

Glass Powder as a Supplementary Replacement of Cementitious Material in Concrete

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Abstract— Today concrete is the most demanded material in the construction world. As day by day increasing construction so concrete demands the large amount of production of cement. Cement manufacturing industry is one of the carbon dioxide emitting sources besides deforestation and burning of fossil fuels. The global warming is caused by the emission of greenhouse gases, such as CO₂, to the atmosphere. 1 Ton of cement production emits 1 ton of CO₂ in the atmosphere. Therefore, to control the environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. There are many researches is ongoing into the use of cement replacements, by using many waste materials and industrial by products. In the present project finely powdered waste glasses are used as a partial replacement of cement in concrete and compared it with conventional concrete. This work examines the possibility of using Glass powder as a partial replacement of cement for concrete. Glass powder was partially replaced with cement as 10%, 20% and 25%. Glass powder a waste material will be used which improves the compressive strength, durability, flexural strength of concrete at later age. The use of glass powder in concrete prevents landfills.

Key words: Glass Powder, Cement, Fine Aggregate, Coarse Aggregate

I. INTRODUCTION

As concrete is most demanded material in construction industries at present easily and cheaply available ingredient and very good mechanical properties. Concrete is an important building material in construction industry. It is a homogeneous mixture of cement, fine aggregate and coarse aggregate along with water, the strength of concrete is mainly depends upon the cement content. The large scale production of Portland cement and the acquisition of aggregates from dredging and quarrying have a dramatic impact on the environment.

The Concrete is world's most commonly used construction material than the total of all other building materials including wood, steel, plastic and aluminum. By growing concrete to the level but as concrete is brittle material so it is weak in tension. So some time cracks occur due to shrinkage and these cracks are dangerous for R.C.C. elements.

The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction. The waste glass from in and around the small shops is packed as a waste and disposed as landfill. Currently most of recovered waste glass is used by glass manufactured company in the production of new glasses such as bottle and etc. But only a limited amount from the waste glass collected and used by glass manufacturing industries is that can be used towards the production of new glass. These is because, manufactures only

can use waste glass that's has been pre-sorted by color and type but are mostly discarded now and this wastes color mixed glass still it ends up at landfill site. Since waste glass still gave us a problem, maybe we try to use it in the concrete mix and find the result whether because if the results gives us a good value, then it will benefit to our earth because we can reduce 1 portion of our waste that cannot dissolved by natural or normal recycling ways.

The main reason of this study is to create a better environment that free from polluted space and also to find a better solution for concrete mixture that can give higher strength to concrete from the waste glass product. Even it may give less cost of using this kind of admixture rather than buying expensive admixture to get great and higher strength in concrete as now days it's the admixture that in market are very expensive and often increase the cost of the construction.

A. Glass Powder

– Glass occurs naturally when rocks high in silicates melt at high temperatures and cool before They can form a crystalline structure. Obsidian or volcanic glass is a well-known example of Naturally occurring glass, although it can also be formed by a lightning strike on a beach, while Contains silicate-rich sand. Early forms of glass were probably rife with impurities and subject to Cracking and other instability, but examples of glass beads, jars, and eating materials first Appeared in ancient Egyptian culture. [1] Due to use of glass products and their growing needs over the year quantity of waste glass has been increased. At the same tie todays annual global cement production has reached 2.8 billion ton per year.[2] Numerous waste materials are generated from manufacturing processes, service industries and municipal solid wastes. The increasing awareness about the environment has tremendously contributed to the concerns related with disposal of the generated wastes. Solid waste management is one of the major environmental concerns in the world. With the scarcity of space for land filling and due to its ever increasing cost, waste utilization has become an attractive alternative to disposal. Research is being carried out on the utilization of waste products in concrete as a replacement of natural sand. Such waste products include discarded tires, plastic, glass, burnt foundry sand, and coal combustion byproducts (CCBs). [3] Normally glass does not harm the environment in any way because it does not give off pollutants, but it can harm humans as well as animals, if does not dealt carefully and it is less friendly to environment because it is non-biodegradable. Thus, the development of new technologies has been required. The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and boro-silicate glass. These types of glasses glass powder have been widely used in

cement and aggregate mixture as pozzolana for civil works [4]. Quantities of waste glass have been rising rapidly during the recent decades due to the high increase in industrialization and the considerable improvement in the standards of living, but unfortunately, the majority of these waste quantities are not being recycled but rather abandoned causing certain serious problems such as the waste of natural resources and environmental pollution. Theoretically, glass is a fully recyclable material. It can be recycled without any loss of quality. There are many examples of successful recycling of waste glass, as a cullet in glass production, as raw material for the production of abrasives, in sand-blasting, as a pozzolanic additive, in road beds, pavement and parking slots, as raw materials to produce glass pellets or beads used in reflective paint for highways, to produce fiberglass, and as fractionators for lighting matches and firing ammunition[5]. As we know that now day, most of developing country facing shortage of post consumers disposal waste site and it' s become very serious problems. For this reason, regenerating and using waste product as resources and prevent environmental pollutions. Therefore in research, considering the post-consumer waste glass, there is effort to recover and use waste glass or otherwise its end up at disposal landfill. Currently most of recovered waste glass is used by glass manufactured company in the production of new glasses such as bottle and etc. But only a limited amount from the waste glass collected is that can be used towards the production of new glass [6].

II. LITERATURE REVIEW:

A. Workability

- When the cement by glass powder the workability of concrete decreases. The reduction is due to decrease in fineness modulus of cementation material, which utility reduce the quality cement paste required for providing easiness per unit surface area of aggregate.[2]
- The slump and weight density of concrete decrease monotonically as the replacement percentage of cement with glass powder increases. The workability decreases when cement is replaced partially with glass powder [4].
- As a conclusion, all the objectives of this study are achieved; concrete with using waste glass powder and crushed glass particles has a very high workability from control sample. This result achieved from the slump test that use of waste glass powder were will increase the workability of concrete [7].
- The slump of concrete containing waste glass as fine aggregate replacement decreased with increases in the waste glass content, but in spite of this decline in the slump, the mixes remained good workability [8]
- The slum value of control mix give value of 33mm compare to concrete mix with waste glass powder of 10% is 60mm, 15% are 63 and 20% are 70mm. Therefore the value of slum its increase if the percentage of waste glass powder increased. Therefore it is shown that compared to control mix, by using waste glass powder will give another benefit which is the workability of concrete which is much higher[6]

B. Compressive Strength

- The strength of concrete containing glass powder when subjected to Sulphate attack and results concluded that highest compressive strength is achieved with 20% of replacement of cement in both the conditions and the strength decreases with increases in percentage beyond 20% [2].
- After the study it was found that the conventional concrete tested at 28 days compressive strength as 31.1 N/mm², Replacement of glass powder in cement by 20%, 30% and 40% increases the compressive strength by 19.6%, 25.3% and 33.7% respectively. [4]
- Conventional concrete shows at 7 days compressive strength as 14.51 N/mm², Replacement of glass powder in cement as well as crushed glass particles in sand by 5%, 10%,15% and 20% increases the compressive strength after 28 days by 9.25%, 38.50%, -70.80%, and33.09% respectively.[7]
- Compressive strength of the concrete with partial replacement of sand by finely crushed waste glass increased with the increment ratio of waste glass, especially at the later ages, with compressive strength at 28 days being 5.28% higher compressive strength for 20% replacement compared to controlled concrete, which also indicated the contribution of pozzolanic reaction.[8]
- The 7 days, 28 days and 60 days compressive strengths of concrete increase initially as the replacement percentage of cement with glass powder increases, and become maximum at about 20% and later decreases[2].
- This paper examine by using glass powder 5,10 and 20 % by replacement of cement increase comp. strength 51.7, 37 and 20.7% at 28 days[1].

C. Tensile Strength

- In their research on concrete containing mineral admixtures at high temperatures resulted that 20% replacement is perfect once concrete isn't subjected to various wetting and drying and as well once concrete subjected to various wetting and drying [2].
- After the study it was found that the conventional concrete tested at 28 days split tensile strength of 2.27N/mm, Replacement of glass powder in cement by 40% increases the split tensile strength by 4.4% respectively. [4]
- Conventional concrete shows at 7 days split tensile strength of 1.88 N/mm², Replacement of glass powder in cement and crushed glass particles in sand by 15% increases the split tensile strength after 28 days by 4.25%.[7]
- The splitting tensile strength of concrete with 20% waste glass content increased by 5.28 %, 18.38% and 8.92% respectively at 28 days.[8]
- Replacement of glass powder in cement by 5%, 10% and 20% increases the tensile strength by 32.3%, 7.28% and 3.64% respectively [1].
- The split tensile strength of concrete increases initially as the replacement percentage of cement with glass powder increases, and becomes maximum at about 20% and later decrease. [4].

D. Flexural Strength

- Experimented flexural strength in his study and resulted that 20% dose of waste glass powder is perfect for replacement cement [2].
- After the study it was found that the conventional concrete tested at 28 days flexural strength of 3.25N/mm², Replacement of glass powder in cement by 20%, 30% and 40% increases the flexural strength by 83.07%, 99.07% and 100% respectively.[4]
- Conventional concrete shows at 7 days flexural strength of 2.72N/mm² Replacement of glass powder in cement by 5%, 10% 15% and 20% increases the flexural strength after 28 days by 5.88%, 30% and 44.85%, and 13.97% respectively[7].
- Replacement of glass powder in cement by 5%,10% and 20% increases the Flexural Strength by 22.97%, 31.45% and 41.34% respectively. [1]
- The flexural strength of concrete with 20% waste glass content increased by 5.28 %, 18.38% and 8.92% respectively at 28 days.[8]
- Experimented on replacement of cement by waste glass powder and concluded that a Considerable improvement in the flexural strength was seen at 10% replacement of cement. [2]

E. Durability

- From the studies concluded that at 28 days the water absorption of concrete decreases as the percentage of waste glass powder and industrial waste increases and at 20% glass powder and 50% industrial waste that is foundry sand it is least.[2]
- The waste glass, if ground finer than 600 μ m shows a pozzolanic behavior. It reacts with lime at early stage of hydration forming extra CSH gel there by forming denser cement matrix. Thus early consumption of alkalis by glass particles helps in the reduction of alkali-silica reaction hence enhancing the durability of concrete [4].
- Water absorption decreased with increase waste glass aggregate ratio. The highest reduction was obtained with 20% of glass aggregate replacement with a reduction of 14.68% at 28-day age compared to control [8].
- They were conducted the study on the effect of 15% and 30% replacement of cement by silica fume, fly ash, and glass powder on compressive strength and durability in the form of capillary absorption.[3]

III. CONCLUSION

Following conclusion can be drawn based on study

- Glass Powder increase Compressive strength, Tensile strength and also Flexural strength of concrete effectively
- Glass Powder Replace with cement 5%, 10%, 20% and 30% increase Compressive Strength at 7, 28 and 56 days.
- It is found from study initial strength gain is very less due to addition of on 7th day but it increase on the 28th Day Replacing cement by glass powder in concrete, not only increase the strength and introduce economy but also enhance the durability.

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