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Experimental Study on Partial Replacement of Coarse Aggregate by Over Burnt Brick with Addition of Crimped Steel Fibres

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ABSTRACT

In this paper an experimental study of concrete which is made of replacing coarse aggregate with over burnt brick and in addition of crimped still fibres. The main intention of using over burnt brick is to eliminate excessive mining or cutting of natural rocks.

The main objective of doing this reach research is to investigate the effect of concrete on fresh and hardened concrete with addition of steel fibres. As over burnt brick bats are of rough surface and having large pores on its structure.

In this experimental study, coarse aggregate is partially replaced with various percentages such as 15, 20, 25, and 30% replacement with over burnt brick bats with a fixed 2% crimped steel fibres.

M60 grade concrete is design and tested on fresh concrete like slump test and hardened concrete like compressive, tensile and flexural strength and it is tested for 7, 14 and28 days of curing. It has been observed that the workability is decreases as a percentage of over burnt brick is increases and there is an increase in the compressive, tensile and flexural strength up to 20% replacement. After that there is decrease in strength as the percentage of OBB is increases.

The chemical admixture is used to increase workability and decrease the water content. Total 45 numbers of cubes, 45 numbers of prisms and 45 numbers of cylinders where casted and tested.

Keywords: Over burnt bricks, Crimped steel fibres, Compressive strength test, Split tensile test, Flexural strength test, Water absorption test.

INTRODUCTION

Concrete is one of the main material in construction industries the main ingredient of which is cement, sand, coarse aggregate and water. Nowadays this natural material can be replaced with other materials like waste or manufactured materials makes significant change in performance as well as cost. The major part of concrete is filled with coarse aggregate. In the last few months the cost of coarse aggregate is rapidly increasing also natural rock is also getting reduced. From the past few years, the over burnt brick waste were partially replaced in concrete. With the use of over burned brick it maintains the strength and performance of the concrete and also reduce the self weight of concrete. The utilization of over burnt brick in construction industries helps in conserving of natural resources. As we all know concrete is a composite material. Composed of coarse granular material embedded in a rigid matrix of substance that fills the space among the aggregate particles and binds them together. Nowadays, admixtures are used to improve the properties of concrete. The ingredients of concrete are cement, fine, coarse aggregate and water. The cement and water mixture coats the surface of aggregate through a chemical reaction the cement-water paste hardens and gradually increase the strength to form a solid structure.

In concrete, aggregate impart major volume and better durability than cement paste in concrete lead to economy in concrete. Coarse aggregate is a natural material it is assumed that their may be scarcity of aggregate for concrete production. Due to increase in the cost of aggregate and increasing infrastructure it is time to think on alternative material for concrete production. Due to rapidly increase in the construction industries the natural material used in concrete, lead to shortage of material in various regions of world. Various research work has been carried out to use various alternative materials like recycle aggregate, over burnt brick, clay aggregate-sand and various other waste material. The materials mentioned above are easily and economical available in abundant quantity which can be used easily in respect of strength and durability. In Karnataka various parts of regions, manufacture and use brick as a major construction material. During the burning process of bricks lots of bricks are burnt more than what actually it has to burn. This over burnt brick has no use in the construction of walls because the over burnt bricks becomes shapeless. The advantage of using this material is that; it is very hard, tough and having less water absorbing capacity.

This research is based on the partial replacement of coarse aggregate with over burnt brick material with addition of steel fibres. The increase in the use of aggregate creates ecological imbalance. Thus partial replacement of coarse aggregate is vital in construction industries. The main purpose of using concrete is due to its high workability. As we are using over burnt brick, the surface of which is rough due to which the workability is decrease and

further the workability is decreases as we are using the steel fibres. Crimped steel fibres are added to decrease or reduce the internal micro- cracks which are developed in concrete as age of concrete increases. As we are adding over burnt brick bats which are not stronger than that of natural aggregate, there may be a chance of developing the cracks or early failure of concrete. To overcome this, the steel fibres were added to enhance the strength and workability. Nowadays the coarse aggregate cost is much high as fine aggregate. The reason behind is that the natural rock are depleting rapidly and the transportation cost is increasing day by day. In some past years the coarse aggregate is available in a huge quantity with a low cost. Now the cost of material is very high in some areas of Karnataka the coarse aggregate itself is not available but the brick manufacturing units are available in a large numbers, from there we can get OBB in large quantity, the cost required to get this over burnt brick is transportation and crushing. The advantage of using over burnt brick is preserving natural resource and reducing the effect of green house gases. On the other hand utilization of waste material that is burden to brick manufacturer. The unit weight of over burnt brick is less as compared to natural aggregate. The utilization of over burnt brick in various components of concrete structure will result in reduction of dead load of structure.

Fig.1 shows the over burnt bricks at manufacturing unit.

LITERATURE REVIEW

[1] KULDEEPAK DWIVEDI (NOV-DEC 2017) : This author has done the experimental study on concrete made with partial replacement of coarse aggregate with over burnt brick chips and demolished concrete waste. The test performed was the compressive strength and split tensile strength when conventional coarse aggregate was replace with 10- 15% of over burnt brick chips and 10-15% of demolished coarse aggregate separately for contacting the study 54 cubes of 150 mm in size and 54 cylinders which is of 150 mm in diameter and 300 mm in height were casted. 27 cubes and 27 cylinders for over burnt brick chips and same number of specimens for demolished concrete waste. The plasticizers was used as 0.8-1% by weight of cement to achieve required work ability. After testing it is found that up to 25% replacement of over burnt brick chips and up to 35% demolished waste the variation in properties of concrete is within permissible limit i.e near to properties of M25 great concrete. It has seen that a replacement of coarse aggregate by over burnt brick up to 25% and by demolished concrete waste up to 35% shows a negligible variation in properties of concrete and the reduction in cost by 10% and 25% respectively.

[2] BIDVE GANESH SHIVKANTH, G.N.SHETE (APR-2019): This author has done the experimental study on properties of concrete. In fresh stage slump test was performed for each percentage of replacement i.e 20, 40,and 60% replacement in harden stage compressive strength test on 150mm size cube is performed after the curing period of 7 and 28 days. Up to 20% replacement there is increase in compressive strength. There is 3% increment when replaced 20% aggregates. Tensile strength:- increment in tensile strength of 5.29% up to 20% replacement. Flexural strength: - There is increment in flexural strength of 7.1% when replaced with up to 20%.

[3] VIKAS KUMAR GAUTAM DIVESH JAYSAWAL,(MAY-2018) : This author has done the experimental research on concrete. The over burnt brick is replaced by 25, 50, 75 and 100 percent replacement with granite mixture. They have casted cube and cylinder specimens. The specimens are tested after 28 days curing of period. They have casted two types of mix that is M15 and M20 grade concrete. After testing there is a decrease in compressive strength of concrete regarding (11 to 87%) at age of 28 days curing. They have also conducted general test like aggregate impact value, specific gravity test, fineness modulus and crushing value test on both granite aggregate and over burnt brick.

[4] ANURAG MISHRA ET.AL. (NOV-2017): The authors have conducted the experimental research and they conclude that using the different types of fibres in concrete improves the durability, mechanical properties and serviceability of structure. They have casted the concrete of M20 grade with varying percentage of fibres such as 0,0.5, 1, 1.5, 2, 2.5 and 3% by weight of cement with aspect ratio of 60 (30 mm length and 0.5 mm in diameter) they have casted cubes and cylinders for testing compressive strength and split tensile strength over a curing period of 7, 14 and 28 days, at the last they have concluded that as the percentage of Steel fibre increases the compressive and split tensile strength increases and workability decreases.

[5] ABDUL GAFFAR ET.AL. (MAR-2014) : The authors have conducted the experimental study on concrete to test the compressive and flexural strength, with varying percentage of hooked Steel fibres with 0-5% at 0.5% interval by weight of cement. The aspect ratio of steel fibre is 80 (60 mm in length and 75 mm in diameter) they have design M35 grade concrete, result of compressive strength shows that, at 28 days curing the compressive strength is more at 3% of Steel fibres the flexural strength increases with increase in fibre content up to 4% and then decreases.

OBJECTIVE

1. To check the workability of concrete after adding over burnt brick bats and steel fibres.

2. To study the variation in compressive strength, tensile strength and flexural strength of concrete made of conventional concrete and concrete made of over burnt bricks.

3. To compare the cost of conventional concrete and the concrete made up of waste material.

4. MATERIAL AND PROPERTIES

4.1 Cement:-

Ultra-tech OPC 53 grade cement is used for experimental study. Basic test like specific gravity, normal consistency, initial setting time and fineness test has been performed on the cement.

Specific gravity = 2.89

Normal consistency = 34

Initial setting time = 35 min

Fineness= 22 m^2/kg or in percentage = 3%

4.2 Sand: -

The sand used for this experiment is locally available shahpur river sand the grade of sand is zone 2 and the sand is free from mud and organic materials. The particles size is less than 4.75 mm.

The basic test where conducted and the results are as follows:

Specific gravity = 2.65

Water absorption = 1.01

Table1. Showing Results of sieve analysis of Fine Aggregate

Sieve Size	Cumulative % Finer	Grading Limits For Zone-II As Per IS 383:1970
4.75 mm	92.6	90-100
2.36 mm	83.2	75-100
1.18 mm	68.5	55-90
600 µ	46.4	35-59
300 µ	5.7	5-30
150µ	0.8	0-10

4.3 Coarse aggregate: -

The crushed basalt stone of size 20 mm and down size is used. The crushed stone is free from dust and mud particles. The basic test is also performed like special gravity, water absorption, crushing value and particle size distribution. The test results are 2.80, 0.54, and 15.26% respectively.

Table 2. Showing sieve analysis of Coarse aggregate

Total weight of sample taken = 3000gm

Sieve size in mm	Wt. of aggregate retained (gm)	% of total wt retained	Cumulative % wt. retained	% passing
20	0	0	0	100
16	142.7	4.75	4.75	95.25
12.5	1485	49.5	54.25	45.75
10	1121.1	37.37	91.62	8.38
4.75	251.2	8.37	100	0
Pan	0	0	100	0

Results: - single graded aggregates

4.4 Over burnt brick bats: -

The over burnt brick are available in brick manufacturing unit in a large quantity. This over burnt brick is taken and crushed into small pieces of 20 mm and downsize. The crushed brick are sieved to remove the dust and fine particles. These over burnt bricks are lighter than the coarse aggregate. After crushing the loose or muddy particles are removed. The crushing can be done with a hammer or crushing machine whichever is required. The water absorption and special gravity test have been performed on crushed particles and the test results are 12% and 2.19 respectively.

Table 3. Showing sieve analysis of over burnt brick bats:

Total weight of sample taken = 3000gm

Sieve size in mm	Wt. of aggregate retained (gm)	% of total wt retained	Cumulative % wt. retained	% passing
20	273.6	9.12	9.12	90.88
16	458.2	15.27	24.39	75.61
12.5	824.3	27.47	51.86	48.14
10	1231.4	41.04	92.9	7.1
4.75	172.2	5.74	98.64	1.36
Pan	40.3	1.34	100	0

Fig.2 shows the sample of crushed over burnt brick bats.

4.5 Crimped steel fibres: -

Steel fibre is added to increase the strength and avoiding the cracks which are developed during fresh and hardened stage of concrete. The steel fibres also increase the durability of concrete.

The crimped steel fibre is better than straight steel fibre in respect with binding. The amount of steel fibre in concrete is expressed as percentage of total volume of concrete and also the amount of cement content. The amount of steel fibre is kept constant at a percentage of 2%. More amount of steel fibre creates the workability problem and also as the aspect ratio increases beyond the limit it is also creates workability problem

The specifications of the material are as follows:

Table 4. Showing specifications of crimped steel fibres.

Sr. No's	Specifications	Values
i)	Shape	Round crimped
ii)	Length	5 cm
iii)	Dia.	0.1 cm
iv)	L/D ratio	50
v)	Color	Grey
vi)	T.S	1000-1400 N/mm^2

Fig.3 shows the crimped steel fibres.

4.6 Quantity of material for M60 Grade Concrete As Per Is 10262-2009:

Water (kg/m³)	cement (kg/m³)	Fine aggregate (kg/m³)	Natural coarse aggregate (kg/m³)	Super plastecizer	w/c ratio
151.066	413.17	718.62	1320.018	2.065	0.33

4.6.1 ***Quantity of material f or 15%Replacement Of Natural Aggregete***

Water (kg/m³)	cement (kg/m³)	Steel fibres (kg/m³)	Fine aggregate (kg/m³)	Natural coarse aggregate (kg/m³)	OBB (kg/m³)	Super plastecizer	w/c ratio
168.75	413.17	8.26	718.62	1128.20	155.81	2.065	0.33

4.6.2 ***Quantity of material f or 20%Replacement Of Natural Aggregete***

Water (kg/m³)	cement (kg/m³)	Steel fibres (kg/m³)	Fine aggregate (kg/m³)	Natural coarse aggregate (kg/m³)	OBB (kg/m³)	Super plastecizer	w/c ratio
174.49	413.17	8.26	718.62	1061.12	206.7	2.065	0.33

4.6.3 ***Quantity of material f or 25%Replacement Of Natural Aggregete***

Water (kg/m³)	cement (kg/m³)	Steel fibres (kg/m³)	Fine aggregate (kg/m³)	Natural coarse aggregate (kg/m³)	OBB (kg/m³)	Super plastecizer	w/c ratio
179.83	413.17	8.26	718.62	996.07	254.39	2.065	0.33

4.6.4 ***Quantity of material f or 30%Replacement Of Natural Aggregete***

Water (kg/m³)	cement (kg/m³)	Steel fibres (kg/m³)	Fine aggregate (kg/m³)	Natural coarse aggregate (kg/m³)	OBB (kg/m³)	Super plastecizer	w/c ratio
185.57	413.17	8.26	718.62	792.79	311.62	2.065	0.33

5. RESULTS AND DISCUSSION

5.1 Test on fresh concrete

5.1.1 Slump test:-

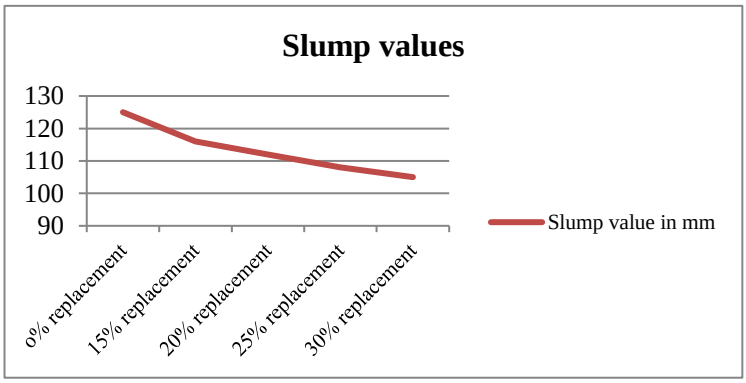
Slump means the difference of height in between support and unsupported concrete which is measured in a mm or cm. This slump test is an experimental test that measures the workability of concrete. More specifically it measures the consistency of concrete for that particular batch. This test is performed to check the workability of fresh concrete. Workability is a term which describes the state of fresh concrete. It refers to ease with which the concrete can mix, transport, laid and compact easily. Higher the workability of concrete higher the slump value, as I have used over burnt brick and steel fibres the

workability was found is less. To increase the workability super plasticizers is added with a fixed percentage. This test is conducted on different mix proportions.

The test results are shown in table

Table 5. Showing slump value of concrete.

Diff. %age	Slump value (mm)
Brick ballast @ 0%	125
15%	116
20%	112
25%	108
30%	105



Graph.1 shows slump value

5.2 Test on hardened concrete

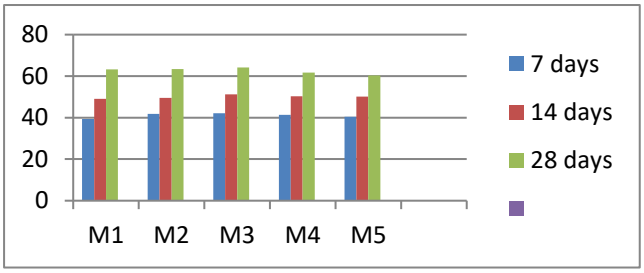
5.2.1 Compressive strength:-

This test is performed on hardened concrete. This test is conducted by casting the cube which is of 150 mm in size, a total number of 45 cubes were casted and cured. These cubes is tested in UTM at a curing period of 7, 14 and 28 days and average value of 3 cubes is noted and the test result is described below:

Fig.4 shows the testing of concrete cube for compressive test.

Table 6. Showing the test result of compressive strength.

Replacement/ curing period	7 days	14 days	28 days
0%	39.31	49.01	63.31
15%	41.89	49.49	63.34
20%	42.12	51.24	64.22
25%	41.28	50.32	61.78
30%	40.41	50.09	60.34



Graph.2 shows the variation of compressive strength test at 7, 14 and 28 days curing

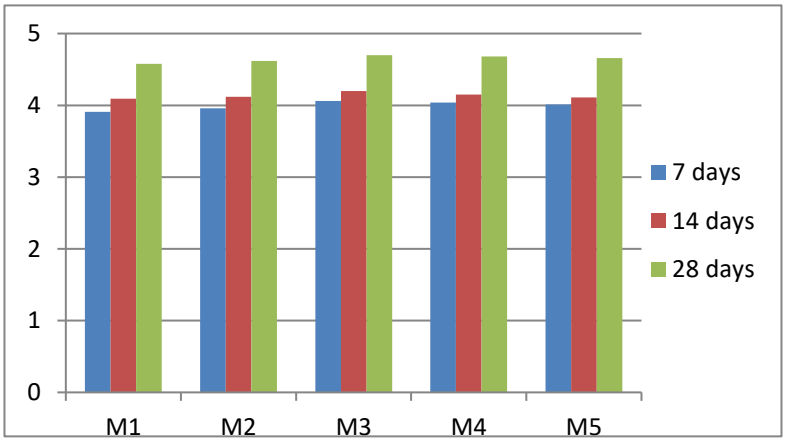
5.2.2 Split tensile strength:-

This test is performed by casting cylinders which is of 150 mm in diameter and 300 mm in depth. These cylinders are prepared with a different percentage of replacement with over burnt brick like 0, 15, 20, 25 and 30 percent with a fixed 2 percent of steel fibres. These cylinders are tested at a curing period of 7, 14 and 28 days. The test is performed by laying the cylinder in a horizontal direction in UTM machine. The readings are noted when the cylinder are split into two pieces.

Fig.5 shows the testing of concrete cylinder for tensile strength test.

Table 7. Showing the result value of tensile strength.

Replacement/ curing period	7 days	14 days	28 days
0%	3.91	4.09	4.58
15%	3.96	4.12	4.62
20%	4.06	4.20	4.70
25%	4.04	4.15	4.68
30%	4.01	4.11	4.66



Graph.3 shows the variation of tensile strength of concrete at 7, 14 and 28 days curing

5.2.3 Flexural strength test:-

This test is performed by casting a concrete prism of size 10 cm x 10 cm x 50 cm and it is cured for 7, 14 and 28 days with a different variation of coarse aggregate replacement, after the curing period the prism is placed on two point load in flexural testing machine. The steel fibres are added to increase durability of concrete by reducing the cracks at the tension zone. The prism is rest over two supports the load is applied on the prism till the prism is cracked and no longer for taking the load. The shorter length from crack to support was measured and an average reading is noted, a total 45 number of prisms are casted, the test readings are listed below,

Fig.6 shows the testing of concrete prism.

Table 8. Showing the result value of flexural strength test.

Replacement/ curing period	7 days	14 days	28 days
0%	4.96	5.41	5.67
15%	5.29	5.55	5.79
20%	5.38	5.62	5.85
25%	5.33	5.59	5.77
30%	5.03	5.57	5.74

Graph.4 shows the variation of flexural strength test at 7, 14 and 28 days curing.

6. CONCLUSION: -

1) The compressive strength of concrete at fixed 2% of Steel fibres with 0, 15, 20, 25 and 30% replacement with over burnt brick are 63.31, 63.34, 64.22, 61.78 and 60.34 respectively at 28 days of curing period.
2) The split tensile strength of concrete at 2% of Steel fibres with different proportion of 0, 15, 20, 25 and 30% are 4.58, 4.62, 4.7, 4.68 and 4.66 respectively at 28 days of curing.
3) The flexural strength of concrete with same mixed concrete at 15, 20, 25 and 30% replacement are 5.67, 5.79, 5.85, 5.77 and 5.74 respectively

at 28 days curing period.

4) With the use of 2% fixed Steel fibres and 20% replacement of coarse aggregate with over burnt brick, the compressive strength is enhanced at 20% replacement at 7, 14 and 28 days curing period, beyond 20% replacement the compressive strength decreases. The percentage increases in compressive strength is 7.14,4.55 and 1.43 respectively.

5) The test result of split tensile strength at 20% replacement with over burn brick are near to target strength beyond which the values are decreases at 7, 14 and 28 days curing period, the percentage increase in split tensile strength at different curing period are 3.83, 2.69 and 2.63.

6) The flexural strength of concrete at 20% replacement is increases at various curing period, the percentage increase in flexural strength at different curing period is 8.4, 3.90 and 3.17 respectively.

7) The utilization of waste and non degradable waste material like over burnt Brick in construction is useful in developing an eco-friendly concrete by reducing and depleting of natural resources and other advantage is reduction in cost of construction.

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