



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 9, September 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



Behaviour of Self-Compacting Concrete with Recycled Brick Aggregate

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ABSTRACT:Self-compacting concrete (SCC) is a new type of high-performance concrete (HPC). It has segregation resistance and excellent deformability. Its flow ability is in such a way that it fills the gaps of reinforcement and corners of moulds and it does not require any vibration and compaction during the placing process. Considering these aspects, an attempt has been made to develop a cementitious composite Self Compacting Recycled Aggregate Concrete (SCRAC) where the waste material, such as recycled aggregate from demolished concrete, have been added to SCC respectively. This paper demonstrates the possibilities of using waste foundry sand as partial replacement of sand in concrete. Experiments was performed to evaluate the strength and durability properties of concrete, in these experiment sands was partial replaced with recycle brick aggregates (RBA) Natural sand was replaced with four percentage (0%, 10%, 15%, 20%) of RBA by weight. Fresh properties of self-compacting concrete were studied. Compression test and splitting tensile strength test were carried out to evaluate the strength properties of concrete at the age of 7, 28, and 56 days. In case of durability properties, sulphate resistance was evaluated at the age of 7, 28 and 56 days and Rapid Chloride Permeability test was conducted at age of 28 days. Test results showed that there is increase in compressive strength, splitting tensile strength of self-compacting concrete by incorporating recycled brick aggregates as partial replacement by sand up to 15%. Test results indicated that there was better enhancement in strength and durability properties of concrete up to 15% replacement of fine aggregate with RBA.

KEYWORDS:Recycling; self-compacting concrete (SCC); high-performance concrete (HPC); recycled concrete aggregate (RCA); natural aggregate (NA); Recycled brick aggregates (RBA).

I. INTRODUCTION

Over the years, there is great improvement of technologies have improved greatly. A greatest innovation of concrete is Self-compacting Concrete. Because Self-compacting concrete (SCC) is a new product and it sees that after the addition of superplasticizer and a stabilizer to the concrete mix it significantly increases the rate of flow. Because of its nature, SCC does not required vibration. It accomplishes compaction into all aspects of the shape or formwork just through its own load with no isolation of the coarse total. Created in Japan and Continental Europe, SCC is presently being utilized all over the place, aside from wellbeing and security benefits, it offers quicker development times, expanded usefulness and simplicity of stream around weighty support. Having no need for vibrating equipment spares workers from exposure to vibration. No vibration equipment also means safe constructionsite. Self-compact ability can be affected due to the characteristics of materials also with the mix proportion. An objective blend plan technique for self-compacting concrete is essential. Okamura and Ozawa have proposed a basic blend proportioning framework expecting general stock from prepared blended substantial plants. The coarse and fine total substance are fixed so self-reduced capacity can be accomplished effectively by changing the water powder proportion and superplasticizer measurements as it were.

The properties of normal and recycled brick aggregates to produce SCC is well known that the volumetric stability of concrete mainly comes from the aggregates where stone chips are commonly used as coarse aggregates in concrete. However, as with technology, many developing countries such as India, Bangladesh, Pakistan, Egypt, etc. still use brick aggregates in concrete [8,9]. Brick is artificially manufactured from clay. Typically, clay is burnt at high

temperature in defined shape before been used as a brick.

II. MATERIALS AND METHODS

Concrete is a composite material, composed of cement (commonly Portland cement) and other cementations materials such as fly ash and slag cement, aggregate (generally coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water and chemical admixtures. The strength, durability and other characteristics of concrete depends on the properties of its ingredients, proportions of the mix, methods of mixing, compaction and other controls during placing, compaction, curing. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement which bonds the other components together eventually creating a robust stone-like material.

A concrete mix can only be classified as Self-compacting Concrete if the requirements for all three characteristics are fulfilled:

- Filling Ability: Ability of to fill a formwork completely under its ownweight.
- Passing Ability: Ability to overcome obstacles under its own weight without hindrance. Obstacles are e.g. reinforcement and small openingsetc.
- Segregation Resistance: Homogeneous composition of concrete during and after the process of transport and placing.

It is important to appreciate that none of the test methods for SCC has yet been standardized, and the tests described are not yet perfected or definitive.

Table 1:Mix proportion of self-compactingconcrete

Type of Cement		OPC	
Specific gravity of cement		3.12	
Specific gravity of Coarse Aggregate		2.65	
Specific gravity of Fine Aggregate		2.75	
Specific gravity of Admixture		1.11	
Material	Water Absorption	Free Moisture	Total Correction
Coarse aggregate			
10mm	0.70%	0.00%	0.00%
Fine Aggregate			
River Sand	1.20%	0.00%	1.20%

Coarse Aggregate		Fine Aggregate	
40.00%		60.00%	
20 mm	10 mm	C.Sand	R.Sand
0.00%	100%	0.00%	100%

Target Mean Strength of concrete	33.25
Water/Cementitious ratio	0.43
Water/Cement ratio	0.43

➤ Testing of Fresh property

The slump flow V-funnel, U-Box, L-box were used to estimate all concrete mixtures' deformability intensity and flow ability. The slump flow research was carried out, as per the American Society for Measuring Materials (ASTM) C 1611. The passing capability of concrete through rebar was tested by measuring the slump-flow. The concrete mix's ability to resist segregation was determined by visually analyzing the concrete mix during the slump flow test and assigning a Visual Stability Index (VSI) value to each concrete mixture. Displays the various studies performed on the most current SCC. In the first stage, the flow ability test was performed using the slump cone and steel base plate with a circle marked at the distance of 500 mm. The flow ability time was recorded, and as per EFNARC standards, the SCC should touch the marked line in (2–5 s), and the slump flow diameter should range from 650 to 800 mm. During trial experiments, several attempts were made to satisfy the acceptance criteria of SCC. During the study's final experiments, the concrete total spread area and timing were recorded (Table 2). After the flowability test, a V-funnel test was performed on SCC, and as per EFNARC standards, the concrete must flow from the funnel in 6 to 12 s. The complete

readings of the V-Funnel test are shown in (Table 2). In the last stage of the fresh test on SCC, in order to study the effect on fresh concrete properties when recycled aggregates is used as a partial replacement of fine aggregate into the concrete, SCC containing different proportion of recycled brick aggregates were tested for Slump flow, V-funnel, U-Box, L-box. The results of fresh properties of all Self-compacting concretes with waste foundry sand are included in Table 4.1. The table shows the properties such as slump flow, V-funnel flow times, L-box, U- box. In terms of slump flow, all SCCs exhibited satisfactory slump flows in the range of 550–800 mm, which is an indication of a good deformability.



(a) Slump flow test conducted for self-compacting concrete



(b) U-Box test



(c) L-Box test



(d) L-Box test

Table2: Fresh concrete properties

Mixture ID	Slump (mm)	V-funnel(seconds)	L-Box(H2/H1)	U-box(H1-H2)
SCC1(0% RBA)	605	7	1	5
SCC2(10% RBA)	625	6.60	0.9	11
SCC3(15% RBA)	625	6.28	1	17
SCC4(20% RBA)	590	9.37	0.8	23

III. RESULTS AND DISCUSSION

The present work investigated the influence of recycled brick aggregate as partial replacement of fine aggregate (sand) on the properties self-compacting concrete. On the basis of the results from the present study, following conclusions are drawn. Self-Compacting Concrete is a greatest innovation over normal concrete. Use of recycled aggregate effectively is a contemporary concept for advancement. To recapitulate the main outcomes of the investigation and to unwrap some potential scopes of further research work related to recycled aggregate are the features of this chapter. This chapter will provide us with the reasonable opportunities and possible benefits of recycling the demolished aggregate. Different parameters related with the strength of concrete prepared with normal aggregate, recycled aggregate here. This study has tried to find the maximum use of recycled aggregate in the strength of concrete. The results obtained in this study indicate an opportunity to use the recycled aggregates in a specific range of percentage.

➤ Strength Properties

• Compressive Strength

- Compressive strength of concrete mixes increased due to replacement of fine aggregate with RBA. However, compressive strength observed was appropriate for structural uses.
- M30 (35.06MPa) grade concrete mix obtained increase in 28-day compressive strength from 35.06MPa to 43.03MPa on 15% replacement of fine aggregate with RBA. Maximum strength was achieved with 15% replacement of fine aggregate with RBA. Beyond 15% replacement it goes to decrease, but was still higher than control concretes



- c) Compressive strength also increased with increase in age of concrete. The rate of compressive development of RBA concrete mixes were higher compared to no waste foundry sand concrete mixes.
- **Split Tensile Strength**
 - a) Concrete mixes obtained linear increase in 28-day splitting tensile strength from 2.84 MPa to 3.31 MPa for concrete mix on replacement of fine aggregate with recycle brick aggregates at various percentages of 0% to 20%.
 - b) Splitting tensile strength of all concrete mixes was found to increase with increase in with varying percentage of RBA.
 - c) Maximum increase in splitting tensile strength was observed at 15% replacement of fine aggregate with RBA at all age for concrete mixes.

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7.569**



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