Influence of Different Curing Ways on the Properties of Concrete

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Abstract

The influence of curing is immensely important on the properties of concrete, especially the complete process of the cement hydration that brings hardened concrete and more durability. In this present work comprises the comparison curing influence that by jute membrane, polypropylene (PP) sheet and ponding. The work deals with physical properties of the concrete, where cubes and cylinders used for the compressive strength and splitting tensile strength tests respectively. Cubes specimens by 150×150×150 mm and cylinders specimens used by size 100×200 mm. In addition, the non-destructive test, ultrasonic and Schmidt hammer test for the specimen tested. The results indicated the ponding curing showed the superior comparing with other types of curing. Compressive strength, splitting tensile strength, Schmidt hammer and ultrasonic pulse velocity of specimen concrete showed higher value for ponding curing when evaluated with polypropylene sheet and jute membrane curing. Besides, the test results of specimen concrete curing by polypropylene sheet noted higher value compared with jute curing.

Keywords- Curing of Concrete, Polypropylene (PP) Sheet, Jute Membrane, Compressive Strength, Tensile Strength, Ultrasonic, Schmidt Hammer

I. INTRODUCTION

Concrete is the material of the most important materials used entering in most areas of construction. Concrete knows the quality of resistance to compressive strength and durability of concrete. As well, it can increase the strength of concrete after hardening if it is appropriate to provide hydration and long enough. Where the ways of concrete curing is concern the quality of the concrete, so necessity provide a suitable environment for concrete to provide proper hydration of the concrete [1]. Curing of concrete stands for procedures devoted to promote cement hydration, consisting of control of time and humidity conditions immediately after the placement of concrete mixture in to form work. Curing designed primarily to keep the concrete moist, by preventing the loss of moisture from the concrete during the period in which it is gaining strength. When the ambient temperature is sufficiently well above freezing, the curing of pavements and slabs can accomplished by ponding or immersion, other structures can be cured by spraying or fogging or moisture-retaining coverings saturated with water, such as burlap or cotton. These methods afford some cooling through evaporation, which is beneficial in hot weather concreting. Another group of methods based on prevention of moisture loss from concrete by sealing the surface through the application of water proof curing paper, polyethylene sheets, or membrane forming curing compounds [2,3]. When the ambient temperature is low, concrete must be protected from freezing by the application of insulating blankets, the rate of strength gain can be accelerated by curing concrete with the help of live steam, heating oils, or electrically heated forms or pads [2]. Curing is the name given to procedures used for promoting hydration of cement, and consists of a control of temperature and moisture movement from and into the concrete [4-6]. (Gokul et al, 2016) [7] Used immersion curing, wet gunny bags curing and accelerated warm water curing. The results of the studies showed, the immersion curing gave that better strength compared with other two types of curing. (Rao et al, 2010) [8] Study the influence of curing on the strength of a standard grade concrete mix. The results showed curing by membrane forming curing compound produced almost the same results as that of conventional wet curing for concrete. (Reddy, 2013) [1] Investigated the methods of curing influence on concrete, and the results showed the ponding curing (immersion in water) contributed the best results compare with other type of curing. (Usman and Isa, 2015) [9] Investigated the effect of curing methods on the strength of concrete. Used four curing methods namely immersion, sprinkling, polythene sheeting and sharp sand coating. The results showed the water immersion curing method plus sprinkling (spraying) methods of curing, present superior results than membrane (polythene sheeting) method of curing. (Ajay et al, 2013) [3] Used three type of curing method were air curing, plastic films and immersion under water. The results showed the immersion under water curing given higher compressive strength compared with other type of curing. Besides, the plastic showed significant results than the plastic films curing.

II. EXPERIMENTAL WORK

A. Materials

Ordinary Portland cement used, it taken from Bazian and Tasluja Cement Factory used throughout this study. Table (1) and (2) show the physical and chemical properties of cement accordance with the standard specification ASTM C 150 [10]. Fine aggregate (sand) supplied from AL-Ekadir in Karbala region, the Fineness Modulus equal 2.3. Table (3) shows the sieve analysis of fine aggregate according to ASTM C 33 [11]. The coarse aggregate (gravel) used as crushed; the maximum size was 12.5 mm. It obtained from AL-Nebai source, Table (4) shows the sieve analysis accordance with the standard specification ASTM C 330 [12].

Table 1: Chemical properties of the cement

Constituent	*Content (%)*	*ASTM C 150 specification*
CaO	*52.21*	-
SiO2	*20.18*	-
Al2O3	*05.00*	-
Fe2O3	*03.60*	-
MgO	*02.31*	*≤6.00*
SO3	*01.44*	*≤3.50*
Loss of Ignition (L.O.I.)	*03.29*	*≤3.00*
Insoluble residue	*01.11*	*<1.5*
Lime Saturation Factor (L.S.F.)	*00.94*	*0.66-1.02*
C3S	*57.04*	-
C2S	*14.83*	-
C3A	*8.60*	-
C4AF	*10.95*	-

Table 2: Physical Properties of the Cement

Physical Properties	*Test results*	*ASTM C 150*
Specific surface area (Blaine method), (m2/kg)	*483*	*Min. 280 m2/kg*
Setting time (Vicate apparatus), *Initial setting (minutes)* *Final setting (minutes)*	 *150* *258*	 *Not less 45 min.* *Not more than 375 min.*
Soundness (Autoclave expansion) (%)	*0.25*	*≤0.8%*

Table 3: Sieve analysis of fine aggregate

Sieve No. (mm)	*% Passing*	*ASTM C 33*
No.4 (4.75)	*95*	*95-100*
No.8 (2.36)	*90*	*80-100*
No.16 (1.18)	*85*	*50-85*
No.30 (0.60)	*70*	*25-60*
No.50 (0.30)	*25*	*5-30*
No.100 (0.15)	*5*	*0-10*

Table 4: Sieve analysis of coarse aggregate

Sieve No. (mm)	*% Passing*	*% Passing ASTM C 330*
1/2 in. (12.5)	*95*	*90-100*
3/8 in. (9.5)	*70*	*40-80*
No.4 (4.75)	*15*	*0-20*
No.8 (2.36)	*5*	*0-10*

B. Mixing Proportions, Mixing Procedure and Casting

The mix proportions used 1:2:4 by weight (1 cement, 2 fine aggregate, 4 coarse aggregate), water cement ratio (w/c) equal to 0.45, where used tap water in the mixing. The mix procedure consist of by blending the cement, sand and gravel and then added the water to obtain the concrete according to the mix 1:2:4. The size of specimens for compressive strength it was cube by size 150×150×150 and the cylinder by size 100 mm in diameter and 200 mm in height for splitting tensile strength according to the BS EN 12390-3 [13] and ASTM C 496 [14], respectively. Three cubes and cylinders cast for compressive strength at age 7 and 28, and 3 specimen for each types of curing. The molds oiled properly for easy out specimen, then fill the mold with three layers of the mixture, and with each layer compacted by tamping rod to ensure out the bubbles and distribution. The specimens demolded after 24 hours of casting and then they transferred to a curing process.

C. Curing

Three types of curing methods used namely ponding, polypropylene sheet and jute membrane. The ponding curing involve immerse the specimen in basin after stripped approximately 24 h with a controlled temperature of 23° C ± 2° C according to ASTM C 192 [15]. Polypropylene (PP) sheet and Jute membrane used, where the polypropylene sheet and Jute membrane coated the concrete specimens of cubes and cylinder in one layer and spray by water on daily at the same time until the polypropylene sheet and Jute membrane moisten. Normal tap water used for all curing types.

D. Texting

The compressive strength was determined, the average of three cubes test (150×150×150 mm) under three type of curing methods, by ponding, polypropylene sheet and Jute membrane. At ages 7, 14, and 28 considered the compressive strength according to the BS EN 12390-3 [13]. The splitting tensile strength was determined, the average of three-cylinder test (100 mm diameter and 200 mm height) under three type of curing methods, by ponding, polypropylene sheet and Jute membrane. At ages, 7, 14, and 28 the test carried out in accordance with ASTM C 496 [14].

The specimen tests non-destructive test by Schmidt Hammer (Proceq Company) according to ASTM C 805 [16]. Where the specimen determine by rebound number (R) of hammer on the surfaces of cubic specimens, and the tested take different places from the same specimen and determine the average of rebound number, then knowing the compressive strength from the rebound number by the curve was gives with device. Specimens at age 28 days tested by ultrasonic pulse velocity (Proceq Company) according to ASTM C 597 [17] to evaluate the feature of concrete.

III. RESULTS AND DISCUSSION

A. Compressive Strength

The results represented the ponding curing of the cubes specimens given 25 MPa, it is the higher compressive strength compare with other type of curing as shown in Figure 1. Polypropylene sheet and Jute membrane curing, the compressive strength value for concrete curing by polypropylene sheet showed higher than Jute membrane curing and less than ponding curing. About 28% increase in the compressive strength curing by ponding compared by Jute Membrane curing, and 14% increased the compressive strength curing by polypropylene sheet compared with Jute membrane curing [18, 19].

B. Splitting Tensile strength

The splitting tensile strength results showed the ponding curing give the higher value where it was 3.15 MPa as shown in Figure 2. Polypropylene sheet and Jute membrane curing, the splitting tensile strength value for concrete curing by polypropylene sheet showed higher than Jute membrane curing and less than ponding curing. About 26% increase in the splitting tensile strength curing by ponding compared by Jute Membrane curing. Beside, 14% increase in the splitting tensile strength curing by polypropylene sheet compared with Jute membrane curing. Polypropylene sheet store the water long time than the jute membrane, and thus it provided with tri-calcium silicate compound with plenty of water, in order to complete the hydrogenation process in concrete.

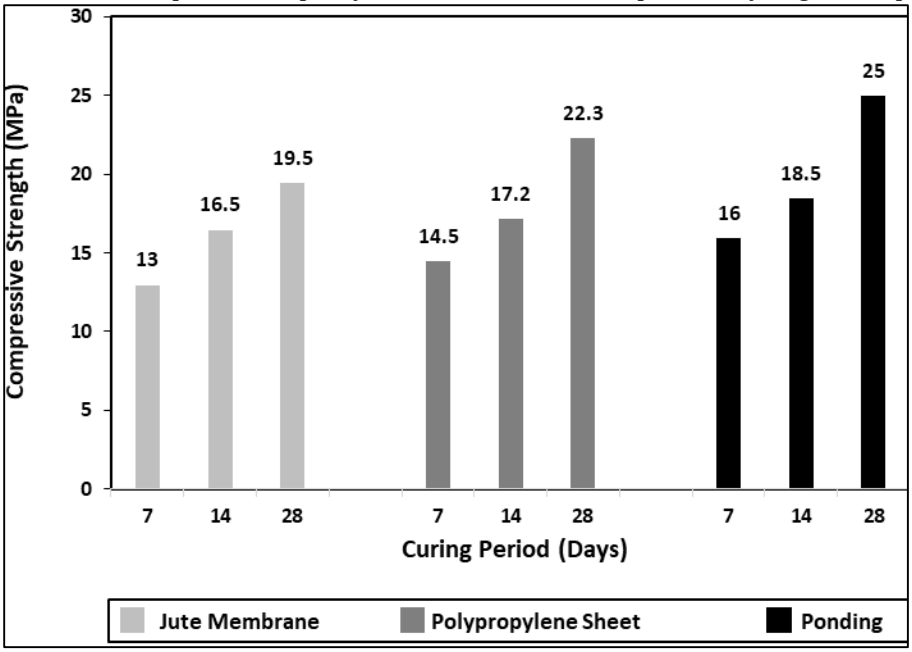

Fig. 1: Influence of curing type on the compressive strength

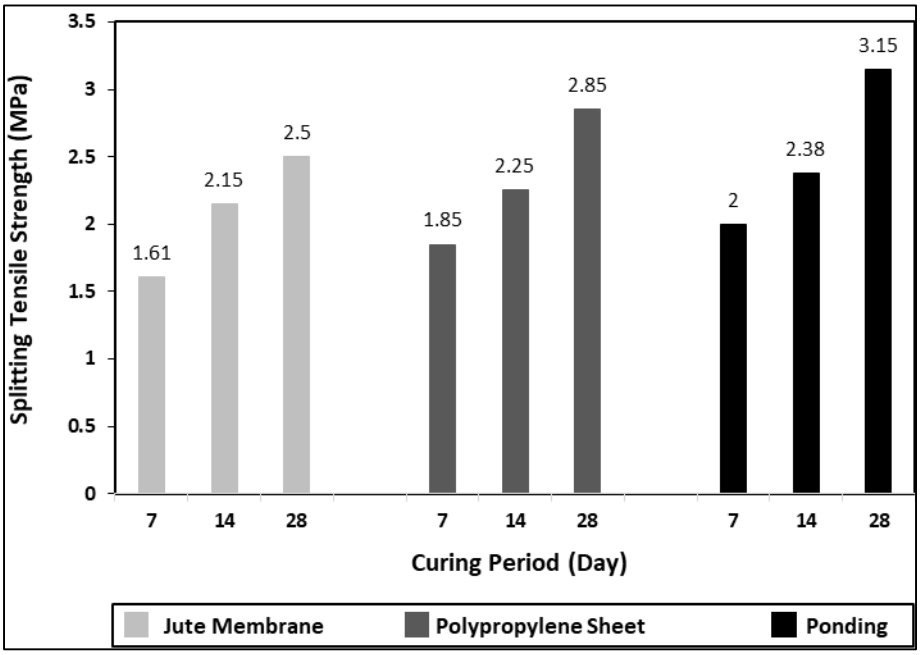

Fig. 2: Influence of curing type on the splitting tensile strength

A. Rebound Number (Schmidt Hammer)

The rebound number of concrete specimens curing by ponding, record high rebound number as shown in Figure 3 than the sample curing by polypropylene (P.P) and jute, because of the hydrogenation process is completed in the sample, to the abundance of the presence of water led to increase the strength and hardness of concrete.

If compared curing by jute membrane and polypropylene sheet, note from Figure 3 that the polypropylene sheet recorded higher results, due to the polypropylene retain water long time and prevent evaporation of water from the concrete.

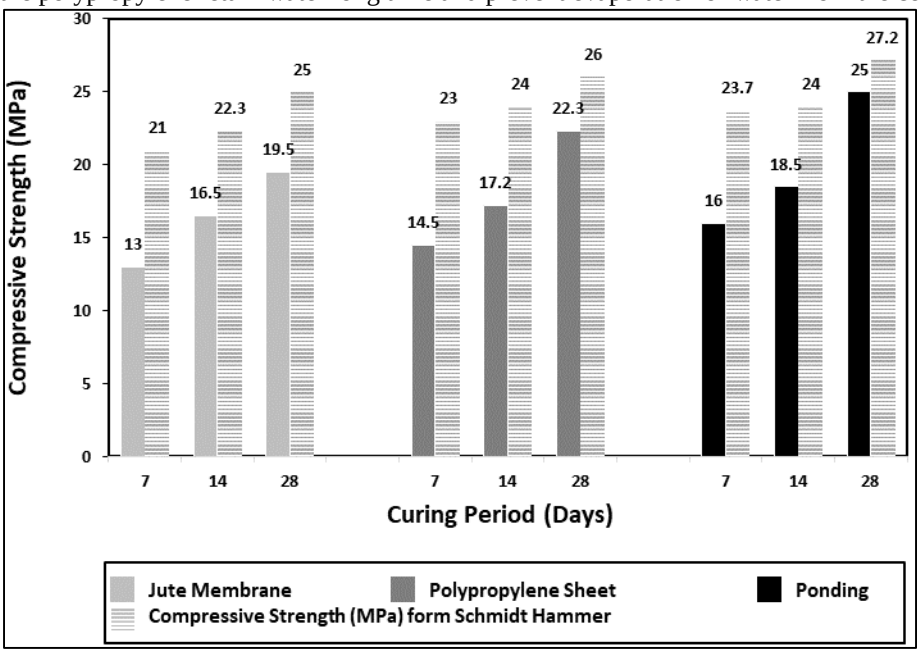

Fig. 3: Relationship between compressive strength and Schmidt hammer value

B. Ultrasonic Pulse Velocity (UPV)

Figure 4 show the ultrasonic pulse velocity for the specimen curing by ponding, polypropylene sheet and jute membrane. Ponding curing showed higher value compared with other type of curing, this is due the high density of sample than other curing, by existence large amount of water, the hydration of sample lead to raise the density. Ultrasonic pulse velocity of specimen curing by jute membrane showed less than the polypropylene sheet curing as show in Figure 4, this is because the length of the period of retaining of the cover with water, that is led to rise hydration of sample and led to increase the density [6].

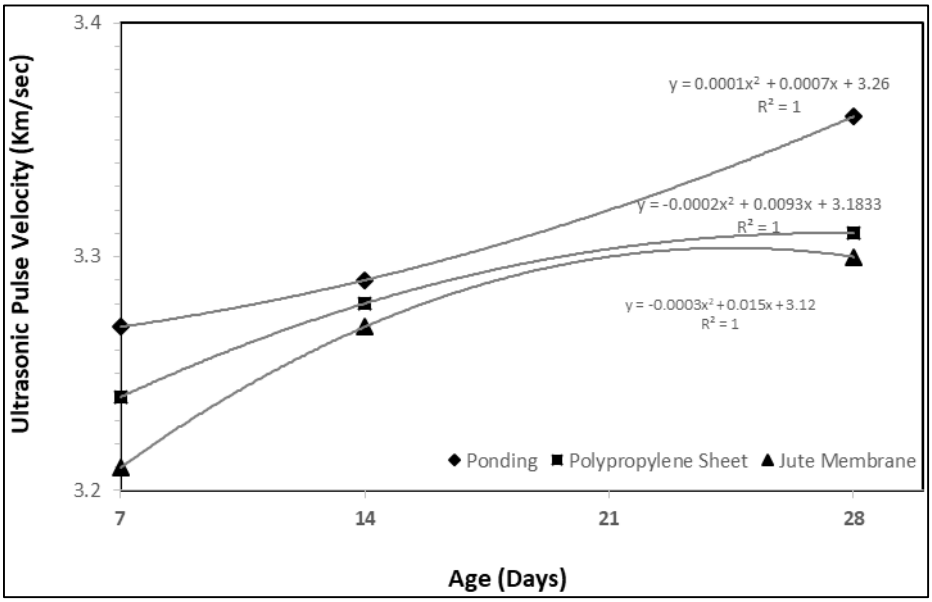

Fig. 4: Influence of curing type on the ultrasonic pulse velocity

IV. CONCLUSIONS

Depending on the research, results exhibited the ponding curing presented the superior value compared with other curing types. All test results compressive strength, splitting tensile strength, Schmidt hammer and ultrasonic pulse velocity showed higher. The test results of compressive strength and splitting tensile strength were 25 MPa, 3.15 MPa respectively. In addition, the polypropylene sheet curing showed significance and advancing results compared with jute membrane curing, where the results of all test presented advanced compared with jute membrane.

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