Prediction of Compressive Strength of Concrete By Accelerating Curing Method

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Abstract- *Conventionally, strength of concrete in construction work is estimated in terms of its 28 days compressive strength of cubes. This procedure involves 28 days of wet curing before testing as per IS: 516 – 1959 (2). This time interval may be considered as a long period. Hence, essentials for an accelerated curing technique have arisen, where 28 days strength of concrete can be easily predicted. The main objective of this paper is to develop mathematical model, which gives relation between warm water accelerated curing strength and normal curing strength for 28 day compressive strength. Warm water curing at 55 ± 2° C is applied to accelerate the strength gain of concrete for early prediction of 28 day compressive strength. Various cement grades OPC43 and OPC53 with different Concrete mixes in terms of water-cement ratio and aggregate –cement ratio was considered to prepared cubes.*

Keywords- accelerated curing, aggregate cement ratio, concrete compressive strength, regression equation, water cement ratio.

I. INTRODUCTION

Latest trend in engineering technology is to develop economic concrete and complete the project within time limit. To develop the economic concrete, mix design is to be developed And to complete project within time limit, the compressive strength of concrete cubes for selected mix design should be determined prior in the laboratory. The compressive strength of hardened concrete is most common property required for the structural use.

The prediction of 28 days strength at early age is needed for different purpose such as, the fast trend of construction progress and its economic benefits achieved from accelerating construction schedule testing for quality control purpose. To check the suitability of concrete mixes much earlier than 28 days test the rate of strength gain mainly depends upon the rate of hydration and the rate of hydration depends on the surrounding temperature. The strength achievement could be accelerated at early age and related to 28 day compressive strength through standardization curves. Various techniques of accelerated curing of concrete are classified as heat water techniques, oven curing techniques, maturity methods, pressure and elevated temperature technique and expanded polystyrene moulds technique. The IS: 9013-1978 (1) Suggests two procedures, which can be used to provide an indication of 28 days strength of concrete only after 24 hours .

- Warm-water method
- Boiling-water method

The aim of this research work is to study the relation between accelerated curing strength at 23 Hrs ± 15 min from the time of addition of water to ingredients.(1 Hr normal curing + 19 Hr ± 50 min +1Hr normal cooling accelerated curing at 55 ± 2° *C*) with normal curing for 28 day concrete by warm water curing method.

II. MATERIAL

A. Cement

Ordinary Portland cement (43 grade) confirming to IS: 12269-1987 (3), OPC 53 IS 1489 Part-I was used for the experimental investigation. The cement was tested as per IS: 4031-1988(4).

B. Fine Aggregate

Natural river sand confirming to zone II as per IS: 383-1987 was used. Fine aggregate of size 1.18 mm down were used. Physical properties of fine aggregate are presented in Table- 1. Crushed coarse aggregate confirming to IS: 383-1987 (3) was used. Coarse aggregate of size 20 mm down were considered. Physical properties of coarse aggregate are presented in Table.

Table 1: Physical Properties of Fine & Coarse Aggregate

Aggregate	Fineness Modulus	Density	Specific Gravity
Fine	3.64	1696	2.58
Coarse	7.07	1770	2.87

III. APPARATUS

A. Cube Mould

As per IS: 10086 – 1982, 150 x 150 x 150 mm size mould have been used.

B. Curing Tank

Curing tank shall be constructed from any material of suitable strength that will resist the effect of corrosion. Internal dimension should be adequate to accommodate the required number and size of test specimen. The tank shall contain sufficient water and be controlled so that temperature of water around the specimen immersed in the tank is maintained at the desired level.

IV. EXPERIMENTAL PROGRAMME

To get the early age strength through accelerated curing, warm water method was adopted. In this method, after the casting of cubes, specimen was cured at normal temperature for 24 hours and then put in accelerated tank on second day with temperature 55 ± 2° *C* for 19 Hr ± 50 min. After period of curing, concrete cube specimen was removed from the accelerating curing tank and immersed in cooling tank at 27 ± 2° *C* at least 1 Hr .After this period of curing, concrete cube specimen and tested for compressive strength and results are co-related with 28 day compressive strength of standard water curing. This co relation of accelerated strength and normal curing strength is achieved for different types of cement. To find the confident level of these relation two different types of cement were used. The composition of different types of cement is given in table. For each type of cement, four different water cement ratio were used. Mix design was prepared by IS method. Different water cement ratios and constituent materials Proportions of the various concrete mixes are given in Table 3. The amount of water is constant and amount of cement is decreased according to w/c ratio. Total 320 cubes of size (150x150x150)mm were casted.

Table 2: Composition of Different Types of Cement

Type	Composition
A	OPC 43
B	OPC 53

V. RESULTS AND DISCUSSIONS

Table 3: 28 day Normal curing compressive strengths and accelerated curing compressive strengths for OPC 43

MIX ID	A/C	W/C	f(Nor)	f(IS)	f(Pre)
A1	4.00	0.40	46.85	47.87	46.81
A2	4.00	0.45	41.44	43.85	42.58
A3	4.00	0.50	39.85	42.25	40.89
A4	4.00	0.55	38.25	39.30	37.79
A5	4.50	0.40	46.48	48.10	47.05
A6	4.50	0.45	42.60	44.20	42.94
A7	4.50	0.50	40.25	42.52	41.18
A8	4.50	0.55	39.05	39.92	38.44
A9	5.00	0.40	48.50	48.77	47.76
A10	5.00	0.45	43.52	44.90	43.68
A11	5.00	0.50	41.67	42.80	41.47
A12	5.00	0.55	40.15	41.17	39.75
A13	5.50	0.40	48.95	49.30	48.31
A14	5.50	0.45	44.22	45.50	44.32
A15	5.50	0.50	43.66	44.42	43.18
A16	5.50	0.55	40.89	41.50	40.10

Table 4: 28 day Normal curing compressive strengths and accelerated curing compressive strengths for OPC 53

MIX ID	A/C	W/C	f(Nor)	f(IS)	f(Pre)
B17	4.00	0.40	48.20	51.50	45.28
B18	4.00	0.45	47.15	51.34	44.32
B19	4.00	0.50	45.24	50.9	43.62
B20	4.00	0.55	43.93	50.67	42.60
B21	4.50	0.40	47.94	52.36	45.93
B22	4.50	0.45	47.63	52.14	44.63
B23	4.50	0.50	45.52	52.02	43.81
B24	4.50	0.55	44.25	51.86	42.76
B25	5.00	0.40	47.22	53.85	46.28
B26	5.00	0.45	47.14	53.44	44.85
B27	5.00	0.50	45.74	53.30	43.89
B28	5.00	0.55	44.81	52.68	42.92
B29	5.50	0.40	47.24	55.20	46.64
B30	5.50	0.45	48.52	54.90	45.00
B31	5.50	0.50	46.20	53.80	43.98
B32	5.50	0.55	45.02	52.66	43.07

The arithmetic equation developed for accelerated curing strength and 28 days normal curing strength

For OPC43 grade cement

$$Y = 1.0528x + 9.7336 \quad (1)$$

For OPC53 grade cement

$$Y = 0.8151x + 12.116 \quad (2)$$

Where,

Y = Compressive strength of normally cured concrete at 28 days
x=Compressive strength of accelerated cured concrete

The Mathematical model established to show the relation between accelerated curing compressive strength and 28 days normal curing compressive strength for OPC is derived from fig :1. Enveloped to show the relation between accelerated curing compressive strength and 28 days normal curing compressive strength for PPC cement is derived from following fig.2.

The Mathematical model which show the relation between accelerated curing compressive strength and 28 days normal curing compressive strength for OPC 43 and OPC 53 cement as under

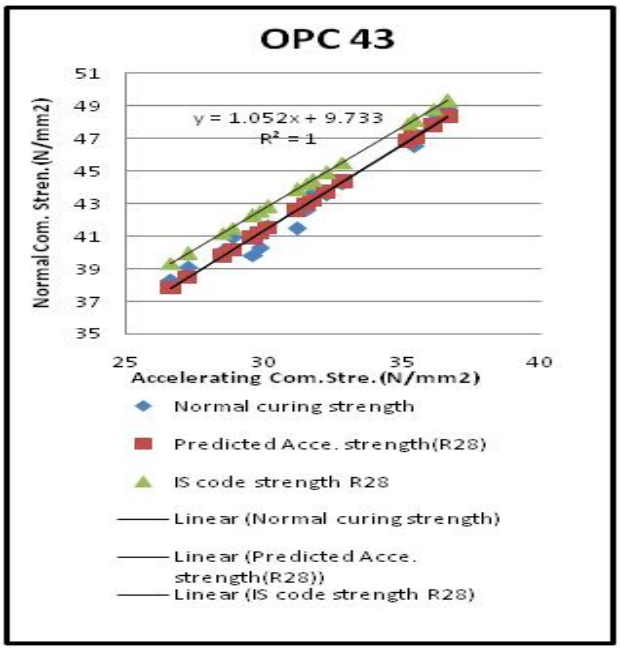

Fig: 1 Graphical Representation of 28 day Normal curing compressive strengths and accelerated curing compressive strengths for OPC 43

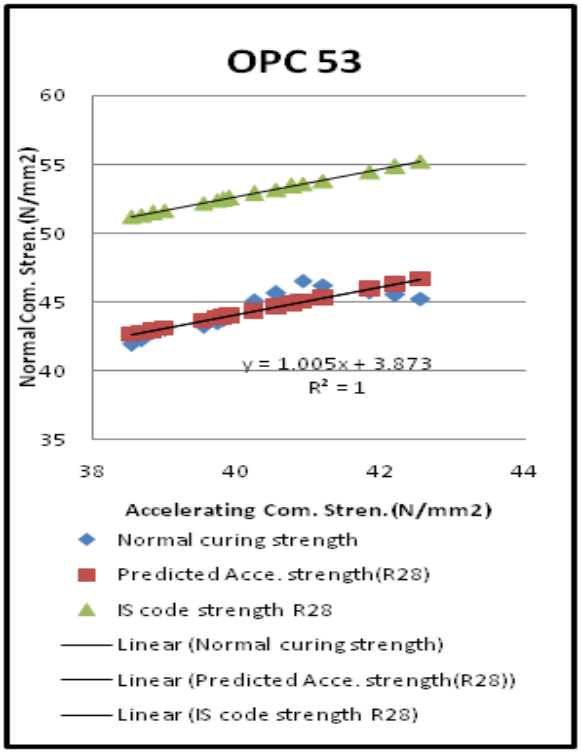

Fig: 2 Graphical Representation of 28 day Normal curing compressive strengths and accelerated curing compressive strengths for OPC 53

VI. CONCLUSION

In present study of early prediction of 28 day compressive strength results through regression equations are not useful for concrete mix containing different grade of cement due to their physical and chemical properties on the rate of strength gain. Obtained Mathematical model for early prediction of 28 day compressive strength of cubes are proposed for OPC 43 cement and OPC 53 cement individually which gives assured level around 95%. Due to this relation, this method will also helpful for Precast Manufactures. Even though it is fastest method to control quality of concrete. It can also be concluded that increase in curing temperature has more favorable effect on the strength gain of concrete.

VII. ACKNOWLEDGMENT

I acknowledge with thanks with the guidance and generous help rendered by my project guide Associate Professor P.M.Shimpale for their valuable guidance &suggestions. I would like to extend gratitude towards D.M.Lokmanwar Associate Professor (Government Polytechnic Nanded) for mentoring us during execution of the project.

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