The Variation of Aggregate Impact Values in Different Rock Types of Sri Lanka

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Abstract

The quality of construction works in Civil Engineering largely depends on the properties of materials. The properties of rock aggregates depend upon the natural condition of different rock types. It has been understood that the changes of engineering properties in different rock types may be related to the rock texture. Therefore studies on the engineering properties of different rock types provide a prior knowledge on the quality of such rock types as well as on potential locations of suitable sources for industry. The objective of this study is to classify different rock types found in Sri Lanka on the basis of their Aggregate Impact Values (AIV).

More than 200 samples collected from quarries and exposed rocks in different localities in Sri Lanka, except in the Northern, Eastern and the Southern provinces, were tested for their Aggregate Impact Values. These rocks were classified according to the ranges of their AIV. This classification may provide valuable information on the locations of suitable sources corresponding to specified ranges of AIV.

The results also show that Charnockite and Pink Ganite are the types of rock most resistant to sudden impact. Different Gneisses show a wide variation in the range of AIV within them. Migmatite and hornblende biotite gneiss are the next suitable rock types among the tested samples.

KeyWords: Rock aggregates, Aggregate Impact Value

Introduction

The rocks have been classified as igneous, sedimentary and metamorphic according to their origin, texture and mineralogy. This classification is not valid for engineering science because rock is another material. Under the civil engineering category "a rock is a hard, consolidated and load bearing material and it cannot be excavated by manual methods". Hence rocks have been classified according to their properties for engineering purposes such as tunnels, underground openings, dam foundations etc. As far as Sri Lankan rocks are concerned, there are no (or very limited) published data to use as literature reviews. A classification of the various engineering properties of Sri Lankan rocks is therefore a necessity because it gives prior knowledge of these properties by identifying the type of rocks in any site. In order to prepare such a classification and provide more detailed literature of Sri Lankan rocks the author carried out a program of research to determine the engineering properties of those. The results of a part of this research have been published (Jayawardena, 2001) and now it is available for reference. It highlights the values of different engineering properties of Sri Lankan rocks and interrelationships among them.

The suitability of aggregates should be found prior to the commencement of civil engineering projects. Generally crushed rocks are used for various construction projects by the contractors with or without knowledge of the quality of those. Highway construction is one of those project and crushed rocks from quarries are used as a major aggregate material.

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Geologically nine tenth (90%) of Sri Lanka is made up of high grade metamorphic rocks of Precambrian age i.e., older than 570 million years, belonging to one of the ancient and stable part of the earth's crust, called the South Indian Shield. Charnockitic Gneiss or charnockite, quartzite, marble, dolomite, granulite, migmatite, gneisses (garnet sillimanite graphite gneiss, hornblende biotite gneiss, biotite gneiss, calc gneiss, cordierite gneiss, wollastonite-scapolite gneiss, granitic gneiss) and amphibolites are the common Precambrian metamorphic rocks in Sri Lanka. The remaining rocks are sedimentary rocks of predominantly Miocene age in the north-west (and very few places of south east) with some Jurassic sediments preserved in small faulted basins. There are recent sedimentary formations, identified as Pleistocene Deposits in a few locations. Intruding the metamorphic rocks of Sri Lanka are some granites, dolerites, pegmatites, quartz veins and carbonatite (Cooray, 1967).

All quarries, except a few, in Sri Lanka belong to one or the other metamorphic rock type (Fig.1). In order to find out differences of rock properties of the crushed rocks, the author carried out another program of research as a continuation of the previous research. It was mainly based on the classification of rock types in quarries for highway materials. The results of Los Angeles Abrasion Values (LAAV) of various rocks in Sri Lanka are presented by Jayawardena (2004).

The objective of this research is to find out better rock types for development of quarries for the highway aggregate materials or any other engineering purpose on the basis of Aggregate Impact Values (AIV), within the preliminary selected areas in Sri Lanka. Both these LAAV and AIV tests indicate the fracturing resistance of crushed rocks under impact loads.

Method of study

Fresh rock samples of different rock types were collected from quarries operating in various locations and exposed rocks in the studied area. For this initial stage, some quarries in Kandy, Matale, Kurunegala, Anuradapura, Polonnaruwa, Moneragala, Ampara, Badulle, Ratnapura, Kegalle, Nuwara Eliya, Gampaha, Colombo, Kalutara, and Puttalama administrative districts were selected. The apparatus called Aggregate Impact Tester was used for the experiment. The tests were carried out according to the standard method BS812: Part3: 1975 in the Materials Laboratory of the Department of Civil Engineering. Two samples from each quarry were tested. Table 1 gives the name of rock type and the number of rock sampling points.

Results and discussion

For this investigation, there were 202 sampling locations within 15 administrative districts in Sri Lanka. Sampling could not be carry out from the Northern, Southern and Eastern (except Ampara) provinces due to many reasons. Therefore, this investigation stage may be considered as the preliminary stage. The investigations in other areas will be carried out in the near future. Samples were obtained from quarries either operating at present or abandoned and exposed bedrock. Although the total sampling points were more than 200, the number of samples for pink granite, pegmatite, quartzo-feldspathic gneiss, garnet sillimanite gneiss, amphibolite and quartzite were less than five. Therefore it is not reasonable to say conclusively about the general range of AIV of these rock types on the basis of this investigation. In Sri Lanka, the widely distributed rocks are charnockite, hornblende biotite gneiss, biotite gneiss, migtmatite, marble, granitic gneiss and quartzite. There are many different rock types in the Sri Lankan land area but they occur as very narrow belts.

Table 1 shows the results of the laboratory tests carried out for AIV in different samples. It is found that the AIV is generally less than 20 % in good charnockite rock which shows higher resistance to impact. In some charnockite rocks, the value goes up to 29%.

The AIV in hornblende biotite gneiss, migmatite/ migmatitic gneiss and granitic gneiss lies between 28%-42% in most of the samples but a few of migmatites also showed values up to 52%. Lowest value in biotite gneiss is 29% but the highest value has been 55%. Most of biotite gneiss samples show AIV above 45%. Both hornblende biotite gneiss and biotite gneiss rocks are good when the appearance is similar to charnockitic type. It is due to the change of mineral assemblages similar to charnockite but the rock consists gneissic texture. Pink granite from Thonigala area and serpentinized marble from Rupaha area also show higher resistance to impact similar to charnockite.

The AIV of garnet sillimanite gneiss and granulite lie within a very wide range (35-70%) but this range is very short in pegmatite, amphibolite, quartzo-feldpathic gneiss and quartzite. However the number of samples tested for these rock types was less and therefore it is not reasonable to say exactly the upper and lower limits now. Marble also shows AIV similar to hornblende biotite gneiss. These results indicate that the resistance to impact varies even in the same rock type probably due to variations in percentages of constituent minerals and /or textural differences in different samples. Generally quartzite and marble are not used as road materials due to some other technical and chemical reasons. Serpentinized marble (Rupaha) cannot be used because it has a national importance due to its' mineralogical composition.

Table 1 also shows the results of the previous investigations carried out by the author to find out the Los Angeles Abrasion Values (LAAV) for the same rock types. The correlation between these two parameters for different rock types will be introduced in future. At present the number of samples tested is not enough to make such a correlation.

Conclusion

Charnockite and the Thonigala Pink Granite are the most suitable rock types to use as construction material for any type of civil engineering construction in Sri Lanka. The recognition of the rock is enough to recommend it without doing the laboratory test. Hornblende Biotite Gneiss and Migmatite are the next most suitable rock

Table 1: Number of Samples and Aggregate Impact Value Ranges for different rock types.

Rock Type	Number of Samples (Sample Locations)	AIV Range	LAAV Range (Jayawardena, 2004)
Charnockite/ Charnockitic Gneiss	46	16%-29%	17%-34%
Charnockitic Biotite Gneiss	09	29%-38%	31%-56%
Biotite Gneiss	16	29%-55%	43%-69%
Charnockitic Hornblende Biotite Gneiss	07	28%-37%	33%-43%
Hornblende Biotite Gneiss	56	28%-52%	42%-62%
Granitic Gneiss (with or without Pink Microcline)	21	28%-42%	42%-58%
Migmatite/Migmatitic Gneiss	10	30%-48%	42%-67%
Granulite (not from a quarry)	09	30%-62%	33%-67%
Quartzite (not from a quarry)	02	35%-40%	41%-45%
Marble	08	30%-50%	40%-69%
Serpentinized (Rupaha) marble (not from a quarry)	02	20%-21%	22%-24%
Amphibolite	05	28%-35%	37%-55%
Garnet sillimanite Gneiss (not from a quarry)	04	35%-70%	38%-80%
Quartzo-fedspathic Gneiss	03	32%-34%	
Pegmatite	02	45%-46%	
Pink Granit (Thonigala)	02	18%-24%	23%-25%
TOTAL SAMPLING POINTS	202		

Fig.1 Some quarries in Sri Lanka

materials which may be used for the same purpose. The qualities of the other rocks are generally not suitable for some civil engineering constructions. There are number of Gneiss type rocks which are named according to the type of mineral percentages and the texture. Therefore the range of AIV varies according to their texture even within the same rock type.

References

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