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Study of Engineering Properties of Bholari Sand Kotri District Jamshoro Sindh Pakistan

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Abstract:
In this study of fine aggregates (BHOLARI SAND) the important engineering properties have been investigated. Some four soil samples were collected from various deposits or stockpiles (RETI DIKKA) CALLED IN LOCAL SINDHI LANGUAGE of Sindh province Pakistan. The samples were analyzed in the Engineering Geology Lab of Centre for Pure & Applied Geology, University of Sindh Jamshoro, Pakistan. Some important tests have been conducted like sieve analysis, specific gravity, bulk density and petrography as well according to ASTM C-295. All results have been found satisfactory according to ASTM specifications. The BHOLARI SAND has been used in construction industry for concrete, mortar and pavement also. The current deposits are vastly finishing, there is a need for detailed geological survey to explore new deposits in the same stream or nearby vicinity because of increasing demand of material after CHINA- PAK ECONOMIC CORRIDOR (CPEC).

Keywords: SIEVE ANALYSIS, PETROGRAPHY, SPECIFIC GRAVITY, BULK DENSITY.

I. INTRODUCTION

Construction industry for mega and micro civil projects like buildings, barrages, dams, highways, airways etc needs both coarse & fine aggregates commonly known as crushed Aggregates and fine sand, the two categories are differentiated by sieve no. 4 (4.75mm) , passing aggregates are called fine while retaining above are called coarse. they may be natural or manufactured or recycled aggregates. The aggregates may contain deleterious materials which may harm the constructed structures, with the help of modern microscopes one can conduct petrographic study to investigate the percent of harmful particles. Concrete consists of 70-75 % of coarse and fine aggregates of total volume, the ingredients of concrete or asphalt should be thoroughly tested before using for construction, the important properties described above may be conducted according to ASTM / AASHTO standards / specifications. Total satisfaction for the purpose of strength / durability may kindly be made by getting results etc. Weathering & erosion is the process which disintegrates rocks into small sizes from boulders to cobbles, pebbles, gravel, sand, silt and clay. The sediments are carried by the weathering agents to far distances, rolling & rounding, getting spherecity, losing the angles is evidence of travel covered by the disintegrated rocks from coarse to medium leading to fine sizes. Weathering / erosion does not affects the mineral composition or chemical composition except some soluble sediments dissolved in river water, but weathering effects the strength and durability of all natural aggregates. It may increase or decrease the percentage of porosity. The shape and size elongation of natural aggregates plays a pivotal role in selecting the material, while manufactured aggregates of desired sizes are mixed some times as per requirement and availability. The uniformity of content material just like sedimentary, igneous, metamorphic origin provides different types of particles if mixed they are not considered suitable as a coarse aggregates, but fine particles have their single element chemistry. Withering for plaster mortar the aggregates must be well graded in size and shape, must be clean, free from dust particles and a suitable clay content. The excess of clay content may produce fractures, cracks in masonry and plaster mortars during flooring of the buildings, piling of foundations, concrete columns or we may say every type of structures. The importance of study of the engineering properties of coarse or fine aggregates has become very high because of high rise buildings, dams, airports, or highways , costly colonies being built world over. Before using the thorough testing of material provided by the supplier and utilized by contractor must be made according to BS, ASTM STANDARDS. SPECIALLY for fine aggregates the sieve analysis, speciphic gravity, bulk density, clay content and petrographic test must be taken carefully.

II. METHODOLOGY

According to ASTM standard specification all four samples were tested in Engineering Geology Lab & advanced Petrographic lab for performing the total experiments. Sieve Analysis test was performed according to C-136, Specific Gravity **ASTM NO. C 127** Bulk Density according to **ASTM NO.C 29,** while petrography by ASTM NO.C-295. The samples were taken from MASTER RETI DIKKA, DOCTOR RETI DIKKA, ZAMMAN RETI DIKKA, FAUJI RETI DIKA, all are lying near the BHOLARI RAILWAY BRIDGE, a bridge built by British India government some 150 years ago, near Kotri Railway station district Jamshoro Sindh, Pakistan. The list of location of BHOLARI SAND coarse aggregates from all the FOURSAND quarries

1. MASTER RETI DIKKA
2. DOCTOR RETI DIKKA
3. ZAMMAN RETI DIKKA
4. FAUJI RETI DIKKA

The tests were conducted according to prescribed procedures in the BS & ASTM standards for concrete, mortar etc for their strength / durability as accepted by SINDH BUILDING CODE, NHA. Complied with the requirements prescribed in BS and ASTM standards and thereby regarded as strong and durable for concrete construction. It is mostly used in Road and Bridge construction recommended by NHA. The sample collection details are given in the Table A. as under:

III. RESULTS AND DISCUSSION

Specific Gravity of Soil Samples

Specific Gravity

The specific gravity of an aggregate is a characteristic of the material, which needs to be determined in making calculations of mix design of concrete.

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

Source: **Bulhari**
Sample No. : 1
Location: StockPile Date:
Proposed Use: Concrete Mix Design Class A-3
•Wt of oven dry sample in air (W1)
•Wt of saturated surface dry sample in air (w2)
•Wt of bottle filled with water (w3)
•Wt of bottle with sat. surface dry sample & water (4)

•Specific Gravity
•Bulk oven dry w1/(w2+w3)-w4
•Bulk , Sat. surface dry w2/(w2-w3)-w4
•Apparent, w1/(w1+w3)-w4
•Absorption (w2-w1) (gm)

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

Absorption % **(w2-w1)/w1 ×100**

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

AASHTO T-85/ASTM C -67					
Source	Fauji crushing plant	Lab No.	Sample No.		
Description	Coarse aggregate for concrete mix design class A-3				
Size of Aggregate	12.7 mm Down	Date Tested			
Purpose of Use	Concrete Work				
Coarse Aggregate					
	Description	1	2		Average
a	Wt of oven dry sample in air (gm)	2005.3	1843.4		
b	Wt of saturated surface dry sample in air (gm)	2019.4	1856.4		
c	Wt of saturated surface dry sample in water (gm)	1265.3	1164.9		
d	Oven dry bulk specific gravity (a)/(b-c)	2.660	2.663		2.662
e	SSD Bulk Specific Gravity (b)/(b-c)	2.678	2.682		2.680
f	Apparent Specific Gravity (a)/(a-c)	2.708	2.714		2.711
g	Absorption % ((b-a)/a)×100	0.67%	0.70%		0.68%

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

AASHTO T-85/ASTM C -67						
Source	BIN QASIM 25 mm	Lab No.		Sample No.		
Description	Coarse aggregate for concrete mix design class A-3					
Site of Aggregate	38 mm Down	Date Tested				
Purpose of Use	Concrete Work:					
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%	

Table 2 showing the results of specific gravity of soil sample.

Table 2. Specific Gravity of Soil Samples

Samples	1	2	3	4	5	6	7	8	9
Test 1	2.69	2.53	2.71	2.71	2.71	2.81	2.63	2.84	2.76
Test 2	2.59	2.63	2.72	2.78	2.72	2.75	2.65	2.83	2.77
Average	2.49	2.62	2.70	2.79	2.70	2.78	2.68	2.82	2.79

The data of the specific gravities range between 2.6 to 2.8. As the quartz is the dominant mineral in the soil sample with other calcitic, marl material, makes varities of values in the sample of different RETI DIKKAS (soil stock piles). this The experimental results are in line with these standards. results show the limits of ASTM / AASHTO standards and may indicate no environmental contamination of other materials.

Unit weight /Bulk Density of Soil Samples

Table 3 shows the test results for bulk densities of the soil material, the average bulk densitiy lies between the range of 1.67-1.68 kg/m3.

Unit weight of Aggregate

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

Compacted									
Sample	1	2	3	4	5	6	7	8	9
Test 1	1538	1585	1613	1487	1887	1436	1633	1641	1627
Test 2	1567	1591	1592	1502	1846	1378	1637	1632	1626
Average Kg/m^3	1553	1587	1603	1495	1866	1406	1635	1636	1624
Loose									
Test 1	942	1013	935	941	942	738	933	942	808
Test 2	938	1012	935	942	956	736	935	940	796
Average Kg/m^3	943	1014	935	940	947	739	936	941	802

The table shows the loose bulk densities between the range of 802-1014 kg/m3, this depends upon the material uncompacted and some light weight material may be included which may be identified as very fine to coarse grains like micaceous material, that's why the resulting values are comparatively low which indicates a fluvial environment. The void space between the particles is some type of wide and the silty particles look dominate.

Silt Contents of Soil Samples

Table 4 showing the result of silt content, silt sizes contain the particles of 2-60 microns and the limit according to ASTM standards is 3-8 percent of the total sample in use.

Table 4. Silt Content of Soil Samples

Samples	1	2	3	4	5	6	7	8	9
Height of Soil Sample (ml)	111.37	106.70	109.60	107.31	109.30	104.90	103.00	109.40	103.15
Height of Silt Layer (ml)	6.17	1.59	4.53	3.44	4.14	2.41	1.01	5.46	1.12
Silt Content (%)	5.55	1.54	4.14	3.23	3.65	2.28	0.98	4.97	1.06

In all the samples the silt content is under standards i.e 3-5 percent, the ranges below 3.0 % and more than 8% indicate insufficient and over sufficient amount of fines which may affect the required amount of cement for mix design of concrete and its workability., for the purpose of adjustment experts advise to mix fine or coarse aggregates according to the required ratio for construction work. Consideration may be taken to silt content of 3-8 % which has direct influence upon the water cement ratio its slump postion , drying of concrete as per mix design.

Sieve Analysis of Soil Samples

Table-5 showing the results of sieve analysis

Sieve Size (mm)	5.00	3.35	2.36	1.18	0.60	0.30	0.15	0.075	PAN
Samples	Percentage Finer (%)								
1	99.19	98.90	98.51	94.15	74.94	42.30	31.28	24.27	0.00
2	96.20	77.46	72.48	49.21	19.50	3.29	3.02	1.54	0.00
3	98.02	95.73	92.24	85.73	79.18	66.66	59.92	46.25	0.00
4	98.31	97.41	95.56	86.56	66.05	33.03	21.24	10.95	0.00
5	98.76	97.94	96.58	91.34	76.28	50.14	39.44	22.30	0.00
6	98.44	97.23	94.83	80.94	50.49	19.20	15.86	7.30	0.00
7	99.12	98.44	96.73	88.23	66.03	15.68	13.37	7.37	0.00
8	98.76	96.95	94.41	84.44	72.20	56.15	46.42	29.35	0.00
9	98.62	97.11	93.62	72.53	44.82	8.91	8.65	6.64	0.00

In all samples the required sizes are satisfying according to ASTM C-136, MASTER, DOCTOR, ZAMAN and FAUJI RETI DIKKAS (Sand Deposits) , because of its quality the material is preferred as number one in high demand of construction industry of Sindh province Pakistan. The sand is being supplied throughout 29 districts for concrete structures, but some times loaders are making problems to carry the material from un recommended layers which may cause some structure problems in the houses / or buildings of layman citizens because they donot go for testing of material and believe upon contractors / masons verbal assurance.

PETROGRAPHY:

Petrography

Fine Aggregate

Sample No. Doctor-1

Medium to fine sand

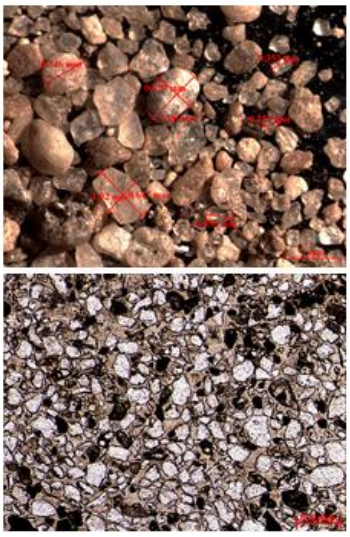
Sand containing carbonate grains, quartz, bioclast and iron oxide fragments.

Carbonate grains and fossil fragments ranges from 50-60 %.

Quartz grains are sub rounded and are more than 30%.

Iron oxide grains are weathered and are upto 7%.
The overall fragments are sub angular to sub rounded.
Size ranges from 0.079 to 2.71 mm.

The sand containing variable size fragments shows moderate sorting.



Petrography
Fine Aggregate

Sample No. Master –Sand-1

Medium to fine sand

Sand containing carbonate grains, quartz, bioclast and iron oxide fragments.

Carbonate grains and fossil fragments are sub angular to rounded and ranges from 45-50%.

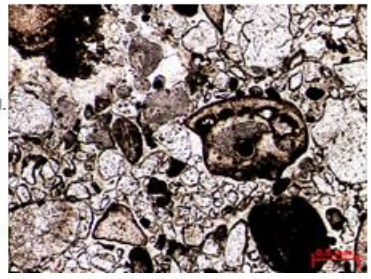
Quartz grains are angular to sub rounded and are more than 40%.

Iron oxide grains are upto 10%.

The overall fragments are sub angular to sub rounded.

Grain size ranges from 0.023 to 2.62 mm.

The sand containing variable size fragments shows moderate sorting.
The quartz grains ranges from 0.025 mm to 1.75 mm. whereas carbonate gains are finer than quartz.



Petrography
Fine Aggregate

Sample No. Master –Medium Sand

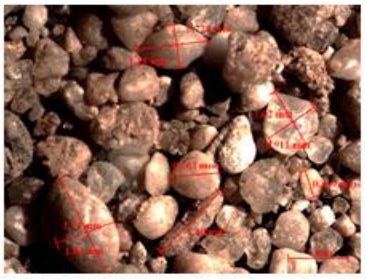
Sand containing carbonate, quartz, bioclast and iron oxide fragments.

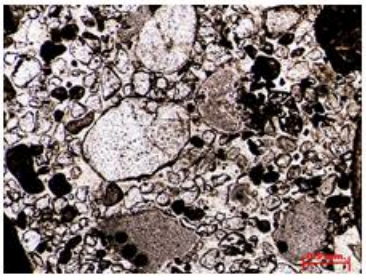
The fragments are sub angular to sub rounded. Size ranges from 0.18 to 4.72 mm.

The sand containing variable size fragments shows moderate sorting.

The quartz grains are sub rounded to rounded in shape.

The iron concretions are scattered throughout the sample.





Petrography
Fine Aggregate

Sample No. Zaman-Sand

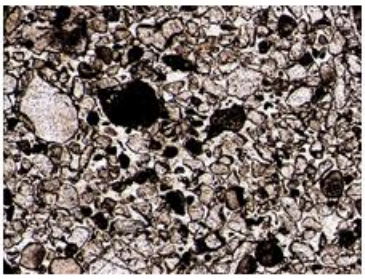
Sand containing carbonate, quartz, bioclast and iron oxide fragments.

The fragments are sub angular to sub rounded. Size ranges from 0.18 to 4.72 mm.

The sand containing variable size fragments shows moderate sorting.

The quartz grains are sub rounded to rounded in shape.

The iron concretions ranges from 0.14 – 2.87 mm. and are scattered throughout the sample.



IV. CONCLUSIONS

Some fine aggregates were established to be sound and good as they fell within the limits of standard specifications while some were found to deviate from limit in certain respect.

The sand quarries around Bholahri specially

1. Zaman RETI DIKKA
2. Master RETI DIKKA
3. Doctor RETI DIKKA
4. FAUJI RETI DIKKA

Quarries complied with the requirements prescribed in BS and ASTM standards and is suitable for concrete construction. It is mostly used in Buildings, Road and Bridge construction and is also recommended by NHA and Building control Authority The Jamshoro area (from Kotri-Bholari&Petaroetc) is full of quality aggregates The petrographic analysis shows the presence of very minute amounts of deleterious contents in limestone aggregates / Bholari Sand which geologically designate it as suitable aggregate source. The values of all engineering parameters are comparable with standard values of AASHTO, ASTM, BS and NHA which infer the Coarse & fine aggregates as excellent aggregate source.

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