

# Load settlement behavior of reclaimed asphalt pavement (RAP) reinforced with polymer geogrid

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**ABSTRACT:** Improvement of Reclaimed Asphalt Pavement (RAP) as generally obtained from milling / removal of bituminous layers of existing flexible pavement can be beneficially used as subbase / base course of new flexible pavement construction. Load settlement characteristics of untreated RAP in general are not very encouraging specially when placed over relatively weak subgrade. However, load settlement behavior of RAP can be substantially improved when the same is reinforced with commercially available polymer geogrid. In the present study, laboratory model tests have been conducted on RAP placed over soft marine clay bed having California bearing ratio value of 1.60 % with and without polymer geogrid reinforcement. Non woven geotextile has been used as a separator layer between soft marine clay bed and RAP layer. Biaxial geogrid having tensile strength of 80 kN/m have been used as reinforcement. Geogrid layer has been placed at different levels within the RAP layer to establish the most suitable location for placement of reinforcement to obtain maximum improvement in load settlement behavior. Based on model study it is observed that load carrying capacity of RAP for 50 mm settlement is increased to 1.26 times when RAP is reinforced by a layer of biaxial geogrid and the maximum improvement is observed when geogrid is placed near the top 1/3 depth of RAP layer.

*Keywords: Reclaimed Asphalt Pavement (RAP), Subgrade, Polymer Geogrid*

## 1 INTRODUCTION

Model tests have been conducted in laboratory using a steel tank of 600mm x 600mm x 600mm and 10 T capacity loading frame developed by the Institute. 300 mm thick soft marine clay bed is placed and compacted in layers. A non woven geotextile layer is placed over soft marine clay bed to act as separator. 150 mm thick RAP materials mixed with required quantity of water to achieve optimum moisture content is placed in layers and compacted. A biaxial geogrid is placed as reinforcement at various levels. A 300 mm x 300 mm x 10mm thick loading plate is placed concentrically just above the prepared RAP layer. Load is applied through a loading jack placed against a 10 T capacity loading frame. The schematic Diagram of the test setup is shown in Figure 1.

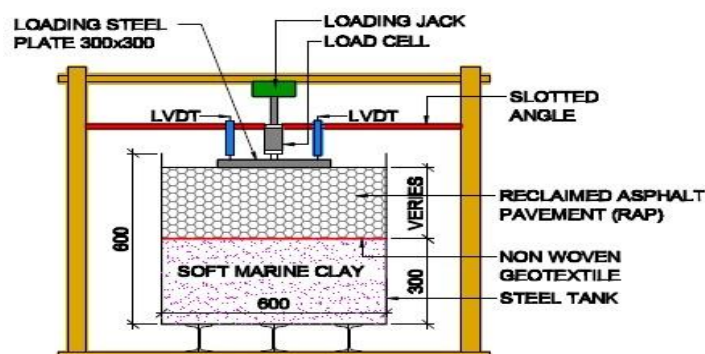


Figure 1. Schematic Diagram of test setup.

## 1.1 Materials

### 1.1.1 Non Woven Geotextiles

STRATA Geosynthetics manufactured 150 GSM non woven geotextile has been utilized as Separation layer between soft marine clay bed and Reclaimed Asphalt Pavement (RAP) materials. The Physical and Strength properties of 150 GSM non woven geotextiles as obtained from its manufacturer (STRATA Geosynthetics) are shown in Table 1.

Table 1. Physical and Strength properties of 150 GSM non woven geotextiles.

Properties	Standard	Unit	Ref. Values	Test values
Tensile Strength	ASTM D4595	kN/m	5.52	4.75
Tensile Elongation	ASTM D4595	%	56.5	45
Grab Tensile Strength	ASTM D4632	N	356	-
Grab Tensile Elongation	ASTM D4632	%	66.5	-
Trapezoidal Tear Strength	ASTM D4533	N	156	-
Mass/Unit area	ASTM D5261	g/m <sup>2</sup>	151	155.5
Thickness	ASTM D5199	mm	1.25	0.895
Puncture Strength (CBR)	ASTM D6241	N	1015	-
Flow Water Rate - 5cm head	ASTM D4491	l/m <sup>2</sup> /s	80	-
Apparent Opening Size (AOS)	ASTM D4751	microns	90	-
Roll Dimensions				
Roll Width	-	m	4	-
Roll Length	-	m	100	-

The testing of 150GSM Non woven textile material and the tensile strength results are shown in figure 2. and figure 3. respectively. From the results, it is observed that tensile strength test results of this non woven geotextile is 4.75 kN/m.



Figure 2. Testing of 150 GSM geotextile.

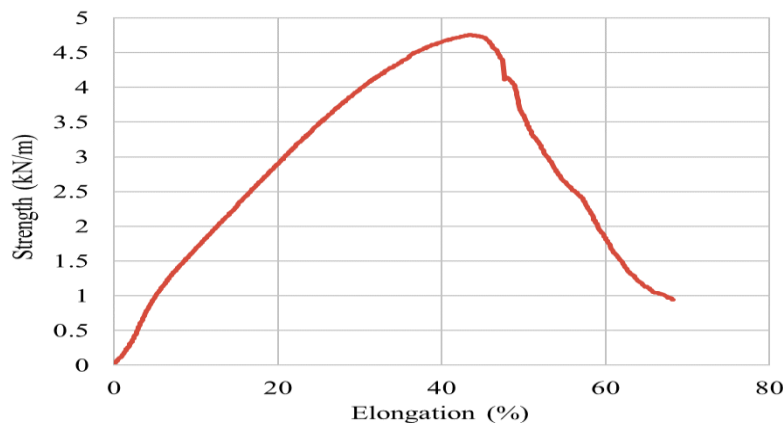


Figure 3. Tensile strength results of 150 GSM geotextile.

### 1.1.2 Polymer Geogrids

Polymer Geogrids of BX 80 manufactured in India by STRATA geosynthetics has been utilized in RAP at various locations for reinforcing the Reclaimed Asphalt Pavement (RAP) in model study. The Physical and Strength properties of BX 80 Polymer Geogrids as obtained from its manufacturer are shown in Table 2.

Table 2. Physical and Strength properties of BX 80 Polymer Geogrids.

Properties	Standard	Test Direction	Unit	Ref. Value	Test values
Roll Dimensions (Width x Length)	-	-	m	3.8 x 100	-
Roll Area	-	-	sq.m	380	-
Product Weight	-	-	g/sq.m	558	746
Weight per roll	-	-	Kg	222	-
Tensile Strength	ASTM D6637	Machine Direction	kN/m	85.5	72.5
Tensile Strength	ASTM D6637	Cross Machine Direction	kN/m	88.1	75.4
Break Elongation	ASTM D6637	Machine Direction	%	17.2	20
Break Elongation	ASTM D6637	Cross Machine Direction	%	14.6	20.8

The BX 80 Polymer Geogrid material tensile strength test set up and the tensile strengths are shown in figure 4. and figure 5. respectively. From the test results, it is observed that tensile strength of this polymer Geogrid is 72.5 kN/m.



Figure 4. Tensile strength test setup for Polymer geogrid (BX 80).

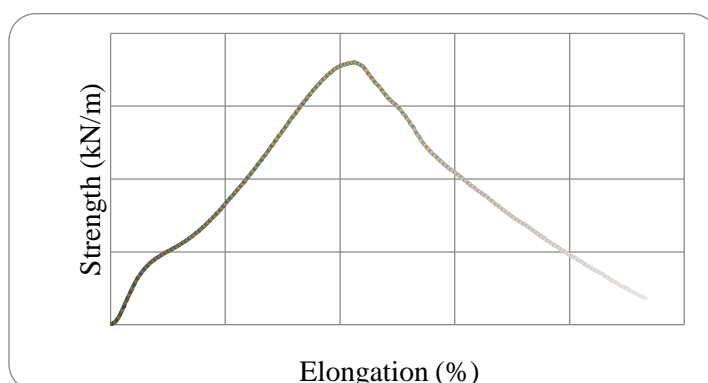


Figure 5. Tensile strength Vs Elongation of Polymer geogrid (BX 80).

## 2 POLYMER GEOGRID REINFORCEMENT IN RECLAIMED ASPHALT PAVEMENT (RAP)

A Non woven geotextile layer is placed over 300mm thick soft marine clay bed. 150mm thick RAP is placed over it in layers of 50mm thick. RAP is thoroughly mixed with adequate quantity of water to achieve optimum moisture content. Polymer geogrid layers are placed at the bottom, 1/3<sup>rd</sup> depth, at the centre and at 2/3<sup>rd</sup> depth of RAP base. Each layer of RAP is thoroughly compacted with modified proctor compaction rammer to achieve 95% of maximum dry density. Schematic diagram and photographs of geogrid placement inside RAP is indicated in figure 6, 7, 8 and figure 9. respectively.

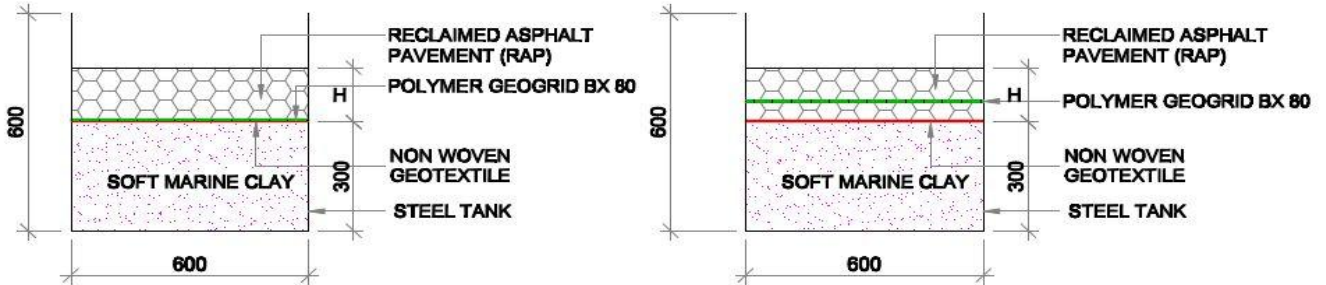


Figure 6. Polymer geogrid (BX 80) placed at Base and 1/3<sup>rd</sup> H.

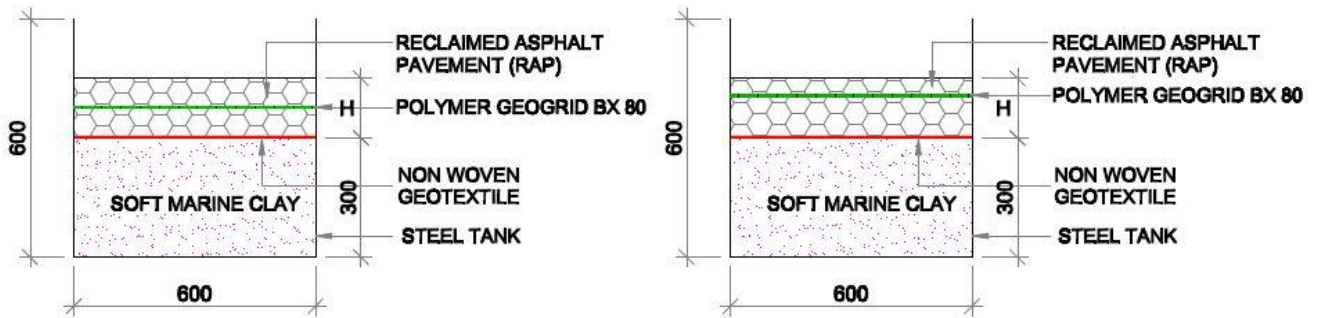


Figure 7. Polymer geogrid (BX 80) placed at centre and 2/3<sup>rd</sup> H.

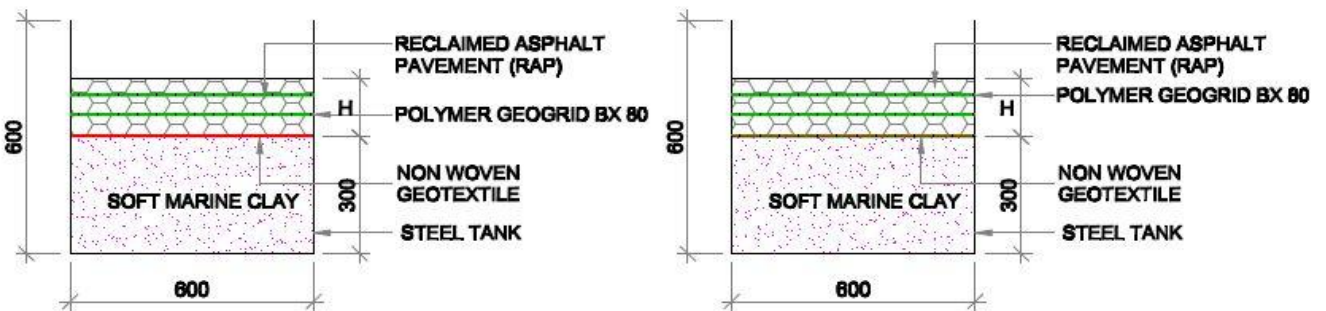


Figure 8. Polymer geogrid (BX 80) placed in 2 and 3 layers.



Figure 9. Polymer Geogrid Placed at RAP Base

### 2.1 Single layer polymer geogrid placed at various locations

Load settlement behavior of Reclaimed Asphalt Pavement (RAP) reinforced with single layer polymer geogrid placed at various locations in RAP layer are indicated in Figure 10.

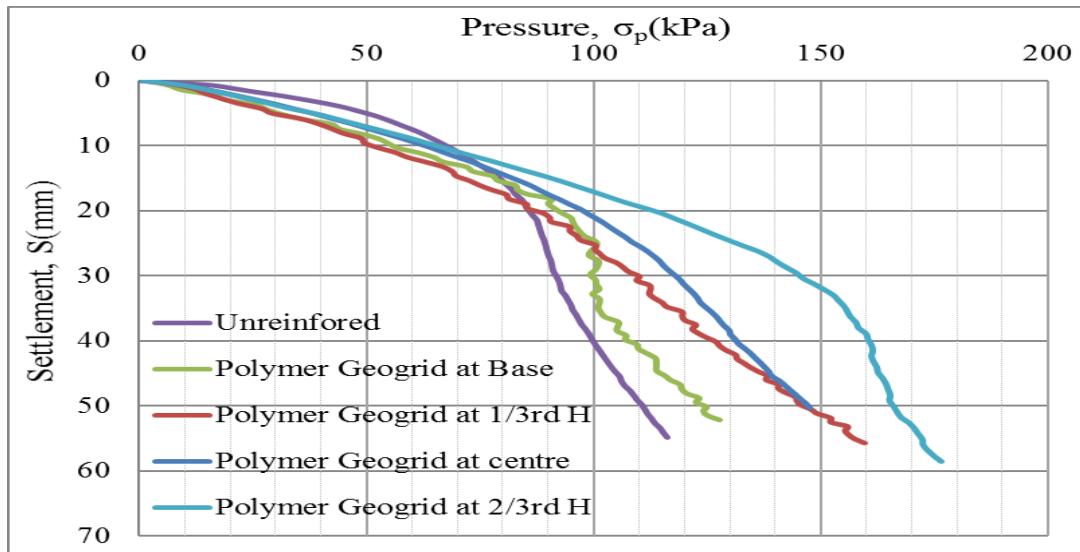


Figure 10. Pressure Settlement for single layer Polymer Geogrid Placed at various locations.

From the Figure.10, it is observed that, the unreinforced 150mm thick RAP layer has a load carrying capacity of 110kPa for a settlement of 50mm and it is also observed that the load carrying capacity is increased by 13%, 31%, 35% and 50% when the RAP layer is reinforced with polymer geogrid reinforcement at base, at 1/3<sup>rd</sup> H, at centre and at 2/3<sup>rd</sup> H from RAP layer respectively.

### 2.2 Polymer geogrid placed in multilayer at various locations

Load settlement behavior of RAP reinforced with single layer, two layers and three layers of polymer geogrid placed in RAP layer are indicated in Figure 11.

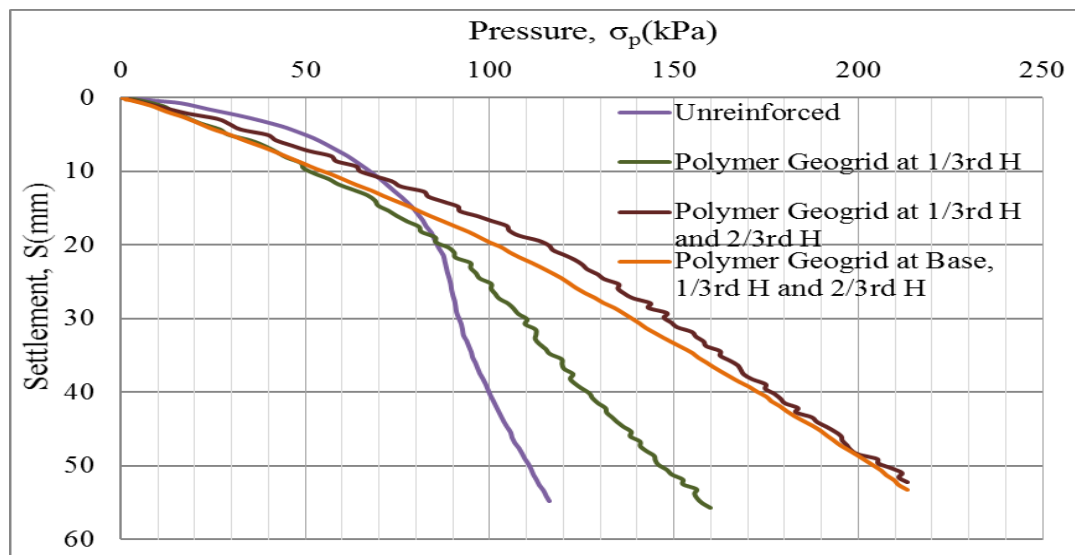


Figure 11. Pressure Settlement for Polymer Geogrid Placed in multilayer at various locations.

From the Figure.11, it is observed that, the unreinforced 150mm thick RAP layer has a load carrying capacity of 110kPa for a settlement of 50mm and it is also observed that the load carrying capacity is increased by 36%, 88% and 89% when the RAP layer is reinforced with polymer geogrid reinforcement at 1/3<sup>rd</sup>H (single layer), at 1/3<sup>rd</sup>H and 2/3<sup>rd</sup> H in 2 layers and at base, 1/3<sup>rd</sup>H and 2/3<sup>rd</sup> H in 3 layers from RAP layer respectively.

### 3 CONCLUSIONS

Based on model testing of Reclaimed Asphalt Pavement RAP over soft marine clay having 4 days Soaked CBR value of 1.6%, the following observations are made:

1. The load carrying capacity of 150mm thick RAP placed over soft marine clay bed is observed as 110 kPa for a settlement of 50mm.
2. The load carrying capacity of RAP is increased by 13%, 31%, 35% and 50% when RAP is reinforced with polymer geogrid placed at Base, 1/3<sup>rd</sup> H, Centre and 2/3<sup>rd</sup> H respectively.
3. The load carrying capacity of RAP base is increased by 36%, 88% and 89% when reinforced with single layer, 2 layers and 3 layers with BX 80 polymer geogrid.
4. RAP reinforced with single layer Polymer geogrid observed to have minimum load carrying capacity when geogrid is placed at base and maximum capacity when placed at 2/3<sup>rd</sup> H from RAP base.

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