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Review On Utilization Of Wastewater Sludge And Fly Ash In Cement Concrete

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Abstract: Sludge refers to the residual, semi-solid material left from industrial wastewater, or sewage treatment process. It is an unavoidable byproduct of wastewater treatment which creates problems in disposal. Increasingly, strict environmental control regulations have resulted in limitations on the disposal of sludge. The organic elements of sludge are decomposed with time but the inorganic elements can't be de-composed with time and also affects the properties of soil and improves its fertility. Fly ash is a fine particulate material generated by the disintegration of bitumen materials and coal in power plants. The utilization of Fly ash in cement concrete as partial replacement of cement is gaining importance day by day. In this research, the sludge is collected from the Sewage Treatment Plant (STP) and the Fly ash is collected from the Thermal Power Plant (TPT). In this study we utilized fly ash and wastewater sludge is replaced by 10%, 20%, 30%, 40% and 50% by the weight of fine aggregate and the weight of cement, and conduct the compressive test of concrete to find out the compressive strength. The water cement ratio of 0.55 and 0.45 for M25 and M30 grades respectively.

Index Terms - Wastewater Sludge, Sewage Treatment Plant (STP), Fly Ash, Thermal Power Plant (TPT), Compressive Strength, Fine Aggregate, Cement.

I. INTRODUCTION

Concrete is a basic engineering material used in most of civil engineering structures. Its popularity as a basic building material in construction is linked to its durability, economic use good compressive strength and ability to prepare on construction sites. The ability of concrete to change it into any shape and size due to its plasticity in fresh form and get hardening to achieve strength is particularly useful. However the production of concrete needs natural resources (water, sand, aggregate and cement) whose production is costly due to the energy required. In order to reduce the use of natural content, wastewater sludge and fly ash is used in the production of cement concrete.

Sludge is a byproduct generated during the treatment of wastewater. It is the solid, semi-solid, or slurry residue that remains after the removal of water from sewage or industrial wastewater treatment processes. The composition of wastewater sludge can vary widely depending on the sources and the treatment methods employed. Continuous application of sludge to land without adequate monitoring and control can result in soil degradation. Excessive levels of certain constituents in sludge, such as heavy metals or salts, may negatively impact soil structure, fertility and the ability of plants to thrive. Some components of sludge, particularly certain persistent organic pollutants, may have long-lasting effects on the environment. If not adequately treated or managed, these substances can potentially accumulate over time.

Fly ash is a fine, powdery residue generated during the combustion of pulverized coal in power plants. It consists of mineral particles that are driven out of solidify into spherical glassy particles. During the transportation, storage, or disposal of fly ash, particulate matter may become airborne. This can contribute to air pollution, affecting air quality and potentially causing respiratory issue for nearby population. Improper disposal or application of fly ash to land can result in soil contamination. The leaching of heavy metals and other substances form fly ash can affect soil quality, impact entering the food chain. If the fly ash is not handled and disposal of properly, there is a risk of exposure to harmful substances.

II. OBJECTIVES

1) The main objective of our study is to utilize the fly ash and wastewater sludge in cement concrete and achieve eco-friendly in nature.
2) To overcome the problems which are generated by sludge and fly ash in the environment.
3) To study the effect of wastewater sludge and fly ash in the cement concrete.
4) To investigate the performance characteristics of concrete by partially replaced with sludge and fly ash such as compressive strength.

III. LITERATURE REVIEW

Jamshidi, Mehrdadi N, Jamsidi M. (2011) [1]:-

They conducted study on dry sewage sludge on concrete performances. The dry sludge was replaced by the weight of fine aggregate in the concrete mix. The concrete blocks were prepared with 0%, 5%, 10%, 20% and 30% proportions of dry sludge to the weight of fine aggregate and find out the compressive strength of the samples.

Shayan Pirouz, Seyed mostafa Khezri (2015) [2]:-

They both conducted the study on sludge from filtration plant. The dry sludge was taken as 0%, 10%, 20%, 30%, 40% and 50% replaced to the weight of cement with water cement ration of 0.60.

Daniel de Almedia Limaa, Charles Zulanasb (2016) [3]:-

They investigated that sludge impacts negatively to the environment. They using 5% sludge content in concrete will have a significant impact on sludge amount in the environment.

Shehdeh Mohammad Ghannam (2016) [4]:-

They conducted the study to find a solution for large volume of sludge produced in the wastewater treatment plants in order to decrease the pollution in environment as well as to access the strength of concrete using treated water and tap water. Based on their studies they found that following conclusion-

1) Low organic sludge with organic content 13% can be used as an additive to concrete mix without causing marked reduction in compressive strength. 5% dry sludge by cement weight can be added to concrete mix without introducing any change in mix proportion. However, increasing the percentage of added sludge more than 5% decreased the workability of the mix and subsequently caused a reduction in the slump value obtained. In general, the rate of strength developed for all sludge concrete were lower compared to control mix without sludge.

2) It is good to use sludge the treated water in making concrete mix, because compressive strength of concrete made by tap water, the results show that the average percentage of compressive made by treated water was 92.7%.

A.D. Mandlik (2018) [5]:-

The paper audits that the increasing percentage of sludge by weight of cement, he found that the compressive strength of M20 grade is decreasing after 15% and for M30 grade is decreasing after 10% of replacement. He also conducted split tensile test and found that the tensile strength of concrete is decreasing after 10% for M25 grade and after 15% for M30 grade of concrete.

K.S. Mojapelo et.al. (2021) [6]:-

They conducted the study on dried sludge and replace it by weight of fine aggregate and concluded the following results are given below-

1) The addition of dry sludge influenced the properties of the concrete in the fresh and curing stage.
2) Sand content in concrete can be replaced up to 7.5% with wastewater sludge for structural applications.
3) Wastewater can be used as a curing medium for concrete, thereby minimizing the use of portable water for curing.

IV. METHODOLOGY

1) Collection of raw materials like- Cement, Sand, Coarse Aggregate, Fine Aggregate, Wastewater Sludge and Fly Ash.
2) Perform the various tests on materials.
3) Determine the water content of aggregates, wastewater sludge and fly ash.
4) Preparation of samples for tests having size of 230mm*110mm*70mm.
5) Mix design of concrete for M25 and M30 grades of concrete.
6) Leave them for curing with portable water.
7) Determine the compressive strength after- 7 days, 14 days and 28 days of curing.

V. EXPECTED OUTCOMES

Based upon the previous literature published on this topic, all analysts gave their results on concrete up to 15-20% substitution with sludge content in which compressive quality is expanded up to 10%. In our project we try to utilize more content of sludge in cement concrete and try to make it eco-friendly in nature and reduce the negative impact of sludge on environment.

VI. FUTURE SCOPE

The strength characteristics of sludge concrete can be further studied by the given parameters-

1) Wastewater sludge and fly ash can be replaced by coarse aggregate in concrete.
2) The strength of sludge concrete can be further studied with the use of different water cement ratio and by varying ratio of sludge and fly ash.
3) Modulus of elasticity, creep and other properties of concrete can be analyzed by the conduction of destructive and non-destructive tests.

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