Journal of Animal and Veterinary Advances 10 (14): 1756-1759, 2011
ISSN: 1680-5593

Effect of Different Cure Conditions on Compressive Strength of Concrete Having Different Properties

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Abstract: This research was carried out to determine unit weights and compressive strengths for the concrete samples produced with normal aggregate obtained Erzurum province and lightweight aggregate obtained Van-Ercis province and cured under different conditions. Unit weights of concrete specimens produced with normal aggregate were 2325 under air cure, 2360 under water cure, 2358 kg m^{-3} under steam cure. Unit weights of concrete specimens produced with lightweight aggregate were 906 under air cure, 1060 under water cure, 972 kg m^{-3} under steam cure. In average, 28 days compressive strength of concrete specimens produced with normal aggregate were 180.3 under air cure, 270.0 under water cure, 240.1 kgf cm^{-2} under steam cure. In average 28 days compressive strength of concrete specimens produced with lightweight aggregate were 60.0 under air cure, 45.2 under water cure, 52.4 kgf cm^{-2} under steam cure.

Key words: Lightweight aggregate, normal aggregate, concrete cure, unit weight, compressive strength, Turkey

INTRODUCTION

Concrete is a building material formed by mixing aggregates (sand, gravel and crushed stone), cement and water in a suitable ratio and having high strength by hardening at the end of certain time (Ekmekyapar and Orung, 2001). It should be initated to cure (maintain) and control of concrete with the end of its production. Concrete needs meticulous care in the next days following production. One of the more important effects on compressive strength of concrete is care (cure) type after its production. With different cure practices different strengths is obtained. After production if not concrete subject to damp cure for a long time, shrinkage cracks (fractures) occur (Lea, 1956). Concrete is a building material having high compressive strength like other crispy materials. So, concrete compressive strength is used in reinforced concrete accounts. Standard compressive strength of concrete is the strength of under axial compression specimens, curing in water for 28 days (Neville, 1983).

In addition to normal aggregate being used in concrete production, usage of lightweight aggregate can be an important source for agricultural buildings near rural provinces.

MATERIALS AND METHODS

In experimental study, normal aggregate provided from sand-gravel bed which Aras river accumulated, obtained Pasinler and Horasan regions of Erzurum province, lightweight aggregate obtained from Van-Ercis province as binder cement and mixing water used. The chemical analysis results of lightweight aggregate shown in Table 1, chemical ananlysis results of portland cement shown in Table 2 and physical and mechanical analysis results of portland cement also shown in Table 3.

Tests for spesific gravity, water absorbtion, organic materials, fine materials and determining the amount of sulfate, related to lightweight aggregate made according to ASTM C 332 (Anonymous, 1998a); TS 13055-1/AC (Anonymous, 2006); ASTM C 136-96 (Anonymous, 1998b); ASTM C 29 M-97 (Anonymous, 1998c); ASTM C 127-88 (Anonymous, 1998d); ASTM C 128-97 (Anonymous, 1998e); ASTM C 40-97 (Anonymous, 1998i); ASTM C 142-71 (Anonymous, 1998f); TS EN 1744-1 (Anonymous, 2010b) and TS EN 1097-6/A1 (Anonymous, 2007).

Concrete options produced from the aggregates applied in experimental study research materials, determined by the way that taking into consideration of steam, water and air curing conditions of specimens.

For structural concrete and masonry units concrete produced with mixed aggregate, maximum size of aggregate chosen 16 mm appropriate to the specified value given in TS EN 13055-1/AC (Anonymous, 2006) and ASTM C 331 (Anonymous, 1998g). Cement dosage is a factor creating important properties and effecting economy at large scale of concrete. Conditions for agricultural building taken into

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Table 1: Chemical analysis results of lightweight aggregate obtained Van-Ercis province

Chemical components	Ratio (%)
MgO	0.01
Al_2O_3	13.20
SiO_2	71.35
CaO	1.84
Fe_2O_3	1.54
SO_3	0.04
K_2O	5.00
Na_2O	3.40
TiO_2	0.25
Ignition loss	3.37

Table 2: Chemical analysis results of PC 325 cement

Chemical components	Ratio (%)
SiO_2	17.69
Fe_2O_3	3.59
Al_2O_3	5.89
CaO	57.69
MgO	3.39
SO_3	2.57
Ignition loss	2.50
Sulphide (S^{-2})	0.27
Chlorine (Cl^{-})	0.04
Insoluble residue	4.86
Undetermined	0.55
Free CaO	0.96

Table 3: Physical and mechanical properties of cement

Parameters	Values
Spesific gravity (g cm^{-3})	3.03
Lightweight (g L^{-1})	1130.00
Spesific surface (cm^2 g^{-1})	3613.00
Remainder on 200 μm sieve (%)	0.10
Remainder on 200 μm sieve (%)	3.10
Setting time initial (h)	2:30.00
Setting time final (h)	3.20
Volume expansion (Le Chotelier, mm)	3.00
2 days	12.25
Compressive strength (N mm^{-2}) days	
7	24.80
28	36.50

consideration in determining strength levels. Cement dosage changes between 90-200 kg m^{-3} range for unreinforced concretes, especially isolation concrete and changes between 300-500 kg m^{-3} range for structural concretes (Hammel and Schumacher, 1975). Due to agricultural buildings usually are single storey, it may be requered more less strength than the other buildings in their conveyor units. By the way that all these factors taking into consideration, cement dosage chosen 250 kg m^{-3}. In the preliminary tests of fresh lightweight concrete specimens, 3-6% air contents was obtained that is appropriate to 4-8% air contents (PCA, 1972; Neville, 1973) which are quite appropriate for the concrete produced with the aggregate having maximum aggregate size as 16 mm. So, it was decided to produce the concrete specimens as pure air.

RESULTS AND DISCUSSION

As a result of preliminary slump tests for concrete specimens produced with lightweight aggregate; values ranged between 3-6 cm which appropriate in terms of workability, so slump value was taken 5 cm in all experimental mixtures. Mixture accounts of concretes produced with lightweight aggregate were made based to (according to) TS 2511(Anonymous, 1977a). This method was also used for the conrete specimens, produced with normal aggregate.

For using in experimental study by making account of mixtures 18 concrete specimens having 250 kg cement dosage were prepared. According to TS EN 12350-2 (Anonymous, 1977b) consistency and according to TS 2941 (Anonymous, 1978a) unit weight of fresh concrete were determined. Specimens produced in shape of cylinder having 15 cm diameter and 30 cm height appropriate to ASTM C 192 ve TS 3323 (Anonymous, 1998h; Anonymous, 1979).

Standard cylinder molds were used for cylinder shaped specimens. After lubricating inside of molds with mineral oil, concrete placed into molds, after sweeling 75 times then surface of concrete specimens levelled with a steel trowel (spatula). To prevent the moisture loss of concrete specimens, upper sides covered with plastic bags and were kept in molds for 24 h (Anonymous, 1978b).

After removing from the molds, concrete specimens were left to cure conditions then at the 28th day they were subjeted to tests (Anonymous, 1978c). According to TS 3624 (Anonymous, 1981) unit weights according to TS EN 12390-3 (Anonymous, 2010a) compressive strength of 28 days aged concrete specimens were determined.

Therotical fresh unit weight values of lightweight concretes were found as 1080-1547 kg m^{-3} and real fresh unit weights of them were found as 1150 kg m^{-3}. Therotical fresh unit weights of normal concrete were found as 2189-2218 kg m^{-3} and real fresh unit weights of normal concretes were found as 2275 kg m^{-3}. Total 28 days air-dried unit weights of hardened conretes were found between 960-1060 kg m^{-3} for the specimens produced with lightweight aggregates obtained Van-Ercis province and between 2325-2358 kg m^{-3} for the specimens produced with normal aggregates.

Unit weights increased depending on humidity increase in the cure environment. When 28 days average compressive strength examined; it is seemed that maximum compressive strength value for lightweight concrete were obtained from air-cured specimen and that of lightweight concrete were obtained from water-cured specimen. The values of 28 days compressive strength and average unit weight for concrete specimens are shown in Table 4. As showed in Table 4 for lightweight concretes, compressive strength decreased with

Table 4: Average unit weight and 28 days compressive strength values of concrete specimens

	Normal aggregate Cure type			Lightweight aggregate Cure type		
Parameters	Air	Water	Steam	Air	Water	Steam
Unit weight (kg m^{-3})	2325	2360	2358	906	1060	972
Compressive strength (kg cm^{-2})	180.3	270	240.1	60.0	45.2	52.4

the increase in cure environment humidity for normal concretes compressive strength increased with the increase in cure environment humidity.

CONCLUSION

Results showed that one of the most important factor effecting concrete compressive strength is curing conditions. Compressive strengths of concretes produced with normal aggregate lower than that of concrete produced with lightweight aggregate. In addition to concretes having inappropriate mixtures, concretes having appropriate mixtures but without having enough cure also have effects at important level on low compressive strength.

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