

State of Art Review on Evaluation of Flyash-Cow Dung as a Partial Replacement in Concrete

Shailendra Mishra ^a, Ashwini Choudhary ^b

^a *Department of Electrical Engineering, Crescent Engineering School, Thiruvananthapuram, India.*

^b *Department of Electrical Engineering, Crescent Engineering School, Thiruvananthapuram, India.*

Abstract

The second most used material in the world, cement is becoming more and more in demand as a result of causes like industrialization and population expansion. Although cement provides strength and durability to structures, its production emits a large amount of CO₂, approximately 0.8-0.9 tons per ton of cement. This has led to the depletion of the ozone layer, environmental pollution, and the greenhouse effect, as well as high costs and the release of large amounts of heat during production. To address these issues, it is necessary to find a binding material for concrete that is environmentally friendly and releases less energy during cement production. The goal of this study is to find the ideal percentage of replacement cement that will provide concrete the required strength and durability by using fly ash and cow dung (FA-CD) in place of some of the cement. CO₂ emissions during the cement production process can be decreased by lowering the amount of cement in concrete. In this paper, a literature review has been conducted on FA-CD, which has seen significant growth in research in both theory and practice. The review identified key articles and authors, and the findings are expected to expand the scope of research in FA-CD in the future.

Keywords: Building Material, Concrete, Fly ash Concrete, Cow Dung Concrete, Sustainable Development.

Introduction

Waste material is any leftover portion of a product or substance that is thrown away because it is not worth much to the owner. The term "waste" usually refers to something that is useless. However, if suitable management practices are followed, the majority of waste materials can be used in a range of various industrial processes including energy production through incineration. For society to have a sustainable future, waste management is absolutely essential. Although it has been practiced since the beginning of human civilization, it wasn't until a century ago that it became a subject of study and debate. There are two possible forms of the waste material: solid and fluid (Shao et al., 2000). Institutional, residential, commercial, municipal, agricultural, treatment plant, industrial (processing), and industrial (non-processing) wastes are the different categories of waste material sources. River sand has long been the main source of fine aggregate, but the concrete industry's excessive usage of it is raising questions about its supply. As a result, restrictions on mining river sand have been imposed. The construction industry heavily relies on cement and other natural resources such as water and aggregates, making it crucial to find high-quality and environmentally friendly materials that require less energy during production. Researchers have looked into using a variety of pozzolanic materials, including fly ash, lime, silica fume, GGBFS, and rice husk, to lower the amount of cement in concrete (Siddique & Klaus, 2009). Concrete is becoming more and more popular as a building material as a result of growing demands for affordable and environmentally friendly structures brought on by factors including population increase, industrialization, and infrastructure development. Concrete uses cement as an efficient binder and has a number of benefits over other materials, including as strength, cost-effectiveness, and temperature resistance. The World Health Organization estimates that the cement sector contributes around 5% of all CO₂ emissions, making cement manufacture an energy-intensive and harmful process. Furthermore, a high temperature of roughly 1500 °C is needed for cement manufacture, which results in a large energy consumption. As a result, attention must be paid to materials that are of superior quality and have lower production energy requirements. Researchers have looked into using naturally occurring elements like fly ash and cow dung as alternative binders in concrete to partially replace cement in order to lessen the environmental impact of cement production (Gómez-Soberó, 2002). The use of fly ash and cow dung ash in concrete is reviewed in this article.

Fly Ash

FA is the pozzolanic substance that is most widely utilized worldwide. FA flaming trash is a finely separated waste that forms when powder coal is consumed, altered by vent gases, and gathered by an electrostatic precipitator. Its construction differs depending on the type of separator, evaporator load, fuel type consumed, etc. FA contains spherical, sparkling particles that range in size from 1 to 150 microns and is thought to be superior to Portland cement. The most well-known and superior substance among the most widely used pozzolans is flyash. The amount of fly ash fuses a spectacular amount of silicon dioxide (SiO₂) (both amorphous and crystalline), calcium oxide, and iron (CaO and Fe₂O₃), while the section of fly searing flotsam and jetsam varies completely depending on the coal's source and expenditure. Flyash material is collected by electrostatic precipitators after solidifying while suspended in the vapour gases. Fly ash has been established and is widely utilized as a mineral admixture or additional setting ingredient in bond to give concrete particular qualities for field use. As seen here, fly ash can be used with cement in three different ways: Flyash particles are for the most part round fit as a fiddle and range in size from 0.5 µm to 300 µm. the state of the molecule enhances the stream capacity and lessen the water necessity (Islam et al., 2017). Flyash is of pozzolanic characteristic happening because of consuming the pounded coal in the warm power plants. Application of Fly Ash shown in Fig. 1.

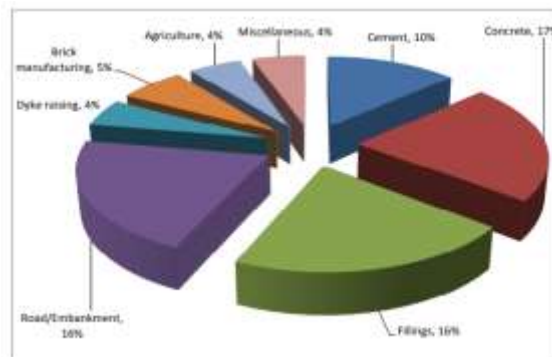


Fig. 1: Application of Fly Ash

Rather than being a part of concrete or fine aggregate, fly ash is utilized as an addition in the production of cement from a development perspective. It can also be utilized as a filler for dams and retaining walls, as well as a base and sub-base material for high-speed construction. Additionally, it is employed in the manufacturing of lightweight building materials (Ganjian et al., 2009).

Cow Dung

Cow dung is a waste product of herbivorous animals that is broken down by bacteria in the animal's digestive system. Cow dung contains mainly salts, oxygen carbon, nitrogen, hydrogen, phosphorus, cells sloughed off during digestion, mucus, cellulose, lignin, urea, and hemicellulose. The addition of cow dung to concrete has been utilized historically and has some advantages. When only 10% is applied, cow dung ash concrete can work well for several wall and floor applications; but, as the proportion rises, more water is needed. Nonetheless, it has the benefit of being lightweight, which makes it a practical building material. According to recent research, cow dung can serve as an extra binder and enhance workability and durability. Cow dung's physical characteristics:

1. It has a large size or volume.
2. It contains a significant amount of ash.
3. After burning, it has a low amount of volatile material.
4. The carbon content is low.
5. The burning ratio is also low.

Literature Review

Numerous studies have investigated the quantity of emissions and their effects on the environment, as well as energy consumption (Ismail & Al-Hashmi, 2008). Some studies have taken the lead in creating cost-effective and environmentally friendly concrete.

In Deo et al., (2016) research on fly ashes, increasing ground fineness by 52% led to a 13% strength increase, while increasing native fineness by 64% resulted in a 77% strength increase. Grinding coarse fly ash did not significantly improve its reactivity. The authors contend that when fly ash is combined with lime, the power of the lime's reactivity becomes more significant. The "role of supplementary cementing materials and super plasticizers in reduction of greenhouse gas emissions" was examined by Zhou et al., (2021), who highlighted a number of strategies to lower CO₂ emissions, particularly in developing nations where infrastructure development uses a lot of cement.

In order to evaluate the mechanical qualities of concrete mixes that partially replaced fine aggregate (sand) with class F fly ash, Siddique (2021) carried out an experimental investigation. The percentages of replacement by weight were 10%, 20%, 30%, 40%, and 50%. The results showed that the compressive strength (CS) rose as the fly ash % rose.

The first phase of a project to look into the usage of significant amounts of high lime fly ash in concrete was detailed by Sarra et al., (2021) (Ismail & Al-Hashmi, 2008). They tested replacement ratios ranging from 0% to 50%, using fly ash to partially replace cement and fine aggregates. According to the study, the best CS was produced by concrete that contained 25–35 percent fly ash.

In research by Gupta et al., (2021), unprocessed low-lime fly ash was used in place of sand in foamed concrete. The study found that the spread obtained on fly ash concrete was up to 2.5 times higher than that of sand mixtures for a given plastic density. Despite the fact that the early age strengths of fly ash and sand concrete were similar, the values by day 28 differ greatly depending on density. By contrast, the strength of fly ash concrete was more than three times higher than that of sand concrete. Additionally, fly ash foamed concrete's strength increased significantly at 56 and 180 days, reaching values up to 1.7 and 2.5 times higher than the 28-day strength, respectively, but the strength of sand mixtures was constant after 28 days (Anwar et al., 2000).

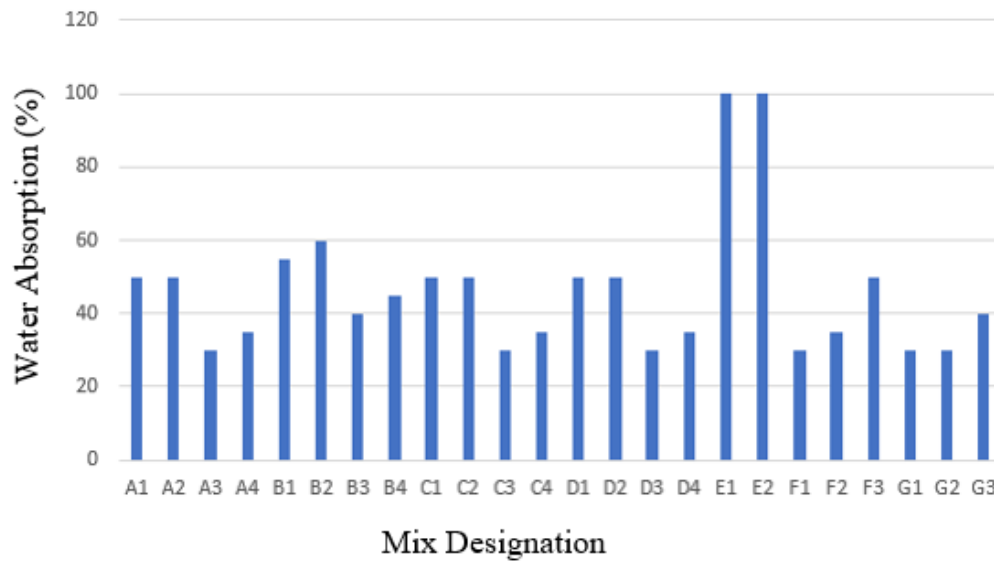
Review Based on Cow Dung Concrete

In the study, Gupta et al., give a summary of the several uses and possible advantages of cow dung as a bioresource for sustainable development. The experts talk about the makeup of cow poo and how it might be converted into biogas, which could be used as an energy source. Because it includes vital elements that can increase soil fertility and boost crop yields, they also look at its use as fertilizer. Additionally, cow dung can be used in the production of biofuels, such as bioethanol and biodiesel. Cow dung can also be used in construction materials, such as bricks and plaster, and as a source of raw material for paper production. The study emphasizes the potential of cow dung as a

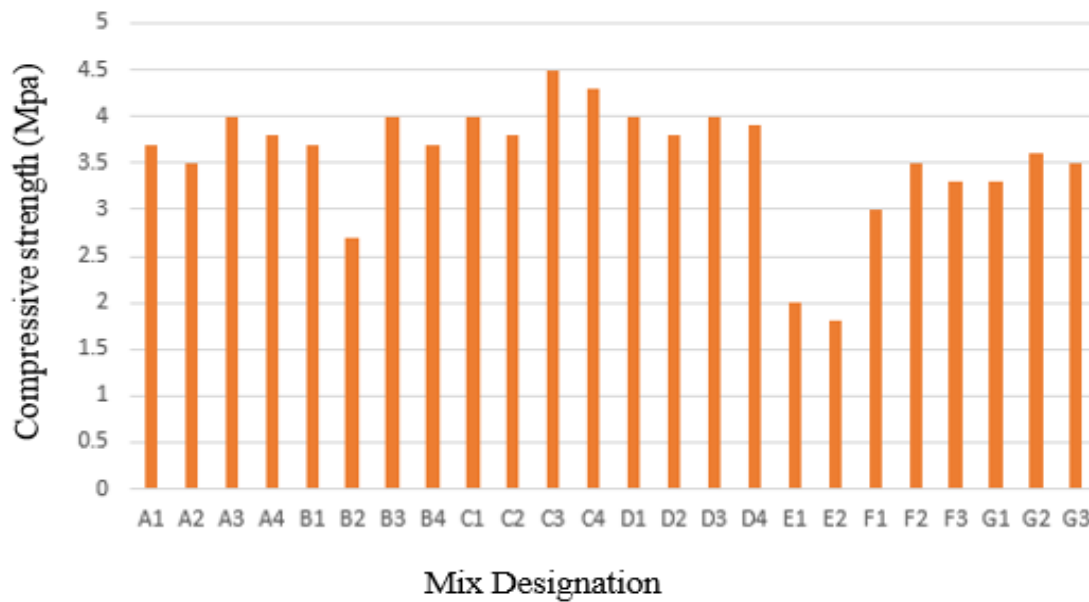
valuable bioresource that can contribute to sustainable development in various sectors, such as agriculture, energy, and healthcare. The researchers suggest that promoting the use of cow dung in these sectors can have significant environmental, economic, and social benefits.

Discussion

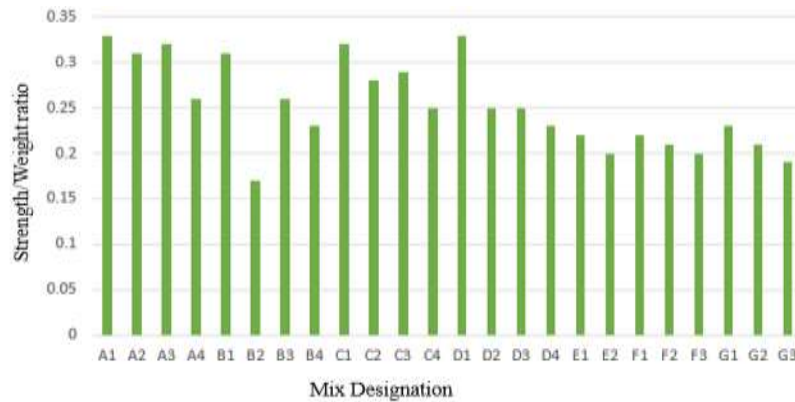
We determined from the review that cow dung and fly ash might be used as substitute materials for brick construction. The goal of this study is to expand the use of fly ash and cow dung in concrete production (Patel et al., 2015). Because of their capacity to absorb huge amounts of fly ash, the use of fly ash and cow dung ash in concrete has emerged as a significant sustainable building resource. An overview of the benefits of adding fly ash to concrete, including improved workability and durability, is given in this publication. The lightweight nature of cow dung ash makes it a valuable building material. Properties of Fly Ash and Cow Dung shown in Fig. 2.



(a)



(b)



(c)

Fig. 2: Properties of Fly Ash and Cow Dung

By using the existing binding material, Environmental pollution increases, the Disposal problem of artificial waste decreases and the green concept increases. Moreover, these Fly ash and Cow dung cost less than conventional materials.

Conclusion

The fast development of the construction industry has prompted civil engineers to seek more efficient and long-lasting alternatives beyond the confines of conventional concrete production. Concrete production from a variety of waste materials has advanced significantly as a result of numerous experiments. An overview of recent studies on the materials and processes utilized in the production of concrete is given in this publication. The current research project also involves experimental studies to examine the chemical and physical characteristics of fly ash cow dung and its potential for use in the production of masonry concrete. Additionally, the researchers looked into how adding FA-CD additives in various amounts affected characteristics like compressive strength and water absorption %. Through a combination of additives with and without sand in FA-CD concrete, an optimal mix was achieved. The strength, ductility, energy absorption capacity, and stiffness of the FA-CD concrete were subsequently examined and compared to those of traditional concrete.

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