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Low Embodied Energy Housing Alternatives at Govardhan Eco Village

Gauranga Das Presidential Board Member of Govardhan Eco Village, Galtare, Hamrapur (P.O), Wada (Taluka), Palghar (District) – 421303, Maharashtra, India

ABSTRACT Housing Industry although a significant contributor to India's GDP and second largest facilitator of employment in the country also contributes significantly to the consumption of energy and emission of carbon dioxide gases. In order to resolve this problem green buildings with alternative low embodied energy housing materials are considered to be viable options. This paper presented a case study of Govardhan Eco Village where these low embodied energy housing materials and techniques were used for construction which not only led to conservation of energy but also lead to cost savings.

KEYWORDS : Sustainability, Green Housing, Mud Blocks, CSEBs, Waste Management

Introduction

Housing is one of the basic needs of survival. The Indian construction industry is projected to contribute INR 11,954 billion by 2017 to the national GDP and provides employment to more than 45 million people either directly or indirectly [1]. However if we see the ecological picture in regards to the construction industry then currently the building industry contributes to 22% of carbon dioxide emissions. The annual energy consumed in India today is a whopping 250 Cr GJ of energy which is equivalent to burning of 15 Cr tons of coal. This requirement is expected to double by the year 2020. In order to address this serious problem, a new revolution is happening all over the world to provide alternative techniques of construction which are eco-friendly, which lead to conservation of natural resources, reduce greenhouse gas emissions and conserve energy in operating the building.

If we see the amount of energy that goes in the buildings then there are two components – Embodied energy and Operational Energy. Embodied Energy is the sum of all the energy required to produce any goods or services which accounts for energy used for raw material extraction, transport, manufacture, assembly, installation, disassembly, decomposition etc. This is an accurate measure in determining the life-cycle impact of any goods or services. Broadly speaking it has 3 components. Firstly the energy consumed in the production of basic building materials, secondly the energy needed for the transportation of the building materials and thirdly the energy required for assembling various materials to form the buildings. The operational Energy is something that is for service, maintenance and waste management.

B.V. Venkatarama Reddy and K.S. Jagdish [2] concludes in their paper that use of energy efficient alternative building technologies can result in considerable reduction in the embodied energy of the buildings. They concluded that Soil–cement block is the most energy efficient walling material and is the second best mortar material after LP mortars. They also mention that there is need to avoid Aluminum which has almost 6 times more embodied energy than steel and need to reduce transportation and relay on local resources & skills.

This paper presents the case study of the Govardhan Eco Village (GEV), a farm community and retreat center located 108 kms on the outskirts of Mumbai, where many of these low embodied energy housing alternatives were applied. Implementation of green buildings helped them in protecting the environment and reducing cost of materials due to significant reduction in the embodied energy.

Govardhan Eco Village – A Case study

The purpose of GEV is to highlight the importance of living in harmony with nature and using the gifts that Nature and God have bestowed upon us to serve the society by setting up a model farm community. At Govardhan Eco Village (GEV), we wanted to create aesthetical and comfortable structures for the residents and guests, while not breaking the harmony with nature and our immediate surroundings. This entailed minimizing resource consumption, waste generation and overall adverse ecological impact. In order to achieve this goal, we wanted to go with a standardized model for Green Buildings which would uphold the balance of sustainability concept along with the community needs in the process of its construction. Hence we decided to conform to GRIHA norms, an initiative of The Energy Resource Institute (TERI). The GRIHA norms entails one to follow various criterions including preserve and protect the landscape and topsoil, reduce air pollution, reduce, recycle and reuse the water utilized for landscape and building construction, reduce the conventional energy demand either through optimal building design or by using low energy materials or by utilizing renewable energy, minimize waste and ozone depleting substances and minimize the depletion of the natural ecosystem etc.[3] In this way by following these norms, we found that we will be fulfilling our purpose of living in harmony with Nature and serving the society by creating an island of excellence for others.

Construction Process

The construction process we followed involved a thorough planning and zoning prior to the construction. Smart sourcing principles were followed in order to reduce the overall carbon foot print and hence 90% of the materials were sourced from within 100 kms radius of our facility. Construction activity was not allowed to spread all throughout the campus. It was restricted to only some areas with all the brick production units strategically placed near those areas to minimize transportation .Simple, natural mud was the key constituent of the construction material. Foundation was of stone masonry with stabilized mud mortar & concrete short poles (as bond stone). The door and windows were made of recycled wood. The walls were made of stabilized mud blocks, the details about which is given in the next section. The roof was made of arch panel with mud tiles, steel and Mangalore tiles (burnt clay tiles) Assembled arches were used in the construction of buildings which saves cost on RCC, saves cost on plastering ceiling with cement, saves wastes in plastering ceiling with cement as lot of cement falls down during plastering and provides more strength and stability. A sloped roof with double layer of Mangalore tiles (Burnt clay tiles) with an air gap between the two layers as insulation. It ensures that the temperature inside the room is moderate as compared to outside. In order to protect the existing ecology a fence was built around the trees and other important ecology.

Technology Spotlight

One of the Technologies utilized in constructing these buildings was the usage of Compressed Stabilized Earth Blocks (CSEB). The fundamental process for making these bricks is by compressing a combination of mud, stone dust and lime. Stabilization is achieved by 5-10% cement. The special feature of these bricks is that plastering and painting is not required. Only pointing is done to fill the cavities between the brick layers. Moreover, lesser amount of

energy is consumed in preparing the Compressed Stabilized Earth Blocks as against the modern day bricks used in construction. While typical brick wall takes 75 MJ of energy, CSEB wall at GEV takes just 0.275 MJ. Moreover, the strength of these bricks is around 65 Kg/ cm^2 as against 40 Kg/ cm^2 for conventional red bricks. Also the size variation for these bricks is only 0-2 mm and is available in 8 possible shapes.

Cost Savings Achieved

In Govardhan Eco Village, Green Buildings following the GRIHA norms lead to cost savings both during the construction phase and post construction phase.

During the construction phase, there are various factors which lead to cost savings. The construction material used in green buildings in GEV is the CSEB blocks (Compressed Stabilized Earth Blocks). These bricks are made locally as against the conventional red bricks which are made somewhere else. Hence there is no transportation cost involved in making these bricks.

Moreover the process for making these bricks involved utilizing the local materials which are cheaper as compared to the primary ingredient coal used for making conventional red bricks. Approximately Rs. 1 gets saved per brick this way and around 2.5 lakhs bricks have been used in construction.

Another thing is that the CSEB blocks have a fix shape and moreover their width is around 7.5 feet as against the red bricks which are irregular in shape and also small. Due to this the number of joints and the mortar used for joining the bricks is very less. This further leads to saving of around 40% of cost for mortar, amounting up to 2.5 lakhs in our case.

Another advantage of implementing green buildings was that it didn't require plaster. Only pointing of the mortar was done on both sides of the bricks which further leads to savings of around 2.5 lakhs. Moreover paint was not at all used in the buildings as the CSEB blocks themselves gave a beautiful appearance. This further lead to savings of 10 lakhs of rupees. The structure of the green buildings is such that there is no usage of any columns or beams or slabs. The load is carried directly by the wall because of the high strength of the CSEB blocks. This further lead to savings of around 7-7.5 lakhs.

Another innovative feature of the CSEB blocks was that dust was used in it which is very cheap and is considered as waste materials (In 2010 it was considered as a waste material and was cheaply available) compared to sand. Sand costed around Rs. 50 per cubic feet while the dust costed only around Rs. 20 per cubic feet. GEV has used around 70,000 cubic feet in construction and that leads to huge cost savings. Also mud mortar is being used for all of the construction which further saved few lakhs of rupees. Following the GRIHA norms GEV involved local laborers more compared to laborers from outside which also lead to significant cost savings.

During the construction phase the cement used had fly ash in it. The nature of such cement is that it uses less water. Also lot of water got conserved as there was no plaster or paint utilized for making the buildings. Hence approximately 25% of water usage gets reduced. In this way GEV saved almost 1 Cr of cost overall by following this whole process.

GEV has also installed an Eco-friendly sewage treatment plant in the campus called the Soil Bio Technology (SBT) plant. During the post construction phase of Green Buildings, this plant processes more than 95% of all the sewage water coming from these buildings, which amounts to 70,000 – 80,000 litres per day, and utilizes it for the irrigation of various agricultural crops in GEV. This saves around Rs. 105,000 in electricity costs annually, which would had been used for pumping equivalent amount of water. The bio-fertilizer produced as a byproduct through SBT amounts to 6 Metric Tons/ annum thus leading to saving cost of equivalent chemical fertilizers.

Also the CSEB blocks used in these buildings have special properties by which they remain hot in winter and cool in summer seasons. Hence almost 50% of cost is saved in electricity as there is no AC usage. Moreover the design of these green buildings facilitate natural lighting thus reducing the electricity cost further down.

Conclusion

The Ministry of New and Renewable Energy and TERI awarded the 5 Star Platinum GRIHA ratings to GEV for Green Buildings. Owing to this GEV has been invited to various conferences to present its case study on Green Buildings like the Indian Green Building Congress, Annual National GRIHA Summit etc. The green buildings are source of attraction for thousands of visitors from all over the world. Annually more than 15000 Visitors from all walks of life and from around the world come to GEV and stay in these green buildings and generate revenue for GEV. In this way GEV provides an excellent case study about the benefits of implementing Green Buildings in its campus.

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