

Basics of Pavement Design / Down to the Sub-Grade

(Subgrade Treatment)

Nayyar Siddiki, MSCE., P.E.
Geotechnical Engineering Division

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Outline

- Subgrade (Section 207)
- Subgrade Treatment Types
- Chemical Modification of Soils (Section 215)
- Cement Stabilization Subgrade Soil (Section 219)
- Resilient Modulus (AASHTO T 307)
- Resilient Modus on No. 53 and No. 53 modified
- Test Section construction



Subgrade

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

(a) Subgrade Construction Methods

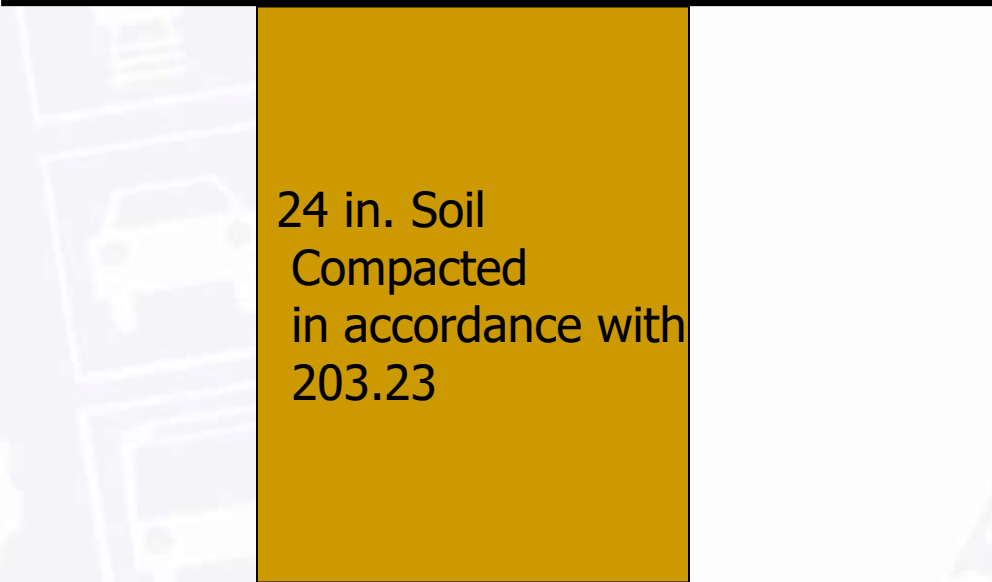
The subgrade shall be constructed uniformly transversely across the width of the pavement including shoulders or curbs unless shown otherwise on the plans, by one of the following methods:

1. chemical modification in accordance with 215;
2. aggregate No. 53 in accordance with 301;
3. Geosynthetics in accordance with 214 placed under coarse aggregate in accordance with 301, or
4. soil compaction to 100% of maximum dry density;

Subgrade Types

Type I

24 in. of soil compacted in accordance with 203.23.



24 in. Soil
Compacted
in accordance with
203.23

Refers to 203.23 for construction

Subgrade Type

Type 1BC

14 in. Cement soil modification using cement




14 in. Cement Soil
Modification

The diagram shows a cross-section of a subgrade. A horizontal black line represents the surface. Below it is a solid purple rectangular layer. The text '14 in. Cement Soil Modification' is centered within this purple layer.

Subgrade Type

Type 1BL

14 in. chemical soil modification using lime



14 in. Lime Soil
Modification

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

Subgrade Type

Type 1C

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

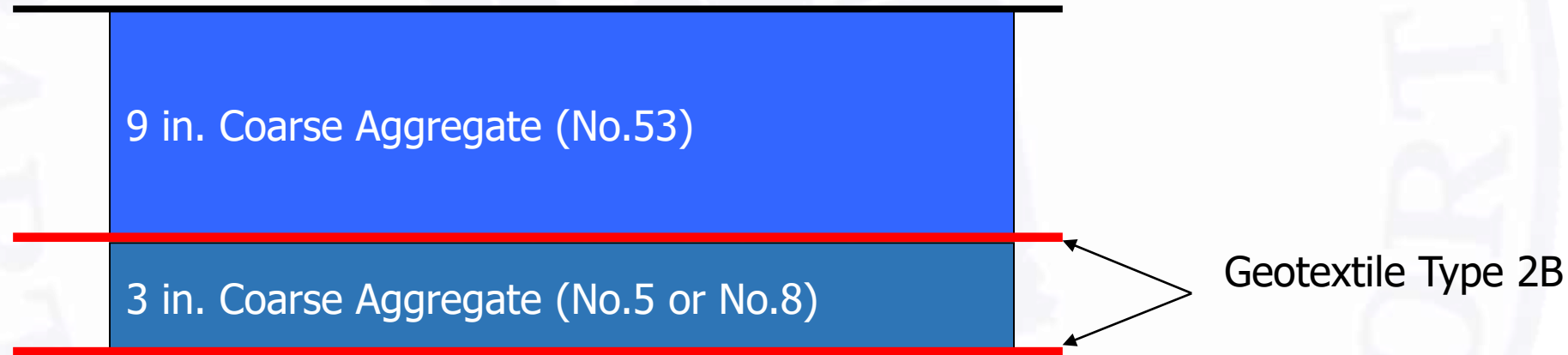
12 in. in. Coarse
Aggregate No. 53

Subgrade Type IC refers to Sec 301 (Aggregate Base) for construction.

Subgrade Type

Type 1D

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



Type 1D subgrade treatment shall be constructed with 9 in of coarse aggregate No 53 over 3 in of coarse aggregate No 5 or No 8.

Type 2B shall be placed above and below the No 5 or No 8.

Subgrade Type

Type II

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

6 in. Coarse
Aggregate No. 53



Subgrade Type

Type III

6 in. thick in-place compaction.



A horizontal line represents the subgrade layer. Below it is a yellow rectangular box with a black border containing the text "6 in. thick in-place compaction".

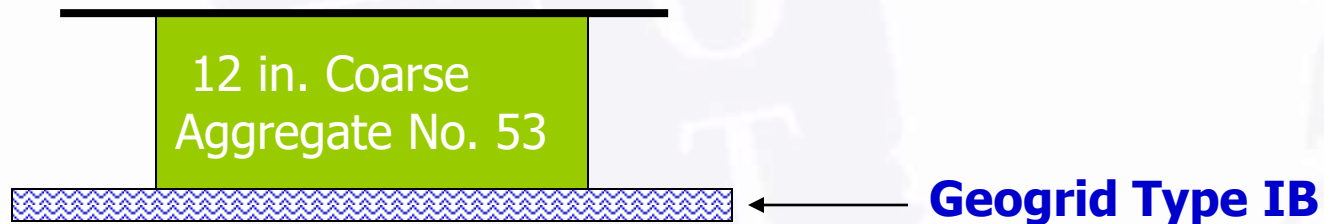
6 in. thick in-place compaction

Refers to Sec 203.23

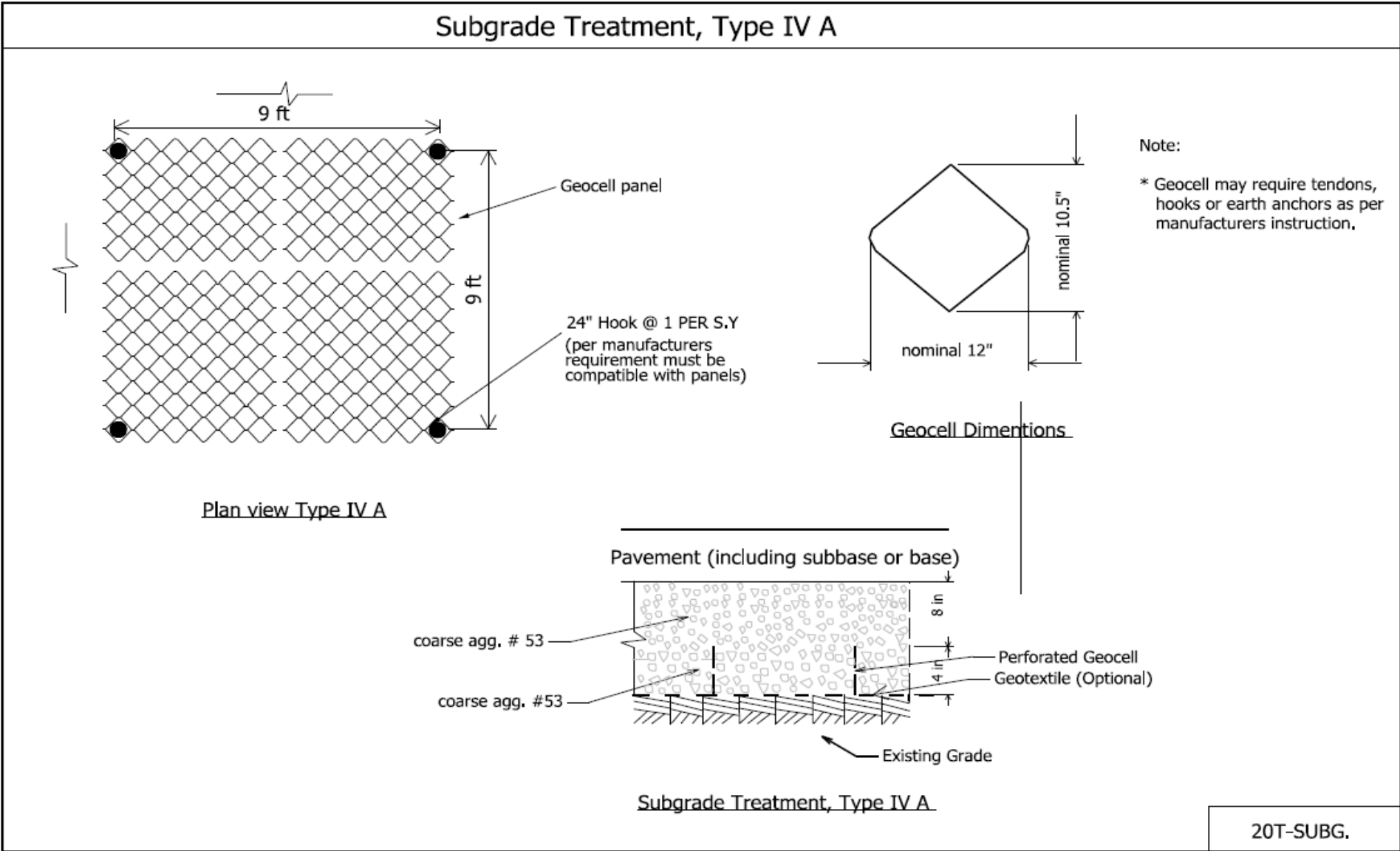
Subgrade Type

Type IV

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



Subgrade Type



Subgrade Type

- Chemical Soil Modifications *(Type IBC and IBL)
- Refer to Sec 215 (Chemical Modification of Soils)
- Cement Stabilized Subgrade Soil (Sec. 219):
Work consists of stabilizing 12 in. of subgrade soils by uniformly mixing Portland cement to achieve the specified unconfined compressive strength in accordance with 105.03.

Most popular Subgrade Type

- Subgrade Type IC: 12 in. coarse aggregate No. 53 in accordance with 301,
- Subgrade Type II : 6 in. coarse aggregate No. 53 in accordance with 301

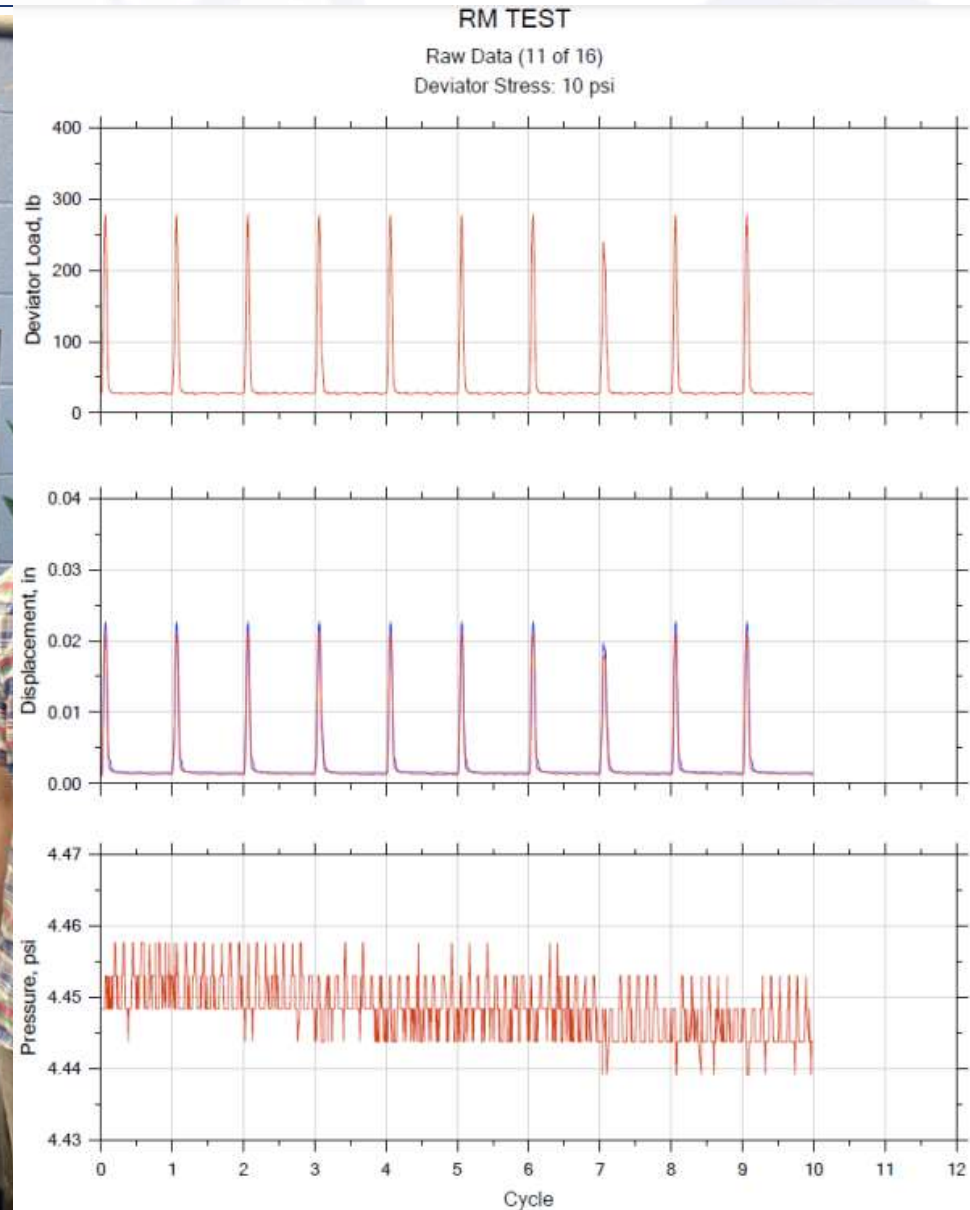
Aggregate Stability

- To determine the aggregate stability of the , resilient modulus is performed in accordance with AASHTO 307.



Resilient Modulus (M_R) - AASHTO T307

- Applying Cyclic loading with maintenance of prescribed confining pressure for each loading sequence.
- 6 inch dia. 12inch height sample.
- Pneumatic Confining Pressure.
- Axial deformation measured by LVDTs.
- Ending test when maximum number of cycles are achieved or maximum strain is accumulated.
- All the parameters of the last five cycles of each sequence.



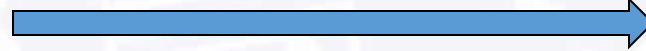
Soil or Aggregate Under Roadway



Total Deformation consists of Two Components:

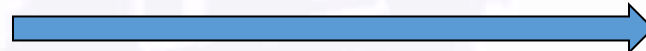
Elastic

Recoverable

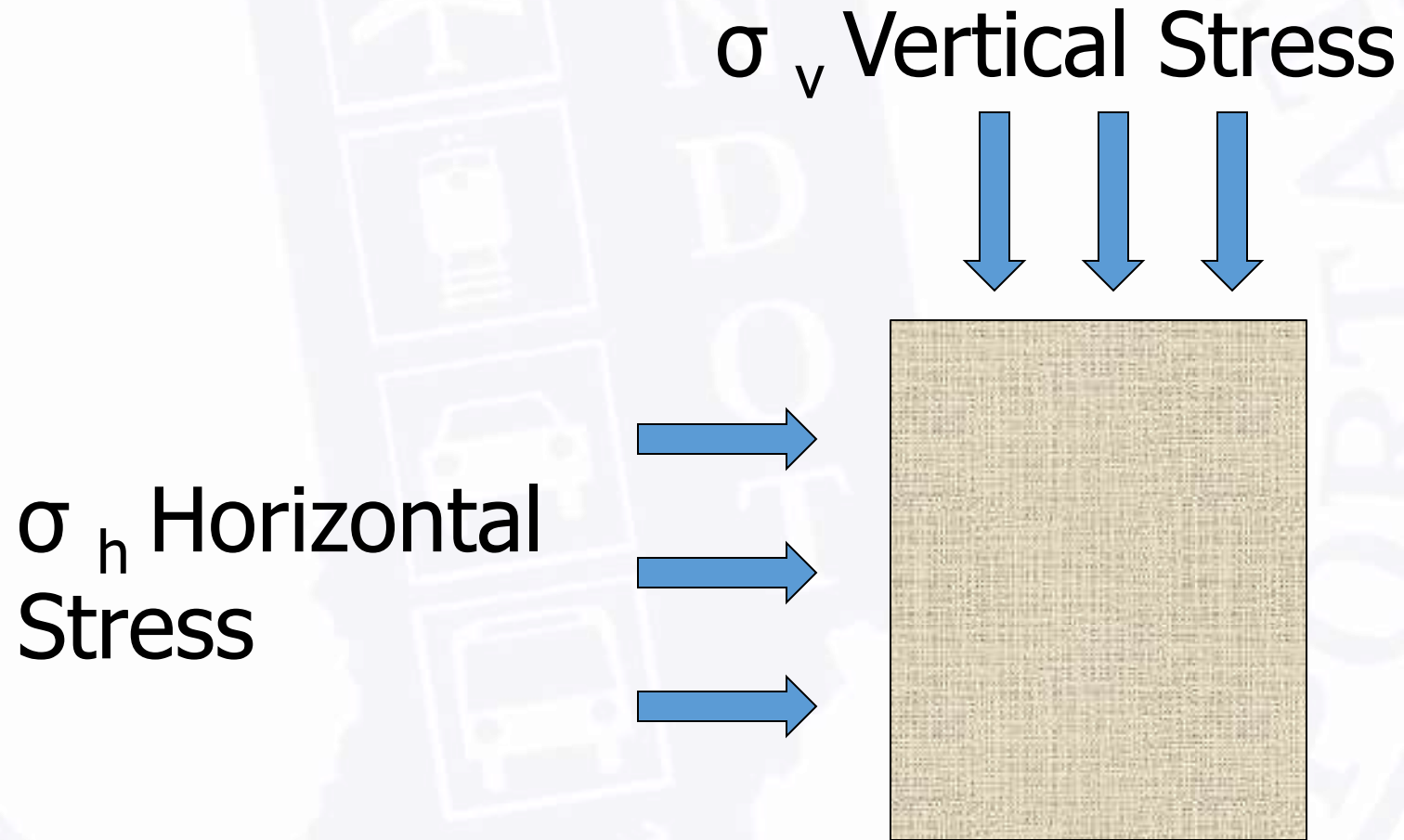


Plastic

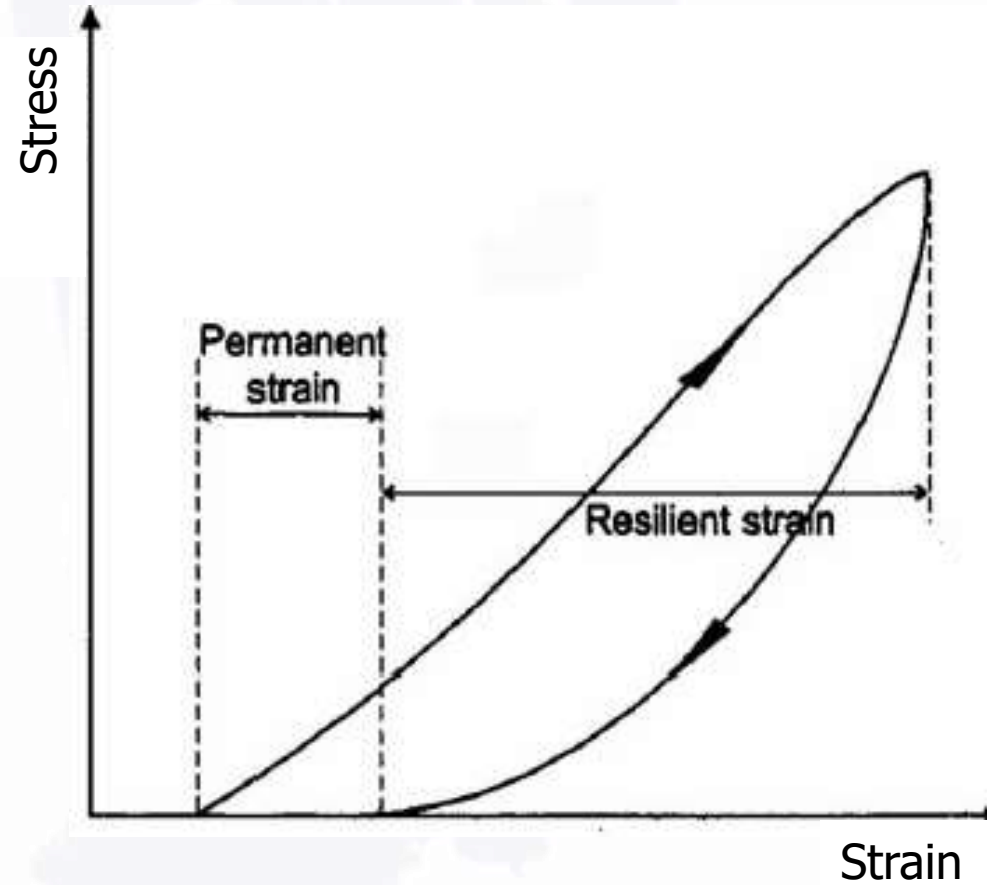
Permanent



Stress Condition of Soil or Aggregate



M_R - Dynamic Deviator Stress/Resilient Strain



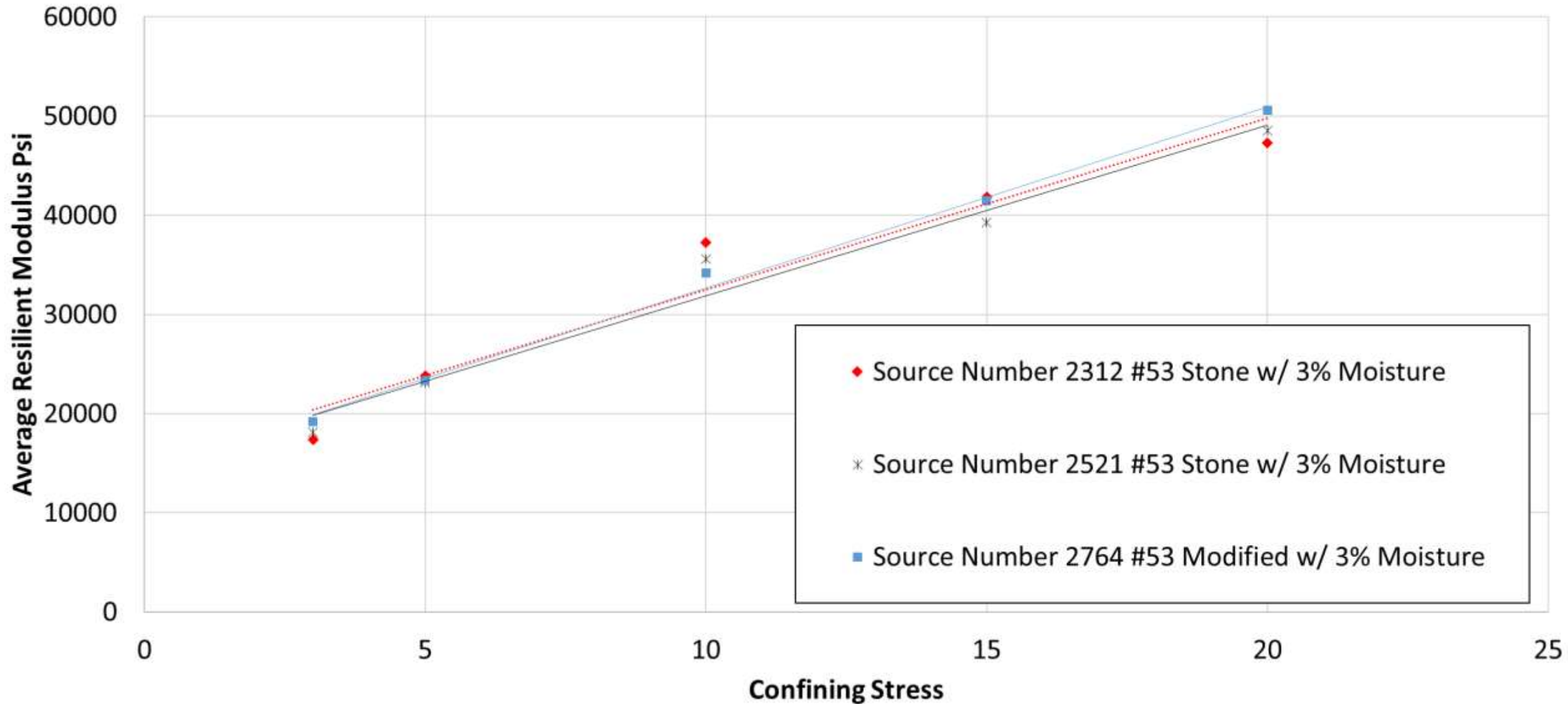
Resilient Modulus (M_R) - AASHTO T307

- Test include the following :
 - Deviator stresses 3, 6, 9, 5, 10, 15, 10, 20, 30, 10, 15, 30, 15, 20, 40
 - Confining stresses 3, 5, 10, 15, 20
 - Sequences 15 Nos and each sequence has 100 cycles
- Typical Stresses on top of base and subgrade
 - Axial pressure = 10.81 psi. Confining pressure = 5.03 psi
 - Axial pressure = 8.19 psi. Confining pressure = 1.39 psi
 - Axial pressure = 4.47 psi. Confining pressure = 4.71 psi

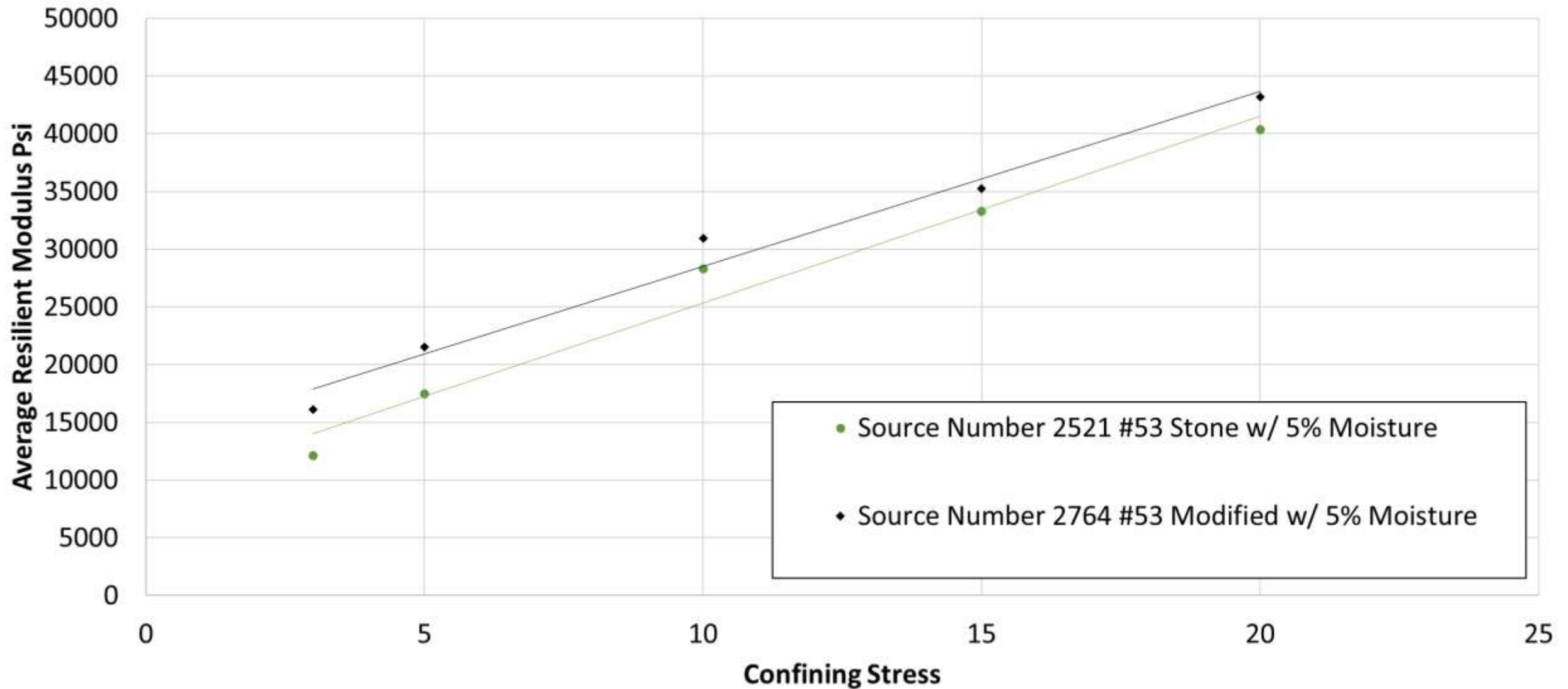
INDOT No. 53 Aggregate

Sieve Size (mm)	INDOT No. 53 Percent Passing	Source Number 2764 #53 Modified Percent Passing	Source Number 0057 #53 Modified Percent Passing
37.5	100	meet INDOT Spec.	meet INDOT Spec.
25	80-100	meet INDOT Spec.	meet INDOT Spec.
19	70-90	meet INDOT Spec.	meet INDOT Spec.
12.5	55-80	meet INDOT Spec.	meet INDOT Spec.
4.75	35-60	meet INDOT Spec.	meet INDOT Spec.
2.36	25-50	meet INDOT Spec.	meet INDOT Spec.
0.6	12-30	meet INDOT Spec.	meet INDOT Spec.
0.075	5-10	14.3	10.7

M_R Comparison – Standard vs. Modified #53 (3% MC)



M_R Comparison – Standard vs. Modified #53 (5% MC)



SECTION 203.24, LWD TEST SETUP



- The stiffness of chemically modified soils or aggregates will be determined by the LWD in accordance with ITM 508.

Allowable Ave. Deflection for Aggregate over Chemically Modified Soil (Sec 215)

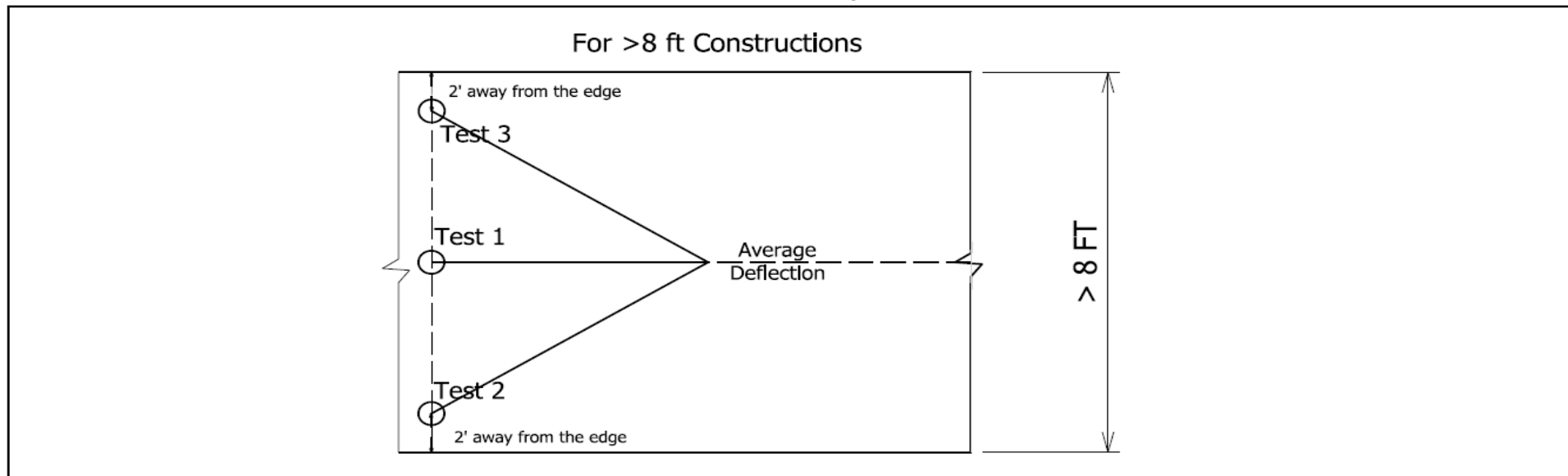
- Allowable Average Deflection for Aggregate over Chemically Modified Soil

Material Type	Allowable Average Deflection (mm)	Maximum Deflection at a Single Test Location (mm)
Aggregate over Cement Modified Subgrade	0.27	0.31
Aggregate over Lime Modified Subgrade	0.30	0.35

LWD Test Setup – Section 203.24

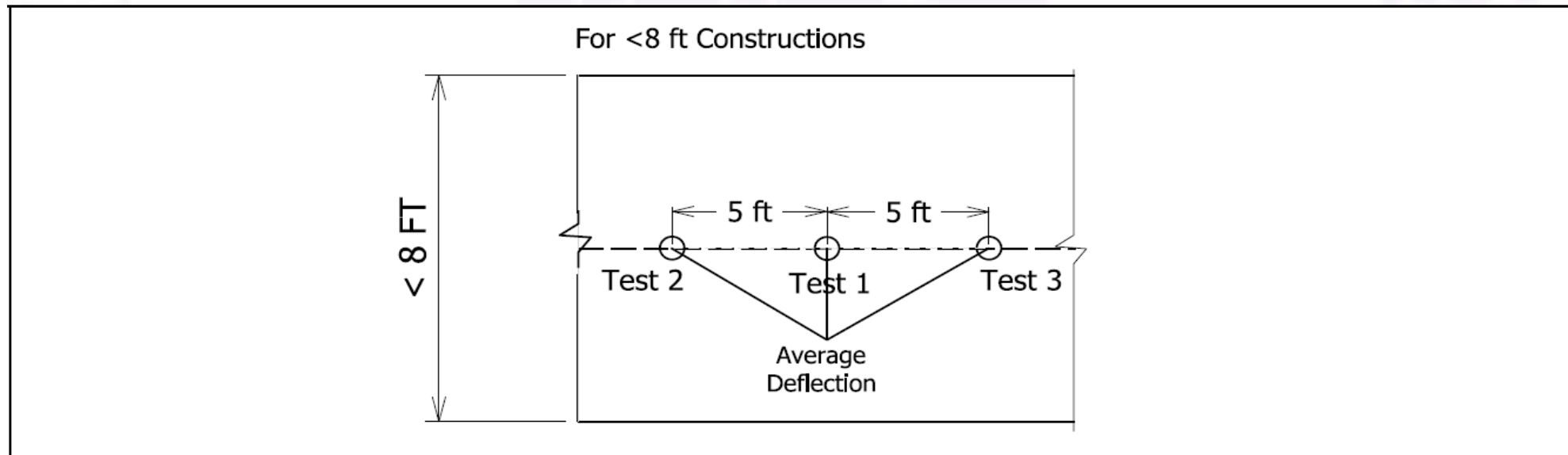
- Construction area is 8 ft wide or more, the location of the three tests will be at 2 ft from each edge of the construction area and at 1/2 of the width of the construction area.

LWD Test Setup



LWD Test Setup – Section 203.24, Cont.

- Construction area is less than 8 ft wide, the location of the three LWD tests will be spaced at 1/2 of the width of the construction area and spaced 5 ft apart in the longitudinal direction.
- The average deflection shall be equal to or less than the maximum allowable deflection allowed in the previous Tables or determined by the test section.





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Questions



Subgrade Treatment Types (207)

Type	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