



Utilizing Recycled Rubber, Tire Fiber, and Glass in Asphalt Pavements

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Overview

- **Field experiments and application of tire rubber**

Overview

- **Field experiments and application of tire rubber**

Subgrade

Engineering the tires, 2005



Recycle Waste Tires as Subgrade for Road, 2022



6 inches tire-derived aggregate layer

Pavement Surface Layer

Terminal Blend Field Demonstration in Keweenaw: Warm Mix and Hot Mix with Rubber, 2015

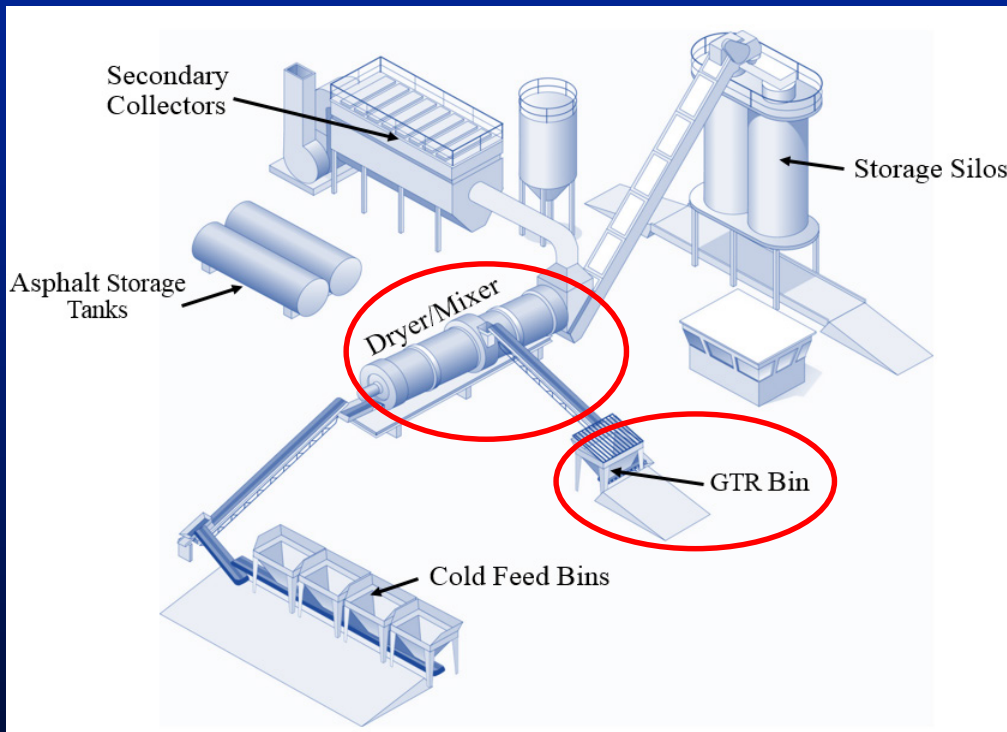
Payne & Dolan,
Inc.



Field Demonstration in Keweenaw, 2015



Dry Process: Kalamazoo, Gap Graded Thin Overlay, 2018



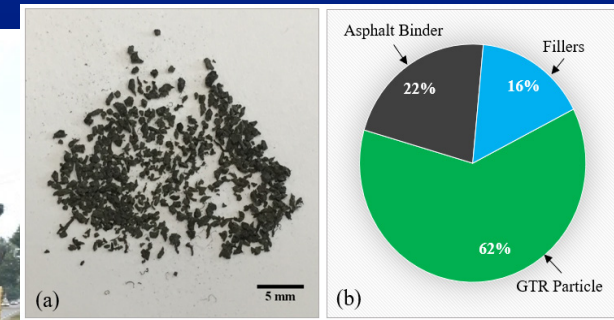
Revised from (Mamlouk, 2017)

Asphalt Plant and Production

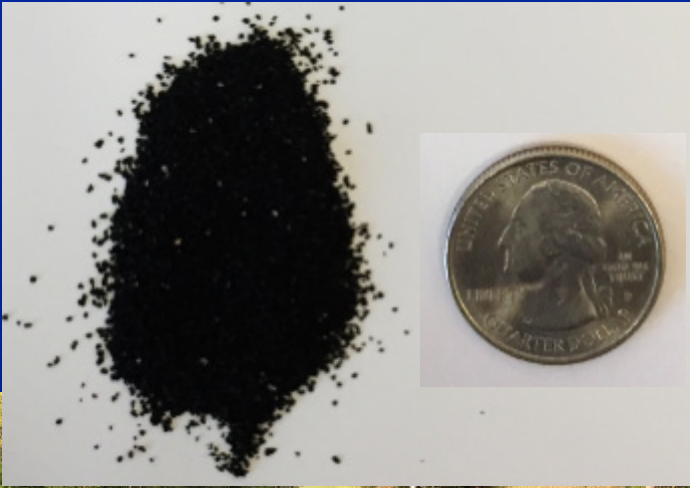


Dry Process: Kalamazoo County, 2018

- PG 58-28 binder
- Treated ground tire rubber, ~18% rubber by asphalt
- Aggregate gradations



Field construction in Dickinson County: Dry Process in Cold Region



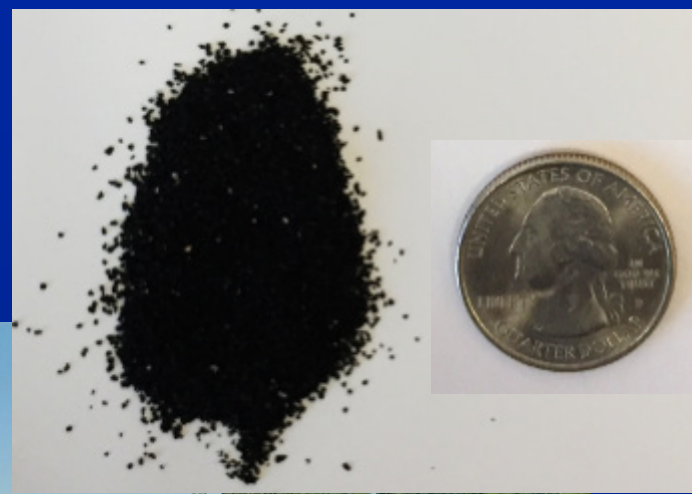
Emulsion application
before surface
placement



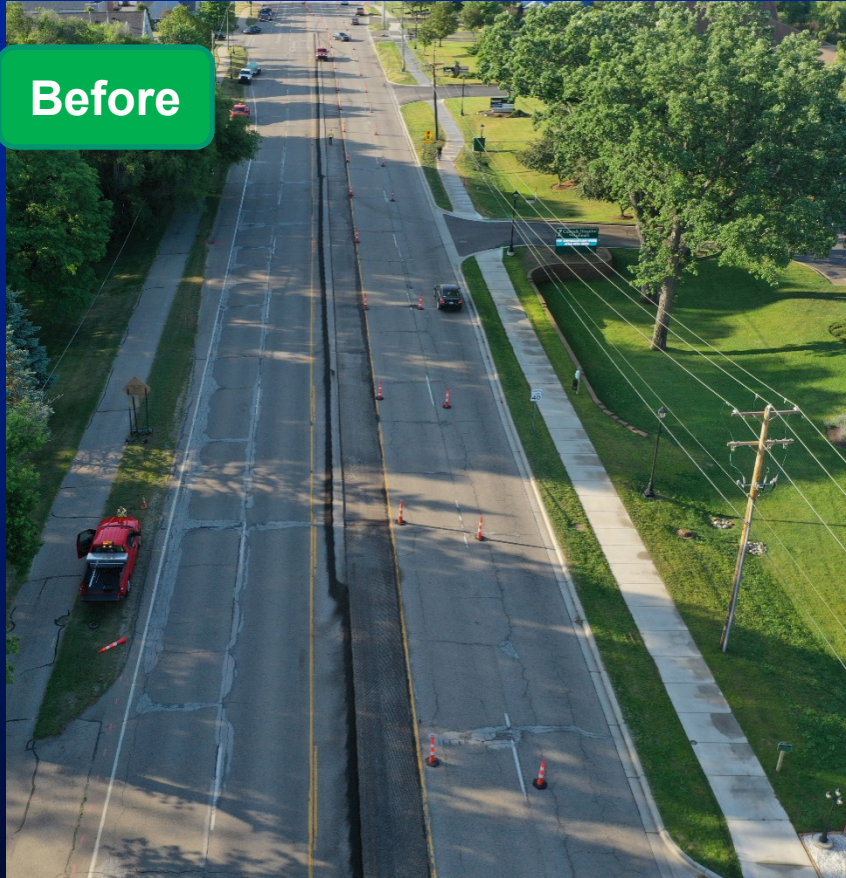
Surface layer
placement



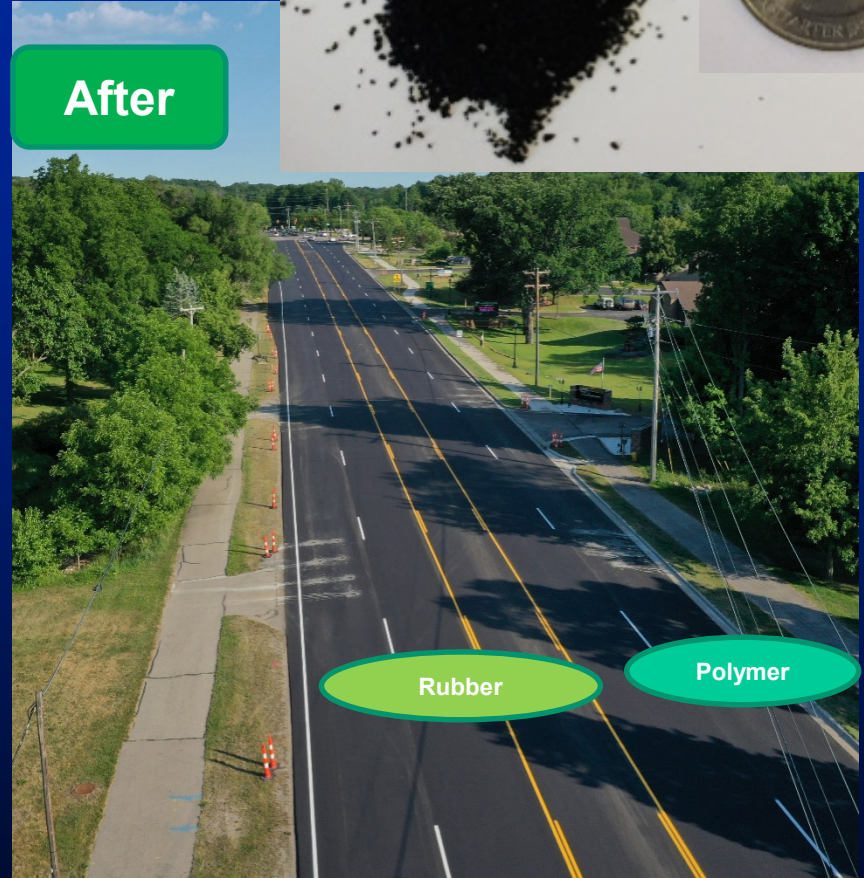
Implementation in Kent County: High Traffic



Before



After



Rubber

Polymer

Pavement Chip Seal: Maintenance

Rubber Chip Seal Construction in Michigan in 2015, 2018, 2021, 2022, 2023

Rubber chip seal field construction locations:

Rubber Asphalt Chip Seal 2015



Hot Rubber Asphalt Prep 2018



Hot Rubber Asphalt Prep 2021



Spray hot rubber asphalt



Apply chips

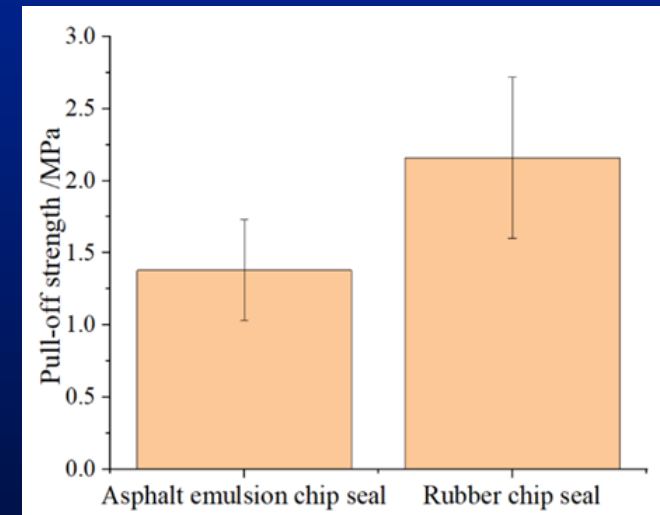
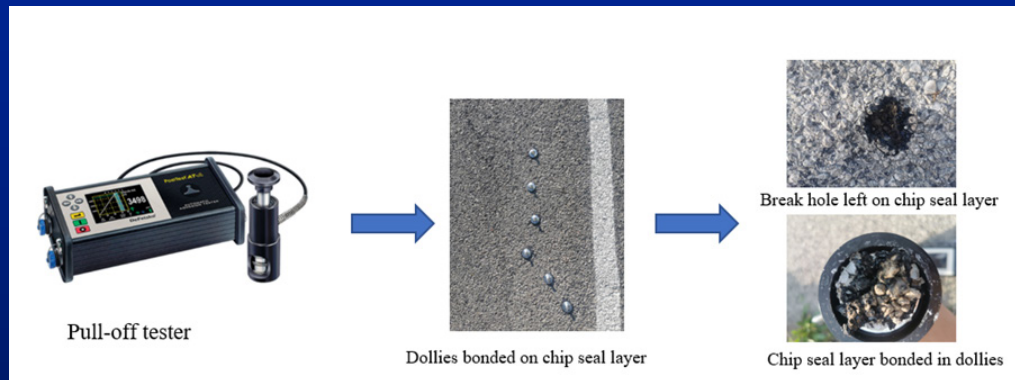


Research: Lab

Chip seal cores



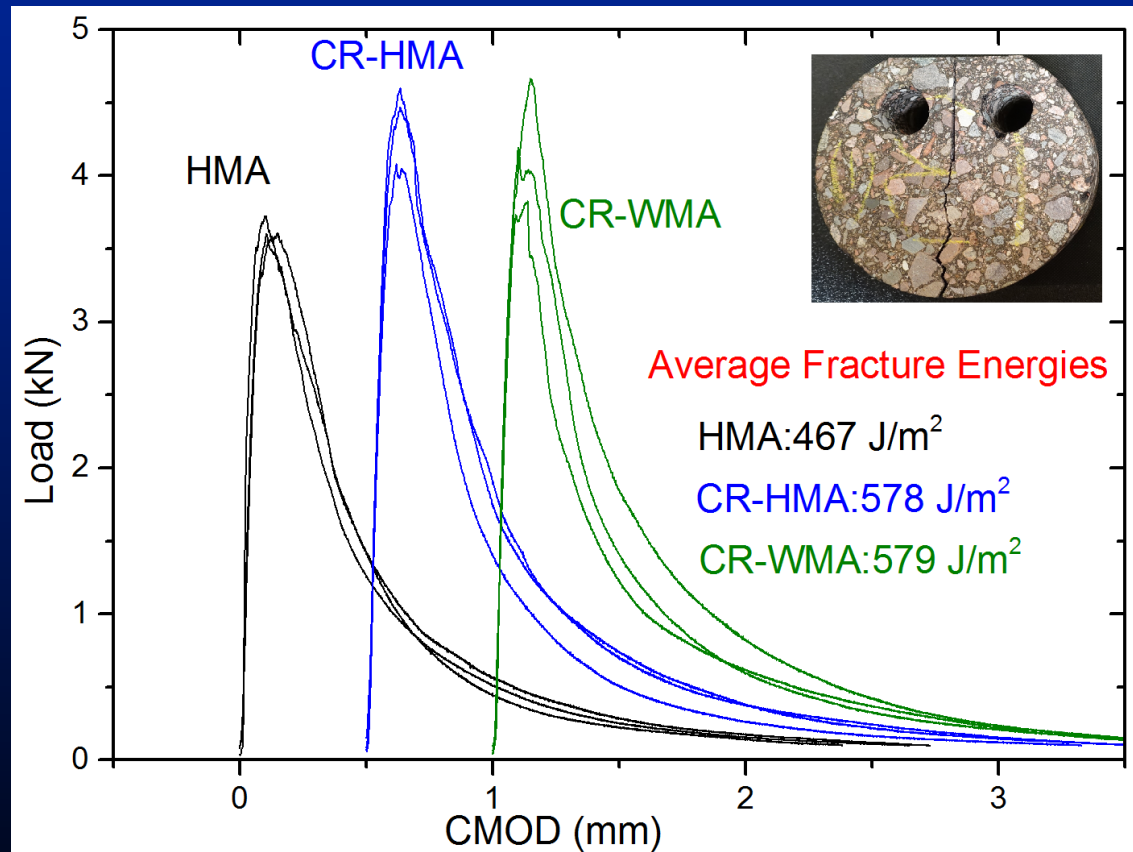
Rubber chip seal pull -off test



Hot rubber asphalt and conventional chip seal in-situ pull-off test results

Terminal Blend: Low temperature performance

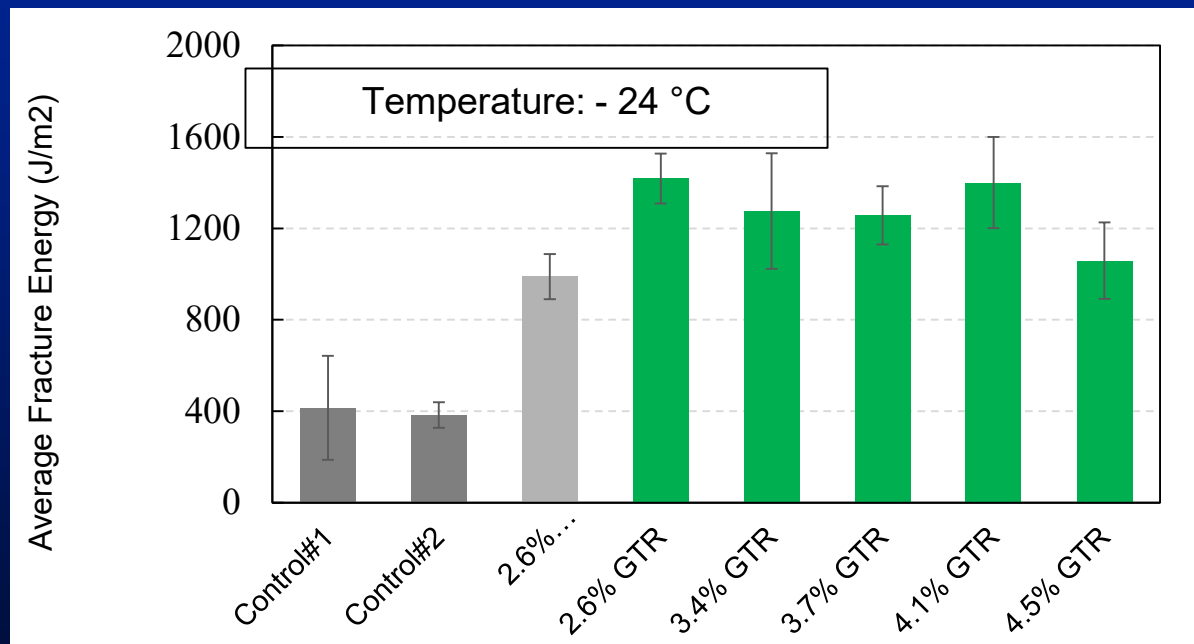
The CR-WMA with Evotherm and the CR-HMA exhibited better low temperature performance than that of the control HMA.



Experimental Program in Kalamazoo

Dry Process, High Rubber, Gap Graded

Disk-Shaped Compact Tension (DCT) Test results



2 to 3 times higher fracture energy than the control mix

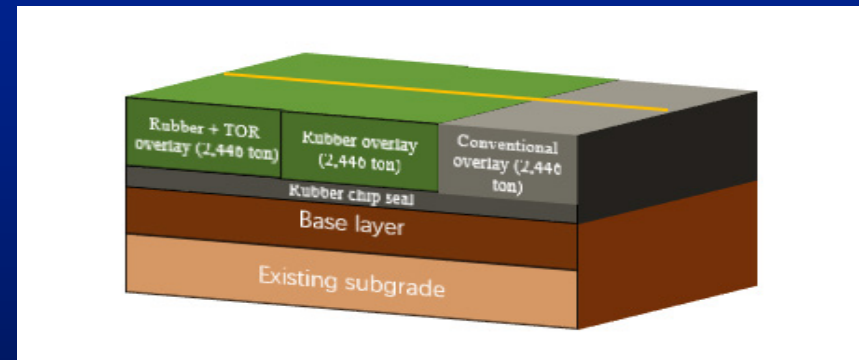
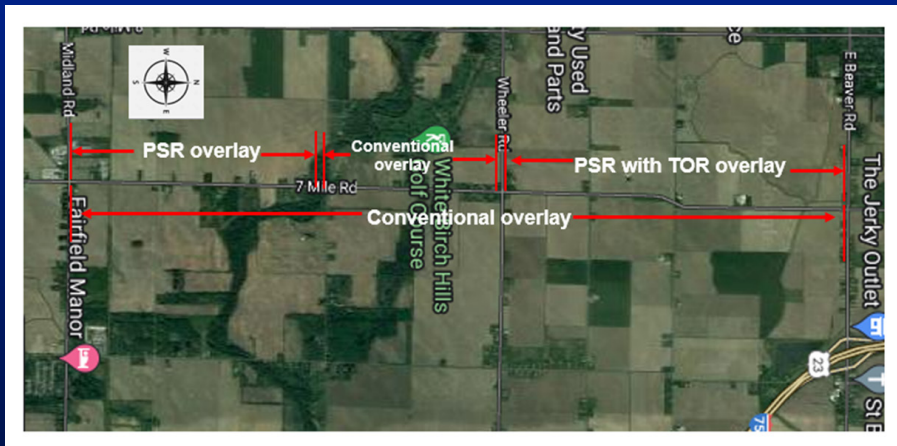
Dry Process with Rubber

SAMI: Bay County

- SAMI- Stress Absorbing Membrane Interlayer
- Dry Process of Overlay
- Wet Process of Rubber Asphalt Chip Seal
- TOR - Trans-Polyoctenamer Rubber

Executive summary

- Conventional overlay and rubber overlay asphalt mixture
- Rubber chip seal after milling



- Rubber content is 10% by mass of asphalt binder, **trans-polyoctenamer rubber (TOR)** is 0.45% by mass of asphalt binder
- Assume asphalt binder content 5.5%
- Anticipated number of equivalent tires: ~5,155

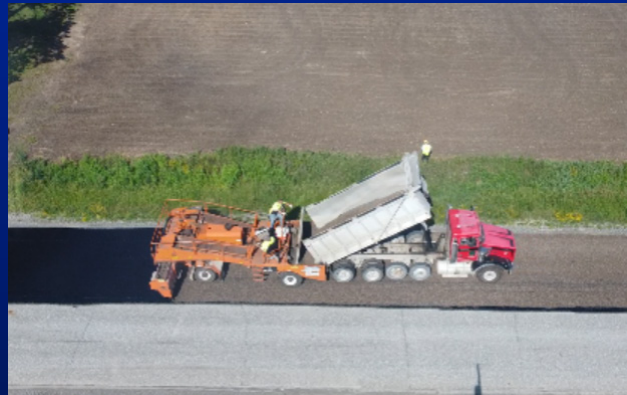
Asphalt Plant



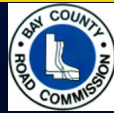
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Chip seal construction



Overlay Construction



Overlay Construction



Pavement condition without SAMI layer

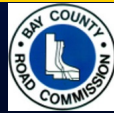


Pavement condition with SAMI layer



Pavement Condition Assessment (1 year)

	Pavement without SAMI layer	Pavement with SAMI layer
Severity level Average cracking frequency	Low Occurred every 6 m	No cracking observed

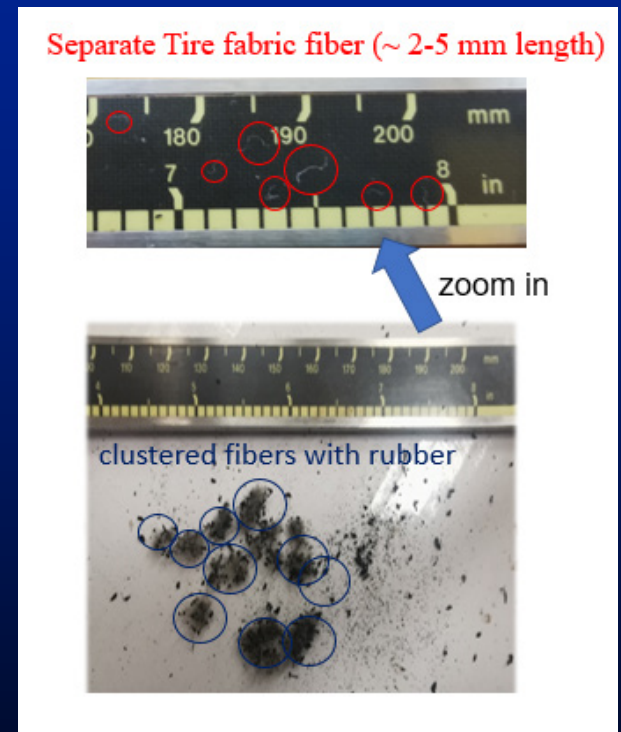


Overview

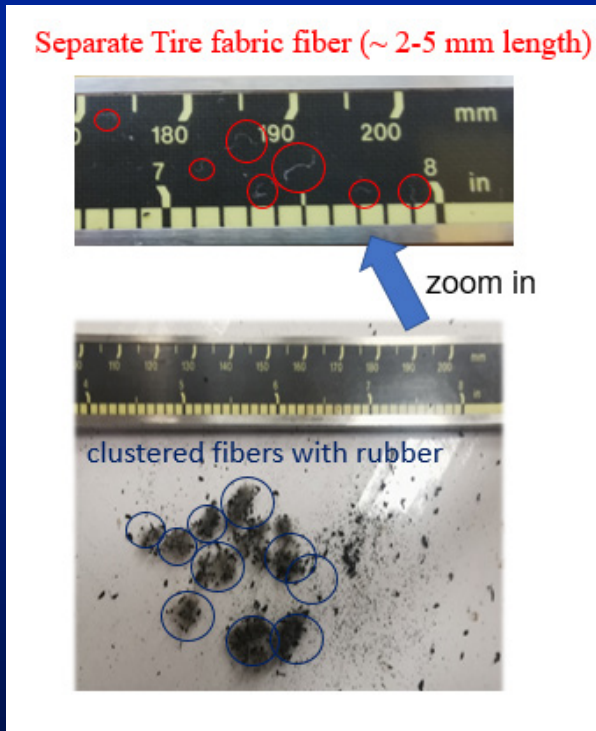
- **Field experiments and application of tire rubber**

Recycle Tire Fiber in St. Clair County

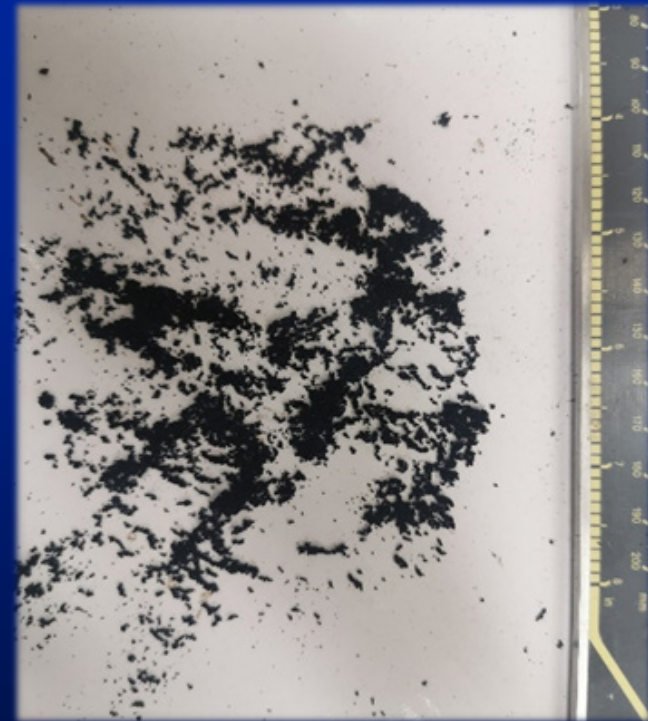
- Tire fiber: polyester cord fabrics, rayon cord fabric, nylon cord fabric, and aramid cord fabric
- Dry process



Materials



Tire fabric fiber



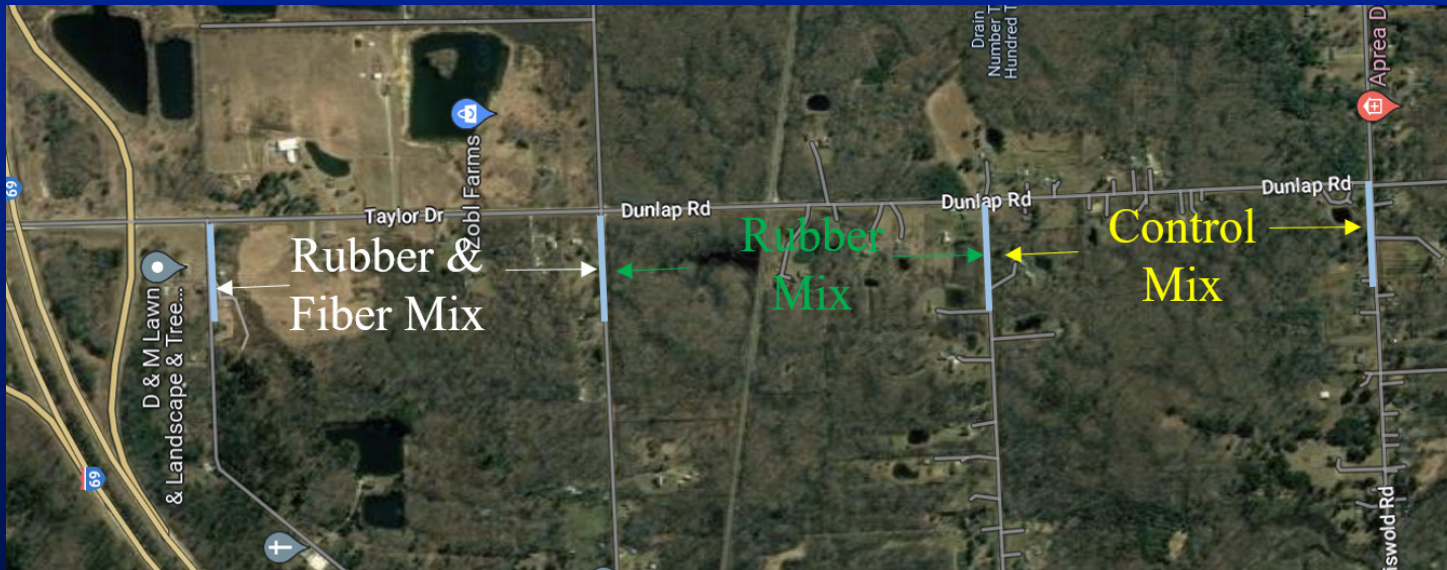
Tire scrap rubber

Plant



Recycled fiber and rubber in this project

Construction site



Recycled fiber and rubber in this project.



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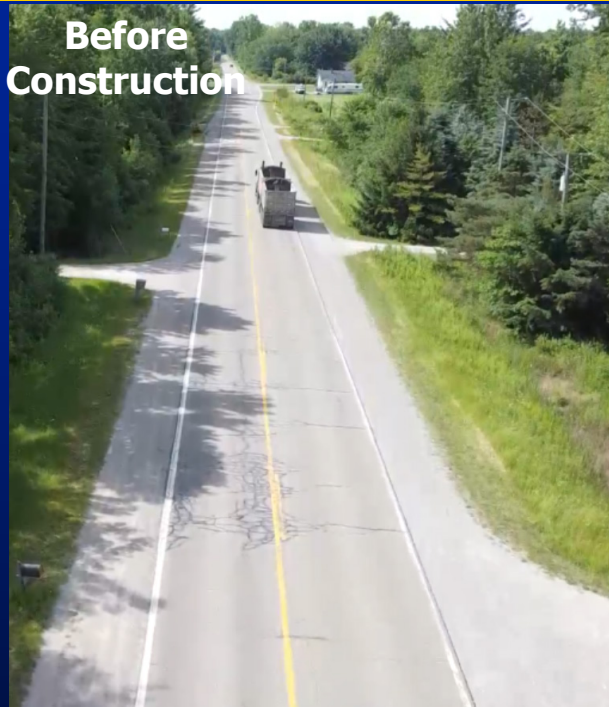
Paving and Compaction



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Construction Completed



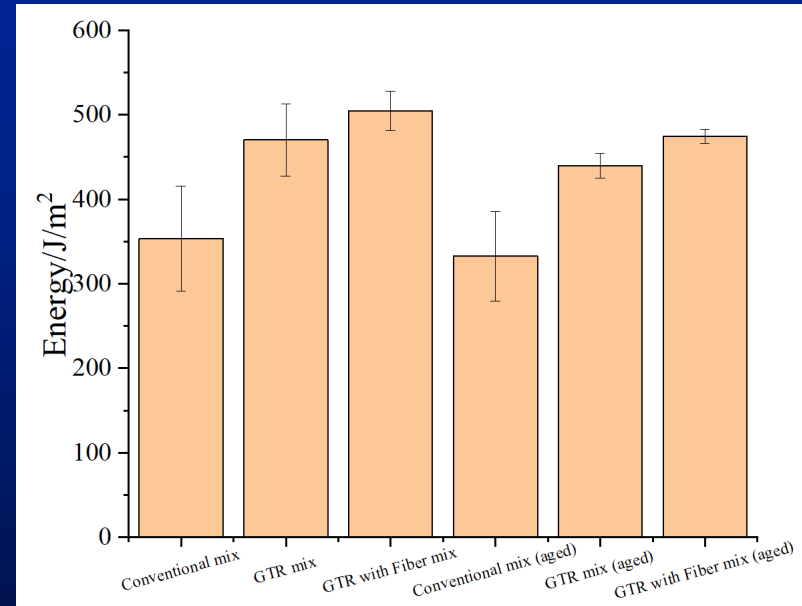
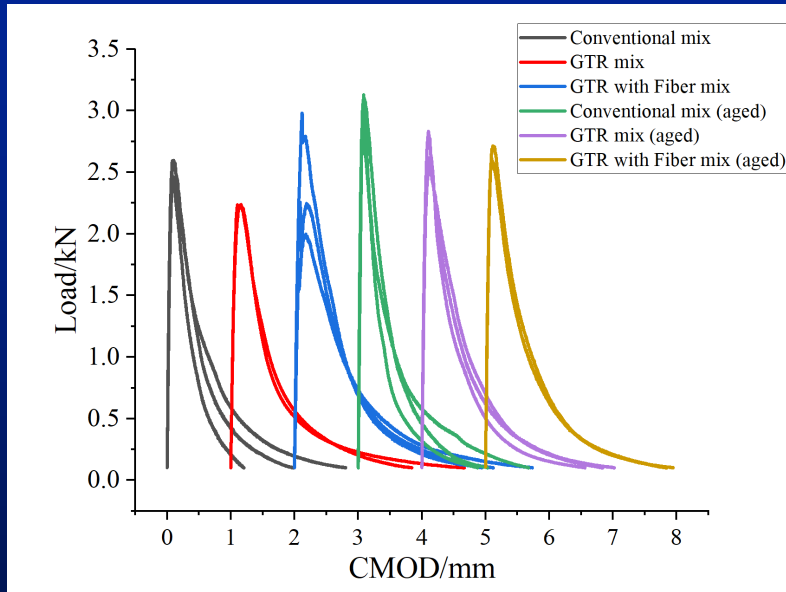
Recycled 2200 pounds of fiber and around 21,000 pounds of rubber in this project.



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Low temperature performance



Compared with the conventional mix, the fracture energy of the rubber modified mix and rubber with fiber modified mix increased by at least 24.4 % and 39.9 %

Overview

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Recycled Glass in Dickinson County



Implementation in Dickinson County: recycled rubber and waste glass



Waste glass aggregate



Asphalt plant in Dickinson County, MI



Paving leveling layer with recycled glass



14 tons of tire rubber recycled

Overview

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Summary and Challenges

Overview

- **Field experiments and application**

R&D Team with local and state partners in 2019



Project team: biking association, road commission, contractor, state government, state senate, and MTU



Award from County Road Association of Michigan

A R&D Team in 2023



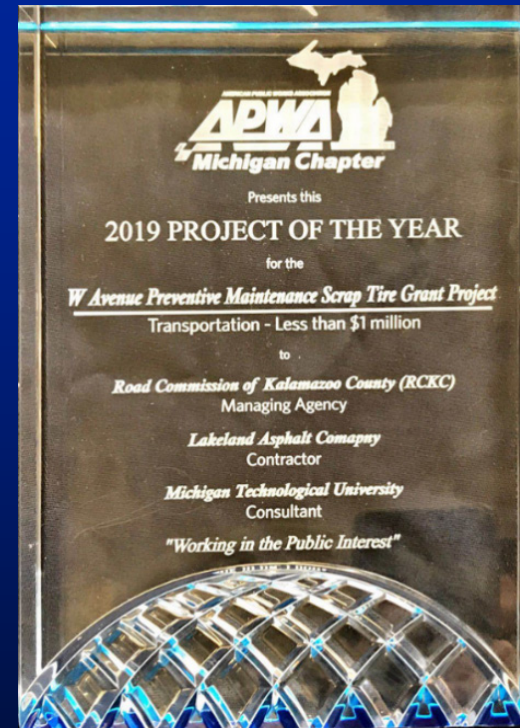
A R&D Team in 2023



R&D Team with local and state partners in 2018

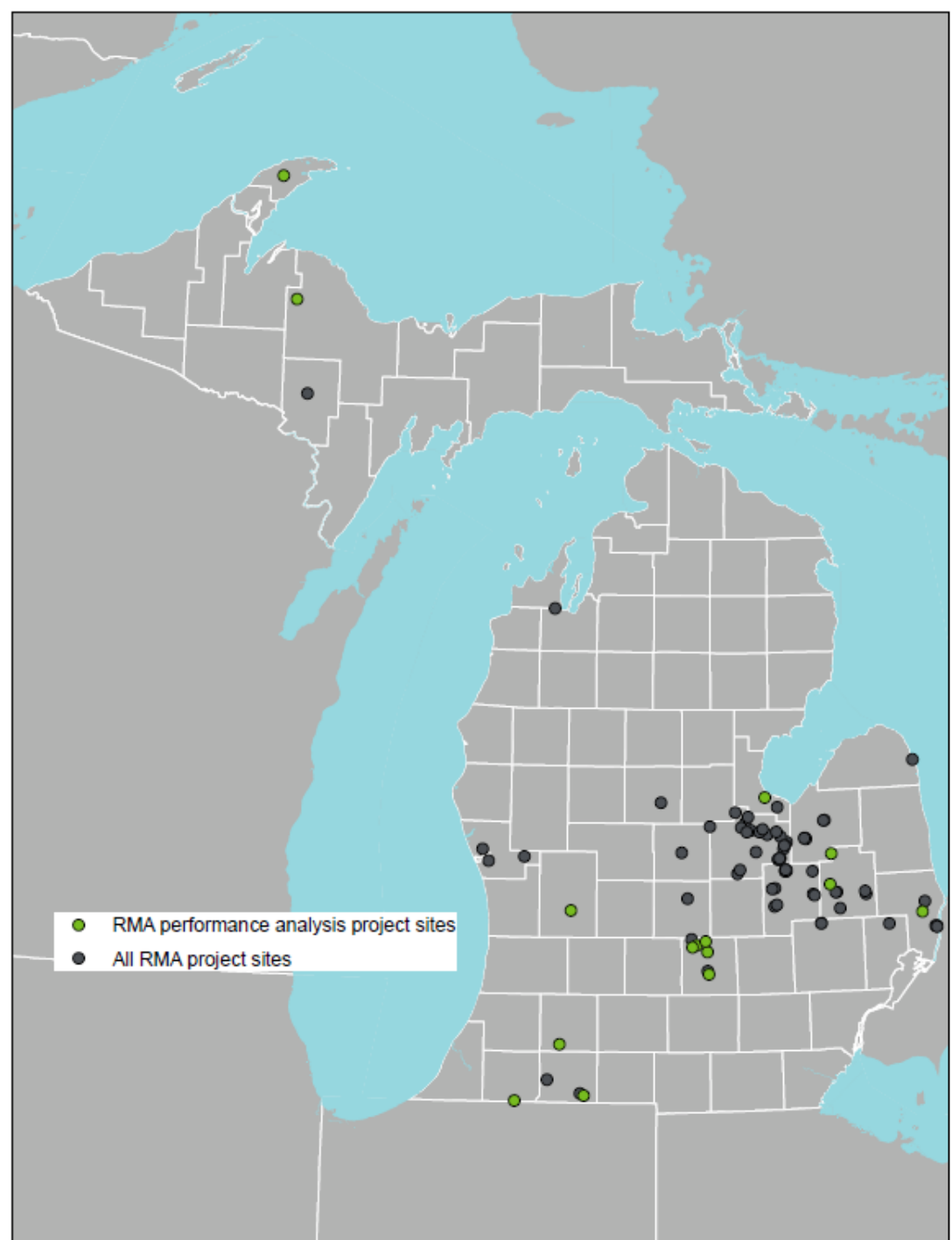


Project team: road commission, contractor, material supplier, and MTU



Award from American Public Works Association

Rubber asphalt projects in Michigan



Credit RRS

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