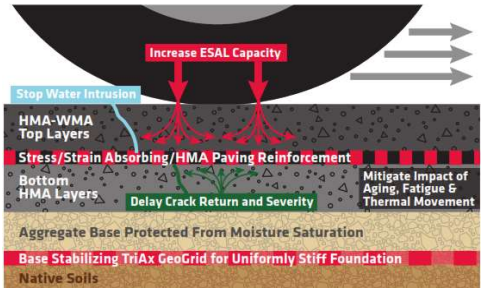
Pavement Reinforcement Products for Improved Pavement Performance



Jordan Rabin – Pacific North Engineering Rep
2019 Idaho Asphalt Conference

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Agenda

- The Basics: What Interlayers are, and Why We Use them
- Problems that Pavement Reinforcement Products Solve / Benefits they Bring
- Independent Verification & Project Examples

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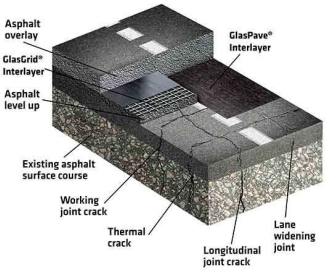
The Basics: What Interlayers are, and Why We Use them

What are Interlayers?

Any material(s) that are used between pavement layers to improve pavement performance.

Functions:

- Moisture barrier
- Reflective crack mitigation
- Reinforcement of asphalt to extend pavement life and loading capacity

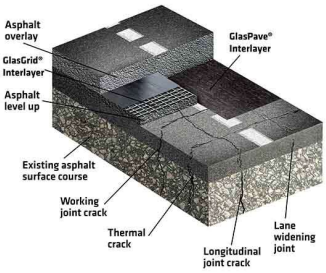


Interlayers ≠ Pavement Reinforcement Products

Any material(s) that are used between pavement layers to improve pavement performance.

Functions:

- moisture barrier
- Reflective crack mitigation
- **reinforcement of asphalt to extend pavement life and loading capacity**



Why are Interlayers Used?

- To reduce maintenance cost and frequency
- To keep up with increased traffic loading
- Some areas just need a little help

To get more life out of your pavement, at a lower cost, over the course of its life

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Building Longer Life, More Maintenance Free HMA Pavements, that Cost Less

OR JUST KEEP MAINTAINING!

Building Longer Life, More Maintenance Free HMA Pavements, that Cost Less

OR NOT!

When Aren't Interlayers be Enough?

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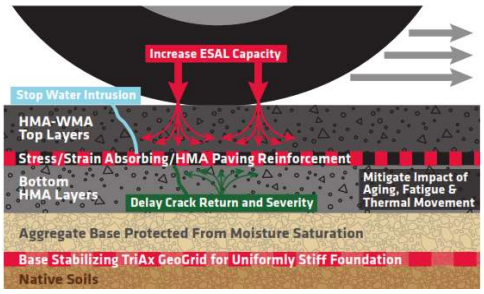
What Can be Done Instead?



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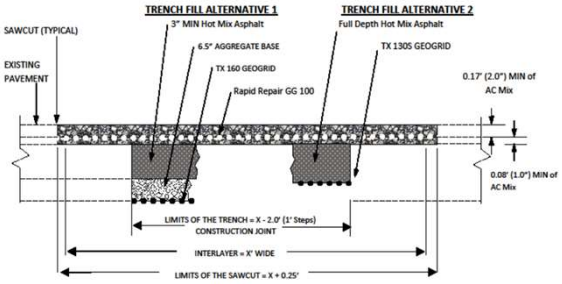
STRUCTURAL – Base Issue CORRECTION

Trench Cut- Dig Out Repairs

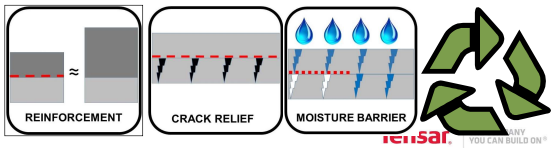
TriAx Geogrid & Rapid Repair GlasGrid 100 Trench Detail Alternatives



Problems that Pavement Reinforcement Products Solve / Benefits they Bring

Benefits Of Pavement Reinforcement Products

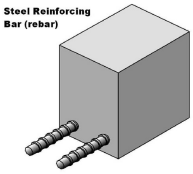
- Reinforcement
- Mitigate Reflective Cracking
- Moisture Barrier
- Sustainability



Reinforcement Matters

1. Structural Reinforcement

Continuous high tensile, pre-coated high temp. with elastomeric polymer, fiberglass is to asphalt as steel rebar is to concrete



Fiberglass has a modulus advantage over the asphalt and is not water/temperature sensitive

REINFORCEMENT MATTERS!

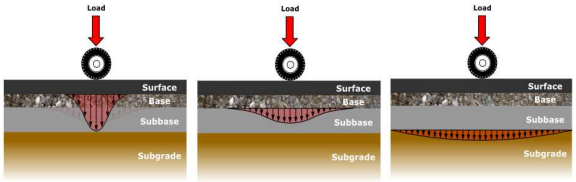
No Reinforcement | **Reinforced with GlasGrid TF**

Over 6.5 Times Longer

Maximum Load Distribution

Load distribution is one of the primary functions of a pavement

Conventional Pavement Load Distribution Curves



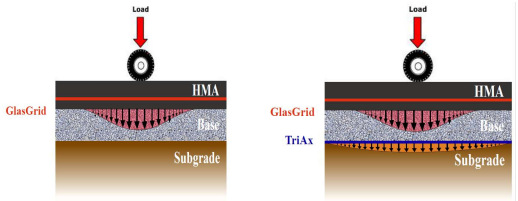
Maximum Load Distribution

Load distribution is one of the primary functions of a pavement

More Cost Effective and Higher Performing HMA Pavements

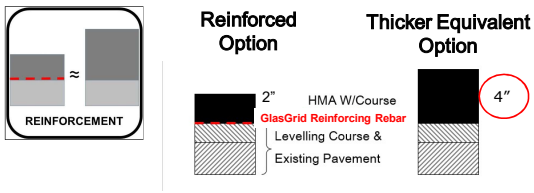
Most Efficient Pavement Load Distribution Curves

Rehabilitation | New or Reconstruct



Equivalent LOAD Design with Reinforcement

AASHTO Design to Increase Load Capacity



1. HMA section must be critical layer
2. Must be placed in the tension zone of the pavement

Slowing Crack Deterioration

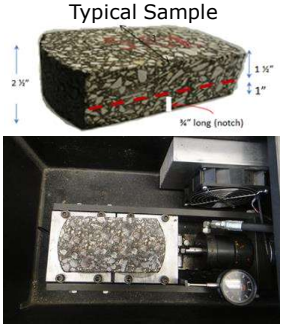
2. Crack Relief

High tensile rebar-type reinforcing
+
Low tensile HMA =
Crack Resistant Pavements

Slowing Crack Deterioration

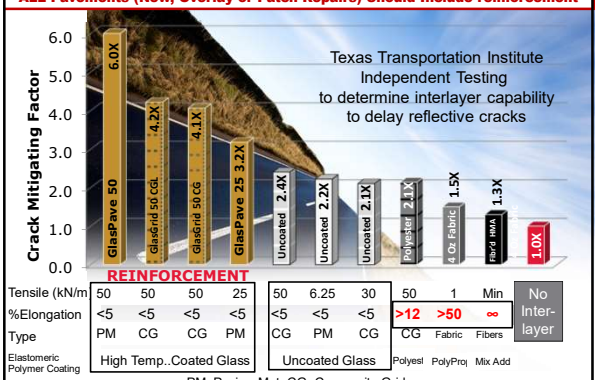
Texas Transportation Institute Overlay Tester

Typical Sample



Pavements Ability to Resist Cracks

ALL Pavements (New, Overlay or Patch Repairs) Should Include reinforcement

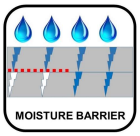


REINFORCEMENT											
Tensile (kN/m	50	50	50	25	50	6.25	30	50	1	Min	No Inter-layer
%Elongation	<5	<5	<5	<5	<5	<5	<5	>12	>50	∞	
Type	PM	CG	CG	PM	CG	PM	CG	CG	Fabric	Fibers	
Elastomeric Polymer Coating	High Temp..Coated Glass				Uncoated Glass			Polyesl	PolyProj	Mix Add	

PM=Paving Mat, CG=Composite Grid

Slowing Impact of Moisture

3. Moisture Barrier

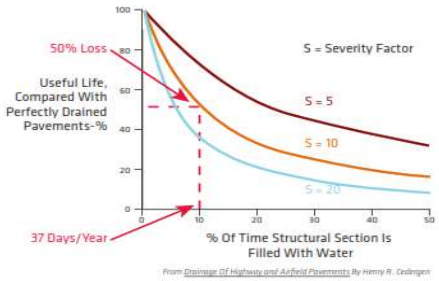


Preserve the traffic bearing capacity of a dry Foundation:

Moisture barrier protects base from top down moisture intrusion into the base

Water in Foundation Deterioration

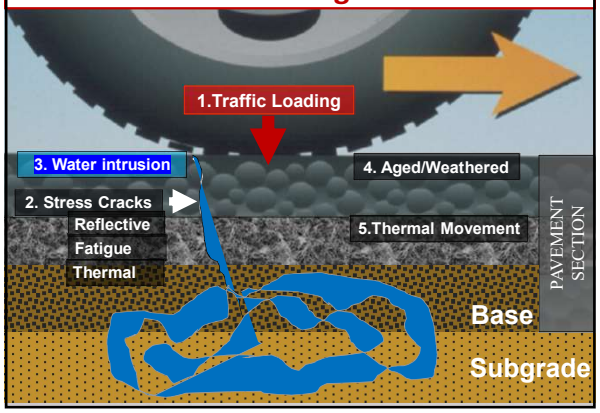
Deteriorating Impact of Moisture Intrusion



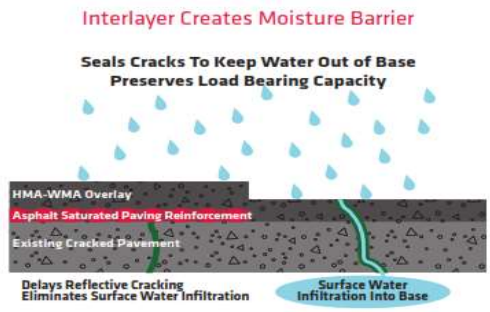
From Drainage Of Highway and Airfield Pavements By Henry R. Cedergren

Graphic 8. The Cedergren study shows that a pavement with base saturated as little as 10% of the time (37 days in a year) will lose 50% of its useful life!

Deteriorating Effect



Mitigate Moisture Intrusion



Graphic 9. Shows how an interlayer creates a moisture barrier to stop top down moisture intrusion

Sustainability

Plus
Sustainable
practices

Must be completely Millable PLUS must be Recyclable back into a new HMA up to 30% with no detriment to that mix

Ability to Mill, Recycle + Add to New HMA

New HMA with up to 30% RAP containing milled GlasPave will pass AASHTO testing T283-07 for rutting and moisture susceptibility + T322-07 low temp cracking

Figure 2 Control RAP mixture (left) and RAP mixture containing GlasPave (right).

National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

The Effect of GlasPave™ in RAP on Asphalt Mixture Performance

RESEARCH SYNOPSIS–NCAT REPORT

Rebar Type Reinforcement for HMA

Key Points

Design and Construct HMA Pavements that:

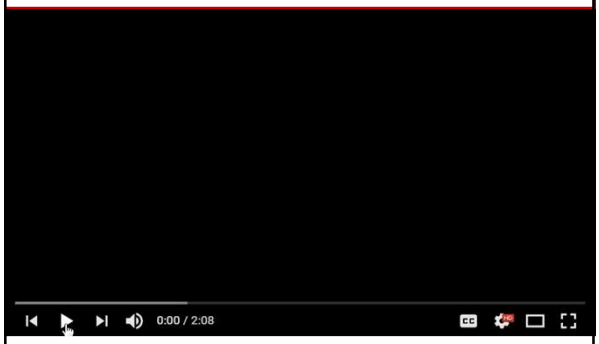
1. **have 2X load capacity (ESALs)**
2. **delayed crack return 3, 6 or 9X longer**
3. **preserved base structure by keeping top down water out of the base**

Plus be completely millable and recyclable

High temperature pre-coated, high tensile, continuous fiberglass rebar type reinforcement in HMA can!

How Flexible Pavements Fail

Source: MODOT youtube site



Independent Verification & Project Examples

Coated Fiberglass Paving Grid

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Loretta Heights, CO Installed 2006
2" HMA overlay on heavily alligator cracked HMA

←BEFORE 2006 Vs AFTER 2017→

2017 Yr. 11 - Minor Crack

Coated Fiberglass Paving Grid

Tensar

Santa Cruz, CA Installed 2004 2" HMA over PCC

←No mat Vs Paving Mat →

2015 Yr. 11 - Minor Crack

Coated Fiberglass Paving Grid

Tensar

LAKE Oswego, 2" HMA over Milled HMA

←BEFORE 2007 Vs AFTER 2015→

2017 Yr. 10 - Minor Crack

Coated Fiberglass Paving Grid

Tensar

Lake Oswego, OR 2" HMA over Milled HMA

Same contractor, same mix, but No reinforcing

Fosburg Rd, Collector, After 7 Yrs.

Coated Fiberglass Paving Grid

Tensar

Project Name:

Rehabilation of Alewa Drive, Unit 49

Pavement Condition Assessment (After 12 Years)

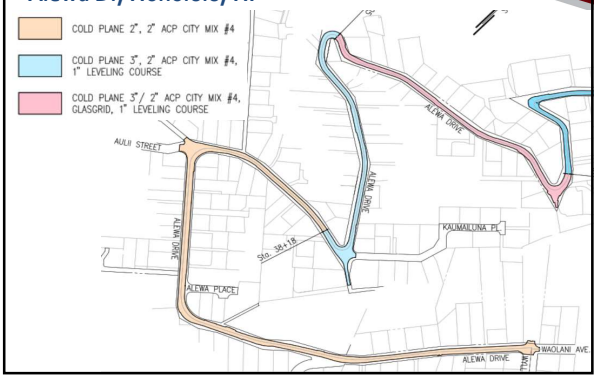
In 2007, the City and County of Honolulu rehabilitated the streets on Alewa Drive, Unit 49. Various rehabilitation strategies were installed based on the condition of the streets.

After 12 years of trafficking, the following pictures compare the performance of the reinforced asphalt sections underlain by Tensar GlasGrid compared to asphalt sections without GlasGrid.

The asphalt reinforced with GlasGrid is currently providing a superior performance (i.e. less cracks on the surface and improved International Roughness Index) compared to asphalt sections without GlasGrid.

Tensar

Alewa Dr, Honolulu, HI



Tensar

Alewa Dr, Honolulu, HI

Tensar

Alewa Dr, Honolulu, HI

Coated Fiberglass Paving Grid

Tensar

Pyramid, Sparks NV 4 lane, Heavy truck traffic, 3" HMA

GlasGrid 8501 Installed 2003 S/B curb lane only

2016 Yr. 13 Still NO CRACKS in S/B Curb Lane

Performance Validation

Tensar

INDEPENDENT VALIDATION

GlasGrid Performance Validation

Tensar

Influence of GlasGrid® on Asphalt Pavement Performance.

- **NCAT Ongoing full scale research**
- **2018 Update: 18 years and 60 million ESAL's of accelerated traffic loading**

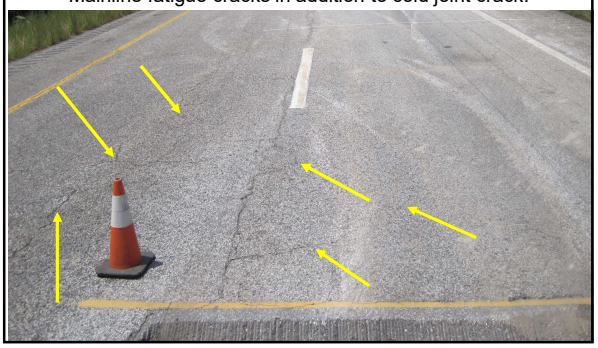
National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

Performance Update 2018

Performance Validation

Tensar

2018 Unreinforced Section: Cracking first observed in 2006. Mainline fatigue cracks in addition to cold joint crack.



Performance Validation

Tensar

GlasGrid Reinforced Section
after 60 Mil ESALs and 18 Yrs.
2018 Still no cracks in mainline only at cold joint

Performance Validation

Tensar

APT

Full Scale in-place testing

The improvement factor is typically in the range of 2-5, and represents the reinforcing benefit of the interlayer. This factor can be used in Mechanistic Empirical design, and applied to the result of the transfer function.

Performance Validation

Tensar

APT

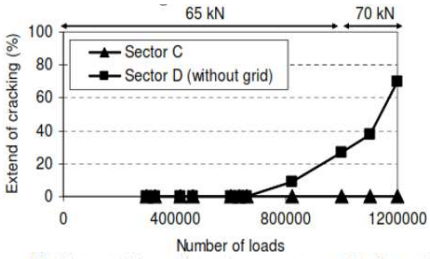


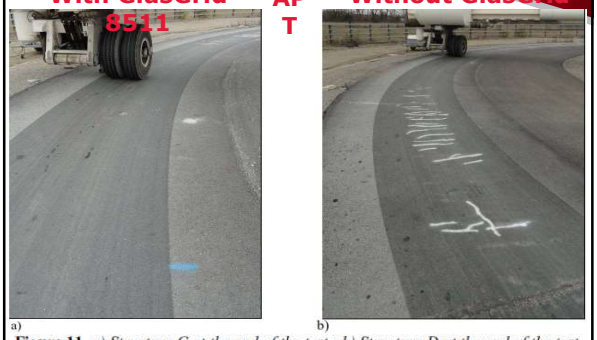
Figure 10. *Extent of cracking, in percent, on the 2 sections*

Fatigue Cracking Section C With GlasGrid 8511
Vs
Section D with NO GlasGrid

Performance Validation

Tensar

With GlasGrid 8511 **APT** **Without GlasGrid**



a) b)

Figure 11. *a) Structure C at the end of the test ; b) Structure D at the end of the test*

Fatigue Cracks at 0% with GlasGrid 8511 vs 70% Without

Performance Validation

Tensar

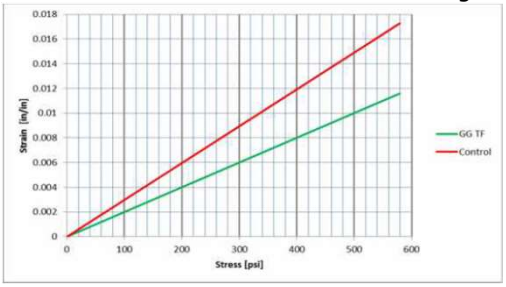
In-Place Plate Load Validation Testing

Figure 2 : Large Vehicle with 18Kip Axle Loads to Perform the Plate Load Test

Performance Validation

Tensar

In-Place Plate Load Validation Testing



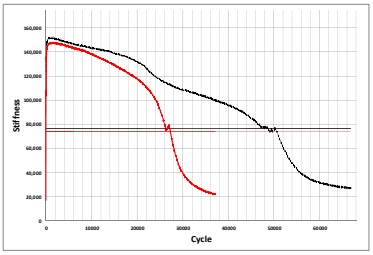
This test with this pavement structure the GlasGrid TF reinforced slabs have a structural contribution that is 2 times stronger than that of the control slab. This structural improvement can be applied to the AASHTO SN equation to determine what the contribution of the GlasGrid TF is to the layer coefficient.

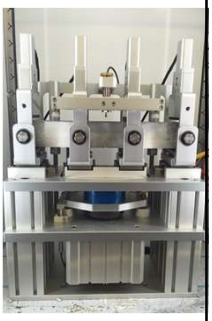
Performance Validation

Tensar

In-Place Validation Testing

4 Point Strain Controlled Beam Test





GlasGrid TF Structural contribution 2 times stronger than the control

PROVEN ReBar Type HMA Reinforcement

VALIDATED HIGH TENSILE STRENGTH, ELASTOMERIC POLYMER COATED PAVING REINFORCEMENTS

TYPE:	PG or GlasPave 25	GlasPave 50	PG or GlasGrid 100	GlasGrid 100TF
				
TENSILE:	25kN/140Lb	50kN/280Lb	100kN/560Lb.	100kN/560Lb.
ELONGATION	< 5%	< 5%	< 3%	< 3%

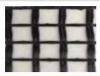
Proper High Temperature Coated, High Tensile, Low Elongating, Continuous Rebar type Reinforcement will:

- **Reinforce to add LOAD Capacity**
- **Delay cracks and their severity**
- **Waterproof to preserve base**

Tensar

Cost by HMA Reinforcement Type

VALIDATED HIGH TENSILE STRENGTH, ELASTOMERIC POLYMER COATED PAVING REINFORCEMENTS

TYPE:	PG or GlasPave 25	GlasPave 50	PG or GlasGrid 100	GlasGrid 100TF
				
TENSILE:	25kN/140Lb	50kN/280Lb	100kN/560Lb.	100kN/560Lb.
ELONGATION	< 5%	< 5%	< 3%	< 3%
Crack Delay	**3X**	**6X**	**9X**	**9X**
Equiv HMA In.	**1+0.5"**	**1+1"**	**2"+**	**2"+**
Waterproof	**YES**	**YES**	**_**	**_**

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Take Away:

With Increased ESAL capacity, Delayed Cracks and a Dry Foundation we can:

1. **More rapidly improve network PCI**
2. **Reduce maintenance cost and intervals**
3. **Less downtime, work zones, liability**
4. **Better Ride, Better looks, longer**

Let us Help You Design & Build More Maintenance free Pavement Structures that Last Longer and Cost Less

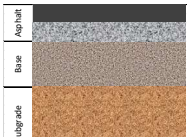
Tensar

Design Services:

HMA Pavement ESAL Increase Worksheet

Project Title: Date:

Project Location:



HMA Overlay Thickness (inches)	
HMA Overlay Modulus (ksi)	
Existing HMA Thickness (inches)	
Existing HMA Modulus (ksi)	
PCC-Other Concrete or Treated Base (inches)	
Base Thickness (inches)	
Base Modulus (ksi)	
Base Type	
Subgrade Thickness (inches)	
Subgrade Modulus (ksi)	
Subgrade CBR (%)	
Subgrade Type	

ADDITIONAL EXISTING INFORMATION	
STRUCTURAL	
CURRENT TRAFFIC INDEX	
CURRENT PCI	
STANDARD SINGLE AXLE LOAD (kips)	18
DUAL/SINGLE WHEEL	
TIRE PRESSURE PSI (PSI)	80
Joint or Crack Wheel Transfer % Efficiency (70% Min)	
RELIABILITY (% per AASHTO 98, typical 80"-95%)	
STANDARD DEVIATION (per AASHTO 98)	0.45

NOTES:
The more complete the information, the more accurate the design.

DESIRED OUTCOMES	
STRUCTURAL	
TRAFFIC INDEX	
PCI GOAL	
PERCENT TRUCKS	%
ESALs PER YEAR 1	
ESALs GROWTH RATE (%)	%
TERMINAL PCI	
DESIGN LIFE (Years)	
FUNCTIONAL	
YEARS TO CRACK RETURN	
YEARS TO FIRST PREVENTATIVE MAINTENANCE	
ANTICIPATED MAINTENANCE CYCLE	

Send to: Tensar Dennis Rogers Phone: 760.668.3436 Email: drogers@tensarcorp.com

Tensar

2. End of Service life ESAL: Existing Section		
	85.00	Reliability
Zr	-1.037	Std. Normal deviate
So	0.45	Overall Std. deviation
ΔPSI	0.01	Design serviceability loss
CBR	3.1	
M_R	4600	Subgrade
Initial	2.01	Serviceability
Terminal	2.0	

Layer	thick (in.)	ai	mi	SN_layer
AC1	4	0.22		0.88
AC2	0	0.22		0.00
AC3	0	0.22		0.00
ABC	12	0.11	1	1.26
ABC	0	0.11	1	0.00
SBC	0	0.08	1	0.00
SBC	0	0.06	1	0.00
Total	16		SN	2.14
4,697	ESALS	TI=	4.76	

Sample of Inputs for: AASHTO 93 Design

Tensar

REHAB: Unreinforced HMA				
Mill Thickness	**5.5**			
Layer Thickness	Inch	ai	mi	SN
New HMA	**5.5**	0.44		2.42
ABC	10.5	0.11	1	1.10
Total	16			**3.52**
614,698	ESAL	TI=	**8.49**	

REHAB 1: HMA, GlasGrid HMA REINFORCEMENT+HMA				
Mill Thickness	**5.5**			
Layer Thickness	Inch	ai	mi	SN
HMA+GGTF	4	0.66		2.64
LvLup HMA	1.5	0.44		0.66
ABC	10.5	0.11	1	1.16
Total	16			**4.46**
2,901,926	ESAL	**TI=**	**10.22**	

REHAB 2: New HMA+ GlasPave50 # HMA Reinforcement				
Milling Thickness	**6.6**			
Layer	Inch	ai	mi	SN
HMA+GP50	4	0.57		2.28
HMA	2.6	0.44		1.13
Existing HMA	0	0.22		0
ABC	9.5	0.105	1	1.00
Total	16			**4.46**
2,908,550	**ESALS**	**TI=**	**10.22**	

Sample AASHTO Design:

Tensar

Sample Design Results:

Performance Comparison	Existing	GGTF Reinforced	GP Reinforced	Unreinforced
Structural Number	2.14	4.40	4.40	4.41
ESAL's	4,697	2,901,926	2,908,550	2,938,770
TI	4.76	10.22	10.22	10.23
Improvement Factor vs No Reinforcement (Traffic Benefit Ratio):		4.7	2.5	--
Added inches of HMA needed to Achieve Same Performance:		2.7	0.0	2.7
Added Crack Delay compared to no Reinforcement		9X	6X	Min.
Waterproof membrane to keep base dry		NO	Waterproof	NO
RAP containing GG/GP can be added back into a new mix up to 30%		YES	YES	
Cost Benefit Analysis				
Installed Cost of added Paving Reinforcement (per SY):		$15.00	$12.00	--
Cost of HMA Installed (per SY):		$45.82	$54.64	$67.89
Total Cost Installed (SY)		$60.82	$66.64	$67.89
Percent Cost Savings vs Equivalent Asphalt		-12%	-2%	

QUESTIONS?

Thank You

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206-518-2318

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INSTALLATION

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Placing HMA Reinforcement

GlasGrid TF Installation

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GlasGrid GlasPave Installation

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PatchGlas 100/25 Installation

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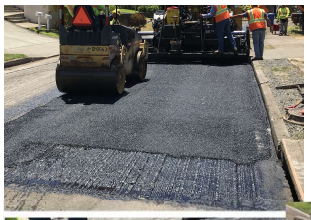

◄ **PREP: Mill, Prime, Level-Up**

Unroll and remove release film ▼

PatchGlas 100/25 Installation

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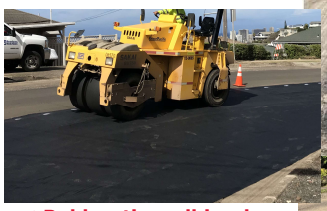
PatchGlas 100/25 Installation

Tensar



▲Rubber tire roll in-place to assure adhesion ►