# Case Studies On Geosynthetic Concrete Use

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***Abstract-*** *Geosynthetic concrete, or concrete canvas, is a groundbreaking development in civil engineering materials that brings together the strength of concrete with the flexibility and convenience of geotextiles. This new composite material is a fabric infused with dry concrete mix, which, upon hydration, sets to create a tough and resilient layer of concrete. The technology has many benefits over traditional concrete construction practices, including quicker installation, less labor, little equipment needed, and greater durability, particularly in distant or environmentally fragile locations.*

*This research investigates the structure, functionality, and different uses of geosynthetic concrete. The article describes the process of installation, highlighting the importance of hydration and curing in developing maximum strength and durability. In addition, the paper contrasts geosynthetic concrete with conventional concrete solutions in mechanical properties, environmental performance, and economic effectiveness.*

*Applications of geosynthetic concrete range across various fields such as slope protection, ditch lining, erosion control, culvert repair, and military applications, highlighting its versatility and flexibility to harsh environments. The study also presents case studies illustrating successful application and performance testing, confirming its usability and long-term reliability.*

*In summary, geosynthetic concrete comes across as a cost-effective, eco-friendly, and high-performance option in contemporary construction. Its application not only accelerates construction schedules but also reduces environmental disruption, making it a first-choice option for fast and durable infrastructure development.*

***Keywords***- Geosynthetic Concrete,Concrete Canvas, Reflective Cracking, HMA Overlay,Erosion Control.

## I. INTRODUCTION

The field application of geosynthetic concrete, also known as concrete canvas, has picked up major steam over the last few years as a result of its quick deployment, versatility, and lower environmental impact.

As a hybrid material in which the structural advantage of concrete is combined with the flexibility of geotextiles, geosynthetic concrete is being adopted more and more on civil engineering projects all around the globe. Its performance has been especially remarkable in situations demanding rapid, long-lasting, and low-maintenance solutions—like slope stabilization, erosion control, drainage channels, and emergency repairs to infrastructure.

This chapter includes a series of case studies that illustrate the actual field performance, challenges, and advantages of employing geosynthetic concrete in various geographical and functional environments.

These researches seek to determine how this new material acts under varying conditions, contributes towards sustainable construction, and presents cost-saving options compared to traditional construction.

Identify the constructs of a Journal – Essentially a journal consists of five major sections. The number of pages may vary depending upon the topic of research work but generally comprises up to 5 to 7 pages. These are:multi-label learning, more than one class can be assigned to an instance. With the increase in the number of data

## II. LITERATURE REVIEW

1) Most HMA overlays develop early cracking patterns resembling the cracking pattern in the old existing pavement. New surface cracking in the overlay results from the overlay's failure to resist shear and tensile stresses generated by localized movements around preexisting cracks in the existing pavement.
2) This movement can be a result of traffic loading creating differential deflections at cracks in the underlying pavement structure, expansion or contraction of subgrade soils, expansion or contraction of the pavement itself because of temperature changes, or combinations of these occurrences. Pavement movement, created by any one of the aforementioned causes, induces shear and/or tensile stresses in the new overlay.
3) When such stresses become more than the tensile or shear strength of the HMA, cracking takes place in a new

overlay. Such spreading of a current pattern of cracking from old pavement to and through a new overlay is referred to as reflective cracking. Reflective cracks in HMA overlays have been a worldwide concern for several decades. Even though reflection cracks tend not to lower the structural capability of a pavement, subsequent penetration of water and influence of the natural environment and traffic can result in premature distress and even failure of the pavement.

4) Numerous treatments have been attempted over the years to prevent reflection cracking; none have succeeded. Yet, certain treatments have revealed notable delays in the occurrence and diminutions in the quantity and severity of reflective cracks. Among the newer and more successful products are geosynthetics. Geosynthetics used for HMA overlay reinforcement to prevent reflective cracking are considered in this literature review.
5) In March 2000, Carver and Sprague (2000) had concluded that asphalt reinforcement technology remains relatively new, and the target pavement problems are sophisticated. Specific determinations of performance and economic advantages will not be available until experience is gained and actual performance is contrasted with that anticipated by design and analysis methods currently available.
6) Lytton (1989) noted that, whenever a load travels over a crack in the existing pavement, three pulses of high stress concentrations are produced at the crack tip, as it extends upward through the overlay. The first stress pulse is a maximum shear stress pulse. The second stress pulse is a maximum bending stress pulse.
7) The third pulse of stress is once again a maximum shearing stress pulse, but this time in the reverse direction to the first pulse of shear. Additionally, due to the presence of often an air space underneath the previous surface,
8) the maximum shearing stress as the load at point C will generally be greater than the same when the load is at point A. These stress pulses take place in an extremely brief amount of time, on the order of 0.05 second. At these high loading rates, the asphalt concrete stiffness in the overlay and in the existing pavement is highly high. Pavement movement causes a small increase in crack length in the overlay. As loadings increase, the degree of movement increases, crack growth rate increases, and overlay reflection cracks develop quickly at the surface of the pavement

## III. LABORATORY PROCEDURES

The laboratory study was undertaken to establish data to assist in the assessment of the comparative merits of available commercial geosynthetic materials to mitigate the severity or postpone the occurrence of reflective cracking in bituminous overlays caused, at least in part, by thermally caused stresses. The present chapter outlines the methods adopted for fabricating and testing HMA test beams containing the geosynthetic materials. Each beam was made in a uniform manner with a TxDOT Type D HMA obtained from a local manufacturing facility. supplies the job-mix formula (JMF) detailing the mixture design. Six geosynthetic material types were obtained from material suppliers and are identified in Table 1. In general, the laboratory testing was conducted as follows. A 1-inch HMA "level-up" mix was compacted and cured in the mold for at least 24 hours at ambient temperature.
A geosynthetic material was placed over the level-up course with the use of AC-20 asphalt cement provided by Gulf States Asphalt Company according to the tack coat rate recommended by the geosynthetic manufacturer. Once the material had time to set overnight and achieve maximum adhesion to the level-up course, the last "overlay" course of HMA was compacted in two 1-inch lifts. The final compacted beam size was 3 inches high by 6 inches wide by 20 inches long. Six beams were geosynthetic-reinforced, and the seventh unreinforced beam served as the "control" beam.

**Table 1:**Geosynthetic Materials Selected for Testing.

**Table 1.**Sample Comparison

| Product | Manufacturer | General Description |
|---|---|---|
| Bitutex Composite | Synteen USA | Woven/Coated Polyester Grid/Nonwoven Composite |
| Pave-Dry 381 | Synthetic Industries | Polypropylene Nonwoven Fabric |
| PetroGrid 4582 | Amoco Fabrics | Woven/Coated Fiberglass Grid/Nonwoven Composite |
| HaTelit C40/17 | Huesker | Woven/Coated Polyester Grid/Nonwoven Composite |
| GlasGrid 8501 | Bayex, Inc. | Woven/Coated Fiberglass Grid |
| StarGrid G+PF | Luckenhaus N.A. | Woven/Coated Fiberglass Grid/Nonwoven Composite |

### 3.1.Material Selection

For this test, researchers chose six geosynthetic products to study their impact on the crack propagation rate in a compacted bituminous mixture. There are several different terms that describe or classify geosynthetic products. Overall, the industry consists of producers that manufacture grids, fabrics, and/or composites. The researchers choose the material on the basis of the objective of covering these three categories of products that are currently claimed to delay or prevent reflective cracking in HMA overlays. The geosynthetic materials chosen and evaluated are tabulated along with a general description of the materials used to manufacture the products. These materials included two fiberglass grid composites, two polyester grid composites, one fiberglass grid, and one polypropylene nonwoven fabric. includes sample identifications for these materials as well as recommended tack coat rates from their respective manufacturers

**Table 2.**Sample Identifications and Manufacturers Recommended' Tack Coat Rates

| Product | Sample Identification | Recommended | Recommended TackCoat Rate (gal/yd2) | Weight of Tack Coat (grams) | Tack Coat Temperature (deg F) |
|---|---|---|---|---|---|
| Bitutex | B | 0.25 | 87.6 | 300 | Bitutex |
| Pave-Dry 381 | PD 3 | 0.20 | 70.1 | 300 | Pave-Dry 381 |
| HaTelit C40/17 | HC | 0.10 | 35.1 | 300 | HaTelit C40/17 |
| PetroGrid 4582 | PG 2 | 0.23 | 80.6 | 300 | PetroGrid 4582 |
| Control Beam | C | None | N/A | N/A | Control Beam |
| StarGrid G+PF | S | 0.25 | 87.6 | 300 | StarGrid G+PF |

### 3.2. Hot-Mix Asphaltic Concrete

To expedite preparation of the test beams and to maximize test beam uniformity, approximately one ton of Type D HMA concrete was acquired from a local supplier in the Bryan District of the Texas Department of Transportation. The JMF detailing the Type D mixture design.


**Figure 1:**Uneven Coverage Using MS-1 Emulsified Asphalt Applied to Sample Beam C-20A with the HaTelit C40/17 Composite Product.


**Figure 2:** To Sample Beam C-3A with the Pave-Dry 381 Fabric.


**Figure 3:**Top 2-Inch Overlays from Failed Beams Containing

Researchers conducted regular assurance tests on HMA samples from the control beams and compared against the JMF. The tests involved bulk specific gravity, rice specific gravity, asphalt extraction, bitumen content, and dry sieve analysis. presents results of these laboratory tests. HMA mix was acquired from a plant production and placed into40 five-gallon metal containers and closed with metal lids that have rubber gaskets. These containers were marked from 1 to 40, in the sequence that they were taken, thenstored for later use. Each can had enough material to make one beam with the following dimensions: 3 inches in height by 6 inches in width by 20 inches in length. Beam identification numbers include the container number from which the sample was compacted. Beam B-5, for instance, was built utilizing Bitutex Composite with material taken from container number 5. Similarly, beam PD3-6 was built utilizing Pave-Dry 381 from container number 6, and so on. Randomity was applied in choosing the containers from which to fabricate beams. provides the containers utilized to make HMA specimens of various geosynthetic materials.

## IV. RESULTS AND DISCUSSION:

This chapter has presented basic engineering fracture mechanics and the elastic-viscoelastic correspondence principle as analytical tools for describing the nonlinear viscoelastic behavior of HMA materials. A sequence of these ideas results in the formulation of pseudo displacement equations that,

when graphed against measured loads from the TTI Overlay Tester, can be employed to determine values of the pseudo J-Integral. This chapter has also shown that the pseudo J-Integral may be employed in a modified form of Paris' Law to determine the rate of crack growth in HMA materials.

The following applies the equations developed in this section to reduce asphalt fracture data obtained with the TTI Overlay Tester. The crack propagation characteristics treated in this chapter will be calculated.

As will be demonstrated, data reduction results in the creation of a reinforcing factor that describes the reinforcing performance offered by the geosynthetic materials.

## V. CONCLUSION

The authors performed a thorough literature review of geosynthetics studies to mitigate reflective cracking in bituminous overlays, as well as a formal TxDOT district engineer survey and an informal survey of some other knowledgeable individuals across the country.

Mechanistic lab testing and tests were carried out to study the relative resistance of the three general types of geosynthetics (fabrics, grids, and composites) in preventing reflection cracking in HMA mixes.

Field trials were set up in three places in Texas having very different climatic conditions. A summary of key findings below.

Following a review of the literature, observation of behavior observed during HMA fabrication and testing of specimens, and fractal analysis of the fracture data, the conclusions to be made in the following items seem appropriate.

Control beams were prepared with and without an asphalt tack coat (0.05 gal/yd2) between the overlay and level-up course. Contrast the number of load cycles to failure of these specimens to show that a thin tack coat doubled the number of load cycles by 131 percent.Thus, in conventional overlay

examination of the crack growth regression coefficients, d and e, in Equation, indicates that smaller values of d indicate a smaller initial crack growth because d is the distance that the crack propagates into the overlay in the first load cycle.

the coefficient, is the gradient of the curve of log C against log N and a reflection of the crack growth rate. Low values of e mean that crack growth occurs at low rates.

Thus, an indication of each geosynthetic's relative performance can be made by comparison of crack growth regression coefficients.

Longer overlay lives can be achieved using low d and e values. Also, long-term crack growth reduction is more sensitive to the coefficient With each beam tested, the d value was below .

the level of geosynthetic material in the specimen, meaning the crack stopped at the level of that material. Higher values of load cycles to failure occurred with lower values.

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