

Straw Bale Construction Need of India

Kranti Mewada¹, Tasnim Depalpurwala², Akansha Agrawal³

^{1,3}Fourth Year Student, Department of Architecture, SDPS Women's College, Indore, India

²Assistant Professor, Department of Architecture, SDPS Women's College, Indore, India

Abstract: Agriculture is an important sector of Indian economy as it contributes about 17% to the total GDP and provides employment to 60% of population. This means that every year a great percentage of straw is disposed of by burning and causing air pollution used for feeding animals and in making other small things. Today everyone wants to live in eco-friendly houses. Therefore, best alternative for this is straw bale houses which are not so popular in our country India where straw is available cheaply and easily. This paper explores the suitable climatic conditions required for straw bale construction, benefits of using straw bale in buildings in India and properties of straw wall

Keywords: Straw Bale

1. Introduction

Straw bale is a natural fiber which we get as a by-product from the agriculture. We get straw from rice, wheat, barley and many other crops. Among all, rice is the toughest one due to the presence of high silica content in it. Straw is considered as agricultural residue which we produce in ample amount in our country India. It is totally biodegradable therefore its construction leads to environment friendly. Today straw is used for feeding animal but other than this large amount of straws are burned annually which leads to air pollution and give birth to many chronic diseases.

A. History of the straw bale buildings

Straw is one of best renewable building material present in many part of the world. The use of straw for the construction has been commenced long back. Straw bale houses have been firstly built in Paleolithic Era in African plains. It was used 400 years ago in Germany, Europe and Asia. It was facilitated by mechanical hay baler in 1850s and promoted by the 1890s. The settlers of the sand hills region of Nebraska firstly use straw bale as a building material. Many buildings, churches, schools, officials and grocery stores are built at that time with straw.

B. Goal of using straw bale as building material in India

Straw Bale construction aim is, To promote Straw bale house in country like India where agriculture is still the main source of income and production of straw is tremendous.

- To build an innovative eco-friendly houses for the people.
- To stop the burning of straw in fields which seriously cause chronic chest diseases and also burning fills the air with gaseous pollutants and also reduce the fertility of the soil.

- To connects people to the nature.
- To reduce the waste of straw which get wasted every year and cost of construction.

2. Properties of straw bale as a building material

Following are the benefits or properties of straw bale as a building material:

- Straw bales buildings are energy efficient. They can reduce the heating and cooling cost of the buildings upto 75%.
- Straw bale buildings are good at reducing the noise pollution with the help of their thick walls.
- Straw bale are fire resistance because of its high density they cut the supply of oxygen.
- Straw bale are totally eco-friendly as they are biodegradable.
- Straw bale buildings are cost efficient because straw is easily and cheaply available.
- Straw bale are highly durable and can resist the moisture content of 10% to 15% present in the air.
- Cheap material and renewable resource.
- Its structural capabilities are high.

3. Structural capabilities of straw bale wall

A bale wall can be built in any form according to the design of the building. Following are some structural capabilities of bale walls:

- Straw bale walls are self-supporting.
- It keeps the moisture and heat outside the building.
- It resists bursting during the earthquake.
- It does not allow cracking in plaster.
- It also absorbs load from and to the plaster.
- Support load (compression) from the roof.
- Reduce damage caused during the heavy winds.

4. Suitable climate for straw bale construction

Straw bale resist the moisture content present in the air between 10% to 15%. Therefore, Dry Climate is good for straw bale construction. This group consist of regions where the rate of evaporation of water is higher than rate of moisture received through precipitation. Moisture content is very low in such climate.

- Tropical Semi-Arid Climate:
 - Receive minimal annual rainfall 40-75cm.
 - Winter month is December (20 to 24 degree Celsius).
 - Hot and dry (upto 32 degree Celsius)- March.
 - Marathwada, Central Maharashtra.
- Sub-Tropical Arid (Desert) Climate:
 - Receive scanty of rainfall annual (less than 30 cm).
 - Summer temperature upto 35 to 50 degree.
 - Thar Desert, Rajasthan (exclusively Eastern and southern fringes)
 - North Gujrat, Kutch Region.
- Sub-Tropical Semi-Arid (Desert)Climate:
 - Annual rainfall 30 to 65 cm.
 - Summer temperature upto 45 degree Celsius.
 - Experience humidity during monsoon only.
 - Malwa region Madhaya Pradesh, east Rajasthan etc.

5. Case study

A. Pilgrims Holiness Church in Arthur, Nebraska

Pilgrims Holiness Church also called Baled Hay Church or Baled Straw Church. It was built in 1928 at Arthur, Nebraska. At that time period traditional building construction material are very expensive or unavailable therefore it was built with straw bale which was easily and cheaply available. It is listed in National Register of Historic places.



Fig. 1. Pilgrims Holiness Church in Arthur, Nebraska

In 1927 Congregationalists started planning of a church. The walls of church are 2 feet thick (60 cm) and made of stacked and baled hay. Stuccoed is done on the outer wall and plaster in inner wall of the church. But at the time of renovation in 1976 found that originally it was plastered with “gumbo mud” in both side of the walls.

B. Straw Bale School in Malawi, South Africa

Straw bale school is located in Malawi, south east of Africa. It is designed by Ar. Nuru Karim. It also won the WA Award Cycle 31.

Site Area: 10676 sq.m

Built-Up Area: 4825 sq.m

Technology: Fire Resistant Timber Frame Structure, Straw Bale, Terracotta.



Fig. 2. Straw Bale School in Malawi, South Africa

A modular “ladder” component is deployed to create a structural system that houses the pedagogical intent of the school. Ladders are created in horizontal and vertical direction in which horizontal angle explore out of the classrooms learning activities including spaces for amphitheater, outdoor workshops and other activities. Voids are left while designing a ladder for proper light and fresh air. Timber frames are used to transfer the load. These all things are done by using straw bale due to its properties like energy efficient, cost effective, fire resistance, eco-friendly, sound insulation etc.

6. Possible problems

- Area of extreme humidity and moisture is not good for straw bale construction.
- Cost of shipping increased if straw bale are not locally available.
- Plumbing is difficult to install in straw houses.

7. Solutions

- Use new technology material like lime for plaster and dehumidification method inside the house to protect it from moisture.
- Use the locally available straw bale for construction to reduce transportation charge.
- Appoint skilled plumber for plumbing work.

8. Conclusion

Now and in upcoming days the rising need of housing is increasing day by day due to rapid growth of population. Today each and everyone wants to live eco-friendly house because they did not want to compromise with affordability, quality and maintain the component of earth system. India is a country where agriculture is the main source of income. Therefore, it is very good option for such countries to built a house by using straw bale which is considered as waste. It aids to maintain the quality of living standard of people because straw house fulfils serviceability and helps to maintain the environmental quality.

Advantages of using straw Bale:

- Straw Bale Construction is eco-friendly.

- Straw Bale is sustainable material.
- It also reduces pollution.
- It is cost efficient construction.

It is good for earthquake prone area because it resists damage during earthquake. It is not widely used due to lack of awareness, surprisingly in countries like India and China who are the world's largest cultivators of rice and wheat. Therefore, research and awareness regarding straw bale construction should be increased in developing countries like India.

References

- [1] <https://worldarchitecture.org/architecture-projects/hefc/straw-bale-school-in-malawi-east-africa-project-pages.html>
- [2] [https://en.wikipedia.org/wiki/Pilgrim_Holiness_Church_\(Arthur,_Nebraska\)](https://en.wikipedia.org/wiki/Pilgrim_Holiness_Church_(Arthur,_Nebraska))
- [3] <http://buildingwithawareness.com/the-pros-and-cons-of-straw-bale-wall-construction-in-green-building/>
- [4] https://en.wikipedia.org/wiki/Straw-bale_construction
- [5] Pragyani Bhattarai, Dharma Raj Dhakal, Keshab Neupane, and K. Shyam Chamberlin, "Straw Bale in construction of building and its future in India," in International Journal of Modern Engineering Research, vol. 2, no. 2, pp. 422-426, March-April 2012.
- [6] Garas Gihan, Allam M.E. and Dessuky R, (2009), Straw bale construction as an economic environmental building alternative- a case study. 4. 54-59.
- [7] <https://www.strawbale.com/>
- [8] https://en.wikipedia.org/wiki/Climate_of_India