Base Stabilization and Innovative Rehabilitation Designs

MnROAD – TERRA Open House
July 30, 2008

Outline

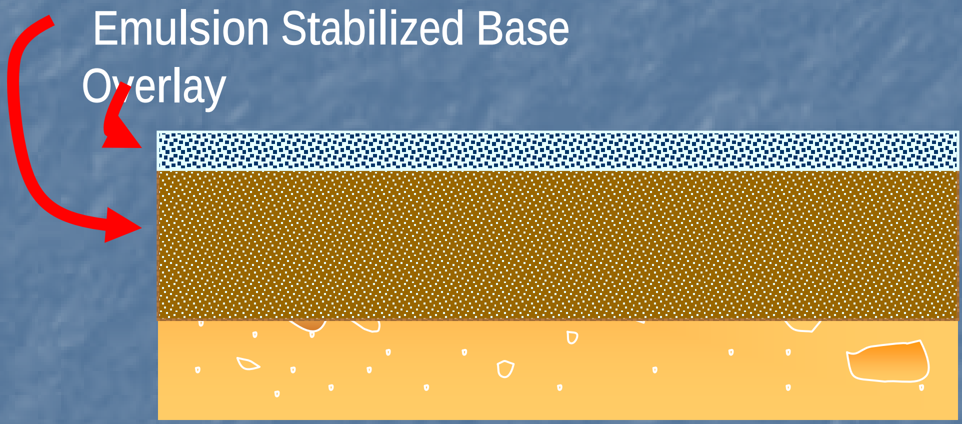
- Base stabilization and FDR description
- Types of roads for base stabilization
- Studies
- Case study
- The Green solution
- Future trends

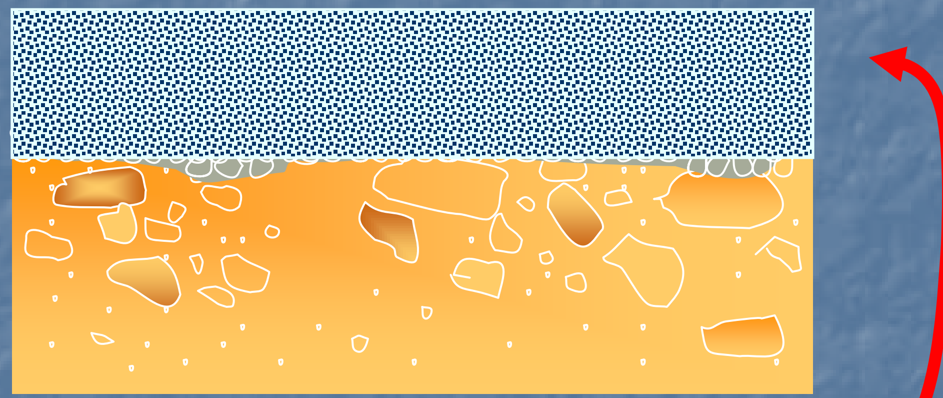
Needs Statement

Township roads, city streets, county roads, and state aid highways which are gravel with over 100 vehicles per day require more maintenance, gravel replacement and have high amount of complaints from dust, mud and roughness.

Paved roads that are rough and beyond their service life must be replaced or repaired.

Emulsion stabilization vs. traditional HMA Overlay





Base Stabilization

- Strengthens base
- Flexible emulsion mix
- Withstands low temperature
- Ready for
  - Stage construction
  - Future growth

4-6” HMA Overlay

- Over existing base
- Poor base ⇒ overlay failure
- Requires widening, curb, gutter, culvert work, etc.

The Process

Rolling

Grading

Finish Rolling

Quality Control

Surfacing

Completed Project - Sealcoat

Finished Project - Thin HMA

Road Types for Stabilization

- Gravel Roads
- City Streets
- Primary Highways

Gravel - Developing

Studies – Gravel Roads

IOWA DOT – HR 265

– *Highway Research Board - 1985*

- Break Even at 100 Vehicles / Day (15 Day Blade Cycle)

When to Pave a Gravel Road

– *Vermont Local Roads Program - 1987*

- 50 Vehicles / Day = Consider
- 400 Vehicles / Day = Serious Consideration

Converting from Gravel Road to Paved

– *Strong But Flexible Foundation for Chisago County – TRB 2004*

- $500,000 per mile for reconstruction
- $174,000 per mile for emulsion stabilization, culvert work, and overlay

Distressed Paved City Street

Studies – City Streets

- TRB 2008 - City of Las Vegas, NV – Washington Ave.
  - 0.8 mile city street, curb and gutter / utilities – 4 lanes plus turn lanes
  - $322,661 cost savings
  - 30% savings compared to typical rehabilitation costs
  - Shortened construction time from 120 days to 40 days
  - 3000 fewer loads of material in and out of project

Distressed primary routes

Studies – Highways

- MoDOT US 71 in 2005
  - 4” CIR and 6” FDR (shoulders) with 1.75 inch HMA overlay
  - Alternative was 6” mill and 7.75” inlay
  - 40% cost savings by recycling compared to alternative

MnRoad I-94 design alternatives

Interstate with Granular Fill

Four Season Analysis

Design Section Number	Subgrade R-Value	Design Subgrade Modulus (psi)	Design Life (years)	Total ESAL	ESAL per Year	UTBWC Thickness (in.)	PMAC Base Thickness (in.)	FDR Base Thickness (in.)	RAP Aggregate Base Thickness (in.)	Granular Fill Base Thickness (in.)		Design Control	Design Life (years)
1	12	7,800	5	3,500,000	700,000	0.75	2.00	6.0	6.0	26.0		fatigue	5.9
2	12	7,800	10	7,000,000	700,000	0.75	2.00	7.5	4.5	26.0		fatigue	10.3
3	12	7,800	20	14,000,000	700,000	0.75	3.25	8.0	4.0	26.0		fatigue	21.5
4	12	7,800	10	7,000,000	700,000	0.75	2.00	7.5	4.5	26.0		fatigue	10.3
5	12	7,800	10	14,000,000	1,400,000	0.75	3.25	8.0	4.0	26.0		fatigue	10.7
6	12	7,800	10	21,000,000	2,100,000	0.75	4.25	8.0	4.0	26.0		fatigue	11.1

MnRoad I-94 FDR Study Plan

Test	Reason	Materials	Quantity	Related to…
FDR Mix Design	Determine optimum emulsion formulation, content, and possibility for additional materials (SemMaterials)	Slabs and base material pre-job (MnDOT)	500 pounds from each of the cells (2, 3, and 4)	Construction parameters
Dynamic Modulus	Determine E* at various frequencies and temperatures; produce master curve (SemMaterials)	Collected on as-constructed material and compacted in SGC on-site (SemMaterials). Alternatively, material without emulsion can be mixed with emulsion in lab.	5 specimens per cell. (5 x 6.2 kg = 75 pounds per cell)	Input into MEPDG
Beam Fatigue	Determine cycles to failure and determine curve coefficients (SemMaterials)	Collected during construction pre-emulsion to be mixed in lab with emulsion sampled during construction (SemMaterials)	Enough for 5 slabs per cell (5 x 15 kg = 165 pounds per cell)	Input into MEPDG and compared to measured cracking
Field observations and FWD testing	Determine distresses over time (MnDOT and SemMaterials joint participation)	--	--	Performance

Case Study - Base Stabilization – Chisago County

- Worked with county and consultant to evaluate roads
- Worked with a new design process and new asphalt emulsion
  - Adjustments made from learning

Why Chisago County Chose Base Stabilization?

- Needed solution
- 130 miles gravel – Chisago County board wanted a paved surface
- Increased traffic
  - 5th fastest growing county in state
- Gravel pits used up / development
- Increased maintenance costs
  - Gravel / Blade: +2 Times/ Week

Options

- Needed economical solution
- County board bonded for road paving program - $6 Million
- Typical approach: Reconstruction
  - Approx. $500,000 / mile
  - Numerous right-of-way issues
- Would have accomplished 12 Miles at best

Decision

- Cost effective vs. Reconstruction
- Longer lasting pavement surface vs. just adding 4” HMA
- Testing after base stabilization = +9 Ton
- Done under traffic
- Time savings in delivering to public
- Minimal rutting / minimal cracking or break-ups to date
- Positive public reaction

Since 2001

- Worked in projects in other states to increase learning
- Several hundred miles have been placed using the engineered FDR system

Pavement Recycling: A “Green” Solution

- From Better Roads, July 1993
  - 20,000 BTU to mix 1 ton of CIR (no agent)
  - 250,000 BTU to dry and mix 1 ton HMA (no asphalt)
- Savings in materials
- Quicker construction

Future Trends and Research

- Mechanistic Empirical Pavement Design Guide
  - Independent research has shown recycling methods need more structural credit than they are given
- Lots of interest right now in recycling
  - National FDR study at SDSM&T
  - Trade publications giving recycling much interest
- Use of recycling is expected to grow

Conclusions

- Recycling is cost effective
- Recycling provides structural support
- Recycling saves time and resources