The Use of Tire Shred in Geotechnical Applications

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Malek Smadi, Ph.D., P.E.
Principal Engineer
Fishers, IN
msmadi@geotill.com
www.geotill.com

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CONTENTS

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Rubber Products

- Tires are the principal product of the rubber industry
  - Tires are about 75% of total rubber tonnage
- Other important products:
  - Footwear
  - Seals
  - Shock-absorbing parts
  - Conveyor belts
  - Hose
  - Foamed rubber products
  - Sports equipment

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Subgrade Fill and Embankments

- Tire shreds can be used to construct embankments on weak, compressible foundation soils. Tire shreds are viable in this application due to their light weight. For most projects, using tire shreds as a lightweight fill material is significantly cheaper than alternatives.

- Indiana General assembly passed the Senate Bill NO 209 and House Bill 1056 which relate to beneficial use of tires in road construction.

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Subgrade Fill and Embankments

Project Location: SR110, 4 miles East of US31 in Marshall County

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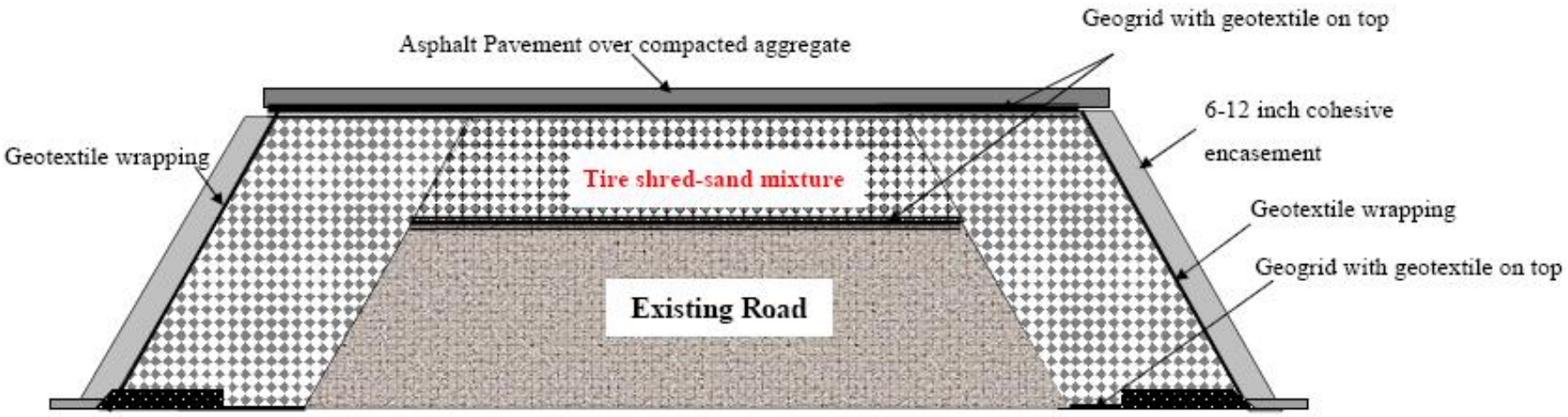
Subgrade Fill and Embankments

Cross-section of embankment at SR110

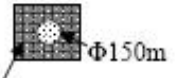
- Existing pavement at SR110 needed widening and raising the level of the pavement



Compaction Details

1. 5 T roller
2. Lift thickness : 12 inches
3. Number of passes: 6

Drain Cross Section



Aggregate for under drains

Lightweight materials used in construction

- Shredded tires

  - 2 inch nominal size
  - Unit weight

    ~ 30 pcf

Subgrade Fill and Embankments

Mixing procedure

Three buckets of shredded tires was piled

Two buckets of sand was dumped on shredded-tire pile

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Mixing procedure

Loader bucket used to thoroughly mix shredded tires and sand

Pile of shredded tire-sand mixture

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Subgrade Fill and Embankments

Filling procedure using mixtures

Mixed material taken to construction site and dumped in place

Mixture spread in lifts of 12 inches using tracked bull dozer

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Filling procedure using mixtures

Mixture being compacted using 5 T smooth-drum roller

Finally, encasing the side slopes with geotextile

Filling procedure using mixtures

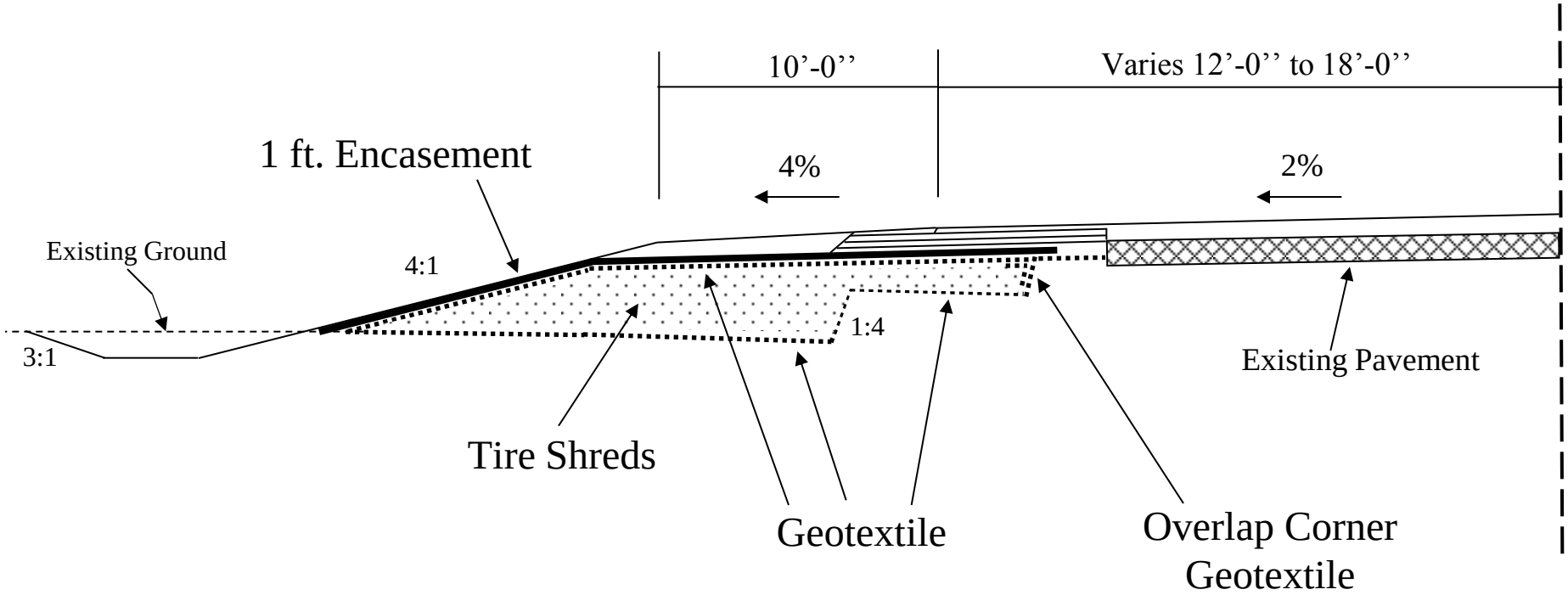
Mixture spread in lifts of 12 inches using tracked bull dozer

SR110 in Marshall County. Road open to traffic in the 3rd week of October 2008

Estimated Quantities

- Shredded tires and sand mixture with mixing ratio of 60: 40 (by volume) of shredded tires and sand was used as fill material
- Total fill : 2200 cubic yards
- Shredded tires : ~ 710 Tons
- B-borrow material : ~ 1580 Tons

Half Section SR 19 in Elkhart County Tire Shred Fill



SR 19 in Elkhart County Tire Shred Fill

Mixture awaiting wrapping of geotextile

Geotextile wrapped around compacted lift of mixture

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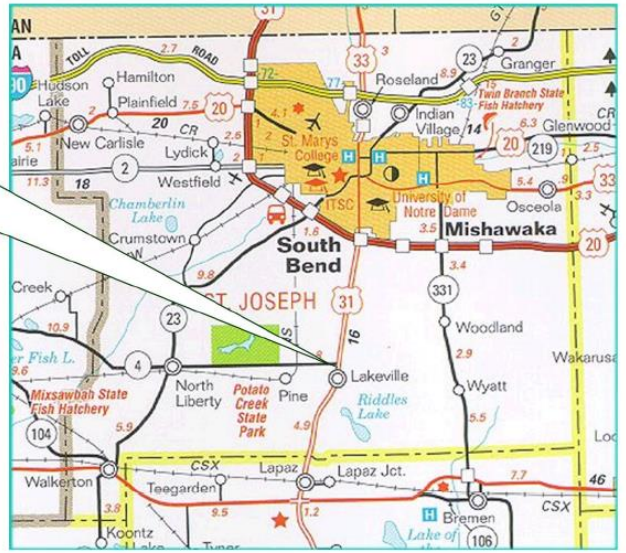
U.S. 31 in St. Joseph County Tire Shred Fill

U.S. 31 in
St. Joseph County



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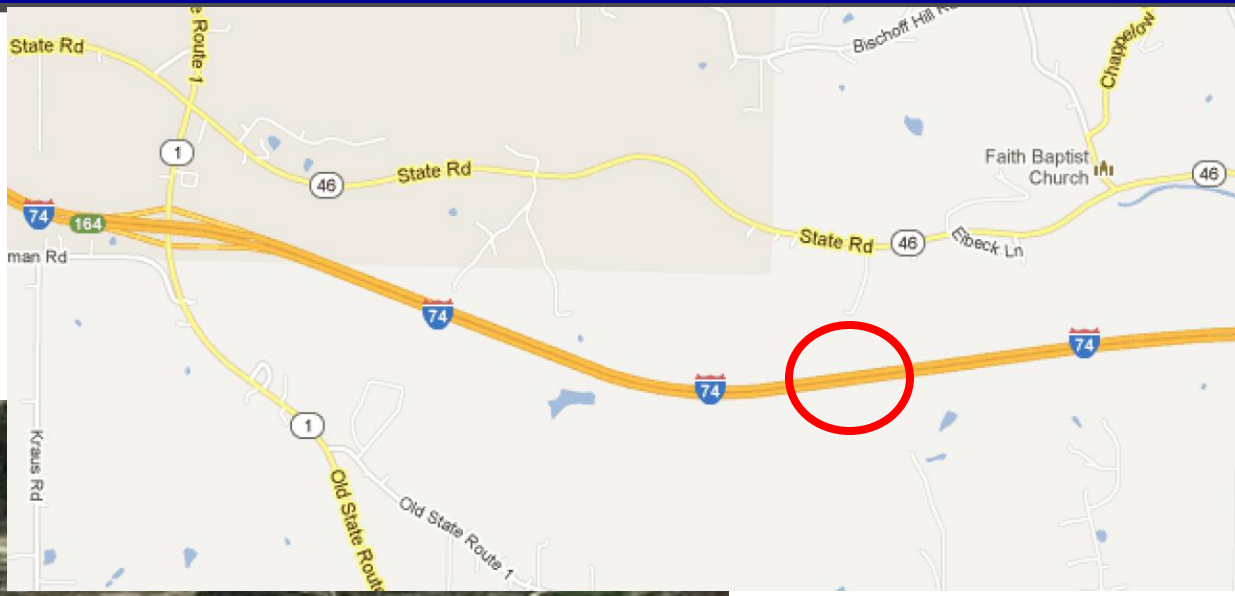
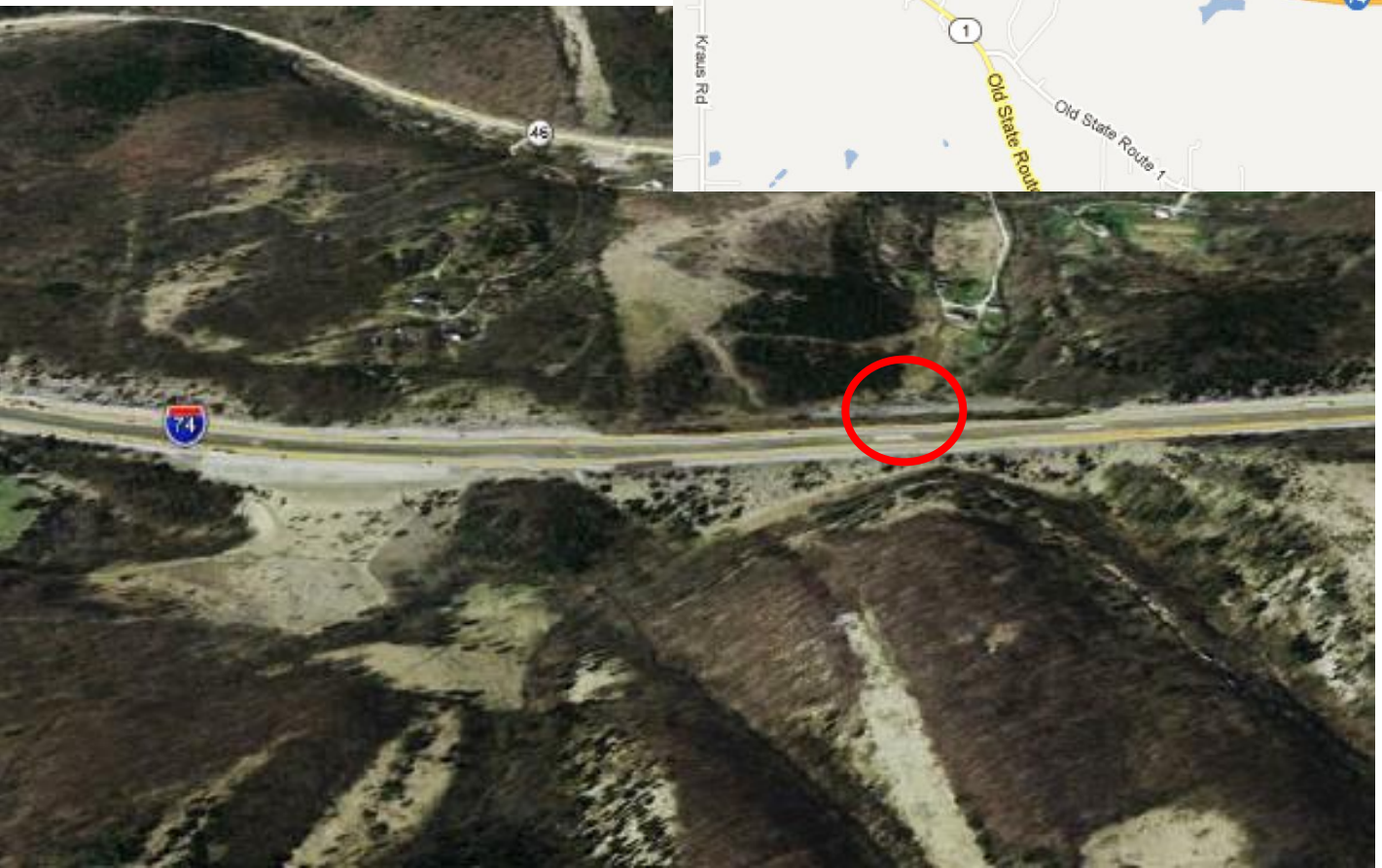
Slope Stabilization

I-74 Landslide Tire Shred





Tire shreds can be used to enhance the stability of steep slopes along highways, and reinforcing shoulder areas.

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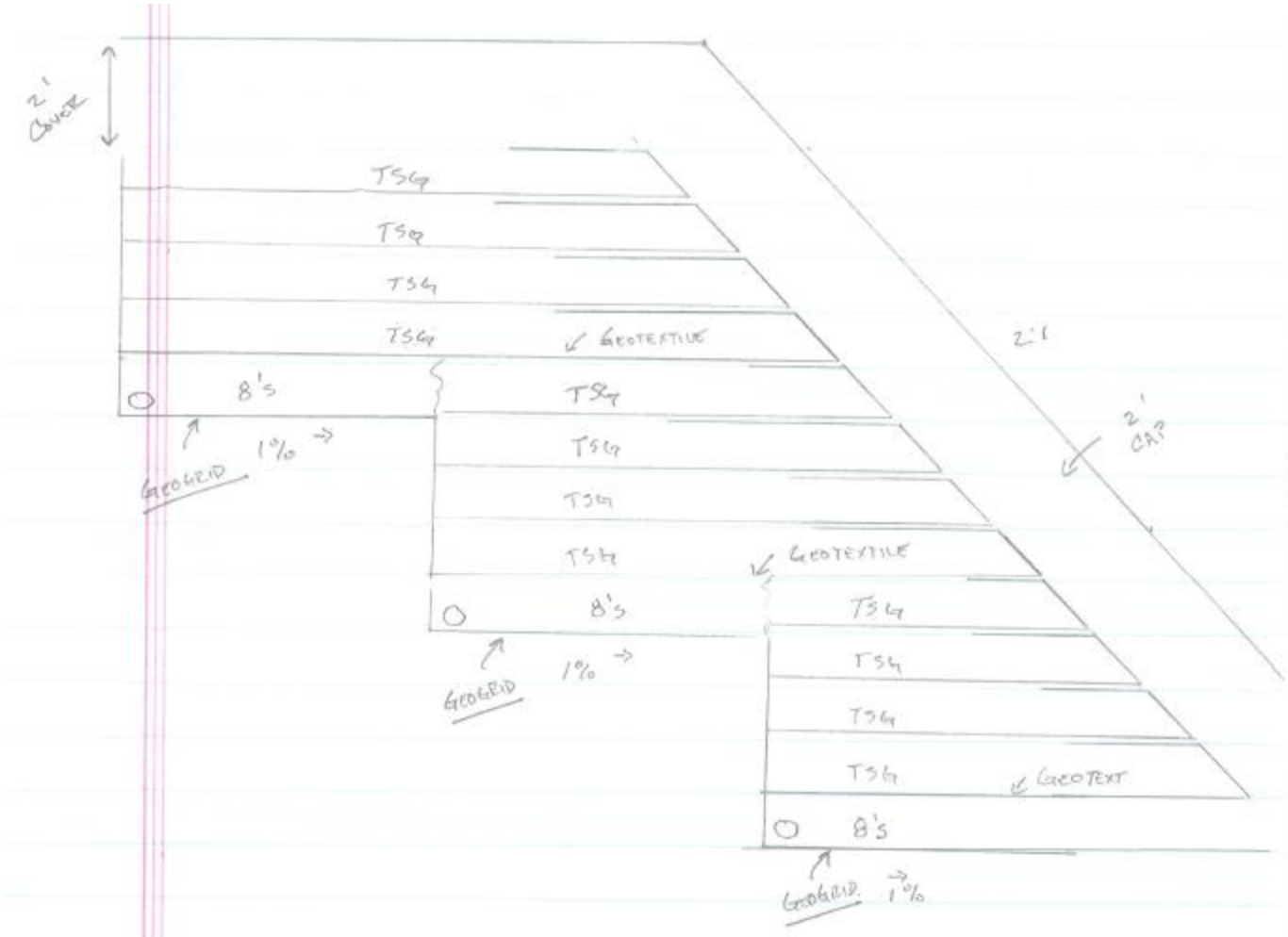
Slope Stabilization



Slope Stabilization

Slide Correction on I-74, 7/10th mile east of SR1 and I-74

Mixture being spread over geotextile

Hauling and compacting the mixture (10 ton roller, lifts of 12 inches)

Slope Stabilization

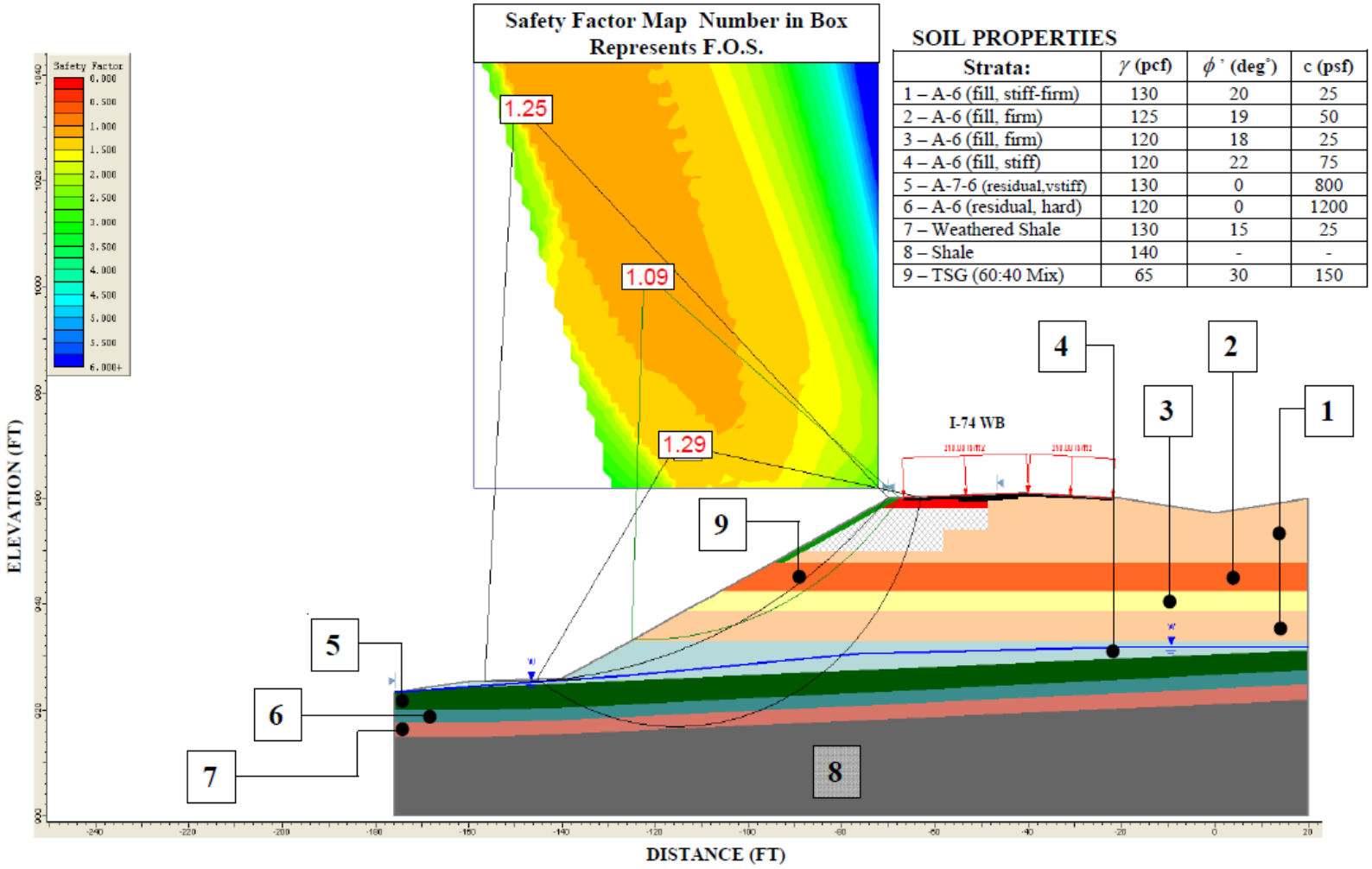
SITE 1
STA 383+75

Subsurface Profile and Analyses

I-74 Landslide – Westbound – 800 ft East of RP164

Post Construction Tire Shreds-Granular (TSG) Mix

Based upon Adjustments to Original Repair Configuration



SOIL PROPERTIES

Strata:	γ (pcf)	ϕ ' (deg°)	c (psf)
1 – A-6 (fill, stiff-firm)	130	20	25
2 – A-6 (fill, firm)	125	19	50
3 – A-6 (fill, firm)	120	18	25
4 – A-6 (fill, stiff)	120	22	75
5 – A-7-6 (residual,vstiff)	130	0	800
6 – A-6 (residual, hard)	120	0	1200
7 – Weathered Shale	130	15	25
8 – Shale	140	-	-
9 – TSG (60:40 Mix)	65	30	150

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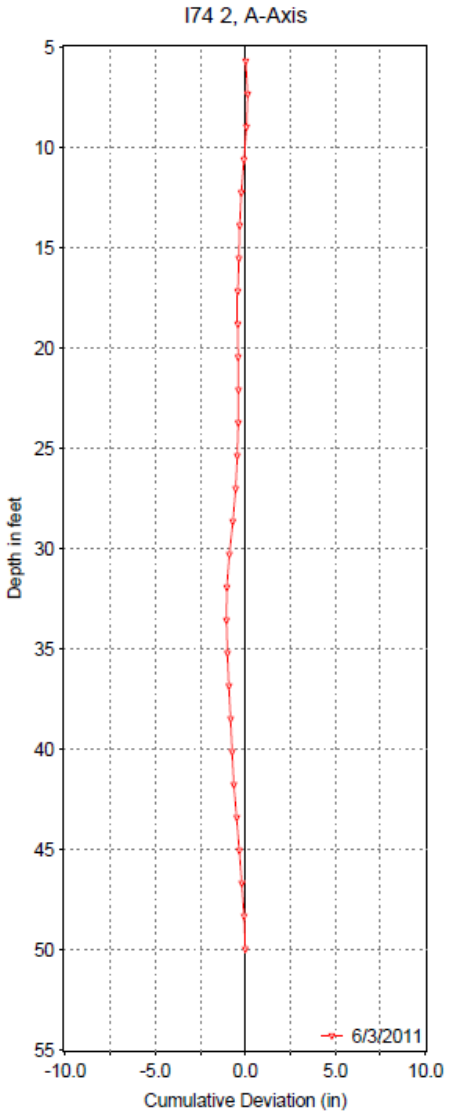
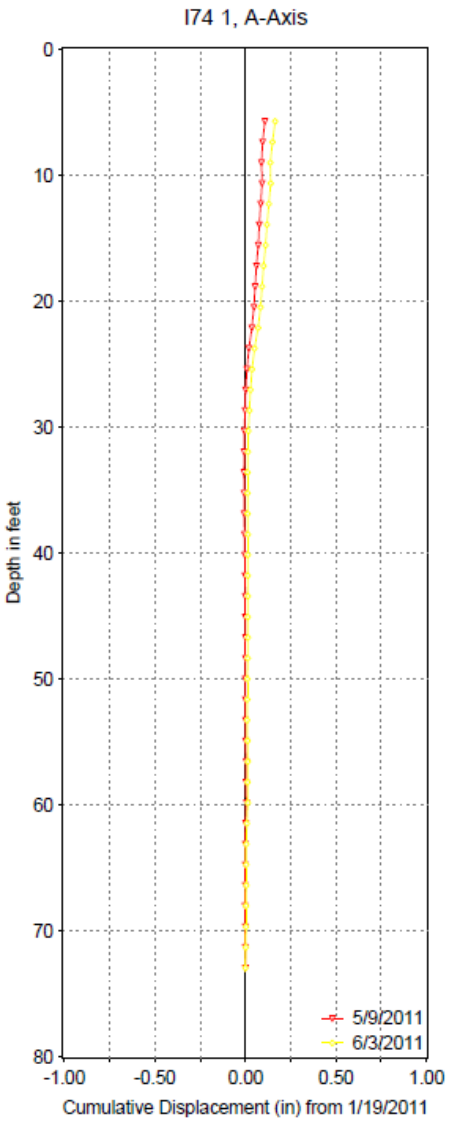
Slope Stabilization





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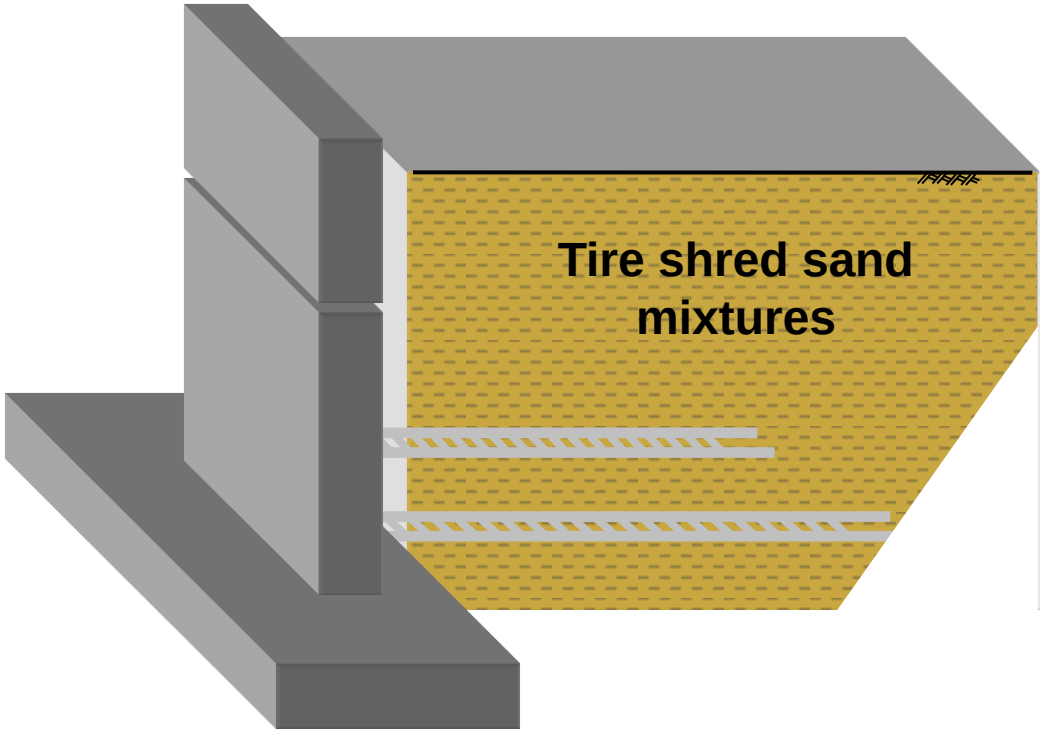
Backfill for Wall and Bridge Abutments

Tire shreds can be useful as backfill for walls and bridge abutments. The weight of the tire shreds reduces horizontal pressures and allows for construction of thinner, less expensive walls. Tire shreds can also reduce problems with water and frost build up behind walls because tire shreds are free draining and provide good thermal insulation.



Backfill for Wall and Bridge Abutments

- ***I-80/94 interchange modification (IR 29901, Wall No. 54)***
- *Wall height = 10 ft*
- *Backfill: tire shred-sand mixture + EPS*
- *Mixing ratio by volume (loose state):*

  60 (tire shred) : 40 (sand)
- *Materials used (compacted state):*
- *Shredded tires: 2100 yd^3*
- *Sand: 2900 yd^3*
- *No. of compactor passes = 4 ~ 5*

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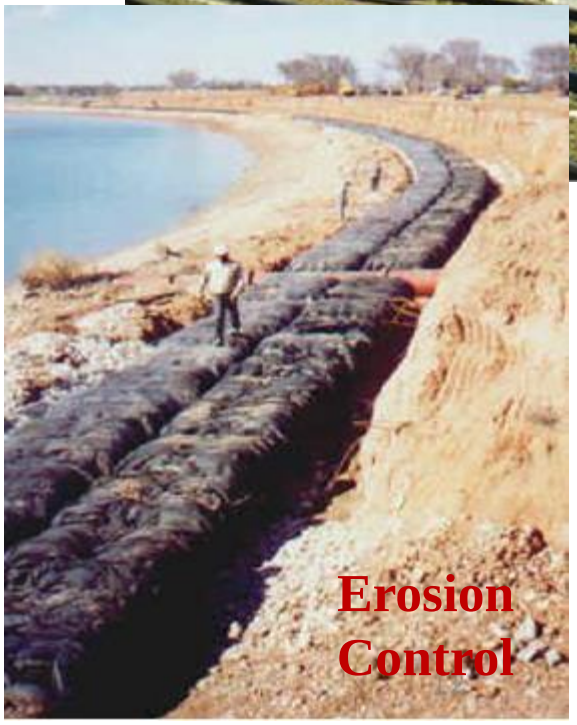
Backfill for Wall and Bridge Abutments



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Subgrade Insulation for Roads

- Placing a 6 to 12-inch thick tire shred layer under the road can prevent the subgrade soils from freezing.

- The high permeability of tire shreds allows water to drain from beneath the roads, preventing damage to road surfaces.

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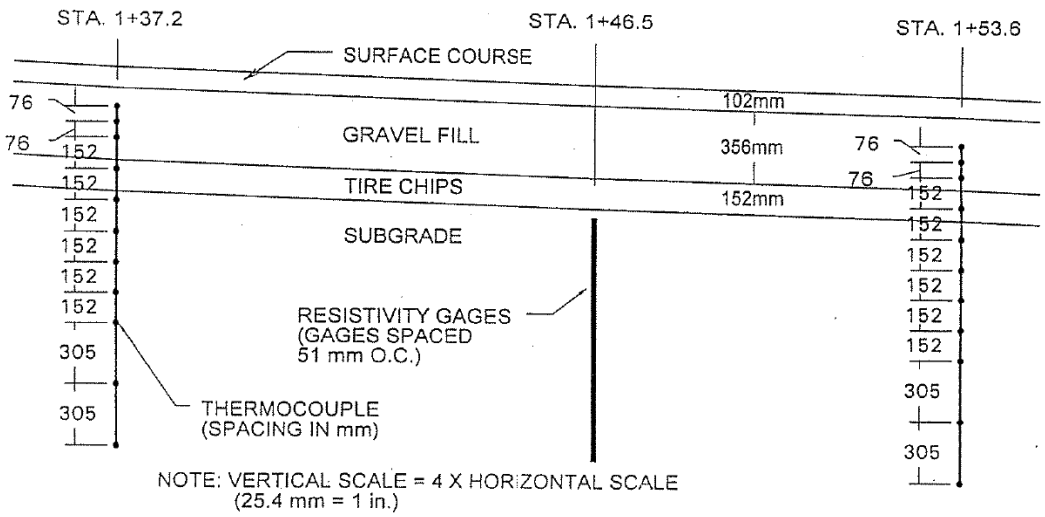
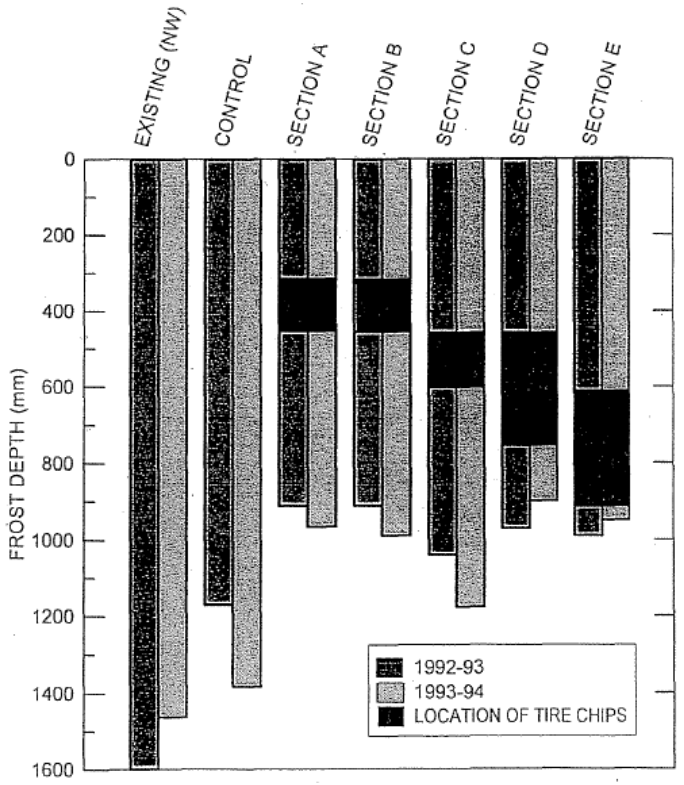
Subgrade Insulation for Roads





It is seen that the depth of frost penetration beneath the existing road and control sections ranged from 1170 mm (46 in.) to 1600 mm (63 in.). In contrast, in tire chip Sections A, B, D, and E the depth of frost penetration ranged from 910 mm (36 in.) to 990 mm (39 in.). Thus, the tire chips reduced the depth of frost penetration by between 15% and 35% compared to the control section.

After Dana Humphry: Test site located on Dingley Road in southern Maine in the Town of Richmond

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Landfills

- Lightweight backfill.
- Landfill capping and closures.
- Material for daily cover

Tire Shreds as Drainage Aggregate

- Drainage around building foundations and building foundation insulation. Tire chips can also hold more water than stone and can be transported more easily due to their light weight.

- Challenges to using tire shreds in drain fields include tire chip quality (tire chips must be clean cut and be of uniform size) and economics—in some areas, stone is abundant and cheap; tire shreds must be cheaper than stone to be used readily.

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Other Uses

- Playground surface material
- Gravel substitute
- Wetlands/marsh establishment (whole tires)
- Crash barriers around race tracks (whole tires)
- Boat bumpers at marinas (whole tires)

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Other Uses


Artificial turf


Road furniture


Running tracks


Sports arenas


Children's play grounds

Environmental Studies on Using Scrap Tires

A literature review was done by the University of Maine on the water quality and environmental toxicology effects of tire-derived aggregate (TDA). The review found that: “TDA has a limited effect on drinking water quality and fresh water aquatic toxicity for a range of applications including lightweight backfill for walls and bridge abutments, insulation and drainage layers beneath roads, free-draining and insulating backfill for residential foundations, vibration damping layers beneath rail lines, landfill leachate collections systems, drainage layers in landfill caps, landfill gas collection systems, and drainage aggregate for drain fields for on-site waste water treatment systems. TDA is unlikely to increase the concentration of substances with primary drinking water standards above those naturally occurring in the groundwater. It is likely that TDA will increase the concentration of iron and manganese, but the data indicates that these elements have limited ability to migrate away from the TDA installation.” This literature review compiled by Dr. Dana Humphrey and Michael Swett of the University of Maine.

Cost of Commonly Used Lightweight Fill Materials

Material	Indiana's Average Cost ($/yd^3)
Extruded Polystyrene	100 ~ 200
Cellular Concrete	60 ~ 80
Expanded Shale	80 ~ 90
Shredded Tires	15 to 30

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Questions ?

Malek Smadi, Ph.D., P.E.
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