



Annual Report 2019 -20



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



Release of Commemorative Technical Souvenir of NIRM by Secretary, MOM, GOI
“Inter- Ministerial Conference on Future Strategies for NIRM” held on 26 April 2019, at New Delhi.

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DIRECTOR'S MESSAGE



Namaste !

I am delighted to present the Annual Report 2019-20 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. During the year, NIRM completed 51 projects and was awarded 59 new projects. Out of 59 new projects, 25 projects were from mining sector, 13 from hydro sector, 9 from nuclear sector, 7 from infrastructure sector, 3 from oil & gas and one each from irrigation and thermal sectors.

In continuation to the interaction with the industrial partners organised earlier at Bengaluru, NIRM organised an inter-ministerial conference on 26th April 2019 at New Delhi along with the Ministry of Mines, Govt. of India, which was chaired by Shri. Anil G Mukim, IAS, Secretary, Ministry of Mines, Govt. of India. More than 50 officers from various ministries of Govt. of India, invited guests from various industries and other prestigious organisations like DRDO, CWC, NIDM, NPCIL, NHPC Ltd., HZL, Northern Railways participated. They shared their previous experiences with NIRM and also highlighted their future requirements. During 2019-20, NIRM also started academic activities by inviting applications for Ph.D. in Rock Mechanics through Visvesvaraya Technological University (VTU), Karnataka. As part of information dissemination and skill development exercise, NIRM conducted one training course for the executives of Druk Green Power Corporation Ltd., Bhutan. NIRM employees participated in national, international conferences, workshops and training programs which enabled honing of skills in the technical and administrative domains as a continued refresher re-training.

During the financial year there was an increased demand for NIRM's participation in mining sector. 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 had been oriented to reduce the risk and hazard by modifying/monitoring the mining methods and adopting best safety practices. NIRM conducted studies viz., design of method of mining, feasibility studies, design of stoping parameters, yield zone & stress distribution determination, review of Ground Control & Management Plan (GCMP), Strata Control & Monitoring Plan (SCAMP) of mines and monitoring of rock burst which is being continued at KGF. Stability studies of pit and dumps, stability analysis through instrumentation and numerical modelling, and monitoring of ground vibration were also undertaken.

NIRM made a notable contribution in Energy sector involving hydro, nuclear and thermal projects. The most significant studies in hydropower projects are conducted in Bhutan (PHEP & Tala) and Nepal (Arun3). For PHEP 3-dimensional numerical models were created for underground caverns and designed monitoring of structures using instrumentation as well as providing technical support for controlled blasting. 3D modelling for underground facilities and in-situ stress measurements were carried out for Arun 3. NIRM continued instrumentation and microseismic monitoring for Tala. For the prestigious Sardar Sarovar project, NIRM continued monitoring at various components of the project. Nathpa Jhakri, Tehri and upcoming Vishnugad Pipalkoti are the other significant Hydropower projects that NIRM supported during this period.

In Nuclear energy sector, NIRM's involvement started from the studies for site selection to foundation clearance through blasting and foundation mapping. Seismotectonic evaluation studies identified suitability of nuclear power plant installations at four

locations in the east coast of India. For Kaiga, technical supports were extended for site specific geological/geotechnical investigations and landslide hazard zonation studies were also carried out. For KKNPP, NIRM is exclusively involved in the blast vibration monitoring. 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 is adopted for the foundation excavation of various components of installations.

During the period, NIRM was involved in three Lift Irrigation Projects (LIP) for various studies. Engineering geological studies were carried out at Palamuru and Kaleshwaram LIPs, In-situ stress studies were conducted for Palamuru and J Chokkarao LIP, whereas 3D modelling studies done for J Chokkarao LIP. NIRM was involved in five marine projects for support of extraction, grading and testing of armour rocks for a breakwater establishment. Technical support is also extended for underground caverns and tunnels. In another significant work, NIRM technically guided controlled blasting for the excavation at Chennai Airport. Geophysical survey was conducted for metro and safety of buried oil pipeline. NIRM also extended services to housing sector for identifying basement configuration and for optimising blasting activity.

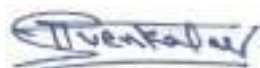
Highly sophisticated DGMS approved testing and laboratory facilities are available with NIRM. During this period, in-situ testing of mining components in the mines viz., SCCL, HZL, HCL, NALCO etc., were carried out by NIRM. Laboratory testing of ropes, material and rock samples for determination of various physico-mechanical properties was also done for various industries including ONGC, Varsha project, Arun-3 and other mining companies.

The 22nd Peer Review Committee meeting of NIRM was held at NIRM HQ on 17th December 2019 under the chairmanship of Prof. B. B. Dhar, former Director CIMFR. Ministry had reconstituted PRC members for the period from 2020 to 2022 and subsequently, 23rd Peer Review Committee meeting of NIRM was held at NIRM HQ on 24th February 2020. Many of our Scientists received national and international recognitions, served as expert members on important committees. As part of academic activities, the Institute supported training and internships to B Tech and MSc students. Thus, past fiscal year witnessed several accomplishments for the vision forward and the people we serve.

The above-mentioned achievements are just illustrative in nature and not exhaustive. These were possible only because of the dedication of Scientists & staff of NIRM. I acknowledge with immense gratitude for the support from the Ministry of Mines, the enduring support extended by the Chairman & members of General Body, Governing Body and Peer Review Committee. I am extremely thankful to our industry partners without their continued support and trust this could not be possible. I am indeed thankful to our external experts also who guided us in our pursuit for excellence.

As I submit this report, we are in the middle of the COVID-19 pandemic and NIRM is taking all possible precautions to prevent the spread by following the guidelines and instructions from the government from time to time. Our committed Scientists & staff have commenced the field trips even under these difficult situations to strive for Aatma Nirbhar Bharat. I am hopeful that like all previous crises, this COVID-19 calamity too will pass in time and a fresh wave of energy will be unleashed.

Jai Hind !

A handwritten signature in blue ink, which appears to read 'H S Venkatesh', is located below the text 'Jai Hind !'.

H S Venkatesh

INTRODUCTION

National Institute of Rock Mechanics provides R&D support and expertise to the mining industry (surface and underground), power industry (hydel, thermal and nuclear) and infrastructure projects (rail, road, metro, irrigation, marine, urban construction etc.) by carrying out varieties of investigations in the area of rock engineering and rock mechanics. Key areas of activities of the Institute include numerical modelling, excavation engineering, controlled blasting, engineering seismology, slope stability analysis, site characterisation (including geological, geophysical and geotechnical investigations), laboratory testing of rock samples, wire ropes, mining accessories and NDT testing (both laboratory and in-situ).

During this year NIRM was involved in 35 projects in the mining sector, out of which 18 were from underground mining and 17 others from open cast mining. Among them 12 projects were completed in all aspects.

Power sector is the backbone of NIRM which accounts for more than 60% of the revenue earning. Extending our expertise by way of providing consultancy services to the power sector in solving the site specific problem, NIRM carried out crucial investigations for the design and development.

During this year NIRM was involved in 51 projects in the power sector, out of which 18 were for nuclear power, 31 for hydroelectric power and 2 for thermal power. Most of the studies were related to the construction stage investigations for safe practice and/or site characterisation for the design implementation. Among them 14 projects were completed in all aspects.

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, urban housing, metro and rail/road projects. During this year NIRM was involved in 24 projects in the infrastructure sector, out of which 7 were related to irrigation projects, 5 marine projects, 2 housing projects, 3 from pipeline, 3 from underground cavern/tunnels 2 from metro projects and one each from airport excavation and investigation on tailing dam failure. Among them 11 projects were completed in all aspects.

NIRM has DGMS approved testing laboratory for testing of material and rope samples. Both destructive and non-destructive testing (NDT) at site for various mining equipment and accessories like winders, wire-rope and shaft components were done. Apart from them, NIRM has rock testing facility where we carried out testing of rock samples for determination of various physico-mechanical properties as per BIS/ISRM/ASTM standards. During this year NIRM was involved in 29 projects of which 11 projects were completed in all aspects.

For ascertaining the safety of Natural Caves, 03 projects were carried out. In addition to them, 04 S&T projects and 02 in-house projects were also carried out.

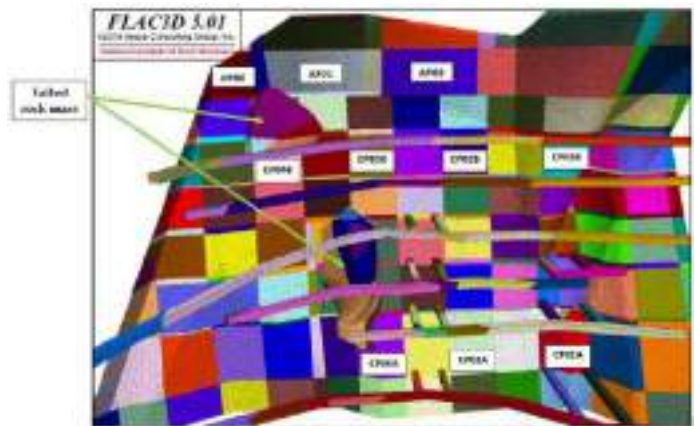
1. Mining Sector

- NIRM reviewed and audited Ground Control and Management Plan (GCMP) of Zawar Group of Mines. The review report was submitted with the recommendations to ensure the stability of the underground workings and running stopes as well as the scope of improvement of GCMP that had been carried out at the mine, for the periods 2017-18 and 2018-19.



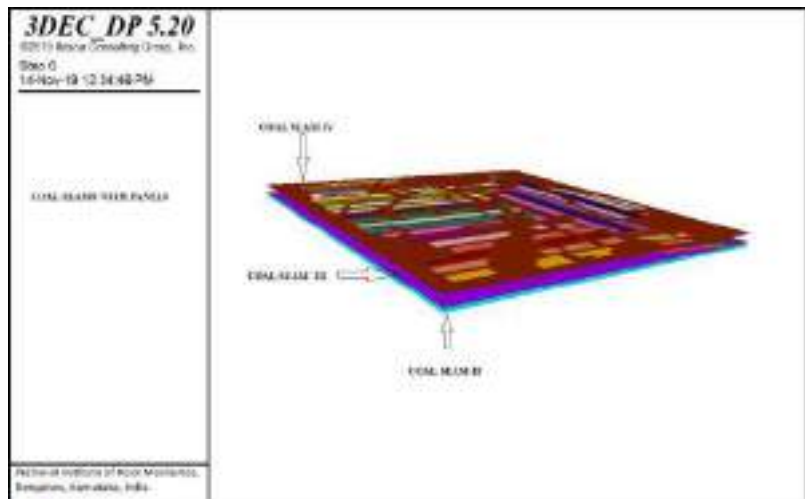
Wiremesh installation in the old drives of Zawarmala

- Geological, geotechnical, empirical and numerical methods of analysis were used for reviewing probable failure characteristics of CP03A stope at India's largest underground lead-zinc mine (Sindesar Khurd Mine). Kinematic, Mathew stability analysis and FLAC3D numerical modelling analysis were carried out to know the yield zone and stress distribution patterns. Suggestions were made to the mine management for safe extraction of ore from primary and secondary stopes.



FLAC3D model of C block at Sindesar Khurd Mine, HZL

- A 3D model was developed in 3DEC for the prediction of subsidence for Bicharpur coal mine. Two alternatives of Bord and Pillar Method with pillar size 40m x 40m and gallery width 5.6m were considered. Two alternatives were suggested. Alternative-1 proposes development in Seam-IV and only partial extraction by "Non-Effective Width" method in Seam-III/IIIA and Seam-II. Alternative-2 proposes partial extraction by "Non-Effective Width" method in Seam-IV, Seam-III/ IIIA and Seam-II. The analysis suggests that both the alternatives do not cause any damage to the surface and water bodies. However, from the point of maximum utilization of the coal reserves, alternative-2 was recommended.



3D numerical model showing three coal seams and the panels

- NIRM carried out vibration study in the quarries located in Nemkal Village, Bommanahal Mandal, Ananthpuramu. The blasts which were carried out during the field investigation period were found safe with respect to ground vibration, air overpressure and flyrock. It was recommended that all the blasts to be carried out using sufficient series of short delay electric detonators and properly muffling the blasts with blasting mats. It was also recommended to restrict the safe maximum charge per delay to 10kg.



Ground vibration monitoring in quarry located in Nemkal village

- To ascertain the feasibility of mining by blasting at the proposed Nayanapalli limestone mine and its probable impact of ground vibration on Belum Caves, generalized attenuation relations, derived from the analysis of a large number of data generated from several sites, were used. Based on the literature review, it was concluded that a limit of 5mm/s is safe for Belum Caves. As a conservative approach, it was recommended to restrict the peak particle velocity to 2mm/s at the Belum Caves till a site-specific vibration study is carried out.



View of proposed mine area and the Belum Caves (Insight)

- NIRM carried out a scientific study on the impact of ground vibration due to blasting at sublevel open stope method on surface structures of Hira Buddini Gold Mine. Eight underground LDBH stope blasts were monitored and a site-specific prediction equation was derived at 95% confidence level. The dominant frequency of the ground vibration was found to be above 15Hz for all the blasts. A conservative permissible limit of 5mm/s was recommended.



Loaded LDBH stope (insight) and monitoring of ground vibration at Buddinni village

- For the safety of the road passing in the vicinity of Dolomite and Shale mines at Mangampet, Kadapa District, NIRM proposed to carry out trial blast and optimize the blast design parameters. Presently field work is under progress.



High speed camera and drone were used to optimize the blast design

- A comprehensive subsurface investigation using multiple geophysical methods and laboratory rock testing were proposed to evaluate the subsurface rock mass condition around the sinkholes and abandoned coal workings in Umari District, Madhya Pradesh. The field investigations have been planned to be taken up shortly.



Site photographs showing damage zones to be investigated

- Seismic monitoring for evaluation of seismic hazard was continued in the KGF mined out area. During this reporting period only five seismic events related to rock burst phenomena was recorded.

- Scientific studies were conducted at A Narrain iron ore mine to suggest ultimate dump slope limit as well as suitable dumping parameters to ensure its stability.



A view of the Dump No. 3 in the mine

Field investigations were conducted at the mine and dump samples were collected. Numerical analysis of dump had been carried out .

- Scientific study, to assess the stability of south side (in-corp) highwall benches at MOCP, RG-1 area, SCCL, Peddapalli District, Telangana State, was conducted. The rock mass towards highwall section, where cracks and subsidence observed was found to be stable during total station monitoring. The study recommended a 25m platform at 100m depth of the pit. The bench dimensions were designed to get an ultimate slope of 40°.
- In order to understand the behaviour of the strata during the depillaring of the panels (9LS & 4LS) of the Kurja underground mine at Anuppur District, Madhya Pradesh, the Strata Control and Monitoring Plan (SCAMP) studies were carried out.

- To understand the behaviour of the strata during the development of panels P1, P2, P3, P4, P5, P6, P7, P8 & P9 in seam no. 7A1 of Rajnagar (R.O.) underground mine, Strata Control and Monitoring Plan (SCAMP) studies were carried out.

- Geological-cum-geotechnical studies were conducted at S M block iron ore mine located at Narayanpur village, Bellary district, Karnataka, to assess the stability of present slopes, and to suggest the ultimate pit slope along with recommendations for remedial measures.



A view of the S M block iron ore mine workings

- Geological mapping, at multiple levels in different segments between 14th Level to 4th Level of the TMPL Mine, UCIL, AP, was carried out for determining geotechnical parameters to evaluate the feasibility of HW lode mining. This study included estimation of average Q and RMR values for different location mapped. Report incorporating these values were submitted.

- Scientific study for stability assessment and monitoring of slopes at Dharmapura Iron Ore Mine of Sri V.N.K Menon, Sandur, Bellary, Karnataka were carried and the final pit slope angle were determined. The final report along with recommendations was submitted.

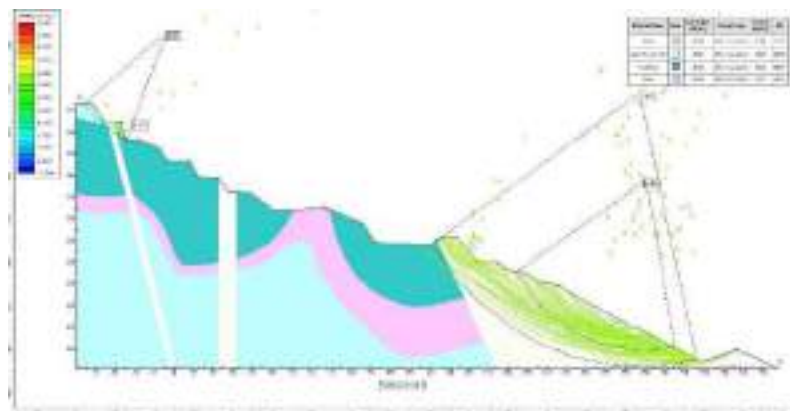


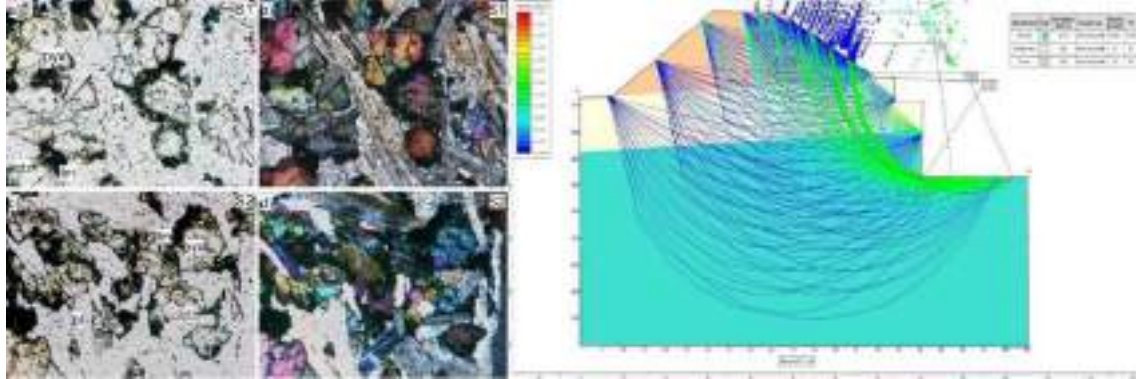
Figure shows FoS value of one of the Sections

- Scientific studies were carried out for the design of slopes and stability assessment of slopes of Dolomite project of APMDC, Vijayawada. The study carried out analysis based on physico-mechanical properties of the material and deformations reported. This also included the analysis of monitoring data. Report was submitted along with recommendations.



Satellite image of the Dolomite Project

- Scientific studies to optimize the bench parameters, design of final pit slope stability and estimation of recoverable blocks of Sy No. 265/1, 2,3A,3B,4,5,264/1,2,266/3,4,269/1,2,3 & 254/2 at Hullepura Village & Yadiyur Village and Sy no. 306 & 308/3 at Kuderu Village of M/s. ALFA ESTATES, Chamarajanagar were conducted and the final recommendations were given in the report.

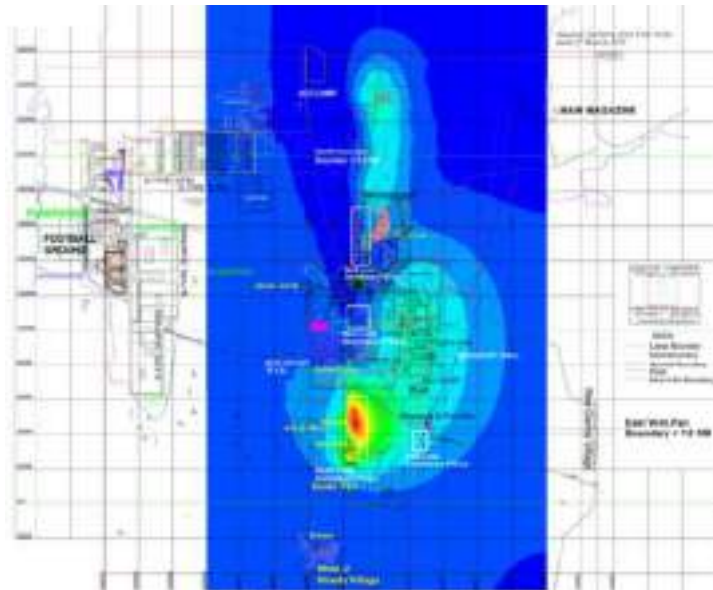


Petrographic and textural study image

Analysis of one of the sections of the granite quarry

- Monitoring using instruments and the instrument data analysis is being carried out at Tummalapalle Uranium Mine, UCIL at Kadapa Andhra Pradesh. Instruments like stress cells, load cells etc have been installed and are being monitored.
- Studies on the design of stoping parameters at different levels of Balaghat Mine and the design of sub-level stoping of Chikla & Munsar mine of MOIL, are being carried out with a view to optimise the stoping parameters through empirical and numerical modelling. In addition to this, at Balaghat, study has been done for (a) feasibility of conversion of in-situ rib pillar to post pillar, (b) deciding dimensions of post pillars & placement of post pillars of varying widths and (c) placing of cable bolts & roof bolts. Data analysis of the instruments installed at Chikla mine is also being carried out.
- Scientific Study for slope stabilization and monitoring of ground movement of South Face, Mine I of NLCIL, Neyveli, TN, was carried out and some immediate corrective measures were suggested to arrest slide failure. The study also included pit slope analysis for determination of optimum slope angle and ultimate depth.
- 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. This was first of its kind in the country where investigation is being carried out for quarry leases more than 30 altogether. Field investigations and analysis of the various sections of the quarry has been completed.
- Scientific Studies are being carried out for stability assessment of slope of pit and dumps of Bina OCP Mine of Northern Coalfields Limited, Singrauli, MP. Initial field investigation has been carried out and tests like in-situ bulk density has been determined in the field. Representative samples were collected for testing in the laboratory.
- Scientific Study for stability assessment of pit and dump of Barsingsar Lignite Mine, Bikaner, Rajasthan is being carried out. Field visits have been planned for collection of samples to determine its various properties.

- For enhancing the production of Rajpura Dariba mine (RDM), by adding new blocks, NIRM reviewed and determined alarming limits for surface subsidence through numerical modelling for the new blocks. A 3D numerical model was developed in FLAC3D by incorporating the previously excavated stopes and the planned stopes for excavation in South, East, Main and North lodes of RDM.



Subsidence prone zones indicated by numerical model



Research methodology adopted for numerical modelling studies at Baroi Mine

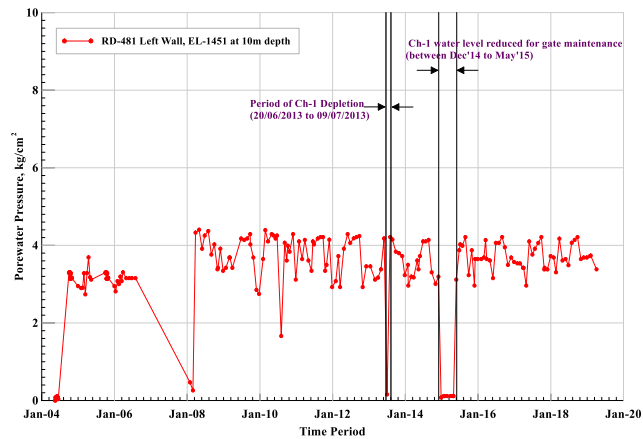
- Hindustan Zinc Limited proposed to enhance the productivity at Sindesar Khurd underground lead-zinc mine by developing the stope blocks at lower levels (600 – 800 m from surface) below the mined-out area. For the designing and developing the stopes, stress measurements were conducted by hydraulic fracturing method at required places and stress magnitude and direction were determined.



Hydraulic fracturing test at Sindesar Khurd Underground Lead-Zinc mine (HZL)

2. Power Sector

- NIRM analysed the instrumentation data of Nathpa Jhakri Hydro Power Station (NJHPS), powerhouse complex, and underground desilting chambers. Analysis of the overall data from four desilting chambers indicated that maximum recorded pore pressure was the least on the left-hand side of Chamber-1 and gradually increased at Chambers 2 & 3. The maximum pore pressure was recorded at left wall of Chamber-4. Convergence observations on walls of machine hall do not show any trend except at EL1003m near unit 3 and unit 1. The displacements on the downstream wall of machine hall cavern showed stabilizing trend.



Piezometer observation at RD 481 Left wall, EL 1451m, DC1

- At Sardar Sarovar Project, the surface MRMPBX data confirmed that the area between the crown and surface was stable. The locations where the displacements exceeded 4mm, anchors were in agglomerate rock and near to shear zone. Instruments at critical chainages also showed stable trend.

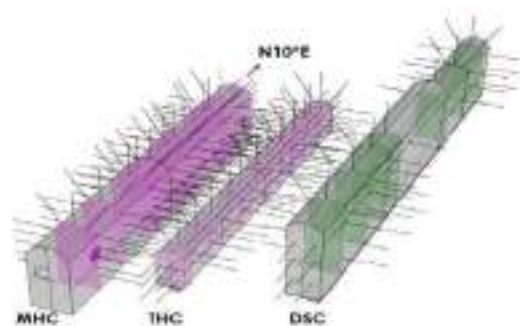


Displacements on u/s at Ch 1558, EL 0m of PHC

- Continuous Geodetic monitoring of the Sardar Sarovar Dam body was carried out on daily basis by NIRM from 13/08/2019 to 30/01/2020. The maximum easting deflection of about 45.8 mm was observed in block no.35, during the reservoir filling period. Honourable Prime Minister Shri. Narendra Modi visited Sardar Sarovar Dam on 17-09-2019. He was shown the data of dam displacement monitored by NIRM.

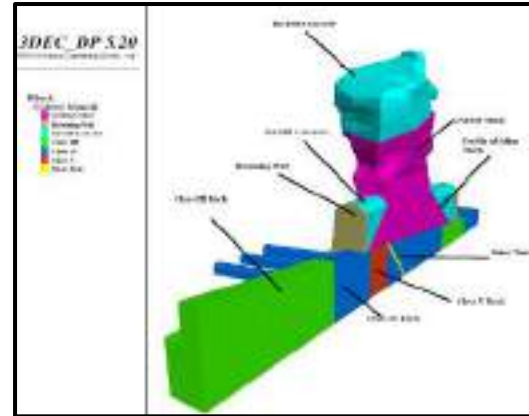
- Geotechnical and geodetic instrumentation network for real time monitoring and automatic data acquisition throughout the life of the project was designed for the largest underground powerhouse caverns at Punatsangchhu-II Hydroelectric Project (PHEP-II), Bhutan.

A 3D instrumentation model incorporating the global positions, geological structures, over-break profiles, and actual positions of instruments was developed for the Punatsangchhu-II hydel project. Detailed direct and derived analysis were carried out for different caverns of the PHEP-II on regular basis. Critical observations and timely recommendations by NIRM helped the project execution team to take up proper strengthening measures for the safety of the underground structures.



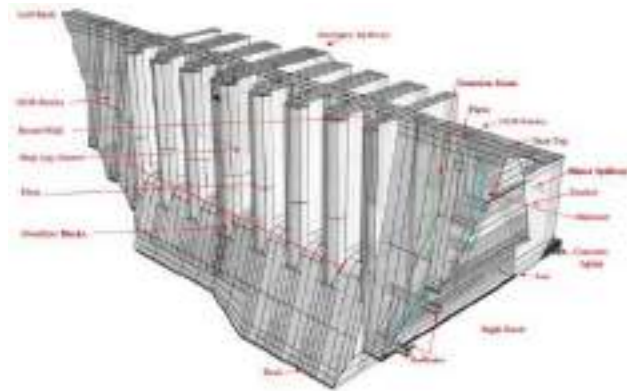
Instrumentation network of PHEP-II, Bhutan

A 3D discontinuum model was constructed with the actual geometry of the layout of downstream surge chamber, powerhouse and transformer hall cavern of the Punatsangchhu-II hydel project. In the third phase of the study, excavation was simulated in the model exactly as carried out at the site. The cavity over downstream surge gallery (DSG) is simulated by way of excavation of the rock mass. Subsequently additional support measures in the powerhouse cavern, transformer hall cavern and downstream surge chamber were simulated along with the treatment of the cavity by way of simulating the retaining wall, backfill concrete and grouting of muck. The results of 3D modelling showed stable cavern after carrying out the cavity filling and all the remedial measures.



FLAC3D model for downstream surge chamber

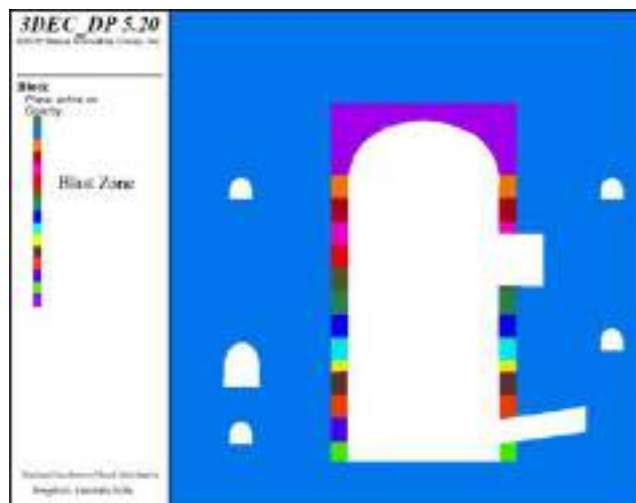
A 3D instrumentation model of Dam complex and geotechnical instrumentation network was developed for 91m high concrete gravity dam incorporating state of the art technology. Stresses, strains, thermal gradients between different blocks, development of pore water pressures in the shear zone had been studied. PHPA was timely advised to execute the suggested remedial measures at site.



3D view of Dam instrumentation model, PHEP-II, Bhutan

- 3D numerical modelling of powerhouse complex is being carried out for Vishnugad Pipalkoti Hydroelectric Project, an upcoming Hydroelectric Project (444 MW) in Uttarakhand. The analysis of the results is in progress.

- With an objective of optimization of support system for different geological properties, THDCIL requested NIRM to re-run the numerical models developed in 2014. Modelling results showed, maximum displacements in crown varied from 129mm to 164mm. Maximum upstream wall displacement observed was 193mm and on downstream wall was 200mm at RD 87 and at EL 590m. Upstream Wall displacements reached 1% strain between elevations 600m to 585m in a limited reach where PQT zone intersected the downstream wall between elevations 600m to 575m.



3DEC model with Blast Zone all around the excavation for MHC

- NIRM is providing exclusive support for excavation of various components of Nuclear installations at Kudankulam (KKNPP). During this period excavations for Hydro Technical Structure of unit 3 and 4 and excavation for construction of unit 5 and 6 were carried out by L&T and SRC Projects Private Limited respectively. The Hydro Technical Structure is located close to the commissioned units 1 & 2. NIRM monitored vibrations at five designated locations closer to the structures of unit 1 & 2(KKNPP). During this study period technical guidance was provided to execute 824 blasts for the excavation for Hydro Technical Structure by maintaining the vibration within the permissible limits.

For the construction of unit 5& 6, a total of 522 blast were conducted during this study period. The recorded vibration did not exceed the permissible level at all the five monitoring locations during entire period of study. The recorded air overpressure levels were also well within the safe limit of 133dB. The study further recommended that the final floor of all the excavations is to be excavated by deploying small hole diameter drilling machines (32/38mm with compressed air jack hammers) and mild blasting is to be carried out.



Controlled blasting adjacent to temporary rock fill dyke



Controlled blasting close to green concrete

Result of presplit in medium hard rock

- To excavate various underground components of Power House Complex of Punatsangchhu II Hydroelectric Project, Bhutan, technical guidance was provided to adopt suitable excavation methods and controlled blast designs were implemented based on the site geological conditions. Parallel hole cut method with various blast design combinations is also used for excavation of tunnels. Excavation was carried out along with stability monitoring procedure in order to control the effect of excavation and blasting on the caverns and tunnels. The results of controlled blast designs implemented were fully effective in controlling the over breaks, ground vibrations and were successful in terms of safety of men and materials.



Excavation of expansion chambers at Punatsangchhu II Hydroelectric Project

Pre and post blast results of Draft tube-VI excavation under critical condition

- NIRM is monitoring ground vibration from excavation for thermal Power Project (Phase III) near Darlipali village in Sundargarh District of Odisha State to ascertain ground vibration levels. During this period, NIRM monitored 660 blasts at two identified locations. The field study is under progress.



Controlled blasting near field hostel for sewerage line, close to the permanent structures of NTPC at Darlipalli STPP

- For the construction of various components of Pazhassi Sagar SHEP, NIRM had been providing technical services required for excavation of hard rock. The suggested permissible peak particle velocity for Pazhassi Sagar barrage was 50mm/s. It was advised to restrict the peak particle velocity to 5mm/s at the private structures located in the vicinity of project area. Similarly, the recommended safe air overpressure level near the private structures was 133 dB. All the blasts (surface and underground) carried out, during the studies were safe with respect to ground vibration, air overpressure and flyrock.



Photograph show post blast and neat profile in Penstock 2

- Engineering geological / geotechnical mapping of the excavated surface of cut slopes (intake pool, upstream and downstream hillock above tunnels), powerhouse area and tail

race pool of Polavaram hydroelectric project, was carried out during this period. Recommendation of permanent support based on rock mass classification system SMR (Slope Mass Rating) and rock support categories were recommended as per engineering geological mapping. Based on design, slope mass rating and engineering judgement slope protection measures were recommended.

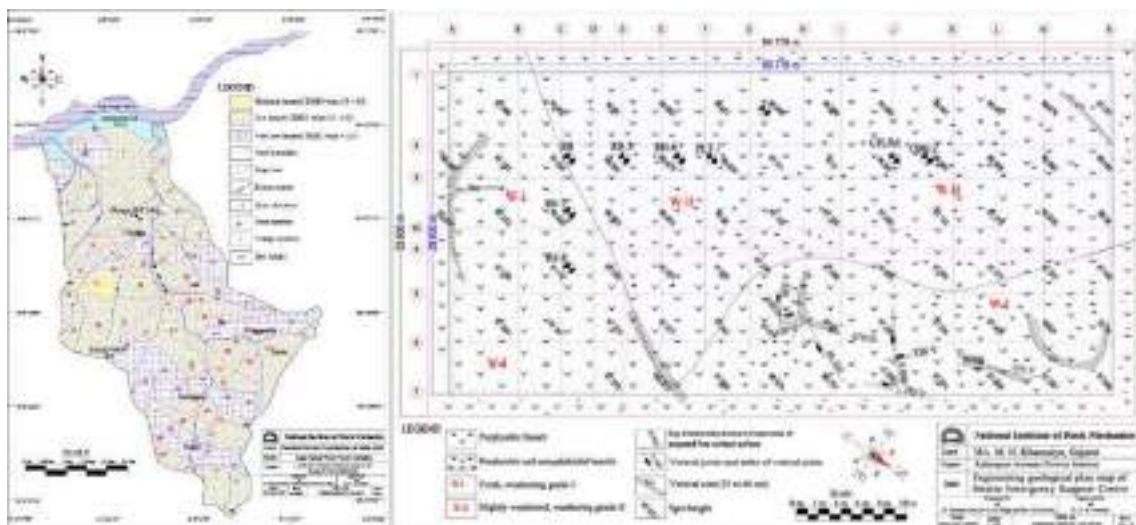
- NIRM had been providing technical guidance for controlled blasting operations and monitoring ground vibration at the Peruvannamuzhi Small Hydroelectric Project site as there were some structures located near the proposed excavation sites. The recommended safe peak particle velocity for Kuttiyady dam was 50mm/s. Based on the DGMS standards, a peak particle velocity of 10mm/s was recommended as safe for private residential structures, and other private structures.



A view of completed D shape portion of pressure shaft from powerhouse

- Macro landslide hazard zonation mapping was carried on 1:50,000 scale based on IS 14496 (Part 2), 1999, for the Kaiga Holhe catchment related to Kaiga Nuclear Power Project site. The aim of this work was to create a prototype map that was 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.

NIRM has also provided the quality assurance support for ongoing geological and geotechnical investigation for the NPCIL Kaiga unit 5 & 6. As an outcome of the work it was found that the subsurface strata condition is good as compared to the Unit 1 to 4.



Landslide hazard zonation map of Kaiga Holhe catchment

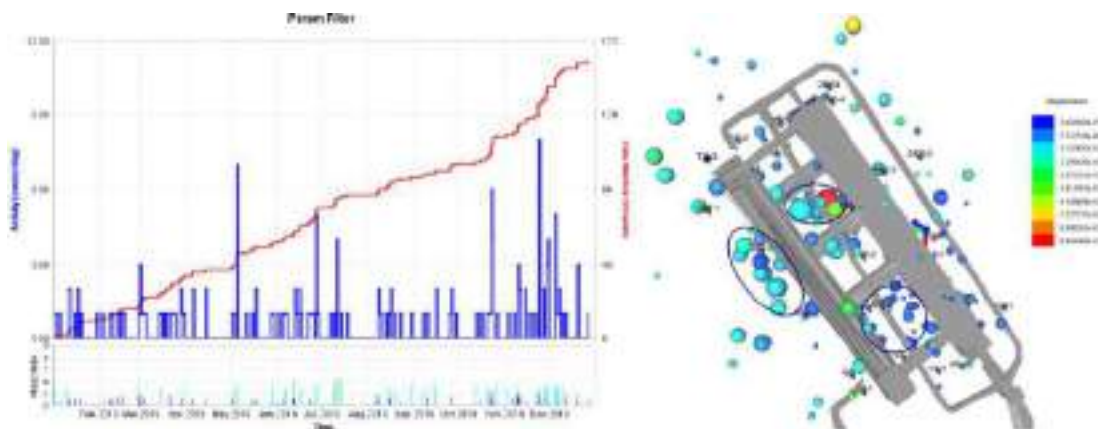
Engineering geological plan map of onsite emergency support center Kakrapar Atomic Power Project

- In order to evaluate the design basis foundation parameters for Onsite Emergency Support Centre (OESC) of Kakrapar Atomic Power Project Units 1 to 4, Kakrapar, Gujarat, engineering geological mapping (on 1:100 scale) was carried out. It was found

that the entire floor area consisted of thick flows of Deccan traps. No evidences of faulting or shearing were observed. On the basis of surface geological mapping and review of drill cores of CBH-1 and CBH-2, the excavated surface was found acceptable for foundation. Based on investigations, recommendations for the treatment of foundation were given.

- At Tala Hydropower Plant, Bhutan, the analysis of instrumentation data in powerhouse complex showed that convergence at the machine hall cavern has been continuing at a lower rate (0.005 to 0.011 mm/day). The failure of rock bolts has been continuing as the stress redistribution was still going on in the rock mass surrounding the caverns. The variation of pore water pressure was in accordance with the water level in the reservoir and water levels in the Desilting chambers at most of the places.

The microseismic monitoring system installed for the powerhouse of the Tala Hydropower Plant, recorded a total of 160 microseismic events in 2019. Variation of seismic source parameters of these events were mapped on the three dimensional cavern plan of the powerhouse. There were three cluster of events occurred in 2019. During the first quarter of 2020, only 24 microseismic event were recorded. Four rock bolts failure occurred in 2019 for which back analysis was done but no accumulation/cluster of events



Activity vs. Cumulative number of events.

Microseismic events cluster (encircled) during 2019

were found around these failed rock bolts zones. There was no significant change in the stress regime nor development of any new stress regime with time. Displacement and seismic potency were also low. Seismic source parameters of the acquired microseismic events indicated that the cavern and its wall was apparently stable.

- As a part of identifying a site for nuclear power plants along the east coast in Andhra Pradesh, NIRM carried out seismotectonic evaluation for 3 locations. The study found that some of the NW-SE trending lineaments were associated with abrupt change in river path or river pattern and were showing signatures of faulting.
- A geological repository is being planned at Vishakhapatnam, Andhra Pradesh by Bhabha Atomic Research Centre (BARC) for long term isolation of high-level nuclear waste. As a part of feasibility studies, in-situ stress measurements were planned to know the stress regime around the area and other geotechnical parameters of the rockmass. Field investigations are under progress.
- Studies are being carried out to evaluate the relationship between the characteristics of failure around an opening (cavern) with certain rock type under applied stress conditions. In this regard, a sophisticated system for the study has been developed. This system has been used to study exactly the ratio, in which, the stress was controlled by the anisotropy

of the rockmass and for assessing the rock failure trend, under polyaxial loading conditions. This will be helpful in presenting the necessary data on the site for a site-adapted layout of the final repository and assessment for long-term stability. Field investigations are under progress.

- Satluj Arun Power Development Company (SAPDC), Nepal proposes to build a switch yard at the left bank of Arun River on underlying soil strata for the construction of Arun-3 Hydroelectric project at Nepal. Plate load test was carried out to determine safe bearing capacity (between 11.2 and 15.4 T/m²), which is an essential parameter for the design of foundation.

In-situ stress, in-situ deformability and in-situ shear parameters of rockmass were also determined at dam and powerhouse sites of Arun-3. Based on the in-situ stress parameters, it was recommended that the long axis of the underground powerhouse should be oriented along N 100° for maximum stability.



In-situ deformability, Shear and Stress measurements at Arun – 3 HEP, Nepal

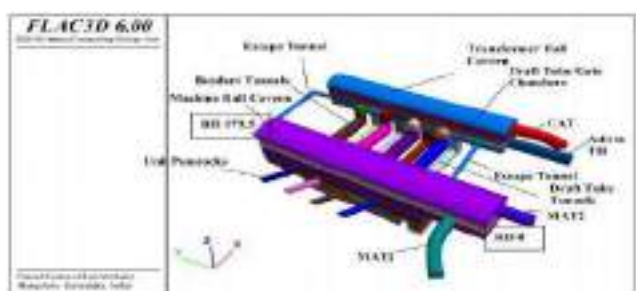
Plate load test was carried out to determine safe bearing capacity (between 40.041 and 40.146 T/m²), for the design of foundation for the construction of coffer dam associated with Arun 3.

For the design of concrete gravity dam structure in Arun 3, shear parameters of the rockmass need to be determined. Field investigations are under progress at the right bank.



Plate load test setup for determining safe bearing capacity

A realistic FLAC3D model was developed for underground powerhouse complex and surge shaft of Arun 3 Hydroelectric Project (900MW), Nepal. The optimum support system was recommended for machine hall cavern, transformer hall cavern and surge shaft.



FLAC3D model showing powerhouse complex for Arun 3 HEP

3. Infrastructure Sector

- NIRM was approached for the advice of controlled blasting for excavation for the terminal building at Chennai airport. Controlled blasts were carried as close as 30 m from aircraft during boarding and de-boarding of passengers. Vibrations were recorded and site-specific predictor equation was derived. Safe maximum charge per delay was recommended for future blasts.



Controlled blasting in an operating airport for expansion work

- Indian Navy is constructing Varsha Inner Harbour Project for their naval base near Vishakhapatnam. As part of this work about 9.3km long break water has to be constructed which requires about 26 lakh tons of eight different graded material in the order of 1 kg to 10 MT size. In order to maximise the output of the graded material



Required armour stone of 6MT

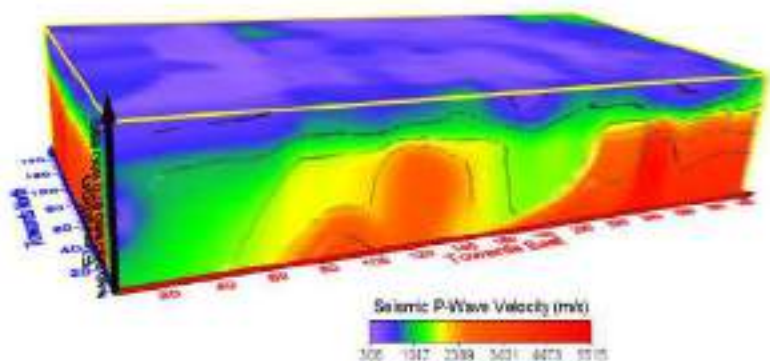
from blasting, NIRM is providing technical advice on blast design for graded material for the construction of breakwater. NIRM is also monitoring and supervising the quality of testing at the accredited laboratory facilities of L&T at site and ensure deployment of tested material for use in the construction.

- NIRM submitted a method statement for the excavation work of Power house area of Indira Sagar Polavaram Hydro Electric Project. Based on analysis of trial blasts the blast design was optimised for bench cutting and for stable



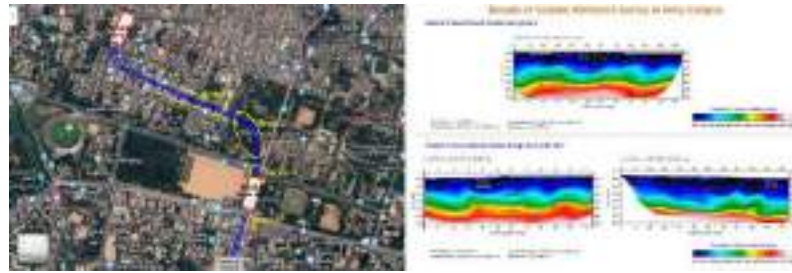
Bieniawski (1989). Based on engineering geological investigations, recommendations for the treatment of foundations and support for draft tubes, bus ducts, delivery mains, shaft and ventilation shafts were given.

- The engineering geological foundation mapping of surge pool and pump house cavities and geological investigations for delivery main shafts and ventilation shafts of Kaleshwaram Lift Irrigation Scheme Package-11 were carried out. Rock Mass Rating (RMR) of Bieniawski (1989) was carried out. Based on investigations, recommendations for the treatments of foundations were given.
- Engineering geological investigation of pump house complex area of J. Chokka Rao Devadula Lift Irrigation Scheme (JCR-DLIS)/ J. Chokka Rao Godavari Lift Irrigation Scheme (JCR-GLIS) phase – III, package – III, Warangal District, Telangana State were carried out. The main objective was to review the engineering geological/geotechnical mapping of the underground pump house complex, estimation of the rock mass quality, suggestion of suitable support measures, site geological conditions and design drawings. 3D geological logging of the pump house and surge pool shafts were carried out on 1:200 scale and Tunnelling Quality Index(Q) was calculated for every 5 m interval.
- Engineering geological investigations of underground lift schemes 1, 5, 8 and 16 which includes tunnel between package 1 to 16, of Palamuru Ranga Reddy Lift Irrigation Scheme (PRLIS) are being carried out. Main objectives of investigations include review of geological / geotechnical mapping of four lifts and tunnels, estimation of the rock mass quality and suggestion of suitable support measures as per engineering geological mapping and site conditions.
- NIRM is engaged in quality control exercise for the gradation and certification of quality of armoured rocks for breakwater structure at Vooderu Quarry (QA/QC Lab), Anakapalli. Each quarry is divided into different parts for drilling, blasting & transportation. The maximum size of various grades rocks produced range from 10 kg to 10 ton. After completion of every blast, the quarry bench rocks are inspected and suitable rocks of various grades are marked. The selected stocks are subjected to various laboratory tests as per prescribed standards. The stocks which pass all quality tests are dispatched from stock in quarry to the construction site with due approval of NIRM.
- For developing a high-rise commercial complex, at a site adjacent to the Yeswanthpur railway station and the Yeswanthpur flyover on NH 75, geophysical studies were conducted to have an accurate information on the subsurface strata. Studies using borehole tomography and seismic refraction survey showed that the rocks in the construction site was quite competent



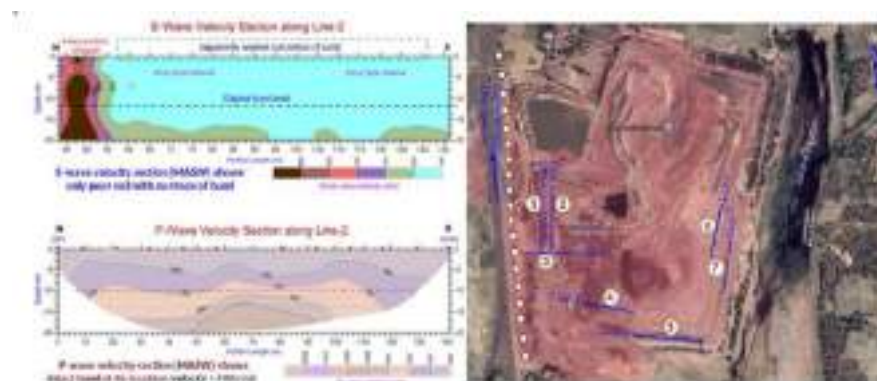
Sample subsurface section obtained by combining borehole and surface survey sections

- NIRM is scientifically assessing the rock mass condition in the subsurface; it is also investigating to identify and locate isolated hard rock boulders between Silk Board Junction and Nagawara of Bengaluru Metro Rail network. Geophysical investigations showed that overburden layer comprised all kinds of soil. The contours of weathered rock layer showed several undulations indicating the presence of embedded boulders. The jointed rock layer ($2500 \text{ m/s} < V_p < 3500 \text{ m/s}$) comprising highly fractured rock mass with large in-situ boulders was mapped between RL=895 and 891 m. Several weak zones which needed strata reinforcement were also identified and marked around the rail level.



Seismic velocity section along TBM alignment of BMRCL, Phase – II

- Geophysical investigations were carried out to find out the cause of breaching of Red Mud Pond (RMP) of alumina refinery of HINDALCO at Muri. The survey was done along seven lines and additionally, vibration data

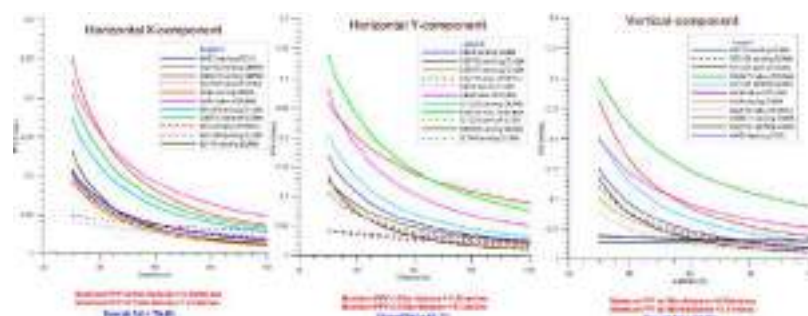


Sample velocity section generated by MASW and SRS survey along line-2

Image showing the over-flown red mud pond with lines of MASW survey SRS and locations of vibration seismographs close to the railway track superimposed.

- were measured closed to the railway track. Based on the seismic wave velocity (P and S wave) data from the three sides of the red mud pond, it was inferred that the foundation at RMP boundary was still intact and the breach had happened due to rupture in the overlying gabion wall due to some suspected fault. Vibration induced surface waves due to movement of trains could be recorded only upto 20m from the track. Thus it was opined that the impact of induced vibration due to movement of trains had no role in the damage or collapse of the RMP boundary.

- NIRM recorded ground vibrations around the Surat Airstrip due to flight movement. The aim was to assess the impact of these vibrations on the SBHT buried gas pipeline of ONGC passing through Surat Airport, some

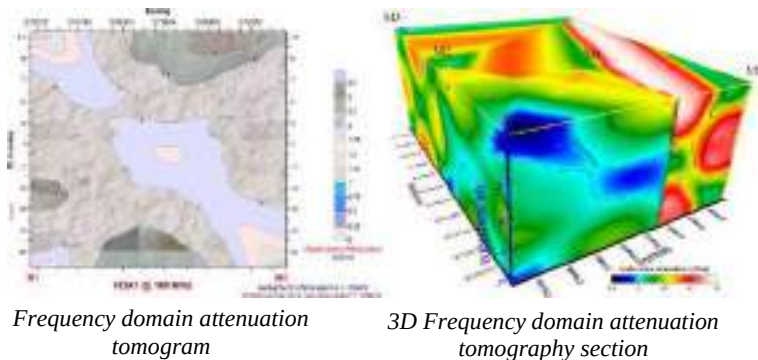


Plot of PPV variation along west side of airport

250m from the present runway. Data was collected on three sides of the runway; left, right and RESA end at 50 m distance from the air strip and on the pipeline itself by exposing it at three different locations. The vibration data were collected for at least 50 sets of impacts due to flights landing/ take-off. A comprehensive analysis of the flight

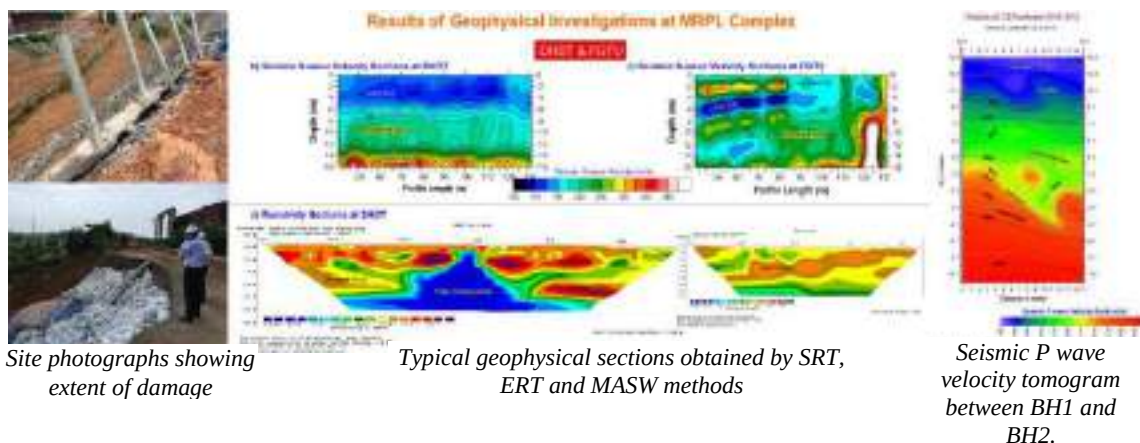
vibration data recording revealed that under the present disposition, the pipeline was absolutely safe in terms of all the four damage indices. None of the three basic criteria for fatigue damage due to induced stresses were applicable even after expansion of airport with doubled flight landing/ take-off per day. Thus, practically there was no effect of fatigue loss due to induced residual stresses even after the proposed expansion of the runway. The study suggested that it was not safe for flight to land/ take-off directly over the pipeline. Therefore, it was safe to extend the runway only till 50 m distance from the pipeline.

- Geophysical investigations were conducted to detect the path of water seepage into the underground metro station box of Mumbai metro. Into the up-line tunnel of MML-03, a low attenuation zone (<2 dB/m) was mapped between boreholes M1 and M4 in



the direction of M1 top to M4 bottom, which might be the probable flow path of water seepage. We recommended to grout this path and suggested the probable borehole location for cement grouting to treat the water pocket responsible for seepage.

- In order to plan a proper restoration work at the site of slope failure within the MRPL Complex, Mangalore, assessment of the sub-surface rock mass condition around the failure location was done. Seismic refraction survey, MASW and cross hole seismic tomography were carried out to determine the P-wave velocities of the different subsurface layers. The first phase of geophysical investigations at the site of failure showed that the top soil was generally loose in nature with hard patches at few locations. Valley type feature in the profile of the bed rock matched exactly with the water saturated zone in the resistivity section where the slope failure had taken place.



- 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 assigned the job of carrying out the hydraulic fracturing tests. Field investigations are under progress.

4. Testing Services

- 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. All the tests were carried out as per Indian standards to meet requirements.



Testing of 14mm, RHL rope and representatives of M/s IMS & Ashok Leyland witnessing the test at NIRM laboratory

- NIRM carried out non-destructive evaluation of three man riding haulage winches and associated components in M/s Arulmigu Dhandayuthapani Swamy Temple. The winch vital components and bogie attachments were found free from surface, sub-surface and internal flaws. The wire ropes and bogie attachments of winch-I, II & III were also free from thermal anomaly. 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 and there was no loss of metallic cross-sectional area (LMA).



Testing of winch vital parts and bogie attachments

- NIRM carried out Wire rope defectograph investigation on the Left side rope of Cable belt conveyor of NALCO's bauxite mine located at Panchpatmali hills in Koraput District of Odisha State. The rope was found to be in deteriorated state with wear characterized with fatigue cracks & broken wires. The percentage reduction in diameter of left side rope was 7.72%. This rope needed a careful handling and regular monitoring with caution.



Inspection of Left side rope

- Zawar Group of Mines comprises four mines namely Balaria mine, Zawar Mala mine, Central Mochia mine and West Mochia mine. NDT was conducted on vital components of the winders and suspension gear parts of the winders. All the tested components were free from surface, sub-surface and internal flaws. The wire ropes used for men and material hoisting were subjected to defectograph tests. It was found that there were no anomaly and they were also free from local faults (LF) such as pitting, corrosion and broken wires and there was no loss of metallic cross-sectional area (LMA).



NDT on winder vital components & suspension gear parts, Zawar Group of Mines, M/s HZL.

- Rajpura Dariba Mines is an underground mine with two vertical access shafts (Main shaft and Auxiliary shaft). NDT was carried out using MPT and UT on winder vital components



Inspection of wire ropes, Rajpura Dariba mines, M/s HZL.

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. The wire ropes in operation were also subjected to NDT using wire rope defectograph. Defectograph studies conducted on all the wire ropes revealed that the tested wire ropes were free from local faults (LF) such as pitting, corrosion and broken wires and also there was no loss of metallic cross-sectional area (LMA).

- Using Magnetic particle test and Ultrasonic test, NDT was conducted on suspension gear parts and wire rope defectograph studies were carried out on cage and skip ropes at Khetri and Kolihan



NDT on winder suspension gear parts and wire ropes, M/s HCL.

Mines of M/s Hindustan Copper Limited, Rajasthan. It was found that all the tested components were free from surface, sub-surface and internal flaws. The test results revealed that the wire ropes were free from Local Faults (LF) such as pitting, corrosion and broken wires and also there was no Loss of Metallic cross-sectional Area (LMA).

- Magnetic particle test and Ultrasonic test, NDT were conducted on suspension gear parts and wire rope defectograph studies were carried out on cage ropes at M/s Singareni Collieries Company Limited (SCCL) of Telangana state. It was found that suspension gear parts were free from surface, sub-surface and internal flaws. All the wire ropes were found to be free from local faults (LF) such as pitting, corrosion and broken wires and also had no loss of metallic cross-sectional area (LMA).



NDT on winder suspension gear parts & wire ropes, M/s SCCL.

- NIRM conducted non-destructive tests on the EOT crane at Shiva hydroelectric power station. The results revealed that tested components of 45T EOT crane vital components and structure/girders with bolts/rivets, 45T EOT crane hook and 10T chain pulley hook were free from surface, sub-surface and internal flaws. NDT evaluation of the structure and its bolts/rivets was found to be intact.



NDT on EOT crane vital components, M/s KPCL, Shivanasamudram

- NDT was conducted on 100HP winder vital components and its trolley attachments of Mahatma Gandhi hydroelectric power station located at Jog Falls. It was found that all the tested components were free from surface, sub-surface and internal flaws. Non-destructive tests found that the wire ropes were free from Local Faults (LF) such as pitting, corrosion and broken wires and also there was no Loss of Metallic cross-sectional Area (LMA).



Inspection of wire ropes, M/s KPCL, Jog Falls

- NIRM conducted direct shear test on twenty samples from Maheshwari mine, West Bengal as per ASTM standard D5607. Tests were carried out at different normal stress ranging from 2.70 MPa to 12.74 MPa. Moulded samples were kept inside the shear box and were sheared at a rate of 0.1 mm/second. Shear stress was calculated from the peak shear load obtained for each normal loading of the sample. The Cohesion and Friction angle for the saw cut samples were determined by computing the normal stress and the shear stress data in the Roc Data software.

- Out of 56 core samples received from three wellbores of Gamej field and Sadra field of Centre for Excellence in Well Logging (CEWELL), ONGC, 33 samples were tested for compressive strength and elastic constants. Average Young's modulus and Poisson's ratio were calculated from the linear portion of the stress-strain curves obtained from uniaxial compression test (20% to 60% of failure stress). 18 samples were subjected to Triaxial compression tests (Multiple failure method) at various confining pressures and determined Cohesion & Friction angle by computing the data using Roc-data software.
- 
- Test setup for uniaxial & triaxial compression*
- Uniaxial compression tests were conducted on 13 specimens and triaxial compression tests were carried out on 10 samples from the 23 specimens received from Arun-3 Power Development Company (P) Ltd.. Biotite Augen Gneiss showed higher compressive strength (10.04 to 29.73 MPa) and modulus of elasticity (6.93 to 22.99 GPa) than Micaceous Augen Gneiss, (6.35 to 13.16 MPa and 4.92 to 9.20 GPa respectively). There was not much variation in values observed for cohesion and friction for these rock types.
 - NIRM conducted laboratory tests to determine physical, and mechanical properties of dimensional stone (granite) for their suitability for global marketability. 10 samples from Archean Industries Private Limited were tested for this exercise. Bulk density, water absorption, compressive strength, flexural strength, modulus of rupture & abrasion resistance were determined as per ASTM standards.
- 

Set up of the direct shear testing equipment with automatic data acquisition system

5. Miscellaneous Sector

- Geological and geophysical studies were conducted in Belum Caves in Andhra Pradesh. The average RMR for different rock type indicated Fair to Good rock. The petro-physical and petro-fabric analysis indicated very compact limestone and quartzitic sand stone. Geophysical investigations indicated water charged zones in the form of lenses and low seismic velocity zones in the form of closed contours in between the competent rock mass.



Bedded Limestone at the opening of the caves

6. Other Important Activities

Inter-Ministerial Conference on Future Strategies for NIRM

NIRM along with Ministry of Mines, Govt. of India organised an Inter-ministerial conference on 26th April 2019 at The Ashok Hotel, New Delhi. Shri. Anil G Mukim, IAS, Secretary, Ministry of Mines, Govt. of India Chaired the conference. Dr. K. Rajeswara Rao, IAS, Additional Secretary, Ministry of Mines and Controller General, Indian Bureau of Mines, Govt. of India graced



The Chief Guest Shri. Anil Mukim, IAS, Secretary, MOM, GOI addressing at the Conference

the occasion. Shri. Dorji P Phuntshok, Director (Projects), Druk Green Power Corporation Ltd, Bhutan was Guest of Honour during the conference. Shri Alok Chandra, Economic Adviser, Ministry of Mines graced the occasion. Dr. H S Venkatesh, Director, NIRM welcomed all and briefed about various activities of NIRM. More than 50 officers from various ministries of Govt. of India, invited guests from industry and other prestigious organisations like DRDO, CWC, NIDM, NPCIL, NHPC Ltd., HZL, Northern Railways participated in this conference; they interacted and shared their past experiences with NIRM and highlighted their future requirements and commitment to engage services of NIRM.

The 22nd Peer Review Committee Meeting

The 22nd Peer Review Committee meeting of NIRM was held at NIRM HQ on 17th December 2019 under the Chairmanship of Prof. B. B. Dhar, former Director CIMFR. Dr. H.S. Venkatesh, Director, NIRM welcomed chairman and members of the Peer Review Committee. The committee reviewed the technical activities of all departments of NIRM and appreciated the activities of NIRM in serving the nation in the diverse areas of Rock Mechanics and Rock Engineering.



Members of PRC, at the Meeting

The 23rd Peer Review Committee Meeting

The 23rd Peer Review Committee meeting of NIRM was held at NIRM HQ on 24th February 2020 under the Chairmanship of Prof. B. B. Dhar, former Director CIMFR. Dr. H.S. Venkatesh, Director, NIRM welcomed chairman and members of the Peer Review Committee. The committee reviewed the technical activities of all the departments of NIRM and appreciated the activities of NIRM in serving the nation in the diverse areas of Rock Mechanics and Rock Engineering.



Technical Discussions at PRC Meeting



Presentation of NIRM activities by the Director, NIRM during Peer Review Committee Meeting

Celebration of 5th International Day of Yoga

International Day of Yoga (IDY-2019) was celebrated at NIRM on 21st June 2019. At Bengaluru, the Yoga session was conducted by the Yoga exponent Shri Devanand and Mrs. Salini, Yoga teachers from Atma Darshan Ashram, Bengaluru. At KGF office Yoga session was conducted by the Guru from Prajapita Brahma Kumaris Ishwariya Vishwa Vidyalaya.



Practice of pranayama under the guidance of Yoga Guru

Yoga Gurus also delivered short speech on the benefits of yoga and urged all the employees to make yoga a daily practice in their lives.

NIRM celebrated Constitution Day

Constitution Day of India is celebrated on 26th November every year. In 2019, it marked the 70th anniversary of the adoption of the Constitution. 26th November has its own importance in the history of independent India because on this day in 1949, the Constitution of India was adopted and it came in to effect on 26th January, 1950, thus, marking the dawn of a new era. To acknowledge the contribution of the framers of the Constitution and to aggravate the people regarding the prominent values, 26th November is celebrated as the 'Constitution Day'. At NIRM HQ, the celebration started with reading the 'preamble' of the Constitution by all the scientists and staff.



Director, NIRM briefing on Constitution Day at HO



Principal Scientist, NIRM RO briefing on Constitution Day

Celebration of Hindi Fortnight

The Hindi fortnight was successfully organized from 14th to 30th September 2019 at NIRM. On this occasion various competitions such as, essay writing, standard noting, word-matching, poetry was organized to encourage employees and to enhance the use of Hindi language. On this occasion, Dr. H.S. Venkatesh, Director and President of Official Language Implementation Committee expressed that every Indian should give value to Hindi language.



Officers and employees participating in word-matching competition.



Director NIRM expressing his views on the importance of Hindi language.

Swachhta Pakhwada

On the occasion of the “Swachh Bharat Mission”, NIRM organized Swachhta Pakhwada in and around its Head Office (HO) and Registered Office (RO) during 16th-30th November 2019. During the



Cleaning activities at NIRM HO and RO

Pakhwada, employees participated in the cleaning activity and cleaned the campus area, laboratories, library, rooms, drainage, and planted trees in the campus.

Swachh Action Plan

NIRM celebrated Swachh Action Plan 2019-20, under the Swachh Bharat Mission at Sri Bhuvaneshwari Mahila Sewa Samaja, Kannada Higher Primary School near Kelasham Nagar, Banashankari in Bengaluru on 12th February 2020. NIRM provided LED tube lights to ensure proper illumination in all classrooms and distributed hygiene kits to the students. NIRM provided all necessary cleaning items to school for keeping it clean and hygienic.



Handing over of cleaning items to the Principal of the School

Distribution of hygiene kit to a girl student by the Principal Scientist, NIRM

International Women's Day

NIRM celebrated International Women's Day 2020 on 9th March 2020 (Monday) at its HO at Bengaluru. On this occasion, the Internal Compliance Committee (ICC - Women) of the Institute invited all the scientists, administrative



Talk on 'Work - Life Balance' Stress Management by Mrs. Devashree (Atma Darshan Yogashram, Bengaluru) and her felicitation by the Director NIRM.

officers and staff of the Institute to attend and actively participate in the programs organized to celebrate the occasion. The ICC members and women employees of the Institute took active initiative in organizing the various activities of the program.

Awareness on COVID-19

With regard to the spread of deadly COVID 19 Dr. Divyalakshmi KS, Scientist & Nodal Officer conducted an awareness program on 11th March 2020. During the interaction



Director, Scientists and staff at awareness program on COVID -19 and precautionary measures

she explained about how the virus spreads from a sick person to the healthy person and what precautions should be taken by individuals. She also demonstrated the usage of various types of preventive masks and proper disposal of it. She also proposed some precautionary measures to be adopted by NIRM HO & RO for the safety of the employees within the office

environment. The program was Chaired by Dr. H.S. Venkatesh, Director NIRM, and he gave instructions to follow the necessary measures to contain spreading of COVID 19 at NIRM HO & RO.

Foreign Visit

- Dr. Yogendra Singh attended and presented a research paper in European General Assembly (EGU 2019) at Vienna, Austria, during 6th - 12th April, 2019.
- Dr. A.K. Naithani and Dr. L.G. Singh attended and presented technical papers in 14th International Conference on Underground Construction, Prague, Czech Republic between 3rd and 5th June, 2019.
- Dr. Rabi Bhusan and Mr. K. Sudhakar attended a short course and presented papers at the 14th International Congress on Rock Mechanics and Rock Engineering during 13th - 14th September 2019, at Foz do Iguassu, Brazil.
- Mr. G. Gopinath attended European Federation of Explosives Engineers (EFEE) 10th World Conference held at Helsinki, Finland from 15th to 18th September 2019.
- Dr. Sripad R Naik, Dr. Rabi Bhusan, Mr. B. H. Vijay Sekar Mrs. Praveena Das Jennifer and Mr. B.N.V. Sivaprasad participated and attended workshop at the 5th International Itasca Symposium on Applied Numerical Modeling in Geomechanics-2020 on 17th February 2020 at Vienna, Austria.
- Dr. H. S. Venkatesh, Mr. R. Balachander attended and Mr. G.C. Naveen presented a paper at the 46th ISEE Annual conference at Denver, Colorado, USA, 26th to 29th January 2020.

Recognition / Awards

- Dr. A.K. Naithani, Dr. D.S. Rawat, Dr. L.G. Singh and Dr. Prasanna Jain received best paper award of Indian Society of Rock Mechanics and Tunnelling Technology (ISRMTT) for paper entitled “Engineering Geological Investigations of deep open surge pool area of lift irrigation scheme – A case study from Telangana State”.
- Dr. A.K. Naithani has been selected as an Expert Member for the evaluation of research proposal submitted to the Scheme for Transformational and Advanced Research in Sciences (STARS) Program of the Ministry of Human Resource Development (MHRD), Government of India.
- Dr. A.K. Naithani has been selected as a Member of Editorial Board for Nanoscience and Nanotechnology Journal, Whoice Pub.
- Dr. Sandeep Nelliath has been selected as a member of Geological Investigation & Subsurface Exploration Sectional Committee, WRD 5 of Bureau of Indian Standards
- Dr. Sandeep Nelliath has been nominated as Member, Board of Studies in Marine Geology and Geophysics, Cochin University of Science and Technology (CUSAT) for a period of four years wef 04.11.2019.
- Dr. H. S. Venkatesh has been nominated as a member of the State Empowered Expert Committee by the Government of Karnataka to review the mining activities near the vicinity of Kumaraswamy Temple, Hospet, Bellary, Karnataka.

Training programme conducted

- One-week training programme was conducted on Microseismic monitoring for the stability analysis of the underground powerhouse cavern of Tala Hydropower Plant for three executives of DGPC Ltd. from April 22nd to 27th, 2019 at NIRM, Bengaluru.

Training attended / Lectures delivered / Other activities

- Dr. D. S. Rawat delivered lectures on engineering geological application for crude oil storage and lift irrigation projects- a case studies, at Ambedkar Technical university Lonere, Maharashtra from 28th to 29th May 2019.
- Dr. A.K. Naithani as a resource person delivered lectures in a National Disaster Management Authority (NDMA) five days training programme on 'landslide mitigation and detailed project report (DPR) preparation' at IISc Bengaluru from 6th to 10th May 2019.
- Dr. A.K. Naithani delivered Geological Society of India monthly scientific lecture on "Rock mass classification and support design using the Q-system" on 14th August 2019 at Geological Survey of India, Bengaluru.
- Dr. D. S. Rawat attended NIAS-DST training program on science, technology and innovation policy during 19-30 August 2019 at National Institute of Advanced Studies Bengaluru (NIAS).
- Dr. A.K. Naithani delivered invited talk on Site development and slope modification regulations in a workshop on challenges on disaster risk reduction of hill towns organized by Sikkim State Disaster Management Authority, Govt. of Sikkim and National Disaster Management Authority, Govt. of India at Gangtok between 18 and 19 September 2019.
- Dr. Sandeep Nelliath delivered the keynote lecture on Seismic Borehole Testing at the TC102 Workshop on "Ground Property Characterization from In-Situ Tests held at IISc, Bengaluru on 27-04-2019. This workshop was organised under the aegis of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE).
- Dr. Sandeep Nelliath attended the Expert Committee Meeting on 24th October 2019 for revision of syllabus for the Master's Degree Courses offered by the Department of Marine Geology and Geophysics, CUSAT.
- Dr. Sandeep Nelliath delivered an Invited Talk on Near Surface Geophysics followed by a practical field session at the Department of Marine Geology and Geophysics, CUSAT on 25-10-2019.
- Dr. D. S. Subrahmanyam, headed as Chairperson for technical session of Characterization of rockmass by in-situ testing at INDOROCK 2019, 8th Indian Rock Conference, 4th – 5th November 2019.
- Mr. A. Rajan Babu delivered a lecture on Dimensional Stone Quarrying and Recovery Percentage (2020) at STONA 2020 held during 06th - 09th February 2020 at Bengaluru.
- Dr. Sripad R Naik and Mr. B. N. V. Sivaprasad delivered invited lecture at Seminar on Geotechnical instrumentation and controlled Blasting organised by Druk Green Power Corporation (DGPC) on 28-29 June 2019 at Thimphu, Bhutan.
- Mr. B. N. V. Sivaprasad delivered lecture on Instrumentation in Hydropower Projects vis-à-vis Quality Control on 28th August 2019 for officials of Punatsangchhu-II Hydroelectric Project, Bhutan
- Dr. Sripad R Naik delivered invited expert lecture on Tala Powerhouse – Geotechnical Appraisal, Stability Issues and Possible Solutions at Seminar on Issues and Stabilization Measures of THP Powerhouse Cavern organised by Druk Green Power Corporation (DGPC), 11-12 September 2019 at Thimphu, Bhutan.
- Mr. N. Jothiappa and Mr M.P. Adithya attended a training program on Recruitment procedures and Latest order & Policy on reservation for Economically Weaker Sections (EWS) along with SC/ST/OBC/PWBD/Ex-Servicemen and Recasting of Post Based Rosters from 28th to 30st August 2019 at Goa.
- Mr. M. P. Adithya attended a training programme on Financial Management in International Trade on 22nd February 2020 at World Trade Centre, Bengaluru.

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, 2020, the Statement of Income & Expenditure & Receipts and Payments for the year ended 31st March 2020 and a summary of significant accounting policies & 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 2020.
- 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 2020.

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 - 26566448, 26577948

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



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.

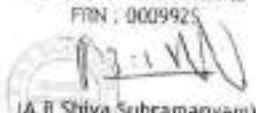
Auditor's Responsibility for the Audit of the Financial Statements

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:

- a) We have sought and obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purpose of our audit and have found them to be satisfactory.
- b) In our opinion, proper books of account as required by law have been kept by the Institute, so far as appears from our examination of those books.
- c) The Balance Sheet and Income and Expenditure Account and Receipts & Payments Account dealt with by this report, are in agreement with the books of accounts.

Place: Bangalore
Date: 09/09/2020

For B.R.V. GOUD & CO.,
Chartered Accountants
FIRN : 0009925

(A.B. Shiva Subramanyam)
Partner
Membership No: 201108
UDIN: 20201108AAAAFH6381

NATIONAL INSTITUTE OF ROCK MECHANICS
BANGALORE.

SCHEDULE-28

SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS FORMING PART OF BALANCE SHEET AND INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31ST MARCH 2020.

1. SIGNIFICANT ACCOUNTING POLICIES: -

Background:

NATIONAL INSTITUTE OF ROCK MECHANICS 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.

A. 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. 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.

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. 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.



G. 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".

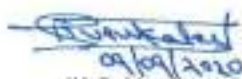
2. NOTES ON ACCOUNTS: -

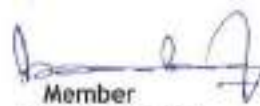
1. Capital Reserve represents value of assets transferred free of cost by BGML during 1988-89.
2. The land and building transferred during the year 1988-89 by BGML to the Institute is subject to receipt of direction from the Government of India. Registration of the transfer of land with sub-registrar 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.



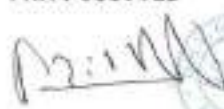
6. The accumulated interest earned on the Fixed deposits of Institute Development fund for Rs.34.84 lakhs transferred to corpus fund i.e. Institute Development Fund during the year 2019-20.
7. The Institute has filed audited accounts & relevant returns up to 31/03/2015 with District Registrar of Societies, 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.10,00,000/- 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 conform with the current year presentation.


(Uma.H.R)
Finance & Accounts Officer


(H.S. Venkatesh)
Director


Member
Governing Body

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


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

Place: Bangalore
Date: 09/09/2020

NATIONAL INSTITUTE OF ROCK MECHANICS

Bangalore

Consolidated Balance Sheet as at 31st March, 2020

(Amount in Rs.)				
Sl. No.	Particulars	Sch. No.	31.03.2020	31.03.2019
I	Sources of Funds			
	Capital Fund:	1		
	(a) Capital Reserve		32,44,334	32,44,334
	(b) Internal Capital Reserve		2,50,42,413	2,50,42,413
	Other Capital Fund:	2		
	(a) Deferred Government Grant		8,10,53,913	8,15,78,357
	(b) Institute's Development Fund		5,99,29,464	5,44,45,024
	Income and Expenditure Account	3	2,78,13,198	2,06,63,786
	Current liabilities and provisions:			
	(a) Sundry Creditors - Staff	4	4,37,804	5,78,425
	(b) Sundry Creditors - Others	5	1,79,43,189	1,03,80,462
	(c) Project Advance Received	6	31,47,00,646	25,14,61,636
	(d) Provisions	7	2,65,20,193	3,18,99,155
	TOTAL		55,67,05,154	48,12,93,792
II	Application of funds			
	Fixed Assets	8	7,58,87,568	7,79,17,098
	Investments	9	28,66,07,939	21,88,87,047
	Current Assets, Loans and Advances:			
	Deposits	10	5,35,628	5,35,628
	Loans and advances:			
	(a) Advances - Staff	11	21,34,233	9,90,106
	(b) Advances - Suppliers	12	92,26,233	78,59,233
	Other Current Assets	13	5,44,76,352	4,39,55,470
	Expenditure on Ongoing Projects	14	7,09,03,109	6,93,08,574
	Sundry Debtors	15	3,48,83,194	4,97,36,617
	Cash and bank balances	16	2,20,50,898	1,21,04,019
	TOTAL		55,67,05,154	48,12,93,792

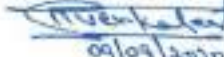
Note : Significant Accounting Policies and other notes to accounts

28

For NATIONAL INSTITUTE OF ROCK MECHANICS

As Per Our Report of even date,
For B.R.V Goud and Co.,
Chartered Accountants
FRN:0009925


(UWA FR)
Finance & Accounts Officer


(H S VENKATESH)
Director


Member
Governing Body


(A B Shiva Subramanyam)
Partner
M. NO. 201/08

Place: Bangalore
Date : 09/09/2020

NATIONAL INSTITUTE OF ROCK MECHANICS

Bangalore

Consolidated Income and Expenditure Account for the year ended 31st March, 2020

(Amount in Rs.)				
Sl. No.	Particulars	Sch. No.	2019-20	2018-19
A	Income			
	Grant-in-Aid received from Ministry of Mines	17	6,73,83,000	7,02,00,000
	Amount Received Against Completed Projects	18	13,77,72,356	13,95,63,405
	Government Grant - Deferred Income	19	5,24,644	5,24,644
	Interest Received	20	1,26,69,213	1,31,20,370
	Miscellaneous Income	21	1,49,922	16,36,942
	TOTAL (A)		21,84,99,135	22,50,45,361
B	Expenditure			
	Administrative Expenses	22	1,10,46,695	1,02,57,798
	Pay & Allowances	23	11,58,24,684	11,07,55,321
	Travel Expenditure	24	11,86,050	18,22,960
	Up Keep of Assets	25	7,49,367	9,49,470
	Expenditure on Completed Projects	26	5,59,90,189	4,10,47,567
	Depreciation on Fixed Assets	6	1,45,80,337	1,11,98,578
	Tax Expenses	27	84,67,961	1,81,50,239
	TOTAL (B)		20,78,45,283	19,41,81,933
C	Excess of Income over Expenditure for the year (A-B)		1,06,53,852	3,08,63,428

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.,

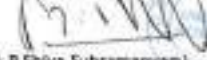
Chartered Accountants

FBN:0009925


(JUNA H R)
Finance & Accounts Officer


(H S VENKATESH)
Director


Member
Governing Body


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

Place: Bangalore
Date : 09/09/2020

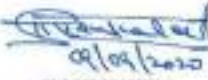
**NATIONAL INSTITUTE OF ROCK MECHANICS
BANGALORE**

Consolidated Receipts and Payments Account for the year ending on 31st March 2020

Receipts			(Amount in Rs)	
	Amount		Payments	Amount
To	Opening Balance		By	
	Cash		TDS on Fixed Deposits	85,468
	Bank	1,21,04,029	TDS on Project Receipts	1,71,89,679
			Payment of GST & Service Tax	3,24,57,929
			payment of income tax	35,32,133
			Purchase of fixed assets	1,40,65,940
	Grant - in - aid	6,73,60,600	Transfer to Fixed Deposits	18,38,67,440
	Licence Fee Received	1,431	Advances to Others	17,30,985
	Other Income Received	6,390	Advance to Staff	1,20,08,806
	Security Deposits/EMD received	0	Administrative Expenses	91,19,203
	Interest Received on Savings Bank Deposits	10,31,000	Salaries & Wages	11,63,96,824
	Interest Received on Term Deposits	55,97,536	Travelling Expenses	12,21,971
	Fixed Deposits Matured	11,61,45,548	Up Keep of Assets	10,28,313
	Advance Received - Sponsored Projects	24,94,15,564	Payment of terminal benefit act)	1,25,000
	Advance Received - Centre for Testing service	73,01,906	Project Contingency (b)	1,34,274
	Other Advances Received	2,32,139	staff welfare	3,01,939
	Income tax refund received with interest	29,86,786	Honorarium/ Incentive (Projects	2,38,89,158
	Input credit of GST received	13,16,785	Expenditure on Running SBT Projects	21,84,480
			Expenditure on Sponsored Projects	2,15,05,518
			Contingency - Centre for Testing Service	6,29,159
			Closing Balance	
			Cash	
			Bank	2,20,50,898
	Total	46,35,23,096	Total	46,35,23,096

For NATIONAL INSTITUTE OF ROCK MECHANICS


(UMA R R)
Finance & Accounts Officer


(H S VENKATESH)
Director

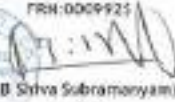

Member
Governing Body

As per report of even date

For B.R.V Gaud & Co

Chartered Accountant

FRN-0009925


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

Place: Bangalore
Date : 09-09-2020

**NATIONAL INSTITUTE OF ROCK MECHANICS
Bangalore**

CONSOLIDATED DEPRECIATION SCHEDULE FOR THE YEAR ENDING 31ST MARCH 2020

Annexure - 8

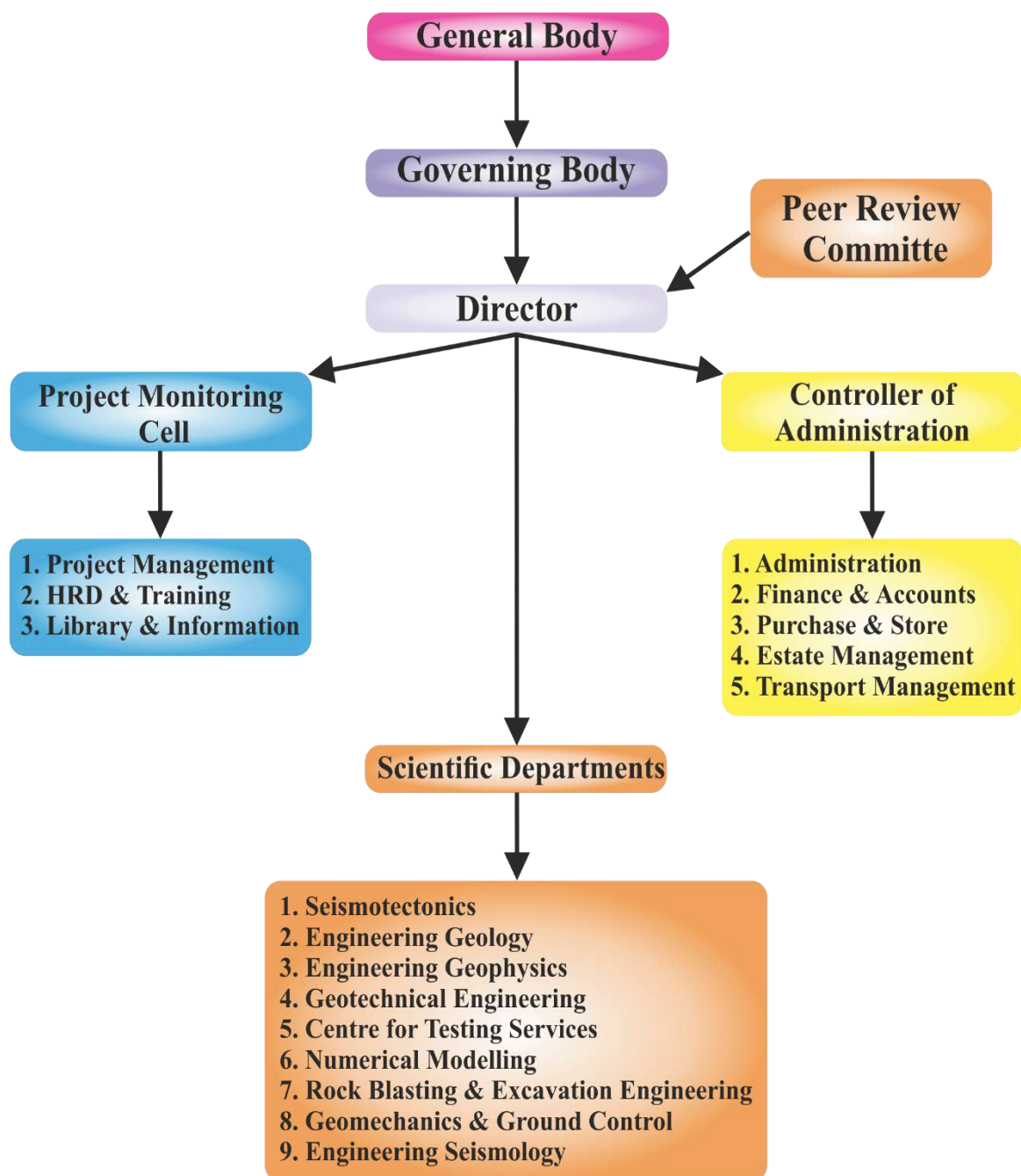
Name of the Assets	Rate of Depreciation %	Balance as on 01-04-2019	Purchase up to 30.03.2019	Perfection between 1.04.2019 to 30.03.2019	Open Book		Depreciation		Net Book	
					Purchase After 01.04.2019	Total as on 31.03.2020 (Col 5+6)	Depreciation for the year	Total Depreciation as on 31-03-2020 (Total of Col 8+9)	As on 31-03-2020 (Col 10)	As on 31-03-2019
1	2	3	4	5	6	7	8	9	10	11
Buildings	5	2,17,12,567				2,17,12,567	1,17,86,002	1,18,75,668	88,40,190	89,40,747
Plant & Machinery	7.5	5,32,42,824				5,32,42,824	3,15,45,754	3,15,45,754	100	100
Motor Supply	5	2,28,918				2,28,918	2,48,603	3,18,816	100	100
Power supply	5	5,83,416				5,83,416	5,51,314	3,03,114	100	100
Furniture	3	66,60,267				66,60,267	34,31,805	58,56,913	93,81,884	17,36,877
Office Equipment	5	38,17,147		8,58,266		46,75,413	21,48,546	33,86,162	34,41,136	16,87,576
Vehicle	7.5	7,83,815				7,83,815	7,81,275	7,83,715	100	100
Laboratory Equipment	7.5	8,52,42,795		55,58,525		9,08,01,320	1,47,50,456	4,17,51,096	5,53,12,782	8,89,46,871
Technical Books	5	44,82,817				44,82,817	39,00,590	46,11,191	5,96,456	6,95,111
Computer Software	15	2,07,03,113				2,07,03,113	1,17,37,084	2,86,52,688	35,56,827	51,72,647
Computer Hardware	25	3,83,25,897				3,83,25,897	1,08,39,357	1,38,40,099	5,89,187	12,34,820
Commission of Power Bus	5	17,39,492				17,39,492	16,00,130	56,54,320	1,08,786	1,95,179
Low Cost Facilities	7.5	21,13,425				21,13,425	15,76,873	24,636	380	34,726
PROBCT										
Vehicle	7.5	45,81,581				45,81,581	9,47,753	12,87,345	39,45,906	15,63,766
Total		21,87,14,248		68,18,811		22,55,33,059	13,17,17,190	1,40,60,157	1,38,87,588	2,79,17,098
Assets and Liabilities		17,62,18,258		20,41,324		21,87,14,248	13,16,35,772	1,11,98,518	1,11,27,283	2,29,17,099
Note: 1. There are no assets charged on Straight Line method.										
2. Depreciation has been charged on Straight Line method.										



ANNEXURE

(1-8)

ANNEXURE-1

Organisation Chart of NIRM

ANNEXURE-2

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, 3 rd 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 Adviser Ministry of Mines, 3 rd Floor, A Wing, Room No.321, Shastri Bhavan, Dr.Rajendra Prasad Road, New Delhi-110 001	Director (Operations) The Singareni Collieries Company Ltd. (SCCL), Kothagudem Collieries , Khammam Dist, Telangana –507 101
Joint Secretary / Economic Adviser (In-charge of NIRM) Ministry of Mines, Room No: 308 - 'A' – Wing 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 (DG) Geological Survey of India (GSI), No.27, Jawaharlal Nehru Road, Kolkata-700 016, West Bengal	Prof. V R Sastry (<i>till 31.12.2019</i>) Department of Mining Engineering, National Institute of Technology Karnataka (NITK), Surathkal. Srinivasnagar -575 025, Karnataka
Controller General (CG) Indian Bureau of Mines (IBM), 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 Tamilnadu
Director General (DG) Directorate General of Mines Safety (DGMS), Hirapur, Dhanbad-826 001 Jharkhand	Director, National Institute of Rock Mechanics (NIRM), Outer Ring Road, Eshwar Nagar, Banashankari 2 nd Stage, Bengaluru-560 070, Karnataka
Director, Central Institute of Mining & Fuel Research (CIMFR), Barwa Road, Dhanbad-826 015, Jharkhand	Dr. P C Nawani (<i>from 01.01.2020 onwards</i>) Ex-Director, NIRM G-202, JMD Gardens, Sohna Road, Sector-33, Gurgaon- 122018, Haryana

ANNEXURE-3

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.	
Members	
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 (CWC), Room No.401 (S), Sewa Bhavan, R.K.Puram, New Delhi-110 066
Joint Secretary & Financial Adviser Ministry of Mines, 3rd Floor, A Wing, Room No.321, Shastri Bhavan, Dr.Rajendra Prasad Road, New Delhi-110 001	Advisor (Projects) Ministry of Coal, 3rd Floor, A Wing, Shastri Bhavan, Dr.Rajendraprasad Road, New Delhi-110 001
Joint Secretary / Economic Adviser (In-charge NIRM), Ministry of Mines, Shastri Bhavan, Dr.Rajendra Prasad Road, New Delhi-110 001	Director (Operations) The Singareni Collieries Company Ltd. (SCCL), Kothagudem Collieries , Khammam Dist- 507 101, Telangana
Director General (DG) 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 (CG) Indian Bureau of Mines (IBM), 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. Tamilnadu
Director General Directorate General of Mines Safety (DGMS), Hirapur, Dhanbad-826 001 Jharkhand	Prof. V R Sastry, <i>(till 31.12.2019)</i> Department of Mining Engineering, National Institute of Technology Karnataka, Surathkal Srinivasnagar-575 025 Karnataka
Director Central Institute of Mining & Fuel Research (CIMFR), Barwa Road, Dhanbad-826 015 Jharkhand	Director National Institute of Rock Mechanics (NIRM), Outer Ring Road, Eshwar Nagar, Banashankari 2 nd Stage, Bengaluru-560 070, Karnataka
Director Indian Institute of Technology (ISM), Dhanbad-826 003. Jharkhand	Dr. P C Nawani <i>(from 01.01.2020 onwards)</i> Ex-Director, NIRM G-202, JMD Gardens, Sohna Road, Sector-33, Gurgaon- 122018, Haryana

ANNEXURE-4

PEER REVIEW COMMITTEE	
Chairman	
Prof. Bharat B Dhar Former Director, CIMFR; Director (Research), AIU Director (R&IC), Amity University; Advisor, HESRT&SD New Delhi – 110 048	
Alternate Chairman	
<i>Alternate Chairman / member till 31st December 2019</i>	<i>Member till 31st December 2019 & Alternate Chairman & member from January 2020 onwards</i>
Prof. V R Sastry, Department of Mining Engineering, National Institute of Technology Karnataka, Surathkal Srinivasnagar-575 025 Karnataka	Shri. A. Sundaramoorthy, Director General (Retd), GSI No.44, VV Nagar, 6th Street, Kolathur (PO), Chennai-600 099 Tamilnadu
Members	
Dy. Director General Directorate General of Mines Safety, South Zone, Koramangala, Bengaluru-560 034, Karnataka	Mr. J. K. Singh, Chief Scientist & Head slope stability research group, Central Institute of Mining & Fuel Research (CIMFR) Dhanbad – 826 015, Jharkhand.
Director (Projects & Planning) The Singareni collieries Co Ltd., Kothagudem Collieries, Khammam Dist, Telangana–507 101. (till 31st Dec 2019)	Prof. T. G. Sitharam, Department of Civil Engineering Indian Institute of Science, Bengaluru-560 001, Karnataka (till 31st Dec 2019)
Prof. VMSR Murthy, Professor, Department of Mining Engineering, IIT (ISM), Dhanbad-826 004, Jharkhand	Sri Syed Abdul Fateh Khalid Executive Director (Mines) Neyveli Lignite Corporation Ltd, Mine 1 & 1A, Administrative Office, Block 26, Neyveli-607 803, Tamilnadu (till 31st Dec 2019)
Prof. N. R. Thote, Professor, Mining Eng dept, Visvesvaraya National Institute of Technology, Nagpur – 440 010 Maharashtra	Director National Institute of Rock Mechanics, Banashankari 2nd Stage, Bengaluru-560 070, Karnataka
General Manager (R&D), The Singareni collieries Co Ltd., Kothagudem Collieries Bhadradi Kothagudem Dist- 507 101, Telangana (from 1st Jan 2020 onwards)	Mr. S Ravi Secretary National Institute of Rock Mechanics Banashankari 2nd Stage, Bengaluru-560 070, Karnataka
Mr. T. K. Sivarajan CE, (Designs (N&W)), Central Water Commission, 8th Floor, Seva Bhavan, RK Puram, New Delhi-110 066	

ANNEXURE-5

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-6

LIST OF COMPLETED PROJECTS

Sl. No	Project No	Title
1	ND-15-08-C	Stability test of Heavy Earth Moving Equipment and Proof Load test & NDT test of Cranes at BIOM, Bachel Complex
2	ND-15-09-C	NDT of 11 winders and suspension gear parts at HGML, Raichur
3	ND-16-08-C	NDT on vital components of south ventilation shaft, Rampura Agucha Mines, HZL
4	ND-18-01A-C	NDT on vital components of winders at RD mines, HZL
5	ND-18-1B-C	In-situ non-destructive test on winders vital components, suspension gear parts and wire ropes at Zawar group of mines
6	ND-18-1C-C	In-Situ non-destructive testing of winch vital components, bogie attachments and wire ropes
7	ND-18-04-C	NDT on Cable belt drive wire ropes at NALCO, Damanjodi Odisha, visit 2 of 6
8	ND-18-05-C	NDT on vital parts of the winders, suspension gear parts and wire ropes at Khetri & Kolihan Mines.
9	ND-19-01-C	NDT on vital components of winders at RD Mines, HZL
10	RF-18-02-C	Laboratory geo-technical investigations on well bore rock core samples from Gamij Field, Khubal Field, Sri Field & Linch Field of CEWELL), ONGC
11	RF-19-01-C	Testing Granite Samples from Archean Industries Private Limited, West Bengal
12	EG-15-04-C	Engineering geological investigations of the cave area of Shri Mata Vaishno Devi Ji, Reasi District of Jammu and Kashmir
13	EG-17-04-C	Engineering geological foundation mapping of surge pool, transformer cavern and pump house cavities and geological investigations for draft tubes, bus duct, deliver main shafts and ventilation shafts of Kaleshwarm Lift irrigation project Package-12, Siddi
14	EG-17-05-C	Engineering Geological Foundation mapping of surge pool and pump house cavities and geological investigations for deliver main shafts (Horizontal & Vertical) and Ventilation shafts of Kaleshwaram LIS-p11
15	EG-18-03-C	Engineering geological investigations of pump house complex area of J.Chokka Rao Devadula Lift Irrigation Scheme (JCR - KLIS)/J.Chokka Rao Godavari Lift Irrigation Scheme (JCR - GLIS) phase - III, package - III, Warangal District, Telangana
16	GP-18-03-C	Geophysical Survey for mapping Sub Surface Strata for rock mass classification - Phase II
17	GP-18-05-C	Geophysical survey to ascertain the risk of possibility of subsidence of 10 CL pipe line form (Ch 257.700 to 258.450) & 244.800 to 245.800
18	GP-18-06-C	Geophysical investigation for mapping hard rock profile at the site of Karle Exports in Yeshwanthpur, Bangalore
19	GE-18-01-C	Determination of In-situ Stress tensor at the proposed underground pump house drift of Devsari H.E.P.

20	GE-18-02-C	Determination of In-situ shear parameters at the proposed water dam locations at Chasnalla Underground mine, Jharkhand
21	GE-18-03-C	Determination of In-situ Stress regimes at the Downstream Surge Gallery, PHEP-II
22	GE-18-04-C	Determination of In-situ stress tensor at the proposed underground pump house of PRLIS, Pkg.1
23	GE-18-06-C	Determination of In-situ stress tensor at the proposed underground pump house of JCRDLIS, Phase-III, Telangana
24	MS-17-01-C	Stability monitoring of power hose cavern of Tala hydro power plant using microseismics
25	NM-17-03-C	Deformation monitoring of U/G powerhouse cavern of Sardar Sarovar project
26	NM-17-17-C	Geological study and assessment of suitable measures for the safety and stability of the Belum caves, Kolimigundla Mandal, Kurnool, Dist. Andhra Pradesh
27	NM-18-01-C	Analysis of Instrumentation data of Desilting Chamber, power house complex, surge shaft, TRT outfall area and Dam at NJHPS.
28	NM-18-05-C	Third Party review of Numerical Analysis of Main Tunnel for Larsen & Toubro Ltd.
29	NM-18-06-C	Analysis of Instrumentation data of Powerhouse Complex and Desilting Chamber (April 1 2018 to March 31, 2019) at Tala Hydroelectric Project, Bhutan
30	NM-18-08-C	Failure Analysis of CP-03A Stope and Evaluation of Extraction Sequence of Different Stopes in C-Block at Sindesar Khurd Mines, HZL, Rajasthan
31	NM-18-07-C	Rerun of 3D Numerical Analysis of Tehri Pumped Storage Scheme with change in geotechnical parameters
32	NM-18-10-C	3D Numerical Modelling of Shafts for Pumphouse and Surge Pool of J. Chokka Rao Devadula Lift Irrigation Scheme (JCRDLIS), Package-III, Telangana
33	NM-19-02-C	Scientific studies for Bicharpur coal mine to finalise the pillar size to achieve ZERO subsidence using by NEW method.
34	RB-18-01-C	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
35	RB-18-05-C	To ascertain the feasibility of blasting for mining operations around Kumaraswamy Temple, Hospet, Department of Mines and Geology, Karnataka
36	RB-18-06-C	Monitoring of blast induced vibration at two identified locations (Phase-III), Darlipalli Super Thermal Power Project (DSTPP), Stage-I (2×800 MW), NTPC Limited, Odisha - Extension-IV
37	RB-18-07-C	Review and endorsement of blast design patterns for excavation of underground man tunnel structures, LDP Project, Vizag, Andhra Pradesh
38	RB-18-11-C	Phase II 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.

39	RB-18-14-C	Monitoring of Ground vibration and air overpressure to blasting carried out for construction of unit 5 and 6 at Kundankulam Nuclear Power Plant, Kundankulam SRC Projects Private Limited, Tamil Nadu
40	RB-18-15-C	Monitoring of blast induced vibration at two identified locations (Phase-III, Darlipalli super thermal power project (DSTPP), Stage-1 (2 x 800), NTPC Ltd. Odisha, Extension-V
41	RB-19-02-C	To ascertain the feasibility of mining by blasting at the proposed Nayanapalli Limestone mine and its probable impact of ground vibration on Belum Caves, Kolimigundla Mandal, Kurnool, Andhra Pradesh
42	RB-19-03-C	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.
43	RB-19-05-C	Phase II-Extn 1-Monitoring of Ground vibration and air overpressure to blasting carried out for construction of unit 5 and 6 at Kundankulam Nuclear Power Plant, Kundankulam SRC Projects Private Limited, Tamil Nadu
44	SS-18-01-C	Scientific studies for final dump slope stability with suitable Bench Parameters for Narrain Iron Mine ,Chitradurga, Karnataka
45	SS-18-02-C	Scientific Study on stability of South Side (in-corp) high wall benches at MOCP, RG - I Area of SCCL, Peddapalli District, Telangana State
46	GC-18-02-C	Design and stability evaluation of proposed deepening of mine workings (from -47 to -66) including the surface dumps stability at Redi iron ore mine of Gogte Minerals. Sindhudurg District, Maharashtra
47	GC-19-01-C	Scientific Study for design of ultimate pit slope and recommendation for stability of pit benches of Dharmapura, Iron Ore Mine, Karnataka
48	GC-18-03-C	Strata Control and Monitoring Plan (SCAMP) for Kurja Mine, HASDEO Area, SECL.
49	GC-18-04-C	Strata Control and Monitoring Plan (SCAMP) for Rajnagar R.O Mine, HASDEO Area, SECL
50	GC-18-05-C	Scientific Studies for the optimization of bench parameters and recommendation for the final pit slope stability of a S M Block iron ore mine M/s. M. Hanumantha Rao at Narayanpur village, Sandur taluk, Bellary district, Karnataka
51	GC-18-06-C	Geological mapping at multiple levels in different segments between 14th level to 4th level of the mine for determining geotechnical parameters to evaluate the feasibility of HW lode mining of TMPL Mine, UCIL, AP

ANNEXURE-7

LIST OF PUBLICATION

1. A.K. Naithani, D.S. Rawat, P. Jain, L.G. Singh, M. Srisailam and V. Venkatramaiah (2019): Rock mass characterization and support system for underground pump house cavern – a case study, India, In Proceedings 14th International Conference on Underground Construction Prague 2019, paper no. S4-OP7, pp 1-9.
2. L.G. Singh, A.K. Naithani, P. Jain and D.S. Rawat (2019): State-of-the-art investigation methods for underground pump house complex site – a case study, India. In Proceedings 14th International Conference on Underground Construction Prague 2019, paper no. S4-PP6, pp 1-8.
3. A.K. Naithani (2019): Rock mass classification and support design using Q-system. Journal Geological Society of India, vol. 94 (4), pp 443-443, DOI: 10.1007/s12594-019-1336-0.
4. D.S. Rawat, A.K. Naithani, L. G. Singh, Prasanna Jain, R.N.S. Babu, Padmaja Reddy K.Ravindra Nath and G. Srinivasa Rao (2019): Excavation of Large Underground Surge Pool Benching and Delivery Mains (Vertical Shafts) with the Alimak Raise Climber Method - A Case Study. Tunnelling Association of India (TAI) Journal, Vol. 8, No. 2, pp 21 – 28.
5. Vikalp Kumar, N. Gopalakrishnan N. P. Singh and Sivakumar Cherukuri (2019): Microseismic monitoring application for primary stability evaluation of the powerhouse of the Tapovan Vishnugad Hydropower Project. Journal of Earth System Science: <https://doi.org/10.1007/s12040-019-1191-9>
6. Vikalp Kumar, Sivakumar Cherukuri and Singh N. P; 2019, Stability analysis of the underground powerhouse in the Himalayan region using microseismic monitoring, Journal of Rock Mechanics and Tunnelling Technology, 25(2), 113-124, ISSN 0971-9059
7. Vikram S, D. Kumar, DS Subrahmanyam, (2019): Impact and Severity of Deep Excavations on Stress Tensors in Mining, Journal of Mining Science, ISSN- 1573-8736, Vol 55, Issue 2, March 2019.
8. DS Subrahmanyam, (2019): Evaluation of Hydraulic fracturing and overcoring methods to determine and compare the in-situ stress parameters in porous rockmass, International Journal Geotechnical and Geological Engineering, ISSN 0960-3182, DOI 10.1007/s10706-019-00937-7, May 2019.
9. DS Subrahmanyam, G Shyam, K Vamshidhar, S Vikram, B Sudhakar, (2019): Influence of in-situ stress parameters for the design of underground pumphouse at various lift irrigation packages of Kaleshwaram Project, Dr. BR Ambedkar Pranahita Chevella Sujala Sravanthi Scheme, Telangana, INDOROCK 2019 8th Indian Rock Conference 4th – 5th November 2019.
10. A Rajan Babu, T Amrith Renaldy, S S Meena, S Kumar Reddy, Bharath Kumar A.Y. (2019): Feasibility of Extraction of Locked Up Ore in the Opencast Benches by Innovative Methods. National Symposium on Mining organised by TNMSA & MEAI TN during 05th & 6th July, 2019.
11. S Kumar Reddy, T Amrith Renaldy, S S Meena, Bharath Kumar A.Y, A Rajan Babu, (2019): Slope Stability Study of Limestone Mine. National Symposium on Mining organised by TNMSA & MEAI TN during 05th & 6th July, 2019.
12. T Amrith Renaldy, Bharath Kumar A.Y., S S Meena, S K Reddy, A Rajan Babu. (2019): Design and stability evaluation of proposed deepening of mine workings including the

- surface dumps stability at iron ore mine. 8th Asian Mining Congress, Nov, 2019 at Kolkata.
13. Bharath Kumar A.Y., G D Raju, A Rajan Babu. (2019): Design and stability assessment of steep slope geometry and ups of an iron ore mine. 8th Asian Mining Congress, Nov, 2019 at Kolkata.
 14. Sripad R Naik, Aditya Mishra, Aman Soni and H S Venkatesh, (2019): Effect of excavation of drives with blasting in paste-filled stopes on the mined-out zone, Rock Dynamic Summit, a Specialized International Conference of ISRM, 7th 11th May 2019, Okinawa, Japan.
 15. Rabi Bhusan, Sripad R Naik, Ravindra Kumar, Sagar B Falke, Gireesh R Valagerehalli, (2019): In-situ blocks and yield dimension stone block size distributions assessment by using 3DEC, ISRM 14th International Congress of Rock Mechanics, 13-18 September 2019, Foz do Iguassu, Brazil.
 16. Sudhakar K and Sripad R Naik, (2019): Long-term stability monitoring of underground cavern using geotechnical instrumentation - A case study, ISRM 14th International Congress of Rock Mechanics, 13th -18th September 2019, Foz do Iguassu, Brazil.
 17. B H Vijay Sekar, Praveena Das J and Sripad R Naik, (2019): A Comparative study of different Numerical Modelling Tools used for stability studies in underground mines, 8th Asian Mining Congress, 6th -9th November 2019, Kolkata, India, pp 311-316.
 18. Rabi Bhusan, (2019): Geological and Geotechnical study for pit slope stability at Basantnagar Limestone Mine of Ramagundam Andhra Pradesh, 8th Asian Mining Congress, 6th -9th November 2019, MGMI, Kolkata, India pp 367-372.
 19. Sripad R Naik, Roshan Nair and Sudhakar Kadiyala, (2020): 3D stability analysis of left and right abutment cut slopes of a hydroelectric project in Himalaya, 5th International Itasca Symposium on Applied Numerical Modeling in Geomechanics-2020, 17th – 21st February 2020, Vienna, Austria.
 20. Rabi Bhusan, Sripad R Naik and B H Vijay Sekar, (2020): Support assessment and 3D stress analysis of large underground excavations: A case study using 3DEC, 5th International Itasca Symposium on Applied Numerical Modelling in Geomechanics-2020, 17th -21st February 2020, Vienna, Austria.
 21. Vijay Sekar B H, Sripad R Naik and Rabi Bhusan, (2020): Design of support system for surge shaft and powerhouse complex using FLAC3D, 5th International Itasca Symposium on Applied Numerical Modeling in Geomechanics-2020, 17th -21st February 2020, Vienna, Austria.
 22. Sivaprasad B N V, Sripad R Naik, Vijay Sekar B H and R Bhusan, (2020): Determination of stoping methodology for mining secondary stopes by FLAC3D, 5th International Itasca Symposium on Applied Numerical Modelling in Geomechanics-2020, 17th -21st February 2020, Vienna, Austria.
 23. Rabi Bhusan, B H Vijay Sekar, K Sudhakar, B N V Siva Prasad and Sripad R Naik, (2020): Stability analysis and optimisation of pit slope for an open cast iron ore mine: A case study, Seminar Recent Practices and Advancement in Mineral Industry (RPAMI), 21st-22nd February 2020, VNIET, Nagpur.
 24. Praveena Das Jennifer, Balasubramaniam V R, Goverdhan K and P Porchelvan, (2020): Assessment and Mitigation of Mining Induced Seismic Hazard in mined out areas with systematic monitoring, International Conference on Disaster Mitigation and Management in Global Context, The Institute of Engineers (India), Odisha State Centre, 7th -8th March 2020, Bhubaneswar.

25. Naveen G C, Balachander R, Gopinath G and H S Venkatesh, (2020):Tunnelling under highly jointed rock mass, 46th Annual Conference on Explosives & Blasting Technique, Denver, Colorado, USA, January 26th to 29th, 2020
26. G. Gopinath, R. Balachander and H. S. Venkatesh, (2019): Impact of Ground Vibrations due to Blasting in Adjacent Mines on an Ancient Temple, 8th Asian Mining Congress scheduled from 6th to 9th November 2019 at Kolkata, India
27. Yogendra Singh, Biju John, and Sivakumar, C 2019. Characterization of a Potential Seismic Source: A field-based study from Peninsular India. EGU, Session TS5.4/NH4.18/SM2.10. EGU2019-2848.
28. Yogendra Singh, Biju John and KS Divyalakshmi (2020): Suspected signature of active tectonism in Palghat Gap, India. Geomorphometry 2020, Perugia, Italy. doi:10.30437/GEOMORPHOMETRY2020_42.
29. K S Divyalakshmi, Yogendra Singh and Biju John (2020): Tectonic Geomorphology of West Bengaluru by analysing the Chick Tore river basin, Karnataka, India, Using ASTER DEM. Geomorphometry 2020, Perugia, Italy. doi:10.30437/GEOMORPHOMETRY2020_36.
30. Biju John, K S Divyalakshmi, Yogendra Singh, SG Dhanil Dev (2020): Response of alluvial river to active faulting example form Peninsular India: Geomorphometry 2020, Perugia, Italy. doi:10.30437/GEOMORPHOMETRY2020_63.
31. C P Rajendran , Singh T, Mukul, M., Thakkar ,M., Kothyari , GC., Biju John and K Rajendran (2020): Paleoseismological Studies in India (2016-2020): Status and Prospects Proc Indian Natn Sci Acad 86 No. 1,March 2020 pp 585-607.

ANNEXURE-8

NIRM STAFF

(as on 31.03.2020)

Director: **Dr H S Venkatesh**

Project Monitoring Cell

Dr Sripad R Naik (O-IC)
Mr Sultan Singh Meena (Sci-IC)

Seismotectonics

Dr Biju John
Dr K S Divyalakshmi
Dr Yogendra Singh

Engineering Geology

Dr A K Naithani
Dr Devendra Singh Rawat
Dr L Gopeshwor Singh
Dr Prasanna Jain

Engineering Geophysics

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

Geotechnical Engineering

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

Centre for Testing Services

Mr A Rajan Babu
Mr S Udaya Kumar
Mr J Raja
Mr Royston Angelo Victor
Mr D Prashanth Kumar
Mr R Prabhu
Mr S Babu

Numerical Modelling

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

Rock Blasting & Excavation Engineering

Dr H S Venkatesh
Mr G Gopinath
Mr G C Naveen
Mr R Balachander

Geomechanics & Ground Control

Mr A Rajan Babu
Mr T Amrith Renaldy
Mr Sultan Singh Meena
Mr Bharath Kumar A Y

Engineering Seismology

Dr V R Balasubramaniam
Mr Vikalp Kumar

Administration

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

Retired

Mr Sivakumar Cherukuri

Resigned

Dr Sandi Kumar Reddy



Vienna, Austria



Prague, Czech Republic



Vienna, Austria



Helsinki, Finland



Colorado, USA



Foz do Iguaçu, Brazil



Research presentation made by NIRM scientists across the globe in International conferences at Austria, Czech Republic, USA, Finland and Brazil

OTHER ACTIVITIES AT NIRM (2019-2020)



Hindi Pakhwada Celebration



Yoga Day Activities at RO and HO



Baba Saheb Ambedkar Jayanti



Invited Talk During Womens Day Celebrations



Swachh Action Plan



Swachh Bharat Mission



Independence Day Celebrations At HO and RO



Republic Day Celebrations At HO and RO



