IMPACTS OF CONCRETE CURING IN SULAIAMNYAREA

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Presented search

HOT WEATHER can lead to many problems in mixing, placing, and curing of concrete that can have an adverse affect on its properties and service life. This guide has been developed by Master Builders, Inc. to assist the entire construction team (owners, specifiers, contractors, and ready mixed concrete producers) in the design, manufacture, delivery, placement and curing of quality concrete in hot weather .

Curing is the process of controlling the rate and extent of moisture loss from concrete during cement hydration. It may be either after it has been placed in position (or during the manufacture of concrete products), thereby providing time for the hydration of the cement to occur. Since the hydration of cement does take time – days, and even weeks rather than hours – curing must be undertaken for a reasonable period of time if the concrete is to achieve its potential strength and durability. Curing may also encompass the control of temperature since this affects the rate at which cement hydrates.

COMPRESSIVE STRENGTH AT 180 DAYS AS % OF CONTINUOUSLY MOIST SAMPLE

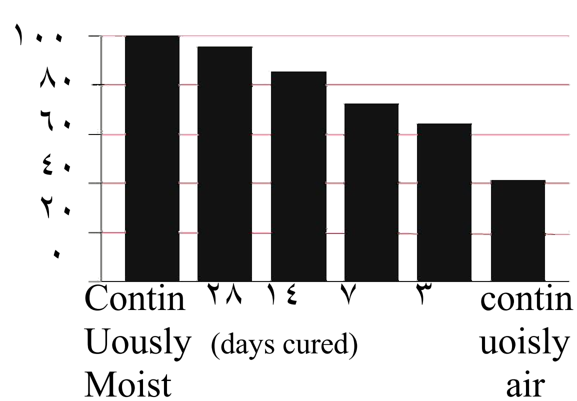


Fig.١ ;Effect of duration of water curing on strength of concrete

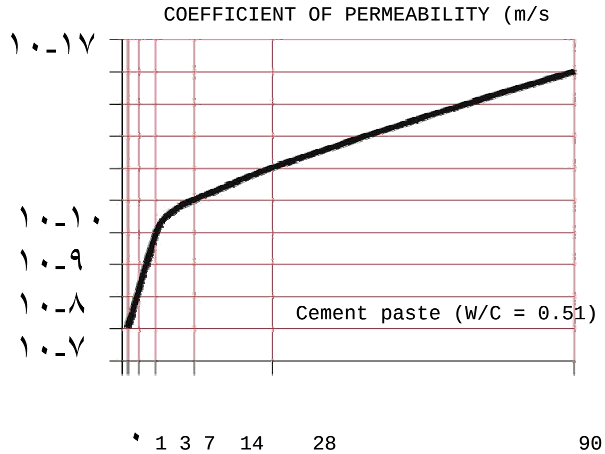


Fig ٢: Effect of duration of water curing on permeability of cement paste

EFFECT OF DURATION OF CURING ON PROPERTIES OF CONCRETE The strength of concrete is affected by a number of factors, one of which is the length of time for which it is kept moist, ie cured. Figure ١ illustrates this, comparing the strength (at ١٨٠ days) of concrete for which the surfaces have been:
n kept moist for ١٨٠ days.
n kept moist for various periods of time and allowed to dry out.
n allowed to dry out from the time it was first made.

This paper presents the efficiency of two concrete curing methods commonly employed in Sulaimanya as a case study for evaluation of curing efficiency under severe hot and dry weather conditions. The competence of curing methods was measured in terms of concrete compressive strength at ٢٨ days. The methods were water terms of concrete compressive strength at ٢٨ days. The methods were water sprinkling two times a day for seven days, which is designated as SWC and water sprinkling two times a day for seven days with a burlap cover, which is designated as SBC. The specimens were tested at ٢٨ days and compared with standard cured specimens, which were designated as STD. A total of ٥٦ cube specimens were collected from construction sites in our project(sharyjwan project) during the sampling period and cured under STD-, SWC-, and SBC- conditions. The ratios of SWC and SBC to STD strengths were plotted on normal probability forms. The mean values of these ratios were ٠.٨٤ and ٠.٩٣, respectively. The probability of these ratios being less than the ACI-٣١٨ general requirement for concrete curing of ٠.٨٥ was ٥٤ and ٢٠ percent, Sulaimanyah or, for that matter, in any other region of similar weather conditions are made.

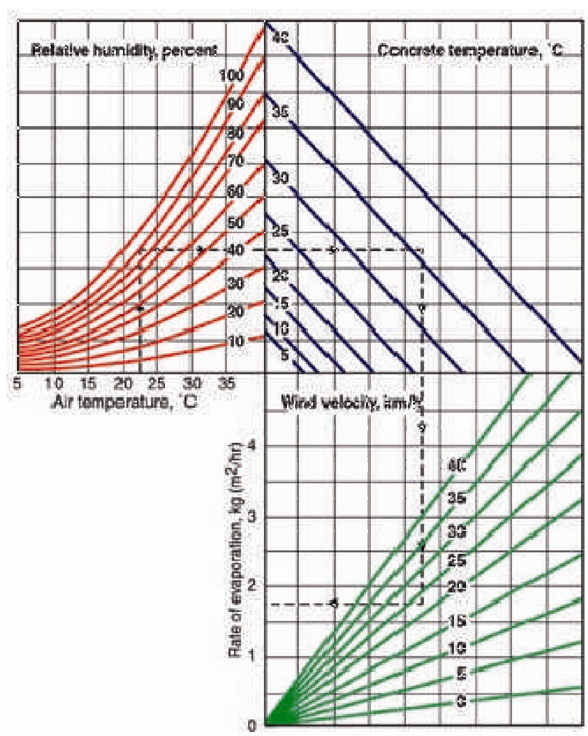
Keywords: Concrete curing, hot weather concreting, concrete durability.

specially for SWC curing. Recommendations for improving the curing methods in

respectively. These high probabilities indicate a deficiency in the curing methods,

Curing should be started as soon as the concrete has set enough to avoid any sur face damage. Concrete should be cured for at least ٧ consecutive days after placing. Ensure that the concrete is kept moist throughout the curing process (see technical bulletin on curing options).

To use this char t: ١. Enter with air temperature, move *up* to relative humidity. ٢. Move *right* to concrete temperature. ٣. Move *down* to wind velocity. ٤. Move *left*; read approx. rate of e vaporation.



١ Introduction

The temperature of the concrete is affected by the surrounding air, absorption of solar heat, heat of hydration of cement and initial temperature of materials. An undesirable reduction in moisture content of the cement paste at this stage tends to reduce hydration and results in drying shrinkage and development of cracks in the paste. In the parlance of concrete technology, hot weather is defined as any combination of high air temperature, low relative humidity, and wind velocity [١].

The effects of hot weather are most critical during periods of rising temperature or falling relative humidity, or both. Undesirable hot weather effects on concrete in the plastic state may include: (a) increased water demand, (b) increased rate of slump loss, (c) increased rate of setting and (d) increased tendency for plastic cracking [١]. Thus, a continuous curing, particularly during the first few hours, is acutely needed. ACI ٣١٨ [٢] and ACI ٣٠٨ [٣] recommend that concrete be maintained in a moist condition for at least the first ٧ days after placement. Alternate cycles of wetting and drying promote the development of pattern cracking and should be avoided. ACI ٣١٨ [٢] specifies that the procedure for curing concrete shall be improved when the strength ratio of field cured specimens to the companion laboratory cured specimens is less than ٠.٨٥ unless the field-cured strength exceeds the specified strength by more than ٣.٥ MPa.
Spears [٤] indicated that proper curing maintains relative humidity above ٨٠ percent and, thereby, advances hydration to the maximum attainable limit. Proper curing decreases concrete permeability, surface dusting, thermal-shock effects, scaling tendency and cracking. It increases strength development, abrasion resistance, durability, pozzolanic activity and weatherability. Haque [٥] investigated the strength development of concrete under the conditions of fog, temperate dry, warm-wet and warm-dry weather conditions. He found that the lack of any moist curing adversely affects the compressive strength of plain concrete at all ages. Martin [٦] demonstrated that rising placing temperatures do not, as a rule, lead to lower strengths. With favorable combinations of cementitious materials and admixtures, the strength performance of concrete can remain unaffected by higher

placing temperatures, or it can even improve over that at lower temperatures.Malvin and Odd [٧] conducted a large-scale field investigation of high-strength light-weight concrete and concluded that maximum curing temperatures of up to ٨٥ C (١٥٣F) did not adversely affect the mechanical properties of the concrete. On the contrary, they observed a slight increase in compressive strength.
Khan [٨] quantified the effect of interrupted curing. He found that the losses in strength of concrete due to an interruption in moist curing can be regained significantly by recuring the concrete.
Carrier [٩] indicated that a short period of drying early in the curing life of concrete specimens prevents water molecules from reaching unhydrated cement particles and prevents concrete from gaining full strength. He also indicated that much of the concrete deterioration that takes place each year should be blamed on inadequate curing. Early and rapid drying can lead to failure such as shrinkage cracks, crazing, wear, dusting, scaling, and spalling. Once a surface has cracked, dusted, scaled or spalled, the entire member is more susceptible to other types of deterioration.

٢ Research significance

Twice a day sprinkling of water with or without burlap cover for seven days are the curing practices used . The average annual maximum temperature of ٤٦ o C and the average annual minimum humidity of ٤.٠ % in summer in the our region and the prevalent methods of curing which are below the required standard practice call for studying their effects on the strength of concrete.

٣ Objective and scope

This paper presents results of an experimental program designed to investigate the influence of the prevalent curing practice on the strength of concrete cast during ten month period in an arid area.

٤ Experimental program

The experimental program was designed to evaluate the influence of the prevalent curing practices on the compressive strength of the concrete.

The Three curing methods which were employed are described and designated as in Table ١.

Concrete samples were collected from randomly selected construction sites in Sulaimanyah . The sampling was done during ten

Table ١. Curing methods used and their designation

Designation	Curing method
SWC	Twice a day sprinkling without cover for seven days
SBC	Twice a day sprinkling with burlap cover for seven days.
STD	Twenty eight day immersion in water, considered standard curing.

A total of ٥٦ concrete samples were collected at construction sites in Sulaimanyah during the sampling period and cast into standard cubes of ١٥٠x١٥٠x١٥٠ mm. Each sample consisted of three pairs of cubes and each cube in a pair was collected from a separate truck(norsoy ready mix). The cubes were left at the site for about ٢٤ hours and then transferred to the laboratory. A pair in a sample was cured by SWC, the second by SBC and thethird by STD method. The cubes were tested for strength at age of ٢٨ days.

٥ Results, analysis and discussion

The ratios R١ and R٢ of the compressive strength of the SWC and SBC cured cubes, respectively, to the STD cured cubes were subjected to analysis by order statistics.

The results are presented in Table ٢ and plotted on a normal probability paper along with the best fit by linear regression in Fig. ٣. The mean values of R١ and R٢ are ٠.٨٤ and ٠.٩٣, respectively. This clearly indicates the beneficial effect of curing with burlap cover in dry-hot weather. The maximum values of the two ratios are ١.٠٩ and ١.١٤, respectively, and their minima are ٠.٦٣ and ٠.٧٥.

Table ٢. Basic statistics of the strength ratios R١ and R٢ in the Sulaimanyah Area.

Ri	Min	٥ percentile	mean	max	COV%	P(R<٠٨٥)
R١	٠.٦٣	٠.٦٧	٠.٨٤	١.٠٩	١٢.٦٠	٠.٥٤
R٢	٠.٧٥	٠.٧٨	٠.٩٣	١.١٤	٩.٨	٠.٢٠

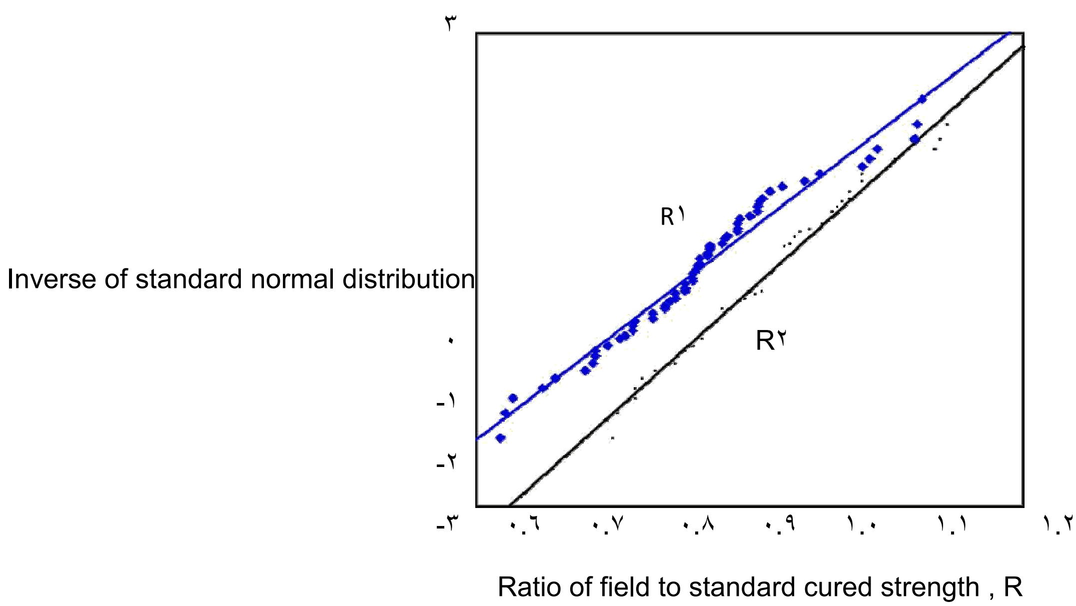


Fig.٣ Influence of curing methods on concrete strength in the central province

It is interesting to note that the variability in compressive strength and curing process can cause these ratios to be higher than unity. The five percentiles (the values with probability of ٥ percent of being not exceeded) of the two ratios are ٠.٦٧ and ٠.٧٨, respectively.

ACI ٣١٨ [٢] specifies that "procedures for protecting and curing concrete shall be improved when strength of field cured cylinders at test age designated for determination of f'_c is less than ٨٥ percent of that of companion laboratory cured cylinders." In the presence of strength variability, there is a possibility of having this ratio less than ٠.٨٥ which is very small with good curing practices, however, this probability will increase when poor practices are employed.

Results indicate that the mean values of R١ are less than those for R٢ while the coefficients of variation of R١ are higher than that of R٢ . As a result, the probability of being R١ less than ٠.٨٥ is ٥٤%, which is very high. This indicates that the SWC curing method does not meet the ACI-٣١٨ requirement in arid areas. The probability of having R٢ less than ٠.٨٥ in sulaimanyah area is about ٢٠%, which is also relatively high.

The authors suggest that the efficiency of curing methods should be based on the ٥ percentile of the distribution function of the ratio R which is affected by both its mean and COV. The results indicate that the ٥ percentiles are ٠.٦٧ and ٠.٧٨, respectively. The curing methods should be improved to bring these values to ٠.٨٥ .

The ACI-٣٠٨ recommends that concrete be maintained in a moist condition for at least the first ٧ days after placement. In arid areas, it is impossible to meet this recommendation using SWC where the available water for concrete curing is very limited. The SBC curing method is more efficient; however, the frequency of water sprinkling per day should be increased so that the ٥ percentile of the distribution of is at least equal to ٠.٨٥. The efficiency of water sprinkling three times a day with a burlap cover is under investigation.

٦. Conclusion

The effect of curing practice was evaluated by statistical analysis of strength ratio, R, of field cured to standard cured cubes. The field curing methods used were sprinkling without cover and with burlap cover. The results in the sulaimanyah area showed that the mean value of R١ & R٢ are ٠.٨٤ and ٠.٩٣ , respectively. The higher value of R٢ indicates the effectiveness of burlap cover in improving the curing process. The probability of having R١ less than ٠.٨٥, specified by ACI-٣١٨, is ٥٤ percent, indicating that curing by water sprinkling without cover twice a day for ٧ days will not satisfy the ACI-٣١٨ requirement. The SBC curing method is more efficient; however, the frequency of water sprinkling per day should be increased so that the ٥ percentile of the distribution of R٢ is at least equal to ٠.٨٥. The efficiency of water sprinkling three times a day with a burlap cover is under investigation.

٨ References

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