Partial replacement of AGGREGATE with BROKEN SOLID WASTE and PIG IRON in CONCRETE

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ABSTRACT:

At this time India is a fastest growing country in the world. In a developing nation the prime requirement is the infrastructure for the industries and offices. Any kind of infrastructure development the basic requirement is the Coarse Aggregate, fine aggregate, cement and water. Aggregate is the natural resource and it is rapidly decreasing due to overexploitation. There has the substitute of aggregate which fulfil the high demand of aggregate. Broken solid waste has fulfilled the aggregate demand in concrete structures. Due to increasing urbanization and modernization demolish the existing building and rapidly build the good looking and attractive houses and building for living and other purposes. Fortunately broken solid waste is freely and easily available around us, and it can be used as an adulterant in concrete. In concrete construction aggregate partially or fully replaced with broken solid waste. In some constituents of broken solid waste gives more strength than aggregate, like granite and marble which give high strength than aggregate so it has to be fully or partially replaced with broken solid waste. The primary goal of this paper is to assess the suitability of broken solid waste in concrete, by the partial replacement of natural coarse aggregate (NCA) with broken solid waste (BSW) in a ratio of 5%,15%,25%,35% and 45%.,and pig iron 5% in each mix proportion of 1:1.5:3 and w/c of 0.46 was selected.

KEYWORDS: *Overexploitation, Adulterant, infrastructure, aggregate, concrete.*

1. INTRODUCTION:

1.1- Cement:

The cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. There are two main forms of cement: Geopolymer cement and Portland Cement. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine

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aggregate produces mortar for masonry, or with sand and gravel, produces concrete. Cement is the most widely used material in existence and is only behind water as the planet's most-consumed resource.

Fig.1.1 Cement

1.2- Fine Aggregate:

Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete.

Fig. 1.2 Fine Aggregate

1.3- Coarse Aggregate:

Those particles that are predominantly retained on the

4.75 mm sieve and will pass through 3-inch screen, are called Coarse Aggregate. The coarser the aggregate, the more economical the mix. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces.

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Fig. 1.3 Coarse Aggregate

1.4- Broken solid waste:

The usage of BSW aggregate as replacement to coarse aggregate in concrete has the benefits in the aspects of cost and reduction of pollution from construction industry. The cost of concrete manufacturing will reduce considerably over conventional concrete by including tile aggregate and granite powder since it is readily available at very low cost and there-by reducing the construction pollution or effective usage of construction waste.

Globally, Inert waste production of 2 to 3 billion tonnes per year is estimated, of which 30-40 % is concrete. Inert waste issues are more important for the developing countries, which are entering or already entered in construction boom era. Hence disposal of these quantity of waste is more crucial. About 600 million people, or more than half of India's population, belong to the middle class.

1.5- Pig Iron:

Pig iron is produced in the blast furnace sector. The raw materials used include ore sinter, coke, lime and various aggregate.

- Pig iron is an intermediate produce of the iron industry, also known as crude iron, which is obtained by smelting iron ore in a blast furnace.
- It contains 3.5 to 4.8% carbon.
- Silicon 1-3% and manganese 0.1-1%
- Phosphorus 0.3-1.5% and sulphur up to 1%.

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2. LITERATURE REVIEW:

1. **Tripathi, B. et al.**, (2012) assessed the strength and abrasion characteristics of Fly Ash Concrete. In their report, they assessed the potential of Fly Ash as sand in concrete, considering the presence of toxic elements (lead and zinc) and their detrimental effects on the early hydration of cement. Equivalent volume of sand was replaced by FLY ASH in different percentages.
2. **Shashidhara and Vyas**, (2010) reported the results of replacing sand in cement concrete using imperial smelting furnace Fly Ash in Indian Concrete Journal. The fine aggregate fraction so produced conformed to the grading requirements of both fine aggregate and all in aggregate. The workability of concrete improved as the replacement level increased, though the packing 7 density of the dry all-in aggregate reduced. Replacing sand with fly ash did not affect the compressive strength, but in a leaching test, complete replacement resulted in Lead (Pb) setting leached above the permissible level. prepared at different water to cement ratios. Compressive, flexural, and pull off strength, along with abrasion resistance, were examined. Results were encouraging because sign of delay in setting was not observed. Improvement in compressive and pull off strength; comparable flexural strength and abrasion resistance; and, leaching of toxic elements within safe limits assured the potential of future use of the Fly Ash as sand in concrete.
3. **Hooper, R. et al.**, (2002) focused on setting characteristics of Fly Ash, the effect of fly ash in minimizing retardation of set as well as the European policies for reuse of secondary materials. According to them, the UK Ten Year Transport Plan, including the development of the highway infrastructure, offers opportunities to demonstrate successfully the consumption of small volume streams of secondary materials, including Fly Ash, within the local Pavement construction offers several opportunities for consumption, the most credible of these being the replacement of the sand fractions by the slag in bound mixtures, cement and bituminous. The paper focused upon cementitious mixtures alone. The presence of zinc and lead ions in the fly ash were proven to have an impact on the setting characteristics of concrete mixtures, although there is little difference in the compressive strengths after 28 days. The leaching, characteristics of the slag suggested that the retardation is not linearly related to the quanta ties of zinc or lead leached. Additionally, leaching tests in combination with pulverized fuel ash (fly ash) and ground granulated blast furnace slag indicated that it might be possible to minimize retardation of set in by including these materials in the concrete mixture.
4. **Morrison and Richardson.**, (2004) stated in their study of Re-use of zinc smelting furnace fly ash in concrete, studied environmental concerns associated with the reuse of slag in concrete due to the presence of heavy metals like Zinc and Lead. They concluded that the fly ash is physically suitable for use as an aggregate, although there are several barriers that must be overcome before it can be used in concrete. The study also reported that the glassy nature of the slag initially raised concerns regarding the potential for alkali–silica reaction (ASR) to occur in concrete.

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3. METHODS & METHODOLOGY:

3.1- Testing of Cement:

a) Consistency Test: This is a test to estimate the quantity of mixing water to form a paste of normal consistency defined as that percentage water requirement of the cement paste, the viscosity of which will be such that the Vicat's plunger penetrates up to a point 5 to 7 mm from the bottom of the Vicat mould.

The water requirement for various tests of cement depends on the normal consistency of the cement, which itself depends upon the compound composition and fineness of the cement.

Fig.3.1 (a) Vicat plunger

b) Soundness Test: It is essential that the cement concrete does not undergo large change in volume after setting. This is ensured by limiting the quantities of free lime and magnesia which slake slowly causing change in volume of cement (known as unsound). Soundness of cement may be tested by LeChatelier method or by autoclave method. For OPC, RHC, LHC and PPC it is limited to 10 mm, whereas for HAC and SSC it should not exceed 5 mm.

It is a very important test to assure the quality of cement since an unsound cement produces cracks, distortion and disintegration, ultimately leading to failure.

Fig.3.1 (b) LeChatelier

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c) Compressive Strength: Compressive strength is the basic data required for mix design. By this test, the quality and the quantity of concrete can be controlled and the degree of adulteration can be checked.

Fig.3.1 (c) CTM

d) Tensile Strength: The tensile strength may be determined by Briquette test method or by split tensile strength test.

The tensile strength of cement affords quicker indications of defects in the cement than any other test. Also, the test is more conveniently made than the compressive strength test. Moreover, since the flexural strength, is directly related to the tensile strength this test is ideally fitted to give information both with regard to tensile and compressive strengths when the supply for material testing is small.

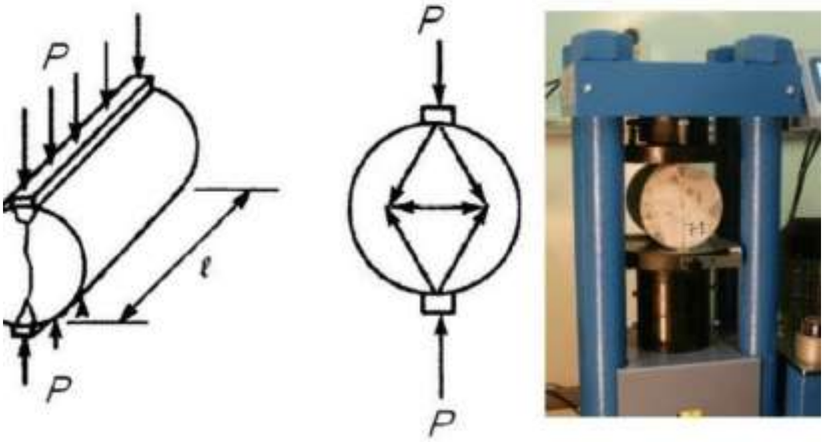

Fig. 3.1(d) Split Test

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3.2- Testing of Aggregates:

a) **Crushing Test:** One of the models in which pavement material can fail is by crushing under compressive stress. A test is standardized by IS: 2386 part-IV and used to determine the crushing strength of aggregates. The aggregate crushing value provides a relative measure of resistance to crushing under gradually applied crushing load.

Fig. 3.2(a) Crushing Test

b) Abrasion Test: Abrasion test is carried out to test the hardness property of aggregates and to decide whether they are suitable for different pavement construction works. Los Angeles abrasion test is a preferred one for carrying out the hardness property and has been standardized in India.

Fig. 3.2(b) Los Angeles

c) **Impact Test:** The aggregate impact test is carried out to evaluate the resistance to impact of aggregate.

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Fig. 3.2(c) Impact Test

d) Shape Tests: The particle shape of the aggregate mass is determined by the percentage of flaky and elongated particles in it. Aggregates which are flaky or elongated are detrimental to higher workability and stability of mixes.

Fig. 3.2(d) Shape Test

CONCLUSION:

- The use of Broken Solid Waste & Pig-iron is showing great application in construction as an alternative to natural aggregate.
- It is eco-friendly.
- It reduces cost of construction.

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- Use of Broken Solid Waste will ensure the sustainable development of society with savings in natural resources, materials & energy.
- Broken Solid Waste Material concrete may be an alternative to the conventional concrete.
- Up to 30% of coarse aggregate replaced by Broken Solid waste & Pig-iron gave strength closer to the strength of plain concrete.

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