# Cow Dung-Clay Composites for Sustainable Masonry

**Bhanu Sharma*, Avnish Negi, Amit Sanoria, Raman Choudhary & Dr Mahesh Kumar Sehra**

**Rajiv Gandhi Government Engineering College Kangra at Nagrota Bagwan (H.P.), Kangra, Himachal Pradesh, India**

**DOI: https://doi.org/10.51584/IJRIAS.2026.11100013**

**Received: 15 October 2026; Accepted: 20 October 2026; Published: 30 October 2026**

## ABSTRACT

Cow dung is a sustainable material that can be used to make bricks; when bricks are made entirely from clay, the top layer of soil is consumed, which is highly fertile and supports large-scale food production. Preserving it is very important for our environment as soil is important for binding trees, plant roots and other vegetation; so preserving it is very important for reducing erosion and landslides, as cow dung is used in place of clay. So, using it also protects the top layer of soil.

In Today's time when we use traditional bricks, the thermal insulation provided by these bricks is less; moreover, the weight of these bricks is also very high. They are also not sustainable for our environment as the production of these bricks not only deteriorate top soil but also leads to the emission of a large amount of carbon dioxide so cow-dung is a good alternative to clay.

This research aims to use cow-dung with clay in different proportions. Cow-dung used in bricks is 15% to 30% by volume. The standard size of these bricks is 19 X 9 X 9 cm. These bricks are kiln-fired as well as sun-dried and the compressive strength of both these samples of bricks is tested. Fibre is also reinforced in the bricks to check the compressive strength and weight.

A total of 24 brick samples are prepared. The compressive strength of these bricks ranges from 5.0 to 6.5 $N/mm^2$ and when it is reinforced with fibre the compressive strength decreases and ranges from 3.5 to 6.0 $N/mm^2$. The compressive strength of sun-dried cow dung bricks reinforced with fibre is also slightly lower than normal sun-dried bricks.

Another aim of this research is to find the weight of the cow dung bricks. The bricks which are sun-dried have weight ranging from 1.890 to 2.100 kg. The bricks which are kiln-fired have weight ranging from 1.770 to 1.960 kg. Generally, these bricks are lightweight. The reinforcement with fibre leads to decrease in compressive strength and a reduction in weight.

**Keywords**: Cow-dung; Sun-dried; Mineral wool; Kiln-baked; Compressive strength.

## INTRODUCTION

Cow-dung is the waste product of bovine animals like cattle. It can be used as organic fertiliser and a fuel source. The construction industry emits carbon dioxide. Brick production leads to the depletion of a large amount of fertile topsoil. This Research paper aims to investigate the compressive strength of cow dung bricks with different proportions of clay and cow-dung and also how the compressive strength of cow dung bricks will change with the reinforcement of mineral wool fibre. This research paper also aims to compare different ratios of cow dung in cow-dung bricks with traditional bricks.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

The construction sector is one of the largest consumers of natural resources which contributes to environmental degradation and the production of a large amount of carbon. Finding alternative construction materials that are environmentally friendly, cost-effective, and readily available is crucial for mitigating these negative impacts[1]. In construction, brick acts as a creative material that we have been using since 4500 years ago and the basis of brick is soil.

Agricultural soil is widely used to make bricks which affect agricultural adversely, as in our Indian economy agriculture employs more than 50% of the workforce and contributes almost 20% to the country's GDP as per economic survey 2021-22[2].

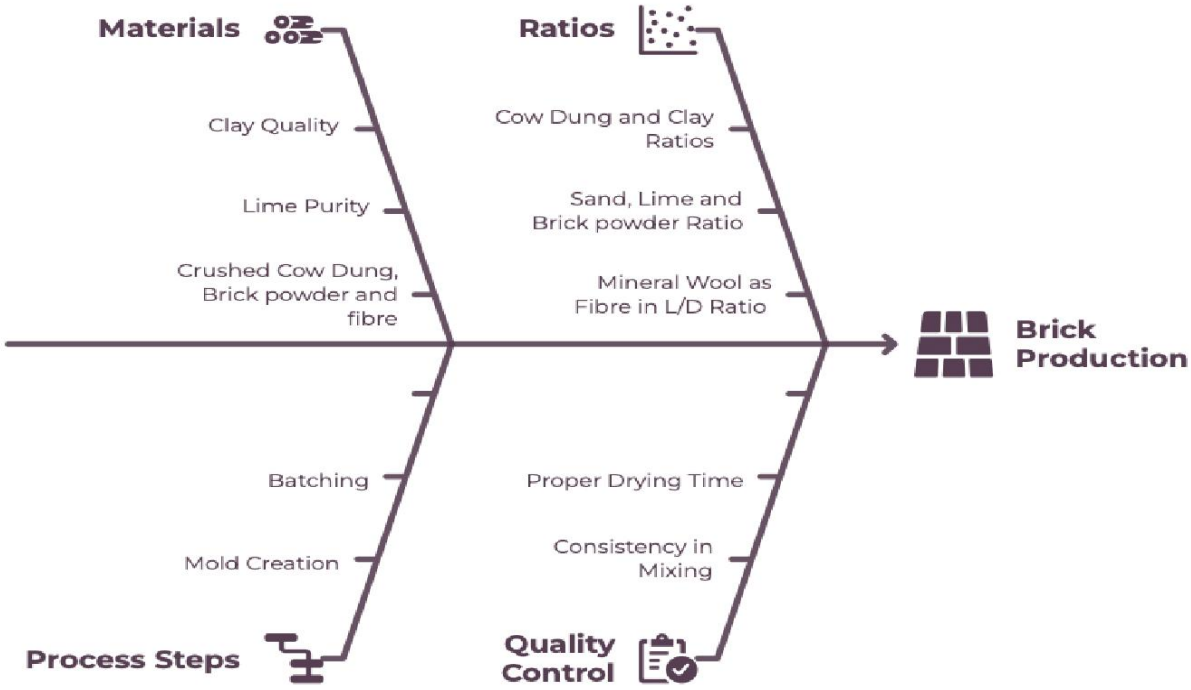
The bricks which are made up of cow dung will reduce carbon emissions, as cow dung is used in them; due to the thermal properties of dried cow dung thermal insulation will be better and the weight of the bricks will also be reduced, which will help in the use of these bricks in high rise building especially on the top floors to reduce structural loads.

The use of cow dung in bricks also reduces cracks due to the natural fibre in cow dung during the sun-drying; if bricks are unfired then fatty acids present in the cow dung will provide water repellent properties. The local agricultural waste makes the bricks cheaper.

| **Property** | **Cow-dung Bricks (15%-30% by Vol., kiln fired)** | **Traditional Bricks** | **Fly Ash Bricks** |
|---|---|---|---|
| **Water Absorption Capacity** | 15%-20% (Due to voids) | 15%-25% (Varies due to soil properties) | 10%-15% (Good water resistance property) |
| **Weight Per Brick** | 2.0-2.6 kg (Light in weight) | 3.0-3.5 kg | 2.8-3.2 kg |
| **Efflorescence Risk** | Nil | Moderate | Nil to Slight |
| **Primary Composition** | 50%-65% clay + 15%-30% cow dung + other components | 100% Topsoil | Fly Ash, Sand dust, lime |
| **Methodology** | Moulded, sun-dried then kiln baked | Moulded, sun-dried then kiln baked | Hydraulic compression and water curing |
| **Thermal Efficiency** | Excellent | Moderate | Good |
| **Ecological Footprint** | Low | High | Very Low |
| **Compressive Strength** | 3.5-6.5 $N/mm^2$ | 3.5-10.0 $N/mm^2$ | 7.5-15 $N/mm^2$ |

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

**Comparison of different bricks**




**Analysing Brick Production**

The use of cow dung in different ratios with clay leads to the formation of lightweight bricks. If sun-dried bricks are formed then it will reduce carbon emissions, methane emission, and reduce the use of the top layer of soil and the bricks will be friendly to our environment.

But the main problem will arise if we want to increase the strength of the bricks by adding fibre and firing the brick in a kiln; then carbon dioxide will be emitted and the fibre which is being used in the kiln should be able to sustain at high temperature. So the cost of production of bricks will also increase. But the use of the top layer of soil will be reduced in both sun-dried samples and kiln-fired samples so both will help in the production of eco-friendly bricks.

The main purpose of the research paper would be to analyse how adding different ratios of material in cow dung bricks by changing different clay to cow dung ratio and adding fibre to the cow dung brick will increase its strength. So that the top layer of the soil can be saved. A proper comparison of the compressive strength of bricks with and without fibre is analysed in this paper.

## OBJECTIVES OF THE RESEARCH WORK

The Main objective of this experimental study is to evaluate properties cow-dung bricks. To achieve this goal the research work is divided into these particular objectives:

- To check the compressive strength of brick containing cow dung by 15 % to 30% by volume of both sun dry and kiln baked samples.
- To check the properties of cow dung bricks by reinforcing fibre in it and then measuring it compressive strength and weight.
- To check the weight of bricks containing cow dung by 15% to 30% by volume.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

# LITERATURE REVIEW

Cow-dung is a waste product of animals like cattle. It is readily available in our surroundings so it can be mixed in different proportions with other components such as clay, lime, brick powder, sand and fibre to make bricks which could have greater compressive strength, better thermal insulation and be lighter in comparison to other bricks. Cow-dung bricks, especially when made sun-dried can have a greater composition of cow-dung in them but when Cow-dung bricks are not made by the sun-dried method then a greater composition of Cow-dung cannot be used in them because Cow-dung will form pores in the brick; in the kiln it will get burnt and the bricks will consequently lose their compressive strength.

So the main aim of this research is to find out the compressive strength of Cow-dung bricks when they are fired in the kiln in which the proportion of Cow-dung used is about 15% to 30% by volume. We will also check the weight of these bricks. Not only this the compressive strength of the bricks when they are sun-dried, in which the Cow-dung is 15% to 30% by volume is also checked. This gives us the idea that when the bricks are being fired in the kiln then how will the compressive strength of bricks changes.

The main aim of using cow-dung in the brick is that top soil which is the most fertile soil and the soil which helps the vegetation to grow, on which the whole agricultural sector is dependent, through which our economy is surviving and also growing can be saved. Not only the top soil will be saved but also the carbon emissions when the bricks are being burnt or fired in the kiln will also reduce because this research paper also tells us the procedure of making sun-dried bricks.

The main problem will arise in the compressive strength of the cow-dung bricks, whether they are sun dried or kiln-fired, as clay generally provides higher adhesive properties than that of cow-dung. So, in this research the cow-dung is mixed in different proportions with respect to clay and other components such as sand, brick powder and lime are kept constant. Further, to increase the compressive strength of the bricks the fibre is also mixed in the bricks; the fibre used should remain unburnt when the bricks are being kept in the kiln for baking. In this research, a non-ceramic fibre which is mineral wool is being used.

There is a need for sustainable methods for construction of low-cost housing. Bricks are the main building material in construction; they are made from clay by a sun-dried process or burnt. In these bricks line prevents shrinkage. The brick which is made up of 15-30 % cow-dung content has dry compressive strength of 6.64 MPa and wet compressive strength of 2.27 MPa. Also, the abrasive resistance is increased by cow-dung content up to 30%[3].

The growing need for insulating fire bricks in the steel, glass industry and in some other industries where chemicals are being processed has led to the use of other more economical methods. When clay and cow-dung are used in different proportions, then:- Linear shrinkage: 6-8%, Permeability: 88-112%, cold crushing strength: 64-152.5 $Kg/cm^2$, Thermal conductivity: 0.156-0.21 W/mk and resistance: 12-30 cycles. The samples made from cow-dung have good insulating characteristics; it suggests that cow-dung bricks can be used as insulating fire bricks[4].

Bricks are not suitable in high seismic zones due to their weight manufacturing the brick through natural resources will reduce its weight and its production also leads to reduction of environmental pollution. 75% of cow dung can be mixed with 10% lime, 5% clay, 1.5% guar gum fibre, 0.5% of citric powder, 3% gypsum and 5% sand can be mixed to form bricks which can have better compressive strength, good water absorption and efflorescence test can also be performed on them[2].

Clay bricks have been used seen 4300BC. Clay forms a coherent sticky mass when it mixes with water. It remains in shape when it is dry but it can be mouldable when it is wet. The use of cow dung in a brick reduces maximum dry unit weight, and the optimum moisture content increases when compression test is performed on cow-dung bricks stabilised with other chemicals, leading to the conclusion that 20% cow-dung sample in the bricks has the highest compressive strength[5].

Microstructural features are studied using Fourier Transform Infrared Spectroscopy (FTIR) and X-ray diffraction (XRD) to study the organic-inorganic interaction. 70% Cow-dung brick has compressive strength 4.2±0.3 MPa (p = 0.002), bulk density = 1480±45 kg/m3 and water absorption of 18.5±1.2% by FTIR and XRD. It is concluded that organic matter is united with mineral phases, which, in the formation of carbonation-derived calcite results also show better thermal insulation and good compressive strength so cow-dung bricks are a cost-effective, environmentally suitable, sustainable alternative for green building and they are technically feasible[6].

Many studies have shown that the water-resistant properties of bricks have increased after adding cow dung to them. Fresh cow dung was separated into fibres and each component was mixed with soil and samples were prepared. Then it was found that small-size aggregate is responsible for water-resistant properties and wet cow dung and reduced fibre content show better water-resistant properties than dry cow dung [7]

## EXPERIMENTAL STUDY

Total 24 cow dung bricks are made (3 prototypes each of 8 different samples) using different cow dung and clay ratios. For this firstly, a mould is to be made with specified dimensions of 19 X 9 X 9 cm. These samples are moulded in wooden moulds. To make a mould we have to take dimensions on the plywood and then we will cut to the desired dimensions. After that, the pieces of wood are cut into smaller pieces by a power saw. Then, they are joined using nails. Finally, a frog is made of wood. For a mould of dimension 19 X 9 X 9 cm, the frog size can be taken as 10 X 4 X 1 cm, and the frog is then attached to the mould.



**24 Bricks Sample with different cow dung proportions**

Materials to be Used for Making Cow Dung Bricks:

- COW DUNG: Cow dung is used for making bricks. It has less embodied energy as compared to other materials. It is also a good material for sustainable development as the top layer of soil is saved by using cow dung in bricks in different volumes. Also when a sun-dried cow dung brick is made, the carbon emission from a traditional brick made from simple clay is also very low. Cow dung is excreta of bovine animals such as cows and cattle. Cow dung consists of organic material with the fibrous material that is passed through the digestive system of a cow. Cow dung chemically consists of nitrogen, carbon, oxygen, hydrogen phosphorus and other salts. The fibre provides cohesive properties to the brick.

- CLAY: Clay is a soil that can be moulded easily. It naturally occurs from the rocks that break down over thousands of years through weathering and erosion. In construction activities, cow dung is widely used in building bricks, roof tiles and mud structures. The refined white clay can be used in magazine pages to make them smooth and glossy and also as a filler in cement, paint and rubber. When clay is in wet form tiny particles are joined by each other in thin layers. The wet clay gives plasticity. When clay is dried then water evaporates and clay becomes firm and rigid. When the clay is heated a chemical reaction

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

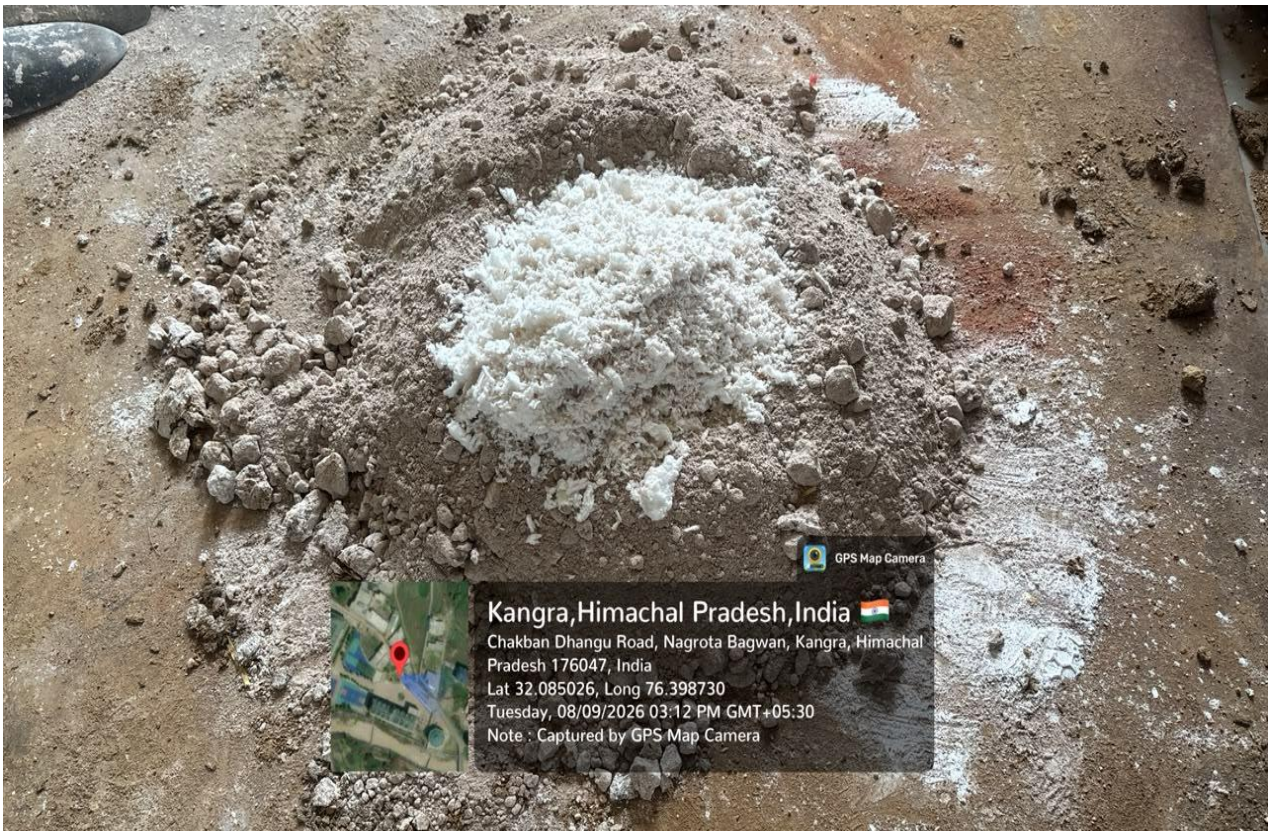
transforms the clay into a stone-hard, permanent material. Other applications are in flower pots, basic pottery, baking dishes and insulators.

- BRICK POWDER: Brick powder is a crushed and sieved extract of traditional brick. It is generally used in repairing construction material, making certain traditional colours and improving soil quality. We have to crush and grind bricks properly to get brick powder to mix it with other components like clay, cow dung, fibre, sand and lime. It helps to improve texture, gives strength and reduces cracks in the bricks.

- SAND: Sand is a mixture of tiny, broken-down rocks and minerals. Sand is transported by wind and water from large mountains, cliffs, and shells over thousands of years. It is made from silicon dioxide. Silicon dioxide is chemically stable and tough. Billions of tons of sand are used in bridges, skyscrapers and to build roads. It is being added to prevent shrinkage and cracking, improve heat circulation and increase durability.

- LIME: It is a white, powdery chemical material. It transforms from hard stone to liquid paste. It is used in mortar and plaster, agriculture, steel making, water treatment and paper and chemical production industries. It is made by crushing natural limestone rock at extreme temperatures. It is used in cow dung bricks as it acts as a strong chemical binder; it is also important for waterproofing and moisture control, and it also prevents cracking and shrinkage.

- FIBRE: Adding fibre to the cow dung bricks will provide better crack binding. If there are any tiny micro cracks in the bricks fibre can bridge these gaps easily and spread the strength in all directions, which helps in the physical binding. In this research basically 8 samples are made. Each of the 8 samples has 3 prototypes. 4 samples are with fibre and 4 are without fibre. So in this research, non-ceramic mineral wool is being used which cannot burn at the high temperature of the kiln. Non-ceramic mineral wool is made from standard rock or slag. It easily handles high temperatures. It has high thermal efficiency and mould resistance. In construction works it can be used for soundproofing between rooms fire barrier construction and HVAC duct wraps.




**Mixture containing fibre with other components**

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

For making cow dung bricks all these materials such as cow dung, clay, brick powder, sand, lime and fibre are collected. These materials are dried in the presence of sunlight and then they are properly crushed. In this research, the dry cow dung cakes are used.

Then these materials need to be properly crushed. After proper drying and crushing these materials are properly mixed in different proportions by weight and volume in the given proportions as under;

**Table 1: Mix Proportions without Fibre (Mineral Wool)**

| **Material** | **Brick 1** | **Brick 2** | **Brick 3** | **Brick 4** |
|---|---|---|---|---|
| Cow Dung | 472.5 | 393.75 | 315 | 236.25 |
| Clay | 4050 | 4455 | 4860 | 5265 |
| Brick Powder | 675 | 675 | 675 | 675 |
| Lime | 675 | 675 | 675 | 675 |
| Sand | 1350 | 1350 | 1350 | 1350 |

**Table 2: Mix Proportions with Fibre (Mineral Wool)**

| **Material** | **Brick A** | **Brick B** | **Brick C** | **Brick D** |
|---|---|---|---|---|
| Cow Dung | 472.5 | 393.75 | 315 | 236.25 |
| Clay | 4050 | 4455 | 4860 | 5265 |
| Brick Powder | 675 | 675 | 675 | 675 |
| Lime | 675 | 675 | 675 | 675 |
| Sand | 1350 | 1350 | 1350 | 1350 |
| Fibre | 292.5 | 292.5 | 292.5 | 292.5 |

Note: Table 1 and Table 2 shows weight of different components of cow dung brick in grams

Brick 1,2,3 and 4 contains 30%, 25%, 20% and 15% of cow-dung by volume and 50%, 55%, 60% and 65% of clay by weight. Three prototype of each brick sample is made so total 24 bricks are made. After mixing different material with water and moulding it with help of wooden mould these samples are need to be sun-dried. After drying, two of the sample of each prototype is put in kiln for the process of firing.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026



**Bricks firing in the kiln**

The weight of different samples of cow-dung bricks is as under:

**Table 3. Sun-dried samples without fibre**

| Sample | Weight (in kg) |
|---|---|
| Brick 4 | 2.100 |
| Brick 3 | 1.960 |
| Brick 2 | 1.910 |
| Brick 1 | 1.890 |

**Table 4. Sun-dried samples with fibre**

| Sample | Weight (in kg) |
|---|---|
| Brick D | 1.990 |
| Brick C | 1.900 |
| Brick B | 1.870 |
| Brick A | 1.780 |

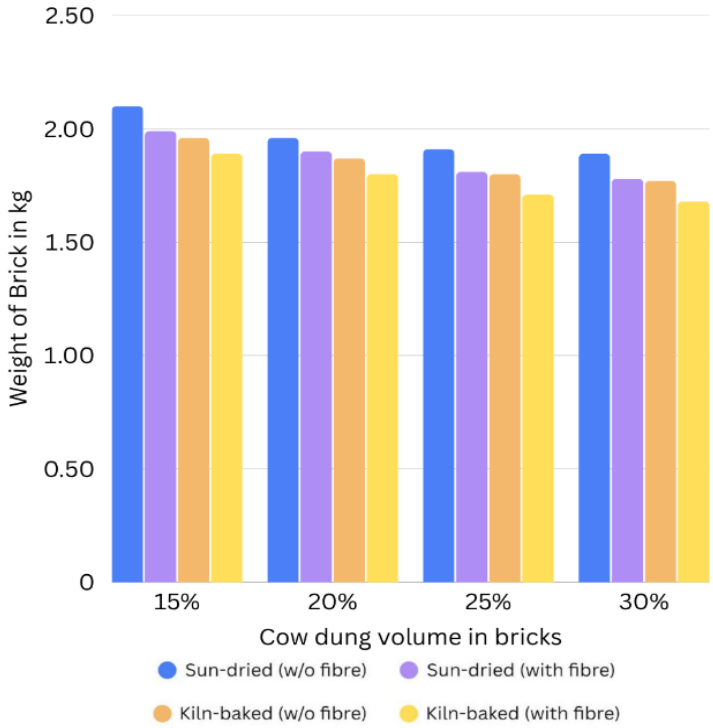
**Table 5. Kiln Baked sample without fibre**

| Sample | Weight (in kg) |
|---|---|
| Brick 4 | 1.960 |
| Brick 3 | 1.870 |
| Brick 2 | 1.800 |
| Brick 1 | 1.770 |

**Table 6. Kiln Baked sample with fibre**

| Sample | Weight (in kg) |
|---|---|
| Brick D | 1.890 |
| Brick C | 1.795 |
| Brick B | 1.710 |
| Brick A | 1.680 |

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026




The y-axis shows weight of bricks in kg and x-axis shows percentage of cow dung by volume from 15 % to 30%.The above graph shows the comparison of weight of sun-dried bricks without fibre, sun-dried with fibre, kiln-baked without fibre and kiln-baked with fibre. The sun-dried bricks are the most heaviest. When fibre is reinforced in sun-dried, cow-dung bricks becomes lighter in weight. Similarly, kiln baked bricks are more heavier than that of kiln baked bricks with fibre. The kiln-baked bricks are the lightest when they are reinforced with fibre.

The Compressive Strength of different samples of cow-dung brick is as under;

**Table 7. Sun-dried samples without fibre**

| **Sample** | **Compressive Strength (in N/mm$^2$)** |
|---|---|
| Brick 4 | 2.2 |
| Brick 3 | 2.0 |
| Brick 2 | 1.8 |
| Brick 1 | 1.6 |

**Table 8. Sun-dried samples with fibre**

| **Sample** | **Compressive Strength (in N/mm$^2$)** |
|---|---|
| Brick D | 2.0 |
| Brick C | 1.8 |
| Brick B | 1.7 |
| Brick A | 1.4 |

**Table 9. Kiln Baked sample without fibre**

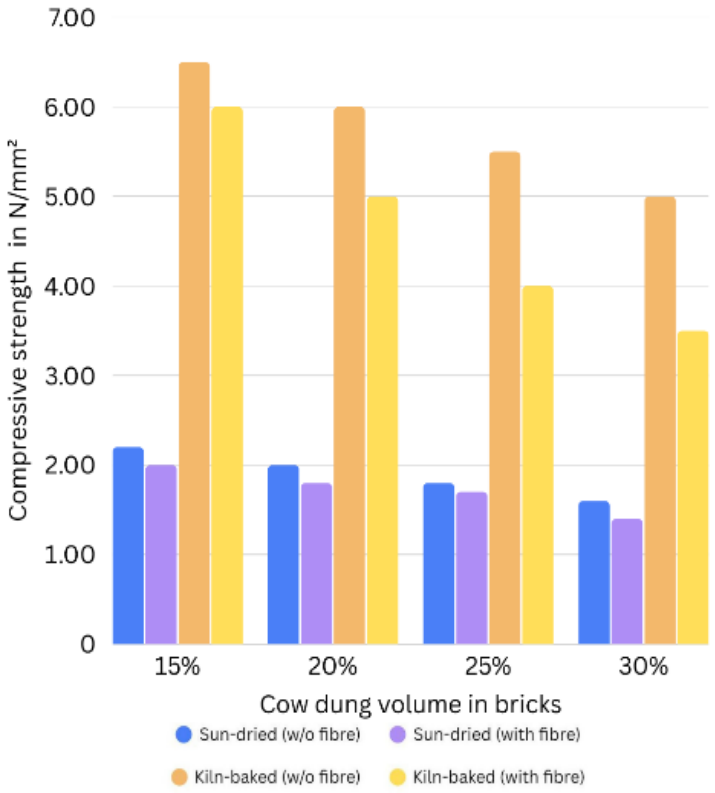
| **Sample** | **Compressive Strength (in N/mm$^2$)** |
|---|---|
| Brick 4 | 6.5 |

**Table 10. Kiln Baked sample with fibre**

| **Sample** | **Compressive Strength (in N/mm$^2$)** |
|---|---|
| Brick D | 6.0 |

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume XI Issue X October 2026

| | | | |
|---|---|---|---|
| Brick 3 | 6.0 | Brick C | 5.0 |
| Brick 2 | 5.5 | Brick B | 4.0 |
| Brick 1 | 5.0 | Brick A | 3.5 |




The y -axis shows the compressive strength of bricks in $N/mm^2$ and x-axis shows the percentage of cow dung by volume in it from 15 % to 30%. graph shows the comparison of compressive strength of sun-dried bricks without fibre, sun-dried bricks with fibre, kiln baked bricks without fibre and kiln baked bricks with fibre. The fibre reinforcement leads to decrease in compressive strength of both kiln baked and sun-dried bricks. The kiln-fired bricks with fibre have the compressive strength which ranges from 3.5 $N/mm^2$ to 6.0 $N/mm^2$. However, compressive strength of bricks which are kiln-fired without fibre ranges from 5.0 to 6.5 $N/mm^2$. The compressive strength of sun-dried bricks is same as of fourth-class bricks.

- These bricks have better thermal insulation properties.
- These bricks are resistant to efflorescence.
- These bricks are water resistant.

## RESULTS

The cow dung bricks containing cow dung by 15% to 30% by volume are light in weight so they can be used in top floor of buildings having low load carrying capacity. The compressive strength of kiln baked bricks ranges from 5.0 to 6.5 $N/mm^2$. However bricks which are reinforced with fibre have compressive strength ranging from 3.5 to 6.0 $N/mm^2$. The compressive strength of sun-dried bricks ranges from 1.4 to 2.2 $N/mm^2$.

When brick are kiln-fired and contain cow dung by 15% by volume then the compressive strength of kiln fired brick is around 6.5$N/mm^2$. The strength keeps on decreasing as more volume of cow dung is used in bricks.

The compressive strength of bricks containing fibre by 20%, 25% and 30% of volume is 6.0 N/mm$^2$, 5.5 N/mm$^2$ and 5.0 N/mm$^2$ respectively. The strength keeps on decreasing as pores formation takes place in the bricks. The weight of bricks keeps on decreasing as we put more cow dung by volume in it. The weight of kiln fired bricks containing cow dung by 15%, 20%, 25% and 30% by volume ranges between 1.770 to 1.960 kg.

When fibre is reinforced in bricks the compressive strength of bricks is decreased significantly. The cow dung bricks containing fibre with cow dung by 15%, 20%, 25% and 30% by volume is 6.0 N/mm$^2$, 5.5 N/mm$^2$, 4.0 N/mm$^2$ and 3.5 N/mm$^2$ respectively. The weight of bricks also decreases when fibre is put in it. Water absorption at higher volume of cow dung increases due to the formation of pores when bricks are heated in kiln.

## CONCLUSION

- The compressive strength of these bricks is less than traditional A class bricks as the cow dung present in bricks get burned in kiln and creates pores as the volume of cow dung decreases after burning. In traditional bricks no material of brick burns in such a way that it will create pores in it so it have better compressive strength.

- But cow dung bricks also have considerable strength and therefore can be used as a building material. Further, fibre reinforcement in cow dung bricks decreases it's strength.

- Sun dry bricks containing cow dung can also be used in temporary buildings and partition walls of buildings. So cow dung bricks should be used in construction not only it have low carbon footprint and it saves top soil from deterioration but it also have good compressive strength and it is light in weight And when these bricks are reinforced with fibre the compressive strength is decreased. Bricks become more light in weight after reinforcing it with fibre.

- Heating of bricks in kiln burns the cow dung present in it and hence creates pores in it due to which water absorption in the bricks is also significantly increased which is one of the major research gap.

- The reinforcement of fibre also lead to the reduction in weight of the bricks which is one of the key advantage of reinforcing fibre in the bricks.

- The reinforcement of fibre in bricks decreases it's strength as it do-not bind with clay and cow-dung. Further, when bricks are kiln-fired the cow dung in bricks burn away and fibre also do-not bind with clay in bricks. So, compressive strength also decreases. Fibre only provides crack resistance to bricks.

## REFRENCES

1. M. Ali and H. Y. Lee, "Sustainable housing construction: A review of brick alternatives," Sustainability, vol. 11, no. 9, Art. no. 2689, 2019, doi: 10.3390/su11092689.
2. G. S. Sutar and P. D. Patil, "Analysis of cow dung brick and compare with other bricks," IJSRD - Int. J. Sci. Res. Dev., vol. 11, no. 11, pp. 45–48, 2024.
3. F. Katre, A. D. Tandulkar, A. A. Bhojane, and N. A. Raut, "Bricks by cow dung using lime and clay," Int. J. Multidiscip. Res. Sci., Eng. Technol., vol. 4, no. 6, pp. 1173–1178, Jun. 2021, doi: 10.15680/IJMRSET.2021.0406033.
4. O. S. Olokode, P. O. Aiyedun, D. M. Raheem, F. T. Owoeye, and B. U. Anyanwu, "Production and characterization of clay–cow dung insulating fire-bricks," Global Adv. Res. J. Eng., Technol. Innov., vol. 1, no. 7, pp. 162–167, Oct. 2012.
5. D. Katale, V. S. Kamara, and A. A. Adedeji, "Significance of use of clay soil mixed with cow dung to produce bricks for low-cost buildings," USEP: J. Res. Inf. Civ. Eng., vol. 10, no. 1, pp. 340–371, 2013.

6. N. Sugandhi, S. Patil, S. Reddy, A. G, and S. Kumar, "Sustainable cow dung bricks: An innovative approach to eco-friendly masonry with enhanced thermal and mechanical performance," J. Sustain. Constr. Mater. Technol., vol. 11, no. 1, pp. 170–185, 2026.
7. Y. Kulshreshtha, P. J. Vardon, G. Meesters, M. C. M. van Loosdrecht, N. J. A. Mota, and H. M. Jonkers, "What makes cow-dung stabilised earthen block water-resistant?," Constr. Technol. Archit., vol. 1, pp. 540–548, 2022, doi: 10.4028/www.scientific.net/CTA.1.540.