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A Review on Application and Analysis of Wastes, Minerals and Fibres in Soil Stabilization

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Abstract - *Soil stabilization is one of the techniques which is responsible for redefining and improving engineering properties of soil such as its mechanical strength, permeability, compressibility, durability and plasticity. Expansive soil is basically not considered for foundation and basement work as the name suggests due to its expansion nature. This nature is due to presence of variety of expansive minerals such as smectite, bentonite, montmorillonite, beidellite, vermiculite, attapulgite, nontronite, and chlorite. There are also some sulphate salts that helps in expansion with change in temperature. Expansive soils also shrink when they dry out. Fissures in the soil can also develop. These fissures help water to penetrate to deeper layers when water is present. This produces a cycle of shrinkage and swelling that causes the soil to undergo great amount of volume changes.To deal with this nature of expansive soil, in this research, it is being dealt with construction and demolition waste, ggbfs and pp fibre. Recycling C&D waste leads to pollution free landfills and environment benefits. Ggbfs reduces the risk of thermal cracking and improves the workability of soil. PP fibre is inexpensive material and possess high flexural strength because of its semi-crystalline nature. So, C&D and GGBFS materials are used in 12,14,16,18 and 20% and pp fibre is used in variety of 0.35, 0.5, 0.65, 0.85 and 1%.*

***Key Words*: Expansive soil, C&D waste, GGBS, PP fibre**

1. INTRODUCTION

The quantity of waste materials generated per annum from construction and demolition activities ranges from 0.27 to 5.18 million tons. Due to the rapid growth in the construction industry, it will be suitable to link construction and demolition waste generation with the Indian economic development. Therefore, appropriate practices are necessary to control construction and demolition (C&D) waste in order to propose an economic approach. Expansive or swelling soils are soils that, because of their mineralogical composition, experience large volume changes or volumetric strains when subjected to moisture changes. Another effective method for expansive soil is stabilization by the use of additives that helps to minimize the volume change due to swelling. The clay minerals are formed through extensive physical and chemical weathering of parent material.

Foundation is very important part of any civil engineering construction work. Load of any structure is ultimately taken by foundation; hence it is very necessary to prepare a sufficient strong base for any structure. Bottom most portion of structure is consisting of natural earth surface, this earth surface is known as soil. For successfully transfer of load of structure on the soil it is necessary to prepare soil with desirable bearing capacity, also it is not possible every time to get soil having sufficient strength at every place. Process of increasing strength of soil by artificial process is known as stabilization of soil. The process of soil stabilization refers to changing the physical properties of soil in order to improve its strength, durability, or other qualities. Soil stabilization is important for road construction, and other concerns related to the building and maintenance of infrastructure.

The increased waste in the construction industry causes a major problem for disposal operation. The waste materials from construction activities are heavy in weight and occupy more storage space.

EPA's waste characterization report, the Advancing Sustainable Materials Management: 2017 Fact Sheet, estimates C&D material generation in the United States.

- 569 million tons of C&D debris were generated in the United States in 2017, which is more than twice the amount of generated municipal solid waste.
- Demolition represents more than 90 percent of total C&D debris generation, while construction represents less than 10 percent.

Observational research has shown that this can be as high as 10 to 15% of the materials that go into a building, a much higher percentage than the 2.5-5% usually assumed by quantity surveyors and the construction industry. Since considerable variability exists between construction sites, there is much opportunity for reducing this waste.

1.1 OBJECTIVES

- To determine the optimum mix proportion for the combination of C&D+GGBFS+PP these materials.
- To study the geotechnical properties of virgin soil variegated with these materials.
- To make certain cost reduction compared to conventional material

1.2 MATERIALS

The materials used for this study are Expansive soil, construction and demolition waste, Ground Granulated Blast Furnace Slag (GGBS) and Polypropylene Plastic Fibres.

- **SOIL:** This soil collection will be from nilaje area, a small town in dombivili, Maharashtra.
  Black cotton soils are inorganic clays of medium to high compressibility and form a major soil group in India. They are characterized by high shrinkage and swelling properties. Because of its high swelling and shrinkage characteristics, the Black cotton soils (BC soils) has been a challenge to the highway engineers.

- **CONSTRUCTION AND DEMOLITION WASTE:** Construction and demolition (C&D) materials are generated when new building and civil-engineering structures are built and when existing buildings and civil-engineering structures are renovated or demolished (including deconstruction activities). Civil-engineering structures include public works projects, such as streets and highways, bridges, utility plants, piers, and dams. The planning for collection of these material is from nearby construction areas in Chandigarh university.

- **GGBS:** GGBS is used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzolanic materials. GGBS has been widely used in Europe, and increasingly in the United States and in Asia for its superiority in concrete durability, extending the lifespan of buildings from fifty years to a hundred years. The main components of blast furnace slag are CaO (30-50%), SiO_2 (28-38%), Al_2O_3 (8-24%), and MgO (1-18%). In general, increasing the CaO content of the slag results in raised slag basicity and an increase in compressive strength. Two major uses of GGBS are in the production of quality-improved slag cement, namely Portland Blast furnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%; and in the production of ready-mixed or site-batched durable concrete.

- **POLYPROPYLENE FIBRE:** PP belongs to the group of polyolefins and is partially crystalline and non-polar. It has similar properties as polyethylene, but it is harder and more heat resistant. It is a white rugged material with a high chemical resistance. Poly propylene is the second-most widely produced commodity plastic (after polyethylene).

PP fiber does not absorb moisture. This means the wet and dry properties of the fiber are identical. It has excellent chemical resistance as this fiber is very resistant to most acids and alkalis.

2. LITERATURE REVIEW

Miss Apurva J Chavan (Apr-2013), "Use of plastic waste in flexible pavements." Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes.

Rifai et al. (2014), "Effect of Volcanic Ash Utilization as Substitution Material for Soil Stabilization in View Point of Geo-Environmental. "Studied the effect of volcanic ash utilization as substitution material for soil stabilization in the view point of Geo-environment. They studied the engineering properties of soil mixture, the effect of volcanic ash content and its finest level. The fineness of volcanic ash is a prime factor in the stabilization. Utilization of volcanic ash with grain size passing sieve no 270 is more effective. The study revealed that the volcanic ash content can improve the engineering properties of soft soil, change the grain size distribution curve by decreasing the fine fraction, decreases the consistency limits and become non plastic soil, increases the bearing capacity and decreases swelling potential.

Edeh et al. (2014), "Evaluation of Sawdust Ash-Stabilized Lateritic Soil as Highway Pavement Material." Conducted laboratory evaluation of the characteristics of lateritic soil stabilized with sawdust ash. The tests performed were unconfined compressive strength and California bearing ratio (CBR). The results of laboratory tests show that the properties of lateritic soil improved when stabilized with sawdust ash (SDA).

N.Vijaya Kumar et al.; (Jan-2014), "Evaluation of wear properties of industrial waste (Slag) reinforced polypropylene composites." A lot of waste is produced by industries and they are piled up on land which creates land and environmental problem. Government policies and regulations force us to look for alternatives. Therefore,

researchers are trying to utilize these wastes as reinforcement in composites. Slag is an industrial waste reinforced in polypropylene composites. The pin-on disc wear testing machine has been used to study the friction and wear behaviour of the polymer composites. The wear loss and coefficient of friction are plotted against the normal loads and sliding velocities. It is observed from the graphical representation of the result that with the increase in load weight loss decreases and increase in sliding velocity weight loss also increases.

A. S. Soganc (2015), the inclusion of fiber within unreinforced and reinforced soil caused an increase in the unconfined compressive strength of expansive soil. Increasing fiber content had increased the peak axial stress and decrease the loss of post-peak strength. For example, unconfined compression strength increased from 202 MPa to 285 MPa for samples reinforced with 1% fiber. The fiber reinforced soil exhibits more ductile behavior than unreinforced soil. Swell percent was reduced as the fiber increased. One dimensional swell decreased considerably with 1% fiber addition. For example it decreased from 11.60% for unreinforced samples to about 5.3% for reinforced samples with 1% fiber.

Jesna Varghese, Remya.U. R (2016), et al Indicated that reinforced soil with fibre has following properties. The relationship between optimum moisture content and maximum dry density of soil significantly affected by the addition of polypropylene fibre. During the study, MDD increases with decreasing OMC. From unconfined compressive test, it was observed that the unconfined compressive strength value of untreated soil was found to be 15.1 KN/m2 and the strength value increased with increase in addition of polypropylene fibre up to 0.05% and then decreases. There is an increase of strength of about 454.37%.That may be due to increase in interfacial shear strength at 0.05 %.For higher amount of polypropylene fibre it shows reverse trend. The strength is increased in low percentage of PPF addition, it ensures more economical in construction. So finally, it was concluded that the polypropylene fibre can potentially stabilize the clayey soil.

3. CONCLUSIONS

The outcome of our experimental works over the black cotton soil was majorly on enhancing its engineering properties, to improve its load bearing capacity and to minimize the swelling. As we know that black cotton soil would swell when it comes in contact with water and it would shrink upon reduction in water. To reduce these effects in this review paper BC soil is incorporated with various dosages of C&D wastes, GGBS and PP fibre to reduce the swelling properties and to increase the load carrying capacity. GGBS and PP fibre is used to increase the maximum dry density of soil.

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