Whole Life Assessment of Low Carbon Emission Green Building for Mitigation of Climate Change

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INTRODUCTION

The Construction sector is the largest global consumer of materials, and buildings are the sector with the largest single energy use worldwide (Krausmann, 2009). Consequently, buildings are also responsible for 19% of global greenhouse gas (GHG) emissions (IPCC, 2014). In the beginning of the industrial revolution, concentration of carbon dioxide in the atmosphere was 270 parts per million. This concentration, which has now risen to 377 parts per million, has been unprecedented not only in the past 740 thousand years, but also perhaps even 55 million years ago (Farshchi, 2009). There are two main reasons for climate change: natural reasons arising from changes in the orbit of the sun and in the parameter of earth orbit, and human related causes, the most important of which is excessive emissions of greenhouse gases through human activities (Azizi, 2004).

OBJECTIVE OF THE STUDY

Consumption of fossil fuels and emissions generated from burning of these fossil fuels are huge threats to the environment. Industrial revolution, sudden increase in consumption of natural resources and invention of technologies that use non-renewable energy sources all together affected our environment in many ways. The problems associated with global warming and climate change move us towards more sustainable approaches in building design. These problems do not affect only our environment but our social and economic life as well. Therefore it is necessary to take global actions towards reducing these emissions specially in building sector which opportunities are numerous.

CARBON DIOXIDE EMISSIONS IN BUILDINGS LIFE CYCLE

Early description of low carbon buildings highlighted balance between the need of living organisms, buildings and climate. Throughout recent years the development of passive low energy building has referred low carbon building in the framework of sustainability. Henceforth, we may redefine the low carbon building as a sustainable building or 'green building' base on human ecology with the sustainable development of economy, society and architecture simultaneously (Li & Colombier, 2009). The Brutland definition of sustainability is "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). That is why it is important to construct buildings which have least possible impact on the nature, and to preserve natural sources for future generations too. Zero carbon buildings are the core driver for sustainable design to mitigate against further climate change.

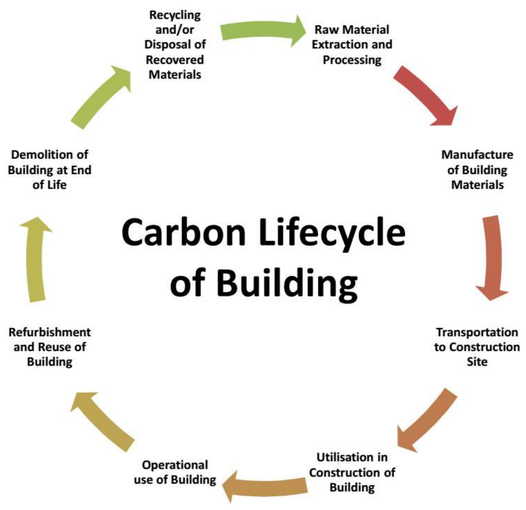

Fig-1: CO_2 emission in building life cycle

WHOLE LIFE CYCLE ASSESSMENT

The pre-stage decision making

At this stage, the developers make the decision on the low carbon building which is perspective of the whole life cycle and set the low carbon building objective from overall view.

Planning and design

In this stage, the concept of low carbon cycle building is considered and the renewable energy and new technology are considered in the planning stage. Taking full consideration between low carbon building and building facilities and renewable or recycle energy to reduce energy consumption and carbon emission.

Construction

This is an important stage to control and reduce energy consumption and carbon emission. Transport and construction process such as the machinery and equipment at the production line and the embodied energy of building materials are generally considered.

Operation and Maintenance

Operation and maintenance consume most energy in the whole life of the building. The management of the building is to promote the efficiency of the energy use and protect environment around the building.

CONSTRUCTION MATERIALS

Cement is an important construction element around the world, and therefore, cement production is a significant cause of global carbon dioxide CO_2 emissions, making up to nearly 2.4 percent of global CO_2 emissions from industrial and energy sources (Columbia, 2012). Cement manufacturing is extremely energy demanding, because of the extreme heat required to produce it. Producing a ton of cement requires 4.7 million BTU of energy, equals to about 400 pounds of coal, and produces nearly a ton of CO_2. Given its high emissions and serious importance to society, cement is an obvious place to look to lessen greenhouse gases emissions (Sustainable Building, 2013)

SUSTAINABLE/GREEN BUILDING MATERIALS

Materials which produce less pollution and waste during manufacturing and construction process are being considered as sustainable building materials. Natural materials are less toxic and their embodied energy is less as compared to artificial materials. Therefore, most of the natural materials are sustainable building materials. Recyclability and biodegradability are also important measures of sustainability. Some materials such as steel and glass are recyclable whereas concrete cannot be recycled, it can only be grounded up and used as aggregate in new concrete. From biodegradability point of view organic materials decompose rapidly, but steel for example takes much longer time. Another important factor is life span of the material. Materials which have longer life need not to be replaced therefore less natural resources are required for manufacturing and less landfill waste is generated. Some sustainable building materials are mentioned below:

Rammed Earth

Not to be confused with mud brick, rammed earth is a precisely controlled mixture of gravel, clay, sand, cement, and sometimes lime or waterproofing additives. The contents are carefully proportioned and mixed, and then machine-compacted in removable formwork to yield a stone-like wall that is massive, water resistant, load bearing and long lasting.

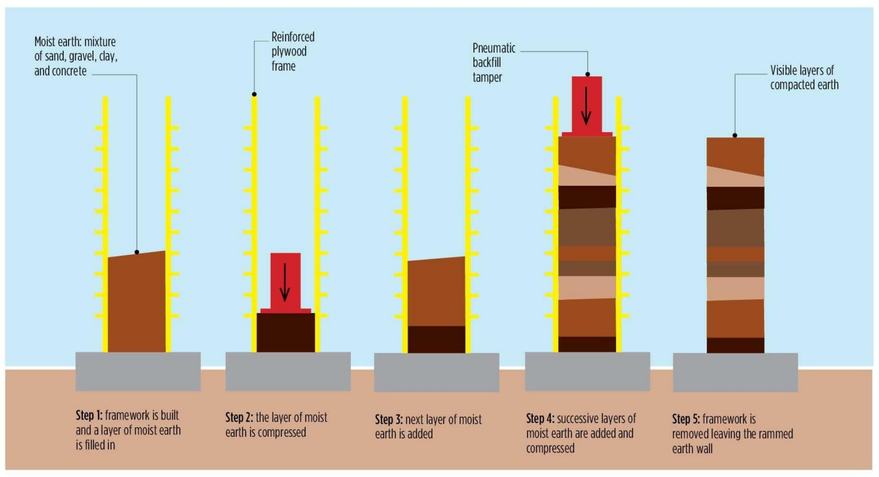

Fig-2: Building With Rammed Earth

Triple Glazed Windows

The three layer glass acts as better insulation as compared to double glazed windows. It avoids air infiltration. Therefore, keeps the building warm in winters, and cool in summers. In double glazed windows argon is injected in each layer of glass whereas in triple glazed windows krypton which is better insulation is injected.

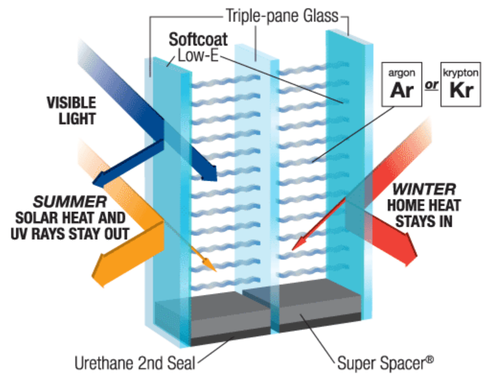

Fig-3: Triple Glazed Windows

Timber

Timber is probably the most commonly used building material there is. It is strong, flexible, and readily available and providing it is sourced properly, is a renewable resource. It is an easy material to work with and requires relatively basic skills, making it ideal for owner-builders.

Bamboo

The versatility of uses to which bamboo can be put is very vast. It can be used in construction of walls, roofs and understructure. When one thinks of bamboo, 'low cost architecture', 'employment generation' are the first few things that cross' one's mind. Due to the tradition of using untreated bamboo mostly in non-permanent applications, one tends to reinforce the idea of bamboo as a low-end material used mainly in temporary structures. Bamboo has great engineering potential. It is said to be the 'green steel' of nature. Bamboo is the building material which is environment-friendly; it is also a renewable resource. Bamboo can be developed commercially as bamboo composites as an alternative to wood. Bamboo sheets are five times stronger than other relevant building materials and they last five times as longer. The bamboo-corrugated mat also acts good regarding thermal comfort and noise resistance.

CONCLUSION

By following the suggested techniques during different stages of building's life cycle, lower carbon emissions from buildings could be achieved, which will help in development of more sustainable, ecofriendly environments. Fortunately, though buildings account for large amount of GHG emissions, there are also lots of opportunities to reduce these emissions. This is where low carbon green building comes into the picture. Following the rating systems, such as LEED (Leadership in Energy and Environmental Design), Energy Star for homes will be useful in reaching desired sustainability. To have sustainable environment friendly world, not only buildings need to be designed and operated based on sustainable considerations, but the whole communities and cities need to be sustainable.

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