



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 12, December 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

Use of Precast Concrete to Minimize Environment Impacts in the Construction Industry

Mary Milani Chamindika Kaviratne

Master Student, Faculty of Graduate Studies, University of Colombo, Sri Lanka

ABSTRACT: This study aims at a precast concrete construction method that can be used as a solution for adverse impacts caused by the construction industry instead of the conventional cast-in-situ method. The objectives of this study are to identify environmental impacts caused by the construction industry and identify the environmental benefits of precast concrete construction instead of cast-in-situ construction. Collected primary data from observations from construction sites. Observation includes underwater precast foundation unit constructions, precast bridge deck beam constructions, precast retaining wall constructions, precast sewer pipe constructions and precast highway beam unit constructions. And secondary data was collected from previous research findings, articles and technical reports. Using the cast-in-situ method contributes to more dust, noise and natural resource depletion like water, soil and removal of vegetation cover in site clearance. But when tending to these constructions as precast units all units can be cast in one separate place and transported to the construction site and placing can be done. This construction site can be used to construct multiple precast unit requirements for multiple construction sites. Therefore all the noise, dust, removal of vegetation cover and water and soil degradation are limited to only one separate precast yard. And precast can be transported at the night time and it is a solution for traffic congestion. It will save the burning of fossil fuels and contribute to a decrease in climate change. Precast construction saves using natural materials such as timber for formwork. Mainly iron formworks use for precast unit constructions that can be reused several times.

KEYWORDS: Precast, Cast in situ, Environment impacts, Construction, minimizing

I. INTRODUCTION

Background: Due to globalization and the development of Technology, the construction industry is increasing day by day. The construction industry is not an environmentally friendly industry that affects the entire lifecycle of development. The development of the construction industry improves social and economic growth, and it enhances the standard of living as well as the quality of life which also contributes to the deterioration of the environment.

This construction industry is a major contributor to greenhouse gas emissions which plays a major role in climate change. Estimates suggest that the construction industry contributes 25% to 40% of the world's carbon emissions and also that emissions from commercial buildings can grow up to 1.8% in 2030 (Mariah, 2019). Every Construction project results in the emission of carbon dioxide, methane, and other waste products that pollute the air and are believed to contribute to global climate change. The operation of heavy machinery in mining projects that harvest raw materials from the Earth is the most detrimental part. The global cement industry contributes approximately 5% of global carbon dioxide emissions (Worrell, 2001).

The construction materials such as cement, steel, wood, paints and machinery are major contributors to the adverse environmental impacts. These materials and the processes of the construction can cause groundwater and surface water depletion, air quality degradation, noise pollution, land and soil degradation, biodiversity degradation, loss of vegetation cover and major bad impacts on the environment.

But all these negative impacts on the environment increase when the construction process goes into the site as in situ construction. Because of the process of cast-in-situ construction, all the construction stages are conducted on the same site. But if these parts of the construction can be cast in a separate specific yard and transported to the site where it needs to fit and the fittings will minimize most of the environmental impacts that can cause by the construction industry.

Problem Statement: In today's world, the construction industry has become a major contributor to environmental effects. Therefore it is important to know adverse environmental impacts caused by the construction industry to minimize environmental effects. And also the benefits of using precast concrete methods to minimize the adverse environmental impacts caused by the construction industry are discussed in this study.

Objective: The main objective of this research is to study how precast concrete minimizes the environmental impacts caused by the Construction industry.

Therefore the other sub-objectives are as follows

- Identify adverse Environment impacts caused by Construction Industry
- Identify the Environmental benefits of precast concrete, compared with in-situ concrete.

II. LITERATURE REVIEW

Sanket Suresh Petkar, (2014) made research on the Environmental impacts of Construction Materials and Practices. A large part of the environmental damages like climate change, wildfires, tsunamis, ozone layer depletion &, etc are caused by the contribution of the construction industry. Cement generates CO₂ and CO₂ generated through transporting these materials and processing these materials. The environmental impact of the construction industry is larger in developing countries than in developed countries. Concrete and steel are the main construction materials that contribute the climate change by burning fossil fuel, energy usage and generating noise, dust, and toxic waste.

Ya Hong Dong, Lara Jaillon, Peggy Chu, C.S. Poon, (2015) made comparing the carbon emission of precast and cast in situ construction methods with the use of high-rise private buildings reveal that the entire residential apartment is considered, the reduction of carbon emission due to precast concrete is 0.31%. In pre-casting, steel formwork is used rather than timber formwork. Steel, as a recyclable and reusable material, performs better than timber formwork.

Alfred A. Yee, P. E., (2001) from their research based on the Social and Environmental Benefits of Precast Concrete Technology revealed that intense activity in conventional in situ works of construction sites causes untidiness, noise, dust, air pollution, traffic congestion and other inconveniences. This will be a disturbance to the people who live near construction buildings and aggravation motorists driving through the construction area. Currently, 50% of the world's population lives in large cities and by the year 2050, it will be 67%. All precast concrete items can fabricate under controlled conditions with sufficient storage spaces. Workers, materials, equipment and other essential items can easily transport to a prefabricated site.

Formwork for precast items can be made out of steel and fiberglass molds that can be economically reused and extensively repetitive. The saving of construction materials will be a result of the saving of natural resources from which these construction materials are derived. And also saving some energy resources.

Belinda Lopez-Mesa, Angel Pitarch, Ana Tomas, Teresa Gallego, (2009) Their research on the Comparison of Environmental impacts of Building Structures with in situ cast floors and precast concrete floors found that the smallest hollow core slab well performed in its structural strength than normally dimensioned in situ floor units. The precast concrete floor has a higher impact compared with in situ cast floors. This study shows environmental impacts are lower in precast concrete floors is a good reason aside from the good quality and easiness of installation than in situ cast concrete floors to choose precast floors for seven-story buildings. But the precast concrete floors are 17.91% more expensive than in situ cast floors. Because of this reason, the advantages of precast concrete floor units are not taken into consideration in the market share of residential buildings.

L.E. Harris, (2009) from his research on Artificial Reefs for Ecosystem Restoration and Coastal Erosion Protection with Aquaculture and Recreational Amenities. This is done by precast concrete blocks made as artificial reefs and submerged in the sea for the above-mentioned purposes by acting that unit as an artificial reef. Natural occurrences like storms and climate change, as well as human activity, can harm and stress these delicate systems. He used precast units for this research because of the easy and economical precast fabrication unit with a patented mold system, deployment is easy because it can float with a lift bag, the unit can be able to anchor to the bottom, and Can be designed as a custom as a habitat of marine species.

III. METHODOLOGY

Justification of Methodology: Secondary data was collected from previous research and other related articles, and technical reports about the precast constructions. Primary data was collected by the observation of sites with precast concrete construction. The comparison of the environmental impact minimization of precast concrete with the cast in situ construction was done by using site observation as an example. A summary of the key findings is taken as the conclusion of this research.

Overview of research methods: The analysis of environmental impact minimization of precast concrete construction with the cast in situ construction was done by comparison. This comparison mainly persuades the importance and the adverse environmental impact minimization of precast concrete construction. And the Secondary data helps to emphasize the adverse environmental impact of the construction industry and the environmental impact minimization from precast concrete constructions.

IV. RESULTS

Findings from previous research, articles and technical reports.

Adverse Environmental Impacts Caused by Construction Industry:

Air pollution - Construction plants and vehicles such as bulldozers, barkers, excavators, and breakers emit carbon dioxide, carbon monoxide, nitrogen oxides and other hydrocarbons into the atmosphere. From global cement production industry estimates that 5% of carbon dioxide emissions by 50% from the chemical process, and 40% from the burning of fossil fuels (Subramanian, 2016). During the construction phase, land clearing and demolition also contributes to air pollution. Paints, oils, thinners, glues and plastic generate noxious vapors. PM10 is another type of construction dust from cement, silica and wood that can be classified.

Water pollution - Diesel and other fossil fuels, paints, solvents, and toxic chemicals can mix with water bodies such as rivers, lakes and oceans. These pollutants can harm to surrounding ecosystem including damage to aquatic life and groundwater resources and causes serious damage to the entire ecosystem of animals, plants, bacteria and fungi. Even without direct discharge, precipitation and stormwater can sweep away these pollutants as runoff and deposit them in surface water which carries to groundwater or causes soil pollution. Clearing the site for construction purposes and removing vegetation cover also causes depletion of groundwater resources. And also clearing land causes damage below ground level by construction sediments. Fine sites can come from loose soil pollutes waterways and damages aquatic habitats. Some underwater constructions, constructions done in wetlands significantly contribute to water pollution directly.

Noise Pollution- Caused by a variety of machines used in demolition, excavation, construction, and landscaping. And also lifting and unloading materials for and construction workers. This can harm the members of the public who live nearby by affecting levels of stress, sleep disturbance, high blood pressure or hearing disturbances. This can cause many environmental impacts such as disturbing the natural cycles of animals, birds and other livelihoods. This affects the distinction of species and the disturbance of migratory patterns by reducing the balance of biodiversity.

Land Pollution - Construction waste is one of the main contributors to industrial waste. Most materials used in construction projects are never reused. Some demolished wastes from construction sites and concrete, steel, metal, steel, gypsum, plastic and wood are some construction wastes mixed with soil. These material particles can mix with soil can cause soil degradation. Removal of topsoil for construction projects and excavations and embankment reduces the bearing capacity of the soil. The removal of vegetation cover for the site clearance phase in the construction project reduces soil fertility. And nailing bore holing, deep foundation excavation reduces the strength of the soil layer which causes landslides and some failure of soils

Habitat loss- Noise, air, and water pollution contribute directly to the habitat loss of flora and fauna by including habitat fragmentation and degradation. Fragmentation refers to the division of wildlife due to roads and industrialization. Destruction, fragmentation, and degradation all leave permanent scars on the land, therefore it's critical to think about wildlife before starting a new project.

Climate Change - Not only in massive construction projects but also in small-scale private construction projects equally contributes to climate change impact. For example, the mining of resources for buildings, the manufacturing of goods for furnishing, transporting vehicles for construction activities, the electricity for use, and generating energy for construction purposes by the burning of fossil fuels are major factors for climate change.

Deforestation - As a result of the increasing growth of the construction industry occurred the insufficient land for the construction project. And massive reservoir projects cause deforestation. There reducing forest cover becomes a major threat. Removing vegetation cover and clearing forest, cutting down trees, and clearing mangrove cover directly affect the depletion of air and water quality, habitat loss, degradation of biodiversity and many more bad impacts for flora and fauna as well as for mankind also. An unbalanced water cycle can cause droughts as well as floods.

Natural resources depletion - Stone, limestone, timber, and sand are widely used natural resources in construction projects. Contractors extract these natural resources by mining and cutting down trees. The development of the construction industry causes the over-extraction of these natural resources for construction purposes. Therefore it doesn't have enough time to generate these natural resources than rapid extraction of these resources. This over-extraction causes the depletion of natural resources and it will affect badly long-time development of the construction industry.

What are the environmental benefits of Precast concrete constructions compared with cast-in-situ constructions?

Unlike conventional cast-in-situ construction methods, precast constructions are cast in another place and transported to the construction site and fit the relevant place. Therefore only one place can cast precast units for multiple construction sites. It reduces air pollution, noise pollution, water pollution, and soil pollution and all these environmental degradations are limited to one precast yard. And also when clearing the vegetation cover and soil degradation is limited to one place where precast units are fabricated.

Untidiness, dust, noise, air pollution, traffic congestion, and other inconveniences resulting from intense activity at the construction site (due to the nature of conventional in situ works), all of which are constant annoyances to people living in nearby buildings, as well as aggravations to motorists driving through the area. Prefabrication of structural and architectural concrete products is done at more accessible sites distant from congested city centers in precast concrete construction. Wall panels, beams, columns, slabs, stairways, architectural façades, and other components are produced in locations with adequate operational and storage space under controlled conditions. These prefabrication sites are easily accessible to workers, materials, equipment, and other goods. When the structural and architectural components are finished, they are temporarily stored before being transported to the project site to be erected. These final components only make one trip through busy city traffic to the construction site. If these components had been manufactured on-site, however, repeated journeys to the site during working hours would have been required to transfer people, materials, and equipment, as well as the disposal of debris, to achieve the same results. Furthermore, precast components can be delivered during off-peak hours, such as late at night, when vehicular traffic is at its lowest volume. To avoid the requirement for outside gondolas or scaffolding and painting on the job site, exterior façade units can be pre-painted at the pre-casting factory.

This decrease in the usage of materials such as cement, stone, sand, steel, timber, formwork, and other ingredients results in a large reduction in energy used in the mining, manufacturing, and processing of these materials, as well as a reduction in air pollution associated with their use. Using fewer construction materials useless traffic impacts highways and reduces the number of transporting trips. It helps to reduce maintenance costs and it will help to reduce air pollution.

Climate change is causing the melting of polar ice caps, increasing sea levels, atmospheric storms, floods, droughts, and other adverse repercussions, according to scientists who have warned of the impending catastrophic impact of weather changes caused by greenhouse gases. The precast concrete construction method reduces exposure to greenhouse gasses and contributes to the lessening of climate change impact.



Precast concrete walls act as a sound barrier between the outdoors and the interior. Buildings are being built closer together and near noise sources such as highways, railways, and airports as land becomes scarce. When compared to wood or steel frame construction, the higher bulk of concrete walls can minimize sound penetration by nearly 80%. Although sound will get through the windows, a concrete structure is typically two-thirds quieter than a wood or steel



frame. Precast concrete panels can also be used to create sound barriers between buildings and highways or between industrial and residential areas.

The precast concrete construction method minimizes the waste generation on-site and reduces pollution and also it reuses dust generation. This precast construction is also suitable for underwater constructions and bridge constructions. It reduces the harmful damage to water resources. If the bridge construction for underwater construction doing as an in-situ construction method it polluted the water resources and is harmful to the fishes and plant species, mixing concrete and other harmful materials with water. And Precast construction method is also applicable to the marine environment which minimizes the negative impact of the construction industry and protects marine species, coral reefs, and the whole biodiversity of the marine environment.

Observations from Construction Sites:

Table 1: Observations from construction sites

	Construction unit	Project	Environmental Benefit by constructed as a precast unit
1	Underwater foundation Unit Construction for quay wall (Caisson) 	Colombo Port Expansion Project – South Container Terminal	<ul style="list-style-type: none"> • Minimizing harm to the marine ecosystem by the mixing of cement, concrete, and other chemicals with seawater • Protect lagoons and estuaries from harmful construction materials and chemicals
2	Precast Bridge deck construction 	Widening of Bridge over Kirulapana Canal – Nawala Road	<ul style="list-style-type: none"> • Minimizing damage case to aquatic habitat, aquatic species and the construction materials mixing with water • Minimize the sound of the construction of the wetland ecosystem. • Minimizing the carbon dioxide emission by lessoning the traffic conjunction.

3	<p>Precast retaining wall construction</p> 	<p>Colombo Port Expansion Project – South Container Terminal</p>	<ul style="list-style-type: none"> • Fewer formwork units save natural materials by reusing formworks by several times • Save soils and groundwater bodies by penetrating cement particles • Save time and energy use for dewatering when the water level is close to the ground level
4	<p>Precast concrete sewer pipe construction</p> 	<p>Colombo Port Expansion Project – South Container Terminal</p>	<ul style="list-style-type: none"> • The possibility of mixing harmful construction material with soil and water is low • Minimize noise pollution • Minimizing damage caused to the marine habitats including corals, fish and other marine species
5	<p>Precast Beam units used for highway construction</p>	<p>Southern expressway</p>	<ul style="list-style-type: none"> • Lowering carbon dioxide emission by



	development project	minimizing traffic conjunction <ul style="list-style-type: none"> • Less waste generation • Minimizing pollution of soil and water by cement and other construction chemicals
--	---------------------	---

V. DISCUSSION

Using the Precast concrete construction method instead of Cast-in situ concrete construction methods can reduce adverse environmental impacts caused by the construction industry. Because precast constructions are cast in separate yards away from the construction site and transported to the construction site and placing can be done. This reduces noise pollution, soil pollution, water quality degradation, air quality degradation and removal of trees and vegetation cover which are harmful to the environment in many ways. All the bad impacts are limited to only one separate yard and not distributed in all construction sites while cast-in situ constructions contribute to all construction sites.

And in the other hand when cast-in-situ constructions are carried the transporting of vehicles for construction purposes is high compared with precast construction. Because transporting vehicles is essential for material transportation, labor transportation by generating more CO₂ in the environment which will directly affect climate change impact. But when using the precast method all the precast units need for construction can transport to the construction site during the night time. Lessening fuel consumption, therefore lessening carbon dioxide emission and other greenhouse gas emissions.

When talking about material efficiency and saving materials like timber, the precast construction method contributes a more environmentally friendly method than cast-in-situ construction. Because when conventional cast-in-situ construction methods carried form - working done by timber. But precast units are normally cast in steel or iron moulds which can be reused several times. Therefore, precast construction is the answer to natural resource depletion and material efficiency.

On the other hand, precast generates low waste compared with cast-in-situ constructions. This helps to reduce water quality degradation, air pollution, and degradation of soil. This helps to save the entire ecosystem from construction waste.

VI. CONCLUSION

Using the precast construction method instead of using the cast-in-situ method minimizes the negative impacts caused to the environment in the construction industry. The precast construction method minimizes air pollution, noise pollution, soil degradation, water quality degradation, biodiversity degradation, habitat losses and many other negative environmental impacts caused by the construction industry. Using precast units for construction minimizing vehicular traffic congestion and contributing harmful carbon dioxide emissions to the atmosphere gives a good solution to the Climate change problem. And this precast method saves natural resources by lessening material depletion. Therefore it will conclude that using precast concrete can minimize the adverse environmental impacts caused by the construction industry.

REFERENCES

- [1] José, M. C. T. (2005). 'Construction site environmental impact in civil engineering education. *European Journal of Engineering Education*, 30(1), 51-58
- [2] Petkar, S. S. (2014). *Environmental Impact of Construction Materials and Practices*. National Institute of Construction Management and Research, India.
- [3] Priya, P. K., & Neamitha, M. (2018). A Review on Precast Concrete. *International Research Journal of Engineering and Technology*, 05(1), 967-971.
- [4] Mourya, M., Chauhan, S. G., & Mathur, A. K. *Environmental Impact of Precast Construction*. Department of civil engineering, Rajasthan technical university, Kota
- [5] Horváth, H. S., & Szalay, Z. (2014). Environmental assessment of a precast concrete building stock in a time perspective. *Environmental Engineering and Management Journal*, 13(11), 2797-2804.
- [6] Dong, Y.H., Jaillon, L., Chu, P., & Poon, C. S. (2015). Comparing carbon emissions of precast and cast-in-situ construction methods – A case study of high-rise private building. *Construction and Building Materials*, 99, 39–53.
- [7] Jaillon, L., & Poon, C.S. (2007). Advantages and Limitations of Precast concrete construction in High Rise Building: Hong Kong Case Studies. *CIB World Building Congress*, 2504-2514.
- [8] Alfred A. Yee, P. E. (2001). Social and Environmental Benefits of Precast Concrete Technology. *PCI Journal*, 46(3), 14-19.
- [9] Mesa, B.L., Pitarch, A., Tomas, A., & Gallego, T. (2009). Comparison of environmental impacts of building structures with in situ cast floors and with precast concrete floors. *Building & Environment*, 44, 699–712.
- [10] Wacker, J. M., & Hieber, D. G. (2005). *Design of Precast Concrete Piers for Rapid Bridge Construction in Seismic Regions*. Department of Civil and Environmental Engineering, University of Washington, Washington.
- [11] Harris, L. E. (2009). Artificial Reefs for Ecosystem Restoration and Coastal Erosion Protection with Aquaculture and Recreational Amenities. *REEF Journal*, 1(1), 235-246.
- [12] Ramli, M.F.S., & Gunasekanran, A. (2016). The Effectiveness Of Concrete Artificial Reefs of Pulau Payar, Kedah. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 10(7), 64-70.
- [13] Enshassi, A., Kochendoerfer, B., & Rizq, E. (2014). An Evaluation of Environmental impacts of Construction Projects. *Construction Engineering Magazine*, 29(3), 234-254.
- [14] Kim, N. H., & Mun, J. I. (2008). A Study on the Erosion Control of Coastal Beach by an Artificial Reef', *KSCE Journal of Civil Engineering*, 12(4):227-235.
- [15] Pacheco-Torgal, F. (2014). Introduction to the environmental impact of construction and building materials. *Eco-Efficient Construction and Building Materials*, 1–10
- [16] Buxton, M., Lumb, J. M., Pears, A., Wilson, C., Nelson, L., Giese, M., & Wishart, F. (2000). *Environmental issues and their impact on Metropolitan Strategy*, Melbourne Metropolitan Strategy Project, Melbourne.
- [17] Han, D., (2012), *Concise Environmental Engineering*, PhD & Ventus Publishing ApS, Bristol, UK.
- [18] Tradesman International, (2017), *Construction Industry: Projected Fast Growth into 2020*. Retrieved from <https://www.tradesmeninternational.com>



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details