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An Experimental Study on Partial Replacement of Coarse Aggregates with Soft Drink Bottle Caps in Concrete

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Abstract: **- As we all know cement concrete is widely and commonly used in construction industry. All the materials required to make the concrete are extracted from the environment. The environmental resources are need to be used in control to protect the environment. There is excess amount of industrial waste that needs to treated so that it won't cause any harm to the surrounding human race and the other environmental elements. Here we are trying to deal with the large amount of metal waste generated in the form of soft drink bottle caps. These caps are hard to biodegrade therefore these can be recycled or reused. The experiment initiated with 0%, 5%, 10%, 15% replacement of coarse aggregate with waste bottle caps. M20 grade mix is used with 0.55 watercement ratio. The mechanical properties are tested by carrying out the compression test, flexural test and split tensile test.**

Keywords**: Soft drink bottle caps, Cement and Aggregates.**

1. INTRODUCTION

Aluminum bottle caps have excellent barrier properties, which can avoid the contamination of products by microorganisms, moisture or gas, so as to ensure safe storage of products, extend shelf life and validity period, and ensure flavor and taste. The bottle caps of the soft drinks and beverages and from some other sources are used as the additional reinforcing material the compressive strength, tensile strength and flexural strength characteristics of concrete are compared with the bottle cap concrete. The bottle caps of the soft drinks and beverages and from some other sources are used as the additional reinforcing material the compressive strength, tensile strength and flexural strength characteristics of concrete are compared with the bottle cap concrete. It sounds like you might be asking about the practice of embedding aluminum caps from soft drink bottles into concrete. This practice is sometimes done as a form of recycling or repurposing, often in DIY or craft projects. When you embed aluminum caps in concrete, they can create interesting patterns or textures, and they can also add a unique aesthetic to the concrete surface. Additionally, the aluminum caps can provide some reinforcement to the concrete, making it stronger in certain applications. However, it's worth noting that this practice may not be suitable for all concrete projects, and it's important to consider factors like the size and shape of the caps, as well as the overall design and intended use of theconcrete object.

2. LITERATURE REVIEW

Following are the research works conducted on concrete with various alternatives as partial to full replacement for coarse aggregate.

Najmtjddin (2014) From the results, it indicates that the optimum strength was achieved at 5.0% brick waste mix proportion and higher compared with the control sample, 0% brick waste mix proportion. The results also indicate that the optimum strength of brick waste concrete has achievedthe grade 25 of concrete.

Mary (2014) A study on the economic aspects was also carried out. The addition of fly ash helps to increase the strength and workability of concrete. The results obtained from above will be compared with conventional concrete of same mix.

Zeeshan (2015) In this work, we have made an attempt to study the compressive, split tensile and flexural strength of M20 grade cement concrete by using steel slag and waste limestone aggregate as partial replacement to fine aggregates and coarse aggregates. The compressive strength test is studied for 7 and 28 days of curing period and the split tensile and flexural strength is studied for 28 days of curing period.

Nilesh (2015) This paper gives idea about various waste materials used in concrete and their effects on various properties of concrete.

Balaraman and Anne (2015) The maximum compressive strength attained was 33.778 MPa and
38.222 MPa at 15% for both M20 and M25 grades of concrete respectively at 28 days. similarly, the maximum split tensile strength attained was 3.206 MPa and 3.819 MPa for M20 and M25 gradesat 15% and 5% respectively.

Shehdeh (2016) From the test results it was observed that the ultimate load carrying capacity of steel tubular beams filled with partial replacement of coarse aggregate by granite is almost the sameas that of conventional concrete.

Yamuna et al., (2016) This research helps to access the behaviour of concrete mixed with seashell and

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determination of optimum percentage of combined mixture which can be recommended as suitable alternative construction material in low-cost housing delivery especially in coastal areas and near fresh water where they are found as waste.

Marian and Johnny (2017) A reduction in the compressive strength as the percentage of e-plastic waste increases was observed, the maximum reduction being 44% with respect to the control mix. In addition, a significant reduction as much as 22% in the density of theconcrete mixes with e-plastic waste was recorded, which means that lighter elements can be produced with this type of concrete.

Shrikant (2017) Similarly the density is reduced as the percentage replacement increased. The compressive strength found to be decreases as the percentage replacement increases.

Rathod et al., (2017) Split tensile and flexural strength of 5.0 % bottle cap Fiber concrete increaseup to 1.72% and 13.23 % more than plain concrete (without bottle cap plastic) respectively.

Akram et al., (2017) Results shows that with the increase in the percentage and size of strips in concrete, the workability of concrete is decreased and the compressive strength is significantly increased in fiber made mix sector.

Etefa and Mosisa (2020) The overall results show that it is possible to use recycled rubber tires in concrete tile production as a partial replacement for coarse aggregates. Nevertheless, the percentage of replacement should be limited to 10%.

Hikmatullah and Vipasha (2020) Researchers suggest some waste material to increase the weakness of tensile strength. By adding soft drink aluminium fiber, it increases both flexural and tensile strength up to 40% than the conventional concrete.

Suryakanta (2021) This mix in the form of cubes and cylinders were subjected to compression and split tension to ascertain the strength parameter. Hence the use of plastic granules in concrete making is not only beneficial concrete. Maximum compressive strength, i.e. 33% more than control mix concrete, is obtained using 1.5" long with 3% of fiber strips.

Oad et al., (2018) Thus, the use of coarse aggregates from demolished concrete in new concrete isproved to be promising partial replacement of coarse aggregate in terms of flexural stress-strain relationship.

Rakesh (2020) Moreover, the concrete mix having 15% metakaolin and 100% RCA exhibits comparable results with control concrete. Therefore, sustainable concrete can be produced by taking the above combination of RCA and metakaolin as maximum waste concrete has been utilizedwithout affecting the properties of concrete.

Akash (2020) Thus, the objective of this review paper is "To review the possible use of sandstones as coarse aggregates obtained from Mahakoshal region, in cement concrete and also find out fresh and hardened state concrete properties."

Aejaz and Rajat (2020) One resulting from cutting worn tyres in the cement concretes. On this subject, several studies concerning the use of rubber aggregates resulting from crushing worn tyres were carried out. These applications prove how interesting it is to pursue new research fields that could show how end- of-life tyres can be reused competitively in the

but also helpful in disposal of plastic wastes.

Pothinathan (2022) The results indicate that replacing both the fine aggregate and coarse aggregate at 5% tend to improve the concrete behaviour adequately enabling the PCB as an ideal choice of replacement thus providing a safer choice to eliminate this e-waste without affecting the ecologicalbalance.

Anil et al., (2023) The rubber tire waste is split into coarse chips and then this crumb tire aggregate is added as 5%, 10%, 15% to replace the coarse aggregate. In this study, workability and compressive of rubberized concrete was evaluated to investigate the optimal use of crumb rubber as coarse aggregate in concrete.

3. EXPERIMENTAL PROGRAM

3.1 CEMENT: Cement when mixed with minerals fragments and water, binds the particles into a whole compact. Cement is the most important and costliest ingredient of concrete. Ordinary Portland cement of 53 grade confirming to requirements of IS: 12269 – 1987.

Table 1: Test results of cement

S.NO	PROPERTY	RESULTS
1.	Specific gravity	3.15
2.	Fineness	2.16 %
3.	Normal consistency	34 %
4.	Initial setting time	40 min
5.	Final setting time	330 min

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3.2 FINE AGGREGATE: As per IS 383-2016, Fine aggregate is defined as material that will pass a 4.75mm sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape.

Table 2: Test results of fine aggregate

S.NO	PROPERTY	RESULTS
1.	Specific gravity	2.63
2.	Fineness modulus	2.55
3.	Bulking	33.33 %
4.	Zone	II

3.3.1 COARSE AGGREGATE: As per IS 383-2016, Coarse aggregates can be defined as irregular broken stone or naturally-occurring rounded gravel used for making concrete. Coarse aggregates are retained on the sieve of mesh size 4.75mm. It acts as volume increasing componentand is responsible for strength, hardness and durability of concrete.

Table 3: Test results of coarse aggregate

S.NO	PROPERTY	RESULTS
1.	Specific gravity	2.72
2.	Fineness modulus	7.2
3.	Aggregate Impact value	20 %
4.	Aggregate Crushing value	21 %

3.3.2 SOFT DRINK BOTTLE CAPS (SDC): It sounds like you might be asking about the practice of embedding aluminum caps from soft drink bottles into concrete. This practice is sometimes done as a form of recycling or repurposing, often in DIY or craft projects. When you embed aluminum caps in concrete, they can create interesting patterns or textures, and they can also add a unique aesthetic to the concrete surface. Additionally, the aluminum caps can provide some reinforcement to the concrete, makingit stronger in certain applications.

Table 4: Test results of soft drink bottle caps

S.NO	PROPERTY	RESULTS
1.	Aggregate Impact value	5 %
2.	Aggregate Crushing value	6 %

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3.4 DESIGN MIX:

Table 5: Mix proportions

	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
By Weight kg/m^3	338.18	714.278	1187.25
By Volume	1	2.11	3.51

4. RESULTS AND DISCUSSIONS

4.1 COMPRESSIVE STRENGTH: The strength in compression has a definite relationship with all other properties of concrete In India cubical mould of size 150mm *150mm*150mm had casted and tested for 7days,14 days and 28days. The test results are tabulated below.

Figure 1: Cube under compression testing machine

Table 6: Compressive strength values

% Replacement of soft drink bottle caps	7 days compressive strength (MPa)	14 days compressive strength (MPa)	28 days compressive strength (MPa)
0	27.55	30.4	43.55
5	24.44	26.66	38.66
10	21.77	25.33	32.44
15	19.55	23.55	30.22

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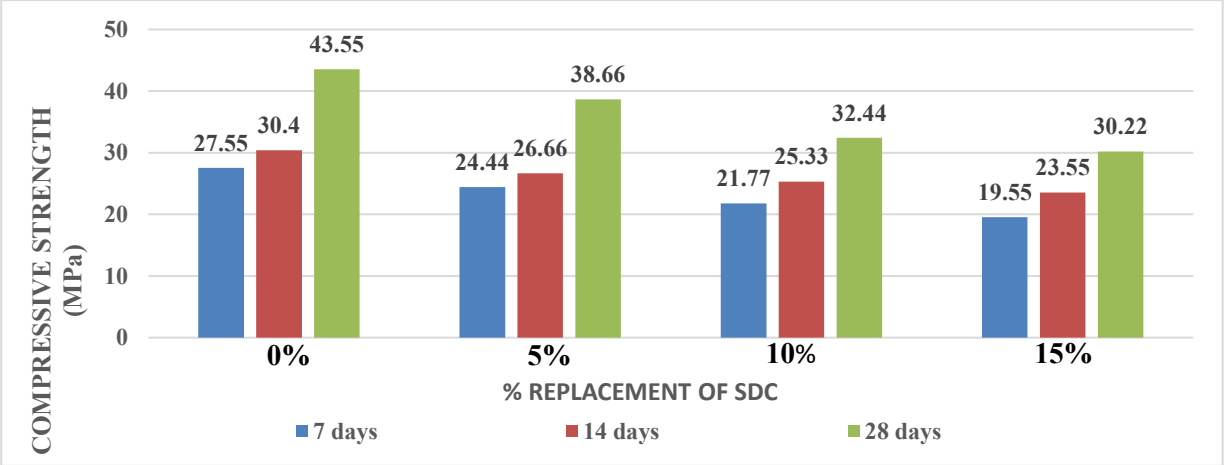

Figure 2: Compressive strength vs % Replacement of soft drink bottle caps

4.2 SPLIT TENSILE STRENGTH: The split tensile strength obtained by testing the specimen for M20 grade of concrete to all the mixes designed for various replacement given below.

Figure 3: Cylinder under split tensile testing machine

Table 7: Split tensile strength values

% Replacement of soft drink bottle caps	7 days split tensile strength MPa	14 days split tensile strength MPa	28 days split tensile strength MPa
0	1.414	1.697	1.768
5	1.202	1.414	1.556
10	1.061	0.99	0.848
15	0.99	0.707	0.565

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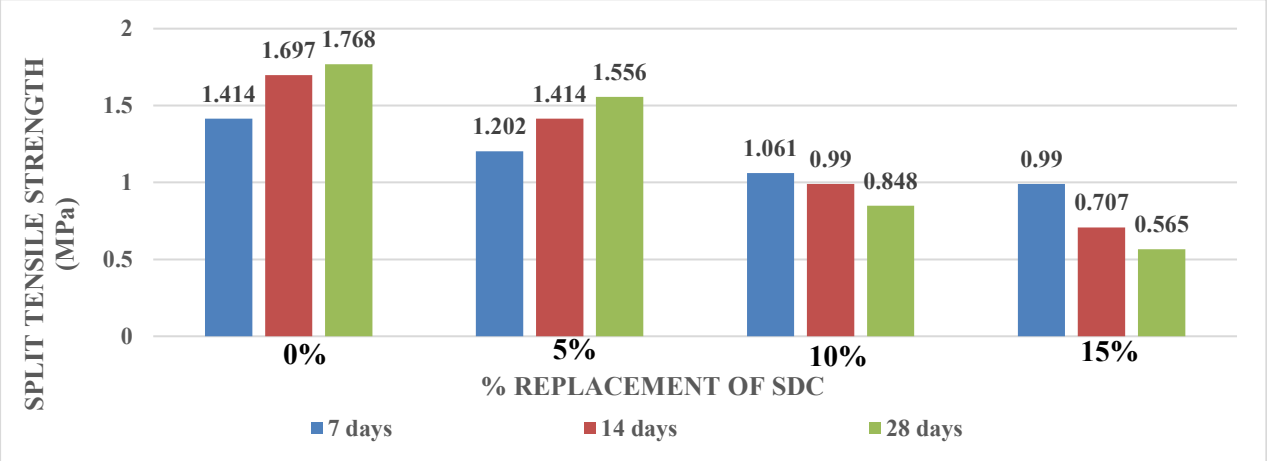

Figure 4: Split tensile strength vs % Replacement of soft drink bottle caps

5. CONCLUSIONS

- For a given water cement ratio, use of soft drink bottle caps in concrete lower the density, compressivestrength and split tensile strength.
- The compressive strength for 0 % replacement of coarse aggregate is 43.55 MPa and for 15% is 30.22 MPa. The tensile strength for 0 % replacement of coarse aggregate is 1.768 MPa and for 15% is 0.565 MPa.
- Soft drink bottle caps can be used to replace coarse aggregate in concrete. The compressive strength varies from 0 % replacement to 15 % replacement of Natural coarse aggregates, but with strength equal toor more than Target mean compressive strength.
- So, 5 % to 15 % Replacement of coarse aggregate with soft drink bottle caps is suggestible. Compressive, tensile strength are decreases from 5% to 15% replacement with Coarse Aggregate.

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