RESEARCH ARTICLE OPEN ACCESS

Durability Study on Replacement Level of Concrete Waste as Fine Aggregate in Concrete

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Abstract:

In this research paper we are discussed about the durability properties of partial replacement of concrete waste as fine aggregate in concrete. The partial replacement of waste concrete as fine aggregate in concrete is 10%,20%,30%,40%,50%. The waste concrete is made as a fine aggregate by using crushing machine. The different particle size distribution of waste concrete as fine aggregate is made by adjusting the crushing blade. In mechanical properties also the strength has to be raised in 30% replacement. In durability properties we have been tested such as water absorption, Sulphate Resistance, Sorptivity and Ponding Test. The water absorption increases when the replacement level rises. It is observed that the water absorption of RFA is higher than the NAC. It is clear shows that there is a loss of compressive strength due to sulphate attack. The percentage loss of compressive strength varies from 17% to 32% for various concrete mixtures. There is higher loss in all RAC mixes. It is observed that the recycled aggregate with 50% replacement shows more permeable with less time when compared to reference concrete. The corrosion rate values of rebar are decreased with increase in replacement level of recycled aggregate.

Keywords — **NAC - Natural Aggregate Concrete, RAC - Recycled Aggregate Concrete , Durability Studies, Water Absorption, Sulphate Resistance, Sorptivity Test , Ponding Test**

I. INTRODUCTION

However, the use of conventional concrete has been claimed to be not environmentally friendly, manifested by frequently voiced negative concerns such as the depletion of the reserve of natural resources, high energy consumption and disposal issues. In the last two decades, a variety of recycling methods for recycled concrete aggregate have been explored and well developed. Such recycling operations have the added benefit of reducing landfill disposal, while conserving primary resources and reducing transport costs.

It is estimated that the construction industry in India generates about 12-14 million tons of waste annually (Yong and Toe, 2009). Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000 million cu.m. The construction of new buildings, as well as the maintenance and or demolition of existing ones, is responsible for the production of large amount of waste, commonly referred to as Construction and Demolition C&D Waste.

Yang et al (2008) In shrinkage test, most shrinkage strains in all concrete (control concrete and recycled fine aggregate concrete) tested occurred in the first 10 days, and then the rate of unrestrained shrinkage strain slowed down. In addition, a lower amount of shrinkage strains developed in recycled aggregate concrete than in control concrete until the age of approximately 10 days, owing to the initial higher water absorption capacity of recycled aggregate.

Katz (2003) reported that there is no significant difference was found between the total absorptions of the recycled concretes made with either of the two types of cement .The absorption was approximately 3.8% for the reference concretes and approximately 7.2% for the recycled concrete. The higher porosity of the recycled concrete is a result of the higher porosity of the recycled aggregate

Shayan and Aimin (2003) which has the highest carbonation depth, has the highest chloride ingress as well, and this may result from a higher porosity. Nevertheless, these mixtures would satisfy the corrosion protection criteria for reinforced concrete, although the reference concrete (D1) has performed better than others.

II. MATERIAL AND MIX PROPORTIONING

2.1Cement

Ordinary Portland cement - 43 grade chettinadu cement is used for the present study. Tested in accordance with IS: 4031-1988. The results of these tests are reported in Table 2.1.

Table 2.1 Physical properties OPC 43 grade cement

Sl.no	Test properties	Results
1	Specific gravity	3.05
2	Initial setting time (min)	100
3	Final setting time (min)	265
4	Consistency (%)	29

2.2 Natural Fine Aggregate

As per IS: 2386-1963 and IS: 383-1970 recommendations the following properties of river sand were determined and presented in Table 2.2.

Table 2.2 Test result for natural fine aggregate

Sl.no	Test properties	Results
1	Specific gravity	2.6
2	Fineness modulus	3.16
3	Bulk density (kg/m^3)	1750
4	Water absorption (%)	1.07
5	Zone	II

2.3 Recycled Fine Aggregate

The results of Recycled Fine Aggregate tests are reported in Table 2.3

Table 2.3 Test result for natural fine aggregate

Test properties	Results	Indian standards
Specific gravity	2.64	IS 2386(part III) 1963
Fineness modulus	3.82	IS 2386(part I) 1963
Bulk density (kg/m^3)	1540	IS 383-1970
Water absorption (%)	6.49	IS 2386(part III) 1963
Zone	II	IS 383- 1970

2.4 Natural Coarse Aggregate

The crushed granite stone is used as natural coarse aggregate

Table 2.4 Properties of natural coarse aggregate

Test properties	Results	Relevant Indian standards
Specific gravity	2.77	IS 2386 (part III) 1963
Fineness modulus	9.13	IS 2386 (part I) 1963
Water absorption (%)	0.6	IS 2386 (part III) 1963
Bulk density(kg/ m$^{3)}$	1510	IS 2386 (part III) 1963

2.5 Water

Ordinary portable water available in Pondicherry engineering college campus is used for the entire experimental investigation including curing of specimens.

2.6 Mix proportioning

Table 2.5 Ingredients for per m^{3}of concrete

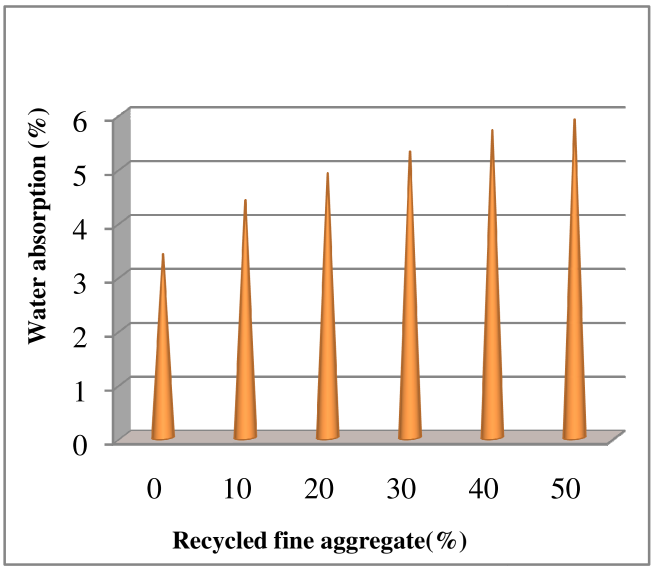
Sl.no	Materials	Quantity
1	Cement	350 kg/m^3
2	Water	157.6 kg/m^3
3	Fine aggregate	758.16 kg/m^3
4	Coarse aggregate	1181 kg/m^3
5	Water/ Cement ratio	0.45
6	Super plasticizer	2.45lit/m^3

III.RESULTS AND DISCUSSION

3.1 Water Absorption

The water absorption results of various concrete mixtures are schematically represented in Fig. 3.1. The water absorption increases when the replacement level rises. It is observed that the water absorption of RFA is higher than the NAC. The percentage difference of RFA10%, RFA20%, RFA30%, RFA40% and RFA50 is 22.7, 30.6, 35.8, 40.4 and 42.4%. It shows that RFA up to 50% gives higher water absorption. This is due to its attached old cement paste and more pores in the recycled aggregate.

Fig. 3.1 Water absorption of concrete at age of 28 days



3.2 Sulphate Resistance

The Fig.3.2 shows the strength of concrete mixes with and without sulphate exposure at 56 days. It is clear shows that there is a loss of compressive strength due to sulphate attack. The percentage loss of compressive strength varies from 17% to 32% for various concrete mixtures. There is higher loss in all RAC mixes.

From the Fig. 3.3, it is inferred that, for both natural and recycled aggregate concretes gives 10% to 47% weight loss due to sulphate attack.

Fig. 3.2 The strength of concrete mixes at 56days.

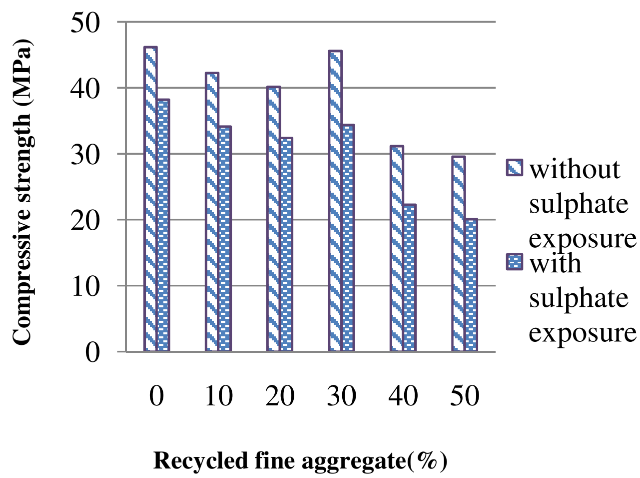
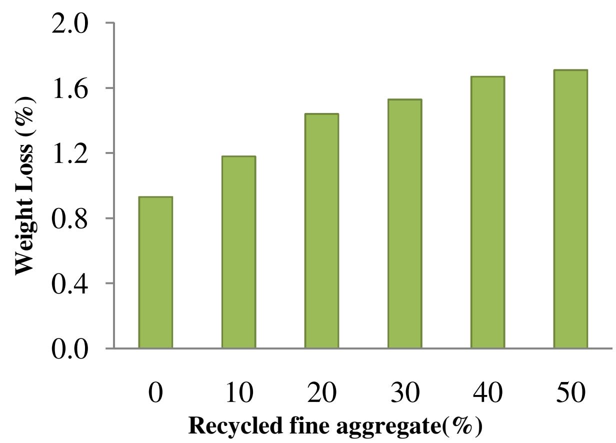


Fig. 3.3 loss due to Sulphate exposure of concrete at 56 days



3.3 Sorptivity Test

From the Fig. 3.4, the absorption of water is found to be increased as the replacement level increases. It is observed that the recycled aggregate with 50% replacement shows more permeable with less time when compared to reference concrete. This is attributed due to the distribution of pore size and pore shape of the concrete.

The maximum water absorption is found in recycled aggregate concrete mixtures containing 34% with 50% replacement level.

Fig. 3.4 Sorptivity of various concrete mixes at age of 28 days

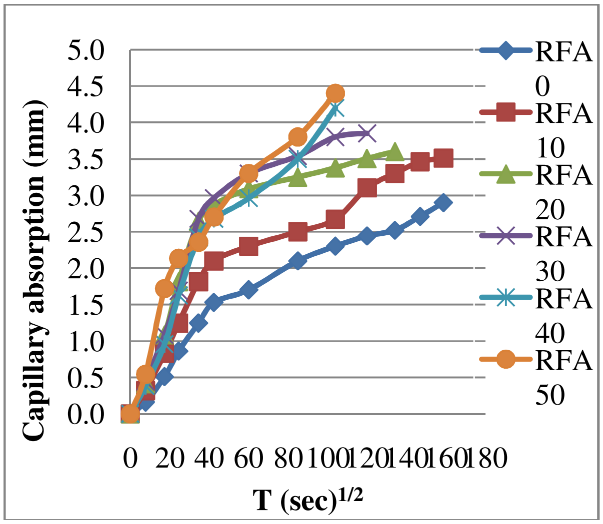
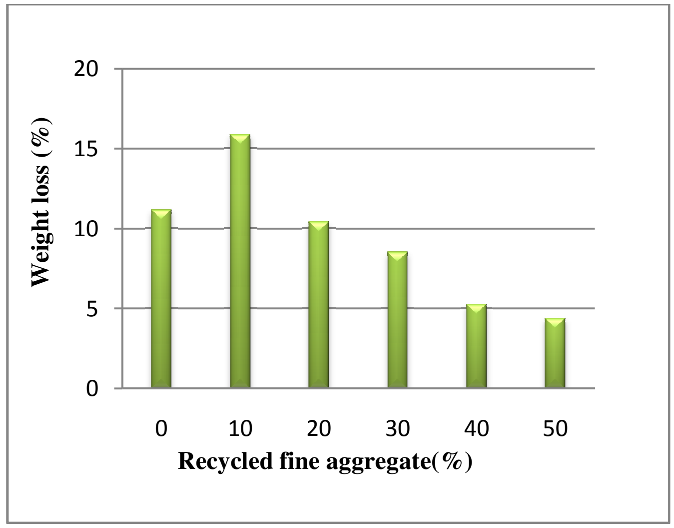


Fig. 3.5 Sorptivity test setup

3.4 90 Days Ponding Test

The corrosion products lead to higher internal tensile stresses in the hardened concrete. Being exposed to these stresses the hardened concrete cracks and splits off. As per test results the corrosion rate values of RFA10% are high when comparing with 0%, 20%, 30%, 40% and 50%. The corrosion rate values of rebar are decreased with increase in replacement level of recycled aggregate. This is due to unhydrated cement particles present in the recycled aggregate concrete that blocked the ingress path on concrete.

Fig. 3.6 Weight loss on rebar at the ages of 90 days



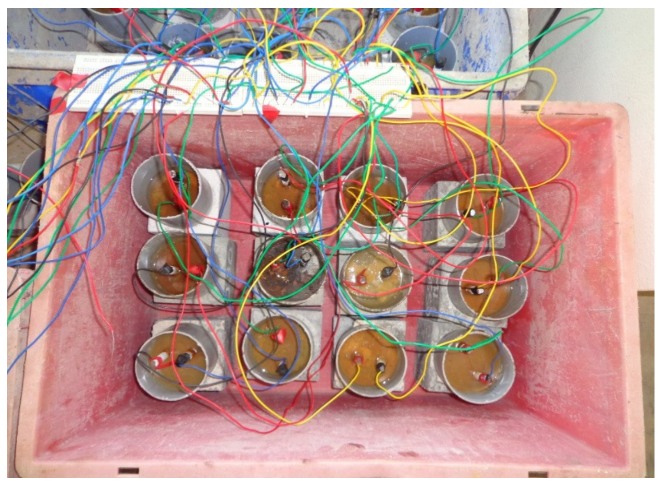


Fig.3.7 90 days Ponding test setup

IV.CONCLUSIONS

1. In terms of water absorption by capillary action, the incorporation of recycled fine aggregate with 50% replacement shows high permeability of around 35% compared with reference concrete.
2. Concrete containing recycled aggregate with exposed to sulphate attack gives 47% less compressive strength and 32% higher weight loss.
3. The corrosion rate values of RFA10% shows 72.3% higher when compared with other mixes.

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