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A Study on Types and Quality of Aggregates Produced in LONI KOT Karachi-Hyderabad Motorway Used in Building Construction

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Abstract:
District Jamshoro (The latitude for Jamshoro, Pakistan is: 25.4168681 and the longitude is: 68.2743064.) contains a hilly terriane and mountain ranges of different formations including natural flood nallas (Streams0 which contain deposits of fine aggregates., in this study Results of tests on coarse and fine aggregate carried out at the Building Materials Laboratory of C P & A GEOLOGY have been carried out for important engineering properties as sieve analysis, soundness, specific gravity and water absorption for fine and coarse aggregate, organic impurities for fine aggregate and flakiness index, elongation index, aggregate impact value, aggregate crushing value, 10%fines value and Los Angeles abrasion value for coarse aggregate. It was observed that the most widely used aggregate types in Sindh, Pakistan mainly are crushed rock as coarse aggregate and river sand as fine aggregate for concrete. The samples brought for testing from coarse aggregates gave satisfactory results except gradation and abrasion. In the case of fine aggregate only 77% complied with the criteria specified for organic impurities. Possible reasons for non compliance and remedial measures are discussed.

Key words: Aggregates, sieve analysis, soundness, specific gravity and water and Los Angeles abrasion value

1. INTRODUCTION

Centre for Pure & Applied Geology has been playing a pivotal role to identify the geological research on various formations for their economic importance that may be specially for Hydrocarbon Development i.e Petroleum & Natural gas, Coal deposits etc. but the construction aggregates have also remained in its technical attention, to investigate the physical and mechanical properties, the coarse and fine aggregates have been selected from LONI KOT AREA, Karachi-Hyderabad Mtorway, used as a building materials throughout Sindh province of Pakistan. This study is based on tests carried out by C P & A GEOLOGY on samples of aggregate carriedout for testing . The objective was to examine the properties and quality of different types of aggregate commonly used in District Jamshoro, Hyderabad, Karachi, Thatta and other parts of Sindh. Most Important properties of aggregates are particle shape, size, density, cleanliness and resistance to fragmentation. Other Properties justascrushing, polishing, abrasion, wear and its composition or origin are important for particular applications of aggregate.

Usually following important properties are tested for fine and coarse aggregates used in concrete

1. Particle size distribution
2. Material finer than 75µm particles
3. Particle density and water absorption
4. Bulk density
7. Soundness
8. Presence of organic impurities
9. Clay lumps and friable particles
10. Shell content

Except and In addition to the above properties coarse aggregates used for particular applications require some other important properties to be tested, namely-
11. Particle shape
11.1 Flakiness index 11.2Elongation index
12. Wet/dry strength variation
13. Loss Angeles Abrasion Value 14. 13. 10% Fines Value or Aggregate Impact Value
14. Aggregate Crushing Value

2. OBJECTIVE

The objective of this study was to examine the process capability of supplying aggregate and the quality assurance provided to the end user. Fine aggregate (sand) is described in many standards as aggregate having particle size up to 5mm (In ASTM Standard up to 4mm(Ref 1). Fine aggregates could be natural sand or may be obtained by crushing hard rocks or gravels. Natural sand is roduced by the natural disintegration of rock. It shall be hard, durable, clean and free from adherent coatings of fine particles such as clay and silt. A small quantity of fines is allowable because it improves workability. However, maximum allowable limit of material finer than 75 µm particle is 4% for natural sand, 9% for crushed rock sand for use in heavy duty floor finishes and 16% for crushed rock sand in normal use(Ref 3). Coarse aggregate is defined as aggregate mainly retained on 5mm sieve. They could be uncrushed, crushed or partially crushed gravels and crushed rocks (including limestones or black rocks).

Purpose of testing aggregate:
Aggregates for use in concrete should satisfy the requirements for grading in order to achieve non-porous, high strength, workability and good finish. Based on the grading, fine

aggregate is classified into three zones- coarse, medium or fine. Aggregate which satisfy with the overall limits and falling within Coarse or Medium zone are recommended for heavy duty concrete floor finishes. It is necessary to have a graded coarse aggregate for good concrete. If it is not possible to purchase a well graded material from crushed aggregate suppliers, then by mixing 20mm single sized and 10mm single sized aggregates a well graded aggregate of 20 to 5mm size could be achieved.To ensure durability of concrete Sodium Sulfate or Magnesium Sulfate soundness test for aggregate is done. In BS EN 12620:2002+A1:2008 (Ref 4) freeze/thaw resistance of coarse aggregate is conducted using magnesium sulfate soundness value. The shape of the aggregates is important; since the workability of concrete depends on it. Use of porous aggregate is not recommended because its water absorption property will affect the workability and strength of concrete.

3. TESTING METHODOLOGY

a. Samples taken for the study
Standards and methods of test:
b.Sieve Analysis

Just as sieve analysis, soundness, specific gravity and water absorption for fine and coarse aggregate, organic impurities for fine aggregate and flakiness index, elongation index, aggregate impact value, aggregate crushing value, 10%fines value and Los Angeles abrasion value for coarse aggregate. British Standard Test Methods and Specification were used (Ref 3). Results obtained from river sand samples are mentioned in Table 3 below in terms of grading envelopes satisfied by them (as percentage of total number tested).Organic impurity test of fine aggregates is done to find out whether it is necessary to perform the test for the effect of organic impurities on the strength of mortar.

Over all limits only	Coarse zone	Medium zone	Fine zone	Outside any limit
9	6	70	10	5

From the test results on crushed rock sand samples grading envelopes satisfied by them are summarized in Table 4 below as percentage of the total number tested.

Table.4. Sieve analysis results of crushed rock sand

Over all limits only	Coarse zone	Medium zone	Fine zone	Outside any limit
-	-	75	-	25

Out of the test results obtained from crushed rock aggregate only 20% complied with the limits specified for 20-5mm graded aggregate. From the test results of aggregate base coarse samples 80% complied with the limits specified for 37.5mm nominal size graded aggregate.

c. Organic impurities in fine aggregates

Standard Test Method and Specification used were ASTM C 40-04, ASTM C 33-07 (Ref.2). The sodium hydroxide colour test showed that 77% of fine aggregate samples tested in laboratory were found to pass in respect of this test.

d. Soundness

Standard Test Method and Specification used: ASTM C 88-05, ASTM C 33-07 (Ref.2). Test results obtained from soundness test are summarized in Table 5: All the samples tested were within the limits specified.

Table.5. Soundness results of aggregates

Statistics	Fine aggregate		Coarse aggregate	
	Na_2SO_4 soundness %	$MgSO_4$ Sound ness %	Na_2SO_4 Sound ness %	$MgSO_4$ soundness %
Range	10-April	7	0-6	0-18
Mode	4	6	0	4
Specified maximum limit	10	15	12	18

Results of tests carried out on aggregate samples carried out from the stock piles present in the crusher plants near the LONI KOT area as mention above , then the testing procedure accorting to ASTM & AASHTO were followed to get the results.. Percentages of different types of aggregate submitted for the tests from the total number of aggregate testing assignments are summarized in Tables 1& 2 below:

Table.1.Types of Fine Aggregate

Rivers and	Crushedrocksand	Off-shoresand	Dunesand
90%	10%	--	--

Table.2. Types of Coarse Aggregate

Crushed rock aggregate for use in concrete	Aggregate for use in road bases	Lime stone
90%	10%	--

e. Specific Gravity and Water Absorption

Standard Test Method used: BS 812: Part 2:1975 Test results obtained from specific gravity and water absorption test are summarized in Table 6:

Table .5. Specific Gravity and Water Absorption results

Statistics	Fine aggregate		Coarse aggregate	
	S/G at oven dry basis	Water Absorption %	S/G at oven dry basis	Water Absorption %
Range	2.42-2.72	0.4-2.2	1.95-2.87	0.2-0.6
Mode	2.61	0.8&1.0	2.71	0.3
Value specified	Not specified in BS; but many handbooks give useful ranges.			

f. Flakiness Index

Standard Test Method used: BS 812:1989:Section 105.1, BS 882:1992(Ref.3)Test results obtained from flakiness index test are summarized in Table 7: All the samples tested passed this test.

Table.6. Flakiness index results

Statistics	Flakiness Index
Range	11-35
Mode	25
Specified maximum Limit	40

g. Elongation Index

Standard Test Method used: BS 812:1989:Section 105.2, BS 882:1992(Ref.3). Test results obtained from elongation index test are summarized in Table 8:

Table.7. Elongation index results

Statistics	Elongation Index
Range	10-37
Mode	27
Specified maximum Limit	not specified in BS 882:1992 (Limits may vary according to applications)

h. Aggregate Impact Value (AIV)

Standard Test Method and Specification used: BS 812:1990:Part112, BS 882:1992(Ref.1). Test results obtained from aggregate impact value test are summarized in Table 9:

Table.8. Aggregate impact value results

Statistics	A.C.V. (%)
Range	17-41
Mode	25
Specified maximum limit	25 for heavy duty concrete finishes 30 for pavement wearing surfaces 45for others

Aggregate Crushing Value(ACV)

Standard Test Method and Specification used: BS 812:Part 3:1975, BS 882:1992(Ref.3). Test results obtained from aggregate crushing value test are summarized in Table10:

Table .9.Aggregate crushing value results

Statistics	A.I.V. (%)
Range	17-41
Mode	28
Specified maximum	25 for heavy duty concrete finishes
limit	30 for pavement wearing surfaces
	45for others

j. 10% Fines Value

Standard Test Method and Specification used: BS Part111:1990, BS 882:1992(Ref.3). Test results obtained from 10% fines value test are summarized in Table11:

Table.10. 10% fines value results

Statistics	10% Fines value (kN)
Range	90-170
Mode	162
Specified minimum Limit	150 for heavy duty concrete finishes 100 for pavement wearing surfaces 50for others

k. Loss Angeles Abrasion Value (LAAV)

Standard Test Method and Specification used: BS EN 1097-2:1998, BS EN 12620:2002 +A1:2008(Ref.4). In-situTest results obtained from Los Angeles abrasion value test are summarized in Table12:

Table.11. LAAV results

Statistics	LAAV
Range	28-72
Mode	47
Specified maximum limit	20 for special cases (regions where studded tyres are in use or for special regional road finish requirements) 30 for road pavement and floor finishes which are subject to impact stresses 40for others

4. DISCUSSION

River sand was the most widely used fine aggregate for concrete because 95% of samples submitted by the X clients were river sand. No dune sand samples were submitted for testing during the above period. (But in Jamshoro district it is the widely used concrete fine aggregate)Crushed rock aggregate was the most widely used coarse aggregate for concrete because all the samples submitted by the X clients during last two years were crushed rock. NoLimestones samples were submitted for testing during the above period (In Jamshoro district it is the widely used concrete coarse aggregate) Most of the river sand available in Sindh satisfied the medium zone size distribution requirement and the limits for material finer than 75µm particles were satisfactory in 97% of the samples tested.80% of crushed rock aggregates for concrete satisfy the grading envelope for 20-5mm graded aggregate. Probable reasons are:

1. Proper sampling method in EN 932-1:1996 was not followed. (Sampling was done by the clients).
2. Difficulty to obtain graded aggregate in single crusher. Suggested remedy: Blending 20mm single sized and 10mm single sized aggregate in calculated proportions to obtain a 20-5mm graded aggregate.

23% of fine aggregates tested in laboratory were found to fail in respect of the colorimetric test for organic impurities. However, mortar strength test for these were not carried out. It may perhaps be due to decisions made by the clients to use aggregate from alternative sources. All samples of fine aggregate tested in laboratory passed the soundness tests. Fine aggregate tested in laboratory had Na2SO4soundness value range 4-10% and mode was 5%.Specified maximum value for this is 10%.Only two samples were tested for MgSO4soundness. Both samples had the soundness valueof 6%. Specified maximum value for this is 15%. All samples of coarse aggregate tested inlaboratory passed the soundness tests. Na2SO4soundness value range was 0-5% and mode was0%. Specified maximum value for this is 13%.Coarse aggregate tested in laboratory hadMgSO4 soundness value range 0-17% and modewas 4%. Specified maximum value for this is 18%.All the samples tested for Flakiness index satisfied the requirements for use in normal concrete applications.

5. CONCLUSION

1 Latest modern sampling technique for coarse and fine aggregates must be followed according to specified ASTM STANDARDS. According to Test results of thae crushed rock coarse aggregate widely used in Jamshoro are extremely sound and have very good resistance against fragmentation, crushing or abrasion. Improper samples of fine aggregates samples (25%) were found to contain organic impurities. It can be because of surficial samples from loose tracks of trucks and loadings including dumpers.

6. REFERENCE

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