"Analysis on Mechanical properties & Durability characteristics of Alkali Activated Concrete Incorporating GGBS"

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Introduction:
Portland cement is one of the most important components of concrete. With the increase of population, the demand for Ordinary Portland cements (OPC) increases. In general 1 tone of cement production generates 1 tone CO2 gas. The cement industry is second only to power generation in the production of CO2 and accounts for 7–8% of the planet’s human-produced CO2 emissions. One of the alternatives to produce more environmentally friendly concrete is to replace the amount of OPC in concrete with by-product materials such as Fly ash, GGBS in the form of blended cement.

Many research works have been conducted in this direction and indicates that the effective usage of these substitute material would increase the strength of concrete and durability property of the concrete. Better results on properties could be achieved over ordinary Portland cement concrete. These substitute materials are being used as partial replacement of cement. Generally, the high performance concrete and high strength concrete is being manufactured by blending these pozzolonic materials. Even though the usage of industrial wastes as supplementary materials of cement, the effective usage is not more than 20%. Research works are required in this area to increase the usage of these substitute materials. One possible alternative is the use of alkali-activated binder using industrial by products containing silicate materials. The most common industrial by-products used as binder materials are fly ash (FA) and ground granulated blast furnace slag (GGBS).

Objectives:
This work has been carried out to study the durability and mechanical behavior of Alkali activated concrete
1. To determine the mechanical properties of alkali activated concrete for varying percentage of GGBS and to arrive at an optimum percentage value
2. Mechanical properties of alkali activated GGBS incorporated concrete with conventional concrete
3. To determine the durability of GGBS incorporated alkali activated concrete and compare it with that of normal conventional concrete.

Literature Review:
Many research works have been carried out on the development of alternative binders to manufacture concrete and the use of mineral admixture such as GGBS in concrete. The literature review on the development of alkali activated concrete is as follows.

According to Vinayak Awasare, Prof. M. V. Nagendra, Use of GGBS as cement replacement will simultaneously reduce cost of concrete and help to reduce rate of cement consumption. This study report of strength analysis of GGBS concrete will give assurance to encourage people working in the construction industry for the beneficial use of it. This research work focuses on strength characteristics analysis of M20 grade concrete with replacement of cement by GGBS with 20%, 30%, 40% and 50% and compare with plain cement concrete.

According to Angel palomo, et al [23], worked on producing geo polymer concrete using different alkaline solutions. They produced geo polymer concrete using only Na OH as the alkaline liquid and cured the specimens at
850°C for 20 hours. The strength reported is 45MPa, another combination of alkaline liquid was 85% Na OH and 15% Sodium Silicate, for the same curing conditions, these specimens had a strength of 52 M Pa. They concluded that the type of alkaline liquid plays an important role in the polymerization process. Reactions occur at a high rate when the alkaline liquid contains soluble silicate, either sodium or potassium silicate, compared to the use of only alkaline hydroxides.

According to Vlastimil Bilek, Jan Hurta, Petra Done, Libor Zidek, Alkali-activated concretes for structures have been developed for last 10 years, especially for the production of precast elements. These concretes were designed as self-compacting with the water to binder ratio 0.5. Later they were modified using PNS-plasticizer. In this way concretes with the water to binder ratios 0.45 and 0.40 and with convenient work-ability were prepared with 28-days strength up to 90 M Pa. These concretes also show improved frost-resistance. Non-destructive tests for compressive strength were performed as well as and new correlation relationships were found. Finally, both fracture properties and fatigue tests were performed. All of these tests are important for a practical application of alkali-activated concretes for structures.

Methodology:

- Collection of GGBS from M-Pro Ready Mix Concrete Plant Mysore
- Collection of Alkali activators NaOH and Ni2SiO3 from chemist
- Fixing Alkali activators ration (Ni2SiO3 to NaOH ) as 2.0
- Fixing Alkali activators to Binder ratio as 0.35
- Casting of cubes and cylinders as per IS specification
- Investigate the Mechanical properties of AAC for 30 and 40 percent replacement of GGBS with Cement
- Durability Characteristics investigations
- Analyses the result obtained from the observe Experiments and Compare with Conventional concrete.

Results and discussions

The above graph indicates the compressive strength of concrete for AAC mixes of 30% and 40% replacement of GGBS with Cement and normal conventional concrete after 3, 7, 28 days of curing.

Split tensile strength

The above graph indicates the split tensile strength of concrete for AAC mixes of 30% and 40% replacement of GGBS with Cement and normal conventional concrete after 28 days of curing.
The above graph indicates the split tensile strength of concrete for AAC mixes of 30% and 40% replacement of GGBS with Cement and normal conventional concrete after 28 days of curing.

**Durability test**

- Immersing of concrete cube specimen using 14M of 5% Sulfuric acid solution for a period of 4 weeks, and then we get the results is mentioned below:

<table>
<thead>
<tr>
<th>Concrete type</th>
<th>Percentage loss of strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% replacement of GGBS</td>
<td>4.8%</td>
</tr>
<tr>
<td>40% replacement of GGBS</td>
<td>4.1%</td>
</tr>
<tr>
<td>Normal concrete</td>
<td>12%</td>
</tr>
</tbody>
</table>

**Conclusion**

- AAC with 30% replacement of GGBS for cement increased the compressive strength for 3, 7, 28 days by 48.26%, 39.20%, 20.70%.
- AAC with 40% replacement of GGBS for cement increased the compressive strength for 3, 7, 28 days by 52.06%, 40.10%, 27.28%.
- Split tensile strength of AAC is increased by 20.54% and 36.08% for 30% and 40% GGBS replaced concrete as compared to conventional concrete.
- Initial strength gain is faster in AAC for oven cured for 24 hours compared to conventional concrete.
- Resistance to acid attack, AAC is better as compared to conventional concrete.

**Scope for future work**

The further study can be done based on the following parameters:

- By changing the percentage of GGBS & OPC by 60%-40% & so on the further work can be carried out.
- By changing the ratio of activator solution the further work can be carried out.
- By changing the Molarity of sodium hydroxide the further work can be carried out.
- By increasing the initial curing temperature the further work can be carried out.

**References**

6. Concrete Technology — M. S. Shetty.