

Behavioural Study on Partial Replacement of Lime and Natural Admixtures in Conventional Mortar

**S. Jeyalakshmi¹, S. Muthupandi², M. Shanmuga Prakash³, M.Thangapandian⁴, M. Vijayakumar⁵,
M.Vijayakumar⁶**

Assistant Professor, Dept of Civil Engineering, Sri Vidya College of Engineering and Technology, Virudhunagar, India¹

Undergraduate Student, Dept of Civil Engineering, Sri Vidya College of Engineering and Technology, Virudhunagar, India²⁻⁶

Abstract: Lime is a versatile material used from the ancient time of construction. It is mainly used as the binding material, also it offers greater durability and less strength compared to cement. The usage of lime is much reduced in the construction field when compared with the cement since cement produces greater strength. In this study, lime is added partially to the cement as lime-cement mortar for enhancing the strength by using different dosages of natural admixtures and also aimed to reduce the emission of Co2 on the environment. The different dosages of natural admixtures are 10%, 20%, 30%, 40%, and 50%.

Keywords: Lime, Cement, Kadukkai, and Jaggery.

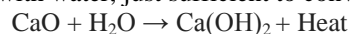
1. INTRODUCTION

Lime is a binding material which is used in the ancient time of constructions. It offers greater durability and less strength compared to cement. Hydrated lime is soft and flexible though it has the ability to move without cracking. The cement also offers less setting time compared to the lime. So the cement has the major advantage on the modernized constructions. But having less durability and emission of carbon dioxide is more the cement affects the environment. It leads to the global warming. It is the important factor that it cannot be neglected at this time of era. In India and other countries, the natural admixtures are used to increase the strength parameters of lime at the ancient time of constructions. The natural admixtures can reduce the emission of carbon dioxide on the environment produced by the cement. Using lime as the partial replacement of cement on the conventional mortar may increase the strength of lime-cement mortar. Also, it will definitely reduce the amount of carbon dioxide emission from the constructions by the usage of natural admixtures. Lime cement mortar is also known as 'compo' mortar or gauged mortar. It is prepared by mixing cement with lime mortar in suitable proportions. Addition of cement increases the hydraulicity and strength. The process of adding cement is known as gauging. It makes the lime mortar economical, strong and dense. Non-hydraulic, semi-hydraulic or hydrated lime are generally used for preparing these mortars.

2. MATERIALS USED

2.1. Lime:

Lime is produced by heating limestone which is more or less pure calcium carbonate. During heating, carbon-dioxide is driven off and non-volatile impurities such as oxides of silicon, magnesium, aluminium, iron, and manganese are left behind in the lime. The type of lime is used in this study was a hydrated lime. The hydrate of lime is formed by the absorption of water by quicklime and is the hydrated oxide of calcium, Ca(OH)₂. A dry powder obtained by treating quicklime with water, just sufficient to convert the lime into calcium hydroxide is called hydrated lime.



2.2. Cement:

Hydraulic cement, more commonly known as cement (also referred to as Portland Cement or Ordinary Portland Cement, O.P.C), is one of the most basic binding material in almost all civil engineering constructions. The term cement is restricted to the bonding materials used with stones, sand, bricks, building blocks etc., which are used in constructions. The compounds of lime are the principal constituents of this type of cement so that in building in civil engineering we are considered with the calcareous cement. The cement is used in making of concrete which has the property of setting and also used in underwater by good qualities of a chemical reaction with it. Thus it is named as hydraulic cement. In this study, the Ordinary Portland Cement (43 Grade) was used. Portland cement is so named because a paste of cement with water after it sets hard resembles in colour and hardness of a Portland stone, a limestone quarried in Dorset.

Table 1. Comparison between Cement and Lime

S.No	Aspects	Cement	Lime
1	Colour	Greenish grey.	White or greyish.
2	Slaking	Does not slake when wetted with water.	Slakes when wetted with water.
3	Setting	Sets rapidly when mixed with water.	Sets slowly when mixed with water.
4	Strength	Artificial cement possesses more strength.	Possesses less strength.
5	Suitability	Can be used for important and heavy engineering structures.	Cannot be used for important and heavy engineering structures.

2.3. Jaggery:

Jaggery is prepared by boiling sugarcane juice for a long time to obtain its solid state without using any chemical substances. It is also called as a natural sweetener. It is normally available in the state of solid blocks and semi-liquid form. It has good binding properties and medicinal properties. It is also used in the making of sweet called “karuppatti”. Jaggery water was used as a natural admixture at the ancient constructions for its good binding properties. Jaggery water is gathered from the palm tree and it has dark brown color. It makes the structure thermally insulated. It has a complex structure combined with sucrose, invert sugar, moisture, and other insoluble matter, like wood ash, proteins, and fibres. The quality of the jaggery can be measured by its colour. Brown means the jaggery contains higher in impurities and golden-yellow indicates that it is relatively pure.



2.4. kadukkai:

Kadukkai is a fruit which can be found throughout in India growing 100 feet height. It is used in the product of many herbal remedies for its good medicinal properties. It has extraordinary binding and hardened properties. Kadukkai can be used in construction only after it is made into a dried powder form for its effective usage. The dried kadukkai powder is mixed with sufficient water and enclosed for three days for making kadukkai paste. This paste is used for the mortar preparation.



3. EXPERIMENTAL

3.1. Mix proportioning:

The mix proportion for this study is 1:3 and it is the rich mortar ratio. The various proportions of natural admixtures like jaggery and kadukkai vary from 10% to 50%. Each proportion of lime-cement mortar cast three specimens for testing.

3.2. Mixing, Casting, and Curing:

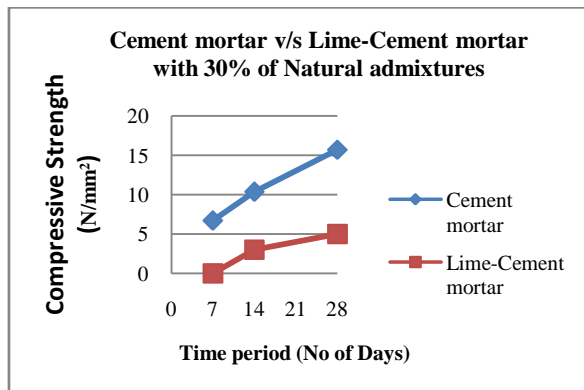
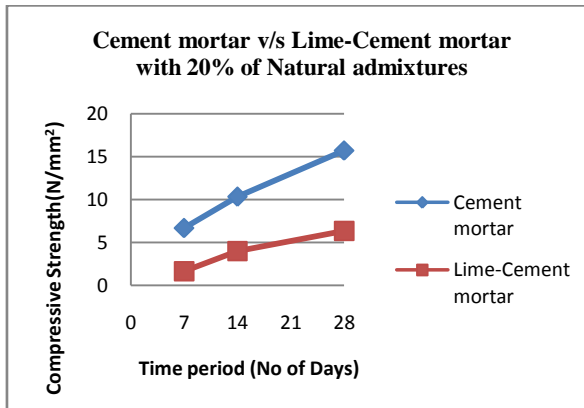
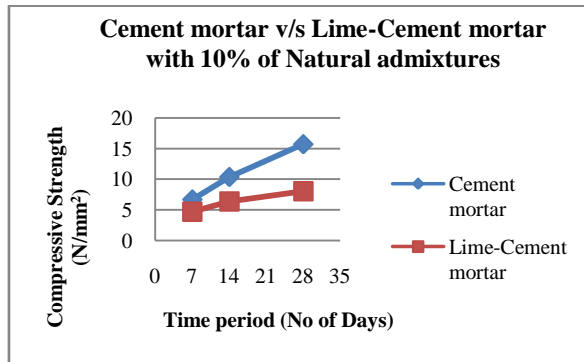
The required amounts of materials are taken as per the mix proportion. The natural admixtures like jaggery water and kadukkai paste were mixed with the water content for its effective usage. The percentage of natural admixtures added to the water content with respect to the weight of lime taken for the mortar. For the conventional mortar the desired

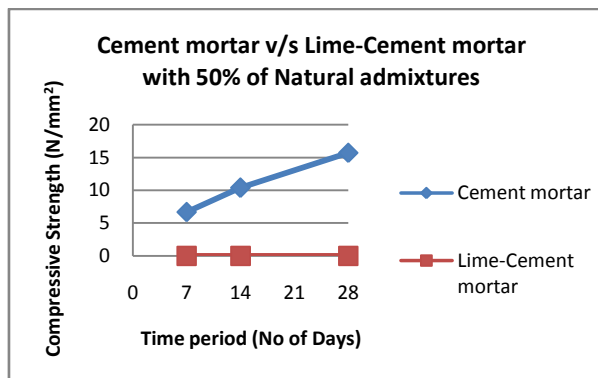
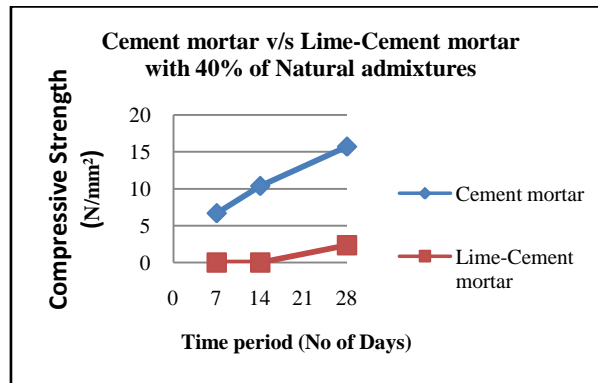
quantity of cement is mixed with aggregates and water (Without Natural Admixtures), but for lime-cement mortar, the quantity of 50% cement was replaced by the hydrated lime powder and they are mixed with fine aggregates(sand) and water (With Natural Admixtures). Then the fresh mortars were cast into 70.6mm cube moulds for compression testing and were removed after 48 hours. The specimens were separated out from the mould and were kept in water for 7-28 days for water curing. These steps are repeated for each proportion(10%, 20%, 30%,40%,50%) of lime-cement mortar.

4. RESULT

Table 3. Compressive strength of cement mortar v/s lime-cement mortar with jaggery and kadukkai

S.No	Percentage of Jaggery and Kadukkai	Compressive Strength (N/mm ²)		
		7 Days	14 Days	28 Days
1	0	6.69	10.36	15.71
2	10	4.68	6.35	8.02
3	20	1.67	4.01	6.36
4	30	0	3.01	5.02
5	40	0	0	2.34
6	50	0	0	0





5. CONCLUSION

This experimental study reveals that the strength of lime-cement mortar decreases when the percentage of natural admixtures increases. The thermal conductivity of the lime-cement mortar is low compared to the cement mortar because of the usage of natural admixtures. And also the compressive strength of lime-cement mortar is lower than the conventional mortar. Only 10% of natural admixture used in lime-cement mortar is obtained the medium level of compressive strength compared to the conventional mortar. For future aspects decreasing the amount of natural admixtures below 10%, may increase the strength of lime-cement mortar.

REFERENCES

1. P. Vijay Prabhu, S. Arther Prabhakar, R. Iyappan and M. Murugan, Experimental Study on Mortar Using Natural Admixtures, International Journal of Scientific & Engineering Research, Volume 7, Issue 5, May-2016.
2. G.K. Patel (M.Tech scholar), S.V.Deo, Parametric Study of Natural Organic Materials as Admixture in Concrete, International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 9 (2016) pp 6271-6277.
3. Giridhar. V, Gnaneswar. K and Kishore Kumar Reddy. P, Effect of Sugar and Jaggery on Strength Properties of Concrete, The International Journal Of Engineering And Science (IJES), Volume 2, Issue 10, 2013.
4. D. Gowrisanker , S. Aslam , R. Sathish Kumar , M.Jaganathan , Er.K.Jegan Mohan, Partial Replacement of Sand With Quarry Dust And Cement With Lime Powder, International Journal of Engineering Science and Computing, March 2016.
5. Md. Moinul Islam and Md. Saiful Islam, Strength Behaviour of Mortar Using Fly Ash as Partial Replacement of Cement, Vol. 1 (3) – September 2010.