Road and Drainage Projects Using Recycled Scrap Tires

EGLE MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY

EGLE Scrap Tire Grants and NextCycle Michigan

- EGLE Scrap Tire offers three types of grants:

  - **Cleanup** – granted first, currently no match component
    - Communities
    - Private Site Cleanups
    - We are looking for Partners to host a cleanup trailer – can your Road Commission assist?
  - **Law Enforcement** – to prohibit dumping of tires
    - Includes purchase of surveillance equipment for problem sites
  - **Market Development**
    - 50% Match
    - Utilize scrap tires in a project (roads) or create a product with scrap tires

  - **NextCycle Michigan** - www.nextcyclemichigan.com
    - Goal – to increase recycling in Michigan
    - One of the six segments is the Roads Track
      - Applications closed for round 1 Roads Track in December, currently reviewing!
    - Public-Private partnership

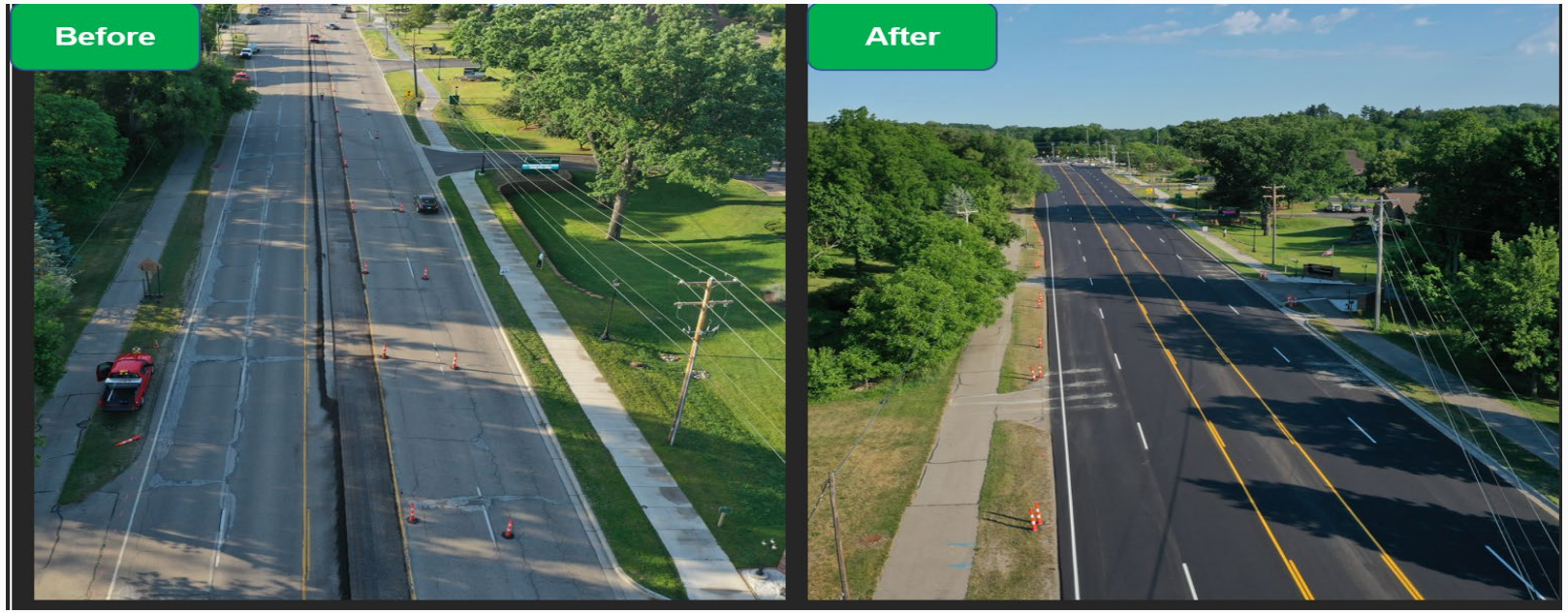
2019 - Dickinson County Road Commission County Road 607 Project

2019 Dickinson County Project Leads to 2021 Kent County Road Commission Cascade Road (Burton to 28th Street)

Partners:

- Kent County Road Commission
- Michigan Technological University
- Asphalt Plus (rubber supplier)
- Reith-Riley (paving contractor)

Right 3 lanes are dry process RMA
Left 2 lanes are conventional asphalt for comparison purposes



2018 Kalamazoo Project Leads to 2021 Project “100 Lane Miles of Chip Seal”

2021 Rubber Modified Chip Seal (RMCS) Project

Partners:

- County Road Commissions:
  - Antrim
  - Bay
  - Wexford
- Entech (rubber supplier)
- Cactus/Entech (paving contractor)

Photo: Cactus Paving
2021 Project Advisor

- 104 lane miles rubberized chip seal
- 290 Scrap Tires used per Lane Mile
- Total use: 422,240 pounds (211.12 T)
- Roads were PASER ratings 3 & 4
- PASER (Pavement Surface Evaluation and Rating) System uses a scale of 1 – 10, with1 being worst condition

2017 Midland County Road Commission
Eastman Road TDA Installation

2017 Midland County Road Commission Leads to 2021 Ingham CRD “Road Lasagna”

Additional Options
Porous Pave, Septic & Rubber Mulch

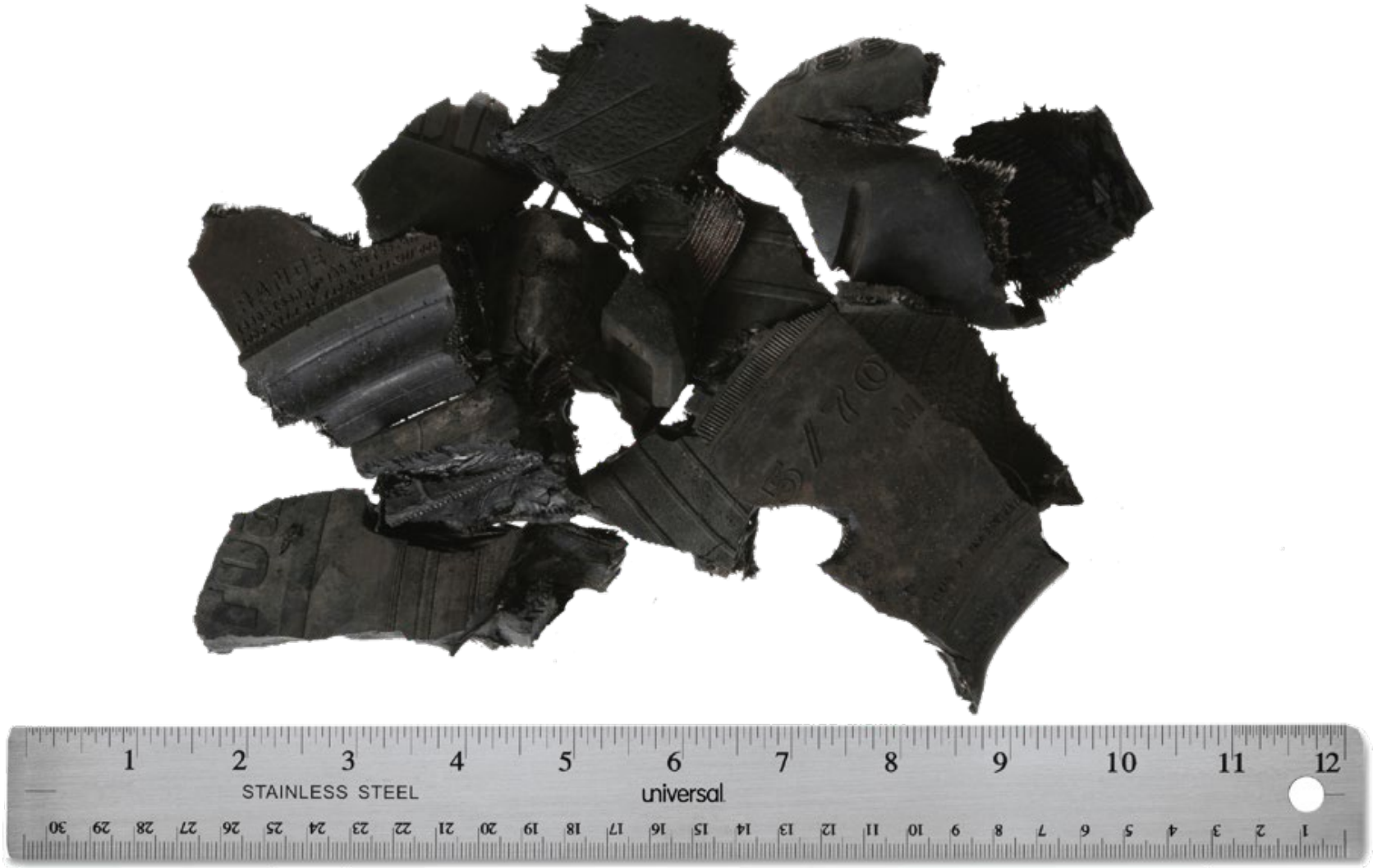
Innovative Applications of TDA

TDA
MANUFACTURING
A Division Of First State Tire Recycling

PRISTINE BY DESIGN

Turning Discarded Tires into TDA Tire Derived Aggregate ASTM 6270 B Material

ASTM D6270 Type B TDA



LIGHTWEIGHT PROPERTY

- Tire Derived Aggregate (TDA) is a **lightweight** material. The Specific Gravity* (SG) of TDA is 1.3. It is **two times heavier** than wood chips, **similar** to expanded shale, and **half as much as** gravel and soil:

Ranking	Material	Specific Gravity, (-)	Reference
1	EPS geofoam	0.01 - 0.04	ASTM D6817 - 13
2	Wood chips	0.50 - 0.56	Smith 1961
3	Expanded shale	1.2	Bundur et al. 2017
4	TDA	1.3	Meles et. al 2013; Mwai et al. 2016
5	Gravel (river bed)	2.6	Mwai et al. 2016
6	Soil	2.7	ASTM D854-92

* Specific Gravity is the ratio of the density of a substance to the density of reference material (in this case water).

Conclusion: TDA can replace traditional aggregates in civil engineering applications to reduce lateral load and earth pressure **two-times** on the soft soil, existing foundations, and walls.

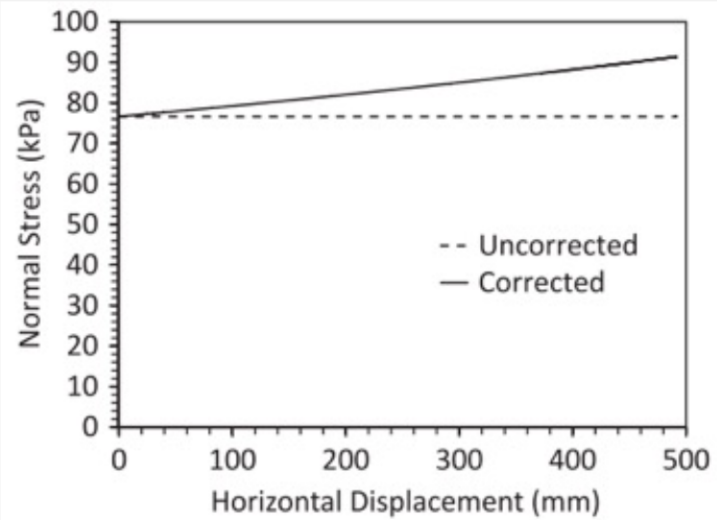
TDA: DRY UNIT WEIGHT [EMPIRICAL]

A loosened TDA, during shipping and stockpiling, has a Dry Unit Weight (DWU) that is **three times lower** than sand [b] and **four-times lower** than clay soil. It is also **half of the** expanded shale aggregate and **similar** to wood chips. A compacted TDA, during field application, has a dry unit weight that **is comparable** to fine expanded shale and soft wood chips. It is **twice lower** than sand and **trice lower** as a clay soil:

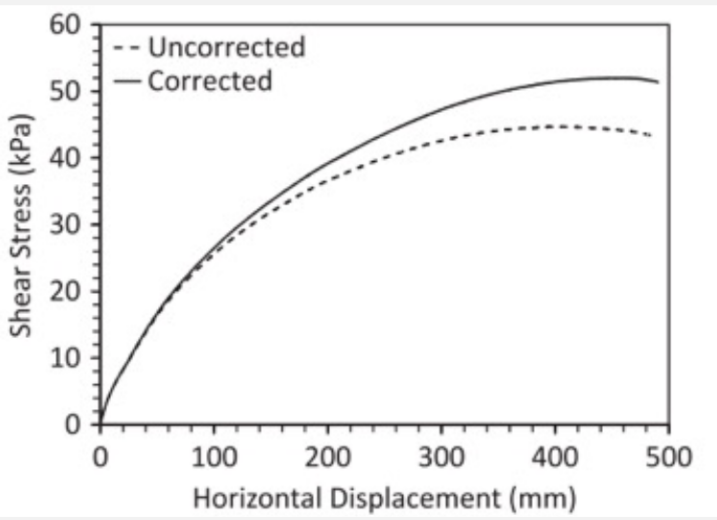
Ranking	Material	Dry unit weight [a], loosened, lb_f/yd^3	Dry unit weight, compacted, lb_f/yd^3	Reference
1	EPS geofoam	35	35	Akay, 2016
2	TDA	675 - 945	1,215 - 1,350	CalRecycle, 2016
3	Wood chips	864 - 1080 [c,1]	1,215 - 1,836 [d,2]	Abu Eusuf & Al Hasan 2012 [1]; Kocsis 2015 [2]
4	Expanded shale	1,134 - 1296	1,323 -1,674	Stoll et al. 1985
5	Sand, CA [b]	1,944 - 2,106	2,322 - 2,970	Lunne et al. 2019
6	Clay soil	2,781 - 2,862 [1]	3,348 - 3,537 [2]	Romero et al., 1999 [1]; Blotz et al. 1998 [2]

❖ [a] Dry unit weight is the weight per unit volume of a material. ❖ [b] Central American ❖ [c] Softwood ❖ [d] Wood chip pellets

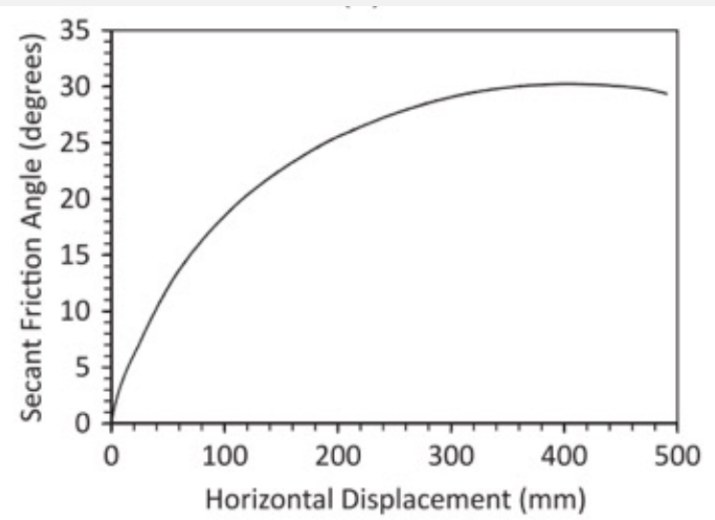
Conclusion: Shipped TDA and Applied TDA has different unit weights. During compaction, dry unit weight of TDA increases twice and volume that TDA occupies decreases twice.



(a)



(b)



(c)

Fig 2. Results for internal direct shear test of TDA: Normal stress(a), Shear stress(b), and secant friction angle(c) (Fox et al. 2017)

TDA: INCREASED SHEAR STRENGTH

- According to Fox and colleagues (2017), TDA yields a peak shear strength of 52 kPa at a horizontal displacement of 460 mm. For initial normal stress of 77kPa, the peak value of secant friction angle is 30.2^0 at 403 mm displacement. Since TDA is placed under 5-20 feet below the surface, as the loading gets larger, the internal strength increases due to mechanical interlocking effect (Balunaini et al. 2009).

MECHANICAL INTERLOCKING PROPERTY: COMPARISON

The shear strength of a soil aggregate is primarily derived from friction between the particles, occlusion and interlocking (Lambe et al. 1991; Wang et al. 2019). TDA also possess interlocking property which increases its shear strength during compaction and compression.

Ranking	Material	Interlocking	Source	Reference
1	TDA ASTM 6270	Yes	Larger pieces and protruding wires	Balunaini et al. 2009
2	Gravel	Yes	Movement of gravel particles into voids leads to local contraction and particle interlocking during shearing.	Li et al. 2013
3	Soil	Yes	Interlocking and occlusion contact	Wang et al. 2019
4	Expanded shale	No	Irregular shape and less smooth surface of crushed expanded shale increases interlocking between cement paste and aggregates	Liao et al. 2019
5	EPS Geofoam	No	-	EPS Industry Alliance 2012

- **Conclusion:** TDA has the highest mechanical interlocking property among other traditional and lightweight aggregates due to larger parts and protruding wires that increase its shear strength.

PERMEABILITY PROPERTY

- TDA is an excellent drainage material due to high porosity and low water absorption. Its permeability is **similar to** very coarse gravel. It surpasses fine gravel **10 times**, wood chips **100 times**, coarse sand **3,000 times** and fine sand more than **30,000 times**.

Ranking	Material	Hydraulic conductivity, m/s	Reference
1	TDA ASTM 6270	0.3 - 0.51	Mwai et al. 2016
2	Clean Gravel	10^{-2} - 1.0	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
3	Expanded Shale	$4x10^{-2}$ - 0.6	Bowders et al. 1997
4	Wood chips	$2.4x10^{-2}$ - $8.4x10^{-2}$ [a]	Ghane et al. 2014
5	Coarse Sand	10^{-4} - 10^{-2}	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
6	Fine Sand	10^{-9} - 10^{-5}	Cabalar & Akbulut 2016; Terzaghi & Peck 1964
7	EPS geofoam	Impermeable ($<10^{-9}$)	Akay et al. 2013

❖ [a] New and old wood chips

Conclusion: TDA is an excellent free draining material that is used as drainage layers for highways, stormwater systems, daily cover layers for landfills, and subgrade support during the spring thaw.

Roadways

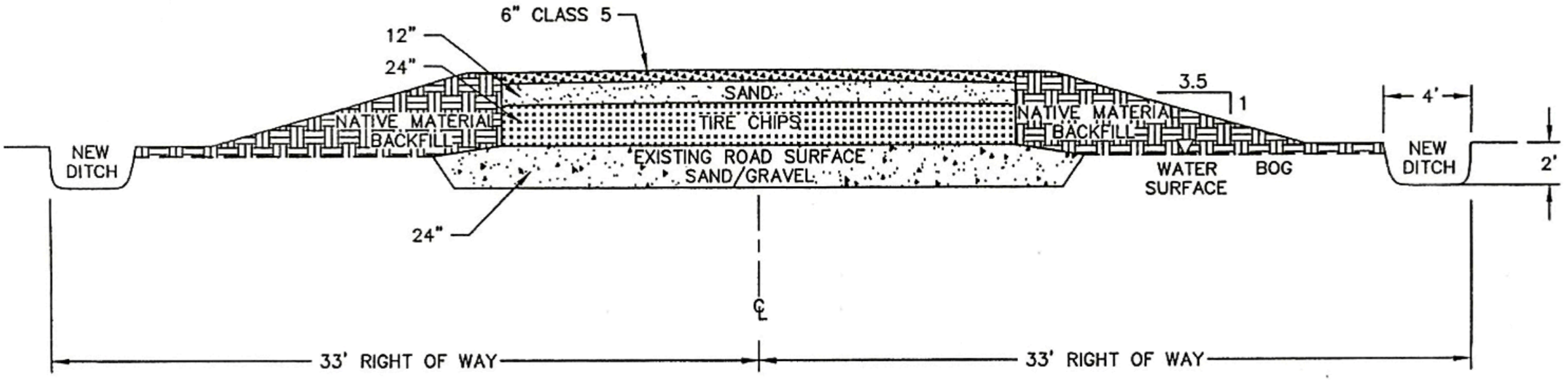
1998-Virgo Street

1998-Virgo Street

1998-Virgo Street

Virgo Street | 2021

Virgo Street Cross Section



Pinnacle Engineering
11000–93rd AVENUE NORTH
MAPLE GROVE, MN 55369
(612) 315–4501

SCHEMATIC CROSS SECTION
VIRGO STREET NE
OXFORD TOWNSHIP
1998 ROAD REPAIR PROJECT

PREPARED BY: MCH
DATE: 4/30/98
FILE NAME: VIRGO.DWG

Lakeview Avenue | Robbinsdale | 2000

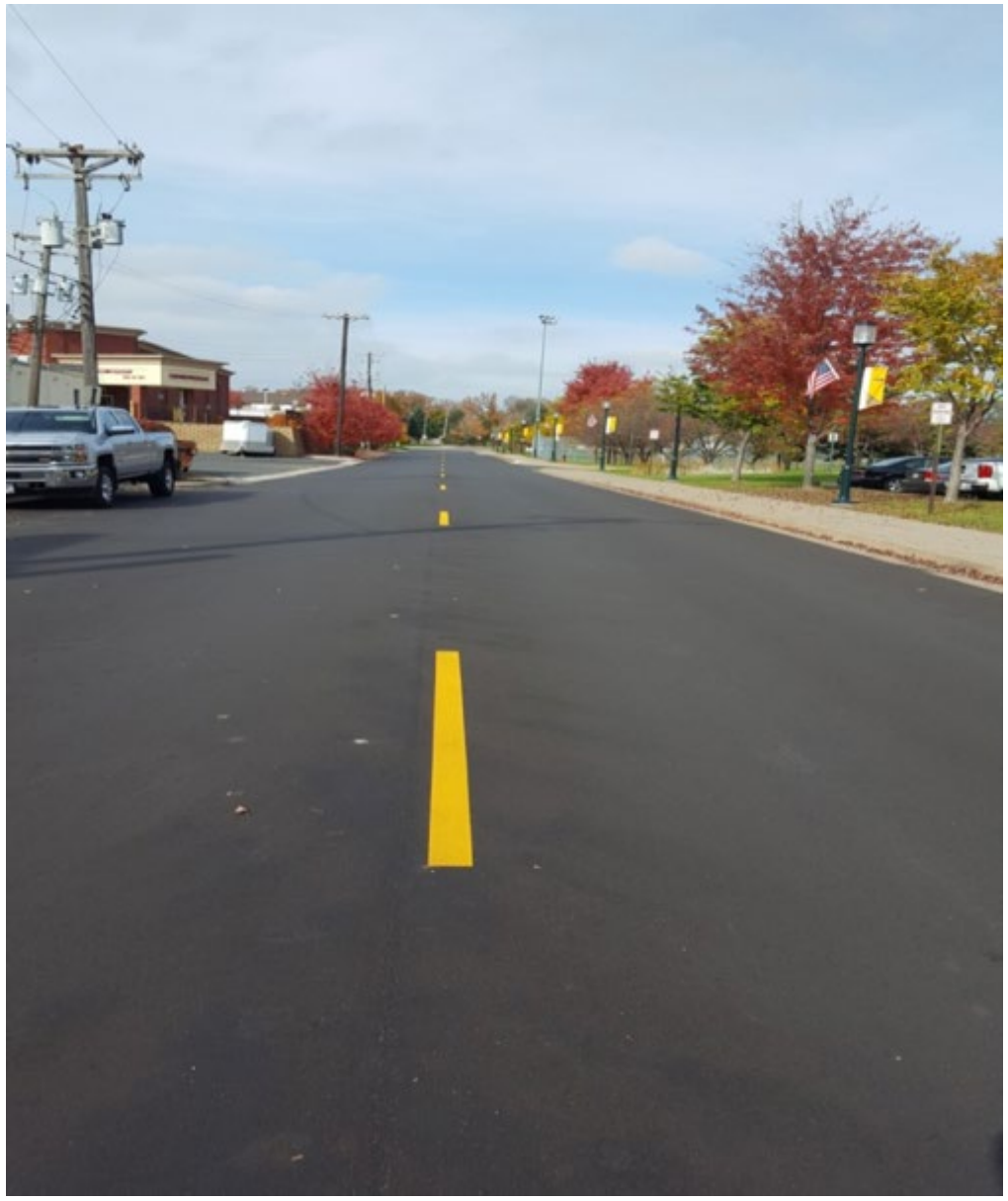
- The underlying soils were inadequate to support the everyday traffic in front of city hall.
- A lightweight aggregate was required to span the heavy weight soils of the old lakebed.
- TDA is a lightweight option that also prevents frost heave.

Lakeview Avenue | Robbinsdale | 2000

Lakeview Avenue | Robbinsdale | 2000

Lakeview Avenue | Robbinsdale | 2000

Lakeview Avenue | Robbinsdale | Present



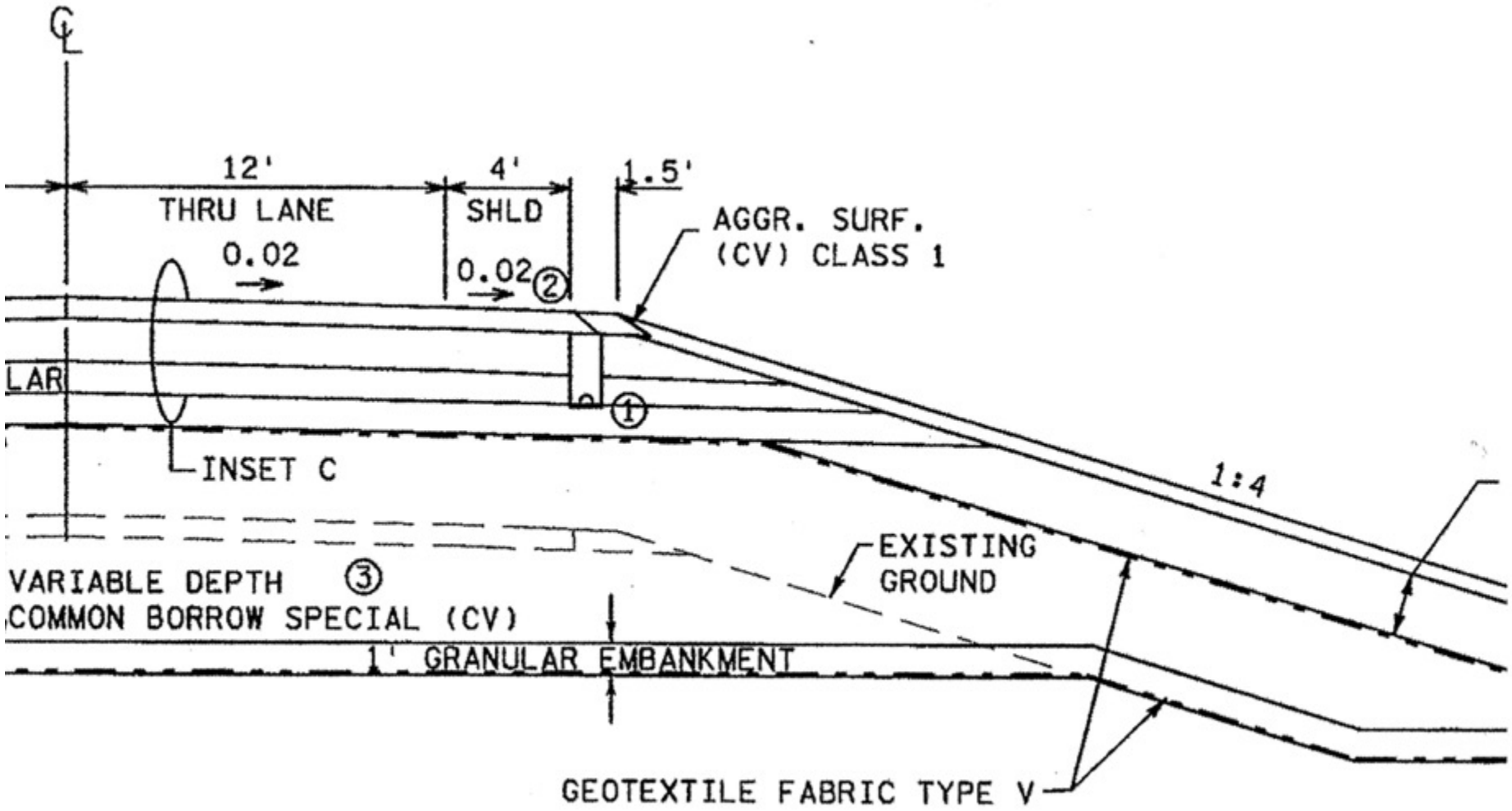
Highways

Hwy 169 | St. Peter | 2014

- After soil testing was completed, the geotechnical engineer determined that approximately 350-feet of the new roadway between Freeman Drive and HWY 169 would need to be constructed on lightweight fill.

- Several options were considered, but TDA was chosen for this application.

Hwy 169 | St. Peter | Cross Section



Hwy 169 | St. Peter | 2014

Hwy 169 | St. Peter | 2014

Hwy 169 | St. Peter | 2014

Hwy 169 | St. Peter | Present

Hwy 169 | St. Peter | 2014

ENTECH, INC.

- Tire Rubber Modified Binder
- Utilized for Hot Applied Chip Seal
- And
- As a Binder in Specialized Hot Mix Materials

From This . . .

To This . . .

How Do We Decide?

Blending and Manufacture

Application

Hot Applied Chip Seal Utilized on Pavements That Have Lower PCI – Expand Your Chip Seal Program


BearCat

2021 RCMS Project Outreach

- Video
  - FINAL - 100 Miles of Rubber Chip Seal.mp4 - Google Drive

Questions & Contact Information

Kirsten Clemens, P.E.
EGLE - Scrap Tire Coordinator
EGLE-ScrapTire@Michigan.gov
517-614-7431

Monte Niemi
TDA Manufacturing
tdamanufacturing@gmail.com
763-444-6017

Jeff Smith
Cactus Asphalt
jsmith@cactusasphalt.com

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY