Scientific Journal of Impact Factor (SJIF): 4.14

e-ISSN : 2348-4470
p-ISSN : 2348-6406

International Journal of Advance Engineering and Research Development

Volume3 ,Issue ,30 March -2017

PARTIAL REPLACEMENT OF SAND BY STEEL SLAG IN TILES

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Abstract — In this project we are making cement mortar tiles. The specialty of these tiles are instead of sand we are using steel slag partially for making. The mixed ratio is 1:3 and the size of the tiles are 300x300x20 mm. The main advantage of the replacement is the increase of compressive strength and reduce in self-weight. Colour pigments are used for different types of colours. Use of steel slag lead to reduce the level of water absorption upto10%.

Keywords- *White cement, Fine aggregate, Steel slag, Pigments.*

1. INTRODUCTION

The utilization of industrial waste or secondary materials has encouraged the production of fine aggregate and cement concrete flooring tiles in construction field. New by-products and waste materials are being generated by various industries. Dumping or disposals of waste materials are causes environmental and health problems. Therefore, recycling of waste materials is a great potential in cement concrete flooring tiles industry.

For many years, by-products such as fly ash, silica fume and slag were considered as waste materials. Over recent decades, intensive research studies have been carried out to explore all possible reuse methods. Construction waste, blast furnace, steel slag and copper slag's are has been accepted many places as alternative aggregates in embankment, roads, pavements, foundation and building constructions.

FLOORING TILES

The paving stones are made by using fly ash and cement aggregates at very high pressure to give a hard faced, strong and durable stone like product with or without beveled edges. These stones do not require a sole concrete and needs just a consolidated sand bed for the support. No boding or pointing is necessary and does not require any cement. Paving stones offer the advantage of removing from position and replacing whenever needed for laying any pipelines etc. and hence eliminates any maintenance expenditure on the flooring. These stones can withstand the weight of a loaded truck and will last for a long time. They are comparatively cheaper compared to concrete and other tiles.

Fig.1 White cement

Fig.2 Sand

Fig.3 Steel slag

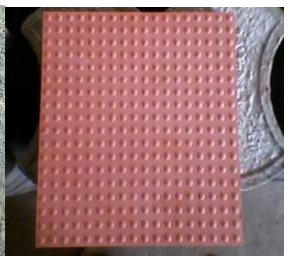

Fig.4 cement concrete tile

2. MATERIAL SELECTION

2.1 **WHITECEMENT:**

White Cement is a binding material. White Cement used in the manufacture of tiles shall be White Portland cement conforming to IS 269. White Portland cement, as the name indicates, is a kind of cement with white color. It is the same as ordinary gray Portland cement except in respect to color and fineness.

2.2 AGGREGATES:

Aggregates used in the backing layer of tiles shall conform to the requirements of IS 383. For the wearing layer, unless other specified, aggregates shall consist of marble chips or any other natural stone chips of similar characteristics and hardness, marble powder or dolomite powder, or a mixture of the two.

2.3 PIGMENTS:

Pigments, synthetic or otherwise, used for coloring tiles shall have durable color.

Table 1 PIGMENTS

Pigments	ref to IS No.
Black or red pigment	IS 44
Green pigments	IS 54
Blue pigments	IS 55 or IS 56
White pigments	IS 411
Yellow pigments	IS 50 (part 1)

2.4 STEEL SLAG:

Global warming and environmental destruction have become manifest problems in recent years, heightening concern about global environmental issues, and a change over from the mass-production, mass-consumption, mass-waste society of the past to a zero-emission society is now viewed as important. The iron and steel industry produces extremely large amounts of slag as by product of the iron making and steelmaking processes, and is therefore continuing to develop slag reduction and recycling technologies and intermediate treatment technologies.

Table 2 PHYSICAL PROPERTIES OF STEEL SLAG

Properties	Percentage
Water absorption	1.9
Crushing strength	29.3
Impact value	29
Abrasion value	28

Table 3 CHEMICAL COMPOSITION OF STEEL SLAG

Constituent	Composition in %
CaO	Nil
SiO_2	11
FeO	76
MnO	5
MgO	Nil
Al_2O_3	1
P_2O_5	Nil
S	Nil
Metallic Fe	6

DIMENSIONS

The size of cement concrete flooring tiles shall be 200x200x15mm, 250x250x16mm, 300x300x20mm, and 400x400x25mm. Half rectangular tiles in shape shall also be available, half tiles for use with full tiles in the floor shall be such as to make two half tiles when joined together match with the dimensions of the one full tile.

OBJECTIVES

Main objectives are listed in bellow:

- To study the effect of plastic waste, steel slag and copper slag in cement mortar and cement concrete flooring tiles.
- By conducting various tests for steel slag tiles obtain the test result and compare the test result with conventional one.
- To reduce the self-weight of the cement concrete flooring tiles by industrial wastes.

SCOPE OF WORK

Some scopes of works are listed in below:

- To utilize the industrial waste in useful manner.
- To reduce the environmental pollution.
- To introduce alternative material for natural fine aggregate.
- To introduce cost effective cement concrete flooring tiles

3. RESULTS & DISCUSSIONS

3.1 WHITE CEMENT

a) Specific gravity of cement: The standard value of specific gravity of WPC was 3.15 and the value is within the permissible value.

b) Fineness of cement: The test results of fineness of White cement obtained was less than 10%.

c) Standard consistency test: The results obtained for standard consistency of White cement was 0.29.

d) Setting time: The results obtained for the initial setting time of White cement was observed as 30 minutes. The final setting time was observed after 10 hours.

3.2 SAND

a) Specific gravity: The specific gravity obtained for fine aggregate is 2.69 also within the permissible value (2.6 to 2.80).

b) Fineness modulus: The fineness modulus of fine aggregate (river sand) is 3.358.

c) Water absorption test: Water absorption test result of fine aggregate is 0.63% is higher than copper slag.

3.3 STEEL SLAG

a) Specific gravity: The specific gravity is obtained for steel slag is 2.63. It is lesser than river sand.

b) Water absorption test: Water absorption test result of steel slag is 0.33% is lower than sand and other fine aggregate.

c) Sieve analysis: The fineness modulus of steel slag is 4.322.

TESTS ON HARDENED CEMENT CONCRETE TILES

The tests on tiles shall not be carried out earlier than 28 days from the data of manufacture.

Table 4 SURFACE HARDNESS TEST

S.No	Sample 1	Sample 2
1.	20	20
2.	18	18
3.	16	18
4.	14	18
5.	20	12
6.	20	12
7.	18	20
8.	14	14
9.	12	22
(Average hardness value)	**16.8**	**17.1**

Table 5 FLATNESS OF TILE SURFACE

Specimens	Results
Conventional tiles	0mm
SS10%+Sand90%	0mm
SS20%+Sand80%	0mm
SS30%+Sand70%	0mm

Table 6 PERPENDICULARITY TEST

Specimens	Perpendicularity results
Conventional tiles	4mm
SS10%+Sand90%	3mm
SS20%+Sand80%	4mm
SS30%+Sand70%	3mm

Table 7 WET TRAVERSE TEST

Wet condition				Dry condition	
S.No	% of steel slag mixed	Breaking load in kg	Flexural strength in N/mm^2	Breaking load in kg	Flexural strength in N/mm^2
1.	Normal	14.08	3.36	15.21	3.55
2.	10	14.57	3.57	15.29	3.83
3.	20	14.70	3.68	15.41	4.26
4.	30	14.84	3.83	15.58	4.18

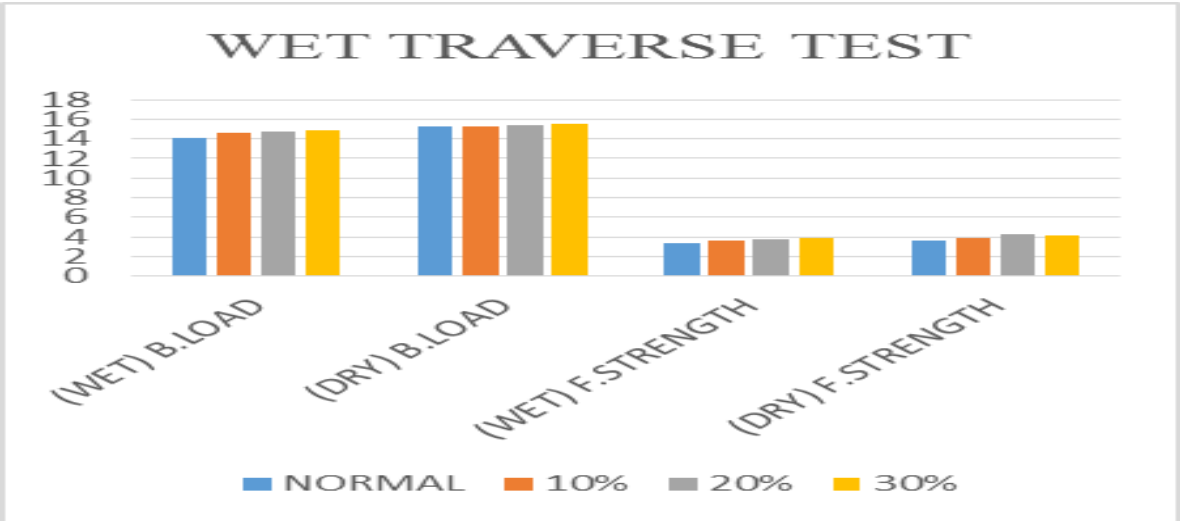

Fig.5 wet traverse test result

Table 8 WATER ABSORPTION TEST

S.No	% of steel slag mixed	Dry weight of paving tiles in g	Wet weight of paving tiles in g	Water absorption in percentage
1.	Normal	4650	4920	6.81
2.	10	4560	4910	7.63
3.	20	4550	4900	7.69
4.	30	4520	4870	7.74
Average water absorption of paving tile is 7.15%				

4. CONCLUSION

The usage of steel slag are alternative fine aggregates in cement concrete flooring tiles. This besides being a solution for reducing environmental pollution and helps in developing characteristics properties of cement concrete flooring tiles. Performance increase and cost reduction. Thus, it can be conclude that the replacement of sand with steel is possible and attaining the strength and also the flexural strength.

Use steel slag in cement concrete flooring tile is possible to manufacture and it was very cheap and gives good results. This study points out the beneficial aspects of using industrial waste as a best replacement material of fine aggregate in tile manufacture.

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