AN EXPERIMENTAL STUDY ON PARTIAL REPLACEMENT OF FINE AGGREGATES BY CRUSHED SPENT KILN FIRE BRICKS (CSKFB) IN CONCRETE

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ABSTRACT

The Construction industry in very much in need of cost efficient and well performing materials acting as substituent to traditional ones. Although natural river sand outperforms all other resources in the production of concrete, its supply is depleting owing to deliberate overexploitation around the world. This project looks into the possibility of using readily available, inorganic, and inert CSKFB waste material to efficiently replace naturally available river sand in the production of good and lasting concretes. Based on its initial physico-chemical resemblance to sand, the Spent kiln fire bricks (i.e., a SW material primarily manufactured in foundries and directly dumped as waste material to MSW) is considered as an alternative material for partially substituting sand in the construction of excellent concrete. As a result, in this study, a combination of "effective waste management" and "resource conservation" was used.

Keywords: *Fine aggregates, Crushed Spent Kiln Fire Bricks, Refractory Bricks, Rapid Chloride Permeation Test.*

1. INTRODUCTION

1.1 GENERAL

Concrete is an extensively used construction material, with applications in structural, geotechnical, environmental, transportation, and highway engineering. This is due to its robust and lasting properties, as well as the fact that it can be molded into a variety of forms and sizes, from basic prisms to curved domes and shells. Aggregates serve a crucial function in the concrete matrix, reducing shrinkage and improving durability. Crushed rock, gravel, and river sand are examples of natural aggregates that may be used in the construction of concrete. Because of its angularity, hardness, and toughness, sand collected from natural stream deposits is ideal for use as FA in concrete manufacturing .Overharvesting of geo-materials in recent decades has resulted in resource depletion, environmental deterioration, and high energy use. As a result, the partial or complete replacement of of fine aggregates by the other compatible materials like sintered fly ash, crushed rock dust, quarry dust, glass powder, recycled concrete dust, and others are being studied over the past 2 decades from the standpoint of ecological protection.

1.2 INVESTIGATION OBJECTIVES

The primary goal of this study is to determine whether locally and freely available SKFB may be used to partially replace natural sand in the manufacturing of good concrete through acquisition of necessary items for trial concretes, including SKFB, and elemental studies to determine appropriate physico-chemical characteristics. Adoption of simplified mix design procedure as per IS: 10262-1982 as design mix to arrive at various M25 concretes leading to the preparation of FB10, FB20, FB30, FB40, FB50, and FB60 as mix proportions according to the respective percentage of effective fine aggregate replacement for efficiency. Fabrication, curing, and testing of several cube, cylindrical of both conventional as well as CSKFB concrete specimens for the various testing aspects took place. Such as:

i. Compression test
ii. Split Tensile Strength Test
iii. Flexural Strength Test
iv. RCPT Test

2. MATERIALS:

Concrete is a heterogeneous mixture of elements such as cement, aggregates, and water in general (i.e., for fresh state). As a result, the quality of the elements used to make concrete is largely determined by their quality. From the period of fresh-state concrete to the hardening stage of concrete, and for several years after concrete application, the various elements will interact effectively. Any concrete's performance characteristics are mostly determined by the quality of cement used in its manufacture.

2.1 Cement:

Any concrete's performance characteristics are mostly determined by the quality of cement used in its manufacture. Despite the fact that a variety of cements are available on the market, the OPC of grade 53 complying to BIS: 12269-1989 was used in both the Ordinary and CSKFB-concrete. Many important physical and strength-related tests were conducted in the laboratory for this purpose.

2.2 Crushed Spent Kiln Fire Bricks:

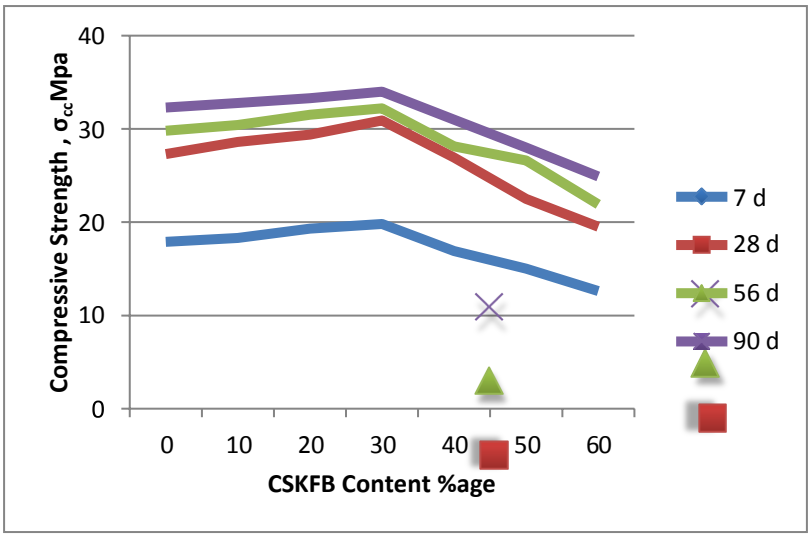
Structures such as Foundry walls, beds, and chimney lining, kilns, and fire boxes are among the industries that employ FB that meets the above standards. They lose a substantial amount of physical and mechanical qualities after being exposed to high temperatures of roughly 1000-1200^{o} C for a period of over 10 days and must be replaced with new FB. As a result, these SFB will become solid waste once every two weeks and are be discarded. These SFB are then cleaned, crushed and graded physically and mechanically respectively conforming to the gradation of fine aggregates. We have employed the same CSKFB in this project.

3. RESULTS AND DISCUSSIONS:

The results of various tests are discussed as follows:

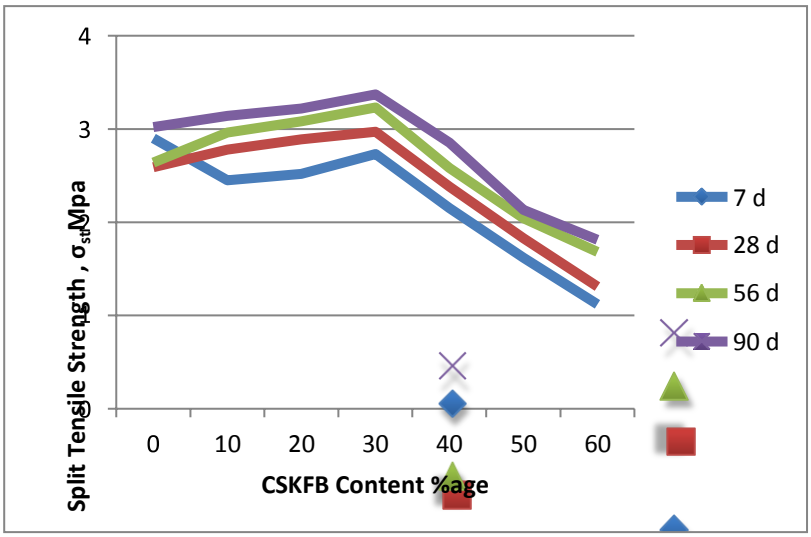
3.1 Compressive Strength:

The σ_{ccs} of standard cube specimens were carried out in accordance with BIS: 516-1959, at suitable curing circumstances and without surface moisture. At the ages of 7, 28, 56, and 90 days after curing, three cubes were evaluated for each mix percentage of 0%, 10%, 20%, 30% and 40% respectively.



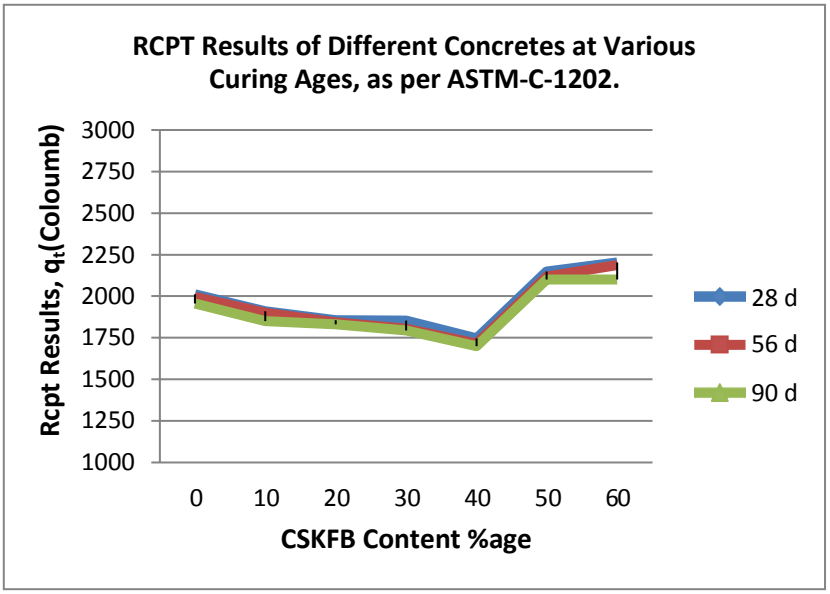
3.2 Split Tensile Strength Test:

Splitting tensile strength or σst, is used as an indirect method of determining the tensile strength of concretes in the laboratory. The split tensile strength is determined using cylinders of 150mm diameter and 300 mm long. At the ages of 7, 28, 56, and 90 days after curing, three cylindrical specimens were evaluated for each mix percentage of 0%, 10%, 20%, 30% and 40% respectively. Yielding results as follows:



3.3 RCPT Test Results:

The RCPT results outperform other durability tests (such as water permeability and DCPT results) for assessing not only Cl- ions, but also indirectly other ions such as SO42-, NO3-, H+, and others (i.e., based on total equivalent charges w.r.t Cl- ions), this test is known as the template or acid test for evaluating Cl- ions ingress. The qT values for various concretes were determined in accordance with ASTMC 1202-94 (1995).



3.4 Discussion:

In this study, the values of compressive and split tensile strength at the conclusion of the curing periods (7 days ,28 days etc.) for different replacement levels of CSFB (0,10,20,30, and 40%) are shown in the graphs above. These figures depict the variance in compressive and split tensile strength with fine aggregate substitution at various curing ages.

The figure shows that when sand is replaced with CSKFB, both the compressive and split tensile strength rises by up to 30%.However when 40 percent of the sand was replaced, the strength acted inverse to the increase in sand replacement proportion.

4. CONCLUSION:

a. The age of curing (i.e., between 28 and 90 days) and CSKFB–content (i.e., 0 and 30%) in concrete have a substantial impact on all strength metrics such as σcc, σst, σfl, and Is. However, the magnitudes of effects on σcc are far greater than those on other strength factors.

b. Under both theoretical and experimental study phases, the different experimental results demonstrate acceptable consistency, sufficient compatibility, and adequate relevance.

c. Unit weight of CSFB is higher than that of river Fine aggregate in dense condition which, in turn contributes to the increase in the unit weight of concrete containing CSFB as a fine aggregate.

d. From the results we observe that the maximum strength and durability is achieved by 30% of CSKFB replacement in concrete. The 40th % of CSKFB replacement in concrete indicates there is no strength gaining after increasing the proportion,

e. The compressive strength of partial replacement of CSKFB aggregate concrete is marginally higher than that of the river sand aggregate concrete at age 7 days, and 28 days respectively,

f. Despite the lack of any admixtures, the workability of CSKFB-concretes remains unaffected

g. The various constituents used to make good concretes are in compliance with the relevant BIS codal rules.

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