Revolutionizing Road Infra with Modern Equipment, Technologies, Sustainable Materials and Policy Guidelines

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Use of Geosynthetics in Flexible Pavements

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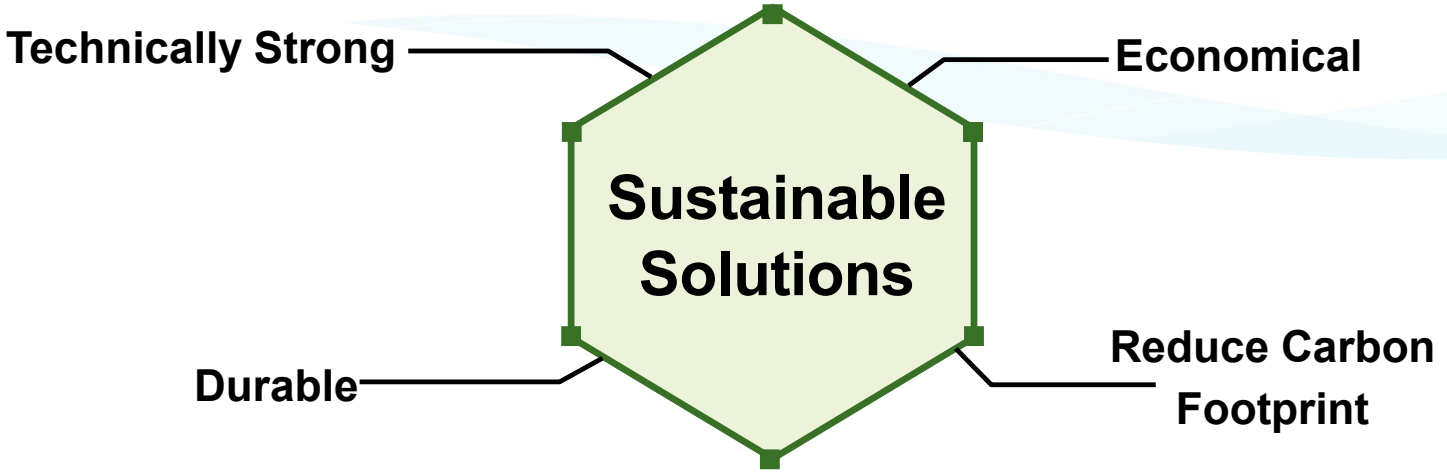


- *Shift from conventional constructional material i. e. concrete, steel, timber etc.*
- *The world is now looking for sustainable solutions like polymers, bioengineering materials*

Classification of Geosynthetics

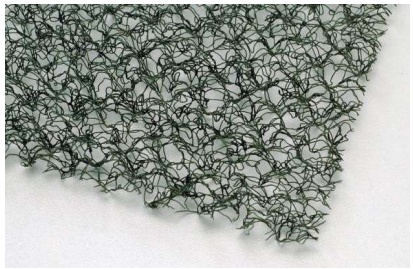
- Material that can enhance engineering properties with provision of sustainability and durability
- More than 150 separate application of Geosynthetics

Geotextile

Geogrid

Geomembrane

Drainage Composite



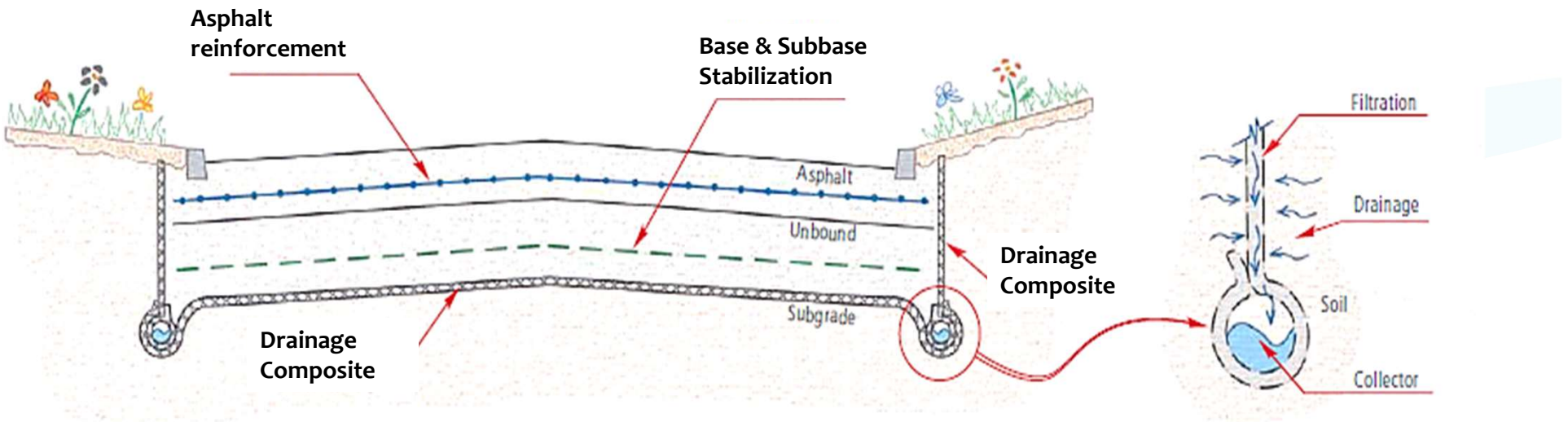
Geomat

Geonet

Why Geosynthetics??

- Improves pavement structure quality and performance
- Improve the mechanical and/or hydraulic behavior of the structure
- Reduce the quantity requirement of base and subbase material
- Increase service life
- Reduces maintenance
- Make use of locally available material

Application of Geosynthetics in Pavements

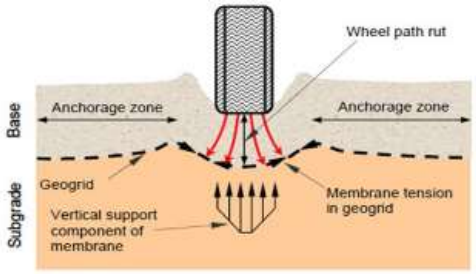


1. **Separation/Filtration**
2. **Drainage**
3. **Reinforcement**
4. **Moisture barrier**

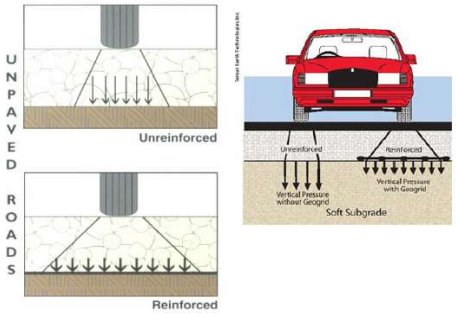
1. **between subgrade & Insitu soil for preventing intermixing**
2. **Horizontal subbase drainage & vertical fin /French drains**
3. **base / subbase stabilization & asphaltic rehabilitation**
4. **Water infiltration in asphaltic layers**

Geosynthetics Mechanism – Extruded Geogrid

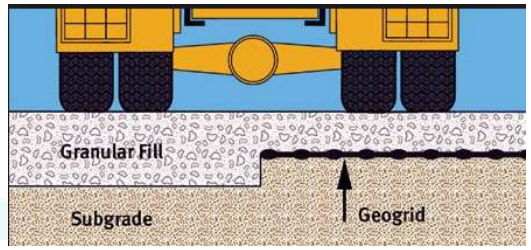
Interlocking (lateral confinement)



Tension membrane effect



Better distribution of load



Thickness reduction

Thickness reduction at equal values of c, φ, N;

Base course reduction (BCR)

Reduction in the reinforced base, or subbase thickness from the unreinforced thickness, with the same material constituents, to reach the same defined failure state

Lifetime increase at equal values of h, c, φ;

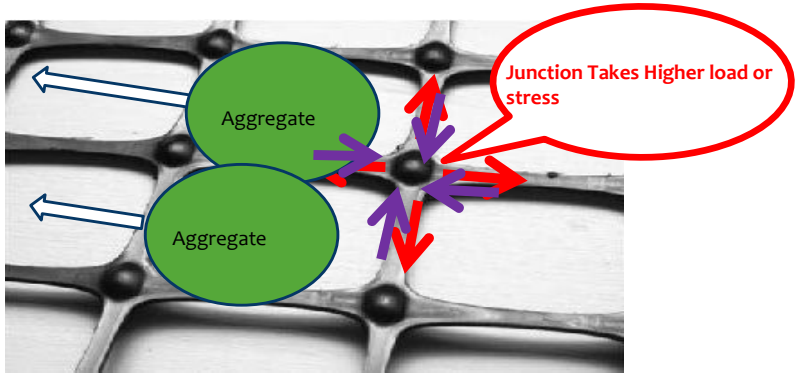
Traffic benefit ratio (TBR)

Ratio of the number of load cycles on reinforced section to the number of load cycles on an unreinforced section, with same geometry and material constituents, to reach the same defined failure state.

TBR is sometimes termed traffic improvement factor (TIF)

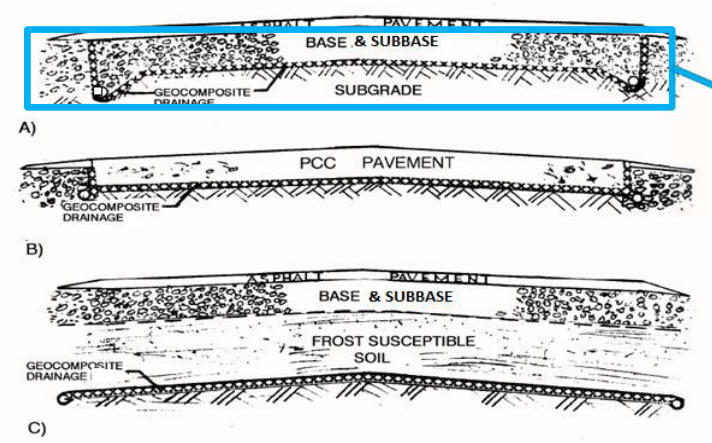
Reduce the quality of fill at equal values of N, h

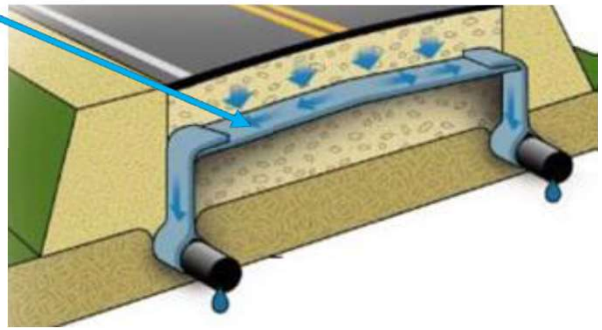
- Reduces the requirement for good quality virgin unbound aggregate
- Geogrid improves the mechanical properties i. e. modulus and bearing capacity of local low quality/marginal aggregates



Distribution of Load

Geosynthetics Mechanism – Drainage Composite





Mechanism

- Capacity to **provide avenue for flow**
- Transmittivity depends upon, thickness and the hydraulic conductivity
- Works on the principle of gravity and pressure.
- Seeped water flows through the geosynthetics.
- Coarser soil retains making a bridge that retains finer particle.

Drainage composite as an alternative to well graded gravel filter

- 'Geosynthetics' has become a simple and effective replacement to various conventional solutions respecting the safety, technical and functional requirements of structure.
- Drainage composite can be used for both horizontal & vertical drainage applications in pavements.
- **Drainage composite** is used as an alternate to conventional granular drainage layer.

Geosynthetics Mechanism – Asphalt Reinforcement

Types of Asphalt Reinforcement

1. Paving fabric

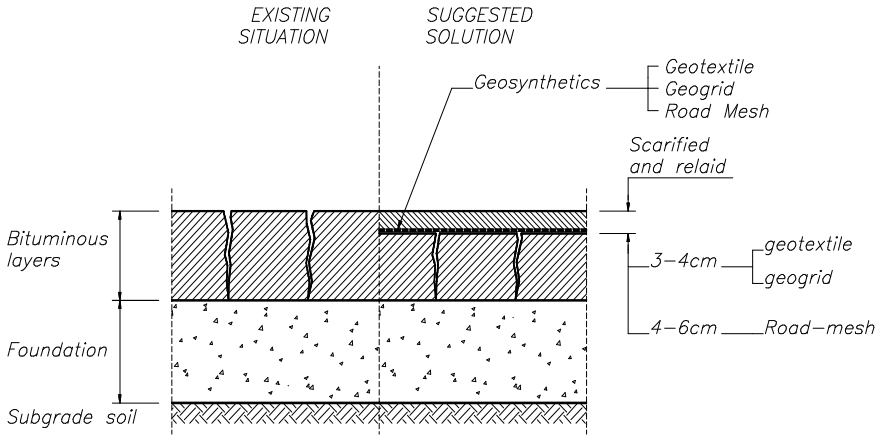
- Made from the fibres with Non-weaving process (Needle punched and heat bonded) and applied by providing tack coat with asphaltic layer.
- Moisture barrier function,
- acts as SAMI layer

2. Paving grid/Glass Grid

- Manufactured from a glass fibre roving or polymeric grid pattern
- It will act as reinforcement layer.

3. Asphalt Interlayer Composite

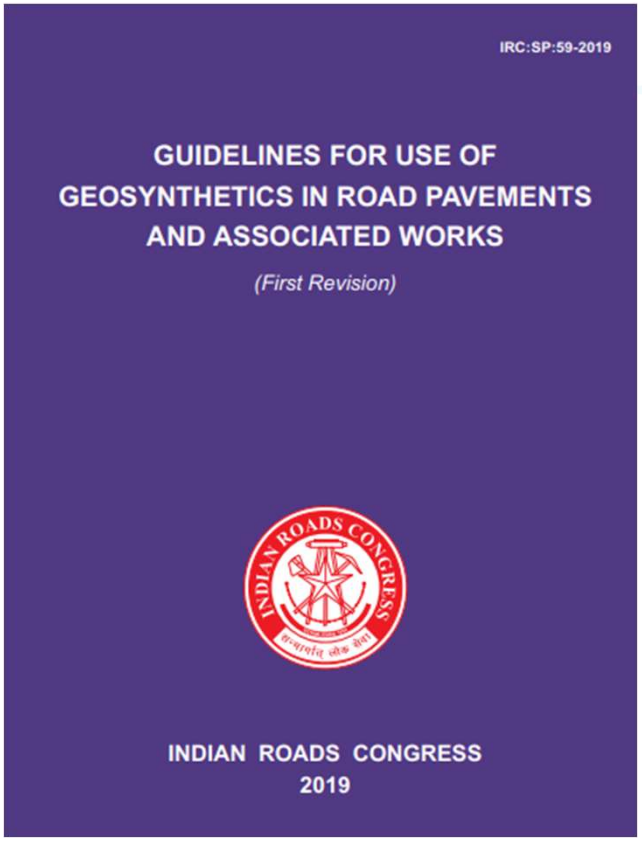
- A Grid combined with a Paving Fabric it is called a Composite.
- Made from Nonwoven Geotextile knitted with Fibre Glass rovings, will provide dual functions.
- Provide the membrane and also high strength reinforcement.



Mechanism

- Barrier against crack propagation
- Prevents reflective cracking by maintaining uniform load distribution
- Provides Stiffness
- Turns the cracks laterally until its energy is exhausted
- Increases bond strength

Technical Specifications, Design & Construction Guidelines



- Chapter-1 Introduction
- Chapter-2 Properties and Test Methods for Different Geosynthetics
- Chapter-3 Design Methodologies
- Chapter-4 Property Requirements& Selection Criteria of Geosynthetics Based on Function
- Chapter-5 Construction Guidelines for Use of Geosynthetics in Road
- Chapter-6 Handling and Storage of Geosynthetics

Annexure I Determination of Layer coefficients

Annexure II Development of the Layer Coefficient Ratio & Modulus Improvement Factor

Annexure III Various design considerations for different Asphalt reinforcements

Annexure IV Worked-out Example Illustrating the Design Methods

References

Case Histories – Bhavnagar

Project

- Road & Building Department, Bhavnanagar
- Creek Kalatalav Sanesh Road, 2012
- M/s Kalathia Engineering & Construction Ltd

Process Followed

- Site Survey & Investigation
- Designing as per IRC codes
- Approvals & Technical Assistance

Proposed Solution

- Biaxial Extruded Geogrids for Reinforcement
- Drainage composite to arrest drainage issues
- Gabion for Confinement on both sides
- Road mesh as Asphalt reinforcement
- Geotextile for separation
- Bonded Geogrid as basal reinforcement

Pain Areas

- Soft In-situ Soil, subgrade CBR<2%
- High ground water table
- Possibilities of the Water on both sides of the road
- High maintenance and repair cost
- Uneven settlement and failures

Inputs

- Subgrade = CBR<2%
- Traffic MSA = 65
- Designed Traffic Life = 15 years
- Strength length of the road need to be improved = 14 Kms

Benefits

Ease and speed of construction

Reduced maintenance

Reinforced design (34 Cr) reduced the cost of the project compared to conventional method (55 Cr) – 14km

30 – 35 % cost saving including Gabions

Case Histories – Bhavnagar

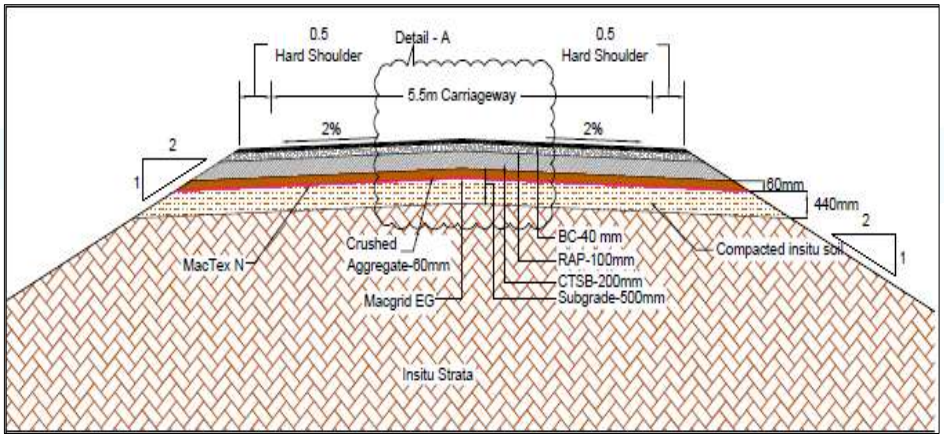
Case Histories – Subgrade Stabilization Works

Project Info
- NHIDCL, Andaman & Nicobar Island
- NH – 223, 2019
- M/s Vasishta Construction

Pain Areas
- Construction to be done before monsoon
- No Material Availability – Locally
- Aggregates had to be brought from Mainland
- Subgrade CBR <2%

Process Followed
- Site Survey & Investigation
- Designing & Approvals
- Supply & Technical Assistance

Proposed Solution
- EG for subgrade stabilization
- GTX for separation



Codes & References

IRC 37, IRC SP 59, MoRTH 700

- Savings 25 lacs/Km , conventional – 1.94cr/km
- Life cycle cost saving will add another 20% to 30% additional benefits

Case Histories – AH 48 Field Trial

Objective:

- Rehabilitation and upgrading to 2-lane with paved shoulders configuration and strengthening of Bhutan Border to Bangladesh Border
- To develop a better understanding of Geosynthetic-reinforced flexible pavements
- Validate the performance & design methodology of Geogrid Reinforced Pavement section by conducting quality research in a field environment.

Placement of Geosynthetics:

- By introducing the Extruded Geogrid, the WMM and GSB layer can be replaced with locally available material.
- Road widening : Road Mesh/Glass grid can be introduced to bridge the junction of Existing and New Pavement to absorb the crack stresses caused by the differential settlement.

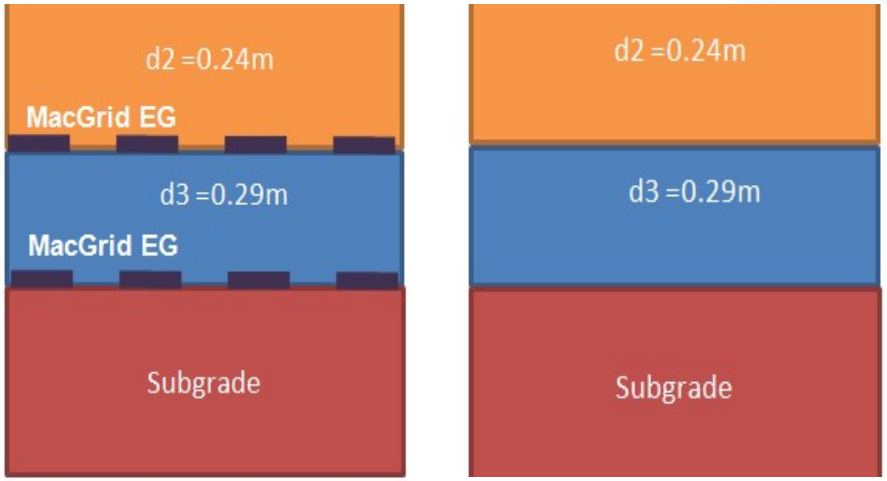
Field Test:

Performed on both reinforced and unreinforced sections

- Field CBR test
- Cyclic plate load test
- Plate Load test
- Filed Density test

Case Histories – AH 48 Field Trial – Field CBR Test Outcomes

The trial stretch is of 30m long (in which 15m is unreinforced and 15m is reinforced) and 4 m width. Extruded biaxial geogrid Macgrid EG 30S is used as reinforcement.



d2 Base Course thickness
d3 Subbase Course thickness

- Compacted the subgrade uniformly to minimum 95% MDD at OMC
- After Subgrade formation, the CBR, Density and Moisture content test has been performed

Field CBR Test results

Pavement Layer	Unreinforced Section CBR%	Reinforced Section CBR %
Subgrade	11.5	
Subbase	22	39.33

	Unreinforced SubBase course	Reinforced SubBase course
CBR	22	39.30
E (Mpa)	127.25	184.47

- Modulus improvement of subbase is 45%
- Above table clearly shows Geogrids shall increase the Elastic modulus of base and subbase

Case Histories – AH 48 Field Trial – Plat Load Test Outcomes

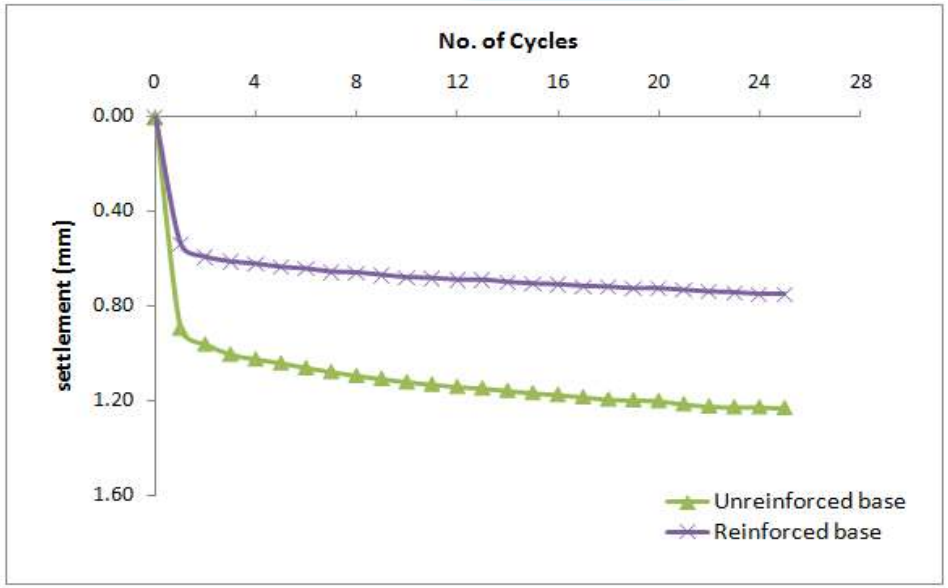
- Plate load test was performed as per IS 9214 (1979): Method of determination of modulus of subgrade reaction (K-Value) of soils in field
- Plate load test had been performed on the prepared subgrade and subbase of both reinforced and unreinforced sections
- On each layer minimum one plate load test had been performed to understand the modulus of soil reaction of the respective layer.
- In this trial test, square plate of 30cm X 30cm size had been used

Pavement Layer	Unreinforced K (kg/cm^3)	Reinforced K (kg/cm^3)
Subgrade	1.72	
Subbase	7.53	8.35

Percentage improvement of Subbase soil reaction modulus K is 11%

The graph of subbase indicates settlement for reinforced section is lower than unreinforced section for repeated load.

This decrement of settlement increases with increase in number of cycles



Summary

Use of Geosynthetics in pavements provides following benefits:

- **Reduce vertical and lateral deformation**
- **Increase the bearing capacity of soft soil**
- **Allows the use of Marginal/ Recycled/ locally available materials effectively**
- **Better drainage**
- **Separation/Filtration layer**
- **Extended Serviceability of the road i.e. Traffic benefit Ratio (TBR)**
- **Reduction in Crust thickness i.e. Base Course Reduction (BCR)**
- **Less periodical maintenance**
- **Reduce construction and operational costs**
- **Lower Carbon Footprint**

Thank You