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Use of Biaxial Geogrid for Reinforcement in Flexible Pavement

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Abstract: Reinforcement of flexible pavements using geo-synthetics—particularly geogrids—has become a widely adopted technique to address the increasing demands on road infrastructure due to growing traffic loads and environmental challenges. This approach enhances the mechanical behavior of pavement systems by improving load distribution, reducing stresses transferred to the subgrade, and minimizing surface deformation such as rutting and cracking. The incorporation of geo-synthetic reinforcement contributes to increased pavement longevity, improved structural integrity, and reduced construction and maintenance costs.

This study presents a comprehensive examination of the design principles, influencing factors, and performance outcomes associated with reinforced flexible pavements. Key parameters such as geogrid stiffness, aperture size, placement depth, subgrade strength, and the thickness of the pavement layers are explored to understand their roles in overall pavement performance. A synthesis of experimental laboratory investigations provides the foundation for developing a regression-based model aimed at predicting the Granular Equivalent (GE) factor. This factor quantifies the reinforcement's contribution to pavement strength, enabling engineers to adjust layer thicknesses without compromising performance. The proposed model is grounded in the AASHTO 1993 pavement design methodology and is validated through back-analysis of a wide range of laboratory test data.

I. INTRODUCTION

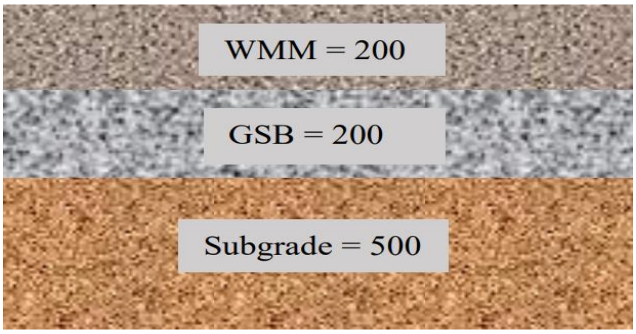
Road pavement is a structural sub caste composed of accoutrements similar as clay, summations, and binding agents like asphalt or concrete, laid over designated routes to grease vehicle and rambler movement. Originally, road shells were formed using only introductory accoutrements like clay and monuments. Still, as construction technology evolved, these were gradationally replaced by further durable options similar as asphalt and concrete. Moment, designing pavements is essential for icing dependable civic structure and enhancing road safety.

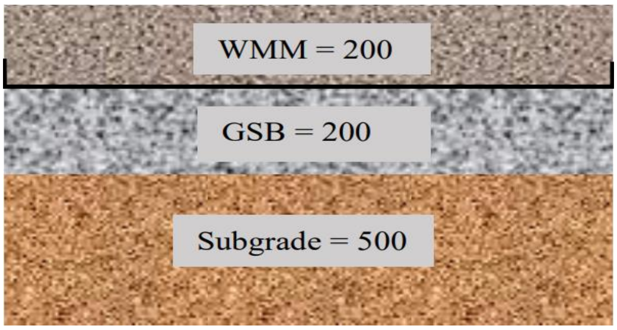
Roads are made both paved and unpaved as per load intensity. In earlier ages, unpaved roads served essential functions like transportation, trip, and indeed hunting, particularly in times when artificial advancements were limited. Although paved roads brought advancements, they introduced new challenges, including high construction costs and the demand for technical outfit and trained labour force. Unpaved roads, while further provident, do not support high- speed trip or insure safe passage for vehicles and climbers

II. LITERATURE REVIEW

Flexible Pavement Using Biaxial Geogrid Reinforcement

Flexible pavements are often subjected to the combined effects of traffic loads, weather conditions, and soil variability, which can lead to rutting, cracking, and overall degradation. To enhance the performance and longevity of flexible pavements, various reinforcement materials have been employed, with geogrids, particularly biaxial geogrids, gaining significant attention in recent years. Biaxial geogrids, with their ability to distribute loads effectively across the pavement structure, have been extensively studied for their potential benefits in flexible pavement construction.





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2.1 Manufacturing process:

- **Extrusion:** To generate the base sheet, a thin sheet of plastic, usually polypropylene is extruded.
- **Punching or Drawing:** The material's distinctive grid structure is created by mechanically punching or drawing the extruded sheet to create a regular pattern of perforations.
- **"Biaxial stretching** is the process of extending a punched sheet in both the cross-machine (widthwise) and machine (lengthwise) directions, which enhances its stiffness and tensile strength through orientation."
- **Quality Assurance:** To guarantee that the finished product satisfies certain requirements, such as tensile strength, aperture size, and resistance to environmental elements like UV exposure, it is put through stringent quality inspections.

2.2 Working process:

1. Materials and Manufacturing
2. Running and Point Storehouse
   - At-site disbursement
   - Point-on Handling
3. Geogrid Biaxial Installations
4. WMM spreading over with grader/paver

III. IMPACT ON LIFESPAN

Compared to non-reinforced pavement, corroborated pavement can last significantly longer

Pavement Type	Typical Lifespan Without Reinforcement	With Reinforcement
Rigid (Concrete)	20–30 years	30–50+ years
Flexible (Asphalt)	10–20 years	15–30+ years
Composite or Stabilized Base	15–25 years	25–40+ years

With vs. Without Reinforcement – Durability Comparison

Factor	Without Reinforcement	With Reinforcement
Crack Resistance	Prone to cracking from temperature & load	Reduced cracking due to tensile strength support
Fatigue Resistance	Degrades faster under repeated loads	Reinforcement helps distribute loads, reducing fatigue
Moisture resistance	Water can penetrate cracks & joints	Less cracking = lower water infiltration
Load-Bearing Capacity	May deform or rut under heavy loads	Enhanced load distribution prevents rutting
Resistance to settlement	Poor subgrade may cause uneven settlement	Reinforced layers help bridge weak spots
Maintenance Frequency	More frequent repairs needed	Longer intervals between maintenance
Durability in Harsh Climates	Susceptible to freeze-thaw damage	Reinforcement limits damage spread

IV. MERITS & DE-MERITS

Merits

1. Reduced Rutting and Enhanced Load Distribution
2. Greater Stiffness and Load-Bearing Capacity
3. Reduced Base Course Thickness
4. Extended Service Life
5. Cost Efficiency
6. Enhanced Performance over Weak Subgrades

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De-Merits
1. Elevated Initial Construction Costs
2. Higher Maintenance Demands
3. Risk of Distress under Load and Environmental Conditions
4. Possible Reduction in Ride Comfort
5. Sensitivity to External Damage

V. CONCLUSION

A conventional flexible pavement is composed of a compacted subgrade, a grainy sub-base(GSB), a wet blend Macadam(WMM), thick bitumen Macadam(DBM), and a bituminous face subcase. The application of geo-replicas, especially geogrids, is becoming less recognized for its role in stabilizing flexible pavements' base and subbase layers. Incorporating these into the base course significantly enhances the overall stability of the pavement system. This enhancement in structural integrity may allow for a reduction in the overall consistence of the pavement, particularly in the bituminous and base layers. However, it is difficult to measure the pavements' increased structural capacity directly. To effectively design a flexible pavement for specific business conditions, it's essential to assess the subgrade conditions and the material parcels, similar as the flexible modulus of the pavement accoutrements.

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