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A Study on Sugarcane Bagasse Fibre as Partial Replacement of Fine Aggregate in Concrete

Jayanth.R.N[1]; Sumanth. H.S[2]; Shivakumar T R[3]; Naveen Kumar T V[4]; Akhilesh Kumar H S[5]
[1]Assistant Professor, Department of Civil Engineering, Acharya Patashala Polytechnic, Bengaluru, India
[2,3,4,5]Assistant Professor, Department of Civil Engineering, Acharya Patashala Polytechnic, Bengaluru, India

Abstract:- Concrete one of the important materials used for the construction for both structural and non-structural works. The materials used for the concrete are cement, fine aggregate (F.A) and coarse aggregate (C.A). Now a day the natural materials are depleting day by day. Therefore, the Research scholars started working on alternative materials for replacement of cement, F.A and C.A. In the present study the F.A. is replaced by sugarcane bagasse fiber (SCBF) at 1.5%, 3% and 4.5% to study the fresh and hardened properties of the concrete. Workability of concrete is determined using slump come test and in the hardened properties compression strength of cube for 7, 14 & 28 days is conducted. The concrete's workability decreases as the SCBF percentage increases. The compressive strength of the concrete was found to be increasing with the replacement of 1.5% and starts decreasing with 3 and 4.5% replacement. The density of concrete was found to be decreasing with the replacement percentage increasing which clearly indicates the lightweight concrete.

Keywords:- *Sugarcane Baggage Fiber (SCBF).*

I. INTRODUCTION

In the Construction industry the concrete plays a vital role since it is used for all the works like foundation, column, beams, roof slabs and all other structural and non-structural elements, but the usage of concrete in an enormous quantity leads to creating problems to the environment. By the year 2030 the greenhouse gas emissions will be 40 billion tons from the building and construction industries. The materials used for the construction plays a crucial role because by understanding the thermo physical properties of the building materials can reduce heat & radiation which improves the insulation & efficient usage of energy. To achieve this, the research on composite materials that incorporates natural fibers is done.

The innovative and sustainable material usage in the concrete reduces the carbon footprint and also other environmental hazards. One such material is the sugarcane baggage fiber which is a by-product of sugarcane obtained after the extraction of liquid content. Sugarcane baggage fiber has the unique properties like high tensile strength, low-density, high-water absorption, good thermal insulation and renewable & biodegradable material which make it suitable for the usage in concrete.

By considering all this factors a study is conducted on the M 25 grade concrete by replacing fine aggregate by SCBF at 1.5%, 3% and 4.5%. The fresh property was determined by slump cone test and the hardened property was determined by compression strength test for concrete cubes of 150mm X 150mm X 150mm after curing for 7, 14 and 28 days. Along with these the concrete density was also determined.

➢ *Objectives*

- To study the literature on SCBF.
- To determine the engineering properties of the raw materials utilized in the study.
- To research the impact of SCBF on concrete's fresh properties
- To investigate the impact of SCBF on hardened concrete.
- To study the effect of SCBF on density of concrete. Concrete.

II. LITERATURE REVIEW

S. ANANDARAJ et.al conducted an investigation on sugarcane bagasse fiber (SCBF) reinforced concrete using bottom ash and SCBF for replacement of Fine Aggregate. In this study the mechanical property where determined using the bottom ash 30% constant by replacing fine aggregate and the SCBF is added at a percentage of 0.5%, 1.0%, 1.5% and 2% to the concrete. It was found that with 30% Bottom ash and 1% SCBF enhanced the mechanical properties compared to conventional concrete

Pandian Venkatesan and Ramaswamy Vasudevan investigated on the behavior of Bagasse ash and Bagasse fiber in concrete. In this study the cement is replaced by 10% and 20% of the bagasse Ash with 1 and 2% of the bagasse fiber is added to determine the mechanical property of concrete. The better results were found with 10% bagasse Ash with 1% of Bagasse fiber.

VM Patel conducted a study on the application of SCBF as concrete composite for rigid payment by adding 0.5%, 1%, and 1.5% to the concrete has natural fiber the mechanical property like compressive strength and structural strength were conducted. The mix with 1% fiber provided optimum results.

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III. MATERIALS

- *Cement*

Grade 53 Ordinary Portland Cement (OPC) is being used in the in latest study in accordance with IS 12269:2013.

Table 1 Properties of cement

Sl.no	Properties	Observed Values
1	Specific gravity	3.15
2	Compressive strength, N/mm2	53
3	Fineness, m2/kg	225
4	Soundness, mm	10
5	Initial setting time, mins	30
6	Final setting time, mins	600

- *Fine Aggregate*

M-sand is used in accordance to IS 383:2016 for the current study.

Table 2 Properties of M-Sand

Sl.no	Properties	Observed Values
1	Specific gravity	2.65
2	Water absorption, %	2.6
3	Fineness modulus	4.29

- *Coarse Aggregate*

For the current investigation, coarse aggregate (CA) is used in accordance with the guidelines of IS 383:2016.

Table 3 Properties of M-Sand

Sl.no	Properties	Observed Values
1	Specific gravity	2.67
2	Water absorption, %	2.00
3	Fineness modulus	5.91
4	Impact Value, %	16.00

- *Sugarcane Baggase Fiber*

Following are the properties of the sugarcane bagasse fiber.

Table 4 Properties of Sugarcane Baggase Fiber

Sl.no	Properties	Observed Values
1	Specific gravity	2.10
2	Water absorption, %	3.65
3	Fineness modulus	4.1

IV. EXPERIMENTAL METHODOLOGY

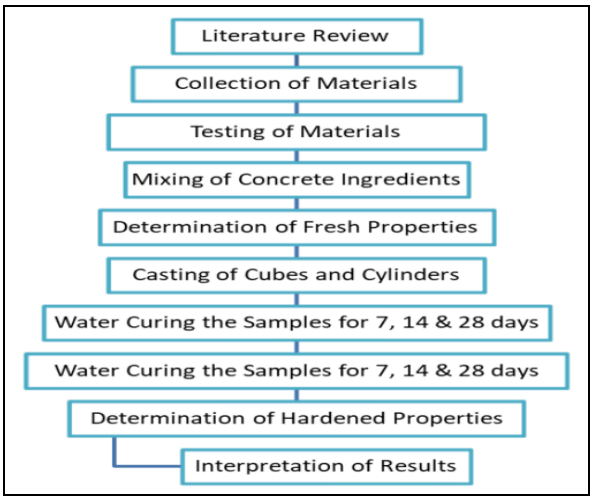

Fig 1 Experimental Methodology

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V. MIX DETAILS

Table 5 Mix code and its PROPORTIONS

Sl.no	Mix Code	Cement in %	Fine Aggregate in %	Coarse Aggregate in %	SCBF in %
1	M_0	100	100	100	0
2	$M_{1.5}$	100	98.5	100	1.5
3	$M_{3.0}$	100	97	100	3.0
4	$M_{4.5}$	100	95.5	100	4.5

VI. EXPERIMENTAL INVESTIGATION

➢ *Slump Cone Test*

The slump test, which offers a quick response at a minimal cost, is the simplest way to determine whether concrete is workable. The procedures described in IS 1199:1959 are followed for conducting the slump test.

Fig 2 Slump Cone Test

➢ *Compressive Strength Test*

Compressive strength is the most crucial property of concrete which tells about the strength achieved after the curing period. In the current study three samples are developed for each combination in accordance with IS 516:1959, and they are subsequently cured for 7, 14, 21 and 28 days and then tested for its strength

Fig 3 Concrete Cubes and Compression Testing Machine

➢ *Density Test*

The mass of a material per unit volume is called its density, and for concrete, this is commonly expressed in pounds per cubic foot (lb/ft³) or kilograms per cubic meter (kg/m³). The density of concrete is influenced by several factors, including the mix proportions of cement, aggregates (sand, gravel, or crushed stone), water, and any additional admixtures or reinforcing materials.

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VII. EXPERIMENTAL RESULTS

➢ *Slump Cone Test*

Table 6 Slump Cone Test Results

Sl.no	Mix Code	Slump in mm
1	M_0	21
2	$M_{1.5}$	23
3	$M_{3.0}$	24
4	$M_{4.5}$	25

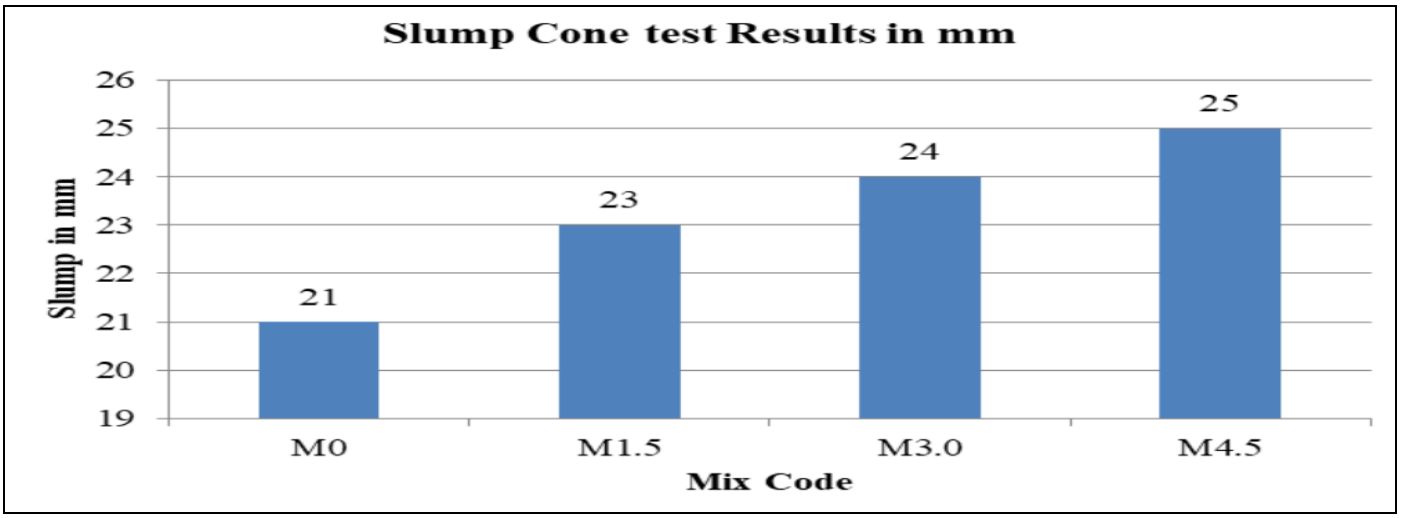

Fig 4 Graph Showing Slump Cone Test Results

The slump results for all the mixes are shown in figure 3. The highest slump value obtained is 25 mm for M4.5 mix and lower slump value is obtained is 21 mm for M0 mix. It was observed that as the replacement percentage of SCBF increases the slump value also increases which indicates the increased percentage of SCBF causes low workability compared to conventional mix.

➢ *Compressive Strength Test*

Table 7 Results of Compressive Strength Test

Sl. No.	Mix Code	Compressive strength in N/mm^2		
		7 days	14 days	28 days
1	M0	16.88	19.11	28.44
2	M1.5	13.77	17.77	30.22
3	M3.0	12.44	16	21.33
4	M4.5	9.77	14.66	20.88

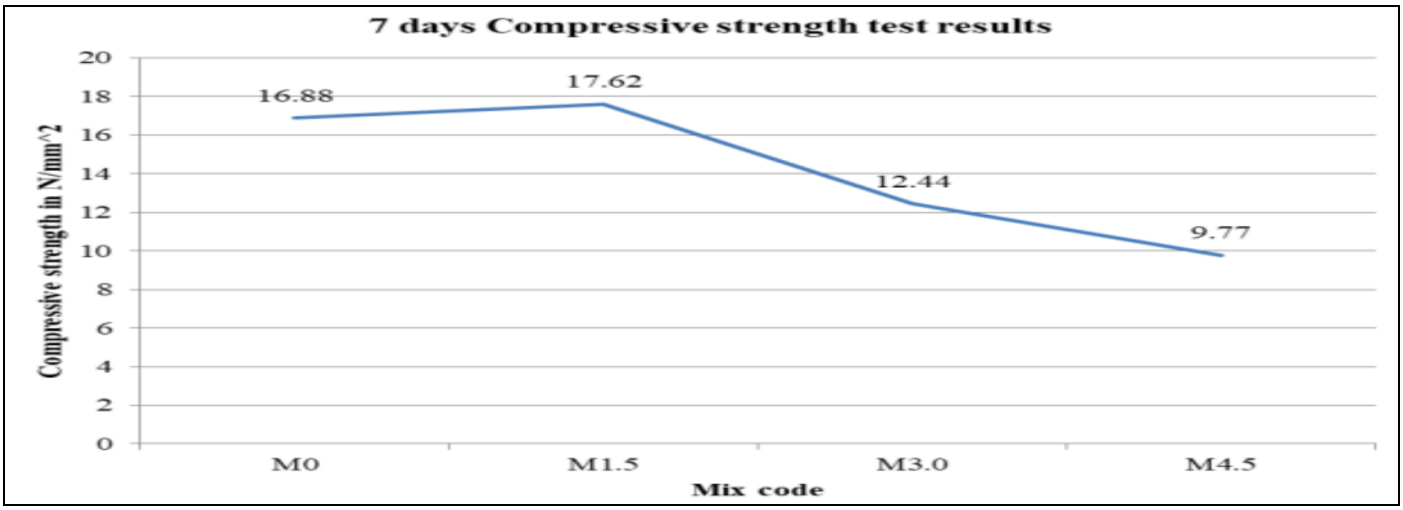

Fig 5 Graphical Results of 7 Days Compressive Strength Test.

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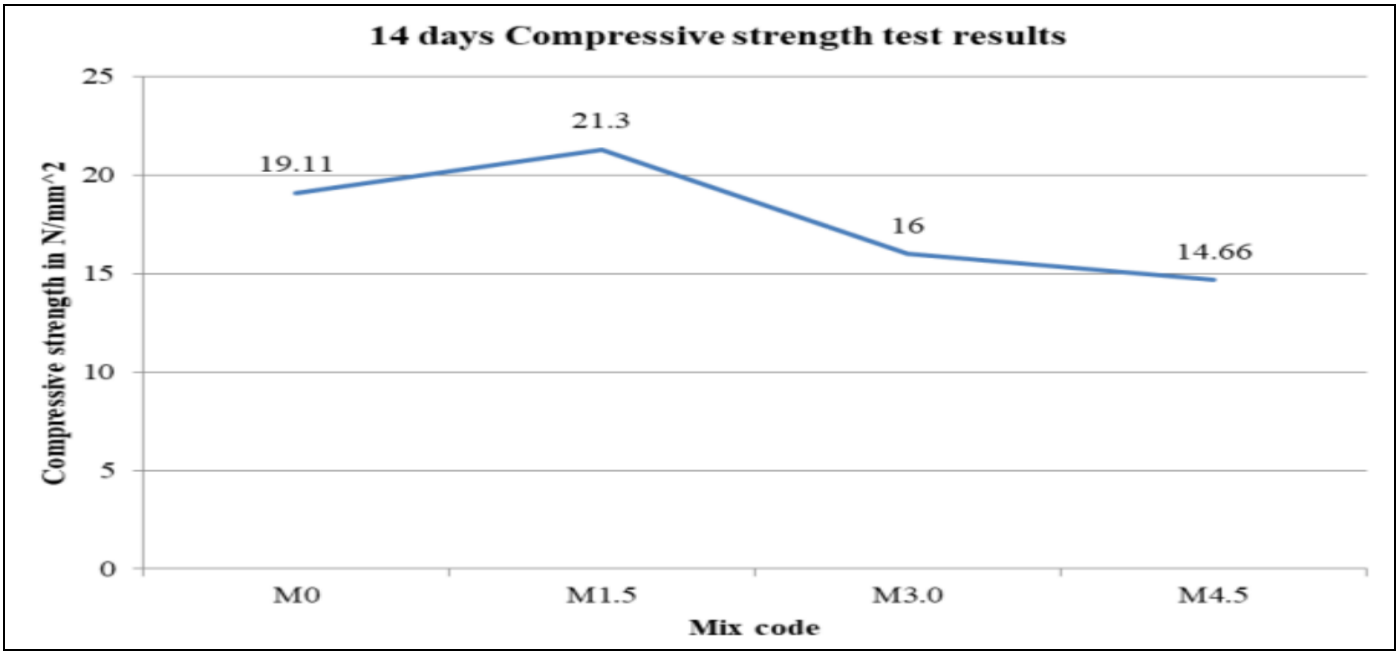

Fig 6 Graphical Results of 14 Days Compressive Strength Test.

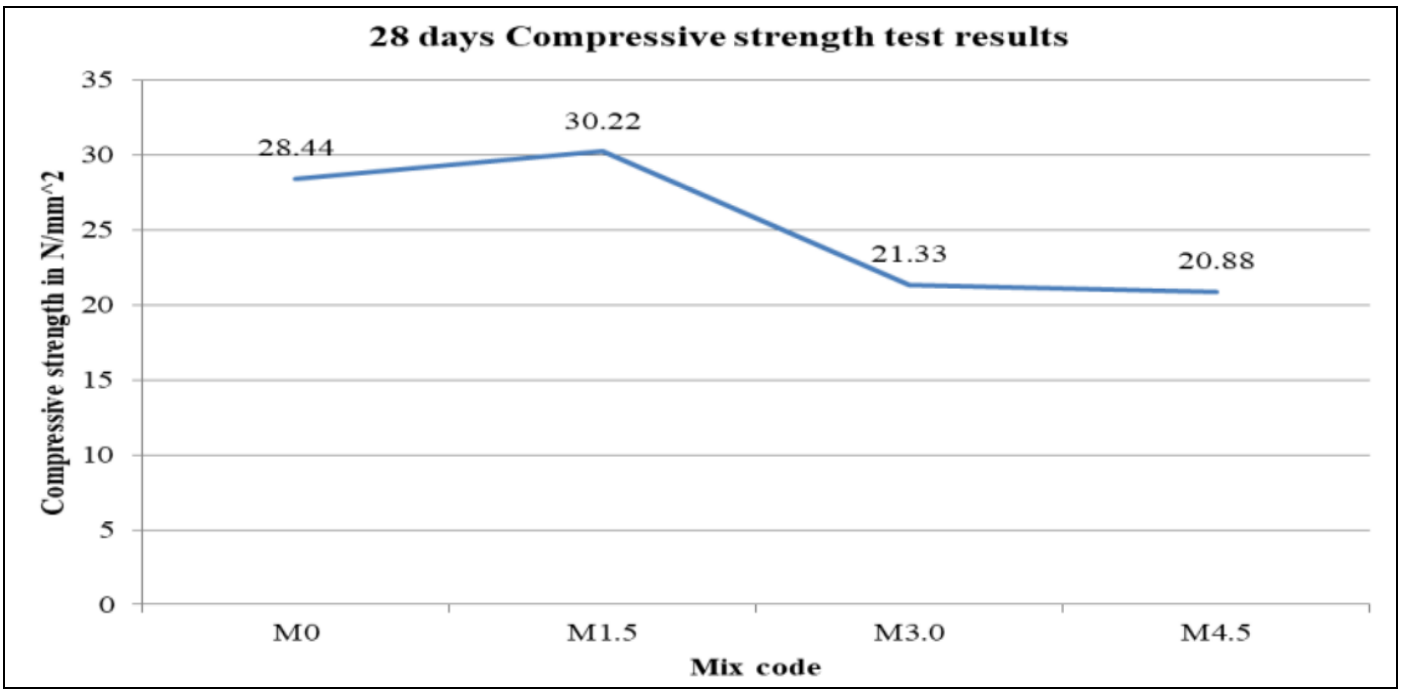

Fig 7 Graphical Results of 28 Days Compressive Strength Test

The table VII and figure 4, 5 & 6 provides the results of compressive strength of 7, 14 and 28 days for all the mix combinations. It is observed that with the SCBF replacement of 1.5% the compressive strength was found to be maximum in all three curing periods. Comparing to the conventional mix the mix with 1.5% SCBF has 5.89% more strength after curing for 28 days. For the M3.0 and M4.5 the strength started to decrease with the increased replacement percentage.

- *Density Test*

Table 8 Results of Concrete Density

Sl. No.	Mix Code	Weight in Kg	Volume in m^3	Density in Kg/m^3
1	M0	8479	0.00375	2261.07
2	M1.5	8462	0.00375	2256.53
3	M3.0	8380	0.00375	2234.67
4	M4.5	8141	0.00375	2170.93

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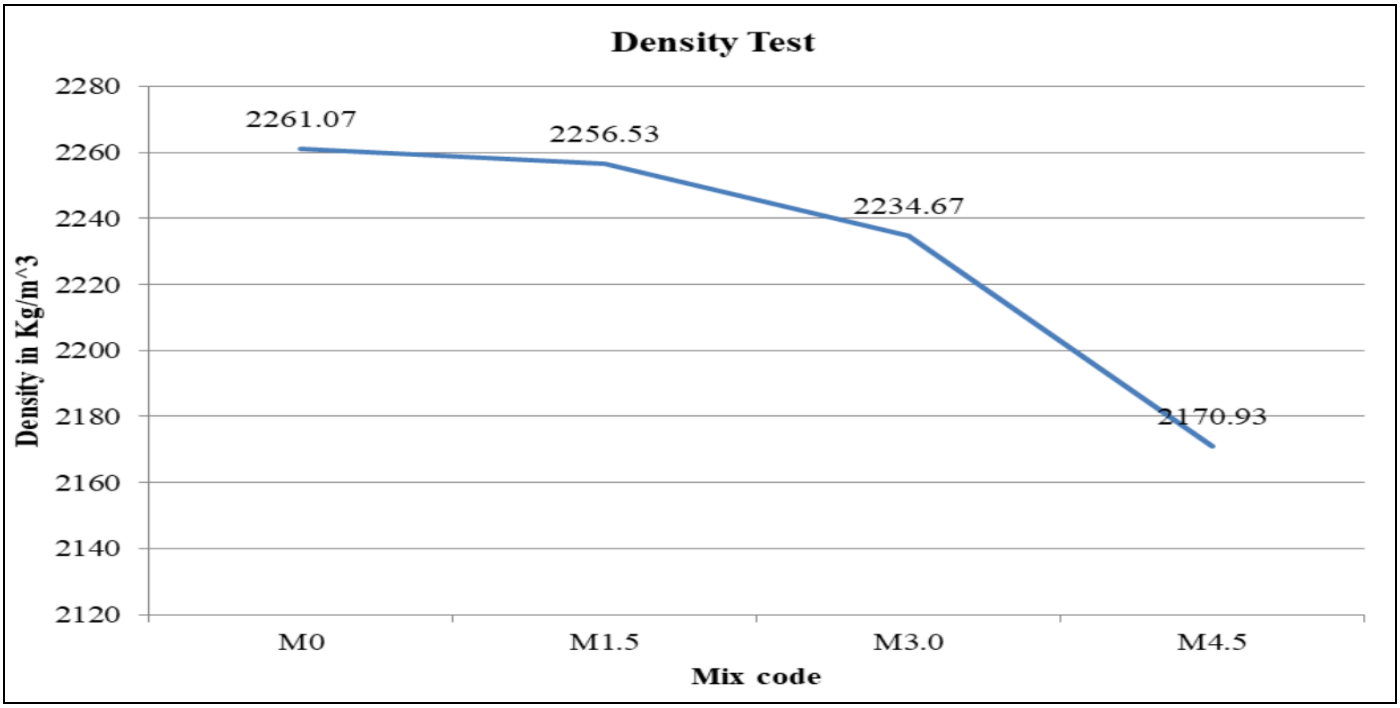

Fig 8 Graphical results of density of concrete after 28 days of curing

The density of the concrete was found to be decreasing as the SCBF replacement percentage increases which indicates higher the SCBF density of the concrete decreases and can be concluded as light weight concrete.

VIII. CONCLUSIONS

- The investigation showed that the workability of the concrete decreases as the replacement % increases.
- The study shows that while increasing the percentage of SCBF replacement tends to reduce the compressive strength of M25 concrete, up to 1.5% replacement by weight is acceptable.
- At 1.5% replacement, the compressive strength remains within acceptable limits, providing a balance between maintaining the concrete's mechanical performance
- As the percentage of sugarcane bagasse fiber replacement increases, the density of the concrete decreases. The decrease in density leads to a reduction in the weight of the concrete.

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