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Use of Iron Powder in Concrete as a Partial Replacement of Cement: A Review Paper

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Abstract: A review research was done in this study to determine the impact of iron powder (Fe2O3) on the binary blended concrete's compressive strength, tensile strength, workability, and porosity. Iron powder was used in place of Portland cement for this project. The water-binder ratio is maintained at a consistent proportion. Cone Abrams method will be used to assess the fresh composite concrete's workability. Mechanical characteristics such as compressive and tensile strengths at 7, 14, and 28 days as well as water absorption and permeable porosity will be used to assess durability.

Keywords – Iron Powder, Cement, Concrete, Workability, Compressive Strength, Tensile Strength.

I. INTRODUCTION

In order to meet the varied qualities of concrete, extensive study has been done on the usage of alternative materials in concrete. One such substitute material that works well to take the place of the natural material is pond ash. Mostly fly ash and bottom ash are created when coal is burnt. By using an electrostatic precipitator, fly ash is collected. The ash that collects at the bottom of the boiler is combined with water, transported through pipes out of the facility and then discharged into a field. Whatever ash is left over after evaporation is known as pond ash.

Pond ash can be used in mass concrete construction, earth fill, geotechnical and highway construction, but its use in structural concrete is restricted due to technical and other considerations. This encourages the usage of a significant quantity of pond ash produced by thermal power plants. In 2012, India's power output is anticipated to increase from 1,12,090 MW to 2,12,000 MW. The amount of ash in ash ponds has increased from about 450 million tonnes in 1999-2000 to more than 900 million tonnes in 2005-2006. Every year, 65 to 75 million tonnes of ash are still left over and discharged there.

Pond ash removal presents a significant difficulty to everyone due to their number, which is always growing.
Consequently, a global search was conducted to One of the most efficient techniques of utilisation is to use this waste material in concrete as a partial replacement for cement. Consideration is given to the idea of using pond ash, a byproduct of thermal power plants, in place of cement in concrete.

II LITERATURE REVIEW

O. A. Mohamed, S. I. El-dek& S. M. A. El-Gamal (2023)
his study focused on investigating the possibility of using different ratios (5, 10, 15 mass%) of recycled alum sludge (RAS) as partial replacement of ordinary Portland cement (OPC), to contribute to solving the problems encountered by cement production as well as stockpiling of large quantities of water-treated sludge waste. MnFe2O4 spinel nanoparticles (NMFs) were used to elaborate the mechanical characteristics and durability of different OPC-RAS blends. The outcomes of compressive strength, bulk density, water absorption, and stability against firing tests fastened the suitability of utilization of RAS waste for replacing OPC (maximum limit 10%). The inclusion of different doses of NMFs nanoparticles (0.5, 1 and 2 mass %) within OPC–RAS pastes, motivates the configuration of hardened nanocomposites with improved physico-mechanical characteristics and stability against firing. Composite made from 90% OPC–10% RAS–0.5% NMFs presented the best characteristics and consider the optimal choice for general construction applications. These hydrates boosted the robustness and degradation resistance of the hardened nanocomposites upon firing.

Ahmed, T.I., Tobbala, D.E. (2022)
A beneficial and convenient substitute for traditional, natural fine aggregate is granite dust. However, engineered cement composites (ECC) can use granite dust. Nevertheless, because it is a non-biodegradable material, numerous health and environmental risks are connected to it. However, it was thought in the current investigation that adding granite dust may greatly improve the technical properties of ECC. Sand is replaced with sections of 5, 10, 15, and 20% of granite dust by weight to create this composite. While the other mixture components are held constant, the primary parameter examined in this study is the % of granite dust replacement. The findings indicate that when granite dust is substituted for sand up to 10%, ECC mixes perform better than the control ECC mix in terms of compressive strength, flexural strength, and bond strength. Thus, the average reduction in water absorption caused by the addition of granite dust to ECC mixes is 28.8%. The reduction in the quantity of pores within the examined specimens has further demonstrated the positive effects of granite dust on the ECC microstructure. Additionally, the

obtained results suggest that granite dust can be used in place of sand to create ECCs with adequate characteristics.

reserved.ShehdehGhannam a , HusamNajm b, ⁎, Rosa Vasconez (2016)

Iron Powder (IP) and Granite Powder (GP) are industrial byproducts that are produced in powder form from the granite milling and polishing industries, respectively. Due to their airborne nature and ease of inhalation, these byproducts are largely left unused and pose a risk to human health. To determine whether granite powder and iron powder could replace some of the sand in concrete, an experimental examination has been conducted. The preparation and testing of twenty cubes and ten beams of concrete with GP and twenty cubes and ten beams of concrete with IP. GP and IP were substituted for sand at weight rates of 5%, 10%, 15%, and 20%, respectively. In comparison to other ratios, it was found that replacing 10% of the concrete's weight in sand with granite powder had the greatest impact on the material's compressive and flexural strengths. According to the test results, concrete with a 10% GP ratio had a 30% improvement in compressive strength over concrete with a normal GP ratio. The flexure also showed comparable outcomes. Additionally, it was found that adding iron powder to concrete instead of sand up to 20% by weight increased the concrete's compressive and flexural strengths.

Srinivasa. C. H.1 , 1Assistant Professor & Dr. Venkatesh2 2 Principal (2015)

Investigations on the optimisation of granite powder and its impact on the fresh and hardened properties of ready-mixed concrete with cement replacement were made. Granite powder and manufactured sand were used in the mix design for M20 Grade, which was completed in accordance with Indian Standard Code IS 10262:2009. Test samples were used to determine the ideal ratio of granite powder to ready-mix concrete for compressive strength. Slump and compacting factor were used to gauge workability. When manufactured sand and granite powder are used to replace 20 percent of the cement in ready-mix concrete, the strength is good. Concrete can be made with granite powder and manufactured sand as feasible substitute ingredients. The application of manufactured sand and granite powder is suggested in this research as a step towards sustainable development in India. This essay explores the viability of utilising granite powder in place of some of the cement when making ready-mix concrete. This report also exhorts engineers, contractors, and the government to accept alternative materials in the interest of a brighter future.

Dean and HOD of Civil Engineering, Dr M.G.R.(2020)

Due to the proliferation of industrial byproducts, environmental issues and its difficulties are quite prevalent in India. The biggest problem India faces is using the massive byproducts produced as a result of industrialization. One of the industrial by-products from the iron and steel manufacturing industries is iron slag. The results of this study now support the idea that using iron slag can reduce environmental pollution and prevent global warming. The characteristics of concretes including waste iron dust as fine aggregate were examined in the current research work. In concrete mixtures, waste iron dust was utilised in place of sand in percentages of 10%, 20%, 30%, and 40%. Concrete that was 7, 14, and 28 days old was tested for compression strength, split tensile strength, and flexural strength. The results were compared to concrete constructed with natural fine particles. This experimental effort demonstrated that the concrete had greater strength when waste iron powder was added than when the concrete was left alone. When natural sand is used in place of waste iron powder, increased strength has been seen. vigour compared to the control ECC mix. Thus, the average reduction in water absorption caused by the addition of granite dust to ECC mixes is 28.8%. The reduction in the quantity of pores within the examined specimens has further demonstrated the positive effects of granite dust on the ECC microstructure. Additionally, the obtained results suggest that granite dust can be used in place of sand to create ECCs with adequate characteristics.

KG. Shwetha a, CL. Mahesh, umar a, VibhaNDalawai b, SB. Anadinni c, GV. Sowjanya (2022)

As a partial replacement for conventional cement and coarse aggregate, various proportions of granite dust and granite chips are used in concrete to study its mechanical properties. In this article, several types of granite chips and dust were combined to form the cubes, cylinders, and beams in place of traditional aggregates and cement for different concrete grades. Different percentages of standard concrete, including 4%, 10%, and 15%, were used in place of the granite dust and chips. A workability test was conducted to establish the ideal water-to-cement ratio for M30 and M40 grade concrete. The ratio of 0.45 w/c was found to produce the highest compressive strength. Before being put through compressive, flexural, and split tensile tests in the lab, these specimens were cured in water for a specific amount of time. The test findings were compared to different types of typical concrete. The modified concrete may be used for non-load bearing structures like dividers and kerbs, among others. In this study, the viability of employing granite dust and chips to boost concrete's compressive, split tensile, and flexural strengths is investigated.

Akshay R. Kohli & Prof. N. G. Gore(2017)

With the development of modern technology, civil structures like tall skyscrapers and long span bridges have more flexibility built into their designs, making them more susceptible to external stimulation. As a result, these structures are susceptible to excessive modes of vibration caused by an earthquake and severe wind. These civil constructions' seismic response, wind force calculations, and forces such support reactions and joint displacement are estimated and incorporated into the structural design of a vibration-resistant structure to guard against serious structural damage. This paper's main goal is to build an earthquake-resistant structure. To do this, a seismic study of the structure using the static equivalent method of analysis will be conducted, and STADD Prosoftware will be used for building analysis and design.A G+11 residential block plan in Mumbai is taken into consideration for this. For earthquake zone 3, response reduction factor 3, ordinary moment resistant frame, and importance factor 1, seismic calculations are performed.Calculating all operating loads on the structure, including lateral loads brought on by wind and seismic excitation, ensures the structural safety of the building.

Aamar Danish a b, Mohammad,AliMosaberpanah b, Muhammad,Usama Salim (2021)

During the procedure (cutting and grinding), marble dust (MD) and granite dust (GD), respectively, are produced. The non-biodegradable dust produced by the aforementioned stones poses a number of environmental and health risks. Due to this, using MD/GD in place of cement to create sustainable cementitious composites (such concrete and mortar) has significantly increased in popularity. The impact of MD/GD on the engineering qualities of cementitious materials is critically discussed in this paper. Additionally, 100 researchers from across the world were questioned about the most important sustainability advantages and significant problems of adding MD/GD in cementitious composites as a cement replacement in order to explore sustainable development and issues linked to the fabrication of MD/GD-modified cementitious materials. According to research responses and published literature, MD/GD are suitable candidates to replace a sizable portion of cement in the preparation of cementitious composites because they can lower costs and environmental pollution without impairing the engineering properties of the finished cementitious composites. Last but not least, a framework for effective creation of cementitious materials containing MD/GD is offered based on participant feedback and published works, which (if used) can boost commercial use of MD/GD like slag.

Mullani Nabil Hasan 1, Abhijeet V. Harde 1, Aniket K. Padmawar 1, K. N. Narasimha Prasad 2, Radhakrishna 3, S. V. Venkatesh (2017)

In order to use less waste and hazardous materials in concrete while simultaneously reducing the amount of man-made CO2 released into the atmosphere, alternative materials for usage in cement and concrete are being explored more and more. It is becoming common to combine alternative materials with cement in binary, ternary, and quaternary blends in order to maximise the benefits of employing supplemental cementitious materials in concrete. In this work, cement is partially replaced with stone dust and a proprietary microfine slag in binary and ternary blends. It is evident that the supplemental cementitious elements have a synergistic effect on the finished concrete when utilised in a ternary blend.

Anayat Ali, Shamshad Alam 2019

Concrete and mortar are the most often utilised materials in infrastructure development and construction worldwide. The primary materials used to prepare mortar and concrete, fine

aggregate and coarse aggregate, both have a key influence in the mix design. Nowadays, river sand is getting increasingly difficult to find. As a result, artificial sand currently plays a significant role in the building sector. Due to overuse, natural resources are also depleting quickly. Finding a substitute material that can entirely or partially replace fine aggregate or coarse aggregate is necessary in order to prevent environmental harm from excessive erosion, which could have a direct impact on the building sector. Therefore, replacing fine aggregate and coarse aggregate has been necessary in recent years. Whether this replacement is partial or total, it will significantly contribute to the nature and environmental issues brought on by the excessive use and disposal of brick debris or construction waste. This examination of the literature will include the partial replacement of fine aggregate with brick dust, methods for reducing reliance on natural resources like sand used as fine aggregate, and a fresh method for getting rid of leftover brick debris. We'll check the various replacement levels of 10%, 15%, and 20%. Different tests revealed that adopting the ideal percentage substitution of natural fine aggregate with brick debris over conventional mortar and concrete increases compressive strength. Descriptors: Good Keywords: Fine aggregate, brick dust, sand, mortar.

III MATERIALS

Cement

Portland cement clinker is a hydraulic material that contains aluminum oxide (Al_2O_3), iron oxide (Fe_2O_3), and other oxides with not less than two-thirds of its mass made up of calcium silicates ($(CaO)_3SiO_2$ and $(CaO)_2SiO_2$). $(CaO)/(SiO_2)$ was less than 2.0 as measured by mass. Magnesium oxide (MgO) was not present in amounts greater than 5.0% (m/m).

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Figure no. 1Portland Cement , Brand; ACC

Iron Powder An industrial byproduct of the steel industry is iron oxide powder (Fe2O3). Iron powder has been shown to improve concrete's compressive strength, flexural strength, and splitting tensile strength when used in specific proportions. In this study, iron powder with a 200 nm particle size distribution was used as-is. At the percentages of 5, 10, 15, and 20% by weight of cement, it was used in place of Portland cement to some extent.

Figure 2: Iron Powder

The physical properties of iron are as follows:
1. It is a heavy metal with a density of 7.9 g/cc.
2. It is a lustrous metal, greyish white in colour.
3. It has highly malleable and ductile.
4. It is a good conductor of heat and electricity.
5. It can be magnetized.
6.It melts at 1536-degree Celsius and boils at 2861-degree Celsius.
7.It dissolved readily in dilute acids.

Fine Aggregates

It is the aggregate whose particles completely block the 0.15 mm mesh sieve despite passing through a 4.75 mm mesh sieve. Sand or crushed stone that has a diameter smaller than 9.55mm is considered a fine aggregate. Examples of fine aggregate include sand, crushed stone, cinder, ashes, and more. Sand is made up of tiny rock fragments and mineral particles and occurs naturally. Depending on the source, its composition varies. Its size distinguishes it as being finer than gravel and coarser than silt.

Figure no.3 Fine Aggregates (**sand)**

Coarse Aggregate

Concrete is made with coarse aggregates, which are granular and irregular materials like sand, gravel, or crushed stone. Coarse is typically found in nature and can be obtained by blasting quarries or crushing them manually or with crushers. Before using them to make concrete, they must be thoroughly cleaned.

Figure no. 4 Coarse Aggregate

Their angularity and strength affect the concrete in numerous ways. Needless to say, the selection of these aggregates is a very important process. Coarse aggregates are particulates that are greater than 4.75mm. The usual range employed is between 9.5mm and 37.5mm in diameter.

Water in Concrete

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. For these reasons, limiting and controlling the amount of water in concrete is important for both constructability and service life.

Figure no. 5 Water in Concrete

IV CONCLUSIONS

From reviewing the above research papers related to use of iron powder in concrete as a partial replacement of cement relevant Conclusions can be made:

(1) In comparison to concrete without iron powder (Fe2O3) particles, the compressive strength was dramatically increased when some of the cement was partially replaced with iron powder.

(2As the amount of iron powder particles increased, the slump of freshly laid concrete reduced.

(3) When the percentage of iron powder rose, the cured concrete absorbed more water.

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