International Journal of Structural and Civil Engineering Research

ISSN 2319 – 6009 www.ijscer.com
Vol. 2, No. 3, August 2013

Research Paper

INTERMITTENT CURING OF M20 CONCRETE

Suresh B Piplewar[1]*, Narendra M Kanhe[2] and Devendra Pandey[3]*

Corresponding author:* ***Suresh B Piplewar,* ✉ *piplewar@gmail.com*

The present paper deals with the effect of intermittent curing methods on the strength of M20 concrete. Concrete specimens were evaluated at temperatures < 25° C. The water curing in the concrete specimens for test included 3,7,9,12,15,18,21,24 and 28 days. The comprehensive and comparative study of intermittent curing and the wet curing of M20 was sought. Studies of the effects upon strength of the various curing periods of alternate dry and wet curing at different air temperatures were done. On the basis of interpretation of the results the following outcomes were made: (1) Full time curing longer than 7 days was seldom justified, (2) If adequate intermittent curing was assured, a 7 days intermittent curing seemed adequate, (3) 3 days intermittent curing for 3 times a day produced a strength 98.95 percent of the 3 days full time curing and (4) a 7 days intermittent curing for 3 times a day produced a strength 95.67 percent of 7 days full time curing (5) a 21 days intermittent curing for 3 times a day produced a strength 94.65 percent of 21 days full time curing. Following fact was disclosed: the intermittent curing of concrete is sufficient and it does not reduce the compressive strength considerably , which is an important conclusion for saving the water and thereby electricity.

Keywords: Curing methods, Intermittent curing, M20 Concrete

INTRODUCTION

Concrete properties vary considerably depending upon the temperature and humidity that they have been subjected to early on in their life. In order to obtain good concrete the placing of an appropriate mix must be followed by curing in a suitable environment during the early stages of hardening. Curing is the name given to procedure used for promoting the hydration of cement and consists of a control of temperature and the moisture movement from and into the concrete (IS: 456, 2000). More specially the object of curing is to keep concrete saturated or as nearly saturated as possible, until the originally water-filled space in the fresh cement paste has been filled the

[1] Department of Applied Mechanics, Manoharbhai Patel Institute of Engineering & Technology, Gondia, Maharashtra State, India.

[2] Gurunanak Education Society's Gurunanak Institute of Engineering & Management, Dahegaon, Kalmeshwar Road, Nagpur 441501, Maharashtra State, India.

[3] Department of Civil Engineering, Manoharbhai Patel Institute of Engineering & Technology, Gondia, Maharashtra State, India.

desired extend by the products of hydration of cement (Shoba *et al.,* 2005, Spears, 1983). The necessity for curing arises from the fact that hydration of cement can take place only in water filled capillaries. This is why a loss of water by evaporation from the capillaries must be prevented. Curing is the procedure of controlling the rate and amount of moisture thrashing from concrete during cement hydration. Concrete permitted to dry out without delay gain only 40% of the strength of the same concrete water cured for the full period of 180 days. Even three days water curing increases to 60%, at the same time as 28 days water curing increases it to 95%. Keeping concrete moist is therefore, a most effective way of increasing its ultimate strength (Arafah *et al*., 1996,). Due to improper curing the concrete may not gain its full strength and hair crack occurs on the concrete and the structure may fail (Rao *et al.*, 2010, Bushlaibi and Alshamsi, 2002).

Intermittent curing of concrete means the curing process should be done intermittently to concrete. The effect upon concrete, from the standpoint of curing of alternate wetting and drying. The data appear to indicate that the amount of mixing water retained in the concrete during the curing period is an important factor in curing, and that satisfactory curing may be obtain in humid areas with a comparatively short initial wet curing period. Generally in practical life curing is done three or four times daily up to seven to ten days (Haque, 1990). In hilly areas where the water availability is less the process of curing is not maintained properly.

METHODOLOGY

The composition of the concretes in the present work was all high strength concretes, prepared with Portland cement only. All the concretes had the same slump (80 to 120 mm).In the present study, series of tests were carried out as per IS: 516-1959 with these concretes, to determine: (1) The Crushing Load and (2) The effect of different modes of curing on the strength. Detailed results regarding the strength development of these concretes were analyzed. Concrete specimens were evaluated at temperatures < 25° C. The water curing of the concrete included 3, 7, 9, 12, 15,18,21,24 and 28 days curing by water. Total 108 concretes cubes were analyzed in the present study as per IS: 9013-1978.

RESULTS AND DISCUSSION

The effect of the different modes of curing on the strength of the concretes is discussed in detail as under. The strength of the concretes with different modes of curing is given in Table 1, 2, 3, and 4. The compressive strength results through an age of 3,7,9,12,15,18,21,24, 28 days are illustrated in the Figure 1,2,3, and 4 below and the compressive strength as a percentage of the standard cured cube (control) at the various test ages is summarized in the Table 1,2,3, and 4.

The strength of the concrete cubes with full time continuous curing is given in Table 1. The compressive strength results through an age of 3, 7, 9, 12, 15, 18, 21, 24, and 28 days full time continuous curing a day is illustrated in the Figure 1. The strength of the concretes with full time continuous curing varies with respect to the number of days increased. The

Table 1: Showing Result of Full Time Continuous Curing

Mode of Curing	Days	Crushing Load in KN			Mean Crushing Load in KN	Mean Strength in MPa
Full Time Continuous Curing	3	290	330	300	306.66	13.37
	7	380	400	390	390.00	17.00
	9	390	400	390	393.33	17.15
	12	440	390	420	416.66	18.17
	15	480	490	470	480.00	20.93
	18	490	500	470	486.66	21.22
	21	520	490	480	496.66	21.65
	24	500	520	530	516.66	22.53
	28	510	500	550	520.00	22.67

Table 2: Showing Result of Intermittent Curing 3 Times a Day

Mode of Curing	Days	Crushing Load in KN			Mean Crushing Load in KN	Mean Strength in MPa
Intermittent Curing 3 Times a day	3	300	310	300	303.33	13.23
	7	380	350	390	373.33	16.28
	9	390	380	400	390.00	17.00
	12	430	410	390	410.00	17.88
	15	440	450	420	436.67	19.03
	18	480	430	460	456.67	19.91
	21	450	490	470	470.00	20.49
	24	490	520	510	506.67	22.09
	28	500	530	520	516.67	22.53

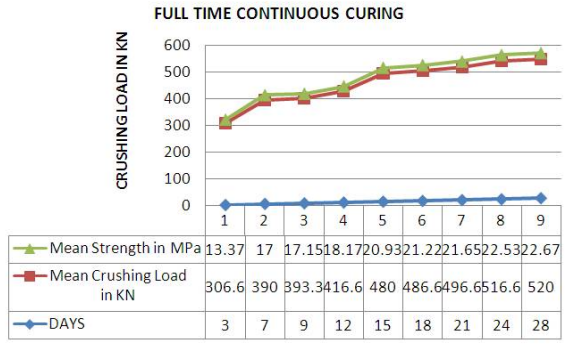
Table 3: Showing Result of Intermittent Curing 2 Times a Day

Mode of Curing	Days	Crushing Load in KN			Mean Crushing Load in KN	Mean Strength in MPa
Intermittent Curing 2 Times a Day	3	280	290	320	296.67	12.93
	7	390	370	350	370.00	16.13
	9	400	380	370	383.33	16.71
	12	390	410	420	406.67	17.73
	15	410	400	440	416.67	18.17
	18	420	440	450	436.67	19.03
	21	450	470	440	453.33	19.77
	24	500	490	470	486.67	21.22
	28	500	530	490	506.67	22.09

Table 4: Showing Result of Intermittent Curing 3 Times a Day

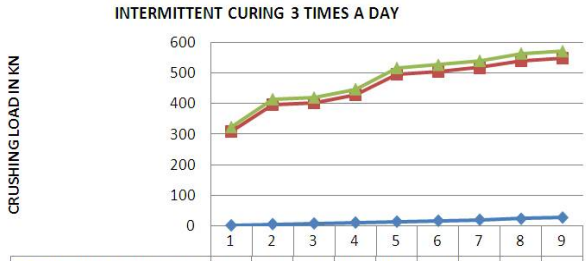
Mode of Curing	Days	Crushing Load in KN			Mean Crushing Load in KN	Mean Strength in MPa
Intermittent Curing 1 Time a Day	3	300	290	270	286.67	12.50
	7	340	330	320	330.00	14.39
	9	360	340	370	256.67	15.55
	12	370	400	360	276.67	16.42
	15	430	380	400	403.33	17.58
	18	420	410	430	420.00	18.31
	21	410	450	460	440.00	19.18
	24	440	470	450	450.33	19.91
	28	450	510	490	483.33	20.93

Figure 1: Showing Full Time Continuous Curing



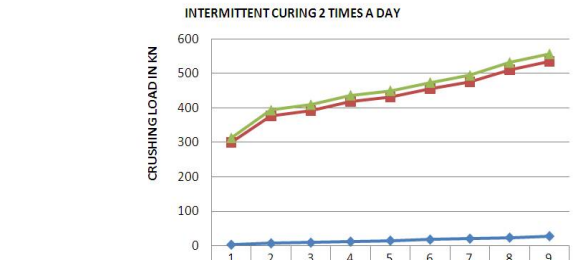
Mean Strength in MPa	13.37	17	17.15	18.17	20.93	21.22	21.65	22.53	22.67
Mean Crushing Load in KN	306.6	390	393.3	416.6	480	486.6	496.6	516.6	520
DAYS	3	7	9	12	15	18	21	24	28

Figure 2: Showing Intermittent Curing 3 Times a Day



Mean Strength in MPa	13.37	17	17.15	18.17	20.93	21.22	21.65	22.53	22.67
Mean Crushing Load in KN	306.6	390	393.3	416.6	480	486.6	496.6	516.6	520
DAYS	3	7	9	12	15	18	21	24	28

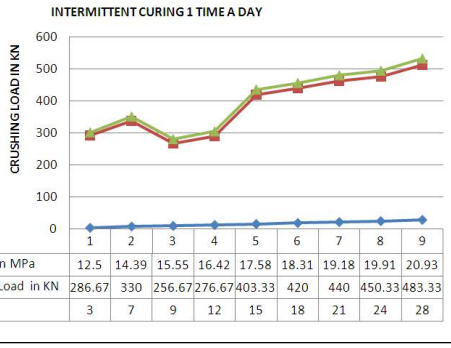
Figure 3: Showing Intermittent Curing 2 Times a Day



Mean Strength in MPa	12.93	16.13	16.71	17.73	18.17	19.03	19.77	21.22	22.09
Mean Crushing Load in KN	296.67	370	383.33	406.67	416.67	436.67	453.33	486.67	506.67
Days	3	7	9	12	15	18	21	24	28

maximum strength developed by the concrete mix-M20 on 28 days curing is 22.67 MPa, whereas after 15 days same concrete mix gains 20.93 MPa. It seems that there is

Figure 4: Intermittent Curing 1 Time a Day



Mean Strength in MPa	12.5	14.39	15.55	16.42	17.58	18.31	19.18	19.91	20.93
Mean Crushing Load in KN	286.67	330	256.67	276.67	403.33	420	440	450.33	483.33
Days	3	7	9	12	15	18	21	24	28

insignificant increment in the strength. Continuous curing 28 days period increased the strength only 1.74 MPa at age 15 days, 1.45 MPa at age 18 days, 1.02 MPa at age 21 days, and 0.14 MPa at age 24 days, respectively.

The strength of the concretes with intermittent curing of 3 times a day is given in Table 2. The compressive strength results through an age of 3, 7, 9, 12, 15, 18, 21, 24, and 28 days with intermittent curing 3 times a day is illustrated in the Figure 2. The strength of the concretes with intermittent curing 3 times varies a day with respect to the number of days increased. The maximum strength developed by the concrete M20 on 28 days intermittent curing 3 times a day is 22.53 MPa, whereas after 15 days same concrete mix gains 19.03 MPa. It seems that there is insignificant increment in the strength. Intermittent curing 3 times a day 28 days period increased the strength only 3.50 MPa at age 15 days, 2.62 MPa at age 18 days, 2.04 MPa at age 21 days,0.44 MPa at age 24 days respectively.

The strength of the concretes with intermittent curing 2 times a day is given in

Table 3. The compressive strength results through an age of 3, 7, 9, 12 15, 18, 21, 24, and 28 days with intermittent curing 2 times a day is illustrated in the Figure 3. The strength of the concretes with intermittent curing 2 times varies a day with respect to the number of days increased. The maximum strength developed by the concrete M20 on 28 days curing is 22.09 MPa, whereas after 15 days same concrete mix gains 18.17 MPa. It seems that there is insignificant increment in the strength. Intermittent curing 2 times a day 28 days period increased the strength only 3.92 MPa at age 15 days, 3.06 MPa at age 18 days, 2.32 MPa at age 21 days,0.87 MPa at age 24 days, respectively.

The strength of the concretes with intermittent curing one times a day is given in Table 4. The compressive strength results through an age of 3, 7, 9, 12, 15, 18, 21, 24, and 28 days with intermittent curing one times a day is illustrated in the Figure 4. The strength of the concretes with intermittent curing one times varies a day with respect to the number of days increased. The maximum strength developed by the concrete mix-M20 on 28 days curing one times a day is 20.93 MPa, whereas after 15 days same concrete mix gains 17.58 MPa. It seems that there is insignificant increment in the strength. Intermittent curing one times a day 28 days period increased the strength only 3.35 MPa at age 15 days, 2.62 MPa at age 18 days, 1.75 MPa at age 21 days,1.02 MPa at age 24 days, respectively.

CONCLUSION

The study was done to see the reduction in compressive strength of concrete due to intermittent curing of concrete in small villages or towns with one or two times a day because of lack of knowledge of house owners or because of lack of funds or due to negligence by contractors and house owners both , which could give a disastrous result to structures due to loads coming on it in its lifetime

The above study demonstrates that there is not much reduction in strength of concrete cubes even with intermittent curing .

The concrete cube with one time curing a day resulted in a reduction of only 7.67 % on an average after 28 days in comparison to full time wet curing of 28 days .

The concrete cube with two times curing a day resulted in a reduction of only 2.56% on an average after 28 days in comparison to full time wet curing of 28 days.

The concrete cube with three times curing a day resulted in a reduction of 0.0 % after 28 days in comparison to full time wet curing of 28 days .

The compressive strength of concrete cubes with intermittent curing of one time , two times and three times for 7 days is also not considerably low . By looking to the above results it can be concluded that it is a very good indication for the construction industry that the intermittent curing of concrete for three times a day is much more sufficient and it does not reduce the compressive strength after 28 days in comparison to full time curing , which is an important conclusion for saving the water and thereby electricity and in turn save cost of construction and there is no need to worry about the full time curing of structures always .

REFERENCES

1. ACI Committee 308, Standard Specification for Curing Concrete, 1998, ACI 308.1-98, American Concrete Institute, Farmington Hills, Michigan, p. 9.
2. Arafah A, Al-Zaid R and Al-Haddad M (1996), "Influence of non-standard curing on the strength of concrete in arid areas", *Cement and Concrete Research*, Vol. 26, No. 9, pp. 1341-1350.
3. Bushlaibi A H and Alshamsi A M (2002), "Efficiency of curing on partially exposed high-strength concrete in hot climate", *Cement and Concrete Research*, Vol. 32, No. 6, pp. 949-953.
4. Haque M N (1990), "Some concretes need 7 days initial curing", *Concrete International*, Vol. 12, No. 2, pp. 42-46.
5. IS: 516-1959, Methods of Tests for Strength of Concrete, Bureau of Indian Standards, New Delhi.
6. IS: 9013-1978, Methods of Making, Curing and Determining Compressive strength of Accelerated-Cured Concrete Test Specimens", Bureau of Indian Standards, New Delhi.
7. IS:456-2000, Plain and Reinforced Concrete-Code of Practice. Bureau of Indian Standards, New Delhi.
8. Lalonde W S, Jr. and Janes F Milo (1961), *Concrete Engineering Handbook*, McGraw Hill book Company, Inc. pp. 45-68.
9. Neville A M (1997), *Properties of Concrete,* 4th Edition, Pitman Publishing Limited, London , pp. 34-53.
10. Orchard D F (1962), *Concrete Technology*, Vol-II Practice, John Willey & Sons, Inc., pp. 24-56.
11. Rao M V Krishna, P Rathish Kumar and Khan Azhar M (2010), "A study on the influence of curing on the strength of a standard grade concrete mix", Facta Universitatis Series: Architecture and Civil Engineering Vol. 8, No. 1, pp. 23-34.
12. Shoba M and Raju P S N (2005), "Effect of Curing Compound on different Concretes", *New Building materials and construction world*, Vol. 11, No. 4, pp. 66-71.
13. Spears R E (1983), "The 80 percent solution to inadequate curing problems", *Concrete International*, pp. 15-18.