

Lime Mortar in Early and Early Medieval India

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Abstract

The history of architecture in the Indian subcontinent is quite diverse. From the period before the first urbanization people tried to build suitable architecture with the easily available materials for living. Mortar was one of the necessary elements in the construction of such architecture. The material called Varjalepa described in ancient texts was the same material as mortar. The process for the preparation of Vajralepa consists of making a concentrated aqueous extract of finely ground fruits, seeds, flowers, and barks of plants rich in gummy and resinous substance by boiling and reducing the decoction to one-eighth of the original volume. On the other hand, mortar is a mixture of lime, sand, and water. It was mainly used in the construction of architectural roof castings and as a joint between two bricks. On the other hand, stucco and lime mortar were identical materials. Although its use dates back to the Indus Saraswati Civilization, lime mortar gained popularity in the early medieval period. During this time, it can be observed in several temples in South and North India. In the period between the 9th to 11th centuries, lime mortar was used in the construction of Buddhist viharas and Jain temples (such as Moghalmari, Kankandighi, Sontapal) in eastern India, which continued into the medieval period. In this article, I will discuss the composition and use of lime mortar in ancient & early medieval India and will also discuss the comparison between stucco and mortar.

Keywords: Mortar, Indus-Saraswati Civilization, Quick lime, Vajralepa, Brihatsamhitā, Amravati, Early Medieval Period, Moghalmari

Introduction

Food, clothing, and shelter are the most essential elements for human survival. Human life is stagnant without these three basic needs. Just as man sustains life and develops his body through food. Through clothes, they overcome their physical shame. The third need that occupies an important place in human life is housing. That is why man has been able to find a better place to live since the beginning of civilization. So, he or she has collected the necessary materials for the construction of the dwelling. Mortar was one of the necessary elements in the construction of such architecture.

Different Types of Mortar and their Usages

Mortar is usually a mixture of lime, water, and sand. Sometimes vegetable and animal fibers are used in this combination. It acts as a bonding material between two bricks and sometimes it is used in the roofing of houses. Different types of mortars have been found in different parts of the Indian subcontinent. Mud mortar, Gypsum mortars, and Lime mortars are quite significant. The use of mud mortar began in Egypt and Mesopotamia in six thousand BCE.¹ Mainly for the construction of large-size buildings and to keep the buildings cool from the heat of the sun, the use of this mortar increased in these regions. The main ingredient of this mortar was mud.

On the other hand, the main component of gypsum mortar was gypsum. The use of this mortar was prevalent in the north-western part of the subcontinent since the pre-Indus Saraswati civilization.² The

main ingredient of lime mortar was lime. The use of this mortar has been prevalent in the subcontinent since the Indus-Saraswati Civilization period. This type of mortar was used in construction work mainly in water-related architectures. Since lime was a water vapour barrier material. Hence this mortar was used to make the brick architecture last for a long time.

Stucco as a Lime Mortar

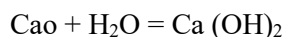
Lime mortar is a different form of stucco. Lime mortar was used in three ways in ancient India.

1. Lime mortar or stucco was used for statuary or artistic purposes 2. Lime mortar is also used in the case of architectural plaster. 3. It was used in architectural construction. I will mainly discuss the second and third points in this article. There are two types of Lime mortars available in the early period. One is the mineral lime mortar and another is the quick lime mortar. Mineral lime mortar is made of a combination of lime, sand, water, etc. and the quick lime is nothing but Calcium Oxide (CaO). Therefore, it can be said that Lime is an important ingredient in making mortars. It was used in different parts of the construction.

Mineral lime (CaCO₃) and water (H₂O) were generally used when preparing mineral lime mortar. In some cases, magnesium was added to it. Quick Lime was an important ingredient in the preparation of Lime-mortar Composition. As mentioned earlier, this quick lime was produced by burning limestone, snail, or oyster shells. Its chemical name is calcium carbonate, whose chemical symbol is CaCO₃. It is mainly composed of three elements namely carbon, oxygen, and calcium. The thermal decomposition of this carbonate yields calcium oxide. Combustion of calcium carbonate at 825°C (1.517°F) produces calcium oxide.³



Mixing water with this calcium oxide produces calcium hydroxide.



The subsequent quick lime is a white, odourless, volatile inorganic substance that is more soluble in cold water than in hot water.⁴

Method of making Quick Lime Mortar

First, quick lime was produced by burning limestone or snail or oyster shells. Then brick powder or brickbats were mixed with quick lime. But before that quick lime was soaked in water for a week so that the lime decomposes well. Then sand was mixed with quick lime and the mixture was soaked in water for a week. The mixture was then taken out and all the water was dried and the whole mixture was thoroughly smoothed by sieving. This mixture was re-mixed with water and used to make architectural plaster or sculpture. However, in the case of plaster, the amount of sand is more than lime. But the exact opposite method was followed in making icons. The quantity of quick lime was

higher than the sand waiting there. In some cases, artists could make quantitative differences in the material if necessary. The best proof of this comes in 1914-15 when Bhandarkar chemically analyzed mortar obtained from Besnagar and found that 22% of quicklime was presented in this mixture, so the sand content was higher because it was used as plaster.⁵ On the other hand, the chemical test of the stucco plaster from the ancient water reservoir in Mohenjodaro showed that the amount of quick lime here was 69%.⁶ So it is understood that the artists used to make the stucco composition by reducing or increasing the number of ingredients as required. However, in this case, the experience and skill of the industry were given considerable importance because if the amount of material was not right, there was a possibility of the material being wasted.

Description of mortar in ancient Indian literature

Various literary sources refer mortar as a constructional material of architecture. There is doubt as to what this material was called in ancient times. K. M. Varma thinks that the word '*Sudhā*' was used to denote mortar or stucco material in ancient times. In the Vedic text *Taittirīya Saṃhitā* (5.6.4.4), (5.2.6.3.4) the word *Śarkarā* is mentioned. Perhaps the term denoted a mixture of brickbats and sand. In ancient times brick was known as '*Iṣṭakā*' and sand as '*Siktā*'. In some cases, quick lime was mixed with a mixture of the two.⁷ On the other hand, the fourteenth-century commentator Sāyanāchārya opined that "*mṛṇmiśritāh Sūkṣmapāsānāh Śarkārāh*" i.e., *Śarkarā* is a small stone, which was mixed with mud.⁸ However, by mud here, Sāyanāchārya means a sticky substance, which would turn into quick lime when heated. It was probably slacked lime. The *Taittirīya Saṃhitā* (5.2.6.2-4) gives some information about the origin of this material. Here *Śarkarā* is compared to the thunderbolt of Lord Indra. On the other hand, Varāhamihira discusses *Vajralepa* in his *Brihatsaṃhitā*, a text of the 6th century CE, which was probably used for making sculptures and plastering the walls of houses.⁹ According to the *Śilparatna* (Chapter 14), this *Varjalepa* was a very helpful material in the building construction. The *Viṣṇudharmottara Purāṇa* mentions that five types of *Vajralepa* were used in ancient India. On the other hand, in the *Mayamatam* described, *Vajralepa* is a mixture of lime, *karāla*, *mudge*, *gulmāṣa*, *kalka*, and *cikkaṇaa*.¹⁰ So the question remains as to whether the content of *Śarkarā* was identical to the content of *vajralapa* in the sixth century CE. Mr. Marshall mentioned that in the north-western part of the Indian subcontinent, small stones were known as '*Vajri*'. It is not difficult to understand the word '*Vajri*' derives from the Sanskrit word *Vajra*. If the Vedic word *Śarkarā* is identical to the present stucco then why compare it with *Vajra* or thunderbolt? The answer is that after applying this combination to architecture and sculpture, it would have become lightning hard. Hence it is compared to thunder. Although the word '*Sudhā*' is found in Vedic texts, *Amṛta* was denoted by this word. But later the term '*Sudhā*' came to denote the stucco material itself. According to *Samarāṅgaṇa Sūtradhāra*, an architectural text composed in the 11th century, multi-storied buildings called *Saudha* were plastered with stucco or lime mortar.

Use of Lime Mortar in Pre-Christian & Early Christian eras

Not only the literary works but also the archaeological materials provide some information regarding lime mortar. The relentless efforts of archaeologists over the past few decades have led to the unearthing of lime mortar or stucco from several archaeological sites in the Indian subcontinent. The use of quick lime was well known by the people of the Harappan civilization. Lime mortar has been found in several places like Kalibangan, Harappa, Mohenjodaro, etc.¹¹

The use of stucco or lime mortar increased in India from the third century BCE onwards. As mentioned earlier, the walls with lime mortar were found in Besnagar. Chemical analysis of the lime mortar used in this wall showed that quick lime, sand, gypsum, water, volcanic ash, etc. were used to make this composition.

In 1816, Mackenzie visited the Amravati region of the Deccan and found several stucco sculptures on broken Buddhist *stupa* which were used for exterior decoration of mortared walls. However, there is no mention of the composition of the mortar in this case.¹²

Between the 2nd century BCE to 2nd century CE, quick lime mortar or stucco was used to protect the *anda* portion of Buddhist *stupas* in Sanchi, Sarnath, Taxila, etc for a long time. However, more quantity of quick lime was given in the formulation of composites. A similar type of stucco or the mortared wall has been discovered at Rajbaridanga in West Bengal which is about 1800 years old. In 1962, Sudhir Ranjan Das carried out archaeological excavations in this area and found mortared walls; several stucco heads, and other important objects from the site.¹³

Use of Lime Mortar in the Early Medieval Period

Mortar has been widely used in masonry construction since the early medieval period. A combination of lime plaster and mortar can be seen in most of the religious and secular architecture built during this period. Lime mortar was used in the construction of several temples and Buddhist monasteries in North India. The use of lime mortar can be observed in the Buddhist monasteries found in archaeological excavations in several villages in Zanskar and Padam taluks of the Kargil district of Kashmir.¹⁴ Besides that, mortars from early medieval layers have been found in villages like Phe, Sani, etc in Himachal Pradesh.

During the Cholas reign of South India, lime mortar was used for the interior decoration of Brihadeeswara Temple. Besides, the chemical analysis of mortar in Kaveripattinam, Nagaswamy temple in South India showed that lime and magnesium were present in almost equal amounts. However, in the mortar samples obtained from Kondapur, the percentage of lime was higher than the magnesium content.

It has been found in several places in eastern India such as Nalanda, Apsad, Kurkihar Chandrakhetugarh, Ballal Dhibi, etc. Even mortars have been discovered from Kankandighi and Moghalmari, both in West Bengal. Chemical analysis of the mortars showed that they contained quick lime mixed with lime powder and brickbats.¹⁵ There were several reasons for the use of mortar in the construction of temples and other architecture all over India; firstly, mortar was a very readily available material, which did not require much time or labour to prepare. Second, this material would become very hard after a few days, which would help strengthen the architecture. Thirdly, the mortar was a water-vapour resistant material so that it would not be damaged by rainwater. For all these reasons, mortar was a favourite material of the architects of ancient and early medieval India. They used lime mortar as well as mud mortar. There are several temples in Deulghata and Bishnupur whose signatures continue to bear.

Concluding Observations

Finally, it may be said that the use of mortar continued from the period of the Indus Saraswati Civilization to the late medieval period the main reason for the use of mortar in religious and secular construction was to increase the durability of the architecture. Architects in ancient India were using such materials that would not damage the architecture when exposed to rainwater. However, the mixture of lime mortar was not uniform all over India. Its composition has varied from time to time. Quicklime mortar has dominated architectural construction in eastern India. On the other hand, some amount of magnesium is added to the mortar mix in the north and south of India. In some cases, conch dust and marble powder were added to this mixture. Chemical tests of mortars of the medieval period in eastern India showed the presence of marble powder, which may have been the reason for the white colour of the mortar. However, the importance of mortar in the history of ancient Indian architectural practice cannot be denied.

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