

**EXPERIMENTAL ANALYSIS OF ARTIFICIAL SAND OF M20 & M25**

Alternative To Natural Sand.

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Abstract —Concrete is a mix of cement, sand and aggregate. There is a large variation in the strength of aggregate used. There is scarcity of natural sand due to heavy demand in growing construction activities which force to find the suitable substitute. The cheapest and the easiest way of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade which would be free from all impurities. V.S.I. Crusher is a most economical machine for Crushing Stone in Cubical shape and manufacturing artificial sand. In this machine, the particles are thrown at a high speed, those particles colloid with each other and shatter in cubical particles. An Anvil ring, Shelf ring (pigeon hole ring) are provided to get the particles edges ground. For the purpose of experimentation concrete mixes are designed for M20 and M25 grade by 100% replacement of natural sand by artificial sand. Compressive test is conducted to study the strength of concrete using artificial sand.

Keywords- Artificial sand, environmental hazard, compressive strength, V.S.I. crusher, Coarse aggregate, Fine Aggregate.

I. INTRODUCTION

Today whole world is running behind the infra-structure development. Due to this, construction industries are rapidly growing. Cement, sand and steel are the back bone of the construction industry. Plenty of natural sand was available when there was slow development. In olden days, rivers and streams were the sources of the natural deposits. In those days excavating machines were not developed so production was limited, so that there was no environmental problem. Due to growth of construction industries, demand of natural sand is higher. Also, the excavating machineries are developed; so the production goes on increasing. Natural sand deposits are being depleted and cause serious threat to environment as well as the society. Increasing extraction of natural sand from riverbeds is causing many problems. Loosing water retaining strata, deepening of river courses and causes bank slide, loss of vegetation on the banks of rivers, exposing the intake well etc. are few example. The Civil engineers, Architects, Builders and Contractors agree that the natural sand, which is available today, is deficient in many respect. It does not content the fine particles, in proper proportion as required. Presence of other impurities such as coal, bones, shells, mica and silt, etc. makes it inferior for the use in cement concrete. The decay of these materials, due to weathering effect, shortens the life of the work. Thus the artificial sand provides the best alternative to the natural sand. It helps in preventing the damage to the environment and also satisfies the increasing demand.

II. DESIGN**2.1 CONCRETE MIX DESIGN OF M20****2.1.1 Stipulations For Proportioning:**

a) Grade designation	:M20
b) Type of cement	:OPC 53 GRADE
c) Maximum nominal size of aggregate	:20mm
d) Minimum cement content	:300 kg/cubic metre
e) Maximum water-cement ratio	:0.50
f) Workability	:125 slump
g) Exposure condition	:Moderate
h) Method of concrete placing	:Pumping
j) Degree of supervision	:Good
k) Type of aggregate	:Crushed Angular Aggregate
m) Maximum cement content	:450 kg/cubic metre
n) Chemical admixture type	:No

2.1.2 TEST DATA FOR MATERIALS:

a)Cement used	: OPC 53 grade conforming to IS 8112
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- b) Specific gravity of cement :3.15
 c) Chemical admixture :no
 d) Specific gravity of
 1)Coarse aggregate :2.80
 2) Fine aggregate :2.673
 e)Water absorption
 1) Coarse aggregate :0.75%
 2) Fine aggregate :1.62%
 f)Free (surface) moisture
 1) Coarse aggregate :NIL
 2) Fine aggregate :NIL
 i)Sieve analysis:

I) Coarse aggregate

IS	Analysis of	Analysis of	Percentage of	Percentage of	Percentage of	Remarks
Sieve	Course	Course	Fraction	Fraction	Fraction	
Sizes	Aggregate	Aggregate				
mm	Fraction	Fraction				
	I	II	I	II	COMBINED	confirming
			60	40	100	to
			percent	percent	percent	table 2
20	100	100	60	40	100	Of IS383
10	0	71.20	0	28.5	28.7	
4.75		9.40		3.7	3.7	
2.36		0				

Table No. 2.1.2 Gradation for coarse aggregate

II) Fine aggregate: Conforming to grading Zone I of Table 4 of IS 383

2.1.3 Target Strength For Mix Proportioning

$$f'_{ck} = f_{ck} + 1.65 s$$

where

f'_{ck} = target average compressive strength at 28 days

f_{ck} = characteristic compressive strength at 28 days, and

s = standard deviation.

From Table I, standard deviation, $s=4$

Therefore, target strength = $25 + 1.65 \times 4 = 31.6 \text{ N/square mm}$

2.1.4 Selection Of Water-Cement Ratio

From Table 5 of IS 456, maximum water-cement ratio = 0.50

Based on experience, adopt water-cement ratio as 0.50

2.1.5 Selection Of Water Content

From Table 2.1.2, maximum water content = 186 litre (for 25 to 50 mm slump range)
for 20 mm aggregate

Estimated water content for 100 mm slump = $186 + 6/100 \times 186$
= 197 litre

2.1.6 Calculation Of Content

Water-cement ratio :0.50

Cement content :186/0.50

:372

From Table 5 of IS 456,

minimum cement content for 'moderate' exposure condition=300kg/ cubic metre

372 kg/cubic metre > 300 kg/cubic metre , hence, O.K.

2.1.7 Proportion Of Volume Of Coarse Aggregate And Fine Aggregate Content

From Table 2.1.2. volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 = 0.60 .

In the present case water-cement ratio is 0.50. Therefore volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.10. the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of ± 0.01 for every ± 0.05 change in water-cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.50 = 0.62.

For pumpable concrete these values should be reduced by 10 percent.

Therefore, volume of coarse aggregate = $0.62 \times 0.9 = 0.56$.

Volume of fine aggregate content = $1 - 0.56 = 0.44$.

2.1.8 Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 cubic metre

b) Volume of cement = $\text{mass of cement} / (\text{specific gravity of cement} \times 1000)$
 $= 372 / (3.15 \times 1000)$
 $= 0.118$ cubic metre

c) Volume of water = $\text{volume of water} / (\text{specific gravity of water} \times 1000)$
 $= 186 / 1000$
 $= 0.186$ cubic metre

d) Volume of all in aggregate = $a - (b + c)$
 $= 1 - (0.118 + 0.186)$
 $= 0.696$ cubic metre

e) Mass of coarse aggregate = $d \times \text{volume of coarse aggregate} \times \text{specific gravity of coarse aggregate} \times 1000$
 $= 0.696 \times 0.56 \times 1000 \times 2.80$
 $= 1091.328$ cubic metre

f) Mass of fine aggregate = $d \times \text{volume of fine aggregate} \times \text{specific gravity of fine aggregate} \times 1000$
 $= 0.696 \times 0.44 \times 1000 \times 2.67$
 $= 817.66$ cubic metre

2.1.9 Mix Proportions For Trial

Cement	: 372 kg/cubic metre
Water	: 186 kg/ cubic metre
Fine aggregate	: 817.66 kg/ cubic metre
Coarse aggregate	: 1091.328 kg/ cubic metre
Water-cement ratio	: 0.50

2.2 CONCRETE MIX DESIGN OF M25

2.2.1 Stipulations For Proportioning

a) Grade designation	: M25
b) Type of cement	: OPC 53 GRADE
c) Maximum nominal size of aggregate	: 20mm
d) Minimum cement content	: 320 kg/cubic metre
e) Maximum water-cement ratio	: 0.45
f) Workability	: 125 slump
g) Exposure condition	: Moderate
h) Method of concrete placing	: Pumping
j) Degree of supervision	: Good
k) Type of aggregate	: Crushed Angular Aggregate
m) Maximum cement content	: 450 kg/cubic metre
n) Chemical admixture type	: No

2.2.2 Test Data For Materials

a) Cement used	: OPC 53 grade conforming to IS 8112
b) Specific gravity of cement	: 3.15
c) Chemical admixture	: no

- d) Specific gravity of
- 1) Coarse aggregate :2.80
 - 2) Fine aggregate :2.673
- e) Water absorption
- 1) Coarse aggregate :0.75%
 - 2) Fine aggregate
 - 1) Coarse aggregate :NIL
 - 2) Fine aggregate :NIL

i) Sieve analysis:

I) Coarse aggregate

IS	Analysis of	Analysis of	Percentage of	Percentage of	Percentage of	Remarks
Sieve	Course	Course	Fraction	Fraction	Fraction	
Sizes	Aggregate	Aggregate				
mm	Fraction	Fraction				
	I	II	I	II	COMBINED	confirming
			60	40	100	to
			percent	percent	percent	table 2
20	100	100	60	40	100	Of IS383
10	0	71.20	0	28.5	28.7	
4.75		9.40		3.7	3.7	
2.36		0				

Table no 2.2.2 Gradation for coarse aggregate

II) Fine aggregate : Conforming to grading Zone I of Table 4 of IS 383

2.2.3 Target Strength For Mix Proportioning

$$f_{ck} = f_{ck} + 1.65 s$$

where

f_{ck} = target average compressive strength at 28 days

f_{ck} = characteristic compressive strength at 28 days, and

s = standard deviation.

From Table I, standard deviation, $s=5$

Therefore, target strength = $30 + 1.65 \times 5 = 38.25$ N/square mm

2.2.4 Selection Of Water-Cement Ratio

From Table 5 of IS 456, maximum water-cement ratio = 0.45

Based on experience, adopt water-cement ratio as 0.45

2.2.5 Selection Of Water Content

From Table 2.2.2, maximum water content = 186 litre (for 25 to 50 mm slump range)

for 20 mm aggregate

$$\begin{aligned} \text{Estimated water content for 100 mm slump} &= 186 + 6/100 \times 186 \\ &= 197 \text{ litre} \end{aligned}$$

2.2.6 Calculation Of Cement Content

Water-cement ratio :0.45

Cement content : $186/0.45$

:413.33

From Table 5 of IS 456,

minimum cement content for 'moderate' exposure condition=320kg/ cubic metre
 413.33 kg/cubic metre > 320 kg/cubic metre , hence, O.K.

2.2.7 Proportion Of Volume Of Coarse Aggregate And Fine Aggregate Content

From Table 2.2.2. volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.45= 0.60 .

In the present case water-cement ratio is 0.45. Therefore volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.10. the proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio). Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.45 = 0.636.

For pumpable concrete these values should be reduced by 10 percent.

Therefore, volume of coarse aggregate = $0.636 \times 0.9 = 0.572$.

Volume of fine aggregate content= $1 - 0.57 = 0.43$.

2.2.8 Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete=1 cubic metre

b) Volume of cement= mass of cement/(specific gravity of cement*1000)
 $= 413.33/(3.15 \times 1000)$
 $= 0.131$ cubic metre

c) Volume of water= volume of water/(specific gravity of water*1000)
 $= 186/1000$
 $= 0.186$ cubic metre

d) Volume of all in aggregate= a-(b+c)
 $= 1-(0.131+0.186)$
 $= 0.683$ cubic metre

e) Mass of coarse aggregate = d*volume of coarse aggregate*specific gravity
 of coarse aggregate*1000
 $= 0.683 \times 0.57 \times 1000 \times 2.80$
 $= 1093.89$ cubic metre

f) Mass of fine aggregate = d*volume of fine aggregate * specific gravity of fine aggregate*1000
 $= 0.683 \times 0.43 \times 1000 \times 2.67$
 $= 784.15$ cubic metre

2.2.9 Mix Proportions For Trial

Cement	: 413.33 kg/cubic metre
Water	: 186 kg/ cubic metre
Fine aggregate	: 784,15 kg/ cubic metre
Coarse aggregate	:1093.89 kg/ cubic metre
Water-cement ratio	: 0.45

III. RESULT

The compressive strength of concrete was determined by testing concrete cube size (150mm X 150mm X150mm) & cylinder having 100mm in diameter & 200mm high. All the specimens were weighted & measured to determine the area of cylinder & cube as well as it's density of concrete. The test were carried out on the concrete at age of 28 days to determine rate of gain of strength.

The compressive strength of concrete is determined by the following formula,

$$F = \frac{P}{A}$$

Where,

F- compressive strength of concrete.

P- maximum Load measured during testing.

A-Area of specimen being tested.

Table no-3.1 -tests results of compressive strength of concrete of grade M20

Sr.no	Testing Date	Weight (Kgs)	Dimension (MM)	Area (sq.mm)	Load (KN)	Strength (N/sqmm)	Avg. Strength N/sqmm
1	5/1/17	8.751	150*150*150	22500	588	26.13	
2	5/1/17	8.689	150*150*150	22500	592	26.31	26.16
3	5/1/17	8.676	150*150*150	22500	586	26.04	

Table no-3.2-tests results of compressive strength of concrete of grade M25

Sr.no	Testing Date	Weight (Kgs)	Dimension (MM)	Area (sq.mm)	Load (KN)	Strength (N/sqmm)	Avg. Strength N/sqmm
1	5/1/17	8.704	150*150*150	22500	722	32.09	
2	5/1/17	8.793	150*150*150	22500	700	31.11	31.66
3	5/1/17	8.667	150*150*150	22500	715	31.78	

4. CONCLUSION

From the review and our experimental work following concluding points can be obtained

- Artificial sand has a potential to provide alternative to natural sand.
- The use of artificial sand reduces impact on environment.
- Presence of fines in artificial sand increases the workability and gives more sound Concrete. The slabs using Artificial sand are leak proof than by river sand.
- The artificial sand can also be used in construction dams, canals and roads.
- The ratio of fines below 600 microns in sand should be less than 30%.
- There should not be any organic impurities
- Artificial sand qualifies itself as suitable substitute for river sand at reasonable cost. Use of this alternative sand reduces the cost of construction.

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