Figure 2.5-143—{RCTS Testing Sample B-773-6 Intake Area}

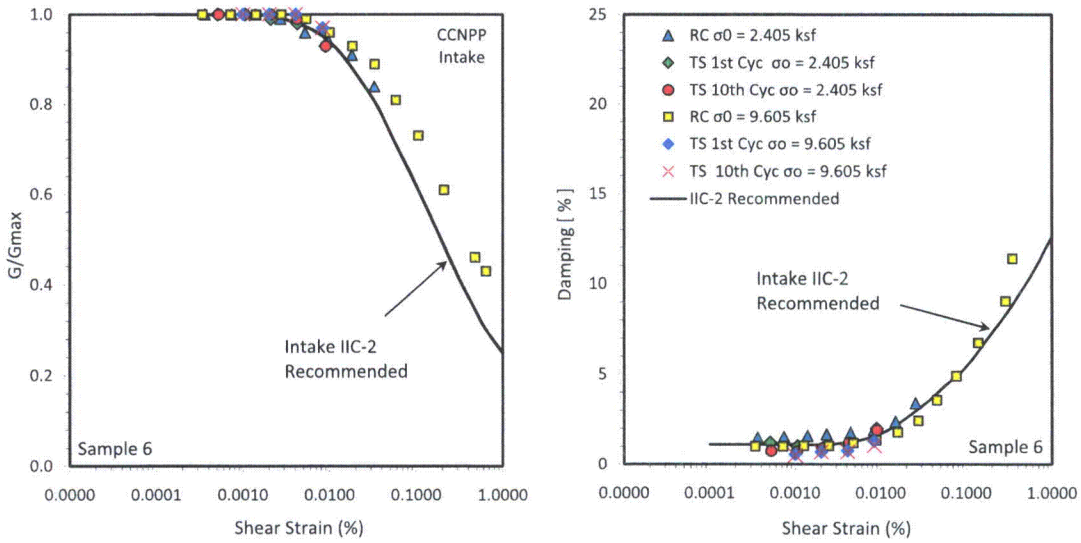

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Figure 2.5-144—{RCTS Testing Sample B-773-7, Intake Area}

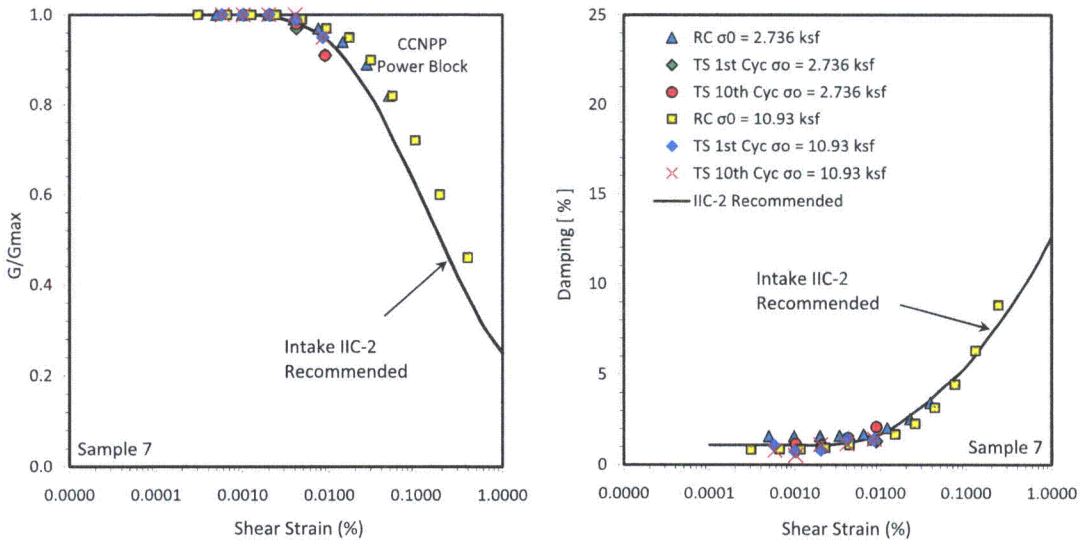

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Figure 2.5-145—{RCTS Testing Sample B-773-9, Intake Area}

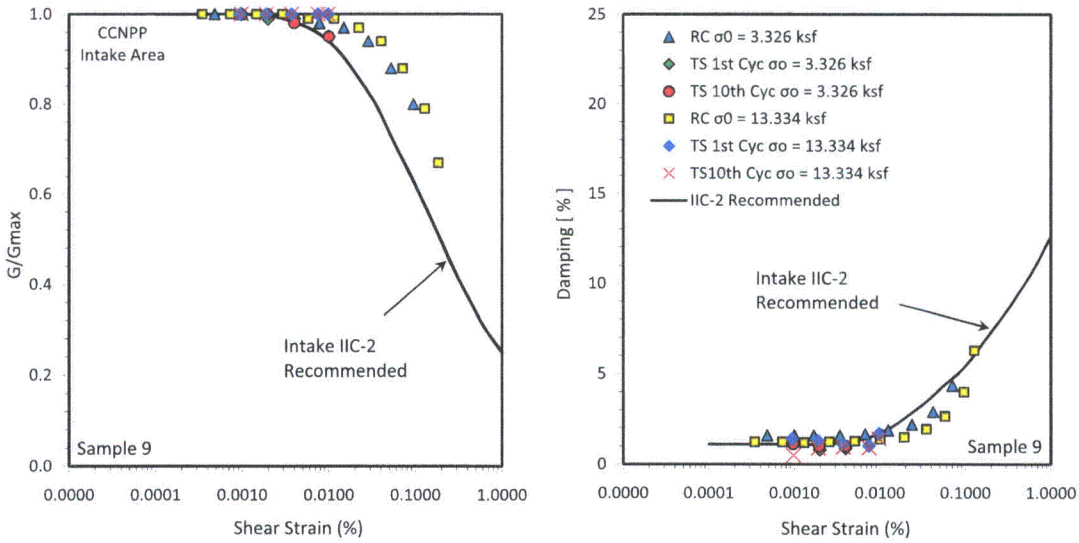

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Figure 2.5-146—{RCTS Testing Sample B-773-11, Intake Area}

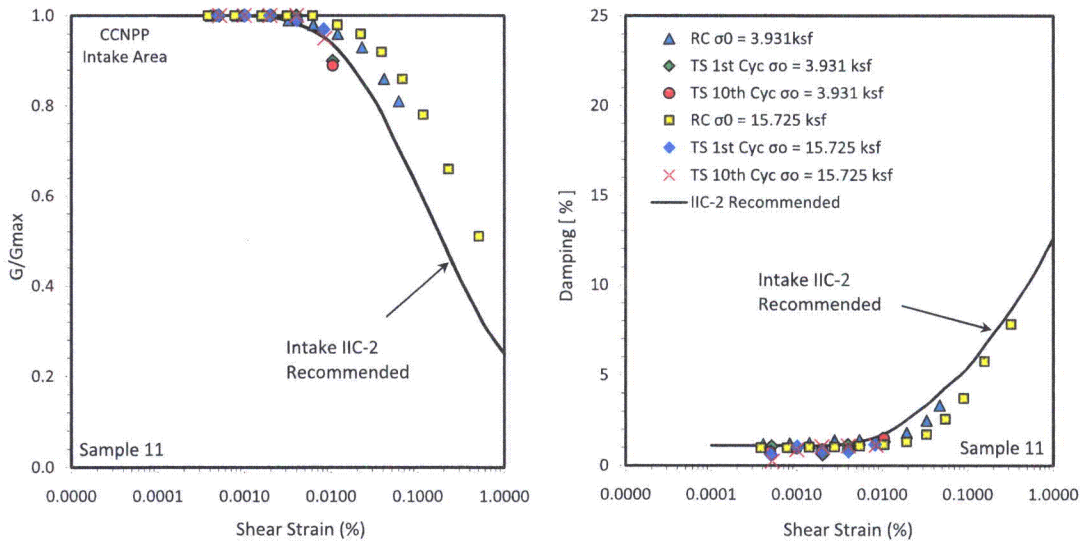

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Figure 2.5-147—{RCTS Testing Sample B-773-13, Intake Area}

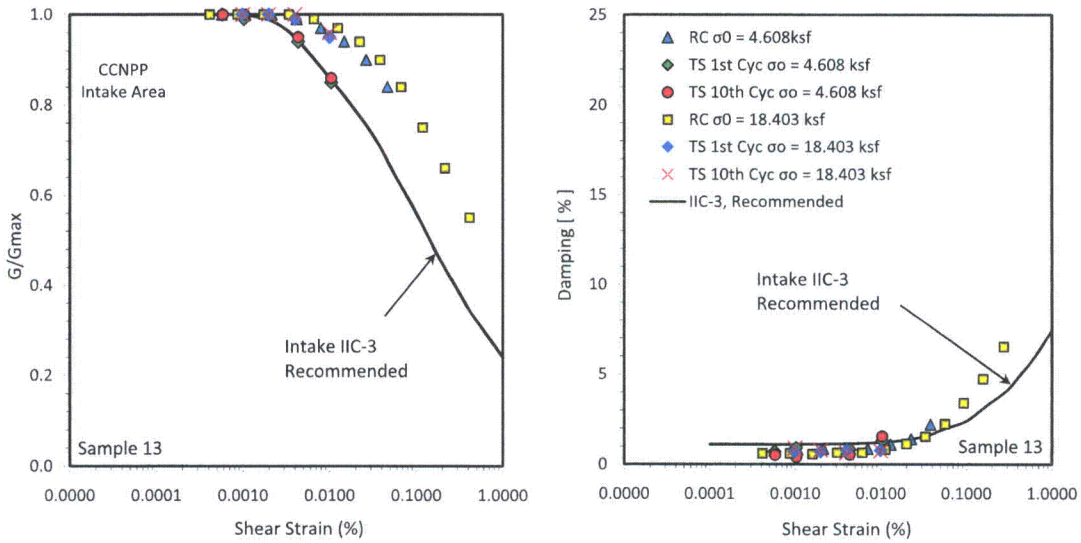

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Figure 2.5-148—{RCTS Testing Sample B-773-15, Intake Area}

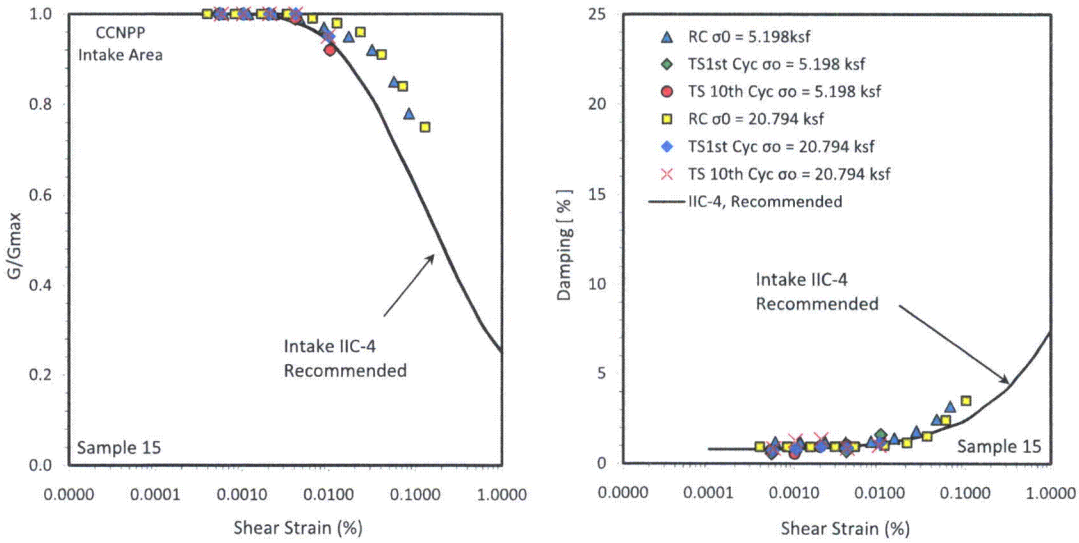

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Figure 2.5-149—{RCTS Testing Sample CR6 Blend, Backfill}

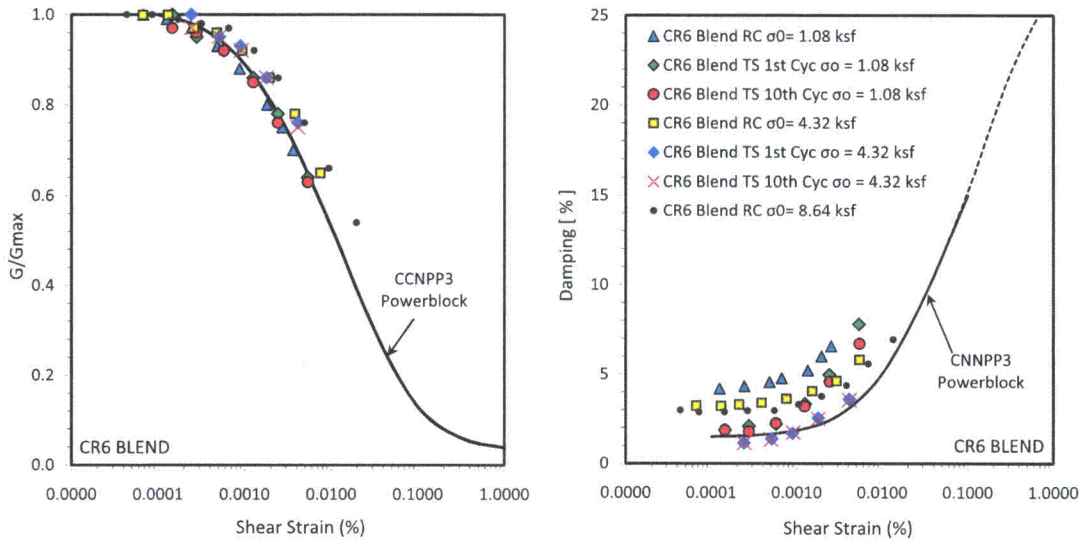

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Figure 2.5-150—{RCTS Testing Sample GAB Blend, Backfill}

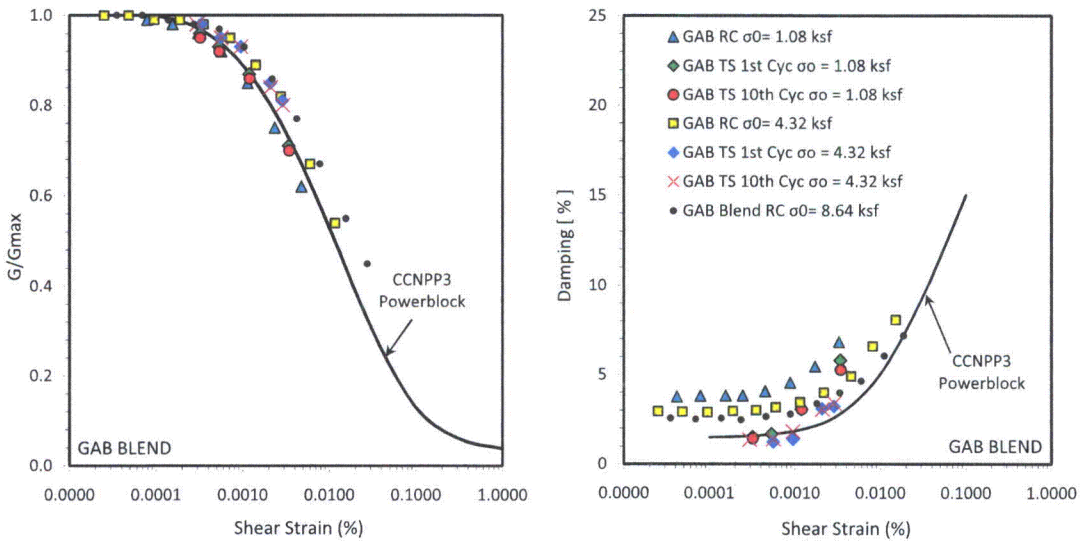

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Figure 2.5-151—{RCTS Testing Sample CR6 Vulcan Average, Backfill}

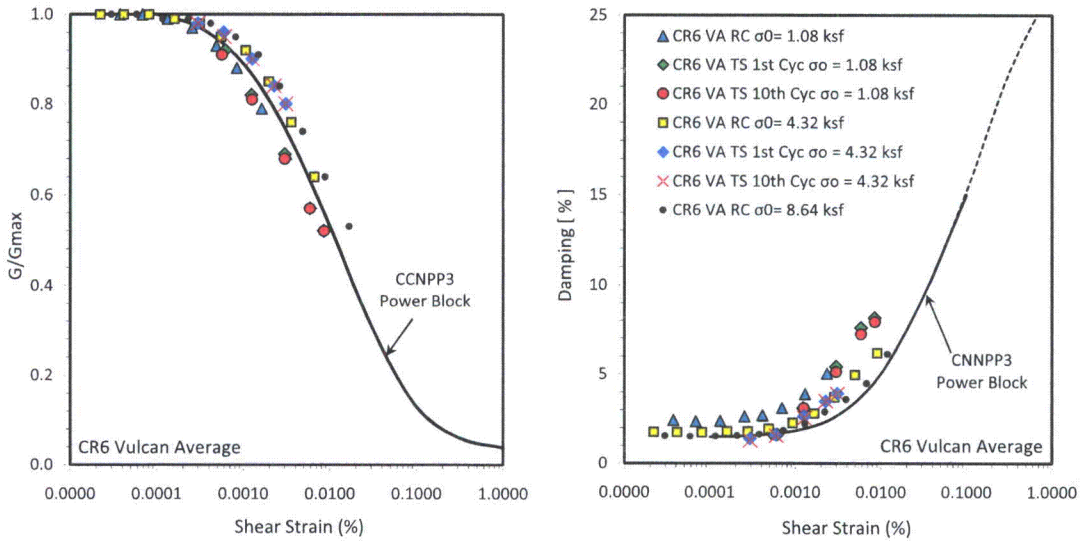

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Figure 2.5-152—{Proximity of Chester and Lexington Park Sites to CCNPP}

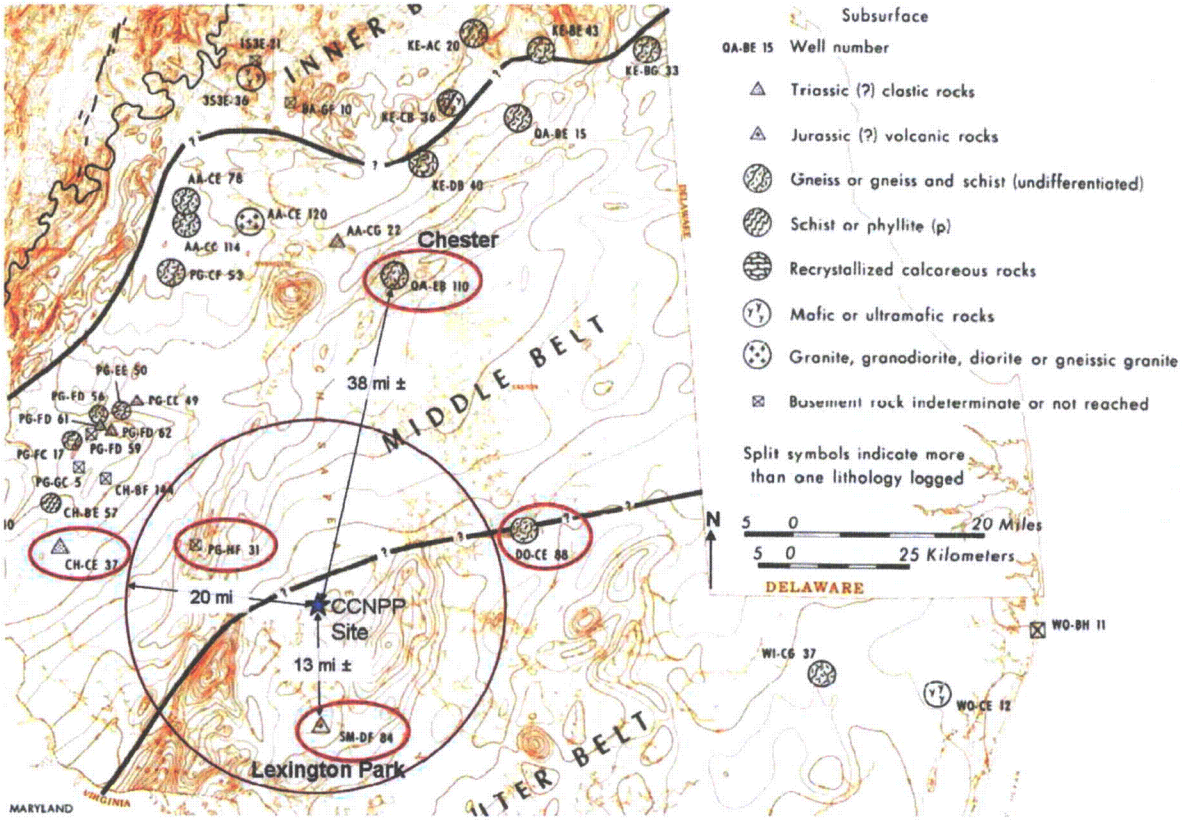

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Figure 2.5-153—{Shear Wave Velocity Based on Chester (Kent Island) Measurements}

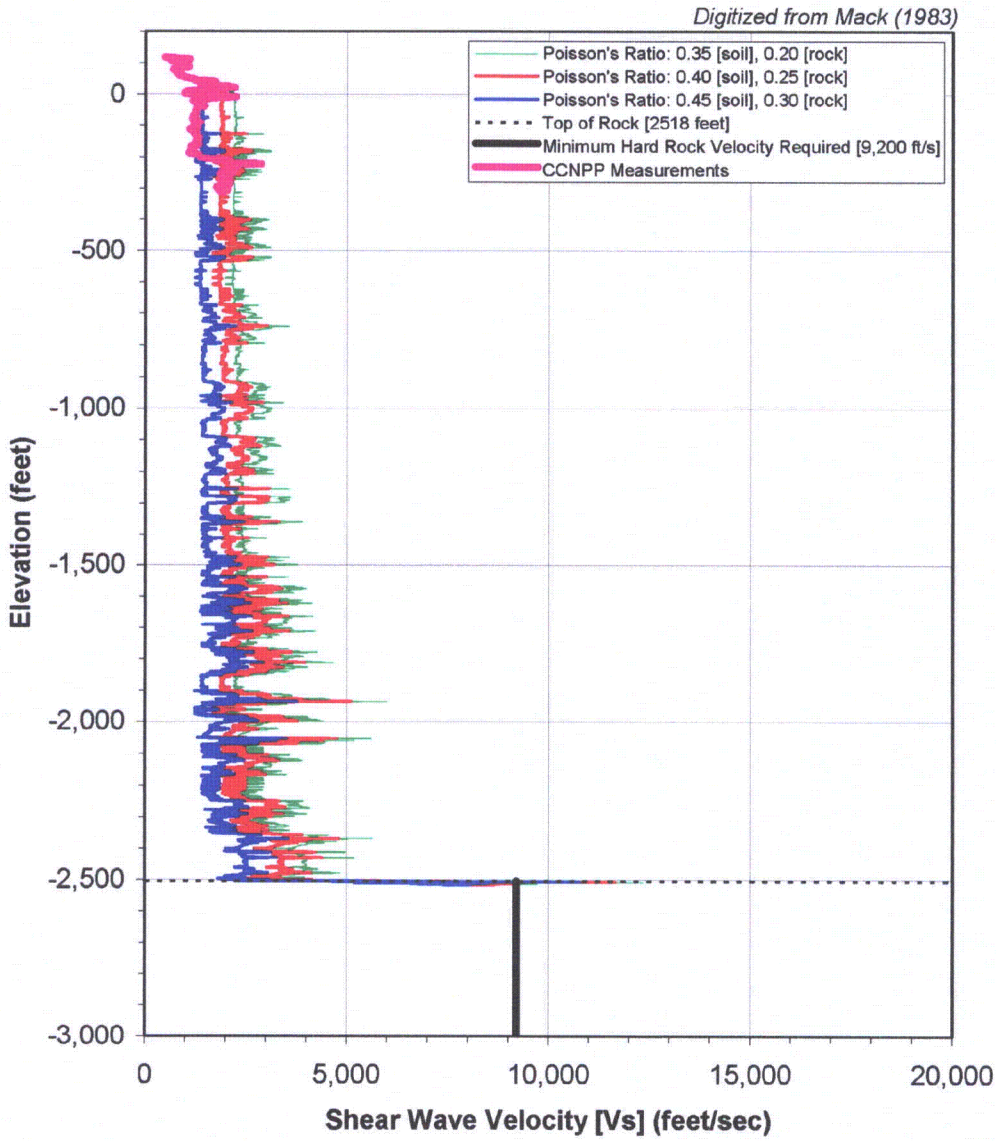

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Figure 2.5-154—{Shear Wave Velocity Based on Lexington Park Measurements}

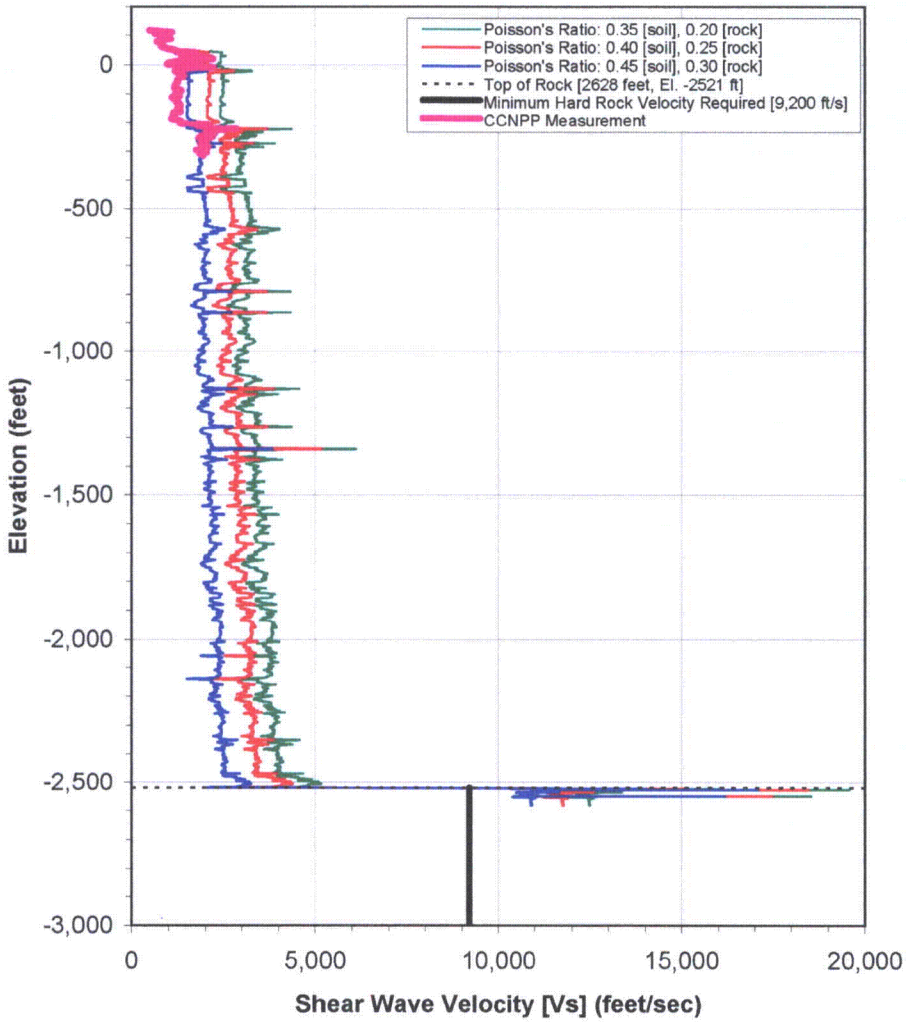

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Figure 2.5-155—{Smoothed and Averaged V_s Log for Chester and Lexington Park Measurements}

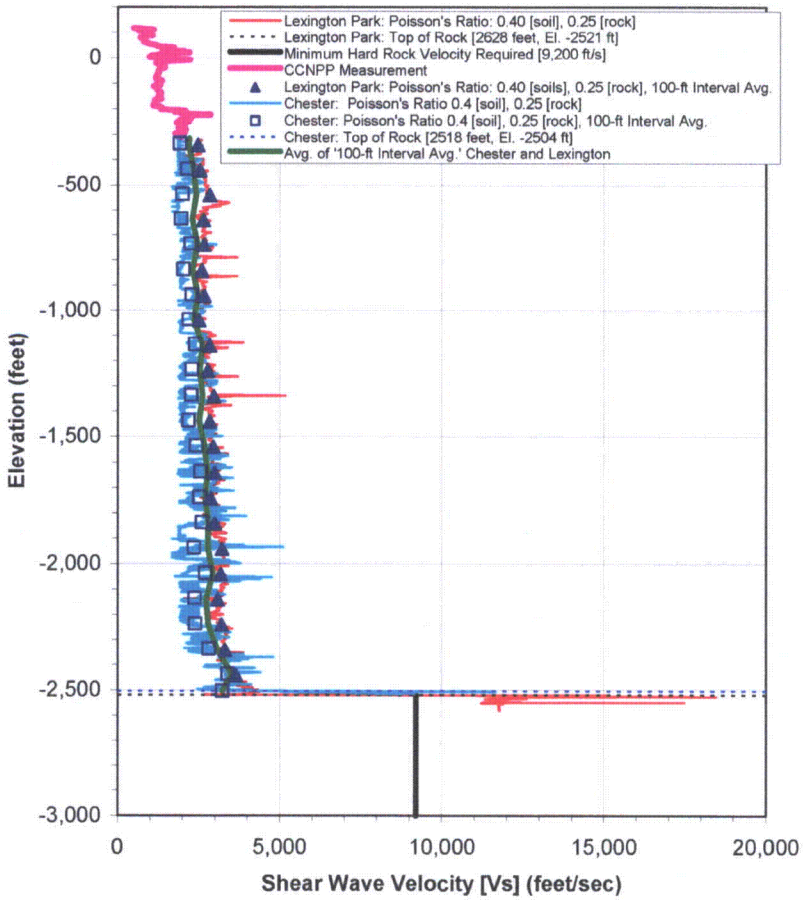

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Figure 2.5-156—{Average V_s, Chester, Lexington Park, Maryland and Deep Measurements in Coastal Plain Soils}

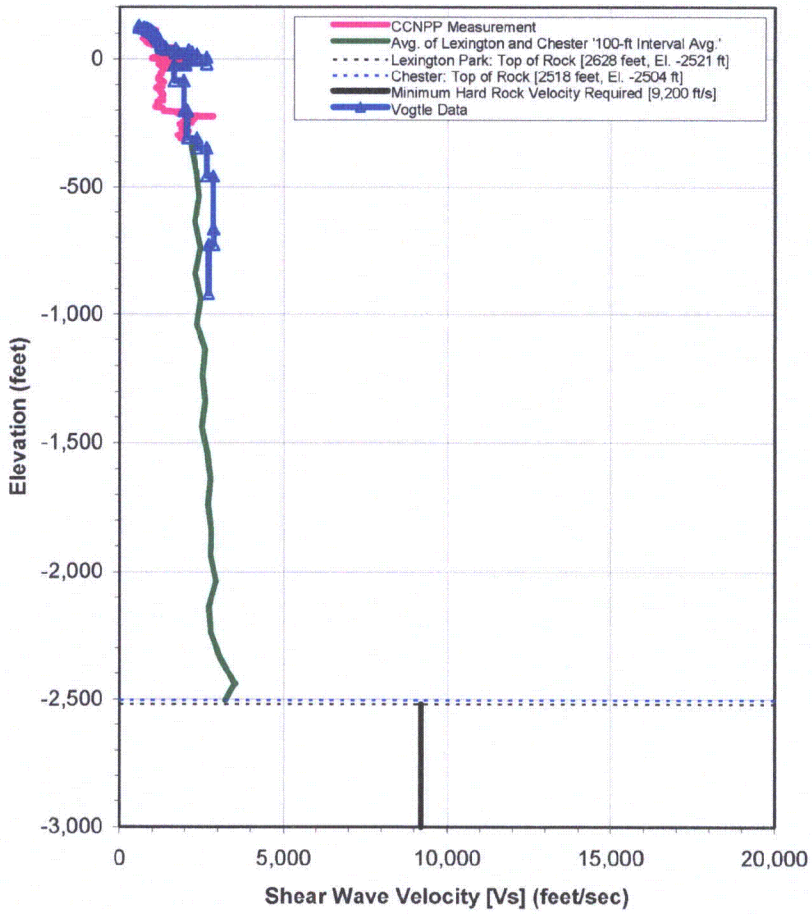

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Figure 2.5-157—{Bedrock V_s Log for Chester (Kent Island), Maryland}

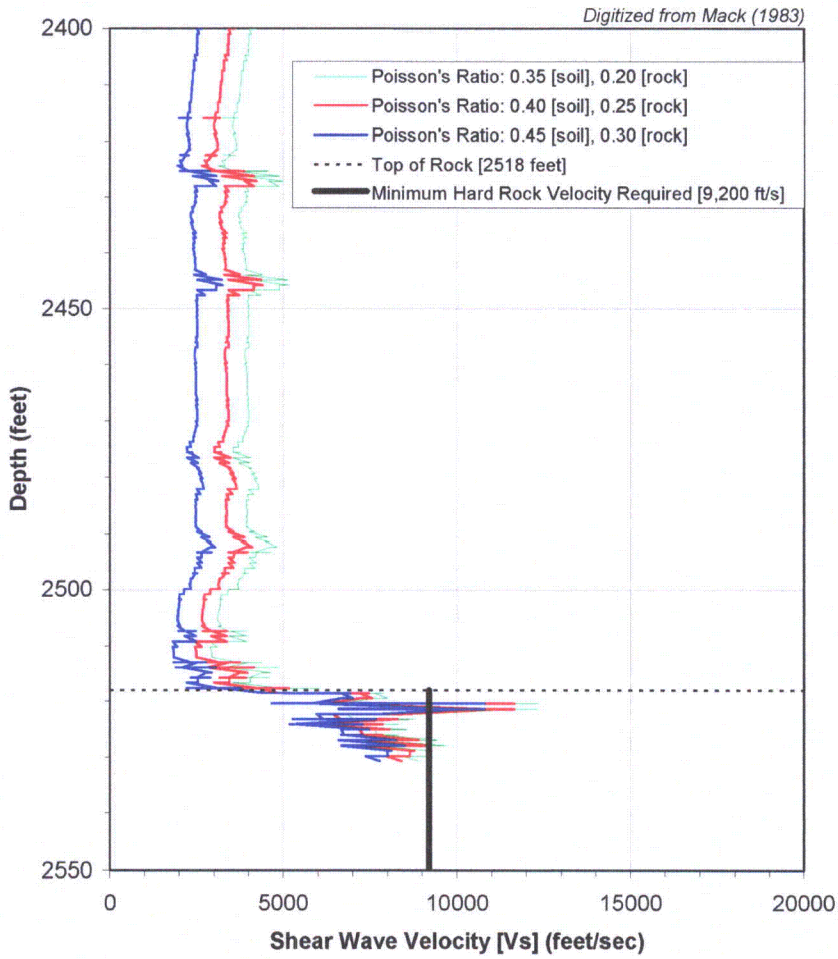

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Figure 2.5-158—{Bedrock V_s Log for Lexington Park, Maryland}

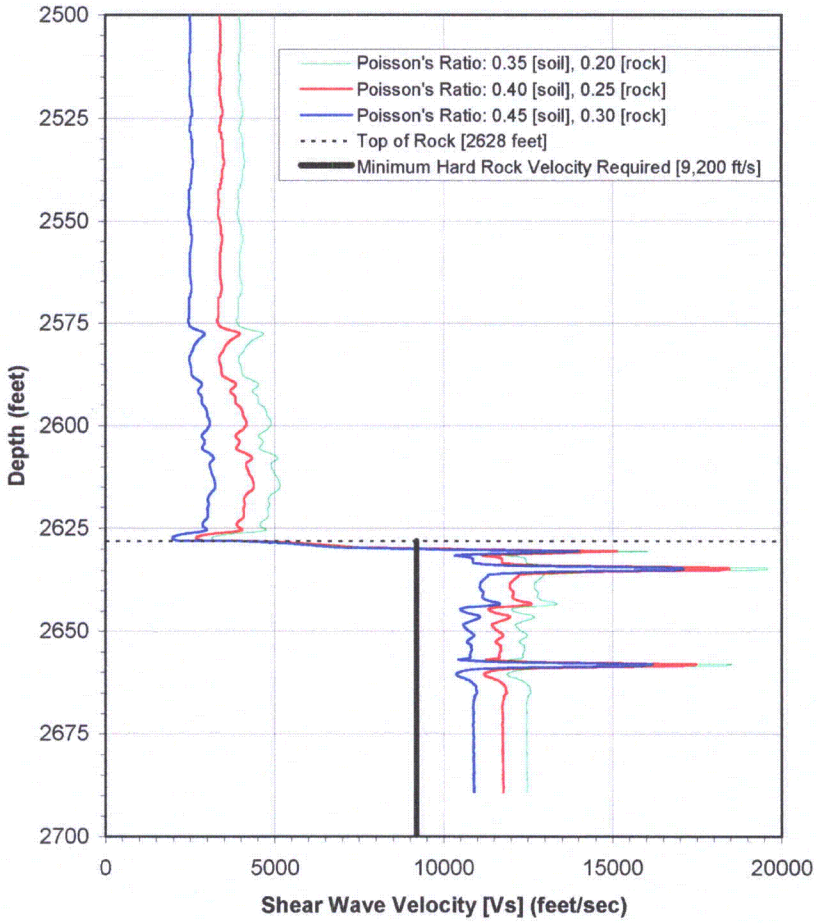

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Figure 2.5-159—{Interpretation of Bedrock Velocity Gradient for Chester Measurement}

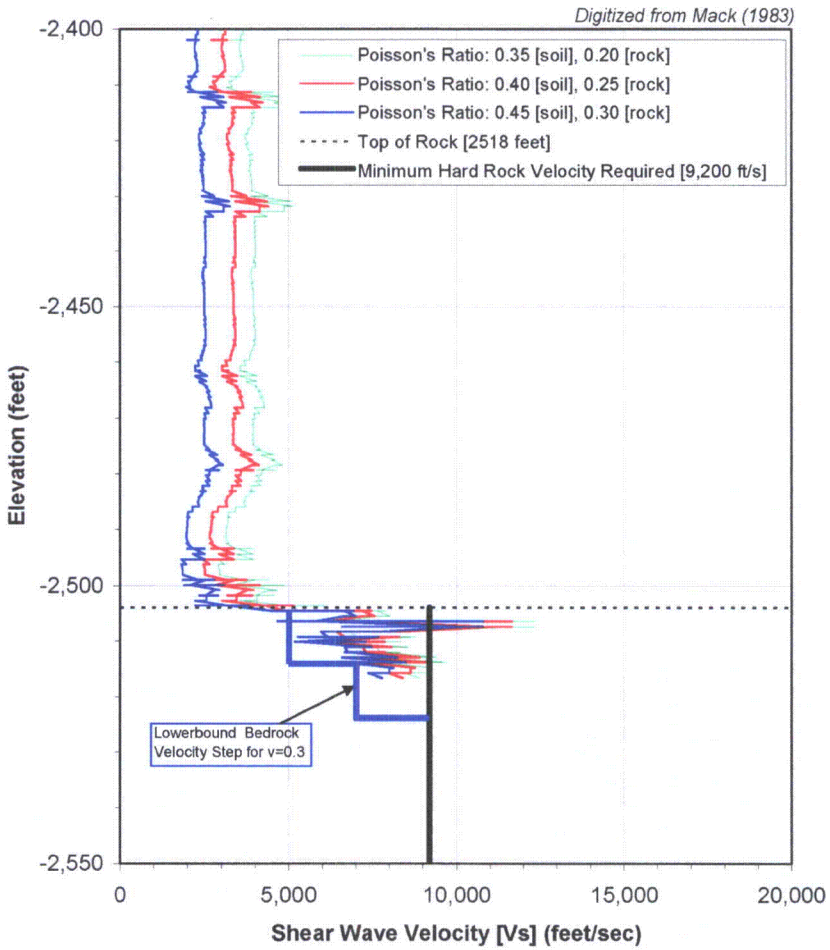

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Figure 2.5-160—{Excavation Profile AA', Powerblock Area}

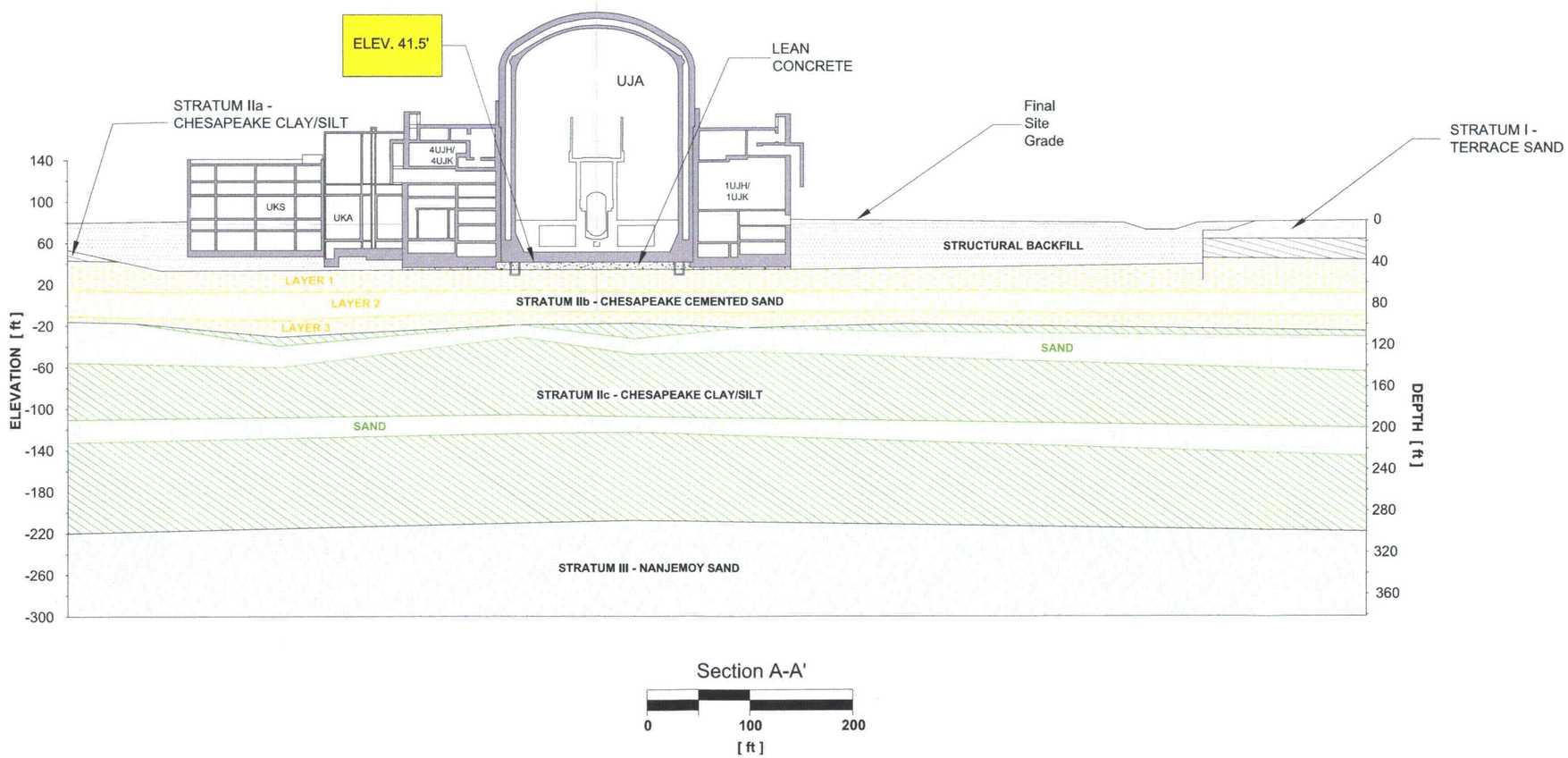

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Figure 2.5-161—{Excavation Profile BB', Powerblock Area}

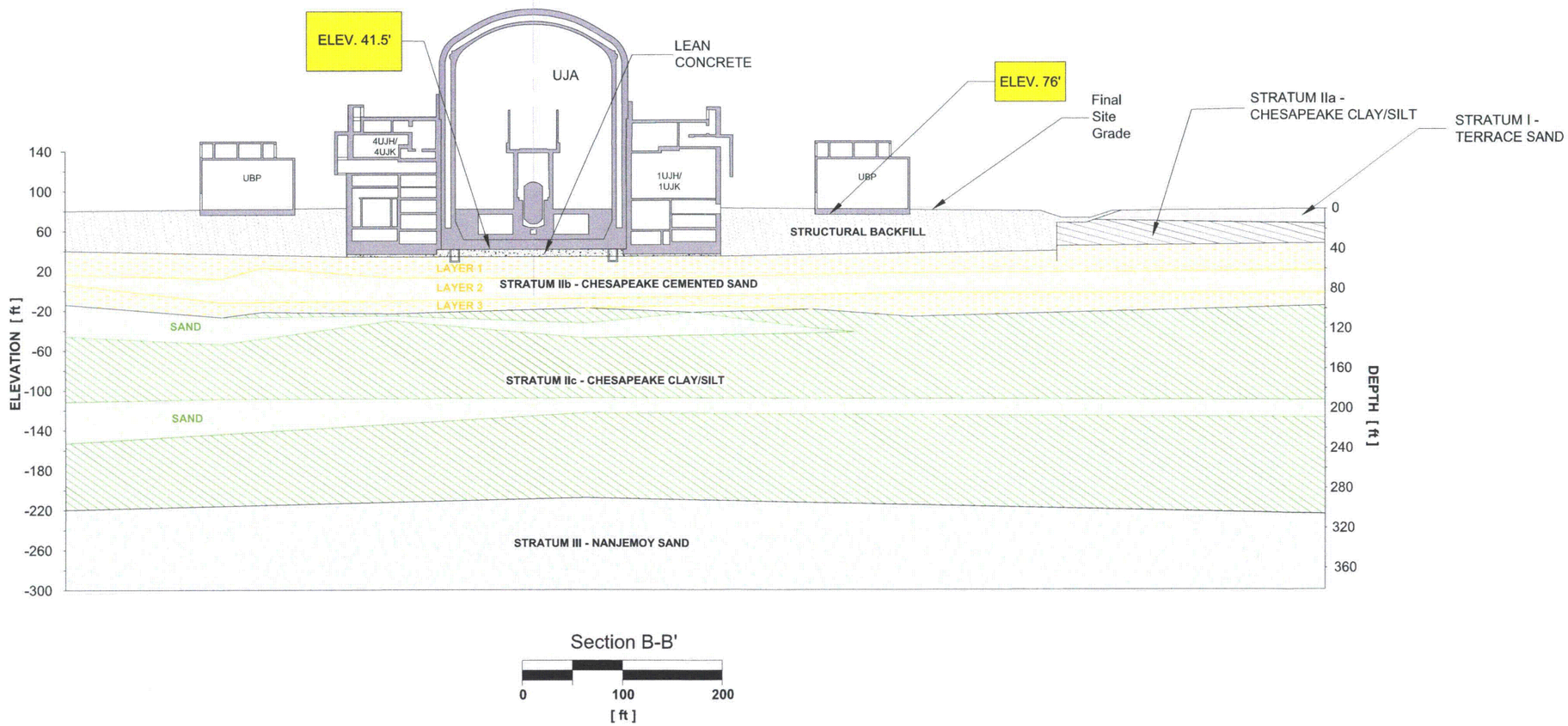

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Figure 2.5-162—{Excavation Profile CC', Powerblock Area}

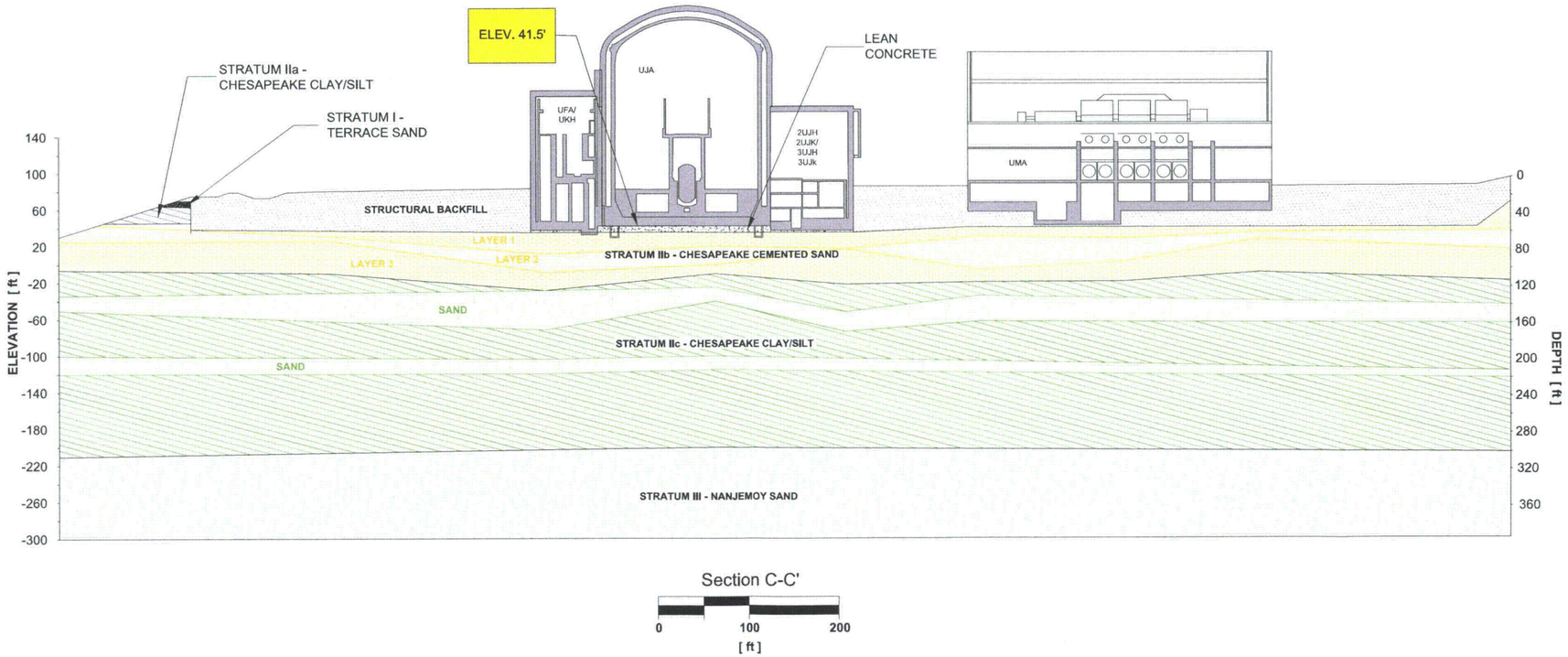

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Figure 2.5-163—{Excavation Profile DD', Powerblock Area}

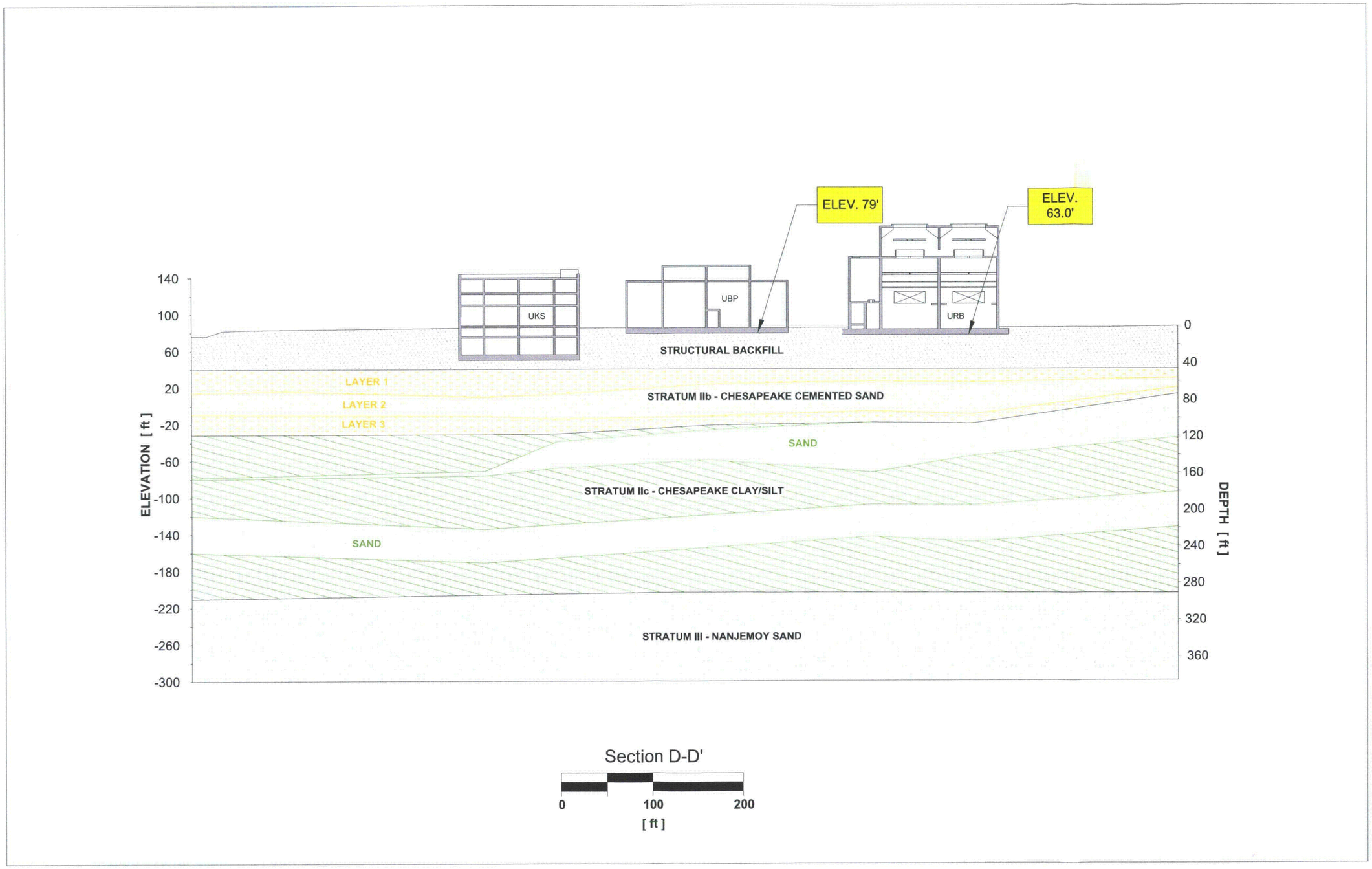

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Figure 2.5-164—{Excavation Profile EE', Powerblock Area}

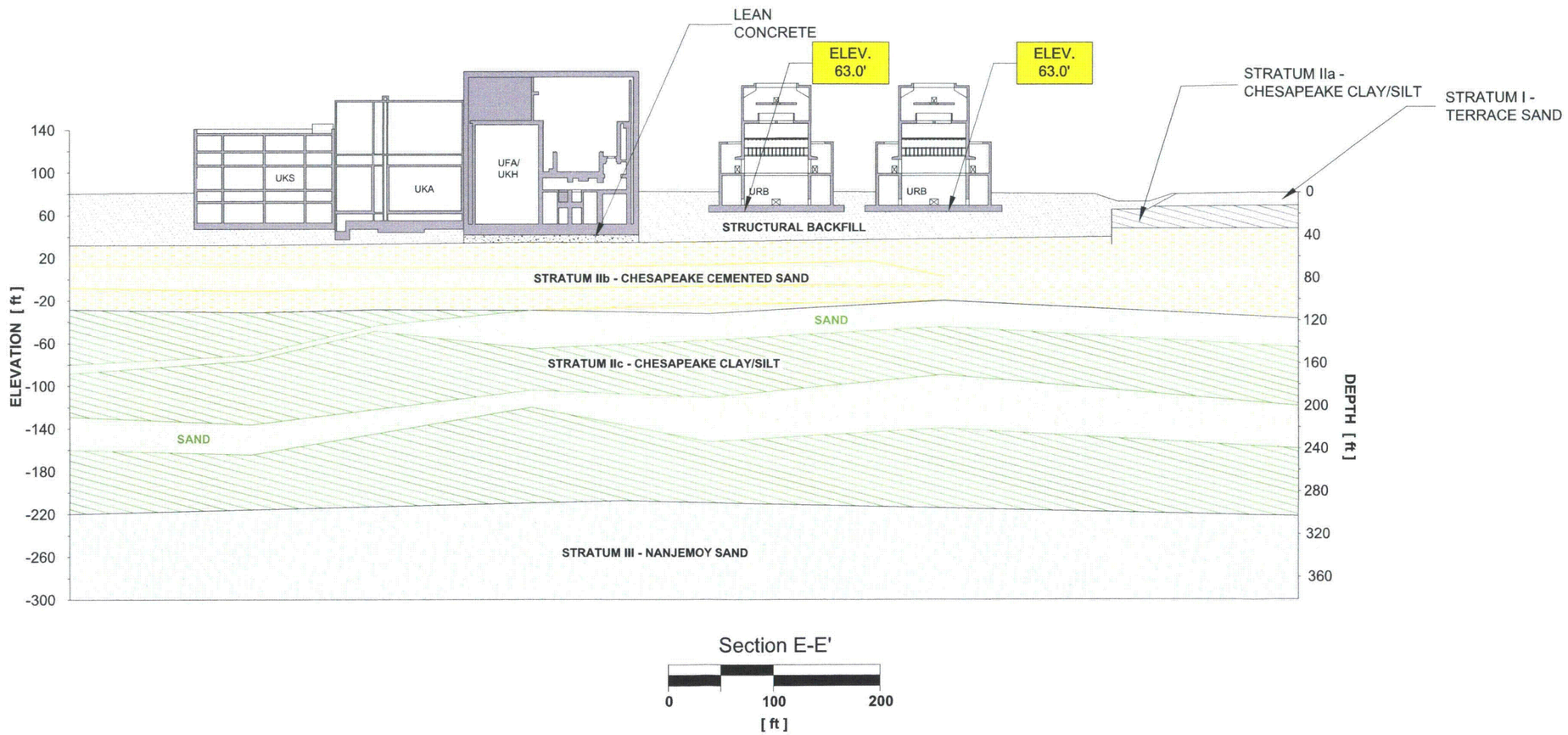

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Figure 2.5-165—{Excavation Profile FF, Intake Area}

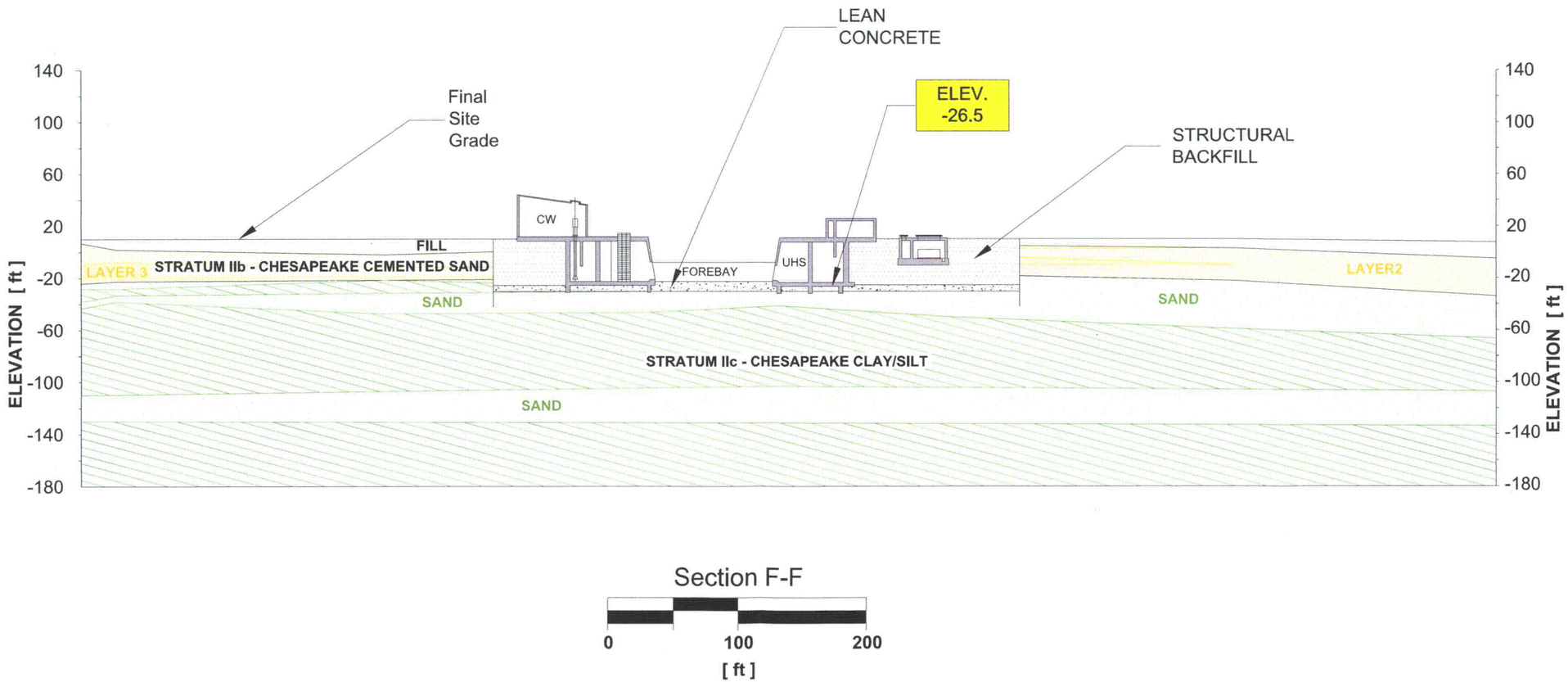

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Figure 2.5-166—{Best Estimate Velocity Profiles, In-Situ condition, Powerblock Area}

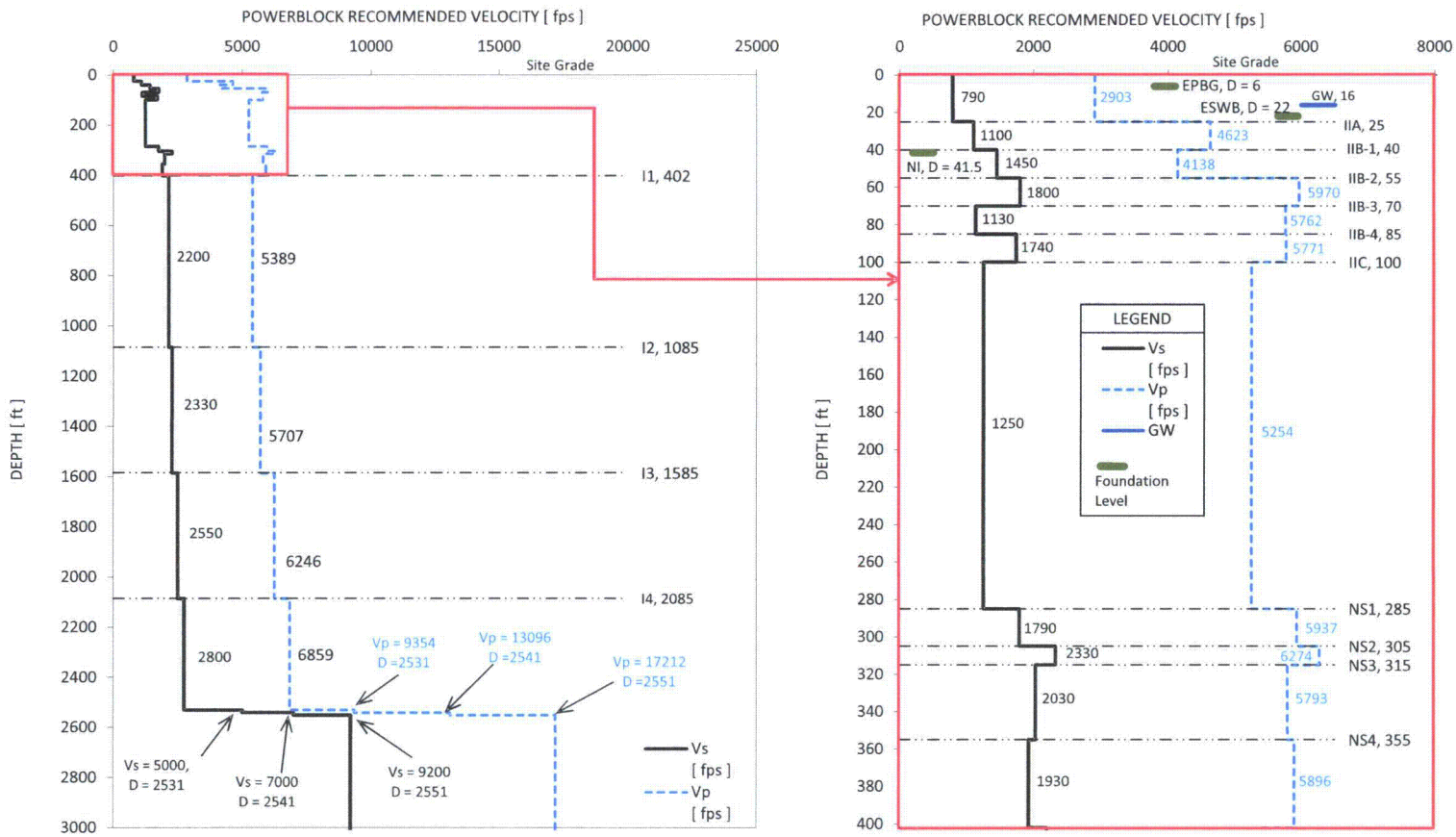

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Figure 2.5-167—{Best Estimate Velocity Profiles with Fill Placement, Powerblock Area}

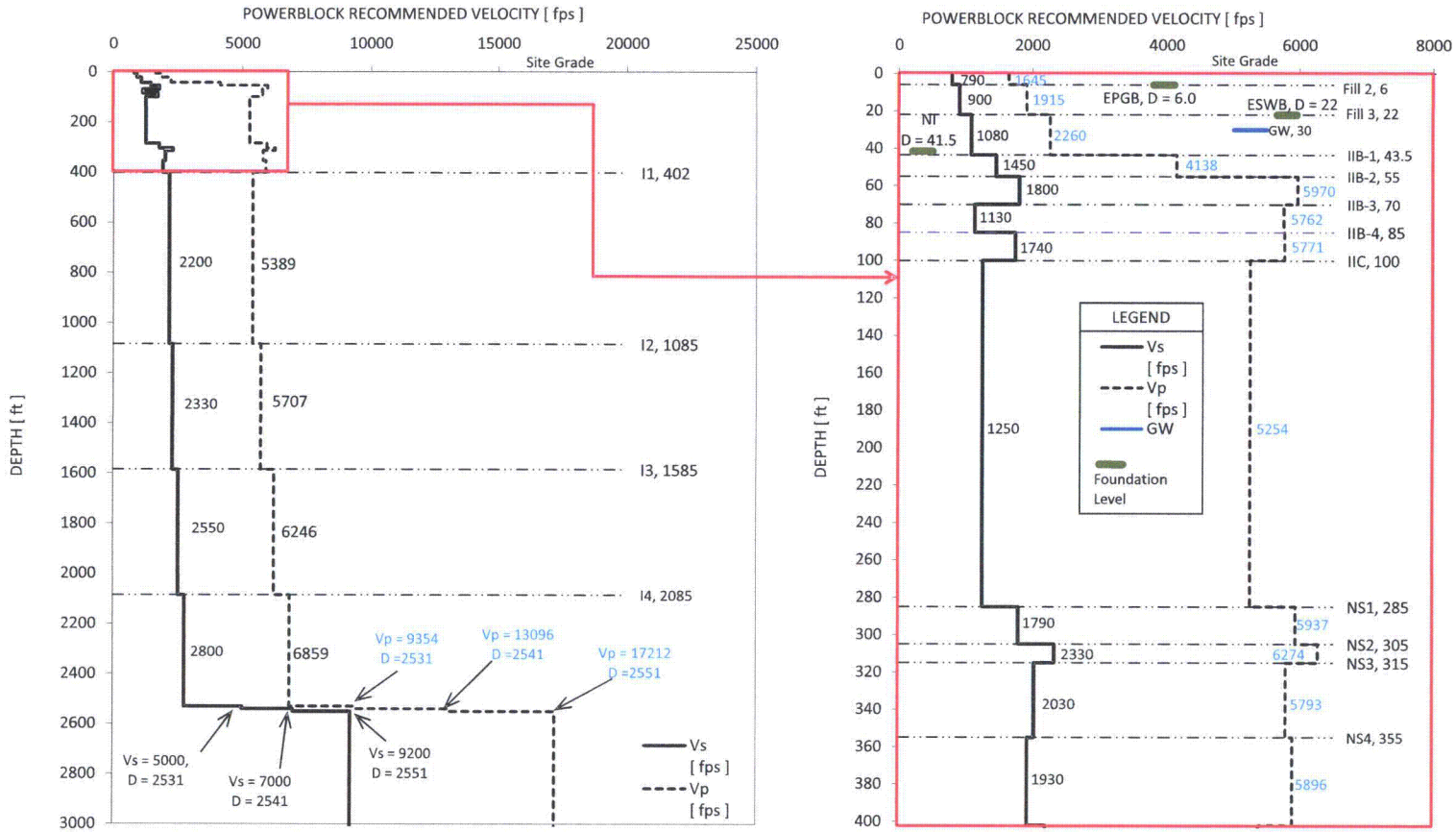

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Figure 2.5-168—{Best Estimate Velocity Profiles, In-Situ Condition, Intake Area}

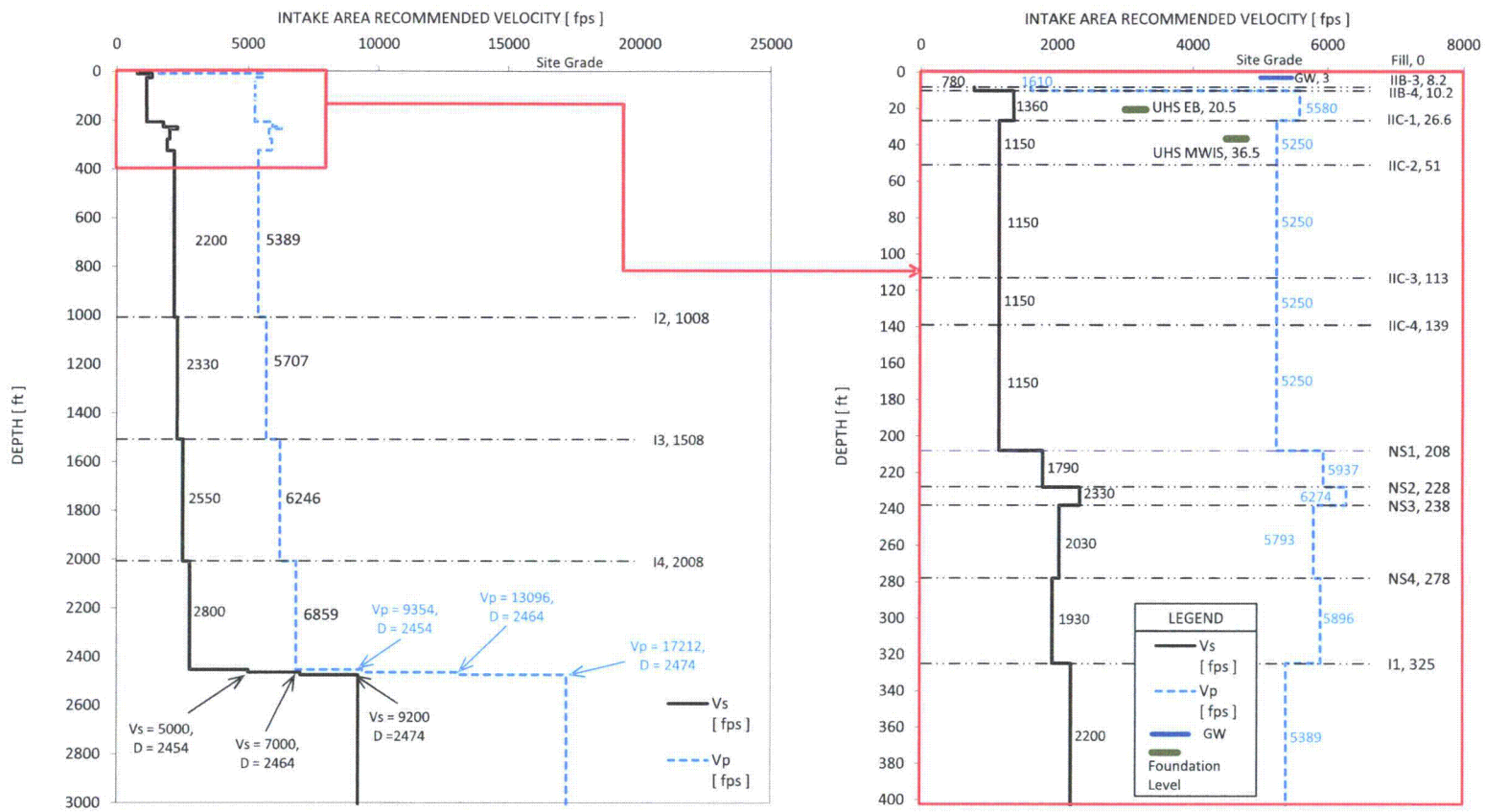

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Figure 2.5-169—{Best Estimate Velocity Profiles with Fill Placement, Intake Area}

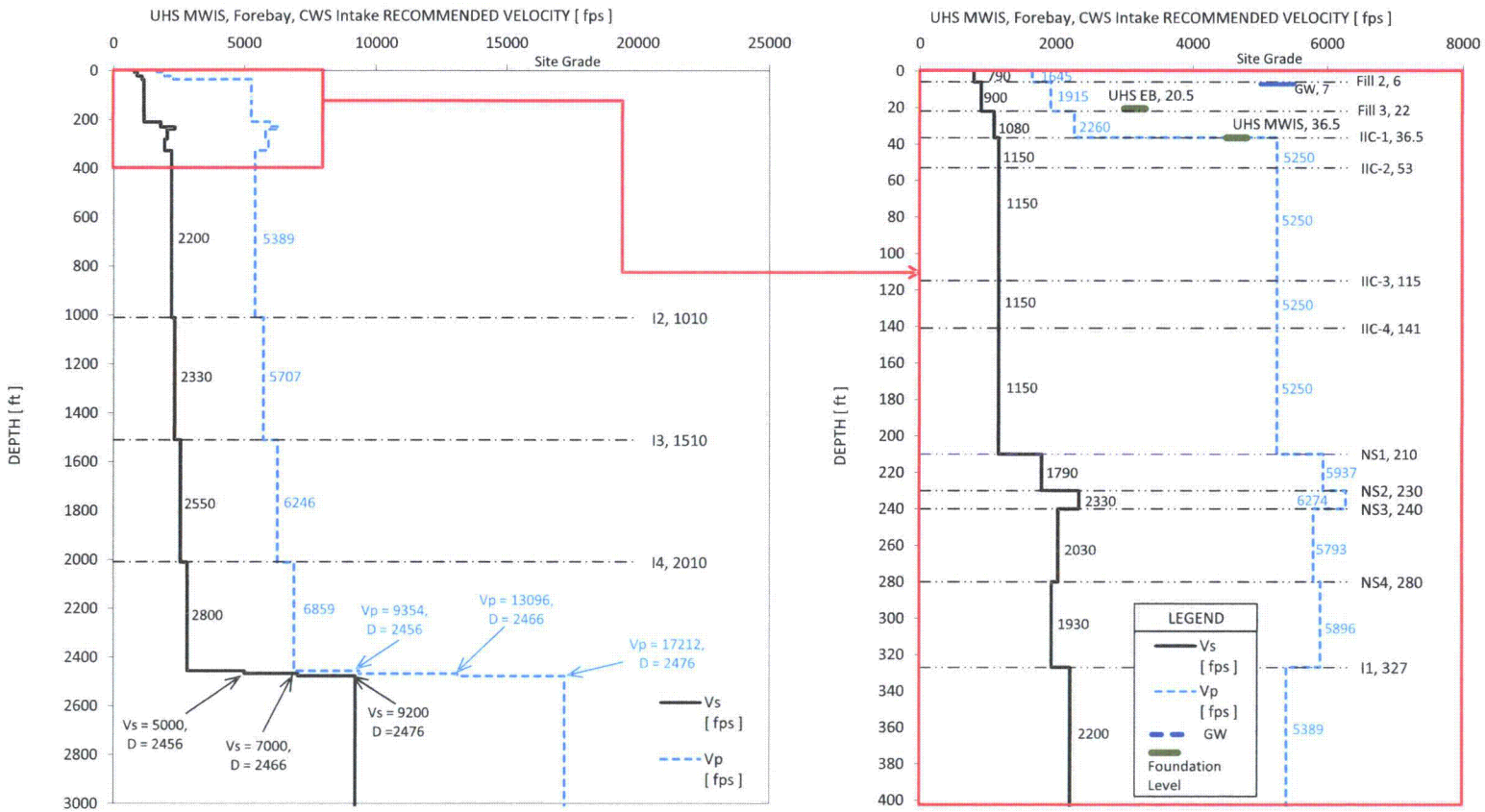

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Figure 2.5-170—{Strain Dependant Properties for Powerblock Area}

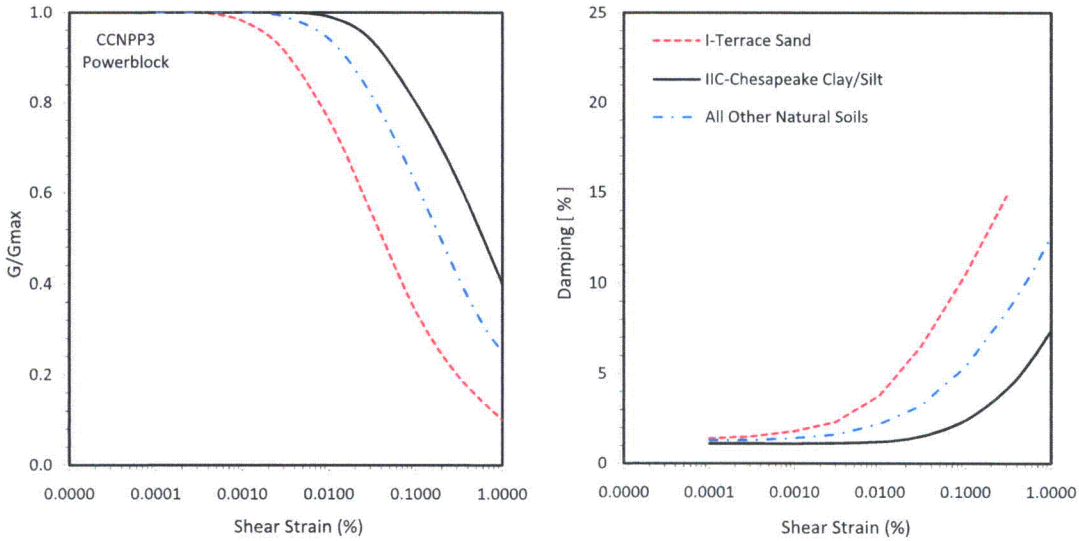

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Figure 2.5-171—{Strain Dependant Properties for Intake Area}

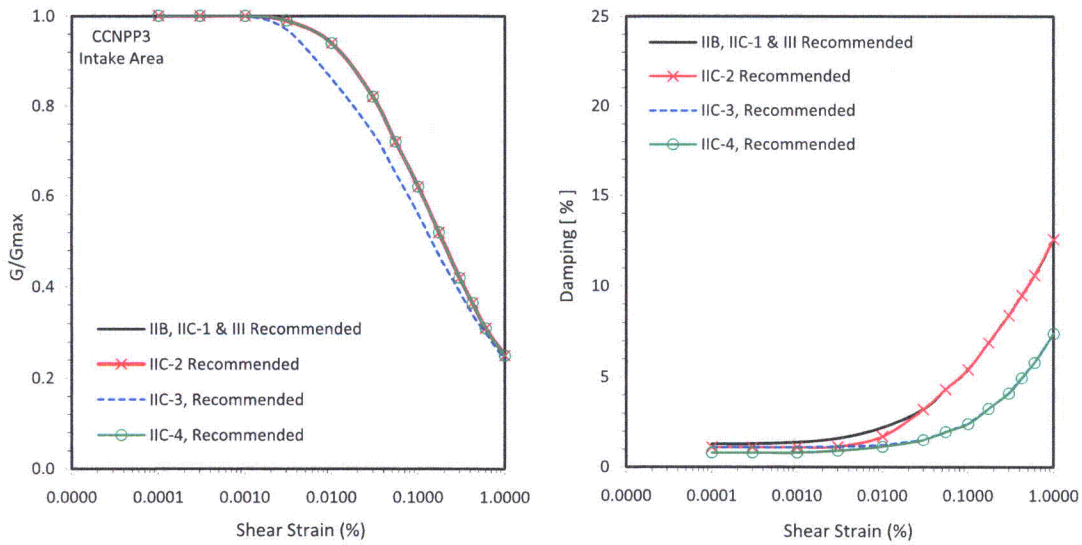

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Figure 2.5-172—{Strain Dependant Properties for Backfill}

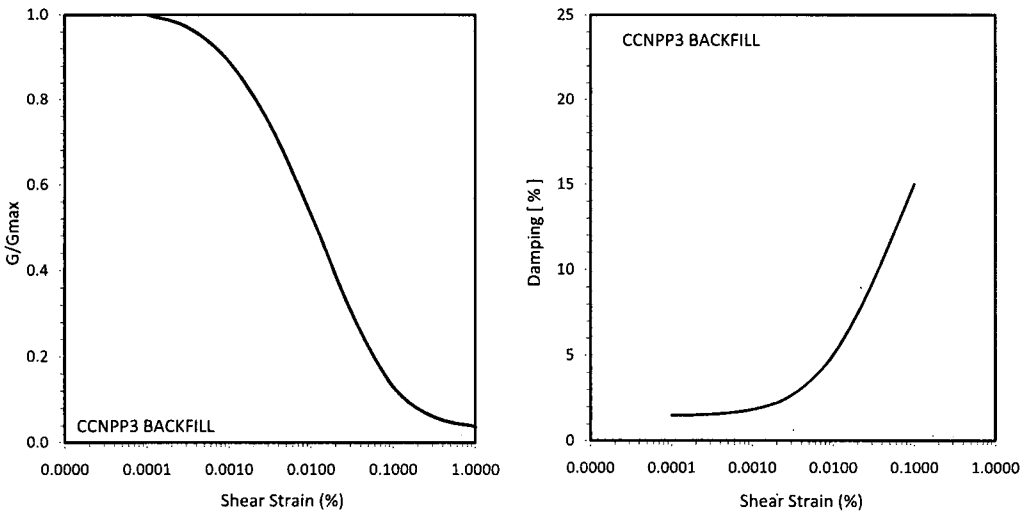

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Figure 2.5-173—{Site Grading Plan}

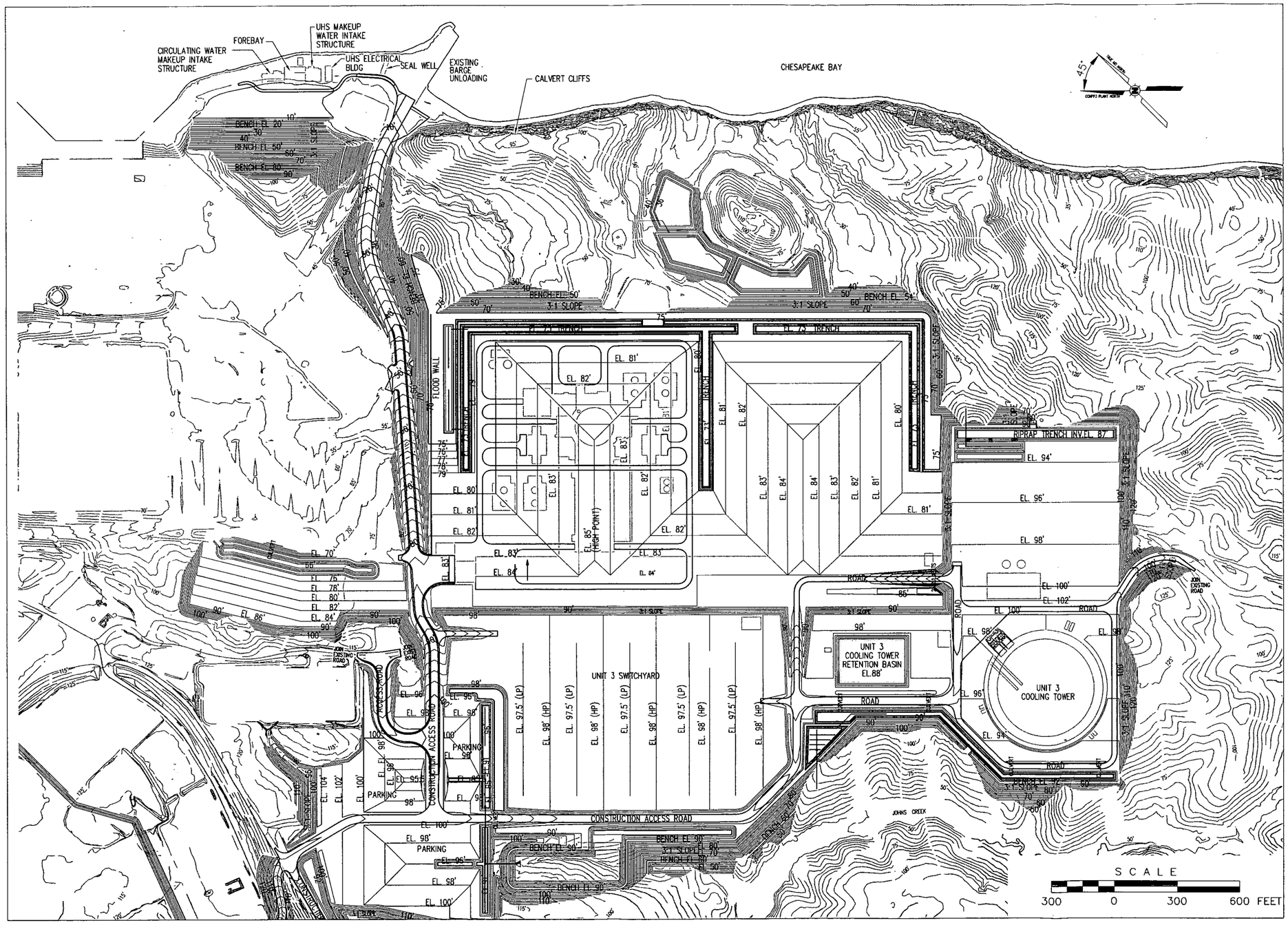

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Figure 2.5-174—{Elevation Contours of Top of Stratum IIb Cemented Sand}

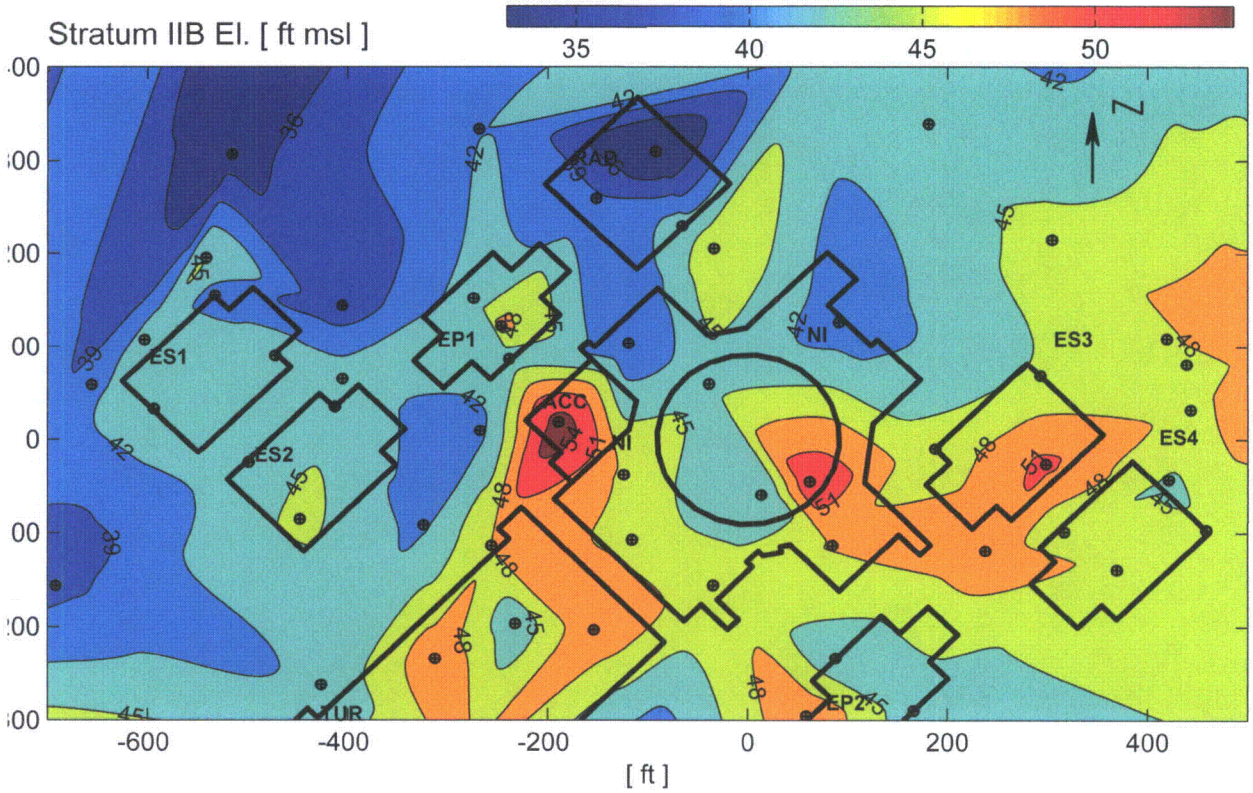

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Figure 2.5-175—{Topography in Powerblock Area}

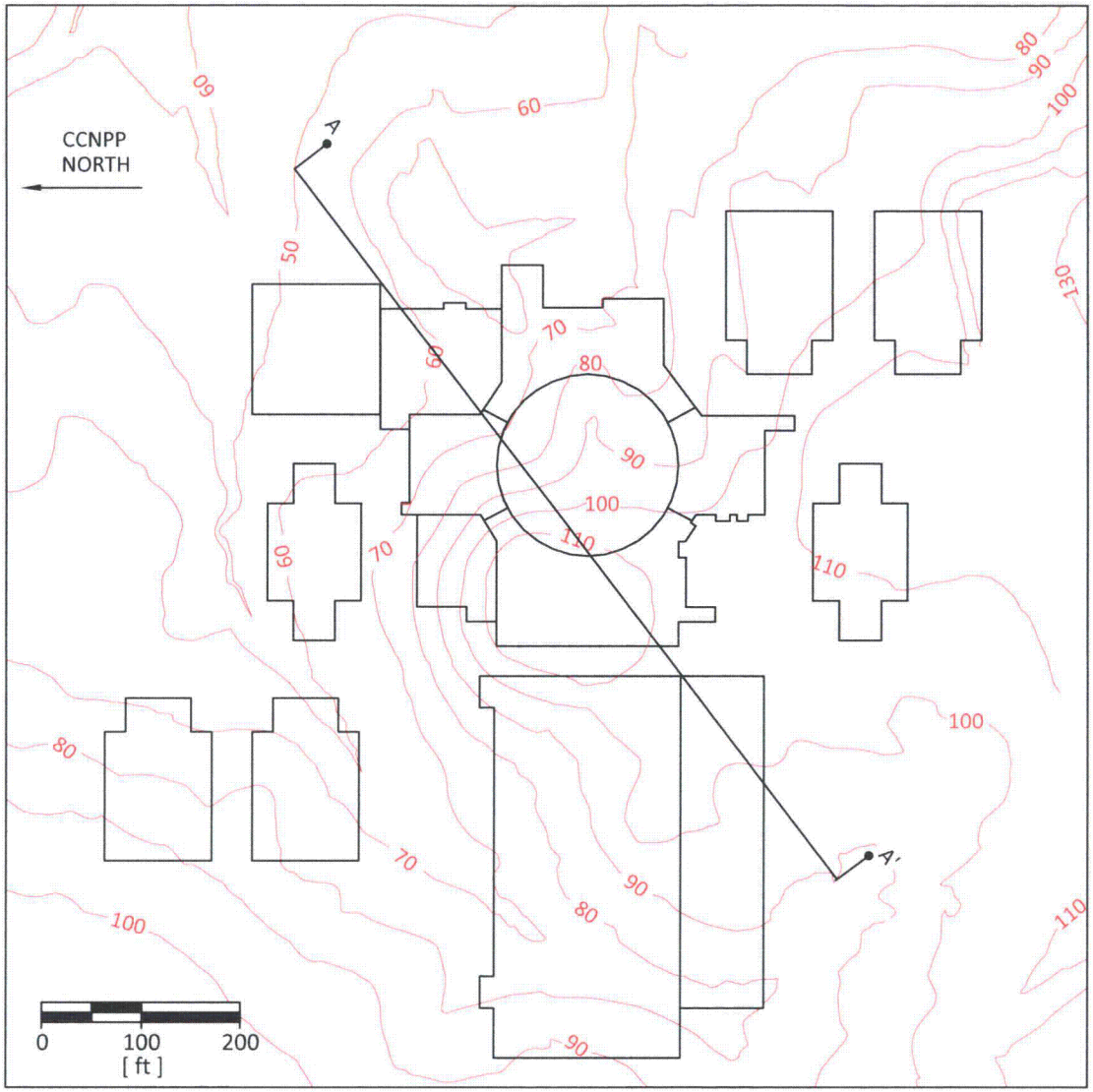

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Figure 2.5-176—{FOS against Liquefaction Based on SPT Data, Powerblock}

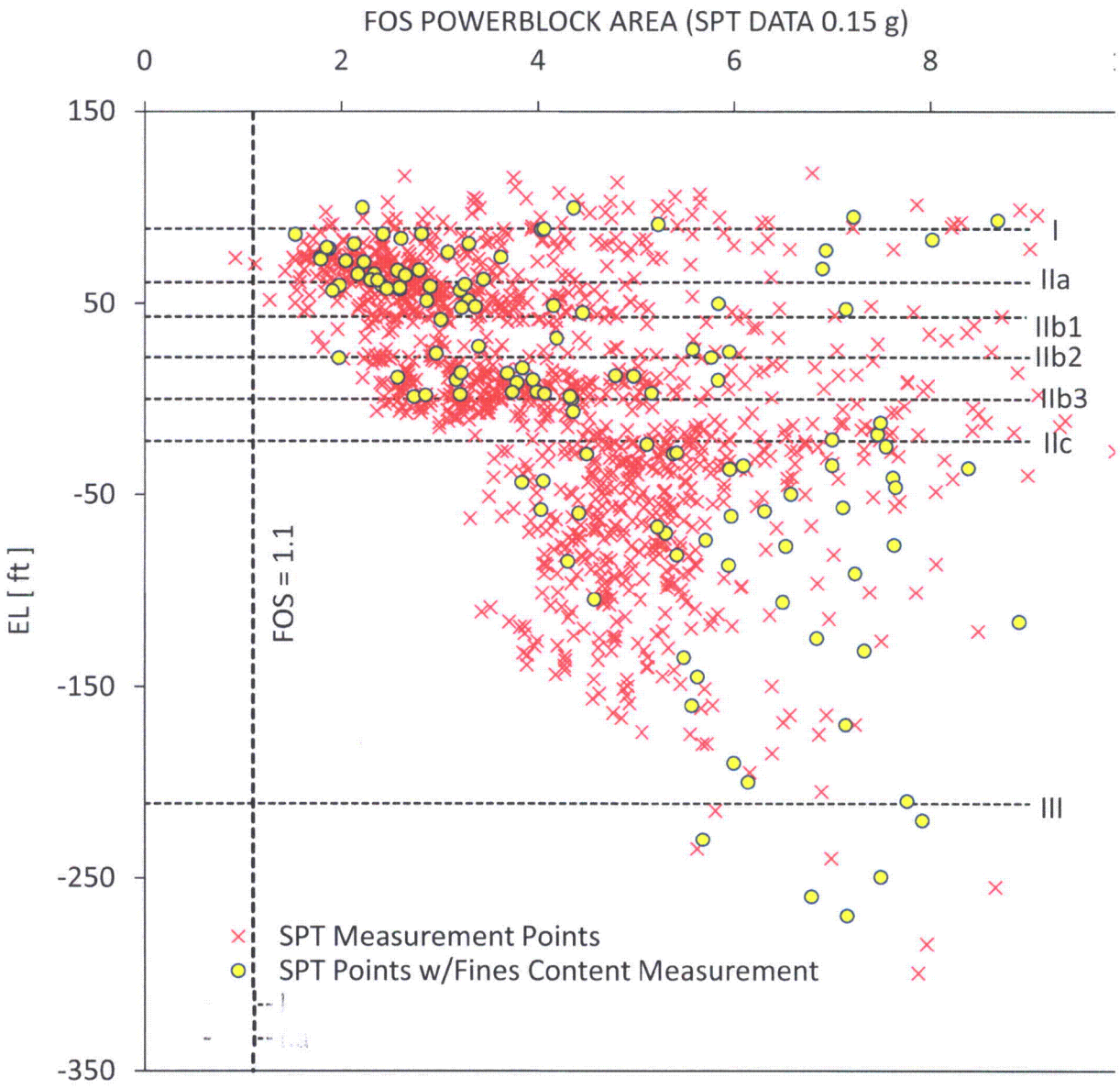

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Figure 2.5-177—{FOS against Liquefaction Based on SPT Data, Intake Area}

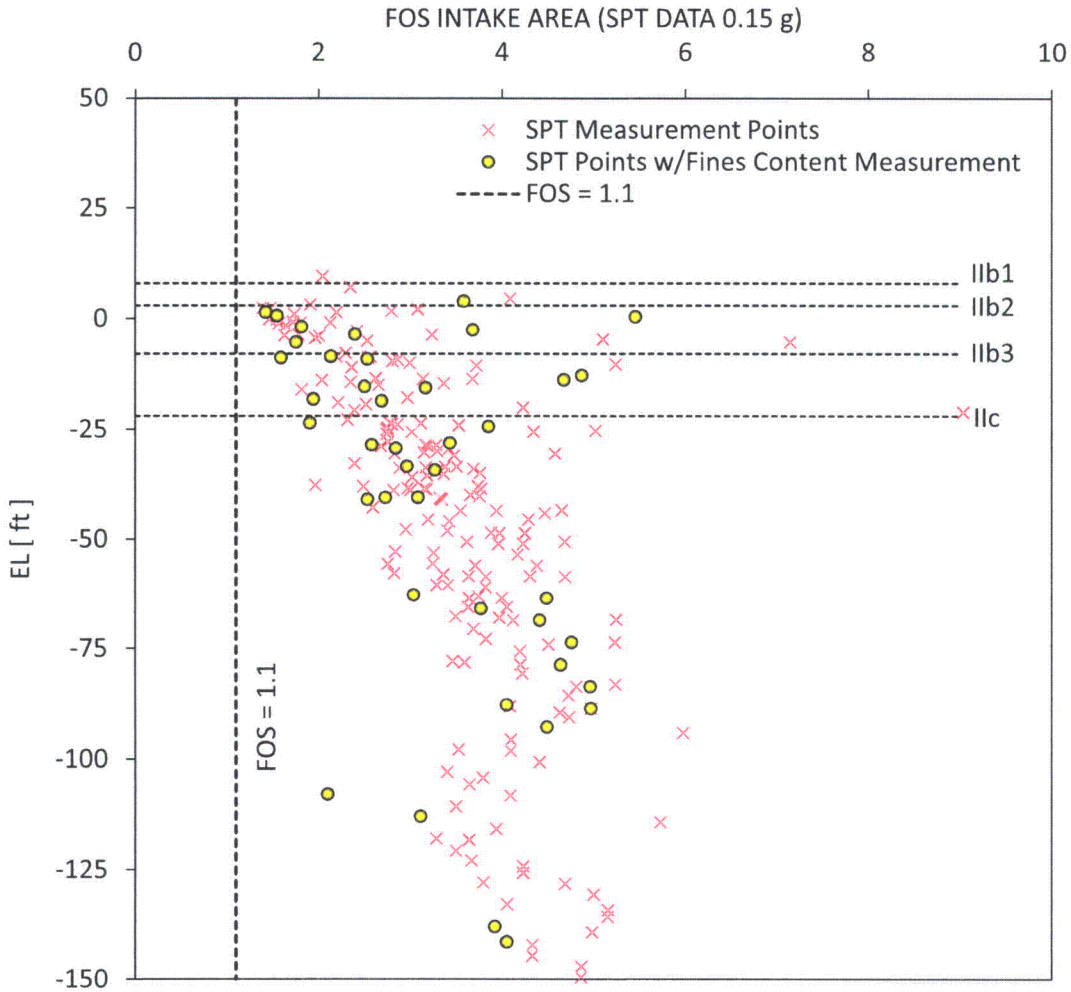

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Figure 2.5-178—{FOS against Liquefaction Based on V_s Data, Powerblock}

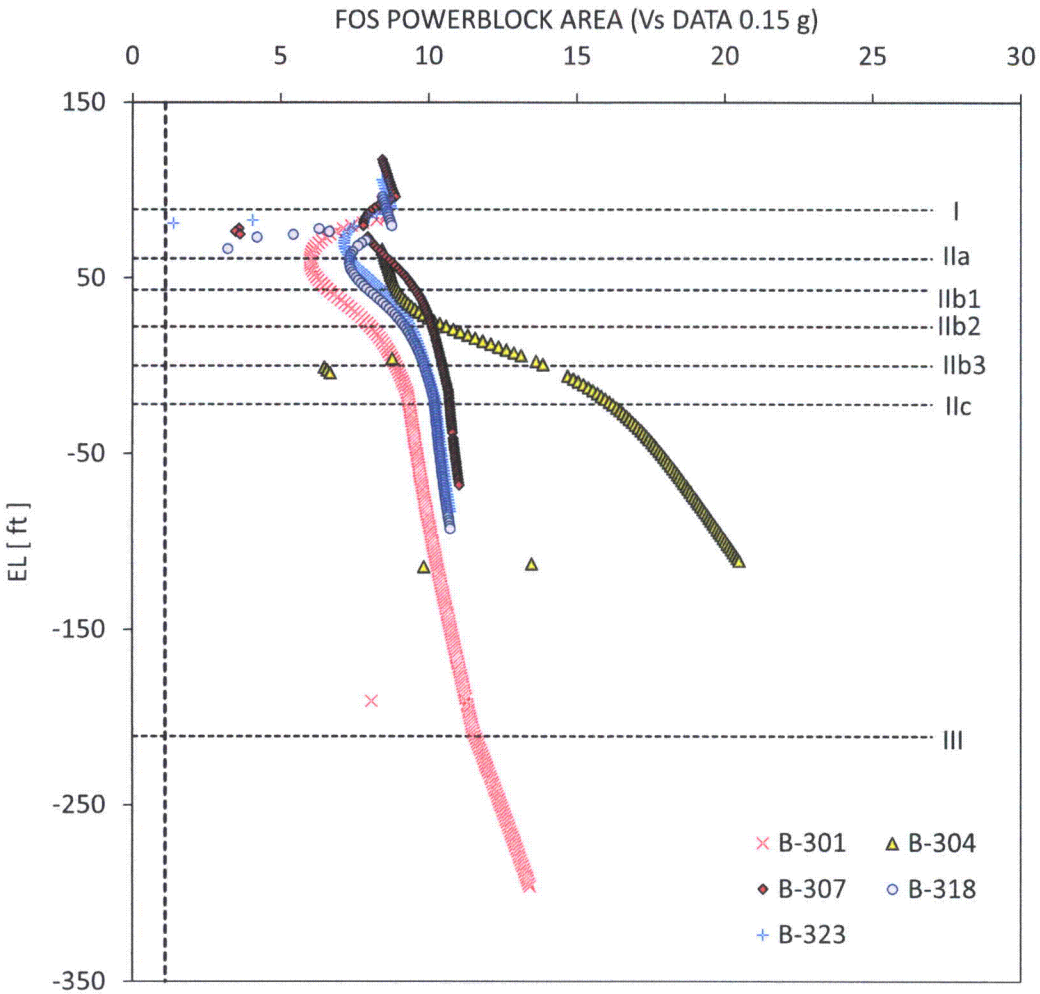

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Figure 2.5-179—{FOS against Liquefaction Based on V_s Data, Intake Area}

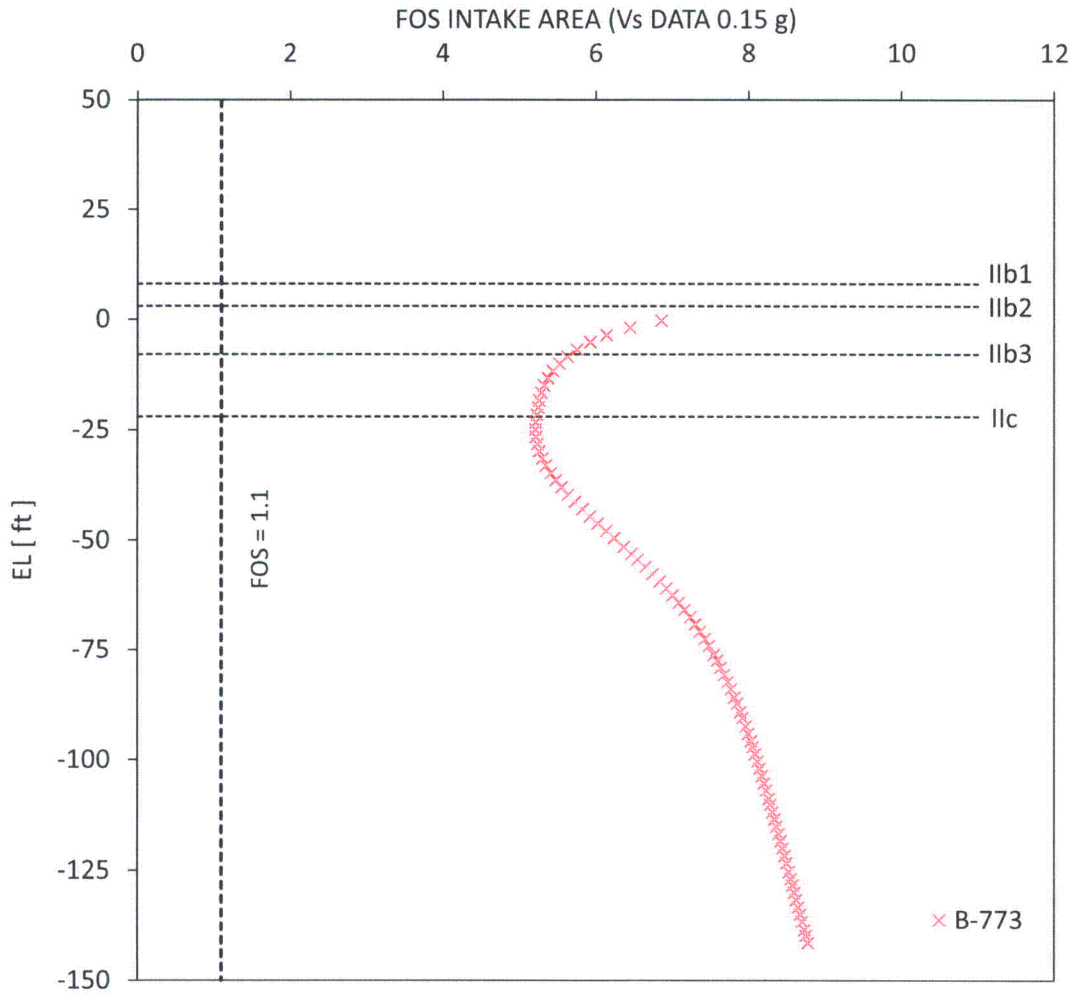

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Figure 2.5-180—{FOS against liquefaction based on CPT Data, Powerblock Area}

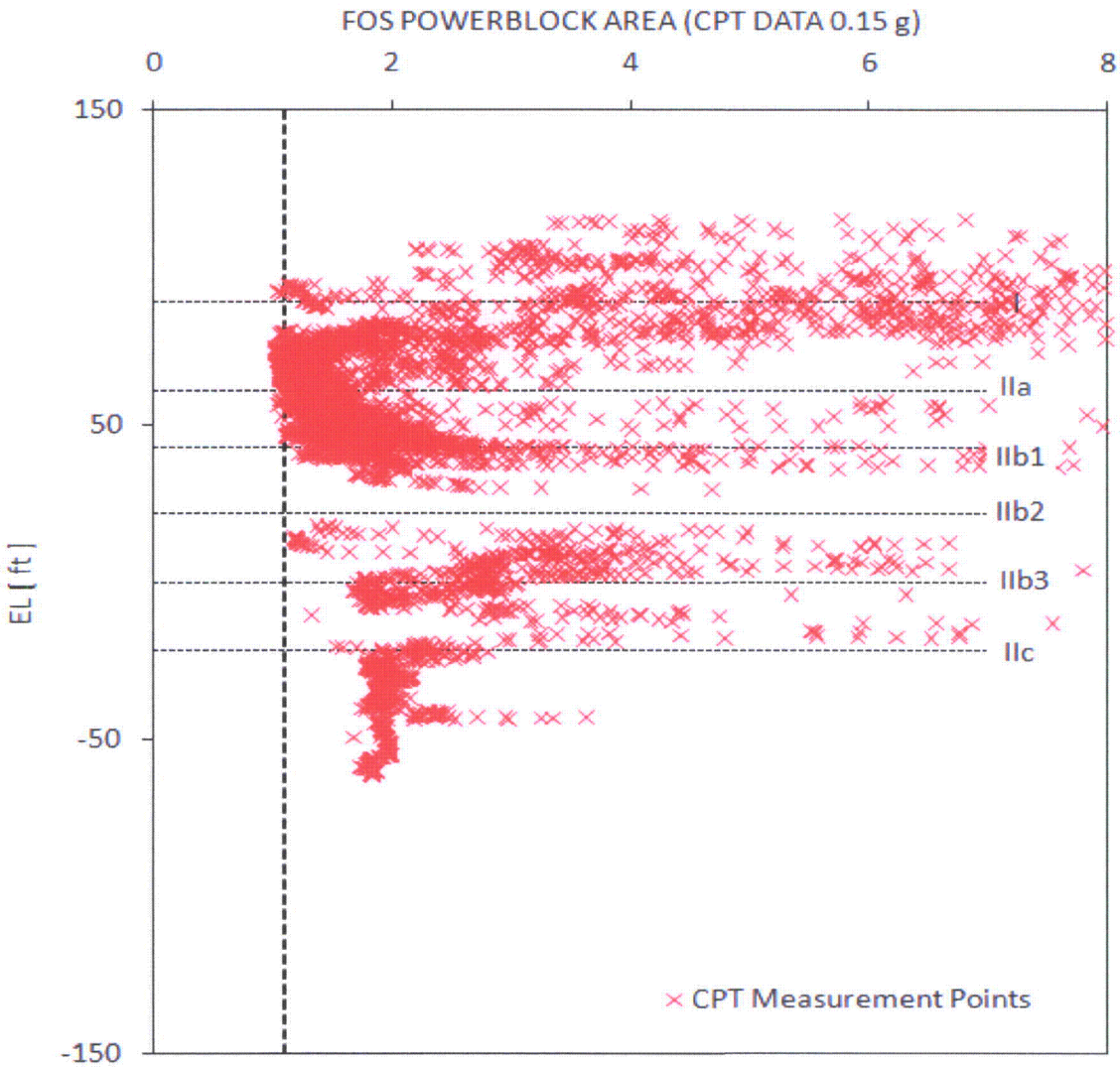

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Figure 2.5-181—{FOS against Liquefaction Based on CPT Data, Intake Area}

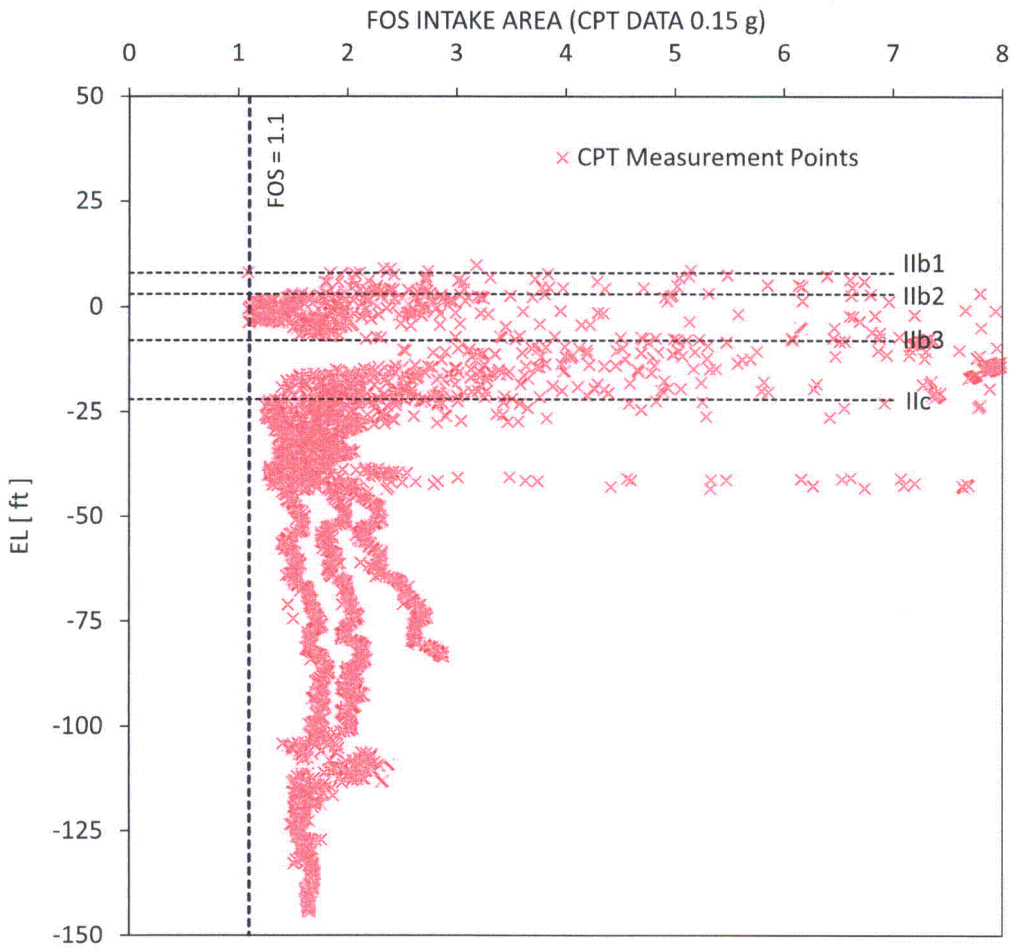

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Figure 2.5-182—{FOS against Liquefaction for Backfill, Powerblock Area}

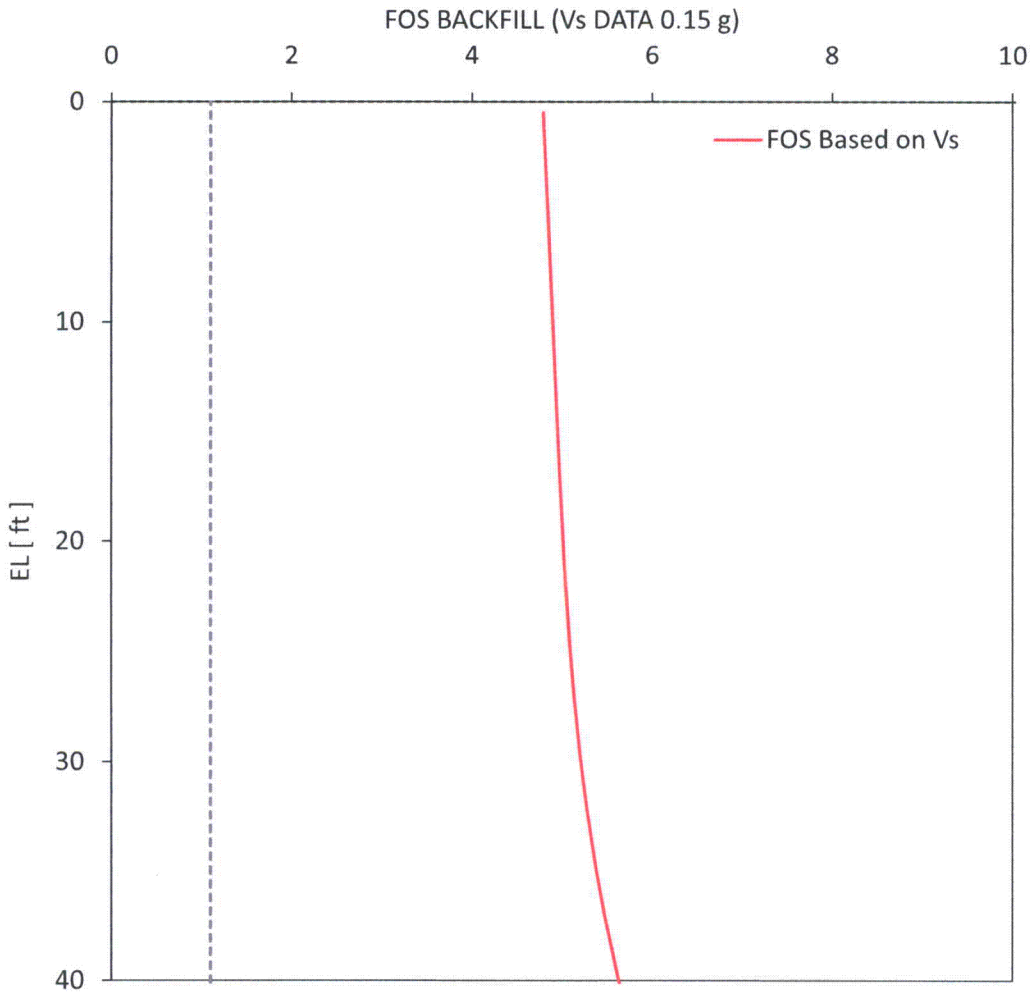

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Figure 2.5-183—{Building Areas, Loads, and Foundation Elevation}

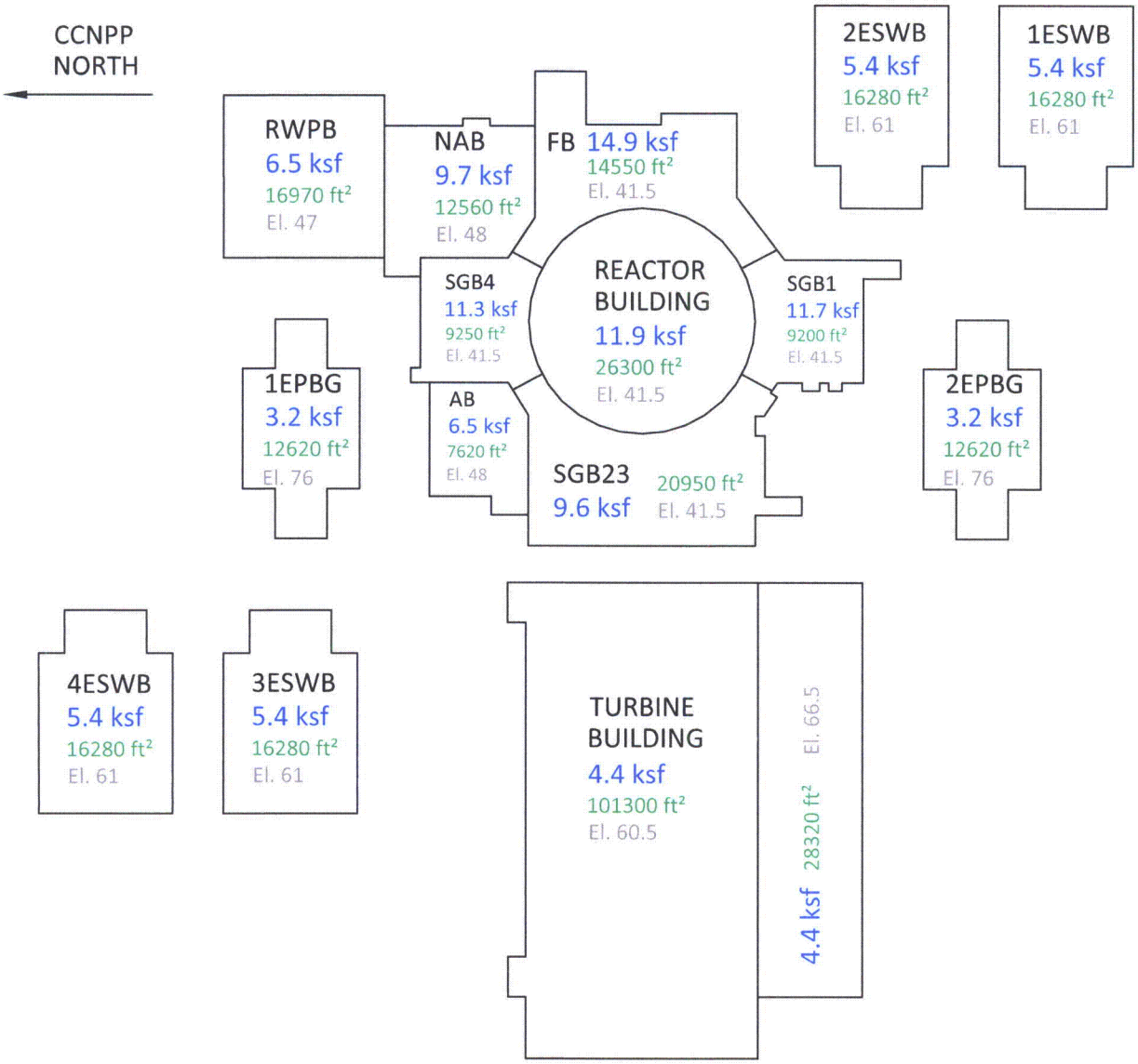

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Figure 2.5-184—{PLAXIS 3D Subsurface Representation}

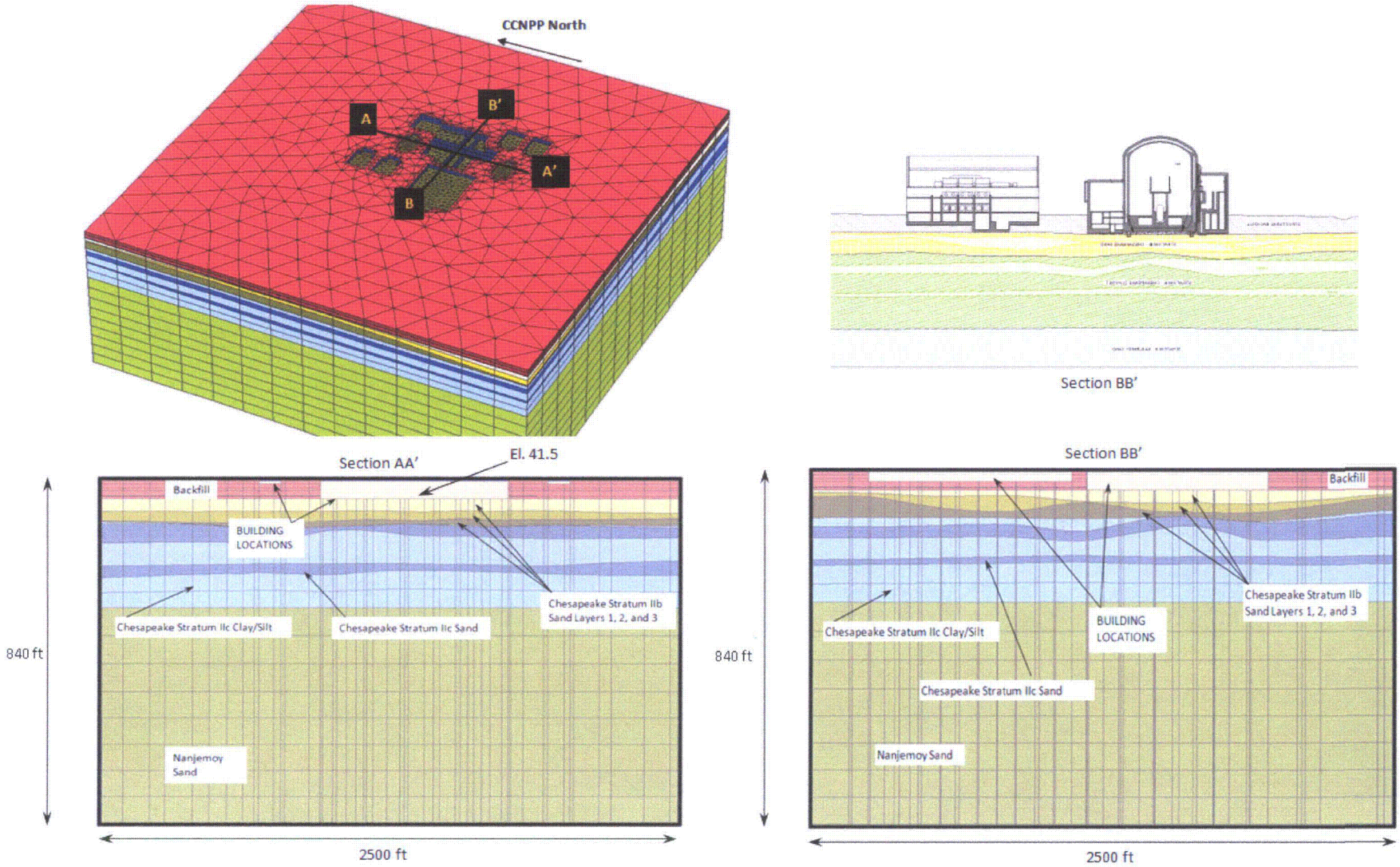

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Figure 2.5-185—{Subdivision of ED Model to Account for Variable Surface Topography}

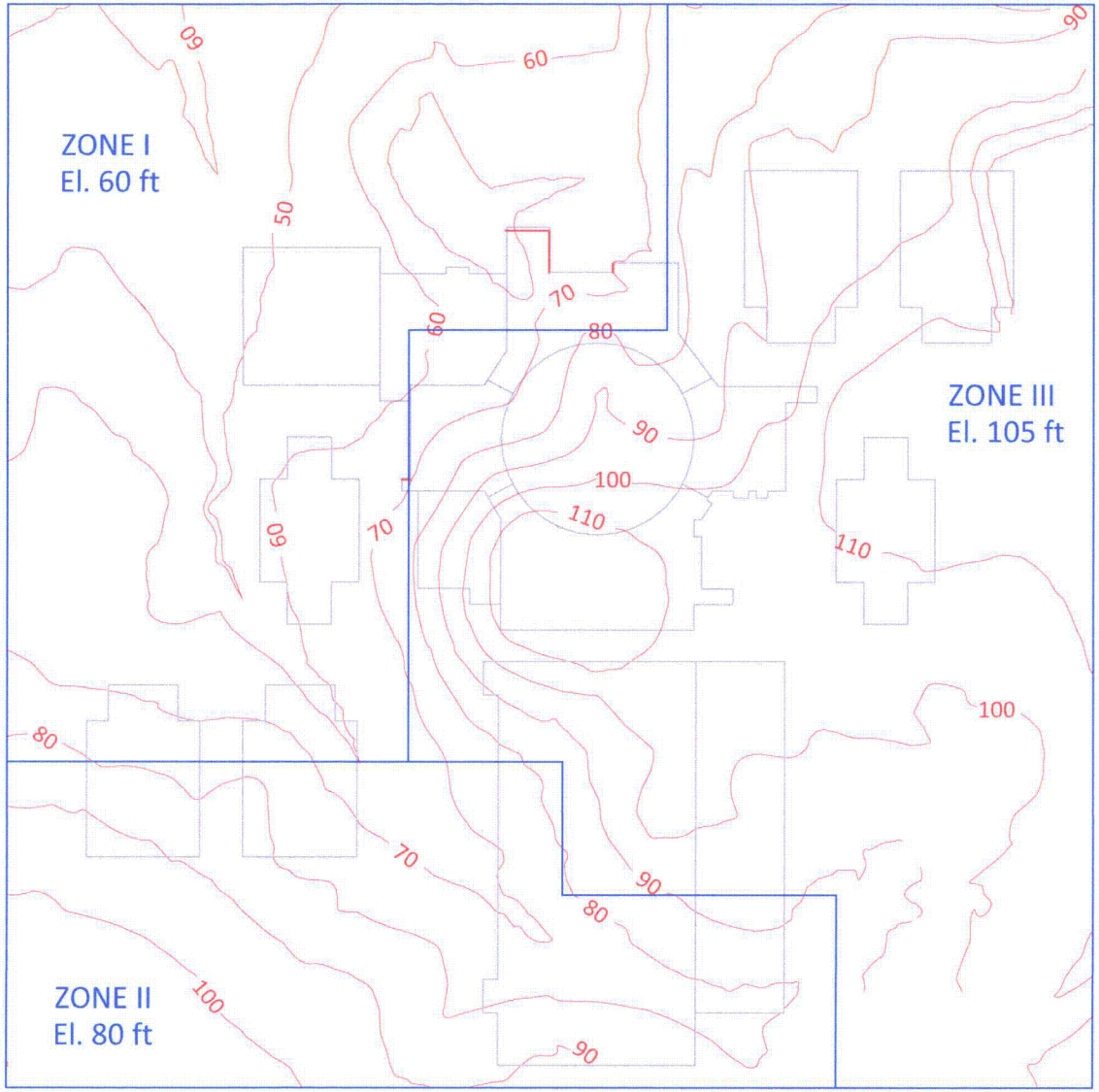

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Figure 2.5-186—{Heave After Excavation}

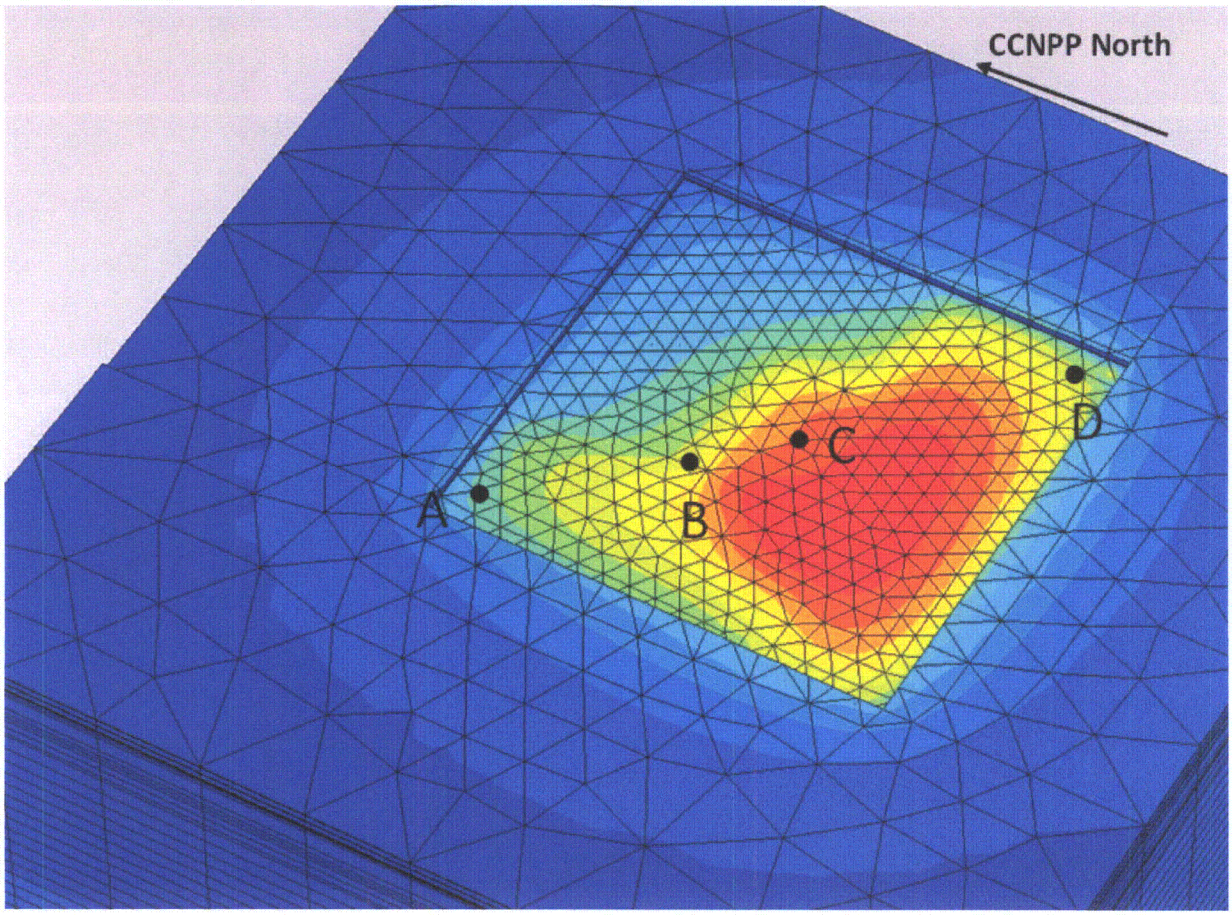

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Figure 2.5-187—{Building Load Construction Sequence}

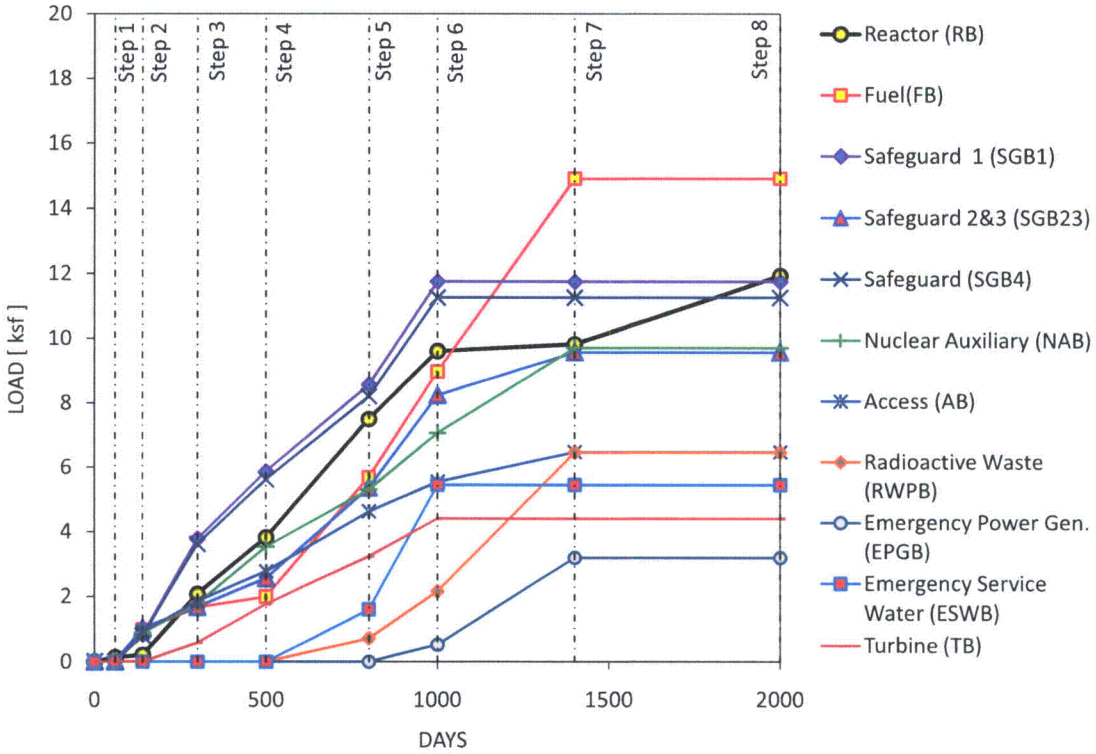

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Figure 2.5-188—{Surface Topography Plan and Cross Section}

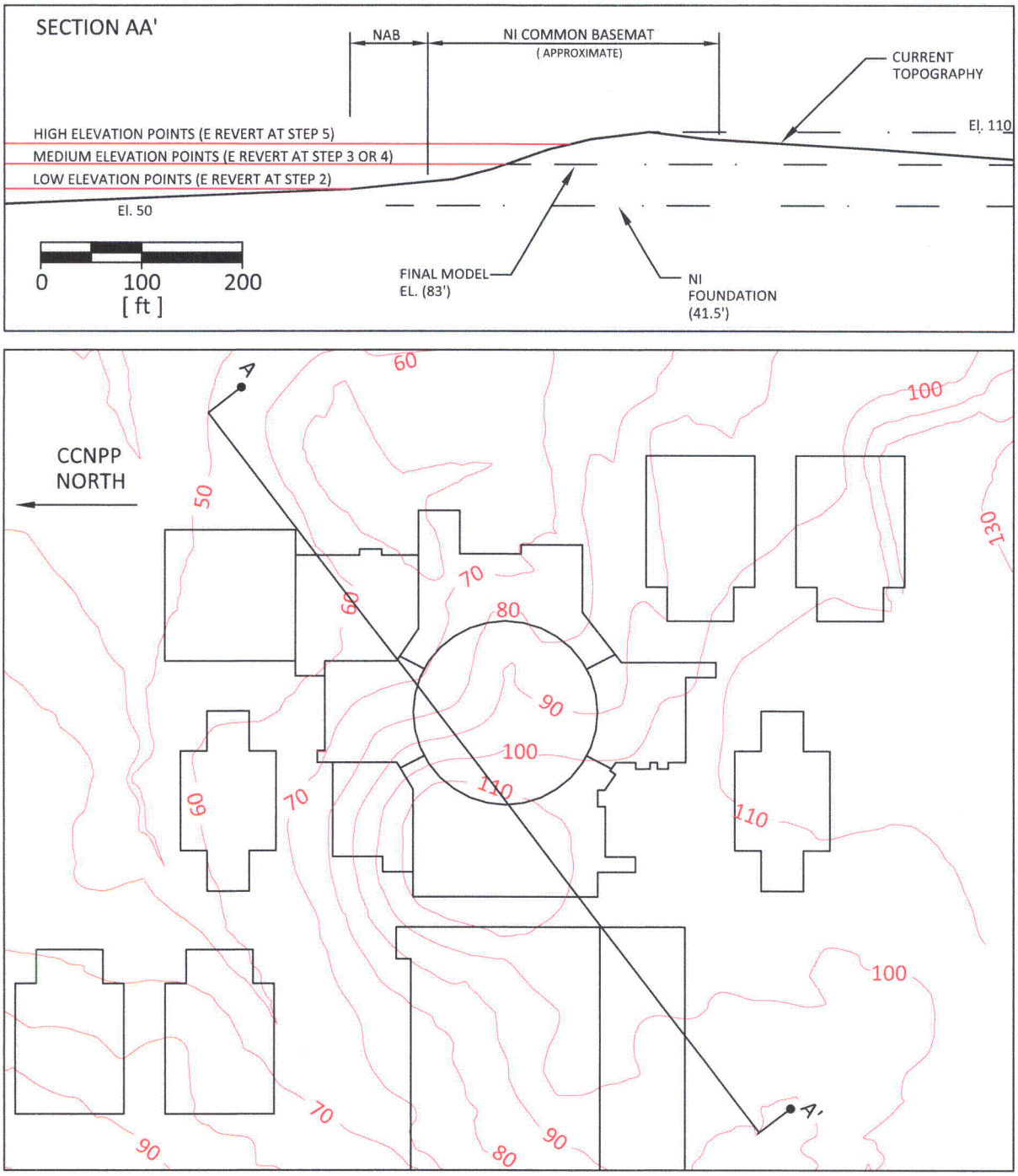

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Figure 2.5-189— {Contour Plots of Incremental Settlement}

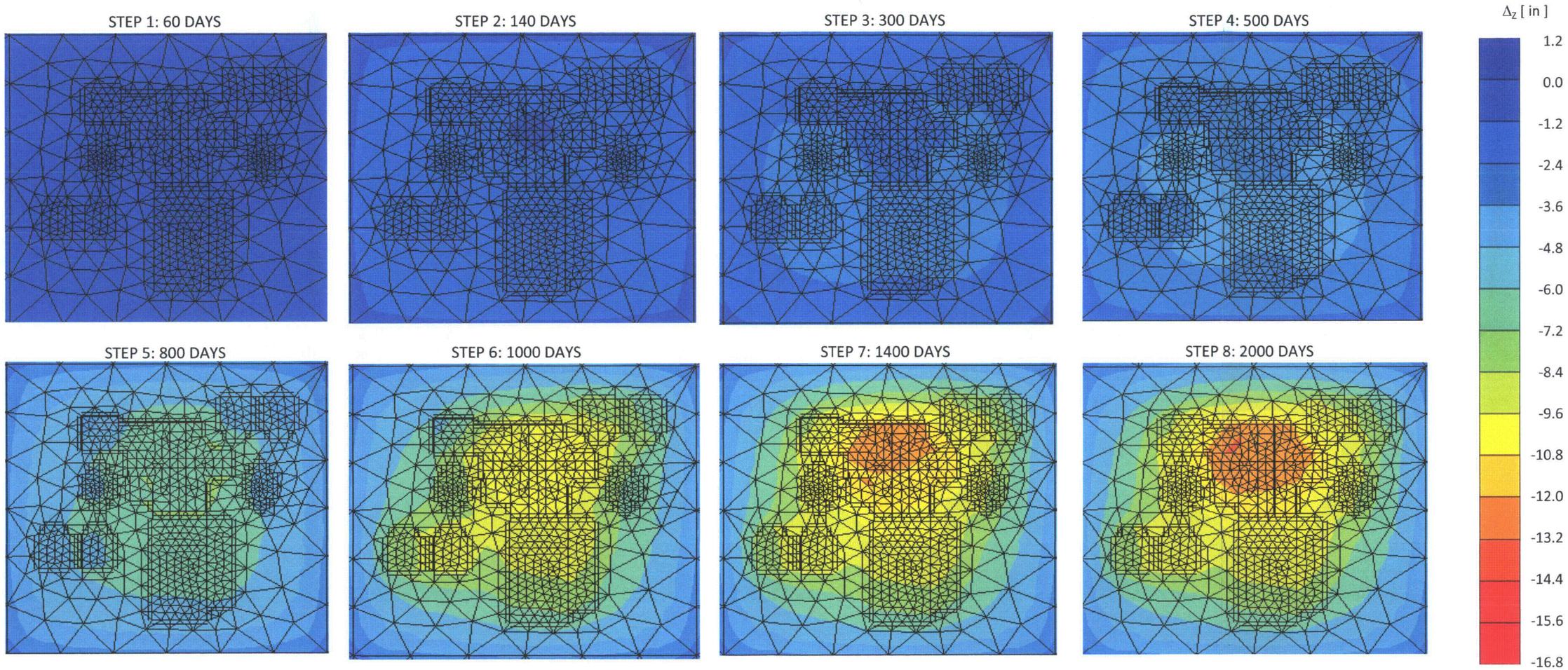

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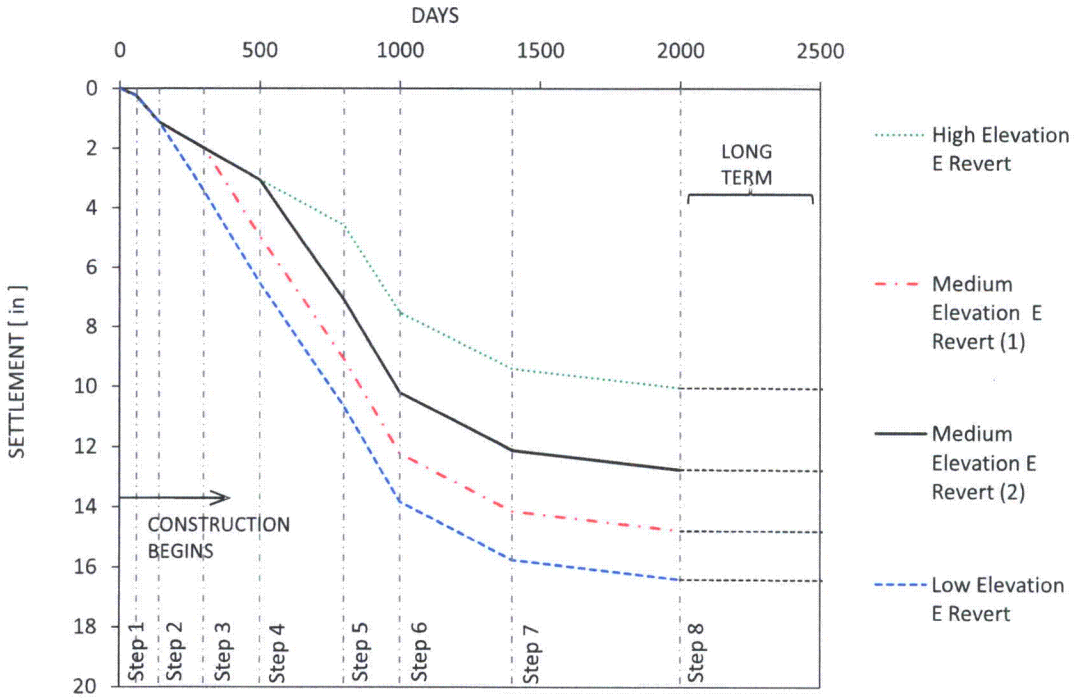
Figure 2.5-190—{NI Settlement Estimate}



Notes:

- Low Elevation: revert to loading modulus at the end of the 2nd load step (140 days)

- Medium Elevation (1): revert to loading modulus at the end of the 3rd load step (300 days)

- Medium Elevation (2): revert to loading modulus at the end of the 4th load step (500 days)

-High Elevation: revert to loading modulus at the end of the 5th load step (800 days)

- Long term settlement estimate due to creep and rewatering offset each other and are not significant

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Figure 2.5-191—{Settlement at Center Point of Safety Related Buildings}

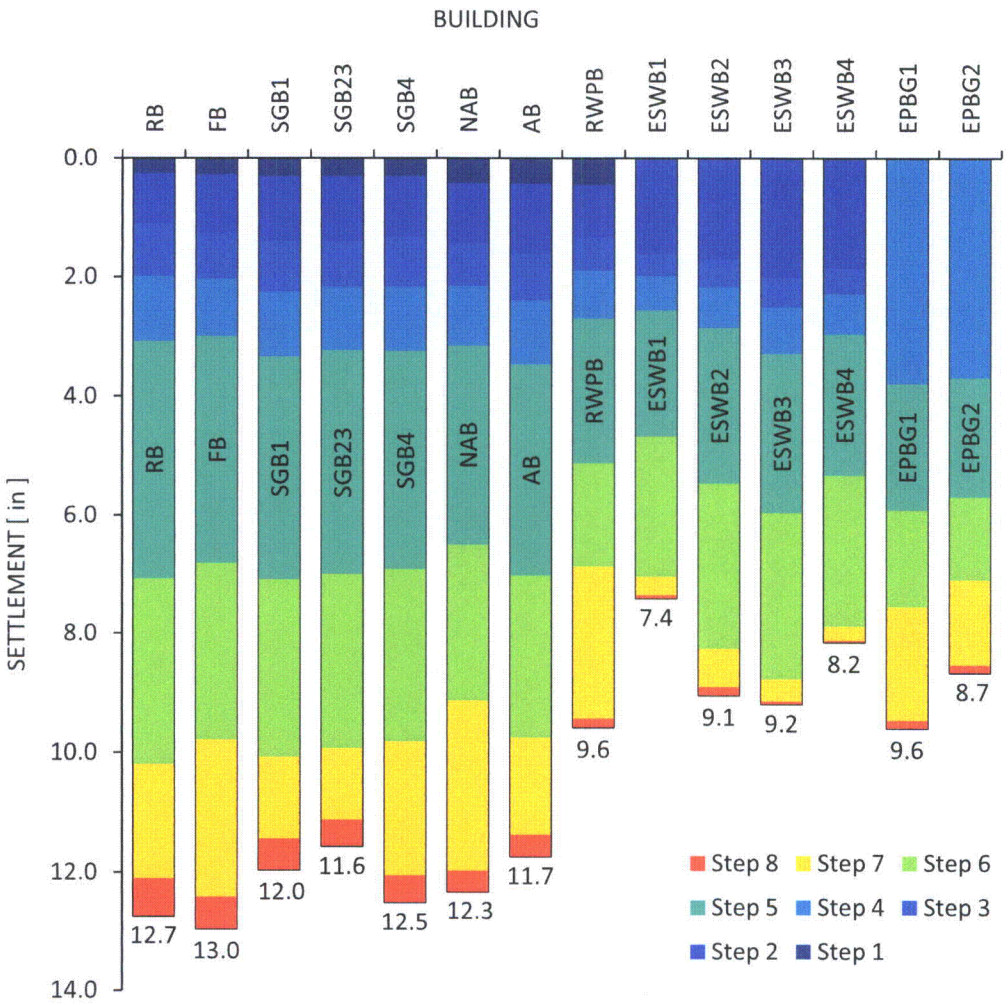

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Figure 2.5-192—{Settlement Tracking Cross Sections}

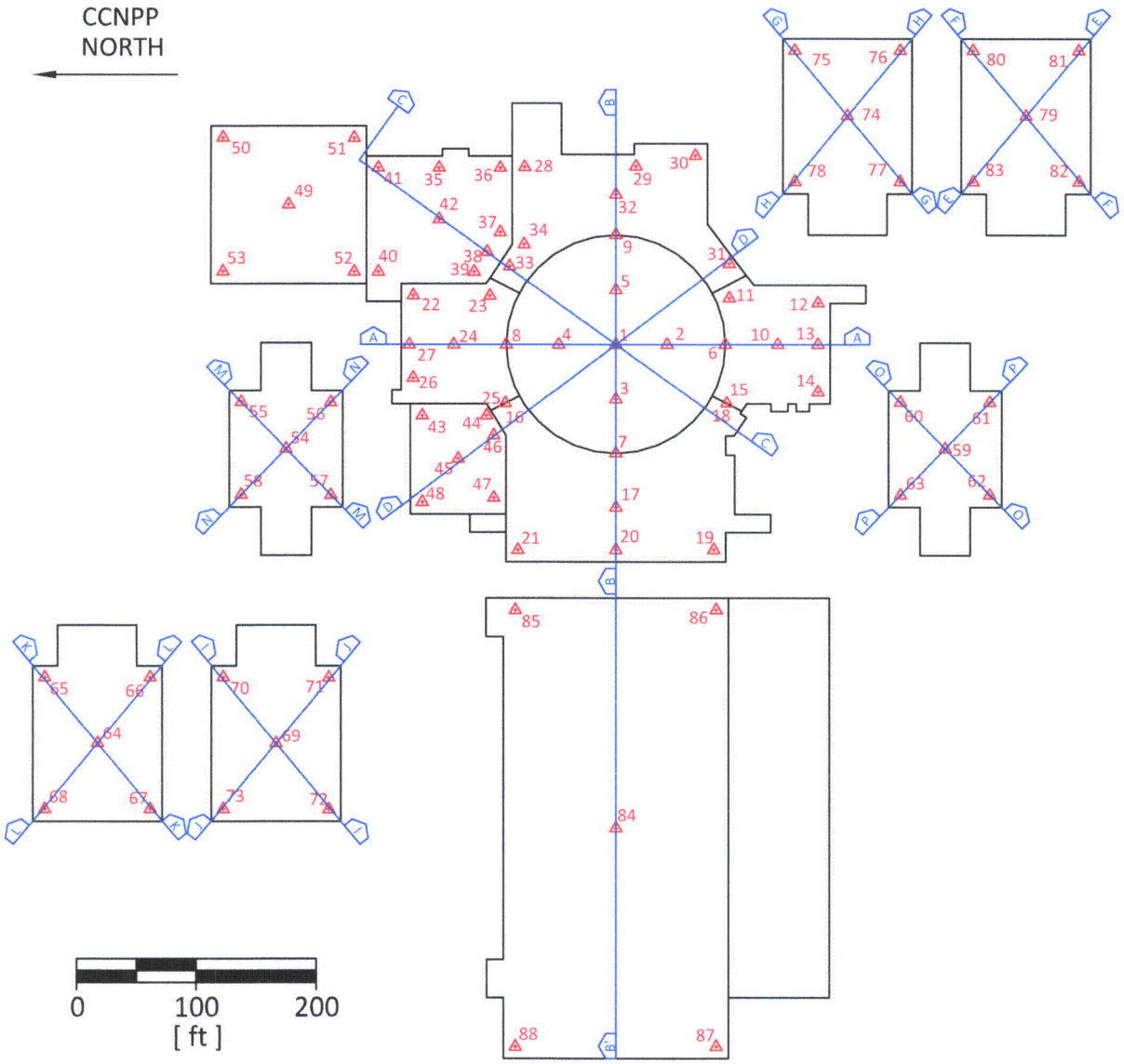

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Figure 2.5-193—{Foundation Settlement across NI and TB Footprint}

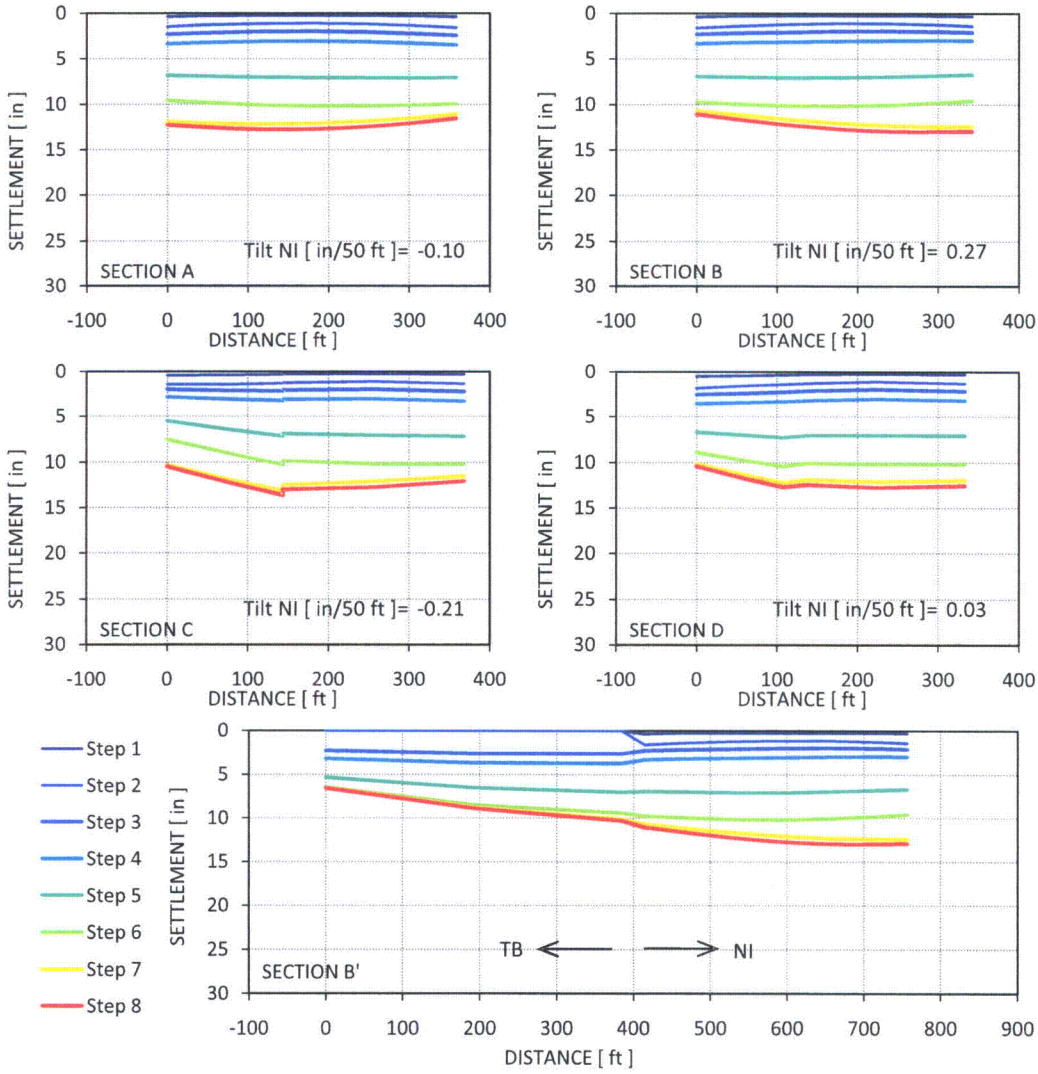

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Figure 2.5-194—{NI Tilt in Four Cross Sections}

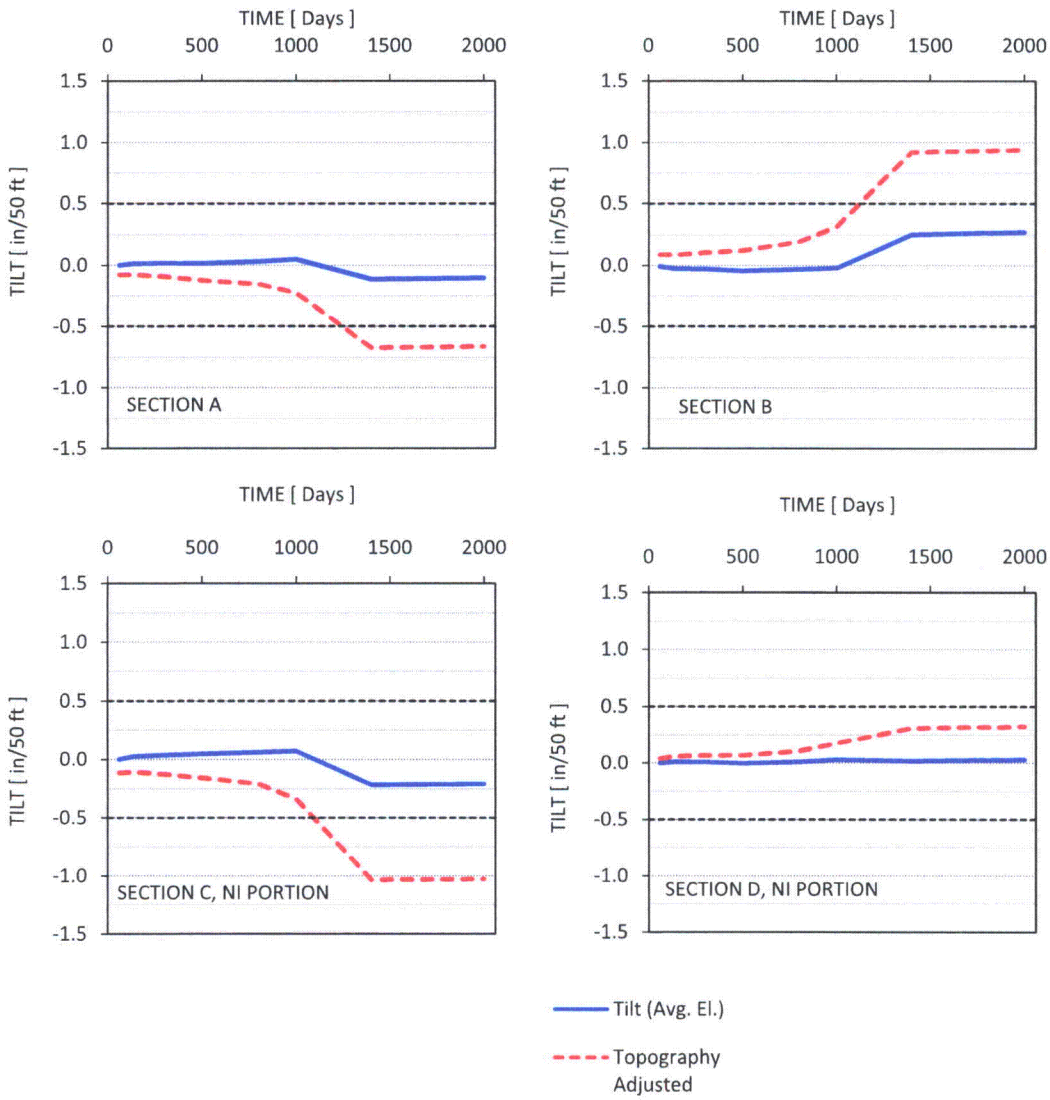

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Figure 2.5-195—{Settlement at Center of Facilities After Adjustment for Topography

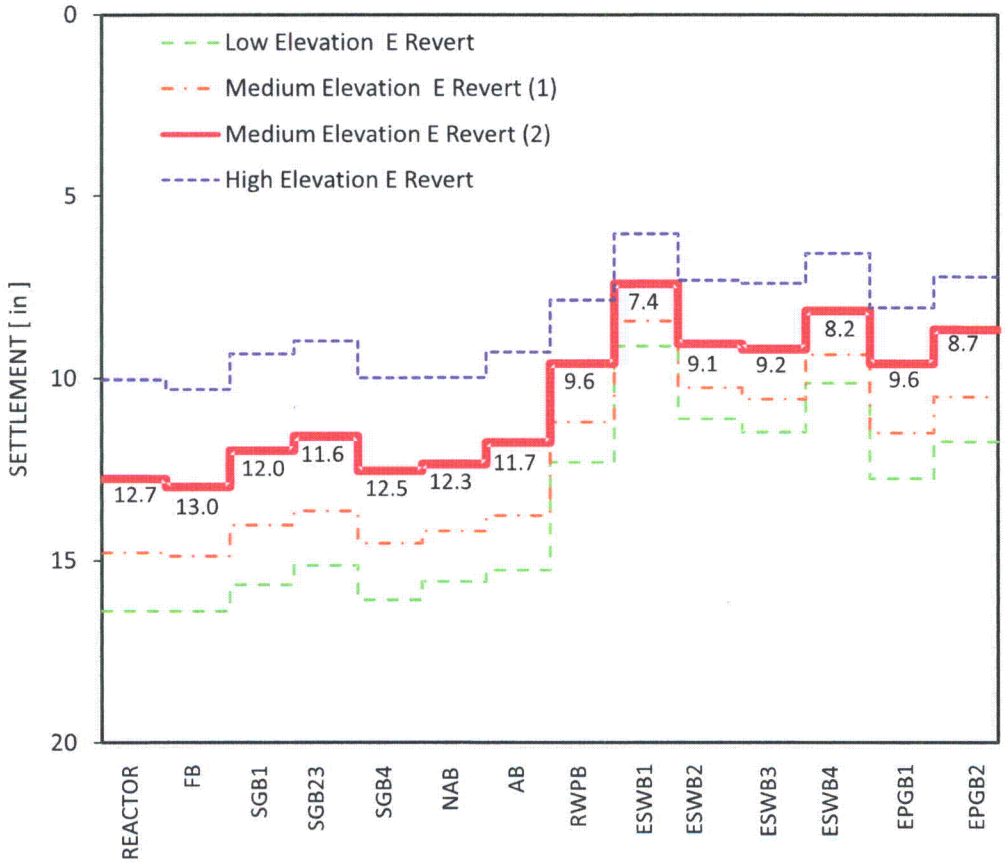

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Figure 2.5-196—{UHS FEM Model}

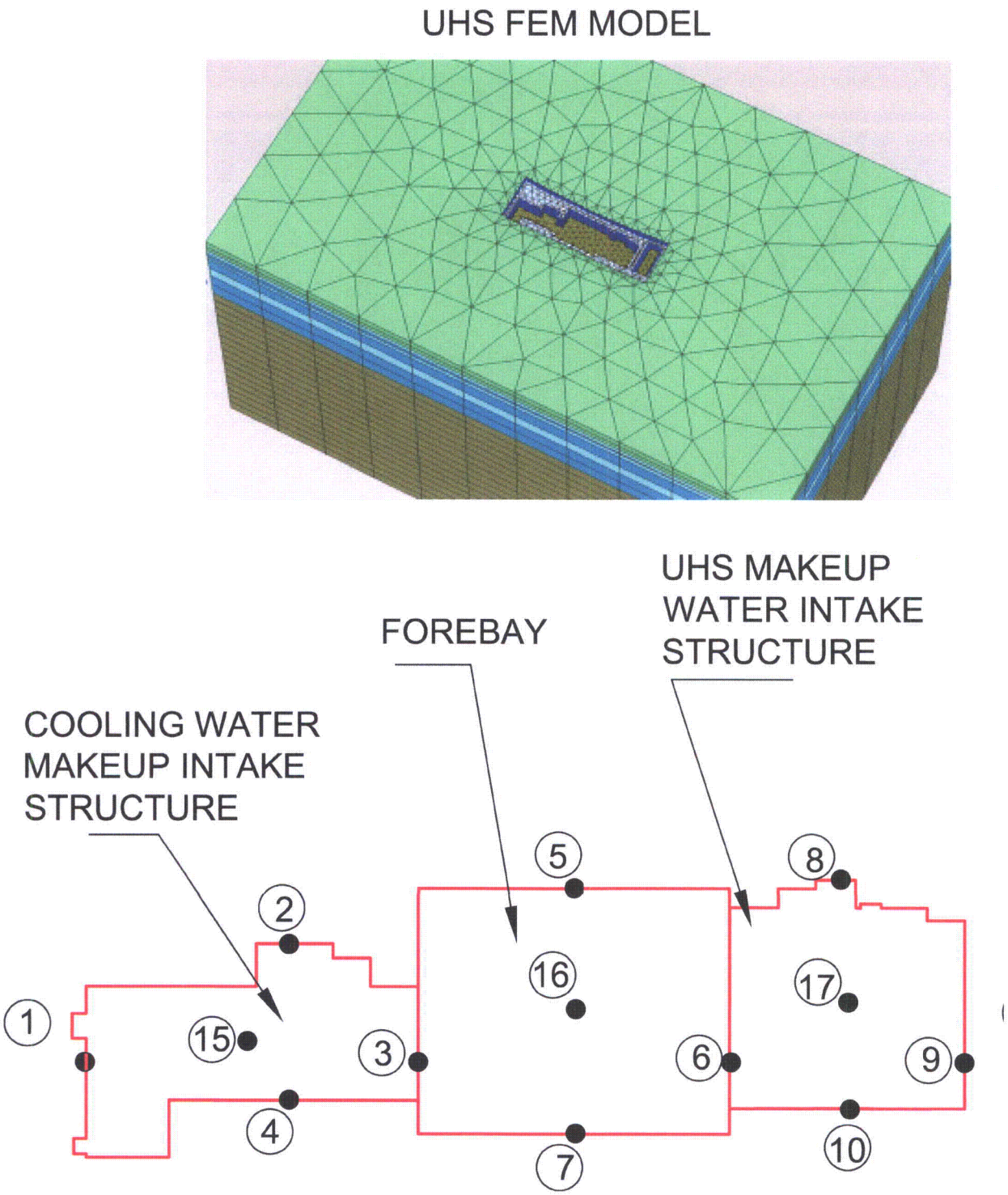

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Figure 2.5-197—{Earth Pressure Representative Diagrams}

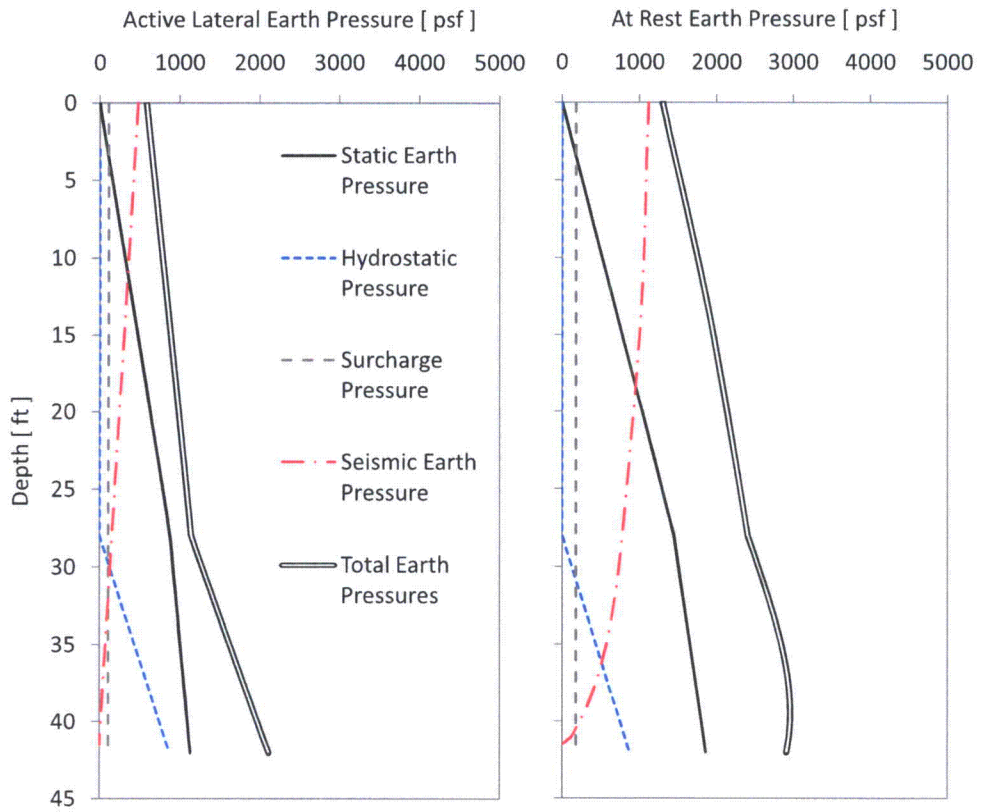

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Figure 2.5-198— {Site Grading Plan with Slope Cross-Sections}

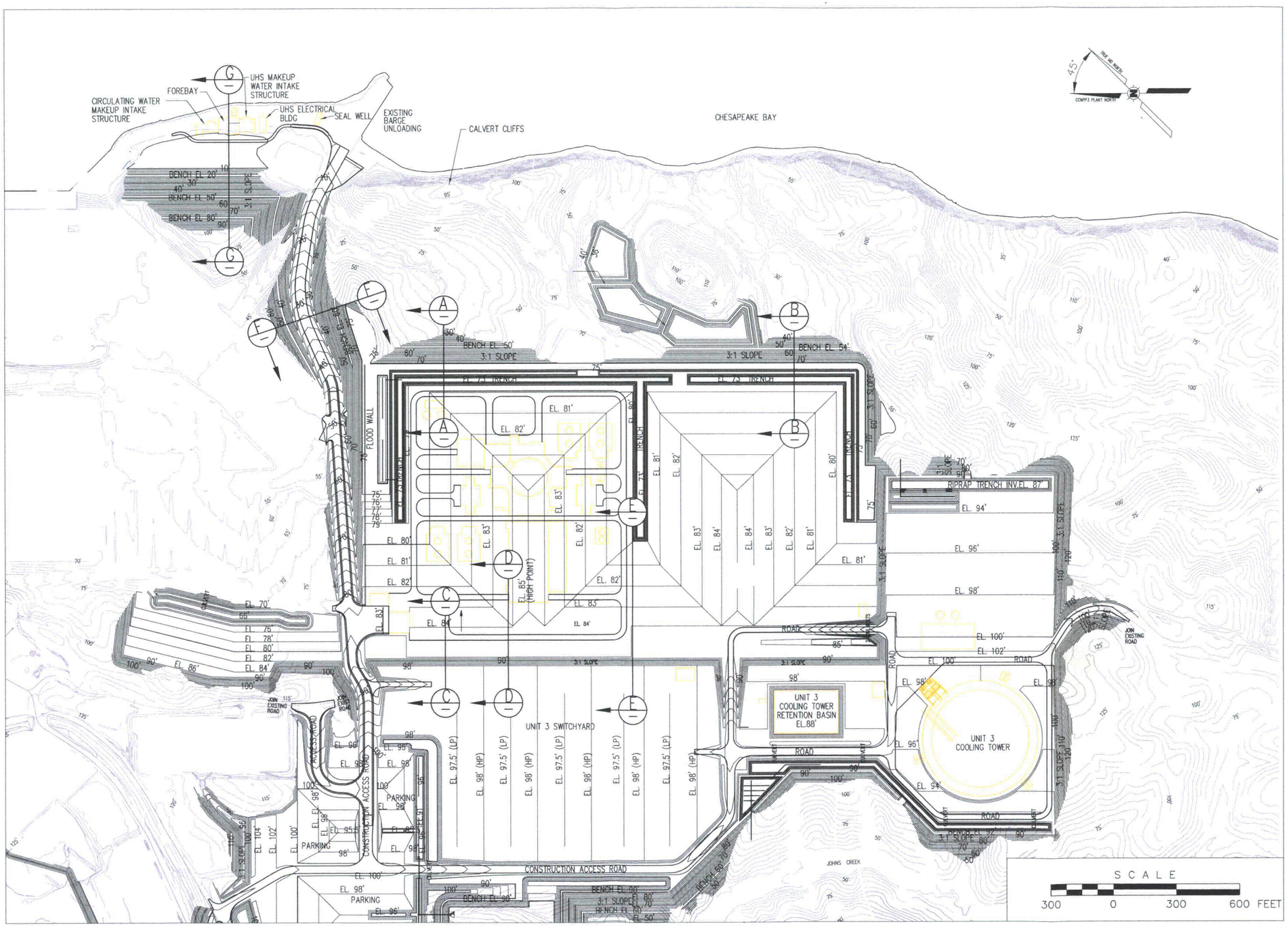

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Figure 2.5-199—{Cross-sections in Powerblock Area}

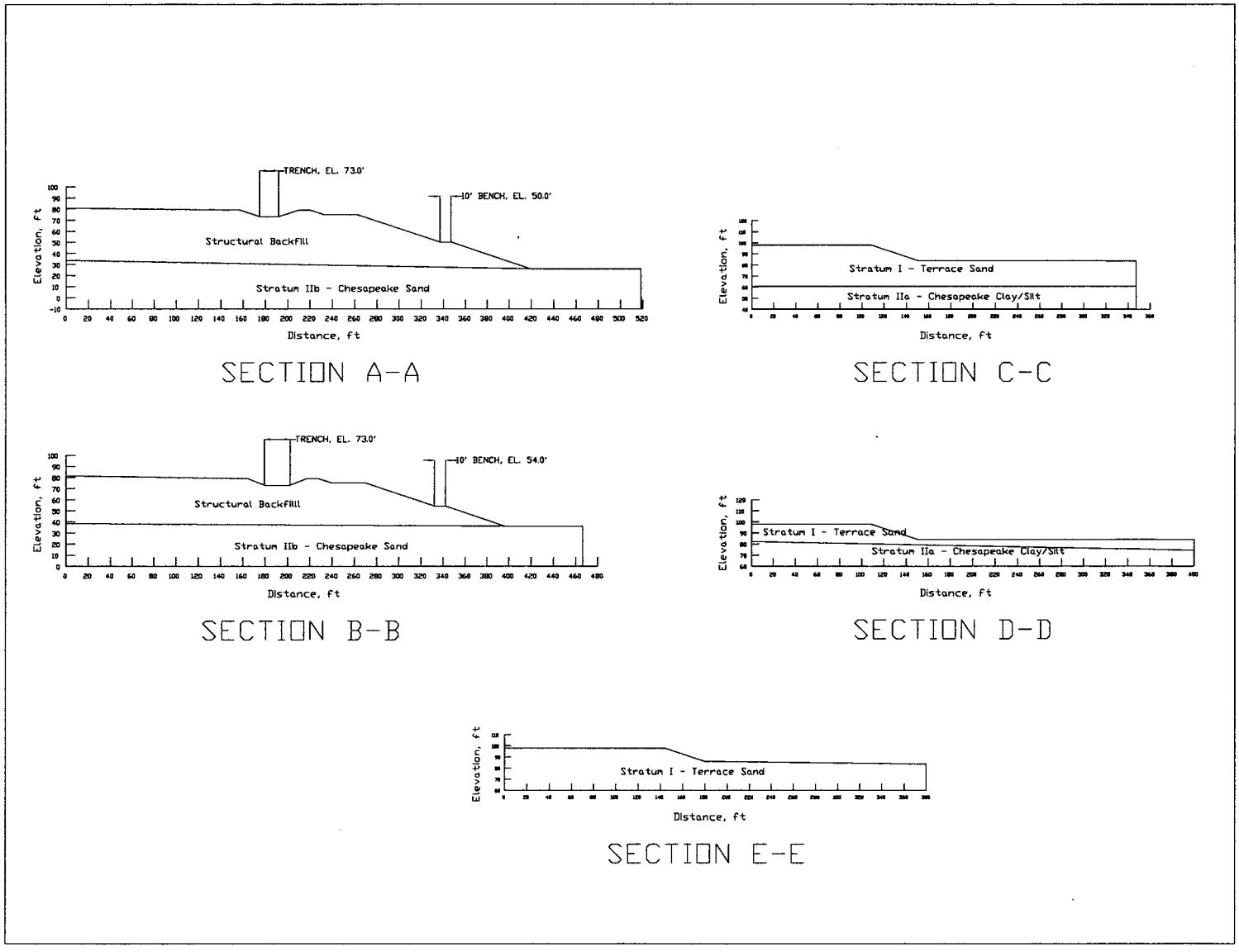

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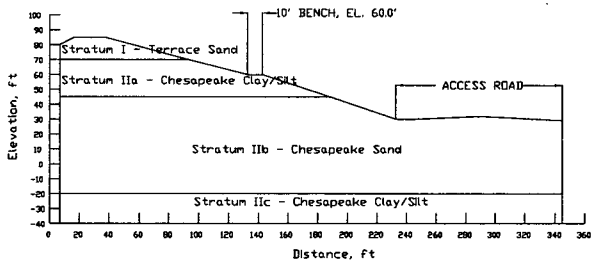
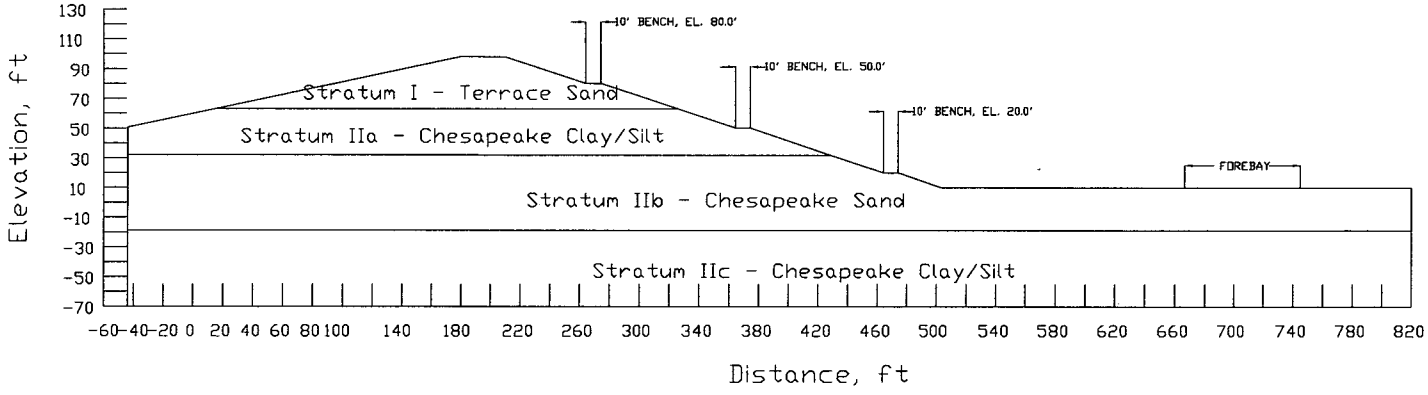
Figure 2.5-200—{Cross-sections in Intake Area and Utility Corridor}



SECTION F-F



SECTION G-G

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Figure 2.5-201— {Location of Excavation Cross-sections in CCNPP Unit 3}

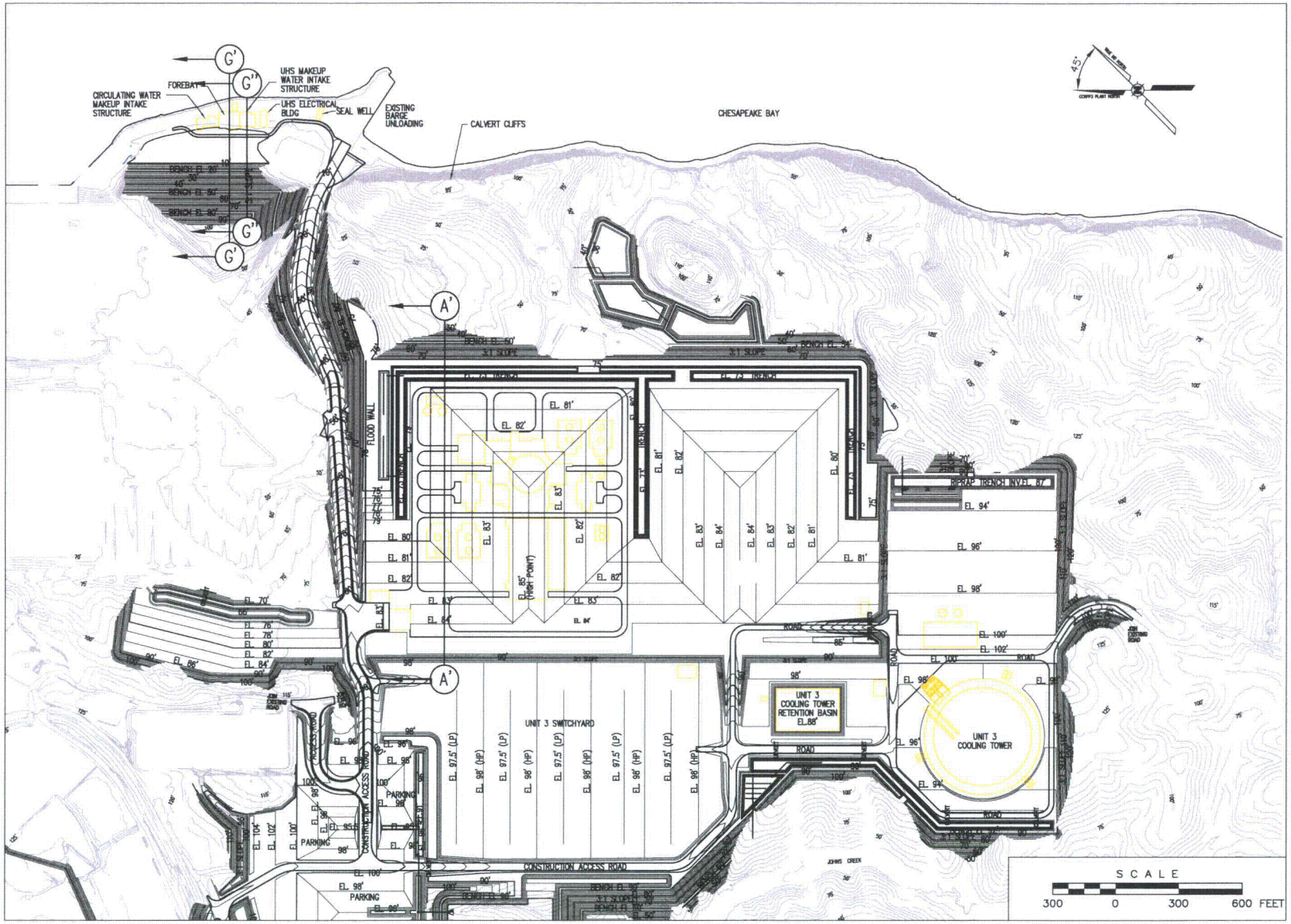

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Figure 2.5-202—{Excavation Cross-sections in CCNPP Unit 3}

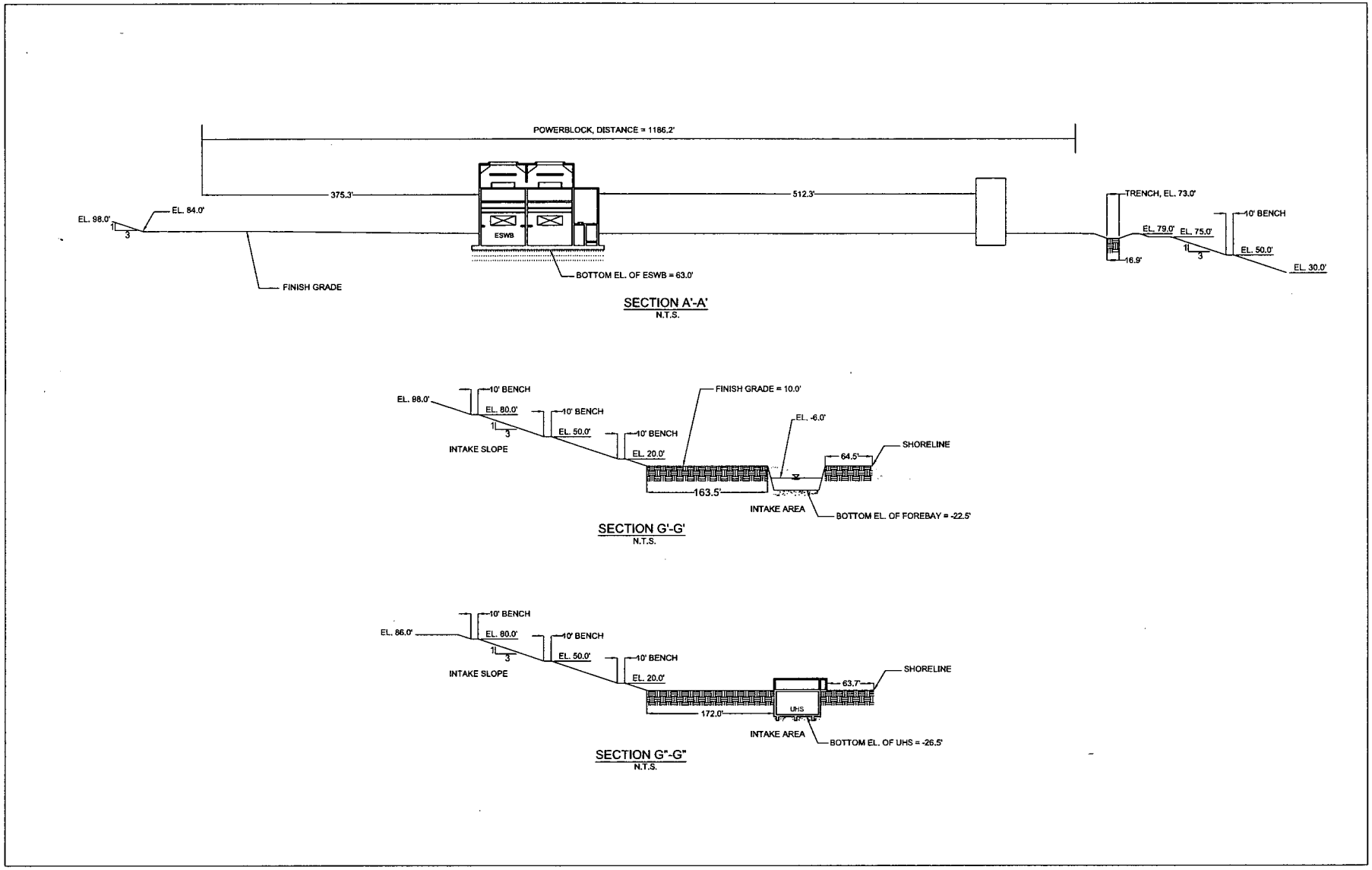

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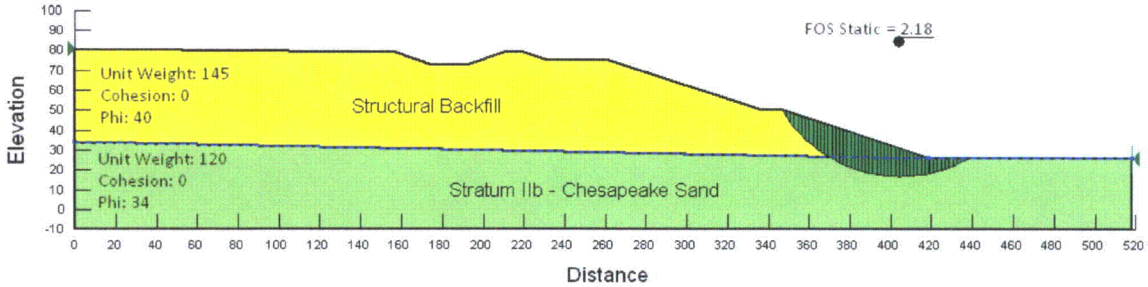
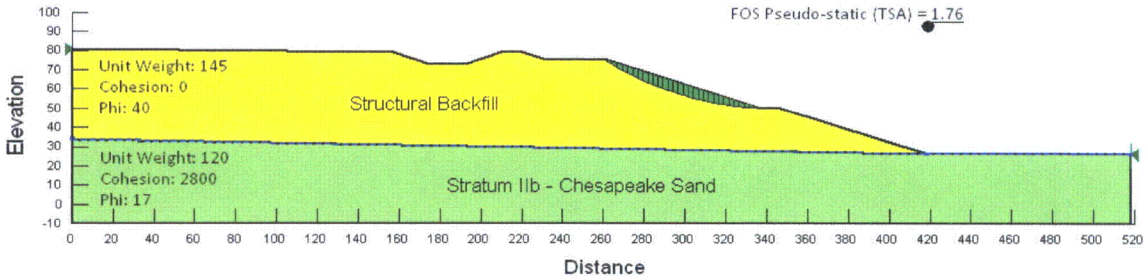
Figure 2.5-203—{Static and Pseudo-Static Stability Analyses of Slope Section A - Case a}





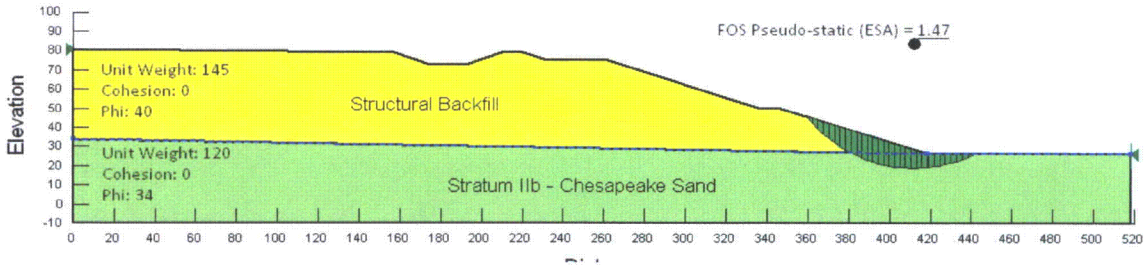


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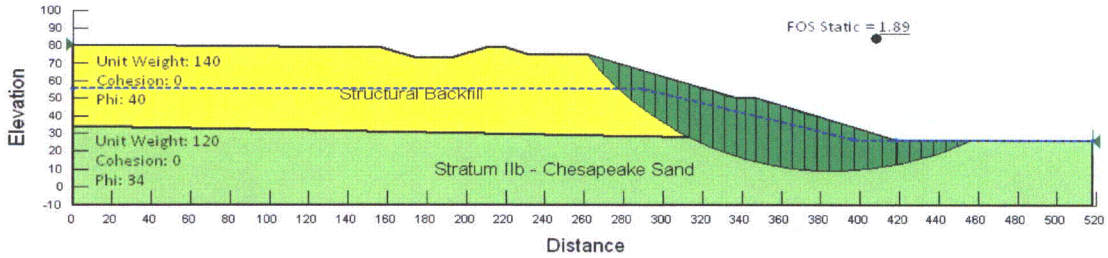
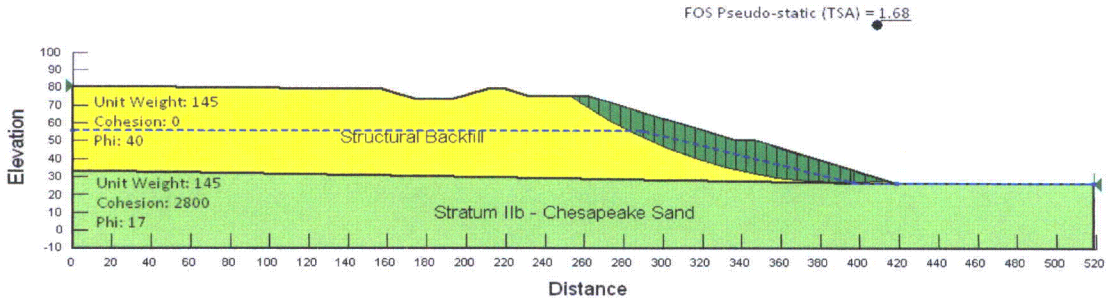
Figure 2.5-204—{Static and Pseudo-Static Stability Analyses of Slope Section A - Case b}





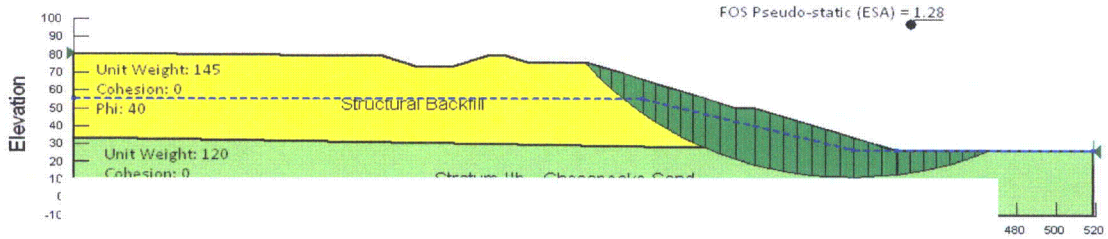


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Figure 2.5-205—{Static and Pseudo-Static Stability Analyses of Slope Section B - Case a}

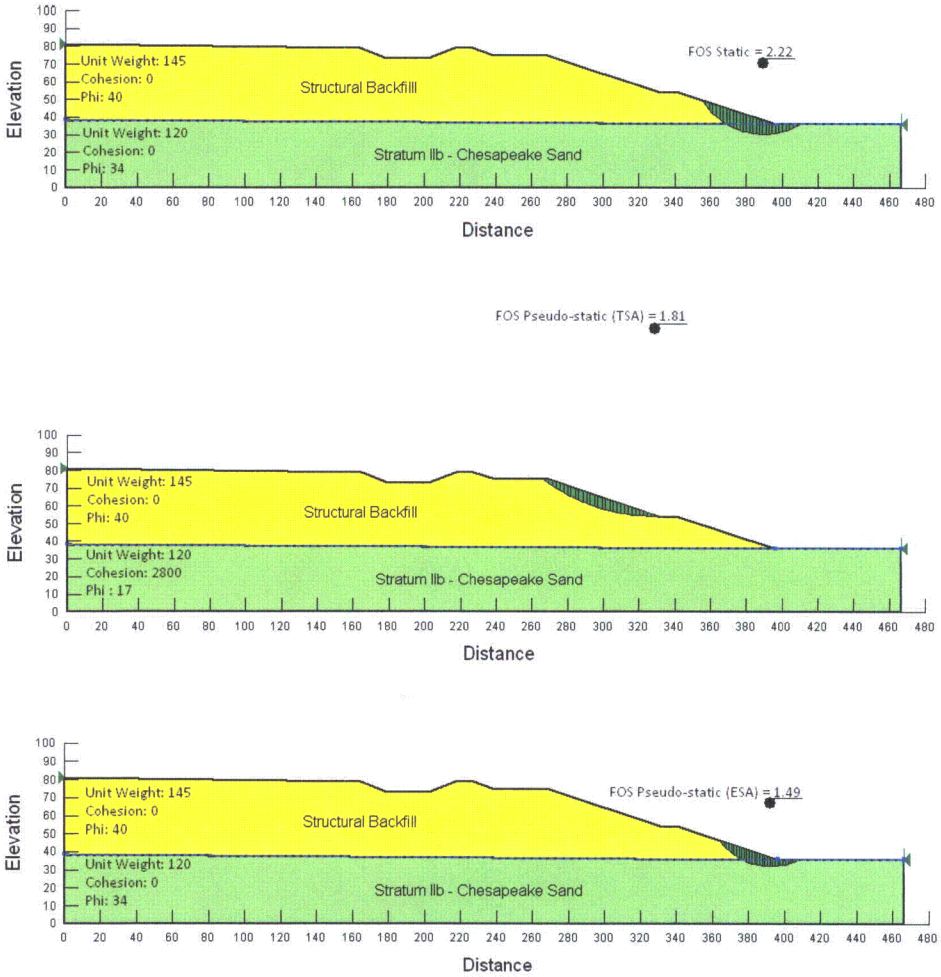

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Figure 2.5-206—{Static and Pseudo-Static Stability Analyses of Slope Section B - Case b}

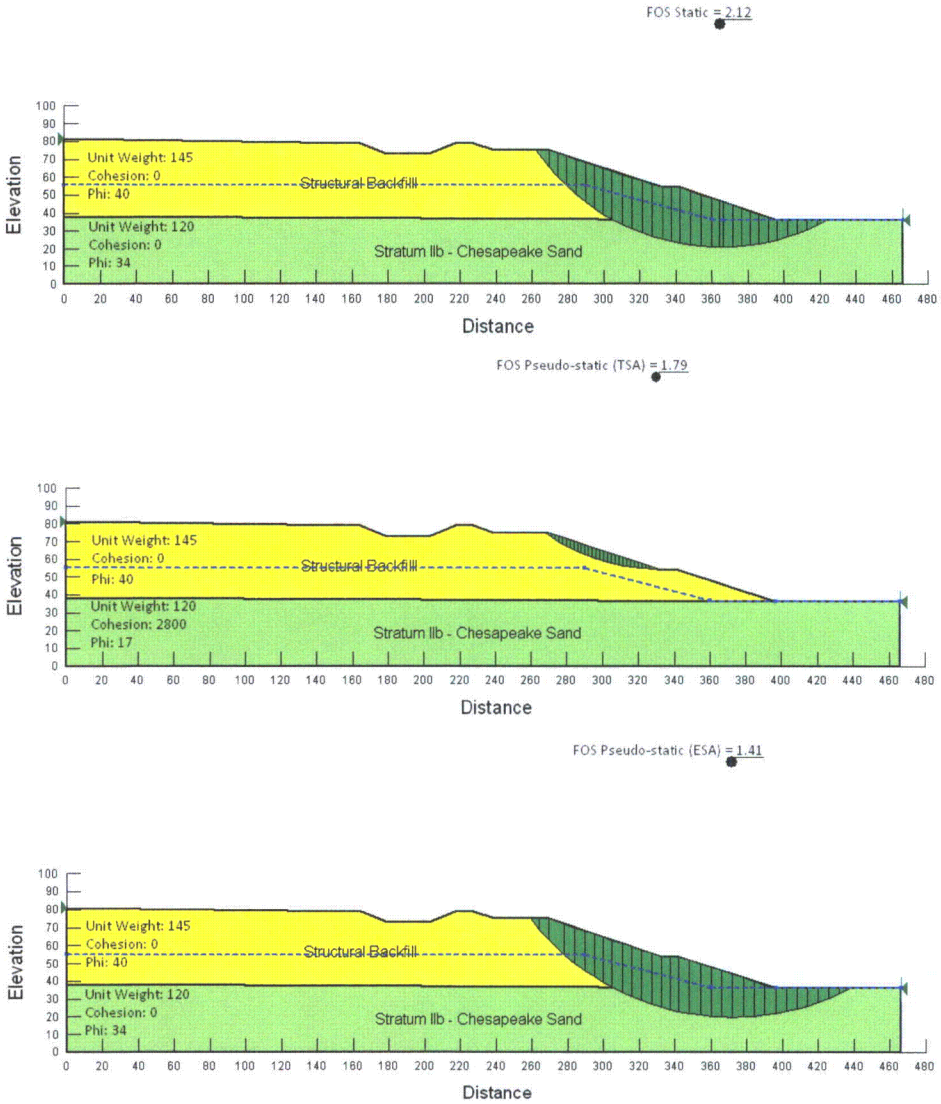

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Figure 2.5-207—{Static and Pseudo-Static Stability Analyses of Slope Section C}

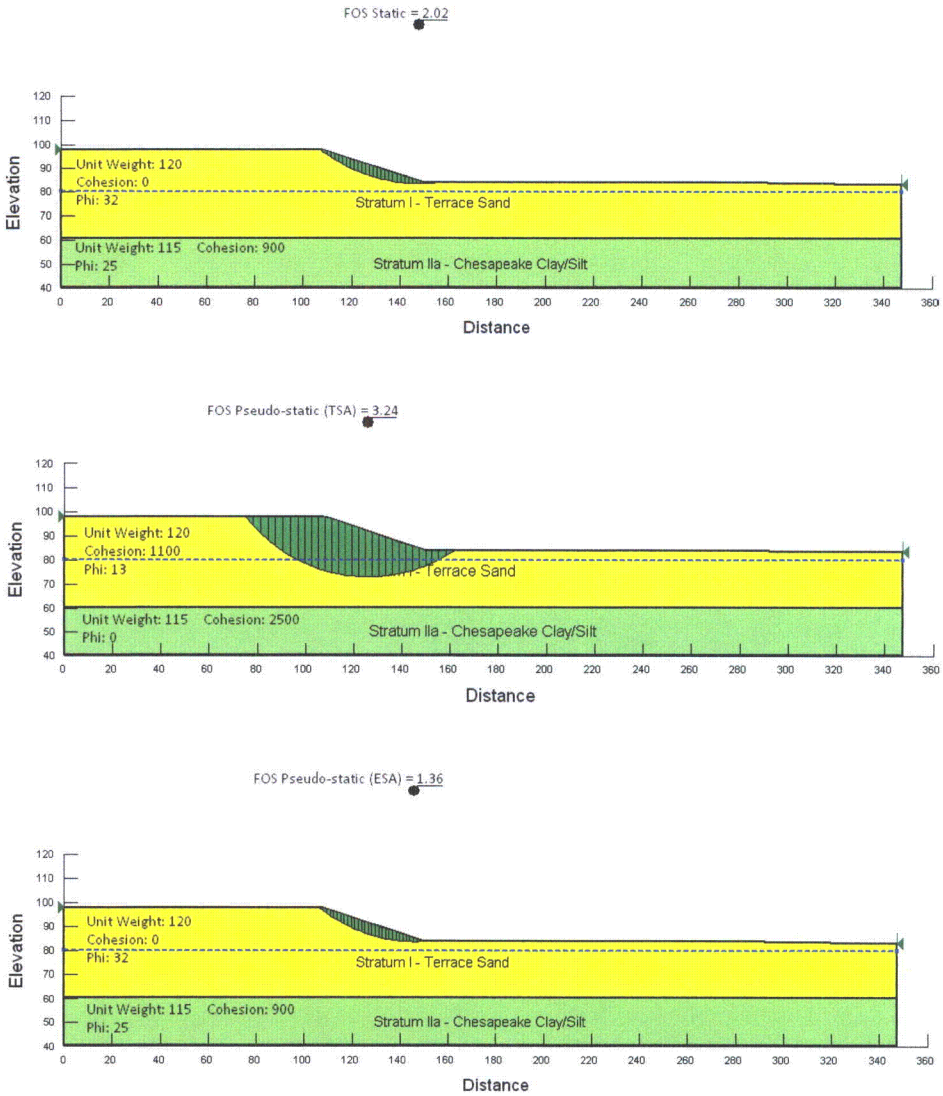

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Figure 2.5-208—{Static and Pseudo-Static Stability Analyses of Slope Section D}

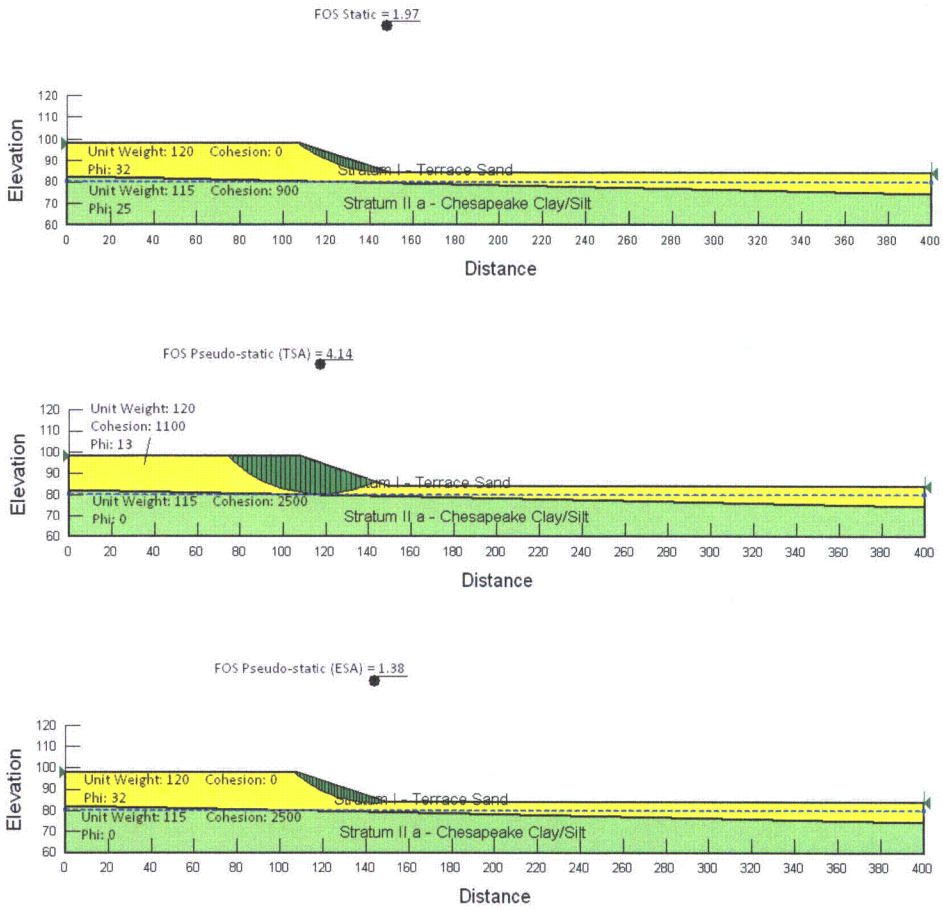

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Figure 2.5-209—{Static and Pseudo-Static Stability Analyses of Slope Section E}

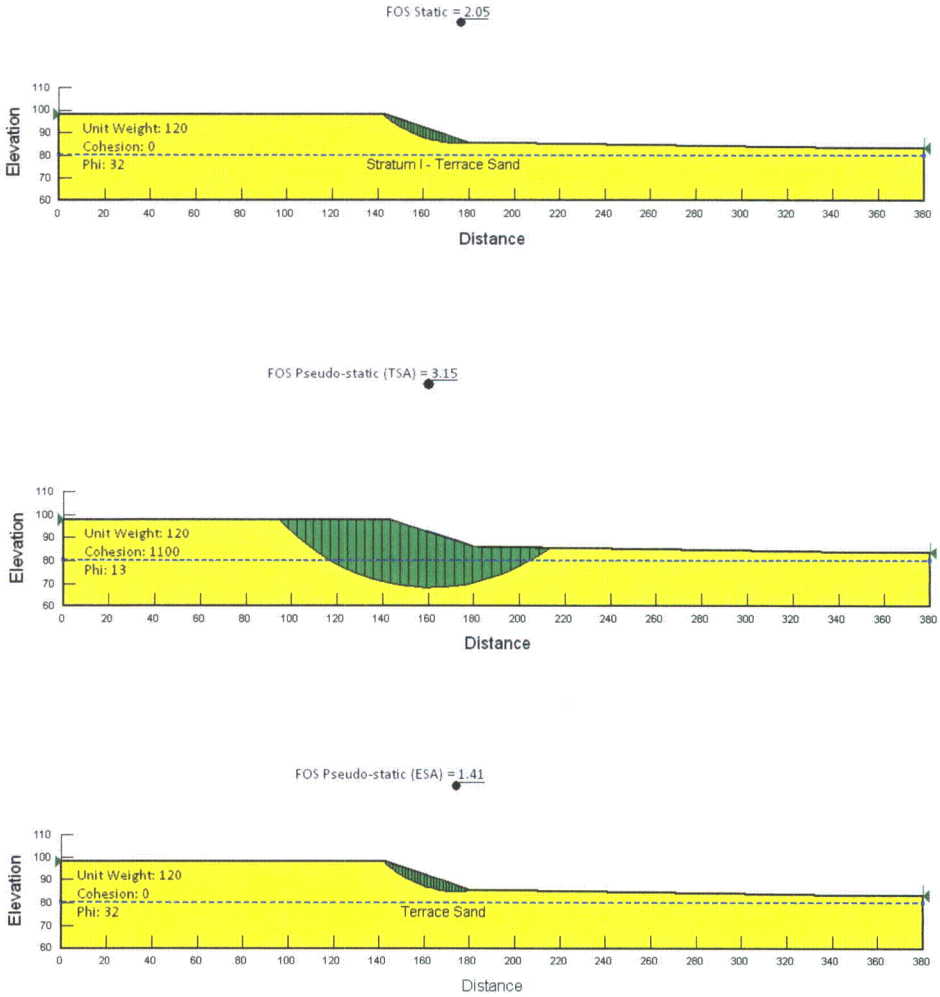

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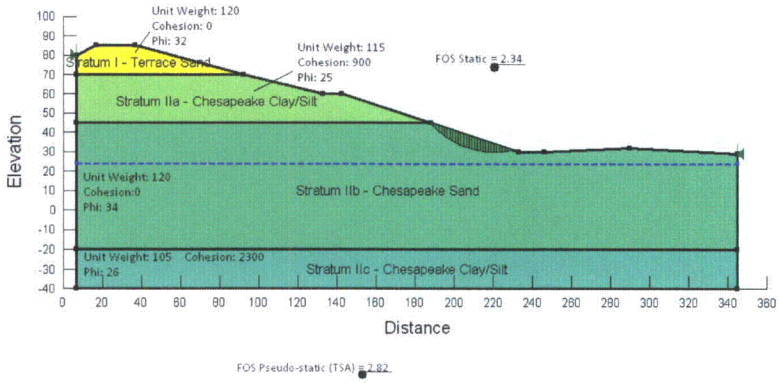
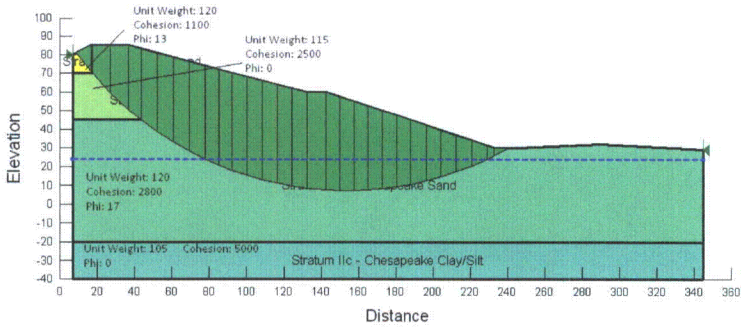
Figure 2.5-210—{Static and Pseudo-Static Stability Analyses of Slope Section F (Utility Corridor}





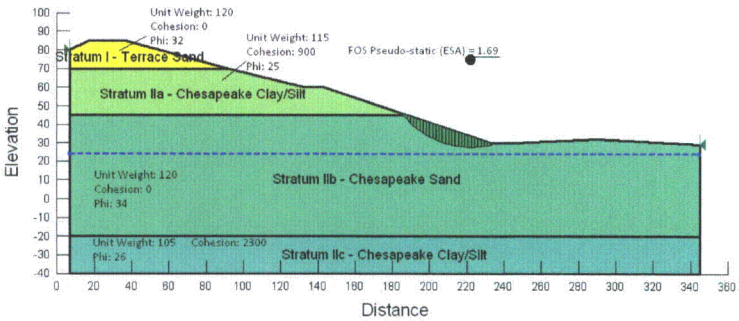


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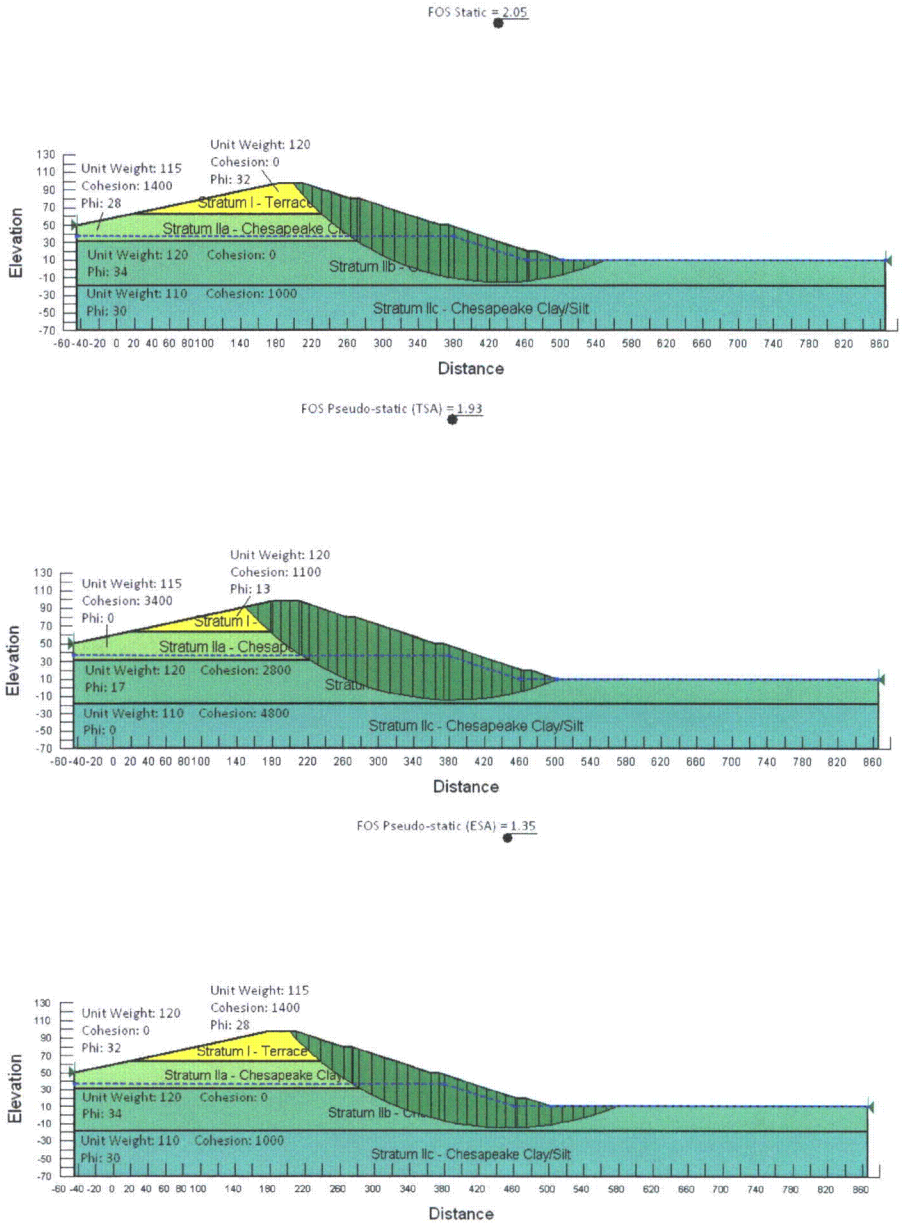
Figure 2.5-211—{Static and Pseudo-Static Stability Analyses of Slope Section G (Intake Area)}



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Enclosure 2

Assessment of the CCNPP Unit 3 FSAR information against industry (non-Unistar) RAI questions.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
Backfill		
Bellefonte 02.05.04-14 Harris 02.05.04-14 Lee 02.05.04-10 Summer 02.05.04-01 Summer 02.05.04-05 Summer 02.05.04-06 Summer 02.05.04-30	Provide parameters of Backfill. Provide information on compaction procedures	The backfill investigation is provided in Section 2.5.4.2.3. The source of backfill for CCNPP Unit 3 is Vulcan Quarry in Havre de Grace, Maryland. Backfill parameters such as weight, strength, etc. are included in multiple tables in Section 2.5 that present the soil parameters. Section 2.5.4.5.3 provides a discussion on the backfill compaction specifications
Bearing Capacity		
Bellefonte 02.05.04-18 Grand Gulf 02.05.04 -14. North Anna 02.05.04-07b North Anna 02.05.04-11 North Anna 02.05.04-19 South Texas 02.05.04-15 Summer 02.05.04-27	Discuss dynamic bearing capacity determination. Describe the effect of eccentricity on the bearing capacity analysis. Describe why an increase of one third over static is adequate for dynamic bearing capacity.	Bearing capacity is discussed in Section 2.5.4.10.1. This section describes the methodology used to determine bearing capacity of the soils. The results of this analysis are contained in Table 2.5-65. The U. S. EPR FSAR defines both a static and a dynamic bearing capacity. The required bearing capacity is 22,000 lb/ft^2 in localized areas at the bottom of the Nuclear Island (NI) basemat and 15,000 lb/ft^2 on average across the total area of the bottom of the NI basemat. The minimum dynamic bearing capacity is 34,560 lb/ft^2 at the bottom of the NI basemat. The Nuclear Island, EPGBs and ESWBs exceed these criteria with a factor of safety of 3.0 for static conditions and 2.0 for dynamic conditions. No minimum bearing capacity has been established for the UHS structures. However the bearing capacities (with factors of safety included) exceed the building loads.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
Boring Campaign		
Grand Gulf 02.05.04-18 South Texas 02.05.04-01 Summer 02.05.04-10 Summer 02.05.04-21	Justify quantity and depth of samples. Justify location of samples. If deviation measurements were made, describe process and results.	The field investigation is discussed in Section 2.5.4.2.2.2. This section provides information on the quantity, location and depth of borings. Deviations are also discussed in this section. Figures 2.5-103, 2.5-104 and 2.5-105 show the boring locations. CCNPP Unit 3 has had an extensive boring campaign, with over 200 boring completed in two phases. This resulted in extensive characterization of the soil beneath the site.
Chemistry		
Summer 02.05.04-19	Discuss soil chemistry and effects on structures.	Soil chemistry of the backfill is described Section 2.5.4.2.4.2 and the results provided in Table 2.5-43. Chemical properties and the effect on structures are discussed in Section 2.5.4.2.5.2.
Consistency of text, tables, and figures		
Grand Gulf 02.05.04-04 Grand Gulf 02.05.04-05 Grand Gulf 02.05.04-07 Levy 02.05.04-12 Levy 02.05.04-13 Levy 02.05.04-18 North Anna 02.05.04-05 North Anna 02.05.04-06 North Anna 02.05.04-18 North Anna 02.05.05-01 Summer 02.05.04-23	Ensure data provided in the FSAR text, tables and figures is consistent.	Many of the RAI questions related to inconsistent data. To ensure consistent data the entire FSAR 2.5.4 re-write was performed by a small team. In addition, multiple reviews were performed by multiple individuals. This section provides the baseline information used in other portions of the FSAR, such as Section 2.4 and 3.7. Analyses for those sections are being performed or re-performed using parameters established in this section.
Construction Dewatering		
Bellefonte 02.05.04-15 South Texas 02.05.04-03	Provide the dewatering plan.	Construction dewatering is discussed in Section 2.5.4.5.4.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
Foundation Sliding		
Grand Gulf 02.05.04-17 Harris 02.05.04-12 North Anna 02.05.04-08 North Anna 02.05.04-17 Summer 02.05.04-31	Discuss factor of safety for sliding for Cat I facilities. Discuss impact of underlying waterproofing material on FOS for sliding.	The coefficient of friction for sliding is discussed in Section 2.5.4.2.5.7 Information is tabulated in Table 2.5-88. Factors of safety range from 2.3 to 3.0. No adjustment has been made for the waterproof membrane that is currently discussed in Section 3.8.
Integrity of Data		
Grand Gulf 02.05.04-06 Grand Gulf 02.05.04-08 Grand Gulf 02.05.04-13 Grand Gulf 02.05.04-16 Grand Gulf 02.05.04-19 Grand Gulf 02.05.04-20 Grand Gulf 02.05.04-23 Lee 02.05.04-02 Lee 02.05.04-04 Levy 02.05.04-09 Levy 02.05.04-15 South Texas 02.05.04-17 South Texas 02.05.04-18 South Texas 02.05.04-19 South Texas 02.05.04-20 South Texas 02.05.05-23 Summer 02.05.05-02 Summer 02.05.05-17 Summer 02.05.05-18 Summer 02.05.05-25 Summer 02.05.05-26	Describe source of parameters such as E, K_o, C_v, etc. and if any values are assumed or estimated provide justification for selected values.	The field and laboratory reports have been included as COLA Part 11J and 11K. This information was used to develop soil (including backfill) parameters. In general, average values from the field and laboratory data were used for the analyses. The development of the soil parameters is discussed in Section 2.5.4.2, and provided in multiple tables in Section 2.5.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
ITAAC		
Grand Gulf 02.05.04-10 North Anna 02.05.04-04 North Anna 02.05.04-13 South Texas 02.05.04-12 Summer 02.05.04-07	Provide a comprehensive ITAAC to demonstrate competency of fill material. Justify Shear Wave Velocity (SWV) less than 1000 fps.	The current ITAAC specifies a SWV of 1000 fps. While the selected fill is high quality, it cannot achieve a SWV of 1000 near the surface. The Best Estimate SWV based upon laboratory data is 900 fps (from 6 feet below the surface to 22 feet below the surface). This Best Estimate is used as an input for the SSI analysis in FSAR Section 3.7. That analysis will develop bounding SWVs. In addition, ITAAC for backfill is an active industry topic being coordinated by NEI. UniStar will update the ITAAC in COLA Part 10 as part of the update of the structural analysis in FSAR Section 3.7.
Lateral Earth Pressure		
Bellefonte 02.05.04-21 Harris 02.05.04-08 Lee 02.05.04-08 Levy 02.05.04-21 North Anna 02.05.04-09 South Texas 02.05.04-14 Summer 02.05.04-29 Vogtle 02.05.04-01	Describe the methodology and results of lateral earth pressure analysis.	Earth pressure analyses are discussed in Section 2.5.4.10.6. Earth pressure coefficients are provided in Table 2.5-58 and representative earth pressure diagrams are provided in Figure 2.5-197.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
Liquefaction		
Bellefonte 02.05.04-17 Grand Gulf 02.05.04-22 Lee 02.05.04-01 North Anna 02.05.04-07a South Texas 02.05.04-05 Summer 02.05.04-08 Summer 02.05.04-09	If screening was used for liquefaction, describe in detail. Perform liquefaction analysis of backfill or justify why not needed. Describe impact of groundwater on liquefaction analysis. Provide graphic showing areas of potential liquefaction.	Liquefaction analysis is described in Section 2.5.4.8. Liquefaction analysis was performed for both existing soil and backfill. Analysis was done based on CPT, SPT and shear wave velocity. Liquefaction does not occur.
Settlement modeling, magnitudes, and monitoring		
Bellefonte 02.05.04-19 Grand Gulf 02.05.04-24 Harris 02.05.04-10 Harris 02.05.04-15 Lee 02.05.04-15 Levy 02.05.04-08 Levy 02.05.04-10 Levy 02.05.04-11 North Anna 02.05.04-07 North Anna 02.05.04-07c North Anna 02.05.04-07d North Anna 02.05.04-07e South Texas 02.05.04-04 South Texas 02.05.04-13 South Texas 02.05.04-21 Summer 02.05.04-28 Vogtle 02.05.04-02 Vogtle 02.05.04-04	Provide details on the settlement model/calculation. Provide settlement information on non-Cat I buildings. Discuss sensitivity of settlement model. Provide settlement results. Describe settlement monitoring program. Discuss actions if settlement or tilt exceeds DCD requirements.	A very detailed settlement model was performed for the CCNPP 3 site. This model and results are discussed in Section 2.5.4.10.2. The model included the Seismic Category I structures as well as the proximate non-Category I structures so that their influence on the Category I was included in the model. The Category II-SSE Fire Protection building was not modeled. Estimated tilt in the NI and the ESWB exceeds the U.S. EPR FSAR criteria of ½ in per 50 ft. A settlement monitoring program will be established as part of construction. FSAR Section 3.8 will discuss the effect of the tilt on the structures.

Core Topic Industry Questions	Representative Issues	CCNPP FSAR Section and information
Slope Stability of Excavation slopes		
Bellefonte 02.05.04-11 Bellefonte 02.05.04-12 South Texas 02.05.04-02	Describe excavation slope stability analysis or controls.	Stability of the temporary excavation slopes is briefly described in Section 2.5.4.2. Excavation slopes will be established at an inclination of not more than 2:1 (horizontal: vertical) with a factor of safety of 1.3 or greater for static conditions.
Slope Stability of Permanent Slopes		
Grand Gulf 02.05.05-01 Grand Gulf 02.05.05-03 North Anna 02.05.05-02 North Anna 02.05.05-03	Describe you slope stability model and inputs. Discuss lateral stability of plant from stability of cliff failure. Use more than one methodology for the analysis. Address dynamic effects, not just static. Describe/defend any assumptions	Slope stability modeling is discussed in Section 2.5.5. Slope stability was analyzed with SLOPE/W. Three modeling methods were used. Results are provided in Table 2.5-72. Slopes have factors of safety greater than 1.5 for static and dynamic conditions.
Uniformity of Site		
Bellefonte 02.05.04-20 Harris 02.05.04-06 Summer 02.05.04-03	Discuss the uniformity or lack thereof of the substrata under the site.	Uniformity is discussed in Section 2.5.4.10.3. The site is uniform.

Enclosure 3

Additional Laboratory Analyses:

Structural Fill Static Laboratory Testing Results, Rev. 1 Mactec, June 17, 2009.

Structural Fill Dynamic Laboratory Testing Results, Rev. 1 Mactec, June 30, 2009.

Intake Samples Laboratory Test Data Report, Mactec, June 29, 2009.

Attachment 3A

MACTEC

Engineering and constructing a better tomorrow

June 17, 2009

Mr. Harry Manolopoulos
Project Procurement Specialist
Bechtel Power Corporation
5275 Westview Drive
Frederick, Maryland 21703

Subject: **Structural Fill Static Laboratory Testing Results, Rev. 1**
Calvert Cliffs Nuclear Power Plant Unit 3
Bechtel Job No. 25237
Bechtel Purchase Order No. 25237-103-P0A-CY05-00001
MACTEC Project Number 6234-08-4783

Dear Mr. Manolopoulos:

MACTEC Engineering and Consulting, Inc. (MACTEC) has provided laboratory testing services for the above-referenced project. The testing was done as requested by Bechtel and includes classification, index property, consolidation, permeability, and strength testing of proposed structural fill materials. The tested materials included Graded Aggregate Base (GAB), Crusher Run Aggregate (CR6), and Coarse Aggregate Underdrain 57 (57), as identified on Attachment 3 of Purchase Order No. 25237-103-POA-CY05-00001.

To date, a total of four batches of samples have been tested. Each batch is identified below:

- Batch 1: Six buckets of each material sent to MACTEC from Vulcan Quarry representatives on September 23, 2008; Testing performed on unblended samples
- Composite(2nd Batch): Same six buckets as Batch 1; Testing performed on blended samples
- Composite(3rd Batch): Eight buckets of CR6, eight buckets of GAB, and six buckets of 57 sampled by MACTEC from the Vulcan Quarry in Havre de Grace, Maryland on December 9, 2008. Laboratory testing performed by MACTEC and TestAmerica on Composite(3rd Batch).
- Composite(4th Batch): Seventeen buckets of each material type sampled by MACTEC from the Vulcan Quarry in Havre de Grace, Maryland on March 19 and 20, 2009. Laboratory testing performed by Fugro Consultants, Inc. (Fugro) on Composite(4th Batch).

The results of the laboratory testing of composite(3rd batch) and composite(4th batch) are presented on the attached sheets for your review. This laboratory data report consists of the following:

- Cover letter dated June 16, 2009,
- Summary sheet of selected geotechnical properties (Table 1: Laboratory Test Summary (Structural Fill), Rev. 4),
- Attachment 1, consisting of a laboratory test report and results from testing performed by MACTEC and TestAmerica, and
- Attachment 2, consisting of a laboratory test report and results from testing performed by Fugro Consultants, Inc.

Each attachment presents a description of the materials tested, the testing performed, and the results of each test (including deviations, as encountered). The attachments also provide information regarding the material sampling dates.

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

74 Pages DCN: CALV-192, Rev 1

We have enjoyed assisting you on this phase of the project and look forward to continuing to serve as your geotechnical and laboratory testing consultant on the remainder of this project.

Very truly yours,
MACTEC ENGINEERING AND CONSULTING, INC.

Steven E. Kiser	Clay E. Sams	Michael O. Hamlett
Project Manager	Senior Principal	Laboratory Principal

Project Name: Calvert Cliffs Nuclear Power Plant Unit 3

MACTEC Project Number: 6234-08-4783

Bechtel Project No. 25237

Bechtel Purchase Order No. 25237-103-P0A-CY05-00001

Table I: Laboratory Test Summary (Structural Fill) Rev. 4

Material	Sample Type	USCS Sample Class. (D 2487)	Sieve Results (D 422)		Atterberg Limits (D 4318)			Chemical Tests			Natural Moisture Content (%)[l] (D 2216)	Organic Content (%) (D 2974)	Specific Gravity (D 854)	Moisture-Density Relationship (Corrected)		CBR Value (Soaked) (D 1883)				Resistivity (G 187)		Min/Max Density Test (ASTM D4253 / ASTM D4254)	Permeability (ASTM D2434)	Shear Strength				Consolidation (D 2435)
																									Test Type[g]	Effective[h]			
			Percent Passing No. 200	Percent Retained No. 4	LL	PL	PI	pH	Chloride (mg/kg)	Sulfate (mg/kg)				Dry Unit Wt. (PCF)	Optium Moisture (%)	Density (pcf)	Moisture (%)	0.1 inch (%)	0.2 inch (%)	Moisture (%)	Resistivity (ohms-cm)	Min Dry Unit Weight(pcf) Max Dry Unit Weight(pcf)	Hydraulic Conductivity (cm/sec)		ϕ' (deg) (k)	ϕ' (deg) (i)	ϕ' (deg) (j)	Apparent Maximum Past Stress (Casagrande) (ksf)
			Composite(3rd Batch)																			Composite(4th Batch)						
GAB	Bulk	GP-GM	7.2	58.1	NV	NP	NP	8.3	<2.1[a]	446	3.0, 3.9, 3.1, 4.2, 3.6, 3.0	0.05	2.82	148.6[d1] 148.5[d]	5.7[d1] 6.5[d]	136.9 136.7 137.4	6.4 4.4 8.4	58.0 70.5 38.9	75.2 61.2 48.6	0.0 4.4 6.4 8.4 19.3	7458000[b] 17628 8814 5085 2373	104.1 141.8	2.9E-02	CU CD	44.2 42.5	44.0 42.5	44.4 NI	(e)
CR6	Bulk	GP-GM	11.4	49.5	NV	NP	NP	8.5	2.2	204	3.7, 3.5, 3.7, 3.5, 3.3, 4.2	0.12	2.72	145.3[d1] 148.0[d]	6.0[d1] 6.0[d]	139.6 138.7 139.3	6.3 4.4 8.4	53.7 92.7 44.8	62.2 88.5 60.2	0.0 4.4 6.4 8.4 17.2	7458000[b] 15594 8136 5085 2915	104.4 143.7	2.7E-02	CU CD	44.0 43.5	44.3 43.0	44.4 NI	54
57	Bulk	GP	0.0	98.2	NV	NP	NP	9.0	<2.0[a]	29.4	0.5, 0.6, 0.5, 0.5, 0.4, 0.5	0.04	2.83	NT	NT	NT	NT	NT	NT	0.0 0.5 1.4 27.5	7458000[b] 508500 244080 15594	86.7 102.1 (88.2)[c] (103.3)[c]	1.0E+00	CU CU[g] CD	43.5 44.8 40.0	43.5 43.9 39.0	43.8 40.9 NI	(e)

Prepared By DAK 6-17-09 Checked By MA 6-17-09 Reviewed By CES 6-17-09

Legend: NV = Non Viscous
NP = Non Plastic
NI = Not Indicated
NT = Not Tested; Test not applicable to this material

Notes: Composite samples tested at MACTEC laboratory (classification, index, chemical, resistivity, compaction) were collected by MACTEC from Vulcan Quary on December 9, 2008. These samples are noted as Composite(3rd Batch)
Composite samples tested at Fugro laboratory (compaction, min/max density, permeability, strength, consolidation) were collected by MACTEC from Vulcan Quary on March 19 and 20, 2009. These samples are noted as Composite(4th Batch)

(a) Estimated result - Result is less than reporting limit of 2.1 mg/kg (GAB) and 2.0 mg/kg (57)
(b) Resistivity of 7458000 ohms-cm represents the maximum recordable reading of the resistivity meter (Nilsson Model 400)
(c) An additional minimum/maximum density test was performed on the 57 material.
(d1) Value determined by test run at MACTEC on sample from Composite(3rd Batch)
(d) Value determined by test run at Fugro on sample from Composite(4th Batch)
(e) The maximum strain generated was insufficent to define the virgin compression slope and the maximum past stress
(f) Remolded to approximately 95% of modified proctor (CR6, GAB) or 80% relative density (57)
(g) Remolded to approximately 100% relative density (57) and triaxial test run at one confining pressure at 150 psi, as requested by Bechtel
(h) Calculated from peak deviator stress
(i) Calculated from peak deviator stress method with $c' = 0$ and a limit of 15% axial strain
(j) Calculated from stress path method, $\tan \Theta = \sin \phi' \ (c' = 0)$
(k) Effective stress friction angles (ϕ') determined by best fit line tangent to the two lower confining stress circles, as requested by Bechtel
(l) Six moisture contents recorded for each material from Composite(3rd Batch); One bag sample was obtained for each bucket

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ATTACHMENT 1

LABORATORY DATA REPORT

GEOTECHNICAL PROPERTIES TESTING PROGRAM FOR STRUCTURAL FILL

CALVERT CLIFFS NUCLEAR POWER PLANT UNIT 3
BECHTEL JOB NO. 25237

MACTEC PROJECT NO. 6234-08-4783

REPORT DATED JUNE 17, 2009, Rev. 1

Prepared By: B J Kerr Date: 6-17-09

Checked By: [illegible] Date: 6-17-09

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

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Section 1
Introduction

General:
This report presents the results of the index and compaction testing program performed by the Charlotte office of MACTEC Engineering and Consulting, Inc. and the results of the chemical properties testing program performed by Test America for MACTEC Project Number 6234-08-4783. These tests were conducted on samples collected by MACTEC representatives (Mr. Steve Kiser and Mr. David Kopitsky) from the Vulcan Quarry in Havre de Grace, Maryland on December 9, 2008. The materials (composite 3rd batch) included eight buckets of GAB, eight buckets of CR6, and six buckets of 57, shipped to the MACTEC Charlotte laboratory.

Subsequent sampling was also performed by MACTEC personnel (Mr. Hunter Hicks and Mr. David Kopitsky) from the Vulcan Quarry in Havre de Grace, Maryland on March 19 and 20, 2009. The material sampled on March 19 and 20, 2009 consisted of 17 buckets of GAB, 17 buckets of CR6, and 17 buckets of 57. This material (composite 4th batch) was transported to Fugro Consultants, Inc. in Houston, Texas, and testing was performed at this laboratory (see Attachment 2 for these results).

Report Format:
This report is organized into four (4) main sections. Section 1 provides introductory information, describes the scope of the testing program, and highlights specific test procedures. Sections 2 through 4 addresses points relevant to the testing done and presents results from individual test types in tabular and graphical forms (if applicable).

- Section 1 – Introduction
- Section 2 – Index Testing
- Section 3 – Chemical Properties
- Section 4 – Compaction Tests

Purpose and Scope of Testing Program:
The purpose of this laboratory testing program is to determine physical properties of materials for potential use as structural fill. Purpose and scopes of the individual test types are as follows:

- To determine index properties and grain size distribution of samples
- To determine chemical characteristics of samples
- To determine compaction characteristics of samples

The following number and type of index and engineering property tests were performed as part of this scope of work.

- Three (3) grain size analysis tests
- Three (3) atterberg limits tests
- Three (3) pH tests
- Three (3) chloride tests
- Three (3) sulfate tests
- Eighteen (18) natural moisture tests (6 bag samples for each sample type; GAB, CR6, 57)

- Three (3) organic content tests
- Three (3) specific gravity tests
- Two (2) modified proctor tests
- Two (2) CBR tests
- Fourteen (14) resistivity tests (at 5 moisture contents for GAB and CR6, and at 4 moisture contents for 57

Test Procedures:
Tests were performed in accordance with the standards and procedures provided in work instructions for each test assigned as summarized in the following sections.

Sample Processing and Test Assignment Process:
The samples collected by MACTEC were shipped in five gallon buckets. Each sample (CR6, GAB, 57) was then individually blended in accordance with ASTM C702 as instructed by work instructions.

Index and Physical Properties Tests:
Moisture content, grain size analysis, Atterberg limits, organic content, specific gravity, and resistivity testing was performed on the blended samples in accordance with the assigned work instructions. The ASTM test methods specified in the work instructions are summarized below.

- Moisture Content – ASTM D2216-05
- Grain Size Analysis – ASTM D422-63(2007)e1 and ASTM D6913-04e1
- Atterberg Limits – ASTM D4318-05
- Organic Content – ASTM D2974-07
  - The organic content test for the 57 material was performed as described in ASTM D2974-07, after crushing of the larger particles in the material. The purpose of the crushing was for safety precautions to minimize the possibility of particle explosion when exposed to the high temperatures required for the organic content test.
- Specific Gravity – ASTM D854-06
- Resistivity – ASTM G187-05
  - The resistivity testing was performed at various moisture contents, as requested. The testing was performed on the following prepared samples:
    - CR6 and GAB
      - Oven dried samples (zero moisture)
      - Samples at approximately -2% of the optimum moisture (determined by modified Proctor tests)
      - Samples at approximately +2% of the optimum moisture (determined by modified Proctor tests)
      - Samples at approximately optimum moisture (determined by modified Proctor tests),
      - Saturated samples
    - 57
      - Oven dried sample (zero moisture)

6

- Sample at approximately saturated surface dry condition
- Sample with surface moisture (saturated, after draining of free water)
- Saturated sample

Chemical Properties:
Chemical testing including pH, chloride, and sulfate tests were performed on the blended samples by Test America in accordance with assigned work instructions.

- Chloride - EPA Method SW-846 9056/300.0
- Sulfate - EPA Method SW-846 8056/300.0
- pH - EPA Method SW-846 9045

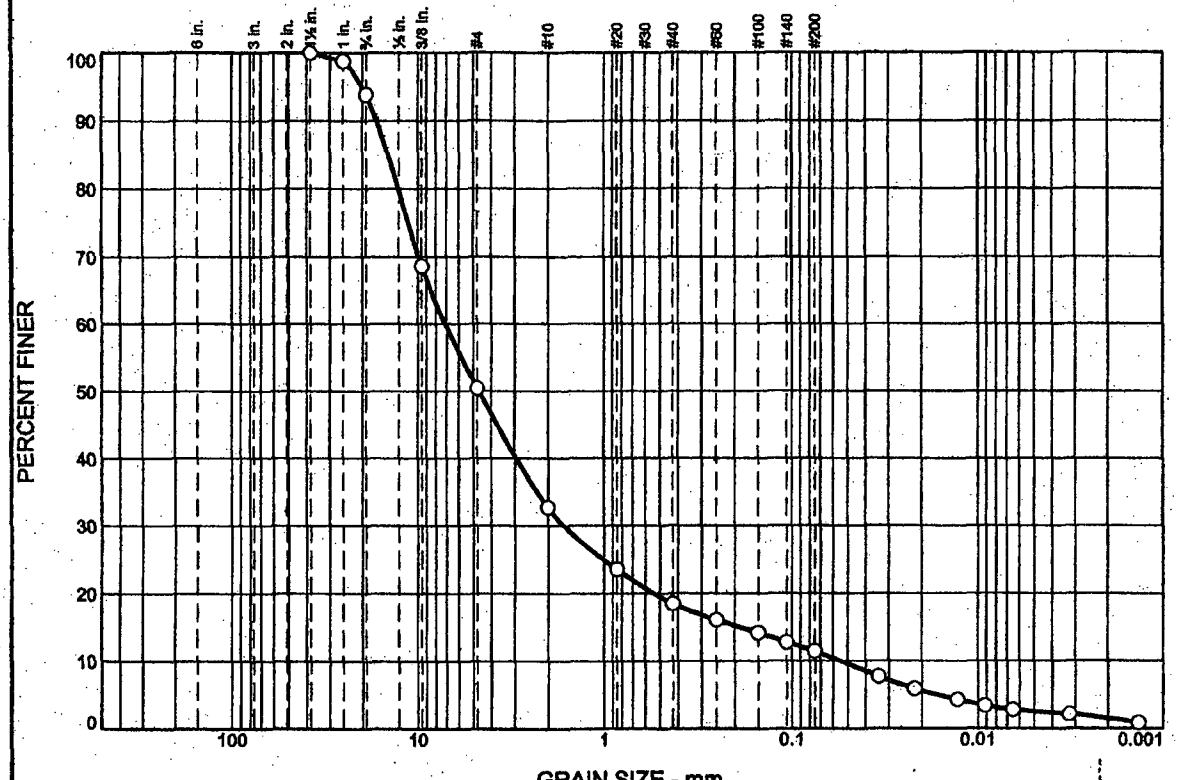
Compaction Tests:
Modified proctor and CBR tests were performed on the blended samples in accordance with the assigned work instructions. The ASTM test methods specified in the work instructions are summarized below.

- Modified Proctor – ASTM D1557-07
  - The modified Proctor tests were performed on CR6 and GAB material after removing particles larger than ¾ inches in diameter, as specified by ASTM D1557-07. Modified Proctor testing of the 57 stone was not performed since the test is not applicable to material with this gradation. The Proctor results are presented with the uncorrected and corrected (for particle size) results.
- CBR Tests – ASTM D1883-07
  - The CBR tests were performed on CR6 and GAB material after removing particles larger than ¾ inches in diameter and at various moisture contents, as requested. CBR testing of the 57 stone was not performed since the test is not applicable to material with this gradation. The testing was performed on the following prepared samples of GAB and CR6:
    - Samples at approximately -2% of the optimum moisture (determined by modified Proctor tests)
    - Samples at approximately +2% of the optimum moisture (determined by modified Proctor tests)
    - Samples at approximately optimum moisture (determined by modified Proctor tests),

Section 2
Index Testing

This section of the report presents the results of the three (3) grain size analysis tests, three (3) Atterberg limits tests, eighteen (18) moisture contest tests, three (3) organic content tests, three (3) specific gravity tests, and fourteen (14) resistivity tests performed for this project. Applicable charts and graphs are presented on the following pages.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.2	43.3	17.8	14.2	7.1	8.9	2.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5in.	100.0		
1in.	98.8		
3/4in.	93.8		
3/8in.	68.6		
#4	50.5		
#10	32.7		
#20	23.5		
#40	18.5		
#60	16.1		
#100	14.1		
#140	12.7		
#200	11.4		

* (no specification provided)

Material Description

Poorly Graded Gravel With Silt and Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 14.5538 D_{60}= 7.1532 D_{50}= 4.6443
D_{30}= 1.6553 D_{15}= 0.1889 D_{10}= 0.0547
C_u= 130.77 C_c= 7.00

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

ASTM D422-63 (2007)
ASTM D4318-05

Sample Number: Composite(3rd Batch) **Depth:** Not Indicated
Location: CR6 Composite(3rd Batch) **Date:** 1-26-09

MACTEC Engineering and Consulting, Inc.

Charlotte, North Carolina

Client: Bechtel Power Corporation
Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL
Project No: 6234084783 **Figure** MA 6-17-09

Tested By: D Kopitsky DAK **Checked By:** D Pryor DWP

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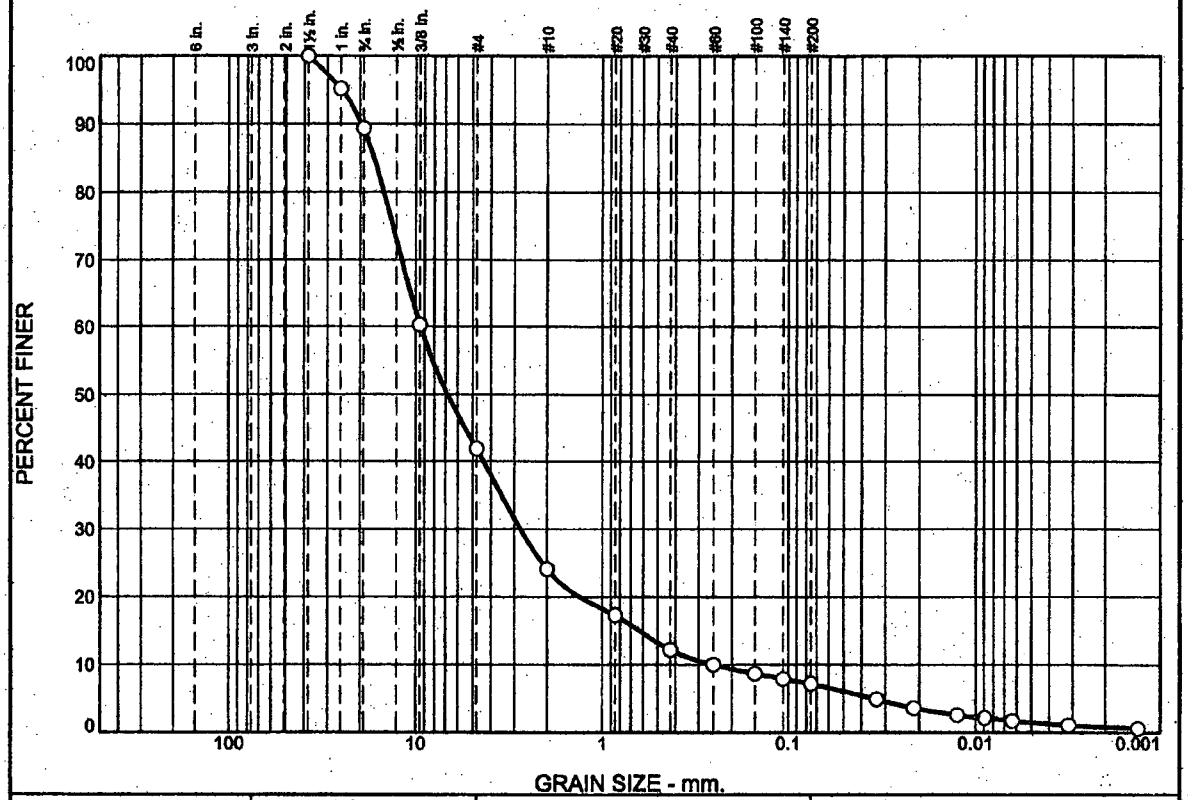
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	10.7	47.4	17.9	11.9	4.9	5.8	1.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5in.	100.0		
1in.	95.1		
3/4in.	89.3		
3/8in.	60.3		
#4	41.9		
#10	24.0		
#20	17.3		
#40	12.1		
#60	10.0		
#100	8.6		
#140	7.9		
#200	7.2		

* (no specification provided)

Material Description

Poorly Graded Gravel with Silt and Sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 16.7829 D_{60}= 9.4546 D_{50}= 6.8262
D_{30}= 2.7909 D_{15}= 0.6280 D_{10}= 0.2507
C_u= 37.72 C_c= 3.29

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

ASTM D422-63 (2007)
ASTM D4318-05

Sample Number: Composite(3rd Batch) **Depth:** Not Indicated
Location: GAB Composite(3rd Batch) **Date:** 1-26-09

MACTEC Engineering and Consulting, Inc.

Charlotte, North Carolina

Client: Bechtel Power Corporation
Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL

Project No: 6234084783 **Figure** 6-17-09

Tested By: D Kopitsky DMK **Checked By:** D Pryor DWP

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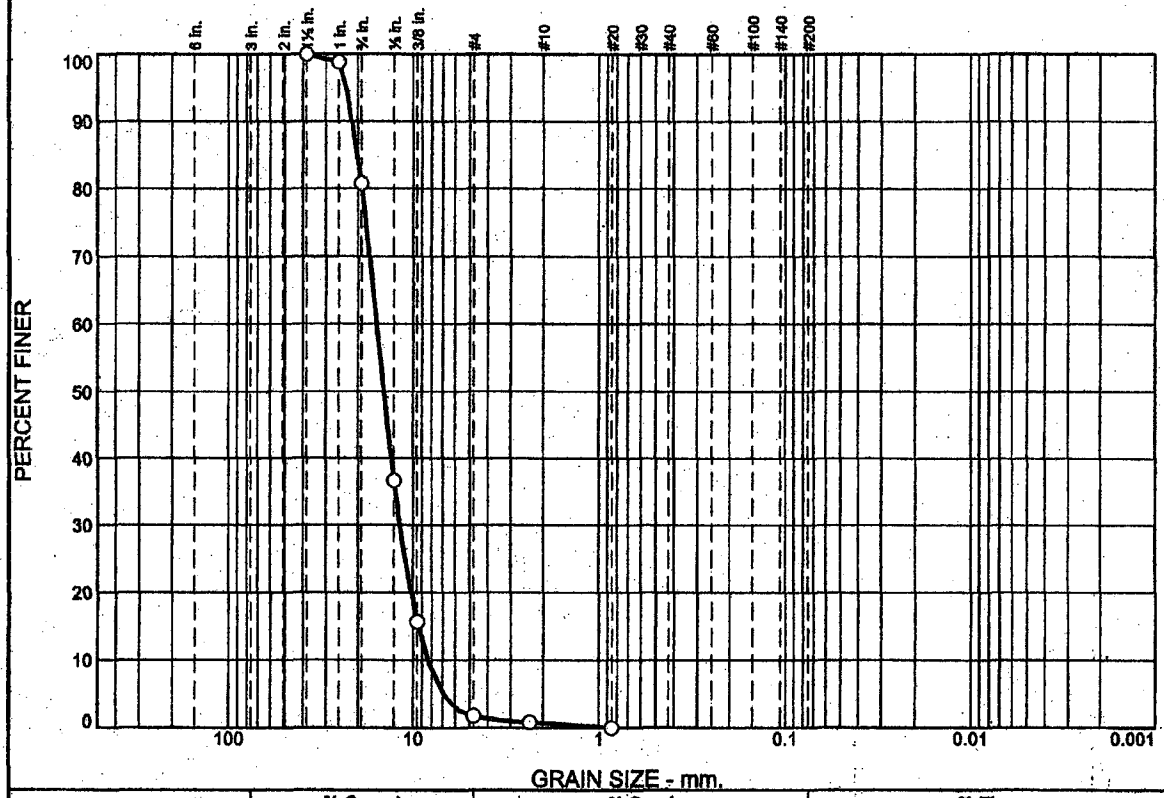
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.3	78.9	1.1	0.7	0.0	0.0	0.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5in.	100.0		
1in.	98.8		
3/4in.	80.7		
1/2in.	36.7		
3/8in.	15.6		
#4	1.8		
#8	0.8		
#20	0.0		

* (no specification provided)

Material Description

Poorly Graded Gravel

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{85}= 19.9917 D_{60}= 15.6996 D_{50}= 14.3909
D_{30}= 11.8025 D_{15}= 9.4167 D_{10}= 8.3777
C_u= 1.87 C_c= 1.06

Classification

USCS= GP AASHTO= A-1-a

Remarks

ASTM D6913-04
ASTM D4318-05

Sample Number: Composite(3rd Batch) **Depth:** Not Indicated
Location: 57 Composite(3rd Batch) **Date:** 1-22-09

MACTEC Engineering and Consulting, Inc.

Charlotte, North Carolina

Client: Bechtel Power Corporation
Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL
Project No: 6234084783 **Figure** A 6-12.a1

Tested By: D Pryor DWP **Checked By:** D Kopitsky DAK

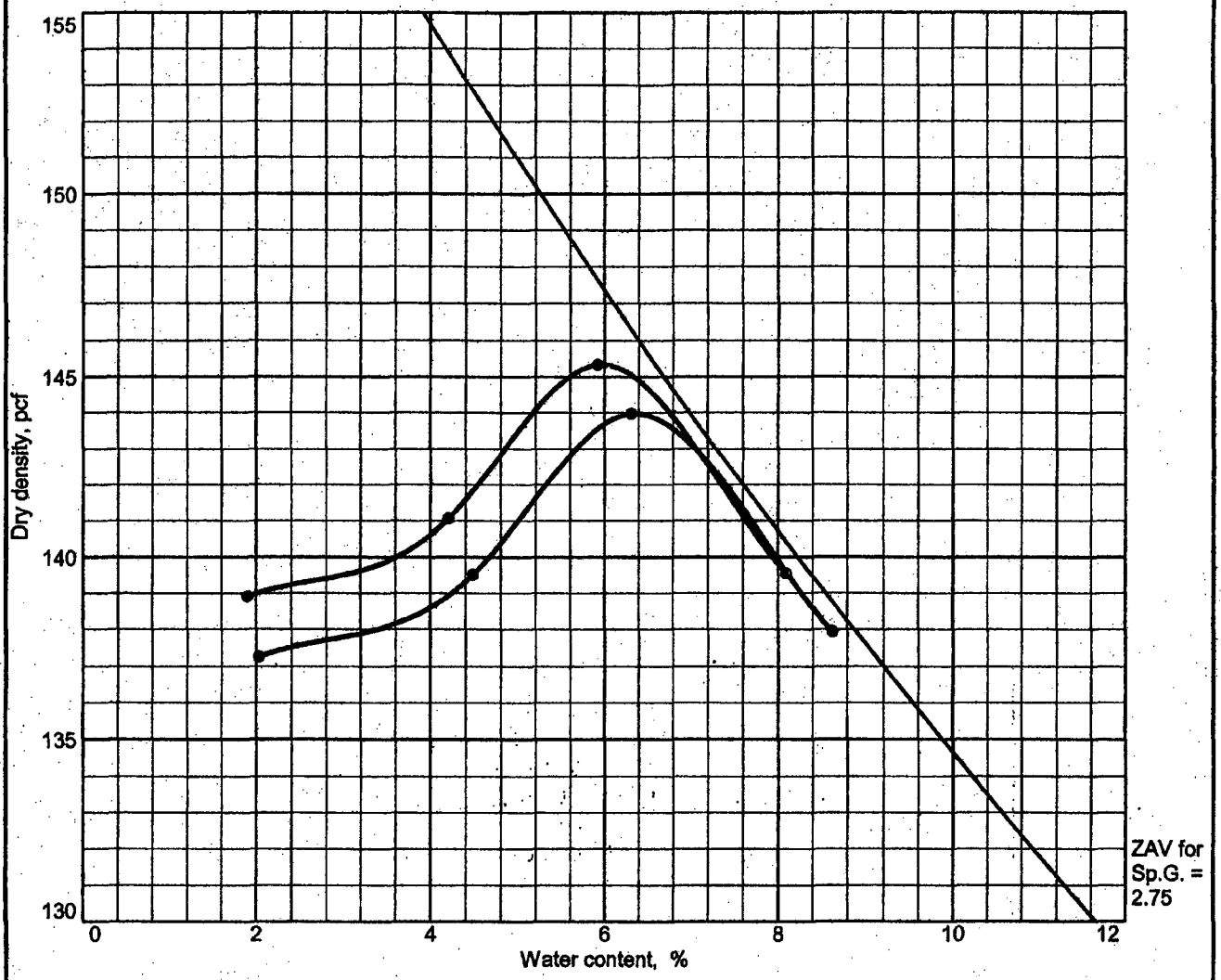
Section 3
Chemical Properties

The results of the three (3) pH tests, three (3) chloride tests, and three (3) sulfate tests performed for this project can be found in the summary table (Table 1: Laboratory Test Summary (Structural Fill), Rev. 4).

Section 4
Compaction Tests

This section of the report presents the results of the two (2) modified proctor tests and two (2) CBR tests (at multiple moisture contents) performed for this project. Applicable charts and graphs are presented on the following pages.

COMPACTION TEST REPORT



Test specification: ASTM D 1557-07 Method C Modified
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
Not Indicated	GP-GM	A-1-a	ND	2.72	NV	NP	6.2	11.4

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 145.3 pcf	144.0 pcf	Poorly Graded Gravel With Silt and Sand
Optimum moisture = 6.0 %	6.4 %	

Project No. 6234084783 **Client:** Bechtel Power Corporation
Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL

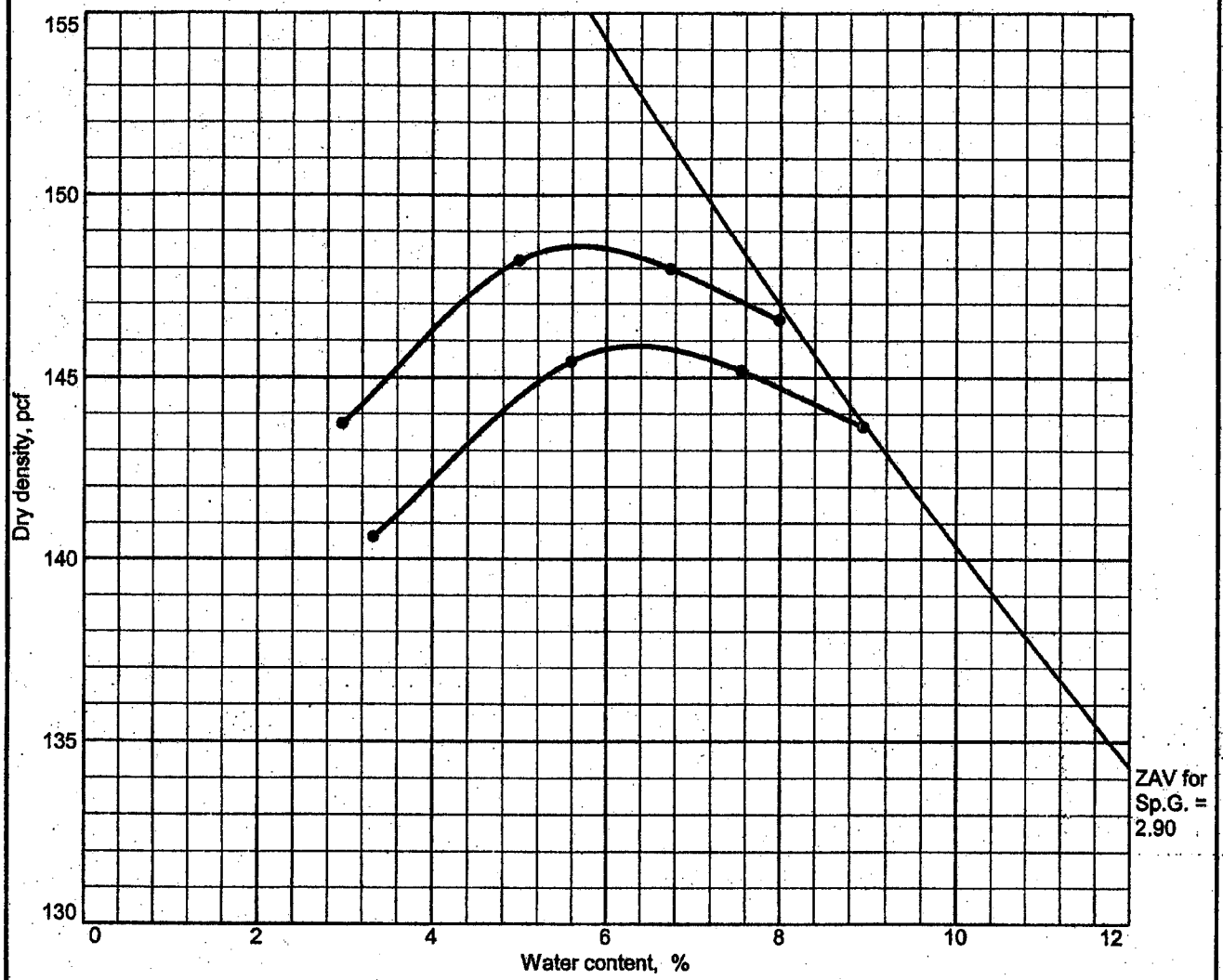
● **Location:** CR6 Composite(3rd Batch)

MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

Remarks:
Prepared by: DWP
Checked by: DAK
Sp.G. for ZAV line is a reporting function and not a measured value.

Figure AA 6-17-09

COMPACTION TEST REPORT



Test specification: ASTM D 1557-07 Method C Modified
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
Not Indicated	GP-GM	A-1-a	ND	2.82	NV	NP	10.7	7.2

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 148.6 pcf	145.9 pcf	Poorly Graded Gravel with Silt and Sand
Optimum moisture = 5.7 %	6.4 %	

Project No. 6234084783 **Client:** Bechtel Power Corporation
Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL

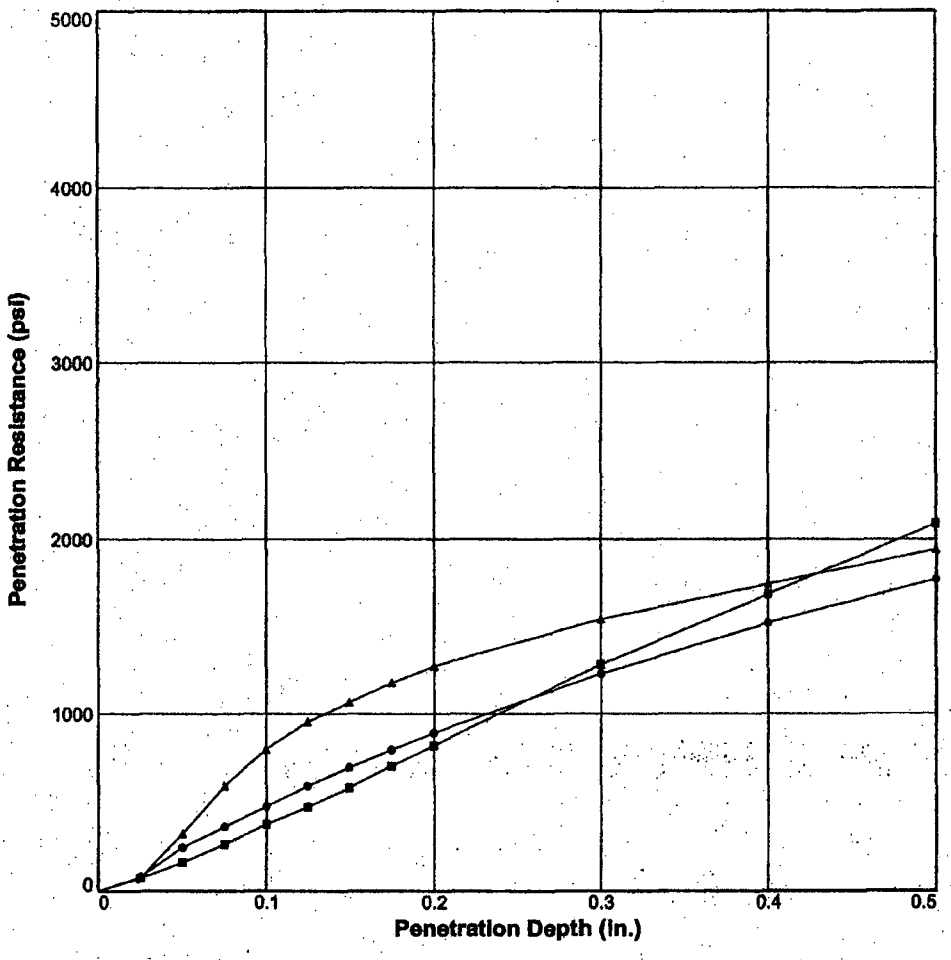
● **Location:** GAB Composite(3rd Batch)

MACTEC Engineering and Consulting, Inc.
Charlotte, North Carolina

Remarks:
Prepared by: DWP
Checked by: OAK
Sp.G. for ZAV line is a reporting function only and not a measured value.

Figure A 6-17-09

BEARING RATIO TEST REPORT
ASTM D 1883-05



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	136.9	94.2	6.3	136.9	94.2	7.4	53.7	62.2	0.013	10.0	0
2 ▲	136.7	94.1	4.4	136.7	94.1	7.4	92.7	88.5	0.021	10.0	0
3 ■	137.4	94.6	8.4	137.3	94.5	7.4	44.8	60.2	0.018	10.0	0

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Poorly Graded Gravel With Silt and Sand	GP-GM	145.3	6.0	NV	NP

Project No: 6234084783

Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL

Location: CR6 Composite(3rd Batch)

Sample Number: Composite(3rd Batch) **Depth:** Not Indicated

Date: 1-26-09

Test Description/Remarks:

Prepared by: JWD

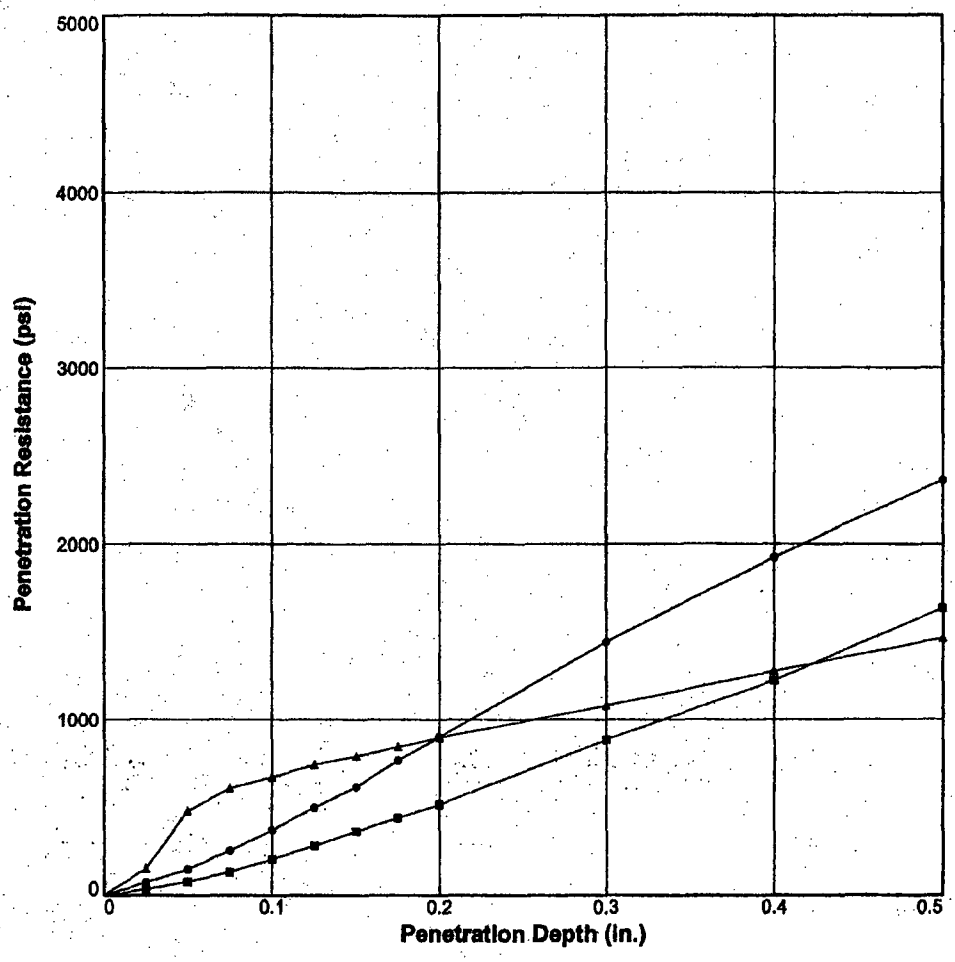
Checked by: DWP

BEARING RATIO TEST REPORT

MACTEC Engineering and Consulting, Inc.

Figure A-6-11-09

BEARING RATIO TEST REPORT
ASTM D 1883-05



	Molded			Soaked			CBR (%)		Linearity Correction (in.)	Surcharge (lbs.)	Max. Swell (%)
	Density (pcf)	Percent of Max. Dens.	Moisture (%)	Density (pcf)	Percent of Max. Dens.	Moisture (%)	0.10 in.	0.20 in.			
1 ●	139.6	93.9	6.4	139.6	93.9	6.7	58.0	75.2	0.042	10.0	0
2 ▲	138.7	93.3	4.4	138.7	93.3	6.8	70.5	61.2	0.012	10.0	0
3 ■	139.3	93.7	8.4	139.3	93.8	7.5	38.9	48.6	0.058	10.0	0

Material Description	USCS	Max. Dens. (pcf)	Optimum Moisture (%)	LL	PI
Poorly Graded Gravel with Silt and Sand	GP-GM	148.6	5.7	NV	NP

Project No: 6234084783

Project: Calvert Cliffs Nuclear Power Plant Unit 3 COL

Location: GAB Composite(3rd Batch)

Sample Number: Composite(3rd Batch) **Depth:** Not Indicated

Date: 1-26-09

Test Description/Remarks:

Prepared by: JMA

Checked by: DWP

BEARING RATIO TEST REPORT

MACTEC Engineering and Consulting, Inc.

Figure M 6-17-09

MACTEC

Engineering and constructing a better tomorrow

ATTACHMENT 2

LABORATORY DATA REPORT

GEOTECHNICAL PROPERTIES TESTING PROGRAM FOR STRUCTURAL FILL

CALVERT CLIFFS COL
BECHTEL JOB NO. 25237

REPORT PREPARED BY FUGRO CONSULTANTS, INC.
FUGRO REPORT NO. 0411-09-1734

REPORT DATED JUNE 15, 2009

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100 • Charlotte, NC 28208 • Phone: 704.357.8600

FUGRO CONSULTANTS, INC.

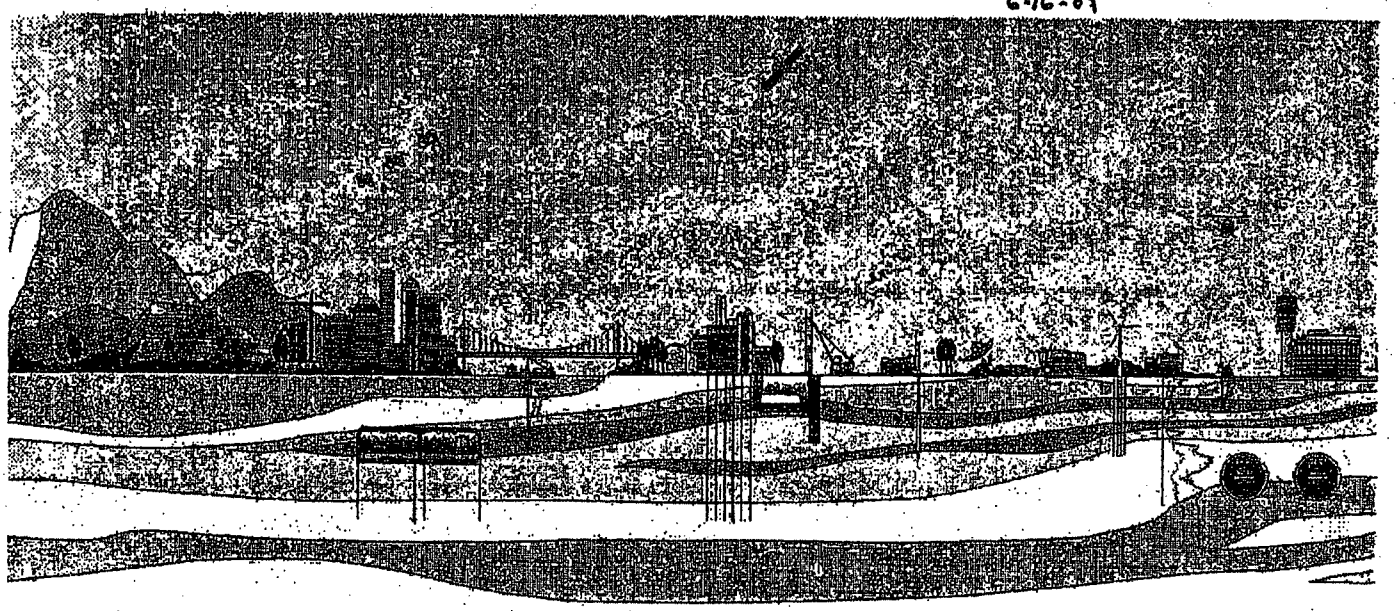
LABORATORY DATA REPORT
GEOTECHNICAL PROPERTIES TESTING PROGRAM FOR STRUCTURAL FILL
CALVERT CLIFFS COL

REPORT NO. 0411-09-1734

Client: MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100
Charlotte, NC 28208

Date of Report: June 15, 2009

Approved:
Michael O. Steen
6-16-09



FUGRO CONSULTANTS, INC.

6100 Hillcroft (77081)
P.O. Box 740010
Houston, Texas 77274
Tel: 713-369-5400
Fax: 713-369-5518

Report No. 0411-09-1734
Date: June 15, 2009

MACTEC Engineering and Consulting, Inc.
2801 Yorkmont Road, Suite 100
Charlotte, NC 28208

Attention: Mr. Steven Kiser, P.E.

Laboratory Data Report

Geotechnical Properties Testing Program for Structural Fill

Calvert Cliffs COL

The Houston Geotechnical Testing Laboratory of Fugro Consultants, Inc. is pleased to present the results of this geotechnical properties testing program for the above-referenced project. This report contains a summary of the procedures and results of the tests performed on soil samples provided by MACTEC Engineering and Consulting, Inc. (MACTEC). This report does not include any engineering analysis of the test results.

We appreciate this opportunity to be of continued service to MACTEC, Inc. We look forward to working with you in future projects.

Sincerely,

Fugro Consultants, LP

Thang Pham
Laboratory Professional

Maurice N. Morvant
Assistant Manager, Geotechnical Laboratory

SECTION 1

INTRODUCTION

General:

This report presents the results of a static geotechnical testing program performed by the Houston Geotechnical Testing Laboratory of Fugro Consultants, Inc. for MACTEC Engineering and Consulting, Inc (MACTEC) Project Number 6234-08-4783. The testing program was conducted on samples provided by MACTEC.

The selection of design parameters is beyond the scope of work. However, comments are provided relating to data trends.

Report Format:

This report is organized into five (5) main sections. This section provides introductory information, describes the scope of the testing program, and highlights specific test procedures. Sections 2 through 5 address key points relevant to individual test types and present results from individual test types in tabular and graphical forms (if applicable). The following presents the individual sections of this report:

- Section 1: Introduction.
- Section 2: Index and Compaction Characteristics
- Section 3: Permeability (Constant Head) Characteristics
- Section 4: One-Dimensional Consolidation Characteristics
- Section 5: Consolidated-Undrained and Drained Triaxial Tests

Purpose and Scope of Testing Program:

The purpose of this laboratory testing program is to determine physical and engineering properties of materials for potential use as structural fill. The three materials tested were a graded aggregate base (GAB), a crusher run (CR6), and AASHTO gradation 57 (#57). Purposes and Scopes of the individual test types are to determine engineering properties of selected materials as follows:

- Index properties and grain size distribution.
- Compaction characteristics.
- Compressibility characteristics.
- Hydraulic conductivity characteristics.
- Static shear strength and stress-strain characteristics of specimen compacted to specific density and moisture conditions under various loading conditions (undrained or drained) and stress levels.

The following number and type of index and engineering property tests were performed as part of the scope of work. The notations used for the various tests are described in the appendix.

- Six (6) grain size analysis tests.
- Two (2) modified proctor tests.
- Four (4) minimum/maximum (Min/Max) density tests.
- Three (3) constant head permeability tests.
- Three (3) one dimensional consolidation (INC) tests.
- Ten (10) static isotropically consolidated-undrained triaxial compression tests, with pore-water pressure (PWP) measurements and strain-controlled loading (CU Trx).
- Nine (9) static isotropically consolidated-drained triaxial compression tests, with volume change measurements and strain-controlled loading (CD Trx).

The following basic physical property determinations were performed in conjunction with each engineering property test specimen.

- Water Content
- Degree of Saturation
- Total Unit Weight

Test Procedures:

The table provided below chronologically lists the work instructions provided by MACTEC and summarizes the tests assigned in each work instruction.

MACTEC Work Instruction	Tests Assigned	Structural Fill Samples		
		CR6	GAB	#57
April 3, 2009 Rev. 04-21-09	MinMax, CU Trx			X
April 21, 2009 Rev. 0	Hyd/Sieve (blended)	X	X	X
April 21, 2009 Rev. 0	Modified Proctor (blended)	X	X	
May 1, 2009 Rev. 0	CU Trx	X	X	X
May 1, 2009 Rev. 1	MinMax	X	X	
May 12, 2009 Rev. 0	CD Trx	X	X	X
May 13, 2009 Rev. 1	INC	X	X	
May 29, 2009 Rev. 0	Permeability	X	X	X
June 2, 2009 Rev. 0	CU Trx			X

Sample Processing and Test Assignment Process - The samples provided by MACTEC were shipped in fifty-one (51) five-gallon buckets, each material having seventeen (17) buckets. A work instruction was assigned for blending and splitting of each of the three materials (CR6, GAB, and #57) in accordance with ASTM Test Method C702-98(2003) and MACTEC work instruction DCN: CALV-089.

Index and Physical Property Tests - Water content, grain size analyses, minimum/maximum density and modified Proctor tests were performed after blending. The ASTM test methods specified in the work instructions are summarized below.

- *Water Content* – ASTM Test Method D 2216-05 as part of performing assigned engineering properties tests. The samples were "scalped" over the ¾" sieve, as indicated in the assigning work instructions.
- *Grain Size Analysis* – ASTM Test Method D 6913-04e1 on blended specimens received "as is" and scalped over the ¾" sieve, in accordance with the relevant work instructions.
- *Minimum / Maximum Index Density* – ASTM Test Method D 4253-00 and ASTM Test Method D 4254-00 on specimens scalped over the ¾" sieve, in accordance with the relevant work instructions.
- *Modified Proctor* - ASTM Test Method D 1557-07 and ASTM Test Method D 4718-87(2007) on specimens scalped over the ¾" sieve, in accordance with the relevant work instructions.

Engineering Properties Tests – Each specimen tested for engineering properties (permeability, consolidation, and shear strength under isotropic confinement) was performed on blended material that was scalped over the ¾" sieve, in accordance with the relevant work instructions. Material was placed and compacted in lifts to produce a specimen of appropriate dimensions, density and moisture content. The approximate dimensions for each engineering property test performed are listed in the appropriate subsequent sections that provide additional test performance details. When required to achieve the required density, a Bosch Hammer Drill (model SDS Max) fitted with a specifically designed 5-¾" diameter circular steel face was used to compact the material to the target density. The CR6 and GAB specimens were compacted to approximately 95% of the uncorrected maximum dry unit weight at the corresponding approximate optimum moisture content. All but one of the #57 specimens were prepared to about 80% relative density. A single consolidated-undrained triaxial compression test at 150 psi confining pressure was performed on a specimen of #57 material compacted to 100% relative density.

Constant Head Permeability Tests – Each test was performed in accordance with the assigning work instruction that specified ASTM Test Method D 2434-68(2006) on a six-inch diameter specimen fitted with #200 sieve screens and reinforcing mesh to allow free flow of water without the loss of granular particles. Specimens tested were approximately four-inches tall. The results of these tests are presented in Section 3 of this report.

One Dimensional Consolidation Tests – Each test was performed in accordance with the assigning work instructions that specified ASTM Test Method D 2435-04. Specimens tested were four-inches tall by six-inches in diameter. Two tests were performed on the CR6 material. The first specimen was tested using a load frame that was limited to an applied vertical effective pressure of 50 ksf. The test was repeated to reach an applied effective vertical stress of 200 ksf. A test was also performed on the GAB material to a maximum vertical effective pressure of 50 ksf. The results of these tests are presented in Section 4 of this report.

Consolidated-Undrained Triaxial Tests - Each static isotropically consolidated-undrained triaxial test with loading/shearing in compression (CU Trx) was performed as a single specimen test. Each test was performed according to the relevant work instructions specifying ASTM Test Method D 4767-04. Each specimen (6 by 12 in.) had top and bottom drainage boundaries during consolidation. Specimen saturation was achieved by first flowing carbon dioxide, at very low pressure, through the base drainage lines into the specimen. Air was permitted to escape through top drainage lines during this process. Since carbon dioxide is heavier than ordinary air, the specimen void spaces not already filled with water are filled with carbon dioxide, which is more readily taken into solution during back-pressure saturation with water. The remaining back-pressure saturation, consolidation and shearing stages were performed in accordance with ASTM D 4767-04.

Consolidated-Drained Triaxial Tests - Each static isotropically consolidated-drained triaxial test with loading/shearing in compression (CD Trx) was performed as a single specimen test. Each test was performed according to the relevant work instructions specifying COE Test Method EM-1110-2-1906, Appendix X (30 Nov 70) "S Test Method". The CD Trx specimens were prepared, saturated and consolidated in the same manner as the CU Trx test specimens.

The results of the consolidated-undrained and consolidated-drained triaxial compression tests are presented in Section 5 of this report.

SECTION 2

INDEX AND COMPACTION CHARACTERISTICS

This section of the report presents the results of the six (6) grain size, two (2) modified Proctors, and four (4) minimum/maximum density tests performed for this project. Tables and graphs presenting select properties for each test are presented on Plates 2-1 through 2-5.

An additional minimum/maximum density test was performed on the #57 material to verify the first set of results. The results of the second are similar to the first.

Sample	Index and Compaction Properties:						
				ASTM D 1557 and ASTM D 4718			
				Uncorrected[1]		Corrected[2]	
	ASTM D 6913 Grain Size Analysis	ASTM D 4253 Minimum Dry Unit Wt. (pcf)	ASTM D 4254 Maximum Dry Unit Wt. (pcf)	Optimum Dry Unit Wt (pcf)	Optimum Moisture Content (%)	Optimum Dry Unit Wt (pcf)	Optimum Moisture Content (%)
CR6	See Plate 2-2	104.4	143.7	145.2	6.9	148.0	6.0
GAB	See Plate 2-3	104.1	141.8	146.3	7.1	148.5	6.5
#57	See Plate 2-4	86.7	102.1	--	--	--	--
#57 (ReTest)	--	88.2	103.3	--	--	--	--

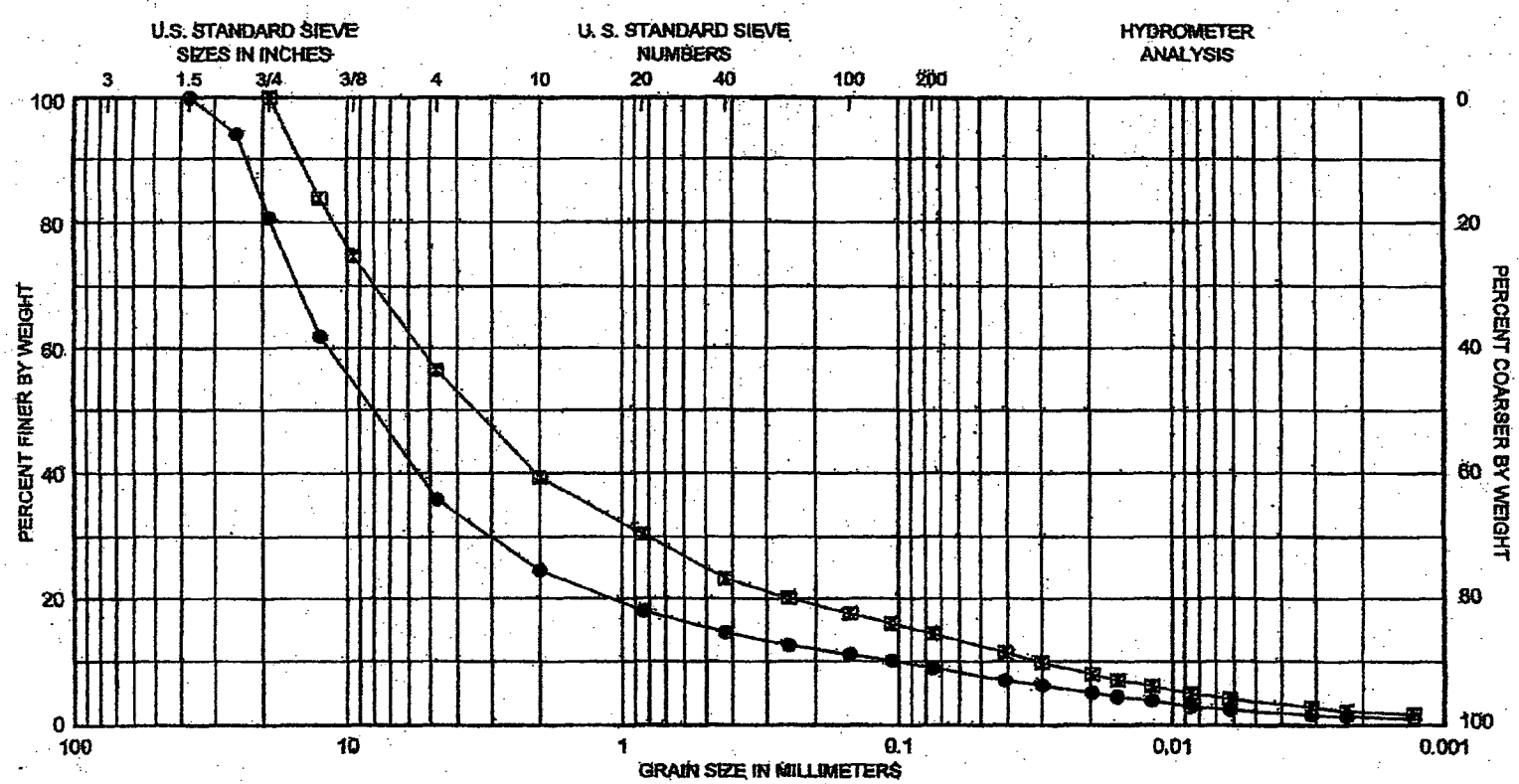
Note: (1) The uncorrected proctor results are based on the blended material scalped over the 3/4-in sieve.
(2) The corrected values have been adjusted, in accordance with ASTM D 4718, for the particles larger than the 3/4-in sieve.

SUMMARY OF INDEX PROPERTIES
Calvert Cliffs Structural Fill Testing
Samples CR6,GAB, and #57

Reviewed By: mnm

PLATE 2-1

26



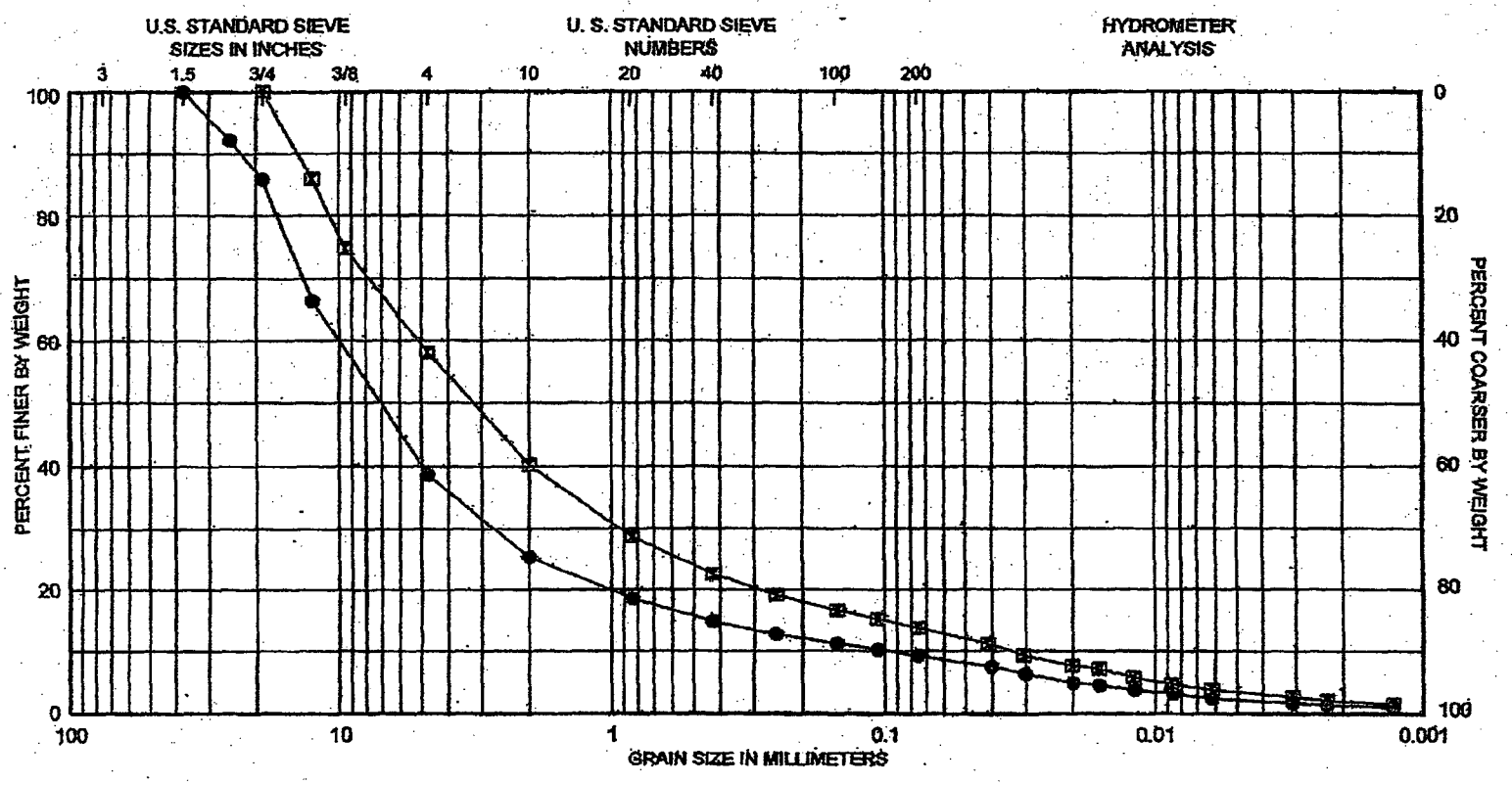
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	C_u	C_c	D_{30}	D_{50}	CLASSIFICATION
●	Blended CR6 as is	0	7.64	113.48	8.03	22.99	Sandy Gravel, greenish gray (GP-GM)
⊠	CR6 scalped by 3/4	0	3.81	174.45	3.43	14.69	Sandy Gravel, greenish gray (GP-GM)

GRAIN SIZE CURVE

PLATE 2-2

27



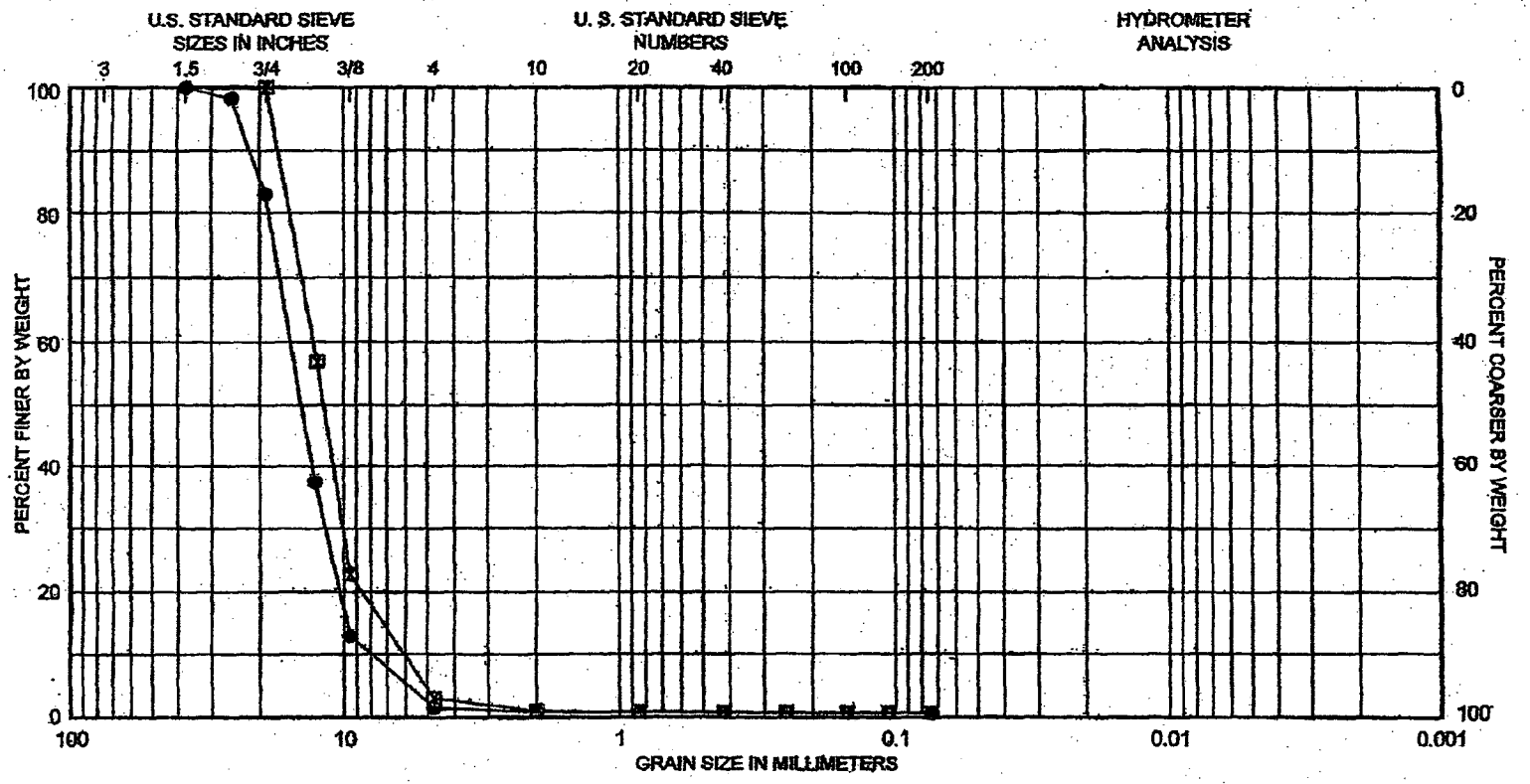
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	C_u	C_c	D_{60}	D_{30}	CLASSIFICATION
●	Blended GAB as is	0	7.42	102.15	7.06	22.75	Sandy Gravel, greenish gray (GP-GM)
⊠	GAB scalped by 3/4	0	4.87	150.82	3.21	14.13	Sandy Gravel, greenish gray (GP-GM)

GRAIN SIZE CURVE

PLATE 2-3

28



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	C_u	C_c	D_{30}	D_{60}	CLASSIFICATION
●	Blended #57 as is	0	1.09	1.95	14.22	21.77	Gravel, greenish gray and light gray (GP)
⊠	Blended #57 scalped by 3/4	0	1.80	2.12	11.82	17.24	Gravel, greenish gray and light gray (GP)

GRAIN SIZE CURVE

PLATE 2-4

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Fugro Consultants, Inc.
6100 Hillcroft, 77081
P.O. Box 740010
Houston, TX 77274
Phone: (713) 369-5500
Fax: (713) 369-5424

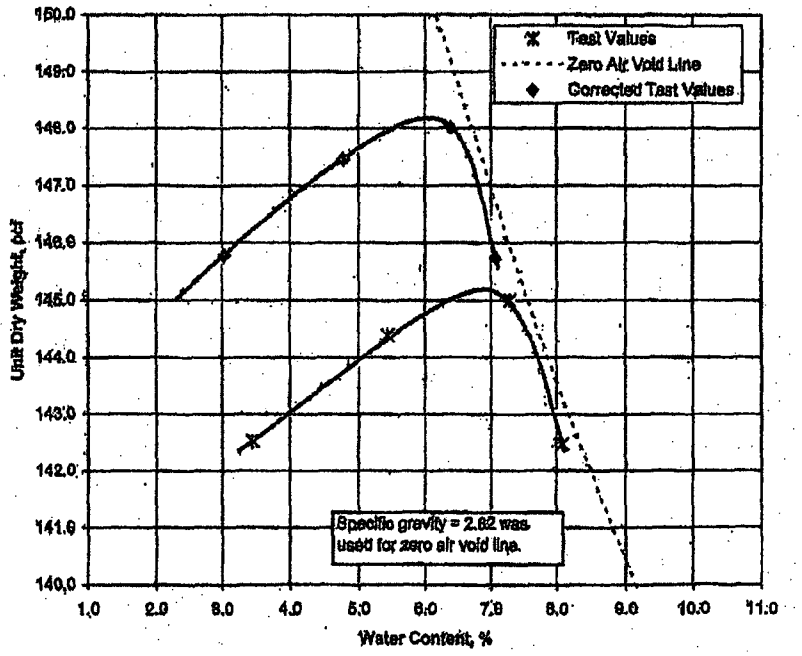
CMT Form S-003, Rev. 01/09

LABORATORY COMPACTION

Project:	Calvert Cliffs Nuclear Power Plant	Project No.:	0411-09-1734
		Test Date:	4/24/09
Client:	MACTEC Engineering and Consulting, Inc.	Report No.:	B
Contractor:	–		

Visual Classification:	Greenish Gray Sandy Gravel	Test Method:	ASTM D1557, Method C
Sample Source:	CR6, Blended	Rammer Type:	Mechanical
Supplier:	–	Prep. Method:	Wet

Test Results:	Uncorrected Value		Corrected Value		Properties:	
Maximum Dry Unit Weight:	145.2	pcf	146.0	pcf	Liquid Limit	ND
Optimum Water Content:	6.9	%	6.0	%	Plastic Limit	ND
Retained on ¾" Sieve:	12.6	%			Plasticity Index	ND
					Specific Gravity	2.72 (Measured [1])



Fugro Consultants, Inc.
Texas Engineering Firm Registration No. 299

Submitted By: Alissa A. Posey

Alissa A. Posey, Laboratory Manager

Note (1): Specific gravity value reported from MACTEC report, "Laboratory Test Summary (Backfill) Rev.2", dated 1/28/2009

Construction Materials
Certificate No. 0023-02

PLATE 2-5

Fugro Consultants, Inc.
6100 Hillcroft, 77081
P.O. Box 740010
Houston, TX 77274
Phone: (713) 369-5500
Fax: (713) 369-5424

CMT Form S-003, Rev. 01/09

LABORATORY COMPACTION

Project: Calvert Cliffs Nuclear Power Plant
Client: MACTEC Engineering and Consulting, Inc.
Contractor: –

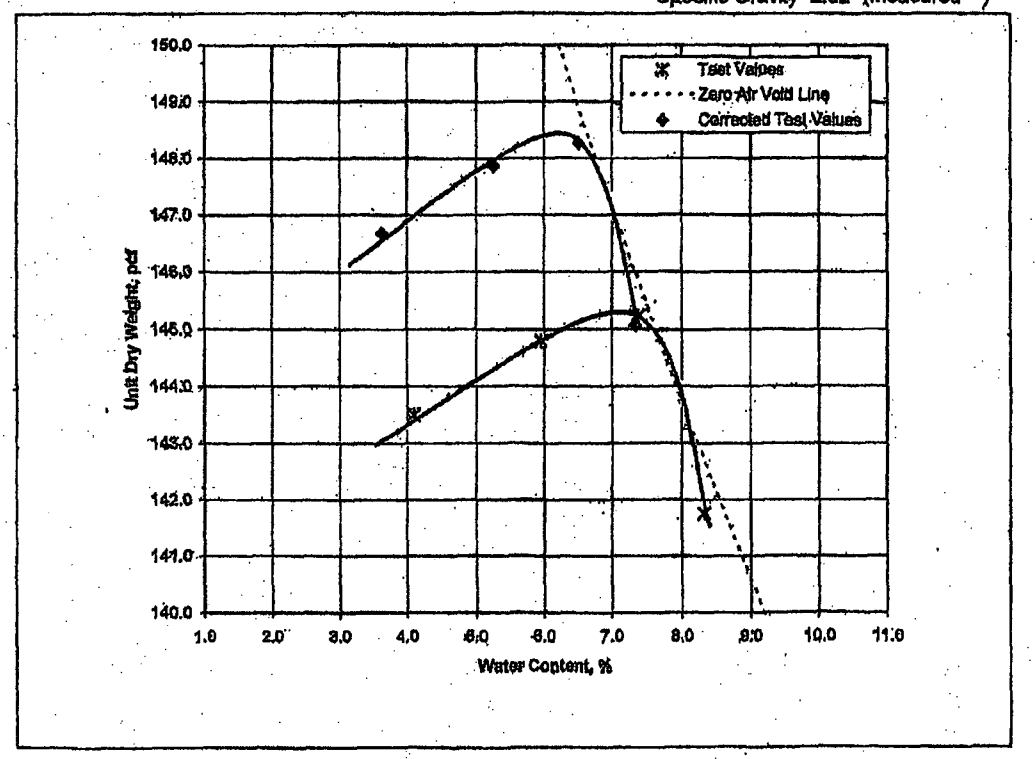
Project No.: 0411-09-1784
Test Date: 4/24/09
Report No.: A

Visual Classification: Greenish Gray Sandy Gravel
Sample Source: GAB, Blended
Supplier:

Test Method: ASTM D1557, Method C
Rammer Type: Mechanical
Prep. Method: Wet

Test Results:	Uncorrected Value		Corrected Value	
Maximum Dry Unit Weight:	145.3	pcf	148.5	pcf
Optimum Water Content:	7.1	%	6.5	%
Retained on ¾" Sieve:	12	%		

Properties:	
Liquid Limit	ND
Plastic Limit	ND
Plasticity Index	ND
Specific Gravity	2.82 (Measured [1])



Fugro Consultants, Inc.
Texas Engineering Firm Registration No. 299

Submitted By: Alissa A. Posey, Laboratory Manager

Note (1): Specific gravity value reported from MACTEC report, "Laboratory Test Summary (Backfill) Rev.2", dated 1/28/2009

Construction Materials
Certificate No. 0023-02

PLATE 2-6

31

DCN: CALV-192, Rev 1

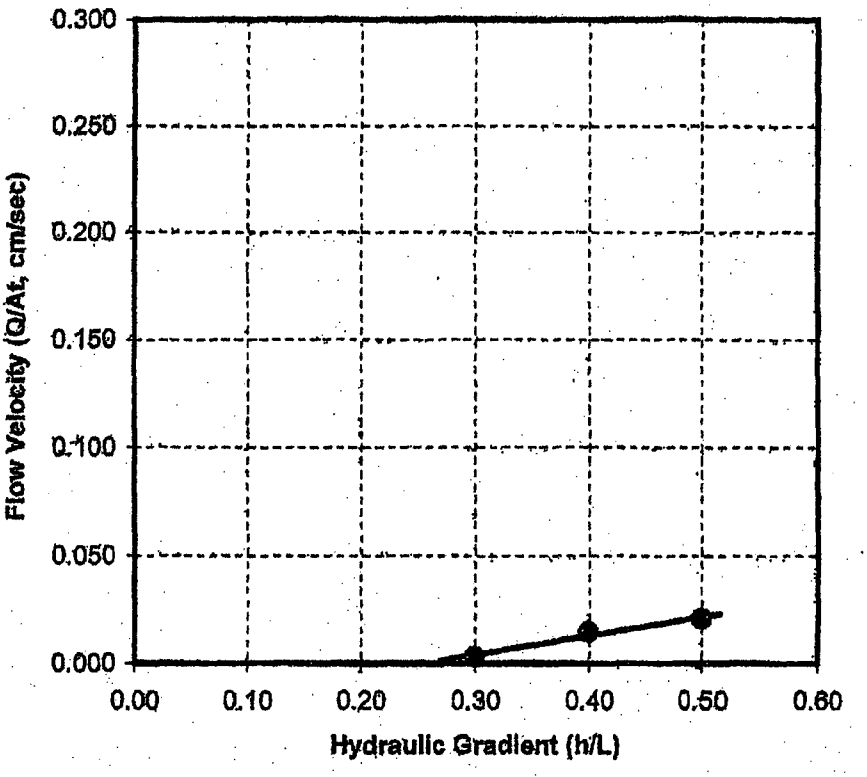
SECTION 3

PERMEABILITY (CONSTANT HEAD) CHARACTERISTICS

This section of the report presents the results of the three (3) constant head permeability tests performed for this project. Tables and graphs presenting select properties and hydraulic conductivity results for each test are presented on Plates 3-1 through 3-3.

The following observations were noted during testing:

- The CR6 and GAB specimens had fines contents of 14%, which is greater than the 10% maximum prescribed in ASTM D 2434-68(2006).
- It was noted that the discharge from the tests performed on the CR6 and the GAB turned cloudy, but still translucent, upon initiating flow through the specimen, and the discharge became clearer within the first few minutes. The discharge becoming clearer with time would suggest that most of the fines were flushed from the specimen at the initiation of flow, and subsequent permeability measurements were made on specimens absent of any appreciable amount of fines. It is not expected the absence or presence of the fines in these specimens would have a significant impact on the measured permeability values.
- The discharge from the #57 specimen became just slightly discolored at the initiation of flow and began to run clear almost immediately.



Summary of Constant Head Permeability Test Results

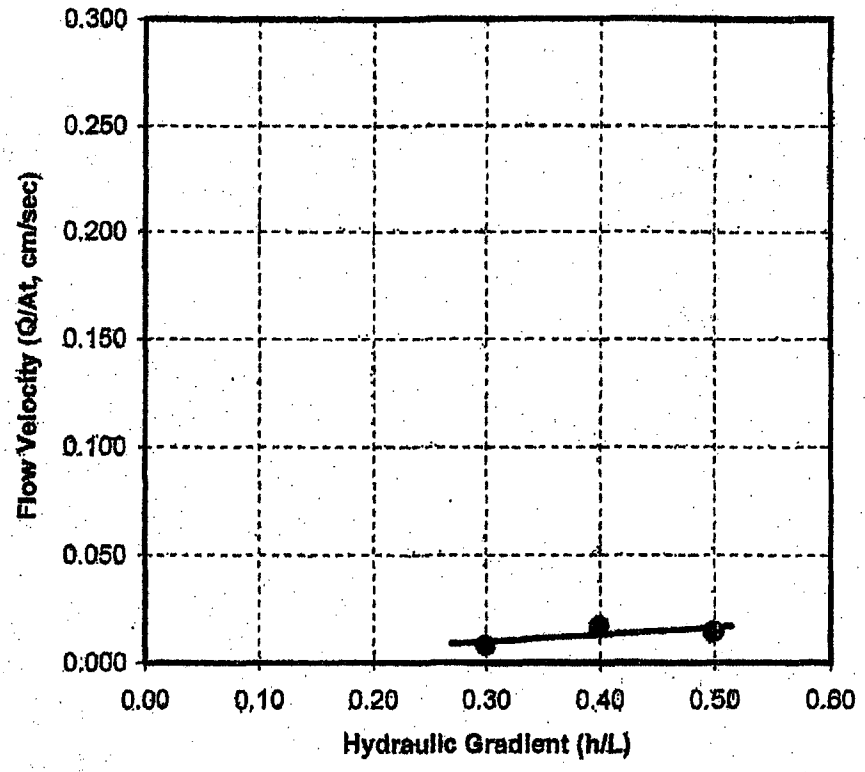
Hydraulic Gradient (h/L)	Flow Velocity (Q/At, cm/sec)	Permeability (K_T, cm/sec)	(K_{T20}, cm/sec)
0.30	3.16E-03	1.1E-02	9.4E-03
0.40	1.48E-02	3.7E-02	3.3E-02
0.50	2.11E-02	4.2E-02	3.8E-02
		Average	2.7E-02

Constant Head Permeability Test
Sample: CR6

Reviewed By: JSY JSY

PLATE 3-1

33



Summary of Constant Head Permeability Test Results

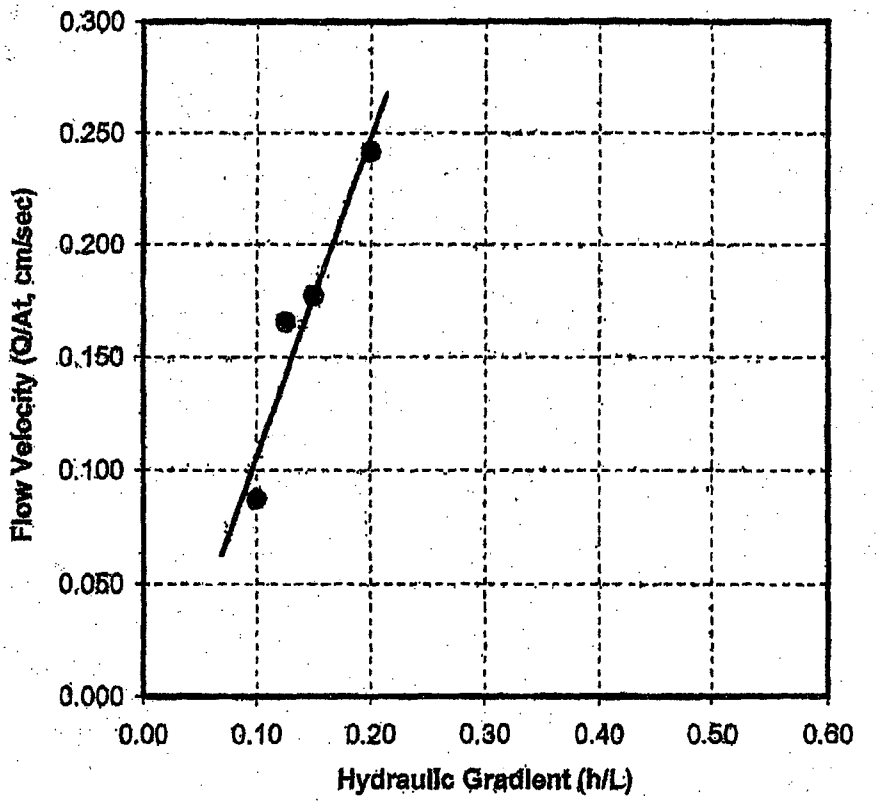
Hydraulic Gradient (h/L)	Flow Velocity (Q/At, cm/sec)	Permeability (K_T, cm/sec)	(K_{T20}, cm/sec)
0.30	7.99E-03	2.7E-02	2.3E-02
0.40	1.71E-02	4.3E-02	3.7E-02
0.50	1.47E-02	2.9E-02	2.5E-02
		Average	2.9E-02

Constant Head Permeability Test
Sample: GAB

Reviewed By: JSY JSY

PLATE 3-2

34



Summary of Constant Head Permeability Test Results

Hydraulic Gradient (h/L)	Flow Velocity (Q/At, cm/sec)	Permeability (K_T, cm/sec)	Permeability (K_{T20}, cm/sec)
0.100	8.76E-02	8.8E-01	7.9E-01
0.125	1.65E-01	1.3E+00	1.2E+00
0.150	1.77E-01	1.2E+00	1.1E+00
0.200	2.42E-01	1.2E+00	1.1E+00
		Average	1.0E+00

Constant Head Permeability Test
Sample: #57

Reviewed By: JSY JSY

PLATE 3-3

35

SECTION 4

ONE-DIMENSIONAL CONSOLIDATION CHARACTERISTICS

This section of the report presents the results of the three (3) one-dimensional consolidation tests performed for this project. Tables and graphs presenting results for each test are presented on Plates 4-1 through 4-4.

The following observations were noted during testing:

- These tests were performed using loading frames to apply the axial stress for consolidation. When reviewing the coefficient of consolidation (c_v) values, it should be recognized that it may take one to two seconds for the actuator to apply the next vertical stress. Free draining materials such as these may be able to consolidate faster than the equipment can apply the stress and the actual coefficient of consolidation, c_v, values may be faster than those determined from these tests.
- There is no "apparent" maximum past stress or yield stress reported for the two tests performed to a maximum vertical stress of 50 ksf. In both tests the maximum strain generated was only about 2.5%, an insufficient amount of strain to define the virgin compression slope required to determine the apparent maximum past stress.

Sample - Speciman No.	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Maximum Effective Vertical Stress Applied (ksf)	Strain at Maximum Vertical Stress Applied (%)	Apparent Maximum Past Stress (Casagrande) (ksf)	Apparent Maximum Past Stress (Becker) (ksf)
CR6 d	6.5	146.3	137.3	50	2.8	(1)	(1)
CR6 j	7.5	146.8	136.5	200	8.3	54	45
GAB -d	5.7	145.0	137.2	50	1.9	(1)	(1)

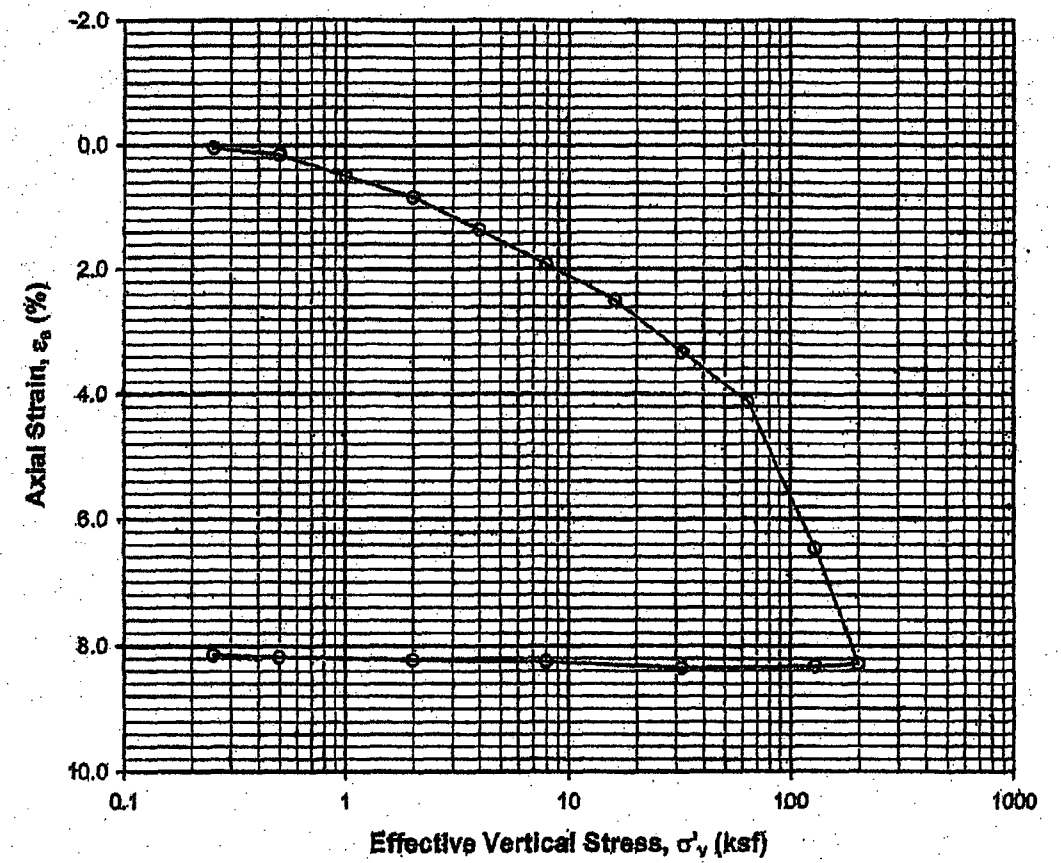
(1) The maximum strain generated was insufficient to define the virgin compression slope and determine the maximum past stress.

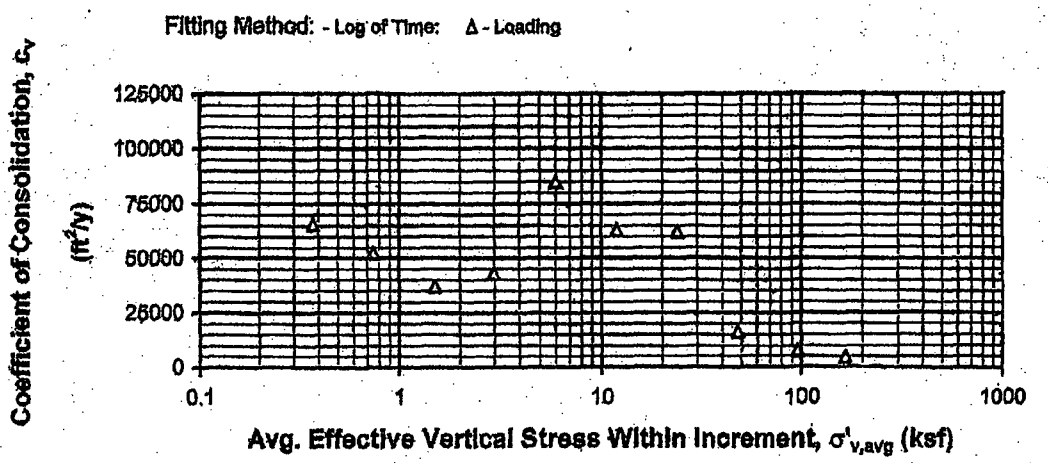
SUMMARY OF 1-D CONSOLIDATION TESTS
Calvert Cliffs Structural Fill Testing
Samples CR6 and GAB

Reviewed By: mhm

PLATE 4-1

37.

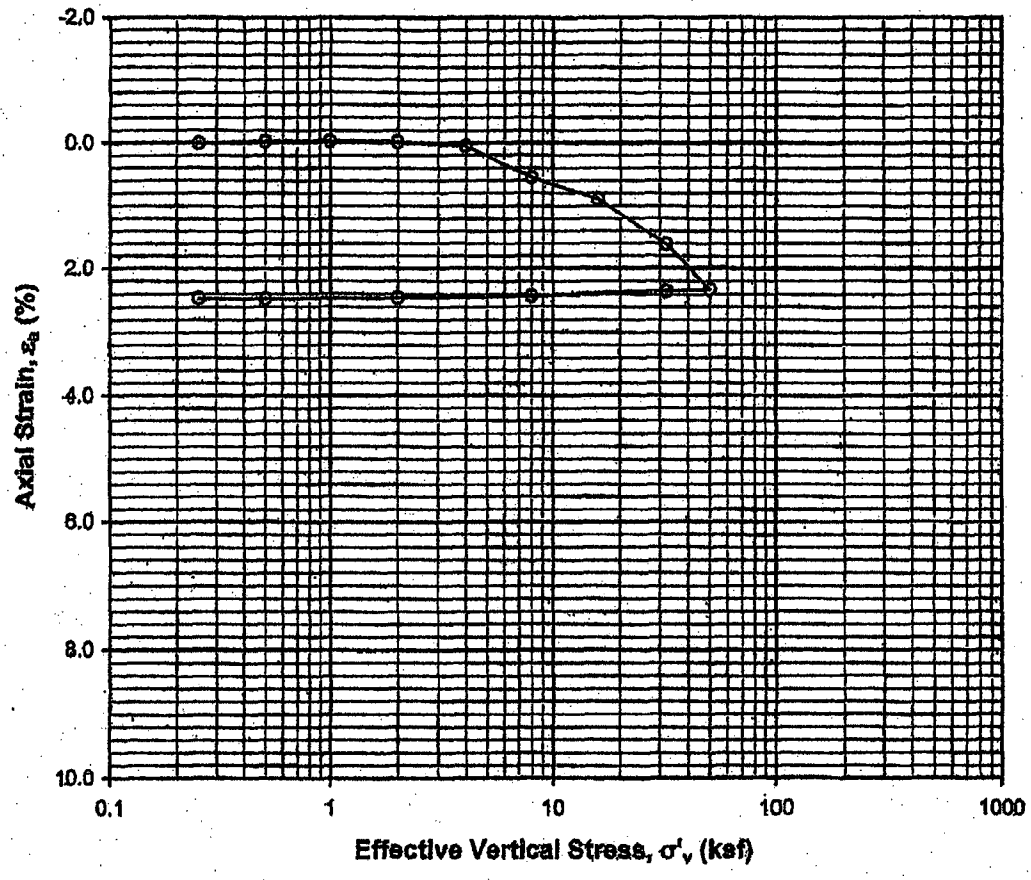


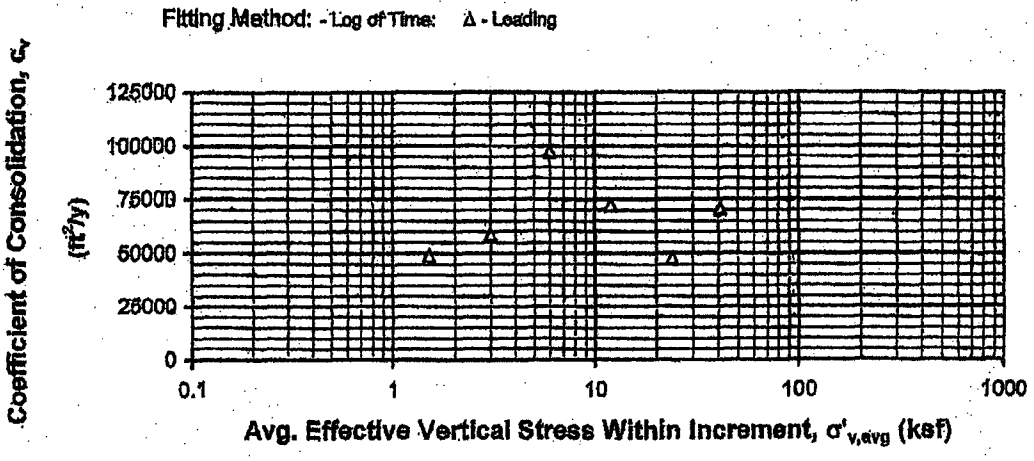


1-D CONSOLIDATION TEST: INC
Sample No. CR6, Compacted to 95% Modified Proctor
200 ksf Maximum Vertical Stress

Reviewed By: TR

PLATE 4-2



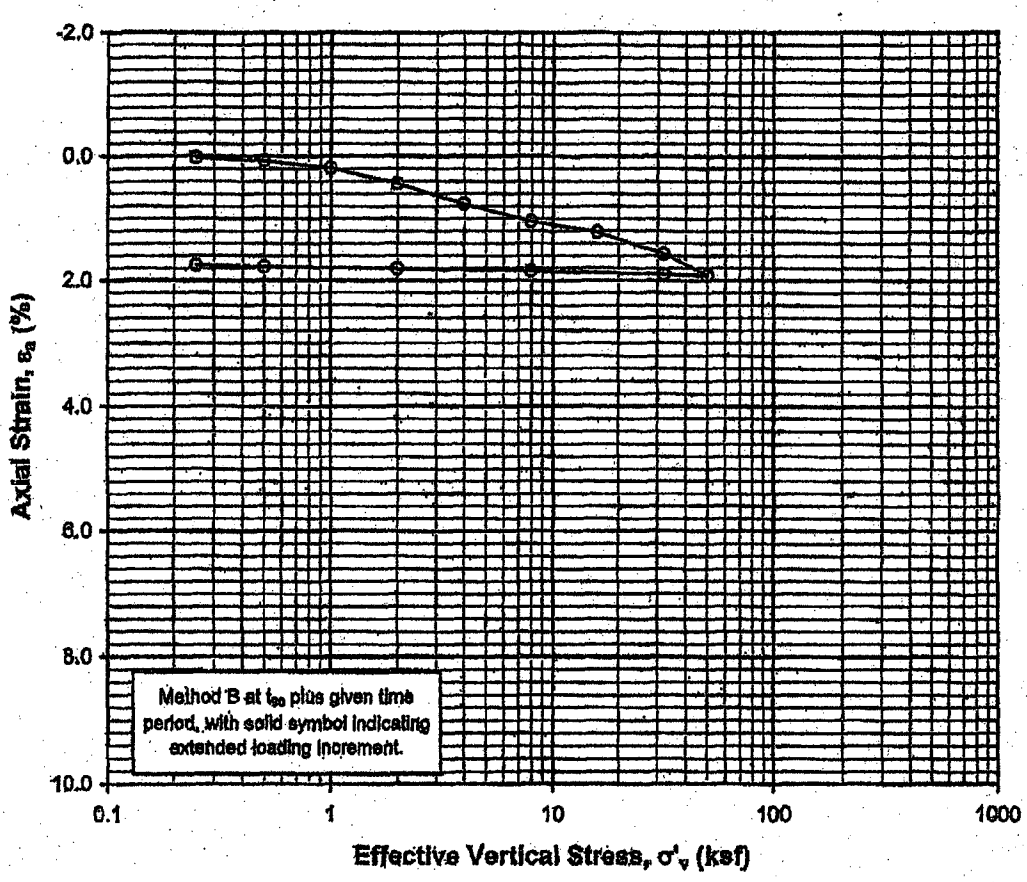


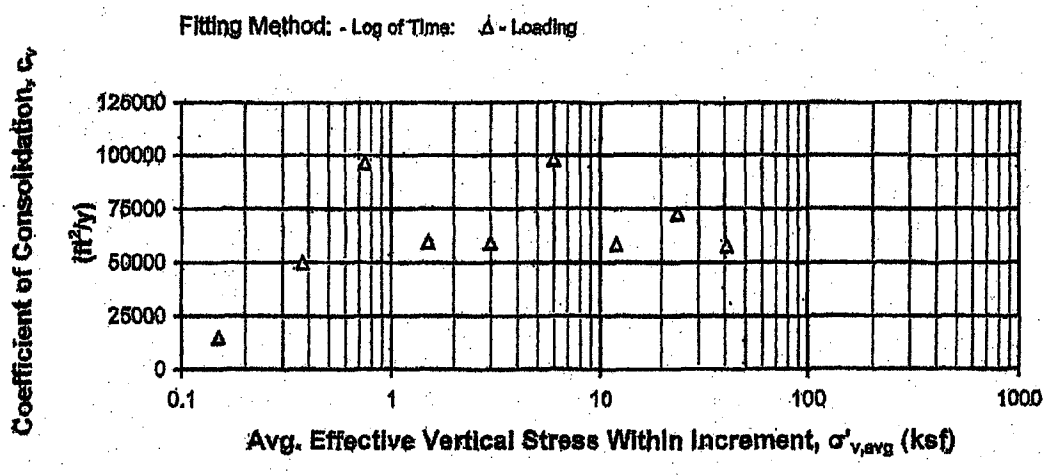
1-D CONSOLIDATION TEST: INC
Sample No. CR6, Compacted to 95% Modified Proctor
50 ksf Maximum Vertical Stress

Reviewed By: TP

PLATE 4-3

39





1-D CONSOLIDATION TEST: INC
Sample No. GAB, Compacted to 95% Modified Proctor
50 ksf Maximum Vertical Stress

Reviewed By: TP

PLATE 4-4

40

SECTION 5

CONSOLIDATED-UNDRAINED AND DRAINED TRIAXIAL TESTS

This section of the report presents the results of the static triaxial tests performed for this project. Tables summarizing selected index or physical properties, shearing parameters, and stress-strain properties for triaxial tests are presented on Plate 5-1 through 5-8. Unless noted otherwise, effective isotropic confining stresses for each triaxial series were 35, 75 and 150 psi (5, 10.8 and 21.6 ksf).

The following graphical data for each consolidated-undrained triaxial test, with five (5) plates per test are presented on Plates 5-2a through 5-5e.

1st Plate (a)

- Mohr-Coulomb Circles at Peak Shear Stresses (Effective Stresses)
- Mohr-Coulomb Circles at Peak Shear Stresses (Total Stresses)

2nd Plate (b)

- Mohr-Coulomb Circles at 15% Axial Strain (Effective Stresses)
- Mohr-Coulomb Circles at 15% Axial Strain (Total Stresses)

3rd Plate (c)

- Shear Stress, q versus Axial Strain, ε_a (%) and Summary Table of Test Results

4th Plate (d)

- Excess Pore Water Pressure, ΔU versus Axial Strain, ε_a (%)
- Obliquity, σ'_1/σ'_3 versus Axial Strain, ε_a (%)

5th Plate (e)

- Shear Stress, q versus Effective Average Principle Stress, p'

The following graphical data for each consolidated-drained triaxial test, with four (4) plates per test are presented on Plates 5-6a through 5-8d.

1st Plate (a)

- Mohr-Coulomb Circles at Peak Shear Stresses (Effective Stresses)

2nd Plate (b)

- Mohr-Coulomb Circles at 15% Axial Strain (Effective Stresses)

3rd Plate (c)

- Shear Stress, q versus Axial Strain, ε_a (%) and Summary Table of Test Results

4th Plate (d)

- Volume Change, ΔV versus Axial Strain, ε_a (%)
- Obliquity, σ'_1/σ'_3 versus Axial Strain, ε_a (%)

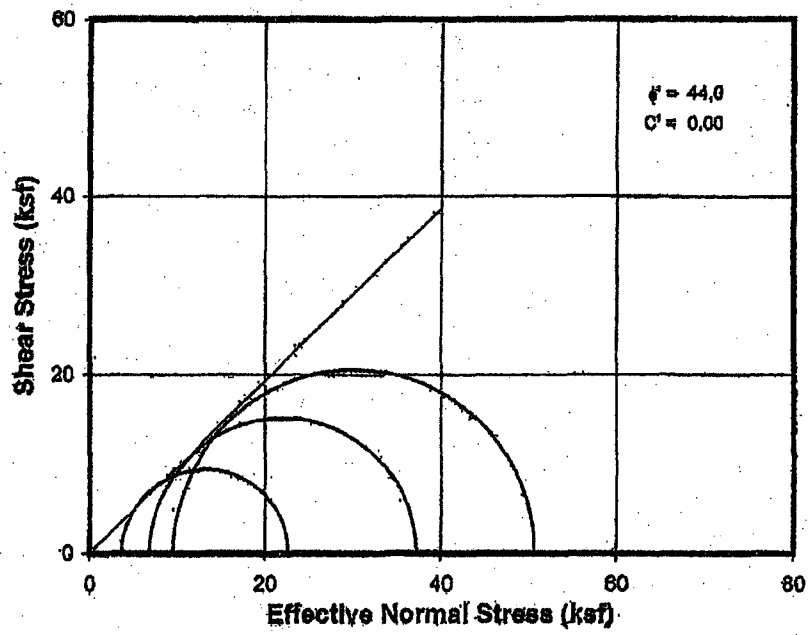
Sample	ϕ' Based on Undrained Triaxial at Peak Deviator Stress and $c' = 0$ (deg)	ϕ' Based on Undrained Triaxial Peak Deviator Stress Limited to 15% Axial Strain and $c' = 0$ (deg)	ϕ' Based on Undrained Triaxial Calculated from Stress Path, θ $\tan\theta = \sin\phi'$ ($c' = 0$) (deg)	ϕ' Based on Drained Triaxial at Peak Deviator Stress and $c' = 0$ (deg)	ϕ' Based on Drained Triaxial Peak Deviator Stress Limited to 15% Axial Strain and $c' = 0$ (deg)
CR6 (95% Modified Proctor)	44.0	44.3	44.4	43.5	43.0
GAB (95% Modified Proctor)	44.2	44.0	44.4	42.5	42.5
#57 Stone (80% Relative Density)	43.5	43.5	43.8	40.0	39.0
#57 Stone (100% Relative Density) (only $\sigma'_3 = 150$ psi)	44.8	43.9	40.9	--	--

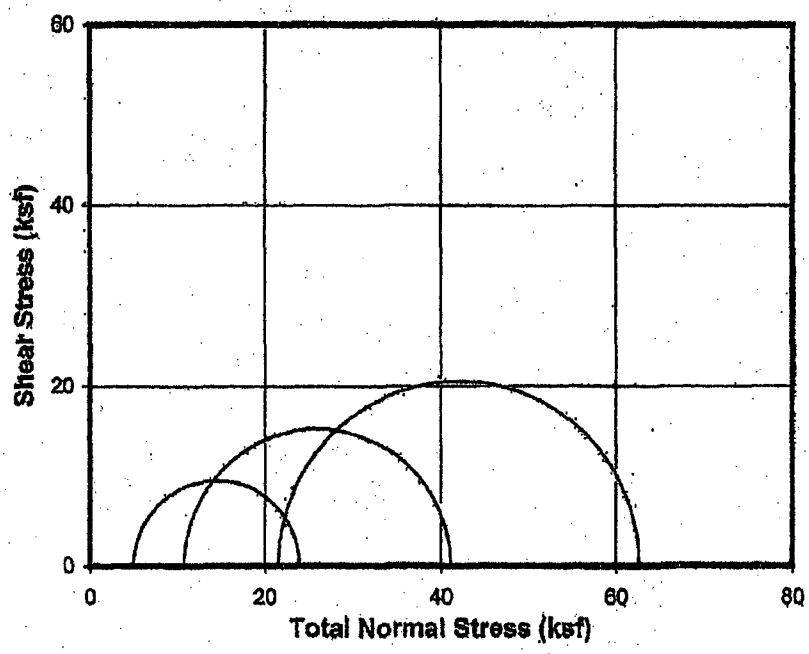
SUMMARY OF FRICTION ANGLES FROM UNDRAINED AND DRAINED TRIAXIAL TESTS
CR6, GAB and #57

Reviewed By: mnm

PLATE 5-1

42

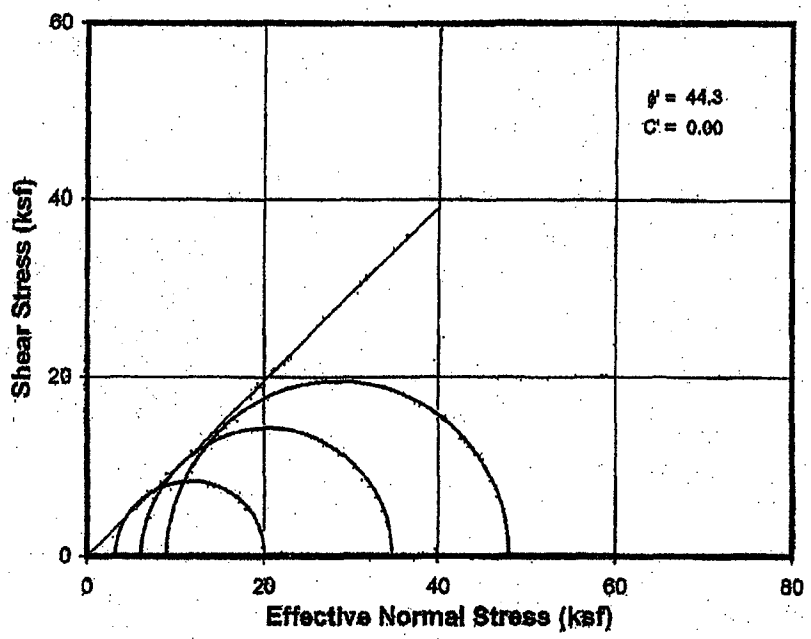


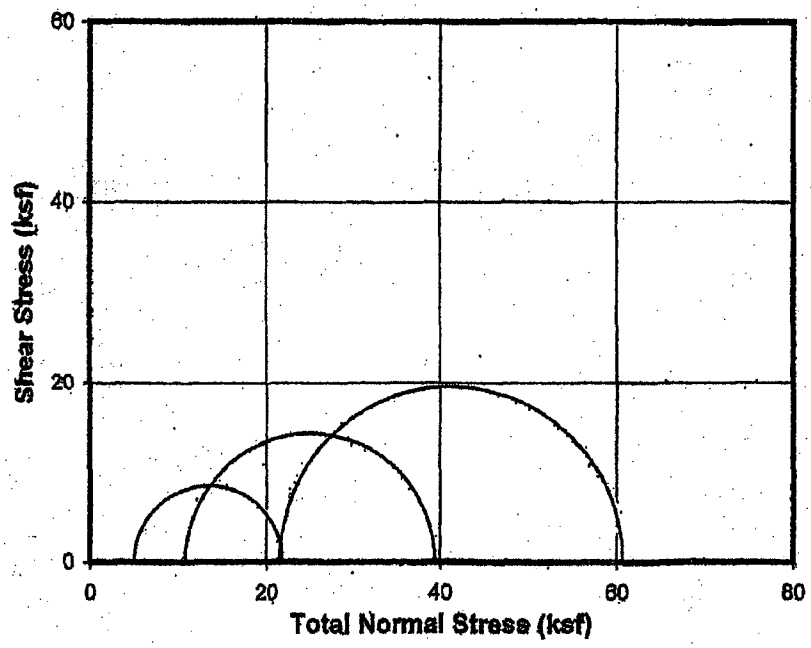


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm MMW

PLATE 5-2a





CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

Isotropically Consolidated

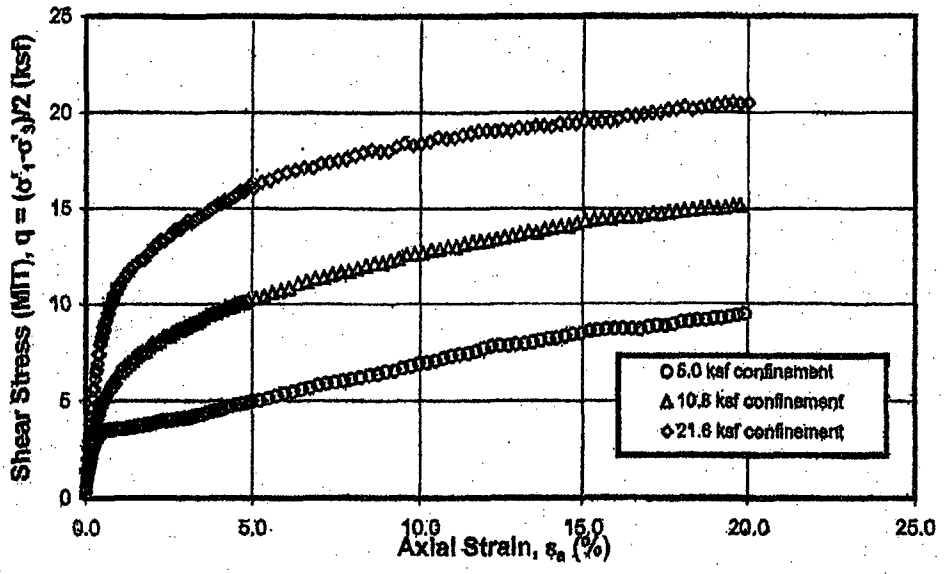
Sample: CR6, Compacted to 95% Modified Proctor

Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-2b

44



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	CR6	a	304.6	5,560	182.4	5.9	147.5	139.3	74.2	0.215
		b	302.2	5,456	180.5	7.5	152.6	141.9	109.3	0.192
2	CR6	a	300.5	5,482	182.4	6.6	149.6	140.3	87.1	0.207
		b	298.4	5,401	181.0	7.5	153.0	142.4	107.6	0.189
3	CR6	a	303.4	5,647	186.1	6.6	145.2	136.3	74.1	0.240
		b	300.8	5,465	181.7	7.7	151.6	140.8	103.7	0.201

Note a: Initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	19.91	9.47	13.25	1.29	22.73	3.78
	Max. Obliquity	3.98	4.54	6.14	3.38	10.68	1.60
2	Max. Shear Stress	19.78	15.17	22.06	3.91	37.23	6.90
	Max. Obliquity	5.12	10.28	14.26	6.79	24.54	3.98
3	Max. Shear Stress	19.54	20.53	30.11	12.01	50.64	9.58
	Max. Obliquity	4.93	16.19	22.98	14.80	39.15	6.78

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

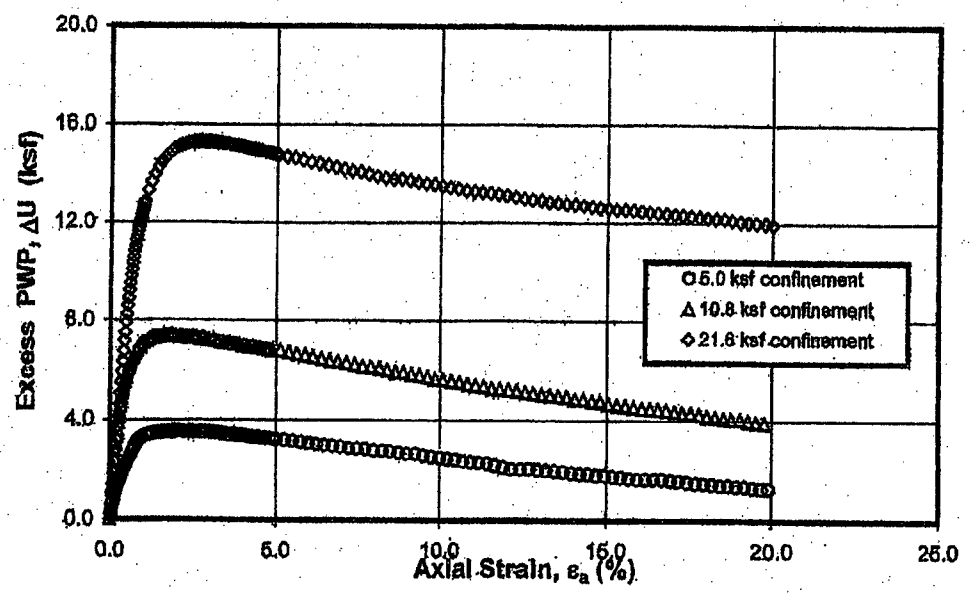
Isotropically Consolidated

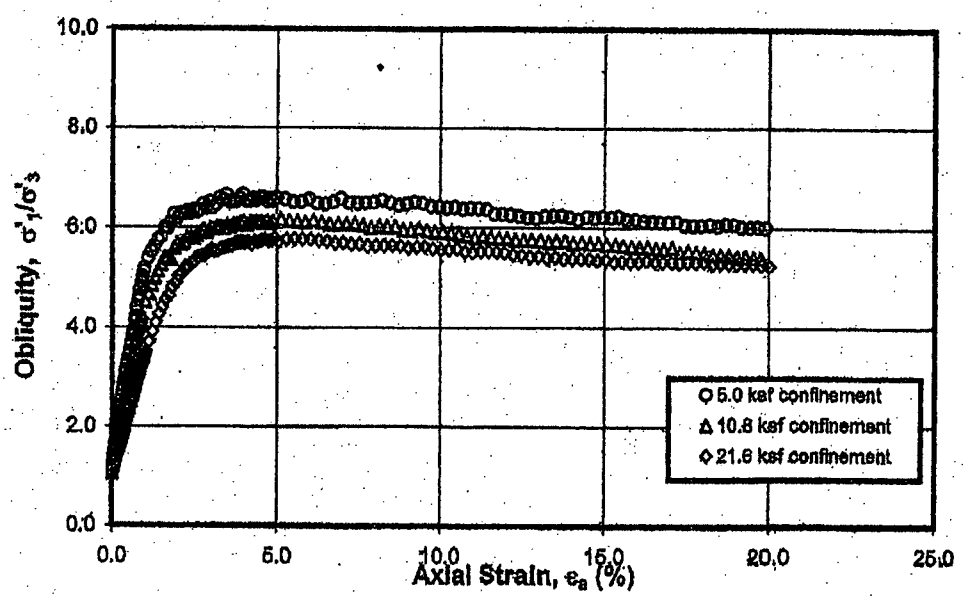
Sample: CR6, Compacted to 95% Modified Proctor

Reviewed By: mmm YWW

PLATE 5-2c

45



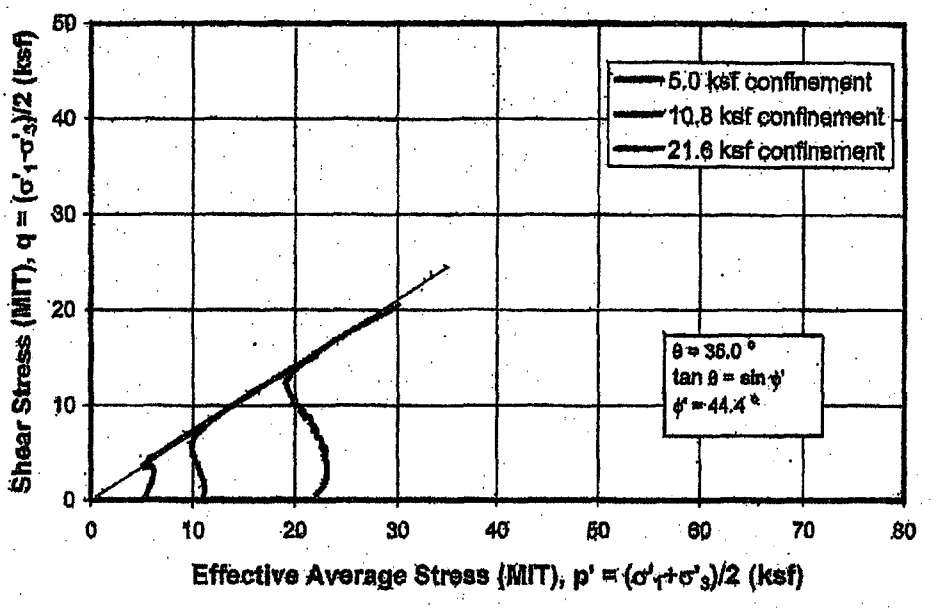


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-2d

46

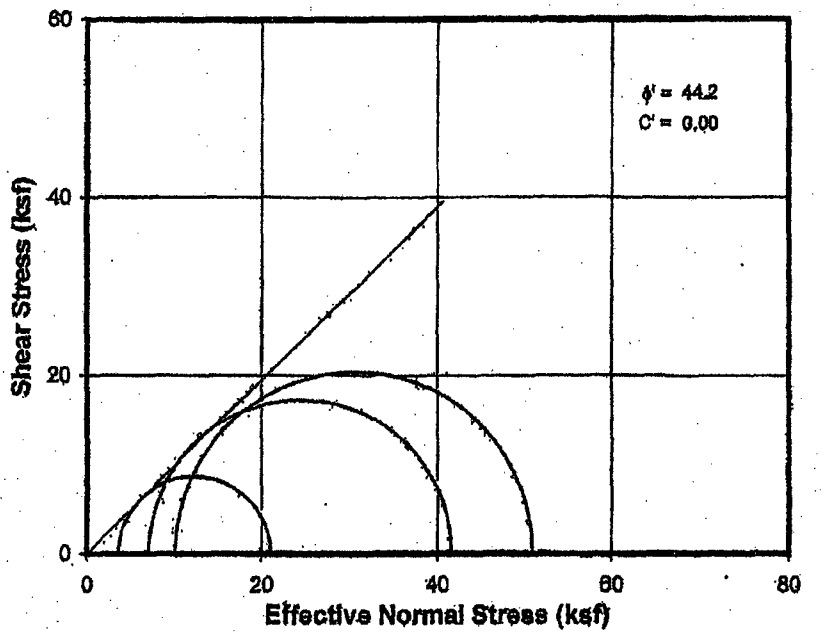


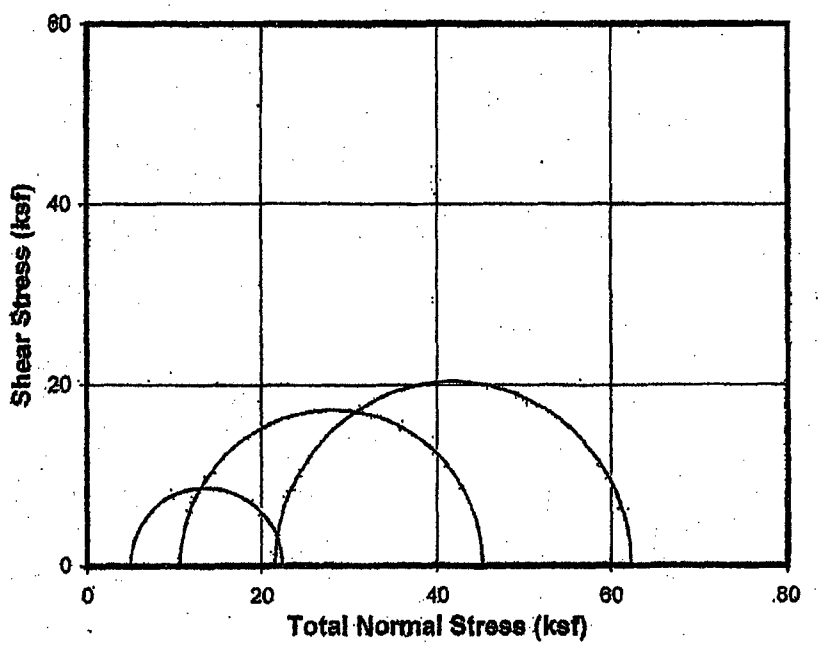
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-2e

47



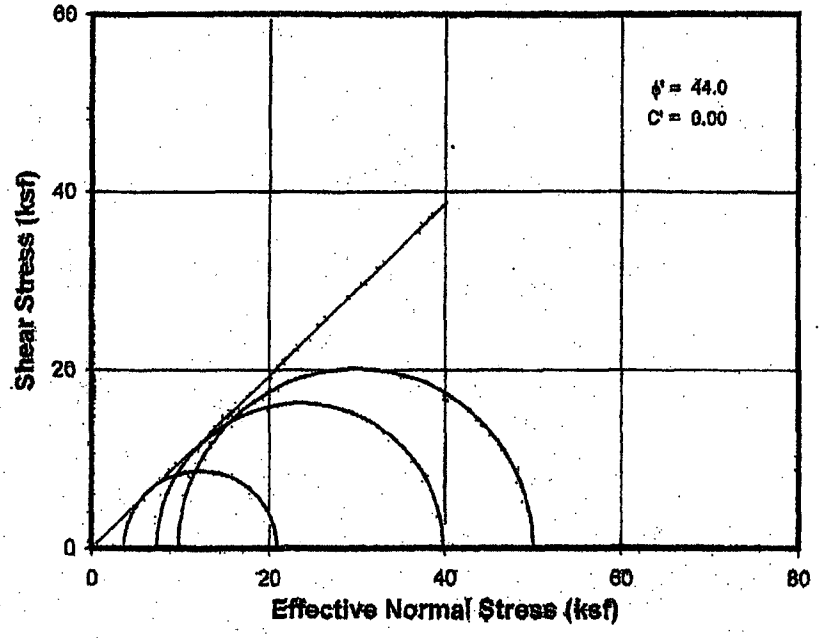


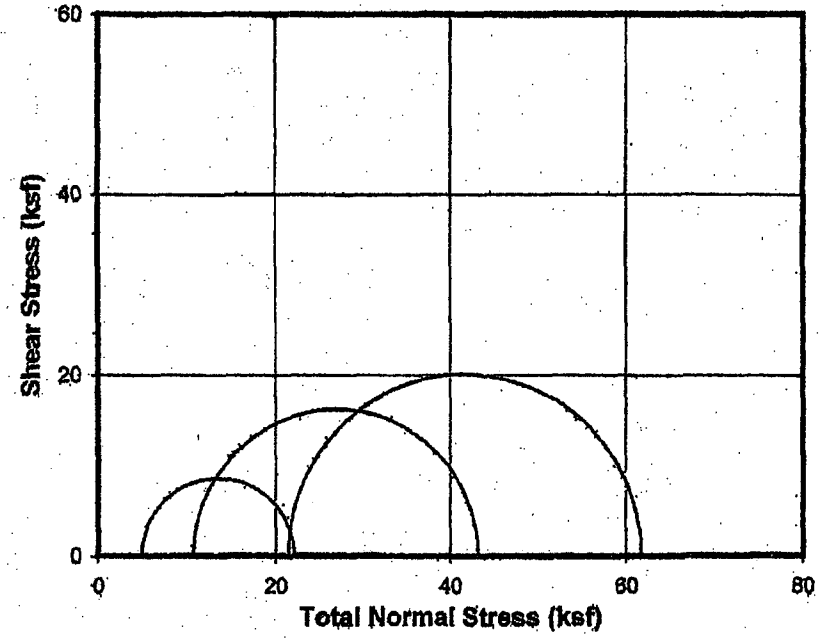
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mrm

PLATE 5-3a

48





CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

Isotropically Consolidated

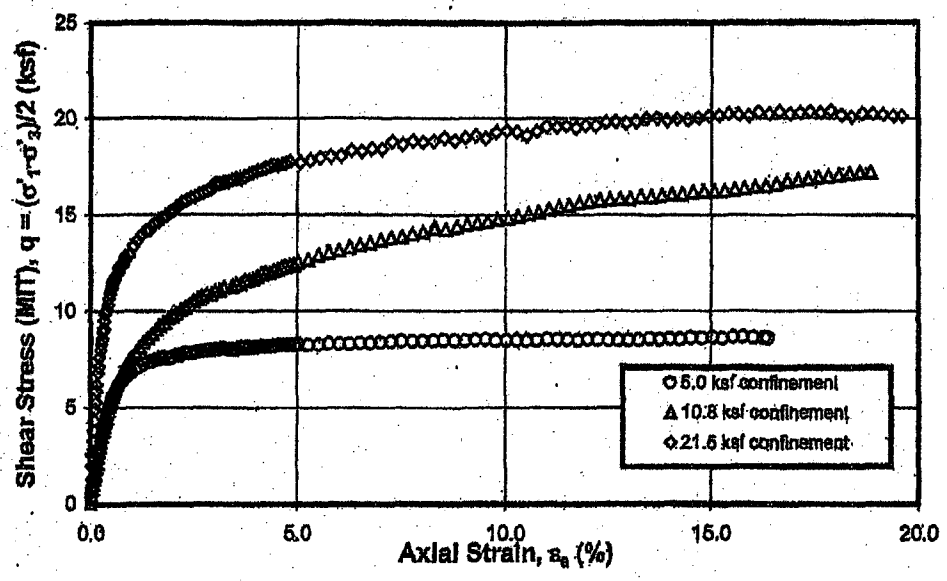
Sample: GAB, Compacted to 95% Modified Proctor

Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm MMM

PLATE 5-3b

49



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	GAB	a	313.4	5,717	182.4	4.9	143.8	137.0	49.0	0.284
		b	312.9	5,658	180.8	9.5	151.5	138.4	98.5	0.271
2	GAB	a	304.5	5,649	185.5	6.0	145.7	137.4	60.6	0.281
		b	302.3	5,502	182.0	8.4	152.9	141.0	86.2	0.248
3	GAB	a	305.5	5,644	184.7	5.8	145.6	137.6	59.1	0.279
		b	302.6	5,531	182.8	8.0	151.6	140.4	88.7	0.253

Note a: initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	15.79	8.66	12.37	1.33	21.03	3.70
	Max. Obliquity	2.33	7.81	10.93	1.81	18.74	8.12
2	Max. Shear Stress	18.84	17.28	24.43	3.63	41.66	7.20
	Max. Obliquity	4.13	11.92	16.80	5.92	28.72	4.89
3	Max. Shear Stress	17.90	20.39	30.66	11.22	51.05	10.28
	Max. Obliquity	4.43	17.57	25.28	13.80	42.85	7.71

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

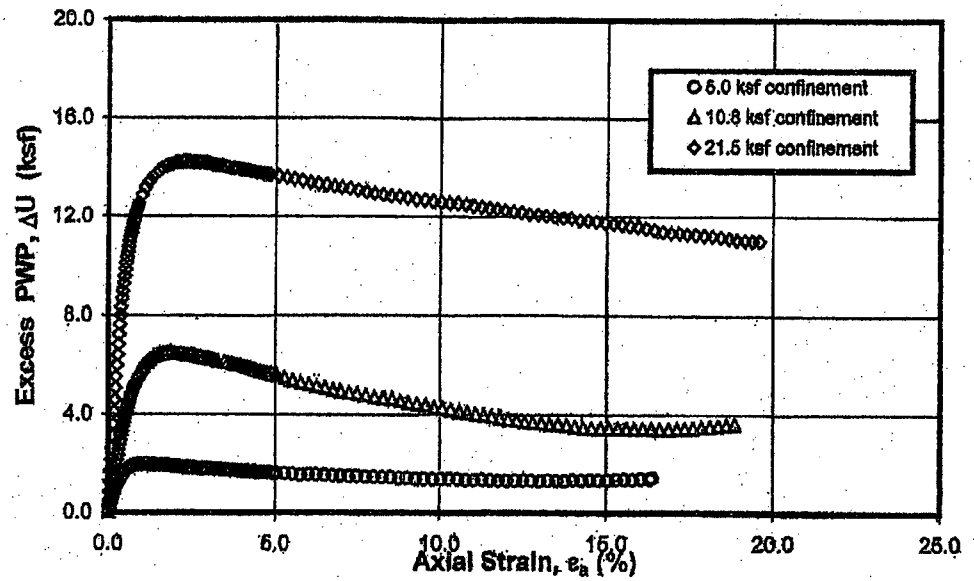
Isotropically Consolidated

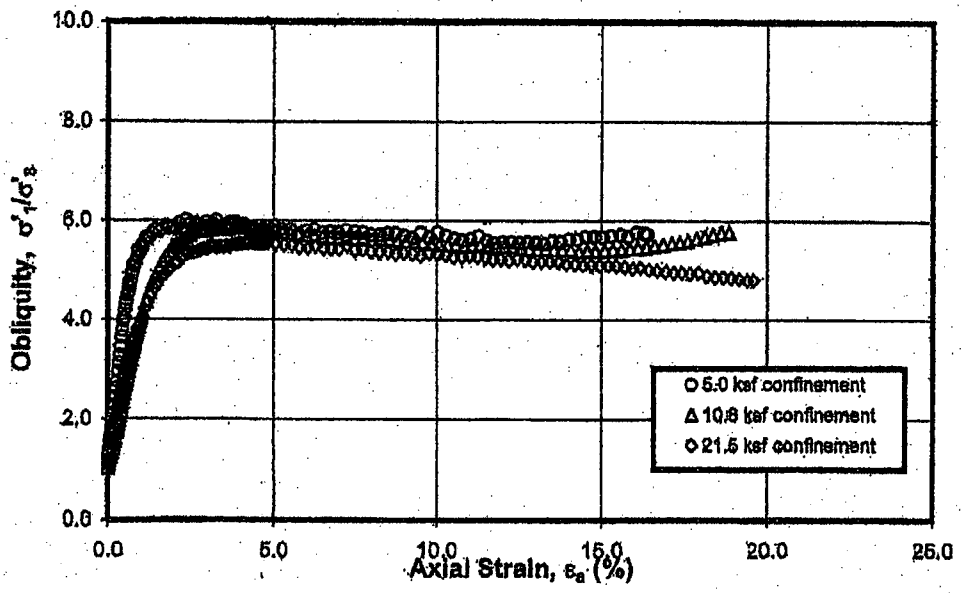
Sample: GAB, Compacted to 95% Modified Proctor

Reviewed By: mnm MMW

PLATE 5-3c

50



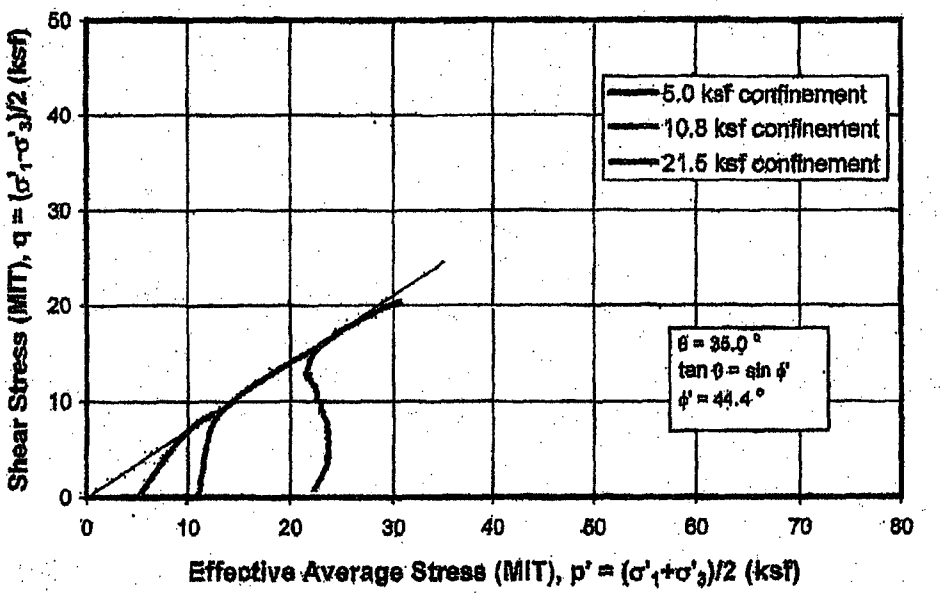


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor

Reviewed By: mmm MMM

PLATE 5-3d

51

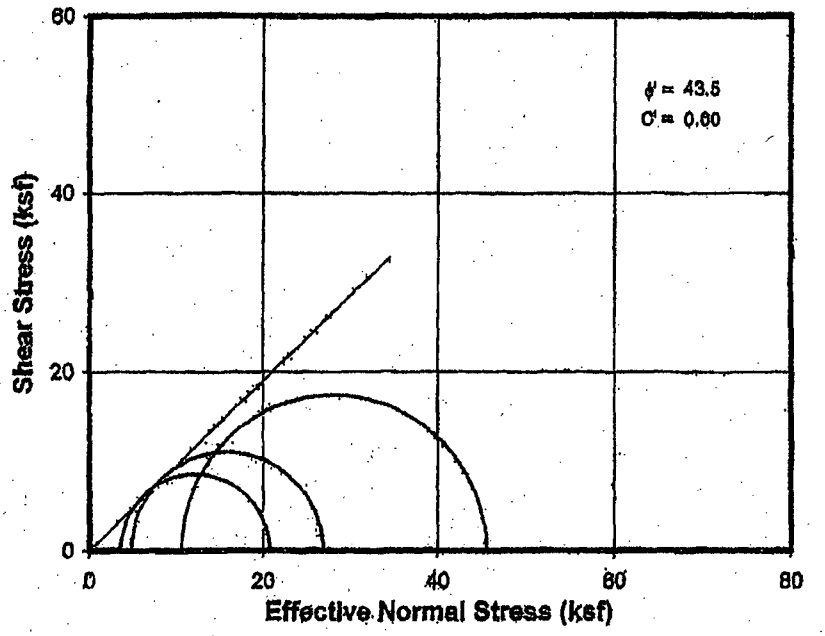


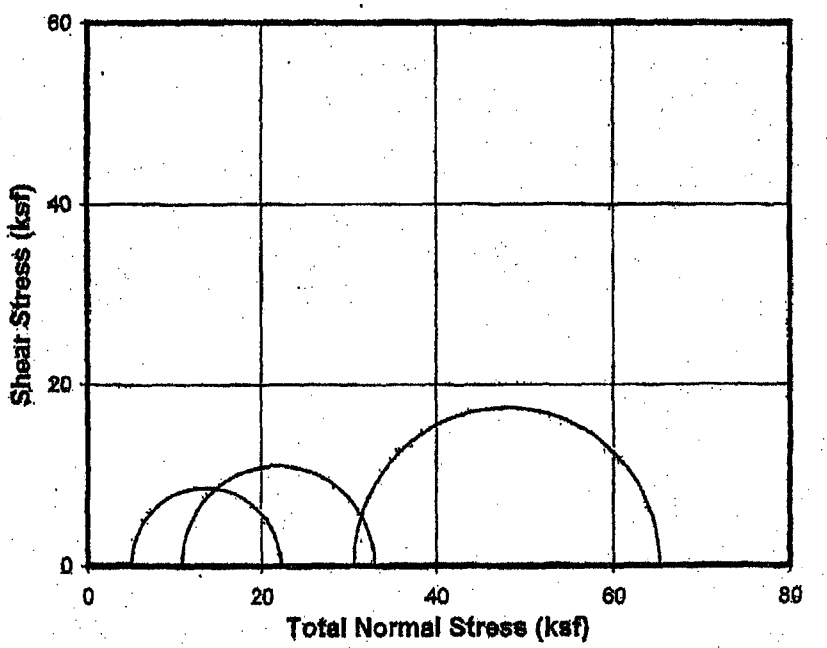
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-3e

52



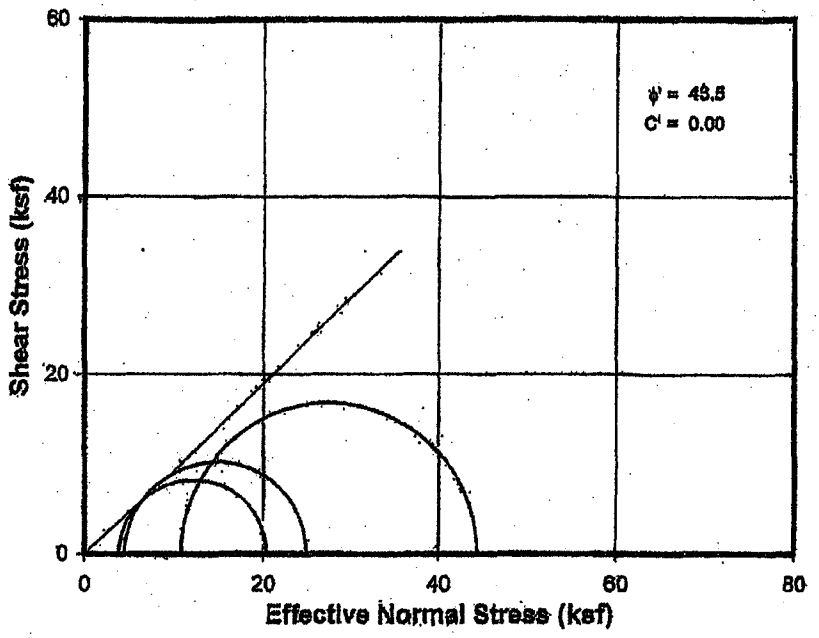


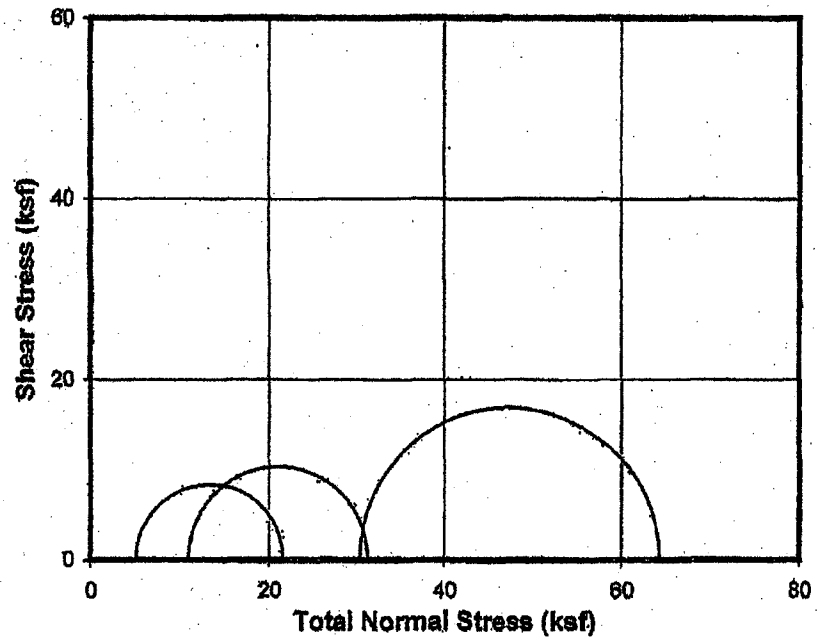
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Denisty
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm

PLATE No : 5-4a

53





CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

Isotropically Consolidated

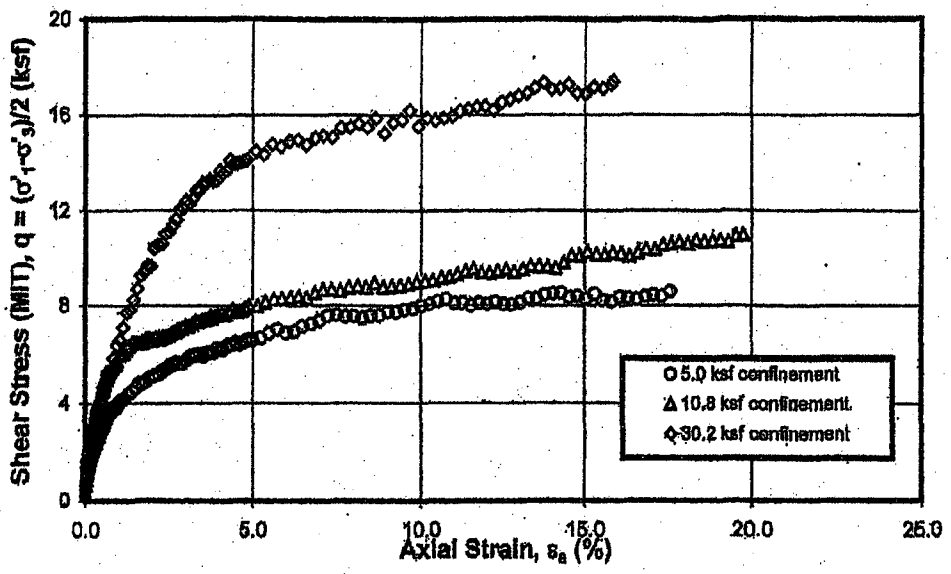
Sample: #57, Compacted to 80% Relative Density

Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-4b

54



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	#57	a	307.5	5,618	182.7	1.1	99.3	98.3	3.8	0.796
		b	306.2	5,437	177.6	23.4	125.3	101.6	89.8	0.738
2	#57	a	303.8	5,540	182.5	1.4	100.7	99.3	5.2	0.778
		b	302.1	5,325	176.2	23.9	128.0	103.3	95.4	0.709
3	#57	a	307.8	5,579	181.4	1.5	100.0	98.6	5.4	0.791
		b	302.0	5,110	169.2	12.7	121.8	107.6	58.3	0.641

Note a: initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	17.56	8.59	12.21	1.42	20.79	3.62
	Max. Obliquity	17.56	8.59	12.21	1.42	20.79	3.62
2	Max. Shear Stress	19.76	11.01	15.86	5.59	26.87	4.85
	Max. Obliquity	15.09	10.29	14.73	6.39	25.02	4.43
3	Max. Shear Stress	15.85	17.41	28.06	19.86	45.48	10.67
	Max. Obliquity	13.75	17.34	27.95	19.84	45.30	10.61

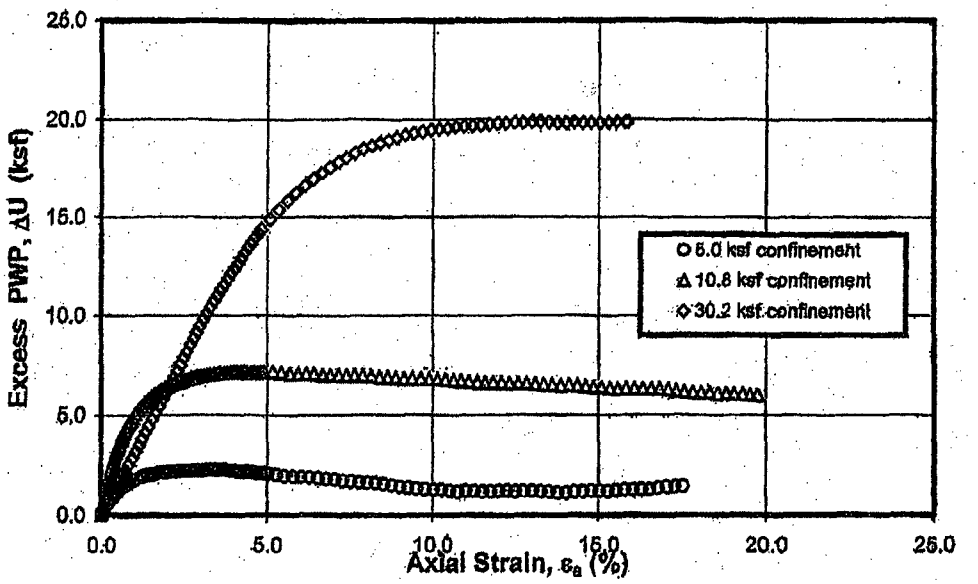
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS

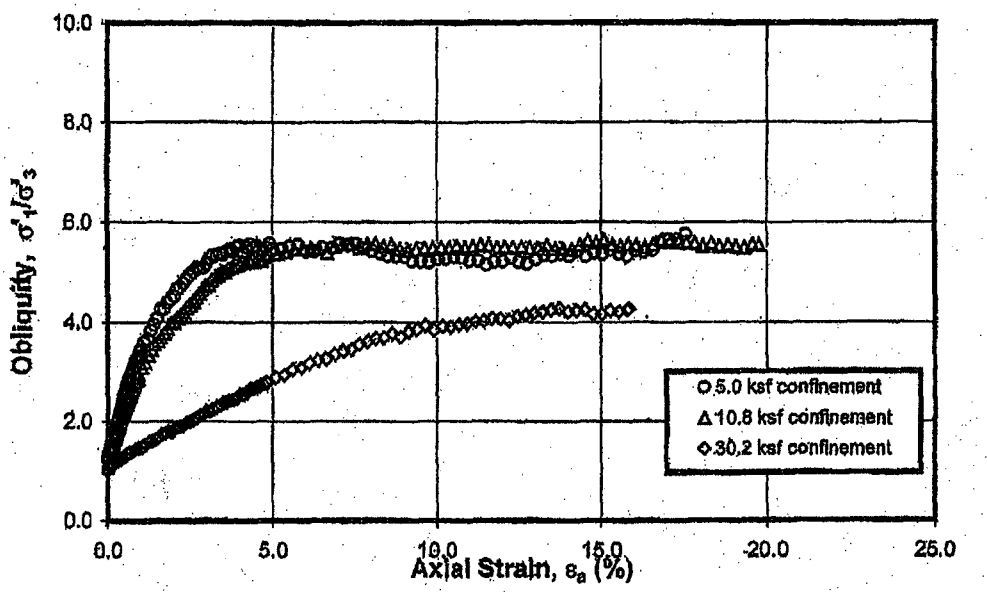
Isotropically Consolidated

Sample: #57, Compacted to 80% Relative Denisty

Reviewed By: mnm/MHN

PLATE 5-4c



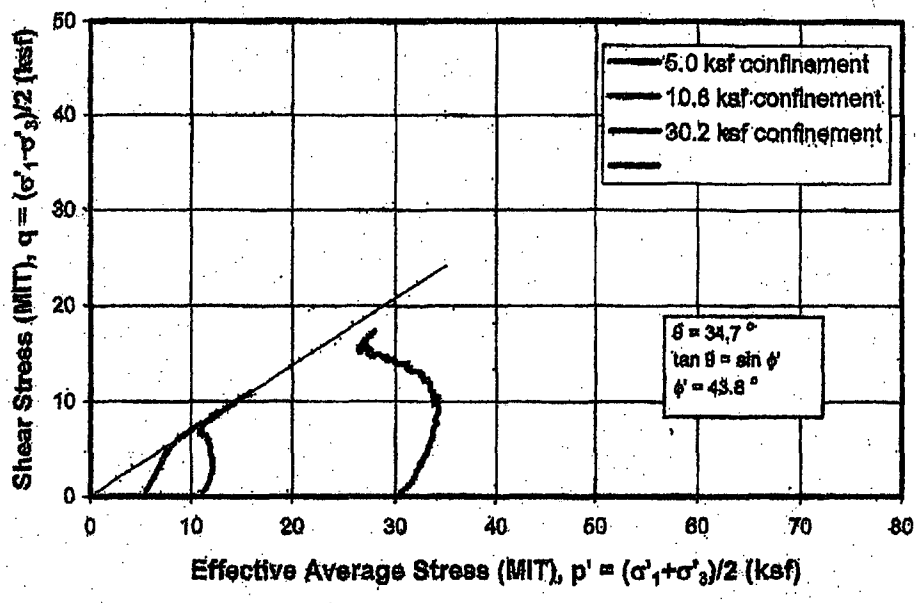


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Denisty

Reviewed By: mnm

PLATE 5-4d

56

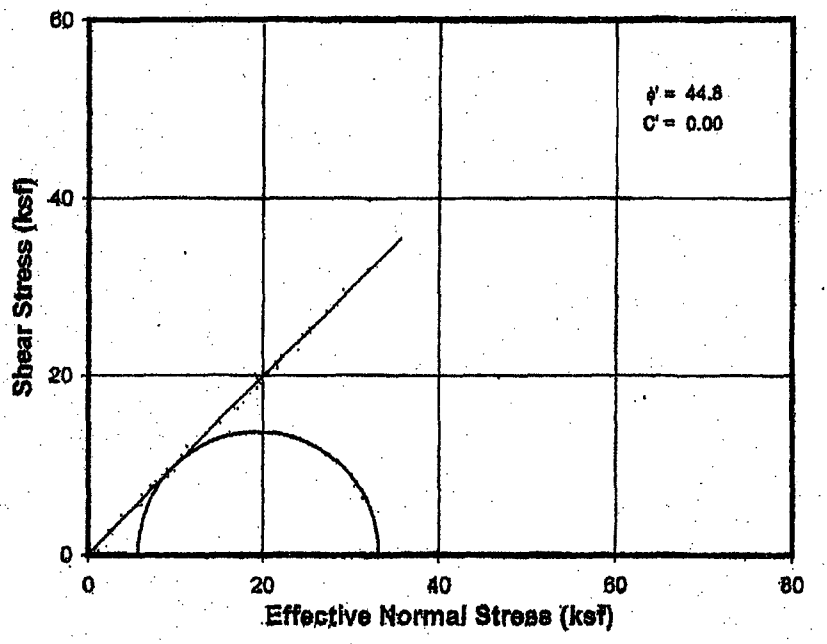


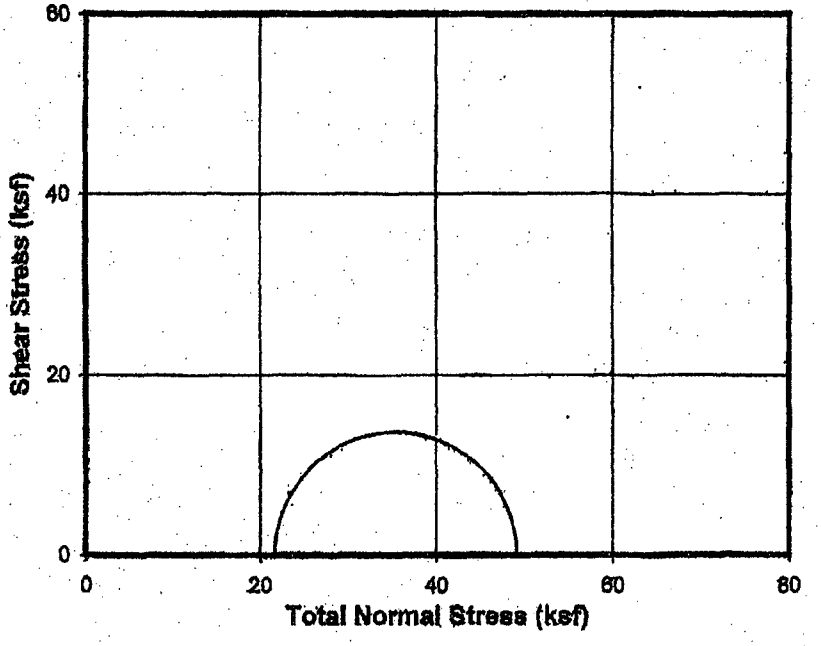
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Denisty

Reviewed By: mnm

PLATE 5-4e

57



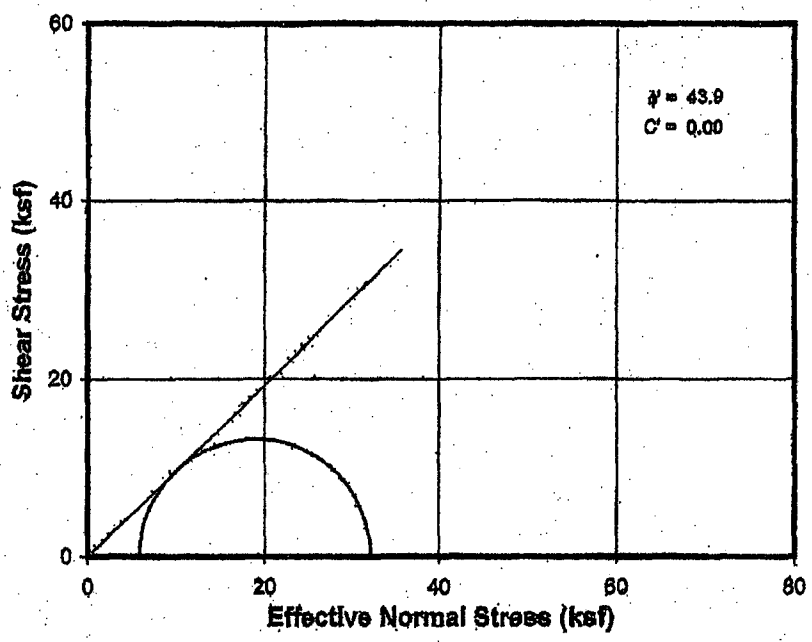


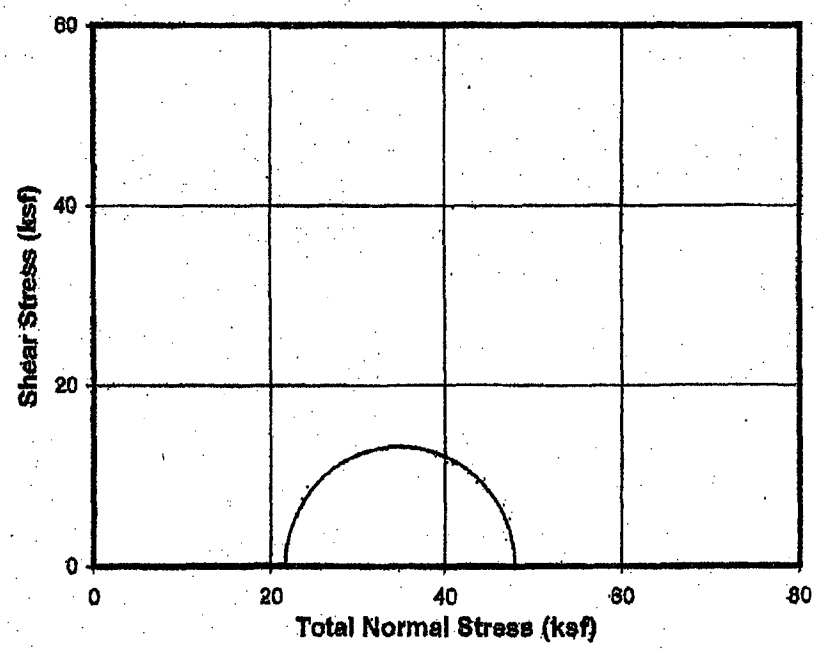
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 100% Relative Density
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm WMM

PLATE 5-5a

58



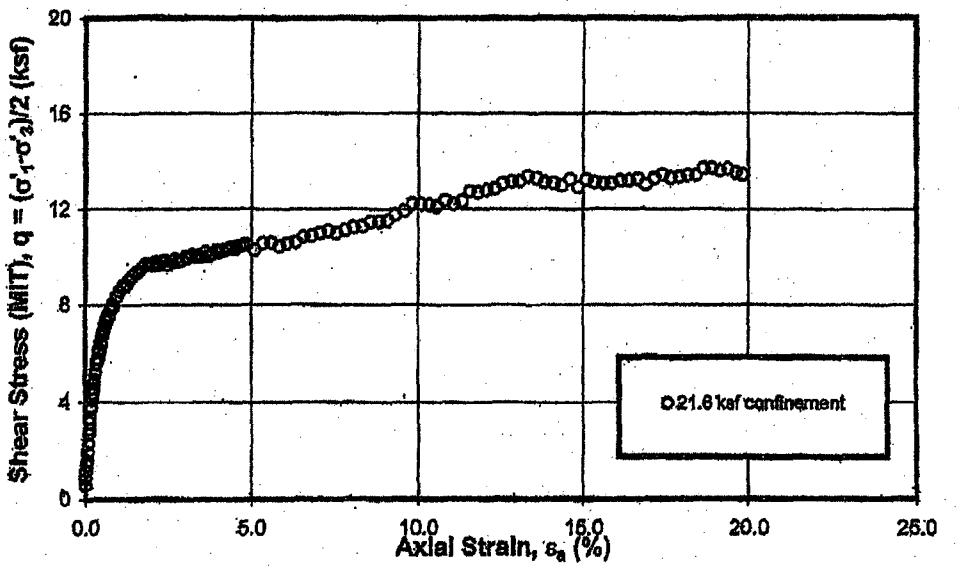


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 100% Relative Density
Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-5b

59



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	#57	a	306.0	5,843	184.4	2.9	103.0	100.1	10.7	0.764
		b	303.6	5,340	175.9	20.1	127.1	105.8	85.2	0.669

Note: a: initial sample condition
b: after application of confining stress

Test Summaries

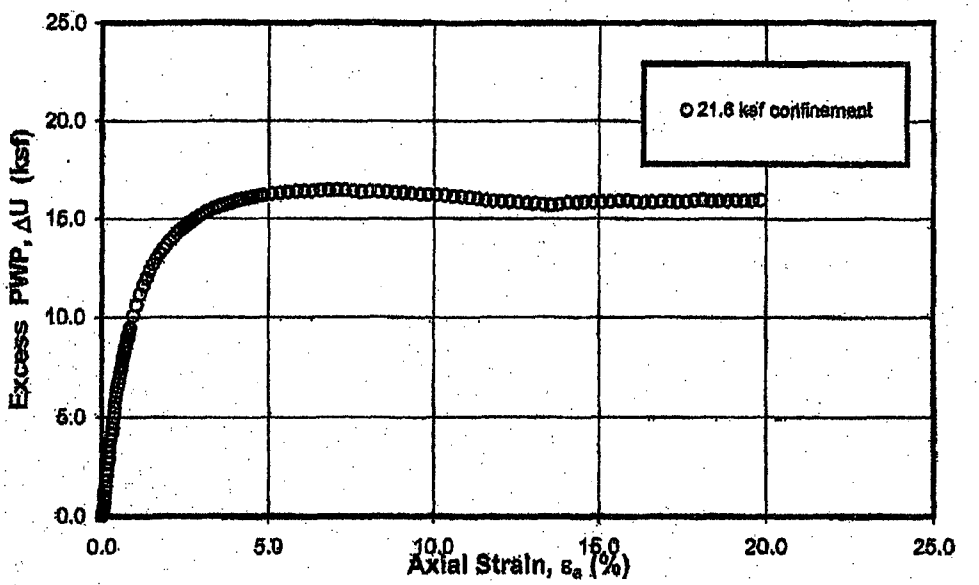
Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	18.86	13.71	19.48	15.80	33.20	5.77
	Max. Obliquity	19.37	13.68	19.44	15.93	33.12	5.75

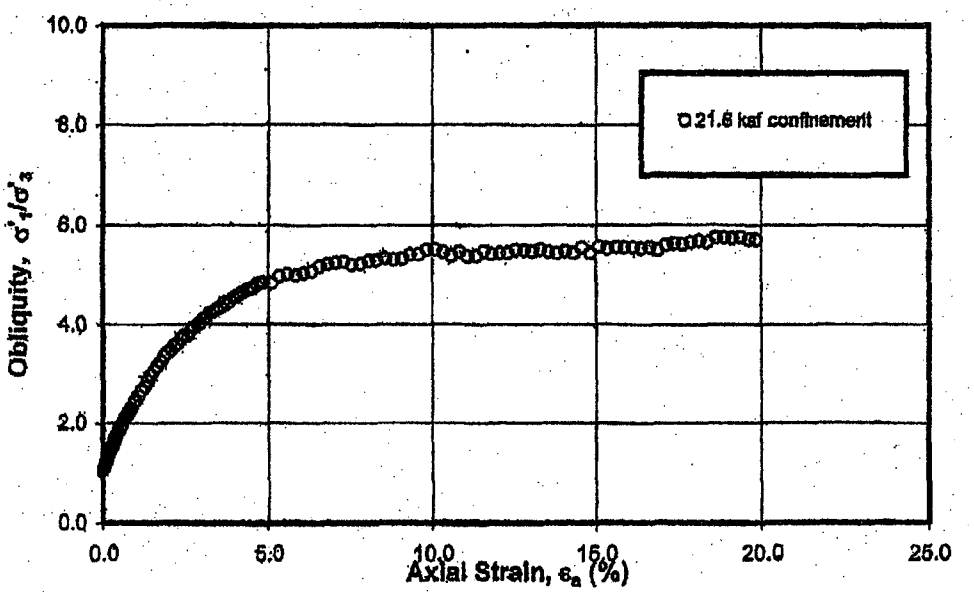
CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 100% Relative Density

Reviewed By: mnm

PLATE 5-5c

60



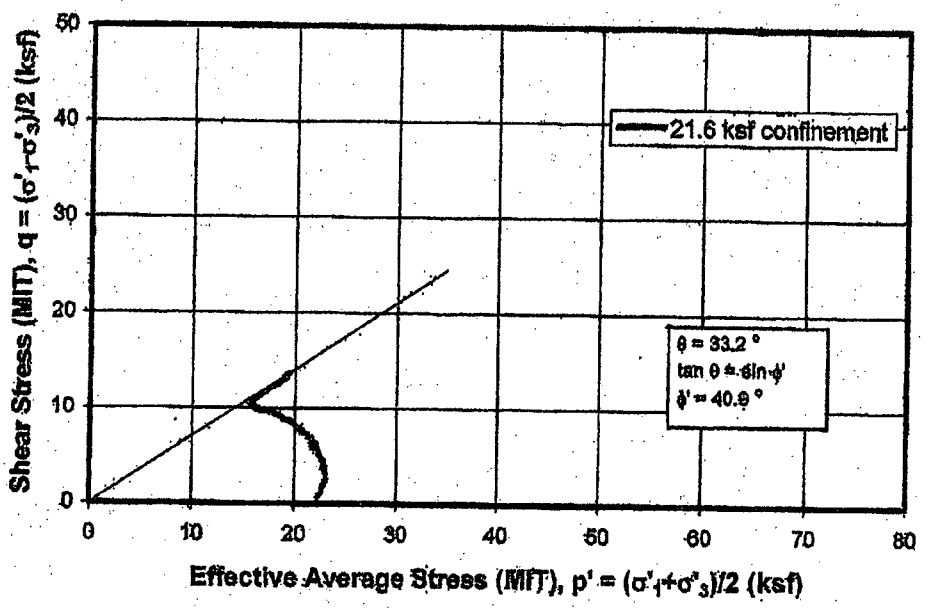


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 100% Relative Density

Reviewed By: mnm

PLATE 5-5d

61

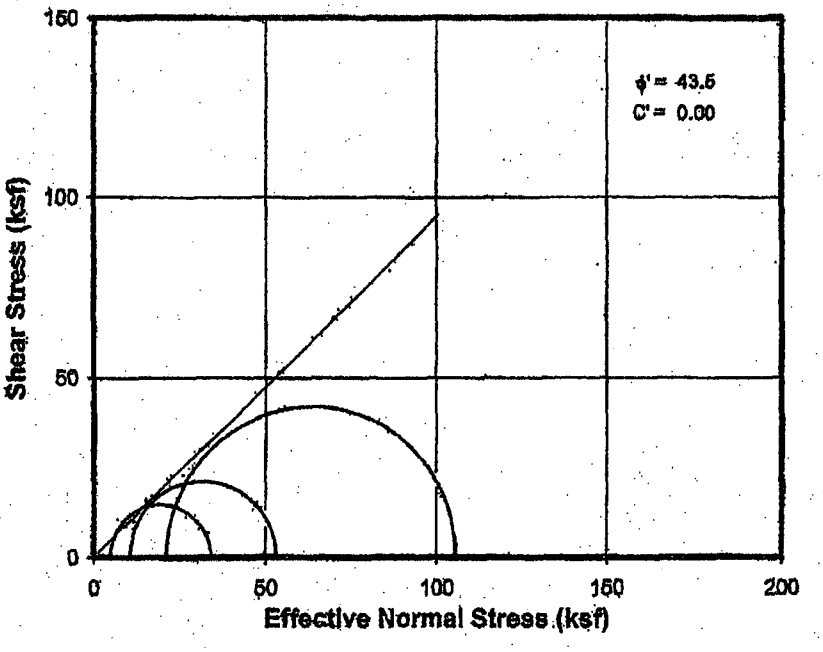


CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 100% Relative Density

Reviewed By: mnm

PLATE 5-5e

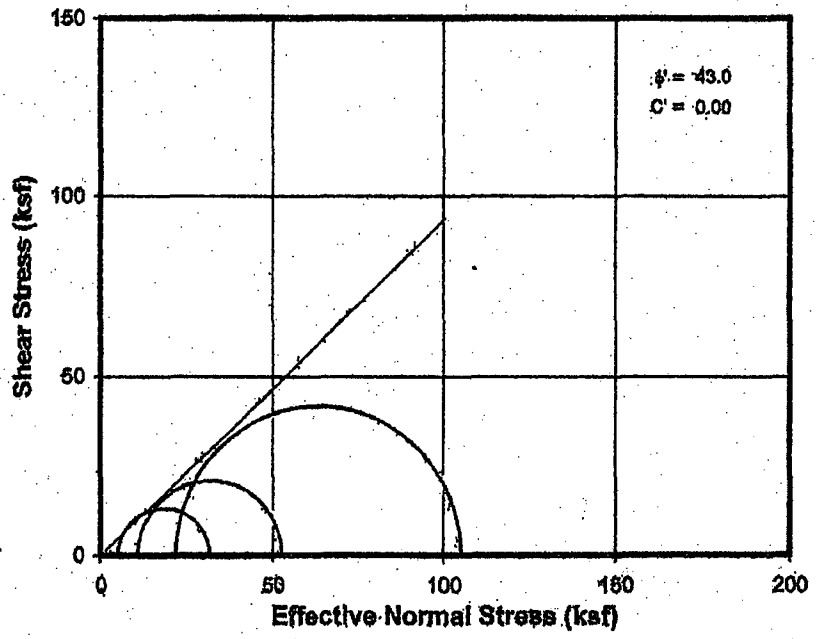
62



CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm

PLATE 5-8a

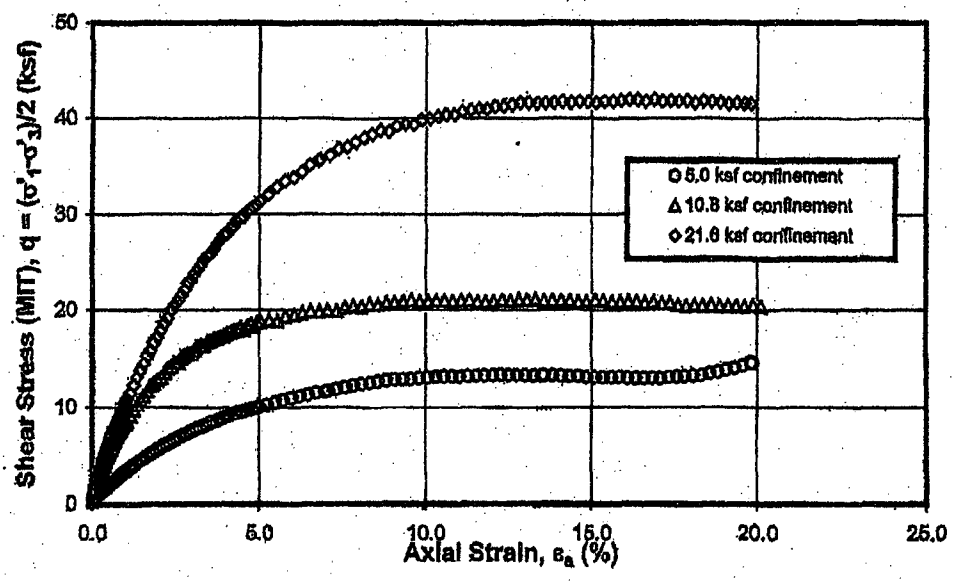


CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor
Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-6b

64



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	CR6	a	304.9	5,677	186.2	7.8	144.5	134.7	66.3	0.311
		b	303.9	5,614	184.8	8.9	148.3	136.2	84.7	0.298
2	CR6	a	304.3	5,649	185.6	8.5	145.2	136.8	73.3	0.242
		b	302.6	5,569	183.8	8.8	150.5	138.4	106.7	0.223
3	CR6	a	304.8	5,658	185.5	6.4	145.4	136.6	81.5	0.209
		b	301.7	5,481	181.7	6.7	150.4	140.9	103.3	0.172

Note a: initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	19.87	14.62	19.70	-0.03	34.32	5.07
	Max. Obliquity	19.87	14.62	19.70	-0.03	34.32	5.07
2	Max. Shear Stress	13.34	21.13	31.91	-0.01	53.04	10.78
	Max. Obliquity	13.34	21.13	31.91	-0.01	53.04	10.78
3	Max. Shear Stress	16.86	42.01	63.71	-0.04	105.72	21.70
	Max. Obliquity	16.13	41.98	63.68	-0.02	105.62	21.65

CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS

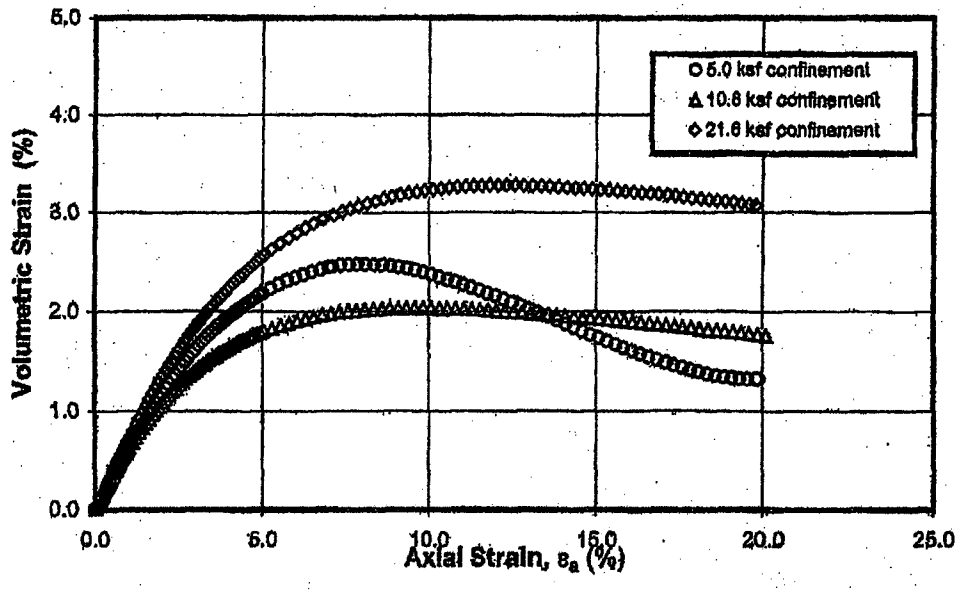
Isotropically Consolidated

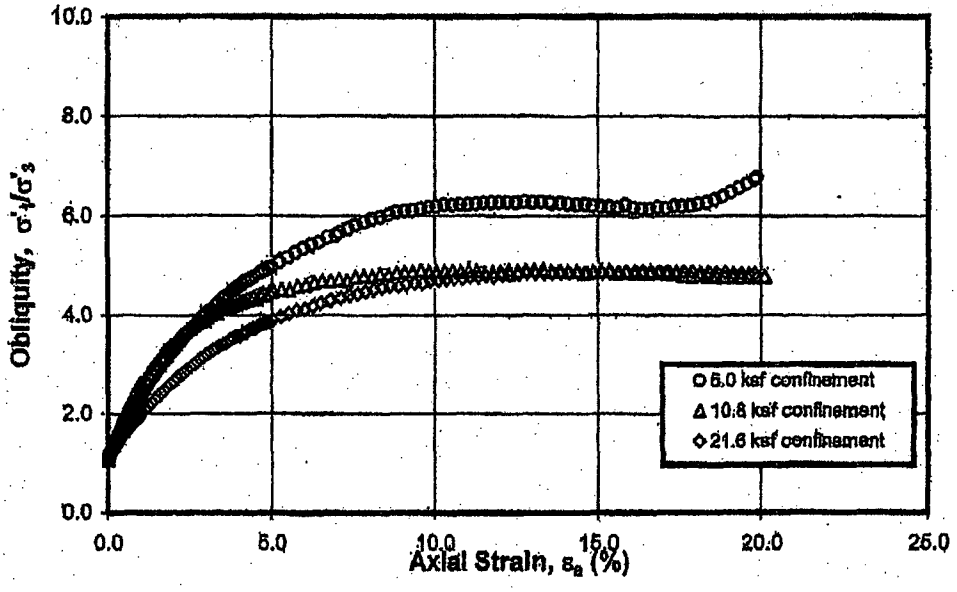
Sample: CR6, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-6c

65



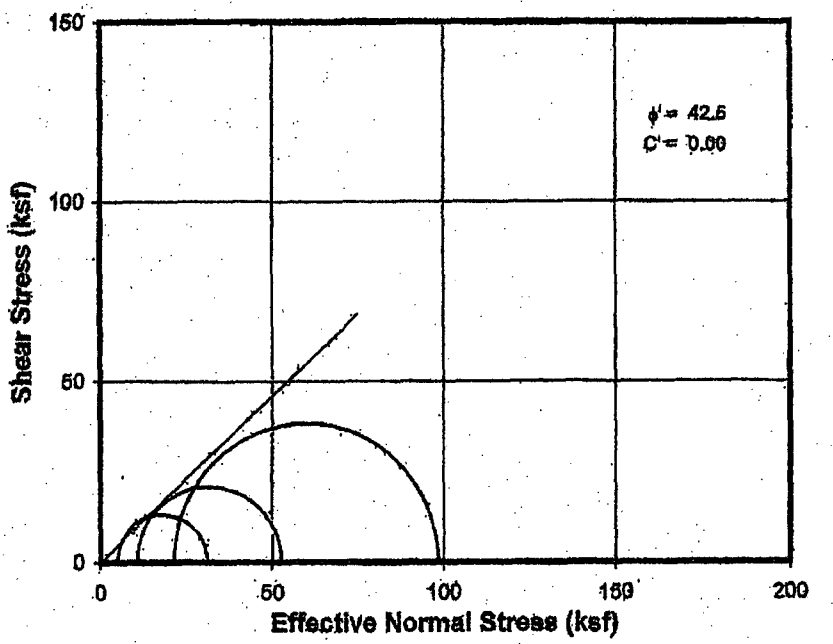


CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: CR6, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-6d

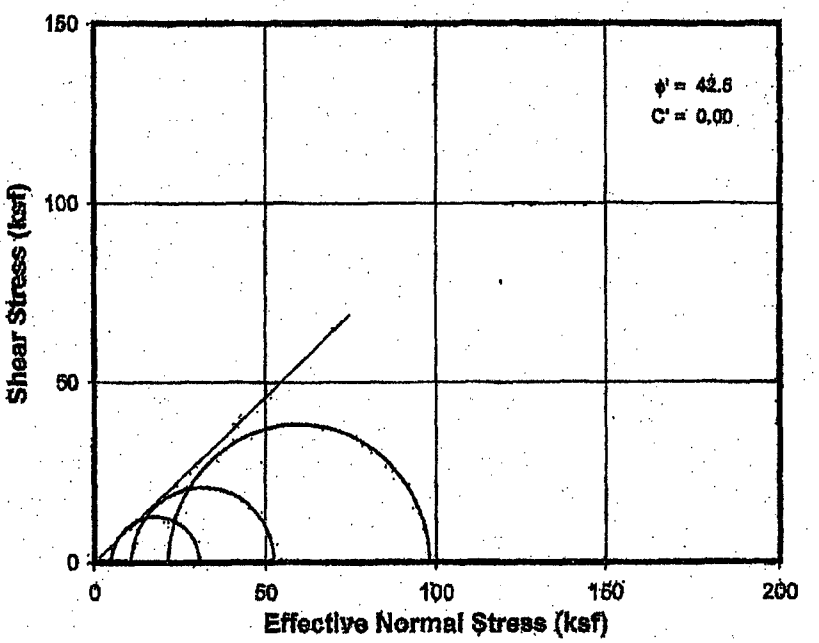
66



CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor
Mohre Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm

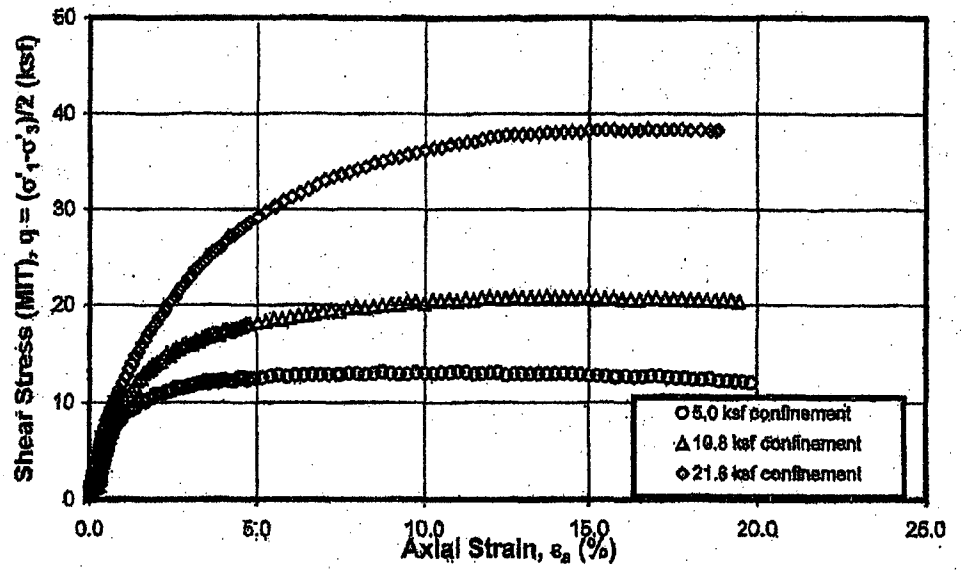
PLATE 5-7a



CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor
Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-7b



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	GAB	a	304.8	5,665	185.9	5.8	145.3	137.3	58.3	0.282
		b	304.0	5,606	184.4	9.6	152.0	138.7	100.5	0.269
2	GAB	a	305.3	5,675	185.9	6.1	144.9	136.6	59.5	0.289
		b	304.2	5,607	184.3	9.5	151.4	138.2	98.6	0.278
3	GAB	a	306.7	5,688	184.3	6.6	144.2	135.3	67.7	0.267
		b	305.9	5,643	184.5	9.1	148.8	136.3	97.7	0.257

Note a: Initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	11.01	13.13	18.19	-0.01	31.32	5.06
	Max. Obliquity	11.01	13.13	18.19	-0.01	31.32	5.06
2	Max. Shear Stress	13.73	20.89	31.75	0.01	52.63	10.86
	Max. Obliquity	13.73	20.89	31.75	0.01	52.63	10.86
3	Max. Shear Stress	16.71	38.37	59.99	0.00	98.36	21.62
	Max. Obliquity	16.71	38.37	59.99	0.00	98.36	21.62

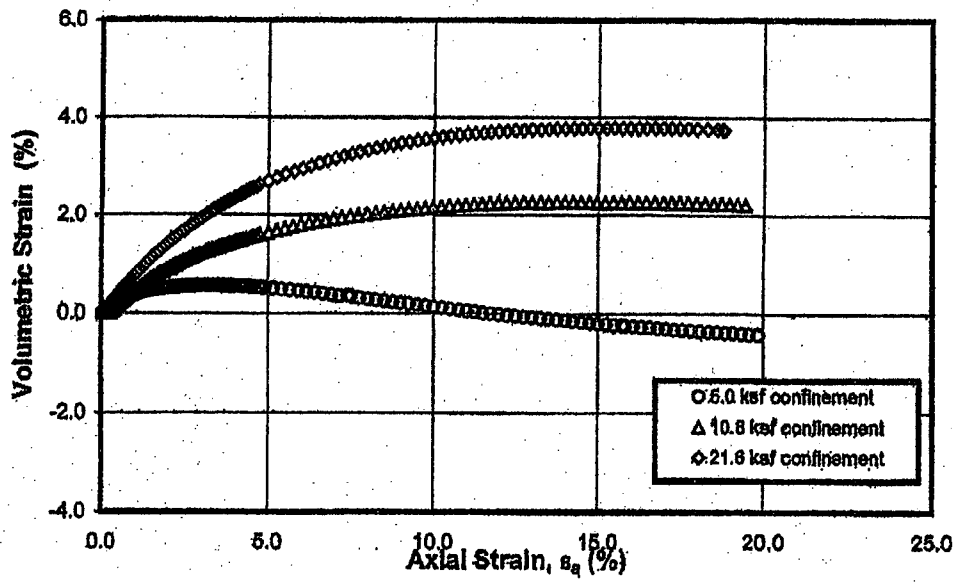
CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS

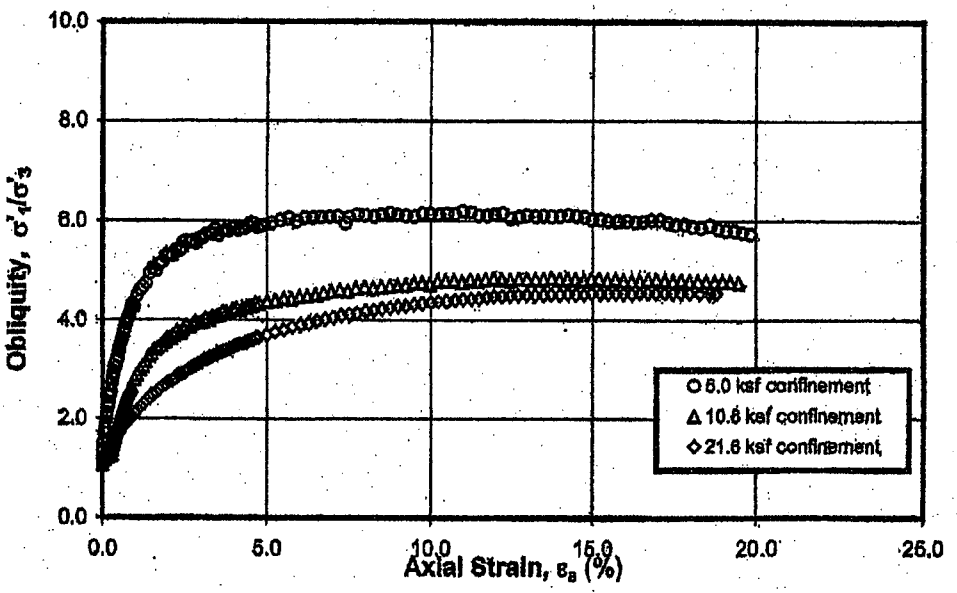
Isotropically Consolidated

Sample: GAB, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-7c



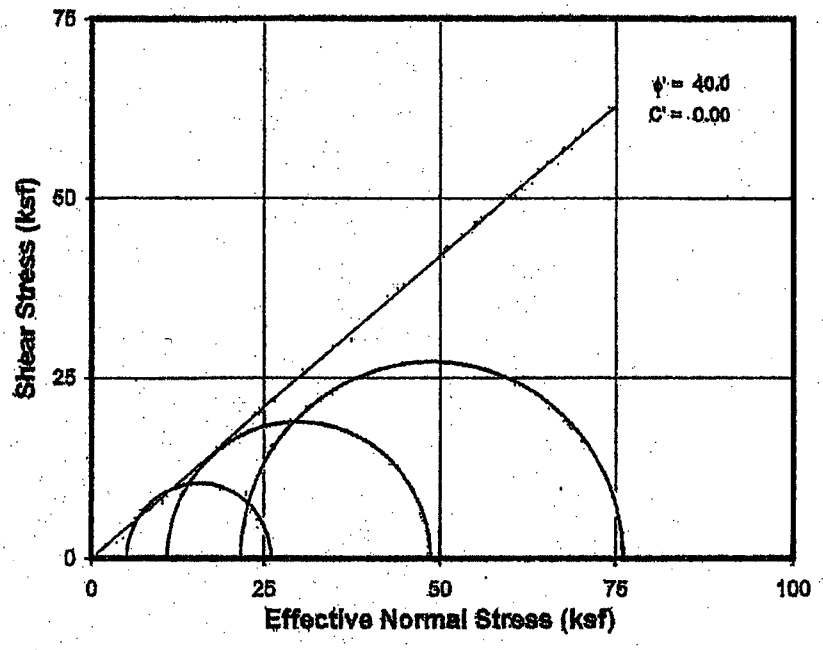


CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: GAB, Compacted to 95% Modified Proctor

Reviewed By: mnm

PLATE 5-7d

70

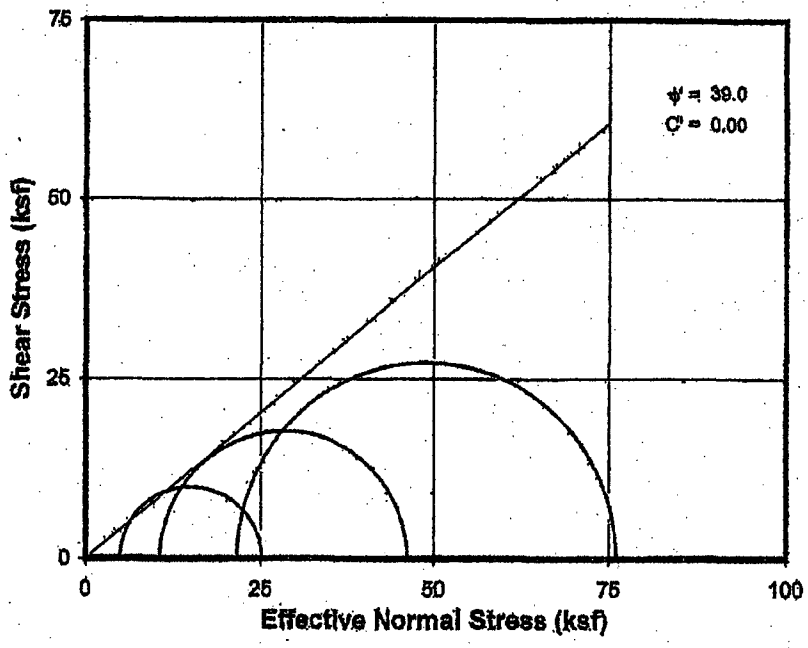


CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Density
Mohrs Circles Constructed Based on Peak Deviator Stress

Reviewed By: mnm

PLATE 5-8a

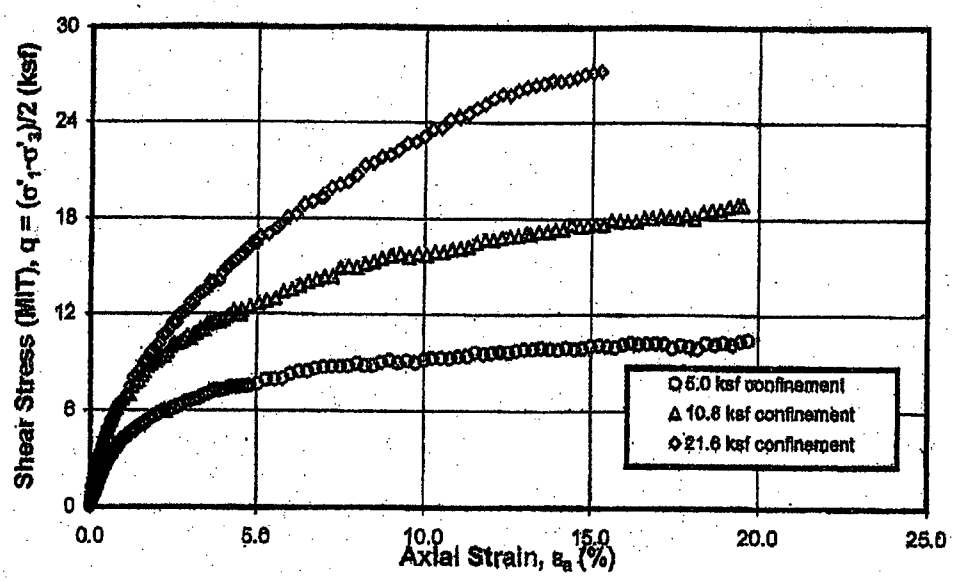
71



CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Density
Mohrs Circles Constructed Based on Peak Deviator Stress Limited to 15% Axial Strain

Reviewed By: mnm

PLATE 5-8b



Initial/Consolidated Specimen Conditions

Specimen	Sample	Condition	Height (mm)	Volume (cm^3)	Area (cm^2)	Water Content (%)	Density Total (lbf/ft^3)	Density Dry (lbf/ft^3)	Saturation (%)	Void Ratio e
1	#57	a	305.0	5,638	184.9	2.2	99.0	98.8	7.6	0.823
		b	303.6	5,454	179.6	23.2	123.3	100.1	86.0	0.764
2	#57	a	305.1	5,590	183.2	2.4	103.0	100.6	8.6	0.755
		b	304.0	5,380	177.0	21.7	127.2	104.5	89.2	0.689
3	#57	a	302.1	5,617	185.9	1.9	102.4	100.5	7.0	0.757
		b	298.8	5,258	175.9	24.1	133.2	107.3	108.0	0.645

Note a: initial sample condition
b: after application of confining stress

Test Summaries

Specimen		ε_a (%)	q (MIT) (ksf)	p' (MIT) (ksf)	ΔU (ksf)	σ'_1 (ksf)	σ'_3 (ksf)
1	Max. Shear Stress	19.70	10.49	15.56	-0.04	26.05	5.07
	Max. Obliquity	19.70	10.49	15.56	-0.04	26.05	5.07
2	Max. Shear Stress	19.51	18.91	29.76	-0.02	48.68	10.85
	Max. Obliquity	19.38	18.89	29.69	-0.02	48.58	10.80
3	Max. Shear Stress	16.26	27.24	48.84	-0.02	76.08	21.59
	Max. Obliquity	16.26	27.24	48.84	-0.02	76.08	21.59

CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS

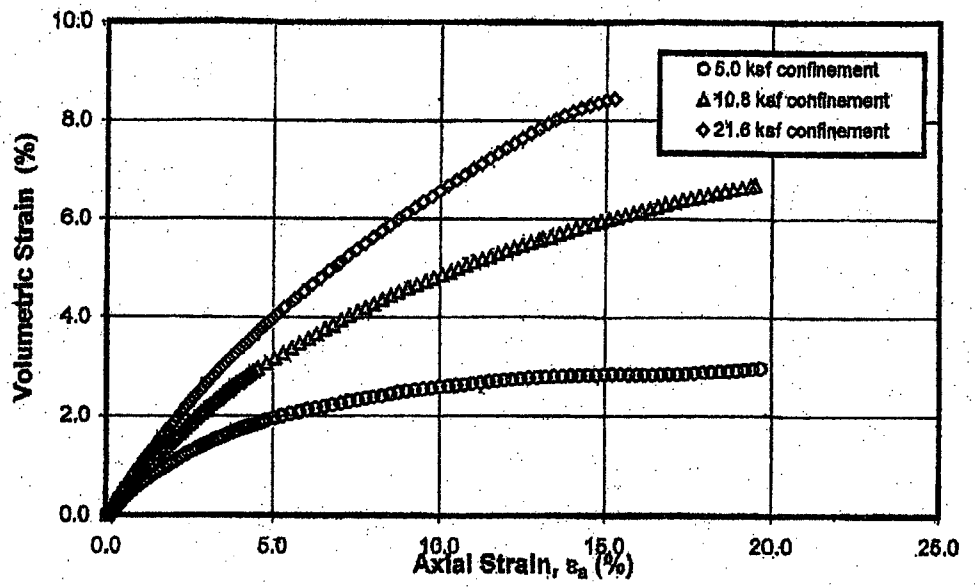
Isotropically Consolidated

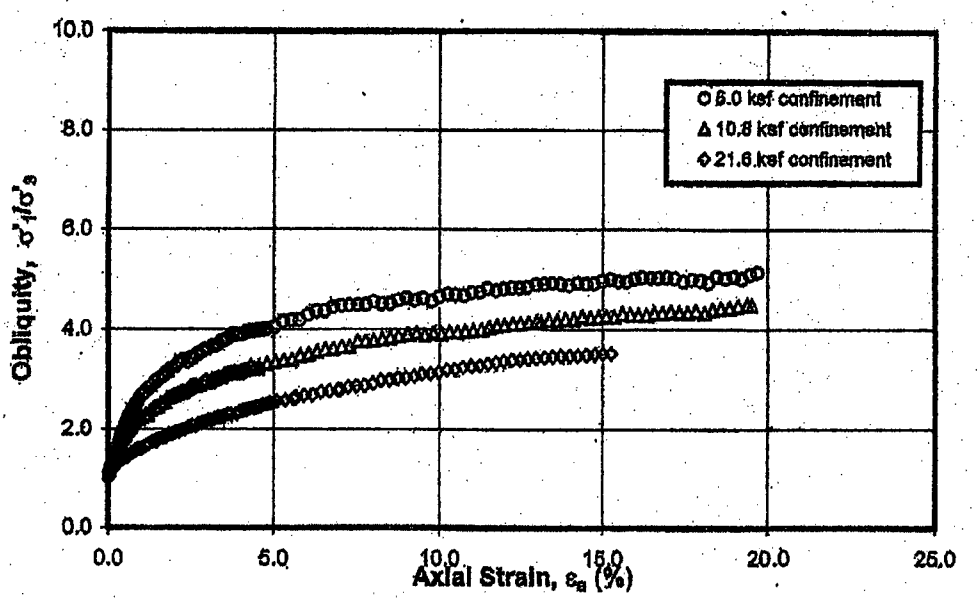
Sample: #57, Compacted to 80% Relative Density

Reviewed By: mnm

PLATE 5-8c

73





CONSOLIDATED-DRAINED TRIAXIAL COMPRESSION TESTS RESULTS
Isotropically Consolidated
Sample: #57, Compacted to 80% Relative Density

Reviewed By: mmm

PLATE 5-8d