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Potential Utilization of Waste Material for Sustainable Development in construction Industry

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Abstract*: *Billions of waste is produced in the world but the wastes are not properly recycled. Recycling of materials also different issues and it needs more energy. The waste materials are stored in a land also create more amounts of problem and it Leeds to land pollution. The utilization of waste materials in the manufacturing of building is a challenging task. But it is the good solution for disposal of waste materials in the developed building materials. We need to analyze the waste materials first then only we can utilize the materials in the perfect way. Now a day's lot of research is going on in the waste utilization area. This literature study mentioned the various waste materials and how it is used in our real construction field. The waste utilization gave two things. First one is reduction of the pollution and the second is save the natural materials for sustainable development. This paper also shows the betterment results of the waste utilization technique.

Keywords* : *Fly ash, Mechanical properties, Waste Materials, Sustainable development,

I. INTRODUCTION

The basic materials used for construction are Bricks, Cement, Course aggregate, Fine aggregate, and Concrete. For Manufacturing of two tonne of cement it emits two tonne of Carbon dioxide and other green house gases. It affects the environment very heavily and it led to green house effect. The temperature of the earth also day by day increasing due to this green house effect.The developing countries like India having more amounts of industries.

Those industries also send the huge amount of waste by products. The disposals of the waste are a big task for the each industry. The industries need to more concentrate on disposal in a perfect way. If they are disposing the waste in rivers then the water is going to be polluted. But the waste materials are depositing the land also a big problem.

The soil conditions are changed and it polluted more. Sometimes it affected the ground water also. So Disposal of waste materials is very difficult task. Lot of small particle waste materials is flying in air and creates some problems in the environment.

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If you utilizing waste materials in proper way then we can get some benefits and also pollution free environment. The natural available materials are saving for the future generation for the sustainable development. Now a day's lot of research is going on in that area of utilization of waste materials.

The researchers are doing the work in replacement the waste materials in cement, Fine aggregate, Course Aggregate and bricks at the time of manufacturing. Some waste materials are directly used and some materials need some treatments.

II. WASTE MATERIAL USED IN CONCRETE

Now a day's lot of waste materials is generated due to increment of development of industrial growth and population density. Due to the increment of the industries lot of wastes are generated. The wastes are as follow

Fly ash

Fly ash is a major by product of thermal power plant industry. Fly ash size is very small and it is replaced by cement in concrete. The fly ash is classified as two types like class C and Class F according to ASTM C618.

Depending upon the Calcium, iron, silicon and aluminium contents are different in the types. Malhotra (1990) experimented class F fly ash having very good Pozzolanic activity and also it gave good mechanical strength, more durability and having low permeability.

Haque et al. (1984) investigated the utilization of high volume fly ash in concrete. His results showed concrete containing 40 to 60% addition of fly ash concrete have very less compressive strength at early age of concrete. But after 28 days the compressive strength of fly ash added concrete is equal to without addition of fly ash concrete. They attained the compressive strength of 35 MPa.

Chung-Ho et al. (2013) studied the mechanical properties of high volume fly ash concrete. They conducted the compressive strength test and Tensile strength test of the high volume added fly ash concrete up to 365 days.

The compressive strength of the concrete was increased gradually. At 365 days we can get the good amount of the strength when compared to the normal mix. Similarly, the flexural strength of the concrete is also increased gradually till 365 days.

The researchers compared the compressive strength and tensile strength of the concrete at the various ages and they derived the relationship between compressive strength and tensile strength of the concrete.

The shrinkage of the concrete mix also calculated and at the age of 244 days the shrinkage of the high volume fly ash concrete have more shrinkage because the increment of the fly ash volume in the concrete. They used two different types of fly ash (Loss of Ignition is different).

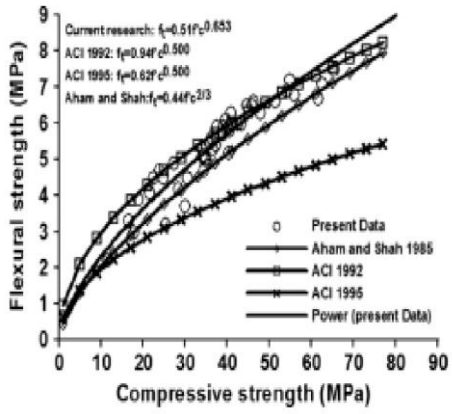

Fig.1 Comparison of Flexural strength and compressive strength of high volume fly ash added concrete (Chung-Ho et al. 2013)

Silica Fume

Silica fume is a byproduct of ferrosilicon alloys industries. It have good pozzolanic properties and also improved the Portland cement properties in concrete. In 1987 on wards the research was started about utilization of Silica fume. Yogendran et al., (1987) examined the effect of silica fume in concrete. They conducted compressive strength test and they got 15 % cement replacement with silica fume gave good result. Due to small size of the particles filler may done and some pozzolanic reaction also happened for the good compressive strength.

Brooks et al. (1998) also studied the properties of silica fume added concrete. The compressive strength was increased by replacing cement with silica fume 10%, 15% of weight of cement. The durability studies also carried out and the test was conducted at the age of 90 days.

Wang et al., (2017) they conducted the silica fume added concrete against sulfate attack. This silica fume added concrete gave good result when compared to normal concrete. Köksal et al., (2008) studied the micro silica particles gave good compressive strength and also added the steel fibres in the concrete.

Heidari & Tavakoli, (2013) made an attempt on adding silica fume and micro silica together in the concrete. The both materials added together gave fine amount of compressive strength in the concrete.

Glass

Glass is an in organic material. Now a day's lot of peoples doing their research in utilization of waste Glass. The was utilized by Course Aggregate (CA), Fine Aggregate (FA), Cement Replacement.

Meyer and Baxter (1997) conducted the test with replacement of glass powder in cement concrete. The specific weight of the concrete also reduced. In 2015, Cota's study focused on the particle size of the glass and metakaolin added concrete. Researcher also discuss about the alkali silica reaction. The strength was increased up to 79% when compared to normal concrete.

Islam et.al. (2017) examined the waste glass powder as a partial replacement of cement in concrete. The compressive strength of the concrete is more with addition of Glass powder between 0 to 20% replacement of cement when compared to normal mix. In the 10% of replacement of glass powder in cement gave more compressive strength when compared to all the mixes.

Sudharsan N & Saravanaganesh S (2019) studied the different types of glass powder properties and tested the mechanical properties. Soda glass powder has good strength when compared to Boron and Coloured glass powders

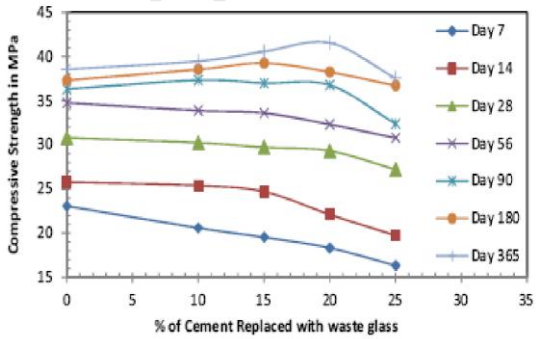

Fig.2 Compressive strength of glass powder added mixes (Islam et.al. (2017)

. **Coconut Shell**

Coconut shell is a one of the waste material and disposed to the land. But coconut has some fiber properties. Some researchers started to work on the utilization of coconut wastes.

Gunasekaran et al., (2012) investigated the coconut shell added concrete have less amount of weight and also have good compressive strength. They also discussed the Long term compressive strength like 365 days strength. The strength was very good when compared to the normal concrete.

They concluded we can utilize the coconut shell as a fine aggregate without any special treatment. In the coconut shells added concrete not give any bond failure at the earlier stages even after 365 days also its behave as same.

In the water absorption point of view, the coconut shells are absorbed the water and it is stored as a reservoir.

Fig.3 Size of the Coconut shells (Gunasekaran et al.,2012)

They conducted the SEM analysis in the coconut shell added concrete and they mentioned its look like a reservoir. They also conducted the coconut shell added concrete have three different types of curing.

Rice Husk Ash

In India, the consumption of rice is more. The rise husk ash also by product of the manufacturing of the rice. The waste is dumped to the soil and the soil also getting polluted more and its led to ground water pollution.

Huang et al., (2017) made an attempt on utilization of Rice husk ash in a concrete. Rice husk ask containing concrete have good compressive strength and also have less water absorption value. The researchers also studied the durability properties and its have good strength against chloride attack. Antiohos et al., (2014). In this area still lot of researches are going and try to improve the durability property of the concrete.

Concrete Waste

At the time of World War II lot of building structures was demolished and lot of concrete waste are generated. Some researchers got more interest in utilization of waste concrete in the form of fine aggregate and course aggregate in the newly prepared concrete.

Merlet & Pimienta, (1993) experimented the concrete waste as a fine aggregate in concrete. As a result drying shrinkage available 30% of waste replaced in concrete. Letelier et al. (2017) studied the concrete containing the concrete waste aggregates and brick powder.

The waste concrete was used as a aggregate and waste brick powder used as a replacement of cement in concrete. The compressive strength of the concrete is increased up to 9% when compared to normal mix. The flexural strength also slightly increased. 30% of recycled aggregate and 5% of waste brick powder mix gave good compressive strength.

Rubber and Tyres

Now a day there is a rapid growth in the vehicles on the road. Due to increase the population density there are lot of vehicles are used in this world. The entire vehicle contains rubber tyres in the wheels.

Due to more number of vehicles lot of rubber tyres are wasted and it destroyed in the land. Some peoples are burning the tyres and the lots of green house gases are formed and the environment gets polluted.

To avoid these situations some researchers made an attempt to utilization of the rubber in the concrete. The waste tyre grinding to a small particles and it is used in concrete replacement of aggregates and cement.

Olivares and Barluenga (2004) studied the waste rubber used as fiber in concrete. If the percentage of the rubber increased automatically the strength of the concrete gets decreased. The rubber content up to 20% used in the concrete the flexural strength was increased nicely when compared to the normal mix specimens. If we added the waste rubber tyre particles the concrete gets more flexibility. (Gupta et al., 2014) studied the concrete containing rubber material. They used the rubber as a fine aggregate and replace the normal fine aggregate. They conducted the compressive strength test at 90 days. There are three different water cement ratios (0.35, 0.45, 0.55) was used in that work. The test results showed in 0.35 water cement ratio the strength gets reduced when compared to other two water cement ratios.

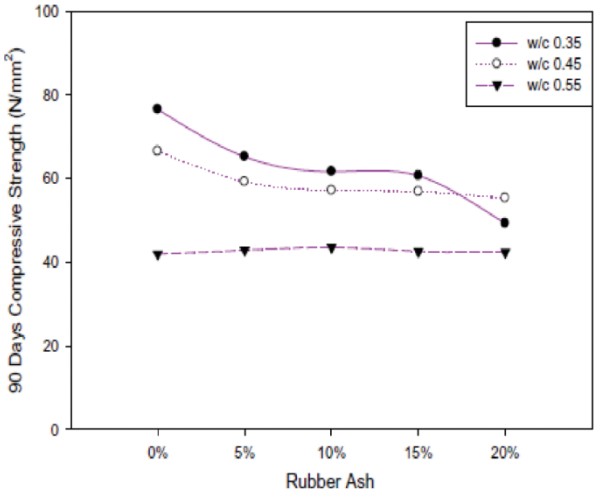

Fig.4 The compressive strength of rubber ash concrete at 90 days (Gupta et al., 2014)

Steel slag

The next important waste material is steel slag. In the manufacturing of one tonne of steel produces nearly 17% of waste steel slag and it is dumped in the land. The utilization of steel slag in concrete is more helpful to avoid the land pollution. In that steel slag contains the various oxides calcium, Silicon and iron.

P.S. Ambily et. al (2015) studied the ultra high performance concrete using waste copper slag. The copper slag was used as fine aggregate and it is compared with Ennore sand. The copper slag was used in the ultra high performance concrete. The compressive strength of the copper slag added concrete is more than the 150 Mpa.

The copper slag was replaced 100 % as a fine aggregate then the compressive strength of the concrete reduced to 10 to 15% when compared to normal mix combinations.

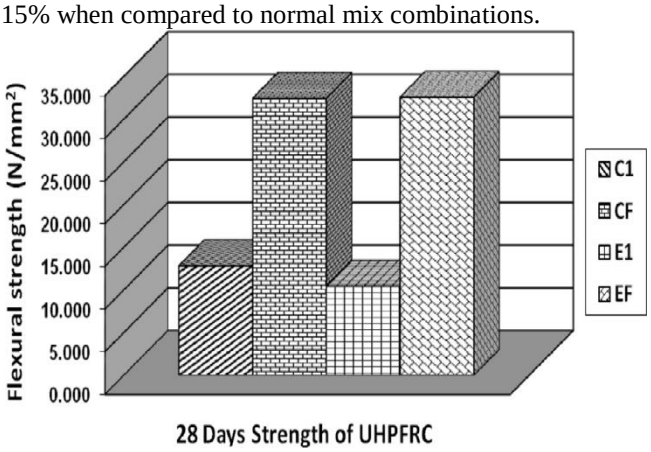

Fig.5 The compressive strength of copper slag added concrete at 28 days ((P.S. Ambily, 2015).

III. CONCLUSION

In the study, the utilization of waste materials in concrete was reviewed. The main objective of the study understands the advantages and disadvantages of the waste materials used in the concrete. Some materials are used instead of course and fine aggregates and some materials are used for cement. Fly ash is utilized more in the cement industries. Silica fume also have some pozzolanic properties. In recent year's waste glass also utilized in the manufacturing of building materials like bricks, paver blocks, etc.

The Steel slag, Rubber and Tyres are also replaced as cement, aggregates in concrete. The main aim of the waste utilization is to control the pollution and keep the sources for the sustainable development.

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