THE ROLE OF ENVIRONMENTAL ENGINEER IN ACHIEVING SUSTAINABILITY IN CONSTRUCTION

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ABSTRACT- Construction has been responsible for causing many environmental problems such as excessive consumption of resources, pollution in the surrounding environment through building operations, and research on green building design and using building materials in efficient way to minimize environmental impact is already underway. So there is a need of maintaining sustainability considering environmental impact and economical aspect at each stage of construction (planning, design, extraction of raw material, manufacturing, transportation and installation, repair and maintenance, and demolition stage). The main objective of this paper is to describe the role of an environmental engineer in ascertaining sustainability in construction at various stages through Environmental Impact Assessment (EIA) and Life Cycle Assessment (LCA).

***Keywords*— Environment Impact Assessment (EIA), Life Cycle Assessment (LCA)**

1. INTRODUCTION

The World Commission on Environment and Development(1987) offered a definition of sustainable development modified by Roy F. Weston (1994): "Sustainable Development is a process of change in which the direction of investment, the orientation of technology, the allocation of resources, and the development and functioning of institutions meet present needs and aspirations without endangering the capacity of natural systems to absorb the effects of human activities, and without compromising the ability of future generations to meet their own needs and aspirations".

It is said that engineers make and move the world and now even make the world communicate. Therefore to make the environment sustainable, engineers has the biggest responsibility to keep the world continuously growing and moving towards a sustainable future. Most of the economic development involves engineering & construction work. Therefore sustainable development implies sustainable engineering, which is the process of planning, designing, manufacturing, constructing, operating and repairing a built environment with optimum use of energy& resources with minimum impact on environment. While creating such a built environment, environmental engineers can ensure sustainability through Environment Impact Assessment (EIA) and Life Cycle Assessment (LCA).Sustainability involves environmental and social issues, engineers probably need greater knowledge of biological and social science in order to be effective leader in sustainable development. Here environmental engineers can take this leadership and fill this gap of socio-environmental knowledge and provide interface between engineering development and environmental issues.

If environmental engineers are to be collaborators in sustainable development, they must be willing to consider and promote reasonable approaches that are based on simple technologies, optimum and efficient design, reduced resource consumption and environmental impact. They should take decisions which are economically feasible, environmentally sound and socially acceptable, concerning future waste management scenarios. Sustainability is about persistence into the future.

2. Sustainability through Environment Impact Assessment (EIA)

The more effective way of achieving sustainability in a development project is to consider environmental issues at a stage even before a design is conceptualized. This can be done through EIA, which has been made mandatory by Govt. Authorities and all prominent development funding agencies such as World Bank, Asian development Bank (ADB) etc. Through EIA environmental engineer help the project proponent and authorities to choose a project that is environmentally and economically sound with minimum impact on the receiving environment.

Development objective has many interfering goals which compete with each other. The interest of stakeholders is often at conflict with each other. The project proponent, the financers tries to maximize their profit with maximum resource utilization, environmentalist and socio-political leaders advocate for protection of environment and their regional resources. In this scenario the environmental engineers have the most important role of coordinating and to provide the interface between these stakeholders by suggesting the most sustainable solution with minimum impact on environment. With the combination of all four criteria as shown in **figure 1**, engineer can facilitate their contribution to sustainability development.(Ding, 2005)

If this EIA is done before and at least along with conceptualizing and designing the project the suggestion of environmental engineer to avoid and mitigate the environment impact can be incorporated and implemented by multidisciplinary engineers to select sustainable, eco-friendly engineering solution with optimum resource utilization without hampering the development and halting the project all together. For instance in case of POSCO steel plant in Orissa, if the environmental engineers had played their role beforehand by selecting proper eco-friendly site with minimum effect on habitation, the project would not have halted for decades.

EIA engineer's goal should be to find the optimum balance in engineering solution using resources in such a way that it satisfies the needs of human societies while minimizing the impacts on the environment and conserving it for future generation.

Land use, soil health, human habitation, health of ecosystem & climate, maintaining biodiversity, resource utilization & conservation, water quality and quantity, solid and hazardous waste disposal are some of the aspects which a EIA has to take into consideration for long term sustainability.

Following sustainability principle need to be followed for maintaining the carrying capacity of the environment and the particular habitat by the EIA engineers and its associated multidisciplinary team of engineers:

- Improvement in design life cycle and efficiency of built environment minimizing the absolute use of resources.
- Use of construction material considering local available options with reuse and recycling of resources.
- Use of renewable energy resources with reduction in carbon footprint.
- Minimizing waste water and solid waste, chemicals and pollutants which accumulate in the environment leading to global warming.
- Designing for deconstruction, reuse and recycling considering End of life (EOL) of project.

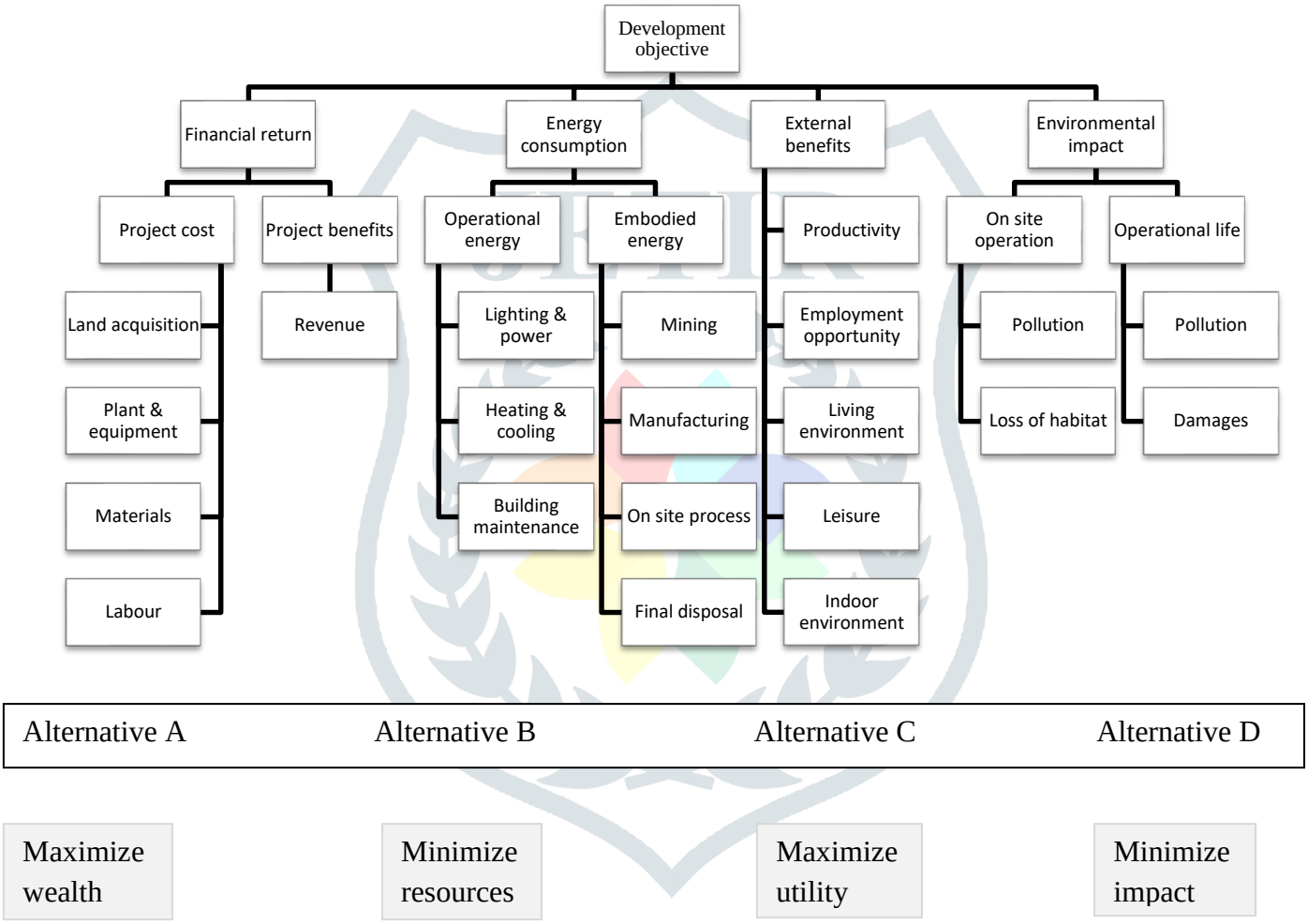

Figure 1.Sustainable development.

3. Sustainability through Life Cycle Assessment (LCA)

The construction industry is concerned with improving the social, economic and environmental indicators of sustainability. Traditional Engineering solutions and practices will not produce sustainable solutions, it will come through critical thinking, innovation and with a mindset which takes social, cultural and environmental aspects into consideration without compromising the interest of future generation. The Life cycle of a built environment or construction project involves extraction of raw material, manufacturing, construction or installation, use of built environment including repair & maintenance and disposal (EOL)

Engineers can apply LCA (Life Cycle Assessment) to optimize these aspects, from the extraction of raw materials to the final disposal of waste material. There is requirement of greater communication, interaction between environmental engineer and multidisciplinary sectors in the construction industry to promote sustainability. An environmental engineer should focus on achieving sustainability by efficient allocation of resources, minimum energy consumption, low embodied energy intensity in building materials, reuse and recycling, pursue quality in creating healthy and non –toxic built environment and protecting natural environment by reducing disposal of liquid, solid and gaseous waste.

3.1 Green Built Environment

A Green built environment is one which conserve and uses less resources, optimizes energy efficiency, generates less waste and provide healthier non-toxic environment to its occupant.

Environmental engineers should focus on designing and developing green built environment with following fundamental principles.

Structural efficiency: This has largest impact on cost and performance and aims to minimize the environment impact on all life cycles.

Energy efficiency aims to provide natural light & ventilation and energy efficient appliances minimizing use of energy and carbon foot print.

Material efficiency aims to use local eco-friendly material, reuse of material, recyclable material

And materials which have less carbon footprint and have less global warming potential.

Waste efficiency works on the principle of reduce, reuse and recycle of resources specially the water which is most important commodity in Indian context.

3.2 Transforming Built environment:

It has been established that the built environment currently consumes the 40% of Europe's overall energy and the need to transform it in the coming years using green sustainable material and processes is imperative (A.Kylili et al,2016).This transformation of built environment can be possible while repairing and renovating with sustainable green solutions. Key consideration for environmental engineers are minimizing disposal of waste to land and water transformation to natural ventilation and illumination, use of energy efficient appliances, reduce use of material with high Global warming potential, reduce and reuse of material, use of recyclable material. All such improvement in built improvement should be done with overall quality control. Poor quality may lead to numerous rework which may defeat the purpose of resource minimization and sustainability.

The reduction of the energy consumption, reuse and use of recycled material, improvement of indoor climate make the environment more sustainable and reduce the carbon footprint. Better indoor quality habitation, less air pollution improves the health and working condition of occupants leads to overall economic sustainable growth.

3.3 Designing End of Life and disposal:

Built environment should be design to deconstruct and dismantle and not demolish. During the planning and design phase, waste manager (environmental engineer) should develop a strategy for end of life, including recyclable materials, ease of dismantling and deconstruction and then allows virtual planning that how the building will be reused.

Engineers should have systemic thinking to decide how construction and demolition waste can be minimized. Environmental engineers can make a framework to maximize 3Rs(reduce, reuse and recycle) into planning, design, extraction of reusable material at construction and demolition stage and minimize the disposal of construction waste by implementing sustainable strategy throughout the lifecycle of construction. The C&D waste management significantly reduces the material in the design and planning stage, reducing scrap and waste at site and to landfill reducing the cost and overall impact on environment.

4. Singapore's strategies towards sustainable Construction: A Case Review

Singapore has little natural resources and nearly all construction materials have to be imported, so sustainable construction is critical to its national development. Singapore has started to adopt sustainable construction strategy through Sustainable Singapore Blue print. One of the key thrust of this Blue print is improving resource efficiency and achieving zero landfill. The two key focus areas are:-

a) Recycling and use of sustainable materials.
b) Efficient design to optimize use of natural resources.

Other initiatives taken for sustainable construction are:-

- Enforcing Demolition Protocol, which is a set of procedures as how demolition waste should be managed to maximize resource recovery for beneficial reuse and recycling. The Protocol includes Pre-demolition audit, sequential demolition and on-site sorting for meaningful collection of recyclables and reusable materials.
- An accreditation scheme of C& D waste recyclers, which aims to improve quality consistency of Recycle concrete aggregate (RCA) production.
- Regulatory framework for reusable structural steel, currently 10-20% RCA use in concrete is allowed in Singapore.
- Promoting sustainable construction in private sector: Notable instances are of Goodwood residence, the developer has embarked upon a "Zero Waste" concept to achieve 100% water recycling. Another commercial building, Tampinesn Concourse, held the distinction as being the First Carbon –neutral building in Asia-Pacific. Recycled material such as Copper slag, RCA and ground granulated blast furnace slag (GGBS) were extensively used in its structural and non structural components. As a result, more than1000 tonnes of natural sand and granite have been saved and 6750 tonnes of carbon dioxide have been offset during construction.

5. CONCLUSION

Built environment or construction is one of the largest end users of resources and one of the largest polluters of the natural environment. Environmental engineer can help in improvement in the performance of built environment with regards to optimization & conservation of resources, reducing, reusing and recycling of waste causing minimum impact on the environment through EIA & LCA. This improvement will indeed encourage greater environmental responsibility and value towards sustainable growth welfare of society without limiting the interest of future generations. The case of sustainable construction in Singapore can be replicated in other countries and states.

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