International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 11 | Nov - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Improving Properties of Laterite Bricks by using Nano-Silica

Ms. P. R. Patil[1], Ajinkya Hajare[2], Darshan Kupanhatte[3], Bramhanand Gurav[4],Pranav Anuse [5]
1 Head of Department, Department of Civil Engineering, SITCOE, Yadrav , Kolhapur
2,3,4,5 Students, Department of Civil Engineering, SITCOE, Yadrav, Kolhapur

---

Abstract -
This study investigates the enhancement of laterite brick properties through the incorporation of nano-silica. Laterite bricks, known for their eco-friendly and cost-effective characteristics, often face challenges such as low strength and durability. By adding nano-silica, the research aims to improve compressive strength, water resistance, and overall performance of the bricks. Experimental results demonstrate that nano-silica enhances the microstructure of laterite, leading to improved mechanical properties. This work highlights the potential of nano-silica as a valuable additive in sustainable construction materials.

1.1. Introduction

Laterite is a soil type rich in iron and aluminum and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterites are of rusty-red coloration, because of high iron oxide content. They develop by intensive and prolonged weathering of the underlying parent rock, usually when there are conditions of high temperatures and heavy rainfall with alternate wet and dry periods. The process of formation is called **laterization**. Tropical weathering is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils. The majority of the land area containing laterites is between the tropics of Cancer and Capricorn.

Laterite has commonly been referred to as a soil type as well as being a rock type. This, and further variation in the modes of conceptualizing about laterite (e.g. also as a complete weathering profile or theory about weathering), has led to calls for the term to be abandoned altogether. At least a few researchers specializing in regolith development have considered that hopeless confusion has evolved around the name. Material that looks highly similar to the Indian laterite occurs abundantly worldwide.

Historically, laterite was cut into brick-like shapes and used in monument-building. After 1000 CE, construction at Angkor Wat and other southeast Asian sites changed to rectangular temple enclosures made of laterite, brick, and stone. Since the mid-1970s, some trial sections of bituminous-surfaced, low-volume roads have used laterite in place of stone as a base course. Thick laterite layers are porous and slightly permeable, so the layers can function as aquifers in rural areas. Locally available laterites have been used in an acid solution, followed by precipitation to remove phosphorus and heavy metals at sewage-treatment facilities.

Laterites are a source of aluminum ore; the ore exists largely in clay minerals and the hydroxides, gibbsite, boehmite, and diaspore, which resembles the composition of bauxite.

In Northern Ireland they once provided a major source of iron and aluminum ores. Laterite ores also were the early major source of nickel.

Laterite bricks are widely used in several parts of India, including Kerala, Karnataka and Andhra Pradesh. They are commonly used for constructing walls, foundations, and other structures. This highly compacted and cemented soil can easily be cut into brick-shaped blocks for building. laterites are of rusty-red coloration, because of high iron oxide content. Laterite bricks are acquired from the mines of laterite crusts and then further they are converted into laterite stones with machine cut method.

Nano-silica is a powder material of particle size <100nm. It features as light and fluffy in volume and high chemical activity. As it contains OH- bond on the surface, nano-silica is an acid oxide belonged to acid radical of silicate, and hydrophilic with above 5 times water absorption than itself.

1.2. Objectives

1)To study the properties of laterite Brick & Nano-silica.

2) To analysis the strength and other important properties of laterite brick by applying nano-silica .

3) Preparation of blocks by using laterite waste and nano silica .

4) To compare and analysis of normal concrete block with the proposed laterite block

2.1. Literature Review

Dr-Parag Govardhan Narkhede

BKPS College of Architecture Pune:Government of Maharashtra- IndiaPhD (Architecture)

This study reports on the chemical and microstructural analysis of laterite from four different quarries for building purposes from Malabar region in Kerala in the south west of India. Wet chemical analysis was performed to determine the amounts of the various oxides present, while the microstructural characteristics such as mineral composition, texture and structure were analysed using advanced instrumental techniques such as polarized petrographic microscope, X-ray diffraction analysis and scanning electron microscopy. An attempt was made to understand the link between physico-mechanical characteristics and the chemical composition and microstructure. The study revealed that high strength laterite was abundant in heavier minerals like hematite and goethite and was marked by dense and continuous crystalline matrix, whereas low strength laterites were abundant in clay minerals (mainly kaolinite), and showed a scattered distribution of iron minerals. In terms of chemical composition, the differences between the four types of laterite were not significant.

Errol Dsouza and U. Dileep Kumar∗
Civil Engineering Dept., Sahyadri College of Engineering & Management, Mangalore 575007

In this study we have classied laterite stone based on its strength characteristics from 5 major quarries of the South Canara region in Karnataka, India. This study includes investigation of the laterite stone for construction purposes. The inherent properties of laterite such as texture, colour, structure and hardness were investigated. The engineering properties laterite building blocks freshly quarried from various depths of the quarry are studied. The mechanical and physical properties of laterite were found to be dependent on the inherent prole characteristics of the quarry. The properties of laterite varied signicantly, depending upon the depth and location of the quarry. The methods of choosing a good laterite block suitable for construction is also discussed in this paper.

Mr. M W Tjaronge

Universitas Hasanuddin | UNHAS · Department of Civil Engineering

Concrete is one of the most durable construction material and cement is one of the most energy intensive structural materials in concrete. This research is conducted to research of the suitability of tap water, river sand and laterite stone which is available abundantly surround the Berau district of Indonesia with Portland composite cement (PCC) and crushed laterite stone to produce concrete. Test result exhibited that fresh concrete had proper workability and all hardened specimens appeared a good compaction result. This paper purposed to utilized tap water, river sand, laterite stone and Portland composite cement to produce the high performance concrete to eliminate the main problems of stone shortage and fine aggregate in the low land areas and the Berau district of Indonesia. Infrastructure development can be sustained through the effective use of available local materials surround the Berau district of Indonesia. The evaluation result on the workability of fresh concrete and strength development of hardened concrete were discussed.

. Santha Kumar
Assistant Professor at Sri Krishna College of Technology, Coimbatore

Laterisation is an uncontrolled natural process that was influenced by the synergetic effect of atmospheric and geological conditions. Laterite soil ‘leached residue’ is the resultant from the process of laterisation and is widely distributed these days throughout the world. Meanwhile, the construction sector is facing sustainability issues these days due to over exploitation of raw material from natural resources and therefore, an ideal solution is to utilize the laterite soil as an alteranative sand / raw material for promoting sustainable development. The present paper presents an overview of the significant studies, based on identification, appraisal, selection and characterization of laterite soil in various aspects and its feasible utilization as an alteranative sand / raw material for the production of bricks, mortar, concrete, geopolymeric products and road pavements. This review paper also summarizes potential future research areas for enhancing the utilization of laterite in construction sector.

3.1 Material:

1. **laterite brick**

Fig 1

Laterite bricks are a type of construction material commonly used in India. They have been used in India for centuries and are still popular today. Made from laterite soil, which is abundant in many parts of the country, these bricks are known for their durability and strength

One of the main advantages of laterite bricks is their cost-effectiveness. They are relatively inexpensive compared to other building materials, making them a popular choice for affordable housing projects. Moreover, laterite bricks are environmentally friendly as they are made from locally available soil, reducing the need for transportation and minimising carbon emissions

- **Advantages of laterite bricks**

Laterite bricks are a popular choice for construction in India due to their numerous advantages. Here are some key advantages of using laterite bricks:

- **Thermal and chemical stability**: Nano-silica is stable and can be used in liquid crystalline matrices to improve thermal stability.

- **Improved durability**: Nano-silica can improve the durability of concrete and other building composites by reducing the ingress of aggressive chemicals.

- **Improved mechanical properties**: Nano-silica can improve the mechanical properties of concrete and other building composites.

- **Functionalization**: Nano-silica can be functionalized with organic molecules and polymers.

- **Properties of laterite stone**
- The physical properties of this stone vary considerably from place to place. Freshly quarried laterite is **Soft and Porous** but when exposed to atmospheric conditions it hardens and makes a very tough material. Therefore, it is always desirable that these stones should be quarried sufficiently ahead of use.

- **Physical Properties of Laterite stone -** Exposed surfaces are blackish-brown to reddish and commonly have a slaggy, or lavalike appearance. Commonly lighter in colour(red, yellow, and brown) where freshly broken, it is generally soft when freshly quarried but hardens on exposure.

- **Thermal insulation property -** Being natural stones, laterite has an inherent cooling property that helps to keep homes cool during summer. This is particularly beneficial for buildings located in hot regions. The thermal insulation property of laterite bricks also allows them to adjust better with the weather.

- **Sustainability -** The production of laterite bricks is environment-friendly in nature. As laterite bricks are most commonly cast in-situ, they do not contribute to the production of greenhouse gases, which helps to reduce carbon dioxide.

- **Durability Laterite -** Bricks come with exceptional durability, whereby they are able to withstand extreme weather conditions and remain in good condition for years on end.

2. silica powder

Nano silica, or nano silica, consists of silicon dioxide (Si O_2) particles that are on the nanometer scale, typically ranging from 1 to 100 nanometers. Due to their extremely small size and high surface area, these particles exhibit unique properties such as increased reactivity and strength compared to larger silica**Fig.3.3 Nanno Silica**

Fig 2

- **Properties of Nano Silica**
- **Thermal and chemical stability:** Nano-silica is stable and can be used in liquid crystalline matrices to improve thermal stability.
- **Improved durability:** Nano-silica can improve the durability of concrete and other building composites by reducing the ingress of aggressive chemicals**.**
- **Improved mechanical properties:** Nano-silica can improve the mechanical properties of concrete and other building composites.
- **Functionalization:** Nano-silica can be functionalized with organic molecules and polymers

3. **Cement**

Cement is defined as a binding agent that is used to bind various construction materials. Given its adhesive and cohesive properties, it is an essential ingredient of concrete and mortar. Cement is mixed with water to form a paste that binds aggregates like sand or crushed rocks. Calcium, silicon, iron and aluminum compounds are closely ground to form a fine powdered product

Fig 3

- **Properties of Cement**
  The following are the various physical properties of cement:

1. **Fineness:**
   It is the size of the particles of the cement. The desired fineness can be achieved by adjusting the grinding of the clinker.

2. **Soundness:**
   Soundness is the ability of the cement to resist shrinking upon hardening. The Le-Chatelier test and Autoclave test help determine the soundness of cement.

3. **Consistency:**
   Consistency of cement is the cement paste's viscosity or its ability to flow.

4. **Strength:**
   The compressive, tensile and flexural strength of cement is measured to assess the durability of cement after an elongated period.

5. **Setting Time:**
   The setting time of cement is defined as the time required for the concrete to change from its liquid state to plastic state, and then from the plastic state to solid state.

- **Applications in Cement:**
  Nano silica is used as an additive in cement to enhance its performance. Here's how it contributes:

1. Improved Strength:

i. **Pozzolanic Reaction:**
Nano silica reacts with calcium hydroxide ($Ca(OH)_2$) produced during the hydration of cement. This reaction forms additional calcium silicate hydrate (C-S-H), which is the primary binding phase in concrete. This increases the overall strength and durability of the concrete.

ii. **Filler Effect:**
Due to its small size, nano silica can fill the microscopic voids within the cement paste, leading to a denser and more compact structure.

2. Durability:

1. **Reduced Porosity:**
The addition of nano silica decreases the porosity of the cement matrix, making it less permeable to water and other harmful substances, which can enhance the durability of the concrete.

2. **Resistance to Chemical Attack:**
By densifying the concrete matrix and consuming calcium hydroxide, which is more susceptible to chemical attack, nano silica improves the chemical resistance of the concrete.

3. Early Strength Development:
Nano silica accelerates the hydration process of cement, which can significantly improve the early strength of concrete. This is particularly beneficial in applications where quick setting and early load-bearing capabilities are required.

4. Workability:
Nano silica can improve the rheological properties of cement paste, making it easier to work with while maintaining high performance. However, its addition must be carefully controlled to avoid negative impacts on the workability of the mix.

3.2 Methodology

1. Collection of material
2. Application of prepared mix on stone
3. Preparation of Block
4. Testing properties
5. Comparison

Analysis.

4.1 Material Collected

1. Laterite Brick
2. Nano-silica
3. Cement
4. Laterite waste

4.2 Ph Testing of Material

- Laterite Soil – 5 (Acidic)
- Nano Silica – 8 (Alkaline)
- Cement – 14 (Alkaline)
- Mix – 12(Alkaline)

4.3 Working on Model:

Fig 5

4

Fig

Fig 6

Fig 7

4.4 Mixture of Nano-Silica & Cement with proper ratio

Fig 8

Fig 9

- **Application with different ratios of mixtures.**

- 1st brick had 50 gm cement,10% nanosilica.
- 2nd brick had 50 gm cement, 20% nanosilica.
- 3rd brick had 50 gm cement, 30% nanosilica.
- 4th brick had 50 gm cement, 40% nanosilica.
- 5th brick had 50 gm cement, 50% nanosilica.

1. **Injecting mixture in Brick.**

Fig 10

Fig 11

Fig 12

Fig 13

1. **Curing Brick for 24 Hours after Injecting Mixture.**

Fig 14

2. **Dried Bricks after curing for 24 Hour**

Fig 15

Fig 16

3. **Weight of brick Before & After Curing**

Fig 17

Sr. No	Weight Before Curing(Kg)	Weight After Curing(Kg)	Water Absobtion Ratio
1	21.125	22.105	4.44%
2	22.255	23.225	4.18%
3	29.170	30.170	3.32%
4	31.055	32.275	3.79%
5	31.520	32.645	3.45%

	Weight Before Curing	Weight After Curing	Water Absobtion Ratio
Normal Brick	30.175	32.565	7.34%

2. **Compressed bricks to check strength of Bricks.**

Fig 18

Fig 19

Fig 20

4.3 Compressive Strength Test

- Dimensions of Bricks- L=250mm, B=220mm, H=160mm

Sr.No	Compressive Strength (N/mm2)
Normal Brick	7.36

Sr. No	Compressive Strength (N/mm2)	% of Nano Silica
Brick 1	7.49	10%
Brick 2	8.4	20%
Brick 3	9.81	30%
Brick 4	10.90	40%
Brick 5	10.92	50%

5. Laterite Waste Collection & Particle Size Distribution.

Fig 21

Fig 22

6. Size Of Sieves

Fig 23

Sizes of Sieves (mm)
25
10
6.75
2.36
4.75

Fig 24

Fig 25

Fig 26

5.1 Blocks Created from waste laterite

Fig 27: Block Casting

Fig 28

5.2 Water Absorbtion test results of proposed brick

Sr. No	Weight Before Curing(Kg)	Weight After Curing(Kg)	Water Absorbtion Ratio	Nano Silica %
Brick 1	7.220	7.305	1.16	0%
Brick 2	7.145	7.225	1.10	2%
Brick 3	7.145	7.230	1.17	3%
Brick 4	7.150	7.240	1.24	5%

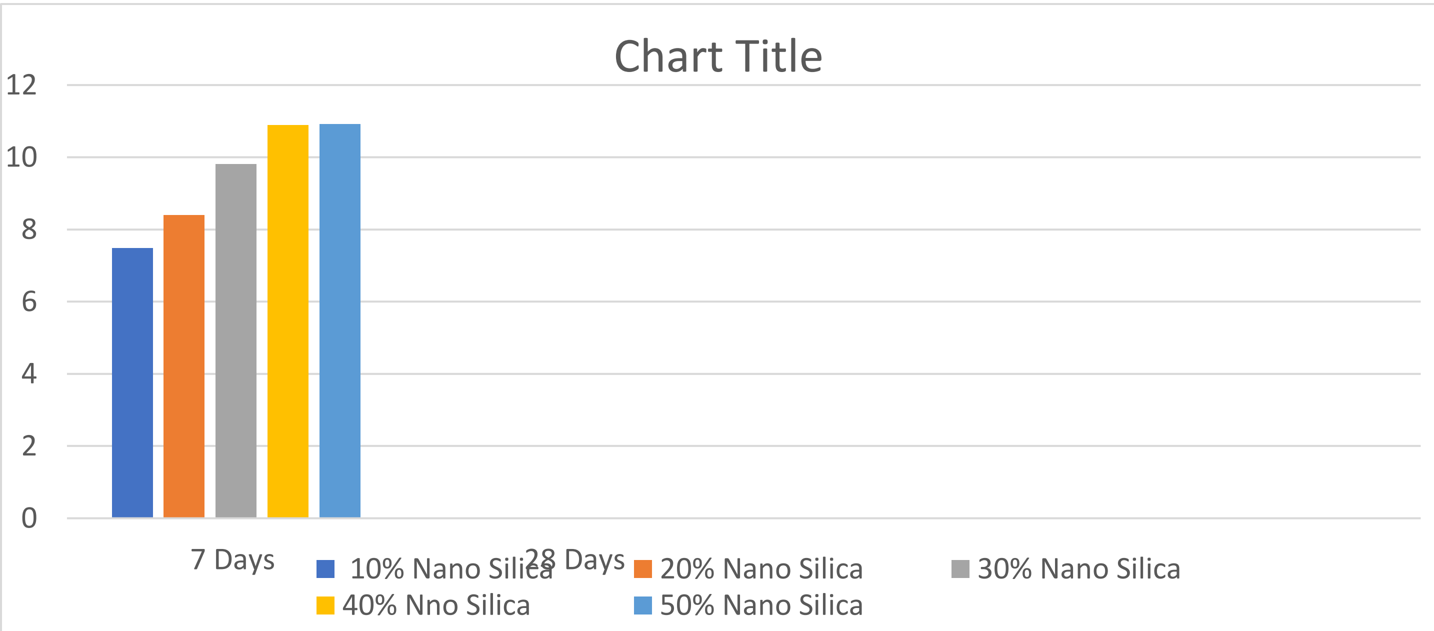
5.3 Compression Test of Created Blocks

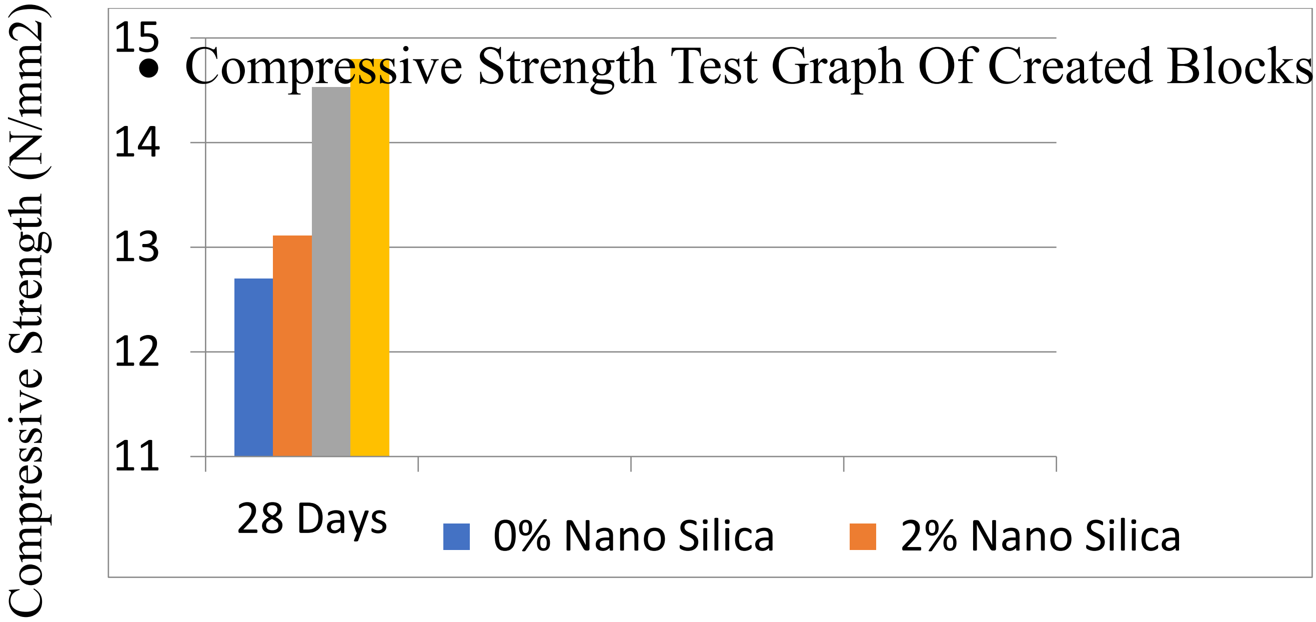
Sr. No	Compressive Strength (N/mm2)	% of Nano Silica
Normal Brick	12.70	-
Brick 1	13.11	2%
Brick 2	14.53	3%
Brick 3	14.80	5%

Fig 29

Normal Concrete Block	9.64 N/mm2

5.4 Compressive Strength Test Graph





6.1 References

- **M. Mostafa et al.**

Experimental analysis of Compressed Earth Block (CEB) with banana fibers resisting flexural and compression forces
Case Stud. Constr. Mater.
(2016)

- **M. Ouedraogo et al.**

Physical, thermal and mechanical properties of adobes stabilized with fonio (Digitariaexilis) straw
J. Build. Eng.
(2019)

- **Y. Millogo et al.**

Experimental analysis of Pressed Adobe Blocks reinforced with Hibiscus cannabinus fibers
Constr. Build. Mater.
(2014)

- **F. Jové-Sandoval et al.**

Assessment of the mechanical performance of three varieties of pine needles as natural reinforcement of adobe
Constr. Build. Mater.
(2018)

- **E. Olacia et al.**

Sustainable adobe bricks with sea grass fibers. Mechanical and thermal properties characterization
Constr. Build. Mater.
(2020)

- **M. Giroudon et al.**

Comparison of barley and lavender straws as bio aggregates in earth bricks
Constr. Build. Mater.
(2019)

7.1 Conclusion

- As per result & discussion 30% to 40% nano silica with cement addition will give better result for laterite stone brick.
- 3% silica with cement gives better result for laterite waste block.
- It will also concluded that acidity of laterite also reduces by using nano silica & cement into mixture.

5. ACKNOWLEDGEMENT

We would like to express our gratefulness and sincere gratitude to my guide Mr. A. B. Jadhav, for guiding us to accomplish this project work. It was our privilege and pleasure to work under his able guidance, we are indeed grateful to him for providing helpful suggestion, from time to time. Due to his constant encouragement and inspiration we are able to present this project. We are thankful to our parents for their moral as well as financial support.

6. REFERENCES

- Delamination-a state-of-the-art review .Dipayan Jana [24 April 2004]
- Development and Implementation of Concrete Floor Finishing . Masaru Soma [13 Oct]
- Laser screed technology: an opportunity to ease in consrtuction sector .Dr. Jayeshkumar Pitroda [29 March 2014]
- The structural model of automated leveling system for a construction machine. Pavel Balashov [30 Jan]
- Experimental and analytical study of vibration parameters in waffle concrete slabs. Moacir Kripka [Oct 2019]
- Automation of Concrete Slab-on-Grade Construction . Osama Moselhi , Paul Fazio[Dec 1, 1992]
- Advances in concrete placement methods and finishing techniques for high performance industrial pavements in australia. Peter Ashford [6 December 2002]