VOL. 13, NO. 23, DECEMBER 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences


www.arpnjournals.com

# STUDY OF STEEL SCRAP REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT WITH BAGASSE ASH

Priyesh P. K. and S. Senthil Selvan
Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai, India
E-Mail: priyesh_pushparaj@srmuniv.edu.in

## ABSTRACT

According to the report published by United Nations Food and Agricultural Organization in 2017, it is estimated that India presently produces 341.2 million metric tonnes of sugarcane, proving the fact that India is the second largest sugarcane producer on the globe. Sugarcane bagasse is a fibrous waste product recovered from the Sugar milling industry. There is an increasing threat of disposing the bagasse ash, as it causes serious environmental hazards. Hence, there is an immediate need to find an alternative solution to use the waste product in the form of bagasse ash, in an effective manner. Thus, this paper dealt with the replacement of cement using the bagasse ash in concrete. Furthermore, there has been numerous research made, into using steel fibre in concrete. Similar to steel fibre is steel scrap, which is a waste material from Lathe machines. Thereby, this paper will also deal with addition of steel scrap to the concrete, as the latter is much cheaper than steel fibres, which are normally used. Hence, a comprehensive study is made in the research, where concrete is prepared by partially replacing cement by bagasse ash and adding steel scrap to the volume of concrete, as a whole. Here, cement is partially replaced by bagasse ash by 0%, 5%, 10% and 15% by weight of cement in concrete. Similarly, steel scrap is added at dosage of 0%, 1% and 2% to the volume of concrete. The studies were conducted on 12 different combinations of bagasse ash and steel scrap being used in M20 grade of concrete. The parameters studied includes compressive strength, split tensile strength and flexural strength of concrete. The results are compared with conventional concrete and, the optimum combination of using both bagasse ash as a partial replacement material for cement and addition of steel scrap to the concrete, is determined.

**Keywords:** bagasse ash, steel scrap, compression test, split tensile test, flexural test.

## 1. INTRODUCTION

Ordinary Portland cement is one of the most frequently used materials by the construction industry all through the world. The cement manufacturing industry is under investigation these days, because of release of large quantum of $CO_2$, during its production. It has been evaluated that for every one ton manufacture of cement, it discharges one ton of $CO_2$ into the atmosphere. On an average, this industry accounts to 5% of worldwide carbon dioxide outflows.

The current pattern all over the world has been to reduce the consumption of cement in construction industry by utilizing the use of wastes from various sources like agriculture, industries, and so forth. In the present study, bagasse ash which is formed by burning the fibrous waste of sugarcane under controlled conditions is utilized efficiently with the view to cut down the consumption of cement in the manufacture of concrete. Earlier, investigations have been carried out on the ashes, which have pozzolanic properties in them, obtained from various sources, on the chances of using them as partial replacement of cement. Therefore, it legitimizes the potential extent of the present investigation which basically intends to decrease the consumption of cement in concrete, where cement is partially replaced by sugarcane bagasse ash, as the burned sugarcane bagasse ash is rich in amorphous silica, which has pozzolanic. In addition to this, steel scrap is added to the concrete in definite ratios, by the volume of concrete, and a study has been made to practically observe the behavior of concrete formed by partially replacing cement by sugarcane bagasse ash and by adding steel scrap.

In the present study, cement is partially replaced by sugarcane bagasse ash, by 0%, 5%, 10% and 15% of the weight of cement in the concrete. Similarly, steel scrap which is obtained from the lathe machine is added to the concrete in definite ratios of 0%, 1% and 2% of the volume of concrete. 12 different combinations of using sugarcane bagasse ash and steel scrap were studied comprehensively.

## 2. OBJECTIVE OF THE STUDY

The fundamental goal of the study was to determine the optimum proportion of using sugarcane bagasse ash and steel scrap in the concrete.

## 3. MATERIALS USED

The materials utilized as a part of the investigation are sugarcane bagasse ash, cement, steel scrap, fine aggregate, coarse aggregate and potable water. Every one of these materials are clarified underneath.

**Cement:** Ordinary Portland cement from 'Penna' cement brand of grade 53 affirming to IS:12269-1987 is used for the entire experimental investigation. The specific gravity of the cement used was observed to be 3.11.

**Fine aggregate:** Natural sand according to the code IS: 383-1987 are used. River sand passing through 4.75mm sieve are used for the casting of specimens. The specific gravity of fine aggregate used was observed to be 2.45.

**Coarse aggregate:** Crushed aggregates affirming to the code IS: 383-1987, passing through the sieve of 20 mm and retained in 16 mm are utilized. Specific gravity of the coarse aggregate was observed to be 2.90.

**Water:** Faucet water available from campus were utilized for the preparation and curing of the test specimens. Clean potable water is used in the entire concrete preparation and during curing periods. The water used for curing purpose are made to switch intermittently.

**Sugarcane Bagasse ash:** Sugarcane bagasse ash are gathered from Madurantakam Co-Operative Sugar Mills Limited, Padalam. These ash are finely powdered to the size of cement from a mill located nearby the campus. They are then made to dry at a room temperature before they are used for casting. The sugarcane bagasse ash which are sieved and retained in 45 μm sieves are utilized for the experimental works. The specific gravity of Sugarcane bagasse ash was observed to be 2.82.

**Steel scrap:** Steel scrap are collected from a steel scrap dealer in Ambattur. They are then made to dry at a room temperature before being used for casting. The steel scrap which are sieved and retained in 4.75 mm sieves are utilized for the experimental works. Figure-1 shows sample of steel scrap utilized in the study. The results of sieve analysis performed on the steel scrap sample used in the study, were graphically represented by means of Semi log chart as shown below:

**Figure-1.** Steel scrap.

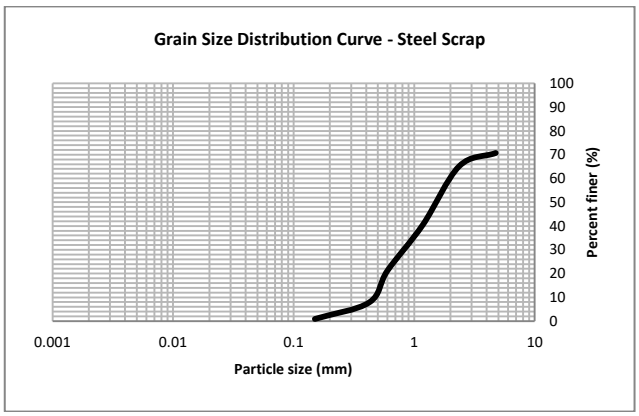


**Figure-2.** Grain size distribution curve - Steel scrap.

## 4. EXPERIMENTAL STUDY

The experimental work begins by figuring out the specific gravity values, to prepare the mix design for M20 grade concrete as per the guidelines given in Indian standard, to achieve the concrete of required strength and quality. The work begins by casting of 72 cubes, 72 cylinders and 72 beams, to explore the strength parameters. The size of mould used for cubes were 150x150x150mm, cylinders were 150mm diameter and 300mm height, and that of beam were 100x100mm cross section and 500mm in length. The concrete mix was prepared for 12 different combinations of sugarcane bagasse ash and steel scrap being used. In the present study, concrete is prepared by partially replacing cement by sugarcane bagasse ash and adding steel scrap to the concrete. Sugarcane bagasse ash is partially added in the ratios of 0%, 5%, 10% and 15%, whereas steel scrap is added in the ratios 0%, 1% and 2% to the volume of concrete. The water cement ratio used in this study is 0.50. The casted concrete specimens were cured under standard conditions in the campus and were tested in the research facility on $14^{th}$ and $28^{th}$ days for compressive strength, split tensile strength and flexural strength.

## 5. EXPERIMENTAL RESULTS

The concrete cubes were tested for compressive strength of $14^{th}$ and $28^{th}$ day of curing in the Standard Compression Testing Machine, and the outcomes were tabulated as follows:

**Table-1.** Average compressive strength.

| Designation of specimen | % of steel scrap | % of Bagasse ash | Compressive strength (N/mm$^2$) | |
|---|---|---|---|---|
| | | | 14$^{th}$ day | 28$^{th}$ day |
| S0B0 | 0 | 0 | 18.78 | 22.18 |
| S0B5 | | 5 | 18.99 | 22.82 |
| S0B10 | | 10 | 19.62 | 23.24 |
| S0B15 | | 15 | 18.91 | 23.01 |
| S1B0 | 1 | 0 | 19.31 | 22.47 |
| S1B5 | | 5 | 19.84 | 22.95 |
| S1B10 | | 10 | 20.13 | 23.55 |
| S1B15 | | 15 | 19.15 | 23.00 |
| S2B0 | 2 | 0 | 19.73 | 23.22 |
| S2B5 | | 5 | 20.09 | 23.78 |
| S2B10 | | 10 | 20.45 | 24.64 |
| S2B15 | | 15 | 19.98 | 24.18 |

Figure-3 represents the graphical potrayal of correlation of average compressive strength values for 12 combinations on 14$^{th}$ and 28$^{th}$ day.

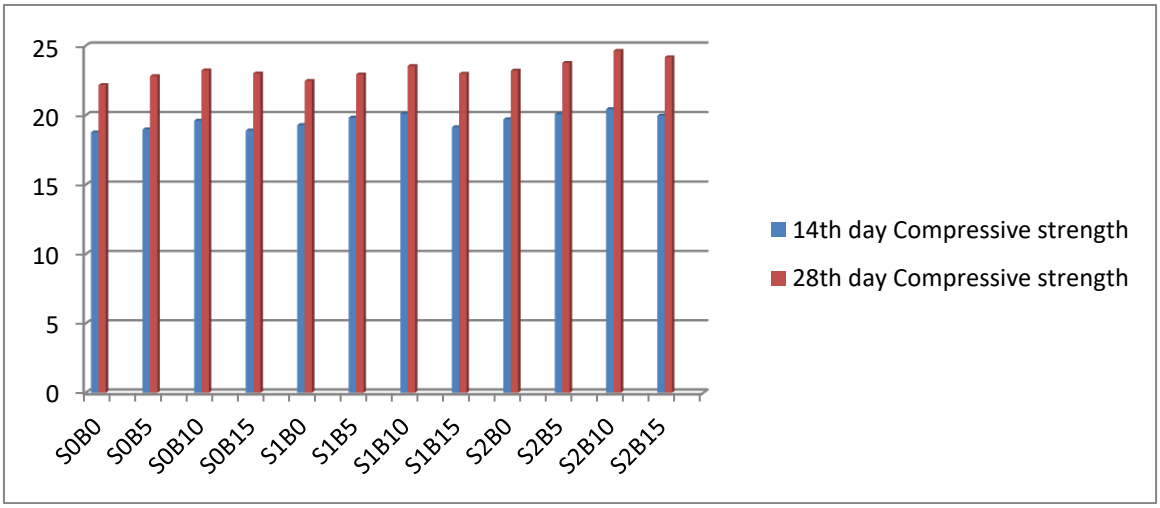


**Figure-3.** Average compressive strength.

The concrete cylinders were tested for split tensile strength of 14$^{th}$ and 28$^{th}$ day of curing and the outcomes were tabulated as follows:

**Table-2.** Average split tensile strength.

| Designation of specimen | % of Steel scrap | % of Bagasse ash | Split tensile strength (N/mm$^2$) | |
|---|---|---|---|---|
| | | | 14$^{th}$ day | 28$^{th}$ day |
| S0B0 | 0 | 0 | 1.812 | 1.990 |
| S0B5 | | 5 | 1.876 | 2.067 |
| S0B10 | | 10 | 1.954 | 2.152 |
| S0B15 | | 15 | 1.904 | 2.110 |
| S1B0 | 1 | 0 | 1.862 | 2.138 |
| S1B5 | | 5 | 1.997 | 2.209 |
| S1B10 | | 10 | 2.067 | 2.279 |
| S1B15 | | 15 | 1.989 | 2.209 |
| S2B0 | 2 | 0 | 1.996 | 2.195 |
| S2B5 | | 5 | 2.060 | 2.301 |
| S2B10 | | 10 | 2.188 | 2.428 |
| S2B15 | | 15 | 2.124 | 2.386 |

Figure-4 represents the graphical potrayal of correlation of average split tensile strength values for 12 combinations on 14$^{th}$ and 28$^{th}$ day,

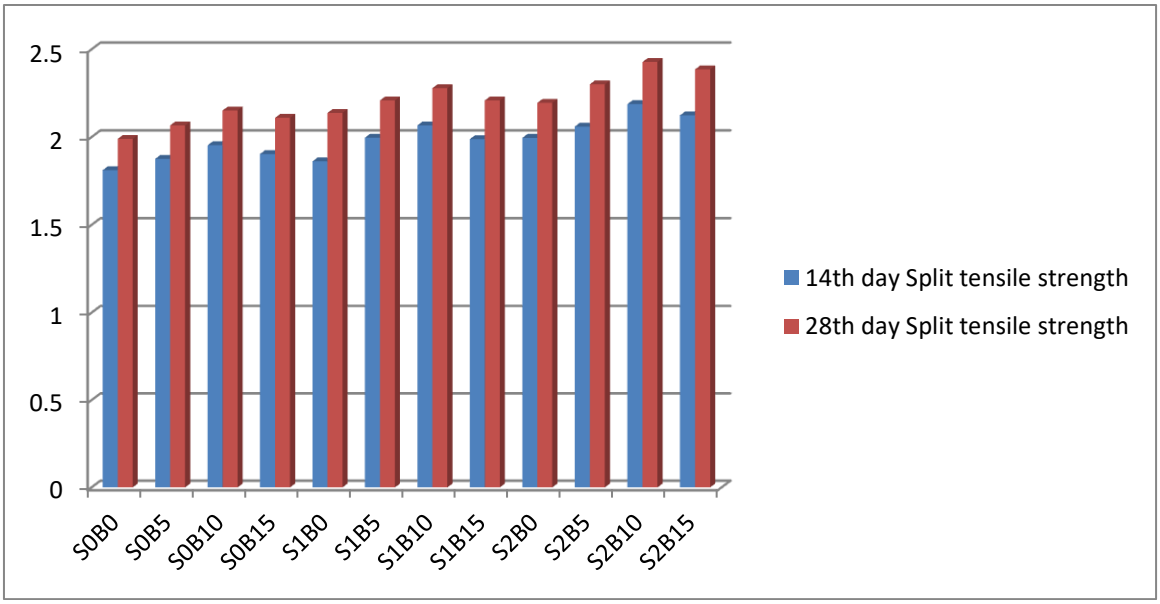


**Figure-4.** Average split tensile strength.

The concrete beams were tested for flexural strength of 14$^{th}$ and 28$^{th}$ day of curing and the outcomes were tabulated as follows:

**Table-3.** Average flexural strength.

| Designation of specimen | % of Steel scrap | % of Bagasse ash | Flexural strength (N/mm$^2$) | |
|---|---|---|---|---|
| | | | 14$^{th}$ day | 28$^{th}$ day |
| S0B0 | 0 | 0 | 2.2 | 3.0 |
| S0B5 | | 5 | 2.6 | 3.4 |
| S0B10 | | 10 | 3.4 | 4.0 |
| S0B15 | | 15 | 3.0 | 3.6 |
| S1B0 | 1 | 0 | 2.6 | 3.0 |
| S1B5 | | 5 | 3.2 | 4.2 |
| S1B10 | | 10 | 3.8 | 5.0 |
| S1B15 | | 15 | 3.4 | 4.6 |
| S2B0 | 2 | 0 | 3.4 | 3.8 |
| S2B5 | | 5 | 3.8 | 5.0 |
| S2B10 | | 10 | 5.0 | 5.8 |
| S2B15 | | 15 | 4.6 | 5.0 |

Figure-5 represents the graphical potrayal of correlation of average flexural strength values for 12 combinations on 14$^{th}$ and 28$^{th}$ day,

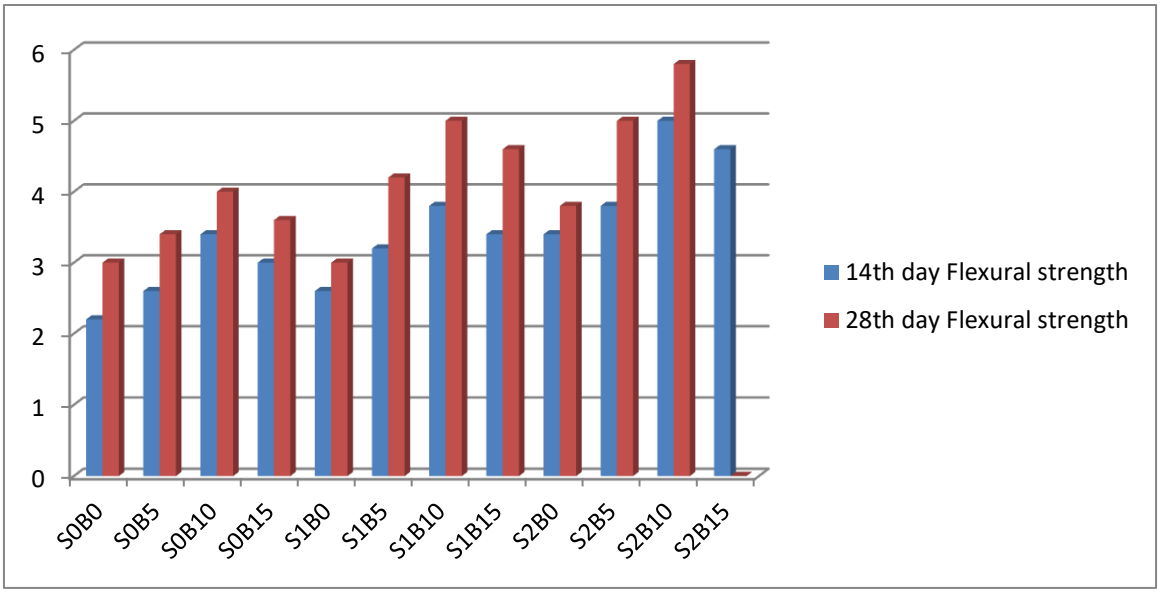


**Figure-5.** Average flexural strength.

## 6. RESULTS AND DISCUSSIONS

Upon comparing the results of compression test, split tensile test and flexural test, it has been evidently found that the optimum combination of using sugarcane bagasse ash and steel scrap in concrete was determined to be S2B10 i.e., (2% Steel scrap + 10% Bagasse ash). On the outcomes got, the percentage increase for the S2B10 specimens by comparing the results of compression tests with the conventional concrete was found to be 8.9% increase for 14$^{th}$ day and 11.1% increase for 28$^{th}$ day. Furthermore, on considering the results of split tensile tests, the percentage increase on comparing with conventional concrete, was 20.75% for 14$^{th}$ day and 22% for 28$^{th}$ day. Additionally, after considering the results of flexural tests, it was noticed that by comparing with the conventional concrete, the percentage increase reached a very high mark for 127% for 14$^{th}$ day and 93.3% for 28$^{th}$ day, respectively.

## 7. CONCLUSIONS

- The experimental outcomes demonstrate that the maximum compressive strength, split tensile strength and flexural strength were achieved for the combination designated as S2B10 (2% Steel scrap + 10% Bagasse ash).

- Post 10% of bagasse ash, the strength parameters were found to decrease. Hence, it reaffirms the statement that 10% is the optimum percentage of sugarcane bagasse ash to be partially replaced in cement.
- Likewise, based on the study conducted, it was also observed that the strength parameters considered, increases with increase in the percentage of steel scrap being added, in the ratios considered i.e., 0%, 1% and 2%, based on the volume of concrete.
- Thus, the optimum combination of using sugarcane bagasse ash and steel scrap was observed to be 2% of Steel scrap and 10% of Bagasse ash.

**REFERENCES**

[1] BIS - IS 10262: 2009. Guidelines for concrete mix design proportioning: Mix Design.

[2] BIS – IS 383: 1970. Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete. Bureau of Indian Standards, New Delhi, India.

[3] BIS - IS 516: 1959. Methods of Tests for strength of concrete. Bureau of Indian Standards, New Delhi, India.

[4] Jayminkumar A. Patel and Dr. D. B. Raijiwala. 2015. Experimental study on compressive strength of concrete by partially replacement of cement with sugar cane bagasse ash. International Journal of Engineering Research and Applications ISSN: 2248-9622, 5(4), (Part -7): 117-120.

[5] R.Srinivasan and K. Sathiya. Experimental Study on Bagasse Ash in Concrete. International Journal for Service Learning in Engineering. 5(2): 60-66, ISSN 1555-9033.

[6] Sultan A. Tarawneh, Emhaidy S. Gharaibeh and Falah M. Saraireh. 2014. Effect of using Steel slag aggregate on Mechanical properties of Concrete. American Journal of Applied Sciences. 11(5): 700-706, ISSN: 1546-9239.

[7] Ashish Kumar Parashar and Rinku Parashar. 2012. Utility of Waste Material as Steel Fibre in Concrete Mix M-20. International Journal of Advancements in Research & Technology. 3(1), ISSN: 0976-4860.