e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 6, Issue 10, October 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

Improvement of Stability of Potholes Using Geocell

Ritika Kiran Tadvi, Prof. Girish Gadve

PG Student, Department of Civil Engineering School of Engineering and Technology Sandip University, Nashik, India

Assistant Professor, Department of Civil Engineering School of Engineering and Technology Sandip University, Nashik, India

ABSTRACT: A pothole is defined as a bowl-shaped depression in the pavement surface. With the climate change such as heavy rains, damaged pavements like potholes are increasing, and thus complaints and lawsuits of accidents related to potholes are growing. There are internal causes to potholes such as the degradation and responsiveness or durability of the pavement material itself to climate change, such as heavy rainfall, and external causes such as the lack of quality management and construction management. Maintenance of paved and unpaved roads and highways has been a major issue for all road owner authorities. When the roads are not appropriately designed and constructed, life of the roads drastically reduces causing disruption of the traffic. Such roads develop pot-holes, develop uneven riding surfaces, and tend to settle over stretches, thereby disrupting traffic movement.

I.INTRODUCTION

Constant increases in traffic frequency and axle loads place great demands on the existing road network. The stresses induced between layers soon result in crack formation, and any local differential settlements may lead to subsequent settlement of upper layers. These stresses results in crack formation in surface layer i.e. fatigue and the settlement by local differential settlement i.e. rutting. The nature of soil present around the world are of many varieties ranging from dense to very loose and stiff to very weak. Since the availability of good construction site is limited, in spite of how weak the soil is, there is need to improve such sites when it is not possible to avoid such sites. For the past few decades, use of geo-synthetics has been gaining advantages over the other improvement methods especially in pavement industry. Recently the application of geocells in pavement layers have been showing much performance improvement as it can provide an additional lateral confinement to the infill material over and above the reinforcement functions provided by conventional geo-synthetics. Several research studies have shown in the past that the geocell reinforcement is effective when a granular infill is used over weak subgrades under monotonic loading conditions. Studies were performed on the flexible pavements with and without geocell reinforced basal layer under static and repeated loading. However, not much information is reported in the literature on repeated load tests on pavement sections reinforced with geocells with extensive instrumentation. Hence, there is a need to understand the behavior of geocell reinforced granular aggregate bases over weak subgrades under repetitive traffic loading. Rutting is a common phenomenon encountered in flexible pavements supported by weak subgrades. Reinforcing the weak subgrades is one of the promising alternatives to counter the pavement surface rutting. Reduction in rut depth can be achieved using Geocell in the bases of flexible pavements. Studies have proved that inclusion of basal geocells can reduce rut depth to a greater extent. Studies have shown that geocell can be used for soil confinement to provide additional strength and stiffness to the base course. Fig. 1.1 shows different types of geo-synthetics useful for pavements.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

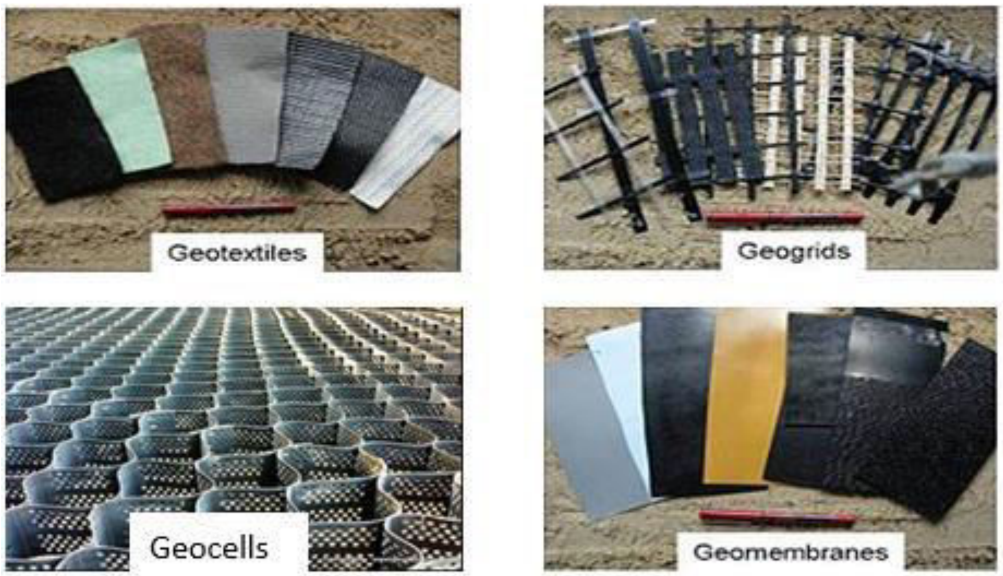

Figure 1.1 Varieties of geo-synthetics used in pavements [1]

Geocell

The concept of lateral confinement by cellular structures dates back to 1970s. The United States Army Corps of Engineers developed this idea for providing lateral confinement to improve the bearing capacity of poorly graded sand (Webster, 1981) [2]. The predecessors of present geocells were sand grids made up of paper soaked in phenolic water-resistant resin. Later, metallic geocells, especially those made of aluminum, were chosen because of strength requirements, but they proved unfeasible because of handling difficulty and high cost. Geocells have also been made using geo-grid sheets jointed by bodkin bars (for example, Carter and Dixon, 1995 [3]). At present, high-density polyethylene (HDPE) is the common polymer used to make geocells by welding extruded HDPE strips together to form honeycombs. Several research studies have shown in the past that the geocell reinforcement is effective when a granular infill is used over weak subgrades under monotonic loading conditions.

II.LITERATURE REVIEW

D.V.arul mozhi bharathi et al., (2018) Geocell reinforcement is a judicious combination of reduction of thickness and improvement of the life time of the pavement in terms of million standard axle (msa) and Bearing capacity of the soil . Geocells acts as a rigid mattress and are light weight with strong three dimensional cellular confinement system which greatly reduces the lateral movement of confined soil particles. The walls of the geocells are specially textured on both the sides for better soil-cell wall interaction and the perforated walls are provided to reduce the pore water pressure. This paper concerned with the design of pavement reinforced with geocell and its cost comparison with conventional flexible pavement.

Supratik Kumar Saha et al., (2018) Intelligent transportation framework (ITS) plans to enhance the transportation system and has turned out to be increasingly prevalent. Enhancing the security of traffic is one of the vital issues of ITS. One of the significant issues in developing nations is maintenance of streets and the potholes on the road which is the reason for serious harm in driver’s safety. Therefore, drivers' safety might be improved with the established of pothole recognition methods. This paper outlines the different pothole detection methods that at present exists and their methods and their limitations.

Vaibhav Joshi et al., (2021) The present study focuses on the more stable solution for pothole repairs. The scope of this study is to understand the contour of the Kaman by Surveying and QGIS Software. Further this study is aims to conduct experimental programme on pothole repair work with various combination of material such as Geocell, Bitumen, Aggregate, Fly Ash and GGBS.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

Jetashri R. Gandhi et al., (2019) The growth of a country depends on the transportation services for traveling safely. Many distresses of asphalt pavements are responsible for the unsafe pavement surface. Potholes are the main reason for the distress of pavement. For detecting and repairing asphalt pavement having potholes, many methods are proposed in the literature for detecting potholes. There are many reasons for the distress of pavement surfaces like heavyweights of vehicles, an unspecified amount of materials, and environmental changes. In this paper, different methods are surveyed like vibration-based method, 3D Reconstruction, and vision-based method for detecting potholes. The vibration- based methods use an accelerometer, 3D laser method uses laser sensor, and vision- based method uses different image processing techniques for detecting potholes. 3D Reconstruction includes 3D laser method, Stereo Vision method, and Kinect Sensor method. The Vision-based method includes a 2D image-based method and Video- based method. In this review paper, the advantages and disadvantages of various methods are also discussed.

Table 2.1 Summary of studies performed on geocell mattress under static loading condition

Study	Type of Facility	Geo- synthetics Used	Remarks
Bush et al. [10]	Embankment	Geocell	Enhanced bearing capacity.
Cowland and Wong [12]	Embankment on soft clay	Geocell	Enhanced bearing capacity
Mhaiskar and Mandal [21]	Soft Clay Subgrade	Geocell	improvement in the ultimate load and reduction in settlement
Krishnaswamy et al. [42]	Embankments constructed over soft clay bed	Geocell	Results depend on Stiffness of the geocell, pocket opening size, height of geocell, type of soil filled inside the geocell and the pattern used to form the geocells.
Dash et al. [15]	Laboratory tank	Geocell	Enhanced bearing capacity of strip footing on sandy ground
Saride et al. [43]	Laboratory tank	Geocell	Substantial increase in the bearing capacity and reduce settlement of the clay and sand subgrades under circular loading
Hegde et al. [23]	Laboratory tank	Geocell	The load carrying capacity of the geocell reinforced bed increased by 13 times for the aggregate in fill, 11 times for the sand infill and 10 times for the red soil infill.

III.METHODOLOGY OF PROPOSED SURVEY

3.1 Characteristics of subgrade soil

The soil used for the study is natural lateritic clayey soil obtained from the permanent campus of Indian Institute of technology Hyderabad.

3.1.1 Sieve analysis

A dry sieve analysis as per IS-2720 (Part4-1985) [32] was performed to determine the particle size distribution of the soil. Fig. 3.1 shows the particle size distribution of clayey soil, which consists of about 40%, fines (i.e. particles smaller than 75μ sieve size). For further classification of the soil, Atterberg's limits tests were performed.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

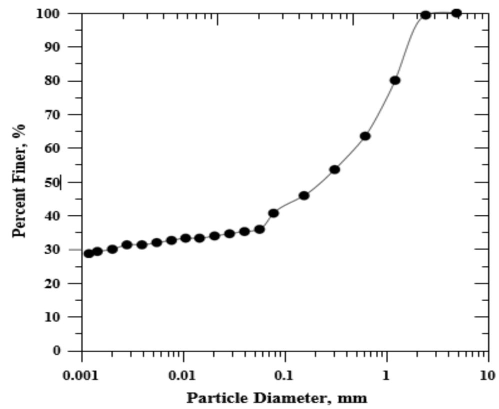

Figure 3.1 Sieve analysis of the subgrade soil

3.1.2 Atterberg's limits

Atterberg's limits including liquid limit (LL) and plastic limit (PL) were conducted as per IS-2720 (Part4-1972) [33]. The images of apparatus used during this test can be seen in Fig.3.2a. Fig. 3.2b shows the flow curve of the soil. The liquid limit and plastic limit of the soil are found out to be 47% and 21% respectively. The Plasticity Index of the soil, which is the difference between LL and PL is found out to be 26%. As per the Indian standard soil classification system, the soil is found out to be well graded sand with clay (SC).

3.1.3 Specific gravity

The specific gravity test is conducted as per IS-2720 (Part3-1980) [34] and the specific gravity is found out to be 2.65. This test is conducted by using density bottle method and the images of the test can be seen in Fig.3.3.

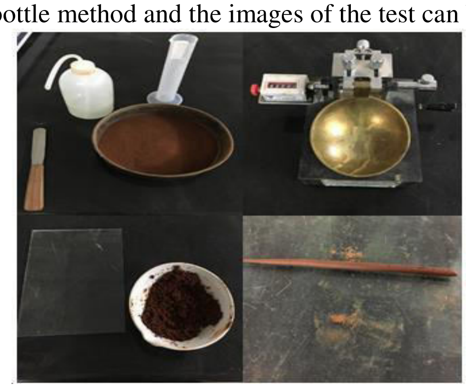

Figure 3.2a Images of the LL and PL test

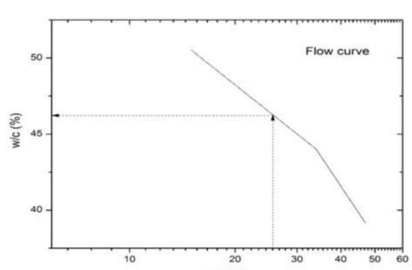

Figure 3.2b Flow curve of clayey soil

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

Figure 3.3 Specific gravity test by density bottle method.

IV. CONCLUSION AND FUTURE WORK

Static load test results

During the first stage, the static load tests were performed on the unreinforced test section having a 440mm thick base course (Fig. 4.4) and a geocell reinforced test section having a 250mm thick base course (Fig. 4.5) to understand the influence of geocell reinforcement in improving the base layer stiffness and also to study the performance of geocell under static load conditions. The loads were applied on the test sections at a constant settlement rate of 0.5mm/min until a settlement of about 25mm is reached and the corresponding load applied are noted. The pressure-settlement curves obtained for the test sections shown in Figs. 4.4 and 4.5 are as presented in Fig. 4.6. From Fig. 4.6, it can be observed that for the same level of settlement the reinforced section is bearing more pressure than the unreinforced one. For instance at 5mm settlement, the bearing pressure in unreinforced case is 900kPa, whereas it is 1200kPa in reinforced case. Similarly at 25mm settlement, the bearing pressure in unreinforced section is 2130kPa as compared to 2330kPa in reinforced section. So, at 25mm settlement a percentage increase of about 9.39% in bearing pressure is observed in reinforced case.

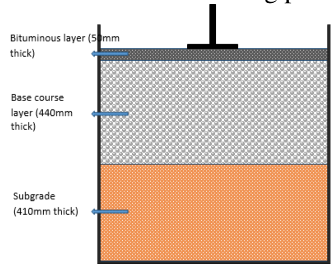

Figure 4.4 Unreinforced test section used in the study

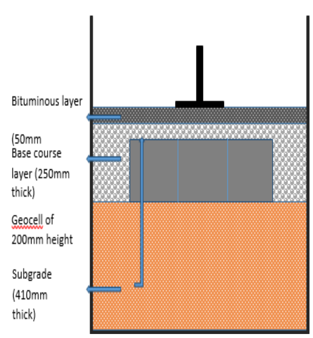

Figure 4.5 Reinforced test section used in the study

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

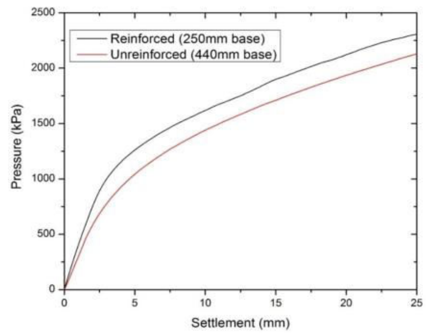

Figure 4.6 Pressure-settlement curve for 440mm thick unreinforced and 250mm thick base geocell reinforced test sections

The surface deformations and the deformation profile for both unreinforced and geocell reinforced test sections were obtained with the help of the displacement sensors located in the actuator and also the LVDTs placed at a distance of 1D and 1.5D on either sides from the centerline of loading point as explained in section 3.6.4. Figure 4.7 presents the deformation profile for the unreinforced test section in the form of deflection basins. The term deflection basin can be defined as the area of pavement deflection under and near the loading region. It can be observed from Fig. 4.7 that with the increase in the pressure applied, the deflection basin gets deeper i.e. the settlement is high. However, the settlement is mainly observed below the loading region and the settlements are observed to be very less to negligible on either sides of the loading region. For Instance, at an applied pressure of 1500 kPa, the settlement of the loading plate is as high as 11mm whereas, the settlements on either sides of loading plate are observed to be 2 mm and 1 mm at a distance of 1D and 1.5D from centerline respectively.

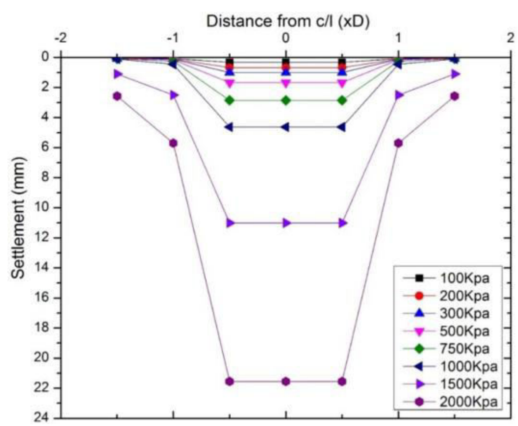

Figure 4.7 Surface deformation profile of unreinforced test section

Similarly, Fig. 4.8 presents the deformation profile of the geocell reinforced test section in the form of deflection basins. It can be observed from Figs 4.7 and 4.8 that for the same amount of pressure applied, the geocell reinforced section has restricted the settlement reasonably. It can also be observed from Fig. 4.7 and Fig. 4.8 that, the settlements in both the test sections are almost similar up to a pressure of 300kPa is applied. Further, with the increase in applied pressure, the settlements in the unreinforced sections has increased drastically compared to the geocell reinforced section. From this observation, it can be inferred that the presence of geocell reinforcement in the base layer has improved the stiffness of the base layer and in turn has reduced the surface settlements of the test section.

The test sections were also instrumented with the pressure cells located at the subgrade level exactly below the loading region and at a relative distance of 1D, 1.5D and 2D from the centerline of the loading region as explained in the section 3.6.4. The pressure acting on the subgrade due to the various intensities of load applied on the surface of the test sections can be determined with the help of this instrumentation arrangement and both the unreinforced and geocell reinforced test

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

sections were instrumented to understand the pressure distribution patterns in the pavement system. Figure 4.9 presents the pressure distribution patterns at the subgrade levels for various intensities of pressure applied on an unreinforced test section. It can be observed that, with the increase in the applied pressure, there is an increase in the pressure acting on the subgrade. The pressure distribution curve gets sharper with an increase in applied pressure i.e. the pressure recorded exactly below the loading region is high. However, the pressure acting at a distance of 1.5D and 2D are relatively less.

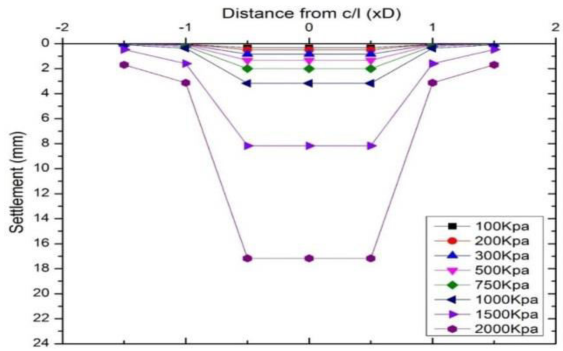

Figure 4.8 Surface deformation profile of reinforced test section (250mm base)

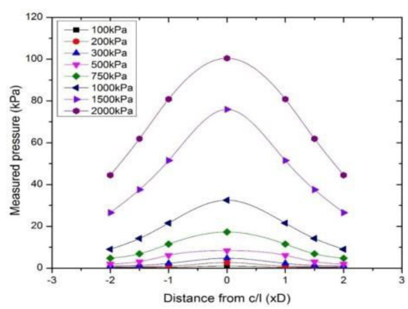

Figure 4.9 Pressure acting on the subgrade at different loads applied (Unreinforced)

Similarly, Fig. 4.10 presents the pressure distribution pattern at the subgrade level for various intensities of load applied on the geocell reinforced test section. It can be observed that there is an increase in the pressure intensities recorded with an increase in the applied pressure. However, the pressure distribution patterns in the reinforced section is observed to be less narrow, unlike the pressure distribution patterns of unreinforced section.

From the Fig. 4.9 and Fig. 4.10, it can be visualized that the pressure experienced at the subgrade level at all the specified locations is less in reinforced pavement section than the unreinforced section. It indicates that the geocell reinforcement is capable of distributing the loads to a wider area which in turn helps in reducing the pressure intensities observed at the subgrade level. About a 30% reduction in the pressure was observed in the geocell reinforced test sections compared to the unreinforced test sections at an applied pressure of 2000 kPa.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 10, October 2023 |

| DOI:10.15680/IJMRSET.2023.0610005 |

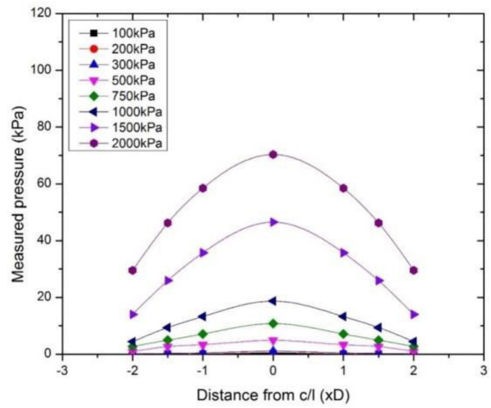

Figure 4.10 Pressure acting on the subgrade at different loads applied (Reinforced 250 mm base)

V.CONCLUSION AND FUTURE WORK

According to AASHTO, the thickness of unreinforced pavement section is 553 mm in place of 440 mm from IRC for the same traffic repetitions. The Indian roads are designed based upon IRC guidelines, which may result in premature failures due to the reason, that the correlations to calculate the resilient modulus of base layer, mentioned in IRC depends only on CBR of subgrade and does not consider resilient modulus of the layer itself. Whereas, in the case of AASHTO, the resilient modulus of individual layers are determined and designed as per the actual values obtained, unlike IRC method.

REFERENCES

[1] Webster, S. L. (1981). Investigation of Beach Sand Trafficability Enhancement Using Sand- Grid Confinement and Membrane Reinforcement Concepts. Report 2. Sand Test Sections 3 and 4(No. WES/TR/GL-79-20). ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTECHNICAL LAB.

[2] Carter, G. R. and Dixon, J. H. (1995). Oriented polymer grid reinforcement. Construction and Building Materials, 9(6), 389-401

[3] Biabani, M. M., Ngo, N. T., and Indraratna, B. (2016). Performance evaluation of railway subballaststabilised with geocell based on pull-out testing. Geo-textiles and Geomembranes, 44(4), 579-591.

[4] Kim, Y. J., Jo, S. H., Lee, S. H., & Kim, N. (2013). Field Applications on Environment- Friendly Permeable Pavements Reinforced by Geocell.Journal of Korean Society of Hazard Mitigation,13(2), 143-149.

[5] Giroud, J. P., and Noiray, L. (1981). Geo-textile-reinforced unpaved road design. Journal of Geotechnical and Geoenvironmental Engineering, 107. (ASCE 16489).

[6] Barker, W. R. (1987). Open-Graded Bases for Airfield Pavements (No. WES/MP/GL-87-16). ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS GEOTECHNICAL LAB.

[7] Haas, R., Walls, J., & Carroll, R. G. (1988).Geo-grid reinforcement of granular bases in flexible pavements (No. 1188). TRB, National Research Council, Washington, DC, USA, 19- 27.

[8] Al-Qadi, I. L., Brandon, T. L., Valentine, R. J., Lacina, B. A., & Smith, T. E. (1994). Laboratory evaluation of geo-synthetic-reinforced pavement sections. Transportation Research Record, (1439).

INNO SPACE

SJIF Scientific Journal Impact Factor

Impact Factor

7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com