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A Review - Partial Replacement of Construction Materials with Waste Materials

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Abstract - Concrete generally used in any types of construction work. Concrete is the mixture of cement sand and aggregate this is a basic definition of concrete but day by day new experiment have going on. Various alternate materials we used in construction industry. Concrete ingredients is different material like binding material (cement+ fly ash), fine aggregate, coarse aggregate and water. Today construction cost is very high with using conventional materials due to unavailability of natural materials. This problem can be solved by total replacement of concrete with different material which is not convenient in terms of required properties. Due to this limitation of unavailability of material which plays the vital role of concrete we have only choice of partial replacement of concrete ingredients by waste materials. Approx. Six billion tons of cement was consumed globally in 2023 based on survey of world coal association and also cement production emits CO2 in to the atmosphere which is harmful to the nature. If we can partially replace the construction materials with the material with desirable properties then we can save natural material and reduce emission of CO2 in to the atmosphere. So use of this waste material in concrete is cost effective as well as environment friendly way to disposal of waste. The primary objective of this study is to select the waste material which gives desirable properties with concrete. This study includes previous investigation done on the mechanical and chemical properties of concrete produced using partial replacement of construction materials by waste materials.

Keywords - cement, sand, aggregate , Concrete, construction materials, CO2

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INTRODUCTION

Cement is a common building block in concrete manufacturing across the globe. The emission of CO_2 into the atmosphere during the production of Portland cement is a major contributor to global warming. To put it another way, every tonne of cement creates one tonne of CO_2 and other greenhouse gases. (Shekhawat et al. 2014). This has resulted in an increase in research into alternative cementing materials such as Supplementary Cementitious Materials (SCM) and pozzolanas. An enormous amount of industrial wastes such flyash, silica fume, waste glass powder as well as residues from the processing of food crops like rice and sugarcane have become problematic for the disposal of these wastes as well as for environmental concerns. It is possible to employ these SCMs and solid wastes in cement systems due to their pozzolanic qualities that have been discovered.

This flexible and frequently used man-made building material has a cheap price tag, high durability and accessibility to the raw components that make it possible to mould into almost any shape or size. As a result, a great deal of work is being done throughout the globe to better understand this special substance in all its facets. The major component in concrete, Ordinary Portland Cement (OPC), binds the fine and coarse particles together and creates concrete. Normal conventional concrete is difficult to fill complex reinforcing without vibration in the absence of a vibratory agitation. There are several benefits to adopting Self-Compacting Concrete (SCC). The SCC meets the requirements for workability, such as the ability to fill and pass and the resistance to segregation. The high-strength concrete adds to the increase of concrete's strength and durability. For high-strength concrete to be produced, the water-to-cement ratio must be drastically reduced, and mineral admixtures must be used.

High Strength Self-Compacting Concrete (HSSCC) using mineral admixes, such as, is the major focus of this study. Fly Ash (FA), Silica Fume (SF), and Ground Granulated Blast Furnace Slag (GGBFS). Mineral and chemical admixtures may be used to enhance workability and decrease segregation, while lowering the water cement ratio can boost strength. High Strength Self Compacting Concrete is examined for its fresh concrete qualities, mechanical properties, and long-term durability.

Thermal power stations generate electricity by burning coal, which produces fly ash, a byproduct. When the ash rises, the electrostatic precipitator collects the extremely tiny particles. Pond ash refers to the ash that collects at the bottom of a body of water. Coal ash includes both fly ash and pond ash. In general, there are two main categories of fly ash: class C and class F. Many methods have been implemented recently to reduce flue emission before fly ash may be discharged into the sky as it did in the past. Among the many uses for fly ash include lessening the occurrence of cracks, improving permeability, reducing bleeding and hydration heat, and lowering the water/cement ratio for comparable slumps. As an alternative to Portland Cement, an inorganic pozzolanic substance called GGBS has evolved (PC). It's a green building material that helps keep pollutants to a minimum while also promoting long-term development. For the most part, this is due to the GGBS particles' dispersion ability and surface properties. Concrete bleeding is less of an issue because to GGBS's finer particle size. Low penetration, superior chloride resistance, and a reduced freeze-thaw impact are all benefits of the GGBS-containing mixture.

Self-Compacting Concrete's capacity to self-compact under the influence of gravity or its own weight, without vibration or segregation, is referred to as self-compaction. Any complex formwork may be taken up by SCC, which has no holes and allows for air to enter, while successfully covering the reinforcement. An inorganic binder has evolved as a novel engineering material to replace the traditional fine aggregate. Fly ash, blast furnace slag, and silica fume may be used as fine aggregate replacement materials to improve concrete's fresh and hardened qualities without raising production costs.For concrete to qualify as SCC, it must possess certain properties, such as the capacity to pass, fill, and resist segregation, among others. With the use of super plasticizers and a reduced water–powder ratio, these characteristics may be achieved (Siddique 2011). This SCC is being studied extensively as a greener alternative to conventional or regular cement concrete. Set and compacted on its own or by its own weight, SCC is like concrete that does not shake or bleed. For structural components with a lot of reinforcement, this material may be poured into a mould without compacting or bleeding (Aswathy 2015). Reduce the need for cement, fine fillers, and sand by using mineral admixtures in the concrete (Okamura 1995). As a greener alternative to ordinary cement concrete, this HSSCC is being explored extensively. In contrast to other technologies, there has not yet been a significant amount of study focused emphasis on the interaction between the workability, mechanical characteristics and durability of HSSCC using fly ash, silica fumes or GGBPS as a fine aggregate replacement material in concrete. Without raising the production costs, it might improve the qualities of the fresh and hardened concrete mixtures. Mineral admixtures have been studied extensively for their usefulness as a substitute for cement in SCC. The use of fly ash, silica fume, and GGBS as fine aggregate replacements in HSSCC has received very limited investigation. It sheds light on how the strength and durability attributes have improved as well as the number of mineral admixtures that have been replaced.

REVIEW OF LITERATURE

Anand G (2022) Concrete is made out of a variety of materials, including cement, fly ash, fine aggregate, and water. Due to the scarcity of natural resources, building costs have skyrocketed in recent years. By replacing concrete with another material that lacks the desired qualities, this issue may be resolved. We can only use waste materials to partially replace concrete components due to the lack of readily available raw resources. It is estimated that over 4.2 billion tonnes of cement were used worldwide in 2018, according to a study conducted by the World Coal Association, and the manufacture of cement also releases hazardous amounts of CO2 into the environment. We can conserve natural resources and minimise CO2 emissions if we substitute some of the cement with a substance with desired qualities. Using this waste material in concrete is a cost efficient and environmentally good approach to dispose of garbage since it not only reduces waste disposal costs but also improves urban aesthetics. This study's major goal is to identify the waste material that best combines with concrete. This study covers prior research on the mechanical and chemical qualities of concrete made by substituting a portion of the cement with waste products.

A J Patel (2015) Binder (cement + fly ash), fine aggregate, coarse aggregate, and water all belong to the concrete family. Due to the scarcity of natural resources, building costs have skyrocketed in recent years. By replacing concrete with another material that lacks the desired qualities, this issue may be resolved. We can only use waste materials to partially replace concrete components due to the lack of readily available raw resources. According to a study by the World Coal Association, over 3.3 billion tonnes of cement were used worldwide in 2010. Cement manufacture also contributes to climate change by releasing carbon dioxide into the environment. We can conserve natural resources and minimise CO2 emissions if we substitute some of the cement with a substance with desired qualities. Using this waste material in concrete is a cost efficient and environmentally good approach to dispose of garbage since it not only reduces waste disposal costs but also improves urban aesthetics. This study's major goal is to identify the waste material that best combines with concrete. This study covers prior research on the mechanical and chemical qualities of concrete made by substituting a portion of the cement with waste products.

Kunchala Anjaneyulu (2017) Reduced waste from corn cob and sawdust, as well as lower concrete costs, are the primary goals of this research. Compressive strength qualities and the workability and workability of cement concrete with different percentages of maize c ob ash and saw dust ash and 100 percent cement were investigated and compared. The water-to-cement ratios ranged from 0.5 to 0.6 and the water-to-cement ratios of 0.5 to 0.75. Corn cob ash and saw dust ash were added to new concrete to conduct a slump test. At a total weight percentage of corn cob and sawdust ash of 0 percent, 10 percent, and 15 percent, 90 concrete cubes were made of 150mm x 150mm x 150mm. At the ages of 7, 14, 21, 28 and 56 days, the concrete cubes were evaluated. Pozolans made from corn cob ash and sawdust ash were shown to be effective. Concrete becomes less workable as the amount of ashes in it increases, as seen by the slump value decreasing as CCA and SDA content rose. The cubes' compressive strength rose as the curing time increased and decreased with the addition of ashes. 0 percent and 10 percent of CCA (M25) had compressive strengths of 24.9N/mm2 and 22.4N/mm2 at 56 days, respectively, whereas SDA (M25) had compressive strengths of 24.9N/mm2, 23.9N/mm2. However, just a 10% CCA and SDA substitution in concrete is sufficient to reap the full benefits of strength increase from CCA and SDA usage, especially in non-load bearing constructions such plain concrete works and non-load-bearing concrete buildings.

Jagdish D. kalapad (2019) Paper sector trash, or pulp, stands out as a particularly hazardous and difficult-to-dispose-of waste from various Indian enterprises. Every year in India, more and more land is being occupied by landfills, reducing the amount of land available for farming. The usage of agriculture fields for dumping pulp, which affects fertility and poses a health risk, has been reported in certain circumstances Pulp dumping into rivers and canals is a major source of pollution to our waterways. Air pollution is caused by paper mills employing incinerators to dispose of waste. The pozzolanic and cementation capabilities of waste paper pulp have been documented and might be utilised as a partial substitute for cement clinker in concrete production. An inquiry on the best percentage of waste paper pulp to employ in concrete is the focus of this article. For this investigation, the M25 grades of concrete were used. There were three distinct levels of waste paper pulp substitution for cement, ranging from 5% to 15%, and a 0% replacement level for comparison. Seven and 28 days after curing, concrete was evaluated for compressive strength. Overall, the results show that up to a 20% replacement level of cement may be improved by using paper pulp as a partial substitute. Additionally, the use of waste paper pulp as a partial substitute for cement significantly decreases the building costs and environmental hazards, which otherwise would have been disposed.

Bahiru Bewket Mitikie (2022) The impact of waste paper pulp ash on concrete quality, as well as the economical and environmental benefits of using it instead of cement, have all been investigated. In four different amounts, waste paper pulp ash was used to replace OPC and PPC in a 25 MPa concrete mix: 0%, 5%, 10%, and 15%. In the study, the maximum compressive strength was 24.36 MPa at the ages of 3, 7, and 28 days, with a The impact of waste paper pulp ash on concrete quality, as well as the economical and environmental benefits of using it instead of cement, have all been investigated. Waste paper pulp ash was used to replace OPC and PPC in a 25 MPa concrete mix at four different percentages, all of which resulted in lower compressive strengths than the control mix. When more waste paper pulp ash was added to a concrete mix, it had a greater ability to absorb water than the control mix. Sulfuric acid solution portions in the control concrete are clearly lower than in the blended OPC-WPPA and PPC-WPPA concretes. Cement and WPPA production may be reduced in cost by using waste paper pulp ash, which is a waste product from the pulping of trees, according to the cost comparison.

Siji Joseph (2016) The use of concrete in building is unavoidable. Cement, fine aggregate, and coarse aggregate are some of the most expensive materials used in building today. It takes a lot of energy to make cement, and it also produces a lot of greenhouse gases. The possibility of using waste material as a replacement for the primary components of concrete is being studied extensively. Energy savings and environmental advantages may be achieved by substituting cement in concrete with a variety of waste materials. In this study, waste material is employed as a partial replacement for cement. This investigation looked at a variety of waste products, including glass powder, silica fume, and fly ash. Other waste materials such as various shell powder and Rice Husk Ash have also been studied in this article.

Uma Shankar Yaligar (2018) Plastic garbage disposal is the most difficult problem for solid waste management in the world. Among the greatest building materials available today, concrete is widely used around the globe. As a result, natural resources are disappearing even faster. Using plastic waste in concrete might be a way to address both the paucity of raw materials and concerns about how to dispose of plastic trash safely. Studying the feasibility of using plastic waste as a cement in concrete has been done. Another method utilised to reap the benefits of concrete mixed with waste plastic is explored in this research. Concrete tiles were used in an experiment to compare the mechanical qualities of waste plastic mix concrete with and without the inclusion of fibre. At a dosage of 10% to 15% by mass, plastic waste is substituted for cement in order to maintain the structural integrity of the finished product. Thus, it can be concluded that a 35 percent substitution of cement with plastic waste may be implemented such that both the disposal of used plastic and the shortage of natural aggregate can be properly controlled. Because of this, it has been discovered that up to 35% of the waste plastic in concrete tiles may be replaced with cement, which boosts compressive strength.

R.Jagadheeswari (2020) This paper's fundamental thesis is that industrial waste may be turned into riches. Eco-friendly cement may be made by including waste items such as fly ash, metakaolin, lime powder, glass powder, and aluminium powder. Concrete's compressive and tensile strength was compared to that of regular concrete in the tests. As long as the new eco-friendly cement has higher strengths than traditional concrete, it may be used in building.

Simratpal Singh (2019) Concrete, a widely used building material, is made out of cement, which is expensive and generates a lot of greenhouse gas emissions during the manufacturing process. Ceramic waste, on the other hand, pollutes the environment when it is dumped in the environment or exposed in fields where it is dumped. For this dissertation, 5 percent, 10 percent, and 15 percent of the M25 grade of concrete's cement is substituted with ceramic waste. As for polypropylene and polyester fibres, they are added to the concrete at 1 percent, 1.5 percent and 2 percent of the M25 grade, respectively. As with traditional concrete, the various concrete mix specimens were cast, tested, and compared for compressive strength and split tensile strength. In order to assess the concrete's qualities, these 7-day, 14-day, and 28-day experiments were carried out. Using ceramic waste in place of some of the cement, as well as fibres, to improve the strength of concrete is the focus of this study.

Bikila Meko Kejela (2020) When it comes to building materials, concrete is among the most adaptable. The manufacturing of cement, which serves as the primary binder in concrete, is both inefficient and environmentally unfriendly. These issues necessitated the use of alternative materials with reduced manufacturing costs, fewer CO2 emissions, and lower energy usage. As a result, Using waste paper ash instead of cement in the production of concrete is the goal of this study. Cement was substituted for cement in various percentages (0% to 20%) according to its chemical compositions and its chemical compositions were studied. Paper ash's influence on the fresh and hardened characteristics of C – 25 concrete were tested to see whether it could be used in concrete manufacturing. According to the findings of this investigation, Waste paper ash's chemical compositions did not fulfil Pozzolanic material criteria. The addition of paper ash to blended cement paste has resulted in longer setting periods and a thicker consistency. The cement paste's consistency was within the usual range even after being replaced up to 10%. There were tests on workability and compressive strength after curing for seven and 28 days. Concrete's workability degraded as the amount of waste paper ash in the mix rose. Concrete's compressive strength has improved significantly throughout the years. The convectional mix's compressive strength outperformed Portland cement by 10% when waste paper ash was replaced for Portland cement. 5.6 percent and 1.2 percent, respectively, were found for replacements of 5 percent and 10 percent. Compressive strength, on the other hand, falls when the replacement of waste paper ash rises over 10%. Concrete with 5% waste paper ash had the maximum compressive strength, measuring 37.89kN/m2.

T.M. Menaka (2019) The expansion of the building business has slowed significantly during the last several decades. Aggregates play a critical role in the formation of concrete. Research into the use of alternate materials is needed due to the depletion of sand's natural resources and its influence on the sustainable environment. However, industrial wastes are stacking up, resulting in environmental contamination. In light of the aforementioned, much research is being done to find alternatives to river sand, including copper slag, steel slag, quarry dust, and more. These studies indicate that the mechanical and durability qualities of concrete are enhanced by the use of other materials. It is determined how much sand can be replaced with the most effective mix of alternative materials. Researchers' technical publications are examined, analysed, and contrasted in this study.

Fasih Ahmed Khan (2020) An investigation into using waste glass powder (WGP) as a cementitious additive to concrete is described in this publication. Concrete samples were produced and tested in accordance with ASTM standards to determine the effect of WGP on the material's mechanical qualities (cylinders and beam elements). 20,000 kPa compressive strength was the goal for the control samples, which were meant to mimic field conditions. WGP was replaced for Portland cement in concrete at a rate of 0 percent to 35 percent by weight, in 5 percent increments. Samples were cured for 28, 56, and 84 days in two curing zones to examine the influence of pozzolanic material on their properties. With a 28-day curing period, the research found a 10% decrease in the compressive strength of concrete when 25% of the cement was replaced with WGP. Another 5 percent of strength loss was minimised with the same replacement ratio and an additional eight weeks of curing. Glass powder injected concrete, on the other hand, showed a considerable loss in workability. As an additional benefit, waste glass powder concrete had a 2 percent greater modulus of rupture than control concrete at the 84-day age point. According to the findings of this research, the optimal replacement ratio for cement is 25 percent replacement with WGP.

Sumit Gaikwad (2019) In terms of greenhouse gas emissions, the worldwide cement sector accounts for around 5% of the total. Cement's negative impact on the environment may be mitigated by finding more environmentally friendly substitutes. For research purposes, industrial waste paper sludge (PS) from paper mills is employed, which pollutes the soil and atmosphere, as well as affecting urban aesthetics. Using waste paper sludge (PS) in lieu of cement in percentages of 5 percent, 10 percent, 15 percent, and 20 percent is the subject of this investigation. Activated charcoal powder made from coconut shells (ACP) is used in concrete with 1%, 2%, and 3% by weight of cement. The concrete mix's desired strength is 40 N/mm2. It was found that a combination of mechanical qualities and individual performance was superior than standard concrete. It has been shown that the ideal PS and ACP values for compression, split-tensile, and flexural testing were undertaken at the ages of 3, 7, and 28 days. The Rapid Chloride Penetration Test (RCPT) was used to perform a durability test in accordance with ASTM C1202. As compared to conventional concrete, PS 10% replacement results showed an increase of 13.15 percent, while the inclusion of ACP resulted in an increase of 10.58 percent, as compared to conventional concrete. When compared to standard concrete, a mixture of 10 percent PS and 1 percent ACP has shown to be more robust in tests of durability.

Bhagyawati M (2018) Concrete research focuses on enhancing the qualities of concrete via the use of suitable components. Using steel chips as a substitute for sand in the making of concrete is the subject of this investigation.... Steel chips are used as a substitute for M-Sand in this research study, which helps protect the environment by reducing pollution by using concrete as a building material. All of these waste were used in varying percentages to replace the M-Sand (15%, 30%, and 60%). This inquiry will include testing for compressive strength, split-tensile strength, and flexural strength of concrete using steel chips as a partial alternative for M-sand. Steel-chip-based concrete was tested and compared to regular concrete. Compressive strength, split-tensile strength, and flexural strength of concrete are all improved when these waste materials are mixed.

Clement M (2018) The automotive and consumer goods industries both employ bakelite in their products. Bakelite waste has increased as a consequence of an increase in bakelite usage. Direct land filling and open burning of Bakelite watses are also forbidden because to their harmful impacts on soil and atmosphere, respectively, by toxic emissions from these methods. In order to store a huge volume of this garbage, it need a large amount of warehouse space. Post-milling waste bakelite (WBCA) was combined with cement mortar with the proportions as a coarse aggregate (WBCA). Compressive strength tests were performed in accordance with ASTM standards on a mortar sample. Mortar compressive test results will be compared to the mortar standard, as well as to ordinary mortar (0 percent WBCA) and waste bakelite mortar. It is possible to forecast the WBM's strength based on the study of the cement mortar mixture. This has led to an investigation into the possible use of waste bakelite in civil engineering projects. Our lecture is focused on comparing and contrasting the qualities of typical concrete materials. By substituting 5,10,15,20,25,30 percent of bakelite with M20 grade concrete manufactured with natural coarse aggregates, 3 cubes of M20 grade concrete were formed. The properties of hardened concrete were determined.

CONCLUSION

Studying all these research paper it is clear that positive and favorable results are obtained if further research work and study is carried out in this field. And by using locally available wastes like glass waste, marble dust powder, ceramic waste, quarry dust, GGBS, Fly ash, RHA, CKD, BSFC, Silica fume, silt, clay, sewage sludge ash and different sludge, Electronic waste etc. as partial substitution at place of concrete ingredients, it may prove more economical than traditional concrete and question of damping of such waste produced by different industries is also get solved

Today we live in the world full of development and enthusiastic for still more comfort and facilities. This leads to innovations and revolutions in each and every field, but on contrary it has negative impact on environment as resources get depleted and pollution to different natural sources are occurred. So after studying all these research paper we concluded that if we can reduce or reuse some material in field of concrete production which is at its top now- a-days then it largely impact environment and leads to pollution free and soothing surrounding. Thus as concluded from above literature review we can research further more in direction of partially replacing cement, sand and aggregate up to most optimum level we can by reusing or introducing waste material as its option. Ultimate goal is to produce economical and eco-friendly concrete with all desired properties and strength which one obtains by regular concrete ingredients.

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