.59
	Analysis-2	1.48
d	CS F-F'(-3100N to -3600N),Shovel Dumper Dump:	1.21
e	CS H-H' (4200E to 4700E), Shovel Dumper Dump:	
	Analysis-1	1.86

	Analysis-2	1.52
f	CS I-I' (-3300N to -3700N),Shovel Dumper Dump:	
	Analysis-1	1.52
	Analysis-2	2.23
g	CS J-J' (-3900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.77
	Analysis-2	1.75
h	CS M-M' (-4000N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.77
	Analysis-2	2.28
	Analysis-3	1.42
i	CS M-M' (-4900N to -4500N), Shovel Dumper Dump:	
	Analysis-1	1.80
	Analysis-2	1.43
	Analysis-3	1.52
j	CS N-N' (-4900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.73
	Analysis-2	1.52
k	CS O-O' (-4900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.40
	Analysis-2	1.66
	Analysis-3	1.54
<b>D</b>	<b>Dragline Dump(western and central Section):</b>	
a	CS B-B'(-2900N to -3100N),Dragline Dump:	1.40
b	CS D-D'(-2900N to -3100N),Dragline Dump:	1.39
c	CS F-F'(-2900N to -3100N),Dragline Dump:	1.81
d	CS G-G'(-3100N to -3300N),Dragline Dump:	1.55

(5.7) Cross Section of Ultimate Pit Slope:

(a) Analysis-1:



Result of the section:

**Multiple Analysis Result Summary - Analysis 1**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	-9.78	323.66	20.40	97.79	115.00	1.329
2	-8.19	324.08	20.40	99.22	115.00	1.330
3	-7.25	323.03	20.40	99.22	113.75	1.330
4	-6.31	321.98	20.40	99.22	112.50	1.331
5	-5.04	324.84	20.40	102.08	115.00	1.331
6	-8.83	322.62	20.40	97.79	113.75	1.331
7	-5.37	320.92	20.40	99.22	111.25	1.331
8	-4.11	323.77	20.40	102.08	113.75	1.332
9	-7.89	321.58	20.40	97.79	112.50	1.332
10	-4.42	319.86	20.40	99.22	110.00	1.332

Analyses

Factor of Safety for initial failure circle approximation: 1.34

1737 Successful analyses from a total of 5625 trial surfaces

3888 Analyses were terminated due to unacceptable geometry

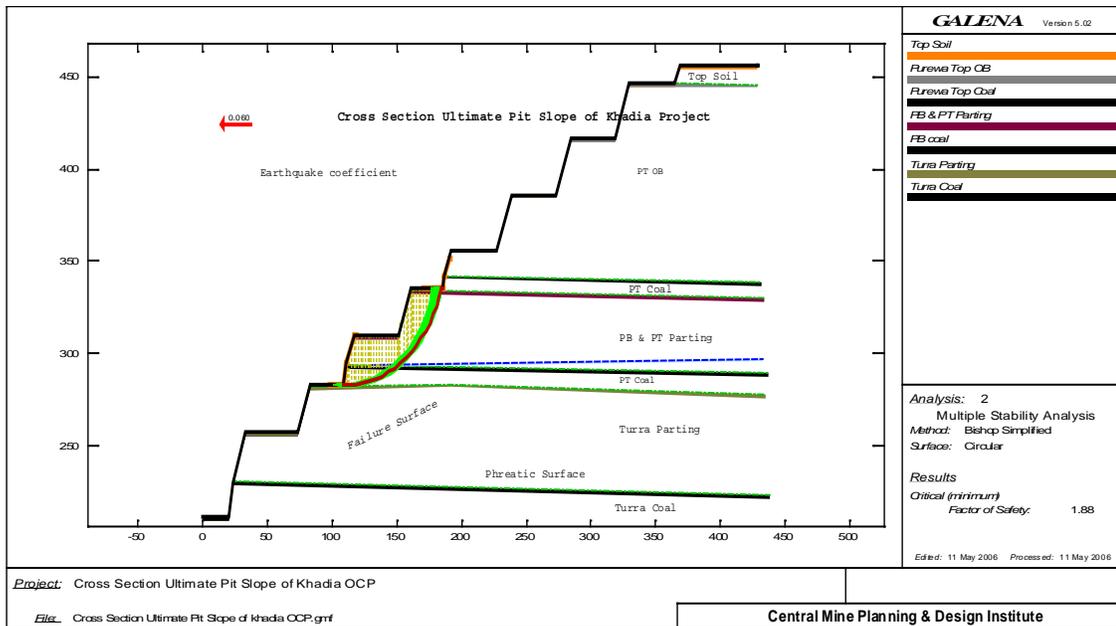
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(b)Analysis-2:



Result of the section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

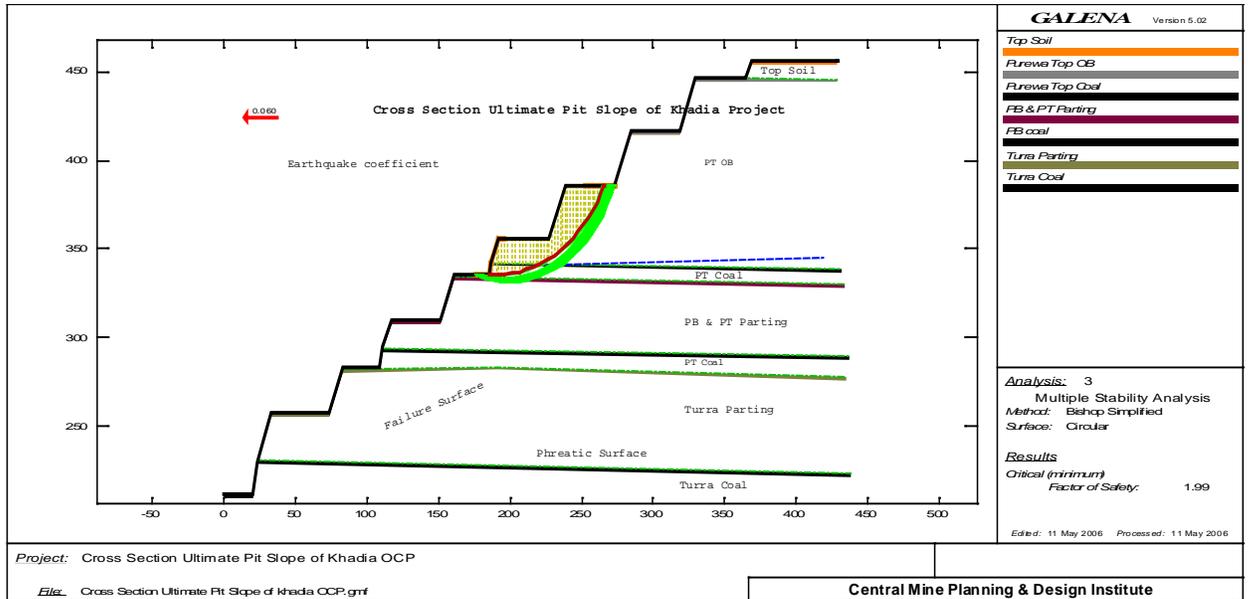
	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	111.43	360.44	108.30	184.64	77.50	1.876
2	110.90	359.21	108.30	183.21	76.25	1.877
3	109.68	362.95	106.87	184.64	80.00	1.878
4	111.79	357.92	108.30	183.21	75.00	1.883
5	112.31	359.14	108.30	184.64	76.25	1.884
6	110.54	361.66	106.87	184.64	78.75	1.885
7	111.29	356.69	108.30	181.78	73.75	1.885
8	110.00	360.44	106.87	183.21	77.50	1.886
9	109.47	359.21	106.87	181.78	76.25	1.887
10	108.81	364.18	105.44	184.64	81.25	1.889

Analyses  
 Factor of Safety for initial failure circle approximation: 1.91

2864 Successful analyses from a total of 5625 trial surfaces  
 2761 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result  
 More information on terminated/failed analyses is provided in the Session Log

Print Close

C. Analysis-3:



Result of the section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	188.25	418.69	185.20	265.36	83.75	1.986
2	196.35	410.86	175.20	271.07	78.75	1.987
3	196.85	412.02	175.20	272.50	80.00	1.987
4	195.85	409.70	175.20	269.64	77.50	1.987
5	188.85	419.92	185.20	266.79	85.00	1.987
6	196.68	408.16	175.20	269.64	76.25	1.987
7	197.16	409.32	175.20	271.07	77.50	1.987
8	195.54	412.37	175.20	271.07	80.00	1.988
9	197.65	410.48	175.20	272.50	78.75	1.988
10	195.04	411.21	175.20	269.64	78.75	1.988

Analyses

Factor of Safety for initial failure circle approximation: 2.06

4023 Successful analyses from a total of 5625 trial surfaces

1602 Analyses were terminated due to unacceptable geometry

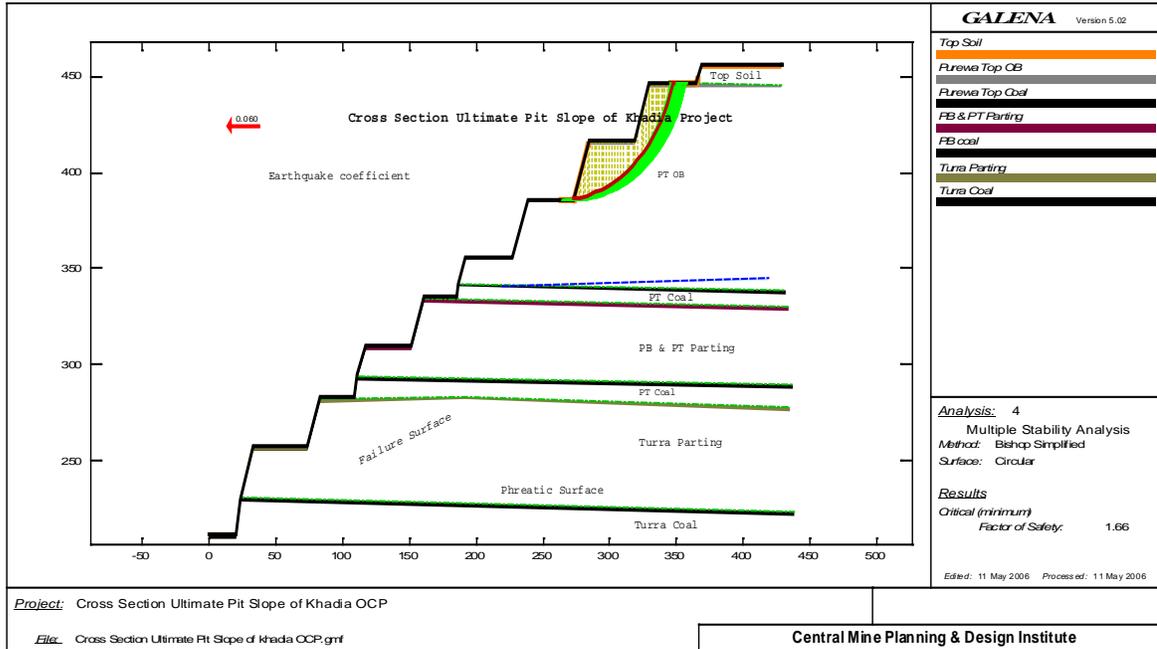
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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D.Analysis-4:



Result of the section:

Multiple Analysis Result Summary - Analysis 4

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	265.88	470.97	273.10	347.13	85.00	1.661
2	267.34	471.08	273.10	348.56	85.00	1.662
3	264.41	470.83	273.10	345.70	85.00	1.663
4	268.80	471.17	273.10	349.99	85.00	1.666
5	266.83	469.79	273.10	347.13	83.75	1.667
6	265.36	469.67	273.10	345.70	83.75	1.668
7	268.29	469.89	273.10	348.56	83.75	1.669
8	270.24	471.23	273.10	351.41	85.00	1.672
9	269.74	469.96	273.10	349.99	83.75	1.673
10	267.79	468.60	273.10	347.13	82.50	1.673

Analyses

Factor of Safety for initial failure circle approximation: 1.88

4950 Successful analyses from a total of 5625 trial surfaces

675 Analyses were terminated due to unacceptable geometry

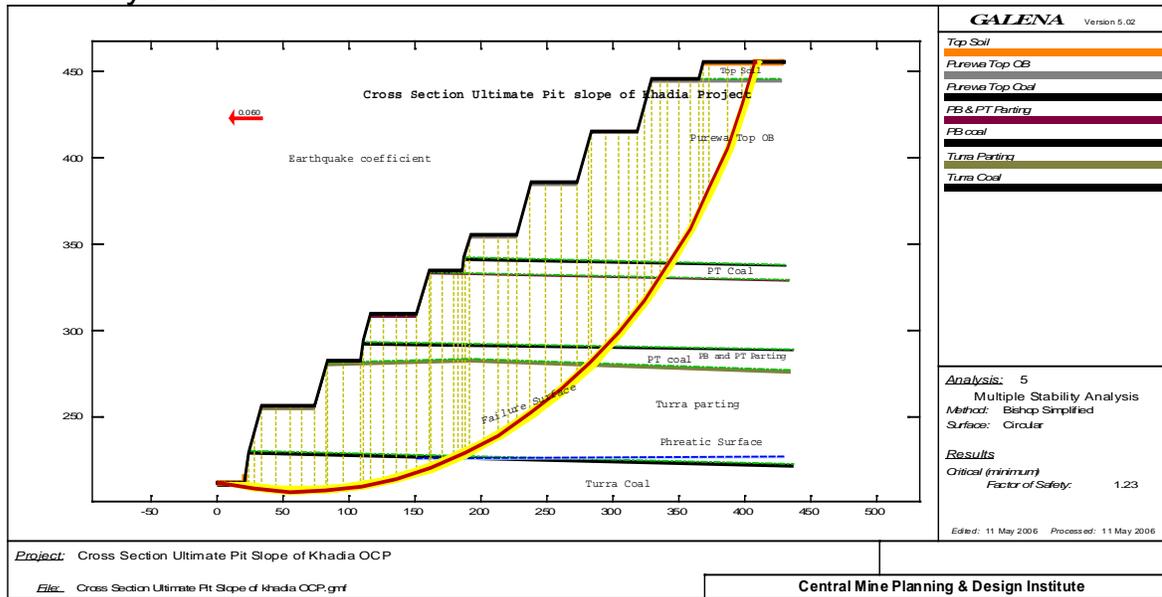
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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E.Analysis-5:



Result of the section:

**Multiple Analysis Result Summary - Analysis 5**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	61.59	571.90	0.80	407.70	365.00	1.234
2	61.67	572.13	2.23	407.70	365.00	1.234
3	62.44	570.49	0.80	407.70	363.75	1.234
4	61.74	572.35	3.66	407.70	365.00	1.235
5	62.51	570.72	2.23	407.70	363.75	1.235
6	61.81	572.56	5.09	407.70	365.00	1.235
7	63.29	569.07	0.80	407.70	362.50	1.235
8	62.94	571.67	0.80	409.13	365.00	1.235
9	62.59	570.94	3.66	407.70	363.75	1.236
10	64.99	566.23	0.80	407.70	360.00	1.236

**Analyses**  
 Factor of Safety for initial failure circle approximation: 1.26

5613 Successful analyses from a total of 5625 trial surfaces  
 12 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result

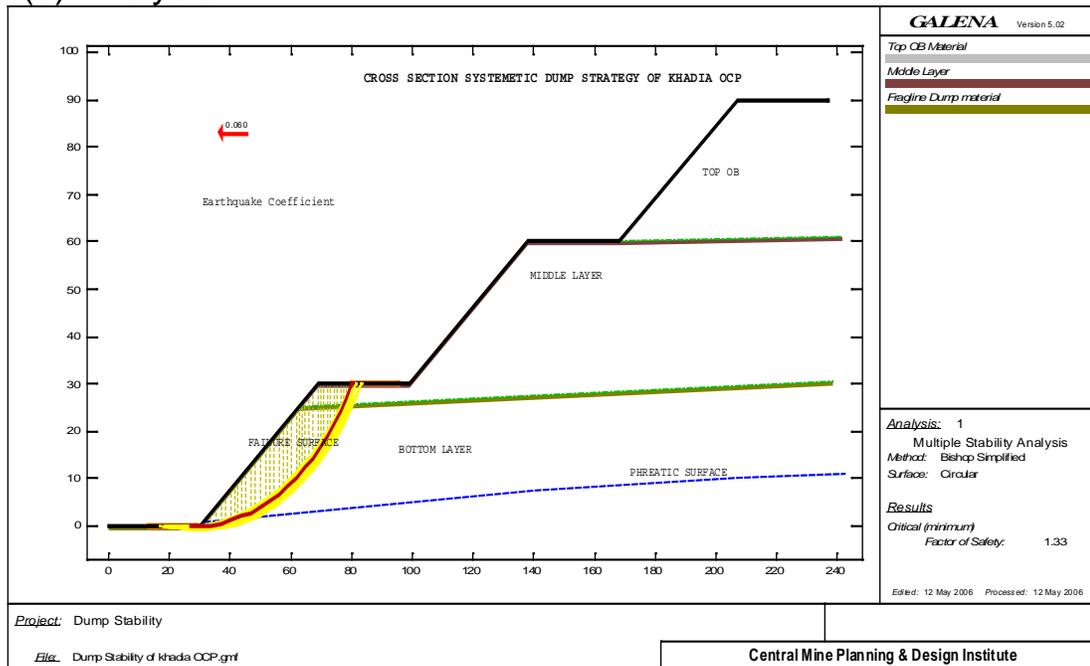
More information on terminated/failed analyses is provided in the Session Log

Print Close

## Result of the Ultimate Pit Slope Cross Section:

SL.NO	Section Name and Analysis	FOS
1	Cross Section of ultimate pit slope Cross Section.	
	Aalysis-1	1.33
	Aalysis-2	1.88
	Aalysis-3	1.99
	Aalysis-4	1.66
	Aalysis-5	1.23

(5.8) Cross Section Systemetic Dumping Strategy of Khadia OCP:  
 (a) Analysis-1:



Result of the Section:

Multiple Analysis Result Summary - Analysis 1

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	28.80	58.54	26.93	79.95	58.57	1.330
2	30.51	55.68	28.60	79.95	55.71	1.333
3	27.95	59.94	25.27	79.95	60.00	1.334
4	29.63	57.08	26.93	79.95	57.14	1.335
5	28.76	58.47	25.27	79.95	58.57	1.339
6	27.11	61.33	23.60	79.95	61.43	1.340
7	31.36	54.22	28.60	79.95	54.29	1.340
8	30.47	55.60	26.93	79.95	55.71	1.341
9	27.90	59.85	23.60	79.95	60.00	1.344
10	29.58	56.98	25.27	79.95	57.14	1.344

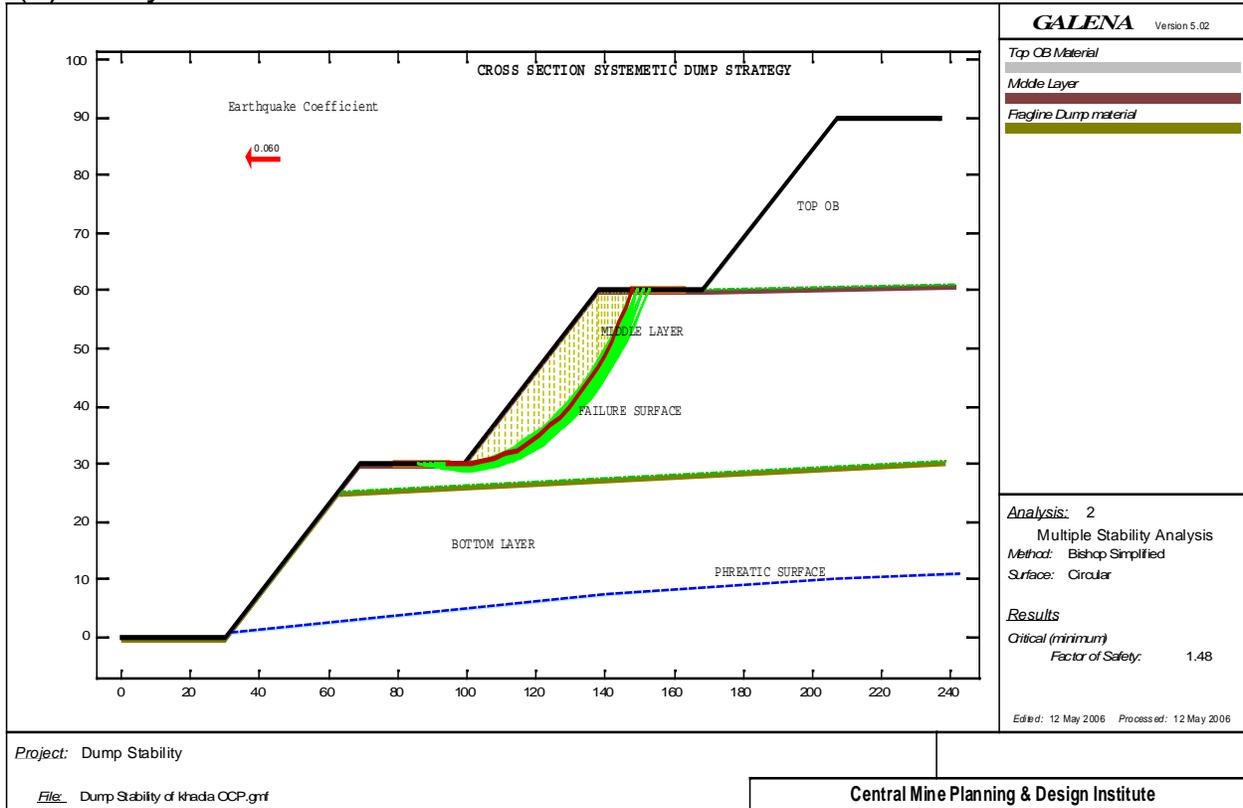
Analyses  
 Factor of Safety for initial failure circle approximation: 1.50

1401 Successful analyses from a total of 1501 trial surfaces  
 100 Analyses were terminated due to unacceptable geometry  
 0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(b) Analysis-2:



Result of the Section:

**Multiple Analysis Result Summary - Analysis 2**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	97.32	87.07	94.40	147.65	57.14	1.479
2	98.16	85.59	94.40	147.65	55.71	1.484
3	96.45	88.45	92.73	147.65	58.57	1.488
4	99.00	84.09	94.40	147.65	54.29	1.489
5	97.27	86.96	92.73	147.65	57.14	1.492
6	97.31	89.93	94.40	149.32	60.00	1.494
7	98.09	85.46	92.73	147.65	55.71	1.496
8	99.86	82.57	94.40	147.65	52.86	1.496
9	98.12	88.45	94.40	149.32	58.57	1.498
10	95.59	89.83	91.07	147.65	60.00	1.499

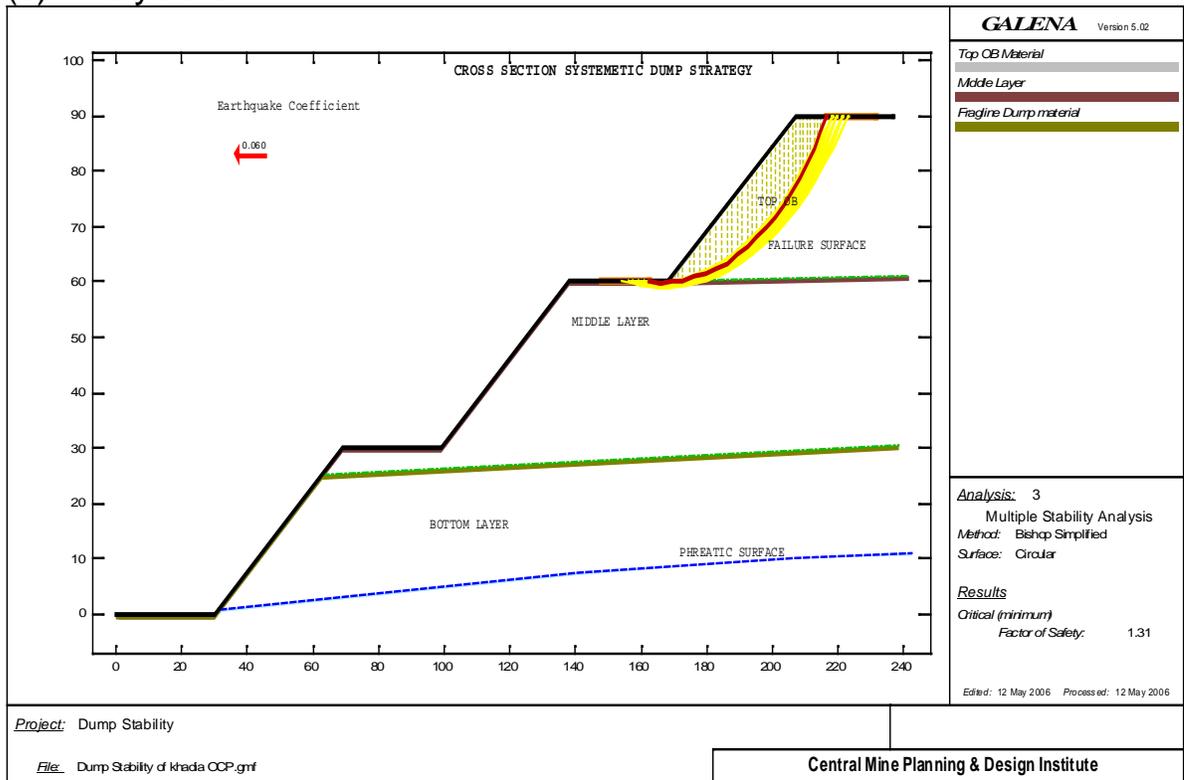
Analyses  
Factor of Safety for initial failure circle approximation: 1.66

1407 Successful analyses from a total of 1501 trial surfaces  
94 Analyses were terminated due to unacceptable geometry  
0 Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

Print Close

(c) Analysis-3:



Result of the Section:

**Multiple Analysis Result Summary - Analysis 3**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	166.06	117.04	162.65	216.40	57.14	1.306
2	166.89	115.55	162.65	216.40	55.71	1.312
3	166.05	119.90	162.65	218.07	60.00	1.316
4	165.19	118.42	160.98	216.40	58.57	1.317
5	167.73	114.05	162.65	216.40	54.29	1.320
6	166.85	118.42	162.65	218.07	58.57	1.321
7	166.00	116.92	160.98	216.40	57.14	1.322
8	165.20	121.28	160.98	218.07	61.43	1.326
9	166.82	115.41	160.98	216.40	55.71	1.328
10	167.66	116.92	162.65	218.07	57.14	1.329

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

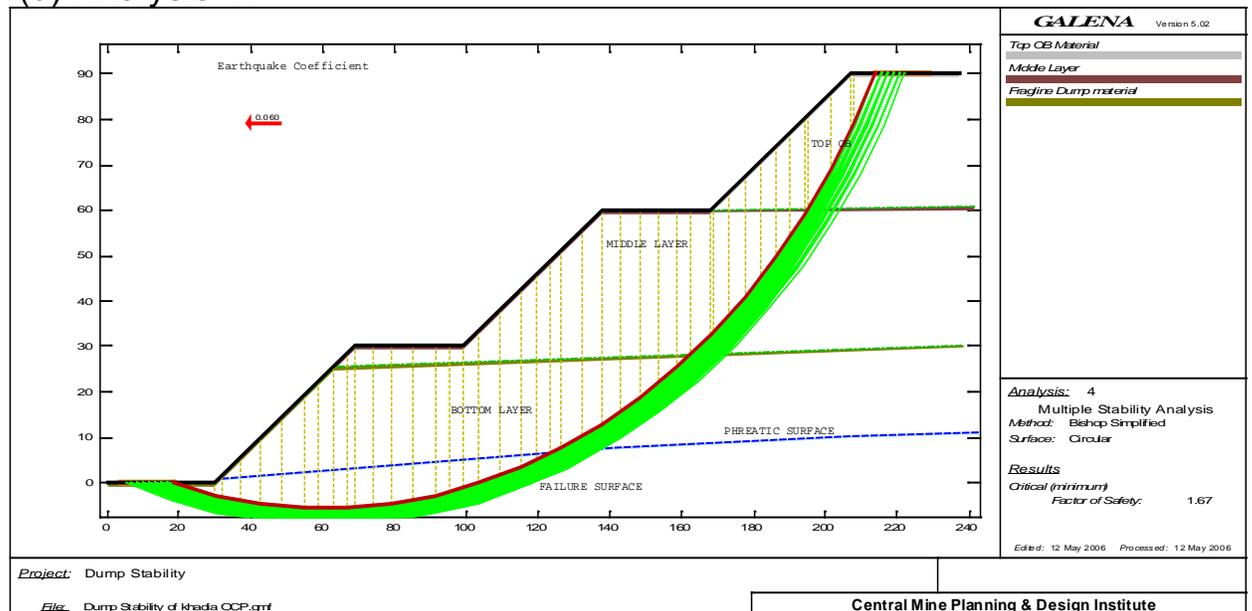
Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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(d) Analysis-4:



Result of the Section:

**Multiple Analysis Result Summary - Analysis 4**

Lowest 20 Factor of Safety Circles

	X-Centre	Y-Centre	X-Left	X-Right	Radius	FoS
1	60.99	164.60	18.50	213.75	170.00	1.670
2	60.81	164.21	16.83	213.75	170.00	1.673
3	62.47	164.21	18.50	215.42	170.00	1.675
4	60.61	163.81	15.17	213.75	170.00	1.676
5	61.77	162.92	18.50	213.75	168.57	1.676
6	62.28	163.81	16.83	215.42	170.00	1.678
7	61.58	162.52	16.83	213.75	168.57	1.679
8	60.41	163.40	13.50	213.75	170.00	1.679
9	62.08	163.40	15.17	215.42	170.00	1.681
10	63.94	163.81	18.50	217.08	170.00	1.681

Analyses

Factor of Safety for initial failure circle approximation

Successful analyses from a total of  trial surfaces

Analyses were terminated due to unacceptable geometry

Analyses did not converge and failed to produce a result

More information on terminated/failed analyses is provided in the Session Log

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Close

Result of Systemitic Dump Strategy Cross Section:

SL. NO	Section Name and Analysis	FOS
1	Cross Section of systematic dump strategy Cross Section.	
	Aalysis-1	1.33
	Aalysis-2	1.48
	Aalysis-3	1.31
	Aalysis-4	1.67

**CHAPTER –VI****Recommendations & Conclusions****6.0 Recommendations:****6.1. Systematic Mining Methods for Shovel Dumper & D/L System:****Mining Technology**

Considering the mining and geological conditions such as:

- Flat gradient of 2 to 3 deg. of the coal seam;
- Mining of multiple seams viz Turra (19-22m), Purewa Bottom (8 -13 m), Purewa Top (8-10m);
- Parting of 53 to 62 m between Turra and Purewa Bottom seams;
- Large scope of work, including 14.00 Mt of ROM coal and peak OBR of 70.14 Mm<sup>3</sup> per annum;

Khadia OCP has been working for last 28 years with combined system of mining using Dragline and shovel-dumper combination. The existing system has been proposed to be continued with up-gradation of equipment size for achieving higher production level.

The review of mining technology will be done when the project boundary reaches the geologically disturbed zone on dip side.

**6.1.1. Recommendation for shovel dumper and Dragline face:**

From the scientific analysis of slope stability in Chapter-V of all sections of Shovel dumper and Dragline combination face of high wall section, the details are tabulated in table 6.1.

**Table- 6.1: Summary of analysis results for shovel dumper face and dragline face in Chapter -V:**

SL No.	Cross Section & Location Khadia OCP	FoS (Min)
<b>A</b>	<b>Shovel Dumper Face (Western,Central and Eastern Section):</b>	
a	CS C-C'(2400N to 2800N),Shovel Dumper Face:	
	Analysis-1	1.96
	Analysis-2	1.76
b	CS E-E'(2600N to 2900N),Shovel Dumper Face:	2.73
c	CS E-E'(2400N to 2600N),Shovel Dumper Face:	1.55
d	CS G-G'(2000N to 2600N),Shovel Dumper Face:	
	Analysis-1	1.90
	Analysis-2	1.51
e	CS I-I'(2000N to 2600N),Shovel Dumper Face:	
	Analysis-1	2.30
	Analysis-2	2.26
f	CS K-K'(3400N to 4100N),Shovel Dumper Face:	
	Analysis-1	1.75
	Analysis-2	2.52
	Analysis-3	2.62
g	CS L-L'(3500N to 4000N),Shovel Dumper Face:	
	Analysis-1	1.32
	Analysis-2	2.90
	Analysis-3	2.34
<b>B</b>	<b>Dragline Face(western and central Section):</b>	
a	CS B-B'(2900N to 3100N),Dragline Face:	1.70
b	CS C-C'(2975N to 2800N),Dragline Face:	1.37
c	CS D-D'(2975N to 2800N),Dragline Face:	1.20
d	CS E-E'(2800N to 2900N),Dragline Face:	1.25
e	CS G-G'(2800N to 3000N),Dragline Face:	1.22
f	CS I-I' (3100N to 3250N),Dragline Face:	1.45

From the above analysis of the shovel dumper face and Dragline face of highwall side it has been found that the factor of safety(FoS) of the highwall face is more than 1.2.

Hence, it is again suggested that the face of high wall section of Dragline system should be kept maintained as per the system parameters and have a FoS more than 1.2 as mentioned below.

### **6.1.2. The System Parameters to be followed for Bench Height and width:**

Elements of mining system have been determined in accordance with the parameters of excavation, transport equipment and the parameters of drilling and blasting.

The mine is being developed in two sections namely Western Section and Eastern Section.

With due consideration to geo-mining characteristics of the deposit, the mine is proposed to be worked by combined system of mining using dragline and shovel-dumper combination. All the OB of expansion area will be dumped in internal dump. Coal in both sections is proposed to be extracted by shovels and transported to receiving pits/coal stock yards by 100 T rear dumpers. While designing the mining system, safety at work places and techno-economic feasibility of the system have been taken care of. On the basis of geo-mining characteristics of the deposit, mining system parameters like slope of the quarry batter, bench height, bench width, dump height; final dump slope and slope of the working benches have been decided. Design of mining system has been done considering technical parameters of HEMM and safety guidelines of Directorate General of Mines Safety (DGMS). However, during mine operations, the safety rules, regulations and various circulars issued by DGMS should be strictly followed and adhered to.

The height of main OB bench over Turra seam, proposed to be side cast by dragline in the previous decoaled cut, would vary from 40m to 45m. The existing dragline cut width is 75m and same has been adopted in the EPR (10.00 Mtpa ).

The upper OB benches are proposed to be worked by 20m<sup>3</sup> Elect Rope Shovels working in conjunction with 190-210 T rear dumpers. The width of the cut of the OB shovel benches has been adopted as 20m. The height of the shovel-benches varies from 15-18m. With two way traffic along the bench, the width of the working benches varies from 55-60m (20m cut width, 10m throw, 20m haul road, 6m for power supply arrangement on alternate benches and 4m safety berm) ,whereas the width of non-

working benches varies from 35-40m. Considering the flat dip ( $2^{\circ}$ - $3^{\circ}$ ) of the seams, it is proposed to excavate the OB from advance benches by inclined layers parallel to seam floor. This eliminates the need to cut new horizons from the side of seam roof and simplifies water drainage from the benches to central sump.

The thickness of Turra seam varies from 16m to 20m in most of the area and it is proposed to be worked in two sub-benches by  $10\text{m}^3$  Elect. Rope Shovel in conjunction with 100 T rear dumpers. The thickness of Purewa Bottom seam varies from 6m to 15m and that for Purewa Top seam 2m to 10m. It is suggested that these two seams should be worked in single bench by using  $10\text{m}^3$  Elect. Rope shovel and 10-12  $\text{m}^3$  Diesel Hyd. Shovel in conjunction with 100 T dumpers.

Persistent bands of thickness more than 1m present in coal seam are proposed to be mined separately. 1 No. 10-12  $\text{m}^3$  FE loader has also been provided for this purpose and other miscellaneous jobs. Elements of mining system have been determined in accordance with the parameters of excavation and transport equipment and the parameters of drilling and blasting.

The width of cut for coal benches has been adopted as 20m. The width of working bench in coal seam has been considered as 45m while width of non-working benches has been kept at 25m. The slope of each bench is proposed as  $70^{\circ}$  in OB and  $80^{\circ}$  in coal. But the overall running slope in working faces are about  $18^{\circ}$  to  $20^{\circ}$ .

The above mining system and system parameters have been proposed for departmental HEMM deployed for coal winning and OB removal as proposed in Option-I & Option-II. For outsourcing of OB as proposed in Option-II (partial OB outsourcing), mining system parameters depends upon the size of equipment deployed by outsourcing agency. In the light of experience gained, the elements of mining system can be modified during the actual mining operation depending upon the physical and mechanical properties of the rock and the permission acquired from DGMS regarding the maximum permissible dragline side cast OB dump height & other parameters.

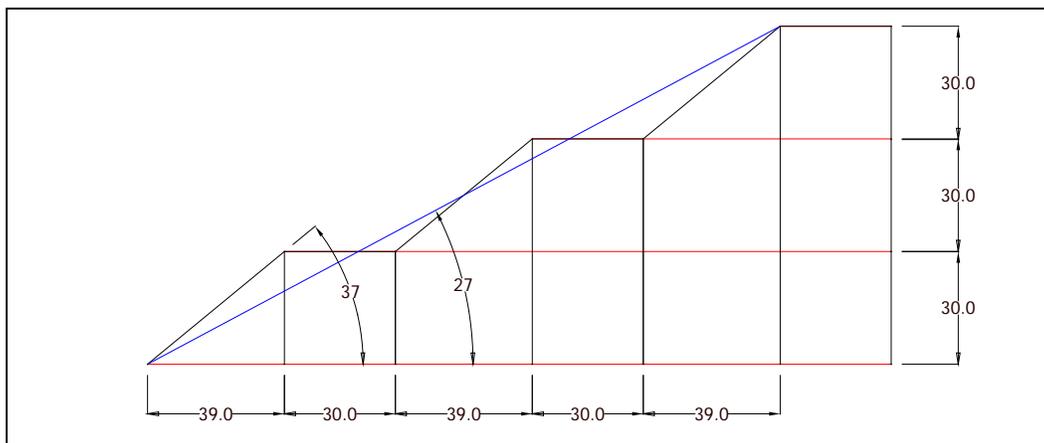
## 6.2 Dumping Strategy

### 6.2.0 Systematic Mining Methods for Shovel Dumper Dumping system:

Bench height of OB dumps formed by Shovel-Dumper system will be 30m and slope of individual dump benches will be  $37^\circ$  (equal to angle of natural repose of OB material). Width of berm between two adjacent benches will be 40m. Overall slope of dump works out to  $28^\circ$ .

While forming any new dumps or modifying the slope profile of existing dumps attention should be given to the CMR guidelines which stipulates that any spoil bank exceeding 30 meter in height shall be benched so that no bench exceeds 30 meter in height and the overall slope shall not exceed 1 vertical to 1.5 horizontal it should be follow

Below is the proposed typical profile of benches for shovel dumper combination Dump to be incorporated in Khadia OCP.



**Fig: 6.1: Typical profile of benches for shovel dumper combination Dump**

The typical section of dump profile has analyzed by GALENA Software in both ways with Earthquake coefficient and it has been found that for all the sections the FOS is more than 1.2. So, it is suggested that it is a safe profile of OB Dump for Khadia OCP.

Result of Systematic Dump Strategy Cross Section:

SL.NO	Section Name and Analysis	FOS
1	Cross Section of systematic dump strategy Cross Section.	
	Aalysis-1	1.33
	Aalysis-2	1.48
	Aalysis-3	1.31
	Aalysis-4	1.67

However, along sections of old and abandoned dumps where active dumping is not proposed or planned, the existing profile may be continued with imposing restrictions on movement of men and machinery by placing proper fence/signboard.

**6.2.1 Recommendation for shovel dumper Dump:**

From the scientific analysis of slope stability of all section of Shovel dumper section of dump, the results are tabulated below.

**Table 6.3: Summary of analysis results for shovel dumper dump**

<b>C</b>	<b>Shovel Dumper Dump (western,central and Eastern Section):</b>	
a	CS A-A' (-3800N to -4100N),Shovel Dumper Dump:	1.65
b	CS A-A' (-3100N to -3500N), Shovel Dumper Dump:	2.11
c	CS D-D' (-3100N to -3500N),Shovel Dumper Dump:	
	Analysis-1	1.59
	Analysis-2	1.48
d	CS F-F' (-3100N to -3600N),Shovel Dumper Dump:	1.21
e	CS H-H' (4200E to 4700E), Shovel Dumper Dump:	
	Analysis-1	1.86
	Analysis-2	1.52
f	CS I-I' (-3300N to -3700N),Shovel Dumper Dump:	
	Analysis-1	1.52
	Analysis-2	2.23
g	CS J-J' (-3900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.77
	Analysis-2	1.75

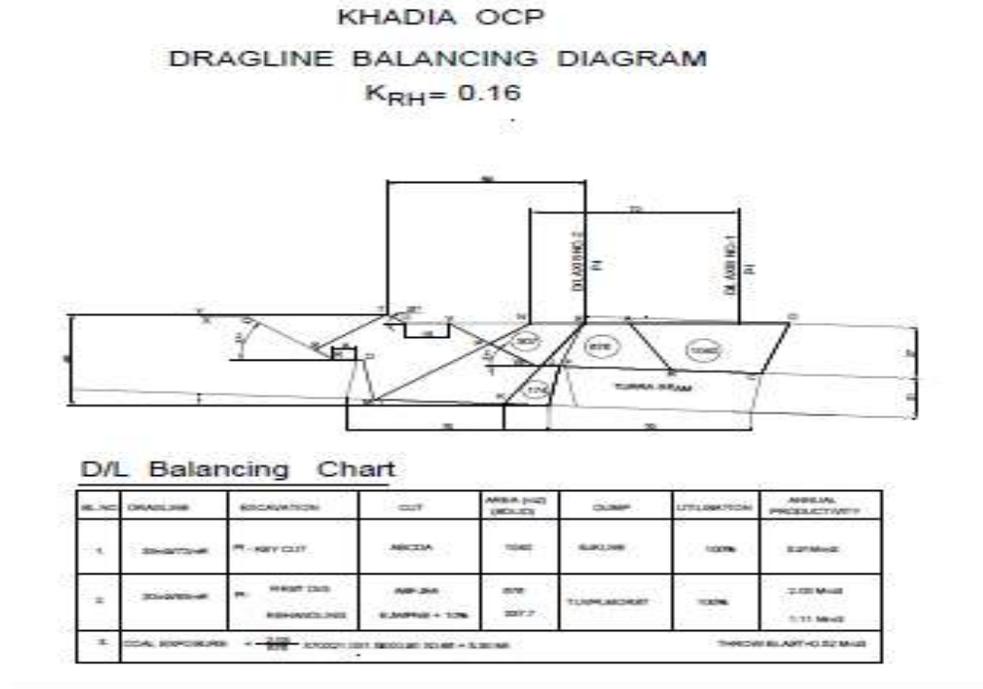
h	CS M-M' (-4000N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.77
	Analysis-2	2.28
	Analysis-3	1.42
i	CS M-M' (-4900N to -4500N), Shovel Dumper Dump:	
	Analysis-1	1.80
	Analysis-2	1.43
	Analysis-3	1.52
j	CS N-N' (-4900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.73
	Analysis-2	1.52
k	CS O-O' (-4900N to -4500N),Shovel Dumper Dump:	
	Analysis-1	1.40
	Analysis-2	1.66
	Analysis-3	1.54

From the above analysis it has been found that the factor of safety(FOS) of all the dump section (Eastern central and western) is more than 1.2. From the above, it can be inferred that the dump of east west and central section is well maintained and it should also be kept maintained for shovel dumper dump as shown in fig-6.1 and have a FOS more than 1.2.

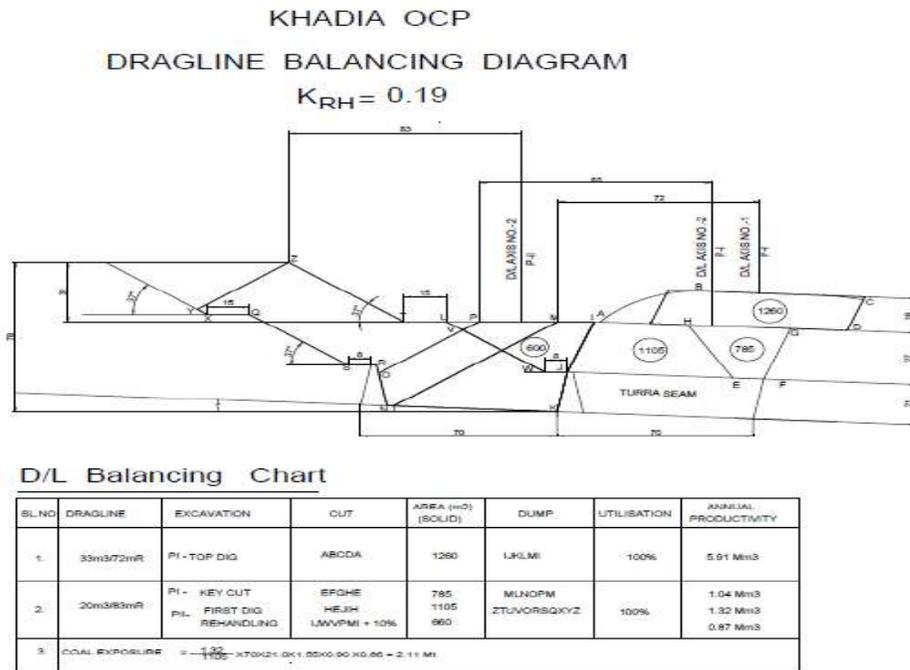
## 6.2. Systematic Mining Methods for Dragline Dumping System:

Presently, Khadia project has 3-No of Draglines, one is 33m<sup>3</sup>/72 and another 2 are 20m<sup>3</sup>/83 mR, where 2 no of Dragline deploying in horizontal tandem method in western section of Khadia OCP. One No Dragline 20m<sup>3</sup>/83 mR is presently breakdown and under maintenance. The working of western section is leading and the East section is lagging. Central section is much advanced.

Below is the suggested typical profile of dragline balancing and Dump profile, having a FOS in excess 1.2, commensurate with the details operational parameter as the dragline deployed in Khadia OCP.



**Fig: 6.2: Dragline balancing using Horizontal tandem Method and dump profile for Khadia OCP**



**Fig: 6.3: Dragline balancing using Vertical tandem Method and dump profile for Khadia OCP**

**6.2.1. Recommendation for Dragline Dump:**

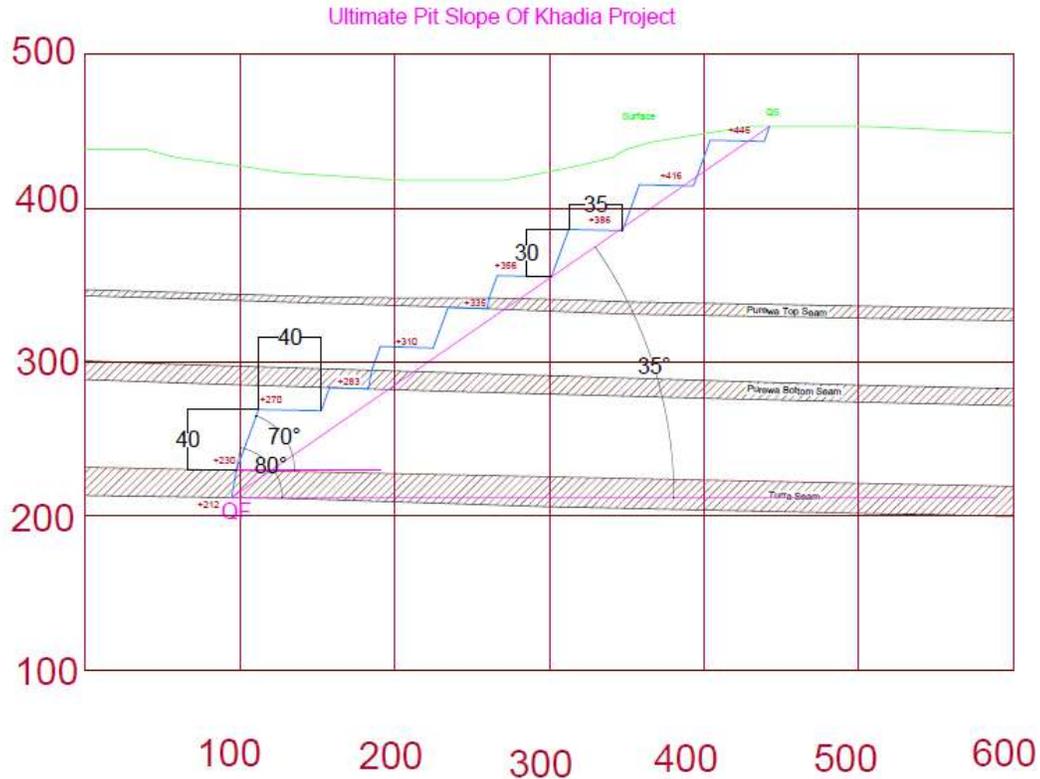
	<b>Dragline Dump(western and central Section):</b>	FOS
a	CS B-B'(-2900N to-3100N),Dragline Dump:	1.40
b	CS D-D'(-2900N to -3100N),Dragline Dump:	1.39
c	CS F-F'(-2900N to -3100N),Dragline Dump:	1.81
d	CS G-G'(-3100N to -3300N),Dragline Dump:	1.55

From the result of scientific analysis in chapter –V, of all sections of dragline dump it is found that FOS of section is more than 1.2, so the Dragline Dump section is well-maintained.

Again,however,it is suggested that the dump shall be designed and kept maintained as shown in the above systemetic dragline balancing and dump profile for Khadia OCP in Fig-6.2 and Fig 6.3 to have a FOS in excess 1.2.

**6.3. Ultimate Pit Slope:**

The final stage pit quarry for the proposed mining of Khadia OCP should be followed. The proposed typical profile of Ultimate pit Slope from Turra floor to Surface at the quarry end of Mining is given in fig. no.6.3.



**Fig. 6.3: Typical profile of Ultimate pit Slope**

Result of the Ultimate Pit Slope Cross Section:

SL.NO	Section Name and Analysis	FOS
1	Cross Section of ultimate pit slope Cross Section.	
	Aalysis-1	1.33
	Aalysis-2	1.88
	Aalysis-3	1.99
	Aalysis-4	1.66
	Aalysis-5	1.23

The analysis of cross section of ultimate pit slope details are given in chapter-V para 5.7 and from the analysis it have been found that the result of FOS is in excess 1.2.

#### 6.4 Monitoring.

1. The failure are not exception in mine. It is a part of mining. So, monitor philosophy and mine should be adopted. The slope monitoring should be done to detect the onset of failure so that early and effective stabilization measures can be taken at the earliest. If the instability is unavoidable then it can be brought down in a predictable manner.
2. Most important parameter to be monitor is movement of soil mass of the dump.
3. Water level should be monitored on regular basis particularly in rainy season.
4. During the rainy season, an officer should be deputed to go in and around the mine in the morning to see the effectiveness of drain. If any blockage is observed, then immediately steps should be taken to make it effective. If any deep tension crack is detected then it should be filled with sandy material and the entry of water inside the crack should be checked.
5. Any type of crack anywhere on the dump should be monitored and examined. The movements of the dump mass should be recorded and if the movement is persistent man and machine should be withdrawn till stabilized.
6. The final resultant dump slope should not exceed the angle of repose of dump material.
7. Slope monitoring is essential to detect any instability in advance to safe guard the loss of men and machinery working in lower level of the mines. The failure are not exception in mine. It is a part of mining. So, monitor philosophy and mine should be adopted.
8. There should be a dedicated team equipped with sophisticated Slope monitoring equipment, to monitor the dump slope stability. The working personals should be imparted advance training on slope stability time to time.
9. The slope stability Monitoring team should monitor all internal, external Dump and high wall benches on fortnightly basis in Monsoon and on monthly basis for rest of the season.
10. Dump profile shall be monitor by target-less theodolite. Coal and OB bench height cut width ,dimension of the coal rib, left of the toe of the dump , width of corridors,

berms of coal seam roof and Dragline sitting level etc. shall be measured at a 50m interval.

11.(a) A continuous monitoring system or any other similar technology giving time to time displacement of strata or dump material, and to warn well in advance of any impending failure shall be installed and put into operation, where any abnormality is noticed (cracks and movements) below which men and machinery are deployed should be ensure safety.

(b) A protocol for such monitoring shall be developed and implemented.

#### 6.5 Safety and mitigation measures against impending failure.

1. Shape of OB dump should be uniform and any curvature will lead to stress concentration thereby causing slope failure
2. The top soil should be dumped separately or at the top of the dump. It should not be placed at intermediate levels of the dumps.
3. Top of OB dump should be graded in such a manner that no water should accumulate there.
4. Proper drainage system should be made to bring down the rain water.
5. If any structure not belong to the owner exists near the OB dump, an earth retaining structure such as retaining wall or gabion wall should be made against OB dump along toe, it should follow as per CMR -2017 guide line.
6. Grass seeding, plantation should be planted at the base of dump up to 50m width from the toe of dump. This measure will hold the soil together as well as it would also prevent generation of dust.
7. Measure for proper vegetation should be taken on top of dump, on berm and slope
8. Any depressed land near the toe of dump or top should be filled up and dozed/leveled so that no accumulations of water take place
9. Garland drains should be constructed and measures for timely maintenance of these drains should be taken.
10. Toe cutting should be avoided in OB dump benches.
11. No water should be allowed to be stagnant near the toe of dump and top of the dump.

12. The dumps should be regularly surveyed to have up-to-date and accurate dump geometry.
13. No Dump bell should be formed, the valley of the Dragline Dump should be levelled to avoid accumulation of rainwater.
14. No heaps of dump should be left on benches or at the top of the dump. The heaps should be levelled to avoid rainwater ponding between the heaps of the dump.
15. The shovel-dumper dumping should not be on or near the currently created dragline dump to avoid the dead loading of the partially consolidated dragline dump. The dumping by shovel dumper should be at least two cuts away.
16. The dragline deployment scheme envisages leaving of coal rib in the balancing diagrams as per provisions of DGMS.
17. It is suggested to extract the coal rib to the extent possible, so that there is no chance of accumulation of water against the coal rib causing hydraulic thrust on the dump.

## 6.6 Limitations

1. Soil is very complex and complicated material in nature, heterogeneous type of soil is found which has different properties at different depth and places.
2. Accurate soil properties cannot be derived in laboratory by merely testing few soil samples. Because no theory can exactly simulate the field conditions.
3. It is very difficult to take the soil sample from the deep inside the OB dump and measures were taken to collect the representative samples as per IS codes.
4. Judicious judgment based on combination of theory and practical experience from the past studies shall help to arrive at right conclusion during making the necessary assumptions for the study.
5. It is very difficult to assess the accurate pore water pressure and phreatic line of the dump and the necessary assumptions were made based on the hydro geology data collected from nearby dug wells and Piezometers.
6. All the software and calculation are based on assumption that OB is homogeneous soil to an extent.
7. In geotechnical engineering field there are many uncertain factors which govern the stability analysis which depends on the assumptions made for the study. As a result, factor of safety determined may vary to some extent from study to study. In this study, all normal failure conditions are checked for determination of FoS with the best possible assumptions and judgment.

## 6.7 Conclusion

Based on cross sections provided, laboratory test results (indicated in table ) for strength properties, assumptions based on judicial assessment of existing site conditions during filed visit and literature review, slope stability analysis was performed using a Limit equilibrium software i.e. GALENA.

The 28 models prepared and 43 no. analysis has been done using GALENA Software, are shown in the summary of the results in chapter V. It is observed that the slope profiles along Shovel dumper system Dump, Dragline Dump, dragline face and Shovel-dumper combination face, sections (A-A', B-B', C-C' , D-D', E-E',F-F',G-G',H-H, I-I',J-J',K-K',L-L' M-M',N-N',O-O' and Two no. Cross section, Ultimate Pit Slope, and Dump Strategy section) have Factor of Safety (FoS) more than 1.2.

Normally, if the FOS is less than 1, it is considered failure surface, and FoS between 1 to 1.2 is a questionable safety zone, so all the section of mines shall be designed and kept maintained as to have a factor of safety in excess 1.2.

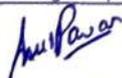
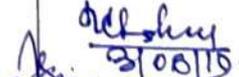
The Dump and Pit of mines are regularly changing, so, it is recommended that fresh geotechnical study should be conducted regularly after a time frame and reviewed for optimization of the present geotechnical study. It would help for optimization/slope steepening of the dump with latest available geotechnical data/information. This fresh geotechnical study would lead to achieve the better financial goals without sacrificing the safety.

**Reference:**

- (1) The slope stability report with the recommendation given by Dr. Indrajit Roy, on Khadia project – titled on “Slope stability study of Dragline Dump at Khadia Project,NCL” ---By BIT,MESHRA, dated-June-2015 submitted to Khadia project Management.
- (2) Other scientific Slope Stability study report by CMPDI, Ranchi (HQ), Jharkhand.
- (3) EMP for Khadia Expansion OCP report (14MTPA), NCL dated -23<sup>rd</sup> March 2016, by CMPDII, RI-6, Jayant.
- (4) EC-14.00 MTPA approved by Govt. of India, MoEFCC, Dated 23<sup>nd</sup> March 2016.
- (5) Latest approved PR/EPR/RPR/Scheme or Mining Plan of Khadia OCP.

**DISCLAIMER**

The report is based on field reconnaissance, laboratory tests as per IS codes on small size soil samples and analysis results using GALENA slope stability analysis software. Neither CMPDI nor any of its employee makes any warranty, express or implied or assume any legal liability or responsibility for the accuracy completeness or use of the result of such information, product or process in the report

<b>Installation and Commissioning Report</b>				
 Environment 24 India Pvt Ltd	Customer	M/S. NCL, KHADIA	Report No:	01/ESA/NCL/INC2019/A1
	End User	M/S. NCL, KHADIA	Date:	15/05/2019
	Customer PO No	63814065/317A1069/CAAQMS	Earlier Report No:	NA
	PO Date:	28.09.18		
VISIT NUMBER	1			
Start Date	22.04.2019			
Install Date	25.04.2019			
Commissioning Date	16.05.2019			
<b>System Description in Brief</b>	<b>System:</b> Continuous Ambient Air Quality Monitoring System (with display) <b>Analyser Detail:</b> PM 10(6869), PM 2.5(6870), SO2(660),NOx(430),CO(503), and Weather sensors <b>Weather sensor detail :</b> Make: Dynalab Temperature, Humidity, Wind Direction ,Wind Speed, Solar Radiation and Rain Gauge. <b>UPS/Battery:</b> 6KVA. Make:Emerson (GXT MT+LB) <b>PC Details:</b> Intel(R) Core (TM), i3 7100p, 64bit OS, 4GB RAM 3.91GHZ, Windows 10 Prof Make: LENOVO <b>Local DAS:</b> SAM WI RPT <b>Display Board:</b> 4ft*2ft, Amber Color Model: 1R 16 P10		Quantity: 1 Nos	
<b>Activity Carried Out:</b>	Installed, calibrated and commissioned 1 nos of AAQMS Station comprising of Dust analysers- PM10 & PM2.5, Gas analysers-SOx, NOx and CO at NCL, Khadia near Ram mandir. Communication to Local DAS established and Data acquisition is started. All Necessary Documents including manuals, software installation CDs and test certificates submitted. Weather sensor functionality. Performance of all analysers checked for 72hrs. Communication of data to display board from PC established.			
Balance Activity:				
Customer Remarks(if				
Conclusion:	System Hand Over: 1 Nos of AAQMS with full functionality on 16-May-2019			
Remark:	The System has been handed over and warranty initiated as per Purchase Order Terms and Conditions. We appreciate and request to call our service no: 022 45020048 or put forward e-mail to "service.in@envea.global" for warranty support.			
I&C Engineer (ENVSA)	Customer Signature (NCL, Khadia)			
 AMIT PAWAR	 31/05/19			
	<b>Staff Officer (Mining)</b> <b>NCL, Khadia Project</b>			

# Northern Coalfields Limited

*A Mini Ratna Company*

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Annexure R-7

## KHADIA PROJECT

# MONSOON ACTION PLAN 2022-23



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# SURVEY DEPARTMENT

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Data for monsoon preparedness plan, 2022-23

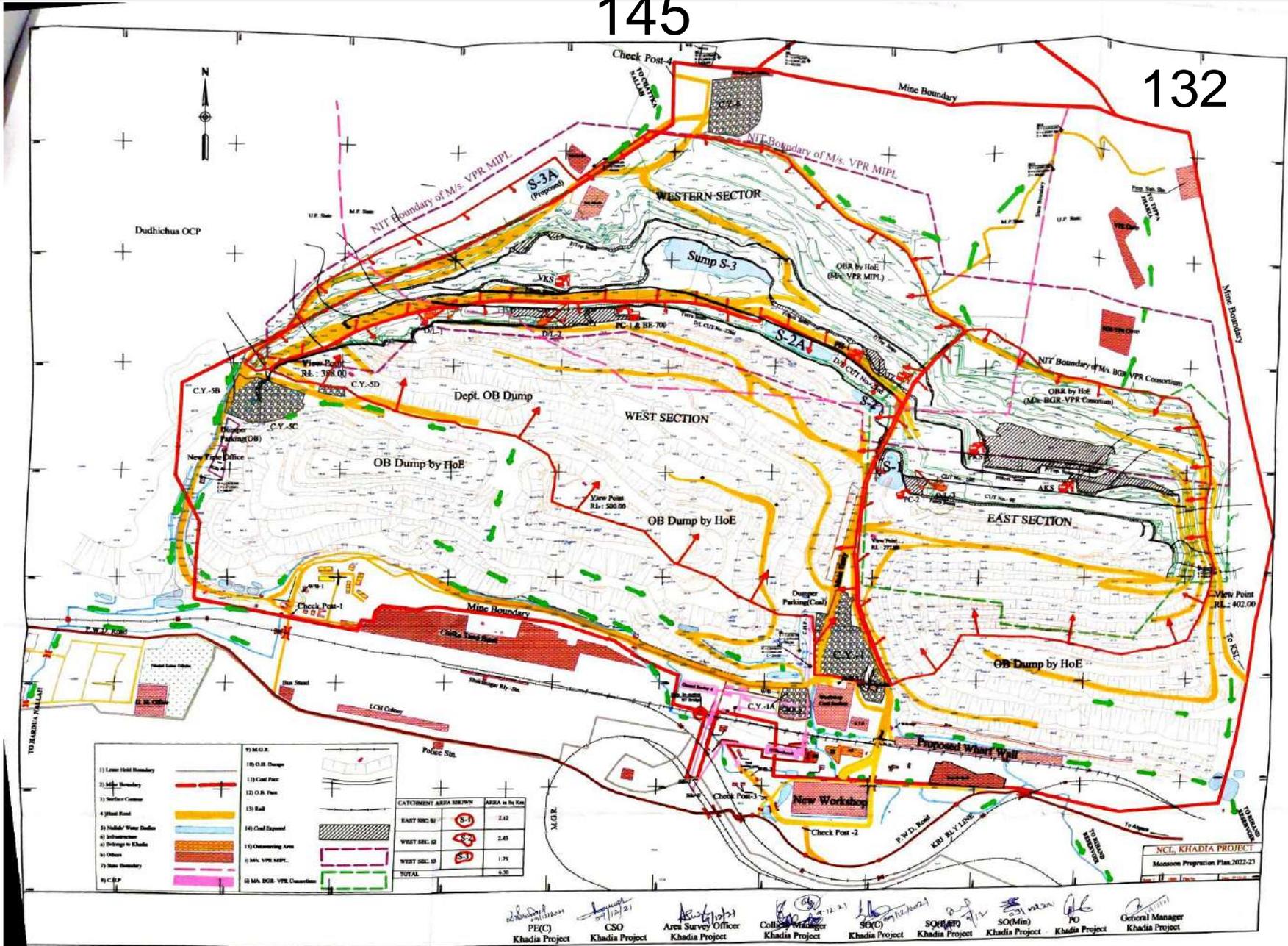
1 Catchment Area (in Sq Km)		Active Area	Back Filled	Total (in Sq. Km)	
a. East Section/ Main Entry(Up Stream), S1		1.11	1.01	2.12	Sq Km
b. West Section/Main Entry (Down Stream),S2		0.10	2.33	2.43	Sq Km
c. West Section-Purewa Seams, S3		1.75	0.00	1.75	Sq Km
<b>Total</b>				<b>6.30</b>	<b>Sq Km</b>
2 a. Maximum Rainfall in a day on 03/09/2014 (in mm)				180	mm
b. Maximum Rainfall in a day for Pumping Capacity (As per PR)				220	mm
b. Maximum Rainfall in a day for Sump Capacity (as per PR)				187	mm
3 Make-up of water (in Cum)- For Sump Capacity at rainfall 187 mm					
a. East Section/ Main Entry (Up Stream)				2,81,248	Cum
b. West Section/Main Entry (Down Stream)				2,34,984	Cum
c. West Section-Purewa Seams				2,94,525	Cum
<b>Total</b>				<b>8,10,757</b>	<b>Cum</b>
4 Make-up of water (in Cum)- For Pump Capacity at rainfall 220mm					
a. East Section/ Main Entry (Up Stream)				3,30,880	Cum
b. West Section/Main Entry (Down Stream)				2,76,452	Cum
c. West Section-Purewa Seams				3,46,500	Cum
<b>Total</b>				<b>9,53,832</b>	<b>Cum</b>
5 Pump Capacity, (Cum/day), Working 20 hrs/day					
	No of Pumps	Capacity in Cum/pump/hr	Capacity in Cum/hr	in m3/ day(65% eff.)	
a. East Section/ Main Entry(Up Stream), S1	3	1100	3,300	42,900	
b. West Section/Main Entry (Down Stream),S2	4	1100	4,400	57,200	
c. West Section-Purewa Seams, S3	4	1100	4,400	57,200	
<b>Total</b>		<b>11</b>	<b>12,100</b>	<b>1,57,300</b>	
<b>Existing Pump available (1100cum/hr cap)</b>		<b>11 No</b>			
Days required to discharge the make-up of water at 187 mm rainfall i.e.				8,10,757	5.15
6 SUMP CAPACITY (at Rainfall 187mm)					
		Yr 21-22 Existing (m <sup>3</sup> )	Yr 22-23 Required (m <sup>3</sup> )	Yr 22-23 Proposed = Req X 1.5 (m <sup>3</sup> )	
a. East Section/ Main Entry(Up Stream)- S1		1,50,000	2,81,248	4,21,872	
b. West Section/Main Entry (Down Stream)-S2 &S2A		2,30,000	2,34,984	3,52,476	
c. West Section-Purewa Seams - S3 & S3A		3,00,000	2,94,525	4,41,788	
<b>Total (S1+S2+S3)</b>		<b>6,80,000</b>	<b>8,10,757</b>	<b>12,16,136</b>	
7 Actual Deployment of Pumps (1100 cum /hr)					
	To be Installed	Stand by at Site	Ready for installation at w/shop	Total	
a. East Section/ Main Entry(Up Stream)-S1	3	1	1	3	
b. Central Section/Main Entry (Down Stream),S2	2	1	1	3	
c. Central Section/Main Entry (Down Stream)-S2 A	2	1		3	
d. Central Section-Purewa Seams, S3+S3A	4	1	1	5	
d. <del>Central Section-Purewa Seams, S3A</del>	<del>1</del>	0		<del>1</del>	
<b>Total</b>		<b>11</b>	<b>4</b>	<b>3</b>	<b>15</b>
Formula and constants : Assessment of volume of water to be pumped in Cum/day = Catchment area in sq m X maximum Run off co-efficient, For mined out area					
				0.9	
				0.5	
				0.15	
				0.15	

ASINGI 8/11/22 Manager (Sur)  
 Area Safety Officer  
 P. S. 8/11/22 S.O.(Civil)  
 S.O.(Civil)  
 R. Lakshmi 8/11/22 SO(E&M)  
 General Manager

# MONSOON ACTION PLAN OF KHADIA PROJECT 2022-23

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CHATKA NALA 146

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TIPPA JHARIA



Dudhichua OCP

WESTERN SECTOR

WEST SECTION

EAST SECTION

Mine Boundary

Mine Boundary

Chika Tand Basti

Shikarpur Pip. Sta.

C.V.-1A

New Workshop

Check Post-3

Check Post-2

P.W.D. Road

NBI RLY LINK

To Agha

RIHAND RESERVOIR

HARDUA NALA

1) Lease Hold Boundary	16) S.G.R.	21) M.C.P.
2) Mine Boundary	17) D.B. Dumps	22) Coal Lane
3) Surface Contour	18) Coal Lane	23) O.B. PACE
4) Road	19) Well	24) Well
5) Nallah/Well Bedline	20) Well	25) Well
6) Instreamine	26) Unsanitary Area	27) No. VPM MPFL
7) Belong to Kharla	28) No. VPM MPFL	29) M.S. BGR-NFR Contour
8) Office	29) M.S. BGR-NFR Contour	
9) Mine Boundary		
10) C.P.		

NCL RAMP PROJECT  
Monsoon Commissioning 2022-23

# Rain Fall Data: Jan 1990- Nov 2021 134

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL (Jan-Dec)	TOTAL (Apr-Dec)	Total (Jun-Sep)
1990	0.00	37.75	48.00	0.00	0.00	159.00	251.75	265.25	97.25	21.50	0.00	0.00	723.50	723.50	723.50
1991	0.00	0.00	0.00	0.00	14.20	133.00	254.50	365.60	438.90	7.25	0.00	29.40	1064.00	946.00	932.75
1992	0.00	0.00	0.00	0.00	0.00	5.40	223.25	360.00	76.00	0.00	0.00	0.00	766.50	766.50	698.00
1993	0.00	0.00	12.50	0.00	0.00	106.75	220.25	214.25	257.50	28.00	0.00	0.00	839.50	768.00	768.00
1994	0.00	0.00	0.00	0.00	0.00	328.25	249.50	219.25	214.25	49.75	0.00	0.00	1333.25	1333.25	1258.75
1995	0.00	0.00	0.00	0.00	0.00	135.00	167.50	273.75	147.25	0.00	0.00	0.00	1076.50	1076.50	1027.75
1996	94.00	24.00	0.00	0.00	0.00	103.75	236.50	458.75	133.75	13.25	0.00	0.00	1064.25	1064.25	892.25
1997	0.00	0.00	0.00	0.00	0.00	66.25	211.75	347.25	72.75	46.50	9.50	12.50	1206.40	1151.90	1065.80
1998	62.25	9.25	0.00	0.00	0.00	128.50	154.25	296.75	188.50	0.00	0.00	0.00	1543.50	1470.00	1382.00
1999	0.00	0.00	0.00	0.00	0.00	239.50	522.50	266.75	230.00	74.50	0.00	0.00	1022.50	993.50	958.00
2000	0.00	0.00	0.00	0.00	0.00	225.25	348.50	166.75	287.25	48.75	0.00	0.00	1094.00	962.00	927.00
2001	0.00	0.00	0.00	0.00	0.00	128.75	494.50	229.50	39.50	172.00	0.00	0.00	1239.50	1178.50	1014.50
2002	7.00	45.50	2.00	0.00	3.35	174.00	155.55	403.75	332.00	78.75	0.00	4.00	1225.00	1025.00	952.00

# Rain Fall Data: Jan 1990- Nov 2021

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2003	5.00	65.00	3.50	33.00	0.00	177.00	237.00	427.00	541.00	49.00	0.00	6.00	1175.00	1103.00	1029.00
2004	11.00	0.00	18.00	10.00	2.50	229.50	295.00	287.00	146.50	21.00	0.00	2.00	1210.00	1200.00	1013.00
2005	66.00	32.00	34.00	1.50	23.50	315.00	118.00	277.00	217.00	9.00	0.00	1.00	987.50	971.50	858.50
2006	0.00	0.00	61.00	35.00	22.00	130.50	419.00	374.00	91.00	107.00	0.00	0.00	1895.00	1846.00	1769.00
2007	0.00	140.00	60.00	14.00	18.00	157.00	241.00	278.00	276.00	19.00	22.00	0.00	1481.00	1434.00	1346.00
2008	50.00	22.00	0.00	12.00	62.00	380.00	201.00	415.00	33.00	0.00	0.00	0.00	1136.00	976.00	836.00
2009	10.00	0.00	0.00	0.00	0.00	74.00	297.00	477.00	165.00	114.00	73.00	0.00	1165.00	1022.00	980.00
2010	5.00	11.00	0.00	0.00	11.00	38.00	405.50	199.00	216.00	97.00	0.00	5.00	825.00	762.00	691.00
2011	38.00	11.00	0.00	7.00	13.00	335.00	316.00	578.00	540.00	57.00	0.00	0.00	1895.00	1846.00	1826.00
2012	47.00	0.00	0.00	0.00	0.00	22.00	538.00	480.00	306.00	38.00	30.00	20.00	1481.00	1434.00	1346.00
2013	0.00	102.00	58.00	11.00	20.00	151.00	316.00	240.00	129.00	109.00	0.00	0.00	1136.00	976.00	836.00
2014	54.00	57.00	32.00	0.00	0.00	144.00	319.00	241.00	276.00	32.00	0.00	10.00	1165.00	1022.00	980.00
2015	25	0	38	16	5	55	300	264	72	50	0	0	825.00	762.00	691.00
2016	0	0	0	0	28	36	449	640	526	94	0	0	1773.00	1773.00	1745.00
2017	8	0	0	0	25	97	542	161	103	34	0	0	970	962	937
2018	0	26	0	0	0	121	313	409	98	4	0	0	971	945	967
2019	06	17	29	0	0	76	332	422	378	48	0	0	1308	1256	1208
2020	28.00	39.00	43.00	10.00	36.00	375.00	241.00	160.00	155.00	67.00	17.00	05	1176.00	1061	931
2021(upto Nov'21)	0.00	3.00	00	00	235.00	669.00	388.00	385.00	341.00	8.00	00	00	2029	2026	1783

- Maximum elevation of the hillock is 490 m above MSL.
- Working of the quarry is yet to reach highest point.
- On the south western side of the quarry mine drainage terminates to the Hardua/Balia Nala and in the south eastern part the mine drainage terminating to Rihand reservoir.
- All the dumps of the Khadia Project is in the southern boundary of the quarry on no coal zone
- There are a natural drains in the northern dip side of the working named as Chatka Nala and Tippa Jharia Nala where garland drains is terminating.

# General Lithology of Khadia Project

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Sl. No.	Particulars	Thickness(m)
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1	Cover above Purewa Top Coal Seam	35-155
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2	Purewa Top Coal Seam	8-10
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3	Parting between Purewa Top & Bottom	31-43
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4	Purewa bottom Coal Seam	8-13
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5	Parting between Purewa Bottom & Turra	53-62
---	---------------------------------------	-------

6	Turra Coal Seam	19-22
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## Natural drainage channel

Following natural drainage channel exists in Khadia Mine which will require cleaning by Civil Contractor.

- |  |           |
|--|-----------|
| 1. Hardua nala in Khadia residential colony area         | – 0.60 km |
| 2. Chilkatand basti nala in Chilkatand basti             | – 0.70 km |
| 3. Near old CHP/ Coal Workshop 02 nos. (2.5 km + 0.5 km) | – 3.00 km |

## Garland drain

Garland drains of about 7.8 km which already exists to prevent rain water from Northern and Western boundary of the mine from hillock/ Dudhichua dump areas will require cleaning and also new drain cutting in south of Eastern dump of about 1.0 km will be required by Civil Contractor.

- |   |          |
|---|----------|
| 1. In North of Khadia Mine cleaning of drain by O/S Agencies        | - 3.0 km |
| 2. In South of Khadia Mine cleaning of drain by Civil Contractor    | - 3.0 km |
| 3. In West of Khadia Mine cleaning of drain by Civil Contractor     | - 1.8 km |
| 4. In South of Khadia Mine new cutting of drain by Civil Contractor | - 1.0 km |

# Drain cleaning works to be taken up

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## **Dump/ Bench Drains ( By Deptt. Means)**

1. Drain cutting in western dump to course water from dump top.
2. Drain cutting in central dump to course water from dump top.
3. Bench drains shall be made by concerned OB/ Coal Section

## **Dump/ Bench Drains ( By Outs. Means)**

Drain cutting in eastern dump to course water from dump top shall be done by M/s. BGR-VPR-Consortium

## **Dumps Benching**

Dump benching at the interval of 30 mtrs has already been done in Year 2017-18. These benches require repairing/ widening and shall be done by departmental means.

# Monsoon Activities by Mining Department 140

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Sl. No.	Activities	Nature of work	Status of work	Responsibility	No v	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Sloping work for top benches of dump for directing water out of the mine	Mining		Incharge HOE								
2	Channeling of water course over dump to prevent the flow in steeper direction	Mining	This is a job of regular monitoring and shall be taken care of by a dump monitoring cell besides regular supervision	Incharge HOE								
3	Dump Management		Headed by section manager a dump monitoring cell is established for regular inspection, observation and implement action of the irregularities , if any. A record will be kept for the purpose and kept for ready for being checked.	Concerned Section Manager								



# Monsoon activity of OB section

**Civil:-**

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1. Hume pipe laying in VPR area in garage road near T/O (20m).
2. Drain along Dudhichua boundary up to double barrel from 5 no. Coal Yard.
3. Hume pipe laying at ramp to take the rain water into S-3 sump.
4. Hume pipe cleaning in new time office haul road near coal yard no. 5.
5. Silt arrestor pond in the toe of Dudhichua dump opposite to Coal yard no. 5.
6. Sump (S-3A) preparation including Shade after lowering of benches along North side by VPR.
7. Stone pitching in between new Time Office & dump.
8. Drain cleaning in lower bench in between New T/O & dump.
9. Cleaning of drain behind Time office (600m)

## **Departmental:-**

1. Drain in all departmental benches as per requirement during monsoon time & to direct all water to P/B sump.
2. Cleaning drains along OB Section haul road and dump area.
3. Drain cutting inside the mine in departmental patch.

## **VPR:-**

1. Garland drain in VPR 1.5 Km in length
2. Drain at all benches in VPR as per requirement.
3. Rain water management in VPR dump as per bench design.

# Monsoon activity in Coal section

## Departmental-

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1. Drain cutting along main haul road-500mtr.
2. Drain cutting along East cut (1km) and West cut (1Km).
3. Cleaning of old drain-2km.
4. Slopping of dumps with regard to water drainage in east and central dump.
5. De-silting of sump near pedestal
6. De-siltation of silt tank North side of haul road

# MONSOON ACTIVITIES IN COAL SECTION

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- 1- Sloping work for top benches of dump for coursing of water out of the mine.
- 2- Channeling of water course over dump to prevent the flow in steeper direction.
- 3- Benching of dump- Existing and it will be repaired as when required
- 4- Sump Calculation - Completed
- 5- Sump Preparation - S1: Partially done  
S2: It will be starts from 15<sup>th</sup> May, 2022
- 6- Drain cutting in benches in coal / OB section. Will be taken up in in mid of May-2022 (depending on current bench position)
- 7- Dump benching in all three dumps – In BGR (East HoE) & VPR west dump in regular process.
- 8- Drain cutting at outer dump – 500 meter - 20 to 30<sup>th</sup> May 2022.
- 9- Drain cleaning along main entry 1-10th April 2022.
- 10 Hume laying East + West) – 15<sup>th</sup> May 2022.

# MONSOON ACTIVITIES IN COAL SECTION

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- 1. Desilting of S3 sump to enhance the capacity of sump. (Upto 15th May)
- 2. S3(A) sump preparation will be completed upto 30th May 2022.
- 3. Drain cleaning and new drain cutting as when required (upto 30th April)
- 4. Rain cut is to be required above 2 no. Coal yard, west section time office, above 5no C/Y and other benches (upto 30th April)
- 5. To protect coal yard no.6 , garland drain to be made and other shall be coursed in natural drain.
- 6. Dumping Bench gradient/slope is making effective to avoid Rain cut and proper drainage to sump and natural garland.
- 7. Clean drain in front/behind of west section time office, all hume pipe, drain outside the working area of mine is to be cleaned and complete as previous precautions with hume pipe laying at vulnerable point.( by Civil Dept.)
- 8. To restrict the erosion of O/B at the level differences Placer sand bag/gabbing is to be provided. (BY CIVIL DEPT.)
- 9. 3 pipeline from S3 sump with complete set of pump and from S3(A) sump ,one set of pump with one delivery to be provided. ( By E&M dept

In charge  
OB section

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# **E&M DEPARTMENT**

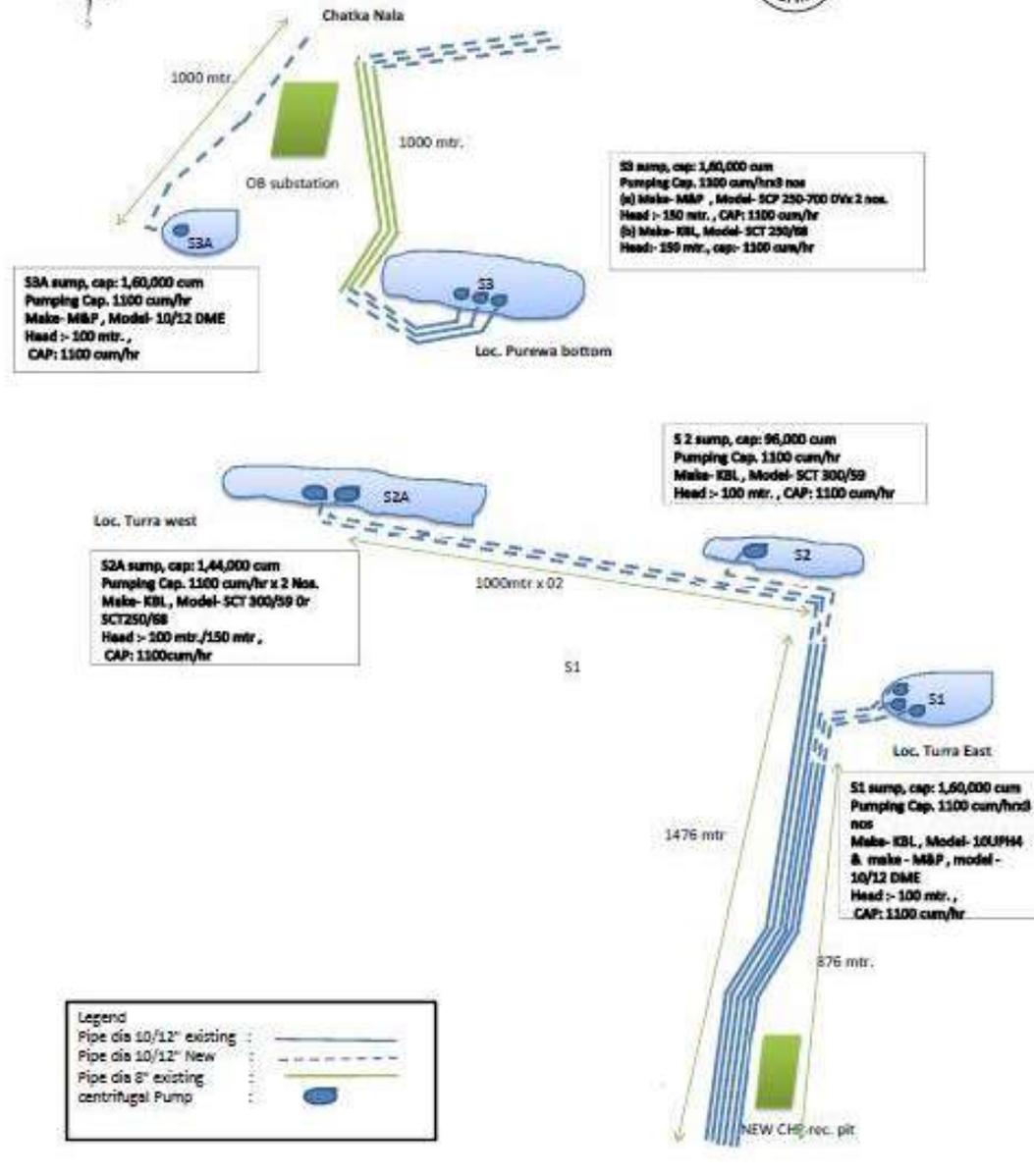
Mine Dewatering Plan 2022-23

KRUMHOLTZ PROJECT

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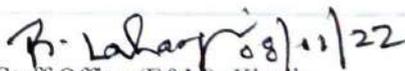
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### Activities & fund requirement under Purchase - Repair for Monsoon 2022-23

Sr. No.	Description of work	Unit	Qty.	Proposed Amount (In Lakh)	Remarks
1	Laying and dismantling of pipeline of and 10/12" dia at different locations of Khadia mine	km	11.6	17.5	
2	Fabrication of MS Pontoon with Walkway and Tin shed(New)	No	3+4	6.5	
3	Repairing of MS pontoon with walkway and Tin shed (Old)	No	6	6.5	
4	Fabrication of drum pontoon of 20 drums (New)	No	30	7.88	
5	Repairing of HT pumps	No	12	16	
6	Repairing of HT starter for Pumps	No	06	2.5	
7	Repairing of different type of valves	No	20	0.76	
8	Different type of structural steel fabrication work for pumping.	MT	4	1.25	
9	Fabrication of universal Joints 10" dia	No	10	1.5	
10	Hiring of 1 no. Covered Bolero Jeep 12Hrs/Day	No.	01	3.5	
11	Day to day operation of pumps in shifts	No.	01	16	
12	Shifting and installation of HT and LT pumps in mines	No.	01	4.0	
13	Day to day running maintenance of pumps	No.	01	10.0	
<b>Total</b>				<b>93.89</b>	

  
 Project Engineer(E&M), Khadia  
 7/1/22

  
 Staff Officer(E&M), Khadia  
 08/11/22

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## Comparative fund required for Monsoon 2022-23

Sr. No.	Description of Work	Proposed Amount 2021-22 (lakh)	Tendered Amount 2021-22 (lakh)	Awarded amount. 2021-22 (lakh.)	Proposed Amount 2022-23 (lakh)	Remarks
1	Laying/relaying and dismantling of pipeline of and 10/12" dia at different location of Khadia mine	16.94	16.94	13.94	17.5	5 KM extra piping due to change of sumping locations. Relocation of existing laid pipes due to advancement of mines
2	Fabrication of MS Pontoon (New)	6.52	6.52	3.78	6.5	
3	Repairing of MS pontoon (old)	7.67	7.67	3.34	6.5	
4	Fabrication of Drum pontoon of 20 Drums (New)	6.75	6.75	3.31	7.88	Increase in wages of approx 4% since last year in all categories of manpower
5	Repairing of HT Pump	17.00	15.44	15.51	16	
6	Repairing of HT starter for Pump	2.50	1.49	0.95	2.5	
7	Different type of valve repairing	1.23	1.23	0.82	0.76	

*(Signature)*  
27/1/22

*B. Lahary* 08/1/22

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8	Different type of structural steel fabrication work for pumping	2.0	2.36	1.13	1.25	Increase in wages of approx 4% since last year in all categories of manpower
9	Fabrication of universal joints 10" dia.	2.59	2.52	1.18	1.5	
10	Hiring 01 no. covered Belero jeep 12 Hrs/day operation for 180 day (6 months)	4.00	3.81	3.54	3.5	
11	Day to day operation of pumps in shifts	nil	33.19	15.44	16	
12	Shifting and installation of HT and LT pumps	nil	42.47	1.88	4.0	Fund provided from Normal PR fund of 2021. However, this being yearly activity including monsoon the period, fund is sought from Monsoon Budget
13	Day to day running maintenance of pumps	nil	25.27	11.99	10.0	
<b>Total</b>		<b>67.2</b>	<b>165.13</b>	<b>76.81</b>	<b>93.89</b>	

*(Signature)*  
 Project Engineer(E&M), Khadia

*(Signature)* 08/01/22  
 Staff Officer(E&M), Khadia

### List of required Consumables

Sl.No	Description of items	Units.	Required	Available	Net required
1	Non-Return Valve 12"	No.	20	Nil	20
2	Sluice Valve 12"	No	20	Nil	20
3	Foot valve 12"	No	15	Nil	15
6	Sluice valve 6"	No	20	Nil	20
7	MS Nut Bolts, 3/4"x4" full thread	Kg	1000	Nil	1000
8	MS Nut Bolts, 5/8"x3" full Thread	Kg	700	Nil	700
9	GI Nut Bolt, 3/8 x3 " full thread	Kg	500	Nil	500
10	Nylon Rope 16mm	mtrs	1000	Nil	1000
11	Manila Rope 25 mm	Kg	100	Nil	100
12	MS Balti	No.	12	Nil	12
13	Flexible Hose pipe 6" and 10"	Nos.	20+30	10+10	10+20

  
Project Engineer(E&M),Khadia

  
Staff Officer(E&M), Khadia

## 166 Requirement of centralized items for Monsoon 2022-23

Sl.No.	Description of items	Unit	Qty
1	MS Black Pipe 10/12" Dia	Mtrs.	5000
2	MS Black Pipe 8" Dia	Mtrs.	2000
3	MS Black Pipe 6" Dia	Mtrs.	4000
4	Mining Cable 3x90sqmm Copper Cable 11kv grade	Mtrs.	1000
5	Mining Cable 3x70sqmm Copper Cable 11kv grade	Mtrs.	250
6	Mining Cable 3x50sqmm Copper Cable 11kv grade	Mtrs.	500
7	Mining Cable 3x35sqmm Copper Cable 11kv grade	Mtrs.	500
8	LT cable 4x16 Sq. mm Copper cable	Mtrs.	1000
9	Angle 50x50x6mm	MT	12
10	Angle 75x75x8mm	Mt	14
11	MS plate 3.15mm	MT	21
12	MS plate 6 mm	MT	4
13	MS plate 12MM	MT	4
14	AAA Conductor 148 Sqmm	KM	10
15	AAA Conductor 84 sqmm	KM	15
16	MS channel 100x50x6 mm	MT	10
17	MS Pipe 2.5 inch	Mtr	250
18	GI Pipe 1 inch	Mtr	1200
19	GI Sheets	Nos.	300
20	MS plate 30mm	MT	3

### Total requirement of Pump and Delivery Range

Name of Location	Pump Capacity	Required no of pumps	Available no of pumps	Shortfall of pump	Required Pipe Range	Available pipe range	Shortfall Pipe range
Turra East S1	1100CuM/H,100 Mtr head	3	3	0	3 Range of 600 Mtr.( total 1800 mtr)	Nil	1000 mtr
Turra West S2 & S2A	1100CuM/H,100 Mtr head	3	3	0	2 Range of 1000mtr (Total - 2000 mtr)	Nil	2000 mtr
Purewa Bottom( S3+ S3A)	1100CuM/H,150 Mtr head	4	4	0	3 Range of 1000 mtr	Nil	3000

### Existing HT Pumps

Sl.No.	Make	Model	KW	Head	Discharge CuM/H	Suction Inch	Delivery Inch	Location	Remark
1	M&P(03 no.)	10/12 DME	400	100	1100	12	10		
2	Kirlosker(02)	10UPH4	400	100	1100	12	10		
3	Kirlosker(02)	SCT300/59	500	100	1100	14	12		
4	Kirlosker(02)	SCT250/68	800	150	1100	12	10		
5	M & P (02 No.)	SCP 250-700 DV	800	150	1100	12	10		

Project Engineer(E&M),Khadia

Staff Officer(E&M), Khadia

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 Details of Break down motors lying at Central Workshop ,Jayant for repairing

Sl. No.	Description of motors	Sl.No. & make	Date of Receiving at CWS	Work order no.
1	6.6KV ,425 KW Induction Motor	TVC 498077/03	07/01/2020	KHA/CWS/19-20/002410/ELE
2	6.6KV ,410 KW Induction Motor	186052/03	20/07/2021	KHA/CWS/21-22/000775/ELE

Project Engineer(E&M),Khadia  
 28/12

Staff Officer(E&M), Khadia

# CIVIL DEPARTMENT

PROPOSED MONSOON ACTIVITY 2022-23 KHADIA PROJECT									
S.No.	Activity	LAST YEAR ACTIVITY - FY 2021-22				For FY 2022-23		Remarks	
		Sanctioned fund in Rs Lakhs (BE 2021-22)	Est. cost (incl. GST)/fund allocation	Awarded value (incl. GST)	Completion period of work	Approx. Estd Cost	Fund Required		
1	Cleaning and removal of silt/earth from nallah/siltation area of mine towards OB time office along railway line up to double barrel culvert and NTPC boundary wall at Khadia Project	100	97.53	44.8	180Days	130.00	130.00	Estimated cost increased due to adoption of updated rate which hikes to 22.54% from last year rate & addl qty 7.60% additionally proposed for this year due to heavy silt deposited in nallah along railway track & double barrel required for desilting. Total Qty increased 7.60% & increased in estimate cost w.r.t. last year estimate is 32.57%. (7.60% increase in Qty wrt last year & estimated cost increased to 32.57%)	
2	Cleaning and Removal of silt from coal yard no 2 to CHP receiving pit, main entry haul road drain, and west sump including CHP, coal workshop, nallah, siltation area etc. at Khadia Project.	60	52.7	23.7	180Days	66.00	66.00	Estimated cost increased due to adoption of updated rate which hikes to 22.71% from last year rate & addl qty 2.02% additionally proposed for this year due to heavy silt deposited in nallah /drain and pond. Total Qty increased 2.02% & increased in estimate cost w.r.t. last year estimate is 25.16%. Qty increased this year 2% & estimated cost increased 25.16 wrt last year estimate.	
3	Providing and placing wire net cages filled with OB boulder, OB/silt filled bags, supply and laying Hume pipe at different location in mine area, 3 Nos structural steel shed and supply of stone metal at Khadia Project	100	99.4	71.18	180Days	140.00	140.00	Qty of Gabbion and P/F of sand bags and road metal qty have been additionally proposed. Estd cost increased due to adoption of New DSR'18 which rates are increase about 30-35%	
4	Removal and cleaning of Nallah/drain for nearby villages i.e Chilkatand, Rajaparaswar, Khadia Village etc at Khadia Project	45	42.25	15.43	180Days	57.70	57.70	Estimated cost increased due to adoption of updated rate which hikes to 24.17% from last year rate & addl qty 9.98% additionally proposed for this year due to heavy silt deposited in nallah /drain and pond. Total Qty increased 9.98% & increased in estimate cost w.r.t. last year estimate is 36.54%	
5	Making of face wall, wing wall of hume pipe insude mine premices and other misc. works.	0	0	0	90 days	50.00	50.00	Damaged face wall & wing wall of existing hume pipe culverts are to be repaired	
6	Hiring of 1 nos. vehicle for supervision during monsoon	7	7	3.5	180Days	5.00	5.00	Required for inspection of monsoon activity.	
7	Making siltation pond with Cleaning of nallah from down stream side of new workshop to Nautola culvert.	0	0	0	90 days	15.40	15.40	Required for arresting silt and proper/guided discharge of surface/storm water towards Nautola culvert. With siltation pond 60mx40mx3mtr and 40mx40mx3mtr	
8	Misc unforeseen works	50	50	-		50.00	50.00	As per requirement on immergent necessity.	
	<b>TOTAL</b>	<b>362</b>	<b>348.88</b>	<b>158.61</b>		<b>514.10</b>	<b>514.10</b>		

*[Signature]*  
08/11/22  
PE(C)

*[Signature]*  
08/11/22  
C.S.O. C.M.

*[Signature]*  
08.01.2022  
P.O. A.S.O.

*[Signature]*  
08/11/22  
Area Survey Officer

*[Signature]*  
08/11/2022  
S.O.(C)

*[Signature]*  
08/11/2022  
G.M./KHD

**Monsoon Action Plan (Civil) 2022-23**

Schedule of Civil works for Monsoon 2022-23 of Khadia Project in Standard format

Sl.No.	Activities	Till 15		From 1st	May	June	July	Aug	Sep	Oct	Nov	Dec	Remark
		Jan	15 Jan to 30 March										
<b>B Monsoon preparation work activities to be done during monsoon period</b>													
1	Cleaning and removal of silt/earth from nallah/siltation area of mine towards OB time office along railway line up to double barrel culvert and NTPC boundary wall at Khadia Project												
2	Cleaning and Removal of silt from coal yard no 2 to CHP receiving pit, main entry haul road drain , and west sump including CHP, coal workshop ,nallah, siltation area etc. at Khadia Project.												
3	Providing and placing wire net cages filled with OB boulder,OB/silt filled bags, supply and laying Hume pipe at different location in mine area,3 Nos structural steel shed and supply of stone metal at Khadia Project												
4	Removal and cleaning of Nallah/drain for nearby villages i.e Chilkatand, ,Rajaparaswar,Khadia Village etc at Khadia Project												
5	Making of face wall, wing wall of hume pipe culverts insude mine premices and other misc. works.												
6	Hiring of 1 nos. vehicle for supervision during monsoon												
7	Making siltation pond with Cleaning of nallah from down stream side of new workshop to Nautola culvert.												
8	Making toe wall at discharge point of Dudhichua drain for protection of road of OB time office												
9	Misc. unforeseen works												
<b>Total</b>													

	Estimation
	Tendering and award
	Execution

*[Signature]* PE(C)     
 *[Signature]* C.S.O.     
 *[Signature]* C.M.     
 *[Signature]* P.O.     
 *[Signature]* A.S.O.     
 *[Signature]* Area Survey Officer     
 *[Signature]* S.O.(C)     
 *[Signature]* G.M./KHD

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THANK YOU



BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

Original Application No. 580 / 2022

B. R. 1838/2022  
Place Waidhan  
Date 15/2/23

IN RE:

Mukesh Singh ..... Applicant  
Versus  
State of Uttar Pradesh & Ors. .... Respondent

I, the undersigned to whom these presents shall ..... General Manager, Khadia Project, NCL  
came that I the above named applicant/respondent do hereby appoint

**ASHUTOSH THAKUR & ASSOCIATES**

ADVOCATES

Chamber No. 321, C.K. Daphtary Block,  
Supreme Court of India,  
New Delhi-110001  
MOB-9717284820, Enrl. D/2638/2009  
ashu2638@gmail.com

(herein after called the advocate/(s) to be my/our advocate in the above noted case  
authorized him:-

To act, appear and plead in the above-noted case in this court or any other Court in  
which the same may be tried or tried or heard and also in the appellate Court including High  
Court subject to payment of fee separately for each court by me/us.

To sign, file, verify and present pleadings, appeals, cross-objections or petitions for  
executions review revision, withdrawal, compromise or other petitions or affidavits or other  
stages subjects to payment of fees for each stage. To file and take back documents, to admit  
and/or deny the documents of opposite party.

To appoint and instruct any other Legal Practitioner authorizing him to  
exercise the power and authority hereby conferred upon the Advocate whenever he may think  
fit to do so and to sign the power of attorney on our behalf.

And I/We undertake that I/We or my/our duly authorized agent would appear in Court  
on all hearings and will inform the Advocate for appearance when the case is called.

And I/We the undersigned to hereby agree not to hold the advocate of his substitute  
responsible for the result of the said case. The adjournment costs whenever ordered by the  
Court shall be of the Advocate which he shall receive and retain for himself.

And I/We the undersigned to hereby agree that in the event of the whole or part of the  
fee agreed by me/us to be paid to the advocate remaining unpaid he shall be entitled to  
withdraw from the prosecution of the said case until the same is paid up. The fee settled is  
only for the above case and above Court.

IN WITNESS WHEREOF I/We do hereunto set my/our hand these presents the contents of  
which have been understood by me/us on this 15<sup>th</sup> day of February, 2023.

Accepted/Identify

ADVOCATEs  
ASHUTOSH THAKUR

CLIENT

Sig. Of Deponent  
Executant



*Anand*  
General Manager  
Khadia Area  
R.L.

*Ramashankar Ghosh*  
Advocate, NOTARY  
Waidhan, Distt. Singrauli (M.P.)

Identified by

CANCELLED  
NOTARIAL  
Affixed