International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Damages of Delay Curing Concrete on Strength

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Abstract:
The aim of treatment is to maintain as much as possible the concrete being saturated or close to saturation until the voids that were initially filled with water in the soft cement paste are filled with the required amount of hydration products. Therefore, delaying curing has negative effects on compressive strength. The resulting damages cannot be canceled even after compensating for the curing period. Many concrete structures are not treated for a sufficient period to ensure obtaining the required properties. The start of curing may also be delayed due to the presence of a holiday after the day of casting or relying on building guards who neglect Correct and adequate treatment.

This research aims to study the effect of delaying the start of curing for a period of one, two, three, and four days after casting, in addition to studying the effect of changing the duration of curing with water, which includes 7, 14, and 28 days, on the compressive strength of concrete. The research includes the preparation of concrete cubes with dimensions (150 * 150 * 150) mm, and the mixing ratio was 1: 1.5: 3 with a water/cement ratio of 0.55. All samples were tested at the age of 28 days. The results showed that delaying the curing of concrete leads to a decrease in the compressive strength for a delay period of (1, 2, 3, 4) days, respectively, and that the greatest effect is when the curing is delayed on the first day, and that there is a significant increase in the compressive strength by 32.8% with an increase in the duration of wet curing. From 14 to 28 days, the concrete curing process must continue for a sufficient period to ensure that the concrete reaches the required design strength at the age of 28 days. Failure to comply with this period may have negative effects on the compressive strength of the concrete. In addition, increasing the duration of wet curing of concrete whose treatment is delayed is necessary to compensate for some loss in strength resulting from this delay, although it may not lead to the complete restoration of concrete properties.

Keywords: Delay, Concrete, Curing, Models. Wet coverage, spray curing

1. Introduction

Concrete is considered the mainstay of construction and construction materials, and the development of this material reflects the development of engineering thinking and in order for concrete to reach its current form as a construction and architectural material in the first place, it went through several stages in terms of industry, construction, and even treatment and its methods.

In terms of industry, the ancient Egyptians used concrete in some of their buildings and temples, primitively, through the use of broken stones as rubble and clay as an adhesive material. Present.

In order to obtain good concrete, it is necessary to treat it after the pouring process by providing the appropriate environment during the early stages of hardening. The term curing refers to the method used to stimulate the hydration of cement and includes control of temperature and the movement of moisture into and out of the concrete. More precisely, the aim of curing is to maintain as much as possible the concrete being saturated or close to saturation until the voids that were originally water-filled in the soft cement paste are filled with the required amount of hydration products. In the case of concrete produced on the job site, the actual curing process often stops long before the maximum hydration occurs.

The importance of curing concrete lies in the fact that hydration of cement does not occur unless the capillary pores are filled with water and for this reason it is necessary to prevent the loss of water from the capillary pores as a result of evaporation. In addition, the water lost internally causes self-drying resulting from the hydration of cement compounds. It must be compensated from the external water by curing.

The curing period cannot be determined easily due to its dependence on many factors such as temperature, relative humidity and the type of cement used in the concrete. However, in general, a period of 7 days is determined as a minimum for curing concrete containing ordinary Portland cement. Likewise, the type of construction has a major role in determining the method of treatment and its period. For example, road tiles need special importance and care for treatment, due to the exposure of their wide surface to the surrounding weather conditions. Also, facilities in which the ratio of surface area to volume is small, their treatment is complex and to facilitate Treatment The mold may be wetted before casting in order not to absorb the water of the concrete mixture as much as possible.

2. Previous studies

A study was conducted by the researcher James, le on the effect of curing methods on the compressive strength of concrete, where the concrete cube models were treated with a mixture ratio of 1: 2: 4 in the laboratory at an average temperature of 28 ° C for 7, 14, 21 and 28 days, where the results showed that the average The compressive strength of the treated models varies according to the processing method. The results showed that the ponds had the highest compressive strength and density, followed by wet coverage, and spray curing [1].

A study was conducted by the researcher Raheem and others on the effect of different curing methods on concrete density and compressive strength. Where the concrete cube models were treated with a mixing ratio of 1: 2: 4, with a water-cement ratio of 0.65. Using six different processing methods including polythene curing, spray curing, submerged water curing and air curing. For ages 3, 7, 14, 21 and 28 days old, the results showed that the average compressive strength of the treated samples differed according to the processing method. The results showed that the wet sand treatment method had the highest compressive strength and the densities of the samples ranged between 2432.59 and 2502.72 kg / m^3[2].
The use of high temperature curing concrete develops early strength in contrast to reductive heat curing, but the strength is generally reduced at 28 days and the later stage [3].

To avoid thermal cracking, the temperature must be uniform on the concrete section. Where experiments in the laboratory showed that it is possible to lose half of the potential strength in a dry environment if the comparison is made with identical concrete that has been cured with moisture [4].

3. Laboratory work

Raw materials for concrete mix

A. Cement: The usual Portland cement (Type 1) of Libyan production was used. The tables show the chemical analysis, the main compounds and the physical properties of the cement, respectively. It was found that the cement used conforms to the Libyan specification for Portland cement.

Table 1: Chemical Composition of Portland cement

Oxides	Percentage%	Limitations of standard Arab specifications
CAO	62.2	-
SiO2	21.2	-
AL203	5.2	-
Fe2O3	3.5	-
Mgo	0.95	≥ 5%
SO3	2.6	≥ 2.8%
Na2O	0.3	-
K2O	0.4	-
Insoluble materials I.R	1	≥ 1.5%
Loss on Burn L.O.I	1.5	≥ 4%

Table 2: Portland cement compounds

Major compounds	%
C_3S	50
C_2S	22.5
C_3A	12
C_4AF	9.2

B. Fine aggregate (sand): The use of natural fine aggregate from the Al-Soudah area, Suknet Al-Jafra, and the tables show the results of the sieve analysis, and the properties of the sand used, respectively.

Table 3: Sieve analysis of fine aggregate

Sieve size (mm)	Percentage passing through the sieve	British specification limits for the year 1992 (13)
9.5	99	100
4.75	97.5	100-89
2.36	92	100-60
1.18	77.5	100-30
0.6	54.5	100-15

0.3	12.4	70-5
0.15	2.7	15-0

Table 4: Physical and chemical properties of fine aggregate

Property	The test result	Specification
Bulk density (kg/m^3)	1487	[14] ASTM C128-01
Compacted density (kg/m^3)	1615	ASTM C128-01
Absorbance %	2.12	ASTM C128-01
% of salts	0.08	Maximum 0.5 **
Specific weight	2.6	-

C. Coarse aggregate (gravel): Use crushed gravel with a maximum size of 19mm and with a gradation that falls within the British Standard Specifications and as shown in the table

Table 5: Sieve Analysis of Coarse Aggregate

Sieve size (mm)	Percentage passing through the sieve	British specification limits for graded gravel measuring 5-20 mm (passing percentage(
19	97.6	100-90
9.5	53.2	60-30
4.5	2.5	10-0

I. Water: Ordinary drinking water is used to prepare the concrete and curing mixtures for the prepared forms. A single mixing ratio was used for concrete, which is 1: 1.5: 3 with a water-cement ratio of 0.55.

4. Results and discussion

❖ Effect of Delayed Curing on Compressive Strength of Concrete

Table 6 shows the effect of delayed wet curing of concrete on its compressive strength. 28%, respectively, for the wet treatment period at the age of 14, 7, and 28 days, respectively, according to the delay period. Where it is noticed that the delay in curing has a negative effect on the concrete, although the continuation of the treatment after the delay in its start leads to an increase in its resistance, but this does not lead to restoring the decrease in the resistance resulting from the delay in starting the treatment. It has been observed that the effect of the greatest is when the start of curing is delayed on the first day, because the concrete is in its weakest state in terms of tensile strength. Volumetric changes, which in turn lead to deformations and cracks inside the concrete, which leads to a weakness in its tolerance to compressive stresses, and also noted that even in the case of compensation for the treatment period after delaying it, the negative effect has occurred and cannot be canceled and the resulting damages that lead to a decrease in compressive strength are neglected.

Table 6: Effect of Delayed Curing on the Strength of Concrete at the Age of 28 Days

Mixture NO	Treatment Delay Period (day)	Compressive Strength for Wet cure time up to 1 day			Decrease in Resistance (%) for wet curing period up to age (day)			Decrease rate
		7	14	28	7	14	28	
0	-	17.1	21.5	26.33	-	-	-	-
1	1	14.4	20.0	22.5	11.7	13.2	13.0	13.0
2	2	14.9	19.1	23.8	13.7	14.1	14.9	13.5
3	3	14.5	15.6	20.6	19.1	21.6	23.5	21.5
4	4	14.4	16.3	21.1	22.5	25.9	26.8	25.1

❖ **Effect of Curing Period on Compressive Strength of Concrete**

One of the most important factors that help to increase the strength of concrete in general and the compressive strength in particular is the duration of curing the forms. with longer curing period, the higher the compressive strength of the concrete.The results in Table 7showed that there is a significant increase in the compressive strength by 32.8% with an increase in the duration of Wet curing from 7 to 28 days, while the increase was about 22.7%, with an increase in the wet curing period from 14 to 28 days. Preventing water loss from the capillary pores due to evaporation.In addition, the water lost internally due to internal dehydration resulting from its consumption by hydration of cement compounds must be compensated from the external water by treatment. Therefore, stopping the treatment at the age of 7 or 14 days may lead to a slowdown in the continuation of hydration due to a decrease in the state of saturation in the capillary spaces, and then a decrease in resistance compared to the samples treated continuously until the age of 28 days.

For all of the above, increasing the duration of the wet curing of the concrete whose curing is delayed is necessary to compensate for some of the loss in strength resulting from this delay, although it may not lead to the recovery of concrete properties and its full durability. Therefore, care must be taken to complete the treatment in a healthy and adequate manner and as soon as possible to ensure obtaining the required properties of the concrete.

Table 7: Effect of Wet Curing Period on Compressive Strength of 28 Days Old Concrete

Mixture NO	Compressive Strength for Moisture Curing Duration (day)			Decrease in Resistance as a Result of the Treatment up to the Age of 7 Days Compared to the Treatment up to the age of 28 Days(%)	Decrease in resistance as a result of the treatment up to the age of 14 days compared to the treatment up to the age of 28 days (%)
	7	14	28		
0	17.1	21.5	26.3	33.5	22.8
1	14.4	20.0	22.5	30.0	21.3

2	14.9	19.1	23.8	31.2	22.6
3	14.5	15.6	20.6	30.6	20.9
4	14.4	16.3	21.1	29.3	20.0

5. Conclusions

- Delaying the curing of concrete leads to a decrease in the compressive strength by an amount ranging between 13 to 28% and depending on the increase in the delay period between 1 to 4 days, and the biggest effect is the number of delays in curing on the first day.
- There is a significant increase in the compressive strength by 32.8% with an increase in the wet curing period from 7 to 28 days, while the increase was by 22.7% with an increase in the wet curing period from 14 to 28 days. Therefore, the concrete curing process must continue for a sufficient period to ensure that the concrete reaches the required design resistance at the age of 28 days. Failure to comply with this period may have negative effects on the compressive strength of the concrete.
- Increasing the duration of the wet curing of the concrete whose treatment has been delayed is necessary to compensate for some loss in resistance resulting from this delay, although it may not lead to the restoration of the properties and durability of the concrete completely.

6. Recommendations

The early curing of concrete gives high resistance compared to the resistance it gives when delaying in curing, which negatively affects the properties of concrete, and this situation often occurs during the work site, so it requires no delay in curing and doing it correctly and as quickly as possible.

Future Research

1- Studying the effect of delayed wet curing for more than four days on the compressive strength of concrete.

2- Studying the effect of the delay and duration of curing with wet burlap on the compressive strength of concrete.

7. References

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