Using Treated Recycled Demolition Aggregate in Concrete

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Abstract. The investigation focuses on the mechanical properties of treated recycled demolition aggregate, which was treated in two ways: one by immersing recycled demolition aggregate in NaOH solution for 24 hours and the other soaking in cement neat. The mixes were produced by substituting treated recycled demolition aggregate for 0%, 20%, 40%, and 60% of the coarse aggregate weight in both methods. The weight of the cement is replaced by 10% silica fume. Compressive strength, splitting tensile strength, modulus of rupture, and density tests were done. The compressive strength and modulus of rupture of treated recycled demolition aggregate concrete rose by 61% and 27%, respectively, as the treated recycled demolition aggregate ratio increased. Treated recycled demolition aggregate concrete has a 17 percent lower tensile strength and 12.5 percent lower density than conventional concrete. Recycled demolition aggregate that has been treated is suitable for use in concrete and meets all requirements.

Keywords: Treated recycled demolition aggregate, coarse aggregate, NaOH, Cement neat, Mechanical properties.

1 Introduction

Concrete is often made with natural elements such as coarse aggregate, fine aggregate, and cement. When pressured, compression has the strength of concrete, but it is brittle. High elasticity, twisting resistance, low creep, and porosity are only a few of the benefits of concrete [1].

Extensive studies have been carried out to assess the use of recycled demolition aggregate (RDA) in concrete. This topic is also important because of the expected increase in noticeable coarse aggregate usage [2]. Demolition is frequently regarded as a waste product as represented in Fig 1. To reduce the negative environmental consequences of waste, a recycling method is required. Demolition trash produces when ancient structures are destroyed by explosion or demolition. Using a way of recycled demolition waste of the buildings would help to enhance the environment. Recycled demolition aggregate (RDA) is a type of demolition waste-derived aggregate [1], [3]. The problem with demolition aggregate is that the dust and other materials in the aggregate cause less bonding between the RDA and the cement

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paste. As a result, it is critical to address this issue by treating the RDA to reduce the effect of these materials [3].
The study aims are to address the mechanical properties of concrete that contains treated recycled demolition aggregate (TRDA). TRDA was treated in two methods: one by immersing RDA in NaOH solution for 24 hours and the other soaking in cement neat. TRDA components are used in various ratios as a partial replacement for coarse aggregate weight in concrete mixes, with varying amounts of (0 %, 20 %, 40 %, and 60 %), for two methods. 10% silica fume is used to replace the cement weight (SF). The mechanical parameters of TRDA concrete are investigated, including compressive strength, tensile strength, density, and modulus of rupture.

Fig 1. Demolition waste.

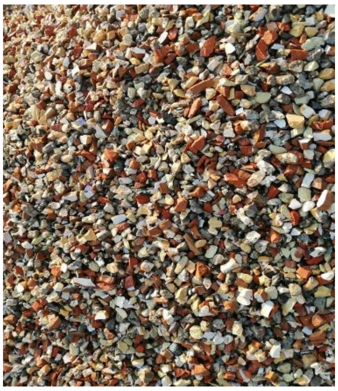
2 Materials and Testbed

The Portland cement type I was utilized. Cement was tested the chemical and physical features according to reference [4]. The sand was used as the fine aggregate. Its tests were performed according to reference [5] sieve grading, chemical, and physical property testing criteria. The normal coarse aggregate (gravel) size was 12.5 mm. Gravel was tested following requirements as in [6].
RDA was gathered from building demolition and used to substitute natural coarse aggregate weight at four different weight ratios: 0%, 20%, 40%, and 60%. As depicted in Figure 2, RDA was created out of brick, ceramic, tile, and concrete elements. RDA was treated in two ways: first, it was immersed in NaOH solution for 24 hours, and then thoroughly rinsed with running water before being left on sheets in the sun to achieve the condition of saturated surface dry SSD. Second, it was immersed in cement neat for two hours before use, as shown in Fig 2. RDA sieve analysis shows that it corresponds to coarse aggregate grading according to reference [6], as shown in Table 1.

Table 1. Sieving of RDA test

Size of sieve	Passing Cumulative (%)	Specifications [6]
20 mm	100	100
14 mm	97	90 – 100
10 mm	71	50 – 85
5 mm	7	0 – 15
2.36 mm	2	0 – 5

a) Demolition collected.



b) Recycled demolition aggregate.

c) RDA treated using cement neat.

b) RDA treated using NaOH

Fig 2. RDA collected and treated.

SF is used in place of the equivalent cement (10 % by weight). SF strengthens the bond between the cement paste and the TRDA, as in previous references [2], [3]. The used mixture is illustrated in Table 2. TRDA is used to replace 0%, 20%, 40%, and 60% of the weight of coarse aggregate in the mixes (two methods of treatment). The normal concrete uses similar mix concrete technique as designated by the ACI code requirements [7].

Standard test specimens were used to test the various parameters. A slump test was performed on all types of combinations in accordance with reference [8]. Reference [9] employed six cylinders with a diameter of 150 mm and a height of 300 mm to determine compressive strength after 28 days of cure. It can be used to determine the splitting tensile strength (ASTM C496 / C496M-17) [10] and the density of concrete (ASTM C29 / C29M-17a) [11]. Prism specimens ranging in size from 100 x 100 x 500 mm were cast to calculate the modulus of rupture, as presented in Figure (3). The test was carried out by reference [12].

Table 2. Materials amounts in mixes.

Mixes	Cement (kg/m^3)	SF (kg/m^3)	Sand (kg/m^3)	Coarse Aggregate (kg/m^3)	Water (kg/m^3)	Treated DA (kg/m^3)		% Replaced
						NaOH	Cement mortar	
NC	490	0	680	960	191	0	0	0
TN20	441	49	680	768	153	192	0	20
TN40	441	49	680	576	153	384	0	40
TN60	441	49	680	384	153	576	0	60
TC20	441	49	680	768	153	0	192	20
TC40	441	49	680	576	153	0	384	40
TC60	441	49	680	384	153	0	576	60

SP : 4.9 kg/m^3

Fig. 3. Modulus of rupture test (sample failure).

3 Results and Discussion

Table 3 shows the outcomes of several concrete compositions. In this investigation, a typical concrete mixture was used as a comparison guide. A major variable was employed in the other mixes to replace the regular coarse aggregates with a TRDA material. In addition, silica fume was used to increase compressive strength. In addition, a super-plasticizer was employed to increase TRDA concrete's workability. An increase in the ratio of TRDA substitution leads to an increase in the slump's results. Because of the super-plasticizer effect, this happened. When the ratio of TRDA in the mixes was increased, the compressive strength increased (TN20, TN40, TN60, TC20, TC40, and TC60). This is due to the use of the SF and SP. SF aids in the strengthening of the bond between the TRDA and the cementitious materials. Furthermore, the SF is stronger than ordinary cement.

TRDA concrete compressive strength and modulus of rupture increased by 61% and 27%, respectively, as the TRDA ratio increased. The use of SF helps in the building on solid bond among the cementitious materials and the TRDA. The role of SF as in previous references [1], [2]. Tensile strength is reduced by 17% when compared to normal concrete. It also show the density of concrete-TRDA is approximately 12.5 % lower than that of normal concrete. The compressive strength of TRDA concrete treated with cement neat is greater than that of NaOH solution. This happened because cement neat bonded better than NaOH solution between concrete components. TRDA is suitable for use in concrete and meets all criteria due to the strength in the limits of the requirements.

Table 3. Concrete mixes results.

Mixes	Slump (mm)	Fresh density (kg/m^3)	Tensile stress (MPa)	Compressive strength (MPa)	Modulus of rupture (MPa)
NC	40	2360	3.89	39.3	10.3
TN20	55	2250	3.79	54.6	13.1
TN40	59	2123	3.65	58.0	12.5
TN60	68	2065	3.39	53.0	12.0
TC20	62	2310	3.68	60.1	12.7
TC40	67	2189	3.43	63.4	12.5
TC60	75	2102	3.22	56.6	11.9

4 Conclusions

A test of the concrete mechanical characteristics including TRDA was provided for the current experimental effort. This is part of a recent trend of studies involving the substitution of rubbish and trash for existing concrete gravel. The following conclusions were reached: The slump's outcomes improve as the ratio of TRDA substitution is increased. The super-plasticizer effect was to blame. By reducing the amount of coarse aggregate used and replacing it with lighter recycled TRDA, a concrete density reduction of up to 12.5 percent of the typical mixed density can be achieved. The recycled TRDA content in the concrete mix, while just a partial substitution for gravel, boosts the compressive strength by roughly 61 percent when compared to standard concrete. Finally, recycled TRDA material has a substantial impact on concrete splitting tensile strength, resulting in a drop of roughly 17 percent, while the modulus of rupture is raised by up to 27 percent in the maximum substitution ratio with recycled TRDA.

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