UTILIZATION OF WASTE SOLE LEATHER WITH FLY ASH FOR SELF-COMPACTING CONCRETE

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ABSTRACT

The majority of solid waste from leather industries comes from various processes after manufacturing leather products, and it has been gathered separately from industries. Sole leathers were also emitted in the leather industry. After used, sole leather is thrown at dump yard and the dumping of sole leather on the ground is highly damaging to the environment's health, and the recycling procedure is approximately expensive, therefore this research examines the creation of Self-Compacting Concrete (SCC) mix using Fly Ash and Sole Leathers. This article examines that the utilization of waste sole leather including F.A. (Fly Ash) and superplasticizer (S.P.) in self-compacting concrete (SCC) mixtures. fly Ash & sole leather is a novel research concept with high deformability and moderate viscosity, which is required to provide consistent solid particle dispersion during shipping, installation, and until the concrete sets. As per obtained the findings of the current research, the addition with sole leather and fly ash in conjunction with a superplasticizer appears to improve the fresh, hardened characteristics developed strength & proper durability qualities in SCC. The maximum compressive strength was obtained for SCC⁵%F.A.+5%S.L. i.e., 41.10 MPa as compare to other mix proportions i.e. SCC¹⁰%F.A.+7.5%S.L. (39.95 MPa) & SCC¹⁵%F.A.+10%S.L. (36.70 MPa).

KEYWORDS: Self-compacting concrete, Fly Ash, Sole Leather, Superplasticizer

1. INTRODUCTION

The concrete has a common structural substance in civil engineering projects. Sole leathers can be utilized in concrete, according to preliminary studies; this sort of material has been a prominent study topic in recent years. The lightweight construction materials are seen to be beneficial in encouraging repurposed materials like sole leathers [1]. The majority of sole leather waste is discarded to a landfill after use, and the majority of leathers are not recycled. The findings indicated that, under the tested conditions, sole leathers did not provide complete environmental protection after being dumped into a dump yard to be utilized in concrete mix. SCC (Self-Compacting Concrete) mixtures applied with F.A. (fly ash), Superplasticizer & Sole leathers is frequently used to amend the characteristics strength of fresh and hardened concrete. Many varieties of leather soles are as robust as, if not more so than, metals. Sole leathers are usually corrosion-resistant, letting them to last eternally in SCC mix outside in protected conditions. Sole leathers are adaptable, light, flexible, and long-lasting. It is widely utilized and accounts for the majority of usage worldwide. Leather production factories are quite common these days, and they produce a lot of sole leathers. Sole leather disposal is a significant problem for society and engineers. Due to rising industrialization, population growth, and urbanization, environmental contamination from the sole leather sector is increasing every day. Sole leather manufacturing factories produce the majority of the sole leathers. As a result, sole leathers from these plants are frequently disposed of in huge numbers. The gap in this project, Sole leathers may aid in the reduction of natural
resource usage while making self-compacting concrete mixtures. As a result, sole leathers might be used as an alternate material in SCC. A treble leather sole may frequently outlive a rubber sole, thus the more layers of leather included, the exponentially stronger they become. In the present study, the purpose of this study is to obtain the fresh and hardened characteristic strength of various materials & self-compacting concrete characteristics with a mix of SCC-01 (SCC5%F.A.+5%S.L.), SCC-02 (SCC10%F.A.+7.5%S.L.) and SCC-03 (SCC15%F.A.+10%S.L.) where, F.A. represents Fly Ash & S.L. represents Sole Leather. In this study, self-compacting concrete has made with a mixture of sole leather, fly ash and super plasticizers with a different-different ratio. The sole leather wastes generated as byproduct material during production processes are used in this project. The purpose of this study is to see how shredded 12.5mm sole leather waste affects the qualities of fresh and hardened self-compacting concrete. The percentage of discarded sole leather material in concrete is one of the factors in this study. The waste percentages employed in the concrete mixture were 5%, 7.5%, and 10% by weight of coarse aggregate. Many tests have been undertaken on the workability & characteristic compressive strength of SCC (self-compacting concrete) using with fly ash & sole leather wastes, both fresh and hardened. The characteristics compressive strength of concrete has found decreasing as an amount of fly ash and sole leather waste in the mix increased. The fresh workability of fresh concrete has improved with adding a maximum of 5% sole leather waste. The workability is higher at 5% sole leather, but as the proportion increases to 7.5% and then 10%, the workability decreases. The “Effects of Rubber and Leather Wastes on Concrete Properties” were discussed in his article. He also claimed that the addition of fine and coarse leather particles to fresh concrete improved its workability. The workability of this concrete was better than that of rubber waste concrete. When utilized as coarse & fine aggregates in SCC (self-compacting concrete), leather waste produces a significant loss in compressive strength after 28 days of proper water curing. Fine leather aggregates, on the other hand, have a greater impact on compressive strength than coarse leather aggregates. SCC (Self-compacting concrete) is a non-secede(segregation), extremely permeable (flowable) Every corner of the formwork is filled with concrete consistently & fully with its own weight and encapsulates reinforcement without causing vibration while preserving homogeneity. Compaction only be accomplished by gravity. Such concrete should have a low yield value to assure high flow ability, a moderate viscosity to resist segregation and bleeding, and maintain homogeneity during shipping, placing, and curing to achieve adequate structural performance and long-term durability [2-3]. There is no standard method for SCC mix design, and many academic institutions as well as admixture, ready-mixed, precast and contracting companies have developed their own mix proportioning methods. As per EFNARC recommendation for SCC mix design, the addition of a mineral additive is one of the most significant differences between Self-compacting Concrete (SCC) and traditional concrete [4]. It is expected that the application of sustainable technologies such as supplemental cementitious materials (SCMs) and/or recycled materials will improve the performance of concrete mixtures. SCC is a new concrete substance that has been developed from traditional concrete [5]. In other hand, Waste tyre rubber could also be used to partially substitute finer and gravels in self-compacting concrete, minimizing sand and gravel consumption even while safeguarding natural environment resources [6]. Research of conventional rubberized concrete (CRC) to self-compacting rubberized concrete (SRC) is conducted done (SCRC). In both CRC and SCRC, the substitution of rubber with coarser gravel ranges from 0% to 20%. Rubber bits sized 5mm and 10mm have been used. Rubber shards account for 40% of coarse aggregate replacement in the 5mm size and 60% in the 10mm size [7]. When compared to normal concrete, the rubberized concrete combinations had a reduced unit weight and better workability. When coarse aggregate was replaced instead of fine aggregate, the results of compressive and flexural tests showed that the mechanical properties of rubcrete were reduced further [8]. Tires that have been worn out have accumulated, posing a fire and health risk. An experimental study was done to explore the possibilities of employing tyre chips and crumb rubber as aggregate in Portland cement concrete as a viable a remedy for the issue of dumping of scrap tyres [9]. The paper summarizes the mechanical behavior of specimens composed of concrete that has been filled with tiny crumbled tyre rubber volumes proportions and polypropylene short fibers at 7 and 28 days under static and dynamic loads. The experimental findings are compared to those of concrete specimens with identical characteristics but no fibres or tyres [10]. All the testing of self-compacting concrete done with the help of EFNARC guidelines [11]. Increasing the admixture content beyond a certain level leads to a reduction in strength and increase in absorption [12].
2. MATERIALS

Materials used for the present investigation on self-compacting concrete are:
1) Ordinary Portland Cement (OPC) of Grade-53
2) Fly ash
3) Fine Aggregate
4) Coarse aggregates
5) Super plasticizer
6) Potable Water
7) Sole Leather

In Self-compacting concrete (SCC) mixes with different replacements of Sole leather (S.L.) & Fly Ash (F.A.) were prepared & scrutinize to calibrate the fresh properties of Self-compacting concrete. Beneath tables represents the composition of Self-compacting concrete (SCC) trial mixtures. The replacement was carried out at levels of SCC5%F.A.+5%S.L., SCC10%F.A.+7.5%S.L. & SCC15%F.A.+10%S.L. of fly ash & sole leather content. After iterative trial mixes the water/powder mass ratio (w/p) was selected as 0.40. The final cementitious content was fixed as 340 KG/m³. The mixes were named using the mix design procedure described in IS 10262-2019. The M-30 mix proportions were designed.

2.1 Cement

Cement company ACC and grade OPC-53 are using as a cement (binding materials). It confirms the IS 12269:1987 standard. Cement properties are investigated in the laboratory. The outcomes are listed in the Table 1: -

| Serial No. | Physical requirements          | Results          | As per IS code          |
|-----------|--------------------------------|------------------|-------------------------|
| 1         | Cement Brand Name              | ACC Limited      | -----                   |
| 2         | Grade of cement                | 53-OPC           | -----                   |
| 3         | IST (Initial setting time) of ordinary cement | 138 Minutes | Not less than 30 Minutes |
| 4         | FST (Final setting time) of ordinary cement | 257 Minutes | Not more than 600 Minutes |
| 5         | Comp. strength of cement @ 28 days | 58.75 MPa | Not less than 53       |
| 6         | Specific gravity of cement     | 3.15             | -----                   |
| 7         | Temperature during testing (°C) | 28.2 °C         | 27±2 °C                 |
| 8         | Normal consistency (%)         | 31 %             | -----                   |
| 9         | Fineness of cement (Sieve method) | 2.54%           | -----                   |

2.2 Fly Ash

The fly ash is employed, according to a requisition from NSPCL Plant, Bhilai, C.G., which confirms to the IS 3812 Part 1(2003) and Part 2(2003) specification. IS 1727-1967 is used to perform and test the physical attributes. It’s employed as a fine (as an alternative to cement) in S.C.C. (self-compacting concrete), where it acts as a powder form content. Table 2 & 3 summarizes the physical and chemical characteristics of fly ash respectively.

2.3 Fine Aggregate (Sand)

Fine aggregate also termed as sand is utilized in this construction projects, that meet the IS: 383-1970 specifications. The finer aggregates is collected the location Mahanadi River bed near Dhamtari district, C.G. The physical properties have been performed and tested, and the results are shown in the Table 2.
Table 2: Fine Aggregate (F.A.) Physical Characteristics

| Serial No. | Properties               | Outcomes          |
|------------|--------------------------|-------------------|
| 1          | Color                    | Whitish greyish   |
| 2          | State                    | Fine Powdered form|
| 3          | Specific Gravity         | 2.01              |
| 4          | Moisture content         | <0.29%            |
| 5          | Residue on 45 µ sieve (%)| 14.9%             |
| 6          | Fineness (m²/kg)         | 359               |

Table 3: Fly Ash Chemical Composition

| Serial No. | Composition of Chemicals | Proportion (%) |
|------------|--------------------------|----------------|
| 1          | Silica (SiO₂)            | 64.9           |
| 2          | Alumina (Al₂O₃)          | 27.9           |
| 3          | Ferric Oxide (Fe₂O₃)     | 2.9            |
| 4          | Lime (CaO)               | 0.9            |
| 5          | Magnesia (MgO)           | 0.9            |
| 6          | Titanium Oxide (TiO₂)    | 0.6            |
| 7          | Sulphur Tri-Oxide (S₀₃)  | 0.3            |
| 8          | Loss of ignition         | 0.3            |

Table 4: Fine Aggregate Physical Composition

| Serial No. | Properties                      | Outcomes            |
|------------|---------------------------------|---------------------|
| 1          | Specific Gravity (S.G.) of F.A. | 2.68                |
| 2          | Water absorption capacity       | 4.9%                |
| 3          | Shape of fine aggregate        | Circular & angular  |

2.4 Coarse Aggregates (Gravel)

The size of coarse aggregate has the most impact on the self-compacting concrete's fresh properties. Because the flowability and passing ability of concrete diminishes when the higher aggregates sizes usage of self-compacting concrete (SCC) has increased, segregation increases. Maximum sizes of C.A. (gravel/coarse aggregates) usage in SCC is sets to provide good flowability and passing ability. The Coarse aggregate is collected from the Mandir Hasaud, near district- Raipur, C.G. The tests are performed in the laboratories which is mentioned in the below Table 5.
Table 5: Coarse Aggregate Composition

| Serial No. | Properties                        | Outcomes   |
|------------|-----------------------------------|------------|
| 1.         | Shape of aggregate                | Angular    |
| 2.         | Specific Gravity (S.G.)           | 2.86       |
| 3.         | Absorption of Water               | 0.8%       |
| 4.         | Maximum Sizes of Aggregates       | 20 mm & 12.5 mm |

2.5 Super Plasticizers

The super plasticizer is used to increase the concrete's workability by lowering the water-to-powder ratio. The compounds **Master Glenium SKY**, which are based on modified **poly carboxylic ethers**, are utilized. The dose is determined by following the recommendations and specifications.

2.6 Water

From IS 456:2000, clean and portable water is used from laboratory.

2.7 Sole Leather

The sole leather wastes generated as byproduct material during production processes are used in this project. The purpose of this study is to see how shredded 12.5mm sole leather waste affects the qualities of fresh and hardened self-compacting concrete. The percentage of discarded sole leather material in concrete is one of the factors in this study. The waste percentages employed in the concrete mixture were 5%, 7.5%, and 10% by weight of coarse aggregate.

3. METHODOLOGY

I.S. & EFNARC guidelines were used to calculate the material mix proportions. It is important to perform a specific test on SCC in order to look into the features of freshness and strength. SCC (Self-compacting concrete's) is to be tested in dual its states of freshness and hardness, with different proportions of fly ash, super plasticizers, and sole leather. Cubes and cylinders are cast using different percentages for different volumes. They are normally cured for up to 28 days before being tested. To ensure that all of the new property standards were met, the following tests were conducted as per standard testing codes:

| Serial No. | Name of Experiments                        | Standard Code       |
|------------|--------------------------------------------|---------------------|
| 1.         | Filling ability test that used with T-slump flow test. | EFNARC guidelines [11] |
| 2.         | Filling ability test that used with T<sub>50cm</sub>-Slump flow test. |                      |
| 3.         | Filling ability test that used with V-Funnel test. |                      |
| 4.         | Passing ability test that used with L-Box test. |                      |
| 5.         | The U-Box test for determining passing ability. |                      |
| 6.         | Compression Strength Test                  |                      |
4. SELF-COMPACTING CONCRETE APPROACH AND WAYS OF APPLYING SOLE LEATHER, FLAY ASH AND SUPERPLASTICIZERS IN CONCRETE

4.1 Approach’s for SCC (Self-Compacting Concrete)
A flawless self-compacting concrete mechanism should perceive superior flowability, ability to filling, ability to passing & resistance to segregation, which also can control the additive(admixture) chemical releases. Self-compacting concrete techniques are good approaches for rehabilitation of concrete. The autogenously self-compacting concrete techniques show good results with sole leather, fly ash & superplasticizers.

4.2 Mechanism of Applying Sole Leather, Fly Ash and Superplasticizers in Concrete
As per literature the sole leather, fly ash & superplasticizers is used to prepare the self-compacting concrete. Previous literature revealed that the application of sole leather, fly ash & superplasticizers in self-compacting concrete by directly, it has been revealed that SCC as a good carrier concrete for construction and it has given better results. The application of self-compaction concreting method used for finding out optimum workability for fresh concrete and hardened strength purpose. The sole leather used in this study was obtained from leather industries. The sole leather waste was applied as chipped to replace coarse aggregates in concrete mixture up to a percentage of 10%. The sole leather waste was obtained from shoes industries and used as small as shredded pieces. The workability of fresh concrete & the compression strength properties of hardened concrete cubes(15cm³) were tested on the self-compacting concrete specimens.

![Fig. 1: Methods to achieving self-compaction ability](image-url)
5. RESULTS AND DISCUSSIONS

5.1 SCC (SELF COMPACTING CONCRETE) FRESH PROPERTIES

5.1.1 TEST FOR T-SLUMP FLOW

SCC’s workability criteria are determined using this test. The findings of this test demonstrate that the concrete has high stuffing capacity (filling ability). Values continue to decline as fine aggregate & sole leather material becomes more abundant. Figure 2 depicts overall outcomes of such T-slump flow testing.

This test is intended to determine the self-compacting concrete's filling ability (high stuffing capacity) and workability standards (SCC). The results of this test reveal that the concrete has good filling ability up to SCC 15%F.A.+10%S.L., beyond which the high stuffing capacity values decrease. It may be due to the coarse material (sole leather & coarse aggregate) contents grow because flowing ability is lesser due to the resistance in materials.

5.1.2 \( T_{50cm} \) - SLUMP FLOW TEST

\( T_{50cm} \) - slump flow test is performed to ascertain the requirements for workability standards, which has stuffing capacity (filling ability) of SCC (Self-compacting concrete). The obtained outcomes are tallied in-to the beneath. Figure 3 depicts overall outcomes of such \( T_{50cm} \) slump flow testing.
In this test, it is used to known the filling ability (high stuffing capacity) and workability criteria of SCC (self-compacting concrete). The result demonstrates that, concrete has good filling ability up to an SCC 15%F.A.+10%S.L and subsequently the values downs(decreases) as the coarse material (sole leather & coarse aggregate) contents grow because flowing ability is low due to higher resistance.

5.1.3 V-FUNNEL TEST

The workability requirements are determined using this test on SCC. The test results are displayed in Fig 4.

![V-Funnel Test Values](image)

In this test, it is used to known the filling ability (high stuffing capacity) and workability criteria (EFNARC guidelines) of self-compacting concrete (SCC). The outcome of this project indicates that the concrete has a satisfactory filling ability up to a SCC 15%F.A.+10%S.L and then the values go on decreasing and segregation & bleeding started with an increase in the fly ash and sole leather contents.

5.1.4 LABORATORY TEST ON L - BOX TEST

L-Box test is intended to appraise both the workability and the ability of pass (passing ability) criteria. Figure 5 depicts overall outcomes of such L-Box testing.

![L-Box Test Values](image)

This test is designed to determine the self-compacting concrete (SCC) passing ability and workability standards. The outcome of this test indicates that the concrete has a strong passing capacity up to a certain point SCC 15%F.A.+10%S.L and then the values go on decreasing and segregation & bleeding started with an increase in the fly ash and sole leather contents.
5.1.5 U-BOX TEST
Self-compacting concrete (SCC) uses this test to determine the passing ability & workability requirements, one of which is transitory ability (passing ability). This test results are listed in Fig. 6.

![U-Box Test Values](image)

**Fig. 6: U-Box Test Values**

This test is designed to determine the self-compacting concrete (SCC) passing ability and workability standards. The outcome of this test indicates that the concrete has a strong passing capacity up to a certain point SCC₁₅%F.A.+₁₀%S.L. and then the values go on decreasing and segregation & bleeding started with an enhance to the fly ash and sole leather contents.

5.2 HARDENED PROPERTIES OF SCC RESULTS

5.2.1 TESTING ON CHARACTERISTICS COMPRESSION STRENGTH
Figure 7 depicts overall outcomes of such Compressive Strength Testing.

![Compression Strength Testing](image)

**Fig. 7: Compression Strength test @ 28 Days.**

The target mean strength (Fₘ) of 15cm³ cubes specimens for Self-compacting concrete with SCC₁₅%F.A.+₁₀%S.L. replacement is greater i.e. 41.10 MPa, which is compared to other concrete mixes SCC₁₀%F.A.+₁₇.₅%S.L. & SCC₁₅%F.A.+₁₀%S.L. replaced Self-compacting concrete with all the mix proportions. The target mean strength (Fₘ) values decreases but
achieve greater value at SCC$_{10\%F.A.+7.5\%S.L.}$ replacement i.e., 39.95MPa and after that target mean strength ($F_{\text{m}}$) values get decreased which is SCC$_{15\%F.A.+10\%S.L.}$ replacement i.e., 36.70MPa at 28 days compressive strength.

6. CONCLUSION

Based on the test results, following conclusions are drawn:

a) Based on the T Slump test, the filling ability of SCC-01 mix is higher as compared to other concrete mixes i.e., SCC-02 & SCC-03.

b) Based on the $T_{50CM}$ Slump flow test, the filling ability of SCC-01 mix is higher as compared to other concrete mixes i.e., SCC-02 & SCC-03.

c) Based on the V-Funnel test, the filling ability (high stuffing capacity) & workability of SCC-01 mix is better as compared to other concrete mixes i.e., SCC-02 & SCC-03.

d) Based on the L-Box test, the ability of pass (passing ability) criteria of SCC-01 mix is better as compared to other concrete mixes i.e., SCC-02 & SCC-03.

e) Based on the U-Box test, the passing ability & workability criteria of SCC-01 mix is better as compared to other concrete mixes i.e., SCC-02 & SCC-03.

f) Based on the concrete compression strength test, the target mean strength criteria of SCC-01 mix is much better as compared to other concrete mixes i.e., SCC-02 & SCC-03.

From these experimental studies, SCC (self-compacting concrete) with sole leather resulted in compressive strength close to the values for concrete only, and no significant reduction in concrete compression strength, but the concrete's compression strength was reduced of SCC-02 i.e., 39.95 MPa & SCC-03 i.e., 36.70 MPa in self-compacting concrete mix design. The workability lowered with increasing percentage of fly ash & sole leather. The specific conclusions are drawn from this study for concrete with sole leather waste. The workability was greater than conventional concrete using sole leather waste. Using sole leather waste causes dramatic decrease after 28 days water curing, when used as SCC$_{15\%F.A.+10\%S.L.}$.

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