Cost Reduction of Quality Controlling in Metal Quarrying

Basnayaka LR, Samarathunga SPGN, Susantha TKJ, Nawaneethan M
*** Wickrama MADMG, Samaradiwakara GVI and Dassanayake ABN**
Department of Earth Resources Engineering, University of Moratuwa.
*Corresponding author-e-mail address: mwickrama@gmail.com

Abstract: Quality controlling of aggregates is a major concern in aggregate industry. Cost of quality controlling can be minimized via finding correlations between different test on aggregates and rocks. Los Angeles abrasion value test, Aggregate impact value test, Uni-axial compressive strength test, Point load index and Schmidt hammer rebound value test were performed on a total of 22 gneissic metamorphic rock samples, which were collected from selected two quarries in Meepe and Nebada areas of Sri Lanka to investigate correlations between these test parameters. Correlations were developed between each parameter to reduce the cost of quality controlling by means of regression analysis. The study found a strong correlation between Loss Angeles abrasion value test and Aggregate impact value test. By analysing correlation between tests, mineralogy and rock properties validity of this correlation can be proved for common application

Kew words: Aggregate impact value, Los Angeles Abrasion Value, Point load index, Regression analysis, Schmidt hammer rebound value, Uni axial compressive strength.

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1. Introduction

Aggregate industry has boomed in the recent past with the mass development activities progressing throughout the island. Large scale constructions which are built to last for generations are heavily dependent on the quality of material used. As a result quality controlling of aggregates is vital. The cost implication of the quality control process is becoming a concern from the entrepreneurial point of concern.

Loss Angeles abrasion value test (LAAV), Aggregate Impact Value test (AIV) are main tests which are used for predicting the quality in aggregate quality controlling. LAAV test is somewhat expensive, cumbersome to perform and time consuming. If LAAV value can be predicted by using less costly tests such as Aggregate impact value test, Schmidt hammer rebound value test, Point load index and Uniaxial compressive strength tests there is a high possibility that the industry will enjoy a cost benefit as well as operational benefits.

2. Methodology

2.1 Sampling

A total of 22 gneissic metamorphic rock samples were collected from selected two quarries in Meepe and Neboda areas of Sri Lanka. Bulk rock samples were collected randomly from quarry faces so that a sample is large enough to prepare test specimens for each test method. Each rock sample was inspected for macroscopic defects to make sure samples were free from fractures, partings, joints, seams and alternating zones.

MADMG Wickrama, B.Sc Eng (Hons) (Moratuwa), AMIE(SL), Lecturer in the Department of Earth Resources Engineering, University of Moratuwa
ABN Dassanayake, B.Sc Eng (Hons) (Moratuwa),M Eng(AIT), AMIE(SL) Lecturer in the Department of Earth Resources Engineering, University of Moratuwa.
SPGN Samarathunga, LR Basnayaka, TKJ Susantha and M Nawaneethan Final year Undergraduate students in the Department of Earth Resources Engineering, University of Moratuwa.

Table 1-Sampling details

Site	GPS Coordinates	Nos. Of Samples
Neboda	6^0 56'66.00" N 80^0 07'90.00"E	16
Meepe	6^0 51'26.66"N 80^0 05'34.23"E	06

2.2 Test Specimen Preparation

Rock samples were cored perpendicular to bedding or foliation plane, in the laboratory by using a NX type (54mm) drill bit in a Hilty core cutting machine (Switzerland HILTI, 2004).

Aggregate samples were prepared from bulk rock samples, after they had been cored for UCS, PLI and SHR. Primary size reduction was obtained by a hammer and further size reduction was achieved by using a proto type jaw crusher (England, Denver, 2004) in the laboratory. Once the rock was broken to approximate sizes, they were sieved to obtain accurate size ranges according to the test standards (ASTM(C 131), ASTM (C125) and (D5731)).

Then cores and aggregate samples were washed and oven dried at 105 ^{0}c for 24 hours to a constant weight and allowed to cool to room temperature before they were tested.

2.3 Testing

2.3.1 Schmidt Hammer rebound value test (SHV)

This test was carried out for 22 core type specimens with length more than 15cm according to ASTM standard (D5873). Schmidt hammer type N was used with impact energy of 2.207 Nm.

2.3.2 Uni-Axial compressive strength test (UCS)

Uni-axial compressive strength value test (UCS) was performed on 22 core specimens which had L/D ratio between 2 to 2.5, according to the ASTM standard (D 2938).

2.3.3 Los Angeles abrasion value test (LAAV)

Crushed products of 22 bulk rock samples were subjected to LAAV test separately according to the ASTM standard (C 131). Grading B was utilized for the test.

2.3.4 Aggregate impact value test (AIV)

AIV tests were performed according to ASTM standard (C125) on crushed products of 22 rock samples separately.

2.3.5 Point load index

Point load test was performed on 22 core type specimens of 6cm long according to ASTM standard (D5731).

2.4 Statistical Analysis

The test data were analysed by the means of least square regression methods such as linier regression, exponential regression, power curve approximation, logarithmic and polynomial regression. Correlation between test methods were obtained and most suitable correlation with the highest correlation coefficient was selected.

3. Results and Discussions

Results of tests performed on rock samples are presented in table-1. When numbering the samples, samples collected form Naboda site were numbered by using letter N and samples from Meepe site by uising letter M.

Table 1- Test Results

Sample NO.	UCS/ (MPa)	PLI / (MPa)	SHV	LAAV (%)	AIV (%)
N 01	124.4	11.0	46.9	63.9	26.4
N 02	67.7	9.4	54.7	58.8	17.9
N 03	72.1	9.2	56.9	68.8	24.7
N 04	111.7	9.6	55.9	67.9	25.0
N 05	111.3	9.1	48.6	65.2	27.7
N 06	43.7	9.9	63.3	60.5	25.8
N 10	47.1	9.4	60.0	55.9	21.7
N 11	50.6	6.0	60.7	58.3	20.9
N 12	75.4	11.2	62.3	59.5	24.8
N 13	72.8	11.2	54.8	63.4	23.7
N 15	44.4	6.7	57.6	55.5	24.9
N 19	63.4	9.2	61.9	59.0	21.7
N 23	49.3	9.2	56.3	58.8	21.4
N 27	42.6	7.8	62.4	66.6	22.1
N 28	50.1	7.8	56.5	62.0	22.0
N 29	40.1	5.3	51.9	64.9	24.7
M 03	45.7	7.1	53.2	47.8	22.9
M 06	80.1	12.4	55.3	35.5	16.0
M 07	91.2	5.9	55.8	37.3	18.1
M 08	47.9	9.8	63.0	38.7	14.6
M 09	114.5	8.2	58.0	34.0	14.2
M 10	102.3	5.7	49.8	46.3	19.6

Test results of expensive tests and inexpensive tests were statistically analysed in order to find correlations between them. The combinations used to find correlations were UCS and LAAV, UCS and AIV, PLI and LAAV, PLI and AIV, SHV and LAAV, SHV and AIV and LAAV and AIV

Determination of coefficient (R^2) values larger than ± 0.50 were considered statistically significant at a 99% confidence level with 10 degrees of freedom (Snedecor GW, 1989).

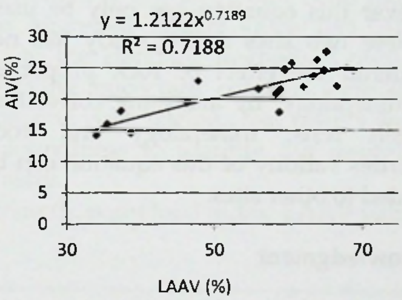

Figure 1 - AIV vs. LAAV

According to the regression analysis (figure 1) LAAV test results were strongly correlated with AIV test results ($R^2 = 0.718$) as shown in equation (1)

$$AIV = 1.212 (LAAV)^{0.718} \quad ....(1)$$

The study was mainly focused on to find out correlations between test parameters on rock samples. In the analysis effects of the mineralogy and the rock properties on test parameters were not considered. This may be the reason that the analysis did not show strong correlations between other tests.

4. Conclusions

The study found a correlation between LAAV test and AIV test for igneous rocks by laboratory testing carried out on 22 gneissic metamorphic rock samples.

It is evident that the found correlation can be utilized to reduce the cost of quality controlling via predicting LAAV value using AIV value since AIV test is more economical than LAAV test.

$$AIV = 1.212 (LAAV)^{0.718} \quad ....(1)$$

However this equation can only be used for these two sites as the study has not considered the effect of rock properties and mineralogy. By analysing correlation between tests, mineralogy and rock properties validity of this equation can be extended to other sites.

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