

SELECTION OF SUSTAINABLE CONSTRUCTION MATERIAL: A REVIEW

Kamlesh Damdoo¹, Vyom Pathak², Bhavin Kashiyani³

Student; M.E. Construction Engg & Managt., SNPITRC, Umrakh- Bardoli, Gujarat, India

Assistant Professor & Research Scholar, Civil Engg; SNPITRC, Umargh, Gujarat, India

Assistant Professor; Civil Engg, SNPITRC, Umargh- Bardoli, Gujarat, India

Abstract: This review paper focuses on the determination criteria of materials based on the principals of construction sustainability. Of all activities, Construction activities consumes the major resources; both of naturally and artificially; and it closely and directly impose impact on surrounding environment. In any construction project, material resources accounts 30-45% of the total project cost and so selection of sustainable construction materials is a key strategy in design and planning of the projects. The proper material selection not only have objective benefits but have economic benefits too. Since there is not any fixed framework for sustainable materials selection, it turns to complexity while choosing the material resources under different projects. The project of sustainable buildings are achieved more actively based on implementation of sustainable materials since the design for sustainability turns lower effective as the durability of projects increases. The construction industry must adopt the development phase under umbrella of sustainability for economic, social and technical benefits pertaining to projects.

Keywords: Economical, Environment, Material Selection, Sustainable

I. INTRODUCTION

The material science and engineering plays a key role in modern age of Infrastructure construction. The selection of products continues throughout the project phase in different scales and variations. The most challenge in sustainable buildings development is the right framework of products selection as each project is unique, the criteria framework if established for one project cannot be effectively utilized for other projects. Materials of twenty first century evolves a large number of products having its own merits and demerits, features and applications. Modern age of construction focuses on environment's impact on building and building's impact on environment, and so the sustainable building projects have a dominant capabilities in framing a valuable and noteworthy role in sustainable development.

In India context of view, not only objective but subjective factors also imparts its role in sustainable products design. Objective factors are those through which technical specification is achievable e.g. durability, material fixation, strength while the subjective factors are those through which social and environmental features is achievable e.g. aesthetics, health and safety. Material selection depends upon the types of projects and locality area of the projects.

The principal of sustainability focuses the utilization of waste products into useful products like the utilization of fly ash in cement manufacturing. There is a limitation of understanding ecofriendly products in construction over the matter on life cycle and long durability and on implementation of natural and ecofriendly resources, environmental and socio-economic negative impose can be controlled in long turn of implementation.

General focus in development framework for successful achievement of sustainability in construction materials selection is “reuse, reduce, and recycle”. In selection of construction products, construction stakeholders should strive to:

- 1) Reduction in utilization of raw resources and energy
- 2) Designing for technical needs and achievable human comforts
- 3) Controlling the negative impacts on environment through sustainable materials designs.

II. PHASES OF CONSTRUCTION MATERIAL SELECTION

A. Pre-Building Phase: Pre Building phase means the initial planning and designing phase of the construction project. It includes the prior selection of material selection that is required for entire projects. The sustainable focus of pre building phase in construction focus on factors like local material selection, exploring the availability of raw materials, managing the transportation facilities of access to the site, initial acquisition and scale of demand of materials. The basic adaptation and implementation of sustainable projects depends upon this phase. This phase offers the maximum opportunities for ecological damage prevention in context of natural sources depletions and its effect to wildlife habitats, water, air and land pollutions.

B. Building Phase: Building phase is the building construction period of the project. In this phase, the economic and technical criteria are focused for material selection under sustainability. The "reuse" of the construction products is decided well in this phase and so the reusability & energy efficiency is maintained under the phase. With proper energy efficiency approach, the wasteful resources can be neglected. The selection of products in this phase decides the durability, life cycle cost and long-term social and environmental benefits.

C. Post-Building Phase: The post building phase is the life cycle period of the building after the building construction phase have been completed. In this phase, socio-economic benefits are focused for material selection under sustainability. The "recycle" of the waste and unused construction materials is decided well in this phase and maintainability during construction and post construction is highly dependent in this phase. For the sustainability of the project, it is important to know the useful life period of the materials used during construction for life cycle achievement of sustainability. In case it may occurs the building may perform sustainability features for a short period but is ineffective in long run of building phase.

III. DOMINANT SUSTAINABILITY CRITERIA FOR MATERIAL SELECTION

A. Cost: This is the market value of the products under use and it varies with region, technical features, artistic look and time phase of period. Under these criteria; the initial acquisition cost reflects the crucial affecting criteria. The cost should fit the functions and optimal worth of the products to be easily usable.

B. Durability: The durability of the material determines the useful life period of the construction products. The selection of products or materials of construction offers advantages over life-cycle cost of the project, maintainability period and resistance from environment impacts. On one side the durable products may possess high initial cost but on other side, it is economic efficient in longer period than changing of products after its useful period.

C. Energy efficiency: Energy efficiency means the proper utilization of energy and improving the wastage of energy from its source. The energy efficiency over the material can be achieved when the amount of energy is efficiently utilized in manufacturing, packing and transportation of the material to the site. Its offers the economic benefits in longer and larger scale of materials.

D. Embodied Energy Reduction: Embodied energy is defined as the total amount of energy required to produce the products including the energy for extraction of raw materials to the final packing of the products. The lower the Embodied energy, the lower is the products cost which directly and indirectly affects many sustainability factors.

E. Air Quality and Reduced Toxicity: Toxicity is the level of dangerous or harmful matters that exist in the materials. The air quality can be improved with addition of special chemicals or products during the construction of materials which impose positive environmental benefits. e.g. use of zeolite in construction blocks is beneficial in absorption of CO₂ gases which is major gas for global warming.

F. Natural Materials Usage: Natural materials utilization in construction is benefited by embodied energy, energy efficiency and is likely to have a lower cost. If available near to site, the transportation cost, material storage cost and many likely to be benefited with utilization of natural materials.

G. Recycled Content: The recycled content in construction materials is benefited from waste minimization, energy efficiency and economical savings. Some recycle material have the depreciation cost too after the useful period of the buildings like metals, plastics, glass etc.

H. Reusability: The Reusability content of the material is benefited in waste minimization, effective resource utilization and economic savings under new material purchase, storage cost, transportation cost etc. The higher is the reusability characteristics of the products, the higher are the adaptation in the construction by various stakeholders.

I. Biodegradability: The biodegradability is the measure of decomposition of the materials after the material is being discarded. In construction a wide range of materials having shorter to longer biodegradability periods exists e.g. wood, organic materials returns to earth in shorter period and have lower biodegradability period while steel, plastic, glass takes a longer period to degrade.

J. Use of local material: Using locally available materials is the best utilization of available material resources. With utilization of local material, the transportation cost, storage cost, security cost is reduced, and the materials are available at required time. The environmental impacts of energy and fuel is benefited.

IV. CONCLUSION

- The paper concludes that the selection of sustainable materials is the dominant approach towards the sustainable buildings which is the demand of modern context.

- The focus on sustainable material selections by the construction stakeholders will provide the environmental and social benefits beyond the economic measures. However the proper selection of materials for sustainable construction is still a challenging task.
- In India context of view, Both subjective and objective play its role for sustainable materials selection.

REFERENCES

- [01] Ashwin Sabapathy, Sameer Maithel, “A Multi-Criteria Decision Analysis based assessment of walling materials in India”, *Building and Environment* 64, 107-117, 2013
- [02] Edwards, K.L., “Selecting materials for optimum use in engineering components”, *Materials & Design*, 26(5), 469-473, 2005.
- [03] Geeta Mehta, Amit Mehta, Bidhan Sharma, “Selection of Materials for Green Construction: A Review”, *Journal of Mechanical and Civil Engineering*; Volume 11, Issue 6 Ver. III, PP 80-83, Nov- Dec. 2014
- [04] Jong-Jin Kim, Brenda Rigdon, “Qualities, Use, and Examples of Sustainable Building Materials”, *Lecture notes of The University of Michigan*, December 1998
- [05] Kannan Govindan, K. Madan Shankar, Devika Kannan, “Sustainable material selection for construction industry – A hybrid multi criteria decision making approach”, *Renewable and Sustainable Energy Reviews*, 2015
- [06] Meg Calkins, “Materials for Sustainable Sites”, eBook, ISBN 978-0-470-13455-9, 2009
- [07] Monika Culakova, Silvia Vilcekova, Jana Katunska, Eva Kridlova Burdova, “Multicriteria Decision Analysis of Material Selection of High Energy Performance Residential Building”, *Journal of Civil Engineering* Vol. 8, Issue 2, 2013
- [08] Orchi Bhattacharyya, Shankar Chakraborty, “Q-analysis in Materials Selection”, *Decision Science Letters* 4, 51–62, 2015
- [09] Peter O. Akadiri, Paul O. Olomolaiye, Ezekiel A. Chinyio, “Multi-criteria evaluation model for the selection of sustainable materials for building projects”, *Automation in Construction* 30 113–125, 2013
- [10] Rees, W.E. “The Ecology of Sustainable Development,” *The Ecologist*, v. 20, n.1, pp. 18-23, 1990.
- [11] Roberts, D.V., “Sustainable Development – A Challenge for the Engineering Profession,” in Ellis, M.D., ed. *The Role of Engineering in Sustainable Development*, 1994