

**EXPERIMENTAL INVESTIGATION ON TILES
USING
AGRO - INDUSTRIAL WASTES**

Submitted in partial fulfillment of the requirements for
the award of Bachelor of Technology degree in Civil
Engineering

By

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

MARCH – 2021



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **RISHI KUMAR R (37200060)** and **VENGADANATHAN SANKAR S (37200075)** who carried out the project entitled "Experimental Investigation on Tiles using Agro - industrial Wastes" under our supervision from October 2020 to March 2021.

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DECLARATION

We **RISHI KUMAR R (Reg.No.37200060)** and **VENGADANATHAN SANKAR S (Reg.No.37200075)** hereby declare that the Project Report entitled “ Experimental Investigation on Tiles using Agro - industrial Wastes ” done by us under the guidance of Mrs Priyadarshini., at Sathyabama institute of science and technology, Jeppiar nagar, Rajiv Gandhi Salai, Chennai-600119 is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Civil Engineering.

1.

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ABSTRACT

Tiles are primarily intended to provide more durable, impact-resistant surfaces; they are traditionally made from available materials such as stones / slate, clay and concrete. Another very important requirement is to replace standard and common impoverished class concrete tiles with even more reliable alternate concrete tiles. And effective and adequate recycling of industrial waste and agricultural wastes are a key factor in waste disposal in the majority of the world.

Having both the issues in a single line, during this project we've prepare the Experimental Investigation on Tiles using Agro - industrial Wastes on concrete tiles using industrial waste and agricultural wastes as staple, It is proposed that we will efficiently replace a significant amount of M sand and cement in the production of concrete tiles. Our 1st replacement material is copper slag, something that we chose because aggregates are in high demand, particularly in civil engineering and concrete construction. Instead of using aggregate in the concrete construction some of the waste by-products can be used, which is of industrial wastes. Where it is suggested that copper slag can efficiently replace fine aggregate on (up to 10%, 15% and 20%). concrete tiles as partial replacement, According to some research, using copper slag as a partial replacement for fine aggregate improves the strength characteristics of materials. Another replacement material is rice husk ash. The rice husk ash had been produced by open air burning the rice husk, and we discovered that it has characteristics comparable to cement, so we considered rice husk ash as a cement substitution (up to 3% , 4% and 5%)for the cement in the concrete tiles. By replacing the M sand by copper slag and Cement by rice husk ash (rha) in making of Concrete tiles and roofing tiles would scale back its manufacturing cost also as asking price and makes it cheaper. Thus preparation of such replaced concrete tiles will significantly reflect economic benefits and healthy environment.

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LIST OF ABBREVIATIONS

RHA	rice husk ash
SiO ₂	silicon dioxide
Al ₂ O ₃	aluminium oxide
Fe ₂ O ₃	ferric oxide
CaO	calcium oxide
MgO	magnesium oxide
Na ₂ O	sodium oxide
K ₂ O	potassium oxide
P ₂ O ₅	phosphorous oxide
TiO ₂	titanium oxide
Cl	chloride

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Tiles are known for the versatile building materials as they are used every building constructions. They will be used mostly for the flooring, for decoration, protection, and some less common applications in addition to walls and flooring. Because they're not heavy and straightforward to put in, any person can effort with tile for a good variety of home developments. Tiles are the most affordable flooring options, particularly when comparing to popular material like as marble. Tiles can endure weighty utilize in all the rooms of the building. Better of all, it is simple to put in-you don't require a large amount knowledge to get the floor tile on your own. Concrete tile is commonly used almost anywhere, both indoors and outdoors, including floors, walls, surrounds, and building roofs. Concrete tile sizes, finishes, and colours are frequently customised for any requirements. Concrete is justly tough substance. despite the fact that it's generally use for viable purpose to face up to wear as well as tear improved than any hardwoods along with ceramics, tiles manufactured as of concrete will be customizable as of a design feature with have establish their position in built-up homes designed for hundreds of years. Tiles are primarily intended to provide more durable, impact-resistant surfaces, Tiles are made from the raw materials like stone / slate, clay and concrete. Another very important requirement is to replace standard and common impoverished class concrete tiles with even more reliable alternate concrete tiles. And effective and adequate recycling of industrial waste and agricultural wastes are a key factor in waste disposal in the majority of the world. Concrete tiles are more sturdy than regular and hardwoods, and it surpasses ceramic tiles as well, making it an excellent choice not only for businesses and large public spaces, but instead as a material used in new or remodeled homes. Concrete tiles were also made from natural materials, and high-quality tiles incorporate natural pigments into their trends. Natural colors do not disappear over time the way that non-mineral based colors do, and even though some of the world's oldest encaustic

tiles still look exceptionally vibrant. For speeding up the process hydraulic press is used at some factories few times for making the concrete tile.

Concrete tiles can take lots of wear and tears, it makes good for high traffic areas , As long as the tiles are installed properly, you won't have to worry about stains or scratches because their surface is extremely hardwearing. Such tiles outlast several other kinds of tiles, such as ceramic tiles. A cement tile floor will look just as nice. And one of its thermal properties , where Thermal mass in the concrete tiles has been high, which means they retain heat well. Implementing a concrete tile floor can help keep your home cool and comfortable and warm during the winter, lowering your air conditioning and heating costs in the summer and winter. Concrete tile servicing requirements vary based on the application and whether the tiles are being used on an exterior or interior surface. Concrete tiles used as interior wall , where it will require less maintenance, whereas when it is used in the exterior surface like a roof or on a floor or countertop, On the exterior surface, it will require more maintainance like cleaning and resealing

1.2 COPPER SLAG

Copper slag is obtained by extraction of copper via smelting process. impurity are converted into slag during the smelting process, that further floats upon this molten material. Slag sated in water generates angular granules, that are either discarded or used. Copper slag is mostly use meant for surface blast clean-up in most of the areas. Abrasive blasting is the one of the method used to scrub and form of the face of metal, stone, concrete as well as further materials. The flow of abrasive grains known as grit is catapulted toward the workpiece material during this procedure. Copper slag is just one of several materials that can be used to make abrasive grit. Rate of the grit consumption, dust generated amount, and surface finishing quality are a number of the variables suffering from the selection as a grit material. Copper slag are often utilized in concrete making as a limited substitution for sand. Copper slag is employed as a artifact, shaped into blocks. So in our experiment we used it rather than sand. Copper slag is fundamentally ferrous silicate, together with $2\text{FeO}\cdot\text{SiO}_2$, $\text{MgO}\cdot\text{SiO}_2$, as well as magnetite. Possessing similar properties as compared to the m sand, So we considered it as suitable replacement materials.

1.3 RICE HUSK ASH

Rice husks are covered with strong or hard layer for the protection coating for the grains which is separated in the milling. Rice husk is a solid waste that is abundant in all rice-producing nations and includes between 30 and 50 percent organic carbon. During a standard milling process, the husks are excluded from the raw grain to reveal all its brown rice, In the case of brown rice, this is done in the subsequent milling process to remove the bran layer, yielding white rice. The country's major rice production is estimated to be approximately 70 crore tonnes. Rice husk financial statement for approximately 20% of the mass and composition of rice. Rice husk ash was formed by the combustion of agricultural waste rice husk. As a result, we used it instead of cement in our experiment.

CHAPTER 2

LITRATURE REVIEW

2.1 GENERAL

Concrete tile is made up of water, coarse aggregate, fine aggregate and fillers so as to fill the gap between the aggregate particle and binds them around each other. Concrete is commonly used in construction of architectural structural, foundations, roads, bridges, highways, parking structures, barrier and even tiles. The primary goal of a literature review is to provide information about the research study and techniques which can be used to conduct additional experiments. The following literature review expands on the review of studies conducted on replacing cement with rice husk ash (rha) and sand with copper slag in concrete tiles.

2.2 REVIEW OF LITRATURE

Al Jabri et al (2005) analyzed the mix of 5 percent cement with past soot + 95 percent cement, it produced the main of 6-month compressive strength point of 42 MPa, compared to 40MPa in support of the medium contain 1.5 percent cement by-product soot plus 13.5 percent copper slag plus 85percent cement According to them, the best copper slag as well as cement by-product powder to use was 5 percent. Furthermore, it be discovered so as to the percentage of cement by-product dust worn was 5 percent. That was calculated that the use of cement by-product dust as a triggering material would be more effective than by means of lime.

Al Jabri et al (2009) It was discovered that increasing the copper slag percentage resulted in a small raise in HPC density of approximately 5 percent, whereas increasing the copper slag proportion resulted in a steady rise in workability. The adding up of close to 50 percent copper slag as a substitution of sand produced similar strength to the control mix up. though, subsequent accompaniments of copper slag resulted in a decrease in strength leading to an increase in the free

moisture content of the mix. Mixtures with 80 percent as well as 100 percent copper slag substitution had the lowest compressive strength of around 80MPa, that was nearly 16 percent less than the strength of the mixing control. The findings also suggest that surface water uptake reduced as the amount of copper slag increased up to 40percent substitution; well beyond replacement level, the absorption rate quickly enhanced.

Khazadi et al. (2009 , When a limestone which is a coarse aggregate was substituted by copper slag that coarse aggregate in elevated strength concrete, an increase in compressive strength of concerning 10 to 15 percent as well as an increase in splitting tensile strength is upto 10 to 18 percent was observed.

Brindha et al. (2010) done a substitution experiment on sand by copper slag, with following percentage , which was 5 percent to 50 perecent, gradually increasing 5 percent upto 50 percent. The compressive strength was higher by 35 to 40 percent and the split tensile strength boosted by 30 to 35 percent as a outcome. This investigation shows the replacement can be done 40% with sand by copper slag. The strength be reported to higher up to 40 percent sand substitution among copper slag, subsequent to which it was establish to be in decreasing.

MR Amarnaath et al. (2015) they cover checked as well as investigated the outcome of copperscum with exchanging it with fine aggregates, as well as that characteristics of materials. They organised five mix design elements for the study, each with a various extent of copperscum ranging from 0 percent to 35 percent and 100 percent. The density tensile force, compressive force, and stability of the concrete mixture substance were all measured. The outcome shows the 5 percent increase in concrete density by means of the add of copperscum material, even as the workability improve rapidly with an increase in copper scum percentage. Calculation of up to 35 percent copper scum as sand exchange has an same strength to the mix proportion. So, it is mentioned so as to 40 wt % of copperscum which know how to be used with exchange of the sand for that to discover out concrete with good strength as well as sturdiness properties.

Sudarvizhi et al. (2011) proposed that copper slag as well as ferrous slag could be used as partial substitute up to 80% of the time. It also mentioned that replacing sand entirely with copper slag and ferrous slag.

Junwei Song (2014) have researched copper slag at ease micro pozzolanic source in the sturdy. The filling effect, action outcome, and rate hike impact of copper slag powder in mixed cementitious materials are all part of the process. Workability of copperslag obtainable concrete is average, except calculation the appropriate amount of micro aggregates be able to get enhanced their workability noticeably. The filling result of copper slag be able to put up medium denser and hydration can speed up the procedure. Experiments and research that conducted to determine the effect of copper slag upon this strength as well as brittleness with concrete. The brittleness of concrete can be reduced by adding together copper slag, and the system is studied.

Najimi et al. (2011), the effective implementation of copper slag substitute in enhancing concrete resistance to sulphate attack by 5%, 10%, and 15% of sand resulted in 57.4 percent, 63.4 percent, and 64.7 percent lower growth than concrete without copper slag.

Arivalagan et al. (2013) has analysed that the flexural strength of the beam increased by 21% - 51% with copper slag substitution. Another conclusion was that with copper slag as a temporary substitute for sand doubled strength by up to 40percent. Because copper slag has a lower water holding capacity, higher tier replacement resulted in isolation as well as bleeding. It was discovered that the energy absorption capacity of the sand substituted by copper slag beams increased.

J RameshKumar et al. (2015) In their study which was about copper slag , which was partially or temporary subsistituted with the sand which is fine aggregate and that they are effect of fly ash as the temporary substituted that of cement on the actions that of concrete. Density of 6 percent with the rise of copper slag proportion which is slightly augment content , That of workability in copper slag proportion. calculation of up to 50 percent of copperslag that sand exchange

yielded comparable strength by means that of the conventional mixture. More mixing of copper slag creates lowering in the strength it is due to of more moisture substance in the mixture

M. Safiuddin, J.S. West, K.A. Soudki (2010) mentioned that such an increase in compressive strength of 6.9 percent at seven days and 6.8 percent at 28 days was achieved with a rise in RHA containment of close to 25 percent, but the numbers are going to be contrasted by more percentage replacement The same pattern was observed for tensile strength, which very increased up to 6.8 percent RHA and then begins to decrease. In terms of compressive strength as well as chloride permeation properties, common procedure of 28 days curing has been considered sufficient. Increase the number of replacements that can be cured to 90. The very same trend was observed for the tensile strength, which increased up to 6.8 percent RHA and was found to be useful only in terms of improving susceptible to water absorption.

K. Kartini, (2012) investigated the Impacts of Silica in Rice Husk (RHA) throughout the Production of High Strength Concrete, One of the factors that influence the quantity of silica added is the quality of rice husk ash through concrete. Because rice husk ash contains 85 to 95 percent weight percent amorphous silica. As a pozzolanic reactive material, rice husk ash could be used to increase the surface area of the passing zone among the microscopic structure of aggregate.

Saraswathy et al., (2007) The corrosion workability of concrete produced with 0,5,10,15,20,25, as well as 30percent RHA as a substitute for cement was investigated. They supervised the open circuit potential readings with relation to a saturated calomel electrode on a regular basis according to ASTM C876, and with there study revealed that the moment of cracking was forty two , seventy two, and seventy four hours for concrete made with 0, 5, and 10percentage RHA, respectively, Even after onserving for 144 hours, there was no cracking in concrete with 15, 20, 25, and 30 percentage RHA.

Salas et al., (2009) explained that decreasing pore size as well as permeability could be accomplished by lowering the cement mix's average pore diameter. RHA can be added to cement paste to decrease pore diameter, which not only reduces permeability but also pore size but also reduces the penetrability of chloride ions in the concrete mix, increasing the concrete durability.

PrasannaVenkatesanRamani et al, in (2015) he stated that RHA can be used as a origin material in Geopolymer concrete in addition with ground granulated blast furnace slag (GGBS). They also discovered that adding more than 10percent RHA had a negative impact on compressive strength. At up to 20percent replacement, the goal strength was exceeded, and compressive strength of up to 51 MPa was achieved after 28 days. The splited tensile and flexural strengths followed a similar pattern to the compressive strength in relation to the RHA proportion. The adding of Rice husk ash to Geopolymer concrete strengthens its chloride resistance. However, adding more than 20percent RHA to Geopolymer concrete is not advantageous. The samples with 30percent RHA replaced did not achieve significant strength or durability.

Harish kizhakkumodom venkatanarayanan at el.(2014) reported that at 360 days concrete containing RHA showed higher resistance than concrete without RHA. They also discovered that as the Water cement ratio increased, so did the opposition to sulphate attack for concrete without RHA, whereas the resistance of concrete to RHA was excellent.

Dao Van & Pham Duy (2006) presented several key RHA properties with high strength concrete RHAs come from two country, From India and Vietnam. The India RHA was far better compared to the Vietnam RHA. The acceptable material is 10percent to replace cement with such a resulting decrease in strength properties. The result was that Rice husk is an more of a waste generated from agriculture area at Vietnam. Superior production of RHA is necessary in the Vietnam.

Harunur & Keramat (2012) Its strength and durability of mortar with various replacement levels (0 percent, 10 percent, 15 percent, 20 percent, 25 percent, and 30 percent) of Ordinary Portland Cement (OPC) by RHA are investigated. RHA was created as a result of an unmanaged burning process. Except for the 25% and 30% replacement levels, all samples passed the 20-cycle test. The paper concludes that the mortar usually contains rice husk ash is much more sturdy than OPC mortar has replacement upto 20 percentage.

CHAPTER 3

AIM AND SCOPE

3.1 AIM OF THE STUDY

To Identify the Cost effective design for the concrete tile with partial substitution of M- sand by copper slag as well as cement by rice husk ash.

3.2 OBJECTIVE OF THE STUDY

- To determine the properties of the Replacement Material (Rice husk Ash) and (Copper Slag).
- To compare the strength of Conventional and Replacement Tiles.
- To derive the cost of the Replacement Material.

3.3 SCOPE OF THE STUDY

The scope of project is,

- To control industrial solid waste.
- To utilize agricultural solid waste.
- To reduce the manufacturing cost of conventional tile by replacing low cost materials.

CHAPTER 4

METHODOLOGY

4.1 METHODOLOGY

The methodology of our project is been displayed in the below flow chart 4.1 repectively. There are various steps involved in this study. Firstly, we need to collect the materials required for the experiment and then we have to determine its properties by testing and studying the following materials used like cement, m sand, course aggregate, copper slag, and rice husk ash (rha). And then their physical properties includes like particle shape, its appearance, its type, specific gravity, bulk density, fineness modulus, water absorption. For the materials copper slag and m sand. And their chemical properties include Silicon dioxide which is (SiO_2), Aluminium Oxide which is (Al_2O_3), Ferric Oxide which is (Fe_2O_3), Calcium Oxide which is (CaO), Magnesium Oxide which is (MgO), Sodium Oxide which is (Na_2O), Postassium Oxide which is (K_2O), Phosphorous Oxide which is (P_2O_5), Titanium Oxide which is (TiO_2) and Chloride which is (Cl) for the materials like cement and rice husk ash (rha). According to the materials properties, we have to prepare its mix design according for the concrete tile. where the mix ratio includes 1 : 1.5 : 3 , we adopted m20 grade concrete for our concrete tile. Where we ratio of 1 cement, ratio of 1.5 sand and 3 aggregate mix for the tile. After the mix design we would cast the specimen in the respective mould. We used 254 * 254 mm and thickness of 12 mm. this size of tile is used for roofing, parking and other building areas. After the specimen casting we need to wait for the full setting of the concrete for 24 hours. After the concrete is done setting, we did the curing part for another 24 hours, we can do curing much longer it can increase the strength of the concrete, but our curing tile will be sufficient to take many of the live load according to the studies. This procedure takes about 2 days for making a fully usable concrete tile. But major tile company were using a chemical named (polycarboxylate ether base) by skipping its curing time , making tiles in a single day. But in our project we didn't used any chemicals, we designed it according to the IS standards. We

elaborated the following use of the materials in tabular column in later materials properties. For this methodology we referred many great journals, and also enquired many tiles company for gaining more knowledge about our work.

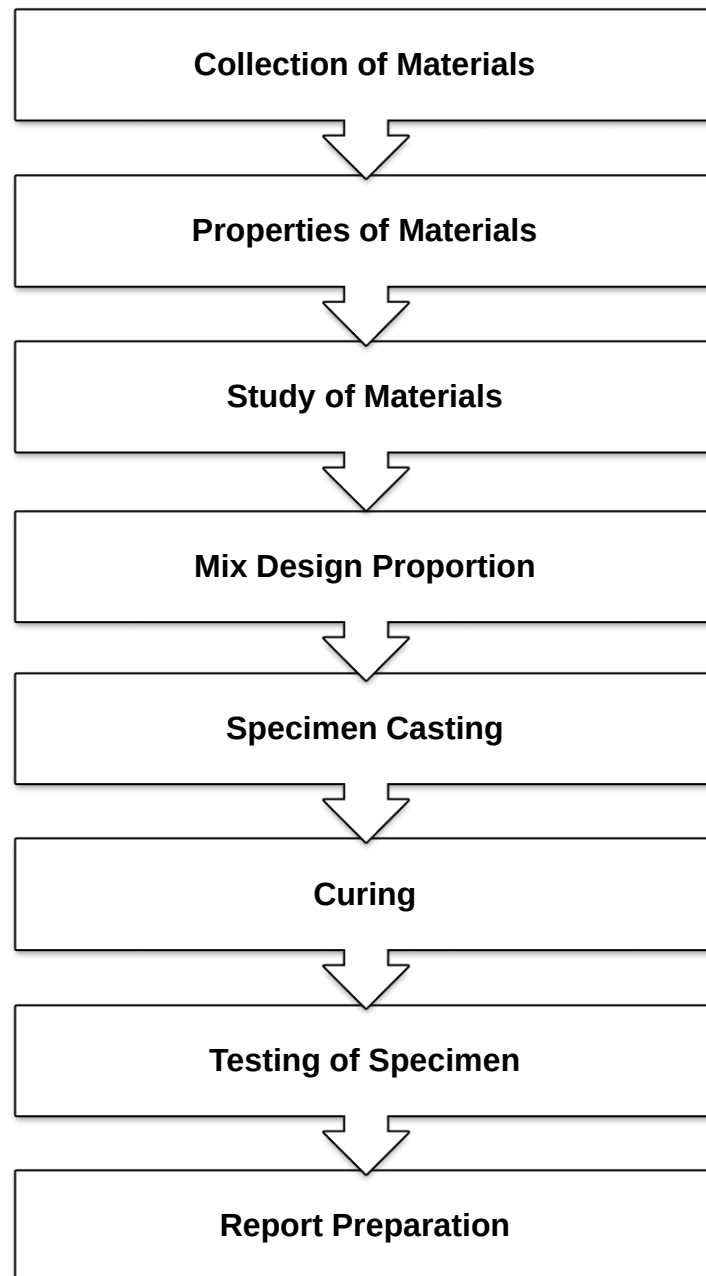


Fig: 4.1: Flow chart

4.2 MATERIALS AND PROPERTIES

The materials which we used were cement, m sand, coarse aggregate, copper slag, and rice husk ash (RHA). Where we replaced cement by rice husk ash (RHA) and m sand by the copper slag, these two specific materials was replaced because of the resembling similar properties. We included our studies and determined materials uses and its properties, which includes its physical as well as its chemical properties. All the information of the materials was taken from popular journal and test research. They all are elaborated and shown in the following tables for the each respective material including our core material and our replacement materials.

4.2.1 CEMENT

Ordinary Portland Cement OPC which is grade 43 be used for the investigation. The cement has been accessible in the Chengalpattu hardware store and was preserved in a dry environment. In which OPC 43 cement must comply with Indian Standards, as well as the calculated strength after 28 days must be at least 43 MPa or else 430 kg/sqcm. Despite the fact that the early strength of 43 Grade cements is lower than that of 53 Grade cements, physical properties were mentioned in the below table 4.1 and chemical properties in 4.2.

Table: 4.1: Physical properties of 43 grade cement

Sl. No	Characteristics	Required Value
1.	Fineness	More than 225 m ² /Kg
2.	Soundness	
	Le Chatelier method	Under 10 mm
	Autoclave test	Under 0.8%
3.	Setting time	
	Initial setting time in minutes	30
	Final setting time in minutes	600
4.	Compressive strength	
	72 +/- 1 hour (3 days)	27 MPa
	B] 168 +/- 2 hours (7 days)	37 MPa

Table: 4.2: Chemical properties of 43 grade cement

Sl. No	Characteristics	Required value
1	Loss on ignition %	Less than 4.0%
2	Magnesia %	Less than 6.0%
3	Insoluble residue %	Less than 4.0%
4	Sulphuric anhydride %	Less than 3.5%
5	Total chloride content %	Less than 0.10%
6	Net proportion of lime to Silica, Alumina and Iron oxide	0.66 – 1.02%
7	Net proportion of Alumina to Iron oxide	More than 0.66%

4.2.2 M SAND

M Sand is known as the manufactured sand it is also used to called crushed sand. It is used for replace the river sand meant for structure effort. It is produced via crushing stones, rocks or large aggregate particles keen on sand size element in a factory. The Crushed sand have a angular figure. The size of the m sand should be less than 4.75 mm. In table 4.3 further properties were shown.

Table: 4.3: Physical Properties of M Sand

Physical Properties	M Sand
Particle shape	uneven
Appearance	grey
Type	M Sand
Specific gravity	2.69
Bulk density g/cc	1.85
Fineness modulus	4.66
Water absorption %	1.96

Moisture content %	5.4
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4.2.3 COPPER SLAG

Copper slag is primarily composed of ferrous silicates such as $2\text{FeO} \cdot \text{SiO}_2$, $\text{MgO} \cdot \text{SiO}_2$, as well as magnetite. Copper slag images are shown in Fig. 4.2. Because copper slag does have the specific gravity index of 4.12 along with a bulk density of 2.31 g/cc, that is elevated than the net river sand (2.6, 1.53 g/cc), this could lead to the production of greater density concrete. Furthermore, the calculated water absorption percent for copper slag was of 0.40 percent, compared to 0.83 percent for sand. Table 4.4 displays the properties of copper slag.



Fig: 4.2: Copper Slag

Table: 4.4: Physical Properties of Copper Slag

Physical Properties	Copper slag
Particle shape	uneven
Appearance	Black
Type	Air cooled

Specific gravity	3.6
Bulk density g/cc	1.9
Fineness modulus	3.47
Water absorption %	1.84
Moisture content %	2.51

4.2.4 RICE HUSK ASH (RHA)

Rice husk ash is known as the Better or Superior to other materials such as silica fume, slag and fly ash. Because it has high pozzolanic activity, which is the similar properties of the cement, where both strength and durability of concrete are to be improved. The Rice husk ash was produced by burning the raw agricultural waste, rice husk. Fig 4.3 shows the images of copper slag and table 4.5 and 4.6 shows its properties.



Fig: 4.3: Rice husk ash (rha)

Table: 4.5: Physical Properties of Rice husk ash

Sr. no	Property	Result
1	Specific Gravity	2.27

2	Particle Size (μm)	10
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Table: 4.6: Chemical Properties of Rice husk ash

Sr. No.	Constituents	Percentage Weight
1	SiliconDioxide (SiO_2)	95.12
2	Aluminium Oxide (Al_2O_3)	0.51
3	Ferric Oxide (Fe_2O_3)	0.38
4	Calcium Oxide (CaO)	0.61
5	Magnesium Oxide (MgO)	0.39
6	Sodium Oxide (Na_2O)	0.42
7	Postassium Oxide (K_2O)	0.98
8	Phosphorous Oxide (P_2O_5)	0.55
9	Titanium Oxide (TiO_2)	0.05
10	Chloride (Cl)	0.09

4.2.5 COARSE AGGREGATE

Coarse aggregates (Gravels) are basically a gained by blasting and crushing in stone quarries it was broken by the help of man power or by the crushers. There are two methods of crushed aggregate which is Machine crushed rocks which consist of rocks of a range of sizes consist of barely particular size stones. That make graded aggregates for best concrete, they were mixed again in the definite extent. River stones, crushed stone from rock quarries, and before used for the concrete are the example of the ground deposits. In our experiment we used chips aggregate. In fig 4.4 shows the image of the coarse aggregate which we used in our experiment.



Fig: 4.4: Coarse aggregate

4.3 MIX DESIGN

For our tile we used mould of the size of 254 * 254 mm and 12 mm thickness. And we adopted mix design of m20 grade for our concrete tile. Concrete mix up ratios are approved relative amount of cement, fine aggregate as well as coarse aggregate to urge the particular potency in concrete. The volumetric mix up proportion of M20 grade is 1:1.5:3, therefore 1 a part of cement, 1.5 a part of "a part of sand and three part of aggregate in volume is required to organize M20 grade concrete. We have replaced cement by rice husk ash and m sand by copper slag. Table 4.7 shows the compressive strength for m20 grade concrete. For the experiment we have prepared 3 different trials of replacement, to determine which mix design can archive better strength as well as workability of concrete tile, the rest of the mixing trials elaborated in table 4.8.

Table: 4.7: Concrete mix ratio

Concrete Grade	Mix Ratio (Cement : Sand : Aggregate)	Compressive Strength
M20	01:1.5:.3	20 N/mm ²

Table: 4.8: Mix designs for each trials

Mix	Rice husk ash (RHA)	Copper Slag	Cement	M-sand	Coarse Aggregate
Conventional tile	0%	0%	15%	25%	60%
Trial 1	3%	10%	12%	15%	60%
Trial 2	4%	15%	11%	10%	60%
Trial 3	5%	20%	10%	5%	60%

For our first trial we partially replaced cement with 3 % of rice husk ash and m sand by 10 % of copper slag, the weight of each material for the concrete tile was taken from calculation of mould volume, which is about 774192 mm³, trial 1 mix were shown in table 4.9.

Table: 4.9: Mix design of Trial 1

MIX (Trial 1)	MATERIALS	PERCENTAGE	WEIGHT (grams)
1	Rice Husk Ash	3 %	7
2	Copper Slag	10 %	35
3	Cement	12 %	200
4	M Sand	15 %	315
5	Coarse aggregate	60 %	780

For our Second trial we partially replaced cement with 4 % of rice husk ash and m sand by 15 % of copper slag, the weight of each material for the concrete tile was taken from calculation of mould volume, which is about 774192 mm³, trial 2 mix were shown in table 4.10.

Table: 4.10: Mix design of Trial 2

MIX (Trial 2)	MATERIALS	PERCENTAGE	WEIGHT (grams)
1	Rice Husk Ash	4 %	9
2	Copper Slag	15 %	52.5
3	Cement	11 %	198
4	M Sand	10 %	298
5	Coarse aggregate	60 %	780

For our third trial we partially replaced cement with 5 % of rice husk ash and m sand by 20 % of copper slag, the weight of each material for the concrete tile was taken from calculation of mould volume, which is about 774192 mm³, trial 3 mix were shown in table 4.11.

Table: 4.11: Mix design of Trial 3

MIX (Trial 3)	MATERIALS	PERCENTAGE	WEIGHT (grams)
1	Rice Husk Ash	5 %	11
2	Copper Slag	20 %	70
3	Cement	10 %	196
4	M Sand	5 %	280
5	Coarse aggregate	60 %	780

4.4 CASTING AND CURING

We used mould of the size of 254 * 254 mm and 12 mm thickness. Which is a PVC rubber mould. The fig 4.5 shows the images of a mould that we used for our experiment. According to the trials mix design, we casted 3 trials, In our first trial we partially replaced cement by 3 % of rice husk ash and m sand by 10 % of copper slag. In our second trial we partially replaced cement by 4 % of rice husk ash and m sand by 15 % of copper slag. And in our final trial we partially replaced cement with 5 % of rice husk ash and m sand by 20 % of copper slag. With the help of mix and required amount of water. The setting time of each tile is about 24 hours, and then we did the curing part for another 24 hours. In total it takes 2 days to make fully usable tiles. We casted 3 respective moulds each days. In total we casted 18 tiles in total with all three trials. Fig 4.6 shows the actual image of concrete filled mould.



Fig: 4.5: Mould used for Concrete Tile



Fig: 4.6: Concrete filled mould

CHAPTER 5

RESULT AND DISCUSSION

5.1 GENERAL

We casted all three trials of our tile, the images of the final trials of the tile were shown in fig 5.1, 5.2 and 5.3, According to IS 1237 for each test, 3 sample of tile is required, so we did following test in falcon laboratories Chennai which includes,

- Abrasion test
- Perpendicularity test
- Straightness test
- Water Absorption test

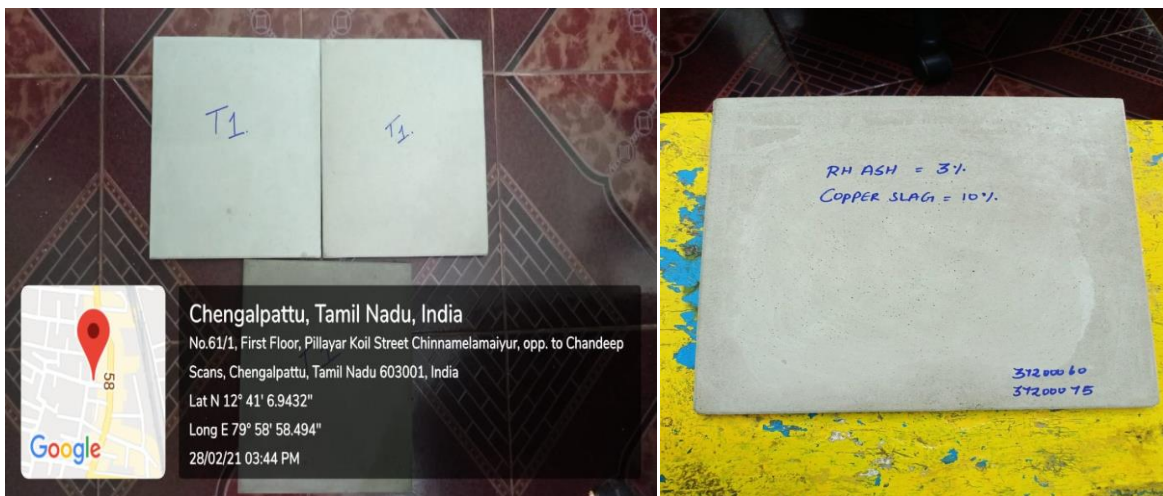


Fig: 5.1: Trial 1 tile (with 3% RHA, Copper Slag 10%)

Mix ratio we adopted for trial 1 tile is of 1:1.5:3, which contains materials and replacement materials such as RHA of 3% , Copper Slag of 10 % , M Sand of 15 % , Cement 12 % and coarse aggregate of 60%.

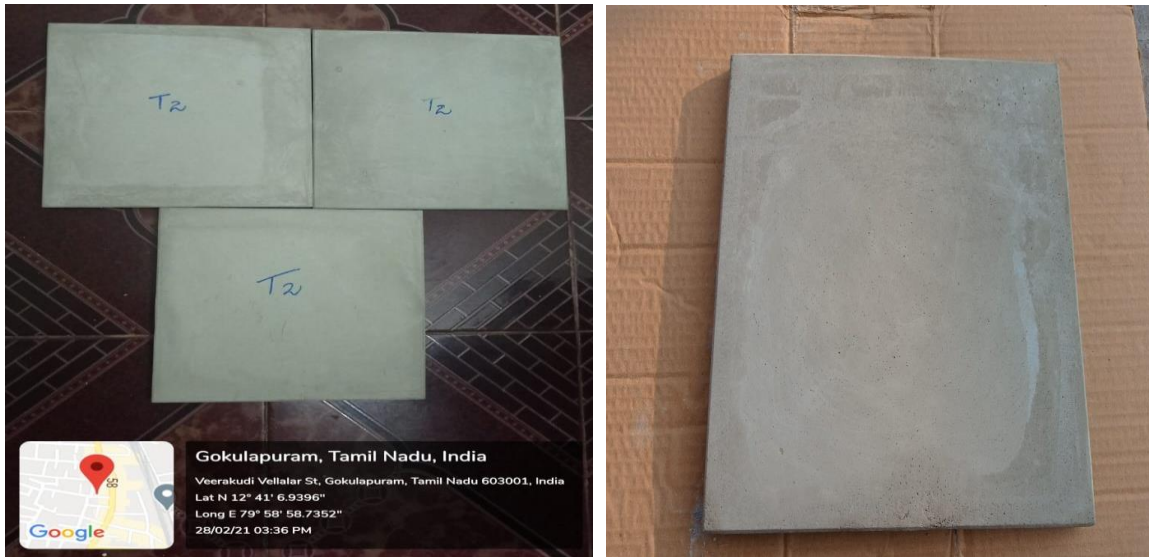


Fig: 5.2: Trial 2 Tile (with 4% RHA, Copper Slag 15%)

Mix ratio we adopted for trial 2 tile is 1:1.5:3, which contains materials and replacement materials such as RHA of 4% , Copper Slag of 15 % , M Sand of 10 % , Cement 11 % and coarse aggregate of 60%.



Fig: 5.3: Trial 2 Tile (with 5% RHA, Copper Slag 20%)

Mix ratio we adopted for trial 3 tile is 1:1.5:3, which contains materials and replacement materials such as RHA of 5%, Copper Slag of 20 % , M Sand of 5 % , Cement 10 % and coarse aggregate of 60%.

5.2 ABRASION

Abrasion testing machine is used to test the abrasive resistance of the solid materials which is abrasion test of the material. Materials we used were concrete that can be tested with these methods. The main objective of abrasion testing is to check resistance to scratching abrasion under a specified condition. For tile we have to put the sample in the abrasion machine and then with another sample we have it into a small cubic square and test it with the abrasion testing apparatus. In table 5.1, 5.2 and 5.3 shows the result of abrasion test for all three trials and fig 5.4 shows the image of abrasion done on concrete tile. Its results are shown in bar graph table 5.4.



Fig: 5.4: Abrasion test done on concrete tile

Table: 5.1: Results of Abrasion test for trial 1

Sr No	Description	Dimensions(in mm)	Abrasion Resistance(mm)
1	250*250mm	250.1 * 250.1	3.1

As per IS 1237:2012 , The wear on individual specimen should not exceed 4mm. for our first trial we got the value of 3.1mm, So it satisfies the required condition for the general purpose floor tiles.

Table: 5.2: Results of Abrasion test for trial 2

Sr No	Description	Dimensions(in mm)	Abrasion Resistance(mm3)
1	250*250mm	250.1 * 250.1	3.6

As per IS 1237:2012 , The wear on individual specimen should not exceed 4mm. for our Second trial we got the value of 3.6 mm, So it satisfies the required condition for the general purpose floor tiles.

Table: 5.3: Results of Abrasion test for trial 3

SI No	Description	Dimensions(in mm)	Abrasion Resistance(mm3)
1	250*250mm	250.1 * 250.1	3.1

As per IS 1237:2012 , The wear on individual specimen should not exceed 4mm. for our final trial we got the value of 3.1 mm, So it satisfies the required condition for the general purpose floor tiles.

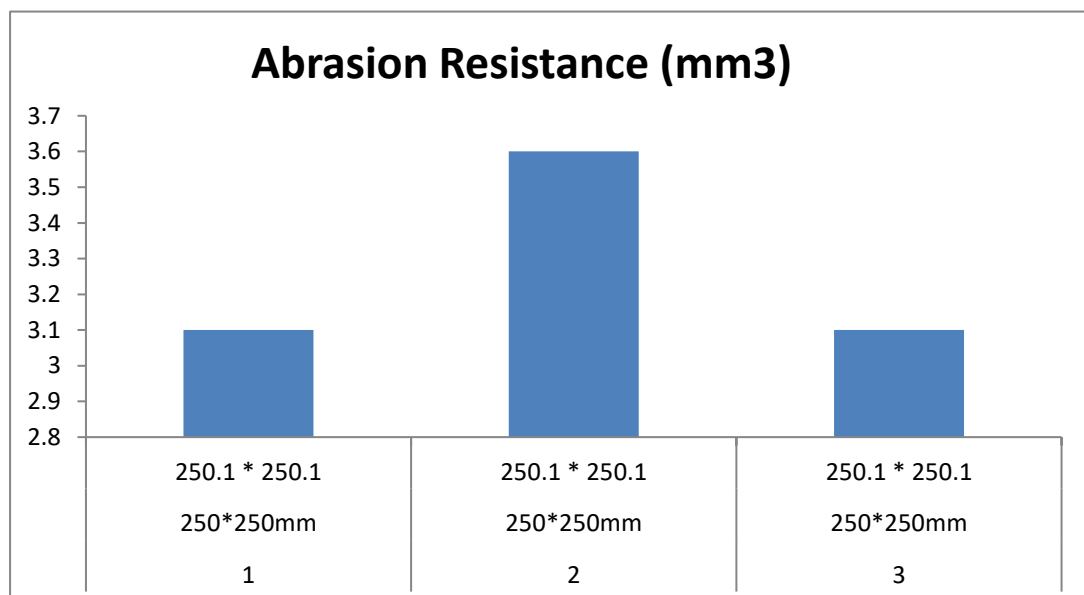


Fig: 5.4: Comparing Abrasion Resistance test for all Trials

5.3 PERPENDICULARITY

When tested in according with the procedure noted down in the IS 1237, the maximum space between the hand or arm of the square and the edge of the tile should not exceed 2 percentage of the length of the edge of the tile. Fig 5.5 and 5.6 shows the perpendicularity test done on all trials, its result were shown in table 5.4, 5.5 and 5.6.

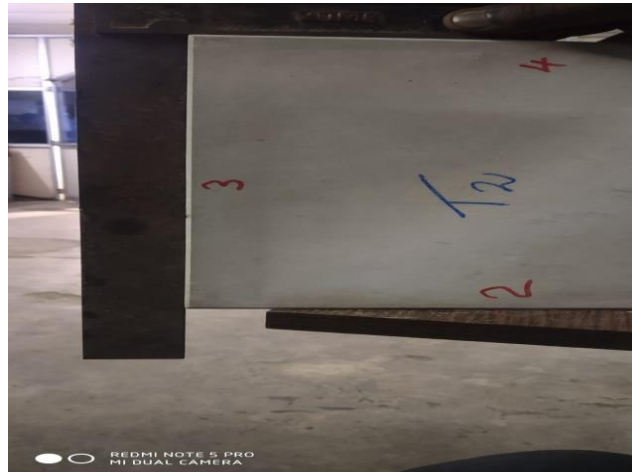


Fig: 5.5: Perpendicularity test done on concrete tile for trial 2

The Fig 5.5 shows the perpendicularity test as per IS 1237:2012, with help of the measuring perpendicularity instrument.

Table: 5.4: Results of Perpendicularity test for trial 1

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS: 13801:1993 (Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.230	Shall not Exceed 2%

As per IS: 13801:1993 (Reaffirmed1998), The perpendicularity test for general purpose concrete tile should not exceed 2 % of the perpendicularity value. For our

first trial we got the value of 0.230 %, So it satisfies required condition for the concrete tile.

Table: 5.5: Results of Perpendicularity test for trial 2

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS: 13801:1993 (Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.190	Shall not Exceed 2%

As per IS: 13801:1993 (Reaffirmed1998), The perpendicularity test for general purpose concrete tile should not exceed 2 % of the perpendicularity value. For our second trial we got the value of 0.190 %, So it satisfies required condition for the concrete tile.

Table: 5.6: Results of Perpendicularity test for trial 3

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS: 13801:1993 (Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.240	Shall not Exceed 2%

As per IS: 13801:1993 (Reaffirmed1998), The perpendicularity test for general purpose concrete tile should not exceed 2 % of the perpendicularity value. For our third and final trial we got the value of 0.240 %, So it satisfies required condition for the concrete tile.

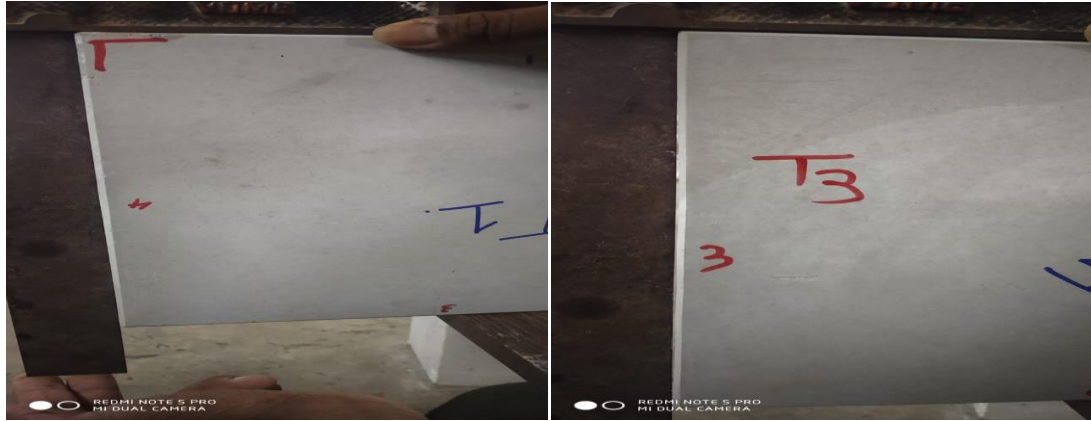


Fig: 5.6: Perpendicularity test done on concrete tile for trial 1 and 3

5.4 STRAIGHTNESS

We tested it according to the procedure given in the Indian standards which is IS 1237, the space between the thread and plane of the tile should not exceed 1 percentage of the length of the edge of the tile. Its test result were shown in table 5.7, 5.8 and 5.9, images of actual test were shown in fig 5.7.

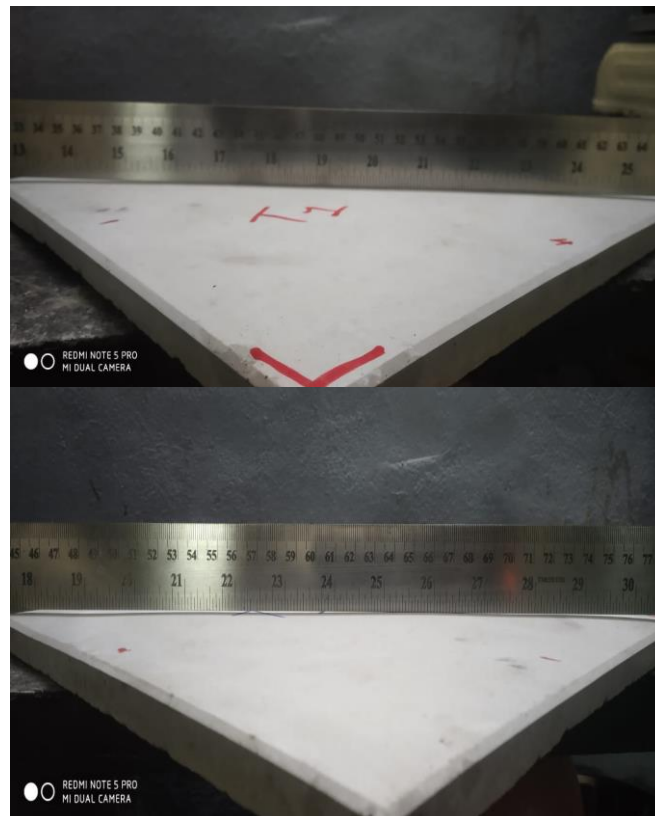


Fig: 5.7: Straightness test done on concrete tile

Straightness of the concrete tile is done by measuring the relative angular positions of number of adjacent sections of the surface to be tested in fig 5.7

Table: 5.7: Results of Straightness test for trail 1

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS:13801:1993(Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.53	Shall not Exceed 1%

As per IS: 13801:1993 (Reaffirmed1998), The Straightness test for general purpose concrete tile should not exceed 1 % of the straightness value. For our first trial we got the value of 0.53 %, So it satisfies required condition for the concrete tile.

Table: 5.8: Results of Straightness test for trial 2

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS:13801:1993(Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.57	Shall not Exceed 1%

As per IS: 13801:1993 (Reaffirmed1998), The Straightness test for general purpose concrete tile should not exceed 1 % of the straightness value. For our second trial we got the value of 0.57 %, So it satisfies required condition for the concrete tile.

Table: 5.9: Results of Straightness test for trial 3

Sl No	Description	Dimensions (in mm)	%Result	Requirement as per IS: IS:13801:1993(Reaffirmed 1998)
1	250*250mm	250.1 * 250.1	0.64	Shall not Exceed 1%

As per IS: 13801:1993 (Reaffirmed 1998), The Straightness test for general purpose concrete tile should not exceed 1 % of the straightness value. For our third trial we got the value of 0.64 %, So it satisfies required condition for the concrete tile.

5.5 WATER ABSORPTION

We tested the concrete tile according with the procedure noted down in IS 1237 code book, the average percentage of water absorption shall not exceed 10 percentage. The average water absorption of the concrete tiles were summarized and Reported as we tested for the absorption. Table 5.10 shows the result of water absorption in concrete tiles. Fig 5.10 and 5.11 images of water absorption in graph.

Table: 5.10: Water Absorption for all Trials

Trial samples of conventional tiles	Average water absorption in (%)
Trial 1 with (3% of RHA , 10% of copper slag)	6
Trial 2 with (4% of RHA , 15% of copper slag)	5.3
Trial 3 with (5% of RHA , 20% of copper slag)	5.5

The average percentage of water absorption shall not exceed 10 % as per IS 1237 :2012 , For the first trial we got the water absorption of 6 % , for the second trial we got the water absorption 5.3 % and for final trail we got water absorption of 5.5 %.

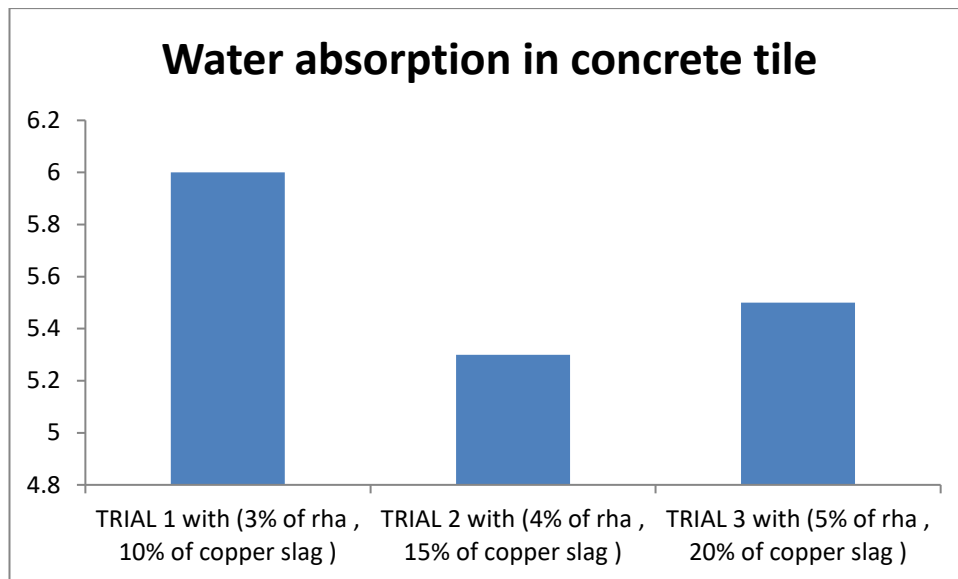


Fig: 5.10: Water Absorption for all Trials in Graph

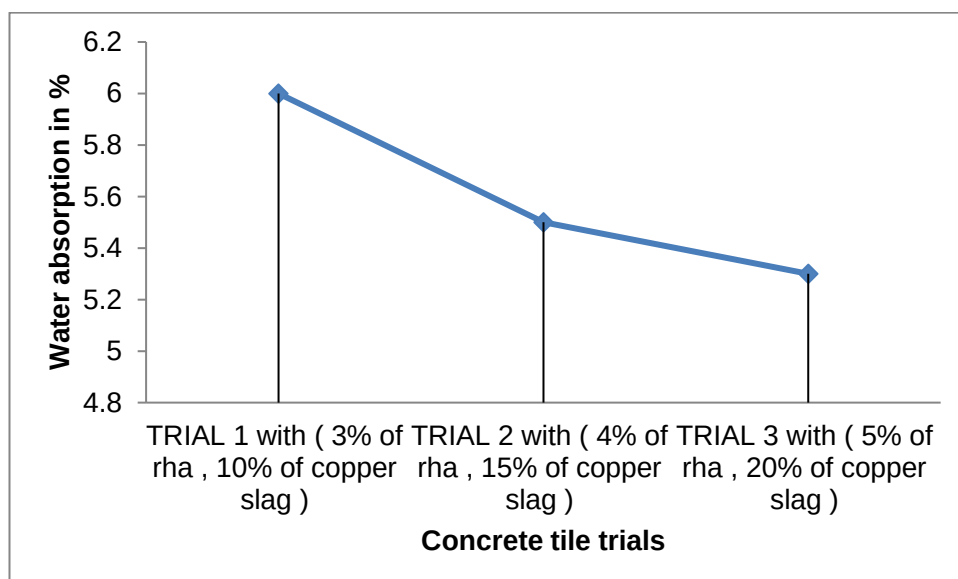


Fig: 5.11: Water Absorption for all Trials in Graph

Both the graph shows the water absorption of the concrete tile, when compared all three trials, trial 3 shows the less water absorption percentage, which is good for the concrete tile, slightly greater absorption is for trial 2 and then trial 3, the criteria of water absorption should not exceed 10 % according to IS 1237 : 2012

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

We have done the project report on concrete tile, The test report of all the tiles has been analyzed, Where we found out the strength and durability of all different trials of our concrete tile, All trial of tiles which we include rha of (3 % of rice husk ash) for first trial, (4 % of rice husk ash) for second trial and (5 % of rice husk ash) for third trial. Copper slag of (10 % of copper slag) for the first trial, (15 % of copper slag) for the second trial and (20 % of copper slag) for the third trial. Shows ideal result to all the shape test including Straightness test and Perpendicularity test where physical properties of the tile is been defined. And some of the tile showed closer to the optimum value for the strength test and some reached ideal for the test, that includes abrasion test and water absorption test in which is strength of the concrete tile. Abrasion resistance was successfully tested on all trials of the tiles. For the first trial of the concrete tile, we got abrasion value of 3.1 mm. Which is optimum value for the general purpose floor tiles, where the average abrasion wear should not exceed 4 mm for the wear on individual specimen which was stated in IS 1237. For the second trial of concrete tile we got the value of 3.6 mm which bit greater than the first trial but it also reached ideal value for the flooring tiles. For our final trial of the concrete tile we got the value as 3.1mm, which is the optimum value for general purpose tiles. Perpendicularity test was successfully tested on all trials of the tiles. For the first trial of the concrete tile, we got perpendicularity value for the tile size of 250 * 250 mm which is about 0.230 percent. Which is optimum percent for concrete tile, According to the IS Standards for concrete tile the ideal value should not exceed value of 2 percent. For the second trial of concrete tile we got the shape value of 0.240 percent. For our final trial of the concrete tile we got the shape value as 0.190 percent, So all the trials of the concrete tiles are totally satisfied the requirement for the shape test of perpendicularity. Straightness test was successfully tested on all the trials of the concrete tiles, The ideal value for concrete tile should not exceed value of 1 percent for the straightness test according to the IS Standards. For the first trial of

the concrete tile we got Straightness value for the tile dimension of (250 * 250 mm) which is about 0.53 percent. Which is ideal percent for concrete tile, And for the second trial of concrete tile we got the straightness value of 0.57 percent. For our final trial of the concrete tile we got the shape value as 0.64 percent, All the trials of the tiles were satisfied the requirement for the shape test of perpendicularity according to IS:13801. Water absorption test was successfully tested on all the trials of the concrete tiles, The ideal percentage for the concrete tile should not exceed value of 10 of water absorption according to the IS1237. For the first trial of the concrete tile we got water absorption of 6 percent. Which is ideal percent for concrete tile because the percentage is less than 10, And for the second trial of concrete tile we got the percentage of 5.3 percent. And for our final trial of the concrete tile we got the 5.5 percent, The limit on water absorption effectively rule out the use of concrete tile. All the percentage of the water absorption for the tiles are satisfactory.

6.2 CONCLUSION

By analyzing all the trials of the tiles, we have concluded different result for each case, For the first trial of the concrete tile the physical properties such as shape test has been satisfactory. Its water absorption capacity has been optimum, And its abrasion resistance has also been ideal. So minimum replacement of rha and copper slag has been reached ideal strength for the flooring tiles, where as compared to the cement and m sands prices, the cost of replacing materials such as copper slag and rha has been much cheaper. So by replacing minimum amount of the material, we can significantly reduce the cost of its manufacturing price. For second trial of concrete tile the physical properties such as shape test has been satisfactory. Its water absorption capacity has been optimum and better than the first trial, And its abrasion resistance has also been also closest to the ideal value. So for this condition also replacement of rha and copper slag has been reached closer to the ideal strength for the flooring tiles while compared to the first trial, And for the last trial of the concrete tile the physical properties such as shape test has been satisfactory like first and second trial. Its water absorption capacity has been optimum and better than the first and second trial, And its abrasion resistance has also been same as the first trial it's been optimum. So for this condition also replacement of rha and copper slag has also been reached satisfied

strength and shape of the flooring tiles.

All the trials of our tile has been satisfied the IS Standards of concrete tile testing, where the maximum replacement of 4 percent rha and 15 percent copper slag has been effective and reached properties of the conventional tile. The copper slag was effective replacement material while compared to r h a. Because more than 4 percent of rha replacement results brittleness in concrete. But in case of copper slag there were so side effects. And prices of the replacement materials are significantly less , where copper slag is available for 7 Rs/per kg , and rha is for 4 Rs/per kg. lesser than m sand and cement. So by replacing 15 percent of copper slag and 4 percent rha, the strength has been reached and can reduce significant amount of manufacturing cost while compared to conventional tile.

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