



2020 -21 Annual Report



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

Head Office

Outer Ring Road, Eshwar Nagar,
Banashankari 2nd Stage, Bengaluru-560070
Karnataka, India

Registered Office

P.O. Champion Reefs,
Kolar Gold Fields-563117
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.

Front Cover photo captions:

- Top:* Installation of strain meter group of nine, along with no-stress strain meter, stress meter, temperature meter and piezometers at dam body of Punatsangchhu-II HEP.
- Bottom:* Installation of plate load test setup for determining the safe bearing capacity of strata at dam site of Punatsangchhu-IHEP.
- Left:* View of control blasting being carried out in the close proximity of a functional power plant.

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DIRECTOR'S MESSAGE



Namaste !

I am pleased to present the Annual Report 2020-21 of National Institute of Rock Mechanics (NIRM), exclusively devoted to applied research in Rock Mechanics and Rock Engineering under the Ministry of Mines, Government of India. This year, though disturbed by the pandemic, we have put our best foot forward to serve the industries in the most efficient way as possible. NIRM has been taking all possible precautions to prevent the COVID-19 spread by following the guidelines and instructions issued by the government on a timely basis and we also extended support to some of the needy families at Kolar Gold Fields during this period. We adopted to changed working scenario very fast and migrated to appropriate digital tools and online platforms to cater the industry. Despite the global hardships, our committed Scientists & staff have carried out field visits uninterrupted under these difficult situations and stood firmly for Aatma Nirbhar Bharat.

Even in these unprecedented challenging times due to COVID-19, NIRM completed 44 projects of which 15 projects were from mining sector, 17 from hydropower sector, 5 from nuclear sector, 6 from infrastructure sector, one from oil & gas. NIRM was awarded 46 new projects during this financial year. Out of 46 new projects, 21 projects were from mining sector, 12 from hydropower sector, 4 from nuclear sector, 5 from irrigation sector, and one each from thermal, marine, railway and allied sectors. We have also made contributions to knowledge generation as evidenced by research papers. As was being achieved, we continued the financial sustainability even under these difficult times by generating 40 percent of our salary expenditure and 100 percent of our administrative expenditure. In addition, we could augment our scientific instrumentation partly through our internal resources too. I am happy to inform that, in accordance with Rule-229 (ix) of GFR-2017, NIRM was peer reviewed during the year 2021 and the report by the concerned has been submitted to the Ministry of Mines, Govt of India.

For commemorating 75 years of Indian Independence, (Aazadi ka Amrut Mahotsav) NIRM has been organising a series of online technical lectures since 12th of March, 2021. NIRM employees participated in online 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 the year 2020-21, NIRM has made significant contributions to the development of safe and economic practices for coal, metal and opencast mines under difficult geomining conditions. Significant 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 Baroi mine in Rajasthan, numerical modelling was carried out to optimise crown and rib pillars for sustaining the rate of production. In-situ stress is determined for designing overlying roof strata and orientation of the longwall panels of the proposed underground mine, below the existing Muraidih Colliery open cast mine at Barora area Jharkand. Impact of ground vibration was studied at Hira Buddini Gold mine, Karnataka and studies were conducted at Mangampet, 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 PHEP II, which is being implemented jointly by the Royal Government of Bhutan and the Government of India. Several 3-dimensional numerical models were created for underground facilities of this project subsequent to the roof collapse that has occurred during the excavation. NIRM designed monitoring of structures using instrumentation, 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 Arun 3 Hydroelectric Project in Nepal, 3D modelling for underground facilities was carried out and shear parameters of the rock mass at the banks of the dam structure were determined. For the prestigious Sardar Sarovar project in Gujarat, NIRM continued monitoring at dam structure and underground facilities. In a significant study, NIRM carried out GPR survey to map the widening of the contraction joint observed at the flip bucket area of Koldam HEP. Nathpa Jhakri, Tehri, Vishnugad Pipalkoti, 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's involvement started from the studies for site selection to foundation clearance through blasting and foundation mapping. Seismotectonic feasibility studies around Chatrapur, Odisha identified suitability

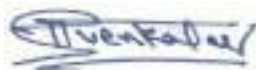
of nuclear power plant. Studies are also under progress for the seismotectonic evaluation of the proposed Jaitapur site. For Mahi Banswara (MBRAPP), technical support was extended for site specific geological/geotechnical investigations. As a part of hazard analysis, landslide zonation studies were carried out for understanding the risk of NPP plants at Kiaga. NIRM exclusively supports the foundation excavation activities at KKNPP, RAPP and Kaiga NPP sites. For Kakrapar, NIRM was involved in the geotechnical assessment of the foundations. NIRM is also involved in the process of selecting site for nuclear repository through in-situ stress studies. For thermal power plant at Darlapalli, Orissa, controlled blasting method of operations was adopted for the foundation excavation of various components of installations.

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. Following the foundation failure along the pipeline carrying hydrocarbon at the complex of Mangalore refinery, NIRM carried out geophysical survey to understand the strata conditions. For railway bridge crossing Gobindsagar reservoir, NIRM conducted cross-hole tomography to understand the strata condition for pillar locations.

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, material and rock samples for determination of various physico-mechanical properties were also done for various industries including ONGC, Arun-3 and other mining companies.

The above-mentioned achievements were possible only because of the dedication of Scientists & staff of NIRM. 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 for 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 Hindustan Zinc Limited (HZL) proposes to enhance the productivity at Sindesar Khurd underground lead-zinc mine by developing the stope blocks at lower levels (600-800 m from surface) below the mined-out area. In-situ stress measurements were carried out by NIRM for designing and developing the stopes. The K value indicates a moderate to high stress magnitude at vicinity of the test sites and the prevailing maximum principal horizontal stress direction is N 20°.



Hydraulic fracturing test - 395 m RL at Sindesar Khurd, Underground Lead-Zinc mine (HZL)

1.2 Muraidih Colliery is a working colliery under Bharat Coking Coal Limited, Jharkhand. The mine authorities are planning to open an underground mine below the existing open cast mine. In-situ stress measurements by hydraulic fracturing method was carried out by NIRM for designing overlying roof strata and orientation of the longwall panels. The K value indicates a moderate stress magnitude and the prevailing maximum horizontal principal stress direction is N 50°.

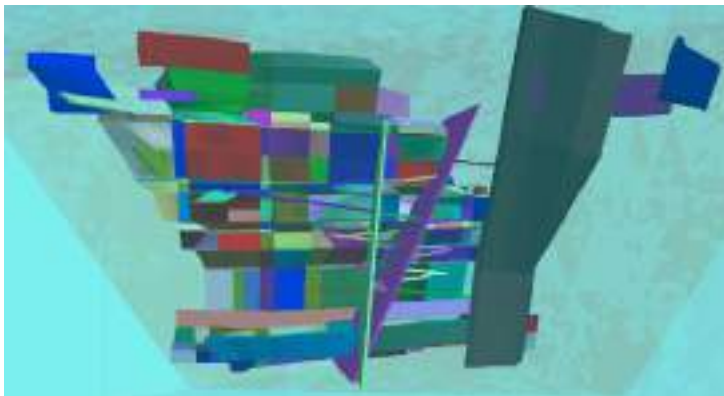


Hydraulic fracture test at BH-02, Nico plant

1.3 Detailed numerical modelling studies were carried out to optimize crown and rib pillars at Central and North Baroi mine (HZL, Rajasthan) with and without cemented rock fill and stand-off distances for footwall drives, ramps and other large excavations from stope boundary was reviewed. An independent 3D numerical

model was developed in FLAC3D for both the mines incorporating the actual ore body extents, surface topography and factual stoping sequence as mined. Various cases were simulated and the optimized stoping configuration along with the safest stope sequence was recommended to HZL.

1.4 To sustain rate of production in long term, Baroi mine of HZL, Rajasthan is going to introduce backfilling and depillaring of remnant pillars. Since the upper stoping block is near to surface (cap rock ~ 70 m), it was deemed essential to assess cap rock stability in BK series vis-a-vis depillaring as well. During the study, depillaring viability of remnant pillars (both rib and crown) in BK Series between 430 mRL and 190 mRL will be determined strategically along with the cap rock stability post depillaring.



3D numerical model of Central Baroi mine

1.5 Scientific studies to optimize the bench parameters and design of final pit slope stability of granite quarry of Sadahalli Building Stone Quarry Lease Holders and Lorry Owners Association has been taken up. As a novel



A view of the quarry working by benches

approach, 44 different Granite quarries were amalgamated and study was conducted considering it as single quarry. The maximum allowable depth and bench design parameters were given as part of recommendations.

1.6 Strata monitoring using instruments and data analysis is under progress at Tummalapalle Uranium mine, UCIL at Kadapa Andhra Pradesh. Instruments like stress cells, load cells etc. have been installed and were monitored. Support system shall be enhanced at critical locations if high deformation is found.

1.7 Studies on design of stoping parameters at 11th, 12th & 13.5th level of Balaghat mine and design of sub-level stoping of Chikla & Munsar mine of MOIL with a view to optimise the stoping parameters by both empirical and numerical modelling is under progress. Instrumentation data analysis at Chikla mine was also carried out.

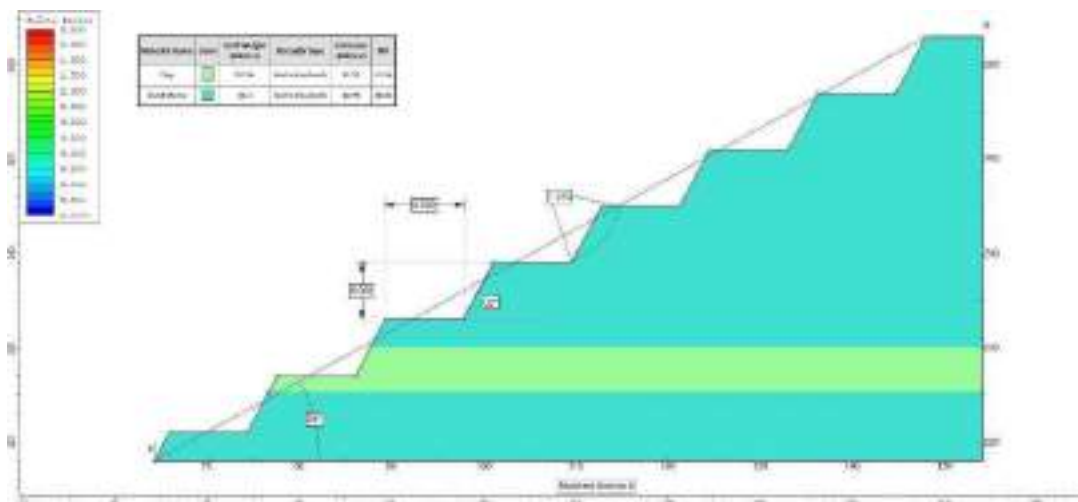
1.8 M/s. Pallava Granites Pvt. Ltd based on the previous study report submitted by NIRM, has requested to review the effective implementations of the stability measures recommended earlier and accordingly, NIRM carried out the investigations. Based on the study results, it was observed “Zero movement” and recommended to carry out the earlier suggested stability measures.

1.9 Scientific Study for slope stabilization and monitoring of ground movement of South Face, mine I of NLCIL, Neyveli, Tamil Nadu was carried out and suggested some immediate corrective measures to arrest further slide failure. Numerical analysis for safe slope was arrived at and recommendations were made for stable slopes. The instrumentation data was also analysed.



Location of monitoring points

1.10 Scientific Study for stability assessment of Pit and dump of Barsingsar Lignite mine, Bikaner, Rajasthan was carried out. Field investigations and numerical analysis of various sections was conducted. Individual bench angle of 62° and ultimate pit slope angle of 28° were recommended with other bench parameters.



FoS values of a modified section

1.11 M/s Minerals and Metals intended to conduct a scientific study for assessment of safe pit slope angle and waste dump at Redi Iron Ore mine located in Redi Village, Vengurla Taluka, Sindhudurg, Maharashtra. Based on the field investigations and analysis, report with recommendations was submitted.

1.12 M/s Redi Iron Ore mine requested NIRM for assessment of pit slope stability and evaluation of monitoring data & analysis of Redi Iron Ore mine located at Sindhudurg District., Maharashtra. Field investigation is under progress.

1.13 NIRM carried out a scientific study on the impact of ground vibration due to blasting at sublevel open stope method on surface structures at Hira Buddini Gold mine, Karnataka. A conservative permissible limit of 5 mm/s was recommended to be safe for the structures near to the mine till the rehabilitation. To keep this vibration limit, maximum charge per delay not exceeding 120 kg was recommended.



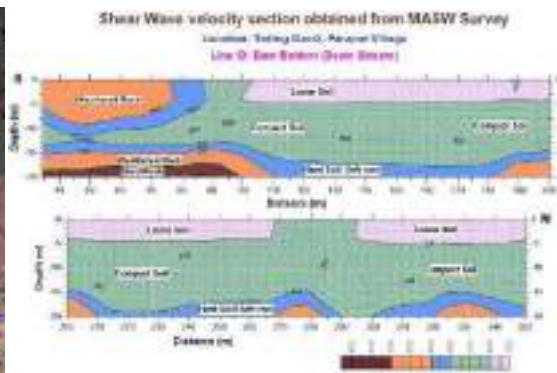
Ground vibration monitoring near Buddini village

1.14 Scientific Study for stability assessment and monitoring of pit and dump at three Limestone mines namely; Budgauna, Hinauti and Majhgawan in Sidhi District, Madhya Pradesh is under progress. Initial field investigation and testing of samples were completed.

1.15 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. The benches were optimized for maximum extraction by practising utmost safety. Analysis of various sections have been done and recommendations were submitted.

1.16 M/s Haripriya Granites, Pearl & Golden Granites and Venus Granites are operating Granite quarries in Chimakurthy, Ongole. Scientific Studies were required for bench optimization and design of final pit slope. Field visit is completed and study is in progress.

1.17 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



Bird's eye view of tailing dam (left), MASW section for tailing dam (right).

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 (1/100 to 1/10000) the expected damage level.

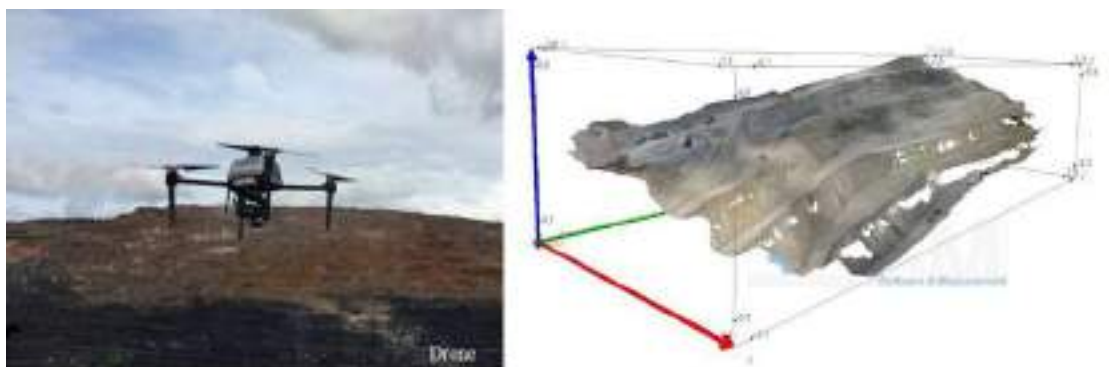
1.18 Due to sinkholes and subsidence in old and abandoned mining area of Umara, Madhya Pradesh the Hon'ble National Green Tribunal (NGT) had directed NIRM to assess the ground condition and submit the report to M/s



Geophysical survey in progress using GPR (left) and MASW techniques (right)

SECL. Accordingly, geophysical survey at four sites within the inhabited area and four in the forest area were conducted at identified locations by using different geophysical methods in March 2021. At some locations, evidence of subsidence, caving and pit of various dimensions were observed.

1.19 Andhra Pradesh Mineral Development Corporation Ltd. had approached NIRM to optimize the blast design at Mangampet, Kadapa District because of the proximity to a public road. NIRM team has carried out field investigation using seismographs, high-speed video camera, drone and scaled photographs. The study is under progress.

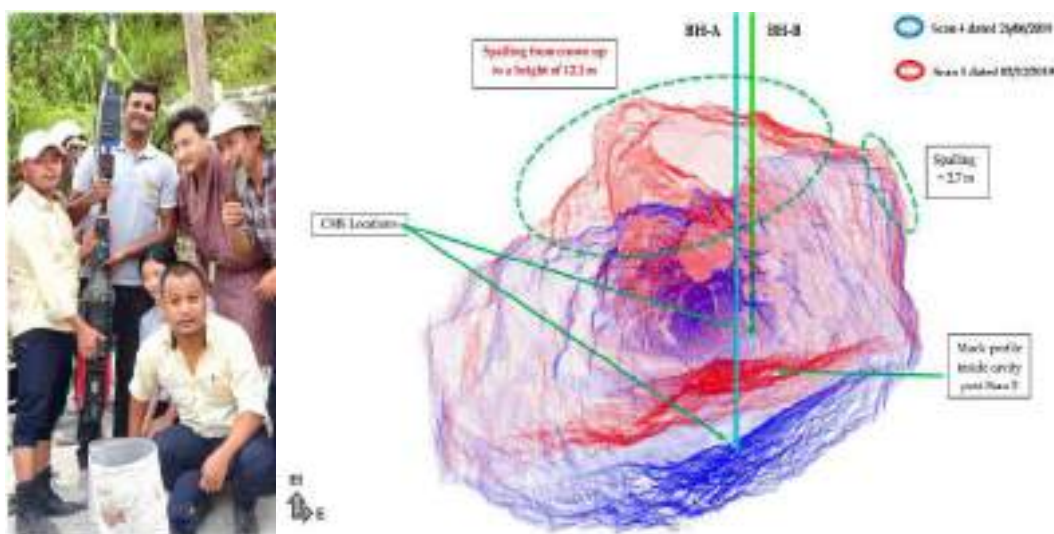


Drone was used to optimize the blast design

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) to be implemented between the Government of India and the Royal Government of Bhutan. NIRM is exclusively helping the project authority in various aspect of the implementation. For powerhouse complex, a 3D discontinuum model was constructed with the actual geometry of the different components. Rock mass collapse at Downstream Surge Chamber (DSC) 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. Using a cavity monitoring system, the void was surveyed and the data



Cavity monitoring survey (left), Dilation of joints at different depths in powerhouse cavern (right)

obtained in the form of point cloud data was analysed periodically to find if there is any further aggravation in cavity dimensions. The process was repeated after every 5 m of cavity filling. The extent of cavity filling was also determined through the data analysis.

NIRM is presently carrying out the stability studies and assessing the support system for the three caverns. Analysis has been carried out for three cases namely design case-PH, TH and DS caverns without cavity over DSC. Present Case- PH, TH and DS caverns with cavity over DSC and Treatment Case-cavity treatment/filling in the DSC cavern. Recommendations were given based on the outcome of the modelling results.

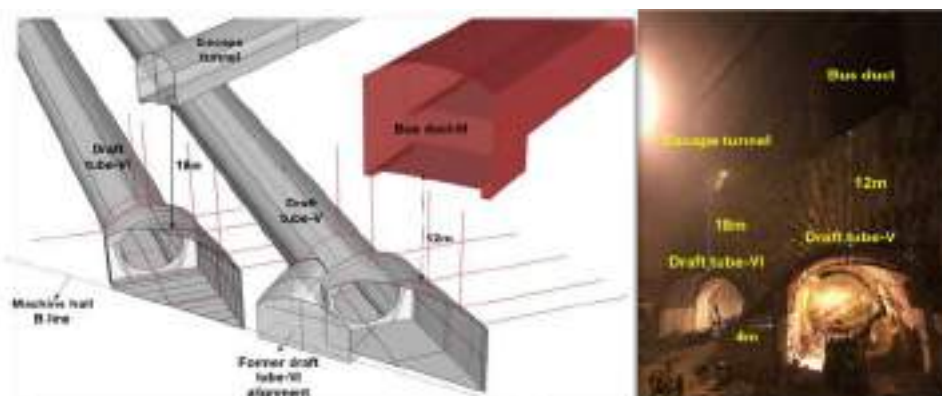
NIRM provided guidance for installing various geotechnical instruments as per the CWC drawing and detailed analysis of instrumentation data acquired since beginning of instrumentation work at 91 m high concrete gravity dam complex. The analysis of instrumentation data indicate that there was a sudden increase in pore pressure in the shear zone during July 2020 as well as in 1st week of March 2021 and subsequently the pore pressure decreased. The increase in pore pressure may be attributed to the effect of increased rainfall during the above said periods.

The work for PHEP-II also includes monitoring stability of underground structures in the vicinity of critical excavations. During execution, several innovative designs of instrumentation setup has been recommended to the client aiding in obtaining critical information required for cavity filling.



Installation of prefabricated setup comprising of load cell and biaxial borehole stress meter, Instrumented Rock Bolt in fallen muck and pressure cells to monitor lateral thrust on the retaining walls of DSC

NIRM has been guiding all the blasting activities in the powerhouse complex of PHEP-II since 2019. The ground vibrations recorded for blasts carried in various components were found to be safe in terms of the stability of surrounding structures.



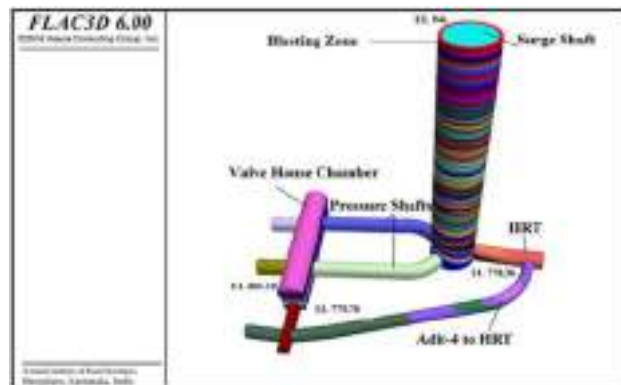
Excavation of different tunnel openings on the downstream wall of powerhouse

2.2 NIRM conducted Plate load tests, as the bearing capacity of the underlying strata for the design of the foundation of an alternate Barrage/Weir proposed in the upstream of the present dam site (PHEP-I). The ultimate bearing capacity at the proposed barrage axis no. 3 ranges between 60.17 to 75.02 T/m².



Plate Load Test (a) load equipment (b) datum bar assembly

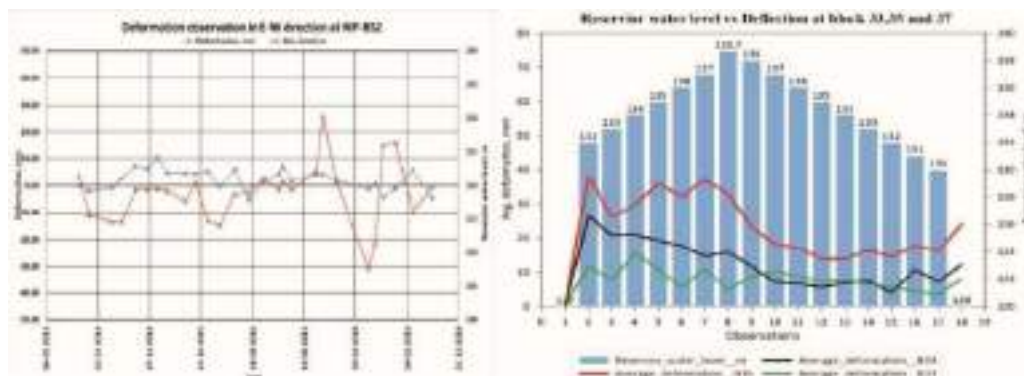
2.3 The 3D numerical model analysis of powerhouse complex of Arun 3 HEP (900 MW), Nepal identified a higher displacement value in crown and invert compared to the walls in machine hall and transformer hall caverns. It was suggested to decrease the spacing and increase the length of rock bolts where rock mass was poor. Surge shaft of Arun 3 was also analysed in FLAC 3D and it was observed that the extent of yield zone is more at EL 833 m where the mica schist band intersects the excavation of shaft area.



FLAC3D model of Arun-3 surge shaft

2.4 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.

2.5 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



Deformation measurement at block no 52 (left);
Avg. easting deflection at overflow blocks 35, 33, & 37 (right)

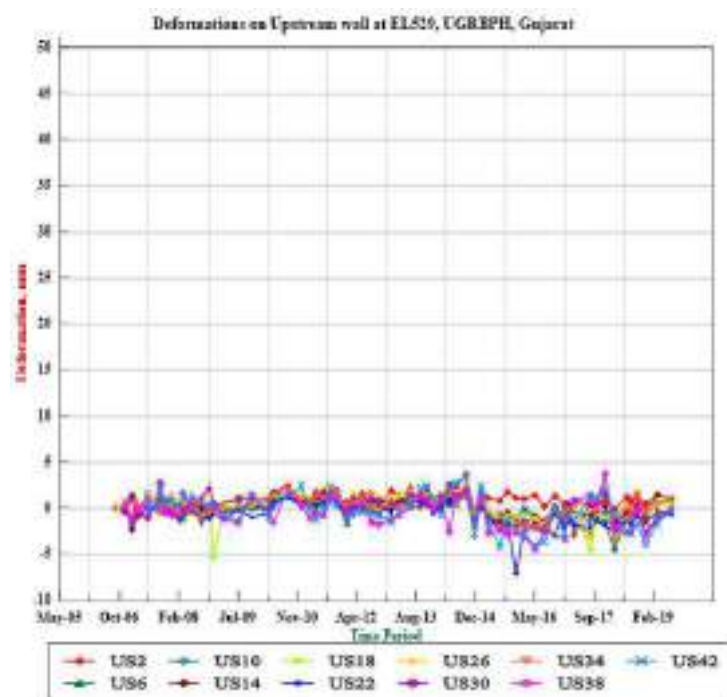
Dam (1,210 m long, 163 m high), continuous monitoring of the dam was carried out from August 2019 to the end of January 2020 through conventional geodetic monitoring of the 23 installed monitoring points. The maximum easting deflection of about 45.8 mm was observed in block no. 35 during the monsoon period. Underground River Bed Powerhouse with installed capacity of 1200 MW is located at 165 m downstream of the dam. The powerhouse

cavern project is being monitored for long-term stability, through borehole extensometer and retro reflective targets. During the monitoring period the displacement of almost all the Magnetic Ring Multi Point Borehole Extensometers (MRMPBX's) at the underground powerhouse showed stable trends. The displacements measured on the columns and beams were negligible and showed stabilizing trend. Geological sections were examined at locations where the displacements exceeded 4 mm and it was found that, all these anchors are located in agglomerate rock near to shear zone.

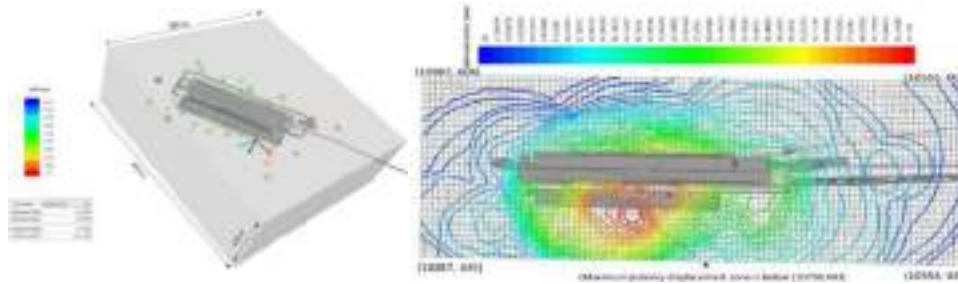
2.6 The 1,020 MW Tala Hydroelectric Project is one of the biggest joint venture between India and Bhutan. The stability monitoring of underground Powerhouse is being carried out by NIRM using a 30 station microseismic monitoring network. From January to December 2020, 109 events were identified as microseismic events in the powerhouse complex. The local magnitude of the microseismic events ranged from -2.9 to 0.6. Majority of events occurred in the upstream wall of the machine hall and at lower elevations of the Powerhouse. Maximum potency displacement is below EL 493 m and appears to occur below the Bus Duct-2. Two rock bolt failures occurred in 2020.

From January to March 2021, 53 events were identified as microseismic events. Maximum microseismic events occurred in and around the level of 474 m below the machine hall. The local magnitude of the microseismic events ranged from -3.9 to -1.8.

There has been no significant change in stress regime and development of any stress regime with time but the upstream wall is highly stressed compared to other walls of the underground structure.



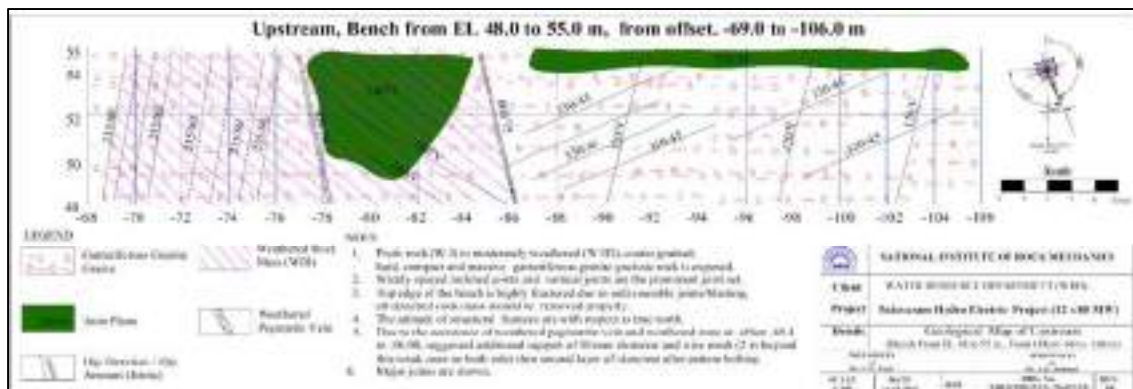
Displacement at u/s wall of PHC at EL 529



Microseismic events on 3D cavern plan (left) ; Potency displacement in the Powerhouse (right)

2.7 Engineering geological investigations, on 1:200 scale, for the excavated surface of cut slopes (intake pool, upstream and downstream hillock above tunnels), powerhouse area and tail race pool of 960 MW Polavaram hydroelectric project (P-HEP) is under progress. The Khondalite suite of rocks exposed in the hill slopes are strong and jointed in nature. At few places, the pegmatite reported is highly weathered, altered and sheared. Recommendations were given for the protection of slopes based on the investigations.

Slope protection measures were also recommended for the excavated surface of cut slopes: upstream and downstream hillock above tunnels and powerhouse area.



Geological map of upstream, bench from EL 48 to 55 m, Offset, -69 to -106 m, P-HEP

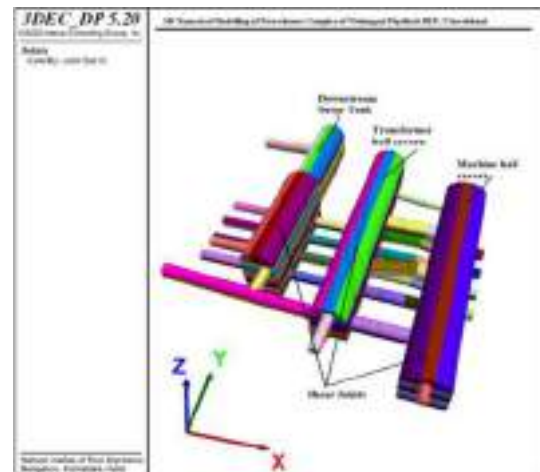
For the construction of powerhouse, NIRM provided technical advice on drilling and blasting for excavations. Using trial blast, NIRM submitted a method statement to optimize the blast design for bench cutting and walls stability. Further blast vibrations were checked at the critical structures and it was found to be within the permissible limits.



Slope obtained as a result of presplit blast design

2.8 NIRM carried out 3D numerical analysis of machine hall cavern for 1000 MW Tehri Pumped Storage Plant with change in geotechnical properties and support system. The model was rerun with different shear strength parameters. The geological formations were changed as per the Geological base line report with shear joints at 10 per 100 m. NIRM carried out six model studies and the results were submitted to the project authority.

2.9 NIRM carried out 3D numerical modelling of powerhouse complex & surge tank of Vishnugad Pipalkoti HEP using discontinuum modelling. From the modelling results, it was noticed that shear joints have considerable influence on the displacement pattern of the crown and walls. Higher values of stress concentrations are observed at the intersection of the tunnels with the caverns. Maximum principal stress values generally ranged between 2 to 20 MPa.



3DEC model of Vishnugad Pipalkoti powerhouse

2.10 In-situ stress measurements were carried out for the proposed underground powerhouse of Sharavathy Pumped Storage Project (1000 MW; Shivamonga, Karnataka). The K value indicates a moderate stress magnitude at the vicinity of the test site and the prevailing maximum principal horizontal stress direction is N 30°.



Hydraulic fracture test in progress at DH-7 location

2.11 The in-situ deformability measurements were carried out at Saundatti Pumped Storage Project (1260 MW), as apart of stability analysis and design of rock structures. The prevailing modulus of deformation (E_m) and modulus of elasticity (E_e) of rock mass ranged from 5.83 to 14.37 GPa and 20.11 to 47.62 GPa respectively. The values indicate rock mass falls under good to very good category.



Goodman Jack test in progress at BH-18

2.12 For lower Kopili Hydroelectric Project (120 MW) Assam, NIRM conducted Goodman jack tests, for in-situ deformability measurements which is required for the stability analysis and design of rock structures. The modulus of deformation (E_m) and modulus of elasticity (E_e) of rock mass at different locations viz. PHS, HRT, SS1, DM5 fall under good to very good category, for DM3 and DM1 under good category, and for DIV3(A) under fair to good category.



Goodman Jack test in progress at test location SS1

2.13 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. For the recorded range of frequency, the permissible peak particle velocity for the residential structures is 10 mm/s. However, it was advised to restrict



Excavation of 3 tunnels near Pazhassi Sagar barrage

the peak particle velocity to 5 mm/s and safe air overpressure level 133 dB for the private structures located in the vicinity of the project area.

2.14 Analysis of instrumentation data of powerhouse complex, of NJHPS (1500 MW), Himachal Pradesh, indicate that the displacements at RD 160 m, RD 123 m and RD 41 m at EL 1014 m on the downstream wall shows stabilizing trend, whereas at RD 184 m EL 1022 m right side of the crown, the 6 m anchor (surface displacement) showed erratic readings up to April 2012.

2.15 Kerala State Electricity Board (KSEB) is implementing Peruvannamuzhi Small Hydroelectric Project (6 MW) at Peruvannamuzhi, Kadiyangad, Kozhikode district.

Based on the vibration study, a peak particle velocity of 10 mm/s is recommended as safe for private residential and other structures near to pressure shaft for the excavation of Head Race Tunnel, Surge shaft, Pressure shaft and other associated excavations.

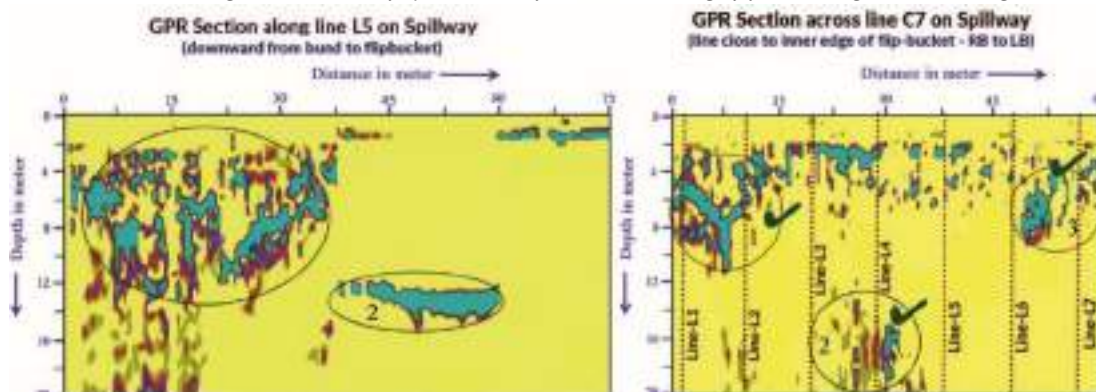


View of Head Race Tunnel (left) and surge shaft (right) excavation

2.16 Widening of contraction joint was observed at the flip bucket area in right guide wall and left guide wall in Koldam Hydroelectric Project (800 MW) Bilaspur, Himachal Pradesh. GPR survey from surface of spillway as well as on side benches was done to map the subsurface trace (to a depth of 10 m) of the feature. Nine anomalous zones were identified. It appeared that the overall signature of the anomaly might be extending from plunge pool end to the flip-bucket/spillway portion.



Visual damage seen around flip-bucket (left) and widening of joints on guide-wall (right)



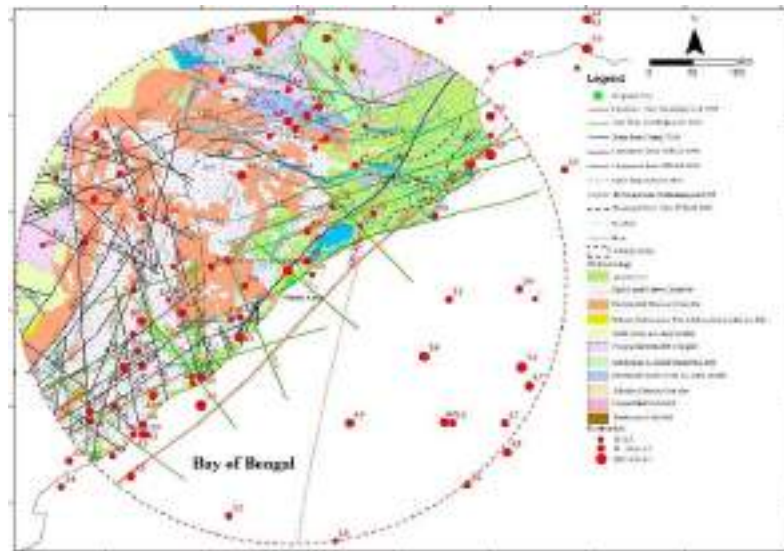
GPR sections on the spillway (line L5 and C7)

2.17 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 thick pile of continental flood basalts erupted on rapid succession nearly 65 million years ago. 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. There are 310 earthquakes reported within 300 km.

2.18 Seismotectonic

Evaluation (Feasibility) of Proposed Nuclear Power Site at Gopalpur, Odisha was carried out during this period. The tentative location of the site is at northeast of Haripur village, near OSCOM and is coming under the seismic Zone III. Geologically, the area forms part of the Eastern Ghat Complex. The



View of the ~301km seismotectonic map around OSCOM

earthquake catalogue is compiled for ~310 km radius area, from the proposed site. Field studies identified some capable faults which need to be studied further. This investigation suggest that the area can be selected for further detailed studies.

2.19 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 (as per the scope of work) has been carried out as per the approved procedures and applicable codes and standard through frequent visits of NIRM scientists.

2.20 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. For hard rock excavation by drilling and blasting methods, NIRM rendered technical guidance on



Controlled blasting close to a temporary dyke

controlled blasting. Blast vibrations were continuously monitored for 115 blasts at the designated locations for the construction of hydro-technical structures. The recorded air overpressure levels were well within the safe limit of 133 dB at the glass structure.



Blasting close to the administrative building at KKNPP

Since the rock excavation was not completed in the prescribed duration, NIRM continued technical guidance to execute further 45 blasts and about 0.14 lakhs cubic meter of hard rock was excavated safely. The recorded air overpressure levels were well within the safe limit of 133 dB at the glass structure.

2.21 Geotechnical assessment for the foundation of Onsite Emergency Support Centre (OESC) of Kakrapar (Gujarat) atomic power project units 3 & 4 (2 x 700 MW) were carried out during this period. Geological foundation mapping done on 1:100 scale indicates thick flows of porphyritic amygdaloidal basalts. No evidences of faulting or shearing were observed along the flow contacts and vertical joints on the surface of floor area. On the basis of surface geological mapping and review of drill cores, recommendations for the treatment of foundation were given.

2.22 Hard rock has to be excavated using drilling and blasting to construct additional units 5 & 6 (2 x 700 MW) at Kaiga power plant of Nuclear Power Corporation of India Limited (NPCIL) near to the existing units 3 & 4. New units are about 225 m and 1450 m away from old units and a quarry respectively. NIRM has conducted preliminary site investigation at the proposed main plant areas 5 & 6 and controlled blasting procedures were submitted to NPCIL.



The proposed old quarry to produce aggregate

2.23 Macro landslide hazard zonation mapping on 1:50,000 scale based on IS 14496 (Part 2), 1999 was carried out for the Kaiga Holhe catchment around Kaiga nuclear power project site. The aim of this work was to create a prototype map that is easy to read and understand and that can be useful in development planning of the area particularly during the execution of the new power units. Based on detailed investigations, appropriate recommendations were made.

2.24 For the construction of Electrical Sub Station Building at HWPF facilities of RAPP, Rawathbhata, Rajasthan, hard rock has to be excavated to a depth of 2 to 9 m.

For this, blasting has to be carried out close to the Cobalt Facility Building and running units 3 & 4 of Rajasthan atomic power plant (2 x 220 MW). After the preliminary site investigation, a method statement was submitted for tentative blast designs, permissible limits of ground vibration for civil structures, industrial structures, concrete of different ages, etc.

2.25 A geological repository is proposed at Vishakhapatnam, Andhra Pradesh by BARC for long-term isolation of high-level nuclear waste. As a part of feasibility studies in-situ stress measurements are being done to know the stress regime around the area and other geotechnical parameters of the rock mass.

2.26 BARC is intended to arrive at a site-specific predictor equation for the Special Material Facility at Challakere site, which will be useful for their future excavation work. NIRM has carried out preliminary site investigation using 15 and 13



Photographs showing the structures close to blasting (left), result of post-blast (right)

respective trial blasts of 115 mm and 38 mm hole diameter and a method statement was submitted which comprised the tentative blast designs, permissible limits of ground vibration for civil structures, industrial structures, concrete of different ages, etc. Ground vibrations and air overpressure was monitored at different locations and a site predictor equation for ground vibration and air overpressure was derived based on the acquired data.

2.27 For Darlipalli Super Thermal Power Project (DSTPP) 2 x 800 MW of NTPC Ltd., Odisha, NIRM has been technically guiding the controlled blasting at various locations of the project site and monitored ground vibrations at two locations. During Phase III Extension - 6 study period, 188 blasts were monitored at the various components and found that the monitored blasts were safe concerning blast vibrations, air overpressure and fly rock. In continuation to these Phase III Extension 7 study was also completed by monitoring ground vibrations at two locations.



Controlled blasting adjacent to the structures

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 Indian Navy is constructing Varsha Inner Harbour (VIH) Project for their naval base near Visakhapatnam. As part of this, NIRM is involved in the selection of armoured rock for the construction of break-water from different quarries of Vishakhapatnam.



View of stock pile (left), Drop test for 1 ton armour rock (right)

For the armoured rocks produced at Vooderu quarry, Anakapalli, NIRM is involved in the quality control exercise for the gradation and certification. For core rock, minimum 600 samples are required for gradation test and for armour rock minimum 50 samples are required for grading, block integrity and shape ratio tests from this quarry.

To increase the yield of armour rock seven experimental blasts were conducted at the site with varying burden, spacing, specific charge, and charge distribution. In addition, several blasts were conducted with the recommended design to ascertain the consistency in the yield from the quarry. Compared to the pre-investigation period, the yield of armour rock has increased significantly with a substantial reduction in the waste rock.



Marking of armour rock at stock pile.



Result of primary blast (left), secondary splitting (right)

To maximize the output of the graded material from blasting, NIRM was involved to provide technical advice on blast design for graded material for the construction of breakwater.

3.2 To construct the breakwater for the development of a deep-water multipurpose International Seaport seaport at Vizhinjam, Kerala, 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 carried out field investigations and a trial blast at one of the four identified quarries. The work is under progress in other quarries.

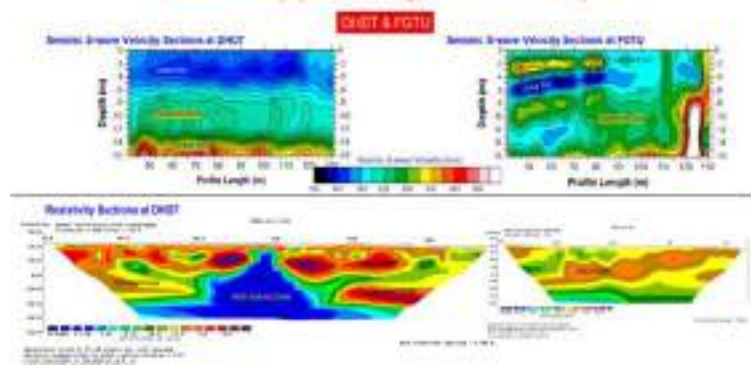
3.3 The interconnecting pipe rack carrying hydrocarbon & utility lines in the Phase-3 complex of Mangalore Refinery and Petrochemicals Limited had suffered massive damage due to slope failure around the foundation area during monsoon. NIRM carried out seismic refraction survey, MASW and crosshole seismic 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 from 3-5.5 m) having hard rock consistent below RL= -4 m. Valley type feature in the profile of the bed rock matched indicate 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.



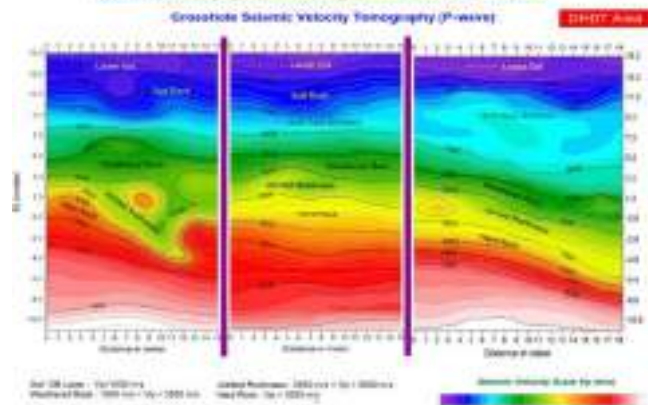
Site photographs showing extent of damage

Results of Geophysical Investigations at MRPL Complex



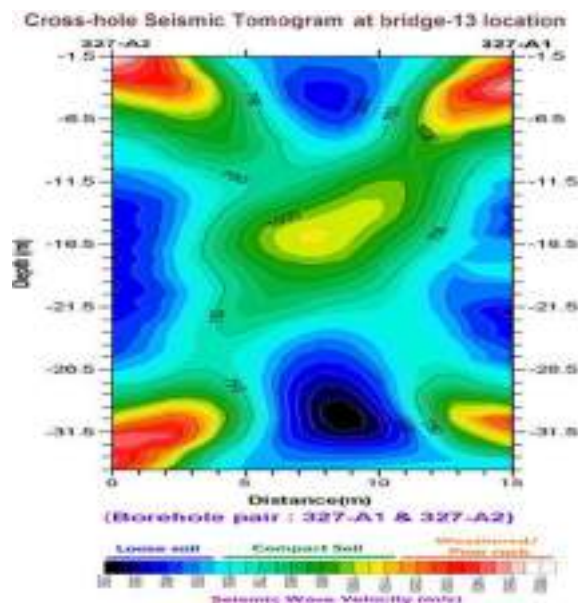
Typical geophysical sections obtained by SRT, ERT and MASW

Results of Geophysical Investigations at MRPL Complex



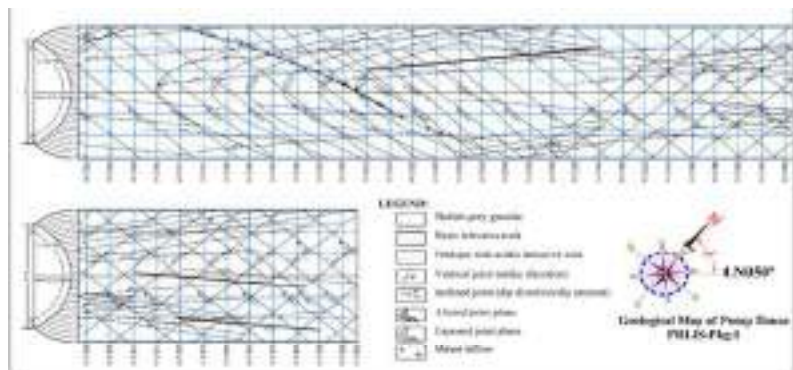
P-wave velocity tomogram between BH1, BH2, BH3, BH4

3.4 The subsurface strata conditions at the foundation of two pillars of the railway bridge in the Gobindsagar reservoir was investigated using crosshole tomography. The entire strata showed a weak zone and there appeared to be loose soil type pocket in the centre of the borehole. Hence, standard well-foundation was not suitable for pillars at these locations. It was recommended that a proper pile foundation, preferably with a group of piles may be designed after detailed analysis of the soil properties for friction parameters. Even pile should reach till the in-situ rock and entire surrounding area should be properly grouted.



Seismic velocity tomogram at bridge-13 location and corresponding tabulation of P-wave velocity.

3.5 Engineering geological investigations of underground pump house complexes of lift schemes 1, 5, 8 and 16 and tunnels of Palamuru Ranga Reddy Lift Irrigation Scheme (PRLIS) are under progress. 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 and quartz-pegmatite-aplite veins trending in different directions. The granites of the project sites are fresh to moderately weathered (WI - VIII) in nature and the joints observed as slightly rough to smooth planar.



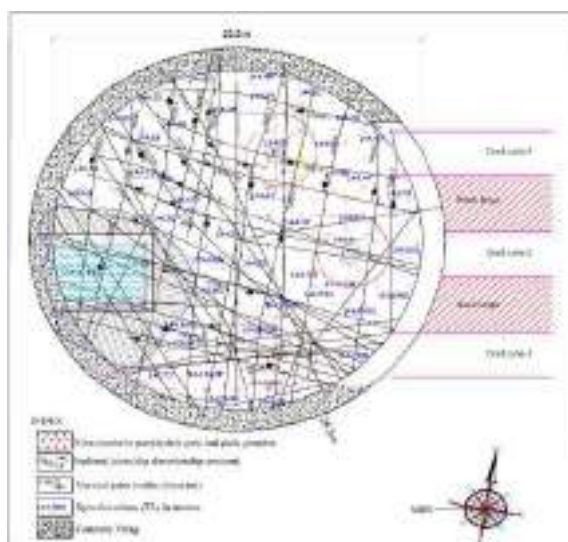
Geological 3D map of heading portion of pump house of PRLIS-P1

3.6 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.

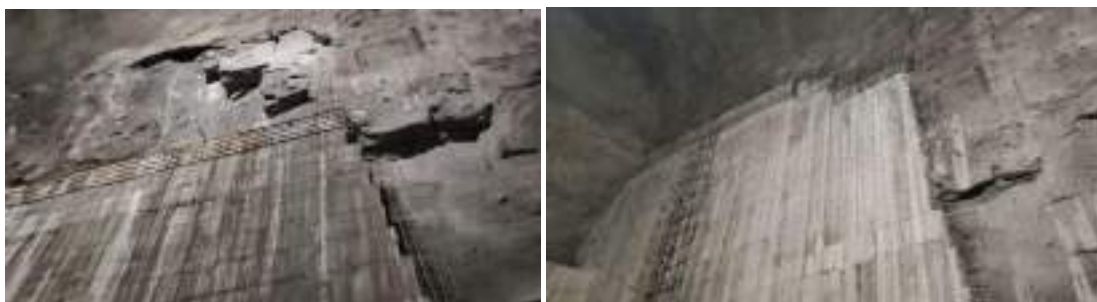
3.7 Engineering geological investigations of the forebay, draft tubes, pressure mains, delivery mains and pump house areas of package-I and II of 1.10 TMC lift system of the Kaleshwaram Project Link-II, Telangana State are under progress. The scope of the work includes rock matrix description; rock discontinuity orientation & description, ground water condition, rock mass quality assessment and suggestion of suitable support measures as per rock mass classification and site geological conditions and provide all the engineering geological / geotechnical support to the I&CAD Department relevant to the geological/geotechnical investigations.

3.8 Engineering geological investigations of unexcavated portion of main tunnel, ventilation shaft and delivery mains of pump house complex area of Kaleshwaram Project-Link-III, Package-9, 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. Innovative methodology was suggested for the treatment of hanging blocks zone of the downstream wall of surge pool (between EL +311.0 m and +315.0 m) and this zone was successfully treated in 25 days.



Foundation floor engineering geological map of pump house, JCRDLIS, Phase-III, P-III.

3.9 Defence Research and Development Organization proposes to construct underground cavern at R&K site, Visakhapatnam. In-situ parameters plays vital role for design of any underground structure. NIRM was engaged to carryout hydraulic fracturing tests. Field investigations are under progress.



View of hanging rock blocks between EL+311.0 m and +315.0 m at D/S surge pool wall (left), View of D/S surge pool wall after treatment (right)

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, 72 steel wire ropes were tested as per Indian standards.

4.2 Wire rope of multi-purpose vehicle by M/s Ashok Leyland Ltd., Tamil Nadu specially designed for Indian Army utility was received at CTS. The tensile test was carried out in order to determine breaking strength of the rope, as a safety requirement from Ministry of Defence on the winch rope.



Testing of 14mm, RHL rope witnessed by representatives of M/s IMS & Ashok Leyland at NIRM laboratory

4.3 NIRM carried out in-situ non-destructive testing on pit bottom buffers designed and manufactured by M/s Mine Tech, to be installed at Balaghat mine of M/s MOIL Ltd. The pit bottom buffers were subjected to drop test, infrared thermography, dye penetrant test, magnetic particle test and ultrasonic test for reliability. The pit bottom



Testing of pit bottom buffers

buffers sustained the drop test were free from thermal anomaly, surface cracks,

surface and sub-surface defects and internal flaws. The pit bottom buffers were found to be safe for use.

4.4 NIRM carried out in-situ non-destructive evaluation of three man riding haulage winches and associated components in M/s Arulmigu Dhandayuthapani Swamy Temple. The winch vital components, bogie attachments and material trolley attachments were found to be free from surface, sub-surface and internal flaws. The wire ropes and bogie attachments of winch-I, II & III were free from thermal anomaly.



Testing of winch vital parts and bogie attachments

Non-destructive tests of wire ropes indicated that there were no anomaly and they were also free from local faults (LF) such as pitting, corrosion and broken wires. There was no loss of Metallic Cross-sectional Area (LMA).



Inspection of winch ropes using wire rope defectograph

4.5 NIRM carried out in-situ non-destructive tests on winder's (electric and steam) vital components and suspension gear parts at Thalcher mines of M/s Mahanadi Coalfields Limited (MCL). The tested components were free from



Testing of winder vital components and suspension gear parts

surface, sub-surface and internal flaws. It was recommended to conduct periodic tests on the components to ensure safety.

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.



NDT on winder vital components & suspension gear parts, Rajpura Dariba Mines, M/s HZL

The wire ropes in operation were also subjected to NDT using wire rope defectograph. These studies conducted on all the wire ropes revealed that the tested wire ropes were free from LF and there was no loss of LMA.



Inspection of wire ropes, Rajpura Dariba mines

4.7 NIRM conducted 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.



Testing of HEMM at Rajpura Dariba mines

5.0 Other Important Activities

5.1 Celebration of Ambedkar Jayanti

NIRM celebrated 129th birth anniversary of Bharat Ratna Dr. Bhimrao Ramji Ambedkar on 14th April amid lockdown due to COVID-19. At the Head Office (HO), scientists garlanded the portrait and remembered his immense contribution in drafting the Indian Constitution and the society. At the Registered Office (RO), KGF, Mr. Rajan Babu, Officer-in-Charge garlanded the portrait and addressed the employees on the occasion. Standard Operating Procedures (SOP) of COVID-19 were followed on this occasion.



Mr. Sultan Singh Meena, Scientist garlanding the portrait of Dr. B R Ambedkar at NIRM HO, B'lore



Mr. Rajan Babu, Officer-in-Charge garlanding the portrait of Dr. B R Ambedkar at NIRM RO, KGF

5.2 Observance of Anti-Terrorism Day

NIRM observed "Anti-Terrorism Day" on 21st May 2020. NIRM Employees took anti-terrorism pledge in both English and Hindi over a web meeting administered by Dr. H S Venkatesh, Director, NIRM.



Dr. H S Venkatesh, Director, NIRM administering anti-terrorism pledge to NIRM

5.3 Celebration of International Day of Yoga

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 20th June 2020. 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. Dr. Prasanna Jain, Scientist and Nodal Officer IDY-2020, NIRM had participated in *My Life My Yoga* video blogging competition organised by the ministry of AYUSH, Govt. of India.



Dr. H S Venkatesh, Director & his family and Senior Scientists



NIRM Employees with their families performing Yoga on International Yoga

5.4 Food Kit distribution to the needy in the Kolar Gold Fields, Karnataka

As a part of Corporate Social Responsibility in relation with COVID-19, NIRM distributed nearly about 100 food grain kit to the needy in KGF in July 2020.



Officer-in-Charge NIRM RO, KGF distributing food kit to the public

5.5 74th Independence Day Celbration

National Institute of Rock Mechanics, H.O., Bangalore and RO, KGF celebrated 74th Independence Day. Dr. HS Venkatesh, Director unfurled the National Flag at Bengaluru and Shri A. Rajan Babu, Officer-in-Charge,

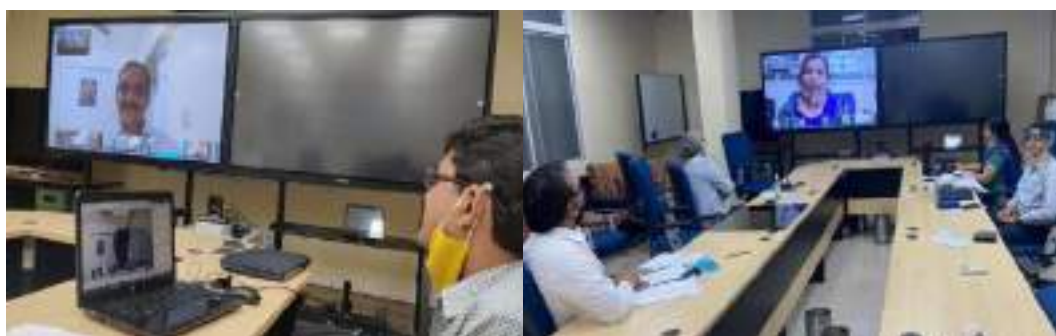


Flag hoisting at NIRM HO (left); NIRM RO (right)

RO unfurled the national flag at the KGF office. The Director and the Officer-in-Charge addressed the employees at Bengaluru and KGF respectively on the occasion. On this occasion, the SOP of Kovid-19 of the Government of India was followed.

5.6 Hindi Pakhwada 2020

Hindi Pakhwada was organized from 14th to 29th September 2020 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 (left); Officers involved in organising the event following social distancing (right)

The Hindi-Pakhwada concluding, and prize distribution function was organized on 29th September 2020 under the chairmanship of Dr. H S Venkatesh, Director, NIRM. All employees attended the event through online. Dr. H S Venkatesh 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. The winners and participants of various competitions were honoured in the prize distribution ceremony.



Posters made by children of NIRM family

5.7 Celebration of 150th Birth Anniversary of Mahatma Gandhi

The two years long commemoration period of 150th Birth Anniversary of Mahatma Gandhi was celebrated on 2nd October 2020. The celebration was started with garlanding the portrait of Mahatma Gandhi at NIRM HO, Bengaluru and NIRM RO, KGF. SOP of COVID-19 were followed on this occasion. All the other programs were conducted online. Dr. H S Venkatesh, Director, NIRM, addressed the employees and advised the employees and their family members to make use of cloth bags for their daily marketing and to avoid use of plastic bags. The Officer-in-Charge, NIRM RO and all HOD's expressed their views on Gandhiji and his ideologies. On this occasion, all employees unanimously agreed to increase use of digital data application for office work to minimize the paperwork.



Garlanding the portrait of Mahatma Gandhi Ji at NIRM HO, Bengaluru (left) and NIRM RO, KGF (Right)

5.8 Observance of Rashtriya Ekta Diwas

A pledge ceremony related to Rashtriya Ekta Diwas / National Unity Day was conducted on 31st October 2020 at NIRM HO and NIRM RO through webinar. Scientists and Staff took pledge in both English and Hindi.



NIRM Employees taking Rashtriya Ekta Diwas Pledge

5.9 Observance of Communal Harmony Campaign Week and Flag Day

NIRM celebrated Communal Harmony Campaign Week and Flag Day during 19th to 25th November 2020. On this occasion, various programs were conducted. The campaign was conducted at NIRM HO, Bengaluru and NIRM RO, KGF under SOP

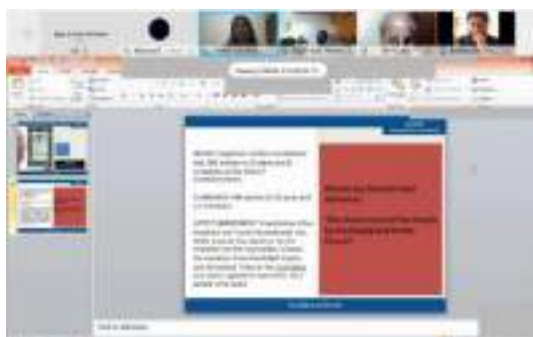
COVID-19. A drawing competition was conducted for all employees and their family members. Children of the NIRM family participated in this competition and expressed their views on Communal Harmony through their drawings/paintings.



Poster related to NFCH displayed at NIRM HO, Bengaluru

5.10 Celebration of the Constitution Day

At National Institute of Rock Mechanics "Constitution Day" was celebrated with exuberance on 26th November 2020 for spreading awareness of Fundamental Duties enshrined in the Constitution of India. The Hon'ble President of India, Shri Ram Nath Kovind read the Preamble of the Constitution of India on the occasion of the 71st Constitution Day. All employees read out the Preamble along with the President of India. A webinar was also conducted and Dr. Sapna S from Christ University, Bengaluru delivered a lecture on "We the People; We the Citizen - The Indian Constitutional Framework". All the employees participated this webinar.



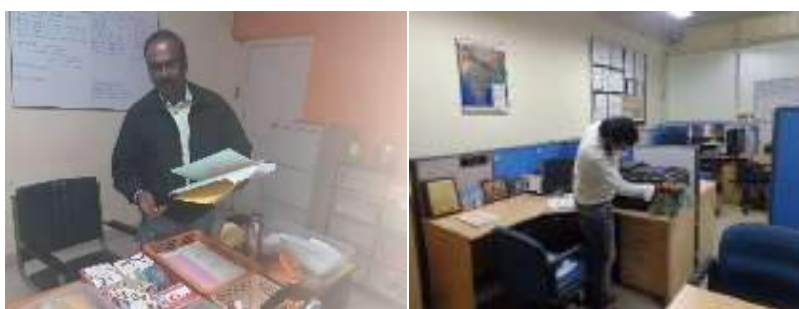
Dr. Sapna delivering a lecture



Employees of NIRM attending the webinar

5.11 Swachhta Pakhwada 2020 and COVID-19 Appropriate Behaviour Campaign

On the occasion of "Swachh Bharat Mission", National Institute of Rock Mechanics organized Swachhta Pakhwada 2020 in and around NIRM HO Bengaluru



Cleaning activities at NIRM RO (KGF) and HO Bengaluru

and NIRM RO KGF from 16th to 30th November 2020 by following SOP of COVID-

19. During the Pakhwada, all employees participated and cleaned the campus area, gallery, rooms, own residents and also campaigned for "MASK UP INDIA".

5.12 Swachhta slogans "व्यक्तिगत स्वच्छता को बढ़ाना है कोरोनावायरस के संक्रमण से खुद को बचाना है" and "कोरोना संक्रमण से बचाव यदि स्वच्छता से हो लागाव" were uploaded on NIRM notice board and website.

5.13 72nd Republic Day Celebration

Celebrated 72nd Republic Day at Headquarters, Bengaluru and Registered Unit, K.G.F. Dr. HS Venkatesh, Director, unfurled the National Flag at Bangalore Office and Mr. A. Rajan



Director NIRM, unfurled the National Flag and addressed the gathering at NIRM Headquarters, Bengaluru (left); National flag hoisted by OIC and Addressed to the gathering at NIRM RO KGF.

Babu, Officer-in-Charge at KGF Office addressed the gathering. On this occasion, SWF distributed sweets.

5.14 International Women's Day 2021

International Women's Day 2021 was celebrated on 8th March 2021 at NIRM HO, Bengaluru. Due to COVID-19 the Director, Head of Departments and Women employees of the Institute only



Mrs. Praveena, Presiding Officer, Internal Committee- Women addressing the gathering (left). Director NIRM felicitating Dr. Meena Jain (Ex-Chairperson of Child Welfare Committee, Bengaluru Urban) (Right)

gathered in the Conference room. A Webex meeting link was sent to all the employees to participate in this program.

The Internal Committee members and women employees of the Institute took active initiative in organizing the various activities of this program. An invited talk on 'Today's Women and the importance of Role play' was given by Dr. Meena Jain (Ex-Chairperson of Child Welfare Committee, Bengaluru Urban) followed by activities and games.

5.15 Recognition / Patent/presentations/other important activities

- i. Dr. H S Venkatesh has been re-elected as the Vice-President, International Society for Rock Mechanics (India National Group).
- ii. Dr. H S Venkatesh has been nominated as a member of the State Empower Committee by the Government of Karnataka to review the mining activities near the vicinity of Kumaraswamy Temple, Hospet, Bellary, Karnataka.
- iii. Mr. Rajan Babu A, attended as the High-Level Expert Member to provide technical assistance and guidance to the District Collector, Madurai, Tamil Nadu to finalize the show cause notices issued in the light of the available technical reports to comply with the order of the Honourable Supreme Court of India.
- iv. Application filed on 01st Nov 2016 for grant of a Patent titled “In-situ Stress Measurements in Fractured Rock mass by using High Flow Rate Technique” published in Official Journal of the Patent office Issue No. 18/2018 dated 04 May 2018. Filed examination report was on 10th Oct 2019. The application is in the amended stage and awaiting for grant of the Patent .
- v. Application filed on 07th Nov 2016 for grant of a Patent titled “In Situ Stress Measurements in Porous Rock Mass by using High Viscous Liquid” published in official Journal of the Patent office Issue No. 19/2018 dated 11th May 2018. Filed examination report on 23rd Oct 2020. Application is in the amended stage and waiting for the grant of the Patent.
- vi. Dr. A K Naithani attended 22nd web-meeting of the Bureau of Indian Standard, WRD 05 Sectional Committee of Geological Investigation and Subsurface Exploration on 25th September 2020.
- vii. Dr. A K Naithani as a member of the Sectional Committee of the Bureau of Indian Standard WRD 5 for making new IS code of geological exploration for tunnels (13036) attended the first-panel web meeting on 20th October 2020.
- viii. Dr. Sandeep Nelliath as a member of the BIS Committee participated in the formalization of the Code of Practice for Geophysical Investigations for River Valley Projects.
- ix. Mr. G Gopinath has been nominated as a member of the Rock Mechanics Sectional Committee, CED 48 of Bureau of Indian Standards.
- x. Dr. Sandeep Nelliath as a member of the Board of studies for the Master’s Program offered by the Department of Marine Geology & Geophysics, Cochin University of Science and Technology, Kochi, Kerala attended a meeting on 22nd June 2020 to finalize the curriculum.
- xi. Dr. A K Naithani attended Doctoral Committee Web Meeting to consider the synopsis of Ph. D. thesis, Vellore Institute of Technology (Deemed to be University), Vellore, Tamil Nadu on 31st July 2020.

- xii. Dr. Biju John as a guide attended the Viva-voce examination of Doctoral student of Vellore Institute of Technology (Deemed to be University), Vellore, Tamil Nadu on 3rd February 2021.
- xiii. Dr. A K Naithani as an external examiner attended Ph.D. Viva-voce examination of the candidate of Department of Geology, Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttrakhand on 5th March 2021.
- xiv. Mr. G C Naveen presented NIRM involvement in PHPA to Shri. Lotay Tshering, Prime Minister of Bhutan during his visit to PHP II project site, Bhutan, in May 2020.
- xv. Dr. Sripad R Naik delivered an invited talk online on “Slope Stability Analysis by using Numerical Methods” at TEQIP-III Sponsored Five-Day National Workshop on Slope Stability & Stabilization Methods in Open Pit mines (SSSMOPM2021) organized by Department of Mining Engineering, NITK Surathkal 8th -12th Feb 2021.
- xvi. Dr. A K Naithani delivered an invited lecture on ‘Rock Mass Classifications for Tunnelling and Underground Rock Cavern Construction’ in the National webinar on ‘Recent Trends in Rock Mechanics and Engineering Geology’ conducted by Adikavi Nannaya University, Rajmundhary, Andhra Pradesh on 7th Aug 2020.
- xvii. Dr. Biju John delivered a Keynote on “Neotectonic Evidences Related with Shear Zones of Southern Peninsular India”, in the National Seminar on Shear Zones and Crustal Blocks of Southern India, organised by Kerala University, Trivandrum during 5th -10th Nov 2020.
- xviii. Mr. G C Naveen presented a lecture in two-day training courses on “Blasting and Excavation Techniques for underground excavation” for DGPC officers in Thimpu, Bhutan on 28th July 2020.
- xix. Mr. Vikalp Kumar, delivered a lecture on “Microseismic Monitoring to Analyze Rock Mass Microcracking in Underground Powerhouse to Mitigate Potential Disaster” in the Virtual Conference on Disaster Risk Reduction Civil Engineering for a Disaster Resilient Society, organised by NIT Surathkal, on 15th -20th March 2021,
- xx. Dr. Prasanna Jain delivered two lectures on “Introduction on Geology and Engineering Geology” and “Evaluation of Engineering Geological and Geotechnical Properties for the Rock Mass Classification” to the students of Govt. JST PG College Balaghat, Madhya Pradesh on 10th Jan 2021.
- xxi. Mr. Vijay Sekar delivered a lecture on “Numerical Modelling of Large Slopes” for the webinar on Slope Stabilization Challenges in Infrastructure Projects organized by ISRM (India) and IGS (Delhi Chapter), 18th -19th Feb 2021



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, 2021, the Statement of Income & Expenditure & Receipts and Payments for the year ended 31st March 2021 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 2021,
- 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 2021,

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.

Qualified Opinion

The physical verification of assets procured prior to the financial year 2008-2009 are yet to be physically verified and reconciled.

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

No 37/1, 1st Floor, M.N.K. Rao Road
Basavanagudi, Bangalore - 560 004
Phone: 080 - 26566440, 26577440

TeleFax: 080 - 26566337
E-mail: audit@brvgoud.co.in
Website: www.brvgoud.co.in

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



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

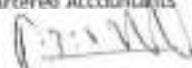
Auditor's Responsibility for the Audit of the Financial Statements

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:

- 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.
- 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.
- 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.

Place: Bangalore
Date: 26/08/2021
UDIN: A1201108AANAMW5843

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

(A B Shiva Subramanyam)
Partner
Membership No: 201108

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 2021.**

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. Physical verification of Fixed Assets, procured during the period of last 11 financial years from 2008-09 to 2018-19 completed. The assets procured prior to the year 2008-09 are subject to physical verification and reconciliation.
5. 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.
6. The accumulated interest earned on the Fixed deposits of Institute Development fund for Rs.35.82 lakhs transferred to corpus fund i.e. Institute Development Fund during the year 2020-21.
7. The Institute has filed audited accounts & relevant returns up to 31/03/2015 with District Registrar of Societies, Kolar, as required under the Societies Registration Act, for renewal without the requisite fee. The Institute has made an adhoc provision in the books of accounts for Rs.12,00,000/- towards society registration renewal fees as the intimation of amount of fee to be remitted is not received from the said authority.
8. The previous year figures have been re-grouped, re-classified or renamed wherever necessary to confirm with the current year presentation.

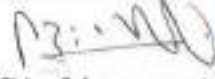

Uma H.R.
Finance & Accounts Officer


H.S. Venkatesh
Director


Member
Governing Body

Date: 26/08/2021
Place: Bangalore

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


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



NATIONAL INSTITUTE OF ROCK MECHANICS
Bangalore

Consolidated Balance Sheet as at 31st March, 2021

(Amount in Rs.)

Sl. No.	Particulars	Sch. No.	31.03.2021	31.03.2020
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 Funds:	2		
	(a) Deferred Government Grant		9,52,21,248	9,10,53,913
	(b) Institute's Development Fund		6,19,11,943	3,99,29,464
	Income and Expenditure Account	3	4,32,66,549	2,78,33,198
	Current liabilities and provisions:			
	(a) Sundry Creditors - Staff	4	5,37,804	4,37,804
	(b) Sundry Creditors - Others	5	2,42,40,690	1,75,43,189
	(c) Project Advance Received	6	31,63,56,878	31,40,00,646
	(d) Provisions	7	3,84,47,112	2,60,20,193
	TOTAL		61,48,73,971	55,67,05,154
II	Application of funds			
	Fixed Assets	8	6,88,16,170	7,58,67,568
	Investments	9	34,03,53,410	28,66,07,939
	Current Assets, Loans and Advances			
	Deposits	10	5,35,628	5,35,628
	Loans and advances:			
	(a) Advances - Staff	11	7,52,341	21,34,233
	(b) Advances - Suppliers	12	1,14,94,869	92,26,233
	Other Current Assets	13	6,69,41,185	5,44,70,352
	Expenditure on Ongoing Projects	14	6,62,10,897	7,09,03,109
	Sundry Debtors	15	3,05,88,182	3,48,83,194
	Cash and bank balances	16	2,71,91,281	2,20,50,898
	TOTAL		61,48,73,971	55,67,05,154

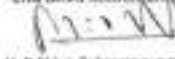
Note : Significant Accounting Policies and other notes to accounts

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


(Uma PR)
Finance & Accounts Officer


(H S Venkatesh)
Director


Member
Governing Body


(A B Shiva Subramanyam)
Partner
AL NO. 101108



Place: Bangalore
Date : 16/04/2021

NATIONAL INSTITUTE OF ROCK MECHANICS
Bangalore

Consolidated Income and Expenditure Account for the year ended 31st March, 2021

(Amount in Rs.)

Sl. No.	Particulars	Sch. No.	31.03.2021	31.03.2020
A	Income			
	Grant-in-Aid received from Ministry of Mines	17	6,74,00,000	6,71,83,000
	Amount Received Against Completed Projects	18	15,27,86,974	13,77,72,356
	Government Grant - Deferred Income	19	5,32,665	5,24,644
	Interest Received	20	87,24,108	1,26,69,213
	Miscellaneous Income	21	2,55,848	1,49,922
	TOTAL (A)		22,94,99,595	21,84,99,135
B	Expenditure			
	Administrative Expenses	22	92,44,096	1,10,46,695
	Pay & Allowances	23	11,45,12,256	11,58,24,684
	Travel Expenditure	24	3,58,846	11,86,050
	Up Keep of Assets	25	6,45,943	7,49,367
	Expenditure on Completed Projects	26	5,69,06,983	5,99,90,189
	Depreciation on Fixed Assets	8	1,42,90,870	1,45,80,337
	Tax Expenses	27	1,27,26,770	84,67,961
	TOTAL (B)		21,04,85,764	20,78,45,283
C	Excess of Income over Expenditure for the year (A-B)		1,90,13,831	1,06,53,852

Note : Significant Accounting Policies and other notes to accounts

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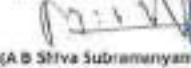
For NATIONAL INSTITUTE OF ROCK MECHANICS

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


(Uina IFRI)
Finance & Accounts Officer


(H S Venkatesh)
Director


Member
Governing Body


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



Place: Bangalore
Date : 26/08/2021

NATIONAL INSTITUTE OF ROCK MECHANICS
BANGALORE

Consolidated Receipts and Payments Account for the year ending on 31st March 2021

(Amount in Rs)

Receipts		Amount	Payments		Amount
To	Opening Balance		By	TDs on Fixed Deposits	59,192
	Bank	2,30,50,898		FDs on Project Receipts	83,22,380
				Payment of GST & Service Tax	1,13,69,804
	Grant-in-Aid (Govt-Plan)	6,74,00,000		Purchase of fixed assets	56,93,754
	Govt. Grant-Capital	1,47,00,000		Transfer to Fixed Deposits	11,87,65,000
	Other Income Received	2,55,848		Advances to Others	77,96,536
	Security Deposits/EMI received	40,000		Advance to Staff	7,82,341
	Interest Received on Savings Bank Deposits	10,88,464		Administrative Expenses	54,21,405
	Interest Received on Term Deposits	13,60,404		Salaries & Wages	11,43,56,712
	Fixed Deposits Matured	6,80,00,000		Traveling Expenses	3,97,837
	Advance Received - Sponsored Projects	17,75,47,734		Up Keep of Assets	7,69,253
	Advance Received - Centre for Testing service	45,28,200		Staff welfare	2,40,000
	Other Advances Received	3,33,740		Honorarium / Incentive (Projects	2,37,55,811
	Retention money on terminal benefit	1,00,000		Expenditure on Sponsored Projects	1,15,97,649
	Input credit of GST received	21,33,038		Contingency - Centre for Testing Services	7,48,567
	Advance received S&T	3,40,000		prior period expenses	2,36,770
				Closing Balance	
				Bank	2,71,91,281
	Total	56,04,75,334		Total	56,04,75,334

Note : Significant Accounting Policies and Notes to accounts

III

For NATIONAL INSTITUTE OF ROCK MECHANICS

As Per Our Report of even date,

For B.R.V Goud and Co.,

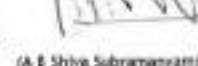
Chartered Accountants

FRN:0005925


(Usha R.R.)
Finance & Accounts Officer


(H S Venkatesh)
Director


Member
Governing Body


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



Place: Bangalore

Date : 26/08/2021

ANNEXURE (A-H)



ANNEXURE-A



ANNEXURE-B

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

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 2 nd Stage, Bengaluru-560 070, Karnataka
Director, Indian Institute of Technology (ISM), Dhanbad-826 003., Jharkhand	

ANNEXURE-D

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

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 (SJVN)
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-F

LIST OF COMPLETED PROJECTS

S.No.	Project No.	Title of Project
1	ND-14-16-C	NDT on vital components of winders at Zawar group of mines, HZL Rajasthan
2	ND-16-06-C	NDT on cable belt drive wire ropeway, Shimla at NALCO, Damanjodi, Odisha
3	ND-17-06-C	Structure stability audit of head gears at GDK-10 incline, 21 Incline yellandu, VK-7 Incline and PVK-5 Incline, SCCL, Telangana
4	ND-18-02-C	Structure stability of HEMM's -Kirundul Complex, NMDC, Chhattisgarh
5	ND-19-03-C	NDT on vital components of Winders at Zawar group of mines, HZL Rajasthan
6	ND-19-04-C	NDT on vital components of winders at RD mines, HZL, Rajasthan
7	RF-19-02-C	Testing Rock Samples from Maheswari Mining Limited, KGF, Karnataka
8	RF-19-03-C	Laboratory geo-technical investigations on well bore rock core samples from Gamij Field & Sadra Field of CEWELL, ONGC
9	RF-19-04-C	Laboratory geotechnical investigations on Rock Samples of Arun-3 HEP, SAPDC, Nepal
10	EG-18-04-C	Engineering geological investigations for cut slopes (intake pool, upstream and downstream hillock above tunnels) powerhouse area and tailrace pool of Indirasagar (Polavarm) Hydroelectric Project (12 x 80 MW), West Godavari District, Andhra Pradesh
11	EG-19-02-C	Macro Landslide hazard Zonation mapping of Kaiga hole catchments Kaiga Nuclear Power Project site, Karnataka
12	EG-19-03-C	Construction Stage Engineering Geological Mapping of the foundation floor of onsite Emergency Support Center of Kakrapar Atomic Power Project Unit III and IV, Gujarat
13	GP-18-04-C	Support for extraction, grading and testing of armored rock at construction site at Vizag, Andhra Pradesh
14	GP-19-01-C	Geophysical survey for mapping rockmass condition and isolated boulders at the two station box location of Bangalore Metro Rail Project, Phase-II, Karnataka
15	GP-19-02-C	Geophysical studies to investigate the strata conditions around the tailing dam site at Muri, Ranchi, Jharkhand
16	GP-19-03-C	Studies of vibration impact analysis on underground 36" SBHT gas pipe line of ONGC passing through premises of Surat airport, Gujarat

S.No.	Project No.	Title of Project
17	GP-19-05-C	Geophysical survey using resistivity imaging and cross hole GPR tomography to detect the path of water seepage into the underground metro station box at Marol Naka in Mumbai, Maharashtra
18	MS-18-03-C	Stability monitoring of powerhouse cavern and transformer hall at THP, DGPC using Microseismics, Bhutan
18	GC-18-07-C	Scientific Study for design of slopes and stability assessment of Dolomite Project at Mangampet, APMDC, Andhra Pradesh
20	GC-19-04-C	Scientific studies to optimize the bench parameter & design of final pit slope stability of Sy. No. 265/1,2,3A,3B,4,5,264/1,2 etc. of M/s. ALFA Estates, Karnataka
21	GE-18-05-C	Determination of in situ rock mechanics parameters at the proposed Arun-3 Hydroelectric Project, Nepal
22	GE-18-07-C	Determination of safe bearing capacity of soil by plate load tests at upstream coffer dam and switch yard of Arun-3 Hydroelectric Project, Nepal
23	NM-17-13-C	Audit of Ground Control Management Plan of Zawar group of mines, HZL, Rajasthan
24	NM-17-14-C	Geodetic monitoring of Sardar Sarovar Dam, Gujarat
25	NM-17-15-C	3D Numerical model studies for stress analysis of underground powerhouse complex & surge shaft of Arun 3 Hydroelectric project, Nepal
26	NM-17-16-C	Development of instrumentation network for C#3 package of Punatsangchhu-II hydroelectric Project, Bhutan
27	NM-18-03-C	Deformation monitoring of U/G powerhouse cavern of Sardar Sarovar project, Gujarat
28	NM-18-04-C	Analysis of Instrumentation data and assistance in installation and monitoring of Instruments at C#3 Package of Punatsangchhu-II hydroelectric Project, Bhutan
28	NM-18-09-C	Review and determination of alarming limits for surface subsidence through numerical modelling at Rajpura Dariba mines, HZL, Rajasthan
30	NM-18-11-C	Scientific Studies for Evaluation of Stope and Pillar Stability vis-à-vis Stope Sequencing through Numerical Modelling at Barol mine, HZL., Rajasthan
31	NM-19-01-C	Networking and Analysis of Instrumentation Data at Dam Complex, Punatsangchhu-II Hydroelectric Project, Bhutan
32	NM-19-05-C	Analysis of instrumentation data and guidance for installation and monitoring of instruments at C#3

S.No.	Project No.	Title of Project
		package of Punatsangchhu-II Hydroelectric Project, Bhutan
33	NM-19-08-C	3D Numerical Analysis of Machine Hall Cavern for Tehri PSP with change in geotechnical properties and support system, Uttarakhand.
34	RB-17-05-C	To suggest suitable controlled blast designs for various excavations and monitoring of blast vibration for Peruvannamuzhi SHEP (6 MW), Kozhikode, KSEB, Kerala
35	RB-17-10-C	Blast design for armor rock to construct break water for varsha project - Visakhapatnam Navayuga engineering company Ltd, Andhra Pradesh
36	RB-17-12-C	Technical guidance for controlled blasting and monitoring of blast vibration for excavating various components at Pazhassi Sagar SHE project, Kozhikode, Kerala
37	RB-18-02-C	To suggest suitable design for excavations of powerhouse at Polavaram irrigation project, Andhra Pradesh
38	RB-18-12-C	Study on impact of Ground Vibration due to Sub level Open Stope Blasting at Hira Buddini Satellite Underground Gold mine on surface structures, Hutti Gold mines Ltd., Hutti, Raichur, Karnataka
39	RB-18-13-C	Technical Guidance for Controlled Blasting for Different Excavation Components of Powerhouse Complex, Punatsangchhu II (1200 MW) Hydroelectric Project, Bhutan.
40	RB-19-04-C	Controlled blast design for the construction of Terminal Building at Chennai Airport near critical structures, L&T construction(Building and constructions), Chennai, Tamil Nadu
41	RB-19-09-C	Phase II Extension 3, 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.
42	RB-19-10-C	Ground vibrations and air overpressure studies at quarries located at survey No,253,Nemakal Village, Bommanahalli Mandal, Anathpuramu District, Andhra Pradesh
43	MS-18-01-C	Geological/Geotechnical support for the studies carried out at Kaiga Nuclear Power Plant, for Unit 5 & 6, Kaiga, Karnataka
44	ST-16-02-C	Seismotectonic evaluation (Feasibility study) for additional NPP sites in Nellore and Prakasam districts, Andhra Pradesh

ANNEXURE-G

LIST OF PUBLICATION

1. Butchibabu, B., Khan, P. K. and Jha, P. C. (2021): Geophysical Investigations for Stability and Safety Mitigation of Regional Crude-oil Pipeline near Abandoned Coal mines, *Journal of Geophysics and Engineering*, Vol. 18(1), pp 145-162. <https://doi.org/10.1093/jge/gxab003>.
2. John, B. and Singh, Y. (2020): Neotectonic Evidences Related with Shear Zones of Southern Peninsular India, *In Shear Zones and Crustal Blocks of Southern India*, Vol. 6 pp. 30.
3. John, B., Singh, Y., Rao, D. T., Barman, M. C., Pradeep, K. A. P. and Sajeew, K. (2021): Observation on Rock Melt Extrusion occurrence in southern part of Tamilnadu, India, *Journal of Geological Society India*, Vol. 97. pp 119-124. <https://doi.org/10.1007/s12594-021-1641-2>.
4. Kumar, V., Jha, P. C., Singh, N. P. and Cherukuri, S. (2021): Dynamic Stability Evaluation of Underground Powerhouse Cavern Using Microseismic Monitoring. *Geotechnical and Geological Engineering*, Vol. 39, 1795–1815. <https://doi.org/10.1007/s10706-020-01588-9>.
5. Naithani, A. K., Prasanna, J., Singh, L. G., Rawat, D. S. and Subrahmanyam, D. S. (2020): Engineering Geological and Geotechnical Assessment of the Foundation of Yaragol Gravity Dam – a Case Study from India, *Journal of the Geological Society of India*, Vol. 97, pp. 497-500. <https://doi.org/10.1007/s12594-021-1715-1>.
6. Naithani, A. K., Rawat, D. S., Jain, P. and Singh, L. G. (2020): Rock Mass Characterization for the Underground Surge Pool Cavern – A Case Study, India, *Journal of the Geological Society of India*, Vol. 96, pp 265-271. <https://doi.org/10.1007/s12594-020-1546-5>.
7. Naveen, G. C., Venkatesh, H. S., Balachander, R. and Gopinath, G. (2020): Tunneling in Thinly Foliated Rockmass Conditions, *The Journal of Explosives Engineering*, Vol. 26.
8. Jennifer, P. D. and Porchelvan, P. (2021): An approach to assessment of post mining-induced seismic hazard in Kolar Gold Fields mines – A Review, *Journal of mines, Metals & Fuels*, ISSN 0022-2755, Vol. 69 (3). <https://doi.org/10.18311/jmmf/2021/27784>.
9. Jennifer, P. D., Balasubramaniam, V. R. and Goverdhan, K. (2020): Assessment of Mining Induced Seismicity in and around the mined-out areas of Kolar Gold Fields, Karnataka, *Journal of Environmental Hazards*, Vol. 4 (3), pp 13.
10. Subrahmanyam, D. S. (2021): Role of geological discontinuities on devising suitable support system in Indian coal mines, *Journal of Rock Mechanics and Tunnelling Technology*, Vol. 27 (1).

11. Subrahmanyam, D. S., Shyam, G., Vamshidhar, K. and Vikram, S. (2020): State-of-the-Art technique to conduct in-situ stress measurements at the deep proposed coal mining blocks of Singareni collieries, India, *Current Science*, Vol. 119 (6), pp 1027-1030.
12. Subrahmanyam, D. S., Shyam, G., Vamshidhar, K. and Vikram, S. (2020): Behaviour of cohesion and angle of friction on variant rockmass foundation for the design of underground dam in Chasnalla colliery, Jharkhand, India, *Journal of Engineering Geology*, XLV (1 & 2), June & December 2020, pp 24-43.
13. Subrahmanyam, D. S., Shyam, G., Vamshidhar, K. and Vikram, S. (2021): Role of In-situ Stress Parameters for the Design of Underground Pump House at Various Lift Irrigation Packages of Kaleshwaram Project, Dr. B.R. Ambedkar Pranahita Chevella Sujala Sravanthi Scheme, Telangana, *ISRM (India) Journal*, Vol 10, No 1, January 2021, pp 39-45.
14. Sudhakar, K., Sekar, B. H. V., Bhusan, R., Praveena, D. J. and Naik, S. R. (2020): Geodetic structural monitoring of concrete gravity dam - A case study, *ICOLD, International Symposium on Sustainable Development of Dams and River Basins*, 24 - 27 February 2021, New Delhi, India.
15. Vikram, S., Subrahmanyam, D. S. and Kumar, D. (2020): Numerical Analysis of Coal mine Roadways Under High Horizontal Stress Conditions, 54th U. S. Rock Mechanics/Geomechanics Symposium, ARMA-2020-1533. <https://onepetro.org/ARMAUSRMS/proceedings-abstract/ARMA20/All-ARMA20/ARMA-2020-1533/447753>.

ANNEXURE-H

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(as on 31.03.2021)

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Retired

Mr. S Udaya Kumar



Goodman jack test conducted in a bore hole drilled at the centre of the river bed of lower Kopili hydroelectric project Assam. Inset showing the closeup view during test.



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: View of the APMDC Dolomite mine at Mangampet.

Bottom: View of P- wave velocity tomogram of Mangalore Refinery and Petrochemicals Ltd site.

Left: View of the pump house of Palamuru Ranga Reddy Lift irrigation project, PKG-5, Telangana.

Right: View of the pre-splitting carried out in weathered rock at KKNPP, Tamilnadu

