International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Ultimate Bearing Capacity of Stabilized Soil in Pavements

Kalvala Abhiram, Mudigonda Harish Kumar

Abstract: ***This paper discusses the Ultimate Bearing Capacity of a stabilized soil by using the fly ash, stone dust and rubber powder for design of a pavement. This paper will help in utilization of locally available waste materials to reuse in the subbase and subgrade layers of pavement. Rubber powder is a waste byproduct generated from the recycling of tires, and is not so easy for degradable, and hence leads to release of harmful gases when it tends to burn. Stone dust is a locally available waste generated product from quarries. The generation of stone dust is increasing day to day in large quantity. The huge quantity of stone dust storage amount will affect the quality of soil. Fly ash is waste combusted coal ash powder generated from the steamers of coal boilers with the burning of fuel gases together. In the sub grade layer the soil is mixed in different proportions with stone dust for hard foundation. In the sub base layer the soil is stabilized with the combination of rubber powder and fly ash. When the rubber powder and fly ash, mixed with water for compaction generates a bond between the soil particles to settle the air fields. In this paper various percentages of rubber powder, stone dust and fly ash with different samples for pavement is layered, and after that plate load test is conducted upon it.***

Key words: ***Fly ash, plate load test, rubber powder, stone dust.***

I. INTRODUCTION:

In general every construction work like buildings, bridges, dams and road pavements, must require a hard foundation. That starts from the foundation level. A good and strong foundation will strengthen the structure above it. Soil is the major foundation material for any construction work. When the soil quality is good the foundation will be strong enough to take the loads acting upon the structure. Soil is a mixture of organic materials and minerals. For construction of pavements the first step we are going to do is check the physical, chemical and biological properties of soil. The physical properties of soils include with the colour, structure, texture, density, porosity, consistence, temperature and air. The colour property is depends upon its moisture content and water, organic matter. The structure of soil and its temperature depends upon the soil particles arrangement. In the same way porosity, soil consistence and density were also depends upon the type of soil and its particle size distribution arrangement. Soil particles are of two types. One is primary particles and other is secondary particles. In primary particles silt, clay and sand comes under.

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
Kalvala Abhiram*, PG Student, Department of Civil Engineering, Holymary Institute of Technology and Science, Rangareddy, Telangana, India. Email.id: ajjuabhiram5955@gmail.com
Mudigonda Harish Kumar, Assistant Professor, Department of Civil Engineering, Holymary Institute of Technology and Science, Rangareddy, Telangana, India. Email: harishkumar.mudigonda@hmgi.ac.in

It is dependent on the diameter or size of soil particles. The primary particles are differs in physical, chemical and biological properties. The fraction of relative proportions called as soil texture and is a fundamental property of the soil. Soil texture is classified into 12 classes, ranging from sand to clay. This is based upon the size and shape of soil by the gradation process. The secondary particles are granules and organic matters. Soil is the major pavement material. In construction of a pavement, the soil is to be tested for its type and strength properties. The strength properties are found by conducting tests like shear test, bearing test, penetration test. If the soil is week, it can be replaced or stabilized with the other soil. In some situations the soil is stabilized with the naturally available waste raw materials. Soil stabilization will increase the strength characteristics of the soil to increase the bearing capacity. Fly ash, rubber powder, Stone dust are one kind of raw materials which are used in this project.

II. LITERATURE REVIEW:

KINJAL C. CHAUDHARI Et al. (2018) was made a literature review on soil stabilization using different materials. He analyzed the soil strength by using different materials like rice husk ash, burnt brick dust and baggase ash. In this he reviewed over the stabilization of these materials with black cotton soil in combination with cement. He concluded that effective use of waste materials can affect the economical values in the construction of low cost roads. He made his work on soils in Surat areas. He made effective results in increment of strength characteristics of soil by its engineering properties.

D.A.M. ARAUJO Et al. (2017) investigated the footing size effect of shallow foundations. Plate load test was conducted on a sand backfill soil. In this test the stress settlement curves were not shown as clear failure. Therefore the conventional failure criterion was used to determine the bearing capacity. In this test the stress is constantly applied, so that the settlement increases with the increase of plate size. He carried out House's three plate load test method. This test adopted to determine the allowable stress criteria. He concluded, when plate dimension increases the stress acting the soil will decreases.

DINESH. A Et al. (2017) is stabilized the soil by using solid waste. He stabilized the black cotton soil with the quarry dust, saw dust, copper dust and fly ash. In his paper he focused mainly on performance of stabilized soil and its properties like atterberg limits compaction characteristics, swelling, shear strength, CBR value and index and engineering properties of soil.

KARTHIK. S Et al. (2014) is stabilized the soil by using fly ash, to increase the physical and chemical properties of the soil.

His main objective is to evaluate the effective use of fly ash from the combustion of sub bituminous coals at the electric power plants. He stabilized this material in fine grained red soil.

CBR test, unconfined compression test, index properties of soils, liquid and plastic limit test were conducted to perform this experiment. He got the plasticity indices ranging in between 25 and 30 and an optimum water content of 9%. The value of CBR for soil sample is 6% is used to reduce the thickness of pavement. At this value he got the increment in bearing capacity of soil.

GHATGE SANDEEP HAMBIRA Et al. (2014) was done a report on soil stabilization using waste shredded rubber tyre chips to increase the load bearing capacity of the soil. Here the material is chosen as the reinforcement material and cement as binding material, which was randomly mixed into the soil at three different percentages i.e. 5%, 10%, 15% by weight of soil. In this mix he was randomly added shredded rubber fibers. Then the sample is subjected to the CBR and unconfined compression test. The results obtained are compared with unreinforced soil samples, and the improvement has been observed in the increment of shear strength and bearing capacity parameters. He concluded that shredded fiber can be considered as a good earth reinforcement material.

MANDEEP SINGH Et al. (2014) made a review on the soil stabilization with waste materials. He mentioned the major solid waste materials like rice husk ash and waste tyres. The disposal of waste materials will cause effect to the environment. With this intension he made a literature review on stabilization of soil by using these waste solid materials. He also discussed the performance of stabilized soil.

AKSHAYA KUMAR SABAT Et al. (2013) stated the improvement of expansive soil properties by using fly ash and quarry dust mixes. He discussed the characteristics of compaction test results, unconfined compressive strength test results, CBR test results, swelling pressures and shear strength parameters. He discussed about the economy of CBR characteristics of flyash and quarry dust stabilized expansive soils.

AMIN ESMAEIL RAMAJI Et al. (2012) was made a review on the soil stabilization using low cost methods. In this paper he reviewed on several reinforcement methods to stabilize the expansive soils. The stabilization is done with chemical additives, rewetting, soil replacement, compaction control and moisture control, surcharge loading and thermal methods. Based on some literature, Portland cement, lime, fly ash, and scrap tyre are low cost and effective to soil stabilization.

Dr. D. KOTESWARA RAO Et al. (2012) did a laboratory study of cyclic plate load test on stabilized marine clay with lime and rice husk ash at sub grade level for flexible pavements. He evaluated the strength characteristics of this particular stabilized soil. He concluded that the ultimate load carrying capacity of stabilized marine clay is more compared to un stabilized marine clay.

RAMDAS, T.L. Et al. (2010) discussed the experimental test results of soil index properties, swelling properties, standard proctor compaction, and unconfined compression strength obtained by testing on expansive clays. These clays are mixed with various proportions of fly ash and stone dust. He observed optimum percentages of 30% stone dust and 25% fly ash. He noted the swelling of expansive clays is almost controlled and noticed an effective improvement in the strength of the soil. He discussed on the combination of fly ash and stone dust is more effective than the addition of stone dust alone. It helps in controlling the swelling of expansive soils. Likewise in the other proportion 20% stone dust and 25% fly ash is added to the expansive soil and found that it is a suitable measure to reduce the swelling and helps in increasing the strength of the expansive soils.

NILO C. CONSOLI Et al. (2003) Discusses the response of load settlement by using steel plate load test (0.3 m diameter, 25 mm thick). He conducted this test on uniformly compacted sandy soils. In this paper he chose two types of soils. One is soil reinforced with polypropylene fibers and other is non reinforced soil. In this the soil is mixed with polypropylene fibers to determine the static stress–strain by adopting tri axial compression test. In this journal the results showed as the stress strain behavior at large strain. The plate load test carried out at high pressures on fiber reinforced soil layer. Hear he got better results in the form of pressure, when compared to the non reinforced soil.

H. A. ALAWAJI Et al. (1998) Discussed about the various factors influencing the wetting induced collapsing of alluvial soils. This is found out by conducting odometer and plate load test. In this test the collected soil samples were compacted in 35 cm height and 45 cm dia steel container. A surcharge pressure of 5, 7, and 9 KPa were applied on the soil. The load settlements were carried out on under dried and soaked condition of soil. He considered water content of 2% and dry density of 1.4 g/cc. The odometer and plate test results were compared and evaluated for collapse characterization.

Y.M. REZNIK (1995) is stated that collapsible soil deformation depends upon the physical and geological properties. These were determined by field and laboratory test methods. In this he performed an analytical formula for the collapsible soils to estimate the bearing plate settlements under applied loads offered for quasi-uniform soils. Field deformation moduli are calculated using suggested formula. Plate load and odometer test deformation moduli are compared and correlation coefficients are calculated as functions of soil void ratios and degree of saturation.

III. MATERIALS USED:

Fly ash: Fly ash is a fine residue or raw material generating from the coal field electric and stream generating plants. Coal is typically pulverized and blown with air in to the boilers to combustion chambers generating heat and producing a molten mineral residue**.** Fly ash is also used in production of Portland cement concrete, soils and pavements stabilization.

Rubber powder: Rubber powder or Micronized rubber powder and it is classified as fine, dry powder from crumb rubber. This is made from vulcanize electrometric material produced from post industrial nitrile rubber, EPDM (Ethylene Propylene Diene Monomer), and natural rubber compounds. The particle size ranges less than 100μm.The size distribution is ranges from 180 μm to 10 μm. The distribution can be achieved from, depending on the classification technology.

Stone dust: Stone dust is a waste generated byproduct from mining industries like quarries, by doing blasting and cutting of stones. Stone dust in some cases generated by doing crushing of stones. In the cutting process the large stone is kept under cutting machine which has screeners.
From the screeners the dust will settle at the bottom and collected to store aside. This stone dust is now-a-days using in all civil related works.

IV. TEST METHODOLOGY:

In this methodology we are adopting the Plate Load Test. This test is done for calculating the Ultimate Bearing Capacity of the soil by observing the deflections. The experimental procedure is as follows:

- In the first step a pit is excavated. According to this project we require one cubic meter pit.
- In the first layer, the digged soil is then stabilized with fly ash by ¼ th of the soil and compacted
- The second layer is stabilized with rubber powder by ¼ th of the soil and compacted.
- The third layer is stabilized with stone dust by ¼ th of the soil and compacted.
- After three layers preparation; the sample is then dried and kept for plate load test setup.
- Plate load test setup of three plates (0.3m, 0.45m, and 0.6 m dia) was kept on the soil sample and a load is applied on it.
- The applied load is the lifted with the jockey and the deflections were not downed on the dial gauge.
- The occurred deflections results the ultimate bearing capacity of that particular soil.
- The deflections were compared to the un-stabilized soil.
- So that we can propose the mix sample as a usable material for highway pavements.

V. CONCLUSION:

Through this paper we can conclude that the analysis of ultimate bearing capacity of stabilized soil for pavement by means of comparing the deflections occurred for un-stabilized soil and stabilized soil. So the results in the form of deflections will indicate the strength analysis of both the samples. By that we can conclude that stabilized soil is more strengthen than un-stabilized soil. Then the mix can be used for highway pavement constructions.

VI. FUTURE SCOPE:

This paper will help in strengthening of the soil for highway pavements by utilization of waste raw materials to stabilize in soil. So the amount of waste materials also decreased and can be utilized. The soil stabilization will increase the bearing capacity of soil to take maximum amount of loading conditions. India is increasing its transportation development. For that, large number of road network is required. The increment in road network will increases the economy of the country for ease transportation. More transportation leads to more traffic of vehicles; to bear all such vehicle loads the soil must be hard and strength enough. Along with the improvement in foundation work, the pavement life time will also increases.

REFERENCES:

1. Kinjal C. Chaudhari, Harsha S. Padvi, Hitaishi V. Patel, Jinal A. Patel , and Mr. Jasmin Tandel (2018), "Literature Review of Soil Stabilization using Different Materials" (International Journal of Technical Innovation in Modern Engineering & Science) (IJTIMES) E-ISSN: 2455-2585, Volume 4, Issue 02.
2. D. A. M. Araújo, C. M. L. Costa, and Y. D. J. Costa (2017), "Dimension effect on plate load test results", (Proceedings of the 2nd World Congress on Civil Structural and Environmental Engineering) (CSEE'17) Barcelona, Spain – April 2 – 4, 2017 Paper No. ICGRE 191, ISSN: 2371-5294 DOI: 10.11159/icgre17.191
3. Dinesh.A, Gokilavani.S, and Ramya. G. (2017), "Stabilization of soil by using solid waste", (International Journal of Engineering Development and Research) (IJEDR), Volume 5, Issue 3, ISSN: 2321-9939.
4. Karthik. S, Ashok Kumar. E, Goutham. P, Elango. G, Gokul. D and Tangaraj. S (2014), "Soil stabilization by using fly ash", (IOSR Journal of Mechanical and Civil Engineering) (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 10, Issue 6, PP 20-26.
5. Ghatge Sandeep hambira, Dr. P. G. Rakaraddi (2014), "Soil stabilization using waste shredded rubber tyre chips", (IOSR Journal of Mechanical and Civil Engineering IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 11, Issue 1, Ver. V, and PP 20-27.
6. Mandeep Singh and Anupam Mittal (2014), "A Review on the Soil Stabilization with Waste Materials", (International Journal of Engineering Research and Applications) (IJERA) ISSN: 2248-9622, National Conference on Advances in Engineering and Technology.
7. Akshaya Kumar Sabat, and Bidula Bose (2013),"Improvement in Geotechnical Properties of an Expansive Soil using Fly Ash - Quarry Dust Mixes", Electronic Journal of Geotechnical Engineering, Vol 18[2013], iBund.Q, Page 3487-3500.
8. Amin Esmaeil Ramaji (2012),"A Review on the Soil Stabilization Using Low-Cost Methods", (Journal of Applied Sciences) Research 8(4):2193-2196.
9. Dr. D. Koteswara Rao, Venkatesh Ganja, and P.R.T Pranav, (2012), "A laboratory paper of cyclic plate load test on lime and rice husk ash treated marine clay sub grade flexible pavements", (International Journal of Modern Engineering Research) ,Vol. 2, Issue. 5, pp-4465-4469, ISSN: 2249-6645.
10. Ramadas T.L., Kumar. N, Darga, and Aparna .G. (2010), "Swelling and Strength Characteristics of Expansive Soil Treated with Stone Dust and Fly Ash", (Indian Geotechnical Conference –2010), Geotrendz December 16–18, 2010 IGS Mumbai Chapter & IIT Bombay.
11. Nilo c. Consoli, Michéle, D. T. Casagrande, Pedro D. M. Prietto and Antonio Thome (2003), "Plate load test on fiber-reinforced soil", (Journal of geotechnical and geo environmental engineering) DOI: 10.1061/(ASCE)1090, 0241(2003)129:10(951)
12. H. A. Alawaji (1998), "Model Plate-Load Tests on Collapsible Soil", (J. King Saud University), Vol. 10, Eng., Sei. (2), pp. 255-270 (A.H. 1418/1998).
13. Y.M. Reznik (1995), "Comparison of results of odometer and plate load tests performed on collapsible soils", (Genesis and Properties of Collapsible Soils) pp 383-408, NATO ASI series book series (ASIC, volume 468) Springer series.

AUTHORS PROFILE:

Kalvala Abhiram, PG Student, Department of Civil Engineering, Holymary Institute of Technology and Science, Rangareddy, Telangana, India.
Email.id: ajjuabhiram5955@gmail.com

Mudigonda Harish Kumar, Assistant Professor, Department of Civil Engineering, Holymary Institute of Technology and Science, Rangareddy, Telangana, India.
Email.id: harishkumar.mudigonda@hmgi.ac.in