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Impact of Partial Utilization of the Recycled Aggregates on the Characteristics of the Concrete

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Abstract: Concrete plays a pivotal role in the infrastructure development. Despite in present era the composite structures are in practise the significance of the concrete structures still remains the same and utterly preferred between the duos. The primary conventional constituents of concrete are cement, fine aggregate, and coarse aggregate subjected to pertinent quantity of water for proper mixing. The major aim of the present study was to investigate the influence of partial replacement of the fine aggregate with the help of steel and wood waste in the conventional concreting technique. The research work includes the investigation of observational changes, compressive strength, and water absorption in composite concrete specimen when fine aggregate was replaced with 5 and 10% dosing of steel and wood waste respectively. Primarily the work focused on interpreting the changes in water absorption and compressive strength of the M_{20} grade of conventional and composite concrete to acquire an explicit idea regarding the dampness and durability of the structure. The experimental work revealed that the water absorption figures are comparatively lower in case of 10% recycled steel aggregate replacement whereas, replacement of wood waste failed to create any positive impact. On the other hand, similar observations were notices in case of durability. Both 5 and 10% replacement subjected to steel waste recorded higher values of compressive strength by 27 and 19 % approximately when compared to conventional M_{20} grade concrete. Contradictorily wood waste aggregate miserably failed to influence the strength and recorded lower than the anticipated values. Based on the observations received from experimental work it can be concluded that the partial replacement of the fine aggregate with the help of recycled steel waste is cost effective, more durable, and recommended.

Keywords: Compressive strength, Water absorption, Fine aggregate, Steel waste, Wood waste

I. INTRODUCTION

One of the most commonly utilized and globally accredited construction materials is Concrete [1]. A combination of coarse and fine aggregate contributes approx. 80% of the entire concrete volume which consumes worldwide 10-14 million tons of natural aggregate on annual basis [2, 3, 4]. Thus, it is clearly showcased that an escalating requirement for concrete aggregates may lead to the overutilization of fine river sand which may cause injurious catastrophes like variability of river bed, change in depth of water table, and negative hydraulic pressure with sea water intrusion. This possible consequences lead to a restriction of river sand extraction threshold by the governmental bodies, furthermore, affecting the cost of fine aggregate and impact the stability of construction market [5, 6]. Path breaking researches in this domain tried to propose sustainable and cost effective alternatives by exploring geophysical properties of recycled materials [7, 8, 9, 10, 11, 12]. But, unfortunately, still there has been a pertaining knowledge gap in terms of ratio of replacement, life period of the ultimate product etc. [13].

The ultimate objective of this research was to explore the feasibility of the recycled wood and steel waste in partial replacement of the river sand for concrete preparation.

II. MATERIALS AND METHOD

The experimental work beginning from the waste collection, processing and transformation, and finally the preparation of the concrete was performed in accordance with the norms prescribed from Bureau of Indian Standards (BIS) and the same has been delineated below.

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A. Waste Collection

Sawdust waste was collected from Sri Satyasai Industries, Hyderabad on the other hand steel waste was gathered from Shree Enterprises for free of cost.

B. Waste Processing

The raw sawdust obtained from the industry was application ready and thus no processing was involved for the same. Whereas, the steel scrap received from the supplier was bulk and needed micronization and homogenization and the same was carried out with the help of lab scale pulveriser. The processed wood aggregate and steel aggregate has been simultaneously portrayed in Fig. 1 and 2.

Fig. 1. Sawdust Aggregate

Fig. 2. Steel Aggregate

C. Ordinary Concrete Preparation

The ultimate step of composite concrete preparation was done by means of homogenously mixing 5 Kgs of cement, 15.43 Kgs of coarse aggregate and 8.755 Kgs of fine aggregate in a large non-absorbent tray. Finally, the mixed slurry was poured inside the cubical mould and water cured for next 28 days.

D. Composite Concrete Preparation

The preparation of the composite specimens was pursued by replacing the river sand 5 and 10% with the help of sawdust and steel waste respectively. Based on the weight mix design ratio 8.318 Kgs of fine aggregate was dosed with 0.437kgs of wood waste and 0.875kgs of steel waste for lab scale experiment.

As per the recommendation of BIS: 456 a mix ratio of 1: 1.5: 3.30 was adopted and the quantities of varies components are tabulated in Table I.

TABLE I
MIX RATIO

Water (lt.)	Cement (Kgs)	Fine Aggregate(Kgs)	Coarse Aggregate (Kgs)
186	372	558.07	1227.78
W/C=0.5	1	1.50	3.30

III. Results and Discussion

All of the specimen cubes were tested with the help of compression testing machines once the curing period got over. The test reports were satisfactory in the case of steel waste aggregate though the sawdust specimens miserably failed to develop the natural bonding and resulted in depleted compressive strength. The results of water absorption and compressive strength test have been tabulated in Table II and III respectively.

TABLE III
COMPARISON OF WATER ABSORPTION FOR 7 DAYS AND 28 DAYS

Type of concrete		7 days (%)	28 days (%)
Normal concrete		0.95	0.94
Wood Concrete	5% replacement	1.02	1.01
	10% replacement	1.73	1.50
Steel Concrete	5% replacement	0.97	0.95
	10% replacement	0.94	0.95

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TABLE IIIII
COMPARISON OF COMPRESSIVE STRENGTH FOR 7 DAYS AND 28 DAYS

Type of concrete		7 days (N/mm^2)	28 days (N/mm^2)
Normal concrete		12.02	19.98
Wood Concrete	5% replacement	9.73	16.21
	10% replacement	8.56	14.26
Steel Concrete	5% replacement	15.32	25.37
	10% replacement	14.28	23.80

The graphical representation of the above phenomenon of has been portrayed in Fig. 3 and 4 and it can be easily observed that sawdust concrete is comparatively weaker than the conventional concrete both in compression and water absorption. At the same time steel concrete showed a higher potential to be a promising alternative.

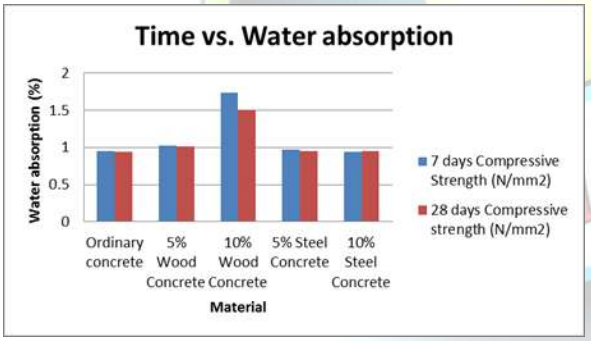

Fig. 3. Water absorption for 7 days and 28 days

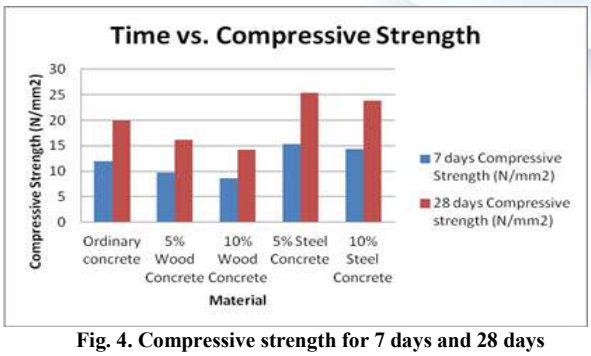

Fig. 4. Compressive strength for 7 days and 28 days

IV. CONCLUSION

The experimental work revealed that the water absorption value is less for the specimen prepared with 10% replacement of the recycled steel waste when compared to ordinary M_{20} grade concrete. Contradictorily the water absorption value is less for the conventional M_{20} grade concrete when compared to recycled sawdust concrete. The similar set of observation was recorded in the case of compressive strength as well. Therefore, it's quite evident to conclude that the partial replacement of the processed steel waste in fine aggregate is merely acceptable for market practise.

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BIOGRAPHY

Konda. Durga Sindhu Sree is a budding professional in the field of applied Environmental Sciences. She holds masters in the discipline of Environmental Engineering. She enhanced her greener outlook towards life and environment through the participation in various national and international environmental summits. Presently, she is employed as an intern at Ramky Enviro Engineers Ltd., Hyderabad.

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