# 6. REFERENCES

[1] J.P. Ashby, "Production blasting and the development of open pit slopes", in 3$^{rd}$ International Conference on Stability in Open Pit Mining, Vancover, B.C., 1981

[2] F.G. Bell, Engineering properties of rocks and soils. Butterworth-Heinemann Ltd., Oxford, UK, 1992, pp. 101.

[3] S. C. Bhanwar, "Firing Patterns and Its Effect on Muckpile Shape Parameters and Fragmentation in Quarry Blasts", International Journal of Research in Engineering and Technology, 2013, pp 83-88.

[4] Z.T. Bieniawski, *Engineering rock mass classifications*. New York: Wiley, 1989.

[5] Z.T. Bieniawski, "Engineering classification of jointed rock masses", 15$^{th}$ Transactions of South African Institute of Civil Engineers, 1973, pp 335-344.

[6] Z.T. Bieniawski, "Classification of rock masses for engineering: the RMR system and future trends", in *Comprehensive Rock Engineering* (J.A. Hudson ed.), Pergamon: 1993, Vol. 3, pp. 553-73.

[7] Z.T. Bieniawski and I. Hawkes, "Suggested methods for determining tensile strength of rock materials", *Int. J. Rock Mech. Min. Sci. & Geomech. Abstr.*, Vol. 15, No.3, pp. 99-103, 1978.

[8] E.J. Cording, and D.U. Deere, "Rock tunnel supports and field measurements", in *Proc. North American rapid excav. tunneling conf., Chicago*, Soc. Min. Engrs, Am. Inst. Min. Metall. Petrolm Engrs, New York, pp. 601-622, 1972.

[9] R.A. Dick, L.R Fletcher and D.V. D'Andrea, Explosives and Blasting Procedures Manual, Information Circular 8925. U.S. Bureau of Mines, 1983.

[10] D.U. Deere, and D.W. Deere, "The rock quality designation (RQD) index in practice", In *Rock classification systems for engineering purposes*, ASTM Special Publication 984, Philadelphia: Am. Soc. Test. Mat. 1988, pp 91-101.

[11] D.U. Deere, A.J. Hendron, F.D. Patton, and E.J. Cording, "Design of surface and near surface construction in rock", In *Failure and breakage of rock*, proc.

8th U.S. symp. rock mech., pp. 237-302. New York: Soc. Min. Engrs, Am. Inst. Min. Metall. Petrolm Engrs, 1967.

[12] C. Fairhurst, "On the validity of the Brazilian Test for brittle materials", in *International Journal of Rock Mechanics and Mining Science*, London: Pergamon Press. 1964, Vol. 1, pp. 535-546.

[13] G. L. Buffington, "The Art of Blasting on Construction and Surface Mining Sites", ASSE Professional Development Conference and Exposition, Orlando, Florida: American Society of Safety Engineers, 2000.

[14] E. Hoek, Strength of rock and rock masses: News J ISRM, Vol 2 (2), pp. 4–16, 1994.

[15] C. J. Konya and E. J. Walter, *Rock blasting and overbreak control*, Precision Blasting Services. U. S. Department of Transportation, Federal Highway Administration, 1991.

[16] M. Heiniö, *Rock Excavation Handbook*, Sandvik Tamrock, 1999

[17] A.H. Merritt, "Geologic prediction for underground excavations", in *Proc. North American. rapid excav. tunneling conf.*, Chicago, pp. 115-132, New York: Soc. Min. Engrs, Am. Inst. Min. Metall. Petrolm Engrs, 1972.

[18] A. R. Muhammad, "The effects of fragmentation specifications on cost", Queens University, Kingston, 2009.

[19] M. Mellor, and I. Hawkes, "Measurement of tensile strength by diametral compression of discs and annuli", *Engineering Geology* Reprint, vol. 5, pp. 194-195, 1971.

[20] L. Obert, , and W.I. Duvall, *Rock Mechanics and the Design of Structures in Rock*. New York: John Wiley & Sons, 1967.

[21] A. Palmstrom, "The volumetric joint count - A useful and simple measure of the degree of rock mass jointing", *IAEG Congress*, New Delhi, pp. 221 –228, 1982.

[22] R. Dhir and C.M. Sangha, "Relationships between size, deformation and strength for cylindrical specimens loaded in uniaxial compression", in *International Journal of Rock Mechanics and Mining Science & Geomechanics*, 1973

# 7. APPENDICES

**Appendix A: Quarries site locations in Western Provincial map**

**Appendix B: Quarries selected for the research and collected data**

**Quarry no 01**: This quarry is situated at Leenawaththa, Padukka area in Colombo district and currently been mined as an active metal quarry. Garnet content of the quarry metal is comparatively high. Figure 7.1 shows view of the front working face of the quarry.



**Figure 7.1: Front working face view of Quarry no 01**

Explosive usage and drilling geometry data of quarry no 01 from January 2016 to July 2016; for consecutive 07 months are tabulated in the table 7.1 below.

**Table 7.1: Explosive consumption and drilling geometry data for Quarry No 01**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
|---|---|---|---|---|---|
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 45.31 | 304.8 | 1.3 | 1.1 | 1557.27 |
| February | 72.25 | 476.2 | 1.3 | 1.1 | 2612.61 |
| March | 26.50 | 173.7 | 1.3 | 1.1 | 900.90 |
| April | 27.37 | 190.0 | 1.3 | 1.1 | 1033.89 |
| May | 16.37 | 122.7 | 1.3 | 1.1 | 561.99 |
| June | 90.75 | 695.5 | 1.3 | 1.1 | 3166.02 |
| July | 39.875 | 270.0 | 1.3 | 1.1 | 1432.86 |

Field data collected at the quarry no 01 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.2 below.

**Table 7.2: Field data sheet for RMR calculation in Quarry No 01**

| Quarry 01 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 50 – 100 Mpa | 50 – 100 Mpa | 50 – 100 Mpa |
| Drill core Quality (RQD) | 50% - 75% | 50% - 75% | 50% - 75% |
| Spacing of discontinuities | >2m | >2m | >2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10 – 20 m | 1 – 3m | 10 – 20 m |
| Separation | < 0.1 mm | None | 0.1 – 1.0 mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Hard Filling < 5 mm | Hard Filling < 5 mm | Hard Filling > 5 mm |
| Weathering | Slightly Weathered | Slightly Weathered | Slightly Weathered |
| Ground water condition | Damp | Damp | Damp |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike perpendicular to blasting axis Drive against Dip $20^0$ - $45^0$ Unfavorable | Strike perpendicular to blasting axis Drive against Dip $20^0$ - $45^0$ Unfavorable | Strike perpendicular to blasting axis Drive against Dip $20^0$ - $45^0$ Unfavorable |

**Quarry no 02**: Charnokitic rock is been mine in this quarry which is situated in Kaduwela area. The rocks encountered in and around the project area are granitic gneiss, charnockitic biotite gneiss and quartz. This quarry has recorded proper Aggregate Impact Value for the road projects. Access ramp and side view of the quarry is shown in the figure 7.2 below.



**Figure 7.2: Access ramp and side view of the quarry no 02**

Explosive usage and drilling geometry data of quarry no 02 from January 2016 to March 2016; for consecutive 03 months are tabulated in the table 7.3 below.

**Table 7.3: Explosive consumption and drilling geometry data for Quarry No 02**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
| --- | --- | --- | --- | --- | --- |
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 172.00 | 1670.0 | 1.5 | 1.2 | 4506.94 |
| February | 112.99 | 895.0 | 1.5 | 1.2 | 2925.41 |
| March | 162.83 | 1816.0 | 1.5 | 1.2 | 4799.87 |

Field data collected at the quarry no 02which were used to calculate Rock Mass Rating (RMR) relevant to the site is tabulated in the table no 7.4 below.

**Table 7.4: Field data sheet for RMR calculation in Quarry No 02**

| Quarry 02 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 50 - 100 MPa | 50 - 100 MPa | 50 - 100 MPa |
| Drill core Quality (RQD) | 90% - 100% | 50% - 75% | 75% - 90% |
| Spacing of discontinuities | 0.6m - 2m | 0.6m - 2m | 0.6m - 2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10m - 20m | 10m - 20m | 10m - 20m |
| Separation | < 0.1m | < 0.1m | < 0.1m |
| Roughness | Slightly Rough | Slightly Rough | Slightly Rough |
| Infilling | Hard Filling<5mm | Hard Filling<5mm | Hard Filling<5mm |
| Weathering | Slightly Weathered | Slightly Weathered | Slightly Weathered |
| Ground water condition | Completely Dry | Completely Dry | Completely Dry |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair |

**Quarry no 03**: This quarry is situated in a private land in Hanwella area in Colombo district. Surrounded are is highly populated and blasting activities carried out with utmost care. Part of the access ramp and working benches of the quarry no 03 can be seen in the figure 7.3 below.



**Figure 7.3: Part of the access ramp and working benches of the quarry no 03**

Explosive usage and drilling geometry data of quarry no 03 from January 2016 to May 2016; for consecutive 05 months are tabulated in the table 7.5 below.

**Table 7.5: Explosive consumption and drilling geometry data for Quarry No 03**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
|---|---|---|---|---|---|
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 219.00 | 4420.0 | 1.8 | 1.7 | 7032.00 |
| February | 205.00 | 4201.0 | 1.8 | 1.7 | 6696.00 |
| March | 168.00 | 3887.0 | 1.8 | 1.7 | 6744.00 |
| April | 248.00 | 4515.0 | 1.8 | 1.7 | 7874.00 |
| May | 140.00 | 2891.0 | 1.8 | 1.7 | 5004.00 |

Field data collected at the quarry no 03 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.6 below.

**Table 7.6: Field data sheet for RMR calculation in Quarry No 03**

| Quarry 03 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 50 – 100 MPa | 50 – 100 MPa | 50 – 100 MPa |
| Drill core Quality (RQD) | 75% - 90% | 75% - 90% | 75% - 90% |
| Spacing of discontinuities | 0.6 – 2 m | 0.6 – 2 m | 0.6 – 2 m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 3 – 10 m | 3 – 10 m | 3 – 10 m |
| Separation | 0.1 - 1 mm | 0.1 - 1 mm | 0.1 - 1 mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Hard Filling < 5 mm | Hard Filling < 5 mm | Hard Filling < 5 mm |
| Weathering | Slightly Weathered | Slightly Weathered | Slightly Weathered |
| Ground water condition | Completely Dry | Completely Dry | Completely Dry |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable |

**Quarry no 04**: Quarry no 04 is situated in Meepe area of the Colombo district. Quarry metal found in this quarry has high garnet content it recorded higher UCS and TS values but low AI values. Overall rock mass shows higher stability hence recorded RMR is comparatively high. Quarry metal loading point and ramp to the upper bench of the quarry no 04 is shown in the figure 7.4 below.



**Figure 7.4: View of quarry metal loading point and a ramp of quarry no 04**

Explosive usage and drilling geometry data of quarry no 04 from January 2016 to June 2016; for consecutive 06 months are tabulated in the table 7.7 below.

**Table 7.7: Explosive consumption and drilling geometry data for Quarry No 04**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
| --- | --- | --- | --- | --- | --- |
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 2,348.00 | 229.50 | 1.8 | 1.7 | 2865.26 |
| February | 2,521.25 | 226.50 | 1.8 | 1.7 | 2895.03 |
| March | 1,935.50 | 246.00 | 1.8 | 1.7 | 2627.98 |
| April | 2,886.00 | 267.13 | 1.8 | 1.7 | 3410.05 |
| May | 1,264.00 | 118.88 | 1.8 | 1.7 | 1521.07 |
| June | 2,544.50 | 222.00 | 1.8 | 1.7 | 2956.59 |

Field data collected at the quarry no 04 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.8 below.

**Table 7.8: Field data sheet for RMR calculation in Quarry No 04**

| Quarry 04 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 100 – 250 MPa | 100 – 250 MPa | 100 – 250 MPa |
| Drill core Quality (RQD) | 75% - 90% | 75% - 90% | 50% - 75% |
| Spacing of discontinuities | > 2m | > 2m | > 2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10 - 20m | 3 - 10m | 3 - 10m |
| Separation | 0.1 – 1m | 0.1 – 1m | 0.1 – 1m |
| Roughness | Rough | Rough | Rough |
| Infilling | None | None | None |
| Weathering | Slightly Weathered | Un weathered | Un weathered |
| Ground water condition | Wet | Wet | Wet |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair |

**Quarry no 05**: Quarry no 05 is situated in Kaduwela area of the Colombo district. It recorded comparatively higher RMR value because of low joint intensity in the rock mass. Quarry has excavated below surface level and a reserve to be excavated is comparatively poor. Current blasting face of the quarry no 05 is shown in the figure 7.5 below.



**Figure 7.5: View of current blasting face of quarry no 05**

Explosive usage and drilling geometry data of quarry no 05 from January 2016 to May 2016; for consecutive 05 months are tabulated in the table 7.9 below.

**Table 7.9: Explosive consumption and drilling geometry data for Quarry No 05**

| Month | Explosives | | Spacing (m) | Burden(m) | Blasted depth (m) |
|---|---|---|---|---|---|
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 234.00 | 2700.0 | 1.8 | 1.5 | 5107.20 |
| February | 253.50 | 2875.0 | 1.8 | 1.5 | 5635.50 |
| March | 182.00 | 2100.0 | 1.8 | 1.5 | 4074.78 |
| April | 214.50 | 2475.0 | 1.8 | 1.5 | 4733.85 |
| May | 247.00 | 2850.0 | 1.8 | 1.5 | 5396.84 |

Field data collected at the quarry no 05 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.10 below.

**Table 7.10: Field data sheet for RMR calculation in Quarry No 05**

| Quarry 05 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 100 - 250 Mpa | 100 - 250 Mpa | 100 - 250 Mpa |
| Drill core Quality (RQD) | 50% - 75% | 50% - 75% | 50% - 75% |
| Spacing of discontinuities | 0.6 - 2m | 0.6 - 2m | 0.6 - 2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10 - 20m | 10 - 20m | 10 - 20m |
| Separation | 1 - 5mm | 1 - 5mm | 1 - 5mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Hard filling < 5 mm | Hard filling < 5 mm | Hard filling < 5 mm |
| Weathering | Slightly weathered | Slightly weathered | Slightly weathered |
| Ground water condition | Dripping | Wet | Wet |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable | Strike perpendicular to blasting axis Drive with Dip $45^0$ - $90^0$ Very Favorable |

**Quarry no 06**: Aggregate Impact Value of metal in this quarry is marginal for road construction projects. The quarry is situated in the Homagama area in the Colombo district. Partially excavated cliff of the quarry is shown in the Figure 7.6 below.



**Figure 7.6: View of partially excavated cliff of the quarry no 06**

Explosive usage and drilling geometry data of quarry no 06 from January 2016 to July 2016; for consecutive 07 months are tabulated in the table 7.11 below.

**Table 7.11: Explosive usage and drilling geometry data for Quarry No 06**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
| | Water-gel (Kg) | ANFO (Kg) | | | |
|---|---|---|---|---|---|
| January | 27.00 | 550.0 | 2.13 | 2.05 | 660.00 |
| February | 27.34 | 654.0 | 2.13 | 2.05 | 767.20 |
| March | 29.38 | 655.4 | 2.13 | 2.05 | 791.00 |
| April | 23.14 | 525.1 | 2.13 | 2.05 | 623.00 |
| May | 25.48 | 563.5 | 2.13 | 2.05 | 686.00 |
| June | 30.16 | 690.2 | 2.13 | 2.05 | 812.00 |
| July | 20.28 | 455.3 | 2.13 | 2.05 | 468.00 |

Field data collected at the quarry no 06 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.12 below.

**Table 7.12: Field data sheet for RMR calculation in Quarry No 06**

| Quarry 06 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 50 – 100 MPa | 50 – 100 MPa | 50 – 100 MPa |
| Drill core Quality (RQD) | 50% - 75% | 50% - 75% | 50% - 75% |
| Spacing of discontinuities | 0.6 – 2 m | 0.6 – 2 m | 0.6 – 2 m |
| Condition Of Discontinuities | | | |
| Discontinuity length | >20 m | >20 m | 10 – 20 m |
| Separation | < 0.1 mm | < 0.1 mm | < 0.1 mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Hard Filling < 5 mm | Hard Filling < 5 mm | Hard Filling < 5 mm |
| Weathering | Slightly Weathered | Slightly Weathered | Slightly Weathered |
| Ground water condition | Wet | Dripping | Dripping |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike parallel to the blasting axis Dip $45^0$ - $90^0$ Very unfavorable | Strike parallel to the blasting axis Dip $45^0$ - $90^0$ Very unfavorable | Strike parallel to the blasting axis Dip $45^0$ - $90^0$ Very unfavorable |

**Quarry no 07:** Metal samples obtained from quarry no 07 contain comparatively higher amounts of quartz. It is situated in the Kaduwela area of the Colombo district. Single high bench in the operating quarry face is shown in the figure 7.7 below.



**Figure 7.7: View of Single high bench in the operating face of quarry no 07**

Explosive usage and drilling geometry data of quarry no 07 from January 2016 to June 2016; for consecutive 06 months are tabulated in the table 7.13 below.

**Table 7.13: Explosive usage and drilling geometry data for Quarry No 07**

| Month | Explosives | | Spacing (m) | Burden (m) | Blasted depth (m) |
|---|---|---|---|---|---|
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 367.50 | 1470.0 | 1.3 | 1.1 | 7056.78 |
| February | 253.50 | 1012.0 | 1.3 | 1.1 | 4858.90 |
| March | 60.00 | 240.0 | 1.3 | 1.1 | 1152.00 |
| April | 120.00 | 480.0 | 1.3 | 1.1 | 2304.00 |
| May | 225.00 | 900.0 | 1.3 | 1.1 | 4320.00 |
| June | 195.00 | 780.0 | 1.3 | 1.1 | 3744.00 |
| July | 180.00 | 720.0 | 1.3 | 1.1 | 3456.00 |

Field data collected at the quarry no 07 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.14 below.

**Table 7.14: Field data sheet for RMR calculation in Quarry No 07**

| Quarry 07 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 25 - 50 MPa | 25 - 50 MPa | 25 - 50 MPa |
| Drill core Quality (RQD) | 75% - 90% | 75% - 90% | 75% - 90% |
| Spacing of discontinuities | > 2m | > 2m | > 2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10m - 20m | 10m - 20m | 10m - 20m |
| Separation | 1mm – 5mm | < 0.1mm | < 0.1mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Soft Filling <5mm | Hard Filling>5mm | Hard Filling>5mm |
| Weathering | Slightly Weathered | Slightly Weathered | Slightly Weathered |
| Ground water condition | Completely Dry | Completely Dry | Completely Dry |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair |

**Quarry no 08:** This Quarry has high quality rock with low quartz content and situated in Homagama area. Though the site has high metal reserve capacity, mining activities already carried out below surface level hence cost of production is comparatively high. Figure 7.8 shows the front view of the quarry face currently been mined.



**Figure 7.8: Front view of the location currently been mined at quarry no 08**

Explosive usage and drilling geometry data of quarry no 08 from January 2016 to July 2016; for consecutive 07 months are tabulated in the table 7.15 below.

**Table 7.15: Explosive usage and drilling geometry data of Quarry no 08**

| Month | Explosives | | Spacing (m) | Burden(m) | Blasted depth (m) |
|---|---|---|---|---|---|
| | Water-gel (Kg) | ANFO (Kg) | | | |
| January | 275.00 | 2091.0 | 1.5 | 1.2 | 5056.52 |
| February | 100.00 | 610.0 | 1.5 | 1.2 | 1592.72 |
| March | 77.00 | 645.0 | 1.5 | 1.2 | 1487.05 |
| April | 34.00 | 350.0 | 1.5 | 1.2 | 755.15 |
| May | 231.00 | 1935.0 | 1.5 | 1.2 | 4461.15 |
| June | 300.00 | 1830.0 | 1.5 | 1.2 | 4778.16 |
| July | 462.00 | 3870.0 | 1.5 | 1.2 | 8922.30 |

Field data collected at the quarry no 08 which were used to calculate Rock Mass Rating (RMR) relevant to the site are tabulated in the table no 7.16 below.

**Table 7.16: Field data sheet for RMR calculation in Quarry No 08**

| Quarry 08 | Location 01 | Location 02 | Location 03 |
|---|---|---|---|
| Strength of intact rock (UCS) | 50 – 100 MPa | 50 – 100 MPa | 50 – 100 MPa |
| Drill core Quality (RQD) | 75% - 90% | 75% - 90% | 75% - 90% |
| Spacing of discontinuities | 0.6m – 2m | 0.6m – 2m | 0.6m – 2m |
| Condition Of Discontinuities | | | |
| Discontinuity length | 10m – 20m | 10m – 20m | 10m – 20m |
| Separation | < 0.1 mm | < 0.1 mm | < 0.1 mm |
| Roughness | Rough | Rough | Rough |
| Infilling | Hard Filling < 5mm | Hard Filling < 5mm | Hard Filling < 5mm |
| Weathering | Un weathered | Un weathered | Un weathered |
| Ground water condition | Damp | Damp | Damp |
| Effect of discontinuity strike and dip orientation in Excavation (Very favorable, favorable, unfavorable, etc…) | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair | Strike parallel to blasting axis Dip $20^0$ - $45^0$ Fair |

**Appendix C: GSMB Mining licensing process**

Geological Survey and Mines Bureau (GSMB) is the Sri Lankan regulatory authority responsible for all mining related activities in the entire country. Ultimate responsibility of the GSMB is to achieve a balance between mineral resources requirement for the development activities in the country and socio-environmental well being.

GSMB is authorized to issue variety of licenses such as exploration licenses, mining licenses, trading licenses, transport licenses as well as export permits. Classification of mining licences currently been issued by the GSMB is shown in the Figure 7.9 below.
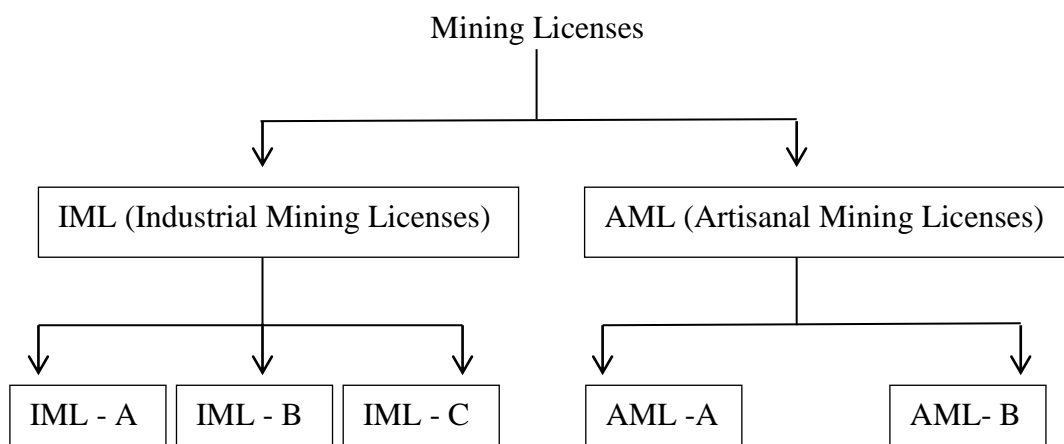


**Figure 7.9: License categories**

**Industrial Mining License Category (IML)**

Category "A" (IML – A)

In IML-A category, multi bore holes blasting is allowed using delay elements. The depth of bore holes can be more than 3.0 meters. However, bore hole depth is decided by Central Environmental Authority and GSMB after conducting a test blast. The production volume can be more than 1500 cubic meters per month. In this

category mining license, mine machineries such as track drills, jack hammers, rock breakers, front end loaders and other machinery can be used.

Category "B" (IML – B)

This industrial mining licenses category allows only single bore hole blasting method. The depth of bore hole should not be less than 1.5 meters and should not be more than 3.0 meters. The production volume allows is not less than 600 cubic meters and not more than 1500 cubic meter per month. Only Jack hammers, excavator machinery are allowed using in this category.

Category "C" (IML – C)

Industrial Mining License "C" category license allows only single shot hole method. The depth of bore hole should be less than 1.5 meters and the production volume should be less than 600 cubic meters per month. Only jack hammers are allowed to use for mining activities.

**Artisanal Mining License (AML) Category**

Category "A" (AML – A)

This category licenses permits depth of bore holes less than 1.5 meters. The production volumes should not be less than 100 cubic meters and should not be more than 600 cubic meters per month. Under the Artisanal Mining Licenses, machinery cannot be used.

Category "B" (AML – B)

Artisanal Mining Licenses "B" category licenses permits bore hole depth less than 1.5 meters. The production volume should not be exceeding 100 cubic meters per month. Depth of excavation should not exceed 2 meters and machinery can not to be used for mining operations (Minister, 1993).