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Sustainable Production of Concrete Using Steel Fiber and Fly Ash:Mechanical Parameters

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A B S T R A C T

Concrete in construction is a structural material composed of hard, chemically inert particulate matter known as aggregate (usually sand and gravel) bound together by cement and water. Concrete is highly compressible but weak in tensile strength, so new technologies have been introduced, such as the use of steel fibers (SF) in concrete to strengthen the tensile areas. When the steel fiber content increases from 1% to 2%, the compressive strength, splitting strength, flexural strength, bending toughness, surface hardness and wear resistance of concrete are improved, and the water absorption and sorption rate are decreased. The amount of fly ash produced by thermal power plants in India is approximately 80 million tonnes per year. The use of fly ash in concrete has been shown to adversely affect initial strength properties. One way to compensate for the premature loss of strength associated with the use of fly ash is to incorporate steel fibers. It has been shown to be very effective in improving the strength properties of concrete. Adding steel fibers to concrete greatly improves structural properties such as static bending strength, impact resistance, tensile strength, ductility and bending toughness.

In the current study, 20%, 40% and 60% of the cement are replaced with FLYASH and a constant SF of 1.5% is added to the total volume of concrete. Freshness, mechanical and durability parameters of modified concrete are investigated to determine the combined effect of SF and Fly ash.

Keywords: Concrete, steel fiber, fly ash and compressive strength

1. INTRODUCTION

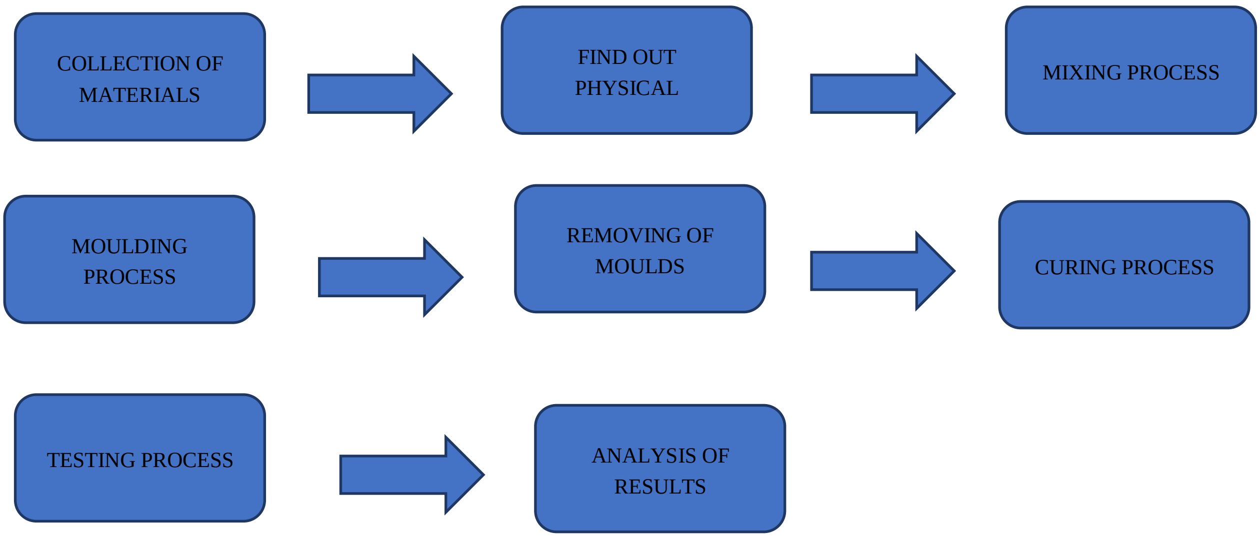
The world that was just left at the end of the 20th century was very different from the world that people inherited at the beginning of this century. The second half of the last century has seen unprecedented technological change and innovation in science and technology, and in the diversity and use of materials in the fields of communications, medicine, transportation and information technology. The construction industry is no exception to these changes, given the exciting achievements in the design and construction of monuments such as buildings, bridges, offshore structures, dams and the English Channel. Tunnel and Millennium Wheel. These dramatic changes in the world's science, technology and industry have undoubtedly brought great social benefits in terms of wealth, prosperity and leisure, at least for the people of the world's developed countries. However, the evolutionary process of this industrial and information technology age, especially in the last 40 to 50 years, has included unprecedented social change, unpredictable cataclysms in the global economy, uncompromising social attitudes, Unacceptable levels of pollution and damage to us continued. natural environment. Globally speaking, the social and social changes that have taken place can be categorized into technological revolutions, population growth, global urbanization, and uncontrolled pollution and waste generation.

2. LITERATURE REVIEW

- Savita, Shwetha(2018) an experimental investigation was carried out with steel fiber reinforced concrete.in this investigation, the fiber is randomly oriented and range from 0.1% to 0.4% at 0.1% interval by weight of cement. The test results show that maximum compressive strength was obtained at.0.3% of fiber at 3and 7days and at 0.2% of fibers at 28days the maximum split tensile strength and flexural strength are found to be at 0.2% of fiber for 7 and 28 days workability decreases with partial replacement of cement by fly ash with the additionalof steel fibers.
- Flexural strength increased with the increase of curing period for all fiber contents and pond ash contents
- B.R. Phanikumar (2015) This paper is based upon an experimental study on engeering properties of pond ash provided concrete reinforced with steel fibers. Pond ash content was varied as 0%, 10%, 20%, and 30% by weight of cement.Grooved steel fibers were varied 0%,0.5%,1% and 2%by volume of Concrete.finally, it was observed that compressive strength split tensile strength

- C.M arthonget.al(2012)used all 33,43 and 53 grades of OPC and replaced it with fly ash by the percentage of 10% , 20% , 30% , and 40 . The final results showed that the strength of concrentereduced as the fly ash contents increases in OPC. Fly ash concrete was more durable as compared to OPC concrete.

3. METHODOLOGY



4. MATERIAL PROPERTIES

4.1 – MATERIALS

The following section discuss consistent materials used for manufacturing M30 grade of concrete physical and chemical properties of the consistent materials at presented in this section.

4.2 – CEMENT

The cement used in this experimental work is 53 Grades Ordinary Portland cement. All

properties of cement are tested by referring IS 12269-1987 specification for 43 Grade Ordinary

Portland cement

TABLE: properties of 53 grade Cement

S . NO	PPHYSICAL PROPERTIES	RESULTS	IS SPECIFICATIONS
1	Fineness of cement	7%	IS 4031
2	Specific gravity of cement	3.10	IS 4031
3	Normal consistency	30%	IS 4031
4	Initial setting time (minutes)	30	IS 4031

4.3 – Fine aggregate

In this study used River sand confirming to zone II fine aggregate. The physical properties of fine aggregate are shown in Table

TABLE: Physical properties of fine aggregate

S. NO	PROPERTIES	VALUE	IS SPECIFICATIONS
1	Specific gravity	2.45	IS 383 - 1970
2	Bulk density	2630 kg/m^3	IS 383 - 1970
3	Fineness modulus	3.53	IS 383 - 1970
4	Bulking of sand	11.11%	IS 383 - 1970

4.5 – Coarse aggregates

Crushed granite stone of size 20mm and 10mm used as coarse aggregates(IS 383:1970). The physical properties of coarse aggregates as shown in table

TABLE: Physical properties of coarse aggregates

S. NO	PROPERTIES	VALUE	IS SPECIFICATIONS
1	Specific gravity	2.53	IS 238 - 1963
2	Fineness modulus	4.15	IS 238 - 1963
3	Nominal maximum size	20mm	IS 238 - 1963

4.6-WATER

Potable water used for prepare the mixture

4.7- STEEL FIBER

Steel fiber with hook end made from high quality low carbon steel wire with characteristics

High tensile strength, good toughness and low price are used in concrete reinforcement.

The content of steel fibers was 0.5% to 2% of the total volume.concrete. The length of the steel fiber to be split is 15 - 40 mm, and the diameter of the steel fiber is0.3 – 0.6mm.

TABLE : Technical specification of steel fiber

Name	Steel fiber
Length of steel fiber	15-40mm
Diameter	0.3-0.6mm
Aspect ratio	30-60

4.8 – FLY ASH

Fly ash is one of the residues from burning coal and charcoal.

It consists of fine particles that rise with the smoke gases. Ashes that do not rise up are called ashes

Bottom ash. Fly ash usually refers to the ash produced when coal is burned. fly ash is

It is generally captured by electrostatic precipitators or other particle filtration devices.

Flue gas enters the chimney of a coal-fired power plant and is discharged with bottom ash

The ash from the bottom of the furnace in this case is commonly called coal ash.

TABLE: Fly ash

1	Silicon dioxide	62.12%
	Aluminium oxide	21.30%
	Iron oxide	5.55%
	Titanium oxide	1.38%
	Magnesium oxide	1.58%
	Calcium oxide	0.53%
	Potassium oxide	4.24%
	Loi	3.30%

5. TEST METHODS

5.1 – SLUMP TEST

This is a test that is widely used in field work throughout the job. Although described in ACI 116R-90 as a measure of consistency, the slump test does not measure the workability of concrete, but rather detects changes in the homogeneity of mixes of specific nominal ratios. very useful for Slump testing is specified in IS: 456 (2000), ASTM C 143 90A and BS 1881 Part 102:1983. The slump test geometry is a truncated cone with a height of 300 mm (12 inches). Lay it on a smooth surface with the smaller opening facing up and fill the concrete in three layers. Each layer is hammered 25 times with a standard 16 mm (5 inch) diameter steel bar to round off the edges. The upper surface is facilitated by handles or footrests attached to the soldered shape. Immediately after filling, the cone slowly lifts and the cantilever concrete sag, hence the name of this test. The reduction in height of slumped concrete is called slump and is measured to within 5 mm (1/4 inch). Reduction is measured to the highest point according to IS: 456-2000 b5 1881: Part 102: 1983, but to the original center displaced according to ASTM 143-90a. To reduce the effect of surface friction changes on slump, wet the inside of the mold and its bottom at the start of each test, and clean the area immediately around the bottom of the cone of accidentally dropped concrete before lifting the mold. is needed. Instead of slumping evenly every round like a real ghetto character does, one of the cones slides down the slope and is considered a shear slump and the test must be repeated. Persistent shear collapse, as is the case with hard compounds

5.2 – COMPRESSION TEST

Compressive strength of concrete is one of the most important properties of concrete in most construction applications. The main purpose of concrete is to withstand compressive stress.

In the study, conventional concrete rice husk ash (RHA), sugarcane bagasse ash (SBA) A 150mm x 150mm x 150mm composite concrete cube was used for compressive strength testing. The cubes are tested on a compression tester with a capacity of 2000 kn. The load was applied at a speed of 315 kn/mm. The load is applied so that his two opposite sides of the cube are pressed against each other.

5.3- TENSILE STRENGTH

Split tensile strength (STS) tests were performed on samples of all blends after 28 days of curing. Three150mm x 300mm cylindrical samples were sorted and tested by age and compound. The load was applied gradually until failure.

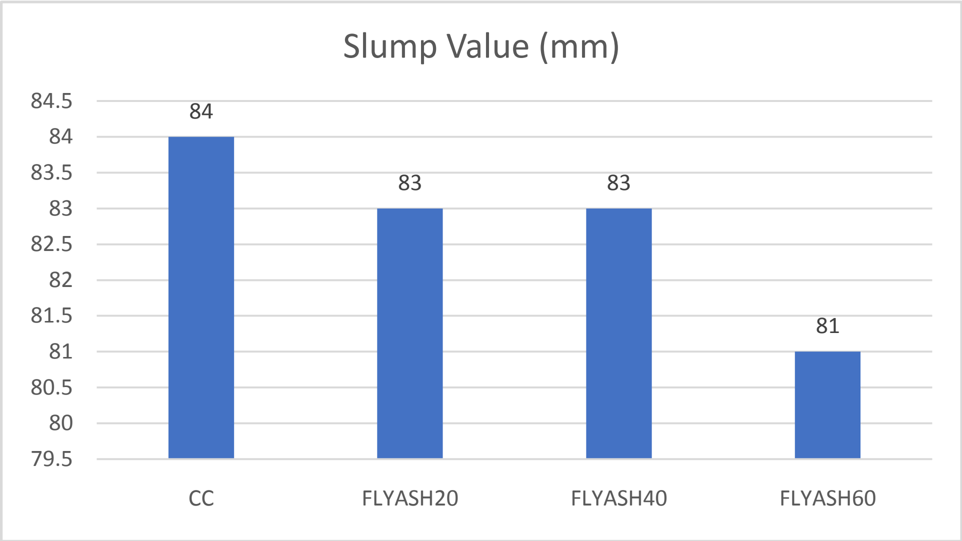
Cement is formed. Then we recorded the maximum load. The length and cross-section of the sample were measured. Cleavage strength(fct) was calculated as: 150mm x 300mm cylindrical samples were cats and tested by age and mix. BurdenedGradually until the cement breaks. Then we recorded the maximum load. The length and cross-section of the sample were measured.

6. RESULTS

SLUMP CONE TEST:

This section describes the slump test of concrete mixes. Slump test results of all mixes are tabulated

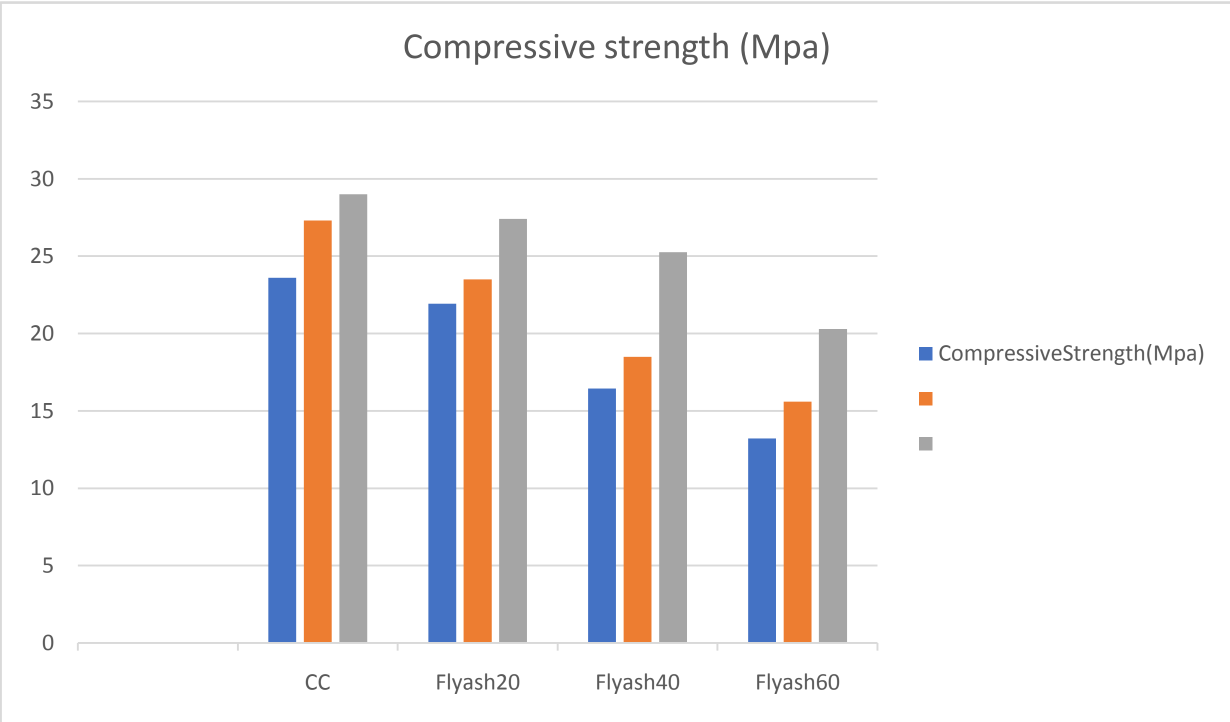
Mixno.	**SlumpValue(mm)**
	84
	83
FLYASH40	83
FLYASH60	81



COMPRESSION TEST :

The above results were obtained by testing 150 mm cubic specimens in a Compression Tester (CTM) and showed a decrease in strength with each replacement rate compared to the control concrete and a higher percentage of replacement fly ash. A decrease in intensity is observed with each increase. concrete. Maximum results were obtained with 20% replacement and minimum results with 60% replacement. Everyone knows why compressive strength is the first and most important test performance anywhere in the world because concrete is compressible and tensile.

Mix.	**CompressiveStrength(Mpa)**		
	7days	**14days**	**28days**
CC	23.6	27.3	29
Flyash20	21.92	23.5	27.4
Flyash40	16.44	18.5	25.26
Flyash60	13.22	15.6	20.3

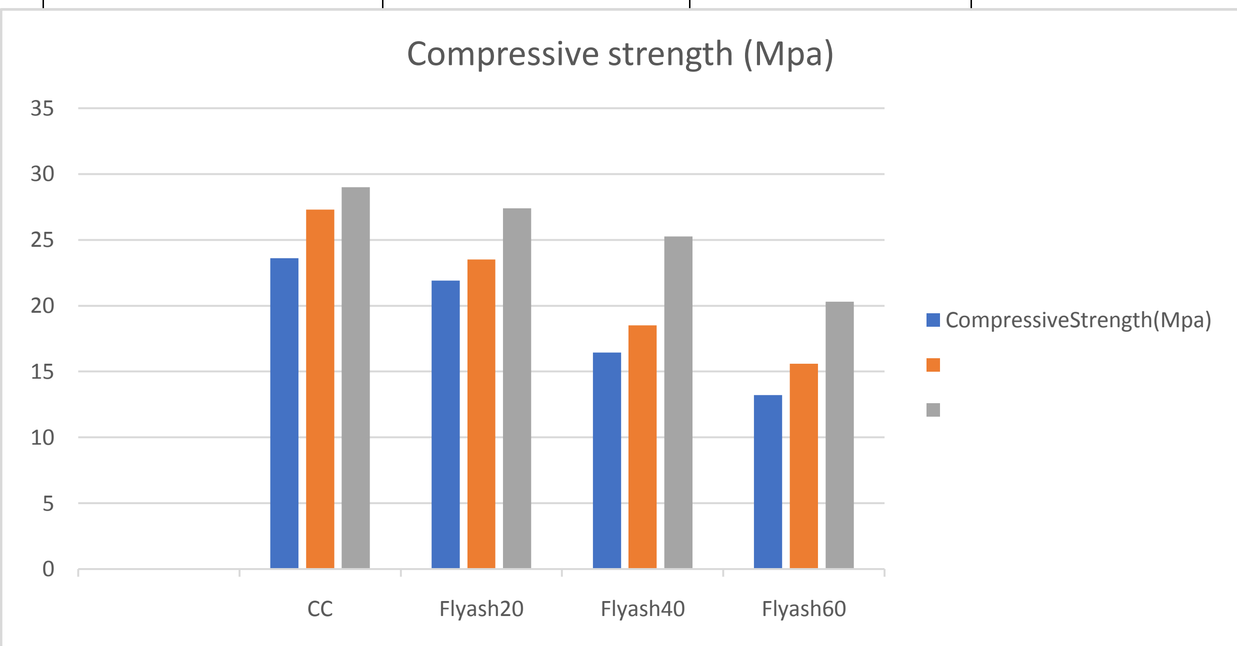


SPLITTENSILESTRENGTH:

Cylinder splitting strength is measured with a compression tester. Results compared to control concrete show minimum strength at 20% fly ash replacement and maximum strength at 40% fly ash at 28 days.

MIX	14 DAYS	28 DAYS

7.



CONCLUSION

Replacing cement with fly ash (20%) and adding 1.5% steel fiber increases compressive strength. Further addition of steel fibers above 1% will reduce the compressive strength. Adding 1% steel fiber increases the tensile strength, while using more than 1% steel fiber decreases the compressive strength. Based on the compressive and tensile strengths, it can be concluded that the optimum proportion of steel fibers to be added to the concrete mix is 1.5% by volume. Based on the research and analysis carried out on the sustainable production of concrete using steel fibers and fly ash, this approach has several advantages both in terms of environmental sustainability and load-bearing capacity. can conclude. First, the incorporation of steel fibers and fly ash into concrete mixes can significantly reduce cement usage, reducing carbon emissions from cement production. Additionally, fly ash is a by-product of coal combustion and can be used as a substitute for cement, reducing waste and landfill usage. Additionally, the addition of steel fibers increases the concrete's tensile strength and ductility, making it more resistant to cracking and improving its overall durability. This also extends the life of structures and reduces the need for maintenance and repairs. Overall, the use of steel fibers and fly ash in concrete production could lead to a more sustainable and long-lasting construction industry. However, further research and development work is required to optimize the mix design and ensure consistent quality and performance of the resulting concrete.

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