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A Workability of Fresh Concrete with Micro Silica Enclosed in Recycled Aggregate

Ketan S. Chavan[1], Manoj P. Wagh[2]
[1]*PG Student,* [2]*PG Guide, Department of Civil Engineering, DVVP COE Ahmednagar, Maharashtra, India*

Abstract: ***The most essential material utilised in the construction sector is concrete. Concrete contains a lot of natural aggregates, which harms the environment. Nowadays, a lot of buildings are torn down and rebuilt, which creates issues with the dumping of waste. Recycling or reusing construction and demolition debris is a crucial component of sustainable construction. It will continue to provide a welcoming, green environment. Concrete using recycled aggregates has low strength and poor workability due to the microcracks on its surface. Micro silica can be used to get around this drawback. In this study, experimental findings for the incorporation of recycled aggregate with micro silica were presented.***
Keywords: Micro silica; Recycled aggregate; Natural aggregate; Construction and demolition waste; Recycledconcrete.

I. INTRODUCTION

Fine aggregate, coarse aggregate, potable water, and the cement-based binder make up the heterogeneous material known as concrete. The heterogeneity is increased more by the presence of coarse particles. About 60 to 75 percent of the total volume of concrete is made up of aggregate. The continuous use of conventional concrete, which is concrete made with virgin aggregates and regular Portland cement, has proven to be very unfriendly to the environment as a result of the depletion of natural resources, despite the fact that concrete is characterised by very advantageous features ranging from cost effectiveness, durability, outstanding compressive strength, and availability. Growing waste management issues and significant energy use in quarrying operations have an impact on the environment. The increasing demand for infrastructure, As a result of industrialization and urbanization has lead to more consumption of concrete. Concrete is the most widely consumed resource in the world after water and also the most widely used construction material in the last few decades. The continuous global demand for concrete comprises that more aggregate and cement requirement. This leads to more extraction, depletion of deposits of natural gravel, and increased CO2 emission from quarrying activities. Partial substitution of natural aggregate with recycled aggregate would lead to reduction in construction cost and carbon emission of the construction industry. During the crushing process and due to having loose mortar cover on surface of aggregate, Recycled aggregate has micro cracks on it. As a result of this, bond between cement and aggregate is weak. This is responsible for the low concrete strength and low workability. By using recycled aggregate compressive strength of concrete get reduced as compare to the concrete from natural aggregate Researchers found that the replacement up to 30% [2], but this replacement gives lower strength than virgin aggregate. The use of mineral admixture (i.e. micro silica) could enhance the physical and engineering properties of recycled aggregate concrete. Micro silica contributes both physically and chemically in concrete mix. The size of micro silica particles is smaller than that of cement. This will results in reduction of the average size ofpores present in cement paste. While the chemical contribution takes place mainly by acting as an efficient pozzolanic material, which enables even distribution and higher volume of hydration products.

A. Research Aim And Objectives

1) Aim: The major aim of this research is to generate conventional standard concrete using recycled coarse aggregates as a replacement for natural coarse aggregate and mineral additive (micro silica).

2) Objectives

The objectives are to;

a) Determining the fresh qualities of concrete with varied amounts of recycled coarse aggregate;
b) Analyze the impact of micro silica, a mineral additive, on the concrete made in (1) above;
c) Identify the best way to use the micro silica needed to build concrete that is good strength in (2) above;
d) Evaluate the workability of nominal reinforced concrete incorporating micro silica which produced the optimal effect in above.

II. EXPERIMENTAL INVESTIGATION

This is an important stage in concrete production since it includes the determination of the relative quantities of the materials that constitute concrete with the object of producing an economical concrete as possible which satisfy certain minimum properties or characteristics such as strength, durability and required consistency.

A. Materials

1) *Cement:* Cement used is Ordinary Portland cement. (OPC). The colour of the cement is due to iron oxide. In the absence of impurities, the color of cement is gray. Ordinary Portland cement (OPC) – 53 grade (Birla Shakti Cement) is used.
2) *Fine Aggregate:* Crushed sand is used which is also called as artificial sand which is locally available in nearby area having specific gravity 2.63.
3) *Coarse Aggregate:* Natural coarse aggregate used which are locally available. Aggregates have specific gravity 2.79. 20mm & 10mm size of aggregate were use, in 60% & 40% respectively.
4) *Recycled Coarse Aggregate:* Aggregate was obtained from college campus, the beam & cube casted for testing purpose was crushed & 20mm & 10mm aggregate were separated by sieving.
5) *Micro Silica:* Micro silica used is ASTM C1240 of cetex brand, having specific gravity 2.11.

When water is added to cement, hydration occurs as shown below:-

OPC + H2O → CSH (Calcium silicate hydrate) + Ca(OH)2(Free lime)

The free lime does not contribute to strength, when combined with carbon dioxide; it forms a soluble salt, which leaches through the concrete causing effloresce, a familiar architectural problem. Concrete is also more vulnerable to chemical attack & detoriation, when it is added, the following reaction takes place.

$Ca(OH)_2 + SiO_2 \rightarrow H_2O + CSH$

Typical properties of microsilica

Form	Description
Colour	Grey
Odour	Odorless
Solubility	Insoluble
Specific gravity	2.11
Bulk density	0.416

6) *Water:* Water fit for drinking is generally considered fit for making concrete. Water should be free from acid, oils, alkalis, vegetables or other organic impurities. Soft water also produces weaker concrete. Water has two functions in concrete mixes. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregate & cement.

III. CONCRETE MIX DESIGN

M-30 Concrete mix was designed as per IS-10262. The 28 days characteristic strength is 30Mpa having water cementratio 0.45.

RCA(%)	**0%**	**25%**	**50%**	**75%**
Cement (kg/m³)	438.00	438.00	438.00	438.00
Sand (kg/m³)	703.48	703.48	703.48	703.48
Gravel (kg/m³)	1111.54	833.65	555.77	277.88
RCA. (kg/m³)	0.00	277.88	555.77	833.65
Water (kg/m³)	197.00	197.00	197.00	197.00
Micro silica (kg/m³)				
5%	0	21.90	21.90	21.90
10%	0	43.80	43.80	43.80
15%	0	65.70	65.70	65.70

IV. SEQUENCE OF LABORATORY WORK

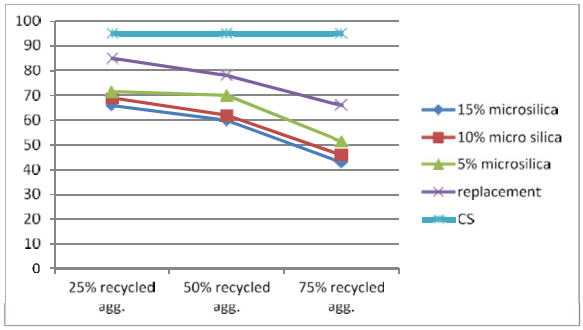
1) Determination of saturated surface dry (ssd) density of natural fine aggregate, natural coarse aggregate and recycled coarse aggregate;
2) Comparison of water absorption in each of the aggregate;
3) Adjustment of concrete mix design with the results obtained in (a) above;
4) Fresh concrete testing (slump test), (compaction factor test);

V. RESULTS AND DISCUSSION

Different tests were conducted on fresh concrete like on fresh concrete slum test and compaction factor test were carried out to know the workability of concrete, and the graph shows the variations with respect to percentage variation of recycledaggregate and microsilica.

A. Workability Test: Slump Test

The slump results indicate that the maximum value of 95 mm was measured at 0% recycled coarse aggregate content while the minimum value of 42 mm, which represents about 54.7% relative reduction from the maximum value in phase 5 was obtained at 75% recycled coarse aggregate content and 15% micro silica. A careful comparison of these results across the concrete mixes indicated that workability decreases as the percentage content of recycled coarse aggregate and micro silica increases due to higher rate of water absorption associated with recycled aggregate and increasing surface area due to micro silica.



RCA --- Recycled Coarse Aggregate, M --- Microsilica

Graph 1: slum value experimental results

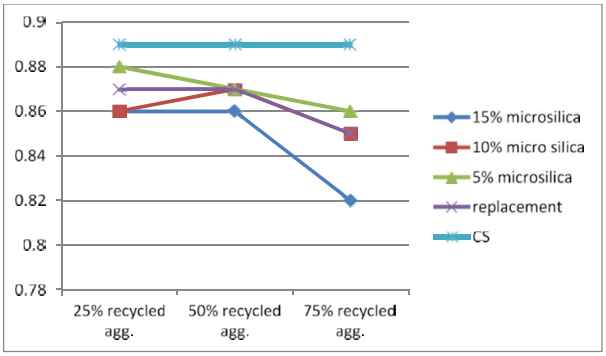
Table1: Result of slump test for concrete mix(mm)

RCA (%)	0% M Phase 1	0%M Phase2	5%M Phase 3	10%M Phase 4	15%M Phase 5
0	95	- - -	- - -	- - -	- - -
25	- - -	84	72.5	70	67
50	- - -	80	73	61	60
75	- - -	69	50	48	42

B. Compaction Factor Test

The results of workability test for each of the concrete mix incorporating 0%, 25%, 50% and 75% recycle coarse aggregate respectively is given in table, From the laboratory observation, concrete mixes in phase 5 prior very low workability in comparison with other concrete mix in Series 1-4. This reduction emanated from the increase in water demand due to the very large surface area of micro silica particles required to be wetted from the free-water. This rendered the concrete less workable while the increasing content of recycled coarse aggregate also affected the workability. However, it can be possible to work with concrete for this low water content. Results of various compaction tests for concrete mixes are going low as compare to control specimen. The incorporation of micro silica in the mix significantly affects the characteristics of fresh concrete due to the strong cohesiveness of

the concrete mix which result in very little bleeding or absence of bleeding in the concrete mix.



Graph 2: Compaction factor results

Table No. 2: Reslt of compaction factor test for phase 1-5 concrete mix

RCA (%)	0% M Phase 1	0%M Phase2	5%M Phase 3	10%M Phase 4	15%M Phase 5
0	0.89	- - -	- - -	- - -	- - -
25	- - -	0.88	0.87	0.86	0.86
50	- - -	0.87	0.87	0.87	0.86
75	- - -	0.85	0.85	0.85	0.82

VI. CONCLUSIONS

The graph plotted using the results are shows results with addition of microsilica. Hence from the results we can conclude that,

1) The water absorption of recycled aggregate is moreas compare to the natural aggregate.
2) As the percentage of microsilica increases workability of concrete get decreases.
3) The incorporation of microsilica, significantly affects the characteristics of fresh concrete due to strong cohesiveness of concrete mix which results in bleeding.
4) Workability decreases due to higher rate of water absorption associated with recycled aggregate and increasing surface area due to micro silica.

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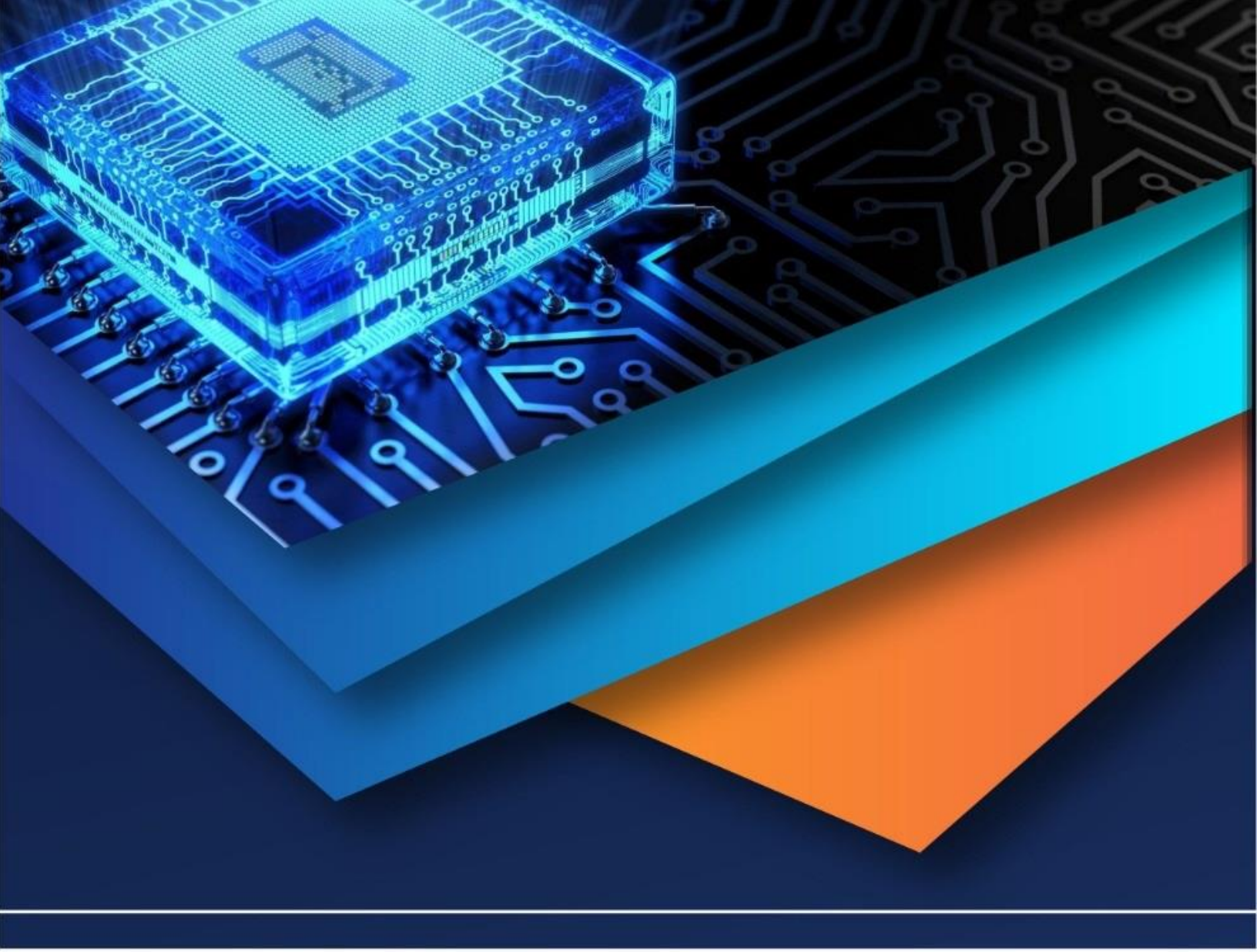

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