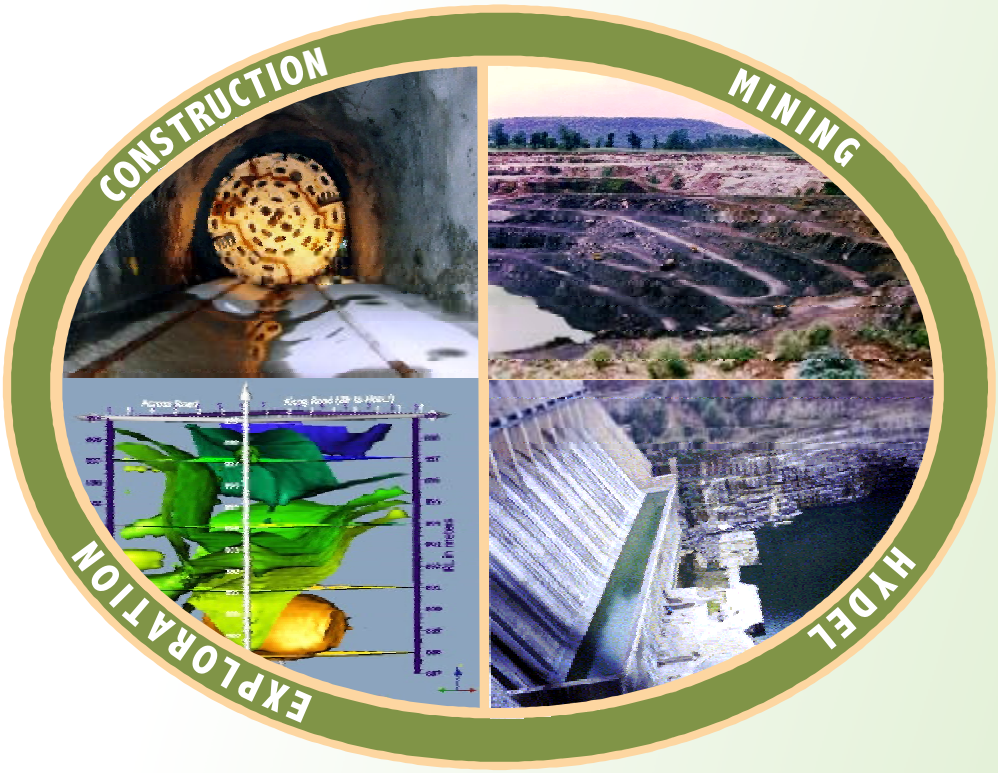
National Institute of Rock Mechanics

(A Premier Centre of Research & Consultancy Services in Rock Mechanics)

N I R M



NIRM

Ministry of Mines
Government of India

http://www.nirm.in

Dedicated to providing environment-friendly solutions for all construction projects !

National Institute of Rock Mechanics

The National Institute of Rock Mechanics (NIRM) is a premier centre for research in applied and basic rock mechanics. It was set up as an autonomous research institute under the Ministry of Mines, Government of India in 1988. The mandate of NIRM is to provide enabling technology to mining, civil engineering sectors and construction industries, both in India and abroad, to achieve improved production, productivity and quality, with enhanced safety and economy. At present, NIRM has strength of 80 (including 56 scientists) which is proposed to be enhanced to 200 over a period of next five years.

The high quality services provided by NIRM have found wide acceptance with the industry. With modern equipment and a coherent team of experienced and dedicated Scientists, NIRM combines research activities and consulting services to provide solutions for a wide range of rock engineering problems. Key to its success lies in growth through innovation and teamwork, by which NIRM is able to beat some of the technical challenges referred by the industry.

The quality policy and objectives of the Institute meet the International Standards and is certified for ISO 9001:2000 standard. No doubt, NIRM is the sole Institution of its kind in south Asia.

The Institute provides its services in the following broad areas :

- Scientific design of mine workings for improved safety, conservation & productivity
- Design of rock excavations and support systems
- Site characterisation practices for foundation evaluation
- Mitigating the environmental impacts in rock excavation engineering, and to undertake EIA and EMP of mega projects
- Monitoring and analysing the rock mass behaviour around excavations for evaluating the safety and stability of the structure
- Specialised testing for rocks and dimensional stones as per ISRM standard

The Institute has a vision to become a self-supporting Centre of International Standing by 2020.

Areas of Specialisation:

With the rich experience of trained scientific personnel and the state-of-the-art equipment, the Institute offers its services in the following areas of specialisation :

- Engineering Geology
- Engineering Geophysics
- Geotechnical Engineering
- Rock Fracture Mechanics & Materials Testing
- Engineering Seismology
- Numerical Modelling
- Rock Blasting and Excavation Engineering
- Mine Design and Ground Control
- Microseismics & Automation
- Environmental Engineering
- Dimensional Stone Technology

These ELEVEN scientific departments form an intricate web to provide single window solution for all types of DPR related investigations for hydel and allied sectors. This is the uniqueness of the Institute to have entire spectrum of rock engineering investigations under one umbrella.

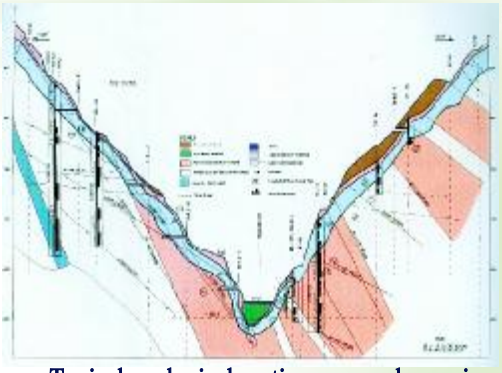
Apart from industry sponsored projects, the Institute takes up research projects (S&T) on development/ field trial of new experimental techniques, and in-house projects in prime research areas. CSIR, AICTE and a number of universities have acknowledged NIRM as a national laboratory for carrying out higher studies in the area of rock mechanics.

As such, the Institute organises training courses in rock mechanics/ engineering and offers research facilities for postgraduate, doctoral and post-doctoral work.

All types of technical / project related matters and liaison with the sponsoring agencies as well as projects monitoring are handled by the Technical Services Department.

ENGINEERING GEOLOGY

Geological and geotechnical inputs are pre-requisite for economic and safe designing of all civil construction projects related to power sector (hydel, thermal or nuclear), communication sector (metros, rails, tunnels, roads, bridges) and mining sector as well as for geohazard assessment and mitigation. This department caters to this need of the construction industry and undertakes works related to detailed geological investigations in various stages of project development, i.e., feasibility report, detailed project report, construction and post-construction stages. With its expertise in engineering geology, remote sensing and micro-earthquake studies, this department offers its services in the following areas :

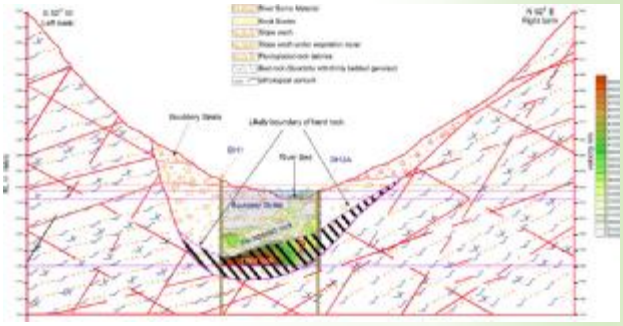


Typical geological section across dam axis

- Compilation and analysis of geological and tectonic map of the area
- Active fault mapping, seismotectonic evaluation
- Detailed geological mapping on 1:500 to 1:100 scale
- Drill-core logging and 3-D mapping (on 1:100 scale) of exploratory drifts
- Engineering geological modelling for designing
- Investigation for construction material, mass wasting activity & hazard zonation
- Foundation evaluation and mapping (on 1:200/1:500 scale) for delineation of fault, shear & weak zones
- 3-D mapping of tunnels, shafts, penstocks/ pressure shafts, and other U/G structures (on 1:200 scale)
- Rock mass assessment and suggesting suitable support system
- Stability analysis of cut slopes and surface excavations
- Time-lapse monitoring of terrain changes and reservoir rim stability studies
- Micro-earthquake investigations (long-term & short-term) for regional stability and seismotectonic studies.

ENGINEERING GEOPHYSICS

This department is actively engaged in carrying out high-resolution shallow subsurface exploration for site characterisation studies. The Institute has state-of-the-art Ground Penetrating Radar (GPR) for high resolution imaging up to ±3mm, multi-channel refraction seismographs and multi-channel resistivity survey/ imaging tool for mapping the subsurface. Besides, it has borehole mapping tools including borehole GPR profiling, 2D and 3D tomographic imaging using GPR and seismic source. The Institute offers services in the following areas of geophysical investigations:

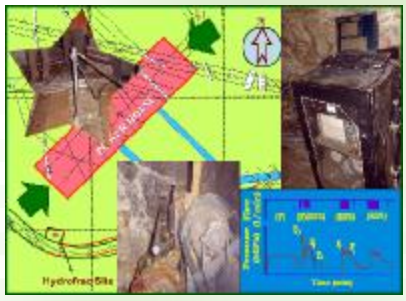


P-wave tomogram at dam axis across Teesta river

- Site characterisation for major subsurface structures
- Location of hidden cavities, fractured & weak zones
- Mapping old water-logged workings in coal mines
- Foundation evaluation for pillars, dams, bridges, pumps, etc.
- Bedrock profiling using seismic refraction survey
- Determining in-situ dynamic shear modulus of strata with seismic survey
- Imaging for fracture and shear zones using electrical resistivity survey
- Cross-hole tomography for strata strength and quality
- In-hole profiling & cross-hole imaging using GPR

GEOTECHNICAL ENGINEERING

Geotechnical investigations are integral to all underground excavation projects – be it civil or mining. All these projects require in-situ geotechnical investigations prior to design. With the increase in size and complexity of rock structures, in-situ geotechnical investigations are gaining importance. The department is a pioneer in different in-situ investigations for different projects which include mining, hydroelectric and underground facilities in India and abroad. For the last 18 years, this department has completed over 100 projects in the field of dam foundation, underground powerhouse, underground storage cavern, mining and slope stability. Thus it has created a *niche* among various government, private and international agencies. Major areas of investigations carried out in this field include:



In-situ stress measurement in progress

- Determination of in-situ stress tensors by hydrofrac method upto a depth of 300 m
- Determination of in-situ deformability parameters of rock mass by plate loading and Goodmanjack methods.
- Determination of in-situ shear parameters of discontinuities/ rock mass by direct shear method
- Determination of in-situ permeability/groutability and transmissivity of rock mass by double packer method
- Borehole logging by acoustic borehole televiewer

ROCK FRACTURE MECHANICS & MATERIAL TESTING

This department is equipped with the most modern laboratory facilities to carry out basic research on rock fracture mechanics and determining the engineering properties of rocks and dimension stones as per the national & international standards. It is engaged in some of the frontier areas of research like thermo-mechanical behavior of rocks and developed expertise in the application of acoustic emission. Materials testing laboratory is recognized by DGMS, Dhanbad to carry out tests on mining machinery parts. Major areas of expertise are:

Shear testing machine

- Research on fracture mechanics of rocks including, thermo-mechanical behaviour of rocks, micro & macro crack growth by acoustic emission, fracture toughness as per ISRM method (level I & II) and deformation studies under elevated temperature
- Physico-mechanical properties of rocks
- Multiple failure triaxial compression test
- Post failure studies under uniaxial & triaxial stress conditions
- Characterization of rock joints
- Properties of dimensional stones as per ASTM, european, IS, BS standards
- Testing of mining & machinery parts like wire rope, chains, carpel, pins etc.
- In-situ Non-Destructive Testing (NDT) of wire rope using defectograph
- NDT using dye penetration, magnetic particle & ultrasonic (laboratory & In-situ)

ENGINEERING SEISMOLOGY

Engineering Seismology department has over 30 years of experience in monitoring of mining-induced seismic events (rockbursts). At present, this department is engaged in regional stability studies of southern shield using micro-earthquake network. A strong-motion-seismograph and a broadband seismic station has been set-up at KGF as a part of regional seismic network. This also records rockbursts occurring at KGF following inundation of closed mines. With a rich experience at its disposal, this department provides its services in the following areas :

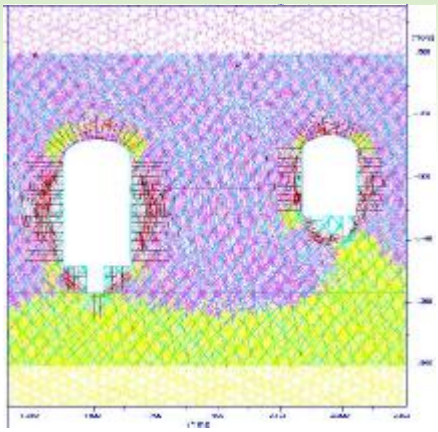
Nanometrics digital seisomgraph installed for rockburst monitoring

- Monitor seismicity in hard rock mines and assess their stability
- Seismic hazard assessment in mines
- Establishing broad-band seismic system for regional seismicity
- Strong motion study for attenuation characterisitics
- Measurement of ambient (seismic) noise levels for site characterisation

NUMERICAL MODELLING

Numerical modelling is one of the major tools for design of excavations in rock. This department has experienced civil and mining engineers with expertise in providing solutions to varied problems related to excavations in rock. Anticipated rock mass behaviour around an excavation can be reliably predicted using the latest FEM and BEM numerical modelling codes (discrete and continuum element methods) available at the Institute. This department offers solutions in the following areas :

- Analysis and design of tunnels, caverns and large underground multiple excavations
- Rock liner interaction analysis for pressure shafts
- Design of supports (rock bolts and SFRS)
- Coupled thermo-hydro-mechanical analysis of the rock mass
- Dynamic analysis including seismic and liquefaction behaviour
- Stability analysis of earth dams and slopes
- Instrumentation for strata and support system monitoring
- Dam Instrumentation



Model of principal stress distribution

ROCK BLASTING & EXCAVATION ENGINEERING

The Department of Rock Blasting & Excavation Engineering is equipped with latest instruments capable of providing innovative solutions to challenging problems in blasting for various mining and civil engineering projects. The department has the latest instruments including seismographs, VOD measuring systems, laser based survey systems, fragmentation assessment system, and digital video camera. This department has completed over 100 projects (Sponsored and S&T) for major mining and hydro electric projects. The department has over 80 technical papers to its credit. With its experienced team, this department provides its services in the following broad areas :

Controlled blasting experiment near existing structure at Koladam Hydel Project site

- Optimisation of blast design parameters for mining and Hydel projects
- Mitigation of adverse impacts of blasting like ground vibration, air overpressure, flyrock and rock mass damage
- Design of controlled blasting (trench blasting, blasting near structures/ habitants)
- Special blasting for armour rock, site grading, urban environment etc.
- Evaluation of explosives performance through in-the-hole VOD monitoring
- Application of image analysis techniques for fragmentation analysis

MINE DESIGN & GROUND CONTROL

This department deals with various aspects of rock engineering in underground and opencast mines, and other civil engineering excavations in rocks. Work spectrum of this department includes :

Monitoring roof behaviour in a coal mine using extensometer and load cell

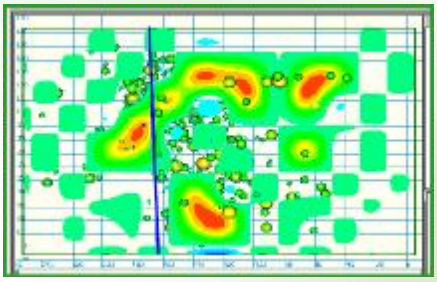
- Rock mass characterization
- Assessment of support requirement, and design of rock reinforcement systems
- Design of mining methods in coal mines for increased productivity under difficult roof conditions and/or under surface structures for thick seams, multiple seams as well as steeply inclined seams
- Strata and support monitoring in coal mines for longwall faces, for blasting gallery panels, for conventional depillaring areas as well as for other critical areas
- Strata and support monitoring in underground caverns and other excavations related to power houses, transformer hall, desilting chamber, surge chamber and tunnels
- Slope stability in opencast mines, Stope and pillar design in hard rock mines
- Numerical modelling for underground and opencast mines using Flac 3D, Flac Slope, Udec and Galena.

The laboratory of this department is equipped with the latest testing and monitoring equipment including point load testers, anchorage testing equipment, torque meters, field shear box, direct Shear, telescopic and remote convergence indicators, multi-point and tell-tale extensometers (vibrating-wire type).

MICROSEISMICS & AUTOMATION

NIRM has developed expertise in the field of microseismic monitoring technology and has proven its capability for applications for evaluating strata stability problems related to underground structures, caverns, mines and landslides. One prestigious coal S&T project for evaluating strata stability over longwall face and for warning of roof falls within goaf using real-time microseismic monitoring was successfully completed. This department custom builds microseismic monitoring network for site-specific requirement and provides its services for real-time data monitoring and analysis of microseismic activities in the following areas :

- Coal mine longwall face for mapping high stress zones above and ahead of mining activity
- Large underground structures (hydel) or storage caverns for evaluating its stability during construction or post-construction stage
- Abrupt roof-falls in coal mines
- Rock slopes for warning of potential landslides



High stress zones mapped by microseismic monitoring

ENVIRONMENTAL ENGINEERING

Environmental Engineering department was set up in 2003 with state-of-the-art equipment like automatic weather station, SODAR, respirable dust samplers, sound level meter, logging noise dose meter, spectrophotometer, digital nephelometer, BOD digital incubator, COD digital reactor, COD photometer, microprocessor based laboratory pH meter, conductivity meter and flame photometer etc. With its excellent laboratory support, this department carries out environmental studies in the following areas:

- Monitoring and assessment of water, air, noise, and soil pollution for the environmental management
- Air pollution modeling
- Environmental auditing in mining and allied industries.
- EIA/ EMP preparation
- Blasting dust management in opencast coal mines
- Remediation measures for the environmental problems
- Waste management

SODAR antenna at a project site

DIMENSIONAL STONE TECHNOLOGY

The Department of Dimensional Stone Technology was set up to assist the granite industry for scientific exploitation of precious reserves. This department is providing the following technical services:

- Geological & geotechnical studies to characterize the deposit
- Rock testing to determine various properties for extraction and marketability of stones
- Planning the quarry for economic operation and selection of equipment
- Application of novel blasting techniques for block splitting
- Planning for waste disposal and utilisation
- Planning for environmental friendly quarrying
- Techno-economic evaluation of the projects
- Conduct training courses and seminars for the quarry personnel

Demonstrating block-splitting of granite

Our Clientele & Associates

Central Govt. Ministries / Departments
- Ministry of Mines
- Ministry of Coal
- Department of Steel
- Department of Atomic Energy
- Ministry of Science & Technology
- Ministry of Water Resources
- Central Water Commission
- Directorate General of Mines Safety

State Govt. Departments
- Kerala State Electricity Board
- Tamil Nadu Electricity Board
- Tamil Nadu Minerals Limited
- Andhra Pradesh Electricity Board
- Himachal Pradesh Electricity Board
- Krishna Bhagya Jala Nigam Limited
- Uttarakhand Jala Vidyut Nigam Limited

International Collaboration
- Norwegian Geotechnical Institute (NGI)
- Skanska Civil Engineering AB, Sweden
- Coyne et Bellier, France
- GEOSTOCK, France
- Nippon Koei, Japan

Hydro-power Projects
- Sardar Sarovar Project, SSNNL, Gujarat
- Srisailam Hydel Project, APSEB, Andhra Pradesh
- Pykara Hydel Project, TNEB, Tamil Nadu
- Lakhwar Hydel Project, Uttarakhand
- Karcham Wangtoo Hydel Project
- Baspa Hydel Project, Jaiprakash, Himachal Pradesh
- Baglihar Hydel Project, Jaiprakash, J&K
- Uri Hydel Project, Shanska, (Sweden), J&K
- Dul-hasti Hydel Porject, J&K
- Dhauli Ganga Hydel Project, NHPC, Uttarakhand
- Tala Hydel Project, THPA, Bhutan
- Pancheswar Hydel Project, Nepal
- Teesta Hydel Project, NHPC, Sikkim
- Allain Dughan Hydel Project, LNJ Bhilwara, H P
- Thottiyar Hydel Project, KSEB, Kerala
- Pallivasal Hydel Project, KSEB, Kerala
- Chamera Stage-II Hydel Project, Jaiprakash, H P
- NSRS Dam, Srisailam. Govt of Andhra Pradesh
- Rampur Hydel Project, SJVNL, HP
- Luhri Hydel Project, SJVNL, HP
- Naitwar-Mori Hydel Project, Uttarakhand
- Nathpa-Jhakri Hydel Project, Himachal Pradesh
- Vishnu Prayag Hydel Project, Jaiprakash, UP
- Kulekhani Stage-III Hydel Project, Nepal
- Upper Subansiri Hydel Project, NHPC,Arunachal Pradesh
- Parbarti Hydel Project, NHPC, Himachal Pradesh
- Pala Maneri Hydel Project, UJVNL, Uttarakhand
- Dibang Multipurpose Project, NHPC, Arunachal Pradesh
- Punatsangchhu Hydel Project, WAPCOS, Bhutan
- Siang Lower Project, NHPC, Arunachal Pradesh
- Malana Hydel Project, Energy Infratech, H P
- Mangdechhu Hydel Project, NHPC, Bhutan
- Sawra Kuddu HE Project, Pabbar Valley Power Corp, H P
- Maniyar Hydel Project, CUMI Ltd, Kerala
- Mandagere Hydel Scheme, Karnataka
- Neria Hydel Scheme, Karnataka
- Koldam Hydel Project, Himachal Pradesh (AFCONS)
- Gokak Small Hydel Project, Karnataka
- Ganvi & Kashang Hydel Projects, Himachal Pradesh
- Larji Hydel Project, HPSEB, Himachal Pradesh
- Indira Sagar Project, MP
- Ghatghar Pumped Storage Project, Koyna, Maharashtra
- Chilime Hydel Project, L&T Ltd., Nepal
- Tehri hydel Project, THDC Ltd., Uttarakhand
- Koteswar Hydel Project, Uttarakhand
- Loharinag Pala Hydel Project, NTPC Ltd., Uttarakhand
- Tapovan-Vishnugad Hydel Project, NTPC Ltd., Uttarakhand

Non-Coal Mining Sector
- Hindustan Zinc Limited
- Hindustan Copper Limited
- Manganese Ore India Limited
- Uranium Corporation India Limited
- Hutti Gold Mines Company Limited
- National Mineral Development Corporation
- Bharat Gold Mines Limited
- Ferro Alloy Corporation Limited, Orissa
- Kudremukh Iron Ore Company Limited
- Associated Cement Companies Limited
- Madras Cements Limited
- MRPL, ONGC, Mangalore
- Storage cavern for oil at Mora, Maharashtra
- Storage Cavern for LPG, Vishakhapatanam

Coal Mining Sector
- Coal India Limited
- Central Mine Planning & Design Institute Limited
- The Singareni Collieries Company Limited
- Western Coalfields Limited
- South Eastern Coalfields Limited
- Eastern Coalfields Limited
- Bharat Coking Coal Limited

Other Organisations
- Krishna Bhagya Jala Nigam Ltd., Bangalore
- Bangalore Metro Rail Corporation Ltd
- Konkan Railway Corporation Ltd
- Bhabha Atomic Research Centre & IGCAR
- Nuclear Power Corporation of India Ltd.
- Subash Kabini Power Corporation Limited
- Sea Bird Project (L&T Hochtief Jt. Venture), Karwar
- Associated Stone Industries (Kota) Limited
- Stanco Granites Limited
- Novel Granites Limited
- Sandvik Asia Limited
- KSK Energy Pvt. Limited
- Energy Infratech Private Limited
- GIEM Limited
- IRCON Ltd
- BEML Limited
- RITES Limited
- WAPCOS Limited
- NTPC Limited
- NHPC Limited

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