IMPACT OF CUPOLA BLAST FURNACE SLAG ON MORTAR AND CONCRETE M20

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Abstract: Concrete is a material which is widely used in construction worldwide. It a backbone of structure for the development of nation. There are huge demands of such type of construction material for development. And due to huge demand we need an alternate material to fulfill the requirement of building material. Similarly from the iron industries and aluminum industries huge amount of waste are generated in the form of waste, such type of waste material is known as blast furnace slag. Cupola blast furnace slag (CBFS) is a waste material which is by product of iron industries. They contain similar property of cement. The waste generation of iron industries is growing continuously from 5% to 8%. The management of CBFS is a serious issue occurring in industries. Therefore cupola blast furnace slag used as a alternative material in mortar and concrete in construction.

In this experiment we are used cupola blast furnace slag as a partial replacement of cement and also used partial replacement of fine aggregate (FA). The percentage of replacement would be 0%, 2%,4%, 6%, 8% and 10% with ordinary portland cement (OPC) and fine aggregate. After the adding cupola blast furnace slag in mortar with cement from 0% to 10% workability, water absorption, tensile test and compressive strength were conducted of cupola furnace cement mortar (CFCM). And similarly the partial replacement fine aggregate in concrete with CBFS from 0% to 10% workability, water absorption test and compressive strength test were conducted of Cupola furnace cement concrete (CFCC).

Keywords: Cupola Blast furnace slag, Ordinary Portland cement, Cupola furnace cement mortar, fine aggregate, workability, compressive strength, water absorption.

Introduction: Now in days this slag is used furnace aggregate for cast iron production. The by product which is formed during the production of cast iron in cupola furnace is termed as cupola slag. In building industry the cupola slag is most widely used. When we compare the blast furnace slag and cupola slag in terms of hydraulicity, cupola slag hydraulicity was incomparable. Utilization of Industrial Waste in India It is very important to reduce the waste and can be utilized and this can be done by material recycling or thermal treatment. There is also another method in which the waste is deposited in a landfill for suitable treatment. This method is done when the other treatment is not possible for technical reasons.

In construction work the waste is also formed in the site and it is very important to reuse and utilize the waste which is found in the construction site . In the building material sectors there is a lots of wastes were used which can be classified as below:

BY-PRODUCT WASTE – It is the type of waste which is produced from the industries during

the manufacturing process from plants, mills and mines . this waste are then stored in landfills which is placed on agricultural fields or around big cities. Some of the byproducts which is found from industrial waste is silica fume, slag, sludge, fly ash, sand paper, metals, glass etc[1].
SILICA FUME – It is obtained from the process of ferrosilicon industries. It is a very fine powder which is convalesces by filters from furnaces. Silica fumes contains 85% and some other quantity such as Fe203 (1.3-4%), Al2O3 (0.85-2.5%), CaO(0.5-0.9%).when the silica fume spread into the atmosphere it will cause environmental pollutions[2].
SLAG- It is the co-product of the iron and steel production . It is the mixture of metal oxides and silicon dioxide. These slag may contains some some elemental metals which can be used in agricultural and in construction industries. In agricultural industry the slag is used for the treatment of soil.
SLUDGE – It is the residual material which is left from industrial wastewater treatment process. This type of waste is is contaminated and toxic in nature. This sludge can be used in cementitious materials in building industries [4].
FLY ASH – During the process of incineration of solid materials some residues are formed in the power plant this residue is termed as fly ash. fly ash is having a cementitious property which is used to prepare the cement by partial replacement. About 35% of fly ash is partially replaced with cement.fly ash produces environmental damage by causing air and water pollution on a huge scale while the cost of storage is very high

.Literature Review-

- **K.Sundara Kumar, K.V.Manikanta (2016)** they replace a coarse aggregate and fine aggregate with blast furnance slag and cusher dust and prepare a concrete. the density of cupola slag(1280kg/m3) is in between that of normal weight aggregate (1600kg/m3) and light weight aggregate (1120kg/m3). The absorption of cupola slag was lower as compare to the structural light weight aggregate[3]. They used air cooled cupola slag in concrete by replacing 10%, 20%,30%,40%, 50% and 60% for the coarse aggregate and crusher dust was used as a partially replacement of the fine aggregate for masonry block and paving stones.

•**M.SOLIMAN (2013)** now a days everyone is using marble as a building material for a decorative purposes. This paper gives a other aspect of marble and its waste dust like its severe effect on environment, health, and other uses.in this study it is found that the waste marble dust can be replaced by sand which gives a improving result, workability and performance of concrete. This marble dust is produce during the process of cutting.
•**R.balaraman, Dr. N S elangone; 2021**: investigation of geopolymer on cupola slag concrete; they investigated that the replacements of cement by cupola furnace slag by 50% and 100% respectively. The charactestics compressive strength is increased by 50% at a time. In other hand the compressive strength and tensile strength is also increased.

- **A.pribulova, P.futas, J.peteric; 2018**: they stated that the blast furnace slag and cupola furnace slag are the both waste of iron industries and both are can be used in construction industries. The particles are more smaller and the structure of consituient is much similar to the cupola furnace slag and blast furnace slag. The main different in both is that only silicon and carbon content only.

• **K. V. Manikanta and K. Sundara Kumar** "performance of concrete by substituting blast furnace slag and crusher dust for coarse aggregate and fine aggregate" Volume 3, Issue 10, June 2016, International Journal of Science & Engineering Research. It said that concrete has employed by products with success. These products include scrap cupola slag and crusher dust from the metal casting industry. Concrete has also utilised cupola slag as coarse aggregate. Cupola slag has a density of 1280 kg/m3, which is in the middle of structural lightweight aggregate (1120 kg/m3) and regular weight aggregate (1600 kg/m3). Cupola slag's absorption was less than that of the structural lightweight aggregate. Crusher dust was used as a partial substitute for the fine aggregate in masonry blocks and paving stones, while air-cooled cupola slag was used as a replacement for the coarse aggregate in concrete at percentages of 10%, 20%, 30%, 40%, 50%, and 60%.

•Abararahemad Khalak, Mr Jaykumar Chaudhary, Experimental Analysis on Cupola Slag Waste as a Partially Replacement in Coarse Aggregate in

3. Materials and Methodology:

the methods used for designing and test conducted for the find out the property of materials. It is also contains different pictures to have clear idea about the methods. in this chapter we are discussed the about mortar which is mixed with cupola furnace slag (CFS) for plastering work and also CFS is used as a aggregate in concrete for different construction work [5].

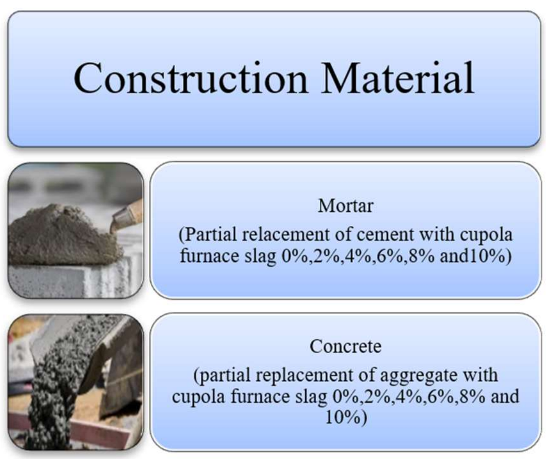

Fig 3.1: Uses of CFS in present experimental work

3.2 Material and There Properties

There is proportion to Mix the Mortar 1:3 and M20 grade of concrete are cement, sand, aggregate (coarse aggregate and fine aggregate) and water with cupola furnace slag (CFS). The ratio for M20 grade of concrete is 1:1.5:3. [6]

In this investigation there are experimental Setup of cement, sand, aggregate and cupola furnace slag is used for the knowing the properties of Mortar and concrete. In this experiment 0%, 2%, 4%, 6% ,8% and 10% of CFS is used for the mortar and concrete both[7].

3.2.1 Cement (Ordinary Portland cement)

In this experimental work ordinary Portland cement OPC is used (Source shiv Shakti cement plant Gondia MH) . to this cement mortar is prepared in proportion of 1:3 and concrete is mixed of grade M20. There are many function of cement in mortar and concrete, different types of cement have different properties and here many types of cement in our construction industries[8].

Cement is a binding material used in construction for binding of bricks, stones etc. when cement is comes to contact with water it is react with water and becomes hardend. There are many types of cement in civil engineering-

- Portland cement
- Ordinary Portland cement (OPC)
- Pozzolana Portland cement (PPC)
- Portland Slag cement
- White cement and colour cement
- Low heat Portland cement
- Air entraining cement
- Rapid hardening cement
- Quick setting cement etc.
- Sulphate resistance cement
- Super sulphate resistance cement
- Naturat cement
- Special cement

- **Properties of Ordinary Portland Cement**

In this experiment, ordinary Portland cement (OPC) is used, grade of cement is 43 grades according to IS: 455-1989 concrete mixed are prepared. the property of OPC cement is carried out according to IS code-

Specific Gravity	Fineness by sieve analysis	Normal consistency
3.015	2.01 %	32-34 %

Table 3.1: Properties of Ordinary Portland cement (OPC)

- **Fineness of cement (%)**

Fineness of cement = initial Wt. of cement- Wt. passed through IS sieve no. 200

3.2.2 Coarse aggregate

The material which has property to enhance the strength to the material, the size of that material will be more than 4.75 mm is known as coarse aggregate, this is a crushed rock form.

3.2.3 Fine aggregate

The size of fine aggregate will be less than 4.75 mm IS sieve. it will be passed from the IS sieve 4.75 mm. and predominantly retained by 74 micron (NO. 200) Sieve[9].

Test on cupola furnace slag (CFS)

There are some test which is carried out on cupola furnace slag (CFS) used as a partial replacement of cement, due to common chemical property of CRF.

- **Fineness test on CRF**

- Setting time test on CRF
- Soundness test on CRF

Experimental Design

- Preparation of cupola furnace slag: The cupola furnace slag CFS was transported to the department of civil engineering, concrete technology lab Kalinga University Raipur. These cupola furnace slag is splite into two part. First part of cupola is pulverized with the help of jaw crusher into below 4.75 mm size for the used as a fine (FA) in concrete and second part is ground into powder form with the help of ball mill the size of 75 microns used as a cement in concrete[10].
- Batching and mixing of concrete: in this research work the grade of concrete is used M20. The ratio of M20 grade of concrete is 1:1.5:3, where the percentage of cement is 1, sand is 2 and aggregate will be 4. The production of concrete water content will be 0.50 (for normal consistency). In this experiment the size of cubes is 150mm*150mm*150mm[11].

Cupola furnace slag is used in form of cement and fine aggregate, 75 micron size cupola furnace is used as a replacement of cement of 2%, 4%, 6%, 8% and 10% respectively and replacement of fine aggregate as 2%,4%,6%, 8% and 10% respectively[14].

Results: The replacement of cement with cupola furnace slag CFS by 0%, 2%, 4%,6%,8% and 10% resp. consistency is a property of cement in which the quantity of water is carried out for better workability of cement with materials. The test result is presented in the below table: the initial setting time of OPC is 70 minute and final setting time is observed 570 minutes[16].

Replacement of cement with CFS in % Initial setting time in min. Final setting time in min.

Replacement of cement with CFS in %	Initial setting time in min.	Final setting time in min.
0	70	570
2	140	650
4	170	680
6	260	720
8	270	730
10	280	735

Setting time of cement OPC with CFS [17]

Conclusion: Cupola furnace slag (CFS) is a industrial waste which is generated from the iron and aluminum industries. This work is related to use of CFS in building material in partial replacement coarse aggregate. In this research work we were replace cement and sand in a percentage of 0%, 2%, 4%, 6%, 8% and 10% respectively[12].

The test was conducted for mortar, modified mortar, normal concrete and modified concrete is workability, water absorption and compressive strength test after 7days and 28 days resp. [13]after the adding of cupola furnace slag the physical property of cupola furnace cement mortar (CFCM) and cupola furnace cement concrete (CFCC) were observed changed.

The following results are analyzing after the experimental work:

- When we add the 10% of CFS in mortar the workability of mortar is observed increased by 11.02% with 0.50 of water content (M5) and after adding the 2% of cupola furnace slag it is increased by 10% (M2).
- The water absorption of modified mortar is gradually decreased with increasing CFS of 2% to 10%. When we add the 10% of CFS the water absorption is decreased by 17% and the compressive strength is gradually increased. After adding the 10% of CFS the CS is increased by 13.40% (M5)[15].

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