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A Study on - Alkali Aggregate Reactivity of Some Quarry Aggregates and River Borne Aggregates Occurring in and Around Lower Assam

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Abstract: **With increasing construction and infrastructure developmental activities in the region, the requirement and necessity of identifying nearby sources for procuring coarse and fine aggregates has become important. However, even if aggregates satisfy some of the parameters with respect to suitability as construction materials, they could be chemically active and thus exhibit expansive behaviour due to the presence of deleterious particles and thus become unsuitable as construction materials. To achieve required dimensional stability, durability and strength of structures, aggregate characteristics and related engineering properties is one of the main issues that are to be addressed.**

An attempt has been made in the present work to analyse the potential alkali reactivity of some major rock units and some river borne aggregates occurring in and around Lower Assam with an object to find their suitability as construction materials.

The results obtained from the chemical test viz. Alkali Aggregate Reactivity Test have shown that all the aggregates have exhibited innocuous characteristics. This is perhaps due to the fact that no significant proportion of deleterious silica particles like opal chalcedony, tridymite and crystobite, xeolite, heulandite, glassy to crypto-crystalline rhyolites, decites, etc. are present in the rock units of the area. Thus the aggregates are found to be suitable as construction materials from alkali aggregate reactivity point of view.

Keywords: **Alkali aggregate reactivity, aggregates, innocuous, deleterious, construction materials**

1. INTRODUCTION

Infrastructure development programme is found top most priority for every government both Central as well as state government. Construction of road network is one of the main pillars of infrastructure development programme. In Assam, the construction works like roads, buildings, etc. are carried out with the rock materials collected from different quarries of the hills as well as some river borne aggregates. Construction and maintenance of roads and buildings have become more costlier now, and therefore, every scientific aspects are to be strongly dealt with before staring the work.

One of the major contributing factors to the quality of road construction or any other construction is the quality aggregates used in the construction. To measure the quality of rock materials used as aggregates, several engineering tests have been developed such as Abrasion test, impact test, shear test, stripping test, etc.

Failure of road surface and concrete structures may start due to expansion behaviour of the aggregates used. The aggregates which contain substantial amount of deleterious silica materials like opal, chalcedomy, tridymite and crytobolite xeolite, beulandite, etc. generally exhibit expansion characteristics.

These characteristics depend on the potential reactivity of aggregates. The I.S. 2386 (Part VII)-1963 describes two tests, one is Mortar Bar method and other is Chemical method to determine the potential expansive alkali reactivity of an aggregate. Aggregates showing expansive characteristics more than specified limit are known as deleterious aggregates and the aggregates showing expansive characteristics less than specified limit are known as innocuous aggregates.

In view of the above facts, the present study is undertaken with an object to know the potential alkali reactivity of some quarry and river borne aggregates found in and around Lower Assam as these are seen to be used as construction materials in the area.

2. SCOPE AND OBJECT OF STUDY

The study is carried out mainly for the following purposes:

a) To study the geo-engineering properties of the quarry and river borne aggregates.

b) To carry out the chemical tests to determine the potential alkali reactivity of the aggregates.

c) And, interpretation of the results to find their suitability as construction materials.

3. METHODOLOGY

The method of work involves-

3.1 Field works

The Field works involves visiting of a number of quarries in the area to study the geological features and collection of rock aggregates for conducting the tests. It also involves visiting a number of river sites for the collection of river borne aggregates.

3.2 Laboratory works

The collected rock and river borne aggregates are subjected to various laboratory tests for studying their different geo-engineering properties

To determine the potential reactivity of aggregates, the I.S. code 2386 (part VII) gives the following two methods:

a) Mortar Bar Method for determination of Potential Alkali Reactivity of cement-Aggregate combinations.

b) Chemical Method for determination of Potential Reactivity of aggregates.

c) In the present study, chemical method is adopted to know the potential reactivity of rock materials and river borne aggregates.

4. QUARRYING FOR AGGREGATES

The area under investigation is a part of the Northern extension of Shillong Plateau which is a part of state of Assam. The various rock unit types, prevalent in the area have been grouped as follows shown in Figure 1 -

Quarrying involves here two processes viz., hill quarrying and river quarrying.

Quarrying generally is the process of collecting rocks from the natural bed rocks and the term "Quarry" itself indicates the exposed surface of the rock beds. This is mostly confined to hill quarrying alone. The method adopted for hill quarrying is mostly blasting. However the river quarrying simply involves the collection of the aggregates from the river beds.

Different sites for collection of rock aggregates and river borne aggregates are mentioned below-

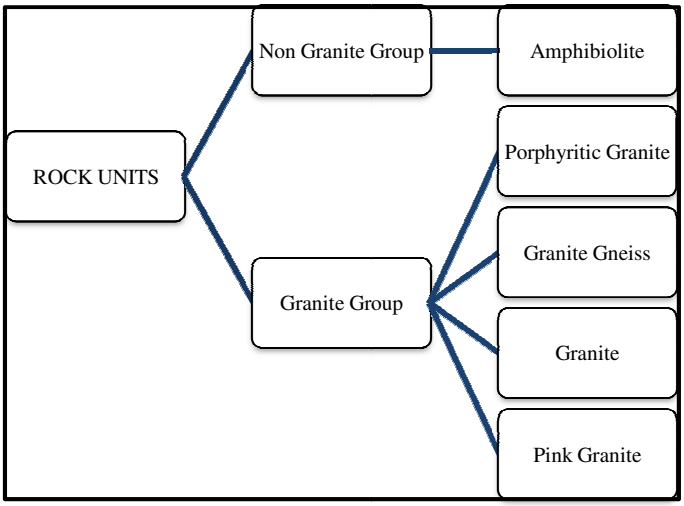

Fig. 1. Field occurrence of Rock Units

Table 1. Collection of Aggregate Samples

Sample	Type of Sample	Sample Collected From	Coordinates
A	Rock (Granite-gneiss)	Pamohi Quarry	26° 06' 01" N 91° 41' 06" E
B	Rock (Granite-gneiss)	Pathar Quarry	26° 10' 03" N 91° 49' 15" E
C	Rock (Porphyritic Granite)	Jalukbari Quarry	26° 08' 57" N 91° 39' 02" E
D	River Borne Aggregate	Kulsi River, Chhaygaon	26° 02' 50" N 91° 23' 18" E
E	River Borne Aggregate	Pagladia River, Nalbari	26° 26' 46" N 91° 27' 48" E
F	River Borne Aggregate	Digaru River, Jorabat	26° 03' 10" N 91° 52' 39" E

5. LABORATORY TEST RESULTS

This method of test covers a chemical method for determining the potential reactivity of an aggregate with alkalis in Portland cement concrete as indicated by the amount of reaction during 24 hr at 80°C between 1 N sodium hydroxide solution and aggregate that has been crushed and sieved to pass a 300-micron IS Sieve and be retained on a 150-micron IS Sieve.

The results of the laboratory tests (viz. Chemical Method) to determine dissolved silica (S_c) and reduction in alkalinity (R_c) of the samples are shown in Table 2.

Table 2. Laboratory Test Result of Alkali Aggregate Reactivity Test

Sample	Sample Collected From	Description Of Sample	Alkali Aggregate Reactivity Test	
			Concentration of dissolved silica "S_c" (millimoles/Litre)	Reduction in alkalinity "R_c" (millimoles/Litre)
A	Pamohi Quarry	Slightly to moderately weathered, fine to medium grained, hard	6.66	92.5
B	Pathar Quarry	Slightly to moderately weathered, fine to medium grained, hard	9.99	135
C	Jalukbari Quarry	Slightly to moderately weathered, medium to coarse grained, hard	13.32	85
D	Kulsi River, Chhaygaon	Fine grained, sub-rounded aggregates	9.99	520
E	Pagladia River, Nalbari	Fine grained, sub-rounded aggregates	13.32	412.5
F	Digaru River, Jorabat	Fine grained, sub-rounded aggregates	16.5	417.5

In general, for most aggregates, a potentially deleterious degree of alkali reactivity is indicated if the plotted data point of a particular test falls to the right of the boundary line of the graph as given in the IS : 2386 (Part-VII) 1963. On the other hand, the innocuous character of the aggregate will be indicated if the plotted data point of the particular test of the aggregate falls to the left of the boundary line of the graph as mentioned above.

The laboratory test results, as presented in Table 2, were represented in the graph in which the dissolved Silica (S_c) plotted in the abscissa and the reduction in alkalinity (R_c) is plotted in the ordinate as shown in Figure 2.

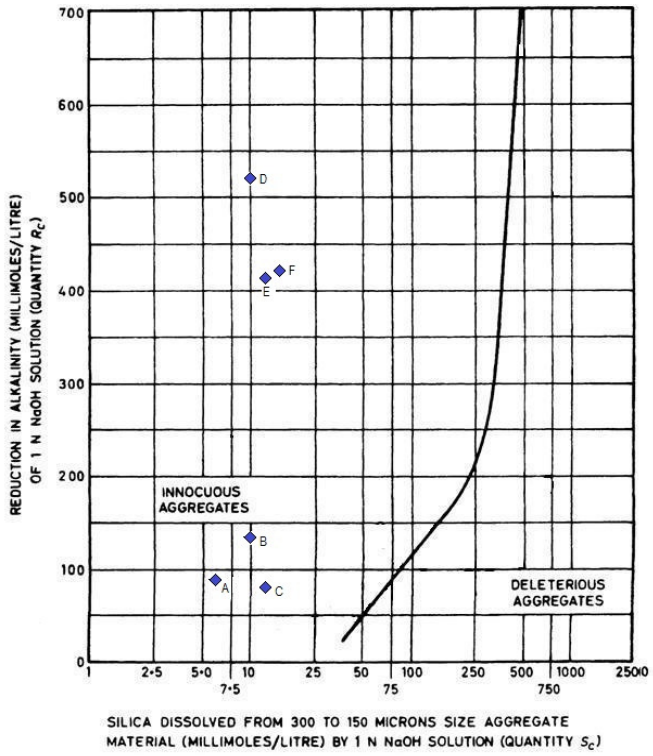

Fig. 2. Representation of Concentration of Dissolved Silica and Reduction in Alkalinity of various samples

(Source: IS : 2386 (Part-VII) 1963)

6. DISCUSSION & INFERENCE

Innocuous aggregate particles are those which do not participate in alkali-aggregate reactions harmful to concrete. These aggregates generally exhibit less expansion characteristics than deleterious aggregates.

Deleterious aggregate particles are those which produce adverse effects on concrete through chemical reactions between particles and cement alkalies. Known reactive substances are the silica minerals, opal, chalcedony, tridymite, and cristobalite, zeolite, heulandite (and probably ptilolite), glassy to crypto-crystalline rhyolites, dacites and andesites and their tuffs, and certain phyllites. IS: 2386 (Part VII) - 1963 gives a boundary line to differentiate innocuous from deleterious aggregates in the form of a graph, which has been used in the present study to represent the alkali aggregate reactivity of the samples viz. A, B, C, D, E & F (Figure. 2). In general, for most aggregates, a potentially deleterious degree of alkali reactivity is indicated if the plotted data point of a

particular test falls to the right of the boundary line of the graph as given in the IS : 2386 (Part-VII) 1963. On the other hand, the innocuous character of the aggregate will be indicated if the plotted data point of the particular test of the aggregate falls to the left of the boundary line of the graph as mentioned above.

Again as per IS : 383- 1970, aggregates shall not contain any harmful material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Aggregates to be used for reinforced concrete shall not contain any materials liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalies of cement are harmful as cracking may take place.

In the present study, the evaluation of the chemical quality of the rock units have been done on the basis of chemical test viz. Alkali Aggregate Reactivity test as described in IS : 2386 (part VII)-1963.

Table 2 shows the overall comparison of chemical quality based on Alkali Aggregate Reactivity test between the different rock and river borne aggregates present in the area under study and Figure 2 shows the graphical representation of the test results. The comparison shows that all the aggregates of the area have exhibited innocuous characteristics from chemical quality point of view (as shown in Table 3).

Table 3. Chemical Quality based on Alkali Aggregate Reactivity Test

Sample	Type of Sample	Sample Collected From	Chemical Quality
A	Rock (Granite-gneiss)	Pamohi Quarry	Innocuous
B	Rock (Granite-gneiss)	Pathar Quarry	Innocuous
C	Rock (Porphyritic Granite)	Jalukbari Quarry	Innocuous
D	River Borne Aggregate	Kulsi River, Chhaygaon	Innocuous
E	River Borne Aggregate	Pagladia River, Nalbari	Innocuous
F	River Borne Aggregate	Digaru River, Jorabat	Innocuous

Further, it can be inferred that among all these aggregate types, Granite-gneiss (sample A & B) and river borne aggregate (Kulsi river) have exhibited highest innocuous characteristics compared to the other types of aggregates. The innocuous characteristics of the various aggregates are shown below in descending order:

Granite- gneiss (Samle A & B) > River borne aggregate (Kulsi river) > Porphyritic granite (Sample C) > River borne aggregate (Pagladia river) > River borne aggregate (Digaru river)

7. CONCLUSION

The requirement of good quality aggregates as construction materials is of paramount importance in the present scenario considering the several ongoing and upcoming infrastructure development schemes launched by the State and Central governments in the area under study.

To achieve required dimensional stability, durability and strength of structures, aggregate characteristics and related engineering properties is one of the main issues that are to be addressed.

The chemical properties of the aggregates chiefly depend on their constituents minerals. Failure of road surface and concrete structures may start due to expansive behaviour of the aggregates used due to the presence of substantial deleterious silica materials.

The rock and river borne aggregates of the area under the present study, have exhibited innocuous characteristics from chemical quality point of the view. Hence these aggregates can be used as construction materials. However, future workers are suggested to carry out such similar studies with greater number of samples for confirmation.

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