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Utilization of Solid Waste Clay Soils in Highways and its Effect on Environment

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Abstract
Expansive soil causes serious problems on civil engineering structures due to its tendency of swelling when it is in contact with water and shrinks when it is dry out .The evaluation involves the determination of the swelling potential of expansive soil in its natural state as well as in varying proportions of marble dust and solid waste (from 0% to 30%). Addition of marble waste and dust decreases liquid limit, plastic index and shrinkage index, increase plastic limit and shrinkage limit. Also experimental result shows that swelling percentage decreases and rate of swell increases with increase percentage of marble dust in expensive soil. The environmental degradation due to marble mining is much less than the environmental degradation caused by the waste from marble processing plants.
Key Words: *plasticity index, shrinkage index, swelling percentage, liquid limit.*

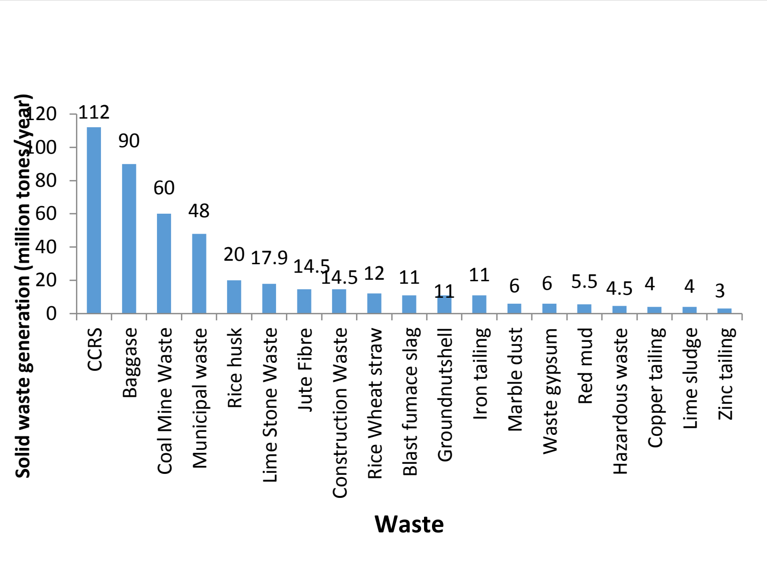
1. Introduction

Stone has played a significant role in our society since last decades and its use has evolved since ancient times. World stone production reached the peak of some 75 million tons and has produced a lot of wastes behind it. Nevertheless, during the process of manufacturing various building materials, especially decomposition of calcium carbonate, lime and cement manufacturing, high concentration of carbon monoxide, oxides of Sulphur, oxides of nitrogen and suspended particulate matter are invariably emitted to the atmosphere. Exposure to such toxic gases escaping into the environment does lead to major contamination of air, water, soil, flora, fauna, and aquatic life and finally influences human health and their living conditions.

2. Manufacturing Process

Marble Production and Waste

During the process of marble the raw stone is cut using blades as demanded either into tiles or slabs of various thicknesses usually 2 to 4 cms. While stone block is cut into sheets of varying thicknesses, water is showered on the blades to cool the blades and absorbs the dusts produced during the cutting operation. The amount of waste water obtained is very large from this operation. As the water is highly alkaline it is not recycled .In large factories where , where the blocks are cut into slabs, the cooling water is stored in pits until the suspended particles settle, then slurry is collected in trucks and disposed off and left to dry. After that slurry dries out in the sun and its particles becomes airborne .Main cause of pollution of the surrounding area is this. Another solid waste generated by the marble units is the cutting waste which results from cutting slabs.



The details on current status of solid waste (non-hazardous and hazardous waste) generation from different sources in India.

3. Environmental impact

In India, about 6 MT of waste from marble industries are being released from marble cutting, polishing, processing, and grinding. Rajasthan alone accounts for almost 95% of the total marble produced in the country and can be considered as the world largest marble deposits. There are about 4000 marble mines in Rajasthan and about 70% of the processing wastes is being disposed locally. The marble dust is usually dumped on the riverbeds and this possesses a major environmental concern. In dry season, the marble powder/dust dangles in the air, flies and deposits on vegetation and crop. All these significantly affect the environment and local ecosystems. The marble dust disposed in the river bed and around the production facilities causes' reduction in porosity and permeability of the top soil and results in water logging. Further, fine particles result in poor fertility of the soil due to increase in alkalinity.

During cutting process, chemical compound release no gases that contribute to global warming as water is used in cutting process to capture dust. The fine particles can cause more pollution than other forms of marble waste unless stored properly in storage tank, and further utilized. The fine particles can be easily dispersed after losing humidity. The white dust particles usually contain $CaCo_3$ and thus can cause visual pollution.

Growth of population, increasing urbanization, rising standards of living due to technological innovations have contributed to an increase both in the quantity and variety of solid wastes generated by industrial, mining, domestic and agricultural activities. Globally the estimated quantity of wastes generation was 16 billion tons in the year 2008 of which 14 billion tons were industrial wastes and 1.6 billion tons were municipal solid wastes (MSW). About 20 billion tons of solid wastes are expected to be generated annually by the year 2025. Annually, Asia alone generates 4.4 billion tons of solid wastes and MSW comprise 790 million tones (MT) of which about 48 (6%) MT is generated in India]. By the year 2047, MSW generation in India, is expected to reach 300 MT and land requirement for disposal of this waste would be 169.6km^2 as against which only 20.2km^2 were occupied in1997 for management of 48MT. Fig. Shows the details on current status of solid waste (non-hazardous and hazardous waste) generation from different sources in India. As can be seen from Fig. that apart from municipal wastes, the organic wastes from agricultural sources alone contribute more than 350 MT per year. However, it is reported that about 600 MT of wastes have been generated in India from agricultural sources alone. The major quantity of wastes generated from agricultural sources are sugarcane baggage, paddy and wheat straw and husk, wastes of vegetables, food products, tea, oil production, jute fiber, groundnut shell, wooden mill waste, coconut husk, cotton stalk etc. The major industrial non-hazardous inorganic solid wastes are coal combustion residues, bauxite red mud, tailings from aluminum, iron, copper and zinc primary extraction processes. Generation of all these inorganic industrial wastes in India is estimated to be 290 MT per annum. In India, 4.5 MT of hazardous wastes are being generated annually during different industrial process like electroplating, various metal extraction processes, galvanizing, refinery, petrochemical industries, pharmaceutical and pesticide industries. However, it is envisaged that the total solid wastes from municipal, agricultural, nonhazardous and hazardous wastes generated from different industrial processes in India seem to be even higher than the reported data. Already accumulated solid wastes and their increasing annual production are a major source of pollution.

4. Materials and Methods

Materials used

Material used are marble dust ,expansive clay soil and bentonite Marble dust was obtained from a cutting/grinding machine of Jaipur (Rajasthan) .The specific gravity of the material is 2.78.the expansive soil was collected from Alwar district (Rajasthan).The soil is classified as high plasticity clay (CH) according to ISI classification system (ISSCS). Bentonite (Montmorillonite) was taken from Barmer (Rajasthan) India in the form of grain size.

Specimen preparation and their properties

The soil sample was prepared by replacing the natural clay by 10% bentonite , then the marble dust was added to prepared sample from 0% to 30% (by weight).Total seven samples were analyzed .Marble dust and bentonite was oven dried at 60% for 24 hours. Before mixing all different materials were sieved through 2.36 mm sieve. The index properties are below in the table:-

Table 1 Index Properties of the samples used

Sample 1	38.2	61.8	2.64	96.3	21.5	74.8	15.1	81.2	CH	1.958	Very High
5% MD	29.1	70.7	2.66	76.1	25.3	50.8	16.7	59.4	CH	1.745	High
10% MD	28.5	71.7	2.68	75.6	28.3	47.3	18.3	57.3	CH	1.659	High
15% MD	26.7	73.3	2.72	72.0	30.7	41.3	20.3	51.7	CH	1.546	High
20% MD	25.8	74.2	2.74	71.3	31.1	40.2	21.8	49.5	CH	1.558	High
25% MD	23.2	76.8	2.74	68.6	32.4	36.2	23.1	45.5	CH	1.560	High
30% MD	20.1	79.9	2.76	62.2	34.3	27.9	25.0	37.2	CH	1.388	Medium

G: Specific gravity, LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, ISSCS: Indian Standard Soil Classification System.

5. Test programs

Hydrometer test, proctor compact test, Atterberg limit and specific gravity were performed according to IS : 2720 .Specific gravity test were performed by picnometer. Clay and silt percentage was found by grain size distribution from hydrometer test .Classification of soil has been done according to Indian standard soil classification system (ISSCS) by plotting test results on plasticity chart. Swelling of each specimen calculated as per plasticity index values and clay percentage.

Activity= (p.i/ Clay percentage)

6. Results and Discussions

Table 1 shows the changes with the addition of marble dust in LL, PL, and SL .It is find out that increase of stabilizer percentages the liquid limit decreases. The maximum reduction was 34.1% at 30% marble dust mixing. Due to increase in percentage of marble dust 12.8 % at 30%, the plastic limit was increased .Same increase was experienced in shrinkage limit when 9.9% at 30% marble dust was mixed.

Plasticity index is the difference between LL and PL. In table 1, the variation is shown clearly in plasticity and shrinkage index. The plasticity index was decreased 46.9% to 30% with the addition of marble dust. Same decrease was found in shrinkage index 44% to 30% with the increase in marble dust.

7. Conclusion

Utilization of solid waste and marble slurry in black cotton soil is one of the best ways to improve soil properties and to protect environment from the harmful effects of disposal of marble waste on land and water. The addition of marble dust and waste to clay reduces to clay contents and thus increase in percentage of coarse particles, reduces the liquid limit, raises the shrinkage limit and decrease in PI of the soil and swelling percentage. Therefore expansive soil can be replaced by marble waste and dust by 25% to 30%.

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