



PERCEPTIONS ON CHALLENGES, MOTIVATING FACTORS AND FUTURE PROSPECTS OF GREEN CONCRETE MANUFACTURING IN INDIA: A STUDY

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Abstract

The intimidation of improvement of urbanization revived positive gain in India's construction industry particularly in infrastructure development, which is also a crucial belief for degradation of the environment. India has acknowledged the requirement for embrace sustainable manufacturing application in the construction industry. The purpose of the current literature review is to investigate the Challenges and Barriers in sustainable manufacturing of green concrete, and to analyze the Motivational factors to promote sustainable manufacturing of green concrete. By exploring the interrelationships and driving/dependence power of the enablers, this study makes crucial recommendations for scholars and policy-makers. The exposures from this study can help the researchers to understand approach, Challenges, Motivating Factors and Future Prospects of Green concrete in India.

Key word:-sustainable manufacturing, green concrete, Motivational factors,

1. Introduction

Industrial revolution has started to rule the global competitive scenario, As the growth in Manufacturing sector, a large amount of pollutants release, which lead to unfavorable effects on the environment and society [1]. As consequence of, development in industrial sector is one of the real reason of the booming in construction sector has resulted in escalation of construction Materials [2]. Cement acts as "glue" in concrete, It is a fundamental component of human society's infrastructure all throughout the world. The process of making cement results in CO₂ emissions, deterioration of the air and water quality, deterioration of population health nearby, and infertility of the soil. [3]. In the present trend of globalisation, manufacturing processes in the construction sector must be environmentally friendly and sustainable so that they can be recycled, renovated, and reused when their useful lives are over. [4]. Green concrete is defined as concrete that uses waste materials as at least one of its constituents or that does not damage the environment during production. [5]. The necessity for green concrete industry is triggered by intensified regulations to cut down the environmental destruction like use of natural resources (limestone, shale, clay), green house gas emission and limited landfill spaces [6]. The current need for natural resources to build infrastructure has created a lot of chances for using waste materials to build green infrastructure, which will lead to sustainable development without using up natural resources. [5,6]. This study will help to recognize the challenges, motivational factor to understand the challenges and explore the future strategies to for successful implementation of green concrete.

2. Background : Green concrete and sustainability

Across the globe Construction practitioners are beginning to acknowledge the convenience of building sustainably for the shake of healthy work environment, work efficiency and better standard of life

[7]. The idea of sustainable building will entitle the industry to be more accountable to the need for environmental safety, including the appropriate use of natural resources and waste management.

[8]. Green concrete contains eco-friendly materials that are sustainable for decreasing the environmental impact, as these green concretes have recycled materials and some have good

manufacturing process and high performance during a building's life cycle [9]. Particularly this article identifies the number of key challenges/obstacles for the implementation of sustainable green manufacturing, i.e. Environmental, Economical and Social challenges. Individually these three challenges in turn involves more individual challenges, and these are recognized and elaborated under each heading. Also it is discuss about the motivational factors to promote sustainable manufacturing of green concrete. Motivational factors like Market demand, Government promotions and environmental regulations, research and the availability of funds for green manufacturing. This paper concludes briefly outlining the challenges and clarity about the motivational factors to promote sustainable manufacturing of green concrete. These article is presented with the ambition for the better understanding to promote the sustainable manufacturing of green concrete among the academic researcher, professional and the general public.

3. Sustainable methodology for green concrete manufacturing

In recent times, climate change and environmental concerns have attracted the attention of scientific researchers and related industries. As a consequence, several tools and indicators have been developed to figure out behind these concerns and take measures to cut down on associated impacts [10]. Though in the "greenest" projects, the majority of the products utilized aren't green by themselves, but are used so that jointly they decrease the environmental impacts of construction. So, sustainable concrete aims to contribute to minimizing the environmental impacts generated in the construction cycle. To determine the environmental effect of building materials, four stages are considered that correspond to a life cycle structure: Material production, construction, life and demolition. Every building material is fabricated from a mixture of raw materials related to energy consumption and waste. The procedure of building a structure need energy consumption and generates wastes that are based on the materials used. Therefore, we should consider material with as small as possible environmental impact [11]. Natural biological concrete has natural elements like bacteria and agricultural waste, such as hemp. They also contain recycling aggregate concrete like the construction and demolition wastes. Using such wastes as aggregates can decrease the landfill potential of concrete by about 50 to 75% and also its embodied carbon by almost 10 to 30%. Calcined clay (CC) and lime have lower energy demand than OPC, So these can also be used as replacement material of OPC in concrete. The OPC replacing percentage and the type of replacement material used can effect the durability and mechanical properties of concrete thereby varying the environmental impact. In blended cement concrete (BCC), several pozzolanic elements known as supplementary cementitious materials (SCM) are used to partially replace OPC in the binder. Alkali activated concretes (AAC), which completely replace OPC, are manufactured with 100% FA precursors (CC) or GGBS and activated with an alkaline solution often comprised of sodium hydroxide or sodium silicate. [12]. Compared to OPC concrete (OPCC), high performance concrete (HPC) is known to have improved mechanical and durability attributes. [13]. Figure 1 below illustrates the specific varieties that can be discovered in the literature and are thought to be more environmentally friendly. [13].

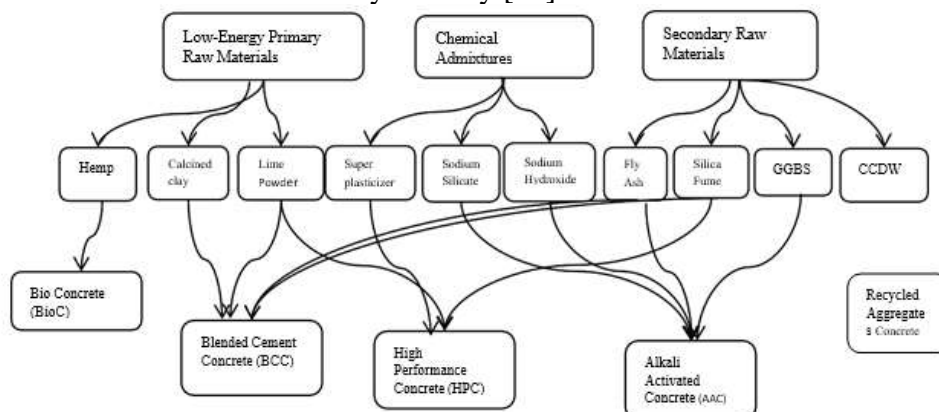


Figure 1: Green concrete strategies



4. Challenges and Barriers in Sustainable Manufacturing for green concrete

The suggested scheme and plan of action is with regard to the present obstacles in adapting flexible as well as green concept that the industries in the field of manufacturing need to face. The present study analyzed and explained analytical practices for presenting the contrasts of the most crucial enablers and hurdles and obstacles for the improving and supporting assessment for the implementation of strategic techniques of green manufacture [4,14]. Taking into account the present obstacles directed in the direction of execution of various types of sustainability at the level of individual. To list a few : ecologically responsible manufacturing, environmental blueprints in manufacturing, environmental management systems, environmental sustainability, environmentally conscious technology conversion, etc.. The study by Mittal et al. describing about the Green manufacturing barriers are provided in Table 1. [16,17]

Table 1. Description of Green Manufacturing Barriers. [16]

Barrier	Description
Weak Legislation	Necessity of environmental laws, ineffective legislation and elaboration of law
Low Enforcement	Infirm / no enforcement of laws, corruption .
Uncertain Future Legislation	Unresolved evolution in legislation, detain investments for upcoming execution
Low Public Pressure	absence of pressure from local people or local politicians .
High Short-Term Costs	Implementing costs and expenditure
Uncertain Benefits	Uncertain economic advantage, consistent investment return, and previous amortisation of older investments
Low Customer Demand	Customers are price conscious and drawn to things that are less expensive, and the environment does not have enough clout in the market.
Trade-Offs	Trading emissions is preferable to decreasing them, environmental concerns should be outsourced, and product life cycles should be short.
Low Top Management Commitment	management or proprietor is not devoted towards green issues, “our company has not an impact in the world”
Lack of Organizational Resources	Green issues have limited priority due to its limited priority towards shortage of skilled staff, lack of experiences, no financial assets/capital access .
Technological Risk	Technological complexity, Probability of executing modern technology, fear of complications, no similarity with existing systems .
Lack of Awareness/Information	No awareness towards green trends, finite approach towards green literature and not adequate understandable information .

The authors highlighted the point that competitive green manufacturing is the primary enabler of globalization. Taking into consideration the social, economical and environment related views, as well as the obstacles in the application and execution of green manufacturing, Table 2. “Explaining about the hurdles related to economy and environment and social hurdles” several business objectives and strategies to entitle the forming of values with the help of “sustainable manufacturing” along with the presentation of a future perception in the direction of green processes and systems [4].



Table 2. The Environmental, Economical and Social challenges[4]

Categorized challenges	Challenges	Description
Environmental challenges	Limited recognition towards sustainable manufacturing	Minimal approach towards sustainability perception and literature
	End-to-end engineering	Reduced groundwork in organization
	Limited service orientation manufacturing	lesser organization support
	Scarcity of benchmarks	lack of practicable framework and guidelines
	Limited service from superior management	Complete abandon from concerned administration in an institution
	Negative view point on sustainability	Overall ignored by concerned top rank holder in an institution
	Execution, operating complication and challenges	Difficulties for the sustainable technology's operations and execution
	Weak legislation	Absence of environmental laws
	Low enforcement	Complexity of law
	Uncertain future legislation	Ineffective legislation
	Green technology adaption	limited understanding of cost-effectiveness and green technology
	Technological risk	Risk of implementing new technology
Economical challenges	Limited funds to green projects	Limited concern of government and unwanted methodology to green funds distribution
	Too high cost	Fundamental expenses are inflated towards the execution of sustainable technologies
	Uncertain benefits	Undetermined economic advantage
	Trade-offs	Slow return on investment
	Scarcity of organizational resources	Because environmental issues are not given enough weight in the market today, there are no financial resources or capital available.
	Ignored perspective for judicious funds	Absent of financial institutes and the distribution of financial resources at reasonable interest rates
Social challenges	Less awareness to local customers in green product	Less environmental oriented
	Scarcity to locally conducted recognition Programme	Lack of workable standards and requirements
	Employee resistance	negative responses to new sustainability principles
	Low public pressure.	Local governments, NGOs, and the media do not exert this kind of public pressure.

5. Motivational factors to promote sustainable manufacturing of green concrete

Numerous investigations have been accomplished to motivate industry for “sustainable manufacturing” of green concrete. There are many factors that can influence and provides an indication to fabricate green manufacturing more efficient for the entire business enterprise. Based on the studies the influencing Criteria , is discussed in the following sections.

5.1. Market demand

In any market, a customers demand and need hold the greatest importance and interest as they are the ultimate buyer and consumer of the product. In the present day, The customer is well aware and acquainted with their rights. This has led them to ask for products as per their needs and desires. Lately,



the customers have been giving preference to the green concrete over the conventional concrete as the cost of the former is seen to be lower than the later, making green concrete a cheaper alternative on the ground of savings in capital and operations costs. Green Concrete has shown upgraded marketability and a rise in public profile. It is also marked for saving energy, thus seeing an increased preference among customers [7,17].

5.2. Potential to use as manufacturing company practices

In present day, the government is on the way to promote “sustainable development”. This entitles green buildings and similar projects to claim rebate on taxes, making it a great motivation for the industries to adapt environmentally friendly and sustainable practices. Greatly productive and effective sciences, technologies, processes and practices that would provide to be beneficial comprise of improvised measure and monitor of indicators of sustainability by companies, Policies and governance of the company centering on sustainability, improvements in efforts checking the environmental impacts of the company, extending the local infrastructure’s capacity, setting up a sustainability-supportive company culture and working conditions, making the suppliers and customers well aware of sustainability and company’s engagement in promotion of sustainability [8,17].

5.3. Research

Further elaborate, point-by-point detailed and vigorous research are required to be carried out for industries and academics in the domain of “sustainability manufacturing” and design for the evaluation of effects on environment as well as, for the all in all development in sustainable manufacturing [8].

5.4. Government promotions and environmental regulations

The rules and orders of the government as well as legislation drives for innovating green products curbing of environmental regulation is largely to wring out Research and Development investment in the government category. Escalated input and encouragement in environmental schemes, technologies, policies, innovations as well as Research and Development funding from government are massive provocation for industries to frame their work keeping in mind the schemes and policies [17, 18]. Basically, the industry wishes to follow the environmental rules, as they want to keep away from all sorts of law suits as a consequence of any anti-environmental exercise as this can pave way for great loss in the grounds of resources and finance. ISO 14001 Certifications are highly crucial for companies as they intensify and boost up the reputation of the company and it marks that the work or the company is validated by the government [17]. The Government’s rules and regulations, schemes and policies are rigidly obeyed and observed as the industry needs to jointly work in conjunction with the government. This is because the companies get contracts by government which requires to obey certain laws and norms decided by the government. Their projects also require clearance from the government [17]. Market influence and Policies from the government in the support of environment will motivate and inspire Indian manufacturing units to take up green manufacturing exercises [1].

5.5. Availability of funds for green manufacturing

The encouraging policies driven by the government promote the practices involving green construction as it grants several tax rebates and relaxations. Monetary benefits and support offered by the Government encourage the organizations to shift towards sustainable exercises [1]. Sustainable green construction practices allow the complete extraction of resource’s usefulness. This leads to overall reduction in the project’s cost, making it economical [1,17].

6. Effective establishment of strategic plan and vision for sustainable production of green concrete

Based on the previous study, it is evident that the adoption of green concrete is necessary for the construction industry. The legitimate circle demands clear inspiration and concerted attempts from the management to generate awareness on all sustainability dimensions and permit employees to consider sustainable manufacturing of green concrete as a strategic means for business growth. Recommended organizational substitutes were also analyzed with consensus being extend throughout the fact that relevant up-skilling of employees regarding the new process through training ,and it is necessary task



for appropriate personnel to conduct and monitor each project's progress. The addition of environmental attention for decision making at all administrative levels and stages is of utmost importance. For example, cement companies focus on the mitigation of environmental harm caused due to the aggregate and cement material extraction for the rehabilitation of the quarried land. At the production stages, the safety improvement, accident prevention and the improvement of personnel welfare are very important.

7. Conclusion

This article covers the methodology, challenges and barriers encountered for the Manufacturing of green concrete and motivational factors coming in the direction of execution for the manufacturing of green concrete. The research interpreted sustainable integrated methods, that are contemplated as a novel and effective approach for reducing the utilization of cement and natural aggregate, leading to an abatement in environmental impacts and the accomplishment of sustainability in the construction materials category. The study demonstrates that, despite the fact that specific solutions might vary depending on the environment, the difficulties facing the green manufacturing industry are universal and should worry most nations and regions. Additional knowledge gaps could reveal crucial insights for both the R&D sector and policy makers. It should be obvious that recognize the nature as well as governing to escalate general environmental recognition in the industrial zone. To transform environmental and technical difficulties into societal challenges and action, collaboration between natural scientists, engineers, and social scientists is absolutely necessary. The evaluation of policy tools and the content of policies both need to be improved. An increased focus on the function of technology-specific policy makes such assessments far from simple. They must pay attention to the roles that various policies play in innovation systems and take into account significant interaction effects; any evaluation must also take into account the gradual evolution of policies.

References

- [1] Malek, J., & Desai, T. N. (2019). Interpretive structural modelling based analysis of sustainable manufacturing enablers. *Journal of Cleaner Production*, 238, 117996.
- [2] Patil, B., Veerendra Kumar, M., & Narendra, H. (2015). Durability studies on sustainable geopolymer concrete. *International Research Journal of Engineering and Technology (IRJET)*, 2(4), 671-677.
- [3] Marinelli, M., & Janardhanan, M. (2022). Green cement production in India: prioritization and alleviation of barriers using the best-worst method. *Environmental Science and Pollution Research*, 29(42), 63988-64003.
- [4] Kumar, R., Tyagi, P., Nagar, L., & Gaur, D. (2020). Challenges of Sustainable Manufacturing for Indian Organization: A Study. In *Recent Advances in Mechanical Infrastructure: Proceedings of ICRAM 2019* (pp. 33-39). Springer Singapore.
- [5] Suhendro, B. (2014). Toward green concrete for better sustainable environment. *Procedia Engineering*, 95, 305-320.
- [6] Liew, K. M., Sojobi, A. O., & Zhang, L. W. (2017). Green concrete: Prospects and challenges. *Construction and building materials*, 156, 1063-1095.
- [7] Abidin, N. Z., & Powmya, A. (2014). Perceptions on motivating factors and future prospects of green construction in Oman. *Journal of Sustainable Development*, 7(5), 231-239.
- [8] Rosen, M. A., & Kishawy, H. A. (2012). Sustainable manufacturing and design: Concepts, practices and needs. *Sustainability*, 4(2), 154-174.
- [9] Marey, H., Kozma, G., & Szabó, G. (2022). Effects of Using Green Concrete Materials on the CO₂ Emissions of the Residential Building Sector in Egypt. *Sustainability*, 14(6), 3592.
- [10] Gursel, A. P., Maryman, H., & Ostertag, C. (2016). A life-cycle approach to environmental, mechanical, and durability properties of "green" concrete mixes with rice husk ash. *Journal of Cleaner Production*, 112, 823-836.



- [11] Arturo, G. C., Homero, M. R., Roberto, U. A., & Antonio, S. M. (2010). Classification of Green Concrete for Sustainable Solutions. In Proceedings of the Second International Conference on Sustainable Construction Materials and Technologies.
- [12] Serres, N., Braymand, S., & Feugeas, F. (2016). Environmental evaluation of concrete made from recycled concrete aggregate implementing life cycle assessment. *Journal of Building Engineering*, 5, 24-33.
- [13] Hafez, H., Kurda, R., Cheung, W. M., & Nagaratnam, B. (2019). A systematic review of the discrepancies in life cycle assessments of green concrete. *Applied Sciences*, 9(22), 4803.
- [14] Jayal, A. D., Badurdeen, F., Dillon Jr, O. W., & Jawahir, I. S. (2010). Sustainable manufacturing: Modeling and optimization challenges at the product, process and system levels. *CIRP Journal of Manufacturing Science and Technology*, 2(3), 144-152.
- [15] Mittal, V. K., Egede, P., Herrmann, C., & Sangwan, K. S. (2013). Comparison of drivers and barriers to green manufacturing: a case of India and Germany. In *Re-engineering Manufacturing for Sustainability: Proceedings of the 20th CIRP International Conference on Life Cycle Engineering*, Singapore 17-19 April, 2013 (pp. 723-728). Springer Singapore.
- [16] Mittal, V. K., & Sangwan, K. S. (2014). Prioritizing barriers to green manufacturing: environmental, social and economic perspectives. *Procedia Cirp*, 17, 559-564.
- [17] Mathiyazhagan, K., Datta, U., Bhaduria, R., Singla, A., & Krishnamoorthi, S. (2018). Identification and prioritization of motivational factors for the green supply chain management adoption: case from Indian construction industries. *Opsearch*, 55, 202-219.
- [18] Guo, Y., Xia, X., Zhang, S., & Zhang, D. (2018). Environmental regulation, government R&D funding and green technology innovation: Evidence from China provincial data. *Sustainability*, 10(4), 940.