CSIR - Central Institute of Mining and Fuel Research, Dhanbad

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FLATTENING OF ULWE HILL AS PART OF LAND DEVELOPMENT WORK FOR NAVI MUMBAI INTERNATIONAL AIRPORT (NMIA)

Salient features:

- 5.5 crore cubic metre rock excavation
- Four package sites & Ulwe river diversion works
- Height of the hill (82 m) to be flattened
- Time duration: 36 months
- Desired fragment size 300 - 600 mm
- 8 villages and many high-rise structures nearby

Award/Citation/Patent: Well covered in National Newspapers

Benefits to the industry: It will help M/s City and Industrial Development Corporation of Maharashtra Limited (CIDCO) for construction of NMIA.

***Benefit to the Nation*:** Help in the Navigation system of India.

Navi Mumbai International Airport (NMIA) is going to be one of the world's largest "Greenfield" international airports, currently being developed, offering world-class facilities for passengers, cargo, aircrafts and airlines. The proposed second airport for MMR is located at Navi Mumbai as the area is expected to cater to the future growth in population, business and commercial activities of MMR. The availability of excellent physical and social infrastructure coupled with an environment-friendly site makes the Navi Mumbai Airport project both technically feasible and financially viable (Environmental Compliance Monitoring Report for NMIA, 2017).

The land development in the core airport areas will be carried out on 1,161 hectare (ha) spanning nearly 6 km from east to west and 2.5 km from north to south. The Airport Site encompasses a hill (namely Ulwe hill) which needs to be flattened. The project involves pre-development activities which includes land development by blasting of hills in the project area, filling/reclamation of the airport area, re-coursing of the Ulwe river flowing through the airport site and shifting of the Extra High Voltage Transmission (EHVT) lines crossing airport land (NMIA Brochure, 2014).

In the initial stage of land development, the Ulwe hill will be flattened from 92 m to 8.0 m and leveling work will be carried out in the remaining part using rock and earth fill material extracted from Ulwe hill. The remaining part will be levelled up to 5.5 meter. The management of CIDCO entrusted CSIR- Central Institute of Mining and Fuel Research (CSIR-CIMFR), Dhanbad for providing scientific and expertise services for

flattening of Ulwe Hill using drilling and blasting as part of the land development works for construction of Navi Mumbai International Airport (NMIA).

The Rock Excavation Engineering Group of CSIR-CIMFR has been assigned to accomplish the work since 1st June 2017. As the project site is being surrounded by villages, controlled blasting has to be implemented at the site. Blast induced ground vibrations were recorded in and around the periphery of the project site to optimize the blast design parameters. The blasts were optimized not just to reduce the ground vibration level but as the blasted muck has to be used for filling the site it was desired to have fragment size of 300 mm to 700 mm for preparation of stable runway foundation.

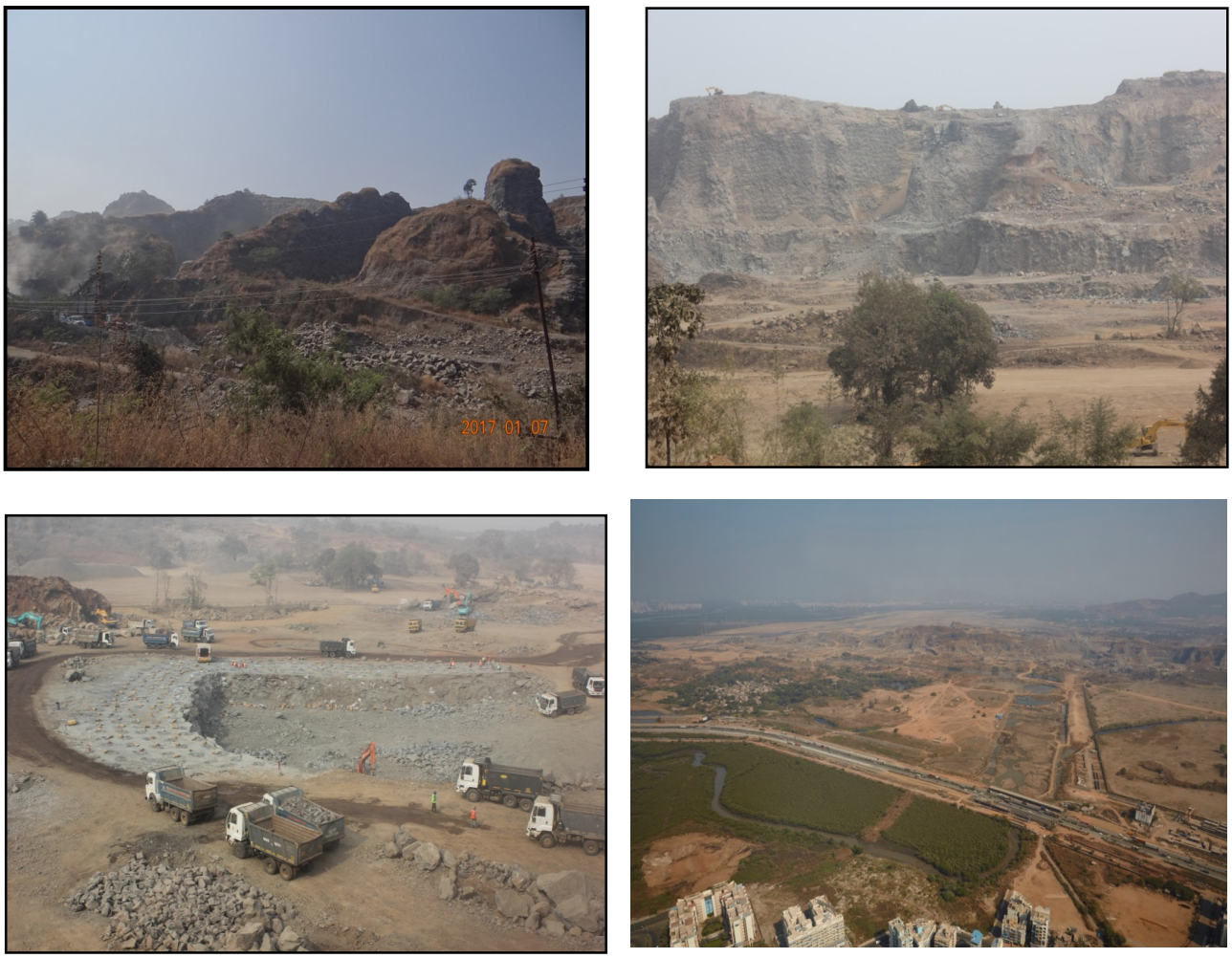


Figure: View of Ulwe Hill site and controlled blasting practices for the flattening of the hill for construction of Navi Mumbai International Airport

2

CHENANI-NASHRI HIGHWAY TUNNEL PROJECT

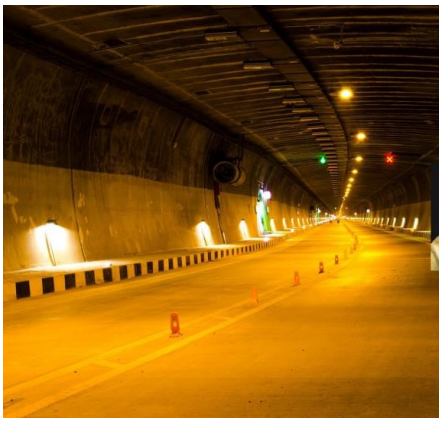
The national highway (NH 44) is strategically important highway providing access to Srinagar (J&K) from rest of the country. The highway has a major bottle neck at Patnitop hill located between Chenani and Nashri villages. The 41 km stretch was completely blocked due heavy snowfall in winters. This created a problem of highway traffic blockage running for more than seven days in a stretch. Number of loops with steep gradient further aggravated the problem in this stretch in terms of excessive fuel and time consumption. On the other hand, in rainy season, rolling stones and landslide prone highway cutting frequented the blockage restricting movement of military forces in turbulent J&K state.

Govt of India through National Highway Authority of India (NHAI) planned to construct Asia's longest bi-directional highway twin tunnels each 9.0 km long. The tunnels are located at an altitude of nearly 4,000 feet in difficult Himalayan terrain. Despite of having been excavated in such adverse geographic conditions, both the tunnels are completely waterproof. Main tunnel of 13 m dia and parallel escape tunnel of 6.0 m dia are interconnected with 29 cross passages at every 300 m intervals. The tunnel is constructed with state of the art with all modern amnesties and safety features such as provision of SOS, fire prevention facilities, illumination and ventilations etc.

CSIR-Central Institute of Mining and Fuel Research Dhanbad provided very vital technical support for construction of the tunnels. CIMFR was associated in this project throughout the construction period for continuous evaluation and design of tunnel and monitoring of the tunnel construction quality. During construction of this tunnels, many challenges such as encountering mixed geological formation and high institute stresses leading to squeezing ground condition were faced. CIMFR Dhanbad has given timely techno-economical solutions for trouble shooting such construction challenges by modifying the support systems with the help of continuous load-deformation behaviour analysis.

The Chennai-Nashari tunnel project was completed in March 2017 and was dedicated to the nation in April 2017 by Hon'ble Prime Minister of India. On completion of this project, numerous societal and economic benefits were achieved. Some of the key benefits are as follows.

- The newly constructed tunnels provide safe, all-weather road protected from avalanche for civilian and army movement
- Travel route of 41km along the highway has been reduced to 9.0 km through newly constructed tunnel.
- The tunnel project reduced the travel time from 2 hour to approximately 11min.
- The project save fuel of about Rs. 27lac every day and contributes in reduction of carbon emission
- Neither the lithology of the ground surface has been disturbed nor deforestation was carried out while construction of the tunnels, and hence it preserves ecological balance all along the tunnel route.
- It will boost economy and tourism in J&K.



3

Controlled blasting technology for construction of Bangalore and Mumbai Metro Rail Projects

CSIR-Central Institute of Mining & Fuel Research was appointed as a technical consultant for Bangalore and Mumbai Metro Rail Corporation for design and monitoring of controlled blasting for rock excavations at three major stations at Bangalore and two major packages covering 6 underground stations at Mumbai. The stations at Bangalore include, City Market, Chikpet and Majestic stations and and 6 stations in Mumbai include MIDC, Marol Naka, SEEPZ, Cuffe Parade, Hutatma Chowk and Church Gate) and 2 TBM Launching sites (Pali Ground Shaft and Seepz ramp) belong to package-1 and 7 of UGC Line-3. All the proposed stations are situated at densely populated places in the heart of the Mumbai city and hence rock excavation by safe blasting for station box cuttings is an essential activity. The proposed blasting zones are surrounded by very sensitive and critical structures like temples, high raise structures old buildings etc. at a minimum distance range of 10-30m, making the blast design as the most challenging task. The rock excavation required at Bangalore Metro was 1.5 lakh cubic meters and at Mumbai Metro was 2.5 lakh cubic meters for both Package-1 &7.

The Mumbai Metro Underground Corridor project is a 33.5 km-long sub-surface transport system, connecting Colaba in South Mumbai to SEEPZ in suburban Andheri, which is going to be 'Game Changer' for heavily packed Mumbai traffic.

As the underground corridor is constructed at about 100 feet below the ground, it requires excavation of soil as well as rock at all the 26 of 27 stations below the grade level. The rock is hard basaltic formation at an average depth of 3-4m at all the stations, which requires blasting for fast and bulk excavations.

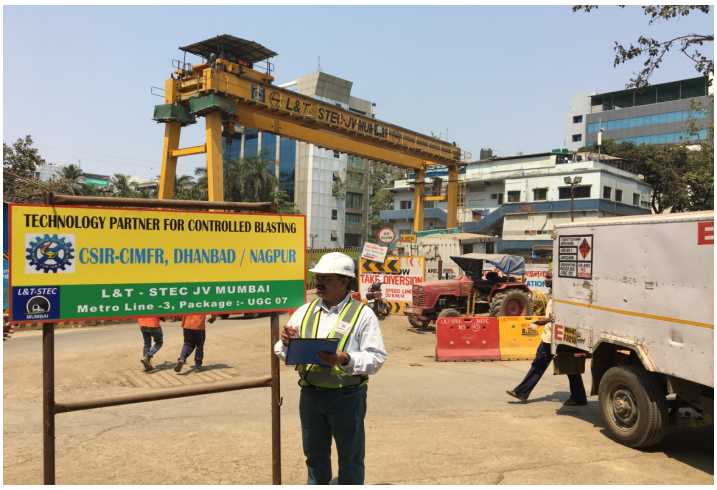
The conventional rock blasting has got the disadvantageous side effects of flyrock ejection, ground vibrations, airblasts and dust generation, which obviously creates annoyance to the local habitats. Meeting the production targets at the same time keeping the side effects under threshold limits has become a challenging task of project. CIMFR overcome all the local resistance by adopting habitat friendly blasting techniques which ensured total control of all the environmental problems due to blasting.

CSIR-CIMFR developed tailor-made controlled blasting technology for opencut applications like Sensitive Urban Metro Rail construction projects as well as for underground civil and infrastructural projects like tunnels and caverns. Application of this technology fetched substantial and consistent revenue for the institute and tangible benefits in terms of safety and productivity improvement to clients These user friendly blasting techniques ensured total control of all the environmental problems due to blasting and confidence building measures in habitats in the vicinity of Metro Rail construction projects.

Apart from the practice of controlled blasting methods like Line drilling, Bottom hole initiation, Pre-splitting and Smooth blasting three more safe, productive and innovative blasting techniques adopted at Metro Rail construction projects, which include Bottom

hole decking technique, Effective delay scattering technique and Bottom hole shock relief technique. The 'bottom hole decking technique' consists of air decking at the bottom of the hole in dry holes by means of a wooden spacer or a PVC pipe for improving fragmentation, reducing specific charge, ground vibrations and overbreak/damage in opencut blasting. This reduced peak particle velocity by 40% and overbreak/damage reduction by 35% and proved that the bottom-hole air decking is an effective technique for improving blasting productivity as well as safety. Another technique was 'effective scattering delay sequence method' involving the delay firing of blast holes in such a way that the destructive interference of vibrations takes place and results in reducing the vibration intensity i.e. peak particle velocity, which is essential in urban blasting near sensitive structures. This delay sequence scattering method' resulted in further reduction of 20-25% of peak particle velocity.

The other innovative method practiced has been 'Bottom hole shock relief technique', which consists of inserting a reinforced concrete balls at the bottom of blast holes for re-orienting the shock energy to the desired directions. This shock energy relief blasting technique greatly reduce the blast vibration intensity by 50% and overbreak/damage by 40%. All the above three new controlled blasting techniques are very simple and easy to practice and proved to be very effective in safety compliance of blasting.



4

Biometric-based Exploder

Brief Description:

Exploder is a device that triggers detonators by generating electric current in order to initiate firing of explosive charges. It is also called blasting machine which helps in safe and controlled blasting to avoid the chances of misfire. It has vast applications in rock excavation in mines, road and other construction activities as well as demolition activities.

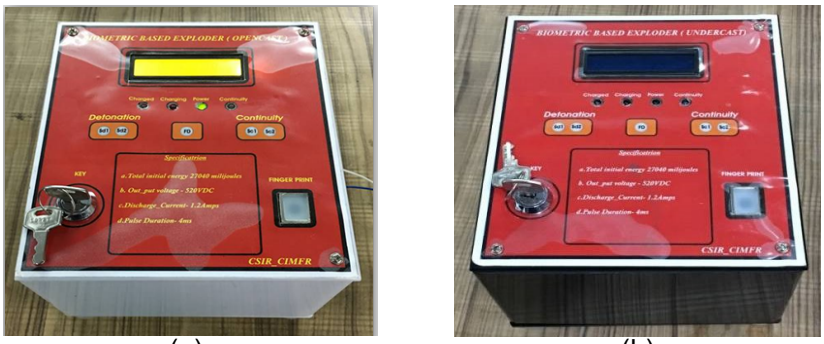
Different types of exploders available in the market are found unsafe if it is stolen and misused by illegal nexus, militants etc. To avoid such type of misuse, the biometric-based exploder has been developed. It can only be operated by those peoples who are biometrically registered with the specific device. The device comprises of an embedded microcontroller, converter circuit, rectification circuit, safe discharge circuit, authentication circuit and display unit. The fingerprint scanner with the help of embedded micro-controller registers authorized personnel using their finger print upto 20 numbers. Once registered, no other person can use these devices. Two types of exploder have been developed, one for underground mines and another for opencast mines. M/s Pranay Enterprises, Hyderabad has been selected for technology transfer and commercialization of the patent filed product.

Major Features:

- The output firing duration is 4 mili-seconds
- The device provides constant current source across its output probes
- The device outputs 1.2 A across any load varying between 4 and 200 Ω, and internally locks itself if the load increases or decreases
- The device is able to fire 30 shots in series for underground mines and 200 shots for opencast mines
- LED indication is provided for circuit continuity
- The biometric exploder is equipped with double push button switch for firing, which will help to eliminate false triggering
- Special ignition type key is used for charging the exploder
- The device is intrinsically safe for underground mine use also

Benefits:

- Control misuse of exploder by the unauthorized person/Naxalites
- Eliminates chance of misfire
- Battery level indication with internal locking of the device to improve safety
- Firing can be cancelled as and when required without any risk



(a) (b)

Biometric-based exploder: (a) for opencast mines and (b) for underground mines

5

Intelligent Dry Fog Dust Suppression System

Brief Description:

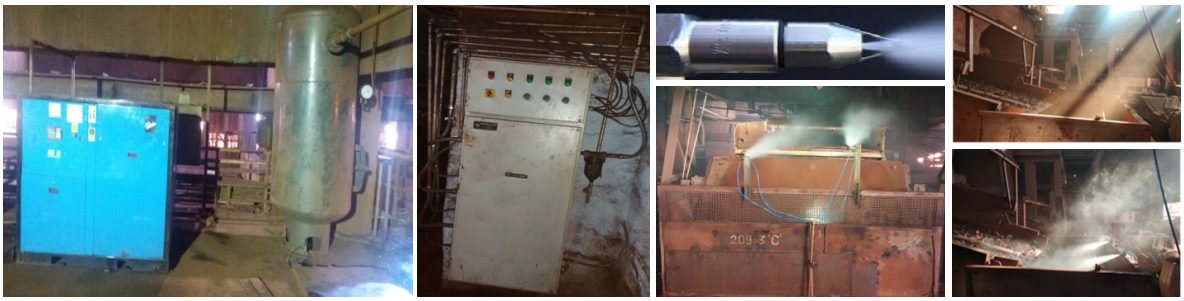
Intelligent dry fog dust suppression system for industrial applications is a smart solution for removing dust generated during different mining activities such as extraction, loading and unloading, transportation, storage and processing as well as other industrial processes. The system utilizes hybrid nozzle by combining the features of ultrasonic nozzle and atomizing nozzle to spray dry fog which provide atomization of water drops in the range of sub-micron metre size (1–20 µm size) for proper agglomeration with dust particles ($PM_{2.5}$ and PM_{10}) and allowing them to settle down by adding less than 0.1% moisture in the surrounding atmosphere. The system can operate in manual as well as automated mode using programmable logic controller, proximity sensor, zero switch sensor, machine status sensor, under belt sensor and pollution sensor, and the automatic operating mode can be selected from remote operation facility. The technology has been filed for patent and licensed to M/s Control Systems and Solutions, Kolkata. The system has been installed in Donimalai Crushing and Screening Plant of NMDC Limited located at Ballery district in Karnataka state.

Major Features:

- Compressed air and water pass through atomization nozzles to form fine droplets (10 to 50 µm with a mean of 20 µm)
- Fine water droplets agglomerate with fugitive dust particles of sub-micron range and settle down
- The process adds only around 0.1% moisture on the processed mineral
- Total operation is automatic using PLC and sensors (under belt sensor, proximity sensor, dust measurement sensor, water level, etc.)

Benefits:

- Effective suppression of dusts
- Optimum use of water and electricity
- Adds only around 0.1% moisture in the application area and does not effect on mineral screening activity
- The system automatically starts spraying only when the conveyor belts or equipment are in operation



(a) (b) (c) (d)

Dry fog dust suppression system installed in Donimalai Iron Ore Mine of NMDC Limited: (a) Air compressor and receiver, (b) Control panel, (c) Dry fog nozzles, and (e) Dust emission status before and after installation of the system DIOM