The Executive Summary of Projects

Project title: Advice for designing of controlled blasting patterns at Mukutban limestone & dolomite mining project of m/s RCCPL Pvt. Ltd. **Project No.** **CNP/4823/2019-20**	**Executive Summary:** This report relates to the scientific study conducted by the Rock Excavation Engineering Division of CSIR-Central Institute of Mining and Fuel Research (CSIR-CIMFR), Dhanbad at Mukutban Limestone and Dolomite Mines of M/s RCCPL Pvt. Limited. The main objective of the study was to develop safe and optimum controlled blast design parameters for day-to-day blasting operations in the mine without affecting the safety and stability of nearby denizen and residential houses of Pimparwadi village. In order to develop safe and optimum blast design patterns, field investigations were carried out during 5th - 8th March 2019. Seven experimental blasts were conducted at different locations of the mine with varying design patterns and explosive loading parameters. Blast- induced ground vibrations and air overpressure/noise generated during the experimental blasts were monitored on ground surfaces at various distances in the direction of Pimparwadi village. Flyrock generated during the experimental blasts were also observed and studied. The investigational works, observations, results of the experimental blasts conducted, analyses of the data, conclusions and recommendations made in the report are summarized below. (1) In total, seven experimental blasts were conducted at more than 450 m away from the nearest structures of Pimparwadi Village. Out of the seven experimental blasts, two blasts were conducted with box cut pattern and the rest five blasts were bench blasting pattern. (2) All the experimental blasts were conducted using 115 mm blasthole diameter. Large diameter cartridge explosive of 83 mm diameter, 2.78 kg weight per cartridge and Nonel (shock-tube) initiation system (DTHs - 400 ms, TLDs - 25 ms& 42 ms) were used in all the blasts. (3) The depth of holes used in the two box cut blasts was 3.5 m with burden and spacing values of 1.75 m and 2.25 m respectively. The total number of holes in a round of blast for both the blasts was 24. The explosive charge per hole, maximum charge per delay and total explosive charges used in both the blasts were 8.34 kg, 16.68 kg and 200.00 kg respectively. The charge factor used in the box cut blasts was 0.60 kg/m^3. (4) In the bench blasts, the depth of holes used varied from 5.0 to 6.0 m. The total number of holes in a round of blast varied from 10 to 14. All the experimental blasts were conducted in the top, soft and weathered overburden strata. Therefore, squared pattern of drilling was used for all the blasts. (5) The burden and spacing values used in the bench blasts varied from 2.5 - 3.0 m and 3.5 - 4.0 m respectively. Top stemming column length varied from 2.5 to 3.2 m. The explosive charge per hole varied from 19.64 to 27.58 kg. The maximum charge per delay and total explosive charge varied from 19.64 - 25.00 kg and 250.00 - 386.10 kg respectively. The charge factor used in the bench blasts varied from 0.33 to 0.52 kg/m^3. (6) Blast induced ground vibrations and air overpressures/noise generated during the different experimental blasts were monitored on compacted ground surface in the direction of Pimparwadi Village using six numbers of digital seismographs. The distances of ground vibration monitoring points from the experimental blast sites varied from 100 to 555 m.

	(7) The magnitude of ground vibrations (Peak Particle Velocity, PPV) recorded nearby the nearest structures of Pimparwadi Village varied from 0.730 to 0.852 mm/s and the peak dominant frequencies varied from 31.75 to 37.0 Hz. The distance of vibration monitoring point nearby the nearest structures of Pimparwadi Village, from the experimental blasting sites varied from 440 to 555 m. (8) The magnitude of ground vibrations (PPV) recorded at the distance of 100 m from the different experimental blast sites varied from 7.507 to 14.26 mm/s and the peak dominant frequencies obtained varied from 23.38 to 72.13 Hz. (9) The highest magnitude of vibration recorded at 100 m distance from the blasting sites was 14.26 mm/sec with the associated dominant frequency of 30.50 Hz. This value was recorded during the experimental blast (B-3) where maximum charge per delay was 55.60 kg and the total explosive charge in the blasting round was 386.10 kg. (10) The magnitude of ground vibrations (PPV) recorded at the distance of 300 m from the different experimental blasts varied from 0.794 to 1.794 mm/s and the peak dominant frequencies obtained varied from 33.0 to 39.13 Hz. Similarly, the ground vibration data obtained were less than 5 mm/s at the distance of 250 m from the experimental sites. (11) In majority, the peak dominant frequency of ground vibration waves obtained at the different vibration monitoring points were more than 25 Hz (i.e. 28.75 - 147.0 Hz).However, dominant frequencies less than 25 Hz, but greater than 8 Hz (i.e. 16.63 - 24.75 Hz) were also obtained in a very few cases. Hence, for better safety of the residential houses and important structures of Pimparwadi Village, PPV value of 10 mm/s has been considered as the threshold, safe level of ground vibration for the mine as per the DGMS Circular No. 7 of 1997. (12) The ground vibration data recorded at 150 m distance and beyond were all less than 10 mm/s. The magnitudes of ground vibration data recorded nearby Pimparwadi Village are also well within the safe limits as per DGMS ground vibration standards. (13) The levels of air overpressure recorded at different vibration monitoring points varied between 103.5 and 131.2 dB (L). The levels of air overpressure recorded are well within the safe limits as per CBPC and International Standards. (14) No flyrock was observed in any of the experimental blasts. The throws of the blasted materials were also controlled and restricted within the blasting areas only. The control of flyrock was achieved through the proper blast design patterns, use of Nonel initiation system for bottom initiation along with proper implementation and supervision of the total blasting operations. (15) The propagation equation for prediction of blast-induced ground vibrations at Mukutban Limestone and Dolomite Mines has been established and is given as ***Equation-7.1*** in the report. The recommended explosive weights per delay for various distances from the residential houses/structures are given in ***Table 7.1*** in the report. (16) Based on the analysis results of ground vibration data collected, experimental blasts results and observations made, the blasting zones have been classified for controlled blasting operations nearby the residential houses/structures of Pimparwadi Village as:

	(A) 50 - 100 m from the village Houses (B) 100 – 200 m from the Village Houses (C) 200 – 300 m from the Village Houses (D) 300 - 500 m from the Village Houses (17) Within the blasting zone of 50 - 100 m from the village, blasthole depth of 3.5 - 5.0 m have been recommended in order to contain ground vibration within safe limits. The recommended blasthole dept within the blasting zone of 100- 200 m from the village is 5 - 6 m. However, use of blasthole depth up to 10 m have been recommended beyond 200 m of the blasting sites from the village. (18) In heavily jointed, soft formation of overburden (OB) and limestone strata, charge factor value 0.28 to 0.30 kg/m^3 was found to be sufficient for obtaining proper breakage. Similarly, squared pattern drilling may be used in softer and jointed formations of OB and limestone strata. However, in hard, massive and compact formation of OB and limestone strata, staggered drilling pattern is recommended. Details of the suggested controlled blast design parameters for the safety of Branch Canals and the residential houses of the nearby villages are described in ***Sections 8.0*** of the report.