RESEARCH ABOUT RECYCLING CONCRETE AGGREGATE

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Abstract: *concrete is considered as the most popular building material because of the many advantages that it has. This comes up with a huge amount of concrete waste. As a way to produce a concrete which is friend to environment, reuse of construction waste gives two aims, the first is to remove large quantities of pollution resulted from these waste, the second provides cheap resources for concrete aggregates. The current study includes testing many properties of concrete mix with local waste concrete as coarse aggregate, after removing coarse gravel, which means using mortar of this waste concrete after crushing, grading and washing. Results show that this recycled aggregate has lower specific gravity and absorption compared with natural aggregate used in Iraq. Results show also that the concrete prepared from this recycled aggregate has acceptable compressive strength and absorption and it has good flexural strength and low dry density as compared with concrete with local natural aggregate. This concrete is suitable for paving and blocks making as cheap products.*

Keywords: *recycled aggregate, materials properties, concrete, recycled aggregate concrete (RAC), cheap building materials.*

ИССЛЕДОВАНИЯ ПО УТИЛИЗАЦИИ БЕТОННОГО ЗАПОЛНИТЕЛЯ

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Аннотация: *в Ираке бетон считается самым используемым строительным материалом. Соответственно отходы бетонного лома - одни из самых часто образующихся видов отходов. Повторное использование бетона после демонтажа строительных сооружений позволяет единовременно решить две задачи: во-первых, избежать загрязнения окружающей среды, к которому может привести складирование строительных отходов, во-вторых, получить дешевые вторичные заполнители. Настоящая работа включает в себя результаты исследований свойств бетонной смеси с использованием вторичного бетона в качестве крупнозернистого заполнителя. Анализ результатов, полученных во всем мире, свидетельствует о том, что применение дробленого бетона в качестве крупного заполнителя очень эффективно. Стоимость бетона на основе крупного вторичного заполнителя на 25% ниже бетона на природном щебне. Переработанный агрегат имеет более низкий удельный вес и абсорбцию по сравнению с природным заполнителем, используемым в Ираке. Бетон, приготовленный на основе переработанного заполнителя, обладает достаточной абсорбцией, хорошей прочностью на сжатие и изгиб, низкой сухой плотностью по сравнению с бетоном на природном заполнителе. Этот бетон подходит для производства дешевых бетонных блоков, которые используются при заливке фундаментов складских и производственных помещений, малоэтажном, многоквартирном и индивидуальном строительстве.*

Ключевые слова: *рециклинг, дешевый вторичный заполнитель, переработка бетона.*

1. Introduction:

Concrete is one of the most important building materials because of its positive properties, especially as it is a cheap and local building material. At the end of the last decade of the twentieth century, the movement of the demolition and reconstruction of buildings for the purpose of suitable new purposes or because of the end of the design life of buildings, which led to the accumulation of large quantities of waste, that form a large part of the

concrete. Global environmental awareness has recently increased and the reuse or recycling of demolition and construction debris is one of the goals of sustainable development that has a significant positive impact on environmental, economic and social aspects. With the use of recycled materials, the environment can be saved and flourish on reusable and recycled materials. Recycling conserves natural resources, saves energy, reduces solid waste, reduces air and water pollutants, and reduces greenhouse gases. Recycling, re-use, and composting create an estimated six to ten times as many jobs as waste incineration and landfills. Recycling has become a policy adopted by many developed countries such as New Zealand, Denmark, as shown in Figure (1). It consists of the collection, treatment and restoration of demolition and construction waste. Re-use, i.e. to return it to its life cycle and make it usable for the same purpose or for other purposes, see Figure (2). This method is environmentally beneficial as it reduces the volume of waste generated and thus provides the area of land utilized as an outpost of waste and contribute to the conservation of indigenous natural resources.

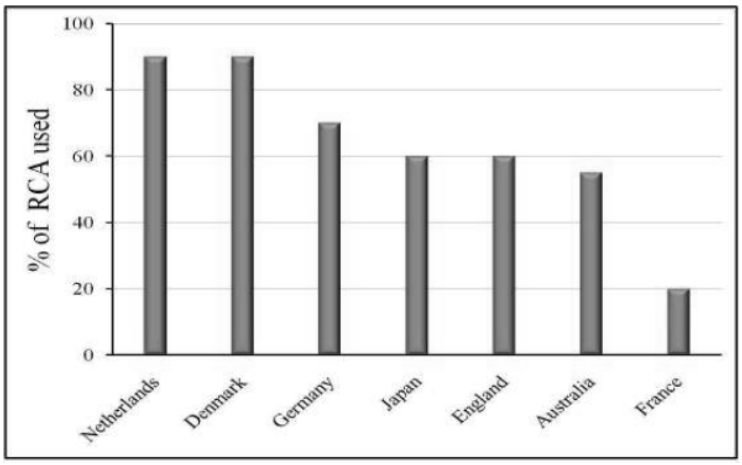

Fig. 1. The amount of concrete waste that is recycled in some countries of the world

1. Related Works

For years, scientist and researchers have been searching possible solutions to environmental concerns of waste production and pollution. Many have found that replacing raw materials with recycled materials reduce our dependency on raw materials in the construction industry. The Federal Highway Administration (FHWA) estimated that building demolition in the United States alone produces 123 million tons of construction waste per year (F. H. A. FHWA, 2004) [1].

Significant number of studies explored recycled concrete aggregate (RCA). Using RCA can be successful with careful consideration given to the properties and physical characteristics of the aggregate, the physical properties of the fresh and hardened concrete and the mechanical behavior of the containing RCA [1].

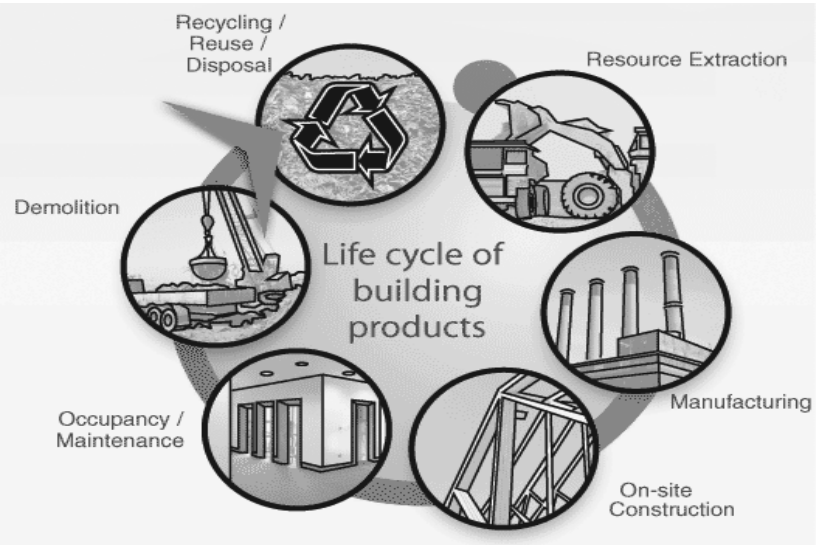

Fig. 2. Life cycle of construction materials [Ref.]

Assay (Montgomery, 1998) try to treat the recycled rubble by grinding it in a rotary mill to remove the old cement dough from its surface. It was found that the cleaner rubble gives higher quality concrete [2].

(Poon et al., 2004) explained that the strength of the concrete produced from the recycled aggregates is affected by the moisture of the recycled aggregate. When using the dryer mounds in the furnace, notice an increase in cone drop due to the high amount of water used to compensate for the high absorption of recycled aggregates [3].

Basques (2009) evaluated different recycled materials and focused his study on RCA as flexible base. In his study, RCA demonstrated a decrease in permeability with an increase in moisture content. His cost analysis also showed by using RCA, savings can be expected during the construction [4].

Several researchers at NC A&T State University (James et al., (2011), Fini et al., (2011), Abu-Lebdeh et al., (2011), (2010), Fini & Abu-Lebdeh, (2011), Hamoush et al., (2010), (2011a& b), Xiu et al., (2010)) and other academia investigated several green materials technologies that reduce environmental effects, and use recycled materials in infrastructures applications.

James et al. (2011) researched the potential of using RCA and fly ash (FA) in concrete pavement. The recycled concrete came from a demolished local site. Their research revealed using RCA up to 25% and FA up to 15% will not have a significant difference (if any) in strength compared with concrete containing virgin aggregate. Thus, using RCA and FA in concrete pavement may promote economic and environmental benefit.

2. Research's Importance and its Objectives:

In Iraq, concrete considered the most widely used building material. Thus, the demolition of existing buildings in the present circumstances resulting in a huge amount of concrete waste that must benefit of them, in order to achieve the economical, environmental, and social benefit all together. This is done through scientific research demonstrates the possibility of benefiting of this waste procedure, and therefore the data available will encourage the government in the future to provide the necessary facilities for the use of recycled aggregates and recycled equipment, and exploiting it usefully and properly. This research aims to study the efficiency of concrete produced from the recycled coarse aggregate; when used - a partial or total - as an alternative to natural coarse aggregate. Through some physical and mechanical characteristics assessing its pressure and modulus of elasticity [5].

3. Practical Program

3.1 Materials used

a) Cement: Ordinary Portland cement was used to conform to the Iraqi standard. Its physical properties as shown in Table (1)

b) Sand: Using river sand; and its gradation conforms to British Standard (5) within an average gradient area, as shown in Table (2).

c) Water: Use the normal lint water in the concrete work

d) Coarse aggregate: It was obtained from concrete blocks after cracking. The large pieces of gravel were removed and then used to conform to British standards. A maximum of 200 mm .Table (3) shows the properties of the concrete that containing the properties of this aggregate[6].

3.2 Concrete Mix:

A concrete mixture was mixed with a weight ratio (4: 2: 1) with a ratio of water/cement (0.55) .In the case saturated dry surface when weighed and mixed with cement and water.

3.3 Laboratory Tests:

The following tests were performed in the laboratory:

1) Compressive strength Test: Six concrete cubes with dimensions (15 X15 X 15 cm) were prepared, then manually pound on layers and then processed by placing them in water until the test date according to the British Standard. Three cubes (7 days) were examined, and three cubes (28 days) were examined and each was average.

2) Absorption of Concrete Test: Three cubes were prepared in the same way as the previous test and the absorption ratio was calculated (28 days) and the average of the three cubes.

3) Resistance to Bending Test: Three concrete beams were prepared according to the British standard and then were examined by age (28 days) in a single point of loading method according to the average of the three models.

4) Dry Density test: Three cubes were prepared and processed by placing them in water at a record temperature, then dried thoroughly in the oven, then weighed and calculated at 28 days, then the average of the three cubes [7].

Table 1. Characteristics of the cement used

Sequence	Property	The result	Limitations of the Standard

1	Standard conditions for temperature and pressure	29.5	———
2	Primary Cohesion Time (min)	80	At least 4
3	Final Cohesion Time (min)	170	Not more than 60
4	Smoothness (m2/Kg)	260	At least 230
5	Compression resistance 3 days old (MPa) **7** days old (MPa)	 18.4 26.9	 Not less than 15 Not less than 23

Table 2. Gradation the sand

Sieve slot (mm)	Percentage Transient (%)	Limitations of the Standard
10	100	100
5	98	100-89
2.36	84	100-65
1.18	75	100-45
0.6	49	100-25
0.3	22	58-4
0.15	3	15-0

Table 3. Characteristics of aggregates

Sieve slot(mm)	Percentage Transient(%)	Limitations of the Standard
50	100	100
37.5	100	100
20	96	100-90
14	66	80-40
10	48	60-30
5	5	10-0
Total qualitative weight (saturated dry surface) Absorption Softness coefficient		2.124 10.8% 6.85

4.Results and discussion:

From the testing of the models prepared from the concrete mix containing the coarse rubble of the concrete waste, the results were obtained as illustrated in Table 4. Accordingly, and from these values we can get several results:

1-From the Table (3) of the properties of recycled aggregates we see that the specific weight of this aggregate is (2.124). It is less than the usual rough local rubble that is usually about (2.65). Moreover, its absorption rate was (10.8 %) they are higher than normal local aggregates that usually range from (0.5-1%) the reason for this is due to the porosity within the granules of this aggregate is higher than the usual aggregates, which reduces the weight and increase the qualitative absorption rate [8, 9].

2-For the values of compressive resistance in Table (4) we believe that these values meet the requirements of the Iraqi standard (1:2:4) which must not be less than (14 MPa) for age (7 days) and about(21MPa) for age (28 days) [10, 11].

3-For the observation of the bending resistance value shown in Table (4), we can see that it is higher than the concrete produced from the conventional aggregates while the Portland Cement Association determined the ratio of bending resistance to compression resistance of concrete with compressive strength limits (20MPa) about (0.16) while the ratio of this concrete was approximation (0.42). This is due to the roughness of the used aggregate surface and its stronger bonding with the cement paste to the smoother surface [12, 13].

4-For the observation of dry density value in Table (4), it is clear that it is less than the usual mass (2200-2600Kg/m3).

5-The absorption value according to Table (4) is considered acceptable if it is compared to the Iraqi standard to absorb the concrete block which must not exceed (10%) For solid blocks type A and allowed higher rates for the rest of the species [14].

Table 4. Characteristics of concrete containing concrete residues

Sequence	Property	The value	Standard Specifications
1	Compression resistance at age (7days) (MPa)	14.6	Not less than 1
2	Compression resistance at age (28days) (MPa)	21.3	Not less than 2
3	Resistant flexion at age(28days) (MPa)	8.9	Not less than 3.3
4	Absorption rate (%)	3.235	Not more than 10
5	Dry density (28 days) (Kn/m 3)	21.98	22.00 - 26.00

4. Conclusions

According to the results obtained, the following points are concluded;

1. The reused aggregates of the concrete wastes have a small qualitative weight and high absorption compared to aggregates the usual rough gravel.

2. The compressive resistance of the concrete prepared from the rubble reused is within the limits of the Iraqi standard of special mixing rate, but close to the minimum limits.

3. The concrete prepared from the recycled aggregates achieved high flexure resistance relative to the compressive strength achieved and compared with the similarity in the concrete with the usual debris

4. The reactive concrete has achieved a relatively low dry density compared to the density of the concrete with normal aggregate.

5. The reclamation value of the concrete with the recovered aggregate was higher than that of the concrete with the usual mass, but it is acceptable to the specifications of the concrete blocks, such as the block and the side and middle profiles of the roads.

Finally, further researches should be undertaken to improve the behavior of this type of concrete either by reducing the ratio of water to cement or by trying to obtain recycled rubble with high quality or through the use of additives such as fibers, pozzolans and others.

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