A REVIEW ON GREEN MANUFACTURING IN CONSTRUCTION SECTOR FOR CLIMATE CHANGE

Charuta S. Waghmare[1*], Bharti S. Motwani[2], Khalid Ansari[3], Shivendra Singh[4]

Article History: Received: 24.03.2023 **Revised:** 09.05.2023 **Accepted:** 03.06.2023

Abstract:

Resources and population are major environmental problems in this global world. Green manufacturing is the new shift towards sustainability which focuses on resources conservation, energy conservation, sustainable development, using cleaner technologies. The circular economy is the shift from linear economy towards circular which mainly focuses on the principle of 3R's (reduce, reuse, recycle). Sustainability is now the need of an hour. Utilization of this waste in construction activities reduces the problem of environmental concern of reuse of waste. Environmental, social and economic are the three pillars of sustainability. LCA is used to evaluate product's sustainability during its entire life cycle.

Keywords: CETP, Circular economy, Green manufacturing, LCA, Sustainability

[1*]Assistant Professor, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra,India

[2]PG scholar, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India

[3]Assistant Professor, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India

[4]Research Consultant, Directorate of Research, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Wardha, Maharashtra, India

Corresponding Email: [1]charutawaghmare@gmail.com

DOI: 10.31838/ecb/2023.12.s3.790

1. Introduction

Manufacturing activity involves conversion of raw materials into finished products by some desired process to be used for some useful purpose. Green represents balance in environment such as natural habitat conservation, biodiversity protection, energy usage and efficiency, waste generation and recycling [2]. It is not constraint up to, air, water, and land pollution only. Manufacturing industry is one of the biggest, major pollution causing too. Globally, it uses 35 % of electricity, and creates 20 % of CO2 emissions, and is responsible for one fourth of natural resources depletion. This creates severe effect on the environment and should be taken into account for climate change. This sector provides 23 % of worldwide employment and cannot be neglected from economic point of view [6]. In a country like INDIA due to rapid urbanization and industrialization, and the ever increasing population we always have resource limitation. The resources need to be extracted very carefully rather to waste. When the amount of manufacturing waste produced starts challenging the net production of manufacture the need of an alternate method is realized and the most probable solution to it is

'Green Manufacturing'.

Green manufacturing is also known as

- Zero emission manufacturing
- Sustainable manufacturing
- Clean manufacturing

Green manufacturing is important since

- Much fresh water has been withdrawn in the last 30 years as in the last three centuries.
- Since 1970 carbon emissions have increased by more than 1.5 times.
- Industrial waste.
- Atmospheric carbon dioxide rate has nearly doubled between 1970 and 2000 when compared between 1960 and 1970.

Green manufacturing-environmental benefits

- The aim of green manufacturing is to reduce the waste to zero and create overall less pollution.
- It Improves ecological cycle and prevents pollution [2].

Need for green:

- Increasing emissions and the associated climate change with it.
- Depleting natural resources.
- Increase in the generation of waste and pollution.

Key aspects of green manufacturing are

- Resource efficiency and management
- Energy conservation.
- Sustainable development
- Using cleaner technology or energy i.e. renewable energy.

Objectives of green manufacturing

- Generating energy from renewable sources.
- Improving energy efficiency
- Reducing Pollution, greenhouse gases and recycling waste
- Conserving natural resources

Technical policies/principles

- ZERO emission
- Waste prevention and control
- Sustainable development
- Carbon offsetting
- Energy conservation
- Using cleaner energy

Sustainability challenge: An increase in the amount of waste generation, electronic waste generation, pollution problems due to improper waste disposal, green house gas emissions, growing population

demand, due to rapid industrialization there is a need to shift towards sustainability. The sustainability challenge can be encountered by shifting towards cleaner energy, developing green products and processes in the economy [6].

Green manufacturing for climate change

'Green manufacturing' or sustainable industrial processes are now the need of an hour. Even if every industrial activity is shut down such as power plant operation, manufacturing of cars and goods, working of factories the average temperature around the globe will still rise by 0.6˚C in the century [2]. The carbon dioxide emissions can be minimized by enhancing green implementations in the power sector followed by transportation and industrial sector.

Contribution of construction sector towards climate change

28 % of global emissions were accounted from building operations while adding another 10 % from construction industries such as cement, glass, etc, according to a building and construction 2020 Report. The carbon dioxide emissions were found to increase due to the increased use of non renewable energy sources used for electricity generation. The greenhouse gases emissions account for some 40 % according to 2019 Global Status Report.

Green manufacturing for mitigation of climate change The change in the manufacturing and production process of industry and establishing environmental friendly atmosphere is known as Green manufacturing. Basically it is the changing of production process, which emphasizes on use of less non renewable resources, minimize pollution and production waste, recycling and reusing materials, and make average emissions. They aim to develop technologies or employ processes so that their impact on the environment is minimized.

Circular economy

The construction industry is a huge industry of the economy. The construction industry is growing worldwide as it contributes a lot to the economic development of the nation. The sector has significant environmental impacts and must be considered for the establishment of environmental friendly atmosphere. More than 30% of the natural resources are extracted from Construction Industry generating about 25% of total solid waste across the world. Circular economy is a new shift for sustainable development in the industry. The construction industry mostly followed the linear economic model of take, make, dispose. Circular economy shift which focuses on the reduction of natural resource extraction and minimize waste generation. The concept of the CE i.e. circular economy is increasing tremendously and has been seen as a major policy maker for the construction industry. The aim of which is to maintain, reuse, refurbish and/or recycle natural resources and materials that are used in the construction sector. Social, environmental and economic are the three pillars of sustainability [1].

Important aspects of circular economy are:

- Energy conservation in buildings.
- Minimizing and managing waste, developing alternative construction materials.
- Sustainable development.
- Developing circular business ideas.
- Development of smart cities and Industrial 4.0 revolution.

The studies seem to focus much on sustainability, energy efficiency, life cycle assessment, renewable energy, and recycling in past few years. Construction industry consumes a large amount of resources nearly 50% of the total extraction of raw materials, and it uses 36% of the global energy. 39% of the energy related emissions are associated

with this sector [1]. The emissions of these greenhouse gases will definitely create havoc if continued to exist at the same rate. A one third of the total solid waste which is generated across the globe is from construction and demolition projects. The major fraction of the waste that is generated is landfill and causes serious environmental pollution and problems. The rise in the price of construction materials is one another cause which must be considered by the sector for the use of energy efficient construction materials which is by reusing and recycling. Thus this is concluded that construction industry needs to shift urgently into a more sustainable regime by adopting the policy of circular economy. The main aim of circular economy is to minimize the waste and make wise use of resources. The key aspects of circular economy reduce, recycle, reuse and recover [9].

CETP's towards green

The common effluent treatment plant (CETP) is a common platform for the cluster of small and medium scale industries. The CETP was established with the purpose of providing technical assistance to industries which cannot provide treatment to their waste either due to the following reasons. Water and waste water treatment requires great amount of energy. Energy consumption is a major requirement in CETP. Water and waste water treatment consumes up to 2% of total electricity generation in the United States. With the growing urbanization, industrialization and the ever increasing population in a developing economy like INDIA the demand for energy is increasing. Green manufacturing in CETP a new concept which focuses on the reduction of consumption of resources and reduce pollution. The CETP's are turning more towards green for achieving sustainability. The CETP's can achieve

sustainability or turn towards green in the following ways.

- Upgrading pump stations
- Optimizing aeration
- Improving sludge management
- Recovering and recycling essential nutrients
- Going light on disinfection
- Update lighting and HVAC systems
- Maximizing gravity flow
- Automate operations

Common issues with CETP waste

The waste generated from this industrial treatment is called sludge (SS). Sewage sludge is partially dried semi solid waste which needs to be disposed off and handled carefully. Due to some common issues related with the sludge waste the waste needs to be handled with care. The most common associated problems with the sludge waste are it may contain certain heavy metals, toxic in nature and it may be even hazardous [11].The major concern for the environment is the waste generated from industries in addition to health and a cause of landfill in current scenario. Sludge placed in the soil has severe environmental effects. Emission of various greenhouse gases due to the burning of sludge cause severe environmental problems. Disposing the toxic sludge on landfill has been the primary method of waste sludge disposal. The cost of the transportation of the sludge in landfill is high [16].

Practices to convert CETP waste into Green

The use of industrial solid wastes especially, use of sludge waste as an alternative to building materials plays an important role considering the environmental concern. The use of sludge in concrete and other building materials will decrease the problem of degradation of land due to dumping of such industrial waste. The recycling of waste in this way seems to be a viable solution to the

environmental concern [4]. The use of waste sludge in construction activities, such as manufacturing of bricks and tiles, as a ingredient material for cement production, as a replacement for aggregates in concrete and cement mortar, as a component material for lightweight construction materials and as a replacement for sand and cement in cement stabilized bases, sub-base and embankments in road constructions are the ways to convert it into green. To eliminate the problem of disposal of this sludge waste, it is essential to develop sustainable construction materials out of them. The waste Sludge placed in concrete and other building materials has no adverse effects on the environment. While sludge placed in landfills creates toxic hazard to the surrounding environment [8].

Utilization of CETP waste for construction purpose

The major concern for the environment is the waste generated from the industries. To eliminate the disposal and pollution problems emerging from these wastes because of landfill, it is essential to develop profitable building materials out of them (Satvik Pratap Singh, Anantha Singh T.S et al 2019). The utilization of this sludge waste in construction seems to be viable solution in addition to removing the problem of disposal. Recycling the excess sludge and converting it into energy-efficient bricks by combining it with clay is the most common means (Dawit Alemu Beshah et al (2021**)** [3]. Energy saved during the firing process of bricks with 10 and 20% sludge was 26 to 50% when compared to pristine clay bricks [3] Utilizing partially dried sludge for low-cost and energy efficient brick production will solve the environmental problems as well as industrial waste disposal issues. [3] The increase in demand for construction materials due to fast growing infrastructural development has called for an effective way to develop construction materials from industrial sludge wastes, which includes sewage sludge ash (SSA). After firing sewage sludge, sewage sludge ash is produced and it needs to be disposed of by different means (Marzena Smol, Joanna Kulczycka et al (2015) [14]. Using SSA for construction purpose such as in production of bricks or tiles ,as a ingredient for the production of cement, as aggregate material for cement and concrete mortar, as a synthetic component for construction of lightweight materials, as replacement material for cement and sand in stabilized bases, sub-bases and road embankments. In this study the use of sewage sludge ash in construction materials as an approach towards circular economy is discussed [8]. To manage the waste properly and for effective waste management the utilization of sewage sludge ash in building construction will be eco-friendly under waste management rather than landfill (Sumit Chakraborty, Byung Wan Jo et al 2017**).** The casting of mortar and concrete with the optimum utilization of sewage sludge ash 70%, with quicklime 20%, and blast furnace slag 10% for the fabrication of concrete would be an effective alternate in sustainable construction material development and managing waste [9]. The textile industries produce a huge amount of chemical sludge that poses a great damage to the environment (Loganayagan.S, Rajkumar G et.al (2020) **[7].** The main aim of this study was to find the possible reuse of this industrial hazardous waste in building construction material. The fine aggregates were made by grinding angular aggregates. The samples were not found to satisfy the desired compressive strength essential for construction applications. It can be concluded from the study that the sludge waste from textile units cannot be used as fine aggregates in concrete. The sludge material gets finer than cement particles which increases its volume and water demand during mixing which reduces the

strength characteristics of the building. The addition of sludge to concrete blocks delays the setting time of it. [7] Experimental approach has been planned to explore the potential feasibility of utilizing textile industry sludge as Supplementary Cementitious Material in concrete, in order to reuse the industry sludge in the construction industry resulting indirectly reducing dumping of sludge in bare lands resulting in land pollution (Mr. S. Vellingiri , Mr. P. Velumani et.al 2015) [17].

Introduction to LCA

LCA a method for determining environmental impacts related with all the aspects of a commercial life of a product, process, or service. In case of manufactured product, environmental impacts are assessed from raw material extraction (cradle), to the recycling or final disposal of product (grave). LCA involves thorough investigation of the energy and materials that are required across the life cycle of the product, process or service, and calculates the significant emissions to the environment. LCA is thus used to calculate potential environmental impacts. The aim is to measure its impact on environment and make necessary changes to improve the environmental profile of the product.LCA studies the environmental parameters and evaluates potential impacts throughout a product's life cycle (i.e. cradle-to-grave) from raw materials extraction to its final disposal and end use. The general
category of LCA includes resource use, human health, and ecosystem consequences. LCA is also called to as **"cradle-to-grave"** analysis https://en.wikipedia.org/wiki/Life-cycle_assessment [19]

The principle stage in the life cycle assessment of any product includes:
1. Extraction of raw materials
2. Materials manufacturing &processing
3. Transportation of extracted materials
4. Use stage
5. Disposal of waste

Goals and purpose of LCA

- Achieving sustainability
- Quantifying inputs and outputs
- Assessing various environmental impacts
- Analyzing input and output quality of materials during the life cycle assessment of product.

2. Conclusions

The construction sector consumes huge amount of resources and it is the most energy efficient sector. Large amount of industrial waste is generated every year from industries. Disposal of sludge waste in land or air causes serious environmental problems. Utilization of sewage sludge in construction activities seems to be a viable solution. The sludge used for construction purpose does not have any environmental effects. LCA calculates potential environmental impacts related with all the stages of a product life cycle. It calculates environmental impacts right from extraction of raw materials to its final disposal. It calculates emissions and global warming potential. It is a tool which calculates sustainability of a product.

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