BEFORE THE NATIONAL GREEN TRIBUNAL, PRINCIPAL BENCH, NEW DELHI

ORIGINAL APPLICATION NO. 304 OF 2019

IN THE MATTER OF:

M. Haridasan ...Applicant

VERSUS

State of Kerala & Ors. ... Respondent(s)

INDEX
VOLUME-II

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Scientific Study on Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor Village, Chirayinkeezh Taluk, Thiruvananthapuram District, Kerala of M/s. Adani Vizhinjam Port Private Limited

ANNEXURE R-13

Submitted

Adani Vizhinjam Port Private Limited
(AVPPL)

To
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By
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Scientific Study on Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor Village, Chirayinkeezh Taluk, Thiruvananthapuram District, Kerala

M/s. Adani Vizhinjam Port Private Limited

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by

Dr. P. Balamadeswaran

Department of Mining Engineering

College of Engineering Guindy
Anna University Chennai

Scientific Study on

Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram, Kerala of M/s. Adani Vizhinjam Port Private Limited

ACKNOWLEDGEMENTS

The author is greatly indebted to the management of M/S **M/s. Adani Vizhinjam Port Private Limited**, for awarding the Scientific Investigation to the Department of Mining Engineering, Anna University, Chennai.

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We express our sincere gratitude to Anna University and its officials for permitting us to take up the work.

28/06/2021

(Dr. P. BALAMADESWARAN)
Assistant Professor

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CERTIFICATION

Certified that this project report (No: AU/CEG/MN/1034/2020-2021) titled "Scientific Study on Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram, Kerala of M/s. Adani Vizhinjam Port Private Limited" is the bonafide work of Department of Mining Engineering, Anna University carried out under my supervision. I hereby affirm, to the best of knowledge and belief, based on the inspections, observations, field trials and upon the equations developed, that this Scientific Study on Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram, Kerala of M/s. Adani Vizhinjam Port Private Limited is completed and operable. The project was completed in accordance with the statutoryrequirements of act, regulations made thereunder and other provisions as recommended by the regulatory body (DGMS).

DEPT. OF MINING ENGG. CHENNAI 600 025 CEG CAMPUS, ANNA UNIVERSITY

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Scientific Study on

Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram, Kerala of M/s. Adani Vizhinjam Port Private Limited

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Blast Induced Ground Vibration for Kadavila-1 Stone Quarry, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram District, Kerala of M/s. Adani Vizhinjam Port Private Limited

EXECUTIVE SUMMARY

The scientific investigation is aimed at assessing the influence of blasting, principally the ground vibrations and noise levels in the Kadavila-1 Stone Quarry of M/s. Adani Vizhinjam Port Private Limited, Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram District, Kerala on the residential and other buildings of the neighbouring villages.

OBJECTIVES

- Study the existing blasting, its design and its influence on the surroundingsin respect of blast induced ground vibrations.
- Design of trial blasts which will
  - restrict blast induced ground vibrations to levels that are tolerable onthe residential and other civil structures not belonging to the quarry owner.
  - restrict generation of fly-rock and their throw to eliminate adverse effect on the residents and agricultural lands of the Nagaroor (Kadavila) village.
- Carry out at least 10 controlled trial blasts and monitor blast induced ground vibrations at least in 25 points and study the distance to which flying fragments are produced.
- Submit the report including suggesting suitable controlled blasting technique(s) including maximum explosive charge per delay in theKadavila-1 Stone Quarry that will limit the blast induced ground vibrations to permissible levels and also suggesting suitable methodology for carrying out regular drilling, controlled blasting operations in the quarry and the appropriate safety measures to be taken to guard against blast induced vibrations and fly-rock.

FIELD INVESTIGATIONS

The Kadavila-1 Stone Quarry is drilling 33 mm diameter holes with Jack hammer drilling machines and blasting with the cap-sensitive Emulsion explosive cartridges of 25 mm diameter. The mine management is presently blasting three to five rows of holes with NONELs having in-hole delay of 250 ms & surface delays of 17/25 ms to mitigate adverse impacts such as air blast, fly rock and ground vibration. The instantaneous electrical detonators are being used for initiating the blasting circuit prepared with NONEL based detonators.

In order to carry out the controlled blasting operations in the Kadavila-1 StoneQuarry approaching towards surrounding villages, the quarry management intended to get the matter scientifically investigated for adopting properly designed controlled blasting techniques to restrict the blast induced ground vibrations to less than the permissible levels the structures in question can tolerate without damage.

The author of this report have carried out ground vibration monitoring of **10 Nos. of controlled trial blasts** with FIVE numbers of seismographs by locating them at different locations in the surface and sensitive buildings located nearer to the Kadavila-1 Stone Quarry at various distances (in the villages as well as inside the quarry) from the blasting site (a total recordings of **47** and the instruments triggered only at 36 stations). These trial blasts were carried out during the period from 16.03.2021 to 17.03.2021.

RESULTS AND DISCUSSIONS

Ten trial blasts were carried out 16.03.2021 to 17.03.2021 and blast vibrations were monitored using five seismographs located at various distances. The minimum and maximum charge per delay varied from 1.07 to 2.17 kg. A maximum of 80 holes were drilled with jack hammer drilling equipment with a maximum number of holes per delay of six. In all the 10 trial blasts, ground vibrations were monitored at 47 locations around the blasting sites and neighbouring village. Out of the total 47 measurements made, vibrations were recorded by the instruments only at 36 stations. The vibrations recorded behind the blast free face were of highest magnitude. The magnitude of vibration recorded in the flank of direction of initiation was lower than those on the opposite side of the flank of blast initiation.

All the 10 blasts were carried out using NONEL shock tube detonators with an in-hole delay of 250 ms and surface delay of 25 ms. Fast attenuation of vibration was recorded at shorter distances whereas at far-off distances the attenuation was slow and was influenced by low frequency blast wave characteristics.

The recorded dominant frequencies of vibrations were in the range of 7.5 to 256 Hz. The Fast Fourier Transform (FFT) analyses of vibration data revealed that the concentration of vibration energy was in the range of 29.30 to 170.6 Hz. However, keeping in view the minimum frequency recorded during the trial blasts and the maximum peak particle velocity(PPV), structures of any type, can tolerate without damage or fall within the frequency range of 8 to 25 Hz. However, to avoid confusion for the people in the field, the maximum explosive charge per delay is calculated for this quarry to restrict the peak particle velocity to 5.0 mm/s only(irrespective of the type of structure), which is more conservative and safer as shownin the Table 2.1. Further it will secure the safety of Domestic houses & structures/Residential buildings located in the Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District, Kerala whose safety is also very important.

The analyses of vibration data recorded from detonation of blasts with higher amount of explosives generated higher level of vibrations at near-by-distances in comparison to the blasts which were detonated at the same bench face with lesser amount of explosives although the blast design and explosives parameters were kept identical. The explosives detonated in a delay in both the blasts were similar in weight.

The propagation equation for prediction of blast vibration have been established and are given as Equations 3. The permissible explosive weight per delay may be computed from the Equation to contain vibration within safe limits for distances of houses/structures concerned. For convenience, the permissible explosive weight per delay has been computed and is given in Table 3.22.

Based on the scientific study, it is concluded that **the blast induced ground vibrations and noise levels generated by the controlled blasting carried out in Kadavila-1 Stone Quarry was within permissible level and therefore is not affecting the residential buildings and other structures. Further, it has been observed that no flying fragments or projectiles travelled beyond 10 m from the site of blast. Hence, controlled blasting can be carried out at Kadavila-1 Stone Quarry** by following the blasting parameters as recommended in the **Table given herewith**.

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SUMMARY OF SUGGESTED CONTROLLED BLAST DESIGN FOR M/S. KADAVILA-1 STONE QUARRY

Sl. No.	Parameter			Value
1.	Blast hole diameter			33 mm
2.	Burden			1.2 m
3.	Spacing			1.5 m
4.	Height of the bench			6.00 m
5.	Stemming length			Minimum 0.70 m
6.	Drilling patterns to be followed			Rectangular / Staggered
7.	Specific charge	For creating Initial (Box) Cut		0.16 to 0.17 kg/m^3
		For production blasting		0.15 to 0.16 kg/m^3
8.	Loading Density	Cap-sensitive Emulsion (or) Slurry Cartridges		0.26 kg/m
9.	Average explosive Quantity/hole	Cap-sensitive Emulsion (or) Slurry Cartridges		0.50 kg
10.	Maximum explosive charge per drillhole during production blasting	Cap-sensitive Emulsion (or) Slurry Cartridges	125 g	0.625 to 0.688 kg
11.	Detonators recommended			NONEL based detonators of 17/25 ms surface delay with an in-hole delay of 250 ms
12.	Type of explosive recommended			Emulsion (or) slurry cartridge type (ø=25 mm)
13.	Initiation system recommended			Inverse initiation
14.	Method of connecting detonator			Series
15.	Maximum charge per delay			As stated in **Table 3.22** based on the distance of the blasting site from the structure and the type of structure to be protected

Team Members involved in this study

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Shri. E. Kumar	:	Teaching Fellow, Department of Mining Engineering, College of Engineering Guindy, Anna University, Chennai - 600 025.
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CHAPTER 1
INTRODUCTION

1.0 GENERAL

In modern mining era, the blasting technique is one of the most adopted techniques for rock breakage and fragmentation due to its economical and efficient aspects. However, the use of explosives for the blasting operation is limited bystatutory regulations as it may have a severe impact on the surrounding environment such as vibration, noise and dust. Especially, a ground vibration induced by blasting has to be paid much attention in the mining operation as it may give an obvious impact on the surrounding facilities and buildings.

Many researches established safe level for blasting criteria, the ground vibration level is characterized by using three parameters; duration, amplitude (peak particle velocity: PPV) and frequency. Current studies on the blast-induced ground vibration is focused on two parameters amplitude (PPV) and frequency suggested by Directorate General of Mines Safety (DGMS) when the concerned subject is structure. Hence, the control of PPV and dominant frequency are very important in order to design an appropriate blasting standard and minimize its environmental impacts.

1.1 BLAST INDUCED GROUND VIBRATIONS - BACKGROUND

Globally, blasting is the principal method of rock breaking in mining and construction industry because of its distinct advantages like economy, efficiency, convenience, ability to achieve large production, high productivity and ability to break the hardest of the rocks.

When an explosive or a blasting agent is initiated, the chemical energy of it is converted into mechanical energy, which is used for breaking the rock. Even in a properly designed blast, only a portion of the total energy of the explosive is used for fragmenting and displacing the rock and the rest utilized in producing undesirable environmental effects like ground vibrations, fly rock, air overpressure (noise) and over-break making them an integral part of blasting. These undesirable effects cause damage to the civil, mining, defence structures and other properties in the vicinity.

With increasing mining and construction activities in areas close to human settlements, ground vibration has become a critical environmental issue as it can cause human annoyance and structural damage.

The adverse environmental effects produced by blasting cannot be totally eliminated, but effectively controlled by proper design of appropriate controlled blasting techniques. Further, optimum design of blast, based on scientific investigations relating to the explosives used, rock properties and other geological aspects, which are site specific, can also address the issues.

Some of the explosive energy (left over after rock breaking), of blasting, is transmitted to the surrounding rocks as elastic waves. As these waves travel, they displace particles in their path causing the particles to oscillate before returning to their original positions. These oscillations constitute ground vibrations. Special three dimensional seismographs are used to measure these vibrations in terms of displacement, velocity, acceleration and frequency.

The ground vibrations generated from the blast are compressive in nature and spread away from the blasting site in all directions like ripples spreading outwards when a stone is dropped in still water in a pond or tank. When these waves reach a free face, they get reflected back and get converted into tensile waves and cause breaking of rock (as rock is weak in tension). When no free face is available, they travel to a longer distance and finally get attenuated. These waves, which are not doing any useful work of breaking the rock, generate ground vibrations and cause damage to the surface structures like dams, places of worship, structures of archaeological importance, quarry slopes, residential buildings, etc. and also underground excavations. The ground vibrations have three mutually perpendicular components namely radial (**R**), transverse (**T**) and vertical (**V**).

1.2 Factors Influencing Blast Induced Ground Vibrations

From the literature, it can be seen that peak particle velocity (PPV) and the frequency of the vibrations are the most important parameters over which the stability of the structures depend. Peak particle velocity is defined as the *greatest velocity with which the ground vibrates during the vibration history and the same is*

measured in millimetres per second. Frequency is the number of cycles of the to- and-fro movement of ground particles per second. The units for measurement of frequency are Hz. The frequency of vibrations depends on the geology of the area, the rock type, etc.

When the frequency of the vibrations is equal to the natural frequency of the structures, maximum damage occurs to the structure. The range of natural frequency of surface civil structures is given in **Table 1.0**

Table 1.0 Natural frequency of surface civil structures (as per Central Mining and Fuel Research Institute (CMFRI), Council for Scientific and Industrial Research, Govt. of India Laboratory **(Report 1991)**

Type of Structure	Natural Frequency, Hz
Single storey brick structures	12-14
Double storey brick structures	8 - 10
Concrete Structures	9 - 16

In addition, blast induced ground vibrations are dependent on many more factors like type of rock and its properties, geological parameters, maximum charge per delay, strength of the explosive, distance of the structure from the blasting site, time delay between holes and rows, choking at the toe of the bench, priming sequence, sequence of blast hole detonation, spacing between holes and burden, angle of drill holes, stemming depth and type, charge length and diameter, confinement, blast geometry, total charge, etc. Amongst them, type of rock and its properties, thecharge per delay and the distance of the blasting site from the structures are themost important ones. To keep the ground vibrations within desired levels, a clear understanding of the causes or factors, which influence generation, and propagation of ground vibration is essential.

1.3 Permissible Limits of Blast Induced Ground Vibrations –Peak Particle Velocity (PPV) for Surface Structures

The permissible levels of vibrations of various surface civil structures and other details specified by Directorate General of Mines Safety (DGMS), Dhanbad and others are given in **Tables 1.2 to 1.8**

Table 1.2 Directorate General of Mines Safety (DGMS) suggested peak particle velocities (PPV) various types of civil structures can tolerate without damage {DGMS (Tech) (S&T) Circular No.7 of 1997} (Ministry of Labour, Govt. of India)

Type of structure			Max. Permissible PPV, mm/s		
			Dominant excitation frequency, Hz		
			<8	8-25	> 25
(A)	Buildings / structures not belonging to the owner				
	(i)	Domestic houses/structures (kutchha brick & cement)	5	10	15
	(ii)	Industrial buildings (RCC & framed structures)	10	20	25
	(iii)	Objects of historical importance & sensitive structures	2	5	10
(B)	Buildings belonging to the owner with limited span of life				
	(i)	Domestic houses/structures(kutchha brick & cement)	10	15	25
	(ii)	Industrial buildings (RCC & framed structures)	15	25	50

Findings of some of the researchers in their investigations regarding the damages to residential structures due to blast induced ground vibrations are given in **Table 1.7**

Table 1.3 Safe Peak Particle Velocities (PPV) Surface Structures can withstand Without Damage as per Indian Standards (IS: 6922 – 1973)

Sl. No.	Type of strata	Maximum permissible PPV, mm/s	
		Where no monitoring is done	Where monitoring is done using suitable instruments
1.	Soils, weathered or soft rocks	50	70
2.	Hard rocks	70	100

Note: ***(1)*** ***the values suggested above are lower than those which may be intolerable to human beings.***

(2) ***the suggested values are appropriate for masonry and will be conservative for concrete of M_{15} (σ_c = 15 MPa) quality***

Table 1.4 USA standard (as per Siskind, et al, 1980)

Type of structure	Peak particle velocity, mm/s	
	Frequency (<40 Hz)	Frequency (>40 Hz)
Modern homes, dry wall interior	18.75	50
Older homes, plaster on wood lath construction	12.5	50

Table 1.5 Australian standard 2008 (AS 2187.2)

Type of structure	Maximum values
Historical building and monuments and building of special value	0.2 mm displacement for frequencies less than 15 Hz.
Houses and low rise residential buildings, commercial buildings not included below.	19 mm/s resultant ppv for frequency greater than 15 Hz
Commercial buildings and industrial buildings or structural of reinforced concrete or steel construction	0.2 mm maximum displacement corresponds to 12.5 mm/s ppv at 10 Hz and 6.25 mm/s at 5 Hz

Table 1.6 German standard (as per German DIN 4150, 1986)

Type of structure	Peak particle velocity at foundation, mm/s		
	<10 Hz	10-50 Hz	50-100 Hz
Offices and industrial premises	20	20-40	40-50
Domestic houses and similar constructions	5	5-15	15-20
Buildings that do not come under the above because of their sensitivity to vibrations	3	3-8	8-10

Table 1.7 Range of Common Residential Criteria and Effects suggested by other researchers

Type of structure and Damage	PPV mm/s	Reference
Plaster-on-lath construction near surface mines (long term, large scale, low frequencies vibrations)	12.7	Bureau of Mines (RI 5807)
Sheetrock constructed near surface mines	19.1	Bureau of Mines (RI 8507)
Residences near surface mines lying within a distance of 92 to1,524 m	25.0	OSM regulatory limits
Widely accepted limit for residents near construction and quarry blasting	50.8	Bureau of Mines (RI 8507)
Minor damage to average house subjected to quarry blasting vibrations	137	Bureau of Mines (656)
About 90% probability of minor damage from construction or quarry blasting. Structural damage to some houses depending on vibration source and character of the vibration	229	---
For close-in construction blasting, minor damage to nearly all houses and structural damage to some at low frequencies, major damage to most houses	501	---

It was opined (based on results of field investigations) by National Institute of Rock Mechanics (NIRM), Kolar Gold Fields, Karnataka (Ministry of Science and Technology, Govt. of India) that the maximum tolerable Peak Particle Velocities (PPV) of various frequencies the buildings of different types can tolerate without damage suggested by Directorate General of Mines Safety are very conservative and requires upward revision and suggested higher values as given in **Table 1.8**.

Table 1.8 National Institute of Rock Mechanics (NIRM) (Ministry of Science and Technology, Govt. of India) **Recommendations regarding the maximum Peak Particle Velocities (PPV) various civil structures can tolerate without damage** (Anon, 2005)

Type of structure			Maximum permissible PPV, mm/s		
			Dominant frequency, Hz		
			<20	20-50	> 50
(A)	Buildings / structures not belonging to the owner				
	(i)	Domestic houses/structures (kutchha brick & cement)	10	15	25
	(ii)	Industrial buildings (RCC & framed structures)	20	25	35
	(iii)	Objects of historical importance & sensitive structures	5	7	10
(B)	Buildings belonging to the owner with limited span of life				
	(i)	Domestic houses/structures(kutchha brick & cement)	15	25	35
	(ii)	Industrial buildings (RCC & framed structures)	55	35	50

Amongst the various norms (guidelines) discussed above, the DGMS norms are the most conservative and hence safest to protect different types of structures. Therefore, the same are adopted for the present study in deciding the maximum charge per delay for different distances of the structures fromthe blasting site in this report.

1.4 Ground Vibration Predictor Equations

For effective prediction and subsequent control of ground vibrations, rock constants which are site specific are determined for every site (by trial blasts) where blasting is to be carried out. These rock constants are used in the predictor equation (Equation 1) to calculate the maximum explosive charge per delay for a given

maximum PPV the structure in question can tolerate without damage and the distance between blasting site and the structure.

The tolerable PPV a structure can withstand (without damage) depends on the frequency of the vibrations, type of structure, material used for the construction of the structure and the type of rock (soft or hard) on which it is fixed.

For predicting ground vibrations, when both blasting and measurements are made on the surface, square root scaled distance formula (Equation 1) is used (as per the DGMS (Tech.) (S&T) circular No.7 of 1997) as it gives very reliable predictions of PPV to protect surface structures by limiting the vibrations to the tolerable levels when maximum charge per delay is restricted.

$$V = k(SD)^{-\beta} \text{..... (mm/s)} \quad \text{...} \quad (1)$$

where,

V	=	Peak particle velocity (PPV), mm/s
SD	=	Scaled distance, m/√kg
k and β	=	Rock constants, which are site specific.

where, SD is calculated by equation (2)

$$SD = \frac{D}{\sqrt{W}} \quad \text{(m/√kg)} \quad \text{...} \quad (2)$$

where,

D = Distance between the blasting site and the vibration monitoring station, m W = Maximum explosive charge per delay, kg

A linear regression analysis between PPV (on the y-axis) and scaled distance (on the x-axis) is to be carried out for the monitored data as per the DGMS guidelines; the best fit curve on log-log scale is to be drawn to determine the rock constants ***k*** and β for square *root* scaled distance formula. Linear regression analysis is a statistical tool to determine the line of best fit through a distribution of points in a graph.

1.5 Human Perception

Human beings are very sensitive and can detect even very low level of vibrations (as low as 0.5 mm/s) which cannot cause damage to the structures. Vibration levels

lesser than the ones that cause damage to the structures could cause rattling of doors or windows. Many a times, the slamming of a door or passing of a loaded lorry by the side of the house generates more vibration than a quarry blast. However, residents become alert and inquisitive by noise and rattling of objects in the immediate surroundings due to blasting in the neighbourhood and start looking for the damages to the structures like cracks in the walls in their residence. Finding a crack that existed even before blasting activity commenced in the neighbourhood,but not noticed, people start worrying and attributing the crack to blasting activity.

Dowding (1996) observed that the human sensitivity gets triggered by vibrations and air blasts and becomes inquisitive and suspicious about them from a blasting activity in the vicinity reaching the structure and resulting in some form of damage to it. The tolerance and reactions of humans to vibrations vary from person to person, the nature of the work he/she is doing, the environment in which they are present at the time of blast, etc. Blast induced ground vibrations may result in annoyance and interference with work proficiency.

1.6 SCOPE OF THE WORK

The management of Kadavila-1 Stone Quarry located at Nagaroor Village, Chirayinkeez Taluk, Thiruvananthapuram District, Kerala of **M/s. Adani Vizhinjam Port Private Limited, Thiruvananthapuram** has requested the Department of Mining Engineering, Anna University, Chennai to carryout scientific investigation into the influence of ground vibrations due to blasting being carried out in the Kadavila-1 Stone Quarry, on the residential buildings and other civil structures of the nearest village, not belonging to the quarry owner.

Based on this, the field investigation has been carried out from 16.03.2021 to 17.03.2021. During the field investigation, ten number of trial blasts were carried out at various locations of the mine with varying designs and charging patterns. The blasts were monitored using five vibration monitoring seismographs which are capable of recording vibrations in all the three directions along with noise/air overpressure. Based on the analysis of the above trial blasts, the following reportwas prepared and submitted.

1.7 OBJECTIVES

The objectives of the study are as follows

- Site visit and collection of data.
- Study the existing blasting, its design and its influence on the surroundings in respect of blast induced ground vibrations
- Design of trial blasts which will
  - restrict blast induced ground vibrations to levels that are tolerable on the residential and other civil structures not belonging to the quarry owner.
  - restrict generation of fly-rock and their throw to eliminate adverse effect on the residents and agricultural lands of the Nagaroor (Kadavila) village.
- Carry out at least 10 controlled trial blasts and monitor blast induced ground vibrations at least in 25 points under the supervision of the author of this report and their team. Similarly, study the distance to which flying fragments are produced.
- Develop a scaled distance equation for the site and determine the site constants which are site specific.
- Fine tune the blast design, if required, which will restrict the blast induced ground vibrations to the levels tolerable to the said structures, and control the fly-rock to minimise their effect on the residents, and people working in the agricultural lands.
- Submit the report including suggesting suitable methodology for carrying out regular drilling, controlled blasting operations in the quarry and also appropriate safety measures to be taken to guard against blast induced vibrations and fly-rock.

1.8 BLAST VIBRATION MONITORING INSTRUMENTATION

Blast induced ground vibrations and air over pressure (noise) are monitored with three dimensional Seismographs. During the field investigations, the blast induced ground vibrations were monitored using two numbers of NOMIS and three numbers of INSTANTEL seismographs.

1.8.1 NOMIS Mini SuperGraph

NOMIS Mini SuperGraph instrument (shown in Figure 1.0) from NOMIS seismograph, Inc., Birmingham, Alabama, U.S.A. are used for monitoring ground vibrations and air overpressure. It is very light, portable and user-friendly instrument for ease of operation in the field. The instrument has tri-axial transducer to record theblast induced ground vibrations in all three directions viz. R, T, V and a microphoneto measure and record the air over pressure levels. The instrument can be operated from mains and rechargeable battery.

The Vibration Monitoring System basically consists of

- Transducers for recording ground vibrations and a microphone for measuring air overpressure that convert physical motion or pressure to an electrical current, which is transmitted through a cable followed by an amplifying system. The vibration events are recorded on to the system.

Figure 1.0 NOMIS Seismograph

The software provided with the instrument works on windows operating system. The software provides for copying, viewing, analyzing and printing the data. The software is also capable of performing advanced analysis of waveforms, etc. for effective analysis of the ground vibrations. The instrument is to be properly fixed (Coupled) to the ground. Some of the salient features of NOMIS Seismograph are given in Table 1.9.

Table 1.9 Salient features of NOMIS Seismograph

S.No.	Parameter	Values
	SEISMIC	
1.	Range	0-254 mm/s
2.	Accuracy	+/- 3%
3.	Frequency Response	2- 400 Hz (1 Hz optional)
	SOUND	
1.	Range	92-148 dB
2.	Accuracy	+/- 0.1dBL at 30 Hz and 127 Hz
3.	Frequency Response	2- 400 Hz
	WAVEFORM RECORDED DATA	
1.	Record Modes	Waveform and Manual
2.	Seismic trigger range	0.19- 254 mm/s, no trigger, manual Lower Levels Optional
3.	Sound trigger range	92- 148 dB, no trigger (other levels optional)
	PHYSICAL SPECIFICATIONS	
1.	Weight	1.9 kg
2.	Battery	6 Volt, gel type rechargeable,14 days duration
3.	Display-LCD	8 lines x 21 characters with backlight
4.	Pc Interface	RS-232 & additional 15 pin auxiliary connector

1.8.2 Instantel DS-077 Minimate & Blastmate

Instruments of Instantel, Canada (Figure 1.1) were also used for monitoring ground vibrations. The instrument can be operated with power from the rechargeable battery. It is very light, portable and user-friendly instrument for ease of operation in the field. The instrument has tri-axial transducer (seismograph) to record the blast induced ground vibration in all three directions viz. radial (R), transverse (T) &vertical (V) directions and a microphone to measure the air over pressure levels. Minimate is a PC compatible computer-based system with inbuilt memory. The seismograph can measure the PPV up to 127 mm/s, frequency in the range of2 - 250 Hz and air over pressure in the range of 100 - 142 dB. For effective recording of the ground vibrations the instrument is properly coupled to the ground either by spiking or grouting or bolting.

1.8.3 Transducer Mounting

Monitoring of ground vibration is to be carried out after properly mounting (coupling) the transducer (Geophone) with the ground to receive and transmit the actual magnitude of the vibrations at that site. There are five methods of mounting the transducer on the ground as shown in Figure 1.2. In the first, the transducer is placed on a horizontal surface without any device to hold it (Figure 1.2 a).

(a) DS-077 Minimate **(b) Minimate Blaster**

Figure 1.1 INSTANTEL Vibration Monitoring Instruments

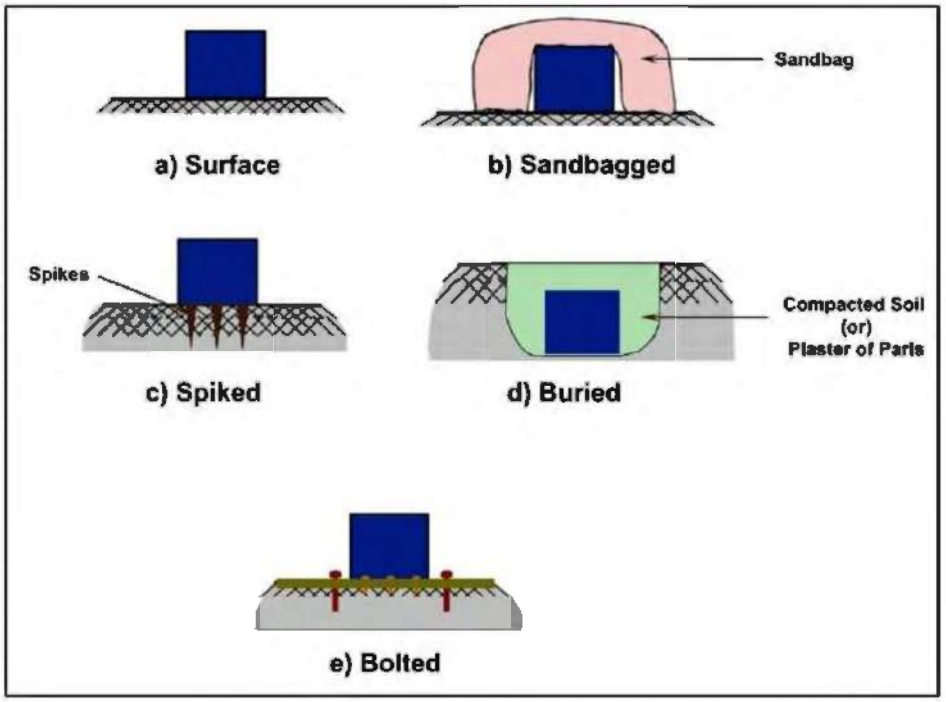


Figure 1.2. Five Common Methods of Transducer Mounting

The second one is also mounted in the same way but a loosely packed sandbag is placed over it so that all sides of the bag are directly in contact with ground (Figure 3b). In the third, the transducer is spiked into the ground (relatively loose) firmly, with the three spikes which are screwed to the transducer, by pressing into the ground

such that the base of the transducer is in direct contact with the ground (Figure 3c). In the fourth method, it is connected to the ground by completely burying it in soil or rock by making an excavation slightly bigger in size than that of the transducer and the soil compacted firmly around and over the transducer (Figure 3d). The same can be achieved by using „Plaster of paris" also. In the fifth method the transducer is bolted to the surface (floor or walls of a structure) to facilitate recording all the vibrations to which the surface is subjected to (Figure 3e).

1.9 CONTROLLED BLASTING

As stated earlier, when an explosive charge is blasted in a shot hole, in addition to doing the useful work of breaking rock and displacing it, it also produces adverse environmental effects like ground vibrations, over-break (back break), fly-rock, air-over pressure (noise) and air pollution with gases and dust. Some of these adverse effects cause damage to the structures in the vicinity and can cause injury to the people. Blasting by eliminating and / or controlling these adverse effects is termed as controlled blasting.

The blast induced ground vibrations get transmitted away from the blast in non-discriminating manner resulting in crushing and fracturing of the rock in the vicinity. This may pose a problem when blasting in the vicinity of the perimeter of a pitor a trench or civil, mining or defence structure. Hence, for the safety of the excavation and nearby structures, creation of new fractures and widening of the existing cracks due to the blasting are to be minimised, by generating less vibrations or preventing the vibrations from reaching the structure. The techniques to achieve this include

- Use of low strength explosives (explosives having less velocity of detonation).
- Reduced charge concentration by using less density explosives in small diameter drill holes.
- Reducing the quantity of explosive blasted at each moment of time by adopting delay blasting technique.
- Selecting optimum delay interval between two successive shots or groups of shots.
- Optimising the blast design parameters, viz. spacing, burden, length of the hole, charge factor, etc.

- Use of small diameter explosive charges (cartridges) in a large diameter holes (de-coupled charges).
- Use of air bags in the shot holes.
- Decking of explosives.
- Creating artificial cracks or discontinuity planes between the blasting site and the structures to be protected to limit the propagation of the radial cracks and transmission of shock waves.

1.9.1 Controlled Blasting Techniques

As on date, many blasting techniques are available to control the adverse effects of blasts. However, the selection of suitable technique primarily depends on the adverse parameter(s) of the blasting to be controlled. Some of the common techniques are (i) limiting the maximum charge per delay; (ii) line drilling; (iii) pre- splitting; (iv) cushion or smooth blasting; (v) air decking; (vi) muffling. Out of these,the first and sixth techniques, i.e. restricting the explosive quantity per delay and muffling with old tyres would be adopted for designing the controlled blasting technique in the Kadavila-1 Stone Quarry to protect the residential structures in the surrounding villages.

1.10 ADVERSE EFFECTS OF BLASTING

1.10.1 Abatement of Ground Vibrations by Controlled Blasting

The control measures for blast induced ground vibrations are:

- Design the blasts appropriate to the site and implement the designscrupulously.
- Exercise good control over drill hole pattern by properly marking the shot holes on the floor of the bench prior to drilling, so that the designed spacing, burden and inclination are achieved.
- Provide maximum relief [by creating free face(s)] to ensure free movement of the rock with appropriate charge factor.
- If no additional free face is available, a properly designed initial cut pattern is to be implemented.
- Select and use appropriate explosives and accessories suitable for the ground conditions prevailing at the site.
- Select the appropriate charge factor (specific charge).

- Select the maximum charges per delay based on the distance of the structure to be protected from the blasting site.
- Select the appropriate delay interval between holes in the same row and rows of the holes.
- Deck the charges in a blast hole.

1.10.2 Fly Rock

When blasting is carried out, the rock gets fragmented and the fragmented material is moved away from the bench and gets piled up as fragmented mass to enable loading by an excavator. In addition to this desirable displacement of broken fragments, some stone pieces travel to certain distance away from the face resulting in scatter of the blasted muck pile and a few of them also project to a greater distance as shown in **Figure 1.3**. This undesirable projection of stones is termed as „**fly rock'**.

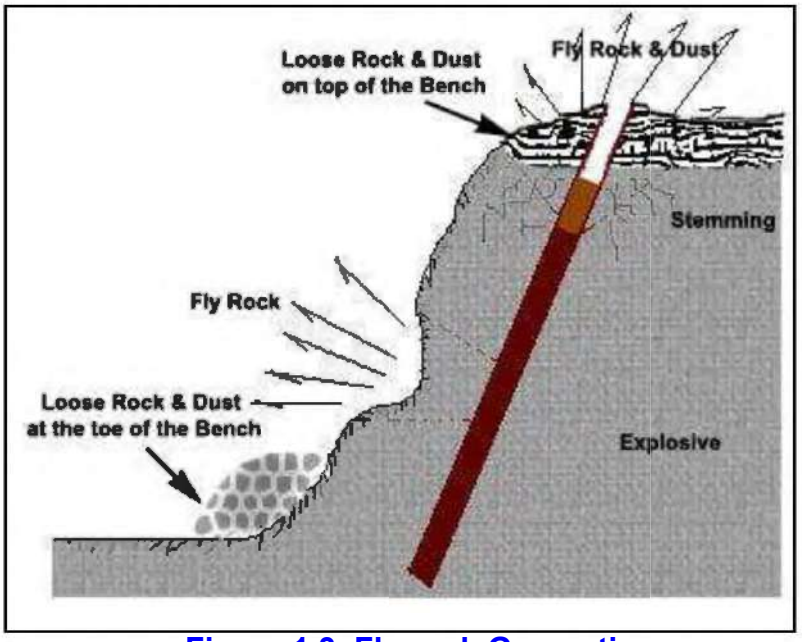


Figure 1.3 Fly-rock Generation

Fly rock is a serious environmental hazard and is often a cause of fatalities and /or serious injuries to the people, cattle, damage to the equipment, buildings and other property. Damage due to fly rock from blasting is one of the main causes of strained relations between the mine management and the people residing, working or passing by in the vicinity of blasting operations. This assumes prominence in mines having small leasehold area (when the danger zone falls beyond the leasehold area) and when the quarry is shallow with reference to the surroundings. These hazards

become serious as the blasting rounds become bigger with larger diameter boreholes, where fly rock of large sizes travel long distances. Fly rock is caused by improper blast design. The important parameters, which cause fly rock problem, are inadequate confinement of the explosive charge, high charge factor, decreased spacing and burden, overcharging, inaccurate drilling, inadequate stemming, faulty delay timing including not using delay detonators in multi-row blasting, improper initiation sequence, overlapping of delays, blast hole diameter, bench height, inclination of holes, charge distribution in holes, loose rock lumps lying on the top of bench or along slope, geological conditions like highly fractured and weathered rock and of course, human errors like - carelessness and improper supervision. In addition, secondary blasting is also a major source of fly rock and hence is to be avoided, wherever possible, or at least minimised by proper primary blast design (considering the above stated parameters) using delay detonators in conjunction withinverse initiation.

1.10.3 Control of fly-rock

Fly rock can be controlled by judicious selection of blast parameters mentioned above based on experience and calculations using certain empirical formulae developed from the site investigations. The fly rocks produced during the blastingcan be controlled by adopting the following measures:

- Proper blast design and its implementation.
- Careful inspection of site before laying out blast holes and deciding the drilling pattern to be adopted based on the bench geometry.
- Drilling in accordance with the requisite blast design.
- Blast hole charging (using optimum charge factor).
- Maintaining the adequate stemming column.
- Use of proper stemming material (small pieces of stones with sharp edges are to be removed from the stemming material to eliminate the possibility of insulation of the detonator lead wires getting damaged or snapping of the lead wires and ultimately resulting in misfires).
- Imparting adequate training to the blasting crew.

In addition to the above, withdrawing all persons, cattle and traffic from the entire area falling **within a radius of 500 meters from the place of firing (hereinafter referred to as the danger zone)** as per **Reg. 188 (2)(b) of MMR 2019** and DGMS **Technical circular No. 2 of 2003,** and positioning of guards (sentries) at all probable entrances into the blasting zone is very essential to prevent inadvertent entry of persons, cattle and traffic.

1.10.4 Air Blast/Noise

When blasting is done, a loud noise is heard which is known as air blast. Air blast, however, is not simply the sound that is heard. Air blast is an increased pressure wave consisting of high frequency sound that is audible (from 20 Hz to 20 kHz) and low frequency sound or concussion (less than 20 Hz) that is sub-audible and cannot be heard. Although air blast seldom causes structural damage but sudden loud noise causes psychological fear in the nearby inhabitants and in some cases even breakage of window panes have been reported (Persson et al., 1994), if any building is present within a short distance from the blasting site. Air blast is influenced by typeand amount of explosive, adequacy and type of material for stemming, direction of blast and meteorological conditions. The main cause of noise is the energy released in open air by the initiation system and inadequate stemming column, burden etc.

Air blasts are produced either by the direct action of the explosion products from the unconfined explosive (like, detonating cord) in air or by overcharging of explosive in a shot hole. The waves produced by the effect of blasting increases the air pressure from ambient pressure to peak and drops to negative (i.e., below ambient pressure) slowly. Its travel thereafter is governed by air temperature, wind direction & speed, and the presence of obstructions in the form of buildings, vegetation, and ground contour. Hence, blasting is to be avoided when the wind is blowing towards a critical area, which influences the air blast propagation. Similarly, blasting early in the morning and late in the evening is to be avoided, as there will be temperature inversions in the atmosphere during these periods of the day. Noise production is more with detonating cord and hence resorting to electric delay detonation reduces noise. However, United States Bureau of Mines (USBM) has correlated the damage due to air over-pressure. The recommended values are given below:

Table 1.10 United States Bureau of Mines (USBM) Values withstand Damage due to Air Over-pressure (Noise)

Over-pressure (dB)	Over-pressure (KPa)	Air Blast Effects
177	14	All windows break
170	6	Most windows break
150	0.63	Some windows break
140	0.20	Some large plate glass windows may break, desk and windows rattle
136	0.13	USBM interim limit for allowable air blast
126	0.05	Complaints likely

1.11 INITIATION SYSTEMS

There are a number of initiation techniques which can be used for supplying necessary energy to a column of explosive and thereby initiate the detonation process. The classification of initiation system is given in **Figure 1.4**

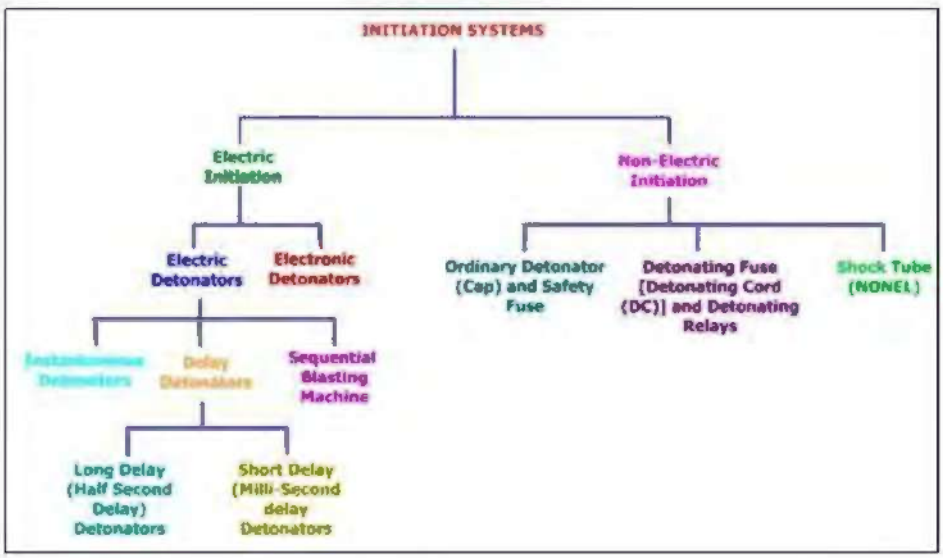


Figure 1.4 Blast initiation systems

Here, cap and safety fuse initiation is not recommended due to the difficulty in counting the number of shots during the firing of more number of holes in a single round creating unsafe situation.

Detonating fuse (DC) initiation system is also not recommended in this case because of its inability to provide inverse initiation (true bottom initiation). In addition, it produces more noise and increased possibility of misfires.

Shock tube initiation system can be used for better results and improved safety but it is more expensive.

Among the above, the **NONEL based initiation system** is having advantages of initiation systems like :

- As opposed to fuse initiation, the time of detonation is always under control.
- No damage is done to the stemming column.
- Delay blasting can be effectively carried out.
- True bottom initiation ensuring effective utilization of explosive energy thereby eliminating the stemming rejection and minimizing the flyrock travelling to large distances.
- No surface noises.
- Occurrence of misfires in the blasting can be minimised.
- Systems are cheaper and safe.

1.11.1 Shock Tube (NONEL)

The role of NONEL shock tube initiation system is the latest and advanced system in quarry blasting. The main component of a non-electric initiation system is shock tube that is a hollow plastic tube made with advanced materials designed to withstand field conditions. The inner walls of the tube are coated with high explosive of 14 to 20 mg/m length (**Figure 1.5**). With the help of non-electric millisecond delay detonators for down the hole initiation, two or three explosive decks in the same drill hole can be detonated by different delays. This reduces the maximum charge per delay thus controlling ground vibrations and can be very effectively used for carrying out controlled blasting operations. Use of NTD (Noiseless trunk line surface delay system) on the surface hook up, in place of detonating cord significantly reduces air blast/noise in view of the non-destructive nature of the tube. NTD or TLD (Trunk line delay) is a non-electric millisecond delay detonator for surface initiation of down line detonators. Combination of DTH and NTD give hole-by-hole initiation as well as sufficient 'burning front' thereby eliminating cut offs and misfires. Shock tube NONEL

system provides a high level of safety against initiation by static electricity, stray electrical currents and radio frequency transmissions.

1.11.2 Advantages of NONELs

- Noiseless, true bottom initiation, down-hole delays, simplified tie-in patterns, no limit on number of holes, reduction in air blasts/ground vibration, safe touse in extraneous electricity environments.

1.11.3 Disadvantages of NONELs

- Lack of firing circuit testing facility before firing (only visual examination is possible).
- Expensive compared to detonating cord and electric delay detonators.

Figure 1.5 Non- Electric Shock Tube Initiation Systems

CHAPTER 2.0
BLASTING PRACTICES IN THE QUARRY

2.0 DETAILS OF THE SITE

2.1 Company Profile

The Adani Group is one of India‟s leading business houses based at Ahmadabad – Gujarat, founded in 1988. Adani has grown to become a global integrated infrastructure player with businesses in key industry verticals – Resources, in coal mining and trading; Logistics, which is spread across ports, logistics, shipping and rail; Energy, with renewable, thermal, solar power generation and transmission businesses and Agro commodities and ancillary industries. The integrated model is well adapted to the infrastructure challenges of the emerging economies.

Adani Vizhinjam Port Private Limited (AVPPL) is a company belonging to Adani group, having their Registered office at Ahmedabad – Gujarat, and the local office at 2nd Floor, Vipanchika Tower, Thycaud, Thiruvananthapuram - 695014. The said company is in various infrastructural and construction activities, they have been awarded by the Government of Kerala for the development of Vizhijam port at Thiruvananthapuram, which is a National Developmental Project / Activity and is alsoa prestigious Sea Port for Kerala State. Hence, M/s. AVPPL is carrying out the stone quarrying operations in Sy. No. 555/2 of Nagaroor village (Kadavila), Chirayinkeezh Taluk, Thiruvananthapuram District over an area of 3.6630 Ha to facilitate the building stone material as the raw material for the development of the breakwater construction project.

2.2 Quarry Details

The present scientific study is in response to the request made by the management of M/s. Kadavila-1 Stone Quarry to investigate into the influence of blasting with emulsion explosives in their quarry relating to ground vibrations on the residential and other buildings of Kadavila village located around the quarry. The study is also aimed at investigating into the generation of the fly-rock, due to blasting and other mining activities of the quarry on the neighbourhood. Accordingly, the author of this report has carried out a preliminary survey followed by **10 number of controlled trial blasts** during **16.03.2021 to 17.03.2021** and prepared this report.

Figure 2.1 depict the Google map of the quarry area indicating the nearby surface structures and Figure 2.2 shows the surface plan of the leasehold area and locations of the nearest settlement and villages from the quarry lease area.

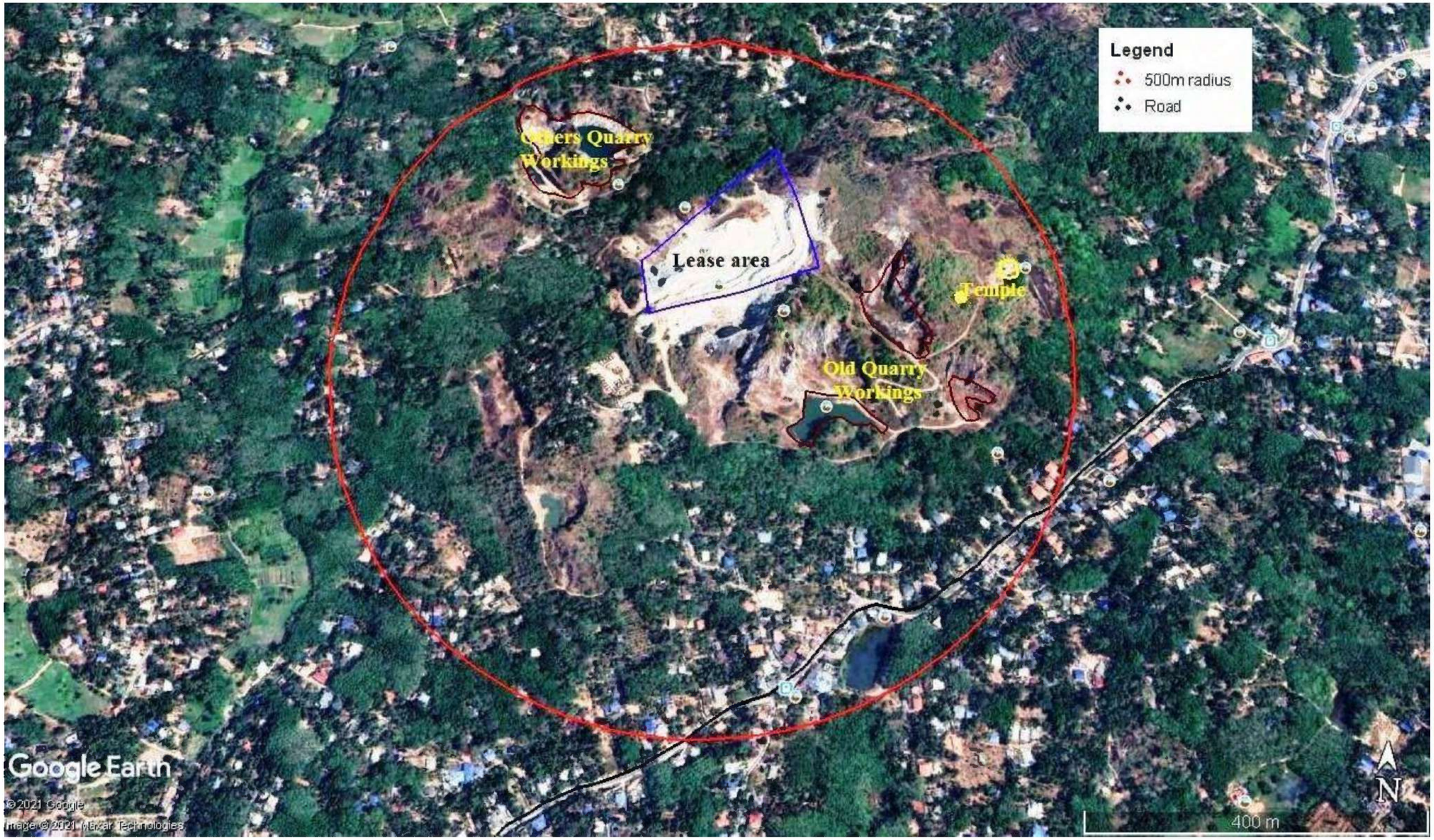


Figure 2.1 Shows the location of M/s. Kadavila-1 Stone Quarry in Nagaroor village, Chirayinkeezh Taluk, Thiruvananthapuram District, Kerala and its surrounding settlement

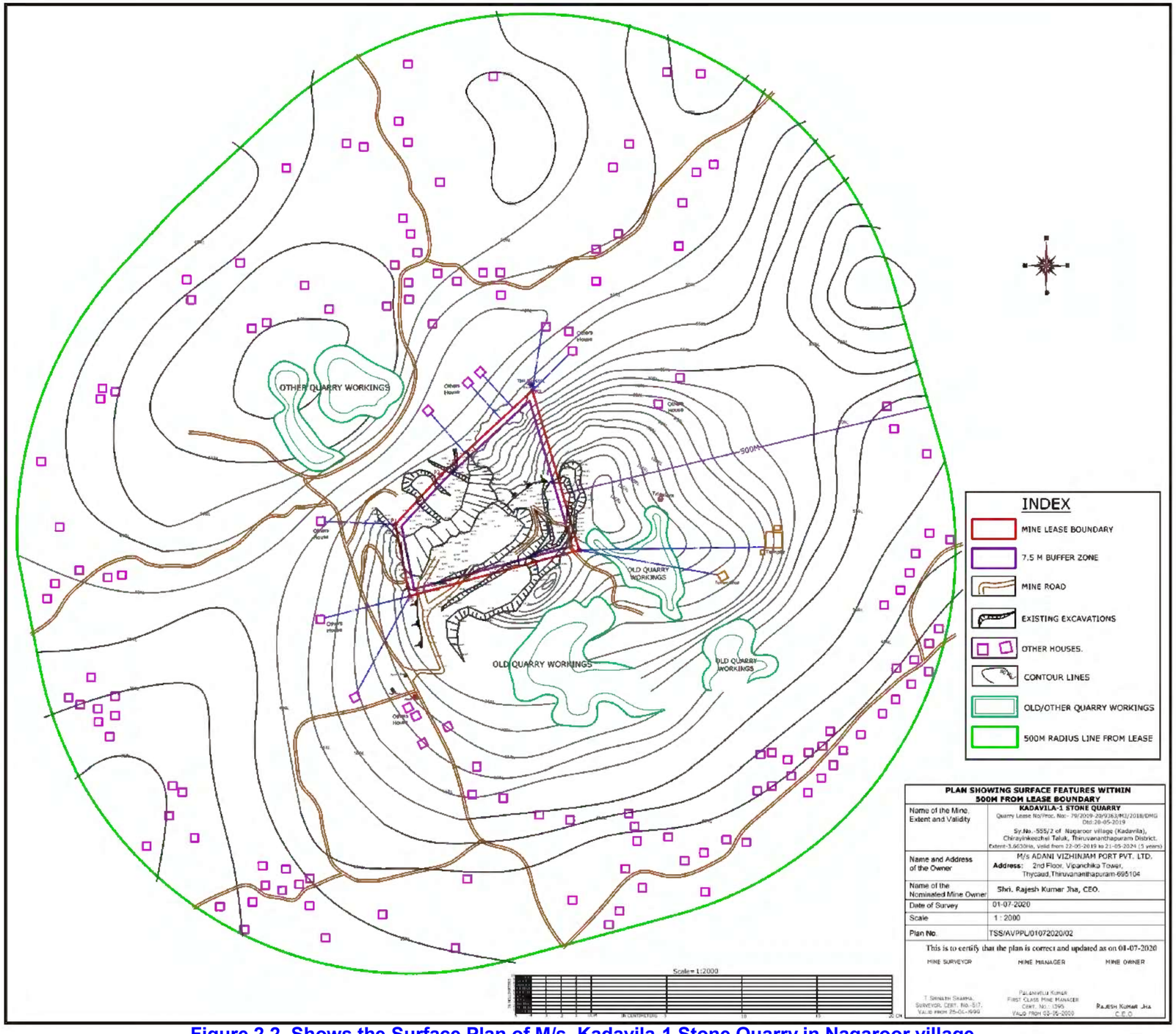


Figure 2.2 Shows the Surface Plan of M/s. Kadavila-1 Stone Quarry in Nagaroor village

The said quarry is located in Kadavila at a distance of 1.20 km towards southwest of Nagaroor village and lies towards north of Kadavila Bus stop at a distance of 0.50 km approximately. This lease area is approachable by all-weather road/s up to theup to Kadavila bus stop, thereafter a kutcha road towards north will leads to area.

The area is located between the geographical coordinates, **latitudes of 08º43' 42.88" N to 08º33' 51.74" N and longitudes of 76º50' 15.26" E to 76º 50' 23.24" E** and the total leasehold area of the mine is **3.6630 Ha (9.051 acres)** in Survey No. 555/2 (Government Land) of **Nagaroor village (Kadavila), Chirayinkeezh Taluk** of Thiruvananthapuram District, Kerala state**.** The Quarry is located at a distance of 35 km (by road) from Thiruvananthapuram which is the district head quarter and state"s capital and at a distance of 13.0 km (by road) from Chirayinkeezh which is the Taluk head quarter, where all the infrastructural facilities are available. The nearest airport is at Thiruvananthapuram at a distance of 35.0 km and sea port at Kollam which is at a distance of 50.0 km. The nearest railhead on Broad gauge is Chirayinkeezh.

2.2.1 Geology of the area and properties of strata

Most of the quarry area is exposed by Charnockite (commercially known as Granite), only towards the north of the quarry area part is covered by topsoil with the thickness varying from 0.75 m to 1.00 m. The overburden is mainly topsoil, intercalated waste and mining rejects. Out of geological reserves of 5.196 million tonnes, only 1.778 million tonnes of reserves can be exploited / mineable, while the balance of 3.417 million tonnes of reserves is getting blocked which cannot be mined due to the boundary and practical constraints. The geological parameters of the ore body as follows:

Strike	:	NW - SE with local variation of 15º– 20º on either side
Dip	:	70° - 80° dipping north
Strike length	:	250 m
Width of deposit	:	150-180m
Depth of deposit	:	50m

2.2.2 Method of Quarrying

Based on the mode and method so adopted and taking into the consideration of geological parameters, the quarry pit is designed such that the height of the bench is kept about 6.0 m maximum, and the width is also kept 6.0 m, maintaining 45˚ pit slope. The haul roads are properly laid and frequently wetted to suppress the dust being produced from the surface (Figure 2.3).

Figure 2.3 Benches and Haul road maintenance in the Quarry Face

Mining operation commenced from higher elevation to the lower elevation, benches developed and advanced in south and west direction laterally. Initially, the height of the highwall bench will be reduced, when it comes to the lower levels, benches will take the circular shapes and pit will be formed. The Mining operation is controlled and supervised by Statutory persons like Mine Manager, Assistant Mine Manager, Mine Foreman, Mining Mate Cum Blaster, who are certified by the Director General of Mines Safety, Dhanbad.

2.3 EXISTING BLASTING PRACTICES

The nature of the rock in the quarry has been found to be hard to medium hard in nature, possessing higher compressive strength and hence it requires drilling and

blasting operations to dislodge / loosen the material from the main rock mass to facilitate subsequent loading and transportation operations effectively.

The quarry is being worked systematically by constructing the benches with a maximum height of 6.0 m. Taking into consideration the parameters such as production requirement, required degree of fragmentation, type and capacity of excavator used, and environmental constraints, the **drill hole diameter of 33 mm** is being drilled using Jack hammer drilling machines. Based on the strength of the rock, the blasting pattern with a **burden** of 1.2 m and the **spacing** of 1.5 m are being maintained in the **row-by-row staggered patterns** (Fig. 2.4). The **hole depth** of 2.4 m for the above blastholes is maintained consistently for all the blasts. In the present case, vertical or inclined holes are used based on the bench conditions. If inclined hole drilling is adopted, the holes should be inclined at an angle of **15 to 20^0** (more orless parallel to the inclined face of the bench) to the vertical and **inclined towards the free face** of the bench**.**

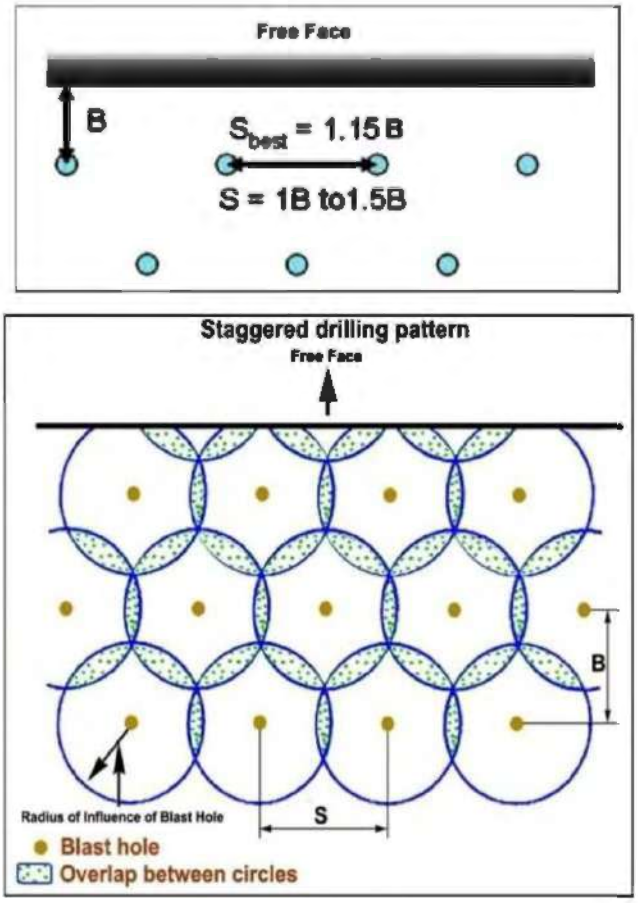


Figure 2.4 Staggered Pattern of Blast Holes

In the present site, a **minimum stemming length** of **0.70 m** is used at the collar of the blast hole. The crushed angular rock of **2 to 4 mm** (**about 10% of blasthole diameter**) is used instead of fine drill cuttings to prevent premature venting of explosive gases. Keeping atleast two free faces during the current blasting practices in the Kadavila-1 stone quarry, a **charge factor** of **0.15 to 0.16 kg/m^3** is adopted for ensuring average charge quantity of 0.500 kg per hole. Accordingly, the cap- sensitive **Emulsion explosive** cartridges of **25 mm diameter** are used to charge the holes in **three to five** rows for ensuring effective fragmentation of rock and to minimise the fly-rock in the quarry. Maximum numbers of holes are being blasted ata time in a round are generally limited to 50 to 80 with Non-Electrical detonators (NONEL) with surface delay of 17/25 ms and an in-hole delay of 250 ms to mitigate adverse impacts such as air blast, fly rock and ground vibration. The instantaneous electrical detonators are being used for initiating the blasting circuit prepared with NONEL based detonators.

After completion of drilling, charging, stemming and hooking up by connecting the trunk-lines of NONEL shock tubes, the place would be ready for blasting (Figure 2.5 and 2.6). All blasting operations are carried out only during the day time (between sunrise and sunset) and under the personal supervision of the Assistant Mines Manager. However, it is ensured that cattle, stray dogs, human beings and traffic on the village road **within a distance of 500 m from the blasting site** (which is termed as blasting zone) are cleared away for the safety purposes. Similarly, the Mining Mate cum Blaster and his assistants are moved to a safe place and the **sentries with red flags and blowing whistles were kept in all the directions along the periphery of the blasting zone** on either side of the road within the blasting zone preventing any unauthorized entry of human beings or cattle or traffic into the blasting zone. After taking **the final clearance** from all sentries and the **final confirmation** from the Assistant Mines Manager, the exploder key is inserted intothe exploder and the button is pressed for the firing.

After the completion of the blasting, the place is inspected for misfires, if any. **If no misfires are identified, all clear signal is given** and subsequently mucking (loading of the blasted rock) can be started.

Figure 2.5 Type of explosives used

Figure 2.6 Drilling and charging of blast holes

The summary of the blast design is given in **Table 2.1**

Table 2.1 Summary of the Blast Design being adopted in M/s. Kadavila-1 Stone Quarry

Sl. No.	Parameter			Value
1.	Blast hole diameter			33 mm
2.	Burden			1.2 m
3.	Spacing			1.5 m
4.	Height of the bench			6.00 m
5.	Stemming length			Minimum 0.70 m
6.	Drilling pattern being followed			Staggered
7.	Specific charge	For production blasting		0.15 to 0.16 kg/m^3
8.	Average explosive Quantity/hole	Emulsion cartridge		0.50 kg
9.	Maximum explosive charge per drillhole used during production blasting	Emulsion cartridge	125 g	0.625 to 0.688 kg
10.	Detonators used			NONEL based detonators of 17/25 ms surface delay with an in-hole delay of 250 ms
11.	Type of explosive used			Cap-sensitive type Emulsion cartridges (ø=25 mm)
12.	Method of initiation system			IED/MSDD
13.	Method of connecting detonator			Series

Blasting shall be recognised as the most critical operation in mining andhence shall be carried out by maintaining highest standards of safety and reliability. Emphasis shall always be placed in creating a work-culture where it is to be emphasized that safety is the responsibility of all personnel working at the site. **Hence, all these operations of drilling and blasting are being carried out under the direct supervision of qualified and experienced Assistant Mines Manager, Mining Mate cum Blaster in Kadavila-1 stone quarry.**

CHAPTER 3.0

MONITORING AND ANALYSIS OF EXPERIMENTAL BLASTS

In response to the request made by the management of M/s. Kadavila-1Stone Quarry to investigate into the influence of blasting with emulsion explosives in their quarry relating to ground vibrations on the residential and other buildings of Kadavila village located around the quarry, **10 number of controlled experimental blasts** were carried out during **16.03.2021 to 17.03.2021**. This scientific study is alsoaimed at investigating into the generation of the fly-rock and airblast (noise) due to blasting activities of the quarry on the neighbourhood.

Accordingly, five numbers of latest version of blast monitoring instruments (Two NOMIS and Three-Dimensional Seismographs of INSTANTEL make) have beenused by the Anna University research team for monitoring blast induced ground vibrations in M/s. Kadavila-1 Stone Quarry.

After carrying out detailed site examination and discussion had with the management, **vibration levels** during the above **10 experimental blasts** were measured at the residential buildings, and other structures in the vicinity. The details of the blast parameters, peak particle velocities, their vectorial sum and the corresponding frequencies measured at the monitoring stations (**47 observations**) and other details of the blasts are given in **Table 3.1**. Regression curve has been drawn to develop the predictor equations for the site. From the predictor equation,site constants for M/s. Kadavila-1 Stone Quarry were determined. This enabled the blasting operations to be designed to maintain the permissible levels of peak particle velocity (blast induced ground vibrations) at any structure within the recommended level. The maximum explosive charge to be used per delay at each site to ensure no risk for the check dam, residential houses and other surrounding structures have been calculated using the **predictor equation with 95% confidence** (**Equation No. 3**) developed for various distance of the of structures from the blasting site.

Table 3.1 Details of the 10 Trial Blasts Carried out at Kadavila-1 Stone Quarry and the Blast Induced Ground Vibrations Recorded

Blast No.	Date	Location of Monitoring Site	Time	No of Holes	Average Depth of the holes	Average Burden & Spacing	Total charge./ Blast	Maximum Charge / delay	Volume of Rock Broken	Charge factor	Distance between the Blasting and Monitoring Site	Vibration measurement recorded							Air Overpressure
												Longitudinal		Transverse		Vertical		Vectorial Sum	
												Peak Particle Velocity	Frequency	Peak Particle Velocity	Frequency	Peak Particle Velocity	Frequency		
				No.	m	m	kg	kg	m^3	kg/m^3	m	mm/s	Hz	mm/s	Hz	mm/s	Hz	mm/s	dB(A)
1	16.03.2021	S1 8°43'39.00" N 76°50'15.00"E	11.03 am	63	2.4	1.2,1.5	43.375	2.16875	265.356	0.1635	213	Not Triggered							
		S2 8°43'44.17"N 76°50'19.87"E	11.03 am	63	2.4	1.2,1.5	43.375	2.16875	265.356	0.1635	62	3.429	170.60	3.429	128.00	3.429	128.0	4.12	71.6
		S3 8°43'48.03"N 76°50'12.81"E	11.03 am	63	2.4	1.2,1.5	43.375	2.16875	265.356	0.1635	190	Not Triggered							
		S5 8°43'41.81"N 76°50'17.47"E	11.03 am	63	2.4	1.2,1.5	43.375	2.16875	265.356	0.1635	105	1.14	7.8	2.79	7.6	0.445	8.0	2.92	35.0
2	16.03.2021	S1 8°43"39.00" N 76°50"15.00"E	11.08 am	30	2.4	1.2,1.5	18.75	1.25	126.36	0.1483	297	Not Triggered							
		S2 8°43"44.17"N 76°50"19.87"E	11.08 am	30	2.4	1.2,1.5	18.75	1.25	126.36	0.1483	85	1.016	256.00	1.143	128.00	1.397	128.0	2.07	69.5
		S3 8°43"48.03"N 76°50"12.81"E	11.08 am	30	2.4	1.2,1.5	18.75	1.25	125.36	0.1483	253	Not Triggered							
		S5 8°43"41.81"N 76°50"17.47"E	11.08 am	30	2.4	1.2,1.5	18.75	1.25	126.36	0.1483	184	2.10	7.8	2.16	7.5	2.54	8.0	3.41	79.0

3	16.03.2021	S1 8°43'39.00" N 76°50'15.00"E	11.11 am	80	2.4	1.2,1.5	50	1.25	336.96	0.1483	267	**Not Triggered**							
		S2 8°43'44.17"N 76°50'19.87"E	11.11 am	80	2.4	1.2,1.5	50	1.25	336.96	0.1483	47	5.334	170.60	3.302	170.60	4.064	128.0	5.58	82.4
		S3 8°43'48.03"N 76°50'12.81"E	11.11 am	80	2.4	1.2,1.5	50	1.25	336.96	0.1483	264	**Not Triggered**							
		S5 8°43'41.81"N 76°50'17.47"E	11.11 am	80	2.4	1.2,1.5	50	1.25	336.96	0.1483	152	1.86	24	2.1	24	2.67	22	2.70	6.9
4	16.03.2021	S1 8°43'39.00" N 76°50'15.00"E	02.43 pm	30	2.4	1.2,1.5	18.75	1.33928	126.36	0.1484	136	0.381	0.0	0.245	0.0	0.254	0.0	0.832	4.5
		S2 8°43'44.17"N 76°50'19.87"E	02.43 pm	30	2.4	1.2,1.5	18.75	1.33928	126.36	0.1484	120	1.905	128.00	2.540	128.00	5.588	128.0	5.87	66.9
		S3 8°43'45.27"N 76°50'31.27"E	02.43 pm	30	2.4	1.2,1.5	18.75	1.33928	126.36	0.1484	465	0.572	8.1	0.889	7.8	0.508	8.0	0.968	6.9
		S4 8°43'41.81"N 76°50'17.47"E	02.43 pm	30	2.4	1.2,1.5	18.75	1.33928	126.36	0.1484	60	**Not Triggered**							
		S5 8°43'52.19"N 76°50'18.62"E	02.43 pm	30	2.4	1.2,1.5	18.75	1.33928	126.36	0.1484	282	1.52	7.7	2.48	7.5	0.953	8.0	2.81	57.3
5	16.03.2021	S1 8°43'39.00" N 76°50'15.00"E	02.45 pm	24	2.4	1.2,1.5	15	1.25	101.088	0.1484	296	0.889	204.80	0.254	68.30	1.143	29.30	1.47	18.9
		S2 8°43'44.17"N 76°50'19.87"E	02.45 pm	24	2.4	1.2,1.5	15	1.25	101.088	0.1484	102	4.064	73.10	4.572	128.00	7.366	102.4	7.52	63.1
		S3 8°43'45.27"N 76°50'31.27"E	02.45 pm	24	2.4	1.2,1.5	15	1.25	101.088	0.1484	359	0.254	8.0	0.381	7.8	0.191	8.0	0.397	12.9
		S4 8°43'41.81"N 76°50'17.47"E	02.45 pm	24	2.4	1.2,1.5	15	1.25	101.088	0.1484	185	**Not Triggered**							
		S5 8°43'52.19"N 76°50'18.62"E	02.45 pm	24	2.4	1.2,1.5	15	1.25	101.088	0.1484	151	0.191	7.7	0.381	7.5	0.191	7.8	0.429	36.1

6	17.03.2021	S1 8°43'41.81"N 76°50'17.47"E	10.55 am	60	2.4	1.2,1.5	37.5	1.875	252.72	0.1484	80	8.509	170.60	5.842	128.00	3.175	73.10	9.8	30.4
		S2 8°43'44.17"N 76°50'19.87"E	10.55 am	60	2.4	1.2,1.5	37.5	1.875	257.72	0.1484	95	1.524	170.60	2.032	256.00	3.302	170.6	3.41	92.6
		S3 8°43'38.74"N 76°50'16.72"E	10.55 am	60	2.4	1.2,1.5	37.5	1.875	257.72	0.1484	174	1.97	7.7	1.84	7.8	1.27	8.0	2.11	6.9
		S4 8°43'48.03"N 76°50'12.81"E	10.55 am	60	2.4	1.2,1.5	37.5	1.875	252.72	0.1484	170	0.635	8.2	0.508	7.7	0.572	7.8	0.778	52.4
		S5 8°43'47.04"N 76°50'12.20"E	10.55 am	60	2.4	1.2,1.5	37.5	1.875	252.72	0.1484	165	0.572	7.8	0.635	7.6	0.318	8.0	0.683	73.4
7	17.03.2021	S1 8°43'41.81"N 76°50'17.47"E	10.56 am	50	2.4	1.2,1.5	31.25	1.736	210.60	0.1484	75	7.747	170.60	10.16	170.60	5.969	128.0	11.09	70.9
		S2 8°43'44.17"N 76°50'19.87"E	10.56 am	50	2.4	1.2,1.5	31.25	1.736	210.60	0.1484	125	1.651	51.20	1.778	170.60	2.032	128.0	2.51	68.2
		S3 8°43'38.74"N 76°50'16.72"E	10.56 am	50	2.4	1.2,1.5	31.25	1.736	210.60	0.1484	157	1.46	7.7	2.10	7.8	1.14	8.0	2.24	6.9
		S4 8°43'48.03"N 76°50'12.81"E	10.56 am	50	2.4	1.2,1.5	31.25	1.736	210.60	0.1484	160	0.953	8.2	0.953	7.7	0.699	7.8	1.17	47.2
		S5 8°43'47.04"N 76°50'12.20"E	10.56 am	50	2.4	1.2,1.5	31.25	1.736	210.60	0.1484	154	1.71	7.8	1.14	7.6	0.572	8.0	1.89	56.3
8	17.03.2021	S1 8°43'41.81"N 76°50'17.47"E	2.37 pm	30	2.4	1.2,1.5	18.75	1.339	126.36	0.1484	105	5.207	170.60	4.826	102.40	2.667	128.0	6.12	64.4
		S2 8°43'44.17"N 76°50'19.87"E	2.37 pm	30	2.4	1.2,1.5	18.75	1.339	126.36	0.1484	68	1.651	56.80	1.270	128.00	2.032	51.20	2.3	78.0
		S3 8°43'38.33"N 76°50'16.63"E	2.37 pm	30	2.4	1.2,1.5	18.75	1.339	126.36	0.1484	218	**Not Triggered**							
		S4 8°43'48.03"N 76°50'12.81"E	2.37 pm	30	2.4	1.2,1.5	18.75	1.339	126.36	0.1484	182	1.08	8.2	0.826	7.7	0.889	7.8	1.40	62.4

		S5 8°43'53.22"N 76°50'22.62"E	2.37 pm	30	2.4	1.2,1.5	18.75	1.339	126.36	0.1484	282	1.27	7.7	0.635	7.6	1.59	7.8	1.68	6.9
9	17.03.2021	S1 8°43'41.81"N 76°50'17.47"E	2.39 pm	24	2.4	1.2,1.5	15	1.071	101.088	0.1484	186	3.302	170.60	2.794	256.0	1.413	170.6	3.47	67.8
		S2 8°43'44.17"N 76°50'19.87"E	2.39 pm	24	2.4	1.2,1.5	15	1.071	101.088	0.1484	91	0.762	36.50	1.016	256.00	1.270	42.60	1.75	69.2
		S3 8°43'38.33"N 76°50'16.63"E	2.39 pm	24	2.4	1.2,1.5	15	1.071	101.088	0.1484	293	**Not Triggered**							
		S4 8°43'48.03"N 76°50'12.81"E	2.39 pm	24	2.4	1.2,1.5	15	1.071	101.088	0.1484	205	0.317	8.2	0.317	7.7	0.317	7.8	0.524	63.7
		S5 8°43'53.22"N 76°50'22.62"E	2.39 pm	24	2.4	1.2,1.5	15	1.071	101.088	0.1484	209	0.889	7.7	0.826	7.6	0.572	7.8	1.00	56.3
10	17.03.2021	S1 8°43'41.81"N 76°50'17.47"E	2.46 pm	25	2.4	1.2,1.5	15.625	1.116	105.3	0.1484	146	2.54	170.60	2.54	256.0	1.397	170.6	3.4	56.2
		S2 8°43'44.17"N 76°50'19.87"E	2.46 pm	25	2.4	1.2,1.5	15.625	1.116	105.3	0.1484	46	1.270	22.20	1.651	256.00	1.778	170.6	2.29	72.1
		S3 8°43'38.33"N 76°50'16.63"E	2.46 pm	25	2.4	1.2,1.5	15.625	1.116	105.3	0.1484	259	**Not Triggered**							
		S4 8°43'48.03"N 76°50'12.81"E	2.46 pm	25	2.4	1.2,1.5	15.625	1.116	105.3	0.1484	245	0.191	8.2	0.191	7.7	0.127	7.8	0.206	59.1
		S5 8°43'53.22"N 76°50'22.62"E	2.46 pm	25	2.4	1.2,1.5	15.625	1.116	105.3	0.1484	243	0.254	7.7	0.191	7.6	0.254	7.8	0.318	56.3

3.1 Trial Blast Details

The details of the trial blasts along with the measured blast induced ground vibrations and blasting pattern are reported in the following paragraphs. From the adopted blasting pattern and charging practices during the aforesaid experimental blasts, maximum charge per delay and predictor equation were determined for the present site.

Blast No: 1: The first trial blast was conducted on 16th March, 2021 and the adopted blasting pattern and details are given in the Table 3.2 and 3.3. The Figure 3.1 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.2

Table 3.2 Co-ordinates of Blast & Instrument Locations

Sl. No	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B1)			8°43'45.19"	76°50'18.17"	---		
2	VMS_1 Location	11772	213	8°43'39.00"	76°50'15.00"	Not Triggered		Belonging to the owner
3	VMS_2 Location	20484	62	8°43'44.17"	76°50'19.88"	4.12 Within permissible limit	71.6	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	190	8°43'48.033"	76°50'12.81"	Not Triggered		Not belonging to the owner
6	VMS_5 Location	4687	105	8°43'41.81"	76°50'17.47"	2.92 Within permissible limit	35.0	Belonging to the owner, maximum value is 15 mm/s

Table 3.3 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	63	0.688	2.168	43.375

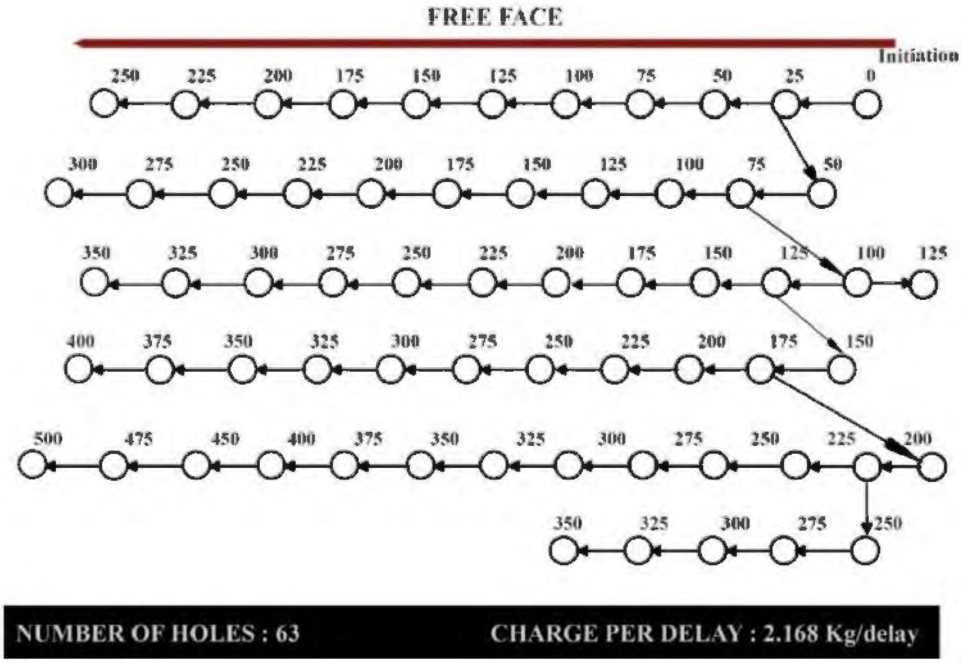


Figure 3.1 Schematic diagram of adopted blasting pattern for the blast 1

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No backbreak was observed.
- Muckpile was loose.
- The throw of the blast has been around 10-15 m which is considered to be normal.
- A drop of about 0.5 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored by the mine management was well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.2 & 3.3.**

VMS_2 Location : EVENT REPORT

SuperGraphics - Report

Company:

Unit #: 20484 3/16/2021 at 11:03:11 Event # 5

Location: Operator:

Notes:

Distance: N Wgt. Per Delay: N Scaled Distance: 0.0

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Seismic

Gain: 1 Trigger: 889 mm/s Vector Sum: 4.12 mm/s @ 170.67 Hz

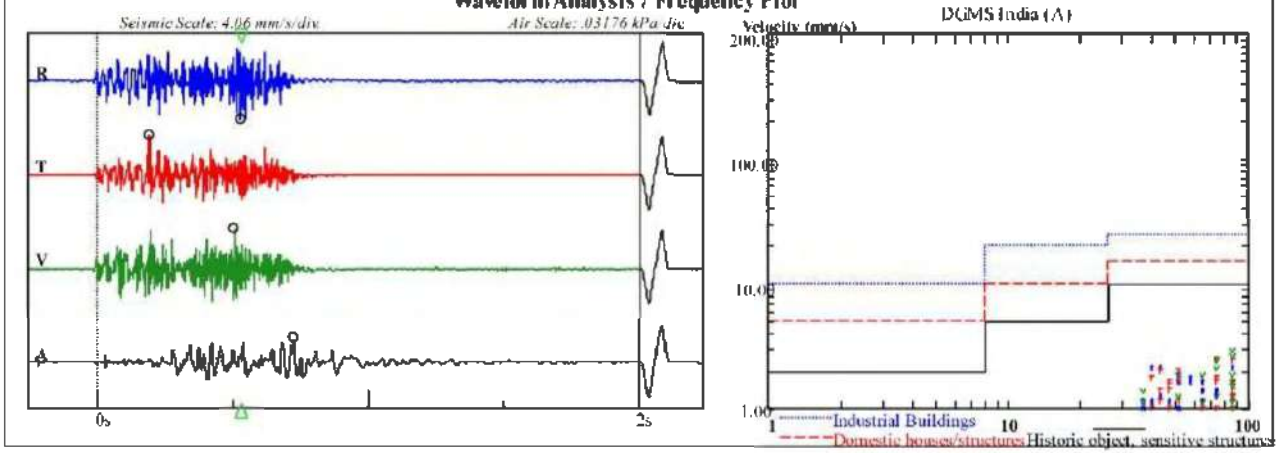
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	3.429	3.429	3.429
Frequency (Hz)	170.60	128.00	128.00
Trigger ::: Peak	529.3	191.4	505.9

Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger ::: Peak
		722.7
kPa	.0162	
dBL	118.2	
Hz	23.2	

Waveform Analysis / Frequency Plot



VMS_5 Location : EVENT REPORT

Instantel

Event Report

Date/Time	MicL at 10:59:23 March 16, 2021	**Serial Number**	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 105 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F687IW9Q.IZ0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 28, 2011 04:50:28 (V8.12)

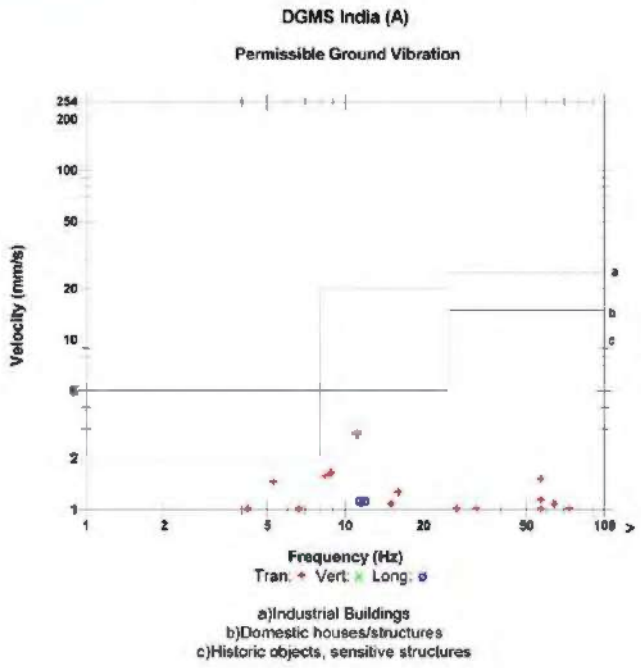
Extended Notes

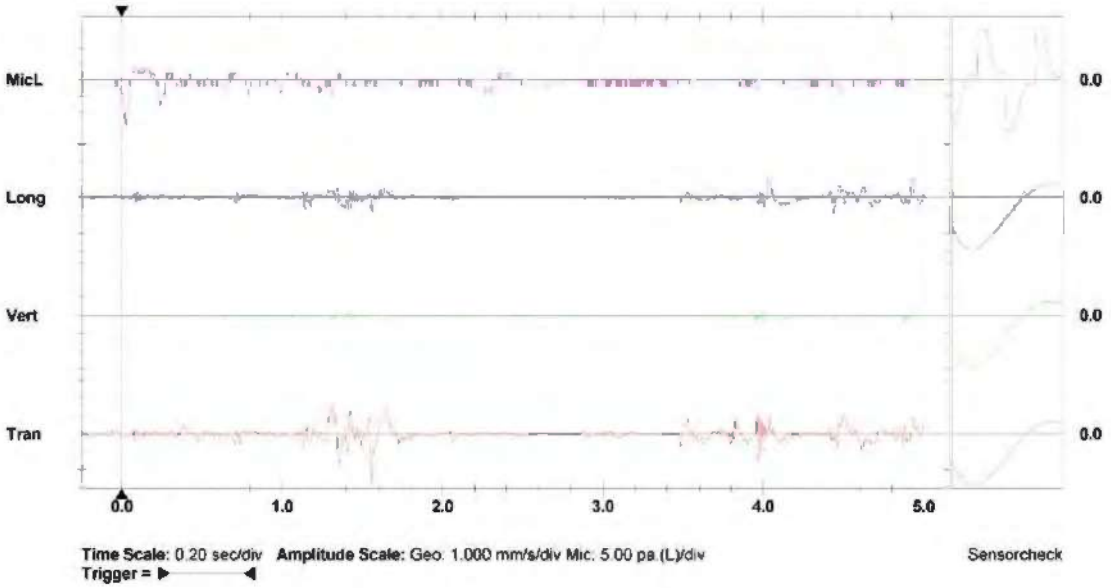
Post Event Notes

Microphone Linear Weighting
PSPL 116.9 dB(L) at 0.027 sec
ZC Freq 7.0 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 503 mv)

	Tran	Vert	Long	
PPV	2.79	0.445	1.14	mm/s
ZC Freq	11	20	11	Hz
Time (Rel. to Trig)	1.561	4.930	4.037	sec
Peak Acceleration	0.0530	0.0265	0.0199	g
Peak Displacement	0.0346	0.00307	0.0151	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	8.0	7.8	Hz
Overswing Ratio	3.6	3.3	3.5	

Peak Vector Sum 2.92 mm/s at 1.562 sec





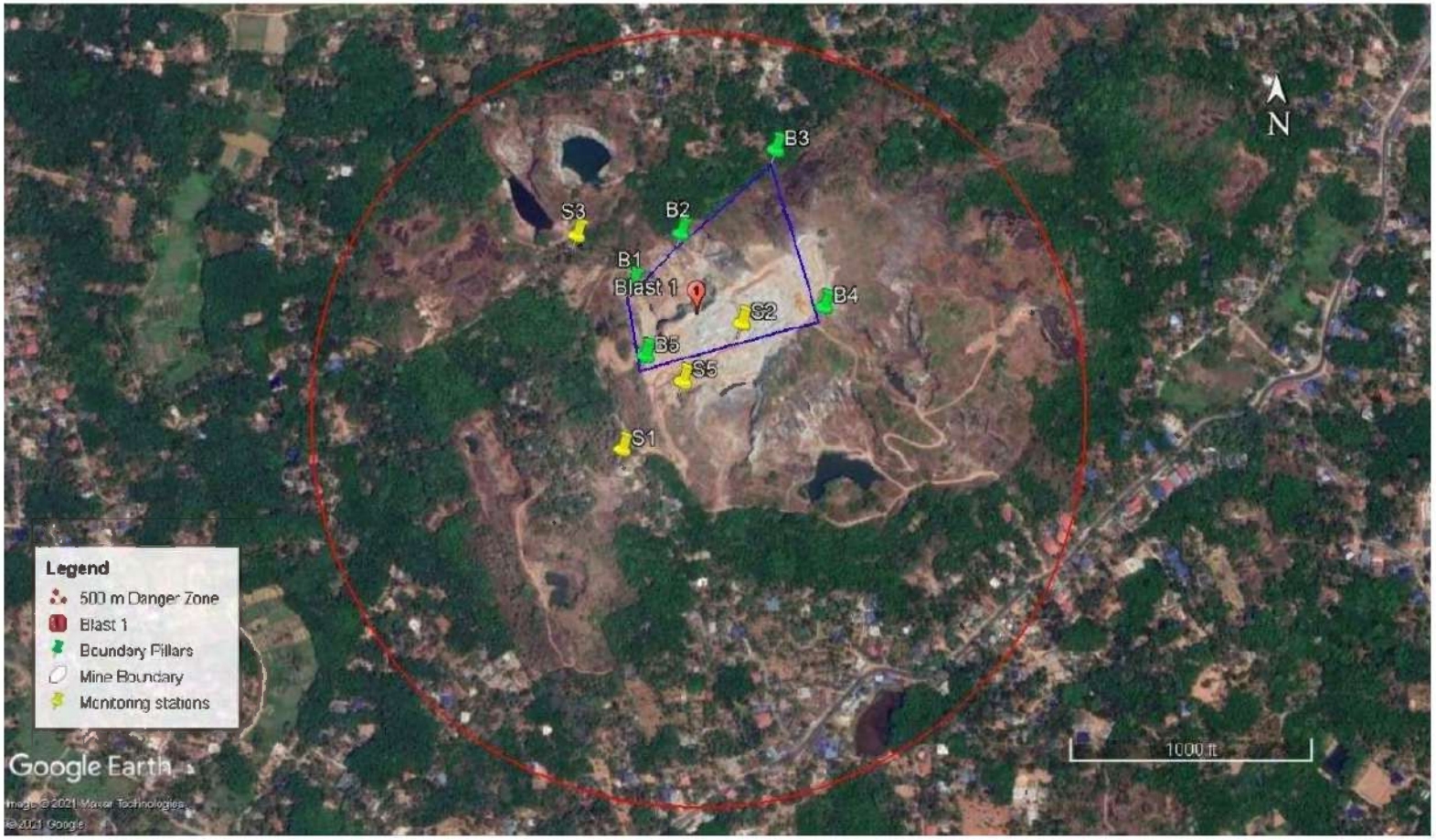


Figure 3.2 Imagery shows the location blast site 1 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 2: The second blast was conducted on 16th March, 2021 and the adopted blasting pattern and details are given in the Table 3.4 and 3.5. The Figure 3.3 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.4

Table 3.4 Co-ordinates of Blast & Instrument Locations

Sl. No	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B2)			8°43'46.73"	76°50'20.89"	---		
2	VMS_1 Location	11772	297	8°43'39.00"	76°50'15.00"	Not Triggered		Belonging to the
3	VMS_2 Location	20484	85	8°43'44.17"	76°50'19.88"	2.07 Within permissible limit	69.,5	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	253	8°43'48.033"	76°50'12.81"	Not Triggered		Not belonging to the owner
5	VMS_5 Location	4687	184	8°43'41.81"	76°50'17.47"	3.41 Within permissible limit	79.0	Belonging to the owner, maximum value is 15 mm/s

Table 3.5 Co-ordinates of Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	30	0.625	1.25	18.75

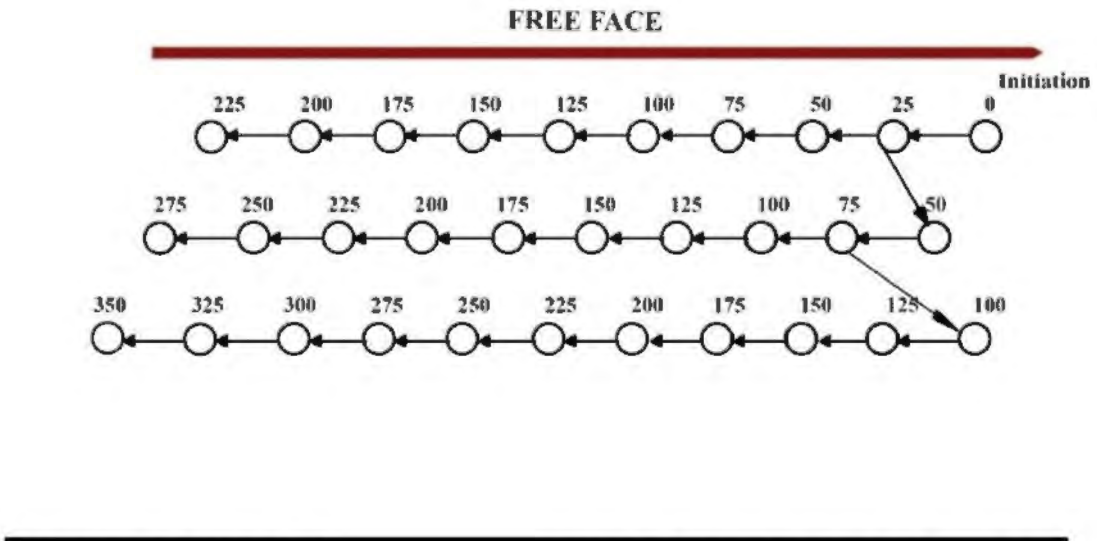


Figure 3.3 Schematic diagram of adopted blasting pattern for the blast 2

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No backbreak was observed.
- Muckpile was found to be loosen.
- The throw of the blast has been around 10-12 m which is considered to be normal.
- A drop of about 1m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 12 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring house was well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.4 & 3.5.**

VMS_2 Location : EVENT REPORT

Version 4.2.4
Executable Date 18Oct2017

File: D:\Kerala\Adani\16.03.21-VMS 2\6.NS8

Nomis Seismographs, Inc

SuperGraphics - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20484

3/16/2021 at 11:08:20 Event # 6

Location:

Operator:

Notes:

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

No GPS Data

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Seismic

Gain: 1 Trigger: .889 mm/s Vector Sum: 2.07 mm/s @ 128.00 Hz

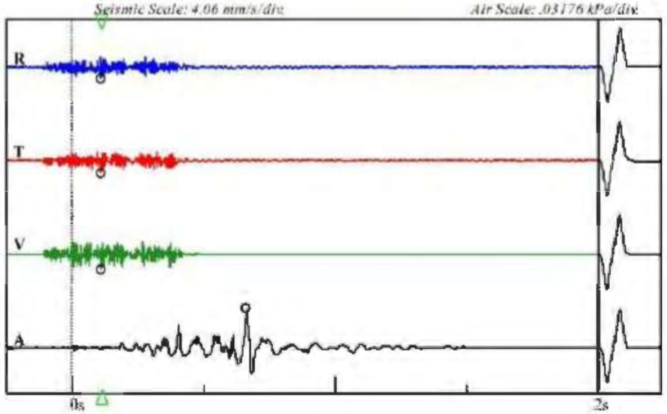
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	1.016	1.143	1.397
Frequency (Hz)	256.00	128.00	128.00
Trigger >>> Peak	108.4	108.4	108.4

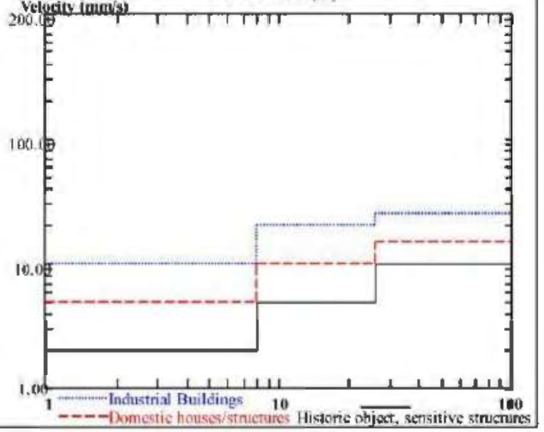
Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger >>> Peak
		661.1
kPa	.0265	
dBL	122.4	
Hz	18.2	

Waveform Analysis / Frequency Plot





VMS_5 Location : EVENT REPORT

Instantel

Event Report

Date/Time	Vert at 11:03:08 March 16, 2021	**Serial Number**	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F687IW9Q.P80
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 25, 2011 04:50:28 (V8.12)

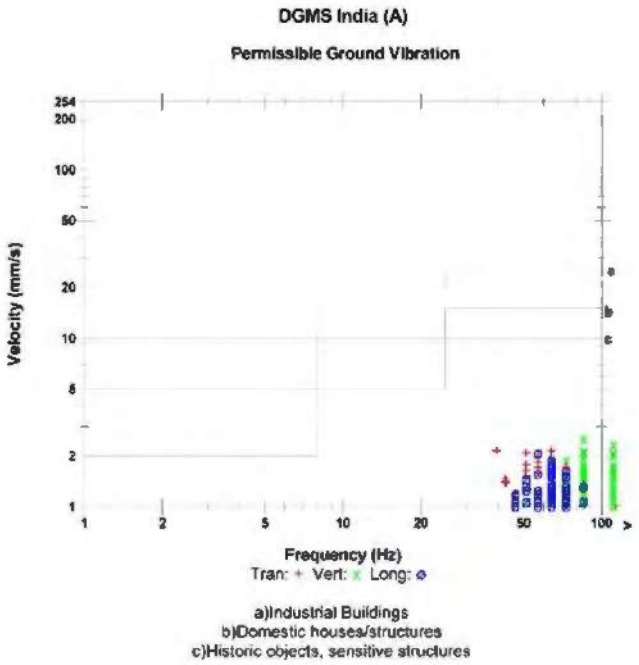
Extended Notes

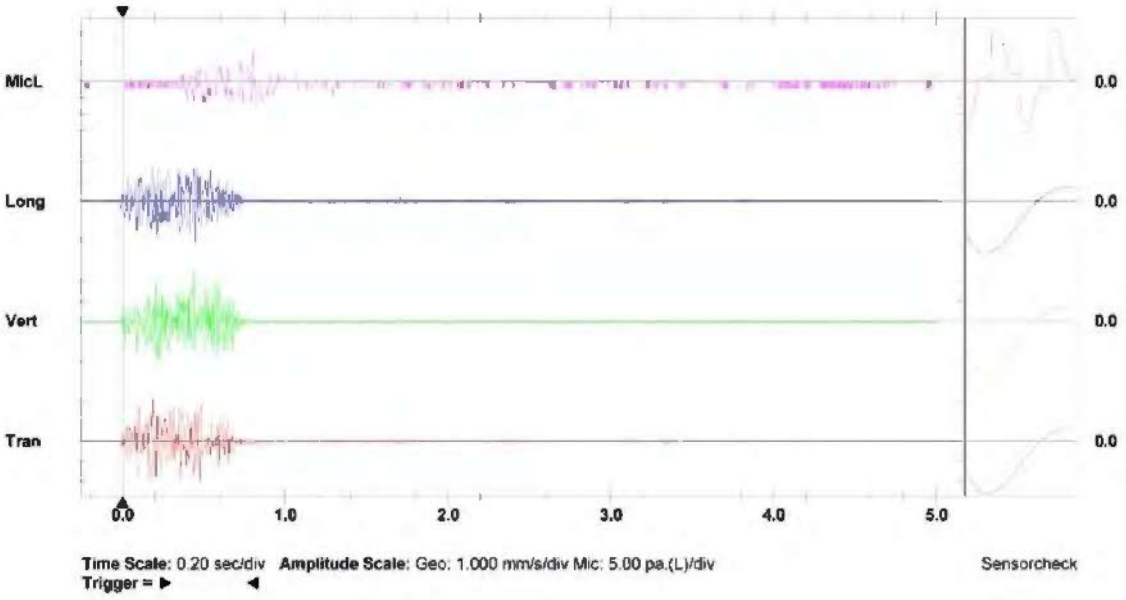
Post Event Notes

Microphone	Linear Weighting
PSPL	114.0 dB(L) at 0.800 sec
ZC Freq	39 Hz
Channel Test	Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	2.16	2.54	2.10	mm/s
ZC Freq	37	85	57	Hz
Time (Rel. to Trig)	0.190	0.441	0.448	sec
Peak Acceleration	0.0928	0.232	0.0994	g
Peak Displacement	0.00595	0.00493	0.00493	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.5	8.0	7.8	Hz
Overswing Ratio	3.6	3.3	3.5	

Peak Vector Sum 3.41 mm/s at 0.441 sec





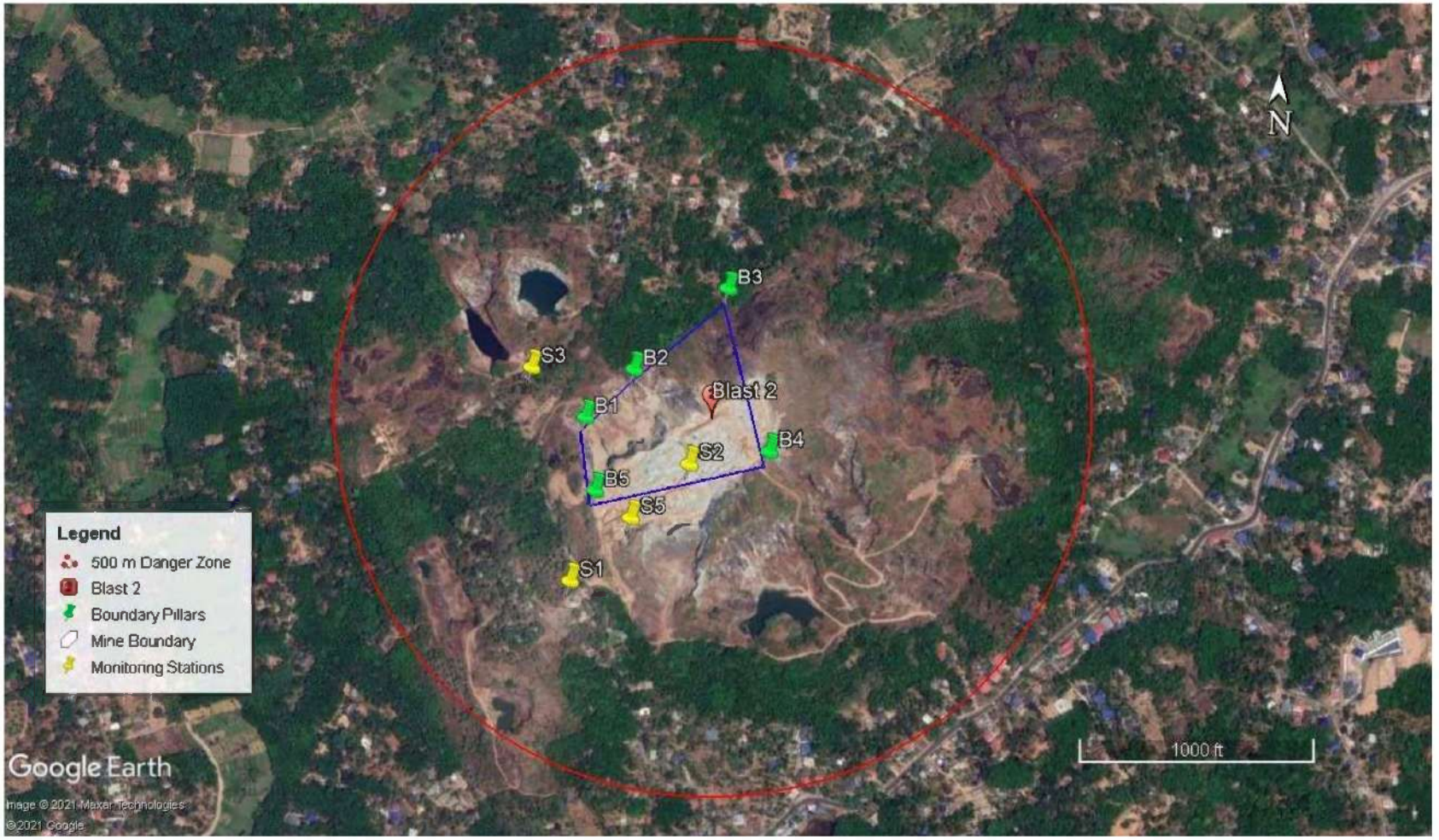


Figure 3.4 Imagery shows the location blast site 2 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 3: The third blast was conducted on 16th March, 2021 and the adopted blasting pattern and details are given in the Table 3.6 and 3.7. The Figure 3.5 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.6

Table 3.6 Co-ordinates of Blast & Instrument Locations

Sl. No	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Nois dB(A)	Type of structure/ Permissible limit
1	Blast Location (B3)			8°43'45.46"	76°50'20.86"	---		
2	VMS_1 Location	11772	267	8°43'39.00"	76°50'15.00"	Not Triggered		Belonging to the owner
3	VMS_2 Location	20484	47	8°43'44.17"	76°50'19.88"	5.58 Within permissible limit	82.4	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	264	8°43'48.033"	76°50'12.81"	Not Triggered		Not belonging to the owner
5	VMS_5 Location	4687	152	8°43'41.81"	76°50'17.47"	2.7 Within permissible limit	6.9	Belonging to the owner, maximum value is 15 mm/s

Table 3.7 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	80	0.625	2.174	50

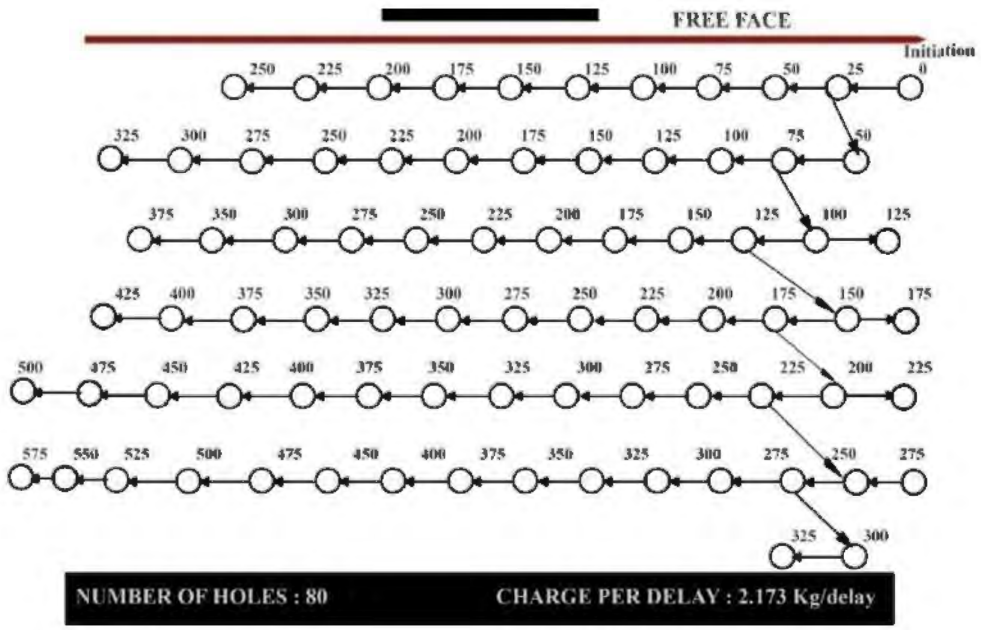


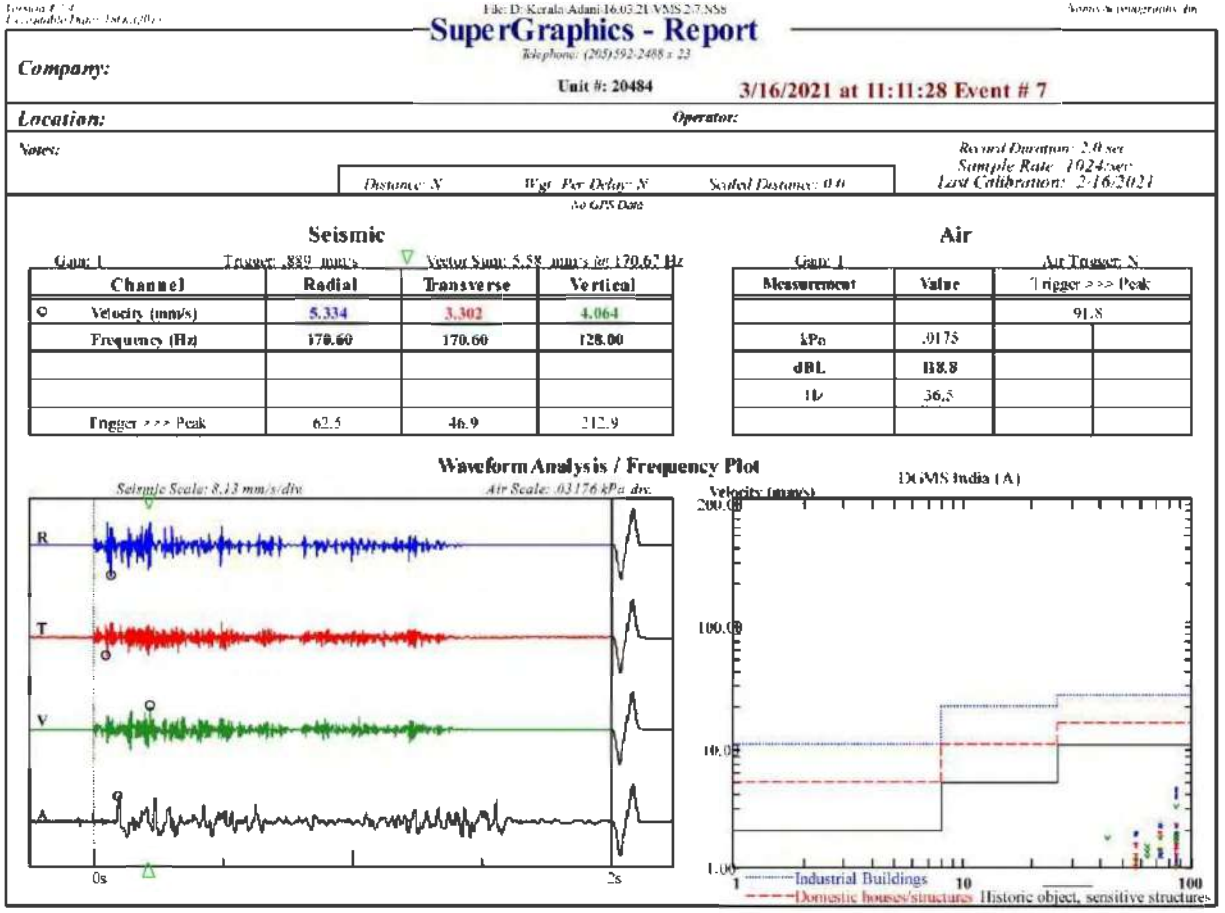
Figure 3.5 Schematic diagram of adopted blasting pattern for the blast 3

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No backbreak was observed.
- Muckpile was found to be adequately loosen.
- The throw of the blast has been around 12-15 m which is considered to be normal.
- A drop of about 1m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring house was well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.6 & 3.7.**

VMS_2 Location : EVENT REPORT



SuperGraphics - Report

Company:

Unit #: 20484

3/16/2021 at 11:11:28 Event # 7

Location:

Operator:

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Distance: N Wgt. Per Delay: N Scaled Distance: 0.0

No GPS Data

Seismic

Gain: 1 Trigger: .889 mm/s Vector Sum: 5.58 mm/s @ 170.67 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	5.334	3.302	4.064
Frequency (Hz)	178.60	170.60	128.00
Trigger >>> Peak	62.5	46.9	212.9

Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger >>> Peak
		91.8
kPa	.0175	
dBL	88.8	
Hz	36.5	

Waveform Analysis / Frequency Plot

Seismic Scale: 8.13 mm/s/div Air Scale: .03176 kPa/div

R

T

V

A

0s 2s

IDGMS India (A)

Velocity (mm/s)

200.00
100.00
10.00
1.00

1 10 100

Industrial Buildings
Domestic houses/structures
Historic object, sensitive structures

VMS_5 Location : EVENT REPORT

Instantel

Event Report

Date/Time	Tran at 11:11:30 March 16, 2021	Serial Number	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	Battery Level	6.4 Volts
	Mic: 106 dB(L)	Calibration	April 21, 2017 by UES, New Delhi
Range	Geo .127 mm/s	File Name	F687IW9R.360
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:50:28 (V8.12)

Extended Notes

Post Event Notes

Microphone Linear Weighting
PSPL 100.0 dB(L) at 0.001 sec
ZC Freq N/A
Channel Test Passed (Freq = 20.0 Hz Amp = 506 mv)

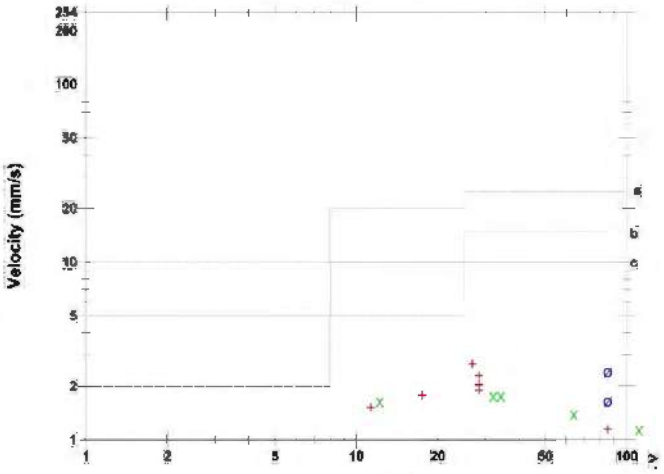
	Tran	Vert	Long	
PPV	2.10	2.67	1.86	mm/s
ZC Freq	24	22	24	Hz
Time (Rel. to Trig)	0.032	0.030	0.029	sec
Peak Acceleration	0.464	0.305	0.212	g
Peak Displacement	0.184	0.0705	0.0206	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.5	7.8	7.7	Hz
Overswing Ratio	3.5	3.3	3.3	

Peak Vector Sum 2.7 mm/s at 0.032 sec

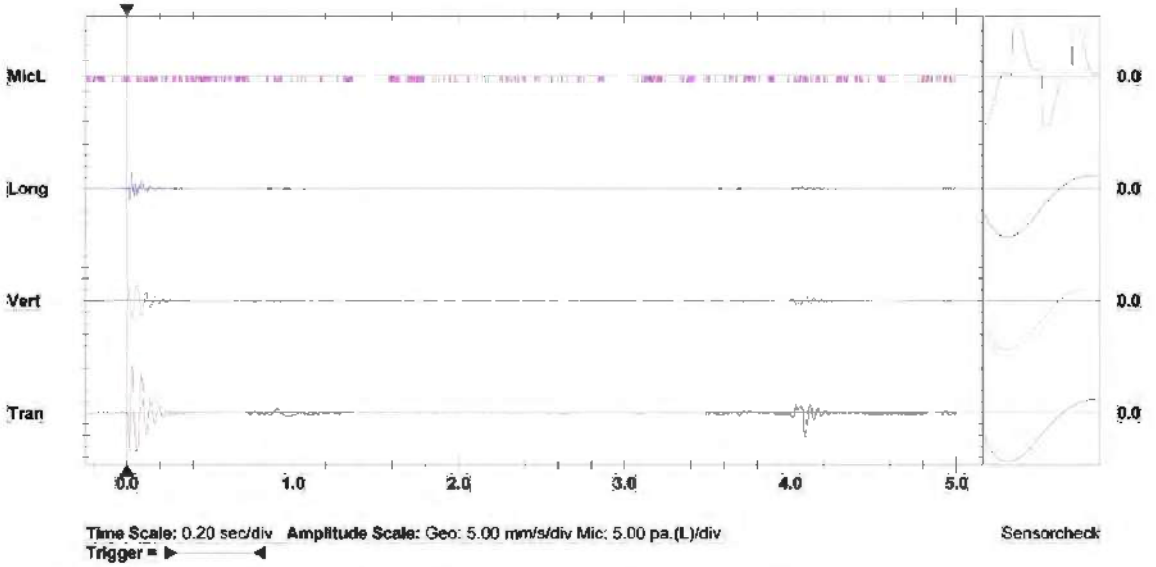
N/A: Not Applicable

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Printed: February 26, 2011 (V 8.12 - 8.12)

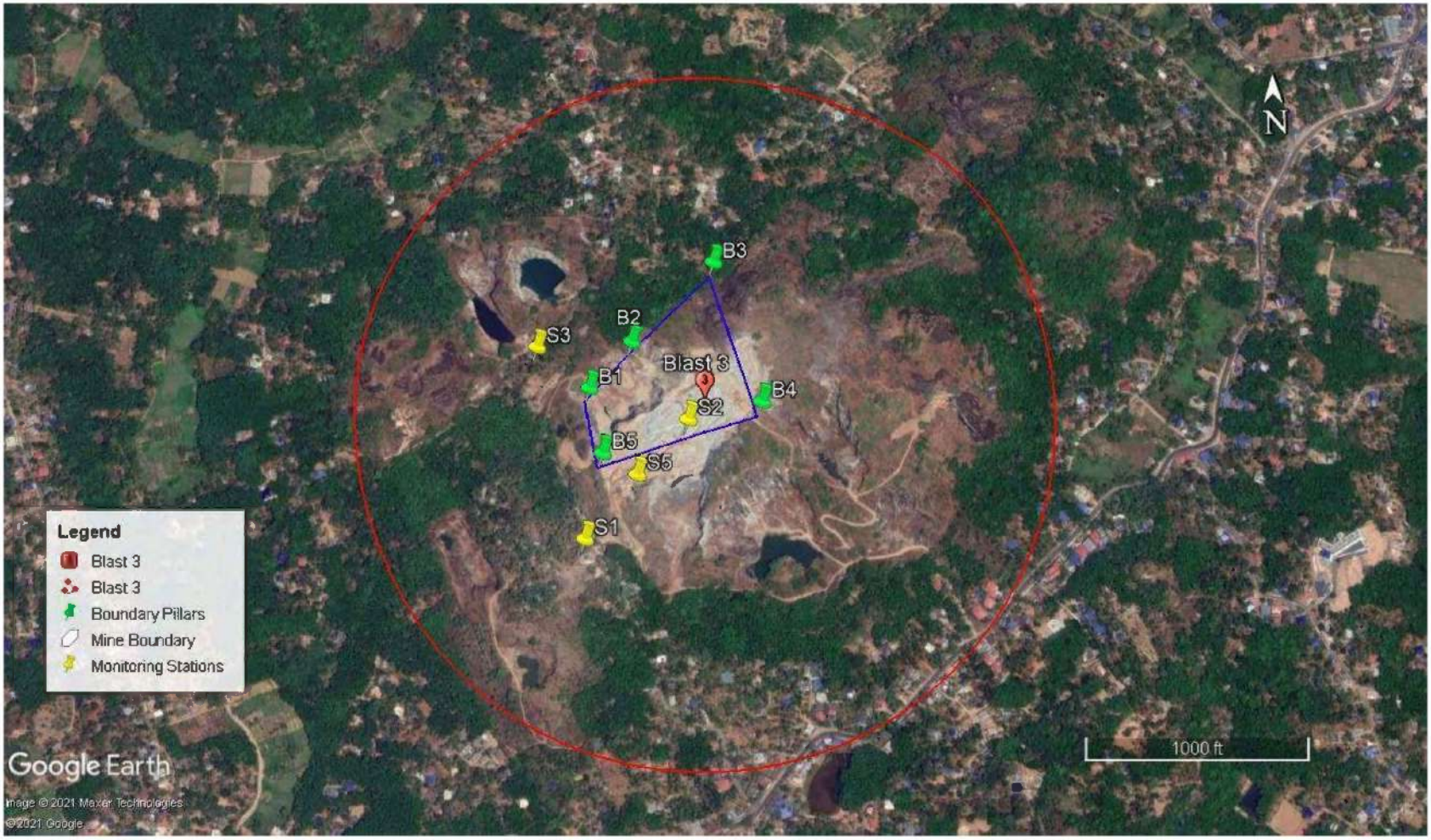


Figure 3.6 Imagery shows the location blast site 3 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 4: The fourth blast was conducted on 16th March, 2021 and the adopted blasting pattern and details are given in the Table 3.8 and 3.9. The Figure 3.7 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.8

Table 3.8 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B4)			8°43'43.29"	76°50'16.16"	---		
2	VMS_1 Location	11772	136	8°43'39.00"	76°50'15.00"	0.832 Within permissible limit	4.5	Not belonging to the owner, maximum value is 5 mm/s
3	VMS_2 Location	20484	120	8°43'44.17"	76°50'19.88"	5.87 Within permissible limit	66.9	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	465	8°43'45.28"	76°50'31.27"	0.968 Within permissible limit	6.9	Not belonging to the owner, maximum value is 5 mm/s
5	VMS_4 Location	4688	60	8°43'41.81"	76°50'17.47"	Not Triggered		Belonging to the owner
6	VMS_5 Location	4687	282	8°43'52.19"	76°50'18.62"	2.81 Within permissible limit	57.3	Not belonging to the owner, maximum value is 5 mm/s

Table 3.9 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	30	0.625	1.339	18.75

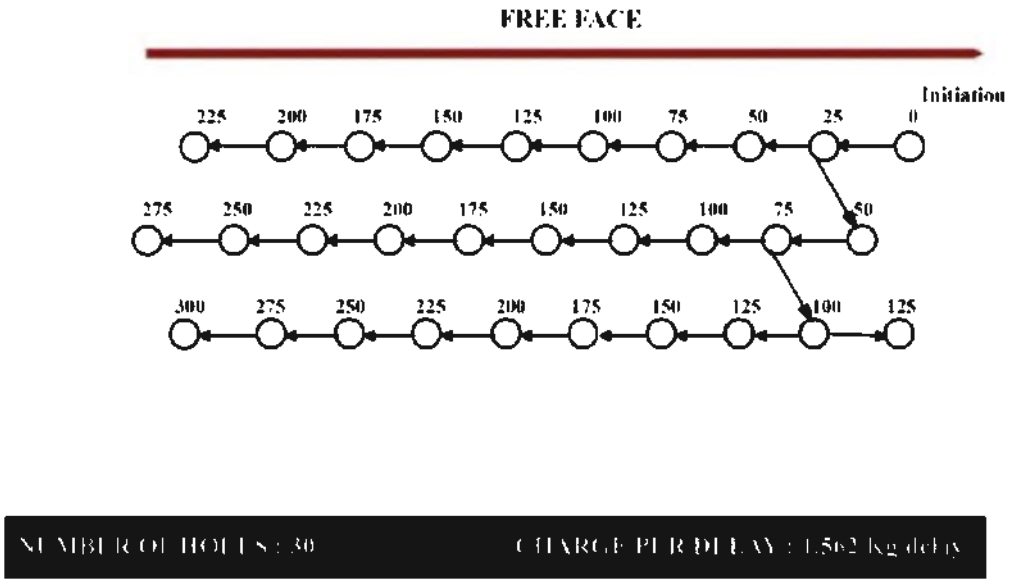


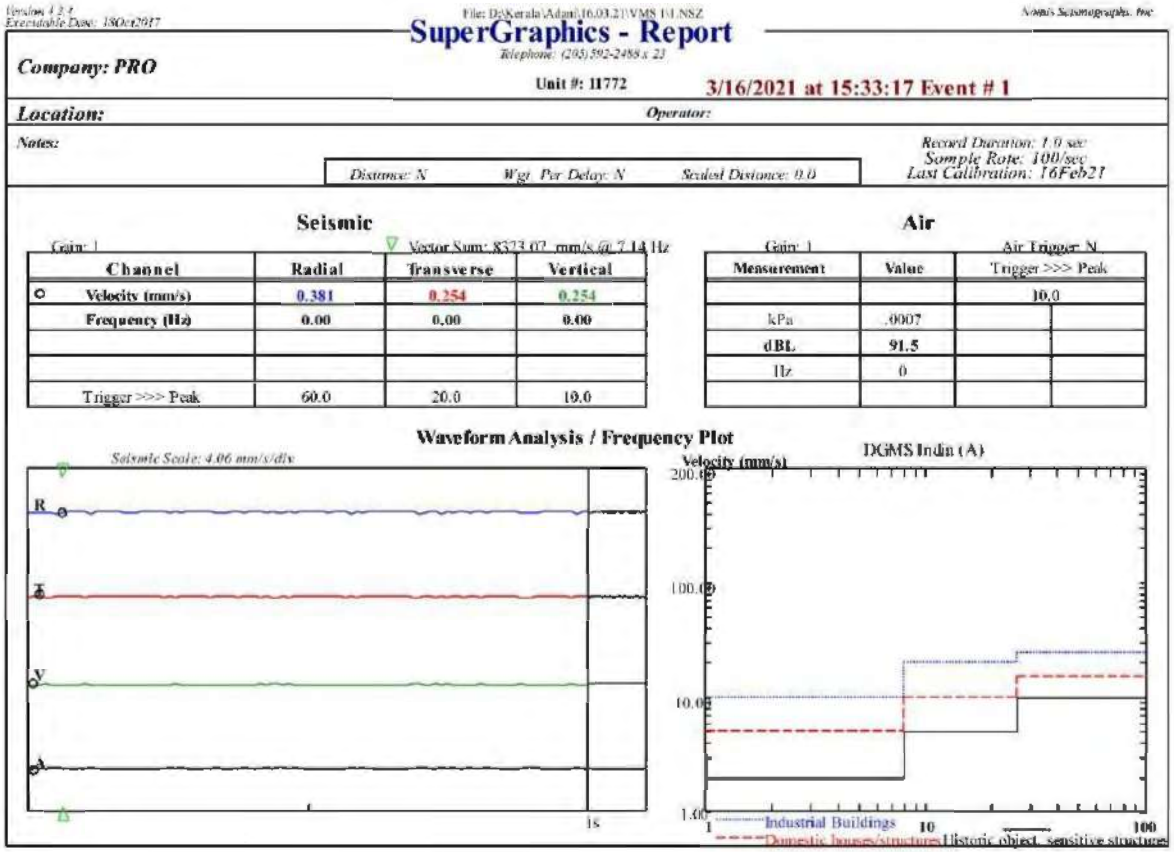
Figure 3.7 Schematic diagram of adopted blasting pattern for the blast 4

Post Blast Observations

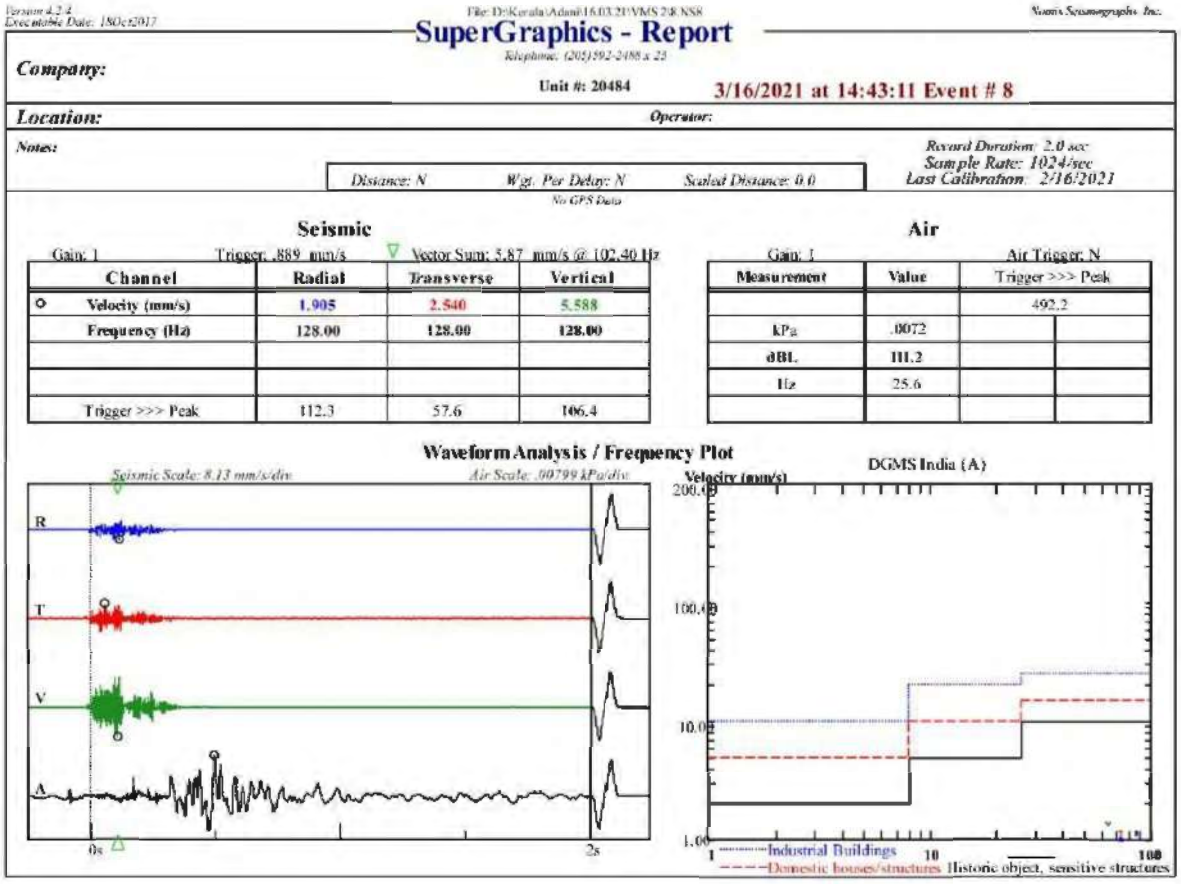
During the post blast observations, the following conditions were identified:

- Backbreak was observed of about 0.5 – 1.0 m.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 15 m which is considered to be normal.
- A drop of about 0.5 to 0.75 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 15 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring village was well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.8 & 3.9.**

VMS_52 Location : EVENT



VMS_53 Location : EVENT



VMS_3 Location : EVENT REPORT

Instantel

Event Report

Date/Time	Tran at 14:41:51 March 16, 2021
Trigger Source	Geo: 0.492 mm/s, Mic: 106.0 dB(L)
Range	Geo: 127.0 mm/s
Record Time	5.0 sec at 1024 sps

Serial Number	5993 V 2.61 MiniMate
Battery Level	6.6 Volts
Unit Calibration	March 1, 2021 by UES New Delhi
File Name	G993IWA0.TR0

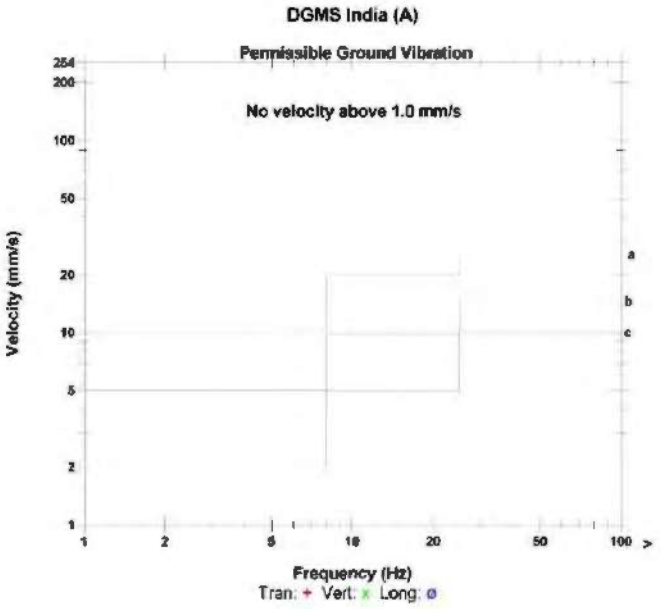
Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 07:25:35 (V8.12)

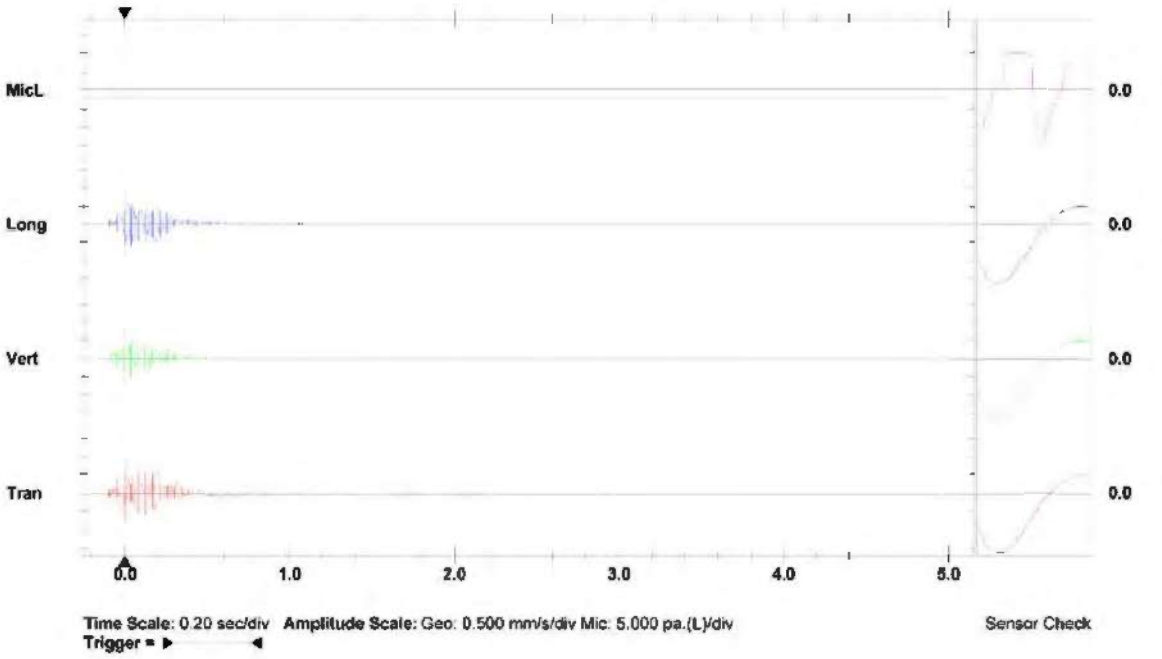
Extended Notes

Microphone	Linear Weighting
PSPL	100.00 dB(L) at 0.293 sec
ZC Freq	N/A
Channel Test	Check (Freq = 0.0 Hz Amp = 30 mv)

	Tran	Vert	Long	
PPV	0.889	0.508	0.572	mm/s
ZC Freq	>100	N/A	N/A	Hz
Time (Rel. to Trig)	0.009	0.038	0.005	sec
Peak Acceleration	0.060	0.053	0.046	g
Peak Displacement	0.001	0.001	0.001	mm
Sensor Check	Passed	Passed	Passed	
Frequency	7.8	8.0	8.1	Hz
Overswing Ratio	3.6	3.5	3.5	

Peak Vector Sum 0.968 mm/s at 0.009 sec
N/A: Not Applicable





VMS_5 Location : EVENT REPORT

Instantel

Event Report

Date/Time	Tran at 14:43:02 March 16, 2021	**Serial Number**	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F687IWA0.VQ0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 07:20:35 (V8.12)

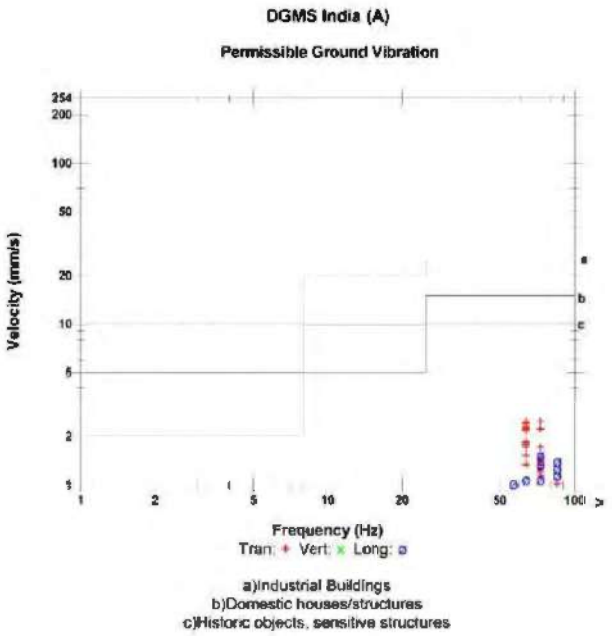
Extended Notes

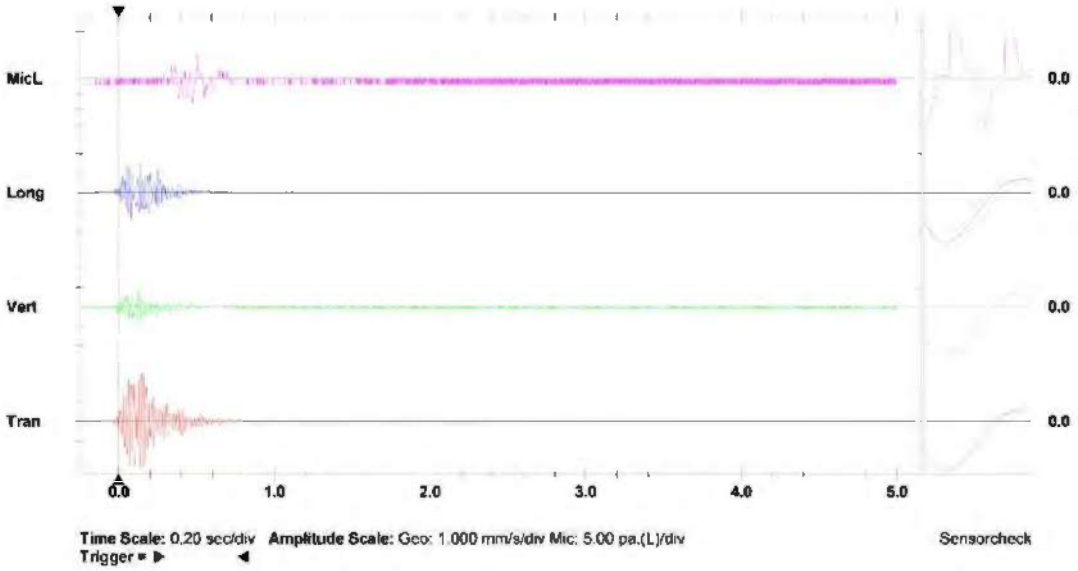
Post Event Notes

Microphone Linear Weighting
PSPL 112.0 dB(L) at 0.479 sec
ZC Freq 17 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	2.48	0.953	1.52	mm/s
ZC Freq	73	64	73	Hz
Time (Rel. to Trig)	0.147	0.126	0.139	sec
Peak Acceleration	0.113	0.0530	0.0729	g
Peak Displacement	0.00629	0.00229	0.00316	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.5	8.0	7.7	Hz
Overswing Ratio	3.5	3.2	3.2	

Peak Vector Sum 2.81 mm/s at 0.140 sec





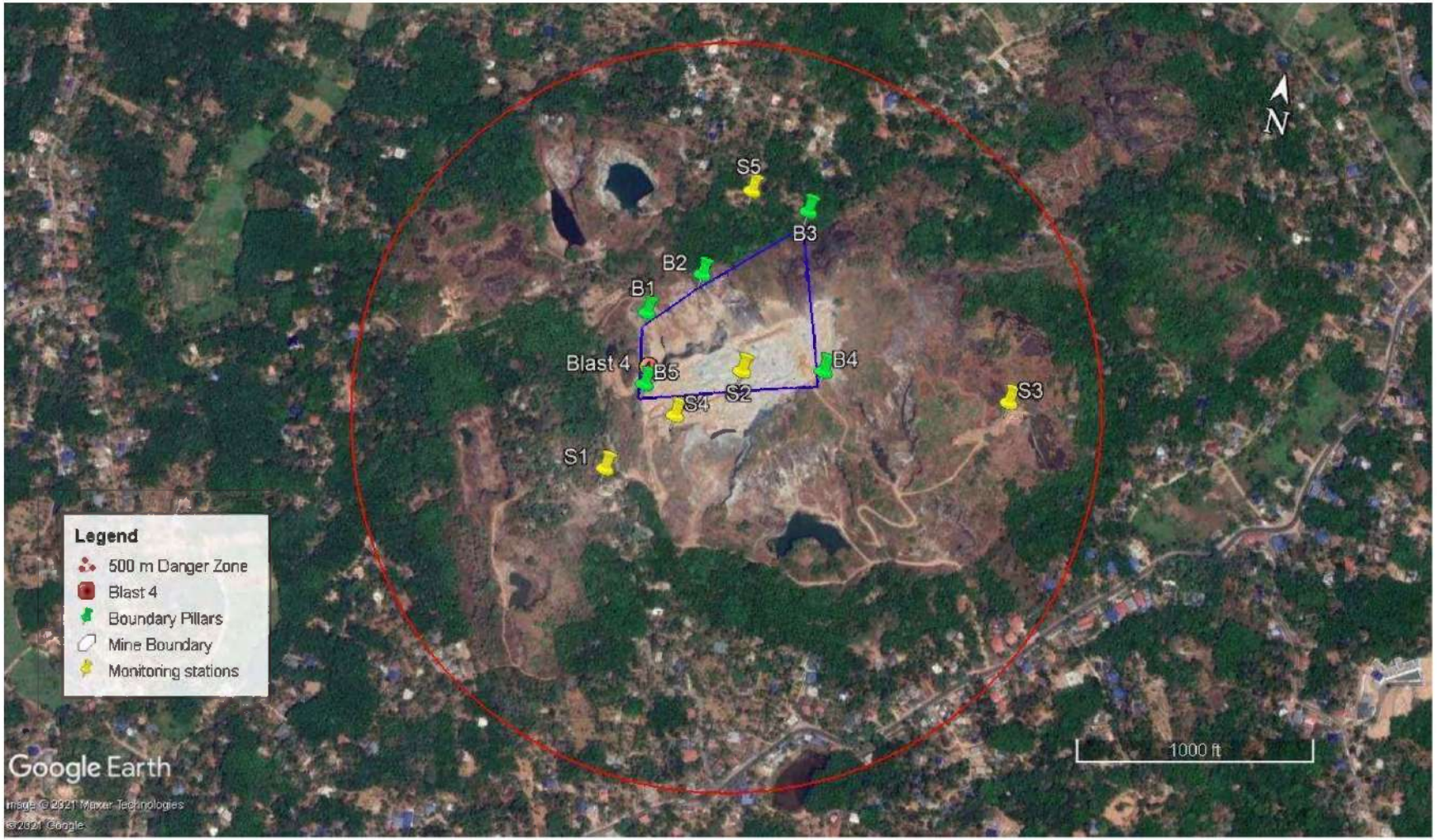


Figure 3.8 Imagery shows the location blast site 4 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 5: The fifth blast was conducted on 16th March, 2021 and the adopted blasting pattern and details are given in the Table 3.10 and 3.11. The Figure 3.9 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.10

Table 3.10 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B5)			8°43'47.55"	76°50'19.50"	---		
2	VMS_1 Location	11772	296	8°43'39.00"	76°50'15.00"	1.47 Within permissible limit	18.9	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	102	8°43'44.17"	76°50'19.88"	7.52 Within permissible limit	63.1	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	359	8°43'45.28"	76°50'31.27"	0.397 Within permissible limit	12.9	Not belonging to the owner, maximum value is 5 mm/s
5	VMS_4 Location	4688	185	8°43'41.81"	76°50'17.47"	Not Triggered		Belonging to the owner
6	VMS_5 Location	4687	151	8°43'52.19"	76°50'18.62"	0.429 Within permissible limit	36.1	Not belonging to the owner, maximum value is 5 mm/s

Table 3.11 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	24	0.625	1.25	15

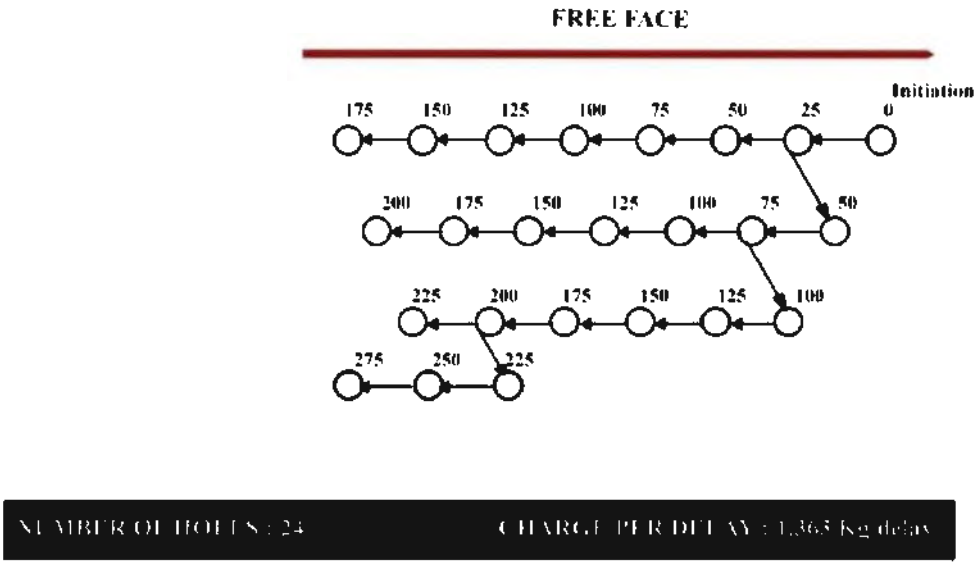


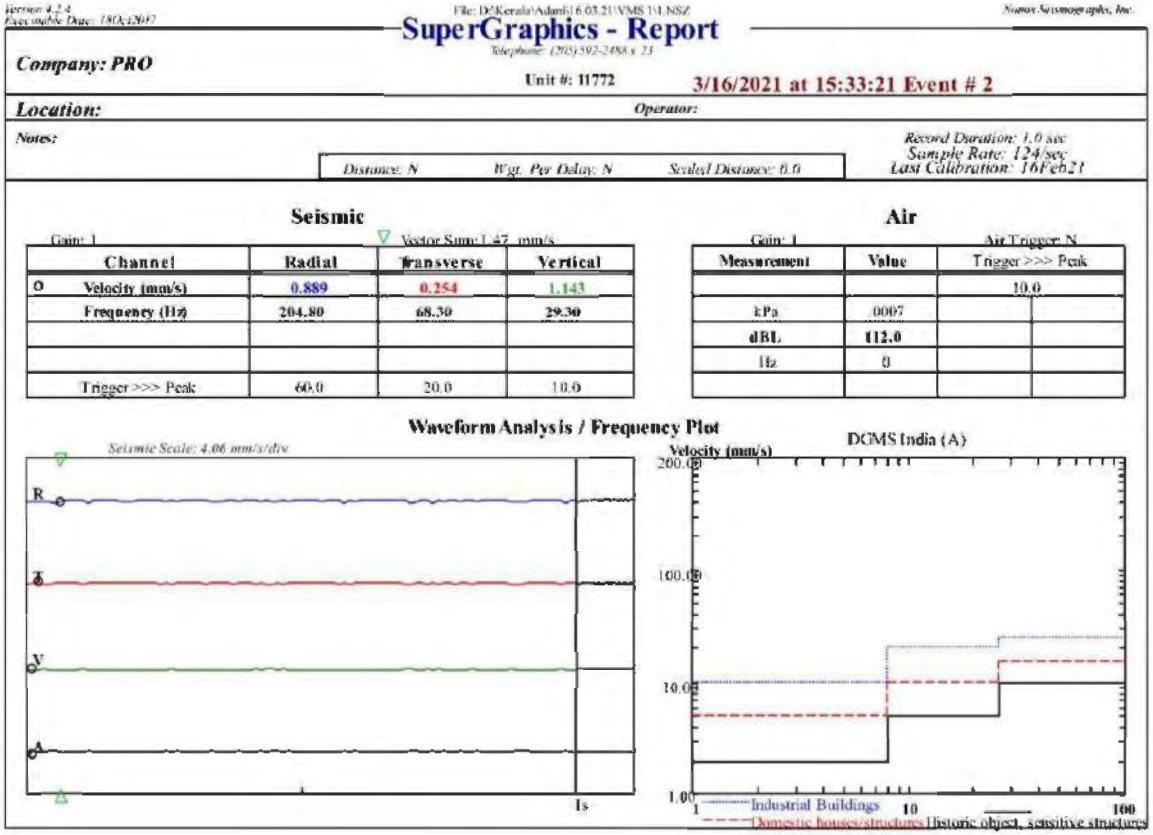
Figure 3.9 Schematic diagram of adopted blasting pattern for the blast 5

Post Blast Observations

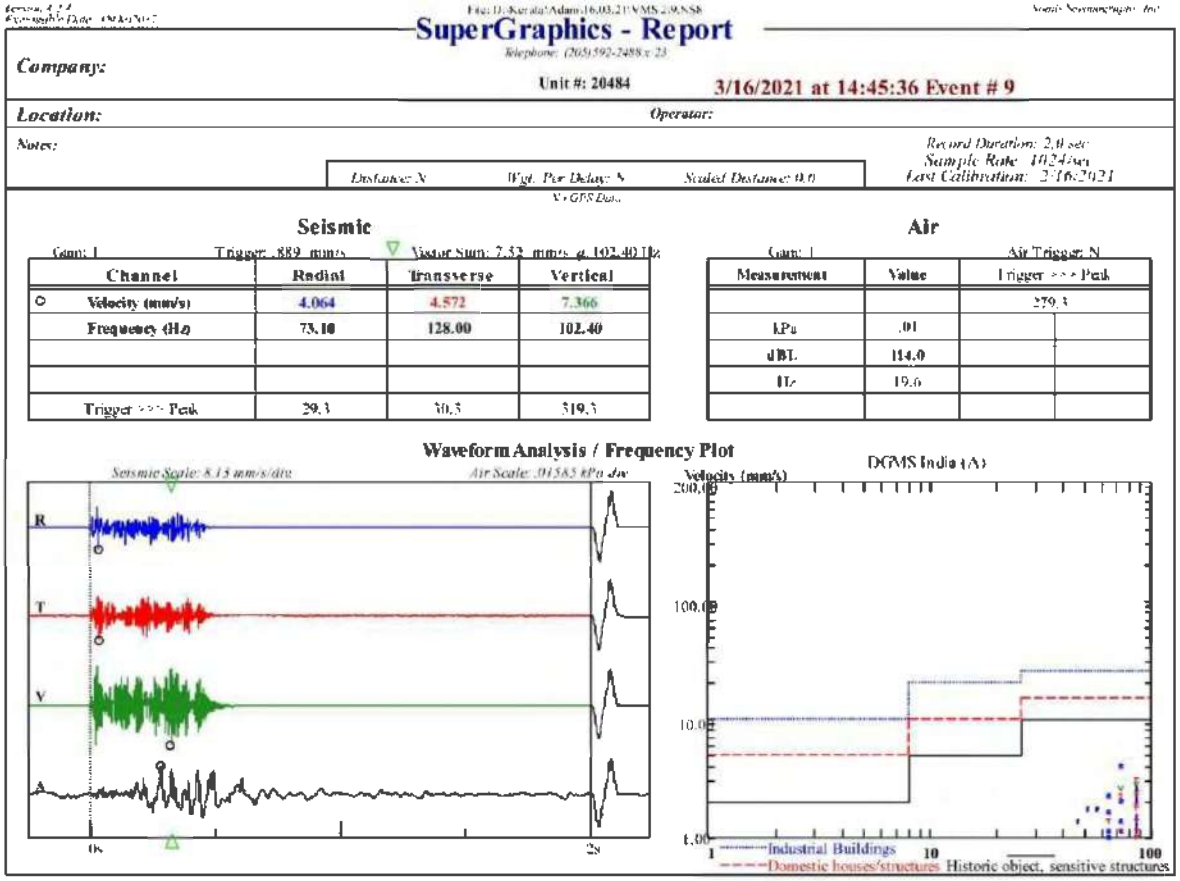
During the post blast observations, the following conditions were identified:

- No Backbreak was observed.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 10 m which is considered to be normal.
- A drop of about 0.75 to 1 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 12 to 15 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring village was well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.10 & 3.11.**

VMS_59 Location : EVENT



VMS_60 Location : EVENT



SuperGraphics - Report

Company:

Unit #: 20484 3/16/2021 at 14:45:36 Event # 9

Location: Operator:

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Distance: N Wgt. Per Delay: N Scaled Distance: 0.0

Seismic

Gain: 1 Trigger: .889 mm/s Vector Sum: 7.52 mm/s @ 102.40 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	4.064	4.572	7.366
Frequency (Hz)	73.10	128.00	102.40
Trigger >>> Peak	29.3	30.5	519.5

Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger >>> Peak
		279.3
kPa	.01	
dBL	114.0	
Hz	19.6	

Waveform Analysis / Frequency Plot

Seismic Scale: 8.13 mm/s/div Air Scale: .01585 kPa/div

R

T

V

A

0s 2s

DGMS India (A)

Velocity (mm/s)

200.00 100.00 10.00 1.00

1 10 100

Industrial Buildings

Domestic houses/structures Historic object, sensitive structures

VMS_3 Location : EVENT REPORT

Instantel

Event Report

Date/Time MicL at 14:44:10 March 16, 2021
Trigger Source Geo: 0.492 mm/s, Mic: 106.0 dB(L)
Range Geo: 127.0 mm/s
Record Time 5.0 sec at 1024 sps

Serial Number 5993 V 2.61 MiniMate
Battery Level 6.6 Volts
Unit Calibration March 1, 2021 by UES New Delhi
File Name G993IWA0.XM0

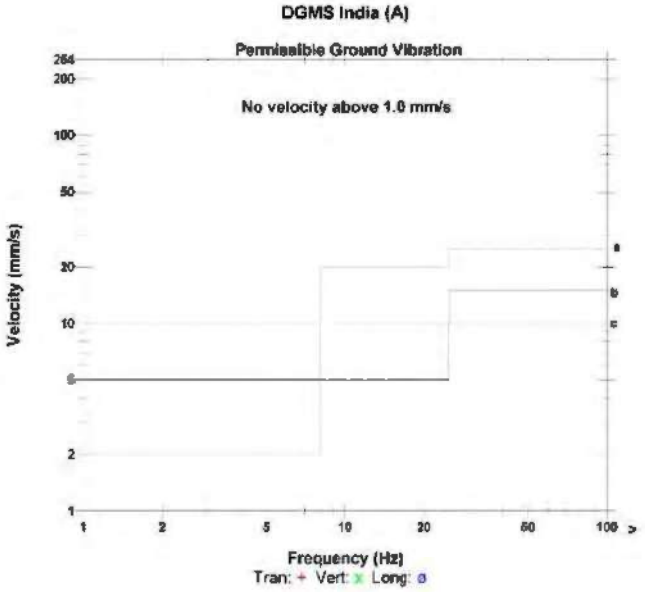
Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 07:25:35 (V8.12)

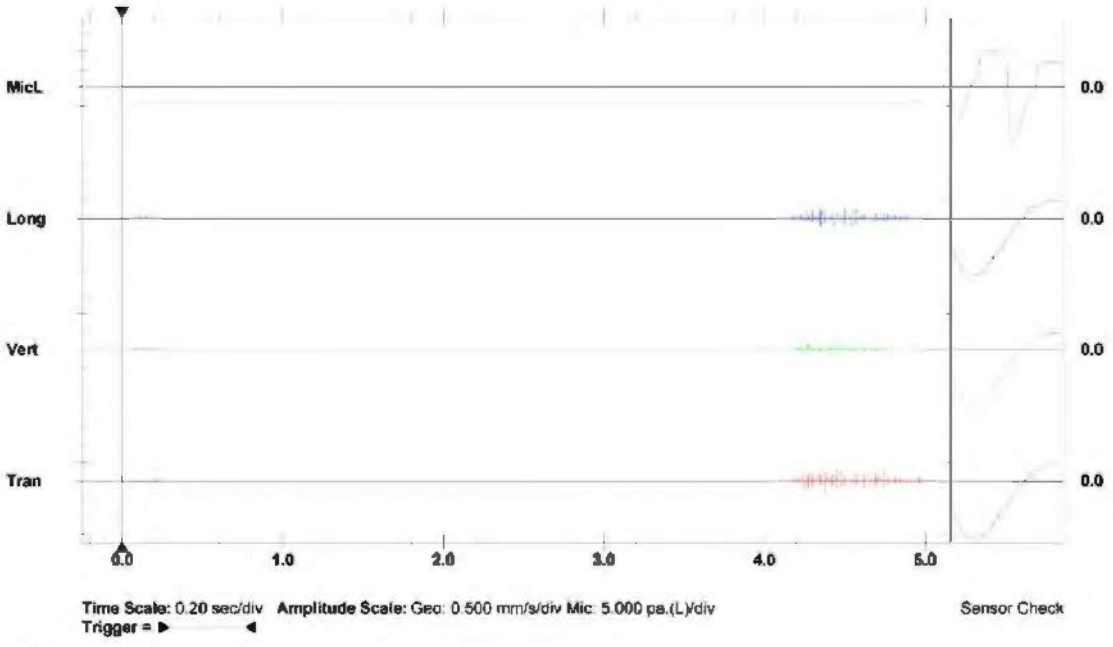
Extended Notes

Microphone Linear Weighting
PSPL 106.0 dB(L) at 0.293 sec
ZC Freq N/A
Channel Test Check (Freq = 0.0 Hz Amp = 27 mv)

	Tran	Vert	Long	
PPV	0.381	0.191	0.254	mm/s
ZC Freq	N/A	N/A	N/A	Hz
Time (Rel. to Trig)	4.392	4.386	4.362	sec
Peak Acceleration	0.027	0.020	0.020	g
Peak Displacement	0.000	0.000	0.000	mm
Sensor Check	Passed	Passed	Passed	
Frequency	7.8	8.0	8.0	Hz
Overswing Ratio	3.6	3.5	3.5	

Peak Vector Sum 0.397 mm/s at 4.392 sec
N/A: Not Applicable





Printed: March 30, 2021 (V 10.72 - 10.72)

VMS_5 Location : EVENT REPORT

Instantel

Event Report

Date/Time	MicL at 14:45:26 March 16, 2021	**Serial Number**	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F687IWA0.ZQ0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 07:20:35 (V8.12)

Extended Notes

Post Event Notes

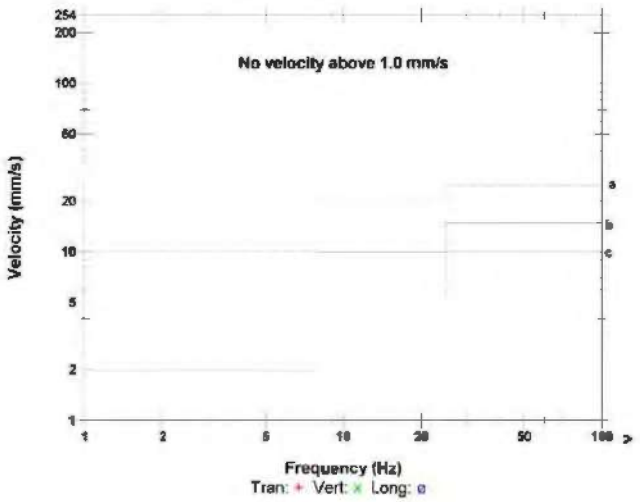
Microphone Linear Weighting
PSPL 109.5 dB(L) at 0.049 sec
ZC Freq 9.1 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	0.381	0.191	0.191	mm/s
ZC Freq	73	64	85	Hz
Time (Rel. to Trig)	-0.169	-0.197	-0.164	sec
Peak Acceleration	0.0199	0.0133	0.00663	g
Peak Displacement	0.00084	0.00003	0.00003	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.5	7.8	7.7	Hz
Overswing Ratio	3.4	3.2	3.2	

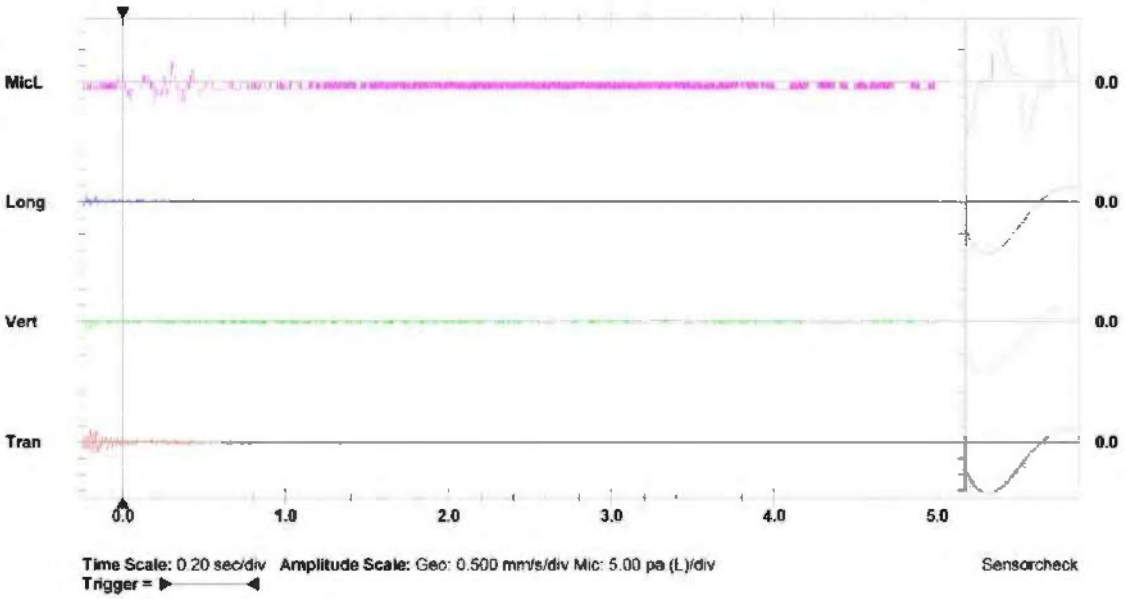
Peak Vector Sum 0.429 mm/s at -0.199 sec

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Time Scale: 0.20 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa (L)/div Sensorcheck
Trigger =

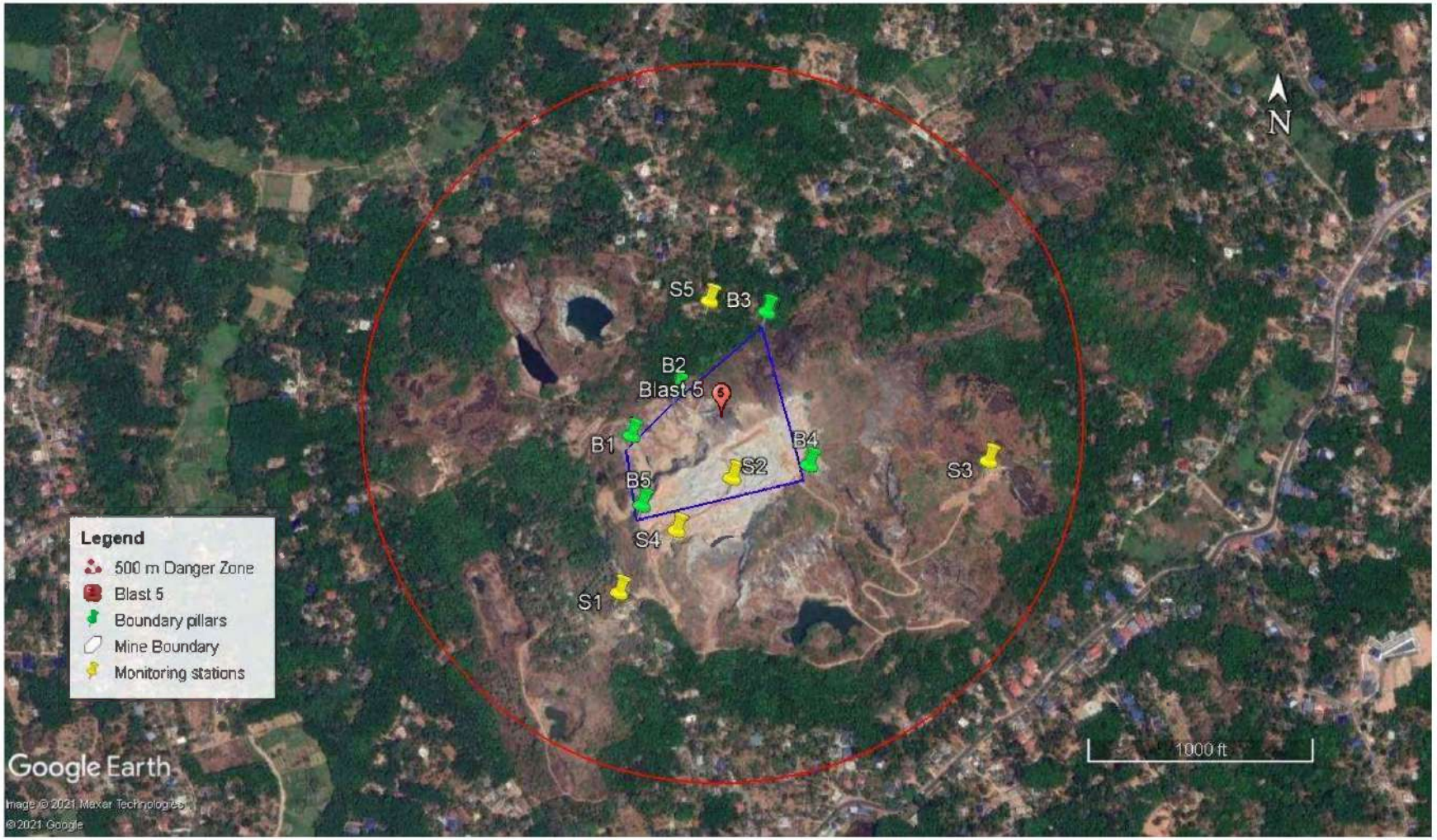


Figure 3.10 Imagery shows the location blast site 5 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 6: The sixth blast was conducted on 17th March, 2021 and the adopted blasting pattern and details are given in the Table 3.12 and 3.13. The Figure 3.11 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.12

Table 3.12 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B6)			8°43'44.44"	76°50'16.85"	---		
2	VMS_1 Location	11772	80	8°43'41.81"	76°50'17.47"	9.8 Within permissible limit	30.4	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	95	8°43'44.17"	76°50'19.88"	3.41 Within permissible limit	92.6	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	174	8°43'38.74"	76°50'16.72"	2.11 Within permissible limit	6.9	Not belonging to the owner, maximum value is 5 mm/s
5	VMS_4 Location	4688	170	8°43'48.033"	76°50'12.81"	0.778 Within permissible limit	52.4	Not belonging to the owner, maximum value is 5 mm/s
6	VMS_5 Location	4687	165	8°43'47.04"	76°50'12.20"	0.683 Within permissible limit	73.4	Not belonging to the owner, maximum value is 5 mm/s

Table 3.13 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	60	0.625	1.875	37.5

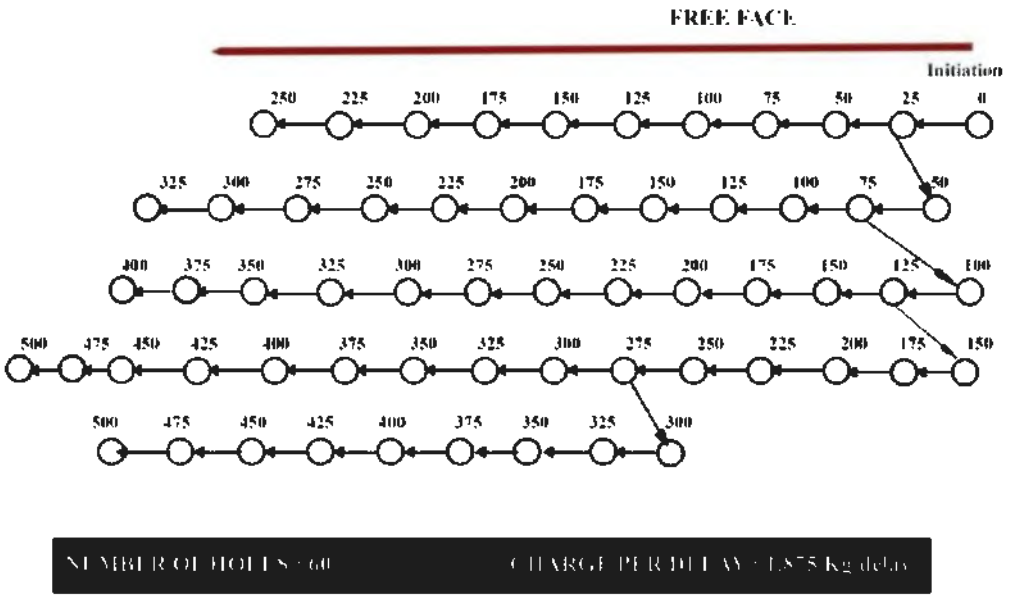


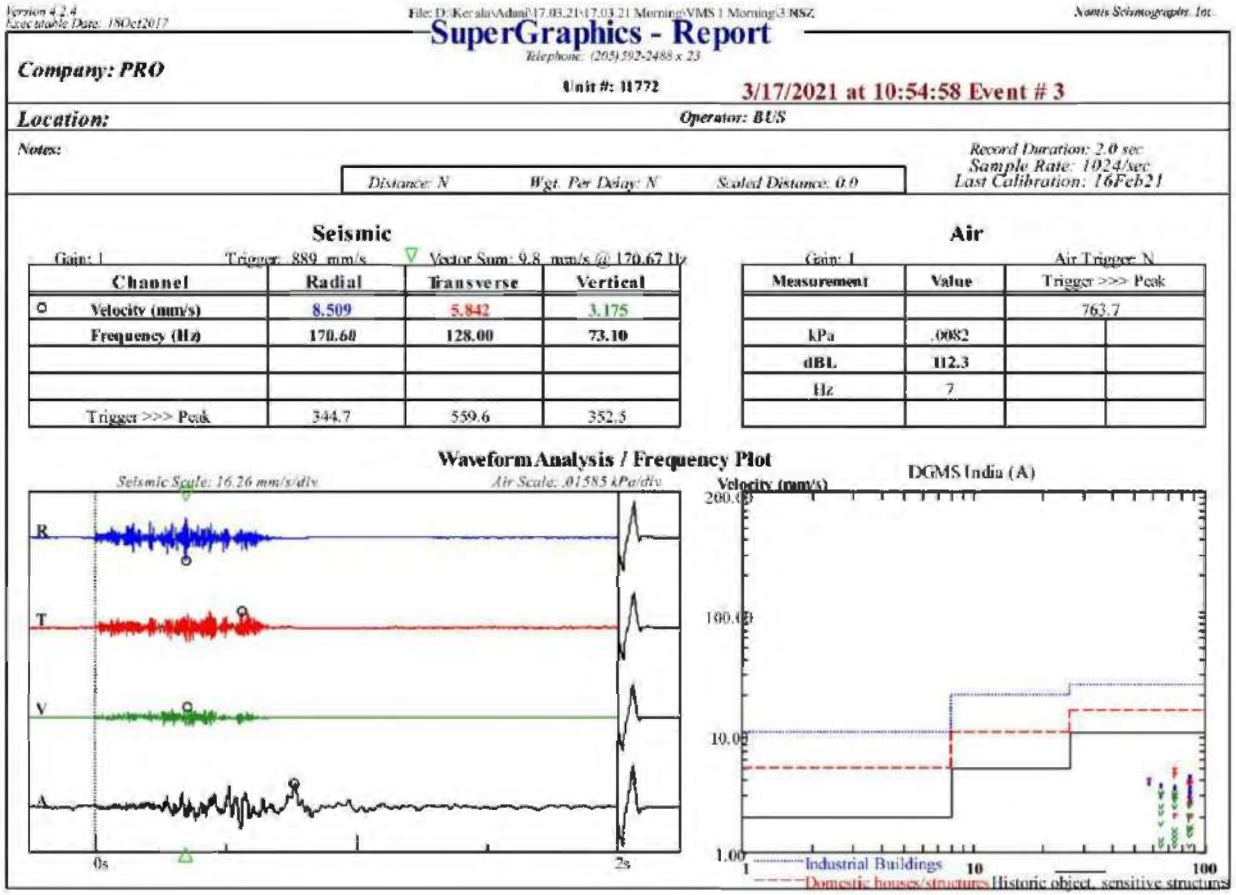
Figure 3.11 Schematic diagram of adopted blasting pattern for the blast 6

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No Backbreak was observed.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 10 to 12 m which is considered to be normal.
- A drop of about 0.75 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring houses were well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.12 & 3.13.**

VMS_66 Location : EVENT



Version 4.2.4
Executable Date: 18Oct2017

File: D:\Kerala\Adani\17.03.21\17.03.21 Morning\VMS 1 Morning\3.MSZ

Nomis Seismographs, Inc.

SuperGraphics - Report

Telephone: (205)592-2488 x 23

Company: PRO

Unit #: 11772

3/17/2021 at 10:54:58 Event # 3

Location:

Operator: BUS

Notes:

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 16Feb21

Seismic

Gain: 1 | Trigger: .889 mm/s | Vector Sum: 9.8 mm/s @ 170.67 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	8.509	5.842	3.175
Frequency (Hz)	170.68	128.00	73.10
Trigger >>> Peak	344.7	559.6	352.5

Air

Gain: 1 | Air Trigger: N

Measurement	Value	Trigger >>> Peak
		763.7
kPa	.0082	
dBL	112.3	
Hz	7	

Waveform Analysis / Frequency Plot

Seismic Scale: 16.26 mm/s/div | Air Scale: .01585 kPa/div

R
T
V
A
0s
2s

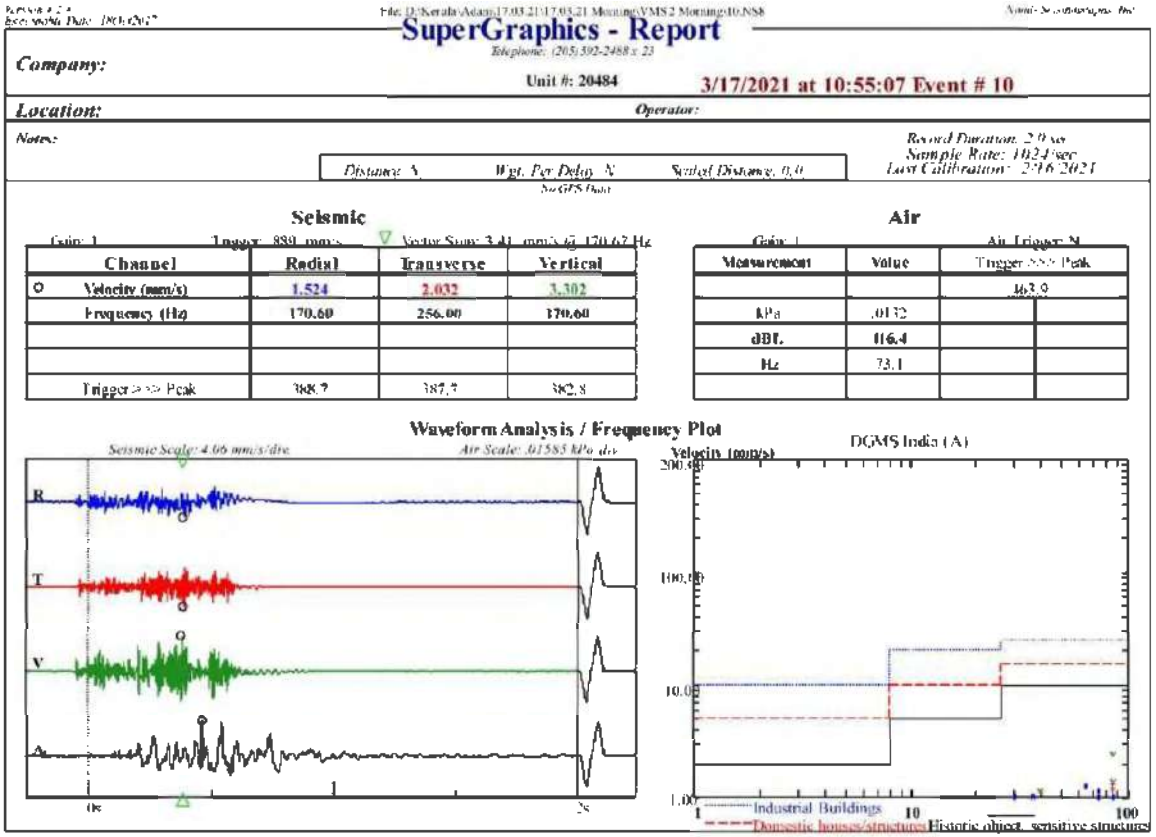
DGMS India (A)

Velocity (mm/s)

200.00
100.00
10.00
1.00
1
10
100

Industrial Buildings
Domestic houses/structures
Historic object, sensitive structures

VMS_67 Location : EVENT



VMS_68 Location : EVENT

Instantel

Event Report

Date/Time	Long at 10:53:35 March 17, 2021	**Serial Number**	5993 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.6 Volts
	Mic: 106 dB(L)	**Calibration**	March 1, 2021 by UES New Delhi
Range	Geo :127 mm/s	**File Name**	G993IWBK.XB0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:03:19 (V8.12)

Extended Notes

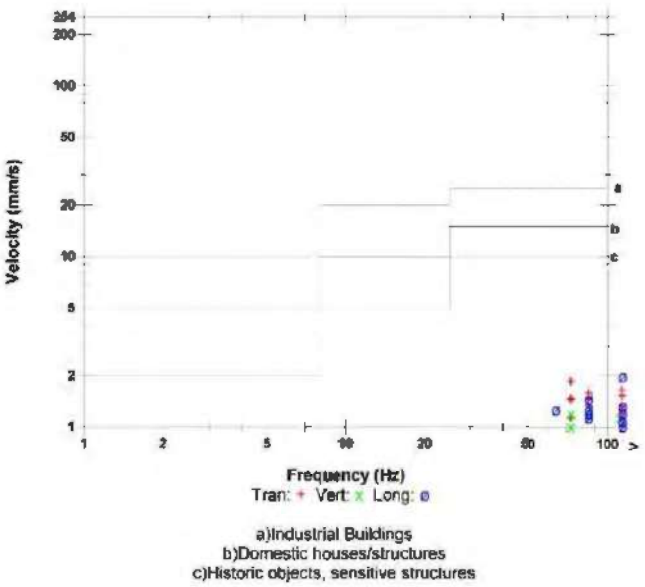
Post Event Notes

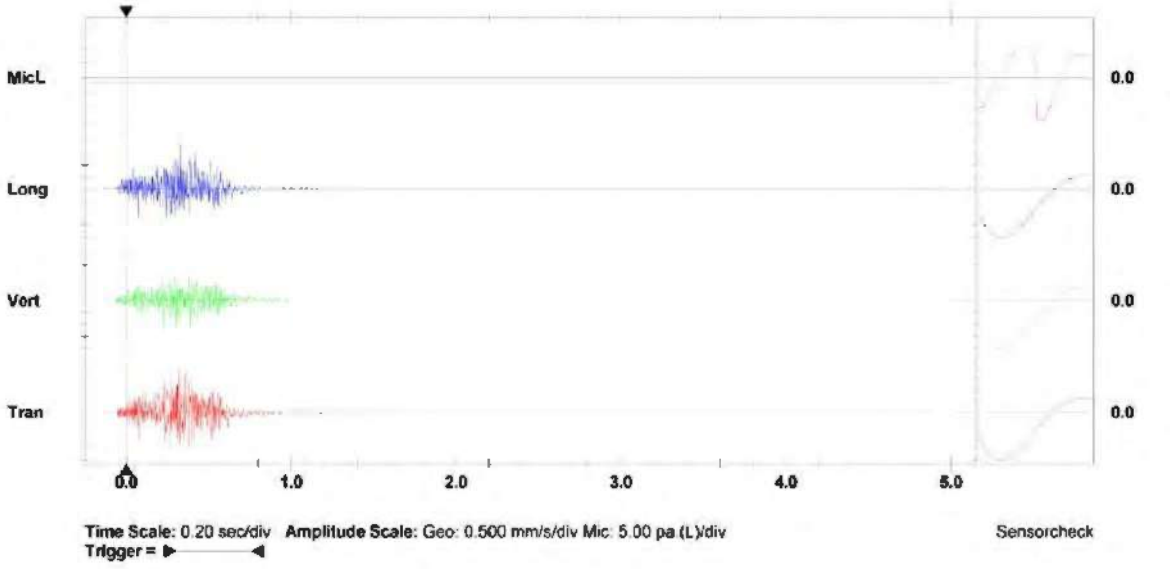
Microphone Linear Weighting
PSPL 100.0 dB(L) at 0.293 sec
ZC Freq N/A
Channel Test Check (Freq = 0.0 Hz Amp = 14 mv)

	Tran	Vert	Long	
PPV	1.84	1.27	1.97	mm/s
ZC Freq	73	85	N/A	Hz
Time (Rel. to Trig)	0.321	0.224	0.323	sec
Peak Acceleration	0.186	0.0994	0.192	g
Peak Displacement	0.00326	0.00205	0.00270	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.8	8.0	7.7	Hz
Overswing Ratio	3.6	3.5	3.7	

Peak Vector Sum 2.11 mm/s at 0.321 sec

N/A: Not Applicable





VMS_69 Location : EVENT

Instantel

Event Report

Date/Time	MicL at 10:54:58 March 17, 2021	Serial Number	4688 V 2.6 MiniMate
Trigger Source	Geo: 0.492 mm/s	Battery Level	6.5 Volts
	Mic: 106 dB(L)	Calibration	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	File Name	F688IWBK.ZM0
Record Time	3.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:00:31 (V8.12)

Extended Notes

Post Event Notes

Microphone	Linear Weighting
PSPL	112.6 dB(L) at 0.604 sec
ZC Freq	14 Hz
Channel Test	Passed (Freq = 20.0 Hz Amp = 490 mv)

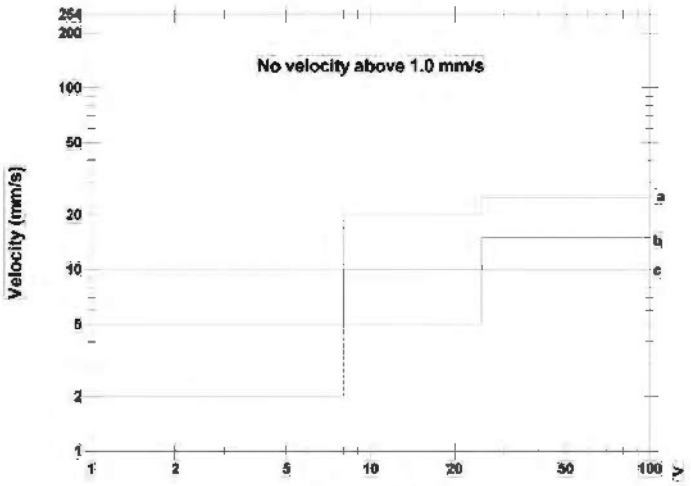
	Tran	Vert	Long	
PPV	0.508	0.572	0.635	mm/s
ZC Freq	85	N/A	85	Hz
Time (Rel. to Trig)	0.298	0.309	0.304	sec
Peak Acceleration	0.0265	0.0464	0.0331	g
Peak Displacement	0.00127	0.00096	0.00112	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.8	8.2	Hz
Overswing Ratio	3.4	3.6	3.3	

Peak Vector Sum 0.778 mm/s at 0.309 sec

N/A: Not Applicable

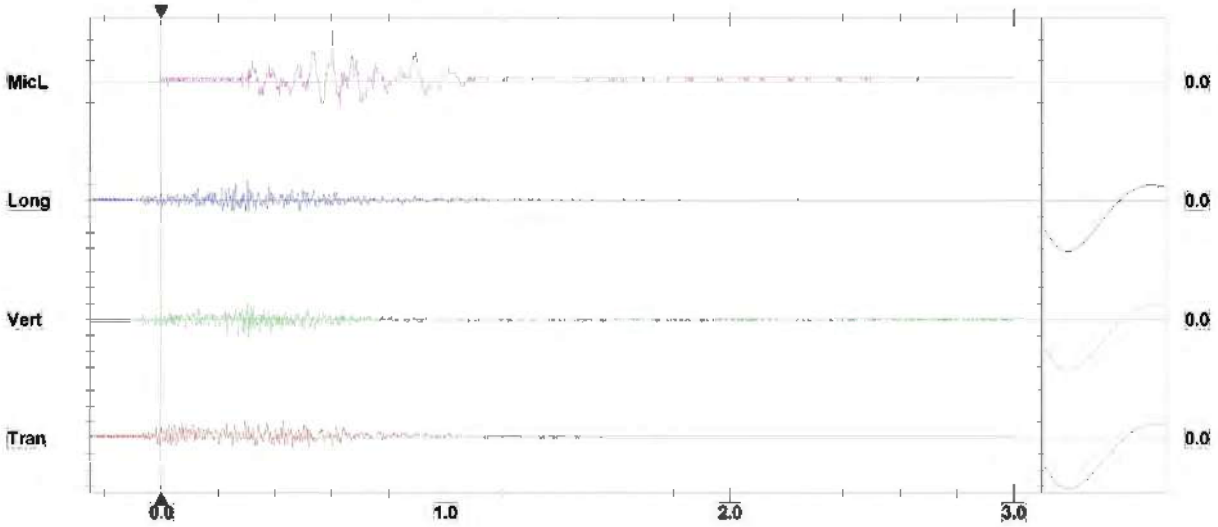
DGMS India (A)

Permissible Ground Vibration



Frequency (Hz)
Tran: + Vert: x Long: ø

a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Time Scale: 0.20 sec/div Amplitude Scale: Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div
Trigger = ▶ ◀

Sensorcheck

Printed: February 26, 2011 (V 8.12 - 8.12)

VMS_70 Location : EVENT

Instantel

Event Report

Date/Time	MicL at 10:54:50 March 17, 2021	**Serial Number**	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo: 127 mm/s	**File Name**	F687IWBK.ZE0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:05:54 (V8.12)

Extended Notes

Post Event Notes

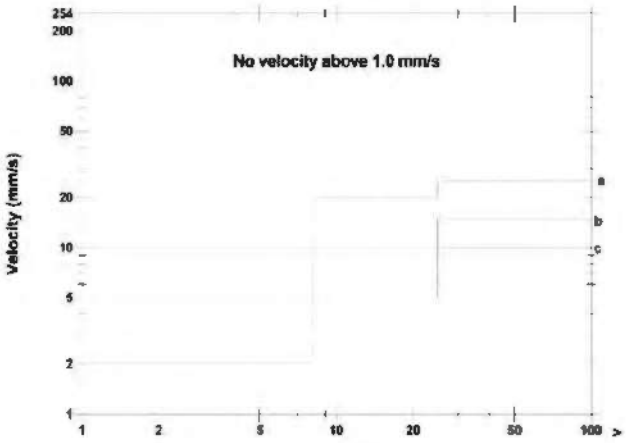
Microphone Linear Weighting
PSPL 114.0 dB(L) at 4.122 sec
ZC Freq 30 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	0.635	0.318	0.572	mm/s
ZC Freq	64	73	57	Hz
Time (Rel. to Trig)	3.755	3.843	3.705	sec
Peak Acceleration	0.0265	0.0199	0.0265	g
Peak Displacement	0.00198	0.00047	0.00149	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	8.0	7.8	Hz
Overswing Ratio	3.5	3.2	3.2	

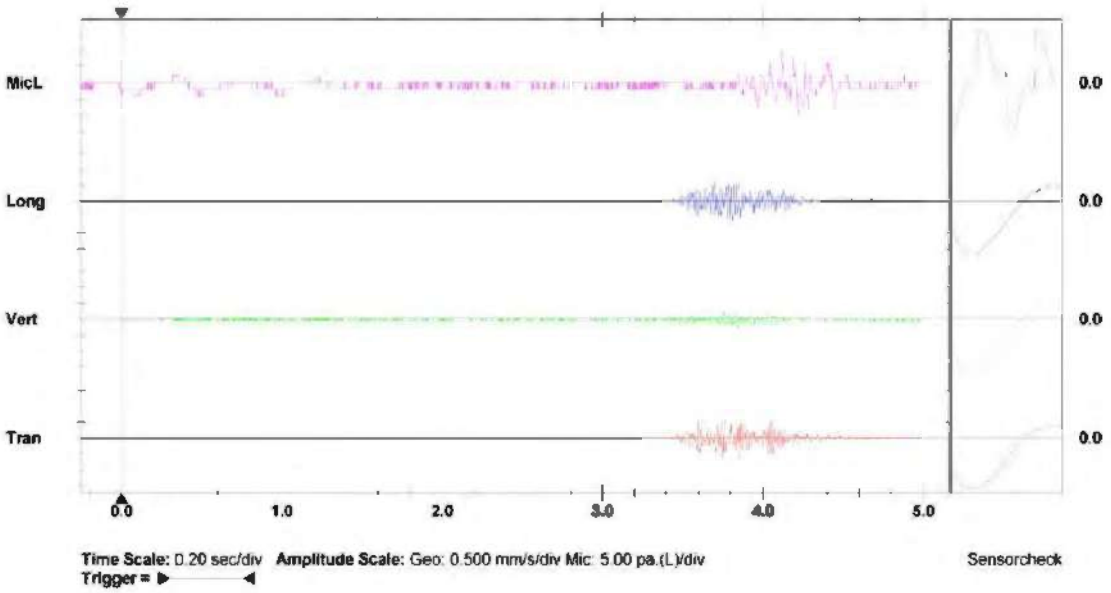
Peak Vector Sum 0.683 mm/s at 3.856 sec

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Time Scale: 0.20 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck
Trigger = ▶ ◀

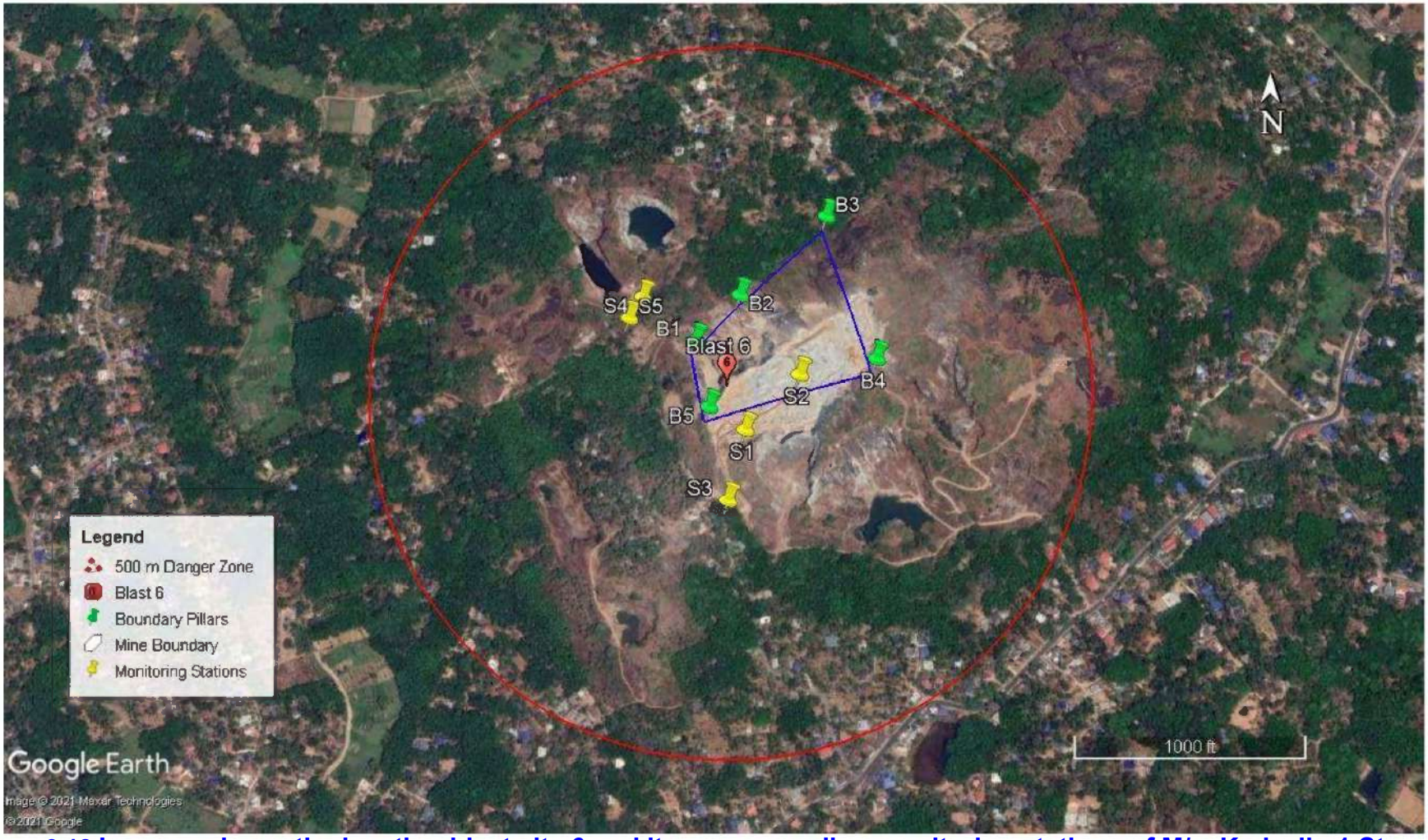


Figure 3.12 Imagery shows the location blast site 6 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 7: The seventh blast was conducted on 17th March, 2021 and the adopted blasting pattern and details are given in the Table 3.14 and 3.15. The Figure 3.13 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.14

Table 3.14 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B7)			8°43'43.82"	76°50'15.93"	---		
2	VMS_1 Location	11772	75	8°43'41.81"	76°50'17.47"	11.09 Within permissible limit	70.9	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	125	8°43'44.17"	76°50'19.88"	2.51 Within permissible limit	68.2	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	157	8°43'38.74"	76°50'16.72"	2.24 Within permissible limit	6.9	Not belonging to the owner, maximum value is 5 mm/s
5	VMS_4 Location	4688	160	8°43'48.033"	76°50'12.81"	1.17 Within permissible limit	47.2	Belonging to the owner, maximum value is 15 mm/s
6	VMS_5 Location	4687	154	8°43'47.04"	76°50'12.20"	1.89 Within permissible limit	56.3	Not belonging to the owner, maximum value is 5 mm/s

Table 3.15 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	50	0.625	1.736	31.25

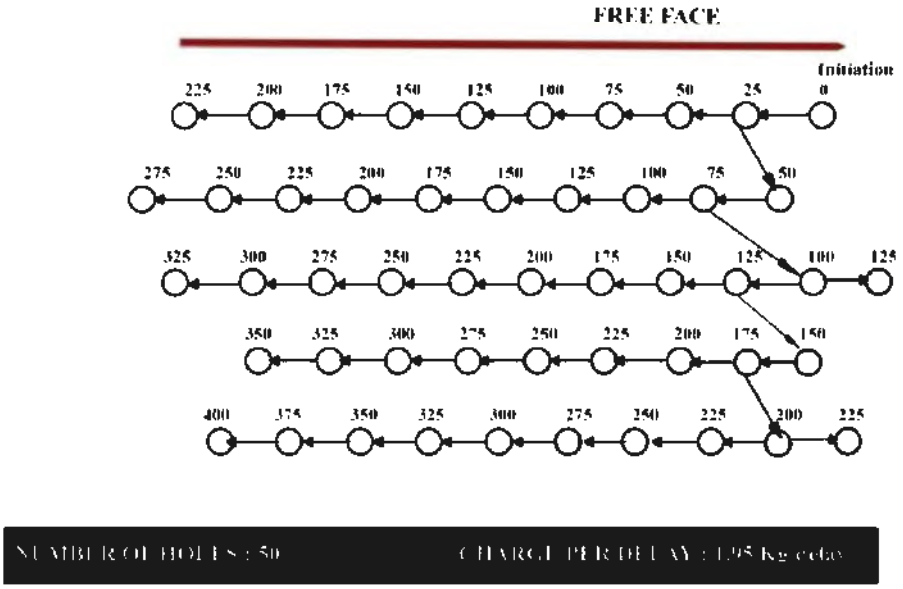


Figure 3.13 Schematic diagram of adopted blasting pattern for the blast 7

Post Blast Observations

During the post blast observations, the following conditions were identified:

- Backbreak was observed of about 0.5 m.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 15 m which is considered to be normal.
- A drop of about 0.50 to 0.75 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 15 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring houses were well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.14 & 3.15.**

VMS_1 Location : EVENT REPORT

Version 4.2.4
Executable Date: 18Oct2017

File: D:\Kerala\Adani\17.03.21\17.03.21 Morning\VMS 1 Morning-4.NSZ

Instantel Seismograph, Inc

SuperGraphics - Report

Telephone: (205)592-2408 x 23

Company: PRO

Unit #: 11772

3/17/2021 at 10:55:33 Event # 4

Location:

Operator: BUS

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 16Feb21

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

Seismic

Gain: 1 | Trigger: .889 mm/s | Vector Sum: 11.09 mm/s @ 170.67 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	7.747	10.160	5.969
Frequency (Hz)	170.60	170.60	128.00
Trigger >>>> Peak	335.0	528.3	487.3

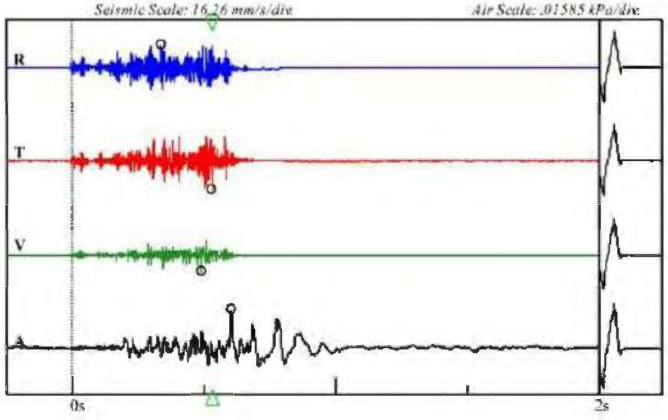
Air

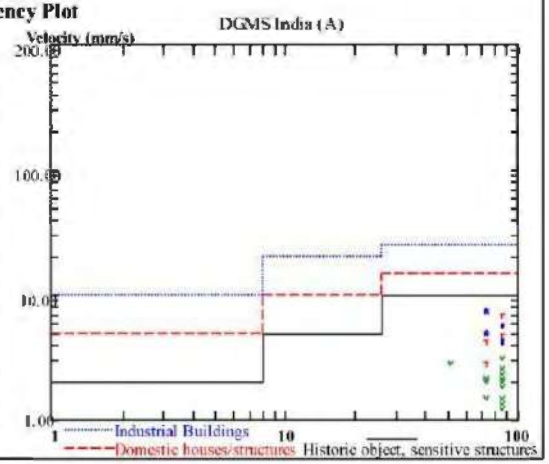
Gain: 1 | Air Trigger: N

Measurement	Value	Trigger >>> Peak	
		601.6	
kPa	.0132		
dBL	116.4		
Hz	24.3		

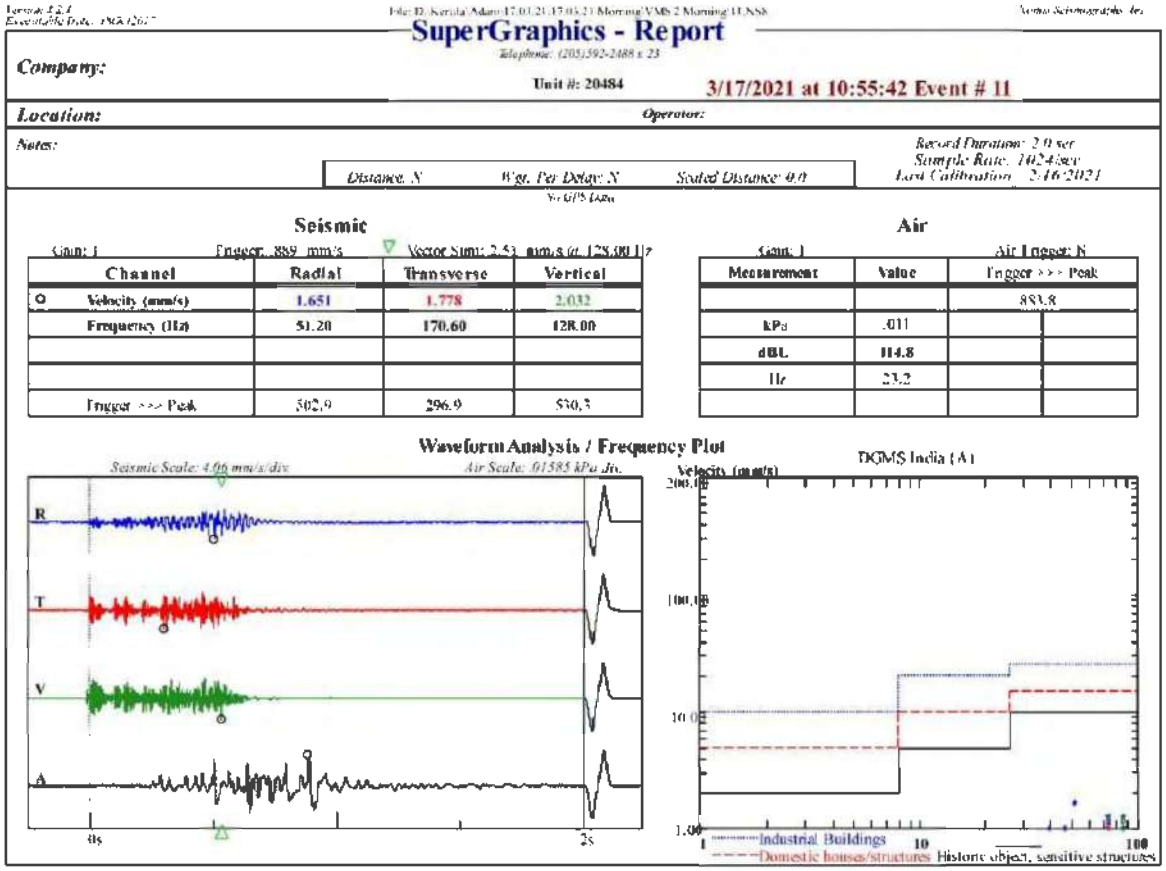
Waveform Analysis / Frequency Plot

Seismic Scale: 16.26 mm/s/div | Air Scale: .01585 kPa/div





VMS_2 Location : EVENT REPORT



SuperGraphics - Report

Company:

Unit #: 20484

3/17/2021 at 10:55:42 Event # 11

Location:

Operator:

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

Seismic

Gain: 1 | Trigger: .889 mm/s | Vector Sum: 2.53 mm/s @ 128.00 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	1.651	1.778	2.032
Frequency (Hz)	51.20	170.60	128.00
Trigger >>> Peak	502.9	296.9	530.3

Air

Gain: 1 | Air Trigger: N

Measurement	Value	Trigger >>> Peak
		883.8
kPa	.011	
dBL	114.8	
Hz	23.2	

Waveform Analysis / Frequency Plot

Seismic Scale: 4.00 mm/s/div | Air Scale: .01585 kPa /in.

R
T
V
A

0s | 2s

DGMS India (A)

Velocity (mm/s)

200.00
100.00
10.00
1.00

1 | 10 | 100

Industrial Buildings
Domestic houses/structures
Historic object, sensitive structures

VMS_76 Location : EVENT

Instantel

Event Report

Date/Time	Tran at 10:54:10 March 17, 2021	**Serial Number**	5993 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.6 Volts
	Mic: 106 dB(L)	**Calibration**	March 1, 2021 by UES New Delhi
Range	Geo :127 mm/s	**File Name**	G993IWBK.YA0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:03:19 (V8.12)

Extended Notes

Post Event Notes

Microphone	Linear Weighting
PSPL	100.0 dB(L) at 0.293 sec
ZC Freq	N/A
Channel Test	Check (Freq = 0.0 Hz Amp = 14 mv)

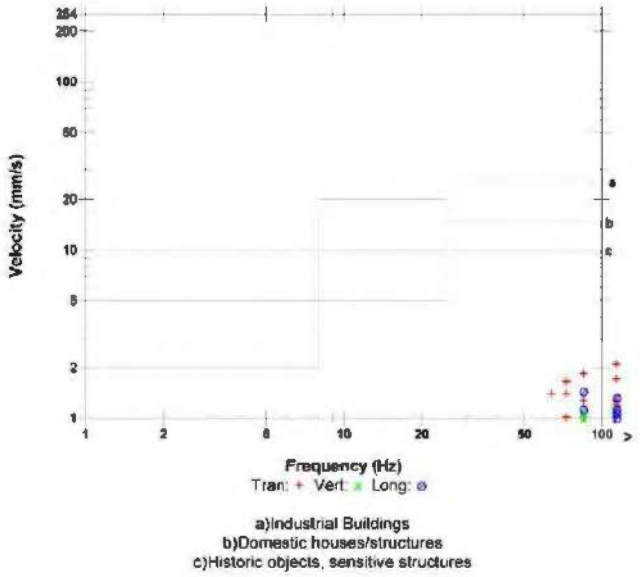
	Tran	Vert	Long	
PPV	2.10	1.14	1.46	mm/s
ZC Freq	>100	N/A	85	Hz
Time (Rel. to Trig)	0.544	0.524	0.526	sec
Peak Acceleration	0.152	0.0862	0.126	g
Peak Displacement	0.00375	0.00251	0.00295	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.8	8.0	7.7	Hz
Overswing Ratio	3.6	3.5	3.7	

Peak Vector Sum 2.24 mm/s at 0.544 sec

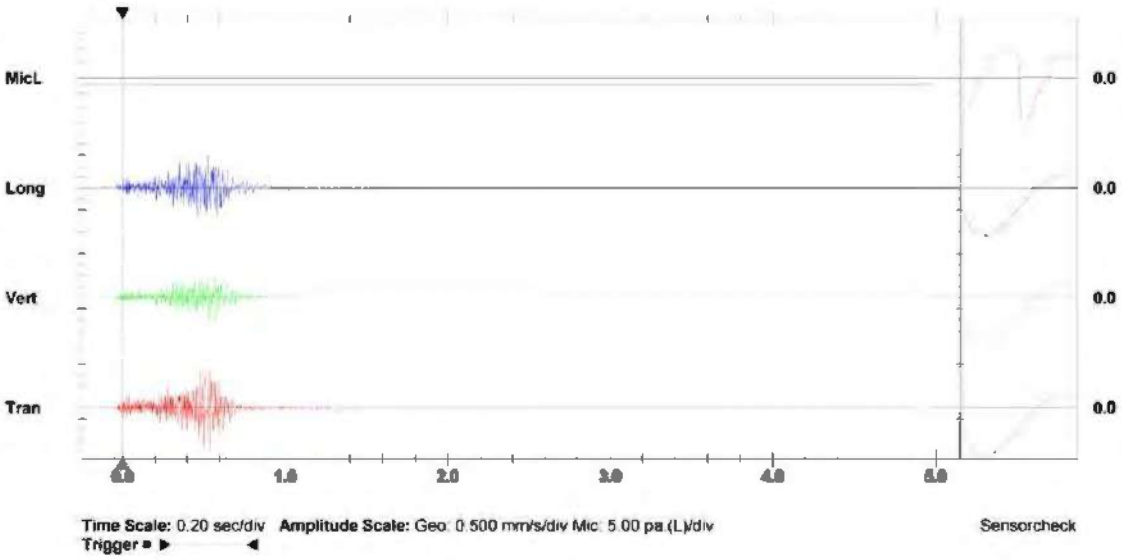
N/A: Not Applicable

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



VMS_77 Location : EVENT

Instantel

Event Report

Date/Time	Long at 10:55:33 March 17, 2021	**Serial Number**	4688 V 2.6 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.5 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F688IWBL.0L0
Record Time	2.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:00:31 (V8.12)

Extended Notes

Post Event Notes

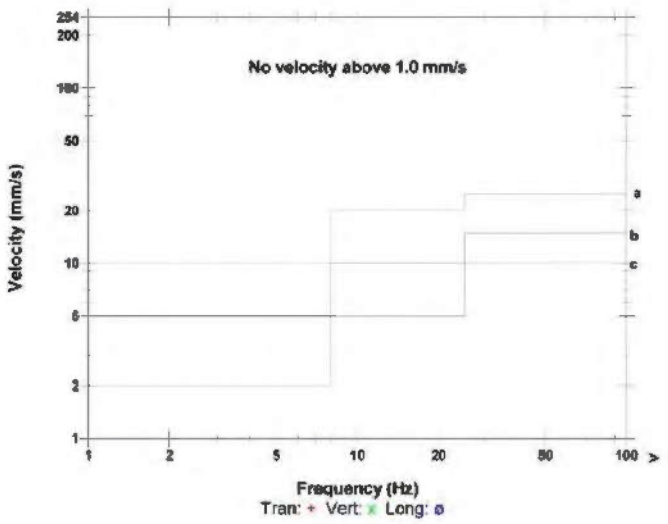
Microphone Linear Weighting
PSPL 112.0 dB(L) at 0.468 sec
ZC Freq 12 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 490 mv)

	Tran	Vert	Long	
PPV	0.953	0.699	0.953	mm/s
ZC Freq	57	>100	73	Hz
Time (Rel. to Trig)	0.111	0.163	0.128	sec
Peak Acceleration	0.0398	0.0398	0.0464	g
Peak Displacement	0.00366	0.00220	0.00198	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.8	8.2	Hz
Overswing Ratio	3.4	3.6	3.3	

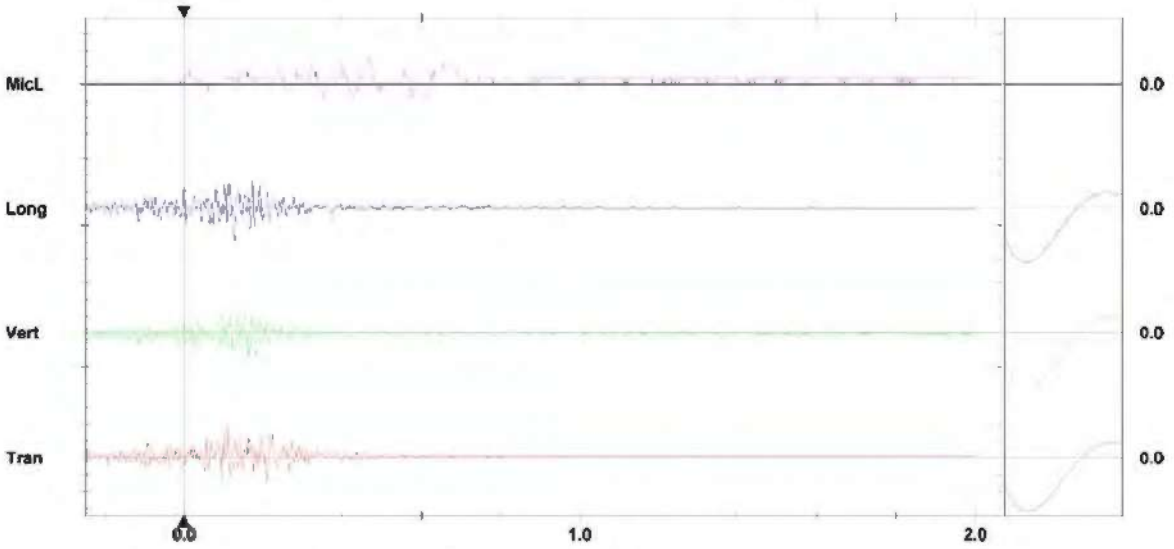
Peak Vector Sum 1.17 mm/s at 0.128 sec

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Time Scale: 0.20 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa.(L)/div Sensorcheck
Trigger = ▶ ◀

VMS_78 Location : EVENT

Instantel

Event Report

Date/Time	Tran at 10:55:28 March 17, 2021	**Serial Number**	4667 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s	**Battery Level**	6.4 Volts
	Mic: 106 dB(L)	**Calibration**	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F667IWBL.0G0
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 05:05:54 (V8.12)

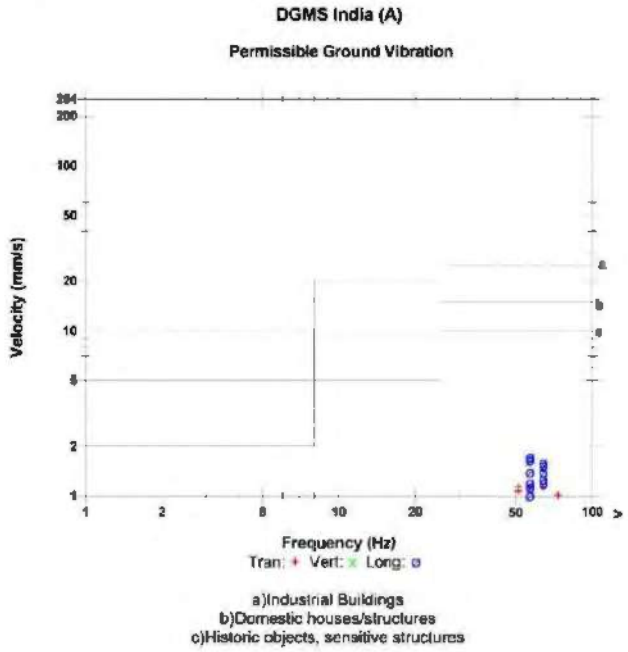
Extended Notes

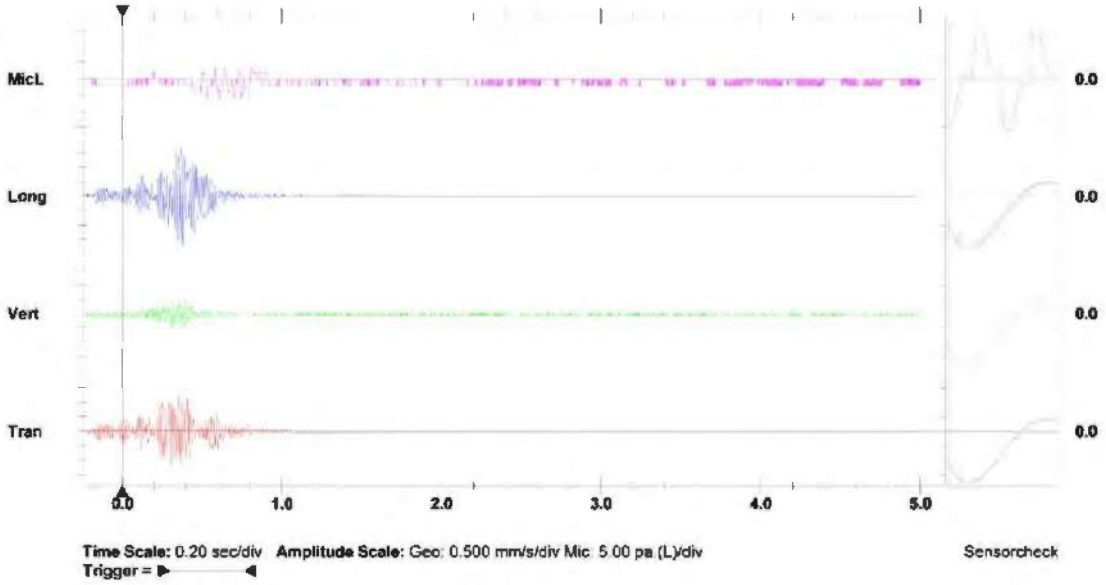
Post Event Notes

Microphone Linear Weighting
PSPL 109.5 dB(L) at 0.527 sec
ZC Freq 18 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	1.14	0.572	1.71	mm/s
ZC Freq	64	64	57	Hz
Time (Rel. to Trig)	0.299	0.312	0.377	sec
Peak Acceleration	0.0530	0.0398	0.0663	g
Peak Displacement	0.00347	0.00146	0.00490	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	8.0	7.8	Hz
Overswing Ratio	3.5	3.2	3.2	

Peak Vector Sum 1.89 mm/s at 0.369 sec





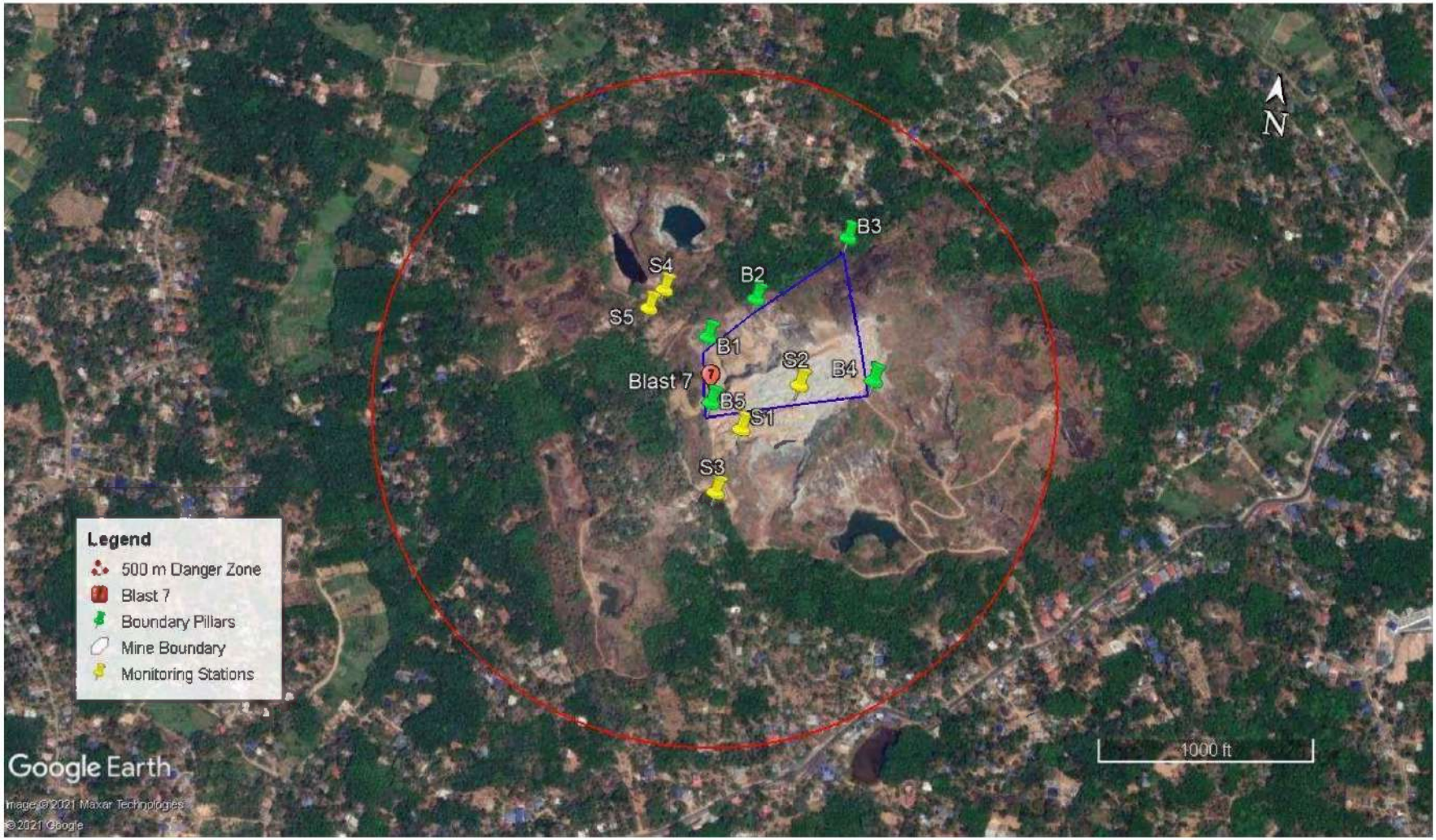


Figure 3.14 Imagery shows the location blast site 7 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 8: The eighth blast was conducted on 17th March, 2021 and the adopted blasting pattern and details are given in the Table 3.16 and 3.17. The Figure 3.15 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.16

Table 3.16 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B8)			8°43'45.29"	76°50'17.95"	---		
2	VMS_1 Location	11772	105	8°43'41.81"	76°50'17.47"	6.12 Within permissible limit	64.4	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	68	8°43'44.17"	76°50'19.88"	2.3 Within permissible limit	78.0	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	218	8°43'38.33"	76°50'16.16"	Not Triggered		Not belonging to the owner
5	VMS_4 Location	4688	182	8°43'48.033"	76°50'12.81"	1.40 Within permissible limit	62.4	Not belonging to the owner, maximum value is 5 mm/s
6	VMS_5 Location	4687	282	8°43'53.22"	76°50'22.62"	1.68 Within permissible limit	6.9	Not belonging to the owner, maximum value is 5 mm/s

Table 3.17 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.50	2.4	30	0.625	1.339	18.75

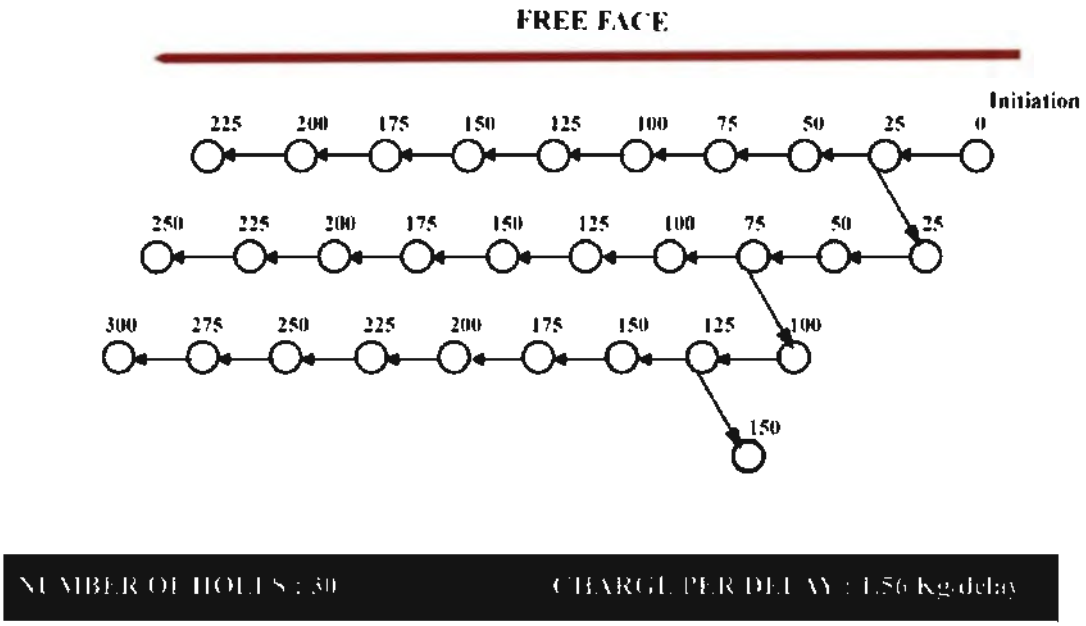


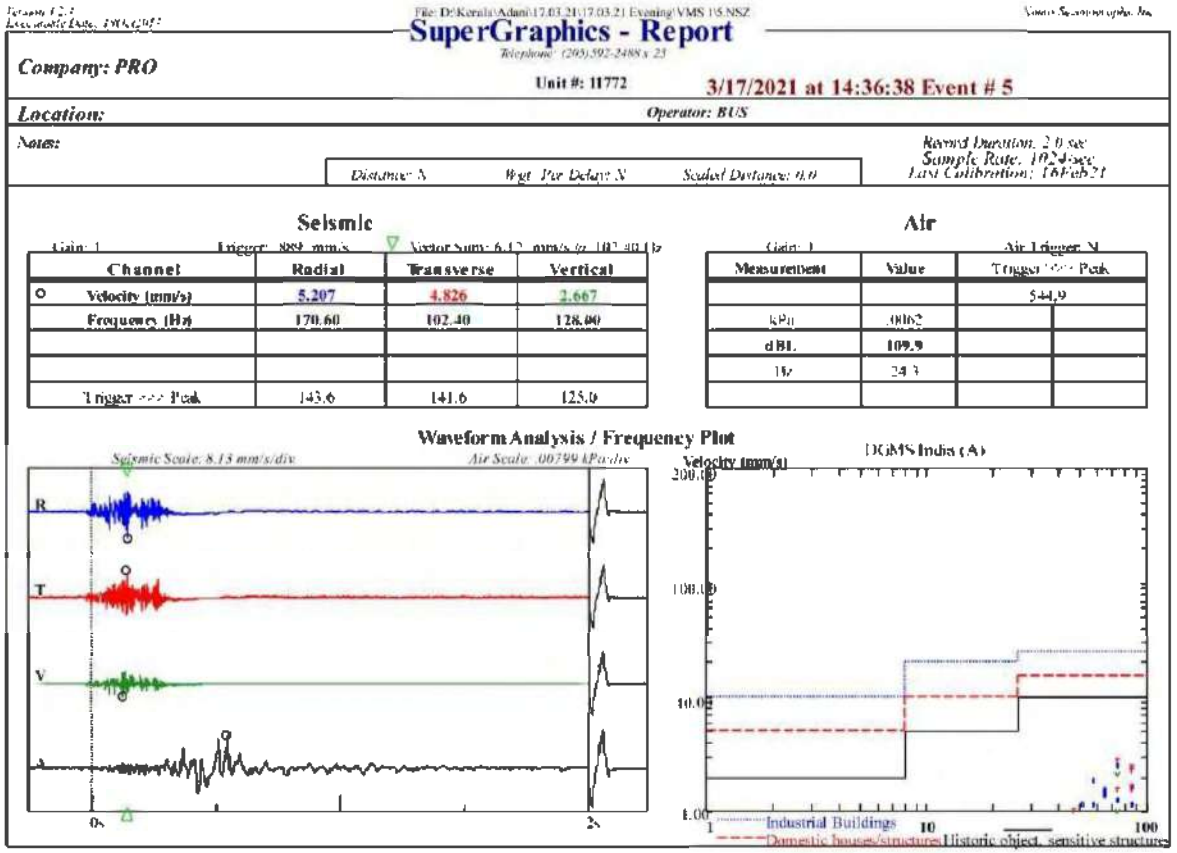
Figure 3.15 Schematic diagram of adopted blasting pattern for the blast 8

Post Blast Observations

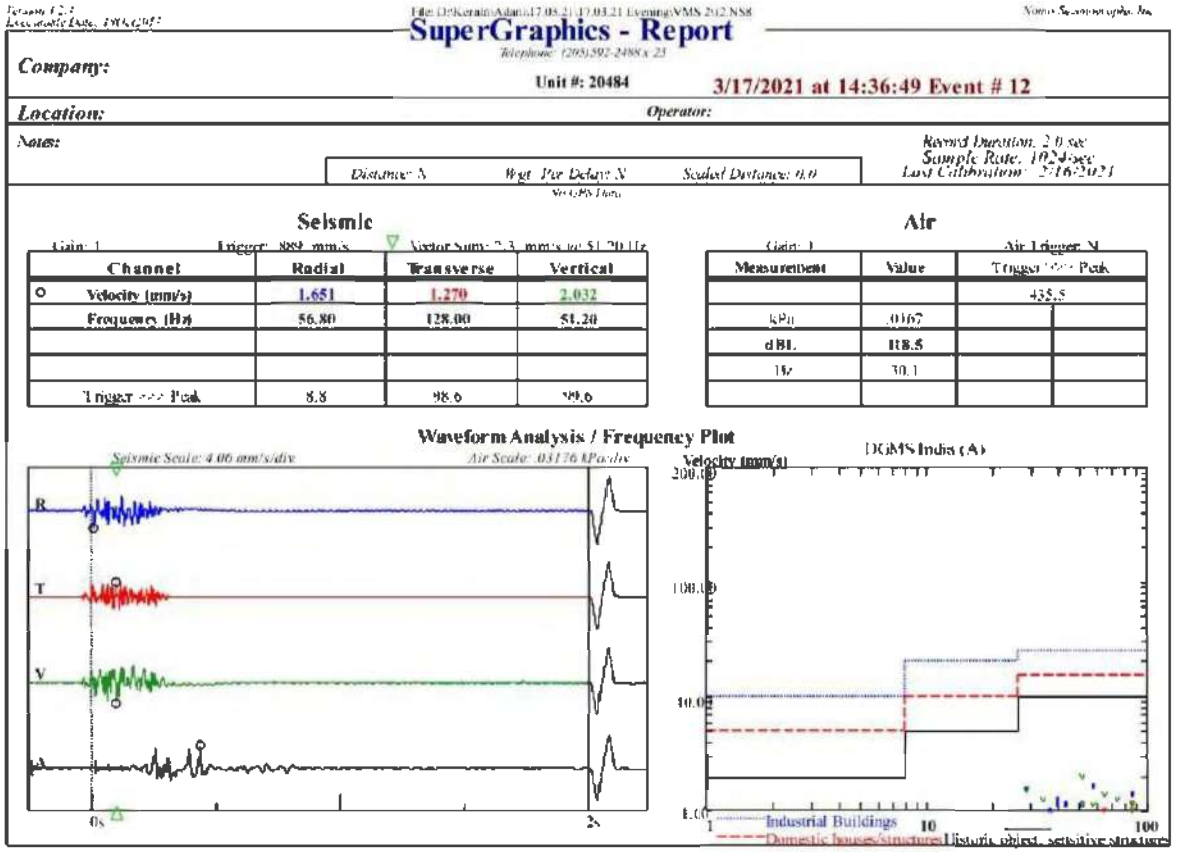
During the post blast observations, the following conditions were identified:

- No Backbreak was observed.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 10 m which is considered to be normal.
- A drop of about 0.75 to 1.0 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring houses were well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.16 & 3.17.**

VMS_82 Location : EVENT



VMS_83 Location : EVENT



SuperGraphics - Report

Company:

Unit #: 20484 3/17/2021 at 14:36:49 Event # 12

Location: Operator:

Notes:

Seismic

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	1.651	1.270	2.032
Frequency (Hz)	56.80	128.00	51.20
Trigger Peak	8.8	98.6	99.6

Air

Measurement	Value	Trigger Peak
		435.5
kPa	.0167	
dBL	118.5	
Hz	30.1	

Waveform Analysis / Frequency Plot

Seismic Scale: 4.06 mm/s/div Air Scale: .03176 kPa/div

R

T

V

0s 2s

DGMS Indus (A)

Velocity (mm/s)

200.0

100.0

10.0

1.00

1 10 100

Industrial Buildings

Domestic houses/structures

VMS_84 Location : EVENT

Instantel

Event Report

Date/Time	Long at 14:36:38 March 17, 2021	**Serial Number**	4688 V 2.6 MiniMate
Trigger Source	Geo: 0.492 mm/s Mic: 106 dB(L)	**Battery Level**	6.4 Volts
		Calibration	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F688IWBV.920
Record Time	2.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:23:50 (V8.12)

Extended Notes

Post Event Notes

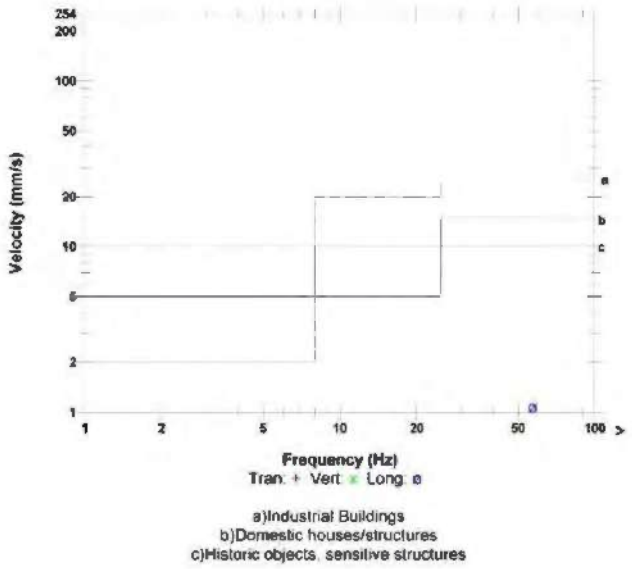
Microphone Linear Weighting
PSPL 115.6 dB(L) at 0.651 sec
ZC Freq 18 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 491 mv)

	Tran	Vert	Long	
PPV	0.826	0.889	1.08	mm/s
ZC Freq	85	57	57	Hz
Time (Rel. to Trig)	0.082	0.083	0.064	sec
Peak Acceleration	0.0398	0.0398	0.0464	g
Peak Displacement	0.00239	0.00276	0.00282	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.8	8.2	Hz
Overswing Ratio	3.4	3.6	3.3	

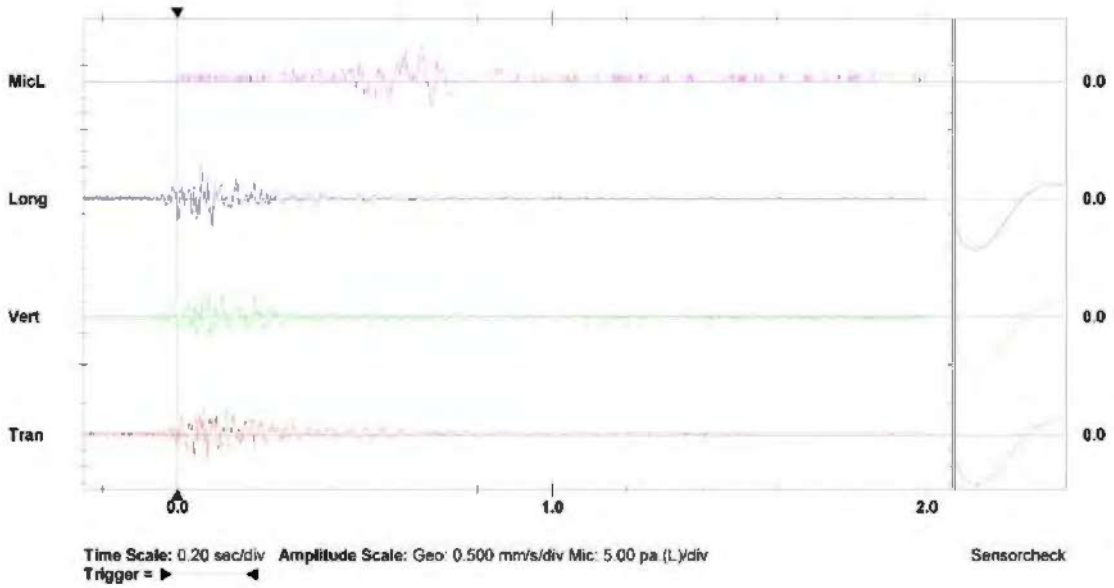
Peak Vector Sum 1.40 mm/s at 0.083 sec

DGMS India (A)

Permissible Ground Vibration



a)Industrial Buildings
b)Domestic houses/structures
c)Historic objects, sensitive structures



Time Scale: 0.20 sec/div **Amplitude Scale:** Geo: 0.500 mm/s/div Mic: 5.00 pa (L)/div Sensorcheck
Trigger = ▶ ◀

VMS_85 Location : EVENT

Instantel

Event Report

Date/Time Vert at 14:37:06 March 17, 2021
Trigger Source Geo: 0.492 mm/s
Mic: 106 dB(L)
Range Geo :127 mm/s
Record Time 5.0 sec at 1024 sps

Serial Number 4687 V 2.61 MiniMate
Battery Level 6.4 Volts
Calibration April 21, 2017 by UES, New Delhi
File Name F687IWBV.9U0

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:26:47 (V8.12)

Extended Notes

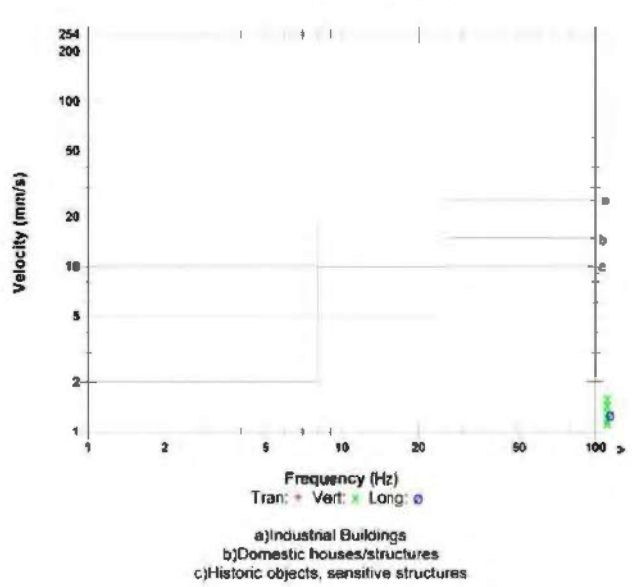
Post Event Notes

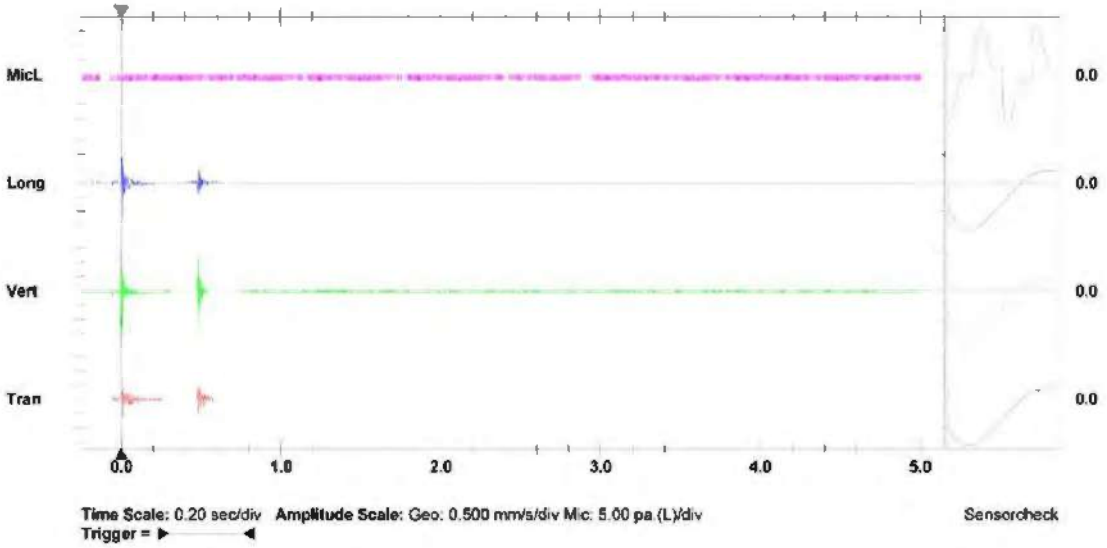
Microphone Linear Weighting
PSPL 100.0 dB(L) at 0.003 sec
ZC Freq N/A
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	0.635	1.59	1.27	mm/s
ZC Freq	N/A	>100	N/A	Hz
Time (Rel. to Trig)	0.007	0.008	0.009	sec
Peak Acceleration	0.0729	0.212	0.133	g
Peak Displacement	0.00099	0.00136	0.00118	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	7.8	7.7	Hz
Overswing Ratio	3.5	3.2	3.6	

Peak Vector Sum 1.68 mm/s at 0.010 sec

N/A: Not Applicable





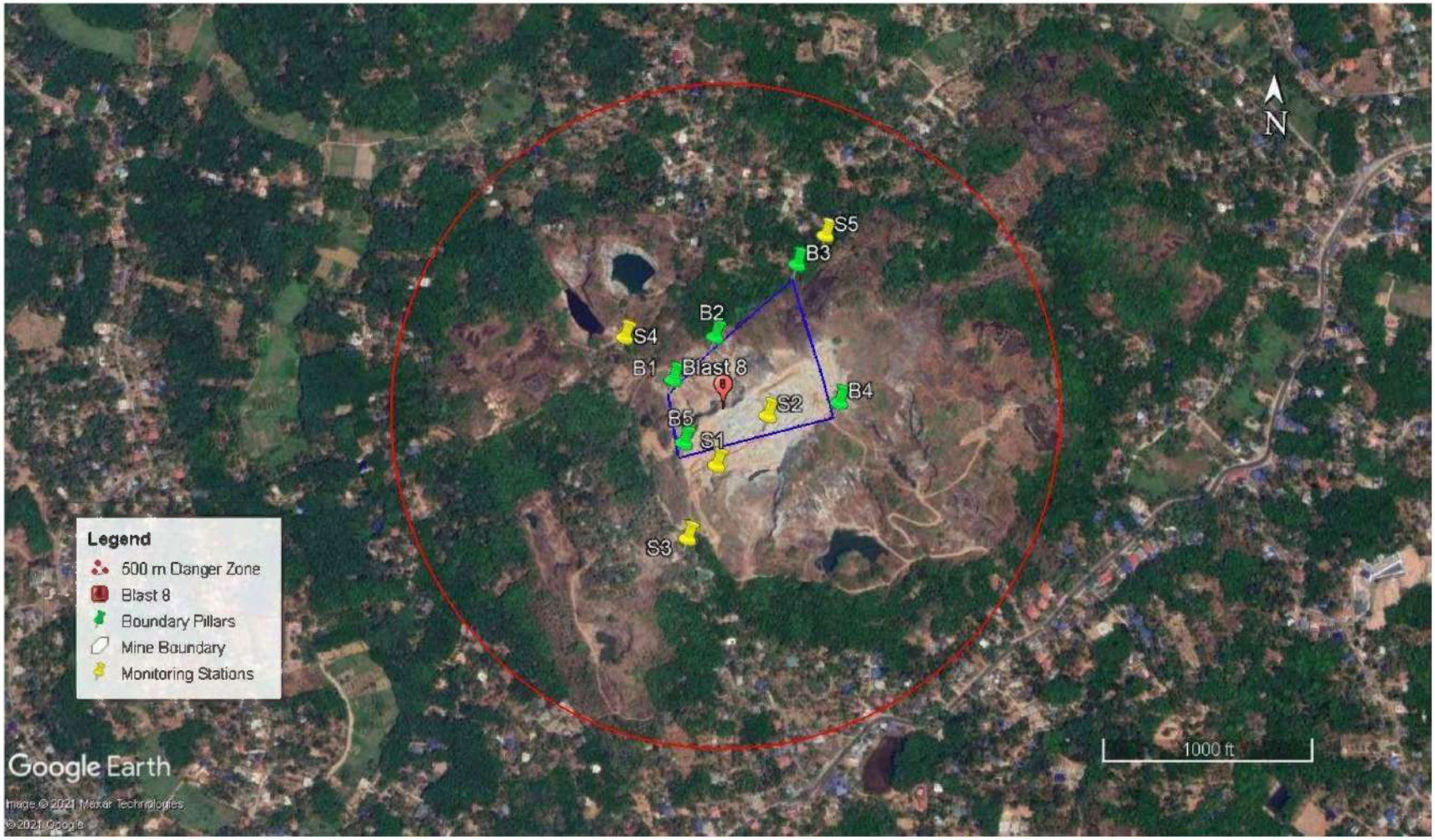


Figure 3.16 Imagery shows the location blast site 8 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 9: The ninth blast was conducted on 17th March, 2021 and the adopted blasting pattern and details are given in the Table 3.18 and 3.19. The Figure 3.17 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.18

Table 3.18 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B9)			8°43'47.24"	76°50'19.47"	---		
2	VMS_1 Location	11772	186	8°43'41.81"	76°50'17.47"	3.47 Within permissible limit	67.8	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	91	8°43'44.17"	76°50'19.88"	1.75 Within permissible limit	69.2	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	293	8°43'38.33"	76°50'16.16"	Not Triggered		Not belonging to the owner
5	VMS_4 Location	4688	205	8°43'48.033"	76°50'12.81"	0.524 Within permissible limit	63.7	Not belonging to the owner, maximum value is 5 mm/s
6	VMS_5 Location	4687	209	8°43'53.22"	76°50'22.62"	1.00 Within permissible limit	56.3	Not belonging to the owner, maximum value is 5 mm/s

Table 3.19 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	24	0.625	1.0714	15

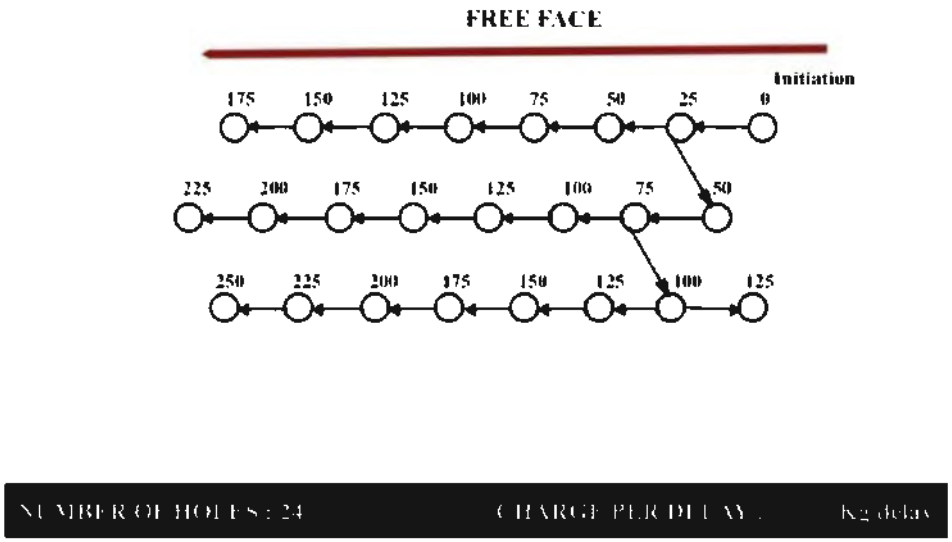


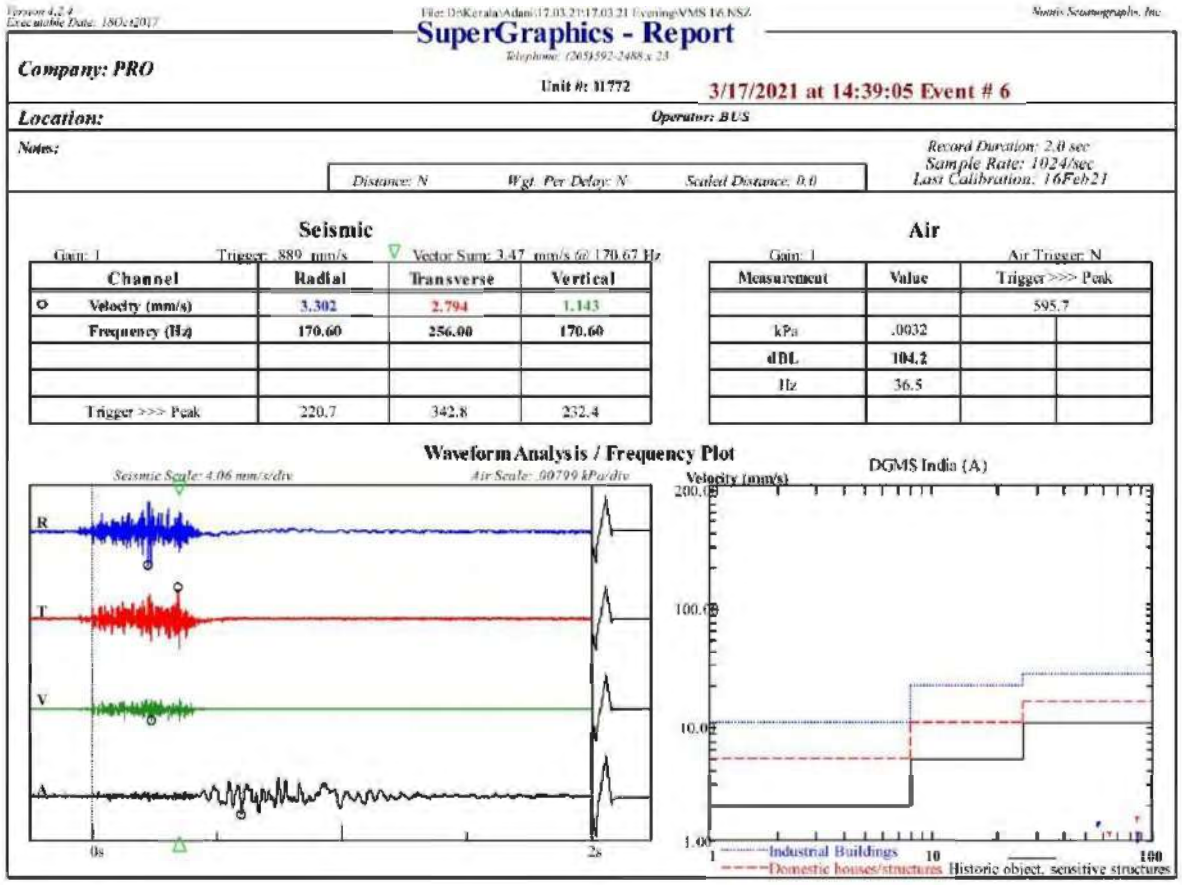
Figure 3.17 Schematic diagram of adopted blasting pattern for the blast 9

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No Backbreak was observed.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 8 to 10 m which is considered to be normal.
- A drop of about 0.50 to 1.0 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring houses were well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.18 & 3.19.**

VMS_89 Location : EVENT



SuperGraphics - Report

Company: PRO

Unit #: 11772 3/17/2021 at 14:39:05 Event # 6

Location: Operator: BUS

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 16Feb21

Distance: N Wgt. Per Delay: N Scaled Distance: 0.0

Seismic

Gain: 1 Trigger: .889 mm/s Vector Sum: 3.47 mm/s @ 170.67 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	3.302	2.794	1.143
Frequency (Hz)	170.60	256.00	170.60
Trigger >>> Peak	220.7	342.8	232.4

Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger >>> Peak
		595.7
kPa	.0032	
dBL	104.2	
Hz	36.5	

Waveform Analysis / Frequency Plot

Seismic Scale: 4.06 mm/s/div Air Scale: .00799 kPa/div

R T V A

0s 2s

DGMS India (A)

Velocity (mm/s)

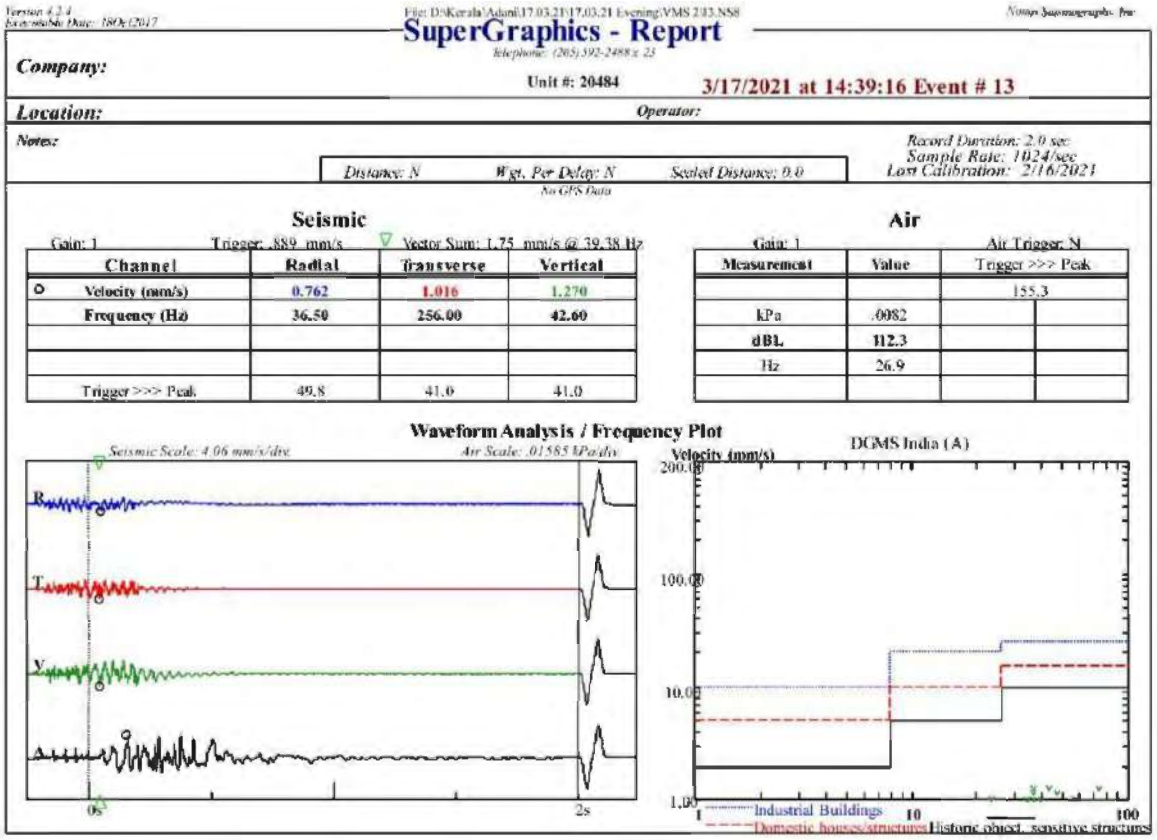
200.0 100.0 10.00 1.00

1 10 100

Industrial Buildings

Domestic houses/structures Historic object, sensitive structures

VMS_90 Location : EVENT



SuperGraphics - Report

Company:

Unit #: 20484

3/17/2021 at 14:39:16 Event # 13

Location:

Operator:

Notes:

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

No GPS Data

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Seismic

Gain: 1 Trigger: .889 mm/s Vector Sum: 1.75 mm/s @ 39.38 Hz

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	0.762	1.016	1.270
Frequency (Hz)	36.50	256.00	42.00
Trigger >>> Peak	49.8	41.0	41.0

Air

Gain: 1 Air Trigger: N

Measurement	Value	Trigger >>> Peak
		155.3
kPa	.0082	
dBL	112.3	
Hz	26.9	

Waveform Analysis / Frequency Plot

Seismic Scale: 4.06 mm/s/div Air Scale: .01585 kPa/div

R T V

0s 2s

Velocity (mm/s)

DGMS India (A)

200.0 100.0 10.0 1.00

1 10 100

Industrial Buildings

Domestic houses/structures Historic object, sensitive structures

VMS_91 Location : EVENT

Instantel

Event Report

Date/Time	MicL at 14:39:04 March 17, 2021	**Serial Number**	4688 V 2.6 MiniMate
Trigger Source	Geo: 0.492 mm/s Mic: 106 dB(L)	**Battery Level**	6.4 Volts
		Calibration	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	**File Name**	F688IWBV.D40
Record Time	2.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 28, 2011 04:23:50 (V8.12)

Extended Notes

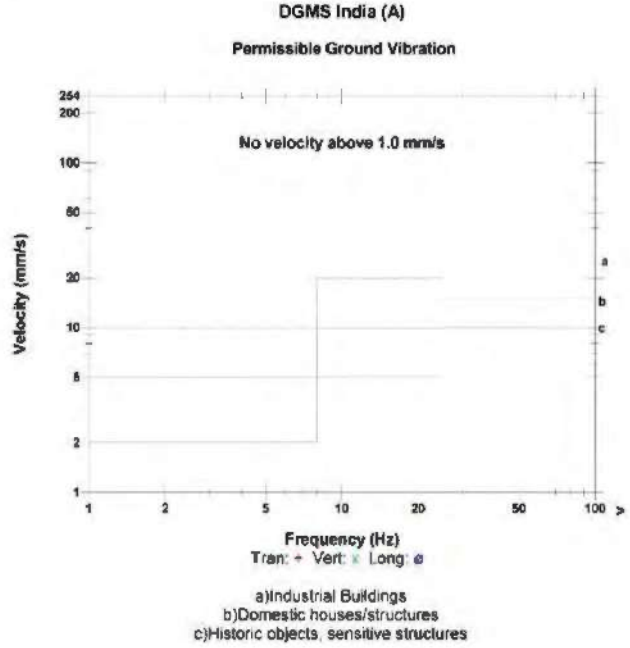
Post Event Notes

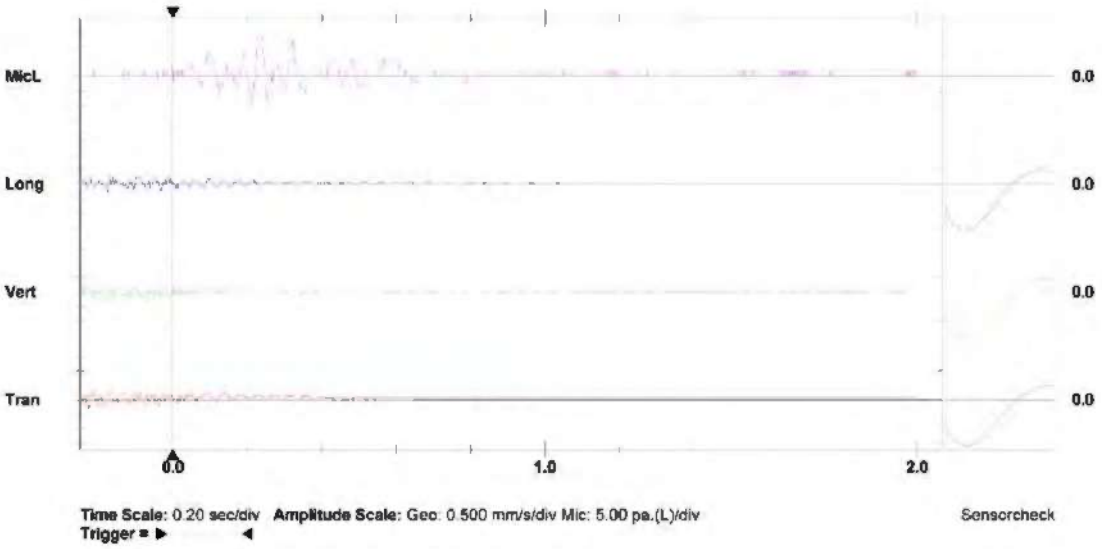
Microphone Linear Weighting
PSPL 116.9 dB(L) at 0.231 sec
ZC Freq 18 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 491 mv)

	Tran	Vert	Long	
PPV	0.318	0.318	0.318	mm/s
ZC Freq	85	64	N/A	Hz
Time (Rel. to Trig)	-0.225	-0.176	-0.175	sec
Peak Acceleration	0.0199	0.0133	0.0199	g
Peak Displacement	0.00127	0.00050	0.00090	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.8	8.2	Hz
Overswing Ratio	3.4	3.6	3.3	

Peak Vector Sum 0.524 mm/s at -0.175 sec

N/A: Not Applicable





VMS_92 Location : EVENT

Instantel

Event Report

Date/Time	Long at 14:39:00 March 17, 2021	Serial Number	4687 V 2.61 MiniMate
Trigger Source	Geo: 0.492 mm/s Mic: 106 dB(L)	Battery Level	6.4 Volts
		Calibration	April 21, 2017 by UES, New Delhi
Range	Geo :127 mm/s	File Name	F687IWBV.D00
Record Time	5.0 sec at 1024 sps		

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:26:47 (V8.12)

Extended Notes

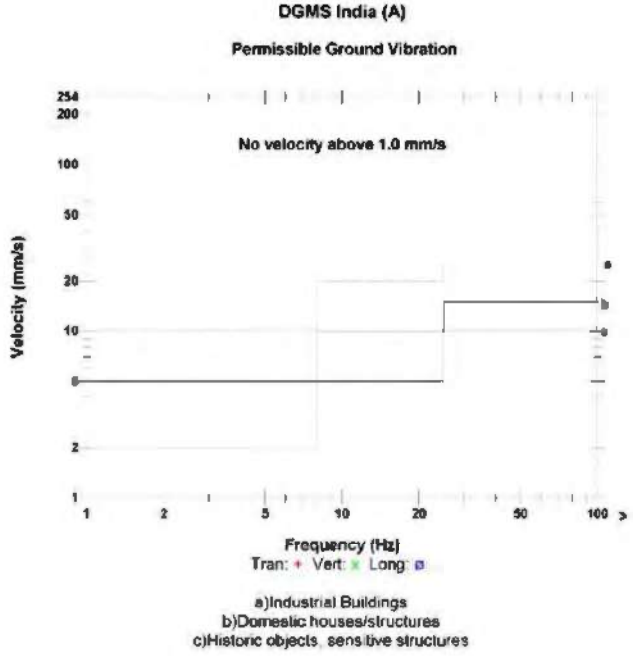
Post Event Notes

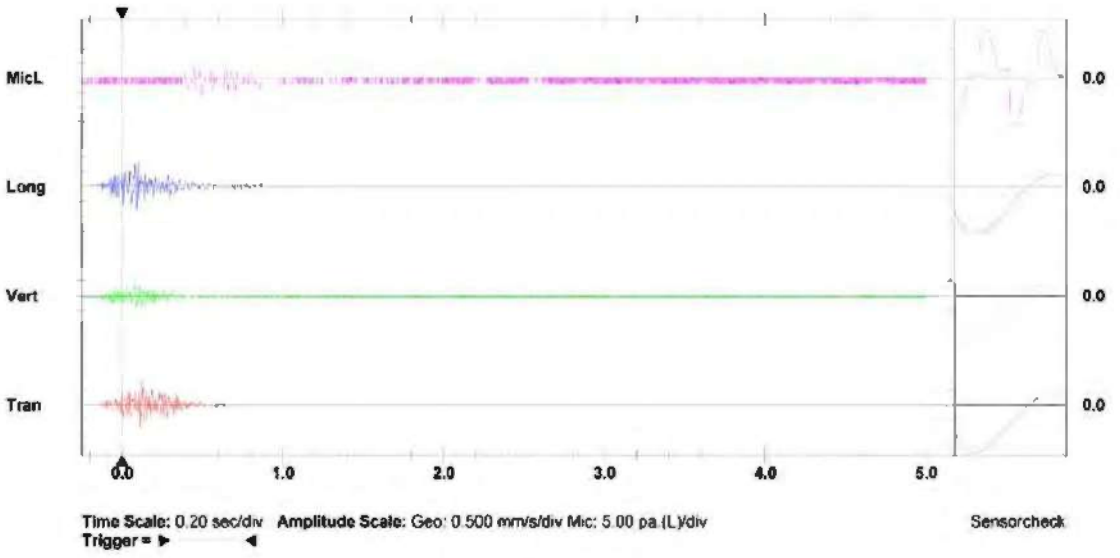
Microphone	Linear Weighting
PSPL	109.5 dB(L) at 0.492 sec
ZC Freq	18 Hz
Channel Test	Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	0.826	0.572	0.889	mm/s
ZC Freq	>100	N/A	>100	Hz
Time (Rel. to Trig)	0.112	0.090	0.101	sec
Peak Acceleration	0.0530	0.0464	0.0464	g
Peak Displacement	0.00121	0.00087	0.00152	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	7.8	7.7	Hz
Overswing Ratio	3.5	3.2	3.6	

Peak Vector Sum 1.00 mm/s at 0.101 sec

N/A: Not Applicable





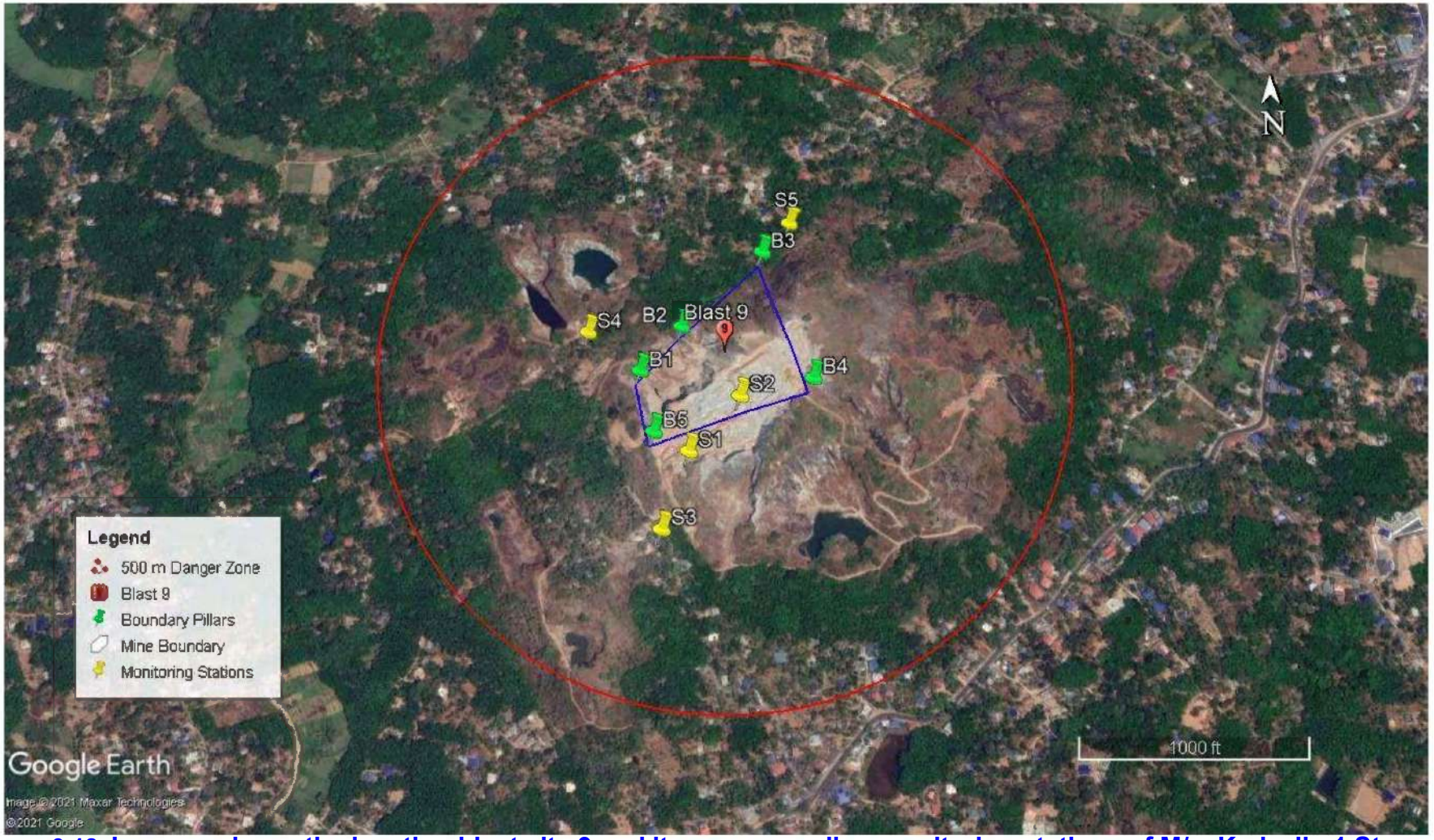


Figure 3.18 Imagery shows the location blast site 9 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

Blast No 10: The tenth blast was conducted on 17th March, 2021 and the adopted blasting pattern and details are given in the Table 3.20 and 3.21. The Figure 3.19 depicts the blasting pattern and location of blasting site and monitoring station is provided in the Figure 3.20

Table 3.20 Co-ordinates of Blast & Instrument Locations

Sl. No.	Location	Serial of Instrument	Distance (m)	Latitude (N)	Longitude (E)	PPV (mm/s)	Noise dB(A)	Type of structure/ Permissible limit
1	Blast Location (B10)			8°43'45.74"	76°50'20.27"	---		
2	VMS_1 Location	11772	146	8°43'41.81"	76°50'17.47"	3.4 Within permissible limit	56.2	Belonging to the owner, maximum value is 15 mm/s
3	VMS_2 Location	20484	46	8°43'44.17"	76°50'19.88"	2.29 Within permissible limit	72.1	Belonging to the owner, maximum value is 15 mm/s
4	VMS_3 Location	5993	259	8°43'38.33"	76°50'16.16"	Not Triggered		Not belonging to the owner
5	VMS_4 Location	4688	245	8°43'48.033"	76°50'12.81"	0.206 Within permissible limit	59.1	Not belonging to the owner, maximum value is 5 mm/s
6	VMS_5 Location	4687	243	8°43'53.22"	76°50'22.62"	0.318 Within permissible limit	56.3	Not belonging to the owner, maximum value is 5 mm/s

Table 3.21 Details of Blast Parameters

Average Burden (m)	Average Spacing (m)	Average Hole Depth (m)	No. of holes (Nos.)	Maximum Charge per Hole (kg)	Maximum Charge per Delay (kg)	Total quantity of Explosives used (kg)
1.2	1.5	2.4	25	0.625	1.1161	15.625

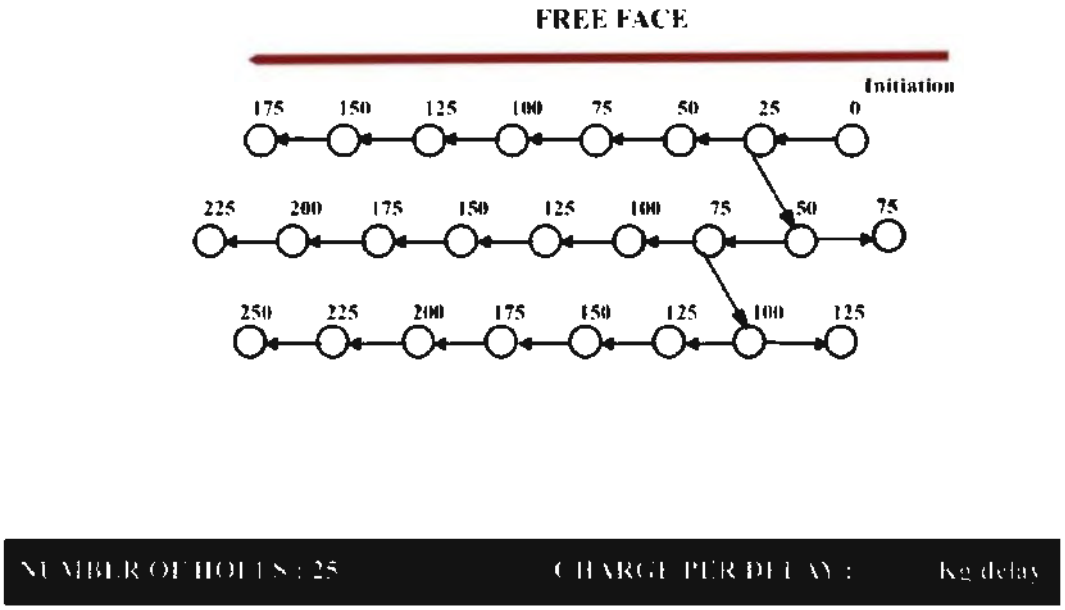


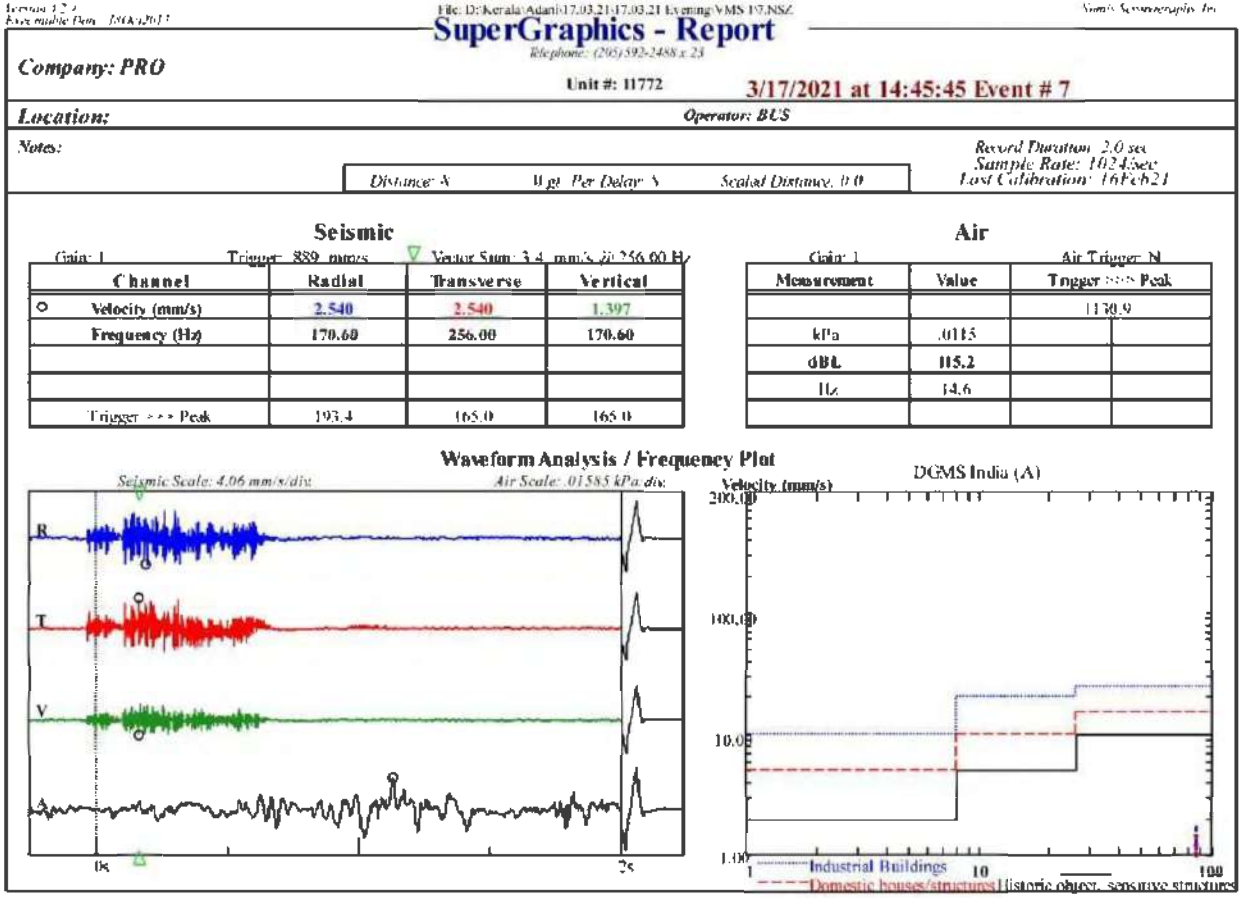
Figure 3.19 Schematic diagram of adopted blasting pattern for the blast 10

Post Blast Observations

During the post blast observations, the following conditions were identified:

- No Backbreak was observed.
- Muckpile was found to be adequately fragmented.
- The throw of the blast has been around 10 m which is considered to be normal.
- A drop of about 0.50 to 1.0 m from the top surface of bench has been found at the rear side of the blasted muck pile.
- No fly rock has travelled beyond 10 to 15 m from the blast.
- No misfires have occurred.
- The ground vibrations level monitored in the Neighbouring houses were well within permissible level.
- Few big sized boulders have been found on the blasted muck pile.
- Summary of the field data related to the above blast is given in **Table 3.18 & 3.19.**

VMS_1 Location : EVENT REPORT



SuperGraphics - Report

Company: PRO

Unit #: 11772

3/17/2021 at 14:45:45 Event # 7

Location:

Operator: BUS

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 16Feb21

Seismic

Channel	Radial	Transverse	Vertical
Velocity (mm/s)	2.540	2.540	1.397
Frequency (Hz)	170.60	256.00	170.60
Trigger ››› Peak	193.4	165.0	165.0

Air

Measurement	Value	Trigger ››› Peak
		1130.9
kPa	.0185	
dBL	115.2	
Hz	14.6	

Waveform Analysis / Frequency Plot

Seismic Scale: 4.06 mm/s/div

Air Scale: .01585 kPa/div

R

T

V

0s

2s

DGMS India (A)

Velocity (mm/s)

200.00

100.00

10.00

1.00

1

10

100

Industrial Buildings

Domestic houses/structures | Historic objects, sensitive structures

VMS_2 Location : EVENT REPORT

Version 4.2.4
Executable Date: 18Oct2017

File: D:\Kerala\Adani\17.03.21\17.03.21 Evening\VMS 214.NSS

Instantel Seismographs, Inc.

SuperGraphics - Report

Telephone: (205)592-2488 x 23

Company:

Unit #: 20484

3/17/2021 at 14:45:55 Event # 14

Location:

Operator:

Notes:

Record Duration: 2.0 sec
Sample Rate: 1024/sec
Last Calibration: 2/16/2021

Distance: N | Wgt. Per Delay: N | Scaled Distance: 0.0

No GPS Data

Seismic

Gain: 1 | Trigger: .889 mm/s | Vector Sum: 2.29 mm/s @ 170.67 Hz

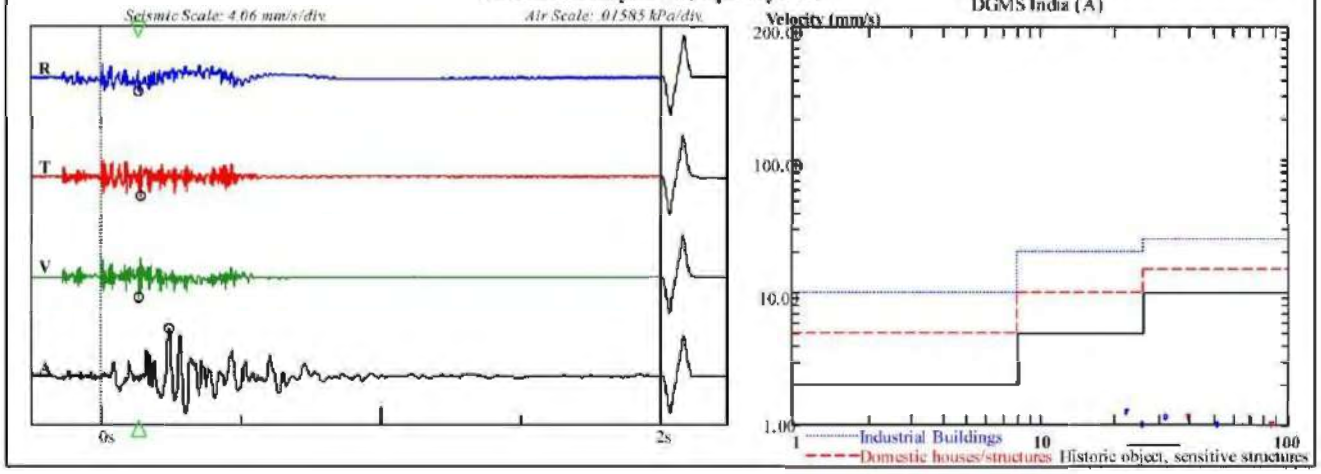
Channel	Radial	Transverse	Vertical
Velocity (mm/s)	1.270	1.651	1.778
Frequency (Hz)	22.20	256.00	170.60
Trigger >>> Peak	135.7	136.7	131.8

Air

Gain: 1 | Air Trigger: N

Measurement	Value	Trigger >>> Peak
		240.2
kPa	.0152	
dBL	117.6	
Hz	24.3	

Waveform Analysis / Frequency Plot



VMS_98 Location : EVENT

Instantel

Event Report

Date/Time MicL at 14:45:43 March 17, 2021
Trigger Source Geo: 0.492 mm/s
Mic: 106 dB(L)
Range Geo :127 mm/s
Record Time 2.0 sec at 1024 sps

Serial Number 4688 V 2.6 MiniMate
Battery Level 6.4 Volts
Calibration April 21, 2017 by UES, New Delhi
File Name F688IWBV.Q70

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:23:50 (V8.12)

Extended Notes

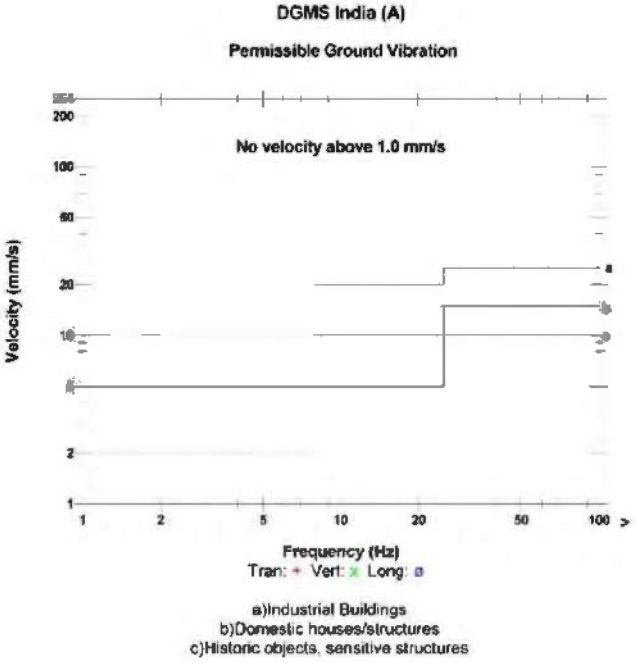
Post Event Notes

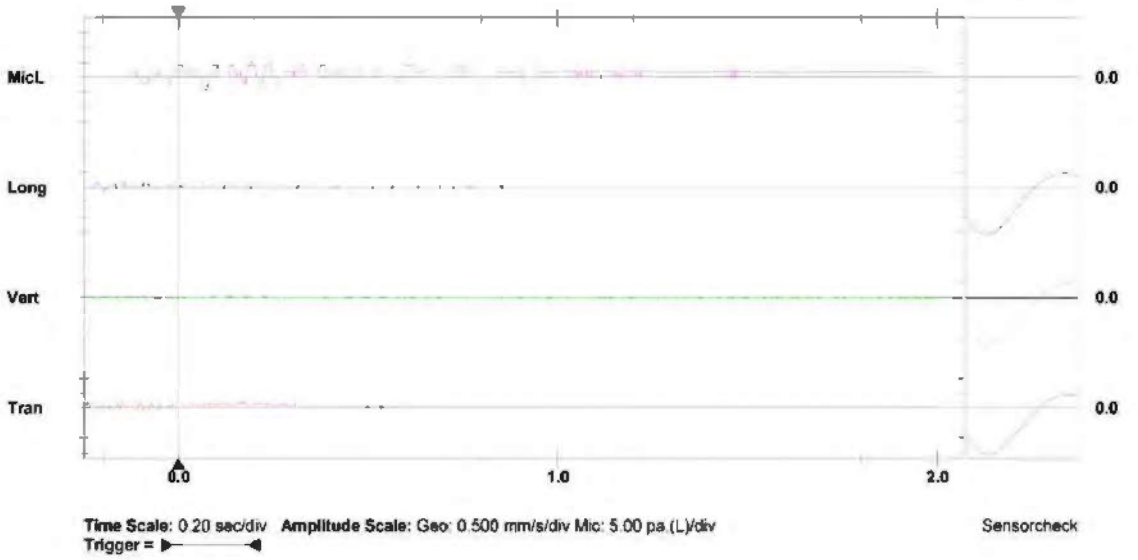
Microphone Linear Weighting
PSPL 109.5 dB(L) at 0.191 sec
ZC Freq 20 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 491 mv)

	Tran	Vert	Long	
PPV	0.191	0.127	0.191	mm/s
ZC Freq	64	N/A	47	Hz
Time (Rel. to Trig)	-0.240	-0.242	-0.216	sec
Peak Acceleration	0.0133	0.00663	0.00663	g
Peak Displacement	0.00003	0.00003	0.00003	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.7	7.8	8.2	Hz
Overswing Ratio	3.4	3.6	3.3	

Peak Vector Sum 0.206 mm/s at -0.240 sec

N/A: Not Applicable





VMS_99 Location : EVENT

Instantel

Event Report

Date/Time MicL at 14:45:38 March 17, 2021
Trigger Source Geo: 0.492 mm/s
Mic: 106 dB(L)
Range Geo :127 mm/s
Record Time 5.0 sec at 1024 sps

Serial Number 4687 V 2.61 MiniMate
Battery Level 6.4 Volts
Calibration April 21, 2017 by UES, New Delhi
File Name F687IWBV.O20

Notes
Location: KADAVILA STONE QUARRY
Client: ADANI PORT PVT LTD
User Name: ANNA UNIVERSITY
Converted: February 26, 2011 04:26:47 (V8.12)

Extended Notes

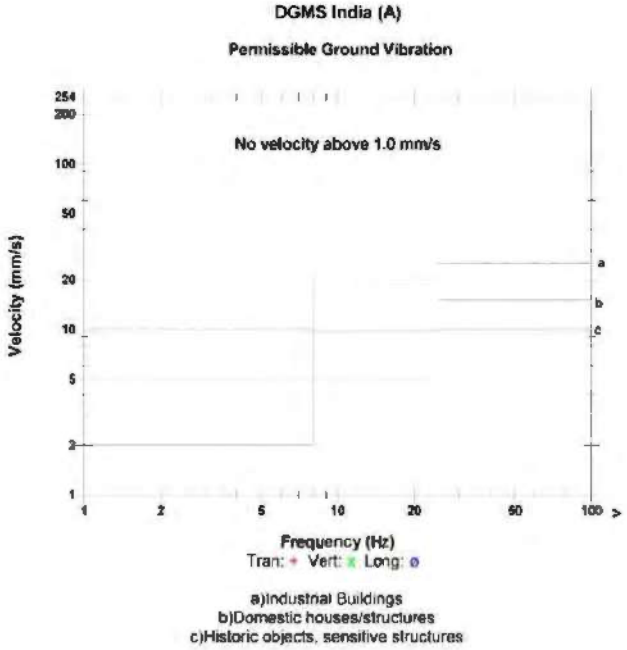
Post Event Notes

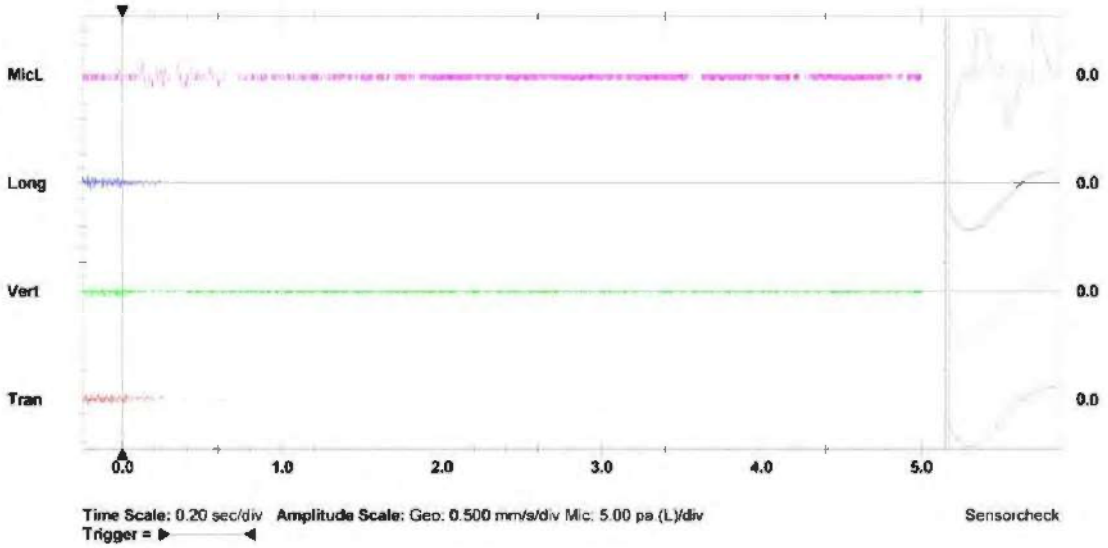
Microphone Linear Weighting
PSPL 109.5 dB(L) at 0.149 sec
ZC Freq 18 Hz
Channel Test Passed (Freq = 20.0 Hz Amp = 505 mv)

	Tran	Vert	Long	
PPV	0.191	0.254	0.254	mm/s
ZC Freq	N/A	N/A	N/A	Hz
Time (Rel. to Trig)	-0.074	-0.005	-0.198	sec
Peak Acceleration	0.0133	0.0199	0.0199	g
Peak Displacement	0.00006	0.00016	0.00019	mm
Sensorcheck	Passed	Passed	Passed	
Frequency	7.6	7.8	7.7	Hz
Overswing Ratio	3.5	3.2	3.4	

Peak Vector Sum 0.318 mm/s at -0.198 sec

N/A: Not Applicable





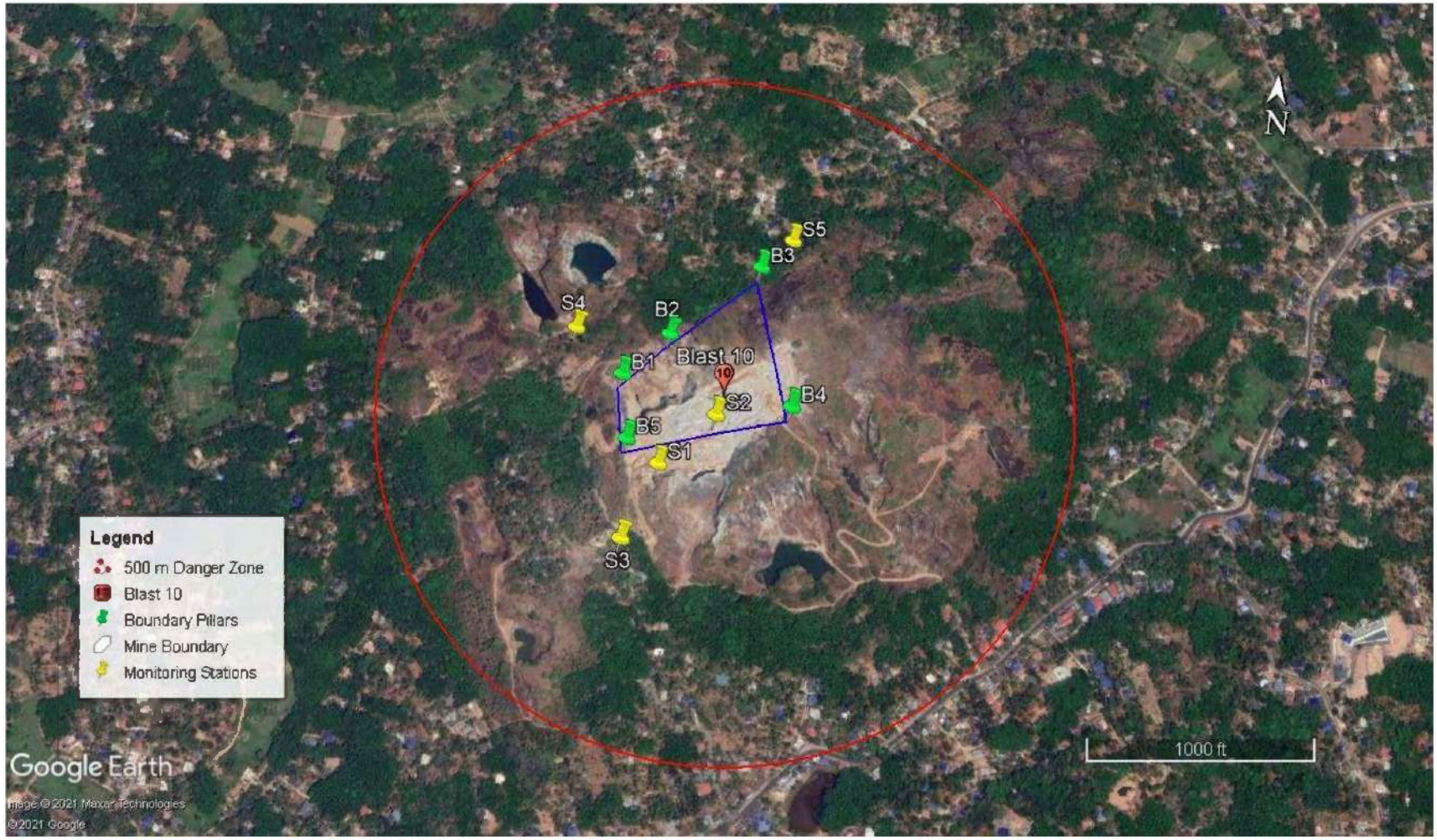


Figure 3.20 Imagery shows the location blast site 10 and its corresponding monitoring stations of M/s. Kadavila-1 Stone Quarry

3.2 Blast Vibration Monitoring

To minimise generation of blast induced ground vibrations and thereby their adverse effects on the residential buildings, and other structures, the blast vibration predictor equation for the quarry area has been developed by determining the field constants (which are site specific) by monitoring ground vibrations during all **10 trial blasts** in M/s. Kadavila-1 Stone Quarry. This monitoring was carried out by five numbers of seismographs of INSTANTEL (3 Nos.) and NOMIS (2 Nos.) make by locating them at different locations and distances from the blasting site.

Based on the parameters like the maximum explosive charge per delay, measured peak particle velocities (PPV), distances of each of the blasting sites to the monitoring stations of that particular blast, predictor equations for the site have been developed using regression analysis. This predictor equation was used to calculate the maximum (safe) explosive charge per delay by substituting the distance of the blasting site from the nearest residential structures.

Blast design for the trial blasts was based on the information collected from the site, the empirical relations normally used for blast design and the current practices prevailing in the quarry. Results of the trial blasts, rock type, height of the bench, existence of structures to be protected from blast vibrations like the residential structures of the village, etc. have been taken into account, in this report, while designing the future blasts for M/s. Kadavila-1 Stone Quarry.

3.2.1 Tolerable PPV Levels of the Residential Buildings and other structures of Nagaroor village (Kadavila village)

The guidelines by DGMS and others (given in **Section No. 1.3**) specify the tolerable PPV levels surface civil structures of various types can tolerate at different frequencies. Amongst them, DGMS recommends the least (most conservative and therefore safe) permissible peak particle velocities to which different types of structures should be subjected to, for ensuring their safety. Hence, these standards are considered for blast design in this report.

The **minimum and maximum blast vibration frequencies** recorded during the trial blasts ranged between **7.5 to 256 Hz** respectively. Keeping in view the minimum

frequency recorded during the trial blasts, the maximum PPV, structures of any type, can tolerate without damage fall within the frequency range of **8 to 25 Hz** recommended by DGMS in the **Table 1.2** and the same are given in the **Table 3.22**. Based on the DGMS recommendations, it is indicated in the **Table 3.22 (A)** that the tolerable PPVs measured at the foundation level of the structures are **10 mm/s for the domestic houses/structures made up of kutchha brick and cement** and **20 mm/s for the Industrial buildings (RCC & framed structures)** not belonging to the quarry management and **5 mm/s** for other **structures of historical importance** like **dam and bridges** if located within the vicinity of the quarry.

However, to avoid confusion for the people in the field, the maximum explosive charge per delay is calculated for this quarry to restrict the peak particle velocity to 5.0 mm/s only (irrespective of the type of structure), which is more conservative and safer as shown in the Table 3.22 (B). Further it will secure the safety of Domestic houses & structures/Residential buildings located in the Kadavila village whose safety is also very important.

Table 3.22 Permissible Maximum PPV for Residential buildings and othercivil structures for blast induced ground vibration frequenciesranging between 8 to 25 Hz

		Type of structure	Max. Permissible PPV, mm/s with Dominant excitation frequency in the range of 8-25 Hz
(A)		**Buildings / structures not belonging to the owner**	
	(i)	Domestic houses/structures (kutchha brick & cement), Residential & other Buildings of Vaniyamkulam village	**10**
	(ii)	Industrial buildings (RCC & framed structures)	**20**
	(iii)	Sensitive structures like Dam & Bridges in the Surrounding villages	**5**
(B)		**Maximum PPV considered for calculation of Max. Charge per Delay**	
		For all types of structure of Nagaroor village	**5**

3.3 Development of Predictor Equation

The vibration data generated during the trial blasts was analysed and a regression curve for the same at **95%** degree of confidence level has been drawn and indicated in **Figure 3.21**. The **95%** degree of confidence level was chosen because this is the minimum level at which all the measured data points were lying below this line(level). Based on the regression analysis, the predictor equation for the area has been developed and given in Equation 3.

$$V = 1026 * (SD)^{(-1.01)} \quad \ldots \quad (3)$$

where,

V	=	Peak particle velocity (PPV), mm/s
SD	=	Scaled distance, m/√kg
k and β =		Rock constants, which are site specific and

SD is calculated by equation **(2)**.

$$SD = \frac{D}{\sqrt{W}} \qquad (m/\sqrt{kg})$$

where,

D	=	Distance between the blasting site and the vibration monitoring station, m
W	=	Maximum explosive charge per delay, kg.

Accordingly, the safe (maximum) explosive charge per delay to be used and the maximum number of drill holes to be charges with same delay number for various distances of the blasting site from the structures like residential buildings and other structures in the Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District, Kerala to restrict the PPV to a maximum of 5.0 mm/s **with 95% confidence** are calculated using the predictor **equation (3)** developed for the site. **Table 3.23** gives the recommended maximum explosive charge per delay and the maximum number of drillholes to be charges with same delay number in M/s. Kadavila-1 Stone Quarry. Similarly, **Figure 3.21** depicts the maximum explosive charge recommended per delay.

Table 3.23 Maximum explosive charge recommended per delay for various distances of the blasting site to the structure to be protected like Residential buildings and other structures to restrict the blast vibrations (Peak Particle Velocity) to a maximum of 5 mm/s with 95% confidence level

Predictor Equation: $V = 1026 * (SD)^{(-1.01)}$		
Sl. No.	Shortest distance between the nearest structure to be protected to the blasting site, m	Maximum permissible explosive charge per delay, kg (rounded off to the nearest kg)
1	150	0.57
2	200	1.01
3	250	1.57
4	300	2.26
5	350	3.08
6	400	4.02
7	450	5.09
8	500	6.28
9	550	7.60
10	600	9.05

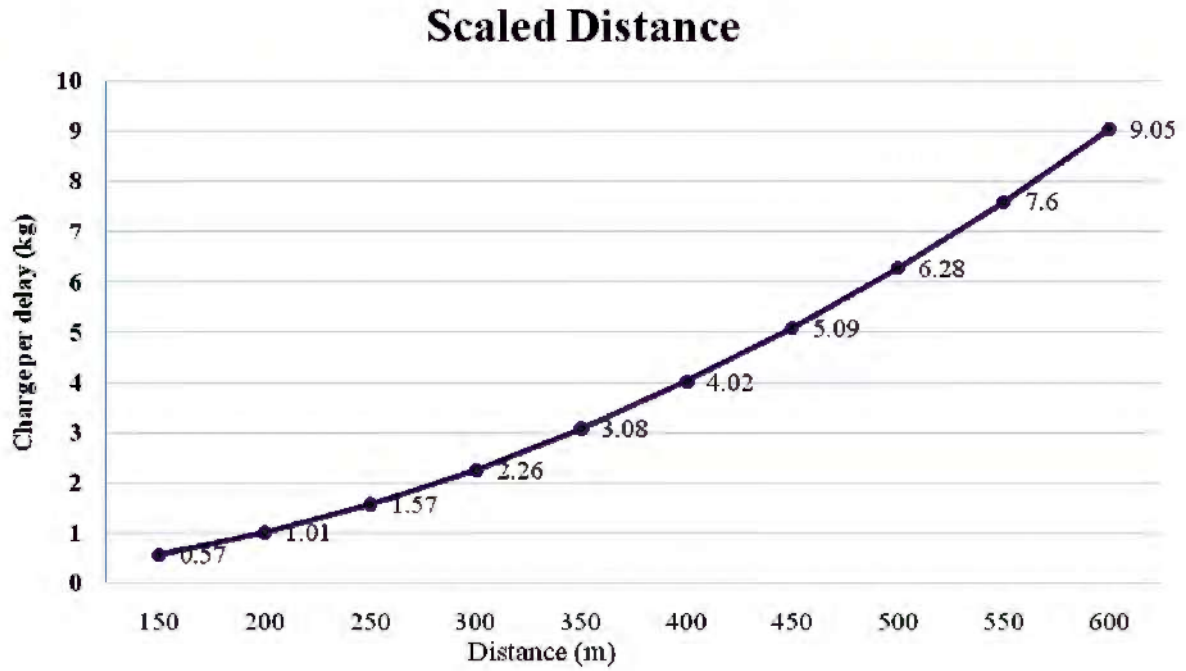


Figure 3.21 Relationship between maximum charge per delay and distance between the blasting site and the structure to be protected to restrict the blast induced ground vibrations (PPV) to a maximum of 5 mm/s

3.4 Results and Discussions

Ten trial blasts were carried out 16.03.2021 to 17.03.2021 and blast vibrations were monitored using five seismographs located at various distances. The minimum and maximum charge per delay varied from 1.07 to 2.17 kg. A maximum of 80 holes were drilled with jack hammer drilling equipment with a maximum number of holes per delay of six. In all the 10 trial blasts, ground vibrations were monitored at 47 locations around the blasting sites and neighbouring village. Out of the total 47 measurements made, vibrations were recorded by the instruments only at 36 stations. The vibrations recorded behind the blast free face were of highest magnitude. The magnitude of vibration recorded in the flank of direction of initiation was lower than those on the opposite side of the flank of blast initiation.

The maximum vibration recorded was 0.968 mm/s with associated dominant peak frequency range of 8.1 at a distance of 465 m from the site of blasting where the total explosive detonated in the blasting round was 18.75 kg and explosives weight per delay was 1.33 kg. Further, the maximum vibration of 0.397 mm/s was recorded at a distance of 359 m with associated dominant peak frequency range of 8 Hz from the blasting site where the total explosive detonated in the blasting round was 15 kg and the corresponding explosives weight per delay was 1.25 kg.

All the 10 blasts were carried out using NONEL shock tube detonators with an in-hole delay of 250 ms and surface delay of 25 ms. Fast attenuation of vibration was recorded at shorter distances whereas at far-off distances the attenuation was slow and was influenced by low frequency blast wave characteristics.

The recorded dominant frequencies of vibrations were in the range of 7.5 to 256 Hz. The FFT analyses of vibration data revealed that the concentration of vibrationenergy was in the range of 29.30 to 170.6 Hz. However, keeping in view the minimum frequency recorded during the trial blasts, the maximum PPV structures of any type, can tolerate without damage fall within the frequency range of 8 to 25 Hz. However, to avoid confusion for the people in the field, the maximum explosive charge per delay is calculated for this quarry to restrict the peak particle velocity to
5.0 mm/s only (irrespective of the type of structure), which is more conservative and safer as shown in the Table 3.22. Further it will secure the safety of Domestic

houses & structures/Residential buildings located in the Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District, Kerala whose safety is also very important.

Similarly, the maximum level of air over-pressure monitored at a distance of 205 m in the neighbouring village as 63.7 dB(A). All the recorded data were well within the threshold level of air over pressure/noise as per DGMS standard {85 dB(A)} and hence it will not cause any damage to the windows etc. of the houses/structures of the concerned village. Further, there was no ejection of flyrocks beyond the distance of 15 m in any of these blasts.

The analyses of vibration data recorded from detonation of blasts with higher amount of explosives generated higher level of vibrations at near-by-distances in comparison to the blasts which were detonated at the same bench face with lesser amount of explosives although the blast design and explosives parameters were kept identical. The explosives detonated in a delay in both the blasts were similar in weight.

The propagation equation for prediction of blast vibration have been established and are given as Equations 3. The permissible explosive weight per delay may be computed from the Equation to contain vibration within safe limits for distances of houses/structures concerned. For convenience, the permissible explosive weight per delay has been computed and is given in Table 3.23.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

4.0 Conclusions and Recommendations

The Anna University team have conducted scientific study to evaluate damage potential of the blast induced ground vibration and air overpressure induced byblasting operations at Kadavila-1 Stone Quarry located in the Nagaroor village.Altogether 10 experimental blast rounds were conducted in Kadavila-1 Stone Quarry. Comprehensive vibration monitoring was carried out during the blasting experiment. In all the 10 trial blasts, ground vibrations were monitored at 47 locations around the blasting sites and neighboring village which includes domestic houses and other prominent structures of the village such as the houses are not belonging to the owner of mine management.

It is observed that the blast induced ground vibration and air overpressure (noise) monitored at the locations such as houses (which are not belonging to the mine management) beyond a distance of 130 m from the blasting site remained **less than 3.00 mm/s** and **63.7 dB(A) against recommended safe values of 5.0 mm/s and 85 dB(A)** respectively. Ground vibration beyond a distance of 300 m decayed to less than 1.0 mm/s in majority of the cases observed. Therefore, it may be concluded that observed blast induced ground vibration values are safe and well within the permissible limit as per recommendations of Directorate General of Mine Safety (DGMS).

Based on the scientific study, it is concluded that **the blast induced ground vibrations and noise levels generated by the controlled blasting carried out in Kadavila-1 Stone Quarry was within permissible level and therefore is not affecting the residential buildings and other structures. Further, it has been observed that no flying fragments or projectiles travelled beyond 10 m from the site of blast. Hence, controlled blasting can be carried out at Kadavila-1 Stone Quarry** by following the blasting parameters as recommended in the **Table No. 4.1**.

Here, it is recommended that the permissible explosive weight per delay may be computed from the Equation to contain vibration within safe limits for distances of houses/structures concerned. Hence, the maximum charge per delay shall not exceed the value specified in **Table 3.22** corresponding to the distance between the blasting site and the residential building or any sensitive structure.

Further, it is recommended to continue the present method of fragmenting the oversized rocks using Rock breakers and wherever possible, to adopt muffling using old tyres / old conveyor belts in the blasting operation which will not only minimize the flyrock generation as well as condense the noise generation considerably.

However, it may be noted that the recommendations of this report are site specific and can be effectively implemented only in M/s. Kadavila-1 Stone Quarry and not to the quarries outside the study area.

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Table 4.1 Summary of suggested Controlled Blast Design for M/s. Kadavila-1 Stone Quarry

Sl. No.	Parameter			Value
1.	Blast hole diameter			33 mm
2.	Burden			1.2 m
3.	Spacing			1.5 m
4.	Height of the bench			6.00 m
5.	Stemming length			Minimum 0.70 m
6.	Drilling patterns to be followed			Rectangular / Staggered
7.	Specific charge	For creating Initial (Box) Cut		0.16 to 0.17 kg/m^3
		For production blasting		0.15 to 0.16 kg/m^3
8.	Loading Density	Cap-sensitive Emulsion (or) Slurry Cartridges		0.26 kg/m
9.	Average explosive Quantity/hole	Cap-sensitive Emulsion (or) Slurry Cartridges		0.50 kg
10	Maximum explosive charge per drillhole during production blasting	Cap-sensitive Emulsion (or) Slurry Cartridges	125 g	0.625 to 0.688 kg
11	Detonators recommended			NONEL based detonators of 17/25 ms surface delay with an in-hole delay of 250 ms
12	Type of explosive recommended			Emulsion (or) slurry cartridge type (ø=25 mm)
13	Initiation system recommended			Inverse initiation
14	Method of connecting detonator			Series
15	Maximum charge per delay			As stated in **Table 3.22** based on the distance of the blasting site from the structure and the type of structure to be protected

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DISCLAIMER

The scientific investigation presented in this report was carried out by Department of Mining Engineering, Anna University, Chennai. The findings were based on **10 Nos**. of **trial blasts** carried out with **33 mm diameter holes** to a maximum **depth** of **2.4 m** using cap-sensitive **Emulsion explosive** cartridges of **25 mm diameter** along with **NONEL.** Blast design for Kadavila-1 Stone Quarry. given in this report is based on the scientific investigations including the results of the trial blasts.

The Department of Mining Engineering, Anna University, Chennai is not responsible for the results produced, if there is any change in the conditions like – increase in strength of the explosives used, using more explosive charge per delay than recommended in **Table – 3.23** of this report, adopting faulty initiation sequence, not following the recommendations of this report etc.

The **Department of Mining Engineering,** Anna University, Chennai **is no way responsible for proper implementation of the recommendations of this report, as the day-to-day activities in the mine are neither under its control nor possible for it to control.**

In view of the above, neither the authors of this report nor the Department of Mining Engineering, Anna University **assume any liability with respect to any claims, damages or losses which may result from the implementation of the conclusions and recommendations / results of this report.** This report is only for the guidance of quarry management and the Kadavila-1 Stone Quarry management has to decide on all other safety and operational aspects of the actual blasting operation for the Kadavila-1 Stone Quarry. It is also the responsibility of the management to take all statutory and other additional safety precautions and measures while carrying out the blasting as the same have not been stated in this report.

DEPT. OF MINING ENGG. CHENNAI 600 025 CEG CAMPUS, ANNA UNIVERSITY

28/06/2021

(Dr. P. BALAMADESWARAN)
Consultant

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ANNEXURE – I

DGMS Technical (S & T) Circular No. 7 of 1997

Sub: Damage of structures due to blast induced ground vibrations in the mining areas.

1. Introduction

In response to increase demand for coal and other minerals, a number of large mechanised opencast mines have come into operation. Some of these opencast workings are located near surface structure like residential buildings, schools, commercial shops, hutments with large number of inhabitants etc. Whenever blasting is done in these opencast mines, ground vibrations are generated outward from the blast area and cause damage to surrounding surface structures. The vibrations radiating from the blast holes while passing through surface structures, induce vibrations on the structures causing resonance. The components of ground motion can affect the structures through compression and tension and also through vertical and horizontal shearing effects. Blast induced ground vibrations create socioeconomic problems for the mine managements as well as the people residing in vicinityof these mines. As only 20-30 % of energy of commercial explosives used in the mines is utilized for fragmenting the rock, the rest of energy is transmitted through the earth in the form of ground vibrations resulting in damage to the surrounding structures.

2.0 Damager Criteria

The peak particle velocity has so far been considered as the best criteria for evaluating blast vibrations in terms of its potential to cause damage. The extensive studies on the problems have established that the frequency of the waves is also equally important factor to consider the effect of damage. The blasting damage is generally classified into following four categories:

Sl. No.	Category	Description of damage
i.	No appreciable damage	No formation of noticeable cracks.
ii.	Threshold damage	Formation of fine cracks, fall of plaster, opening & lengthening of old cracks, loosening of joints, dislodging of loose objects etc.
iii.	Minor damage	Superficial not affecting the strength of structure(s). Hair line cracks in masonry around openings near partition, broken windows. Fall of loose mortar etc.
iv.	Major damage	Formation of several large cracks, serious weakening of structures, shifting of foundation, fall of masonry, ruptures of opening vaults etc.

3.0 Natural Frequencies

Elements of building construction such as sprung floors, stud partition walls, ceiling and windows can all react as mass-spring systems; each with its own natural frequencies of about 4-24 Hz (low frequencies) Ground vibrations at these frequencies amplified by the structures increase the risk of damage. When the low frequency ground vibration coincides with the natural frequency of the structure resonance in originated. The resonance is a state in which the structure absorbs most energy progressively becoming deformed with time, untilplastic deformation occurs. Therefore even the low peak particle velocity of ground vibrations at natural frequency of structure is more harmful to the structure. Natural frequencies of brickand concrete structure generally vary from 8-16 Hz.

4.0 Structural response

All structures develop cracks from natural causes like periodic changes in humidity, temperature and wind velocity. Changes in soil moisture cause foundation cracks. The width of old cracks change seasonally and number of cracks increase with the time. This damage is independent of damage caused by blasting.

The cracking location and the wall material have an influence on the particle velocity at which cracking begins. If the entire structure is not inspected thoroughly, there may be chances of biased opinion on the type of cracks. Thus it is important to place transducer properly for the correct assessment of damage.

In the mud houses, number of cracks develop before blasting and these cracks widened and et extended with the passage of time. These cracks are further widened and get extended due to blast induced ground vibrations. Concrete structures vibrate for longer duration that brick and mud structures. Concrete walls have free top and show no cracks at vibration levels for which mud and brick walls can damage Cracks develop in concrete walls withlarge vibration level. Cracks in brick- structures can be observed in junction of walls, roof andat window corners. Brick walls with clay mortar and cement- sand mortar behave in same fashion. Steel structures can sustain more vibration level.

The magnitude of vibrations on structures in much is more than on the ground. Duration of vibration in structure is also longer than, that of ground vibration. Multi-storied buildings are more sensitive to blast vibration that the single-storied buildings.

To predict the extent of damage and to take preventive measures, it is necessary to measure ground vibrations due to blasting. Studies on structural response of ground

vibration in the structures of different constructions within the mining areas under Indian condition are limited and therefore such study should be carried out to ascertain the degree of damages for improvement and standardization of damage criteria under Indian conditions.

5.0 Measurement of blast induced vibrations

5.1 Instrumentation

The instrument selected for monitoring blast induced ground vibration shall be simple, light, compact, easily portable, battery operated, digital form output, triggering by geophone etc. Triaxial transducers for recording blast vibration shall have a liner frequency up to 500 Hz and capable of recording particle velocity up to 100 mm/s.

5.2 Methodology

The transducers shall be placed near the structure on the solid undisturbed ground and should be placed well in contact with the ground. For structural response, the transducers shall be placed horizontally over the wall, floors and ceiling. A minimum of 15 points of observations corresponding to a minimum of 10 blasts shall be made for better prediction with a high index of determination.

5.3 Predictor Equation

The least means square method of regression analysis shall be used to interpret the date. The square roof scale distance shall be used for analysis and interpretation of data when blasting is done on surface and measurements are taken on the surface, or the blasting is done underground and measurements are taken underground. On the other hand, if blasting is done on the surface and the measurements taken underground the cube root scaled distance shall be used.

6.0 Guidelines on experimental blasting

6.1 Factors

Major factors affecting particle velocity of ground vibration are type and amount of explosive charge used, distance from the charge to the point of observation (surface structures), geological, structural and physical properties of the rock that transmits the vibrations, height of structures and blast geometry. Use of safe charge/delay, in hole delay with non- electric initiation systems. Proper burden, inclined holes in conformity with slope of bench, deck charge, air deck, sequential blasting, clearing off loose pieces of rocks from the blast site and proper stemming of holes bring reduction in blast induced ground vibrations. Controlled blasting methods in conjunction with effective muffling of holes will control ground vibrations and also arrest fly rock.

6.2 Plan

A plan showing structures belonging to the to the owner and not belonging to the owner in different prominent shades should be prepared. The plan shall incorporate details of construction of the structures in a tabular form. Plan should also show 50 m., 100m, 200 m and 300 m zones from the structures, the place of experimental study and the limit upto the which blasting is proposed to continue.

6.3 Study/ observations

In a particular mining area with built-up structures where deep hole blasting is to be introduced for the first time, experimental blasting shall be carried out by any research/ academic institute much before the structures fall within the blasting danger zone. The typeof instruments, the methodology and predictor norm as recommended in para 5.0 shall be followed in measurement of blast induced vibrations. Based on the study, the safe chargesfor different zones shall be determined and recommendations made in the report. In a clusterof buildings of different types existing close to each other, the charge for the buildings/ structures requiring greater protection against damage shall be assessed and recommended.

6.4 Structural response

During the study the response of the structures assuming different natural frequenciesshould be calculated and plotted on a figure. Software with the different programmes are available now for the said plot and should be used for convenience.

6.5 Monitoring

In order to ensure effective control over the vibration and related damages there is a need for regular inhouse monitoring and the managements should train the blasting personnel during the experimental study and start observations on their own during the regular blasting operations.

7.0 Recommended permissible standards of blast induced ground vibrations:

7.1 Technical considerations

Permissible standards for different type of structures have been arrived at considering the importance of building and structures. The buildings of historical importance and multi- storied structures are likely to get damaged with low level of vibration and therefore permissible standards are to be lowest. Similarly buildings not belonging to the owner but with mud/brick in cement construction and others with good construction (RCC and framed structures) should also be protected but higher permissible standards than that of the level

fixed for first category has been allowed. The buildings belonging to the owner of the mine are constructed for a limited period generally equal to the life of the project. The management accept that these buildings constructed within the mining area are likely to suffer some damages during the extraction of minerals, but the damages should be repairable. Therefore, slightly higher permissible levels of vibrations have been allowed in such cases.

7.2 Permissible standards

Depending on the type of structures and the dominant excitation, the peak particle velocity (ppv) on the ground adjacent to the structure shall not exceed the values given below in the table.

Table: A1 Permissible Peak Particle Velocity (ppv) at the foundation level of structures in Mining Areas in mm/s

Type of structure			Dominant excitation frequency, Hz		
			<8 Hz	8-25 Hz	> 25 Hz
(A)	Buildings / structures not belonging to the owner				
	(i)	Domestic houses/structures (kutchha brick & cement)	5	10	15
	(ii)	Industrial buildings (RCC & framed structures)	10	20	25
	(iii)	Objects of historical importance & sensitive structures	2	5	10
(B)	Buildings belonging to the owner with limited span of life				
	(i)	Domestic houses/structures(kutchha brick & cement)	10	15	25
	(ii)	Industrial buildings (RCC & framed structures)	15	25	50

In view of the complexities of the problems I hope you all would take adequate measures as recommended above to ensure that the blasts near surface structures are carried out with utmost care and precautions. The blast induced ground vibration should be within the permissible limits as specified above.

ANNEXURE – II
PROCEDURE FOR DEALING WITH MISFIRES

Abstract of Regulation No. 167 of Metalliferrous Mines Regulations 1961 on Misfires:

(1) When shots are fired electrically, no person shall re-enter or be permitted to re-enter the place of blasting until 5 minutes after firing of the shots and the source ofelectricity has been disconnected from the cable.

(2) In the event of a misfire, the entrance or entrances to the place shall be barricaded or fenced so as to prevent inadvertent access; and no work other than that of locating or relieving the misfire shall be done therein until the misfire has been located and relieved. The place of the misfire shall be marked with a red flag.

(3) In the event of a misfire, the tamping may be sludged out with compressed air or water under pressure. The hole shall thereafter be re-primed and fired.

(5) Except where the misfire is due to faulty cable or a faulty connection, and the shot is fired as soon as practicable after the defect is remedied, or where a shot has been re-primed and fired under sub-regulation (3) another shot shall be fired in a relieving hole which shall be so placed and drilled in such a direction that at no point shall it be nearer than 30 centimetres from the misfired hole. The now hole shall be bored in thepresence of a blaster, preferably the same person who fired the shot.

(7) If a misfired hole is not dislodged by a relieving shot, the procedure laid down I sub-regulation (5) and (6) shall be repeated. A misfired hole which cannot be dealt with in the manner so prescribed shall be securely plugged with a wooden plug; and no person other than a blaster or a mining official or a person authorised for the purpose shall remove or attempt to remove such plug.

(8) When a misfired shot is not found, or when a misfired shot is not relieved or re- blasted, the blaster shall, before leaving the mine, give information of the failure to such official as may relieve or take over charge from him. He shall also record, in a bound paged book kept for the purpose, a report on every misfire, whether suspected, and whether relieved or not relieved. It shall be the responsibility of the relieving blaster or official also to sign the report and later to record in the said book the action taken for reliving the misfired shot hole.

(9) The blaster of the next shifts shall locate and re-blast the misfired hole, but if after a thorough examination of the place where the misfire was reported to have occurred, the blaster or other competent person holing a Manager‟s or Foreman‟s certificate appointed for the purpose by the Manger, is satisfied that no misfire had actually occurred, they may permit drilling in the place.

ANNEXURE - III

DGMS Technical (S & T) Circular No. 1 of 1995

Sub: Danger due to lightning/storm during blasting operation in mines

Recently, three accidents took place due to premature blasting by lightning when persons were killed/injured/escaped while they were in the process of charging explosives/connecting detonators etc. These accidents occurred as mentioned below:

1. While 9 deep holes and a number of secondary holes were being charged to be connected in series and fired, a lightning discharge due to thunderstorm caused premature firing of the deep holes, killed three persons and inflicted serious bodily injuries to one.
2. While a Blaster was carrying 100 primed cartridge of explosives with electric detonators in a card-board box on his shoulder, the cartridges exploded suddenly resulting in instant death of the Blaster.
3. While a Blaster and his helpers were about to take shelter after charging of the holes, suddenly there was a lightning/thunder-storm resulting in premature blast of the holes. Persons escaped unhurt.

Accidents due to above causes continue to occur despite very clear safety precautions laid down while granting permission under Reg. 106(2) (b) of MMR 1961 and Reg. 98 of CMR 1957 and also Circulars issued by DGMS recommending additional precautions to prevent such accidents. These precautions in brief are given below:

1. Shots shall not be fired except during the hours of daylight or until adequateartificial light is provided; all holes charged on any one day shall be fired on the same day as far as practicable.
2. As far as practicable, shotfiring shall be carried out either between shifts or during the rest interval or at the end of work for the day.

During the approach and progress of an electric storm, the following precautions shall be taken:

(a) Neither explosives not detonators shall be handled;
(b) If charging operations have been commenced, the work shall be discontinued until the storm has passed;
(c) If the blast is to be fired electrically, all exposed wires shall be coiled up and, if possible, placed in the mouth of the holes or kept covered by something other than a metal plate,
(d) All wires shall be removed from contact with the steel rails of a haulage track, so as to prevent the charge being exploded prematurely by a local strike of the lightning;
(e) If the firing circuit has been set up before the thunderstorm came on, the persons at the site should withdraw at the earliest and the blast should be fired off immediately;
(f) All persons shall be withdrawn from the danger zone.

ANNEXURE – IV
Procedure for Warning and Withdrawing of Persons from the Blasting Zone

1. The Quarry management should employ persons possessing statutory qualifications of Blaster‟s Certificate from Directorate General of Mines Safety (DGMS) to handle and use explosives. The Blaster will be in-charge of receipt, transport, use and return of unused explosives and accessories.
2. All blast site employees shall follow the instructions of the Blaster and they shall use and adhere to every precaution to ensure employee safety including, but not limited to, visual and audible warning signals, flags, etc.
3. The Blaster should possess the Exploder Key with him during the entire process of charging and firing and he should not hand over it to any other unauthorised person.
4. All shots will be fired by the Blaster himself.
5. The blaster shall keep an accurate, up-to-date record of explosives and blasting accessories used in each blast and shall keep an accurate running inventory of all explosives and blasting accessories in his custody.
6. The Quarry management will maintain an inventory of the explosives and accessories received, issued, used and returned in a bound paged notebook kept for the purpose. A competent person will be in-charge of these operations.
7. The storage and handling of explosives will be in accordance with the provisions of Explosive Rules.
8. No explosives or accessories shall be abandoned.
9. Smoking, firearms, sparks, open flame or heat producing devices (including cell phones and battery operated watches) will be prohibited where explosives are being stored, handled, transported or used.
10. Electric Detonators shall never be pulled, stretched, kinked, twisted, mashed or abused in any way which could cause the tube to break or otherwise malfunction.
11. Electric detonator connections and splices shall be competent and positive in accordance with the manufacturer‟s recommendations.
12. No blast will be fired if any person is present in the vicinity of the blasting area. If any person is present or any operations are being carried out, steps will be taken to withdraw such persons or suspend above operations completely.
13. The Quarry management will establish a code of blasting signals as noticed below and all blast site employees will be familiarized with them: It is obligatory on the partof every employer and other person in the blasting zone to adhere to the code and keep away from the blasting zone during the blasting operations.

- contain audible pre-blast and all clear signals
- contain an emergency method for guards, flagmen, or authorized employees to signal "do not fire", and
- prohibit sounding of the all clear signal until the blaster has checked the blast site for misfires. The following table that would meet these requirements.

Signal	Meaning
WARNING SIGNAL	A one minute series of long hooter / siren / blasts 5 minutes prior to blast signal.
BLAST SIGNAL	A series of short hooter / siren / blasts one minute prior to the shot.
ALL CLEAR SIGNAL	A prolonged hooter / siren / blast following the inspection of blast area.

14. Blasting flags (red flags) shall be displayed around the blasting zone before blasting to facilitate clearing of all persons from the blasting zone.
15. Flagmen will be safely stationed on all sides of the blasting area so as to stop any inadvertent entry.
16. In the event of any misfires, the blaster will determine the suitable method(s) to detect misfires and take preparatory steps (e.g., noting obvious indications of misfire, or other appropriate means). Misfires shall be handled in accordance with the requirements of Metalliferous Mines Regulations - 1961 (given in **Annexure–II**).
17. All lines shall be carefully traced and a search made for unexploded charges before giving all clear signals.
18. No drilling, or loading shall be permitted until all misfires have been cleared.
19. The safety zone of 500 m is to be maintained at the time of blasting
20. All blasting operations will be conducted between sun rise and sun set (during the daylight hours) and preferably during a specific period of time like 12.00 noon to 3.00 p.m.

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ANNEXURE - V

The monitoring instrument (S5) is located at the distance of 282 m from the blasting site (B8)

The monitoring instrument (S5) is located at the distance of 282 m from the blasting site (B4)

The monitoring instrument (S3) is located at the distance of 174 m from the blasting site (B6)

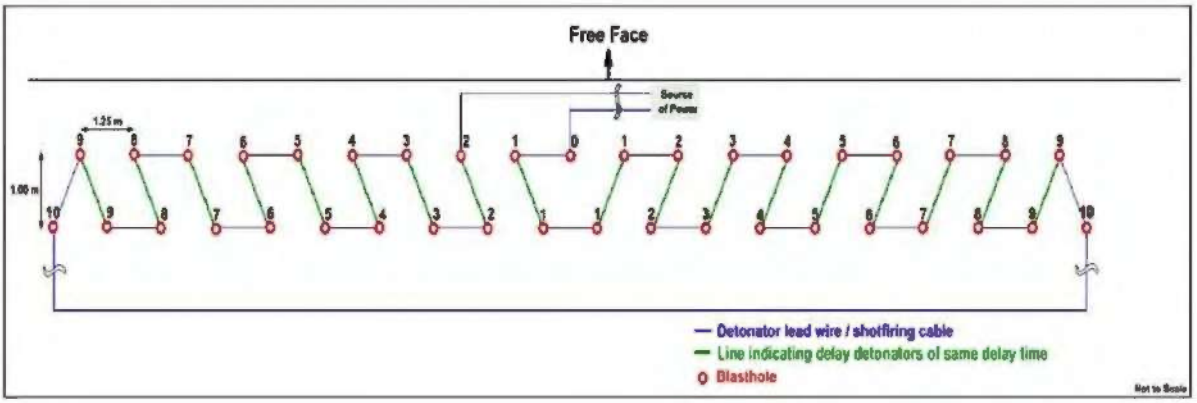
The vibration monitoring station (S1) is located at the distance of 297 m from the blasting site (B2)

The monitoring instrument (S3) is located at the distance of 465 m from the blasting site (B4)

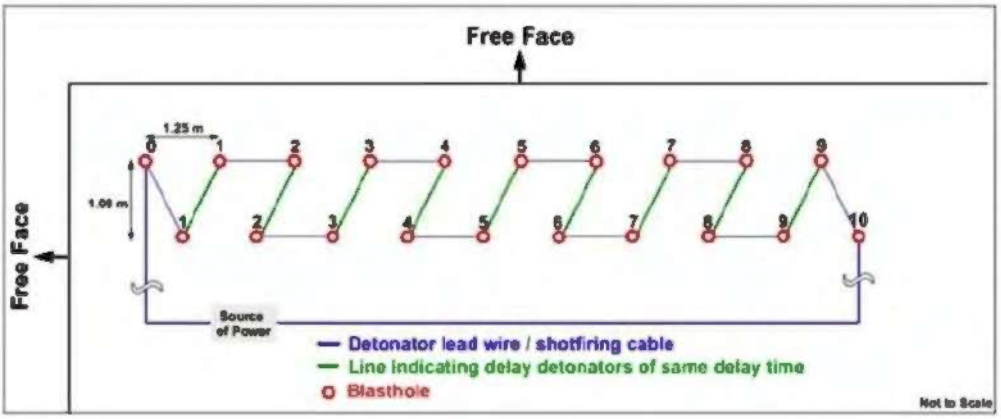
The vibration monitoring station inside the Temple near to Kadavila-1 Stone Quarry

ANNEXURE - VI

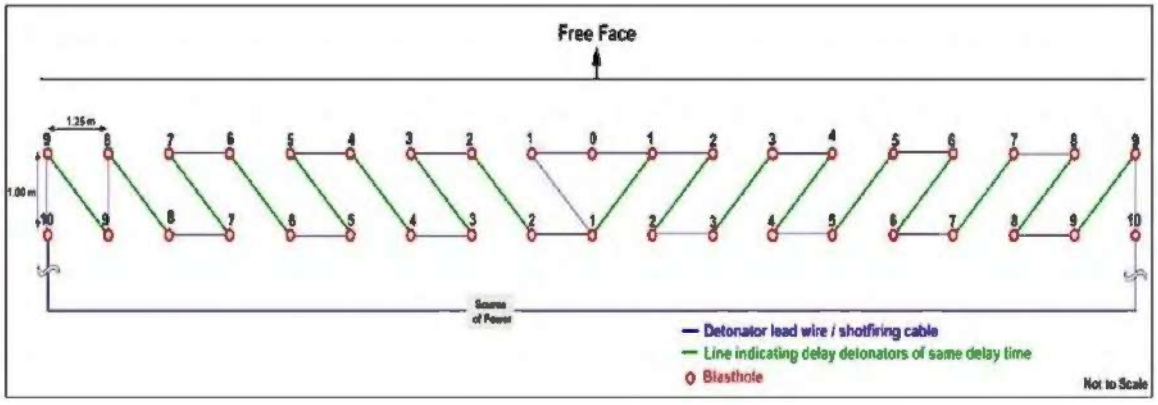
Suggested Blasthole Patterns & Initiation Sequences



Multi row Staggered blasthole pattern with 'V' initiation sequence for benches with SINGLE free face



Multi row staggered blasthole pattern with 'V' initiation sequence for benches with TWO free face



Multi row Square/rectangular blasthole pattern and initiation sequence for benches with ONE free face

ANNEXURE-R14

GOVERNMENT OF KERALA

Abstract

Fisheries & Ports Department - Vizhinjam International Seaport project –Condoning the delay occurred for the completion of the Project and extension of the Scheduled Completion Date of the Project for a period of 5 years, Extension of the Concession Period by 5 years, Signing the Tripartite Agreement as Confirming Party, withholding an amount of Rs. 219 Crores as Commitment Fee Deposit from the Equity Support - Sanction Accorded- Orders Issued.

FISHERIES & PORTS (E) DEPARTMENT

G.O(Ms)No. 2/2024/F&PD Dated, Thiruvananthapuram, 15-02-2024

Read:
1. Letter F.No.3D(2)/1/2014-PPP(Vol-III) of PPP Cell, DEA dated 03-02-2015 from the Department of Economic Affairs, Ministry of Finance, Government of India.
2. Concession Agreement executed between Government of Kerala and Adani Vizhinjam Port Private Limited on 17-08-2015
3. Letter F. No. 2/2/2018-ISD dated 27-07-2022 from the Deputy Secretary to GoI, Ministry of Economic Affairs, Ministry of Finance.
4. E-mail dated 03-11-2022 from the Deputy Director, Infrastructure Support and Development Division (ISDD) Department of Economic Affairs, Ministry of Finance.
5. Letter No. SS GK 7/2023/AG dated 25-04-2023 from the Advocate General of Kerala, Ernakulam.
6. Minutes of the High Level Meeting convened by Chief Secretary on 08-01-2024.
7. Letter Nos. AVPPL/GoK/2023-24/2503 dated 28-10-2023 from the M.D. & C.E.O. Adani Vizhinjam Port Private Limited & AVPPL/GoK/2023-24/2793 dated 08-01-2024 from the M.D. & C.E.O AVPPL.
8. Letter No. SS GK 7/2023/AG dated 09-02-2024 from the Advocate General of Kerala, Ernakulam.

ORDER

As per the letter read as 1st paper above, In-Principle approval for Viability Gap Funding (VGF) for the development of Vizhinjam International Deepwater Multipurpose Seaport was accorded by the Department of Economic Affairs, Ministry of Finance in 2015. Following this, Government of Kerala completed the bid process and the Letter of Award was issued to the selected bidder, M/s.Adani Ports and Special Economic Zone Ltd (APSEZ) on 13th July 2015. Accordingly, the Concession Agreement(CA) for the

Project was executed between Government of Kerala and the Concessionaire, M/s. Adani Vizhinjam Port Private Limited (AVPPL) on 17th August 2015. As per the CA, the Scheduled Completion Date (SCD) is 03-12-2019, i.e. 1460 days from the Appointed Date.

2. The Concessionaire has not been able to complete the Project even after the cure period of 270 days from the original SCD. The Concessionaire at different points of time had raised 16 numbers of Force Majeure Events which were rejected by Vizhinjam International Seaport Ltd (VISL), the SPV constituted for the purpose of implementing the Seaport project. Due to the non-completion of the project, VISL had issued notice for levying the liquidated damages from the Concessionaire on account of the Concessionaire Default. It was also intimated to the Concessionaire that since further time is required for resolving the disputes raised by the Concessionaire, it is premature and irregular on their part in invoking arbitration without completing the steps under Article 45.2 of the Concession Agreement. In spite of this, the Concessionaire moved with arbitration proceedings.

3. The claims of the Concessionaire before the Arbitration Tribunal are extension of Scheduled Completion Date from 03rd Dec 2019 to 03rd Dec 2024 (5yrs), extension of Concession Period from 40 to 45 yrs (i.e. by 5 yrs) & an amount of Rs.3854 Cr which includes Equity Support of Rs.1227 Cr. The VISL has furnished their counterclaims including non-extension of the Scheduled Completion Date, non extension of the Concession Period and an amount of Rs.911 Cr which includes damages for delay in completion of port. The Arbitration proceedings are ongoing now.

4. As per the letter read as 3rd paper above, the Department of Economic Affairs, Ministry of Finance has conveyed GOI's final approval of Viability Gap Funding(VGF) support for the development of Vizhinjam International Multipurpose Seaport Project. In continuation to this, vide the e-mail read as 4th paper above, the Deputy Director, Infrastructure Support and Development Division (ISDD), Department of Economic Affairs, Ministry of Finance has forwarded the premium sharing agreement and the Tripartite agreement that needs to be signed by the concerned parties and requested to forward the Tripartite agreement duly signed by the Concessionaire, LFI and DEA and confirmed by PSA (Government of Kerala) for further necessary action.

5. As per the letter read as 5th paper above, the Advocate General opined that due to the provision in 3.2 (h) in the Tripartite Agreement, Govt of Kerala cannot confirm the Agreement as Arbitration proceedings are pending in the Arbitral Tribunal and the Concessionaire is in default of the CA.

6. As per the letter read as 7th paper above dated 28-10-2023, the M.D. & C.E.O. AVPPL expressed their willingness to withdraw the Arbitration.

7. Based on this, a High Level Committee Meeting convened by Chief Secretary on 08-01-2024 decided that the construction delay of 5 years can be condoned and Scheduled Completion Date can be extended till 3rd December 2024. But the Concession Period and the Revenue sharing should remain the same as per the Concession Agreement. The High Level Committee negotiated with AVPPL officials and asked them to submit their contentions for the delay in implementing the project in writing.

8. The M.D. & C.E.O AVPPL vide letter read as 7th paper above dated 08-01-2024 furnished their contentions in writing and reported that the challenges faced by them included Cyclones, Adverse weather conditions, Floods, Covid-19 pandemic, Public Agitations, and other numerous Force Majeure Situations and also put forth certain suggestions.

9. Based on the suggestions putforth by AVPPL, the opinion of Advocate General was sought for and vide letter read as 8th paper above, the Advocate General opined that the proposal can be approved. There is no legal impediment in arriving at settlement of disputes and that in the long run the settlement as proposed could be in the best interest of the State.

10. Having examined all matters in the interest of the State and taking into account the opinion of the Advocate General, Government are pleased to issue the following orders:

1) The delay occurred in completing the Vizhinjam International Seaport project by AVPPL is condoned and the Scheduled Completion date is extended for a period of 5 years (i.e from 03-12-2019 to 03-12- 2024)

2) The Concession Period is extended for 5 years (i.e from 2055 to 2060), subject to the following conditions:

   (i) AVPPL shall withdraw all the arbitration claims filed before the arbitral tribunal;
   (ii) the Revenue sharing should remain the same i.e. the 15th Anniversary (from 2034) as per the Concession Agreement;
   (iii) The capacity augmentation shall be achieved by 2028 itself;

3) In addition to the above, following financial arrangements shall be made with AVPPL:

   i) An amount of Rs. Two Hundred and Nineteen Crores is withheld as Commitment Fee Deposit from the Equity Support to be given by Government of Kerala to AVPPL.
   ii) From the amount so withheld, an amount of Rs. 175.2 Crores (43.8 x 4) shall be released to AVPPL once the 2nd and 3rd phases of the project are completed in 2028.
   iii) An amount of Rs. 43.8 Crores shall be retained by GoK.

4) Chief Secretary is entrusted to ensure that AVPPL shall comply with the above conditions and also to sign the Tripartite Agreement as Conforming Party once AVPPL takes action to withdraw the arbitration proceedings.

(By Order of the Governor)

K.S. SRINIVAS
Principal Secretary to Government

To

The Advocate General, Kerala (with c/l)

The Managing Director, Vizhinjam International Seaport Ltd., Thiruvananthapuram

The Managing Director & Chief Executive Officer, Adani Vizhinjam Ports Private Ltd.

The Principal Accountant General (Audit), Kerala, Thiruvananthapuram.

The Accountant General (A&E), Kerala, Thiruvananthapuram.

General Administration (SC) Department (vide Decision No. 2053 dated 14-02-2024 & Decision No. OA. No. 2065 Dated 15-02-2024)

Finance Department (file No. 2266720/PU-B3/136/2022/Fin dated 13-04-2023

Law Department (file No. 62/convey 1/2022/Law dated 13-12-2022 & No.15/LS/2024/Law dated 15-02-2024.)

The Information Officer, Web & New Media, Information and Public Relations Department (for uploading in the Government web site.)

SF/OC.

Forwarded/By Order

Section Officer.

Copy to :- The Private Secretary to Chief Minister
The Private secretary to Minister (Ports, Co-operation)
PA to Principal Secretary, Ports.

Regn. No. KERBIL/2012/45073
dated 5-9-2012 with RNI
Reg. No. KL/TV(N)/634/2015-17

കേരള ഗസറ്റ്
KERALA GAZETTE

അസാധാരണം
EXTRAORDINARY

ANNEXURE-R15

ആധികാരികമായി പ്രസിദ്ധപ്പെടുത്തുന്നത്
PUBLISHED BY AUTHORITY

വാല്യം 6 / Vol. VI — തിരുവനന്തപുരം, വെള്ളി / Thiruvananthapuram, Friday — 2017 ജൂൺ 23 / 23rd June 2017 — 1192 മിഥുനം 9 / 9th Mithunam 1192 — 1939 ആഷാഢം 2 / 2nd Ashadha 1939 — നമ്പർ / No. 1290

GOVERNMENT OF KERALA

Industries (A) Department

NOTIFICATION

G. O. (P) No. 25/2017/ID.

Dated, Thiruvananthapuram, 22nd June, 2017
8th Mithunam, 1192.

S. R. O. No. 346/2017.—In exercise of powers conferred by sub-section (1) of section 15 of the Mines and Minerals (Development and Regulation) Act, 1957 (Central Act 67 of 1957), the Government of Kerala hereby make the following Rules further to amend the Kerala Minor Mineral Concession Rules, 2015 issued by notification under G. O. (P) No. 16/2015/ID dated 7th February, 2015 and published as S.R.O. No. 72/2015 in the Kerala Gazette Extraordinary No. 288 dated 7th February, 2015, namely:—

PRINTED AND PUBLISHED BY THE SUPERINTENDENT OF GOVERNMENT PRESSES AT THE GOVERNMENT CENTRAL PRESS, THIRUVANANTHAPURAM, 2017.
33/2190/2017/S-5.

RULES

1. *Short title and commencement.*—(1) These Rules may be called the Kerala Minor Mineral Concession (Amendment) Rules, 2017.

(2) They shall come into force at once.

2. *Amendment of the Rules.*—In the Kerala Minor Mineral Concession Rules, 2015,—

in rule 2, in sub-rule (1),—

(i) after clause (ix), the following clause shall be inserted, namely:—

"(ix)(a) "Minor Mineral" means building stones, gravel, ordinary clay, ordinary sand other than sand used for prescribed purposes, ordinary earth and such other minerals declared as minor minerals by the Government of India";

(ii) for clause (xv), the following clause shall be substituted, namely:—

"(xv) "Quarrying Permit" means a short term permit granted under these rules for a period not exceeding one year at a time to extract minerals specified in item numbers 1, 2, 3 and 5 of Schedule I";

(iii) for clause (xvi), the following clause shall be substituted, namely:—

"(xvi) "Quarrying Lease" means a mining lease granted under these rules for extraction of minerals specified in item numbers 4, 5, 6, 7, 8 and 9 of Schedule I, for a period as specified in Rule 39";

(2) in rule 3, in sub-rule (1), for the words "other than dimension stone," the words "other than the minerals specified in item numbers 4, 6, 7, 8 and 9 of Schedule I" shall be substituted;

(3) in rule 7, the following proviso shall be inserted, namely:—

"Provided that in cases where extraction of minerals are from Revenue Puramboke lands or from lands possessed by other Government Departments or Local Self Governments, the person who extracts minerals

from such lands shall pay compensation or value of minerals, as the case may be, to the department concerned for the quantity of such extraction, as fixed by such departments from time to time."

(4) in rule 9,—

(i) in sub-rule (1), for the existing proviso, the following proviso shall be substituted, namely:—

"Provided that the approved mining plan shall not be insisted, for the grant and renewal of quarrying permits for ordinary earth, ordinary clay, and laterite (building stone), in cases where the depth of mining does not exceed 2 metres.";

(ii) in sub-rule (2), after the words "No Objection Certificate etc." the words "as the case may be" shall be inserted.

(5) in rule 10,—

(i) in clause (a), in the second proviso, the words, symbols and figures "The Regional Controller of Mines, Yeshwantpur, Bengaluru-560 022" shall be omitted.

(ii) for clause (f), the following clause shall be substituted, namely:—

"(f) the permit holder shall not carry on or allow to be carried on any quarrying operations at or to any points within a distance of 100 metres from any railway line except with the previous written permission of the Railway Administration concerned and any bridge on National Highway or 50 metres from any reservoir, tanks, canals, rivers, bridges, other public works, residential buildings, the boundary walls of places of worship, burial grounds, burning ghats or village roads or one kilometre from the boundaries of National Park or Wildlife Sanctuaries except with the previous permission of the authorities concerned or the Government or the competent authority.";

Provided that the Railway Administration or the State Government or any other authority in this behalf may in granting such permission impose other such conditions as may be found proper and necessary:

(6) in rule 13, for the words and figures "3 years", the words "five years" shall be substituted;

(7) in rule 14,—

(i) in sub-rule (2), for the existing provisos the following proviso shall be substituted, namely:—

"Provided that in cases where transportation of ordinary earth is required, the owner of the land shall obtain mineral transit passes for the quantity to be transported under the Kerala Minerals (Prevention of Illegal Mining, Storage and Transportation) Rules, 2015 after making payment of royalty, on an application submitted in this regard. Such application shall be accompanied by (1) valid building permit for construction of building obtained from the Local Self Government authorities concerned, (2) land development permit obtained from the Local Self Government authorities concerned in cases where the levelling of the land and extraction of ordinary earth is involved and (3) possession and enjoyment certificate of the land issued by the Village Officer concerned:

Provided further that in cases where levelling of land and extraction of ordinary earth is involved, the building permit shall be accompanied by an approved building plan obtained from the Local Self Government authorities concerned which shall contain the area of land to be developed for the construction of the building and the quantity of ordinary earth to be extracted for such construction.";

(8) (ii) after sub-rule (2) the following sub-rules shall be inserted, namely:—

"(3) A person who applies for mineral transit passes for transportation of ordinary earth under this rule shall also submit along with the application a sworn affidavit in stamped paper to the effect that he will carry out the proposed construction as per the building plan and building permit and shall complete at least the construction of basement of the building within one year from the date of issuance of mineral transit passes and intimate the same to the competent authority.

(4) In the event of extraction of ordinary earth outside the permitted area, the permission granted for extraction and transportation shall be liable for cancellation and the offender shall be liable to pay an amount equal to five times the royalty of the ordinary earth extracted outside the area of permission as penalty.

(5) In the event of failure to complete at least the construction of basement of building within one year from the date of issuance of mineral transit passes the act of extraction of ordinary earth shall be treated as illegal and the offender shall be liable to pay an amount equal to five times the royalty of the ordinary earth extracted from the area, in addition to the amount already paid.";

(9) in rule 18, in item (ii), before the words "all those group of rocks" the words "Granite (building stone) which includes" shall be inserted.

(10) in rule 32, after sub-rule (2), the following sub-rule shall be inserted, namely:—

"(3) In cases where extraction of minerals is from Revenue Puramboke lands or from lands possessed by other Government Departments or Local Self Governments, the person who extracts minerals from such lands shall be liable to pay compensation or value of minerals, as the case may be, to the department concerned for the quantity of such extraction, as fixed by such departments from time to time.".

(11) in rule 37, in sub-rule (1), after the existing proviso, the following proviso shall be inserted, namely:—

"Provided further that in the case of silica sand, the restrictions in minimum area for grant and renewal of quarrying lease shall not be applicable.";

(12) in rule 40, in sub-rule (1),—

(i) for clause (i), the following clause shall be substituted, namely:—

"(i) the lessee shall not carry on or allow to be carried on any quarrying operations at or to any points within a distance of 100 metres from any railway line except with the previous written

permission of the railway administration concerned and any bridge on National Highway or 50 metres from any reservoir, tanks, canals, rivers, bridges, public roads, other public works, residential buildings, the boundary walls of places of worship, burial grounds, burning ghats or one kilometre from the boundaries of National Park or Wildlife Sanctuaries except with the previous permission of the authorities concerned or the Government or competent authority:

Provided that the railway administration or the State Government or any other authority in this behalf may in granting such permission impose such other conditions as may be found proper and necessary.";

(ii) item (ii) of clause (m) shall be omitted.

(13) after rule 45, the following rule shall be inserted, namely:—

"45A. *Amalgamation of quarrying leases.*—The State Government or the competent authority may, in the interest of quarry development, with reasons to be recorded in writing, permit amalgamation of two or more adjoining leases held by a lessee:

Provided that the period of amalgamated leases shall be co-terminus with the lease of which period will expire first:

Provided further that the leaseholds to be amalgamated shall be contiguous:

Provided also that along with the application for amalgamation of leases, copy of the survey map of the combined area for amalgamation attested by an officer not below the rank of a Tahsildar of the Department of Land Revenue or Assistant Director of the Department of Survey and Land Records shall be submitted:

Provided also that amalgamation of leases shall be subject to submission of approved mining plan for the entire leasehold and Environmental Clearance.";

(14) after rule 65, the following rule shall be inserted, namely:—

"65A. The holder of a quarrying permit/a quarrying lease issued under these rules after the date of commencement of the Kerala District Mineral Foundation Rules, 2017, shall pay to the District Mineral Foundation of the district in which the mining operations are carried on, an amount equivalent to such percentage of the royalty/consolidated royalty paid, as may be prescribed in the Kerala District Mineral Foundation Rules, 2017 in addition to the royalty/ consolidated royalty instead of quarry safety fund specified in rules 63, 64 and 65 of these rules.

Note:—Rules 63, 64 and 65 shall cease to operate from the date of commencement of the Kerala District Mineral Foundation Rules, 2017.";

(15) in rule 66,—

(i) for sub-rule (1) the following sub-rule shall be substituted, namely:—

(1) "Where quarrying operations for minor minerals have been undertaken before 7th day of February, 2015 without an approved mining plan, the holder of such lease shall not be permitted to operate such quarry unless he submits a mining plan for the remaining period of lease to the competent authority in this behalf.";

(ii) sub-rules (2) and (3) shall be omitted;

(16) in rule 89, after sub-rule (3), the following sub-rule shall be inserted, namely:—

"(4) In cases where the lessees who opted for registration of metal crusher units under sub-rule (1) for a financial year do not desire to opt for such registration in the succeeding year they shall pay royalty at the rates specified in Schedule I for removal and transport of balance quantity of granite aggregates stocked in the crusher units during the period of registration.";

(17) for rule 95, the following rule shall be substituted, namely:—

"95. *Cancellation of registration.*—If a lessee operates any type of machine that is not included in the registration certificate or fails to comply with any of the conditions of registration, the competent authority shall, by an order in writing, rescind the registration granted to the metal crusher unit.";

(18) for rule 104, the following rule shall be substituted, namely:—

"104. *Power to grant special permission to extract and remove minor minerals in special circumstances.*—In certain cases where extraction and removal of minor minerals is inevitable and in which the Government is of the opinion that the extraction is not for the purpose of winning the minerals and for reasons to be recorded in writing, the Government may by an order grant permission with conditions as they deem fit.";

(19) in rule 108,—

(i) in sub-rule (2), in the first proviso, the words and symbols "limited to twice the royalty amount," and "In such a case while calculating the amount of royalty and price payable, the amount already paid by the permit holder/lessee for obtaining permission shall be deducted" shall be omitted;

(ii) after the 2nd proviso, the following note shall be inserted, namely:—

"*Note:*—In this rule the price of the mineral shall be limited to two times the royalty.";

(iii) after sub-rule (3), the following sub-rule shall be inserted, namely:—

"(4) whenever any person raises without any lawful authority any mineral from any land for the purpose of winning minerals and for that purpose brings on the land any tool, equipment, vehicle or any other thing, such mineral, tool, equipment, vehicle or any other thing shall be seized by an officer or authority specially empowered in this behalf by the Government.";

(20) in the SCHEDULES,—

(i) in SCHEDULE I, for the entry against item number 5 in column (2), the following entry shall be substituted, namely:—

"Granite (building stone) and Laterite (building stone)"

(ii) after item number 5, and the entry against it in columns (2) and (3) the following items and entries shall respectively be inserted, namely:—

6.	Laterite (used for industrial purposes)	95 (Ninety-five) per tonne
7.	China clay/Kaolin including ball clay, white shale and white clay	
	(i) Crude	(i) 50 (Fifty) per tonne
	(ii) Processed/washed	(ii) 750 (Seven hundred and fifty) per tonne
8.	Silica sand	250 (Two hundred and fifty) per tonne
9.	Quartz	50 (Fifty) per tonne

(iii) for Schedule III, the following shall be substituted, namely:—

"SCHEDULE III

CONSOLIDATED ROYALTY

(*See* rule 89)"

Sl. No.	*Description of Crusher*	*Annual Consolidated royalty per machine (in Rupees)*
(1)	(2)	(3)
Secondary Jaw Crusher (in terms of area of feed opening)		
1	Up to 929.03 sq.cm.	2,00,000
2	Greater than 929.03 sq.cm. but less than or equal to 1548.38 sq.cm.	4,00,000
3	Greater than 1548.38 sq.cm.	6,00,000

(1)	(2)	(3)
Cone Crusher (in terms of 'Horse Power' of motor used)		
4	Up to 300	16,00,000
5	Greater than 300	26,00,000
Sand Making Units (in terms of 'Horse Power' of motor used) (for those who use sand making machine only)		
6	Up to 300	16,00,000
7	Greater than 300	26,00,000 .";

Exemption from payment of consolidated royalty is applicable to Vertical Shaft Impactor, Horizontal Shaft Impactor, Auto Sand Units which are fed by granite aggregates produced in the secondary jaw crushers or cone crushers for which the consolidated royalty has been paid and are located in the premises of those crusher units;

(iv) in Schedule IV,

(i) under the heading "A. Granite (Building stone)" for the entry against serial number 5 in column (3), the figures "7000" shall be substituted;

(ii) under the heading "B. laterite (Building Stone)" for the entry against serial number 5, in column (3), the figures "7000" shall be substituted;

(21) in Form D, the words "The Regional Controller of Mines, Yeshwantpur, Bengaluru-560 022" shall be omitted.

(22) in Form H, for condition No. 7, the following condition shall be substituted, namely:—

The lessee shall not carry on or allow to be carried on any quarrying operations at or to any points within a distance of 100 metres from any railway line except with the previous written permission of the railway administration concerned and any bridge on National Highway or 50 metres from any reservoir, tanks,

canals, rivers, bridges, public roads, other public works, residential buildings, the boundary walls of places of worship, burial grounds, burning ghats or one kilometre from the boundaries of National Park or Wildlife Sanctuaries except with the previous permission of the authorities concerned or the Government or competent authority:

Provided that the railway administration or the State Government or any other authority in this behalf may in granting such permission impose such other conditions as may be found proper and necessary.

By order of the Governor,

PAUL ANTONY,
Additional Chief Secretary to Government.

Explanatory Note

(This does not form part of the notification, but is intended to indicate its general purport.)

The Kerala Minor Mineral Concession Rules, 2015 were framed by the Government of Kerala to regulate extraction of minor minerals in the State. As per S.O. 423 (E) of Ministry of Mines dated 10th February, 2015, thirty-one minerals have been included in the category of minor minerals. Among these minerals mining leases were being granted to laterite used for industrial purpose, china clay, silica sand and quartz as per the provisions contained in the Mineral Concession Rules, 1960. As these minerals are now declared as minor minerals, these minerals are to be included in the Kerala Minor Mineral Concession Rules, 2015. When the minerals are extracted from the Government owned lands, the Government have to get compensation for the minerals extracted other than the mere payment of royalty and hence new provisions have been introduced in rules 7 and 32. The Regional Controller of Mines, Bengaluru is not the authority to deal with mining of minor minerals and hence there is no need to send Form 'D' of the rules to the said authority. In the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016 for major minerals the distance criteria adopted for the mining activities were retained as stipulated earlier in the Mineral Concession Rules, 1960. Hence a different criterion cannot be adopted in

the case of minor minerals. In such circumstances, in order to make it in tune with the Minerals (Other than Atomic and Hydro Carbons Energy Minerals) Concession Rules, 2016, it is decided to incorporate the same distance criterion in Rules 10 and 40 as well as Form H. As per S.O. 141(E) dated 15-1-2016, environmental clearance has been exempted for digging of foundation for buildings which do not require prior environmental clearance and hence amendment is necessitated in rule 14. In Writ Petition (C) No. 29710/2014 and 23251/2016, the Honourable High Court of Kerala has observed that there is possibility of misuse of rule 14 in the guise of building permit issued by Local Self Government authorities and directed the Government to find ways to avoid such misuse. Hence an amendment to this extent is necessitated. Since mining plan has been introduced in the rules, it is impractical for the lessees who have obtained two or more leases adjacent to one another to leave, a buffer zone of 7.5 meter between two lease areas and hence a new rule, 'Amalgamation of quarrying leases' has to be introduced in the rules for practicing scientific mining. Since quarry safety related activities mentioned in rule 65 have been included as one of the permissible activities in Kerala District Mineral Foundation Rules, rules 63, 64 and 65 have to be amended. As per rule 66 mining plan is to be submitted by the existing lessees within a period of one year from 7th February, 2015. As per existing sub-rules (2) and (3) of rule 66, there is provision for extension of time for one year for those who cannot submit mining plan within such period. Now two years have been passed by and there is no need to give time extension. In order to rectify this, an amendment is necessitated. In order to clarify the price of the mineral to be realized while compounding offences, amendment is to be made in rule 108. Provision for seizure of tools, minerals and equipment as existed in the earlier rules is reintroduced by amending rule 108. Since there are different sizes of jaws as stipulated in Schedule III available, it is difficult to fix royalty for a jaw crusher which is not mentioned in Schedule III. Since the area of a feed opening of a jaw crusher is the basic criteria for determining the quantum of production of granite building stone aggregates, this can be included in Schedule III instead of sizes of jaws for easy determination of royalty for a different size of jaw crusher and hence this notification.

The notification is intended to achieve the above objects.

ANNEXURE R-16

Building Stone Quarry Project

Survey No. 555/2 at Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District

Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019

Half Yearly Compliance Report (HYCR) for the Period October 2022 to March 2023

Project Proponent

adani

Adani Vizhinjam Port Private Ltd. (AVPPL)

May 2023

adani

Ports and Logistics

Ref: AVPPL/MoEF/2023-24/2436

Date: 24th May 2023

To,
Ministry of Environment Forest and Climate Change (MoEF&CC),
Regional Office (Southern Zone), Kendriya Sadan,
IVth Floor, E&F Wings, 17th Main Road, IInd Block,
Koramangala, Bangalore-560034
rosz.bng-mefcc@gov.in

Subject: Submission of **Half Yearly Compliance Report (HYCR)** to Conditions of Environmental Clearance (EC) for the Period October 2022 to March 2023 - Reg.

Reference: EC for Building Stone Quarry in Survey No. 555/2 at Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District, Kerala; by M/s. Adani Vizhinjam Port Pvt. Ltd. vide **No. 1200/EC2/2018/SEIAA dated 01.03.2019**

Dear Sir/Madam,

This has reference to the Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA issued on 1st March 2019 (vide reference cited) by the State Environmental Impact Assessment Authority (SEIAA), Kerala for the building stone quarry project in Survey No. 555/2 at Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District, Kerala; of M/s. Adani Vizhinjam Port Private Limited (AVPPL).

The Half Yearly EC Compliance Report (HYCR) of the conditions stipulated in the cited reference for the period from **October 2022 to March 2023** is enclosed herewith for record and reference. You are requested to kindly acknowledge the receipt of the same.

Thanking You.

Yours Sincerely,

Rajesh Jha
MD & CEO – Authorized Signatory

Enclosed: As mentioned above

Copy to: State Environment Impact Assessment Authority (SEIAA), K.S.R.T.C Bus Terminal Complex, 4th Floor, Thampanoor, Thiruvananthapuram, Kerala

Adani Vizhinjam Port Pvt Ltd
3rd Floor, Aspinwall House,
Kuravankonam
Thiruvananthapuram,
Kerala-695003

Tel +91 471 2772 100
Fax +91 471 2325 600
project.vizhinjam@adani.com
www.adani.com
CIN: U61200GJ2015PTC083954

Registered Office:
Adani Corporate House, Shantigram, Near Vaishno Devi Circle, S. G. Highway, Khodiyar, Ahmedabad-382421

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
Specific Conditions		
1	The mining should be conducted with Non-Electric Detonator (NONEL) Method thereby minimizing air blast, fly rock and ground vibration.	**Complied** Mining is being conducted using Non-Electric Detonator (NONEL) method of controlled blasting only; to minimize the air blast, fly rock and ground vibration. To date no incident of fly rock has been recorded. Adani Vizhinjam Port Pvt. Ltd. (AVPPL) had engaged Anna University, Department of Mining Engineering, Chennai to conduct a scientific study on Blast Induced Ground Vibration for the Quarry. Altogether 10 experimental blast rounds were conducted, and comprehensive vibration monitoring was carried out during the blasting experiment. In all the 10 trial blasts, ground vibrations were monitored at 47 locations around the blasting sites and neighboring villages, which includes domestic houses and other prominent structures of the village. Based on the scientific study, it is concluded that the blast induced ground vibrations and noise levels generated by the controlled blasting carried out in the quarry are safe and well within the permissible limit as per recommendations of Directorate General of Mine Safety (DGMS) and therefore is not affecting the residential buildings and other structures. Further, it had been observed that no flying fragments or projectiles travelled beyond 10 m from the site of blast. Hence, it was inferred through the study report that controlled blasting can be carried out at the Quarry. The Anna University Study Report was submitted along with the HYCR for the period April 2021 to September 2021.
2	Extract a maximum of 7 lakh tons of building stone within a period of two years. Further permission for mining may be considered based on the requirement then and environmental assessment.	**Will be Complied** In view of the additional requirement of building stone for completion of phase 1 of the Vizhinjam project, State Environmental Impact Assessment Authority (SEIAA), Kerala decided to issue EC for the extraction of a further 10.79 Lakh Tons granite rock for the period from 2021-22 to 2023-24 subject original EC conditions vide their order

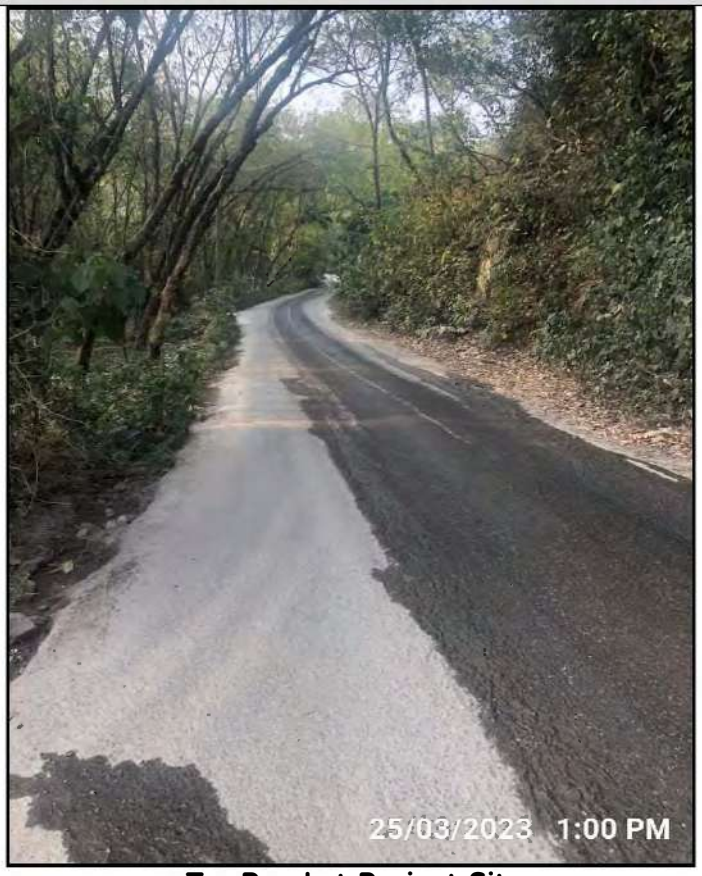
Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		No. 1200/EC2/2018/SEIAA dated 16.11.2020 (A copy of the order was submitted along with the HYCR for the period October 2020 to March 2021). The Modified Approved Mining Plan was submitted along with the HYCR for the period April 2021 to September 2021). Therefore, permission is accorded for a total of 17.79 (7 + 10.79) Lakh Tons of building stones to be extracted from the quarry. During the compliance period (October 2022 to March 2023), a total of 2.002 Lakh Tons of building stones have been extracted and a total cumulative quantity of 15.113 Lakh Tons of building stones have been extracted from inception of mining on 02.07.2019 till 31.03.2023.
3	The proponent shall file an affidavit that he will expend Rs. 15 lakhs as a part of CER in consultation with Local Self Government.	**Complied** AVPPL have submitted to SEIAA an affidavit dated 08.11.2019 duly signed by the MD and CEO vide letter AVPPL/SEIAA/2019-20/945 dated 15.11.2019 that Rs. 15 Lakhs will be spent as a part of Corporate Environment Responsibility (CER) in consultation with the Local Self Government. A copy of the affidavit was submitted along with the HYCR for the period October 2019 to March 2020. As of March 31, 2023, AVPPL has spent Rs. 35.89 Lakhs towards CER Activities. Despite having exhausted the agreed-upon funds for CER activities, AVPPL remains committed to environmental responsibility and has exceeded the required expenditure of Rs. 15 Lakhs as stated in the affidavit.
4	The proponent should follow the closure plans (progressive closure and final closure) as per KMMC Rules.	**Will be Complied** AVPPL will follow the closure plans (progressive closure and final closures) as per Kerala Minor Minerals Concession (KMMC) Rules and Mine Closure Plan in the Modified Approved Mining Plan (The Modified Approved Mining Plan was submitted along with the HYCR for the period April 2021 to September 2021).

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		The closure procedure (progressive closure and final closures) shall be documented prior to and during the closure of the mine.
General Conditions		
1	A separate environmental management and monitoring cell with qualified personnel should be set-up under the control of a Senior Executive, who will report directly to the Head of the Organization.	**Complied** A separate Environmental Management and Monitoring Cell (EMMC) with qualified personnel has been set up by AVPPL. The cell is under the control of the Head of Department (HoD), Environment who reports directly to the Chief Executive Officer (CEO), AVPPL. The details of the constitution of EMMC were submitted along with HYCR for the period April 2019 to September 2019. EMMC meeting is being conducted frequently to monitor the environmental issues at the quarry.
2	Suitable avenue trees should be planted along either side of the tarred road and open parking areas, if any, including of approach road and internal roads.	**Being Complied** There is already an existing plantation along the tar road. AVPPL have planted avenue trees at suitable locations, such as buffer zones for greenbelt development and the saplings planted are growing well and have started to bear fruits; as seen in the image below.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		 **Avenue Plantation**
3	Sprinklers shall be installed and used in the project site to contain dust emissions.	**Being Complied** Regular water sprinkling through water tankers is being carried out on haul roads and other dust prone areas such as loading and unloading of minerals.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		 **Water Sprinkling through Tankers**
4	Eco-restoration including the mine closure plan shall be done at the own cost of the project proponent	**Will be Complied** Eco-restoration including Mine Closure Plan is provided in the Modified Approved Mining Plan (Submitted along with the HYCR for the period April 2021 to September 2021). The same shall be implemented during the closure at the cost of AVPPL.
5	In view of the deep pits left after the excavation, stacking at maximum top level should be carried out.	**Not Applicable** The Stacking of materials is not being carried out, as all the produced materials are used for Breakwater Construction at Vizhinjam Port. They are being transported directly to the Port site and not stacked at the quarry site. As per the mine closure plan the pit will be utilized for storing water as a rainwater harvesting method and will also be induced to sustain the groundwater table. As for the post mining land use, an area of 0.9540 Ha will be used for water pond for storage of water.
6	Corporate Environment Responsibility agreed upon by the proponent should be implemented.	**Being Complied** AVPPL is coordinating with the Local Self Government regarding approval of the proposed CER plan with expense heads under specific activities in line with MoEF&CC Office Memorandum (OM) F.No.22-65/2017-IA.III dated 01.05.2018.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		AVPPL had prepared a budget plan and had submitted the same to the Nagaroor Gram Panchayat seeking their confirmation and go ahead for the proposed CER (Proposed plan was submitted along with HYCR for the period October 2019 to March 2020). Correspondence to the President of the Nagaroor Gram Panchayat was submitted along with HYCR for the period April 2019 to September 2019. Considering the necessities of the community and discussions with the local panchayat, AVPPL has implemented CER activities in the surrounding areas of the quarry site (Details have been submitted along with earlier compliance reports). As per affidavit dated 08.11.2019 duly signed by the MD and CEO vide letter AVPPL/SEIAA/2019-20/945 dated 15.11.2019, that Rs. 15 Lakhs will be spent as a part of CER, AVPPL have surpassed the required expenditure of Rs. 15 Lakhs and spent Rs. 35.89 Lakhs towards CER activities. Despite having exhausted the agreed upon funds for CER activities, AVPPL are committed towards Environmental responsibility.
7	The project proponent shall comply the conditions stipulated by the statutory authorities concerned.	**Being Complied** AVPPL is complying with all applicable conditions stipulated by respective competent statutory authorities.
8	Tarring /multiple options on the access roads shall be undertaken so as to reduce dust pollution during movement of vehicle.	**Complied** AVPPL has developed a tar road of around 0.9 km from the quarry project site gate to Kadavilla Junction (which is connected to SH46 and onto NH66) for movement of vehicles; thereby reducing the dust pollution.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		 **Tar Road at Project Site**
9	Overburden materials should be managed within the site and used for reclamation of mine pit as per mine closure plan / specific conditions	**Being Complied** As such, the quarry had been mined earlier by another party and since this is already an open mine, there was no topsoil or overburden available in the quarry; all the produced materials are being used for Breakwater Construction at Vizhinjam Port. However, due to certain geological disturbances in the formation, some overburden has been found in between the rock formation after attaining 6 m on the western slope between p3 and p4 pillars. AVPPL have shifted the topsoil and overburden on the western slope to an area of land in the lower portions of the quarry along with 150 m gabion wall protection. The overburden materials will be managed in this area within the site as per mine closure plan.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		 **Gabion Wall**
10	Height of benches should not exceed 5 m, and width should not be less than 5 m, if there is no mention in the mining plan/specific condition.	**Being Complied** As per the Modified Approved Mining Plan, the bench height and width need to be maintained at a maximum of 6.0 m. Also, a 45° pit slope will be maintained; which is currently being adhered to.
11	Ground level should be fixed in individual cases separately	**Being Complied** For every bench, ground level is fixed in MSL as individual cases separately. Surface plan with MSL levels is provided in the Modified Approved Mining Plan (Submitted along with the HYCR for the period April 2021 to September 2021).
12	No mining operations should be carried out at places having a slope greater than 45.	**Being Complied** No mining operations are being carried out at places having a slope greater than a 45 degrees angle.
13	Acoustic enclosures should have been provided to reduce sound amplifications in addition to the provisions of green belt and hollow brick envelop for crushers so that the noise level is kept within prescribed standards given by CPCB/KSPCB. This condition is applicable only in such cases if a crusher is adjacent to the quarry	**Not Applicable** There is no crusher adjacent to the quarry and the same is not proposed.
14	The workers on the site should	**Being Complied**

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
	be provided with the required protective equipment such as ear muffs, helmet, etc.	All employees are provided with relevant Personal Protective Equipment (PPEs) like Helmets, Shoes, Fluorescent Reflective Jackets, etc.  **Employees with PPEs**
15	Garland drains with clarifiers to be provided in the lower slopes around the core area to channelize storm water.	**Being Complied** Mining operations are being carried out at the top level during the compliance period. However, garland drainage/garland canals of 60 m have been developed in the lower slopes to channelize storm water.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		 **Garland Drain** A siltation pond has been created by constructing a check dam, which is up to 10m X 1.5m in size, at the bottom of the quarry area to prevent the run-off of water and flow of sediments. The collected water is being utilized for watering the mine area, roads, greenbelt development, etc.  **Check Dam**

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
16	The transportation of minerals should be done in covered trucks to contain dust emissions. The proponent should plant trees at least 5 'times of: the loss: that has been occurred while clearing the land for the project. SEAC should assess the number of trees in each project site before the issuance of EC so as to ensure the promptness in, planting.	**Being Complied** The transportation of minerals in trucks is being undertaken covered with tarpaulin cover. Since this is an existing quarry which was already mined earlier, the quarry is in open condition. There was no clearing of land for the project and no trees have been cut down as there are no trees inside the lease area.  **Truck with Tarpaulin Cover**
17	Explosives should be stored in magazines in isolated place specified and approved by Explosives Department	**Being Complied** AVPPL constructed 500 Kgs portable explosives magazine at an area called Chappath; which is 65 km away from the quarry location. AVPPL are transporting the explosives and detonators from Chappath to Kadavilla quarry through two authorized explosives vans for which following licenses were obtained from PESO: • Explosives magazine license E/SE/KL/22/331(E121778) dated 13.09.2021 • Explosives van-1 (KL01CP2414) license E/SE/KL/25/99(E135886) dated 22.09.2021 • Explosives van-2 (KL01CP2472) license E/SE/KL/25/99(E135883) dated 22.09.2021 Copies of the above mentioned licenses were submitted along with the HYCR for the period April 2021 to September 2021. Operations at Explosives Storage at Chappath began in October 2021.
18	A minimum buffer distance of 100m from the boundary of the quarry to the nearest dwelling	**Complied** As per the Government of Kerala (GoK) State Gazette Notification G.O. (P) No. 25/2017/ID

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
	unit or other structures, not being any facility for mining shall be provided.	dated 22.06.2017, permit holder shall not carry on or allow to be carried on any quarrying operations at or to any points within 50 m from any residential buildings or from the nearest dwelling unit or other structures. Also, as per the Consent to Operate (CTO) obtained from KSPCB, quarrying activities are restricted to a distance more than 50 m from the nearby residential buildings. Further, DMG had communicated to SEIAA vide its letter No. 9363/M3/2018 dated 23.03.2019 (A copy of the letter was submitted along with the HYCR for the period October 2019 to March 2020) that as per Rule 40 1(i) of the KMMC Rules, the lessee is permitted to carry out mining at 50 m from the residential houses. As per the map prepared by the village officer, the nearest house is ~60 m from the boundary of the quarry.
19	50 m buffer distance should be maintained from forest boundaries.	**Not Applicable** There are no forests in the vicinity of the project site.
20	Consent from Kerala State Pollution Control Board under Water and Air Act(s) should be obtained before initiating mining activity.	**Complied** CTO has been obtained from Kerala State Pollution Control Board (KSPCB) vide Consent No. PCB/TVM-DO/ICO/QRY/103/2019 dated 05.03.2019 valid up to 27.02.2021. A copy of the same was submitted along with HYCR for the period April 2019 to September 2019. Further, The CTO was renewed vide Consent No. PCB/TVM-DO/CHZ/ICO(R)/QRY/128/2020 dated 18.12.2020 valid up to 28.02.2024. Copy of the renewed CTO is was submitted along with HYCR for the period October 2020 to March 2021.
21	All other statutory clearances should be obtained, as applicable, by project proponents from the respective competent authorities including that for blasting and storage of	**Complied** AVPPL have obtained all applicable statutory clearances from the respective competent authorities. The following clearances have been obtained: • No Objection Certificate (NoC) from

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
	explosives.	Trivandrum District Collector vide Letter No. B7-40269/2017 dated 30.04.2018 for Govt. land. • Letter of Intent from DMG vide Letter No. 9363/M3/2018 dated 04.09.2018 • CTO has been obtained from KSPCB vide Consent No. PCB/TVM-DO/ICO/QRY/103/2019 dated 05.03.2019 valid up to 27.02.2021. Further, The CTO was renewed vide Consent No. PCB/TVM-DO/CHZ/ICO(R)/QRY/128/2020 dated 18.12.2020 valid up to 28.02.2024. • Purchase and Use of Explosives Approval from Petroleum & Explosives Safety Organization (PESO), Ernakulam vide Letter No. E/Misc/Expl dated 27.03.2019 • Dangerous and Offensive Trade (D&O) License from Nagaroor Gram Panchayat vide License Number A2.1836\2019 dated 01.04.2019 • NoC for Use of Explosives from District Collector, Thiruvananthapuram vide File No. DCTVM/2436/2019-A17 dated 09.05.2019 • Approved Mining Plan by District Geologist, Trivandrum vide Letter No. 1716/DOT/ML/18 dated 20.05.2019 • Lease Order from DMG vide Letter No. 9363/M3/2018 dated 20.05.2019 • Lease Execution from Additional Director of Mining and Geology vide Letter No. 79/2019-20/9363/M3/2018/DMG dated 20.05.2019 • Quarrying Lease Registration Agreement in Form H at Chirayinkeezhu Register Office dated 22.05.2019 • Explosives magazine license E/SE/KL/22/331(E121778) dated 13.09.2021. • Explosives van-1 (KL01CP2414) license E/SE/KL/25/99(E135886) dated 22.09.2021. • Explosives van-2 (KL01CP2472) license E/SE/KL/25/99(E135883) dated 22.09.2021. • Modified Approved Mining Plan by District Geologist, Trivandrum vide Letter No. 2436/DOT/ML/2020 dated 16.11.2020 Copies of the above mentioned approvals were submitted along with HYCR for the period April

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
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		2019 to September 2019. Copy of the renewed CTO was submitted along with HYCR for the period October 2020 to March 2021. Copies of the explosives vans and magazine licenses and Modified Approved Mining Plan was submitted along with the HYCR for the period April 2021 to September 2021.
22	In the case of any change(s) in the scope of the project, extent quantity, process of mining technology involved or in any way affecting the environmental parameters/impacts as assessed, based on which only the E.C is issued, the project would require a fresh appraisal by this Authority, for which the proponent shall apply and get the approval of this Authority	**Complied** In view of the additional requirement of building stone for completion of phase 1 of the Vizhinjam project, SEIAA decided to issue EC for the extraction of a further 10.79 Lakh Tons granite rock for the period from 2021-22 to 2023-24 subject original EC conditions vide their order No. 1200/EC2/2018/SEIAA dated 16.11.2020 (A copy of the order was submitted along with the HYCR for the period October 2020 to March 2021). Therefore, permission is accorded for a total of 17.79 (7.00 + 10.79) Lakh Tons of building stones to be extracted from the quarry. During the compliance period (October 2022 to March 2023), a total of 2.002 Lakh Tons of building stones have been extracted and a total cumulative quantity of 15.113 Lakh Tons of building stones have been extracted from inception of mining on 02.07.2019 till 31.03.2023.
23	The Authority reserves the right to add additional safeguard measures subsequently, if found necessary, and to take action including revoking of the environment clearance under the provisions of the Environment (Protection) Act, 1986, to ensure effective implementation of the suggested safeguard measures in a time bound and satisfactory manner.	**Being Complied** Based on the SEIAA order No. 1200/EC2/2018/SEIAA dated 16.11.2020 (A copy of the order was submitted along with the HYCR for the period October 2020 to March 2021), as an additional precautionary safeguard measure, Authority decided to constitute a monitoring team to monitor the functioning of the quarry. The team will inspect the quarry at least once every 3 months and prepare an inspection report. The team will also suggest corrective measures for irregularities if any. The project proponent will provide logistic support for field inspection. The first visit was completed and AVPPL have complied with all observations and

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
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		recommendations of the monitoring committee. Thereafter, in line with email from SEIAA dated 03.11.2022 (**Annexure 1**), a second site visit and field inspection of the monitoring team consisting of Dr. R. Ajayakumar Varma, Chairman, SEAC and Er. M. Dileep Kumar was held on 12.11.2022. The field Inspection report was discussed in the 135th SEAC Meeting between 07.12.2022 to 17.12.2022, wherein the committee decided to recommend additional points for compliance. The observations and recommendations of the monitoring committee were received from SEIAA vide letter No. 1200/EC2/2018/SEIAA dated 30.12.2022 (**Annexure 2**). In this regard, AVPPL have complied with all the observations and recommendations of the monitoring committee and details of the same are given in **Annexure 3**.
24	The stipulations by Statutory Authorities under different Acts and Notifications should be complied with, including the provisions of Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and control of Pollution) act 1981, the Environment (Protection) Act, 1986, the Public Liability (Insurance) Act, 1991 and EIA Notification, 2006.	**Noted**
25	The project proponent should advertise in at least two local newspapers widely circulated in the region, one of which (both the advertisement and the newspaper) shall be in the vernacular language informing that the project has been accorded Environmental Clearance and copies of clearance letters are available with the State Environment	**Complied** EC for the project was issued on 01.03.2019. Advertisements, that the project has been accorded EC were published within Ten days in two widely circulated local newspapers: The Hindu (English) on 09.03.2019 and Mathrubhumi (Malayalam – vernacular language) on 10.03.2019. Also, copy of the EC is available with the SEIAA office and it is also available on the website of the Authority at www.seiaakerala.in. Screenshot of the website showing the details of the EC was submitted along with HYCR for the

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
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	Impact Assessment Authority (SEIAA) office and may also be seen on the website of the Authority at www.seiaakerala.org. The advertisement should be made within 10 days from the date of receipt of the Clearance letter and a copy of the same signed in all pages should be forwarded to the office of this Authority as confirmation.	period October 2019 to March 2020. Extracts of these newspaper clippings with the advertisements were submitted along with HYCR for the period April 2019 to September 2019. Copy of the advertisements signed on all pages were submitted to SEIAA vide Letter No. AVPPL/SEIAA/2019-20/731 dated 01.04.2019 was submitted along with HYCR for the period April 2019 to September 2019. The copy of EC is uploaded to the company website: https://www.adaniports.com/ports-downloads?port=Vizhinjam-Port Screenshot of the same was submitted along with HYCR for the period April 2019 to September 2019.
26	The Environmental Clearance shall be put on the website of the company by the proponent.	**Complied** The copy of EC is uploaded to the company website: https://www.adaniports.com/ports-downloads?port=Vizhinjam-Port. Screenshot of the same was submitted along with HYCR for the period April 2019 to September 2019.
27	Proponent shall submit half yearly reports in soft copy and SEIAA will upload it on the website.	**Being Complied** HYCRs on the status of compliance of the stipulated clearance conditions are being submitted to all the concerned agencies. As per the Notification of Ministry of Environment and Forests & Climate Change (MoEF&CC) dated 26.11.2018, wherein submission of HYCRs by email/soft copy is declared acceptable, soft copy of HYCR for the period April 2022 to September 2022 has been submitted vide email dated 30.11.2022 (a copy of the email is enclosed as **Annexure 4**).
28	The details of Environmental Clearance should be prominently displayed in a metallic board of 3 ft x 3 ft with green background and yellow letters of Times New Roman font of size of not less than 40. Sign board with extent of lease area and boundaries shall be	**Complied** The details of EC have been displayed at the site next to the entrance of the quarry, visible to the public.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
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	depicted at the entrance of the quarry, visible to the public	 **EC Details Displayed on Board at Site**
29	The proponent should provide notarized affidavit (indicating the number and date of Environmental Clearance proceedings) that all the conditions stipulated in the EC shall be scrupulously followed.	**Complied** AVPPL has submitted Notarized Affidavit dated 03.04.2019 to SEIAA stating that all the conditions stipulated in the EC shall be scrupulously followed. Copy of the affidavit and the cover letter vide No. AVPPL/SEIAA/2019-20/731 dated 01.04.2019 have been submitted along with HYCR for the period April 2019 to September 2019.
30	No change in mining technology and scope of working should be made without prior approval of the SEIAA, No further expansion or modifications in the mine shall be carried out without prior approval of the SEIAA, as applicable	**Noted for Compliance**
31	The Project proponent shall ensure that no natural water course and/or water resources shall be obstructed due to any	**Not Applicable** There are no natural water courses and/or water resources of first order streams in and around the mine lease area.

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	mining operations. Necessary safeguard measures to protect the first order streams, if any, originating from the mine lease shall be taken.	
32	The top soil, if any, shall temporarily be stored at earmarked site(s) only for the topsoil shall be used for land reclamation and plantation. The over burden (OB) generated during the mining operations shall be stacked at earmarked dump site(s) only. The maximum height of the dumps shall not exceed 8m and width 20m and overall slope of the dumps shall be maintained to. The OB dumps should be scientifically vegetated with suitable native species to prevent erosion and surface run off. In critical areas, use of geo textiles shall be undertaken for stabilization of the dump. The entire excavated area shall be backfilled. Monitoring and management of rehabilitated areas should continue until the vegetation becomes self-sustaining.	**Being Complied** As such, the quarry had been mined earlier by another party and since this is already an open mine, there was no topsoil or overburden available in the quarry; all the produced materials are being used for Breakwater Construction at Vizhinjam Port. However, due to certain geological disturbances in the formation, some overburden has been found in between the rock formation after attaining 6 m on the western slope between p3 and p4 pillars. AVPPL have shifted the topsoil and overburden on the western slope to an area of land in the lower portions of the quarry along with 150 m gabion wall protection. The overburden materials will be managed in this area within the site as per mine closure plan. It will be ensured that the maximum height of the dumps shall not exceed dimensions specified and overall slope of the dumps shall be maintained to 37.5 degrees. The overburden dumps will be vegetated with suitable native species and monitoring and management of the area shall be done until the vegetation becomes self-sustaining.
33	Catch drains and siltation ponds of appropriate size shall be constructed around the mine working, mineral and OB dumps to prevent run off of water and flow of sediments directly into the river and other water bodies: 'The water so-collected should be utilized for watering the mine area, roads, green belt development.etc. The drains shall be regularly desilted	**Will be Complied** The quarry has been mined earlier by other parties and is an already open mine and hence there is no topsoil or overburden available in the quarry. Also, there are no mineral dumps since all the produced materials are used for Breakwater Construction at Vizhinjam Port. Therefore, catch drains for prevention of run-off is not required at the project site. A siltation pond has been created by constructing a check dam (up to 10m X 1.5m size) at the

<table>
<tr><th colspan="3">Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023</th></tr>
<tr><th>S. No.</th><th>Conditions</th><th>Compliance Status as on March 31, 2023</th></tr>
<tr><td></td><td>particularly after monsoon and maintained properly.</td><td>bottom of the quarry area to prevent run-off of water and flow of sediments. The water collected is being utilized for watering the mine area, roads, greenbelt development, etc.

The drains will be regularly desilted particularly after monsoon and maintained properly.</td></tr>
<tr><td>34</td><td>Effective safeguard measures such as- regular water sprinkling shall be carried out in critical areas prone to air pollution and having' high levels. 'of PM 10, and PM 2.5, such as haul Road, loading and unloading points and transfer points— it shall 'be ensured that the Ambient Air Quality parameters conform to the norms prescribed by the Central Pollution Control Board in this regard</td><td>Being Complied
Regular water sprinkling through water tankers on haul road and other dust prone areas such as loading and unloading of minerals is being carried out.

Environment Monitoring at the site has been carried out by NABL accredited laboratory; M/s. Standards Environmental & Analytical Laboratories. Summary of the Ambient Air Quality Monitoring (AAQM) during the compliance period at 5 monitoring locations is mentioned below.

<table>
<tr><th>Parameter</th><th>Unit</th><th>Max</th><th>Min</th><th>Perm. Limit</th></tr>
<tr><td>PM_{10}</td><td>$\mu g/m^3$</td><td>58.7</td><td>50.9</td><td>100</td></tr>
<tr><td>$PM_{2.5}$</td><td>$\mu g/m^3$</td><td>34.6</td><td>28.3</td><td>60</td></tr>
<tr><td>SO_2</td><td>$\mu g/m^3$</td><td>BDL</td><td>-</td><td>80</td></tr>
<tr><td>NO_2</td><td>$\mu g/m^3$</td><td>BDL</td><td>-</td><td>80</td></tr>
</table>

The Ambient Air Quality Monitoring Report is enclosed as Annexure 5. All the monitored parameters were found within the prescribed limits.</td></tr>
<tr><td>35</td><td>Fugitive dust emissions from all the sources should be controlled regularly. Water spraying arrangement on haul roads, loading and unloading and at transfer points should be provided and properly maintained</td><td>Being Complied
AVPPL have developed a tar road of around 0.9 km from Kadavilla Junction to the quarry project site gate for movement of vehicles: thereby reducing the dust pollution.

Also, regular water sprinkling through water tankers on haul road and other dust prone areas such as loading and unloading of minerals is being carried out.</td></tr>
<tr><td>36</td><td>Measures should be taken for control of noise levels below 85 dBA in the work environment.</td><td>Being Complied
The following measures are being taken for the control of noise levels:
• Drilling: Good captive silencers are being used</td></tr>
</table>

<table>
<tr><th colspan="3">Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023</th></tr>
<tr><th>S. No.</th><th>Conditions</th><th>Compliance Status as on March 31, 2023</th></tr>
<tr><td></td><td></td><td>in drilling equipment.
• Blasting: AVPPL uses the NONEL method - bottom initiation to reduce the noise of blasting.
• Machinery & Tippers: It is ensured that equipment is fitted with effective silencers, mufflers, acoustic linings, or shields, as necessary.
• It is ensured that vehicles transporting the materials follow the speed limit to maintain the noise level.
• Vehicles are serviced regularly and maintained properly to avoid any unwanted generation of noise or vibration from them.

Ambient Noise is being monitored by NABL accredited laboratory; Standards Environmental & Analytical Laboratories as per Noise Pollution (Regulation & Control) Rules, 2000 (Rules 3 (1) and 4(1)) at 5 locations.

Summary of the Ambient Noise Monitoring during the compliance period at 5 monitoring locations is mentioned below:
<table>
<tr><th>Location</th><th>L_{eq} Day time</th><th>L_{eq} Night time</th></tr>
<tr><td>Quarry Area (Project Site)</td><td>58.3</td><td>42.3</td></tr>
<tr><td>Near Operators Rest Room (North Side)</td><td>53.9</td><td>41.8</td></tr>
<tr><td>Vanchiyoor UP School (West Side)</td><td>52.6</td><td>41.6</td></tr>
<tr><td>St. Joseph of Cluny Public School (South Side)</td><td>50.6</td><td>41.3</td></tr>
<tr><td>Viswanadhapuram Shiva Temple (East Side)</td><td>50.4</td><td>40.6</td></tr>
</table>
The results obtained were compared with Noise Pollution (Regulation & Control) Rule, 2000 (Rule 3(1) and 4(1)) and it is observed that the noise readings were within limits at all monitoring locations. The Noise Monitoring report is enclosed as Annexure 6.</td></tr>
<tr><td>37</td><td>The funds earmarked for environmental protection measures and CER activate</td><td>Being Complied
AVPPL has entered into a Concession Agreement with GoK for the construction and operation of</td></tr>
</table>

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
	should be kept in separate account and should not be diverted for other purpose. Year wise expenditure should be reported to the State Environment Impact Assessment Authority (SEIAA) office.	Vizhinjam Port whereby it is mandated under Article 32 (copy submitted along with HYCR for the period April 2019 to September 2019) that an Escrow Account must be opened by AVPPL. All deposits must be made into this account and all payments have to be routed through this account for the construction of the port. This account is directly under the monitoring of both the Central and State governments through the Senior Lenders. Therefore, it is requested that the provision of opening of separate account be absolved as there will be a direct contradiction to the Concession Agreement. As the owner of the quarry, AVPPL guarantees that the amount of Rs. 15.00 Lakhs earmarked for CER and funds earmarked for environmental protection measures will be kept as a balance in the current Escrow Account. Furthermore, as provided above the account will be monitored by the government. Expenditure statement for CER and environmental protection measures is enclosed as **Annexure 7**.
38	The Regional Office of MOEF & CC located at Bangalore shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (S) of the Regional Office by furnishing the requisite data/information/monitoring reports.	**Will be Complied** All necessary support will be extended to the Regional Office of MoEF&CC located at Bangalore for the monitoring of the compliance of the stipulated conditions Office by furnishing the requisite data/information/monitoring reports.
39	Any appeal against this Environmental Clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.	**Noted**

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
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40	Concealing the factual data or submission of false/fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of Environment (Protection) Act, 1986.	**Noted**
41	The SEIAA may revoke or suspend the order, for non-implementation of any of the specific or this implementation of any of the above conditions is not satisfactory. The SEIAA reserves the right to alter/modify the above conditions or stipulate any further condition in the interest of environment protection	**Being Complied** Refer Point No. 23 above.
42	The above conditions shall prevail notwithstanding anything to the contrary, in consistent, or simplified, contained in any other permit, license on consent given by any other authority for the same project.	**Noted**
43	The Environmental Clearance will be subject to the final order of the courts in any pending litigation related to the land or project, in any court of law.	**Noted**
44	The mining operation shall be restricted to above ground water table and it should not intersect ground water table	**Complied** Based on observations made in and around the quarry area, it was found that the general ground level in the area is 32 m above MSL and the general groundwater table is 8 m below the general ground level i.e., 24 m above MSL. During monsoons the ground water table will rise by 2-3 m. The lease area is situated on an isolated hillock where the topmost working level is about 106 m above MSL, and the lowest working level is 70 m above MSL. The total depth will be 36 m.

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
		Therefore, mining operations will be restricted to workings at a higher level at the quarry and will not touch the ground water table.
45	All vehicles used for transportation and within the mines shall have 'PUC' certificate from authorized pollution taking centre. Washing of all vehicles shall be inside the lease area	**Complied** It is ensured that all vehicles used for transportation are having valid Pollution Under Control (PuC) certificate from authorized centers.  VAHAN NR e-Services Ministry of Road Transport & Highways Government of India RC STATUS KL02BB0914 Status: ACTIVE Goods Carrier(HGV) DIESEL Not Available BHARATBENZ 2523 C 6X4 4275 DAIMLER INDIA COMMERCIAL VEHICLES PVT. LTD ATTINGAL RTO, Kerala Owner Name 'A''U' Registration Date 08-Jun-2017 Validity Fitness/REGN 28-Jun-2023 MV Tax 31-03-2023 PUCC 23-Sep-2023 **PuC Certificate**
46	Project proponent should obtain necessary prior permission of the competent authorities for drawl of requisite quantity of surface water and ground water for the project	**Not Applicable** AVPPL is not withdrawing the surface water or ground water from the project area for any purposes.
47	Regular monitoring of flow rates and water quality upstream and downstream of the springs and perennial nallahs flowing in and around the mine lease area shall be carried out and reported in the six monthly reports to SEIAA	**Not Applicable** There are no springs and perennial nallahs flowing upstream and downstream of the mine lease area as there are no water courses and/or water resources of first order streams in and around the mine lease area.
48	Occupational health surveillance program of the workers should be under taken periodically to observe any contractions due to exposure to	**Being Complied.** The medical health test checkup of the employees, workers, and laborers as per Director General of Mines (DGM) prescribed statutory format are being taken up periodically by the

Half Yearly Compliance Report (HYCR) on Conditions Stipulated in Environmental Clearance (EC) Order No. 1200/EC2/2018/SEIAA dated 01.03.2019 for the Period October 2022 to March 2023		
S. No.	**Conditions**	**Compliance Status as on March 31, 2023**
	dust and take corrective measures, if needed	contractor involved in the mining operations to observe any contractions due to exposure to dust and take corrective measures.

FORM 'O'
[Refer rules 29 – F (2) and 29 – L]

REPORT OF MEDICAL EXAMINATION UNDER RULE 29 – B
(To be issued in triplicate)

Certificate No.

Certified that Shri George Xavier Selvaraj employed as Blaster in AVPPL - Kadlavila mine. For D. No. has examined for an initial/periodical medical examination. He appears to be 46 years of age. The findings of the examining authority are given in the attached sheet. It is considered that Shri George Xavier Selvaraj

a) Is medically fit for employment in mines.
b) Is suffering from ______ and is medically unfit for
   i. Any employment in mines; or
   ii. Any employment below ground; or
   iii. Any employment or work ______

c) Is suffering from ______ and should get this disability cured / controlled and should be again examined within a period of ______ months. He will appear for re-examination with the result of test of ______ and the opinion of ______ he may be permitted / not permitted to carry on his duties during this period.

Signature of the examining authority

Name and Designation in block letters

Place: PHC Nagaroor
Date: 29/03/23

Medical Examination Report (Form O)

Enclosures:

Annexure Number	Details of Annexure
Annexure 1:	Email from SEIAA for SEAC Site Inspection
Annexure 2:	Letter from SEIAA based on Field Visit Report
Annexure 3:	Compliance of Recommendations by SEIAA Appointed Monitoring Committee
Annexure 4:	Email Submission of HYCR for the period April 2022 to September 2022
Annexure 5:	Ambient Air Quality Monitoring Report
Annexure 6:	Noise Monitoring Report
Annexure 7:	CER and EMP Expenditure Statement

Annexure 1: Email from SEIAA for SEAC Site Inspection

From:	Jesse Benjamin Fullonton
To:	Jesse Benjamin Fullonton
Subject:	FW: SEIAA - Site inspection Intimation-File No.1200/EC2/2018/SEIAA
Date:	Monday, May 29, 2023 1:24:38 PM
Importance:	High

From: seiaa kerala [mailto:seacseiaakerala@gmail.com]
Sent: Thursday, November 3, 2022 8:20 PM
To: kadavilaland1@gmail.com; Hebin Chenthamarakshan <Hebin.C@adani.com>; Dr. R. Ajayakumar Varma <akvarmaseac@gmail.com>; M Dilipkumar <dileeppcb@ymail.com>
Subject: SEIAA - Site inspection Intimation-File No.1200/EC2/2018/SEIAA

Sir,

As per the decision of SEAC meeting, Dr.R.Ajayakumar Varma, Chairman, SEAC (Contact No.**9447048526**) & Er.M.Dileep Kumar (Contact No.**9895623767**) will visit your project site on 12.11.2022 . Hence you are requested to be present with your RQP/Consultant during the site visit and make necessary arrangements for the same. You can contact the members for further details

Mr.Rajesh JHA, CEO, M/s Adani Vizhinjam Port Ltd- 9099005722

Mr.Hebin, M/s Adani Vizhinjam Port Ltd- 9099056757

Regards,

Administrator, SEIAA

Annexure 2: Letter from SEIAA based on Field Visit Report

State Environment Impact Assessment Authority (SEIAA) Kerala

KSRTC Bus Terminal, 4th floor, Thampanoor, Thiruvananthapuram - 695 001

Ph: +91471-2334262 (Off) +91471-2334265 (Fax)

e-mail:seacseiaakerala@gmail.com

web:www.seiaakerala.org

No. 1200/EC2/2018/SEIAA **Date: 30.12.2022**

From

The Administrator
State Environment Impact Assessment Authority
Thiruvananthapuram

To

Mr. Rajesh Kumar Jha,
Chief Executive Officer,
M/s Adani Vizhinjam Port Private Limited,
2nd Floor, Vipanchika Tower, Thycaud,
Thiruvananthapuram - 695014

Sir,

Sub:-SEIAA – Monitoring functioning of quarry of M/s Adani Vizhinjam Port Pvt. Ltd- Field inspection report - reg.

Ref :- Minutes of the 135th SEAC meeting held on 07th to 09th & 14th & 17th December, 2022

Attention is invited to the reference cited. The Committee in its 135th SEAC meeting, discussed the Field Inspection Report and decided to recommend the following points for compliance by the Proponent with immediate effect.

1. Install adequate sprinkling arrangements in the project area as no sprinklers are found installed in the project site to contain dust emissions except a small mobile water tanker. Sprinklers should be provided at the loading areas, vehicle parking areas and haulage roads
2. Improve the stormwater channelization by providing improved garland drain and silt traps.
3. Provide adequate sanitation arrangements to the workers at the site.
4. As per the approved mining plan, deep hole blasting (depth of the hole 6.5 m, dia 115 mm and 20 to 25 kg explosives per hole) was permitted. Considering the requirement of stringent norm of distance criteria, the Proponent stated that, now 33 mm dia holes of depth 2.4 m used for controlled blasting. The maximum explosive used per hole is

625 gm. This has to be complied with.

5. Deep hole blasting should be strictly avoided as dwelling units and built structures are located in the vicinity of the mine.
6. Green belt development in the buffer zone and the nurturing of plants should be done with more vigour.
7. Garland drain should be developed all around the mine and provided with intermittent silt traps to minimize the discharge of turbid water to the siltation pond and further to the natural drain.
8. Temporary shelters for the mine workers should be provided to safeguard themselves during the blasting events.
9. The Audit report received from the Mining & Geology Department should be shared with the SEIAA.

Hence you are requested to submit the compliance of the above mentioned points

Yours faithfully,

Sd-/
Harikumar.A.S
Administrator,SEIAA

Approved for issue

A&S-Section officer

Annexure 3: Compliance of Recommendations by SEIAA Appointed Monitoring Committee

Annexure 3

S. No.	Condition	Compliance
1.	Install adequate sprinkling arrangements in the project area as no sprinklers are found installed in the project site to contain dust emissions except a small mobile water tanker. Sprinklers should be provided at the loading areas, vehicle parking areas and haulage roads.	**Being Complied** Mobile Water Sprinklers are modified with good sprinkling capacities and are available to sprinkle water till the loading faces, Parking areas, Haulage roads, etc., and separate pipe is provided from the mobile tanker to spray all over the areas where the tanker is unable to reach.  **Tanker with Pipeline for Sprinkling**
2.	Improve the storm water channelization by providing improved garland drain and silt traps.	**Complied** The area between the gabion wall and garland drainage is concreted for the proper channelization of storm water.
3.	Provide adequate sanitation arrangements to the workers at the site.	**Complied** e-Toilet has been installed for the sanitation requirements of workers at the site.  **Bio-Toilet at Site**

S. No.	Condition	Compliance
4.	As per the approved mining plan, deep hole blasting (depth of the hole 6.5 m, dia 115 mm and 20 to 25 kg explosives per hole) was permitted. Considering the requirement of stringent norm of distance criteria, the Proponent stated that, now 33 mm dia holes of depth 2.4 m used for controlled blasting. The maximum explosive used per hole is 625 gm. This has to be complied with.	**Complied** 33 mm dia holes of depth 2.4 m used for controlled blasting. The maximum explosive used per hole is 625 gm. This criterion is followed.
5.	Deep hole blasting should be strictly avoided as dwelling units and built structures are located in the vicinity of the mine.	**Complied** Deep hole blasting is not being undertaken.
6.	Greenbelt development in the buffer zone and the nurturing of plants should be done with more vigour.	**Complied** Greenbelt is developed and maintained in the buffer zone.

S. No.	Condition	Compliance
		 **Greenbelt Development**
7.	Garland drain should be developed all around the mine and provided with intermittent silt traps to minimize the discharge of turbid water to the siltation pond and further to the natural drain.	**Complied** The area between the gabion wall and garland drainage is concreted for the proper channelization of storm water.

S. No.	Condition	Compliance
		 **Garland Drain**
8.	Temporary shelters for the mine workers should be provided to safeguard themselves during the blasting events.	**Complied** A temporary shelter is available at the site for workers to safeguard themselves during blasting events.  **Temporary Shelter**
9.	The Audit report received from the Mining & Geology Department should be shared with the SEIAA.	**Complied** The audit report by Director of Mining & Geology was submitted to SEIAA vide our letter AVPPL/SEIAA/2022-23/1981 dated 07.06.2022; which was also included as a part of the Half Yearly Compliance Report for the Period April 2022 to September 2022 as Annexure 3.

Annexure 4: Email Submission of HYCR for the period April 2022 to September 2022

Jesse Benjamin Fullonton

From: Rajesh Kumar Jha
Sent: Wednesday, November 30, 2022 12:51 PM
To: rosz.bng-mefcc@gov.in; rosz.bng-mef@nic.in
Cc: seiaa kerala; Hebin Chenthamarakshan; Jesse Benjamin Fullonton; Snehal Jariwala; Environment Avppl; Palanivelu Kumar
Subject: EC No. 1200/EC2/2018/SEIAA dated 01.03.2019 - HYCR - Apr 2022 to Sep 2022 - Kadavilla-1 - Reg.
Attachments: EC No.1200_EC2_2018_SEIAA dated 01.03.2019-HYCR-Apr22-Sep22_22.11.2022.pdf

Dear Madam/Sir,

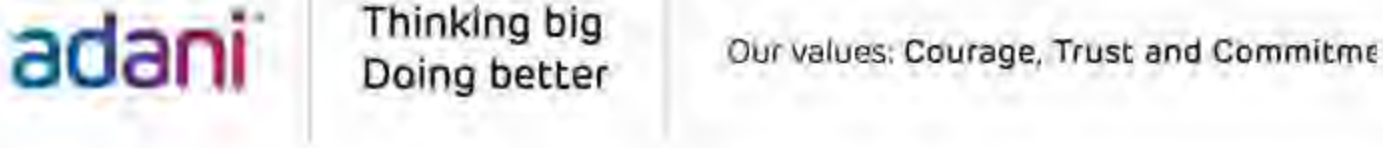
This has reference to the Environmental Clearance (EC) Order **No. 1200/EC2/2018/SEIAA issued on 01.03.2019** by State Environmental Impact Assessment Authority (SEIAA), Kerala to Adani Vizhinjam Port Private Limited (AVPPL) for our **Building Stone Quarry Project in Survey No. 555/2 at Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District**.

The Half Yearly Compliance Report (HYCR) of the conditions stipulated in the EC for the period **April 2022 to September 2022** is attached vide reference AVPPL/MoEF/2022-23/2223 dated 22.11.2022; for record and reference please.

You are requested to kindly acknowledge the receipt of the same.

Thanks & Regards,

Rajesh Jha
MD &CEO
Adani Vizhinjam Port Pvt Limited
Third Floor, Aspinwall House, Kuravankonam, Kowdiar, Thiruvananthapuram, Kerala - 695003
Mobile: +91 471 277 2116
www.adani.com



Annexure 5: Ambient Air Quality Monitoring Report

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003281F		
LRI No.: SEAAL23021248A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt : 14-02-2023

SAMPLE DETAILS			
Product Category	Atmospheric Pollution	Sample Code	EN23020414
Sample Name	Ambient Air	Sample Received on	17-02-2023
Sample Conditions at Receipt	Fit for Analysis	Test Commenced on	17-02-2023
Sampled by	Lab Authorized Sampler	Test Completed on	24-02-2023

DETAILS OF SAMPLING			
Sampling Location	Project Site	Date of Sampling	14-02-2023
Sampling Procedure	SEAAL/ENL/GEN/SOP/02	Humidity	72 %
Latitude	8° 43'42.7" N	Longitude	76° 50'16.1" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	TEST METHOD	UNIT	RESULT	NAAQ STANDARDS
1	Particulate matter (PM_{10})	IS 5182 (Part 23): 2006	µg/m^3	58.7	100 (Max)
2	Particulate matter ($PM_{2.5}$)	IS 5182 (Part 24):2019	µg/m^3	31.4	60.0 (Max)
3	Sulphur dioxide (SO_2)	IS 5182 (Part 2): 2001	µg/m^3	< 4.00	80.0 (Max)
4	Nitrogen dioxide (NO_2)	IS 5182 (Part 6): 2006	µg/m^3	< 4.00	80.0 (Max)

Remarks: The Air sample complies with National Ambient Air Quality Standards with respect to above parameters tested.

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003282F		
LRI No.: SEAAL23021249A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt : 14-02-2023

SAMPLE DETAILS			
Product Category	Atmospheric Pollution	Sample Code	EN23020415
Sample Name	Ambient Air	Sample Received on	17-02-2023
Sample Conditions at Receipt	Fit for Analysis	Test Commenced on	17-02-2023
Sampled by	Lab Authorized Sampler	Test Completed on	24-02-2023

DETAILS OF SAMPLING			
Sampling Location	Near Operators Rest Room North Side (2.33 km away from Project Site)	Date of Sampling	14-02-2023
Sampling Procedure	SEAAL/ENL/GEN/SOP/02	Humidity	73 %
Latitude	8° 43'11.2" N	Longitude	76° 49'6.9" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	TEST METHOD	UNIT	RESULT	NAAQ STANDARDS
1	Particulate matter (PM_{10})	IS 5182 (Part 23): 2006	µg/m^3	52.6	100 (Max)
2	Particulate matter ($PM_{2.5}$)	IS 5182 (Part 24):2019	µg/m^3	29.1	60.0 (Max)
3	Sulphur dioxide (SO_2)	IS 5182 (Part 2): 2001	µg/m^3	< 4.00	80.0 (Max)
4	Nitrogen dioxide (NO_2)	IS 5182 (Part 6): 2006	µg/m^3	< 4.00	80.0 (Max)

Remarks: The Air sample complies with National Ambient Air Quality Standards with respect to above parameters tested.

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental & Analytical Laboratories
Accreditation & Approval: NABL accredited Testing Laboratory as per ISO/IEC 17025:2017
vide Certificate No. TC - 5402 & "A" Grade Laboratory approved by KSPCB.
K.J. Tower, Pathalam, Udyogamandal P.O., Ernakulam-683 501, Tel. 0484-2546660, 93 87 27 24 02, 90 74 34 14 43
Web: www.sealabs.in, E-mail: seaalab@gmail.com

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003283F		
LRI No.: SEAAL23021250A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt : 14-02-2023

SAMPLE DETAILS			
Product Category	Atmospheric Pollution	Sample Code	EN23020416
Sample Name	Ambient Air	Sample Received on	17-02-2023
Sample Conditions at Receipt	Fit for Analysis	Test Commenced on	17-02-2023
Sampled by	Lab Authorized Sampler	Test Completed on	24-02-2023

DETAILS OF SAMPLING			
Sampling Location	Vanchiyoor UP School West Side (0.85 km away from Project Site)	Date of Sampling	14-02-2023
Sampling Procedure	SEAAL/ENL/GEN/SOP/02	Humidity	73 %
Latitude	8° 43'16.5" N	Longitude	76° 50'7.1" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	TEST METHOD	UNIT	RESULT	NAAQ STANDARDS
1	Particulate matter (PM_{10})	IS 5182 (Part 23): 2006	µg/m^3	55.3	100 (Max)
2	Particulate matter ($PM_{2.5}$)	IS 5182 (Part 24):2019	µg/m^3	32.7	60.0 (Max)
3	Sulphur dioxide (SO_2)	IS 5182 (Part 2): 2001	µg/m^3	< 4.00	80.0 (Max)
4	Nitrogen dioxide (NO_2)	IS 5182 (Part 6): 2006	µg/m^3	< 4.00	80.0 (Max)

Remarks: The Air sample complies with National Ambient Air Quality Standards with respect to above parameters tested.

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental & Analytical Laboratories
Accreditation & Approval: NABL accredited Testing Laboratory as per ISO/IEC 17025:2017
vide Certificate No. TC - 5402 & "A" Grade Laboratory approved by KSPCB.
K.J. Tower, Pathalam, Udyogamandal P.O., Ernakulam-683 501, Tel. 0484-2546660, 93 87 27 24 02, 90 74 34 14 43
Web: www.sealabs.in, E-mail: seaalab@gmail.com

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003284F		
LRI No.: SEAAL23021251A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt : 14-02-2023

SAMPLE DETAILS			
Product Category	Atmospheric Pollution	Sample Code	EN23020417
Sample Name	Ambient Air	Sample Received on	17-02-2023
Sample Conditions at Receipt	Fit for Analysis	Test Commenced on	17-02-2023
Sampled by	Lab Authorized Sampler	Test Completed on	24-02-2023

DETAILS OF SAMPLING			
Sampling Location	St. Joseph of Cluny Public School South side (1.01 km away from Project Site)	Date of Sampling	14-02-2023
Sampling Procedure	SEAAL/ENL/GEN/SOP/02	Humidity	73 %
Latitude	8° 43'35.3" N	Longitude	76° 50'48.2" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	TEST METHOD	UNIT	RESULT	NAAQ STANDARDS
1	Particulate matter (PM_{10})	IS 5182 (Part 23): 2006	µg/m^3	57.4	100 (Max)
2	Particulate matter ($PM_{2.5}$)	IS 5182 (Part 24):2019	µg/m^3	34.6	60.0 (Max)
3	Sulphur dioxide (SO_2)	IS 5182 (Part 2): 2001	µg/m^3	< 4.00	80.0 (Max)
4	Nitrogen dioxide (NO_2)	IS 5182 (Part 6): 2006	µg/m^3	< 4.00	80.0 (Max)

Remarks: The Air sample complies with National Ambient Air Quality Standards with respect to above parameters tested.

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental & Analytical Laboratories
Accreditation & Approval: NABL accredited Testing Laboratory as per ISO/IEC 17025:2017
vide Certificate No. TC - 5402 & "A" Grade Laboratory approved by KSPCB.
K.J. Tower, Pathalam, Udyogamandal P.O., Ernakulam-683 501, Tel. 0484-2546660, 93 87 27 24 02, 90 74 34 14 43
Web: www.sealabs.in, E-mail: seaalab@gmail.com

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003285F		
LRI No.: SEAAL23021252A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt : 14-02-2023

SAMPLE DETAILS			
Product Category	Atmospheric Pollution	Sample Code	EN23020418
Sample Name	Ambient Air	Sample Received on	17-02-2023
Sample Conditions at Receipt	Fit for Analysis	Test Commenced on	17-02-2023
Sampled by	Lab Authorized Sampler	Test Completed on	24-02-2023

DETAILS OF SAMPLING			
Sampling Location	Viswanadhapuram Shiva Temple East Side (1.09 km away from Project Site)	Date of Sampling	14-02-2023
Sampling Procedure	SEAAL/ENL/GEN/SOP/02	Humidity	73 %
Latitude	8° 44'17.6" N	Longitude	76° 50'10.4" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	TEST METHOD	UNIT	RESULT	NAAQ STANDARDS
1	Particulate matter (PM_{10})	IS 5182 (Part 23): 2006	µg/m^3	50.9	100 (Max)
2	Particulate matter ($PM_{2.5}$)	IS 5182 (Part 24):2019	µg/m^3	28.3	60.0 (Max)
3	Sulphur dioxide (SO_2)	IS 5182 (Part 2): 2001	µg/m^3	< 4.00	80.0 (Max)
4	Nitrogen dioxide (NO_2)	IS 5182 (Part 6): 2006	µg/m^3	< 4.00	80.0 (Max)

Remarks: The Air sample complies with National Ambient Air Quality Standards with respect to above parameters tested.

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Annexure 6: Noise Monitoring Report

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003286F		
LRI No.: SEAAL23021253A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt: 14-02-2023

DETAILS OF MONITORING			
Product Category	Atmospheric Pollution	Sample Code	EN23020419
Sample Name	Ambient Noise	Monitoring Commenced on	14-02-2023
Monitoring Location	Project Site	Monitoring Completed on	15-02-2023
Test Method	IS 9989:1981	Monitored by	Lab Authorized Sampler
Latitude	8° 43'42.7" N	Longitude	76° 50'16.1" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

MONITORING RESULTS - Leq

TIME	RESULTS dB(A)	TIME	RESULTS dB(A)	TIME	RESULTS dB(A)
06:00	44.6	14:00	59.8	22:00	43.2
07:00	47.8	15:00	60.3	23:00	39.1
08:00	52.9	16:00	61.6	24:00	41.9
09:00	57.0	17:00	62.1	01:00	42.7
10:00	59.8	18:00	55.7	02:00	42.3
11:00	63.5	19:00	51.5	03:00	43.1
12:00	60.3	20:00	46.9	04:00	41.9
13:00	59.3	21:00	46.4	05:00	43.9

TEST RESULTS– CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	UNIT	RESULT	Limit as per Noise Pollution (Regulation and Control) Rules, 2000 (Industrial Area)
1	Ambient Sound Level (Leq) Day Time (06:00 to 22:00)	dB(A)	58.3	75 dB (A)
2	Ambient Sound Level (Leq) Night Time (22:00 to 06:00)	dB(A)	42.3	70 dB (A)

Remarks: The Noise level Monitoring complies with the Noise Pollution (Regulation and Control) Rules, 2000 (Rules3 (1) and 4(1)).

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003287F		
LRI No.: SEAAL23021254A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt: 14-02-2023

DETAILS OF MONITORING			
Product Category	Atmospheric Pollution	Sample Code	EN23020420
Sample Name	Ambient Noise	Monitoring Commenced on	14-02-2023
Monitoring Location	Near Operators Rest Room North Side (2.33 km away from Project Site)	Monitoring Completed on	15-02-2023
Test Method	IS 9989:1981	Monitored by	Lab Authorized Sampler
Latitude	8° 43'11.2" N	Longitude	76° 49'6.9" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

MONITORING RESULTS - Leq

TIME	RESULTS dB(A)	TIME	RESULTS dB(A)	TIME	RESULTS dB(A)
06:00	41.3	14:00	55.4	22:00	40.0
07:00	44.3	15:00	55.8	23:00	38.6
08:00	49.0	16:00	57.1	24:00	41.4
09:00	52.8	17:00	57.5	01:00	42.2
10:00	55.4	18:00	51.5	02:00	41.8
11:00	58.8	19:00	47.7	03:00	42.6
12:00	55.8	20:00	43.5	04:00	41.4
13:00	55.0	21:00	42.9	05:00	43.4

TEST RESULTS– CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	UNIT	RESULT	Limit as per Noise Pollution (Regulation and Control) Rules, 2000 (Industrial Area)
1	Ambient Sound Level (Leq) Day Time (06:00 to 22:00)	dB(A)	53.9	75 dB (A)
2	Ambient Sound Level (Leq) Night Time (22:00 to 06:00)	dB(A)	41.8	70 dB (A)

Remarks: The Noise level Monitoring complies with the Noise Pollution (Regulation and Control) Rules, 2000 (Rules3 (1) and 4(1)).

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003288F		
LRI No.: SEAAL23021255A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt: 14-02-2023

DETAILS OF MONITORING			
Product Category	Atmospheric Pollution	Sample Code	EN23020421
Sample Name	Ambient Noise	Monitoring Commenced on	14-02-2023
Monitoring Location	Vanchiyoor UP School West Side (0.85 km away from Project Site)	Monitoring Completed on	15-02-2023
Test Method	IS 9989:1981	Monitored by	Lab Authorized Sampler
Latitude	8° 43'16.5" N	Longitude	76° 50'7.1" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

MONITORING RESULTS - Leq

TIME	RESULTS dB(A)	TIME	RESULTS dB(A)	TIME	RESULTS dB(A)
06:00	40.4	14:00	54.1	22:00	39.1
07:00	43.3	15:00	54.5	23:00	38.4
08:00	47.8	16:00	55.7	24:00	41.2
09:00	51.6	17:00	56.2	01:00	42.0
10:00	54.1	18:00	50.3	02:00	41.6
11:00	57.4	19:00	46.6	03:00	42.4
12:00	54.5	20:00	42.4	04:00	41.2
13:00	53.7	21:00	41.9	05:00	43.2

TEST RESULTS– CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	UNIT	RESULT	Limit as per Noise Pollution (Regulation and Control) Rules, 2000 (Industrial Area)
1	Ambient Sound Level (Leq) Day Time (06:00 to 22:00)	dB(A)	52.6	75 dB (A)
2	Ambient Sound Level (Leq) Night Time (22:00 to 06:00)	dB(A)	41.6	70 dB (A)

Remarks: The Noise level Monitoring complies with the Noise Pollution (Regulation and Control) Rules, 2000 (Rules3 (1) and 4(1)).

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^S Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003289F		
LRI No.: SEAAL23021256A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt: 14-02-2023

DETAILS OF MONITORING			
Product Category	Atmospheric Pollution	Sample Code	EN23020422
Sample Name	Ambient Noise	Monitoring Commenced on	14-02-2023
Monitoring Location	St. Joseph of Cluny Public School South side (1.01 km away from Project Site)	Monitoring Completed on	15-02-2023
Test Method	IS 9989:1981	Monitored by	Lab Authorized Sampler
Latitude	8° 43'35.3" N	Longitude	76° 50'48.2" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

MONITORING RESULTS - Leq

TIME	RESULTS dB(A)	TIME	RESULTS dB(A)	TIME	RESULTS dB(A)
06:00	38.9	14:00	52.1	22:00	37.7
07:00	41.7	15:00	52.5	23:00	38.1
08:00	46.1	16:00	53.7	24:00	40.9
09:00	49.7	17:00	54.1	01:00	41.7
10:00	52.1	18:00	48.5	02:00	41.3
11:00	55.3	19:00	44.9	03:00	42.1
12:00	52.5	20:00	40.9	04:00	40.9
13:00	51.7	21:00	40.4	05:00	42.8

TEST RESULTS– CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	UNIT	RESULT	Limit as per Noise Pollution (Regulation and Control) Rules, 2000 (Industrial Area)
1	Ambient Sound Level (Leq) Day Time (06:00 to 22:00)	dB(A)	50.6	75 dB (A)
2	Ambient Sound Level (Leq) Night Time (22:00 to 06:00)	dB(A)	41.3	70 dB (A)

Remarks: The Noise level Monitoring complies with the Noise Pollution (Regulation and Control) Rules, 2000 (Rules3 (1) and 4(1)).

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Standard^{S} Environmental Monitoring

TC-5402

TEST REPORT

ULR No: TC540223000003290F		
LRI No.: SEAAL23021257A	Date: 25-02-2023	Page 1 of 1

CUSTOMER DETAILS	
Customer Name & Address	**M/s Adani Vizhinjam Port PVt Ltd** Nagaroor, Chirayinkeezhu, Thiruvananthapuram District.
Customer Reference	Test Request dt: 14-02-2023

DETAILS OF MONITORING			
Product Category	Atmospheric Pollution	Sample Code	EN23020423
Sample Name	Ambient Noise	Monitoring Commenced on	14-02-2023
Monitoring Location	Viswanadhapuram Shiva Temple East Side (1.09 km away from Project Site)	Monitoring Completed on	15-02-2023
Test Method	IS 9989:1981	Monitored by	Lab Authorized Sampler
Latitude	8° 44'17.6" N	Longitude	76° 50'10.4" E

INFORMATION PROVIDED BY CUSTOMER - SAMPLING SITE DETAILS			
Re - Survey No	555/2, Block No.37		
Village	Nagaroor	Taluk	Chirayinkeezhu
District	Thiruvananthapuram	State	Kerala

MONITORING RESULTS - Leq

TIME	RESULTS dB(A)	TIME	RESULTS dB(A)	TIME	RESULTS dB(A)
06:00	38.7	14:00	51.9	22:00	37.5
07:00	41.5	15:00	52.3	23:00	37.4
08:00	45.9	16:00	53.5	24:00	40.1
09:00	49.5	17:00	53.9	01:00	40.9
10:00	51.9	18:00	48.3	02:00	40.5
11:00	55.1	19:00	44.7	03:00	41.3
12:00	52.3	20:00	40.7	04:00	40.1
13:00	51.5	21:00	40.2	05:00	42.1

TEST RESULTS – CHEMICAL DISCIPLINE

Sl. No.	PARAMETERS	UNIT	RESULT	Limit as per Noise Pollution (Regulation and Control) Rules, 2000 (Industrial Area)
1	Ambient Sound Level (Leq) Day Time (06:00 to 22:00)	dB(A)	50.4	75 dB (A)
2	Ambient Sound Level (Leq) Night Time (22:00 to 06:00)	dB(A)	40.6	70 dB (A)

Remarks: The Noise level Monitoring complies with the Noise Pollution (Regulation and Control) Rules, 2000 (Rules3 (1) and 4(1)).

End of Report

Shency Joy
Dy.TM-Chemical
Checked by:

Laiju P.N.
Laboratory Head
Authorized Signatory

Annexure 7: CER and EMP Expenditure Statement

Annexure 7

Expenditure Statement for CER for the FY 2022-2023:

S. No.	CER Activity	Expenditure (Rs. Lakhs)
	Total FY 2020-2021	**8.05**
	Total FY 2021-2022	**6.25**
1.	Onam Kit (Groceries & Provisions) Distribution to BPL Families	3.00
2.	Strengthening of Ayiravally Temple Road	18.59
	Total FY 2022-2023	**21.59**
	Cumulative Total till date	**35.89**

Expenditure Statement for EMP for the FY 2022-2023:

S. No.	EMP Expenditure	Expenditure (Rs. Lakhs)
	Total FY 2019-2020	**4.95**
	Total FY 2020-2021	**7.34**
	Total FY 2021-2022	**8.89**
1.	Water Sprinkling	10.40
2.	Greenbelt Development/Sapling Plantation	3.51
3.	Environmental Monitoring	0.68
	Total FY 2022-2023 (till 30.09.2022)	**14.59**
	Cumulative Total till date	**35.77**

Half Yearly Compliance Report (HYCR)
October 2022 to March 2023

Building Stone Quarry Project: Survey No. 555/2 at Nagaroor Village, Chirayinkeezhu Taluk, Thiruvananthapuram District

Adani Vizhinjam Port Private Ltd. (AVPPL)

Gmail

Rajesh Chauhan <chauhanrajes@gmail.com>

RE: Service of Reply on behalf of on behalf of Respondent Adani Vizhinjam Port Private Limited in Original Application No. 304 of 2019 in the matter of "M. Haridasan Vs. State of Kerala & Ors."

1 message

Arshit Anand <arshit@aglaw.in> Sat, Feb 24, 2024 at 5:55 PM
To: "panjwanivijay62@gmail.com" <panjwanivijay62@gmail.com>, "2abhilashmr@gmail.com" <2abhilashmr@gmail.com>, "56chamber@gmail.com" <56chamber@gmail.com>
Cc: Rajesh Chauhan <chauhanrajes@gmail.com>, Geetika Sharma <geetika.sharma@aglaw.in>

SERVICE OF REPLY

Dear sir/mam,

Please find below one drive link containing Service of Reply inaptioned Original Application No. 304 of 2019 in the matter of "M. Haridasan Vs. State of Kerala & Ors." on behalf of Respondent Adani Vizhinjam Port Private Limited for your kind reference.

You are requested to kindly acknowledge receipt of the service of the same.

M Haridas Vs. State of Kerala - Additional Reply Vol-I.pdf
M Haridas Vs. State of Kerala - Additional Reply Vol-II.pdf

Best Regards,
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