

A Comparative Study of Geotechnical Properties of Two Major Tributaries (Dhansiri and Burhidihing) of River Brahmaputra as a Source of Construction Material (fine aggregates)

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ABSTRACT: Being a large source of fine aggregates (sand), the fine aggregates of the river Dhansiri of Darrang District, Assam and the fine aggregates of the river Burhidihing of Dibrugarh District, Assam are used in a very huge amount in various construction purposes of these two districts and also in the nearby districts, Mainly in various governmental projects and locally for the construction of residential buildings and in all other concrete structures. Therefore, in this paper an attempt has been made to study various geotechnical properties of the fine aggregates of these two rivers as per Indian standard codes, So that it become possible to find out whether the properties are within the permissible limit or not and to compare the same.

KEYWORDS: Fine aggregate, Geotechnical, Indian Standard Code, Permissible Limit.

I. INTRODUCTION

Natural sand are weathered and worn out particles of rock and are of various grades or sizes depending on the accounting of wearing. The main natural and cheapest resource of fine aggregate is river sand. As a rapid growing pollution in river water due to manmade and different environmental agencies, the sand in the river water gets affected and it may hamper the construction work. So it is utmost important to check the properties as well as the amount of impurities present in the aggregate, which may degrade the quality of sand and ultimately affect the structure. The work in this paper is divided into four categories, 1) Collection of sample; 2) Performance of various experiments; 3) Collection of experimental results; 4) Interpretation of test results. For this purpose, sand samples were collected from Kopati sand quarry (Latitude- 26.5841965, Longitude- 92.2320211) near Khazuabil about 30 Km. from Mangaldai town (District- Darrang, Assam, India) towards east and form Bhekulajan sand quarry (Latitude- 27.496, Longitude- 94.88445) near Tengakhat about 35 Km. from Dibrugarh town (District- Dibrugarh, Assam, India) towards east. After the collection of samples, various laboratory experiments were performed on these samples by following the Indian Standard Codes. The experimental results were compared with prescribed permissible values by Indian Standards and other Civil Engineering laboratory manuals and finally an interpretation was done.

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II. RELATED WORK

Sometimes materials of poor quality may damage the whole construction work. As one of the core ingredients of a concrete mixture, fine aggregate of poor quality may tremendously affect the structure. For this reason, an attempt has been made to check the properties of the fine aggregates of the above mentioned Rivers. The work related to this paper can be divided into four categories and can be summarized as follows-

- a. **Collection of sample:** Finalizing the location of sample collection was a difficult task. The locations as mentioned above are finally selected considering the fact that, these two quarries are of great importance. Since, the aggregates from these two quarries are used at a very huge amount in various construction works of the nearby places. After the decision was made, the samples were collected in proper containers and brought to the laboratory of Assam Engineering College.
- b. **Performance of various laboratory experiments:** In this paper, total fourteen (14) experiments are performed. The procedures of performing these experiments are as per Indian Standard Codes and laboratory manuals.
- c. **Collection of experimental results:** Each experiment is performed for at least two times and the average values of the experimental results are taken, which made the experimental work and the results more accurate.
- d. **Interpretation:** Finally, an interpretation of the results has been done, which helped us to compare the results with IS standards.

After these four stages, we have found the limit of utilization of these fine aggregates.

III. EXPERIMENTAL RESULTS

Following are the various tests that were performed as per Indian Standard Codes and Laboratory Manuals and its results-

1) Grain Size Distribution (As Per IS: 383-1970)

a) Dhansiri River Sand Sample:

Weight of sample taken = 500 gm

Table-1: Sieve analysis of fine aggregates (sand) of Dhansiri River.

Sl. No.	I.S sieve (mm)	Weight retained in gm	% retained	Cumulative % retained	Cumulative % finer
1	10	0	0	0	100
2	4.75	2	0.4	0.4	99.6
3	2.36	10	2.0	2.4	97.6
4	1.18	22	4.4	6.8	93.2
5	600 μ	16	3.2	10	90
6	300 μ	266	53.2	63.2	36.8
7	150 μ	156	31.2	94.4	5.6

Weight of sample retained on the pan = 26 gm

From table-1, Fineness Modulus (F.M) = $\frac{\sum \text{cumulative \% retained on each sieve}}{100}$
 $= \frac{177.2}{100} = 1.77$, Therefore the aggregate (sand) is very fine.

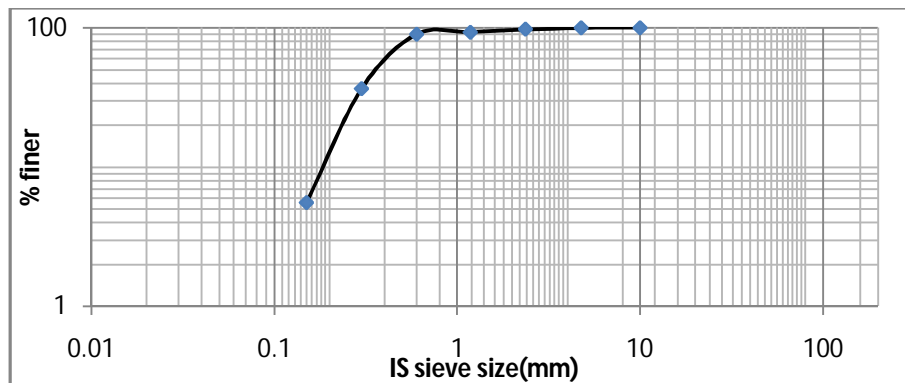
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Graph-1:



The graph (Graph-1) is for the Dhansiri River sand sample and is prepared from the results of the sieve analysis (Table-1). This graph shows almost a straight line for the IS sieves of size 10mm and 4.75 mm because the particles of these two sizes are not available in Dhansiri river sand sample. The shapes of the curves indicate the nature of the soil tested. In this case, the line is nearly vertical and that is why soil is uniformly graded.

From graph-1,

$$D_{10} = 0.183$$

$$D_{30} = 0.28$$

$$D_{60} = 0.36$$

Therefore,

$$\text{Uniformity co-efficient (Cu)} = \frac{D_{60}}{D_{10}} = \frac{0.36}{0.183} = 1.97$$

$$\text{Coefficient of curvature (Cc)} = \frac{D_{30}^2}{D_{10} \cdot D_{60}} = \frac{0.28^2}{0.183 \cdot 0.36} = 1.19$$

b) Burhidihing River Sand Sample:

Weight of sample taken = 500 gm

Table-2: Sieve analysis of fine aggregates (sand) of Burhidihing River.

Sl. No.	I.S sieve (mm)	Weight retained in gm	% retained	Cumulative % retained	Cumulative % finer
1	10	0	0	0	100
2	4.75	0	0	0	100
3	2.36	0	0	0	100
4	1.18	2	0.4	0.4	99.6
5	600 μ	2	0.4	0.8	99.2
6	300 μ	380	76	76.8	23.2
7	150 μ	108	21.6	98.4	1.6

Weight of sample retained on the pan = 176.4 gm

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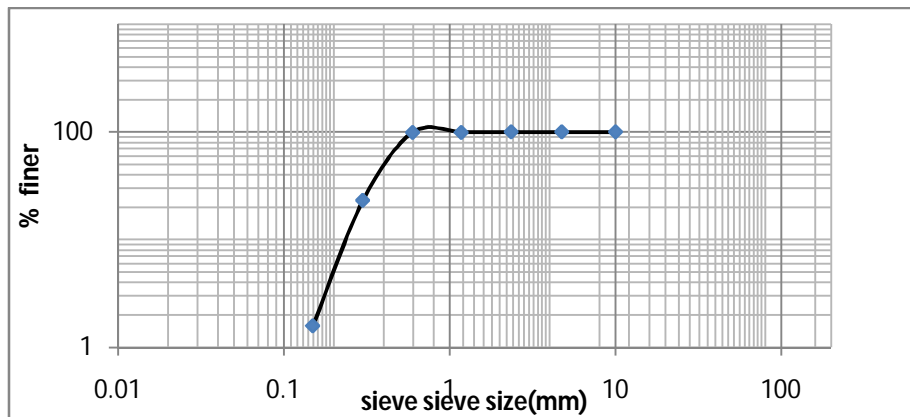
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From table-2, Fineness Modulus (F.M) = $\frac{\text{Cumulative \% retained on each sieve}}{100}$
= $\frac{176.4}{100} = 1.76$, Therefore the aggregate (sand) is very fine.

Graph-2:



The graph (Graph-2) is for the Burhidihing River sand sample and is prepared from the results of the sieve analysis (Table-2). This graph shows almost a straight line for the IS sieves of size 10mm, 4.75 mm and 2.36mm because the particles of these three sizes are not available in Dhansiri river sand sample. The shapes of the curves indicate the nature of the soil tested. In this case, the line is nearly vertical and that is why soil is uniformly graded.

From graph-2,

$$D_{10} = 0.22$$

$$D_{30} = 0.32$$

$$D_{60} = 0.4$$

The shapes of the curves indicate the nature of the soil tested. In this case, the line is nearly vertical and that is why soil is uniformly graded.

Therefore,

$$\text{Uniformity co-efficient (Cu)} = \frac{D_{60}}{D_{10}} = \frac{0.4}{0.22} = 1.82$$

$$\text{Coefficient of curvature (Cc)} = \frac{D_{30}^2}{D_{10} \cdot D_{60}} = \frac{0.32^2}{0.22 \cdot 0.4} = 1.16$$

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All the other experimental results are given below in tabular form-

Table-3: summary of the test results

Sl. No.	Properties	IS Codes and Laboratory Manuals	Values of Dhansiri River Sand	Values of Burhidihing River Sand
2	Natural Moisture content (%)	As Per Engineering soil testing manual by Samsher Prakash and P.K.Jain	16.54	7.14
3	Specific Gravity	As Per IS:2386(Part III)-1963	2.68	2.67
4	Apparent Specific Gravity	As Per IS:2386(Part III)-1963	2.87	2.86
5	Water Absorption (%)	As Per IS:2386(Part III)-1963	2.51	2.46
6	Bulking of Aggregate (%)	As Per IS:2386(Part III)-1963	29.03	33.33
7	Permeability (cm/sec)	As Per Engineering soil testing manual by Samsher Prakash and P.K.Jain	0.0636	0.0593
8	Soundness Test (%)	As Per IS:2386(Part V)-1963	7	10
9	Compaction Test	As Per IS:2720 (Part VII)-1974	a) 22	a) 19.75
	a) Optimum Moisture Content (%) b) Maximum Dry Density (g/cc)		b) 1.696	b) 1.669
10	Direct Shear Test	As Per IS: 11229-1985	a) 0.13	a) 0.08
	a) Cohesion (C) (Kg/cm ²) b) Angle of Internal Friction (φ)		b) 33 ⁰	b) 31 ⁰
11	Organic Impurities	As Per IS:2386(Part II)-1963	NIL	NIL
12	Silt and Clay (%)	As Per Engineering Test Manual provided by civilblog.org	2.17	1.09
13	Compressive Strength(N/mm ²)			
	3 Days	As Per IS:2386(Part VI)-1963	9.76	10.29
	7 Days		15.11	14.92
28 Days	35.97		35.11	
14	Mica Content (%) (Petrographic Test)			
	a) Manual Observation	As Per DIS:2386(Part VIII)-1963	4.30	0.32
	b) Microscopic		4.96	1.93

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Microscopic Photographs of sand samples (taken during the petrographic test) are given below:

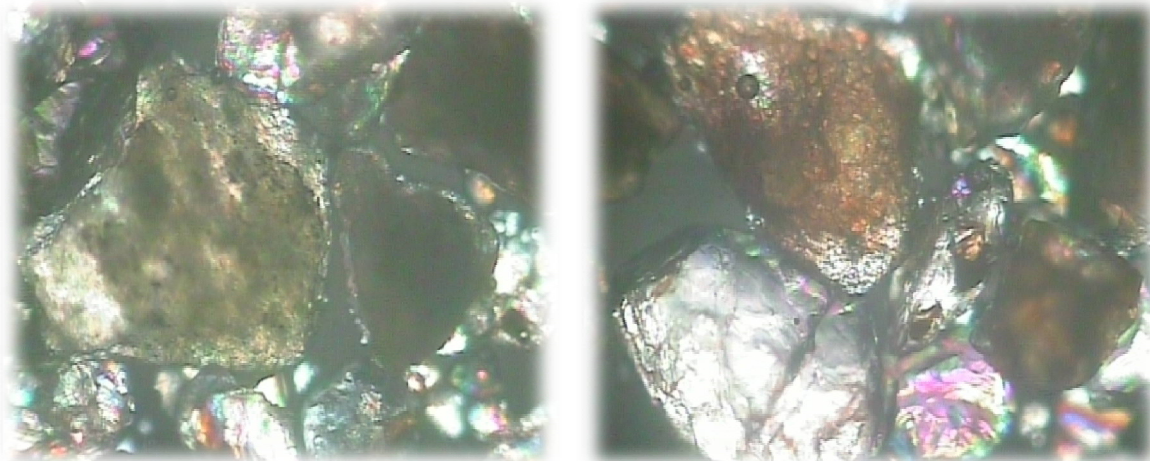


Fig.1. Above two photographs are the microscopic view of the Dhansiri River sand sample. The completely white shiny particles are Mica. The effect of these particles is similar to that of a flakey particle in concrete.

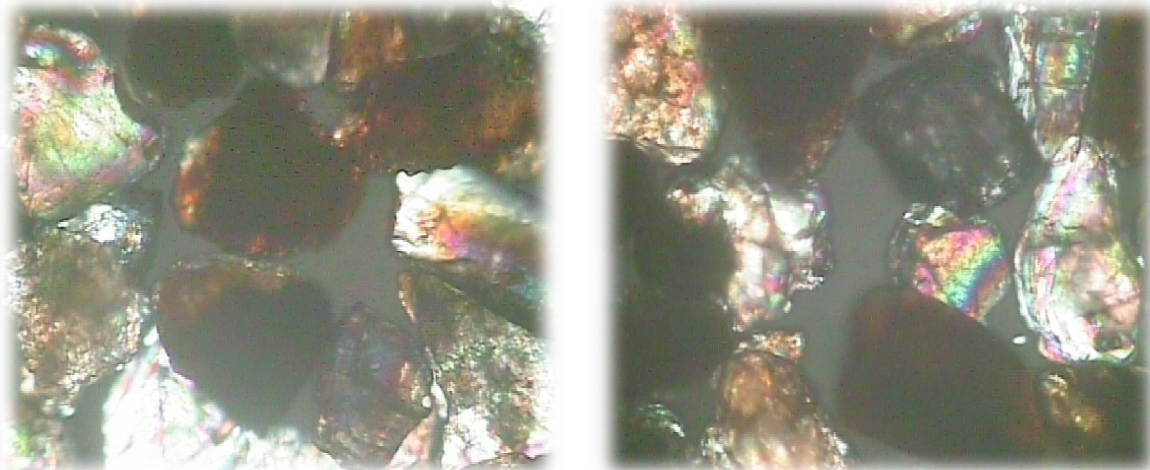


Fig.2. Above two photographs are the microscopic view of the Burhidihing River sand sample. The completely white shiny particles are Mica. The effect of these particles is similar to that of a flakey particle in concrete. Since the percentage of this mica content in Burhidihing River sand sample is very low, that is why this aggregate is free from the adverse effect of mica.

IV. INTERPRETATION

Both the sand samples fall in the Zone-IV (as per IS: 383-1970), which means the aggregates are very fine. Therefore the aggregates from this part of the river will not be suitable for the structures with very high loads. But if the aggregate is collected from further upstream or collected going deep to the river bed, it may be possible to get coarser fine aggregate (sand). The fineness may be the reason behind getting low compressive strength of the cement (OPC-43) using these sand samples. Permeability is also very low due to the fineness of the aggregate and in comparison to the

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Dhansiri River sand sample, the permeability of Burhidihing River sand sample is low. It is because of the Burhidihing River sand is finer than that of the Dhansiri River sand. Though all the other results are within the permissible limit, the natural moisture content may vary depending on the season of collection of the sample and the containers used to collect and transport the samples.

V. ECONOMIC AND ENVIRONMENTAL ASPECT

Since economy is one of the prime factors which govern the implementation of a project and the cost benefit ratio of the project will indicate whether a project will be taken up or not for execution, study of the cost of aggregates takes major share of it. Being naturally available, collection of fine aggregate from rivers is very much economic provided the royalty and transportation cost is low. Here blasting and crushing is not required and a large area of river bed accommodating huge number of labor for work attributes employment generations as well as airy working condition. Collection of huge amount of sand from the same river may change the course of the river and also during rainy season no collection can be made, so all collection have to be made during dry season to fulfill the demand round the year. Considering the above facts, it may be concluded that the economic aspect of fine aggregates collected from river bed is satisfactory for use in different construction works.

VI. CONCLUSION

From the study, it is observed that though some of the results are within permissible limits, but being both the river sands are very fine, they are not suitable for heavy construction works. The fine aggregate of these two rivers may be coarser if it is collected from further upstream or going deep to the river bed. Much research work has not been reported on the fine aggregates of these two rivers. Farther laboratory based work would be required on this field, So that we could be able to use good quality construction material to have a strong and durable structure.

VII. ACKNOWLEDGEMENT

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