SOME PROPERTIES OF NO-FINES POLYMER CONCRETE

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Abstract

This research includes the study of the properties of No-fines concrete using 10-mm maximum size of aggregates and improved by SBR polymer. The concrete mixes by weight were (1:5) , (1:6) and (1:7) (cement:aggregate) respectively .The polymer was added as percentages of cement weight and were 5% , 7.5% and 10%. Reference mixes were made for every case.

The density of concrete varied between 2030 and 2170 . kg/m^3, and the thermal conductivity of this concrete was in range recommended by the ACI 213-87 committee for the structural lightweight concrete.

Keywords: No-Fines; Polymer; Concrete; SBR; Conductivity; Properties

1-INTRODUCTION

No fines concrete is a type of lightweight concrete [1]. It consists of coarse aggregates, cement and water excluding fine aggregates. Accordingly, it contains many voids, which play the major role in defining its properties. In Iraq, no- fines concrete while the other type (lightweight aggregate concrete and aerated concrete) are of limited use because their basic constituents are scarce in our country (Iraq) [2].

No –fines concrete is suitable in precast industry for many reasons; being lightweight, good thermal and acoustic insulation and the good quality control related to such industry. It can be used for bearing and non-bearing walls, small retaining walls and in temporary structures for the low cost and easy demolition of no-fines concrete.

Neville [3] classified no-fines concrete as lightweight concrete and stated that its density depends langly on aggregates grading. The lower density of no- fines concrete is due to the use of coarse aggregate of one size. The density of concrete with graded aggregate is 15% higher then of the one size aggregate.

Table (1): typical properties of no- fines concrete (9.5-19mm aggregate).

Aggregate/cement ratio by volume	water/cement ratio by weight	Density Kg/m^3	28-day compressive strength MN/m^2
6	0.38	2020	14
7	0.40	1970	12
8	0.41	1940	10
10	0.45	1870	7

2- POLYMER PORTLAND CEMENT CONCRETE (PPCC)

American concrete institute committee 548 [4] defines the PPCC as an ordinary concrete mix with emulsified polymers added during mixing

The result is a uniform polymeric mesh within the hydration products of concrete.

3- MATERIALS USED IN THE RESEARCH

3.1. Cement

Ordinary Portland Cement (OPC) ASTM Type I from Kubaisa cement factory is used. The cement is complied to Iraqi specification No.5/ 1984.

3.2. Aggregates

Coarse aggregates from Aljrayeshi area in Al- Anbar Governorate was used . Aggregates of size larger than 10mm were excluded. The grading is conformable with British specifications BS 410:1976 [5]

3.3. Polymer

Styrene Butadiene Rubber (SBR) is used. The specification of which is listed in Table2:

Table 2: Specification of (SBR)

1	IR Test	The testing of polymer by Infra Red test refers to that the most content of this subject is Styrene Butadiene Rubber with low percentage of additives.
2	pH	9.59
3	Water content	50.97%
4	Solid content	49.02%

4- MIXING AND COMPACTION OF CONCRETE

Mixing operations were made in the concrete laboratory in the civil engineering department of Al-Anbar University. A 0.1m^3 pan mixer was used. Pouring the coarse aggregates made mixing and cement in two alternate times and mixing them dry while adding the polymer until a homogenous dry mix is obtained. The water is added then and mixing continued until final mixing mix is obtained.

The concrete mix is poured, in three layers, in the molds. An electrical vibrator made compaction for not more than 10 sec.

5-CURING

The specimens were unmolded after 24hrs.in laboratory. They were submerged in water to the time of test.

6-THE MIXES

The following used (Table 3)
The reference mixes is shown in Table 4.

Table(3): Mixes which are used in the research

Cement:aggregate	Water:cement%	Polymer: cement %
1:5	%40	5%
1:5	%40	7.5%
1:5	%40	10%
1:6	%40	5%
6:1	%40	7.5%
6:1	%40	10%
7:1	%40	5%
7:1	%40	7.5%
7:1	%40	10%

Table (4):Reference mixes.

Cement:aggregate	Water:cement%
1:5	%45
1:6	%45
1:7	%45

7-TESTS

7.1. Density

The weight of every specimen was recorded air-dry and dimension prior to test.

7.2. Ultrasonic Test .

Pundit instrument [6] was used with 54khz transducers. Thin layer of engine oil is applied on surfaces of prisms to facilitate wave transmission and to reduce the effects of surface voids.
Wave velocity(v) can be calculated by

$$V = L / T \quad \ldots\ldots \qquad \ldots\ldots (1)$$

where V = ultrasonic wave velocity (km/sec)
L= wave path length (km)
T= time required for the wave to pass L (0.001sec)

Wave velocity indicates the concrete structure, furthermore, it can be used to indicate the deterioration in concrete with time due to various reasons. The product (ρv) namely (density X velocity) is called the ***acoustic impedance***, and the product (ρv^2) is called elasticity ***acoustic constant***, because it is strongly related to modulus of elasticity [7].

7.3. Thermal Insulation:

The test specimen is a two-part parallelogram of (200X100X150mm) for each face to touch the hot plate in their interior face, which the cold plates touch the outer faces. All these are kept in a thermally insulated cabinet. The thermal conductivity is calculated from the heat transferred through the specimens unit area in a unit time, and recording the difference in temperature of the specimen faces when thermal balance is reached.

8. RESULTS AND DISCUSSION:

8.1 Density – Polymer Content Relationship:

The results of no-fines polymer concrete (NFPC) revealed that the lowest 28-day density (air-dry) reached 2030 kg/m^3 for 1:7 cement:aggregate with 5:100 polymer:cement. The highest was 2170 kg/m^3 for 1:6 cement:aggregate with 10:100

polymer cement. The reference concrete (without polymer) ranged 1950 to 2096 kg/m^3 for cement:aggregate 1:7 and 1:6 respectively.

The SBR effect is clear in increasing the no-fines concrete density (see Fig.1). This can be attributed to the polymer filling of the concrete voids and to the polymer role as a plasticizer in reducing friction among particles thus increasing density.

Similar finding in ordinary concrete was reached by Folic[8].

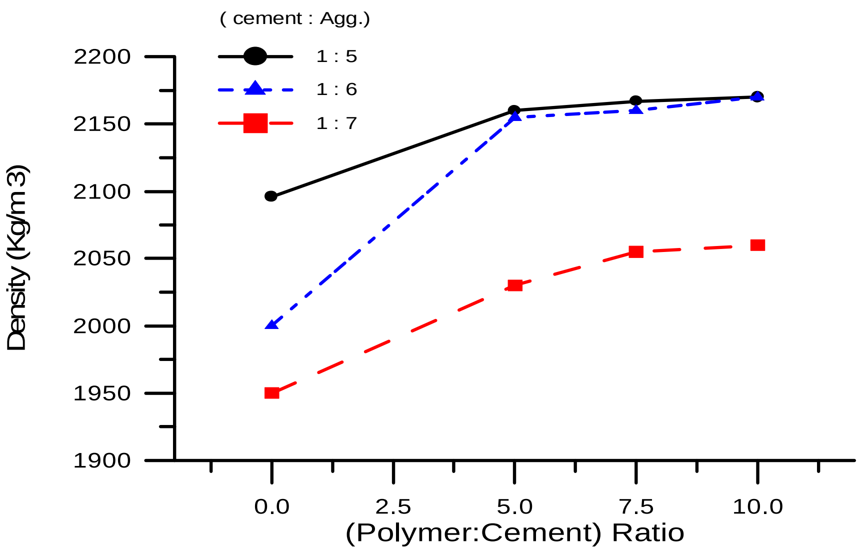


Fig 1:The relationship between density and cement:aggregate ratio for the (NFPC) with different cement:aggregate ratios.

8.2.Acoustic Impedance and Acoustic Elastic Constants:

Figs(2) and (3) show the effects of cement/aggregate and polymer/cement ratios on Acoustic Impedance and Acoustic Elastic constant. The highest values for each were reached for 1:5 cement:aggregate and the lowest was for 1:7 . The increase in polymer content also increases these values . This shows the effect of cement and polymer in increasing the wave velocity and increase in Acoustic Impedance and Acoustic Elastic Constant.
The values of Acoustic Impedance are ranged 6782 to 10433 Rayls.

8.3.Thermal Conductivity:

Fig .(4) shows that the thermal conductivity increases with polymer:cement ratio . This can be attributed to the reduction in void contents in the NFPC structure due to polymer effects in filling these voids.

The Fig. Shows also that the thermal conductivity of NFPC increases with the reduction in cement:aggregate . This means the increase in aggregate content, which have the higher conductivity.

However NFPC gives 0.5 W/m.K conductivity (5% polymer). The highest value is 2.75. These values are in conformity with ACI 217-87[9] values for lightweight concrete.

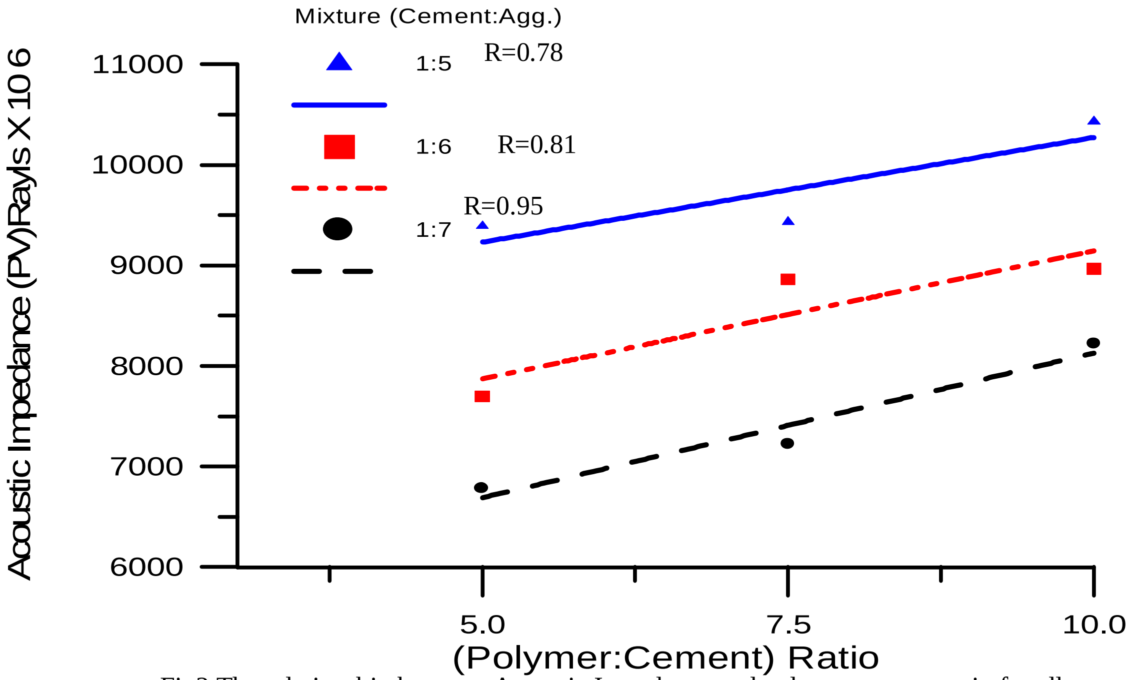


Fig2:The relationship between Acoustic Impedance and polymer:cement ratio for all different mixtures.

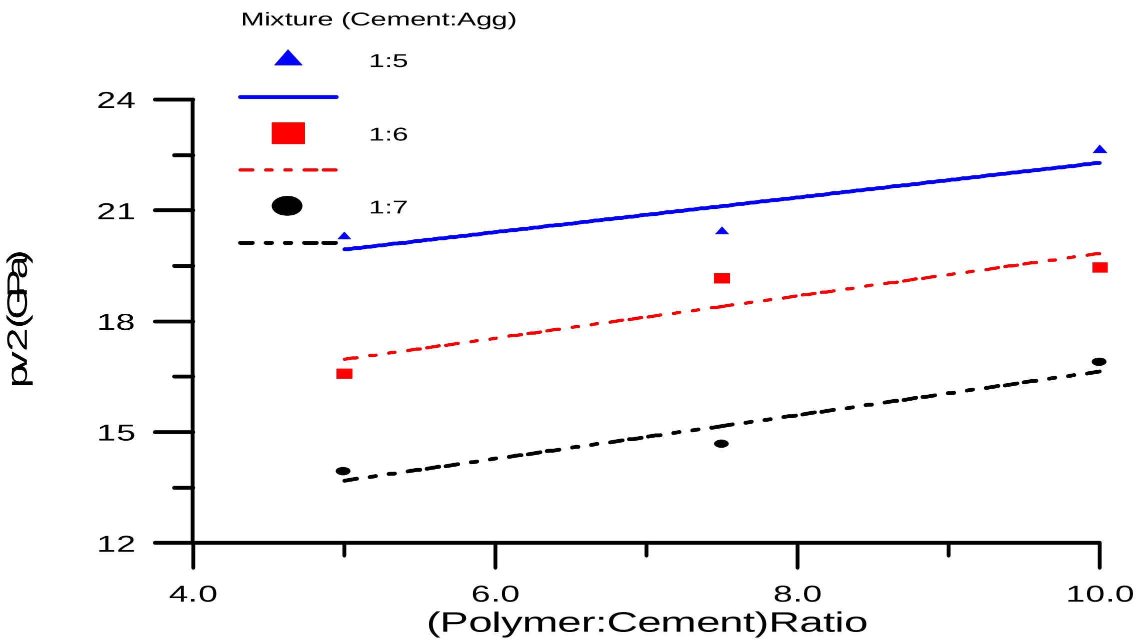
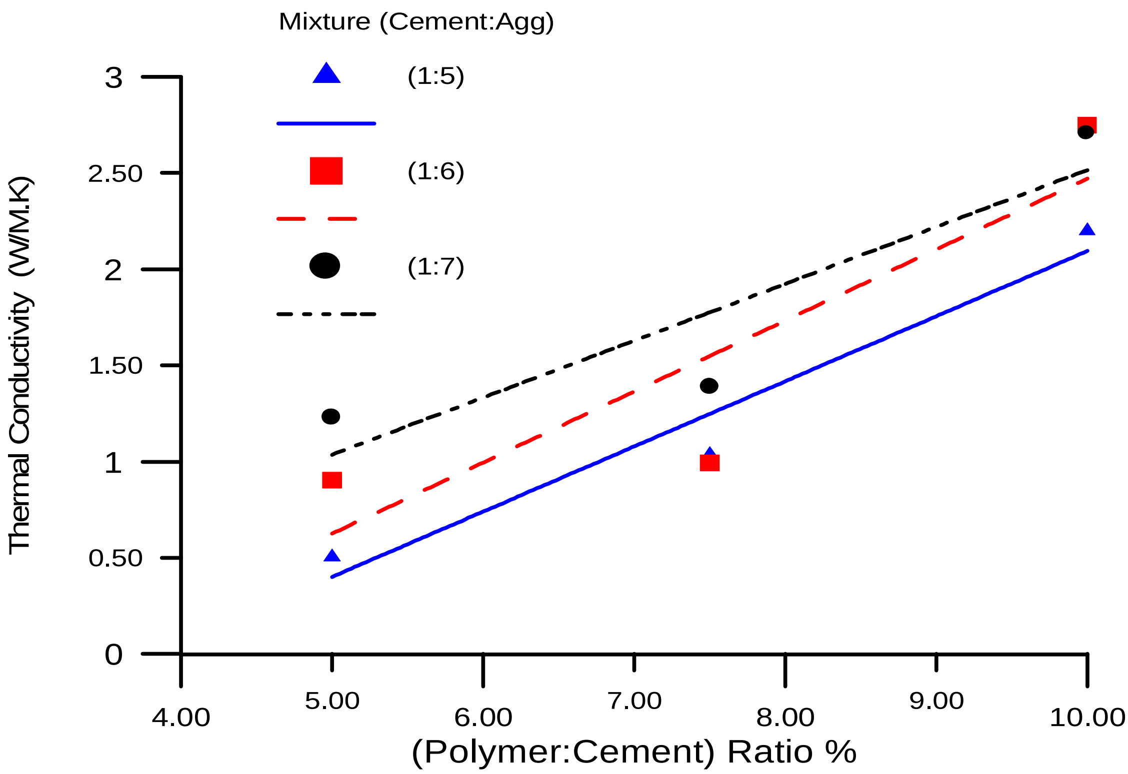


Fig3:The relationship between polymer:cement ratio and Acoustic Elastic Constant for all different Mixtures.



Fig(4):The relationship between Thermal Conductivity and the polymer:cement ratio.

REFERENCES

1. 1-Al-khalaf, Moayed N. and Yousif, Hana A.: Concrete Technology. 1st ed. Baghdad , University of Technology Presses , 1984, 558p.
2. 2-Al-Sammar'y ,Mufeed Abdulwahab and Abood , Abdulmuhsin. Use of No-sand Concrete in Structural Works. National Center for Construction Labs, 1983,18p.
3. 3-Neville, A.M.: Properties of Concrete . 3rd ed. London, Pitman Publishing Limited , 1981,779p.
4. 4-ACI committee: 548-1990: Guide for the Ues of Polymer in Concrete: ACI Manual of Concrete Practice-Part 5, Detroit , Michigan, 1990, 86p.
5. 5-BS: 812-1975:Test Sieves: Method s for sampling and testing of mineral aggregate sands and filers.London.1975.
6. 6-C.N.S Electronic Ltd., London . Pundit Manual , London.
7. 7-Al-Jeelawey, Nada Mehdy Fawzi: Properties of Lightweight Concrete Manufactured from Local Row Materials. M.Sc. Thes., Baghdad University, Baghdad, 1995.
8. 8-Folic, R.J.: Experimental Research on Polymer Modified Concrete. ACI Material Journal , May-June, 1988: 463-469.
9. 9-ACI Committee: 217-1990: ACI Manual Practice ,Detroit , Michigan,1990.