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Recovering the Pan American road in area of Chiriqui in Panama with geosynthetics, using fiberglass geogrid.

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1. ABSTRACT

The application of geogrids for asphalt layers in road pavements has been studied since the early 1980s. This type of geosynthetics has as its main objective to mitigate reflective cracking and prolong the life of fatigue, that is, to reinforce asphalt layers within the pavement structure. Until now, many laboratory and field studies have demonstrated significant benefits of using geogrids, but still several aspects of their working mechanism within adjacent asphalt layers are not yet fully understood and should be further explored. This paper shares a recent experience of 2019 in Panama to assess the benefits of using geogrids within asphalt layers. This document presents its use in the Pan-American Highway, the central axis of the country, along 55 km. Although the construction work at the close of this paper continues; It is necessary to develop an official design monitoring procedure for pavements with asphalt fiberglass geogrid layers in Panama.

2. KEYWORDS

Panama, Chiriqui, Panamerican Highway, PRO GEO, MOP, fiberglass geogrid, asphalt, geogrid.

3. INTRODUCTION

The main road axis of the Americas is the Pan-American highway that connects from north to south, interrupted in Panama by the Darien Gap, a serious jungle area threatened. On the border of Panama and throughout the Province of Chiriqui, border province, there is an intense commercial movement of cargo vehicles.

The original section of the Pan-American Highway was built more than half a century ago and the other section of the road was built about 15 years ago. The Pan-American Highway project, section: David – Frontera (Chiriqui) , has a length of approximately 55.1 kilometers, which will be rehabilitated, through the placement of asphalt binder, replacement of concrete slabs, replacement of protective barriers, cleaning of gutters and construction ditches, cleaning pipes and boxes, placement of thermoplastic paint and vertical among others. The work includes the maintenance of 11 pedestrian bridges, in addition to 26 vehicular bridges with sense of David - Border and viceversa. The Ministry of Public Works, MOP, is the state entity in Panama that regulates the use of different construction techniques through its ETG General Technical Specifications. Chapter 40 defines the "Geosynthetic Protector in the Rehabilitation of the Pavement". where it establishes the minimum requirements.

The MOP established that the gaps that could be presented in the Technical Specifications will be supplemented with the content of the Supplementary Specifications and, failing that, with the corresponding standards contained in the A.A.S.H.T.O. (American Association of State Highways and Transportation Officials), A.S.T.M. (American Society for Testing of Materials), A.I.S.C. and other widely accepted North American manuals in the Republic of Panama.

PRO GEO support the MOP and the construction company in the advice and supply during its construction process. The GA100 bi-axial fiberglass geogrid product exceeded the serviceability requirements for which the route would be rehabilitated and that the MOP had proposed. It began with an evaluation of pavements and made replacement of them to those that were necessary. In this case other geosynthetics were used, such as co-extrusion geogrids and geotextiles. The resurfacing work was phased since the length of the road is 55.1 kilometers on a main road in Panama

Figure No.1 Location of Panama in America

Figure No.2 Location of resurfacing work

A tropical, humid and rainy climate in Panama, made rigorous placement techniques, starting with the use of the binder, the leveling folder and the fiberglass geogrid. All geosynthetics product properties are important, however, those that prevail are those that must be controlled in the field during installation for example melting point coating and melting point glass. Providing the correct opening size of the geogrid is essential since together with the design of the aggregate of the asphalt mixture it will achieve better effectiveness and results. In our case 25.4mm x 25.4mm was used.

The hot asphalt mixtures used were both with Superpave and Marshall methodology with thicknesses from e = 5 cm to e = 10 cm. The asphalt irrigation to be used lowered RC-250 will be applied at a rate between 0.25 and 0.70 liters per square meter and its application temperature may vary between 66o C and 107o C. For a cationic asphalt emulsion irrigation, it will be applied at a rate between 1.5 and 2 liters per square meter for an application temperature at room temperature. There were several typical sections of pavement for example from the station of the 5k + 800 to 25k +800 where there were combinations of the asphalt, superpave and Marshall mixtures, and the fiberglass geogrid behaved satisfactorily. The overlap transverse joints 75mm-150mm in the direction of the paver and 25mm-50mm overlapping longitudinal joint were very verified to warranty a good installation. Adhesion test to determine to correct installation were made in few zones. As an experience we recommend regulating the minimum amount per kilometer that adhesion tests should performance.

4. SPECIFIC OBJETIVES

Promote the use of geogrids in the rehabilitation of pavement structures, such as paving and resurfacing.

Expose the example of the use of a geogrid in the project that is in the Pan American Highway David-Frontera, also show the use of the fiberglass geogrid in the resurfacing of one of the runways of the CPA Highway Pacora-24 de Diciembre.

5. HYPOTHESIS

The purpose of this paper is to promote, in a theoretical way, the feasibility of using reinforcement geogrids to avoid and stop reflective cracks, in the bearing layers of flexible pavement structures, in addition to determining that the cost-benefit ratio exceeds the option of fully rebuild a specific section on a route paved
Also show that a partial reconstruction of a pavement structure, without the use of a geogrid, would involve cracking, in the short term, of the bearing layer, thus reflecting the poor condition of the base and sub-base layers.

6. SCOPES

Theoretically show the viability of the use of geogrids in pavement structures, in Panama's own conditions and the behavior of the pavement with the use of this technique in high traffic conditions and subject to overloading. Project, based on the David– Frontera section, the estimated useful life of the intervention performed with this technique.

7. LIMITATIONS

With this paper of using geogrids for the reinforcement of asphaltic overlays, it is not intended to demonstrate the structural contribution. The working mechanism of these geogrids is not clearly stated in specific bibliographies, which will make it difficult to formulate reliable design procedures. The effect of the geogrid cannot be measured in extreme deterioration situations, for example, subsidence due to seismic failures, subsidence due to poor water evacuations, landslides and landslides, among other unforeseen situations.

8. OUTCOME

It is expected with the development of this work to deliver a quick, practical and economical solution, which allows for a longer time to control the progress of cracks or severe cracks in the bearing layer, without these having already affected the rest of the structure, in addition It is intended to provide incentives for this technique to be used and recommended nationally in Panama and Central America.

Table No.1 of Chapter 40 of the General Technical Specifications of the MOP of Panama

MINIMUM REQUIREMENTS OF THE GEOSYNTHETIC IN THE REHABILITATION OF PAVEMENTS IN PANAMA

REQUIREMENTS	MINIMUN	OBSERVATION
Mass per unit area, g/m^2	140	ASTM D 3776**
Tensile strength by grip, N	400	According to ASTM D 4632**
Elongation at break%	50	According to ASTM D 4632**
Asphalt retention liters /m^2	0.90	Texas DOT* Item 3099**
Melting point (oC)	150	ASTM D 276

*Texas Department of Transportation, Manual of Test Procedures.
** At the beginning of the project, the Contractor must supply the type of geosynthetic that will be used with their respective properties, which must be supplied by the distributor of the product.

9. DESCRIPTION Resurfacing costs with and without geogrid

What will be verified below is whether using this geogrid for reinforcement of the section CPA Highway 24 December - Pacora, the cost of a given project will benefit or not with it.

An analysis of the total section measuring 6245 linear meters was made, the width is 8.5 meters, therefore for the periods of 12 and 15 years of design you have in the following tables No.1, No.2, No.3 and No.4.-

Table No.2 Project cost at 12 years without geogrid

Section Length (m)	6245
Section Width (m)	8.50
Thickness of the envelope layer (cm)	10.40
Theoretical maximum (ton / m2)	2.40
Amount of mix to be placed (ton)	13,250
* Price / Ton placed	$115
Total amount	**$1,520,607**

Table No.3 Project cost at 15 years without geogrid

Section Length (m)	6245
Section Width (m)	850
Thickness of the envelope layer (cm)	10.50
Amount of mix to be placed (ton)	13,250
* Price / Ton placed	$115
Total amount	**$1,769,170**

Table No.4 Project cost at 15 years with geogrid

Section Length (m)	6245
Section Width (m)	8.50
Thickness of the envelope layer (cm)	8.50
Theoretical maximum (ton / m2)	2.40
Amount of mix to be placed (ton)	10,830
* Price / Ton placed	$115
Subtotal 1	**$1,24,.805**
Fiberglass geogrid amount to be placed (m2)	**53,082**
Total amount	**$1,769,170**
* Price / m2 of geogrid	**$6.39**
Subtotal 2	**$339,718**
Total amount	**$1,581,976**

Results obtained by including the geogrid for both periods

Table No.5 Project cost at 12 years with geogrid

Section Length (m)	6245
Section Width (m)	8.50
Thickness of the envelope layer (cm)	6.80
Theoretical maximum (ton / m2)	2.40
Amount of mix to be placed (ton)	8663
* Price / Ton placed	$115
Subtotal 1	**$994,243**
Fiberglass geogrid amount to be	**53,082**
Total amount	**$1,769,170**
* Price / m2 of geogrid	**$6.39**
Subtotal 2	**$339,718**
Total amount	**$1,333,415**

When reviewing and comparing the tables, it is observed that the cost of rebuilding an existing pavement structure is much higher than if we use resurfacing with fiberglass geogrids in a preventive and routine manner.

Examples of some typical sections of pavement in the rehabilitation of the road David- Frontera in the following figure No. 3. The decision of the Ministry of Public Works of Panama was important to further boost the use of geosynthetics in the Central American region.

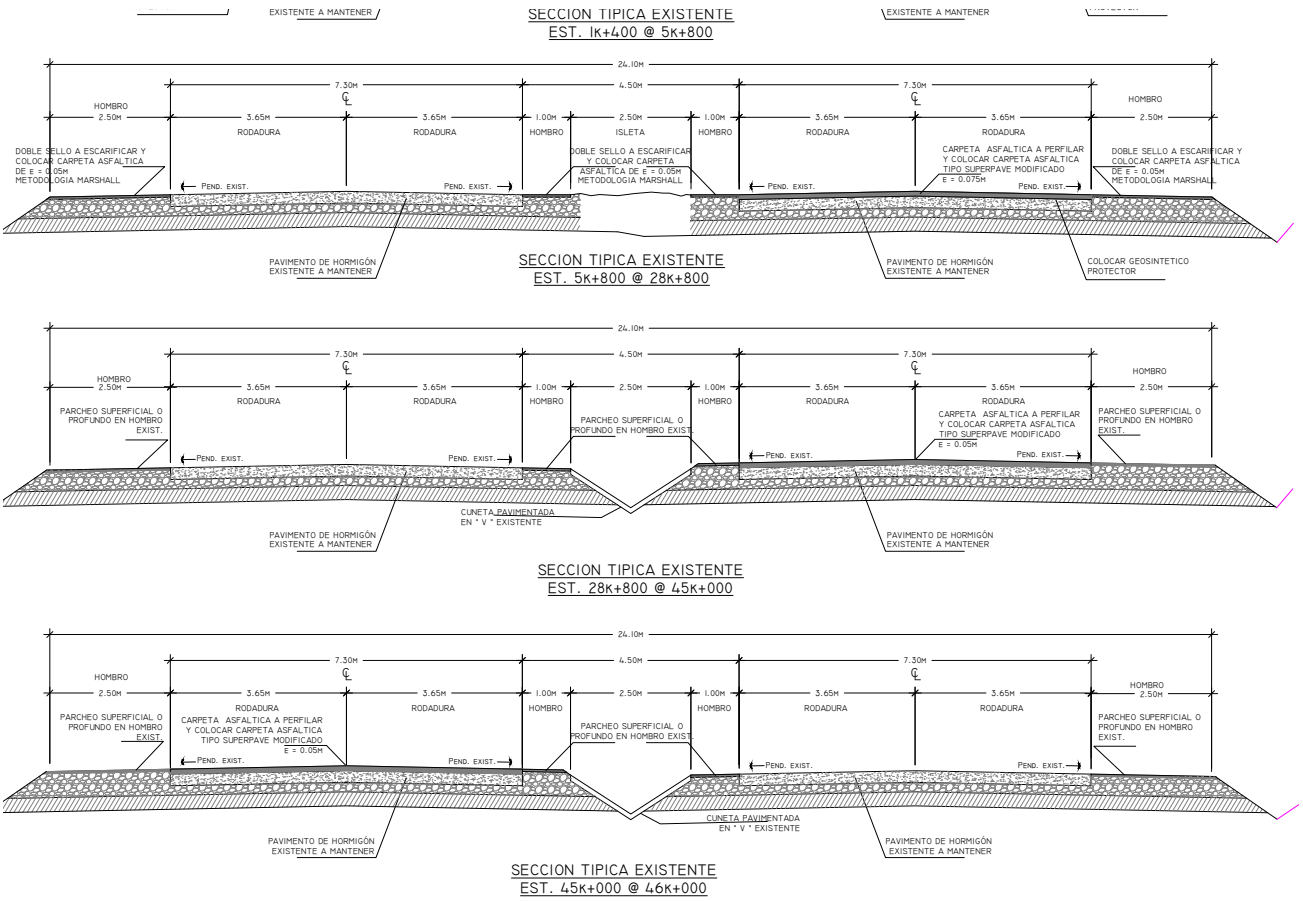

Figure No. 3 Some typical sections of pavement in the rehabilitation of the road David- Frontera

For the installation of the fiberglass geogrid, it was started manually or later mechanically, giving good productivity results.

Figure No.4 Prior to resurfacing

Figure No. 5 Manual placement of the fiberglass

Figure No.6 Fiberglass geogrid 100 KN/100 KN

Figure No.7 After the fiberglass geogrid and new asphalt binder

10. PUNCTUAL CONCLUSIONS

- We observe from the comparative tables that it is more economical to use fiberglass geogrid for resurfacing than replacing slab.
- The Ministry of Public Works of Panama is recommended to have control routes in order to monitor with real statistics the projection of the improvement of the use of signature glass geogrids for resurfacing. There are two examples in this paper, one last and one running.
- A project of this length on a main road is a unique opportunity to have monitoring test sections and validate the experimental results against the field performance, the structural longevity of the rehabilitated pavement sections with fiberglass geogrid by MOP

11. REFERENCES

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