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Soil Stabilization Using Polymer Modified Bitumen Emulsion

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***Abstract*— Subgrade Soil is among the most plentiful pavement construction materials in nature.Almost all construction is built upon or with the soil. A significant part of road pavement is subgrade soil. A certain amount of soil stabilization is necessary if the soilstrength is inadequate. Often, the subgrade is stabilized or replaced with more vigorous soil to improve stability. This stabilization is also applicable when available subgrade consists of weedy soil weedy soil. Increasing the strength of the subgrade can reduce the thi ckness of a pavement. Soil stabilization methods include adding lime cement, fly ash, and fibers. In this undertaking, soil strength increments by adding polymer modified bituminous emulsion as opposed to supplanting it with more rich soil. Strength is determined through tests, such a standard proctor compaction test and California Bearing ratio test as well as Atterberg limit tests (Plastic Limit, Liquid limit, Shrinkage Limit and Swelling index tests).The outcomes acquired are then contrasted and the Soil treated without and with 2.5%, 5%, 7.5%, and 10% polymer modified bitumen emulsion.**

***Keywords* - Subgrade soil, road pavement, bearing ratio**

I. INTRODUCTION

For a pavement proper stability, Subgrade is work as a prime member and foundation of a pavement structure. If pavement need to be stable and strong for long time, it needs to have a strong foundation. The subgrade soil around foundations play a central role in supporting that pavement structure.So, we must know about the soil properties and factors which affect its behavior. The soil adjustment process accomplishes the necessary properties in the soil required for the kind of construction work. Undertaken study is the purpose is to be increase subgrade strength and reduce pavement thickness. Reduce thickness of pavement is increase economically effective.

A. Objective

- To improve the stability and physical properties of Subgrade soil for increase life and strength of pavement.
- Evaluating the Quality of Modified Bitumen Emulsion.
- Assessment of actual (Physical) properties and strength properties of soil with and without modified bitumen emulsion in different proportion.
- Different type of subgrade soil tests is preformed with or without added Polymer modified bitumen emulsion in different proportions.
- Evaluation of pavement Design with different subgrade composition over without treated subgrade with PMBE and subgrade in which maximum CBR achieve after treat with Polymer Modified Bitumen Emulsion.
- Reduce pavement thickness for cost effectiveness and examine pavement design is feasible or not.

B. Scope

Main scope of the undertaken study and research Strength of subgrade soil increase by increasing the content and proportion of Polymer modified bitumen emulsion which is added in soil.

II. LITERATURE REVIEW

During the writing literature review for the research and study, we referred quite a few books on soil, technical and research papers from various national and international journals. This part focuses on the literature on improvement of soil using bitumen emulsion and on various studies related to improvement of soil using bitumen emulsion.

1. Hani Baloochi et al (2020) [1]: This Study examined soil stabilization by using waste paper fly ash.

According to study there is mineralogical characterization replicate presence of lime same as cementitious phase. From this research said to be paper used to waste and can be use as fuel in waste to energy plant. Due to burning process of paper residue in form of paper fly ash and it have cementitious properties contains. So, it has to possibility to replace cement by waste paper fly ash. From studies waste paper contains cementitious properties like silicon, calcium and aluminum so these minerals are shows presence of lime and calcium in paper fly ash. From experimental studies in short term expansion compressive strength of soil is decreased and moreover in long term strength increased and no expansion is observed. And according to experimental study for avoid possible expansion delay time minimum required 30 min and decrease in water content in mixing by proctor point. And waste paper fly ash binder sound right by soil.

2. Fuhai Zhang et al (2019)[2]:This study examined expensive soil stabilization by polyvinyl Alcohol and potassium carbonate. Author said and also past studied expensive soil having properties of large volume change so this soil cause of slope failure and soil settlement. In experimental study's author perform various test like Free swell Test, Oedometric swell Test, UCS Test, Weathering Test, SEM Test and Infiltration Test. All tests are performed against natural soil as well as soil mixed with potassium carbonate and Polyvinyl Alcohol.

- With free swell test soil is more effective when soil mixed with polyvinyl alcohol and potassium carbonate instead of individually.
- SEM shows soil is denser when its treated.
- Oedometric test result said to be potassium carbonate and Polyvinyl Alcohol when mixed with soil its control volume change.

3. Nilo Cesar Consoli et al (Nov-2018) [3]:This Study examined soil stabilization by using sustainable binder which are domestic waste such as ground grass, coal ash & Lime and stabilize base or subgrade of pavement. This study only on examined over sandy soil treated with industrial and domestic waste in term of binder. In this study soil treated with pozzolana and carbide lime both are industrial and domestic residue mixed with and compacted to be use for different purpose like earthwork, subgrade and subbase and it can be applied to sustainable geosolution. Also, different proportion of ground glass and lime and discrete dry unit weight and experiment are valid for different curing period. Studied conclude different relationship between different kind of binder for porosity lime index and porosity binder index.

4.Ayininuola Gbenga Matthew et al (2018) [4]:This study examined effect of stabilizing lateritic soil with combination of bitumen emulsion and cement. Three percentages of additives were considered: 4%, 6% and 8%. The bitumen emulsion and cement contents were combined in percentages: 100:0, 75:25, 50:50, 25:75 and 0:100 to form five additives. Geotechnical properties of soil which is evaluate by performed test which are UCS and CBR.

Author mix the additives substance at 4% and 8% with above said proportion and evaluate different corresponding CBR as well as UCS value. Both soil properties examine by 4% and 8% substance added with cement soil of different proportion and studies seen that CBR and UCS increase were Cementous part is increase for both soil sample. Settling laterite with combination of bitumen emulsion and concrete worked on the strength of the dirt. Hence cement can improve the strength of soil.

5. Shubham Langer & Er Paramjeet (2018) [5]: Investigate the use of bitumen in soil stabilization, author said lowest layer of pavement is subgrade which is ultimately support all layer of pavement against traffic load, so failure of subgrade is result in failure of pavement and failure of pavement reflect on surface of pavement in form of surface distress.

Author conclude drawn from study are following.

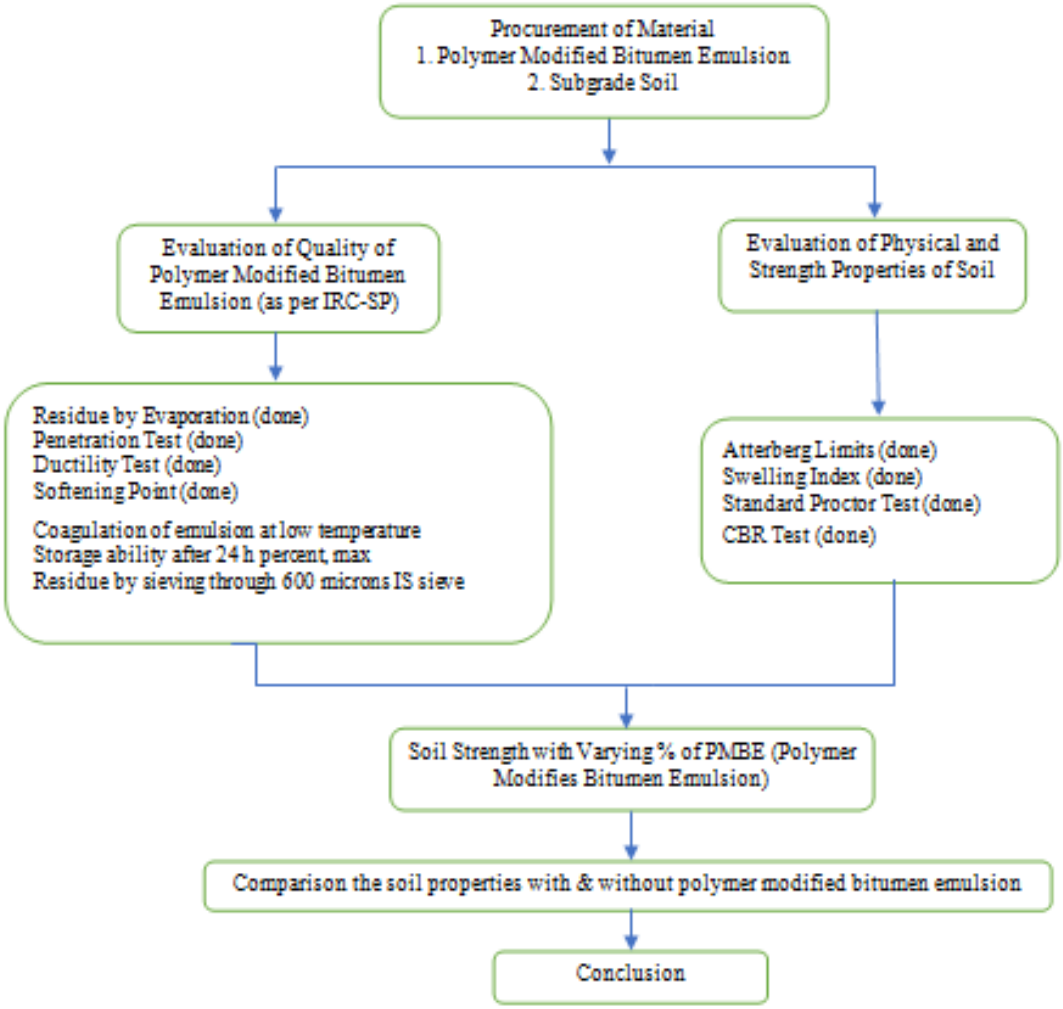
(i) Due to addition of admixture such as bitumen emulsion result is increasing unconfined compressive strength.
(ii) Reduction in plasticity when addition of bitumen emulsion significantly.
(iii) Bitumen emulsion to balance out uniform grained soil can make further develop ground layer.
(iv) When Bitumen emulsion blend with rock soil further Specific gravity of soil tends to amplified.

III. MATERIAL AND METHADOLOGY

For our study and research around how can be reduce overall pavement thickness after altering and treated subgrade material with polymer modified bitumen emulsion. Research having prime material is subgrade soil and Polymer modified bitumen emulsion.

A.) Soil.
B.) Polymer Modified Bitumen Emulsion.

Flow Chart of Investigation-



IV. TEST RESULTS

Various tests are performed on Polymer modified bitumen emulsion and subgrade soil for pavement with different proportion of polymer modified bitumen emulsion.

A.) Test Result on Polymer Modified Bitumen Emulsion

S.no	Test	Result
1.	Residue by Evaporation Test	Residue Remaining **64%**
2.	Softening Point Test	Softening point found on **47 Degree C**.
3.	Penetration Test	Penetration value **10.4 mm**
4.	Ductility Test	More than **100cm**.

B.) Test Result on Subgrade Soil

i) Swelling Index Test

S.no	Description	Result
1.	Swell index Without PMBE	**10 %**
2.	Swell index with PMBE	**7.86%**

ii) Atterberg Limit Test

S.no.	Description	Liquid Limit	Plastic Limit
1	0% Bitumen Emulsion	31.93%	20.64%
2	2.5% Bitumen Emulsion	27.22%	25.17%
3	5.0% Bitumen Emulsion	33.96%	22.03%
4	7.5% Bitumen Emulsion	33.34%	23.47%
5	10.0% Bitumen Emulsion	32.01%	24.02%

iii) Standard Proctor Test

S.no.	Description	Result (Optimum Moisture Content)
1	0% Bitumen Emulsion	11.20%
2	2.5% Bitumen Emulsion	11.33%
3	5.0% Bitumen Emulsion	12.92%
4	7.5% Bitumen Emulsion	13.65%
5	10.0% Bitumen Emulsion	14.59%

iv) California Bearing Ratio

S.no.	Description	Result (2.5 mm)	Result (2.5 mm)
1	0% Bitumen Emulsion	3.193	3.248
2	2.5% Bitumen Emulsion	5.208	5.653
3	5.0% Bitumen Emulsion	6.150	6.260
4	7.5% Bitumen Emulsion	4.127	4.023
5	10.0% Bitumen Emulsion	3.498	3.520

- Minimum Strength evaluate through all soil test when soil is not added with PMBE and maximum strength of soil as per CBR value over 5.0% PMBE added with soil.

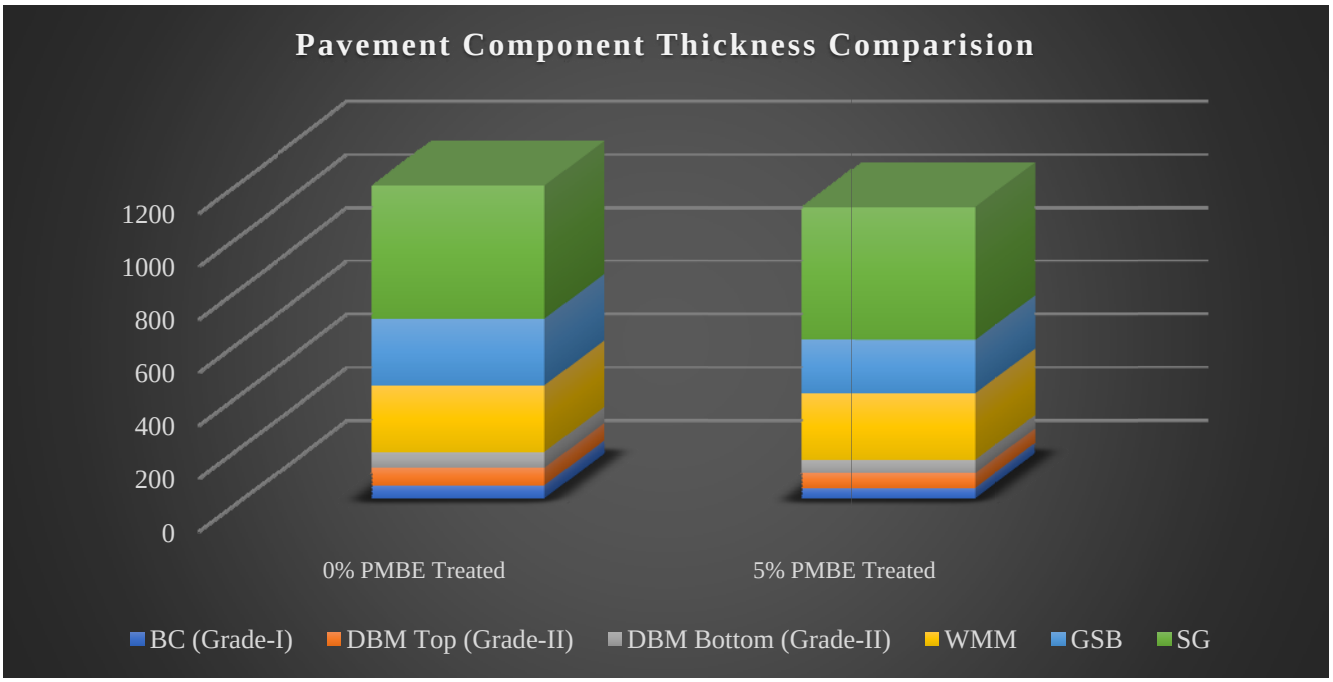
V. PAVEMENT DESIGN

There is main objective of pavement design for study how much effective of treatment of soil by using PMBE with comparison of without treated natural soil. Because as above we already studied maximum CBR achieved by using 5% PMBE with soil so for further experiment undertaken pavement design comparison of Untreated natural soil and 5% PMBE treated soil.

The primary goal of pavement design is to determine the total thickness of the pavement structure as well as the thickness of individual structural components. The plan is to use IRC methods to calculate the requisite crust thickness.Pavement design by using IRC:37-2018 of its current edition and fourth revision of IRC Guideline of flexible pavement design. Method of the pavement design procedure is undertaken below

Pavement Design Result:

S.No.	Description	Untreated Soil	Treated Soil With 5% PMBE
1	Bituminous Concrete (VG-40)	50 (Grade-I)	40 (Grade-I)
2	Dense Bituminous Macadam Top (VG-40)	65 (Grade-II)	55 (Grade-II)
3	Dense Bituminous Macadam Bottom (VG-40)	60 (Grade-II)	50 (Grade-II)
4	Wet Mix Macadam (WMM)	250	250
5	Granular Sub Base (GSB)	250	200
6	Sub Grade	500	500



VI. CONCLUSION

- The impact of soils on the performance of polymer-modified bitumen emulsions was investigated in depth in this study. The tests revealed the properties of the soil sample, and identical experiments were carried out on the soil sample combined with four different quantities of bitumen emulsion (2.5 percent, 5 percent, 7.5 percent, and 10 percent). The soil strength increases with bitumen emulsion in the soil sample until a 5 percent proportion ratio is reached, according to the test results. After then, the adding percentage of bitumen but just after 5%, soil strength decreases while increasing the soil proportion. The results show that the soil's strength is good when 5 % bitumen emulsion is added.
- Also, from the above study and experimental exercise of pavement design for different CBR, the first is untreated natural soil. The second is natural subgrade soil treated with 5% polymer modified bitumen emulsion. And Mixing PMBE with soil increases soil strength and reduces the total thickness of the pavement structure, according to a study or experiment.
- The overall thickness of pavement for Untreated soil is 1.175 m,
- The overall thickness of pavement for Treated soil is 1.095
- Reduction in pavement thickness is cost-effective for the project. Pavement thickness is inversely proportional to soil strength; when soil having higher strength, the thickness of pavement is less respectively, same as when soil having less strength, the thickness of pavement is higher respectively.

VII. REFERENCES

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