EasyChair Preprint

№ 7370

Viability of Bio Construction Units in Indian Environment

Rupali Khadtar and Mary Christine George

January 27, 2022

Viability of Bio Construction Units in Indian Environment

Rupali Pratik Khadtar[1], Mary Christine George[2]

[1,2] *Anjuman-I-Islam's Abdul Razzak Kalsekar Polytechnic*
Thana Naka, Panvel, Mumbai
[a]*rupali.khadtar@aiarkp.ac.in.*, [b] *mary.george@aiarkp.ac.in*

Abstract. Until 1824, lime led the role in masonry structures as a binding agent but with the advent of cement, lime lost its popularity. Cement was opted for in this space age because of its quick setting properties compared to lime. However, lime has its own advantage of being less brittle. Lime helps to reduce moisture and improve the environment of the home. The production of lime does not cause global warming like cement. Lime can be manufactured on a small scale. Nature can provide materials that are more durable than man-made materials and processes that use less energy without harming the environment Lime prepared from limestone is harmful to the environment whereas lime prepared from seashells are a boon to the construction industry and sustains the environment. Seafood is common in the coastal region. "The proper disposal procedure for shell waste is in landfill, which costs a lot of money and can be a big burden for shellfish farmers and seafood producers." So, by adopting the process of producing lime from seashells, the landfilling of seashells can be reduced. Hence in this paper we will study the scope of producing lime based bricks(shellcrete), tiles, mortar etc. from seashells in India.
Keywords: Cement, Lime, Coastal region of India, Limestone, Shells, Shellcrete

INTRODUCTION

Seashells, namely from bivalves and gastropods, are fundamentally composed of calcium carbonate

Along the Gulf Coast of the United States, oyster shells were mixed into cement to make "shellcrete" which could form bricks, blocks and platforms. It could also be applied over logs. A notable example is the 19th-century Sabine Pass Lighthouse in Louisiana, near Texas.

Shellcrete is an on-going project transforming shell wastes from fisheries and seafood restaurants into architectural and landscape materials and features. The process of transforming sea shells into building materials dates back over a thousand years. It has evolved from communities lacking certain natural resources for construction. For the last 15 years we have studied worldwide the historic examples of these inventive processes. The technique of making shell-based building lime is widespread across the globe in communities that don't have access to limestone bedrock. Often it's island cultures on volcanic rock outcrops, or coastal communities with abundant shell material.

Lime A Promising Building Material

Lime is usually made by burning limestone rocks to create a dry white powder or wet putty that is used as a lime wash paint, or mixed with aggregates to make a mortar for stone or brick masonry, plasters, renders and sometimes cast as solid walls.
It is different to modern cements in that it cures and hardens by absorbing carbon dioxide from the air, re-crystallizing back to its original limestone chemistry. It is softer, more flexible and breathable compared to hard, brittle cements and crucially allows for masonry units such as bricks and stone to be easily cleaned and reused. It is made from one source ingredient, whilst cements are a blend of limestone with other, often harmful and toxic substances. Cements are also burnt at much higher temperatures in the kiln, emitting huge amounts of CO_2 in their production.

Lime has been made and used for 1000s of years in all climates around the world, and only fell out of favor in the 1950s as cements became the go-to material for increased speed of construction and amazing strength. Shells from oysters, mussels, scallops, whelks, crabs and lobsters can all be processed into building lime.

Why switch to seashells?

The traditional materials used in the manufacture of cement and concrete could be relatively cheap; however, there are considerable environmental issues (i.e., ecological damage, disruption of eco-system and air contamination) as well as intense energy consumption associated with the exploitation of depleting natural resources. Waste shells are a renewable and cheap alternative, and will simultaneously decrease manufacturing cost while reducing their burden on the environmentally to avoid taking them to a landfill already has economic value!"

Construction material that can be made from seashells.

An Oyster Based Lime Mortar

An oyster based lime mortar for buildings can be produced. The mortar can be produced in large quantities and consolidated into timber shuttering, like rammed earth, to produce solid thick walls and buildings. The material could be a mixture of calcined (burnt) oyster shell (the lime binder), ash (from the burning process) and sand. The ash from the burning of the shells adds strength to the final mortar.

Bedding Mortar for The Large Stones

Shell sand can be burnt for quicklime and added to the beach deposit (aggregate) to make the bedding mortar for the large stones. The shell sand can also be used in its raw state as internal flooring.

FIGURE 1. Bedding Mortar for The Large Stones

Lime for internal plastering and decorative applications

It is possible to use oyster shells as a source material for lime production. They can make a beautiful mortar that is very pure and easy to work with. Oyster lime is a very fine material, possibly saved just for the best work such as internal plastering and decorative applications.

Shellcrete tiles

Shell wastes from fisheries and seafood restaurants are transferred into architectural and landscape materials and features.

FIGURE 2. Shellcrete tile

Viability of Bio Units in India

9 Coastal States of India

India has a coastline of 7516.6 km-- 5422.6 km of mainland coastline and 2094 km of island territories. Indian coastline touches nine states-- Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and two unions territories-- Daman and Diu and Puducherry. The two island territories of India are-- Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea.

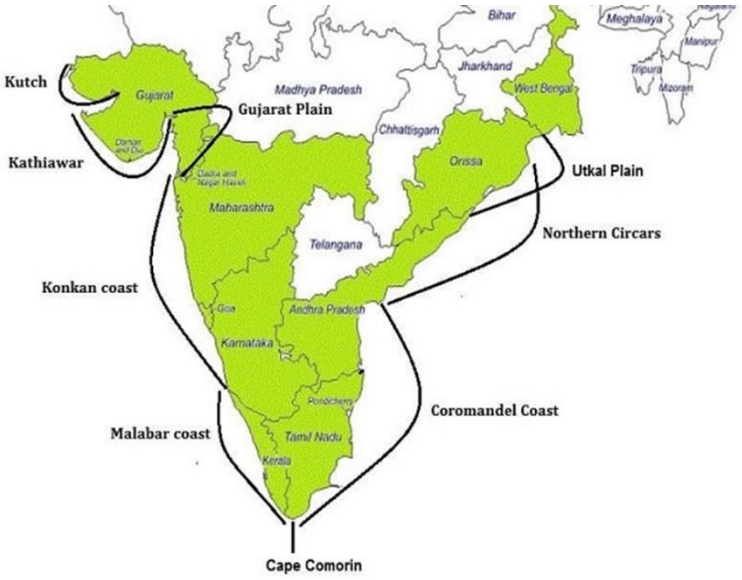

FIGURE 3. Coastline of India

Gujarat has the longest coastline in India which lies in the Kathiawar region of the state and is 1,600 km long.

The coastline in the state of Tamil Nadu is the second largest coastline in India (1,076 km long) and is known as the coromandel coast.

The state of Andhra Pradesh has the third-longest coastline in India and lies in the region of Coastal Andhra. The coastline is 972 km long along with the Coromandel Coast between the Eastern Ghats and Bay of Bengal.

The state of Maharashtra has a coastline of 720 km and is known as Konkan Coast.

Kerala has the fifth largest coastline of 590 km in India and is called Malabar Coast. It starts from the south-western coast of Maharashtra and along the coastal region of Goa, through the entire western coast of Karnataka and Kerala and reaches Kanyakumari.

The state of Odisha has a coastline of 485 km long called coastal Odisha or the Utkal Plains. The region is bounded by the Lower Ganges Plain in the north, the Bay of Bengal in the east, the Tamilnad Plains in the south, and the Eastern Ghats in the west.

The coastal area of Karnataka is known as Kanara which is 300 km long.

The coastal plain of West Bengal is located in Purba Medinipur and South 24 Parganas district and has a coastline of 158 km long.

Occurrence of Limestone in India

Almost all the states of India produce some quantity of limestone.
Over three-fourths of the total limestone of India is produced by Madhya Pradesh, Rajasthan, Andhra Pradesh, Gujarat, Chhattisgarh and Tamil Nadu.

Madhya Pradesh

Madhya Pradesh is the largest producer of limestone [16 per cent].
Large deposits occur in the districts of Jabalpur, Satna, Betul, etc.

Rajasthan

Rajasthan has about 6 per cent of the reserves and produces over 16 per cent of the total limestone of India. Production occurs in almost all districts.

Andhra Pradesh

Andhra Pradesh possesses about one-third of the total reserves of the cement grade limestone in the country.
Extensive deposits occur in Cuddapah, Kumool, Guntur, etc.

Gujarat

Gujarat produces only about 11 per cent of the total limestone of India.
High grade limestone deposits occur in Banaskantha district.

Chhattisgarh

Chhattisgarh accounts for more than nine per cent of total limestone of India. Deposits of limestone occur in Bastar, Durg and surrounding districts.

Tamil Nadu

Large scale reserves in Ramnathapuram, Tirunelveli, Salem, Coimbatore and Madurai districts.

Karnataka

Gulbarga, Bijapur and Shimoga districts.

Scope of finding seashells

Seafood is common in the coastal region. “The proper disposal procedure for shell waste is in landfill, which costs a lot of money and can be a big burden for shellfish farmers and seafood producers."

Primary Advantages of Lime, Mortar and Concrete Made from Shells

1. Contains fibers to reduce micro cracking and improve durability.
2. Easy to apply and excellent workability.
3. Non shrink, non-toxic and non-corrosive.
4. Water and weatherproof.
5. Reduces carbonation significantly.
6. Excellent adhesion and mechanical strengths.
7. Contains no chlorides or salts that may cause corrosion.
8. Gives better control than two part systems.
9. Good color matching to concrete.
10. Non sagging.
11. Good resistance to chlorides and sulphates.

Secondary Advantages of Lime, Mortar and Concrete Made from Shells

1. Reduction of seashells in landfills for disposal.
2. Lime from seashells is environment friendly.

CONCLUSION

Considering the vast coastline of India, the availability of seashells is not a question. Moreover, the food habits of coastal people are such that a large amount of empty seashells are produced on a daily basis. Instead of resorting to landfilling these seashells can be conveniently recycled and used for a better purpose that is the production of lime. The lime produced from seashells is eco-friendly and reduces pollution at manufacturing and utilization stages. Even the states like Andhra Pradesh which is rich in limestone can use this technology to have a healthy environment. Hence we can conclude bio units are viable in India.

ACKNOWLEDGEMENT

This paper and research is an outcome of the experience and expertise gained in Anjuman-I-Islam's Abdul Razzak Kalsekar Polytechnic during our years of service at the institute. We are grateful to the institute for giving us an opportunity to train the future generation in the engineering field and also sharpen our skills in the same field. We take this opportunity to that Prof. Ramzan Khatik for his leadership qualities which constantly motivate us to strive for our betterment and reach for higher horizons. We are also grateful to our colleagues in the Civil Engineering Department who provide us healthy competition and challenge us to reach new goals.

REFERENCES

1. S Amziane, L. Arnaud, Bio-aggregate based building materials: Application to Hemp C Concretes, ISTE Ltd and John Wiley & Sons, 2013.V. Nozahic, S. Amziane, G. Torrent, K. Saïdi, H. De Baynast, Design of green concrete made of plant-derived aggregates and a pumice-lime binder. Cem Concr Comp (2012) 34: 231-241
2. V. Nozahic, S Amziane, G. Torrent, K. Saidi, H. De Baynast, Design of green concrete made of plant derived aggregates and pumice lime binder, Cem Concr Comp, 2012, 34:231-241.
3. Garcia, I.; Heras, E.; Puertas, F.; Oteiza, I.; Martin-Consuegera, F.; Legarra, J.J., Tests on mortars and concrete made with seashells as aggregate, 2013
4. Ohimain, I.E.; Bassey, S.; Bawo, D.S.D., Uses of seas shells for civil construction works in Coastal Bayelsa State, Nigeria: a waste management perspective, 2010
5. Yoon, G.L.; Kim, B.T.; Kim, B.O.; Han, S.H., Chemical-mechanical characteristics of crushed oyster-shell, 2011
6. Adel Abidou, MadihaAmmari, Z.J. Mohammed Ghoraishi, Rajai Al-Rousan, Z. (2017) Sand with crushed sea shells and its effect on the strength of mortar and concrete used in the United Arab Emirates, International Journal of Civil Engineering and Technology, Vol.8, Issue.9, pp.462-470.
7. Bruno Henriques, Filipie Silva, S. Guimaraes, JounaMesquita, Marico Fredel, C. and Thamyres Silva, H. (2019) The potential use of oyster shell waste in new value added by-product.
8. Hema, P.Indhu, S.Mohanalakshmi, V. and Prabha, V.C. (2017), Developing Concrete using sea shell as a fine aggregate,International Journal for Innovative Research in Science & Technology, Vol.3, Issue.10.
9. Herald Lessly, S.Manvitha, T.Subhashini, S. and Yamuna Bharathi, R. (2016) Experimental study on partial replacement of coarse aggregate by sea shell and partial replacement of cement by fly ash, International Journal of Latest Research in Engineering and Technology, Vol.2, Issue.3, pp.69-76.