Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

A PROJECT ON GREEN CONCRETE

Mr. DHARAVATH VENKATESH, Head of the Deperatment,
NIKHILESH KAMISETTY, M.Tech Student,
Mrs V Devi, Assistant Professor
DEPARTMENT OF CIVIL ENGINEERING
SIDDARTHA INSTITUTE OF TECHNOLOGY AND SCIENCES, Ghatkesar(M), Medchal.
vpersonal114@gmail.com, nikhilesh6798@Gmail.com

ABSTRACT

Green Concrete is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998. Green concrete has nothing to do with color. It is a concept of thinking environment into concrete considering every aspect from raw materials manufacture over mixture design to structural design, construction, and service life. Green concrete is very often also cheap to produce because for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided, energy consumption in production is lower, and durability is greater. Green concrete is a type of concrete which resembles conventional concrete, but the production or usage of such concrete requires minimum amount of energy and causes least harm to the environment. The CO_2 emission related to concrete production is between 0.1and 0.22 t per ton of produced concrete.

However, since the total amount of concrete produced is so vast the absolute figures for the environmental impact are quite significant, due to the large amounts of cement and concrete produced. Since concrete is the second most consumed entity after water it accounts for around 5% of the world's total CO_2 emission. The solution to this environmental problem is not to substitute concrete for other materials but to reduce the environmental impact of concrete and cement. The potential environmental benefit to society of being able to build with green concrete is huge. It is realistic to assume that technology can be developed, which can halve the CO_2 emission related to concrete production. During the last few decades society has become aware of the deposit problems connected with residual products, and demands, restrictions and taxes have been imposed.
Thus, environmental aspects are not only interesting from an ideological point of view, but also from an economic aspect. Green concrete has manifold advantages over conventional concrete. Since it uses the recycled aggregates and materials, it reduces the extra load in landfills and mitigates the wastage of aggregates. Thus, the net CO_2 emission is reduced. The reuse of materials also contributes intensively to the economy. Green concrete can be considered elemental to sustainable development since it is eco-friendly itself. Green concrete is being widely used in green building practices.

***Keywords*: Green concrete, recycled, cement, coarse and fine aggregates**

I. INTRODUCTION

1.1 What is green concrete?

Concrete which is made from concrete wastes that are eco-friendly are called **"Green concrete".** Green concrete is the production of concrete using as many recycled materials as possible and leaving the smallest carbon footprint possible**.** The other name for green concrete is resource saving structures with reduced environmental impact for e.g., Energy saving, co2 emissions, wastewater.

"Green concrete" is a revolutionary topic in the history of concrete industry. This was first invented in Denmark in the year 1998 by Dr. WG.

Concrete wastes like slag, power plant wastes, recycled concrete, mining and quarrying wastes, waste glass, incinerator residue, red mud, burnt clay, sawdust, combustor ash, plastic and foundry sand.
Green Concrete is a term given to concrete that has had extra steps taken in the mix design and placement to insure a sustainable structure and a long-life cycle with a low maintenance surface e.g., Energy saving, CO_2 emissions, wastewater.
Green concrete is defined as concrete which uses waste material as at least one of its components, or its production process does not lead to environmental destruction, or it has high performance and life cycle sustainability.
The goal of the Centre for Green Concrete is to reduce the environmental impact of concrete. To enable this, new technology is developed. Technology considers all phases of a concrete construction's life cycle, i.e., structural design, specification, manufacturing, and maintenance, and it includes all aspects of performance, i.e.

1) Mechanical properties (strength, shrinkage, creep, static behavior etc.)
2) Fire resistance (spalling, heat transfer etc.)
3) Workmanship (workability, strength development, curing etc.)

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

4) Durability (corrosion protection, frost, new deterioration mechanisms etc.)
5) Thermodynamic properties (input to the other properties)
6) Environmental aspects (CO2 emission, energy, recycling etc.)

1.2 SUITABILITY OF GREEN CONCRETE IN STRUCTURES

Several factors which enhance the suitability of green concrete in structures includes:
o Reduce the dead load of the structure and reduce the crane age load; allow handling, lifting flexibility with lighter weight.
o Reduction of emission of CO2 by 30%.
o Increased concrete industries' use of waste products by 20%.
o Good thermal and fire resistance, sound insulation than the traditional concrete.
o Improve damping resistance of the building.
o Use of new types of residual products, previously land filled or disposed of in other ways.
o No environmental pollution and sustainable development.
o It requires less maintenance and repairs.
o Compressive strength behavior of the concrete with water cement ratio is more than that of conventional concrete.
o Flexural strength of the green concrete is almost same as conventional concrete.
o CO2-neutral, waste-derived fuels shall substitute fossil fuels in the cement production by at least 10 %.
o Use of concrete industries own residual products

1.3 Here is a list of 4 benefits to using green concrete.

1.3.1 Lasts Longer: Green concrete gains strength faster and has a lower rate of shrinkage than concrete made only from Portland cement. Structures built using green concrete have a better chance of surviving a fire (it can withstand temperatures of up to 2400 degrees on the Fahrenheit scale). It also has a greater resistance to corrosion which is important with the effect pollution has had on the environment (acid rain greatly reduces the longevity of traditional building materials). All of those factors add up to a building that will last much longer than one made of ordinary concrete. Similar concrete mixtures have been found in ancient Roman structures and this material was also used in the Ukraine in the 1950s and 1960s.

1.3.2 Uses Industrial Waste: Instead of a 100 percent Portland cement mixture, green concrete uses anywhere from 25 to 100 percent fly ash. Fly ash is a byproduct of coal combustion and is gathered from the chimneys of industrial plants (such as power plants) that use coal as a power source. There are copious amounts of this industrial waste product. Hundreds of thousands of acres of land are used to dispose of fly ash. A large increase in the use of green concrete in construction will provide a way to use up fly ash and hopefully free many acres of land.

1.3.3 Reduces Energy Consumption: If you use less Portland cement and more fly ash when mixing concrete, then you will use less energy. The materials that are used in Portland cement require huge amounts of coal or natural gas to heat it up to the appropriate temperature to turn them into Portland cement. Fly ash already exists as a byproduct of another industrial process, so you are not expending much more energy to use it to create green concrete. Another way that green concrete reduces energy consumption is that a building constructed from it is more resistant to temperature changes. An architect can use this and design a green concrete building to use energy for heating and cooling more efficiently.

1.3.4 Reduces CO2 Emissions: To make Portland cement–one of the main ingredients in ordinary cement–pulverized limestone, clay, and sand are heated to 1450 degrees C using natural gas or coal as a fuel. This process is responsible for 5 to 8 percent of all carbon dioxide (CO2) emissions worldwide. The manufacturing of green concrete releases has up to 80 percent fewer CO2 emissions. As a part of a global effort to reduce emissions, switching over completely to using green concrete for construction will help considerably.

1.3.5 Use of Plastic waste: Due to increased urbanization across the globe, the concrete production demand has been at an all-time high. Usage of plastic as a substitute material in the concrete could reduce the usage of other non-replenishing sources used in the concrete. It is for the best to use the substitute materials in Concrete by safeguarding its properties, we protect the natural deposits. The recyclability is based on the quality of the plastic. After overstepping the limit, they aren't useful for recycling.
Herein, fine aggregates in the concrete mix are replaced with reused plastic such as polyethylene terephthalate (PET) & polypropylene (PP) partially. By introducing PET flakes and PP, the fresh and hardened properties of concrete are considered. Then a further comparative study is made for replaced plastic waste in conventional.

Although countable practical structures and structural parts have been constructed of plastic containing concrete, the worldwide use of plastic fiber in construction without compromising strength requires deeper and deterministic research regarding the utilization of waste material in concrete. Concrete containing plastics have been used in various projects

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

and countries. Sasaki (2006) reported that PET fiber reinforced concrete was successfully used.
Workability of concrete containing waste plastic begins to decrease as the amount of waste plastic increases.

Objectives of green concrete:

- To reduce greenhouse gas emissions, i.e., carbon dioxide emissions from the cement industry.
- To reduce the usage of pure resources such as limestone, clay, shale, natural river sand, natural rocks that are being used to make conventional concrete.
- Also, to reduce the wastage of materials in the concrete leading to air, land, and water pollution.
- It has sufficient strength and durability in comparison with standard concrete.
- Also has distinctive resistance to corrosion and effectively prevents acid rain.
- Buildings made of green concrete use less energy because they are more resistant to temperature changes, thus saving heating and cooling costs.
- Transferring this concrete for construction reduces the effect of global warming to some extent.

1.4. SCOPE OF GREEN CONCRETE

Green concrete is a revolutionary topic in the history of concrete industry. As green concrete is made with concrete wastes it does take more time to come in India because of industries having problem to dispose wastes and, having reduced Environmental impact with reduction in CO2 emission. Use of green concrete can help us reduce a lot of wastage of several products. Various non-biodegradable products can also be used and thus avoiding the issue of their disposal.

1.5 Types of wastes used in concrete

Recycled Demolition Waste Aggregate

CUBICS INDUSTRIES

Manufacturing of sand(M-Sand) for Concrete

Recycled Glass Aggregate

Recycled Concrete Material (RCM

Recycling plastic waste used for Rural Concrete Road Construction in India

II. About Green Concrete - Journals

2.1 Sustainable Green Concrete by using Biomass Aggregate - March 2020

The use of concrete for construction had become very common in developing countries. But concrete is not a friendly environment because it consumes huge quantities of natural materials and production of the cement, which is a major contributor to greenhouse gas emissions and global warming. The aim of this study is to investigate the Sustainable Green Concrete (SGC) which contains biomass aggregate; fly ash and Superplasticizer. Biomass aggregate and fly ash are waste industry products which are environmentally friendly. The study was carried out to identify the chemical properties of biomass aggregate, and to determine the chemical properties and optimum mix design of the Sustainable Green Concrete (SGC). A total of 90 cube samples were cast and compressive strength were tested at the age of 7, 14 and 28 days. The overall results showed that the workability and compressive strength were decreased with the increase of the replacement of natural aggregate with biomass aggregate. Besides that, the workability and compressive strength was increased with the incorporation with the replacement cement by fly ash. The SGC gained highest compressive strength for the concrete mixes of 39.3 N/mm2 with the optimum percentage used of SGC in producing concrete not exceeding 30% biomass aggregate and 6% of fly ash as a partial replacement with natural aggregate and cement respectively. The results obtained and observation made in this study suggested that biomass aggregate and fly ash are successfully used as partial replacement in producing SGC and can perform better strength development.

2.2 Prediction of mechanical properties of green concrete incorporating waste foundry sand based on gene expression programming – February 2020

Waste foundry sand (WFS) is a major pollutant generated from metal casting foundries and is classified as a hazardous material due to the presence of organic and inorganic pollutants which can cause adverse environmental impact. To promote the re-utilization of WFS, gene expression programming (GEP) has been employed in this study to develop empirical models for prediction of mechanical properties of concrete made with WFS (CMWFS). An extensive and reliable database of mechanical properties of CMWFS is established through a comprehensive literature review. The database comprises 234 compressive strengths, 163 split tensile strength and 85 elastic modulus results. The four most influential parameters i.e., water-to-cement ratio, WFS percentage, WFS-to-cement content ratio and fineness modulus of WFS are considered as the input parameters for modelling. The mechanical properties can be estimated by the application of proposed simplified mathematical expressions. The performance of the models is assessed by conducting parametric analysis, applying statistical checks, and comparing with regression models. The results reflected that the proposed models are accurate and possess a high generalization and prediction capability. The findings of this study can enhance the re-usage of WFS for development of green concrete leading to environmental protection and monetary benefits.

2.3 Environmental impact of sustainable green concrete 2020

The manufacture of cement contributes to about 8%–10% of CO_2 emission and globally increases the temperature of the environment. The development of sustainable green concrete by recycling the waste materials minimizes the usage of natural resources used for cement and concrete production and reduces its adverse effect on the environment. There are numerous waste materials from different industries and agriculture which are disposed of as landfills, without the knowledge of recycling the materials. To reduce the consumption of raw materials during cement production and other natural resources used during the concrete casting, these waste materials should be replaced in the concrete mix. The selection of materials for concrete mix would be based on the materials performance and cost. The new research trend showed the importance of nanotechnology by replacing existing materials with nanoparticles or nanomaterials. This will lead to the development of eco-friendly Green Concrete as a stronger and more durable concrete. This green concrete mix will have potential for commercialization, by providing developers and contractors with an alternative concrete. In this chapter, the importance of manufacturing Green Concrete using recycled waste materials and nanoparticles with their advantage and scope will be discussed in detail.

2.4 Evaluation of environment and economy viable recycling cement kiln dust for use in green concrete - November 2020.

The use of industrial plant wastes such as fly ash (FA) and cement_kiln dust (CKD) is an optimal solution to improve some of the fresh and hardened properties of concrete and also a rational choice to reduce the effect of carbon dioxide in the construction industry. In this study, different amounts of CKD (0–40%), as a waste material, and FA (0–30%) as a pozzolanic material, were used as a single and hybrid replacement of cement. Then, Taguchi method with two parameters of water to binder ratios and cement replacement ratio was used to determine the optimal mixing designs before construction from environmental and economic points of view. Comparison of the Taguchi method and experimental results for selecting the most favorable mixture designs showed that Taguchi method exhibited suitable choices in the range of optimal experimental results with regard to the initial parameters. This means that if the water-to-cement, CKD-to-cement, and the fly ash-to-cement ratios were 0.45, 9%, and 14%, respectively, it would be possible to obtain the best possible values for the strength to price, CO2 emission factor, and the standard deviation ratio.

III. PROJECT OVERVIEW

- Normal Concrete
- Design Mix done M25 for Multiple types of GREEN CONCRETE
- Comparison between compressive strength, technical details and costing of nominal concrete and replaced/Green concrete.
- Cement partly replaced by glass (Manufacture of Cement) and Fly ash (field mixing in concrete use)

- Coarse aggregates are replaced by debris of building material, plastic pet material and industrial waste.
- Fine aggregate is replaced by M-sand and plastic waste.

IV. PROJECT IMPLIMENTION
4.1 NOMINAL CONCRETE
Nominal Concrete Mix Design – M25
Data Required for Concrete Mix Design
(i) Concrete Mix Design Stipulation

(a) Characteristic compressive strength required in the field at 28 days grade designation — M 25 (b) Nominal maximum size of aggregate — 20 mm (c) Shape of CA — Angular (d) Degree of workability required at site — 50-75 mm (slump) (e) Degree of quality control available at site — As per IS:456 (f) Type of exposure the structure will be subjected to (as defined in IS: 456) — Mild (g) Type of cement: PSC conforming IS:455 (h) Method of concrete placing: pump able concrete

(ii) Test data of material (to be determined in the laboratory)

(a) Specific gravity of cement — 3.15 (b) Specific gravity of FA — 2.64 (c) Specific gravity of CA — 2.84 (d) Aggregate are assumed to be in saturated surface dry condition. (e) Fine aggregates confirm to Zone II of IS - 383

Procedure for Concrete Mix Design of M25 Concrete
Step 1 — Determination of Target Strength

Himsworth constant for 5% risk factor is 1.65. In this case standard deviation is taken from IS:456 against M 20 is 4.0.

$f_{target} = f_{ck} + 1.65 \times S$

$= 25 + 1.65 \times 4.0 = 31.6\ N/mm^2$

Where, S = standard deviation in N/mm^2 = 4 (as per table -1 of IS 10262- 2009)

Step 2 — Selection of water / cement ratio: -

From Table 5 of IS 456, (page no 20) Maximum water-cement ratio for Mild exposure condition = 0.55 Based on experience, adopt water-cement ratio as 0.5. 0.5<0.55, hence OK.

Step 3 — Selection of Water Content

From Table 2 of IS 10262- 2009, Maximum water content = 186 Kg (for Nominal maximum size of aggregate — 20 mm)

Table for Correction in water content

Parameters	Values as per Standard reference condition	Values as per Present Problem	Departure	Correction in Water Content
Slump	25-50 mm	50-75	25	(+3/25) x 25 = +3
Shape of Aggregate	Angular	Angular	Nil	-
			Total	+3

Estimated water content = 186+ (3/100) x 186 = 191.6 kg /m^3

V. DETAILS ABOUT RECYCLE MATERIALS FOR PRODUCING GREEN CONCRETE
5.1 GLASS AS A CEMENTACEOUS MATERIAL

Millions of tons of waste glass is being generated annually all over the world. Once the glass becomes a waste it is disposed as landfills, which is unsustainable as this does not decompose in the environment. Glass is principally composed of silica. Use of milled (ground) waste glass in concrete as partial replacement of cement could be an important step toward development of sustainable (environmentally friendly, energy-efficient and economical) infrastructure systems. When waste glass is milled down to micro size particles, it is expected to undergo pozzolanic reactions with cement hydrates, forming secondary Calcium Silicate Hydrate (C–S–H). In this research chemical properties of both clear and colored glass were evaluated. Chemical analysis of glass and cement samples was determined using X- ray fluorescence (XRF) technique and found minor differences in composition between clear and colored glasses. Flow and compressive strength tests on mortar and concrete were carried out by adding 0–25% ground glass in which water to binder (cement + glass) ratio is kept the same for all replacement levels. With the increase in glass addition mortar flow was slightly increased while a minor effect on concrete workability was noted. To evaluate the packing and pozzolanic effects, further tests were also conducted with same mix details and 1% super plasticizing admixture dose (by weight of cement) and generally found an increase in compressive strength of mortars with admixture. As with mortar, concrete cube samples were prepared and tested for strength (until 1year curing). The compressive strength test results indicated that recycled glass mortar and concrete gave better strength compared to control samples. A 20% replacement of cement with waste glass was found convincing considering cost and the environment.

Specific gravity and fineness of clear and colored waste glass powders (prepared by ball mill) were 3.01 & 0.9%

(#200 sieve) and 3.02 & 0.9% respectively as per ASTM standard mentioned above. Chemical composition of both glass powders was examined using an XRF-1800 Sequential X-ray fluorescence spectrometer. 20% binder was added to 80% glass powder to keep the material in position during the test.

Then the whole mixture was pressed using 140 KN pressing force. The chemical composition of glass powder is compared with other pozzolanic materials in the discussion. As the results of fineness, specific gravity and chemical composition test of color and clear glass powder were found similar, further experimental work with mortar and concrete was conducted with clear glass power.

5.2 FLY ASH AS A CEMENTACEOUS MATERIAL

5.2.1 About Fly ash

Fly ash is a fine powder which is a byproduct from burning pulverized coal in electric generation power plants. Fly ash is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water. When mixed with lime and water it forms a compound like Portland cement. The fly ash produced by coal-fired power plants provides an excellent prime material used in blended cement, mosaic tiles, and hollow blocks among others.

Fly ash can be an expensive replacement for Portland cement in concrete although using it improves strength, segregation, and ease of pumping concrete. The rate of substitution typically specified is 1 to 1 ½ pounds of fly ash to 1 pound of cement. Nonetheless, the amount of fine aggregate should be reduced to accommodate fly ash additional volume.

5.2.2 Fly Ash Applications

Fly ash can be used as prime material in blocks, paving or bricks; however, one the most important applications is PCC pavement. PCC pavements use a large amount of concrete and substituting fly ash provides significant economic benefits. Fly ash has also been used for paving roads and as embankment and mine fills, and its gaining acceptance by the Federal government, specifically the Federal Highway Administration.

5.2.3 Fly Ash Drawbacks

Smaller builders and housing contractors are not that familiar with fly ash products which could have different properties depending on where and how it was obtained. For this reason, fly ash applications are encountering resistance from traditional builders due to its tendency to effloresce along with major concerns about freeze/thaw performance.

Other major concerns about using fly ash concrete include:

- Slower strength gain.
- Seasonal limitation.
- Increase in air entraining admixtures.
- An increase of salt scaling produced by higher fly ash.

5.2.4 Fly Ash Benefits

Fly ash can be a cost-effective substitute for Portland cement in some markets. In addition, fly ash could be recognized as an environmentally friendly product because it is a byproduct and has low embodied energy. It's also available in two colors, and coloring agents can be added at the job site. In addition, fly ash also requires less water than Portland cement and it is easier to use in cold weather.

5.2.5 Fly Ash Types

Currently, more than 50 percent of the concrete placed in the U.S. contains fly ash. Dosage rates vary depending on the type of fly ash and its reactivity level. Typically, Class F fly ash is used at dosages of 15 to 25 percent by mass of cementitious material, and Class C fly ash at 15 to 40 percent.

Class F fly ash, with particles covered in a kind of melted glass, greatly reduces the risk of expansion due to sulfate attack as may occur in fertilized soils or near coastal areas. Class F are generally low- calcium fly ashes with carbon contents of less than 5 percent but sometimes as high as 10 percent. Class C fly ash is also resistant to expansion from chemical attack, has a higher percentage of calcium oxide, and is more commonly used for structural concrete. Class C fly ash is typically composed of high-calcium fly ashes with carbon content less than 2 percent.

VI. PLASTIC AS PARTIAL REPLACEMENT OF FINE AGGREGATE:

Plastic

Synthetic and the semi-synthetic materials today are referred to as plastics. These plastics have applications in many areas like Health care, Transport, Packaging, Construction, Agriculture, Sports, Electronics, Energy, etc. since they are a versatile substance. Cellulose, natural gas, coal, and mixed oils are some of the core/raw materials that produce plastic. Plastics are of relatively low density and corrosion resistant materials. They are also excellent thermal as well as electrical insulators. The circular economy can be established by recycling plastic waste.

As there is a low degradability factor for plastics, it would inevitably create problems for the environment which includes animals and mammals.

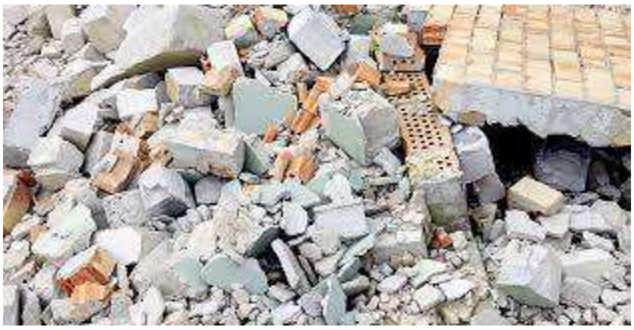
Plastic in Concrete:

Due to increased urbanization across the globe, the concrete production demand has been at an all-time high. Usage of plastic as a substitute material in the concrete could reduce the usage of other non-replenishing sources used in the concrete. It is for the best to use the substitute materials in Concrete by safeguarding its properties, we protect the natural deposits. The recyclability is based on the quality of the plastic. After overstepping the limit, they aren't useful for recycling.

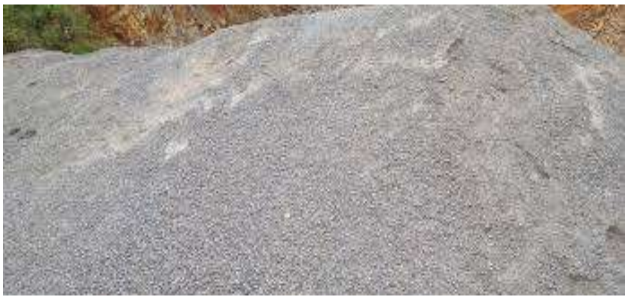
Herein, fine aggregates in the concrete mix are replaced with reused plastic such as polyethylene terephthalate (PET) & polypropylene (PP) partially. By introducing PET flakes and PP, the fresh and hardened properties of concrete are considered. Then a further comparative study is made for replaced plastic waste in conventional.

Fine recycled aggregate: Recycled fine aggregates (RFA) are **sustainable materials for constructions**. RFA content and porosity are major factors that influence the durability of concrete. Optimum percentage replacement of river sand by RFA was found 30%. The duration of concrete increased with the age of the concrete irrespective of RFA content.

Demolished brick waste: Demolition wastes are heterogeneous mixtures of building materials such as aggregate, concrete, wood, paper, metal, insulation, and glass that are usually contaminated with paints, fasteners, adhesives, wall coverings, insulation, and dirt.

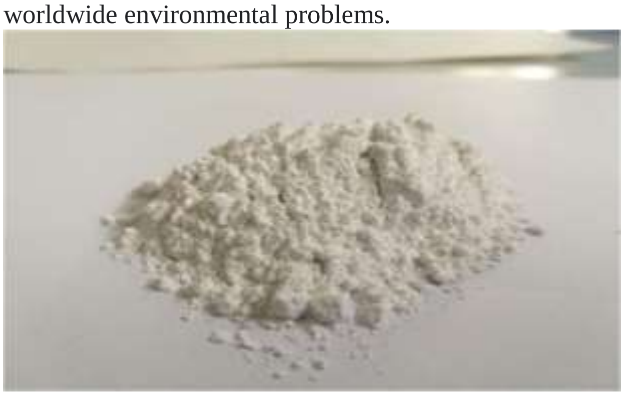


Quarry dust: Quarry dust is **a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates**. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste.



Waste glass powder: Glass powder (GP) is **a reactive pozzolan and effective ASR inhibitor**. • GP can enhance the properties of concrete with selective particle size and dosage. • GP can facilitate the geo polymerization process of alkali activated materials.

Marble sludge powder: Marble has been commonly used as a building material since ancient times. The disposal of waste materials from the marble industry, consisting of **sludge that is composed of powder mixed with water**, is one of the current worldwide environmental problems.



Rock dust and pebbles:

Stone dust is a waste material obtained from crusher plants. It has potential to be used as **partial replacement of natural river sand in concrete**. Use of stone dust in concrete not only improves the quality of concrete but also conserves the natural river sand for future generations.

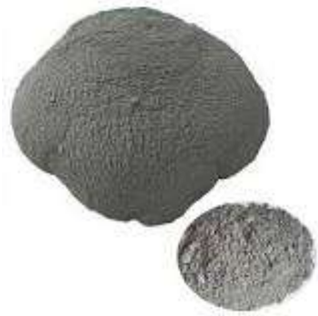
Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

Artificial sand: Manufactured sand or manufactured fine aggregate (MFA) is **produced by reducing larger pieces of aggregate into sand-sized aggregate particles**. Manufactured sands tend to be used in mixtures in areas where natural sand is not available or not cost effective to be hauled to the needed location.

Waste glass: Waste glass is **another waste material that is produced in large quantities and is difficult to eliminate**. It is known that most of the waste glass is collected, especially container glasses, remelted, and used to produce new glass. However, not all of the waste glass is suitable for the production of new glass.

Fly ash and Micro silica:

Silica fume has higher compressive strength than the fly ash. For example, long term strength will increase up to 25% with 30% Class C fly ash mix, whereas 15% microsilica mix will increase strength by 30%. Silica fumes also have significant advantage over fly ash when permeability is a factor.



Bottom ash of Municipal solid waste: The use of **MSW incinerated bottom ash (MIBA) has an exceptional potential of supporting sustainability by conserving natural resources**. The paper targets the possible benefits of MIBA in various construction and soil improvement projects by compensating the primary aggregates.

Waste Marble Dust:

Marble disposal may contain very fine powder. Marble powder is produced from the marble processing plants during the cutting, shaping, and polishing and during construction. During these processes, about 20-25% of the process marble is turned into powder form. India is topmost exporter of marble.

VII. METHODOLOGY

Specifications

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

- M25 Grade concrete
- Water cement ratio = 0.45
- Coarse aggregate of 20mm size(1600kg/m3)
- Fine aggregate (Dry sand 1600kg/m3)
- Cement – OPC (Grade 45) (unit weight- 1440 kg/m3)
- Glass
- Fly ash (from NTPC power plant, Dadri)

Apparatus:

- Cube Mould (150x150x150 mm or 100x100x100 mm)
- Tamping bar (16 mm diameter and bull-nosed)
- Steel Float/Trowel.
- Compressive strength Testing machine
- Curing Tank
- Weighing machine
- Pan
- Hammer
- Cylindrical mould
- Sieving machine

Procedures of Making Concrete Cube:

1. Cleaning & fixing mould
2. Breaking of Glass
3. Mixing cement, glass, and Fly ash.
4. Placing, Compacting & Finishing concrete
5. Curing

Cleaning & fixing mould

- Clean the cube-mould properly and apply oil on the inner surface of mould. But no oil should be visible on the surface.
- Fix the cube mould with base plate tightly. No gap should be left in joints so that cement-slurry doesn’t penetrate.

Breaking of Glass

- We bought the glass from a nearby rag picker shop.
- The glass is broken into very small pieces with the help of a hammer.
- The grinded glass is then put in a sieving machine.
- Sieving is done for 15 min.
- The last sieve used in the sieve test is a 1.41 mm sieve and glass passing through this sieve is used.

Mixing cement glass and Fly ash

- Amount of cement, glass, and fly ash to be used is bought into a pan.
- The mixture formed is either mixed with the hands or with the help of a trowel.
- The whole ingredients are mixed till the color of the mixture matches with the cement color.
- Proper precautions should be taken while mixing cement and glass as both these elements can cut skin.

Placing, Compacting & Finishing concrete.

- Take concrete from three or four random mixes.
- Place concrete into mould in three layers. Compact each layer by giving 35 blows of tamping bar.
- Remove excess concrete from the top of mould and finish concrete surface with trowel. Make the top surface of concrete cube even and smooth.
- Left the mould completely undisturbed for first four hours after casting.
- After ending the undisturbed period, put down casting date and item name on the top of concrete specimen with permanent marker.

Curing

Curing is the maintaining of an adequate moisture content and temperature in concrete in the early Ages so that it can develop properties the mixtures were designed to achieve. Curing begins Immediately after placement and finishing so that concrete may develop the desired strength and Durability.

Without an adequate supply of moisture content, the cementitious materials in concrete cannot

React to form a quality product. Drying may remove the water needed for this chemical reaction called hydration and the concrete will not achieve its potential properties. Temperature is an important factor in proper curing, since the rate of hydration, and therefore, strength development, is faster at high temperature. Generally, concrete temperature should be maintained above 50F for an adequate rate of strength development. Further, a uniform temperature should be maintained through the concrete section it is gaining strength to avoid thermal cracking. For exposed concrete, relative humidity and wind condition are also important; they contribute to the rate of moisture loss from the concrete and could result in cracking, poor surface quality and durability. Protective measures to control evaporation of moisture from concrete surfaces before it sets are essential to prevent plastic shrinkage cracking.

Liquid after finishing. Do not apply to concrete that is still bleeding or has visible water seen on the surface. While a clear liquid may be used, a white pigment will provide reflective properties and allow for a visual inspection of coverage. A single coat may be

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 3, March : 2023

adequate, but where possible a second coat, applied at right angles to the first, is desirable for even coverage. If the concrete membrane- forming curing compounds conform to ASTMC309. Apply to the concrete surface for about one hour will be painted, or covered with vinyl or ceramic-tile, then a liquid compound that is non-reactive with the paint or adhesives must be used or use a compound that is easily brushed or washed off. On floors, the surface should be protected from the other trades with scuff-proof paper after the application of the curing compound.

Plastic sheets - either clear, white (reflective) or pigmented. Plastic should conform to ASTM C 171, be at least 4 milli thick, and preferably reinforced with glass fibers. Dark colored sheets are recommended when ambient temperatures are below 60°F (15°C) and reflective sheets should be used when temperatures exceed 85°F (30°C). The plastic should be laid in direct contact with the concrete surface as soon as possible without marring the surface. The edges of the sheets should overlap and be fastened with waterproof tape and then weighed down to prevent the wind from getting under the plastic. Plastic can make dark streaks wherever a wrinkle touches the concrete, so plastic should not be used on concretes where appearance is important. Plastic is sometimes used over wet burlaps to retain moisture Waterproof – used like plastic sheeting but does not mar the surface. This paper generally consists of two layers of craft paper cemented together and reinforced with fiber.

PROCESS INVOLVED

How fly ash and glass works with cement in concrete?

Ordinary Portland cement (OPC) is a product of four principal mineralogical phases. These phases are Tricalcium silicate- C3S (3CaO.SiO2), Dicalcium Silicate – C2S (2CaO.SiO2), Tricalcium Aluminate- C3A (3CaO. Al2O3) and Tetra-calcium alumino-ferrite – C4AF (4CaO.Al2O3 Fe2O3). The setting and hardening of the OPC takes place as a result of the reaction between these principal compounds and water. The reaction between these compounds and water are shown as under:

2C3S + 6H = C3S2H3 + 3CH

tricalcium silicate water C-S-H gel Calcium hydroxide 2C3S + 4H 3S2H3 + CH

The hydration products from C3S and C2S are similar but quantity of calcium hydroxide (lime) released higher in C3S as compared to C2S.

The reaction of C3A with water takes place in the presence of sulphate ions supplied by dissolution of gypsum present in OPC. This reaction is very fast and is shown as under:

C3A + 3(CSH2) +26H 3 A(CS)3H32

tricalcium aluminate +gypsum +water C3A + CSH2 + 10H C3ACSH12

mono-Sulphur-aluminate hydrate.

FLYASH FOR CEMENT CONCRETE

Tetra-calcium-alumino-ferrite forms hydration product similar to those of C3A with iron substituting partially for alumina in the crystal of ettringite and mono-sulpho-aluminate hydrate.

The above reaction indicates that during the hydration process of cement, lime is released out and remains as surplus in the hydrated cement. This leached out surplus lime renders deleterious effect to concrete such as make the concrete porous, give chance to the development of micro-cracks, weakening the bond with aggregates and thus affect the durability of concrete.

If fly ash is available in the mix, this surplus lime becomes the source for pozzolanic reaction with fly ash and forms additional CS-H gel having similar binding properties in the concrete as those produced by hydration of cement paste. The reaction of fly ash with surplus lime continues as long as lime is present in the pores of liquid cement paste.

VIII.CONCLUSION

The tests were conducted, and the observed values are concluded as follows:

- We can replace cement by glass safely up to 30% and little more but we cannot replace it by 45 % & more.
- We can replace cement with (glass + fly ash) up to 30% but we cannot replace it by 45 % & more.
- 28 days strength obtained from (glass + fly ash) is more than 28 days strength of glass replacement.
- On strength, criteria by glass + fly ash replacement is better than by only glass-replacement.
- It reduces the CO2 emission up to 30%
- At 15% replacement by glass powder strength came 24.2% more than normal concrete.
- At 30% replacement strength came 5.37% more than normal concrete
- At 15 % replacement by (glass +fly ash) strength came 34 % more than normal concrete.
- At 30% replacement by glass + fly ash strength came 6.48% more than normal concrete.
- By using the ceramic tile aggregate, the mass of aggregate reduces about 50 % which in turn reduces the weight of concrete.
- Ceramic waste can be used as coarse aggregate as the properties of ceramic waste coarse aggregate are within the range of the values of concrete making aggregate according to Indian Standards.
- By observing the test results, it is concluded that the aggregates which are obtained naturally can be replaced by recycled

aggregate about fifty percent is being recommended since it attains the similar strength compared to normal concrete. Further replacement above 50% can be done by introducing some admixtures to maintain workability.

- A mining process is required for obtaining the normal aggregates, but for recycled aggregates this process can be avoided. The results of this paper give the strength qualities of RCA's for using them effectively in structural concrete which is having higher strength.

- As the population is increasing in the world, the material waste is also increasing drastically. So, the research on the recycling of waste materials is given a great importance now a days. As the recycled aggregates are cheaper and more easily available when compared to the normal aggregates, so many of the investigations are done on it.

REFERENCES

1)Zhen Chen, Chi Sun Poon (2016). "Comparing the use of sewage sludge ash and glass powder in cement mortars".
2) Dr.G. Vijaykumar, Ms.H. Vishaliny, Dr. D. Govindarajulu (2013). "Studies on glass powder as partial replacement of cement in concrete production".
3) Neeraj jain, Mridul Garg and A.K. Minocha (2015). "Green concrete from sustainable recycled coarse aggregates, mechanical and durability properties".
4) V. A. Fulari (2014). "Effect of fly ash".
5) Hongjian du, Kiang hwee Tan (2014). "Waste glass powder as cement replacement in concrete".
6) Abbas mohajerani, John vajna (2017). "Practical recycling applications of crushed waste glass in construction materials".
7) G.M.Sadiqul Islam, (2016). "Waste glass powder as partial replacement of cement for sustainable concrete practice".
8) N.A. Soliman, A.Tagnit-Hamou (2016). "Development of ultra-high-performance concrete using glass powder".
9) P.R.Wankhede (2014). "Effect of fly ash on properties of concrete".
10) Aci Materials journal, (2014). "Concrete with recycled glass as fine aggregates".
11) V. A. Fulari (2014). "Effect of fly ash".
12) Fasih Ahmed khan, Muhammad Fahad, khan Shahazada, Haris Alam Naveed Ali (2015).
"Utilization of waste glass powder as a partial replacement of cement in concrete".
13) IS 19262- 1982 (reaffirmed 2004).

14) **Mohd Mustafa Al Bakri**, H. Kamarudin, Che Mohd Ruzaidi, Shamsul Baharin, R. Rozaimah, Nur Khairiatun Nisa. Concrete with Ceramic Waste and Quarry Dust Aggregates. 5th Annual Conference Management in Construction Researchers Association, 2006: 383-388.

15) **Nehdi Monce, Khan Ashfaq**. Cementitious Composites Containing Recycled Tire Rubber: An Overview of Engineering Properties and Potential Applications. Cem Concr Aggregates 2001; 23(1): 3–10.

16) **Basri HB, Mannan MA, Zain MFM**. Concrete Using Waste Oil Palm Shells as Aggregate. Cem Concr Res 1999(29): 619–22.

17) Radonjanin, Vlastimir, Mirjana Malešev, Snežana Marinković, and Ali Emhemd Saed Al Malty. "Green recycled aggregate concrete." *Construction and Building Materials* 47 (October 2013): 1503–11. http://dx.doi.org/10.1016/j.conbuildmat.2013.06.076.