Study of Strength of Earthbrick Reinforced with Coirfibre and Cowdung

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***Abstract*— The need for locally manufactured building materials has been emphasized in many countries of the world. Earth is one of many alternative materials that can be used in place of residential stick building. A number of binders have been used to stabilize earth, for construction. Such binders are aimed to improving water proofing or wear resistance properties of vulnerable earth based construction. Tropical countries are rich in fine grained cohesive soil, coir fiber and cow dung are naturally available raw material for building construction. But it potential in block making is not yet satisfactorily explored. This study focuses on an experimental investigation for improvising stabilized earthen blocks with coir cutting wastes from coir industry and cow dung from farm houses a reinforced elements. 15%,20%,25% of cow dung and 0.5%,1%,1.5% coir fibers are used for making different combination of stabilized earth bricks. First reference block are prepared using cohesive soil. Then blocks were prepared by stabilizing it further with waste fibrous additives and cow dung tested for strength and durability. Sustainable building materials are highly in demand today. Manufacturing of these blocks are easy and economical. The main objective of this project is to analyze the characteristics of stabilized earthen soil block and investigate the possibility of enhancing its strength and durability by reinforcing with degradable waste material.**

Keywords—Clay, coir fibte,cowdung, dry compressive strength ,wet compressive strength

I. INTRODUCTION

Sustainable building materials are highly demand today. Locally available clay is used for building construction. Manufacturing of these blocks are easy, economical and got a comparable strength compared to that of conventional brick. Fibrous material addition as a reinforcing element is one of the promising outcomes of ongoing researches. Kerala state in India produces 60% of the total world supply of coir fiber. This industry produces fibrous waste during the processing. Even though the coir waste is biodegradable, the rate of biodegradation is very slow due to high lignin content. Accumulation of this material causes environmental issues. Utilization of fibrous coir wastes is explored in the production of clay bricks. The main objective of this work is to analyze the characteristics of earth bricks reinforced with cow dung and coir fiber. Investigate the possibility of enhancing its strength and durability by reinforcing with degradable waste material. Some of the major objectives this work are ;to determine the properties of clay ,determine the compressive strength of brick with varying percentages of cow dung and coir fiber which is kept at room temperature for one day and sundried for six days and then fired in a kiln for three day and night completely and tested .The abundance of clay, cow dung and coconut fiber in this country, these bricks are used for various construction works such as load bearing or non-load bearing walls for resisting static loading. This will reduce the cost of construction materials and environmental pollution. , although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

II. METHODOLOGY FOR EXPERIMENTATION

A Material and Testing

The various material used as Clay,Coirfibre,Cowdung,water. The various experimental result for the material are shown

1.Specific Gravity test for Clay

Table1 Specific gravity test observation

Mass of pycnometer,m1	662g
Mass of pycnometer and soil,M2	976g
Mass of pycnometer+soil+water,M3	1724g
Mass of pycnometer + water M4	1534g

Specific gravity, G = (M2-M1) /(M2-M1)(M3-M4)
= (976-662)/(976-662)(1724-1534)
=2.53

2. Compaction test for Clay
(i) Observation and Calculations
Weight of mould (W_1) =4.100kg
Volume of mould (V) = 942.47 m^3
Wet weight of soil = 3kg
Assume natural moisture content =3 %
Dry weight of soil ($\gamma_{d)}$ = γ/(1+w) =3/ (1+.03) =2.912 kg
Assume amount of water added for first trial =4% γ_d = 116ml

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Table 2 Proctor Compaction test observaton

Sl no	Wt of mould + compacted soil(kg)	wt of compacted soil(w2-w1)	Wet density	Dry density
1	5.5	1400	1.485	1.442
2	5.64	1440	1.527	1.427
3	5.776	1476	1.566	1.411
4	5.838	1538	1.631	1.418
5	5.98	1880	1.994	1.675
6	5.95	1850	1.962	1.595

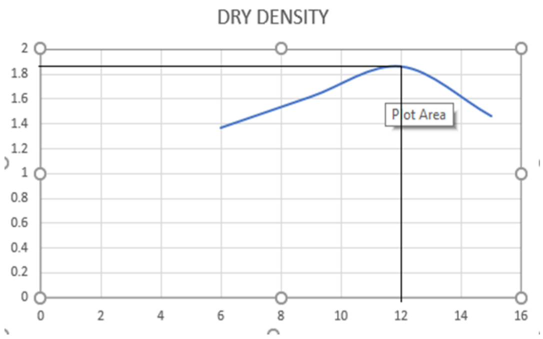

Fig 1 Compaction Curve

Maximum drydensity=1.84g/cm^3
Optimummoisturecontent=12%

3 UCC

Sample diameter =3.8
Cross section area of sample = $\pi/4$ *d^2
= $\pi/4$ (3.8^2)
= 11.34
Height of sample = 75 mm
Strain rate = 1.25 mm/min
Proving ring constant = 0.263
Least count of deformation dial gauge= 0.01
Sample calculation (sample no .2)
Proving ring reading= 3
Load in kg= 0.789
Deformation dial gauge reading= 100
Compression ϱl= 100*0.01
=1.00
Strain, e= ϱl/l
=1/75
=0.013
Increased cross section area of sample, A_1 = A/1-e
=11.34/1-0.013
=11.48 cm^2

Actual stress= Load/A_1
= 0.789/11.48
=0.068kg/cm^2

TABLE 3 UCC TEST OBSERVATION

Proving ring reading	Load in kg	Defor-mation dial gauge reading	Compr-ession ϱl	Strain ϱl/l	Increased c/s area A_1=a/1-e	Actu-al stress=load/area
2	0.526	50	0.5	0.006	11.408	0.046
3	0.789	100	1	0.013	11.489	0.068
3	0.789	150	1.5	0.02	11.571	0.068
4	1.052	200	2	0.0267	11.651	0.090
5	1.315	250	2.5	0.033	11.727	0.112
5	1.315	300	3	0.04	11.8125	0.112
6	1.578	350	3.5	0.467	11.895	0.133
7	1.841	400	4	0.053	11.975	0.154
7	1.841	450	4.5	0.06	12.064	0.153
8	2.104	500	5	0.067	12.154	0.173
8	2.104	550	5.5	0.073	12.233	0.172
9	2.367	600	6	0.08	12.326	0.192
9	2.367	650	6.5	0.0867	12.416	0.191
10	2.63	700	7	0.093	12.503	0.210
10	2.63	750	7.5	0.1	12.6	0.210
11	2.893	800	8	0.1067	12.694	0.228
11	2.893	850	8.5	0.113	12.785	0.226
12	3.156	900	9	0.12	12.886	0.244
12	3.156	950	9.5	0.1267	12.985	0.243
12	3.156	1000	10	0.133	13.79	0.241

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4 ATTERBERGS LIMITS

(i)Liquid limit

TABLE 4 DETERMINATION OF LIQUID LIMIT

No. of blows	Water content (%)
35	32.2
33	33.2
31	34.2
28	35.2
25	36.2
23	37.2
19	38.2

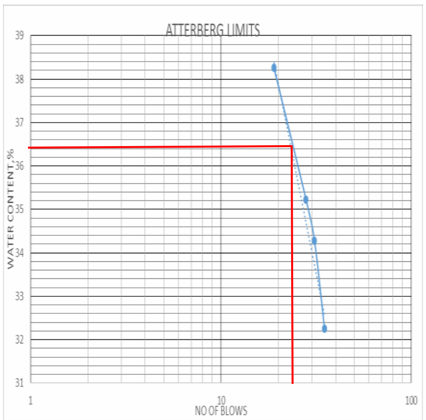

Fig 2 Flow Curve

Table 5 Plastic Plastic limit

Weight of dish (W_1)	48gm
Weight of dish + wet soil(W_2)	65gm
Weight of dish+ dry soil(W_3)	63gm
Weight of water,W_2-W_3	2gm
Weight of dry soil,W_3-W_1	15gm

weight of water/ weight of dry soil

= (2/15) *100

= 13.3 %

Plasticity index, Ip = W_L-W_P

= 36.4-13.3

= 23.1%

(ii)Discussion:

Plastic index is obtained as 23. 1%.

Liquid limit> Plastic limit.

MANUFACTURING OF REINFORCED SPECIMEN

Reinforced bricks are prepared by mixing the clay with different percentages of cow dung and coir fiber. 20% and 25% of cow dung (out of total weight of clay) and 1%and 1.5% (out of total weight of clay) of coir fibers are used for the making of reinforced bricks .Using 20% of cowdung and 1% of coir fiber, 3 bricks are casted. Similarly using 20% of cowdung and 1.5% of coir fiber, 3 bricks are casted. Likewise bricks are casted in the combinations of 25% cowdung and 1 % coir fiber and also in 25% cowdung and 1.5% coirfiber. Three bricks are casted from each batch. Otherthan these 3 bricks with only clay are also casted.

Water used for mixing is 30% of that of total weight. The mixing, moulding , compacting as well as curing process were same as that of reference block preparation. Here the testing is done on the 7th day after firing in the kiln. First it is kept at room temperature for one day. Then it is sundried for 6 days. After that it is fired in a kiln for 3 days completely and tested after 7 days.The procedure is as follows.

1 Coir fibers are cut into small piece.

Fig 3Cutting Coir Fiber

2 Cowdung is dried and crushed into smaller particles passing through the sieve of 4.75 mm.

Fig 4 Dried Cow Dung

3 Clay is crushed and sieved through IS sieve of 4.75mm.

Fig 5 Crushed Cow Dung

Fig 6 4.75mm Sieve

4 Clay coir fiber and cow dung are weighted and separated in different proportions.

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FIG 7 Different Proportion Of Cow dung And Coir fiber

5Dry mix of raw materials are done.

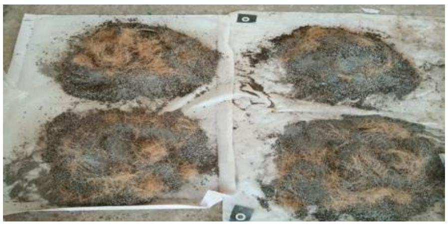

Fig 8 Dry Mix

6 Water is added and wet mix is prepared.

Fig 9Water mix

7Greece is applied on mould**.**

Fig 10 **A**pplying Greece

8The mixture is kept in the mould and tamped using tamping rod.

Fig 11 Tamping

9 Brick is removed from the mould.

Fig 12 Brick removed from mould

10 Bricks are kept in room temperature for 1 days and then kept under sunlight for 6 days.

Fig 13Sun dried of brick

11 Bricks are fired at kiln for 3 days

Fig4.20 kiln

Fig 4.21 Brick after burned kiln

TESTS CONDUCTED ON SPECIMEN

1) DRY COMPRESSIVE STRENGTH TEST

All electrically operated s compression machine was used for the compressive strength test on the reference and earth brick reinforced with cow dung and coir fiber. The blocks were subjected to compressive strength at 7^{TH} day after taking from the kiln and 2 replicas for each mix and average compressive strength was calculated. In crushing test care was taken to ensure that blocks were properly positioned and aligned with the axis of the thrust of compression machine to ensure uniform loading on blocks. The bearing surface of the testing machine was cleaned and the specimen was placed in such a manner that load shall be applied to the opposite sides of the block specimen. The movable portion was gently rotated by hand and as it touches the top of surface of specimen and the load was applied gradually at the rate of 140Kg/cm²/min till the specimen fails. The maximum load was noted and recorded.

Table6 Dry compressive strength

Sl.no	Percentage cow dung	Percentage coir fiber	Load (KN)	Compressive strength (N/mm²)
1	0	0	170	8.5
2	20	1	179	8.95
3	20	1.5	172	8.6
4	25	1	177.5	8.876
5	25	1.5	178.2	8.91

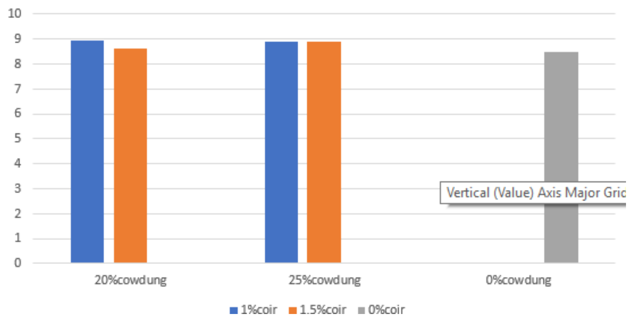

fig 13 Dry Compressive Strength

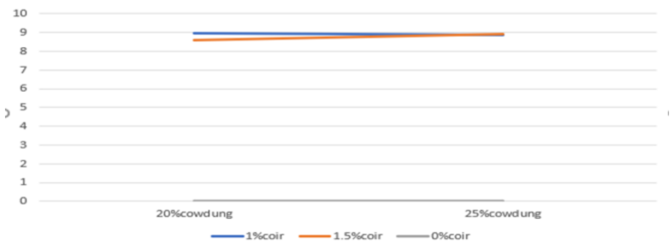

Fig 14 Max Dry Compressive strength

Graph shows the relationship between the compressive strength and different combinations of cow dung and coir fiber. The maximum dry compressive strength obtained is 8.875 KN/m², which is obtained by the addition of 20% cow dung and 1% coir fiber. But after 1% and 20% addition the dry compressive strength decreases.

2) *WET COMPRESSIVE STRENGTH TEST*

The compressive strength after immersion in water for 24 hour at the age of 7 days.In crushing test care was taken to ensure that blocks were properly positioned and aligned with the axis of the thrust of compression machine to ensure uniform loading on blocks. The bearing surface of the testing machine was cleaned and the specimen was placed in such a manner that load shall be applied to the opposite sides of the block specimen. The movable portion was gently rotated by hand and as it touches the top of surface of specimen and the load was applied gradually at the rate of 140Kg/cm²/min till the specimen fails.The maximum load was noted and recorded.

Table7 wet compressive strength

Sl. No.	Percentage Cow dung	Percentage Coir Fiber	Load (KN)	Compressive Strength (N/mm²)
1	0	0	121	6.05
2	20	1	142	7.1
3	20	1.5	138	6.9
4	25	1	134	6.7
5	25	1.5	128	6.2

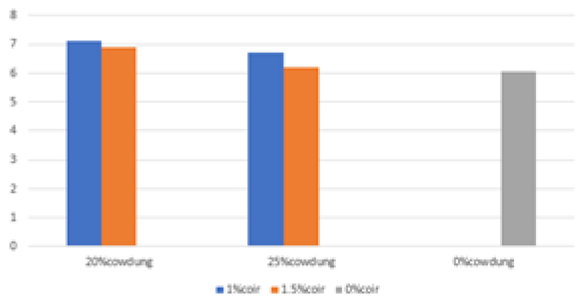

Fig15 wet compressive strength

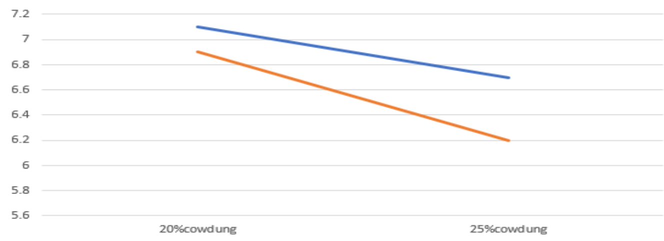

Fig 5.7 Maximum Wet Compressive Strength

The observation clearly indicates that the earth brick reinforced with coir fibre and cow dung provided with 20%cowdung and 1% coir fibre exhibits maximum compressive strength as compared to normal bricks.immersion in water for 24 hour reduced the compressive strength for cow dung and 1% coir samples compared to the compressive strength in their dry state. Furthermore, complete disintegration of un- stabilised specimens was observed in a few minutes after immersion in water. Again bricks with 20% cow dung and 1% coir fiber content as stabiliser had the highest wet compressive strength of 7.1 N/mm

III. CONCLUSION

Strength and durability characteristics of earth brick reinforced with coir fiber and cow dung was found to be improved than the normal bricks. The earth bricks stabilized with 20% cow dung and 1% coir fiber exhibits maximum compressive strength and abrasive strength which indicates the best combination.

Considerable improvement in compressive strength and and reduction in mass were exhibited by earth bricks reinforced with cow dung and coir fiber.

Dry compressive strength: Coir has potential to increase the compressive strength of bricks. An increment in compressive strength with increase in % of coir fibre upto 1% and cow dung upto 20% was observed. Further addition of cow dung and coir fiber leads to the reduction of compressive strength.

Wet compressive strength : Immersion in water for 24 hour reduced the compressive strength compared to the compressive strength in their dry state.

Environment and economy : Use of cow dung and coir fiber minimizes the environmental problems of waste deposition in addition to the cost of construction of building .

It is cost effective because of the quantity of clay is more in conventional brick compared to the reinforced brick. The coir fiber and cow dung are easily available and cheap value which makes the modified brick as cost effective by minimizing quantity of clay required,so we can save money.

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