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# An Experimental Study on CLSM Bricks using Flyash and Construction Debris waste

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**ABSTRACT**: Controlled Low-Strength Material (CLSM) is a flowable state cementitious fill at the time of placement and has restricted compressive strength to facilitate successive excavation. It is also known as Flow-Crete and controlled density fill as well as by various names. In this present study CLSM ingredients proportions are varied to makes bricks by achieving good strength. Materials used are cement, Flyash, M- sand, Construction Debris and Laterite soil with 0.8 water cement ratio. Strength and other parameters of bricks such as flow table test, compressive strength test, water absorption, soundness test, impact test, and brick pillar test were tested. Brick having 15% and 20% cement shows high strength and all the other bricks of different mixes satisfied I S standards and are recommendable.

KEYWORDS: Controlled Low-Strength Material (CLSM), Flyash, Construction Debris and Compression Strength.

## I. INTRODUCTION

Controlled Low-Strength Material (CLSM) is a cementitious fill that is in a flowable state at the time of placement and has limited compressive strength to facilitate successive excavation. CLSM is also known as Flow-Crete and controlled density fill as well as by various proprietary names. CLSM can be designed with varying strength and density, considering the cost and future needs, low strength CLSM shall be necessary to allow future excavation, whereas if the there is no scope for future excavation the strength can be at higher side, further the density of CLSM can be modified as per the cost and material needs. Properties of CLSM can be enhanced as per the requirement to compensate particular need like corrosion resistance, Exacavatability, strength flow ability etc. Material properties such as shrinkage, subsidence and settlement are not considered as specification performance or requirement properties. Construction debris consists of unwanted material produced directly or incidentally by the construction or industries. This includes building materials such as insulation, nails, electrical wiring, shingle, and roofing as well as waste originating from site preparation such as dredging materials, tree stumps, and rubble. Construction waste may

### II. NEED OF THE STUDY

With the increase in the rate of construction of structures there is a need to save environment by making construction green. There are materials which are used in the preparation of concrete mix which may cause harm to the environment. Production of waste materials is increasing day by day which also causes environmental problems. So here in this study use of waste materials as the construction materials is done. This will create green construction.

contain lead, asbestos, or other hazardous substances.



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### III. OBJECTIVE OF THE STUDY

The main objectives of CLSM bricks are as follows:

- 1. To determine the properties of lateritic soil, M-sand, Cement and Flyash.
- 2. Selection of best CLSM mixes for the production of bricks by varying the material percentage based on Compressive strength.
- 3. To determine the strength characteristics of CLSM bricks.

### IV. REVIEW OF LITERATURE

**Darshan et al.**, (2017) used low strength material in order to make bricks the ingredient materials percentage is varied to achieve more strength. Materials used are cement, GGBS, M- sand and Laterite soil with 0.8 water to cement ratio. Strength and other parameters of bricks were tested such as flow table test, compressive strength test, water absorption, soundness test , impact test, durability test and brick pillar test. Carried out water absorption test for different proportions for 24hrs and observed results which are less than 20%. Hence it satisfies the I.S standards and it is good to use for construction. Durability test is done by carrying compressive strength test after 7 and 14 days

**Nataraj and Vadiraj(2016)** investigated on effective replacement for the compacted backfill using fly ash, cinder aggregate, water with the fine aggregate to achieve controlled low strength materials .in this experiment cinder aggregate acts as coarse aggregate. This CLSM mix absorbs more water initially at 30 minutes after mixing and for the 15% of cinder aggregates in the mix gives optimum unconfined compressive strength at 28 days. Density of all different mix trials more than 800kg/m3. So, from this study concluded that coarse aggregate in this study is satisfied. Also this CLSM mix can be excavated.

**Gaurav and Karna (2015)** carried out experimental investigation on Laterite Soil Bricks using Cement and Fly ash along with the Laterite soil. The bricks were prepared with fly ash (20%), cement (5-10%) and soil (70-75%). The experiment is conducted to different percentage of fly ash and laterite with 5 to 10% of cement to obtain the best percentage of fly ash that can be added with cement and soil to manufacture low cost bricks. Size of brick is 20x10x10cm and that casted bricks are tested using ctm to carry out compression strength test on fly ash mixed cement laterite bricks 9.5N/mm2. The CLSM bricks with fly ash 20% and cement 10% show a compressive strength of 9.5 N/mm2 higher than Laterite bricks. When compared laterite stone it is having 4.5-time greater compression strength result and this type of bricks can be used as a load bearing wall bricks.

**Naik et. al.**, (2004) prepared CLSM mix using wood ash, cement, sand, fly ash and water. Mix contained with 80% of wood ash, 15% of sand and 5% of cement showed strength of 0.8 N/mm2 in 28 days and attained 1.4N/mm2 after a year. Compressive strength test result is optimum for s-1 mix that is 0.8mpafor 28 days but for one year age s-2 mix gives 14.4mpa optimum strength because combination of wood fly ash and coal fly ash increases the compressive strength with the increase in age. Water permeability of s-2 and s-3 decreases with the increase in age when compare to s-1 mix because of the improvement. The researchers observed the reduction in permeability of CLSM with the age.

### V. MATERIALS USED

## 1. CEMENT

In the present work Ordinary Portland Cement (OPC) of 43 grades collected from RMC Mangalore was used. The properties are determined as per IS: 8112-1989 and the test results are tabulated in Table1



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#### Table 1: Properties of cement

Properties	Result	IS code Requirement	
Specific gravit	3.05		
Standard consiste	ency	31%	
Catting time	Initial(Minutes)	33 min	30 minimum
Setting time	Final(Minutes)	380 min	600 maximum
Commencesive strength (MDs)	7 days	32	33
Compressive strength (MPa)	28 days	46	43

#### 2. M SAND

The Manufactured sand obtained from a quarry at Mudipu, Mangalore confirming to IS: 383-1970 and having specific gravity of about 2.59 was used to cast cubes. The physical properties are tabulated in Table 2

Table 2: Properties of M- sand

Properties	Value
Specific gravity	2.65
Water absorption (%)	2.8%
Fineness modulus	3.46

#### 3. LATERITE SOIL

Laterite soil used in this study was collected at the depth of 1m from Bearys Institute of Technology, Innoli region located in Dakshina Kannada district.

SI No.	Properties	Value
1	Specific gravity	2.51
2	Grain size distribution (%)	
	Gravel	5
	Sand	52
	Silt and clay	43
3	Consistency Limits (%)	
	Liquid limit	53.95
	Plastic limit	30.48
	Plasticity index	23.47
4	IS Soil Classification	SP CH

#### Table 3: Properties of Laterite Soil

### 4. FLY ASH

Flyash used in this study was collected from RMC Mangalore located in Dakshina Kannada district.

	Table 4: Properties of Flyash	
Sl. No	Physical Properties	Value
1	Color	Whitish grey
2	Bulk Density (g/cm <sup>3</sup> )	1
3	Specific Gravity	2.29
4	Moisture (%)	3.14
5	Average Particle Size(micro meter)	6.92



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### 5. CONSTRUCTION DEBRIS

Construction Debris used in this study was collected from Mangalore located in Dakshina Kannada district

Sl.No	Physical properties	Test Results
1	Maximum Size (mm)	20
2	Fineness Modulus	7.358
3	Specific Gravity	2.64
4	Bulk Density(kg/m3)	1356-1510
5	Water Absorption (%)	0.55
6	Aggregate crushing value (%)	29.58
7	Aggregate Impact Value (%)	18.36
8	Moisture Content (%)	4.2

#### Table 5: Properties of Construction Debris

### VI. RESULT AND DISCUSSIONS

### 1. MIX PROPORTIONS

Depending upon the trial and error method different proportions are selected. Water Cement ratio is decided depending upon the Literature survey and different mixes are decided based on the trial and error methods.

Trial No	Cement (%)	Flyash (%)	M-Sand (%)	L-Soil (%)	Construction Debris (%)	W/C ratio
1	5	25	20	30	20	0.8
2	5	25	17.5	35	17.5	0.8
3	5	25	15	40	15	0.8
4	5	25	12.5	45	12.5	0.8
5	10	20	20	30	20	0.8
6	10	20	17.5	35	17.5	0.8
7	10	20	15	40	15	0.8
8	10	20	12.5	45	12.5	0.8
9	15	15	20	30	20	0.8
10	15	15	17.5	35	17.5	0.8
11	15	15	15	40	15	0.8
12	15	15	12.5	45	12.5	0.8
13	20	10	20	30	20	0.8
14	20	10	17.5	35	17.5	0.8
15	20	10	15	40	15	0.8
16	20	10	12.5	45	12.5	0.8

#### Table 6: Mix Proportion



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### 2. COMPRESSIVE STRENGTH RESULTS

Test results are carried to 70.7mm\*70.7mm\*70.7mm mould having a 50cm2 area. The different mixes are casted and tested for 3 and 7days. The Table 7 shows the compressive strength results.

	r				1		
Trial No	Cement (%)	Flyash (%)	M-Sand (%)	L-Soil (%)	Construction Debris (%)	W/C ratio	Compressive Strength (MPa)
1	5	25	20	30	20	0.8	2.12
2	5	25	17.5	35	17.5	0.8	1.56
3	5	25	15	40	15	0.8	1.48
4	5	25	12.5	45	12.5	0.8	1.52
5	10	20	20	30	20	0.8	6.12
6	10	20	17.5	35	17.5	0.8	5.58
7	10	20	15	40	15	0.8	5.18
8	10	20	12.5	45	12.5	0.8	5.20
9	15	15	20	30	20	0.8	11.79
10	15	15	17.5	35	17.5	0.8	7.08
11	15	15	15	40	15	0.8	5.8
12	15	15	12.5	45	12.5	0.8	5.8
13	20	10	20	30	20	0.8	11.79
14	20	10	17.5	35	17.5	0.8	7.76
15	20	10	15	40	15	0.8	6.65
16	20	10	12.5	45	12.5	0.8	5.94

Table 7: Compression Test on Cubes

Based on the Compressive Strength results four Mix Proportions were selected to manufacture the CLSM Bricks. Table 8 gives the selected mix proportions details

Brick	Mix Proportion (%)	Cement (%)	Flyash (%)	M-Sand (%)	L-Soil (%)	Construction Debris (%)	w/c ratio	Compressive Strength (MPa)
Brick A	10:20:20:30:20	10	20	20	30	20	0.8	6.12
Brick B	15:15:20:30:20	15	15	20	30	20	0.8	11.79
Brick C	15:15:17.5:35:17.5	15	15	17.5	35	17.5	0.8	7.08
Brick D	20:10:20:30:20	15	15	20	30	20	0.8	11.79

Table 8: Selected Mix Proportions for CLSM Bricks

#### 3. BRICK TESTS

Standard tests are conducted on CLSM bricks as per IS standards. such as Compressive strength test, Water absorption, Soundness test, Impact test, Hardness test, Structure of brick, Efflorescence test and brick column test.

#### 1. Water Absorption Test

The water absorption test decides the strength and stability of the brick. The selected four design mixes are then tested further water absorption. Table 9 shows water absorption test results of CLSM bricks.

Table 9: Water Absorption Test Results of CLSM Bricks



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Name	Mix-proportion C:G:M-S:CD:LS	Weight of brick before soaking(kg)	Weight of brick after soaking for 24 hrs (kg)	Water absorption (%)
Brick A	10:20:20:30:20	2.20	2.26	2.65
Brick B	15:15:20:30:20	2.18	2.23	2.24
Brick C	15:15:17.5:35:17.5	2.29	2.38	3.78
Brick D	20:10:20:30:20	2.18	2.22	1.80

Water absorption test results of CLSM Brick A, B, C and D are 2.65%, 2.24%, 3.78% and 1.80% respectively, which is less than 20%. This satisfies the IS: 3495 (Part 2):1992 code standards, hence it is advisable to use for construction of wall.

#### 2. Soundness Test

After 28 days of curing two CLSM bricks are struck each other to know the resistance of CLSM bricks on unexpected impact. CLSM bricks gave clear ringing bell sound when struck each other. This shows that there is no void or air pocket inside the. Fig.1 shows the Soundness test for CLSM bricks.

#### 3. Impact Test

In This Test Bricks Are Allowed To Fall from Height of 1m. CLSM Bricks Didn't Break After Fall. If Bricks Break Then It Has Low Impact Value and is Not Suitable for Construction.

#### 4. Hardness Test

In This Test Brick Is Scratched Using Sharp Tool Or Finger Nail. If There Is No Scratch Impression On Brick Then It Is Said To Be Hard Brick. The Fig.2 Shows Hardness Test of Brick.



Fig 1: Soundness test for CLSM bricks.

Fig 2: Hardness Test of Brick.



Fig.3: Inner Structure of Brick

#### 5. Structure of Bricks

To know the structure of brick, select any one CLSM brick and break it. Observe the inner portion of broken brick. It is free from lumps and voids. The Fig.3 shows the inner structure of brick

### 6. Compressive Strength of Brick

Compressive strength of portable water cured bricks having standard size of bricks 190mmx90mmx90mm. 3 samples of bricks are tested and average values are considered. The Graph1shows compressive strength of potable water cured bricks



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Graph1: Compression Strength on Brick.

In compressive strength test for 28 days all bricks types satisfies IS standards that is > 6.5 N/mm2. Hence it advisable to use for load and non load bearing walls.

### 7. Brick Pillar Test

Brick pillar consist of 3 bricks of dimension L\*B\*W::19\*9\*9cm are used for masonry with 1:3 mortar proportion. All bricks types satisfy I S standards. Hence it is advisable to use for load bearing walls. Fig.4 shows brick column test result respectively. From the graph 2, it is shown that all bricks types satisfy I S standards that are > 6.5 N/mm2 for 14 days. Hence it advisable to use for load bearing walls.



Fig.4: Brick Column Test



Graph 2 Compressive Strength test Result

## VII. CONCLUSIONS

- 1. Water absorption test is conducted for different proportions for 24 hrs and observed results such as 2.65%, 2.24%, 3.78% and 1.80% which is less than 20%. Hence it satisfies the I.S standards and it is good to use for construction.
- The bricks which are tested for impact, soundness, hardness and structure tests are having good results and satisfy the Codal provision.
- 3. In compressive strength test for 28 days all bricks types satisfies IS standards that is > 6.5 N/mm2. Hence it advisable to use for load and non load bearing walls.



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4. Brick pillar consist of 3 bricks of dimension l\*b\*w::19\*9\*9cm are used for masonry with 1:3 mortar proportion. All bricks types satisfy I S standards that is > 6.5 N/mm2 for 14 days. Hence it advisable to use for load bearing walls.

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