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STUDY OF SOME PROPERTIES OF NO – FINES CONCRETE USING LOCAL MATERIALS

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ABSTRACT

No – fines concrete is obtained by omitting fine aggregate from the mix and the coarse aggregate particles are surrounded by a coating of cement paste.

In the present work, well-graded coarse aggregate (20 mm maximum size) was used in preparing the mixes, instead of single sized coarse aggregate as recommended always for No – fines concrete. Concrete mixes with different aggregate /cement ratios were prepared to find an optimum mix giving the highest strength.

The influence of aggregate /cement ratio on the unit weight, absorption and compressive strength were studied at different conditions of curing. It was found that the strength of No – fines concrete is lower than that of ordinary concrete. Also, this type of concrete behaves like the ordinary concrete relating to the growing of strength with the age. According to the properties investigated, No – fines concrete is sufficient enough to be used in different constructions, like low-rise buildings, pavements and other applications.

KEYWORDS: No –fines concrete, pervious concrete, Pavements, Low cost housing, Lightweight concrete.

دراسة بعض خواص الخرسانة الخالية من الركام الناعم باستخدام مواد محلية

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الخلاصة:

يتم الحصول على الخرسانة الخالية من الركام الناعم بإلغاء الركام الناعم من الخليط واستخدام الركام الخشن فقط، بحيث تصبح حبيبات الركام الخشن محاطة بطبقة من عجينة الاسمنت.

في هذا البحث. تم استخدام ركام خشن متدرج ذات مقاس اقصى (20 ملم) في تحضير الخلطات الخرسانية بدلا من الركام الخشن ذات المقاس الواحد الذي يستخدم عادة مع الخرسانة الخالية من الركام الناعم . وتم تحضير عدة خلطات خرسانية مختلفة من حيث نسبة الركام الى الإسمنت، لإيجاد الخلطة المثالية التي تعطي أعلى مقاومة. وتم دراسة تأثير نسبة الركام إلى الإسمنت على وحدة الوزن، الامتصاص ومقاومة الانضغاط تحت ظروف مختلفة من المعالجة. وقد وجد أن مقاومة الخرسانة الخالية من الركام الناعم هي أقل من مقاومة الخرسانة الاعتيادية. كما وأن هذا النوع من الخرسانة، يتصرف مثل الخرسانة الاعتيادية فيما يتعلق بنمو المقاومة مع العمر. استناداً الى الخواص التي تم دراستها فانه يمكن اعتبار الخرسانة الخالية من الركام الناعم كفوءة إلى حد ما لاستخدامها في مختلف أنواع الانشاءات كالأبنية ذات الارتفاعات الواطئة، التبليط والارصفة الجانبية وتطبيقات اخرى.

1. INTRODUCTION

No – fines concrete is a type of lightweight concrete produced by omitting the fines from conventional concrete. It is a two – phase material – single sized coarse aggregates, surrounded by a coating of thin layer of cement paste.

The single sized aggregates make a good No – fines concrete, which in addition to having large voids and hence light in weight, also offers architecturally attractive look.

The history of pervious concrete dates back to 1852 in England with the construction of residential houses and it became considerably more widespread during the material shortages after World War II, for cast in place load bearing walls of single and multistoried buildings. The use of No – fines concrete in pavement applications had started in US and Japan since 1980s. Since then a lot of researches have been done on pervious concrete in developed countries like US and Japan and they have been extensively used in field. In the United States, pervious concrete is mostly used for light – duty pavement applications, such as residential streets, parking lots, driveways, and sidewalks. Such applications require the pervious concrete pavement to carry a normal traffic load.

No – fines concrete contains large voids that decrease its compressive strength comparing with conventional concrete, and due to the absence of large surface area of fine aggregate particles, then cement content may be lower than that used with conventional concrete. This may be one of the advantages of this type of concrete besides lower density and good thermal insulation.

The voids in this type of concrete are being large enough to prevent the movement of water through the concrete by capillary action. Also, it does not segregate, hence can be dropped from a considerable height, and does not pose any serious problems for compaction.

The slump test is not good for testing No – fines concrete due to the cohesion between the aggregate particles.

The strength of the pervious concrete depends on the properties of the cement paste and the interface between the paste and the aggregate. To improve the strength of such concrete, three components must be improved; strength of the paste, the paste thickness around the aggregate, and the interface between the aggregate and the paste. The compressive strength ranging from 1.4 to 13.7 MPa is more common (Malhotra, 1976).

Abadjieva & Sephiri (2000) have identified No – fines concrete as having a density around 1600 – 2000 Kg/m^3, this compares well with traditional concrete whose density is between 2300 – 2400 Kg/m^3, with the highest tensile and flexural strengths being achieved at an aggregate – cement ratio of 7:1, (the studied ratios are between 6:1 to 10:1).

In some regions where sand is not available, the No – fines concrete should become a popular construction material. It is a viable material that has the potential to replace the use of traditional concrete pavements in situations where heavy traffic is limited, such as car parks, residential streets and driveways.

The objective of the present work is to study the properties of concrete mixes without fine aggregate using well – graded course aggregate instead of single sized aggregate and to see if it is possible to use this type of concrete in constructions like walls in low-rise and low cost housing and in pavements.

2. MATERIALS AND EXPERIMENTAL WORK

Cement: The cement used was Turkish cement that was available in Duhok city and used widely in construction works.

Coarse aggregate: well – graded 20 mm coarse aggregate was used in preparing the mixes (BS. 882. 1983), its grading shown in the Table 1.

Concrete mixes with different aggregate / cement ratios 6:1, 7:1, 8:1, 9:1, and 10:1 by volume were prepared and casted in cubes with a side of 150 mm. (BS. 1881; PART 113: 1983). The specimens were prepared without compaction and they were cured as two groups, first group was cured in water and the second in air.

The tests were carried out are: the unit weight (density), absorption, and the compressive strength (7 & 28 day's age) and the specimens cured in two different conditions (water & air).

The average of three specimens is considered for each test above.

Table 1. Grading of coarse aggregate

Sieve size (mm)	Percentage by mass passing	
	Graded aggregate (BS.882/1983) (20 to 5) mm	Sample
50	-	-
37.5	100	-
20	90-100	95
14.0	-	-
10.0	30-60	40
5.0	0-10	5
2.36	-	-

3. RESULTS AND DISCUSSION

3.1. Unit Weight

The unit weight or the density of any type of concrete depends on grading of aggregate, and since a single sized aggregate was used in No – fines concrete, then this caused a lower density for the No – fines concrete.

In the present work, a well – graded aggregate was used and examining the Table 2, the unit weight of the No – fines concrete varies between 1920 for aggregate /cement ratio of (10:1) to 2110 Kg/m^3 for aggregate /cement ratio of (6:1) with an average of about 2015 Kg/m^{3}as shown in Table 2, that is lower than the unit weight of ordinary concrete by about 17 percent (the unit weight of ordinary concrete is between 2300 – 2400 Kg/m^3). For this reason No – fines concrete is classified as a lightweight concrete.

Fig. 1 showed the influence of aggregate / cement ratio on the unit weight of No – fines concrete. It was clear that with an increase in aggregate / cement ratio, the unit weight or the density decreases. This behavior was also clear in the Table 2.

Table 2: Results of unit weight and absorption capacity

Mix No.	Aggregate / cement ratio	Water / Cement ratio	Unit weight Kg/m^3	Absorption %
1	6:1	0.40	2110	4.1
2	7:1	0.41	2040	4.4
3	8:1	0.42	2010	4.8
4	9:1	0.43	1960	5.5
5	10:1	0.44	1920	6.0

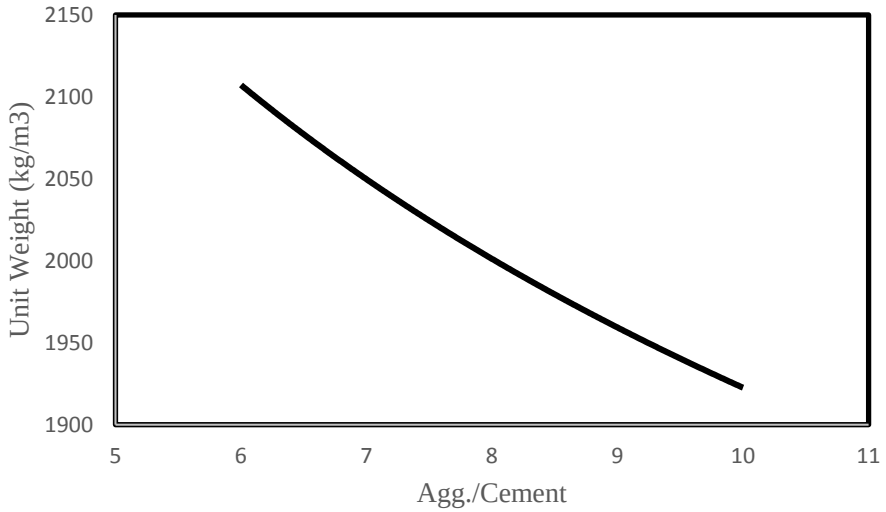

Fig. 1. Influence of Aggregate/Cement Ratio on Unit Weight of No-fines Concrete

3.2. Absorption

It can be seen from Table 2**,** that the absorption capacity of No – fines concrete ranges from 4.1% to 6.0% for the used mixes. The absorption capacity increases with increasing the aggregate / cement ratio.

These values may not differ than that of ordinary concrete, although the absorption of No – fines concrete may be as high as 12 percent by weight (Neville & Brooks, 2008).

The reason of these lower values of absorption is due to using a well-graded aggregate instead of a single sized in all mixes in the present work.

3.3. Compressive Strength

The compressive strength of No – fines concrete for the two types of curing considered was determined at ages of 7 and 28 days.

Figs. 2 and 3 show the effect of aggregate /cement ratio on the compressive strength of No – fines concrete. It is seen from the figures, that the compressive strength of No – fines concrete increases with the age as the ordinary concrete.

Tables 3 and 4 show the variation of compressive strength with the curing. The strength ranges from 4 to 9.8 MPa for air curing and 3.6 to 9.0 MPa for water curing, depending on the aggregate /cement ratio.

It is seen that the mix with aggregate /cement ratio 6:1 gives the highest strength in both cases of curing. The compressive strength of No – fines concrete varies between 1.4 and 14 Mpa depending mainly on its density, which is governed by cement content. Whereas for ordinary concrete made with well – graded aggregate, the water /cement ratio is the controlling factor in strength (Neville & Brooks, 2008).

Also, the results show that gives strength about 14% and 16% higher than that of water curing for 7 and 28 days age respectively.

Fig. 4**,** clarify the relation between the unit weight and the compressive strength of No – fines concrete. Lower than that of ordinary concrete, this strength coupled with the lower self – weight is sufficient for the use in buildings, pavements, and in many other applications.

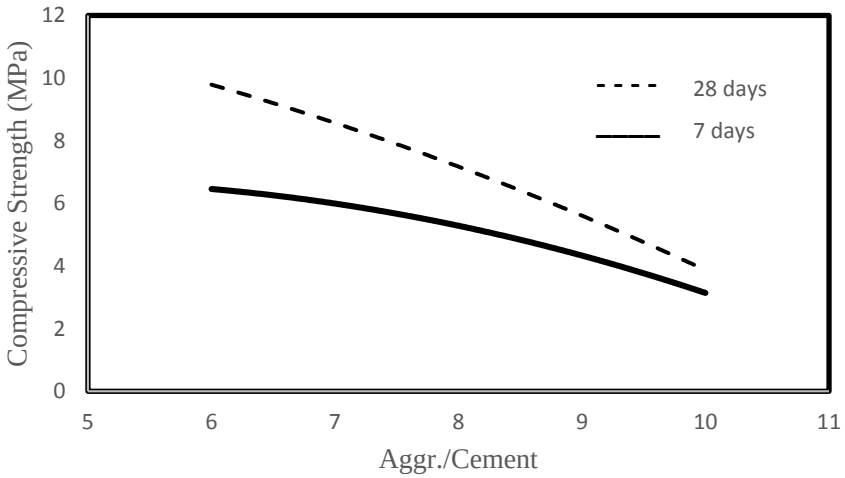

Fig. 2. Influence of Aggregate/Cement Ratio on Compressive Strength (Specimens cured in Air)

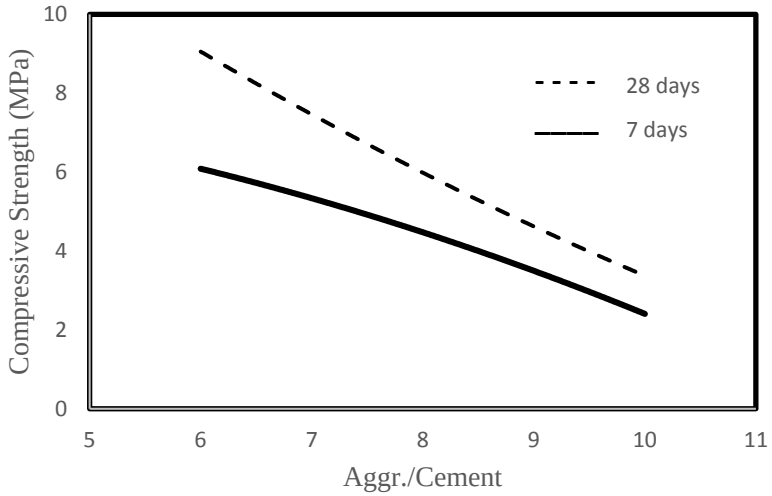

Fig. 3. Influence of Aggregate/Cement Ratio on Compressive Strength (Specimens cured in Water)

Table 3. Results of compressive strength (curing in air)

Aggregate / Cement	7 days (MPa)	28 days (MPa)
6:1	6.6	9.8
7:1	5.7	8.4
8:1	5.3	7.6
9:1	4.6	5.2
10:1	3.0	4.0

Table 4. Results of compressive strength (curing in water)

Aggregate / Cement	7 days (MPa)	28 days (MPa)
6:1	6.1	9.0
7:1	5.2	7.4
8:1	4.8	6.5
9:1	3.2	4.0
10:1	2.5	3.6

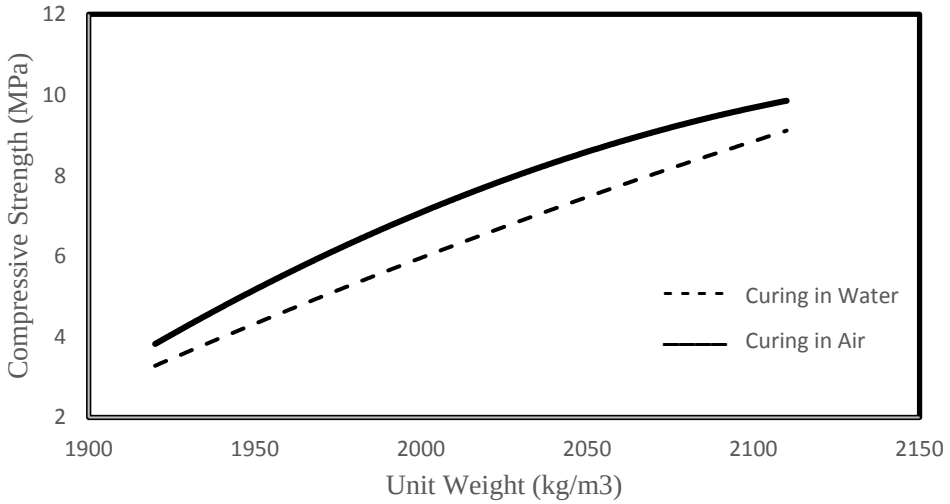

Fig. 4. Relationship between Unit Weight and the Compressive Strength of No-Fines Concrete

4. CONCLUSIONS

1. It is clear from the results of the present work that the unit weight and compressive strength of No – fines concrete are lower than those of ordinary concrete. The strength is low for lower density mixture due to the increment of voids throughout the sample.
2. The behavior of No – fines concrete is similar to that of ordinary concrete relating to the rate of 7 & 28 days compressive strength.

3. Using well – graded coarse aggregate in No – fines concrete is possible and gives reasonable results. The best mix is found to be (6:1) that gives maximum compressive strength (9.8 MPa, (curing in air) and 9.0 MPa, (curing in water)). Also, it gives maximum unit weight (2110 Kg/m^3) in the present work.
4. The air curing gives strength about 14% and 16% higher than that of water curing for 7 and 28 days age respectively.

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