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STRAWBALE CONSTRUCTION – A LEAST EMBODIED ENERGY MATERIAL

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ABSTRACT

In the present scenario, the need for sustainable solutions is increasing, as our world is facing various difficult challenges. Due to the effects of global warming and the exhaustion of natural resources, the importance of low impact construction alternatives is increasing. A great amount of energy is consumed in production of building materials, and conventional construction is responsible for it, due to which the natural resources are being drained. Construction alternatives have promising potential for the construction industry needs, to introduce natural renewable materials that offer low impact and low embodied energy. This paper emphasizes on Straw bale construction, by undertaking an embodied energy analysis. The purpose of writing this paper is to study existing construction materials, in order to understand the impact they pose on the environment. The materials with higher embodied energy affect the environment in a negative way, which require more resources, and most likely cause more waste being discharged along the production line.

KEYWORDS: Embodied Energy & Strawbale Construction

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Original Article

INTRODUCTION

The mankind has slowly begun to realize that earth's resources are not endless, so we have to think before extracting raw materials. People are reevaluating old building techniques, as there is growing need of using toxic-free and renewable materials.

Sustainable materials and sustainable building techniques is one important aspect to how the building industry can contribute towards creating a sustainable society. Materials having beneficial environmental properties are needed to be chosen, such as:

- They must be derived from renewable resources
- They must be biodegradable
- They must serve as carbon storage
- They must be within a reasonable shipping distance
- They must not require extraction from the ground
- They must come from an abundant resource
- They must have low embodied energy
- They must be non-toxic

Embodied energy refers to the energy consumed by all of the processes associated with the production of a product or a service from the acquisition of natural resources to the final delivery, and is a significant component of the lifecycle impact of a product. The embodied energy of a building constitutes approximately 15% of its lifetime energy consumption and the energy consumed in all the activities to support a process, and is divided into two components: direct and indirect energy. The energy used on site for the construction of a building is direct energy and indirect energy is other direct energy embodied in inputs of goods and services to the construction process, as well as the energy embodied in upstream inputs to those processes.

Embodied energy of maximum traditional constructing materials may be very high, and some are even toxic and wasteful. The built surroundings' money owed for about 40% of the world's total number one energy consumption and contributes to as much as 30% of global annual greenhouse gas emissions. Greenhouse gas emissions should be stopped and the ways of recycling and reusing waste needs to be evolved. As the constructing enterprise is economically driven, there may be continually need of locating cheaper, faster and greater efficient ways of building. Earning is a motive that many sustainable building strategies have no longer yet entered the economic building enterprise. The opportunity of exchanging a sustainable alternative is nearly zero, if it does no longer yield a better income than the already existing one.

The measures taken for reducing embodied energy: To use locally produced construction materials is advantageous. The energy consumed in the building of a house using materials available on the site is compared to a concrete house, typical for the study area. According to the study, by adopting local materials, the amount of energy used in building decreased up to 215% and the impact of transportation by 453%.

EMBODIED ENERGY OF STRAWBALE

In comparison to the conventional style, the embodied energy of strawbale wall section is six times smaller. The embodied energy of plaster mix containing increased amount of cementious materials(equal parts of cement and lime) has smaller embodied energy value that can be utilized both in conventional construction industry, as well to further improve the performance of strawbale structures. It makes sense to use sustainable materials, since straw is a natural material. Depending on the choice of material, construction limits can be created in terms of shape and height etc.

Embodied energy assessment is done in two stages:

- Measure all the energy requirements and outputs of the process. At this stage, sufficient information can be obtained from the technical specifications of a mechanical baler. The efficiency of the baler (meaning how many bales are produced per fuel unit) can be obtained from the manufacturer. Fuel used by the baler is the direct energy requirement of the process.
- Indirect input into the value of embodied energy of straw bales can be identified as energy required for manufacturing of the mechanical equipment-the baler. The composition of the baler has to be established. The second indirect energy input is associated with the construction of shelter, needed to keep the bales dry. The energy inputs into the construction of the storage facility must be added.

COMPARISON OF EMBODIED ENERGY OF STRAWBALE WITH OTHER MATERIALS

One of the reasons for claims that strawbale construction is environment friendly and that, it is purported to have low embodied energy compared to other construction techniques. Some sort of waste is produced in all constructions today, most of which ends up in landfills. On a straw bale construction site, the waste straw can either be composted or used for animal bedding. It can simply be biodegraded by exposing it to the elements promoting biodegradation. Insulation is also an important issue in construction. The energy required for the heating and cooling of buildings caused by air leakages is approximately 40%. Additional energy can be consumed occasionally by these leakages, in order to maintain a constant ideal indoor temperature. This energy can be reduced up to 30% by proper insulation.

Straw bales are natural materials, unlike many manufactured building products. Straw bales are chemically stable, as they do not contain any toxic ingredients. In case of fire, they will also not emit poisonous fumes. Organically grown straw must be used to avoid the use of pesticides in buildings.

As compared to most of the traditional constructing substances, straw has very low embodied energy that is the entire power required for generating it; for extracting, processing, transporting and many others. As the production and transport to the building site of straw bales consumes little or no strength consequently, this production technique has minimal effect on the environment. Straw absolutely has lower embodied energy than wood on the grounds that, wood calls for a lot greater energy for the manufacturing and processing, and it also produces an awful lot more carbon dioxide in the production and processing in comparison with straw bales.

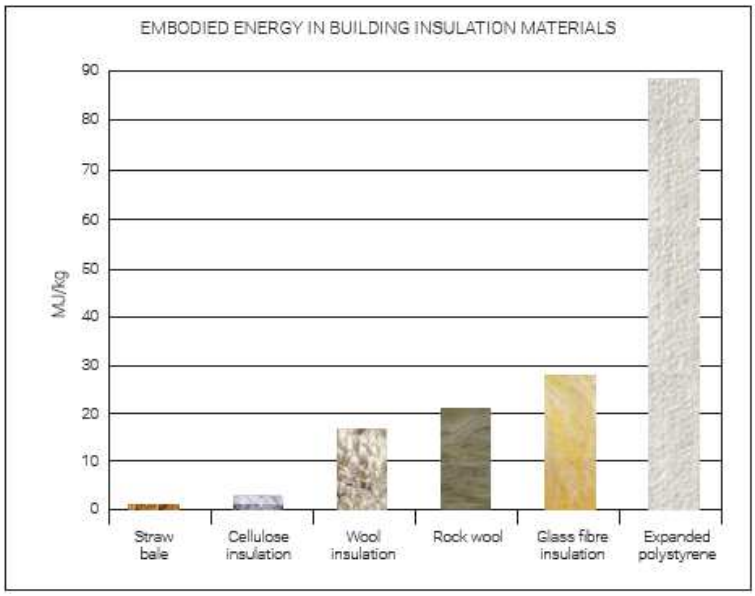

Figure 1

Desk 1: The table shows the embodied energy of building substances with the use of figures from the sustainable energy research group(SERT). Embodied energy is right here defined as 'the full primary electricity consumed at some point of all activities from cloth extraction, manufacturing transport till the finished product is ready.'

Straw bales are one of the first-rate substances in terms of embodied energy. A graph of embodied electricity in extraordinary insulation substances may be visible in the table 1.

Straw additionally soak up and store carbon dioxide during photosynthesis, consequently it acts as a carbon sink. 15 kg of carbon dioxide is being absorbed by means of each 10 kg of straw, and seals it inside the walls for the lifetime of the constructing. Wood might appear as a better carbon garage in comparison to straw, as bushes can seize almost three times the quantity of carbon dioxide, 15 heaps of carbon dioxide consistent with hectare, and it may take 50 years to develop new bushes for wooden, while straw is produced each year with the cereal vegetation.

To make energy green or environmentally friendly, building straw bales alone are not sufficient while present day homes are constructed with sustainable strategies, and compromises and alternate-offs are necessary. Local legal guidelines and regulations must be met, appropriate choices regarding climate and geography and geology should be made at the equal time. The best technique is to evaluate answers with conventional alternatives. The environmental effect of a construction is likewise laid low with how the bigger scheme of factors come together, from the groundwork to operational and protection factors, and what happens with the substances after demolition [1].

EMBODIED ENERGY ANALYSIS OF WALL SYSTEMS

In order to compare various wall systems, a unit segment of wall, one meter wide by 2.4m high was taken. The mass and volume of the various materials in this wall segment were calculated. Values of embodied energy per unit mass or volume for each of the construction materials were obtained from the literature. The total values of embodied energy for each type of the wall were calculated by summing the values of individual in required quantities.

Three wall systems are analyzed including

- Strawbale load bearing
- Strawbale post and beam
- Prefabricated strawbale panels

Wall system 1 represents Strawbale construction in its original form. Approximately 60% of strawbale homes in Ontario are built using this style.

Wall system 2 is another popular natural building option chosen by many strawbale builders.

Wall system 3, prefabricated strawbale panels are becoming more common, as they allow builders to take advantage of strawbale construction while mitigating some of its drawbacks, especially susceptibility to moisture.

Elements of Strawbale wall and construction materials needed for their assembly:

Table 1

Wall Element	Material
Base Plate, top plate	Timber, plywood
Strawbales	Strawbales
Lime based plaster	Sand, water cement, lime
Earth plaster	Clay or soil from the site, water

EMBODIED ENERGY ANALYSIS OF PLASTER

Whenever the environmental benefits of strawbale construction are discussed, the focus remains on its low embodied energy. The entire wall surface in a strawbale house must be covered by plaster with a minimum thickness of 25

mm on each side of the wall, which results in considerable volume of plaster. The high density of these materials and high volume necessary for the completion of the wall are factors that contribute to the embodied energy of straw bale wall system.

The roof load is typically given as a force per unit area, and will include the roof self weight and environmental loads such as snow that depend on location. The ultimate design load to be carried by each strawbale wall is calculated by using equation,

P=Roof load/2*L*l kN. Where, l is wall length and L is roof span.

Knowing the density of each plaster component, its mass can be calculated and multiplied by the normal embodied energy value to determine the embodied energy of each plaster component of the wall segment. The partial composition of the plaster can be varied to reduce plaster's embodied energy value, while keeping the plaster strength at a satisfactory level.

CONCLUSIONS

Straw bale building could succeed and equate to a niche sustainable building method as compared to transition theories in the literature. Its positive factors are that it is a cheap, provide energy efficient homes, natural material to provide very high levels of insulation, and is a relatively quick and easy construction method to learn.

To make straw bale creation commercially possible, the marketplace conditions need to be proper and the transition may want to take many years, given that diversifications to the approach are required. Straw bale building may want to probably turn out to be a sturdy influence in the layout of sustainable housing, consequently being unrealistic to trust that straw bale building will absolutely update modern building methods. Elements including the use of straw for insulation, prefabricated straw panels or rendering with lime might be subsumed into conventional residence constructing. It would pave the way for straw bales to come to be an extensive detail of cheap, sustainable housing in the destiny.

Strawbale walls are known for their high insulating qualities. Houses constructed with straw, normally do not require any additional wall insulation, and still perform better compared to those constructed with the use of commercially manufactured insulation. The R-Value is a measure of thermal resistance used in heat transfer problems and used to characterize thermal insulation materials in buildings. R-value for strawbale walls has been reported to range between R-17 and R-65.

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