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Geotech Properties of Petaro Crushing Plants Coarse & Fine Aggregates used in Concrete Asphalt in Road & Building Construction, District Jamshoro Sindh, Pakistan

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Abstract:
Jamshoro district of SindhProvincePakistan is hilly terrain and mountaneous hillocks in all four talukas known as KOTRI, THANO BULA KHAN, and MANJHAND& SEHWAN. PETARO IS A FAMOUS CADET COLLEGE since last 50 years producing navy cadets for Pakistan Navy, a a small village located at the north of Jamshoro Railway station (an education hub of Sindh province having general, medical & engineering universities all together.I t has a vast potential resources of coarse aggregates. Aggregates are widely used in every type of construction of civil engineering projects, the engineering properties play a vital role in consideration of suitability.(9) For the purpose of research the samples were taken from four important crush plants known as qasim, Parkar, Haroon &Sundas crushers of Petaro area, The ASTM standards were followed for sampling / analysis to investigate the important engineering . The lab tests werer performed as sieve Analysis / Gradation, Specific Gravity, Los Angeles Test, Unit Weight etc . The results were found according to ASTM / AASHTOO SPECIFICATIONS, Except that the petrographic study was also done to investigate the deleterious materials in aggregates which cause the fractures & cracks in civil structures.(5)

Key Words: Sieve analysis, Petrography, Specific gravity, Unit weight.

I. INTRODUCTION

In modern construction the concrete containing coarse & fine aggregates with a suitable ratio of cement in mix design is widely used all over the world for construction of little houses to highrise buildings in developed countries. The basic raw material provided by the preexisting rocks present on the surface of earth in the form of boulders, cobbles, pebbles, gravel, sand, silt & clay. The material is again manufactured for desired sizes for use in different phases of different civil engineering projects like buildings, barrages, dams, bridges, highways etc. aggregates are considered as about 70-80 % of the toal concrete volume or weight (2). The coarse aggregates are the essential part of the structure built with or without reinforce and are considered a source of strength. For the purpose of suitability they have a great preference right from foundation to multistory construction to top level roof. The aggregates are much cheaper and economical part of the concrete.(3) Every civil engineering projects are considered for their safety, strength, durability and life guaranty like for 100 + years, for this purpose the different concrete ratios as M5-M80 are considered for mix design for which some engineering or geo-tech properties are investigated on the aggregate samples like los angles abrasion test, specific gravity, bulk density , soundness test, etc. such type of tests if found satisfactory according to ASTM / AASHTO standards & specification, gives the guarantee for use in construction with strength & durability of the structures. Alongwith that there are some geological considerations for the source rocks like hardness, composition, structure & texture, mineralogy, porosity / permeability, water absorbtion, particle size distribution, petrography, weathering effects etc. concrete is largely concerned and connected with all these parameters.(6)

II. SAMPLE COLLECTION.

The procedure recommended for the sampling from stock pile was using a front-end loader, dig into the stock pile for 20mm, 25 mm, 38mm and manually by climbing on stock pile taking with a ratio of 11% from top, 60 % from mid and remaining 29 % from bottom of the stock pile from all four locations of qasim, haroon, parkar, &sundas crusher plants of Petaro area, Jamshoro. Three samples 20 mm, 25mm, 38mm from each crusher plant were taken and toatal 12 samples were collected and brout for research study. Below is given photographs showing the location & site of samples.(1)

Showel taking samples from stockpile of coarse aggrgates

III. METHODOLOGY

For the purpose of study the geological & geotechnical In the first phase of testing, physical and mechanical properties of the selected aggregates were determined. Afterwards, the properties of the hardened concrete prepared using the aggregates, were investigated to assess the effect of the coarse aggregates.

The important physical properties of the aggregates were studied: (2)

1) bulk density
2) water absorption
3) specific gravity
4) petrography
5) Imapact value

BULK DESITY (ASTM C29 / C29M - 17a Standard Test Method for Bulk Density (Unit weight) OF AGGREGATES) ..

It is the mass of the unit volume of bulk aggregate material. The term volume includes the volume of the individual particles and the volume of the voids between the particles. Bulkdensity is used in weight and volume batching.

Table.1. Unit weight of Aggregate

Lab No.	Sample No. 1	Test Dated:	
Description:	Aggregate for Concrete	DETERMINATION	
A LOOSE WEIGHT DETERMINATION			
	1	2	3
Wt. of measure filled with aggregate: g.	12625	12632	12629
Wt. of measure g.	4994	4994	4994
Net Wt. of Aggregate: g.	7632	7638	7635
Volume of measure	5445.8		
Unit Wt. of Aggregate c.c.	1.401	1.403	1.402
Loose Unit Wt. of Aggregate c.c.	1.402		
B ROODED WEIGHT DETERMINATION			
Wt. of measures filled with aggregate g.	13880	13868	13858
Wt. of measures g.	4712	4712	4712
Net Wt. of Aggregate: g.	9168	9156	9146
Volume of measure	5445.8		
Unit weight of Aggregate	1.683	1.681	1.679
Average Unit Weight	1.681		
(C) VOLUME OF MEASURE	AVERAGE		
Temperature of Water ċ	25 ċ		
Wt.of measure + Water g.			
Wt. of measures g.			
Net Wt. of Water to fill measure g.			
(II) Volume of measure c.c.			

Voids: It is the space between the individual particles in a unit volume of the aggregate mass and is not occupied by the solid mineral matter.Voids within the particles, either permeable or impermeable are not included in the voids for the determination of bulk density by this method.(4)

ASTM C127 - 15 : Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse AggregatES

***Water absorption*:** The ratio of the water weight absorbed by aggregates to the weight of dry sample of aggregates expressed in percentage, is termed as the water absorption. It excludes the water adhered to the surface of the particles [13]. Water absorption of selected aggregates was determined using the ASTM C-127 standards. The aggregate specimens were surface dried by placing them in an oven. Afterwards, the aggregates were immersed in water for 24 hours and then weighed in saturated surface dry condition (SSD). Aggregates were then placed in an oven at 110 ºC for 24 hours and weighed again. ***Specific gravity of aggregates*:** Specific gravity of tested aggregates was determined in accordance with ASTM C-127. Oven dried bulk specific gravity, apparent specific gravity and saturated surface dry bulk specific gravity were calculated by weighing aggregates in different states i.e., saturated surface dry, saturated and oven dry conditions. (6)

Table.1. Table of specific gravity of aggregates water absorption

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

AASHTO T-85/ASTM C -67					
Source	NOORIABAD	Lab No.			
Description	Coarse aggregate for concrete mix design class A-3				
Size of Aggregate	38 mm Down	Date Tested			
Purpose of Use	Concrete Works				
Coarse Aggregate					
	Description	1	2		Average
A	Wt of oven dry sample in air (gm)	2006.3	1913.4		
B	Wt of saturated surface dry sample in air (gm)	2019.8	1926.9		
C	Wt of saturated surface dry sample in water (gm)	1268.3	1206.9		
D	Oven dry bulk specific gravity (a)/(b-c)	2.670	2.658		2.664
E	SSD Bulk Specific Gravity (b)/(b-c)	2.688	2.676		2.682
F	Apparent Specific Gravity (a)/(a-c)	2.719	2.708		2.713
G	Absorption % ((b-a)/a)×100	0.67%	0.70%		0.68%

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE ASTM-C128 / AASHTO T-84

1. Wt of oven dry sample in air (W1)
2. Wt of saturated surface dry sample in air (w2)
3. Wt of bottle filled with water (w3)
4. Wt of bottle with sat. surface dry sample & water (4)
5. Specific Gravity

a) Bulk oven dry w1/(w2+w3)-w4

b) Bulk , Sat. surface dry w2/(w2-w3)-w4

c) Apparent , w1/(w1+w3)-w4

6. Absorption (w2-w1) (gm)
7. Absorption % (w2-w1)/w1 ×100

Determination No.		
1	2	Average
296.8	296.9	
300.0	300.0	
688.4	681.3	
877.0	870.1	
2.664	2.67	2.667
2.693	2.698	2.696
2.743	2.747	2.745
1.08	1.04	1.06

The mechanical properties of the aggregates were examined using impact value and crushing value tests.

***Impact value of aggregates*:**

Impact value of aggregates was determined using British Standard (BS-812). It measures the resistance of the aggregates against crushing when impact loads are applied (15). Impact value can be calculated as follows (Eq. 3).

Impact Value = (3) 100 12 □ WW

Where, *W1* = weight of the tested aggregates and *W2* = weight of the aggregates passed through 2.36 mm sieve after applying impact loads.

Table.2.Table of impact value of aggregates

Classification of aggregates using Aggregate Impact Value is as given below:

Aggregate Impact Value	**Classification**
<20%	Exceptionally Strong
10 – 20%	Strong
20-30%	Satisfactory for road surfacing
>35%	Weak for road surfacing

Name of Sample = **1**					
Sample No	**Wt of sample A (gm)**	**Wt of sample passing BS No. 7 Sieve B (gm)**	**Wt of sample retained on BS No. 7 Sieve C (gm)**	**Impact Value = (B/A) x 100 (%)**	**Type Of Aggregate**
1	375	22	347	6.72	good
2	381	33	352	8.09	good
3	355	23	328	7.08	good

Name of Sample = **2**					
Sample No	**Wt of sample A (gm)**	**Wt of sample passing BS No. 7 Sieve B (gm)**	**Wt of sample retained on BS No. 7 Sieve C (gm)**	**Impact Value = (B/A) x 100 (%)**	**Type Of Aggregate**
1	348	42	294	14.04	fair
2	356	42	306	13.07	fair
3	340	31	311	8.8	good

Name of Sample = **3**					
Sample No	**Wt of sample A (gm)**	**Wt of sample passing BS No. 7 Sieve B (gm)**	**Wt of sample retained on BS No. 7 Sieve C (gm)**	**Impact Value = (B/A) x 100 (%)**	**Type Of Aggregate**
1	350	45	315	11.58	fair
2	358	34	316	10.73	fair

***Crushing value of aggregates*:**

Crushing value of the aggregates was evaluated following the British Standard (BS-812). It measures the resistance of the aggregates against crushing using the compressiveloads (8). Crushing value of the aggregates is given by (Eq. 4):

$$\text{Crushing Value} = \frac{W_2}{W_1} \times 100 \qquad (4)$$

Where, *W1* = weight of tested aggregates placed in three layers in steel cylinder and *W2* = weight passed through 2.36 mm sieve after applying compressive loads.

See Table. 3. The table below shows limits of aggregate crushing value for different types of road construction:

Types of Roads / Pavements	Aggregate Crushing Value Limit
Flexible Pavements	
Soling	50
Water bound macadam	40
Bituminous macadam	40
Bituminous surface dressing or thin premix carpet	30
Dense mix carpet	30
Rigid Pavements	
Other than wearing course	45
Surface or Wearing course	30

3.RESULTS AND DISCUSSION

3.1 Water Absorption of Aggregates

The table given below shows the result of water absorption for all four. Water absorption indirectly measures the porosity in aggregates. In addition, it represents the resistance against frost action. More water absorption of aggregates indicates higher porosity, which lead to serious durability concerns [13]. Fig. 3 shows that QASIM aggregates have the highest water absorption (1.49%) and HAROON aggregates have the lowest (1.0%). PARKAR aggregates have higher water absorption value than SUNDAS aggregates. PARKAR aggregates have approximately the same water absorption as HAROON aggregates (1.04%). specific gravity and the bond strength, which leads to enhanced concrete strength.

As the specific gravity is indicated high, certainly this is a sign of high strength, so the other mechanical properties like AIV, ACV WILL JUST VERIFY THE QUALITY OF AGGREGATES. Fig. 4 depicts that QASIM aggregates have the highest bulk specific gravity (2.83) which infers smaller pores as well as greater strength when used in concrete. As different rocks show the different water absoption like limestone, sandstone etc, sand stone depicts higher higher water absorption comparatively. [15]. As sand stone is major component of HAROON aggregates [11], therefore, results of this study are similar to the previously published literature.

3.3 Bulk Density and Voids

Bulk density is a measure of the effort required to compact the concrete. Generally, for normal weight concrete, the bulk density of aggregates varies from 1200 to 1760 kg/m^3 [13]. The percentage of voids affects the grading of aggregates, which is important for concrete strength. Bulk density and voids values are shown in Table 2. Fig. 5 and 6 reveal that QASIM aggregates have the highest bulk density (1601 kg/m^3) and the lowest percent voids (34%).

This indicates that these aggregates are denser and the product concrete will have a higher strength. But this was not true with concrete having PARKAR aggregates. Because of their river source, PARKAR aggregates were mostly round and smooth; that resulted in reduced strength as observed during the study. Besides, concrete having PARKAR aggregates needs lesser compaction effort. PARKAR aggregates have the lowest bulk density (1508 kg/m^3) and the highest voids (45.56%). HAROON and SUNDAS aggregates have the values of bulk densities in between those of QASIM and PARKAR aggregates. The results show that bulk density of aggregates has an inverse relation to the air voids which is in close agreement with previous research [10].

Table .4. Comparison between engineering properties of various types of coarse aggregates

Test	QASIM Crush	HAROON Crush	SUNDAS Crush	PARKAR Crush
Water absorption (%)	1.31	1.01	1.03	1.48
Specific gravity	2.73	2.73	2.61	2.41
Bulk density (kg/m^3)	1507	1534	1596	1602
Voids (%)	45.51	42.88	37.70	34.13
Impact value (%)	16.51	12.60	19.90	14.20
Crushing value (%)	28.80	18.90	27.00	29.20

3.4 Impact Value of Aggregates

Impact values of various aggregates are shown in Table 2. The aggregate with the impact values below 10 are considered as strong while above 35 are normally regarded as weak aggregates for construction applications [13]. Fig. 7 shows that HAROON aggregates are the strongest against impact loading as they have minimum impact value of 11.6%. SUNDS aggregates have maximum impact value of 20.8%. QASIM and PARKAR aggregates have good impact values of 16.5% and 13.2%, respectively. It may be concluded that HAROON, QASIM and PARKAR aggregates have adequate strength.

3.5 Crushing Value of Aggregates

Results of crushing values for different aggregates are summarized in Table 2. Crushing values of aggregates less than 30% are acceptable. The lower the crushing value, the stronger will be the aggregates [13]. Fig. 8 shows that HAROON aggregates have minimum crushing value of 17.8% and are therefore, the strongest among all. QASIM aggregates have maximum crushing value of 29.8%, therefore, can be considered as weaker than HAROON. SUNDAS and PARKAR have crushing values closer to QASIM aggregates. In general, all the four aggregates showed satisfactory results against crushing limit (30%).

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