Title of the Project: STABILIZATION AND SOLIDIFICATION OF MINE TAILING USING WASTE MATERIALS

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INTRODUCTION

MINE TAILING

Mine tailings, the residue left over from mining operations, are a significant environmental concern worldwide. As per the statistical data on the 15th May 2021, estimated **217 billion m³** of mine tailings that exist around the world. The mining of manganese and iron ore often generates large quantities of tailings, which pose challenges in terms of their disposal, potential environmental impact and long-term management. Understanding the characteristics and environmental implications of these tailings is crucial for developing effective strategies for their remediation and sustainable utilization. These tailings typically contain a mixture of finely ground rock, minerals, water and chemicals used during the extraction process.

LITRATURE STUDY

1.0 Yazeed Alsharedah, Mohamed H. EI Naggar; "*Mine tailing stabilization using waste materials*", Resilient Infrastructure, 2016
   - This application supports the sustainability of society by using wastes as beneficial materials that results in reduction of cost for MT stabilization & eliminates the cost of waste disposal.

2.0 Francisco Araujo et.al.(2022), "*Recycling and Reuse of Mine Tailings: A Review of Advancements and Their Implications*", vol 3, 2022.
   - This research paper supports the application of recycled mine tailings like iron ore, copper, gold tailings etc can be used as construction materials.

CURRENT STUDY

To stabilize and solidify the mine tailing, in this study cement, lime, sisal fibres, waste foundry sand & fly ash have been added in various proportions to prepare the cylindrical & cube samples after curing period of 7, 14 & 28 days, the samples were tested for UCS & Compressive strength.

OBJECTIVES

1. Characterizing the physical, chemical, and mineralogical properties of manganese and iron ore tailings to understand their composition and behaviour.
2. Assessing the environmental risks associated with these tailings, including the potential for leaching of toxic elements and heavy metals.
3. To determine the compaction characteristics & CBR value of stabilized MT.
4. To determine the compressive strength of stabilized & solidified cylinders & cubes.
5. Exploring potential utilization options for manganese and iron ore mine tailings such as subgrade material for the construction of pavements.
6. To solidify the mine tailing to achieve higher stability and compressive strength by using various proportion of waste materials.

METHODOLOGY

MATERIALS

- To stabilize the mine tailing ordinary Portland cement & lime in various proportion have been added.

- To reinforce the stabilized MT, natural fibres (sisal fibres) are used.
- To solidify the mine tailing waste foundry sand & fly ash have been added in various proportions along with the activators (sodium silicate & sodium hydroxide) to promote the geopolymeric reaction.

METHODS

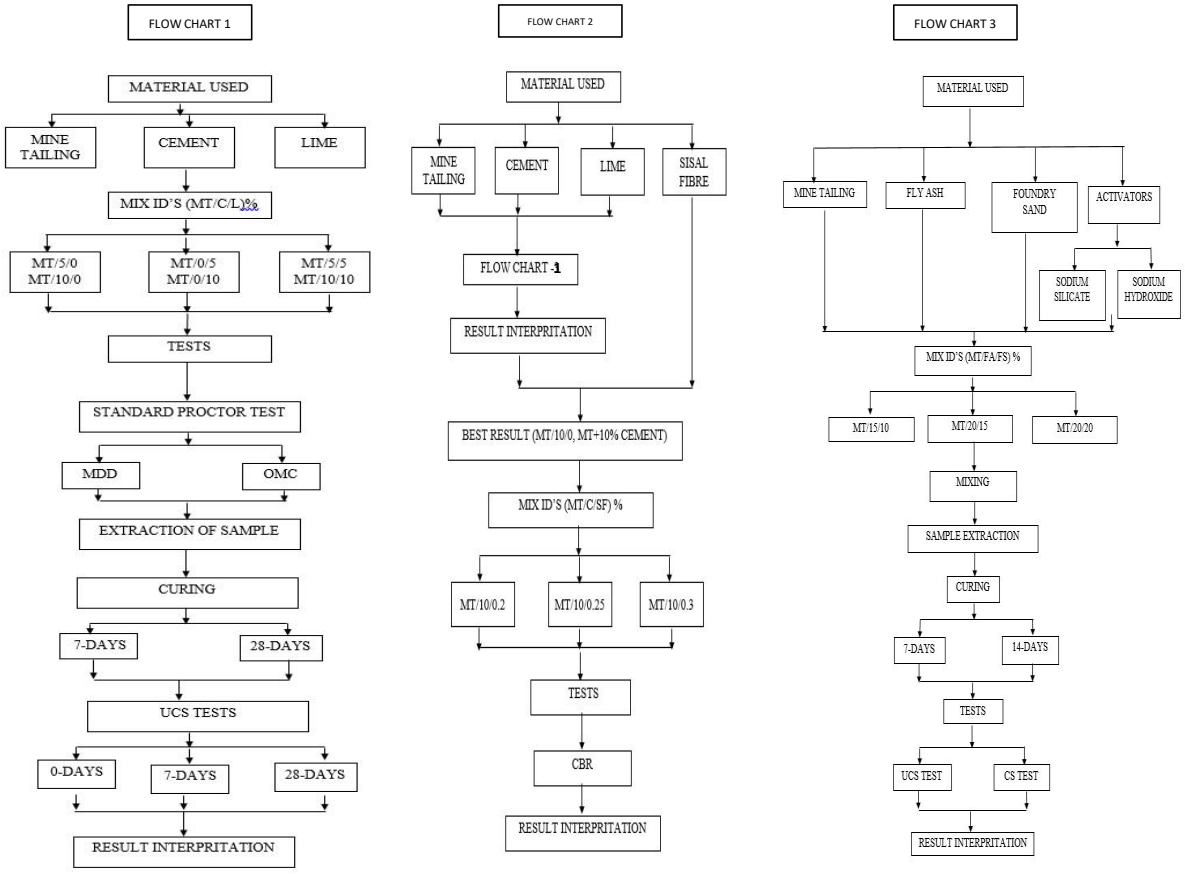
- For the characterization of mine tailing physical, chemical & mineralogical tests were conducted.
- Selection of Stabilizing Agents: Based on the characteristics of the mine tailings and the contaminants present, selection of appropriate stabilizing agents were done
- Mix Design: Based on the results of the bench-scale tests, developed a mix design that specifies the optimal dosages and proportions of stabilizing agents for full-scale application.

DETAILS OF WORK CARRIED OUT

Following tests were carried out

- Physical characteristics of MT
  1. Specific Gravity test (IS: 2720 (PART III)-1964)
  2. Determination Of Liquid Limit And Plastic Limit: (IS: 2720 (PART V)-1985)
  3. Wet Sieve Analysis: (IS: 2720 (PART IV)-1995)
- Chemical Characteristics of MT & additives (IS : 2720 (PART XXV))
  1. Determination Of pH & Electrical Conductivity
  2. Determination Of Silica Oxide, Iron Oxide & Aluminium Oxide
  3. Determination Of Calcium Oxide & Magnesium Oxide
- Mineralogical Characterization : XRD Test
- Heavy Metal Analysis: ICP – OES Test
- Compaction Characteristics (IS: 2720 (PART VII & VIII)-1980&1983)
- Unconfined Compression Test: (IS: 2720 (Part X)-1973)
- California Bearing Ratio Test (CBR Test): (IS: 2720 (Part XVI)-1979)
- Compression Strength Test (IS: 4031 (Part VI)- 1988)

FLOW OF WORK CARRIED OUT



STABILIZATION OF MT SOLIDIFCICATION OF MT

RESULTS AND CONCLUSIONS

1. **GEOTECHNICAL PROPERTIES OF MT:** MT is classified as poorly graded sand (SP), non-plastic in nature having 93% of sand with specific gravity 4.02. The MT lacks in cohesive binding properties, so additives like Cement, Lime and water to stabilize, in addition to solidify waste materials like foundry sand and fly ash are used.
2. **CHEMICAL CHARACTERISTICS OF MT & ADDITIVES:** The main chemical composition of MT, cement, lime, foundry sand and fly ash used in the study, pH of MT is 6.83 it is acidic in nature. Iron content of MT is about 25.34 %.
3. **XRD TEST:** The MT sample showed the presence of Iron oxide as a prominent composition along with minor peaks of aluminium, manganese & calcium oxide & MT+10% CEMENT sample showed the peaks of calcium iron silicate & calcium aluminate silicate. Their peaks were matched with standard JCPDS cards.
4. **ICP-OES TEST:** The qualitative analysis of selected toxic heavy metals (Cd & Pb) and metalloid (As) as well as the traced element (Zn) in MT and MT+10%C has been carried out & the presence of cadmium, palladium, zinc & silver were traced in the samples.
5. **COMPACTION CHARACTERISTICS ON MT & MIX ID'S:** For the mix id MT/10/10, the MDD is continuously decreasing due low specific gravity of cement and high specific gravity of MT & OMC is increasing due to the addition of pozzolanic material cement due to its high specific surface area.
6. **UCS TEST:** UCS strength with MT/10/0 showed the improvement of 99% for 28 days curing w.r.t MT/0/0 for 28 days curing.
7. **CBR test:** Addition of SF in MT for mix id MT/10/0.3 (MT/C/SDF) resulted in 34.55% of enhancement in CBR value.
8. **SOLIDIFIED UCS TEST:** The solidification process of MT by addition of waste foundry sand & fly ash for mix id MT/25/20 (MT/FS/FS) along with activators has shown increase in UCC with increase in curing period due to geopolymeric reaction by 40%.
9. **SOLIDIFIED COMPRESSIVE TEST RESULTS:** The marginal compressive strength increases with increase in FA + FS percentage. The mix id MT/25/20 is the maximum & compressive strength is increased by 20% with 14 days curing.

INNOVATION IN PROJECT

- The stabilized MT with cement & natural fibres has been proved as a potential high strength subgrade material for road pavement.
- The disposal of solidified MT, with addition of waste material like foundry sand & fly ash solves the problem of ground water pollution from loose deposits of MT, fly ash 7 foundry sand.
- The solidified blocks of high strength can be utilized to prepare bricks and pavers.

SCOPE FOR FUTURE STUDY

- The effect on various proportion of alkali activators with different concentration on compressive strength blocks can be studied.
- Bricks, pavers can be casted with the solidification process by various combination & compressive strength can also be studied.
- Leachate study needs to be carried out on these stabilized and solidified MT mixes.

Guide

Prof. Bharathi Chinivalar