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"STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH IRON ORE MINE TAILING AND GROUND GRANULATED BLAST FURNACE SLAG"

[1] Akshay Jain, [2] Anubhav Rai, [3] Y. K. Bajpai

[1] Research Scholar, Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India
[2] Assistant Professor, Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India
[3] Professor and Head of the Department of Civil Engineering, G.G.I.T.S. Jabalpur, M.P, India

ABSTRACT: *In this research the study of compressive strength and flexural strength of concrete as partial replacement of cement by Iron ore tailing and Ground Granulated blast furnace slag is carried out. The study is done by replacing cement (by weight) individually by Iron ore tailing 0%, 5%, 10%, 15% for , individually Ground granulated blast furnace slag 0%, 5%, 10%, 15% and together by both Iron ore & Ground granulated blast furnace slag for 0%, 5%, 10%, 15% for M-25 grade. For Compressive strength test 120 cubes were casted of size 150mm x 150mm x 150mm for 7,14, 21 and 28 days. For flexural strength test 30 beams were casted of size 150mm x 150mm x 700mm for 28 days.*
The test for compressive strength and flexural strength has been done and results are shown in graph. Graphs are plotted between flexural strength and compressive strength and percentages of IOT & GGBFS.
This research has shown that the IOT and GGBFS have the potential to produce high strength concrete at reasonable cost. As the graphs showing increasing slope indicating strength is achieved by replacing cement by IOT & GGBFS at different percentages.

KEYWORDS: *- Compressive strength, Flexural strength, Ground Granulated blast furnace slag, Iron ore tailing.*

INTRODUCTION: Concrete is the basic engineering material used in civil engineering structures. Its popularity as basic building material in construction is because of, its economy of use, good durability and ease with which it can be manufactured at site. The concrete ability to get moulded into desired shapes and sizes, because of its properties of plasticity in the green stages and its subsequently hardening property to achieve strength, is very important and useful. Concrete like other engineering materials needs to be designed for properties like strength, durability, workability and cohesion. The ability to mould it into any shape and size, because of its plasticity in green stage and its subsequent hardening to achieve strength, is particularly useful. Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, binding material and water. Concrete mix design is process of selecting proportions of the ingredients of concrete such as fine aggregates, course aggregate and water to achieve the desired properties for construction works such as strength, workability ,hardness etc. It is conventional that cement is used as binding material in the concrete. The production of Portland cement is not only energy intensive and costly, but it also produces large amounts of carbon emissions in the environment. It is obtained from the research that "The production of one ton of Portland cement produces approximately one ton of CO2 in the atmosphere".
The function of the cement is to assist in producing binding of fine and coarse aggregates. Large industries are set-up for the manufacturing of cement. Now-a-days cement becomes very costly and harms the environment. Hence we are forced to think of alternative materials. The IOT (Iron Ore Tailing) and GGBFS (ground granulated blast furnace slag) may be used in the place of cement fully or partly.
A comparatively good strength is expected when cement is replaced partially or fully with or without concrete admixtures. It is proposed to study the possibility of replacing cement with locally available IOT and GGBFS waste without sacrificing the strength and workability of concrete. However, it should be borne in mind that mix design when adopted at site should be implemented with proper understanding and with necessary precautions.

MATERIALS:
The various material used in carrying out this project are iron ore mine tailing and Ground granulated blast furnace slag.

1) IRON ORE MINE TAILING: Mine tailing is a waste material of Iron industries. Iron ore mine tailing was obtained from an open dump from Jain mines and minerals India Pvt. Ltd. HARGARH INDUSTRIAL AREA, JABALPUR District, MADHYA PRADESH, INDIA. After removing the vegetation and other matter on the surface of mine dump, it was air dried, pulverized and passing through 425 micron BIS sieve was used in different proportion from 0% to 15% at the interval of 5% in the present investigation.

Fig 1 Iron ore mine tailing dump

Table 1: Physical properties of IOT

Parameters	**IOT**
Particle shape	Spherical
Density	14.4 KN/ m^3
Specific gravity	3.10
Colour	Dark tan (brown)
Optimum Dry Density (ODD)	1.71 gm/cc
Optimum Moisture Content (OMC)	21 %

2) GROUND GRANULATED BLAST FURNACE SLAG: GGBFS is a by-product of Iron making industries. The granulated blast-furnace slag is sand-type slag manufactured by spraying high-pressure water jets on a blast-furnace molten slag. GGBFS was obtained in an open dump from UTTAM GALVA STEEL INDUSTRY, MAHARASTRA, INDIA. After removing the impurities and other matter on the surface of dump the GGBFS was collected and then it was oven dried, and passing through 425 micron BIS sieve was used in different proportion from 0% to 15% at the interval of 5% in the present investigation.

Fig2 Ground Granulated Blast Furnace Slag

Table 2: Physical properties of GGBFS

Parameters	**GGBFS**
Colour	Off white
Density units	2.94
Specific gravity	2.9
Fineness	450m^2/kg

VARIOUS WAYS TO USE IOT AND GGBFS IN CONSTRUCTION

1. Use of industrial waste in construction reduces the environmental pollution.
2. Use of industrial waste in construction will save natural resources.
3. Use of industrial waste in construction solves the problem of dumping area.
4. Sometime saving in energy and saving in cost can also be achieved by use of industrial wastes, thus achieving economy.

Experimental Work:

A. Compressive Strength on Concrete Cubes-: The strength characteristics of concrete with varying percentage of IOT and GGBFS were studied by casting cubes. The constituents of the concrete that is, cement, fine aggregate and coarse aggregate were mixed to appropriate proportion by adding water in accurate proportion. IOT and GGBFS are added to the different mix in varying proportion of 0%, 5%, 10%, 15% as a partial replacement for cement. Moulds for cube of size 150x150x150 mm were prepared and concrete was poured in to the mould layer by layer and vibrate thoroughly. The specimens were detached from the mould after 24 hours and then specimens were cured with water for 7, 14,21 and 28 days.

Fig 3. Deformed sample after testing

Table 3: Compressive Strength of Cube for Various Percentages of Cement Replacement by IOT.

% of Iron ore tailing	Cube compressive strength for 28 days (N/mm^2)
0	31.70
5	33.30
10	36.52
15	38.43

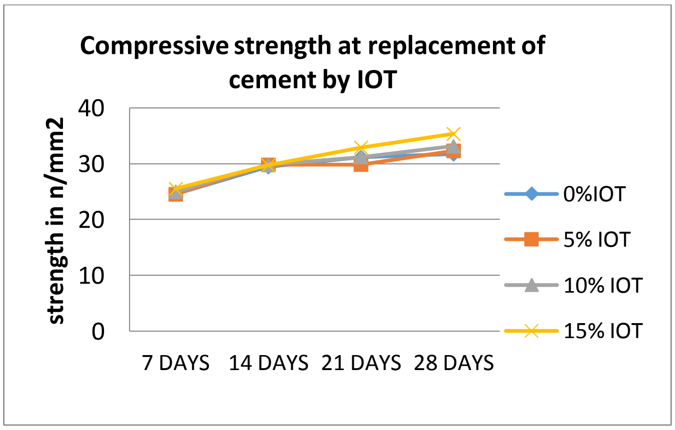

Fig 4. Graph showing compressive strength Development with days

Table 4: Compressive Strength of Cube for Various Percentages of Cement Replacement by GGBFS.

% of GGBFS	Cube compressive strength for 28 days (N/mm^2)
0	31.70
5	34.26
10	36.55
15	38.90

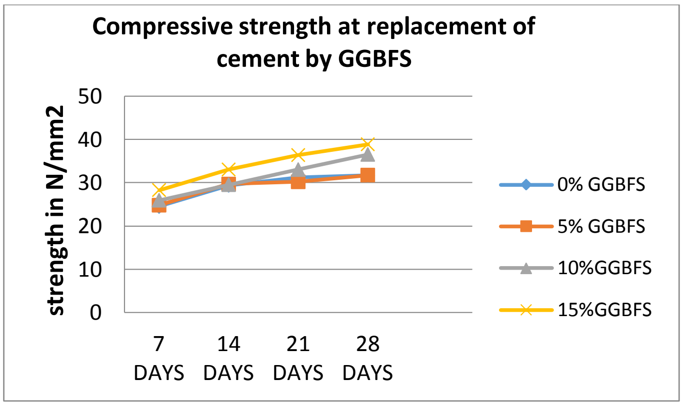

Fig 5. Graph showing compressive strength Development with days.

Table 5: Compressive Strength of Cube for Various Percentages of Cement Replacement by IOT+GGBFS

% of IOT+GGBFS	Cube compressive strength for 28 days (N/mm^2)
0	31.70
5	34.45
10	36.60
15	39.10

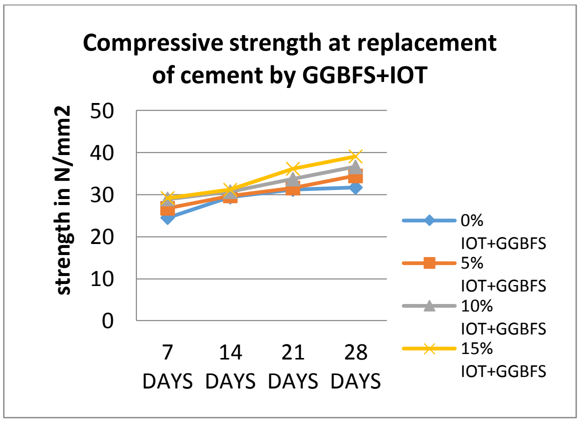

Fig 6. Graph showing compressive strength Development with days.

B. Flexural Strength on Concrete Beams-:

Cement concrete beam of size 700*150*150 mm is casted. The beams were casted by replacing 0%, 5%, 10%, and 15% of cement by Iron ore tailing and Ground granulated blast furnace slag and then cured for 28 days. Total 30 specimens were casted.

Fig 7. Three point load test on beam

Table 6: Flexural Strength of beam for Various Percentages of Cement Replacement by IOT

% of Iron ore tailing	Beam flexural strength for 28 days (N/mm^2)
0	4.78
5	4.96
10	5.52
15	5.75

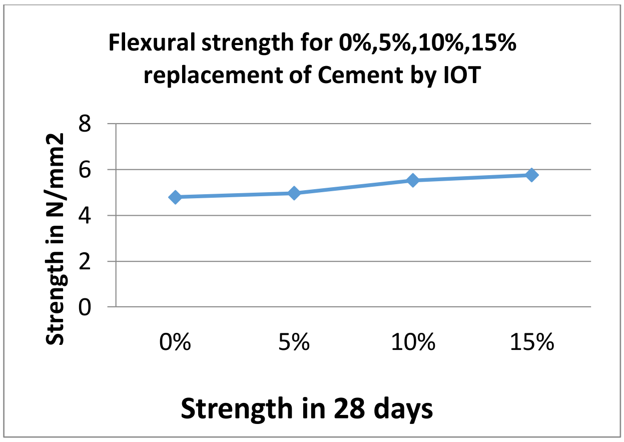

Fig 8. Graph showing Flexural strength development in 28 days

Table 7: Flexural Strength of beam for Various Percentages of Cement Replacement by GGBFS

% of GGBFS	Beam flexural strength for 28 days (N/mm^2)
0	4.78
5	4.95
10	5.48
15	5.74

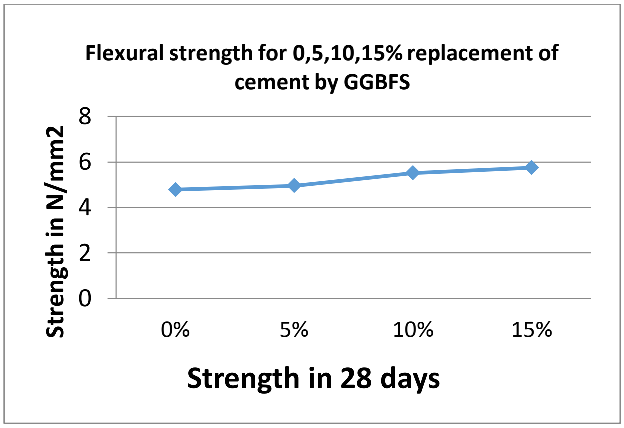

Fig 9. Flexural strength development in 28 days

Table 8: Flexural Strength of beam for Various Percentages of Cement Replacement by GGBFS + IOT

% of IOT+GGBFS	Beam flexural strength for 28 days (N/mm^2)
0	4.78
5	5.02
10	5.49
15	5.82

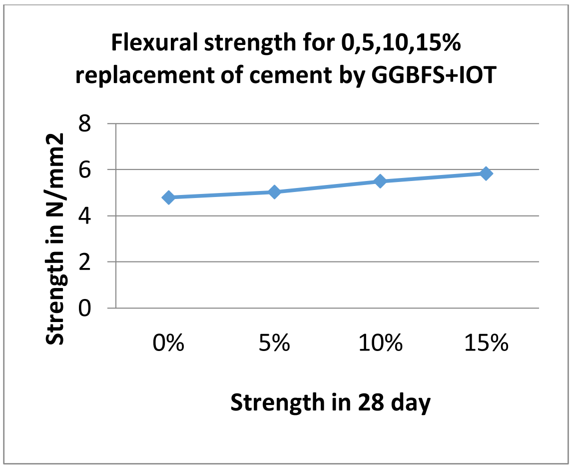

Fig 10. Flexural strength development in 28 days

CONCLUSION-:

The following conclusions are made from the above experimental work:

- The compressive strength of concrete is not affected by replacing cement by Iron ore tailing and Ground granulated blast furnace slag. On other hand there is increase in compressive strength due to cement replacement by Iron ore tailing and Ground granulated blast furnace slag.
- For 15% replacement of cement by IOT 28 days compressive strength increases 21.23%, for GGBFS 22.71% and for GGBFS+IOT 23.33% then of control mix M-25.
- Replacement of 15% Iron ore tailing and Ground granulated blast furnace slag by cement individually as well as together gives the maximum compressive strength which is more than the reference mix.
- The flexural strength of concrete beams is increased by replacing cement by Iron ore tailing and Ground granulated blast furnace slag.

- For 15% replacement of cement by IOT Flexural strength increases 20.29%, for GGBFS 20.08% and for GGBFS+IOT 21.75% then of control mix M-25.
- Hence as per the results obtained , it can be suggested that use of Iron ore tailing and Ground granulated blast furnace slag in replacement of cement will be beneficiary.

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