Assessment of Mechanical Properties of Concrete Made by using Industrial Waste

Introduction:

Many industrial activities worldwide generate a huge amount of waste by-products specifically fly ash, ground granulated blast furnace slag, red mud, phosphorus slag, micro silica, metakaolin, rice hush ash, and so on every year. Either these wastes are disposed of near the industrial plant where it is generated or on valuable lands of several hectares. This causes a huge environmental degradation; as those lands can either be forest land or can be used for agricultural purposes if we only think about the Green belt. Therefore, reusing the GGBS reduces the material that is to be landfilled. In addition to landfilling, lands are also been destroyed by extracting raw materials from quarries for cement production. "Scientists connect climate change to greenhouse gas (GHG) emissions, giving carbon dioxide (CO_2) the first position with 82% of the total." [1]. Like other sources such as the transportation sector and electricity production, the cement industry also emits CO_2. "It contributes approximately 5 to 7 % of global manmade CO_2 emissions." [1][2]. "It is estimated that CO_2 emitted during cement production is approximately 0.9 to 1.0 tonnes per tonne of clinkers, and 0.79 tonnes per tonne of cement." [2]. As a result of urbanization and industrialization, cement demand will grow in the future which will directly increase CO_2 emissions. This has forced the researchers to find a measure to reduce CO_2 emissions.

This leads to the usage of different fuels having less carbon content while burning clinkers, as well as using alternating raw materials while producing cement. "In Portland cement production, grinding and calcination at 1500 °C of raw materials approximately require the energy of 4000 MJ/tonne of cement. Whereas using different slags as a cementitious material reduces a considerable amount of energy as it only requires grinding. Grinding GGBS requires only 10% of the total energy which is required in producing Portland cement." [4].

On the other hand, reducing the dead weight of the structure has been a crucial task nowadays. "As the weight of the structure is proportional to the lateral earthquake forces affecting the structures" [3]. These are the structural designers who are promoting materials that may reduce the self-weight of the structures.

As a result of all the points discussed above, it has been observed that there is a considerable need to improve the handling of manufacturing industry by-products. The usage of supplementary cementitious material (SCM) in the production of concrete has become a hot topic among researchers. Using SCMs reduces CO_2 emission, serves as a primitive method of waste disposal, and preserves the non-renewable materials used in cement production. “Including SCMs affects concrete properties in both fresh and hardened conditions. It affects setting time, workability, early age strength, etc. it shows the similar filler effect and pozzolanic reaction” [7].

Also, some previous articles stated that GGBS can directly replace cement at a varying replacement ratio between 30% and 85% [5].

Objective:

1. To compare properties of fresh concrete made by GGBS with the conventional concrete.
2. To study the mechanical properties of harden concrete by varying concentration of chemical admixture.
3. To study the durability of harden concrete by varying concentration of chemical admixture.
4. To study the microstructural patterns of harden concrete by varying concentration of chemical admixture.

Scope:

This project will present the results of an investigation done on concrete after replacing cement with an SCM i.e. GGBS. The workability, density, strengths and rheological properties of concrete having M30 grade were investigated to determine the effects of using ground granulated blast furnace slag (GGBS) as a material to replace cement (100%), in addition to sodium hydroxide (NaOH). The work on the replacement of cement with GGBS with percentage variation has already been done by many researchers. But for various percentage combinations, the least studies have been made with the addition of an alkaline solution of a different mole in GGBS. Hence the study will provide a comparison between the mechanical properties of concrete made by cement and concrete made by GGBS, having identical mix proportions. Hence, the five inherent parameters of modern concrete will be taken care off in the study which are workability, strength, durability, microstructure, and sustainability.

Methodology:

To achieve the above mentioned objectives a series of designs and tests are to be generated with varying parameters. As a part of it various tests are identified at different phases of the projects.

Phase I: Testing the materials (Cement, GGBS, Aggregates) for the suitability

Phase II: Finalization of water-cement ratio (0.35, 0.40, 0.45, 0.50) having different concentration of NaOH (2M, 5M, 10M, 15M).
16 mix | 30 samples each

Phase III: Analyse the properties of fresh concrete having different concentration of NaOH (2M, 5M, 10M, 15M).
4 Mix | 30 samples each.

Phase IV: Analyse the properties of cubes, beams and cylinders having different concentration of NaOH (2M, 5M, 10M, 15M) for different curing days (7^{th}, 28^{th}, 90^{th}, 180^{th} and 365^{th} day).
4 Mix | 150 specimens of each concentration | Total 600 specimen for each strength test.

Parameters of fresh and hard concrete under consideration

1. Fresh Concrete:
    a. Slump
    b. Compaction factor
    c. Rheology
    d. Electrical Resistivity
    e. Shrinkage
2. Harden Concrete:
    a. Strength: Compressive, Flexural and Tensile Strength
    b. Micro structure Analysis
    c. Durability: Degree of Hydration, XRD, Carbonation and Electrical resistivity

Facilities:

1. Materials: Cement, Aggregate (Fine and Coarse), GGBS and NaOH.
2. Instruments: the instruments will be required to conduct the above mentioned tests.
3. Resource person: test like Micro structural analysis and XRD requires experts for supervision.

Program Schedule:

Expected Time: 3 Years

Sr. No.	Task Description	Duration (month)	Duration (weeks)	Start date	End date	2023				2024				2025			
						1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Literature Survey	6.0	26	2 Jan, 23	30 Jun, 23												
	Training	4.0	16	2 Jan, 23	22 Apr, 23												
	Writing	2.0	10	24 Apr, 23	30 Jun, 23												
2	Material & Design Methodology	11.0	48	3 Jul, 23	31 May, 24												
3	Test & Evaluation	14.0	60	6 May, 24	28 June, 25												
4	Analysis	7.8	34	7 Oct, 24	31 May, 25												
5	PhD Thesis	8	31	31 Mar, 25	31 Oct, 25												

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