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Review Paper on Usage of Geogrids in Flexible Pavement Design

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Abstract — The growing need for efficient and sustainable transportation infrastructure has led to the integration of advanced materials in road construction. One such material, geogrid, has gained significant attention for its role in flexible pavement design. This review paper presents an in-depth analysis of the use of geogrids in flexible pavements, examining their functionality, types, advantages, limitations, and impact on pavement performance. Through an overview of experimental studies, case applications, and comparative evaluations, this paper aims to provide a comprehensive understanding of how geogrids enhance the longevity, load-bearing capacity, and overall performance of flexible pavements.

Keywords: Geogrids, Flexible Pavement Design, Pavement Performance, Load Distribution, Stabilization, Pavement Reinforcement, Sustainability

I. INTRODUCTION

Flexible pavements are the most commonly used pavement systems due to their cost-effectiveness and ease of construction. However, the durability and performance of these pavements depend heavily on the materials used in their design and construction. In this context, geogrids—polymeric materials formed in a grid-like pattern—have emerged as a viable solution for reinforcing flexible pavements. Geogrids are typically used in soil stabilization and load distribution, thereby improving the structural integrity of the pavement.

This paper reviews the function of geogrids in flexible pavements, discussing the types of geogrids, their applications, the mechanical properties of geogrid-reinforced pavement systems, and the challenges associated with their implementation.

A. *What Are Geogrids?*

Geogrids are high-strength polymeric materials that are manufactured with a grid-like structure, designed to interlock with the surrounding soil, aggregates, or other materials. The primary function of geogrids in pavement systems is to provide reinforcement, prevent lateral displacement of the aggregate base, and distribute loads more efficiently.

There are various types of geogrids, categorized based on their material composition, such as:

- Polymeric Geogrids: Made from materials such as polyester, polypropylene, or polyethylene.
- Steel-Geogrids: Reinforced with steel fibers to provide high tensile strength.
- Fiberglass Geogrids: Composite materials combining fiberglass with polymer resins for improved performance under extreme conditions.

Each type of geogrid offers specific benefits depending on the application and environmental conditions.

II. LITERATURE SURVEY & BACKGROUND

According to Mehndiratta et al. (1993) and Patel (1990), a typical mold with a diameter three times that of the plunger is insufficient for determining the CBR value since the tiny size of the mold will provide the geotextile more confinement. As a result, the mold's diameter is raised to five times the plunger's. Additionally, the mold-plunger diameter ratio (D/d) is altered from 2 to 5 to ascertain the impact of lateral confinement on the CBR value of reinforced soil, while the vertical pressure (surcharge), specimen thickness, and compaction technique remain unchanged from the normal test.

CBR and plate load tests were performed on unreinforced and geotextile-reinforced subgrade by Mehndiratta et al. (2005). It was found that replacing coir with synthetic geosynthetic geotextiles only resulted in a 5% increase in the elastic moduli of the coir-reinforced layer. By speeding up its degradability, they also looked into how long coir lasts. They found that phenol-treated coir lasts longer. A collection of Rao's work on geosynthetics and cutting-edge advancements was released in 2007.

Based on data from laboratory experiments and mathematical formulations, Babu et al. (2008) established a design technique for coir geotextile reinforced roads following IRC principles.

Saride, S., Pratico, F., and Puppala, A. J. In order to improve the performance of low-volume roads, [2011] investigated a new conceptual engineering economics tool based on the Life Cycle Cost Analysis (LCCA) for optimizing and selecting the optimal stabilizer and stabilization procedure for a particular subgrade soil with certain traffic scenarios.

Kneebone, E., and Parsons, R. L. In order to determine the extent of improvement brought about by Class C fly ash and the extent to which improvements were advantageous, [2005] evaluated the field performance of fly ash stabilized subgrades of pavement. From zero to nine years, dynamic cone penetrometer data were acquired for five sub-grade untreated roads and twelve sub-grade fly ash treated roads. All sub-grade ash treatments showed higher strengths than the untreated soil below. For the subgrades that were assessed, there was no discernible decline with time. Laboratory and field studies using fly ash demonstrate that fly ash increases soil stiffness and strength while decreasing its plasticity and swelling potential.

The performance of the entire test section of the low volume road with a base layer of soil lime was examined by Behak, L. [2011]. The kind of soil, the amount of lime present, the stabilized soil's compacting qualities, and the outcomes of the CBR laboratory tests were all taken into consideration while designing the test section. Visual inspection and Benkelman beam deflection measurements were used to assess two 50-meter test sections, one with a base layer of soil and 3 percent lime and the other with 5 percent lime. The average deflection values changed from 244 x 10−2 cm just after the section was built to 77 x 10−2 cm evaluated four months later, despite a few structural issues. According to research, using soil lime mixes for low-volume road foundation layers is a practical and cost-effective way to significantly enhance the rural road network.

In order to investigate the appropriateness of stabilized pond ash for road base and sub base construction, Ambarish Ghosh [2010] conducted a number of laboratory experiments on Class F Pond ash both alone and stabilized with varying amounts of lime 4, 6, and 10% and PG 0.5 and 1.0%. To find out the stabilized pond ash's compaction properties, light and heavy proctor compaction tests were performed. Specimens compacted with an ideal moisture content determined by testing and cured for 7, 28, and 45 days were subjected to bearing ratio tests. Tests of bearing ratios are conducted in both moist and unsoaked conditions. The test findings demonstrate how the curing duration, PG content, and lime concentration affect the stabilized pond ash's bearing ratio.

In order to enhance the physical and strength characteristics of a reddish-brown lateritic soil, Manasseh Joel and Isaac O. Agbede [2011] conducted experiments. In order to stabilize the soil sample by 3 to 12% by dry weight of cement, 15 to 60% of the soil sample's dry weight was made up of sand. Specimens were tested for classification, compaction, California bearing ratio, and unconfined compressive strength. When treated with a 60% sand and 6% cement combination, the plasticity index dropped from 17% to 2.5%. According to the results of the light and heavy compaction tests, the ideal moisture level rises as cement content rises and sand content falls. When soil samples were combined with 45% sand and 6% cement, 30% sand and 6% cement, 15% sand and 6% cement, 30% sand and 3% cement, and 45% sand and 3% cement, respectively, the CBR specifications for the base material were satisfied.

Aditya Kumar Anupam, Praveen Kumar, and G D Ransinchung R N [2013] looked into and demonstrated how fly ash, bagasse ash, and rice husk could be assessed for shrinkage, compaction, and CBR behavior by varying by 5 to 35% by soil weight. All combinations showed an increase in shrinkage limit values, while the RHA soil mixture showed an increase from 16% of natural soil to 33%. This is because the presence of free lime allows flocculated clay particles to reduce friction and replace particles. By raising the content of mixes, optimal moisture content accelerates a trend. The authors discovered that because RHA blended soil contains silica and calcium oxide, it has a greater value than other materials. This means that more water is required for chemical reactions. Because of cementation, the dry density of all mixes falls as stabilizer concentration increases. CBR values for the RHA and BA blended sample after 4 days of water soaking were improved to 25%; this was suggested for curing times of 3, 7, 14, and 28 days. The findings showed that after 3 to 28 days of curing, BA exhibits CBR 6 to 7.8% and RHA mixes 10.2 to 12.4%. The authors came to the conclusion that RHA blended samples worked better than FA, BA, and RSA and that they needed to cure for 28 days to reach their maximum strength.

E. Using cement and RHA blended soil samples, Basha et al. [2005] examined soil characteristics including strength, compaction, and plasticity behavior using a unique X-ray diffraction approach. The results of this investigation indicate that rice husk ash and cement both lessen plasticity behavior; cement-stabilized soils show notable decreases. While the OMC increases gradually when RHA and cement are combined, the MDD of cement-stabilized residual soil marginally falls as the cement concentration rises. The unconfined compressive strengths of cement-stabilized soils are increased by adding RHA, and a lesser amount of cement is needed to achieve a given strength than when cement stabilized. An increase in cement content causes the CBR value to rise, and adding RHA to cement-treated soil raises the CBR. The combination of 4% cement and 5% RHA yields the maximum CBR, which is around 60%. It is advised to utilize 6 to 8% cement and 10 to 15% rice husk ash as the ideal level quantity from the standpoints of plasticity, compaction, and strength as well as economics.

The geotechnical properties of the cement (3%) stabilized fly ash-silt specimens with 1% randomly oriented polyester fiber were investigated by Kaniraj and Havanagi. According to one investigation, adding 1% fiber causes the 56-day UCS of cement-stabilized fly ash-silt to rise from 500 kPa to 1050 kPa. Additionally, the inclusion of fiber transformed their brittle characteristic into ductile behavior.

The split tensile load-deformation strength and toughness characteristics of a granular soil that has been chemically stabilized with cement (2–10%) and class C fly ash (2–10%) and mechanically reinforced with recycled plastic strips (0.25-0.8% by weight) made of High-Density Polyethylene (HDPE) derived from post-consumer milk or water containers were assessed in experiments by Sobhan and Mashnad. The findings showed that after 28 days of curing, a mix with 8–10% cement and the equivalent quantity of fly ash had a compressive strength in the range of 4500–5600 kPa. It was discovered that while adding HDPE fibers greatly increases the composite's overall toughness, it has no discernible effect on its tensile strength. Additionally, it was shown that, regardless of the kind and quantity of fibers utilized, mixtures that included fly ash as an additional cementitious ingredient were the only ones that showed a discernible increase in strength as a result of fiber reinforcing.

The effects of lime stabilization and polyester fiber inclusions on the geotechnical properties of fly ash-soil mixtures were investigated by Kumar and Walia. In an expanding soil, lime and Fly ash was provided in increments of 1–10% and 1–20%, respectively. Tests for compaction, unconfined compression, and split tensile strength were conducted on the test specimens. Tests were performed utilizing 0, 0.5, 1.0, 1.5, and 2% plain and crimped polyester fibers based on dry weight to identify the optimal composites, which incorporated 15% fly ash.

ash and 8% lime. In comparison to the same combination without fibers, it was found that adding 1.5% of 6 mm plain fibers or 1.0% of 6 mm crimped fibers enhanced the unconfined compressive strength by almost 74%. Additionally, compared to the same combination without fibers, the split tensile strength increased by almost 135% when 1.5% of 6 mm crimped fibers or 1% of 12 mm plain fibers were added.

Tang et al. looked at how distinct short polypropylene fiber (PP-fiber) affected the mechanical properties and strength of both uncemented and cemented clayey soil. The cement concentration was 5% and 8% by weight of soil, while the PP fiber content was 0.05%, 0.15%, and 0.25% by weight of soil. When fiber was added, the failure strain rose from 0.5% to 1.25%. After adding 0.05% fiber, the UCS values for cemented soil specimens with 5% and 8% cement content rose noticeably from 0.40 to 1.02 MPa and from 0.63 to 1.28 MPa, respectively.

In order to determine how much geo-synthetic reinforcement contributes to the stiffness and strength of asphalt pavements, Ling and Liu (2001) conducted a number of static and dynamic tests on model sections. After the sub-grade was covered with the geo-grid reinforcement layer, the last layer of asphalt concrete was applied. Comparing reinforced pavement to un-reinforced pavement, the study found that the former had less settling over the loading area.

A.K. Among the sub-grade, Choudhary et al. (2011) positioned many layers of reinforcement, namely geo-grid and jute geo-textile. He discovered that once the soil is reinforced with a single layer, the enlargement quantitative relation decreases and continues to decrease as the number of reinforcing layers increases. This decrease is crucial only in the case of jute geotextile and marginal in the case of geogrid, indicating that the insertion of reinforcement regulates soil swelling. As the number of reinforcing layers increases, so will the soil's quantitative relation value in the United States. Although geo-grid is more effective at strengthening than jute geo-textile, it is nevertheless profitably used in low-value road projects.

The report on the stabilization of soil of Indian origin was examined by Chander Bhal Roy (2015). There is a lot of interest in using these nonhazardous wastes to reduce the detrimental effects of these depositions and to improve property development. Scrap tires are being produced and stockpiled in vast quantities, posing a rising threat to the atmosphere. The possibility of using rubber from old tires in various technological projects has been researched for more than 20 years. Tyre trash is used as a lightweight material in the form of chips, powder, slices, and whole tires. Tire rubber applications have attempted to be successful in safeguarding natural resources and the atmosphere. They are employed both underwater and above. The use of tires is mostly fenced shredding, metal reinforcing removal, and more shredding until the necessary elements are obtained. An automobile tire includes about 26 atomic numbers. In the meantime, Bharat is producing one hundred thousand MT of recycled rubber, which is sold out, at a cost of Rs 70 per metric weight unit. This is the 47th natural rubber unit of caoutchouc.

D.S.V. Prasad et al. (2010) prepared a model of a versatile pavement that included a zero-meter-deep subgrade of expansive soil that was compacted into ten layers and two layers of gravel sub-base that were each 0.07 meters thick and used a layer of different reinforcing materials, such as Geo-grid, hydrocarbon-coated chicken mesh, and hydrocarbon-coated bamboo mesh for reinforcement. Waste plastic and tire rubber were mixed evenly throughout. The sub-base material was ordered for those two WBM-II layers, each with a compacted thickness of 0.075 meters. The cyclic plate load assessment was used to determine the best type of reinforcement for multifunctional pavement. It was discovered that the availability of a completely new reinforcing material caused the overall and elastic deformation values of the flexible pavement system to decrease. The geo-grid reinforcement has the highest load bearing capacity and the lowest rebound deflection compared to the other reinforcement. The author's work primarily focuses on using geo-grid in conjunction with other reinforcing components, such as waste plastic, bamboo mesh, and chicken mesh. Therefore, the data obtained do not appear to provide a clear picture of how reinforcing elements contributed to the sub-base's strength advancement.

Geo-grid reinforcement is used by Evangelin Ramani Sujatha et al. (2012) to strengthen poor soil. The author carried out research in California. Conducting quantitative relation tests on soil in single, double, and triple layers with geo-grid inserted at completely various depths inside the sample, it was shown that the geo-grid performs best in the single layer when it is positioned two thirds of the way from the bottom. and located that the Calif. Geo-grid reinforcement applied in an extremely single or multilayer to the sub-grade will increase the strength of the soil and thereby reduce the thickness of the pavement, even though the quantitative relationship worth of three layers of Geo-grid is less than that of two layers. Nevertheless, over a single layer, Geo-grid will increase the strength of the sub-grade soil in both soaked and unsoaked conditions.

Ghate Sandeep Hambirao (2015) gave instructions on how to use waste-cut rubber tire clips for soil stabilization. It is considered dangerous to build an engineering structure on soft or weak soil. A variety of ground enhancement methods will be used to increase the bottom's capacity to support loads. Cut rubber from trash may be used as cement and reinforcing material in the gift investigation since the binding agent was randomly encased in the soil at three completely distinct fiber content levels, namely five-hitter 100% and 15 August 1945 by soil weight. The strength of the soil reinforced with randomly sliced rubber tires has been the main focus of the discussion. The samples underwent unconfined tests and quantitative relation testing in California. The shear strength and bearing capacity characteristics of the investigated soil are unquestionably present in the routes. To improve transportation performance, Hossein Moayedi et al. (2009) add geo-grid reinforcement to asphalt roads. In his experimental work, he provides geo-grid reinforcement at three completely different locations (i.e., zero.5m, 0.25m, and at zero.05 from very cheap of the model). He found that most shear stress and traditional stress will increase once the geo-grid is placed at a distance of zero.5m from very cheap. He also found that the vertical deflection beneath the center of the load decreases with the use of geo-grid just below the asphalt layer, indicating that the effectiveness of the geo-grid is further enhanced once The placement occurs at a low cost for the asphalt concrete, contingent upon the maintenance of an effective bond between the asphalt concrete and the geo-grid. The author employed the FEM model for AC pavement but did not provide any analytical correlation for the results obtained. The author has not conducted tests on sub-grade soil, nor has the exploitation tests, such as the California Bearing ratio, been verified through experimentation.

The study conducted by IJATRME in 2015 utilized cement as an additive alongside copper dross to evaluate the properties of black cotton soil. Black cotton soil, one of the soil types found in India, occupies an area exceeding three lakh square kilometers. In India, black cotton soils are classified as expansive soils due to their tendency to swell upon water absorption and shrink upon evaporation. The foundations of structures constructed on these soils undergo stress due to the cyclical expansion and contraction. For each heap of metal produced, approximately 2.2 heaps of slag are generated.

Copper dross, which is produced during the process of assembling copper from the copper ore, comprises materials such as iron, corundum, quicklime, silica, etc. Such dross's marketing and disposal lead to problems in the home and environment. In order to reduce the swelling of expansive soils, copper dross is applied. Copper dross may be exploited as artifact materials in this article. Cohesive bond developments in a highly cement-stabilized copper dross cushion are intended to prevent heaves. The survey's analysis suggests a solution to the widespread soil heave issue. It also partially addresses the issue of copper dross and disposal.

J.G. In Milam Country, Texas, Zornberg et al. (2009) offered his field knowledge of pavement over vast soil. The pavement section's in-depth longitudinal fracture network was identified. It was considered to use reinforcement by applying a layer of geo-grid at the interface between the sub-grade and the bottom, followed by an asphalt seal coat on top and a sub-grade treated with lime. To assess the effect of geo-grid, two geo-grid reinforcement sections were constructed in addition to a controlled (unreinforced) section. In contrast, testing using a falling weight deflectometer (FWD) was done to measure the pavement's performance. According to a visual examination of the pavement, the management portion developed longitudinal cracks in a very little quantity everywhere, but the two geo-grid-bolstered sections performed well and showed no signs of longitudinal cracking.

Research on the usage of construction and demolished trash was carried out by Kumar (2015). The construction and dismantled waste matter must have a gradation according to IRC. Alternatively, it should be used as soil when testing on leach ability, sturdiness, and unconfined compressive strength. He concluded that bricks, concrete, tiles, and other materials are also used for mechanical stabilization of extremely poor soils by adding additional cementatious materials or business stabilizers authorized by IRC. This type of blend of components is also used to stabilize bad soil on its own, in combination with other sensible soils, or with the right additions when the results are adequate. According to the updated IRC, the unconfined compressive strength that is produced must be 0.88 MPa for sub base and 1.75 MPa for base coarse.

Kumrawat (2014) conducted an applied laboratory investigation on the effectiveness of black cotton soil treated with stone mud and carbide residue (CCR). By combining stone mud and carbide residue (CCR) in varying amounts with Mary soil, they are prepared to examine the sample. They carried out a variety of investigations, including UCS and cosmic radiation. According to the examined sample, the mixture of equal amounts of stone mud and carbide residue (CCR) (10%–10%) is less complicated than the combination of stone mud and carbide residue alone in terms of the predominant swelling behavior of black cotton soil.

A replacement-style approach for useful road sub-grade exploitation geo-grid reinforcement was developed by Mihai Iliescu and Ioan Ratiu (2012). They concluded from their trials that geo-grids will enhance the sub-grade soil's performance. In order to validate the trial findings and the membrane theory of Giroud & Noiray, they conducted extensive static and dynamic plate bearing tests under a variety of scenarios. They also created style graphs for multifunctional geo-grids in temporary and unpaved roads. A laboratory California Bearing magnitude relation analysis was conducted by Mayura Yeole and Dr. J.R. Patil (2013) on granular soil that was layered in one or two layers within the mold, whether or not it included geotextile. The maximum California Bearing magnitude relation was at 25 mm when the single layer of geo-textile was positioned at a depth of 25, 50, and 100 mm from the top of the mold. When the geo-textile was positioned in two layers, the California Bearing magnitude relation was multiplied, reaching its maximum at 25 and 75 mm. This resulted in a 37.21% increase when compared to the California Bearing magnitude relation of no geo-textile.

N. Vijay Kumar (2014) discussed the characteristics of plastic composites reinforced with business waste (slag). Industries generate a significant amount of rubbish, which they then pile on top of the soil to cause issues for the state and the environment. The US is forced to look for picks by laws and government rules. In order to strengthen the composites, researchers attempt to use these wastes. A related industrial waste that is reinforced in plastic composites is called dross. The stick has been used to investigate the compound composites' wear and friction characteristics. The classic masses and slick speeds are intentionally targeted for damage, wear and tear, and friction. The result's graphical representation shows that weight loss decreases as load increases while weight loss increases in tandem with an increase in slippy speed.

Gh and Omid Azadegan. In order to determine the impact of geogrid applications on the geotechnical behavior of lime/cement treated soil used as base, sub-base, or structural foundation materials, R. Pourebrahim (2010) investigated the effects of geogrids on the compressive strength and modulus of the soil. A study on compressive treated soil samples with or without geo-grid layers found that facet deformation of the cylinder decreases as the modulus of snap and cohesion, which are produced by the pozzolanic reaction of cement and lime, increase by an associated degree. This, in turn, reduces the strain created in the reinforcement and the confinement forces.

Singh Pradeep and K.S. In order to determine the best location for geo-grid reinforcement in sub-grade soil, Gill (2012) conducted experiments in California. bearing unconfined compressive check and quantitative relation check. In California, he discovered that adding geo-grid reinforcement at zero.2H from high produced a significant improvement. quantifying the sub-grade soil's value and stress-strain behavior.

In their investigation into ground improvement methods, Rakesh Kumar and P.K. Jain (2013) discovered that the formation of granular piles in expansive soil enhances the soil's capacity to support loads. Through laboratory model testing, they also developed a trial to investigate the development of load carrying of granular piles with and without geo-grid incasement. They found that adding geo-grid to the pile will boost its load carrying capacity.

The findings of the plate load examination on fiber-reinforced cohesive soils are reported by Rabindra Kumar (2015). This report examines the load settlement response from three plate tests (0.3 m x 0.3 m sq., 25 metric linear units deep) conducted on a thick, solid layer of cohesive soil that has been compacted and reinforced with randomly distributed plastic and fiber fibers, as well as on constant soil that has not been reinforced. When the soil fiber layer was subjected to relatively high pressures during the plate load examination, the reaction seemed to be stiffer than that of the bolstered stratum. Plate load experiments have shown that the bolstered soil settles more than the bolstered soil below a chosen load, with the soil reinforced with plastic fibers exhibiting the lowest settlement. The ultimate word load for the unreinforced soil is 42 KN, whereas the values for the soil reinforced with plastic and fiber fibers are 70 and 80 KN, respectively. Therefore, in comparison to unreinforced soil, the ultimate word load of the soil reinforced with 0.8% fiber fibers and 0.5% plastic fibers will rise by a factor of 67 and 90. Before failing, fiber-bolstered soil may withstand a significant amount of strain energy. As a result, soil fiber may also be utilized as an enhanced material in geotechnical engineering.

S. Naeini, A., and R. In their research, Ziaie Moayed (2009) prepared three types of soil samples with radically varying clay proportions in California. In one or more layers, bearing quantitative relation tests were conducted with or without geo-grid reinforcement. The outcome demonstrates that a rise in the physical property index lowers the Calif. possessing a numerical relationship value in both drenched and unsoaked conditions. California. Victimization geo-grid reinforcement in two layers may greatly increase the bearing quantitative relation as compared to unreinforced, but it is less valuable when compared to a single superimposed reinforcement. There is a significant rise in California when geo-grid is installed at layer two. In both drenched and unsoaked settings, bearing quantitative connection worth compared with unreinforced soil. In unsoaked California, two layers of the geogrid were victimized at layers one and three. The value of bearings will be higher than that of unreinforced soil. Nevertheless, this increase is far smaller than what would occur after Geo-grid is installed on layers a and two. And the wet California. The value of the bearing quantitative relation is higher than the value of each geogrid layer alone. It's important to understand that the author brought up the outcome of PI in combination with geo-grid, which does affect California. having a quantitative relationship. Perhaps this could explain why, under consistent Geo-grid conditions, wet and unsoaked samples produced entirely different findings; moreover, the soaked state is prevalent in the field. Therefore, more experiments must be conducted to ensure the outcome.

Chauhan et al. looked at how well fiber reinforcement—both synthetic and coir—affects the strength of subgrade soil. Because of its greater coefficient of friction, coir fiber had a more robust reaction when compared to synthetic fiber. At a confining pressure of 25 kN/m2, the axial stress at failure rose from 720 kN/m2 (for the unreinforced specimen) to 990 kN/m2 when the sample was reinforced with synthetic fiber and to 1180 kN/m2 when the sample was randomly reinforced with coir fiber. Resilient strains were 0.3% and 0.32%, respectively, using coir fiber reinforcement.

Reinforced fly ash was the subject of a research by Kumar and Singh [84] to examine the composite as a subbase material. Conventional fly ash metrics, including unconfined compressive strength, modulus of elasticity, shear strength, and California bearing ratio, were shown to be impacted by the addition of polypropylene fiber (0.1–0.5%). It was discovered that fiber reinforcing improved the strength at failure; at aspect ratio 100, it rose from 162 to 243 kPa with a 0.1–0.4% increase in fly ash fiber content. At a specific aspect ratio, it was discovered that the CBR of fly ash rose as the proportion of fiber content increased. However, increases in CBR values were greater up to 0.3% fiber content, after which they decreased for both wet and unsoaked CBR instances. According to the findings, fly ash may be used as subbase if propylene fiber is used for reinforcement.

Research by Abu and Jaladurgam [88] examined the reaction of fly ash and plastic waste mixtures and their application in road building. Numerous testing were carried out, including classification tests, compressibility tests, unconfined compression strength tests, consolidated undrained (CU) tests, and CBR tests. The maximum undrained cohesion rose from 15 kPa for 0% plastic waste to 24 kPa for 1% plastic waste, according to the UCC test findings.

According to Mehndiratta et al. (1993) and Patel (1990), a typical mold with a diameter three times that of the plunger is insufficient for determining the CBR value since the tiny size of the mold will provide the geotextile more confinement. As a result, the mold's diameter is raised to five times the plunger's. Additionally, the mold plunger diameter ratio (D/d) is changed from 2 to 5 to assess the impact of lateral confinement on the CBR value of reinforced soil, but the vertical pressure (surcharge), specimen thickness, and compaction technique remain unchanged from the normal test.

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III. CONCLUSION

Geogrids offer a promising solution for improving the performance of flexible pavements. By enhancing load distribution, stabilizing the soil, and reinforcing pavement structures, geogrids contribute to the long-term durability and cost-effectiveness of roadways. While there are challenges associated with their use, such as installation complexity and material costs, the advantages of geogrid-reinforced pavements are clear, particularly in areas with weak subgrade soils. Continued research into their long-term performance and further innovation in geogrid materials will ensure that they remain a vital component in the design of sustainable and efficient flexible pavements.

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