Mechanical Concrete for Heavy Duty, Low Volume Roads...and more.

PIOGA
2012 Winter Meeting

John A. Nawn, P.E., PTOE, FNSPE

February 8, 2011
Mechanical Concrete®

- John A. Nawn, PE, PTOE, FNSPE, FACFEI
  - Over 25 years roadway/civil engineering experience
  - Licensed Professional Engineer in 7 states
  - Executive Vice President/Chief Engineer with Czop/Specter, Inc.
  - Vice President, Pennsylvania Society of Professional Engineers
Mechanical Concrete®

• Czop/Specter, Inc.
  – 30 year old, Pennsylvania based, award winning, Civil Engineering Consulting firm
  – Survey, Engineering, Construction Management, Environmental Permitting.
  – 60 employees throughout Pennsylvania
  – PIOGA Member
Mechanical Concrete®

• Patented, licensed product/process
• By the Reinforced Aggregates Company
• Developed by Samuel G. Bonasso, P.E.
  — Former Secretary of Transportation for WVDOT
• www.mechanicalconcrete.com
• Engineered Product/Process
Mechanical Concrete®

- Independent consultant
- No contractual relationship between The Reinforced Aggregates Company and Czop/Specter, Inc.
- Likewise, no contractual relationship between John Nawn and Sam Bonasso.
Tire-Derived-Cylinder (TDC)-Mechanical Cement®

+ 

Stone Aggregate Material
How **Mechanical Concrete®** works

Gravity & Loads

↓

(create)

Lateral Pressure

→ ←

↓↑

Soil Pressure = Gravity & Loads

- Gravity & Loads on Particles ↓ create
- Soil Pressure Reaction ↑ also
- Creates & Transmits Lateral Pressure →
- *(TDC) Mechanical Cement®* Cylinder Direct Lateral Support for particles (→ ←)
Holistic Sustainability Criteria

- **Economically Viable**—Reduces initial costs, maintenance, & extends useful life
- **Technically Feasible**—Effective, Simple, Fast & Rugged (high design factor)
- **Environmentally Friendly**—Reuses & Uses Less: Material, Energy & Labor
- **Socially Supportive**—Preserves scarce resources & improves worker productivity
The Tire Problem

• 300 Million scrap tires/year
  – About 40% turned to crumb rubber and reused or stockpiled in monofills
  – About 50% burned: Tire Derived Fuels
  – The other 10% - 30 million tires
    • Can’t land fill, tires float
    • Can’t fill completely in current form
First Wall Section
Basic Load Research Information

• HS 25 Truck  Road Tire Pressures ≤ 100psi
• Contact area: 20,000 lb. wheel load ≥ 200 in$^2$
• Allowable bearing pressure sand 8000-4000 psf ≤ 42psi—21psi

• By what factor will confinement increase this bearing capacity?
R & D

WVU CE Laboratory Tests

TDC 50K Column Strength

Stone Aggregate Behavior
Aggregate Materials Tested

- Compacted Course Sand
- Compacted Crusher Run Limestone
- Compacted AASHTO #8 Limestone
- AASHTO #57 Limestone
Test Results 12” Long 20’φ Tube

**SAND AGGREGATE**

12" tube w/ 6’φ loading plate (28 in²) (6000lb max @ 200psi) Bearing Failure at 1800 lb, approx. 63psi

12" tube w/ 12’φ plate (113 in²) sand (200psi) (23,000lb max) (HS 25 Wheel 20,000lbs at 100psi)

12” tube / 18’φ plate (255 in²) sand (200psi) (50,000lb max) (HS 25 Wheel 20,000lbs / 100psi)
More R & D Was Performed

• Performance in the field
• Speed of Construction
• Effect of tire sizes
• Worker Learning Curve
• Quality Tolerances
• Applications
• Weather and Climate
• Behavior During Construction & Use
• Economics
Standard Aggregates

Uncompacted

– AASHTO #57 Crushed Stone
– Any Relatively Uniform Size, #3, #1 Structural Aggregate Material

Compacted

– Sands & Graded Aggregates
– Indigenous materials
– Existing roadway base materials
– All Recycled aggregate materials
Wall Construction Field Trials Laurel Aggregates Quarry in PA
Wall Tests
First Demonstration Projects
West Virginia
Division of Highways

Demo Project Doddridge County
Morgan Run Road Base
350 Mechanical Cement®
Tire-Derived-Cylinders (TDC)
September, 2006
Test Road filled TDC
Test Road Surfaced

September 27, 2006
First Israel Run Flood  April 1, 2007
Israel Run, June 2008
Flooding Damage
2 Feet of Water
Bowie, Inc.
Clarksburg, WV

January 2007 Demo Project
Sorbello Gas Well
20’ x 40’ Service Pad
200 Mechanical Cement® TDC
TDC Layout
Dozer
Bowie/Sorbello
Gas Well Service Pad—2 Hours
TRIAD MSE Wall Demo Project June, 2006

- Larger Structure Demonstration
- 650 Mechanical Cement® Steel Belt Truck TDC
- Mechanically Stabilized Earth, MSE
- Use of Medium Truck Tires
- Impacts of Tire Size Variations
- Interconnections between cylinders
Retaining Wall Construction
TRIAD MSE Retaining Wall
650 TDC Medium Truck Tires Total Length 190’x15’ Max. Height
First Demo & R/D Outcomes

• Fast, Strong & Economical
• May be surfaced with any material
• Erosion Resistant
• Climate and Weather Resistant (5+yrs.)
• Engineered Product
• Interfaces well with traditional means and methods

• worked as predicted(+)!
Mr. Samuel G. Bonasse, P.E.
The Reinforced Aggregates
208 Wagner Road
Morgantown, West Virginia 26501

Dear Mr. Bonasse:

The West Virginia Department of Transportation, Division of Highways, (WVDOT/WVDOH) Materials Control, Soils and Testing Division has evaluated your submittal of Mechanical Concrete per Materials Procedure (MP) 106.00.02. The material used to fill the used tires is listed as AASHTO #57. This material should always be inspected and approved prior to use on any Highways project. With the use of an approved aggregate and the use of used tires, MCS&T would approve the product for material acceptance on a per project basis. In order to get your product to be continuously incorporated into Highways projects, you will need to promote your product to our various Divisions. I have emailed you a copy of contact listings for our ten Divisions. These contact individuals will be most helpful to determine if a project using your product would be suitable for our needs. The more often your product gets incorporated into Highways’ projects, the more likelihood there is that a specification will be written to address the use. Please feel free to use this materials approval for your promotional needs.

Thank you for your interest in providing the WVDOH/WVDOH with new technology/product. If you have any further questions, please contact Mr. John Taylor of this Division at (304) 558-9876.

Very truly yours,

Aaron C. Gillispie, P.E.
Director
Materials Control, Soils and Testing Division

ACG:FJms
Reinforced Aggregates Company

• Patent and Trademark Licensor
    • Contractor, Manufacturer, Project, Agency, Et. Al. Licenses
  • Mechanical Concrete® & Mechanical Cement®

• Construction Technology R & D
  • Basic Designs, Details, Specs & Standards

• Construction Market Developer
Specifier
• Engineer specific applications and uses
• Technical support: Design & Construction
• Design/Build
2009 USDHS-CBP Productivity Assessment

Gibbons Ranch Road, Douglas, AZ
1400 feet unpaved, one lane
3000 Mechanical Cement®
Tire-Derived-Cylinders

Sundt Construction
Tempe, AZ
TDC In Place
Filling TDC with Stone
Filled TDC
Stone Surface
Site / Roadway Construction Productivity Rates

- **Auto Tire Derived Cylinder (TDC) Placement**
  - 1 Labor Hour = 150-AutoTDC 27”φ x 8”
  - 800 ± sf Placed and Attached
  - 80 Labor Hours per 12’ Lane Mile
  - 55 Labor Hours per Acre

- **Stone Spreading w/ 3 cy Wheel Loader**
  - ± 2400sf / 88 tons per hour
  - 27 Machine Hours per 12’ lane mile
  - 18 Machine Hours per acre

- **Roadway / Site Coverage**
  - 12,000 - 27” φ ATD Cylinders per 12’ lane mile
  - 8100 27” φ ATD Cylinders Per Acre
How it supports loads
Sundt Construction
Tempe, AZ

2010 USDHS-CBP Border Roads Project

2 miles—20’ roadway in 4 sections

**Mechanical Concrete®** 8” Base

Soil-Tac Resin Wearing Surface (6”ABC)

40,000 Tire-Derived Cylinders
USDHS CBP
Imperial Dunes, CA Section 1 mile
USDHS CBP
Imperial Dunes, CA Section
USCHS CBP
O'Neal Valley, CA Section +/- 0.5Mile
USDHS CBP
O Neal Valley, CA Section
Dana Prime #1 Mine
Coal Haul Road

Laurita, Inc.
Morgantown, WV
REAGCO N. WV Licensee

Project Features

• 10 inch Reinforced Concrete Surface
• 8 inch Mechanical Concrete® Base
• 2 inch AASHTO #57 Cover
• 1450 Mechanical Cement® Cylinders
• 300 40Ton Coal Trucks per Day
TDC Placement
TDC Filling w/
ASHTO # 57
Concrete Slab Placement
Finished Coal Haul Road
Laurita, Inc.
CORESCO Mon River
Barge Loading Facility
Morgantown, WV

Project Features

• 10” Reinforced Concrete Scale Approaches
• 8” Compacted Limestone Road Surface
• 9” Mechanical Concrete® Base
• 300 Coal Trucks Per Day
CORESCO Tire-Derived-Cylinder Placing
CORESCO TDC Placing and Filling
CORESCO Scale Approach
CORESCO Finished Stone Surface
Longview Power Plant Haul Road—
Crafts Run Road

N. WV/SW PA Licensee
Laurita, Inc. ARTBA Member
July, August 2011Morgantown, WV

• 10 inch Mechanical Concrete® Base w/ 6” topping
• 10 inch Reinforced Concrete Surface 500 feet
• 6 inch Asphalt Wearing Surface 400 feet
• 600 Coal and Refuse Trucks Per Day
Laying the base
Base w/ Geo-Grid Mesh
w/Reinforced Concrete surface
Base Course
Base Course
First Ohio Project

Liberty Tire Recycling
Monofill Industrial Roadway
Minerva, OH
November, 2011
Liberty Tire Road Under Construction
Liberty Road Completed In Use
Mechanical Concrete®

- **Economic and Sustainable**
- UTUBE Videos Available under “mechanical concrete”
3-D Aggregate Confinement

- **Sustainably** increases aggregate load carrying capacity by 3x or more
- Eliminates water-based failure mechanisms in aggregates
- Less Base Failures & Maintenance for
  - Pothole, Ruts, & Aggregate Binder Loss Issues
  - Road intersections, Interfaces and Boundaries
  - Soft Subgrade Destabilization
  - Ditch Line & Shoulder Drainage, Erosion, & Collapse
12 foot wide, 1 mile long, Road

**Mechanical Concrete Base**
- Excavation = $24,000
- 12,000 TDCs = $38,000 (includes licensing cost)
- Crushed Aggregate Base = $85,000
- **TOTAL = $147,000**

**Conventional Base Course**
- Excavation = $53,000
- Subbase (6”) = $64,000
- Crushed Aggregate Base = $114,000
- **TOTAL = $213,000**

MC is 64% of the cost of conventional construction
- Quicker, less material, less labor, less equipment, no compaction required.
  - Based on current PennDOT Statewide average costs
Other Potential Uses

• Retaining Walls
• Stream Bank Restoration
• EV Access Roads
• Limited use/reserve/overflow parking
• Bridge Abutments
• Drainage
• Beach stabilization