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Investigation of Properties of Concrete Containing Recycled Aggregates and Waste Rubber with Micro Silica

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ABSTRACT: The main purpose of this study is to experimental investigation the properties of concrete containing recycled concrete aggregates and waste rubber with micro silica. For this purpose, recycled concrete aggregates in the amount of 0%, 25%, 50% and 100% by weight have replaced with coarse aggregate and micro-silica at the amount of 10% by weight have replaced with cement. Also, in two specimens with 50% recycled concrete aggregate, first without micro silica and second with micro silica, waste rubber with 30% by volume of fine aggregate has been replaced and used. In the next step, the amount of slump, compressive strength, tensile strength, flexural strength, stress-strain curve, density and permeability of the specimens are evaluated. The results of this study show that the presence of recycled aggregates reduces the compressive strength from 3.2% to 14.5% and also adding waste rubber powder to the specimen with 50% recycled aggregates reduces the compressive strength to the 71% compared to the reference specimen (specimen with natural aggregates and without micro-silica). All specimens with micro silica have higher compressive strength than similar specimens without micro silica. The highest compressive strength is related to the specimen with 25% recycled aggregate and micro silica, which is 9.6% higher than the reference specimen. Specimens containing 50% recycled aggregate in the presence and absence of waste rubber powder have 55 and 72% lower tensile strength and 30 and 67% lower flexural strength, respectively, than the reference specimen. The lowest water absorption is for the specimen without recycled aggregates with micro silica at the amount of 0.5%.

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1- Introduction

The use of concrete around the world is increasing day by day. For this reason, in the near future, we will face a shortage of natural aggregates and we must inevitably seek to find a suitable alternative to natural aggregates[1, 2] . On the other hand, due to the large number of old concrete buildings and their destruction and waste production, which is harmful to the environment, these materials can be recycled and used as aggregates in concrete. Due to the many benefits of recycling building materials and reuse, in other words, due to the necessity and importance of using recycled aggregates, in recent years, several laboratory studies on the use of recycled materials such as rubber, recycled concrete aggregates, Due to the many benefits of recycling building materials and reuse, in other words, due to the necessity and importance of using recycled aggregates, in recent years, several laboratory studies on the use of recycled materials such as rubber, recycled concrete aggregates , Plastics, shards of glass, etc. have been done in the manufacture of concrete, including the studies of Kazemian et al. In 2019 [3]or the studies of Jokar et al.[4] and .... Pointed out.

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2- Methodology

According to other researchers, the use of concrete waste aggregates as a substitute for natural aggregates will reduce the mechanical properties of hardened concrete. In this regard, although researchers have done many studies, but the effect of simultaneous use of different percentages of recycled concrete aggregates and micro silica or the effect of simultaneous use of recycled concrete aggregates and waste rubber and micro silica, has rarely been investigated. In other words, the innovation in this research is the answer to the question, "What is the effect of using micro silica on concrete with different percentages of recycled concrete aggregates replaced by natural coarse?", As well as "the effect of simultaneous use of waste rubber as a fine alternative What about natural grain and recycled concrete aggregates as a substitute for cement? Therefore, according to past research, the main purpose of this study is to investigate the effect of recycled concrete aggregates and waste rubber with micro silica on the properties of hardened concrete. For this purpose, recycled concrete aggregates at the rate of 0, 25, 50 and 100% by weight of coarse grain and micro silica at the rate of 10% by weight of cement, cement substitute, have been used. Also, in two laboratory samples, one with micro silica and the other without micro silica, but both containing

50% recycled concrete aggregate, waste rubber powder with a volume of 30% by volume of sand has been replaced by sand. In total, 10 concrete samples were made and tested in this research. Also in this research, ACI regulations have been used for concrete mixing design. In the next step of slump, compressive strength, tensile strength, flexural strength, stress-strain diagram, hardened concrete density and permeability of the samples are investigated.

3- Discussion and Results

Investigation of slump test results in this study shows that the use of concrete waste will reduce slump and the use of micro silica and waste crumbs will increase slump. Also, the review of the current results of the density test shows that the concrete waste aggregates will not have much effect on the density. study of the results of compressive strength shows that with increasing the percentage of recycled aggregates, compressive strength decreases so that the maximum decrease in compressive strength of the sample has 100 recycled waste aggregates and the amount of 14.5%. By adding micro silica to experimental specimens due to its adhesive properties, it will increase the compressive strength. This is also true for tensile, with the addition of micro silica to the reference specimen increasing the tensile strength by 11%. Also, the sample has 50% of waste aggregates in the presence and in the absence of micro silica, their tensile strength is 14 and 6% less than the reference specimen, respectively. The results of flexural testing show that the addition of rubber aggregates and waste rubber powder reduces the flexural strength, while the addition of micro silica improves the amount of flexural strength compared to the reference specimen. Also, the results of water absorption test show that the addition of concrete aggregates increases water absorption while the addition of micro silica reduces water absorption. Also, comparing the stress-strain curve of experimental specimens in this study, it can be concluded that the stress-strain curve of specimens with waste aggregates are not much different from the reference specimen.

4- Conclusion

The results of this research are summarized as follows.

1-In the sample with 25 and 100% recycled aggregate without micro silica, the compressive strength decreased by 3.2 and 14.5%, respectively, compared to the reference sample. Also, the addition of rubber powder to the samples has caused a greater reduction in compressive strength than the reference sample. The highest compressive strength is related to the sample with 25% recycled aggregate containing micro silica, which is 9.6% higher than the reference sample.

2-According to the test results, tensile strength in the sample with 50% recycled aggregate, 14% and the sample with 50% recycled aggregate and rubber powder, 72% reduction in tensile strength compared to the reference sample was obtained by adding micro silica to the samples. The strength was 9% for the sample with 50% recycled aggregate and 55% for the sample with 50% recycled aggregate and rubber powder.

3-The results of flexural strength test were as follows: for the sample with 50% recycled aggregate 5% and for the sample with 50% recycled aggregate and rubber powder 77% reduction in strength compared to the reference sample was observed by adding micro silica to the mentioned samples with 50 Recycled aggregate% We see an increase in strength of up to 13% more than the reference sample. Also, for the sample with 50% recycled aggregate and rubber powder, compared to the reference sample, a 53% decrease in strength is observed.

4-The lowest water absorption was observed in the sample without recycled aggregates with micro silica with 0.5% and the highest water absorption was observed in the sample with 50% natural aggregate and rubber powder with 1.8%. By adding micro silica to the samples, water absorption was reduced in all samples.

5-The lowest slump reduction is related to the sample with 25% recycled aggregate at 6% and the highest slump reduction is related to the sample with 100% recycled aggregate at 50% compared to the reference sample. The highest slump was related to the sample with 25% natural aggregate and micro silica, which is 27% more than the reference sample.

6-Addition of waste concrete aggregates and micro silica did not have a significant effect on the density of concrete, while the addition of rubber waste with micro silica reduced the density by 11% compared to the reference sample.

7-The initial slope of the stress-strain diagram is approximately equal in all samples with micro silica-free waste aggregates. The sample contains 25 and 50% more brittle waste concrete than other samples. The sample with 100% concrete waste aggregate behaves similarly to the reference sample. In all samples, the addition of micro silica increased energy absorption compared to similar samples without micro silica.

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