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Reuse of Plastic Waste for Improving Bearing Capacity of Sand

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ABSTRACT :

Soil stabilization is a technique to improve the engineering properties and performance of soil, which is used to enhance the engineering quality of soil in various types of engineering works. Sandy soil due to it's poor strength and less bearing capacity does not support the structural load coming on it during it's life span. As we know that while plastic has made life easier on one hand, on the other hand it has also created many dangers for the environment and become a serious problem. This experiment has been done at two different places namely Virendra colony and Sukva of Nowgong. Soil bearing capacity test and compaction test were performed on the surface received 24 hours after compacting using three types of soil samples namely; (i) in natural soil, (ii) in stabilized soil with 2% coal tar and 5% plastic waste, (iii) in stabilized soil with 5% coal tar and 8% plastic waste. As a result we observed that by adding plastic waste and coal tar to natural soil, the bearing capacity of the soil increases. The bearing capacity test that where the safe bearing capacity of natural soil was 1.56 kg/cm2, while mixing 2% coal tar and 5% plastic waste to natural soil, the safe bearing capacity of soil was found to be 2.54 kg/cm2 and mixing 5% coal tar and 8% plastic waste to natural soil, the safe bearing capacity of soil was found to be 3.26 kg/cm2 i.e. there has been an increase of 0.98 kg/cm2 and 0.72 kg/cm2. In the term of compaction of mix of plastic waste, coal tar and natural soil is also achieved more than natural soil. The compaction test that where the compaction 94.52 % of the natural soil was obtained, the compaction 100.10 % of the mix of 2% coal tar and 5% plastic waste with natural soil has been obtained and compaction 102.70% of the mix of 5% coal tar and 8% plastic waste with natural soil has been obtained. That is, there has been an increase of 5.58 % and 2.6% in the compaction. Resultant the permeability of mix of plastic waste, coal tar and natural soil also decreases. The developed the engineering technology is a new initiative in the direction of reducing plastic pollution and protecting the organisms and soil properties.

Keywords: Soil stabilization, Plastic waste, Coal tar, Natural soil, Air pollution

Introduction:

Soil stabilization is a technique to improve the engineering properties and performance of soil, which is used to enhance the engineering quality of soil in various types of engineering works. Sometimes soil stabilization can also be seen in the context of reducing the cost of construction [1]. Today many methods of soil stabilization are prevalent but that method will more beneficial for the environment and the living beings [2]. As we know that while plastic has made life easier on one hand, on the other hand it has also created many dangers for the environment. The bigger the world of plastic, the more dangerous it is, from the environment to the ecology, this plastic has become a serious problem. The ill effects of plastic can now be clearly seen from land to sea. Its most adverse effect is on the earth and sea creatures. Today, the use of plastic is increasing day by day, if plastic is not disposed of properly, then by 2050 billions of tons of plastic waste will accumulate around us [2, 3]. The increasing use of plastic has become a global problem today. China, USA, Germany, Brazil and Japan are the top five plastic waste producing countries. In India ranks 15th in the world in terms of production of plastic waste. Maharashtra, Gujarat, Tamil Nadu, Uttar Pradesh and Karnataka are the top five Indian plastic waste producing states. In the year 2017, 17800000 Tons of plastic waste was produced in India annually. According to a Report (2017-18) by the Central Pollution Control Board, about 9.4 million Tons plastic waste was produced in India every year. 50% of the plastic in India is thrown away as garbage after a single use whereas in the UK only a quarter of the plastic is recycled [4]. The main purpose of this study is to improve the bearing capacity of sandy soil by adding plastic waste with coal tar. Some other objects of this study to reduce seepage in the embankment. To improve compaction in the sub grade. Working in the direction of recycling and reuse of plastic waste. Working on 4R technology for plastic management. Working in the direction of separating food waste and plastic waste.

2. Literature Review

Wayal and Ameta (2013) had used ceramic dust for stabilized the dune sand. When ceramic dust was mixed with sand in different percentages and tested by them, as a result it was found that with an increase in the percentage of ceramic dust, the maximum dry density of sand also increases [5]. It was concluded from the test results that adding ceramic dust also increases the internal angle of friction of the sand thereby increasing the bearing capacity. Arvee, Sujil and Johnson, Anitha. K.R,R. Ashalatha (2009) studied on kaolinite soil, red soil, and Lateritic soil the effect of a replacement

stabilization product RBI Grade-81.The kaolinite soil, Red soil and lateritic soil were mixed with distinct percentage of RBI Grade-81(0%, 2%, 4%, 6% and 8%) for blending of specimen [6]. The CBR test was carried out on the prepared sample. Test result concluded that the value of CBR increases with increase in RBI Grade-81 percentage. Ankit Singh Negi, Mo. Faizen,(2013) conducted a study to improve the engineering properties of soil by use of lime as stabilizer, different proportion of lime is mixed with soil 1%,2%,4% and 6% of lime is mixed. CBR, compaction and consistency test were done by them on these mixtures [7]. It was found that the value of CBR increases by 4 to 10 times of than that of untreated soil. Brooks M. Robert et al. (2009) studied about the soil stabilization using fly ash and rice husk ash. He had conducted CBR test and concluded that increasing rice husk ash to the soil increase the value of CBR [8]. He suggest that optimum fly ash and rice husk ash content was found to be 25% and 12% respectively. Nsaif Hatem et al (2013) concluded by mixing plastic waste pieces with clayey and sandy soil at different mixing ratio like 0%,2%,4%,6%, and 8% by weight respectively that, there is significant improve in strength of soil because increase in angle of internal friction of soil [9]. The increase amount of angle of internal friction for sandy soil is grater than in clay soil but no any change in cohesion of both type of soil [10]. Hence due to low gravity of plastic waste pieces there is decreases in MDD and OMC of the soil. Lavanya et al. (2011) studied about utilization of copper slag in geotechnical applications. In our research investigated about the Index properties, compaction properties, CBR. She concluded that the partial replacement of copper slag with B.C soils, then the increase in properties of the B.C. soil for sub grade, sub base of road and embankment of dam [11].

Babu Ramesh et al. (2017) had investigated about the behaviour of black cotton soil by mixing of copper slag and steel slag. Compaction and CBR tested on this specimen [12]. After conducted it concluded that CBR, optimum moisture content and maximum dry density are increased when the soil is added with 20% of copper slag and steel slag. Michael Tiza et al. (2016) had reviewed about the stabilization using industrial solid wastes. In this research, he studied about the addition of different materials such as Red mud, copper slag, brick dust, polyvinyl waste, ceramic dust, and fly ash with soil [13]. Atterberg limits, CBR and compaction test was done on the prepared soil sample. He had concluded that Red mud, copper slag, brick dust, polyvinyl waste, ceramic dust, and fly ash have the ability to improve the engineering properties of soil with low cost. Paliwal et al. (2016) had researched about the stabilization of sub grade soil by using foundry sand waste. In this study he tested atterberg limit, plasticity index, MDD, OMC, CBR and Direct shear test [14]. He concluded that the CBR value and angle of internal friction of soil was improved with adding 20% foundry dust and OMC shows a lower value for 10% replacement of foundry waste. Sharma and Shivapullaiah (2011) had studied the compaction behaviour and effect of strength of soil stabilized with jute and gypsum. They found that the mixing of jute with and without gypsum has significant influence on the geotechnical characteristics of the soil [15].

3. Material and Methodology

Sandy soil is the main material used for shoulder, embankment and subgrade construction. The performance of embankment and flexible pavement depend on the property of subgrade soil. In this study soil sample taken from Nowgong. Plastic waste is easily available waste everywhere. In this study plastic waste collected from waste processing centre NOWGONG MUNICIPAL.

Procedure

This experiment has been done at two different places. The first experiment was carried out to assess and increase the bearing capacity of sandy soil in a residential building constructed in VIRENDRA colony of NOWGONG. Second experiment was carried out to assess and increase the compaction of sandy soil in a rural road (20 meters length) in NOWGONG to SUKVA. The method of this experiment is explained in following steps:-

- Plastic waste was collected from the waste processing center of NOWGONG and separated from other waste by manually.
- The separated plastic waste was dried in natural sunlight for 24 hours to remove the moisture.
- Dried plastic waste was divided into small pieces by a sharp knife.
- Soil samples collected from the field are placed in a drum and heated to 150 ^{0}C and pieces of plastic waste are mixed with it.
- Soil and plastic waste are mixed until a coating is formed on the sand particles.
- In the second drum the coal tar is heated to 160 ^{0}C and the hot coal tar is mixed with the mix kept in drum no. 1
- A mixture of sand, plastic waste and coal tar is mixed until its temperature is reduced to 140-145 ^{0}C.
- The mix thus obtained starts behaving like soil concrete which is loaded in trolley and brought to the field.
- Before using this mix in the field, it is necessary to note that the temperature of the mix should not be less than 100 ^{0}C.
- This soil concrete is used in foundation, embankment and road sub grade. Soil concrete is laid in layers and each layer is compacted by manually or roller.
- Soil bearing capacity test and compaction test were performed on the surface received 24 hours after compacting

4. Experimental Work

The two test are performed namely compaction test and soil bearing capacity test

4.1 Compaction Test

Compaction is a process by which the soil particles are artificially rearranged and closely packed together by mechanical means in order to decrease the voids ratio of the soil and increase it's dry density using core cutter method. The core cutter is a test used to determine the in situ density of soil. After calculate the dry density we have find the compaction of soil. For this we will three types of soil samples.

- In natural soil
- In stabilized soil with 2% coal tar and 5% plastic waste
- In stabilized soil with 5% coal tar and 8% plastic waste

Apparatus require

- Cylindrical core cutter (10 cm diameter and 12.74 cm height)
- Steel dolly 2.5 cm height and 10 cm internal diameter.
- Steel Rammer in 9kg,overall length 90cm.
- Weighing balance, accuracy 1g.
- Palette Knife
- Rapid moisture meter
- Calcium Carbide powder
- Straight edge, steel rule etc.

Procedure

- In first steps we have determine the mass (M1) of the core cutter.
- After mass (M1) calculation place the dolly over the top of core cutter and press the cutter into the soil mass using the rammer. Stop the pressing when about 1.5 cm of the dolly protrudes above the compacted soil surface.
- Remove the soil surrounding the core cutter and take out the core cutter form ground and also remove dolly from core cutter.
- Weigh the core cutter filled with the soil (M2).
- Remove the soil from core cutter and also take a representative soil sample for water content calculation.
- In the last step of the procedure, we calculate the water content(w) with the help of rapid moisture meter in this test 6 kg wet soil required and is mixed sufficient quantity of fresh Calcium Carbide powder. The result can be obtained in 5 to 10 minutes from dial gauge
- The dry density is obtained as:

$$\rho d = \rho /(1+w)$$

$$= (M/V)/(1+w)$$

$$= (M2-M1)/(1+w)\times V$$

5. Result and Discussion

1. COMPACTION TEST: 1.Compaction of natural soil is 94.52 %.

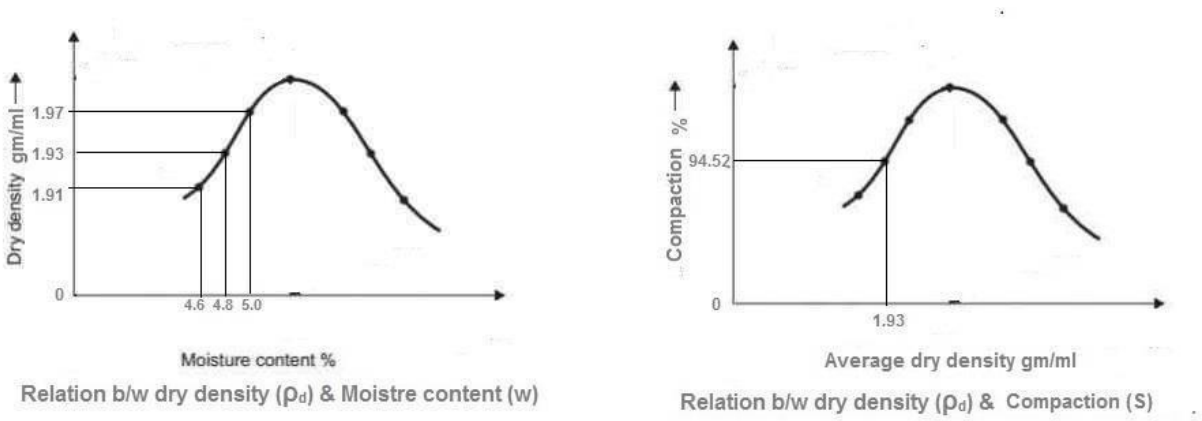

Fig. 1 Graphical representation of dry density, moisture content and compaction

1. Compaction of stabilized soil with 2% coal tar and 5% plastic waste is 100 %.

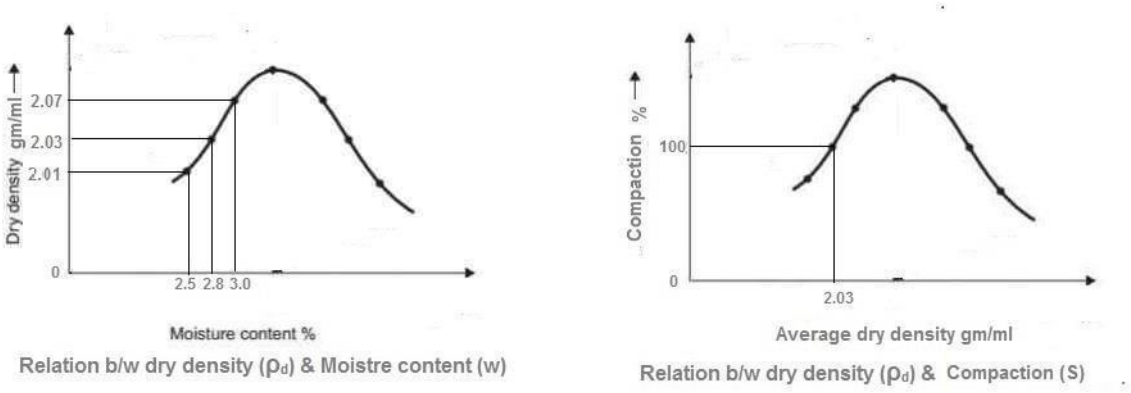

Fig.2 Graphical representation of dry density, moisture content and compaction

2. Compaction of stabilized soil with 5% coal tar and 8%plastic wasteis 102.70%.

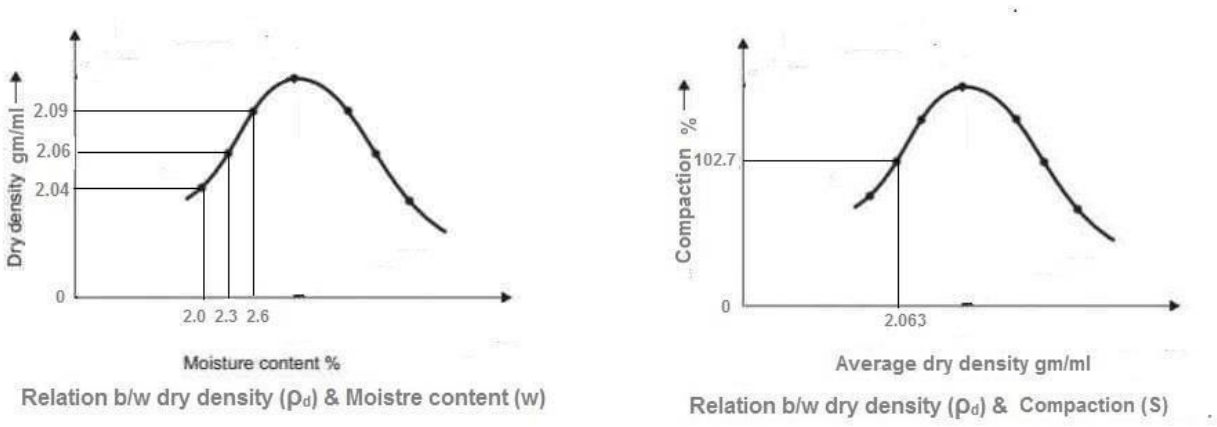

Fig. 3 Graphical representation of dry density, moisture content and compaction

6. Conclusion

By adding plastic waste and coal tar to natural soil, the bearing capacity of the soil increases. It is clear from the bearing capacity test that where the safe bearing capacity of natural soil was 1.56 kg/cm2, while mixing 2% coal tar and 5% plastic waste to natural soil, the safe bearing capacity of soil was found to be 2.54 kg/cm2 and mixing 5% coal tar and 8% plastic waste to natural soil, the safe bearing capacity of soil was found to be 3.26 kg/cm2 i.e. there has been an increase of 0.98 kg/cm2 and 0.72 kg/cm2. Compaction of mix of plastic waste, coal tar and natural soil is also achieved more than natural soil. It is clear from the compaction test that where the compaction 94.52 % of the natural soil was obtained, the compaction 100.10 % of the mix of 2% coal tar and 5% plastic waste with natural soil has been obtained and compaction 102.70% of the mix of 5% coal tar and 8% plastic waste with natural soil has been obtained. That is, there has been an increase of 5.58 % and 2.60% in the compaction. It can also be concluded from the above findings that the permeability of mix of plastic waste, coal tar and natural soil also decreases. In order to develop the engineering properties of soil, this technology is a new initiative in the direction of reducing plastic pollution from the environmental and protecting the organisms.

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