

ANALYSIS OF ODOT SUBGRADE STABILIZATION PRACTICES: A CASE FOR GLOBAL CHEMICAL STABILIZATION



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INTRODUCTION

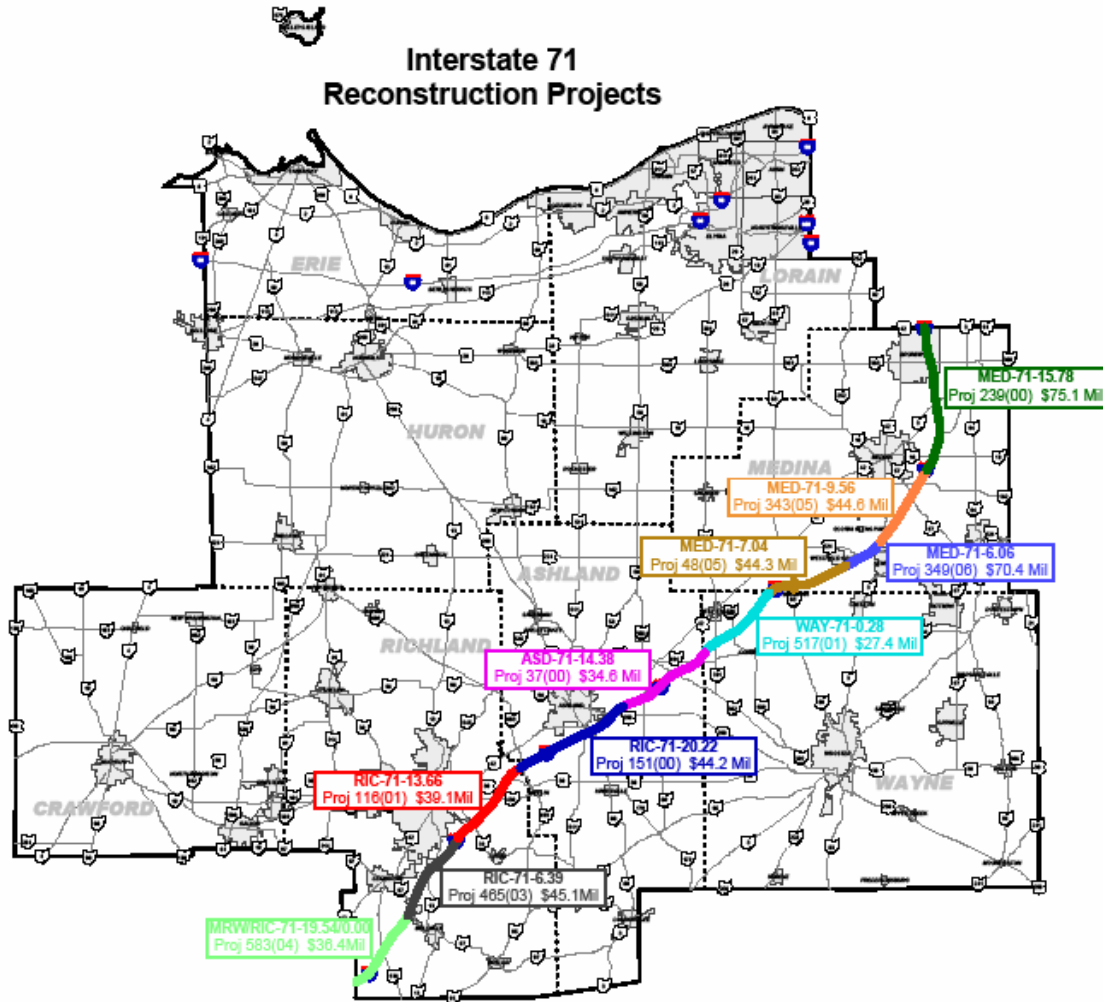
- Should ODOT expand its use of global chemical stabilization of the subgrade for new construction and pavement reconstruction projects?
 - Costs and benefits
 - Comparison with ODOT's current guidelines



BACKGROUND

- 1999: ODOT announced a 10-year plan to rebuild and add a third lane on IR-71 between Cleveland & Columbus
- 2000: Construction begins in District 3
 - Four counties, 71 miles
 - ADT 49,000; 25% - 31% trucks
 - 10 projects
- October 2007:
 - 9 of 10 projects complete
 - 10th project's estimated completion date July 2010

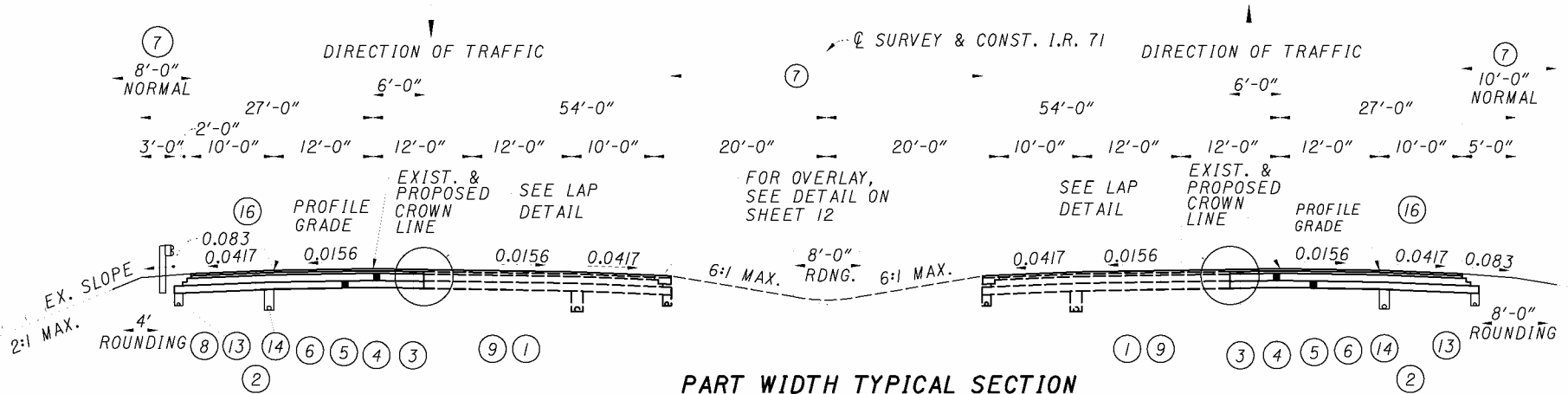
BACKGROUND



District 3 IR-71 Projects

BACKGROUND

- Plan Design
 - ODOT and consultants designed plans
 - Plans include information about general soil types and treatments
 - Subgrade soils mostly silts and silty clays
 - General subgrade treatments were to excavate and replace poor soils with granular material
 - Pavement designs based on a subgrade CBR of 5 or 6, with ±14" of warranty asphalt on 10" of Item 304, Aggregate Base



**PART WIDTH TYPICAL SECTION
ABUTING PREVIOUS PAVING**

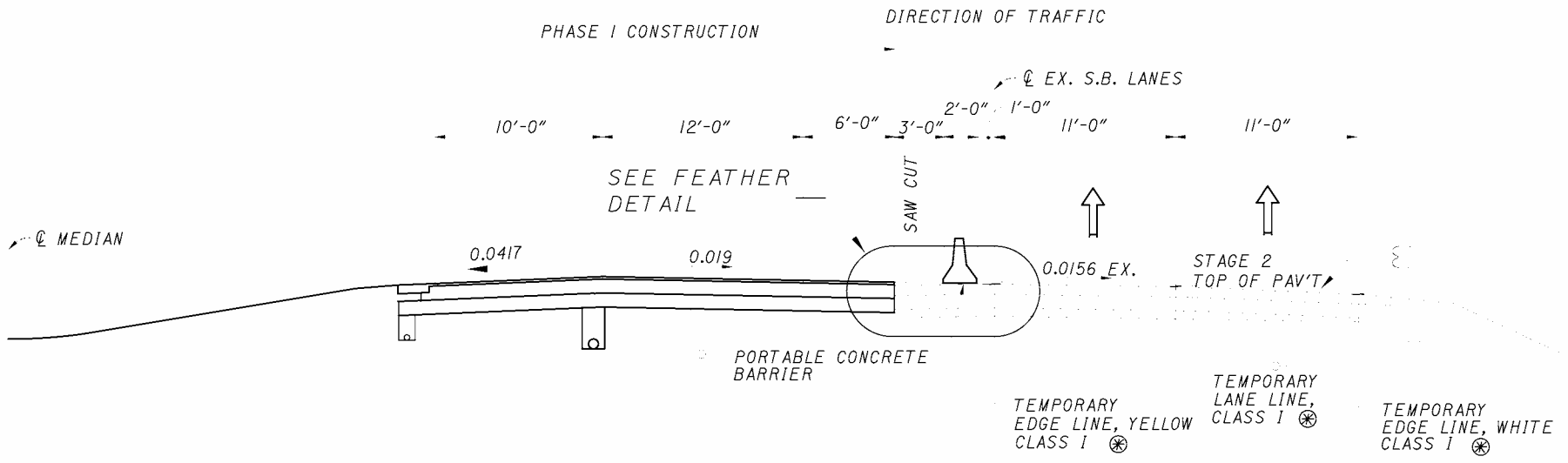
SB LIMITING STATIONS
 STA. 320+00.00 TO STA. 336+00.00 = 1600.00'
 STA. 486+28.80 TO STA. 504+75.00 = 1846.20'

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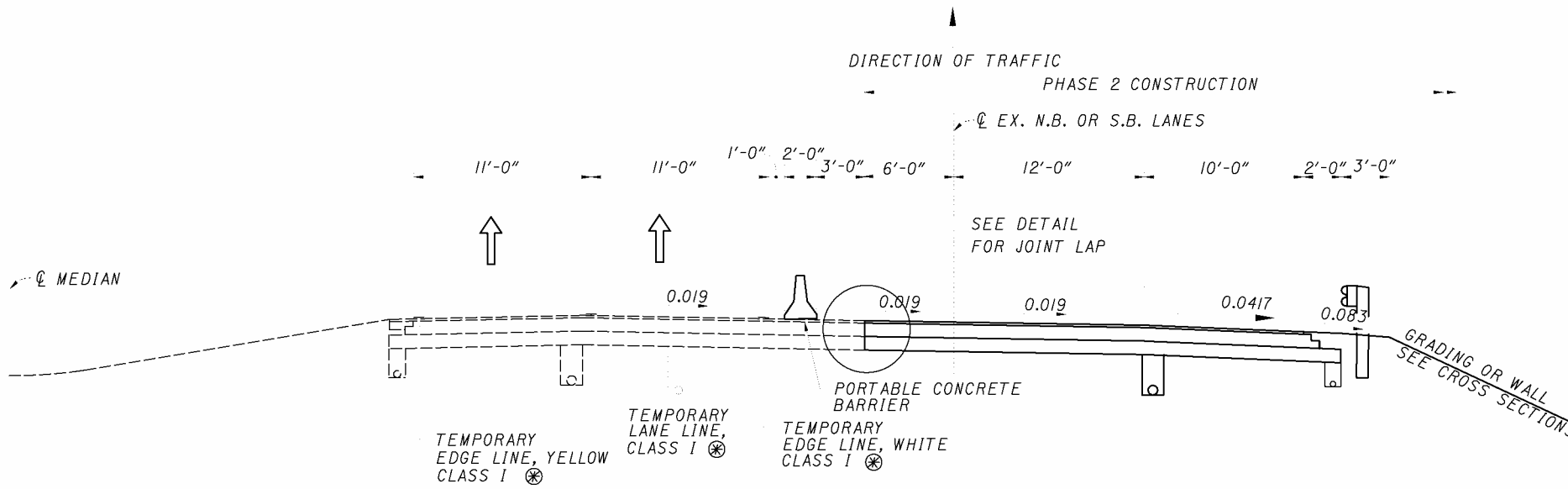
- # (1) 446 1 1/2" ASPHALT CONCRETE SURFACE COURSE, TYPE 1H
- # (2) 407 TACK COAT FOR INTERMEDIATE COURSE (SEE GENERAL NOTE)
- # (3) 446 1 3/4" ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 2, PG64-28
- # (4) 302 1 1/2" ASPHALT CONCRETE BASE, PG64-22
- # (5) 304 10" AGGREGATE BASE

BACKGROUND

- Plan Construction
 - Phased construction method
 - Phase 1:
 - Traffic maintained on driving lane and outside shoulder to rebuild part of old passing lane, add new lane, build paved shoulder, and median
 - From April – July
 - Phase 2:
 - Finish old passing lane, driving lane, and outside shoulder
 - From August – December



**MAINTENANCE OF TRAFFIC TYPICAL SECTION
REQUIRING LONGITUDINAL BUTT JOINT
PHASE 1**



**MAINTENANCE OF TRAFFIC TYPICAL SECTION
REQUIRING LONGITUDINAL BUTT JOINT
PHASE 2**

BACKGROUND

- March 2000 to November 2001: 3 projects in construction
 - All had unanticipated subgrade problems



BACKGROUND

- MED-71-15.78
 - Severe subgrade issues
 - Added \$10.8 million to cost of project
 - Caused ODOT to review approach towards subgrade improvement



IMPLEMENTATION BY PLAN

- District Three's IR-71 Projects:
 - Quantities were provided for planned locations for subgrade improvements
 - Repairs were also required at random locations that failed proofrolling or were determined to be weak from construction traffic
 - Always insufficient quantities for repair work
 - Approximately one-fourth to one-third of subgrade area was repaired
 - Chemical stabilization added by change orders
 - Acceleration added by change orders

IMPLEMENTATION BY PLAN

- Unplanned subgrade work created tension between ODOT and the contractors
- ODOT incurred huge costs for addressing contractors' claims, acceleration, or maintaining a work zone during the winter

Completed Projects	Plan Costs (\$)	Change Order Costs (\$)	Ratio Actual vs. Planned
ASD – 71 – 14.38	268,254.10	1,545,024.90	6.8
WAY/MED – 71 – 7.04/0.00	530,286.65	695,583.75	2.3
MED – 71 – 9.56	430,348.00	1,127,763.04	3.6
MED – 71 – 15.78	763,105.40	10,845,810.77	15.2
MRW – 71 – 19.54	2,242,682.65	691,927.09	1.3
RIC – 71 – 6.39	400,703.90	528,448.40	2.3
RIC – 71 – 13.66	342,125.00	543,011.50	2.6
RIC – 71 – 20.22	0	3,041,143.93	?
WAY – 71 – 0.28	835,101.00	277,289.50	1.3
Total	\$5,812,606.70	\$19,296,002.88	4.3

IMPLEMENTATION BY PLAN

- Cost Summary:
 - To stabilize subgrade:
 - \$25 million for all 9 projects
 - 3.3 times more than the expected cost
 - Cost 1.6 times more than expected without considering MED-71-15.78



CHEMICAL STABILIZATION COMPARISON

- Costs based upon historical data from Office of Estimating
- Generally, the cost ranged from \$5.45 to \$5.70 per square yard
- Average cost was \$5.56 per square yard over the period of time the projects were let



CHEMICAL STABILIZATION COMPARISON

- Cost comparison to determine whether global chemical stabilization provides benefits

Table 2 – Actual Costs vs. Chemical Stabilization Costs		
Project	Actual Costs (\$)	Chemical Stabilization Costs (\$)
ASD - 71 - 14.38	1,813,279.00	2,472,005.25
WAY/MED - 71 - 7.04/0.00	1,225,870.40	2,469,684.36
MED - 71 - 9.56	1,553,111.04	1,409,882.76
MED - 71 - 15.78	11,608,916.17	4,074,231.04
MRW - 71 - 19.54	2,934,609.74	2,687,188.77
RIC - 71 - 6.39	929,152.30	2,681,442.50
RIC - 71 - 13.66	885,136.50	2,617,860.00
RIC - 71 - 20.22	3,041,143.93	3,199,664.00
WAY - 71 - 0.28	1,164,331.50	2,560,010.40
Total	\$25,155,550.58	\$24,171,969.08

CHEMICAL STABILIZATION COMPARISON

Observations using global chemical stabilization:

1. Three of the nine projects would have been less expensive
2. A fourth project would have cost about the same
3. The overall cost for the nine projects was almost identical for both subgrade improvement strategies
4. ODOT could have built a superior roadway for approximately the same amount of money



CHEMICAL STABILIZATION COMPARISON

A global chemical stabilization design could have produced the following benefits:

1. Improve budget accuracy
2. Facilitate scheduling by identifying all subgrade work at time of bid
3. Reduce or eliminate construction arguments, issues, and claims related to subgrade
4. Increase productivity by providing a stable platform for the Contractor

CHEMICAL STABILIZATION COMPARISON

Benefits (continued):

5. Allow work on subgrade immediately after a rain, reducing weather delays
6. Provide a uniform and superior subgrade for the pavement, improving performance and durability
7. Allow for an improved subgrade CBR and reduce the overall pavement thickness
 - A. A 1.5” reduction in asphalt thickness would have saved \$12.0 million
 - B. A superior roadway could have been built for \$12.0 million less

STRATEGY FOR IMPROVEMENT

- **Subgrade Treatment**
- **Pavement Design**



STRATEGY FOR IMPROVEMENT

Subgrade Treatment

- November 1, 2001: Office of Geotechnical Engineering issued interim guidelines for subgrade treatment
- July 11, 2003: Guidelines formally adopted by Geotechnical Bulletin GB1 Plan Subgrades
 - Used for all pavement replacement, pavement widening, or rubblize and roll projects
 - The last three D-3 projects were designed and constructed using GB1

STRATEGY FOR IMPROVEMENT

Subgrade Treatment

- GB1 gives exploration requirements
- Results determine location, type, and depth of stabilization to be provided in the plans and design CBR
- GB1 stabilization types:
 - Undercut and replace with granular material
 - Chemical stabilization with lime or cement
 - If 30% or more of subgrade should be stabilized, a cost analysis is done to see which is more economical

STRATEGY FOR IMPROVEMENT

Subgrade Treatment

- GB1 has significantly improved ODOT's ability to predict quantity of subgrade stabilization and include quantities in plans
 - A few years ago, change orders for earthwork items completed over a rolling 12-month period peaked at 50%, but are now at 15%
- GB1 does not help predict locations of subgrade stabilization
 - Field verifications need to be performed to verify or modify the extent and depth of stabilization to be performed

STRATEGY FOR IMPROVEMENT

Subgrade Treatment

- District 3 has built three IR-71 projects using GB1
- WAY/MED-71-7.04/0.00
- MRW-71-19.54
- MED-71-8.26
(part of MED-71-6.06)

STRATEGY FOR IMPROVEMENT

Subgrade Treatment

- GB1 analysis increased plan quantities above projects not analyzed by GB1 guidelines
- GB1 is better at predicting subgrade repairs, but can still underestimate work needed
- Without knowing extent of subgrade work needed, cost comparisons cannot be accurately made

STRATEGY FOR IMPROVEMENT

Subgrade Treatment

Recommendation:
Use global chemical stabilization on major projects regardless of soil conditions. Provide superior product at no additional cost.



STRATEGY FOR IMPROVEMENT

Pavement Design

Subgrade stiffness could be improved by adjusting CBR values in the plans.

- Projects 23(00) and 148(99) in Erie County had modified CBR values
- Using an average CBR of 46 and a design CBR of 23 translates into a reduction in asphalt thickness on IR-71 between 1.5” – 2”
- Reducing the pavement thickness by 1.5” would have reduced the asphalt base by 194,400 CY
- Cost savings would have been \$12.0 million

STRATEGY FOR IMPROVEMENT

Pavement Design

Recommendation:
Include the strength benefits of chemically stabilized subgrades into the pavement design. Savings could be up to 50% of actual stabilization costs.



QUESTIONS?



THANK YOU!