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Self Compacting Concrete by Using E-Waste and Coconut Shell

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A B S T R A C T

High-performance concrete that can be poured and compacted under its own weight without the use of outside vibration is known as self-compacting concrete (SCC).This study looked into the possibility of using coconut shell and e-waste to partially substitute natural aggregates in SCC. E-waste and coconut shell were substituted for fine aggregates and coarse aggregates, at varying percentages of 3%, 6%, and 9% and 7%, 14%, and 21% respectively. The purpose of this study is to examine the usage of coconut shell and electronic waste (e-waste) as partial replacements for fine aggregate and coarse aggregate in SCC of M30 grade. According to the study, the compressive strength and tensile strength of SCC were decreased when coconut shell and e-waste were used as partial replacements for fine aggregates and coarse aggregates. However, The decrease was, within the allowed limits and can be made up for with a higher proportion of cement. The partial replacement of aggregates with e-waste and coconut shell had little or no effect on the fresh qualities of SCC. The research also demonstrated that using coconut shell and e-waste in the creation of SCC has a favorable effect on the environment by lowering the amount of garbage that is dumped in landfills.

Keywords: Self Compacting Concrete, E-Waste and Coconut Shell, Workability of concrete.

1. Introduction

SCC which stands for Self-Compacting Concrete is a type of concrete that has gained popularity in recent years due to its ability to flow easily and fill up complex moulds and structures without the need for vibration. This type of concrete is also known as self- Consolidating concrete, self-levelling concrete, or self-placing concrete, and is used in a wide range of construction projects, including buildings, bridges, and tunnels.SCC are gives smooth surface, reduced noise, less energy consumptions, less equipments, less labor, enhanced pumping, and high workability comparing with regular concrete, but SCC Construction costs increase, compared with regular concrete.

This paper The use of replacement for natural aggregates can be the best ways possible for making SCC economical besides without any change of mechanical properties to the concrete. Coming to the replacement materials we are using e-waste and coconut shell were used as a replacement for fine aggregates at different percentages of 3%, 6%, and 9%, and also natural coarse aggregates at and different percentages of 7%, 14%, and 21%.E-waste and coconut shell partial replacement of fine aggregate and coarse aggregates in the production of self-compacting concrete (SCC). This project aims to explore the feasibility and potential benefits of using these waste materials in SCC production. The increasing generation of e-waste and coconut shells have become a significant concern globally due to their adverse impact on the environment. However, by incorporating these waste materials in SCC production, we can not only reduce their environmental impact but also produce sustainable and cost-effective building materials. This project will provide a comprehensive overview of the research objectives, methodology, and expected outcomes of this project. It will also highlight the potential benefits and challenges of using e-waste and coconut shell as partial replacements of fine aggregate and coarse aggregates in SCC.

1.1 Objective of Project

- To determine optimum percentage of replacement of fine aggregates and coarse aggregates with e- waste and coconut shell.
- To determine mix design of the self compacting concrete for M30 grade.
- To find the fresh properties like workability of self compacting concrete with and without replacement of e- waste and coconut shell.
- To find the strength properties compressive test and tensile test of self -compacting concrete with and without replacement of e- waste and coconut shell.
- To make our structure in an economical cost without compromising the strength.
- To eliminate the e waste in the environment by using it in the concrete as aggregates.
- To investigate mechanical properties of self compacting concrete with e- waste and coconut shell as replacement for natural aggregates.

1.2 Scope of Project

- The project would involve developing an SCC mix design incorporating e-waste and coconut shell. The mix design would consider the desired properties of SCC, such as workability, strength, durability, and consistency.
- The fresh and hardened properties of SCC with e-waste and coconut shell would be evaluated using various standard tests. The properties to be tested would include compressive strength, splitting tensile strength.
- The project would also assess the environmental impact of using e-waste and coconut shell in SCC. This would include the potential reduction of e-waste and coconut shell in landfills, reduction of carbon footprint, and energy savings.
- The project would compare the properties of SCC with e-waste and coconut shell with those of conventional SCC to determine the feasibility of using e-waste and coconut shell as partial replacements for conventional aggregates.
- Finally, the project would conduct a cost analysis to determine the feasibility of using e-waste and coconut shell in SCC in terms of cost-effectiveness compared to conventional SCC.

2. Literature review

1) Prof. Pamnani Nanak J.et.al.(2013)

SCC is achieved by reducing the volume ratio of aggregate to cementitious materials, increasing the paste volume and using various viscosity enhancing admixtures and superplasticizers. It is observed that the behaviour of the design concrete mix is significantly affected by variation in humidity and temperature both in fresh and hardened state. In this paper effect of few water retaining curing techniques on compressive strength of M30 grade self-compacting concrete (SCC) is discussed.It is observed that polyethylene film curing gives very good compressive strength at 28 days about 95% of strength achieved through immersion method for curing; however early age compressive strength of specimens cured polyethylene film is more than immersion method.

2) VIJAI.K., et al. (2010)

SCC is achieved by reducing the volume ratio of aggregate to cementitious materials, increasing the paste volume and using various viscosity enhancing admixtures and superplasticizers. It is the use of superplasticizer which has made it possible to use w/c ratio as low as 0.25 or even lower and yet to make flowing concrete to obtain strength of the order 120 MPa or more. Building elements made of high strength concrete are usually densely reinforced.

3) GritsadaSua-iam, BurachatChatveera (2021)

The objective of this study is to investigate the influence of combined effects of substituting PCB dust as filler material and FA as pozzolanic filler material on the workability and mechanical properties of SCC. The design of the experiment set the level of FA replacement for 10%, 20%, and 30% and the level of PCB dust replacement for 5–30% by volume of cement. The effect of E-waste substituting for fine aggregates substitution was also studied and decreasing workability with the increasing percentage of E-waste substitution was reported which aligned with the results of the other mechanical properties.

4) Mazaheripour et al. (2011)

Studied influence of polypropylene fibers on Lightweight Self-Compacting Concrete (LLSCC) in fresh and hardened conditions. They found that polypropylene fibers did not affect elastic modulus and compressive strength of LLSCC due to their many parameters such as: maximum aggregate size, fiber volume, fiber type, fiber geometry, and fiber aspect ratio, fiber inclusion to concrete reduces the workability of concrete and they become viscid when added in LLSCC.While, usage of maximum percentage volume of polypropylene fibers, which it determined in their study, could increase flexural and splitting tensile strengths by 10.7% and 14.4% respectively.

5) A.RAVI TEJA et al (2022)

The strength property of M30 grade concrete was found. Mechanical parameters such as compressive strength, split tensile strength, and flexural strength are evaluated on a regular basis up to 28 days after curing.The current research compares self-curing concrete qualities with LECA as self-curing agents for water retention. In this investigation, lightweight aggregate (LECA) 0 percent, 10%, 15%, 20%, and with nano silica 1%, 2%, and 3% by volume percent were chosen. As the amount of self-curing chemicals in concrete grows, so does its workability. 0020At 15% of LECA, the highest compressive strength was 40.89 N/mm2. The corrosion of concrete was improved at 40% LECA, and by increasing the percentage of LECA above 40%, the corrosion was decreased, and the least corrosion was achieved at 100% LECA mix by adding 1% Nano silica to 100% LECA mix. SEM photos indicate that adding 1% Nano Silica to 100% LECA mixes fills all gaps and capillary channels, making the concrete.

6) Vedhasakthi and Saravanan(2014)

For denser and improving its mechanical and durability qualities. TheNormal Strength Self Curing Concrete of grade M20, M30 and M40, IS method of mix design was adopted. Mix proportions of High Strength Self Curing concrete of grade M60, M70 and M80 were obtained based on the guidelines given in modified ACI 211 method suggested by P.C.AITCIN. Super plasticizer dosage was varied with grade of concrete. Trial dosages of 0.8%, 1% and 1.2% of the weight of cement were used for M60, M70 and M80 grades of concrete respectively. Two self curing agents have been tried, out of which one has been found to be very effective. Trial dosage of 0.25% and 0.3% of the weight of cement was used for normal strength concrete and trial dosage of 0.4% of the weight of cement was used for High strength concrete.From the workability test results, it was found that the self curing agent has improved workability. It is found that concrete with this self curing agent gives more strength than that of the conventionally cured concrete.

3. MATERIALS AND METHODOLOGY

3.1 MATERIALS:

Cement*:*Ordinary Portland cement (OPC) of 53 grades was used in this project. SCC has become increasingly popular in the construction industry due to its advantages, including reduced labor costs, improved quality of finishes, and reduced noise pollution. Cement is a crucial component of SCC, as it is responsible for binding the aggregate particles together.

Water: This is the least expensive but most important ingredient of concrete. The quantity and quality of water is required to be looked in to very carefully. In practice very often great control on the properties of all other ingredients is exercised, but the control on the quality of the water is often neglected.

Fine Aggregate: Fine aggregates are defined as the material that passes through a 4.75mm sieve and retained on a 75-micron sieve. They are commonly used in construction works as a filling material, bedding material, and in the production of concrete, mortar, and asphalt. The Indian Standard code IS 383:2016 gives the specifications for fine aggregates in construction works.

Coarse aggregates: Thecoarse aggregate was obtained from a local crushing unit having varying sizes. Those aggregates were sieved Size of coarse aggregates of 4.75 mm to 10mm with 65% and 10mm to 20mm with 35% for use. 20mm well graded aggregate according to IS: 383-1970 was used in this investigation. Specific gravity of the coarse aggregate is 2.82.

3.2 Admixtures:

3.2.1 Mineral Admixtures:

GGBS: GGBS (Ground Granulated Blast Furnace Slag) is a byproduct of the steel industry and is widely used as a supplementary cementations material in the production of concrete. SCC (Self-Compacting Concrete) is a type of concrete that can flow and fill in complex shapes without the need for external compaction. The use of GGBS in SCC has several benefits. Firstly, GGBS can enhance the workability of concrete, making it easier to mix and pump. This can lead to improved efficiency and reduced labor costs during construction. GGBS can improve the durability and strength of concrete. The use of GGBS can reduce the permeability of concrete, which can prevent the ingress of harmful substances such as chloride ions and sulphates. This can help to increase the lifespan of concrete structures and reduce maintenance costs.

Fly Ash: Class C Fly ash was used with Specific Gravity 2.13, Ultra Tech RMC Plant, Dist. East Godavari, Andhra Pradesh India. The properties of Fly ash used are given in Table 1. Fly ash is a by-product of coal combustion in thermal power plants, and it is widely used as a supplementary cementations material in concrete. Self-compacting concrete (SCC) is a type of concrete that can flow and fill in all the spaces within the formwork without the need for vibration. The use of fly ash in SCC has several benefits. Firstly, it improves the workability of the concrete due to its fine particle size and spherical shape.

3.2.2 Chemical Admixtures:

Superplasticizer: Composed of more advanced, higher-value chemicals than standard and mid-range water reducers, superplasticizers decrease the water-cement ratio while providing such benefits as: increased density. improved bond strength. greater volume stability and reduced shrinkage cracking. We can use MYK arment,AquaArm proof WP10. Integral water proof liquid. It is make concrete denser, enhances workability, and chloride free.

3.3 Replaced Materials:

E-Waste: E- waste (PCB’s) is collected from electrical waste stores. It used were of size below 16mm so that it can easily replace the both fine aggregate and coarse aggregate with 3%, 6%, 9% percentage before mixing in concrete.

Fig 1: Before Cutting of E-Waste

Fig 2: After Cutting of E-Waste

Coconut Shell: Coconut shell is collected from oil industries, coconut forest. In this project crashed coconut shell are used of below 19mm size used as replacement the fine aggregate and coarse aggregate with 7%, 14%, 21% percentage before mixing in concrete.

Fig 3: Before Crashing of Coconut Shell

Fig 4: After Crashing of Coconut Shell

3.4 Finale Mix Proportion of SCC and Preparation of Specimen:

After doing number of trial mixings based on IS 10262, 2019 The finally mix proportion of SCC and preparation of specimen, There is no standard method for SCC mix design and many academic institutions, admixture suppliers, ready-mixed, pre cast and contracting companies have developed their own mix proportioning methods. Various trials were performed with 0.01 m3 of concrete with locally available materials and checked the fresh property tests (Slump flow, L-box and U-box) according to the standards of European Guidelines and IS 20162 2019 and finalized the mix proportion of M30 grade of SCC. Once the mix design was achieved, concrete cubes were cast. Slump Flow Test was carried out on each batch in order to ascertain concrete flow for self-compacting concrete. All concrete batches were prepared in rotating drum mixture. First, the aggregate are introduced and then one-half of the mixing water was added and rotated for approximate two minutes. Next, the cement, GGBS and fly ash were introduced with super plasticizer already mixed in the remaining water. Most manufactures recommend at least 5 minutes mixing upon final introduction of admixture.

Table-1 Mix proportions for reference mix design, Materials/m 3

Mix proportions for reference mix design, Materials/m 3	
Cement Kg	365
Fly-Ash , Kg 30%	163
GGBS, Kg 4%	22
Fine Aggt., Kg	785
Coarse Aggt., Kg	735
Water, Lit.	214.5
SP	1.07%

E-Waste and Coconut Shell are used about 10%, 20% and 30% of volume fraction of total volume of natural aggregates. Detaille cutting e-waste are replaced 3%, 6%, and 9% of fine aggregates and coarse aggregates of volume. And also coconut shell are replaced 3%, 6%, and 9% of fine aggregates and coarse aggregates of weight.

Table-2 Quantity of E-Waste And Coconut Shell

E-Waste (kg/m3)			**Coconut shell (kg/m3)**		
3%	**6%**	**9%**	**7%**	**14%**	**21%**
45.6	91.2	136.8	106.4	212.8	319.2

4. EXPERIMENTAL WORKS AND RESULTS

4.1 TESTS ON FRESH CONCRETE:

4.1.1 FILLING ABILITY TEST

It is the ability of SCC to flow into all spaces within the formwork under its own weight. Tests, such as slump flow, V-funnal etc, are used to determine the filling ability of fresh concrete. It is essential to reduce the coarse aggregate volume compared with conventional concrete, and to increase the volume of fine aggregate and the paste volume to enhance the filling ability.

Slump Flow Test: The Slump Flow Test is a common test for Self-Compacting Concrete (SCC) that determines the flow ability of the concrete mixIt is done to examine when freshly poured concrete is workable and, consequently, if concrete flows easily. It can also be used as a sign of a batch that was not properly blended. Due to the straightforward gear and straightforward process, the test is well-liked.

4.1.2 PASSIVE ABILITY TESTS

It is the ability of SCC to flow through tight openings, such as spaces between steel reinforcing bars, under its own weight. Passing ability can be determined by using U-box, L-box, Fill-box, and J-ring test methods.Passing ability is one property among the ones required in a self-compacting concrete, which verifies the concrete flowing capacity over the form, by passing through the concrete reinforcement without segregation or outflow obstruction occurrence.

L-Box Test: The L-box test measures both the passing ability and the filling ability of SCC because the extent to which concrete flows down the horizontal portion of the box depends on the yield stress (filling ability) of the concrete and the extent of blocking caused by the row of bars.

U-Box Test:U Box test is used to measure the filing ability of self compacting concrete. The apparatus consists of a vessel that is divided by a middle wall into two compartments; an opening with a sliding gate is fitted between the two sections

Table -3 Workability Test Results of SCC

s. no	**Test method**	**Units**	**Typical range of values as per EFNARC**	**Results of test**
1	Slump flow	mm	600 to 800	620
2	T 50-slump flow	Sec	2 to 5	3.8
3	L -box	h2/h1	0.8 to 1.0	0.83
4	U –box	h2-h1	0 to 30	10.2

4.2 HARDENED CONCRETE TESTS

4.2.1 Compressive Strength of SCC:

Table- 4 Results of Compressive Strength of SCC Using E-Waste And Coconut Shell

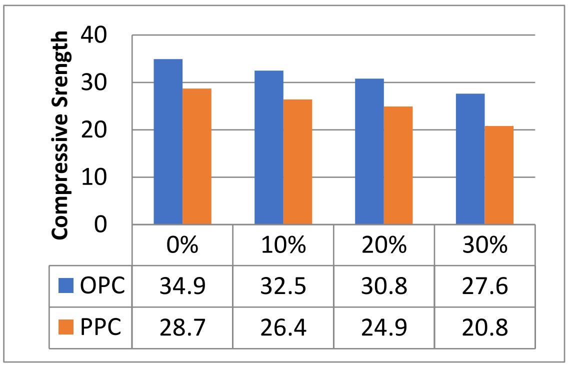
Types of cement	Percentage of e-waste and coconut shell	Duration of curing KN/m2	
		14 days	28 days
PPC	0%	25.83	28.7
OPC	0%	31.41	34.9
OPC	10%	29.16	32.5
OPC	20%	28.42	30.8
OPC	30%	20.35	27.6

4.2.2 Tensile Strength of SCC:

Table -5 Results of Tensile Strength of SCC Using E-Waste And Coconut Shell

Types of cement	% of e-waste and coconut shell	Duration of curing KN/m2	
		14 days	28 days
PPC	0%	3.55	3.75
OPC	0%	3.92	4.1
OPC	10%	3.78	3.99
OPC	20%	3.73	3.88
OPC	30%	3.66	3.67

4.3 DISCUSSIONS:



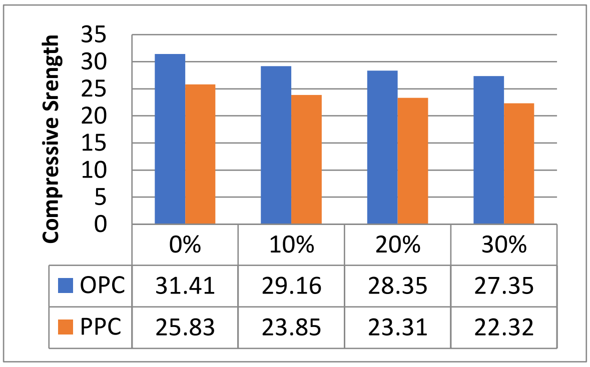
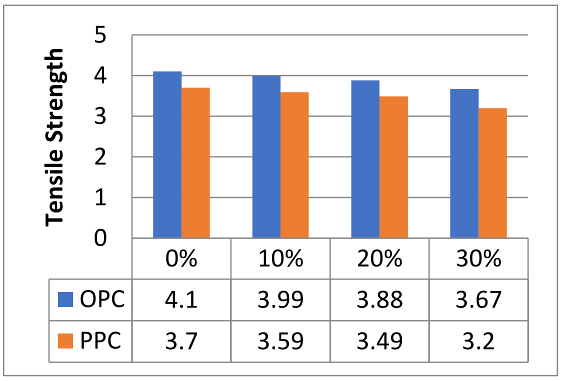


Fig 5: SCC Compressive strength of 28 days with e-waste and coconut shell

Fig 6: SCC Compressive strength of 14 days with e-waste and coconut shell

In chart 1 and chart 2 Compressive strength values of 28day and 14 days were obtained by dividing the loads the cubes can sustain by the area of cubes (15cmx15cm). From the table 5. it is evident that compressive strength of specimen decreased compared to the controlled specimen. Decrease in compressive strength is 6.8%, 11.74%, and 20.91% for 10%,20%,30% e-waste and coconut shell replacement respectively for M30 grade of self compacting concrete. It is evident that for M30 grade of self compacting concrete the maximum decrease in compressive strength is observed for 30% of e-waste and coconut shell replacement with fine aggregate and coarse aggregate. The values obtained showed that there is continuous decrease in Compressive strength with increase in e-waste and coconut shell content for each mix of concrete. The graph shows the both type of cement concrete cube there are OPC and PPC



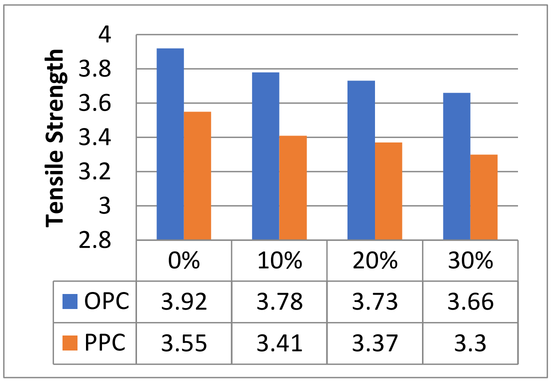


Fig7: **SCC Tensile strength of 28 days with e-waste and coconut shell**

Fig 8: SCC Tensile strength of 14 days with e-waste and coconut shell

In chat 3 and chat 4, The results from Split tensile strength test showed that the values are decreasing with increase in percentage of e-waste content i.e. 3%, 6% and 9% along with 7%, 14% and 21% coconut shell respectively. For M30 grade using OPC the decrement is 3.57%, 4.84%, and 6.63% for 10, 20, and 30 percentage replacement of e-waste and coconut shell respectively.The decrement is found to be maximum for 9% replacement of e-waste with

21% coconut shell for M30 grade of concrete. Maximum decrement in split tensile strength 6.63%. After comparing the values with compressive strength values it is observed that the percentage decrease in strength is less for split tensile test than compressive strength test.

6. CONCULUSION

Replacing of e-waste and coconut shell to the coarse aggregates & fine aggregate resulted in a decrease of compressive strength of specimen for the grade of concrete. Maximum decrease in strength was for 9 percentage replacement of e-waste & 21 percentage of coconut shell. Split tensile strength also decreased with increment in replacing of e-waste and coconut shell. Workability of SCC is good replacing of fine aggregate and coconut shell with e-waste and coconut shell. The study found that the use of e-waste and coconut shell as partial replacements for fine aggregate and coarse aggregates resulted in a reduction in the compressive strength of SCC. However, the reduction was within acceptable limits and can be compensated by using a higher proportion of cement or by combining e-waste and coconut shell in the same mix. The study also showed that the use of e-waste and coconut shell in SCC production has a positive impact on the environment by reducing the amount of waste that goes to landfills.

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