A Review on Assessment of Environment Impact of Cement Industry

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Abstract—An Environmental Impact Assessment (EIA) is a comprehensive investigation that is carried out in order to evaluate the potential environmental impacts, whether a project's potential effects on the environment would be beneficial or detrimental. Research projects that are part of environmental impact assessments entail the investigation of environmental, social, and economic factors. For the purpose of this essay, the Environmental Impact Assessment (EIA) studies that were conducted in the cement sector are especially investigated. The purpose of this research is to determine the precise characteristics that have to be taken into account while evaluating the influence that a planned cement firm would have on the environment. Efforts are made to establish a standardized structure for submitting the Environmental Impact Assessment (EIA) report to the regulatory authority. The rules of each country require the mandatory submission of EIA reports. The style, structure, legislation, or laws that regulate compliance with Environmental Impact Assessment (EIA) and the amount of factors needed by EIA studies may vary correspondingly.

Keywords—Cement industry, sustainability, EIA, Cement manufacturing

1. INTRODUCTION

India has been an important participant in the global cement industry since 1982, ranking as the second-largest cement manufacturer worldwide and making a considerable contribution to the country's economy. The industry has garnered substantial investments from both domestic and international investors owing to its potential for infrastructure and building development. The cement industry is anticipated to get a significant boost from recent efforts such as smart cities, with international businesses playing a big role in government-driven projects [1]. Housing and real estate industries are the primary factors that stimulate the demand for cement, constituting around 65% of the overall consumption in India. Furthermore, cement usage is also influenced by the presence of public infrastructure and industrial expansion. As of 2017-18, India has a total cement manufacturing capacity of around 460,000 tons. It is anticipated that cement consumption would increase by 5% in 2019 owing to a rise in housing demand and greater investment on infrastructure. The industry plans to produce 300 megatons to meet domestic demand and five megatons for exports. The top twenty cement organizations account for 77% of the total cement production, while the remaining 400 small plants account for the rest. The government has sanctioned investment projects to facilitate the growth and prosperity of private sector enterprises in the industry. In 2018-19, the government introduced a housing fund of Rs 25,000 crore via the national housing bank, aimed at promoting affordable housing. This initiative is anticipated to stimulate the demand for cement in the construction sector. The cement industry is projected to achieve an annual production of 550-600 million tonnes by 2025, driven by growing needs from sectors like housing, commercial development, and industrial construction.

An Environmental Impact Assessment (EIA) is a crucial process in the Indian cement industry, involving a comprehensive study of the environmental and social impacts of the entire life cycle of cement production. This assessment includes collecting data on existing environmental conditions, identifying and assessing potential environmental and social impacts at different stages of the cement production process, assessing pollutants, evaluating noise and vibration levels, assessing mining activities, evaluating solid and hazardous waste generation, energy consumption patterns, and estimating greenhouse gas emissions [2]. The EIA process is a regulatory requirement in many countries, including India, and involves collaboration between the project proponent, environmental experts, regulatory authorities, and affected communities. In order to achieve the goal, it is necessary to make informed judgments that strike a balance between economic growth and environmental and social sustainability [3]. The specifics of an Environmental Impact Assessment (EIA) for a cement plant in India would be determined by the volume of the project, its geographical location, and the unique characteristics of the facility.To ascertain the proposed cement plant's potential effects on the environment and society, the Environmental Impact Assessment (EIA) process is compulsory. This evaluation ensures that the factory will adhere to environmentally aware practices and will be viable in the long run. Engaging with local communities and stakeholders via public consultation procedures is essential for gathering input, addressing problems, and incorporating local expertise into the decision-making process.

2. CEMENT INDUSTRY

The cement industry plays a vital role in constructing national infrastructure due to its increasing share of global output. The corporation has relocated its cement production operations to nations with less strict environmental rules due to increasing environmental concerns in emerging countries, particularly in Europe, to support its fast growth [4]. Cement manufacture is usually used to make concrete, a composite material made of sand, gravel, broken stones, and cement. Cement is crucial for the advancement and improvement of infrastructure, serving as a vital component in economic and social domains. Accounting for 5-6% of the carbon dioxide emissions created by human activity, it plays a significant part in creating global warming. In addition, it disperses microscopic particles, dangerous metals, and persistent chemical contaminants like dioxins. Just under one percent of the power that the US produces goes toward energy use.The cement industry faces environmental challenges due to its high energy intensity and calcination process, which releases carbon dioxide as a byproduct. The IEA Greenhouse Gas R&D Program has commissioned studies to assess CO2 emissions and suggest potential remedies. The industry's use of raw materials, fuels, and chemical additives contributes to environmental pollution [5]. Ecofys Energy and Climate and Berkeley National Laboratory are addressing these concerns. Pollution is carbon dioxide, hydrocarbons, sulfur oxides, nitrogen oxides, and particulates. Air pollution and global warming result from these contaminants. Climate change makes greenhouse gas emissions a big issue. Over 7% of worldwide CO2 emissions come from cement production. When considering its impact on global warming, it ranks as the second most damaging chemical in the world. The environmental difficulties in the cement business need a comprehensive strategy including the advancement and implementation of cleaner technology, enhancements in energy efficiency, and the investigation of alternative materials or processes with reduced environmental implications [6, 15]. Sustainable cement sector environmental solutions need governments, industry stakeholders, and academia. Cement industry environmental issues. The cement industry is recognized for its high energy intensity, with a considerable amount of worldwide primary energy consumption allocated to its activities. Calcination of cement clinker releases carbon dioxide. This increases industrial carbon emissions. The IEA Greenhouse Gas R&D Program, Ecofys Energy and Climate, and Berkeley National Laboratory are studying cement industry carbon dioxide emissions and offering solutions. Raw materials, fuels, and chemical additives used in cement manufacture harm the environment [7]. According to the IEA, cement companies could cut their carbon emissions by 56 percent by 2050 if they used carbon capture and storage (CCS). A substantial portion of greenhouse gas emissions originate from the energy and process needs of the cement industry. Ten countries produced cement accounted for a staggering 63 percent of global carbon emissions in 1994.Carbon emissions of 307 million metric tons were anticipated from cement production. Several strategies to reduce emissions include using more efficient energy sources, transitioning to low-carbon oil, recycling spent oils, including additives into cement, and ultimately eliminating CO2 emissions while substituting cements derived from clinker kiln flue gas.

Pollution from cement factories affects the atmosphere, leading to a 37.7% increase in CaO levels in soil samples near the cement mill. The most hazardous regions are located within a radius of 0–2 kilometers from the cement industry. To protect people and the environment, cement companies should be subject to strict pollution control laws and a buffer zone should be set up around them. Cement production in Egypt rose from 4 million metric tons in 1975 to 46 million metric tons in 2009. In sum country provides 1.5% of the world's cement. In the vicinity of cement plants, dust emissions may account for up to 30% of PM10, but in Greater Cairo, they only constitute 6%. The current dust emissions from existing facilities will decrease from 300 to 100 mg/m3, while new plants' emissions will decrease from 100 to 50 mg/m3 under the revised regulatory standards expected to be approved in 2010. Potential solutions to cement industry pollution and cleaner development include switching to alternative fuels for kiln operation, cutting down on nitrogen oxides (NOx), eliminating dust emissions, recycling silica waste into cement, reusing bypass dust, and finally, finding a safe place to dispose of radioactive waste [12]. Calcium sulfoaluminate and b-Ca2SiO4-rich cements are two alternatives that may reduce energy consumption and carbon dioxide emissions. Under the right circumstances, cement factories may make use of waste products including tires, fuels, U.S. solid waste, and solvents as supplemental fuel. Recycled materials such as glass, plastic, and rubber may be encased in concrete.

3. EMISSIONS FROM CEMENT MANUFACTURING

Emissions released during the cement-making process are the main environmental health and safety risk. There is a chance that the cement sector will contribute significantly to air pollution caused by human activity. Approximately 5% of the total anthropogenic CO2 emissions occur during cement production. While making cement, several different gases are discharged into the air, including particulate matter, dioxins, sulfur oxides, NOx, CO, CO2, H2S, volatile organic compounds, and CO. Gaseous and particle-based pollution are the two main categories. Burning fossil fuels releases dangerous air pollution [9]. Nitrogen oxides, sulfur gas, carbon monoxide, and volatile organic chemicals are examples. Particulate matter, mostly composed of dust and carbon particles, is produced by a wide variety of industrial processes, including clearing roads, packing, stacking, cement processing, blasting, transportation, and packaging. Additional emissions during cement manufacturing come from transportation equipment used for mining and delivering raw and finished materials [14]. Additionally, there are emissions from the fuel used for electrical generating, which supports other processes in cement production. Resources that cement manufacturers in certain nations use as fuel.Many limited resources, including fossil fuels and raw minerals, are required for the cement production process. Cement manufacture contributes to around 5-6% of human-caused emissions of greenhouse gasses and carbon dioxide. A cement kiln may discharge a variety of air pollutants, such as sulfur dioxide, carbon monoxide, nitrogen oxides, water, oxygen, sulfur dioxide, fluorides, and chlorides, as well as trace amounts of heavy metals and organic compounds.Toxic organic compounds and metals are released when refuse is burned in cement kilns [10]. Material-handling equipment including the clinker cooler, crushers, and grinders are sources of air pollution. These emissions may cause eye irritation, respiratory infections (including TB), chest pain, chronic bronchitis, asthma attacks, heart problems, and early death, according to study. Air pollution is known to harm ecosystems and humans. Infrastructure growth has boosted the cement industry worldwide, degrading the environment and harming human health [11]. The emissions of gases and particles from cement factories are causing a decline in air quality, resulting in significant environmental degradation, particularly air pollution.

4. ENVIRONMENTAL IMPACT OF CEMENT INDUSTRY

The cement industry has a major role in energy consumption and environmental effect. Critical climate and security concerns related to cement manufacturing are air pollution and substantial energy use. Cement manufacture needs substantial amounts of raw materials and fossil fuels, both of which are finite resources. Cement manufacture contributes to around 5-6% of anthropogenic carbon dioxide emissions. The release of solid particles and gasses into the environment results from the use of natural energy sources and materials. Heavy metals, sulfur dioxide, NOx, carbon monoxide, water, oxygen, and minor quantities of particulate matter, chlorides, fluorides, and CO are cement kiln emissions [8]. Incinerating industrial waste in cement kilns leads to the emission of toxic metals and organic substances. Crushing and grinding machinery, the clinker cooler, and other material handling equipment all generate particle emissions. After China, India ranks as the world's second-largest cement manufacturer. To make cement, a powder called "raw meal" is made by drying, crushing, and combining limestone with additions like bauxite and iron ore [13]. The raw material is heated, processed, and then cooled using an air conditioning system in a precalciner and kiln to yield clinker, a semi-finished product. Ordinary Portland Cement (OPC) is made by cooling the clinker (which makes up 95% of the material) with air and then mixing it with gypsum (which makes up 5%). It is necessary to thoroughly mix different types of cement with other basic materials. Essential cement properties are developed by the inclusion of numerous materials with clinker; these qualities, in turn, determine the cement's eventual usage [16

Fig. 1 Environmental impact of cement industry

Table 1 Environmental impact of cement industry

Impact Area	Description	Severity	Mitigation Strategies
Air Pollution	emissions of pollutants such as NOx and SOx as well as greenhouse gasses (CO2) during the fuel burning and limestone calcination processes.	High	Decrease the clinker factor, or the clinker to cement ratio. Utilize waste biomass as an alternative fuel; Apply cutting-edge technologies to increase kiln efficiency.
Land Degradation	Landscapes are disturbed by the mining of limestone and other raw materials.	Moderate	After mining, carry out plans for land reclamation. Reduce the footprint of the quarry by using effective extraction techniques.
Water Pollution	Water resources in the area may be depleted by the processing and dust suppression uses of water. Additionally, contaminants may be present in wastewater discharge.	Moderate	Employ water-conserving technology Utilize recycled process water . Before discharging, treat wastewater
Biodiversity Loss	Plant and animal life may be harmed by habitat damage brought on by dust deposition and quarrying.	Moderate	Reduce habitat disruption when quarrying; put dust control measures in place; and replace damaged areas with natural plants.
Dust Emissions	The processing, grinding, and transportation of suspended particles can have an adverse effect on respiratory health and air quality.	Moderate	Use dust suppression methods (water sprays) to automate and enclose material handling activities.
Energy Consumption	Greenhouse gas emissions are a result of the energy-intensive cement production process.	High	Invest in production processes and kilns that are energy-efficient, and whenever feasible, use renewable energy sources.
Solid Waste Generation	Waste items that need to be disposed of properly include kiln dust and leftover quarry material.	Moderate	Examine the possibilities for utilizing kiln dust in the manufacturing of cement or for other purposes. Implement plans for responsible disposal of waste.
Noise Pollution	Noise disturbances resulting from transporting, grinding, and crushing operations may affect neighboring populations.	Moderate	Use equipment with noise reduction technology and adopt operational procedures to reduce noise (e.g., crushing during off-peak hours)

Environmental impact of cement industry

The cement industry has a significant environmental impact, primarily due to the following factors:

Greenhouse Gas Emissions: The chemical conversion of lmanufacture. This is a big greenhouse gas emitter. Cement kilns emit CO2 by burning fossil fuels.imestone into clinker releases CO2 during cement .

Energy Consumption: Cement manufacture demands a lot of energy, notably clinker formation at high temperatures. Use of fossil fuels like coal increases energy consumption and emissions.

Raw Material Extraction and Processing: Degradation of ecosystems, loss of biodiversity, and disturbance of habitats can result from mining and the extraction of raw materials (such as clay and limestone).

Air Pollution: Particulate particles, sulfur dioxide (SO2), nitrogen oxides (NOx), and volatile organic compounds (VOCs) are among the air pollutants released during this cement manufacturing process. Air pollution, which these pollutants exacerbate, is harmful to both people and the planet [17].

Water Consumption: Cement production involves significant water consumption, both for raw material extraction and in the production process itself. Excessive water usage can lead to local water scarcity and negatively impact aquatic ecosystems.

Waste Generation: Cement production generates by-products and waste, including dust, ash, and kiln slag. The management and disposal of these materials can pose environmental challenges.

Transportation: The transportation of raw materials, clinker, and finished cement products contributes to carbon emissions, especially if long distances are involved.

Various techniques and technologies may be applied to reduce the environmental effect of the cement industry.

Alternative Raw Materials and Fuels: Lessening the load on conventional resources and the environment is possible via the use of biomass and other alternative fuels and raw materials.

Energy Efficiency: Integrating energy-efficient technology and practices in production may decrease energy use and related emissions.

Carbon Capture and Storage (CCS): CCS systems may be used to collect and retain CO2 emissions generated in the cement production process.

Use of Sustainable Practices: Employing sustainable mining practices, water recycling, and reclamation of mined areas can help reduce the environmental impact of raw material extraction.

Recycling and Reuse: Encouraging the use of recycled materials in cement production and finding ways to reuse by-products can contribute to waste reduction.

Emission Standards and Regulations: Stringent environmental regulations and emission standards can drive industry-wide adoption of cleaner technologies and practices.

5. RESEARCH AND DEVELOPMENT

Investing in research and development for greener cement technologies, such as low-carbon or carbon-neutral cements, can help in the long-term transition to more sustainable practices. Overall, addressing the environmental impact of the cement industry requires a combination of technological innovation, regulatory measures, and industry-wide commitment to sustainability.

6. CONCLUSION

In India, the EIA (Environmental Impact Assessment) of the cement industry is governed by Acts and regulations. The efficacy of the Environmental Impact Assessment (EIA) can only be comprehended when accurate data and its analysis are provided by the industry, and policymakers acknowledge the accuracy of the data supplied at the grassroots level. Decisions should then be made appropriately to limit the impact of industrial activities. Thus, an industry must thoroughly consider all ways to reduce the environmental effect of a proposed project. Furthermore, the industry must commit to adhering to the regulations set by both the State Government and the Central Government of India, which are periodically enforced. Subsequently, a formal request may be sent to the appropriate authority for the approval of the planned project. The theoretical framework prioritizes a collaborative and multidisciplinary approach, incorporating the cooperation of environmental specialists, engineers, social scientists, regulatory agencies, and impacted populations. The purpose is to strike a balanced equilibrium between economic advancement and environmental and social well-being, while also following legal requirements and ensuring transparency in decision-making.

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