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Geotextile paving fabric for airport rehabilitation works: The Philippine field experience

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ABSTRACT: This paper describes the successful use of reinforced glass paving fabric for Subic international airport runway rehabilitation works in The Philippines which was recently completed. The paving fabric consists of a continuous filament nonwoven needle punched polypropylene geotextile reinforced with high strength glass fiber. The paving fabric was capable of undertaking stress absorption, waterproof barrier and reinforcement. The nonwoven component provides stress absorption and waterproof barrier while the glass fiber provides tensile strength between the new asphalt overlay and the old pavement. Laboratory trial has shown that the use of paving fabric delays cracks propagation of the old pavement reflecting up to the new asphalt overlay. It can extend the design life service of the new asphalt overlay by more than twice (2) compared to the conventional overlays method without paving fabrics. The installation procedure; bitumen selection and the bitumen tanker spray rate of application are the key to the success of the paving fabric application are documented in this paper. An important highlight of this paper is the testing method and procedures used for testing. The adhesion between the new asphalt overlay – paving fabric – old asphalt concrete. Core samples were taken after the resurfacing works showed that the bonding between the old asphalt concrete pavement, paving fabric and the new asphalt concrete acts as a homogeneous layer. To verify the performance of the adhesion between the old asphalt concrete pavement, paving fabric and the new old asphalt concrete, tensile test was carried out on the core samples with and without paving fabric. The tensile test results on core with paving fabric showed excellent adhesion and this validate that excellent bitumen – impregnated geotextile bonding provides its function as a waterproof barrier, high interface shear resistance, stress absorbing membrane interlayer (SAMI) and reinforcement to ensure long term serviceability and performance of the airport runway.

1 INTRODUCTION

The Subic International Airport located in Western Luzon was originally constructed in 1956 as the Naval Air Station (NAS) of the United States Navy. When it was turned over to the Philippine government in 1992, the government created the Subic Bay Metropolitan Authority (SBMA) to administer the facility as part of the special economic zone, the Subic Bay Freeport. The total length of the existing runway was 2,740 meters long and 60 meters wide including 7.50 meter paved shoulders. The pavement at the existing runway touchdown zone area consists of concrete pavement while the middle section was bituminous asphalt concrete which was last rehabilitated in 1995.

In 2004 a major rehabilitation program was carried out by SBMA to rehabilitate the airport pavement which has showed deterioration of joint sealant at the concrete pavement and fatigue cracking at bituminous asphalt concrete pavement. The rehabilitation program was carried based on information obtained from the as-built drawings, reports, studies and evaluation previously prepared for the airport pavements.

LEDFAA (airport pavement design program) computer program was used by the pavement specialist from the consultant team in the modeling two types of rehabilitation treatment works. First option presented to SBMA is the reinforced glass paving fabric + 50 mm Thk. of Asphalt overlay; second option is the conventional design overlay of 75 mm Thk. asphalt pavement base on aircraft traffic studies and gross tonnage. After series of presentation to SBMA regarding the two types of rehabilitation works, two critical factors were taken into account by the SBMA board; the pavement design analysis and the cost implication to the project. The first option carries a greater weighted average against to the conventional design.

The reinforced glass paving fabric consists of a nonwoven needle punched polypropylene geotextile reinforced with glass grid was chosen as the best options for the rehabilitation works as it provides the following functions as a waterproof barrier, stress absorption and reinforcement between the new asphalt concrete overlay and the old pavement. Experience has shown, in order for these functions to be fully utilized, the paving fabric must have optimum physical and mechanical properties, properly installed with a good combination of tack coat, spray quantity and curing time for it to work effectively as a stress absorbing interface and reinforcement of the new asphalt overlay. Both field monitoring and laboratory test has shown that paving fabric can increased the design life of pavement new asphalt overlay compared to conventional pavement rehabilitation technique. Feasibility studies done by the project consultant has shown a saving of more than 28% cost implication in using paving fabric compared to conventional overlay technique in the rehabilitation works.

The rehabilitation works at Subic airbase started in January 2005 involved installation of about 14,500 m^2 of paving fabric under a tight working schedule and was successfully completed in February 2005.

2 PAVING FABRIC PROPERTIES AND FUNCTION

2.1 *Paving fabric properties*

The fundamental purpose of the paving fabric as an individual component in the system is to contain a defined amount of bitumen. Over thirty years of experience shows that the optimum amount of bitumen required within the fabric is 1.0 kg/m^2-1.1 kg/m^2. Less than this quantity reduces adhesion between the old pavement and new overlay and increases the risk of delamination of layers. More than this amount results in “bleeding” and increased risk of rutting of the overlay under heavy traffic.

Therefore the most important property of a paving fabric is its capability to absorb and hold between 1.0 kg/m^2 and 1.1 kg/m^2 of residual bitumen. Spunbonded nonwoven type paving fabrics achieve this property without complication. Additionally because they are manufactured from continuous or endless filaments and reinforced with glass fiber, they exhibit good tensile strength, which is necessary to resist tensile tearing during the asphalting process when the tracks of the paving machine exert great stress directly onto the fabric and also to transfer the high impact traffic intensity. (Figure 1). The properties of the glass paving fabric used at Subic International Airport (SIA) rehabilitation works are summarized in Table 1.

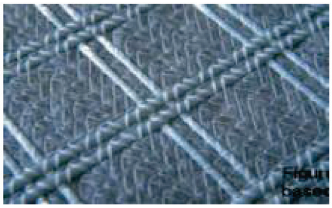

Figure 1. Nonwoven polypropylene geotextile reinforced with glass grid.

Table 1. Properties of reinforced paving fabric geotextile.

Properties	Test method	Unit	Type A
Tensile strength	ISO 10319	kN/m	100/100
Elongation at break Strength at 2% strain	ISO 3341	% kN/m	3 68/68
Mesh width of the glass filament		mm	40 × 40
Mass per unit area	EN 965	g/m^2	430
Asphalt retention	ASTM D 6140	$1/m^2$	1.1
Melting point	ASTM D 276	°C	165
Recycling	100% recyclable		

2.2 *Paving fabric function*

2.2.1 *Sealing function*

The main function of the bitumen – impregnated paving fabric is a barrier to prevent the penetration of surface water and oxygen into the pavement structure. If the sealing effect is not permanent, the penetrations of oxygen will results into ageing of the surface course and subsequent cracking due to brittleness. The infiltration of moisture will weaken the shear strength of the base layer and in time, under traffic loading will lead to rutting and loss of bonding.

Comprehensive laboratory tests carried out by Resource International Laboratories, Ohio USA, have quantified the sealing properties of bitumen impregnated paving fabrics. In the tests, the highest possible maximum hydrostatic pressure corresponding to that of both passenger cars and trucks over cracked road filled with water was applied. In the test the effects of moisture penetration corresponding to a pressure of 276 kPa, equivalent to a car and 517 kPa equivalent to a truck was measured. The results showed a significant reduction in forced moisture and oxygen

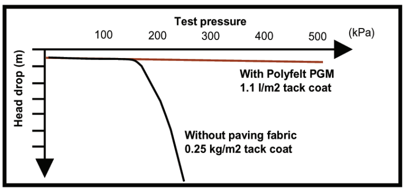

Figure 2. Sealing benefits of paving fabric.

penetration of the asphalt is achieved when bitumen impregnated paving fabric are used.

2.2.2 *Bonding – Reinforcement*
Additional, tests to measure the effects of paving fabrics on the adhesive qualities of bitumen saturated paving fabrics between new and old asphalt layers have been undertaken. This property is critically important when the pavement to be treated is heavily trafficked and the old pavement surface is badly cracked, and in instances where paving fabrics are laid in airport taxiways and runways. To effectively transmit load stress down through the pavement surface layers into the base course the shear resistance at the interface between the old and new overlay must be high enough to prevent shear yielding through stress caused by high impact loading, braking or turning manoeuvres.

2.2.3 *Reflective cracking*
Reflective cracking in a new overlay constructed on an old pavement can be reduced and decelerated by the application of a paving fabric. The bitumen – impregnated and compressible paving fabric act as a stress absorbing membrane interlayer (SAMI) at the bottom of the new overlay. Recently published results of tests conducted at Alun Regional Road Laboratory, France to evaluate the stress absorbing effect of paving fabric showed that bitumen impregnated paving fabric has an essential effect on the crack propagation and retard reflective cracking to a substantial extend. The series of tests evaluated and compared the results of various systems. From the test results, not only is the start of the crack delayed in the system using paving fabric, the life span is increased by 2 times with a bitumen impregnated paving fabric compared with 6 cm asphalt concrete without any paving fabric (Figure 3).

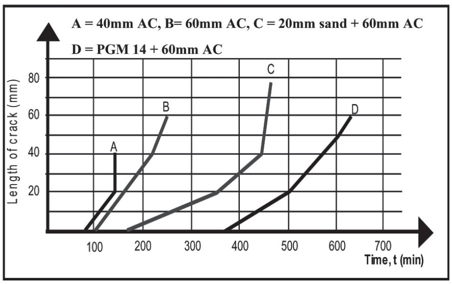

Figure 3. Crack propagation in asphalt concrete pavement.

3 CONDITION OF OLD RUNWAY PAVEMENT

Based from the as built drawings of the 1995 reconstruction works, the strengthened section of the runway pavement at the touchdown zone areas of runway 07 and runway 25 is 30.40 meters wide at the central section with concrete pavement from Chainage 0+000 to 0+461 and Chainage 2+201 to 2+740. The pavement was reconstructed to 440 mm thick using concrete at runway 07 and 455 mm thick at runway 25 on a 100 mm thick cement treated base in 1995. The outer concrete slabs were maintained as per its 1956 construction with a 300 mm thick concrete on a 200 mm coral base. The middle asphalt surfaced section was reconstructed with a bituminous overlay consisting of a variable thickness of bituminous base course and a 40 mm bituminous surface course from Chainage 0+461 to 2+201.

During visual inspection, it was observed that the west and east end sections of the runway on concrete pavement showed deterioration of joint sealants. Spalling on the joints and corner slabs were also noted. On the eastern end, the joints between the 1956 pavement and the 1995 reconstructed pavement has been partially repaired and rehabilitated.

The bituminous surface section at the touchdown zone area of Runway 07 has show signs of fatigue cracks in the center section of the runway along the path of the aircraft gears.

Figure 4. Fatigue cracking of asphalt concrete pavement and spalling and disintegration of joint sealer at concrete pavement.

4 CONSTRUCTION METHODOLOGY

The resurfacing works was carried out with the 50 mm milling of the asphalt concrete pavement only at the centre 24 meters of the runway. It was then cleaned prior to the spraying of 1.1 l/m^2 or 1.1 kg/m^2 pure bitumen AC 80/100 tack coat using a calibrated dispenser truck. The rate is required for optimum absorption of the bitumen into the geotextile and hence to achieve sufficient bonding of the paving fabric to the old pavement. A special installation rig was used for installation of the paving fabric over the pure bitumen tack coat. The rig included mechanism to allow tensioning to be applied to the geotextile and brushed into place over the bitumen to avoid wrinkles developed in the paving fabric. This is important to ensure that the reinforcement function in the paving fabric is fully exploited. A layer of 50 mm stone mastic asphalt (SMA) overlay was then installed immediately over the paving fabric.

Figure 5. Installation of paving fabric with a mechanical rig.

5 PAVEMENT ADHESION TESTING METHOD AND PROCEDURE

5.1 *Testing procedure*

Adhesion tests was carried out on nine number of cored samples from the runway according to ONORM B 3639-2 (1997) Test Standard on Asphalt Road for Road Construction and Related Purpose – Testing – Pull – off Resistance in Contact Surfaces of Asphalt Layers.

Modification was done on the loading plates of the tensile machine to ensure that the tensile force can be applied uniformly over the cored sample of about 95 mm diameter. Both ends of the cored samples were smoothed and glued firmly onto the loading plates. The testing temperature was maintained at 25-27°C as this reflects the working temperature at the ground in South East Asia region instead of the suggested temperature of 0°C in the original German Standard. The tension pull off tests were carried out using displacement rate control with 0.025 to 0.10 mm/min rate, which corresponding to a force loading rate of 10 N/s at the beginning of the test and gradually reduced to about 2 N/s at the peak tension force stage.

5.2 *Results and discussion*

For the samples without paving fabric, all samples failed at the weakest section within the asphalt concrete material. No failure occurred at the glued surfaces. For the samples with paving fabrics, all the failure took place at the interface either between the upper surfaces of the paving fabric of the new overlay or between the lower surfaces of the paving fabric of the old asphalt concrete material.

It appeared that test results of sample with H/D less than 1.1 gave much higher pullout resistance as compared to the test results of sample with H/D > 1.1, due to boundary effect. The average pull-off resistance of the nine samples is 144.82 kN/m^2 with a standard deviation of 46% and is wider than acceptable variation of the test results. However, if the test samples with H/D < 1.1 removed. The average pull-off resistance is 114.20 kN/m^2 with a standard deviation of 17% of the average value. Thus samples with H/D < 1.1 were discarded in the analysis.

The results showed that paving fabrics induced a higher and more uniform bond strength than is achieved with conventional (no fabric interfaced) overlays (Table 2). Correspondingly it is this superior, uniform bonding of layers which improves the effective transfer of traffic stress down through the whole pavement structure, contributing to extended pavement life service.

Table 2. Adhesion test of pavement with and without paving fabric.

Properties	Unit	Without	With
Mean value of adhesive strength	kPa	109.2	117.95
Standard deviation of adhesive strength	kPa	29.31	12.71
Variation of adhesive strength	%	26.84	10.78

Figure 6. Adhesion tests show paving fabrics improve bonding between layers.

6 CONCLUSIONS

The use of a reinforced glass paving fabric with the right selection of tack coat, spray rate and correct installation method was successfully used for the runway rehabilitation works at Subic International Airport, The Philippines.

Core samples taken after the rehabilitation works showed that the old pavement, paving fabric and the new asphalt concrete act as a homogeneous unit. This excellent bitumen – impregnated bond provides its function as a waterproof barrier, high interface shear resistance, reinforcement and stress absorbing membrane interlayer (SAMI) to ensure long term serviceability and performance of the airport runway and taxiway pavement.

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