**KARNATAKA STATE COUNCIL FOR SCIENCE AND TECHNOLOGY**

46th SERIES OF STUDENT PROJECT PROGRAMME

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| **Project Reference Number**: | 46S_BE_2813 |
| **Project Title:** | Study on the production of tiles using industrial wastes |
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| **Keywords:** | Industrial by-products, Tiles, Alkali activated materials, Eco-friendly materials |

**Introduction:**

Tiles from industrial waste will be an innovative research and sustainable solution in the field of construction materials. Industrial waste or by-products, such as fly ash, ground granulated blast-furnace slag (GGBS), and metakaolin, can be combined with alkaline activators along with the small portion of fine aggregates. This combination of materials allows for the production of eco-friendly tiles while effectively utilizing waste products from various industries. Literature provides information about use of alkali activated materials with many industrial wastes (Zhang et al 2020). Whereas limited studies are related to tiles production with industrial waste or by-products. In recent studies, the researchers used a variety of mix proportion with varying proportions of cement concrete, geopolymer concrete, GGBS and M-Sand to produce tiles (Balakumaran et al 2015, Pavithraa and Porkodi 2021). However, the use of GGBS as a binder alone in the tiles can lead to cracks other durability problems. In continuation to the study, this investigation about the tiles production using fly ash, GGBS, metakaolin, alkaline activators, and fine aggregates which can be a promising solution for sustainable materials. Their utilization not only reduces waste generation and environmental pollution but also contributes to the conservation of natural resources and the promotion of greener building practices.

**Objectives:**

- To determine the suitable process for the production of tiles using selected raw

materials.

- To study the basic properties of the produced tiles and compare with the local available tiles.

| **Methodology:** | In the present experimental study for production of tiles will be carried out in the following tasks |
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TASK-1: COLLECTION AND CHARACTERISATION OF RAW MATERIALS

The raw materials from different industrial waste/by products such as fly ash, GGBS, micro-silica will be collected and characterised for basic properties. Along with these materials, binder material like alkaline solutions such as sodium hydroxide and sodium silicate will be procured from local sources for the study.

TASK-2: COMPOSITION OF RAW MATERIALS TO PRODUCE TILES

In this task, the raw materials are mix proportioned and characterized for the fresh and harden properties.

TASK-3: PRODUCTION OF TILES WITH SUTIABLE PRODUCTION PROCESS

The production of tiles with selected mix proportion from task 2 is executed in the selected process such that mixed can be mould to form a tile. A detailed study is necessary to optimize the mix proportion and process of production of tiles which will be carried out in this task.

TASK-4: CHARACTERISATION OF PRODUCED TILES

The produced tiles from task 3 will be characterized for properties of tiles as per Indian standard and compare with the local available tiles.

TASK-5:REPORTING

After the complete investigation of the above said tiles, a detailed report on the study will be reported as per the guidelines.

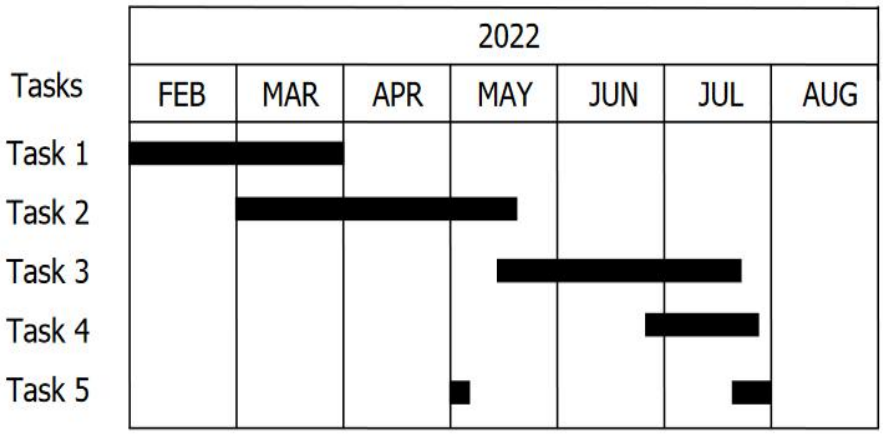


**Figure 1: Time schedule of work plan of proposed project**

**<u>Results and Conclusion</u>:**

Procured raw materials are characterised for its materials properties and it is presented in the Table 1. Fine aggregate used in the study also characterised and properties are presented in Table 2. Trail mixes to understand the behaviour of alkali activated materials are studied and

the details are as follows. Table 3 provides the mix details of trial mixes and materials used in trail mixes are in kilograms.

Table 1: Binder materials properties

| Material | Fly ash | GGBS | Metakaolin |
|---|---|---|---|
| Specific gravity | 2.11 | 2.63 | 2.49 |

Table 2: Fine aggregates properties

| Properties | M-sand |
|---|---|
| Specific gravity | 2.67 |
| Fineness modulus | 3.4 |
| Water absorption (%) | 1.4 |
| Bulking of sand (%) | 4.0 |

Table 3: Mixes details of trail mixes

| Materials | Mix 1 | Mix 2 | Mix 3 |
|---|---|---|---|
| Fine aggregates | 1.90 | 3.53 | 3.60 |
| GGBS | 1.90 | 1.76 | 1.80 |
| Fly Ash | 1.14 | 1.06 | 1.08 |
| Metakaolin | 0.76 | 0.71 | 0.72 |
| Sodium Silicate | 1.37 | 1.16 | 1.08 |
| Sodium Hydroxide | 0.30 | 0.25 | 0.23 |
| Water | 0.62 | 0.52 | 0.49 |
| Alkaline solution / Binder | 0.60 | 0.55 | 0.50 |

The fresh and harden state properties are investigated as per the IS codes. The flow table test results are presented in the Figure 2. It is observed that the flow value decreased with decrease in the alkaline solution to binder ratio.

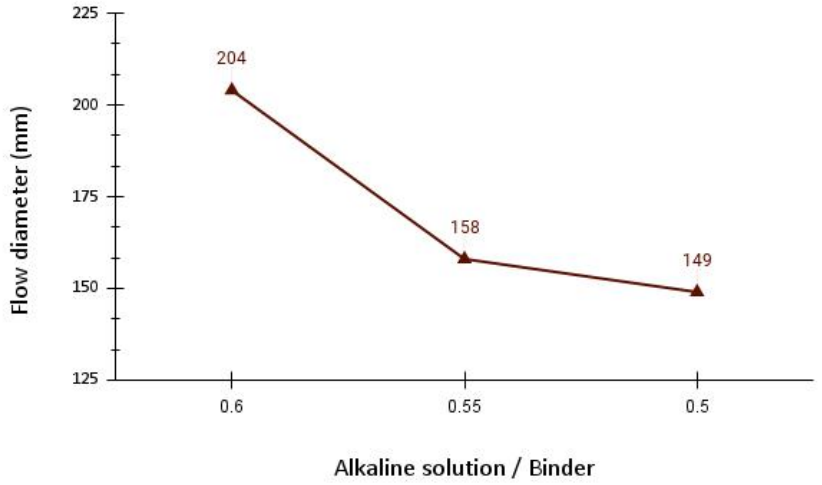


Figure 2: Flow table test

Compressive strength of the all trail mixes are presented in the Figure 3. It is observed that the mix 2 showed highest compressive strength of 72.3 MPa.

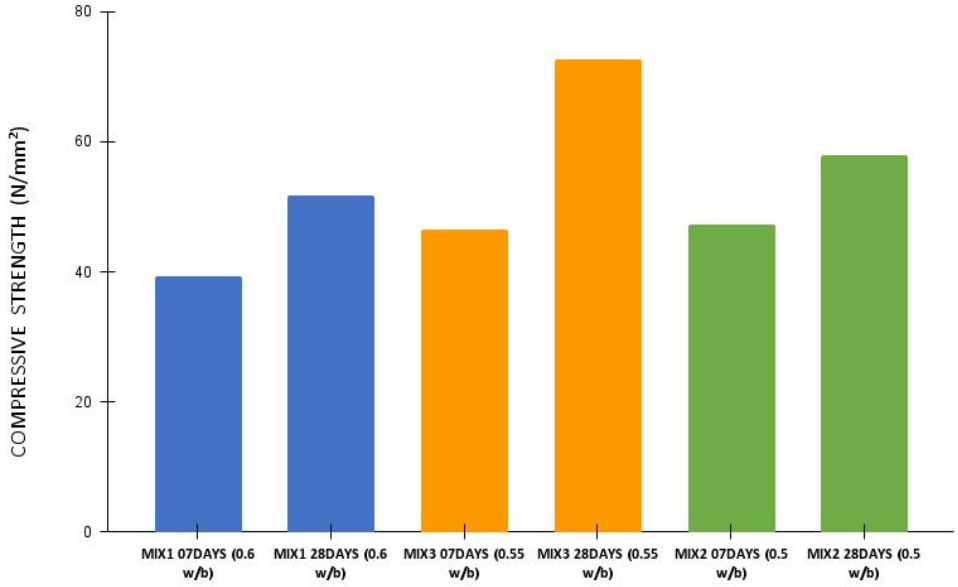


Figure 3: compressive strength of trail mixes.

Further Testing: These results provide a starting point for our project, but it's important to conduct further testing and analysis to optimize the mix design for our specific requirements. This may involve testing additional mix variations, evaluating other properties such as flexural strength and water absorption tests to ensure consistent tile production.

| **Scope for future work:** | |
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**Optimization of Mix Proportions**: Further research can focus on optimizing the mix proportions of fine aggregates, fly ash, ggbs, and metakaolin with alkaline activators to achieve the desired properties of tiles. The effect of varying ratios and combinations of these materials can be studied to identify the most optimal mix design.

**Surface Modification**: Develop surface treatments or coatings for geopolymer tiles to improve their aesthetic appearance and stain resistance etc This can involve exploring color pigments, or texture modifications.