“PROJECT WORK(18CVP83)”

A Presentation on

EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH BRICK POWDER

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CONTENT

INTRODUCTION

- As an estimate, 11 billion metric tons of concrete is produced annually, with the aggregates covering 70–75%, water 15%, and the cementitious binder about 10–15% volume of concrete. Cement production was estimated to increase nearly four times from the year 1970–2020. Approximately, one ton CO_2 is emitted from the production of one ton of cement.
- The process of clinker formation produces nearly 50% of CO_2, 40% is released from burning of coal and fuel and remaining 10% is produced from transportation and electricity used during the production.
- Dumping of dust and other waste brick particles, flakes etc. not only occupy land but also create environmental problems. The problem could be reduced to a large extent by using these waste material in cement concrete. the main aim of this study to investigate the feasibility of using waste brick powder in concrete as partial replacement of cement.
- The landfilling of this material degrades the quality of soil and also contaminates the ground water of that area. It is finely ground bricks, orange in color and Sp. gravity 2.52. Particle size of brick powder is about 20 to 60 microns. Calcination temperature of bricks ranges from 900 to 1000 degree Celsius. The SiO_2 content in brick powder is about 54.8% and Al_2O_3 content is about 19.1%.
- In this research, the waste bricks from demolished buildings are used as partial substitute of cement in concrete. Based on the previous studies, two replacement levels i.e. 5% and 10% were chosen. Preliminarily studies confirmed that the waste powder possesses strong pozzolanic properties, and can be beneficially used as partial replacement of cement.
- Cement is replaced by waste brick powder in different proportions. The reason for using brick dust include economical gain and it also reduces the total amount of cement being used in concrete experimental results indicate that brick dust could be used for partial replacement of cement in concrete.
- concrete cubes prepared with some % of cement replaced by brick powder shows compressive strength comparable to conventional concrete cubes. Prepared with ordinary Portland cement.

- The presence of brick powder shows the certain properties of concrete could be improved by using brick dust in combination with ordinary Portland cement. The result of the investigation confirm the potential use of this brick powder material to produce pozzolanic concrete.
- In fresh state, density and workability were examined. In hardened state, both early and final mechanical characteristics were determined. The results showed that the modified samples have lower density, higher workability and strength. Schmidt Rebound Hammer and Ultrasonic pulse velocity tests showed better quality of concrete with waste brick powder.
- The microscopic study confirmed the formation of early ettringite (stable even after 28 days), along with additional CSH, which contributed to higher strength. Use of 10% waste brick powder as partial replacement of cement yields stronger finished products with lower density and higher workability and is beneficial in reducing the environmental burden; additionally, one bag out of ten of cement can be saved in concrete construction.

SCOPE: To use waste brick powder as a construction material.

OBJECTIVES:

- To check the suitability of brick powder as partial replacement material in place of cement for preparation of concrete by evaluating some mechanical properties.
- Characterization of waste brick powder
- To evaluate the soundness and compressive strength of WBP in making of cement mortar as partial replacement material.
- Proportioning of M25 concrete using cement, brick powder by trail
- Workability- slump test on M25 concrete with and without brick powder
- Compressive strength test and Flexural strength test on M25 concrete with and without brick powder
- Cost analysis

CHAPTER-1

LITERATURE REVIEW

- **A. Schackow, D. Stringari b, L. Senff c, S.L. Correia a, A.M. Segadães (2015)** The use of metakaolin is known to help improve properties of Portland cement-based mortars. The presumed similarities between the characteristics of metakaolin and those of a powdered (<45 µm) fired clay brick clean waste (CBW) led to the investigation of the effect on the durability of mortars of partial replacement (10, 25 and 40 wt.%) of Portland cement by CBW. Properties such as 28 and 90 days-compressive strength, water absorption, apparent porosity, absorption by capillarity, chloride retention, carbonation depth and sulphate resistance were evaluated. The CBW-containing cured mortars showed improved strength and density, as the result of combined physical and pozzolanic pore filling effect of added CBW. However, CBW-free mortar exhibited larger spreading and, being more porous, higher sulphate resistance and ability to absorb chlorides. Optimum performance was found for the 40 wt.% CBW mortar whose compressive strength can be up to 130% higher than that of the CBW-free mortar.

- **B.Mahesh Babu and Dr.K.Chandramouli (2017),** The use of cement supplementary materials in structural concrete is widely accepted by the construction industry for technical, economical and environmental reasons firstly this study aimed to investigate crushed clay brick, originated from demolished masonry was ground in the laboratory and used as a partial replacement of cement. Three replacement levels 10%, 20%, 30% were compared with conventional concrete. Addition of brick powder in concrete decreases the strength. At 10% replacement level 28 days compressive strength will be approximate to control concrete. The best replacement level 10% will be taken as a reference and another supplementary cementitious material was metakaolin. The replacement levels of metakaolin are: 5%, 10%, 15%, 20% these will be blended with 10%level of brick powder and cement separately ([C+10%B.P+M.K].The optimal replacement of the cement, brick powder and metakaolin based mixtures [C+10%B.P+15%M.K]. The use of cement supplementary materials in structural concrete is widely accepted by the construction industry for technical, economic and environmental reasons firstly this study aimed to investigate crushed clay brick, originated from demolished masonry was ground in the laboratory and used as a partial replacement of cement.

- **TUFAIL AHMAD MALIK (2017),** Concrete is the most trusted and widely used building material in today's world. Concrete is made by mixing coarse aggregates, fine aggregates, binding material (cement) and water in a definite proportion. To meet the strength characteristics and other properties of concrete for special purposes, efforts have been made to improve some special properties by adding pozzolanic materials. Some of the materials have been effectively utilized which improve fresh properties like workability, consistency, settlement and bleeding, plastic shrinkage etc. and various hardened properties such as strength, durability, porosity and density, thermal and acoustic insulation, impact resistance etc. of concrete. Efforts are being made to use the waste materials in concrete, which are hazardous to environment, easily available and reduce the overall cost of project. Ground brick powder has been potentially used as a partial replacement of cement and scrap rubber pieces as a partial replacement of coarse aggregates. The use of these waste materials in concrete not only decreases the waste from the environment but also decreases the overall cost of the structures, without affecting the properties of concrete. Brick powder can be potentially replace cement by some percentage without affecting the properties of concrete, however improving its permeability properties and reduces its heat of hydration in the initial stages

- **Rohit Sharma (2018),** Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This threat to ecology has led to researchers to use industrial by products as supplementary cementations material in making concrete. The main parameter investigated in this study is M20 grade concrete with partial replacement of cement by silica fume by 0, 5, 10, 15 and by 20%. This paper presents a detailed experimental study on Compressive strength, split tensile strength, flexural strength at age of 7 and 28 day. Durability study on acid attack was also studied and percentage of weight loss is compared with normal concrete. Test results indicate that use of Silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.

- **AFSAL P K, AKSHAY DEV, ALI MISHAB, BINCY U I (2019),** The purpose of this research is to study the properties of fresh and hardened states of M40 grade concrete using brick powder as partial replacement of cement at 5%,10%,15% and fly ash at 15%,30%and 45%. This project investigates quantitatively the strength of concrete mix at different ages.

- **Ke-Quan Yua, Wen-Jun Zhub, Yao Ding (2019),** The recycled fine-powder (RFP), produced during the recycling process, will induce a serious impact on the environment with improper disposition. A potential green way to reuse RFP is to add it as supplementary cementitious material in concrete. The effects of RFP on the hydration, microstructure, shrinkage and mechanical properties of ultra-high performance engineered cementitious composites (UHP-ECC) with different replacement ratios up to 50% were investigated. The hydration kinetics were compared among the different replacement ratios using the isothermal calorimetry, which demonstrated an accelerating effect of RFP to the hydration of UHP-ECC matrix. The phase development was quantified by the thermal gravimetric analysis and proved the pozzolanic effect of RFP. The compressive and tensile properties of UHP-ECCs were obtained at 3, 7 and 28 days, respectively, to trace their development along the curing ages. The addition of RFP significantly reduced the autogenous shrinkage of UHP-ECC. Besides, the single fiber pullout test was investigated to quantify the influence of RFP at the fiber level. The environmental scanned electron microscope analysis was conducted to study the morphology of PE fiber at the fracture surface.

- **Qin Tang (2020),** Recycled powder (RP) is the main by-product in the reclamation of construction and demolition (C&D) waste. A body of literature on the use of RP as supplementary cementitious materials (SCMs) in concrete is currently available, whereas a detailed review on the properties of RP concrete has been lacking until now. Considering that concrete and brick waste account for a large proportion of C&D waste and that other components have specific recycling paths, this paper provides a critical review on the utilization of recycled concrete powder (RCP) from concrete waste and recycled brick powder (RBP) from brick waste in new concrete. The preparation technology of RP and the properties of RP concrete are systematically reviewed; in addition, improvement methods and a benefit evaluation of RP concrete are further introduced. Based on statistical data that describe the activity index of RP and the compressive strength of RP concrete, the median diameter and replacement ratio of RP in concrete preparation should be below 30 μm and 30%, respectively. Furthermore, the use of RP in concrete has good economic and environmental benefits. Therefore, one expects that this review helps the further use of RP in concrete.

- **B.V.Ramanamurthy (2020),** Cement is a good binding material and widely used in construction but the emission of CO2 is increased day by day in manufacturing of cement. To mitigate the emission of CO2, we have to depend on alternate binding material. But till now no other material fulfill the requirements of cement. So scientists, research scholars, institutions etc., are trying to find out alternate replacement materials in place of cement in construction industry. In this regard we investigate the feasibility of brick powder as a partial replacement material in place of cement in making of mortar and concrete. This experimental study shows the performance of brick powder in making of cement mortar and determination of workability and some of the mechanical properties of concrete as a partial replacement material.

- **Zhiming Ma1, Qin Tang, Huixia Wul, Jianguang Xul, Chaofeng Liang2 (2020),** The use of waste brick powder (WBP) as supplementary cementious material (SCM) provides an effective approach to reclaiming construction and demolition (C&D) waste. This research shows the evolution of preparing eco-friendly mortar with various fineness levels and replacement ratios of WBP from waste brick in C&D waste. Due to the pozzolanic activity and filler effect of WBP, incorporating an appropriate content and fineness of WBP refines the pore network of cementitious materials, while the number of hydration products decreases with WBP addition. With WBP incorporation, the water demand increases 14 and mixture slump decreases, while the use of WBP improves the drying shrinkage resistance. The pozzolanic activity increases with increasing WBP fineness; when the WBP fineness is 16 higher than the cement fineness, the compression strength with WBP contents up to 15% is 17 superior to that without WBP, while the compression strength decreases with WBP incorporation when the WBP fineness is close or lower than the cement fineness. Incorporating an appropriate WBP content decreases the water absorption of mortar, and the water absorption further decreases with increasing WBP fineness; for example, when the median diameter of WBP is 6 μm and 42 μm, the capillary absorption coefficient of mortar with 30% WBP is 34.1% lower and 10.3% higher than that of plain mortar, respectively. In addition, a similar conclusion is observed for the water distribution in WBP mortar.

- **Murat Ozturka, Muharrem Karaaslanb, Oguzhan Akgolb, Umur Korkut Sevim (2020),** In this study, cement additives were replaced with cement in mortar mixtures by mass. Mortar specimens were prepared with different additives and dosages which were mechanically and electromagnetically tested. According to the compressive strength test results, mortars containing ground granulated blast furnace slag had weak early age strength and strong later age compressive strengths values, mortars containing fly ash had lower compressive strength value with increasing amount of additives in the mortar mixture for both 7 and 28-day samples, mortars containing silica fume had the maximum strength values at 20% replacement level and lastly the mortars including more than 10% rice husk ash showed weaker strength behaviors with increasing amount of rice husk ash. Hence, it is expected that the absorption values must be high due to dependency of absorption to reflection and transmission, and it can be said that mortar with rice husk ash exhibits a strong absorber behavior.

- **Gomasa Ramesh (2021),** Now a day's industrial wastages are polluting the environment. this study aims at reuse of such waste by products for new purpose. This glass waste can satisfy the users. This waste glass modified into powder for reuse. Percentage replacement of glass powder at the proportion proportions 0%,2.5%,5%,7.5%,10%, at water cement ratio of 0.45 and curing period is 7,14,28 days. Addition of glass powder may lead to small changes in workability of concrete and slight increase in mortar flow. Tests are conducted on respected replacement of glass powdercornetite glass powder results in increase of strength of concrete. Glass powder has pozzolanic reactivity nature. it has the Within the alkaline surroundings of concrete, glass is unstable and This deleterious alkali-silica response problems. Using of glass powder in concrete is to reduce money which is investing on disposal of glass powder. In this we observe the differences between the properties of concrete with finely powdered glass and normal concrete. According to effects received, it's determined that the tumbler glass powder can be reused as cement percentage replacement fabric as much as particle size less than 300μm to save you alkali silica response. Convincing results at 5% glass powder.

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 cement using brick powder.

CHAPTER-2

MATERIALS

- **CEMENT:** Ordinary Portland cement of grade 53 conforming IS code.
- **FINE AGGREGATE:** Crushed demolition waste passing 4.5mm IS sieve.
- **COARSE AGGREGATE:** Segregated aggregates retaining 4.5mm IS sieve and passing 20mm IS sieve.
- **WATER:** Required amount of water as per IS code recommendation.
- **SUPERPLSTICIZERS:** If required.
- **WBP:** Waste brick powder.

CEMENT:

- 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.

- Cements used in construction are usually inorganic, often lime or calcium silicate based, which can be characterized as **non-hydraulic** or **hydraulic** respectively, depending on the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).
- **Non-hydraulic cement** does not set in wet conditions or under water. Rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.
- **Hydraulic cements** (e.g., Portland cement) set and become adhesive due to a chemical reaction between the dry ingredients and water. The chemical reaction results in mineral hydrates that are not very water-soluble and so are quite durable in water and safe from chemical attack. This allows setting in wet conditions or under water and further protects the hardened material from chemical attack. The chemical process for hydraulic cement was found by ancient Romans who used volcanic ash (pozzolana) with added lime (calcium oxide).

- **FINE AGGREGATE:** Aggregate is the granular material used to produce concrete or mortar and when the particles of the granular material are so fine that they pass through a 4.75mm sieve, it is called fine aggregate. It is widely used in the construction industry to increase the volume of concrete, thus it is a cost saving material and you should know everything about the **fine aggregate size**, its density and grading zone to find the best material.

- **Role of Fine Aggregate in Concrete Mix:**

- Fine aggregates provide dimensional stability to the mixture.
- The elastic modulus and abrasion resistance of the concrete can be influenced with fine aggregate
- Fine aggregates quality also influence the mixture proportions and hardening properties.
- The properties of fine aggregates also have a significant impact on the shrinkage of the concrete.

- **Grading Zone of Fine Aggregate:** 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. Zone I : 15% to 34%
2. Zone II : 34% to 59%
3. Zone III : 60% to 79%
4. Zone IV : 80% to 100%

You can assess the quality of fine aggregate with help of the grading zones. However, for precise assessment, you can seek help from experts who are well versed in performing tests for bulk density, bulkage, and specific gravity to find the best in class material.

- **COARSE AGGREGATE:** 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.

- **Size of Coarse Aggregate:** It all depend on structure, whether it is plain cement concrete or reinforced cement concrete. Most commonly used aggregate size in construction is 20mm, 40mm and 75mm. Aggregate size 20mm used in RCC structure, 40mm aggregate size used in PCC structure or mass concreting and 75 mm and more size used in retaining wall construction.

- fine gravel -4 to 8 mm
- medium gravel- 8 to 16 mm
- coarse gravel -16 to 64 mm

- pebbles -4 to 64 mm
- cobbles -64 to 256 mm
- boulder – more than 256 mm

❑ **WASTE BRICK POWDER:**

Bricks are a widely used construction and building material around the world. In developing countries bricks are still one of the most popular construction materials. India is the second largest producer of fired clay bricks after china. 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 cement. 5, 10, 15, and 20% brick powder is used as replacement for cement 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 a 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.

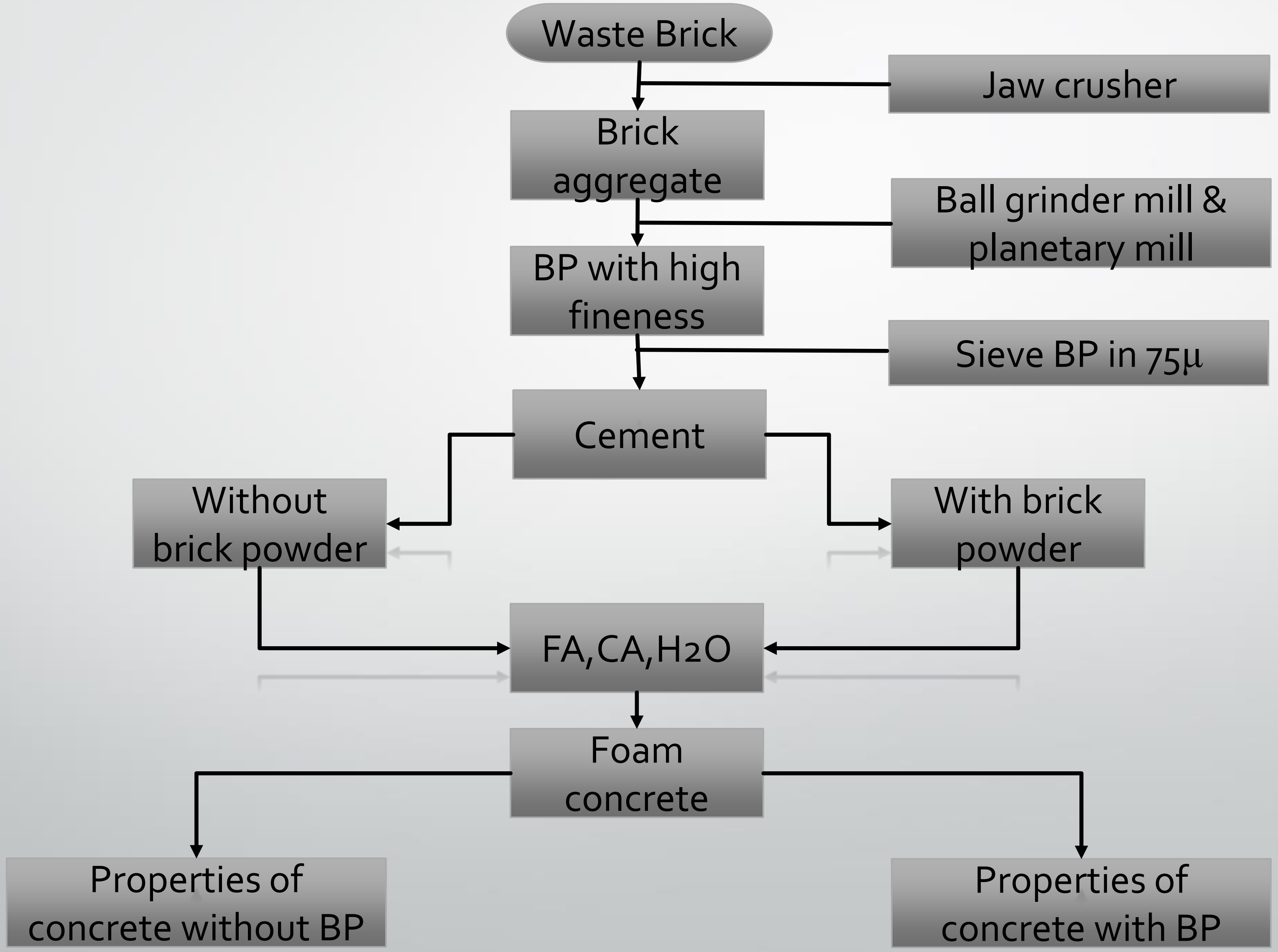
- **Bricks waste may come from two sources.** The first source is the bricks industry, and this waste is classified as non-hazardous industrial waste, the second source of bricks waste is associated with construction and demolition activity, and constitutes a significant fraction of construction and demolition waste. Therefore, the replacement of cement by bricks wastes has the advantage of solving several environmental problems. Preparation process of waste burnt brick powder (WBBP): (a) collection site of waste bricks; (b) collected bricks are crushed into smaller size and washed to remove dirt; (c) the wet pieces of waste bricks are dried under sunlight for 1 day; (d) The sun-dried sample is converted into powder using the ball milling process; (e) to remove any moisture content, the WBBP is oven-dried for 24 h; (f) the oven-dried powder is converted into ultrafine particles through manual pulverization, and then it is sieved through a 75 µm sieve and stored in airtight buckets.

MIX PROPORTON OF CONCRETE

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

METHODOLOGY

FLOW CHART:



PROCEDURE

- Collect the waste bricks and crush the bricks into aggregates using jaw crusher.
- Flow the brick aggregate into ball grinder mill to form a powder of brick aggregate. sieve the brick powder in 75µ sieve.
- Calculate the total amount of cement, fine aggregate and coarse aggregate for M25 grade concrete. And calculate the amount of water cement ratio.
- Replace the cement with brick powder for 0%, 5%, 10%, &15%.
- Prepare a dry mix of cement, fine aggregate and coarse aggregate with 0% of brick powder for 1^{st} trail.
- Replace the cement with 5% of brick powder for 2^{nd} trail and mix the cement, brick powder & aggregates without water.
- Add required amount of water into the dry mix sample and mix it thoroughly to form a concrete.
- Place the concrete in a cube and allow it to dry for 24hrs
- Repeat the same procedure for 10%,15% replacement of cement with brick powder.
- Conduct the tests on the prepared sample.

FRESH PROPERTY OF CONCRETE

WORKABILITY:

- **SLUMP TEST:** The slump is carried to know the workability of concrete. The mix design of concrete is done for 25mm to 50mm slump. The test will be carried on cylindrical cone of size 150*300*300mm.The test is carried on concrete with and without brick powder. Based on the outcome of slump, the results will evaluated.

CASTING AND TESTING:

In the present study, four different M25 concrete mixes were considered of which one mix without brick powder and three with brick powder of percentages 5%, 10% and 15% respectively. After assessing fresh properties, the concrete will be casted in different moulds. The moulds used are either made of caste iron or wood. The cube size is 150mm (compressive strength), cylindrical mould of size 150*300mm (tensile strength).After filling the mould the casting surface will be leveled and finished using trowel. The moulds are kept undisturbed for 24 hours. After 24 hours, the moulds are re-moulded and the specimens were immersed in water for curing under controlled environment. The specimens are tested at 7 days and 28 days, and the results will be analyzed.

HARDENED PROPERTY OF CONCRETE

COMPRESSIVE STRENGTH: Compressive strength can be defined as the maximum stress, a material can sustain under crushing loading. Compressive strength is calculated by dividing the maximum load by the original cross-sectional area of a specimen. In the present investigation, uniaxial compression test were carried on concrete cubes of size 150mm using a universal testing machine of load 1000kN.The results are noted and evaluated.

TENSILE STRENGTH: Concrete is inherently weak in resisting the tensile forces. Addition of brick powder will enhance the tensile capacity of concrete and the range of enhancement depends on various parameters. To evaluate the tensile capacity, split tensile test was carried out in cylindrical specimens. The test was done by introducing a cylindrical specimen horizontally between the loading surface of the compression testing machine and the load is applied until the failure of the cylinder, along the vertical diameter. When the load is applied, vertical diameter of the cylinder is subjected to a horizontal stress of $2P/\pi ld$. The obtained results are noted and evaluated.

SUMMARY: