# A Study & Analysis of Waste Management by Using Marble Dust, Red Mud & Fly ash

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**Abstract:**
Waste Management is the powerful term used as part of effective solid waste management technique. Under this preview, the definitive objective should be to convert completely waste material produced into useful engineering material. Civil engineers around the world are in search of utilization of Red mud, Fly ash and Marble dust, which are required both for cost effective solutions for roads and for preservation of scarce natural resources. At the end, we found that large scale utilization of this waste material is possible in these fields. Also, in order to utilise these waste materials, there has been a growing interest among the researchers to study their engineering properties for civil engineering application. In this context, red mud-fly ash-marble dust mix holds promise for civil engineering application.

**Introduction:**

Now-a-days disposal of different wastes produced from different Industries is a great problem. These materials pose environmental pollution in the nearby locality because many of them are non-biodegradable. The use of waste and by-products materials in the construction of pavements has benefits in not only reducing the amount of waste materials requiring disposal but can provide construction materials with significant savings over new materials. Recycling of waste construction materials saves natural resources, saves energy, reduces solid waste, reduces air and water pollutants and reduces greenhouse gases. It is necessary to utilize the waste effectively with technical development in each field. Further, in India, a large number of construction activities are underway requiring a large quantity of good materials which otherwise is becoming scarce. Moreover use of waste materials can result in saving of the natural material and savings on difference in cost of natural material, besides environmental protection.Also, in order to utilise these waste materials, there has been a growing interest among the researchers to study their engineering properties for civil engineering application. In this context, red mud-fly ash-marble dust mix holds promise for civil engineering application.

**Objectives of Study:**

With the above in view, the present studies are planned primarily to understand the application potential of the following materials:

- Red mud
- Fly ash
- Marble dust

The behavior of red mud with the addition of fly ash and marble dust is studied thoroughly through unconfined compressive strength, split tensile strength, durability, bearing ratio and UU tests.

More specifically, the proposed research included.

1. To study the compaction behaviour of different percentage of fly ash and marble dust powder in red mud and to decide the optimum mix.

2. To study the unconfined compressive strength behavior of reference mix of red mud-fly ash-marble dust at different curing periods,

3. To study the split tensile strength behaviour of reference mix of red mud-fly ash-marble dust at different curing periods,

4. To study the durability characteristics of stabilized fly ash at different curing periods,

5. To study the California bearing ratio of stabilized fly ash at different curing periods,

6. To study unconsolidated undrained strength of reference mix of red mud-fly ash-marble dust at different curing periods.

**Analysis & Research Methodology:**

As pointed out in the previous chapter, it is proposed to study the compaction, unconfined compressive strength, tensile strength and durability characteristics of red mud-fly ash-marble dust composite cured for 7, 28, 56 and 90 days. The specifications of the materials used, experimental procedures adopted, equipment used and test program me are presented in this chapter.

**Material**

Fly Ash The fly ash used in the study was brought from Ropar Thermal Power Plant, Punjab, India, which was available free of cost. Fly Ash is classified as silt of low compressibility. Fly Ash from Electrostatic Precipitator (ESP) is continuously removed to buffer hopers located near ESP by means of vacuum pumps. From buffer hoppers, dry fly ash is conveyed to storage silos, from there it can be unloaded dry to pneumatic tank trucks or conditioned with water by hydro mix dust conditioners for discharge to open bed trucks, Ash to be stored is removed by belt conveyers to ash storage area. For the present investigation, dry fly ash from hopper is collected in polythene bags. It had a specific gravity, maximum dry unit weight and optimum moisture content of 1.78365, 12.65 kN/m3 and 26% respectively. The Fly ash used in the thesis is shown in the Fig. 1. The X-ray difractogram and SEM of the fly ash is shown in Fig. 2 and Fig. 3. It indicates that few silica peaks and mullite peaks.

**Fig. 1. Fly ash used in the work**

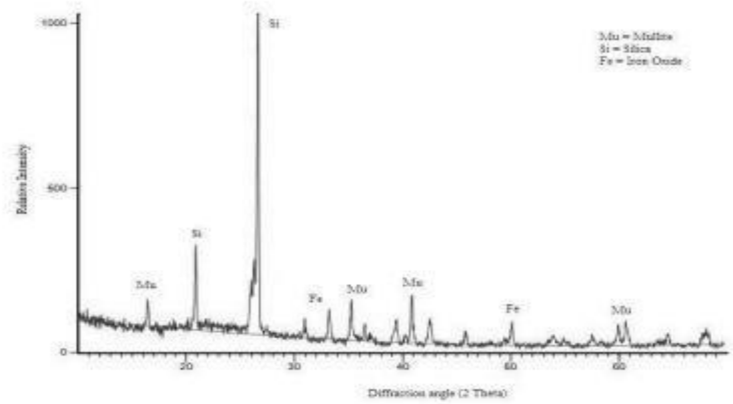


**Fig. 2. X.R.D of Fly Ash**

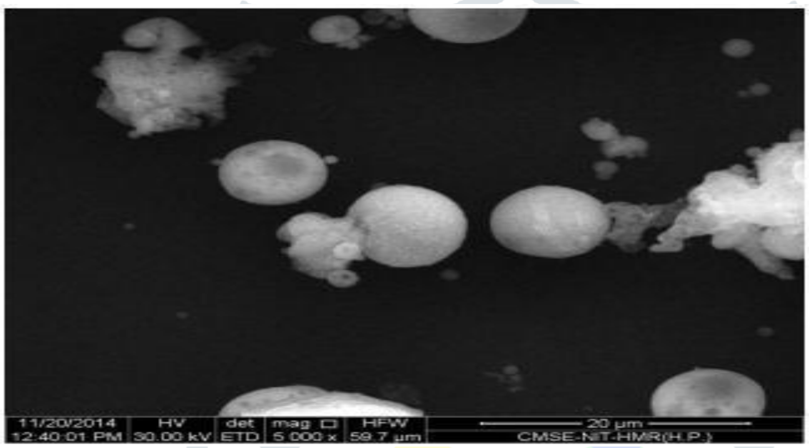


**Fig. 3. SEM of fly ash (30kV, X5000, 20µ)**

**Red Mud**

The red mud used in this work was brought from from HINDALCO (Hindustan Aluminium Company) at Renukoot, Shonbhadra (U.P.) India. This Red mud is the solid waste residue of the digestion of bauxite ores with caustic soda for alumina (Al2O3) production. It is a mixture of compounds originally present in the parent mineral bauxite and of compounds formed or introduced during the Bayer cycle. The red mud had a specific gravity, MDD, OMC of 2.676, 14.518 kN/m3 and 38 %. The Red Mud used in the work is shown in th Fig. 4.

**Fig. 4. Red Mud Used in the Work**

The results of the various engineering properties such as compaction, unconfined compressive strength, split tensile strength, durability, California bearing ratio, Unconsolidated untrained triaxial test and mineralogical & morphological studies performed on the reference mix and their variation with curing period (from 7 to 90 days), are presented in this chapter. It may be recalled that the above tests are conducted on the reference mix containing 70% red mud + 30 %fly ash + 8%marble dust of dry weight of red mud-fly ash mix and cured for 7, 28, 56 and 90 days using Dessicator method of curing.

**Compaction**

Compaction studies are carried out to fix the reference mix of red mud, fly ash and marble dust.. Red mud content in fly ash was varied from 10 to 90 % .One whole weight was selected and then of those whole weight respective weights of fly ash and red mud was calculated from their respective percentages. But from compaction studies no productive results were deduced to fix the percentages of red mud-fly ash mix as therefore, UCS tests on freshly casted samples of various percentages of red mud-fly ash mix were conducted to fix the optimum at red mud – 70% and fly ash 30% as. Then Marble Dust was varied from 4 to 10 % and optimum was fixed at 8 % of the red mud-fly ash mix as shown in Fig. 5. and

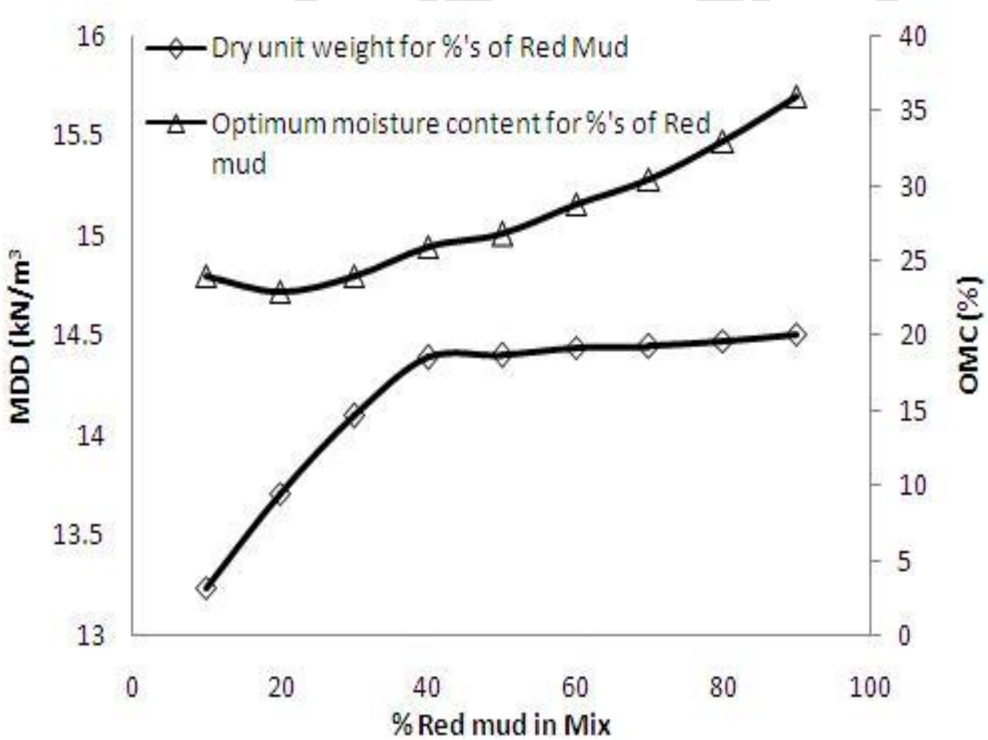


**Fig. 5. Variations of dry unit weights and optimum water contents with increase in percentages of Red mud**

**DISCUSSION**

Most developed and developing countries all over the world have huge resources of waste materials such as red mud(waste produced during extraction of alumina from bauxite using Bayer's process), fly ash (residue generated by coal combustion) and marble dust (a waste collected from marble cutting and polishing industries). These waste materials contain large quantities of impurities which may pollute the subsoil or ground water if disposed off in an open environment. The quantity of waste materials produced around the world is huge and causing disposal problems that are both financially and environmentally expensive. Due to lack of existing alternatives, other than diverting waste fractionally by increasing informal recycling sector's role, closing existing landfills would mean finding new sites. Finding new landfills in and around cities is nearly impossible. One method is to reduce some portion of their disposal problem is by mixing them together in the presence of stabilizers and utilizing the composite so produced for civil engineering applications. Civil engineers around the world are in search of new alternative materials which are required both for cost effective solution for roads and for conservation of scarce natural resources. Towards this end unconfined compressive strength, tensile strength, durability, bearing ratio and unconsolidated undrained triaxial tests were conducted on red mudfly ash-marble dust composite.On the basis of the results and discussion presented in this chapter, the following is concluded.

1. The unconfined compressive strength of the red mud-fly ash-marble dust composite increased with the increase in curing period.

2. The split tensile strength of the red mud-fly ash- marble dust composite increased with the increase in curing period. The composite satisfies the requirements of tensile strength at 7 days.

3. The CBR percentage of the red mud-fly ash- marble dust increased with increase in curing period. The composite satisfies the requirement of bearing ratio for all curing period.

4. The durability of the red mud-fly ash- marble dust improved with the increase in curing period. The composite satisfies the requirement of durability at all the curing periods.

5. The deviator stress increased with the increase in curing period for unconsolidated undrained triaxial test.

6. The friction angle increased and cohesion decreased up to 56 days curing period, when the curing period was increased from 56 to 90 days the friction angle decreased and cohesion increased.

On the whole, the thesis has attempted to provide an insight into the various engineering aspects of red mud-fly ash-marble dust through laboratory studies. The final mix at all curing periods satisfies the requirements of split tensile strength, durability and California bearing ratio as a sub grade materials in low volume roads. Therefore this final composite of red mud-fly ash-marble dust can be suggested for construction of sub grade in road pavements. However the assessment needs to be supplemented subsequently with field trials.

**Conclusions & Future Scope:**

In an attempt to conserve scarce non-renewable natural resources in construction activities the search for new alternate materials is ongoing. In this thesis an attempt has been made to assess the suitability of red mud-fly ash-marble dust composite for the road applications through comprehensive laboratory studies. This chapter presents an overview of the work carried out and the salient conclusions drawn are highlighted. Most developed and developing countries all over the world have huge resources of waste materials such as red mud(waste produced during extraction of alumina from bauxite using Bayer's process), fly ash (residue generated by coal combustion) and marble dust (a waste collected from marble cutting and polishing industries). These waste materials contain large quantities of impurities which may pollute the subsoil or ground water if disposed off in an open environment. The quantity of waste materials produced around the world is huge and causing disposal problems that are both financially and environmentally expensive. Due to lack of existing alternatives, other than diverting waste fractionally by increasing informal recycling sector's role, closing existing landfills would mean finding new sites. Finding new landfills in and around cities is nearly impossible. One method is to reduce some portion of their disposal problem is by mixing them together in the presence of stabilizers and utilizing the composite so produced for civil engineering applications. Civil engineers around the world are in search of new alternative materials which are required both for cost effective solution for roads and for conservation of scarce natural resources. Towards this end unconfined compressive strength, tensile strength, durability, bearing ratio and unconsolidated untrained triaxial tests were conducted on red mud fly ash-marble dust composite.

Although a number of researchers have worked with red mud and fly ash as a potential ground improving materials individually or in combination with other cementations materials like lime, cement etc. there remains still a lot of unexplored fields where marble dust can be used as an effective additive to change/improve the engineering properties of the soil. From the current study the properties of red mud-fly ash-marble dust have been evaluated.

However to enable field applications of such composite the following research is desirable. In this section the possible scopes of future works are highlighted as follows.

1. Extensive study may be undertaken to investigate the effect of admixtures to modify the properties of red mud-fly ash.

2. Large-scale model tests on red mud-fly ash-marble dust and different chemicals like marble dust, lime sludge, phosphogypsum, Sodium metasilicate, Sodium Silicate, Sodium Chloride, Sodium Sulphate, Potassium Hydroxide, Potassium Chloride, Ferric Chloride, and EDTA etc. need to be conducted to validate the composite for use in highway pavement.

3. Roads pavements are subjected to many loading cycles due to the traffic. To simulate the field condition, studies are required to analyze the behavior of the red mud-fly ash and different chemical mix using dynamic tests.

4. Large scale model tests and instrumented field trials may be conducted on red mud-fly ash to validate the results.

5. Cyclic triaxial tests on reference mix need to be conducted to evaluate the dynamic behavior.

6. Leaching behavior of the red mud-fly ash-marble dust and different chemical mix needs to be studied so that the composite in contact with water may not pollute the ground water due to the presence of hazardous chemicals and heavy metals.

7. Flexure strength behavior of red mud-fly ash stabilized with different stabilizers need to be studied for assessing their application in highway pavements.

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