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EFFECT OF RICE HUSK HASH ON MECHANICAL PROPERTIES OF M25 GRADE CONCRETE USING RECYCLED AGGREGATES ALONG WITH STEEL FIBERS

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***Abstract**:* This present paper deals with the concrete mix of M25 grade which was made using OPC 53 grade of cement and in which rice husk ash recycled aggregates and steel fibers are used to replacing the cement, natural coarse aggregates and natural fine aggregates. Rice husk ash in structural concrete is a sustainable solution to dealing with solid waste. This technology reduces the serious impact on ecological environments caused by a shortage of natural mineral resources. The aim of the present study is to investigate the coupling effects of incorporating rice husk ash on the compressive and split tensile performances of selected M25 grade concrete. Casting of Cubes and Cylindrical Specimens of (150*150 mm) and (150 mm diameter and 300 mm Height) in Sizes to find out the fresh and hardened properties of M25 grade concrete mix for 7 and 28 days.

Index Terms **Rice husk ash, recycled aggregates, steel fibers, Concrete Mix, Compressive strength, Split Tensile strength and Ordinary Portland Cement.**

I. INTRODUCTION

1.1 INTRODUCTION TO CONCRETE:

The most widely used construction material in the world is probably the concrete because Concrete makes a building fire safe due to its non-combustible nature and is free from defects and flaws and is more economical, maintenance cost is almost negligible. The key to achieving a strong, durable concrete rests in the careful proportioning and mixing of the ingredients.

1.1.1 CEMENT

Cement is a binding material and is responsible for interlock between constituents present in concrete. Cement is a basic ingredient of concrete, plaster and mortar and is formed by calcinations of Argillaceous, calcareous and siliceous compounds and which responsible for formation of calcium hydrates in cement hydration and which affects the strength and setting time of concrete.

1.1.2 FINE AGGREGATES

Fine aggregates/sand that have been sorted out and isolated from the natural material by the activity of streams of water or by winds crosswise over bone-dry grounds are by and large entirely uniform in size of grains. Generally business sand is acquired from waterway beds or from sand rises initially framed by the activity of winds. Natural sand means River sand collected from near and is passing through 4.75mm and is free from clay, silt and other organic matters does not exceed the specified limit.

1.1.3 COARSE AGGREGATES

Coarse aggregates are classified based on its shape, size and texture etc. Depends on it, the volume of this occupies in the concrete varies. A continuous gradation of particle sizes is desirable for efficient use of the paste. In addition, aggregates should be clean and free from any matter that might affect the quality of the concrete. Which is angular in shape and size about 20mm is taken for experimental investigation.

1.1.4 WATER

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life..

1.2 NEED OF ALTERNATIVE MATERIALS IN CONSTRUCTION FIELD

The Demand of building materials like cement, sand and coarse aggregates are increases rapidly due to industrial, constructional and domestrial expansion by increasing population. .

1.3.1 RICE HUSK ASH:

All the materials required to produce such huge quantities of concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strains. On the other hand, human activities on the Earth produce solid waste in considerable quantities of over 2500/MT per year, including industrial wastes, agricultural wastes and wastes from rural and urban societies.

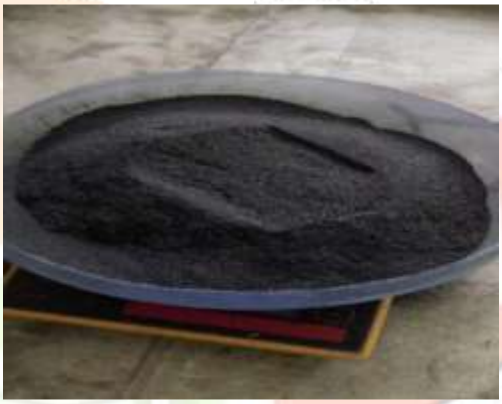

Fig 2: Rice husk ash

From the middle of 20th century, there had been an increase in the consumption of mineral admixtures by the cement and concrete industries.

PHYSICAL PROPERTIES

Table 1: properties of rice husk ash

S. No	Particular Properties	
1	Color	Gray
2	Shape Texture	Irregular
3	Mineralogy	Non Crystalline
4	Particle Size	< 45 microns
5	Specific Gravity	2.37
6	Odor	Odorless

Rice milling generates a by-product known as husk. This surrounds the paddy grain. During the milling of paddy about 78 % of weight is received as rice, broken rice and bran. The rest 22 % of the weight of paddy is received as husk. This husk is used as fuel in the rice mills to generate steam for the parboiling process. This husk contains about 75 % organic volatile matter which burns up and the balance 25 % of the weight of this husk is converted into ash during the firing process, which is known as rice husk ash (RHA). Rice husk was burnt approximately 48 hours under uncontrolled combustion process. The burning temperature was within the range of 600 to 850 degrees. The ash obtained was ground in a ball mill for 30 minutes and its color was seen as grey. This RHA in turn contains around 85%-90% amorphous silica. So for every 1000 kg of paddy milled, about 220 kg (22%) of husk is produced, and when this husk is burnt in the boilers, about 55 kg (25%) of RHA is generated.

CHAPTER III

METHODOLOGY

The methodology adopted for completion the project is as shown in below flow chart.

literature study

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selection of best alternatives in concreter mix(Steel fibers, Recycled aggregates and Rice husk ash)

↓

selection of percentage replacement of alternatives from literature

↓

mix design for M25 grade concrete

↓

conducting laboratory tests on concrete

↓

casting samples (cubes and cylinders) for conducting the compression test and split tensile strength test

↓

conducting tests on cubes and cylinders

↓

comparision of test results with different % of alternatives and identification of best proportion

↓

conclusions

2.1 PERCENTAGE OF ALTERNATIVE MATERIALS

FIVE concrete mixes have been made and the ratios of the mixes are given in the Table 2.

Table 2: Design mix ratios proposed for the tests

S NO.	% OF CEMENT	% OF STEEL FIBERS
1	100	0
2	100	1
3	100	2
4	100	3
5	100	4

S NO.	% OF NATURAL COARSE AGGREGATES	% OF RECYCLED AGGREGATES
1	100	0
2	90	10
3	80	20
4	70	30
5	60	40

S NO.	% OF CEMENT	% OF RICE HUSK ASH
1	100	0
2	99	1
3	98	2
4	97	3
5	96	4

2.2 SLUMP CONE TEST

Slump test was carried out to determine the workability of each mix. The tests were carried out in all cases in accordance with the requirements of BS 1881: Part 102(1983) for slump test and BS 1881: Part103 (1983) for compacting factor tests.

2.3 CASTING OF SPECIMENS

The concrete cubes were prepared in accordance to IS: 516.The binder, sand and aggregates first premixed dry for 1 min. to ensure homogeneity. Then Wet mixing with a total mix time of 4.5 min. Cast the concrete in a steel molds with the dimensions of (150 x 150 x 150) mm and cylinders with dimensions of (150mm*300mm) then Remold the concrete specimens after 24 hours, and then keep the cubes for water-curing in an opened container. Test the three cubes to check its compressive strength after 7 and 28 days.

2.4 COMPRESSIVE STRENGTH TEST

By testing the concrete cubes using CTM with constant loading rate find the average of the strength of three cubes per test.

2.5 TENSILE STRENGTH TEST

The tensile strength are found by conducting split tensile test of the concrete cylinders at 7 and 28 days respectively according to IS 516-1959 after taking their weights in order to ascertain their densities. Results were recorded based on the average tensile strength.

CHAPTER III

LITERATURE REVIEW

3.1 DESCRIPTION

This chapter deals with the review of the existing literature on the employ of properties of concrete. The most important investigations, related to the current investigation, are summarized and salient facts which seem to emerge from the research discussed. The discussion is generally confined to the stress strain behavior of the M25 grade concrete.

3.2 PERTINENT STUDIES

Biel Lee [1] in 1994, in this paper authors have published that used recycled tire in concrete mixes made with magnesium oxychloride cement, where the aggregate was replaced by fine crumb up to 25% by volume. The results of compressive and tensile strength tests indicated that there is better bonding when magnesium oxychloride cement is used. The researchers discovered that structural applications could be possible if the content is limited to 17% by volume of the aggregate.

Fattuhi] [3] in 1996, proposed that, the cement paste, mortar, and concrete (containing OPC or grade obtained from shredding scrap tyres. Properties examined for the 32 mixes prepared included density, compressive strength, impact and fire resistances, and nailability. Results showed that density and compressive strength of various mixes were reduced by the addition of . (type had only marginal effect.) Density varied between about 1300 and 2300 kg/m3. Compressive strength reduced by 70% when the proportion of to total solid content by mass of concrete reached about 13%.

GuoqiangLi [4] in 2004, conducted investigation on chips and fiber's. The tyre surfaces are treated by saturated NaOH solution and physical anchorage by drilling hole at the centre of the chips were also investigated and they concluded that fiber's perform better than chips: NaOH surface treatment does not work for larger sized tire chips: using physical anchorage has some effect. Further efforts will be geared toward the enlarging he hole size and insuring that the hole be through the chip thickness entirely. Fiber length restricted to less than 50mm to avoid entangle: steel belt wires provide positive effect on increasing the strength of concrete.

Gintautas skripkiūnas, et al [5], proposed that, waste additives reduced both static and dynamic modulus of elasticity. Strains of the concrete with the same compressive strength with waste from used tires (3.2% from aggregate by mass) deformations are 56 % – 63 % higher after the static loading, while set deformations after the unloading is 219 % – 360 % higher than for the none ized concrete. Cyclic loading of 20 cycles have no influence on the prismatic compressive strength of both concrete with and without waste (3.2% from aggregate by mass). And Ultimate strains on concrete failure load are 36 % – 47 % higher for concrete with tyre waste additive.

CHAPTER IV

OBJECTIVES AND DETAILS OF INVESTIGATION

4.1 DESCRIPTION:

To achieve the objectives of the study, an extensive experimental program was planned and which included evaluation of best and Economical proportion of the concrete mix having materials powder and rice husk ash as partially replacement of materials such as natural sand, cement and coarse aggregates respectively at 7 and 28days of age of concrete. Initially powder used in different proportions means 0%, 5%, 10%, 15% and 20% as partial replacement of natural sand and find out the best proportion. For that proportion of powder based concrete Rice husk ash added in 0, 1, 2, 3 & 4 percentages to find out the best proportion at which concrete shows optimum results. Similarly the best proportions of steel fibers and Recycled aggregates also determined.

4.2 OBJECTIVES OF THE STUDY:

Mechanical properties such as hardening and fresh properties those are displayed by concrete to be obtained, all tests are conducted for concrete mix. Which is done by using concrete specimens means cylindrical concrete specimens that it shows less strains, high modulus of elasticity and the concrete also having good strength and slump of concrete using slump cone shows good workability of concrete that mix of concrete find out and it will be discussed and investigated within this thesis and the following overall primary objectives have been selected.

The objectives of the present research work are

1. Mix design of M25 grade of concrete
2. Workability of concrete mix at various proportions of steel fibers, recycled aggregates, powder and Rice husk ash.
3. Compressive and Split tensile strength properties
4. Addition of steel fibers to the concrete mix (1%, 2%, 3%, 4% and 5%) of cement weight.
5. Partial Replacement a fine aggregate of standard concrete mix with different weight ratios of scrap tires (both crumb and chipped) as (0%, 5%, 10%, 15%, and 20%)
6. Partial Replacement a Coarse aggregate of standard concrete mix with different weight ratios of Recycled aggregates as (0%, 10%, 20%, 30%, and 40%)
7. Respectively and partial replacement of cement of standard concrete with different weight ratios of rice husk ash as (0%, 1%, 2%, 3% and 4%)
8. To find which one of additive has excellent properties for civil construction applications.

4.3 RESEARCH SIGNIFICANCE:

The research work done for M25 grade of concrete to find out the best mix of concrete having steel fibers as additional admixture, Recycled aggregates and Rice husk ash as partial replacement of materials such as coarse aggregates, natural sand and cement respectively that it shows good compressive and split tensile strength and is also workable.

CHAPTER V

MATERIAL PROPERTIES

4.1 MATERIALS:

Raw materials required for the concreting operations of the present work are

- Cement
- Rice husk ash
- Natural Fine aggregates
- Steel fibers
- Natural Coarse aggregates
- Recycled aggregates

- Water

4.1 MIXING OF MATERIALS:

The raw materials for the proposed concrete mix should be available in the required proportion. After this the mixing of concrete is carried out. It is of two types: Mixing by Hand and Mixing by Machine. For mixing by hand, the material should be kept in a water proof tank. Before adding water, the material should be properly/thoroughly mixed till the color of the mix becomes uniform in dry state and only after that the suitable amount of water should be added to make the mix workable one.

4.1 ORDINARY PORTLAND CEMENT:

Cement is a binding material and is responsible for interlock between constituents present in concrete. Cement is a basic ingredient of concrete, plaster and mortar and is formed by calcinations of Argillaceous, calcareous and siliceous compounds and which responsible for formation of calcium hydrates in cement hydration and which affects the strength and setting time of concrete. The ordinary Portland cement is shown in the following figure-5.1.

Fig 5.1: Ordinary Portland cement

5.3.1 PROPERTIES OF PORTLAND CEMENT:

This was done by taking the location of various standard books, journals and some standard code. Here our aim is to determine actual chemical work of the sample provided by the company. The chemical analysis of Portland cement is listed in Table No.3

Table No 3: The chemical analysis of Portland cement

S. No.	Compounds	Percentage
1	Cao	64.00
2	Sio_2	22.00
3	$Al2o_3$	4.10
4	Fe_2o_3	3.60
5	Mgo	1.53
6	So_3	1.90

The following details are taken from the information gained from the laboratory experiments done on this in the laboratory. The Physical properties of Portland cement are listed in the Table No. 4 this is shown in below.

Table No 4: Physical properties of cement

S.NO		PROPERTY	VALUE
1		Specific gravity	3.15
2		Normal Consistency	32%
3		Fineness of cement	7%
4	I) ii)	Setting time Initial Setting time Final setting time	30 min 358 N

5.4 RICE HUSK ASH:

Rice husk ash is lighter material compare to ordinary Portland cement. It sources are indigenous lateritic soils and sludge from the paper recycling industry. Highly reactive Rice husk ash formed by water processing, which removes impurities to make it 100%reactive puzzolonic material. This forms the CSH (calcium silicate hydrate) and CASH (calcium alumino silicate hydrate) when combines with calcium hydroxide produced during cement hydration.

Puzzolonic reaction in concrete

Rice husk ash combines with free calcium hydroxide produce during cement hydration generating additional cementing compounds contributing to enhanced strength and durability. It modifies the microstructure and the weak zone is strengthened due to higher bond developed between two phases which are paste phase and aggregate phase.

Properties of Rice husk ash given below and details of the chemical composition is given in the below Table 5.

Table 5. Chemical composition of RHA

S.No.	Constituents	Percentage value
1	Fe2O3	0.54
2	K2O	0.1-2.54
3	SiO2	62.5 - 97.6
4	CaO	0.1 - 1.31
5	MgO	0.01 - 1.96
6	Na2O	0.01 - 1.58
7	P2O5	0.01 - 2.69
8	SiO3	0.1 – 1.23
9	Carbon	2.71 – 6.42

The following details are taken from the supplier of Rice husk ash is Aswin ceramics in Chennai.

The Physical properties of Portland cement are listed in the Table No.6 this is shown in below.

Table No 6: Physical properties of Rice husk ash

Form	white powder
Specific gravity	2.46
Density	2640kg/m3
Brightness	76%
Residue	on 375 mesh Max 0.5%
Fineness	15000-30000m2/kg

5.6 Fine Aggregates:

Fine aggregates/sand that have been sorted out and isolated from the natural material by the activity of streams of water or by winds crosswise over bone-dry grounds are by and large entirely uniform in size of grains. Generally business sand is acquired from waterway beds or from sand rises initially framed by the activity of winds. Natural sand means River sand collected from near and is passing through 4.75mm and is free from clay, silt and other organic matters does not exceed the specific limit.

The material Natural Sand is shown in the following figure-5.2.

Figure-5.2: Natural Sand

5.7 Sieve Analysis of sand

The Sieve Analysis of sand is carried out to know the zone of the sand. The results of sieve analysis are given in the below table no 7.

Table-7: Sieve Analysis of sand

Sieve size (mm)	Weight retained in gm	% passing
4.75	16	98.4
2.36	11	97.3
1.18	65	90.8
600 micron	391	51.6
300 micron	420	9.4
150 micron	82	1.2
Total	1000 gm	0

From the sieve analysis result, sand falls under zone II.

Table No 8: Properties of Fine Aggregate

S.NO	PROPERTY	VALUES
1.	Specific Gravity	2.77
2.	Water Absorption	NIL
3.	Bulk Density i. Loose State ii. Compacted State	 15.75 KN/mm^3 17.05 KN/mm^3
4.	Fineness modulus	2.6

5.8 Coarse Aggregates:

Coarse aggregates are classified based on its shape, size and texture etc. Depends on it, the volume of this occupies in the concrete varies. The major portion of the concrete mix is occupied by the coarse aggregates.

The material Coarse aggregates is shown in the following figure-4.

Figure-5.4: Coarse aggregates

Which is angular in shape and size about 20mm is taken for experimental investigation. Which having particle size as are retained on I.S.sieve 4.75mm and which occupies large portion of concrete .The properties of coarse aggregates are given in the following table

Table No 11: Properties of coarse Aggregate

S.NO	PROPERTY	VALUES
1.	Specific Gravity	2.77
2.	Water Absorption	1%
3.	Bulk Density I. Loose State II. Compacted State	 14.13 KN/mm^3 16.88 KN/mm^3
4.	Fineness modulus	7.2

5.9 Recycled aggregates

Recycled aggregate concrete (RAC) is concrete made with recycled concrete aggregate (RCA) instead of natural aggregate (NA). RCA are aggregates obtained by recycling of clean concrete waste where content of other building waste must be very low – less than a few percent. For example, British standard BS 8500–2 (BSI, 2006), defines RCA as recycled aggregate with maximum masonry/fines content of 5%, maximum lightweight material/asphalt content of 0.5% and maximum other foreign materials content of 1%.

The presence of adhered mortar on the surface of crushed concrete aggregate generally degrades the quality of the recycled aggregate and consequently the fresh and hardened properties of concrete made from it.

Compared to natural aggregates, recycled concrete aggregates have (Marinković *et al.*, 2012):

- Decreased density up to 10%,
- Higher porosity and higher water absorption: for coarse RCA it ranges from 2% to 9% and for fine RCA from 5.5% to 13%,
- Increased Los Angeles abrasion loss up to 70%.

Figure-5.4: Recycled coarse aggregates

5.10 Steel fibers

Steel fiber reinforced concrete is a castable or sprayable composite material of hydraulic cements, fine, or fine and coarse aggregates with discrete steel fibers of rectangular cross-section randomly dispersed throughout the matrix. Steel fibers strengthen concrete by resisting tensile cracking.

Fig. 5.5 steel fibers

5.11 Water:

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life. Ordinary potable tap water available in laboratory was used for mixing and curing of concrete and is free from impurities and micro-organisms.

CHAPTER VI
MIX DESIGN OF CONCRETE

This chapter deals with the design procedure adopted for preparation of concrete.

5.6 MIX DESIGN PROCEDURE:

a) The strength of the cement as available in the country today has greatly improved since 1982. The 28-day strength of A, B, C, D, E, F. Category of cement is to be reviewed.

b) The graph connecting, different strength of cements and W/C is to be reestablished.

c) The graph between 28-day compressive strength of concrete and W/C ratio is to be extended up to 80Mpa, if this graph is to be cater for high strength concrete.

d) As per the review of 456-2000, the degree of workability is expressed in terms of slump instead of compacting factor. This results in change of values in estimating fairly accurate sand and water contents for normal concrete up to 35Mpa and high strength concrete above 35Mpa. The table giving adjustment of values in water content and sand % for other than standard conditions requires appropriate changes and modifications.

e) In the view of the above and other changes made in the revision of IS456-2000, the mix design procedure as recommended in IS 10262-2009 is required to be modified to the extent considered necessary and examples of mix design is worked out.

5.7 MIX DESIGN FOR M25 GRADE OF CONCRETE:

1) Design procedure:

Characteristic compressive strength required in the field at 28 days=25Mpa

Maximum Size of aggregate=20mm

Degree of Workability=0.9

Type of exposure = mild

2) Test Data for materials:

Specific gravity of cement=3.15

Specific gravity of fine aggregate=2.65

Specific gravity of coarse aggregate=2.77

From observing the code book zone-2 as per the IS-code 10262-2009 and IS456-2000 are considered for mix design.

Step-1

Determination of target strength

$F_{tar} = f_{ck} + 1.65 * S$

$= 25 + 1.65 * 4 = 31.6 \ N/mm^2$

Where S=standard deviation as per table-1 of IS-code 10262-2009

Step-2

Selection of water/cement ratio

From table 5 of IS 456(page no 20)

Maximum water-cement ratio for mild exposure condition=0.50

We adopted w/c ratio=0.50, hence ok

Step-3

Selection of water content

From table 2 of IS-code 10262-2009,

Maximum water content=186litres (FOR NOMINAL Maximum size of aggregate-20mm)

We have taken 186litres, hence ok

Table for correction of water content

Parameters	Value as per standard reference condition	Value as per present Problem	Departure	Correction in water Content
Slump	25-50mm	50-75mm	25	+3/25*25=+3
Shape Of Aggregate	Angular	Angular	Nil	_

Estimated water content=186+ (3/100)*186=191.58kg/m^3

The cement content=191.58/0.50=383.16 kg/m^3

Step-4

Estimation of coarse Aggregate proportion
From Table 3 of IS-code 10262-2009,
For Nominal Maximum Size of aggregate=20mm,
Zone of fine Aggregate=zone 2 and w/c ratio=0.50
Volume of coarse Aggregate unit volume of total Aggregate=0.62 then sand content=0.38
There is no change required for coarse aggregate content because maximum water cement ratio that is 0.50 is taken in to consideration.

By considering 2% of entrapped air is then
(1-2/100)= (191.58+383.16/3.15+1/0.38*f_a/2.65)*1/1000
From that f_a=671.45kg/m^3
The coarse aggregates
(1-2/100)= (191.58+383.16/3.15+1/0.62*c_a/2.77)*1/1000
From that c_a=1145.125kg/m^3
The mix ratio
Water: Cement: F_a: C_a=191.8:383.16:671.45:1145.125=0.50:1:1.752:2.985

Step-5

The Final contents of mix proportion of M25 grade is
Water content=191.8 kg/m^3
Cement content=383.16 kg/m^3
Fine aggregate=671.45 kg/m^3
Coarse aggregate=1145.125 kg/m^3

Mix proportion of M25 mix concrete at various proportions of steel fibers is given below.TABLE-12(a)

Mix	Water (lit/m3	Cement (kg/m3)	River Sand (kg/m3)	Coarse aggregates (kg/m3)	Percentage Steel fibers
M00	191.8	383.16	671.45	1145.13	1
M01	191.8	383.16	671.45	1145.13	2
M02	191.8	383.16	671.45	1145.13	3
M03	191.8	383.16	671.45	1145.13	4
M04	191.8	383.16	671.45	1145.13	5

Mix proportion of M25 mix concrete at various proportions of Recycled aggregates is given below.
TABLE-12(b)

Mix	Water (lit/m3	Cement (kg/m3)	River Sand (kg/m3)	Coarse aggregates (kg/m3)	% of Recycled aggregates(kg/m3)
M05	191.8	383.16	671.45	1145.13	0
M06	191.8	383.16	671.45	1030.60	10(114.53)
M07	191.8	383.16	671.45	916.11	20(229.02)
M08	191.8	383.16	671.45	801.60	30(343.53)
M09	191.8	383.16	671.45	687.08	40(458.05)

Mix proportion of M25 mix concrete at various proportions of Rice husk ash is given below TABLE-12(d)

Mix	Water (lit/m^3)	Cement (kg/m^3)	Rice husk ash (kg/m^3)	River Sand (kg/m^3)	Coarse aggregates (kg/m^3)
M6	191.8	383.16	0	671.45	1145.13
M7	191.8	379.33	3.83	671.45	1145.13
M8	191.8	375.5	7.66	671.45	1145.13
M9	191.8	371.67	11.49	671.45	1145.13
M10	191.8	367.84	15.32	671.45	1145.13

CHAPTER VII
EXPERIMENTAL INVESTIGATIONS

7.1 WORKABILITY OF CONCRETE:

Slump cone test is considered in this investigation to study the workability of concrete by means of slump. The slumped concrete takes various shapes and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump. If a shear or collapse slump is achieved, a fresh sample should be taken and the test repeated. A collapse slump is an indication that the mix is too wet.

Figure6 (a) Tampering of materials in the slump cone Figure6 (b) slump of concrete mix on the tray.

5.6 CASTING OF SPECIMENS:

1. In this investigation cylindrical specimens are used to study the tensile strength behavior and mechanical properties of M25 mix of concrete.
2. The Cylindrical Specimens are cleaned and oil is applied inside the specimens.
3. Hand mixing is preferred in this investigation.
   - Materials are taken for the 3 cylinders for each set of casting of 3 cylinders.
   - That means required amount of cement, sand, aggregates and the materials Rice husk ash are taken by using weighing machine.
   - Cement is placed in the tray and after that Rice husk ash sand, aggregates are added in required proportions.
   - All these building materials are mixed using trowel after adding of required amount of water.
4. After mixing the concrete paste is placed in the 3 layers in the cylindrical specimens by tamping 25 times at each time using tamping rod.
5. These specimens are placed on table vibrator one by one to vibrate it for 3to4minutes.
6. After that, these are placed in dry place for 24 hours before placing in the curing tank.

The casting of cylindrical specimens is shown in the Figure 7.1(a) and 7.1(b).

Figure7.1 (a) concrete specimen filling Figure 7.1 (b) concrete specimen on table vibrator

5.6 CURING OF CYLINDRICAL SPECIMENS:

After 24 hours from the casting cylindrical specimens are taken and these are placed in the curing tank. These cylindrical specimens which are casted and placed in the curing tank are taken after 7 and 28 days respectively to test them. At the age of 7 days these specimens hardened and are gaining strength on later ages, At 28 days generally 90% strength achieved by the specimens. Before testing, these are placed in the dry place for 24hours.After completion of this time specimens are taken from the cylinders to test them

.

The specimens after casting and in the curing tank is shown in the below figures 7.2(a) and 7.2(b).

Figure 7.2 (a): specimens after casting

Figure 7.2 (b): specimens in the curing tank

7.3.1 PRECAUTIONS:

The below precautions should be followed during mixing and placing concrete:

1. The plastic straws and sheets taking should be cut up to our requirements without error.
2. The water used for curing should be examined every 7 days and its temperature must be at 27±2°Centigrade.
3. The hardened concrete should be carefully removed from moulds, placed in water without causing any failure.

7.4 TESTS ON HARDENED CONCRETE:

7.4.1 COMPRESSIVE TEST:

After curing, drying of these cylindrical specimens for 7 amd 28 days are taken to test them to get the peak load at which specimen fails. These specimens are placed in CTM and load is applied gradually until the specimen fails.

Compressive stress at this breaking load=P/A
Where P=Breaking load,
A=Cross Sectional area of the specimen

The specimens before and after placing of loads are shown in below figures 7.3.

Figure 7.3: Compressive strength test setup

CHAPTER VIII
TEST RESULTS AND DISCUSSIONS

8.1 NORMAL CONSISTENCY OF CEMENT:

Table: 13: Normal consistency of cement

Trail no.	Weight of Cement(gm)	% of Water added	Depth of Penetration (mm)
1	400	28	15
2	400	30	10
3	400	32	7

Hence the Consistency of cement is **32%**.

8.2 INITIAL SETTING TIME OF CEMENT:

Weight of cement sample taken = 400gms
Consistency of cement = 32% as obtained above
Volume of water to be added = 0.85*32/100*400=108.8m
Initial setting time obtained =**30 minutes.**

8.3 FINAL SETTING TIME OF CEMENT:

Weight of cement sample taken = 400gms
Consistency of cement = 32% as obtained above
Volume of water to be added = 0.85*32/100*400=108.8m
Final setting time = **358 minutes.**

8.4 WATER ABSORPTION TEST:

Weight of oven dried aggregate = 500g
Weight of aggregate soaked in water for 24 hours = 505g
Percentage of water absorbed = (505-500)/500*100= **1%**

8.5 SPECIFIC GRAVITY OF CEMENT:

Weight of empty specific gravity bottle W1 = 44.1 gm.
Weight of sp.gr bottle + wt. of cement W2 = 70.00gm (1/3 rd to 2/3 rd of bottle full)
Weight of specific gravity bottle + cement + kerosene (W_3) = 103.20 gm
Weight of specific gravity bottle+ kerosene (W4) = 83.80 gm
Specific gravity of kerosene = 0.79
Specific gravity of cement = (W2-W1)/{(W4-W1)-(W3-W2)} = **3.15**

8.6 SPECIFIC GRAVITY OF COARSE AGGREGATES:

Weight of saturated aggregates A = 500gms
Weight of dry aggregates D = 495gms
Weight of Pycnometer = 610gms
Weight of Pycnometer+ Water C = 1597gms
Weight of Pycnometer+ Water+ aggregates B = 1918gms
Specific gravity of coarse aggregates = D/ {A-(B-C)} = **2.77**

8.7 SPECIFIC GRAVITY OF FINE AGGREGATES:

Weight of empty Pycnometer W1 = 610 gm.
Weight of Pycnometer + fine aggregate W2 = 1110 gm.
Weight of Pycnometer + fine aggregate + water W3 = 1908 gm.
Weight of Pycnometer + water W4 = 1597 gm.
1) Dry weight of aggregate = W2-W1
2) Weight of equivalent volume of water = (W2-W1)-(W3-W4)
Specific gravity of fine aggregates = (W2-W1)/ {(W2-W1)-(W3-W4)} =**2.65**

8.8 WORKABILITY OF CONCRETE:

Table for Workability of concrete at various proportions of steel fibers is given below.

TABLE-14

%0f steel fibers	**Workability Slump(mm)**
0	60
1	58
2	56
3	52
4	51

By increasing percentage of steel fibers in concrete mix it reduces the workability and the values of compressive and split tensile strength at peak loads considered to decide the best proportion of mix at which that shows optimum results.

Table for Workability of concrete at various proportions of recycled agregates is given below.

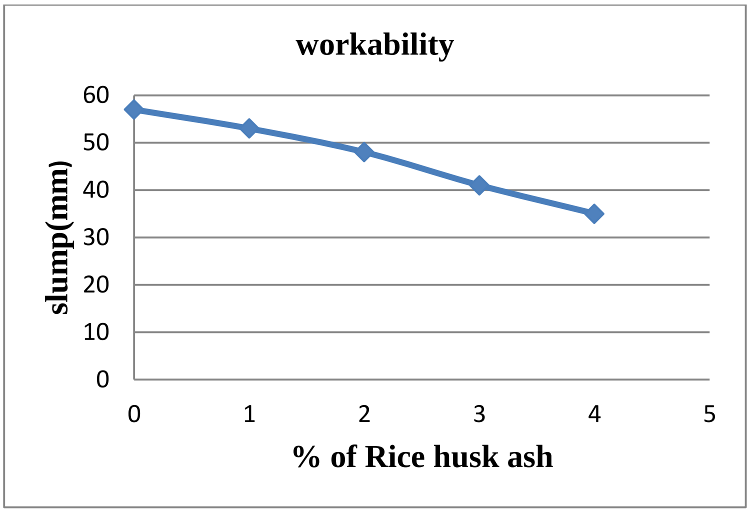
TABLE-15

% 0f Recycled aggregates	Workability Slump(mm)
0	61
10	58
20	54
30	52
40	49

Table for Workability of concrete at various proportions of Rice husk ash is given below. TABLE-17

%0f Rice husk ash	Workability Slump (mm)
0	57
1	53
2	48
3	41
4	35

GRAPH-2



By increasing percentage of Rice husk ash in concrete mix it reduces the workability and the values of compressive and split tensile strength at peak loads considered to decide the best proportion of mix at which that shows optimum results.

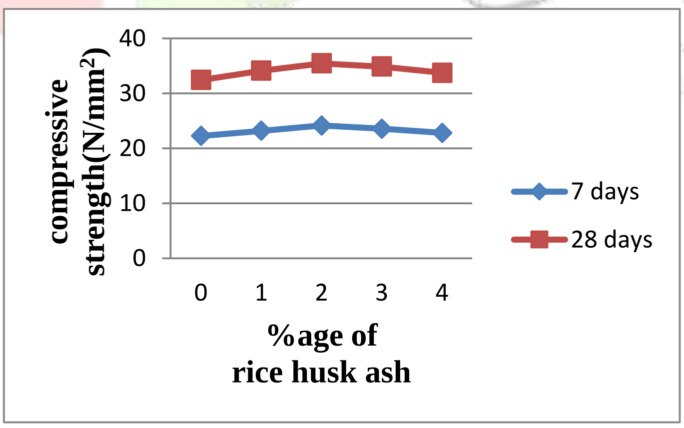
Here at 2 % of rice husk ash in concrete mix shows good workability and optimum strength.

The compressive strength values at various proportions of Rice husk ash given in the following Table-15.

TABLE-19

%AGE OF RICE HUSK ASH	compressive strength(N/mm^2)	
	7-DAYS	28-DAYS
0	22.249	32.430
1	23.191	34.127
2	24.134	35.447
3	23.569	34.882
4	22.814	33.750

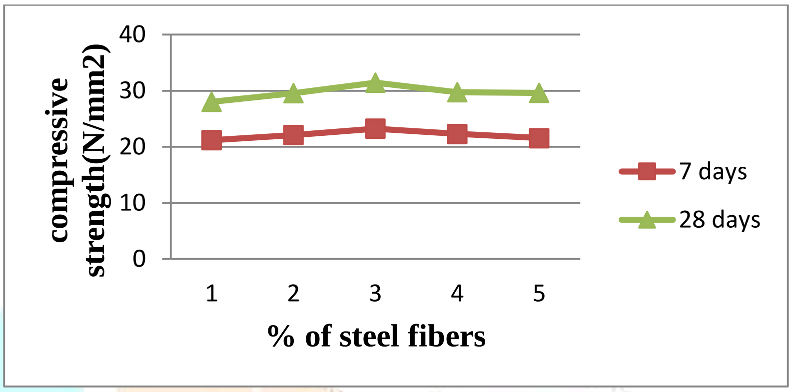
GRAPH-4



The compressive strength values at various proportions of steel fibers given in the following Table-15.

Table-20.

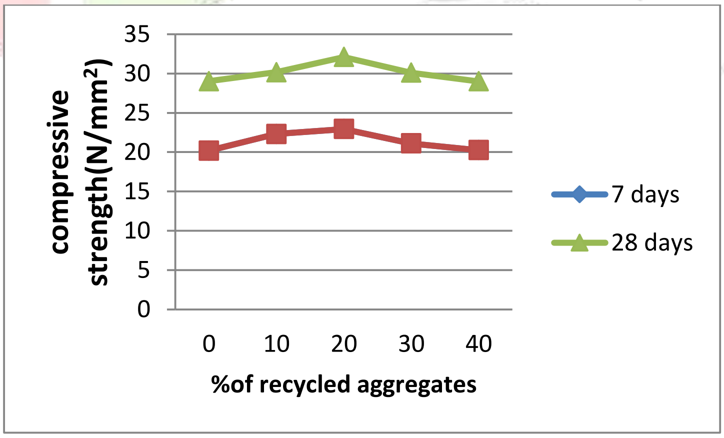
%Age of steel fibers	Compressive strength(N/mm^2)	
	7-Days	28-Days
1	21.182	28.037
2	22.117	29.557
3	23.249	31.430
4	22.315	29.746
5	21.560	29.614



Graph plot for variation of compressive strength with different % of steel fibers

The compressive strength values at various proportions of Recycled aggregates given in the following Table-21.

%Age of Recycled aggregates	Compressive strength(N/mm^2)	
	7-Days	28-Days
0	20.182	29.037
10	22.317	30.157
20	22.949	32.109
30	21.115	30.106
40	20.260	29.014



Graph plot for variation of compressive strength with different % of Recycled aggregates

Table for split tensile strength of concrete at various proportions of Rice husk ash is given below.

TABLE-23

%AGE OF Rice husk ash	Split tensile strength(N/mm^2)	
	7-DAYS	28-DAYS
0	2.310	3.348
1	2.405	3.536
2	2.551	3.725
3	2.449	3.631
4	2.357	3.348

GRAPH-6

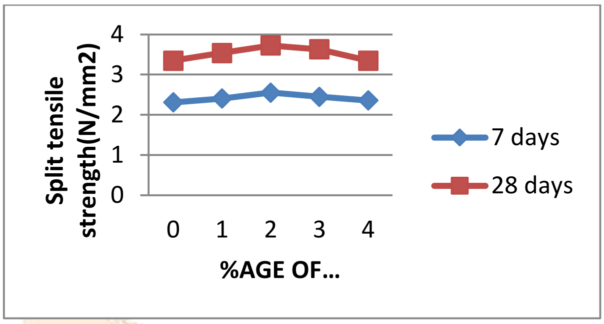


Table for split tensile strength of concrete at various proportions of steel fibers is given below. Table -24

%AGE OF STEEL FIBERS	Split tensile strength(N/mm^2)	
	7-DAYS	28-DAYS
1	3.210	4.248
2	3.305	4.436
3	3.451	4.625
4	3.349	4.531
5	3.257	4.248

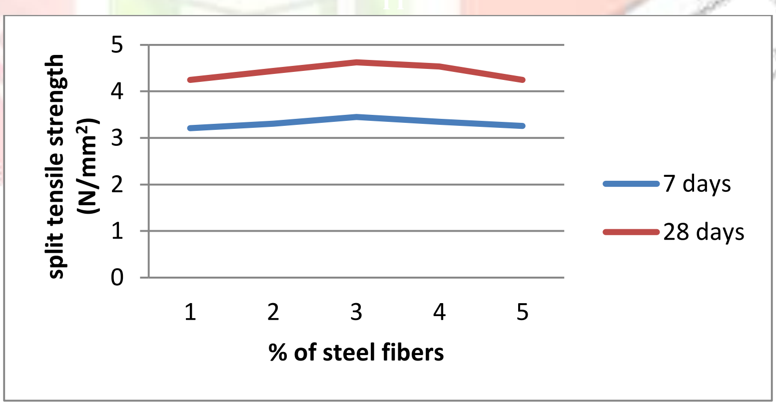
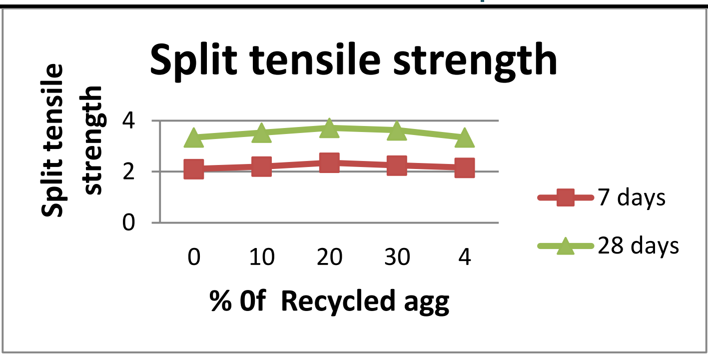


Table for split tensile strength of concrete at various proportions of Recycled aggregates is given below. Table-25

%AGE OF Recycled agg	Split tensile strength(N/mm^2)	
	7-DAYS	28-DAYS
0	2.110	3.348
10	2.205	3.536
20	2.351	3.725
30	2.249	3.631
40	2.157	3.348



From this table we get that workability of concrete decreases with the increase of powder content and the compressive strength and Split tensile strength increases up to 50 percent decreases more than that percent in early and lateral ages also.

At which percent that means 10 percent of powder properties of the concrete mix are given below.

The Workability of concrete mix by means of slump (mm) =57
At 7-Days, The % of increase of compressive strength =10.241%
The % of increase of Split tensile strength =16.666%
At 28-Days, The % of increase of compressive strength =11.688%
The % of increase of Split tensile strength =17.285%

TABLE-27
Properties for Concrete mix for various proportions of Rice husk ash

%0f Rice husk ash	Workability Slump(mm)	Compressive strength (N/mm^2)		Split tensile strength (N/mm^2)	
		7-DAYS	28-DAYS	7-DAYS	28-DAYS
0	57	22.249	32.430	2.310	3.348
1	53	23.191	34.127	2.405	3.536
2	48	24.134	35.447	2.551	3.725
3	41	23.569	34.882	2.449	3.631
4	35	22.814	33.750	2.357	3.348

From this table we get that workability of concrete decreases with the increase of Rice husk ash and the compressive strength and Split tensile strength increases up to 2 percent decreases more than that percent in early and lateral ages also.

At which the Workability by means of slump (mm) =48
At 7-Days, The % of increase of compressive strength =9.303%
The % of increase of Split tensile strength =10.43%
At 28-Days, The % of increase of compressive strength = 8.472%
The % of increase of Split tensile strength =11.26%

TABLE-28 Properties for Concrete mix for various proportions of steel fibers

% 0f steel fibers	Workability Slump(mm)	Compressive strength (N/mm^2)		Split tensile strength (N/mm^2)	
		7-DAYS	28-DAYS	7-DAYS	28-DAYS
1	60	21.182	28.037	3.210	4.248
2	58	22.117	29.557	3.305	4.436
3	56	23.249	31.430	3.451	4.625
4	52	22.315	29.746	3.349	4.531
5	51	21.560	29.614	3.257	4.248

From this table we get that workability of concrete decreases with the increase of steel fibers content and the compressive strength and Split tensile strength increases at 3 percent. At which percent that means 3 percent of steel fibers properties of the concrete mix are given below.

The Workability of concrete mix by means of slump (mm) =56
At 7-Days, The % of increase of compressive strength =14.180%
The % of increase of Split tensile strength =7.589%
At 28-Days, The % of increase of compressive strength =12.101%
The % of increase of Split tensile strength =8.870%

TABLE-29

Properties for Concrete mix for various proportions of Recycled aggregates

%0f Recycled aggregates	Workability Slump(mm)	Compressive strength (N/mm^2)		Split tensile strength (N/mm^2)	
		7-DAYS	28-DAYS	7-DAYS	28-DAYS
0	61	20.182	29.369	2.110	3.348
10	58	22.317	30.157	2.205	3.536
20	54	22.949	32.109	2.351	3.725
30	52	21.115	30.106	2.249	3.631
40	49	20.260	29.014	2.157	3.348

From this table we get that workability of concrete decreases with the increase of recycled aggregates content and the compressive strength and Split tensile strength increases up to 20 percent.

At which percent that means 20 percent of Recycled aggregates properties of the concrete mix are given below.

The Workability of concrete mix by means of slump (mm) =54
At 7-Days, The % of increase of compressive strength =13.71%
The % of increase of Split tensile strength =11.42%
At 28-Days, The % of increase of compressive strength =9.329%
he % of increase of Split tensile strength =11.26%

From the experimental investigation, consider 3 percent of steel fiber as admixture, 20 percent of recycled aggregates as replacement of coarse aggregates, 2 percent of rice husk ash as replacement of cement and 10percent of powder as replacement of fine aggregates is chosen for this study and conducted test for determining compressive strength and split tensile strength for M25 mix.

THE AIM OF THIS RESEARCH IS TO:

CHAPTER-IX
CONCLUSION

From the investigations carried out, the following conclusions can be made:

1. The Compressive Strengths of concrete reduced as the percentage RHA replacement increased.
2. Partial fine aggregates replacement in concrete mix by powdered leads to a reduction in the density of the final product, because the specific gravity of used was less than that of fine aggregates.
3. Decreasing in the concrete strength (compressive and tensile strength) with the increasing powdered content in the mixture is always detected as shown in Figs. 16 and 17. The strength reduction may be attributed to two reasons. First, because the particles are much softer (elastically deformable) than the surrounding mineral materials, and on loading, cracks are initiated quickly around the particles in the mix, which accelerates the failure of the cement matrix. Second, soft particles may behave as voids in the concrete matrix, due to the lack of adhesion between the particles and the cement paste.
4. The workability of concrete mix decreases with the increase of the Rice husk ash at 50 percent and the workability is 53mm of slump at 1 percent of Rice husk ash and 35 mm of slump at 4 percent of Rice husk Ash
5. Compressive strength and Split tensile strength of concrete mix increases at 2 percent of Rice husk ash and Compressive strength and split tensile strength of concrete mix increases at 10% of powder.

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