STUDY ON STRENGTH AND DURABILITY CHARACTERISTICS OF CONCRETE CONTAINING RICE STRAW ASH AND FOUNDRY SAND

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ABSTRACT

The production of raw cement results in carbon emissions into the environment which is also a serious agenda that needs to be solved quickly before it's too late for the environment. Almost 8% of total carbon emissions from all over the world come from the cement industry. Billions of tons of carbon dioxide gas are being released into the environment when cement is produced in the manufacturing plants which are damaging the ozone layer of the earth. In current study, the sustainable concrete of M35 grade using rice straw ash (5%, 10%, 15% and 20%) and foundry sand (5%, 10%, 15% and 20%) by substituting cement and fine aggregates respectively was prepared and its various strengths were determined.

Keywords: Sustainable Concrete, Rice Straw Ash, Foundry Sand.

INTRODUCTION

Concrete structures, the most common structures, are being constructed with cement, aggregates, water, reinforcing bars (steel bars) with the addition of an external enhancing agent. This material in the fresh stage shows different behavior than the behavior of hardened concrete. millions of raw cement, sand (both coarse and fine), water, and steel bars are being excavated or produced in different parts of the world to meet the high demand of construction industries. The study and investigation of the properties at different stages of concrete and its application comes under the field of concrete technology. all the load-bearing structures are being with concrete as they can easily withstand heavy loads. Different kinds of cement such as OPC, PPC, Rapid hardening cement, etc are being used in daily constructional work.

In modern world, thousands of researchers play an impeccable role and without all these researches and researchers, the enormous and complicated structures would not have been possible to construct. The work of such an industry continues even in times of pandemic and becomes essential after calamities. Thousands of companies are operating different small scale and large scale projects throughout the world and millions of people are working in such companies with different skill sets and different academics. Each year for the construction industry is much more innovative and focused than the previous year.

MATERIAL USED:

Cement: Ordinary Portland cement (grade 43) was taken confirming to IS: 8112 code. The different cement properties like consistency, initial and final setting time, specific gravity, etc were determined in the laboratory.

Table: 1. Physical Properties of OPC 43 grade.

S. No.	Properties	OPC 43 Grade	Requirement As Per IS Code
1.	Standard Consistency	28.8%	-
2	Initial Setting Time (min.)	135	>30
3	Final Setting Time (min.)	346	<600
4	Specific Gravity	3.15	3-3.15
5	Specific Surface Area (cm2/g)	2736	>2250

Fine Aggregates: The size of the fine aggregates lies between the 4.75 mm and 75 microns. The determination of physical properties and sieve analysis confirming to IS 383:2016 of fine aggregates was done and the results are shown in the tables given below:

Table: 2. Physical Properties of Fine Aggregates

Test	Result
Specific Gravity	2.64
Fineness Modulus	2.84
Water Absorption	1.16%

Coarse Aggregates: Angular shaped and crushed aggregates were used as coarse aggregates in the present experimental study. The 10 mm coarse aggregates were selected for the current study. The determination of physical properties and sieve analysis confirming to IS 383:2016 of coarse aggregates was done and the results are shown in the tables given below:

Table: 3. Physical Properties of Graded Coarse Aggregates

Test	Result
Color	Grey
Shape	Angular
Specific Gravity	2.68
Water absorption	0.61%

Rice Straw Ash: Rice straw is the end product of rice production and is obtained after the harvesting of rice. It is separated from the rice grains while harvesting the rice crop and is piled up in the corner through different machines. Straw to paddy ratio normally ranges from 0.7 to 1.4 which is highly dependent on the variety of rice and its growth methodologies. The specific gravity of RSA is 2.25 g/cc.

Foundry Sand: Foundry sand is high-quality, clean, and uniform-sized silica sand with constant physical features. It is an end product of the ferrous and non-ferrous metal manufacturing companies. The sand is connected to form molds or patterns used for ferrous (iron and steel) and non-ferrous (copper, aluminum, brass) metal castings. In everyday foundry utilization, sand is commonly reclaimed and reused when it is processed through many different cycles. The foundry sand has the capacity to replace the fine aggregates in concrete. The specific gravity of foundry sand is 2.65 g/cc.

CONCRETE MIX PROPORTION

The various concrete mixes i.e. control concrete mix and replacement concrete mixes were prepared as per the addition of different proportions of replacement materials. The total 5 concrete mixes were developed in current study as Cm, M1, M2, M3 and M4.

Table: 4. Different Concrete Mix Designations

Mix Design	Rice Straw Ash %	Foundry Sand %
CM	0	0
M1	5	5
M2	10	10
M3	15	15
M4	20	20

RESULTS AND DISCUSSION

Slump test results:

The slump value of control mix (without any replacements) comes out to be 105mm. whereas, the slump value for concrete mix M1, M2, M3 and M4 comes out to be 96 mm, 89 mm, 75 mm and 71 mm respectively.

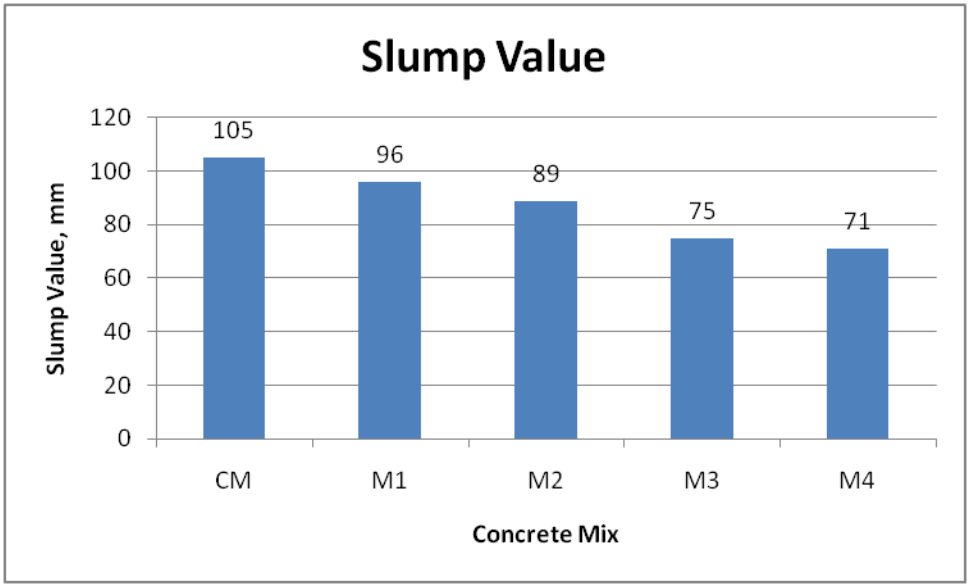

Figure 1. Slump Values for various Concrete Mixes

Compressive Strength:

The compressive strength of control mix (without any replacements) comes out to be 29.02 MPa at 7 days and 44.75 MPa at 28 days. Whereas, the Compressive strength for concrete mix M1, M2, M3 and M4 comes out to be 30.84 MPa at 7 days and 45.98 MPa at 28 days, 32.87 MPa at 7 days and 47.16 MPa at 28 days, 34.11 MPa at 7 days and 48.01 MPa at 28 days, 29.41 MPa at 7 days and 45.17 MPa at 28 days respectively.

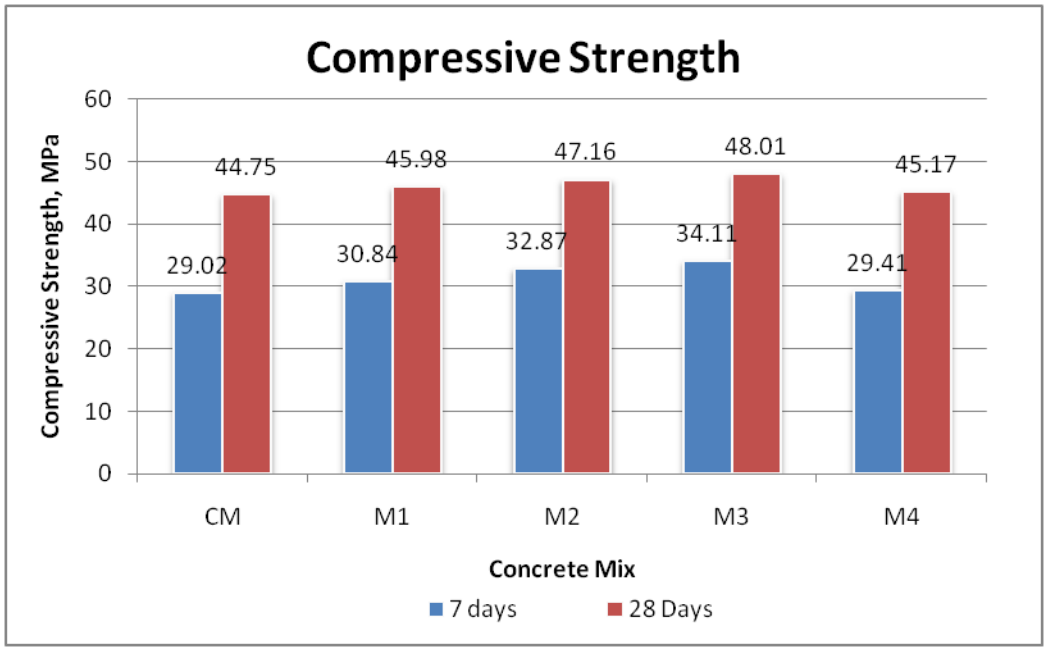

Figure 2. Compressive strength of various Concrete Mixes.

Split Tensile Strength:

The Split tensile strength of control mix (without any replacements) comes out to be 2.15 MPa at 7 days and 3.14 MPa at 28 days. Whereas, the Compressive strength for concrete mix M1, M2, M3 and M4 comes out to be 2.49 MPa at 7 days and 3.67 MPa at 28 days, 2.84 MPa at 7 days and 4.09 MPa at 28 days, 3.31 MPa at 7 days and 4.81 MPa at 28 days, 2.24 MPa at 7 days and 3.09 MPa at 28 days respectively.

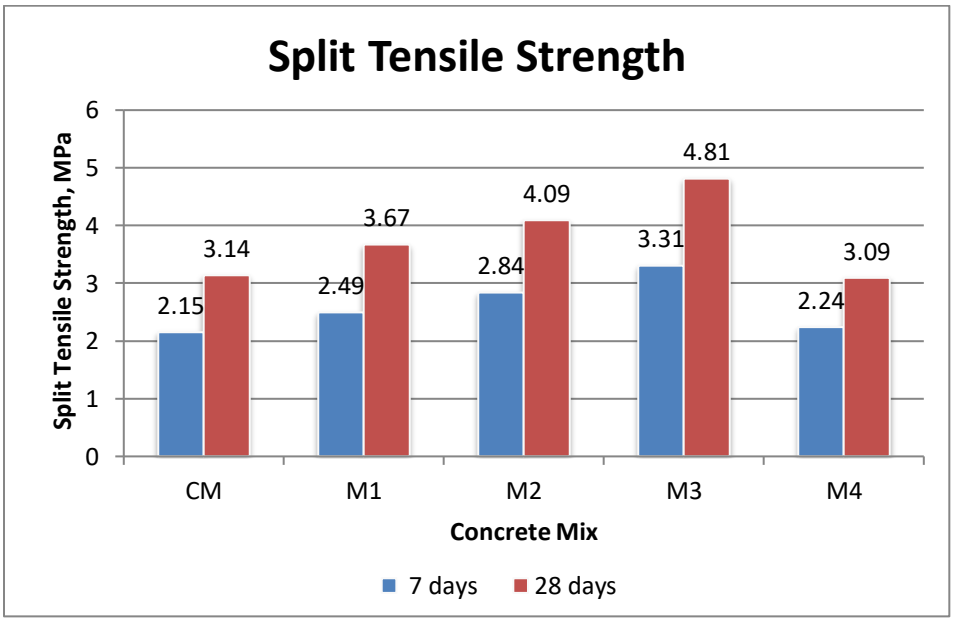

Figure 3. Split Tensile strength of various Concrete Mixes.

Flexural Strength:

The Flexural strength of control mix (without any replacements) comes out to be 3.51 MPa at 7 days and 5.04 MPa at 28 days. Whereas, the Compressive strength for concrete mix M1,

M2, M3 and M4 comes out to be 3.74 MPa at 7 days and 5.31 MPa at 28 days, 3.99 MPa at 7 days and 5.71 MPa at 28 days, 4.21 MPa at 7 days and 6.01 MPa at 28 days, 3.71 MPa at 7 days and 5.19 MPa at 28 days respectively.

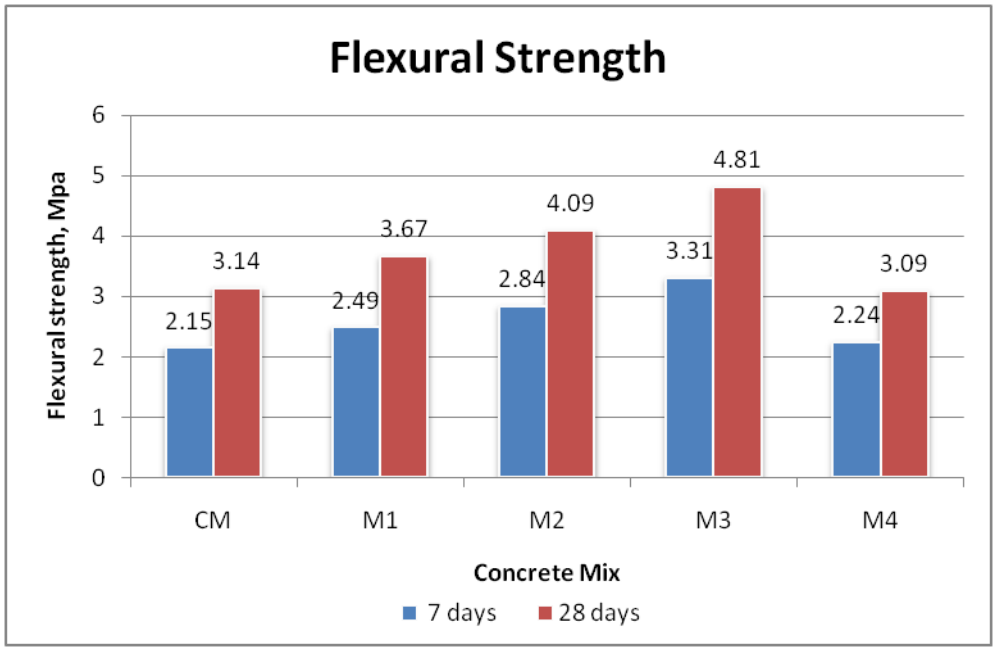

Figure 4. Flexural strength of various Concrete Mixes.

Water Absorption Test:

The % water absorption of control mix (without any replacements) comes out to be 2.72 %. Whereas, the % water absorption for concrete mix M1, M2, M3 and M4 comes out to be 2.55%, 2.48%, 2.43% and 2.39% respectively.

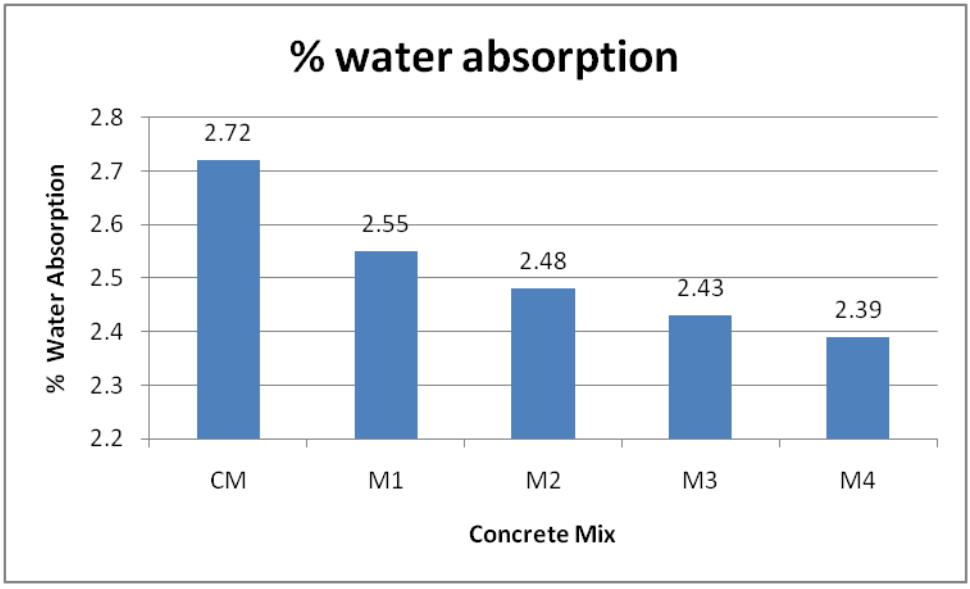

Figure 5. % Water Absorption of various Concrete Mixes.

CONCLUSION

After scrutinizing the results of all the laboratory results, the conclusions for the current experimental study was drawn and optimum dosage of the replacement material was suggested. The conclusions of the study are as follows:

i. The slump value of control mix comes out to be 105 mm. From the results, it is concluded that the slump value tends to decrease with the addition of replacement materials i.e. rice straw ash and foundry sand. The percentage decrease in the slump value for concrete mix M1, M2, M3 and M4 is -8.57%, -15.2%, -28.57% and -32.38% respectively.

ii. The compressive strength of control mix comes out to be 29.02 MPa at 7 days and 44.75 MPa at 28 days. The percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 7 days is +6.27%, +13.2%, +17.54% and +1.34% respectively. Whereas, the percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 28 days is +2.75%, +5.39%, +7.28% and +0.94% respectively.

iii. The Split tensile strength of control mix comes out to be 2.15 MPa at 7 days and 3.14 MPa at 28 days. The percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 7 days is +15.81%, +32.09%, +53.95% and +4.19% respectively. Whereas, the percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 28 days is +16.88%, +30.25%, +53.18% and -1.59% respectively.

iv. The Split tensile strength of control mix comes out to be 3.51 MPa at 7 days and 5.04 MPa at 28 days. The percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 7 days is +6.55%, +13.68%, +19.94% and +5.70% respectively. Whereas, the percentage increase/decrease in the compressive strength value for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 28 days is +5.26%, +13.29%, +19.25% and -2.98% respectively.

v. The % water absorption of control mix comes out to be 2.72 %. The percentage decrease in the % water absorption for concrete mix M1, M2, M3 and M4 w.r.t. control mix at 7 days is -6.25%, -8.82%, -10.66% and -12.13% respectively.

It can be clearly seen that the strength parameters of concrete mix M3 is maximum. Therefore, it is finally suggested to collectively utilize 15% of Rice Straw Ash and 15% Foundry Sand to obtain optimum strength of concrete.

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