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Importance of Alternative Construction Technology in Steel for Better Ecological Sustainability: Reminiscence and Future Outlook

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ABSTRACT: Sustainability is always expressed in terms of the endurance of systems and processes. The objective for ecological sustainability is sustainable development of human shelters. A building is a designed intervention into the natural setting of the environment. The existing ecosystem always gets a deep impact due to the decision of constructing a building. Architecture in a broader sense serves to human comfort which is inherently the main objective of design. While catering to this need, the designer is into difficult situation to maintain the balance of natural ecosystem and human comfort. With current global awareness of sustainability, it has become prime duty of an architect to be extremely sensitive towards the environment. In green building practice, both the structure and the processes need to be environmentally responsible, resource efficient, throughout the life cycle of the building. A conscious approach is to be maintained in the design and execution of a building, which will create a good harmony with the built and unbuilt environment. Steel proves to be a versatile material for construction of buildings because of its, strength, uniformity, ease of operation and many other desirable properties. Similarly every component of steel used in construction contains recycled content. Steel components can be recovered and recycled periodically into new high quality products. Steel is durable, safe, and strong. Steel used for framing will last from hundreds to over a thousand years due to its zinc coating, a natural element. Steel structures require less material to carry the same loads as concrete or masonry units. Thus steel has been largely recommended to use as green material by experts. Steel projects can ensure for a building that is durable, proves true to the test of time and available for generations to come without creating a threat to the environment. The current research paper focuses on the intervention of design and execution of building in the unbuilt environment due to steel construction. The researcher reviews the research papers available, and find out the future potential of steel as an effective construction material with the approach of sustainable ecosystem. The researcher tries to find out how use of steel for human shelters can promote a more sensitive sustainable construction practice which is the need of the time.

Keywords: Ecological sustainability, steel, construction

I. INTRODUCTION

Ecological sustainability focuses on systems and processes which conserve and enhance the resources of the community without hindering the future generations. Thus, sustainable ecosystem provides biological environment that is able to support itself on its own. Human activities for the need of material and energy always have serious impacts on the environment. These activities eventually create hazardous conditions for environment and human health. Construction of building is an ever increasing activity in India putting enormous pressure on naturally existing setting of the environment. So the environment is degraded to a greater extent. In other words, a building is a designed intervention into the natural setting of the environment. According to Kilbert (2005) buildings are responsible for over 10%of world's freshwater withdrawals,25%of wood harvest,40%of material and energy flow to global scale. This clearly indicates the need of the time to have a very sensitive approach right from site planning phase. An awareness regarding this approach has been observed widely at global level with titles of sustainable construction, green construction, bio climatic design etc. This is the need of the time for current Indian construction practices and for future as well.

II. SUSTAINABLE CONSTRUCTION

Sustainable construction is always commonly understood as that type of practice which creates a

design solution with a high sensitivity towards the environment, puts minimum impact on the environment and adds value. There are many organizations who preach and practice the approach of sustainable construction. As discussed earlier, a building creates threatening situation for the survival of ecosystem around. According to a proverb, when a tree is cut, a complete habitat burns. The ecosystem is highly affected due to the complete life cycle of that building. The natural growth of ecosystem is hampered due to the building construction activity. Due to this ever increasing growth of buildings, there are many adverse effects on nature like destruction of naturally existing habitats, deforestation, soil erosion, tremendous depletion of precious natural resources and pollution of the air, water etc. This has already given an alarming signal to the construction practices of the world and various movements for environment protection and conservation are initiated. In India, it is observed that there is lack of awareness regarding this initiative since the stakeholders are often oblivious to it. Considering the huge population and rising need of food and grains to cater to this number, more focus is needed to protect environment and promote agriculture activity which is the life for the humanity. The population can not survive without food.

III. SUSTAINABLE CONSRTUCTION AND INDIAN CONSTRUCTION INDUSTRY

The concept of sustainable construction is not new to the Indian construction industry. Building rating systems, Life cycle analysis are the two approaches followed to evaluate a building on sustainability parametres. LEED and GRIHA are the available rating systems. A common observation is lack of awareness amongst stakeholders and people. LEED was launched in 2006 and it rates environmental performance of the building. India's construction sector has private investments and foreign direct investments. This makes India stand in the top ten spending nations in the construction world. A recent report Global construction 2020 estimates that India will be the third largest global construction market after China and USA.(Manjrekar, Sustainability initiatives for construction industry in India).As per the study, the main hurdle the construction industry is facing is infrastructure bottlenecks. Non availability of infrastructure leads to lack of awareness towards sustainable construction. It is clearly observed that if this unprecedented growth of construction in India is not regulated by sustainability parameters, the consequences are to be suffered by future Indian generations. Exploitation of natural resources like soil, water, vegetation, addition of manmade materials and chemicals has created the most dangerous situation for the survival of natural setting of the environment.

IV .CONVENTIONAL PRACTICE OF REINFORCED CONCRETE CONSTRUCTION IN INDIA

Unlike Western countries, Indian construction construction industry has a conventional practice of R.C.C. structural system. This systems uses huge amount of concrete as main constituent and steel as reinforcing material. Concrete is a largest synthesized material which has a per capita consumption 1.5 tons per Alum in India. Concrete is widely used due to its properties like easy availability, adaptability to any size and shape, no requirement of skilled labour, low initial and maintenance costs and it consumes less energy in manufacturing in comparison with steel and aluminium. Inspite of these advantages, there is a huge concern of reuse of recycled concrete which has not been really explored. Millions of tons of R.C.C waste is generated every year. This is also creating a major shortage of dumping grounds in India. This creates a major threat to the naturally existing environmental conditions. According to the research done, only 10% of recycled concrete is actually used in construction like plinth filling, pavements etc. With the awareness of sustainable construction, this R.C.C. system is to be seriously evaluated with provision of alternative construction technology. This technology would provide a better solution promoting green practice and would also create a good harmony between built and unbuilt environment

V. ALTERNATIVE TECHNOLOGY OF STEEL CONSTRUCTION

Steel construction technology has been used since so many years in developed countries. Light weight construction and pre engineered buildings are the terms used commonly in today's era. In India, there are specific requirements of a design of a typical factory layout where huge spans are to be covered without intermediate columns. This is required for smooth operations of shop floor activities. That's why steel construction with portal frames and lattice girders is a common practice for industrial buildings in India. As per observations, there are many upcoming good designs getting executed in steel but that is restricted only for public buildings like commercial buildings and educational institutes. It is very rare to have major residential units or human shelters in steel.

Some commonly known reasons are non availability of technical knowhow at designer and execution level, on availability of skilled labour, little more expensive as compared to concrete at initial level and lack of awareness regarding strength and durability in terms of life of building for common people. If the R.C.C structural system is closely analyzed throughout life cycle of a project ,there are many advantages due to which steel construction proves itself a more sustainable technology. In the current Indian practice of water scarcity, it is becoming very difficult day by day to provide water for concrete buildings. R.C.C building requires huge quantities of water for mixing and curing. Out of which very little quantities are actually consumed, remaining quantity goes waste. Steel construction requires very little quantities of water as compared to concrete buildings. water which can be the greatest advantage at the moment.

Steel construction can be used as an alternative technology to conventional practice in India. Being a resource intensive industry, it is clearly understood that conventional technology is no longer going to be a sustainable technology. Steel technology is unique with steel as a construction material which can be used endlessly without using properties of the material. Steel is such a material which is only reused and never consumed which is a great attribute Scrap steel can be reused completely with the same physical and chemical properties throughout the span of life of building.

Fig.1 shows that global scrap consumption is much more than production.

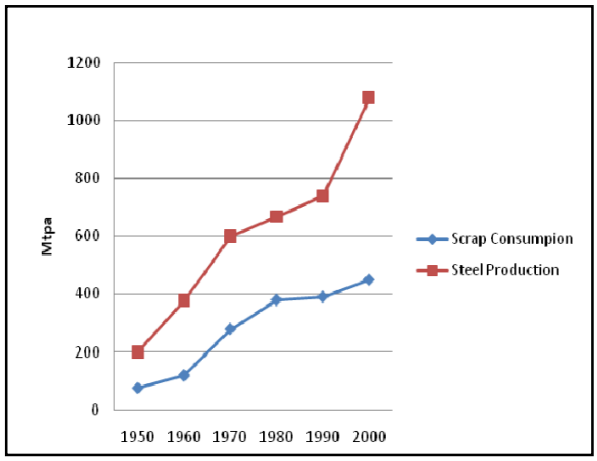

Fig. 1. Global scrap consumption Vs steel production (Europher 2006).

Steel is world's most recycled material. This means the huge energy required to extract steel from iron ore is completely saved. Availability of huge scrap from old products like old automobiles, structural members, electric gadgets etc.can be a good resource to this activity.

A. Potential of steel for Indian construction practice. India is the third largest producer of steel after China and Japan.(World Steel Association)According to World steel Association 50% of the global steel is used for building and infrastructure like housing, rail, bridges etc.

Fig. 2. Comparison of global apparent steel use, production and making capacity(World Steel Association).

The above figure shows that global steel making capacity was over 700 million metric tons larger than production in 2015 and 800 million metric tons larger than demand. Thus, there is a lot of potential for Indian practice to adapt the technology of steel construction which is a very common or conventional practice for western countries.

VI. GREEN BUILDING INITIATIVES IN INDIA

With the establishment of Green building council the concept of Green buildings has come into existence. This council works as a nodal point to promote the practice of green buildings with defined objectives. It has sensitized the stakeholders of construction industry-architects, builders, manufacturers, similar research organizations etc. Still, there is a common picture of conventional construction site in India with dumps of sand cement bags and aggregate. There is a big gap between the stakeholders and the organizations who promote non conventional practice of green building.

VII. STEEL CONSTRUCTION AS ALTERNATIVE CONSTRUCTION PRACTICE

As per a French case study by Ecobalance, comparing the embodied energies of two similar buildings, one steel and one concrete, it was shown that when steel with approx 87% or greater recycled content was used, the steel structural system has less embodied primary energy than concrete. When the steel with less than 87%recycled content was used, concrete had less embodied primary energy.(Christopher Hewitt, The real deal: Sustainable steel).

Steel component manufacturings

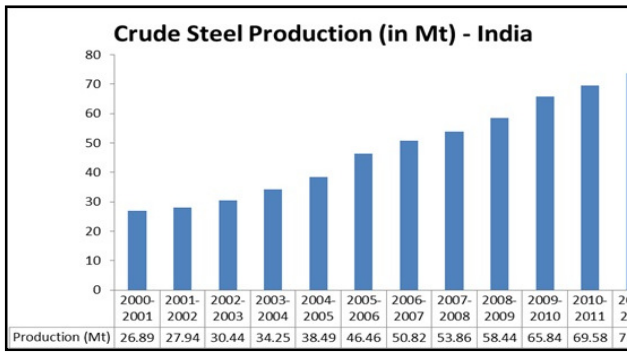

Fig. 3. Crude steel production: India(Garg Mani Mahesh, Strength for Indian steel).

The above figure shows that India is gradually increasing the quantity of crude steel production creating a lot of potential for steel building construction.

There are two commonly known methods of steel manufacturing. EAF(Electric arc furnace) and BOF (Basic oxygen furnace)The first one uses maximum recycled content and second one 25%.The second one is used for non structural applications. Still beyond these comparisons of embodied energies, steel can contribute to sustainable design in many ways.

- Reuse and Disassembly

As per previous discussion,it is known that markets for scrap steel are emerging but there is a possibility of structural system where steel comonents can be refabricated and disassembled.Thus,new buildings can be erected without recycling.

- Integrated approach

Achieving synergy between steel structural system and other services in building is essential for integrated approach. Coordination of all agencies for better air flow, better painting of reflective surfaces, anticipation of future extensions in fabrication are the examples for achieving sustainability to a greater extent.

The figure below shows how there is a possibility of sustainability attribute through life cycle of a project.

- Huge saving on water

As per previous discussion, it is understood that steel construction proves itself better and eventually sustainable since it requires very little quantities of water. Steel construction rests on concrete foundation which requires water for achieving required strength of foundation.

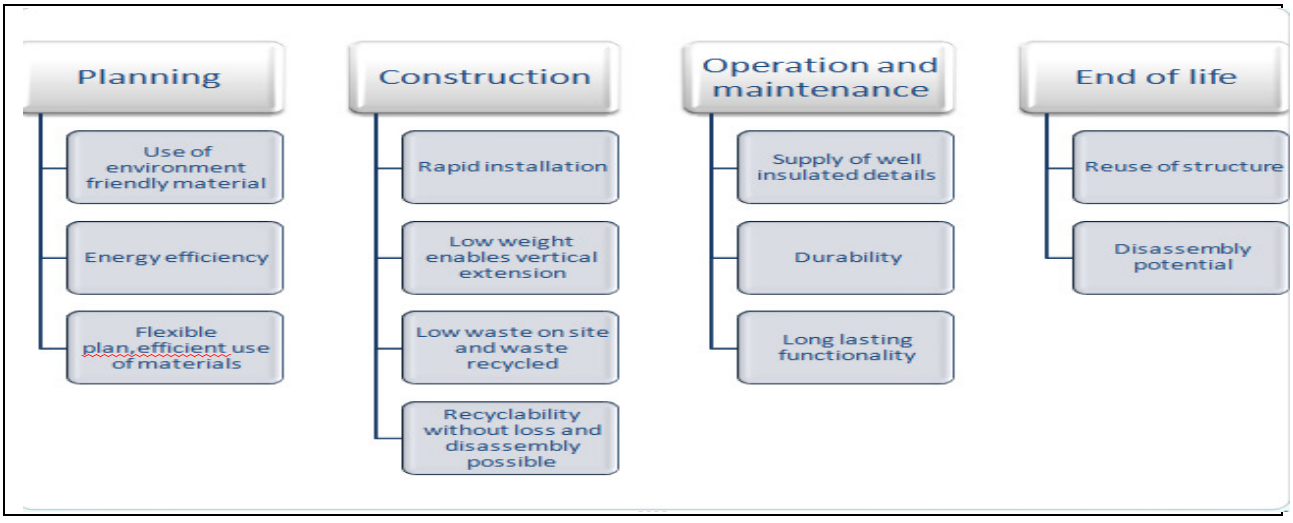

Fig. 4. Possible attributes of sustainability through steel in life cycle of a building.

VIII. CONCLUSIONS

For promoting better and better sensitive construction practice towards nature and implementing strategies, steel construction system can be one of the solutions. Considering the resource intensive nature of construction practices, it is essential to follow a practice which puts minimum impact on the environment through resource consumption. It is to be practiced by the stakeholders due to its huge potential of sustainability attributes. Life Cycle Analysis has to be done more intensely. Stakeholders awareness and participation by people is the future outlook. More propagation of these structural systems will lead to setting up a conventional practice for architects in steel construction. Since steel is not consumed ever and just recycled periodically, it is the environment friendly material with minimum impacts. Infinite recyclability without loss of properties along with strength, durability, versatility and availability make steel a unique material on the earth for construction. Promotion of the practice of steel construction is the need of the time. Top to bottom approach is required from stakeholders to labour working on site. Students in educational institutes need to be made aware of the advantages of the steel technology. Similarly, environmental awareness is equally essential to make the next generations of experts more sensitive towards the environment.

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