

# Experimental Study on Lime Mortar using Flyash and Gallnut As Additives

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**Abstract**— As concern the environmental impacts and high cost of cement which is widely used, clearly requires alternate protective binder. But in the first civilization, lime is used as biodegradable binding material which is also composed of additives such as pozzolana and traditional herbs. In the present study lime mortar with composition of flyash as pozzolana which enables mortar to set rapidly in the ratio of 1:1:2 (lime:pozzolana:sand) as per IS:4098 – 1983. Also used extracts of kadukkai (gallnut) and palm's jaggery in the proportion of 5%, 10% and 15% of the weight of binder. As the result, on addition of 5% herbal extract in pozzolanic lime mortar improves workability and increases tensile strength, also enhanced increased compressive strength about 55% compared to nominal lime mortar . It is used for repairing and restoration of historical or ancient monuments.

**Keywords** — Lime, pozzolana, kadukkai and biodegradable.

## I. INTRODUCTION

Lime is the true green and versatile building material. It is the most sustainable binder due to lower production energy needs, lower  $CO_2$  emission during production and  $CO_2$  absorption by carbonation. Lime mortar has one part lime and 3 part of sand (1:3). lime mortar has a natural ability to both hold and evaporate moisture from the walls thus maintaining a state of balance with the surrounding atmosphere. Lime mortar can absorb and evaporate moisture freely. Lime is soft and flexible recyclable material. Lime mortar gradually been used less due to its long term strength development yet they have high durability. To increase the strength by addition of cement of lime mortar would affects the durability. As traditional method, the addition of pozzolana in lime mortar will modify its characteristic. It will tend to produce a harder mortar by rapid setting and increment its density and reduce cracking by letting moisture freely acts as self healing material. In the study flyash as a pozzolana to ensure the setting with more protection from wet conditions and chemical attack. Lime is the true green and versatile building material. It is the most sustainable binder due to lower production energy needs, lower  $CO_2$  emission during production and  $CO_2$  absorption by carbonation. The traditional additives namely kadukkai (gallnut) and palm's jaggery are added in the proportion of 5%, 10% and 15% of weight of binder to improve the workability and strength parameters. The objective of the study to know the improvement of mechanical parameters such as compressive

strength and tensile strength of lime mortar have been studied.

## II. METHODOLOGY

Lime is a binder which is in general, the purpose of the binder is to hold the sand particles together and to fill the voids in between the grains of sand. Hydraulic lime used in building construction. Sand is the most common aggregate in mortars. the potable water should be used in appropriate amount till attain required consistency. Flyash , kadukkai ( Terminalia chebula) and palm's jaggery are additives of lime mortar.

### A. Mix design

Table 1: mix design

Mortar code	Hydraulic lime	Pozzolana	Sand	Herbal extract
A	1	-	3	-
B	1	1	2	-
C	1	1	2	5%
D	1	1	2	10%
E	1	1	2	15%

### B. Preparation of herbal extract

Crushed kadukkai and palm's jaggery are separately fermented for one day in the portable water .

It is used as additives in the proportion of 5%, 10% and 15% of the weight of binder.

### C. Preparation of lime mortar

- Mix all dry elements by chisel.
- Mixing herbal extract in required proportionate.
- Adding portable water till attain its consistency.
- Mix well for 5 minutes.
- The lime mortar is filled to the mould after the mortar attains its proper consistency.



Figure 1: preparation of pozzolanic lime mortar



Figure 3: curing of specimen

#### D. Casting of specimen

- Filling into the mould of 50mm x 50mm x 50mm cube.
- Initially first half of the mould is filled with lime mortar and tampered for 25 blows with 5mm diameter tamper.
- Then the remaining mould is filled and again tampered for 25 blows. After Casting, the specimen was allowed for setting.



Figure 2: casting of specimen

#### E. curing of specimen

- After Casting, the specimen was allowed for setting.
- After 24 hours, all the specimens were by wet sack for curing at 7, 14 and 28 days.
- The portable water should be used for curing.

### III. RESULT AND DISCUSSION

#### A. Compressive strength testing

The compressive strength of lime mortar cubes can be determined by the universal testing machine where the loads are applied generally and then the compressive strength can be calculated. Determination of compressive strength for lime mortar cubes of 7 days, 14 days and 28 days of curing. Mean values of compressive strength are listed in Table 2, Table 3 and Table 4.

The test carried out on 50mm x 50 mm x 50 mm size cubes are used as per IS 712-1984. The test specimens are marked and placed in the universal testing machine to conduct the test. The specimen is placed between the steel plates of the machines then the load is applied gradually and observed for the ultimate load.

Table 2: Compressive strength for 7days

Binder code	Compressive strength (7days)N/mm <sup>2</sup>
A	0.5117
B	0.7296
C	1.248
D	1.136
E	0.948

Table 3: compressive strength for 14 days

Binder code	Compressive strength (14days)N/mm <sup>2</sup>
A	1.23
B	1.526
C	2.463
D	1.916
E	1.813

Table 4: compressive strength for 28 days

Binder code	Compressive strength (28days)N/mm <sup>2</sup>
A	2.63
B	3.67
C	6.41
D	5.62
E	4.73

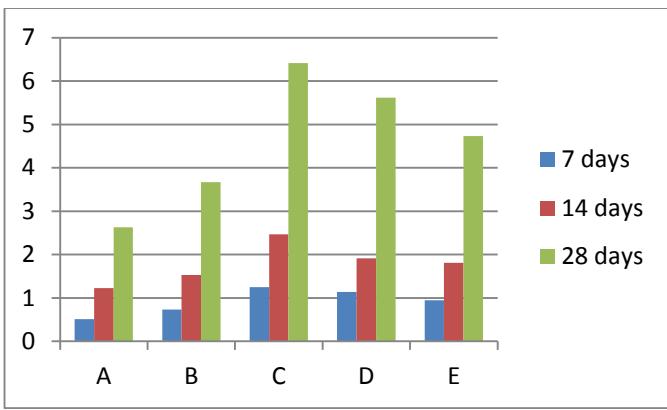


Figure 4: Compressive strength for 7, 14 &amp; 28 days

#### B. Tensile strength testing

The experiment consists of casting and tension the testing specimen are cured for 7 days, 14 days and 28 days. Load is applied uniaxial load until the specimen split. The maximum stress can be calculated by the following equation.

$$\sigma = \frac{F_n}{A}$$

Where,

F is the tensile force in N

A is the nominal cross-section of the specimen in mm<sup>2</sup>. This is an indirect test. The strength can be determined by split tensile test which is believed as close to the direct tensile strength method. The test is carried out in the universal testing machine as per IS 712-1984.

The tensile strength of various proportionate of lime mortar is tabulated for 7, 14 and 28 days in table 4, table 5 and table 6.

Table 5: Tensile strength for 7 days

Binder code	tensile strength (7days)N/mm <sup>2</sup>
A	0.1327
B	0.165
C	0.59
D	0.453
E	0.347

Table 6: Tensile strength for 14 days

Binder code	tensile strength (14days)N/mm <sup>2</sup>
A	0.531
B	0.736
C	1.153
D	0.8223
E	0.79

Table 7: Tensile strength for 28 days

Binder code	tensile strength (28days)N/mm <sup>2</sup>
A	1.25
B	1.71
C	2.34
D	1.82
E	1.49

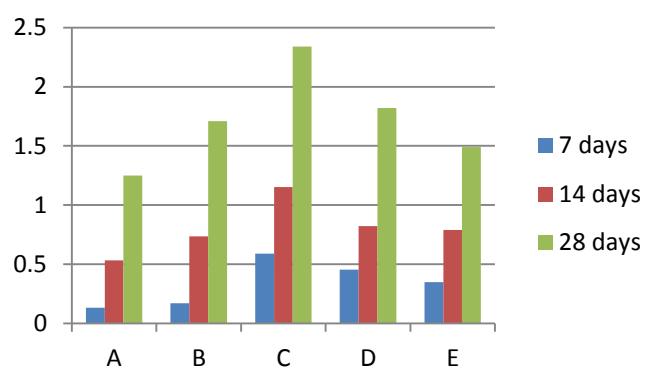


Figure 5: Tensile strength for 7, 14 &amp; 28 days

#### C. Discussion

As the result of this study shows that the herbal extract is added in a little amount 5% it improves mortar's consistency, but at higher additions of 10% and 15% of herbal extract the increased cohesion results into very stiff mortar which consequently requires more kneading water to reach appropriate workability. After 28 days of curing, the strength of Modified mortars containing pozzolana (codes C, D and E) developed higher compressive strengths comparing to the reference mortars.

Treating lime mortar with 5% herbal juice provides greater compressive strengths. The compressive strengths are increased by 55% respectively in comparison with plain lime mortar. Hence, addition of herbs and flyash can greatly enhance the compression stress of lime mortar.



Figure 6: Testing of specimen

#### IV. CONCLUSION

- The pozzolanic admixture chosen in this work for the improvement of mechanical properties of lime mortar was found to play a very positive role in this respect.
- These admixtures modify the fresh and hardened property of the lime mortar.
- The study shows on addition of 5% herbal extract in pozzolanic lime mortar improves workability and increases tensile strength.
- It also enhanced increased compressive strength about 55% compared to nominal lime mortar .
- In 5% addition the effect is positive – the cohesion between binder grains leads to increased consistency, which is still sufficient for required workability.
- It is used for repairing and restoration of historical or ancient monuments.
- Also in building eco-friendly structures.

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