Course Name: Building Materials as a Cornerstone to Sustainability

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Lecture 01

Strawbale

Dear students, last time we saw binders and we saw how lime is used as a binder and how cow dung is also used as a binder and how many contemporary applications of cow dung have come up. Cow dung paints, cow dung bricks and so on. So, having studied so much about binders, now we will move on to the next topic. A building material which is a vernacular building material widely used and that is straw bale. First we will see straw bale and the next class we will see laterite quarry waste. I predict it will be a short class compared to the last two classes which were a little long.

So, let us now look at straw bale as a building material. Now straw bale houses have been built on the African plains since the Paleolithic era. Straw bales were used in construction 400 years ago in Germany and straw thatched roofs have long been used in Northern Europe and Asia. While straw has been used as a building material for centuries, modern straw bale construction gained popularity in the late 20th century as a sustainable and energy efficient building material.

200 million tons of waste straw are produced in the US alone. Thus, it is an effective waste management solution to incorporate straw bale in buildings. The method involves stacking straw bales to create walls, providing natural insulation and often combined with other materials for structural support. Straw bale wall systems are three times more energy efficient than conventional framing, saving 75% in energy costs. Straw bale houses, three times more fire resistant than conventional homes, which is becoming more relevant as the risk of wildfire grows.

They perform much better in earthquakes because they are lightweight. They are more resistant to pests and worming if treated properly. They have much healthier indoor air quality. They can save the owner a lot of money. And when built well, their longevity outweighs conventional housing.

Not only does straw bale construction contribute to energy efficiency but it also offers

cost effectiveness, ease of construction and a unique aesthetic appeal. Now let us look at the method of building with straw bale. One is the load bearing method also called as the Nebraska style. In this method, it involves stacking straw bales on a raised footing or foundation to create a structural wall. It eliminates the need for a separate structural frame.

Contrary to common belief, tied straw bales when well pressed are sturdy and cannot be huffed and puffed away. Regardless of one's respiratory fortitude, it cannot be done. They can support their own weight as well as that of a roof. The main advantage of this approach is its simplicity. It does not require much carpentry skills, which is why it is popular among self-builders who often simply seek a modest home with a lower environmental footprint.

So, just stacking of straw bales happens here. Whereas, in the non-load bearing or infill method, it is another approach. And in this stacking straw bales happens between vertical posts or studs. So, there are vertical posts or studs between which. So, this is the vertical post and in between that filling happens in the form of stacking the straw bales.

and anchoring them firmly in place. The primary role of straw here is to provide insulation while load bearing capacity is provided by the structural frame. This technique requires more experience with wooden construction, but it also enables greater design flexibility. The Nebraska style frameless houses are restricted in terms of wall length, height and window size. Whereas in the non-load bearing method, we can have more number of posts and support and use the straw bales as infill material.

You can see that there is a sturdy base on top of the sturdy base. There is a framework and then the straw bale placed and then it is tied to the framework and covered with panels as desired. Well let us now look at some of the benefits. Intuition can be to think that straw bale is a big fire hazard.

But straw bale homes resist fire very well and can even outlast regular homes during wildfires. These walls have a fire resistant rating up to 1 hour. The one characteristic that reliably shines through the fog of misconceptions. Few would deny the effectiveness of straw as insulation material. Straw is an excellent insulating material with an R value of 7.

The oldest straw bale houses are more than 100 years old and they are still living examples. Despite old age, they remain unfazed by harsh weather conditions. Straw has a one-year growth cycle compared to 40 years of trees. Moreover, grain crops suitable for straw construction are grown all across the planet. The process of photosynthesis allows

straw to bind carbon dioxide from the atmosphere during its growth.

So, the carbon dioxide is then safely stored within buildings which results in a positive impact on the climate. Often overlooked, the sound absorption capability of walls is an important factor to consider. This is where straw truly shines as it creates a quiet and serene environment. There are certain limitations of straw. Straw can be damaged by moisture.

There is vulnerability during prolonged construction. Fire consistently ranks among top concerns of straw homes. The true enemy, however, is water. Building codes can vary significantly between countries. When it comes to straw bale construction, particularly of the Nebraska style kind, local authorities may have some reservations.

Local authorities may question its sturdiness. The answers, valid as they may be, need not always lift the concerns. Uncertified bales bought from farmers can have imperfections and inconsistent quality. As a result, the construction process requires adjustment and is more complicated. Self-builders often lack the know-how and experience which can lead to poor results.

Building with straw bales requires a considerable amount of time and physical effort. Builders often need to rely on the help of friends, family or neighbours to complete construction in a reasonable time frame. the longer the process goes on, the higher the risk of rain, leakage and damage. Let us now look at a couple of applications of straw bale. Now, here we are looking at straw bale house which is made up of straw and timber and is a duple house in the German countryside.

The two-story duple houses have views in all the four directions. On entering, each floor has eight uniform square rooms measuring 4 by 4 meters. All facades of straw bale house use the straw bale construction method including the floor slab and the roof. The house is raised from the ground by an entire floor and rests on a concrete cross and four columns to protect the floor slab from water. Compared to a new conventional semi-detached house of the same size that is made of bricks and tiles and with classic insulation, nearly 95% of CO_2 emission has been stopped.

If the same house were built with modern materials, almost 95% of carbon dioxide emissions would have happened. This shows and proves what a eco-friendly material straw bale is. Straw bale has great advantages and at the same time it has great limitations also. We must understand that it is very difficult to use straw bale in high rise buildings. In all low rise buildings, in buildings which require good thermal insulation, straw bale can be an excellent material.

It is not very difficult to manufacture straw bale at all. Straw bale which is otherwise a waste from the agro industry has to be tied and compressed under large mechanical loads to form straw bales. In the countryside, what people also do is they tie the straw bale manually and use these blocks as temporary partitions. These are non-structural walls. They cannot have any load on them.

These merely function as a small 3 feet or a 4 feet partition between two spaces. They are used probably in cattle sheds and so on. But architecturally in buildings, straw bales are a verified and usable material which fulfill all the function yet it is a green material and it has extreme carbon sequestration which means it holds its carbon and does not release it. In fact, if you start looking at the local availability of straw bale and its application in architecture, it could even emerge as a carbon negative building material.

Therefore, straw bale is a very effective net carbon zero building material if it is used appropriately. It is not very difficult to handle the material. It has certain limitations and one of its limitations is the inability to use straw bale in high rise buildings or taller buildings. If the Nebraska style is not used then it is just the question of number of posts that are required and straw bales as a block can function to act as a partition wall. So, in this building this is the plan of this building and you can see that it is a fairly large building. And it is a ground floor. It is a ground floor raised on stills and two floors high made up of straw bales which have a board on top of it and yet it stands sturdy. So, comprising of two interlocking duplex houses, this straw bale house is designed with some flexibility and transformation in mind. Each home has an entrance on the ground floor and is accessed by a single flight of stairs. The two-storey duplex houses have views all along the four sides, which means window openings are also highly possible as you can see here. It has windows also on all the four sides.

So, by virtue of using straw bale, nothing is limited in this house. except for being not being high rise. Besides we have already discussed that it has good fire resistant properties not fire fighting properties and it is light in weight. So, it is very appropriate for earthquake resistant houses.

So, with this we will stop this class. It was a short class no doubt compensated for the long classes done last two classes and we will stop here and continue next class with yet another building material. Thank you.