Development of WPC Spacer Blocks using Waste Plastic

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Abstract: This study develops Wood-Plastic Composite Spacer Blocks (WPC-SB) using waste plastic and sawdust as sustainable alternatives to conventional concrete spacers. Samples were fabricated in varying ratios (e.g., 1:25 and 1:30 wood-to-plastic) and tested for water absorption (IS-3495:1992) and compressive strength (IS-14858:2000). The 1:30 sawdust-to-plastic ratio showed optimal performance, with low water absorption (4.11–5.26%) and strength up to (1.11–1.24 kN). Environmental tests confirmed eco-friendly, with minimal impact to the water quality (pH 8.67, turbidity 3.4 NTU, Dissolved Oxygen 23.4mg/lit). WPC-SB combines waste recycling, durability, and compliance with construction standards, offering a practical solution for sustainable infrastructure.

Keywords: Wood-Plastic Composite (WPC), Spacer blocks, Wood-Plastic Composite Spacer Blocks (WPC-SB), Mix Aggregate (MA), Waste Plastic (WP), Sawdust (S)

I. INTRODUCTION

The function of a spacer block in reinforced concrete is to support and secure reinforcing steel in proper position during construction so that the required concrete cover is achieved (IS 456). Following code is used for practicing and design standards for RCC structures.[1] Spacer Blocks play a very essential & vital role in maintaining the quality & strength of the structure. A good quality cover block with the correct thickness is essential to ensure the durability of the whole structure, in particular, to protect reinforcing steel against corrosion.
[1]

Plastics are widely used in various applications, ranging from bottles to tanks, toys to furniture, pens to computers, and clothes to vehicles, making it nearly impossible to measure their versatility. With the rising demand for plastic products, many industries either manufacture plastics or incorporate them into their products to meet consumer needs. Global plastic production is growing at an annual rate of approximately 8.6% (Plastics Europe, 2016), and it is estimated that by 2050, worldwide plastic manufacturing will reach 0.85 billion tons.[3] The lifeline and quality of waste plastic depends highly on the chemical & environmental characteristics of the deposit.[3]
Wood plastic composite (WPC) is a material made from a combination of wood fibers or sawdust and thermoplastic polymers such as polyethylene, polypropylene, or polyvinyl chloride.[2] This mix design utilizes the advantages of both wood and plastic, offering improved durability and resistance to moisture, insects, and decay compared to traditional wood products. They can be manufactured into various shapes and sizes, making them suitable for a wide range of applications, particularly in construction and outdoor structures.[2]

II. MATERIAL & METHODS

The research was conducted in Priyadarshini College of Engineering, Nagpur, India. It is located on 21°06'15"N & 79°00'27"E.

Methodology:

1. Selection of the raw materials.
2. Determining the physical & chemical properties of the raw materials.
3. Development of the spacer blocks with varying proportions of sawdust, plastic & mix aggregate.
4. Strength analysis of the developed spacer blocks.
5. Compression between the commercially available spacer blocks & developed WPC spacer blocks.

The material collected for the experiment was collected locally from hardware stores the sawdust obtained is of timber wood used for making house furniture. The sawdust particles were sieved 1.00 mm & 2.00 mm sieve[3]. The sawdust particles were completely dried in open atmosphere before use. The
plastic used was collected from old broken chairs collected from local venders. The plastic chairs were then shredded into small fine particles. The particles were sieved with 3.00 mm to 7.00 mm sieve.[4]

The particles were then fed in for open air heating together making them in following proportion of wood : plastic and wood : mix aggregate.

Table 1: Experiment Layout for Composite used

Sample	Name of proportion	Ratio	No. of Samples
Sample 1	Wood : Plastic	1:25	3
Sample 2	Wood : Mix Aggregate	1:25	3
Sample 3	Wood : Mix Aggregate	1:30	3
Sample 4	Wood : Plastic	1:30	3

The molten mixture was then placed into custom made oiled wooden mould of size (50mm* 40mm * 30mm) 3 samples of each ratio were developed, the moulds were allowed to settle and harden in the moulds for 24 hrs. and then were removed for determining the physical & environmental factors.

Physical Properties

1.Water Absorption Test:

The physical properties were determined by testing and analysing the different tests like water absorption test (Indian Standard: IS-3495:1992), the samples were submerged completely in water for 24 hrs. then was allowed to oven dry for next 24 hrs. both the initial and final weights of the samples were recorded and the water absorbed was recorded according to the following formula.

$$\frac{W2-W1}{WA} = \frac{}{W2} \times 100$$

WA = Water Absorption (%), W2 = Initial weight (g), W1 = Final weight (g)

2. Strength Test:

The strength analysis of the WPC-SB was determined by testing and analysing the compressive strength using the CTM (Compression Testing Machine) (Indian Standard: IS-14858:2000), the blocks were subjected to compressive load and the load was applied to until the breaking point & the readings were recorded accordingly.

Environmental Properties

The environmental properties were taken to determine the environmental impact caused by the waste plastic used in the WPC-SB samples, to determine the impact the blocks were submerged and allowed to rest in distilled water for 24 hrs. The following tests were performed on the distilled water.

1. **pH test:**
   To test the pH of the water sample (NAME OF EQUIPMENT) was used and the results were ***8.67.***
2. **Turbidity test:**
   To test the turbidity of the water sample (NAME OF EQUIPMENT) was used and the results were **3.4 NTU.**
3. **Dissolved Oxygen test:**
   To test the DO presence of the water sample (NAME OF EQUIPMENT) was used and the results were ***23.4 mg/lit.***

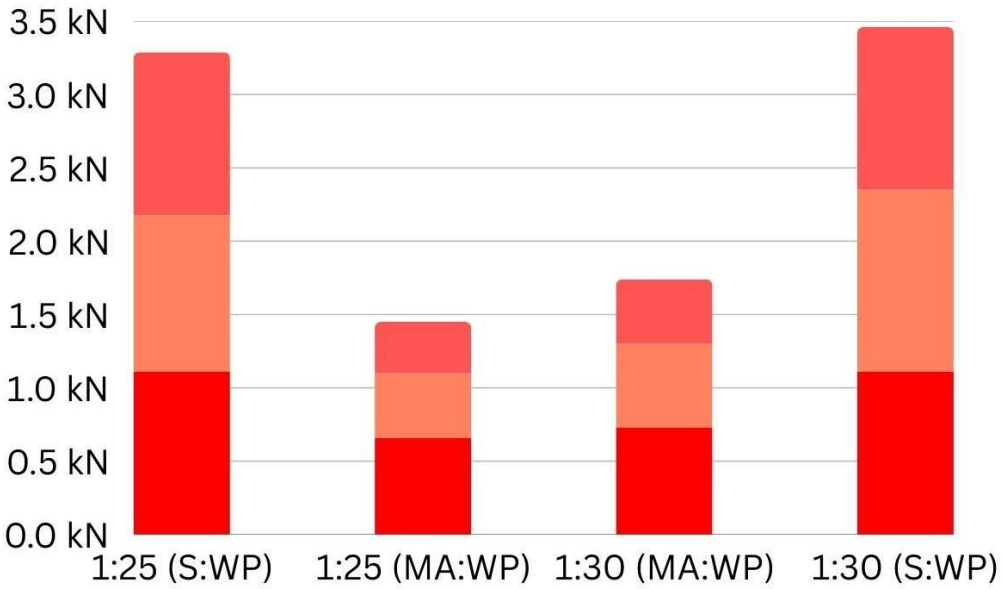
III. RESULTS AND DISCUSSIONS

The results of the water absorption test came as per the following table.

Sr. No.	Ratio	Oven Dried weight of WPC-SB (W1)	Saturated weight of WPC-SB (W2)	Water Absorption [(W2-W1)*100]/W2
1.	1:25 (sawdust:waste plastic)	65	70	7.65
2.		64	68	6.25
3.		78	69	11.53
4.	1:25 (mixed aggergate:waste plastic)	95	101	6.31
5.		100	108	8.00
6.		87	93	6.45
7.	1:30 (mixed aggergate:waste plastic)	80	87	8.04
8.		96	105	8.57
9.		79	86	8.86
7.	1:30 (Sawdust:waste plastic)	72	76	5.26
8.		70	73	4.11
9.		68	71	4.22

The results of the strength test came as per the following table.

Sr. No.	Sample	Load Resisted
1.	1:25 (sawdust:waste plastic)	1.11 kN 1.067 kN 1.11 kN
2.	1:25 (mixed aggergate:waste plastic)	0.66 kN 0.44 kN 0.35 kN
3.	1:30 (mixed aggergate:waste plastic)	0.73 kN 0.57 kN 0.44 kN
4.	1:30 (Sawdust:waste plastic)	1.11 kN 1.24 kN 1.11 kN



S- Sawdust, MA- Mix Aggregate, WP- Waste Plastic

Fig. Graph for strength test on spacer blocks

IV. CONCLUSION

This study has shown that development of WPC-SB is possible and also is actually a better alternative to commercially available SB as physical properties are better, also the used waste plastic is completely eco- friendly and is not leaving any harmful residue.

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