SELF COMPACTING CONCRETE WITH USE OF FLYASH AS MINERALADMIXTURE

A Report

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ABSTRACT

Self compacting concrete has ability involves not only high deformability of paste or mortar, but also resistance to segregation between coarse aggregate and mortar when the concrete flows through the confined zone of reinforcing bars. The production of such mixes often used less expensive admixtures and very low quantity of cement. self-compacting concrete is the use of mineral admixtures suchas silica fume, ground granulated blast furnace slag and fly ash, which is finely, divided materials added to concrete during mixture procedure. When these mineraladmixtures replace a part of the Portland cement, the cost of self-compacting concrete will be reduced especially if the mineral admixtures are waste or industrial by-product. Compacting increases the strength of structure. Designing of a Self compact concrete mix having 29% of coarse aggregate content and 388 litre /m3 of paste volume, 5%, to 20% replacement of cement with Metakaolin and10% to 30% replacement with class F fly ash and 0.36 water/cement ratio (by weight).

This section discusses the effect of mineral admixtures on self compacting concrete's durability, strength and fresh properties which were considered from the previous research studied in literature.

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CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

1.1 GENERAL

Concrete being a versatile construction material is not only the most utilized construction material globally, but also the second largest material used world over. Concrete structures are durable, possesses thermal mass efficiency and aesthetically too pleasing. These qualities make concrete a versatile building material. Apart from being so advantageous over other construction materials, it has numerous limitations, out of which depletion of natural esources in the form of aggregates is very serious. In addition to this, lack of its proper compaction results in air entrapment and drastically reduces its strength which in turn affects the overall performance of the structure. Moreover in high-rise buildings, the reinforcement at joints gets congested to the level that itsaffects the flow of concrete, thus making concrete construction difficult. All these issues with conventional concrete lead to the development of self-compacting concrete (SCC). Self-compacting concrete is an extremely fluid mixture that can flow very easily within and around the formwork. It does not require any vibration or tamping after pouring and is thus able to consolidate under its own weight without undergoing any significant segregation.

In the past, termie’s method has been widely used for placing concrete in inaccessible areas like underwater concreting. The concrete obtained with this method possessed low strength and required large amount of cement and costly admixtures. This marked the beginning to look foralternative approaches to tackle the problem under consideration. Thus in 1980s, SCC was developed in Japan. SCC is used when large areas need concreting and dense reinforcement makes normal vibration hard.

SCC is a concrete that does not require any vibration. It is able to spout under its own weight and achieve the full compaction even in the occurrence of congested reinforcement. It utilizes super plasticizers & stabilizers to increase the rate of flow. It accomplishes compaction into all aspects of formwork without any segregation and bleeding. SCC mixes contain admixtures to provide stability, Super plasticizers and/or viscosity modifying agents to maintain the required fluidity.

The tests carried out by Assie et al. [1] stated that cement, the most costly material used in concrete, if minimised can prove to be economical andhence can lead to sustainability. Thus utilizing mineral admixtures is a sustainable way of reducing cement content. These admixtures not only improve the particle packing of concrete but also increase the durability and decrease the permeability of concrete. They also revealed that the durabilityof both the concretes could be regarded as equivalent, thus at the same level of compressive strength, SCC can be considered to be as vibrated concrete. The research carried out by Deepa & Paulose [2] indicated that use of fly ash in SCC increases the passing ability of concrete mix.Better mechanical and physical properties of concrete can be obtained with the replacement of cement with fly ash. Inclusion of fly ash also reduces the bleeding and segregation in concrete mixes. The research carried out by Dhiyaneswaram etal. [3] indicated that SCC with fly ash shows higher compressive strength and acid resistance as compared to mixed without fly ash. Thus a better workable concrete can be achieved by using fly ash replacement. Moreover, saturated water absorption percentage decreases with the increase in fly ash content andthus indicates the limited porosity that can inhibit high flow of water into the concrete. Dinesh etal. [4] stated that fly ash can play a significant role in reducing the environmental hazards and thus can increase the workability of SCC. John Jino et al. [5] conducted an extensive research and stated that the increasing shortage of natural materials and the need to protect the environment against the contamination has emphasized the significance of developing the new building materials. Fly ash is an industrial waste material produced from the ignition of coal in thermal power plants. It can be used as an admixture or as a partial replacement of cement or aggregates. Fly ash improves the strength and durability properties of concrete and hence can achieve better properties of concrete. The tests carried out by Prajapati khrishnapal et al. [6] showed that the flow property and passing ability of SCC increases with the increase in percentage of fly ash content and thereforeshow better workability for same w/c ratio.

Kurita & Nomura [7] observed that the utilization of fly ash material can enhance the rheological properties of concrete. It can reduce the heat of hydration of cement and thus decreases the cracking ability of concrete. The tests carried out by Rafat Siddique [8] indicated that it is possible to design SCC mixes incorporating fly ash content up to 35% .The SCC mixes containing lesser amounts of fly ash has better and improved compressive strength than those with the higher amounts of fly ash and w/c ratio. Moreover the carbonation depth increased with increase in age for all the SCCmixes. The experimental work carried out by Yahia et al. [9] to study the effects of rheological parameters on self compatibility of concrete containing various mineral admixtures revealed that the utilization of fly ash can reduce the amount of super plasticizer dosage required to obtain comparative slump flow compared to the concrete mixes containing only Portland cement.

1.2 USES AND ADVANTAGES OF SCC

At present self-compacting concrete (SCC) can be classified as an advanced construction material. The SCC as the name suggests, does not require to he vibrated to achieve full compaction. This affer benefits and advantages over conventional concrete.

- Faster construction Improved quality of concrete and reduction of onsite repairs.
- Reduction in site manpower Better surface finish
- Easier placing
- Improved durability and reliability of concrete structures
- Greater freedom in design
- Thinner concrete sections
- Reduced noise level Safer working environment

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1 GENERAL

This chapter presents an overview of literature of the various experiments conducted by many authors on the replacement of fly ash instead of cement in construction works. It include the literature about high class "C" and "F" fly ashconcrete.

2.2 EARLIER RESEARCHES

Ozawa et al. (1989) focused on the influence of mineral dmixtures, like fly ash and blast furnace slag on the flowing ability and segregation resistance of self- compacting concrete. They found out that on partially replacement of OPC byfly ash and blast furnace slag the flowing ability of the concrete improved remarkably. He concluded that the best flowing ability and strength characteristics 10-20% of fly ash and 25-45% of slag cement by mass.

Domone and His-Wen (1997) performed a slump test for high workability concrete. A beneficial correlation between the slump values and flow was obtained from the laboratory test. It showed satisfying value of the slump flow. Bui et al. (2002) discussed a speedy method in order to test the resistance to segregation of Self-compacting concrete. Extensive test programme of SCC with different water-binder ratios, paste volumes, combinations between coarse and fine aggregates and various types and contents of mineral admixtures was carried out. The test was helpful in concluding the method along with the apparatus used for examining the segregation resistance of SCC in both the directions (vertical and horizontal).

Xie et al. (2002) presented the preparation technology of high strength self- compacting concrete (SCC) containing ultrapulverised fly ash (UPFA) and superplasticizer (SP).Various parameters of concrete were selected namely good workability, high mechanical properties and high durability and SCC was developed. There was low slump loss in the fresh SCC mixture. The workability of high strength SCC containing UPFA and SP can be evaluated by the method of combining slump flow and L-box test. Slump flow was 600-750 mm. Flow velocity of L-box test was 35-80 mm/sec.

Lachemi and Hossain (2004) presented the research on the suitability of four types of Viscosity Modifying Agent (VMA) in producing SCC. Fresh and hardened properties of SCC were studied by adding different VMA to SCC. The deformability through restricted areas can be evaluated using v-funnel test. In this test, the funnel was filled completely with concrete and the bottom outlet was opened, allowing the concrete to flow out. The time of flow from the opening of outlet to the seizure of flow was recorded. Flow time can be associated with a low deformability due to high paste viscosity, higher inter particle friction or blockage of flow. Flow time should be below 6 sec for the concrete to be considered as SCC. All the mix performed well with no significant segregation and jamming of aggregate was noticed.

Cengiz (2005) used fly-ash with SCC in different proportional limit of 0%, 50%and 70% replacement of normal Portland cement (NPC). He investigated the strength properties of self compacted concrete prepared using HVFA (high volume fly ash). Concrete mixtures made with water-cementitious material ratios ranged from 0.28 to 0.43 were cured at moist and dry curing conditions. He investigated the strength properties of the mix and developed a relationship between compressive strength and flexural tensile strength. The study proved that it is possible to convert an RCC (zero slump) concrete to a workable concrete with the use of suitable superplasticizer.

Ferrara et al. (2006) evaluated the HLSCC for all the basic properties namely flowability, segregation resistance ability and filling ability of fresh concrete.

The tests of slump flow

(for measuring of flowability) and the time which is required to reach the 500 mm of slump flow (S) (for measuring of segregation resistance ability) of HLSCC satisfied the expected capacity level in all mixes, the time is notedwhich is required to completely flow through V-funnel (S) (for measuring of segregation resistance ability) only satisfied the level in most of the LC mixed concrete (mix no. 2-4) and one of mixed concrete (mix no. 6).Kumar (2006) reported the history of

SCC development and its basic principle, different testing methods to test high-flowability, resistance against segregation, and passing ability. Different mix design methods using a variety of materials has been discussed in this paper, as the characteristics of materials and the mix proportion influences self-compact ability to a great extent, also its applications and its practical acceptance at the job site and its future prospects have also been discussed. Orimet test was performed, the more dynamic flow of concrete in this test simulates better the behavior of a SCC mix when placed in practice compared with the Slump-flow variation. The Orimet/J-ring combination test shows great promise as a method of assessing filling ability, passing ability and resistance to segregation.

Sahmaran et al. (2007) presented a paper on study of fresh and mechanical properties of a fibre reinforced self-compacting concrete incorpating high- volume fly ash in mixtures containing fly ash. Fifty percent of cement by weight was replaced with fly ash. It was found that the slump flow Diameters of all mixtures were in the range of 560-700 mm which was in acceptable range and the slump flow time was recorded to be less than 2.9 seconds.

Khatib (2008) investigated the properties of self-compacting concrete prepared by adding fly ash (FA). FA was used as a replacement for Portland Cement (PC). PC was replaced 0-80% by fly ash. For all the mixes water binder ratio was maintained as 0.36. Strength properties as well as the workability, shrinkage, absorption and ultrasonic pulse velocity were studied in this research. From the observations it was concluded that 40% replacement of FA resulted in strength of more than 65 N/mm2 at 56 days. On increasing the amount of fly ash the high absorption values were obtained and absorption of less than 2% was exhibited.

Grdić et al. (2008) presented the properties of self compacting concrete, mixed with different types of additives: silica fume and fly ash. L-box test was used to assess the passing ability of SCC to flow through tight openings including spaces between reinforcing bars and other obstructions without segregation or blockage. L- Box has arrangement and the dimensions by difference with the height of the horizontal section of the box, these three measurements are used to calculate the mean depth of concrete as h2 mm.

Miao (2010) conducted a research on developing a SCC with cement replacement up to 80% in all the mixes and examining its fresh properties. Result show that the fly ash acts as a lubricant material; it does not react with superplasticizer and produce a repulsive force and the superplasticizer may only act on the cement. As a result, the larger the amount of fly ash contained, lesser the superplasticizer needed.

Heba (2011) presented an experimental study on SCC with two cement contents; the work involved three types of mixes, the first considered different percentages of fly ash, the seconds used different percentages of silica fumesand the third used mixtures of fly ash and silica fume. It was concluded that higher the percentages of fly ash the higher the values of concrete compressive strength until 30% of FA, however the higher values of concrete compressive strength is obtained from mix containing 15% FA.

CHAPTER III

EXPERIMENT INVESTIGATIONS

3.1 INTRODUCTION

This chapter describes the experimental works carried out in this present investigation. This chapter deals out with the experiments on the materials(Cement,Flyash,Fine aggregate,Coarse aggregate).

3.2 TEST ON MATERIAL USED

3.2.1 CEMENT

Selection of the type of cement depends on the overall requirements for concrete, such as strength and durability. Concrete produced from Portland cement is one of the most versatile construction materials available in the world. In this study Ordinary Portland cement (OPC) 43 Grade which is extensively used in India was used in all the test specimens. The specific gravity of cement used was taken as 3.15.

Cement used in the experimental work is ORDINARY PORTLAND CEMENT of 43 grades conforming to IS: 8112/1989. The physical properties & chemical properties of the cement obtained on conducting appropriate tests are as per IS: 269/4831 and the requirements as per IS: 8112/1989 are given in the Table 3.1

Table 3.1 Physical Properties of f 43 grade ordinary Portland cement

PHYSICAL PROPERTIES	**RESULTS OBTAINED**	**IS:8112/1989 SPECIFICATION**
Fineness of cement %	8%	10 %
Setting time (Minutes) 1.Initial 2. Final	 170 235	 30(min) 600(min)
Nominal Consistency Specific Gravity	28% 3.15	

3.2.2 Coarse Aggregates

Machine crushed angular granite metal of 20mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, clay particles and organic matter etc. The course aggregate is also tested for its various properties. The specific gravity, bulk density and fineness modules of course aggregate are found to be 2.70, 1560 kg/eum and 7.1 respectively. Coarseaggregates consisted of stone chips collected from a local source, up to 4.75 mm IS sieve size. Its specific gravity was found as **2.75**. Standard tests were conducted to determine their physical properties as summarized in Table 3.2

Table 3.2 Physical Properties of coarse aggregate

SL.NO	PARTICULARS	TEST RESULTS
1	Specific Gravity	2.7
2	Fineness Modulus	6.2
3	Water Absorption	0.4(%)

3.2.3 Fine Aggregates

The locally available sand is used as fine aggregate in the present investigation. The sand in free from clayey matter, salt and organic impurities. The sand is tested for various properties like specific gravity, bulk density etc., and inaccordance with IS 2386- 1963. The fine aggregate is conforming to standard specifications. Fine aggregates, remaining of stone crusher dusts were collected from a crusher plants with the retaining value from 4.75 mm and retained on

0.075 mm IS sieve. Its specific gravity was found as 2.6**.**

Table3.3 Physical Properties of fine aggregate

SL.NO	**PARTICULARS**	**TEST RESULTS**
1	Specific Gravity	2.65
2	Fineness Modulus	2.47
3	Water Absorption	0.85(%)

3.2.4 Flyash

Fly ash is a fine inorganic material with pozzalanic properties which can be added to SCC to improve its properties. Fly Ash is a by-product obtained fromburning pulverized coal in electric power generating plants. Fly ash conformingto class F was used as partial replacement for cement in the present work havingspecific gravity of 2.89.

3.2.5 WATER

Water used was fresh, colourless, odourless and tasteless potable water freefrom organic matter of any type.

3.2.6 ADMIXTURE

The incorporation of a superplasticizer not only reduces the inter-particle friction but also maintain the deformation capacity and viscosity. The locally available admixture that is, CONPLAST SP 430 G8 was used as a superplasticizer with density 1.2kg/l, specific gravity= 2.10 at 30oC, air entrainment = 1% (approximately) and blackish in colour. Conplast SP 430 G8 is based on sulphonated naphthalene polymers and is instantly dispersible in water. It has been specially formulated to give high water reduction up to 25% without loss of workability or to produce high quality concrete of reduced permeability. The volume of the conplast used in self-compacting concrete is taken as 1.2% of the volume of the cement.

3.3 MIX PROPORTIONS

The process of mix proportioning is one of the most important tasks for achieving the required SCC properties. Many different test methods have been developed in attempts to characterize the properties of self-compacting concrete. So far, no single method has achieved the universal approval and as such no method has been found that can characterize all the relevant workability aspects.Therefore, a mix design procedure to get the proportion of the ingredients in the SCC is not standardized. No method specifies the grade of concrete in SCC, except the Nan Su et al. method [10]. In this study, mix designing was carried out for M40 grade concrete, and the procedure is based on the method proposed by Nan Su et al. This method was preferred as it has the advantage of considering the strength of the SCC mix. It gives an indication of the target strength that will be obtained after 28days of curing.

3.4 SELF-COMPACTABILITY TESTS ON SPECIMEN

Batching of trial mixes was carried out according to their respective proportions. The concrete ingredients were mixed manually to attain uniform consistency.

1. FRESH PROPERTIES

The Self-Compactibility properties of the trial mixes were determined by using slump flow test. The tests were conducted in following order:

- Slump flow test .

2. STRENGTH PROPERTIES

From each trial mix, a total of 18 concrete specimens were casted for determiningthe compressive strength, split tensile strength and flexural strength after 7 and 28 days of water curing for each trial mix.

CHAPTER IV

ANALYSIS OF TEST RESULTS AND DISCUSSIONS

CHAPTER IV

ANALYSIS OF TEST RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

In this chapter Result and Observation of check administrated in previous chapter is conferred, analysed and discuss.

4.2 Properties of Fresh Concrete

4.2.1 Slump Test

The slump flow test judges the capability of concrete to deform under its own weight against friction of the surface with no restraint present. The slump flow represents the mean diameter of the mass of concrete after release of a standard slump cone (Diameter is measured in two perpendicular directions).In slump test, the cone is filled with concrete and then lifted vertically and the time measurement is started. The effectiveness of flow i.e the flowability of SCC under congested reinforcement can be studied through the slump test. A slump flow ranging from 650mm to 800mm is considered as the slump required for a concrete to be self-compacted. At more than 800mm the concrete might segregate and at less than 650mm the concrete is considered to have insufficient flow to flow through highly congested reinforcement. From the Slump test it is seen that 30% replacement of fly ash behaves better compared with other ratios. The slump values for different mixes are given in Table 4.1 Results of Slump flow test.

Fig 4.1 Slump Flow Test In Progress

Table 4.1 Results of Slump Flow Test

Sl no	% of cement	% of flyash	Slump value in mm
1	100	0	40
2	90	10	38
3	80	20	35
4	70	30	32
5	60	40	30
6	50	50	27

4.2. Properties of Hardedned Concrete

Compressive strength, flexural strength and splitting tensile strength study results at differentages are given in table-7, 8 & 9 respectively. When compared to the control mixture,increasing amount of fly ash increased the strength. 30% replacement showed better performance with respect to strength properties of concrete.

4.2.1 Compression strength

Compressive Strength testing machine is used to determine the compressive strength of a test specimen. The size of cube specimen used to perform test is 150mm × 150mm × 150mm. A test result is the average of at least three standard cured specimens made from the same concrete sample and tested at the same age. From each trial mix, a total of six concrete cube specimens of150mm side were casted for determining the compressive strength after 7 and 28 days of water curing for each trial mix. The moulds were oiled properly for easy demoulding. The moulds were filled with concrete in three layers. Since this is a Self Compacting concrete, the concrete will flow under its own weight, therefore, the moulds were not vibrated. The specimens were demoulded after 24 hours of casting and then they were transferred to a curing tank. The specimens were cured in the water tank for 28 days. The Compressive strength was calculated bydividing the failure load by the average crosssectional area of the specimen.

4.3 Water Absorption Test

The water absorption test was performed using BS 1881: Part 122: 1983. This Part of this British Standard specifies a method for the determination of water absorption of concrete specimens cored from a structure or precast component. The 50 mm Ø x 100 mm height cylinder was used for casting. The cylinder was immersed in water for 7 days and 28 days curing period. The specimen were dried in oven for 3 days and immersed in water at 30 minutes interval for 4 hours. The results for 7 days and 28 days test for water absorption of control and all SCC mixes with different mix designations are shown in the table 3. The water absorption of SCC containing fly ash and quarry dust in grade 35 concrete according to immersion time of 7 days and 28 days curing were classified as having average water absorption. The water absorption of concrete after 7 days curing at initial 30 minutes water immersion were not all below 3% except for QDFA30 which is slightly above 3% and for after 28 days curing it can be seen that most of the mix designation are below 3% and so this concrete can be classified as having low water absorption. The fly ash added to the SCC mix served as a filler and helped to fill up the capillary pore structures that reduced water absorption in the SCC mix. Thus, reducing the size of the pores and the transport of water in the concrete mix. Water absorption of QDFA30 was 27.03 28.48 24.37 25.32 29.19 28.32 36.15 36.39 34.82 35.67 38.77 36.24 0.00 5.00 10.00 15.00 20.00 25.00 30.00 35.00 40.00 45.00 CM SP QDFA10 QDFA20 QDFA30 QDFA40 Compressive Strength (MPa) Mix Designation 7 Days 28 Days.

International Journal of Scientific and Research Publications, Volume 8, Issue 10, October 2018 382 ISSN 2250-3153 http://dx.doi.org/10.29322/IJSRP.8.10.2018.p8248 www.ijsrp.org lower than the control mixes for both 7 days and 28 days curing. Therefore, it shows that durability of QDFA30 was improved and made better compared to the control mix concrete. Figure 4 indicated that water absorption for initial 30 minutes are not all below 3% after 7 days curing butfor the bar chart of the results in Figure 10 most of the mix designations are all below 3% after 28 days curing therefore all concrete mixes can be classified as having good water absorption since 3% is the limiting value specified for initial surface water absorption. Based on the two graphs it can be seen that water absorption at 7 days curing is higher than water absorption at 28 days curing. Thus, water absorption of concrete reduces with the age of concrete. From the results of water absorption stated below we can see that the SCC mix with mix designation QDFA30 had the least percentage of water absorption than the other mixes. Therefore, the optimum percentage of quarry dust in SCC with respect to water absorption is 30%.

Table 4.1 Results of Water Absorption Test

Sl no	%of Cement	% of Flyash	Normal Weight	Water Absoption in 7 days	Water absorbtion in 14 days	Water Absoption in 21 days

				(in kg)	(in kg)	(in kg)
1	100	0	8492	8542	8553	8456
2	90	10	8490	8523	8500	8477
3	80	20	8446	8492	8430	8372
4	70	30	8272	8320	8290	8230

CHAPTER V

CONCLUSION

5.1 General

The present experimental study was carried out to describe the effects of agro industrial by product i.e fly ash on SCC using various percentage replacement levels of fly ash to determine the best performance of fly ash. The investigation shows that it is possible to design SCC mixes incorporating fly ash content up to 30%. The main conclusion drawn from the results are summarized below:

1) Slump flow of SCC mixes were in the range of 650-710, flow time for all the mixes was less than 4.8secs , V funnel time was in the range of 8.35 – 11secs and L box ratio was greater than 0.8 for all the mixes.

2) The fresh properties for 30% fly ash replacement were observed to be better as compared to the other replacement levels (10%, 15%, 20%, & 25%).

3) The strength properties have shown significant performance differences and thus it is perceptible from the test results that the compressive strength increases with the increase in the percentage of fly ash content.

4) From five trial mixes, a mix with 30% replacement of cement with fly ash was found to meet the compatibility criteria and possessed maximum strength.

5) The SCC mixes developed compressive strength ranging from 33.4 to 39.16 Mpa at 7 days and 45.8 to 53.21 Mpa at 28 days.

6) The compressive strength of SCC specimens increased with the time of curing.

7) The split tensile strength for 7 days was found to be in the range of 2.83 to 4.57Mpa and 3.98 to 5.23 Mpa for 28 days.

8). The flexural strength developed by SCC mixes decreased with the increase in the percentage of fly ash content.

5.2 Future Scope

Here are the diagram of gthe future scopes:

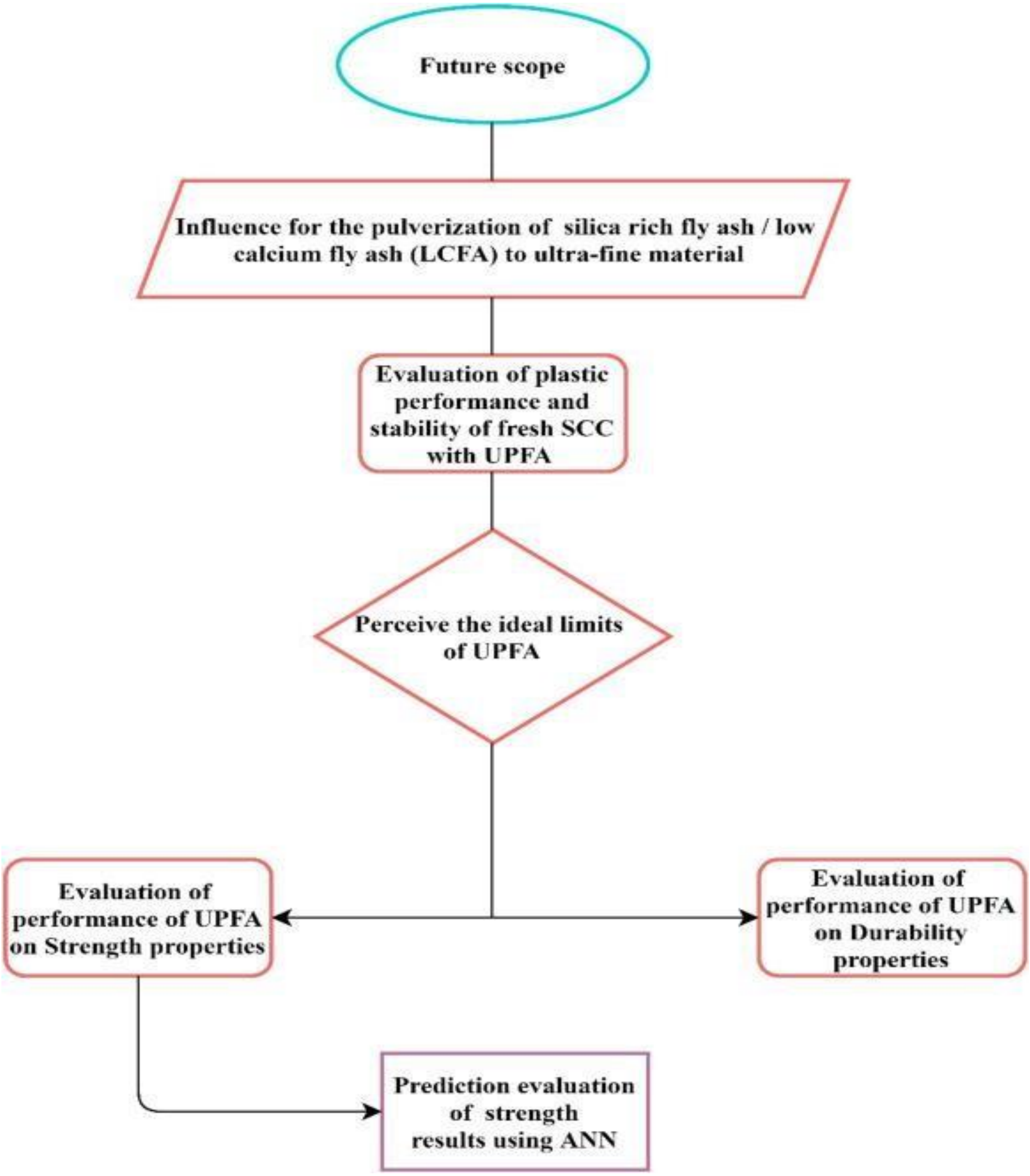

Fig 5.1

The schematic flow, as shown in Figure, implements the future scope. The process begins with the design and development of a cement-based SCC mix using constituent raw materials in accordance with Indian standards and EFNARC guidelines. To achieve the standard qualified classes, two fixed parameters, flowability and passing ability, will be used to determine the proportions. Furthermore, the flowability, passing ability, stability (static and dynamic), and retention period of SCC with mechanically activated UFFA are investigated. The optimal UFFA limits will be determined based on the feasibility of new concrete combinations. Besides this, the effect of UFFA will be evaluated on mechanical strength and transport (durability) properties.

The best performing ideal UFFA percentage will be determined based on this overall experimental evaluation. ANN prediction models will be used to validate the strength behaviour and efficacy of UFFA in SCC mixes.

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