EXPERIMENTAL AND COMPARATIVE STUDY OF SELF COMPACTING CONCRETE USING BAGASSE ASH AND POLYPROPYLENE FIBRES

Vishal.R (PG Student)
Department of Civil Engineering
MNM Jain Engineering College
Thoraipakkam, Chennai 60097

Mr. M. N. Dinesh (Guide)
Department of Civil Engineering
MNM Jain Engineering College
Thoraipakkam, Chennai 60097

Abstract— **The purpose of the experimental investigation is to evaluate the flexural and mechanical behavior of self-compacting concrete with partial replacement of bagasse ash and polypropylene fibres. The percentage of bagasse ash is taken as 10% and varying percentage of polypropylene fibres from 0.1%, 0.2%, and 0.3% to the total volume of cement are chosen and blended with cement respectively. Conventional self-compacting concrete beam is casted. Bagasse ash and polypropylene fiber partially blended with cement beam is also casted. Both are tested for flow parameters, compressive strength and indirect tensile strength. The compressive strength and flexural strength test results of self-compacting concrete with partial replacement of bagasse ash and polypropylene fibre blended with cement are compared with conventional self-compacting concrete specimens and the results are evaluated.**

Keywords— **Polypropylene Fiber, Bagasse Ash, Self-Compacting Concrete.**

I. INTRODUCTION

A. General

The development of Self compacting concrete (SCC) is considered as a milestone achievement in concrete technology due to several advantages. High performance of both fresh and hardened concrete like high flowing ability and segregation resistance, low porosity, durability and high strength. SCC is a special concrete that provides excellent flowing ability in fresh stage. SCC is considered as a concrete which can be placed and compacted under its self-weight with little or no vibration effort. SCC also has the ability to flow through the congested reinforcement and uniformly filling the formwork and achieving good compaction.

The hardened concrete thus obtained is dense and homogeneous and has similar properties as that of conventional concrete. The main advantage of using SCC is that it offers high homogeneity, fluidity and less segregation, minimal concrete voids and uniform concrete strength. Since low cement ratio is adopted it is possible to achieve early strength, quicker remoulding and faster use of elements and structures.

The impact due to the use of vibrators is eliminated by the use of SCC in construction. Compaction of SCC is carried out in all parts of the formwork, including the hardly accessible parts, without any additional external force and no gravitational force that is as a result of self-weight of concrete. The filling ability and stability of SCC in the fresh state can be defined by four key characteristics: passing ability, flow ability, segregation resistance and viscosity. Such properties are achieved by addition of chemical additives to the concrete such as super plasticizers.

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregate and water only, but has become an engineered custom tailored material which several new constituents to meet the specific need of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability.

The elimination of vibrating equipment improves the environment on and near construction and precast sites where concrete is being placed, reducing the exposure of workers to noise and vibration. The improved construction practice and performance, combined with the health and safety benefits, make SCC a very attractive solution for both precast concrete and civil engineering construction.

Sustainability and long term performance of concrete structures are the two important criteria with respect to the prevailing environmental conditions. Sustainability cannot be sacrificed to attain high strength. High ultimate strength is generally accompanied by a low W/C ratio. Good quality fine particles of waste materials or by-products particularly mineral admixtures and super plasticizer make the cement concrete sustainable with improved long term performance because of least permeability and very slow chemical reaction with harmful compounds present in the concrete.

B. Bagasse Ash

Sugarcane bagasse ash is a by-product of sugar factories found after burning sugarcane bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this material is already causing environmental problems around the sugar factories. On the other hand, the boost in construction activities in the country created shortage in most of concrete making materials especially cement, resulting in an increase in price. This study examined the potential use of sugarcane bagasse ash as a partial cement replacement material. Its chemical properties were investigated. The bagasse ash was then ground until the particles passing the 63μm sieve size reach about 85% and the specific surface area about 4716 cm^2/gm. Ordinary Portland cement and Portland Pozzolana cement were replaced by ground bagasse ash at different percentage ratios. Normal consistency and setting time of the pastes containing the compressive strengths of different mortars with bagasse ash addition were also investigated. The test results indicated that up to 20% replacement of cement by bagasse ash results in

better or similar concrete properties and further environmental and economic advantages can also be exploited by using bagasse ash as a partial cement replacement material.

Fig. 1. Bagasse Ash

C. Polypropylene Fibre

Due to enhance performances and effective cost-benefit ratio, the use of polypropylene fibres is often recommended for concrete structures recently. PFRC is reduces the rebound effect in sprayed concrete applications by increasing cohesiveness of wet concrete. Being wholly synthetic there is no corrosion risk. PFRC shows improved impact resistance as compared to conventionally reinforced brittle concrete. The use of PFRC provides a safer working environment and improves abrasion resistance in concrete floors by controlling the bleeding while the concrete is in plastic stage. The possibility of increased tensile strength and impact resistance offers potential reductions in the weight and thickness of structural components and should also reduce the damage resulting from shipping and handling.

Polypropylene fibres help reduce shrinkage and control cracking. To use these fibres, concrete mix design does not have to be altered, and no special equipment or slump modifications are required, even for pumping or shotcreting.

Polypropylene fibres are manufactured in small bundles. During the mixing operation, the movement of aggregate shears these bundles into smaller bundles and individual fibres. Longer fibres can be used when larger aggregates are present to shear the bundles of fibre apart. Short fibres are used with small or lightweight aggregate.

Fig. 2. Polypropylene Fibre

II. LITERATURE REVIEW

Partial replacement of cement content in SCC may substantially improve the general properties of concrete. These are some of the literatures focusing on the performance of SCC by the replacement of cement with like Bagasse ash and other agricultural waste and addition of polypropylene fibre in concrete.

A. Overview Of The Literature

Lachemib(2000),The self-Compacting mixtures had a cement replacement of 40%, 50%, and 60% by Class F fly ash. Tests were carried out on all mixtures to obtain the properties of fresh concrete in terms of viscosity and stability. The mechanical properties of hardened concretes such as compressive strength and drying shrinkage were also determined.

Mizra(1996),A comprehensive set of experimental data were generated regarding the effects of collated fibrillated polypropylene fibers at relatively low volume fractions (below 03%) on the compressive, flexural and impact properties of concrete materials with different binder compositions. Statistical analysis of results produced reliable conclusions on the mechanical properties of polypropylene fiber reinforced concrete, and also on the interaction of fibers and pozzolanic admixtures in deciding these properties.

Rishi Gupta(2006), Plastic shrinkage cracking remains a primary concern for placements with high surface/volume ratios that are subjected to early age drying. Polypropylene fiber reinforcement controls such cracking, but the exact influence of fiber diameter, length and geometry remains unknown. A test program was carried out to understand the influence of these variables. Four commercially available polypropylene fibers were investigated at dosage rates varying from 0.1% to 0.3%. A recently developed technique of shrinkage testing using a finally bonded overlay was employed. In this technique, a fiber reinforced concrete overlay is cast on a fully matured subbase with protuberances and the whole assembly is allowed to dry in an environmental chamber.

Radix(2005), This paper addresses experiments and theories on Self-Compacting Concrete. First the features of Japanese and Chinese Methods are discussed, in which the packing of sand and gravel plays a major role. Here, the grading and packing of all solids in the concrete mix serves as a basis for the development of new concrete mixes. Mixes, consisting of blended cement, gravel (4716 mm), three types of sand (071, 072 and 074 mm) and a polycarboxylic ether type superplasticizer, were developed. These mixes are extensively tested, both in fresh and hardened states, and meet all practical and technical requirements such as medium strength and low cost. It follows that the particle size distribution of all solids in the mix should follow the grading line as presented Furthermore, the packing behavior of the powders (cement, fly ash, stone powder) and aggregates (three sands and gravel) used are analysed in detail. It follows that their loosely piled void fraction are reduced to the same extent (23%) upon vibration (aggregates) or mixing with water (powders).

Nuntachai Chusilp(2008), The physical properties of concrete containing ground bagasse ash (BA) including compressive strength, water permeability, and heat evolution, were investigated. Bagasse ash from a factory was ground using a ball mill until the particles retained on a No. 325 sieve were less than 5wt%. They were then used as a replacement for Type 1 Portland cement at 10, 20, and 30wt% of binder. The water to binder (W/B) ratio and binder content of the concrete were held constant at 0.50 and 3501(g/m^3) respectively. The results showed that, at the age of 28 days, the concrete samples containing 10to30% ground bagasse ash by weight of binder had greater compressive strengths than the control concrete(concrete without ground bagasse ash), while the water permeability was lower than the concrete.

El-Dieb(2011), Self-compacting concrete (SCC) possesses exceptional flowability characteristics in its fresh state. While fibers are specified for their ability to limit concrete shrinkage cracks at early age and to enhance some of the concrete properties, inclusion of such fibers is expected to affect the flowability characteristics of SCC. This study investigates how the inclusion of fibrillated polypropylene fibers with different fiber content and the inclusion of steel fiber types with different aspect ratio and volume content affect the flowability of SCC. The flow characteristics were assessed by considering the slump flow test, V-funnel test and filling box test. It was found that it is quite possible to achieve selfcompacting properties while using fiber reinforcement. While the mix composition and fiber type can greatly influence concrete flowability, there exists a maximum fiber content that could be used to produce fiber reinforced self-compacting concrete (FR-SCC). Moreover, our observations were used to develop a new acceptance criterion for FR-SCC.

Machine Hsie (2008), this paper investigates the mechanical properties of polypropylene hybrid fiber-reinforced concrete. There are two forms of polypropylene fibers including coarse monofilament, and staple fibers. The content of the former is at 3 kg/m^3, 6 kg/m^3, and 9 kg/m^3, and the content of the latter is at 0.6 kg/m^3. The experimental results show that the compressive strength, splitting tensile strength, and flexural properties of the polypropylene hybrid fiber-reinforced concrete are better than the properties of single fiber-reinforced concrete. These two forms of fibers work complementarily. The staple fibers have good fineness and dispersion so they can restrain the cracks in primary stage. The monofilament fibers have high elastic modulus and stiffness. When the monofilament fiber content is high enough, it is similar to the function of steel fiber. Therefore, they can take more stress during destruction. In addition, hybrid fibers disperse throughout concrete, and they are bond with mixture well, so the polypropylene hybrid fiber-reinforced concrete can effectively decrease drying shrinkage strain.

Nan Su(2015),this paper proposes a new mix design method for self-compacting concrete (SCC). First, the amount of aggregates required is determined, and the paste of binders is then filled into the voids of aggregates to ensure that the concrete thus obtained has flow ability, self-compacting ability and other desired SCC properties. The amount of aggregates, binders and mixing water, as well as type and dosage of super plasticizer (SP) to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, Lflow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicate that the proposed method could produce successfully SCC of high quality. Compared to the method developed by the Japanese Ready-Mixed Concrete Association (JRMCA), this method is simpler, easier for implementation and less time-consuming, requires a smaller amount of binders and saves cost.

Okan Karahan (2011), this paper reports of a comprehensive study on the durability properties of concrete containing polypropylene fiber and fly ash. Properties studied include unit weight and workability of fresh concrete, and compressive strength, modulus of elasticity, porosity, water absorption, sorptivity coefficient, drying shrinkage and freeze–thaw resistance of hardened concrete. Fly ash content used in concrete mixture was 0%, 15% and 30% in mass basis, and fiber volume fraction was 0%, 0.05%, 0.10% and 0.20% in volume basis. The laboratory results showed that inclusion of fly ash improves; however, polypropylene fiber decreases the workability of concrete. Moreover, polypropylene fiber addition, either into Portland cement concrete or fly ash concrete, did not improve the compressive strength and elastic modulus. The positive interactions between polypropylene fibers and fly ash lead to the lowest drying shrinkage of fibrous concrete with fly ash. Freeze–thaw resistance of polypropylene fiber concrete was found to slightly increase when compared to concrete without fibers. Moreover, fly ash increased the freeze–thaw resistance more than the polypropylene fibers did.

Mazaheripour (2011), this paper evaluates the LECA Lightweight Self-Compacting Concrete (LLSCC) manufactured by Nan-Su, of which the Packing Factor (PF) of its design mixing method has been modified and improved. The study analyzes the impact of polypropylene fibers on LLSCC performance at its fresh condition as well as its mechanical properties at the hardened condition. The evaluation of Fiber Reinforced LLSCC (FR-LLSCC) fluidity has been conducted per the standard of second class rating of JSCE, by three categories of flow ability, segregation resistance ability and filling ability of fresh concrete. For the mechanical properties of LLSCC, the study has been conducted as follows: compressive strength with elapsed age, splitting tensile strength, elastic modulus and flexural strength, all of which were measured after the sample being cured for 28 days. When self-compacting concretes were lightened to 75% of their normal weight, their fresh properties are affected immensely. Applying 0.3% volume fractions of polypropylene fiber to the LLSCC resulted in 40% reduction in the slump flow (from 720 mm to 430 mm). In general, the rate of slump flow over Super Plasticizer (SP) volume percentage reduced with the use of polypropylene fibers in the FR-LLSC. Polypropylene fibers did not influence the compressive strength and elastic modulus of LLSCC, however applying these fibers at their maximum percentage volume determined through this study, increased the tensile strength by 14.4% in the splitting tensile strength test, and 10.7% in the flexural strength.

Elias Molaei Raisi (2018), Self-compacting concrete (SCC) is a highly-workable concrete that fills the formwork under its own weight without needing vibration. The application of byproducts or waste materials as cement substitutes in SCC can enhance its mechanical performance. Rice husk ash (RHA) is one of the highly reactive byproducts. The pozzolanic performance of RHA due to high silica content makes it a suitable supplementary cementitious material for being used in SCC. In this paper, mechanical behavior of SCC was studied by 240 hardened concrete specimens with different variables i.e. partial replacement of cement with RHA (0%, 5%, 10%, 15% and 20%), concrete aged (3, 7, 28, 90, 180, and 270 days), and water to binder ratio (0.38, 0.44, 0.50, 0.56, 0.62, and 0.68). Fresh concrete properties were measured by V-funnel flow time, L-box, and slump flow diameter and time tests. Mechanical properties were determined in terms of compressive strength, modulus of elasticity, splitting tensile strength, and compressive stress-strain relationship tests. The test results showed that the workability of SCC containing RHA is decreased by increasing the RHA replacement ratio. On the contrary, compressive strength, modulus of elasticity, and splitting tensile strength increase with increasing the percentage of RHA up to 5% replacement.

N.B. Singh (2000), Hydration of bagasse ash (BA) -blended Portland cement has been studied by employing a number of experimental techniques. It is found that in presence of BA setting times are increased and free lime is decreased. The compressive strength values increased with hydration time in the presence of BA and the values were found to be higher than that of control. The blended cement was found to be more resistant in an aggressive environment.

Song (2004), The strength potential of nylon-fiber-reinforced concrete was investigated versus that of the polypropylene-fiber-reinforced concrete, at a fiber content of 0.6 kg/m^3. The compressive and splitting tensile strengths and modulus of rupture (MOR) of the nylon fiber concrete improved by 6.3%, 6.7%, and 4.3%, respectively, over those of the polypropylene fiber concrete. On the impact resistance, the first-crack and failure strengths and the percentage increase in the post first-crack blows improved more for the nylon fiber concrete than for its polypropylene counterpart. In addition, the shrinkage crack reduction potential also improved more for the nylon-fiber-reinforced mortar. The above-listed improvements stemmed from the nylon fibers registering a higher tensile strength and possibly due to its better distribution in concrete.

Uysal (2012), in this study, an artificial neural network model for compressive strength of self-compacting concretes (SCCs) containing mineral additives and polypropylene (PP) fiber exposed to elevated temperature were devised. Portland cement (PC) was replaced with mineral additives such as fly ash (FA), granulated blast furnace slag (GBFS), zeolite (Z), limestone powder (LP), basalt powder (BP) and marble powder (MP) in various proportioning rates with and without PP fibers. SCC mixtures were prepared with water to powder ratio of 0.33 and polypropylene fibers content was 2 kg/m3 for the mixtures containing polypropylene fibers. Specimens were heated up to elevated temperatures (200, 400, 600 and 800 C) at the age of 56 days. Then, tests were conducted to determine loss in compressive strength. The results showed that a severe strength loss was observed for all of the concretes after exposure to 600 C, particularly the concretes containing polypropylene fibers though they reduce and eliminate the risk of the explosive spalling. Furthermore, based on the experimental results, an artificial neural network (ANN) model-based explicit formulation was proposed to predict the loss in compressive strength of SCC which is expressed in terms of amount of cement, amount of mineral additives, amount of aggregates, heating degree and with or without PP fibers. Besides, it was found that the empirical model developed by using ANN seemed to have a high prediction capability of the loss in compressive strength of self-compacting concrete (SCC) mixtures after being exposed to elevated temperature.

Zhu (2003), Permeation properties, which include permeability, absorption, diffusivity etc., have been widely used to quantify durability characteristics of concrete. This paper presents an experimental study on permeation properties of a range of different self-compacting concrete (SCC) mixes in comparison with those of selected traditional vibrated reference (REF) concretes of the same strength grade. The SCC mixes with characteristic cube strength of 40 and 60 MPa were designed containing either additional powder as filler or containing no filler but using a viscosity agent. The results indicated that the SCC mixes had significantly lower oxygen permeability and sorptivity than the vibrated normal reference concretes of the same strength grades. The chloride diffusivity, however, appeared to be much dependent on the type of filler used; the SCC mixes containing no additional powder but using a viscosity agent were found to have considerably higher.

Cordeiro (2008), Sugar cane bagasse ash (SCBA) is generated as a combustion by-product from boilers of sugar and alcohol factories. Composed mainly of silica, this by-product can be used as a mineral admixture in mortar and concrete. Several studies have shown that the use of SCBA as partial Portland cement replacement can improve some properties of cementations materials. However, it is not yet clear if these improvements are associated to physical or chemical effects. This work investigates the pozzolanic and filler effects of a residual SCBA in mortars. Initially, the influence of particle size of SCBA on the packing density, pozzolanic activity of SCBA and compressive strength of mortars was analyzed. In addition, the behavior of SCBA was compared to that of an insoluble material of the same packing density. The results indicate that SCBA may be classified as a pozzolanic material, but that its activity depends significantly on its particle size and fineness.

Filho (2009), Sugar cane bagasse ash, a byproduct of sugar and alcohol production, is a potential pozzolanic material. However, its effective application in mortar and concrete requires first the controlled use of grinding and classification processes to allow it to achieve the fineness and homogeneity that are required to meet industry standards. The present paper investigates the role of mill type and grinding circuit configuration in grinding in laboratory- and pilot plant-scale on the particle size, specific surface area and pozzolanic activity of the produced ashes. It was observed that, although different size distributions were produced by the different mills and milling configurations, the pozzolanic activity of the ground ash was directly correlated to its fineness, characterized by its 80% passing size or Blaine specific surface area. From a low pozzolanic activity of less than 50% of the as-received ash, values above 100% could be reached after prolonged grinding times. Electric power requirements to reach the minimum pozzolanic activity were estimated to be in the order of 42 kWh/t in an industrial ball mill. Incorporation of an ultra-finely-ground ash in a high-performance concrete in partial replacement of Portland cement (10, 15 and 20% by mass) resulted in no measurable change in mechanical behavior, but improved rheology and resistance to penetration of chloride ions.

Ganesan (2008), the utilization of waste materials in concrete manufacture provides a satisfactory solution to some of the environmental concerns and problems associated with waste management. Agro wastes such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolanic materials for the development of blended cements. Few studies have been reported on the use of bagasse ash (BA) as partial cement replacement material in respect of cement mortars. In this study, the effects of BA content as partial replacement of cement on physical and mechanical properties of hardened concrete are reported. The properties of concrete investigated include compressive strength, splitting tensile strength, water absorption, permeability characteristics, chloride diffusion and resistance to chloride ion penetration. The test results indicate that BA is an effective mineral admixture, with 20% as optimal replacement ratio of cement.

Tayyeb Akram (2015), in this research, the main variables are the proportion of bagasse ash, dosage of super plasticizer for flow ability and water/binder ratio. The parameters kept constant are the amount of cement and water content. Test results substantiate the feasibility to develop low cost self compacting concrete using bagasse ash. In the fresh state of concrete, the different mixes of concrete have slump flow in the range of 333 mm to 815 mm, L-box ratio ranging from 0 to 1 and flow time ranging from 1.8 s to no flow (stucked). Out of twenty five different mixes, five mixes were found to satisfy the requirements suggested by European federation of national trade associations representing producers and applicators of specialist building products (EFNARC) guide for making self compacting concrete. The compressive strengths developed by the self compacting concrete mixes with bagasse ash at 28 days were comparable to the control concrete. Cost analysis showed that the cost of ingredients of specific self compacting concrete mix is 35.63% less than that of control concrete, both having compressive strength above 34MPa. The possibility of developing low cost SCC using bagasse ash is feasible. Low cost SCC can be made, by incorporating some percentage of bagasse ash along with the main ingredients of concrete (cement, fine aggregate and coarse aggregate) and super plasticizer for flow ability.

Gencel (2012), in the present study, the workability and mechanical properties of SCC with fly ash reinforced with monofilament polypropylene fibres were investigated. The addition of fibres to fresh concrete results in a loss of workability. Self-compacting concrete (SCC) is an innovative concrete that is able to flow under its own weight, completely filling formwork and achieving full compaction without vibration. Two cement contents at 350 and 450 kg/m³ were studied as well with four fibre contents at 3, 6, 9 and 12kg/m³. The water/cement ratio, fly ash and superplasticiser contents were kept constant at 0.40, 120 kg/m³ and 1% of cement content respectively. Slump flow, J ring, Vfunnel and air content tests were conducted for evaluating the fluidity, filling ability and segregation risk of the fresh concretes. Unit weight, compressive strength, splitting tensile strength, flexural strength, and pulse velocity and elasticity modulus of concrete were determined. The materials used in this study exhibit no problems with mixing or workability when the fibre distribution is uniform. The polypropylene fibres enhance the strength of SCC significantly, without causing well known problems associated with steel fibres. It was found that for all the mixture proportions there were no problems in mixing while the fibre distribution was uniform. The air content of concrete has increased depending on the increase in fibre content. Fibre inclusion up to 9 kg/m³ has provided satisfactory results. While fibres in general cause loss of flow and workability, in all the mixtures, the fibres in this study have good flow and workability, even if some mixtures are somewhat below the limits of EFNARC.The authors recall that these limits have been suggested for conventional concretes. Adding PP fibres to concrete has decreased the unit weight of concrete and increased the compressive strength of concrete. Monofilament PP fibres can be used at much lower content than steel fibres; the lowest steel fibre content used is 60 kg/m³. Compressive strength, splitting tensile strength and especially flexural strength and elasticity modulus have been increased by PP fibre inclusion while pulse velocity has decreased.

Slamet Widodo(2012), This research conducted to evaluate the effects of polypropylene fibre addition on fresh state characteristics of SCC mixes, and investigate the effects of polypropylene fibre on some hardened properties of SCC. In this research, concrete mixes were added with polypropylene fibre of 0%, 0.05%, 0.10%, and 0.15% volume fraction. Fresh characteristics were evaluated based on its passing ability, flowability, viscosity, and segregation resistance using Jring, Slump flow, and Sieve Segregation Resistance tests. After 28 days of curing, compressive, splitting tensile strength, and drop-weight impact resistance were tested. Tests results indicate that polypropylene fibres tend to reduce the flowability and passing ability but will increase viscosity and segregation resistance of SCC. Furthermore, it can be concluded that polypropylene fibre reduce deformability of SCC in the fresh state. After 28 days of curing, concrete specimens' tests indicate that polypropylene fibre addition up to 0.10% of volume fraction tend to improve the compressive strength, tensile strength, and impact resistance of hardened SCC. It also can be suggested that polypropylene fibres allowed to be added into SCC mixes up to 0.10% by volume of concrete. In the fresh state of SCC, when the presence of polypropylene fibre increased it caused

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 05 | May -2020 ISSN: 2582-3930

lower flowability (Slump Flow) and Passing ability (J-Ring) of SCC mixes. On the other hand, the viscosity and the segregation ratio of the mixes increasing in accordance with the volume fraction of polypropylene fibres content.

III. METHODOLOGY

The methodology worked out to achieve the above-mentioned objectives is followed as shown in the flow chart below

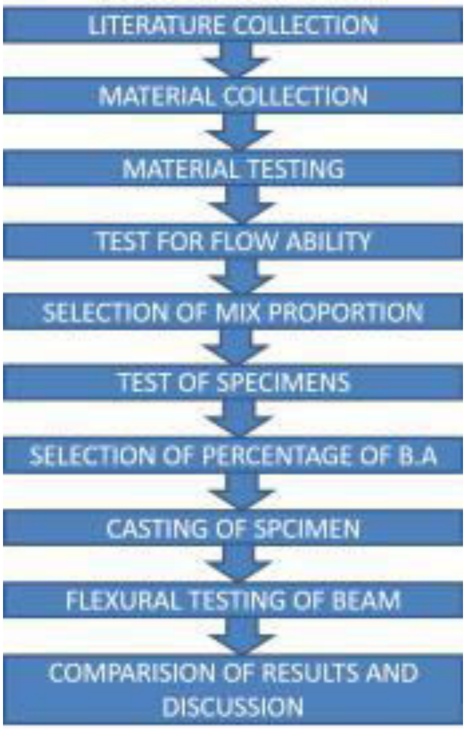

Fig. 3. *Methodology*

IV. EXPERIMENTAL PROGRAM

A. Mix Design

TABLE I. MIX DESIGN

Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water (Kg/m^3)	W/C	VMA (%)
462.93	759.45	928.21	208.3	0.45	0.3%

TABLE II. MIX DESIGN RATIO

CEMENT	FINE AGGREGATE	COARSE AGGREGATE	WATER	PLASTICIZER
1	1.64	2	0.45	0.3% of cementitious material

B. Testing Procedure – Fresh Concrete

1. Slump flow test

The slump flow test is done to assess the horizontal flow of concrete in the absence of obstruction. It is most commonly used test and give good assessment of filling ability and also indicate the resistance of segregation. The usual slump cone is used with base plate square shape having at least 700mm side. Concentric circle are marked around the centre point where slump cone is to be placed. A firm circle is drawn at 500mm diameter. After filling the cone completely with tamping, raise the cone vertically and allow concrete to flow freely. Higher the flow value, greater its ability to fill the formwork under its own weight. A flow diameter value of at least 600mm -800mm is required for SCC. Following are slump flow values measured for 0%, 10%, 15%and 20% of bagasse ash replaced by cement.

Fig. 4. Slump flow test

2.L box test

The test assesses the flow of concrete and also extent to which the concrete is subjected to blocking by reinforcement. About 14 litre of concrete is required for this test. Ensure that the sliding gate is closed before pouring the concrete in L-box. Lift the sliding gate and allow the concrete to flow out into the horizontal section. Simultaneously start the stop watch and record the time taken for the concrete to reach 200 and 400mm marks. When the stops flowing, the height h1 and h2 are measured. Calculate h2/h1, the blocking ratio. If the concrete flows as freely as water, at rest it will be horizontal. Therefore nearer the test values, the blocking ratio is to unity, the better the flow of concrete. The European Union research team suggested a minimum acceptable value of 0.8-1.

Fig. 5. L box test

C. Testing Procedure – Hardened Concrete

1. COMPRESSIVE STRENGTH TEST

The test was conducted as per **IS 516-1959**. The specimens were kept in water. During testing surface dry

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 05 | May -2020 ISSN: 2582-3930

conditions were obtained by wiping water on the surface. The load was applied without and increased continuously at a rate of approximately 140kg/cm^2/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen was then recorded and the Appearance of the concrete for any unusual features in the type of failure was noted. Average of three values was taken as the representative of the batch.

Fig. 6. Compressive Strength Test

2. INDIRECT TENSILE STRENGTH TEST

The test was conducted as per IS 5816-1999. The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength on concrete cylinder is a method to determine the Indirect tensile strength on concrete cylinder.

The concrete is very weak in tension due to the brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it's necessary to determinate the tensile strength to determine the load at which the concrete members may crack.

3. FLEXURAL STRENGTH TEST

For determining the flexural strength of concrete a RC beam specimen of size 150mm x 150mm x 1000mm had casted. A structural loading frame had been used for the test. The testing machine may be set to any reliable type of sufficient capacity for the test. Permissible errors should be not greater than – 0.5%.

The flexural strength or modulus of rupture should be calculated using the formula given below

Where a is the distance between support and the crack (mm),

d is the measured depth (cm),

L is the length (mm) of the span on which the specimen is supported,

and P is the maximum total load (N) applied to the specimen.

Fig. 7. Indirect Tensile Strength Test

Fig. 8. Flexural Strength Test

V. RESULTS AND DISCUSSIONS

1. SLUMP FLOW TEST

Fig. 9. Slump Flow Test

Following are slump flow values measured for 0%, 10%, 15% and 20% of bagasse ash replaced by cement.

TABLE III. SLUMP FLOW TEST

Bagasse Ash (%)	Flow value (mm)
0	640
10	625
15	612
20	590

2. V-FUNNEL TEST

Fig. 10. V-Funnel Test

Following are V-Funnel flow test values measured for 0%, 10%, 15% and 20% of bagasse ash replaced by cement.

TABLE IV. V - FUNNEL TEST

Bagasse Ash (%)	V-Funnel Flow(sec)
0	8
10	9
15	11
20	12

3. L-BOX TEST

Fig. 11. L- Box Test

TABLE V. L-BOX TEST

Bagasse Ash (%)	L-Box Flow(h_2/h_1)
0	0.93
10	0.89
15	0.84
20	0.79

4. COMPRESSIVE STRENGTH TEST

The below table are compressive strength at 7days and 28days testing of M30 grade concrete with various proportion of bagasse ash without polypropylene fibre.

TABLE VI. COMPRESSIVE STRENGTH TEST – BAGGASE ASH

Specimen Mix	At 7 Days (N/mm^2)	At 28 days (N/mm^2)
SCC control	19.33	31.06
Bagasse Ash with 10%	20.22	32.10
Bagasse Ash with 15%	17.78	29.40
Bagasse Ash with 20%	16.89	28.70

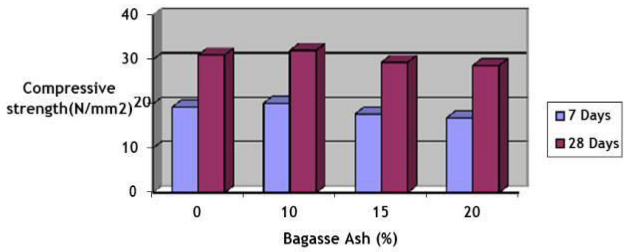

Fig. 12. Compressive Strength – Baggase Ash

TABLE VII. COMPRESSIVE STRENGTH TEST – BAGGASE ASH & POLYPROPELENE FIBER

Specimen Mix	At 7 Days (N/mm^2)	At 28 days (N/mm^2)
Bagasse Ash 10%	19.42	32.44
B.A 10% P.P.F 0.1%	21.65	36.10
B.A 10% P.P.F 0.15%	19.83	33.46
B.A 10% P.P.F 0.2%	17.22	28.70

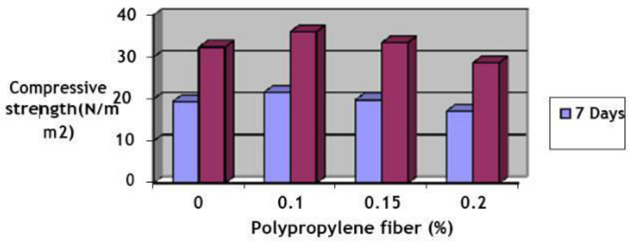

Fig. 13. Compressive Strength – Baggase Ash & PolyPropelene Fiber

5. SPLIT TENSILE STRENGTH TEST

The curing period was 28days and tested to find the split tensile of concrete placing horizontally to the testing and the result obtained is being tabulated below.

TABLE VIII. SPLIT TENSILE STRENGTH TEST – BAGGASE ASH

Specimen Mix	At 28 days (N/mm^2)
SCC control	2.94
Bagasse Ash with 10%	3.11
Bagasse Ash with 15%	2.82
Bagasse Ash with 20%	2.66

Fig. 14. Split Tensile Strength

TABLE IX. SPLIT TENSILE STRENGTH TEST – BAGGASE ASH & POLYPROPELENE FIBER

Specimen Mix	At 28 days (N/mm2)
Bagasse Ash 10%	3.23
B.A 10% P.P.F 0.1%	4.52
B.A 10% P.P.F 0.15%	3.90
B.A 10% P.P.F 0.2%	2.72

6. FLEXURAL STRENGTH TEST

TABLE X. FLEXURAL STRENGTH TEST

Specimen	Flexural strength (N/mm^2)
SCC control beam	11.15
10% of Bagasse ash	12.19
10% of B.A and 0.1% of P.P.F	18.95
10% of B.A and 0.15% of P.P.F	13.98
10% of B.A and 0.2% of P.P.F	10.11

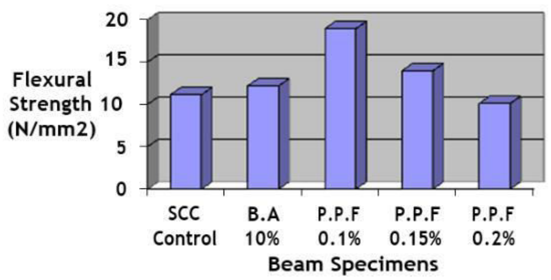

Fig. 15. Flexural Strength

6. LOAD VS DEFLECTION

The Beam of SCC with control mix, bagasse ash and with P.P fibre for M30 grade concrete is kept in 28 days and taken out from curing cleaned completely. The beam is then gone whitewash and marking are done for loading test in load frame. By placing the beam in the support load vs. deflection curve is obtained.

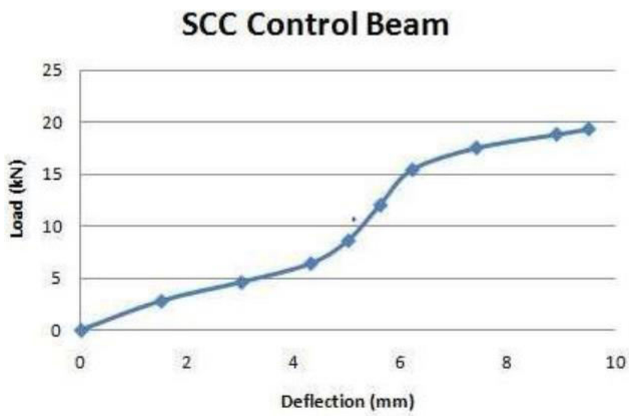

Fig. 16. Load vs Deflection – Control Beam

Fig. 17. Load vs Deflection – Bagasse Ash – 10%

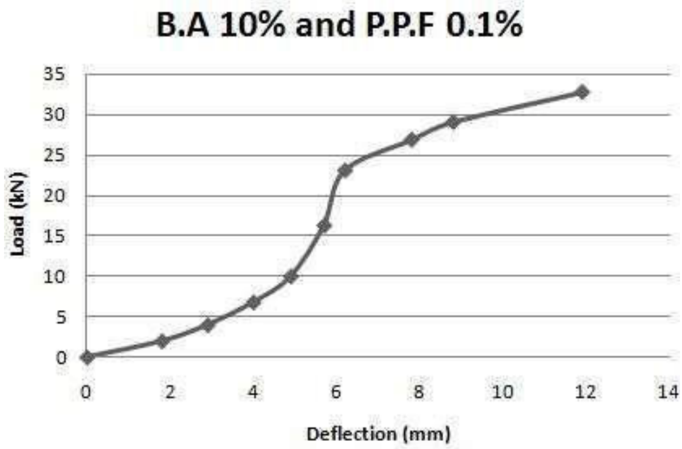

Fig. 18. Load vs Deflection – Bagasse Ash – 10% & Polypropylene Fiber – 0.1%

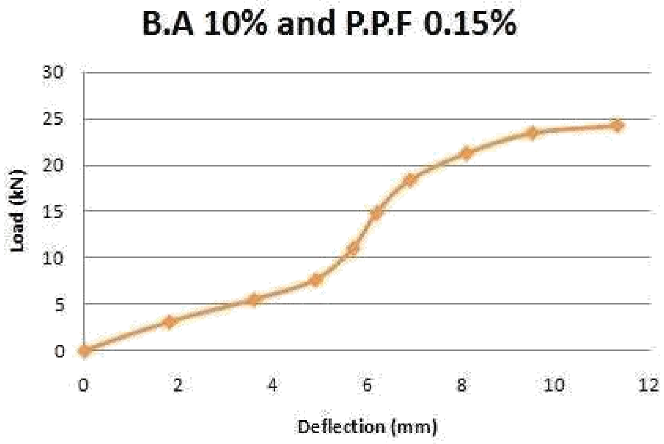

Fig. 19. Load vs Deflection – Bagasse Ash – 10% & Polypropylene Fiber – 0.15%

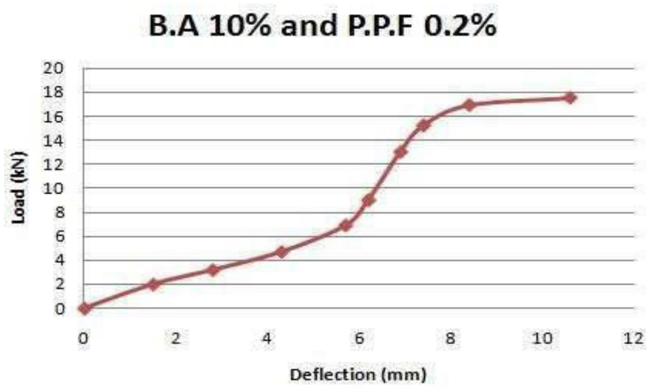

Fig. 20. Load vs Deflection – Bagasse Ash – 10% & Polypropylene Fiber – 0.2%

TABLE XI. ULTIMATE LOAD, MAX DEFLECTION & FLEXURAL STRENGTH - COMPARISON

Specimen	Ultimate Load (kN)	Max. Deflection (mm)	Flexural Strength (N/mm^2)
SCC control beam	19.3	9.5	11.15
10% of Bagasse ash	21.1	10.2	12.19
10% of B.A and 0.1% of P.P.F	32.8	11.9	18.95
10% of B.A and 0.15% of P.P.F	24.2	11.3	13.98
10% of B.A and 0.2% of P.P.F	17.5	10.6	10.11

CONCLUSIONS

Based on the experimental study on the Flexural behaviour of beam made using sustainable concrete, the following conclusions are made. The study of properties of SCC gives favourable results with Flow ability and Passing ability of concrete for M30 grade mix proportion. Compressive strength and split tensile strength of SCC control specimen gives higher strength compare with cement replaced by 10% Bagasse ash specimen. The experimental results of all the control beams and partially replaced by Bagasse ash beams and added polypropylene fibre beams are being compared. Their behaviour throughout the test is described using mechanically obtained data on deflection behaviour and the load carrying capacity. The beams are tested and their ultimate strengths and flexural strength are obtained. It was observed that the 10% replacement of Bagasse Ash concrete has 9.3% higher strength compare to SCC control beam. By using Bagasse Ash the amount of cement used for concrete will be reduced by 10%. Availability of bagasse ash is easier in all sugarcane mills at free of cost, only the transport charge will be considered. So the overall cost will be reduced. By adding polypropylene fibre with 0.1% and 0.15% the initial shrinkage is reduced and the load carrying capacity is increased with 55% and 14.6% respectively compare to SCC replaced with B.A beams. The beam replaced with 10% of Bagasse ash and 0.1% of polypropylene fibre are obtained good strength and gives cost effective compare to other obtained results.

REFERENCES

[1] IS: 12269-1987, Indian standard specification for 53 grade ordinary Portland cement (first reprint 1993), Bureau of Indian standards, New Delhi.

[2] IS: 383-1970, Indian standard specification for coarse and fine aggregate from natural sources for concrete (second revision), Bureau of Indian standards, New Delhi.

[3] IS: 2386(part I)-1963, Indian standard Methods of test for aggregate for concrete part I particle size and shape (Eleventh reprint), Bureau of Indian standards, New Delhi.

[4] Self-Compacting Concrete - Procedure for Mix Design, Paratibha Aggarwal, Rafat Siddique, Yogesh Aggarwal, Surinder M Gupta, Leonardo Electronic Journal of Practices and Technologies, Issue 12, Page 15, June 2008.

[5] A Simple Mix Design Method for Self-Compacting Concrete, Nan Sua, Kung-Chung Hsub, His-Wen Chaic, Elsevier Science Ltd., Volume 2, Issue 9, Page 179, June 2001.

[6] A Simple Tool For Self-Compacting Concrete Mix Design, J. Guru Jawahar,

[7] C. Sashidhar, I.V. Ramana Reddy and J. Annie Peter, International Journal of Advances in Engineering & Technology, Volume 3, Issue 2, Page 550, May 2012.

[8] Production Of Low Cost Self Compacting Concrete Using Bagasse Ash, Tayyeb Akram, Shazim Ali Memon, Humayun Obaid, Elsevier, Volume 23, Page 703, Apirl 2009.

[9] Self-Compacting Concrete Made with Partial Replacement of Sugarcane Bagasse Ash, Mahavir Singh Rawat, SSRG International Journal of Civil Engineering (SSRG-IJCE), Page 113, Apirl 2015.

[10] Flexural Strength Of Self Compactimng Concrete With Silica Fume And Polypropylene Fibres With And Without Reinforcement, Jagadeesh K.A, E. Ramesh Babu, International Journal of Advanced Technology in Engineering and Science, Volume No.02, Issue No.07, Page 463, July 2014.

[11] Experimental Studies on Self Compacting Concrete by Partial Replacement of Cement by Rice Husk and Bagasse Ash, Shravya H.M, H.S Narashimhan, ISRASE First International Conference on Recent Advances in Science & Engineering, 2014.

[12] Mechanical properties of self-compacting concrete reinforced with polypropylene fibres, O. Gencel, C. Ozel, W. Brostow and G. Martinez- Barrera, W. S. Maney & Son Ltd, Volume No.15, Issue No.3, Page 216, February 2011.

[13] Fresh and hardened properties of Polypropylene fibre added Self-Consolidating Concrete, Slamet Widodo, International Journal of Civil and Structural Engineering, Volume No. 3, Issue No. 1, Page 85, July 2012.

[14] Effect of Polypropylene Fibres on Fresh and Hardened Properties of Self- Compacting Concrete at elevated temperatures, Arabi Nawwaf Saoud AL Qadi, Kamal Nasharuddin Bin Mustapha, Sivakumar Naganathan, Australian Journal of Basic and Applied Sciences, Volume No. 5, Page 379, 2011.

[15] Concrete Technology Theory and Practice, M.S. Shetty, S.Chand Publishing, Third Reprint, Page 615 – 635.