International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 04 | Apr 2022 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY ON REPLACING FINE AGGREGATE IN MORTAR WITH CONSTRUCTION AND DEMOLITION (C&D) WASTE

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Abstract - *Now a days Cement and sand are basic needs for construction field. The fine Aggregate Sand (FAS) is a initial material that used in preparation of mortar for mix design of concrete. Now-a-days Erosion of rivers considering environmental issues. Based on environmental issues we have to find new another material to replace the river sand, in present days the sand availability is decreased. Almost 30% of original constructions are coming to the demolished site. In evolving states including India supervision of annihilation debris has become an interesting issue. While the mandate for aggregate is increasing day-by-day the natural resources like sand, gravel is reducing around the world. The essential for the reusing of aggregate improved from the rubble is the necessity to chance the expanding demand. So, we replaced the construction and demolition waste as fine aggregate and prepared mortar cubes at 0%,20%,40%,60%,80%,100% replacement and are tested for strength and durability tests at 7,14,28 days respectively.*

***Key Words*: Sieve analysis of sand, Specific gravity of sand Bulking of sand, and Compressive strength of cement mortar.**

1. INTRODUCTION

The first mortars were made of mud and clay. As of a lack of pebble and an wealth of clay, Babylonian creations were of seared brick, using lime or terrain for mortar. Gypsum mortar, too called plaster of Paris, remained used in the construction of the Egyptian pyramids too many other ancient structures. It is complete fromgypsum, which needs a lower firing temperature. Cement mortar is an intact combination of cement and sand mixedwith sample amounts of water to create synthetic paste. Its adhesive characteristics vary, depending on the amount of water added the mixture.

1.1 Types of Mortar Mixes

1.1.1 Lean Mortar (LM): Mortar having a minimal amount of cement content is called lean mortar.

1.1.2 Rich Mortar (RM) : mortar having high a high volume of cement content is called rich mortar.

1.1.3 Neat Mortar (NM): mortars having pure cement , meaning it has no sand content is called neat mortar.

1.1.4 Aggregate Mortar (AM) : mortars having coarser materials, usually gravel or fragmented rock is called aggregate mortar.

1.2 Bricklaying or Pebble Resting Mortar (BRM)

Normally, in masonry stockades the structural items such as stones or else bricks stand bonded composed by using mortar. The scopes of elements for this determination are decided through respect towards the kind of mandatory substantial used.

Fig 1.1 Bricklaying or Pebble Laying Mortar

1.3 Finishing-Mortar (FM)

Finishing mortar is used for pointing and plastering works. For general type of plastering cement or lime mortar is used. Finishing mortar is also used for architectural effects of building to give aesthetic appearances. The mortar secondhand for ornamental finishing's must take great strength, flexibility and resistance against atmospheric action like rain, wind,etc.

Fig 1.2 Finishing Mortar

1.4 Heavy-Mortar (HM)

Generally heavyweight quartzes stand as adulterants in HM-mortars. The mortar which taking bulk density (BD) of 15 KN/m^3 or more then it is called as HM.

1.5 Light weight mortar (LWM)

Generally light spongy sands, easy sands are used as adulterants in LWM Mortar. The mortar taking bulk density (BD) of less than 15 KN/m^3 then it is calledas light mortar.

1.6 Classification of Mortar

Mortar is secret by ASTM-C-270, Usual Specification for Mortar-Unit-Masonry. Around four main types of mortar, which are labeled below. In addition, Type-K mortar is from time to time used, but comprised in the ASTM- C-270 standard.

1.7 Important Engineering Properties of Mortar

The properties of mortar which are wanted to use in masonry are: Workability, Water-Retentivity, Rate of Stiffening (RS), Strength, Resistance to Rain Penetration (RRP)and Durability. These properties havebeen discussed below explaining their effect on masonry. Choice of masonry mortar is governed by several considerations such as

- Type of masonry unit and its properties,
- Degree of exposure to weather and environments,
- Strength requirements, etc.

2. METHODOLOGY

2.1 Grading of Sand in Zones I and IV

Table-1: Grading of sand in zones 1 and 1V

	Percentage passing for			
IS sieves	Grading zone I	Grading zone II	Grading zone III	Grading zone IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
600microns	15-34	35-59	60-79	80-100
300microns	5-20	8-30	12-40	15-50
150microns	0-10	0-10	0-10	0-15

2.2 Sieve Analysis of Sand (SAS)

Sieve analysis helps to regulate the quality modulus and the particle scope distribution of the coarse and fine aggregates. This is done by sieving the aggregates as per IS: 2386 (part-1)-1963. The standard IS code as been taken.

Apparatus: A set of IS sieves 4.75mm, 2.37mm, 1.19mm, 425microns, 300microns, 150microns, Balance or scale with an accuracy to measure 0.1 percent of the weight of thetest sample.

Table -2: Sieve Analysis of River Sand

Sieve size	Weight retained	Cumulative Weight retained	Cumulative %weight retained	Cumulative %of weight passing
4.75	1	0.2	0.2	99.8
2.36	7	1.4	1.6	98.4
1.18	74	14.8	16.4	83.6
600	124	24.8	41.2	58.8
300	170	34	75.2	24.8
150	110	22	97.2	2.8
pan	14	2.8	100	0

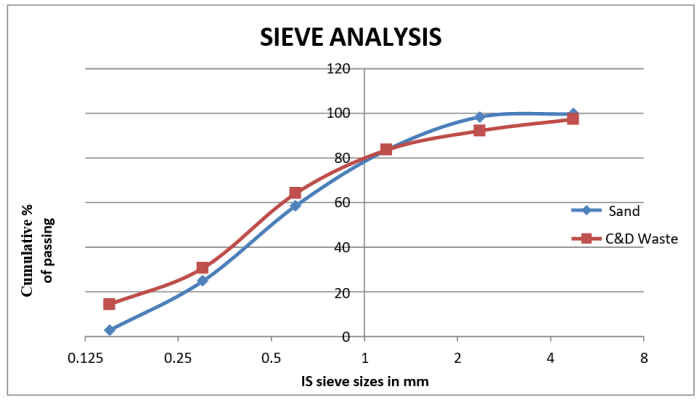

Chart -1: Sieve Analysis of Sand and C&D Waste

S.NO	W1	W2	W3	W4	W2-W1	W4-W1	W3-W2	(W4-W1)-(W3-W2)	Specific gravity
1	650	1100	1800	1520	450	870	700	170	2.647
2	650	1130	1819	1520	480	870	689	181	2.65
3	650	1118	1813	1520	468	870	695	175	2.66

Table -3: Specific gravity of river sand

Fig -1: Apparatus for sieve analysis

2.3 Specific gravity of Sand (SGS)

Specific gravity of fine aggregate is made use in design calculations of concrete mixes. Specific gravity of fine aggregate is also required to find out the compact factor while doing workability measurements. Specific gravity of fine aggregate is requiredto be measured when the deal with light and heavy weight concrete. Average specific gravity of the sand varies from 2.6-2.8.

Apparatus: pycnometer, stability, weight box, oven, desiccators, desired distilled water, vacuum source and thermometer.

2.4 Bulking of Sand (BS)

It is done to determine the bulking characteristics of sand. The increase in moisture of sand increases the volume of sand. The motive is that moisture sources film of water about sand elements which grades in the increase of volume of sand. Generally, moisture content percentage differ from 5.2 to 8.5 but sudden increase in volume up to 20 to 40% depending upon sand. If the sand finer will remain more increase in volume. This is known as Bulking of sand.Thus, it helps in determining the actual volume of sand, the dry sand is decreased. Thus, filled with water will have the exact volume. The volumetric-proportioning of sand is greatly affected by bulking of sand to a greater extent.The affected volume will be great for fine sand and will be less for coarse sand.

Apparatus: Measuring jar, balance, oven dried sand and distilled water.

Table -4: Bulking of river sand

S.NO	% of water added	Volume of sand v (c.c)	% bulking of sand
1	2%	560	12
2	4%	590	18
3	6%	600	20
4	8%	580	16
5	10%	550	10
6	12%	520	4
7	14%	500	0

3. EXPERIMENTAL TEXT PROCEDURE

3.1 Design of Cement Mortar Mix

3.1.1 Scheming of materials for 1 cum of 1.3 cement mortar with river sand

- Specific gravity of cement=3.15;
- Density of cement=1440gg/cum
- Specific gravity of sand=2.65;
- Density of sand=1765gg/cum @ 5% moisture First of all we have calculate yield of 1
- cement bag-(50kg) mixed in 1:3 Weight of cement=50kg
- Weight of sand mixed=3 X 50=150kg (contains 5% moisture also)
- Approximate volume of sand=150/ (2.65X1000) =0.0567 cum (contains 5% moisture also)Weight of only sand=95% of 150kg=142.5kg
- Absolute volume of cement=50kg/ (3.15X1000) =0.016cum
- Absolute volume of sand=weight of sand / (2.65X1000) =142.5/ (2.65X1000) =0.054cum Let volume of water added=25 liters=0.025cum
- Moisture present in the sand= 150-142.5=7.5 liters=0.0075cum
- Total volume of water=0.025+0.0075=0.0325cum
- Let, Air content in the mortar=2% of yield
- Total yield Y=0.1025/0.98=0.104cum
- 1 bag of 50kg cement produces=0.104cum of 1:3 cement mortar with 0.0567 cum(equals to150kg) of sand @5% moisture and 25 liters of water.
- Therefore, 1 cum of 1:3 cement mortar requires:

- Cement=1 bag X 1/0.104=9.615 bags Sand=150X1/0.104=1442 kg
- Water=25 X 1/0.104=240 liters

3.1.2 Calculation of materials for 1 cum of 1.3 cement mortar with C&D sand

- Specific gravity of cement=3.15; Density of cement=1440gg/cumSpecific
- gravity of sand=2.82; Density of sand=1550gg/cum
- First of all we have calculate yield of 1 cement bag (50kg) mixed in 1:3Weight of cement=50kg
- Weight of sand mixed=3 X 50=150kg
- Approximate volume of sand=150/ (2.82X1000) =0.0532 cumWeight of sand=150kg
- Absolute volume of cement=50kg/ (3.15X1000) =0.016cum
- Absolute volume of sand=weight of sand / (2.82X1000) =150/ (2.82X1000) =0.053cum Let volume of water added=25 liters=0.025cum
- Total volume of water=0.025cum
- Let, Air content in the mortar=2% of yield
- Y=0.094/0.98=0.096cum1 bag of 50kg cement produces=0.096cum of 1:3 cement mortar with 0.0532 cum (equals to150kg) of sand and 25 liters of water.
- Therefore, 1 cum of 1:3 cement mortar requires:
- Cement=1 bag X 1/0.096=10.42 bags
- Sand=150 X 1/0.096=1563 kg
- Water=25 X 1/0.096=260 liters

Fig-2 Moulds of size 70.6x70.6x70.6

Fig-3 Compressive testing of mortar cube

4. RESULTS AND DISSCUSION

Compressive strength test were carried out on 70.8 mm X 70.8 mm X 70.8mm specimen for that three cubes were prepare for each mix. The compressive strength of mortar goes on reducing with increase in percentage of c & d but the rate of reducing compressive strength is very low.

❖ 0%replacement

S.NO	LOAD (N)	AREA (mm^2)	STRESS (N/mm^2)
1	$127.5x10^3$	$5x10^3$	25.5
2	$129x10^3$	$5x10^3$	25.8
3	$124x10^3$	$5x10^3$	24.8
Average stress			25.3

❖ 100%replacement

S.NO	LOAD (N)	AREA (mm^2)	STRESS (N/mm^2)
1	**$211x10^3$**	**$5x10^3$**	**42.2**
2	**$207.5x10^3$**	**$5x10^3$**	**41.5**
3	**$203x10^3$**	**$5x10^3$**	**40.6**
Average stress			**41.4**

S.NO	LOAD (N)	AREA (mm^2)	STRESS (N/mm^2)
1	$157.5x10^3$	$5x10^3$	31.5
2	$155.5x10^3$	$5x10^3$	31.1
3	$154x10^3$	$5x10^3$	30.8
Average stress			31.13

Table -5: compressive strength of cement mortar (1:3) for 28 days in H_2SO_4 sol

5. CONCLUSIONS

Based on the experimental study, it can be concluded that

- The compressive strength of CDW mortar is Comparatively similar to that of conventional mortar.
- CDW can be replaced as sand to 40 % for important engineering works.
- CDW can be replaced as sand to 100% for unimportant engineering works.
- The effect of sodium chloride (Nacl) on mortar (1:3) is quite low and not harmful.
- The effect of Sulphuric acid (H2so4) on mortar (1:3) is high and risky.
- CDW can be used as alternate material for fine aggregate and the usage of river sand can be reduced.
- By replacing the river sand with CDW, usage of natural resources can be minimized.
- The use of CDW is cost effective because it can be available from the locallydemolished buildings.
- The workability of CDW sand is quite similar to river sand.
- CDW sand has potential to provide alternate to natural sand and helps in maintaining the environment as well as ecological balance.
- By replacing the natural sand with CDW sand the erosion of rivers can be reduced.

5.1 RECOMMENDATIONS

The following recommendations can be made based on the research observations andconclusions

- CDW sand is alternate material for river sand. It is recommended to use inconstruction works.
- The use of CDW in constructions will reduce the total cost of construction. It is well suitable for economic structures.
- CDW sand can be used 100% in laying pavements, flooring, plastering, and also forbrick work.

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