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A COMPARATIVE GEOTECHNICAL STUDY OF NATURAL, CRUSHED AND MIXTURE OF NATURAL AND CRUSHED RIVER BORNE AGGREGATES OF THE RIVER CHAMPABATI

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ABSTRACT: ***With the increasing demand of construction, use of aggregates has become equally necessary. Aggregates can be collected from the river sites or by blasting of rocks in the quarries. However, collection of aggregates by rock blasting creates huge amount of pollution and disturb the whole environment. Thus, it has become necessary to locate the alternative sources of locally available natural aggregates. There are a good number of rivers in the North-Eastern part of the country which carry considerable amount of aggregates. The engineering properties of such river borne aggregates is needed to be studied in details for better evaluation of their utility as construction material. Especially for engineering construction, the study of river borne aggregates is of paramount importance. They are economical in use if available at close proximity of the work site. In the present study, aggregates have been collected from river Champabati, at Amlaiguri site, Kokrajhar district, Assam. In this study, an attempt has been made to carry out a comparative geotechnical study of natural, crushed and mixed proportion (i.e. 75% natural and 25% crushed; 50% natural and 50% crushed) of river borne aggregates of river Champabati to evaluate their suitability as construction material. It is expected that the present study will benefit the quality of construction in this region.***

KEY WORDS: Aggregates, field work, laboratory test, geological properties, engineering properties

INTRODUCTION:

Aggregates play an important role in civil engineering construction. It is impossible to construct a city without using natural aggregate- sand, gravel, and crushed stone. Aggregate is used to build and maintain urban, suburban, and rural infrastructures including commercial and residential buildings; highways, bridges, sidewalks and parking lots; factories and power generation facilities; water storage, filtration, and delivery systems; and waste water collection and treatment systems. The aggregates used are normally of the maximum size 80mm, 40mm, 20mm, 10mm, 4.75mm, 2.36mm, 600 micron, 300 micron and 150 micron. The aggregate fractions from 80mm to 4.75mm are termed as coarse aggregate and those fractions from 4.75mm to 150 micron are termed as fine aggregate. In the past, the river borne aggregates and aggregates collected from quarry were both used in construction purposes depending upon their availability. Quarrying by blasting create excessive destruction of hilly structures and forest materials. Thus, it has become necessary to locate alternative sources of locally available natural aggregates.

In construction works, aggregates are generally used as:
i) Natural river borne aggregate
ii) Crushed aggregate
iii) Mixture of both natural and crushed aggregate
No systematic and academic study has been done on comparison of aggregates in its natural, crushed and mixed proportion i.e a combination of Natural River borne aggregate and Crushed aggregate. With this view in mind, a study on Natural, Crushed and combination of these two forms of aggregates (75% N + 25%C and 50%N + 50%C) of the river CHAMPABATI of Kokrajhar district with particular reference to better evaluation of their utility as road and other construction material has been under taken.

STUDY AREA

The test samples were collected from Champabati river bed in the year 2014. Amlaiguri which is in Kokrajhar district was the name of the place from where the samples were collected.

RIVER CHAMPABATI- A REVIEW

Champabati river flows west to Aai River. It is a combination of three rivers- "Bhur River", "Mora Bhur River", "Lopani" and "Dhol pani" which are flowing out from Bhutan hills. Among them "Bhur River" is biggest. Bhur River is originated from a place called Gurungdando andflows 14 km south east to Bhur Village and entered into Assam near post no.267 and flows south for 2km and takes a small river called "Patiakhola" in it's left. Then the river turned into a narrow sandy form and flows 13 km through Manas National Park and arrives at Shantipur. From Shantipur the river flows 4km in south west direction and entered into Bengtal Sanctuary taking Khungrung river at its right in Hantupara. After coming through the sanctuary for 2km,a tributary flows out to south taking the name of Baahbari River. 1Km from that another tributary flows out to south. Then the Bhur River flows another 1 km to reach the Saalbari Bhurpar which is in south of Baahbari forest. After 2.5 km from that, the river takes two tributary from phoolkumari River in its both sides. From this place the river flows 2 km to meet with the Dholpani river which is west to centre Ranikhata and it finally takes the name of Champabati River. Dholpani is Champabati's one of the most prominent tributary. The Dholpani river is initiated in Bhutan and it flows 9 km south and reach near to Assam and west to Bhur River. Then it flows in Assam Bhutan border and flows 3 km in south west and enters into Assam. Near the border Dholapani takes Arne Khola river in its right. Then the river flows 4km south and takes Tiniabadhi river in its right and turns to south east. The river flows through Chirang sanctuary for 12 km and takes Champabati in its right. Then the river flows for 1km and takes Kalikhola or potolsonol river river in its right and flows south west and flows for 1km and reach Charaguri. Then the Dholpani river turns into a sandy river and flows for 7km and then takes Lopani River in its right.

This Lopani River is also a big river. Lopani flows west to Dholpani. Kharpani river enters into Assam and flows south east for 1km and takes kofole khola river to its left and forms Lopani River. Then the river flows through Chirang forest for 9 km and takes a tributary from Jhora Beel to its right and flows for 12 km before it meets the Dholpani river.
Dholpani and Lopani combined themselves to take the name of Champabati river. It flows to south east for 3 km and join Bhur River to its right in Centre ranikhata and then it flows as Champabati river. After flowing for 2km in south from centre Ranikhata a tributary is emerged and takes the name of Demdema river and flows to west for 2km and again join Champabati. Then the Champabati flows for another 2km and takes Raampati river to its left. Then the river flows for 3km south and takes Morabhur River to its left. 4

In Saalbari Champabati divides into two parts after crossing 31(c) National Highway. The main part flows to south east and the other past flows in the south west in Tarang River's path. The main Champabati river slows south and takes a zig zag path and after flowing for 5km it takes Sukti river in its left in Tirimari. From Tirimari the river flow for 3km in south east and takes Shakati River in its left. From that the river flows for 1.5 km and takes kakormari dokong river in its left and flows another 1 km before it crossed railway line 2km from Basugaon Railway station. Then the river flows for 10 km in south east direction in zigzag path and then follow a straight path before reaching Tilakgaon. Here it takes Duramari river in its left. Then near Bidyapur it takes Kujia river in its left. Then west to Lathuri Tila the river flows for 2.5 km and reach Naaldoba. Here the river again divided itself into 2 parts. The main part flows south east and near bamuni Tila it flows for 5km and takes Ghoga River to its left. Then eventually the two parts meet again and flows for another 1 km before crossing 31St National Highway. From here it flows for 3km and opposite to Jalikura it takes Tunia river in its left. Then the river flows to south west. Then it flows for 3km and takes Garojhara in its right. Then it flows for 2km and it reach Chapar town. From Chapar the river flows for 1km and joins Brahmaputra.

Champabati River
DMS Latitude = N 26° 15' 44.352"
DMS Longitude= E 90° 28' 39.54"

OBJECTIVES OF STUDY

The main objectives of the project are as follows:
1) To study the geology of the river borne aggregate such as rock unit, shape, size, surface texture etc.
2) To carry out engineering test on river borne coarse individual natural, individual crushed and combination of both natural and crushed aggregate in different proportion.
3) To carry out a comparative geotechnical study between natural, crushed, and mixed proportion (i.e. 75% natural and 25% crushed; 50% natural and 50% crushed) of river borne aggregates for assessing their better utilization as construction material.
4) To interpret the results to find their suitability as construction material.

METHODS OF WORK

The following methodology has been adopted during the project works.

1) Field work
2) Laboratory work

The field work involves collection of river borne aggregates by visiting the river sites. Collection is done manually by using hand tools. The collected samples were brought to the laboratory and crushed manually and testing were done according to IS specification. Laboratory tests were carried out to find the various properties like Specific Gravity, Water Absorption, Aggregate Impact Value, Aggregate Crushing Value, Los Angeles Abrasion Value, Flakiness and Elongation Value, compressive strength of concrete cube etc.

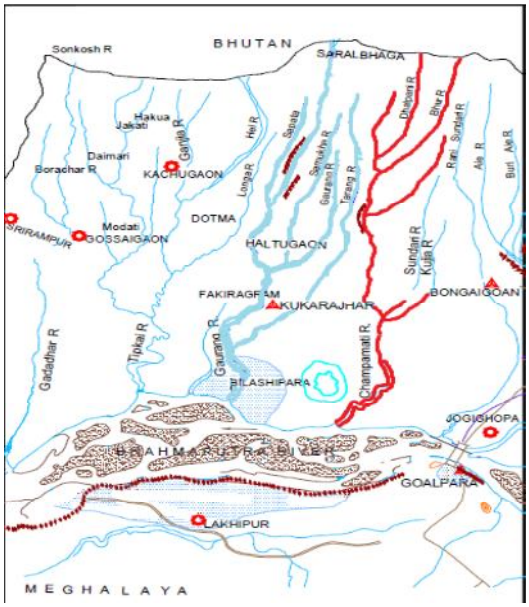

Fig 1: Map of River Champabati

RESULTS

TABLE 1: AN OVERVIEW OF THE ENGINEERING PROPERTIES OF COARSE RIVER BORNE AGGREGATE OF RIVER CHAMPABATI

Sl no.	Property		Sample Type			
			Natural	Crushed	75%N+25%C	50% N+ 50% C
1)	Flakiness index		12.19	15.22	14.41	15.75
2)	Elongation index		20.75	9.74	21.41	15.32
3)	Impact value		15.61	19.22	16.66	17.64
4)	Crushing value		19.78	25.78	22.76	23.99
5)	Abrasion value	Grade A	24.34	29.78	26.22	27.36
		Grade G	22.78	27.15	24.14	26.12
6)	Specific Gravity		2.666	2.621	2.655	2.633
7)	Water absorption		0.6	0.896	0.650	0.799
8)	Soundness value		1.2	3.46	1.46	2.4
9)	Compressive strength	7 day	22.74	26	23.63	24.22
		28 day	32.22	37.48	33.92	34.29

SUMMARY AND CONCLUSION

1) According to MORTH, for Bituminous Macadam, the maximum permissible limit of flakiness index is 35%. No recognized limit has been laid for Elongation Index. So, from flakiness index, the aggregates are suitable for all types of construction work but natural aggregates have been found to be most suitable.

2) According to IS specification, for impact test, the maximum permissible limit for bituminous macadam is 30%. So from impact test, the aggregates are suitable for all types of construction work. But natural aggregates have been found to be most suitable.
3) According to IS specification, for abrasion test, the maximum permissible limit for Bituminous Surface Dressing is 35%. So, from abrasion test, the aggregates are suitable for all types of construction work. But natural aggregates have been found to be most suitable.
4) IS 384-1970 specifies that when aggregate crushing value is determined in accordance with IS 2386(part IV)- 1963; it shall not exceed 45% for aggregate used in concrete other than for wearing surfaces and 30% for concrete for wearing surfaces, such as runways, roads and pavements. So, from crushing test, the aggregates are suitable for all types of construction work. But natural aggregates have been found to be most suitable.
5) Higher is the specific gravity, more suitable will be the aggregate. So from table (1) natural aggregates has been found to be the most suitable. The usual allowable limit for Water Absorption is 2% (maximum). IRC: 23-1966 has specified maximum value of Water Absorption is 1% for Two Coat Bituminous Surface Dressing. So, based on water absorption, the aggregates are suitable for use and natural aggregates are the most suitable as they absorb less amount of water compared to the others.
6) As a general guide, it can be taken that the average loss of weight after 10 cycles should not exceed 12% and 18% when tested with sodium sulphate and magnesium sulphate respectively. (Shetty, 1988). So, from the results it has been found that natural aggregates are the most suitable as the percentage of loss in natural aggregate is the lowest but other aggregates can also be used for construction purposes.
7) According to I.S:456-2000;
The characteristic compressive strength of concrete:-
For M-20 or above,
28-day compressive strength $\geq f_{ck}$ + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2)
or f_{ck} + 4 N/mm^2 whichever is greater.
F_{ck}+0.825 X established standard deviation
=20 + 0.825 X 0.4 =20.33 N/mm^2
Or
F_{ck} +4= 20+4 =24N/mm^2
So, the 28-days compressive strength of concrete made by using aggregates of river Champabati have been found to be suitable for use in concrete works. But here, crushed aggregates have been found to be the most suitable.
8) The use of natural river- borne aggregates is more economical than the crushed ones considering the cost of production and transportation to work site. Collection and stock piling of aggregates in large scale during the winter season is suggested to meet the demand during the summer as collection is almost not possible during that period due to the floods. This will minimize the high cost of production during the off season. From the overall comparative study of engineering test results of the aggregates of Champabati River, a trend has been observed in most of the properties except Elongation Index and Compressive Strength values. Among the different forms of aggregates which were tested, the Natural aggregates shows better suitability than followed by 75%N+25%C, 50%N+50%C and then finally Crushed aggregate. But crushed aggregate shows better quality based on Compressive Strength test values and Elongation Index values. So, it can be concluded that, though both the types of aggregates are suitable for use in pavement and concrete construction, natural aggregates have an edge over crushed aggregates as far as geotechnical properties and economy is considered.

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