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PERFORMANCE BASED EVALUATION OF RIVER-BORNE AGGREGATES ON CONSTRUCTION WORK

INDIRA BARUAH GOGOI[1] Dr. DIGANTA GOSWAMI[2] Dr. GIRINDRA DEKA[3]
Associate Professor *Associate professor* *Retired Associate Professor*
Department of Civil Engineering, Assam Engineering College, Assam, India

ABSTRACT-- The economy and safety of an engineering project is greatly dependent upon the proper understanding and determination of the properties of the rock aggregates. The most important property of rock in construction work is the strength. The Compressive strength test of Concrete and Shear strength test of aggregate has been performed on river-borne aggregates to see the influences of shape and surface texture on strength properties in natural and crushed form. It is observed that though crushed river-borne aggregate shows slightly higher strength both in concrete and shear strength values than the natural form, both the forms of aggregates are usable in concrete and pavement construction works from strength point of view.

KEYWORDS-- River-borne aggregates, performance, WBM, sub-microscopic, cohesion less, infrastructure

1. INTRODUCTION

The aggregate provides about 75 percent of the body of the concrete and pavement works. The properties and performance of concrete and other construction works are dependent to a large extent on the characteristics and properties of the aggregates. In Assam, a good number of rivers flowing through it and carry a huge volume of aggregate by them. Though the natural river-borne aggregate are found to be suitable in construction works and constantly using by different government and non-government organization in Assam and other North-Eastern part of India, yet no detailed and systematic study has been found on these aggregates. In view of this, a study has been carried out to see the performance of the aggregate in pavement and concrete under field condition. Aggregates have been collected from the river Pagladiya, Baksa district and river Nanoi, Darrang district, Assam on the basis of large scale occurrences of aggregates which leads to frequent flood in nearby areas in these two districts.

2. INFLUNCE OF SHAPE AND SURFACE TEXTURE IN CONSTRUCTION

The shape of aggregates has definite bearing upon use of a particular type of aggregate for concrete or pavement construction. The river-borne aggregates are less preferred in granular, WBM and bituminous constructions. Generally, locally available river borne aggregates are of good quality and rounded and smooth textured. Some engineer prohibits the use of rounded aggregates on the plea that it yields poor concrete due to lack of bond between the smooth surface of the aggregates and cement paste. This concept is not fully justified for the reason that even the so called smooth surface of the rounded to sub rounded aggregates are rough enough to develop a reasonably good bond between the surface and the sub-microscopic cement gel.

3. EXPERIMENTALS

To see the performance, the aggregates have been collected from the above mentioned two rivers and compressive strength test of concrete cube and Shear strength test of aggregates by Large Direct Shear Box has been performed on natural and crushed form of the aggregates.

3.1 Compressive strength of concrete

The strength of concrete is dependent on the bonding between the cement paste and the aggregate. Shape and Surface texture also influences the strength of concrete. A highly polished particle has less bonding area with the concrete matrix than rough particle of same volume.

For compressive strength test, concrete cube has been prepared by river-borne aggregates of natural and crushed form separately. Other parameters such as sand, cement, water-cement ratio are keeping constant, only the aggregates are change - natural and crushed.

3.1.1 **Specification of materials:**

Grade of concrete: M 20
Water-cement ratio: 0.50

Fine aggregate:
Natural sand (river)
Colour: Light brown
Fineness Modulus: 2.42
Zone : II

Cement:
Brand: Star cement
Grade: 43, Type: PPC (Portland Pozzolana Cement)
Colour: grey,
Initial setting time: 2 hours
Final setting time: 3.23 hours, consistency: 30.3 %

3.1.2 Test results

Test results are shown in Table i and fig 1.

TABLE I- TEST RESULTS OF COMPRESSIVE STRENGTH OF CONCRETE

Sample no. & source	Type of aggregates	7 days compressive strength (N/mm^2)	28 days compressive strength (N/mm^2)
1 (Pagladiya)	N	30.29	37.7
	C	30.81	43.4
2 (Nanoi)	N	23.25	39.89
	C	26.67	41.81

N.B. 'N' indicate Natural, 'C' indicate Crushed.

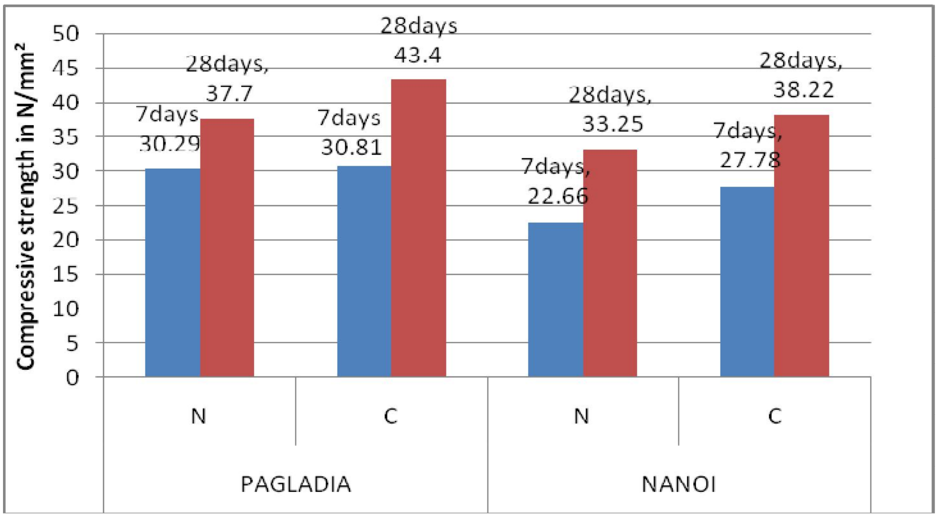

Fig 1 Bar diagram showing Compressive Strength of concrete using natural and crushed aggregate

OBSERVATION: It is observed that in M20 grade of concrete, after 7 days, the compressive strength in both forms are almost similar in nature. But after 28 days, the compressive strength of crushed river-borne aggregate is slightly higher than the natural aggregates. In both form of aggregates, the compressive strength is much higher than the target strength and they can be used in both natural and crushed form in concrete works.

3.2 DIRECT SHEAR TEST (Large Shear Box)

Shear strength may be defined as the maximum resistance to deformation due to shear displacement caused by a shear stress. A knowledge of shear strength of a rock is necessary to deal with the situation where the rock mass is subjected to shear. To measure the shear strength of the aggregates Large Direct Shear Box test has been performed. It is the simplest, the oldest and the most straightforward method for the 'immediate' or short-term shear strength of materials.

The large shear box is 30cm square and height is 15 cm. The direct shear test covers the method of determination of shear strength of rock aggregates with a maximum size of 40 mm in undrained and drained conditions. The 50 KN direct shear apparatus designed for a maximum normal stress of 5 $kg/cm^2$and maximum shear of 5000 kg. Resistance against shear is measured traditionally by the parameters 'C' (cohesion with respect to effective stresses) and Ø (angle of shearing resistance with respect to effective stresses). Angle of internal friction (Ø) is the measure of the resistance of aggregate to sliding along a plane. It is depends upon the shape of particles, surface roughness and type of interlocking. Cohesion(C) is the property of the aggregate holding its particle together.

For cohesionless material such as rock fragments C should be zero by definition. However, some value for C is often found in shear tests due to interlocking of the compacted particles. This is of course small enough to be negligible as a contributing factor to shear resistance. This leaves only Ø to be considered as the parameter for shear resistance. Thus the contribution of all the variables such as size, shape, surface texture of the particles and the particle size distribution and density of the compacted granular assembly can be collectively measured by Ø.

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3.2.1 THE RESULTS OF LARGE DIRECT SHEAR BOX TEST

Direct Shear Test Results
(Applying normal load of .5kg/cm², 1kg/cm², 1.5kg/cm² and 2kg/cm²)
Area of the specimen = 30x30cm²
Volume of the specimen =30x30x15cm³
Proving ring constant = 5.67 kg/division
Corrected area Ca = 900 X ((3-d)/3), where d is the displacement

TABLE- II RESULTS OF DIRECT SHEAR TEST - ANGLE OF INTERNAL FRICTION (Ø) & COHESION(C)

Source& Type of aggregates		Normal stress in Kg/cm^2				Corresponding shear stress at failure (kg/cm^2)				Value of Ø degree)	Apparent cohesion C Kg/cm^2)
1 (Pagladia)	C	0.5	1	1.5	2	1.1	1.8	2.6	2.9	51.6	0.55
	N	0.5	1	1.5	2	1.4	1.8	2.3	2.7	41.20	0.95
2 (Nanoi)	C	0.5	1	1.5	2	1.14	1.7	2.24	2.73	46.43	0.625
	N	0.5	1	1.5	2	1.26	1.685	1.968	2.441	36.52	0.85

TABLE III- NORMAL STRESS VS MAXIMUM SHEAR STRESS OF CRUSHED AGGREGATE-1(PAGLADIYA)

Normal stress(Kg/cm^2)				Corresponding shear stress at failure kg/cm²			
0.5	1	1.5	2	1.4	1.8	2.6	2.9

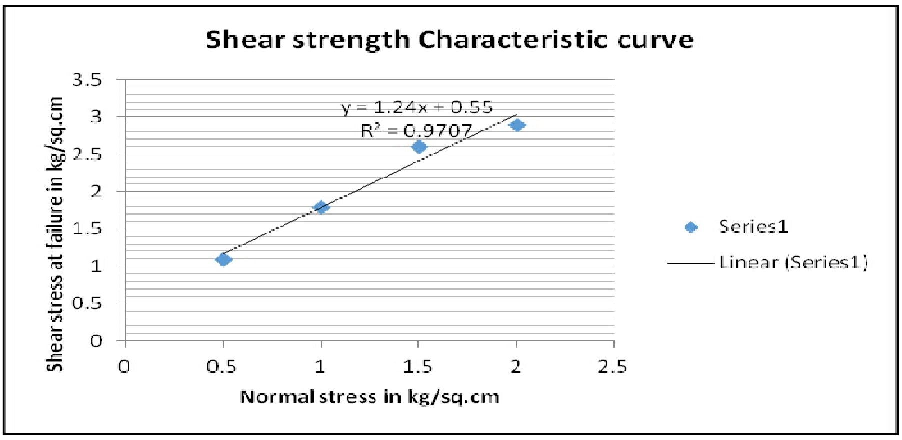

Fig2 Plot of four direct shear tests of crushed aggregate- sample 1 (Pagladiya)

Ø = 51.6°, C = 0.55 kg/cm^2

TABLE IV- NORMAL STRESS VS MAXIMUM SHEAR STRESS OF NATURAL AGGREGATES-1(PAGLADIYA)

Normal stress in kg/cm²				Corresponding shear stress at failure (kg/cm²)			
0.5	1	1.5	2	1.4	1.8	2.3	2.7

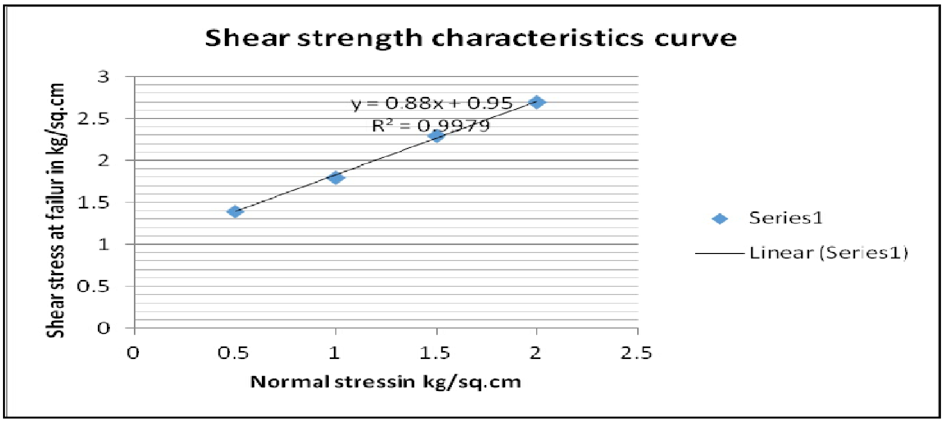

Fig3 *Plot of four direct shear test- natural aggregate- sample 1 (Pagladiya)*

Ø =41.20° , C = 0.95 kg/cm^2

TABLE V- NORMAL STRESS VS MAXIMUM SHEAR STRESS OF CRUSHED AGGREGATE -2 (NANOI)

Normal stress in kg/cm^2				Corresponding shear stress at failure (Kg/cm^2)			
0.5	1	1.5	2	1.14	1.76	2.24	2.73

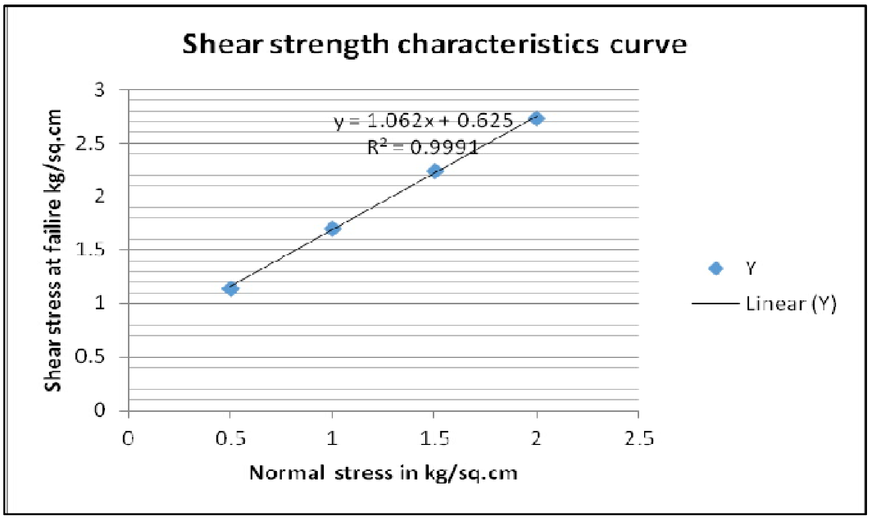

Fig4 Plot of four direct shear test of crushed aggregate- sample 2 (Nanoi)|

Ø = 46.43° , C = 0.625kg/cm^2

TABLE VI- NORMAL STRESS VS MAXIMUM SHEAR STRESS OF NATURAL AGGREGATES-2 (NANOI)

Normal stress in kg/cm²				Corresponding shear stress at failure (kg/cm²)			
0.5	1	1.5	2	1.26	1.685	1.968	2.441

SHEAR STRENGTH CHARACTERISTICS CURVE

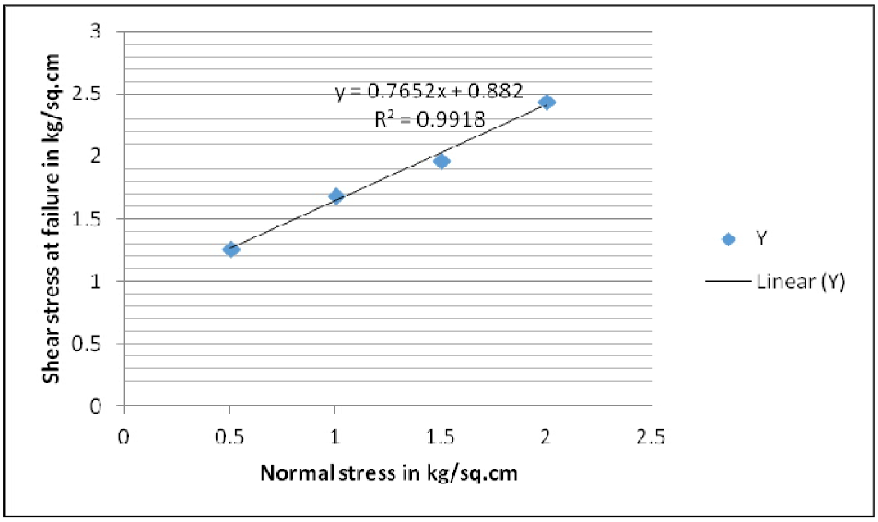

Fig 5 Plot of four direct shear test- natural aggregate (Nanoi)

Ø = 36.52°, C = 0.85 kg/cm^2

4. CONCLUSION

The North-Eastern region of India is growing rapidly in every aspect with the development of major infrastructures like express highways, state highways, sports complex, educational institutions, hospitals, flyovers, multiplex, airport etc which require huge volume of materials. The cheapest source, river-bore aggregate is abundantly found in the state Assam. From the test results of compressive strength of concrete and shear strength of aggregate, it can be concluded that river borne aggregates of river Pagladiya and Nanoi possess higher strength in both natural and crushed form and can be used in all types of concrete and pavement constructions. Economy is another deciding factor of implementation of any project. Sometimes it is necessary to use locally available aggregate of known quality rather than using better quality costly aggregates from economic point of view.

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