

Performance Investigation of Cement Concrete Under Variation of Curing Time

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Abstract— Today there is a need of speedy construction as the world is growing and developing at a fast rate. Time is as precious as money. Curing each and every element of structure for 28 days sometime becomes a problems due to shortage of time and resources. This work is concerned with finding an experimental research of variation of curing time on concrete compressive strength. For this concrete cubes were cast for a design mix of M-20, 1:1.777:2.826 by weight and 0.47 water cement ratio and M-25, 1:1.432:2.472 by weight and 0.414 water cement ratio using OPC 43 grade, OPC 53 grade and PPC cement as per guidelines for concrete mix proportioning with a slump of 75 mm to 100 mm. The concrete cubes gain about 85%, 94%, 108%, and 124% of target characteristic compressive strength for PPC if cured for first 7, 14, 21 and 28 days respectively.

Keywords—Compressive strength, concrete cubes, curing, OPC 53 grade, OPC 43 grade, PPC, variation.

1 INTRODUCTION

Concrete is an artificial construction structural material made from the mixture of aggregates (course and fine), water, Portland cement and small amount of air bubbles, incorporated and stabilized into cement mix. Concrete is formed when Portland cement is hydrated and forms cement paste, which when mixed with aggregates hardens and binds into solid mass. Concrete is currently the most widely used construction material as it can be cast to any form and shape at site very easily. Concrete is used in large quantities; almost everywhere mankind has a need of structure. It is very tough to find an option for concrete in construction, which is durable and economic.

Curing can be achieved by keeping the concrete element completely saturated or as much saturated as possible until the water-filled spaces are substantially reduced by hydration products. If the concrete is not cured and is allowed to dry in air, it will gain only 50% of the strength of continuously cured concrete. Improper curing would entail insufficient moisture and this has been found to produce cracks, compromise strength, and reduce long-term durability. The scope of discussion in this study is to investigate the effect of variation of curing time on characteristic compressive strength of concrete.

In the present study, concrete with Pollozona Portland cement (PPC), Ordinary Portland Cement (OPC) 53 grade and Ordinary Portland Cement (OPC) 43 grade, is adopted. Concrete grade of M-25 design mix with a slump in between 75 to 100 mm were considered in the study. We cure the concrete cubes for 7, 14, 21, 28 days and test for characteristic compressive strength.

2 NECESSITY OF PROJECT

It is well known fact that as curing time increases strength of

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concrete increases however in practice this curing time varies due to multiple reasons, shortage of water, inadequate knowledge, other construction constraints, etc. Hence, optimum curing period for type of cement grade is not available in practice.

Now, considering these several reasons, variation in curing time on compressive strength of concrete needs to be investigated as time and condition may not allow 28 days of curing. In this we study the effect of curing time on design mix of M-25 with different types of cement available in market to obtain best possible result.

3 LITERATURE REVIEW

Malhotra V.M. (1988) said that cement generally represent 12-14% of concrete weight. It plays an active part in the mixture by ensuring cohesion between aggregate grains and it introduces a decisive contribution to concrete mechanical strengths. During the hardening process, it generates shrinkage and heat dissipation phenomena which lead to material cracking. **Ramezaniapour et.al (1995)** concluded that if a concrete is not well cured, particularly at the early age, it will not gain the required properties at desired level due to a lower degree of hydration, and would suffer from irreparable loss. **Mamlouk et.al (2006)** said if concrete is cured for only three days, it will reach about 60% of the strength of continuously cured concrete; if it is cured for seven days, it will reach 80% of the strength of continuously cured concrete. If curing stops for some time and then resumes again, the strength gain will also stop and reactivate. **BarisOzer et.al (2004)** said that the curing conditions affect the strengths of both the OPC concrete and pozzolanic cement concretes. However, poor curing affects the strength properties of pozzolanic cement concretes more adversely that those of the OPC. For pozzolanic cement concretes, at least an initial 7-day water curing is necessary to expose the pozzolanic activity. Pozzolanic cement concretes, water-cured for at least 14 days, can reach the strength level of the OPC concrete cured continuously in water in periods shorter than 2 months. **Usman et.al (2006)** concluded curing plays an important role in strength of concrete.

4 MATERIALS AND METHODOLOGY

4.1 Materials

The detail of various materials used in the experimental investigation will be:

- Coarse Aggregate:-Crushed granite stone aggregate of maximum size 20 mm conforming to IS 383-1970 was used. The specific gravity was found to be 2.925.
- Sand (Fine Aggregate):- The fine aggregate used was sand passing through 4.75 mm sieve. The specific gravity was found to be 2.83. The grading zone of fine aggregate was zone I as per IS specification.
- Cement:- OPC 43 grade, OPC 53 grade, PPC (Ultratech Cement) was used.
- Water:- Ordinary clean potable water free from suspended particles and chemicals was used for mixing and curing of concrete.

4.2 Methodology

Experimental Procedure: To investigate the effect of variation of curing time on compressive strength of concrete, half of the concrete cubes were cast and cured with normally and were tested for the age of curing and half of the concrete cubes were cured for 7, 14, 21 and 28 days and were tested for characteristic strength. The concrete cube size measuring 150×150×150 mm in dimension will be used. The batching of the concrete was carried out by weight for strength of 25 N/mm². The mould were filled in three layers tamping each layer 25 times.

Workability: Workability of cubes mixed was measured before casting of cubes. The workability maintained was medium i.e. slump was maintained between 75 mm to 100 mm for mass concrete.

Experimental Procedure: The compressive strength is taken as maximum compressive load resisted by per unit area.

Test Results: The concrete cubes were tested in “Compression Testing Machine of Technical and Scientific Sales Instruments” which has a capacity 200 tones. The tests were carried out at “Vidya Vikas Pratishthan Polytechnic, Solapur”.

Results indicate that, the percentage of strength obtained for PPC are greater than OPC 53 grade and OPC 43 grade.

TABLE 1
QUANTITIES FOR 12 CUBES, M-20

Grade	M-20
Proportions	1 : 1.777 : 2.825
W/C Ratio	0.47
Cement	24 kg
Fine Aggregate	42.648 kg
Coarse Aggregate	67.642 kg
Water	11.28 kg

TABLE 2
QUANTITIES FOR 12 CUBES, M-25

Grade	M-25
Proportions	1 : 1.432 : 2.472
W/C Ratio	0.414
Cement	24 kg
Fine Aggregate	34.368 kg
Coarse Aggregate	59.328 kg
Water	9.936 kg

TABLE 3
TEST RESULTS FOR M-20 (OPC 43 GRADE)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	20.351	21.744	81.744
14 Days	27.759	24.401	91.733
21 Days	30.338	26.377	99.161
28 Days	32.055	31.914	119.977

(Laboratory: VVP Polytechnic, Solapur)

TABLE 4
TEST RESULTS FOR M-20 (OPC 53 GRADE)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	20.979	22.056	82.917
14 Days	28.191	24.512	92.150
21 Days	30.939	27.442	103.165
28 Days	32.811	33.362	125.421

(Laboratory: VVP Polytechnic, Solapur)

TABLE 5
TEST RESULTS FOR M-20 (PPC)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	20.772	22.911	86.131
14 Days	28.121	25.197	94.725
21 Days	30.911	28.803	108.282
28 Days	32.062	33.094	124.414

(Laboratory: VVP Polytechnic, Solapur)

TABLE 6
TEST RESULTS FOR M-25 (OPC 43 GRADE)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	24.045	25.599	81.009
14 Days	32.242	29.092	92.063
21 Days	35.804	31.679	100.25
28 Days	37.572	37.07	117.31

(Laboratory: VVP Polytechnic, Solapur)

TABLE 7
TEST RESULTS FOR M-25 (OPC 53 GRADE)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	24.502	26.346	83.373
14 Days	32.734	29.138	92.208
21 Days	36.418	32.427	102.617
28 Days	37.884	38.779	122.718

(Laboratory: VVP Polytechnic, Solapur)

TABLE 5
TEST RESULTS FOR M-25 (PPC)

Curing Time	Test on Respective Day	Characteristic Compressive Strength	Strength %
7 Days	24.303	27.111	85.794
14 Days	32.675	29.808	94.329
21 Days	36.239	32.797	103.788
28 Days	37.8	37.515	118.718

(Laboratory: VVP Polytechnic, Solapur)

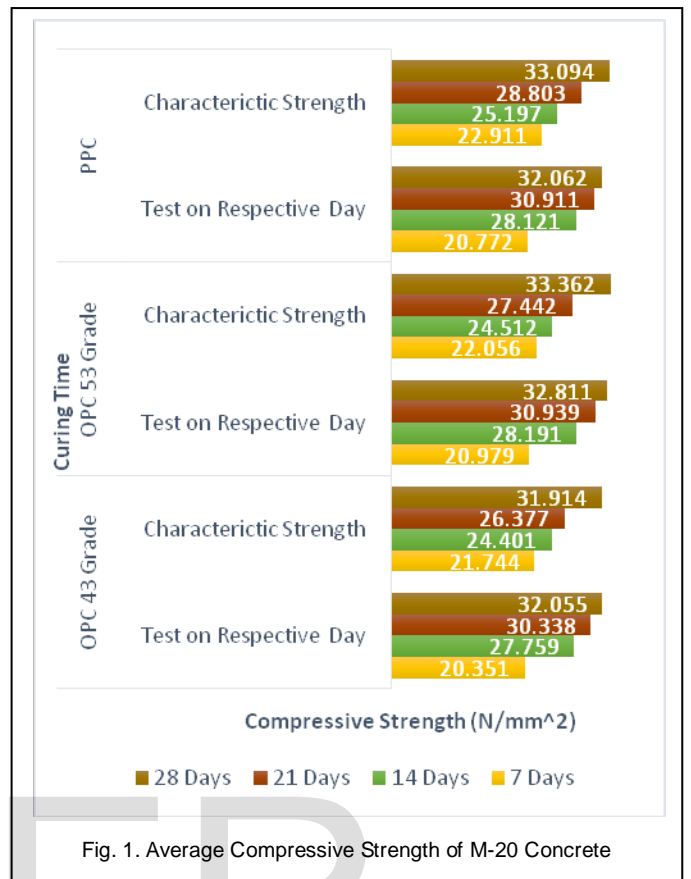


Fig. 1. Average Compressive Strength of M-20 Concrete

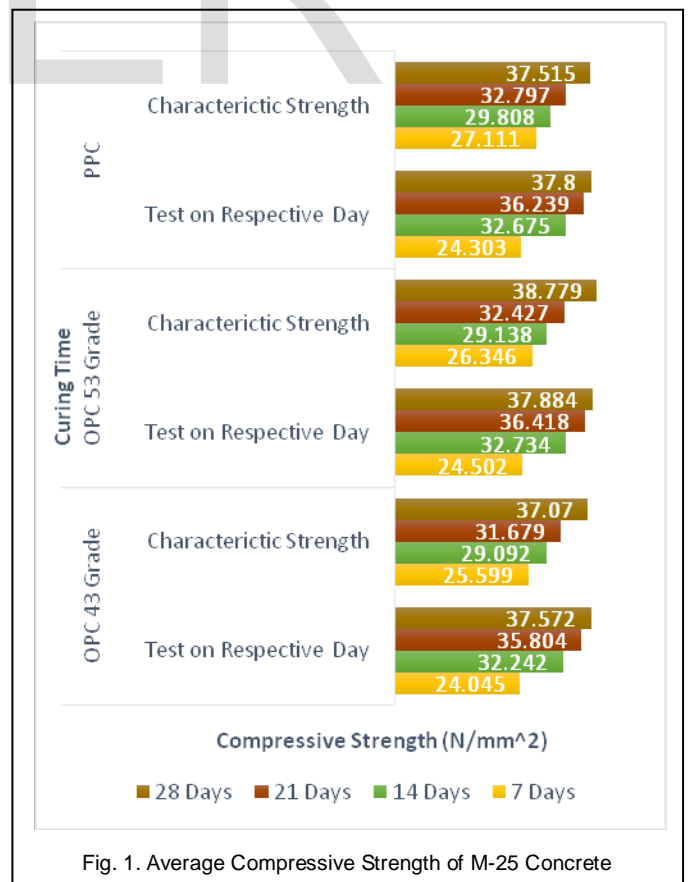
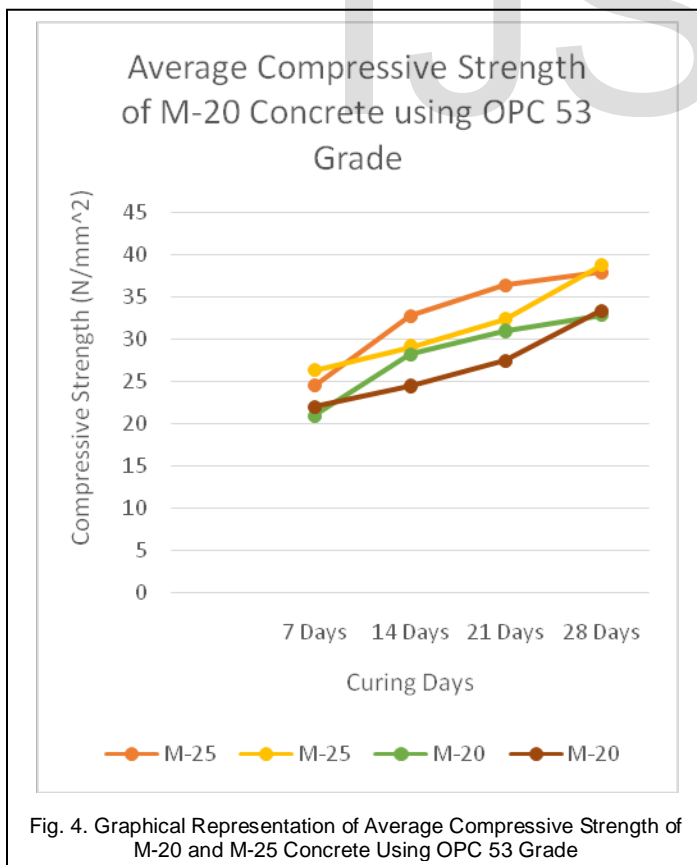
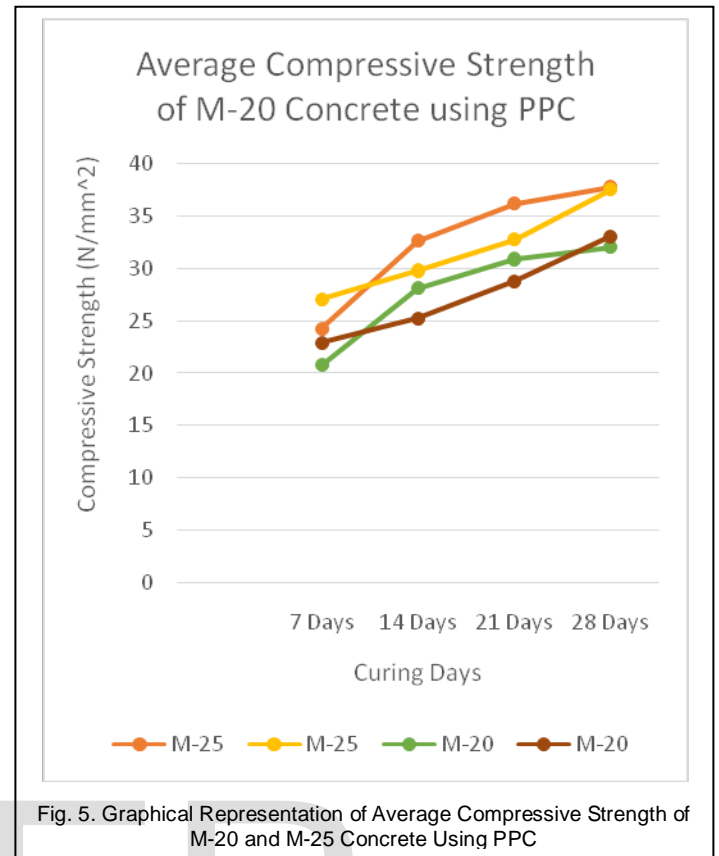
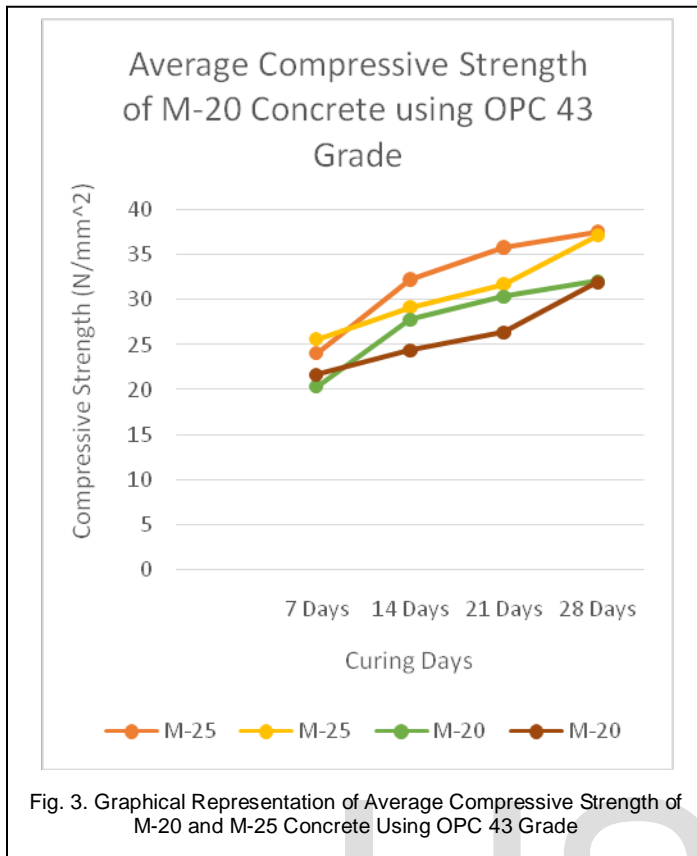


Fig. 1. Average Compressive Strength of M-25 Concrete



5 CONCLUSIONS

1. Series of experiments were conducted on M-20 concrete. From the results it can be said that, compressive strength attained by 21 days curing is almost equal or more than target strength.
2. Concrete cubes cast with PPC cement gives better results than OPC 43 grade and OPC 53 grade.
3. 7 days, 14 days, 21 days and 28 days curing give 81-82%, 91-93%, 99-101%, 117-119% of the target characteristic strength which is 26.6 N/mm² and 31.6 N/mm² for M-20 and M-25 grade of concrete respectively if OPC 43 grade cement is used.
4. 7 days, 14 days, 21 days and 28 days curing give 82-84%, 92-93%, 100-103%, 122-125% of the target characteristic strength which is 26.6 N/mm² and 31.6 N/mm² for M-20 and M-25 grade of concrete respectively if OPC 53 grade cement is used.
5. 7 days, 14 days, 21 days and 28 days curing give 85-86%, 95-96%, 103-109%, 120-127% of the target characteristic strength which is 26.6 N/mm² and 31.6 N/mm² for M-20 and M-25 grade of concrete respectively if OPC 43 grade cement is used.
6. Studies may be carried out for other types of cements, other types of admixtures and ground granulated blast furnace slag cements etc.

From the above finding we can conclude that 21 days curing can be enough as concrete cubes gain about 99-109%.

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