Concrete Mix Theories (Comparative Study between is Code and ACI Code)

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Abstract— With the development of concrete technology and through the growing number of tall building structures, the use of higher strength concrete is becoming more popular. High strength concrete has grown quite attractive to civil engineers and substantial scientists as it displays advanced workability, superior mechanical properties and improved durability. High strength concrete (HSC) has been progressively used in the structures like tall buildings, flyovers, bridges and offshore structures. In (India) as well in our state (J&K) the use of HSC is gaining importance, for example M45 grade of concrete has been utilized in Jahangir Chowk-Rambagh flyover. Now the problem lies in the mix design of concrete by nearby obtainable materials. As mix design is a method of stipulating the combination of constituents mandatory to come across expected properties of fresh and hardened concrete. Concrete mix design is a well-established exercise round the globe. Wholly advanced countries, in addition to numerous emergent countries, have established their concrete mix design method an acute assessment of mix design approaches have been approved out for M40 grade of concrete using American Concrete Institute (ACI) and Bureau of Indian Standards (BIS) methods to find the resemblances and alterations between the two design theories. The scope of our study is to compare ACI and IS recommended mix design guidelines for High Strength Concrete (M40). The purposes of the study is to develop concrete of grade M40 using native materials under local environmental conditions using IS and ACI methods.

Keywords: Concrete Mix Theories, High strength concrete (HSC), American Concrete Institute (ACI) and Bureau of Indian Standards (BIS) methods

I. Introduction

The use of concrete dates back from early periods for building purposes like construction of buildings, bridges, roads etc. It has been assessed that the present consumption of concrete is around 9.5 billion tons in the domain every year. In the older plus in present, efforts are put to improve the properties of Concrete like compressive strength, tensile strength, durability etc. This is attained by many ways and one of the approaches is decrease in the water cement ratio (w/c).At very small water cement ratio, it becomes difficult to mix the concrete to desired workability. To overcome this problem chemical admixtures like plasticizers and super plasticizers are used. The use of super plasticizers is the greatest significant development in concrete know-how in the past 30 years. The reason that super plasticizers are gaining more importance as related to further chemical admixture is as they improve workability, compatibility and facilitate reduction in W/C ratio, and thereby upsurge the strength of concrete.

II. LITERATURE REVIEW

Ravinder Singh and Dr. S.K Verma (2017) did a comparative study of different testing procedures of concrete mix design of M20 and M25 grades. Different structures were being measured for testing the constraints relating to designed testing methods. This analysis is witnessed for overall strength and behavior of testing specimens which were used for testing, and this is relevant to both grade which was considered i.e. M20 and M25. The mean strength examination for ACI process in case of M25 was unsuccessful to achieve the preferred outcome which was obvious for design parameter, thus failed test for M25 relating to mean strength in case of ACI.

Deepa A. Sinha(2015) The main objective of the study was to design M25 concrete mix and find the compressive strength using different mix design methods like IS10262-1982, IS 10262-2009, ACI method. (Alccofine has distinctive property to improve the „performance of concrete' in fresh and hardened stages due to its much finer particle size. Alccofine is processed by certain measured circumstances with special method to yield micro fine size. Alccofine is largely two kinds one is low calcium silicate which is Alccofine 1203 and other is high calcium silicate which is Alccofine 1101.).It amplified the strength and workability of the concrete.

III. Materials Used

A. Cement

In the present study, ordinary Portland cement 53 grade with brand name 'TCI CEMENT' with properties as discussed below was used. The cement was of uniform color i.e., grey with light greenish shade.

B. Fine Aggregate

The sand used as fine aggregates is locally available natural river (Jhelum) sand of the size less than 4.75mm.

C. Coarse Aggregate

Locally available coarse aggregate having the maximum size of 20mm was used in this work.

D. Water

Water suitable used for drinking purposes was used in concrete. It was recognized to be free from suspended solid and organic materials.

E. Admixture

Super plasticizer Structure 480 has been utilized as a water reducing admixture. The standard dose series is from 1.0 to 4.0 litre/cum of concrete material. Generally, the admixture should then be supplementary to the concrete with the water mixing to gain the best results.

F. Rice Husk Ash

Rice Husk Ash (RHA) is a waste product which is produced as a by-product of rice milling industries. As the consequence of increasing pollution use of rice husk has involved abundant attention.

IV. MIX DESIGN

A. Mix design of grade M40 by ACI method

1) Trial I

Proportions of materials (w/c ratio=0.4)

Cement	CA	FA	Water	Superplasticizer
1.0	2.72	1.767	0.40	0.01
32.8	98.0	58.00	13.50	0.33

2) Trial II

Proportions of Materials Obtained In ACI Method (W/C Ratio=0.37)

Cement	CA	FA	Water	Superplasticizer
1.0	2.51	1.56	0.37	0.01
35.89	90.00	55.98	13.50	.36

3) Trial III

Proportions of Materials Obtained In ACI Method (W/C Ratio=0.35)

Cement	CA	FA	Water	Superplasticizer
1.0	2.72	1.7675	0.40	0.01
32.8	98.00	58.00	13.50	0.33

B. Mix design of grade M40 by ACI method

1) Trial I

Proportions of materials obtained in IS method (w/c ratio=0.4)

Cement	CA	FA	Water	Superplasticizer
1.0	3.4	1.53	0.40	0.01
32.31	111.50	50.06	12.921	0.323

2) Trial II

Proportions of materials obtained in IS method (w/c ratio=0.37)

Cement	CA	FA	Water	Superplasticizer
1.0	3.033	1.369	0.37	0.01
35.35	107.25	48.43	12.921	.35

3) Trial III

Proportions of materials obtained in IS method (w/c ratio=0.35)

Cement	CA	FA	Water	Superplasticizer
1.0	2.72	1.767	0.40	0.01
32.8	98.00	58.00	13.50	0.33

V. REPLACEMENT OF CEMENT WITH RICE HUSK

Control specimen (MCS) was designed as per IS 10262-2009 to achieve M40 grade of concrete with w/c ratio of 0.4. Concrete were produced with 0, 9.5, 12.0 and 15% of the RHA as cement replacement levels.

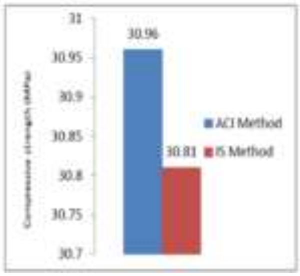
Mix	MCS	MR 9.5	MR12.0	MR15.0
Cement (kg/m^3)	493.7	442.5	428.4	418.63
FA (kg/m^3)	755	755	755	755
CA (kg/m^3)	968	968	968	968
Water (lit/m^3)	197	197	197	197
RHA (%)	0%	9.5%	12.0%	15%

VI. RESULTS & DISCUSSIONS

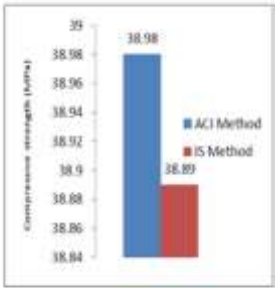
IS method proves less economical than ACI technique so as to enrich the strength and to decrease the cement content in IS method rice husk ash as a limited replacement for cement was proven to be economical and improves the strength in IS method.

A. Compressive Strength Test

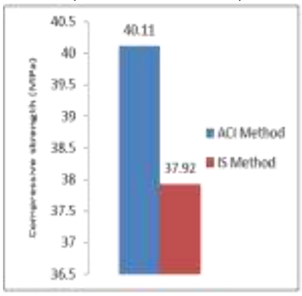
Comparison of compressive strength is done for same water cement ratio (w/c ratio) as shown



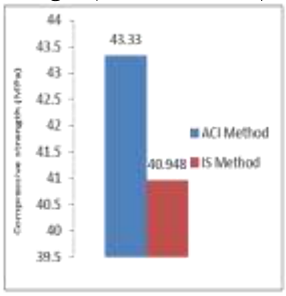
7 day compressive strength (W/c ratio = 0.4)



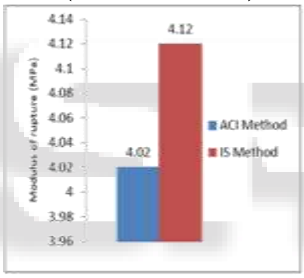
28 day compressive strength (W/c ratio = 0.4)



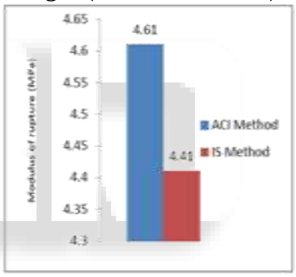
7 day compressive strength (W/c ratio = 0.37)



28 day compressive strength (W/c ratio = 0.37)



7 day compressive strength (W/c ratio = 0.35)



28 day compressive strength (W/c ratio = 0.35)

The above given figures also indicate that ACI method performed better with some exceptions in some cases. This is also obvious that in general modulus of rupture and compressive strength are directly proportional.

VII. ENHANCEMENT OF STRENGTH BY ADDING RICE HUSK AT WATER CEMENT RATIO OF 0.40 WITHOUT ADDITION OF SUPERPLASTICIZER (IS METHOD)

The area of interest of the thesis was to compare the results the ACI code and IS code. The conclusion drawn from research was IS method gives less strength and is less economical than ACI method. Now another idea was how to improve the strength and become more economical. As rice hush ash is readily available and is available on low cost it was used as partial replacement of cement. Strength properties were compared with that of IS method. The chief aim of the partial replacement of cement was how to upsurge the compressive strength for comparison with the ACI method.

Compressive strength obtained by IS design method was less than ACI method and was less economical than ACI method. In order to enhance the Strength properties and to be on economical side partial replacement of cement with rice husk ash was done. Compressive strength results at various ages such as 7, 28 days for different replacement levels such as 0%, 9.5%, 12% and 15% of cement with Rice husk ash have been shown in the table

Mix	% RHA	7days strength	28 days strength
MCS	0	27.34	40.05
MR 9.5	9.5	31.51	40.11
MR 12	12	36.81	42.13
MR 15	15	30.28	42.01

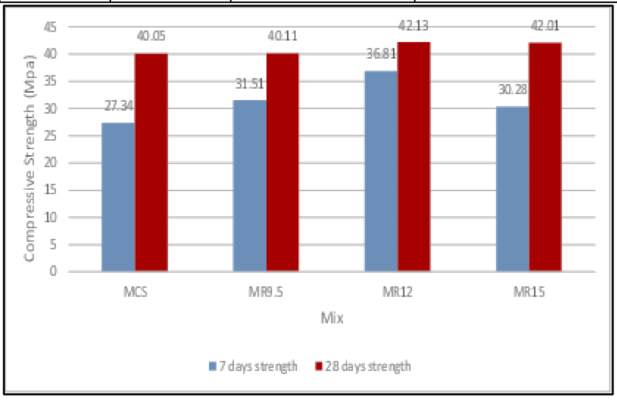


Fig. 4: Comparison of Compressive Strength Results for various mixes

VIII. Conclusions

Grounded on the examination of the trials, we arrived at the below mentioned conclusions:

1) Fines content in ACI is higher, which makes for higher workability. Presumably, this similarly adds to improved strength as the cavities are occupied, particularly as witnessed in the 40 MPa trial cases. While considering ISI, fine aggregate content is decreased as the design strength requisite increases. Thus, cavities are expected to be greater for greater strengths, therefore causing reduced strength in such cases.
2) The quantity of cement for greater strengths in ISI upsurges because of fine aggregates, contributing for generally lesser fines to coarse ratio, which perhaps affects the strength accomplishment.
3) ACI proved to be more economical.
4) The empirical formula for modulus of rupture remains valid.
5) The correlation between 7 day and 28 day strength and also between 14 day and 28 day strength was different as because of use of higher grade of cement which resulted in early achievement of strength.
6) 7 and 28days compressive strength of mixes that contained Rice husk ash was more than that of mixes without Rice husk ash in IS method. Thus, addition of Rice husk ash as partial replacement to cement increases the strength. Rice husk ash acts as pozzolanic material, increasing the strength of concrete.
7) The compressive strength of concrete was compared at a water cement ratio of 0.4 and there was a good development in compressive strength and was established to be much more economical.
8) The strength characteristics at 0.4 water cement ratio showed a steep increase in strength at 12% replacement of cement with rice husk ash.
9) 28days compressive strength of mix 12% RHA showed the highest strength when compared to other replacement levels of RHA with Cement.
10) As the replacement of cement by RHA in concrete upsurges, the workability of concrete declines.

References

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