2019-20
Annual Report

Receiving CSIR Technology Award- 2019 from Hon'ble President of India on 26th September 2019 at Vigyan Bhawan, New Delhi

सीएसआईआर - केंद्रीय खनन एवं ईंधन अनुसंधान संस्थान
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)
CSIR - CENTRAL INSTITUTE OF MINING AND FUEL RESEARCH
(COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)
बरवा रोड, धनबाद - 826015 झारखंड, भारत
BARWA ROAD, DHANBAD - 826015, JHARKHAND, INDIA

Signing of a Project-specific Agreement between CSIR-CIMFR, Dhanbad and OFDR, Pune on 06.02.2020

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वार्षिक प्रतिवेदन

ANNUAL REPORT

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सीएसआईआर - केंद्रीय खनन एवं ईंधन अनुसंधान संस्थान

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From Director's Desk

It gives me immense pleasure in presenting the abridged Annual Report of CSIR-Central Institute of Mining and Fuel Research, Dhanbad for the year 2019-20. A brief resume has been configured in this report to accustom the readers with the activities of CSIR-CIMFR which embrace the fields of mining, fuel and allied sciences.

The report manifests that the institute continues to achieve its technical objective by linking research & technology and maintaining a high standard of service to meet the needs of its customers. The outstanding performance has been established from the fact that the institute has achieved an all time record in external cash flow of Rs.1011.53 crore from industry stakeholders as externally funded projects. Besides, one CSIR Young Scientist Award; two CSIR Technology Awards for Business Development and Technology Marketing and Physical Sciences including Engineering and two Geosciences awards are new fringes in the clinch of the institute. This year CSIR-CIMFR dealt with 434 sponsored, 123 consultancy, 7 gap and 22 in-house projects. Four patents were filed, 2 were granted and 20 copyrights were registered during the period as a part of intellectual property. Forty two agreements / MoU's were also signed during the reporting year.

CSIR-CIMFR is continuously sharing hand with its commendable R&D work for the betterment of the country. The institute has been carved a niche in the fields of mining, fuel and allied sciences by introducing different techniques for extraction of coal & minerals, effective management of civil construction for border roads, tunnels, metros, railways, airport development, hydroelectric projects, etc.

The institute has also rendered R&D and technical intervention in the field of coal and energy sectors by addressing coal quality assessment, coal beneficiation, carbonization, combustion, gasification, liquefaction and associated issues. The environmental management and environmental impact assessment studies were undertaken to overcome the problems caused due to mineral extraction.

The state of art testing facilities were provided to the manufacturers and users of various types of mining and allied engineering components, wire ropes, miners' safety equipments, flameproof equipments, explosives and other chemicals. Calibration services were also extended for quality measuring instruments, mine ventilation and safety equipments, etc.

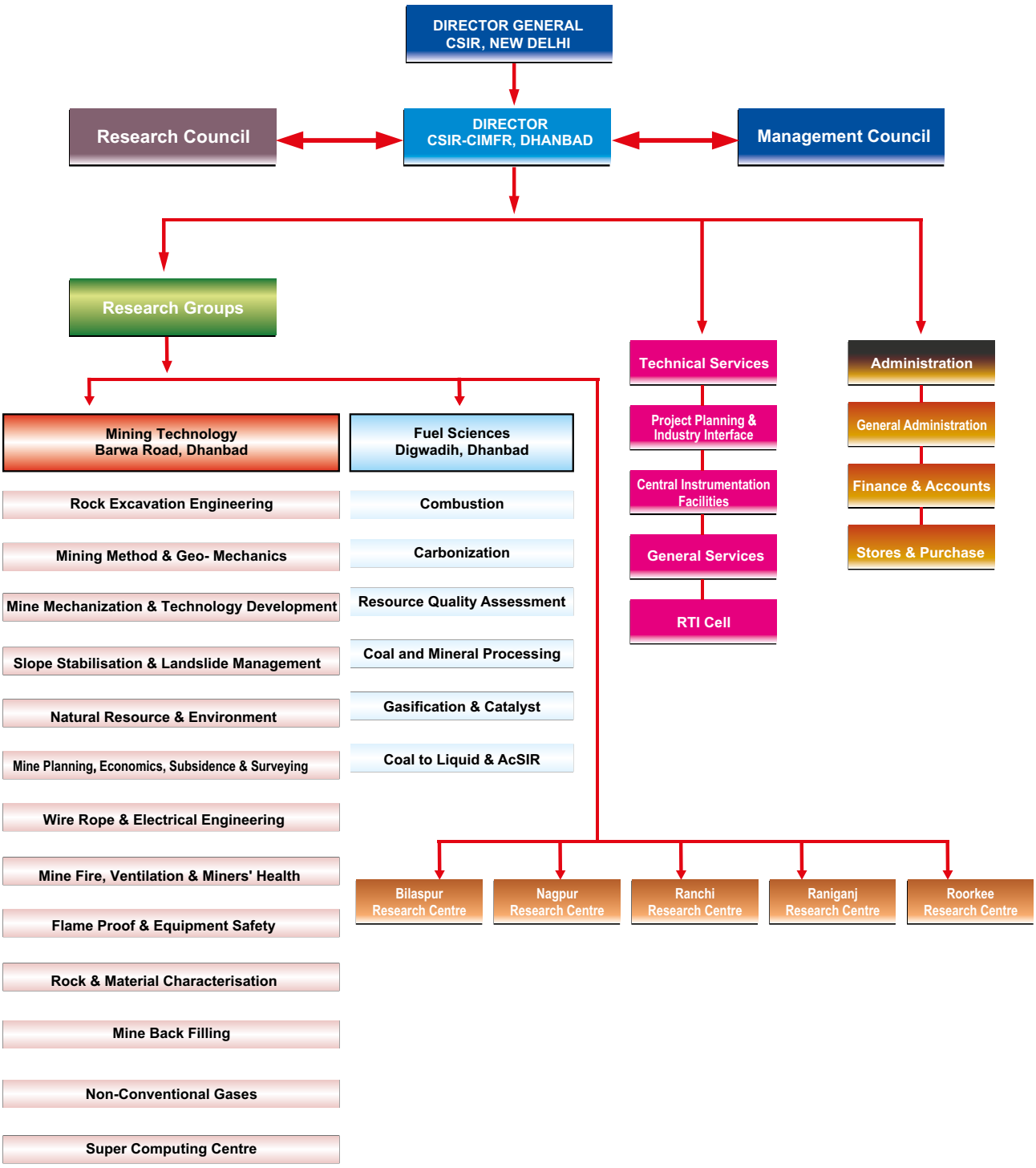
The performance of the institute during the reporting year is remarkable due to the untiring efforts and dedication of the well versed researchers as well as the support from the mining, fuel and allied industries.

I express my sincere thanks to all our clients for their faith and confidence on us by reaping the benefits of CSIR-CIMFR advice, technologies, designs & developments and services. At the same time, I am happy to appreciate the whole-hearted and unwavering co-operation received from my colleagues in every aspect of Research and Development activities.

P K Singh

(Pradeep K Singh)
Director

CSIR-CIMFR Organisational Structure



CONTENTS

A

MINING AND OTHER ALLIED SECTORS

A. MINING AND OTHER ALLIED SECTORS

1. ELECTRICAL DESIGN & CONDITION MONITORING OF WIRE ROPES

During April, 2019 to March, 2020, Electrical Design and Online Monitoring of Wire Rope Health Section has undertaken various assignments on in-situ study and advice on the condition of steel aerial ropes (track and haulage) and mine winder ropes (cage and skip).

The clients of this Section included:

1. M/s Timber Trail, Asia Resorts Limited, Parwanoo, H.P. for its Passenger Aerial Ropeway Installation.
2. M/s Damodar Ropeways & Infra Limited, Kolkata for (1) Digha Ropeway, West Bengal, (2) Bi-cable Aerial Ropeway Passenger Cable Car installation at Gangtok, Sikkim, (3) Namchi Ropeways, Section – I and Section – II, Sikkim, (4) Maihar Ropeway, M.P. and (5) Shri Naina Deviji Ropeway, H.P.
3. M/s Mahagiiri Mines (Chromite) of IMFA Ltd., Odisha.
4. M/s Garhwal Mandal Vikas Nigam Ltd. (GMVN), Joshimath, Uttarakhand for Joshimath-Auli Ropeway.
5. M/s Conveyor & Ropeways Services Pvt. Ltd., Kolkata for (1) DRV Passenger Ropeway at Darjeeling, West Bengal and (2) Tsomgo Ropeway at Gangtok, Sikkim.
6. M/s Samir Damodar Ropeways Pvt. Ltd. for Passenger Ropeway of M/s Guwahati Metropolitan Development Authority, Assam.
7. Himachal Pradesh Public Works Department, Kullu, H.P. for motorized Passenger Ropeway from Chulla to Seoh, H.P.
8. M/s Jagson International Limited, H.P. for Jakhu Ropeway at Shimla, H.P.
9. M/s Lucky Exports India Pvt. Ltd, for Dreamland Amusement Park, Siliguri, West Bengal.
10. M/s Nicco Parks and Resorts Ltd., Kolkata for Amusement Park at Salt Lake.
11. M/s Steel Authority of India Limited (SAIL) for Chasnalla Colliery, Dhanbad, Jharkhand.
12. M/s SKI Himalayas Ropeways Pvt. Ltd., Manali for Ropeway at Solang Nalla, H.P.
13. M/s Shree Hanogi Mata Temple Trust, Hanogi, Mandi, H.P. for Motorized Passenger Ropeway across the river Beas.

(A) ELECTRICAL MAINTENANCE AND GENERTOR

Electrical Maintenance and Generator Section is engaged in support service for uninterrupted power supply to scientific activities of the office in addition to regular electrical maintenance work at CIMFR estate. The department hosts a complete 11 KV distribution system within the campus combined with 600 KVA & 380 KVA capacities Diesel Generator backup. Essential modifications are made from time to time as & when required to upgrade the existing facilities to accommodate new research and scientific facilities.

A 340 KWp rooftop solar panel Renewable Energy system was also installed at CSIR-CIMFR, Barwa Road Campus. In all, 1064 Solar panel modules are installed each with 324 Wp capacity, (Voc – 46 V, Isc – 9 A, Vmp – 37 V, Imp – 8.6 A) on five different buildings within the campus to harness the solar energy in coordination with CSIR-MNRE project guidelines. Being Grid Integrated system along with Net-metering, it will be helpful to cut cost on energy bills to the institute.

Along with general maintenance work, the section undertook and completed electrification works at following places:

1. Design, I&C of Electrical Supply system for newly installed MTES Rock Testing Machine at CSIR-CIMFR, Dhanbad for maximum load of 400 amps.

2. Electrification of New Dispensary at CSIR-CIMFR, Barwa Road Colony, Dhanbad.
3. Electrification work of VVIP Guest house 'Abhinandan' at CSIR-CIMFR, Barwa Road, Dhanbad.

All the departmental activities have been carried out during the reporting period by the following team members: (1) Dr. D. Basak, Chief Scientist, (2) Shri S.Waghmare, Technical Officer and Head of Section, (3) Shri Gautam Gorai, Technician Gr. II(1), (4) Shri Bhubneswar Mahato, Lab Assistant, (5) Shri Marshal Topno, JSA, (6) Shri Vikash Kumar Kushwaha, MTS and (7) Shri Mantu Rajwar, T.S.

Some photographs of in-situ study of winder ropes and aerial ropes

Photographs of rooftop solar panels installed in CSIR-CIMFR, Barwa Road, Dhanbad

2. MATERIAL TESTING LABORATORY (Mechanics of Solid Research Group)

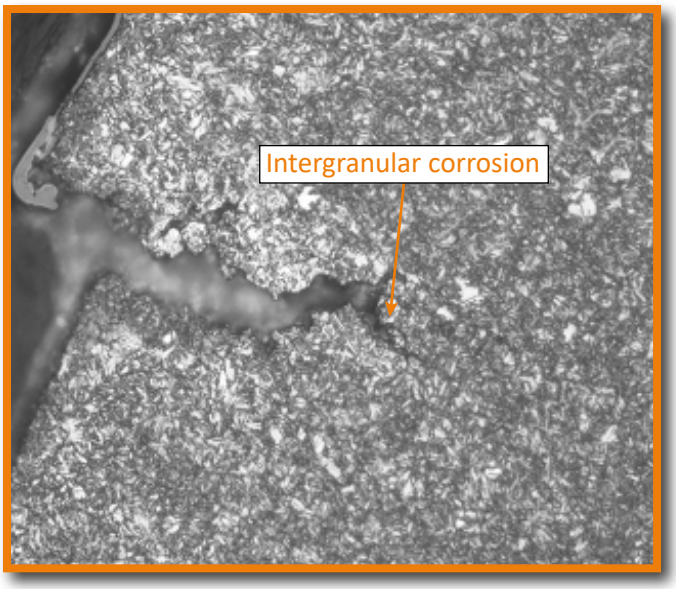
Material Testing Laboratory of CSIR-CIMFR has undertaken various R&D assignments related to safety in mining as well as other industries which are given below:

1. Study and advice on the condition of various size winding ropes of Chasnalla Colliery (SAIL): Advice and study on winding ropes of various sizes used for hoisting at Chasnalla Colliery

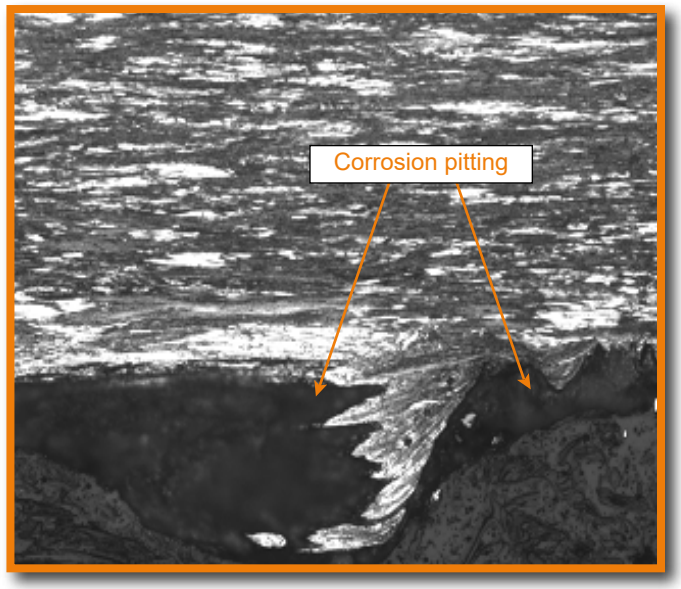
(SAIL) has been carried out during this period to assess the quality of the winding ropes after using in mines. Six wire ropes of different size have been investigated. The ropes were found in good condition suitable for reuse.

2. Quality evaluation of winding / haulage rope through destructive and non-destructive test of Tata Steel Limited

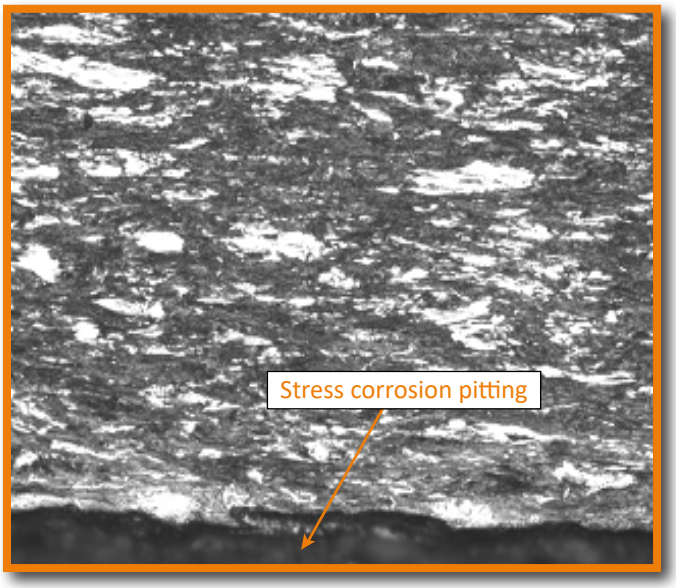
Winding /haulage rope used in Tata Steel Limited has been investigated after being used in mines. Nineteen ropes has been studied through destructive testing i.e. by breaking load test, tensile, torsion, reverse bend, wear & corrosion, lubrication and micro-examination. The study reveals that the conditions of the ropes are good except few ropes which shows microstructural defects caused during its operation shown in figure below.



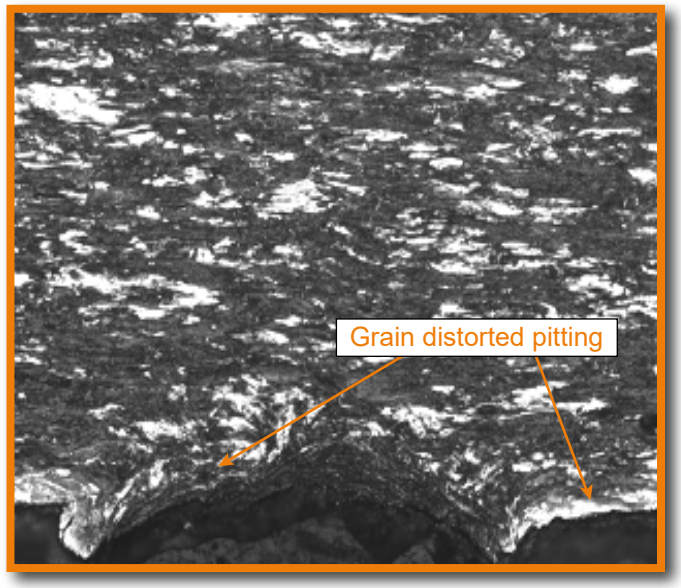
Fine pearlitic structure with intergranular corrosion in transverse Section



Cold drawn structure with stress corrosion pitting in longitudinal Section



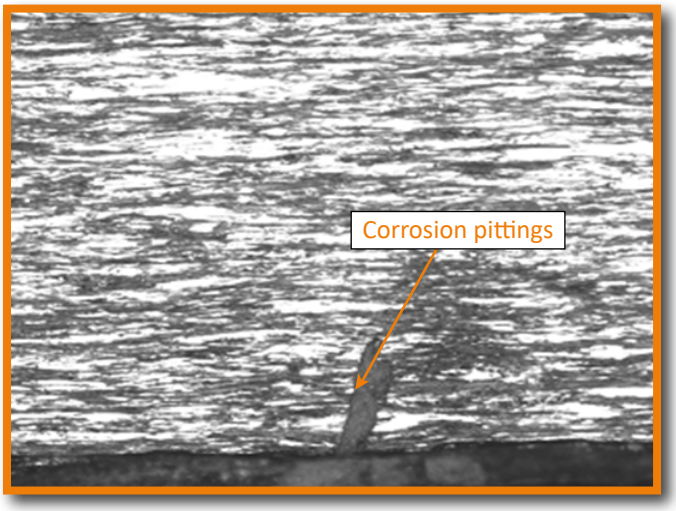
Cold drawn structure with stress corrosion pitting in longitudinal section



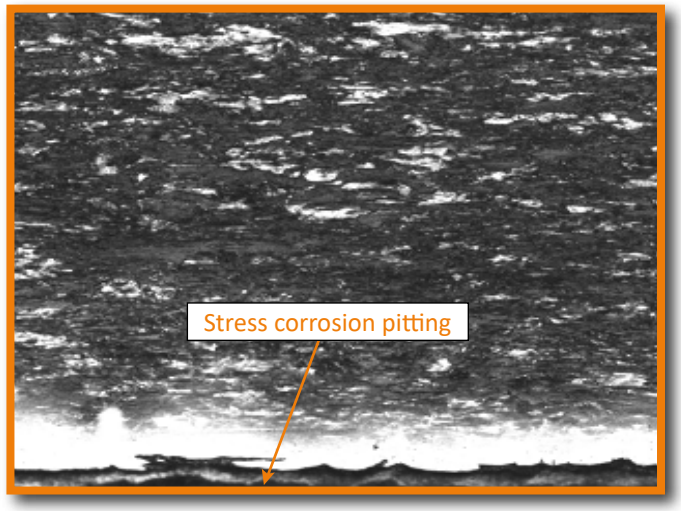
Cold drawn structure with distortion of grain on the wear surface in longitudinal section

3. Study the condition of different size wire ropes of Hindustan Copper Limited, Ghatsila

Six wire ropes of Hindustan Copper Limited of Ghatsilawere received to study their condition for further use in mines. The wire ropes and individual wires were subjected to different tests like visual examination, break load test, wear & corrosion test, lubrication test, tensile test, torsion test and reverse bend test. On the basis of the above investigation the wire ropes stood satisfactory results. Two ropes have developed corrosion on the surface due to wear & tear during operation shown in figure below. It indicates that it is suitable for use in mines with proper lubrication to avoid wear and tear.



Cold drawn structure with corrosion pitting in longitudinal Section



Cold drawn structure with stress corrosion in the longitudinal section

4. Study and advice on 35 mm dia. rope used for hoisting at Katghori shaft of Churcha Mine (RO)

Four 35 mm diameter of full locked coil wire ropes samples have been received for the study and thereby advice for reuse. The ropes were subjected to breaking load, tensile, torsion, reverse bend, wear and corrosion, lubrication and micro examination to study its condition. The ropes were in good condition and possess good strength. So they can be further reuse in mines. Below figure shows the breaking load test at 500 T horizontal tensile testing machine before and after the test.

Breaking load test before breaking

Breaking load test after breaking

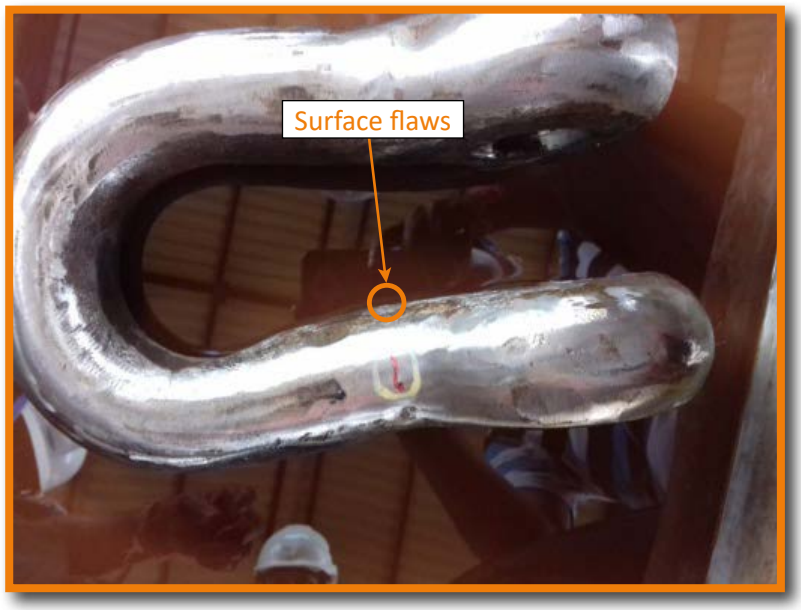
5. Study and advice on the condition of vital components of winder, installed at Mahagiri mines through NDT

The study on the condition of vital components like C.S. gear, chain sling, safety hook, friction wedge rope cappel, shackle with pin, link plate etc.is carried out throughnon-destructive testing. To detect the surface and subsurface flaws, Magnetic particle crack detection (MPCD) is used and to detect the internal flaws, Ultrasonic technique is used. Conditions of most of the vital components of Man Riding system were found satisfactory.

Part of a Winder installed at mines

6. Study the mechanical integrity of six numbers of C.S. Gear installed at Kenda area, ECL

Mechanical integrity of six numbers of C.S. Gearlike friction wedge ropecappels, D Plate, Safety Hook, 'D' shackles, Tie Rods, Triangular Plateetcinstalled at ECL, Kenda area has been carried out through non-destructive testingto study their condition. Conditions of most of the vital components of C.S Gear were found satisfactory except cage shackle. It revealed the presence surface imperfection of harmful character as shown in below figure.



3. MINE BACK FILLING RESEARCH GROUP

During April 2019 to March 2020, the Mine Backfilling Research Group has undertaken various assignments on mine backfilling for both underground and opencast mines, fly ash utilization, Blind backfilling and stability of old unapproachable workings below surface constraints.

During this period, this research group has taken up industry sponsored projects related to opencast filling using fly ash and overburden (OB) mainly from, Jindal Steel & Power Limited (JSPL), Tamnar, Manikpur Opencast Mines using ash from LANCO Amarkantak Power Limited, Korba, Gidhumuri and Paturia opencast mine using ash from CSPGCL and Gare Pelma Sector III opencast coal mine using ash from CSPGCL, Korba. Fig. 1 illustrates the scheme of opencast filling using fly ash and OB.

Fig.1. Ash filling in opencast mines

The laboratory and field experimentation of bottom ash stowing at Jitpur colliery, SAIL is unique of its kind, as for the first time bottom ash from Damodar Valley Corporation (DVC) and Chandrapura Thermal Power Station (CTPS) were used for underground coal mine backfilling. A brief of this work is presented in Fig. 2.

Fig. 2. Bottom ash stowing in underground coal mines and laboratory experimentations

One of the major highlights in this financial year of Mine Backfilling Research Group is the Blind backfilling and stability of underground unapproachable areas in Talcher area, MCL, Odisha. Stability analysis of underground workings of Handidhua colliery, Deulbera colliery, Talcher colliery and Nandira colliery of Talcher area were conducted. Blind backfilling was initiated at Handidhua and Deulebera colliery (Fig. 3). This type of blind backfilling is unique in India.

Fig. 3. Blind backfilling in Talcher area, MCL

The cemented hydraulic filling at Mahagiri mines, IMFA has been upgraded and higher filling rate has been achieved. The proper backfilling of underground stopes of Mahagiri mines, IMFA has resulted in free standing backfill wall after extraction of adjacent stope (Fig. 4a). Also experimentations were conducted to use OB as backfilling material for underground metal mines (Fig. 4b)

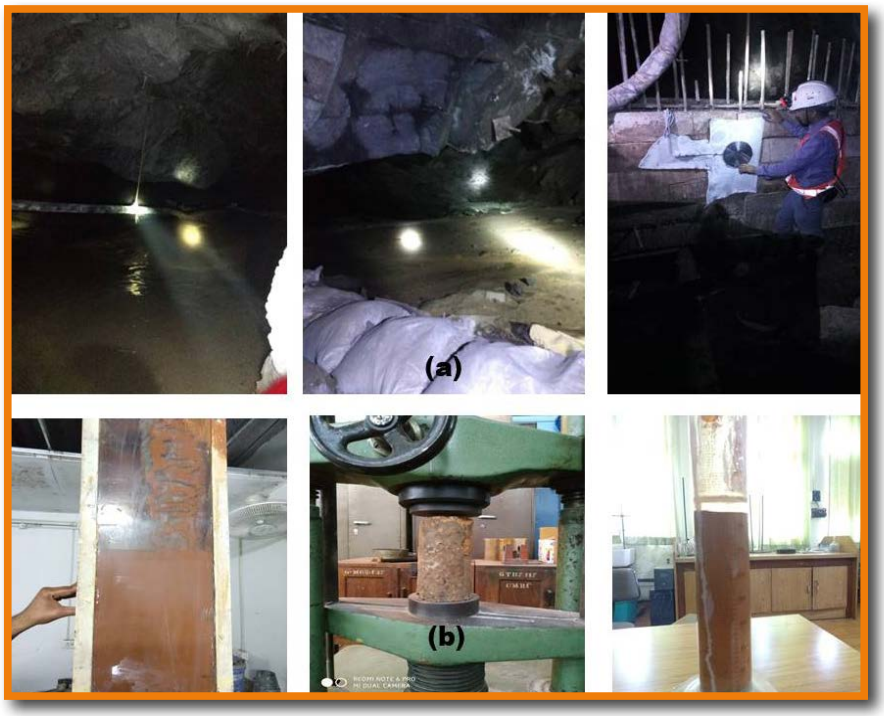


Fig. 4. Backfilling at Mahagiri mines (a) Backfill pouring and stable backfilled stope (b) Experimentations with OB

Also, the industry sponsored works carried out in paste backfilling is remarkable. To list a few, the fly ash replacement in paste backfill for Rampura Agucha mine and Rajpura Dariba, HZL, optimizing binder of paste backfill, dry rock filling and backfill fines optimization for Rajpura Dariba mines, HZL. These assignments were challenging and vast in nature and benefited to industry both by technically and economically. A glimpse of these project works are shown in Fig.5

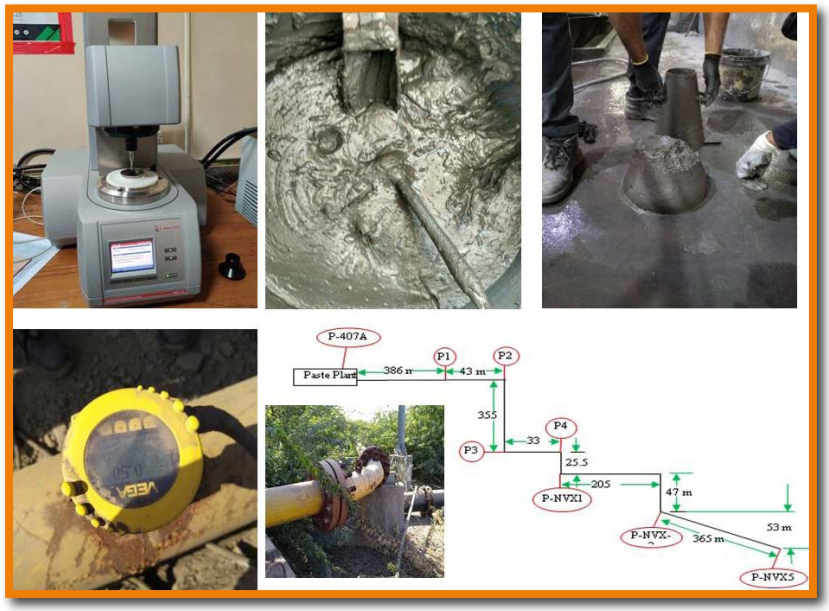


Fig. 5. Paste backfilling for underground metal mines

For the first time in India, paste backfilling in underground coal mines is to be implemented. For this noble work a GAP project has been granted by CIL R & D board. The GAP project aims at developing a suitable Paste Fill material from Fly Ash (Power Plant Reject) and its transportation system to underground coal mines for stabilisation of working as an alternative of sand stowing for increasing the percentage of extraction of coal and to ascertain its cost effectiveness with due regard to safety and environment in Sarni UG Mine, Pathakhera Area, WCL. Preliminary experimentation of mix optimization is in progress (Fig.5).

Fig. 5. Paste fill preparation using fly ash

4. MINE FIRE, VENTILATION, MINERS' SAFETY AND HEALTH

One R&D project on Coal Dust Explosibility study sponsored by CIL R&D Board, Kolkata is being implemented in the department. Various industry sponsored projects related with the problems of oppressive climatic condition at workplaces in underground mines, prevention and control of fire in coal mines, extent and rate of progress of fire in abandoned mines are also undertaken by the department. It has also undertaken various assignments, viz. air borne respirable dust study & free silica determination, performance evaluation of self-rescuers and breathing apparatus, calibration of various instruments used in mines, and testing & certification of PPEs aiming to create a healthier workplace environment and ensure occupational safety for the miners through research activities and providing consultancy services to industry to achieve the same. Testing of brattice cloth as per BIS norms and calibration of Mechanical Anemometer, Digital Anemometer have also been carried out as a routine job. Details of the work taken during the year 2019-20 are as follows:

(A) R& D project

1. The project entitled "Development of Guideline for Prevention & Mitigation of Explosion Hazard by Risk Assessment and Determination of Explosibility of Indian Coal incorporating Risk based Mine Emergency Evacuation and Re-entry Protocol" has been undertaken with an aim to create a national facility for testing of explosibility of coal dust and framing of guidelines for prevention and mitigation of explosion hazard in Indian coal mines. Under this project coal characteristics of 76 coal samples collected from fiery and degree III gassy mines covering as many as six subsidiaries of CIL have been determined by various experimental methods, viz. Proximate and Ultimate analyses, Gross Calorific Values, Differential Scanning Calorimetric study. Further, first phase of installation of 20 litre explosion chamber and MIE apparatus has been completed. Analysis of coal samples through Particle Size Distribution Analyser have been completed and experiment using TGA-DSC are in progress. CFD simulation for dispersion of coal dust in 20 litre spherical chamber has been carried out. The project is in implementation stage.

Fig.1 20l explosion chamber

Fig.2 Minimum ignition energy apparatus

Fig. 3 TGA-DSCSet up

Fig. 4 Critrical oxidation Set Up

Fig. 5 Particle Size Distribution Analyser

(B) Industry Sponsored Project

1. An international consultancy assignment sponsored by Druk Green Power Corporation, Thimpu, Bhutan for resuming Exploratory Drift Work of Nyera Amari II Powerhouse at Martshala Samdrup Jongkhar was taken up. There was an explosion in the tunnel during drivage leading to some casualties and stoppage of the work. The assignment completed successfully which lead to resumption of work and advises for future to avoid such untoward occurrences.
2. The problem of oppressive workplace environment in five mines, viz. Bahula mine of Kenda Area, ECL, Shankarpur Colliery, ECL, Zawarmala, Mochia and Balaria Mines of Zawar Group of Mines of HZL have been taken up by way of applying basic principles of fluid dynamics, carrying ventilation investigation, identifying the responsible parameters for deterioration in climatic condition and prediction of results after rectification/ modifications of ventilation network of the mine by computer simulation studies. The work of Bahula mine of Kenda Area, ECL and Zawarmala mine, Mochia and Balaria Mines of Zawar Group of Mines of HZL have been completed successfully. The project relates to Shankarpur Colliery, ECL is in progress. A project was undertaken to examine the design of ventilation system and fire safety design of three tunnels (220 m, 2600 m and 300 m length) at Panvel-Karjat double line suburban corridor of Mumbai Vikas Corporation Ltd., Mumbai. The work is in progress.

3. Environmental monitoring in the longwall panel no. 2 of AdriyalaLongwall Project of SCCL is being carried out by CSIR-CIMFR Dhanbad with a view to improve production and productivity of the mine keeping due importance to safety. The mine is having Tube Bundle system for monitoring of underground environment and the project is in progress.
4. Air- borne respirable dust survey comprising of static sampling and personal sampling was carried out at Hutti (an underground mine), Uti(an open cast mine) and Heerabuddini(exploratory mine)gold Mines of The Hutti Gold Mines Company limited, Raichur, Karnataka. Assessment of respirable dust, personal exposures of miners and free silica contents in dust were undertaken to find out the associated health risk of mine workers. Direct-on-Filter method using Fourier Transform Infra-red (FTIR) Spectroscopy determined free silica in respirable dust. The project completed successfully. To create a healthier workplace environment and to ensure occupational safety for the miners with the analysis of percentage of silica in mine dusts and DPM (Diesel Particulate Matter) which can help in adopting suitable control technologies and developing specific monitoring techniques in order to reduce silica as well as DPM exposure, an industry sponsored project was taken from Rampura Agucha Mine, HZL. The project is in progress.
5. Extent and rate of progress of fire below sub surface at XIII, XIV and XV Seam of Kankanee colliery (BCCL) have been determined by the data obtained through boreholes made at strategic locations measuring the fire parameters, viz. pressure, temperature, gas compositions of fire area and advised for its control.
6. The problem of spontaneous heating/ fire in different coal mines, viz. Rajmahal OCP, ECL, Integrated Coal Mining Limited, Sarisatolli, Dulanga coal mining project of NTPC Ltd., Sundergarh, Ramnagore Colliery, Kulti, ISP, SAIL was dealt with successfully. Scientific advice was also given in dealing with OB dump of Eastern quarry of Pakri-Barwadih coal mine project, NTPC, Hazaribag. Incubation period of coal seam was also determined. These projects are in progress.
7. A project was undertaken for Land Use and Land Cover (LULC) study using satellite imagery. The project is funded by Thriveni sainik Mining Private Limited. The project is in progress.

(C) Testing

A glimpse of the major testing services offered to industry are mentioned below:

- **Performance Evaluation of Various Safety & Rescue Equipment Used in Mines:**

  Self-Contained Self Rescuer (SCSR) and Close Circuit Breathing Apparatus are the major life support equipment during disaster in coal mines. To ensure their performance during emergency, their periodical evaluation as per Indian Standard is required. A total of 145 SCSR samples of different make and model from various manufacturing industries and coal mines have been evaluated using artificial breathing simulator machine and other associated setups in laboratory condition as per IS 15803:2008, DGMS (Tech.) Circular No. 08A of 2008.

- **Testing of Miner's Safety Equipments**

  Mining operations around the world pose a great risk to worker's health and safety. Thus, it becomes inevitable that the PPEs which are going to be donned by the workers are quality tested and meet all the standards. The department has a wide range of state-of -the-art facilities to test the sound quality of the PPEs which include: Safety Helmets, Safety Boots, Safety Flame Lamp, LED Caplamp, brattice cloth and calibration of other major underground instruments viz. methanometer, anemometer, Multigas Detector, LMD etc. For the year 2019-2020, a total of 23 anemometers and 54 methanometers from different user industry were calibrations. For the testing of safety equipments, one batch of brattice cloth, four batches of flame safety lamp, two batches of safety helmets comprising of 08 helmets each and a total of nine helmets were tested for impact test and one batch of LED Cap lamp was tested at our laboratory.

- **Respirable Dust Analysis**

  Occupational exposures to silica are associated with the development of silicosis, lung cancer, pulmonary tuberculosis, and respiratory diseases. Mining is one of the sectors more impacted by the exposure to silica.

Hence, determination of % silica in mine dusts is statutory requirement. It also helps in adopting suitable control technologies. Accordingly state of the art lab facilities have been developed to analyse of air borne respirable dust samples collected on filter paper for free silica analysis, respirable dust concentration and maximum exposure limit using Direct-on-filter method of FTIR Spectroscopy conforming to DGMS (Tech)(S&T) Circular No.1,2010. For the year 2019-20, a total of 39 dust samples were analysed for silica determination for various collieries.

During this period, our services reached out to different organizations and companies NorAAAthern Coalfields Limited (NCL), Western Coalfields Ltd. (WCL), South Eastern Coalfields Ltd. (SECL), Mahanadi Coalfields Limited (MCL),Eastern Coalfields Ltd. (ECL), Hutti Gold Mines Co. Ltd. (Karnataka), Industrial Components (Kolkata), TATA Steel Pvt. Ltd., J.K. Dey & Sons (Kolkata), Intech Safety Pvt. Ltd.(Kolkata), Suparna Chemical Ltd. (Mumbai), Industrial Precision Products (Kolkata), Industrial Appliances and Products (Kolkata), K.D. Chopra & Co. (Kolkata), etc.

5. MINE MECHANIZATION, AUTOMATION & TECHNOLOGY DEVELOPMENT GROUP

I. S&T Projects:

1. Development of Digital Mine using Internet of Things

CSIR-CIMFR, Dhanbad and IIT Kharagpur have been implementing a S&T project entitled “Development of Digital Mine using IoT”, which has been sponsored by Ministry of Electronic and Information Technology (MeitY), Government of India. Under the project, a 3D virtual mine using integrated monitoring and hazard prediction system is being developed for improving safety and productivity in underground mines. The integrated system includes different modules covering: (i) Miners tracking and voice communication, (ii) Environment and gas monitoring, (iii) Strata monitoring, (iv) Store inventory management, (v) On-line production and dispatch monitoring, (vi) Personnel management, (vii) Fire and explosivity status monitoring, (viii) Rescue and disaster management, (ix) Machine health condition monitoring, (x) On-line form submissions and e-governance, (xi) Training module, etc. The system uses IoT-enabled sensors and control units, flameproof and ingress protected devices, and data acquisition and prediction software for3D digital mine.

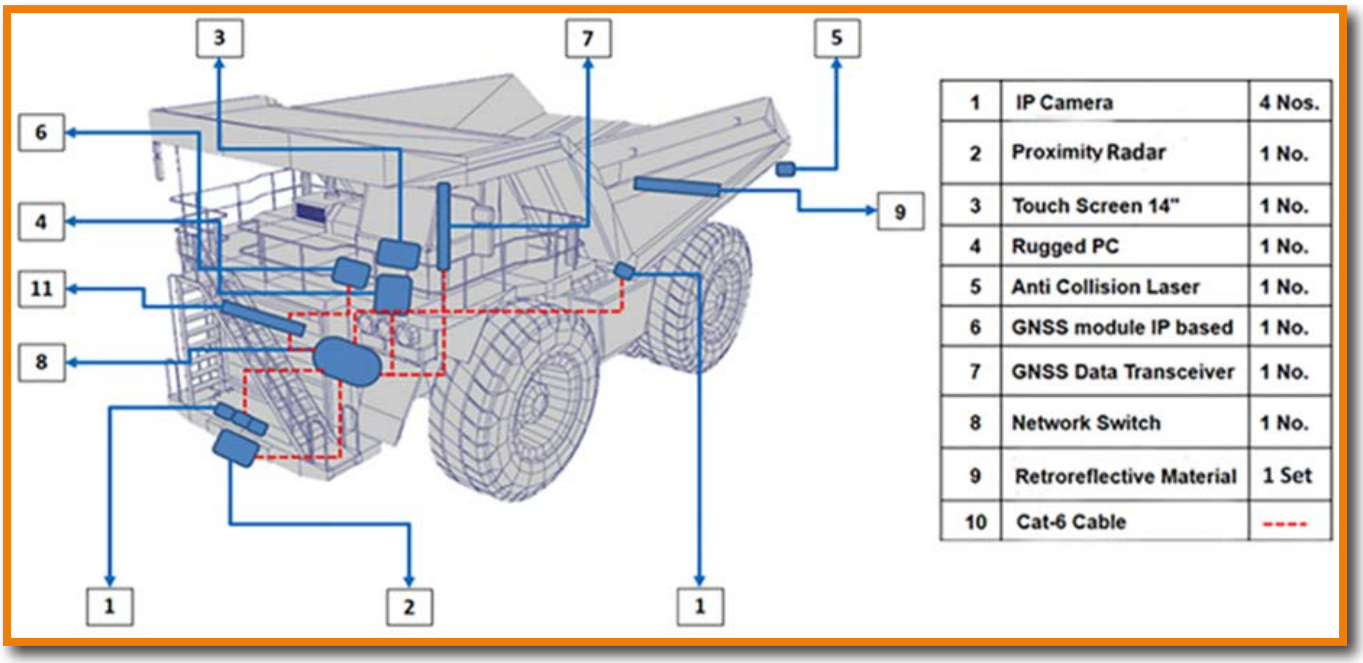
2. Assessment of Rock Bolting In –Situ by Ultrasonic Guided Waves for Human Safety in Underground Mines

This project has been undertaken, as a Mission project of (4M) Theme of CSIR, withthe objective to establish and standardize ultrasound guided wave technique for testing of roof bolts in in-situ grouted condition. This will help us to assess its integrity, residual bolt strength, condition of the bolt in terms of corrosion patches, necking, bending, loss of cement/resin encapsulation etc, and develop guidelines for testing of roof bolts in in-situ grouted condition. Numerical Modelling tool will be used to know stress pattern in a bolt during depillaring operation and the effect of the bolt length.

3. Development of Vision Enhancement System for Foggy Weather

CSIR-CIMFR, Dhanbad has developed a vision enhancement system to continue opencast mining operation during foggy weather sponsored by Ministry of Electronic and Information Technology (MeitY), Government of India. The system mainly consists of 3 sensors/devices installed on Heavy Earth Moving Machinery (HEMM) which includes (a) IP based thermal cameras and high definition (HD) cameras, (b) Global Navigation Satellite System (GNSS) module, and (c) Proximity radar (Fig. 3.1). The system provides 180° panorama field of view through real-time video stitching, back view while reversing the vehicle, object detection through proximity radar, real time location of the vehicles by GNSS modules, audio-visual alarm to driver on object detection (Fig. 3.1),processed and integrated outputs displayed on a touch screen display board/ dashboard(Fig. 3.2) and display screen logically splitted in to 4 quadrants. Further, anti-collision laser light, Retroreflective material and flasher lights, LED fitted vest, thermal binocular, self-regulating heating cable placed along both sides of road and flasher lights on junction points are also included for better visibility in adverse foggy weather conditions.

Patent application has been filed for the developed technology and it has been transferred to M/s Dadhwal Weighing Instruments, Dhanbad for implementation in different mines of the country.



1	IP Camera	4 Nos.
2	Proximity Radar	1 No.
3	Touch Screen 14"	1 No.
4	Rugged PC	1 No.
5	Anti Collision Laser	1 No.
6	GNSS module IP based	1 No.
7	GNSS Data Transceiver	1 No.
8	Network Switch	1 No.
9	Retroreflective Material	1 Set
10	Cat-6 Cable	----

Fig. 3.1: Layout of system deployment on dumper for foggy weather

Fig. 3.2: Pictorial representation of dashboard in front of driver's seat

4. Setting-up of Information and Facilitation Centre for Empowering Living of Schedule Caste in Jharkhand State

CSIR-CIMFR, Dhanbad has taken up a R&D project for "Setting-up of Information and Facilitation Centre for Empowering Living of SC in Jharkhand State", which has been sponsored by Ministry of Electronics and Information Technology (MeitY), Government of India. The objectives of the project are: (i) Development of Facilitation Centre, (ii) Selling of village products through e-commerce portal (Fig. 4.1) to establish direct link between farmers and sellers, and (iii) Analysis of soil and drinking water quality for rural population using IoT based sensors (Fig. 4.2).

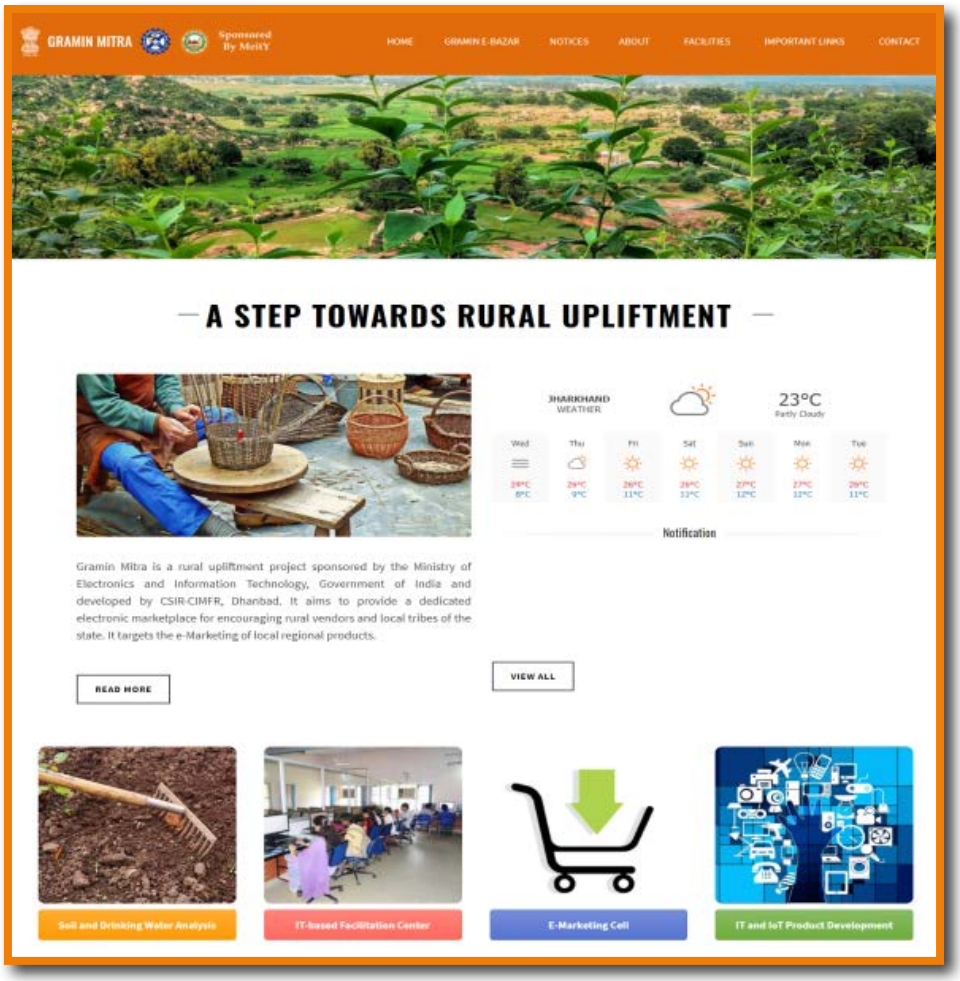


Fig. 4.1: Gramin Mitra site for facilitation of rural people

Fig. 4.2: Sensor-based soil testing facility

5. Setting-up Safety Testing Laboratory for Electronics and Information Technology Products

Under this project sponsored by Ministry of Electronics and Information Technology (MeitY), Government of India, CSIR-CIMFR, has established a new testing laboratory, "Electronics and Information Technology products Safety Testing Laboratory (EISTL)", to cater the need of manufacturing industries. Testing and certification as per the Indian Standards/IEC are being done at EISTL for different electronics and IT products for the benefit of domestic industry, exporters, importers, entrepreneur, small and medium enterprise, existing academic and research institutions, and electronic products standard setting bodies. The laboratory of CSIR-CIMFR has been accredited by NABL and recognised by Bureau of Indian Standards for testing and certification with an objective to provide quality testing services using latest test and measuring instrument as well as qualified and experienced professionals. The safety testing facilities for following products are available in EISTL with different IS codes (Fig. 5.1):

- As per IS 616 /IEC 60065: Electronic Games (Video), Optical Disc Players with built in amplifier of input power 200 W and above, Amplifiers of input power 2000 W and above, Electronic Musical System with input power 200W and above, Power Adopters for Audio, Video and Similar Electronic Apparatus, Plasma/LCD/LED/Television of Screen Size 32'' and above
- As per IS 13252(Part 1)/IEC 60950-1:Laptop/Notebook/Tablets Machine, Visual Display unit, Video monitor of screen size 32'' & above, Printer and Plotters, Scanners, Wireless Keyboard, Telephone Answering Machine, Set Top Box, Power Adopters for IT Equipment, Mobile Phone, Point of Sale Terminals and Power Banks for use in portable applications.
- As per IS 16242(Part 1)/IEC 62040: UPS/Inverters of Rating ≤ 5KVA
- As per IS 16046(Part 1 , Part 2)/IEC 62133(Part 1 , Part 2): Secondary Cells and Batteries containing Alkaline or other non-acid Electrolyte

Fig. 5.1: Electronics and IT products testing facility at CSIR-CIMFR, Dhanbad

6. Design and Development of Truck Mounted Mobile Coal Sampler for Instant Coal Ash & Moisture Analyser at Site from Railway Wagon / Truck

This Truck Mounted Mobile Coal Sampler (TMMCS) with Instant Ash & Moisture Analyser as shown in Fig. 6.1 (a,b,c) for collecting an unbiased coal sample from open railway Wagon/Truck have been developed in this project funded by Ministry of Coal, Govt. of India. The coal collected from the loaded Wagon/Truck will provide a true random representative sample (up to 6 feet depth) which would be analysed for quality determination for Ash & Moisture to get GCV value. The nuclear technique method with Dual-gamma-ray Transmission has been used for analysis of coal ash and moisture content. The developed technology has given satisfactory output values of coal ash and moisture content within the permissible range to get instant GCV. An integrated Truck Mounted Mobile Coal Sampler was designed and developed in this project and field trial was successfully conducted at SCCL mines. This system will help coal producers as well as coal purchasers to get instant results of GCV of the samples.

Fig. 6.1 a

Fig. 6.1 b

Fig. 6.1 c

7. Design Guidelines for underground coal extraction beneath Massive Competent Strata: A case study validation

In this project funded by Coal India R&D Board, a mining depillaring method with staggered panels was designed for extraction of coal(depillaring) below massive competent strata. Field investigations were carried out at the site to comprehend the geo-mining conditions and to obtain rock and coal samples from which physico-mechanical properties were determined from laboratory tests. A layout of staggered panels was prepared within the study area for extraction taking into consideration the Non-Effective Width for massive competent basalt strata lying at a horizon around 18 m above the coal seam. Rigorous numerical modelling was carried out to analyze the stability of the barrier pillars and to devise measures to mitigate uncontrolled and dynamic rock mass movements, of the roof rocks/basalt. The observations of the numerical models were compared with conventional/ non-staggered panel cases. It was found that, as compared to conventional/non-staggered panel cases, the safety factor of the barrier pillars enhanced by ~17% when the panels were staggered. At present, the mine management is trying to obtain necessary permissions from statutory bodies to initiate field trial and show-case demonstration of this innovative method of mining.

8. Design & Development of Wheel controlled Sewage Discharge System in Trains

This project has been undertaken as In-house project under 'Dehradun Declaration', Bharat Swachh Mission, a flagship programme of Prime Minister of India, to design and develop a Wheel controlled Sewage Discharge System in Trains with a view to make the railway track/platform as well as total environment more hygienic and health. The procurement and fabrication of the prototype working model as shown in Fig.8.1 is in process. The patent has been filed for this novel design.

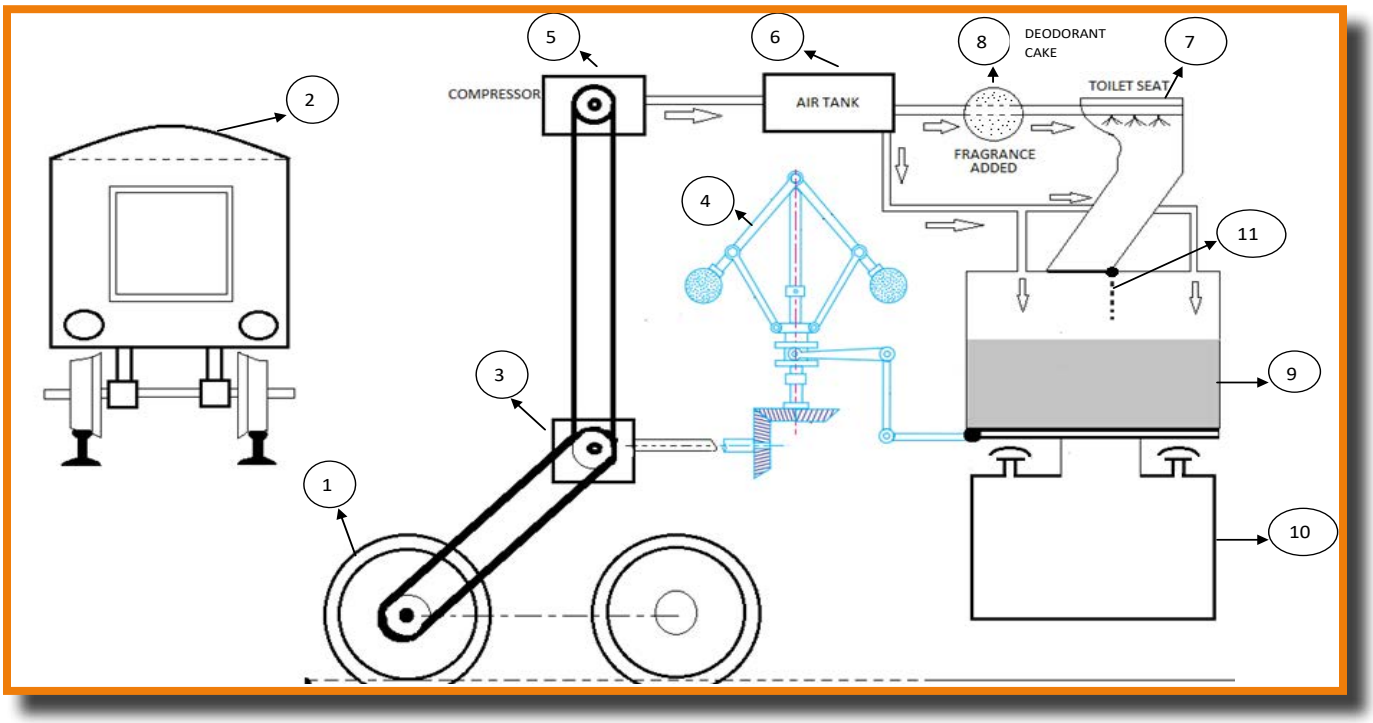


Fig.8.1Wheel controlled Sewage Discharge System in Trains

9. Design and Stability of Pillars/Arrays of Pillars for Different Mining Methods in Coal Mine Workings

This project funded by Ministry of Coal, Govt. of India, aims to develop a guideline for design of stable pillars and arrays of pillars in coal mine workings at deeper horizon. Multiple field visits have been conducted at the identified sites viz., Moonidih Project of BCCL, Churcha mine of SECL, Adriyala Project Colliery and Shantikhani mine of SCCL. Instrument for measuring in-situ stress regime has been ordered and the experimentation sites have been identified at Moonidih Project and Churcha R.O. mine. Relevant data on geo-mining conditions, rock strata and physico-mechanical properties and strata monitoring of past extracted panels have been collected. Using these data and with the help of numerical modelling, design of chain pillars have been done for Moonidih Project, Adriyala Longwall Project and Shantikhani mine. Design of rhombus-shaped pillars for trunk roadway development have also been done for Shantikhani mine. Currently strata monitoring is being done at Adriyala and Shantikhani mine of SCCL.

II. SPONSORED R&D PROJECTS:

1. Intelligent Dry Fog Dust Suppression System

An automated and smart dust suppression system has been developed under this project sponsored by NMDC Limited. This system uses hybrid nozzles, sensors, actuators, controllers, screw compressors, air receiver, pumps, motors, and arrangement of water with filtration facility (Fig. 2.1.1). The developed system has been installed in a crushing and screening plant of an iron ore mine. Fugitive dust emission was measured to be 354–7040 µg m–3 in different locations of the crushing and screening plant before installation of dust suppression system. However, it was reduced to 91–300 µg m–3 after installation of dust suppression system, which was much lesser than the permissible limit of 1200 µg m–3 at a distance of 25±2 m in the predominant downwind direction from emission sources. The installed dry fog system reduced work zone dust concentration to 0.10–0.17 mg m–3 from the prevailing dust concentration of 0.62–1.73 mg m–3 before installation of the system. Percentage of free silica in the work zone dust reduced to traces from 3.61–4.80% prior to installation of the system. The recorded moisture addition was found to be 0.032% of material weight. Thus the system efficiently controls fugitive dust emission from various mining activities without affecting the performance of mineral processing.

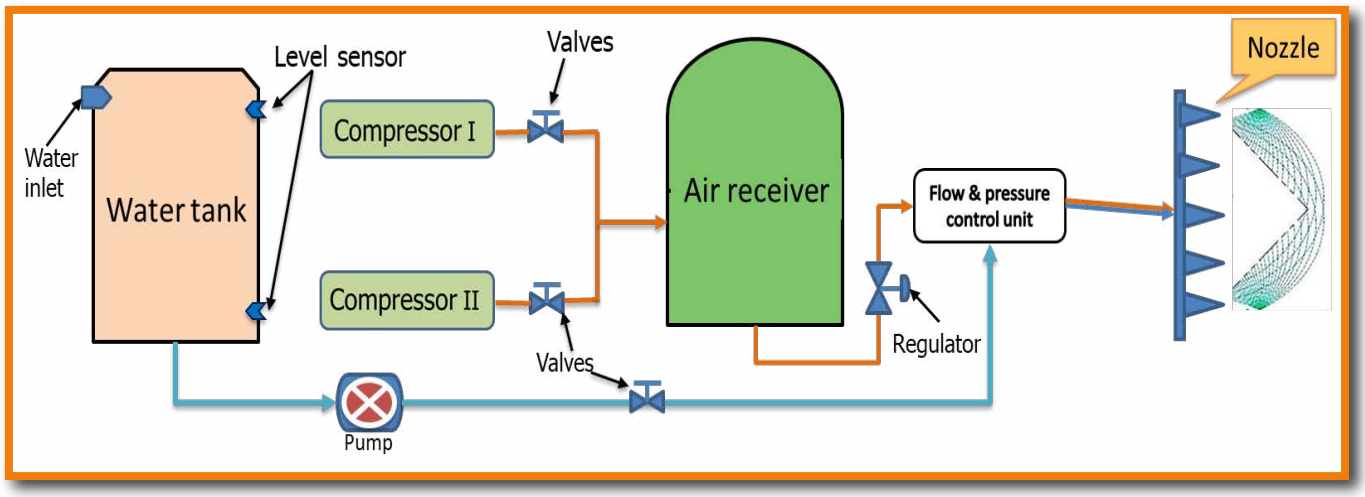


Fig. 2.1.1: Block diagram of dry fog dust suppression system

2. Mine Transport Surveillance System

A "Mine Transport Surveillance System (MTSS)" has been developed under a Grants-in-Aid project sponsored by Ministry of Electronics and Information Technology (MeitY). Under this project, sponsored by NMDC Limited, CSIR-CIMFR has installed similar MTSS system (Fig. 2.2.1) at Kumaraswamy Iron Ore Mine (KIOM), Donimalai Iron Ore Mine (DIOM) and Pellet Plant at Donimalai Complex of NMDC Limited.The systems scans front, rear & top views of empty & loaded trucks as per CVC guidelines, provides proximity warning for HEMM as per DGMS guidelines and uploads of weighing data to a central server of NMDC for transparency and fool-proof weighing as per CAG report. This system helps in improving safety, production and productivity in mines.

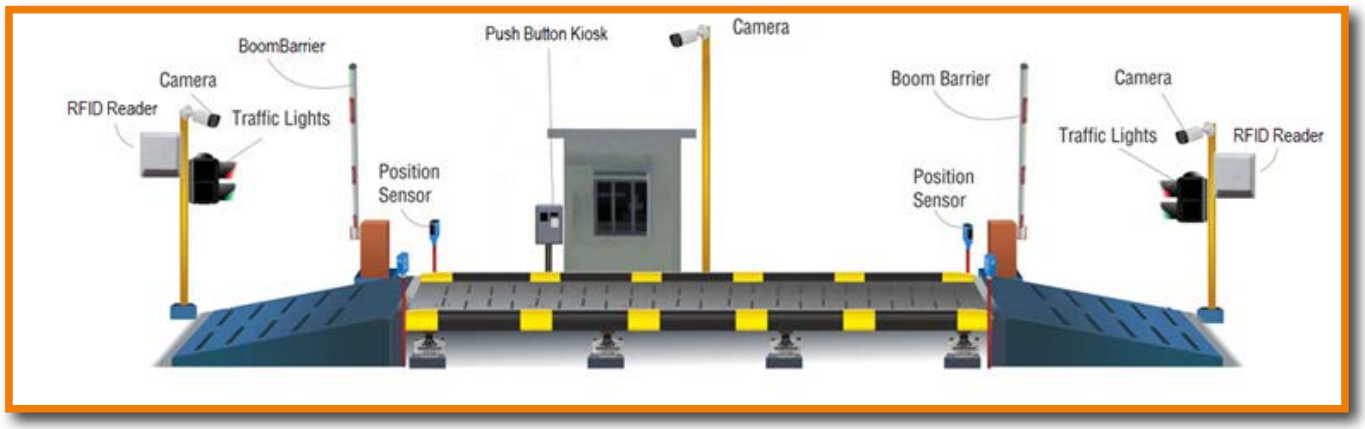


Fig. 2.2.1: Schematic diagram of weighbridge automation system

3. Design and planning for longwalling at Shantikhani Mine, MM Area, SCCL

The SCCL management has entrusted the work to CSIR-CIMFR, Dhanbad and after thorough and intensive study of the overlying strata and by numerical modelling, a design of suitable pillars of rhombus shape has been prepared for working Top Section in trunk roadway and Bottom Section along gate roadway with Bolter Miner. Further, with the help of numerical modelling and by use of empirical-cum-statistical equations, the design of support system for development of longwall gate roads & trunk roadways was done. The instrumentation and strata management plan suitable for working Salarjung Seam at Shantikhani Longwall Project have also been done. The total design was discussed with the mine management and officials of regulatory agency.

4. Adequacy of barrier to be left against water and TG1 of LWP of ALP for drivage of inspection route, SCCL

The SCCL management has entrusted the work to CSIR-CIMFR, Dhanbad to design the size of barrier to be left against water-logged workings of GDK10 Incline mine and TG1 of Longwall Panel 1 of Adriyala Longwall Project, Adriyala Project Area, SCCL for drivage of a tunnel to inspect the water dam erected at GDK10 Incline mine. After an exhaustive study of the surrounding strata and with the help of numerical modelling, a design of suitable-sized barrier pillars, dimensions of the inspection tunnel with required support system has been prepared and discussed with the mine management.

5. Advice regarding caving behaviour of Adriyala Longwall Panel No. 2 of Adriyala, SCCL

The Management of Singareni Collieries Company Ltd. entrusted CSIR-CIMFR to make a scientific study of strata and support behaviour while extraction of retreating Longwall panel No. 2 of Adriyala Longwall Project, SCCL. The panel under study lies in seam 1 at an average depth of 416.56 m under the Ramagundam coal belt. The area of extraction was 12661 sq.m at main fall with the corresponding face retreat of 38.25m to 41.7m. After main fall, periodic weightings are coming regularly with an interval of ranging 9m to 21.7m. The average periodic weighting interval is 15-16m. Every 4th or 5th periodic weighting (depending on weighting interval) is increasing intensity compare to other periodic weightings. The average weighting zone is 30th chock to 130th chock. Around 30 to 40% of the chocks were bleeding in the weighting zone. The MLD is shown in Fig. 2.5.1

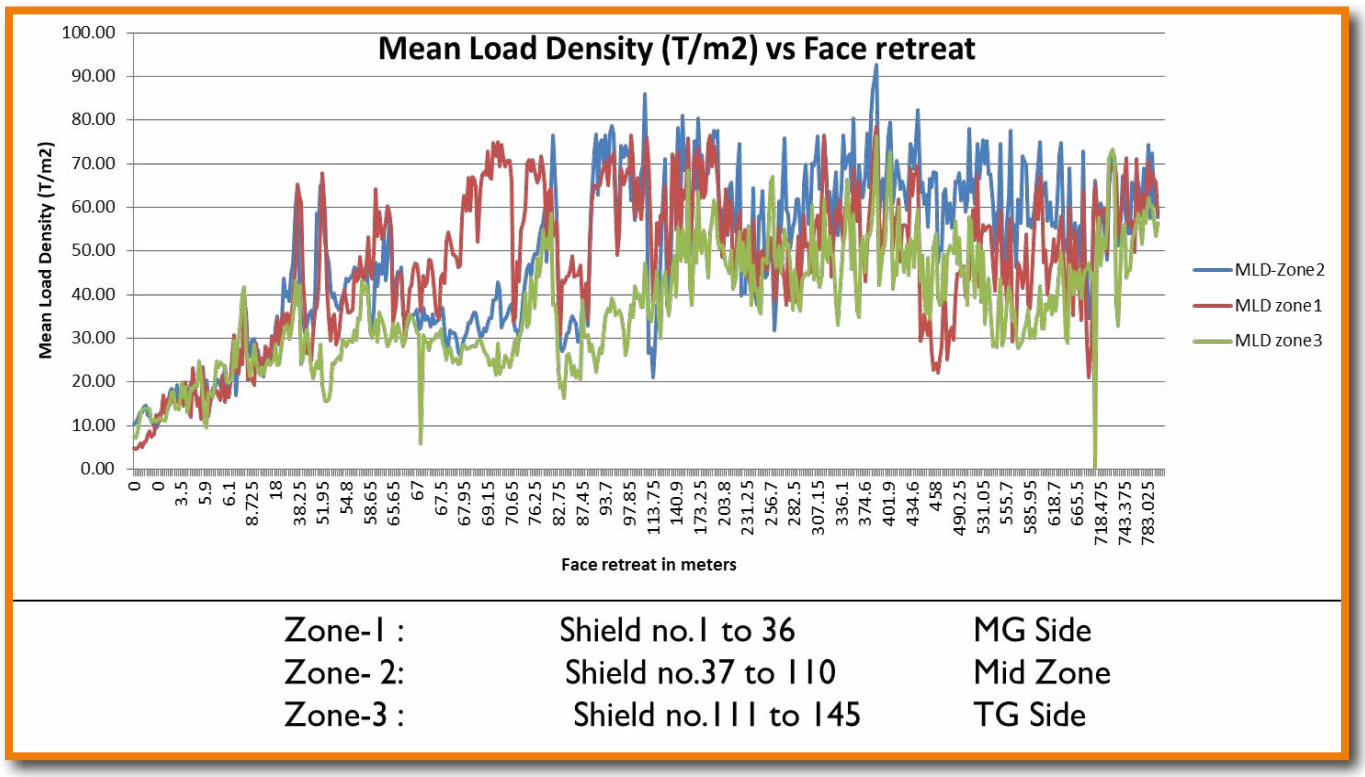
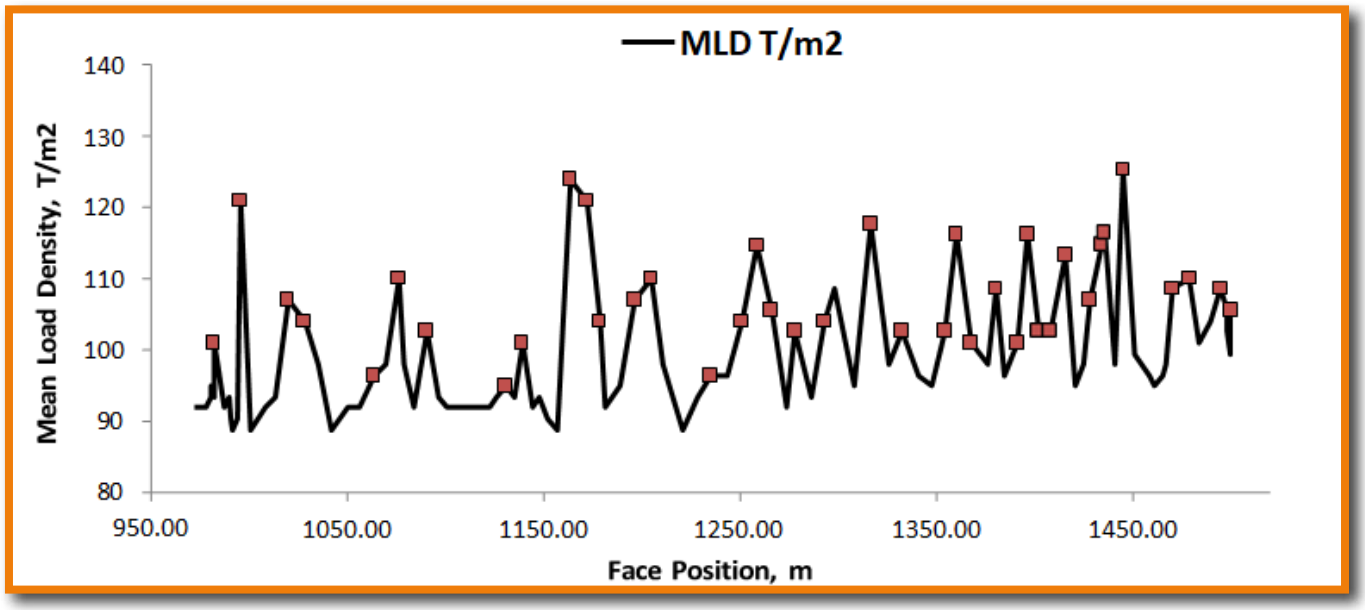


Fig. 2.5.1: Variation of Mean Load Density (MLD) with face retreat

6. Strata and support behaviour investigation of longwall panel-3 in R-VI seam of Jhanjra Project Colliery, ECL

Under the project titled "Strata and support behaviour investigation of longwall panel-3 in R VI seam of Jhanjra project", M/s Gayatri Project Limited, Hyderabad entrusted CSIR-CIMFR, Dhanbad to conduct a scientific study of strata and support behaviour monitoring while extraction of retreating Longwall Panels of R VI seam at Jhanjra Longwall Project. A comprehensive study on strata and support behaviour investigation of Longwall Panel-3 was carried out and report was submitted by CSIR-CIMFR during the period October 2018 to July 2019.

The panel was extracted successfully. The snapshots of loading on supports in terms of Mean Load Density with face position from 950m to 1450m are given below:



7. Design and planning of longwalling at Muraidih Colliery, Barora Area, BCCL.

The mine management has entrusted CSIR-CIMFR, Dhanbad to carry out scientific study on design of support system for development of trunk roadways and gate roadways using Bolter Miner for longwalling in Seam III and Seam I at Muraidih Colliery, Barora Area, BCCL. The work has been initiated, field visits have been made to observe the strata and data collection is being done for numerical analysis.

6.a. MINING METHODS AND MINE DESIGN SIMULATION SECTION (Under Mining Methods and Geo-Mechanics Research Group)

PROJECT REPORT:

Mining Methods and Mine Design Simulation Section plays an important role and has significant contribution for safe operations of underground coal and metal mines across pan-India with due regard to conservation and productivity. This section is entrusted with number of R&D works, including sponsored and consultancy assignments referred by the mining industry related to the method of mining, numerical modelling, rock mechanics, ground control problems and strata monitoring and management. During the period April 2019 to March 2020, this section has initiated twenty two new industry-sponsored projects, grant-in-aid project from Ministry of coal (MoC) and also completed a number of projects taken earlier. The clients included Singareni Collieries Company Limited, M/s Hindustan Zinc Limited, Tata Steel, Gainwell Commo sales Pvt Ltd, GMMCO Ltd, Ergo Exergy Technologies, Canada, various subsidiaries of Coal India Ltd etc. A brief overview of some of the notable completed and ongoing projects by the section is as follows:

Mechanisation is the best option to ramp up production in underground coal mines. This section is contributing significantly for the mechanised extraction of underground coal seams. Continuous miner (CM) based mechanisation is getting preference by the industries, mainly due to its easy adaptability in the Indian geomining conditions by a moderate level of investment with comparatively higher production and productivity. In India, a number of coal seams are being extracted by using CM based technology. As the multiple coal seams exist in most of the coalfields, the CM is deployed to extract the coal pillars under the goaved-out workings in some places. There would be a need in future to deploy CM below goaved-out workings at a number of sites. It is itself challenging to work under goaved-out workings, especially

when the overlying goaves are highly asymmetric in nature like consisting of caved zones, barrier pillars, etc. above the workings. The problems increase when the working is at a higher depth of cover. This section is engaged at VK-7 Incline mine of the Singareni Collieries Company Limited (SCCL), where the developed coal pillars in the King seam under the goaf of Queen seam (Top seam) are being extracted by the deployment of the CM. Another such noteworthy research work is design of extraction method of coal seam beneath massive competent dolerite sill at Churcha RO mine. Here, an innovative design 'T-split method' has been given to address ground control issues like severe side spalling. The section is also involved in design of low height CM (LHCM) panels at 3 & 4 Incline of Jhanjra Project Colliery and other normal height CM panels like Jhanjra MIC and PVK-5 Incline. On umpteen occasions, the surface properties like densely habitated land, water bodies, etc are to be protected by suitably designing the methods of mining which have been done at Bijuri underground mine, PVK-5 Incline and Churcha RO mine. Liquidation of 5A top seam and 4A seam at a parting less than 3.0m and beneath surface and sub-surface properties at West Jhagrakhand Colliery, SECL has also been designed.

Number of strata control and monitoring plan (SCAMP) projects related to development by CM at 800m depth cover and stowing panels of thick seam extraction of Tata Steel Limited and caving panel of low height seam of Jhanjra 3 & 4 Incline have been completed. The section has undertaken a project related to Instrumentation and strata monitoring during drivage of the Inclines by Roadheader, interconnection and one inset in seam IV and seam III at Bicharpur underground coal mine in Shahdol district of Madhya Pradesh. Based on the field investigation, physico-mechanical properties and numerical modelling, support system, instrumentation and strata monitoring have been recommended.

The section has completed a research project related to advice on the feasibility of underground mining of marble of Zarivav Marble mine of M/s D. K. Trivedi & Sons located at Banaskantha district of Gujrat state. This will be the first underground mining of marble in India. In this study, suitable dimension of the gallery and pillar including the assessment of the stability of the surrounding rock mass, crown pillars and the support system for development workings have been designed.

The section has conducted a pre-feasibility study from rock mechanics point of view and related geotechnical issues for underground coal gasification (UCG) mining operation, targeting residual coal resources of Jamadoba Group of Collieries of Tata Steel Limited. In this study, primarily the rock mechanics aspects and related subsidence management, including stress re-distribution and impact assessment of designed barrier pillars between two extraction spans are finalized.

The section has taken up a new project regarding advice on mining sequence and geotechnical monitoring during stoping with top down approach, the first in India at Rampura Agucha underground mine, HZL

One ongoing MoC S&T Grant project and one ongoing CIL R&D Board sponsored research projects are expected to address the two important but new areas of research broadly as "Design of Pillars for Different Mining Methods in Deep Coal Mine Workings" and "Establishing Underground Coal Extraction Methodology beneath Massive Competent Strata: Design and Demonstration at Mauri Mine, Kanhan Area, WCL", respectively. Another newly approved CIL R&D Project "Development and adoption of Real-time Prognosis System (RTPS) for cost effective safe operation of mobile machinery: show-cased demonstration of dumper fleet" has important deliverable impacting the mining industry.

This section also developed a number of empirical formulations for the strength of inclined coal pillar. Some of the works done by the section are shown in Figures 1 and 2.

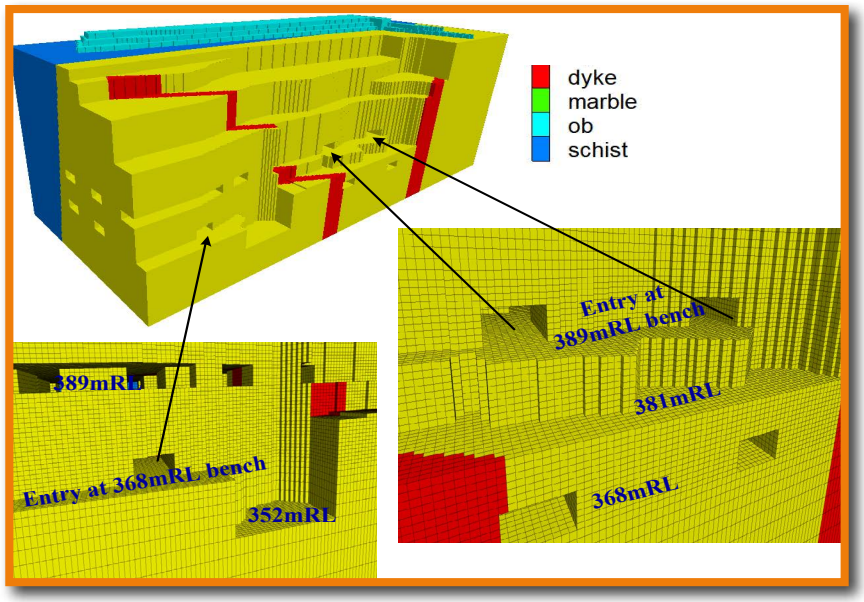


Figure 1: Numerical modelling grid showing the development of the roadways from the opencast bench.

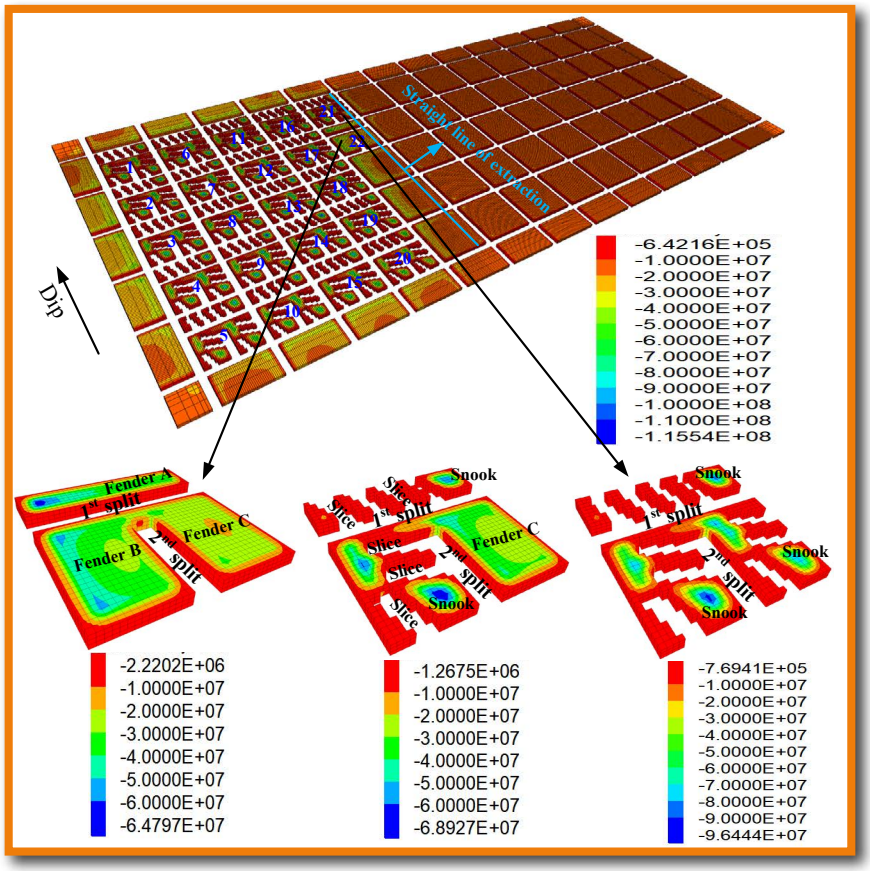


Figure 2: Vertical stress (Pa) contours on different structures during depillaring operation in seam V at Churcha mine (RO), SECL

Apart from the project-related activities, the department imparted training to the students (under the HRD banner of CSIR-CIMFR) of various engineering colleges and Universities. Scientists and staff of the department are also associated with different inter-departmental projects.

i. National Conference on Advances in Mining (AIM-2020) Organised:

A National Conference on Advances in Mining (AIM-2020) has been jointly organised by CSIR-Central Institute of Mining and Fuel Research and The Institution of Engineers (India) on February 14-15, 2020 at CSIR-CIMFR Auditorium, Barwa Road, Dhanbad under the Chairmanship of Dr Pradeep K. Singh, Director, CIMFR-CIMFR, Dhanbad. Dr Satyendra K. Singh, Chief Scientist was the Organising Secretary, Dr Prabhat Kumar Mandal, Chief Scientist was the Convener and Dr Ranjan Kumar, Principal Scientist and Shri Arka Jyoti Das, Scientist were the Co-conveners of this event.

The conference provided an effective common platform for interactions and deliberations amongst the participating dignitaries and delegates from mining companies, academic and research institutes and regulatory bodies. The recent advances in mining were discussed, exchanged ideas and addressed the core issues of mining for further advancement and promote the growth and sustainable development of mining industries.

Her Excellency Smt. Droupadi Murmu, Hon'ble Governor of Jharkhand, as Chief Guest of Inaugural Function, emphasised that the mining sector is essential for the growth of the Indian economy and need to be very sensitive to the environment and tribal people during mining operations. The national conference on "Advance in Mining" may come out with solutions to conserve our environment while continuing developmental activities. Shri Laxman Singh Shekhawat, Director (Operations), Hindustan Zinc Limited graced the occasion as Guest of Honour and highlighted that the advancements in mining are highly pertinent for safety and productivity with the conservation of mineral and environment especially related to deep mines.

Dr. Aboobacker Siddique, Secretary cum-Commissioner, Dept. of Mines & Geology, Govt. of Jharkhand graced the occasion as the Chief Guest of this Valedictory Function. He stressed that mining should give due regards to the environment and society through technological advancements in the mining sector. Shri Prem Sagar Mishra, Chairman Cum-Managing Director, Eastern Coalfields Limited was the Guest of Honour. He emphasized that ECL will adopt the modern method of underground mining for producing most of its coal from underground mines.

There were 21 broad themes in the conference covering different emerging areas of mining. Total of 54 papers has found their places in the proceedings for oral presentations. 10 technical sessions have been conducted with parallel sessions in the two days of the conference including the Keynote Session. Around 50 Academic institutions, Govt. organisations, Public and Private Companies have participated in this conference in different capacities. The conference has been attended by more than 230 delegates and around 20 experts and invited guests.

Welcome of Her Excellency Smt. Draupadi Murmu, Hon'ble Governor of Jharkhand, as Chief Guest of the Inaugural function of AIM-2020 by Dr. Pradeep K. Singh, Director, CSIR-CIMFR

Welcome of Dr. Aboobacker Siddique, Secretary cum-Commissioner, Department of Mines & Geology, Govt. of Jharkhand and the Chief Guest of the Valedictory function of AIM-2020 by Dr. Pradeep K. Singh, Director, CSIR-CIMFR

Inaugural Session (From left-to-right: Dr. S. K. Singh, Shri L. S. Shekhawat, Smt. Draupadi Murmu, Governor of Jharkhand, Dr. Pradeep K. Singh & Dr. Prabhat K. Mandal)

Valedictory Session (From left-to-right: Dr. R. Kumar, Shri Prem Sagar Mishra, Dr. Abubaker Sidique, Secretary, DMG, Government of Jharkhand, Dr. Pradeep K. Singh & Dr. Prabhat K. Mandal)

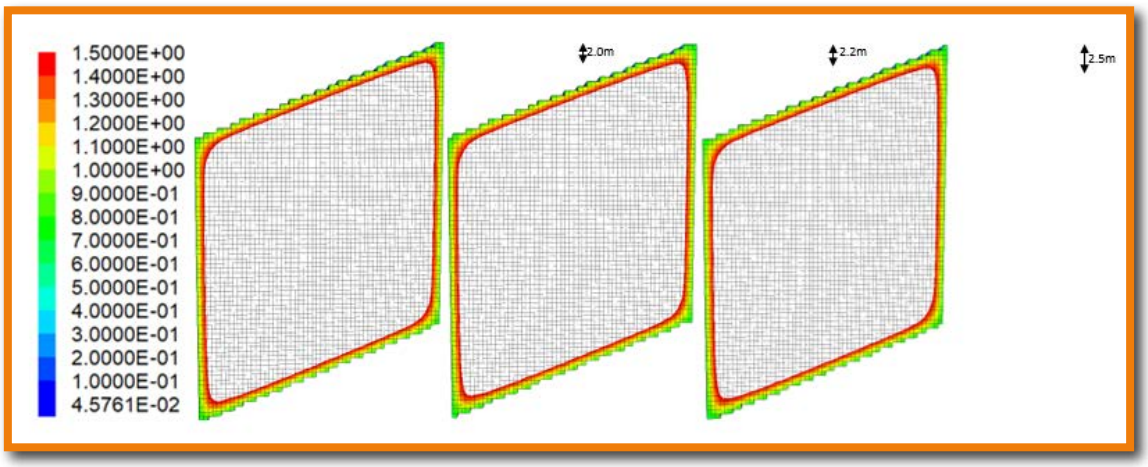
Part of the participants of the conference attended the Inaugural Session of AIM-2020

Part of the participants of the conference attended the Valedictory Session of AIM-2020

6.b. STRATA MECHANICS & GEOMECHANICS SECTION

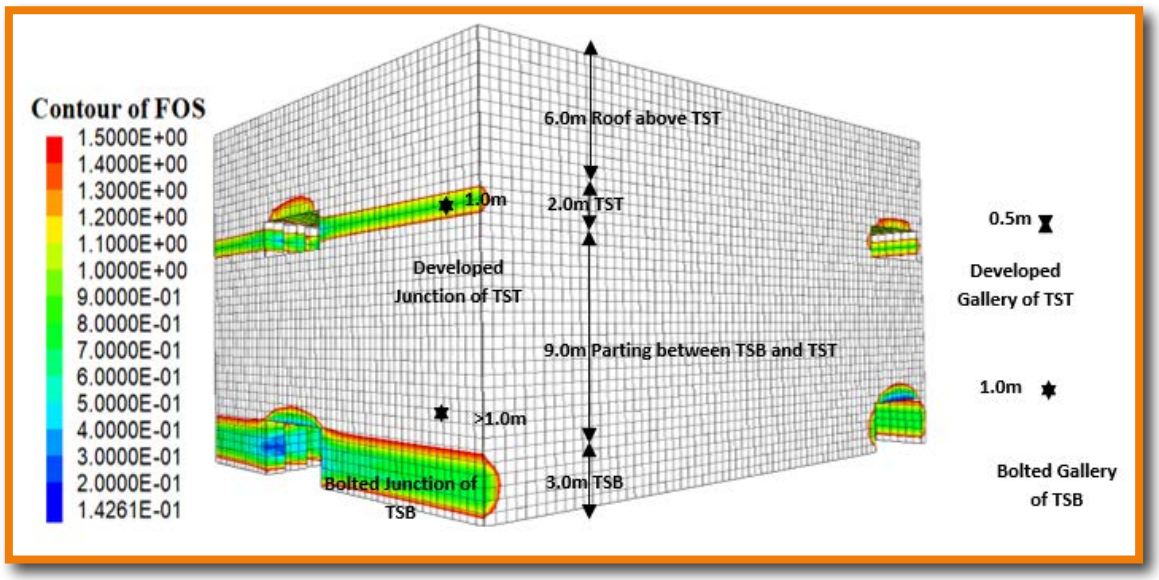
During April 2019 to March 2020, Strata Mechanics and Geo-mechanics Section has undertaken R&D onan in-house project titled “Laboratory experimentations-based design of goaf edge support using high capacity roof bolts”. Also, this Section was engaged in various industries sponsored and consultancy assignments related to rock mass characterization and determination of RMR (Rock Mass Rating) for support design, safe development and design of galleries, rhomboid shaped pillars and support system, ground control and assessment of support system efficacy with reduced pillars size and continuous monitoring of the strata movement against air-blast and subsidence from the time of working to the life of the mine. These assignments were received from companies like M/s Singareni Collieries Company Limited (SCCL), M/s SMS Limited, Kondapuram, M/s Eastern Coalfields Limited (ECL), M/s Western Coalfields Limited (WCL), M/s Bharat Coking Coal Limited, M/s Indian Metal and Ferro Alloys Limited (IMFA), Odisha, M/s Techno-Blast Private Limited, Chhattisgarh, and Jitpur Colliery of Steel Authority of India Limited (SAIL).

CSIR-CIMFR visited the sites located in different parts of India to conduct scientific study for safe development and extraction of pillars by installing strata control instruments and carrying out parametric study on numerical models for different panels of the mentioned mines. Considering the site details of Kondapuram Underground Mine of SCCL, galleries, rhomboid shaped pillars and support system was designed for Thick Seam Top (TST) and Thick Seam Bottom (TSB) using the existing CM technology. CSIR-CIMFR conducted the strata behaviour study in E3panel of Sarni underground mine, WCL during depillaring for assessment of support system efficacy with reduced pillars size and continuous monitoring of the strata movement against air-blast and subsidence from the time of working to the life of the mine. Detailed methodology was suggested for the final extraction of coal pillars using sand stowing and caving techniques in different panels of mines at Satgram Area and Amritnagar Colliery in ECL, including roof bolts as support system at the goaf edges, strata control and management plan (SCAMP).A parametric study is conducted on a number of calibrated models in FLAC^{3D} for design of roof bolts in underground coal mines by varying the values of confining horizontal stress as experienced at the goaf edge for the in-house project.

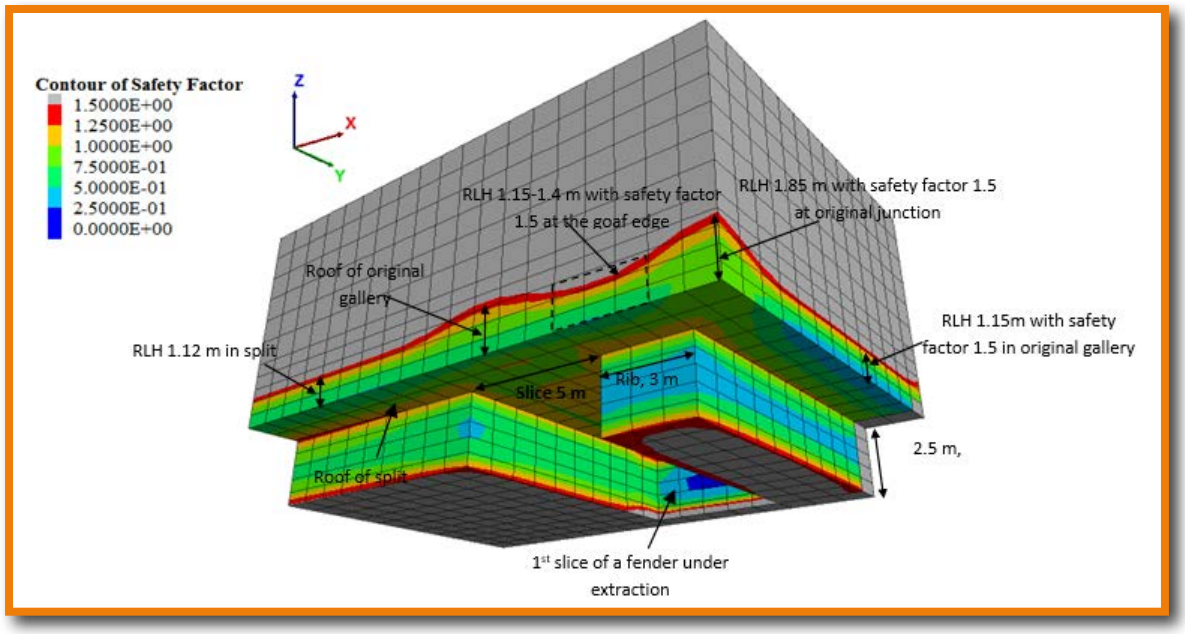


(a) 6.0m (b) 6.5m (c) 7.0m

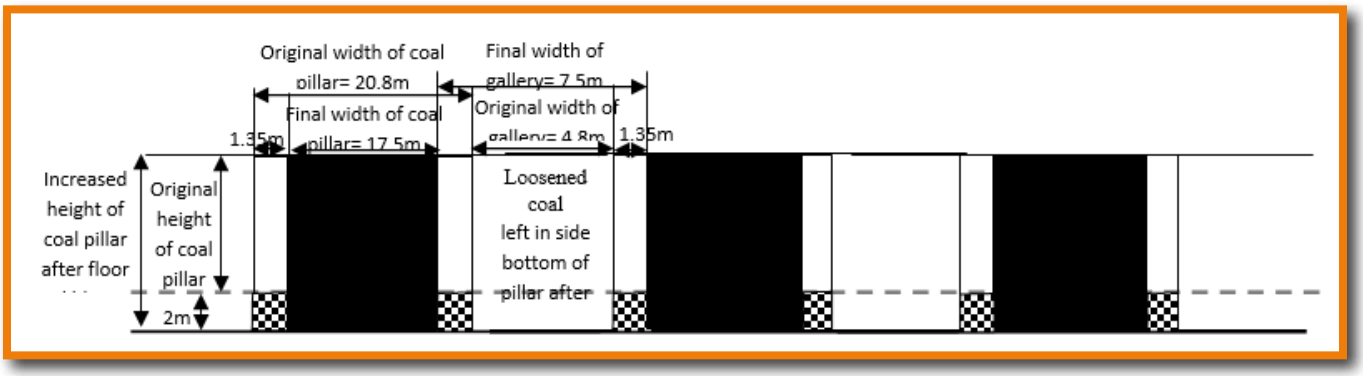
Safety factor contour on rhombus pillar with 70° acute corners and different gallery widths for development of galleries and pillars at Kondapuram Underground Mine.



Safety factor contour at junction and gallery in immediate roof of TST (after development of 6m wide galleries) and TSB (after bolting of developed galleries in TSB) with 70° acute pillar corners at Kondapuram Underground Mine.



Rock load height observed in unsupported immediate roof of original/split galleries, original/slice junctions and at goaf edge in the numerical model for preparation of SCAMP at JK Nagar Project, Satgram Area, ECL.



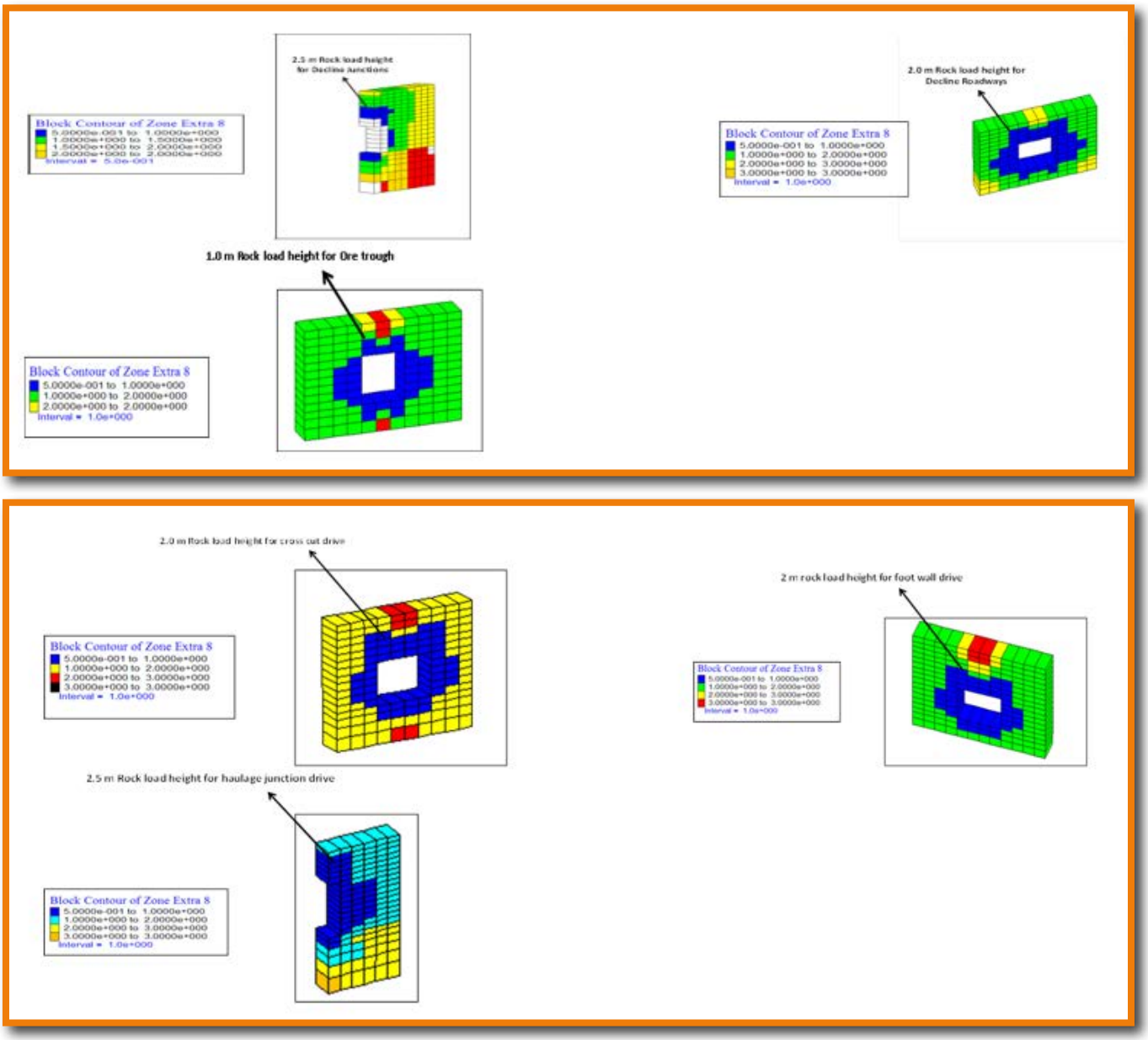
Heightening and widening of galleries in E3 panel of Sarni Mine, WCL.

Support design has been formulated for the stability evaluation of declines, cross cuts, cross cut junctions and ore drive at Mahagiri Mines (chromite), IMFA Ltd. Based on Rock Mass Rating (RMR). RMR is determined by applying two geo-mechanical classification system namely CMRI Geo-mechanical Classification System and Bieniawski's Classification System and rock load is estimated using both of the classification systems as well as from numerical models. It was found that the rock load obtained from Bieniawski's Classification System is on higher side compared to the CMRI Geo-mechanical Classification System. Therefore, rock load obtained by Bieniawski's Rock Mass Classification System is considered for design of support system in the view of permanency of engineering structure. Rock load height is determined for crosscut drive, footwall drive and haulage junctions by numerical modelling at Mahagiri Mines (chromite), IMFA Ltd. RMR of six different coal seams of Gare Palma IV/8 Mine, ACL, Raigarh is determined using CMRI Geo-mechanical Classification System.

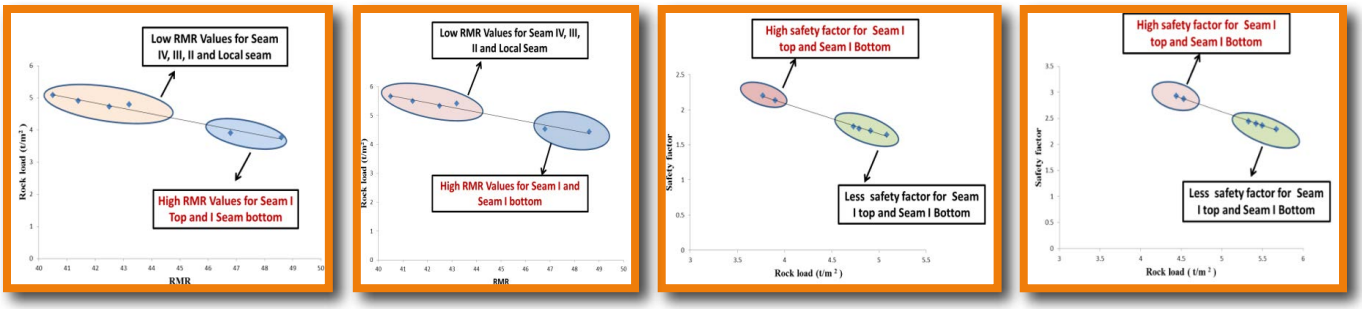
Study was conducted for the determination of RMR and preparation of SCAMP including support design and instrumentation scheme in the developed panels of different mines in ECL. The estimated RMR of the investigated site of the mine was 56.7 (Class III B, Fair roof) and the obtained safety factor of the suggested support system was more than 2 for both galleries and junctions, which found to be safe and stable. In case of observation of higher rate of convergence (>2 mm/day) at working site, extra precautionary measures are suggested to take in terms of support density. The study for determination of RMR of R III/II seam (one district), R IV seam (two districts), V seam

(one district) and VI (one district) at Khottadih colliery in Pandaveshwar Area of ECL was done. Strata movement and efficacy of existing support system was done in Longwall panel of Block 14 to 17 of XIV seam at Jitpur Colliery, SAIL with the help of geotechnical instruments. It helps the mine management to assess the roof behaviour during final extraction and take remedial measures. Research work was also undertaken for Techno blast limited to suggest a suitable support system for underground working at Sial-Ghogri Mine, Chhindwara. The mine is operational after implementation of the suggested support system in the mine.

This Section has signed two memorandum of understandings (MoUs). The first MoU is signed with SMS Limited, Nagpur for design of different elements of mechanised mining technology for safe extraction of coal using continuous miner (CM) packages at Kondapuram Mine, Manuguru Area, Singareni Collieries Company Limited (SCCL) for a duration of 10 years. Another MoUis signed with Institute of Geonics of The Czech Academy of Sciences, Czech Republic for Joint Research in Mining and Applied Rock Mechanics.



Determination of rock load height for decline junctions, decline roadways and ore trough by numerical modeling at Mahagiri Mines (chromite), IMFA Limited.



(a) Galleries (b) Junctions (c) Galleries (d) Junctions

Variation in rock load with respect to RMR and variation in safety factor with respect to rock load for galleries and junctions for different seams at ACL, Raigarh

7. MINE PLANNING AND SURVEYING

7.a. MINE PLANNING, MACHINE HEALTH MONITORING & ERGONOMICS DIVISION

During April 2019 to March 2020, the Mine Planning, Machine Health Monitoring & Ergonomics Division has undertaken various assignments on mine planning and design for opencast and underground mines, tunnel design and industrial automation.

1. Design of safe excavation pattern and support system for proposed new railway tunnel between Ratanpur and Jamalpur stations

Eastern Railway has assigned this project to CSIR - CIMFR to design a new tunnel and monitoring of existing tunnel in Jamalpur. The length of tunnel is about 300m. The main objectives of this projects are to design a safe excavation and support system for the proposed tunnel and monitoring of existing tunnel in Jamalpur.

The core samples collected from six boreholes i.e. (three in the existing tunnel and three in proposed tunnel) were tested for various physico-mechanical properties. All the boreholes are drilled in the core alignment of the tunnel. The details of the core samples provided firsthand information about the rock quality near the borehole, as well as structural information and indications of the amount of water present.

To reduce the risk of accident, detailed monitoring scheme of blast induced ground vibration and strata behavior has been prepared. It was recommended that the monitoring job should be carried out in regular basis both in the existing and proposed tunnels. This project is ongoing.

Figure: Tunnel under construction at Jamalpur, Eastern railway

2. Data collection for preparation of mine closure plan of Kharga-Joydev coal Mine of M/s DVC

Damodar Valley Corporation (DVC), Kolkata Division has assigned to CSIR- CIMFR to collect relevant data and informatios to prepare mine closure plan of Kharga-Joydev coal Mine, Birbhum (WEST BENGAL).As per mining plan of this mine the annual production target is 3.0 MT. The Geological Khagra-Joybev block covering an area of 16.20 km2 lies to the North-East of Kanchanpur Sectors of Rangamati 'B' Block.

The main objective of this project is Collection of data and study of Mining plan for preparation of Mine closure plan with progressive Mine closure plan for KhargaJoydeb Coal mine of M/s DVC, Kolkata for the approval from the Ministry of coal.

3. Preparation of Mine closure plan in respect of Khagra-Joydev Coal Mine

Damodar Valley Corporation (DVC), Kolkata Division has assigned this project to CSIR- CIMFR to prepare mine closure plans as per the MOC guidelines. In this project, efforts have been made to minimize mining footprints on surrounding ecosystem. The baseline data has been collected for mine closure process such as geological, mining scheme, safety and environmental control measures. A schedule for mine closure activity is proposed in sync with the mine life. Financial outlay for mine closure activities are estimated to ensure zero effect on socio-economic and environmental aspects after the mine plan. This project is ongoing. The objective of the project is to protect public health and safety, productive and sustainable after use of the site, protect the flora and fauna of the area, minimize environmental damage and thereby encourage environmental sustainability.

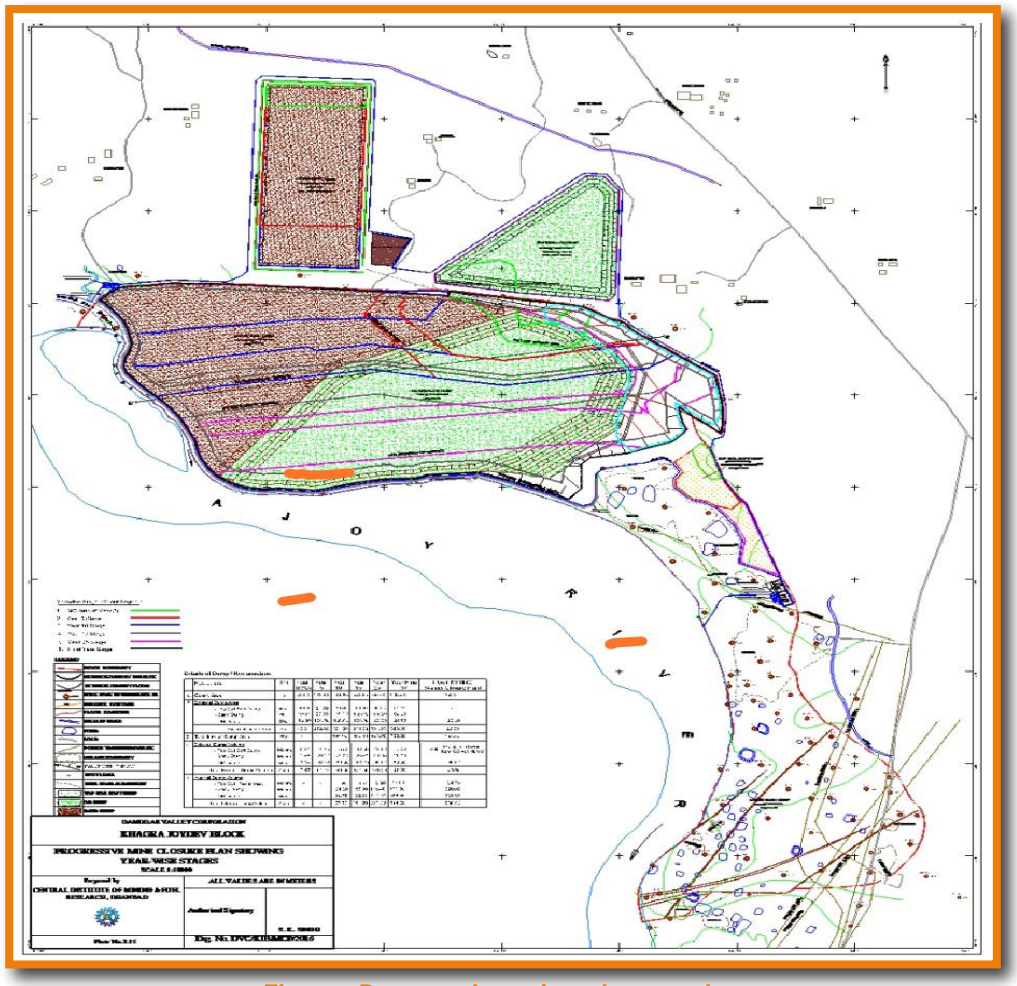


Figure: Progressive mine closure plan

4. Development of microcontroller based fully automated coal transportation system

An in house project has been taken up for automation of the existing manually operated coal handling pilot plant of Digwadih campus using different sensors and IoT technique. The present system is manually operated from control room using push button switches. In total 8 push button switches are being used for operating the pilot plant. The proposed system will convert this manual control unit to a fully automated mobile based control unit. Here the processing unit also communicates with gateway module to send information to cloud database for remote monitoring. To make the system efficient, fast and user friendly, the operator can use android based smart phone to monitor and operate motors of coal handling pilot plant. This developed technology going to implement in large scale, firstly at coal handling pilot plant at Digwadih Campus, later on it will be implemented in various mines.

Figure: Developed system of Coal Handling Plant(CHP)

5. Monitoring of the excavation and support efficiency for the proposed new tunnel between Ratanpur and Jamalpur

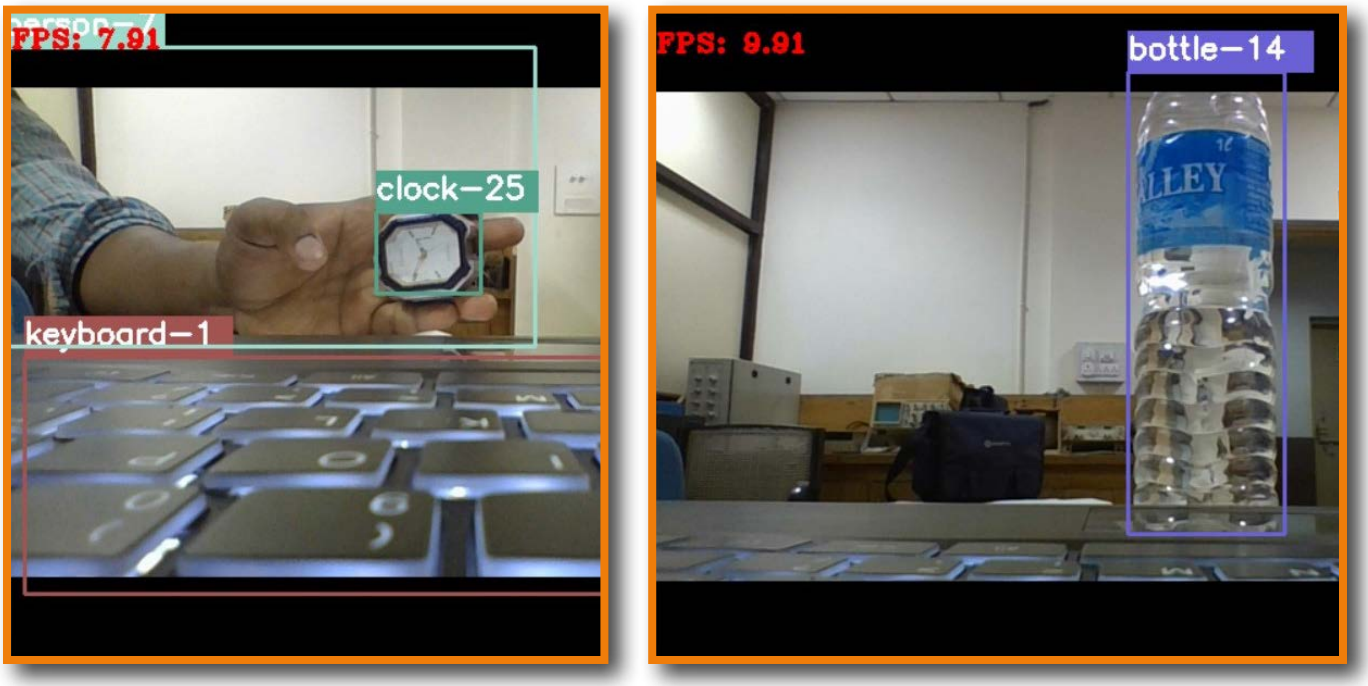
Eastern Railway has assigned this project to CSIR - CIMFR to monitor ground behaviour for safe excavation of the proposed tunnel ensuring long term stability of both the tunnels. This will help the railway management to safely drive and permanently support and stabilize a new tunnel beside an old adjacent tunnel for laying double track, between Jamalpur and Ratanpur railway stations.

Monitoring of the excavation on regular basis is carried out by measuring the blast induced vibration on the adjacent tunnel by using Geophone, deformation of side wall of old tunnel to ensure the safety of old tunnel. (This is on-going project).

Figure A: Blasting operation and blast vibration monitoring at Jamalpur
Figure B: Construction of Railway Tunnel at Jamalpur based on CSIR-CIMFR design

6. Development of continuous monitoring device to identify the rock fall in railway tunnel using Internet of Things (IoT)

An in-house project has been taken up for identification of sudden rock fall in railway tunnel which using the sensors and IoT techniques. The laboratory prototype intelligent system has been developed by using the machine learning technique, which is able to detect the objects in real time and further to develop a full-fledged intelligent system, we need to train the different data sets to perform most effectively and can generate alarm to the concerned authorities by identifying the rock fall in real time. This developed system needs to be tested in real time in the field at Jamalpur tunnel, Eastern railway. Once developed, further it will be implemented in different locations. (This is on-going in house project).



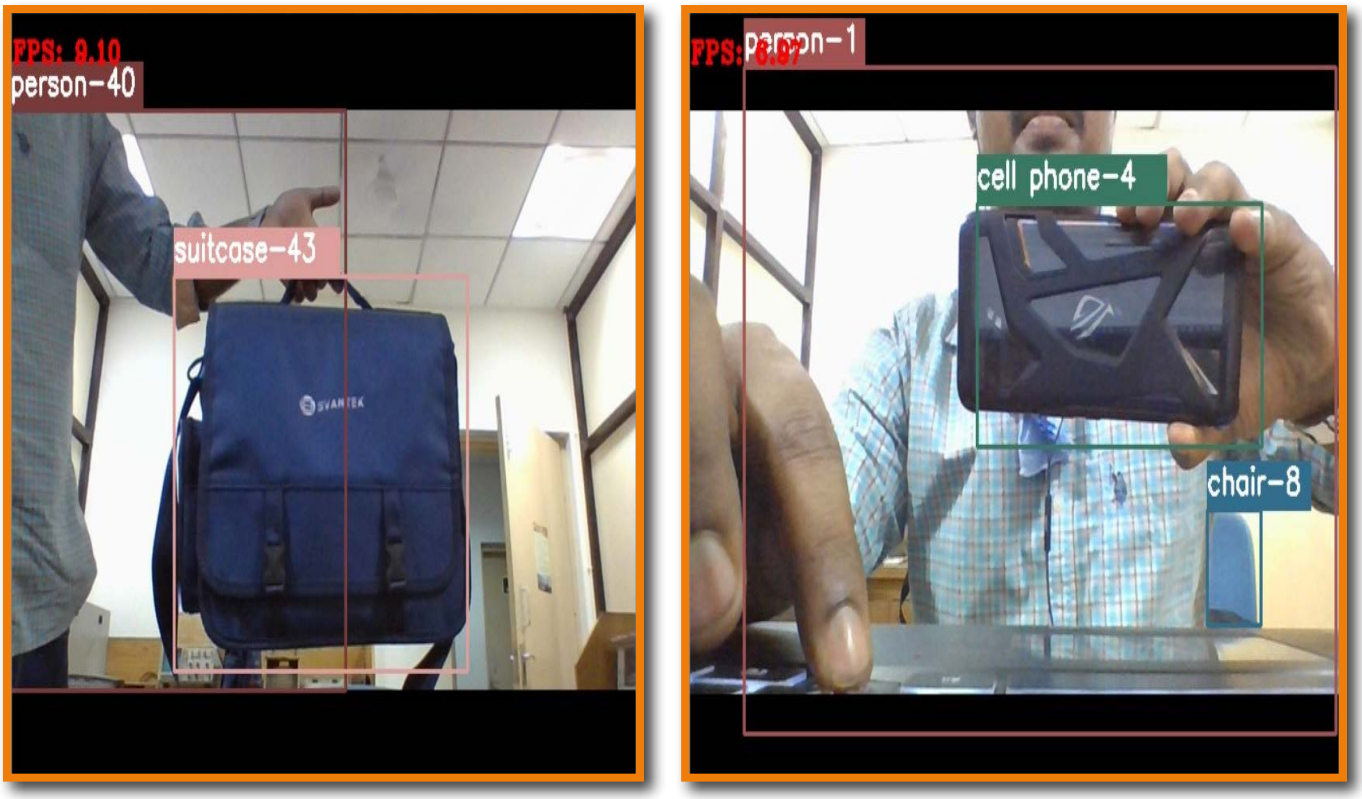


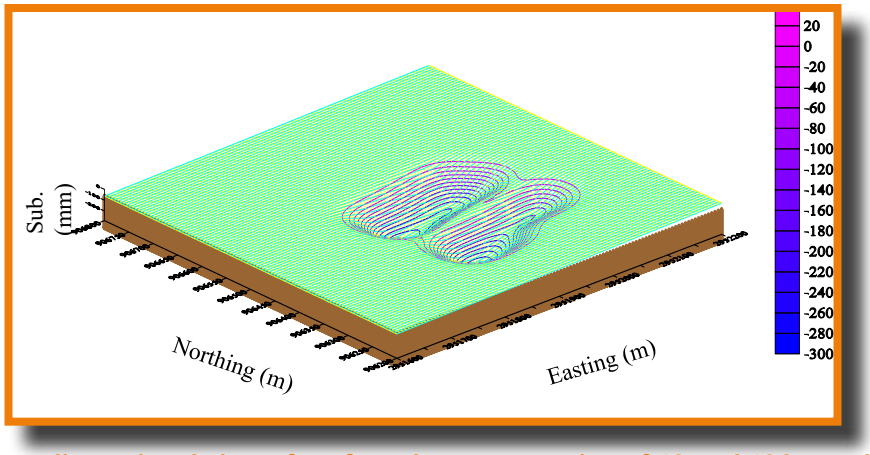
Figure: Machine Learning based object detection system at CSIR-CIMFR

7.b. MINE SUBSIDENCE AND SURVEYING

Mine Subsidence and Surveying Section conducted survey and three dimensional prediction of subsidence in coal mines located in different parts of India. Projects carried out during the period from April, 2019 to March, 2020 are briefed below:

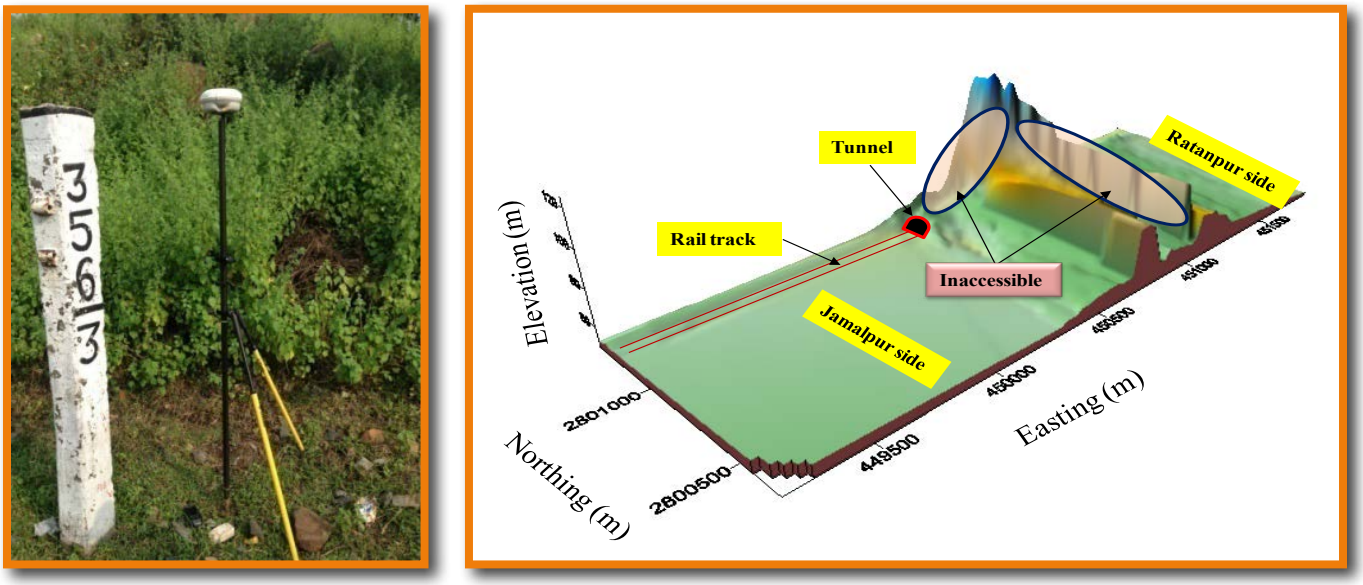
The Gare Pamla IV/5 coal mine of M/s Hindalco Industries Limited, Raigarh proposed to extract 10 and 10A panels of seam II with hydraulic bottom ash stowing. The panels, having a dip of 1 in 21.45, are proposed to be extracted by bord and pillar method of mining up to a height of 2.8 m with 80 percent of extraction. The important surface features and structures over and around the proposed panel-10 is electric line. The land above panel-10A is free from surface structures except electric line. The proposed panel is overlain by virgin seam III, having a parting of 31.80 m from seam II. The subsidence prediction is done by modified influence function method on the surface as well as on the floor of seam III due to the extraction of proposed 10 and 10A panels of seam II. The maximum subsidence, slope, compressive and tensile strain at the surface due to 2.8 m height of extraction of 10-panel with 20 cm stowing gap are 286 mm, 5.57 mm/m, 2.18 mm/m and 1.44 mm/m respectively. The maximum subsidence, slope, compressive and tensile strain at the floor of seam III due to 2.8 m height of extraction of 10-panel with 20 cm stowing gap are 334 mm, 13.32 mm/m, 2.80 mm/m and 2.80 mm/m respectively. The strain values are within the safe limit of 3 mm/m under this mining condition. The maximum subsidence, slope, compressive and tensile strain at the surface considering the combined effect of both the panels on the surface due to 2.80 m height with 20 cm stowing gap are 286 mm, 5.65 mm/m, 2.46 mm/m and 2.66 mm/m respectively. The strain values at the surface are within the safe limit of 3 mm/m under this mining condition. However, the strain value is likely to exceed the permissible limit at the floor of the III seam amounting to 3.44 mm/m. The above magnitude of ground movements are well within the safe limit (i.e. strain less than 3 mm/m) at surface. These anticipated subsidence values are not likely to cause any damage to surface features and structures. For restricting the strain values within 3 mm/m at the floor of III seam it is recommended to extract 2.50 m height coal with 80 percent of extraction in

conjunction with hydraulic bottom ash stowing. It is recommended to maintain stowing gap less than 20 cm for safety viewpoint. It is recommended to monitor subsidence movements during depillaring of the panels to know the actual ground movement and to validate the subsidence prediction model as well. During the course of depillaring operation, the stowing gap can be measured by intrinsically safe and flameproof 3D Laser Scanner. Any other cost effective method can be adopted by the mine management.



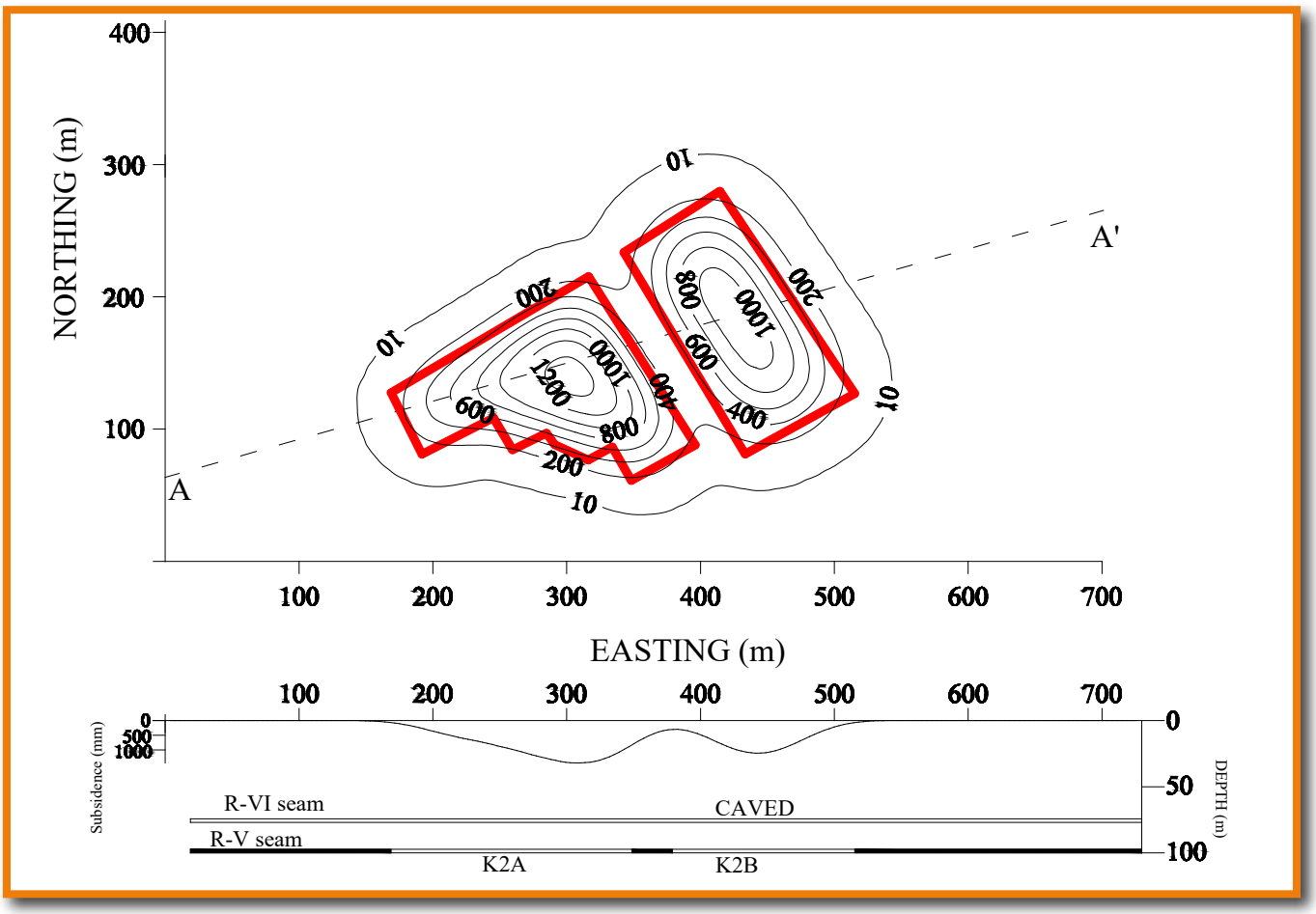
Three dimensional view of surface due to extraction of 10 and 10A panels

A D-shaped tunnel, constructed in 1861, is situated between Jamalpur and Ratanpur railway station in Rajmahal region in the state of Bihar. It is having a length of 275m oriented in East-West direction having a single broad gauge track line. The tunnel is partially lined with brick masonry passes through two different categories of rocks, viz. hard and strong quartzites towards the Jamalpur portal and comparatively weak and charged with water slates. Eastern Railway has proposed to construct a new tunnel through the Jamalpur hill parallel to the existing one. Global Navigation Satellite System and Total Station were used to conduct topographical survey of Jamalpur hill, survey of existing tunnel and demarcation of new tunnel alignment. A Base Station i.e. reference point was established on the terrace of the railway office by keeping the antenna for 12 hours. Twelve permanent survey points, located at both sides of the tunnel, were established for future reference. Topographical survey of the study area was conducted, covering the hill where accessible. Centre line of the proposed rail track was demarcated at an offset of 25 m towards south of the existing track. Tunnel dimension i.e. height and width were measured at an interval of 6 m.



GNSS SurveyThree dimensional view of surface survey at Jamalpur

Khottadih colliery is located in the north-eastern part of Raniganj coalfield of Paschim Burdwan district in West Bengal. The colliery management proposed to extract K2 panel by caving in R-V seam. The height of extraction of K2 panel is equal to the seam thickness i.e. 3.01m whereas depth of extraction varies between 91 m and 130 m. The dip of the seam is 1 in 10. The panel is proposed to be extracted by bord and pillar method of mining with 67 percent of extraction. The surface is covered by an active overburden dump of 30 m height. The proposed panel is located below the caved workings of R-VI seam with an average parting of 23 m. The subsidence prediction is done by modified influence function method on the surface as well as on the floor of R-VI seam due to the proposed extraction of K2 panel of R-V seam and the possible impact of mining is evaluated. The maximum subsidence, slope, compressive and tensile strain on the floor of R-VI seam due to extraction of K2 panel with caving are 1391 mm, 67.33 mm/m, 14.39 mm/m and 14.56 mm/m respectively. The maximum subsidence, slope, compressive and tensile strain at the surface due to extraction of K2 panel with caving are 1488 mm, 27.85 mm/m, 18.94 mm/m and 12.64 mm/m respectively. The above magnitude of ground movements are much above the safe limit (i.e. tensile strain of 3 mm/m) at the surface as well as on the floor of R-VI seam. The anticipated subsidence would alter the surface topography with development of trough formation thereby affecting the active dump. Development of cracks with openings on the intact ground surface around the periphery of the panel is expected. Therefore, it is recommended that there should not be logging of water in the caved portion of the R-VI seam above the proposed panel to prevent seepage of water to the workings of R-V seam. The surface should remain filled-up with dump for minimal accumulation of water at the trough portion. It is also recommended to restrict the movement of men and vehicles over and around the active dump during depillaring. As surface is free from any structures except dump, K2 panel of R-V seam can be depillared with 67 percent of extraction for 3.01 m thick coal by caving with proposed recommendations.



Subsidence profile along section A-A'

8. NATURAL RESOURCE AND ENVIRONMENT MANAGEMENT(NREM) GROUP

I. Projects:

A. Grant-In-Aid Projects:

1. Integrated Cost-effective Technology for Attaining Zero Liquid Discharge in Steel Plants with Emphasis on Steel Slag Utilization

This project for attaining zero liquid discharge is funded by Ministry of Steel, Government of India, as a Grant-in-aid /S&T project. The physico-chemical properties of slag have been evaluated. Wastewater matrix that can be remediated by slag has been identified. Subsequently designs have been finalized for laboratory level prototype; for which a copyright of design has been filed.

2. Standalone Forward Osmosis for energy efficient and sustainable industrial wastewater treatment

This project is funded by DST in February 2020. The central aim of the project is to develop a broad spectrum forward osmosis system which merges upstream and downstream processes. The design and process development towards multiple usages of draw solutes in a single step has been explored. A single step energy-efficient portable osmotic setup has also been developed.

3. Technology development for treatment of acid mine water for its reuse and safe disposal

This project funded by Meghalaya State Pollution Control Board aims to convert acidic water to potable water. For this purpose, a 250 litre/hour pilot plant will be setup in the outskirts of Shillong, Capital city of Meghalaya. Laboratory experimentations towards removal of sulfate, aluminum, iron have been undertaken. Currently design optimizations for fabrication of the pilot plant are being undertaken.

B. Sponsored research projects

1. Groundwater quality assessment and soil infiltration test in Fatehpur district of Uttar Pradesh

This project is funded by WAPCOS Ltd., Delhi having objective to study Groundwater quality assessment and soil infiltration in Fatehpur district of Uttar Pradesh. In this groundwater samples were collected from shallow and deep aquifers of the district and analyzed for major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}), anions (F^{-}, Cl^{-}, HCO_3^{-}, NO_3^{-} SO_4^{2}), heavy metals (Fe, Mn, Cu, Pb, Zn, Ni, Cr, Se, and As) and other general parameters. Similar study was also carried out in Ghazipur and Punjab district, where about 1100 groundwater samples were collected from the depth of 100, 200 and 300 m and tested for the assessment of water quality for different uses.

2. Long term study on radioactivity and heavy metals content in coal and fly ash of Talwandi Sabo Power Limited

In this project quantification of heavy metals content and natural radioactivity levels of raw coal and coal residue and assessment of the associated health risk was evaluated.

3. Sampling, analysis and evaluation of environmental suitability of Red mud, Soil, Ground water and Surface water in the vicinity of Hindalco Industries limited, Muri works, Ranchi

Sampling of red mud, soil, surface and ground water from different places at HINDALCO Industries, Muri works, Ranchi was carried out. Analysis of obtained samples using Indian Standard procedures was carried out for different water quality parameters. On the basis of results obtained the evaluation of Environmental suitability of analyzed samples was carried out.

C. EIA –EMP projects

1. Baseline data generation and preparation of EIA/EMP of Mata No Madh Lignite Mine, Taluka-Lakhpat, Dist. - Kutch, Gujarat

This is funded by Gujarat Mineral Development Corporation Limited (GMDCL) for detailed study of Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). The scope of the study includes detailed characterization of exiting status of environment in the study area with respect to various environmental

components, viz. air, noise, water, land, biological and socio-economic components and other parameters of human interest. Site visit has been undertaken and survey will start soon.

2. Generation of baseline data and preparation of EIA/EMP of Amod (G-19 Ext.) Lignite Mine Project, Taluka Jhagadia, Dist. Bharuch, Gujarat

This project is funded by Gujarat Mineral Development Corporation (GMDC) to carry out EIA/EMP study based on one season (non-monsoon) monitoring of all the environmental component of present mining. It involved air, noise, water (surface and groundwater), soil-along with one season meteorological data coinciding with the same season for AAQ collection. The Terms of Reference (TOR) was approved by Ministry of Environment and Forest, Govt. of India. The study was conducted from October, 2019 to February, 2020. Survey has been done.

3. EIA/EMP of Khanak stone mine of HSIIDC at Bhiwani, Haryana

This project is funded by Haryana State Industrial & Infrastructure Development Co. Limited (HSIIDCL) to study Environmental Impact Assessment (EIA) of the running Khanak stone mine and to suggest suitable Management Plan (EMP), so that stone mining can be carried out with eco-friendly and sustainable manner. The scope of the study includes detailed characterization of exiting status of environment in the study area with respect to various environmental components, viz. air, noise, water, land, biological and socio-economic components and other parameters of human interest.

4. EIA study of Mica, Quartz and Fluorspar mine of Kalichedu village, Sydapuram Mondal, Nellore district, Andhra Pradesh

This project is funded by M/S SreeKalyan Rama Company, Nellore, Andhara Pradesh . In this project Environmental monitoring like air, water, noise level, soil and quality of life studies were undertaken in and around Mica, Quartz and Fluorspar mine of Kalichedu village, Sydapuram Mondal, Nellore district, Andhra Pradesh during January, 2019 to March 2019 with one time baseline data generation. The EIA study has been undertaken for various components of Environment and to prepare an effective Environment Management Plan including estimation of ecological damage with quantification. Beside that remediation plan, natural and community resource augmentation plan corresponding to the ecological damage assessed and economic benefits derived due to violation has been satisfactory done and remediation and alternate damage plan has been suggested accordingly. Along with geo-hydrological studies has been also conducted of that area. The final presentation for this project has been made satisfactory in February, 2020 at MoEF, New Delhi Environmental committee made for Violation.

5. To study the Physicochemical properties of riverine soil for the qualitative and quantitative assessment with its mitigation measures funded by P&M Solutions, Noida, Uttar Pradesh

This project is funded by P&M Solutions, Noida, Uttar Pradesh to study the physico-chemical properties of 100 samples of riverine soils for the qualitative and quantitative assessment with its mitigation measures. In this riverine soil has been collected by standard soil sampling method which was analyzed through standards prescribed for soil physic-chemical analysis like textural (sand, clay, silt) analysis, pH, EC, WHC, permeability and BD.

6. Baseline data generation and Preparation of EIA/EMP of Surkha (N) Lignite Mine village Surkha, Taluka Ghoha, District Bhavnagar (Gujarat)

This project is funded by Gujrat Mineral Development Corporation (GMDC), Ahmadabad, Gujrat.In this project, based on secondary environmental data and mine plan the pre-feasibility report (PFR) and Form-I of the above said mine has been prepared and submitted to Gujrat Mineral Development Corporation (GMDC), Gujrat for onward submission to MoEF&CC, New Delhi for further compliance and ToR presentation. First site visit of mine has been done to finalize the sampling locations for generating one season primary data of environmental component e.g. air, water, soil, noise, socioeconomic survey, hazardous waste, biodiversity, etc by respective FAE's teams.

D. Environmental monitoring projects:

1. Environmental quality monitoring, mitigative measures and related advice for Kathautia Open Cast Coal Mine, Daltonganj, Jharkhand

The environmental study of Kathautia Open Cast Coal Mine, a captive mine of M/s Hindalco Industries Ltd., situated at Daltonganj district of Jharkhand was carried out to know the current environmental status of the mining area. The detailed study with respect to air, water, noise, soil and Flora & Fauna has been carried out in the year 2019-20. Sampling and analysis of $PM_{2.5}$, PM_{10}, SO_2 and NO_2 have been carried out on seasonal basis for the monitoring year in five sampling stations. Surface water, effluent and groundwater samples were also collected. Noise level study has been done for monitoring the ambient noise level in the leasehold area. Based on analytical evaluation of data preventive measures were suggested like use of sprinkling system on haul and transport road, regular maintenance of the heavy earth moving machines and wetting of active OB dumps to avoid wind erosion. The mine management has been implementing, these measures to make mining operation eco-friendly in this coal mine of M/s Hindalco Industries Ltd.

9. ROCK EXCAVATION ENGINEERING RESEARCH GROUP

The Rock Excavation Engineering Research Group of CSIR-CIMFR is formed by the amalgamation of the erstwhile Blasting Department and Explosives & Explosion Laboratories. During the period April 2019 to March 2020, the Research Group has carried out a number of important projects in the field of rock blasting and explosives. The different project works which have been carried out during the reporting period can be divided broadly into four categories as:

(1) Design and development of controlled blasting for safe and optimum blasting operations within the danger zone in various opencast mines and quarries.

(2) Optimisation of blast design parameters for enhanced production in underground metal mines.

(3) Design of safe and effective blasting for hard rock excavations in various civil engineering projects including demolition blast of old structures.

(4) Development of new explosives and quality testing of explosives and its accessories.

I. Design and Development of Controlled Blasting in Opencast Mines & Quarries

The Research Group has successfully developed controlled blast design patterns for conducting safe and optimum blasting operations without affecting the nearby denizens and their residential houses and other important surface structures in many opencast mines and quarries viz. Pachhwara (North) Coal Mine Project of M/s West Bengal Power Development Corporation Limited; Mukutban Limestone & Dolomite Mining Projects of M/s RCCPL Pvt. Ltd.; Gagal limestone Mines of M/s ACC Limited (HP); Banduhurang Opencast Uranium Mines of M/S Uranium Corporation of India Ltd. (UCIL); Gere Stone Mining Project of M/s Katyayni Contractors Pvt. Limited; Aditya Limestone Mines of M/s UltraTech Cement Limited, Shambhupura, Chittorgarh; Godadih Mahal No 2 Limestone Mine of M/s Jindal Steel Power Limited; Rajanka Limestone Mines (F-South Area) of M/s ACC Limited (Unit-Chaibasa Cement Works), Jhinkpani; Pachar Stone Mine of M/s KPS structure Makers Pvt. Limted; Hinauti Limestone Mine of M/s Sidhi Cement Works; Barjora North coal mine of M/s Montecarlo Limited; Stone Quarry Mauza Katnikol, Block No. 15, Sheikhpura, Bihar of M/s Broadway Links Pvt. Ltd. etc.

Apart from the above mentioned mines, studies on blast fragmentation and optimisation of blast design parameters have been carried out at Bailadila Iron Ore Mines (both in Kirandul Complex and Bacheli Complex) of M/s NMDC Limited; Noamundi Iron Ore Mine, Katamati Iron Ore Mine, Joda East Iron Ore Mine and Khondbond Iron Mines of M/s Tata Steel Ltd. and Sukinda Chromite Mine of M/s Tata Steel Limited. In Bailadila Iron Ore Mine, the critical blast vibration limit assessment approach was used to decide the optimum charge weight per delay for proper movement of the rock strata with minimal back-break. The predicted charging and delay parameters were used to suggest the blast design and the suggested blast design was further validated at the mine site. The trial for validation reveals that there was a significant improvement in face movement, fragmentation and back-break minimization from the suggested blasting pattern.

Comparison of magnitude of back break for the experimental blasts conducted during review and validation period at Bailadila Iron Ore Mine

II. Optimization of blast design parameters for enhanced production in underground metal mines

The optimization of blast design parameters for underground production stope blasting and design of blast for faster rate of development drivages has been carried out at the various underground mines of Hindustan Zinc Limited viz. Rampura Agucha Mine, Zawar group mines, Kayad Underground Mine, Sindesar Khurd Underground mine, Balaria, Baroi, Mochia and Zawarmala Underground mines. The impacts of blast-induced ground vibrations generated from the production blasts in underground mines on the safety and stability of surface structures/ village houses located above the underground workings have also been assessed and evolved the safe blast design patterns for stope blasting and mine development blasting.

III. Design of safe and effective blasting for hard rock excavation in civil engineering construction projects

In civil engineering construction works, the Research Group has been engaged in a number of important projects of the country for designing safe and faster rate of hard rock excavations using controlled blasting. The brief works carried out and the significant achievements in some of the projects are listed below.

- The land development works for the construction of Navi Mumbai International Airport required flattening/ cutting of Ulwe Hill (91 m height, 2.5 km length and average width of 1.2 km) and diversion of Ulwe River by constructing 120 m width and 3.2 km length Diversion Channel using controlled blasting. The design of controlled blasting, supervision and continuous monitoring of the total blasting operations have been carried since June, 2017. Nearly 60% of the hill cutting works have been completed and Ulwe river has been diverted successfully in June, 2019 before the onset of monsoon, creating huge relief for the adjoining flood affected inhabitant areas. The project is continuing.
- A massive landslide took place on the right bank abatement in July 2013 while dam excavation work was under progress at Punatsangchhu-I Hydroelectric Project, Bhutan. In August 2016, one further slide took place after extensive stabilization of the failed slope. The feasibility of hard rock excavation works and clearance of landslide debris using controlled blasting within the landslide affected area for the dam construction has been assessed. The blast design patterns and methodology to be followed for safe excavation of rock and clearance of landslide debris have been developed. The excavation works in Dam Block No. 6 have been completed successfully using controlled blasting. The project is continuing.
- The scientific study for safe and economical excavation of rock for the open and underground structures has been started since June 2019 at Pakal Dul Hydro Electric Project (1000 MW) of M/s Chenab Valley Power Projects Pvt. Limited, Kishtwar District, J&K. In the majority of tunnel blasts, more than 85% pull has been achieved using powder factor of 1.75 kg/m^3. More than 1.8 km long tunneling has already been completed safely and economically. The horizontal benching operation at Diversion Tunnel has been carried out using

5.5 m long holes where more than 5 m pull were also obtained with powder factor less than 1.0 kg/m^3. The overbreak generation in Diversion Tunnel and Adit 1 and 1A blasts were also restricted within 6% in most of the rock category of Class III and above. The project is continuing.

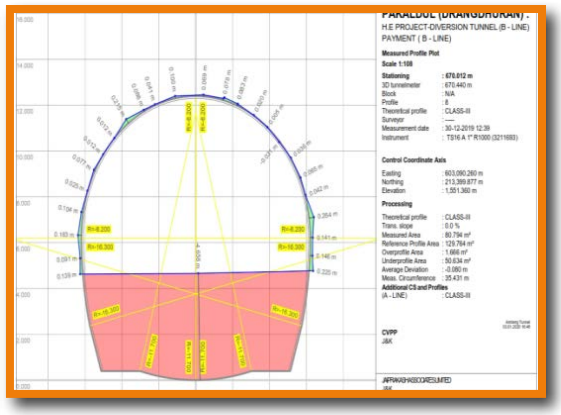
- The land development work for construction of 2 x 660 MW Obra-C thermal power plant is under progress using drilling and blasting techniques. The overall land development work includes blasting at different difficult sites viz. chimney area, wagon tippler area, track hopper area etc. The day-to-day planning and execution of the blasting works have been carried out under the guidance of CSIR-CIMFR. The blasting site in the wagon tippler area was in close proximity to the Indian Railway line within a distance of 60 m only. The blast design along with all the necessary safety precautions, which included block period for train movement, covering the track during the blast, etc. were taken during the blasts. The other required blasting sites were track-hopper area, chimney area, near Obra Market and Pollice station. Controlled blasting works at all these sites have been completed successfully without any damage to the nearby structures and affecting the nearby habitats. The project is continuing.
- The MoU was signed between CSIR-CIMFR and BRO to provide the technical know-how for expediting the pace of rock excavation at the various road construction sites of BRO along the Indian Borders. The Research Group has provided consultation at ten critical roads being constructed near the Indo-China and Indo-Pak borders. The BRO has confirmed the increased pace of excavation at the roads post-CIMFR intervention. The benefits achieved include (a) Increased pace of construction and widening will reduce the construction time of these important roads, (b) Time taken by Indian army and strategic goods to reach the border via roads will drastically reduce, (c) Roads are considered as vehicle of social and economic transformation. Migration of citizens living in these areas to the neighboring country/state in search of better opportunity will reduce, (d) Increased tourism, (e) Diplomatic relationship with friendly countries and (f) Stable slopes will reduce the accident mortality rate of troops and passer-by on the roads.
- Flattening of unstable slopes at Bordave and Shirsawane Cutting Sites (1.15 km length) of Konkan Railway has been carried out successfully using the Directional Controlled Blasting Technique during the period of 23rd December 2019 to 22nd March 2020. The throws of the blasted materials towards railway tracks have been restricted and controlled without damaging the tracks and hampering the movement of trains.
- Railway Over Bridge (ROB) No. 91, located near Pirpainti Yard/station was successfully and safely demolished using controlled blasting on 12th January, 2020. The total blast design, protective measures along with full supervision of the total blasting operations were furnished by the Research Group. Altogether, six numbers of ROB had already demolished and the ROB No. 91 was the last bridge to be demolished. Demolition of the old ROBs enables the Eastern Railways to construct double-lane, electrified railway lines between Pirpainti and Bhagalpur Sections.

View of diversion of Ulwe river at Navi Mumbai International Airport Construction Site

Viws of landslide and required blasting site at the dam construction of Punatsangchhu-I HEP, Bhutan

View of benching operation in Diversion Tunnel in Pakal Dul HEP

View of charging at Adit 1 to HRT, Pakal Dul HEP



Cross-section of Diversion tunnel having 2% overbreaks in Class III rock at Pakal Dul HEP

View of blast face in track hopper area of 2 x 660 MW Obra-C Thermal Power Plant

View of drilling at the road construction site of BRO as per the design provided for safe and speedier progress

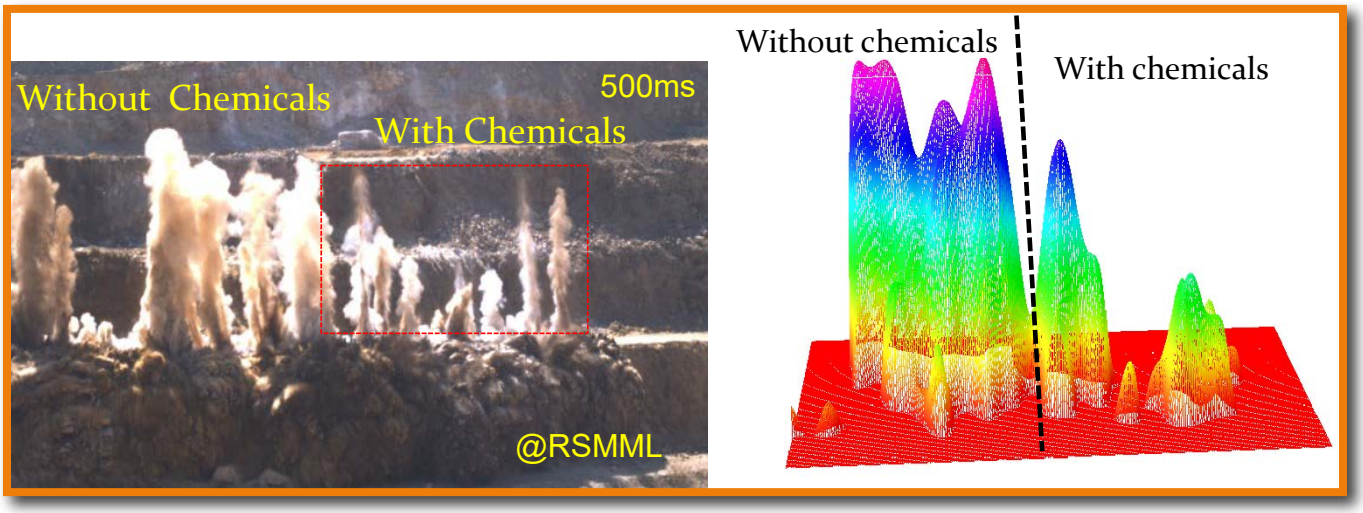
View of blast and throw of post blast rock materials (Throw controlled within blasting area) at Bordave and Shirsewane Cutting sites in Konkan Railway

Views of before and after demolition of ROB No. 91 near Pirpainti Station, Bihar using controlled blasting

IV. Development of new explosives and quality testing of explosives and its accessories

The R&D works carried out in the field of explosives include the development of water-resistant ANFO and replacement of Fuel Oil by the alternative fuels or by the addition of special chemicals in ANFO explosives to enhance the overall performance. The testing and evaluation of explosives and blasting accessories being supplied by the different explosive companies have also been carried out at the opencast mines viz. Jhamarkotra Rock Phosphate Mines of M/s Rajasthan State Mines & Minerals Limited (RSMML) and the various Iron Ore Mines of M/s Tata Steel Limited.

Other than the R&D works in the field of explosives, a chemical composition has been developed which can significantly reduce the dust generated during blasting operations. The trails have already been conducted using the developed chemicals in different rock strata. The morphology analysis of the chemical compositions at various temperatures has also been performed and confirmed the enhancement of networking structures at higher temperature. The technology is in the development stage where the Patent for the developed technology has already been filed.



The comparison of dust generated in a blast with and without the developed chemical for dust control in blasting

Awards

CSIR Technology Award - 2019 in 'Physical Sciences and Engineering' for Controlled Blasting Techniques developed for safe extraction of minerals from mines and construction of various civil infrastructure projects. The award was presented by Hon'ble President of India on the occasion of CSIR Foundation Day on 26th September 2019 at Vigyan Bhawan, New Delhi.

Receiving CSIR Technology Award- 2019 from Hon'ble President of India on 26th September 2019 at Vigyan Bhawan, New Delhi

Agreement Signed

CSIR-CIMFR has signed Project-specific Agreement with Ordnance Factory Dehu Road (OFDR), Pune on 06.02.2020 at Lucknow during the Defence Expo 2020, organized by Ministry of Defence. This agreement has been signed for the construction of underground Magazines and Underground Proof Range for the storage of explosives and ammunition.

Signing of a Project-specific Agreement between CSIR-CIMFR, Dhanbad and OFDR, Pune on 06.02.2020

10. ROCK MECHANICS LABORATORY

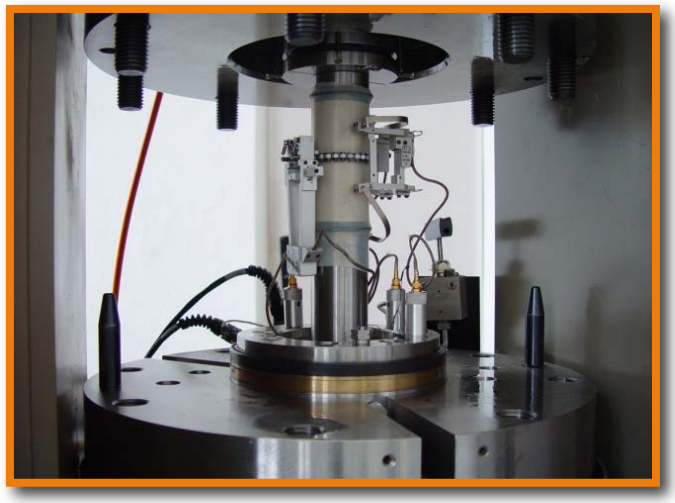
During the month of April, 2019 to March, 2020, the Rock Mechanics Laboratory, under the research group of Mechanics of Solid of CSIR-CIMFR has undertaken various assignments on Physico-Mechanical properties investigation for different rocks from different Coal field, Mineralized zones and different exploratory basins.

During this period, our team offered recommendations for Physico-Mechanical properties of Rock/coal cores on the basis of various geotechnical investigation and statistical assessment. The esteemed organizations were M/s Birla Corporation Limited, Chittorgarh, Rajasthan, M/s Adani Enterprise Ltd., M/s Odisha Mining Corporation Limited, Odisha, M/s Inspectorate Griffith India Pvt. Ltd., Dhanbad and various Regional Institutes of CMPDI etc.

The MTS 815.02 Stiff Testing machine, a state of the art machine for static cum dynamic testing of rock has been installed and commissioned at Advanced Rock Mechanics Laboratory in Bhagwant Singh Building and inaugurated by Governor of Jharkhand on 14.02.2020. MTS 815.02 Stiff testing machine have a Load frame stiffness of 9.0 x 109 N/m, capable of testing rock specimen in high axial force, with compression ratings up to 2700 kN and tension ratings up to 1350kN. Triaxial test facility with confining pressure upto 80MPa. Uniaxial Compression test with capability to measure Axial Strain, Circumferential Strain, Load and Displacement. Load cell range: 25kN, 100kN, 250kN, 500kN and 1000kN. Facility for Indirect Tension Test, Direct Tension Test, Ultrasonic Pulse Velocity measurement and Fracture Toughness Test.

The department has guided six master's dissertations in the field of geology and applied geo informatics from Central university of Karnataka.

The projects undertaken by Rock Mechanics Laboratory during this period are presented here under. The objective of all this project were to determine the statistically significant value of Physico-Mechanical Properties



of various rock formations encountered at various depth of different coalfieild/hydropower projects. This data are very useful in reliable analysis and design of mining and civil engineering projects.

- Estimation of Physical and mechanical properties of BH# CNPKD-25, of Pakribarwadih coal Block, North Karanpura Coalfield, Hazaribagh, Jharkhand, SSP/368/2019-2020
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment of Physico-Mechanical Properties of BH # MBS1R-141 (P-21) of Bhalukasba Surni Phase – I block, Rajmahal coalfield, SSP/369/2019-2020
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Study of Geo-technical properties of coal bearing strata of the western part of Gorhi-Mahloi block of Mand-Raigarh Coalfield and advice thereof, CNP/4820/2019-20
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)

- Assessment of Physico-mechanical properties of Limestone rock core samples from Birla Corporation Limited, Chittorgarh, Rajasthan and advice thereof, CNP/4861/2019-2020
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment of Physico-mechanical properties of Borehole rock core samples from BH # SKP-TR 29 & SKP-TR 30, South Kaliapani Mines, OMC Ltd., Odisha, CNP/4863/2019-2020
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment of Physico-mechanical properties of BH # KEC-11 (P-99) of Kente Extension block, Chhatisgarh, SSP/395/2019-2020
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment of Physico-Mechanical Properties of four borehole from Pachwara South Coal block of Rajmahal Coalfield, Dumka, Jharkhand, SSP/437/2019-20
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment Of Physico-Mechanical Properties of BH # CMBS-54 of Salbhadra Gomarpahari Block, Birbhum Coalfield, SSP/392/2019-20
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)
- Assessment of Physico-Mechanical Properties of BH # MRKB-43 (P-53) of Kabitirtha Block, Raniganj Coalfield, SSP/391/2019-20
  (John Buragohain, Saurav Rukhaiyar, B. Sadhukhan, Shailendra Kr. Singh and Pappu Rabidas)

11. CSIR-CIMFR, ROORKEE RESEARCH CENTRE (Geotechnical Engineering and Underground Space Utilization)

During April 2019 to March 2020, the CSIR-CIMFR Research Centre Roorkee has undertaken assignments of translational research and extended technical expertise as knowledge partner in various projects of National importance in the areas related to (i) Design of highway, railway and hydroelectric power tunnels, (ii) Design of cut slopes along roads, in mines and above tunnel portals, (iii) Rock mass characterization, (iv) Tunnel instrumentation and monitoring, (v) Optimization of rock excavation by blasting and (vi) Safety related problems for tunnelling sectors

The major clients are - Rail Vikas Nigam Ltd., Kolkata & Rishikesh; THDC India Ltd., Tehri; Central Railway, Mumbai; ITNL (IL&FS), Ahmedabad; M/s Larsen & Toubro Construction; M/s Hindustan Construction Co., Mumbai; M/s Consulting Engineers Group Ltd. (CEG), Udaipur; Rithwik Power Projects Ltd., Joshimath; Indic Geo Resources Ltd. (Chandan Steel Ltd.), Mumbai; Haryana State Industrial Infrastructure Development Co., Panchkula and M/s Ultratech Cement, Kovaya.

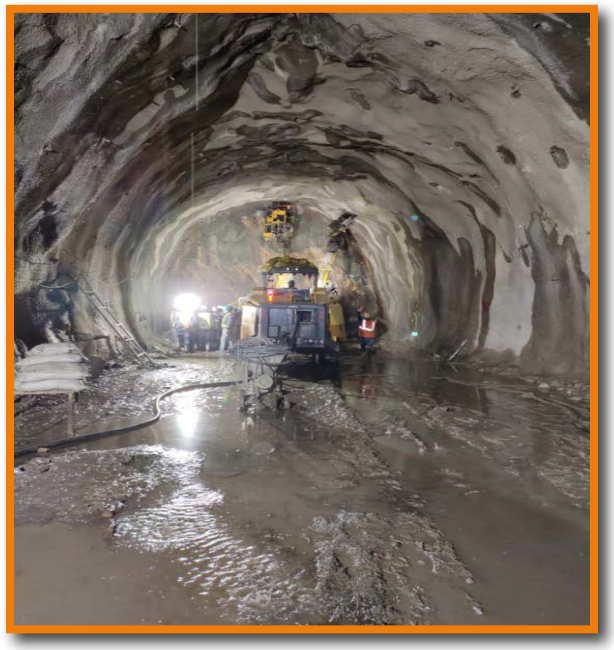
A. PROJECT DETAILS:

1. Rishikesh-Karnaprayag Rail Link Project: Adits 1, 2 and 3

Rishikesh-Karnprayag rail link project is one of the nationally important projects. The proposed rail link will have 12 railway stations between Rishikesh and Karnprayag. The route is 125km long, which involves 105 km tunnelling. In addition to the Geotechnical investigation review of package 2, CSIR-CIMFR Roorkee Centre has been entrusted by RVNL for the consultation work for support design, excavation methods and instrumentation scheme for Adits 1, 2 & 3, which will connect main rail tunnels T1, T2 & T3 respectively. The Adits will open new faces for working in respective main tunnels. Adit 1 of 349.29m length is proposed to traverse through overburden material and inter beded limestone and shale with varying Q-value (0.08-4.4) under overburden of 1.6-166m. The first stretch of about 75m from the portal is full of highly jointed and weathered limestone inter bedded with shale giving a challenging task of establishment of portal. Adit 2 of 612m length will traverse through quartz arenite with varying Q-value (0.95-6.6) under overburden of 3.9-187m. 809m long Adit 3 will traverse through grey limestone with inter bedded shale having Q-value in the range of 0.17-2.64 at rock cover of 5-236m. First stretch of about 70m has to be excavated through silty soil mixed with cobbles and pebbles.

The shape of adits would be modified horse-shoe of size 8.6m x 6.9m. Excavation of Adit 3 has been started and reached uoto 16m from the portal. This stretch is being supported with pipe roofs (104mm, 4mm), steel ribs equivalent to ISHB 200, wire mesh and fibre reinforced shot crete. Adits 1 has just started and Adit 2 is almost completed.

Construction of Adit-1 portal



Installation of wire-mesh in Adit-2

Shotcrete portion of Adit-3

Installation of rib in Adit 3

2. Bhanupalli- Bilaspur-Beri new BG rail link tunnelling (T1-T7)

Government of India through Ministry of Railways entrusted Rail Vikas Nigam Ltd (RVNL) called as Client here, a PSU under Ministry of Railway, with the responsibility of executing 63.10 kms long new single line Broad Gauge (BG) connection from Bhanupali to Bilaspur to Beri. This strategically important railway line is a link providing

significant social benefits and is further proposed to be extended to Leh. The proposed alignment starts near a famous religious shrine Anandpur Sahib, in Rupnagar district, on the edge of Shivalik Hills, in the state of Punjab and goes to Bilaspur and Beri in Himachal Pradesh. The 63km of rail stretch involve seven tunnels (T1-T7) having length of 655m, 787m, 118m, 669m, 632m, 142m and 290m respectively. Figures 1-5 show various tunnel portal under construction.

Fig.1: Slope above tunnel portal T1P2 under excavation

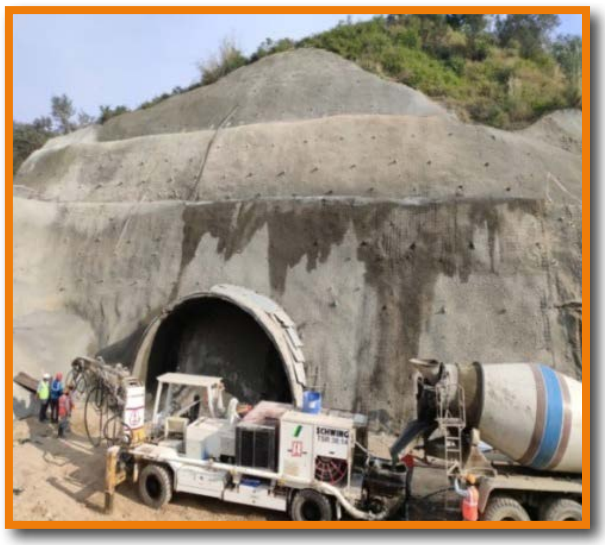


Fig.2: Slope above tunnel portal T2P1 and fixing of false portal after pipe roof umbrella

Fig.3: False portal of T2P2 with supported slopes

Fig. 4: Unstabilized slope, drainage and tunnel face

Fig. 5: Face with roof-pipes at T4P1

3. Construction of Underground Kalvadevi Metro Station using NATM Approach for UGC-02 Package of HCC-MMS JV for Mumbai Metro Line-3

M/s HCC-MMS-JV in constructing underground station at Kalvadevi (Package UGC02) as part of metro line -3 in Mumbai using NATM Approach. M/s HCC have entrusted the work of scientific study for technical assistance in construction of underground station to CSIR-Central Institute of Mining and Fuel Research Institute (CSIR-CIMFR) Roorkee.

The Mumbai metro line-3 works is going under constrained construction environment due to presence of large number of the housing structures along the alignment. Some of the structures are high-rise and in dilapidated conditions too. The cover along the alignment of the underground works is less than 18 m. Moreover, there are sensitive structures like Wadiaji Atash Behram. Hon'ble Supreme Court of India have also restricted permissible level of the ground vibration to 2.544 mm/s peak particle velocity at the Atash Behram. In this regards, blast design was carried out for the faces of Adits 1, 2 & 3 and blast-induced ground vibrations were measured and optimized in order to restrict the vibration limits below the limit decided by Honorable Supreme Court.

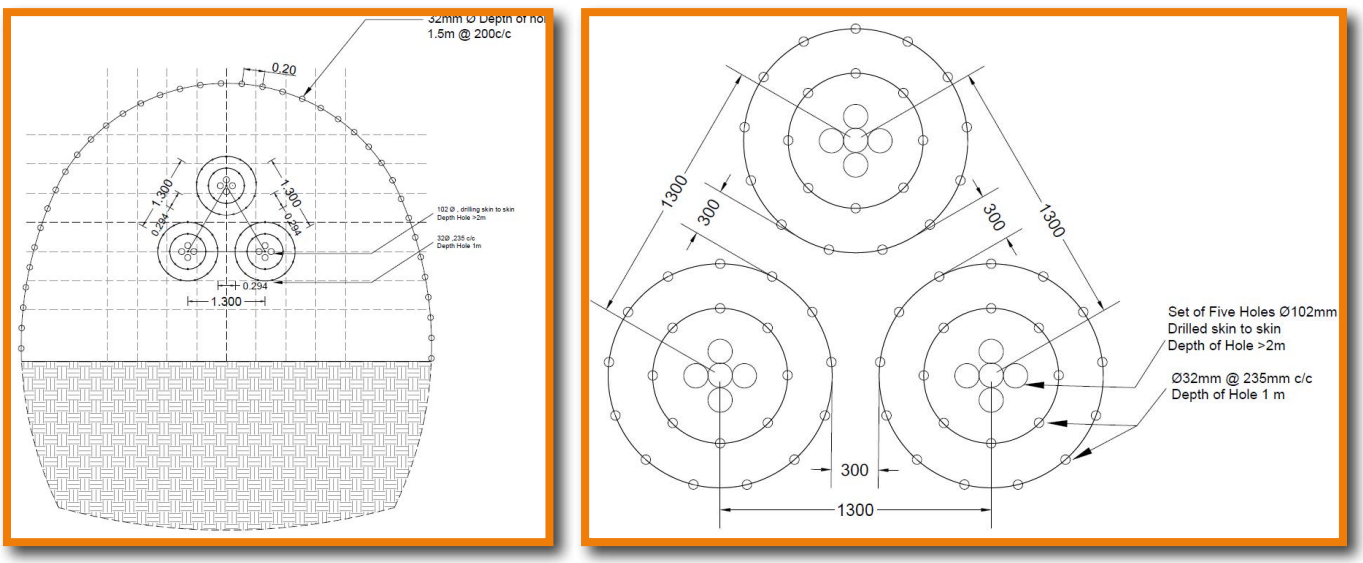


Fig 1: Scheme of blasting widening central pilot hole by blasting

Blasting of shot-hole present in the 1st ring

Blasting of shot-hole present in the 3rd ring

4. Evaluation of Design for Western Railway Tunnel at Pithampur Indore

The single line broad gauge railway tunnel of 2.8 km long in between Tihi and Pithampur stations near Indore in connection with construction of New BG line between Indore-Dahod via Sardarpur, Jhabua & Dhar of Western Railway shall serve the important rail network. The tunnel is located at average shallow cover of approx. 10-12m consisting of soil and weathered basalt as shown in Fig.1. So far about fifty percent excavation work has been completed in these challenging geo-technical conditions. Presently tunnel is supported by primary support using shot crete, rock bolts, wire mesh and lattice girders as shown in Fig. 2. The final RCC lining with water proofing membrane is to be done for maintaining its stability and to accommodate the surrounding challenges such as (i) The tunnel is aligned along the major National Highway (NH-3), there can be heavy vibration impact on the surface of tunnel and at the same time two connecting roads are crossing over the tunnel alignment which can also make impact on tunnel surface due to less cover. Therefore, tunnel has to be adequately supported to accommodate future impact of heavy traffic vibration and load at crossing points over the tunnel and (ii) There is a nearby perennial water pond namely Sanjay Jalashay of Pithampur, which is just across the highway. Its highest water level can be above crown level of the tunnel and it may be a problem of water seepage in future. To overcome this problem, it is proposed to use cement grout before laying waterproofing membrane on the circumference of the whole tunnel from east to west portal. The membrane shall be behind the concrete lining so that seepage if any can be transferred to bottom drain without affecting the lining.

Fig.1: Railway tunnel with soil in crown and weathered basalt in bottom of the face

Fig.2: Primary support using shotcrete, rock bolts, wire mesh and lattice girders

5. Sirohi Bypass Tunnel Project

M/s L&T has constructed 290m long 4-lane tunnel on Beawar-Pali-Pindwara section in NH44 in the state of Rajasthan under NHDP of National Highway Authority of India. This NH-14 highway is in operation since 2014. Twin tunnels, each of 13.36 m wide and 99.0 m height, were constructed between Chainage 220+900 and 221+220 m bypassing Sirohi city. The tunnels are typical D-shaped, 13.360 m wide and 9.0 m height. The tunnels are located below opposite rocks slopes of the two ridges which form a small discontinuous gorge above the tunnels. During monsoon of 2015 and 2016, heavy seepage of water from crown and side wall are observed at several points inside tunnel. M/s L&T requested CSIR-Central Institute of Mining and Fuel Research, Regional Research Centre Roorkee for undertaking a study to evaluate the causes leading to extensive failures of the excavated slope and the reason for the seepage of water inside the tunnel (Photo 5 a & b). During the period tunnel portal support system having rockbolt and shot crete system were implemented at site(Photos 5 a & b). The measures suggested for drainage system along the tunnel alignment have reduced water seepage problem to a large extent and improved the safety of users. The project work is in progress.

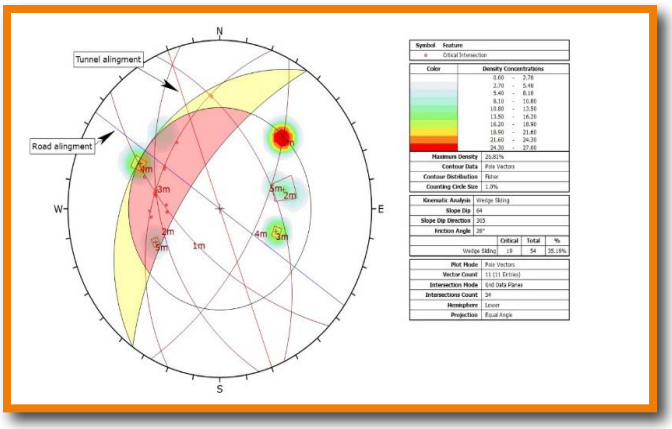


Photo 5 (a) Kinematic feasibility at Portal slope; (b) stabilized section with rock bolt and DT mesh

Photo 5 (a): Pindwara end portal (Before)

Photo 5 (b): Pindwara end portal (After)

6. Vishnugaad-Pipalkoti Hydroelectric Project

Pipalkoti is important World Bank funded hydropower project located in Chamoli District of Uttarakhand. CSIR-CIMFR Roorkee centre is giving technical assistance for rock mass excavation using controlled blasting techniques for construction of various underground hydropower structures such as power house, transformer hall, head race tunnel,

desilting chamber etc. Transformer hall, surge tank and powerhouse are to be excavated in extremely unfavorable rock mass conditions. The work is continuing from previous year. CSIR-CIMFR Roorkee Centre has optimized blast design parameters by monitoring blast induced ground vibrations with varying geology. So far, heading in transformer hall, powerhouse, surge shaft chamber are completed. Rock excavation in benching of Desilting Chamber (DC1, DC2 & DC3) and Head Race Tunnel (HRT) & Open cutting for Dam is in progress (Photo 1&2).

Photo 1: Charged face of Open Bench for DAM Cutting

Photo 2: Benching in Desilting Chamber (DC 3)

7. Agwali Silica Sand Mine of M/s Shivalik Silica

Bharatpur, Rajasthan: CSIR-CIMFR Roorkee Centre has undertaken "Scientific studies on assessment and mitigation of blast induced ground vibration and air overpressure at the Agwali Sand Mine". Also provided the technical assistance in decking, charging, spacing & burden optimisation for having better fragmentation, and to obtain maximum charge per delay (MCD) for mitigation of blast induced ground vibration.

Photo: Blast Induced Ground Vibration Study at Silica Sand Mines & Fragment Size of Blasted Bench, Easily Handled with low capacity Excavator

8. Underground Construction Project of L&T at Vizag

CIMFR Roorkee is assisting in Controlled blasting operations and supervision of the blast induced ground vibration monitoring during rock excavation for large underground construction project of L&Tat Visakhapatnam, Andhra Pradesh.

9. Bhilwara Project

The project is undertaken jointly with IIT Roorkee and CSIR-CBRI on request from Office of District Collector & District Magistrate, Bhilwara to Carry out scientific study and find out the causes & effect of development of cracks in buildings/ structures/roads/drains in and around Pur village of Bhilwara District. The affected area is located about 2 km from the nearby operating Iron Ore Mines of M/s Jindal Saw Ltd. It is to be find out whether mine blastvibrations are responsible for development of cracks in the buildings.

CSIR-CIMFR Roorkee Centre has started the scientific study & assessment of blast induced ground vibration & AOP by monitoring experimental blast in Iron Mine of M/s Jindal Saw Ltd and analysed the attenuation characteristics to establish the vibration prediction model. Accordingly, optimum blast design has been proposed to eliminate the effect of blasting on the buildings of nearby Pur village.

Photo: Iron Ore Mine of M/s Jindal Saw Ltd.

Photo: Cracks in Houses of Pur Village

Training organized:

Two short term training courses on "Tunnel Engineering" were organized for site geologists and engineers engaged on tunneling works of RVNL projects during 7-9May 2019 and 17-19 July 2019 at CSIR-CIMFR, Roorkee Research Centre.

Training Course on Tunnel Engineering, organised by CSIR-CIMFR, Roorkee Research Centre in association with ISRMTT, Roorkee Chapter during 7-9 May, 2019 at Roorkee

Training Course on Tunnel Engineering, organised by CSIR-CIMFR, Roorkee Research Centre in association with ISRMTT, Roorkee Chapter during 17-19 July, 2019 at Roorkee

12. SLOPE STABILITY AND SAFETY GROUP

12.a. FLAMEPROOF & EQUIPMENT SAFETY

When installing electrical circuits in hazardous locations, some form of explosion protection must be applied in the industries. These hazardous areas can vary greatly in size, explosive fuel, or use of equipment. This department has utilized the knowledgebase to enhance the safety of men and materials in hazardous locations. In order to facilitate the safety in industries, this department has carried our various projects such as Advice on electrical safety parameters of Two nos. of Increased Safety Ex 'eb'/'ec' motors rated at 1350KW, 6.6KV, 2Pole Frame size 1SD7452-2; 745KW, 6.6KV, 2Pole Frame size 1MA17636-2 as per IS/IEC 60079-7:2006 at M/s BHEL, Bhopal. The project work regarding safety parameter of one no. Pressurized (Ex 'p') Motor rated at 4800KW/4Pole/11KV in Frame Size 1SB1903-4 as per IS/IEC: 60079-2:2014 for use in Zone-1 & Zone - 2 for Gas Group IIA, IIB & IIC hazardous areasis also completed successfully at M/s BHEL, Bhopal. Based on the test results and design evaluation, the Purged Controlpanel and increased safety motors were found to be compliance with relevant standards and suitable for use in Zone 1 and 2 for Gas Group IIA, IIB, IIC hazardous area.

The project work on Assessment and Technical Advice on surface temperature rise classification and Overpressure of flameproof Motor rated 1HP/4P, Frame Size: 80FLP IF3, rated 2HP/4P, Frame Size: 90S/L FLP IE3 and rated 20HP/4P, Frame Size: 160M/L FLP IE3 for use in hazardous area is completed. This project was sponsored by M/s HEM Industries, Mumbai.M/s. Electronic Instrumentation & Control Pvt. Ltd., Ahmedabad offered project work regarding advice on electrical safety parameters of Partially Purged Control Panel Ex 'pz' in size of 1600mmx 800mmx 2000mm, 1000mmx800mmx1600mm and 800mmx800mmx1600mm as per IS/IEC 60079:2-2007 and NFPA-496-2017 suitable for use in hazardous area. The project work on Advice on electrical safety parameters of one no. partially Purged Panel (size: 2100X800Wx800) for use in Zone 1 & 2 for Gas Group IIC hazardous area is successfully completed at M/s Analyser Instrument, Rajasthan.

Advice on safety parameter like insulation resistance, high voltage, ingress protection no load run test condition of motor rated at 110kW, 6.6KV, 4Pole, 50 Hz. in frame size: DC315F800; 450kW, 3.3KV, 4Pole, in frame size: DC355F3; 550kW, 6.6KV, 4Pole, 50Hz. in frame size: DC400F3 and 200kW, 3.3KV, 6Pole, 50Hz. in frame size: DC450F3, of M/s. Marathon Electric Motors (India) Limited, Kolkata is successfully carried out.M/s Bharat Heavy Electrical Limited, Bhopal offered project titled Assessment and Technical Advice on Surface Temperature rise classification of flameproof motor rated at 850KW/6.6Kv/2P in Frame size: 1MJ7714-2 for use in Zone 1 & 2 for Gas Group IIC atmosphere. On the basis of Assessment of electrical safety parameters and advice as per IS/IEC 60079-15: 2005, the motor under reference confirms to the applicable requirements of type of protection for use in Zone-2 for Gas Group IIA, IIB & IIC hazardous area as defined in IS: 5572. The rotor temperature in locked rotor condition is calculated as per Equation-3 andis limited to temperature class T3 at an ambient temperature of max. 45^{0}C.The various categorised service to industry projects were carried out in the area of inspection of factory as required for the first time manufacturing of flameproof equipment for use in hazardous areas at M/s. Galaxy Flameproof Electrical Control, Vapi, Valsad, Gujarat;M/s. Athom Electric private Limited, Uttar Pradesh (UP); M/s. Siddhivinayak Manufacturing Services, Vadodara. External Cash Flow (ECF) details are as follows:

ECF for FY 2018-19	ECF for FY 2019-20	Remarks
Rs. 1, 97, 61, 829=00 (Rupees one crore ninety seven lakhs sixty one thousand eight hundred twenty nine only)	**Rs. 3,07,86,682** (Rupees three crore seven lakhs eighty six thousand six hundred eighty two only)	Net increase of **56%** approx. compared to last year's ECF.

12. b. SLOPE STABILITY DEPARTMENT

1. Project Report :

1. Scientific study to ascertain the cause and circumstances of strata failure at Bharatpur OCP, Bharatpur Area, MCL

An accident occurred on 23-07-2019 at Bharatpur Opencast Project in Bharatpur Area of Mahanadi Coalfields Limited (MCL) in which the barrier pillar and adjoining dump mass failed. The accident occurred in the Rakas district near Padmabatipur village of Bharatpur Opencast Project of Bharatpur Area of Mahanadi Coalfields Limited at about 10.25 pm on 23-07-2019, in which unfortunately four persons died after getting trapped under the debris and nine persons received minor injuries. Moreover, many HEMM like dumpers, dozers, shovel, continuous miner working in that area were damaged. Photographs given below shows the accident site and damaged HEMM at Bharatpur OCP.

MCL management requested CSIR-CIMFR for scientific study to ascertain the causes and circumstances of strata failure on 23.07.19 at Bharatpur opencast project of Mahanadi Coalfields Limited. Based on the observations at the accident site, discussions with mine management, past records, plan and sections, reports of geotechnical cell of Bharatpur area, monitoring results and analysis of effect of different factors and their possible combinations, possible causes and circumstances have been found out which resulted in failure of barrier pillar and adjoining dump mass in Rakas district of Bharatpur OCP, MCL on 23.07.2019. These results are not presented here as the matter is still sub-judice.

2. Advice on pit slope stability of Kerandari Coal mining Project of NTPC Ltd.

M/s NTPC Limited entrusted CSIR-CIMFR the scientific study for slope design of ultimate pit of Kerandari Coal Mining project. The optimum slope design was worked out for pit depth upto 130m. As the mine is not yet opened there is likely to be variation in the geo-mining conditions, mine management was advised to revalidate the slope design within five years of start of operation of mine or before reaching 320m RL whichever is earlier. It would help in optimization / slope steepening of the pit slope design with latest available geotechnical data/ information. This fresh geotechnical study may lead to achieve the better financial goals without sacrificing the safety.

3. Advice for optimum design of three nos. of external overburden dumps of 120m height and one number of internal dump upto ultimate pit limit at Pakri Barwadih coal mining Project of NTPC Ltd.

M/s Thriveni Sainik Mining Private Limited entrusted CSIR-CIMFR the scientific study for optimum design of slopes of three nos. of external dumps and one number of internal dump of Pakri - Barwadih Coal Mining Project (PBCMP). Dump slope faces are designed to be stable, but where they are located in naturally variable or uncertain conditions, failure inevitably develop. The loss following a slope failure is more than simply a cost encompassing unbudgeted expenditures and revenue but can result in to physical loss from injuries or, worse, fatalities. Mine management was interested to increase the height of external dump from previously approved 90m height to 120m height to accommodate additional waste material within same demarcated dump area. Proposed internal dump of the mine was of 420m RL difference which is possibly one of the highest proposed internal dump in Indian coal mine and thus was a challenging task to design. Relative positions of different external dumps – A, B & C and internal dump of Pakri - Barwadih Coal Mining Project (PBCMP) have been shown in Figure below.

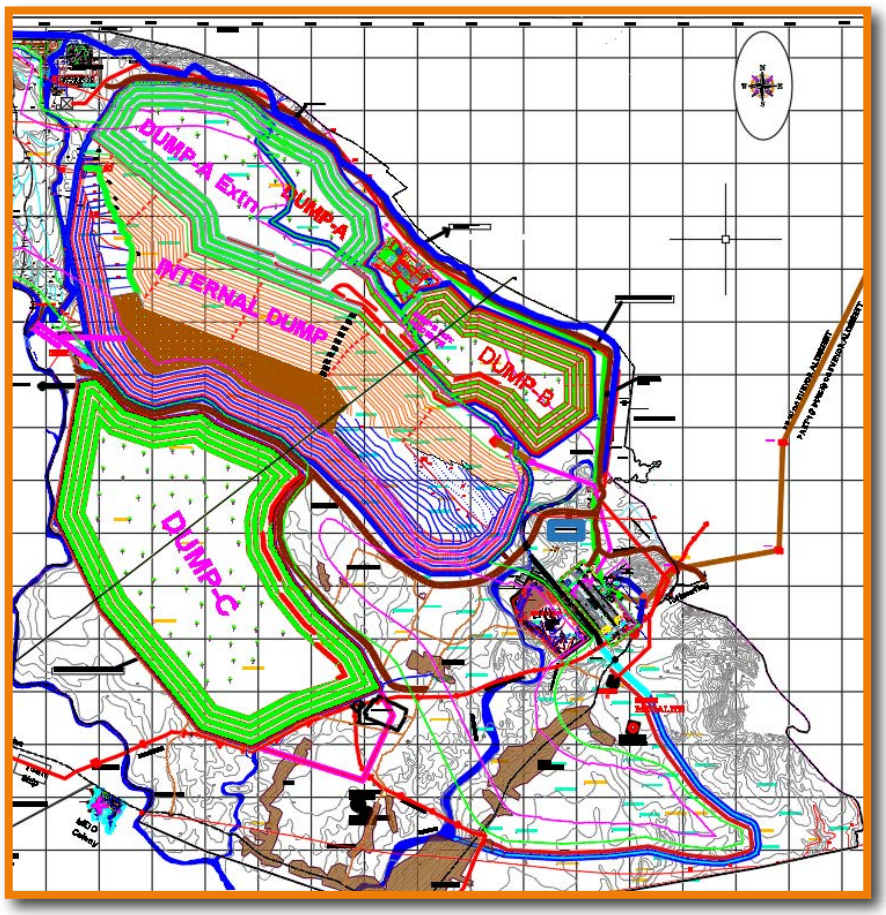


Figure: Position of different external and internal dumps of PBCMP

Geo-mechanical properties of the dump materials collected from different parts of existing dumps were determined in the laboratory. Different possible combinations of bench height and width of the different dumps were analysed to come out with the optimum design of the external and internal dumps.

4. Advice on optimum slope design of pits and dumps at Katamati, Noamundi, Joda East , Khonbond Iron Ore mines of Tata steel

M/s Tata Steel entrusted CSIR-CIMFR the scientific study for optimum design of slopes of total 11 nos. of pits and 16 nos. of dumps of four mines namely Katamati, Noamundi, Joda East, Khonbond Iron Ore mines. All these pits and dumps were of different depths and heights and were comprised of varying lithological units. Considering the geo-mining conditions and results of laboratory experimentations for assessment of geo-technical properties, optimum combination of bench height, width and slopes were suggested considering safety, cost-effectiveness and conservation points of view. Appropriate safety and precautionary measures were also suggested to avoid their failures.

5. Scientific study for dump slope monitoring of quarry-D of South Kaliapani mine, OMC Ltd.

Quarry-D of South Kaliapani Mine is a Chromite mine belonging to Odisha Mining Corporation Ltd. Work was awarded for Studying the condition of dump slope with respect to instability of the slope. CSIR-CIMFR Dhanbad carried out the work of the slope monitoring successfully giving appropriate advice to mine management from time to time regarding measures to be taken to ensure slope stability.

6. Scientific study for slope stability of pit and dump at Sukinda Mine (Chromite) of IMFA

M/s Indian Metals and Ferro Alloys (IMFA) awarded the work of assessing slope movement conditions of pit and dump slopes of its chromite mine. Work was executed for a period of one year by taking movement observation four times in a year. The study helped the mine management in ensuring the stability of pit, dump and running the mine scientifically.

7. Advice on Slope steepening and optimum pit slope design for quarry D of south kaliapani chromite mine, OMC

Quarry-D of South Kaliapani mine of OMC entrusted the work of redesign of pit walls to CSIR-CIMFR as the pit had acquired significant depth of about 130m. Earlier design of pit was reviewed and additional slope stability study was conducted along with fresh testing of samples of different lithologies of mine. This study helped the mine management in further steepening of pit walls to 30°.

B

INFRASTRUCTURE AND TECHNICAL SERVICES

B INFRASTRUCTURE AND TECHNICAL SERVICES

13. BUSINESS DEVELOPMENT & INDUSTRIAL LIAISON

13.a. BDIL

The following events were organized by BDIL Division during 2019-20:

1. **Shri V. K. Saraswat,** Hon'ble Member, NITI Aayog, New Delhi was the Chief Guest of 73rd CSIR-CIMFR Foundation Day held on 02.04.2019 at CSIR-Central Institute of Mining and Fuel Research, Dhanbad. He has delivered Foundation Day lecture on "New Frontiers of Engineering" at CSIR-CIMFR Barwa Road campus on 2nd April, 2019.
2. **National Technology Day** was celebrated at CSIR-Central Institute of Mining and Fuel Research, Dhanbad on 11.05.2019. Dr. P. D. Chawan, Sr. Principal Scientist, CSIR-CIMFR delivered a lecture on "Coal gasification scenario in India". It was attended by all Scientists of CSIR-CIMFR, Dhanbad.
3. **World Environment Day** was celebrated at CSIR-Central Institute of Mining and Fuel Research, Dhanbad on 05.06.2019 in association with Institution of Engineers, Dhanbad Chapter. Prof. A. K. Singh, Head, Centre for Mining Environment Deptt., IIT (ISM), Dhanbad delivered a lecture on "Air Pollution".
4. **Prof. Rudra Pratap,** Deputy Director, Centre for Nano Science & Engineering, Indian Institute of Science, Bengaluru visited CSIR-CIMFR, Dhanbad as Chief Guest of 78th CSIR Foundation Day celebration. He delivered foundation Day lecture on "How Do Crickets Sing So Loudly? The Mechanics behind Nature's Micro-Transducer Orchestra" in the Auditorium of CSIR-CIMFR, Barwa Road, Dhanbad on 27.09.2019.
5. **National Science Day** was celebrated on 28.02.2020 at CSIR-Central Institute of Mining and Fuel Research, Dhanbad. Dr. Prasanta Sanyal, Professor, Deptt. of Earth Sciences, Indian Institute of Science Education & Research (IISER), Kolkata delivered the Chief Guest address on "Evolution of Indian Monsoon (Summer & Winter) and its impact on vegetation and river dynamics".

13.b. HRD, SKILL DEVELOPMENT & JIGYASA

Following are the HRD Activities during 1st April, 2019 – 31st March, 2020:

1. Two Executive Development Programmes / Skill Development Programmes were conducted by HRD, CSIR-CIMFR, Dhanbad for knowledge dissemination

Sl. No.	Name of Course	Duration	Participating Organisation
1.	Executive Development Programme on "FLP Equipment"	25-29 November, 2019	Executives from ONGC
2.	Short Term Course cum Workshop on "Global environment and Green House Gases from Energy System: Estimation and Mitigation" (GEM 2020)	20-25 January, 2020	Oil India Ltd., BCCL, TATA, MCL, Reliance Industries, MECON, NTPC, ECL, SECL, etc.
3.	Skill Development Cum Training Programme on Precise Surveying using Modern Equipments"	24-28 February, 2020	BCCL, Students from BIT Sindri, KK College of Engineering & Management, etc.

2. IN-House Training arranged:

Sl. No	Name of the Course	Duration	Participants
1.	Orientation Training Programme	29-30 August, 2019	Newly Recruited JSA & Jr. Stenographer, CSIR-CIMFR
2.	Induction Training Programme organized by CSIR-HRDC, Ghaziabad	3-7 September, 2019	Technical Officer of CSIR-CIMFR

3. **Vocational/Project Training** for the PG & UG Engineering and Science students were arranged according to their academic session. **109 PG** Science/Engineering and **207 UG** Science/Engineering a total of **316** students of different streams like Computer Science, EEE, Mechanical Engineering, Applied Geology, etc. were benefited from the Vocational/Project Training during the said period. Students from different Colleges/Universities namely IIT (ISM), Dhanbad, BIT Sindri, BHU, IIT, NIT, BITS Pilani, Central University, Patna University, etc come to get their project training/internship as their academic requirement.
4. **Facilitated CSIR-CIMFR personnel to attend in organised Seminar, Symposium, Workshop: 374** S&T personnel of the institute attended in various National & International Conferences/ Seminars/ Workshops at national & international platform as a part of knowledge sharing & knowledge management.
5. **Participated in Mining Exploration Convention & Trade Show (Mining Mazma-2019)** 12-14 September, 2019 at Bengaluru.
6. **Workshop on "Recent Advancement in Coal Carbonization Opportunities & Challenges"** was organized at CSIR-CIMFR, Digwadih Campus (28 – 29 November, 2019)
7. **National Conference on "Advances in Mining" (AIM)** during 14 – 15 February, 2020 was organised at CSIR-CIMFR, Dhanbad.
8. **Jigyasa Programme**
   i. **Two days interactive chemistry laboratory session** under the JIGYASA program. was organized by CSIR - CIMFR on 19/12/2019, 100 students from KV Bokaro, DAV, Sanskriti Vidyamadir and Carmel visited CSIR-CIMFR, digwadih campus. A team of scientists visited KV, BINOD NAGAR Dhanbad on 20/12/2019 where the hands on demonstration programme was held for another 100 students.
   ii. **Two Days Hands-On Training-cum-Workshop on Robotics & Internet of Things** at Kendriya Vidyalaya on 11-12 February, 2020 was organized.
9. **Twenty Two lectures were** organised on Technical Topics from experts from industries.
10. **Four Numbers of visit of students** from different Colleges/Universities like IIT(ISM), Dhanbad, BHU, Govt. Polytechnic Koderma, AISECT University, Hazaribagh visited to different labs of CSIR-CIMFR, Dhanbad to get acquainted with the knowhow and enhance their knowledge in engineering science – total participants : **136.**
11. **Awards Received by CSIR-CIMFR and Scientists during 2019 – 2020**

i.	CSIR-CIMFR	CSIR-Technology Award 2019 - Physical Sciences Including Engineering 2019 for Controlled Blasting Techniques developed for Safe Extraction of Minerals from Mines and Construction of various Civil Infrastructure Projects
ii	CSIR-CIMFR	CSIR- Technology Award 2019 - Business Development and Technology Marketing 2019
iii	Dr. Bodhisatwa Hazra	CSIR Young Scientist Award-2019
Iv	Dr. Raj Shekhar Singh	National Geoscience Award in 2019
v	Dr. Arun Kr Singh	National Geoscience Award in 2019

13.c. INFORMATION TECHNOLOGY & PROJECT MONITORING SECTION

Mandate:

- Project cell acts as a bridge between the Project Leaders and the Sponsoring Agencies on one hand and facilitator between Scientists, Director, and different wings of administration including accounts on the other hand.

The Main Activities:

- Project cell acts as repository of the project documents, progress reports, fund receipt and project completion reports.

- Coordination of all externally funded projects.
- Help in review meeting to Project Leaders and Project Coordinators of CSIR-CIMFR Plan projects.
- Comprehensive development and maintenance of project related database.
- Convening review meeting of In-house projects.
- Preparation of annual budget in consultation with the scientists.
- Coordination of IT facilities of CSIR-CIMFR.

External Cash Flow (ECF)

CSIR-CIMFR, Dhanbad received external cash flow of Rs.1011.53Crorein the financial year 2019-20, of which Public Sector Rs. 958.95 Crore, Private Sector Rs. 42.97 Crore, Government fund is Rs. 9.36 Crore and Foreign agencies 0.25 Crore as depicted in Fig.1.

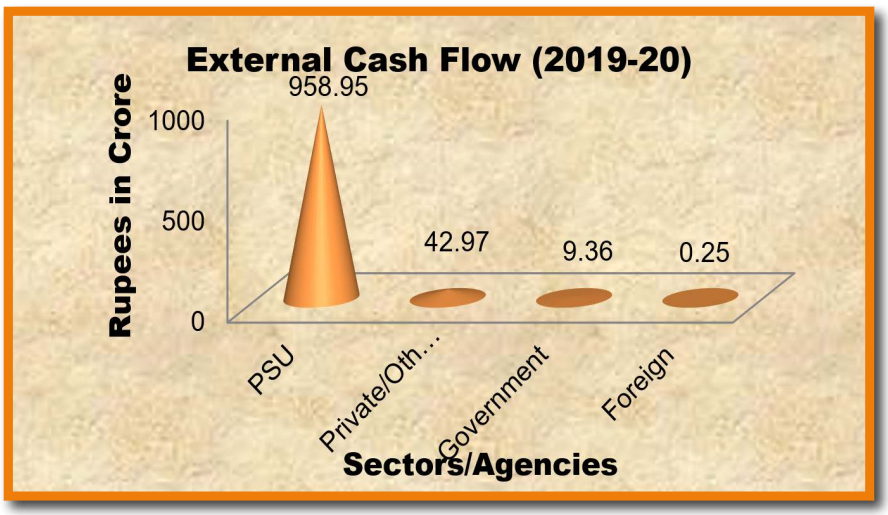


Fig. 1: External Cash Flow for 2019-20

Performance of the institute in terms of external cash flow generated in the financial year 2019-20 is compared with that of last four years as shown in Fig.2.

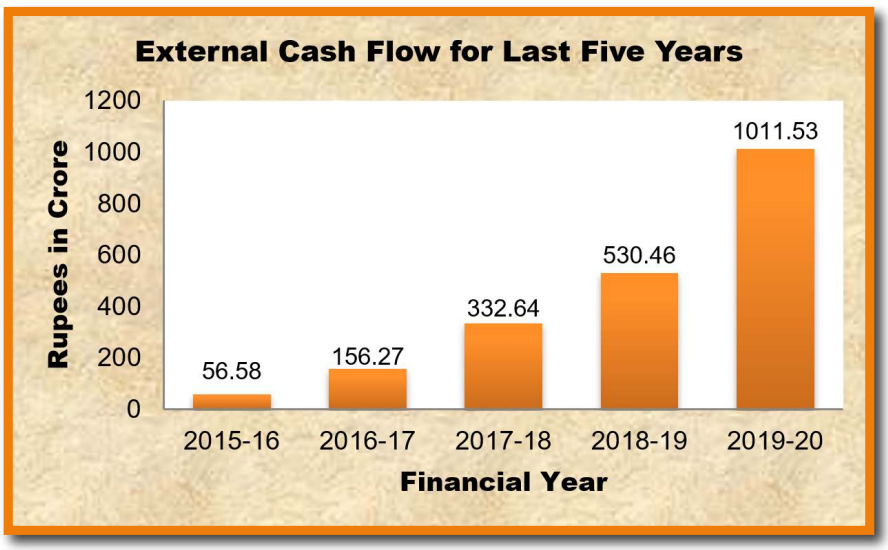


Fig. 2: External Cash Flow for last five years

13.d. STANDARDS, TECHNOLOGY MANAGEMENT, ISTAG, PUBLICATION & KNOWLEDGE CENTRE

13.d.i. KNOWLEDGE CENTRE

CIMFR KRC is actively engages in acquision technical processing and updating the collection and providing a platform for E- access of information sources to expand the horizon of information base to the scientific community.

KRC (library) is also playing a coordinating role between users and the literature, providing personal information service through current Awareness (CAS) and Selective Dissemination of Information (SDI) using modern information technology.

Besides the day to day circulation, reference and reprographic service, KRC is also rendering the following service Documentation, List of latest addition, Bibliographic service, OPAC search, CD-ROM search, In-house database, Internet Facilityand Access to E-Journals.

As per the instructions of the official language implementation, KRC has been developing a variety of collection in Hindilanguage.

Institutional Repository (IR) has been established using open source software with an aim to provide online access to CSIR-CIMFR research articles. Users have also been guided to maximize utilization of E-Resources.

KOHA library management software has been successfully installed and Union catalogue of CSIR (KNOWGATE) was implemented. The total collection of KRC was bar-coded and EM security system was also implemented at KRC

Books Reports, Standards, Specification and Bound volumes 34066.

13.d. ii. PUBLICATION

Annual Report: Reports on all the R&D activities and supporting services as also other technical as well as financial information of the institute for the year 2018-19 were collected, compiled, edited and published in the form of CSIR-CIMFR Annual Report for distribution to the policy makers of the country, higher ranks of the mining and fuel sectors and academic as well as research institutes of India and abroad.

Technical Notes and Write-ups: Technical notes and write-ups on various R&D work and other important activities were prepared and issued to different organizations and individuals when asked for.

CSIR Annual Report: A report covering the summary of the major accomplishments of CSIR-CIMFR in R&D work during 2018-19 was prepared and sent to CSIR for inclusion in CSIR annual report.

Display Advertisements: A good number of display advertisements were prepared and released during the year to keep up good images of the institute.

Distribution of Publications: Regular as well as special publications were distributed among the people and organizations connected with mining, fuel and allied industries of India and abroad.

Mailing List: The mailing list covering the addresses of different organizations as well as distinguished persons connected with mining, fuel and allied industries in India and abroad was updated regularly for distribution of publications and selection of experts as well as referees.

CSIR-CIMFR Project & Work Record Book: CSIR-CIMFR Project &work record book for the year 2020 was published and distributed amongst scientists, officers and other staff members of the institute.

13.d.iii. STANDARDS, TECHNOLOGY MANAGEMENT & ISTAG

A. ON ISO 9001:2015 Certification Program:

External Audit successfully completed as per ISO 9001:2015 during November' 2019 at CSIR-CIMFR Barwa Road Campus, Digwadih Campus, Ranchi unit and Nagpur unit by TUV NORD, Germany/ India. The certification recommended for next one year. One round of Internal Audit were also conducted. For the

close monitoring & review of Quality Management System, Management Review Meeting (M.R.M) were held. Revision of departmental quality manuals and Apex Quality Manual were completed. Calibration were done for instruments/ equipment.

B. B. Twenty One (21) Scientists and Officers were on Deputation abroad for attending Seminar/ Symposia/ Conference, Meeting, Business Development, Bilateral Exchange Program and for International Project.

C. Total External Cash Flow (ECF) generated during this Period in the form of Pemia and Royalty was ₹34.79 Lakhs (Rupees Thirty Four Lakhs & Seventy Nine Thousand Only).

D. Agreements/ MoU's signed:

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
1	Tripartite Agreement for Development of a selection method for Road Header & Tunnel Boring Machine in different geological conditions for tunneling	CSIR-CIMFR, Dhanbad; IIT (ISM), Dhanbad and NHPC Limited, NHPC Office Complex, Sector-33, Faridabad, Haryana	NA	24.4.2019
2	Bilateral Agreement between NTPC Limited and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and NTPC, NTPC Bhawan, Core – 7, Scope Complex, 7 Institutional Area, Lodhi Road, New Delhi – 110 003	Khargone Super Thermal Power Projects, Selda, PO-Khedi Bujurg, Dist-Khargone, M.P	15.4.2019
3	Bilateral Agreement between Lanco Amarkantak Power Limited and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Lanco Amarkantak Power Limited, Lanco House, Plot No.- 4, Software Units Layout, HITEC City, Madhapur, Hyderabad – 500 081, Telangana	Lanco Amarkantak Power Limited, Unit – I (300 MW), Village – Pathadi, P.O. – Tilkeja, Distt. – Korba, Chattisgarh	15.5.2019
4	Bilateral Agreement between Nabinagar Super Thermal Power Project and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and NTPC, NTPC Bhawan, Core – 7, Scope Complex, 7 Institutional Area, Lodhi Road, New Delhi – 110 003	Nabinagar Super Thermal Power Project, Shivanpur, P.O. – Ankorha RS, Distt. – Aurangabad, Bihar	15.5.2019
5	Licensing of Water Resistant Ammonium Nitrate Fuel Oil Mixture for Watery Hole Blasting and Process for preparing the Fuel Composition "WANFO"	Smartchem Technologies Limited (STL), SaiHira, Survey No: 93, Mundhwa, Pune	₹25.00 Lakhs Plus GST	10.6.2019
6	Agreement for the work of sampling & analysis of imported coal.	Maharashtra State Power Generation Company Ltd., Prakashgad, Bandra (E), Mumbai	₹2.20 Crores	12.6.2019
7	Agreement for the work of Third Party Sampling and Analysis for dispatch of Iron Ore at Donimalai complex	NMDC Limited, 10-3-311/A, KhanijBhawan, Castle Hills, Masab Tank, Hyderabad– 500 028	As per the contract	13.6.2019

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
8	Bilateral Agreement between NTPC Limited and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and NTPC, NTPC Bhawan, Core – 7, Scope Complex, 7 Institutional Area, Lodhi Road, New Delhi – 110 003	NTPC, Gadarwara Super Thermal Power Project, PO – Gangai, Distt – Narsinghpur, Madhya Pradesh	18.6.2019
9	Tripartite Agreement between Northern Coalfields Limited; Bajaj Energy Ltd. and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Northern Coalfields Limited (NCL), Singrauli, M. P and M/s Bajaj Energy Ltd., Khambarkhera, Shardanagar Road, LakhimpurKheri,U. P.	Kundarki – IPP, Village – Kundarki, Distt. – Gonda, U.P. – 271 301	18.6.2019
10	Tripartite Agreement between Northern Coalfields Limited; Bajaj Energy Ltd. and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Northern Coalfields Limited (NCL), Singrauli, M. Pand M/s Bajaj Energy Ltd., Khambarkhera, Shardanagar Road, LakhimpurKheri–U P.	Khambarkhera-IPP, Village – Khambarkhera, Distt. – Lakhimpur Kheri, U.P – 261506	18.6.2019
11	Tripartite Agreement between Northern Coalfields Limited; Bajaj Energy Ltd. and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Northern Coalfields Limited (NCL), At + PO – Singrauli, M. P. – 486 889 and M/s Bajaj Energy Ltd., Khambarkhera, Shardanagar Road, LakhimpurKheri–U P.	Barkhera-IPP, Village – Barkhera, Distt., - Pilibhit, U.P – 262 201	18.6.2019
12	Tripartite Agreement between Northern Coalfields Limited; Bajaj Energy Ltd. and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Northern Coalfields Limited (NCL), At + PO – Singrauli, M. P. – 486 889 and M/s Bajaj Energy Ltd., Khambarkhera, Shardanagar Road, LakhimpurKheri–U P.	Utraula – IPP, Village – Itai Maida, Distt. – Balrampur, U.P – 271 607	18.6.2019
13	Tripartite Agreement between Northern Coalfields Limited; Bajaj Energy Ltd. and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and Northern Coalfields Limited (NCL), At + PO – Singrauli, M. P. – 486 889 and M/s Bajaj Energy Ltd., Khambarkhera, Shardanagar Road, LakhimpurKheri–U P.	Maqsoodapur-IPP, Village–Maqsoodapur, P.O. – Banda, Distt., - Shahajahanpur, U.P – 262 202	18.6.2019

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
14	Agreement for Methodology for Excavation, recommendations for support system, ventilation and fire safety design and monitoring during excavation of three tunnels, and open excavations at Panvel Karjat Double line suburban corridor	Mumbai Railway Vikas Corporation Limited, 2nd Floor, Church Gate Station Building, Mumbai	₹3.95 Crore plus GST	20/6/2019
15	Agreement for Design of different elements of mechanical mining technology for safe extraction of coal using continuous miner packages at Singareni Collieries Company Limited	SMS Limited, Nagpur, 20 IT Park, Parsodi, STPI, Gayatri Nagar, Nagpur - 440 022	₹44.45 Lakhs Plus GST	24/6/2019
16	MoU for Shale gas and coalbed methane reservoir studies: Desorption and adsorption isotherm studies, geochemical and other properties of carbonaceous shale/ coal samples	Geological Survey of India, Ministry of Mines, Natural Energy Resources, Mission-IIB, BhuBijnan Bhavan, DK-6, Sector-II, Salt Lake City, Kolkata	As per the contract	25/6/2019
17	Agreement for Scientific investigations for planning, designing and supervisions of controlled blasting to permanently annihilate all the abandoned and illegal rat-hole mines in the state of Meghalaya	Meghalaya State Pollution Control Board, 'Arden' Lumpyngngad, Shillong – 793014, Meghalaya	₹14.75 lakhs including GST	28/6/2019
18	Agreement for Technology development for treatment of Acidic mine water for its reuse and safe disposal	Meghalaya State Pollution Control Board, 'Arden' Lumpyngngad, Shillong, Meghalaya	₹50.00 Lakhs Plus GST	28/6/2019
19	Agreement for sampling and analysis of Imported and Indigenous coal unloaded at VOC Port, Tuticorin, Tamil Nadu	NLC-Tamilnadu Power Ltd. (NTL), Mayor Sathyamurthy Road, FSD, Egmore Complex of Food Corporation of India, Chetpet, Chennai	As per the contract	01/7/2019
20	Agreement for Development of Vision Enhancement System for Foggy Weather	NMDC Limited, 10-3-311/A, KhanijBhawan, Castle Hills, Masab Tank, Hyderabad – 500 028	₹279.24 Lakhs	22/7/2019

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
21	Non-Disclosure Agreement for project title "Advice on pre-feasibility from rock mechanics point of view and related geotechnical issues for future application of UCG at Jamadoba, Tata Steel"	Ergo Exergy Technology Inc., Montreal, Canada	NA	22/7/2019
22	Bilateral Agreement between NTPC Limited and CSIR-CIMFR, Dhanbad	CSIR-CIMFR, Dhanbad and NTPC, NTPC Bhawan, Core – 7, Scope Complex, 7 Institutional Area, Lodhi Road, New Delhi – 110 003	NTPC, Barauni Thermal Power Station, PO-BTPS, Distt. – Begusarai, Bihar, PIN: 851116	22.7.2019
23	Tripartite Agreement between South Eastern Coalfields Limited (SECL), NTPC Limited and CSIR-CIMFR, Dhanbad	South Eastern Coalfields Limited, Seepat Road, Bilaspur (CG) - 495006 and NTPC Limited, Core-7, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi - 110003	NTPC, Gadarwara, Super Thermal Power Project, PO- Gangai, Thana- Dongargaon, Dist. Narsinghpur, Madhya Pradesh.	08.8.2019
24	Tripartite Agreement between Western Coalfields Limited (WCL), NTPC Limited and CSIR-CIMFR, Dhanbad	Western Coalfields Limited, Coal Estate, Civil Lines, Nagpur – 440 001 and NTPC Limited, Core-7, Scope Complex, 7, Institutional Area, Lodhi Road, New Delhi - 110003	NTPC, Gadarwara Super Thermal Power Project, PO- Gangai, Thana- Dongargaon, Dist. Narsinghpur, Madhya Pradesh.	21.8.2019
25	Bilateral Agreement between Tenughat Vidyut Nigam Limited and CSIR-CIMFR, Dhanbad	Tenughat Vidyut Nigam Limited, Hinoo, Doranda, Ranchi, Jharkhand – 834 002	Tenughat Thermal Power Station, Lalpania, Bokaro, Jharkhand - 829149	24.9.2019
26	MoU between CSIR-CIMFR, Dhanbad and RGIPT, Amethi	Rajiv Gandhi Institute of Petroleum Technology, Jais, Amethi, U.P	NA	10.10.2019
27	MoU between CSIR-CIMFR, Dhanbad and Bundelkhand University, Jhansi	Bundelkhand University, Jhansi, U.P	NA	11.10.2019
28	Tripartite Agreement between Chhatishgarh State Power Generation Company Limited (CSPGCL) and CSIR-CIMFR, Dhanbad	Chhatishgarh State Power Generation Company Limited, Vidyut Sewa Bhawan, Dangania, Raipur – 492013 (C.G)	2X500 MW ABV Thermal Power Station, SPO – Vidyut Nagar, Lachanpur – 495669, Dist. Janjgir-Champa (C.G)	05.11.2019

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
29	Tripartite Agreement between Odisha Coal and Power Limited (OCPL), Odisha Power Generation Corporation Limited (OPGC) and CSIR-CIMFR, Dhanbad	Odisha Coal and Power Limited, Fortune Tower, Chandrashekharpur, Bhubneswar and Odisha Power Generation Corporation Limited, 7th Floor, Fortune Tower, Chandrashekharpur, Bhubneswar	IB Thermal Power Station, Banharpalli, District Jharsuguda, Odisha	05.11.2019
30	Tripartite Agreement between South Eastern Coalfields Limited, NTPC Limited and CSIR-CIMFR, Dhanbad	South Eastern Coalfields Limited, SECL Bhawan, Seepat Road, Bilaspur-Chhattisgarh and NTPC Limited, Scope Complex, Institutional Area, Lodhi Road, New Delhi – 110003	Lara Super Thermal Power Project, Village Chhapora, PO & PS-Pussore, Raigarh, Chhattisgarh, Pin-496440	19.11.2019
31	Tripartite Agreement between Mahanadi Coalfields Limited, D B Power Limited, and CSIR-CIMFR, Dhanbad	Mahanadi Coalfields Limited, Jagriti Vihar, Sambalpur, Odisha and D B Power Limited, DB City, Area Hills, Bhopal	D B Power Limited, Village- Badadarha, P.O: Kanwali, Dist.: Janjgir-Champa, Chhattisgarh	19.11.2019
32	Memorandum of Agreement for Design & Development of Model Conjunctive water use plan and aquifier management in Fatehpur district, U.P	WAPCOS Ltd., Govt. of India, New Delhi	NA	19.12.2019
33	Tripartite Agreement between Northern Coalfields Limited, Dist. Singrauli, M.P; Nabha Power Limited and CSIR-CIMFR, Dhanbad	Northern Coalfields Limited, Dist. Singrauli, M.P and Nabha Power Limited, Rajpura, Dist.-Patiala, Punjab	Rajpura Thermal Power Plant, Village - Nalash, Rajpura, Dist.-Patiala, Punjab	26.12.2019
34	Agreement for Know How Transfer of Soft Coke Making a CSIR-CIMFR Technology	Eastern Fuels (Pvt.) Ltd., Patanwa, Post Basant Nagar, Ramnagar Industrial Area, Chandauli, U.P	₹8.00 Lakhs Plus 18% GST Non Exclusive	03.01.2020
35	Agreement for Know How Transfer of Soft Coke Making a CSIR-CIMFR Technology	Sidhgiri Holdings Pvt. Ltd., Ravinagar, Mughalsarai, Distt. Chandauli, U.P	₹8.00 Lakhs Plus 18% GST Non Exclusive	03.01.2020
36	Project Specific Agreement bet' CSIR-CIMFR, Dhanbad and Ordnance Factory Dehu Road, Pune	General Manager, Ordnance Factory Dehu Road, Dehu Road, Pune -412 101, Maharashtra	Not applicable	06.02.2020
37	Tripartite Agreement between Mahanadi Coalfields Limited, D B Power Limited, and CSIR-CIMFR, Dhanbad	Mahanadi Coalfields Limited, Jagriti Vihar, Sambalpur, Odisha and D B Power Limited, DB City Park, DB City, Area Hills, Bhopal	D B Power Limited, Village- Badadarha, P.O: Kanwali, Dist.: Janjgir-Champa, Chhattisgarh	12.02.2020

Sl. No.	Title of the Agreement	Party Name and Address	Amount (₹) / Power Plant Address	Date
38	Tripartite Agreement between Northern Coalfields Limited, Madhya Pradesh Power Generating Company Ltd., and CSIR-CIMFR, Dhanbad	Northern Coalfields Limited, Dist. Singrauli, M.P and and Madhya Pradesh Power Generating Company Ltd., Shakti Bhawan, Vidyut Nagar, Rampur, Jabalpur	Sanjay Gandhi Thermal Power Plant, Birsinghpur, Umaria, M.P	12.02.2020
39	Tripartite Agreement between Northern Coalfields Limited, Nabha Power Limited, and CSIR-CIMFR, Dhanbad	Northern Coalfields Limited, Dist. Singrauli, M.P and and Nabha Power Limited, P. O Near Village Nalash, Rajpura, Dist. Patiala, Punjab	Rajpura Thermal Power Plant, Village-Nalash, Near Rajpura, Dist. Patiala, Punjab	12.02.2020
40	Licensing agreement for Implementation of Vision Enhancement System for Foggy weather	Dadhwal Weighing Instruments Repairing Works, Vasant Vihar, Joraphatak Road, Dhanbad	Lump Sum Premium: ₹5.00 Lakhs Plus 18% GST: Rs.5,90,000=00 Royalty @ 3%	24.02.2020
41	Memorandum of Understanding bet' CSIR-CIMFR and Institute of Geonics of The Czech Academy of Sciences for Joint Research in Mining and Applied Rock Mechanics	Institute of Geonics of The Czech Academy of Sciences, Czech Republic	NA	25.02.2020
42	Tripartite Agreement between Bharat Coking Coal Limited, Nabha Power Limited, and CSIR-CIMFR, Dhanbad	Bharat Coking Coal Limited, Dhanbad and Nabha Power Limited, P. O Box No. 28, Near Village Nalash, Rajpura, Dist. Patiala, Punjab	Rajpura Thermal Power Plant, Village-Nalash, Near Rajpura, Dist. Patiala, Punjab	03.03.2020

13.e. TESTING CELL

Testing Cell of CSIR-CIMFR, Barwa Road Campus, Dhanbad is a single window system which provides ready assistances to the manufacturers of Mining and Allied Industries in getting their different equipment / component / materials tested, evaluated, calibrated and certified. The Cell co-ordinates and monitors the testing analysis and calibration related activities of eleven laboratories, after mergers these laboratories are reduced to seven at present. The relevant Information's, Estimated test charges, PI/Quotations, Tax Invoices and Test Certificates/Reports releases to the concerned customers for both Indigenous and Foreign make equipment/components.

The various activities of the concerned testing laboratories are covered under ISO 9001:2015 to satisfy customers need in getting systematic, transparency and quality oriented services in respect to the testing and certification of equipment/component/materials.

Testing and evaluation reports of various samples including equipments/components were issued by the cell during the period from 1st April' 2019 to 31st March' 2020 are 537(five hundred and thirty seven) numbers only in Total and an amount of revenue Rs. 3, 39, 06,419.30 (Rupees three crores thirty nine lakhs six thousand four hundred nineteen and paisa thirty) only was generated through the same.

C

FUEL SCIENCES

C.FUEL SCIENCES

14. COAL, MINERALS & HEAVY METAL RESEARCH GROUP

National Inventory development of Mercury in Emission sector in India.

The Minamata Convention on Mercury is a legally-binding multilateral environmental agreement under the aegis of UN Environment that aims to protect human health and environment from anthropogenic emissions and releases of mercury and mercury compounds.

In this regard UNDP and MoEF & CC in association with six other Ministries (ministry of Coal, ministry of power, ministry of health & Family, ministry of Chemical & Fertilizers, ministry of Commerce & Industry, ministry of finance) had initiated a project, on development of National Mercury Inventory in India. CSIR-CIMFR has been given the important responsibility of developing mercury inventory in emission sector. Our department is engaged in preparing mercury emission inventory from four major sub-sectors comprises of various industrial sectors e.g. power, steel, metal production, Fuel production, cement etc. Presently our department engaged in evaluation of mercury emission from 15 different industries to develop country specific emission factors.

For inventory level 1, we have identified sources of mercury emission in India. Coal combustion, cement production, Zn, Cu & Pb smelters are the major sources of mercury. Other than that oil and natural gas combustion, ferrous and non-ferrous metal production, paper industries are important sources of mercury emission. Level 1 inventory was prepared based on the UN Toolkit emission factors. This inventory further refined using actual field data collected by CSIR-CIMFR team. We have estimated country specific input and out factors for various sectors like coal combustion, oil & natural gas uses, primary metal production (Steel, Zinc, lead, copper, alumina), cement production. The refined level 2 inventory provides better picture of mercury emission in India. We have also prepared a document to identify the priority sector and proposed an Action plan with strategy and interventions for mercury management in emission sector.

Based on the findings UNDP have submitted following documents to MoEF&CC.

- India: Mercury Action Plan
- India: Minamata Initial Assessment,
- Inventory of Mercury Emissions and Releases in India (Level-I Assessment)
- Level-II Assessment report has been finalized.

Fuel gas Mercury Monitoring in Thermal Power Plant

15. COAL PREPARATION AND MINERAL BENEFICATION GROUP

1. Project Report

During April 2019 to March 2020, the Coal Preparation section has undertaken various projects on washability, sampling of indigenous and imported coals, flotation, dewatering, tumbling etc.

The clients included SAIL, Kolkata, Singareni Collieries Company Ltd., Hyderabad, Bharat Coking Coal Limited, Tata Steel, Chandan Steel, Abhinav Group, Western Coalfield Ltd., JSW Steel Limited, NTPL Tuticorin, Tamilnadu, SAIL Collieries Division, Chasnalla.

Project: "Sampling and Analysis of imported coal unloaded at Port ends for Steel Authority of India Limited"- CSIR - CIMFR was involved during the sample collection while the coal was discharged at the ports of Haldia, Paradeep, Bamra and Vizag. The sample preparation was done at the respective sites for the general analysis and the prepared samples were sent by SAIL to CSIR-CIMFR for its complete characterization. During the period 2019 - 20 sampling of total of four (4) vessels was carried out at unloading ports and the analytical report was submitted.

Project : "Sampling and analysis of slurry/ Rejects lying at different coal washeries of Bharat Coking Coal Limited : CSIR - CIMFR was involved during the sample collection at different washeries like Bhojudih, Sudamdih, Patherdih, Madhuban etc from the heap/ponds. The sample preparation was done at the respective sites for the general analysis and the prepared samples were sent by SAIL to CSIR-CIMFR for its complete characterization. During the period 2019 - 20 sampling was done at five sites of different washeries and the analytical report was submitted.

Project : "Substitution of Imported Coal through beneficiation, blending and coke making from indigenous raw materials" The main objective is to substitute the imported coal by beneficiation belnding and coke making from indigenous raw material sources of Chasnalla, SAIL, Dhanbad by conducting detailed studies on the cleaning potentialities of high ash coals supplied to Chasnalla Wahsery, Jhama and coal fines. Evaluation of performance of these cleans individually and in blends with coal fines, Jhama for preparation of metallurgical coke. The detailed studies on carbonization tests revealed that indigenous coal/jhama to the tune of 50%may be blended with imported coking coal to achieve a good metallurgical coke.

Project : "Sampling and Analysis of Imported Coal and Indigenous coal unloaded at VOC Port end, Tuticorin for NTPL". The main objective is to characterize the imported coals and Indigenous coal after collecting the representative samples during unloading at the port ends and preparation of samples for characterization as per the standard procedure and as desired by the sponsor. During the period 2019-20 a total of 2646009 tonnes was sampled of which the quantity sampled for indigenous coal was 1548034 tonnes approximately, while the quantity sampled for imported coal was 1097975)tones approximately.

Project : "Coal Characterization and washability test of coal sample combined Kamptee – Inder Mines Area, WCL". The objective is characterization and washability studies of coal sample from Inder- Kmaptee OC Mines, WCL. The washability characteristics of coal tested is easy to wash. By screening the ROM into different fractions viz., + 100mm, -100 + 13 mm (dry screening) or + 100mm, -100 + 13 mm (dry screening), -13 + 3 mm (wet screening), the target ash of <34% ash with requisite recovery may be achieved. Scope exists to generate clean coal at 20% ash content by simple washing, and see its suitability for cement industry or utilize as a blend for application in corex process.

Project : "To study the raw coal characteristics vis-à-vis clean coal yield parameters by collecting coal samples from different mines of MM and BPA Areas of SCCL Coalfields". The cleaning potentialities of the coal were carried out by standard washability tests for the different size fractions. From the size analysis data it was seen that to achieve the target ash content in cleans the whole coal is to be washed. A conceptual flow sheet was prepared based on the practical achievable yield considering the efficiency values of Batac Jig and combination of Heavy Medium Bath and Cyclone.

Project : "Characterization of Graphite samples from lying at Lamdak and Bopi, Dist. Upper Subansiri Arunachal Pradesh (150 Nos.)". The bore core samples from different seams, outcrops were sent by the party

and the samples were characterized with respect to proximate, density etc., and the analysis data showed that the quality of the graphite is poor and needs beneficiation, for its utilization.

Project : "Studies on the cleaning potentialities of the coking coal samples from BCCL, supplied by JSW Steel Limited for metallurgical use". A total number of seven low volatile coking coal samples from Eastern and Western Jharia coalfields were collected and detailed washability studies were carried out to understand the cleaning potentialities. The total theoretical recovery of the clean coal at 18% ash content varied from 20 to 80%, depending upon the washability characteristics of the raw coal. A suitable flow sheet was suggested to the sponsor.

Project: Wet Tumble Test (with steel cubes for 5 minutes)of samples collected from CV-302 conveyor of existing DMC plant – Adani Enterprises Limited, To have a data on the in plant generation of coal fines, the standard test is to conduct the wet tumbler test. The samples from feed to the washing unit were collected and the tumbler tests were conducted. It was observed that the in plant generation of coal fines is varying from 13 to 17 percent.

Project: Study for reduction of Sulphur content in the coal samples from the opencast projects of BPA Areas, SCCL Coalfields: All the samples contain high sulfur and it is in pyritic form. The washability studies of different size fractions, had shown that the pyritic sulfur may be removed by simple washing, it was observed that major quantity of sulfur was reported to the sinks. A suitable washer was suggested to the party based on the washability data.

Project : Moisture Reduction of Sized Coal with and without reagent addition using Pilot Scale Centrifuge – HINDALCO Limited: Moisture plays an important role on the overall quality parameters of the feed coal to the power stations. Dewatering studies using a pilot centrifuge was carried out and

It was observed that nearly 5.5% of Total moisture reduction may be possible (without adding any surfactant), while allowing the fraction -50 + 1mm fraction to pass through a centrifuge. It was also observed that nearly 6.3% of Total moisture reduction may be possible (with addition of surfactant), while allowing the fraction -50 + 1mm fraction to pass through a centrifuge.

Project: Laboratory Flotation Tests using the chemicals supplied by Somu Organo-Chem (P) Ltd. Four new chemicals was supplied by M/s Somu Organo-Chem (P) Ltd and the flotation response was tested by varying the dosages. The results were compared with standard reagents being presently used and it was observed out of four chemical, one chemical had given better recovery at the same ash content compared to the presently used chemicals.

16. COMBUSTION, CARBONIZATION & NON CONVENTIONAL GASES RESEARCH GROUP

The thrust areas of the combustion group are to study on impact of coal qualities, blending in power plant performance, clean coal technology, GHG emission and estimation of normative coal requirement for different industries. The department is having three major facilities for combustion studies. The three facilities are lab scale Thermogravimetric Analyser (TGA), bench scale Drop Tube Furnace (DTF) and pilot scale Fuel Evaluation Test Facility (FETF). These three facilities are utilized for studying combustion characteristics of coals, coal blends, coal-biomass blends and previously we are serving different industries like NTPC, Reliance Energy, Tata Steel, Gondowana Geotech Pvt. Ltd., NALCO.

During April 2019 to March 2020, combustion group of CSIR-CIMFR has undertaken different R&D and consultancy projects in the area of Quality monitoring of Iron ore at NMDC, Donimalai Complex, GHG emission inventory, Normative requirement of coal for different industries.

The research group is involved in setting up modalities for normative coal requirement for different sectors which provide the scientific basis of estimating the normative requirement of coal in different sectors/industries at India to Coal India Limited. This will help to take policy decision by Ministry of Coal for judicious coal allocation and to prevent misuse of precious coal of different grades presently mined in India.

Energy sector Inventory [Biennial Update Report (BUR-2, BUR-3) and Third National Communication (TNC)– To be communicated by Govt. of India to United Nations Framework Convention on Climate Change (UNFCCC)]: In this nationally important project the combustion group is involved in i) preparation of national GHG inventory for Energy and Manufacturing Industries for different years ii) estimation of country specific and sector specific NCVs and CEFs for Indian coal iii) estimation of oxidation factor for coal combustion in thermal power plant. This activity is a significant contribution towards the preparation of National Energy Sector Inventory of GHG emission for onward communication of Govt. of India to UNFCCC.

The research group is also involved in scientific study on Quality Monitoring of Iron ore at dispatch points of Donimalai Complex Iron Ore Mines of NMDC. This project is sponsored by NMDC, Limited. Scientific inputs of CSIR-CIMFR scientific team help the company in maintaining their product quality.

CSIR-CIMFR team in NMDC Donimalai in connection with Quality Monitoring of Iron ore

R&D activity of the carbonization group is focused on impact of coal qualities on coke making, study on blending different coals and their effect on coke property, carbonization of coal, bio-mass and other non-conventional carbonaceous raw materials, investigation for better coke making technique, designing different type of soft coke and hard coke oven for commercial coke production as well as research activity. R&D study for value addition of coal and coke fine by briquetting and pelletization is another important thrust area of this research group. The research group has pilot plants for both low and high temperature carbonization study, stamp charging facility, pilot plants for briquetting and centrifugal pelletization of coal and coke fines, facilities for thermal curing of briquette and pellet, various testing facilities like, CRI/CSR, Micum index, Shatter index, rheological properties of coal and point crushing strength for testing coal coke and briquettes.

In 2019 the group successfully commissioned a soft coke oven for commercial coke production in the factory premises of M/S Hari Om Coke industries, Aurangabad. In this improved soft coke oven coking time is less and productivity is high. Patent was filed for protecting the technology. Subsequently the technology has been transferred to two firms namely M/s Eastern Fuel Pvt. Ltd., UP and M/s Sidhgiri Holdings Pvt. Ltd. UP.

Soft Coke Oven Plant

The carbonization group is also involved in the project "Studies on preparation of alternative fuel for metallurgical industries using available Indian carbonaceous materials and their blends by pre-heating and compaction of the Hot coal mass". Progress of this project: i) various Indian and foreign coals are investigated for selection of coal with variation of their coking properties. Ii) Eight coals are selected. Coke making study with different coals and their blends are carried out using various coking technique

iii) Preheating at tarrification level and compaction of the hot coal mass produce encouraging results. Iv) This tecnique improved coking property (CRI/CSR) to a significant extent. v) Larger quantity of low rank coal with suitable matched coal also able to produce good coke.

The carbonization group is also involved another project entitled "Experimental study for the production of needle coke from coal-tar/pet coke and preparation of graphite electrode". This is a multi-Laboratory project, funded by CSIR-CIMFR. Progress of this project: i) Different process flow diagram for delayed coking process was studied and finalized process steps for delayed coking of coal tar. ii) Investigated for sizing of equipment for different process steps like, coal tar refining, calcinations of raw pet coke, extruding, baking and impregnation and graphitization.

Beside the above activities staff members of combustion and carbonization section of the research group actively involved in the mega project "Quality Coal for Power Generation". Contributed in sampling and analysis of coal at loading and unloading points in different sites.

The Nonconventional Gases Section has R &D expertise on safety in underground coal mines from methane emission, evaluation of coalbed methane/shale gas resource potential in virgin coal blocks, estimates of greenhouse gas emission from coal mining and handling activities and oil and natural gas systems, CO_2 sequestration in geological formation and the CBM wells and underground coal gasification.

S & T Research Projects

(i) Estimation of Fugitive Carbon Dioxide Emissions from Indian Coal Mining Activities. (SERB, DST, New Delhi)

During mining operation and coal handling activities Methane, Carbon dioxide, Nitrogen and other gases emit in the atmosphere. These gases are found in coal pores, fissures and cleat system as free and adsorbed on the internal surface of coal pores. Methane and carbon dioxide gases are greenhouse gases which are responsible for global warming. The main objective of this research project is to develop an emission coefficient of carbon dioxide gas which may be used for the quantification of fugitive carbon dioxide emission during coal mining and handling activities in India.

(ii) Improved fugitive methane emission factors for coal mining and handling activities in India including abandoned mines (MoEFCC, GOI)

Field investigation has been conducted in coal mines (open cast and underground), measurement was made and sample were collected at the main return as well as at the district return for the determination of methane emission factors for different degree of gassiness of coal seam. The methane emission factors were used for quantification of fugitive methane emission from coal mining and handling activities. The work is in progress.

(iii) Studies on Sorption-Induced Strain and Permeability Changes in Coal and Shale as a Result of CO_2 Injection

The pore pressure and permeability of cleat structure that regulates the production of coal bed methane was reflected. In this paper the overview of coal bed methane generation and production, gas transport in in coal matrix, changes in coal matrix during adsorption/desorption process, permeability behaviour of coal matrix and impact of spatial stress-strain on coal matrix were studied. The pore pressure and permeability of cleat structure that regulates the production of coal bed methane was reflected. In this paper the overview of coal bed methane generation and production, gas transport in in coal matrix, changes in coal matrix during adsorption/desorption process, permeability behaviour of coal matrix and impact of spatial stress-strain on coal matrix were studied.

Coalbed methane production is regulated by the cleat system developed during coalification process. The main objective of the project is to investigate changes occurred in coal matrix during adsorption/desorption process and impact of sorption-induces strain as a result of CO_2 injection for secondary recovery of CBM. The specification and designed/drawing of sorption induced setup with high-pressure vessel have been finalized to develop the set up for the measurement of micro strain/deformation as a result of CO_2 and other gases sorption. Physical and chemical properties, total organic carbon (TOC), XEM, FTIR and XRD of coal/shale core samples of different coalfields have been determined to study the change in strain/deformation as the result of CO_2 sorption by the coal sample. The work is in progress.

(iv) Shale Gas Potentiality Evaluation of Damodar Basin of India

The measurement of 3D/2D seismic study has been completed at Rangamati, ECL and Radhanagar, Jharia coalfield by CSIR-NGRI for identification of subsurface lithology, type of formation and occurrence of thick shale beds. The drilling and sample collection was completed at the drill point selected at Rangamati and Radhanagar for shale reservoir characterization. Megascopic properties like colour, hardness, fracture, specific gravity, homogeneity, banding etc. have been done for shale core samples. Surface area, pore size and pore volume were measured for shale core samples to evaluate pore characteristics and pore structures. Detailed mineralogical and Petrographical-maceral studies, FTIR, XRD analysis, Rock-Eval pyrolysis, SEM-EDAX analysis have been completed. A draft final report has been submitted to CMPDIL, Ranchi

Industry sponsored Projects

1. Investigation on gas desorption characteristics of coal/rock core samples and prediction of specific emission at XI Seam, Jamadoba Colliery, Jharia Division, Tata Steel Ltd.

In situ gas content of XI seam, on as received basis, varies from 1.67 to 3.89 m^3/t for the samples retrieved from the borehole TJS/257/A/16 drilled in Pattiya Village while it varies from 0.67 to 2.16 m^3/t for horizontal

borehole drilled in XI seam at Jamadoba Colliery. Methane is found to be the prime hydrocarbon constituent ranging between 94.75 and 98.69% with minor amount of other higher hydrocarbons. Maximum predicted values of specific emission were 5.69 m^3/t corresponding to borehole no. TJS/257/A/16 drilled in Pattiya Village and 4.56 m^3/t for the set of boreholes TJU001/002/004 drilled from Jamadoba Colliery. Predicted values of specific emission for high rates of production may be useful for ventilation purpose at high rates of production. The work is completed.

2. Investigation on Methane Emission for categorization of degree of gassiness of coal seam R-VII, Searsore colliery, Satgram Area, ECL and Associated Gas Hazards

Insignificant rates of methane emission per tonne of coal produced, negligible methane percentage in general body and low methane percentage in the borehole air samples indicated that gas hazards at R-VII coal seam of Pure Searsole Colliery, Satgram Area, ECL can be safely tackled by the ventilation system of the mine as per the statutes of DGMS. However, it is strongly recommended that regular check on general body air sample and air velocity at the out-bye end of the return airways may be made to detect any presence of methane as a preventive measure against any possible gas hazard during mining operation. The work is completed.

3. Gas Desorption and Adsorption Study of Coal Core Samples at Near Ramgarh/Kuju Drilling Site (BK#28), ONGC, Bokaro

Coal/shale core samples collected from borehole No. BK#28 drilled by ONGC Bokaro at Kuju area has been analysed for in-situ gas content, proximate and high- pressure adsorption isotherm analysis. The depth of the samples varies from 356.20m to 362.50m. The proximate constituents like moisture, ash, volatile matter and fixed carbon varies from 1.10 to 2.70, 20.99 to 83.21, 10.31 to 28.47 and 5.39 to 47.85 wt.% respectively. Similarly, the in-situ gas content and sorption time varying from 1.90 to 5.49 m^3/t and 0.25 to 0.32 days. The maximum sorption capacity (Langmuir volume, VL) and Langmuir pressure (PL) was measured in the range of 8.6 to 15.9 cc/g and 1754 to 3058kPa respectively. The determined maximum sorption capacity compared with in-situ gas content reveals that shale/coal beds are under saturated with gas. Further, it was observed that carbon content controls the storage of gas in coal/shale samples.

17. GASIFICATION, CATALYSIS AND CTL (COAL-TO-LIQUID) RESEARCH GROUP

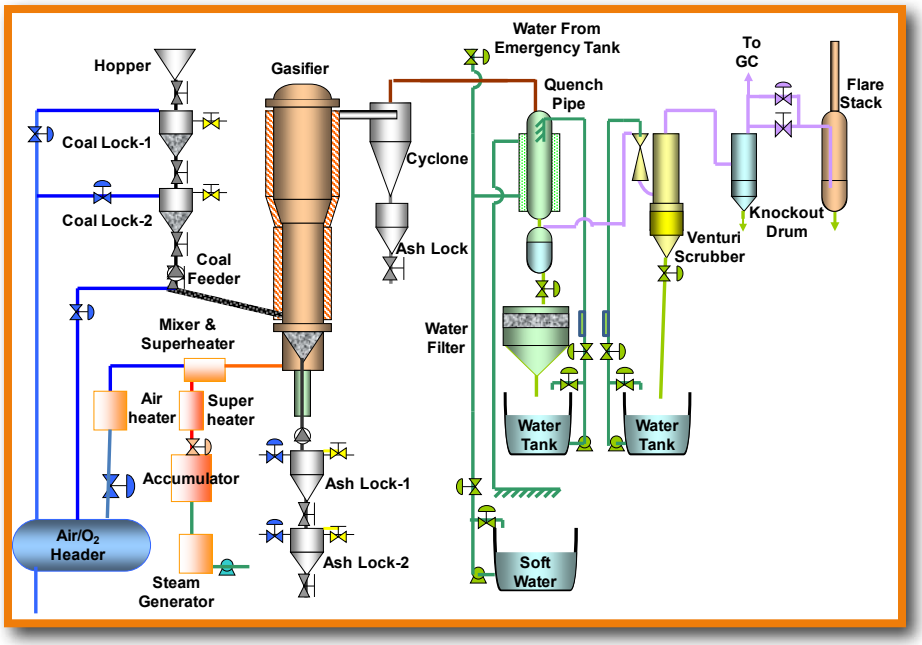
During the period of April 2019 to March 2020, the Gasification, Catalysis and CTL Research Group of CSIR-CIMFR has undertaken various R&D activities in the areas of gasification to develop oxy blown pressurized fluidized bed gasifier, gasification potential mapping of Indian coal, catalytic petcoke gasification, feasibility study on coal gasification, coal briquetting for gasification, Syngas to Methanol and coal fly ash as a source of rare earth elements.

1. Project Report:

- This Research Group has already developed a pilot scale Air Blown Fluidized Bed Gasifier (FBG) of 20 kg/h feed rate capacity. From the experience gained in this pilot scale with high ash Indian coal, it is found that high ash coal can be gasified in FBG without any operational issues such as agglomeration and clinker formation by proper synchronization of operating parameters. Based upon previous experience, it is obvious that fluidized bed gasifier is most suitable to handle high ash coal. Further, FBG is an attractive option for generation of tar free syngas for different industrial applications such as methanol, power, liquid fuels, fertilizer, chemicals and other thermal applications. NITI AAYOG, Govt. of India has already initiated a colossal program to develop indigenous gasification technology for coal to methanol programme involving different stake holders. As a member of this consortium, this Research Group under the aegis of NITI AAYOG, Govt. of India is presently executing a program on **Development of Oxy Blown Pressurized Fluidized Bed Gasifier (PFBG) of 1.5 TPD Feed Rate Capacity** with the following objectives:
  - Development of oxy blown pressurized fluidized bed gasifier (PFBG) along with suitable fuel feeding, ash extraction system and retrofitting with available facility.

- Evaluation of the gasification performance of high ash coals and maximization of performance by adjusting the operating parameters and blending with biomass feeds.
- Study the techno-economic feasibility, operational performance and issues of fluidized bed gasifier with different feed stocks like high ash coals and its blends with biomass.

The developed system will represent the hydrodynamics and other features of large scale commercial gasifier and will help to design and develop commercial scale gasifier for utilizing high ash coal for different applications. The gasifier system is presently under installation and commissioning. Following figures shows the schematic diagram of PFBG:



1.5 TPD Oxy Blown Pressurized Fluidized Bed Gasification Facility

❖ The department was also involved in the project entitled **Gasification Potential Mapping of Indian Coal and utilization Strategy** under the aegis of NITI Aayog, Govt. of India. Considering the potentiality of indigenous coal resources towards different energy forms and chemicals, NITI Aayog is presently exploring suitable technology options and roadmap for surface coal gasification. In this perspective, a Technical Committee on Surface Coal Gasification was constituted by NITI AAYOG and intended that the detailed analysis of the coal from potential operational mines/blocks with respect to Surface Coal Gasification (SCG) would be carried out jointly by CSIR-CIMFR, Dhanbad and CMPDIL, Ranchi. With this background present activity entitled "**Gasification Potential Mapping of Indian Coal and utilization strategy**" was executed.

Objectives of the project:

- Gasification potential mapping of Indian coals.
- Development of utilization pattern and strategies for gainful management of coals having a wide range of properties vis-a-vis matching gasification technology.

In this context, detailed physico-chemical characterization towards gasification potentiality and utilization strategy of the coal samples collected from Mahanadi Coal Field Limited (MCL), Central Coal Field Limited (CCL) and Eastern Coal Field Limited (ECL) have been completed and **project report submitted to NITI Aayog, Govt. of India**. Gasification potential mapping of Indian non-coking coal will not only direct to select coal for efficient gasification technology, but it will also guide towards utilization patterns and strategies for gainful management of coal resources.

Coal CharacterizationMatrix

❖ During this period, the Research Group has undertaken the project on **Catalytic petcoke Gasification**. This is a CSIR funded Focused Basic Research (FBR) project under Chemical Theme. Gasification may be an effective option for converting petcoke into syngas. However, gasification is an energy intensive process. Again, conversion of petcoke requires higher temperature (above 1500 °C) due to its poor reactivity towards gasification. Higher temperature of the gasification imposes several operational problems. Further, higher operating temperature reduces overall (cold gas) efficiency of the gasification process. In this regard, Process Intensification (PI) through catalytic gasification may definitely improve the gasification performance of the petcoke. Keeping in view these aspects, catalytic petcoke gasification may be a solution towards utilization of petroleum bottom fractions with value addition. The objectives of the project are:

- Identification of most effective catalyst with respect to gasification conversion using thermo-gravimetric method, operating temperature in the range of 1000°C suitable for low temperature gasifiers.
- Evaluation of gasification performance of petcoke with selected catalyst.

This study will help to achieve significant conversion of petcoke at lower temperature around 1000°C which will reduce various operational problems of high temperature gasification like refractory failure, penetration of slag into refractory lining and refractory falling as well as issues related to slag flow-ability. Lower operating temperature and reduced operational problem will also ultimately lead to lower CAPEX and OPEX of the system and process. The project is completed and report submitted to CSIR.

Moreover, this group supports industries to address the issues related to gasification as well as enhancing the performance with judicious use of different feed stocks. During this period, this group has completed two **Industrial projects**, such as,

❖ **Feasibility Study on Coal Gasification Project** for JSW Steel Ltd, Ballary, Karnataka. This study will guide for proper designing of gasifier. Hydrodynamic study of the proposed JSW gasifier based on existing facility of cold fluidization setup at CSIR-CIMFR and theoretical calculation for material and energy balance as well as comparison with ideal case will evaluate the hydrodynamics parameters as well as prompt the design accuracy of the proposed JSW gasifier. The project is completed and report submitted to JSW Steel Ltd, Ballary, Karnataka.

- **Coal briquetting and characterization towards gasification** sponsored by M/s Transworld Furtichem Pvt. Ltd. Navi Mumbai-400705. This study will guide to utilize coal fines through formation of briquettes of appreciable strength by blending with coal having good caking or binding or agglomeration property. The Project is completed successfully and report submitted to M/s Transworld Furtichem Pvt. Ltd. Navi Mumbai.
- **Syngas to Methanol:** NITI Aayog, Govt. of India has already taken initiative for the conversion of Coal to Methanol. Under the aegis of NITI Aayog, CSIR-CIMFR has initiated the activities for the conversion of High ash coal to Syngas and subsequently Conversion of Syngas to Methanol in pilot scale level. The objectives of Coal to Methanol Pilot Plant are given below:
  - Syngas to methanol conversion Process involves the Development of Pilot Plant for study of catalytic conversion of Indian coal derived syngas to methanol at elevated pressure (35 – 70 bar) and temperature (200 – 300°C).
  - Study of proper syngas cleaning and water gas shift reaction assembly to maintain the desired H2/CO ratio and avoid the deactivation of catalyst.
  - Study of the operational performance and issues associated with Pilot Plant.
- This research group also received the project entitled, "**A Study to Explore the Potentiality of Using Coal Fly Ash (CFA) derived from Indian Thermal Power Plants as a resource of Rare Earth Elements (REEs)**" funded by the Science and Engineering Research Board, DST, GOI. The objectives of the project are:
  - Study of the physicochemical properties including particle size and shape of the fly ash and bottom ash collected from important Thermal Power Plants.
  - Study of REE concentration in source coal and enrichment there off in fly ash.
  - Identification of distribution pattern of REEs in different size fractions as well as different mineral phases, with light REE in the CFA.
  - Development of a classification scheme for CFA with respect to REE content.
  - Identification of potential CFAs for extraction of REE.

18. INDUSTRIAL BIOTECHNOLOGY AND WASTE UTILIZATION RESEARCH GROUP

During 2019-2020 the Industrial Biotechnology and Waste Utilization Research Group was actively engaged in various research projects (including CSIR Mission, FTC, GAIL, CPRI funded projects) in the area of environmental friendly utilization of industrial wastes.

Biomass and spent wash incineration ashes are menace to the industry. Process developed for conversion of waste ash to potassium fertilizer. Process optimized at laboratory scale and demonstrated at a third party plant facility. Based on the results, M/s EID Parry has accepted for pilot scale testing and subsequent commercial production at all of their plants.

Nitride based fertilizer was prepared from coal ash. The N content in the product is 15 %. Working towards the target to increase the N content to 25 – 30 %.

Process developed and optimized for conversion of coal washery waste and locally available organic waste to methane. Gasification of coal through biological means is one of the possible ways to obtain highly efficient and environment acceptable clean fuels from coal. Microbial methanogenesis of coal is of particular interest to gas producers as it represents an ecofriendly energy source and is relatively cheap.

GAIL has sponsored a project for demonstration of CO_2 capture through microbial route at their plant at Pata, UP. CO_2 capture is currently an important technological, economical and global issue.

Central Power Research Institute, Bengaluru has funded a project for bioprocessing of coal industrial effluents using aquatic plants. This integrated technology will help to recover coal fines and aquatic biomass from coal washery effluent.

In-house funded project for making art, craft and jewellery from coalwill lead to skill development and economical upliftment of rural women in coal settings.

1. National workshop on 'NEED FOR INDIAN STANDARDS ON SOLID BIOFUELS', CSIR-CIMFR, Digwadih Campus, 27 January 2020.

Director CSIR-CIMFR welcoming Mrs. Nisha Bura of BIS, New Delhi in the National Workshop

2. Meeting of the 'BIS Solid Biofuels Sub-Committee (PCD 7:6)', 28 January 2020, CSIR-CIMFR, Digwadih Campus,

Group photo of the BIS sub-committee meeting held on 28/01/2020

19. a. INDUSTRY INTERFACE:

We are providing various test facilities for coal, coke and coal ash to the industries. We also do water analysis for the industries. We have done tests for 67 number of samples during the period. Some of the parties for which we have carried out test are as- Public Sector undertakings: Bokaro Steel Plant; NTPC, Dadri; NTPC, Kudgi etc. Private Parties: Bhagwati Enterprises; Chhabra Coal and Beneficiation Ltd. etc. Government Sector: East Coast Railway; CMERI, Durgapur. Test reports are sent to the parties as and when report is complete.

We also entertain the queries of parties through e-mail. This year we have received Rs. 1200000/- approx. as revenue for the institute.

19. b. PROJECT MONITORING & EVALUATION

i. Sponsored Projects Taken up : 339

ii. Consultancy Projects Taken up : 03

iii. Grant-in-Aid Projects Taken up : 01

iv. In-House Projects Taken up : 10

Patent Filed In India:

Sl. No	NF Number	Title	Inventors	Complete FilingDate	Application Number
1.	0056NF2019	Self-Retractable Cover System For Dump Trucks	Ranjan Kumar, Ashish Narayan, Niraj Kumar, Afzal Hussain, Gautam Banerjee	02-May-19	201911017477
2.	0095NF2017	A Device For Wheel Controlled Odourless And Waterless Sewage Discharge System In Trains	Sudhir Kumar Kashyap, Pradeep Kumar Singh	14-Jun-19	201911023586
3.	0090NF2018	A System And Method For Real-Time Monitoring Of Strata Behavior In Underground And Opencast Mine	Ranjan Kumar, Dilip Kumbhakar, Sujit Kumar Mandal, Jitendra Kumar Singh, Sandip Oraon, Gautam Banerjee	15-Nov-19	201911046581
4.	0173NF2019	A Composition And Method For Preparation Thereof For Suppression Of Dust Generated In Blasting Operations	Firoj Ali, Braj Mohan Pat Pingua, Pradeep Kumar Singh	03-Jan-20	202011000277

Patent Granted in India: 2

S/N	NF Number	Title	Inventors	Complete Filing Date	Application Number	Date of Grant	Patent Number
1.	0012NF2012	A Biodegradable and Eco - friendly dust suppressant chemical for unpaved haul roads and stock pile, blasted material handling in mines and other dust prone areas	Pandey Jai Krishna, Trivedi Shrenik Madhusudan, Trivedi Rushay Shrenik, Jani Urja Falgun, Vyas Bhavtosh Rajnikant, Kumar Ajay	13-3-13	0410DEL2012	27-5-19	313204
2.	0117NF2009	A Device for Roof Support of Underground Mine/Tunnel	Sudhir Kumar Kashyap, Amalendu Sinha	21-Jan-11	0374DEL2010	23-10-19	323530

Copyright Filing and Registration

Sl. No	CR Number	Title	Inventors	Date of Filing	Registration Number	Registration Date
1.	006CR2019	Mechanically Powered Self-Sliding Portable Forward Osmosis Assembly	Pallabi Das, K.K.K. Singh, P.K.Singh	26/04/2019	L-82982/2019	07/06/2019
2.	007CR2019	Calendar for Airborne Algae of Bokaro City	S.K.Bharti	01/05/2019	L-83468/2019	26/06/2019
3.	035CR2019	Integrated Hollow Fibre Fo - Uf With Tubular Assembly In a Cross Flow Channel	Pallabi Das,S. Dutta, K.K.K. Singh, P.K.Singh	06/11/2019	L-88587/2020	07/01/2020
4.	036CR2019	Double Blinding Encryption System (Dbes) For Coal Sampling And Analysis Tracking	Ranjankumar, Md. A. Hussain, G. Banerjee, A.K.Singh	——	———	———
5.	039CR2019	Flotation Reagent For The Beneficiation of Coking Coal Fines	Sanjay Chaudhuri, T. GouriCharan	21/11/2019	L-88644/2020	08/01/2020
6.	040CR2019	Bottom Pulsated Jig	Subhash Chandra Maji, S.K.Kabiraj, M. Kumar, U.S. Chattopadhyay, T. GouriCharan	22/11/2019	L-88849/2020	15/01/2020
7.	041CR2019	Heavy Medium Cyclone Test Rig For Beneficiation of Small and Fine Coals	K.M.K. Sinha, T. GouriCharan	——	———	———
8.	043CR2019	Serial and Parallel Programs for one Dimensional (1d) and two Dimensional (2d) Finite Element Analysis	Ranjan Kumar, A. Narayan, A. Hussain, G. Banerjee	20/12/2019	SW-13219/2020	03/02/2020
9.	012CR2020	Coal Characterization Matrix to Evaluate Gasification Potentiality	Sujan Saha, P.D. Chavan,G. Sahu, S. Datta	18/02/2020	———	———

Sl. No	CR Number	Title	Inventors	Date of Filing	Registration Number	Registration Date
10.	003CR2020	Hybrid Algal Race Way Photo-Bioreactor for High Rate CO_2 Capture	V. Anguselvi, M Kumar, A. Mukherjee, P.K.Singh, A.K.Singh, E. Masto, T. GouriCharan, S. Kumar, R. Yadav, P.Sinha	——	——	——
11.	004CR2020	Selection Matrix : Physico-Chemical Properties of Solid Fuels Vis-a-Vis Suitable Type of Gasifier	Prakash D. Chavan, S. Saha, S. Datta, G. Sahu	——	——	——
12.	005CR2020	Pythonic Data Logging Software (PDLS)	Ranjan Kumar, Md. A. Hussain, D. Kumbhakar, P.K. Mandal, P.K.Singh	——	——	——
13.	006CR2020	Internet Based Real Time Safety Analysis (iRTSA) Software	Ranjan Kumar, Md. A. Hussain, D. Kumbhakar, P.K. Mandal, P.K.Singh	——	——	——
14.	007CR2020	DM - Digital Mine Software	S.K.Chaulya, G.M.Prasad, S.K.Mandal, G. Banerjee, P.K.Singh, P.K.Mandal, A. Verma, D. Pandit, M.Mitra, K.Kumari, S.N.Mishra, P.Dey, C. Kumar.	——	——	——
15.	008CR2020	MEMP - Mine Environment Monitoring and Prediction Software	S.K.Chaulya, S.K.Ray, D. Mishra, G.M.Prasad, S.K.Mandal, G. Banerjee, P.K. Singh, C. Kumar, D. Pandit, M. Mitra, K. Kumari, P. Dey	——	——	——
16.	009CR2020	Sustainable Development Tree Model	V. Anguselvi, A.K.Singh, A. Mukherjee, R.E. Masto, P.K.Singh	——	——	——

Sl. No	CR Number	Title	Inventors	Date of Filing	Registration Number	Registration Date
17.	015CR2020	Real time image processing method and software	S.K.Chaulya, G.M.Prasad, S.K.Mandal, G. Banerjee, P.K. Singh, A. Chowdhury, S. Kumari, M. Choudhury, P. Dey, K. Kumari	——	———	———
18.	016CR2020	Method and software for real time image stitching and object detection	S.K.Chaulya, G.M.Prasad, S.K.Mandal, G. Banerjee, P.K. Singh, V. Kumar, S. Kumari, M. Choudhury, P. Dey, K. Kumari	——	———	———
19	017CR2020	High Ash Indian Coals : Gasification Strategy	Prakash D. Chavan, S. Saha, S. Datta, G. Sahu	——	———	———
20.	018CR2020	Blast Guide Mobile App for Android Smartphone	Harsh Anand, Aditya Rana, Pradeep Kumar Singh	——	———	———

19. c. KNOWLEDGE RESOURCE CENTRE

Knowledge Resource Centre of CSIR-CIMFR Digwadih Campus plays important role in providing information and knowledge for its esteemed users viz. Scientists, Technical staff, JRF, SRF, Project Assistants and other staffs members of CSIR-CIMFR Digwadih Campus. In addition of printed documents which will always be the main resource in KRC, internet based access to e-Journals has been also integrated into current practice as they have advantages because of quick search and dissemination. KRC-DC is always keeping pace with latest trends which are being followed in other CSIR KRCs. KOHA library management software has been successfully installed and union catalogue of CSIR (KNOWGATE) was implemented.

Collection Strength

Books, Reports, Standards, Specifications and Bound Volumes	34066
CD Collection	149
Current Journals subscription	66

PUBLICATION AND INFORMATION : Publication of Annual report, Technical books, Seminar proceedings, Souvenir, Brochures, Leaflets, Management manual, Project Work and Record Book etc. are published time to time. Sales and distribution of publications are also done. Information services are provided when any requests comes.

REPROGRAPHY SERVICES : Photocopying of documents, books official papers are done. Photographic services are done from outsourcing as and when required.

RIGHT TO INFORMATION CELL : Under RTI Act-2005 information is provided to the requester. 23 cases were dealt during the period. No penalty was imposed to any body.

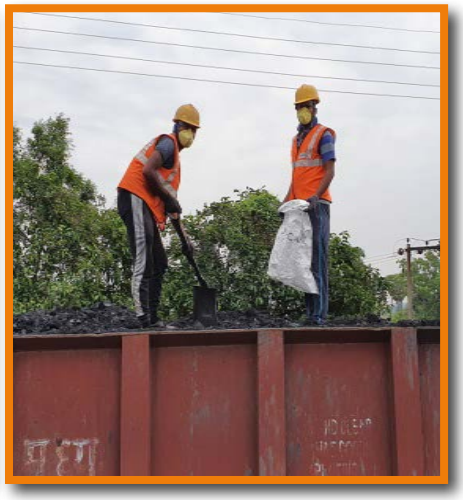
20. RESOURCE QUALITY ASSESSMENT RESEARCH GROUP (RQA)

1. Project Report (R & D / Testing)

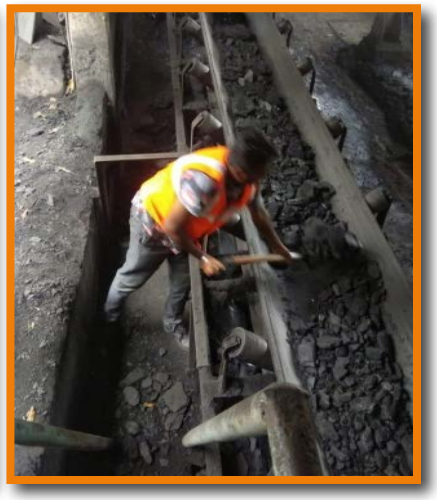
During April 2019 to March 2020, Resource Quality research group of CSIR-CIMFR, has undertaken significant strides in scientific study of coal quality loaded from various sidings of Coal India Limited subsidiaries, and subsequently unloaded at power utilities of NTPC, DVC, various State Gencos such as MSPGCL, MPPGCL, TSGECO, APGENCO, PSPCL etc and Private Power Plants. The outstanding objective of the Mega project on coal quality monitoring is to improve the quality of coal being supplied to the thermal power plants for its effective utilization.

The Coal Quality Monitoring project involves collection of sample from rail rakes/conveyor belt/truck as per Fuel Supply agreement (FSA) between Coal India / SCCL, CIMFR and the different Power Utilities at the loading points, and between CSIR-CIMFR and the relevant power utilities at unloading points. Total Moisture content is determined at the site and the parameters such as ash, equilibrated moisture and GCV are determined in the laboratory using the relevant IS/ASTM standards. The grade of the coal is determined depending on the analyzed GCV.

Coal Sampling from Trucks



Coal Sampling from Rail Rakes



Coal Sampling from Conveyor Belts

As on date CSIR-CIMFR has made tripartite and bilateral agreements for coal India, SCCL & most of the power plants of India, and covers 564.194 Million metric tonnes through tripartite agreements for loading end, and 333.522 Million metric tonnes through bilateral agreements for unloading end. The mandate of the Coal Quality Monitoring work encompasses efficient utilization of coal, enhancing the power plant performance, improving the quality of coal used in different power plants of India, providing cheap electricity, and minimizing import of coal for power plants. Meticulous and stringent approach towards Coal Quality Monitoring has resulted in supplying better quality of coal to the thermal power plants, and thereby reducing the cost of electricity. It has also resulted in reducing the specific coal consumption.

2. Bore Hole Coal Core Analysis

Though its units at Digwadih, Ranchi, Nagpur and Bilaspur, CSIR-CIMFR annually receive and characterize around 65000 meters of borehole coal cores. Since its inception, CSIR-CIMFR (erstwhile CFRI) has worked in close association with different agencies viz. Geological Survey of India (GSI), Mineral Exploration Corporation Limited (MECL), Central Mine Planning and Design Institute (CMPDIL) and has developed a comprehensive scientific procedure for characterizing coal cores. The protocols followed by CSIR-CIMFR are recognized by National Accreditation Board for Testing and Calibration Laboratories (NABL) and International Standards Organization (ISO- 9001).

The coal core evaluation process involves geological logging and chemical analysis in two stages: a) band by band, and b) seam overall analysis.

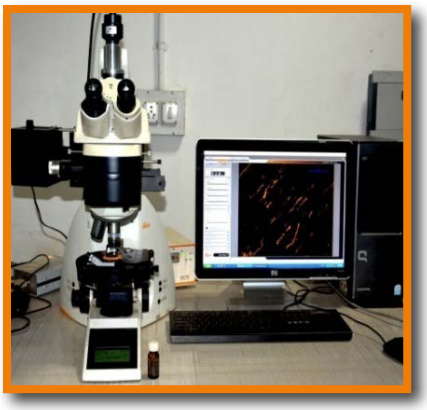
a) The band by band analysis is done based on geological megascopic identification and determination of contents of ash and moisture in the coal. It helps in identifying the nature and type of coals and associated rocks viz. shaly coal, carbonaceous shale, jhama and dirt bands like grey shale, sandstone etc.

b) Depending on the results of band by band analysis, seam overall samples are prepared in order to study the nature of composite seam. There are generally two types of seam overall samples viz. (i) ex-band (excluding band), which includes only coal bands, and (ii) in-band (including band), which includes coal as well as dirt bands. In both cases, the samples are mixed in proportion with respect to their weights. The composite sample thus obtained is thoroughly mixed, sub-sampled and analyzed. These studies reveal the nature, mode of occurrence and physical variation of the sub-surface coal. From the geological and geochemical data generated after core logging and analysis, fixation of coal seam within horizons become possible. The three-dimensional disposition of the coal seams (obtained from borehole correlations), the volume of inter-seam non-coaly portions, the compositional characters of the coals, helps in calculating the grade and tonnage of the coal deposit. An idea about the quality of coal seam subjected to beneficiation is obtained. Finally, the feasibility of mine development is also drawn from the seam overall study of an area. From coal core studies, we further decipher the geological disturbances such as folds, faults, fracture, cleavage pattern, and degree of alteration of coal by the heat released from igneous intrusions (sills and dykes).

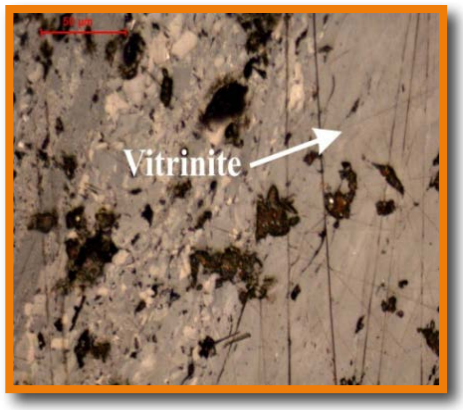
20. a. COAL PETROLOGY

The present Coal Petrology section of CSIR-CIMFR Dhanbad, earlier known as Geology Section had been actively engaged with the Resource Quality Assessment activity since inception of CSIR-CIMFR (erstwhile CFRI). Initially the section was engaged in detailed geological investigation for exploration of new coal measures in the country in association with Geological Survey of India along with characterization of the coal for specific end uses.

The basic coal petrologic data viz. maceral composition and thermal maturity level, finds application in coal carbonization and combustion industries. Using thermogravimetry-calorimetry in combination with coal petrology, the role of petrographic constituents on combustion performance of inertinite rich Indian coals has been evaluated. Using V-step distribution i.e. distribution of vitrinite reflectance percentage, optimization of coal blends for suitable coke making is routinely carried out at CSIR-CIMFR. Currently, as part of the International Committee for Coal and Organic Petrology (ICCP), the researchers of coal petrology is involved in optimisation of vitrinite reflectance measurement on complex blends. In one of the most recent prestigious recognitions, CSIR-CIMFR was part of the ICCP team to formulate a petrographic classification system for organic particles affected by self-heating in coal waste. In one of their pioneering works, heat-affected coal seams from Jharia basin, India were characterized and a classification scheme for the microtextures of natural coke, generated due to in situ carbonization was proposed. Using basic coal petrology data, for the first time an entirely new perspective on alteration in macerals caused due to intrusive generated heat (carbonization) in Jharia coalfield and a new model on magmatic intrusion and its effect on coals from the basin was introduced. More recently, the undersatndings from coal petrology has brought in new understandings about the role of petrographic constituents in generation and retention of hydrocarbons in shale-petroleum systems. In a recent key novel work using petrology data of Indian Gondwana shales, the potential effects of inert organic matter and rock-matrix-retention of hydrocarbons on the TOC-S2 relationship was determined. With the target of exploiting unconventional hydrocarbon reservoirs, recent works on coal petrology has focused on evaluating the pore structural framework and fractal dimensions in coals and shales as a function of thermal maturity levels, macerals and mineralogy, using low-pressure gas adsorption, optical and electron microscopy, and Rock-Eval techniques. In an effort to expand their analytical facilities, CSIR-CIMFR is currently in the process of establishing a Rock-Eval facility for source-rock evaluation, in addition to using petrographic techniques for the same. Presently, the institute provides facility in the field of coal petrography following ISO and BIS standards. Research microscopic facility such as Leica DM 4500 P and DMRX-P with fluorescence attachment and advanced software like Leica QWin and Petrog is available here.



Petrology Microscope



Vitrinite Maceral

Liptinite Maceral

3. Pilot Project on Auger Sampling

It is considered that the manual sampling from stationary lots, like wagons, heap etc. are considered as the last option when the other preferred methods of moving stream sampling are not available. In the absence of auto mechanical sampling system at most of the loading and unloading sites, manual sampling from wagon top is the prevalent practice in most of the sites.

Manual method of coal sampling from wagon top following IS 436 part 1 section 1, 1964 (Reaffirmed 2001) is a time consuming and tedious task. In day to day work, where supply of coal and fast movement of rakes get priority, collection of representative samples from wagons becomes difficult. In this situation, coal producers and consumers follow a modified method as laid down in their Fuel Supply Agreement. Sampling from reduced number of wagons as laid down in FSA, may be convenient in completing the sampling task within the constrained time frame, but it leads to obvious decreases of the precision of the result. An alternative method is the introduction of mechanical sampler, like auger with proper design and dimension for collection of samples from stationary wagons. This, in theory, ensures better representativeness of the samples compared to wagon top sampling by manual method as the auger is capable to collect the samples from maximum depth (up to 1.50 meter) from the railway wagon. Like all mechanical system auger will have a bias but it is relatively free from any manual intervention in collection of samples.

National Thermal Power Corporation (NTPC) is one of the largest consumers of non-coking coals in India and took the initiatives through its Talcher Super Thermal power Plants, Kaniha to get a comprehensive study on standardization of the coal sampling from wagon top by mechanical auger and entrusted CSIR-CIMFR to undertake the study on wagon top sampling by mechanical auger.

In the above context, CSIR- CIMFR was entrusted with the work to carry out a pilot project on auger sampling with the following objective and scope of work:

- Collection of 55 samples from 55 rail rakes from Lingaraj/Kaniha Siding of MCL.
- The sampling and analyses as per Fuel Supply Agreement (FSA), BIS and Mobile Mechanical Auger.
- Preparation of coal samples to -3.35 mm at loading sites.
- Samples in size of BS 212 micron to be brought to CSIR-CIMFR Dhanbad or Regional Research Centres for analyses (Proximate analysis, Equilibrated Moisture, Moisture (AD), Total Moisture and GCV).
- Screen analysis of 10 coal samples on top size 100 mm.
- Comparative evaluation of the data generated from the three methods.

The sampling experiments were carried out at two sidings i.e. Kaniha and Lingaraj under MCL. At both the sidings, coal produced from different quarries of Kaniha and Lingaraj areas were dumped and loaded in MGR/ Railway rakes by pay-loaders. Generally, for MGR, 40 No. of wagons and for railway rakes, 58 No. of wagons

were being loaded at Kaniha and Lingaraj respectively. Coal was sampled from MGR/Railway rakes in five and six sub-lots respectively. Total forty rakes were covered at Kaniha and 15 rakes at Lingaraj sidings. There was overhead electric wire at Lingaraj Sidings, so the coal samples were collected after taking due precautions after adjusting the boom height of auger and some time slanting the boom.

The collected samples were prepared for analysis and analyzed for proximate analysis and Gross calorific value (GCV) at 60 % RH and at 40 °C, at CSIR-CIMFR. Total moisture of the samples was also determined for all the samples. Besides these, screen analysis of 10 coal samples on top size 100 mm was also performed. Preparation of report is under process for comparison of all the sampling methods as envisaged above.

20. b. CSIR-CIMFR, BILASPUR RESEARCH CENTRE

1. PROJECT REPORT

During April 2019 to March 2020, CSIR-Central Institute of Mining and Fuel Research, Regional Research Centre, Bilaspur has undertaken various assignments on Coal Quality Monitoring and Borehole Coal Core Analysis.

1.1 Coal Quality Mega Project

During this period, Coal Quality Monitoring has been undertaken for various organizations and companies viz. South Eastern Coalfield Limited and North Eastern Coalfields of Coal India Limited, different power plants of Chhattisgarh State Power Generation Corporation Limited, Madhya Pradesh Power Generation Corporation Limited, Gujarat State Electricity Corporation Limited, Rajasthan Rajya Vidyut Utpadan Nigam Limited, Maharashtra State Power Generation Company Limited,Uttar Pradesh Power Corporation Limited, Adani Power, Lanco Amarkantak, DB Power Limited, Dhariwal Infrastructure, GMR Warora, Jay Prakash Power, Jindal Power Limited, Jhabua Power Limited, MB Power Limited, Maruti Power,Adani Power Dahanu, RKM Power, SKS Power, Torrent Power, TRN Energy and Various NTPCs.

CIMFR Bilaspur Centre collected and analyzed large number of coal samples from coal producers, SECL and NECL for determining the actual quality of coal sent to and received by the power plants (Tripartite and Bilateral Agreement) as part of the Coal Quality Mega Project. The exercise has resulted in amicable settling of issues related to quality of coal consignments. The details of number of samples collected and analyzed are given below.

Table 1: Details of coal samples analyzed at CIMFR Research Centre, Bilaspur

Sr. No.	Source of Samples/Type of samples	Number of Samples
1	Samples Collected at Loading end	25331
2	Samples Collected at Unloading end	10490
3	Total Moisture Samples	9993

1.1.1 Sampling Work at different sampling points

As mentioned above large quantity of samples were collected and analyzed at different loading and unloading points. The samples were collected from a) Rode Mode Dispatch b) Rail mode c) Rail Mode by Rapid Loading System d) Conveyer Belt. Figure 1 shows samples collection from different modes.

i. **Rode Mode Dispatch**

ii. **Rail mode**

iii. Rail Mode by Rapid Loading System

iii. **Conveyer Belt**

Figure 1: Different modes of sample collection under Coal Quality Mega Project at CIMFR Bilaspur

1.1 Borehole Core Coal Characterization Project

CSIR-CIMFR, Bilaspur Research Centre is fully committed to studies on coal characterization and quality evaluation of coal resources in the states of Madhya Pradesh, Chhattisgarh and Orissa. The laboratory is serving as single analytical facility for processing and Quality Assessment of coal cores generated through exploration agencies like Geological Survey of India (GSI), Central Mine Planning & Design Institute (CMPDI), in the area. Borehole core coal analysis of different coalfields has been undertaken in this period. The number of different types of samples of Boreholecore coal of different coalfields analyzed by regional center, Bilaspur and explored by Central Mine Planning and Design Institute (CMPDIL) and Geological Survey of India (GSI) is listed here. Details of the Borehole Core Coal samples taken up during this period are presented in table 2.

Table 2: Details of the Borehole Core Coal samples taken up during this period

Sr. No.	Types of Analysed Samples	Number of samples
1	Total Meterage	9734.28 Meter
2	No of B/B Samples	17250
3	No of Prepared Overall Samples	5630
4	No of HGI Samples	1609

Coal cores received are visually logged for variation of coal quality in sections constituting the core profile, and these differentiated sections are then made in to individual samples for detailed analysis of coal quality. From the geological and geochemical data generated after core logging and analysis of coal samples, fixation of coal seam within horizons becomes possible. Also, reserve estimation of a particular area or block can be done once the disposition and lateral extent of the coal seams and the quality of coal it harbors is known. Finally, the feasibility of mine development is also drawn from the overall study of an area.

Under technical aid to industries, that includes Coal Controller Organization (CCO) and other commercial industries like that of cement manufacturing, paper mills, sponge, iron and steel etc., required analysis was carried out for 475 numbers of coal samples.

CMPDIL			GSI		
State	Coalfield	Block	State	Coalfield	Block
Chhattisgarh	Bishrampur	Pathakpur	Chhattisgarh	Tatapani Ramkola	Sendur
		Shivsagar			
		Tulsi			
	Korba	Bhilai Bazar			
		Sonpuri			
		Kewai			
		South Sonpuri			
		Bundeli			
		Amgaon			
	Mand-Raigarh	Nayadih		Mand Raigarh	Tendumuri Jobro west
		Nayadih Sarapal			
		Orgaon Potia			
		Namakkal			Kida
		Barod Bijari			
		Teran			
		Kusumghat			
Madhya Pradesh	Sohagpur	Singhpur North	Madhya Pradesh	Sohagpur	Tummi Kharsal
		Kewai			
		Chulia Bhulia Central			
		Chulia Bhulia East			
		Campa			
		Baherabandh west			
		Dhanpura			

CMPDIL			GSI		
State	Coalfield	Block	State	Coalfield	Block
Madhya Pradesh	Sohagpur	Chainpa	Madhya Pradesh	Singrauli Sonvalley	Sarai Upharadol
		Jamui			
		West of Sahdol			
	Singaurali	Thara			
Orissa	NIL	NIL	Orissa	IB- River	Teliabahal
					Kendudihi
				Talcher	Kantaikaliya North
					Khandanal

20. c. CSIR-CIMFR, RANCHI RESEARCH CENTRE

Ranchi Research Centre is one of the leading Scientific and Research Centre at CSIR-CIMFR, that undertakes various research projects on coal sample collection, preparation, quality analysis, quality monitoring, borehole coal core analysis, party sample analysis, as per the IS standard and Fuel Supply Agreement (FSA) at Mahanadi Coalfield Limited (MCL), Central Coalfield Limited (CCL), and various power plants of National Thermal Power Corporation Limited (NTPC), to improve the quality of life towards power utilization in India. The centre plays a key role in coal mining and power sector to support Indian Government.

The centre fosters partnerships with a network of coal mining and power plants, nationally on matters of continuous coal quality analysis and monitoring. During the financial year 2019-20, CSIR-Central Institute of Mining and Fuel Research, Regional Centre, Ranchi has undertaken various coal quality monitoring project sponsored various power plants and coal mining companies, such as Mahanadi Coalfields Limited (Lingaraj, Kaniha, Jagannath, Bharatpur, Lakhanpur, IB Valley, Basundhara), Central Coalfields Limited (North Karanpura, Piparwar, Kujju, Barkasyal, Argada, Hazaribagh, Magadh & Amarapali, Rajrappa) and power utility's, Karnataka Power corporation Ltd, NLC Tamil Nadu Power Ltd, NTECL, Tamil Nadu Generation And Distribution Company Ltd, Andhra Pradesh Power Generation Corporation Limited, Simhadri Super Thermal Power Plant, Talcher Thermal Power Station, Talcher Super Thermal Power Station, Odisha Power Generation Corporation, Maharashtra State Power Generation Company Limited, Vedanta Power Limited Jharsuguda, Talwandi Sabo Power (TSPL), Jindal Power Ltd, Hinduja National Power Corporation Ltd, Haldia Energy Ltd, Haryana Power Generation Corporation Ltd, West Bengal Power Development Corporation Ltd, Adani Power Ltd, Damodar Valley Corporation, Durgapur Projects Ltd, Mauda Super Thermal Power Station, Solapur Super Thermal Power Project, Jhabua Power Ltd, Lara Super Thermal Power Station, Darlipali Super Thermal Power Station, Indira Gandhi Super Thermal Power Project, Bhartiya Rail Bijlee Company Limited, Kanti Bijlee Ulpadan Nigam Ltd, National Capital Power Project Limited (NTPC), Barh Super Thermal Power Project, Sipat Super Thermal Power Station(NTPC), Nation Capital Power Station Dadri (NTPC), Tanda Thermal Power Station ,NTPC Ltd, ROSA Power Supply Company Limited (RELIANCE), Bajaj Energy Limited, Guru Gobind Singh Super Thermal Power Plant, Guru Nanak Dev Thermal Plant, Guru Hargobind Thermal Plant, Paricha Thermal Power Plant, Patratu Thermal Power Station, Maithon Power Limited, Jhajjar Power Limited and Tenughat Thermal Power Station etc.

The Research Centre Ranchi also involved and fully dedicated to quality assessment of the borehole coal core received from various drilling agencies like Mining Associate Pvt.Ltd, APC Drilling and construction Pvt. Ltd, Thriveni Earthmovers Pvt.Ltd, South West Pinnacle and Central Mine Planning & Design Institute (CMPDI) of various part of Jharkhand, Odisha, Chhattisgarh, West Bengal, Maharashtra, Madhya Pradesh and the coal fields namely Rajmahal (Bhalukasba), Raniganj (Kabitirtha, Lalgang, Shunuri, Itapara south), Birbhum (Salbhadra Gomarpharil), East Bokaro (Chalkari Extension Angawali), Auranga (Rajbar), IB Valley (Rampaia Dip Extn), Sohagpur (Chainpa, Shahdol, Jamui), Singrauli (Hatta Dhudhmania, Bandha North) and North Karanpura (Badam dip side, Dhadhu East). Total coal core received in financial year 10680.86 meters and coal core logging

has done, 17948 number of sample has generated for band by band analysis as per the advice. Based on band by band results we have received seam over analysis advice from client and generated 4089 number of samples for SOV and GCV analysis. Special test significant quantity for the same bore holes, 498 samples Ultimate Analysis, 535 samples Ash Fusion Temperatures (AFT), 508 samples Hardgrove Grindability Index (HGI), 42 samples LTGK coke type, 80 samples swelling index and 321 samples total sulphur.

Based on CSIR - Central Institute of Mining and Fuel Research analytical data the coal resources and reserve estimation has been calculated and ore body modeling will be made by concern mining companies. These reserve estimation and ore body modeling will more effective to prepare mining scheme and mining plan in mining industries. And the special test analytical data will be used in power plants and steel plants for smooth functioning plant and to enhance the production in power sector as well as steel industries.

CSIR-CIMFR Ranchi also provide the consultancy services to government and private organization by analysis of coal samples received from different parties namely Punjab state power co. ltd, Jharkhand state mineral development co. Ranchi, Nabha power ltd, NTPC Kahalgaon, Vimul Dugdha Utpadak and Bihar state milk co foundation. Ranchi etc. which helped them proper economic way of production and utilization of coal.

Ranchi Research Centre is well equipped with adequate infrastructure for testing and analysis of coal and providing services to various Industries. The sophisticated facilities available are Proximate Analysis both Air dried & 60% RH & at equilibrated basis, Determination of Moisture and Ash both AD & Equilibrated, AFT (Ash Fusion Temperature Range), CHNS & CHNSO, Direct Determination of Sulphur, Determination of Phosphorus % (by conventional method), Ash Analysis, Swelling Index SI, LTGK Type (Low Temperature Grey King Assay), Distribution of Sulphur etc.

Running projects:

A. Project title: Characterization studies of coals from different coal field explored by CMPDIL, through Borehole Coal Core study. (SSP-7254, 7301, 7325, 7324, 7635, 7577, 7578, 7650)

B. Project title: Scientific study of quality monitoring of coal at unloading of various power plants. (SSP-7463, 7698,7700, 7728, 7729, 7805, 7835, 7910, 7914, 7915, 7976, 7836, 8057, 8088, 8106, 8107, 8113, 8145, 8146)

C. Project title: Scientific study of quality monitoring of coal at loading end of MCL for different power plants. (SSP-7361, 7364, 7467, 7490, 7491, 7493, 7495, 7510, 7563, 7574, 7576, 7594, , 7603, 7604, 7701, 7702, 7718, 7775, 7819, 7864, 7894, 7911, 7931, 7951,7971, 7975, 7978, 8050, 8051, 8087, 8104, 8112, 8119, 8122, 8133, 8143, 8144, 8148, 8166, 8172, 8211, 8215.)

D. Project title: Scientific study of quality monitoring of coal at loading end of different areas of MCL. (SSP-7458, 7459, 7460, 7464, 7465, 7466,7657, 7776, 7982, 7983, 7984, 8002, 8011, 8012, 8013, 8014, 8082, 8210, 8212, 8213, 8214.)

E. Project title: Scientific study of quality monitoring of coal at loading end of CCL for different power plants. (SSP-7505, 7791, 7801, 7802, 7810, 7841, 7842, 7843, 7865, 7886, 7887, 7888, 7889, 7890, 7891, 8054, 80818105, 8108, 8114, 8115, 8120, 8121, 8129, 8141, 8142, 8265)

F. Project title: Scientific study of quality monitoring of coal at loading end of different areas of CCL for different power plants (SSP-7390, 7411, 7412, 7468, 7470, 7471, 7473, 7616, 7617, 7663, 7368, 7618, 7703, 7704, 7705, 7716, 7717, 7732, 7890, 7810, 7886, 7887, 7891, 7842, 7843, 7865, 7888, 7888, 7889, 7901, 7902)

Project Completed and submitted:

A. Project title and No.: Characterisation Testing and analysis of coal CC/T & A/RAN/2019-20.

B. Project title: Characterization studies of coals from different coal field explored by CMPDIL, through Borehole Coal Core study. (SSP-7253, 7278, 7310, 7319, 7727)

C. Project title: Scientific study of quality monitoring of coal at unloading of various power plants. (SSP-7358, 7362, 7366, 7367, 7462, 7575, 7512, 7587, 7588, 7596, 7628, 7699, 7836, 8001)

D. Project title: Scientific study of quality monitoring of coal at loading end of MCL for different power plants. (SSP-7359, 7363, 7365, 7412, 7461, 7489, 7492, 7494, 7511, 7562, 7595, 7627)

E. Project title: Scientific study of quality monitoring of coal at loading end of different areas of MCL for different power plants. (SSP-7458, 7459, 7460, 7464, 7465, 7466, 7657, 7658, 7776)

F. Project title: Scientific study of quality monitoring of coal at loading end of CCL for different power plants. (SSP-7504, 7506, 7616, 7617)

G. Project title: Scientific study of quality monitoring of coal at loading end of different areas of CCL for different power plants (SSP- 7414, 7469, 7472, 7474, 7369, 7370)

20. d. CSIR-CIMFR, NAGPUR RESEARCH CENTRE (MINING TECHNOLOGY)

1. PROJECT REPORT (Grant-in-Aid Projec/Consultancy/Sponsored/)

1. Development of a Selection Methodology for Roadheader and Tunnel Boring Machine in Different Geological Conditions for Rapid Tunnelling. The study was initiated to characterize the intact rock and rock mass with more precise and established methods such as in-situ dynamic properties and laboratory properties namely Drilling Rate Index (DRI), Bit Wear Index (BWI) and Cerchar Abrasivity Index (CAI) using Linear Cutting Rig (LCR).
2. Studies on design and construction of underground sections including one underground station at Cuffe Parade and associated works at Mumbai Metro Rail Project, UGC-01, Phase-III, Mumbai. The objectives of this project include i) Studies on new controlled blasting methods and blast vibration monitoring for rock excavation and ii) development of innovative vibration controlled measures at Churchgate Station.;Studies on controlled blast design and establishing safe blast parameters at Star Cement Mine. CSIR-CIMFR provided technical solutions to all the blast induced vibration and flyrock problems near sensitive structures like National highway and high tension powerlines.
3. Design of tunnel support system and other requirements for tunneling works for construction of tunnels in connection with Pune-Miraj doubling project, Central Railway. CSIR- CIMFR provided technical solutions to all the problems related tunnel support system and controlled blasting to reduce damage and improve productivity at all the four tunnels of Central railway.
4. Study for evolving strategies for control of blast induced environmental effects at limestone mines of Maratha Cements, Gadchandur. Detailed analysis of the blast vibrations and air overpressure due to blasting was investigated. Based on the attenuation results and observed data a comprehensive blast design was suggested to control ground vibrations in the nearby localities.
5. Study for evolving strategies for control of blast induced environmental effects at limestone mines of M/S Orient Cement Ltd., Chittapur, Karnataka. Blast monitoring was conducted in two phases and sufficient data was generated to identify the cause of ground vibration related issues in a nearby village. Strategies to control the vibration and air overpressure for smooth operations was devised through a proper blast design.
6. Study for evolving strategies for control of blast induced environmental effects at Jaypee Limestone Mine of Ultratech Cement Ltd., Bela (Rewa), Madhya Pradesh. A detailed analysis of the geological conditions of the mine was evaluated and blasts were monitored along with the fragmentation details. Blast design was recommended for smooth operations of the mines without damaging nearby structures and without compromising fragmentation.
7. Advice and design of stoping parameters for future areas at Mahagiri underground Mine of Indian Metal and Ferro Alloys Ltd. ; The optimum parameters are redesigned to ensure better stability for the stopes in the top level.
8. Numerical modelling and advice on stoping parameters for K1 lens (400-450mRL), S1 lens (300-450mRL) and Block 1 (375-400mRL) of Kayad Mine, Hindustan Zinc Ltd; **Project No. SSP/N/387/2019-20;** Optimum

stoping parameters are designed and ground supports are recommended to achieve zero possibility of surface damage and safe stoping operations.

9. Design and advice of stoping method in Block-1 and Block-2 and Upper portion between -80L and -105L at Rampura Agucha Mine, Hindustan Zinc Ltd. In Rampura Agucha mine of Hindustan Zinc limited the extraction lead Zinc deposit is now continuing by underground stoping below the open pit. The underground operations are done leaving 60 m crown pillar from the bottom of the open pit. This study is to asses the Feasibility of extracting the Block 1, Block 2 and upper portion between -80 mRL and -105 mRL and to come up with an extraction strategy. Numerical modelling is performed to assess the stability scenario of the proposed stoping. From the studies it is found feasible to extract the proposed Block 1 at Northern side (from -80 mRL to 173 mRL and N 870 to N 390) and Block 2 at Southern side (-80 mRL to 73 mRL and S 705 to S 435) by sub level stoping using cemented paste back fill. However for upper level stopes it is anticipated that yielding in the rock mass may go up to about 20 m above -80 mRL. This may result in chimneying to such height if any premature collapse of a stope takes place, and hence to be done only partially and with great caution.
10. Numerical modelling study for underground mining below -55 mRL at Zawarmala Mine, Hindustan Zinc Ltd. Stability analysis and determination of safe standoff distance for permanent excavations like declines, sumps, substations, shafts, shaft-insets, crusher chambers, workshop and footwall drive etc. are also arrived at.
11. Scientific study for optimization of stoping parameters and sequence of mining for BLOCK-III Eastern Fringe between 230 to 110 mRL of Kayad mine, Hindustan Zinc Ltd. In the current study an optimum stoping strategy for mining Block III eastern fringe is devised using transverse stoping in tandem with Cemented Rock Fill (CRF). A feasible sequence of extraction, design of post pillars and the overall stability are assessed using three-dimensional numerical modeling.
12. Scientific Study for Support Design of Tunnel at PVK 5 Incline, Kothagudem Area, SCCL. Through application of various approaches, the estimation of support requirement and alternative excavation methodologies are being suggested. In addition to this various other approaches are also being used to come to the conclusion and to add to the confidence while recommending safe tunnel incline excavation methodology and support requirement of the PVK 5 incline.
13. Studies on design and construction of underground sections including one underground station at SCG station, Churchgate and associated works at Mumbai Metro Rail Project MMRC, UGC-01, Mumbai. M/s L&T – STEC Joint Venture, Mumbai referred the study to provide design methodology for safe blasting to excavate rock for development of metro rail in highly congested Churchgate Area in Mumbai. CIMFR conducted studies for containing ground vibrations, airblasts and flyrock for facilitating rock excavation for station box of Churchgate station of package-1.
14. Scientific blasting study to evaluate blast induced ground vibrations at Dhedwas opencast iron ore mine of M/s Jindal Saw Limited – Bhilwara. This scientific blasting study was initiated by M/s Jindal Saw Limited – Bhilwara received from the Office of The District Collector Bhilwara. The study report encompassed the monitored blast design parameters, seismograph event records and recommendations which can be implemented alongwith existing blasting practices being followed in Dhedwas opencast iron ore mine.
15. Scientific consultancy services for conducting geophysical survey of seismic profiling by surface-wave tomography for Kanhan Diversion Project, Maharashtra.
16. Advice on rock characterisation for categorizing hard and soft formation at dryport project of JNPT, Wardha.
17. Geotechnical study for Support Design in D2(1) Depillaring Panel with caving including Hydrogeological Assessment at Belgaon Underground Coal Mine.
18. Geotechnical Study for optimum size of Crown Pillar and stope back support at Proposed Palaspani Underground Manganese Mine.

19. Evaluation of waste dump stability through slope monitoring at Rampura Agucha opencast mine.
20. Design of 120 m high waste dump at Nimbeti limestone mine (Shree Cement Ltd.).
21. Evaluation of threshold values for pit slope and waste dump based on the analysis of slope monitoring data at Rajpardi Lignite Project (GMDC Ltd.).
22. Scientific study for advice on pit slope management at Morwad & Dharmeta Marble mines (M/s RK Marbles Pvt. Ltd.).
23. Design of Pit slope and waste dump at Kotputli limestone mine (Ultratech Cement Ltd.).
24. Asessment of the stability of 140 m high waste dump through slope monitoring at Rampura Agucha Opencast Mine (Hindustan Zinc Ltd.).

20. e. CSIR-CIMFR, NAGPUR RESEARCH CENTRE (FUEL SCIENCES)

THIRD PARTY SAMPLING

During April 2019 to March 2020, CSIR-CIMFR Nagpur Research Centre(Fuel sciences) has undertaken scientific assessment study of coal quality, loaded from various sidings of WCL (Ballarpur, Chandrapur, Umrer, Nagpur, Kanhan, Pench, Wani-North, Wani, Pathakhera, Majri areas)& SCCL (Ramagundam, Bellampalli, Bhupalpalli, Kothagudem regions)and unloading sites at power utilities of NTPC, MSPGCL, MPPGCL, TSGECO, APGENCO, KPCL and GSECL.The objective of Mega project of coal monitoringis to study the quality of coal loaded from different sidings for effective utilization at thermal power stations.The study involves collection of sample from rail rakes/conveyor belt/truck as per Fuel Supply agreement (FSA)between Coal Producers and Power Utilities. The quality monitoring is not only beneficial for the society by decreasing the cost of generation but also contributes in reduction of green house gases.

IMPORTED COAL SAMPLING

Maharashtra State Power Generation Co. Ltd (MAHAGENCO) has given work order for sampling and analysis of 20,00,000 ± 50 % MT of non-coking steam coal of foreign origin at its Koradi, Chandrapur&Bhusawal TPS &5,00,000 ± 50% MTdischarge ports at Vishakapatnam, Gangavaram, Kakinada and Dharamtarsea ports.

Sampling of imported coal at Kakinada port Auger sampling for imported coal

Total moisture and percentage fines below -2.36 mm are determined at site and 250 micron samples reached to lab for further analysis.

Analysis of coal samples in accordance with relevant ASTM standards. The ranges of various parameters as per MOU between Mahagenco and the parties were; Ash% (ADB) up 12%,VM (ADB) 25-45%, Fixed carbon 40-60%, Total sulphur upto 0.9% and GCV (ARB) 4400- 4800 Kcal/Kg. The parameters for samples analyzed were mostly consistent and fall within range.

ASSESSMENT OF BOREHOLE COAL CORES:

CSIR-CIMFR Nagpur Research Centre (Fuel Sciences) is engaged in the quality assessment of coal/lignite seams encountered in the exploratory boreholes drilled by agencies such as GSI, CMPDI, MECL, State departments of Geology & Mines and private agencies in the different blocks of virgin coalfields of India. During this period Nagpur Research Centre carried out the study of **6322.69 m** of coal core received from GSI, CMPDI and Private Exploration agencies.Coal core was received from 19 blocks of 6 coalfields and are summarized in the table below.

Coalfield	Blocks
Wardha Valley	Penganga Deep, Yekona, Temburda, Borda, West of Kiloni, BaranjMaora-Takli, Bhatadi Deep, Madheri, Purad
PenchKanhan Valley	KahuaKhetri, Urdhan Jamunia, NaheriyaDhankasa, Sagoniya, Thesgora A dip side
Godavari Valley	Sambayyagudem, Tadicherla
Ib Valley	Rampia dip side
Kamptee	Gondegaon-Ghatrohan
Bander	NandGokul

The data generated is used by exploratory agencies in preparation of National Inventory of coal resources and is of immense use to earmark deposits for industries as per requirement resulting in effective utilization of coal resources.

Fig 1.Band by band separation of coal seams

Fig 2 Float sink test of coal cores

D

STAFF NEWS AND OTHERS

D. STAFF NEWS AND OTHERS

I. PAPERS PUBLISHED IN INTERNATIONAL JOURNAL

1. Aditya Rana, Narayan K. Bhagat, G.P.Jadaun, S.Rukhaiyar, A. Pain and P. K. Singh (2020): Predicting Blast-Induced Ground Vibrations in Some Indian Tunnels: a Comparison of Decision Tree, Artificial Neural Network and Multivariate Regression Methods. Mining, Metallurgy & Exploration: pp.1-15. Published online on 28th March 2020.
2. Ahirwal Bhagirath and Vishwakarma R.K. (2019): Study of temperature classification, spark ignition and drop test assessment on secondary cells for intrinsically safe equipment for explosive atmospheres, Process Safety Progress, USA, 38 (4), pp. 1-7, 2019.
3. Ahirwal Bhagirath, Chatterjee T.K. and Singh A.K. (2019): Design, analysis and comparison of methods to increase time tEof increased safety motor for hazardous area, Journal of Electrical Engineering, Romania, 19 (3), pp. 513-521, 2019.
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12. Chattaraj S., Mohanty D., Kumar T., Halder G. and Mishra K. (2019): Comparative study on sorption characteristics of coal seams from Barakar and Raniganj formations of Damodar Valley Basin, India. International Journal of Coal Geology, 212: 103202, 1-19. https://doi.org/10.1016/j.coal.2019.05.009.ass failure criterion. Rock Mechanics and Rock Engineering, 52(10), 3921-3946.
13. Chaulya S.K., Trivedi R. Kumar A. Tiwary R.K. Singh R.S. Pandey P.K. and Kumar R. (2019): Air quality modelling for prediction of dust concentrations in iron ore mines of Saranda region, Jharkhand, India. Atmospheric Pollution Research. 10 (3), 675-688 Elsevier (2019).
14. Das A. J., Mandal P. K., Prakash A., Roy L. B. and Tewari S. (2020): Underground extraction methodology of contiguous coal seams ensuring the safety of the parting and the surface structures. Safety Science, 121, 215-230.

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23. Kumar A., Kumar D., Singh A.K., Ram S., Kumar R., Singh A.K., Sarthi A. and Majhi S. (2019): Strength estimation of irregular shaped heightened rib/snook for mechanised depillaring. In: Proceedings of 8th Asian Mining Congress. November 06-09, 2019, Kolkata, India, The Mining Geological & Metallurgical Institute of India, pp. 529-538.

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29. Kumar A., Singh J.K., Roy S.K., Kumar R., Varwade K. and Kumar P. (2020): Enhancement of Stability of Over Burden Dumps Using Fly Ash-A Review, National Conference on Advances in Mining (AIM-2020), 14-15 February 2020, Dhanbad, India.

30. Kumar R. and Tara K. (2020): Corporate Social Responsibility in Coal mining Sector: A Case Study, In the Proceeding of National Seminar on Advances in mining (February 14-15, CSIR-CIMFR, Dhanbad.

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54. Sekhar S, Porathur J L, Bagde P, Sharma D N, Binjhade P and Verma C. P. (2020): "Recent Practice in barricade construction using shotcrete-design and implementation", National Seminar on Recent Practices and Advancement in Mineral Industry (RPAMI), 21st – 22nd Feb. 2020, pp. 12 – 19, VNIT Nagpur

55. Sheikh A.,Verma C.D., Sangode A.G and Kumbhakar S. (2020): Paste fill technology -a smart way to dispose mill tailing, National Seminar on "Recent Practices and Advancement in Mineral Industry (RPAMI)" 21-22 February, 2020, pp-58-61, VNIT Nagpur.

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61. T.Gouri Charan, K.M.P. Singh, P.S. Prasad and U.S. Chattopadhyay (2019): "Beneficiation, Carbonization and Blending Studies of LVC Coals – A Case study, National Seminar on Recent Advancements in Coal Carbonization: Challenges and Opportunities" held at CIMFR (DC)
62. T. Gouri Charan (2019): "Beneficiation of Indian Coking and Non-Coking Coals for different end uses : Present status and future scope for Young Engineers" Advancement in Mineral Processing Techniques with Special References to Iron Ore& Coal" held at NIT Jamshedpur
63. T.Gouri Charan, U.S.Chattopadhyay, K.M.K.Sinha, K.M.P.Singh, S.C.Maji and Pradeep Kumar Singh (2020): "Studies on The Cleaning Potentialities of W-V And W-VI Grade Coking Coals Of Jharia Coalfields" Workshop on Coal Beneficiation: Optimization of Clean Coal Yield at Lower Ash% held at CMPDI Ranchi
64. U.S.Chattopadhyay, K.M.K.Sinha, S.C.Maji, Sanjay Choudhuri and T.Gouri Charan (2019): "Pulverized Coal Injection – Use Of Indian Non Coking Coals After Beneficiation" National Seminar on Recent Advancements in Coal Carbonization: Challenges and Oppurtunities" held at CIMFR (DC)
65. Verma Chandrani P., Porathur John Loui and Sheikh A. S. (2020): Web Pillar sssDesign for Highwall Mining at Medapalli Opencast Mine, National Conference on Advances in Mining (AIM 2020), 14th – 15th Feb, 2020, pp. 134 – 144 at CSIR-CIMFR, Dhanbad.
66. Vishwakarma A. K., Himanshu V. K., Kumar S and Roy M. P. (2020): Over break control in development face blasting of underground metal mine – A Case Study. Proceedings of National Seminar on Advances in Mining (AIM-2020). pp 473-482.

V. BOOK PUBLISHED

1. Hazra, B., Wood, D.A., Mani, D., Singh, P.K., Singh, A.K., 2019. Evaluation of Shale Source Rocks and Reservoirs. Springer Nature.
2. Mohanty D., 2019. Coal Seam Gas - Evaluation, Extraction and Environmental Issues (Chapter 7). In: Kundu, S. N., Nawaz M., (Eds.), Sustainable Energy and Environment: An Earth System Approach. Apple Academic Press [ISBN: 9781771887632 (Hard Cover), ISBN: 9780429430107 (eBook)], 173-200.
3. Mandal P.K., Kumar R., Das A.J., Singh P.K., 2020. Advances in Mining. National Conference Proceedings (ed.) on Advances in Mining (AIM-2020), 14-15 February, 2020, CSIR-CIMFR Dhanbad, pp.1-510.
4. Ramulu M., Sitharam,T.G., Chapter-9: Effect of Repeated Blast Vibrations on Rock Mass Damage in Tunnels, Recent Challenges and Advances in Geotechnical Earthquake Engineering (Ed. T.G. Sitharam (Indian Institute of Science, India) and J. S. Vinod (University of Wollongong, Australia), IGI Global Publications, New York, USA.
5. Ramulu M., 2019. Infrastructure Design, Signalling and Security in Railway, Chapter title: Special Tunnel Blasting Techniques for Railway Projects, INTECHOPEN publisher, UK. Revised edition, 2019, pp.479-502.
6. Selvi, V.A., Masto, R.E., Mukherjee, A., Singh, P.K., 2019. CO2 Capture for Industries by Algae, In. Algae (Edited by Yee Keung Wong), Intech Press, Print ISBN: 978-1-83880-562-3.
7. Singh S. K., 2019. How to Obviate Inundation Hazards by Application of Concept of Harmless Subsidence at Non-effective width of extraction, September 2019, Chapter-III "Future lines of research", A Handbook on Inundation Management in Indian Coal Mines, (ed. T. K. Mozumdar), ACME Enterprise, Kolkata, pp.133-135.
8. Soni Abhay Kumar, 2019. Mining of Minerals and Groundwater In India, A Book Chapter in Intech Open book titled "Groundwater", 33 pages (published on 29/3/2019). http://dx.doi.org/10.5772/intechopen.85309.

VI. HONOURS

1. Dr. A.K. Raina, Senior Principal Scientist received appreciation from International Journal of Rock Mechanics and Mining Sciences as a reviewer.
2. Dr. A.K. Soni, Chief Scientist, appointed as Chairman, Course Committee (2018 -20) for Diploma Programme in Mining and Mine Surveying (MS) / Mine Engineering (MN) and Mining Engineering (MZ) by Maharashtra State Board of Technical Education (MSBTE), Mumbai (for framing new curriculum scheme and programme Structure).
3. Dr. A.K. Soni, Chief Scientist, appointed as 'Book Editor' for a Book project on "Mining Technique" by Intech Open, London UK (19/07/2019).
4. Dr. Jai Krishna Pandey, Chief Scientist, served as a Member of Expert Appraisal Committee (EAC) of Ministry of Environment, Forest and Climatic Change (MoEF&CC) Govt of India, for environmental clearance of Thermal and Coal mine projects
5. Dr. Jai Krishna Pandey, Chief Scientist, is a Nominated Member of CHD 8, CHD8:1 and CHD19 Committees, Bureau of Indian Standard, New Delhi.
6. Dr. More Ramulu, Sr. Principal Scientist, Editorial board member of International Journal of Geotechnical Earthquake Engineering, IGI Global publications, An official publication of the Information Resources Management Association
7. Dr. More Ramulu, Sr. Principal Scientist, Editorial board member of Journal of explosives safety and technology society 'Visfotak', India.
8. Dr. More Ramulu, Sr. Principal Scientist, Editorial board member of Indian Mining & Engineering Journal, Bhubaneswar, India.
9. Dr. More Ramulu, Sr. Principal Scientist received Appreciation from Springer Nature as a reviewer.
10. Dr. D. Basak has guided three engineering students during training at summer in Electrical Design and Online Monitoring of Wire Rope Health Section of CSIR-CIMFR, Dhanbad.
11. Dr. D. Basak was the Organizing Secretary of "One day All India Workshop" under Electrical Engineering Division of Institution of Engineers (I) India, Dhanbad Local Chapter and TEQIP III, BIT Sindri on "Innovations for Sustainable Energy Systems (ISES 2019) on 21st Sept., 2019 at BIT, Sindri.
12. Dr. D. Basak is
    a. Member of BIS Committee on "Continuous Bulk Conveying, Elevating, Hoisting, Aerial Ropeways and Related Equipment Sectional Committee, ME-06".
    b. Member of Panel – 1 on 'Aerial Ropeways', MED 06 and contributed in the work related to the cause of standardization/revision of following Indian Standards: (1) IS 9228:2019, (2) IS 9706:2019, (3) IS 17232:2019, (4) IS 17233:2019, (5) IS 17234:2019, (6) IS 17235:2019, (7) IS 17236:2019, (8) IS 17237:2019, (9) IS 17238:2019, (10) IS 17239:2019 and (11) IS 17240:2019 (July).
    c. Alternate Member of BIS Committee on "Wire Ropes and Wire Products Sectional Committee, MED-10".
13. Dr. D. Basak is
    i. Member of the Editorial board for "Amity Journal of Operations Management (AJOM)"
    ii. Member of the Editorial Team for "Journal of Mechanical Engineering Research"

VII. AWARDS

1. CSIR Technology Award - 2019 in 'Physical Sciences and Engineering' for Controlled Blasting Techniques developed for safe extraction of minerals from mines and construction of various civil infrastructure projects to given to CSIR-CIMFR team. The award was presented by Hon'ble President of India on the occasion of CSIR Foundation Day on 26th September 2019 at Vigyan Bhawan, New Delhi.

2. CSIR Technology Award for Business Development and Technology Marketing – 2019 to given to CSIR-CIMFR team for Significantly Enhancing the Business and Marketing of their Knowledge. The award was presented by Hon'ble President of India on the occasion of CSIR Foundation Day on 26th September 2019 at Vigyan Bhawan, New Delhi.
3. CSIR- Young Scientist Award 2019 to Dr Bodhisatwa Hazra in the field of Earth, Atmosphere, Ocean and Planetary Sciences.
4. Dr. R.S Singh was awarded National Geosciences Award by Ministry of Mines, Govt of India, Sept 2019.
5. Dr. Santosh Kumar Ray, Principal Scientist, received MEAI-Service Excellence Award 2019 for extraordinary services to MEAI and Mineral Industry of India.
6. Dr. R.D. Dwivedi, Dr. R.K. Goel and Dr. P.K. Singh received ISRMTT Best Paper Award-2018 under the category of Rock Testing, Monitoring and Instrumentation for their paper on Study of thermal behaviour of micro-cracks in granulite. JRMTT, (2018) 24(1), pp. 27-37. The award was presented on Nov.4, 2019 at New Delhi.
7. Dr. Abhay Kumar Singh has appointed as an Associate Editor for Springer Group Journal "Mine Water and the Environment".
8. Amar Kumar Singh was awarded for Hindi Translation and Essay Competition at Hindi Pakhwara, Communal Harmony and Vigilance Awareness Week.
9. Mr. Ashok Kumar, Scientist, received MEAI- Sitaram Rungta Memorial Award for presenting an excellent paper on mining related issues in the year 2019. a. Dr. Ashish Kumar Ghosh, Principal Scientist was awarded Radiological Safety Officer certificate from Atomic Energy Regulatory Board, Government of India, Mumbai.
10. Dr. (Mrs.) Chandrani P. Verma, Principal Scientist received The Institution Prize of IEI under subject prize category for the paper titled "Numerical Modeling of Pot-Hole Subsidence Due to Shallow Underground Coal Mining in Structurally Disturbed Ground" published in the series 'D' Journal of IEI, Vol. 99, Issue 1. Prize awarded in 34th Indian Engineering Congress on 27th Dec. 2019 at Hyderabad.

VIII. ATTAINMENT OF QUALIFICATION

1. Dr. Amit Kumar Singh, Senior Technical Officer-1 was awarded Ph.D. degree from Mahatma Gandhi ChitrakootGramodayaVishwavidyalaya, Chitrakoot-485334, Satna (M.P.). The title of his thesis was "Impact of mining on Socio-economic status of beneficiary in coal mining area of district Dhanbad (Jharkhand)
2. Mr. Avinash Paul,Principal Scientist submitted his Ph.D. thesis to Indian Institute of Technology (Indian School of Mines), Dhanbad, Jharkhand, India. The title of his thesis is "Development of Rock Mass Classification(RMRdyn) for rock load estimation incoal mine developmentheadingsof Bordand Pillar workings".
3. Shri Rabi Narayan Senapati, Technical Officer was awarded Ph. D. degree in January, 2020 form IIT (ISM), Dhanbad. The title of the Thesis was "Heteropoly Acid based Catalysts for Ammoxidation and Dehydrocyclisation Reactions"
4. Shri Rabi Narayan Senapati, Technical Officer was awarded Ph. D. degree in January, 2020 form IIT (ISM), Dhanbad. The title of the Thesis was "Heteropoly Acid based Catalysts for Ammoxidation and Dehydrocyclisation Reaction
5. Dr. Sahendra Ram, Senior Technical Officer-1 was awarded withPost-Doc research work from the Institute of Geonics of the Czech Academy of Sciences, Ostrava, Czech Republic.The title of his research work was "Numerical modelling of fracturing rock mass using in FLAC3D".
6. Shri. U.S.Chattopadhyay, Senior Principal Scientist was awarded PhD degree in2020 from IIT (ISM), Dhanbad. The title of the thesis was " Laboratory and Pilot Plant studies on recovery of coal values from settling pond slurry and its coking propensities"

IX. DEPUTATION ABROAD

1. Dr. Ashok K. Singh(with Dr. P. K. Singh, Director CSIR-CIMFR) attended International Conference "International Round table on the Future of Coal" at Cape Town, South Africa.
2. Dr Ashok K. Singh and Dr. Prabal Boral attended International Pittsburgh Coal Conference and presented a Paper at Pittsburgh, USA during 03.09.2019 to 06.09.2019.
3. Dr Ashok K. Singh attended ISO/TC-27 meeting at Tokyo, Japan during 06.10.2019 to 11.10.2019.
4. Dr. Jai Krishna Pandey, Chief Scientist, Dr. Niroj Kumar Mohalik, Principal Scientist and Debashish Mishra, Scientist visited Bhutan during 10.04.19 to 13.04.19 in connection with a consultancy project entitled "Scientific investigation on resuming exploratory drift work of Amari II Powerhouse at Martshala, Samdrup, Jongkhar, Bhutan and Advice thereof"
5. Dr. KKK Singh was deputed to participate in International Conference on Environmental Protection and Climate Change" held on November 04-05, 2019 at Barcelona, Spain in the capacity of a Keynote Speaker and as a session co-chair
6. Dr. More Ramulu, Senior Principal Scientist visited Muscat, Oman during 9-14, February, 2020 for a 'study on the efficacy of a new rock breaking system by conducting experimental trials'.
7. Miss Pallabi Das received DST international Travel Support to attend European Membrane Society Summer School held in University of Edinburgh, United Kingdom, June 23-28,2019.
8. Dr. Prabhat Kumar Mandal, Chief Scientist attended International Congress on Rock Mechanics and Rock Engineering, Foz da Iguassu in Brazil during 13 September to 18 September 2019 and presented a research paper entitled "Stability evaluation and safe designing of barriers against rivers in an
9. Dr. Raj S. Singh was deputed to participate in International Conference on Environmental Protection and Climate Change" held on November 04-05, 2019 at Barcelona, Spain in the capacity of a Keynote Speaker and as a session chair
10. Dr. Sahendra Ram, Senior Technical Officer-1 visited Czech Republic to complete last 3 months of his Post-Doc research work from the Institute of Geonics of the Czech Academy of Sciences, Ostrava, Czech Republic from February 2019 to April 2019.
11. Dr. Satyendra K Singh, Chief Scientist attended 53rd US Rock Mechanics/ Geomechanics Symposium during 23 June to 26 June 2019 in New York, USA and presented research paper entitled "Geomechanics challenges during coal pillar recovery: A success narrative in a high-production mechanized Indian coal mine".
12. Shri T. B. Das chief scientist, participated in the 27th Meeting of TC-27 of International Organization for Standardization (ISO) held at Minato, Tokyo, Japan during 6th -11th October, 2019.

X. SEMINAR, SYMPOSIUM, WORKSHOP AND LECTURE ARRANGED

A National Conference on Advances in Mining (AIM-2020) has been jointly organised by CSIR-Central Institute of Mining and Fuel Research and The Institution of Engineers (India) on February 14-15, 2020 at CSIR-CIMFR Auditorium, Barwa Road, Dhanbad under the Chairmanship of Dr Pradeep K. Singh, Director, CIMFR-CIMFR, Dhanbad. Dr Satyendra K. Singh, Chief Scientist was the Organising Secretary, Dr Prabhat Kumar Mandal, Chief Scientist was the Convener and Dr Ranjan Kumar, Principal Scientist and Shri Arka Jyoti Das, Scientist were the Co-conveners of this event.

The conference provided an effective common platform for interactions and deliberations amongst the participating dignitaries and delegates from mining companies, academic and research institutes and regulatory bodies. The recent advances in mining were discussed, exchanged ideas and addressed the core issues of mining for further advancement and promote the growth and sustainable development of mining industries.

Her Excellency Smt. Droupadi Murmu, Hon'ble Governor of Jharkhand, as Chief Guest of Inaugural Function, emphasized that the mining sector is essential for the growth of the Indian economy and need to be very

sensitive to the environment and tribal people during mining operations. The national conference on “Advance in Mining” may come out with solutions to conserve our environment while continuing developmental activities. Shri Laxman Singh Shekhawat, Director (Operations), Hindustan Zinc Limited graced the occasion as Guest of Honour and highlighted that the advancements in mining are highly pertinent for safety and productivity with the conservation of mineral and environment especially related to deep mines.

Dr. Aboo Backer Siddique, Secretary cum-Commissioner, Dept. of Mines & Geology, Govt. of Jharkhand graced the occasion as the Chief Guest of this Valedictory Function. He stressed that mining should give due regards to the environment and society through technological advancements in the mining sector. Shri Prem Sagar Mishra, Chairman Cum-Managing Director, Eastern Coalfields Limited was the Guest of Honour. He emphasized that ECL will adopt the modern method of underground mining for producing most of its coal from underground mines.

There were 21 broad themes in the conference covering different emerging areas of mining. Total of 54 papers has found their places in the proceedings for oral presentations. 10 technical sessions have been conducted with parallel sessions in the two days of the conference including the Keynote Session. Around 50 Academic institutions, Govt. organizations, Public and Private sectors.

XI. RESEARCH COUNCIL

Sl. No	Name & Designation	Portfolio
1.	**Prof. E.S. Dwarakadasa,** Former Professor, Department of Metallurgy, Indian Institute of Science, Bangalore and Chairman Karnataka Hybrid Micro Devices Ltd., Plot 103, 4th Cross, Electronic City, Bangalore – 560 100	Chairperson
2.	**Prof. Rudra Pratap,** Deputy Director, Indian Institute of Science, CV Raman Road, Bengaluru - 560012	External Member
3.	**Prof. Kamal K. Pant,** Professor, Department of Chemical Engineering, Indian Institute of Technology, Hauz Khas, New Delhi - 110016	External Member
4.	**Prof. Sunil Kumar Singh,** Director, National Institute of Oceanography, Dona Paula, Goa - 403004	External Member
5.	**Shri Ramesh Babu V,** Director (Operation), National Thermal Power Corporation Limited, NTPC Bhawan, SCOPE Complex, Institutional Area, Lodhi Road, New Delhi – 110 003	External Member
6.	**Shri Bhola Singh,** Director, Technical (Project & Planning), Central Coalfields Limited, Darbhanga House, Kutchery Road, Ranchi – 834029 (Jharkhand)	External Member
7.	**Shri Rajendra Dashora,** SBU Director, Rajpura Dariba Complex, Hindustan Zinc Limited, Vendanta Resources, Yashad Bhawan, Udaipur- 313004	Agency Representative
8.	**Dr. Suman Kumari Mishra,** Head, Human Resources, CSIR-National Metallurgical Laboratory, Jameshedpur – 831007	DG's Nominee
9.	**Dr. N. Kalaiselvi,** Director, CSIR-Central Electrochemical Research Institute, CECRI, Nagar, Karaikudi – 623006	Sister Laboratory
10.	**Dr. Pradeep Kumar Singh,** Director, CSIR - Central Institute of Mining and Fuel Research, Dhanbad - 826015	Director
11	**Dr. Rama Bansal,** Head, International S&T Affairs Directorate, Council of Scientific and Industrial Research, Rafi Marg, New Delhi – 110 001	CSIR Hqrs. Invitee
12	**Dr. Siddharth Singh,** Sr. Principal Scientist, CSIR - Central Institute of Mining and Fuel Research, Dhanbad - 826015	Secretary

XII. MANAGEMENT COUNCIL

Sl. No	Name & Designation	Portfolio
1	**Dr. Pradeep Kumar Singh**, Director, CSIR-CIMFR, Dhanbad	Chairman
2	**Dr. K. Muraleedharan**, Director, CSIR-CGCRI, Kolkata	Member
3	**Dr. R.V.K. Singh,** Chief Scientist & Head, BDIL, CSIR-CIMFR	Member
4	**Dr.Sujit Kumar Mondal,** Chief Scientist, CSIR-CIMFR	Member
5	**Dr. Ashok Kumar Singh,** Sr. Principal Scientist, CSIR-CIMFR	Member
6	**Dr. P. B. Choudhury,** Sr. Principal Scientist, CSIR-CIMFR	Member
7	**Dr. V. Anguselvi,** Principal Scientist, CSIR-CIMFR	Member
8	**Sri Dayakant Kumar,** Finance & Account Officer, CSIR-CIMFR	Ex-Officio Member
9	**Sri Rakesh Kumar Singh,** Sr.Technical Officer (1), CSIR-CIMFR	Member
10	**Sri Dasmath Murmu,** Administrative Officer, CSIR-CIMFR	Ex-Officio Member-Secretary

XIII. STRENGTH AS ON 31-03-2020

Group / Grade	Total
Director	01
Group IV	134
Group III	142
Group II	51
Group I	77
Administrative	148
Total	553

XIV. EXPENDITURE FOR THE YEAR 2019-20

Head	Amount (Rs. in Lakh)
Capital	2117.942
Revenue	7321.705
Staff Quarters	75.000
Total	9514.64

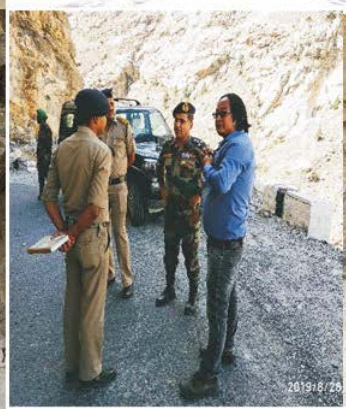
XV. SOME IMPORTANT ACTIVITIES AND DEVELOPMENTS

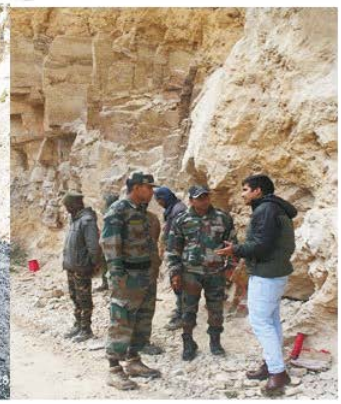
Inaugural Session of Platinum Jubilee Foundation Day Celebration of CSIR-CIMFR

Facility dedicated to the Nation on the occasion of Platinum Jubilee Foundation Day Celebration of CSIR-CIMFR

CSIR-CIMFR has signed an agreement with Ordnance Factory, Ministry of Defence for the construction of underground Magazines and Underground Proof Range for the storage of explosives and ammunition

Technical know-how and R&D support will continue to be provided to Border Roads Organization (BRO) till 2025 for expediting various strategic road construction works near the Indo-China and Indo-Pak borders against the MoU signed with DDG BRO.



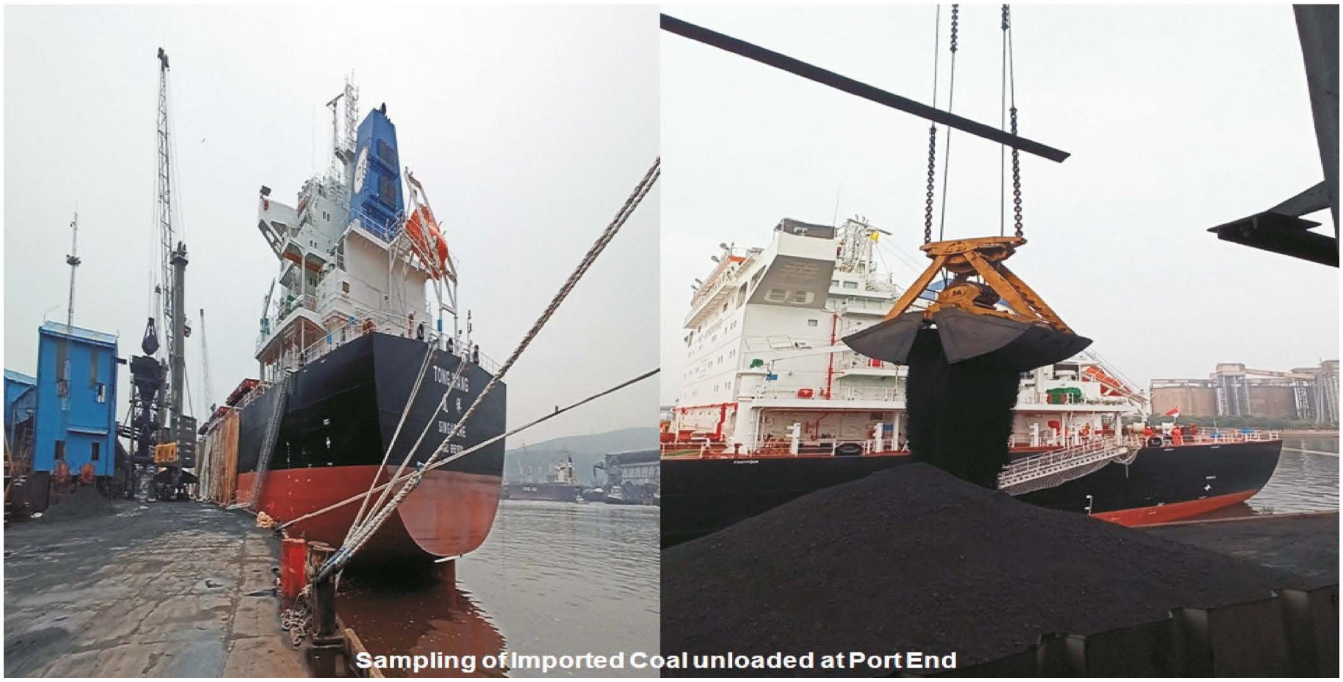


Facility dedicated to the Nation on the occasion of Platinum Jubilee Foundation Day Celebration of CSIR-CIMFR

Facility dedicated to the Nation on the occasion of Platinum Jubilee Foundation Day Celebration of CSIR-CIMFR

Stamp charging technology for coke-making at CSIR-CIMFR

Sampling of Imported Coal unloaded at Port End by CSIR-CIMFR



Contribution of CSIR-CIMFR in Metro project of Bengaluru and Mumbai by providing controlled blasting technique in successful completion

Controlled blasting for safe and economical open and underground excavation of rock using DBM at Pakal Dul Dam Project (J&K). It was successfully completed in October, 2020

CSIR-CIMFR Open Day program for students (JIGYASA)

International Women's Day 2020 Being Celebrated at CSIR-CIMFR

Flag hoisting by Dr. P.K.Singh, Director, CSIR-CIMFR on Independence Day on 15.08.2019. Shri Amarjeet Singh, Security Officer is also seen

Visit of dignitaries in Coal Preparation laboratory on 28.08.2019. Dr. T. Gouricharan is explaining about the activities of the lab. Dr. Ashish Mukerjee and other scientists and staff members are also seen

Opening of portico over statue of Netaji Subhash Chandra Bose at CSIR-CIMFR, DC Club Complex by Dr. P.K.Singh, Director, CSIR-CIMFR on 15.08.2019. Dr. Ashish Mukherjee, Shri T.B.Das, Dr. A.K.Singh and Shri S.K.Jha are also seen

A view before the start of workshop on Methanol Economy on 28.08.2019. Dr. P.K.Singh, Director, CSIR-CIMFR and other dignitaries are also seen

Visit of dignitaries in gasification laboratory on 28.08.2019. Dr. Prakash Chavhan is explaining about the activities of the laboratory

Visit of dignitaries in coal to liquid plant on 28.08.2019. Dr. Sudip Maity explaining about the methodology of operation of the plant

Visit of Prof. Ashwani Kumar Nangia, Director, CSIR-NCL, Pune in Coal combustion laboratory on 28.08.2019. Dr. Ashish Mukherjee explaining about the activities of the laboratory

Inauguration of Hindi Pakhwara on 13.09.2019. On the podium Prof. Pramod Pathak, Chief guest of the occasion. On the dais (L to R) Dr. N.K.Srivastava, Dr. Satyendra Singh, Dr. Ashish Mukherjee and Shri T.B.Das

Visit of dignitaries in Resource Quality Assessment Laboratory on 28.08.2019. Dr. A.K.Singh explaining about the activities of the laboratory

Under Hindi Pakhwara-2019 programme competitive examination is going on for staff members on Anuvad avum Nibandh Pratiyogita on 18.09.2019

Conduction of competitive event of Hindi Pakhwara-2019 on 19.09.2019 (L to R) Smt. Anita Kumar, Hindi Teacher, Dr. N.K.Srivastav, Scientist and Dr. Rajesh Kumar, Scientist

Under Hindi Pakhwara-2019 competitive examination is being conducted for staff members on Tippri and Prarupan on 19.09.2019

Jigyasa programme for students on 19.12.2019. Dr. Arindam Rana, Associate Professor, City College, Kolkata, Chief Guest of the programme is delivering Inaugural Speech

A group photograph of security personnel on Republic Day after flag hoisting by Dr. P.K.Singh, Director CSIR-CIMFR on 26.01.2020 in front of main building of CSIR-CIMFR-Digwadih Campus. In front row(L to R) Shri. Hiraman Singh, Dr. P.K.Singh, Dr. Ashish Mukherjee and Shri Amarjeet Singh

Prof. E.S. Dwarka Das, Chairman, Research Council, CIMFR, is visiting Coal mineral and heavy metal research Laboratory on 15.11.2019. Shri T.B. Das explaining about activities of the laboratory.

On the occasion of Jigyasa programme on 19.12.2019 participation of school children and teachers

Inauguration of workshop on need for Indian Standards on Solid Biofuels on 27.01.2020. Shri T.B. Das on the podium. On the dais (L to R) Dr.R.E. Masto, Dr. P.K. Singh, Director and Dr. Nisha Bura, Scientist, BIS, New Delhi

Part of the participants of the conference attended the Valedictory Session of AIM-2020

Inaugural Session of AIM-2020 (From left-to-right: Dr. S. K. Singh, Chief Scientist, CSIR-CIMFR, Shri L. S. Shekhawat, COO, Hindustan Zinc Ltd., Smt. Draupadi Murmu, Hon'ble Governor of Jharkhand, Dr. Pradeep Kumar Singh, Director, CSIR-CIMFR and Dr. Prabhat K. Mandal, Chief Scientist, CSIR-CIMFR)

सीएसआईआर - केंद्रीय खनन एवं ईंधन अनुसंधान संस्थान

(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्)

CSIR - CENTRAL INSTITUTE OF MINING AND FUEL RESEARCH

(COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

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