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COMPARATIVE STUDY ON COMPRESSIVE STRENGTH OF BLOCKS MADE BY WASTE PAPER SLUDGE AS PARTIAL REPLACEMENT WITH CEMENT

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Abstract

Nowadays, Paper production industries are producing large amount of solid waste. Many companies burn their sludge in incinerators which leads towards air pollution. This research is aim to evaluate the addition of waste paper to cement mortar blocks, to study the effect of waste paper on the strength of cement mortar blocks, and also worked on testing of waste paper sludge to find out the amount of chemical compounds are present which is co-related to cement.

The work shows the comparison of compressive strength of blocks made by waste paper sludge (WPS) as partial replacement with cement, normal cement mortar blocks and conventional clay bricks by taking a mould size as a standard size of conventional brick 19cm x 9cm x 9cm. We have used waste paper sludge as partial replacement with ordinary portland cement by 5%, 10%, 20% and 30% respectively and cure the blocks for 7days, 14 days and 21 days to compare the compressive strength by graph.

Keywords- *Low Cost Technology, Waste Paper Sludge, WPS Blocks, Normal Cement Mortar Blocks, Compressive Strength.*

I. INTRODUCTION

In order to make concrete industry sustainable, the use of waste materials in place of natural resources is one of the best approaches. Industrial waste is produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as that of factories, mills and mines.

Some example of industries waste is: Rubber, Plastic, Chemical solvent, Fly ash, Polymer fibers, Waste Paper, leather, glasses, wooden pieces, metals, PVC materials etc.

Recycling of this product is great way to dispose of industrial waste because the waste can be reused to make new product. Material such as glass and aluminum can be recycled and used in manufacturing other products. If there is industrial waste is can't be recycled in our planet anywhere waste seen therefore recycled is best way to make our planet green.

Production of paper all around world is about 8.4 to 11.2 metric tons per annum. Paper producing industries produce a large amount of solid waste. Many companies burn their sludge in incinerators which leads towards air pollution. Paper making generally produces a large amount of solid waste. Paper fibers can be recycled only a limited number of times before they become too short or weak to make high quality paper. It means that the broken, low quality paper fibers are separated out to become waste sludge. Uses of hypo sludge in brick can save the paper industry disposal costs and produce a 'greener' bricks for construction. An innovative supplementary compendious construction material formed through this study.

Figure 1. Waste Paper Sludge

II. MATERIAL SPECIFICATION & BLOCK DIMENSIONS

2.1. Cement

The most common cement used is an ordinary Portland cement. The Ordinary Portland cement of 53 grades conforming to (IS: 12269 1987) is use. Many tests were conducted on cement; some of them are standard consistency tests, Initial Setting Time (43 min) &Final Setting Time (5 h: 4 min). Specific gravity of cement is taken 3.15.

2.2. Sand

Sand used throughout the work comprised of clean river sand size of 0.425mm to 2.0mm. Suitable zone II as per IS383-1970 with specific gravity (G) of 2.6 and Bulk Density is 1588.98 Kg/m^3.

2.3. Water

The water used in the manufacture of WPS Blocks is potable water.

2.4. Waste Paper Sludge (WPS)

Waste paper sludge was obtained from Ashapura paper mill at NANIRELDI, DISTRIC KUTCH, Bhuj - 370105, Gujarat, India.

Figure 2: Waste paper sludge

Sludge disposal was in semi liquid form when we were collected it from factory. It is required to put waste paper sludge in sunlight to make it dry. After that it is required to grind dry material to convert it in powder form and checked that from which I.S. sieve this material would pass. It is find out that from 2.36 mm I.S. sieve, this material is passed.

Figure 3: Waste paper sludge in semi liquid form

Figure 4: Waste paper sludge in semi dry form

2.5. Chemical Components Present in WPS

Table 1: Chemical Components Comparison of waste paper sludge and opc cement

Waste Paper Sludge		OPC Cement	
Component	**Mass %**	**Component**	**Mass %**
SiO_2	4.88	SiO_2	19 to 23
SO_3	4.64	SO_3	1.5 to 4.5
Fe_2O_3	2.05	Fe_2O_3	0 to 6
Al_2O_3	3.12	Al_2O_3	2.5 to 6
CaO	83.5	CaO	61 to 67

After performing XRF Analysis on waste paper sludge, it was found that similar chemical components are present in percentage of mass in waste paper sludge and ordinary Portland cement. For that purpose we have used waste paper sludge as partial replacement with cement.

30	2.5	3.5	20	1.5	1		

2.6. Size of CLC Blocks

We have to prepare a mould as same size of the conventional brick. The standard size of conventional brick is 19cm x 9cm x 9cm. So we have casted same size of WPS blocks and check its compressive strength after 21 days of curing in lab.

Figure 5: Wooden formwork

III. MANUFACTURING PROCESS

3.1. Casting of WPS blocks

In this paper, we have casted total 45 blocks including normal cement mortar blocks and WPS blocks. The method of casting of WPS blocks is same as like normal cement mortar block. The standard size of the brick is 19cm x 9cm x 9cm, therefore same size of blocks are casted for comparison of compressive strength in different blocks after 7days, 14 days and 21 days of curing.

3.2. Quantity of materials

Here the volume of one block is 1.539 x 10-3 m^3, therefore the volume of nine blocks is 0.013851 m^3. The quantity of waste paper sludge material as partial replacement with cement in percentage of 5%, 10%, 20%, and 30% is given in blow table.

We have used the Mix Proportions of 1:4 and w/c ratio is 0.5.

Table 2: Mix proportion for volume of block 0.01385 m^3

Waste Paper Sludge replacement in (%)	Water content (lit)	Cement (kg)	Sand (kg)	Waste Paper Sludge (kg)	Additional water (lit)
0	2.5	5	20	0	0
5	2.5	4.75	20	0.250	0.7
10	2.5	4.5	20	0.5	0.8
20	2.5	4	20	1	0.8
30	2.5	3.5	20	1.5	1

IV. TEST RESULTS

4.1. Weight of blocks

This test is represents the comparison between convectional clay brick and waste paper sludge mortar blocks. The bases of this comparison are weight and compressive strength of convectional clay bricks and waste paper sludge mortar blocks.

Table 3: Weight comparison

Sr. No.	Waste Paper Sludge replacement in (%)	Weight of wet blocks (Kg)	Weight of dry blocks (Kg)
1	Clay brick	-	2.95
2	0 (Normal brick)	3.14	2.97
3	5 (WPS block)	3.20	3.02
4	10(WPS block)	3.21	3.10
5	20(WPS block)	3.09	2.94
6	30(WPS block)	3.04	2.94

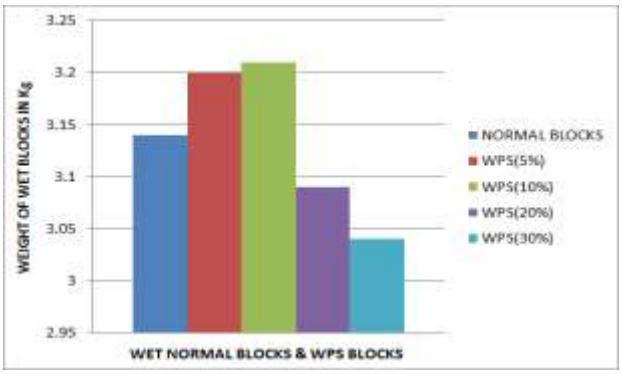

Figure 6: Weight of wet blocks

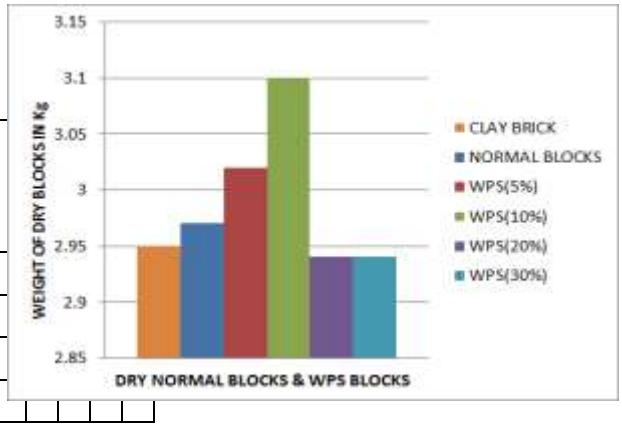

Figure 7: Weight of dry blocks

Table 4: Average Compressive Strength of different blocks after 7 days of curing

Sr. No.	Types of blocks	Average Compressive Strength (N/mm²)
1	Normal blocks	11.10
2	WPS replace by 5%	9.95
3	WPS replace by 10%	9.12
4	WPS replace by 20%	5.98
5	WPS replace by 30%	5.36

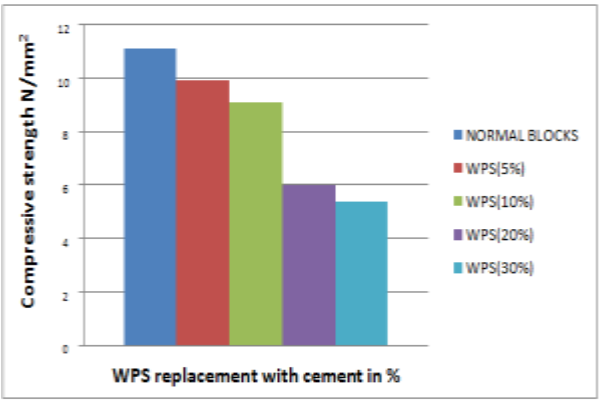

Figure 8: Strength of blocks after 7 days of curing

Table 5: Average Compressive Strength of different blocks after 14 days of curing

Sr. No.	Types of blocks	Average Compressive Strength (N/mm²)
1	Normal blocks	12.08
2	WPS replace by 5%	10.03
3	WPS replace by 10%	9.27
4	WPS replace by 20%	7.28
5	WPS replace by 30%	6.89

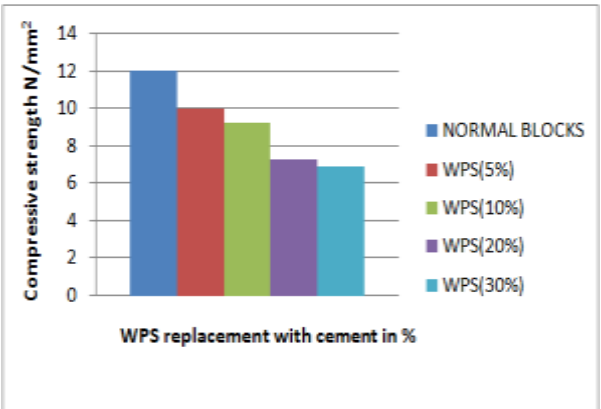

Figure 9: Strength of blocks after 14 days of curing

Table 6: Average Compressive Strength of different blocks after 28 days of curing

Sr. No.	Types of blocks	Average Compressive Strength (N/mm²)
1	Normal blocks	14.20
2	WPS replace by 5%	11.10
3	WPS replace by 10%	9.53
4	WPS replace by 20%	8.44
5	WPS replace by 30%	7.03

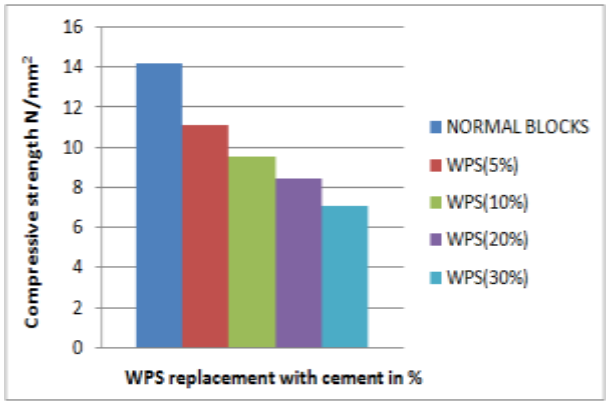

Figure 10: Strength of blocks after 28 days of curing

Table 7: Average Compressive Strength of different blocks after 7, 14 and 28 days of curing

Partial replacement of WPS with cement in (%)	Strength of block 7 days (N/mm²)	Strength of block 14 days (N/mm²)	Strength of block28 days (N/mm²)
Clay brick	-	-	4.5
0(Normal Block)	11.10	12.08	14.20
5(WPS Block)	9.95	10.03	11.10
10(WPS Block)	9.12	9.29	9.53
20(WPS Block)	5.98	7.28	8.44
30(WPS Block)	5.36	6.89	7.03

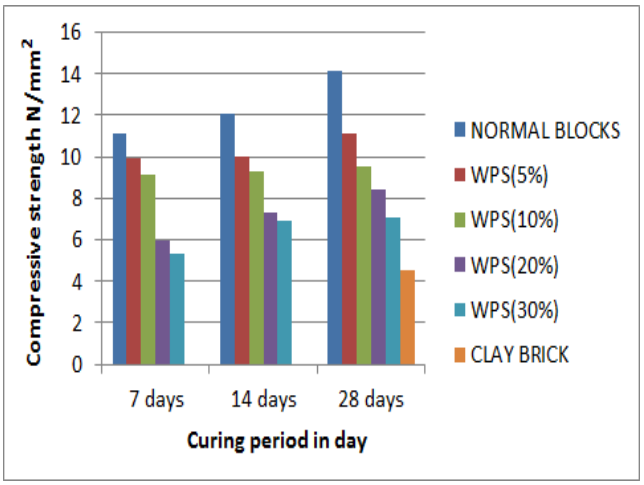

Figure 11: Strength of blocks after 7, 14 and 21 days of curing period

Table 8: Cost of blocks

Sr. No.	Types of blocks	Total cost of blocks in Rs.
1	Clay brick	7
2	Normal blocks	8.15
3	WPS replace by 5%	8.06
4	WPS replace by 10%	7.95
5	WPS replace by 20%	7.72
6	WPS replace by 30%	7.50

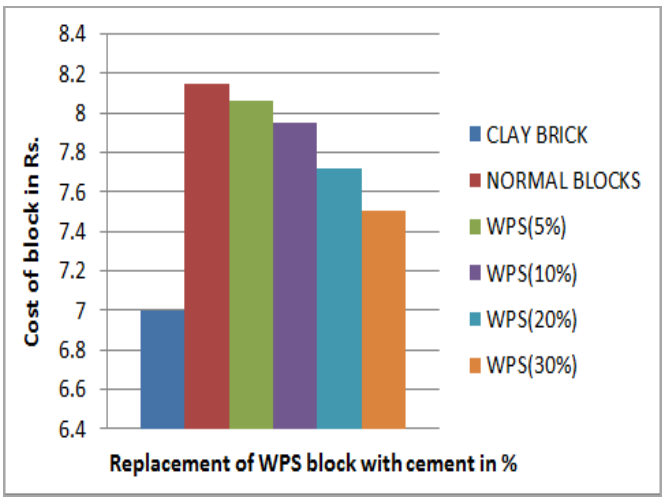

Figure 12: Cost of different blocks

CONCLUSION

The following conclusions are obtained from above study:

1) The most suitable mix proportion for partial replacement of waste paper sludge to cement is 5% to 10% because of strength is 24.97% increasing as compared as 20% and 30% replacement blocks 28 days.
2) Increase in waste paper sludge content in mix proportion then increase percentage of water absorption in block.
3) Weight of block is increasing 2.94% in waste paper sludge ratio 0% to 10% and weight decreasing 1.01% in waste paper sludge ratio 10% to 30%.
4) Workability of block decreases with increase in waste paper sludge content.
5) Compressive strength is decreases 24.97% in 20% to 30% by replacing cement with waste paper sludge and it is remain constant at 5% replacement with cement.
6) Maximum use of waste paper sludge replacement with cement will demolish disposal problem of waste paper sludge emission of harmful pollutants by burning waste paper.
7) Cost difference of clay brick and 30% waste paper sludge block is more than 0.50 Rs. cost of 30 % waste paper sludge block is 0.50 Rs more than clay bricks but strength of 30% waste paper sludge block is more than 35.98 % as compared clay bricks. That we can use waste paper sludge block for construction purpose.

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