

**CRRI****केन्द्रीय सड़क अनुसंधान संस्थान**

पी. ओ., सी. आर. आर. आई., मथुरा रोड

नई दिल्ली - 110020, (भारत)

डॉ. सुनील बोस**Dr. Sunil Bose**

Head, Flexible Pavements Division

Central Road Research Institute

(Council of Scientific & Industrial Research)

P. O. CRRI, Delhi-Mathura Road

New Delhi-110020 (India)

QSP/FPD/IPPL/2010-11/652

13th January, 2011

Sh. P. Ghosh
India Polyroads Pvt. Ltd.
808-809, E-Block, International Trade Tower
Nehru Place, New Delhi -19

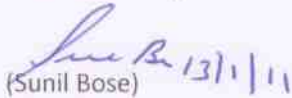
Sub : Feasibility Study on use of Soil Tech MK III for use in in-situ stabilization of soil

Please find enclosed herewith the Final Report on the above captioned project. Kindly acknowledge the same.

In case of any clarifications/doubts regarding the technical content of the report, please feel free to contact us.

Thanking You,

Yours Sincerely,


(Sunil Bose) 13/1/11

Enclosed : Copy of the Final Report (02 No.)





**FEASIBILITY STUDY ON USE OF SOILTECH MK III FOR USE
IN IN-SITU STABILIZATION OF SOIL**

FINAL REPORT

Sponsored By

M/s India Polyroads Pvt. Ltd.

Flexible Pavement Division

January, 2011



**केंद्रीय सड़क अनुसंधान संस्थान,
नई दिल्ली - 110020
CENTRAL ROAD RESEARCH INSTITUTE
NEW DELHI - 110020**

FEASIBILITY STUDY ON USE OF SOIL TECH MK III FOR USE IN IN-SITU STABILIZATION OF SOIL

Dr. S. Gangopadhyaya : Director
Dr. Sunil Bose : Head, Flexible Pavement Division

PROJECT TEAM

Sh. Abhishek Mittal : Scientist (**Project Leader**)
Sh. J. Ganesh : Scientist
Sh. Girish Sharma : Technical Officer
Sh. Gajender Kumar : Technical Officer

TECHNICAL ASSISTANCE

Sh. N. K. Sakkarwal : Technical Officer
Sh. Amit Kumar : Junior Technical Assistant

Disclaimer

All the data and technical information furnished in this report are based on the investigation carried out in the laboratories of Central Road Research Institute (CRR I), New Delhi for the soil sample supplied by the client. The test results are based on the testing done on the soil sample supplied by the client. These test results should not be generalised and may not hold valid for other kind of soils. The responsibility of CRR I is limited to the technical and scientific matters contained in this report.

Any use of the finding of the report without consulting CRR I by any other agency or person other than the client is solely at their own risk and responsibility.

Acknowledgements

Central Road Research Institute, New Delhi, would like to place on record its sincere thanks to M/s India Polyroads Pvt. Ltd. for sponsoring this project to the Institute. The cooperation and assistance rendered by Mr. P. Ghosh, CEO and Mr. Babula Polai during the course of the study is thankfully acknowledged.

1. INTRODUCTION

1.1 General

CRRI was requested by M/s India Polyroads Pvt. Ltd. to take up the assignment for study on the feasibility on use of Soil Tech MK III for use in insitu stabilisation of soil vide letter no. IPPL/C.O/CRRI/10-11/002 dated 19th April, 2010.

CRRI agreed to take up the above consultancy project to carry out the required studies before and after stabilization with Soil Tech MK III vide letter no. QSP/FPD/2A(0)/435 dated 10th May, 2010.

1.2 Objectives and Scope of the study

The main objective of the study is to check the feasibility on use of Soil Tech MK III for use in in-situ stabilization of soil and make recommendations.

To fulfil the above objective, the scope included the following:

- 1) Testing of engineering properties such as Liquid Limit (LL), Plasticity Index (PI) and Grain Size Analysis
- 2) Determination of Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of the soil
- 3) Determination of California Bearing Ratio (CBR) of the soil before and after stabilization
- 4) Determination of Unconfined Compressive Strength (UCS) before and after stabilization
- 5) Preparation of report and recommendations on use of Soil Tech MK III

The testing for Resilient Modulus of the soil has not been done due to the non-availability of the equipment.

2. LABORATORY TEST RESULTS AND ANALYSIS

To assess the suitability of Soil Tech MK III as soil stabiliser, the soil sample provided by the client was taken for the study. Laboratory tests were done to determine the engineering properties of soil and strength characteristics of soil before and after stabilisation with Soil Tech MK III. The soil was tested to determine its various Engineering properties such as Particle Size

Distribution, Atterberg's limits (Liquid Limit and Plasticity Index), Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). The Grain Size Analysis is presented in **Table 1**. It was also tested for strength parameters such as California Bearing Ratio (CBR) and Unconfined Compression Strength (UCS) before and after stabilization with 0.5 % dosage of Soil Tech MK III.

2.1 Determination of Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)

To determine the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) of the soil, compaction test was done using heavy compaction as per IS:2720 (Part 8)-1983 (Reaffirmed 2006). Three samples were made for the soil and the mean value of the test result has been taken. The results are given in **Table 2**.

2.2 California Bearing Ratio (CBR) Test

This test is carried out to determine the strength of soil in terms of California Bearing Ratio (in %). It is a ratio expressed in percentage of force per unit area required to penetrate a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. The ratio is usually determined for penetration of 2.5 and 5.0 mm. The test is done as per IS:2720 (Part16)-1987 (Reaffirmed 2002). California Bearing Ratio of soil was determined for soil before and after treatment (Stabilisation).

2.2.1 Test Procedure for Untreated Samples

The untreated samples were prepared at the pre-determined MDD and OMC for the soil (obtained from Proctor Test) and compacted as per the procedure given in IS:2720 (Part-16) for statically compacted specimens. After preparation as per the as per Untreated soil samples were soaked in water for 4 days (i.e. 96 Hours) and were then tested to determine its CBR value. Three samples were prepared for the soil and the mean value of test result has been taken as CBR of the soil.

2.2.2 Test Procedure for Samples Treated with Soil Tech MK III

For the preparation of soil samples treated with Soil Tech MK III, the following procedure was adopted :

- (a) The weight of the material to be placed in the mould was determined (based on MDD of the soil).
- (b) One half of the pre-determined percentage of OMC was taken and mixed with the soil.
- (c) 0.5 % (by weight of the soil) of Soil Tech MK III was taken and mixed with the remaining 0.5 % of OMC and mixed with the soil.
- (d) The soil was thoroughly mixed to ensure uniform distribution of the moisture throughout.
- (e) The soil was then placed in the CBR mould in 5 layers and given 55 blows per layer. The sample was then allowed to cure in sunlight for 5 days.
- (f) After 5 days (i.e. on the 6th day), 10 ml of Soil Tech mixed with 10 ml of water was sprayed on the top and sides of the specimen and was allowed to cure for an extra 2 days in sunlight.
- (g) After 7 days of curing (i.e. on the 8th day), the sample was completely submerged in a water tank for a period of 4 days (i.e. 96 hours).
- (h) After 4 days soaking in water, the mould was taken out, allowed to drain for 30 minutes and tested for soaked CBR in the CBR testing apparatus. Three samples were prepared for the soil and the mean value of test result has been taken as CBR of the soil. The CBR test results are reported in **Table 2**.

2.3 Unconfined Compressive Strength (UCS) Test

The unconfined compressive strength is defined as the ratio of failure load to cross sectional area of the soil samples if it is not subjected to any lateral pressure.

$$q_u = P/A_c$$

Where,

q_u = unconfined compressive strength

P = failure load

A_c = corrected area at failure

The test was done as per IS:2720 (Part 10)-1991 (Reaffirmed 2006). Unconfined compressive strength of the soil was evaluated for untreated samples and samples treated with 0.5 % dosage of Soil Tech MK III. After preparation of the samples, the test samples (for both treated and untreated) were kept in desiccators (100 % humidity chambers) to retain moisture of the samples so that reaction between soil particles and Soil Tech MK III may be continued. The test result for untreated and treated samples are given below in **Table 3**. Three samples were made for each set of test and the mean value has been reported as UCS of the sample.

Table 1 : Grain Size Analysis

| IS Sieve size (mm) | % Passing by Weight |
|--------------------|---------------------|
| 10 | 100.0 |
| 4.75 | 94.0 |
| 2.36 | 79.4 |
| 0.425 | 31.9 |
| 0.075 | 17.4 |

Table 2 : Laboratory Test Results

| S. No. | Properties of soil | Laboratory Test Results | |
|--------|--------------------------------------|-------------------------|--|
| | | Untreated Sample | Treated Sample (0.5 % of Soil Tech) |
| 1 | Maximum Dry Density (MDD), gm/cc | 2.10 | - |
| 2 | Optimum Moisture Content (OMC), % | 9.0 | - |
| 3 | California Bearing Ratio (CBR), % | 4.8 | 34.0 |
| 5 | Liquid limit, % | 34.0 | - |
| 6 | Plastic limit, % | 21.3 | - |
| 7 | Plasticity Index, % | 12.7 | - |

Abhishek
(Abhishek Mittal)
Scientist, CRRI

Su
(Sunil Bose)

Table 3 : UCS Test Results

| Duration of Curing | UCS value (KN/m ²) | |
|--------------------|--------------------------------|--------------------------------------|
| | Untreated Sample | Treated Sample (0.5 % of Soil Tech) |
| 7 days | 368.7 | 444.1 |
| 14 days | - | 503.4 |
| 28 days | - | 518.1 |


3. CONCLUSIONS AND RECOMMENDATIONS

Based on the laboratory studies, the following conclusions were drawn :

- (a) The CBR value of the soil was found to increase from 4.8 % (for untreated sample) to 34.0 % (for treated sample with 0.5 % Soil Tech MK III). The increase in the CBR value of the soil was found to be about 600 % (based on the CBR of untreated sample).
- (b) The improvement in UCS value of the soil after treatment with Soil Tech MK III was found to be about 20 % (after 7 days) and 41 % (after 28 days) when compared with the UCS value of the untreated sample.

So, it was concluded that Soil Tech MK III is effective in improving the strength properties of the soil sample. This indicates that if used in the field for stabilization of in-situ soil, use of Soil Tech MK III may result in substantial reduction in pavement thickness.

However, since the performance of Soil Tech MK III has been tested for only one kind of soil (which was provided by the client), therefore, it is recommended that the properties of the in-situ soil needs to be evaluated before the application of Soil tech MK III in field conditions. Also, the dosage of Soil Tech MK III to be used in field for in-situ stabilization of soil needs to be optimised based on the type of the in-situ soil encountered and economic considerations.


(Abhishek Mittal)


(Sunil Bose)

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