

AN EXPERIMENTAL INVESTIGATION OF FIBRE REINFORCED SELF COMPACTING CONCRETE

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Abstract: This study reviews the development of Self-Compacting Concrete (SCC) incorporating different mineral admixtures and fibers. The rapid growth of modern construction has increased the need for massive and complicated structural elements, where concrete placement becomes difficult, especially in heavily reinforced sections. In such members, conventional compaction methods using hand tools or vibrators may not provide complete densification, often resulting in voids and honeycombing. To solve these problems, Self-Compacting Concrete was introduced. SCC is designed to flow freely under its own weight, move easily through closely spaced reinforcement, and fill every part of the mold without external vibration. It is also known as self-consolidating concrete and is recognized as a high-performance concrete. Because of its superior flow characteristics and stability, SCC minimizes segregation, eliminates trapped air pockets, and provides better surface finish. The use of SCC can reduce manpower, save construction time, and lower energy usage while improving structural quality. This review focuses on the role of fibers and mineral admixtures in enhancing both fresh-state behavior and hardened properties of Self-Compacting Concrete

Keywords: Fly ash, Super plasticizer, GI, Polythene, Compressive Strength, Split tensile

I. INTRODUCTION

Modern Self-Compacting Concrete (SCC) originated from research initiatives in Japan during the late 1980s aimed at enhancing the reliability of concrete construction. Engineers found that incomplete consolidation of conventional concrete was a key reason for defects and lower durability in many structures. As it was difficult to guarantee proper compaction on-site using vibrators or manual methods, researchers explored an alternative concrete that could settle and densify under its own weight. These studies led to the successful development of the first workable SCC mixture by Okamura and Ouchi at the University of Tokyo.

Self-Compacting Concrete (SCC) is a concrete that spreads and compacts by its own weight without the use of vibration. It gives smooth finish, better quality work, fewer repairs at site, less labour requirement, faster completion of construction, and lower total cost. It is also suitable for modern construction methods using machines and automated systems. The mix contains a higher quantity of fine materials, which allows the use of industrial waste powders and by-products that are otherwise difficult and costly to dispose of.

In India, many large and complicated structures are being constructed, where placing concrete becomes difficult. In narrow sections and heavily reinforced areas, the use of vibrators is not easy and may create safety problems for workers along with noise. In such places, proper compaction of normal concrete is always a concern, which can reduce the strength and durability of the structure over time.

Hence, avoiding external vibration in concrete construction is considered advantageous whenever it can be achieved. Nations such as Japan, Sweden, Thailand, and the United Kingdom have already advanced Self-Compacting Concrete from experimental studies to practical construction use. In contrast, the understanding and large-scale implementation of this technology in India still need greater expansion.

II. LITERATURE REVIEWS

Dr. Mrs. S.A. Bhalchandra et.al The properties of steel fibre reinforced self-compacting concrete have attracted research interest, since conventional self-compacting concrete has been widely examined, whereas SCC containing fibres has not been explored as thoroughly.

‘Prof. Aijaz Ahmad Zende et.al This research examines ‘ Self-Compacting Concrete (SCC) and evaluates its characteristics in relation to Normal Concrete (NC). Across the world, the construction industry is facing a significant reduction in the availability of trained workers, which has increased the importance of innovative concrete materials. As concrete remains the second most utilized material after water, the need for improved and efficient concrete systems is steadily rising. “Special Concrete” refers to mixtures developed to deliver unique properties and performance levels that are difficult to obtain using conventional ingredients and standard placing methods. Self-Compacting Concrete is one such advanced material that can spread, fill, and compact solely through its own self-weight, eliminating the requirement for mechanical vibration, weight thereby eliminates the problems of placing concrete in difficult conditions and also reduces the time in placing large sections and at the same time giving high strength and better durability characteristics as compared to the Normal Concrete. This paper discusses the various aspects of SCC including the materials and mix design, different test methods such as V-funnel test, L- Box test etc., and also its performance characteristics and properties in the fresh and [hardened state](#).

Pratibha Aggarwal et.al prepared an experimental procedure for the design of self-compacting concrete mixes. This section presents the outcomes of the standard acceptance tests conducted on self-compacting concrete, namely slump flow, J-ring, V-funnel, and L-box tests. It also includes the measured compressive strength values obtained after curing periods of 7, 28, and 90 days.

Esraa Emam Ali et.al The research examined the use of waste recycled glass as a partial replacement for natural fine aggregate in Self-Compacting Concrete (SCC) and its impact on both fresh and hardened properties. Eighteen trial mixes were cast using cement contents of 350, 400, and 450 kg/m³ with a

constant water–cement ratio of 0.40. Fine aggregate was replaced by recycled glass at levels of 0%, 10%, 20%, 30%, 40%, and 50%. The observations revealed that flowability improved with increasing glass content, as reflected by higher slump flow values. In contrast, strength-related properties including compressive strength, split tensile strength, flexural strength, and modulus of elasticity showed a decreasing trend as the percentage of glass increased. Even with these reductions, the study demonstrated that recycled glass waste can be suitably incorporated in the manufacture of Self-Compacting Concrete.

OBJECTIVES

1. The Behavior of FRSCC by GI Fibres.
2. The Behavior of FRSCC by Polythene Fibres
3. Flow parameters of Slump flow Test.
4. Flow parameters of V Funnel with J-Ring Test.
5. Flow parameters of L-Box Test.
6. Flow parameters of U-Box Test.
7. Flow parameters of Orimet Test.
8. The Strength Characteristic of Compressive Strengths.
9. The Strength Characteristic of Split Tensile Strengths.
10. The Strength Characteristic of Shear Strengths.

III. MATERIALS AND METHODOLOGY

- **Cement:** - For the experimental investigation, 43 Grade Ordinary Portland Cement was selected as the binding material, meeting the standards prescribed under IS: 8112-1989.

Table 4.1 Ordinary Portland cement - Physical properties (IS: 8112-1989)

Properties	Results	Permissible limit according to IS:8112-1989
Fineness	286m ² /kg	Should not be < 225 m ² /kg
Normal consistency	32%	-
Specific gravity	3.08	-
Time of Setting a. Initial b. Final	120 min 540 min	Should not be < 30 min Should not be > 600 min

- **Coarse Aggregates:-** Maximum size of coarse aggregate used in experiment is Limited to 12.5 mm.

Table 4.2 Coarse Aggregate - Physical and Mechanical Properties

Properties	Results	Permissible limit as per IS:2386-1989
Impact value	10.04%	Should not be $\geq 30\%$ used for concrete
Specific gravity	2.64	-
Moisture content	0.5%	-

- **Fine Aggregate:** - Used natural river sand up to size of 4.75mm.

Table 4.3 gives the Physical properties of Fine Aggregate (IS: 2386-1963) & Table 4.5 gives the sieve analysis of Fine Aggregate.

Table 4.3 Fine Aggregate - Physical Properties (IS: 2386-1963)

Properties	Results	Permissible limit as per IS:2386-1986
Specific Gravity	2.65	-
Moisture Content	2.5%	-

- **Water:** - Ordinary potable water was used for mixing and curing.
- **Mineral Admixture:**

Flyash: - For the experimental program, fly ash was procured from Raichur Thermal Power Station. The material showed a specific gravity of 2.213, while its chemical composition is detailed in Table 4.6.

- **Chemical Admixture:**

Super plasticizer: - Trade name of superplasticizer used in experiment is Aura mix 400(INBNG 1). It is manufactured by **Fosroc chemicals (India) private limited**. Its specific gravity is found to be 1.09. It is based on Sulphonated Naphthalene Formaldehyde condensates.

DEVELOPING SCC MIXES

SCC mixes must meet three key properties:

1. Ability to spread freely and fully occupy complicated or detailed formwork solely due to its self-weight.
2. Ability to move through densely reinforced sections and achieve proper contact without external compaction
3. High resistance to aggregate segregation.

Mix proportion w.r.t Cement: (By Nan-Su-Method)

Cement:	Fly ash :	Fine Aggregate:	Course Aggregate :	Water
192.20	: 266.20:	834.62	: 649.152	: 242.32
1	: 1.38	: 4.34	: 3.37	: 1.26

IV. RESULTS AND DISCUSSIONS

Test Results of SCC by using GI Fibres.

For FRSCC the material properties and basic test parameters were found by conducting following methods

5.1.1 Flow Characteristics of SCC by using GI Fibres: - Following tables give the flow characteristics of SCC by using GI fibres as measured from Slump flow test, Orimet test, V- funnel test, U-box test and L-box test.

Table 5.1-Slump flow results of SCC using GI Fibres

Percentage of fibre	Slump flow dia (mm)
0.0	740
1.0	710
2.0	680
3.0	650

Table 5.2 V-Funnel results of SCC using GI Fibres

Percentage of fibre	Time in sec
0.0	8
1.0	9

2.0	10
3.0	11

Table 5.3 L-Box results of SCC using GI Fibres

Percentage of fibre	H1-H2 in mm
0.0	8.0
1.0	8.5
2.0	9.0
3.0	9.7

Table 5.4 U-Box results of SCC using GI Fibres

Percentage of fibre	H1/H2 in mm
0.0	00
1.0	07
2.0	12
3.0	15

Table 5.5 Orimet results of SCC using GI Fibres

Percentage of fibre	Time in sec
0.0	3
1.0	4
2.0	4
3.0	5

Table 5.6 Overall results of Compressive Strength of SCC using GI Fibres

Percentage of fibres	7 days compressive strength (MPa)	21 days compressive strength (MPa)	28 days compressive strength (MPa)

0 (Ref)	2.66	16.51	20.50
1.0	4.14	18.58	25.10
2.0	5.70	19.18	27.00
3.0	8.51	19.84	29.50

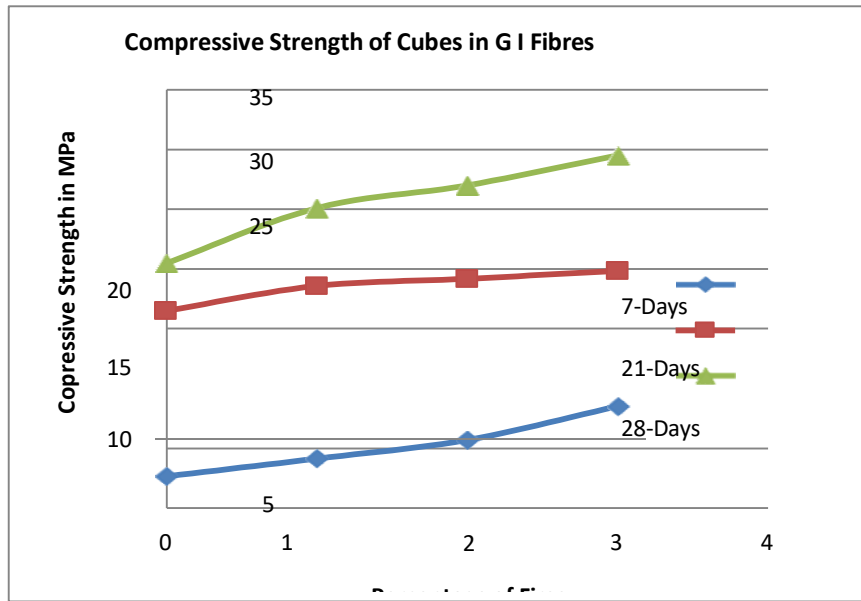


Fig 5.1 Variation of Compressive Strength of SCC using

Table 5.7- Overall results of Split Tensile Strength of SCC using GI Fibres

Percentage of fibres	7 days Split tensile strength (MPa)	21 days Split tensile strength (MPa)	28 days Split tensile strength (MPa)
0 (Ref)	0.40	2.33	3.30
1.0	0.68	2.59	3.81
2.0	0.89	2.92	4.12

3.0	1.30	3.13	4.49
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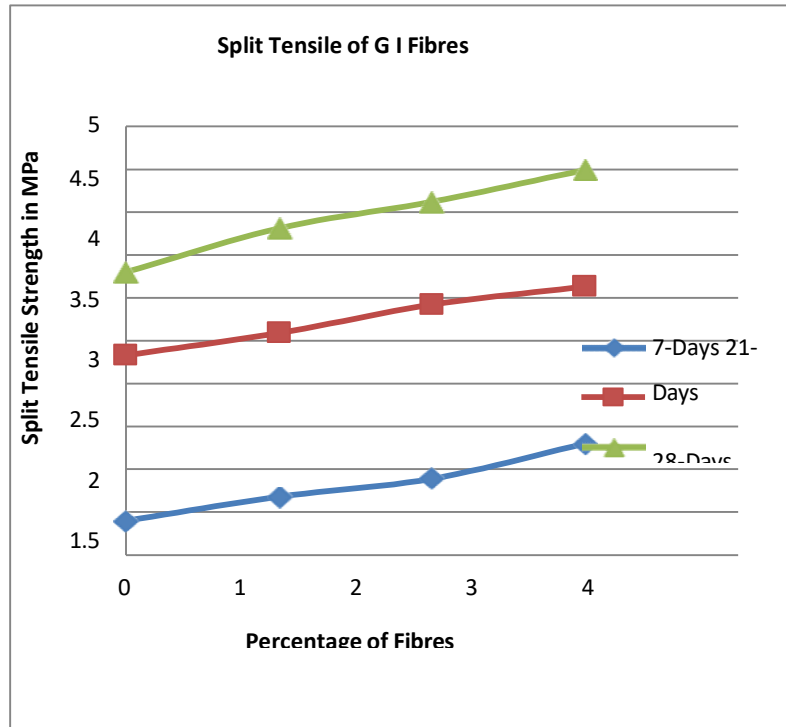


Fig 5.2 Variation of Split Tensile Strength of SCC using GI fibres.

Test results of SCC by using Polythene Fibres

For FRSCC the material properties and basic test parameters were found by conducting following methods

5.2.1 SCC Flow Characteristics by using Polythene Fibres:- Following tables give the SCC flow characteristics by using Polythene fibres as measured from Orimet test, V-funnel test, U-box test, L-box test and Slump flow test.

Table 5.8-Slump flow results of SCC using Polythene Fibres

Percentage of fibre	Slump flow dia (mm)
0.0	740
1.0	700
2.0	650
3.0	630

Table 5.9 V-Funnel results of SCC using Polythene Fibres

Percentage of fibre	Time in sec
0.0	8
1.0	10
2.0	11
3.0	12

Table 5.10 J-Ring results of SCC using

Percentage of fibre	Flow dia in mm	Outer ht in mm	Inner ht in mm
0.0	700	17.5	37.5
1.0	675	15.0	38.0
2.0	650	14.0	40.5
3.0	630	12.0	42.5

Table 5.11 L-Box results of SCC using Polythene Fibres

Percentage of fibre	H1-H2 in mm
0.0	8.0
1.0	8.2
2.0	8.5
3.0	9.0

Table 5.12 U-Box results of SCC using Polythene Fibres

Percentage of fibre	H1/H2 in mm
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0.0	00
1.0	05
2.0	08
3.0	10

Table 5.13 Orimet results of SCC using Polythene Fibres

Percentage of fibre	Time in sec
0.0	3.0
1.0	3.5
2.0	4.0
3.0	4.5

Table 5.14-Overall results of Compressive Strength of SCC using GI fibres

Percentage of fibres	7 days compressive strength (MPa)	21 days compressive strength (MPa)	28 days compressive strength (MPa)
0 (Ref)	2.66	16.51	20.50
1.0	3.92	18.21	24.82
2.0	5.48	18.66	26.36
3.0	8.15	19.63	27.70

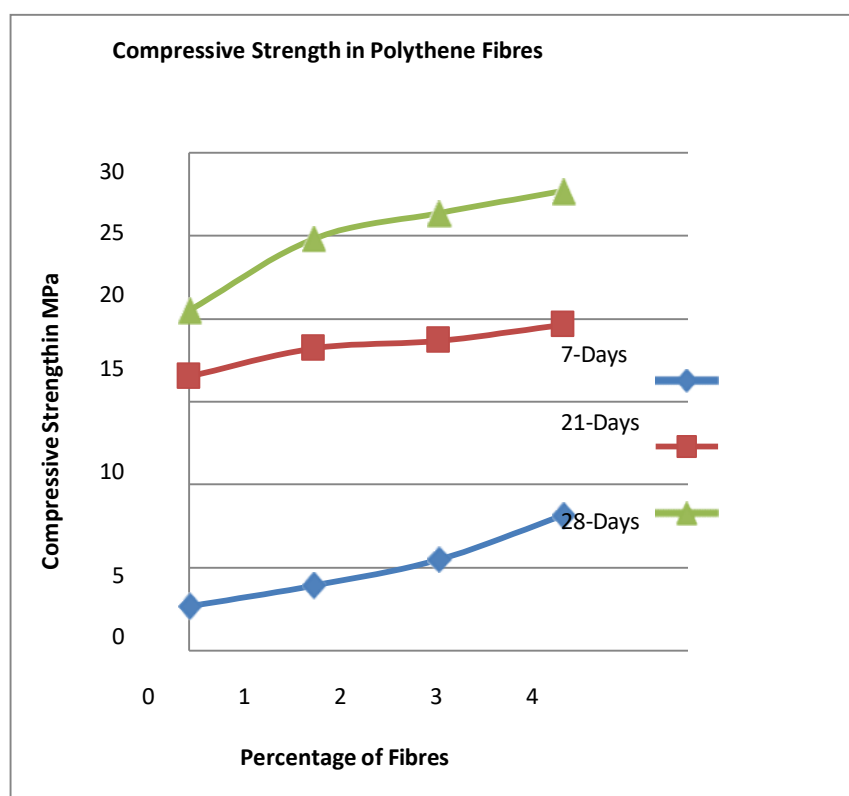


Fig 5.3 Variation of Compressive Strength of SCC using Polythene Fibres.

Table 5.15- Overall results of Split Tensile Strength of SCC using Polythene Fibres

Percentage of fibres	7 days Split tensile strength (MPa)	21 days Split tensile strength (MPa)	28 days Split tensile strength (MPa)
0 (Ref)	0.40	2.33	3.29
1.0	0.63	2.54	3.71
2.0	0.89	2.86	3.99

3.0	1.20	3.11	4.47
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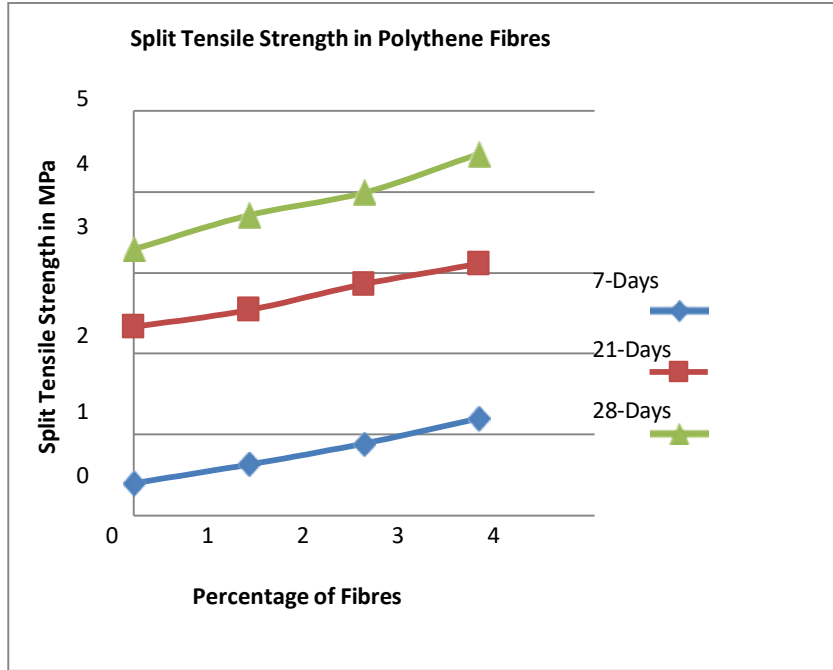


Fig 5.4 Variation of Split Tensile Strength of SCC using Polythene fibres.

V. CONCLUSION

1. The fresh flow performance of SCC with G.I. fibres declines progressively when the fibre dosage is increased.
2. Higher amounts of G.I. fibres lead to improved compressive strength at 7, 21, and 28 days.
3. Split tensile strength measured at 7, 21, and 28 days shows a positive increase with greater G.I. fibre content.
4. SCC incorporating polythene fibres exhibits reduced flow ability as the fibre proportion rises.
5. Compressive strength values at 7, 21, and 28 days increase with additional polythene fibre content.
6. Split tensile strength at 7, 21, and 28 days also improves when the percentage of polythene fibres is increased.

7. By the investigation of GI fibre flow characterises were found good Compared to Polythene fibres.
8. By Considering Compressive strength, Split Tensile strength the GI fibres performance quite good for M20 grade concrete and gives better results by comparing Polythene fibre.
9. Providing different percentage of GI fibre and Polythene fibre with 0% (Ref) to 3% with the interval of 1% replacement. By 3% GI fibre gives 100% Strength of M20 grade concrete.

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ALL BIOS ARE REQUIRED

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