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Partial Replacement of Sand in Mortar by Brick Dust and Saw Dust

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Abstract: ***The use of sawdust and brick dust in partial replacement of sand in the mortar will reduce the dependency on the natural sand. Extracting of sand from rivers led to the ecological imbalance of aquatic life. The sand is an important part of the construction field as it is used in both motors as well as in concrete which is the backbone of construction. Day by day the construction is increasing rapidly so is the need for sand. So, it is necessary to find the replacement of sand. the sawdust and brick dust is a waste product of their respective industries, so it is feasible to use them as partial replacement of sand. In the present study, the mixture is taken as (1:3). The partial replacement of sand is done in three different percentages (10%,20%,30%). In the first mix, 10% of sand is replaced with 5% each of sawdust and brick dust. Similarly, in the next two mixes, 20% and 30% of sand are replaced. For all the mix strength tests, the abrasion test is carried out at 7, 14 and 28 days. Compressive strength increases to 20% and decreases afterwards. Higher compressive strength is at a 10% replacement of sand. The resistance to abrasion in partially replaced mixes in more than of conventional mortar. In all the mix, a 20% replacement of the sand shows higher resistance to the abrasion.***

Keywords: sawdust, brick dust, replacement, mortar.

I. INTRODUCTION

As all of you know civil engineering depends upon construction materials like cement, coarse aggregates and fine aggregates. These materials form the base of civil engineering projects. Projects like airports railway stations expressways etc. use a lot of aggregates and cement in the form of concrete and mortar. India is a fast-growing country so it is its development of infrastructures. The use of aggregates and cement is rising exponentially. While making concrete or mortar 70 to 75 % of aggregate is used. Sand has a vital role in making concrete or mortar which is obtained from natural resources and is exhausting. So, there is a need for finding an alternative to the sand. Now a day's different type of alternates is used for sand and coarse aggregates on which research is doing a lot of hard work. Different types of alternates used in concrete and mortar are slag manufactured sand brick waste etc. While obtaining sand from natural resources there is an ecological imbalance, so we must look for an alternate. Brick dust is a waste in Brick kiln. Brick is a form of clay which is burnt at a high temperature. So, brick dust has the same property as of clay. Sawdust is also a waste product Timber industry it can be used as a fine aggregate because of its size of the particles.

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The density of sand waste is less as compared to sand. Both brick dust and sawdust contain silica. Many researchers are going on finding the best suitable replacement for sand. Some studies are listed in this paper.

Manoj Kumar etl conducted a study on the partial replacement of sand with the brick waste in concrete. They studied replacement at various percentages between 0 to 31%. They found maximum strength increase at 28%. The sand used was sieved through IS sieve 4.75mm and was of zone II grade as per IS 383:2016. The cement used was 43 grade OPC and water-cement was taken as per IS 456: 2000. The grade of concrete considered for the study is M25. The tests which were conducted were the slump test and split tensile strength.

M Usha eta conducted an experimental study on the replacement of fine aggregate in concrete by crushed bricks. Many types of research are going on to find the suitable replacement of sand. Three different replacement of sand was made i.e. 15%,20% and 25%. Tests were conducted to check the mechanical properties such as flexural strength, compressive strength and split tensile strength. It was found out that there is an 18.67% increase in flexural strength as compared to conventional concrete. Similarly, a 7.638% increase in split tensile strength and a 22% increase in compressive strength. The water-cement ratio is 0.5 and the mix is 1:1.61:3.15.

Olugbena joseph Oyedepo eta investigated on partial replacement of fine aggregates in concrete by sawdust. They replaced sand in different percentages at a regular interval of 25% starting from 0% to 100%. The mix proportion taken is 1:2:4 and water-cement ratio as 0.65.the tests were conducted as per British standards BS 812-110 1992. The test conducted is density test, slump test, compressive test and air entrainment test. The slump is found high at 25% replacement that was 9mm and compressive strength was less than 17 N/mm^2 which is minimum for lightweight concrete.

Mortar

It is a binding material consisting of a binding material like cement, lime clay, pozzolana etc. and fine aggregates like sand, rice husk, Turki, straw etc. In mortar one or more binding material can be used and the same with the fine aggregates.

The mortar can be used for different types of works such as binding material in brick masonry, stone masonry, painting, plastering, gap-filling etc.

There are different types of mortar.

- Cement mortar
- Lime mortar
- Surkhi mortar
- Gauged mortar
- Mud mortar

Cement mortar: This type of mortar consists of cement as binding material and sand as fine aggregates. The cement ratio to sand varies from 1:2 to 1:9. This type of mortar is used for brick masonry, stone masonry, plastering etc.
Surkhi mortar: This type of mortar consists of lime as binding material and surkhi as fine aggregates
Gauged mortar: This type of mortar consists of both lime as well as cement as binding material and sand as fine aggregates.
Lime mortar: This type of mortar consists of lime as binding material and sand as fine aggregates. The lime ratio to sand varies from 1:2 to 1:7. This type of mortar is used for brick masonry, stone masonry, plastering etc. pyramid at Giza have been plastered with lime mortar.
Mud mortar: This type of mortar consists of clay as binding material and straw or rice husk as fine aggregates. This is used in kaccha bricks works or as plastering.

II. MATERIALS AND METHOD

Cement: cement is used for 43 grade OPC. it is available locally in the market.
Sand: sand is obtained from the rivers. the sand is sieved through is sieve 4.75mm.
Saw Dust: sawdust is the by-product of the wood industry. when the wood is given the shape of the required products sawdust is also obtained. It is taken from the local wood industry. It was Sieved through IS sieve 2.36 mm.
Brick dust: it is the waste product in the brick industry. It was taken from the local brick kiln. It was Sieved through IS sieve 2.36 mm

Properties of material

Table-1 shows the properties of materials

Material	Density g/cm^3	Specific Gravity
Cement	1.45	3.19
Sand	1.61	2.66
Brick Dust	1.88	2.71
Saw Dust	0.21	0.85

Mix design

The mix design is carried out for 4 different proportions. M1 is taken for reference. the mix design is design with wastage of 10%. The test is carried out for 7,14 and 28 days and curing are done for 6,13 and 27 days approximately. For each test 3 trails and 12 number of samples were cast.

Table-2: shows the mix design for four different proportions

Mix Design for compression test and abrasion							
				Materials(kg)			
Mix	Proportion	Mould size	No. of cubes	Cement	Sand	Brick dust	Sawdust
M1	1:3:0:0	70.6mm x70.6mx70.6 mm	9	2.088	7	0	0
M2	1:2.7:0.15:0.15		9	2.088	6.3	0.408	0.0456
M3	1:2.4:0.3:0.3		9	2.088	5.64	0.817	0.091
M4	1:2.1:0.3:0.3		9	2.088	4.9	1.2267	0.137

Tests

- Strength test
- Abrasion test

Strength test: the mould of size 70.6 mm x 70.6 mm x70.6 mm is taken. 12 cubes were prepared. For each mix design i.e., M1, M2, M3 and M4, three cubes were prepared for each mix to be tested at 7,14 and 28 days. Oil coat is applied to the inner sides of the mould to restrict the bond between the mould and mortar. Each mould is filled in three layers and each layer is compacted uniformly by 25 number of blows. After 24 hours the specimens are kept for curing for 6,13 and 27 days. Each cube is tested after 7,14 and 28 days. The compression test is carried out in UTM (Universal Test Machine) and breaking load (P) is noted down. The compressive is calculated as

Compressive Strength = load/area

Abrasion test: the mould of size 70.6 mm x 70.6 mm x70.6 mm is taken. 12 cubes were prepared. For each mix design i.e., M1, M2, M3 and M4, three cubes were prepared for each mix to be tested at 7,14 and 28 days. Oil coat is applied to the inner sides of the mould to restrict the bond between the mould and mortar. Each mould is filled in three layers and each layer is compacted uniformly by 25 number of blows. After 24 hours the specimens are kept for curing for 6,13 and 27 days. Each cube is tested after 7,14 and 28 days. The is carried out in a tile abrasion testing machine.

The final depth after 200 revolutions is noted down. The load applied is kept constant i.e 7.5 kg.

III. RESULTS

Compression test results: The compression test is carried out in UTM and breaking load (P) is noted down. The compressive is calculated as

Compressive Strength = load/area

Area = 70.6*70.6 = 4984.36mm^2

Table-2: shows the compressive strength after 7 days

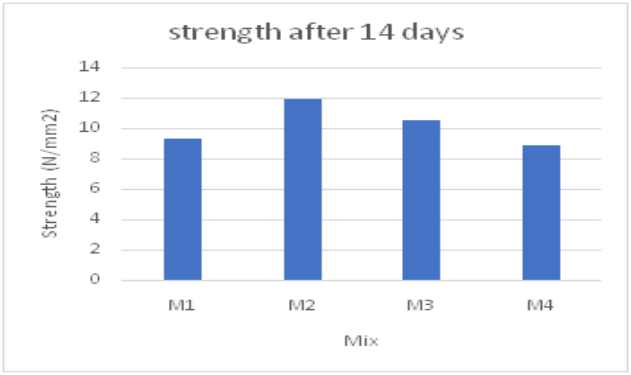
Compressive Strength (7 Days)			
Mix	Load (N)	Area(mm2)	Strength(N/mm^2)
M1	36600	4984.36	7.34
M2	47230	4984.36	9.47
M3	42200	4984.36	8.57
M4	35600	4984.36	7.14

Table-2: shows the compressive strength after 14 days

Compressive Strength (14 Days)			
Mix	**Load (N)**	**Area(mm^2)**	**Strength(N/mm^2)**
M1	46384	4984.36	9.3
M2	59340	4984.36	11.9
M3	52630	4984.36	10.55
M4	44200	4984.36	8.86

Table-2: shows the compressive strength after 28 days

Compressive Strength (28 Days)			
Mix	**Load (N)**	**Area(mm2)**	**Strength(N/mm^2)**
M1	56730	4984.36	11.38
M2	73200	4984.36	14.68
M3	64530	4984.36	12.94
M4	54930	4984.36	11.02



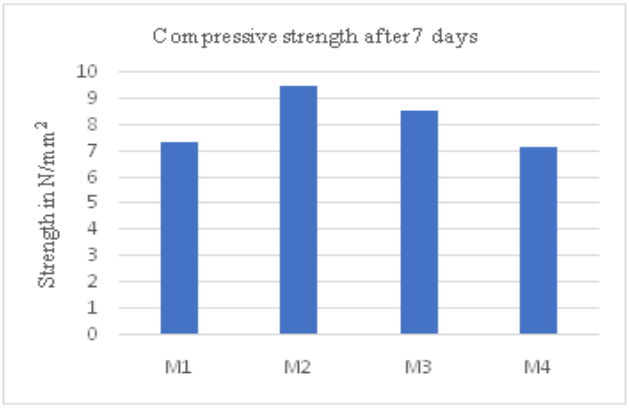


Fig. 1 shows the compressive strength after 7 days

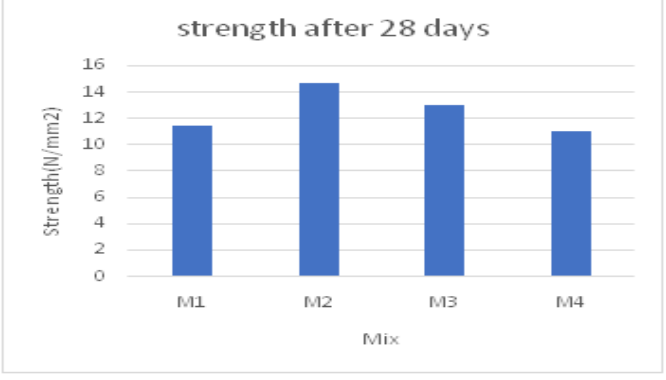


Fig. 1 shows the compressive strength after 14 days

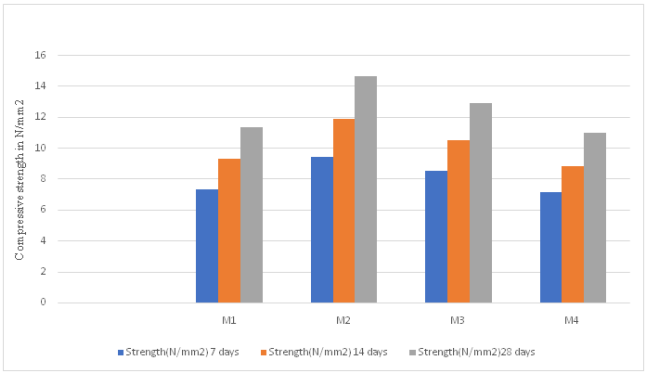


Fig. 1 shows the compressive strength after 28 days

The M2 shows the highest strength in all the mixes. The composition of M2 is 10% replacement of sand with the brick dust and sawdust 5% each. The strength decreases after 20% of the sand replacement with 10% each by brick dust and sawdust. There is a significant increase in the strength of mixes as compared to the conventional mortar. The tests were conducted after 7,14and 28 days. In each test M2 and M3 show the increase in compressive strength. The M2 and M3 showed an increase in compressive strength by nearly 28% and 14% respectively as compared to the conventional mortar (1:3). It was found that the optimum percentage of replacement of sand is 10% with 5% of brick dust and sawdust.

Abrasion test results

The test is carried out on the tile abrasion testing machine.

Table-2: shows the compressive strength after 7 days

Abrasion test (7days)			
MIX	**Size of Cube in mm**	**initial depth (mm)**	**final depth (mm)**
M1	70.6x70.6x70.6	70.6	68.1
M2		70.6	68.9
M3		70.6	70
M4		70.6	68.6

Table-2: shows the compressive strength after 7 days

Abrasion test (14days)			
MIX	**Size of Cube in mm**	**initial depth (mm)**	**final depth (mm)**
M1	70.6x70.6x70.6	70.6	68.5
M2		70.6	69.2
M3		70.6	70.1
M4		70.6	68.9

Table-2: shows the compressive strength after 7 days

Abrasion test (28days)			
MIX	**Size of Cube in mm**	**initial depth (mm)**	**final depth (mm)**
M1	70.6x70.6x70.6	70.6	68.8
M2		70.6	69.5
M3		70.6	70.3
M4		70.6	69.3

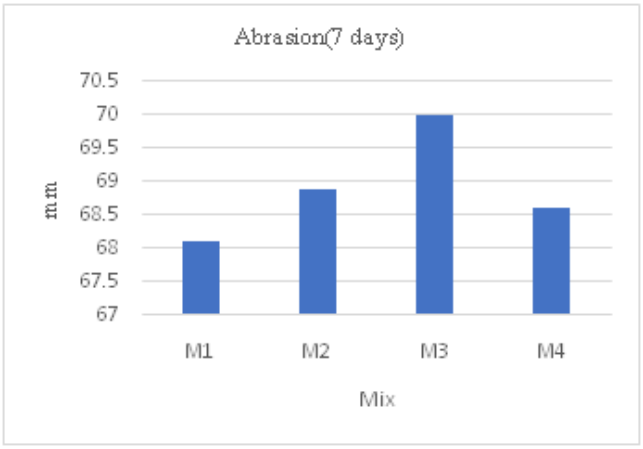


Fig. 1 shows the abrasion values after 7 days

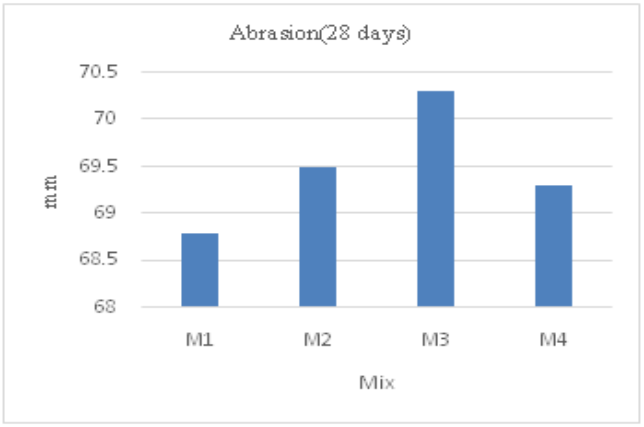


Fig. 1 shows the abrasion values after 14 days

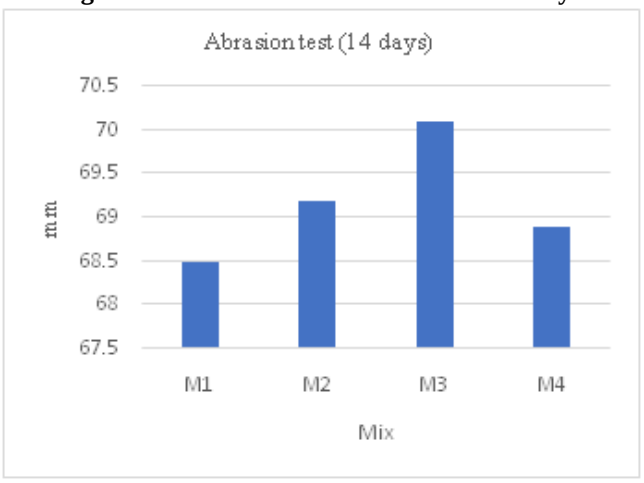


Fig. 1 shows the abrasion values after 28 days

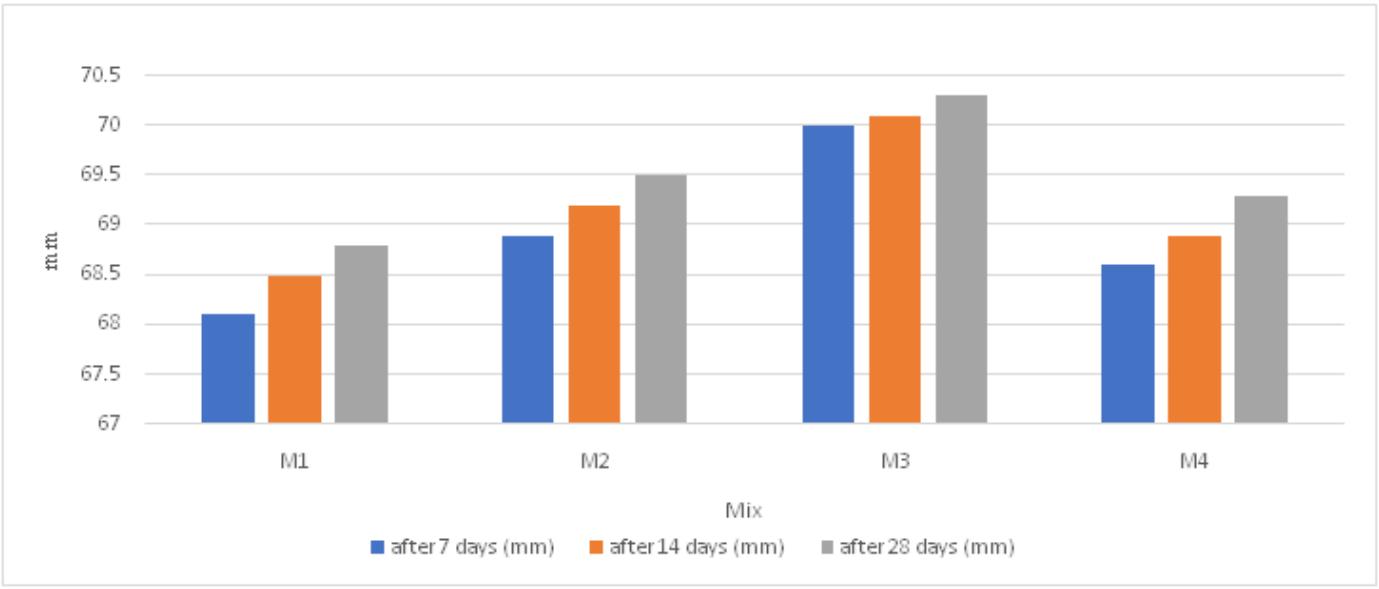


Fig. 1 shows the comparison of abrasion values

The M3 shows the highest resistance to the abrasion in all the mixes. The composition of M3 is 20% replacement of sand with the brick dust and sawdust 10% each. There is a significant increase in resistance to the abrasion of mixes as compared to the conventional mortar. The tests were conducted after 7,14and 28 days. In each test M2 and M3 show the increase in resistance to the abrasion. The M2 and M3 showed an increase in resistance to the abrasion by nearly 7% and 5% respectively as compared to the conventional mortar (1:3). It was found that the optimum percentage of replacement of sand is 20% with 10% of brick dust and sawdust each.

IV. CONCLUSIONS

- With the replacement of sand in the mortar by sawdust and brick dust is feasible as it increases strength and resistance to abrasion.
- At 10% replacement of sand, the increase in compressive strength is optimum and at 20% replacement, the compressive strength is higher than that of conventional mortar.

After 20% replacement the compressive strength decrease.

- The resistance to the abrasion is higher in the partial mixes than of the conventional mortar. The optimum percentage is 20% where it shows higher resistance to the abrasion. The 10% replacement shows higher resistance to that of a 30% replacement.

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