

# Pavement Subgrade Treatment Options

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# Outline

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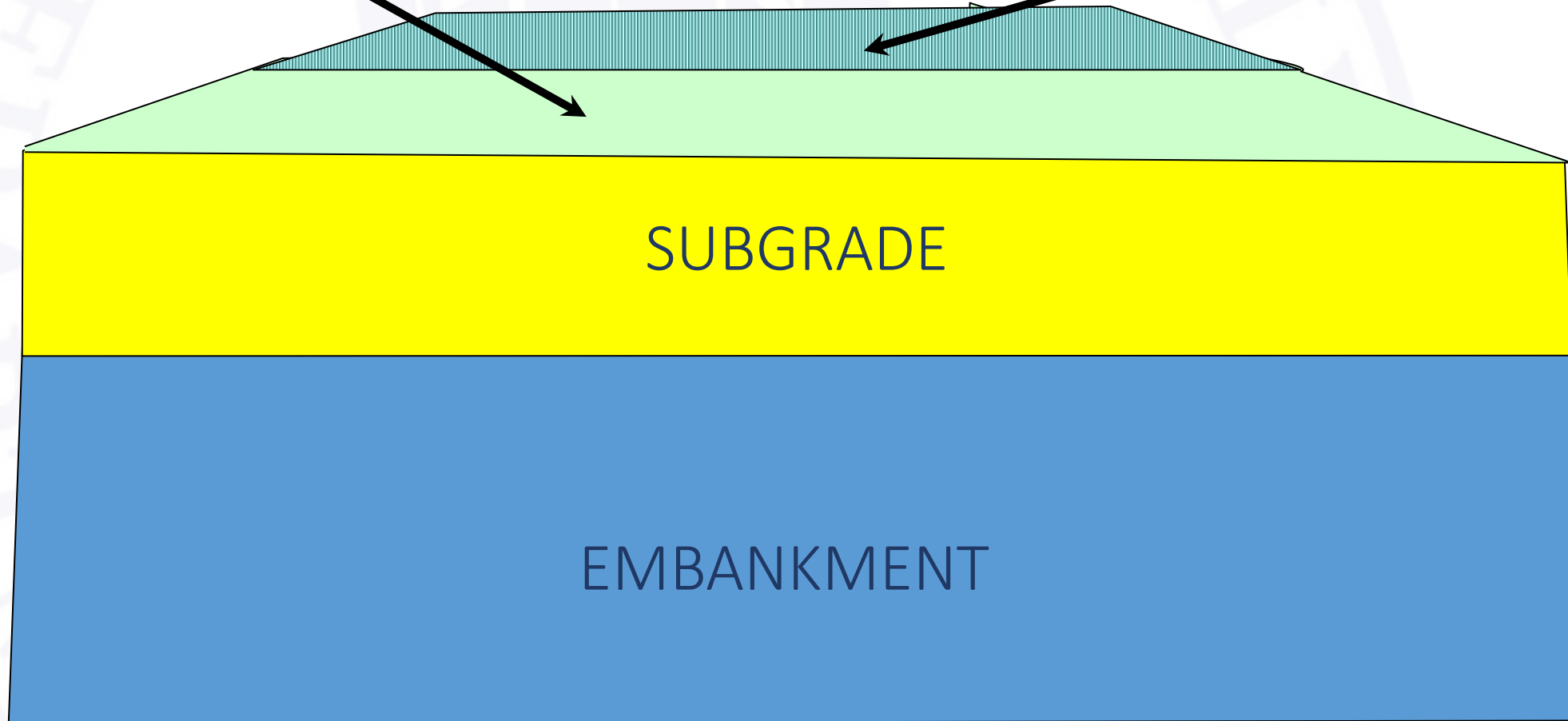
- Introduction
- Old Subgrade Treatment
- New Subgrade Treatment
- Subgrade Selection Guidelines
- Modification vs Stabilization
- Construction
- Recommendations



# Roadway Cross-section

SUBBASE

PAVEMENT



SUBGRADE

EMBANKMENT

# Subgrade?

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As written in the Standard Specifications Book,  
Glossary of Terms:

**101.62 Subgrade.** The upper portion of a roadbed upon which the pavement structure and shoulders are constructed.

# Subgrade for Pavement Design

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- Natural Subgrade (Foundation Soil)
- Prepared Subgrade (Subgrade Treatment)



# Natural Subgrade





# Rutting in subgrade





# Subgrade Treatment

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## Section 207

# Old Subgrade Treatment

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## Special Subgrade Treatment

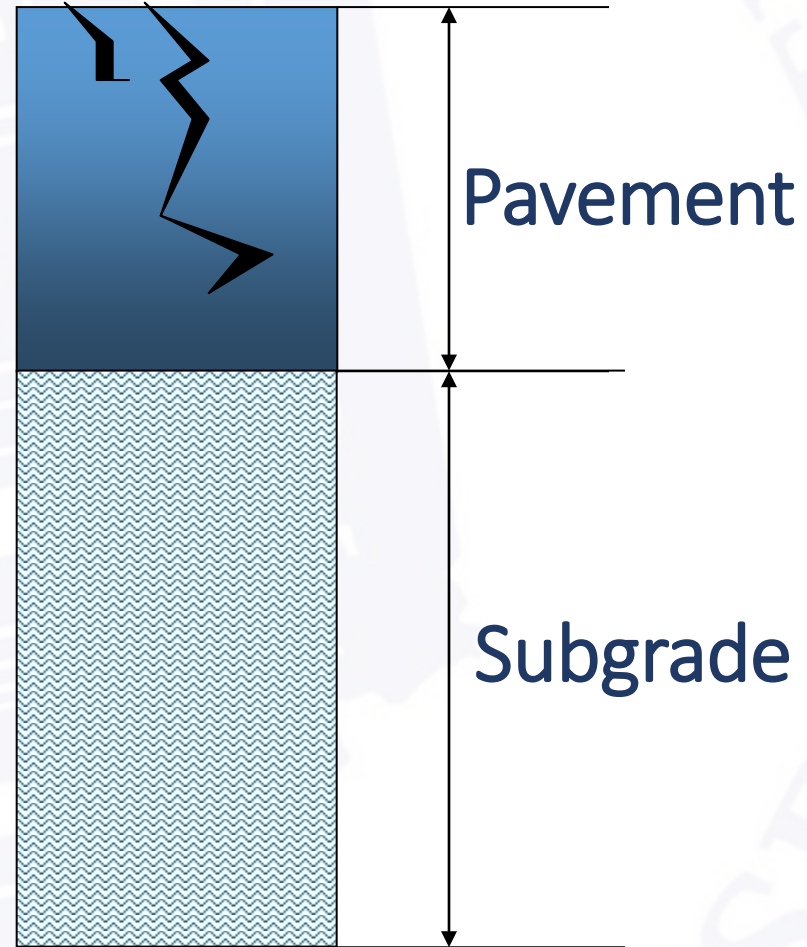
First 24 inches below the pavement subgrade shall be uniform and compacted to 100% of the maximum dry density (AASHTO T-99).

# Old Design Criteria for Subgrade Treatment

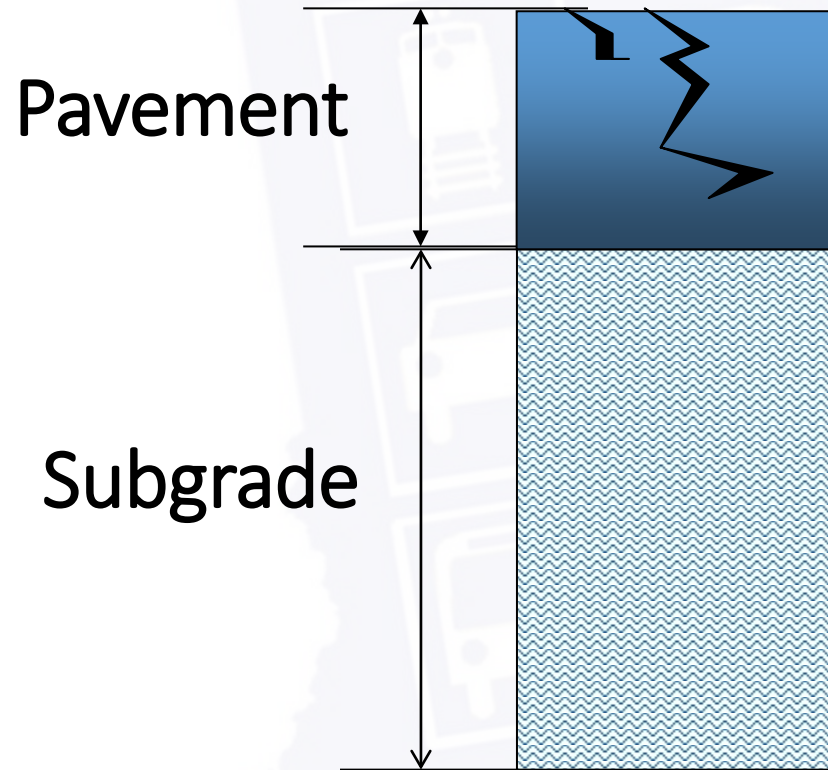
Type of Project	Type of Subgrade Treatment	Remarks
In Fill	24 inches Special Subgrade Treatment	Moisture Density Control
In Cut/At-Grade	6 inches Special Subgrade Treatment	Secondary and Low Traffic Road
	24 inches Special Subgrade Treatment	High Volume/Major Traffic Road



# Pavement Replacement Project



# Pavement Replacement Project



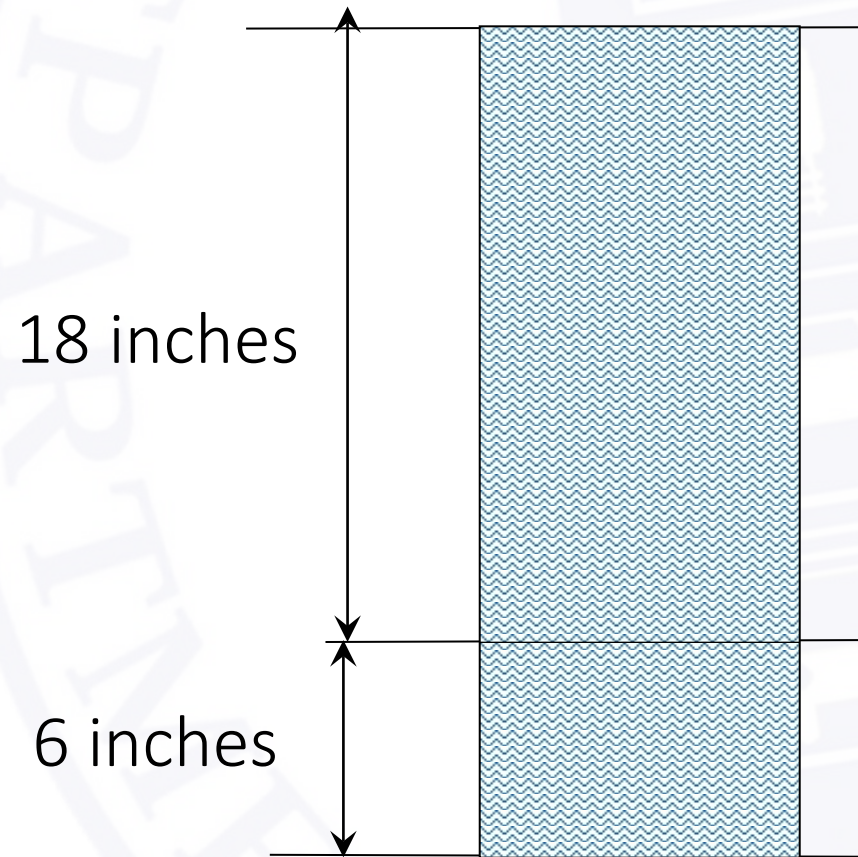
# Un-modified Subgrade





# 24 inches Special Subgrade Treatment

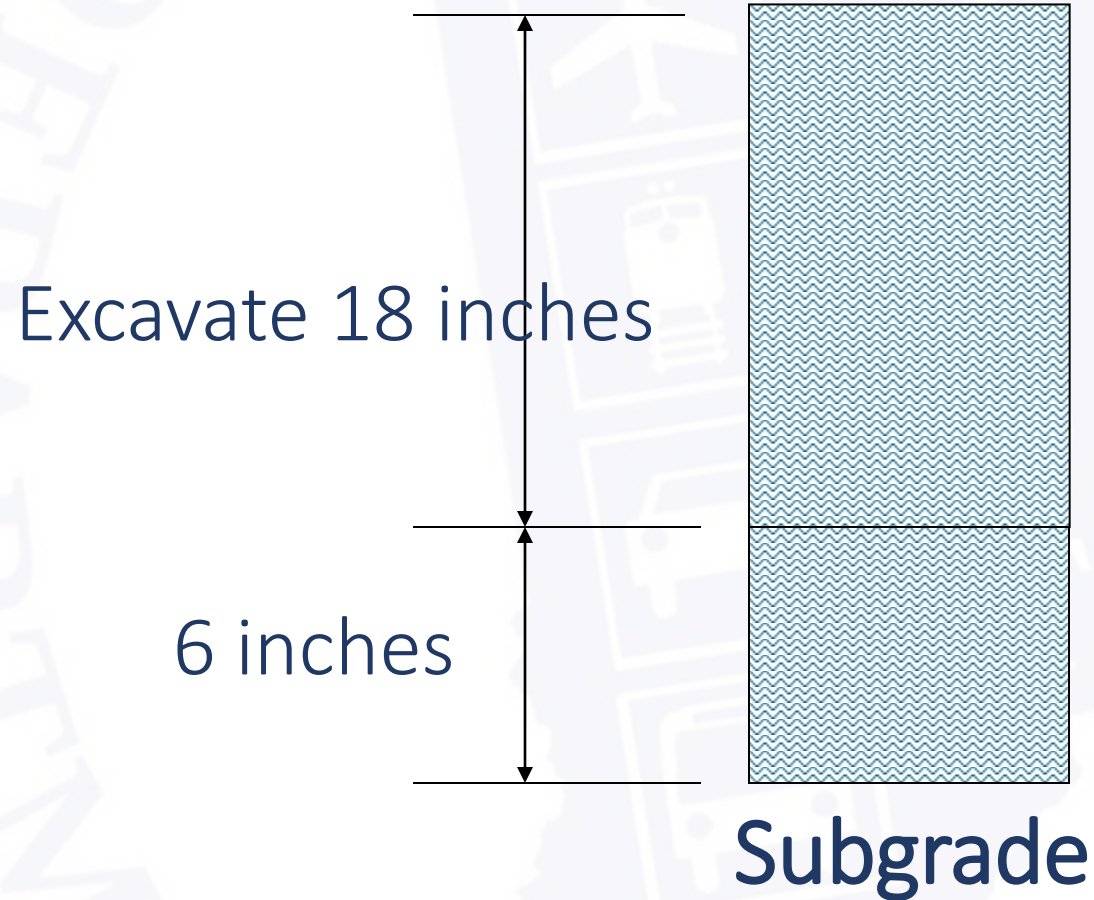
## At Grade or in Cut



First excavate, and re-compact in 6" lifts to 100% (AASHTO T-99)

6 inches compaction in-place to 100% (AASHTO T-99)

# Special Subgrade Treatment



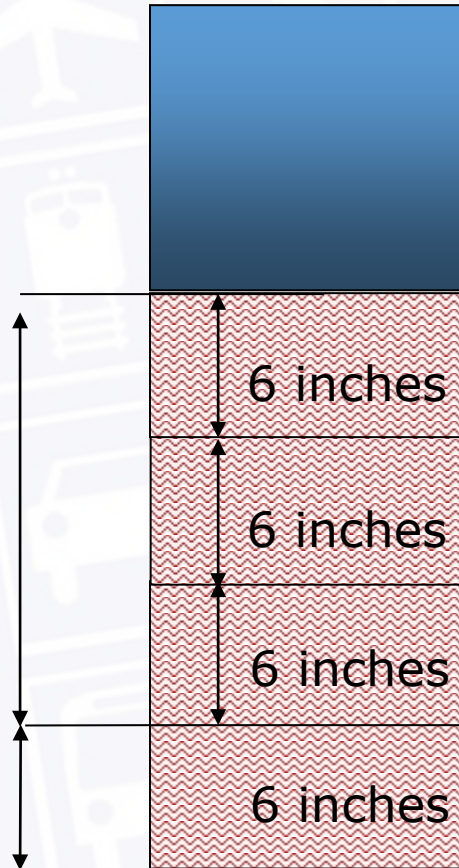
# Pavement Placement and Special Subgrade Treatment

**Pavement**

**Subgrade**

Compact in 6" lifts to 100% (AASHTO T-99)

6" compacted in place to 100% (AASHTO T-99)

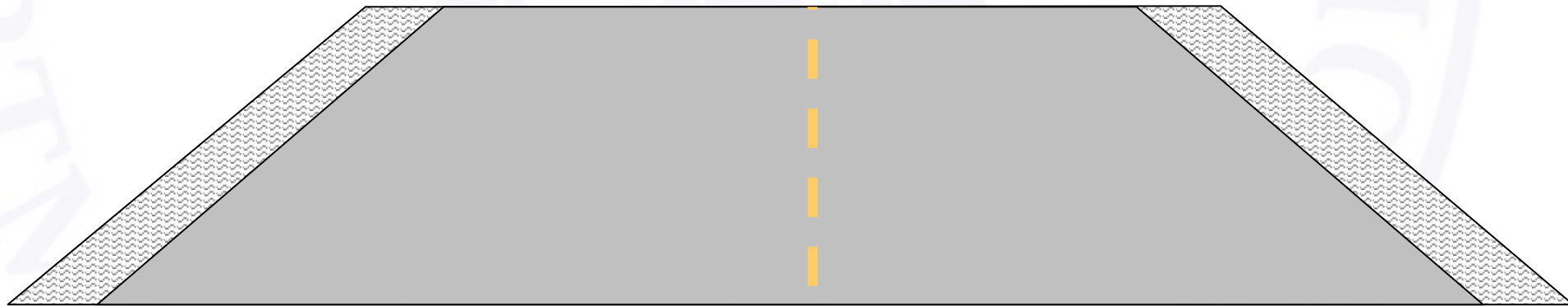




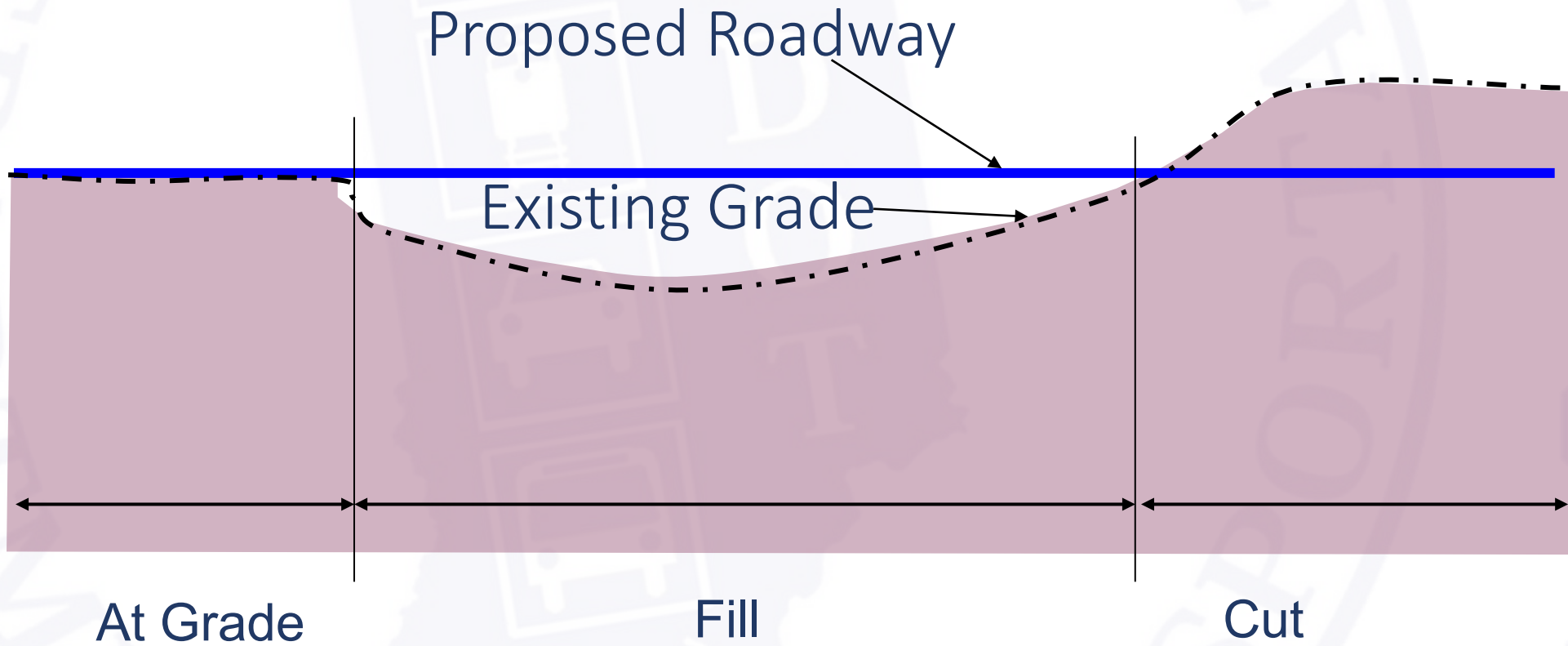
# New Subgrade Treatment

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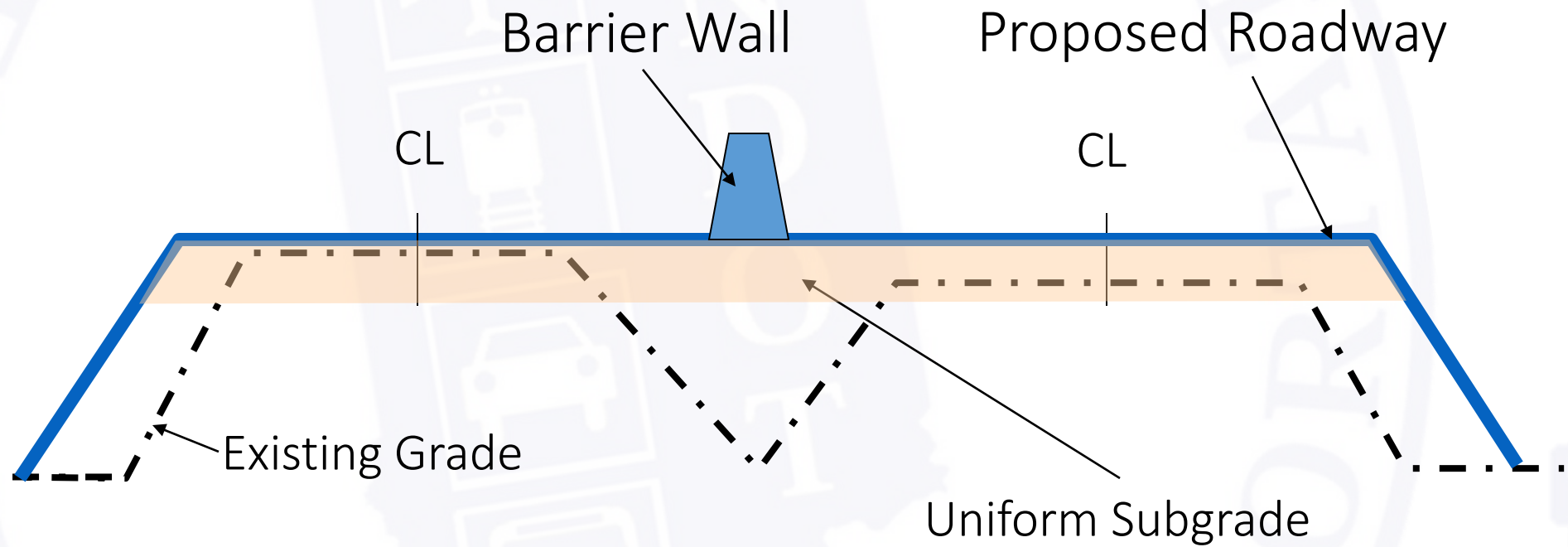
The subgrade shall be constructed uniformly transversely across the width of the pavement including of shoulders or curbs unless shown otherwise on the plans.



# Roadway Profile

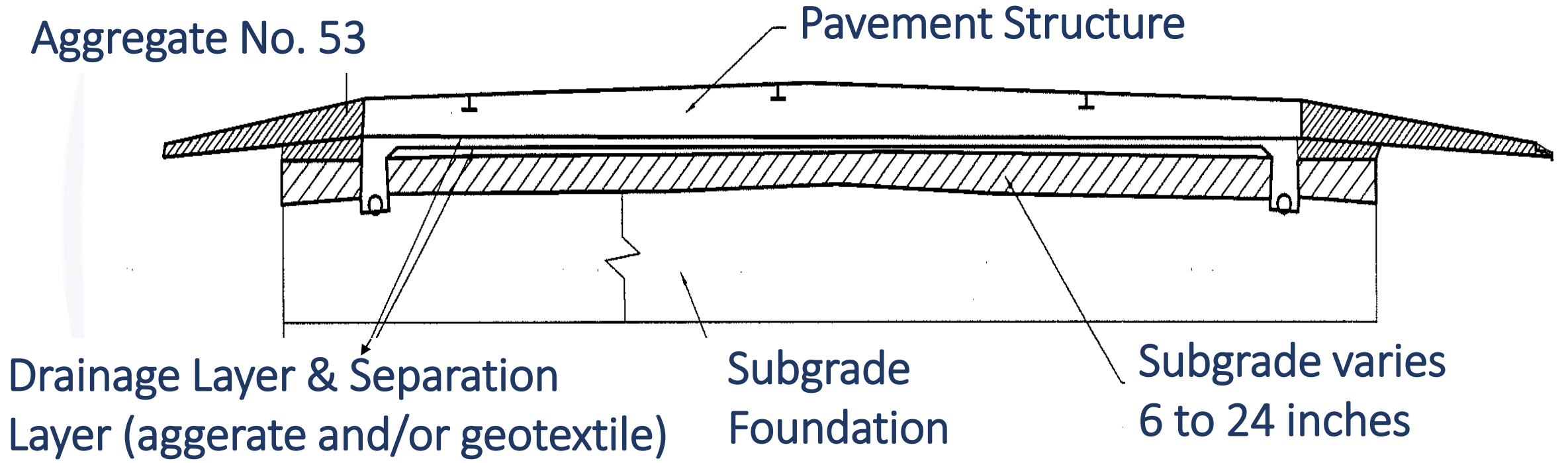


# Cross Section





# Pavement, Subgrade & Its Foundation Section



# Subgrade Construction Requirements

According to the 2022 INDOT Standard Specifications Book

## 207.03 Construction Requirements

### (a) Subgrade Construction Methods

The subgrade shall be constructed uniformly transversely across the width of the pavement including shoulders or curbs unless shown otherwise on the plans, by one of the following methods:

- (a) chemical modification in accordance with 215.
- (b) aggregate No 53 in accordance with 301.
- (c) geogrid in accordance with 214 placed under aggregate No. 53 in accordance with 301.  
or
- (d) soil compaction to 100% of maximum dry density.

## 207.04 Subgrade Treatment Types

The subgrade treatment type shall be as specified on the contract plans. If required, the subgrade foundation shall be corrected as directed by the Engineer prior to subgrade treatment.

# 207.04 Subgrade Treatment Types

Type	Subgrade Description
I	24 in. of soil compacted in accordance with 203.23
IA	[blank]
IBC	14 in. chemical soil modification using cement
IBL	14 in. chemical soil modification using lime
IC	12 in. coarse aggregate No. 53 in accordance with 301
ID	12 in. coarse aggregate with Type 2B geotextile in accordance with 918.02(c)
II	6 in. coarse aggregate No. 53 in accordance with 301
III	In-place compaction in accordance with 203.23
IV	12 in. coarse aggregate No. 53 with Type IB geogrid in accordance with 214
IVA	12 in. coarse aggregate with geocell confinement system in accordance with 214
V	3 in. of subgrade excavated and replaced with 3 in. coarse aggregate No. 53

# Summary of Subgrade Treatment Recommendations

Area of Project	State Road 249
Recommended Resilient Modulus ( $M_R$ ) Value for Existing Subgrade Soil, lbs./sq.in.	6,000
Recommended Resilient Modulus ( $M_R$ ) Value for Prepared Subgrade, lbs./sq.in.	9,000
Critical/Predominant Soil Type	Sand (A-3)
Percent Passing No. 200 Sieve	5
Percent Silt	4
Liquid Limit, percent	NP
Plastic Limit, percent	NP
Plasticity Index, percent	NP
Approximate Depth to Ground Water, ft.	25
Dry Density of Natural Subgrade Soil, lbs./cu.ft.	100
Moisture Content of Natural Subgrade Soil, %	8
Organic Content, percent	N/A
Marl Content, percent	N/A
Water Soluble Sulfate Content, ppm	340**
Approximate Depth to Bedrock, ft.	>150
Filter Fabric Required for Underdrains	Yes
Subgrade Treatment Type*	Type IB-Cement Only***

\* Subgrade Treatment Type according to INDOT Standard Specifications Section 207.04.




# Subgrade Type

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## Type I

24 in. of soil compacted in accordance with 203.23.



24 in. Soil  
Compacted  
in accordance with  
203.23

# Subgrade Type

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## Type 1BC

14 in. Cement soil modification using cement in accordance with 215




14 in. Cement Soil  
Modification

# Subgrade Type

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## Type 1BL

14 in. chemical soil modification using lime in accordance with 215



14 in. Lime Soil  
Modification

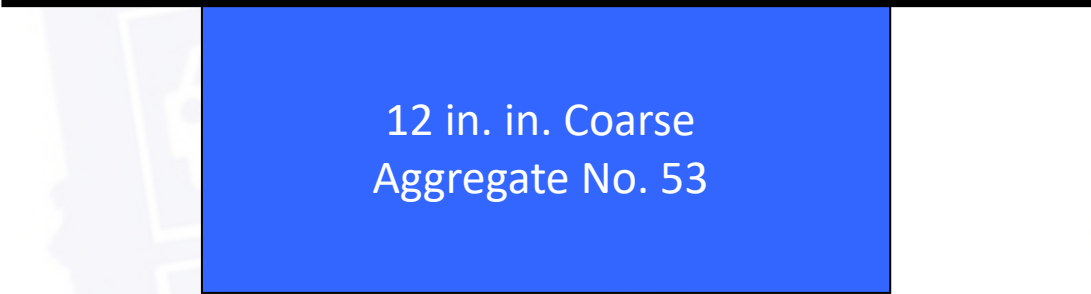
The diagram shows a cross-section of a subgrade layer. A horizontal black line at the top represents the surface. Below it is a solid purple rectangular block representing the 14-inch lime soil modification layer. The text '14 in. Lime Soil Modification' is centered within this purple block.

# Subgrade Type

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## Type 1C

12 in. coarse aggregate No. 53 in accordance with 301 (Aggregate Base).



12 in. in. Coarse  
Aggregate No. 53

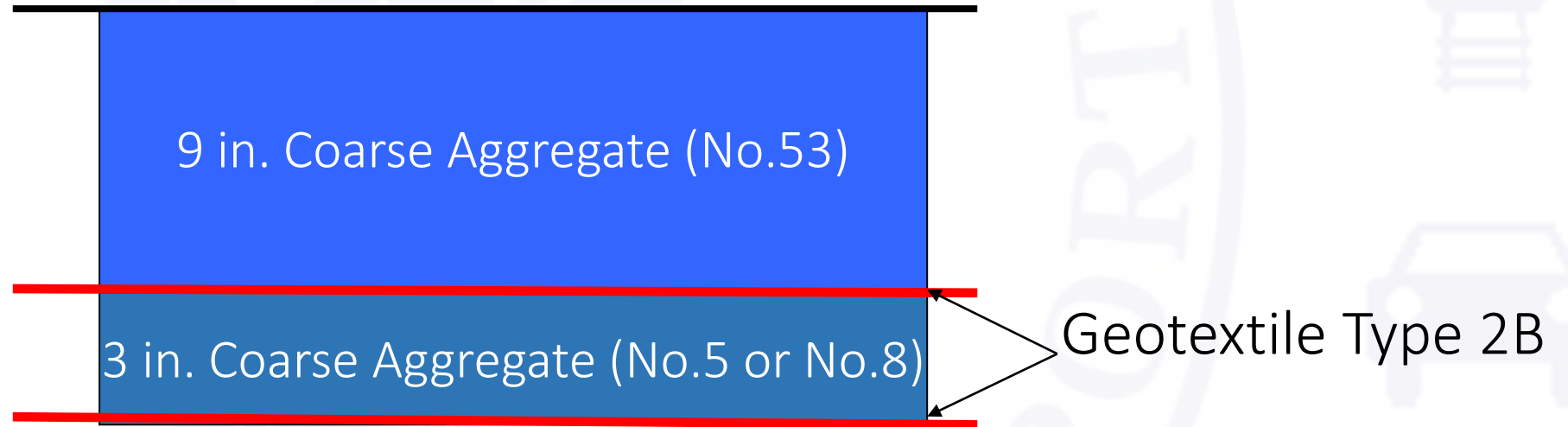
The diagram shows a blue rectangular block representing the aggregate layer, positioned below a horizontal line. The text '12 in. in. Coarse Aggregate No. 53' is centered within the blue block.



# Subgrade Type

## Type 1D

12 in. coarse aggregate with Type 2B geotextile in accordance with 918.02( c )



# Subgrade Type

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## Type II

6 in. coarse aggregate No. 53. in accordance with 301.

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6 in. Coarse  
Aggregate No. 53

# Subgrade Type

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## Type III

6 in. thick in-place compaction in accordance with 203.



6 in. thick in-place  
compaction

# Subgrade Type

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## Type IV

12 in. coarse aggregate No. 53 with Type IB geogrid in accordance with 214.

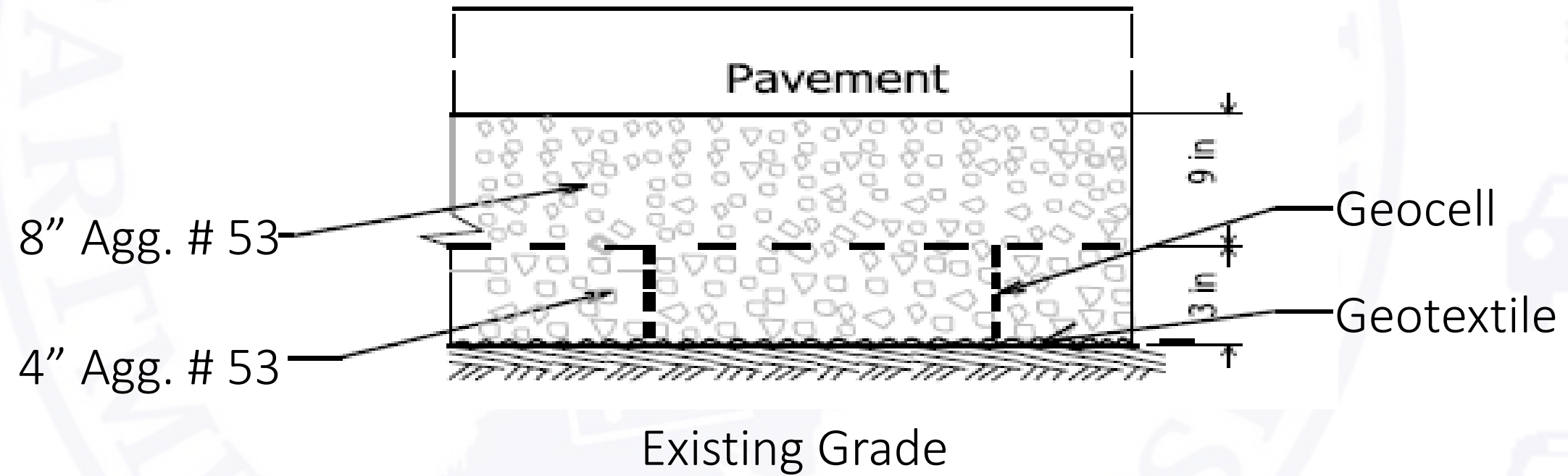




# Subgrade Type

## Type IV A

12 in. Coarse Aggregate with Geocell confinement System in accordance 214.



# Subgrade Type

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## Type V

### Subgrade Treatment for Trails on Abandoned-Railroad Corridor

- *3 in. (75 mm) of the subgrade excavated and replaced with 3 in. (75 mm) coarse aggregate No. 53.*



3 in. Coarse  
Aggregate No. 53

# Special Cases

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1. Subgrade on Rock: Excavate 12 in. and replace with No. 53.
2. Conditions below the specified subgrade treatment depth prevents achieving Subgrade Treatment. Corrective measures as per 203 shall be taken and paid for.

# Subgrade Selection Guidelines

## Subgrade Type Recommendations- Used for Guidance Only

Road Description	Type of Work	Subgrade Length	MR Value at Optimum Moisture Content	Subgrade Type and Description	Remarks
SR/US	New Road, Road Reconstruction and > 8 ft Widening	> 800 ft	Maximum Design MR 12500 psi (Max)	<b>Type IBC *</b> 14 in. cement soil modification	Cement only, perform MR test on molded specimens
I	New Road, Road Reconstruction and > 8 ft Widening	> 800 ft	Maximum Design MR 15000 psi (Max)	12 in. cement stabilized subgrade	Geotechnical recommendation should include the cement stabilization
SR/US	New Road, Road Reconstruction and > 8 ft Widening	> 800 ft	Maximum Design MR 10000 psi	<b>Type IBL**</b> , 14 in. lime soil modification	Lime only, perform MR test on molded soils
SR/US/I	New Road, Reconstruction, or Widening	Urban areas or ≤ 800 ft	Maximum Design MR = 15000 psi (Max)	<b>Type 1C</b> 12 in. coarse aggregate	-
SR/US	Road Reconstruction or Widening ≤ 8 ft	≤ 800 ft	Maximum Design MR = 7500 psi(max)	<b>Type II</b> Construct with 6 in. aggregate	Patching with or without Biaxial Geogrid
SR/US/I	Reconstruction or Widening	≤ 800 ft	Maximum Design MR = 15000 psi	<b>Type IV or Type IV A</b>	Where weak soils encountered (MR ≤ 5000 psi)
SR/US	Widening ≤ 8 ft	≤ 800 ft	Maximum Design MR = 6000 psi( Max)	<b>Type I</b>	-
Bike Path/Trails/Entrances	Reconstruction or Widening	-	Maximum Design MR = 4500 psi	<b>Type V, Type II or Type III</b>	-
MOT for US/I	Reconstruction or Widening	-	Maximum Design MR = 7500 psi	<b>Type II</b> with or without Biaxial Geogrid	-

Moisture-management-geotextile-may-be-used-below-the-aggregate-subgrade-if-the-moisture-content-of-foundation-soils-is-5%-higher-than-the-optimum.¶

Foundation-improvement-consisting-of-6"-to-12"-thick-#2-stone-may-be-used-below-the-aggregate-subgrade-treatment-Geotextile-in-accordance-with-918.02-(c)-28-shall-be-used-between-#2-and-aggregate-subgrade.¶

Type-IBC-and-Type-IBL-are-not-allowed-over-MSE-Walls-to-avoid-damaging-the-earth-reinforcements.¶

Subgrade-treatment-using-slag-aggregate-is-not-allowed-over-MSE-Walls¶

Suggest-keeping-the-number-of-subgrade-treatment-types-to-a-minimum-in-the-same-product.¶

\*Clay content ≤ 30% and PI ≤ 20

\*\* Clay content > 30% and PI > 20

SR - State Road, US- US Route, I- Interstate

Rev. 3/6/2023



# Modification vs Stabilization

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## Modification:

- Working platform for equipment.
- Strength gain not accounted for in Design.
- Simple design procedure and non-extensive quality control as per 215

## Stabilization:

- Strength gain accounted for in design
- Possible reduction in Pavement thickness.
- Strict specifications using QC/QA as per Sec. 219

# Modification vs Stabilization

Chemicals	Strength Gain for Chemical Modification	Target Design Strength for Chemical Stabilization
Quicklime or Hydrated Lime	50 psi	150 psi
Lime By-product	50 psi	Not recommended
Cement	100 psi	300 psi <sup>1</sup>
Fly ash	50 psi	Not recommended

Note 1: Strength tested at 7 days

# Construction

## Proof Rolling





# Construction

## Subgrade with Geogrid





# Construction

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## Prepared subgrade





# Construction

## Proof Rolling





# Construction

## Proof Rolling



# Construction

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## Prepared Subgrade





# Recommendations

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- In general, all recommendations should be specific, delineated and have unique special provisions.
- Subgrade constructability, run around, and pavement maintenance records shall be evaluated.
- The geotechnical engineer should limit the use of multiple subgrade treatment on a project to avoid many different operations.

# Recommendations

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- The contractor should not perform subgrade treatment if planning to close the work for the season before placing the pavement.
- The designer should evaluate the site conditions for positive drainage for underdrains and their outlet locations.
- The designer should pay more attention to geotechnical recommendations for foundation improvement and its limits.





# Questions?