CHAPTER 3
CASE DESCRIPTION
3.1 Introduction

To comply with the objectives of research work, the sites for experimental blasts were selected considering almost similar geo-mining conditions. The field studies were planned and carried out in three limestone quarries (quarry A, quarry B and quarry C), located in Chittorgarh town of Rajasthan. In the said limestone quarries, the rock formation belongs to the Nimbahera limestone formation deposits. Limestone, shale and clay are the major rock types of this formation. The deposit was multidirectional jointed type and the limestone was fine grained, and massive in structure. The total thickness of the Nimbahera limestone is estimated to be 144 m of which, the bottom 9 m was deep reddish purple in colour while the upper 135 m was grey in colour, fine grained and was thinly bedded. The annual production of the studied mine are 1.7 – 1.9 million ton and on the daily basis it produces 4500- 5000 ton per day.

The deposit is located between Latitude $24^0$45’ – $25^0$13’ North and Longitude $74^0$12’ – $75^0$49’ East in the South East part of Rajasthan State (Figure 3.1).

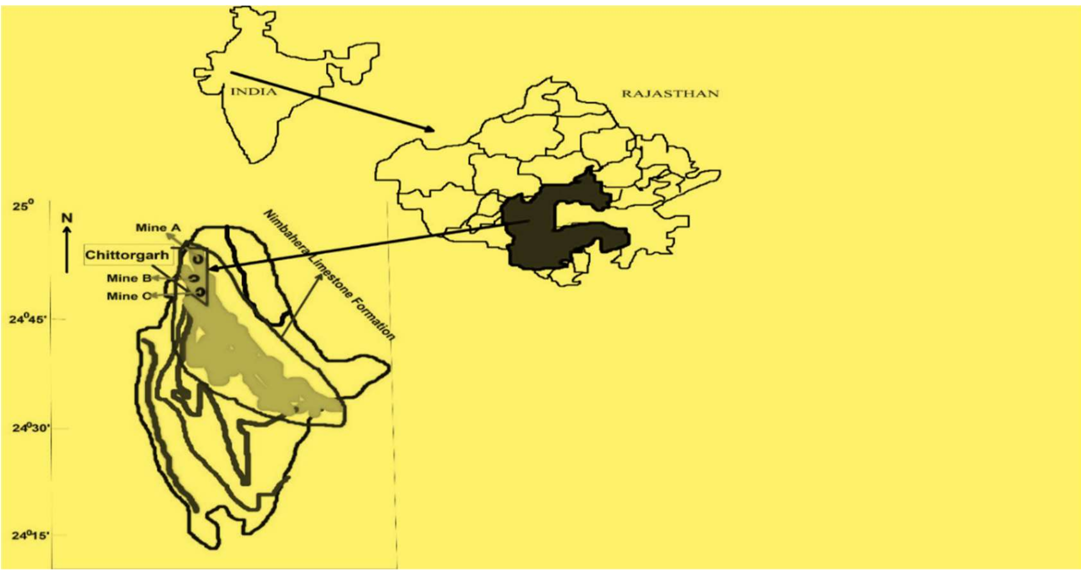

Figure.3.1: Location of the study quarries

3.2 Significant Properties of Nimbahera limestone formation

The deposit was exposed to structural disturbances of subdued magnitude as evidenced by minor folds and joints. The general dip of the deposits and associated formation varied from 0^0 to 20^0 towards east-west synform fold, which were observed on the exposed face of the quarries. The geological properties, geotechnical properties, mineralogical properties and chemical properties of Nimbahera limestone are tabulated in tables 3.1 to table 3.4 respectively.

Table 3.1: Geological properties of Nimbahera limestone formation

Age & Group	Formation	Major Rock Type	Appearance	Texture and Color
Khori Group Lower Vindhyan Age	Nimbahera Formation	Sedimentary rock (Limestone, Shale and Clay are present in this formation).	Structure- Massive Grain Size- Fine Powder Color- White	Texture- Granular Color- Light to Dark Grey

Table 3.2: Geotechnical properties of Nimbahera limestone formation

Hardness	Density	Porosity	Compressive Strength	Dip Direction
Soft to Moderate Hard Value- 2.5 to 4 on Moh's Scale of Hardness	2000 to 2600 Kg/t	Low (3 to 6.5)%	40 to 50 Mpa	0^0 to 20^0 towards East-West

Table 3.3: Mineralogical properties of Nimbahera limestone formation

Origin	Major Minerals Present
Organic Origin (Formed from the Skeletal remains of Marine Organisms)	Calcite ($CaCO_3$), Dolomite (($CaMg(CO_3)_2$)

Table 3.4: Mineralogical properties of Nimbahera limestone formation

Chemical Formula	Composition
$CaCO_3$	CaO- 42 to 44% MgO- 1 to 2% SiO_2- 14 to 18 % Al_2O_3- 0.2 to 0.6 % Fe_2O_3- 0.1 to 0.5 %

3.3 Field description

A total of 285 number of blasts (from three quarries) were conducted, out of which 75% were used for development of related statistical and neural network models in form of equations and 25% were used for validation of the developed equations.

The quarry produced cement grade limestone with $CaCO_3$ varying from 70-76% and SiO_2 ranging from 14-18%. The height of benches varied from 9.0-11.0 m. Excavation of the limestone was done by conventional drilling and blasting using ANFO (ammonium nitrate mixed with fuel oil) primed with cap-sensitive slurries. Blast holes were initiated on a Staggered patterns using bottom initiation systems by use of Nonel. The explosive and initiation system were same and provided by same supplier in the group of quarries owned by JK cement.

The blast holes was drilled by using diesel operated Ingersoll Rand IBH-10 and BVB-25 rotary percussive drill machine capable of drilling 110 to 150 mm diameter holes.

The blasted muck was removed by using 3.2 m^3 and 4.6 m^3 hydraulic shovels and 35 t rear dump trucks. The dumpers carrying muck were weighed at the pit head weigh bridge before being despatch final from the quarry. The dumpers unloaded the material in the crusher. The maximum feed size of the crusher was 800 mm.

3.4 Details of blasting design for the three quarries

The drilling pattern of holes and the longitudinal blast hole section for all the three quarries has been discussed herewith quarry wise:

3.4.1 Blasting Pattern details for Quarry 'A'

A total of 97 number of blasting round were recorded for the quarry A. The details of these blasting round are given in Appendix A.1.

The diameter of the blast hole was 110 mm or 150 mm, avge. bench height varied from 10-11 m and distance of vibration measurement point varied from 200-400 m. The drill holes were drilled in staggered pattern and fired on row-to-row pattern.

Representative drilling and firing pattern for Quarry A with 2 and 3 drilling rows are shown in Figures 3.2 and 3.3 respectively. The Figures Clearly indicate 2 or 3 number of drill hole rows (from highwall side to the free face of the bench) drilled on staggered drilling pattern and fired on diagonal pattern with inter-hole and inter-row delay sequence of 17ms, 25/42ms respectively.

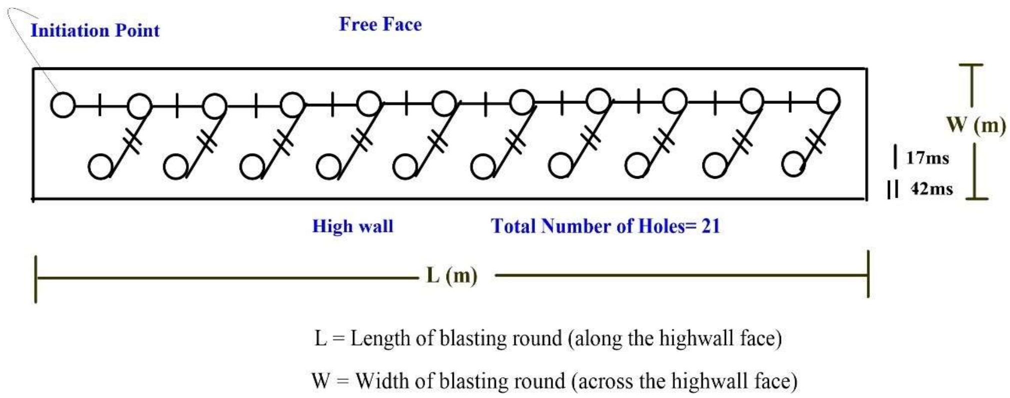

Figure 3.2: Representative drilling and firing pattern for quarry A with two rows (not to scale)

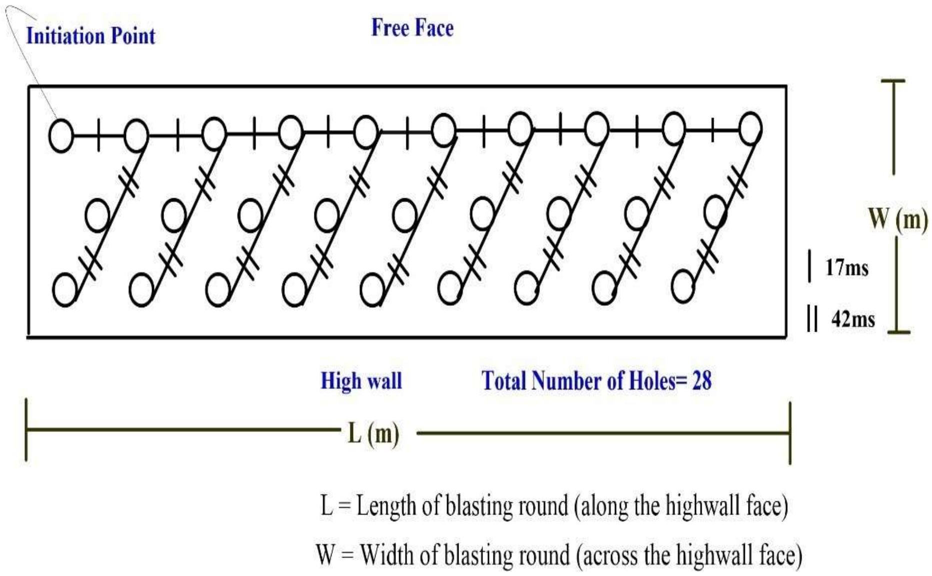

Figure 3.3: Representative drilling and firing pattern for quarry A with three rows (not to scale)

Similarly, the representative longitudinal sections of 110mm and 150mm dia. Blastholes are illustrated in Figures 3.4 and 3.5 respectively.

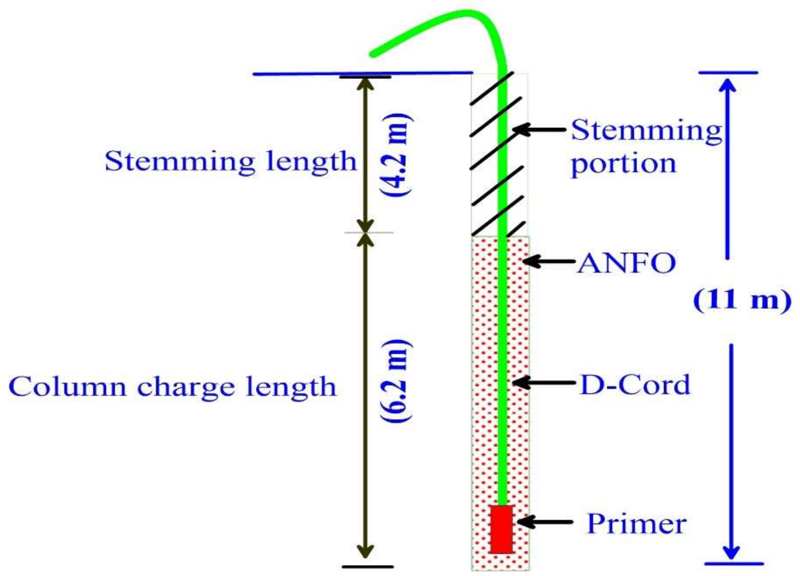

Figure 3.4: Representative blast hole section (diameter 115 mm) (not to scale)

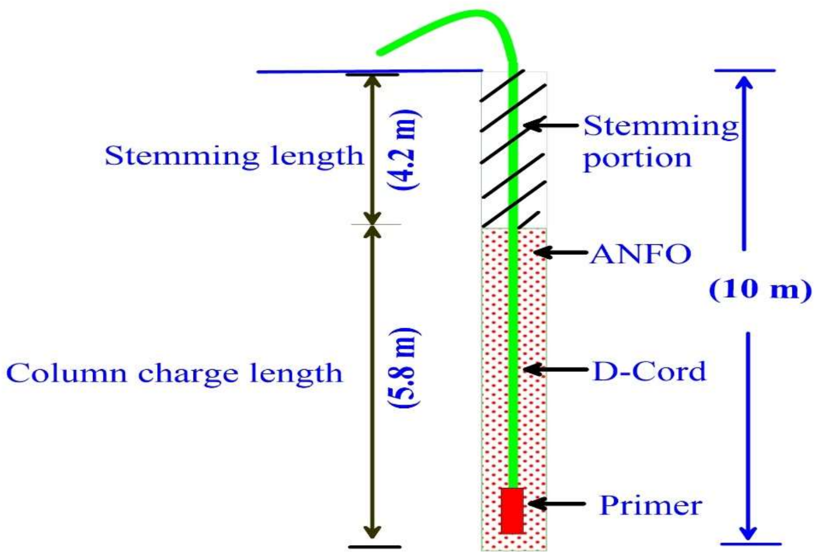

Figure 3.5: Representative blast hole section (diameter 150 mm) (not to scale)

Field images of quarry blast round during and after blasting are shown in Figures 3.6 and 3.7 respectively.

Figure 3.6: Blasting operation in Quarry 'A'

Figure 3.7: Post-blasting muck profile in Quarry 'A'

3.4.2 Blasting Pattern details for Quarry 'B'

A total of 88 number of blasting rounds were recorded for the quarry B. The details of these blasting round are given in Appendix A.2.

The diameter of the blast hole was 110 mm or 115 mm, average bench height varied from 9-10.5 m and distance of vibration measurement point varied from 140-350 m. The drill holes were drilled in staggered pattern and fired on row-to-row pattern.

Representative drilling and firing pattern for Quarry A with 2 and 3 drilling rows are shown in Figures 3.8 and 3.9 respectively. The Figures Clearly indicate 2 or 3 number of drill hole rows (from highwall side to the free face of the bench) drilled on staggered drilling pattern and fired on diagonal pattern with inter-hole and inter-row delay sequence of 17/25ms, 42ms respectively.

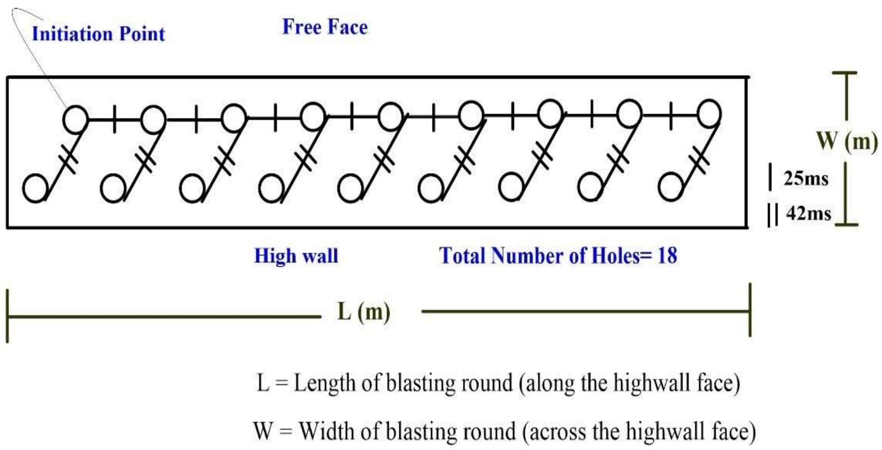

Figure 3.8: Representative drilling and firing pattern for quarry B with two rows (not to scale)

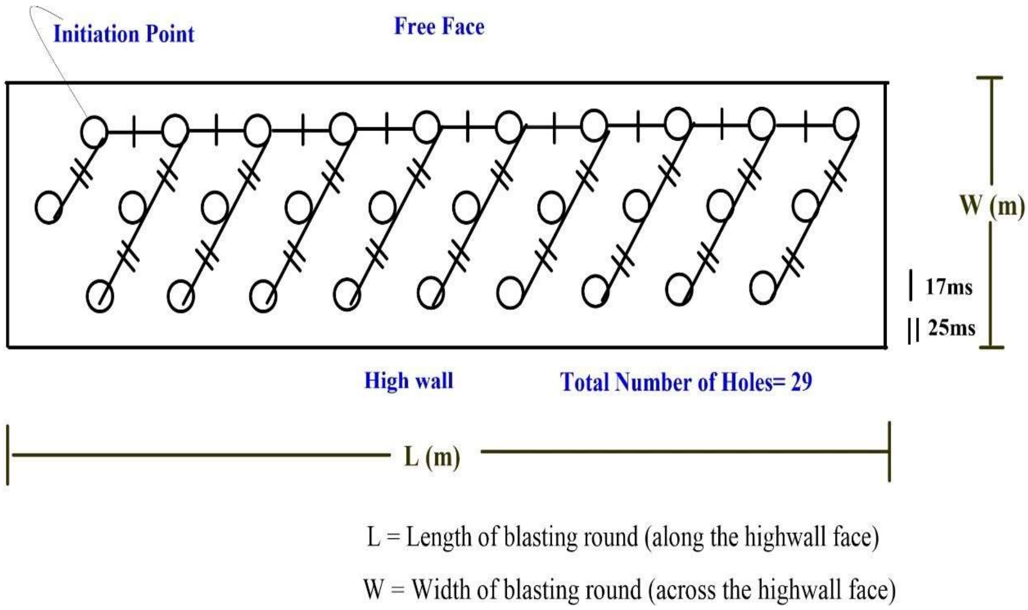

Figure 3.9: Representative drilling and firing pattern for quarry B with three rows (not to scale)

Similarly, the representative longitudinal sections of 110mm and 115mm dia. blast holes are illustrated in Figures. 3.10 and 3.11 respectively.

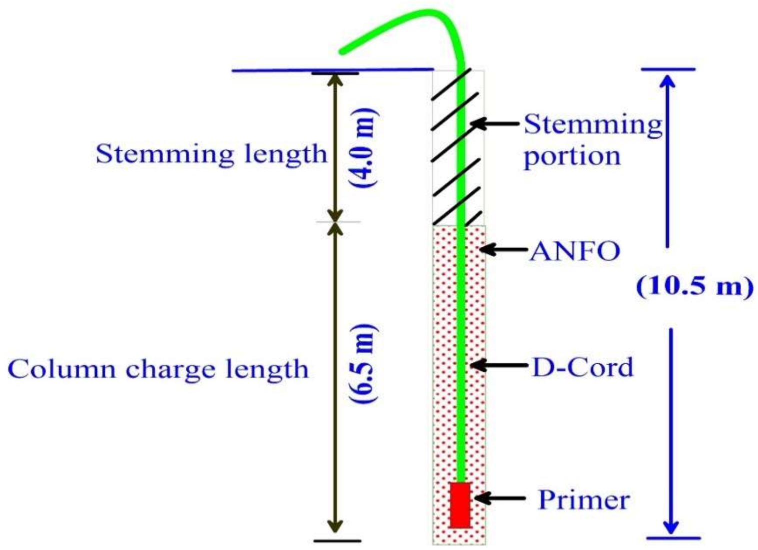

Figure 3.10: Representative blast hole section (diameter 115 mm) (not to scale)

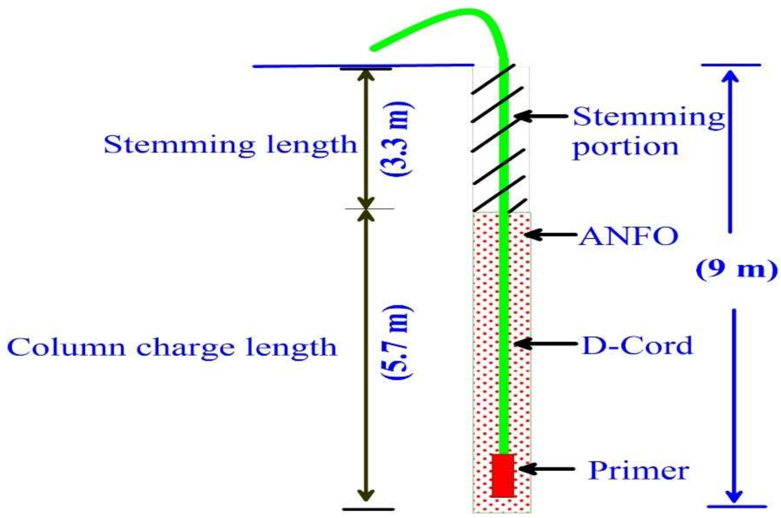

Figure 3.11: Representative blast hole section (diameter 150 mm) (not to scale)

Field images of quarry blastround during and after blasting are shown in Figure 3.12 and 3.13 respectively.

Figure 3.12: Blasting operation in Quarry 'B'

Figure 3.13: Post-blasting muck profile in Quarry ‘B’

3.4.3 Blasting Pattern details for Quarry ‘C’

A total of 100 number of blasting rounds were recorded for the quarry C. The details of these blasting round are given in Appendix A.3.

The diameter of the blast hole was 115 mm or 150 mm, avge. bench height varied from 10-11m and distance of vibration measurement point varied from 150-500 m. The drill holes were drilled in staggered pattern and fired on row-to-row pattern.

Representative drilling and firing pattern for Quarry A with 2, 3 and 4 drilling rows are shown in Figures 3.14, 3.15 and 3.16 respectively. The Figures Clearly indicate 2, 3 or 4 number of drill hole rows (from highwall side to the free face of the bench) drilled on staggered drilling pattern and fired on diagonal pattern with inter-hole and inter-row delay sequence of 17/25ms, 42ms respectively.

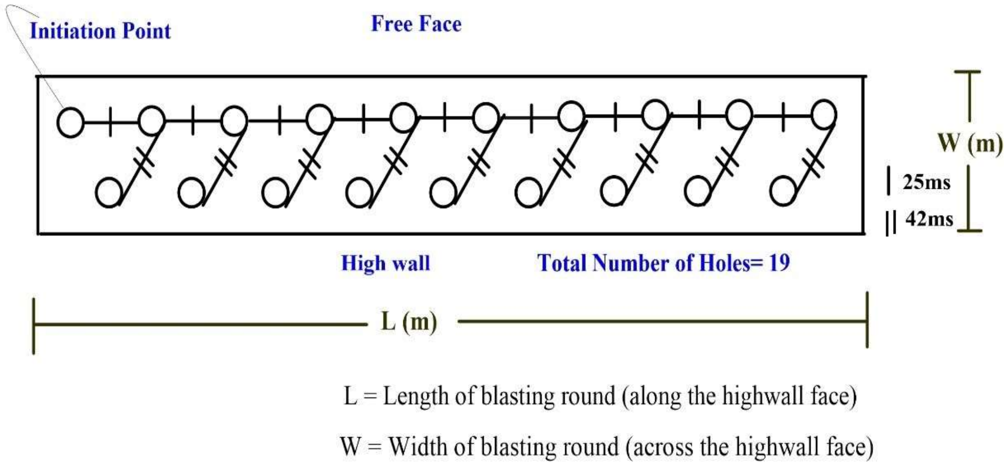

Figure 3.14: Representative drilling and firing pattern for quarry C with two rows (not to scale)

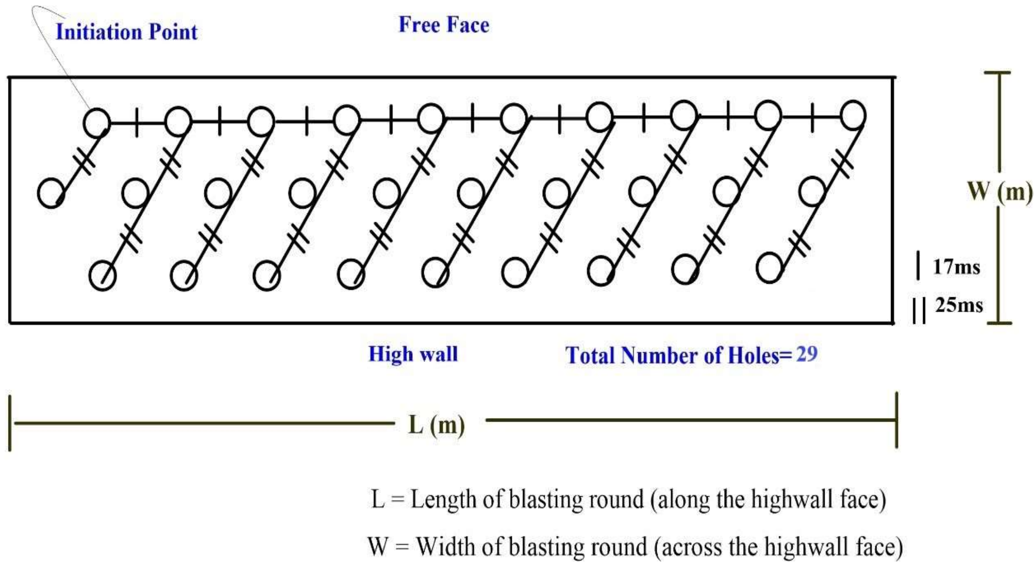

Figure 3.15: Representative drilling and firing pattern for quarry C with three rows (not to scale)

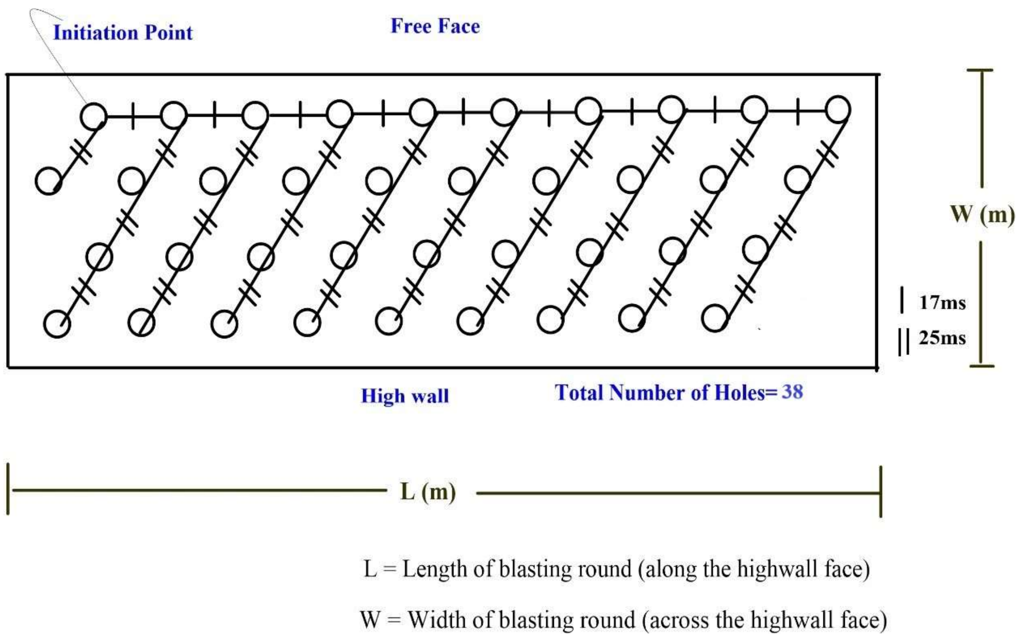

Figure 3.16: Representative drilling and firing pattern for quarry C with four rows (not to scale)

Similarly, the representative longitudinal sections of 115mm and 150mm dia. blast holes are illustrated in Figures 3.17 and 3.18 respectively.

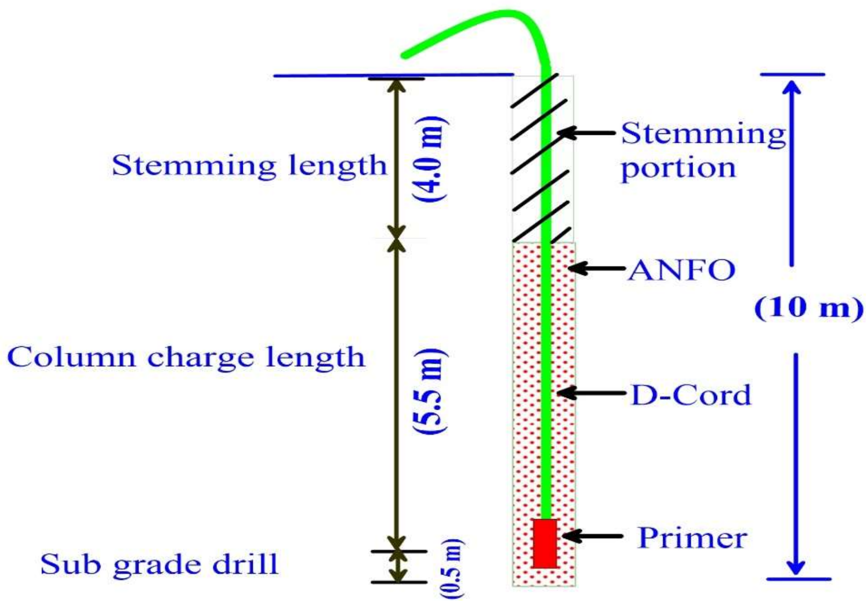

Figure 3.17: Representative blast hole section (diameter 150 mm) (not to scale)

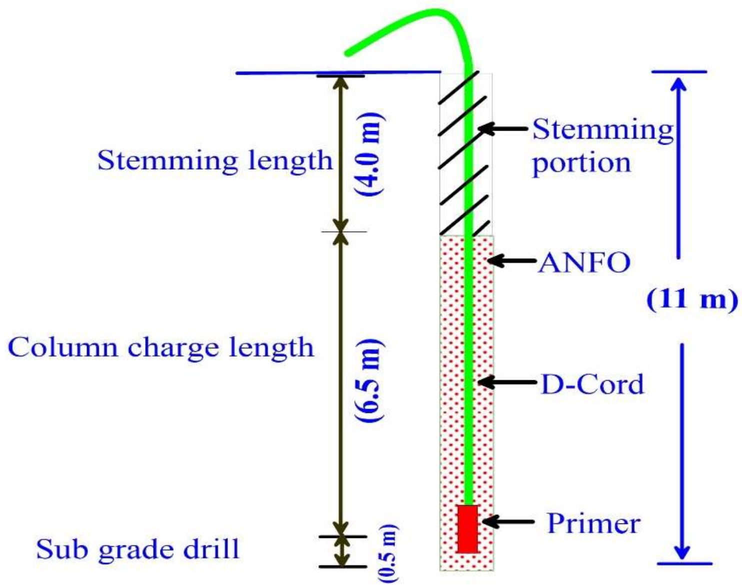

Figure 3.18: Representative blast hole section (diameter 115 mm) (not to scale)