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Study On Properties of Concrete Using Overburent Brick Chips and Demolished Concrete Waste As Partial Replacement Of Coarse Aggregate

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Abstract: *Concrete is a mixture of cement fine aggregate coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., building, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. So the rapid increase in consideration activities has led to a dramatic increase in the price of conventional construction materials. Additionally various government agencies have put restrictions on sand and stone quarrying to conserve this diminishing natural resource. This has prompted many engineers to look for alternate materials that are cheaper while possessing similar characteristics. In this context an experimental study was carried out to find the suitability of the alternate materials such as over burnt brick chips and demolished concrete waste as a partial replacement of coarse aggregate because these materials are easily available at very low cost as compared to conventional coarse aggregates. The study was conducted to analyze the compressive and split tensile strength of concrete when conventional coarse aggregate was replaced with 10 to 50% of over burnt brick chips and 10 to 50% of demolished concrete waste separately. For conducting the study 54 cubes (150mmx150mmx150mm) and 54cylinders (150mmx300mm) were casted, 27 specimens of cube and 27 specimens of cylinder for over bunt brick chips and same number of specimens for demolished concrete waste were casted and tested. To increase the workability of concrete SUPER PLAST-HS plasticizer was used as an admixture. The plasticizer was used as 0.8 to 1% by weight of cement to achieve required workability. It is found that up to 25% replacements by over burnt chips and up to 35% replacement by demolished concrete waste the variation in properties of concrete is within permissible limit i.e. near the properties of M25 grade concrete. The study concludes that the over burnt brick chips can be used up to 25% and demolished concrete waste can be up to 35% effectively as an alternative to conventional coarse aggregate for m 25 grade of concrete. It has been seen that a replacement of coarse aggregate by over burnt brick up to 25% and by demolished concrete waste up to 35% shows a negligible variation in properties of concrete. The reduction in the cost of coarse aggregate by 10% in case of over burnt brick chips and in the case of demolished waste that is 25%.*

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I. Introduction

1.1 General

Concrete is the second largest material consumed by human beings after food and water As per WHO. It is obtained by mixing cement, fine aggregate, coarse aggregate and Water in required proportions. The mixture when placed in forms and allowed to cure becomes hard like stone. The hardening is caused by chemical action between water and the cement due to which concrete grows stronger with age.

Today, the rate at which concrete is used is much higher than it was 40 years ago. It is estimated that the present consumption of concrete in the word is of the order of 11 billion metric tones every year. There are at least three primary reasons. First, concrete possesses excellent resistance to water. Unlike wood and ordinary steel, the ability of concrete to withstand the action of water without serious deterioration makes it an ideal material for building structures to control, store, and transport water. In fact, some of the earliest known applications of the material consisted of aqueduct and waterfront retaining walls constructed by the Romans. The use of plain concrete for dams, canal linings, and pavements is now a common sight almost everywhere in the world structural element to moisture, such as piles, foundation, footings, beams, columns, roofs, exterior, wall, and pipes, are frequently built with reinforced and pressurised concrete. Reinforced concrete is concrete usually containing steel bars, which on designed in the assumption that two materials act together in resisting tensile force. With pressurised concrete by tensioning the steel tendons, as per compression is introduced such the tensile stresses during service are counteracted to prevent cracking. Large amounts of concrete find their way into reinforced or pre stressed structural elements. The durability to aggressive waters is responsible for the fact its use extended to service industrial and natural environments.

1.2 Material Used in Concrete

There are many types of Concrete available, created by Varying the proportions of the main ingredients below. By varying the proportions of materials or by substitution for the cement and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties.

The mix design depends on the type of structure being built, how the Concrete will be mixed and delivered, and how it will be placed to firm this structure.

1.2.1 Cement

The name cement goes back to Raman time when a Concrete-like masonry of crushed stone pieces with burned lime and water as binding material was called Opus Cementation. Later the Combination of brick powder and volcanic tuff with burned lime used as hydraulic binder was called Cementation and Cement. The importance of clay content concerning the hydraulic properties if n naturally occurring mixture of limestone and was discovered by j. Smeaton of England as he was looking for a water resistant mortar.

1.2.1.1. Portland Cement

Portland Cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. English masonry worker Joseph Asp din patented Portland cement in 1824, it was named because of its similarity in colour to Portland limestone, quarried from the English isle if Portland and used extensively in London architecture. It consists of a mixture of oxide of calcium, silicon and aluminium. Portland cement and similar materials are made by heating limestone are made by heating limestone(a source of calcium) with clay, and grinding this product (called clinker) with a source of sulphate (most commonly gypsum). The manufacture of Portland cement creates about 5 percent of human CO_2 emission.

1.2.1.2 Portland Pozzolana Cement (IS 1789-1991) [1]

The history of pozzolanic material goes back to Raman's time. Portland Pozzolana cement (PPC) is manufactured of OPC clinker with 10 to 25 percent if pozzolanic (as per the latest amendment, it is to 35%). A pozzolanic material is essentially properties a siliceous or aluminous material which while in itself possessing no cementitious properties, which will , in finely divided form and in the presence of water, react with calcium hydroxide, liberated in the hydroxide process at ordinary temperature, to form compound possessing cementitious properties

1.2.2 Water

Hydration process gradually bond together the individual sand and gravel particles, and other components of the concrete to form as solid mass.

Reactions:

Cement chemist notation: $C_3S + H \rightarrow C\text{-}S\text{-}H + CH$

Standard notation: $Ca_2 SiO5 + H_2O \rightarrow (Cao).(SiO_2).(H_2O) + CA(OH)_2$

Balanced: $2Ca_2Sio_5 + 7h_2O \rightarrow 3(Ca_2).2(SiO_2)4(H_2O(gel) + 3Ca(OH)_2$

1.2.3 Aggregates

Decorative stone such as quartzite, small river stone or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish popular among landscape designers.

1.2.3.1 Over Burnt Brick

In brick making a large number of brick are rejected, due to nonconformity with required specifications. One such major nonconformity is the distorted form of brick produced due to the uneven temperature control in the kiln.

1.2.3.2. Demolished concrete waste

Construction and demolition waste (C&D) is produced during new construction refurbishment or renovation of building. Demolition waste includes material from complete building removal as well as partial removals when aspects of the buildings are retained. Waste include bricks, concrete, masonry, soil, lumber, paving materials glass, plastic, aluminium, steel drywall(gypsum), plywood(formwork), plumbing fixtures electrical, and roofing materials . C&D waste will increased from time to time proportionate with the development of the town country. Thus, the necessity of finding appropriate C&D waste destination must be clear. Reducing, reusing and recycling appear to be profitable alternatives that will increase the lifetime of landfills and reduce exploration of natural resource exploration of natural resources.

Lots of construction activities are going on in around the world and lots of demolition of old concrete works are also taking place, This demolished of old concrete , if it can be recycled & used as recycled aggregate concrete their their disposal which is gigantic task can never be problem.

1.2.4. Admixtures

Admixtures are defined as materials other aggregates, cement, and water, which are added to the concrete batch immediately or during mixing. The use of admixtures in concrete is now widespread due to many benefits which are possible by their

Application For instance chemical admixtures can modify the setting and hardening characteristic of the cement paste by influencing the rate of cement hydration. Water reducing admixtures can plasticize fresh concrete mixtures by reducing the surface tension of water; air entraining can improve the durability of concrete exposed to cold weather; and mineral admixtures such as (material containing reactive silica) can thermal cracking in mass concrete.

1.2.4.1. Pozzolana

- Fly
- Silica Fume
- Rice Husk Ash
- Metakaolin

1.2.4.2 Chemical admixtures

Chemical admixtures are materials in the form of powder or fluids that are added to the concrete to give it certain characteristic not obtainable with plain concrete mix. In normal use, admixture dosages are less than 5 % by cement, and are to the concrete at the time of batching/ mixing. The common types of admixture are as follows.

1.2.4.3. Super Plasticizer

Super Plasticizers, also known as high range water reducers, chemical used as admixtures where well dispersed particle is required. These polymers are used as dispersants to avoid particle aggregation, and improve the flow characteristic of Suspension such as in concrete applications. Their addition to concrete or mortar allows the reduction of the water to cement ration not affecting the workability of the mixture, and enamels the production of self consolidation concrete and high performance concrete. This effect drastically improves the performance of hardening fresh paste. Indeed the strength of concrete increases whenever the amount of water used for the mix decreases. The super plasticizer used in the study was CICO SUPER PLAST HS which is based on specially selected high molecular organic polymers.

1.3 Mix design

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as possible, is termed the concrete mix design.

1.3.1 Principal of Concrete mix design

Design of concrete mixes involves determination of the proportion of the given constituents, namely, cement, water, coarse and fine aggregates and admixture, if any, which would produce concrete possessing specified properties both in the fresh and hardened states with the maximum overall economy. Workability is specified as the important of concrete in the state; for hardened states compressive strength and durability are important. The mix design is, therefore, generally carried out for p particular compressive strength if concrete can be designed for flexural strength or, for that matter, for any other specific property for concrete.

The proportioning of concrete mixes is accomplished by the use of certain relationships established from experimental data, which afford reasonably accurate guide to select the best combination of ingredients so to desirable the properties. The following basic assumptions are made of plastic concrete mixes strength:

II. Review Of Literature

2.1 General

The aggregate element in concrete comprises some 60-75% of the total volume of aggregate inclusion in concrete reduces its frying shrinkage and improves many other properties. Aggregate is also the last expensive par weight unit. It is costly to trans- port so local sources are needed, but due to the extensive use of aggregate on the construction of building and roads, local sources are no longer available in urban counties .

2.2 Previous works on Replacement of Conventional Aggregate by Some Alternatives
Akhtaruzzaman et al (1983) [3] carried out some research using well burn brick as coarse aggregate in concrete. They found that it was possible to achieve concrete of high strength using crushed brick as course aggregate. Their research primarily.

III. Experimental Program

3.1 Introduction

An extensive experimental program has been executed to ascertain the compressive and split tensile strength of concrete when conventional coarse aggregate is replaced by over brunt brick and demolished concrete waste. The experiment was conducted on nine different proportions of conventional coarse aggregate replaced by above mentioned. The experimental program involved the evaluation of compressive strength and split tensile of concrete.

The description of the aforementioned experimental program is put forth in the chapter under various heads giving insight into the material properties, mix proportions, casting procedure curing and the testing carried out to achieve the objectives.

3.2 Properties of Constituents of Concrete

The determination of the properties of the constituents of concrete is necessary to ensure that they do not contain any deleterious element which may affect the behaviour of the composite or they may not conform to the specified requirements necessary to achieve a standard of performance. The subsection under this head give the detail of the work test carried out and the specification as mentioned in IS codes.

3.2.1 Test on Cement
Portland pozzolana Cement of 43 grade was use throughout the experimental investigation the recommendation stated in IS (1999) [31] have been strictly adhered to during the investigation

3.2.1(a) Consistency of Cement
The basic aim is to find out the water content required to produce a cement paste of standard consistency as specified by the IS: 4031 (Part 4) -1988. The principal is that standard consistency of cement is that which the Vicat plunger penetrates tp a point 5-7 mm from the bottom of Vicat mould.

3.2.1 (b) Initial Setting Time It's the time from which cement starts the setting process after water is added. Usually it is 30 mm. It can be delayed or advanced using chemicals.
Vicat Apparatus conforming to IS: 5513*1976[32] balance, whose permissible variation at a load of 1000g should be + 1.0g Gauging trowel conforming to IS: 10086-1982 [33].

Characteristics	Observed values
Fineness modules	0.92
Specific gravity of conventional aggregate	2.64
Specific gravity over brunt brick aggregate	2.40
Specific gravity of demolished concrete waste aggregate	2.62

3.2.4 Water
As per recommendation of IS : 456 (2000) [36] the water to be used for mixing curing of concrete should be free from deleterious material . Potable water was used in the present study in all operations control over water quality.

3.2.5 Super Plasticizer
In the present study CICO SUPER PLAST HS used as a super plasticizer to meet the required workability. CICO SUPER PLAST HS is a concrete admixture based on specially selected high molecular weight organic polymers. This has a high plasticizing effect which is retained over a longer period and act as a high range water reducer for concrete and mortar.
The primary advantages of SUPER PLAST HS are as fol

3.3 Mix Design Procedure

To design a concrete mix for s desired strength, first we need to decide the constituents of concrete mix such as cement, fine aggregate. Course aggregate, admixture etc. and their optimum quantity that will results in achievement of the requisite performance. In general the acceptance criteria of a concrete mix are its workability in fresh state and compressive strength at the age of 28 days. Detailed procedure for mix design adopted in the present study is given below

(6) Calculation of cement content
Water cement ratio = 0.43
Cement content c= 191.58/0.43= 445.53Kg/m^3
So water content = 162.843 Kg/m^3
From table 5 IS 456, minimum cement content for mild exposure condition = 300 Kg/m^3
445.54 Kg/$m^{3>}$ 300 Kg/m^3 OK

(7) Proportion of volume of coarse and fine aggregate
From table 4, for 20 mm avg. Nominal size aggregate and sand for forming to to zone 1 sand content as % age of aggregate by absolute volume = 35
Correction required in sand content
For the zone 1 conforming IS 383 = +1.5% (form table 6-11)
True% age of fine content = 100-33.5=66.5

3.4 Prepartion of Specimen

The quantities of the constituents of the concrete were obtained from the Indian standard mix design procedure. The variation in strength of hardened concrete using over burnt brick chips and demolished concrete waste as a partial replacement of coarse aggregate is studied by casting cube and cylinders. The concrete was prepared in the laboratory using concrete mixer .The cement, fine aggregate and course aggregate were mixed in dry state and calculated of water is mixed to achieve required workability super plasticizer was added and the whole concrete was mixed

3.5 Casting Mixing and Curing

After the preliminary tests on the constituents of concrete confirmed the suitability of ingredients and the design mix was found to be satisfactory , the task of casting cube and cylinder was taken up. the available laboratory equipments were utilized in the accomplishment of the experimental program . The guidelines in the IS 10262:

(1982) [40] ,were strictly adhered to in the process of mixing concrete . Firstly ,the coarse aggregate was washed a day before casting in order to make it silt free and was laid to dry . On the following day, the coarse aggregate was found to be satisfactorily moisture. This was necessary to prevent absorption of moisture by the aggregate from the water being added mix i.e the design water cement ratio had to be carefully regulated. Next silica fume in case of high strength concrete mixes. with silica fume in case of high strength concrete mixes.

The plasticizer was mixed with water and a part of this was added to the mixture of coarse and fine aggregate. Following this cement and silica fume were added with the remaining water. The process of mixing was perform in tilting type rotary drum mixer 100 Kg capacity with process being carried out for at least 2-3 min. The concrete was filled in three layers in all the moulds and manually compacted.

IV. Conclusion

The effect on the properties (28 Days compressive and split tensile strengths) of normal strength concrete with partial replacement of coarse aggregate by over burnt brick chips and demolished concrete waste, with water cement ratio of 0.40 is studied. The percentage replacement of coarse aggregate by over brick is varied from 10% to 50% while that for by demolished concrete waste is varied from 10% to 60 % at an interval of 5%.

The following conclusions are drawn from the present study:

1. The compressive and split tensile strength of concrete up to 25% replacement of coarse aggregate by over burnt brick chips and that of up 35% replacement of demolished concrete waste reveals approximately same strength as compared to concrete made by conventional coarse aggregate.
2. Although it is found that the compressive and tensile strength of conventional concrete is always higher for both the case (i.e. in case of over burnt brick chips and demolished concrete waste.) but up to 255 and 35% replacement of conventional coarse aggregate by over burnt brick chips and demolished concrete waste respectively the variation in these properties are very less.
3. All the mixes of over burnt brick chips shows better performance in splitting tensile strength test as compared to demolished concrete waste mixes.
4. Over burnt bricks and demolished concrete waste have a potential to provide alternative to conventional coarse aggregate and helps in maintaining the environment as well as economical balance.
5. There is a 10% saving of money if conventional aggregate is replacement by over brunt brick chip and about 25% of saving of money if conventional aggregate is replacement by demolished concrete waste.

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