

INDIANA DEPARTMENT OF TRANSPORTATION



INTER-DEPARTMENT COMMUNICATION

Standards Section X Room N642



Writer's Direct Line

232-6775

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DESIGN MEMORANDUM No. 04-06 TECHNICAL ADVISORY

TO: All Design, Operations, and District Personnel, and Consultants

FROM: /s/ Anthony L. Uremovich
Anthony L. Uremovich
Design Policy Engineer
Contracts and Construction Division

SUBJECT: Subgrade Treatment

EFFECTIVE: January 19, 2005, Letting

SUPERSEDES: *Indiana Design Manual* Section 17-3.02

I. DETERMINATION OF SUBGRADE TREATMENT LIMITS

The practice of specifying subgrade treatments has been further revised. The subgrade area should be computed for **all areas of new pavement or shoulders, including cuts and fills**. The width of the treatment is between points which are **0.6 m (2 ft)** or as determined outside the edges of paved shoulders or back faces of curbs, as shown in *Indiana Design Manual* Chapter Fifty-two, or as instructed by the Materials and Tests Division's Geotechnical Section. The lateral limits and type of subgrade treatment should be shown on the Typical Cross Sections on the plans.

II. SUBGRADE TREATMENT TYPES

For each of the subgrade treatment types described below, the contractor is to choose from the applicable options for each type. Where subgrade treatment other than that described here is recommended by the Geotechnical Section, a special provision should be prepared.

The subgrade treatment methods are as follows:

- A. Type I.** The contractor's options are as follows:
1. 400 mm (16 in.) chemical soil modification;
 2. 300 mm (12 in.) of the subgrade excavated and replaced with coarse aggregate No. 53; or
 3. 600 mm (24 in.) of soil compacted to density and moisture requirements.
- B. Type IA.** The contractor's options are as follows:
1. 400 mm (16 in.) chemical soil modification; or
 2. 300 mm (12 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.
- C. Type II.** The contractor's options are as follows:
1. 200 mm (8 in.) chemical soil modification;
 2. 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53; or
 3. 300 mm (12 in.) of soil compacted to density and moisture requirements.
- D. Type IIA.** The contractor's options are as follows:
1. 200 mm (8 in.) chemical soil modification; or
 2. 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.
- E. Type III.** The contractor's options are as follows:
1. 150 mm (6 in.) of soil compacted to density and moisture requirements; or
 2. 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.
- F. Type IIIA.** This treatment consists of 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.
- G. Type IV.** This treatment consists of 225 mm (9 in.) of the subgrade excavated and replaced with coarse aggregate No. 53 on geogrid.

III. SUBGRADE TREATMENT TYPE DETERMINATION

A. Projects With Subgrade Treatment Type Determined per Former Practice

The designer should transmit a memorandum to the Geotechnical Section. Such memorandum should request that the Geotechnical Section review the pavement design to determine the subgrade treatment type or types required as described herein. Once the Geotechnical Section transmits its determination to the designer, the designer must revise the plans, pay items, and pay quantities accordingly.

Designers should request subgrade treatment information from the Geotechnical Section for projects on the January and February 2005 lettings before requesting such information for projects on later lettings. Designers should make note that some projects that did not require subgrade treatment per former practice will likely do so now.

B. Projects With Subgrade Treatment Type Yet to be Determined

The preliminary field check plans should include projected AADT figures and subgrade treatment areas tabulated for each survey line as shown in Figure 04-__A. During the field check, the Geotechnical Section should be informed of possible shallow utilities, temporary pavement, and need for a temporary runaround or night construction so that they can make suitable recommendations for subgrade type. Such considerations should be documented in the field check minutes.

Metric Units Project			English Units Project		
Line	Design-Year AADT	Treatment Area, m ²	Line	Design-Year AADT	Treatment Area, SYS
“A”	20,000	9000	“A”	20,000	10,000
“S-1-A”	300	450	“S-1-A”	300	500
“S-2-A”	400	850	“S-2-A”	400	950

EXAMPLE TABULATION OF SUBGRADE TREATMENT INFORMATION TO ACCOMPANY MEMORANDUM TO MATERIALS AND TESTS DIVISION

Figure 04-__A

The type or types of subgrade treatments described in Section II of this memorandum to be used will be specified in the Geotechnical Report. If the Geotechnical Report for a given project does

not specify the subgrade treatment type, the designer should send a memorandum requesting the subgrade treatment to the Materials and Tests Division's Geotechnical Section.

For some projects, the field check may have already been conducted, but the Geotechnical Report may not yet have been received by the designer. For this situation, the designer should submit to the Geotechnical Section the tabulation and information regarding shallow utilities, temporary pavement, and need for a temporary runaround or night construction so that they can make suitable recommendations for subgrade type.

IV. DETERMINING PAY ITEMS AND QUANTITIES

The specification references, code numbers, and pay item names for this work are as follows:

207-08262	Subgrade Treatment, Type I
207-08263	Subgrade Treatment, Type IA
207-08264	Subgrade Treatment, Type II
207-08265	Subgrade Treatment, Type IIA
207-08266	Subgrade Treatment, Type III
207-08267	Subgrade Treatment, Type IIIA
207-08268	Subgrade Treatment, Type IV

The pay unit for all of the above pay items is square meter (square yard).

The pay items for Subgrade Treatments type A, B, C, D, and E have been obsoleted.

Divided highways may have parallel but separate subgrade treatment areas, likely of the same type, depending upon the width of the median. Isolated areas such as those on S-lines, median crossovers, or possibly portions of the mainline, may be of a different treatment type than that of the mainline. Quantities should be determined for each required subgrade treatment pay item.

V. RECURRING SPECIAL PROVISION

Recurring Special Provision 207-R-481, Subgrade Treatment, attached hereto, should be called for through the August 17, 2005, letting. Beginning with the September 14, 2005, letting, the recurring special provision will be incorporated into revised Standard Specifications Section 207. The provision will then no longer be required to be called for in specific contracts.

SUBGRADE

The Standard Specifications are revised as follows:
SECTION 203, BEGIN LINE 193, DELETE AND INSERT AS FOLLOWS:

If the same or similar material is being used in the upper lifts of embankment as shall be used in ~~subbase~~ *the subgrade* at that location, these lifts shall be placed in smooth uniform layers for the full width of the embankment.

SECTION 203, AFTER LINE 934, INSERT AS FOLLOWS:

If the Contractor chooses the option of coarse aggregate No. 53 as subgrade treatment in accordance with 207.04, the embankment material including the aggregate will be measured in accordance with 203.27(b). The aggregate will also be measured as subgrade treatment in accordance with 207.06.

SECTION 203, AFTER LINE 952, INSERT AS FOLLOWS:

If the Contractor chooses the option of coarse aggregate No. 53 as subgrade treatment in accordance with 207.04, the borrow material including the aggregate will be measured in accordance with 203.27(b). The aggregate will also be measured as subgrade treatment in accordance with 207.06.

SECTION 207, DELETE LINES 1 THROUGH 154.

SECTION 207, AFTER LINE 155, INSERT AS FOLLOWS:

SECTION 207 – SUBGRADE

207.01 Description. *This work shall consist of the construction of the subgrade in accordance with 105.03.*

MATERIALS

207.02 Materials. *Materials shall be in accordance with the following.*

Chemical Modifiers

<i>Fly Ash</i>	<i>901.02</i>
<i>Lime</i>	<i>913.04(b)</i>
<i>Portland Cement, type I</i>	<i>901.01(b)</i>
<i>Coarse Aggregate, Class D or Higher, Size No. 11, 12, 53, or 73</i>	<i>904</i>
<i>Geogrid, Type I</i>	<i>913.21</i>
<i>Water</i>	<i>913.01</i>

Recycled concrete pavement meeting the requirements of coarse aggregate size No. 53 may be used when crushed stone size No. 53 is specified.

CONSTRUCTION REQUIREMENTS

207.03 General Requirements. *The subgrade shall be constructed uniformly transversely across the width of the pavement including 0.6 m (2 ft) outside the edge of 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.*

Longitudinally, the treatment may vary depending on the method of construction.

Soils containing greater than 3% by dry weight calcium, magnesium carbonate, or organic material, or with a maximum dry density of less than 1600 kg/m³ (100 pcf), or with liquid limit of greater than 50, will not be permitted within the specified thickness of the subgrade. Density shall be determined in accordance with AASHTO T 99 and loss of ignition shall be determined in accordance with AASHTO T 267. Liquid limits shall be determined in accordance with AASHTO T 89.

Coal within the specified thickness of the subgrade shall be excavated if directed, and disposed of in accordance with 202.05. Coal or coal blossoms that are allowed to remain shall be mixed thoroughly with subgrade soils and compacted in accordance with 207.04.

All rock greater than 150 mm (6 in.) shall be removed or broken off at least 150 mm (6 in.) below the subgrade surface. Holes or depressions resulting from the removal of unsuitable material shall be filled with an acceptable material and compacted to conform with the surrounding subgrade.

During subgrade preparation, adequate drainage shall be provided at all times to prevent water from standing on the subgrade.

Even though the subgrade has been previously accepted, the condition of the subgrade at the time paving material is placed shall be in accordance with 105.03 and 207.04. Just prior to placing the base course on the subgrade, proofrolling in accordance with 203.26 shall be completed. Undue distortion of the subgrade shall be avoided. If limits of the work make mechanical preparation of the subgrade impractical, appropriate hand methods may be used.

The grade and cross section of the subgrade shall be finished within a tolerance of 13 mm (1/2 in.) from the true subgrade. It is permissible to finish within this tolerance by blading or other mechanical means without the use of side forms. If these methods do not finish within this tolerance, side forms shall be used.

207.04 Subgrade Treatments. *The subgrade treatment type shall be as specified on the contract plans.*

Within each of the following subgrade treatment types the Contractor shall choose from the listed options for each type.

- Type I. 400 mm (16 in.) chemical soil modification, 300 mm (12 in.) of the subgrade excavated and replaced with coarse aggregate No. 53, or by 600 mm (24 in.) of soil compacted to density and moisture requirements.*
- Type IA. 400 mm (16 in.) chemical soil modification or 300 mm (12 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.*
- Type II. 200 mm (8 in.) chemical soil modification, 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53, or 300 mm (12 in.) of soil compacted to density and moisture requirements.*
- Type IIA. 200 mm (8 in.) chemical soil modification or 150 mm (6 in.) of the subgrade excavated and replaced with coarse aggregate No. 53.*
- Type III. 150 mm (6 in.) of soil compacted to the density and moisture requirements or 150 mm (6 in.) of subgrade excavated and replaced with coarse aggregate No. 53.*
- Type IIIA. 150 mm (6 in.) of subgrade excavated and replaced with coarse aggregate No. 53.*
- Type IV. 225 mm (9 in.) of the subgrade excavated and replaced with coarse aggregate No. 53 on geogrid.*

Where the density and moisture controls option is used, compaction of embankment areas shall be in accordance with 203.23. In cut and transition areas, the top lifts shall be removed and the bottom 150 mm (6 in.) compacted in-place to comply with the specified density and moisture requirements. The excavated material shall then be replaced and compacted in 150 mm (6 in.) lifts to comply with the specified density and moisture requirements. Removal of the upper lifts may be waived and only the upper 150 mm (6 in.) treated in accordance with 207.03 when it is determined, through testing in accordance with 203.24, that the lower lifts comply with the specified density and moisture requirements.

In sections where shale or shale and rock mixtures are encountered, these materials shall be undercut 300 mm (12 in.) below the subgrade elevation and replaced with coarse aggregate No. 53 or No. 73 and compacted in accordance with 301.06. All irregularities and holes shall be graded to provide positive drainage. Where necessary, finishing to subgrade elevation shall be accomplished using No. 11 or No. 12 crushed stone.

When conditions are encountered below the specified subgrade treatment depth that prevent achieving the specified subgrade compaction, such conditions shall be treated as directed.

207.05 Method of Measurement. *Subgrade treatment will be measured in both cut and fill areas by the square meter (square yard) per type. Chemicals for modification, excavation, aggregates, and geogrid materials will not be measured.*

The undercutting of rock, where encountered, will be measured in accordance with 203.27(b).

207.06 Basis of Payment. *The accepted quantities of subgrade treatment, will be paid for at the contract unit price per square meter (square yard) per type, complete in place.*

The undercutting of rock, where encountered, will be paid for in accordance with 203.28.

Payment will be made under:

Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
Subgrade Treatment, Type _____	m2 (SYS)

The cost of subgrade treatments including testing, sampling, aggregates for cut or at-grade areas, chemicals for modification, geogrid, water, and the excavation required for the methods chosen by the Contractor shall be included in the cost of the pay item for subgrade treatment, type.

Compacted aggregate used for subgrade treatment in fill areas will also be measured and paid for as either embankment or as borrow, as appropriate, in accordance with 203.27 and 203.28.

SECTION 215, BEGIN LINE 1, INSERT AS FOLLOWS:

SECTION 215 – CHEMICAL MODIFICATION OF SOILS

215.01 Description. *This work shall consist of the modification of soils by uniformly mixing dry portland cement, fly ash, lime, or a combination of the materials with soil to aid in achieving the workability of soils having an excessive moisture content.*

MATERIALS

215.02 Materials. *Materials shall be in accordance with the following:*

Fly Ash	901.02
Lime.....	913.04(b)
Portland Cement, Type I.....	901.01(b)
Water.....	913.01

CONSTRUCTION REQUIREMENTS

215.03 Testing and Mix Design. *The Contractor shall be responsible for all tests required to determine the optimum chemical modifier content for modification of the soils. The modifier selection, laboratory testing, and mix design shall be performed by an approved geotechnical consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization.*

The quantities for hydrated lime, quicklime, or portland cement shall be based on $4.0 \pm 0.5\%$ by dry unit mass (weight) of the soils. The quantities for lime by-products shall be based on $5.0 \pm 1.0\%$ by dry unit mass (weight) of the soils. The quantities for fly ash class C shall be based on $12.0 \pm 2.0\%$ by dry unit mass (weight) of the soils. Class F fly ash shall not be used except in combination with lime or cement.

If hydrated lime, quick lime, or cement are used, test results, recommendations, and a type A certification for the chemical modifiers, except for cement, shall be submitted to the Engineer prior to use. If fly ash, lime, lime by-products, or any combination of chemical modifiers are used, test results, recommendations, and type A certifications for the chemical modifiers shall be submitted to the Engineer and to the Materials and Tests Division for approval at least five days prior to use. Cement, if used, shall be from the Department's list of Approved Cement Sources.

The quantity of chemical modifier may be adjusted for different soil types. However, the source or type of chemical modifier shall not be changed during the progress of the work without approval. A change in source or type shall require a new mix design.

215.04 Storage and Handling. *The chemical modifier shall be stored and handled in accordance with the manufacturer's recommendations.*

215.05 Weather Limitations. *The chemical soil modification shall be performed when the soil has a minimum temperature of 7°C (45°F), measured 100 mm (4 in.) below the surface, and with the air temperature rising. The chemical modifier shall not be mixed with frozen soils or with soil containing frost.*

215.06 Preparation of Soils. *The soils shall be prepared in accordance with 207.03. All aggregates which are larger than approximately 75 mm (3 in.) encountered before or after mixing the soils and chemical modifiers shall be removed.*

215.07 Spreading of Chemical Modifiers. *Where type A-6 or A-7 soils are used or encountered, the surface shall be scarified or disked to the specified depth prior to distribution of the chemical modifier. If a combination of modifiers is used, it shall be mixed mechanically prior to being incorporated. The chemical modifier shall be distributed uniformly by a cyclone, screw-type, or pressure manifold type distributor. The chemical modifier shall not be applied when wind conditions create problems in adjacent areas or create a hazard to traffic on any adjacent roadway. The spreading of the chemical modifier shall be limited to an amount which can be incorporated into the soil within the same work day. If weather causes stoppage of work or exposes the chemical modifier to washing or blowing, additional chemical modifier may be spread when the work resumes.*

215.08 Mixing. *The chemical modifier, soil, and water when necessary, shall be thoroughly mixed by rotary speed mixers. The mixing shall continue until a homogenous layer of the required thickness has been obtained. One hundred percent of the material, exclusive of rock particles, shall pass a 25 mm (1 in.) sieve and at least 60% shall pass a 4.75 mm (No. 4) sieve. The mixing depth shall be 400 mm (16 in.).*

215.09 Compaction. *Compaction of the mixture shall begin as soon as practicable after mixing. Compaction after mixing shall be as follows:*

- (a) For cement modified soils, mixing shall be completed within 30 min of cement placement and compaction shall be completed within 3 h after mixing.*
- (b) Fly ash modified soils shall be compacted within 4 h.*
- (c) Lime modified soils shall be compacted within 24 h.*

Compactive efforts shall be in accordance with 203 or 207.03 as applicable.

Maximum dry densities will be determined in accordance with AASHTO T 272 at the same time and location as each in-place density test is performed when in-place densities do not meet AASHTO T 99. The field in-place dry density shall be in accordance with AASHTO T 191 or AASHTO T 310.

The moisture content of the mixture shall be between the optimum moisture and the optimum moisture plus 2.0%. Aeration or drying by further mixing, or the addition of water and further mixing, may be required to obtain the optimum moisture content.

Construction traffic or equipment shall not be on the treated soils within 72 h of compaction.

215.10 Method of Measurement. *The accepted quantity of chemically modified soils will be measured by the square meter (square yard), complete in place. All excavation required to modify the soils below the specified depth will be measured in accordance with 203.27(b).*

215.11 Basis of Payment. *The accepted quantity of chemically modified soils will be paid for by the square meter (square yard), complete in place. All excavation required to modify the soils below the specified depth will be paid for in accordance with 203.28.*

Adjustment of materials for chemical modification that exceeds the limits of 215.03 will be included in an extra work agreement developed in accordance with 109.05 for materials only and paid for as chemical modifier adjustments. If mix design test results show that hydrated lime, quicklime, lime by-products, or fly ash are not appropriate and moisture-density compaction can not be achieved, a price adjustment will be made for the use of cement. The price adjustment will be calculated at a cost equal to the difference in the invoice cost of the cement and the invoice

cost of the hydrated lime An extra work agreement will be developed in accordance with 109.05 and will be paid for as chemical modifier adjustments.

Payment will be made under:

<i>Pay Item</i>	<i>Metric Pay Unit Symbol (English Pay Unit Symbol)</i>
<i>Chemical Modification, Soils.....</i>	<i>m2 (SYS)</i>

The costs of performing the laboratory tests, providing an approved geotechnical consultant, scarification of the subgrade, spreading and mixing of the chemical modifier and soil, compaction of the resultant mixture, shaping the subgrade, work required due to adjustments of modifier proportioning, additional modification required due to weather conditions, correction of deficient areas, water required for the modification process, modified subgrade trimming, and all operations needed to meet the requirements of this specification shall be included in the costs of the pay item.

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