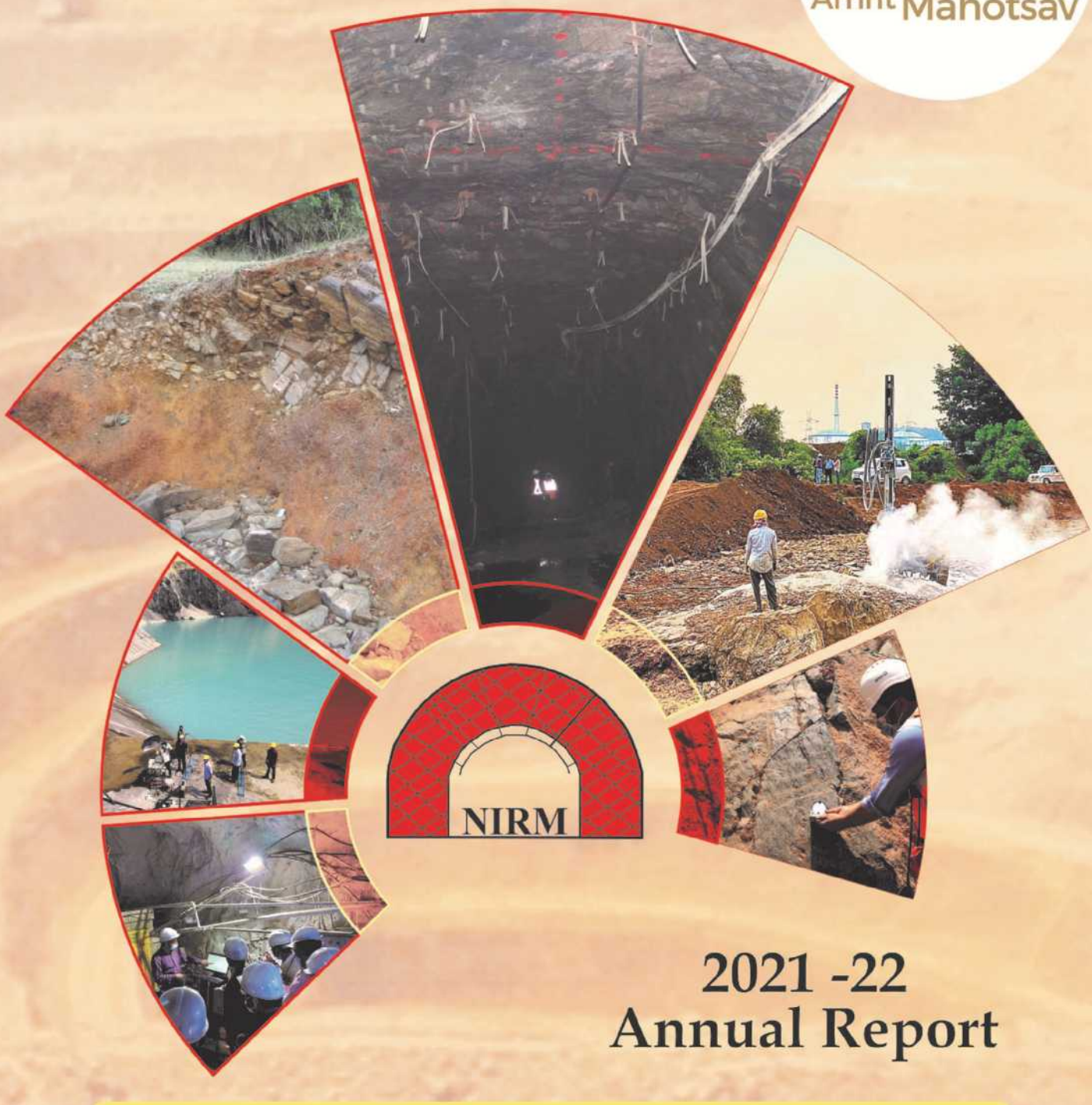
Azadi Ka Amrit Mahotsav



2021 -22
Annual Report

National Institute of Rock Mechanics
(Ministry of Mines, Government of India)

Head Office
Dr. Puneet Rajkumar Road, Eshwar Nagar,
Banashankari 2nd Stage, Bengaluru-560070
Karnataka, India

Registered Office
P.O. Champion Reefs,
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Karnataka, India

Quality Policy

- **Carry out advanced research in the areas of Rock Mechanics and Rock Engineering to remain a centre of excellence.**
- **Provide quality services to the total satisfaction of our clientele with strict adherence to contractual specifications.**
- **Enhance knowledge and skill of the employees on continuous basis.**

Quality Objectives

- **Excel as an R&D organisation by providing high quality, need based, value added services in the emerging areas of rock mechanics and rock engineering for surface and underground excavations.**
- **Develop innovative technologies for improving productivity and safety.**
- **Information dissemination of knowledge and expertise by organising seminars and conferences and by conducting training courses and workshops for professionals.**
- **Publication of papers in national and international journals.**
- **Facilitate skill enhancement of employees by participating in training and workshops.**

Discussion of Shri. Niranjan Nayak, Chief Engineer, IRSE with Dr. H S Venkatesh, Director, NIRM regarding issues related to rock mechanics at west coast of India, in Sep 2021.

Front Cover photo captions (left to right):

First: *Microseismic monitoring training to the participant at Raichur, HGML mine site, sponsored by Min. of Mines, Govt. of India.*

Second: *GPR investigations at NTPC Koal dam site, Himachal Pradesh.*

Third: *Neotectonic fault identified at the east coast of India around Gopalpur, Odisha.*

Fourth: *Geological data collection for 3D modelling studies, from underground mine of Malanjkhand Copper Project.*

Fifth: *Controlled blasting and vibration monitoring at Kaiga NPP unit 5 & 6, NPCIL, Karnataka.*

Sixth: *Geological data collection for 3D modelling studies, from open pit mine of Malanjkhand Copper Project.*

Annual Report
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CONTENTS

DIRECTOR'S MESSAGE

Namaste !

I am pleased to present the Annual Report of National Institute of Rock Mechanics (NIRM), for the year 2021-22 which highlights in brief the overview of all our activities in the areas of rock mechanics, rock engineering and allied fields for the development of mining, power, nuclear, infrastructure and other related sectors. NIRM is a premier Institute exclusively devoted to applied research in Rock Mechanics and Rock Engineering under the Ministry of Mines, Government of India. Our vision lays special emphasis on quality, innovation, professional competency and skill development, so as to serve all the stakeholders in the identified sectors.

Despite the constant global competitions during this transitory period of recovery from COVID-19, NIRM has tided over and achieved the targets having successfully completed 50 projects of which 21 projects were from mining sector, 15 from hydropower sector, 5 from nuclear sector, Thermal sector 2, (power sector 22) and 6 from infrastructure sector, one from oil & gas. NIRM was awarded 56 new projects during this financial year. Out of 56 new projects, 24 projects were from mining sector, 14 from hydropower sector, 3 from nuclear sector, 14 from infrastructure sector, and one from thermal sector.

In the Economic sphere, we were able to achieve reasonable growth and generated 40 percent of our salary expenditure and 100 percent of our administrative expenditure. Additionally, we could augment our scientific instrumentation and upgrade facilities to upkeep with the changing global needs and advancements partly through our internal resources too.

NIRM has been organizing a series of online technical lectures since March 2021, commemorating 75 years of Indian Independence, (Aazadi ka Amrut Mahotsav) and has been successful in completing around 44 lectures during this reporting period. NIRM employees participated in both online and offline national, international conferences, workshops and training programs which enabled honing of skills in the technical and administrative domains as a continued refresher re-training and knowledge sharing. Many of our employees have contributed to engineering decision making, nation building and societal improvements through their contributions by field studies, project meetings, research meetings, committees, professional bodies etc. During this year, the Institute has to its credit

more than 26 technical research papers being published in National and International Journals, and conference. NIRM conducted online Training-cum-Field-Workshop on "Importance of Microseismic Monitoring in Underground Excavation" sponsored by the Ministry of Mines, Govt. of India under the Sathyabhama Grant in aid. As part of information dissemination and skill development exercise, NIRM conducted two training courses for the executives of Druk Green Power Corporation Ltd., Bhutan. Several of our scientist have been member of Expert Committees for BIS, ISRM, ISEG, MEAI, KSDC, etc.

I am delighted to present the significant contributions which were made by the Institute this year in various sectors in accord with the vision of the Institute. During the year 2021-22, NIRM has made remarkable contributions to the development of safe and economic practices for coal, metal and opencast mines under difficult geomining conditions. Major projects have been oriented to reduce the risk and hazard by modifying/monitoring the mining methods and adopting best safety practices, while enhancing/sustaining the rate of production. For Malanjkand copper mine, numerical modelling was carried out for slope stability assessment for the open cast and to design underground stope dimensions, sequence and support system. In-situ stress was determined for designing the proposed underground mining at Baroi-Zawarmala, Mochia-Balaria and Rampura Agucha. Impact of ground vibration was studied at Zuari limestone mine, Andhra Pradesh and studies were conducted at Chintalayapalle, Kanakadripalli, and Kolimigundla limestone mines Kurnool District, Andhra Pradesh to optimize the blast design. Geophysical studies were carried out to determine the strength of the foundation of tailing dam at Bailadila iron ore mine and to access the ground conditions of abandoned coal mining area at Umaria, Madhya Pradesh. Stability studies of pit and dumps, stability analysis through instrumentation and numerical modelling were also undertaken.

NIRM made a substantial contribution to the Energy sector involving hydro, nuclear and thermal projects. NIRM is exclusively involved in solving various critical and complicated issues encountered in the hydroelectric project Punatsangchhu HEP II, which is being implemented jointly by the Royal Government of Bhutan and the Government of India. Several 3-dimensional numerical models were analyzed and a cavity monitoring system was developed subsequent to the roof collapse that had occurred during the excavation. NIRM designed instrumentation network layout for monitoring of structures as well as provided technical support for controlled blasting. For the other bilateral endeavour at Tala HEP, NIRM continued microseismic monitoring of the powerhouse. For the prestigious Sardar Sarovar project in Gujarat, NIRM continued monitoring at dam structure and underground facilities. Experiments were also conducted by the team of NIRM and BioID, Germany on the Dam Model using ADMON fiber optic technology (a proprietary technology of BioID, Germany). Sunni, Vishnugad Pipalkoti, Luhri, Pakal Dul, Kirthai and Kopili are the other Hydroelectric projects in Himalaya that NIRM supported during this period. NIRM

also extended the requested technical support for the implementation of several hydroelectric projects in peninsular India viz., Polavaram, Sharavathy, Saundatti, Pazhassi Sagar and Peruvannamuzhi.

In Nuclear energy sector, NIRM involved in several scientific studies for siting of NP sites. Studies are progressing for the seismotectonic evaluation of the proposed Jaitapur site. For Mahi Banswara (MBRAPP), technical support continued for geotechnical investigations. NIRM exclusively supports the foundation excavation activities at KKNPP and RAPP NPP sites. For thermal power plant at Darlapalli, Orissa, controlled blasting method of operations was adopted for the foundation excavation of various components of installation.

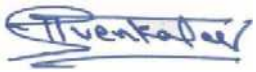
During this period, NIRM supported the selection/grading of armoured rock for the construction of breakwaters. Studies were also conducted in quarries for producing material for breakwater construction for Vizhinjam seaport, Kerala. Engineering geological studies were carried out for Palamuru, J Chokkarao and Kaleshwaram Lift Irrigation Projects.

Sophisticated DGMS approved testing and laboratory facilities are available at NIRM. During this period, in-situ testing of mining components in the mines viz., SCCL, HZL, HCL, NALCO etc., were carried out by NIRM. Laboratory testing of ropes and material for determination of various physico-mechanical properties were also done for various industries. To ensure the quality of stone blocks which is to be installed for the construction of Shri Ram temple, the temple Trust (Ayodhya) approached NIRM for expert advice and monitoring the quality of material of the stone being used in construction of the Shri Ram Janmbhoomi Temple at Ayodhya.

It is anticipated that with the collaboration of mining, power, nuclear and infrastructure sector organizations both public and private, NIRM shall gear up to reach new horizons towards a coherent future with a stable strategy to face the future global competitions.

The high degree of expertise and dedication showcased by our team of Scientists & staff has made it possible to place the Institute on the international stage in various sectors. I acknowledge with immense gratitude for the financial and administrative support received from the Ministry of Mines, the enduring support extended by the Chairman & members of General Body, Governing Body and Peer Review Committee. I am extremely thankful to our industry partners without whose continued support and trust this could not have been possible. I am also thankful for our external experts, who guided us in our pursuit for excellence.

Jai Hind !



H S Venkatesh

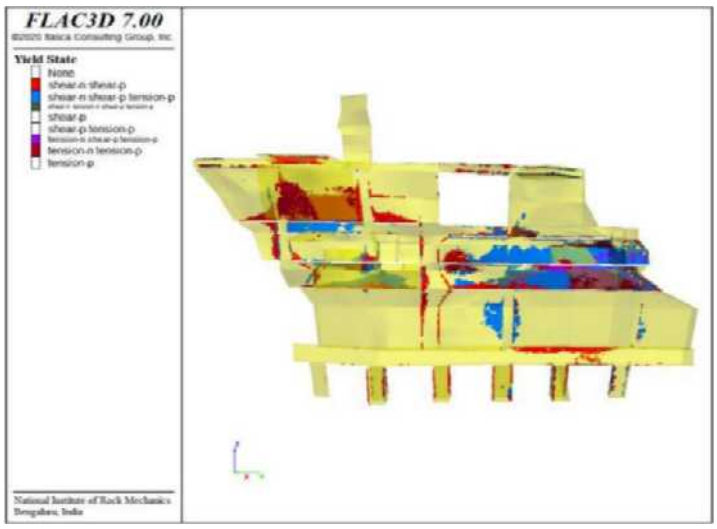
1.0 Mining Sector

National Institute of Rock Mechanics provides R&D support and expertise to the mining industry (surface and underground) by carrying out various types of investigations in the area of rock engineering and rock mechanics. During this period, NIRM conducted studies viz., design of method of mining, feasibility studies, design of stoping parameters, yield zone & stress distribution determination and stability studies of pit & dumps, stability analysis through instrumentation and numerical modelling and monitoring of ground vibrations.

1.1. Zawar group of mines is one of the oldest metal mines in Asian continent. Both, Mochia – Balaria and Baroi-Zawarmala mines are in expansion stage with annual production of 3.3 MT. The mining of the ore has reached up to 500 m below surface. The mine authorities are planning to develop stope blocks at lower levels below the mined-out area. In-situ stress is one of the important input parameters which dictates the size of the stopes. The stress measurements were carried out.

Hydraulic fracturing test at Zawar mines (HZL)

1.2. HZL management intended to review options for depillaring of remnant pillars in BK series to add a new production center considering backfilling of voids in the BK series at Baroi Mine of Hindustan Zinc Limited, Rajasthan. For this, a three-dimensional numerical model was developed, and the simulation of various cases have been completed.



Model state results presenting the extent of yield in shear and tension

MINING SECTOR

1.3. After reaching ultimate pit limit of open cast mine of Malanjkhand Copper Project (MCP), the management of HCL intended to conduct geotechnical mapping of the open pit mine, followed by 3D numerical modelling studies for slope stability assessments. The risk and impact assessment are also under the scope of work. The transition of MCP, HCL open pit to underground has also invited scope for geotechnical mapping, stability assessment of caprock and underground mine. Accordingly, numerical modelling works was taken up to assess the stability of underground workings, to design the stope dimensions, sequence, and support system.

Geotechnical mapping at drive of Malanjkhand Underground Copper Mine

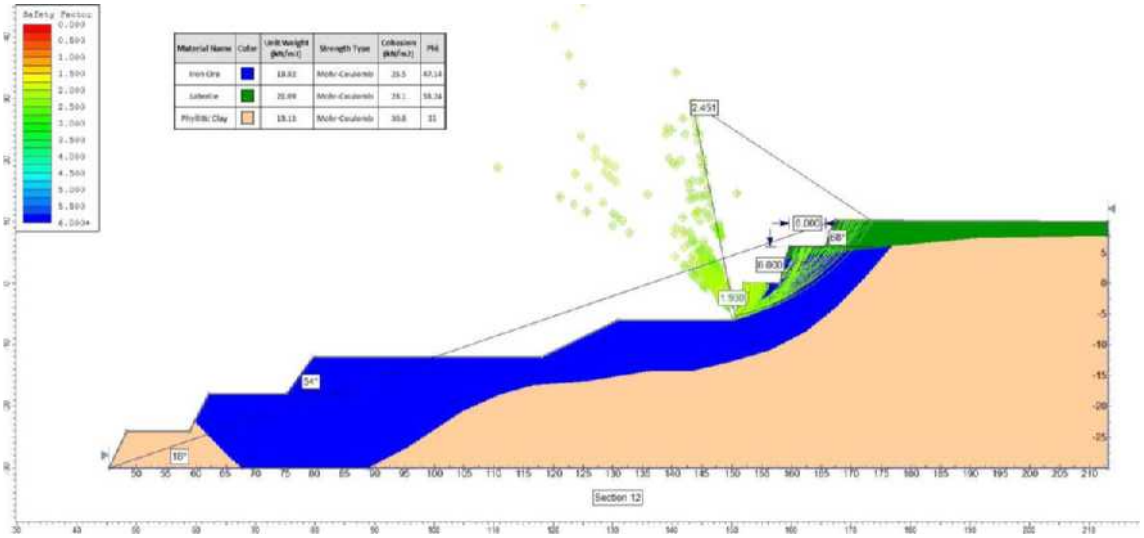
1.4. A review study was conducted for the effective implementations of the stability measures recommended earlier to M/s. Pallava Granites, Chimakurthy, Andhra Pradesh. Based on the study, the steps taken towards stabilizing walls of the quarry was found to be very effective and created stable walls. Analysis of monitoring data indicated no movement of highwall/benches.

1.5. The Ramco Cements Limited is setting up a green field cement plant with 3.15 MTPA Clinker, 2 MTPA Cement and 50 MW power plant at Kolimigundla Mandal, Kurnool District, Andhra Pradesh. The mine management is planning to start excavation of limestone by blasting in three of the mine leases. Though there are no private structures located within the Danger zone of 500 m from the proposed Chintalayapalle and Kanakadripalli limestone mines, the Kolimigundla limestone mine lease covers pockets of habitation, school building, public roads etc which are falling within the danger zone of blasting area. Keeping this in view, the Ramco Cements Limited awarded the scientific study to NIRM to conduct ground vibration and air overpressure studies at these three mines.

1.6. NIRM conducted study on ground vibration due to blasts at Zuari limestone mine, Andhra Pradesh thrice in July 1995, August 2013 and August 2018. NIRM has now taken up the work to conduct ground vibration study and to suggest safe permissible limits of vibration for various structures located beyond 100 m (including public road and high-tension power lines) from the mine as per the

DGMS norms. During 2021 for each blast, blast ground vibration was monitored at six locations with Micromate seismographs. Regression analysis and a site-specific predictor equation was derived for ground vibration and air overpressure.

1.7. Scientific study was conducted at Redi Iron Ore Mine of M/s. Minerals and Metals, Redi Village, Vengurla Taluka, Sindhudurg, Maharashtra. The safety of the



Analysis of left side section of a pit

mine pit and waste disposal (dump) by keeping the minimum distance from the houses/structures to its maximum depth of working and safe minimum distance from waste dump along with safe ultimate pit slope was evaluated. The safe pit slope angle of the mine pit and waste disposal (dump) by steep working of the mine pit by leaving minimum distance from the houses/structures to its maximum depth of working and safe minimum distance from waste dump were also determined.

1.8. M/s Jindal Steel Work (JSW) is operating an open cast Narayana iron ore mine near the village Narayanapura, Hospet. The nearest structure/house of the village is located at 200 m from the mine lease boundary and about 300 m from the present blasting location. As the village is located in the vicinity of Narayana Mines, blasting is to be carried out with additional measures to control the fly rocks, air overpressure and ground vibrations. NIRM was requested to arrive at better blast design parameters to minimize side effects and also to optimize the fragmentation, NIRM carried out initial field investigations. Work is under progress.

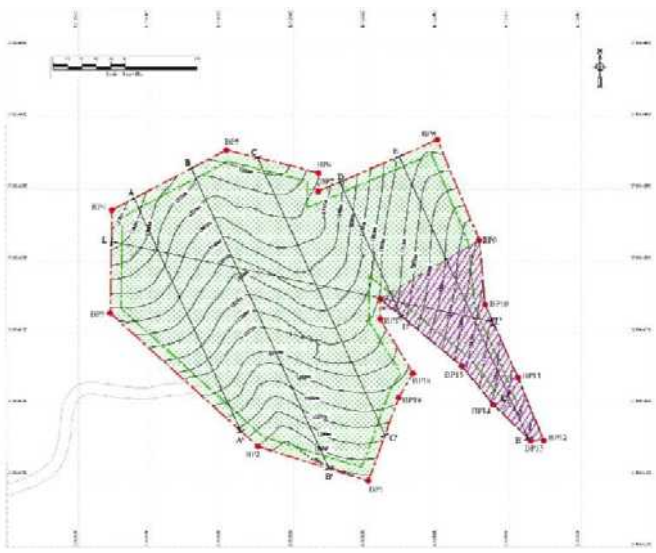
1.9. M/s. UltraTech Ltd has approached NIRM to conduct Scientific Study for stability assessment and monitoring of Pit and Dump at 3 sites namely Budgauna, Hinauti and Majhgawan Limestone mines at Sidhi Cement works. Field investigation is completed and samples were collected for laboratory testing. Based on results of the numerical analysis, the parameters were suggested and accordingly slope geometry recommended.

1.10. Hindustan Zinc Ltd. is the largest zinc –lead mineral producing company in India. One of their mines Rampura Agucha is the second largest zinc mine in the world with an annual production capacity of 4.5 MT. It is currently operating through both open-cast and underground mining methods. The mine authorities are planning to develop stope blocks below the mined-out area. In situ stress is one of the important input parameters which influences the size, support design and stability of the stopes. The stability of the structure gets enhanced if the long axis of the mine workings is oriented along or sub-parallel to that of maximum principal stress direction. HZL Rampura Agucha Mine has installed a seismic monitoring system to monitor mine induced seismic events as the mining horizons go deeper. For this the NIRM is associated with RAM for microseismic monitoring work for supporting the microseismic monitoring System recording, processing, analysis and assessing the seismic hazard status of the mines based on the data analysis and interpretation.

1.11. Scientific Study for slope stabilization and monitoring of ground movement of South Face, mine 1 of NLCIL, Neyveli, Tamil Nadu was carried out. No significant movement was observed. So, the entire south flank is considered to be stable. Proper compaction of the benches was also recommended on south side of the mine by use of rollers. This will significantly improve the stability.

1.12. M/s Midwest Granite Pvt Ltd., intended to carryout scientific studies for optimizing the bench parameters and design of final pit slope to work up to a depth of 150 m from the surface. Analysis of various sections have been done. The maximum allowable limit was calculated. The benches were optimized for maximum extraction by practising utmost safety.

1.13. Advice and preliminary technical guidance on scientific quarrying, bench parameters & final pit slope for the proposed dimensional stone black granite quarry of M/s. Stone Trust Enterprises has been offered. The factor of safety for the proposed sections of quarry with bench height, width and bench angle of 5 m, 5 m, 90° respectively.

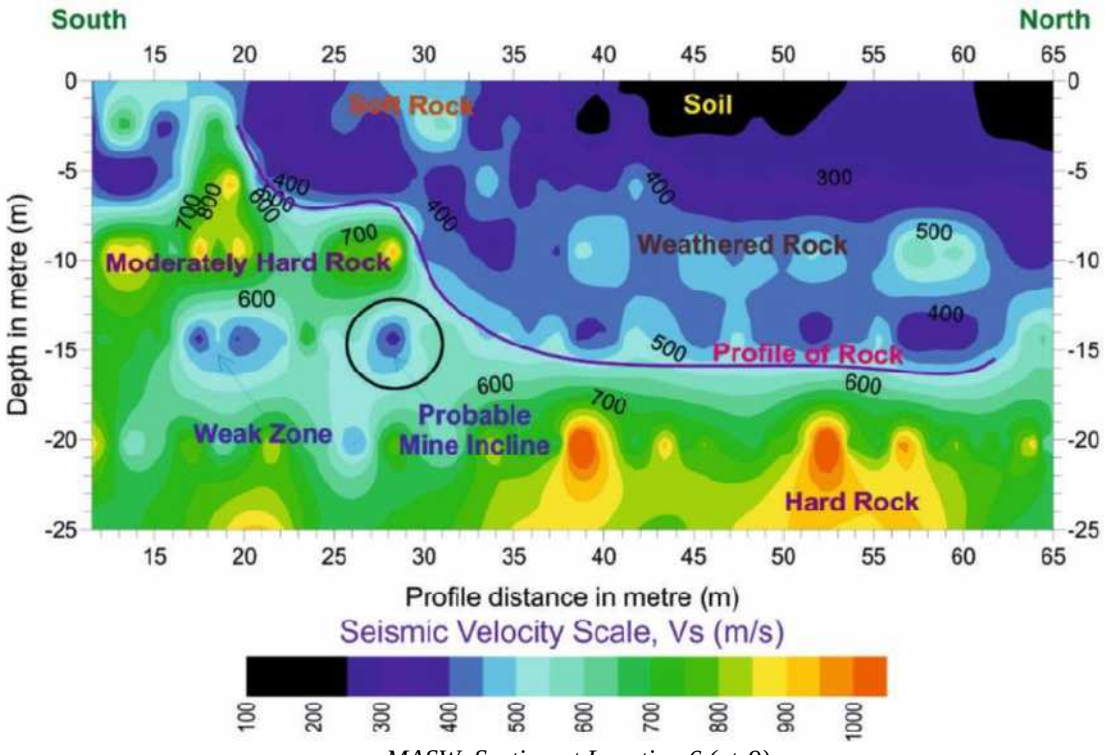


Surface Plan of a Granite Quarry located in Elapara, Kerala

1.14. M/s Haripriya Granites, Pearl & Golden Granites, Venus Granites, Bash Granites, RRR Granites, Rasun Granites are operating Granite quarries in Chimakurthy, Ongole. Scientific Studies were required for bench optimization and design of final pit slope. The work is in progress.

1.15. NIRM carried out MASW survey and vibration data at the top and bottom of three tailing dam of the Bailadila iron ore mine of National Mineral Development Corporation Limited in Bastar, Chhattisgarh. In tailing dam-1, shear wave velocity sections indicated that the dam foundation is safe. Tailing dam-2, is resting on a firm foundation of compact soil and hard rock. In tailing dam-3, a depression like feature was mapped at 8 m depth from dam top with an associated water-seepage observed on the surface. The vibration induced by traffic/cultural noise were found far below (1/100th to 1/10000th) the expected damage level.

1.16. The assessment of ground conditions around the sites of sinkholes and subsidence in the coal mining district of Umaria, Madhya Pradesh was taken up by NIRM in compliance of the directions of the Hon'ble NGT. Surface and borehole surveys using various geophysical methods were carried out at eight locations, which had some tell-tale signature of surface disturbance. Out of them four (4) sites fall within the inhabited area and remaining four (4) sites fall in the forest area. Surface geophysical survey using Seismic Refraction (SR) survey, Multichannel Analysis of Surface Waves (MASW) survey and Electrical Resistivity Imaging (ERI) survey was done at two locations in the forest area. At

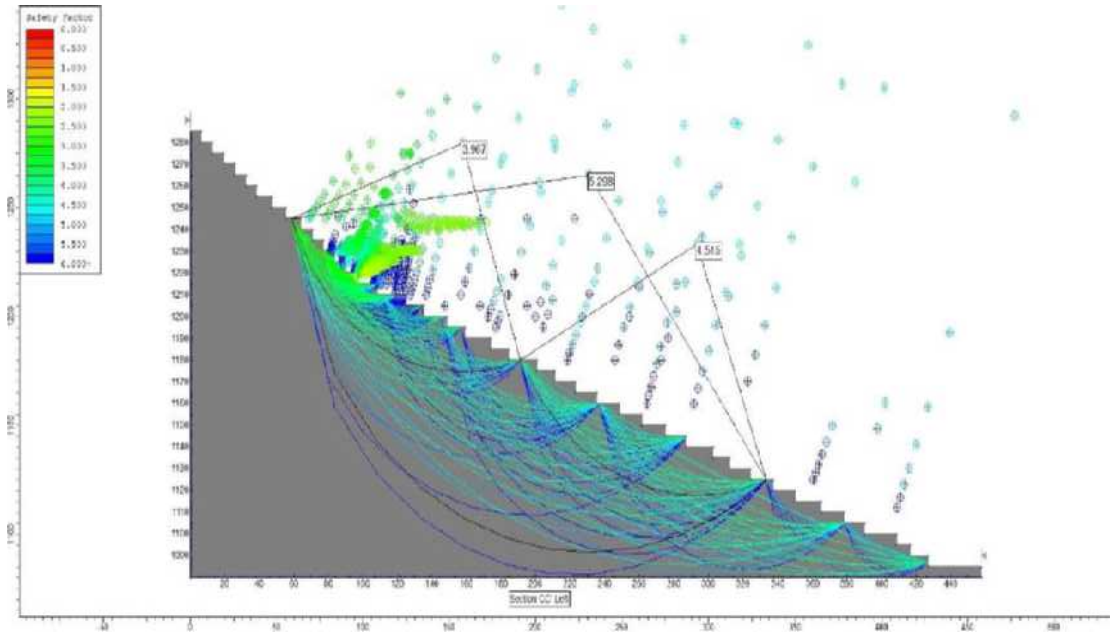


MASW Section at Location 6 (qtr9)

MINING SECTOR

Jhiriya Mohalla, borehole survey using Crosshole Seismic Tomography (CST) was also done. Data processing and analysis is in progress.

1.17. Three Geotechnical investigations were conducted to ascertain the stability of slopes of Rock Quarry in the Sy. No 184/1A located in Elappara



Analysis of a section of the granite quarry

Village, Peermade Taluk, Idukki District, Kerala State. Most of the lease area is exposed with rock cover with no vegetation and there are hardly any soil strata observed in the quarry site. Systematic slopes were designed and analysis of the quarry was carried out to assess its stability. The quarry benches are designed for a safe bench height of 5 m, width of 6 m and a slope angle of 90° for the individual benches. A minimum factor of safety of 1.3 was considered for the long-term stability of the benches. The derived minimum factor of safety being 1.9 and maximum is 5.29 indicating long term stability of the benches.

1.18. M/s. Minerals and Metals is operating Iron Ore Mine at Kalane village, Dodamarg Taluka, Sindhudurg district, Maharashtra state. The total lease area is 32.25 Ha. A detailed geotechnical study was conducted to design the slopes and assess the stability of the pit The analysis is carried out for the existing slope parameters of the mine benches and to suggest modified sections for safe mining. The factor of safety for the existing sections and modified sections for bench height is 6 m and bench width of 8 m are analysed and reported.

1.19. NIRM conducted trial blasts at Andhra Pradesh Mineral Development Corporation Ltd (APMDCL), dolomite open cast mine at Mangampet, Kadapa District, to optimize the blast design for excavation. Blasting is to be carried out in the vicinity of a public road (500 m from mining area). Thirteen experimental blasts were carried out in different benches and by varying the maximum charge per

delay. In total, 49 sets of ground vibration data were used for regression analysis. Based on the site-specific predictor equation derived, the safe maximum charge per delay for different distances was suggested. As per DGMS norms, permissible vibration levels for villages and structures not belonging to the owner was 5 mm/s. The flyrock distances were within 100 m from the blast.

View of the benches at Baryte mine at Mangampet.

1.20. The NLC India Ltd (formerly Neyveli Lignite Corporation Limited), is operating a captive Barsingsar Lignite Mine of 2.10 MTPA (peak) near Barsingsar village, Bikaner District, Rajasthan. A detailed geotechnical study was conducted to assess the stability of pit slope and dump of the mine. As part of recommendations individual bench parameters and ultimate pit slope angle was suggested. Based on the analysis, geometry for the pit and dump determined.

Aerial view of Lignite mine located in Barsingsar, Rajasthan

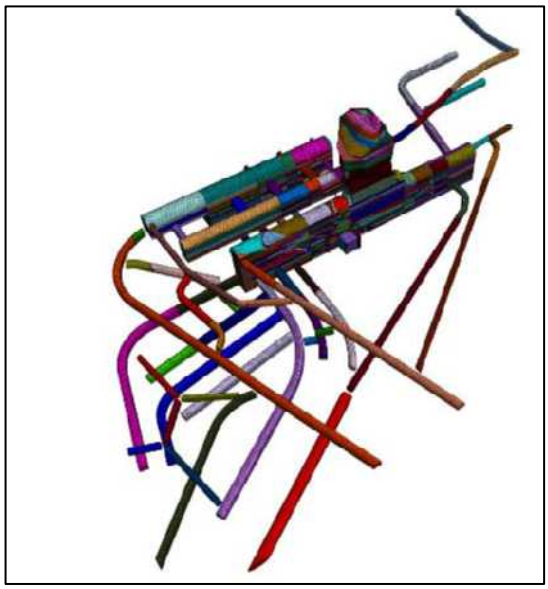
2.0 Power Sector

Power sector is the backbone of NIRM which accounts for more than 50% of the revenue earning. NIRM is extending the expertise by providing consultancy services to the power sector in solving the site specific problem related with the wide spectrum of rock engineering and rock mechanics and carried out crucial investigations for the design and development. The following are the work carried out during this period.

2.1. Punatsangchhu-II Hydroelectric Project (PHEP-II) is one of the significant bilateral Hydroelectric Project (1200 MW) between the Government of India and the Royal Government of Bhutan. NIRM is exclusively helping the project authority in various aspect of its implementation. NIRM provided technical guidance for the following tunnels of HRT during its excavation: N1a additional surge tunnel (80m), permanent access tunnel (100m), construction tunnel of 15m, draft tube tunnels (I to VI), additional surge tunnels south in multiple faces (≈ 507 m), downstream surge gallery benching (2000 m3). The blast induced ground vibration limits was under the prescribed vibration limit of 50mm/s at the structures by adopting site specific controlled blast design.

Final benching excavation in AST-N1a at RD 110

NIRM is presently carrying out studies and assessing the support during execution. Several innovative designs of instrumentation setup has been recommended to the client aiding in obtaining critical information required for assessing the stability of powerhouse caverns, surge tunnels besides aiding process by continuous monitoring and conducting cavity scans during cavity

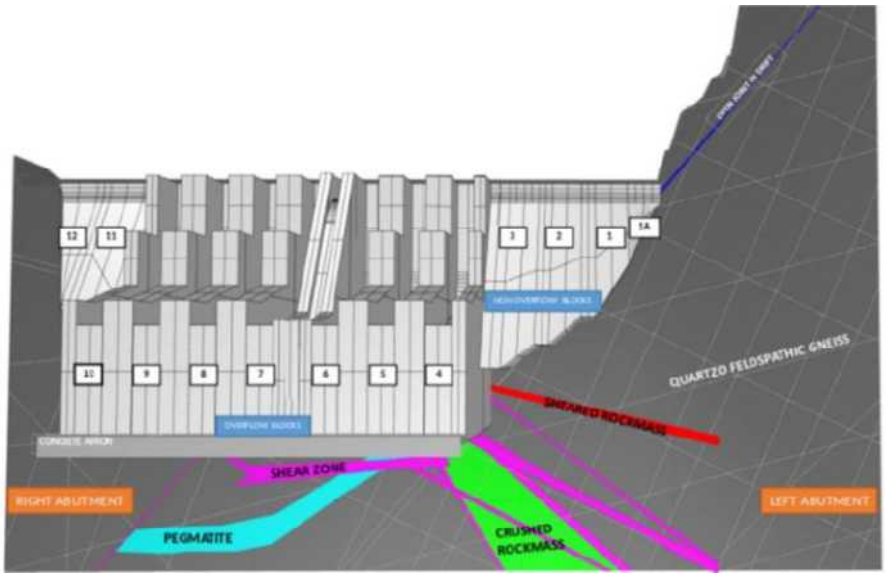


3DEC model of PHPA-II Powerhouse complex

POWER SECTOR

filling. Critical observations and suitable recommendations are made to the project execution team for timely action to prevent any further mishap. Excavation in DSC and AST by drilling and blasting methods may change the deformation and the stress distribution around the cavern.

To study the effect of cavity formation in downstream surge chamber on powerhouse cavern and transformer hall cavern, three-dimensional numerical modelling for powerhouse complex was carried out using 3D discontinum models in 3DEC. The following cases have been simulated: Design case - PH, TH and DSSG caverns with full excavation, actual site conditions without cavity over DSSG with actual sequence of excavation and supports, Post collapse scenario - PH, TH and DSSG caverns with full excavation, actual site conditions with cavity over DSSG along with all shear zones and joints and Treatment – Analysis was carried out for treatment/filling of cavity and muck in the cavern in place.



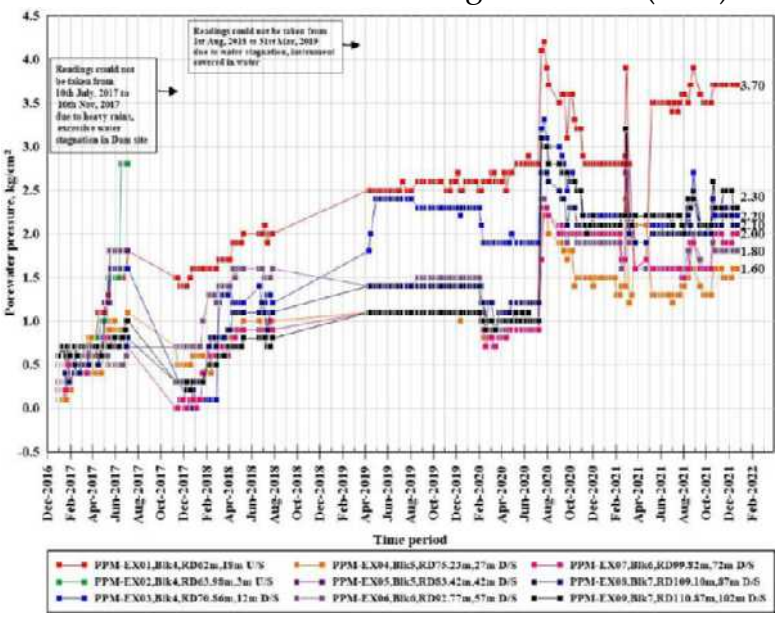
3D view of PHEP-II Dam, Bhutan (left)

Analysis of Punatsangchhu-II Hydroelectric Project Dam (91 m high concrete gravity dam) Instrumentation data analysis showed an increase in pore pressure in July 2020 (0.50 kg/cm^2 to 1.0 kg/cm^2) in the shear zone and instrumented blocks. It was also observed that there was an increase in pore pressure in shear zone in 1st week of March 2021 (from 2.40 kg/cm^2 to 3.90 kg/cm^2) followed by a sudden decrease in pore pressure in the last week of March 2021 (from 2.20 kg/cm^2 to 1.60 kg/cm^2). The changes in pore pressure may be attributed to the increased rainfall during the above said periods. Fluctuation in MPBX readings were observed at some of the anchors of MPBX 13, 15, 18, 19 & 28 and is being monitored.

Piezometers showed an increase in pore pressure from 3.5 kg/cm^2 to 3.90 kg/cm^2 on PPM-EX01 (18 m U/S) and 0.7 kg/cm^2 increase in pore pressure recorded on PPM-EX03 (12 m D/S). There was a change of up to 0.3 kg/cm^2 recorded on the other piezometers installed in the downstream. A trend in pattern has been observed that in the monsoon period from July to September, there is an

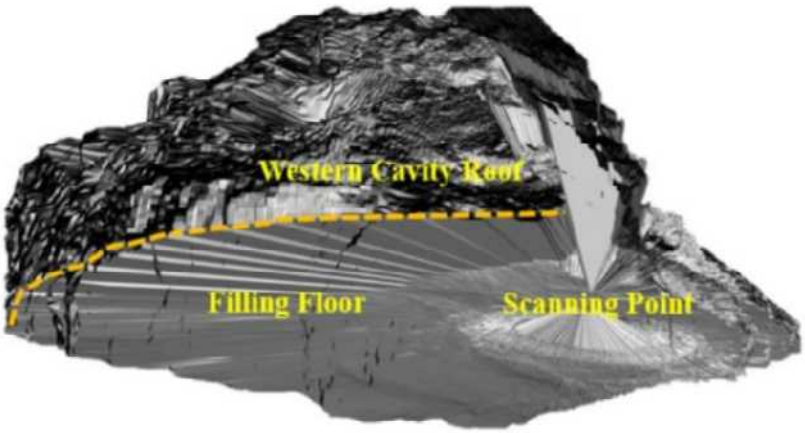
increase in pore pressure, may be attributed to rainfall and subsequent accumulation of water at the foundation level of the dam. To observe the sudden increase in pressure in the shear zone, additional piezometers are suggested to be installed in the upstream side of the shear zone blocks.

There was a collapse of the crown of the Downstream Surge Chamber (DSC) on 3rd March 2016 at Punatsangchhu -II Hydroelectric Project (PHEP-II), Bhutan. Rock mass collapse at downstream surge chamber of PHEP-II has led to flow of over one lakh cubic meters of muck into the cavern and formation of cavity extending upto ~96 m above the crown of the DSC. The cavity needs periodic monitoring to determine the extents of cavity and to assess if there is any increase in its dimensions. Using a cavity monitoring system, the void is surveyed, and the data obtained in the form of point cloud data is analysed. This process is repeated after every 5 m of cavity filling. The extent of cavity filling is also determined from the data analysis.



Piezometer observations at Shear zone EL 752m

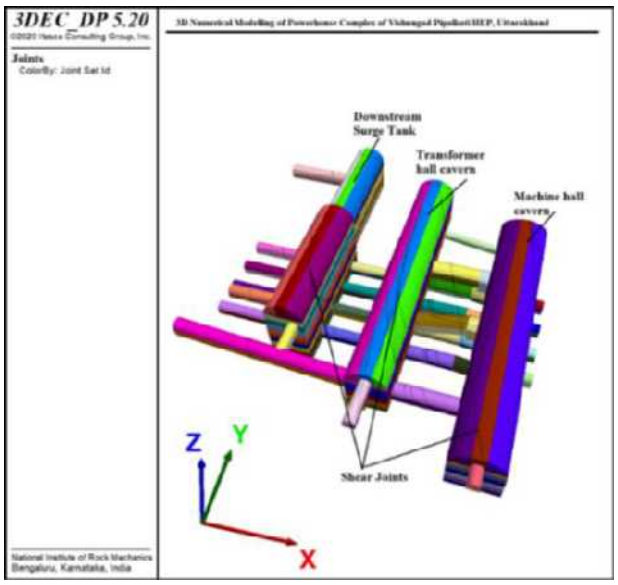
Cavity filling activity began on 19-05-2020 and was completed on 14-12-2021. The total backfill material estimated by using the Cavity Monitoring System (CMS) of 45692 m^3 and actual filled material of 47657 m^3 was consumed at the site, indicating about 96% accuracy in assessment. Further, from the regular monitoring and analysis of the instrumentation data from the instruments installed in the vicinity of the cavity, there are no significant variations in the data trend recorded.



Scan image of the partially filled cavity

POWER SECTOR

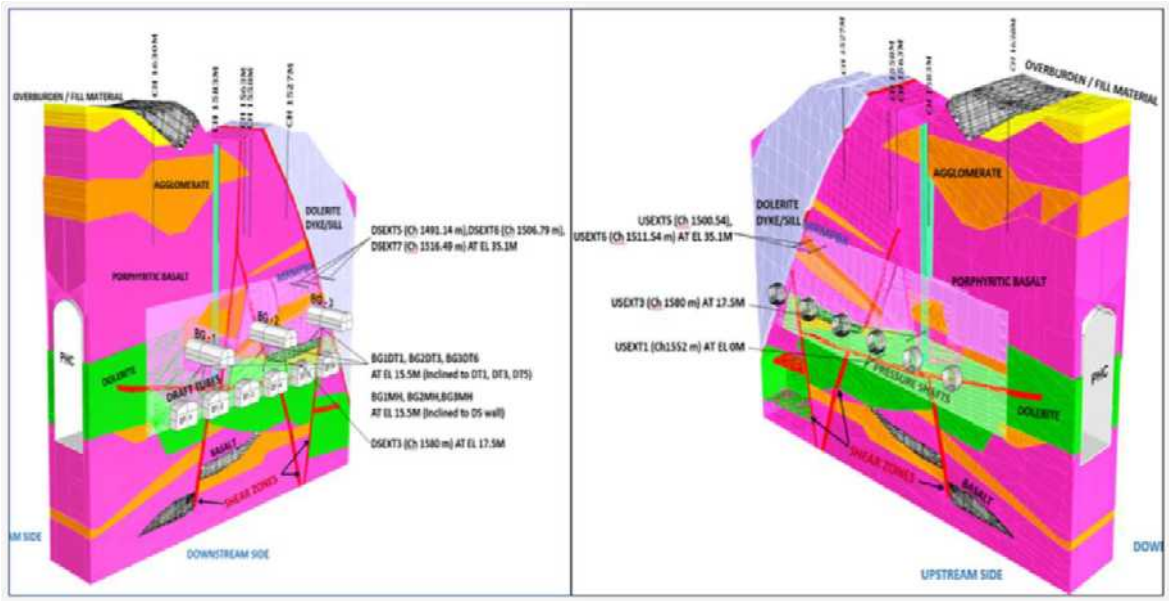
2.2. 3D Numerical modelling of powerhouse complex & surge tank for Vishnugad Pipalkoti Hydroelectric Project, Uttarakhand has been carried out by NIRM. The work objective includes checking the efficiency of the installed/proposed support system based on the modelling results. A 3DEC numerical model is developed for powerhouse complex consisting of machine hall cavern, transformer hall cavern and downstream surge tank.



3DEC model of Vishnugad Pipalkoti Powerhouse Complex

2.3. For the proposed 70 m high concrete gravity dam across river Arun, Sankhuwasabha, Nepal. Investigations for the shear parameters of the rock mass at right bank are under progress, as these parameters are required for designing of the dam structure.

2.4. The Sardar Sarovar Project is a prestigious multipurpose project on river Narmada in the state of Gujarat. In view of filling to full level of the Sardar Sarovar Dam (1,210 m long, 163 m high), continuous monitoring of the dam was carried out from 2019 monsoon period onwards. regular monitoring was carried out daily. Maximum deflection of 39.3 mm was observed in block no.33. Keeping the long-term monitoring perspective, it is recommended to go for advanced automatic geodetic monitoring system using Global Navigation Satellite System (GNSS) and automatic total stations. Based on this study permanent points on main dam is



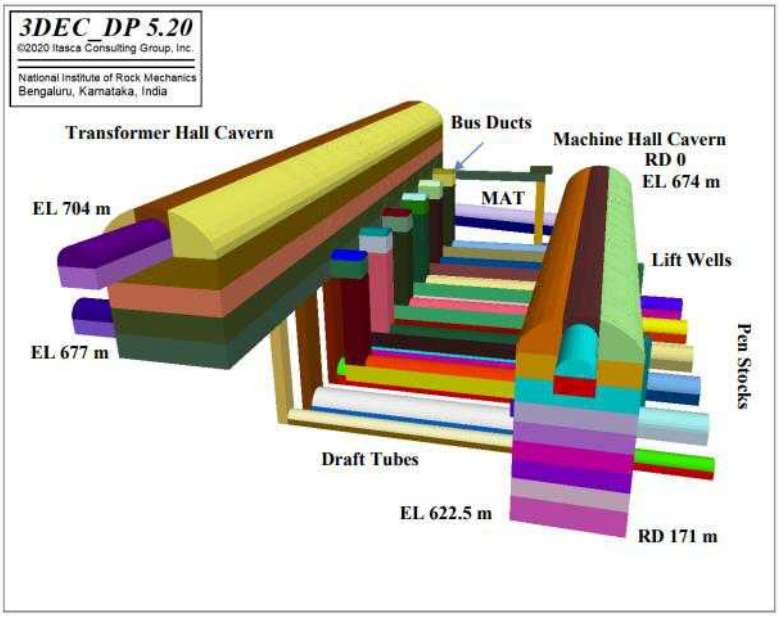
Location of extensometers in 3D view of RBPH with geology and shear zones

established using DGPS survey for monitoring structural deformations during reservoir highest and lowest water levels of the reservoir.

In September 2021, NIRM jointly with BioID, Germany proposed implementation of an advanced automatic geodetic monitoring system for Sardar Sarovar Dam using Fiber Optic technology. Based on the discussions, experiments were conducted by the team of NIRM and BioID, Germany on the Dam Model using ADMON fiber optic technology (a proprietary technology of BioID, Germany) in December 2021 on the existing dam model of Sardar Sarovar Dam (1:150 scale) at Gujarat Engineering and Research Institute (GERI), Vadodara in presence of SSNNL officials. The powerhouse cavern project is being monitored for long-term stability. Based on the instrumentation data up to July'21, it shows a stable trend except at the location near bus gallery one.

Upstream side – temperature and strain sensor cable layout

2.5. NIRM Carried out 3D Numerical Modelling of Powerhouse Complex for Sunni Dam Hydroelectric Project (382 MW), Himachal Pradesh. 3D discontinuum modelling studies has been carried out for machine hall cavern and transformer hall cavern using 3DEC software.



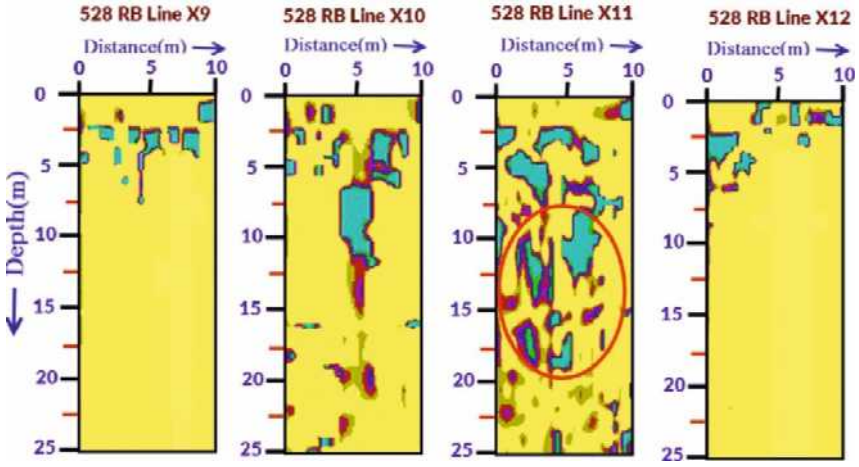
3D view of powerhouse complex for Sunni dam HEP

2.6. The 1,020 MW Tala Hydroelectric Project is one of the biggest joint venture between India and Bhutan. The stability monitoring of underground Powerhouse is being carried out by NIRM using a 30 station microseismic monitoring network.

From 01st January 2021 to 31st December 2021, 178 sets of seismograms were accepted as microseismic events that occurred due to fracturing in the rockmass of the powerhouse. The local magnitude of the microseismic events is in the range of -3.0 to -1.0, with the majority of the events between -2.95 to -1.64. Maximum potency

displacement is from RD 137 to 145 m and EL 493 to 504 m in the upstream wall of the machine hall. Based on the study it is recommended to monitor the micro-earthquakes within a 25-50 km radius of the underground powerhouse. In the upstream wall of the machine hall, combining both Potency and McGarr Displacements, it is recommended to take safety measures from (10795, 20703, 495) to (10810, 20691, 485).

2.7. The Koldam hydroelectric project (situated in Himachal Pradesh) of M/S NTPC has 800 MW power generation capacity with a surface-type powerhouse operated with 144m hydraulic head an open-type tail-race channel. This dam has a chute-type spillway with six radial gates (17.1 m x 17.74 m) situated to the left of the dam/ reservoir. Widening of contraction joint was observed at the flip bucket area in right guide wall and left guide wall. The slopes of the plunge pool were also showing signatures of instability.



GPR Sections across lines X9-X12 on EL 528 m cladding

Categorical interpretation of the GPR sections (radargrams) along various lines of survey identified distinguished set of anomalous zones.

2.8. NIRM provided technical guidance for controlled blasting and monitoring of blast vibration for excavation of various components of Pazhassi Sagar Hydro Electric Project (7.5 MW), Kerala. NIRM has been associated with this the work since last year and has been requested to extend the services till completion of excavation work.

2.9. The Luhri HEP Stage-I (210 MW), a Joint Venture of Government of India and the Government of Himachal Pradesh, is under construction. NIRM monitored ground vibration for 20 blasts by deploying six seismographs at different locations in LHEP Stage 1 project area. A site-specific predictor equation for ground vibration was derived based on the monitored data. The permissible peak particle velocity suggested was 5 mm/s for the structures in the nearby villages and safe air overpressure was 133 dB based on the DGMS norms. NIRM suggested to avoid ANFO/D- cord/Ordinary electric detonators and to adopt shock tube initiation system for all the blasts.

2.10. NPCIL plans to set up four atomic power units (4 x 700 MW) on the bank of Mahi River at Banswara, Rajasthan. For this project NIRM is providing QA support

for the ongoing Geological / Geotechnical investigations at the site. Since the award of the work, NIRM is ensuring that tests / investigations have been carried out as per the approved procedures of Atomic Energy Regulatory Board through frequent visits of NIRM scientists. These services were extended up to 13 months.

2.11. New units 3 & 4 of Kudankulam nuclear power plant (KKNPP), Tamil Nadu (2 x 1000 MW) near operating units 1 and 2 is under construction. As part of this work, hard rock has to be excavated by drilling and blasting methods which are closer to the ongoing construction structures. The recorded vibration was well within the permissible limits

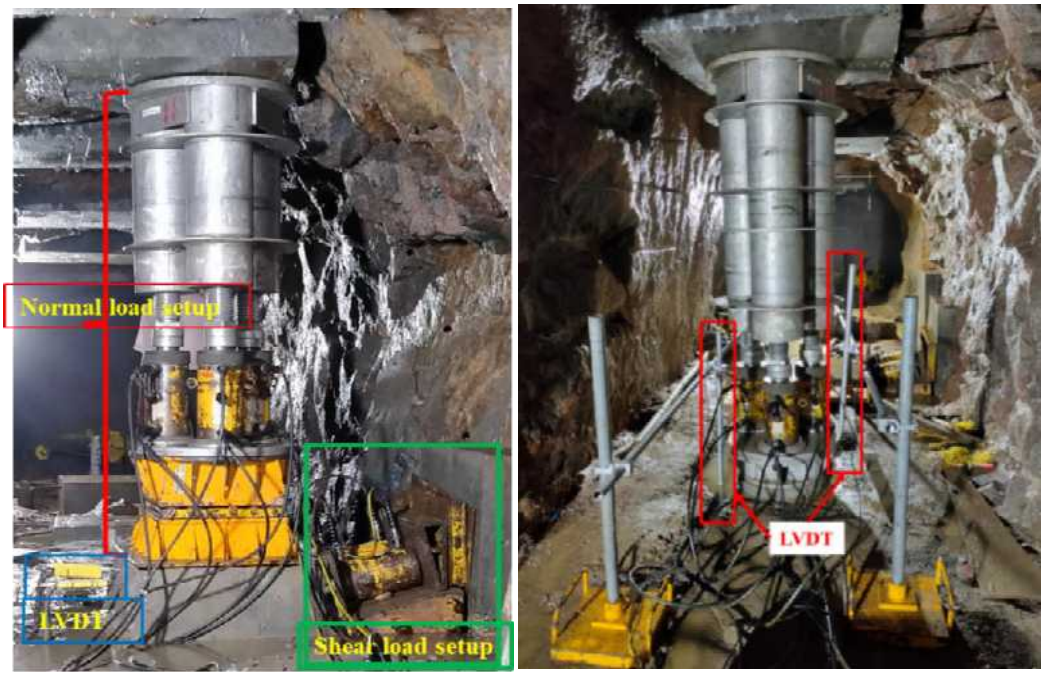
2.12. Studies are also going on for Seismotectonic Evaluation of the proposed Nuclear Power Plant (6 x 1650 MW) within 50 km of radius, Jaitapur, Maharashtra. Geologically, this area is located along the south-western fringe of the Deccan Traps. A 500 km long fault passing in the region (Vijayadurg fault) of the site, is the important structure to be evaluated during the current investigations. The present study identified 122 lineaments within 50 km of the area.

Waterfall observed at the lithological contact

2.13. The Pakal Dul Hydro Electric Project is proposed on river Marusudar, a tributary of Chenab River, located in Kishtwar district of Jammu & Kashmir. The project is envisaged as a storage scheme and is in construction phase. The technical features of the project include a Concrete Face Rock-fill Dam (CFRD) of height 167 m from deepest foundation level, 2 x 7.2 m dia head race tunnel of length 10 km and an underground powerhouse which houses 4 vertical Francis turbine to generate 1000 MW power. For the design and orientation of the tunnel (HRT) in situ stress plays an important role. Field investigations are completed and final report is under progress.

2.14. Lower Kopili hydroelectric project is proposed to construct at east of Karbi Anglong and west of Dima Hasao districts on river Kopili. It is designed for a concrete gravity dam of 70.13 m high dam wall with total capacity of 120 MW in two power plants. The modulus of deformation of rock mass determined at right

bank by NIRM. The results of the investigations as the Modulus of Deformability (Em) and Modulus of Elasticity (Ee) of rock mass at dam site right bank drift are under fair category. In-situ shear parameters shows as low cohesion and friction angle of the rock mass at the proposed dam axis.



Complete set up of the direct shear test and plate loading test equipment

2.15. Kirthai-II hydroelectric project is a run of the river scheme conceptualized on the river Chenab and falls in Paddar Tehsil of Kishtwar District of J&K. It envisages construction of 121 m, high concrete dam and a powerhouse with installed capacity of 840 MW (6x140 MW) and Dam Toe powerhouse of 90 MW (2x35 MW + 2x10 MW). For the design of the dam foundation, in situ geotechnical parameters viz., deformation modulus and shear parameters of rock mass are required. Site preparation is under progress.

2.16. For Technical guidance on controlled blasting for excavations for the construction of various civil constructions at HWPF near RAPP 3 & 4, NIRM carried out preliminary site investigation and a method statement was submitted which comprised the tentative blast designs, permissible limits of ground vibration for

Pre and post blast photographs near sensitive

POWER SECTOR

civil structures, industrial structures, concrete of different age etc. During the field investigation, fifteen trial blasts were carried out towards construction of Electrical Sub Station Building at HWPF facilities work and twelve trial blasts towards the construction. The suggested permissible level of air overpressure for glass structure at the project sites was 133dB and 140dB respectively.

2.17. For Darlipalli Super Thermal Power Project (DSTPP) 2 x 800 MW of NTPC Ltd., Odisha, NIRM has been technically guiding controlled blasting operations at various locations of the project site since 2016. During Phase III Extension 7, 206 blasts were carried out at various components of DSTPP like ST-1, MGR-1, MGR-2, Block-11, DD-4 and in MGR Dhulhanga etc. During Phase III of Extension 8, 77 blasts were monitored at various identified locations and the vibration values were within the permissible limits as per the DGMS standards. Recommendations and methodologies to be followed by the operating agencies during blasting were provided by NIRM. All the monitored blasts were safe with respect to blast vibrations, air overpressure and flyrock.

2.18. During this period, the Seismotectonic Evaluation (Feasibility) of Proposed Nuclear Power Site at Gopalpur, Odisha was carried out. As per earthquake catalogue there are two historical events located within 20 km radius of the site, falling close to the regional lineament 'VGL4'. Among the other regional lineaments VGL1 lineament is associated with four seismic events and ML1 lineament associated with six seismic events. So, all events are falling outside 20 km radius. Present study recommends detailed study of N4/T5, N7, N8 and N9 lineaments for final seismotectonic evaluation.

Buckling, brecciation and rotation of rock observed along shear.

3.0 Infrastructure Sector

Apart from the key work areas of mining and power sector, NIRM extends its R&D support and expertise to the infrastructure sector which includes irrigation, marine projects, drinking water, metro and rail/road projects. The following are the works carried out during this period.

3.1 NIRM is involved in the selection of armoured rock for the construction of break- water from different quarries of Vishakhapatnam. In order to maximize the output of the graded material from blasting, L&T, Construction, had requested NIRM to provide technical advice on blast design for graded material for the construction of breakwater.

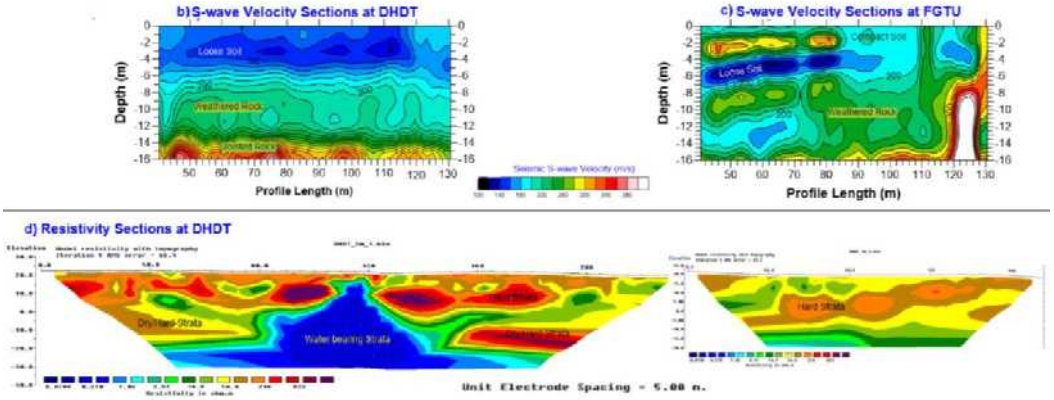
Apart from optimization of blast design, NIRM provided technical advice on testing of material at site for the construction of breakwater. NIRM was requested for support in proper choice of quarry site for extraction of graded rock, monitor work continuously and to supervise the quality testing at the accredited laboratory facilities of L&T at site and ensure deployment of tested material for use in the construction. NIRM was also involved in the quality control exercise for the gradation and certification of the armoured rocks produced a Vooderu Quarry, Anakapalli for use in the breakwater structure near Visakhapattanam.

3.2 Vizhinjam International Seaport Limited (VISL) is developing a deep-water multipurpose seaport at Vizhinjam, Kerala. To construct the 3.1 km break water, it requires about 4.7 million metric tons of four different graded materials (1 kg to 500 kg, 1 MT to 2 MT, 2 MT to 4 MT and 3 MT to 6 MT). NIRM completed the field investigations.

3.3 DSR-SR Prime Spaces LLP, Hyderabad is planning to construct multi floors residential buildings "The World at Jubilee Hills" in Film Nagar, Hyderabad. For site grading and foundation purpose, hard rock strata has to be excavated to a depth of about 40 m. The area is surrounded by private villas, high-rise buildings in West, North and South and the Rama Naidu Studio in the East. The residential structures are located at a distance of 25 m to 130 m from the blasting faces and the Rama Naidu studio is located adjacent to the blasting locations. NIRM was consulted for technical guidance and monitoring during the field investigation 20 trial blasts were carried out (5 blasts with 51mm hole diameter). Twelve blasts with 46mm hole diameter and 3 blasts with 32mm hole diameter. Since the excavation area is surrounded by private structures, there is a requirement to restrict flyrock, ground vibration and air overpressure within permissible limits.

3.4 The interconnecting pipe rack carrying hydrocarbon & utility lines in the Phase-3 complex of Mangalore Refinery and Petrochemicals Limited had suffered massive damage due to slope failure around the foundation area during monsoon

of 2019. NIRM carried out seismic refraction survey, MASW and crosshole seismic tomography to determine the P-wave velocities of the different subsurface layers. It was found that the weathered rock layer is very undulating (thickness varying



Typical geophysical sections obtained by SRT, ERT and MASW methods

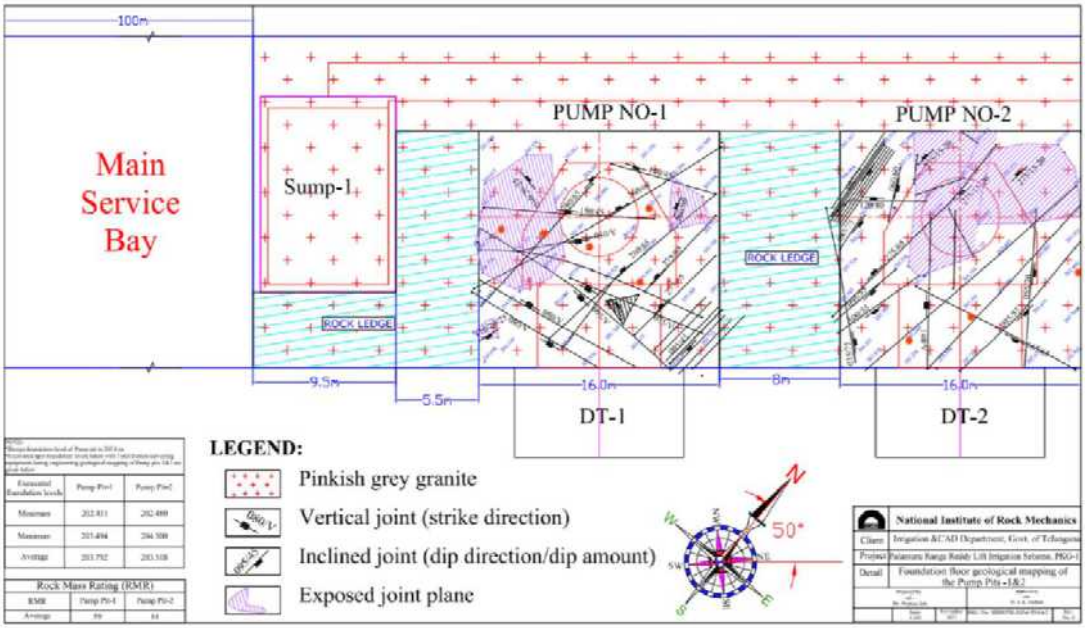
from 3-5.5 m) having hard rock consistent below RL= -4 m. Valley type feature in the profile of the bed rock indicated water saturated zone in the resistivity section where the slope failure had taken place. Low velocity layer was sandwiched between two higher velocity layers indicating presence of uncompact material which might be saturated.

3.5 Southern Railway (SR) is proposing five tunnels for the doubling the track between Trivandrun to Kanyakumari. These tunnels are 200, 230, 130, 80 and 40 m in length with cover varying from 8 m to 15 m. For feasibility of these tunnels, NIRM is carrying out geological, geotechnical, and geophysical investigations and the design of tunnels or cut and cover sections. The scope also include construction methodology for the proposed tunnels or alternative methods and design of instrumentation for monitoring during excavation and post excavation. Field investigations for all the five numbers of tunnels was carried out and after completion of boring, longitudinal geological sections were developed. It is also proposed to conduct in-situ modulus of subgrade reaction by plate load test using IS standards at the proposed tunnel locations.

3.6 Engineering geological investigations of underground pump house complexes of lift schemes 1, 5, 8 and 16 includes tunnel between package 1 to 16 of Palamuru Ranga Reddy Lift Irrigation Scheme (PRLIS) was carried out by NIRM. Main objectives of investigations include review of geological / geotechnical mapping of these pump house complexes and tunnels, estimation of the rock mass quality and suggestion of suitable support measures as per design, engineering geological / geotechnical investigations and site characteristics.

The pump house complexes of lift schemes 1, 5, 8 and 16 form a part of Eastern Block of Dharwar Craton mainly comprised of Archaean granites which are intruded by mafic dykes age ranging from Archaean to Upper Proterozoic. Granites and gneisses. These formations are traversed by several dolerite dyke, quartz-

pegmatite-aplite veins trending in different directions. The granites of the project sites are fresh to moderately weathered (WI – WIII) and joints are slightly rough to smooth planner.



Geological map of pump pit-1&2 foundations for PRLIS, Pkg-1

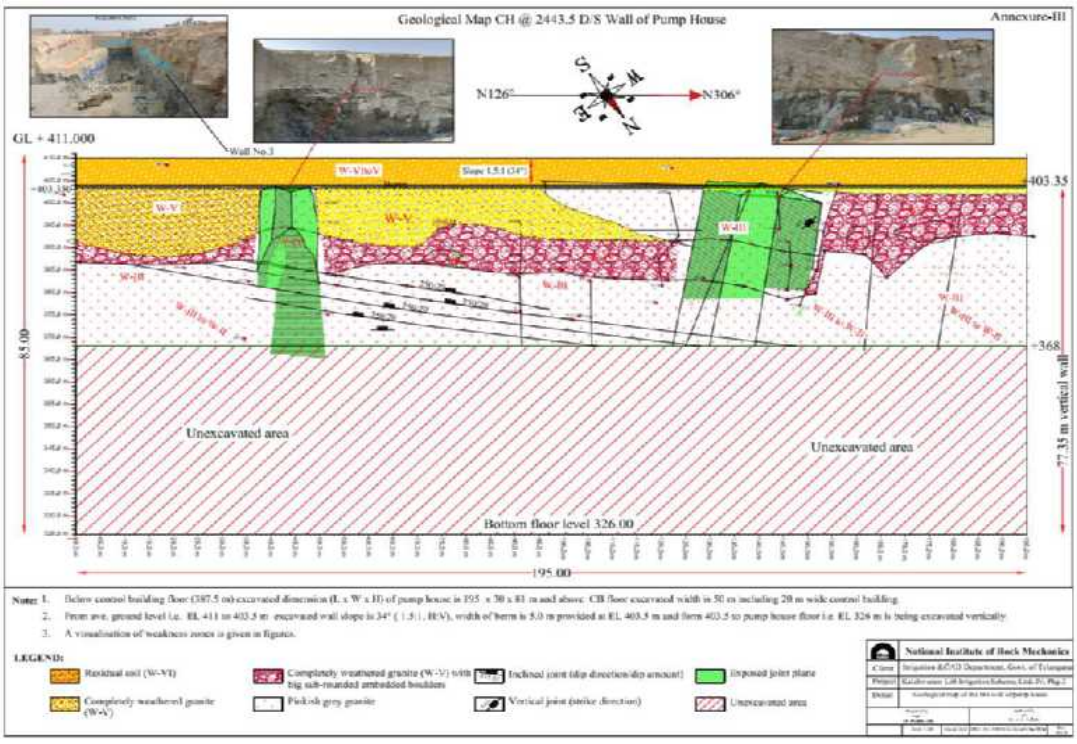
3.7 Engineering geological investigations of the tunnel of J. Chokka Rao Devadula Lift Irrigation Scheme (JCR-DLIS)/ J. Chokka Rao Godavari Lift Irrigation Scheme (JCR-GLIS) phase – III, package – III is under progress. The main objectives of the study were to review the engineering geological / geotechnical mapping of the main tunnel, S-tunnel and draft tubes to estimate the rock mass quality and suggest suitable support measures. On the basis of review of engineering geological data and site geological condition, support system was recommended for all the above-mentioned structures.

3.8 Engineering geological/geotechnical mapping and characterization of rock mass for power house block and pressure tunnels of Polavaram Hydro Electric Project(PHEP) (12 x 80 MW) is being carried out by NIRM. The geological mapping is being carried out using Total Station surveying equipment on 1:200 scale.

Panoramic view of all pressure tunnels from the intake site of PHEP

Recommendation of permanent support (a combination of rock bolts, fibercrete and steel ribs) and rock support categories are being suggested. In power house area and intake pool, the rock types mapped are quartzo-felspathic-garnetiferous granite gneisses with intermittent bands of pegmatite belonging to Khondalite suite of Eastern Ghat Mobile Belt of Archean age. As the excavation was progressed and it reached up to design profiles/levels, for all the slopes, berms and excavated portals, recommendations are being given for the protection of slopes.

3.9 Engineering geological investigations of Kaleshwaram Project-Link-III, Package-9, link-II, packages-1 & 2 and link-IV, package-2 and package-4, were carried out. Supports for main tunnel, intersection between permanent adit tunnel & service bay, ventilation shaft and pump house seepage measures were given on the basis of review of engineering geological data and site geological condition for Project-Link-III, Package-9. Geological mapping on 1:100 to 1:200 m scales, rock matrix description; rock discontinuity orientation & description, ground water condition, rock mass quality assessment and suggestion of suitable support measures and provide technical support to I&CAD Department relevant to the geological/geotechnical investigations were carried out for Package-9, link-II. Rock support for the walls of excavated pump house and surge pool is recommended based on engineering geological mapping and site geological conditions for link-IV, package-2 and package-4



Geological map of pump house downstream wall of KLIS, link-IV package-2

4.0 Testing Services

NIRM has DGMS approved laboratory facility for testing of material and rope samples. Both destructive and non-destructive testing (NDT) for various mining equipment and accessories like winders, wire-rope and shaft components were done at site. Apart from them, rock samples were tested for the determination of various physico-mechanical properties as per BIS/ISRM/ASTM standards. The following are the details of the tests conducted during this period.

4.1 NIRM conducts destructive test on steel wire ropes to determine the residual life. The destructive tests carried out are comprehensive test (Tensile, Torsion & Reverse bend test on individual wires) and tensile test on complete wire rope sample. During this period, 32 steel wire ropes were tested as per Indian standards.

4.2 Wire ropes of Sindeskar Khurd Mine of M/s Hindustan Zinc Ltd. were tested at NIRM laboratory subsequent to an accident. Based on the observation and test result. It is concluded that the reason for failure can be attributed to mechanical damage.

4.3 NIRM carried out tests on the components of winding installations installed by M/s SEPC ltd at the new shaft constructed at Hutti gold mine. The applied proof load is 3 times of safe working load of components. Non-destructive tests using Ultrazonic and Magnetic particle tests suggest that the components are free from internal flaws and surface and subsurface flaws.

Testing of suspension connecting plate

4.4 NIRM carried out Proof Load Test and NDT on 16 Bolt Ham Bone Clamp & Z-Bracket of M/s APHMEL, Andhra Pradesh. One end of 16 bolt ham bone was clamped on the rope to the fixed head and other end of the rope was socketed using white metal clamped to the movable head. The component was subjected to proof load by applying a load three times the safe working load. The proof load test carried out on 16-bolt ham bone clamp (1 & 2) & Z- Bracket was found to withstand, the load applied upto 15t and no deformation was observed on the tested component. Non-destructive tests using Ultrazonic and Magnetic particle tests

suggest that the components are free from internal flaws and surface and subsurface flaws.

4.5 NIRM conducted In-situ Non-Destructive evaluation on Winder vital components and attachments of Production and Service Winder, Wire Rope Defectograph studies on steel wire ropes and Structural stability test on head gear at Sindersar Khurd Mines, M/s HZL, Rajasthan. The NDT tests on vital components indicate that they were free from surface, sub-surface and internal flaws. Defectograph studies conducted on all the wire ropes revealed that the tested wire ropes were free from local faults (LF) such as pitting, corrosion and broken wires and also there was no loss of metallic cross-sectional area (LMA). On inspection of working length of all the four head ropes of production winder (E1, E2, E3 &E4), It is found that E2 and E4 have severe cluster fatigue cracks and isolated broken wires throughout the working length. E1 &E3 ropes have observed isolated fatigue cracks throughout the working length.

4.6 Rajpura Dariba mines is an underground mine with two vertical access shafts (Main shaft and Auxiliary shaft). NDT was carried out using Ultrasonic testing (UT), Magnetic Particle testing (MPT), on winder vital components and suspension gear parts. The NDT results on winder vital components and suspension gear parts indicated that they were free from surface, sub-surface and internal flaws.

UT and MPT on winder and suspension gear parts.

4.7 NIRM conducted NDT on 45 t EOT crane at Shiva Power House, M/s KPCL, Shivanasamudram. Vibration and noise test on Heavy Earth Moving Machinery (HEMM) at Rajpura Dariba mines, Rajasthan for M/s Hindustan Zinc Limited. Based on the tests conducted on 30 number of HEMM, the vibration and noise test signify that all the HEMM are within the permissible limit. The NDT results on winch vital components and suspension gear parts indicated that they were free from surface, sub-surface and internal flaws. Defectograph studies conducted on all the wire ropes revealed that the tested wire ropes were free from local faults (LF) such as pitting, corrosion and broken wires and also there was no loss of metallic cross-sectional area (LMA).

4.8 NIRM conducted In-situ NDT on various vital parts of the HEMM, Winder and suspension gear parts of Kayad Mines, M/s HZL, Rajasthan. Non-destructive tests conducted indicate that that all the tested components were free from surface, sub-surface and internal flaws.

4.9 NIRM conducted in-situ non-destructive tests on winch vital components, bogie attachments and wire rope defectograph studies on steel wire ropes of Palani temple. At winch-3 wire rope, there were some critical observations made and recorded which was directly influencing the safety of the rope and it continuation for further use. Therefore it is recommended to suspend the use of this wire rope forthwith (Ref IS 4309 Edition 2010) and withdraw hoisting of the passengers.

4.10 To ensure the quality of stone blocks which is to be installed for the construction of Shri Ram temple, the temple Trust (Ayodhya) approached NIRM for expert advice and monitoring the quality of material of the stone being used in construction of the Shri Ram Janmbhoomi Temple at Ayodhya. NIRM has so far tested a total of 2000 granite blocks. Cracks found in the blocks were rejected. Other natural defects such as intrusions, mineral concentrations, quartz veins, hairline random fissures, foliation patters etc., were critically examined for qualifying the stones. In total 09 blocks were rejected.

Some of the techniques used for quality assessment of stone blocks

4.11 Laboratory Geotechnical Investigations/tests on Rock Samples from Palamuru Ranga Reddy Lift Irrigation Scheme was conducted at NIRM. All the tests were conducted as per International Society for Rock Mechanics (ISRM) standards. The scope of work includes determination of the following properties on the rock samples. a) Bulk Density, b) Tensile strength, c) Uniaxial compressive strength, Young's modulus and Poisson's ratio, d) Cohesion, Friction angle and 'm' constant from triaxial compression test.

4.12 NIRM Conducted Laboratory Geotechnical Investigations on Rock Core Samples from Borehole BH-5, BH-7, BH-8 & BH-9 of Bicharpur Coal Mine Ultratech Cement Limited, Madhya Pradesh.

5 Other Important Activities

5.1 Celebration of Ambedkar Jayanti

NIRM celebrated 130th birth anniversary of Dr. Babasaheb Ambedkar on 14th April 2021. At the Head office, scientists paid their respect to Bharat Ratna Dr. Bhimrao Ramji Ambedkar and remembered his immense contribution in drafting the Indian Constitution and the society. At the Registered office, KGF, Mr. Rajan Babu, Officer-in-Charge garlanded the portrait of Dr. B R Ambedkar and addressed a few personnel present on the occasion. During the gathering, social distancing norms and other lockdown guidelines were strictly followed.

Mr. Sultan Singh Meena, Scientist garlanding the portrait of Dr. B R Ambedkar at NIRM HO, B'lore (left)
Mr. Rajan Babu, Officer-in-Charge garlanding the portrait of Dr. B R Ambedkar at NIRM RO, KGF (right)

5.2 Observance of Anti-Terrorism Day

NIRM observed "Anti-Terrorism Day" on 21st May 2021. NIRM Employees took anti-terrorism pledge in both English and Hindi over a web meeting administered by Dr. H S Venkatesh, Director, NIRM.

5.3 Celebration of International Day of Yoga

Dr. H S Venkatesh, Director & his family and officers performing yoga on International Yoga Day

In continuation of the tradition of participating in the worldwide programme on International Day of Yoga, NIRM employees celebrated by performing Yoga Session in their respective homes with family on 21st of June. On this occasion, with help of common yoga protocol videos and booklet designed by Ministry of AYUSH, Govt. of India practice of asanas (physical postures), pranayama (breathing exercise) and dhyana (meditation) were performed. During Lockdown Dr. Prasnna Jain, Scientist and Nodal Officer IDY-2021, NIRM motivated and taught Yoga in his apartment by maintaining social distancing.

5.4 Hindi Pakhwada 2021

Hindi Pakhwada was organized from 06th September to 20th September, 2021 with various programs aimed at promoting progressive use of Official Language Hindi at HO, Bangalore and RO, KGF. In view of preventive measures to contain the spread of COVID-19, competitions and closing ceremonies were organized through email and webex meetings. Essay writing, Hindi Divas and poster making related to Hindi language, slogan composition, and poetry recitation competitions on the topic "Importance of Hindi Pakhwada celebration in the implementation of Hindi language" were organized during Hindi Pakhwada.

Dr. H.S. Venkatesh , Director and President of Official Language, expressed his views on the importance of Hindi language

Hindi Day was celebrated on 14th September 2021 under the chairmanship of NIRM Director and Chairman Official Language Committee, Dr. H.S.Venkatesh. Shri Niranjan Nayak, Chief Engineer, IRSE. (Construction), Southern Railway and Shri S. Chandru Prakash, Deputy Chief Engineer, IRSE, were present as the chief guest and they congratulated and expressed their happiness on the celebration of Hindi Pakhwada 2021.

"Vandana of Maa Saraswati" presented in a beautiful dance form by the little children of NIRM family (right), Posters made by children of NIRM family (left)

The Hindi-Pakhwada concluding, and prize distribution function was organized on September 2021 under the chairmanship of Dr. H.S. Venkatesh, Director, NIRM. He conveyed that Hindi is the identity of Indianness. Elaborating the meaning of Hindi usage, he said that we should adopt Hindi in the daily work of the office along with the progress of the Institute.

5.5 Observance of Rashtriya Ekta Diwas

A pledge ceremony related to Rashtriya Ekta Diwas / National Unity Day was conducted on 31st October 2021 at NIRM HO and NIRM RO through webinar. Scientists and Staff took pledge in both English and Hindi.

5.6 Observance of Communal Harmony Campaign Week and Flag Day

National Institute of Rock Mechanics (NIRM) celebrated Communal Harmony Campaign Week and Flag Day during 19th to 25th November 2021. A quiz competition was conducted for all employees through google forms. On the occasion of Flag Day on 25 November, Flag stickers were sold to collect donations for the National Foundation for Communal Harmony. A collection box was kept at the institute entrance and the Scientists also collected some amount at the Gate of NIRM HO, Bangalore. Maximum collection of donations was collected by digital payment mode. Total collection of Rs. 9910/- was collected from NIRM HO, NIRM RO and from the public. The amount was transferred to the account of National Foundation for Communal Harmony.

Flag Day celebration in Public and fund collection from Public

5.7 Celebration of the Constitution Day

At National Institute of Rock Mechanics "Constitution Day" was celebrated with exuberance on 26th November 2021 for spreading awareness of Fundamental Duties enshrined in the Constitution of India. During this celebration, COVID-19 SOP was followed. The Hon'ble President of India, Shri Ram Nath Kovind read the Preamble of the Constitution of India on the occasion of the 72nd Constitution Day. All employees read out the Preamble along with the President of India. Most of the employees read from the website and obtained certificates.

5.8 Swachhta Pakhwada 2021

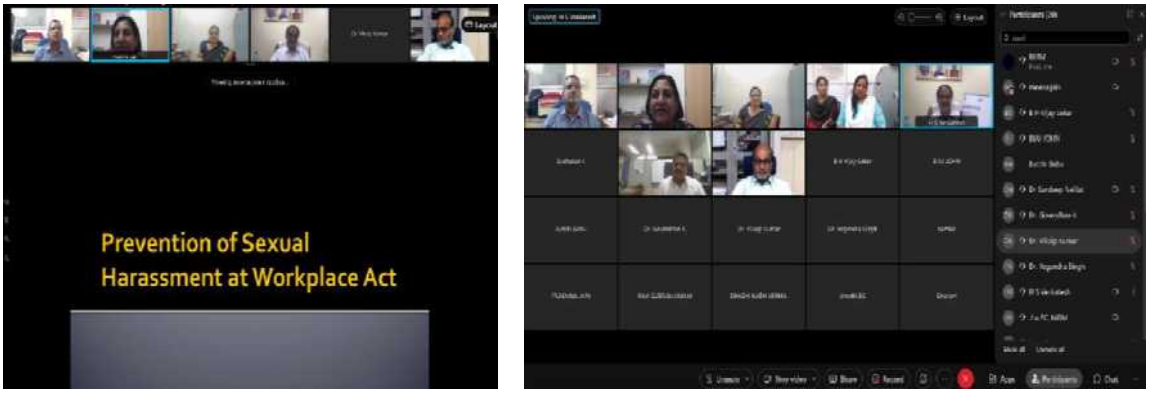
On the occasion of "Swachh Bharat Mission", National Institute of Rock Mechanics organized Swachhta Pakhwada 2021 in and around NIRM Head Office Bengaluru and NIRM Registered Office KGF from 16th to 30th November 2021. Standard

Operating Procedure (SOP) were followed on this occasion in view of COVID 19 pandemic. During the Pakhwada, all employees cleaned their rooms, office gallery, office premises, participated in various competitions and tree plantation etc. at NIRM HO, Bengaluru and NIRM RO, KGF. Swachhta slogan "स्वच्छता हम अपनायेंगे" was uploaded on NIRM notice board and website.

Cleaning at NIRM HO (left) and RO (right) during Swachhta Pakhwada 2021

5.9 Commemoration of eighth anniversary of Sexual Harassment of women at workplace, (Prevention, Prohibition and Redressal) Act 2013

National Institute of Rock Mechanics conducted an awareness program for all the employees of NIRM on 9th December 2021 to commemorate the eighth anniversary of notification of said landmark legislation. The awareness session was conducted by inviting Dr. Meena K Jain, Ex-Chairperson of Child Welfare Committee, Bengaluru Urban and a Certified POSH Trainer and Consultant, who delivered a lecture on the topic "The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013" followed by discussion on the topic with the employees.



Awareness session conducted by Dr. Meena K Jain - online participation by employees

5.10 International Women's Day 2022

International Women's Day 2022 was celebrated on 8th March 2022 at NIRM HO, Bengaluru. On this occasion, the Internal Committee (IC - Women) of the Institute invited all the Scientists, Head of Departments, and staff of the Institute attended and actively participated in the program. An invited talk on the topic "Women's achievements, initiatives for eliminating gender-based discrimination and violence for bringing about a perceptible change and positive shift towards real empowerment of women" was given by Ms. Piyali Bagchi (Senior legal professional

and a POSH Consultant) followed by activities and games. Employees at both NIRM HO, Bengaluru and NIRM RO, KGF actively participated in the program and made the event successful.

Mrs Uma H R, Presiding Officer, Internal Committee-Women addressing the gathering

Director NIRM felicitating Ms. Piyali Bagchi (Senior legal professional and a POSH Consultant)

5.11 Swachchata Action Plan- 2021-22

As per the direction from the Ministry of Jal Shakti, Govt. of India (Ref: no. S/10//2016-0/o Secy (DWS), National Institute of Rock Mechanics celebrated the Hygiene/cleanliness program under Swachchata Action Plan-2021-22 during March 2022, at Govt. Higher Primary School, Kumaraswamy Layout, Bengaluru, Government High School, Kysamballi and St. Theresa's Girls High School, Robertsonpet in Kolar Gold Fields. On the occasion of SAP-2021-22 at Bengaluru,. NIRM provided steel plates to ensure hygiene to serve mid-day meals and distributed handkerchief to all students. Scientists educated about the benefits of hygiene with the students.

NIRM employees and the Principal and teachers of St.Theresa's Girls High School, Robertsonpet in KGF

The President, SWF, NIRM handing over sanitary items to the Principal of Govt. Higher Primary School, Bengaluru

During the celebration of SAP 2021-22 at KGF, the Officer-in-charge and employees shared various information about the benefits of hygiene with students. NIRM provided all necessary cleaning items like liquid soap, soapbar, phenyl, bleaching powder, harpic, brooms, dust bins, hand towels, Dettol etc. to all schools to keep them clean and hygienic.

5.12 Azadi ka Amrut Mahotsav technical lecture series

NIRM started online technical lecture series to commemorate Azadi ka Amrut Mahotsav from 12th March 2022 and continued till 01st July 2022 and in all 44 lectures were delivered under this series. The lectures were attended by practicing

engineers from the mining, energy and infrastructure projects, academicians and students of civil and mining engineering. There were six experts from overseas from USA, Australia, Germany, Canada and Bhutan. The lecture series covered various topics from engineering geophysics, excavation and blasting, Numerical modelling and instrumentation, Engineering Geology, Seismotectonics, Cyber Security, metro construction, Slope Stability and landslides etc. The lecture series was a huge success and was appreciated across the industry and was beneficial to all the participants.

5.13 Recognition / Patent/presentations/other important activities

1. NIRM conducted six days online Training-cum-Field-Workshop on "Importance of Microseismic Monitoring in Underground Excavation" from 28th February 2022 to 08th March 2022. This event was sponsored by the Ministry of Mines, Govt. of India under the Satyabhama Grant in aid of the research and awareness programme for the Mining Industry.
2. Dr. DS Rawat attended a webinar on "Iron Ore Exploration in India" organized by Geological Society of India, Bengaluru on 9th June 2021.
3. Dr. AK Naithani attended 23rd web meeting of the Bureau of Indian Standard, WRD 05 Sectional Committee of Geological Investigation and Subsurface Exploration on 21st June 2021.
4. Dr. D S Rawat attended a webinar on "Rivers of Carbon: using river corridor science to understand carbon dynamics" by Prof. Ellen Wohl, Department of geosciences, Colorado state university, USA, organized by Geological Society of India, Bengaluru on 30th June 2021.
5. As a panel member Dr. AK Naithani attended pre-conference panel discussion webinar on 25th July 2021 on tunneling and underground excavation conducted by Geotropik, Universiti Technologi Malaysia, Malaysia. International Conference on geotechnical challenges in mining, tunneling and underground structures was conducted between 20-21st December 2021. The objective of this webinar was to introduce the motives of the conference to all the stakeholders; to identify and explore research ideas for authors.
6. Dr. AK Naithani attended two days virtual training course on "Geotechnical Investigations for Earth and Rockfill Dam" on 29th & 30th July 2021 organised by Central Soil and Materials Research Station, Govt. of India, New Delhi.
7. As a part of the Advances in Subsurface Mechanics for Energy and Environment (ASMEE) webinar series Dr. AK Naithani attended a lecture on "Three-Dimensional Modeling of Multi-Stage Hydraulic Fracturing and Wave Propagation in Fluid-Filled Fractures within a Generalized Finite Element Framework" delivered by Prof. Carlos Armando Duarte of The University of Illinois at Urbana-Champaign, USA on 6th August 2021.

8. Dr. AK Naithani attended 6th web meeting of the Technical Advisory Committee (TAC) on landslide mitigation and management in India held on 13th August 2021 conducted by Ministry of Mines, New Delhi. Meeting was Chaired by Shri Alok Tandon, IAS, Secretary MoM and Chairman TAC and attended by the members of many organizations and representatives of States Disaster Management Authority.
9. Dr. LG Singh, presented a paper in "International Conference on Recent Advances in Geotechnics (EGCON 2021)", organized by Indian Society of Engineering Geology (ISEG) in association with NHPC Limited (A Government of India Enterprise) held from 9-11th December 2021.
10. Dr. AK Naithani, Dr. LG Singh, Dr. DS Rawat and Dr. Prasnna Jain attended "International Conference on Recent Advances in Geotechnics (EGCON 2021)", organized by Indian Society of Engineering Geology (ISEG) in association with NHPC Limited (A Government of India Enterprise) held from 9-11th December 2021.
11. Dr. AK Naithani, GC Naveen, Vijay Shekar, Praveena Das Jennifer, Buchibabu, B, Bharat Kumar AY Sudhakar K., Vikram S, and Siva Prasad BNV, presented papers in International Web Conference on Geotechnical Challenges in Mining, Tunneling and Underground Infrastructure (ICGCMTU-2021) organized by Universiti Teknologi Malaysia, Malaysia held between 20th and 21st Dec. 2021.
12. Dr. Prasnna Jain attended International Web Conference on Geotechnical Challenges in Mining, Tunneling and Underground Infrastructure (ICGCMTU-2021) organized by Universiti Teknologi Malaysia, Malaysia held between 20th and 21st Dec. 2021.
13. Dr. AK Naithani attended 24th web meeting of the Bureau of Indian Standard, WRD 05 Sectional Committee of Geological Investigation and Subsurface Exploration on 7th January 2022.
14. Dr. AK Naithani, as a member of Technical Evaluation Committee (TEC) of NDMA, attended meeting to Review Progress in Landslide Risk Mitigation Scheme (LRMS) by the Technical Evaluation Committee (TEC) members under chairmanship of Shri Uma Maheswara Rao, Joint Advisor and Member Secretary TEC on 28th Jan. 2022.
15. Mr. R Balachander visited the site to study the effect of blasting at Yaganti Umamaheshwara Temple, Kurnool District, AP by Maha Cement Limestone Mine on request from the Vice Chancellor, Adikavi Nannaya University, AP.
16. Mr. R Balachander delivered lecture on Drilling and Blast Design for Surface Mines at Professional Development Program organised by MEAI on 04/03/2022.
17. Mr. R Balachander attended a meeting chaired by the Honourable Minister for Department of Mines and Geology, Govt. of Karnataka on 03/02/2022 at Khanij

Bhavan, Bangalore to discuss the issues related to mining operations carried out in and around Krishna Raja Sagar Dam, Karnataka.

18. Mr. G Gopinath, presented a technical paper Blasting problems in stone quarries and Iron ore mines at National seminar on Safe Usage of Explosives and Winning of Minerals organised by MEAI Bangalore Chapter on 03/03/2022
19. Mr. GC Naveen received Best Paper Award (Session 2-Tunnelling and case studies) for our paper presented in ICGMTU 2021, Malaysia.
20. Dr. Biju John participated BIS meetings of Bureau of Indian Standards CED 39 Earthquake Engineering Sectional Committee.
21. Mr. G Gopinath participated BIS meetings as a member in Bureau of Indian Standards CED 48 Rock Mechanics Sectional Committee.
22. Mr. G Gopinath participated as a member in department advisory committee of Dr. T Thimmaiah Institute of technology Mining department.
23. Mr. Vikalp Kumar, awarded Ph. D. on the subject "Dynamic Stability Analysis of the Underground Powerhouse Caverns using Microseismic Monitoring in the Himalayan region" from Department of Geophysics, Banaras Hindu University, Varanasi-221005.
24. One week online training programme was conducted on "Microseismics application for underground powerhouse cavern strata monitoring" for three DGPC Ltd. executives from 19th -24th April 2021.
25. One week training programme was conducted on "Microseismics application for underground powerhouse cavern strata monitoring" for three DGPC Ltd. executives from 19th -25th January 2022 at THP, Bhutan.
26. Dr. Balasubramaniam VR, Dr. Divylakshmi KS and Dr. Vikalp Kumar attended an online workshop conducted by IMS, Australia from 07th -09th February 2022 on Mine Seismology.
27. Mr. Rajan Babu. A, Delivered a talk in the Seminar organised by Federation of Indian Granite and Stone Industry (FIGSI) with the Government of Karnataka on challenges & opportunities in Dimensional Stone Industry, 24th November, Bengaluru.
28. Mr. Rajan Babu. A, delivered a talk in the Workshop organised by Karnataka State Minerals Corporation Limited on Opencast Mining, Recovery in Dimensional Stone Granite quarries and latest technologies adopted for production, 28th March 2022 at Hotel Lalit Ashok, Bengaluru.
29. Dr. Balasubramaniam VR attended 26th Karnataka State Disaster Committee meeting held on 24th February 2022 to discuss seismic activities occurring recently in Karnataka
30. Dr. Balasubramaniam and Dr. Biju John visited Chikkaballapura district on 03rd February 2022 with the KSDNMDC Scientific team subsequent to earthquake occurred between 22nd Dec 2021 to 05th Jan 2022.

ANNUAL ACCOUNTS

B.R.V. Goud & Co.
Chartered Accountants

INDEPENDENT AUDITOR'S REPORT

To the Members of National Institute of Rock Mechanics

Opinion

We have audited the accompanying financial statements of **NATIONAL INSTITUTE OF ROCK MECHANICS**, which comprises the Balance Sheet as at March 31, 2022, the Statement of Income & Expenditure & Receipts and Payments for the year ended 31st March 2022 and a summary of significant accounting policies and notes to accounts.

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required and give a true and fair view in conformity with the accounting principles generally accepted in India:

1) In case of Balance Sheet, of the state of affairs of **National Institute of Rock Mechanics**, as at 31st March 2022.
2) In case of the Income and Expenditure Account, of the **Surplus**, being Excess of Income over Expenditure for the year ended on that date.
3) In case of Receipts & Payments Account of receipts & payments for the year ended 31st March 2022.

Basis for Opinion

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by Institute of Chartered Accountants of India. Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are Independent of the Company in accordance with the Code of Ethics issued by the Institute of Chartered Accountants of India, and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of the financial statements. This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate implementation and maintenance of accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give

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Website: www.brvgoud.co.in

B.R.V. Goud & Co.
Chartered Accountants

a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

We further report that:

a) We have sought and obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purpose of our audit and have found them to be satisfactory.

b) In our opinion, proper books of account as required by law have been kept by the Institute, so far as appears from our examination of those books.

c) The Balance Sheet and Income and Expenditure Account and Receipts & Payments Account dealt with by this report, are in agreement with the books of accounts.

for B.R.V. GOUD & CO.,
Chartered Accountants

(A B Shiva Subramanyam)
Partner
Membership No: 201108

Place: Bangalore
Date: 21/09/2022
UDIN:22201108ATQNWI4411

ANNUAL ACCOUNTS

NATIONAL INSTITUTE OF ROCK MECHANICS
BANGALORE.

SCHEDULE-28

ACCOUNTING POLICIES AND NOTES ON ACCOUNT FORMING PART OF BALANCE SHEET AND INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2022.

1. ACCOUNTING POLICIES :-

A. Background:

The entity is an autonomous body under the administrative control of Ministry of Mines, Government of India, registered as Society under the Karnataka Societies Registration Act, 1960. It carries on activities of research in the field of Rock Engineering.

Basis of Preparation:

The financial statements have been prepared under the historical cost convention on an accrual basis. The accounting policies have been consistently applied by the Society and are consistent with those used in the previous year.

B. Fixed Assets:

Fixed Assets are initially recorded at acquisition cost, as and when the asset is put to use by the Institute and carried at such cost less accumulated depreciation and impairment loss, if any.

C. Foreign Exchange Transactions:

Foreign currency transactions are recorded in the reporting currency by applying to the foreign currency amount the exchange rate between the reporting currency and the foreign currency at the date of the transaction. Monetary items, if any, are reported using the exchange rate prevailing at the closing rate. Exchange differences, if any are recognized as income or expense in the income and expenditure statement.

D. Revenue Recognition:

Revenue from services as well as from research and consultancy projects are recognized under Completed Service Contract Method.

E. Treatment of Government Grant:

Grant received from Ministry of Mines under "Non plan is utilized to meet "Pay & Allowances". Grants received under "Plan" is utilized to meet capital expenditure.

The Capital Grant for 'Plan' received as per sanction order from Ministry of Mines, is credited to Deferred Government Grants Account and is allocated to income over the period in the same proportion as the depreciation is charged on the depreciable assets purchased out of these Capital Grant. Balance of capital grants appear as Deferred Government Grants in balance sheet under "Other Funds". Non Plan grants, being revenue in nature, when received are directly taken as Revenue in Income and Expenditure Account.

F. Retirement / Long Term Employee Benefits:

The Institute has made arrangement with Life Insurance Corporation of India for payment of gratuity and leave encashment under the Group Gratuity Scheme and group leave encashment scheme. Expenses for the gratuity and leave encashment is accounted as per calculation made under Projected Unit Credit Method and intimated by the Insurance Company and is charged as expense in the Income and Expenditure Statement under "Pay & Allowances".

Regarding Provident Fund accumulation, this Institute has been enrolled with the Employees Provident Fund Organization. The Institute's contribution towards the Provident Fund is charged as expense in the Income and Expenditure Statement under "Pay & Allowances".

G. Depreciation:

Depreciation is charged on straight-line basis as per the method specified by the Government of India, Department of Economic Affairs vide their letter No.4/24/63-GS dated 27th September 1968.

As per this letter, depreciation on additions to Fixed Assets during the year has to be charged at full rate if they are put into use before 30th September, at half of the rate, if they are put into use between 1st October and 31st December and at one fourth of rate, if assets are put to use after 31st December of the relevant financial year. Upto 1998-99, the one-fourth rate of depreciation for assets put to use for less than three months was not implemented.

2. NOTES ON ACCOUNTS: -

1. Capital Reserve represents value of assets transferred free of cost by BGML during 1988-89.

2. The land and building transferred during the year 1988-89 by BGML to the Institute is subject to receipt of direction from the Government of India. Registration of the transfer of land with sub-registrar and other related formalities are pending. The title of these land and buildings in the name of the Institute is thus subject to the foregoing.

3. Accounting for expenses and liability towards group leave encashment and group gratuity is based on contributions sought by LIC of India, with whom

the Institute has entered into an arrangement for payment of gratuity and leave encashment.

4. Provision for the income tax has been measured at the amount expected to be paid to the tax authorities in accordance with the Income Tax Act, 1961. Tax Expenses debited to the income & expenditure account comprises of provision of current tax for the year & the differences between tax deducted at source claimed by the Institute and that allowed by the department for the past years.

5. The accumulated interest earned on the Fixed deposits of Institute Development fund for Rs.28.87 lakhs transferred to corpus fund i.e. Institute Development Fund during the year 2021-22.

6. The previous year figures have been re-grouped, re-classified or renamed wherever necessary to confirm with the current year presentation.

Uma.H.R	H.S. Venkatesh	Member
Finance & Accounts Officer	Director	Governing Body

As Per Our Report of even date,
For B.R.V Goud and Co.,
Chartered Accountants

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

(A B Shiva Subramanyam)
Partner
M. NO. 201108

Date: 21/09/2022
Place: Bangalore

ANNUAL ACCOUNTS

ANNUAL ACCOUNTS

NATIONAL INSTITUTE OF ROCK MECHANICS

Bangalore

Consolidated Balance Sheet as at 31st March, 2022

(Amount in Rs.)

Sl. No.	Particulars	Sch. No.	31.03.2022	31.03.2021
I	Sources of Funds			
	Capital Fund:	1		
	(a)Capital Reserve		32,44,334	32,44,334
	(b)Internal Capital Reserve		2,50,42,413	2,50,42,413
	Other Capital Fund:	2		
	a) Deferred Government Grant		11,88,95,683	9,52,21,248
	b) Institute's Development Fund		6,63,99,399	6,35,11,943
	Income and Expenditure Account	3	6,81,08,610	4,32,64,549
	Current liabilities and provisions:			
	a) Sundry Creditors - Staff	4	2,97,804	5,37,804
	b) Sundry Creditors - Others	5	3,78,91,891	2,92,47,690
	c) Project Advance Received	6	32,26,73,866	31,63,56,878
	d) Provisions	7	1,79,21,341	3,84,47,112
	TOTAL		**66,04,75,341**	**61,48,73,971**
II	Application of funds			
	Fixed Assets	8	8,41,22,483	6,88,16,170
	Investments	9	40,35,94,418	34,03,53,418
	Current Assets, Loans and Advances			
	Deposits	10	5,35,628	5,35,628
	Loans and advances			
	a) Advances - Staff	11	6,00,551	7,52,341
	b) Advances - Others	12	1,57,57,633	1,34,84,869
	Other Current Assets	13	4,23,05,600	6,69,41,185
	Expenditure on Ongoing Projects	14	5,41,11,477	6,62,10,897
	Sundry Debtors	15	2,89,41,060	3,05,88,182
	Cash and bank balances	16	3,05,06,491	2,71,91,281
	TOTAL		**66,04,75,341**	**61,48,73,971**
	Note : Significant Accounting Polices and other notes to accounts	28		

For NATIONAL INSTITUTE OF ROCK MECHANICS

(Uma H R)
Finance & Accounts Officer

(H S Venkatesh)
Director

Member
Governing Body

As Per Our Report of even date,
For B.R.V Goud and Co.,
Chartered Accountants

(A B Shiva Subramanyam)
Partner
M. NO. 201108

Place: Bangalore
Date : 21-09-2022

NATIONAL INSTITUTE OF ROCK MECHANICS
Bangalore

Consolidated Income and Expenditure Account for the year ended 31st March, 2022

(Amount in Rs.)

Sl. No.	Particulars	Sch. No.	31.03.2022	31.03.2021
A	Income			
	Grant-in-Aid received from Ministry of Mines	17	7,19,77,000	6,74,00,000
	Amount Received Against Completed Projects	18	16,37,91,622	15,27,86,974
	Government Grant - Deffered Income	19	13,25,565	5,32,665
	Interest Received	20	1,77,84,009	87,24,108
	Miscellaneous Income	21	2,08,872	2,55,848
	TOTAL (A)		25,50,87,068	22,96,99,595
B	Expenditure			
	Administrative Expenses	22	1,11,48,252	92,44,096
	Pay & Allowances	23	12,12,18,947	11,45,12,256
	Travel Expenditure	24	3,21,056	3,58,846
	Up Keep of Assets	25	7,23,618	6,45,943
	Expenditure on Completed Projects	26	6,04,77,507	5,89,06,983
	Depreciation on Fixed Assets	8	1,18,56,645	1,42,90,870
	TOTAL (B)		20,57,46,025	19,79,58,994
C	Excess of Income over Expenditure for the year (A-B)		4,93,41,043	3,17,40,601
	Less: Provision For Tax -Current Year		1,75,00,000	1,25,00,000
	Earlier Year		41,09,526	2,26,770
D	Net Surplus/(Deficit) for the year		2,77,31,517	1,90,13,831

Note : Significant Accounting Polices and other notes to accounts 28

For NATIONAL INSTITUTE OF ROCK MECHANICS

As Per Our Report of even date,
For B.R.V Goud and Co.,
Chartered Accountants

(Uma H R)
Finance & Accounts Officer

(H S Venkatesh)
Director

Member
Governing Body

(A B Shiva Subramanyam)
Partner
M. NO. 201108

Place: Bangalore
Date : 21-09-2022

ANNUAL ACCOUNTS

ANNUAL ACCOUNTS

NATIONAL INSTITUTE OF ROCK MECHANICS

BANGALORE

Consolidated Receipts and Payments Account for the year ending on 31st March 2022

(Amount in Rs)

Receipts	Amount	Payments	Amount
Bank - Opening Balance	2,71,91,281	TDS on Fixed Deposits	2,07,115
Grant-in-Aid (Non-Plan)	7,19,77,000	TDS on Project Receipts	1,34,98,821
Govt. Grant-Capital	2,50,00,000	Payment of GST & Service Tax	1,83,02,886
Other Income Received	1,79,392	Purchase of fixed assets	2,72,44,374
Security Deposits/EMD received	20,65,450	Investment in Fixed Deposits	16,45,50,000
Interest Received on Savings Bank Deposits	13,42,813	Advances to Others	40,67,886
Interest Received on Term Deposits	20,71,137	Security Deposits/EMD	18,70,000
Fixed Deposits Matured	10,58,83,000	Advance to Staff	8,20,754
Advance Received - S & T projects	5,38,000	Administrative Expenses	1,28,85,421
Advance Received - Sponsored Projects	20,09,57,870	Salaries & Wages	12,06,64,854
Advance Received - Centre for Testing service	31,02,340	Travelling Expenses	3,21,056
Income tax refund	1,18,53,270	Income tax paid	55,04,480
		Up Keep of Assets	7,23,617
		Retention money on terminal benefit	2,40,000
		staff welfare	3,00,000
		Expenditure on Sponsored Projects	5,04,53,797
		Bank - Closing Balance	3,05,06,491
Total	45,21,61,553	Total	45,21,61,553

For NATIONAL INSTITUTE OF ROCK MECHANICS

As Per Our Report of even date,
For B.R.V Goud and Co.,
Chartered Accountants
FRN:000992S

(Uma H R)
Finance & Accounts Officer

(H S Venkatesh)
Director

Member
Governing Body

(A B Shiva Subramanyam)
Partner
M. NO. 201108

Place: Bangalore
Date : 21-09-2022

ANNEXURE
(A-H)

ANNEXURE-A


Organisational Chart of NIRM
General Body
Governing Body
Peer Review Committee
Director
Project Monitoring Cell
Controller of Administration
1. Project Management
2. HRD & Training
3. Library & Information
1. Administration
2. Finance & Accounts
3. Purchase & Store
4. Estate Management
5. Transport Management
Scientific Departments
1. Seismotectonic
2. Engineering Geology
3. Engineering Geophysics
4. Geotechnical Engineering
5. Centre for Testing Services
6. Numerical Modelling
7. Rock Blasting & Excavation Engineering
8. Geomechanics & Ground Control
9. Engineering Seismology

ANNEXURE-B

<table>
<tr><th colspan="2">MEMBERS OF THE GOVERNING BODY</th></tr>
<tr><td colspan="2"><u>Chairman</u></td></tr>
<tr><td colspan="2">Secretary, Ministry of Mines
Government of India
3rd Floor, A Wing, Room No. 320,Shastri Bhavan, Dr. Rajendra Prasad Road,
New Delhi – 110 001.</td></tr>
<tr><td colspan="2">Members</td></tr>
<tr><td>Additional Secretary, Ministry of Mines,
3rd Floor, A Wing, Room No.327,
Shastri Bhavan,
Dr.Rajendra Prasad Road,
New Delhi-110 001</td><td>Director,
Indian Institute of Technology (ISM),
Dhanbad-826 003
Jharkhand</td></tr>
<tr><td>Joint Secretary & Financial Advisor,
Ministry of Mines,
3rd Floor, A Wing, Room No.321,
Shastri Bhavan,
Dr.Rajendra Prasad Road,
New Delhi–110 001</td><td>Director (Operations),
Singareni Collieries Company Ltd.,
Kothagudem Collieries ,
Khammam Dist,
Telangana –507 101</td></tr>
<tr><td>Joint Secretary / Economic Advisor,
(In-charge NIRM)
Ministry of Mines,
Shastri Bhavan,
Dr.Rajendra Prasad Road,
New Delhi–110 001</td><td>Prof. Bharat B Dhar,
Former Director CIMFR,
Director (Research), AIU,
Director (R&IC), Amity University,
Advisor, HESRT&SD,
D-20, Pamposh Enclave,
New Delhi-110 048</td></tr>
<tr><td>Director General,
Geological Survey of India, (GSI)
No.27, Jawaharlal Nehru Road,
Kolkata-700 016, West Bengal</td><td>Shri. A Sundaramoorthy,
Director General (Retd), GSI
No.44, VV Nagar, 6th Street,
Kolathur (PO), Chennai-600 099
Tamil Nadu</td></tr>
<tr><td>Controller General,
Indian Bureau of Mines,
Indira Bhavan,
22/1, Civil Lines, Nagpur-440 001
Maharashtra</td><td>Dr. P C Nawani,
Ex-Director, NIRM
G-202, JMD Gardens
Sohna Road, Sector-33
Gurgaon- 122018, Haryana, India</td></tr>
<tr><td>Director General of Mines Safety,
Hirapur, Dhanbad-826 001
Jharkhand</td><td>Director,
National Institute of Rock Mechanics,
Banashankari 2nd Stage,
Bengaluru-560 070, Karnataka</td></tr>
<tr><td>Director, CIMFR,
Central Institute of Mining & Fuel Research,
Barwa Road, Dhanbad-826 015,
Jharkhand</td><td></td></tr>
</table>

ANNEXURE-C

MEMBERS OF THE GENERAL BODY	
Chairman	
Secretary, Ministry of Mines Government of India 3rd Floor, A Wing, Room No. 320,Shastri Bhavan, Dr.Rajendra Prasad Road, New Delhi – 110 001.	
Additional Secretary, Ministry of Mines, 3rd Floor, A Wing, Room No.327, Shastri Bhavan,Dr.Rajendra Prasad Road, New Delhi-110 001	Member (D & R), Central Water Commission, Room No.401 (S), Sewa Bhavan, R.K.Puram, New Delhi-110 066
Joint Secretary & Financial Advisor, Ministry of Mines, 3rd Floor, A Wing, Room No.321, Shastri Bhavan,Dr.Rajendra Prasad Road, New Delhi–110 001	The Advisor (Projects), Ministry of Coal, 3rd Floor, A Wing, Shastri Bhavan,Dr.Rajendraprasad Road, New Delhi–110 001
Joint Secretary / Economic Advisor, (In-charge NIRM) Ministry of Mines, Shastri Bhavan,Dr.Rajendra Prasad Road, New Delhi–110 001	Director (Operations), Singareni Collieries Company Ltd., Kothagudem Collieries , Khammam Dist, Telangana–507 101
Director General, Geological Survey of India, (GSI) No.27, Jawaharlal Nehru Road, Kolkata-700 016 West Bengal	Prof. Bharat B Dhar, Former Director, CIMFR Director (Research), AIU; Director (R&IC), Amity University, Advisor, HESRT&SD, D-20, Pamposh Enclave, New Delhi-110048
Controller General, Indian Bureau of Mines, Indira Bhavan, 22/1, Civil Lines,Nagpur-440 001 Maharashtra	Shri. A Sundaramoorthy, Director General (Retd), GSI No.44, VV Nagar, 6th Street, Kolathur (PO), Chennai-600 099 Tamil Nadu
Director General of Mines Safety, Hirapur, Dhanbad-826 001 Jharkhand	Dr. P C Nawani, Ex. Director, NIRM G-202, JMD Gardens, Sohna Road, Sector-33, Gurgaon- 122018 Haryana, India
Director, Central Institute of Mining & Fuel Research, Barwa Road, Dhanbad-826 015, Jharkhand	Director, National Institute of Rock Mechanics, Banashankari 2nd Stage, Bengaluru-560 070, Karnataka
Director, Indian Institute of Technology (ISM), Dhanbad-826 003., Jharkhand	

ANNEXURE-D

<table>
<tr><th colspan="2">MEMBERS OF THE PEER REVIEW COMMITTEE</th></tr>
<tr><td colspan="2">Chairman</td></tr>
<tr><td colspan="2">Prof. Bharat B Dhar
Former Director, CIMFR; NEW DELHI – 110 048</td></tr>
<tr><td colspan="2">Shri. A Sundaramoorthy,
Alternate Chairman & Member
Director General (Retd), GSI
No.44, VV Nagar, 6th Street,
Kolathur (PO), Chennai-600 099
Tamil Nadu</td></tr>
<tr><td colspan="2">Members</td></tr>
<tr><td>Dy. Director General,
Directorate General of Mines Safety,
South Zone, Koramangala,
Bengaluru-560 034, Karnataka</td><td>Mr. T K Sivarajan,
CE, (Designs(N&W)),
Central Water Commission,
8th Floor, Seva Bhavan,
RK Puram, New Delhi-110 066</td></tr>
<tr><td>Prof. V M S R Murthy,
Professor, Department of Mining Engineering
IIT (ISM), Dhanbad-826 004
Jharkhand</td><td>General Manager (R&D),
The Singareni collieries Co Ltd.,
Kothagudem Collieries
Bhadradri, Kothagudem Dist,
Telangana – 507 101.</td></tr>
<tr><td>Prof. N R Thote, Professor,
Mining Eng dept,
Visvesvaraya National Institute of Technology, Nagpur – 440 010.
Maharashtra</td><td>Director,
National Institute of Rock Mechanics,
Banashankari 2nd Stage,
Bengaluru-560 070, Karnataka</td></tr>
<tr><td>Mr. J K Singh,
Chief Scientist & Head slope stability research group,
CIMFR
Dhanbad – 826 015, Jharkhand</td><td>Shri. S Ravi,
Secretary
National Institute of Rock Mechanics
Banashankari 2nd Stage,
Bengaluru-560 070, Karnataka</td></tr>
</table>

ANNEXURE-E

SUPPORTING ORGANISATIONS & MAJOR CLIENTELE

Central Government Ministries & Departments

Ministry of Mines
Ministry of Coal
Ministry of Earth Sciences
Department of Science & Technology
Department of Atomic Energy
Indian Railways
Atomic Minerals Directorate for Exploration and Research (AMD)

State Government Ministries & Departments

Andhra Pradesh Heavy Machinery and Engineering Limited (APHMEL)
Andhra Pradesh Power Generation Corporation (APGENCO)
Karnataka Power Corporation Limited (KPCL)
Kerala State Electricity Board (KSEB)
Shri Mata Vaishno Devi Shrine Board (SMVDSB), J&K
Singareni Collieries Company Limited
Telangana State Power Generation Corporation (TSGENCO)
Irrigation & CAD Department, Government of Telangana
TANGEDCO, Tamil Nadu

Public Sector Organisations

Coal India Limited (CIL)
Hindustan Copper Limited (HCL)
Hindustan Petroleum Corporation Limited (HPCL)
Hindustan Zinc Limited (HZL)
Hutti Gold Mines Limited (HGML)
Indian Oil Corporation Limited (IOCL)
Manganese Ore India Limited (MOIL)
National Aluminium Company Ltd. (NALCO)
National Hydroelectric Power Corporation (NHPC Limited)
NTPC India Limited
Nuclear Power Corporation of India Limited (NPCIL)
Oil and Natural Gas Corporation (ONGC)
Sardar Sarovar Narmada Nigam Limited (SSNNL)
Satluj Jal Vidyut Nigam Limited (SJVNL)
South Eastern Coalfields Limited (SECL)
THDC India Limited
Uranium Corporation of India Limited (UCIL)
Western Coalfields Limited (WCL)
Neyveli Lignite Corporation India Ltd. (NLCIL)

Private Companies

Balasore Alloys Limited Ltd.
China Coal No.5 Constructions Pvt Ltd.
Ferro-Alloys Corporation Limited (FACOR)
Technology House (India) Pvt. Ltd.
Chennakeshava stone crusher.
RS DCI Pvt. Ltd.
Secon Pvt. Ltd.
MSRDC, Mumbai
Prathima Infr.Ltd.
Kalyani developers, Bengaluru
SDFI Pvt. Ltd.
Gammon India Ltd.
HES Infra Private Ltd
Hindustan Construction Company Limited (HCC)
India Resources Limited.
IOT Infrastructure & Energy Services Ltd.
Jindal Power Limited
Kare Power Resources Private Limited (KPRPL)
Larsen & Toubro (L&T) Construction
Megha Engineering & Infrastructures Ltd.
Navayuga Engineering Company Limited
Navyuga Kommu Venkateshwara Metal Miners
Patel Engineering Ltd.
Prathima Infrastructures Ltd.
Ramco cements Ltd.
Sesa Mining Corporation Ltd.
Shaft Sinkers Mauritius Ltd.
Shriram EPC Limited
SNC-Lavalin Infrastructure Private Ltd.
Soham Renewable Energy Private Limited (SREPL)
The India Cements Limited (ICL)
Transstroy-AFCONS JV, Chennai
Transstroy-JSC-EC-UES, AP
Zeenath Transport Company (ZTC)
Zuari Cement Limited
RIL,Yargol

International Organisations

Druk Green Power Corporation Limited (DGPCL), Bhutan
Mangdechhu Hydroelectric Project Authority (MHPA), Bhutan
Punatsangchhu II (1020 MW) HEP, Bhutan
SJNV Arun-3 Power Development Company (SAPDC), Pvt. Ltd., Nepal

ANNEXURE - E

ANNEXURE-F

LIST OF COMPLETED PROJECTS

Sl. No	Project No	Title of Project
1	*ND-16-05-C*	*NDT on man-winding systems (4 units) at M/s. SCCL*
2	*ND-19-02-C*	*NDT cable belt drive wire ropes at NALCO, Damanjodi, Odisha.*
3	*ND-19-07-C*	*NDT on 45t EOT crane at Shiva generating station, M/s. KPCL, Karnataka*
4	*ND-19-08-C*	*NDT on vital components of Trolley system &wire rope at M/s. KPCL, Karnataka.*
5	*ND-19-09-C*	*NDT on Suspension gear parts & wire ropes at Zawar Group of Mines, M/s.HZL*
6	*ND-19-10-C*	*NDT on Suspension gear parts & wire ropes at RD mines, M/s.HZL*
7	*ND-20-01-C*	*NDT on critical winch vital components &wire rope defectograph studies at Arulmigu Dhandayuthapani Swamy Thirukoil, Tamilnadu*
8	*ND-20-03-C*	*NDT on suspension gear parts, winders vital parts& wire rope defectograph studies at RD Mines, M/s.HZL*
9	*ND-21-03-C*	*NDT on suspension gear parts &wire ropes at RD Mines, M/s. HZL, Rajasthan.*
10	*EG-19-01-C*	*Engineering Geological Investigations of Four Lifts and Tunnels of Palamuru Ranga Reddy Lift Irrigation Scheme, Telangana State.*
11	EG-20-01-C	*Engineering geological investigations of tunnel of J. Chokka Rao Devadula Lift Irrigation Scheme (JSR-DLIS)/ J. Chokka Rao Lift Irrigation Scheme (JCR-GLIS) phase-III, package -III, Telangana State.*
12	EG-20-03-C	*Construction Stage Engineering Geological investigation of Main Tunnel, Ventilation Shaft and Delivery Mains of Pump House Complex Area of Kaleshwaram Project-Link-III, Package-9, Malkapet, Rajanna Sircilla District, Telangana.*
13	*GP-17-03-C*	*Conducting of Cross hole (including deviation survey)at GHAVP, Fatehabad, Haryana.*
14	*GP-19-06-C*	*Geophysical Investigations in MRPL complex of ONGC at Mangalore.*
15	*GP-19-07-C*	*Support for extraction, grading and testing of armoured rock at NECL Quarry Located at Vooderu in Visakhapatnam*
16	*GP-20-01-C*	*GPR Survey to find the cause of instability of Spillway, Flip Bucket, and plunge pool slopes at NTPC, Koldam Hydro power Project.*
17	*GP-20-03-C*	*MASW survey and measurement of vibration parameters around tailing dam of Bailadila mines*
18	*MS-19-02-C*	*Stability monitoring of the powerhouse complex at Tala Hydro Power plant (THP), DGPC, Bhutan using Microseismics*
19	*GC-18-08-C*	*Scientific Study for slope stabilization and monitoring of ground*

		movement of South Face, Mine I of NLCIL, Neyveli, Tamil Nadu
20	*GC-19-02-C*	*Scientific studies to optimize the bench parameters and design of final pit slope stability of granite Building Stone quarry of Sadahalli Building Stone Quarry Lease Holders and Lorry Owners Association*
21	*GC-19-08-C*	*Scientific study for stability assessment of Pit and Dump of Barsingsar Lignite Mine, Bikaner, Rajasthan.*
22	*GC-20-01-C*	*Review of the effective implementation of recommendations on stability of High Wall of Pallava Industries (India) Granite Quarry and study on monitoring of pit stability.*
23	*GC-20-03-C*	*Scientific Study for assessment of safe pit slope angle and waste dump at Redi Iron Ore Mine of M/s. Minerals and Metals, Redi Village, Vengurla Taluka, Sindhudurg, Maharashtra.*
24	*GC-20-04-C*	*Scientific Study for stability assessment and monitoring of Pit and Dump at 3 nos. Budgauna. Hinauti and Majhgawan Limestone mines at Sidhi Cement works*
25	*GC-20-06-C*	*Scientific Study to ascertain the stability of the high wall of Granite Quarry of M/s Midwest Granite Pvt ,Ongole*
26	*GC-21-04-C*	*Geotechnical investigations to ascertain the stability of slopes of Rock Quarry in the Sy.No. 184/1A,located in Elappara Village, Peermade Taluk, Idukki District, Kerala State.*
27	*GC-21-05-C*	*Technical guidance for scientific quarrying and suitable pit slope for the proposed dimensional stone black granite quarry of M/s.Stone Trust Enterprises, Semmedu, Villupuram District, Tamilnadu*
28	*GC-21-06-C*	*Scientific study on design of pit benches and stability assessment of the pit of Kalane Iron Ore Mine located in Sindhudurg, Maharashtra*
29	*GE-17-06-C*	*Determination of In-situ deformability parameters by pressure meter method in soil –cement GI Mock-up area at Gorakhpur Haryana, Anu Vidyut pariyojana,Haryana.*
30	*GE-19-02-C*	*Determination of In-situ Stress Parameters for the design of stopes at Sindesar Khurd mine, HZL, Rajasthan*
31	*GE-20-01-C*	*Determination of In-Situ stress parameters of the overlying roof strata for orientation of Longwall panelat Muraidih Colliery of BCCL, Dhanbad.*
32	*GE-20-02-C*	*Determination of in-situ stress parameters at the proposed Underground powerhouse of Sharavathi pumped Storage project.*
33	*GE-20-03-C*	*Determination of in-situ deformability modulus at Saundatti Pumped Storage Project (PSP)*
34	*GE-20-04-C*	*Determination of safe bearing capacity of underlying strata by Plate load test for the design of barrage at Punatsangchhu-I Hydroelectric project, Bhutan*
35	*GE-20-05-C*	*Determination of in-situ deformability parameters by Goodman Jack tests at the proposed Lower Kopili*
36	*NM-19-03-C*	*Deformation Monitoring of Underground Powerhouse cavern of*

ANNEXURE - F

		Sardar Sarovar Project
37	*NM-19-04-C*	*Analysis of Instrumentation Data of Desilting Chambers, powerhouse complex, Surge Shaft, TRT outfall area and Dam at NJHPS*
38	*NM-19-07-C*	*Geodetic Monitoring of Sardar Sarovar Dam.*
39	*NM-20-01-C*	*Analysis of Instrumentation Data at Dam Complex, Punatsangchhu-II Hydroelectric Project, Bhutan.*
40	*NM-20-02-C*	*Analysis of Geotechnical & Geodetic Instrumentation Data at C-3 Package of Punatsangchhu-II Hydroelectric Project, Bhutan (2020-21)*
41	*NM-20-03-C*	*Analysis of Cavity Monitoring System Data for the Void above Downstream Surge Chamber at C-3 Package of Punatsangchhu-II Hydroelectric Project, Bhutan (2020-21)*
42	*NM-20-04-C*	*Cap Rock Stability at Central Baroi Mine vis-a-vis Depillaring of Remnant Pillars – A Critical Appraisal*
43	*NM-20-05-C*	*Geodetic monitoring of Sardar Sarovar Dam.*
44	*RB-19-01-C*	*Optimization of blast design for Mangampet Dolomite mine, APMDC Ltd., Vijayawada.*
45	*RB-19-08-C*	*Monitoring of blast induced vibration at two identified locations (Phase-III), Darlipalli Super Thermal Power Project (DSTPP), Stage -I(2*800MW), NTPC Limited. Odisha-Extension-VI*
46	*RB-19-11-C*	*Phase 2 Extension 4, Monitoring of ground vibration and air overpressure due to blasting carried out for construction of Hydro-Technical Structure of unit 3 and 4 at Kudankulam Nuclear Power Plant, Kudankulam, L&T, Tamil Nadu.*
47	RB-19-12-C	*Extension of Services for Technical Guidance for Excavation of various components of Powerhouse Complex of Punatsangchhu-II (1020MW) Hydroelectric project by Controlled Blasting, Project Authority Punatsangchhu-II Hydroelectric Project Authority (PHPA-II), Bhutan (EXTENSION-1)*
48	RB-20-03-C	*Technical guidance for rock excavation by controlled blasting for site grading work at SMF plant site, Challakere, Chitradurga.*
49	RB-20-04-C	*Procedure for controlled blasting and monitoring of ground vibration for rock excavation at Kaiga 5&6 site, Kaiga.*
50	RB-20-05-C	*Monitoring of blasting induced vibration at two identified locations(Phase-III),Darlipalli Super Thermal Power Project(DSTPP),Stage-I(2×800MW),NTPC Limited, Odisha-Extension-VII (Field 15 Nov.2020to 15 Jan.2021)*

ANNEXURE - F

ANNEXURE-G

LIST OF PUBLICATION

1 Balachander, R., Gopinath, G. and Venkatesh, H. S., 2022, Blasting problems in stone quarries and Iron ore mines" National seminar on Safe Usage of Explosives and Winning of Minerals organised by MEAI Bangalore pp. 45-51.

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4 Butchibabu B, Jha P C, Sandeep N, Sivaram Y V., 2022, Delineation of Water Seepage Flow Path in the Underground Metro Rail Tunnel Using Cross-Hole GPR Tomography: A Case Study. Proceedings of Geotechnical Challenges in Mining, Tunneling and Underground Infrastructures (ICGMTU 2021), Malayasia, Vartuval conference, 20 – 21 December 2021, pp. 371-382.

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9 Kumar Vikalp, Jha P. C. & Balasubramaniam V. R., 2021, New domain application of microseismic monitoring in underground excavation., International Conference on Recent Advances in Earth Sciences: A Conference Organized by: Institute of Earth and Environmental Sciences Dr Rammanohar Lohia Avadh University, Ayodhya, U.P. India in association with the International Academy of Physical Sciences, Prayagraj (CONIAPS- XXVII); 26-28 October 2021, p. 21.

10 Kumar Vikalp, Jha P. C., Singh N.P. and Shivakumar,C., 2021, Application of Microseismic Monitoring in Analysing the Stability of Underground Cavern. Journal of the Geological Society of India, v. 97, pp. 1379–1386.

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12 Naithani, A.K. Prasnna Jain, Singh L.G. and Rawat, D.S., 2022, Engineering geological characteristics of the underground surge pool cavern – a case study, India, International Journal of Geo-Engineering, Vol. 13(7), pp. 1-12.
13 A.K. Naithani, L.G. Singh, Prasnna Jain, D.S. Rawat and R.N. Suribabu, 2022, Construction of Underground Pump House Cavern in Medium Stress Condition – A Case Study from India, A. K. Verma et al. (eds.), Proceedings of Geotechnical Challenges in Mining, Tunneling and Underground Infrastructures, Lecture Notes in Civil Engineering 228, Springer Publ., pp 405-418.
14 Naveen, G. C., Siva Prasad, BNV., Balachander, R., Gopinath, G., Venkatesh H S and Sripad R Naik, 2022,Tunnel Excavations in highly stressed weak rock mass condition, Proceedings of Geotechnical Challenges in Mining, Tunneling & Underground structures, (ICGMTU-2021) 20-21 Dec 2021, Johor Bahru, Malaysia, pp.241-258.
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17 Praveena Das Jennifer , Porchelvan P and Sripad R Naik, 2022, Numerical Modelling of Mining Induced Seismicity in deep closed mines: A case study, Proceedings of Geotechnical challenges in Mining, Tunneling & Underground structures, (ICGMTU-2021) 20-21 Dec 2021, Johor Bahru, Malaysia, pp.437-455.
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20 Singh, L.G., Naithani, A.K., Prasnna Jain, Rawat D.S. and Jala Ramesham, 2021: Rock mass assessment and rock support system for underground extended pump house cavern – a case study from lift irrigation project, India, Proceedings EGCON-2021 International Conference on Recent Advances in Geotechnics, India, pp. 253-265.
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Tunnelling Projects, Indian Geotech Journal, p. 765-779. doi.org/10.1007/s40098-022-00608-0.

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24 Sudhakar, K. Rabindra Kumar Sinha and Naik, S. R., 2022, Safety and Stability Monitoring of Underground Structures - Role of Geotechnical Instruments Proceedings of Geotechnical challenges in Mining, Tunneling & Underground structures, (ICGMTU-2021) 20-21 Dec 2021, Johor Bahru, Malaysia, pp.419-433.

25 Sudhakar, K. Sekar B.H.V. and Naik, S. R., 2022, Surge Shaft Instrumentation and Monitoring in Himalayan Hydroelectric Projects, Proceedings of Geotechnical challenges in Mining, Tunneling & Underground structures, (ICGMTU-2021) 20-21 Dec 2021, Johor Bahru, Malaysia, pp.259-271.

26 Vijay Sekar, BH., Rabindra Kumar Sinha and Naik, S. R., 2022, Estimation of Deformation Modulus of Rock Mass for an Underground Cavern Based on Back Analysis, Proceedings of Geotechnical challenges in Mining, Tunneling & Underground structures, (ICGMTU-2021) 20-21 Dec 2021, Johor Bahru, Malaysia, pp. 393-404.

ANNEXURE-H

NIRM STAFF

(as on 31.03.2022)

Director: ***Dr. H S Venkatesh***

Project Monitoring Cell
Dr. Sripad R Naik
Mr. Sultan Singh Meena

Seismotectonics
Dr. Biju John
Dr. Yogendra Singh

Engineering Geology
Dr. A K Naithani
Dr. Devendra Singh Rawat
Dr. L Gopeshwor Singh
Dr. Prasnna Jain

Engineering Geophysics
Dr. P C Jha
Dr. Sandeep Nelliat
Dr. Butchi Babu Bongu
Mr. Y V Sivaram
Mr. Goverdhan Kantepudi
Mr. Shashi Nath Verma

Geotechnical Engineering
Dr. D S Subrahmanyam
Mr. G Shyam
Mr. K Vamshidhar
Mr. Vikram S
Mr. Shashidhara K N

Centre for Testing Services
Mr. A Rajan Babu
Mr. Royston Angelo Victor
Mr. Prashanth Kumar D
Mr. Prabhu R
Mr. Babu S

Numerical Modelling
Dr. Sripad R Naik
Dr. Rabi Bhusan
Mr. B H Vijay Sekar
Mrs. Praveena Das Jennifer
Mr. K Sudhakar
Mr. B N V Siva Prasad

Rock Blasting & Excavation Engineering
Dr. H S Venkatesh
Mr. Gopinath G
Mr. Naveen G C
Mr. R Balachander

Geomechanics & Ground Control
Mr. A Rajan Babu
Mr. T Amrith Renaldy
Mr. Sultan Singh Meena
Mr. A Y Bharath Kumar

Engineering Seismology
Dr. Balasubramaniam V R
Dr. Divyalakshmi K S
Mr. Vikalp Kumar

Administration
Dr. Sandeep Nelliat
Mr. S Ravi
Mrs. Uma H R
Mr. N Jothiappa
Mr. J Raja
Mr Adithya M P
Mrs. Shruthi B S
Mrs. P Janaki Bhavani
Mr. Venkata Reddy K
Mr. K Manjunath

Microseismic monitoring training to the participant at Raichur, HGML mine site, sponsored by Min. of Mines, Govt. of India.

Independence Day celebration at
NIRM HO, Bengaluru and NIRM RO KGF

Republic Day celebration at
NIRM HO, Bengaluru and NIRM RO KGF

Back Cover photo captions (top to bottom):

First: *Controlled blasting at power house of Punatsangchhu II, HEP, Bhutan.*

Second: *Testing of granite blocks pertaining Sri Ram Janma Bhumi, Ayodhya temple.*

Third: *Insitu stress measurements at Silla Halla PSP, Ooty, Tamilnadu.*

G20

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