A Review Paper on Utilization of Waste Material for Strengthening of Pavement Subgrade

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Abstract— From a long period onwards in road construction work soil is used as base, sub-base and subgrade material. While constructing a road in the weak soil areas or subgrade has poor strength, in such cases the improvement of soil is necessary. The improvement of the soil is done by replacing of loose soil by the stronger soil or stabilization with the waste material. Dispose of these waste materials is essential as these are causing hazardous effects on the environment. With the same intention, the literature review is undertaken on the utilization of waste materials for the stabilization of soils and their performance is discussed. The waste material is one of the best solutions to the improvement of submerged properties in an economical manner. This review paper presents a brief exposure to the stabilization of soil with waste material like industrial waste, agriculture waste and constructional waste materials.

Keywords: Agriculture Waste, Base Material, Constructional Waste, Industrial Waste, Sub Base and Subgrade

I. INTRODUCTION

Generally In rural areas the low volume unpaved and paved roads are used. These roads are plays a important role in economy of rural area, resources supply to industries like mining and transportation to agricultural production areas. When low volume roads are laid on a poor sub grade soil large deformation occurs in the pavement, which increases the cost of maintenance work and interruption to traffic service. It's necessary to achieve the properties of sub grade soil to overcome the failure due to deformation in sub grade layer. The stabilization process is help to achieve required properties to sub grade with usage of waste materials obtained from industries and agriculture. In our country in the year of 1970 the modern stabilization of soil is commenced with usages of petroleum and aggregates [1].

Purposes of stabilization of rigid/flexible pavement resting on trouble soil or weak soil is to achieve desirable properties to subgrade. The properties likes shear strength, high compressive, permanency strength under all loading and weather conditions, ease of drainage, ease of permanency compaction and volume changes occurs due to low susceptibility and frost action. The subgrade is soils complex material it's largely depend on the density, texture of particles, strength and moisture content of subgrade material.

The performance of pavement is dependent on the stability of subgrade layer. For pavement design and construction purposes a stiffness pavement subgrade is required. During the Phase of construction to improves the stability of soil the mechanical methods like rammers, rolling and vibrators are used, when small portion of problematic soil are occurs those soil is remove with suitable soil [2]. In case of large project works to improve the subgrade strength, chemical stabilization methods like cement, fly ash, lime, quarry dust, rubber or the combinations like cement/fly ash/lime is also used. Compare to the removal and replace option to the subgrade soil with the stabilization processes is provides a more uniform support to the pavement structure whole of the project, its provided the good platform for the construction equipment to speed up construction activities. The method of mix design and performance of stabilization with materials are studied well in documentary.

II. LITERATURE REVIEW

Mehmet Saltan et al., (2011) [2]. He conducted a comprehensive study of the pumice waste soil stabilizer and its effectiveness on sub-base and sub-grade soils. The reactions of the soils treated with the pumice was observed and recorded and compared to the untreated control Samples, the variation in properties was observed over a short period only and it was found that in clayey subgrade soil there was no major variation in properties during the early days but the soil showed improved performance progressively.

Prakash Chavan et al., (2014) [3] intended to grace the properties of Black cotton soil by the implementation of bagasse ash at 0%, 3%, 6%, 9%, and 12% replacements. From his study, he concluded that the plasticity index of parent soil changes from 24% to 17.40% when 9% of Bagasse ash used. The MDD of parent soil increased from 1.57 to 1.78g/cc and OMC are decreased from 17.20% to 15% at 9% addition. The UCS of soil is increased from 93 KN/m2 to 429 KN/m2, free swell index of soil is decreased by 60% to 40% and soaked CBR value of soil increased from 1.16% to 6.8% for 9% of bagasse ash. He concluded that the usage of 9% bagasse ash is effectively used in the stabilization of black cotton subgrade soil.

Chayan gupta et al., (2014) [4] He conducted field studies on improvement of plantation roads. The road was unpaved road and it affects badly due to adverse weather conditions. Micro silica fume was treated to 27.2 km of the road and the sections were then monitored on the surface erosion for two monsoon seasons. No damage was noticed and there searches have concluded that Micro silica fume stabilization can convert the road to all weather roads that has minimum destruction in hot and wet seasons.

Nishantha Bandara et al., (2015) [5] He has conducted laboratory studies on use of Recycled material (CKD, LKD, Fly ash and Concrete fines)l for stabilization of three types of soils namely, clay of high plasticity, clay of low plasticity and silt of low plasticity. It was found that soil shows a marginal improvement in CBR value and substantiates reduction in saturation moisture after four weeks of stabilization. The Sub grade soil shows a marginal improvement in unconfined compressive strength.

Magdi M. E. Zumrawi et al., (2015) [6] He conducted an experimental study of the expansive clayey sub

grade stabilization with fly ash activated by cement in different proportions of fly ash content with 5% cement content. Based on the lab experiments there is marginal improvement in CBR and UCS values.

AltugSaygili et al., (2015) [7]in his work he intended to the utilization of marble dust to improve the engineering properties of kaolinite clayey with disparate proportions of marble dust is 0%, 5%, 10%, 20% and 30% in substitution of kaolinite clay soil. It has been observed from tests that with increases of marble dust the OMC is decreased and dry unit weight is increasing but the max dry unit is 18kN/m^3 with OMC of 15.5% is obtained at 30% marble dust added to the soil. The UCS of stabilized soil is increased from 150kpa to 260kpa at 28 days test for 30% marble dust. The free swell properties of soil are decreased from 21% to 13% for 30% marble dust. So it has been concluded that marble dust up to 30% is effectively used in kaolinite clayey subgrade soil to improve its engineering properties soil.

N.V.Gajera et al., (2015) [8] studied the stabilization of the black cotton soil with groundnuts shell ash with various percentages 0%, 2%, 4%, 6%, 8%, and 10%. Addition of the groundnut shell ash to the black cotton soil the index properties of black cotton soil are improved, with an addition of the 8%ground nut ash shell to the soil the MDD is increased and OMC is decreasing, further increasing content the MDD is decreased and OMC is increased. But the peak CBR value is obtained at 10%addition of groundnut shell ash. It concluded that 10% of groundnut shell ash is effectively used for increasing properties of black cotton soil.

Nirmal R et al., (2017) [9]. She has investigated the suitability of waste glass powder to enhancing the properties of highly clayey sub grade soil. Based on the laboratory tests it concluded that the waste glass powder with the 40% replacement in the clayey sub grade soil.

Manju Suthar et al., (2017) [10] He has conducted experimental studies on improvement of properties of the clayey sub grade soil with the help of lime and recron3s fibers. For the laboratory experiments purposes the recron3s fiber of 6mm and 12mm lengths are used. From SEM analysis and CBR test the bond between soil with fiber are shows that there is increases the strengthen properties.

RajaMurugadoss et al., (2017) [11] says that Mixing of the Waste rubber and Cement in different proportions are added to the clayey soil. Cement used is OPC53 grade which is acting as the binding agent between soil and rubber. For different mix proportion added to soil, based on CBR values the mix of the 4% cement with 10% rubber is effectively used for the clayey soil to improve its strength.

Parveen Kumar et al., (2017) [12] used Crumb rubber obtained from automobiles tires in the process of recycling steel and fluff are separated from the tires and the selected rubber is in the form of granular consistency. This continued process with mills the particle sizes is further is reduced and finally obtained the powder form. In his study, he studied that waste is used as Crumb rubber for the stabilization of clayey soil with a proportion of 5%, 10%, and 15%. With the adding of the 15% of crumb rubber to the clay soil the LL is decreased from the 39% to 34.6% and the obtained max dry density is decreased from 16.35kN/m^3 to 14.973 KN/m^3.By the study its clearly evident that the gap between crumb rubber and clay is an indication of the strength loss process. So the use of crumb rubber in stabilization purposes is reducing the cost and waste disposal of the rubber.

Hussien Aldeeky et al., (2017) [13]. He has investigated the suitability of fine steel slag for the unpaved road to improve its properties. It is concluded that, based on economic analysis and strength test results, 20% fine steel slag can be effectively used for the road work.

Ruqayah Al-Khafaji et al., (2017) [14] Studied with the waste GGBS for the stabilization of soft soil. The proportion of GGBS is integrated to soil in proportion of 0%, 3%, 6%, 9% and 12%. From tests, it's observed that by adding the GGBS the Atterberg's limits are decreases gradually. From compaction test, the soft soil of MDD is increased from 1.51g/cm^3 to 1.63g/cm^3 and OMC of soft soil is decreased from 20.5% to 19.4% it's achieved at 9% replacement of GGBS. From the UCS test, it's observed that the soft soil is increased from 190kpa to 350kpa. The max UCS of 350kpa is achieved at the 6% replacement of GGBS, 9% replacement of GGBS the UCS is 310kpa.it shows that the usage of 6% of GGBS the strength is increased 80% of parent soil. It concluded that the usage of 6% GGBS in soft soil subgrade to improve its properties.

Divya Patle et al., (2017) [15] Studied with the plastic waste for the stabilization of Black cotton soil. In this study plastic waste in 0%, 2%, 4%, 6% and 8% addition are used. The density of the plastic strips 0.44g/cc is used. From modified proctor test the MDD of the soil is increased from 1.62g/cc to 1.81g/cc and OMC is decreased from the 20.5% to 18.5% is obtained in 4% of plastic waste used. An Increase in the content of plastic the OMC is decreased, but MDD is also decreased. The soaked CBR increased from 1% to 11.70% is obtained at 4% plastic waste used. It concluded that 4% of plastic waste is effectively used in black cotton subgrade soils.

Tao Zhang et al., (2018) [16] He conducted a laboratory study on the silty content sub grade soil stabilization with lignin. The laboratory tests of Atterberg's limit, Particle size distribution, Compaction and CBR are conducted on both untreated and treated samples. By addition lignin to the soil the volume of pores in the soil is decreases, based on experiments it concluded that 12% lignin can be added to the silty sub grade soils.

Sharmila KC et al., (2018) [17] Studied with the Cashew nuts shell ash and lime waste for the stabilization of clayey soil. The Cashew nuts shell ash with various percentages like 5%, 10%, 15%, 205 and 25% along with a lime percentage of 5%. With the addition of the Lime and Cashew nuts shell ash to the soil the MDD and OMC are decreased, but the CBR value of the soil is increased, in case of a soaked condition the stabilized CBR is 2.38 times more than untreated soil and the soaked condition is 2.33 times more than untreated soil. It concluded that 20% Cashew nuts shell ash and 5% lime is effectively used in clayey subgrade soil which economical for road construction.

Sooraj P. Sudhakaran et.al., (2018) [18] Studied with the Bottom ash and Areca fiber wastes for the stabilization of clay soil. The varies volumes are substitution of bottom ash in percentages is 0%, 10%, 20%, 30% and 40%, the Areca fiber percentages is 0%, 0.5%, 1%, 1.5% with an addition of 3% cement used. From the test results, it's

observed usage of Bottom ash the MDD is increased gradually 1.44g/cc to 1.65g/cc. the max occurs at 30% of bottom ash if adding more than 30% the MDD is decreased. OMC is decreased from 28.7% to 18.5% for the addition of 30% of Bottom Ash. CBR for soil in case of unsoaked condition its increases from 2.25% to 39.45% , soaked condition it's increases from 1.2% to 29.98% a mix of (30% bottom ash + 1.5 areca fiber + 3% cement). It concludes the improve the properties of clayey subgrade soil by use of 30% bottom ash along with 1.5% areca fiber and 3% cement in soil content.

III. CONCLUSION

The following concluded were drawn from a broad overview of the literature review.

1) The waste materials like fly ash, baggage, GGBS, plastic waste, and rice husk ash are easily available in many parts of India and also have a low cost compared to other conventional material.
2) Adding of the waste material to expansive soil like black cotton soil we can control the swelling nature of the soil and increase the properties of the soil.
3) Usages of waste material in the highway field we have not only protect the environment but also to achieve the sustainable development of the country. The utilization of industrial wastes are economical for the local area and it is environmentally friendly.
4) Adding of fiber to waste material we can improve the properties of soil effectively.
5) Stabilization of soil sample with the combination of cement with other material can be effectively used to compare to the combination of lime with other material.

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