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MULTI-STOREY HYBRID BUILDINGS USING TIMBER-STEEL

Siddesh R. Sable
M.Tech, Project & Construction Management,
MITCOM, Pune, Maharashtra, India- 412201
ar.siddeshsable@gmail.com

Mr. Shankar Banerjee
Assistant Professor, Project & Construction Department,
MITCOM, Pune, Maharashtra, India- 412201

ABSTRACT:

Timber construction is mostly used and best suited for multi storey buildings as it has very high strength to weight ratio. Timber construction is well suited for earth quake prone areas as timber is light in weight. Timber construction also has an advantage of reduced load on foundation as compared to traditional reinforced concrete building. The timber construction can be used for both residential as well as commercial. Properly designed timber buildings can have large number of rooms on each floor also it can sustain permanent load because of permanent wall. Timber construction is widely used in Europe and Turkey as it has light framing. To increase the lateral load resistance, more number of walls is built. But in practice timber multi storey buildings has an possesses an open spaces and very few walls. Timber columns and beams has an limitation that they are visible from outside. In this paper more focus is given on the energy consumption and global warming potential of various building is also been briefed.

KEYWORDS: Construction material, timber, timber plus, energy consumption and GWP etc

INTRODUCTION:

Timber is mostly preferred construction material in the last few decades, especially dawn civilization as it is largely available in nature. Timber is found to be high ratios of stiffness and it has a great advantage of strength to weight. The most preferred advantage of using timber material is it can be modified in any shape with ease. In many developed countries government is focusing on building design and its effective utilization of natural resources.

Structural systems using wide range of timber structure are listed below with brief description.

- Traditional heavy timber frame construction
- Light timber frame construction
- Historical timber buildings
- Cross laminated timber (CLT)
- Post-tensioned timber frames and walls

Timber is used as a construction material since many centuries and found most used in construction of multi storey pagodas- Asia, stave churches in Scandinavia combined timber and masonry building in many European cities.

Fig.1: Khmer house made by timber

TRADITIONAL HEAVY TIMBER FRAMES:

A traditional heavy timber frame construction has an very large dimensions beams and columns. The beams and columns are connected together by using a steel dowels or timber dowels or in latest homes plywood gusset plates are also found for better moment resistance. This type of construction can be found few centuries ago and even in latest era of technology. The timber and columns can be made from sawn timber, ghulam timber, rough members and also from hewn from logs.

LIGHT TIMBER FRAME:

It is the widely used material for making multi storey apartment. Light material frames structure uses an very small sections of sawn timber, floor joists or studs. In this type of construction joists and stud sizes are of 250mm x 50mm and 90mm x 40mm or sometimes little bit more. This type of construction has gained popularity, especially, in North America and very parts of Asia. This type of construction is also very popular by the name of "two by four constructions" or "wood frame construction". While making structural walls or flooring plywood or particle boards are used extensively. For building internal walls gypsum plasterboards are used as it gives great finishing. While making this type of construction utmost care has been taken for improvement of acoustic and thermal performance. To improve the same floor and wall cavities are filled with light weight insulating material.

HISTORICAL TIMBER BUILDINGS:

Timber is been used as a construction material from ancient times it includes structures like multi storey pagodas in Asia and few churches in Scandinavia. In old European cities timber is combined with masonry to give higher strength.

CROSS LAMINATED TIMBER (CLT):

Cross laminated timber is structures used in European countries for making prefabricated multi storey timber buildings. CLT is uses a large number of solid wood yielded for many layers of sawn timbers in alternate structure, the same type of construction as plywood possesses. Then the boards are glued or dowelled together

for construction of the panels. The boards are normally of the size 90mm X 20mm size. Panels are made in two thickness 100mm and 200 mm and used according to strength it required.

POST-TENSIONED TIMBER FRAMES AND WALLS:

It is very new technique to build multi storey timber construction innovated in New Zealand, and uses very recent technologies for reinforced concrete construction in seismic areas. In this areas post tensioned timber walls and frames are commonly use.

EFFECT ON ENVIRONMENT OF CONSTRUCTION MATERIAL:

For determining the influence of construction materials on environment, construction material life cycle and global warming potential (GWP) parameters are considered. To compare this parameter same type of comparable buildings need to be prepare having similar energy consumption, so that it will follow meaningful analysis of the important parameters like energy consumption and GWP. Few researchers are worked on operational energy for various construction materials e.g. timber, steel, concrete and timber plus buildings can all be designed to consume less energy. From the various research papers it is observed that around 82-87kWh/m^2/year energy is required for all types of construction material.

Table 1: Percentage of operational, initial embodied and maintenance related embodied energy to total energy over the full lifetime of the buildings

Parameters	Concrete	Steel	Timber	Timber Plus
Operational energy to total lifetime energy (%)	89	87	91	94
Initial embodied energy to total lifetime energy (%)	9	11	7	5
Maintenance related embodied energy to total lifetime energy (%)	1	1	1	1

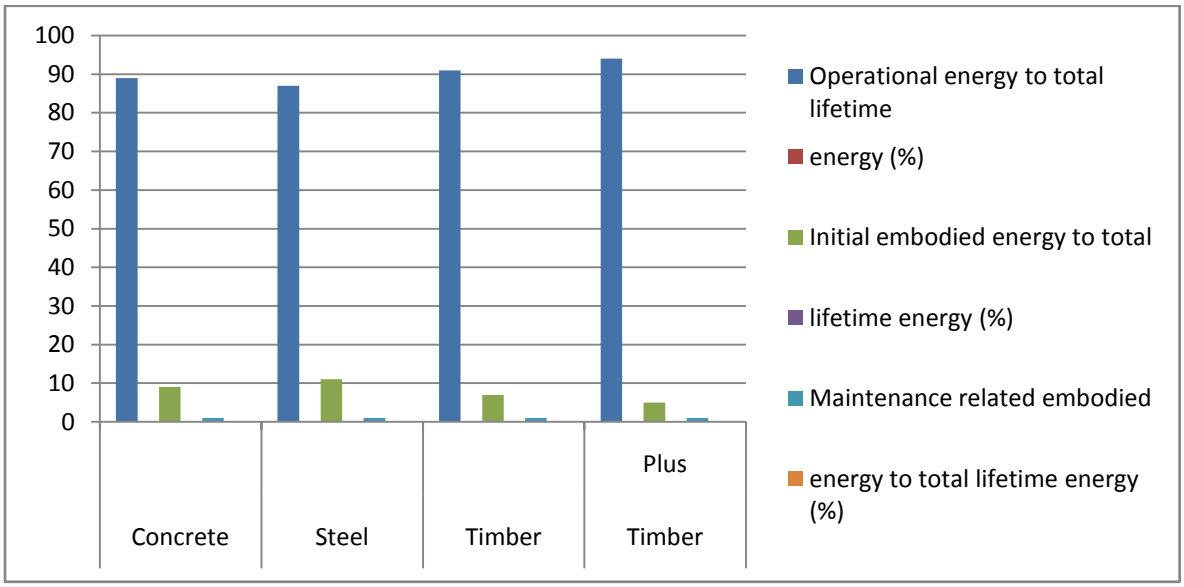

Fig 2: Percentage of operational, initial embodied and maintenance related embodied energy to total energy over the full lifetime of the buildings

Table 2: Percentage of operational GWP, initial embodied GWP and maintenance related embodied GWP to total GWP emissions over the full lifetime of the buildings

Parameter	Concrete	Steel	Timber	Timber Plus
Operational GWP to total lifetime GWP (%)	72	73	86	95
Initial embodied GWP to total lifetime GWP (%)	23	23	16	11
Maintenance related embodied GWP to total lifetime GWP (%)	2	2	2	2

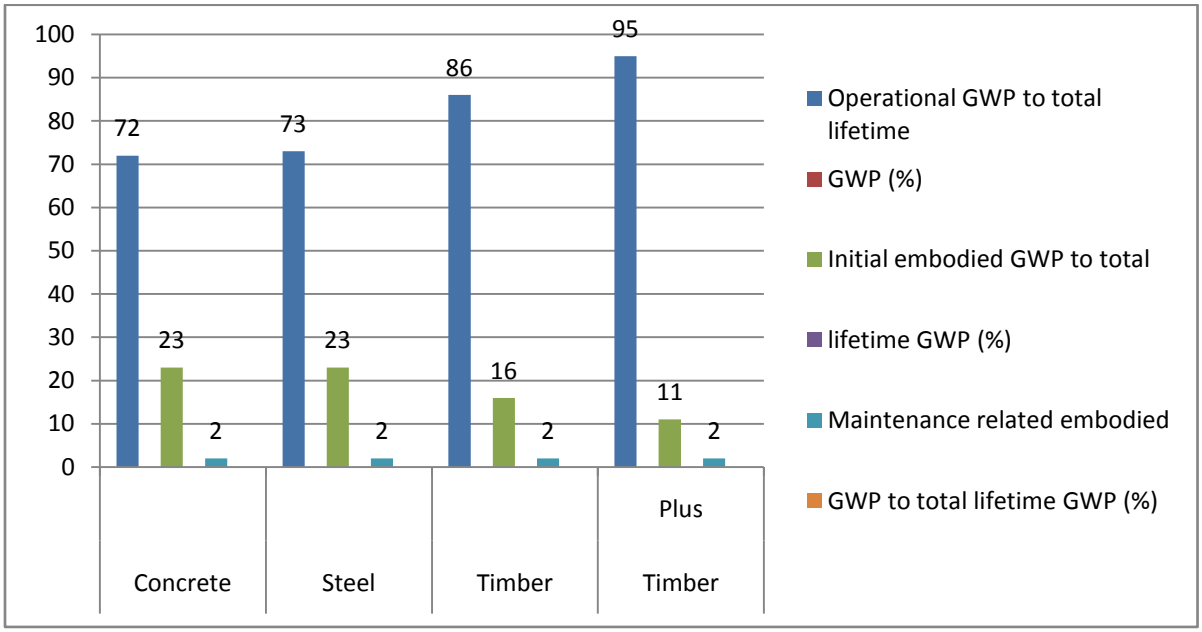

Fig 3: Percentage of operational GWP, initial embodied GWP and maintenance related embodied GWP to total GWP emissions over the full lifetime of the buildings

It is observed that total operational energy consumption is almost similar to all construction material but amount of energy required for heating and cooling may be different and it depend upon different thermal envelops and thermal mass of where building is constructed. The trends for energy consumption are also applicable to global warming potential in view of the operations made in building. Little variations are observed due to difference in primary energy mix and differences in manufacturing, mainly in concrete which may produce CO_2.

MODERN BUILDINGS USING TIMBER- STEEL HYBRID MATERIAL:

Many of the experimentations are going on now days to replace the conventional materials with the other possible construction materials. The timber-steel hybrid structure is one of the attractive experimentation for the modern multistory buildings.

Fig 4: Modern Buildings using timber-steel hybrid material

The innovation in the constriction technology is leading to the development of the sustainable, low cost and attractive buildings. The laminated shapes of the timber are found suitable to replace the slabs of the multistory. The steel frame fulfills the need of the beams in the structure. The presence of the steel adds the extra strength to the structure. The advantage of this system is, the same structure can be replaced with other or the structure can be deconstructed as and when required. The creation of the hybrid beams is cost competitive option when compared with the conventional beams. The better capacity to bear a load for such beams is also an important advantage.

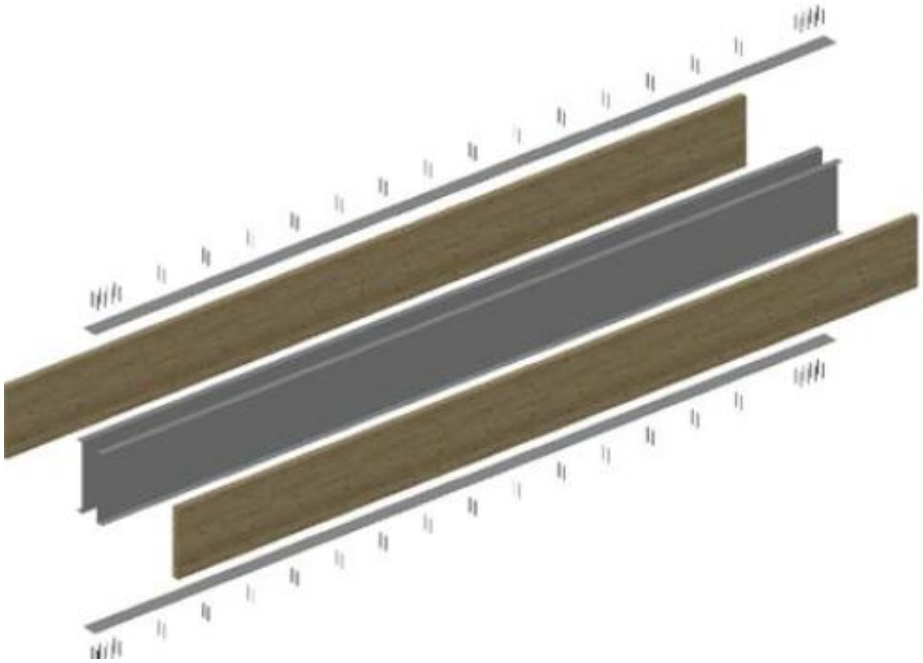

Fig 4: Components of hybrid timber- Steel beam

The layers of the timber and steel are combined together to form a strong structure. This structure is used as a beam. A complete beam capable to be utilized in multistory building is shown in the figure 5 below.

Fig 5: Hybrid timber- Steel beam

The main advantage of these types of the hybrid beams is their great capacity to bear a load. The cross section is not necessary to increase for better capacity to handle a load.

CONCLUSION:

In this paper various types of timber construction are briefed. The comparison between timber, concrete, steel and timber plus material for construction for energy consumption and GWP is made. Life cycle of the buildings, new GWP emissions for the timber made construction houses are more only by 10% as compared to concrete and steel building. The very reason behind this is heavy amount of carbon is stored in wood based building and it does balances GWP. The hybrid beams, their advantages and applications in multistory buildings are very crucial. The buildings are made attractive, efficient, and low cost with same capacity of handling the load with the help of hybrid concept presented in this paper.

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