International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 10 | Oct 2019 www.irjet.net p-ISSN: 2395-0072

Replacement of Sand in Mortar

Shivam Malviya[1], Arbaz Baig[2], Arjun Singh Rajawat[3]

[1]Dept. of Civil Engineering, Swami Vivekananda College of Engineering Indore, M.P
[2,3]Dept. of Civil Engineering, Malwa Institute of Technology, Indore, M.P

Abstract - *This paper reports results of study on standard masonry mortar containing sand and sawdust as aggregates in a mix prop Portion of 1:3 and water-cement ratio of 0.55. A customized mortar of same design mix proportion (1:3) but varying water/cement ratio and constant slump of 74.3 mm to accomplish superior workability was also evaluated. Six dissimilar percentages (5, 10, 15, 20, 30 and 50%) of sand substitute were investigated. The flexural tensile strength, compressive strength, dry density, masonry wallet compressive strength, water absorption and slump were evaluated. The British code recommended masonry wallet compressive strength of 5.3 N/mm2 was achieved with 8 and 13% sawdust contents in the regular and customized mortars, correspondingly. Such mortars can be used as jointing and rendering materials on interior walls of building where water absorption by the mortar would be reduced. This study also emphasizes on the use of rubber ash from waste tires in cement mortar.100mm cubic specimens were formed by adding rubber ash volume ratios of 0%, 3%, 5% and 7% as a sand substitution in M30 quality cement mortar. A compressive stress test and a density test were conducted at the end of 7, 14, and 28 days. The outcome shows that 5% is the optimum value for sand substitution in the cement mortar. Hence, rubber ash is acceptable to be used as sand substitution*

1. INTRODUCTION

1.1- Mortar

Mortar is used to grip building materials such as brick or rock together. It is collected from a thick blend of water, sand, and cement. The water is used to hydrate the cement and grip the mix jointly. The water to cement ratio is elevated in the mortar than in concrete in order to form its binding ingredient. When mixed, it is a much thicker material than concrete, making it idyllic as glue for building resources like a brick. Because mortar must be replaced every 25-50 years, it isn't realistic for structural projects.

Mortar, which is a combination of water, cement, and sand, has an elevated water-to-cement ratio than concrete. It has a thicker constancy which makes it an immense adhesive and bonding mediator for bricks and tiles. Mortar mix can be used for the structure and repair of brick, block, and stone for barbecues, pillars, walls, tuck-pointing mortar joints, and planters.

1.2- Rotational

As nowadays, the natural sand available at the river banks, seashores, etc. The construction of structures is getting those rives banks and seashores depleted hence, the government of India is bringing some new changes in the code of construction to partially replace the natural sand.

Therefore we came up out with our own concept that what if we can completely replace the sand in the mortars and still can achieve approximately the same or better strength characteristics.

2. GOAL

The goal of this research project is to search for a complete and suitable replacement of sand in the mortars so that the use of natural sand can be avoided at the same time maintaining all the requirements as stated below:

*It should be able to bind building blocks such as bricks, concrete masonry, stones, etc. properly

*It should be able to be used in filling gaps sealing the cracks properly

*It should be moldable.

3. OBJECTIVE

The objective of this work is to prepare new ideas in the current scenario of materials used in mortars, keeping in mind the various aspects of its characteristics. For this it requires:

* Review and study different materials that can be proposed as a replacement for a particular existing material.

* To find out the difference in the initial method and new method that we used in our project

* To provide a faster and better solution through our proposed experiment.

4. METHDOLOGY AND ANALYSIS

We replaced sand fully from the mortar by three materials.

(a). Surkhi.

(b). Marble powder + Small grains of marble.

(c). Lime + Rubber pieces

We applied this test on Four types of moulds, first one is normal which is made by cement, sand and water but in other three mould we replaced sand by material which is listed above.

4.1 Preparation of material and test

4.1.1 Cement sand

The ratio contains 25% of cement and 75% of sand and water is taken as 35-40% of cement weight. The cement used was Portland pozzolana cement, and river sand is used in mortar. Cube size was 7.3*7.3*7.3

Volume of cube = 0.073 x 0.073 x 0.073

= 0.000389 m3

Density of cement: - 1440 kg/m3

Density of sand: - 1600 kg/m3

Volume of cement = 0.000389/4

= 0.000098 m3

Volume of sand = 0.000389 * 3/4

= 0.000292 m3

Density = weight / volume

By using above formula find the amount of cement required in making 1 block of cement-sand mortar.

Weight of cement = 1440 * 0.000098

= 0.141 kg

Find the amount of dry cement required in making 1 block of cement-sand mortar.

Dry weight of cement = 0.141 * 1.33

= 0.19kg

So, the amount of dry cement required in making 1 block of cement-sand mortar is 0.19 kg.

Now, find amount of dry cement required in making 9 block of cement-sand mortar in kg.

Total dry cement required for 9 blocks = 0.19 * 9

= 1.71kg

Now find the amount of sand required in making 1 block of cement-sand mortar.

Density = weight / volume

Weight of sand = 1600 * 0.000292

= 0.4672 kg

Find the amount of dry sand required in making 1 block of cement-sand mortar.

Dry weight of sand = 0.4672 * 1.33

= 0.62kg

So, the amount of dry sand required in making 1 block of cement-sand mortar is 0.62 kg.

Now, find amount of dry sand required in making 9 block of cement-sand mortar in kg.

Total dry sand required for 9 blocks = 0.62*9

= 5.58kg

So, the amount of dry sand required in making 9 block of cement-sand mortar is 5.58 kg.

Now we apply compressive strength test on mould by U.T.M. after 3 days of continue curing.

Block	Load(KN)	Average load (KN)
1	54	56.27
2	58.8	
3	56	

Compressive strength test on mould by U.T.M. after 7 days of continue curing.

Block	Load(KN)	Average load (KN)
1	56.6	58.2
2	60	
3	58	

Compressive strength test on mould by U.T.M. after 28 days of continue curing.

Block	Load(KN)	Average load (KN)
1	70	81.67
2	95	
3	80	

Strengths of cement sand mortar blocks after 3, 7 and 28 days.

Strength= Load*Area

S. No.	Days	Load(KN)	Area(mm^2)	Strength(N/mm^2)
1	3	56.27	73*73	10.559

2	7	58.2	73*73	10.921
3	28	81.67	73*73	15.325

So we can conclude that the strength for the above mortar block is found to be 15.325 N/mm^2.

4.1.2. Cement + Surkhi

RATIO: - 1:3

The ratio contains 25% cement and 75% Surkhi.

MOULD SIZE: - 0.073m x 0.073m

The mould is made of steel or it can be of any other material which does not absorb water.

CEMENT: - P.P.C.

The cement used is Portland Pozzolana cement.

SURKHI: - Class 'B' bricks are used here as Surkhi.

WATER CONTENT: - It is taken as 35% to 40% of cement weight after that it can be added as per desired workability.

DENSITY OF CEMENT: - 1440 kg/m3

DENSITY OF SURKHI: - 1600 kg/m3

CALCULATIONS: - for 1 block mortar.

Ratio: - 1:3

Volume of cube = 0.073 x 0.073 x 0.073

= 0.000389 m3

Volume of cement = 0.000389/

= 0.000098 m3

Volume of surkhi = 0.000389*3/4

= 0.000292 m3

Density = weight / volume

By using above formula find the amount of cement required in making 1 block of cement-surkhi mortar.

Weight of cement = 1440 * 0.000098

= 0.141 kg

Find the amount of dry cement required in making 1 block of cement-surkhi mortar.

Dry weight of cement = 0.141 * 1.33

= 0.19 kg

So, the amount of dry cement required in making 1 block of cement-surkhi mortar is 0.19 kg.

Now, find amount of dry cement required in making 9 block of cement-surkhi mortar in kg.

Therefore,

Total dry cement required for 9 blocks = 0.19 * 9

= 1.71 kg

So, the amount of dry cement required in making 9 block of cement- Surkhi mortar is 1.71 kg.

Now find the amount of sand required in making 1 block of cement-Surkhi mortar.

Density = weight / volume

Weight of Surkhi = 1600 * 0.000292

= 0.4672 kg

Find the amount of dry sand required in making 1 block of cement-surkhi mortar.

Dry weight of Surkhi = 0.4672 * 1.33

= 0.62 kg

So, the amount of dry sand required in making 1 block of cement-surkhi mortar is 0.62 kg.

Now, find amount of dry sand required in making 9 block of cement-surkhi mortar in kg.

Total dry Surkhi required for 9 blocks = 0.62 * 9

= 5.58 kg

So, the amount of dry sand required in making 9 block of cement-surkhi mortar is 5.58 kg.

Now we apply compressive strength test on mould by U.T.M. after 3 days of continue curing.

Block	Load(KN)	Average load (KN)
1	30	32.06
2	34	
3	32.2	

Compressive strength test on mould by U.T.M. after 7 days of continue curing.

Block	Load(KN)	Average load (KN)
1	36.2	36.13
2	38	
3	34.2	

Compressive strength test on mould by U.T.M. after 28 days of continue curing.

Block	Load(KN)	Average load (KN)
1	60	56.8
2	52	
3	58.4	

Strengths of cement surkhi mortar blocks after 3, 7 and 28 days.

Strength= Load*Area

S. No.	Days	Load(KN)	Area(mm^2)	Strength(N/mm^2)
1	3	32.06	73*73	6.016
2	7	36.13	73*73	6.800
3	28	56.8	73*73	10.658

So we can conclude that the strength for the above mortar block is found to be 10.658 N/mm^2.

4.1.3 CEMENT + MARBLE POWDER + FINE GRAINS OF MARBLE.

RATIO: - 1:2:1

The ratio contains 25% cement and 50% marble powder and 25% fine marble grains.

MOULD SIZE: - 0.073m x 0.073m x 0.073m

The mould is made of steel or it can be of any other material which does not absorb water.

CEMENT: - P.P.C.

The cement used is Portland Pozzolana cement.

MARBLE POWDER: - White Marble powder.

FINE GRAINS OF MARBLE: - White Marble Grains.

WATER CONTENT- It is taken as 35% to 40% of cement weight after that it can be added as per desired workability.

DENSITY OF CEMENT- 1440 kg/m3

DENSITY OF MARBLE POWDER: - 1300 kg/m3

DENSITY OF FINE GRAINS OF MARBLE: - 2600 kg/m3

CALCULATION: - for 1 block mortar.

Ratio: - 1:2:1

Volume of cube = 0.073 x 0.073 x 0.073

= 0.000389 m3

Volume of cement = 0.000389 * 1/4

= 0.000098 m3

Volume of marble powder = 0.000389 * 2/4

= 0.000195 m3

Volume of fine marble grains = 0.000389 * 1/4

= 0.000098 m3

Density = weight / volume

By using above formula find the amount of cement required in making 1 block of cement-marble mortar.

Weight of cement = 1440 * 0.000098

= 0.141 kg

Find the amount of dry cement required in making 1 block of cement-marble mortar.

Dry weight of cement = 0.141 * 1.33

= 0.19 kg

So, the amount of dry cement required in making 1 block of cement-marble mortar is 0.19 kg.

Now, find amount of dry cement required in making 9 block of cement-marble mortar in kg.

Therefore,

Total dry cement required for 9 blocks = 0.19 * 9

= 1.71 kg

So, the amount of dry cement required in making 9 block of cement-marble mortar is 1.71 kg.

Now find the amount of marble powder required in making 1 block of cement-marble mortar.

Density = weight / volume

Weight of marble powder = 1300 * 0.000195

= 0.254 kg

Find the amount of dry marble powder required in making 1 block of cement-marble mortar.

Dry weight of marble powder = 0.254 * 1.33

= 0.34 kg

So, the amount of dry marble powder required in making 1 block of cement-marble mortar is 0.34 kg.

Find the amount of dry marble powder required in making 9 block of cement-marble mortar.

Total dry marble powder required for 9 blocks = 0.34 * 9

= 3.06 kg

So, the amount of dry marble powder required in making 9 block of cement-marble mortar is 3.06 kg.

Now find the amount of fine marble grains required in making 1 block of cement-marble mortar.

Weight of fine marble grains = 2600 * 0.000098

= 0.254 kg

Find the amount of dry fine marble grains required in making 1 block of cement-marble mortar.

Dry weight of fine marble grains = 0.254 * 1.33

=0.34 kg

So, the amount of dry fine marble grains required in making 1 block of cement-marble mortar is 0.34 kg.

Find the amount of dry fine marble grains required in making 9 block of cement-marble mortar.

Total dry fine marble grains required for 9 blocks = 0.34 * 9

= 3.06 kg

So, the amount of dry fine marble grains required in making 9 block of cement-marble mortar is 3.06 kg.

Now we apply compressive strength test on mould by U.T.M. after 3 days of continue curing.

Block	Load(KN)	Average load (KN)
1	62.2	73.00
2	80.2	
3	76.4	

Compressive strength test on mould by U.T.M. after 7 days of continue curing.

Block	Load(KN)	Average load (KN)
1	115	112.6
2	112.6	
3	110.2	

Compressive strength test on mould by U.T.M. after 28 days of continue curing.

Block	Load(KN)	Average load (KN)
1	155	151.2
2	148.6	
3	150	

Strengths of cement surkhi mortar blocks after 3, 7 and 28 days.

Strength= Load*Area

S. No.	Days	Load(KN)	Area(mm^2)	Strength(N/mm^2)
1	3	73	73*73	13.698
2	7	112.6	73*73	21.129
3	28	151.2	73*73	28.373

So we can conclude that the strength for the above mortar block is found to be 28.373 N/mm^2.

4.1.4 Cement + Lime + Rubber Pieces

RATIO: - 25 %: 65 %: 10 %

The ratio contains 25% cement, 65% lime, 10% rubber pieces.

MOULD SIZE: - 0.073m x 0.073m

The mould is made of steel or it can be of any other material which does not absorb water.

CEMENT: - P.P.C.

The cement used is Portland Pozzolana cement.

LIME: - Powdered lime.

RUBBER PIECES: - Waste tube of vehicle.

The size of rubber pieces taken here varies between 2mm to 5mm.

WATER CONTENT: - It is taken as 35% to 40% of cement weight after that it can be added as per desired workability.

DENSITY OF CEMENT: - 1440 kg/m3

DENSITY OF LIME: - 1200 kg/m3

DENSITY OF RUBBER PIECES: - 1000 kg/m3

CALCULATION: - for 1 block mortar.

Ratio = 25 %: 65 %: 10 %

Volume of cube = 0.073 x 0.073 x 0.073

= 0.000389 m3

Volume of cement = 0.000389 * 0.25

= 0.000098 m3

Volume of lime = 0.000389 * 0.65

= 0.00026 m3.

Volume of rubber pieces = 0.000389 * 0.10

=0.0000389 m3

Density = weight / volume

By using above formula find the amount of cement required in making 1 block of above mortar.

Weight of cement = 1440 * 0.000098

= 0.141 kg

Find the amount of dry cement required in making 1 block of above mortar.

Dry weight of cement = 0.141 * 1.33

= 0.19 kg

So, the amount of dry cement required in making 1 block of above mortar is 0.19 kg.

Now, find amount of dry cement required in making 9 block of above mortar in kg.

Therefore,

Total dry cement required for 9 blocks = 0.19 * 9

= 1.71 kg

So, the amount of dry cement required in making 9 block of above mortar is 1.71 kg.

Now find the amount of lime required in making 1 block of above mortar.

Weight of lime = 1200 * 0.00026

=0.312 kg

Find the amount of dry lime required in making 1 block of above mortar.

Dry weight of lime = 0.312 * 1.33

=0.414 kg

So, the amount of dry marble powder required in making 1 block of above mortar is 0.414 kg.

Find the amount of dry lime required in making 9 block of above mortar.

Total dry marble powder required for 9 blocks = 0.414 * 9

= 3.726 kg

So, the amount of dry lime required in making 9 block of above mortar is 3.726 kg.

Now find the amount of rubber pieces required in making 1 block of above mortar.

Weight of rubber pieces = 1000 * 0.0000389

= 0.0389 kg

Find the amount of dry rubber pieces required in making 1 block of above mortar.

Dry weight of rubber pieces = 0.0398 * 1.33

= 0.0517 kg

So, the amount of dry rubber pieces required in making 1 block of above mortar is 0.0517 kg.

Find the amount of dry rubber pieces required in making 9 block of above mortar.

Total dry rubber pieces required for 9 blocks = 0.0517 * 9

= 0.470 kg

So, the amount of dry fine marble grains required in making 9 block of above mortar is 0.470 kg.

Now we apply compressive strength test on mould by U.T.M. after 3 days of continue curing.

Block	Load(KN)	Average load (KN)
1	30	30.07
2	32.2	
3	28	

Compressive strength test on mould by U.T.M. after 7 days of continue curing.

Block	Load(KN)	Average load (KN)
1	56.6	58.2
2	58	
3	60	

Compressive strength test on mould by U.T.M. after 28 days of continue curing.

Block	Load(KN)	Average load (KN)
1	94.6	103.2
2	110	
3	105	

Strengths of cement surkhi mortar blocks after 3, 7 and 28 days.

Strength= Load*Area

S. No.	Days	Load(KN)	Area(mm^2)	Strength(N/mm^2)
1	3	30.07	73*73	5.642
2	7	58.2	73*73	10.921
3	28	103.2	73*73	19.366

So we can conclude that the strength for the above mortar block is found to be 19.366 N/mm^2.

5. RESULT AND CONCLUSION

5.1 Result

From the above experiments we have obtained the following characteristics of mortar by using different materials in complete replacement of sand. The data and observations that we came about strength of various mortars we prepared are as follows:-

This table shows the results in percentage increase and decrease in strength with respect to strength of cement sand mortar.

S. No.	Type of mortar	% Increase	% Decrease
1	Cement + Surkhi		30.45
2	Cement + Marble Powder + Marble Grains	85.14	
3	Cement + Rubber Pieces + Lime	26.37	

5.2 Conclusions

5.2.1 Cement + Surkhi Mortar

If we talk about Surkhi as a modification of Sand there are some factors which it fulfills. First of all the cost of this mortar is less as compared to normal cement mortar making it an interesting pick. The strength is somewhat reduced but as we are talking about mortar, strength factor is not that much important as it does not have to bear high load. We can use this type of mortar where economic factor is to be achieved without sacrificing much of strength. So therefore Mortar with Surkhi can be a very good option in coming future taking all these factors in mind.

5.2.3 Cement + Marble Mortar

If we talk about Marble as a modification of Sand there are some factors which it fulfills. First of all the strengths of this mortar was the best till date better than any other mortar. The strength of this type of mortar is comparatively much higher than that of cement sand mortar. It satisfies the strength criteria, but its cost is somewhat greater than cement sand mortar so, it can be used as a flooring material, for making sculptures and where good aesthetic view has to be provided because of its strength and good aesthetic appearances.

5.2.3 Cement + Rubber + Lime Mortar

If we talk about rubber as a modification of Sand there are some factors which it fulfills. Firstly, Rubber being a non-biodegradable substance is a threat to environment if it's not degraded or recycled properly, also there are many other disadvantages of Rubber. Rubber tires are scrapped at a rate of 1.1 tire/person/year leading to over 300 million tires scrapped per year. Therefore, to use it is as replacement of sand is a remarkable idea. The talking about its use in mortar it has a great advantage in a strength, it's strength is somewhat same as that of cement sand mortar making it impressive and also tyre rubber waste is available at an economical rate of ₹15 per tonne therefore making it cost-efficient and economical. It is the only material which satisfies the strength criteria as well as the economy criteria, thus making it the best alternative of sand replacement among all. Therefore, keeping in mind the following factors use of rubber can be a very good and astonishing idea in coming future.

Therefore in coming future the idea of sand replacement can be achieved keeping the following conclusions in mind.

6. REFFRENCES

Research papers:

[1] African Journal of Environmental Science and Technology Vol. 5(5), pp. 381-388, May 201 ISSN 1996-0786 ©2011 Academic Journals.

[2] The conducted research programme was realized as a part of research project entitled “Impact resistant concrete elements with nonconventional reinforcement” and founded by Polish “National Science Centre” (decision number: DEC- 2011/01/B/ST8/06579).

[3] IOP Conf. Series: Materials Science and Engineering 160 (2016) 012055 doi:10.1088/1757-899X/160/1/012055.

[4] Journal of Civil Engineering and Construction Technology, Vol. 8(6), pp. 59-66, July 2017 DOI:10.5897/JCECT2017.0450 Articles Number: 97BC2B264932 ISSN 2141-2634.

[5] Hindawi Publishing Corporation Advances in Materials Science and Engineering Volume 2014, Article ID 626425.