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Evaluation of different grades of concrete designed as per BIS and USBR methods using rounded aggregates

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Abstract - ***this paper represents the outcomes of the concrete designed as per BIS and USBR methods of mix design using rounded aggregates as coarse aggregates. In this research study, M35 and M40 grades of concrete were selected for determining the properties. The result indicates that the USBR method delivered better compressive strength as compare to BIS method for both M35 and M40 grades. M35 grade of concrete designed as per BIS method failed to achieve the target strength, but M40 grade showed satisfactory results. Split tensile and flexure strength results achieved by both methods were satisfactory.***

Key Words: *rounded aggregates, BIS and USBR methods, compressive, flexure and split tensile strength*

1. INTRODUCTION

Concrete is an assortment of paste and aggregates. The paste composed of Portland cement and water, coats the surface of the fine and coarse aggregates. It is widely used material due to its ability to form any shapes when in plastic state and acts like rock mass when hardened, which provides strength and an aesthetic view to the structure. It can be designed up to 140 MPa of compressive strength; the desired strength entirely depends on the constituents of concrete. To achieve a strong and durable concrete, careful selection of its ingredients should be practiced. Concrete is designed by various methods, consists of various empirical relations, charts, graphs, tables designed according to material availability. Out of these methods best method should be practiced which gives the strength and also economy. In this paper, two methods were studied i.e. BIS and USBR, designed with rounded aggregates. BIS is the Bureau of Indian standard and USBR is the United States Bureau of Reclamation. For this study M35 and m40 grades were selected. These two methods have different design parameters and proportions of constituents. The influence of these parameters was studied on M35 and M40 grades with different aggregates. Apart from the material, the properties of concrete depends upon the proportions selected i.e. cement, water, aggregates, which differs from method to method.

2. EXPERIMENTAL PROGRAM

This research programme consist the study of various strength properties conducted on M35 and M40 grades of concrete designed as per BIS and USBR methods using rounded aggregate as coarse aggregates. To determine the compressive, tensile and flexure strength of concrete, standard size cubes, cylinders and beams were casted, cured and tested after 7 and 28 days. In this study, cement content was kept same for both methods and other parameters i.e. water cement ratio, fine and coarse aggregates were adjusted and compared accordingly. The cement content was taken as 415kg and 430kg for M35 and M40 grades of concrete respectively. The detail of materials proportion adopted by BIS and USBR methods for comparison is described in the table.

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Table 1: Cement content and water cement ratio of M35 and M40 grades of concrete designed as per BIS and USBR using rounded aggregate.

Grade	Method	Cement	w/c
M35	BIS	415	0.40
	USBR	415	0.42
M40	BIS	430	0.38
	USBR	430	0.41

3. MATERIAL DETAILS

Portland pozzolona cement as per IS: 1489-1, locally available fine aggregate (specific gravity = 2.54), zone-4. 20 mm graded rounded aggregate having (specific gravity = 2.66), unit wt. = 1608 kg/m^3. The properties of aggregates were evaluated as per IS: 383-1970. chemical admixture was taken 0.8% and 1% was taken for M35 and M40 grades of concrete by both BIS and USBR methods respectively to achieve the required slump. The detail of the final mix proportions of M35 and M40 grades of concrete designed as per BIS and USBR methods is described in table 1,2.

Table 2: Final mix proportions of BIS method

Concrete grade	Cement	F.A	C.A	w/c	Plasticizer (%)
M35	1	1.35	3.01	0.40	0.8
M40	1	1.34	3.03	0.38	1

Table 3: Final mix proportions of USBR method

Concrete grade	Cement	F.A	C.A	w/c	Plasticizer (%)
M35	1	1.71	2.53	0.4	0.8
M40	1	1.72	2.39	0.4	1

4. MIXING CASTING TESTING

Materials were mixed in rotating pan type mixer with fixed scrapper and rotating shaft which provides the counter current motion. This mixer thoroughly stirred the mixer and good uniform mix was achieved. This mix was poured into the moulds of standard size cubes, prismatic beams and cylinders. Moulds were thoroughly cleaned off from dust particles and properly oiled before concreting. Pouring was done in three equal layers of concrete and then the moulds were put on the table vibrator for removal of pores, excess concrete was removed off from the moulds by trowel and top surface was finished off to smooth level. These filled moulds were kept for 24 hours, and after that samples were taken off and put it into the curing tank of temp $23 \pm 2^{o}C$.

5. COMPRESSIVE STRENGTH

The compressive strength of cubes of size $150 \times 150 \times 150$ mm was determined by the uniaxial compression testing machine. From the results of the test performed on concrete, it can be interpret that the compressive strength demonstrated by concrete prepared as per USBR method is better as compared to BIS method for both grades M35 and M40. M35 grade of BIS method did not show satisfactory results as it failed to achieve the target strength where as USBR method showed 10 % and 28% increase in strength at 7 and 28 days respectively. M40 grade of concrete designed as per BIS and USBR method illustrate satisfactory results as both specimens achieved the target strength. USBR method attained nearly 45% increase in early strength at 7 days (for M40 grade) but the ultimate strength attained by both methods was similar.

Table 4: compressive strength of M35 and M40 grades of concrete attained BY BIS and USBR methods at 7 and 28 days

S. No.	Concrete Grade	Method	Strength (MPa)	
			7 days	28 days
1	M 35	BIS	33.7	37.7
2	M 35	USBR	37.3	48.44
3	M40	BIS	29.51	48.44
4	M40	USBR	43.11	49.7

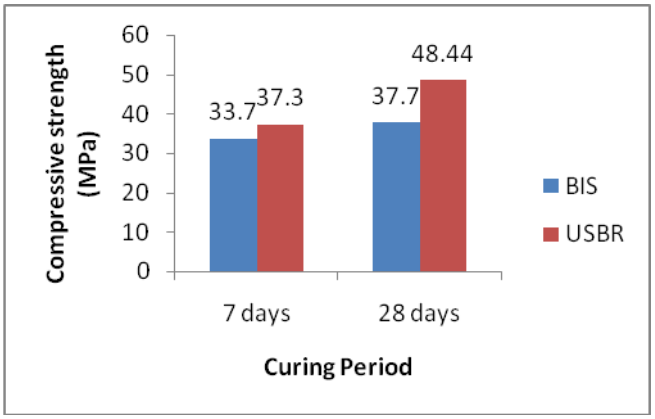

Chart 1: compressive strength result of M35 grade concrete designed as per BIS and USBR methods.

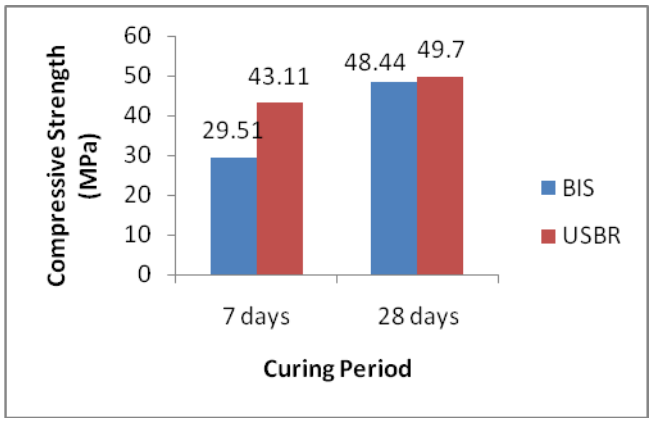

Chart 2: compressive strength result of M40 grade concrete designed as per BIS and USBR methods.

6. TENSILE STRENGTH

Cylinders of dimensions 100mm diameter and 200mm length was prepared, cured and tested after 7 and 28 days. Three numbers of specimens were casted and an average of strength was plotted. It was observed that the

tensile strength of concrete designed as per BIS and USBR method was almost similar in case of M35 grade, though BIS method accomplished better initial strength (7 days) than USBR method. In case of M40 grade concrete, BIS method demonstrated better strength i.e. 20% than the USBR method, but initial strength was better procured by USBR.

Table 5: Split tensile strength of M35 and M40 grades of concrete attained BY BIS and USBR methods at 7 and 28 days

S. No.	Concrete Grade	Method	Strength (MPa)	
			7 days	28 days
1	M 35	BIS	2.7	3.1
2	M 35	USBR	2.6	3.12
3	M40	BIS	2.54	3.8
4	M40	USBR	2.8	3.1

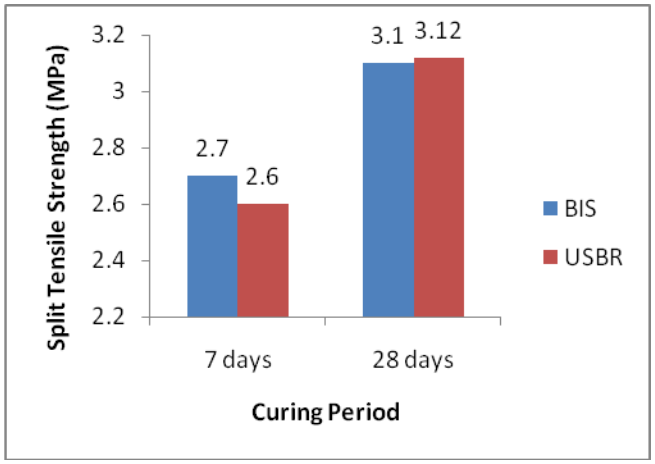

Chart 3: Split tensile strength result of M35 grade concrete designed as per BIS and USBR methods.

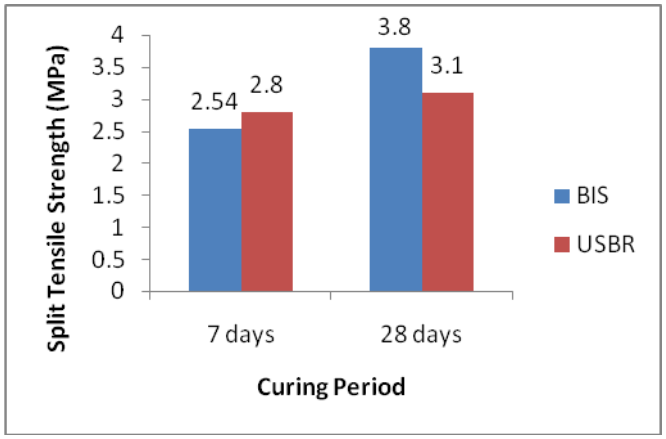

Chart 4: Split tensile strength result of M40 grade concrete designed as per BIS and USBR methods.

7. FLEXURE STRENGTH

An average of three prismatic beams of size 100×100×500 mm was taken and the test data is plotted in the table. Tests results showed that the USBR method gained better strength than BIS method for both M35 and M40 grade of concrete. In case of M35 grade concrete, initial 7 days strength was almost 25% less than the BIS method, but the ultimate 28 days strength was increased by 16% approx. For M40 grade, both 7 days and 28 days strength was better attained by USBR method than the BIS method

Table 6: Flexure strength of M35 and M40 grades of concrete attained by BIS and USBR methods at 7 and 28 days

S. No.	Concrete Grade	Method	Strength (MPa)	
			7 days	28 days
1	M 35	BIS	4.36	5.04
2	M 35	USBR	3.2	5.89
3	M40	BIS	2.9	5.93
4	M40	USBR	3.84	6.25

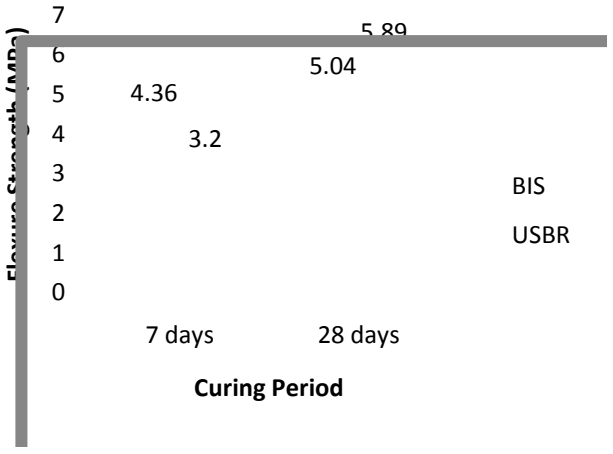

Chart 5: Flexure strength result of M35 grade concrete designed as per BIS and USBR methods.

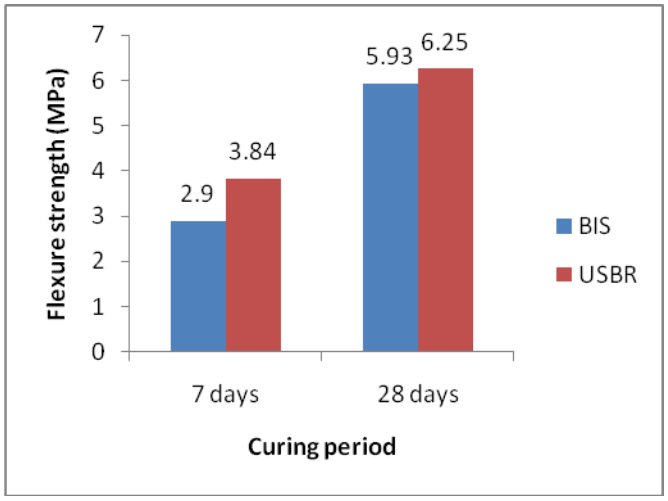

Chart 6: Flexure strength result of M40 grade concrete designed as per BIS and USBR methods.

8. CONCLUSION

The study was conducted to compare the properties like compressive, split tensile and flexure strength obtained by BIS and USBR methods, designed using rounded aggregates. M35 and M40 grades were selected for this study.

It was observed that the concrete desired as per USBR method delivered better compressive and flexure strength than BIS method for both M35 and M40 grades.

Compressive strength gained by M40 grade of concrete designed as per BIS method was not satisfactory as it failed to achieve the target strength.

Split Tensile strength was better procured by BIS method as compared to USBR method for both M35 and M40 grades.

It was observed that the USBR method contains more quantity of fine aggregates as compared to BIS method.

Water cement ratio in USBR method was higher than BIS method for grades.

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