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CHAPTER-1

## INTRODUCTION

## GENERAL

### Concrete:

Concrete is defined as a mixture of sand, gravel and water which dries hard and strong & is used as a material for building. Concrete, usually **Ordinary** **Portland Cement Concrete**, is a composite material composed of fine and coarse aggregate bonded together with a fluid cement that hardens overtime most frequently in the past a lime-based cement binder, such as lime-putty, but sometimes with other hydraulic cements, such as calcium aluminates, cement or portable cement. It is distinguished from other non- cementitious types of concrete all binding some form of aggregate together, including asphalt concrete with a bitumen binder, which is frequently used for road surfaces, and polymer concrete that use polymers as a binder.

Concrete is one of the oldest and most common construction materials in the world, mainly due to its low cost, availability, its long durability, and ability to sustain extreme weather environments. Concrete is a brittle material that has a high compressive strength, but a low tensile strength. Thus, reinforcement of concrete is required to allow it to handle tensile stresses.

**WASTE BRICK POWDER:**

Bricks are widely used construction and building material around the world. Bricks have been major construction and building material for a long time. The worldwide annual production of bricks is currently about 1391 billion units and the demand for bricks is excepted to be continuously rising. Since the increasing demand on building materials in the last decade, the civil engineers have been in challenged to covert the industrial wastes into useful building and construction materials. Accumulation of unmanaged wastes especially at the developing countries as a result in an increase on environmental concern. Recycling of such wastes as building material appears to be viable solution not only to solve such pollution problem but also to the problem of economic design of buildings.

The increase in popularity of using environmentally friendly and low cost construction materials in building industry has brought about the need to investigate how this can be achieved by benefiting to the environment as well as maintaining the material requirements affirmed in the standards.

**Brick powder** is obtained from the dust of disintegrated bricks also the waste bricks are obtained from garbage of a brokenbuilding. The collected waste bricks are pulverized to get the particle passing through 75-micron sieve to get the grading of fine aggregate for 5%, 10%, and 15% brick powder is used as replacement for fine aggregate in the experiments.

Brick dust occurs from loading or unloading, construction sites and brick kilns. This dust is used in dumping and filling. There are thousand Tons of brick waste generated each year around the world which goes in unplanned way. Pozzolanic materials such as brick dust and other ceramics powder has been used in concrete since ancient times. In ancient times the brick dust was used according to experiences and experiments as they were unaware of the properties of brick dust. Bricks are made up of different types of clays and other materials like sand. Clay composed up of 20-30% Alumina, 50-60% Silica, and other carbonates and oxides. The waste bricks used in this study were obtained from recycled bricks. Cracked pieces of bricks were crushed by a jaw crusher. And at laboratory scale the bricks wastes were ground with an air jet mill to obtain bricks powder. The resulting powders were sieved through a 45-µm (325 mesh) sieve. The chemical compositions of brick pastes were analyzed and results obtained.

**Bricks waste may come from two sources:** The first source is the bricks industry, and this waste is classified as non-hazardous industrial waste, the second source of bricks waste is associated with construction and demolition activity, and constitutes a significant fraction of construction and demolition waste. Therefore, the replacement of fine aggregate by bricks wastes has the advantage of solving several environmental problems.

## Scope of the Study:

* To use waste brick powder as a construction material.
* Grade of M20 grade Concrete.
* Mechanical Properties of Concrete are limited to Compressive strength, Flexure strength and Tensile strength.
* Durability tests on Concrete.

## Objectives:

The main objectives of present study are:

* To study the suitability of waste brick powder in concrete.
* To study the mechanical properties of waste brick powder in concrete.
* To study the durability of waste brick powder in concrete.
* Cost Analysis.

CHAPTER**-2**

## LITERATURE SURVEY

The literature review is a written overview of major writings and other sources on a selected topic. The literature review provides a description, summary and evaluation of each source. It is usually presented as a distinct section of a graduate thesis or dissertation.

**J. Martina Jenifer (2016):**

Concrete is the most material being used in infrastructure development throughout the world. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not readily available, it is transported from a long distance. Those resources are also exhausting very rapidly. The non-availability or shortage of river sand will affect the construction industry, hence there is a need to find the new alternative material to replace the river sand, such that excess river erosion and harm to environment is prevented. Many researchers are finding different materials to replace sand. This study aimed to investigate the suitability of using crushed brick in concrete. Crushed brick originated from demolished masonry was crushed in the laboratory and added partial sand replacement. Three replacement levels, 15%,20% and 25%, were compared with the control. The tests on concrete showed that the mechanical properties (compressive, flexural and splitting tensile strengths) of concrete containing crushed brick were well comparable to those of the concrete without ground brick.

**Thamilselvi, Et.al (2017):**

In the construction industry the widely used material is concrete. Fine aggregate is one of the important constituent in it. Bricks being an integral part of the wall can be used as recyclable construction material. Fire bricks are the products which are manufactured from refractory grog, plastic and non-plastic clays of high purity. The different raw materials are properly homogenized and pressed in high capacity presses to get the desired shape and size. Finally, these are fired in oil-fired kiln at a temperature of 13000 c. Due to the exposure to continuous high temperature for a period of 10 to 15 days, some physical

And mechanical properties are changed. They were physically cleaned and mechanically crushed to a size gradation conforming to fine aggregates.

**Diniya David, Et.al (2017):**

Light weight concrete has tremendous advantages such as lower density and thermal insulation property and also strong enough to be used for structural purposes. Cellular concrete comes under the classification of this light weight concrete. Most important property of cellular concrete is low thermal conductivity. This property can be improved by decreasing the density. It will significantly reduce the dead load of structural elements. In this present experimental investigation, the cellular property is achieved by addition of aluminum metal powder in varied percentages such as 0.5, 1, 1.5, 2, 2.5, and 3%. Crushed clay brick is used as replacement of conventional fine aggregate with varied percentages such as 10, 20,23,25,27 and 30% in each percentage of cellular concrete. The cellular property is improved by increased addition of aluminum metal powder. The compressive strength will increase up to 25% replacement of crushed clay brick in cellular concrete. It is concluded that addition of 1% of aluminum metal powder along with varied crushed clay brick percentages, satisfy the light weight property and compressive strength. From these experimental results we can say that, this concrete belongs to structural light weight concrete.

**A.Siva, Et.al (2017):**

Fine aggregate is a widely used construction material all over the world. Various researches have been done for the replacement of the construction materials for efficient purposes of which crushed spent fire bricks is one of them. This project explains about the replacement of fine aggregates by partially crushed spent fire bricks. Therefore, varying percentage of fine aggregates by crushed spent fire bricks with varying percentage of 10%, 15%, 20% & 25% and optimum percentage of replacements is made and strength and workability parameters are studied. The workability of concrete gets decreased with the addition of the crushed spent bricks. From the test results, crushed spent fire bricks replaced for fine aggregates give a maximum strength at 20% when compared to conventional concrete. Then the optimum percentage of replacement of fine aggregates by crushed spent fire bricks are

used in combination as partial replacement in concrete and the optimum percentage of the combination is obtained.

**Awadhesh Chandramauli, Et.al (2018):**

India is a developing country. Developing infrastructure leads to consumption of concrete. Sand have big value in concrete. But natural sands are limited resources. River sand is most common fine aggregates in concrete. Due to excessive production of the river sand, it is banned by the government of India. Thus replacement of sand becomes need in last decays and the partially replacement will contribute to a good point to the research area. Number of researcher doing work on the replacement of sand by number of material like waste glass powder, crushed fir bricks and etc. Fire bricks are used to prevent the heat transfer in industries, lining furnace and fire places. The waste material of fire bricks can be used as fine aggregates. Properties of fire bricks are increases the strength of concrete. This research able to reduce the dependency on sand and open a new option to dispose of waste fire bricks. Partial replacement is done at 0%, 22%, 25%, 28% and 31% in this project. The test result says the 28% replacement gives the maximum tensile strength.

**R. Veerakumar, R. Et.al (2018):**

Concrete is the most material being used in infrastructure development throughout the world. Fine aggregate is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Fine aggregates are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a day’s fine aggregate is not readily available, it is transported from a long distance. Those resources are also exhausting very rapidly. The non-availability or shortage of fine aggregate will affect the construction industry, hence there is a need to find the new alternative material to replace the fine aggregate, such that harm to environment is prevented. Many researchers are finding different materials to replace fine aggregate. This study aimed to investigate the suitability of using brick debris in concrete in place of fine aggregate. Brick debris originated from demolished masonry walls crushed in the laboratory and added in partial fine aggregate replacement. Four replacement levels, 5%, 10%, 15%, and 20%, were compared with the control. The tests on concrete showed that the mechanical properties (compressive strength

test) of concrete containing brick debris were well comparable to those of the concrete without ground brick.

**Shruthi H G, Et.al (2018):**

Concrete is the most important material being used in infrastructure development throughout the world. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not readily available, it is transported from a long distance. Those resources are also exhausting very rapidly. The non-availability or shortage of river sand will affect the construction industry; hence there is a need to find the new alternative material to replace the river sand, such that excess river erosion and harm to environment is prevented. Many researchers are finding different materials to replace sand. This study aimed to investigate the suitability of using crushed brick in concrete. Crushed brick originated from demolished masonry was crushed in the laboratory and added partial sand replacement. Five replacement levels, 10%,20% ,30%,40%, 50%, were compared with the control. The tests on concrete showed that the mechanical properties (compressive strengths) of concrete containing crushed brick were well comparable to those of the concrete without ground brick.

**Anayat Ali, Et.al (2019):**

The widely used material in infrastructure development and construction throughout the world is concrete and mortar. A significant role in the mix design is played by fine aggregate and coarse aggregate which are the prime material used for the preparation of mortar and concrete. River sand is becoming a scarce commodity nowadays. Hence the manufactured sand is playing a major role in the construction industry nowadays. The natural resources due to excessive use are also exhausting very rapidly. Shortage of fine and coarse aggregate may affect construction industry directly, therefore there is a need to find an alternative material which can replace fine aggregate or coarse aggregate fully or partially so that the damage due to excessive erosion to the environment is prevented. Thus, the replacement of fine aggregate and coarse aggregate became a necessity in the recent times and this partial

or complete replacement will contribute a lot to nature and environmental problems created due to excessive use and dumping of brick debris or construction waste. This research review will discuss the partial replacement of fine aggregate with brick dust and how to reduce the dependency on the natural resources such as sand used as fine aggregate and provide a new way to dispose of waste brick debris. Different replacement levels 10%, 15%, and 20%, will be checked. Different tests showed that the compressive strength is enhanced by using optimum percentage replacement of natural fine aggregate with brick debris compared to conventional mortar and concrete.

**Rafat Siddique b, Et.al (2019):**

In the present study, the influence of using marble waste as fine aggregates in concrete is investigated. The marble waste is used as partial replacement of natural river sand, with the replacement levels varying from 10 to 60%. The effect of using marble waste aggregates is investigated in terms of workability, compressive strength, drying shrinkage and micro-structural properties of concrete. Test results indicate that marble waste aggregates can be incorporated into concrete to improve its strength and shrinkage properties. There is an improvement in compressive strength by 20% with the incorporation of marble waste aggregates, with the corresponding decrease in drying shrinkage by 30%. Maximum benefit in terms of compressive strength and drying shrinkage was observed till 40% replacement level. Microstructural analysis also revealed densification of concrete matrix, which is attributed to refinement of pores due to physical and chemical changes in the concrete matrix. A comparison of observed shrinkage strains with the predicted values obtained from the well-established prediction models confirm the requirement for incorporation of an additional parameter based on the percentage of marble waste to be adopted to predict the shrinkage values of such mixes accurately. Further, a multivariable regression model is developed for the prediction of shrinkage strain of mixes containing marble waste aggregates. The various parameters included in the prediction model are 28-day compressive strength, drying duration and proportion of marble waste used as fine aggregates. A high correlation coefficient (R2) obtained between the experimental and predicted values indicate the effectiveness of the proposed model.

**A.B.M.A. Kaish a, Et.al (2021):**

Water treatment plant generates alum sludge as waste during the process of treating drinking water for human consumption. Notwithstanding the benefits of treating water, there are still problems associated with the disposal of waste generated from the water treatment plant after the treatment process. Studies have shown that the conventional disposal method is associated with environmental hazards; and there is a need to derive more sustainable method of alum sludge disposal. This study focused on investigating the properties of concrete incorporating alum sludge as a partial replacement of fine aggregate. The alum sludge used in this study as replacement of fine aggregate was prepared in two ways; oven-dried under temperature 105 degree Celsius and 300-degree Celsius heated alum sludge (heated in the furnace). Both alum sludge (oven-dried alum sludge, degree Celsius heated alum sludge) was crushed/grinded to obtain a maximum particle size of 65 mm and used to replace fine aggregate in different proportions (0%, 5%, 10% and 15%). The produced concrete was tested for fresh properties; and then cured at 7, 28, 56, 90 and 180 days to test for hardened and durability properties. The results from the study showed that oven-dried alum sludge and 300-degree Celsius treated alum sludge produce a workable mix and can be used as replacement of fine aggregate with optimum replacement content of 10%. Both alum sludge improved the density of the concrete, strength properties of the concrete and concrete durability. At 15% replacement content of fine aggregate with oven dried and 300-degree Celsius heated alum sludge, yield a decrease in workability and strength properties, with poor durability properties.

**Kirti Vardhan a, Et.al (2019)**

In the present study, the influence of using marble waste as fine aggregates in concrete is investigated. The marble waste is used as partial replacement of natural river sand, with the replacement levels varying from 10 to 60%. The effect of using marble waste aggregates is investigated in terms of workability, compressive strength, drying shrinkage and micro-structural properties of concrete. Test results indicate that marble waste aggregates can be incorporated into concrete to improve its strength and shrinkage properties. There is an improvement in compressive strength by 20% with the incorporation of marble waste

aggregates, with the corresponding decrease in drying shrinkage by 30%. Maximum benefit in terms of compressive strength and drying shrinkage was observed till 40% replacement level. Microstructural analysis also revealed densification of concrete matrix, which is attributed to refinement of pores due to physical and chemical changes in the concrete matrix. A comparison of observed shrinkage strains with the predicted values obtained from the well-established prediction models confirm the requirement for incorporation of an additional parameter based on the percentage of marble waste to be adopted to predict the shrinkage values of such mixes accurately. Further, a multivariable regression model is developed for the prediction of shrinkage strain of mixes containing marble waste aggregates. The various parameters included in the prediction model are 28-day compressive strength, drying duration and proportion of marble waste used as fine aggregates. A high correlation coefficient (R2) obtained between the experimental and predicted values indicate the effectiveness of the proposed model.

**Temple Chimuanya Odimegwu Et.al (2021):**

This study aimed at investigating the effect of different industrial waste material as partial replacement of fine aggregate on strength properties of normal concrete. For economical and sustainability of natural resources, use of some industrial waste can demonstrate numerous benefits for the construction industry. Nevertheless, there is limited study on the use of industrial waste as replacement of fine aggregate in normal strength concrete especially, using alum sludge from water treatment plant as replacement of fine aggregate. The material used in this study as replacement of fine aggregate (river sand) was oven-dried alum sludge. While quarry dust and limestone dust were also employed as non-reactive industrial waste material, to identify the specific effect of oven-dried alum sludge in concrete. All the materials were crushed to obtain smaller particle size and then used as replacement of fine aggregate in different percentages (5, 10 and 15%). The results from the experiments shows that addition of industrial waste material improved the concrete density, compressive, flexural, and splitting tensile strengths. The result also shows that optimum replacement content of fine aggregate with industrial waste were 10% for oven-dried alum sludge, whereas 15% for quarry and limestone dust content that improved all strength properties

investigated in this study. All industrial waste employed in this study as fine aggregate have proven to be a good filler material by filling the concrete internal void and improving the strength properties for a normal strength concrete.

**Esraa Emam Ali a, Et.al (2021)**

Glass has been indispensable to man’s life due to its properties, including pliability to take any shape with ease, bright surface, resistance to abrasion, reasonable safety and durability. Waste glass creates serious environmental problems, mainly due to the inconsistency of waste glass streams. With increasing environmental pressure to reduce solid waste and to recycle as much as possible, the concrete industry has adopted a number of methods to achieve this goal. Self-Compacting Concrete (SCC) may lead to evolution of a more quality controlled concrete, assuring a better workability and avoiding human errors with regard to mixing and workability issues. On the other hand, it resolves the problem of noise and vibration during installation. The object of this research work is to study the effect of using recycled glass waste, as a partial replacement of fine aggregate, on the fresh and hardened properties of Self-Compacting Concrete (SCC). A total of 18 concrete mixes were produced with different cement contents (350, 400 and 450 kg/m3) at W/C ratio of 0.4. Recycled glass was used to replace fine aggregate in proportions of 0%, 10%, 20%, 30%, 40%, and 50%. The experimental results showed that the slump flow increased with the increase of recycled glass content. On the other hand, the compressive strength, splitting tensile strength, flexural strength and static modulus of elasticity of recycled glass (SCC) mixtures were decreased with the increase in the recycled glass content. The results showed that recycled glass aggregate can successfully be used for producing self-compacting concrete.

**APPARAISAL OF LITERATURE REVIEW:**

A comprehensive review of literature covering papers from Journals and conferences was carried out: papers reviewed were predominantly based on Waste brick powder. The literature review indicates that very few publications are available on the waste brick powder, Variables such as aspect ratio, different grades of concretes and different percentages of brick powder are simultaneously not covered in papers reviewed. No work is reported in the development of mathematical models and their validation using own experimental values and values from other researches. considering parameters like compressive strength and Flexural Strength for partial replacement of fine aggregate using brick powder.

**CHAPTER-3**

## MATERIALS

* 1. **Cement:** 53 Grade ordinary Portland cement conforming to IS 12269.

A **cement** is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource.

### Aggregate

* + 1. **Coarse Aggregate** - 20mm size

**Coarse** aggregates refer to irregular and granular materials such as sand, gravel, or crushed stone, and are used for making concrete. In most cases, Coarse is naturally occurring and can be obtained by blasting quarries or crushing them by hand or crushers.

* + 1. **Fine Aggregate** - Passing through 4.75mm sieve.

A good concrete mix must include aggregates that are clean, hard, strong and free of absorbed chemicals or coatings of clay and other fine materials. Ignorance of these characteristics can cause the deterioration of concrete, thus regulatory authorities have decided **grading zone of fine aggregate,**where each zone defines the percentage of fine aggregate passed from the 600 microns’ sieve size.

* 1. **Waste Brick powder:** Bricks are widely used construction and building material around the world. Brick powder is obtained from the dust of disintegrated bricks also the waste bricks are obtained from garbage of a broken building. The collected waste bricks are pulverized to get the particle passing through 75-micron sieve to get the grading of fine aggregate 5, 10, 15, and 20% brick powder is used as replacement for fine aggregate in the experiments. The waste bricks used in this study were obtained from recycled bricks. Cracked pieces of bricks were crushed by a jaw crusher. And at

laboratory scale the bricks wastes were ground with an air jet mill to obtain bricks powder. The resulting powders were sieved through a 75-µm (325 mesh) sieve. The chemical compositions of brick pastes were analyzed and results obtained.

**3.4 MIX PROPORTON OF CONCRETE**

* The mix proportion is designed for M25 concrete conforming IS codes.

**Concrete Mix Design for M – 25 Grade of Concrete**

* **Step-1 STIPULATION FOR PROPORTIONING**
* Grade= M25
* Type of cement= PPC 53 Grade
* Max. size of aggregate= 20mm
* Min. cement content and max. water cement ratio = Mild (IS-456 Table 9)
* Workability= 100mm Slump
* Method of placing = pumpable
* Type of aggregate= crushed angular
* Fine aggregate= Zone – 2
* **Step-2 TEST DATA**
* Specific gravity of cement= 3.25
* Specific gravity of coarse aggregate= 2.55
* Specific gravity of fine aggregate= 2.53
* Water absorption= 0.15%-2.2%

**Specific gravity of water = 1**

* **Step-3 TARGET STRENGTH**

f’ck= fck+1.65(S) (where S=4)

= 31.6 N/mm2

  f’ck= fck+**x** (where **x**= 5.5)

= 30.5 N/mm2 (Therefore take maximum value)

Therefore **f’ck= 31.6N/mm2**

* **Step-4 WATER CEMENT RATIO**

0.6 (AS PER IS:456 TABLE 5)

* **Step-5 SELECTION OF WATER CEMENT RATIO**

For 20MM aggregate – 186 kg for (50 mm slump)

For every 25mm add 3%

186+6% of 186

= 196 kg

* **Step- 6 CALCULATION OF CEMENT CONTENT**

W/C RATIO = W/C

C = W/(W/C)

= 197/0.5

= 394 kg/m3 > 300 kg /m3

* **Step-7 Proportion Between Coarse Aggregate and Fine Aggregate**

IS- 10262 Table – 5 (1.5.5.1)

Zone 2 = 0.02 (For w/c = 0.5)

Volume of coarse aggregate = 0.62

Volume of fine aggregate = 1 -0.62 = 0.38

* **Step-8 Adjustment of Water**
* **For Fine Aggregate:** -

Density = Mass of fine aggregate/ (1+ water ratio/100)

= 656.63 / (1+2.2/100)

= 642.49 kg/m3

* **For Coarse aggregate: -**

Density = mass of coarse aggregate/ (1+water ratio/100)

= 1078.82 kg/m3

**The Extra Water to Be Added for Absorption by Coarse Aggregate and Fine Aggregate**

1. Fine Aggregate

656.63 -642.49 = 14.14 Kg

2. Coarse aggregate

= 1079.82 – 1078.82 = 1 Kg

* **Mix Proportion After Adjustment**

Cement= 394kg/m3

Water (to be added) = 212.14 kg/m3

Fine aggregate (dry) = 642.49 kg/m3

Coarse aggregate(dry) = 1078.82 kg/m3

Water cement ratio = 0.5

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