

Study on the Compressive Strength of Lime Mortar Using Admixtures

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ABSTRACT

Lime is a binding material which is used from ancient times for the construction of buildings. Since the strength of lime is very less compared to cement, cement has been used as the major construction material. Due to environmental aspects, there is a need to reduce the usage of the cement in the construction industry. So, in this study an effort is made to improve the strength parameters of the lime mortar by using natural admixtures. The natural admixtures that are found to improve the strength are kadukkai and Jaggery. The compressive strength of varying proportions of admixtures is found out by experimental study and the values are compared with the conventional lime mortar. The proportions of admixtures are varied from 2.5% 5% 7.5% 10% 12.5% and 15%. The results show that the admixtures improved the strength of the lime mortar.

Keywords

Lime, Jaggery and Kadukkai.

1. INTRODUCTION

Lime is arguably the world first true green and versatile building material. The traditional lime binder offers greater durability but less strong compared to cement. The objective of the study is to improve the strength parameters of lime. Compared to modern structures, traditional structures in India can be adopted by the people of all generation since the fundamental nature of construction is always flexible and in tune with the rhythmic forms to suit the taste of every generation. Indian traditional structures built with mortar which is more than 4,000 years old like Mohenjo-Daro are still a heritage monument of Indian civilization. This traditional concept will definitely provide inputs to supplement modern construction methods and this will pave a flexible way by extracting the essence from ancient texts and interpret it to suit modern constructions. In recent past, attempts are being made to enhance the strength parameters by addition of chemical admixtures in cement concrete, though it is performing well in all mechanical characteristics. But the long term durability of cement has not been ascertained since cement came into existence in the past century. Lime allows the building to "breathe". Water can escape by evaporation, unlike cement where the only way the water can escape is by being adsorbed into the bricks. Lime is soft and flexible. It allows the building to move without cracking and letting water in and thus self healing. Lime is biodegradable and recyclable.

1.1 Importance of Lime

Lime, a white powdery substance obtained from limestone, coral, oyster shells, and other substances containing calcium carbonate. Pure lime is calcium oxide. Most commercial lime, however, contains magnesium and other impurities. Lime is produced by heating limestone or a similar substance in a kiln at a temperature of about 982 degree Celsius. The heat drives off carbon dioxide and converts the calcium carbonate into calcium oxide, or quicklime. When water is added to it, quicklime becomes slaked, or hydrated, lime. Hydraulic lime is made from limestone containing alumina, silica, and iron. Other variations or mixtures of lime include limewater (a suspension of slaked lime in water) and chlorinated lime. Hydraulic lime is a variety of lime a slaked lime used to make lime mortar. Hydraulicity is the ability of lime to set under water. Hydraulic lime is produced by heating claiming limestone that contains clay and other impurities. Calcium reacts in the kiln with the clay minerals to produce silicates that enable the lime to set without exposure to air. Any unreacted calcium is slaked to calcium hydroxide. Hydraulic lime is used for providing a faster initial set than ordinary lime in more extreme conditions (including under water). The comparison between lime and cement is given in table.

Table 1. Comparisons of lime and cement

Sl.no	Property	Hydraulic	Non hydraulic	Cement (opc)
1	Breathable	Yes	Yes	No
2	Setting Speed	Medium	Low	High
3	Flexibility	Medium	High	No
4	Durability	Medium	Low	High
5	Labor	Low	High	Low
6	Cost	High	Medium	Low

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Table 2. Chemical composition of lime

Chemical Name	Calcium magnesium hydroxide, Calcium carbonate, and anhydrous aluminium silicate.
Chemical Family	Alkaline earth hydroxides and carbonates and calcined kaolin.
Chemical Formula	$\text{CaMg}(\text{OH})_4$, CaCO_3 , $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$
Molecular Weight	$\text{CaMg}(\text{OH})_4 = 132.41$, $\text{CaCO}_3 = 222.13$, $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2 = 100.09$.
Trade Name	Bended hydraulic name, artificial hydraulic lime, synthetic hydraulic lime.
Material Use	Masonry mortar, plaster, whitewash.
Specific gravity	1.2 -3.2.

2. MATERIALS USED

2.1. Jaggery

Jaggery is fermented for one day and 25gms of jaggery is mixed with 1000ml of water.

2.2. Kadukkai

Kadukkai is fermented for three days and 25gms of kadukkai is mixed with 1000ml of water.



Figure 1. Jaggery Sample



Figure 2. Kadukkai Sample

3. MIX PROPORTIONING

The mix proportion adopted is 1:3 (lime:sand) and the water cement ratio is 0.65. various mix proportions are arrived by varying the proportion of jaggery and kadukkai separately and also with the uses of both. The jaggery proportions are varied from 2.5% to 15% and the kadukkai proportions are varied from 2.5% to 15%. Then the compressive strength of different proportions of cubes are compared with the compressive strength of the cube with both the admixtures.

3.1. Jaggery Lime Mortar

25gms of jaggery is mixed with 1000ml of water for 2.5% concentration and so on. The jaggery is fermented for one day. 500 g of lime, 25ml jaggery extract and 475ml of ordinary water is added as proportions. Needed quantity of sand is added and the mixture is grinded before casting.

3.2. Kadukkai Lime Mortar

25gms of kadukkai is mixed with 1000ml of water for 2.5% concentration and so on. The kadukkai is fermented for one day.

500 g of lime, 25ml kadukkai extract and 475ml of ordinary water is added as proportions. Needed quantity of sand is added and the mixture is grinded before casting.

3.3. Jaggery and Kadukkai Lime Mortar

1.25g of kadukkai and 1.25g of jaggery is mixed with 1000ml of water for 2.5% concentration and so on. The kadukkai and jaggery is fermented for one day. 500 g of lime, 25ml of extract and 475ml of ordinary water is added as proportions. Needed quantity of sand is added and the mixture is grinded before casting.

4. RESULTS

The compressive strength of the different proportions are arrived and the results are compared with the reference lime mortar. The compressive strength of various proportions are listed in table.

Table 3. Compressive Strength of Reference Lime mortar

S.No	Water/Lime Ratio	14 Days Compressive Strength (N/mm ²)	28 Days Compressive Strength (N/mm ²)
1	0.6	1.43	1.84
2	0.6	1.43	1.84
3	0.6	1.43	1.84
4	0.65	1.43	1.63
5	0.65	1.22	1.63
6	0.65	1.22	1.63

Table 4. Compressive Strength of Lime mortar with kadukkai

S.No	Percentage of Kaduka	Compressive Strength N/mm ²
1.	2.5	1.48
2.	5.0	1.59
3.	7.5	1.84
4.	10	2.04
5.	12.5	1.43
6.	15.0	1.22

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Table 5. Compressive Strength of Lime mortar with Jagerry

S.No	Percentage Of Jagerry	Compressive Strength N/mm ²
1.	2.5	1.29
2.	5.0	1.56
3.	7.5	1.91
4.	10	2.44
5.	12.5	1.84
6.	15.0	1.56

Table 6. Compressive Strength of Lime mortar with Jagerry and Kadukkai

S.No	Percentage of Jagerry and Kadukkai	Compressive Strength N/mm ²
1.	2.5	1.22
2.	5.0	1.22
3.	7.5	1.03
4.	10	1.63
5.	12.5	2.24
6.	15.0	1.63

The comparison between the strength of different proportions of the admixtures is shown in figure 2 and figure 3.

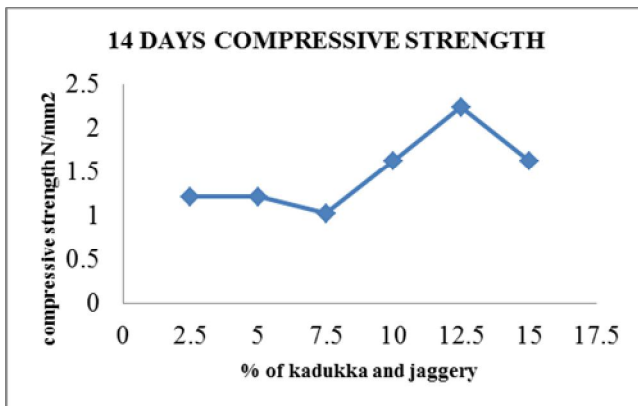


Figure 3. 14 days compressive strength of lime mortar with varying proportions of Jagerry and Kadukkai

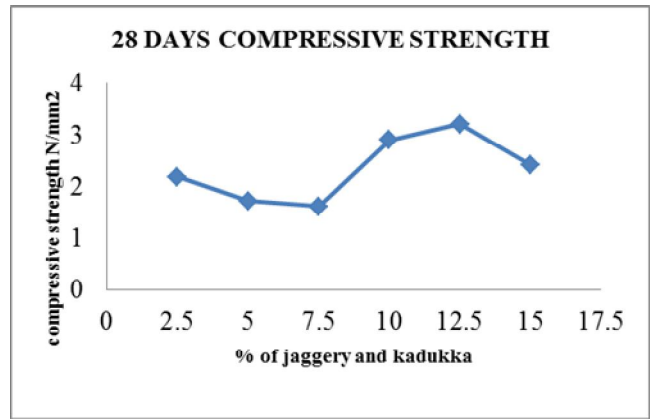


Figure 4. 28 days compressive strength of lime mortar with varying proportions of Jagerry and Kadukkai

4. CONCLUSION

This study reveals that the addition of natural admixtures to the lime mortar will increase its compressive strength. These admixtures modify the fresh and hardened property of the concrete. The maximum compressive strength of lime mortar obtained at 10% of jagerry at 28 days is found to be 3.71 N/mm² and 2.34 N/mm² for 10% of Kadukkai. The optimum percentage of both kadukkai and jagerry which gives high compressive strength is 2.5%.

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