PERFORMANCE EVALUATION OF CEMENT CONCRETE SOLID BLOCK BY PARTIAL REPLACEMENT OF FINE AGGREGATES BY SAWDUST AND CHARCOAL

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Abstract : There are many materials available for construction of solid blocks. Out of which in the current project, the M- sand solid block obtained by complete replacement of sand is taken as a reference block and then it is replaced by saw dust and charcoal partially and compared with the reference block. Meanwhile tests like Normal consistency, Specific gravity, Fineness modulus, Bulk Density and Sieve analysis, Setting time are conducted for materials used in the project and then compression strength are determined and compared. The block comprises good compressive strength is suggested.More over with the use of saw dust, charcoal powder the weight of the solid block reduces. This makes the solid blocks as a light weight block which in turn is an add on for light weight construction. Based on the experimental investigation concerning compressive strength, workability and the water absorption of the solid block are noted.

***Index Terms* – Cement, Fine aggregates, Sawdust, Charcoal.**

I.INTRODUCTION

Utilization of waste materials in concrete mixes is now recognized as one of the meaningful ways to dispose the solid waste from other industries. Apart from reducing the cost of concrete delivered, they provide several technical advantages such as reduced heat of hydration, improved cohesiveness and chemical resistance reduced bleeding and permeability and continuous strength improvement with age.The utilization of M-sand has been accepted as a building material in industries. As a result of sustained research and development works undertaken with respect to increasing application of the industrial waste, the level of utilization of M-sand in industrialized nations like Australia, France, Germany and UK has been reached more than 60% of its total production. The use this in India has not been much when compared to other countries.This project report discusses the result of an experimental investigation into the effect of the mix composition of the properties of M-sand block with charcoal powder and sawdust block.The purpose of this study is to develop a suitable mix composition of M-sand, charcoal powder and saw dust blocks using a locally available saw dust charcoal powder for the purpose of producing effective and economic load bearing lightweight blocks.Concrete blocks are made from cast concrete, e.g. Portland cement and aggregate, usually sand and fine gravel for high-density blocks. Lower density blocks may use industrial wastes as an aggregate. It has many advantages, such as durability, strength and structural stability, fire resistance, insulation, sound absorption and economical construction. Concrete masonry units are used for both load-bearing and non-load bearing walls, partitions and panel walls. Concrete masonry building units which are used in the construction of load-bearing and partition walls such as Hollow and Solid load- bearing and non-load bearing concrete blocks shall conform to the IS: 2185-1 (2005).

II.OBJECTIVES

To study the influence of saw dust and charcoal as partial and complete replacement on M-sand for solid block.To provide information on use of combination of M-sand ,charcoal powder and saw dust.To compare the compressive strength of M-sand solid block with saw dust, charcoal powder and their combination with M-sand.To make it as a light weight solid block as alternative to conventional solid block.In this project the main objective is to utilize sawdust charcoal and their combination as a replacement of M-sand .

III.METHODOLOGY

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IV.TESTS ON CEMENT

1.1 Specific Gravity

Table 1.1: Specific gravity test on cement

Description of item	Trial 1	Trial2	Trial 3
Weight of empty bottle W1 g	51	51	51
Weight of bottle +Cement W2g	77	68	71
Weight of bottle +Cement + Kerosene W3 g	149	143	146
Weight of bottle + Full Kerosene W4 g	130	130	130
Weight of bottle + Full Water W5 g	150	151	150

1.2 Consistency Test

Weight of given sample of cement is 100 gm.The normal consistency of a given sample of cement is 31%.Volume of water addend (0.85 times the water required to give a paste of standard consistency) for preparation of test block 30.4 ml.

1.3 Setting Time Test

Initial Setting Time=48mins.
Final Setting Time=6hrs 40mins.

V.TESTS ON FINE AGGREGATES

2.1 Specific Gravity

Table 2.11: Specific gravity test on M-Sand

W1- Weight of empty pycnometer with lid	0.627kg
W2- Weight of pycnometer + M-sand	1.107kg
W3 –Weight of pycnometer +M-sand + water	1.771kg
W4-Weight of pycnometer +water	1.482kg
Specific gravity of M-Sand	**2.513**

Table 2.12: Specific gravity test on Sawdust

W1- Weight of empty pycnometer with lid	0.627kg
W2- Weight Of Pycnometer + Sawdust	0.710kg
W3 -Weight Of Pycnometer +Sawdust+Water	1.509kg
W4-Weight of pycnometer +water	1.471kg
Specific gravity of sawdust	**1.903**

Table 2.13: Specific gravity test on Charcoal

W1- Weight of empty pycnometer with lid	0.627kg
W2- Weight of pycnometer + charcoal	0.772kg
W3 -Weight of pycnometer + charcoal + water	1.39kg
W4-Weight of pycnometer +water	1.471kg
Specific gravity of Charcoal	**0.659**

2.2 Fineness Modulus

Table 2.21: Fineness modulus on M-Sand

Mass of M-sand taken (M)=0.5Kg

Sieve Sizes	Mass of empty sieves (M1) (Kg)	Mass Of The Sieve + Mass Of The M-Sand (M2) (Kg)	Mass Of The M-Sand(M2-M1) (Kg)	%Retained In Each (M2-M1)/M *100	Cumulative	% Finess
4.75mm	0.372	0.373	0.001	0.2	0.2	99.8
2.36mm	0.328	0.375	0.047	9.4	9.6	90.4
1.18mm	0.333	0.475	0.142	28.4	38	62
600µ	0.313	0.413	0.1	20	58	42
300µ	0.335	0.474	0.139	27.8	85.8	14.2
150µ	0.306	0.342	0.036	7.2	93	7
75µ	0.298	0.324	0.026	5.2	98.2	1.8
Pan	0.297	0.311	0.014	2.8	101	0
Fineness modulus =4.83%						

Table 2.22: Fineness modulus on Sawdust

Sieve Sizes	Mass of empty sieves (M1) (Kg)	Mass Of The Sieve + Mass Of The M-Sand (M2) (Kg)	Mass Of The M-Sand(M2-M1) (Kg)	%Retained In Each (M2-M1)/M *100	Cumulative	% Finess
4.75mm	0.372	0.373	0.001	0.2	0.2	99.8
2.36mm	0.328	0.334	0.006	1.2	1.4	98.6
1.18mm	0.333	0.440	0.107	21.4	22.8	77.2
600µ	0.313	0.590	0.277	55.4	78.2	21.8
300µ	0.335	0.408	0.073	14.6	92.8	7.2
150µ	0.306	0.324	0.018	3.6	96.4	3.6
75µ	0.298	0.306	0.008	1.6	98	2
Pan	0.297	0.301	0.004	0.8	98.8	1.2
Fineness modulus =4.88%						

Table 2.23: Fineness modulus on Charcoal

Sieve Sizes	Mass of empty sieves (M1) (Kg)	Mass Of The Sieve + Mass Of The M-Sand (M2) (Kg)	Mass Of The M-Sand(M2-M1) (Kg)	%Retained In Each (M2-M1)/M *100	Cumulative	% Finess
4.75mm	0.372	0.374	0.002	0.4	0.4	99.6
2.36mm	0.328	0.441	0.113	22.6	23	77.7
1.18mm	0.333	0.509	0.176	35.2	58.2	41.8
600µ	0.313	0.384	0.071	14.2	72.4	27.6
300µ	0.335	0.426	0.091	18.2	90.6	9.4
150µ	0.306	0.329	0.023	4.6	95.2	4.8
75µ	0.298	0.316	0.018	3.6	98.8	1.2
Pan	0.297	0.305	0.008	1.6	100.4	0.4
Fineness modulus =5.39%						

2.3 Bulk density of Fine aggregates

Diameter of the container (d)	150mm
Height of the container(H)	172mm
Area of the container (A)	$0.0176m^2$
Volume of the container (V)=(A*H)	$3.039*10^{-3}m^3$

Table 2.31: Bulk Density of M-Sand

State	Empty Weight of Container (M1kg)	Empty Weight of Container +M sand(M2kg)	Volume of the Container(m^3)	Bulk Density In Kg/ m^3
LOOSE	1.940	6.760	$3.039*10^{-3}m^3$	1586.07
COMPACT	1.940	7.440	$3.039*10^{-3}m^3$	1809.805

Table 2.32: Bulk Density of Sawdust

State	Empty Weight of Container (M1kg)	Empty Weight of Container +M sand(M2kg)	Volume of the Container(m^3)	Bulk Density In Kg/ m^3
LOOSE	1.940	2.76	$3.039*10^{-3}m^3$	269.92
COMPACT	1.940	2.9	$3.039*10^{-3}m^3$	335.61

Table 2.33: Bulk Density of Charcoal

State	Empty Weight of Container (M1kg)	Empty Weight of Container +M sand(M2kg)	Volume of the Container(m^3)	Bulk Density In Kg/ m^3
LOOSE	1.940	3.400	$3.039*10^{-3}m^3$	4480.56
COMPACT	1.940	3.56	$3.039*10^{-3}m^3$	533.07

2.4 Bulking density

Table 2.41: Bulking of M-Sand

Sl.No	Description	Sample Number		
1	Volume of loose M-sand (mL)	1000	1000	1000
2	Volume of water (mL)	500	500	500
3	Volume of saturated M-sand (mL)(Y)	820	800	780
4	Bulking of m-sand (%) =((1000-Y)*100)/Y	21.95	25	28.2

Table 2.42: Bulking of Sawdust

Sl.No	Description	Sample Number		
1	Volume of loose Sawdust (mL)	1000	1000	1000
2	Volume of water (mL)	500	500	500
3	Volume of saturated Sawdust(mL)(Y)	650	600	620
4	Bulking of Sawdust(%) =((1000-Y)*100)/Y	35	40	38

Table 2.43: Bulking of Charcoal

Sl.No	Description	Sample Number		
1	Volume of loose Charcoal (mL)	500	500	500
2	Volume of water (mL)	250	250	250
3	Volume of saturated Charcoal (mL)(Y)	400	380	350
4	Bulking of Charcoal (%) =((1000-Y)*100)/Y	20	24	30

VI.TESTS ON COARSE AGGREGATES

2.5 Specific Gravity

Table 2.51: Specific Gravity of Coarse Aggregate

W1- Weight of empty pycnometer with lid	0.627kg
W2- Weight of pycnometer + C.A	0.958kg
W3 -Weight of pycnometer + C.A+ water	1.684kg
W4-Weight of pycnometer +water	1.480kg
Specific Gravity of Coarse aggregate=2.606	

Table 2.52: Fineness modulus of coarse aggregate

Sieve Sizes	Mass of empty sieves (M1) (Kg)	Mass Of The Sieve + Mass Of The M-Sand (M2) (Kg)	Mass Of The M-Sand(M2-M1) (Kg)	%Retained In Each (M2-M1)/M *100	Cumulative	% Finess
40	0.880	0.880	0.	0	0	100
25	0.820	1.140	0.320	6.4	6.4	93.6
20	0.840	2.080	1.24	24.8	31.2	68.8
16	0.920	3.060	2.140	42.8	74	26
12.5	0.760	1.74	0.980	19.6	93.6	6.4
10	0.780	0.988	0.200	4	97.6	2.4
4.75	0.820	0.92	0.100	2	99.6	0.4
Fineness modulus =5.02%						

Table 2.53: Water absorption test

Sl. No	Property	Result	Standard value
1.	Water absorption	0.8%	Less than 2.5%

VII.CASTING

The samples were casted by using mould of size 400mm*150mm*200mm. The concrete mix of different proportions of various fine aggregates was filled in the mould in 3 layers by using mechanical compaction. The following samples were casted:

9- samples of 100% M-sand solid block
9- samples of 25% charcoal +75% M-sand solid block
9- samples of 50% charcoal + 50% M-sand solid block
9- samples of 75% charcoal + 25% M-sand solid block
9- samples of 25% sawdust + 75% M-sand solid block
9- samples of 50% sawdust + 50% M-sand solid block
9- samples of 75% sawdust + 25% M-sand solid block
9- samples of 50% m-sand +25%sawdust + 25% charcoal solid block

VIII.CURING

Curing of Concrete is a method by which the concrete is protected against loss of moisture required for hydration and to keep within the recommended temperature range. Curing will increase the strength and decrease the permeability of hardened concrete. A curing practice involves keeping the concrete damp or moist until the hydration of concrete is complete and strength is attained. In this investigation, immersion method of curing was practiced.

Immersion Method:-This is the best water curing method. In immersion method, finished concrete blocks will be immersed in the curing tank or curing pond. This method of total immersion is practically not possible unless the concrete is a laboratory test specimen for small precast units.

IX.RESULTS

2.6 Compressive Strength

Total no.of blocks casted:9 blocks

Dimension of the block: Length(l)=400mm Breadth(b)=200mm Depth(h)=150mm

Area=l*b=80*$10^3$$mm^2$

Table 2.61: Type of Block:100% M-sand solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	15/03/19	23/03/19	05/04/19
Weight of Block(kg)	28.89	30.96	32.7
Load at failure(kN)	961.67	1141.33	1583.5
Compressive Strength(N/mm^2)	12.02	14.26	19.79
Density of Block(kg/m^3)	2407.5	2580	2725

Table 2.62: Type of Block:75% M-sand 25% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	15/03/19	22/03/19	05/04/19
Weight of Block(kg)	24.66	25.83	26.3
Load at failure(kN)	292	360.5	461.5
Compressive Strength(N/mm^2)	3.65	4.5	5.76
Density of Block(kg/m^3)	2055	2152.5	2191.66

Table 2.63: Type of Block:50% M-sand 50% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	16/03/19	22/03/19	05/04/19
Weight of Block(kg)	22.48	23.35	24.6
Load at failure(kN)	127.5	151.5	261
Compressive Strength(N/mm^2)	1.59	1.89	3.26
Density of Block(kg/m^3)	1873.33	1945.8	2050

Table 2.64: Type of Block:25% M-sand 75% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	16/03/19	22/03/19	05/04/19
Weight of Block(kg)	24.25	21.34	20.435
Load at failure(kN)	272.5	324	349.5
Compressive Strength(N/mm^2)	3.405	4.04	4.365
Density of Block(kg/m^3)	2020.83	1778.33	1702.9

Table 2.65: Type of Block:75% M-sand 25% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	09/03/19	11/03/19	11/03/19
Date of Curing	18/03/19	18/03/19	18/03/19

Date of Test	25/03/19	01/04/19	15/04/19
Weight of Block(kg)	22.2	23.98	24.38
Load at failure(kN)	22.5	26	32
Compressive Strength(N/mm^2)	0.275	0.323	0.395
Density of Block(kg/m^3)	1850	1998.33	2031.66

Table 2.66: Type of Block:50% M-sand 50% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	15/03/19	22/03/19	05/04/19
Weight of Block(kg)	22.44	22.34	22.64
Load at failure(kN)	19.5	21.5	23.5
Compressive Strength(N/mm^2)	0.24	0.268	0.29
Density of Block(kg/m^3)	1870	1861.6	1886.66

Table 2.67: Type of Block:25% M-sand 75% Charcoal solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	07/03/19	08/03/19	08/03/19
Date of Curing	08/03/19	09/03/19	09/0319
Date of Test	15/03/19	22/03/19	05/04/19
Weight of Block(kg)	17.39	17.64	18.295
Load at failure(kN)	14.5	17	19.5
Compressive Strength(N/mm^2)	0.17	0.21	0.243
Density of Block(kg/m^3)	1449.16	1470	1524.58

Table 2.68: Type of Block:25% sawdust and 25% charcoal and 50% m-sand Solid Block

Days of Casting	7^{th} Day	14^{th} Day	28^{th} Day
No.of Blocks casted	3	3	3
Date of Casting	22/04/19	22/04/19	22/04/19
Date of Curing	23/04/19	23/04/19	23/0419
Date of Test	30/04/19	06/05/19	16/05/19
Weight of Block(kg)	27.15	28.18	28.135
Load at failure(kN)	258.5	291.66	317.66
Compressive Strength(N/mm^2)	5.24	10.58	12.65
Density of Block(kg/m^3)	2262.5	2348.33	2344.583

Table 2.69: Comparison Of Compression Strength Behaviour Different Type Of Blocks

Sl.No	Type of Sample	Average compressive strength (N/mm2)
1.	100% m-sand	26.59
2.	25% charcoal +75% M-sand	11.458
3.	50% charcoal + 50% M-sand	7.49
4.	75% charcoal + 25% M-sand	5.36
5.	25% sawdust + 75% M-sand	0.456
6.	50% sawdust + 50% M-sand	0.25
7.	75% sawdust + 25% M-sand	0.23
8.	25%sawdust+25%charcoal+50% M-sand	12.53

2.7 Water Absorption Test

Table 2.71: Type of Block:100% M-sand solid Block

Days	7th	14th	28th
Dry weight of solid block	28.89	30.96	32.7
Saturated weight of solid block	31.88	33.06	35.4
Water absorption in %	10.36	6.78	8.28

Table 2.72: Type of Block:75% M-sand 25% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	24.66	25.83	26.3
Saturated weight of solid block	28.4	29.30	28.4
Water absorption in %	15.16	13.43	7.98

Table 2.73: Type of Block:50% M-sand 50% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	22.48	23.35	24.6
Saturated weight of solid block	24.85	25.34	26.85
Water absorption in %	10.54	8.52	9.14

Table 2.74: Type of Block:25% M-sand 75% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	24.25	21034	20.43
Saturated weight of solid block	26.75	23.43	23.14
Water absorption in %	10.3	9.79	13.26

Table 2.75: Type of Block:75% M-sand 25% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	22.20	23.98	24.38
Saturated weight of solid block	25.4	27.48	28.14
Water absorption in %	14.41	14.5	15.42

Table 2.76: Type of Block:50% M-sand 50% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	22.44	22.34	22.64
Saturated weight of solid block	26.48	26.5	26.91
Water absorption in %	18	18.62	18.18

Table 2.77: Type of Block:25% M-sand 75% Charcoal solid Block

Days	7th	14th	28th
Dry weight of solid block	17.39	17.64	18.295
Saturated weight of solid block	20.98	20.56	21.4
Water absorption in %	20	16.85	16.9

Table 2.78: Type of Block:25% sawdust and 25% charcoal and 50% m-sand Solid Block

Days	7th	14th	28th
Dry weight of solid block	27.15	28.18	29.42
Saturated weight of solid block	29.28	30.14	32.14
Water absorption in %	7.84	6.95	9.84

CONCLUSIONS

On the basis of results obtained during the experimental investigation, following conclusions are drawn

- When compared to M-sand solid block there is a gradual decrease in compressive strength of solid block made with 25% 50% and 75% charcoal by partial replacement of M-sand .
- Similarly there is a continuous decrease in compressive strength of solid block made with 25% ,50% and 75% of sawdust with partial replacement of M-sand.
- It is observed that there is decrease in density of 25% 50% and 75% charcoal solid block when compared to 100% of M-sand solid block. Similarly there is a decrease in density of 25%,50% and 75% sawdust solid block when compared to 100% of M-sand solid block.
- Moreover with the use of sawdust and charcoal , the weight of solid block reduces.
- It was also observed that water/cement ratio increases as the percentage of sawdust increases.
- At 25% sawdust replacement, there is about 25% reduction in weight of solid block.
- The research work confirms that the presence of tannin in sawdust acts as a retarder, adversely effect the solid block strength.
- Experimentation and data analysis shows that the higher the saturation of water deposits in the sawdust particles during curing tends to weaken the sample, making it softer than it was designed for , thus this the reason for making sawdust solid blocks weak.
- With regards to costs the price of sawdust per sack in comparison with M-sand and charcoal was also lesser the usual since sawdust is a waste material.
- Water absorption capacity of charcoal solid block increases with increase in % of charcoal used. Similarly water absorption capacity increases in sawdust solid block with increase in % of sawdust used.
- The charcoal solid blocks changes to black on increase in percentage and contains smooth uniform surface. Also use of charcoal as a partial replacement of m-sand can provide an effective and economic light-weight load bearing solid block.
- Hence from the investigation it is observed that use of charcoal as partial replacement of M- sand solid block can be used for both load bearing and non-load bearing walls. And it is conform to Grade-C as per IS 2185-1(2005).

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