REVOLUTIONARY NANOTECHNOLOGY FOR CONSTRUCTING IMPERVIOUS, DURABLE ROADS BY ADAPTATION OF ORGANO-SILANE CHEMICAL COMPOSITION

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ABSTRACT:- The flexible pavement construction in India involves different types of layers over Sub-grade, such as GSB, WMM, DBM and BC. They are being constructed with large quantity of aggregate by crushing rocks. As development of highways in India is a continuous process and makes lot of impact on natural resources. Due to depletion of the sources of stone, value of the construction material will increase. In some areas where the soil and aggregate properties are not suitable for construction for highways, it's necessary to use different material for construction which might cut back the value of pavement construction. Stabilization of the sub grade soil will result in reduces the thickness of the pavement layers and it works to be economical. Cement may be a very affordable stabilizer everywhere in the globe significantly for coarse grained soils. Soil stabilization is that the permanent alteration of any property of the soil to enhance its engineering performance. From the economical purpose of road, stabilised gravel road may be made within the areas wherever traffic volume is low. For the stabilization of soil, modification may be done by adding additives like lime, cement, ash etc, to extend the strength, sturdiness and performance of the soil in order that it may be used for the development of sub-base or base in construction. Now-a-days variety of different proprietary additives are also being employed for stabilization of various types of soils, which frequently accomplished by physical or chemical stabilization. In stabilization method, soil stabilization depends principally on chemical reactions between stabilizer and soil minerals to realize the required impact. During this study, cement stabilization is employed to change soil properties together with little amount of Organo-silane (Terrasil & Zycobond) a type of Nano technology materials. This additive eliminates capillary rise and water ingress and reduces water permeability. It reacts permanently with soil surface, chemically changes water absorbing silanol group to water resistant alkyl siloxane at room temperature. It increases soil CBR value up to 100%, and reduces expansiveness of soil. This additive maintains breathability by creating a one way barrier. Due to this Organo-silane soil Sub-base remains dry all over rainy season due to reduction in water ingress. By using Organo-Silane, soil deformation resistance increases.

Keywords: Organo-Silane, Flexible pavement

1. INTRODUCTION

The Concept of Stabilization is the Criteria for improving the engineering Properties of soils and Granular materials used for Pavement base Courses, Sub base Coarses and Sub grade by use of additives/Stabilizers. Which are mixed into soil/Granular material to effect the desired improvements. In times past, various types of materials have been added to soil in order to increase its stability, for use as an engineering construction material. But these materials such as Cement, Lime & Fly Ash increasing the engineering Properties and reduce Permeability and water proofing Properties up to some extent only. But The Incorporation of NANO materials including Cement will increase impermeability and also increase the durability of Pavements up to maximum extent.

Some of practical advantages such as:

- A wide availability of products from the market place
- The relative ease of shipping and field handling (flexibility)
- Fast speed of construction, without the need for heavy equipment such as earth-moving machines.
- Lightweight in comparison with other construction materials, therefore imposing less stress upon the foundation
- Durability and long life when properly selected
- General environment safety, since they will not degrade.

OBJECTIVES:-

The reason for this research work is to assess the various types of Nano materials available and to estimate the potency of Stabilization by mixing cement with Nano materials in pavement construction and upkeep. To achieve this aim, the below objectives have been identified:

1. To assess the performance of the Nano materials (Terracil & Zycobond) by contrasting the normal stretch with the stretch using Nano materials with Cement stabilized stretch.
2. To consolidate the Nano materials including cement in some collected in situ soil materials and assess performance.
3. To investigate the outcome and make fitting proposals for ideal use.

II. MATERILAS USED

1. **SOIL:-** Locally available Soil sample was collected and used for soil stabilization. The current Paper

provides the strength and sturdiness characteristics of soil with and while not stabilizer.

2. **CEMENT:-** Cement could be a binder, a material used for construction that sets, hardens and adheres to various materials, irrevocable them along. Cement is rarely used on its own, however rather to bind sand and gravel (aggregate) along. Cement is employed with fine mixture to provide mortar for masonry, or with sand and gravel aggregates to provide concrete. Ordinary Portland Cement (OPC) of Grade 43 was used for stabilization.
3. **TERRASIL:**- It is H2O soluble, easy to apply, nanotechnology admixture. It is an Ultraviolet & heat steady reactive soil modifier to stabilize and water resistance soil sub grade. It is a green technology permit minimal use of aggregates. It reacts with H2O loving silanol sets of sand, silt, clay, and aggregates to transform it to highly stable water impervious alkyl siloxane bonds and shapes a breathable in-situ layer. It solves the critical sub-surface problems.
4. **ZYCOBOND**:- It is acrylic co-polymer scattering for the soil particles and imparting resistance to soil erosion and dust prevention. It is mixed with Terrasil and spray on compacted soils. It intensifies the quality of soil membrane, prevents soil deterioration, fast drying of soil layers/earth pavement after downpours and thus it helps in minimize maintenance cost.
5. **STABILIZER:**- The choosing of stabilizer is depending on plasticity and particle size of the material to be treated. The appropriate stabilizer can be selected according to the benchmark shown in the table 5 of IRC: SP: 89.

III. EXPERIMENTS COUNDUCTED

TESTS CONDUCTED ON SOIL:-

1. Liquid Limit Test For Soil
2. Plastic Limit Test Of Soil
3. Shrinkage Limit Test
4. Standard Proctor Test For Soil
5. California Bearing Ratio Test (CBR) For Soil
6. Free Swell Index Test For Soil
7. Unconfined Compression Test
8. Direct Shear Test
9. Gradation Distribution
10. Specific Gravity Test Of Water

TESTS CONDUCTED ON CEMENT:-

1. Finess of Cement
2. Consistancy of Cement
3. Test To Find Initial And Final Setting of Time of Cement
4. Specific Gravity of Cement.

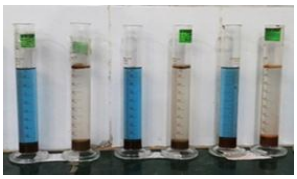

Fig. -1 –Free Swell Index Apparatus

Fig. -2–Unconfined Compression Test Apparatus

Fig. 3 –V-Cat Apparatus

Fig. 4 –Density Bottle Apparatus

IV. RESULTS

4.1 LIQUID LIMIT

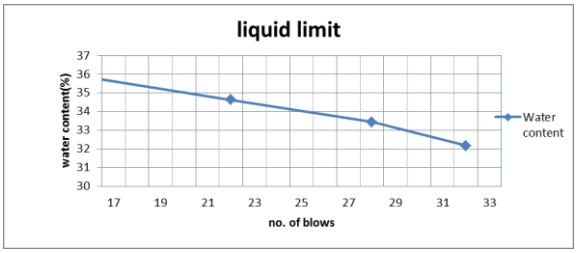

Fig. 5 Graph Representing Liquid Limit for SAMPLE X

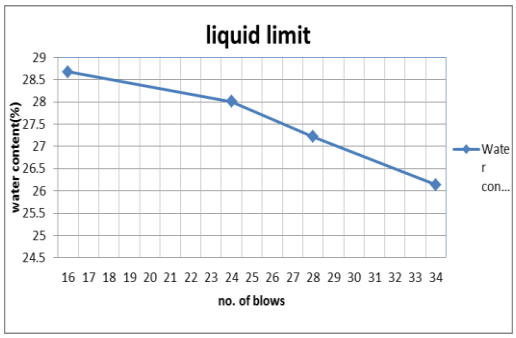

Fig. 6 Graph Represents Liquid Limit for SAMPLE Y

According to the AASHTO classification, SAMPLE X as shown above ranges between fine sand and fine gravel, it is therefore an A-2-7 soil (Silty or clayey gravel sand), while Sample Y ranges between the sand and gravel sizes. The material is gravelly sand with one. 84% clay fractions; it is classified as A-2-4. SAMPLE Z which ranges from clay to fine sands is A-6 soil (Clayey soil).

4.2 COMPACTION TEST FOR SAMPLE X

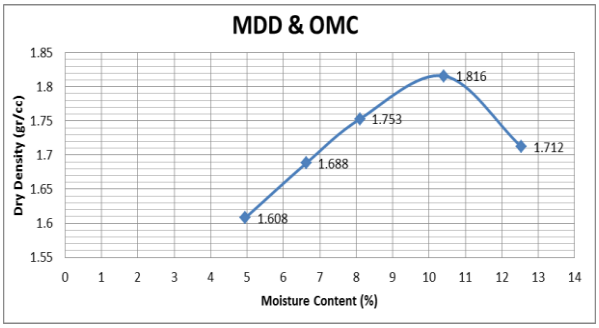

Fig. 7-Graph Representing the MDD & OMC of sample X

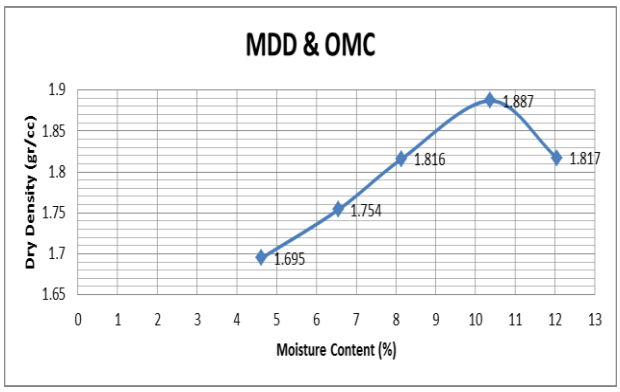

Fig. 8-Graph Representing the MDD & OMC of sample V

This check was performed on the natural soil samples to specify appropriate wetness content for field compaction. The laboratory results square measure shown in appendix III with the graphs showing the connection between dry density and wetness content for the soil samples. SAMPLE X includes a most dry density (MDD) of 1887 kg/m3and optimum wetness content (OMC) of ten.37%, Sample-B has MDD of 1857 kg/m3, OMC of 10.34% and Sample-C has MDD of 1816kg/m3, OMC of 10.9%.

4.3 FREE SWELL INDEX TEST FOR SAMPLE X:-

Table -1 Observation of Free Swelling Index of soil on SAMPLE X

SL NO	Sample Level in Water (Vw)	Sample Level in Kerosene (Vk)	Free Swell in Water (Vw-Vk)	Free Swell index (Vw-Vk)/Vk x100)
1	11	9.5	1.5	15.79
2	10.5	9	1.5	16.67

Table No: 2 Observation of Free Swelling Index of soil on SAMPLE Y

SL NO	Sample Level in Water (Vw)	Sample Level in Kerosene (Vk)	Free Swell in Water (Vw-Vk)	Free Swell index (Vw-Vk)/Vk x100)
1	10.5	9	1.5	16.67
2	11	9.5	1.5	15.79

Table No: 3 Observation of Free Swelling Index of soil on SAMPLE Z

SL NO	Sample Level in Water (Vw)	Sample Level in Kerosene (Vk)	Free Swell in Water (Vw-Vk)	Free Swell index (Vw-Vk)/Vk x100)
1	11	9.5	1.5	15.79
2	11.5	10	1.5	15.00

4.4 CBR TEST FOR SOIL SAMPLES

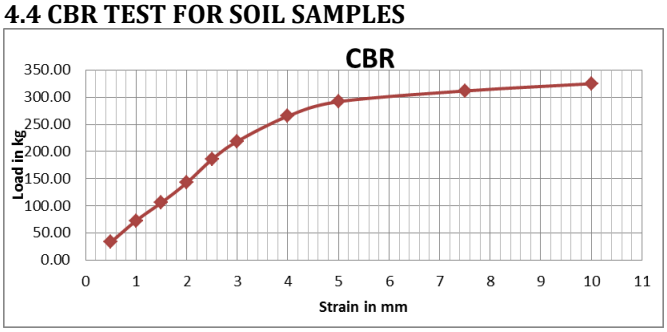

Fig. 9 Graph Representing California Bearing Ratio of sample X

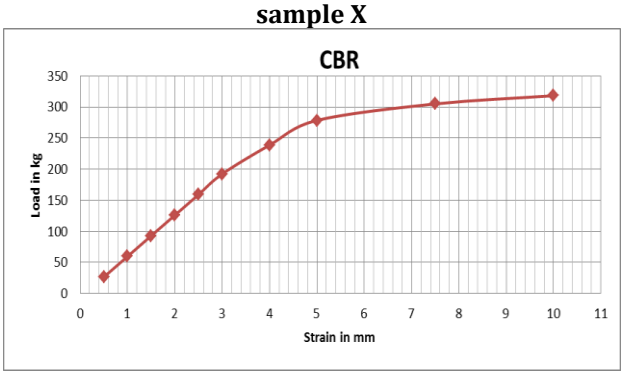

Fig. 10 Representing the California Bearing Ratio of sample Y.

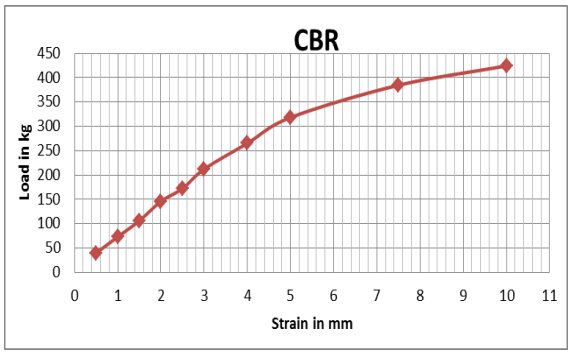

Fig. 11 Representing the California Bearing Ratio of SAMPLE Z

4.5:- PROCTOR COMPACTION TEST FOR STABILIZED SOIL SAMPLE

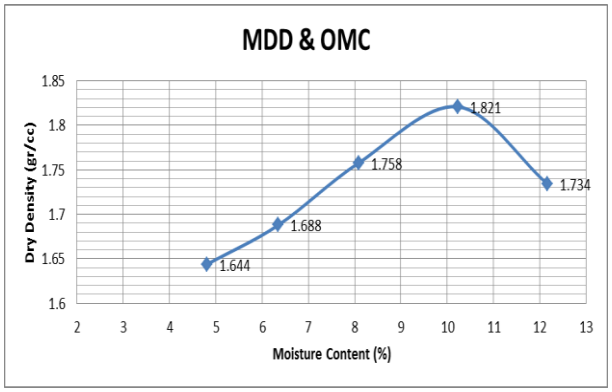

Fig. 12 Graph Representing MDD & OMC of Stabilized soil SAMPLE X

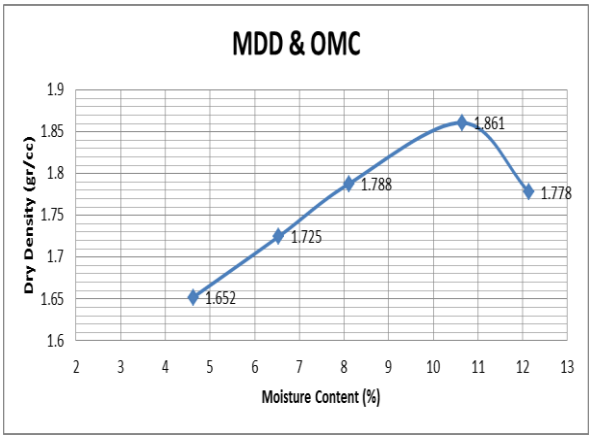

Fig. 13 Graph Representing MDD & OMC of Stabilized Soil SAMPLE Y.

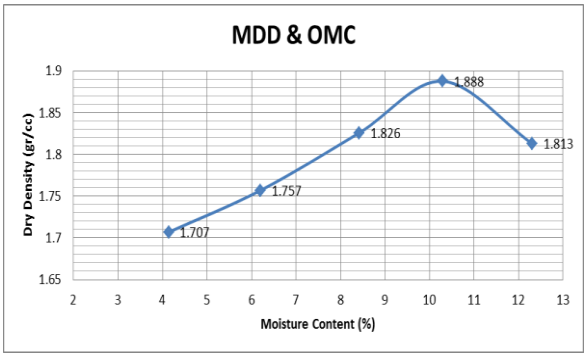

Fig. 14 Graph Representing MDD & OMC of Stabilized Soil SAMPLE Z

4.6 PROCTOR SOIL COMPACTION TEST FOR IN-SUIT SOIL SAMPLES

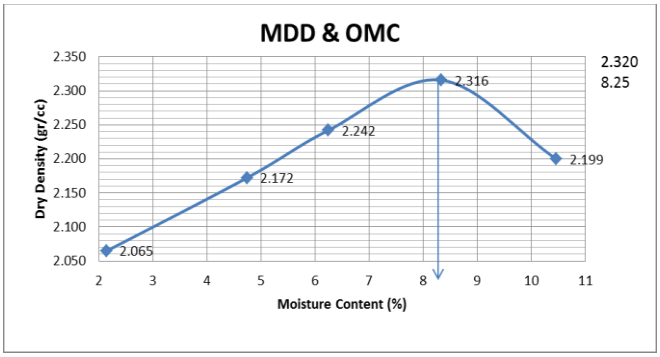

Fig. 15 Graph Representing MDD & OMC of in Suit SAMPLE X.

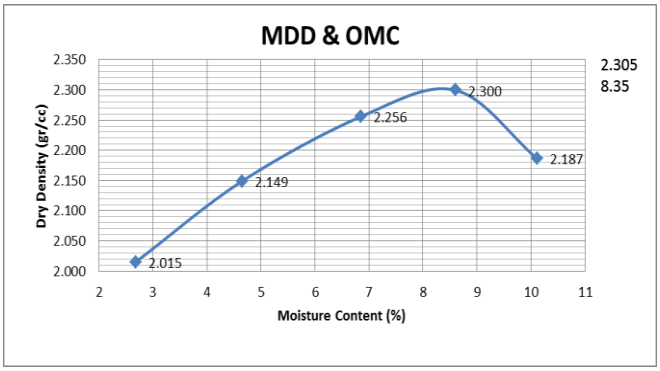

Fig. 16 Graph Representing MDD & OMC of in Suit SAMPLE Y

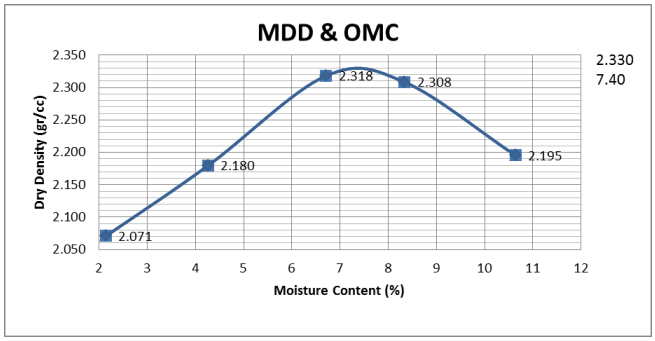

Fig. 17 Graph Representing MDD & OMC of in Suit SAMPLE Z

V. CONCLUSIONS

FOR NON TRAFFIC ZONE:-

- I have collected three soils samples at non traffic zone which are named as SAMPLE X, SAMPLE Y, SAMPLE Z and I investigated the engineering properties of the soil samples. From the data, I have made the following conclusions
- The SAMPLE X, SAMPLE Y and SAMPLE Z are having the O.M.C of 10%, 10.7%, 10.9% respectively, M.D.D of 1.849 g/cc,1.843 g/cc,1.867 g/cc respectively, C.B.R values of 11.29%, 12.21%, 10.32% respectively and having free swell index values of 16.23%, 15.79%, 14.65% respectively.
- Based on above values SAMPLE X got better results, but it has low U.C.S strength as per IRC

recommendations. But as per IRC SP: 89 – 2010, The Required UCS value for NON TRAFFIC ZONE is 1.5 to 3.0 N/mm2. In order to make the soil sample as pavement sub grade material and shoulder material, I choose cement, Terracil &Zycobond with different proportions. I treated the soil sample with admixtures with different mixing proportions and finally got the required UCS value is achieved at 5.0% of Cement and Terracil & Zycobond 0.6 Kg/m3.

- The above proportion of admixtures (5.0 % of Cement and Terracil & Zycobond 0.6 Kg/m3) is adopted for all three soil samples A,B, and C. and I observed the following values, The SAMPLE X, SAMPLE Y, SAMPLE Z are having the O.M.C of 11%, 11.6%, 11.30% respectively, M.D.D of 1.865 g/cc, 1.862 g/cc, 1.866 g/cc respectively, C.B.R values of 64.20%, 62.21%, 70.97% respectively and free swell index values of 10.2%, 7.6%, 9.3% respectively.
- Based on above values I am suggesting that, all the three soil samples can be used as shoulder material for pavement in non traffic zone area.
- By using this stabilizing technique we can reduce the quantity of soil that can be used in non traffic zone as a shoulder material hence the cost of project is also reduced.

FOR TRAFFIC ZONE

- I collected the three existing road samples at traffic zone which are named as SAMPLE X, SAMPLE Y and SAMPLE Z, I investigated the engineering properties of the soil samples. From the data, I have made the following conclusions,
- The SAMPLE X, SAMPLE Y and SAMPLE Z are having the O.M.C of 10.50%, 10.00%, 11.00% respectively, M.D.D. of 2.30g/cc, 2.305g/cc, 2.31g/cc respectively, C.B.R values are 12.04%, 13.33%, 13.74% respectively, free swell index values are 13.16%, 16.23%, 14.65%respectively.
- Based on among the values SAMPLE X got better results, but this soil sample having low U.C.S strength as per IRC recommendations. But as per IRC SP: 89 – 2010, The Required UCS value for TRAFFIC ZONE IS 10 to 13 N/mm2. In order to make the soil samples as pavement sub grade material, I choose cement, Terracil & Zycobond with different proportions. I treated the soil sample with admixtures with different mixing proportions and finally got The Required UCS Value is achieved at 12 % of Cement, Terracil & Zycobond 1 Kg/m3.
- The above proportion of admixtures (12 % of Cement, Terracil & Zycobond 1 Kg/m3) is adopted for all three soil samples A,B, and C. and I observed the following values, The SAMPLE X, SAMPLE Y and SAMPLE Z having the O.M.C of 6.2%, 6.1%, 6.5% respectively, M.D.D. of 2.392 g/cc, 2.376 g/cc, 2.370 g/cc respectively, C.B.R values of 201.60%, 207.40%, 2.370 % respectively and free swell index values of 10.27%, 7.6%, 9.30% respectively.
- Based on above values I am suggesting that, all the three soil samples as pavement sub grade material in traffic zone area.
- By using this stabilizing technique we can reduce the thickness of soil sub grade layer in traffic zone. Hence the cost of project is reduced, quantity of soil used in project is reduced and time of the project is also reduced.

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