International Journal of Scientific Research and Management (IJSRM)
||Volume||5||Issue||07||Pages||6377-6383||2017||
Website: www.ijsrm.in ISSN (e): 2321-3418
Index Copernicus value (2015): 57.47 DOI: 10.18535/ijsrm/v5i7.72

Comparative Study of M20 and M25 grades of Concrete by ACI, DOE and BIS Methods of Mix Design Using Crushed Aggregate

Ravinder Singh[1], Dr. S.K Verma[2]

PG Student, M.E (Structural Engineering), Dept. of Civil Engineering,
PEC University of Technology, Chandigarh.[1]
Associate Professor, Dept. of Civil Engineering,
PEC University of Technology, Chandigarh India.[2]

Abstract: ***The basis of this paper is to analyse comparative study of different testing methods of concrete mix design of M20 and M25 grades. Different structures are being considered for testing the parameters relating to designed testing methods. Design mix is process of amalgamating different composition of material so as to adhere the final composed material with required compressive strength, practicability, and resilience. The appropriate mixture of cement, sand aggregate and water are fabricated to achieve desired design mix. The test methods are internationally adopted accordingly the countries requirement and their acceptability of designing their structures. The specimens tested was compressive test- cube test, flexural test-beam test and split tensile test-cylinder test. The design method considered for testing was BIS method, DOE method & ACI method for defining the structure design for concrete. The study shows designs of concrete derived from DOE testing method are more superior to other two methods which were used for designing of concrete. This analysis is witnessed for overall strength and behaviour 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 analysis for ACI method in case of M25 was failed to attain the desired result which was marked for design parameter, thus failed test for M25 relating to mean strength in case of ACI. The specimens i.e. cubes, beams, and cylinder was moulded for both grades M20 and M25 accordingly there strength parameters. The curing was taken up at 7 day and 28 day process follow-up which is standard norm for all methods. The comprehensive analysis of both curing periods were listed out and thus comparison of strengths for all moulds were evaluated for better insight into the strength relation with curing period. It's is approximately similar for all methods thus showing curing period is independent of test method used. The DOE method showed best results among the listed methods taken up for study and DOE has competitive advantage in strength and its performance.***

Keywords: Mix design, compressive test, flexural test, split tensile test

1. Introduction

Concrete usage is increasing with the advancement of Indian economy boosting the infrastructure including buildings, public usage toilets, roads, railways and other areas of development. Strength of concrete is studied as major parameter and subject for consideration into application in various areas. Concrete is composed of physical mixture of cement, aggregate materials deriving from sand and water so as to arrive it to certain design specific mixture. Countries around the world has standardize the design of concrete which is based upon some methodology and follow up of these methods are mandatory in most of the countries. The design methods available for testing the mixture of concrete are: ACI mix design, DOE mix design method and BIS mix design method. These methods are based on ISI recommended guidelines and being used for testing's in this paper. The Bureau of Indian Standards (BIS), the National Standards Body of India responsible for formulating Indian Standards. Product certification is also an important wing of BIS to ensure the compliance adherence of specific material. The American concrete institution (ACI) is widely used in U.S and many of the norms is widely accepted around the world which take their references from ACI. In Indian context of testing methods, BIS and ACI are quite similar but difference lies in estimating the relative proportion of fine and coarse aggregates. The three methods which is used for analysis are ACI, DOE, and BIS methods for concrete mix design analysis on the basis of strength and performance for construction works including the highway and buildings. The test specimens which were moulded and tested was taken for 7 and 28 days curing period as per the International standards

2. Experiment objective

The experimental program aims to study the change in properties and performance of concrete. It is evaluated with the change in ratio of aggregates added to concrete and how final properties of concrete is related with composition when they are fabricated by different design text methods. The test methods considered were ACI, BIS and DOE.

Main Objectives:

i. To design the concrete mix adhering to two grades namely: M20 and M25.

ii. To design grades accordingly four test methods namely: ACI, BIS and DOE.

iii. To test 3 different specimens i.e. flexural-beam, compressive-cube and split tensile- cylinder and how their properties vary accordingly the different grades made out of test method and there performance. The Experiment consist of laboratory testing of different concrete designs which were prepared as per on the basis of methods i.e. ACI, BIS and DOE. The main purpose of testing this design is to figure of strength and performance of concrete which are carved out accordingly the guidelines mentioned in different test methods. The comparative analysis of different test methods results are also evaluated and laid down. The specimens considered are cube, cylinder, and beam to test compressive, split tensile and flexural strength. For each kind of specimens and test methods two different grades are considered i.e. M20 and M25. The curing norms of 7 and 28 days are kept same for all test methods. The experiment concludes the best results achieved from different kind of test methods which is laid in tabular format

. Composition

3.1 Cement

Portland cement of grade 43 is considered for fabricating the concrete structure.

The listed down tests were conducted for cement properties:

- Fineness test
- Standard consistency test
- Initial setting time test
- Final setting time test
- Specific gravity test
- Compressive strength test

3.2 Fine aggregate

The fine aggregates considered for the experiments is naturally available sand which is free from dirt, dust and other impurities. The sand considered was from Ghaggar River.
Few sand tests were also conducted for sand quality.

- Particle size by sieve analysis.
- Bulking of sand by volume method.
- Specific gravity test

3.3 Coarse aggregate

The slit free coarse aggregates were used which is derived from hard broken granite which is of size 12.5 mm and 20 mm. The guidelines were followed to ensure the coarse aggregates are used up in desired sizes.

3.4 Water

The potable tap water is considered which is free from any suspended particles and having a within range of BOD and COD properties. The same water is used for mixing and curing of the structure

4. Mix Designs

Properties of Aggregates:

Fine aggregates (Specific gravity) = 2.55
Coarse aggregates (specific gravity) = 2.65
Fineness modulus of fine aggregates = 2.14
Specific gravity of cement (OPC) = 3.14
Grading zone of fine aggregates = Zone 3
Characteristic compressive strength required = 25 N/mm^2
Maximum size of aggregate = 20 mm
Degree of workability required= 0.9 compaction factor
Quality control expected =Good
Cement used= OPC

Table 1: Mix proportions of M20 obtained as per different Mix Design Methods (kg/m^3)

Sr. No.	Type of mix design	ACI	BIS	DOE
1	W/C	0.52	0.50	0.52
2	Cement content	355	372	366
3	Coarse aggregates	1016	1195	1232
4	Fine aggregates	799	640	662
5	Water content	185	186	190

Table 2: Mix proportions of M25 obtained as per different Mix Design Methods (kg/m^3)

Sr. No.	Type of mix design	ACI	BIS	DOE
1	W/C	0.49	0.47	0.49
2	Cement content	378	383	387
3	Coarse aggregates	1016	1198	1255
4	Fine aggregates	776	630	618
5	Water content	185	180	190

5. Testing

The compression test, flexural test and split tensile strength test marks important basis of this paper and its observations are laid down so as to give detailed analysis on results and performance of concrete mix made out of both grades and with different text methods.

5.1 Compression Test

The compressive strength based on cubic specimen which is being used is analysed for both curing period of 7 and 28 days. The size of edge of cube under testing was 150 mm which was under continuous load of 14Mpa/min.

Observations

For the grade M20, the comparison was laid all cubical specimens of concrete based on different design methods and it was observed that all achieved target mean strength. The design method as per DOE method attributed to highest compressive strength and performance more than the target strength. The ACI and BIS showed same set of passed test with approximately same results. Overall all achieved the targeted strength.

For the grade M25, ACI was unable to reach the threshold targeted strength. The DOE and BIS methods attained the threshold value of strength. The redesigning was done for ACI method with increased amount of cement and found the results achievable which leads to a conclusion that ACI required more cement that other test methods. Overall the results obtained from DOE methods were quite impressive among the listed test methods

Figure 1:- Compressive strength of M20 grade of concrete

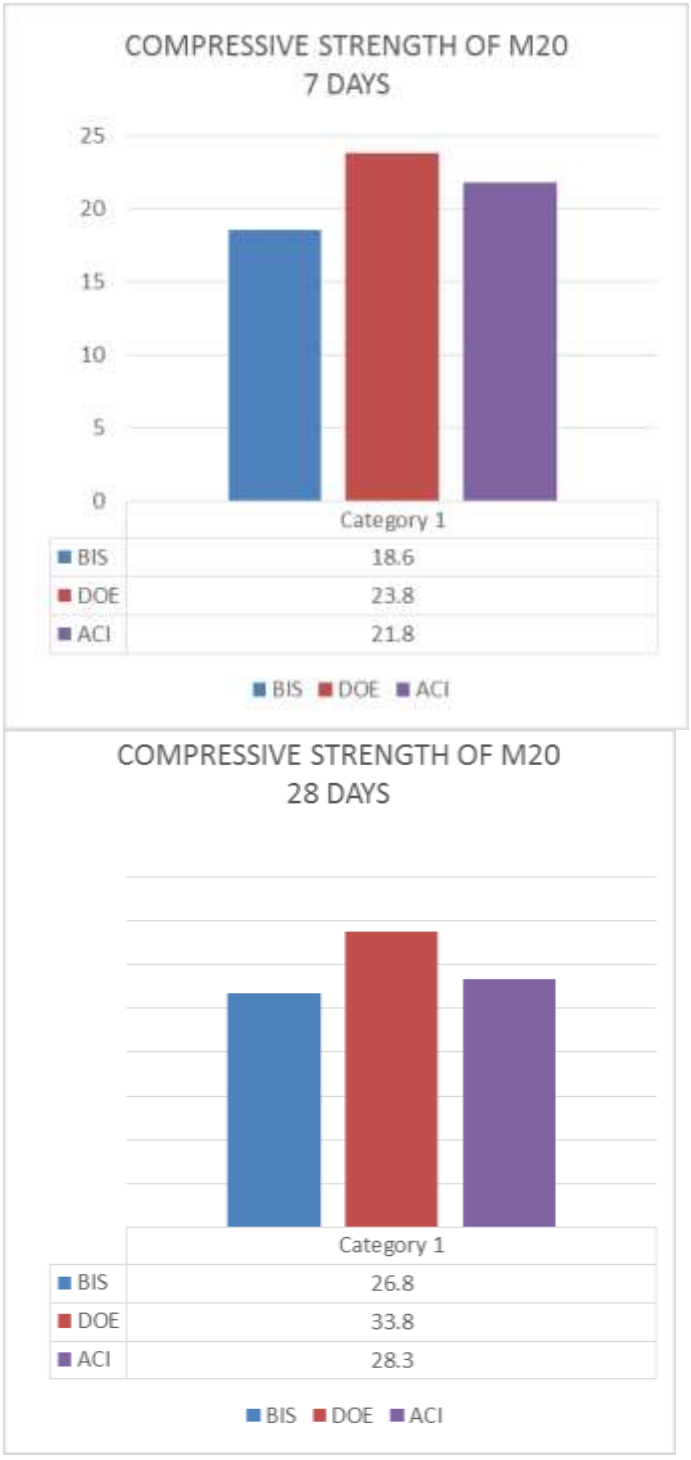
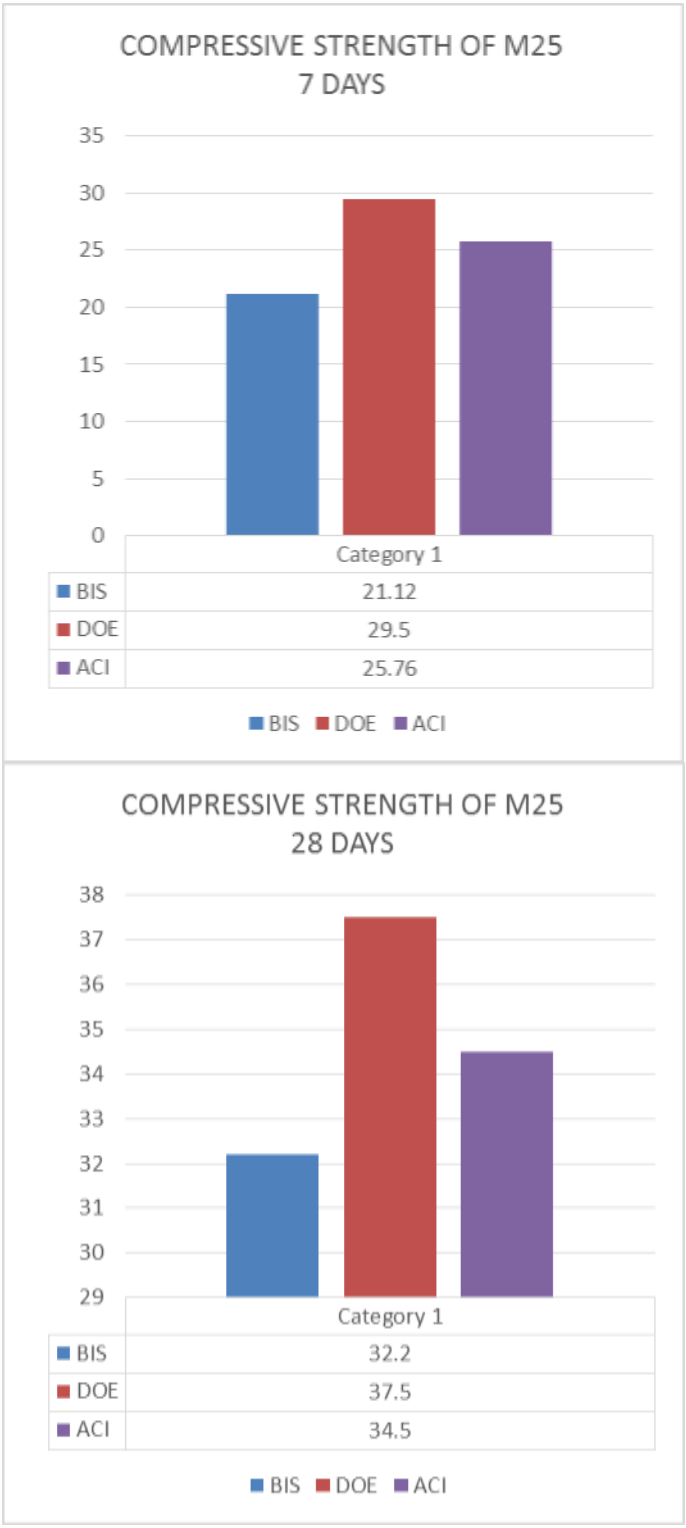


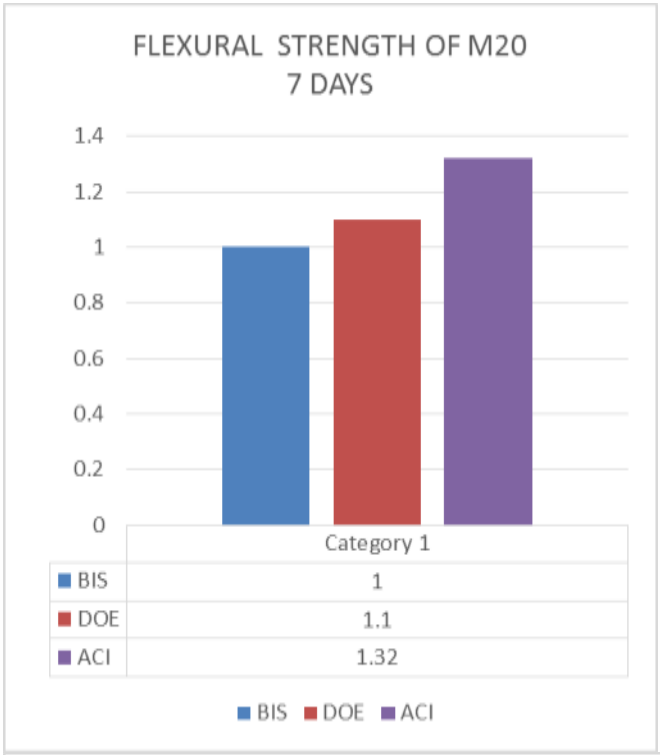
Figure 2:- Compressive strength of M25 grade of concrete

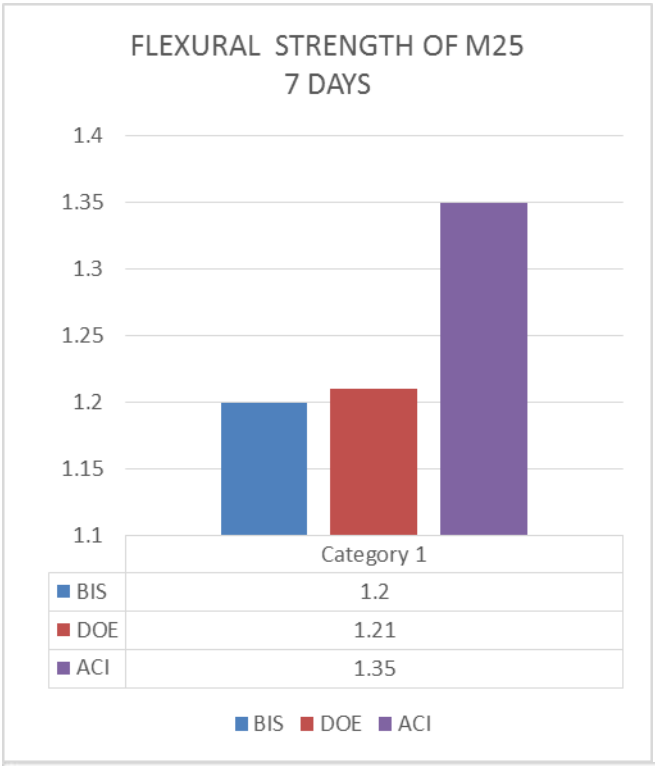


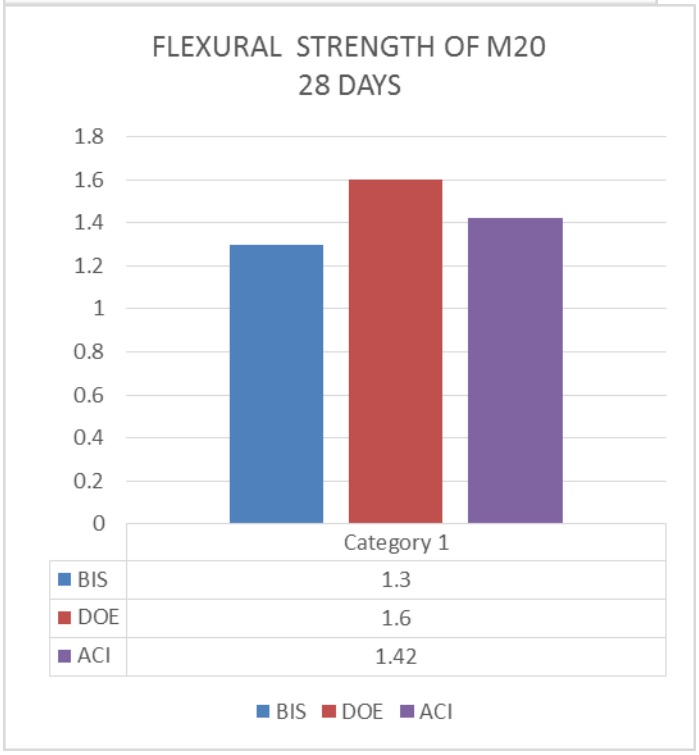
5.2 Flexure test of beams

The flexural strength of different samples was tested after 7 and 28 days of curing. The beam were tested on a flexural testing machine at loading rate 1kn/m. The ultimate flexural strength of the beams designed with different mix design methods is tabulated below

Figure 3:- Flexural strength of M20 grade of concrete







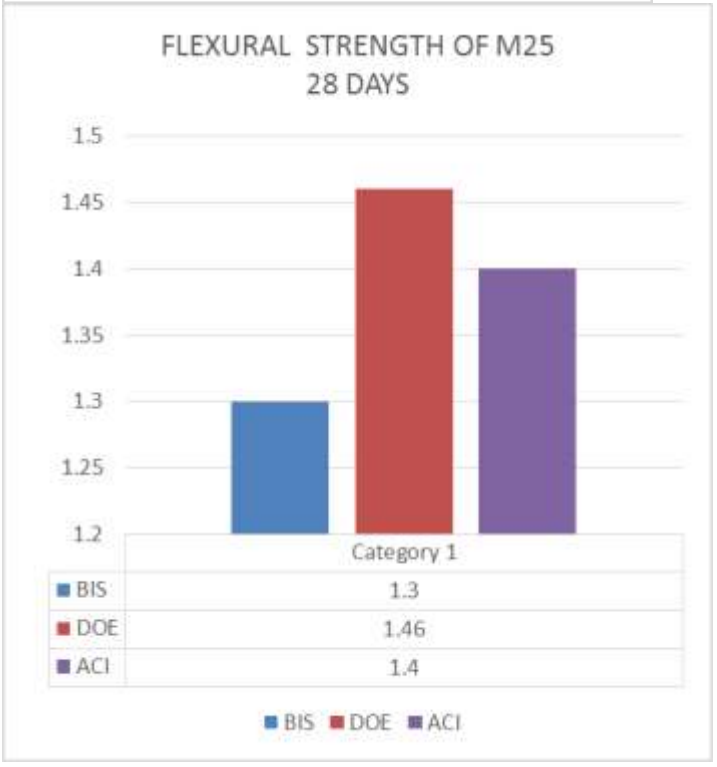


Figure 4:- Flexural strength of M25 grade of concrete

Observations

From experimental investigations, it was observed that flexure strength at concrete designed as per DOE method increased with time and is highest among the methods used after 28 days curing. After 28 days of curing both DOE and ACI methods attain a higher amount of flexural strength than rest of the methods. The BIS method achieved the least flexural strength even then it meets the minimal requirements of flexural strength. For M25 grade of concrete the BIS method delivered the best results in terms of flexural strength. Even DOE method exhibit much higher flexural strength than the ACI method

which was designed with an increased amount of cement to meet the minimum requirements of strength.

5.3 Split tensile strength

Test data obtained from the split tensile test .The split tensile strength of different cylinders was tested after 7 and 28 days of curing. The cylinders were tested on compression testing machine when loaded in a split tensile testing assembly under continuously increasing load @ 1 kN/min. The split tensile strength of the beams designed with different mix design methods is tabulated below

Figure 5:- Split tensile strength of M20 grade of concrete

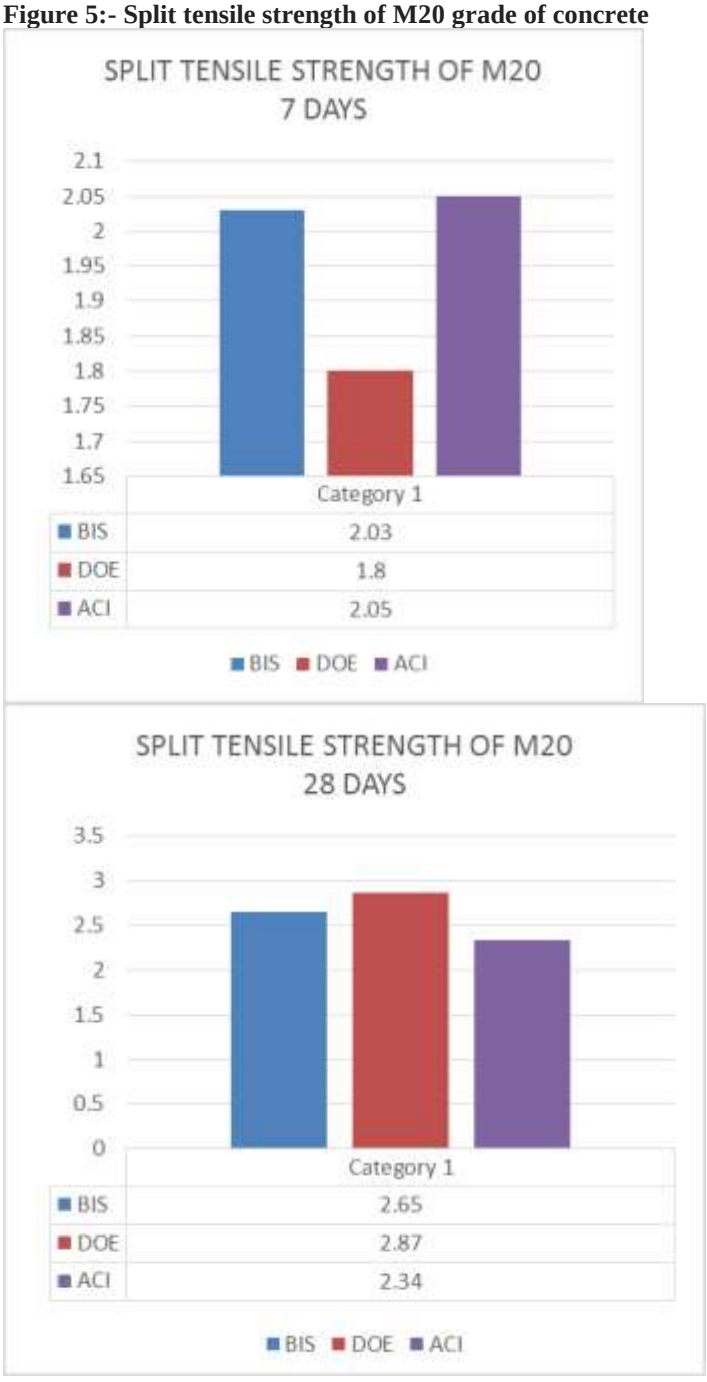
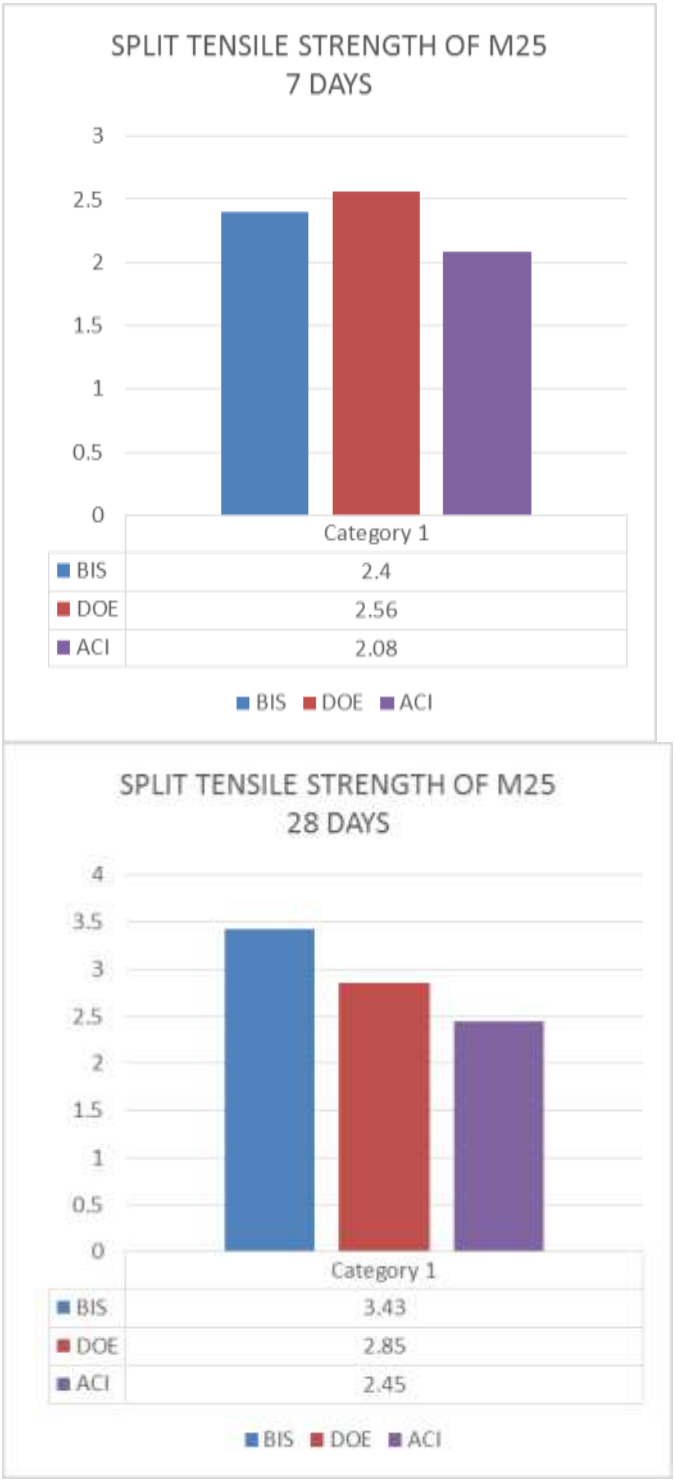


Figure 6:- Split tensile strength of M25 grade of concrete



Observations

After analysing the outcomes of split tensile test of concrete it was observed that for M20 grade. The concrete designed with DOE method owns maximum split tensile strength and that of by ACI method has the least among the four methods used for comparison. The split tensile strength BIS method has a marginal difference. For M25 grade the BIS method shows a vast increment in the split tensile strength as compared to M20 and achieved highest strength among the rest of the methods. Whereas the ACI method shows a marginal increase in split tensile strength again having the least strength as in case of M20. Turning down the pattern of M20. The marginal difference between split tensile strength of DOE is converted to

a reasonable difference in the split tensile strength for M25 grade. As the primary attributes of crushed aggregates that are of importance are the interlock and better quality of paste Presumably, the higher content of coarse aggregate in DOE and BIS method are responsible higher values of split tensile strength

6. Conclusions

Comparing the proportions of ingredients obtained by different mix design methods, it was observed that the DOE method uses the least amount of FA whereas, these are highest in ACI method. DOE method is using also a higher ratio of FA than BIS method providing a better packing of aggregates. The highest amount of aggregates is used in BIS method and least is in ACI method. For compressive strength of both M20and M25 grades the DOE and BIS methods are more adaptable. The Flexure strength of beams (M20) designed as per DOE method increased with time and is highest among the methods used after 28 days of curing. Although, after 28 days of curing both BIS and DOE methods attain a higher amount of flexural strength than rest two methods. After analysing the outcomes of split tensile test of concrete it was observed that for M20 grade, the concrete designed with BIS method owns maximum split tensile strength. The split tensile strength of DOE and ACI method has a marginal difference. For M25 grade the BIS method shows a vast increment in the split tensile strength as compared to M20 and achieved highest strength among the rest of the methods Overall behaviour of M20 in terms of mechanical properties of concrete was observed much better than that of the M25. Even the performance of concrete designed as per ACI method was admirable for this grade of concrete

References

[1] ACI Committee 211, 1991 (re-approved in 2002), Standard practice for selecting proportions for normal, heavyweight and mass concrete. American Concrete Institute, USA

[2] Aginam C. H., Urnenwaliri S. N. and Nwakire. C..."Influence of mix design methods on compressive strength of concrete",ARPN Journal of Engineering and Applied Sciences, Vol. 8, No. 6, .Tune 2013.

[3] Amarjit Singh and Kamal Gautama, "Comparison of IS and ACI methods for absolute volume concrete mix design", 30th Conference our world in concrete and structures: 23 -24 August 2005, Singapore

[4] Aruiraj.G Price and Rajam C.M Sruthi, "A Comparison between the Old and New Indian Codes for Concrete Mix", the International Journal of Engineering and Science (HES) Volume2, Issue 5, 2013Bureau of India Standard "Indian standard concrete mix proportioning Guidelines", (First revision) IS-l0262:2009, New Delhi, India.

[5] Bureau of India Standard, "Indian Standard Method Permeability of Cement Mortar and Concrete". IS: 3085 - 1965, Reaffirmed 2002, New Delhi, India

[6] Bureau of India Standard, "Code of practice for plain and reinforced concrete", fourth edition, IS-456; 2000, New Delhi.

[7] BIS Code IS: 456-2000. Code of Practice for Plain and Reinforced Concrete (fourth revision).

[8] BIS Code IS: 10262-2009. Code of Practice for Concrete Mix Proportioning- Guidelines (First Revision)

[9] BIS Code IS: 383-1970. Pacification for Coarse and Fine Aggregate from Natural Source for Concrete (Second Revision)

[10] Ritish. Code of practice for Concrete Mix Proportioning –Guidelines Concrete Mix Proportioning", Second national seminar on advances in materials and structure. IIT. Chennai, India

[11] Dimitri V Val and Mark "Life-cycle cost analysis reinforced concrete structures in marine Structural Volume 75. October 2008.

[12] Ellices M. and Rocco CG... "F Detect of Aggregate Size on the Fracture and Mechanical Properties of a Simple Concrete Engineering Fracture Mechanics, 75(la). 3889-3851, 2008.

[13] Erdem R, Tugrik and Kozanoglu Celal, "Investigation of Crushing Type of Concrete Aggregates on Mechanical Properties of Concrete," International Journal of Materials Engineering, 2012.

[14] Kannada A. and Kurama Eflfecrs of Coarse Aggregate types on Rh c Concrete."

[15] Mommies. Ehsani M.R... Ramezanianpour A.A. and H. Rajaie, "Comparison of methods for evaluating bond strength between concrete substrate and repair materials", Cement and Concrete Resea1*chi, Volume 35, Issue 4, April 2005

[16] Ozturan Turin et.al. "Effect of Coarse Aggregate Type on Mechanical Properties of Concretes with Different Strengths," Elsevier Ltd., 1997.

[17] SiaKeeSiegn, "Comparative study of reinforced*_concrete of column between American code (ACI 318-05) and British standards,'(BS 81 10-97) University Malaysia, 1 November 2010.

[18] Karma Singh and Praveen. ," Comparative Study of Concrete Mixed Design, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 9, September 2016.

[19] Kurnbhar P. D. and Mural P. B., "A New Mix Design Method for High Performance Concrete under Tropical Conditions", Asian Journal of Civil Engineering, Vol. 15, No. 3, 2014

[20] L. Francois and B. Albert. "The Influence of Aggregate on the Compressive Strength of Normal and High-Strength Concrete," September 1, 1997.

[21] M.C. Nararaja and LelinDas. "Concrete mix proportioning as per IS 10262:2009 Comparison with US 10262; 1982 and ACI 2111-91"

[22] Neville. A. M... "Concrete Technology". Fourth edition. Pearson Educatlon. New Delhi.

[23] Natraja, M.C, Lelin Das and N. Richard Sandeep "Comparison of Indian Standard Draft method and ACI Method

[24] Popat D. Kumbhar, Pradesh B. Murna1,"Assessment of suitability of existing mix design methods of normal concrete for designing high performance concrete mixes", International Journal Of Civil and Structure Engineering,Vo1ume 3, No 1, 2012

Author Profile

Ravinder singh received B.Tech degrees in Civil Engineering from Punjabi University Patiala, Punjab. Currently pursuing M.E. in Structure Engineering from PEC University of Technology, Chandigarh. His research interest lies in concrete mixed design.

Dr. S.K. Verma working as Associate professor in Civil Engineering Department of PEC University of technology, Chandigarh. His major research work lies in Wind Engineering, concrete behavior, Anlysis and design of structure