STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

BEVERLY EAVES PERDUE
GOVERNOR

EUGENE A. CONTI, JR.
SECRETARY

MEMO TO: Roadway Design Project Engineers and Division Design Engineers

FROM: Jay A. Bennett, PE
State Roadway Design Engineer

DATE: October 7, 2010

SUBJECT: Aggregate Subgrade Provision and Guidance for Shallow Undercut Quantities in Final Roadway Design Plans

The purpose of this memorandum is to provide updated guidance regarding the Aggregate Subgrade Provision information dated October 9, 2009. Engineers should incorporate the following information for any project with aggregate subgrade and/or shallow undercut.

Earthwork Balance Sheet: Quantities for Shallow Undercut and Class IV Subgrade Stabilization will be provided to Roadway Design (or the engineer in charge) in the Geotechnical Recommendations by specifying a station range and/or a quantity as a contingency item. Shallow Undercut is a separate pay item from Undercut Excavation and should not be referenced in the Undercut column in the body of the earthwork balance sheet. The quantities of Shallow Undercut and Class IV Subgrade Stabilization will be shown as separate line items below the grand total of the earthwork balance sheet. An example of the earthwork balance sheet with these items is attached and the balance sheet template on the roadway web page has been updated. The Roadway Design website has also been updated with more detailed information and help on calculating the excavation and stabilization quantities.

CADD Drawings: Shallow undercut listed by a station range shall be shown on our cross sections (shaded and not cross hatched) and shall be shown on the typical sections. Shallow Undercut will not be shown on the profile. Note: standard undercut should always be shown on the profile, even if undercut areas do not cross the center-line of divided or undivided facilities.

Cross Sections: Levels, cells, and input files have been developed for Roadway to draw shallow undercut on the cross sections. An input file has been created to calculate the volume of the shallow undercut (located in our workspace named "suc.inp"). This calculated shallow undercut volume will be used in lieu of the quantity provided by the Geotechnical Engineering Unit. If the calculated quantity differs greatly from the quantity provided by the Geotechnical Engineering Unit, the Roadway squad leader should inform

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
ROADWAY DESIGN UNIT
1582 MAIL SERVICE CENTER
RALEIGH NC 27699-1582

TELEPHONE: 919-250-4016
FAX: 919-250-4036

WEBSITE: WWW.NCDOT.ORG/DOH

LOCATION:
CENTURY CENTER COMPLEX
BUILDING A
1000 BIRCH RIDGE DRIVE
RALEIGH NC

the Regional Geological Engineer that the shallow undercut quantities differ. The input file will also calculate a new tonnage of Class IV Subgrade Stabilization, which will supersede the quantity of Class IV Subgrade Stabilization provided by the Geotechnical Engineering Unit. Please note that for the final estimate of quantities, the contingency quantities of Shallow Undercut and Class IV Subgrade Stabilization may need to be added to the calculated quantities to determine the total Shallow Undercut and Class IV Subgrade Stabilization required. Also, calculation of quantity sheets should be created for both the Shallow Undercut and Class IV Subgrade Stabilization. The undercut log file will also contain these quantities.

Typical Sections: An inset (graphic cell) for the typical section has been created for placement on projects that require aggregate subgrade. This inset will list the station ranges and will be edited to show the shallow undercut thickness recommended from the Geotechnical Recommendations. The letter codes of the Pavement Schedule have been revised to include Class IV Subgrade Stabilization (L2) and Fabric for Soil Stabilization (N2). The Roadway Design Manual will be revised to reflect these changes. An example of the pavement schedule changes is attached.

Form Letters: In order for Pavement Management to review the aggregate subgrade recommendations, half size copies of the title sheet and typicals will be sent to the Pavement Management Unit (PMU) at the Combined Field Inspection (CFI) or the Pre-Let Field Inspection (PLFI). The field inspection form letters have been updated to include this change and the Printing Unit Supervisor will make the appropriate copies for delivery. Note: due to the fact that numerous pay item quantities and recommendations are provided in the Geotechnical Recommendations for Pavement Design, Geotechnical has moved Roadway Design from the "cc:" list to the "To:" list with the Pavement Management Unit to place more emphasis on these quantities. The Pavement Management Unit has also added the following statement to their Final Pavement Design memorandum:

"See Geotechnical Recommendations for Pavement Design dated ..... for additional recommendations, quantities and details."

The Roadway Design Unit (or engineer in charge) is responsible for incorporating these recommendations and/or pay item quantities into the final plans, specifications and estimate package. If you have any questions in regard to these recommendations, please contact Glenn Mumford, PE, at 919-250-4016.

JAB/jam
Attachments

cc: Randy Garris, PE
Njoroge Wainaina, PE
Judy Corley-Lay, Ph.D., PE
Clark Morrison, Ph.D., PE
Rodger Rochelle, PE
Cynthia Perry, PE
Larry Strickland
Frankie Draper

K ~~Soil-Cement Base~~ / ~~Lime-Treated Soil~~ } Chemically Stabilized Subgrade

L ~~Stabilizer~~ Aggregate Stabilized Subgrade

M Soil Type Base Course

N Engineering Fabric

Code Letter Page 6-1D

L1 Base to be stabilized with 200 to 400 lbs. per sq. yard of Stabilizer Aggregate mixed with the top 3" of subgrade soil at locations directed by the Engineer.

L2 Class IV Subgrade Stabilization

M1 Prop. 8" Soil Type Base Course, Type A

M2 Prop. 10" Soil Type Base Course, Type _____

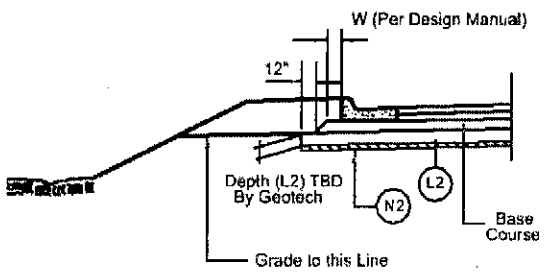
N1 Geotextile for Pavement Stabilization

N2 Fabric for Soil Stabilization

Code Sample Page 6-1D (F-1)

Typical Sections

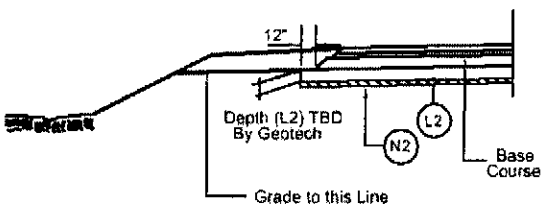
Curb & Gutter



L2 Class IV Subgrade Stabilization

N2 Fabric Stabilization

Shoulder



L2 Class IV Subgrade Stabilization

N2 Fabric Stabilization

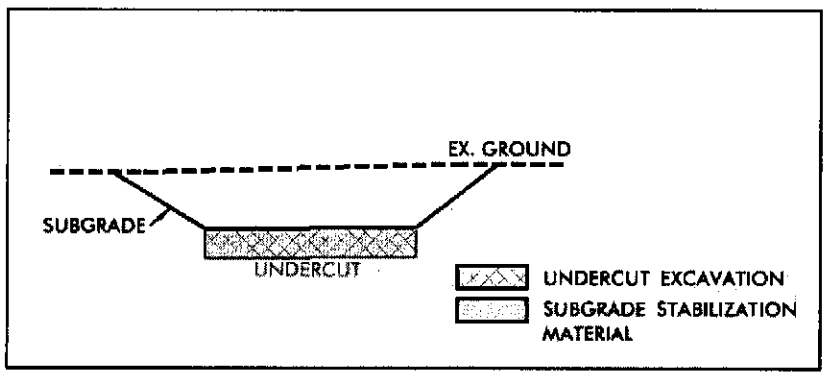
CORRIDOR MODELING
Roadway Home
Corridor Modeling Home
Roadway Design Workflow
Getting Started
Setting Up Preferences
Open Create Template Dialog
Template Library
Roadway Designer
Drive Roadway Dialog
Draw Cross Sections from Surfaces
Cross Section Labeling
Appendix
Common Mistakes / Known Issues
Parametric Constraints Chart
Pavement Vol. Conversion
Earthwork
Undercut
Earthwork Shrinkage Factors Undercut
Definition of Terms
Drafting Standards
Question & Answer
Site Map

Undercut, Shallow Undercut, and Aggregate Subbase (Subgrade Stabilization)

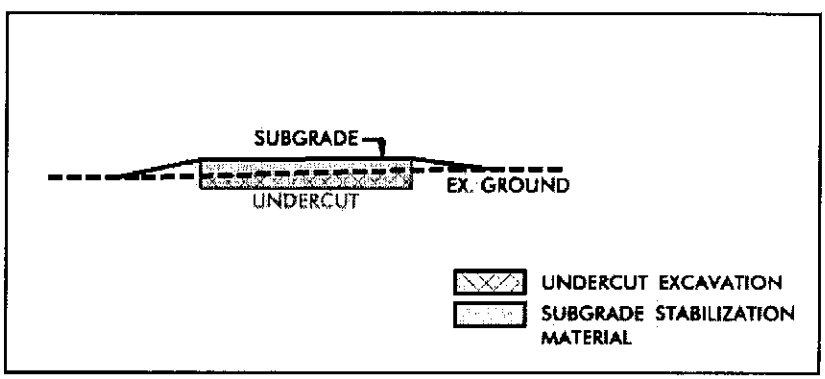
Subgrade Stabilization

Subgrade stabilization is mostly called for by the Geotechnical Unit and on rare occasions may be called for by Pavement Management. It is done to stabilize the subgrade earthwork to work properly, the undercut component must tie to the subgrade line. In most cases, the quantities for Undercut Excavation and Subgrade Stabilization Material r There are three conditions in which undercut is used and further explanation of the derived quantities is needed.

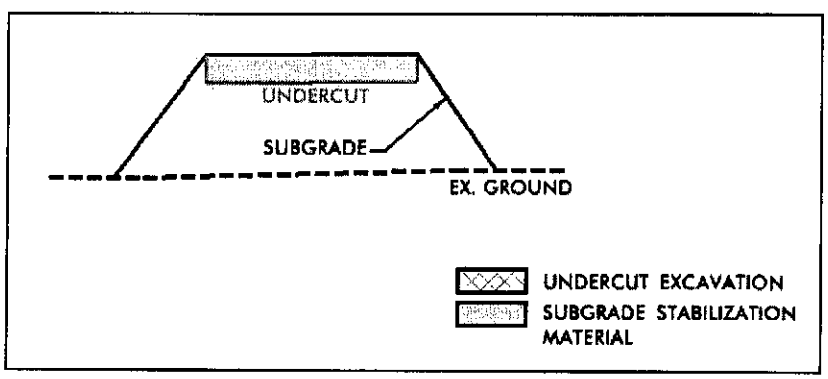
Proposed Undercut (Subgrade Stabilization) below Existing Ground



Proposed Undercut (Subgrade Stabilization) Partially Above and Below Existing Ground



Proposed Undercut (Subgrade Stabilization) Above Existing Ground

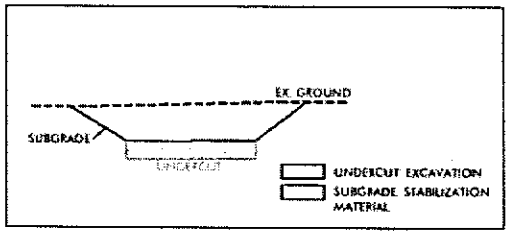


Undercut, Shallow Undercut, and Aggregate Subbase (Subgrade Stabilization)

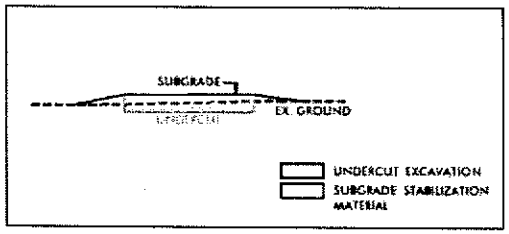
Subgrade Stabilization

Subgrade stabilization is mostly called for by the Geotechnical Unit and on rare occasions may be called for by Pavement Management. It is done to stabilize the subgrade when required. For earthwork to work properly, the undercut component must tie to the subgrade line. In most cases, the quantities for Undercut Excavation and Subgrade Stabilization Material must be calculated. There are three conditions in which undercut is used and further explanation of the derived quantities is needed.

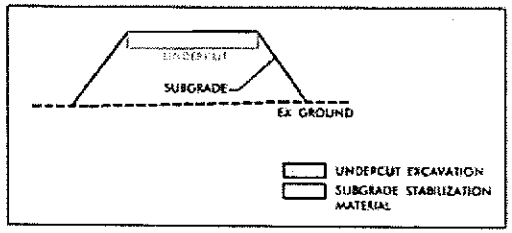
Proposed Undercut (Subgrade Stabilization) below Existing Ground. Note all undercut excavation is considered.



Proposed Undercut (Subgrade Stabilization) Partially Above and Below Existing Ground. Note only partial undercut excavation is considered.

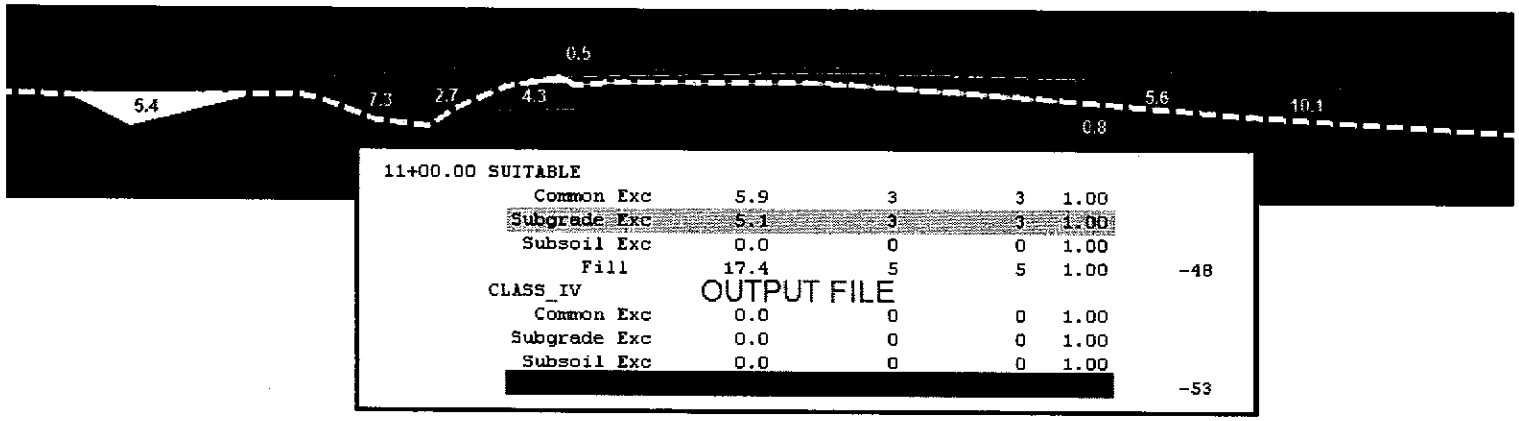


Proposed Undercut (Subgrade Stabilization) In Fills. Note, there is no undercut excavation in this case.



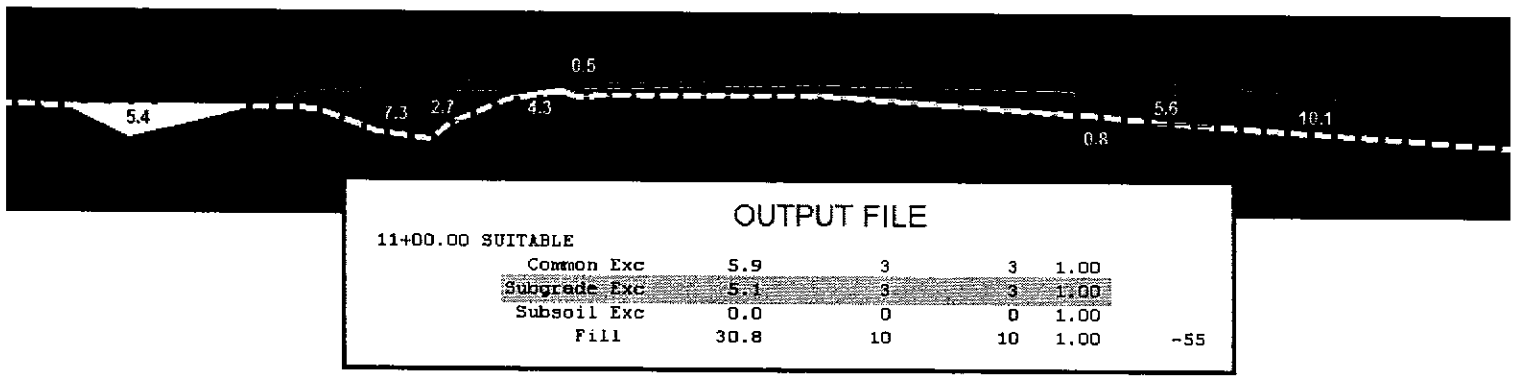
Earthwork Computation

SHALLOW UNDERCUT



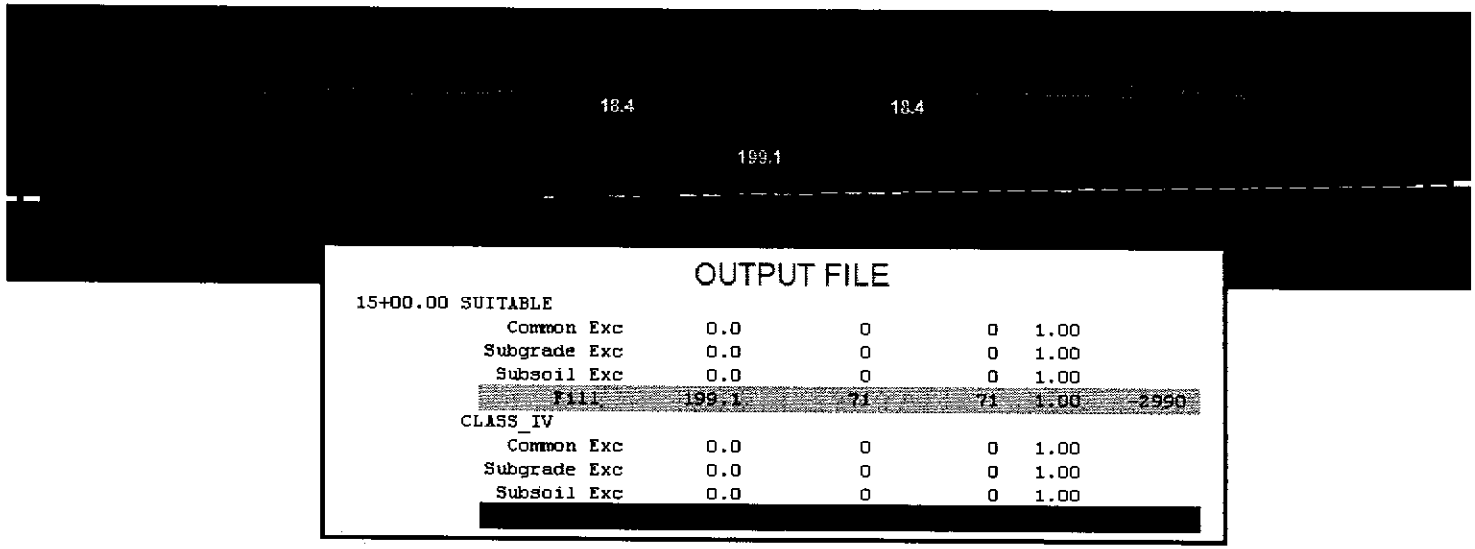
(Suitable) Subgrade Excavation - The amount of shallow undercut excavated (shown in red shapes as excavation only).
(Class IV) Fill - The amount of Class IV material to be backfilled (shown in red shapes).

UNDERCUT (REGULAR)



(Suitable) Subgrade Excavation - The amount of undercut excavated (shown in blue shapes as excavation only).
(Suitable) Fill - Include earth material to be backfilled of undercut (shown in blue shapes).

SUBGRADE STABILIZATION IN FILLS



(Suitable) Fill - Amount of earth material required for roadway embankment(shown in blue shapes).
(Class IV) Fill - Amount of subgrade stabilization material in fills (shown in red shapes).

The North Carolina Department of Transportation

North Carolina Division of Highways
ROADWAY DESIGN UNIT

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Roadway Design Workflow
Getting Started
Setting Up Preferences
Open Create Template Dialog
Template Library
Roadway Designer
Drive Roadway Dialog
Draw Cross Sections from Surfaces
Cross Section Labeling
Appendix
Common Mistakes / Known Issues
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Earthwork Shrinkage Factors Undercut
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Drafting Standards
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Pavement Volume to Tonnage Conversion

Mix Type	Rate (lbs/yd^2· in)	Conv. Factor (ton/yd^3)
Surface		
S4.75A	100	1.800
SF9.5A	110	1.980
S9.5B	112	2.016
S9.5C	112	2.016
S9.5D	112	2.016
S12.5C	112	2.016
S12.5D	112	2.016
Intermediate		
I19.0B	114	2.052
I19.0C	114	2.052
I19.0D	114	2.052
Base		
B25.0B	114	2.052
B25.0C	114	2.052
PADC, P-57	90	1.620
PADC, P-78M	90	1.620
ABC	---	2.025*

* Includes 1.5 depth compaction factor.

RATE FOR
CLASS IV SUBGRADE STABILIZATION

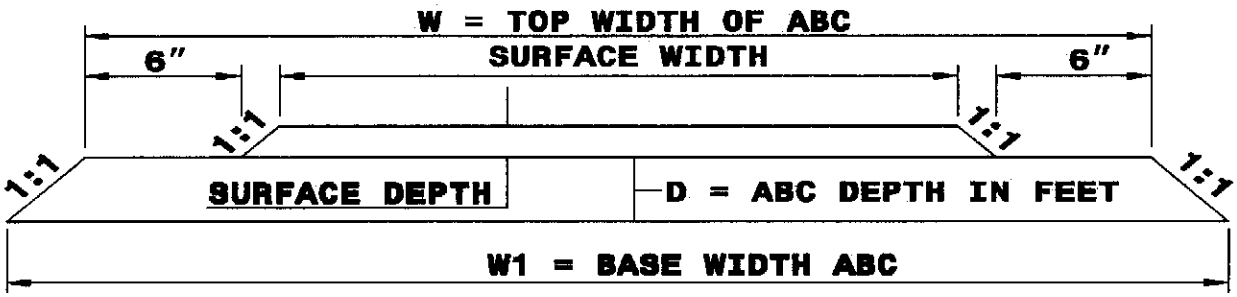
2.025 TONS/CY

The North Carolina Department of Transportation

10/5/2010

PROJECT NO.: SHEET OF
COMPUTED BY:
CHECKED BY: SECTION: 520

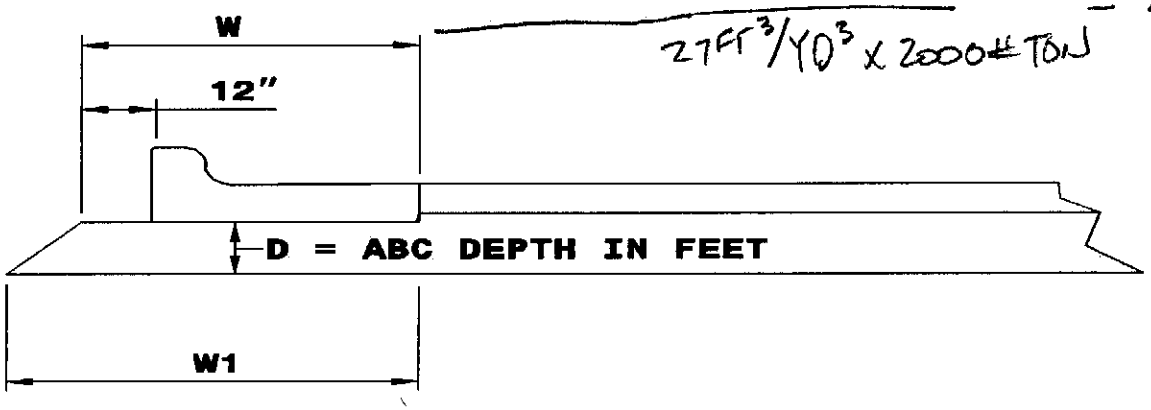
AGGREGATE BASE COURSE



CALCULATE ABC: 3FT X 3FT 3.FT

ABC = $\dfrac{\text{LENGTH X ((W+W1)/2) X 1.5(D) X 2700\# / YD}^3}{\text{27 FT}^3\text{ / YD}^3\text{ x 2000\# / TON}}$ = _____ TONS

$\dfrac{3 \times 3 \times 1.5 \times 3 \times 2700\ \#/YD^3}{27FT^3/YD^3 \times 2000\#\ TON} = 2.025$ TON/CY



CALCULATE ABC:

ABC = $\dfrac{\text{LENGTH X ((W+W1))/2 X 1.5(D) X 2700\# / YD}^3}{\text{27 FT}^3\text{ / YD}^3\text{ x 2000\# / TON}}$ = _____ TONS

NOTE: WHEN ALL CALCULATIONS ARE COMPLETE AND TOTALED SEE THE ROADWAY DESIGN MANUAL, PART I, 11-B".

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

BEVERLY EAVES PERDUE
GOVERNOR

EUGENE A. CONTI, JR.
SECRETARY

October 9, 2009

MEMORANDUM TO: Jay Bennett, P.E.
State Roadway Design Engineer

Division Engineers

FROM: Randy Garris, P.E.
State Contract Officer

SUBJECT: Aggregate Subgrade and
Select Granular Material Pay Items

The Contract Standards and Development and Geotechnical Engineering Units have completed the development of two new special provisions entitled "Aggregate Subgrade" and "Select Granular Material" to be effective with the March 16, 2010 letting. These new provisions include changes to the pay items and plans. The purpose of this memorandum is to inform groups involved in plan and quantity estimate preparation about how to handle these pay item changes.

The new "Aggregate Subgrade" provision will replace the current "Shallow Undercut" provision. The *Class IV Subgrade Stabilization* and *Fabric for Soil Stabilization* pay items will remain the same for the new provision. However, the new "Aggregate Subgrade" provision includes a new *Shallow Undercut* pay item to replace the *Undercut Excavation* pay item used in the current "Shallow Undercut" provision. Projects with geotechnical recommendations recommending shallow undercut will need to be revised. The *Undercut Excavation* quantity for shallow undercut should be deducted from the total *Undercut Excavation* quantity and included in the estimate as *Shallow Undercut*. If the *Undercut Excavation* quantity for shallow undercut is not clearly stated in the geotechnical recommendations, contact the Geotechnical Engineering Unit for clarification.

The new "Select Granular Material" provision will replace Section 265 of the standard specifications. The *Select Granular Material* pay item for the new provision has not changed from Section 265. However, to aid in contract administration during construction, select granular material will be paid for differently when it comes from the same source as the borrow excavation. As a result, comprehensive (Lump Sum) grading projects with select granular material should be handled differently if the geotechnical recommendations

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Fax: 919-250-4119

Website: www.ncdot.org./doh

LOCATION:
CENTURY CENTER COMPLEX
ENTRANCE B-3
1020 BIRCH RIDGE DRIVE
RALEIGH NC 27610

recommend the use of select granular material and it is not a contingency item. For this situation, undercut and borrow quantities should be included as individual items under Sections 225 and 230 of the Standard Specifications.

In addition, we recommend revising the Roadway Design Manual and Calculation of Quantities to reflect this memorandum. If there are any questions regarding this memorandum, please contact Scott Hidden, P.E. of the Geotechnical Engineering Unit at (919) 250-4088.

Attachments

cc: Andy Gay, P.E., Proposals and Contracts Engineer
Cynthia Perry, P.E., Plans and Standards Engineer
Ron Davenport, P.E., State Estimating Engineer
Njoroge Wainaina, P.E., State Geotechnical Engineer
Ron Hancock, P.E., State Construction Engineer
Scott Hidden, P.E.
Division Project Managers

AGGREGATE SUBGRADE:

(3-16-10) SP2 R35

Description

Construct aggregate subgrades in accordance with the contract or as directed by the Engineer. Undercut as needed in cut areas. Install fabric for soil stabilization and place Class IV Subgrade Stabilization at locations shown on the plans.

Materials

Refer to Division 10 of the *Standard Specifications.*

Item	Section
Select Material, Class IV	1016
Fabric for Soil Stabilization, Type 4	1056

Use Class IV Select Material for Class IV Subgrade Stabilization. If Class IV Subgrade Stabilization does not meet the requirements of Article 1010-2 of the *Standard Specifications*, the Engineer may consider the material reasonably acceptable in accordance with Article 105-3 of the *Standard Specifications*.

Construction Methods

When shallow undercut is required to construct aggregate subgrades, undercut 6 to 24 inches as shown on the plans or as directed by the Engineer. Perform undercut excavation in accordance with Section 225 of the *Standard Specifications*. Install fabric for soil stabilization in accordance with Article 270-3 of the *Standard Specifications*. Place Class IV Subgrade Stabilization (standard size no. ABC) by end dumping ABC on the fabric. Do not operate heavy equipment on the fabric until it is covered with Class IV Subgrade Stabilization. Compact ABC to 92% of AASHTO T180 as modified by the Department or to the highest density that can be reasonably obtained.

Maintain Class IV Subgrade Stabilization in an acceptable condition and minimize the use of heavy equipment on ABC in order to avoid damaging aggregate subgrades. Provide and maintain drainage ditches and drains as required to prevent entrapping water in aggregate subgrades.

Measurement and Payment

Shallow Undercut will be measured and paid for in cubic yards. Shallow undercut will be measured in accordance with Article 225-7 of the *Standard Specifications*. The contract unit price bid for *Shallow Undercut* will be full compensation for excavating, hauling and disposing of materials to construct aggregate subgrades.

Class IV Subgrade Stabilization will be measured and paid for in tons. Class IV Subgrade Stabilization will be measured by weighing material in trucks in accordance with Article 106-7 of the *Standard Specifications*. The contract unit price bid for *Class IV Subgrade Stabilization* will be full compensation for furnishing, hauling, handling, placing, compacting and maintaining ABC.

Fabric for Soil Stabilization will be measured and paid for in accordance with Article 270-4 of the *Standard Specifications*.

Payment will be made under:

Pay Item	**Pay Unit**
Shallow Undercut	Cubic Yard
Class IV Subgrade Stabilization	Ton

SELECT GRANULAR MATERIAL:

(3-16-10) SP2 R80

Revise the *Standard Specifications* as follows:

Page 2-29, Delete Section 265 **SELECT GRANULAR MATERIAL** and replace it with the following:

Description

Furnish and place select granular material in accordance with the contract or as directed by the Engineer.

Materials

Refer to Division 10 of the *Standard Specifications.*

Item	Section
Select Material, Class II	1016
Select Material, Class III	1016

Construction Methods

Use Class II or III Select Material over fabric for soil stabilization and only Class III Select Material for backfill in water.

Place select granular material to 3 ft above fabric and water level.

Measurement and Payment

Select granular material will be paid for as *Select Granular Material* unless the material is obtained from the same source as the borrow material. When this occurs and the contract includes a pay item for *Borrow Excavation*, select granular material will be paid for as *Borrow Excavation* in accordance with Article 230-5 of the *Standard Specifications* and no payment for *Select Granular Material* will be made.

Select Granular Material will be measured and paid for in cubic yards. When *Undercut Excavation* is in accordance with Section 226 (Comprehensive Grading) of the *Standard Specifications* and the Engineer requires undercut to be backfilled with select granular material, the second sentence of the sixth paragraph of Article 226-3 will not apply, as payment for the backfill will be made as specified in this provision.

Select granular material will be measured by in place measurement in accordance with Article 230-5 of the *Standard Specifications* or by weighing material in trucks in accordance with Article 106-7 of the *Standard Specifications* as determined by the Engineer. When select granular material is weighed in trucks, a unit weight of 135 pcf will be used to convert the weight of select granular material to cubic yards. At the Engineer's discretion, truck

measurement in accordance with Article 230-5 of the *Standard Specifications* may be used in lieu of weighing material in trucks.

The contract unit price bids for *Select Granular Material* and *Borrow Excavation* as described above will be full compensation for furnishing, hauling, handling, placing, compacting and maintaining select granular material.

Payment will be made under:

Pay Item	**Pay Unit**
Select Granular Material	Cubic Yard

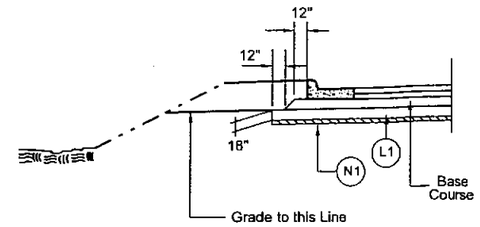
PROJECT REFERENCE NO.	SHEET NO.
U-2809B	2
ROADWAY DESIGN ENGINEER	PAVEMENT DESIGN ENGINEER

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

PRELIMINARY PAVEMENT SCHEDULE

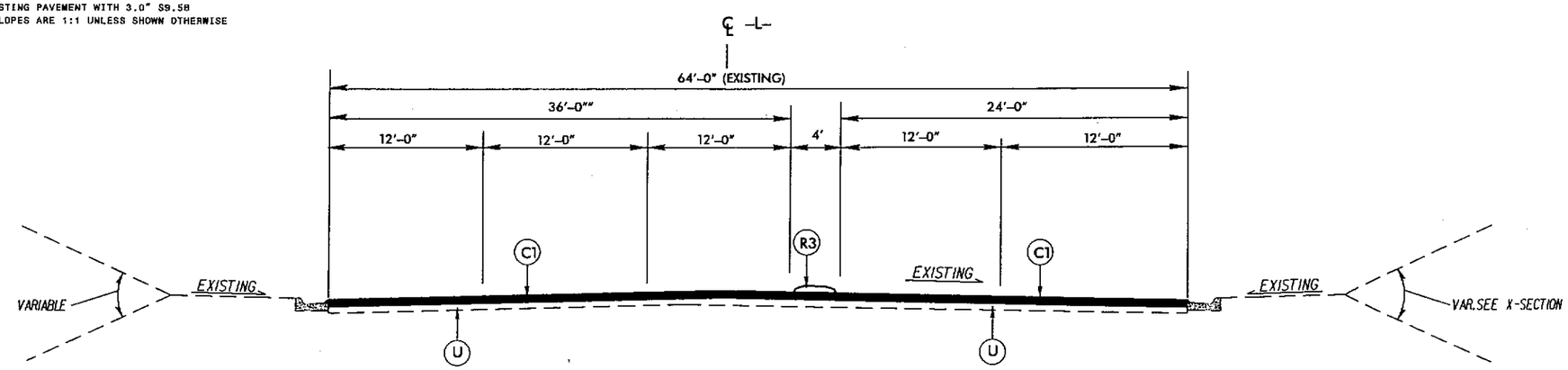
C1	PROP. APPROX. 3" ASPHALT CONC. SURFACE COURSE, TYPE S9.5B, AT AN AVERAGE RATE OF 336 LBS. PER SQ. YD. IN EACH OF TWO LAYERS.	L1	Class IV Subgrade Stabilization
C2	PROP. VAR. DEPTH ASPHALT CONC. SURFACE COURSE, TYPE S9.5B, AT AN AVERAGE RATE OF 112 LBS. PER SQ. YD. PER 1" DEPTH, TO BE PLACED IN LAYERS NOT TO EXCEED 1½" IN DEPTH.	N1	Fabric Stabilization
D1	PROP. APPROX. 2.5 " ASPHALT CONC. INTERMEDIATE COURSE, TYPE I19.0B, AT AN AVERAGE RATE OF 228 LBS. PER SQ. YD. IN EACH OF TWO LAYERS	R1	2'-6" CONCRETE CURB AND GUTTER.
D2	PROP. VAR. DEPTH ASPHALT CONC. INTERMEDIATE COURSE, TYPE I19.0B, AT AN AVERAGE RATE OF 114 LBS. PER SQ. YD. PER 1" DEPTH, TO BE PLACED IN LAYERS NOT LESS THAN 2¼" IN DEPTH OR GREATER THAN 4" IN DEPTH.	R2	2'-9" CONCRETE CURB AND GUTTER.
E1	PROP. APPROX 3" ASPHALT CONCRETE BASE COURSE, TYPE B25.0, AT AN AVERAGE RATE OF 342 LBS. PER SSQ. YD.	T	EARTH MATERIAL.
E2	PROP. VAR. DEPTH ASPHALT CONC. INTERMEDIATE COURSE, TYPE I19.0B, AT AN AVERAGE RATE OF 114 LBS. PER SQ. YD. PER 1" DEPTH, TO BE PLACED IN LAYERS NOT LESS THAN 4" IN DEPTH OR GREATER THAN 5 1/2" IN DEPTH.	U	EXISTING PAVEMENT.
J1	PROP. 8" AGGREGATE BASE COURSE.	W	VARIABLE DEPTH ASPHALT PAVEMENT. (SEE WEDGING DETAIL)

NOTE: OVERLAY THE EXISTING PAVEMENT WITH 3.0" S9.5B
NOTE: PAVEMENT EDGE SLOPES ARE 1:1 UNLESS SHOWN OTHERWISE



Use
Aggregate Subgrade Detail

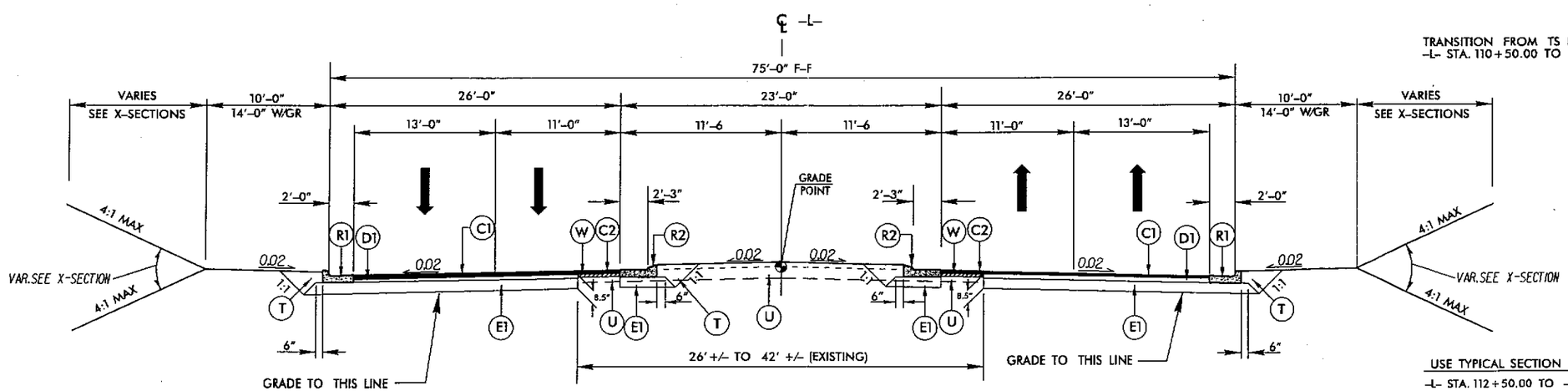
-L- STA. 112+50.00 TO -L- STA. 114+20.00
-L- STA. 120+00.00 TO -L- STA. 125+00.00
-L- STA. 240+50.00 TO -L- STA. 250+50.00



TYPICAL SECTION NO. 1

USE TYPICAL SECTION NO. 1
-L- STA. 109+50.00 TO -L- STA. 110+50.00

TRANSITION FROM TS NO.1 TO TS NO. 2
-L- STA. 110+50.00 TO 112+50.00



TYPICAL SECTION NO. 2

USE TYPICAL SECTION NO. 2
-L- STA. 112+50.00 TO -L- STA. 253+12.20

EARTHWORK BALANCE SHEET

Volumes in Cubic Yards

PROJECT: _____ COUNTY: Cumberland DATE: February 22, 2010 COMPILED BY: _____ SHEET_ OF SHEETS

STATION	STATION	EXCAVATION					EMBANKMENT				BORROW	WASTE			
		TOTAL UNCLASS.	ROCK	UNDERCUT	UNSUIT. UNCLASS.	SUITABLE UNCLASS.	TOTAL	ROCK	EARTH	EMBANK. +25%		ROCK	SUITABLE	UNSUIT.	TOTAL
-L- 11+00	15+50	188				188	111		111	139			49		49
-L- 18+00	48+00	797			121	676	7,118		7,118	8,898	8,222			121	121
-L- 48+00	78+00	2,156				2,156	4,409		4,409	5,511	3,355				
-L- 78+00	105+50	3,005				3,005	5,580		5,580	6,975	3,970				
	SUBTOTAL	6,146			121	6,025	17,218		17,218	21,523	15,547		49	121	170
-Y1 12+75	15+75	59				59	43		43	54			5		5
-Y2- 10+00	12+08.32	141				141	33		33	41			100		100
-Y4- 10+49.11	11+50	18				18	24		24	31	13				
-Y5- 13+86.36	23+25	656				656	185		185	231			425		425
	SUBTOTAL	874				874	285		285	357	13		530		530
RAMP C 10+75	12+00	121				121	35		35	44			77		77
RAMP D 10+75	12+00	93				93	63		63	79			14		14
	SUBTOTAL	214				214	98		98	123			92		92
TOTAL		7,234			121	7,113	17,601		17,601	22,002	15,560		671	121	792
LOSS DUE TO CLEARING & GRUBBING		-3,250				-3,250					3,250				
WASTE IN LIEU OF BORROW											-671		-671		-671
SHOULDER MATERIAL							150		150	188	188				
PROJECT TOTAL		3,984			121	3,863	17,751		17,751	22,190	18,327			121	121
EST. 5% TO REPLACE TOP SOIL ON BORROW PIT											916				
GRAND TOTAL		3,984			121	3,863	17,751		17,751	22,190	19,244			121	121
SAY		4,000									19,300				
EST. UNDERCUT CONTINGENCY				350 CY											
EST. SHALLOW UNDERCUT BY STATIONS				1466 CY											
EST. SHALLOW UNDERCUT CONTINGENCY				500 CY											
TOTAL SHALLOW UNDERCUT				1966 CY											
CLASS IV SUBGRADE STABILIZATION				4760 TONS											
S[illegible]CT GRANULAR MATERIAL				600 CY											

NOTE: EARTHWORK QUANTITIES ARE CALCULATED BY THE ROADWAY DESIGN UNIT. THESE EARTHWORK QUANTITIES ARE BASED IN PART ON SUBSURFACE DATA PROVIDED BY THE GEOTECHNICAL ENGINEERING UNIT.