FILE

Revised Structure Type Study

Ramp C over Fairground Road

SCI-823-0.00
PID No. 19415

Prepared for

Ohio Department of Transportation

March 2007

CH2MHILL

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1. Introduction

On July 14, 2005, CH2M HILL submitted a Structure Type Study for the Ramp C over Fairground Road structure located at the proposed US 23/SR 823 Interchange. This structure was designed to have both abutments supported behind a Mechanically Stabilized Embankment (MSE) wall due to not only the inexpensive nature of this type of wall construction, but also the reduced bridge costs, including life cycle maintenance costs. Subsequent ODOT review comments of the Structure Type Study on September 1, 2005 recognized the economic benefit of the recommended MSE wall abutments; however, ODOT Office of Structural Engineering (OSE) commented that *"The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure Type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office."*

All retaining wall justification and wall type studies were to be conducted by another consultant and coordinated with CH2M HILL. Since a Wall Type Study was not submitted, the Ramp C over Fairground Road bridge has not been approved by OSE to-date. In December 2006, the Wall Type Study work was transferred to CH2M HILL. To assist ODOT OSE in performing a comprehensive review of this report, the Wall Type Study is submitted concurrently with this report.

In October 2006, the project's geotechnical consultant, DLZ, submitted a revised *"Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23/SR 823 Interchange"* report, which included the design calculations requested by ODOT OSE. The report concluded that *"MSE walls can be safely constructed using staged construction and ground modification techniques at this interchange. However, due to the relatively poor subsurface conditions, the risk of detrimental differential settlement is greater when constructing the MSE walls using staged construction."* Due to concerns over the existing soil conditions at the proposed interchange location, additional ground improvement and/or wall alternatives were investigated in a Wall Type Study in conjunction with revising the original Structure Type Studies for this location. To determine the most economical solution, various bridge layouts and types were matched with these walls/ground improvement alternatives. For a summary of the wall / ground improvement alternatives and the preliminary structural foundation recommendations presented by DLZ, see Appendix E.

2. Major Developments

The following is a summary of the changes made to the previous Ramp C over Fairground Road Structure Type Study submission.

- Five (5) bridge/wall alternatives were considered to determine the most economical, combined structural system:
    1. Single span bridge behind MSE Walls constructed on soil that has been surcharged in stages;
    2. Single span bridge behind MSE Walls utilizing deep soil mixing for ground improvement;
    3. Three span bridge behind 2:1 spill-through slopes;

4. Single span bridge behind 2:1 spill-through slopes; and
5. Single span bridge behind pile-supported, reinforced CIP walls on soil that has been surcharged

Each bridge/wall alternative was evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, aesthetics, constructability, and maintenance of traffic. Based on these evaluations, one alternative is recommended for further design development in the Bridge Preliminary Design Report stage.

- The existing Fairground Road pavement width is 21'-0". Discussions between Scioto County and ODOT District 9 determined that there are no future plans to widen Fairground Road, but it was recommended that the proposed structure allow for a 24'-0" future pavement width.
- New pricing information for several structural items in 2006 dollars was used in this Structure Type Study re-submittal.
- Geotechnical consultant, DLZ, revised foundation and wall recommendations. A copy of DLZ's foundation report, including logs, is attached in Appendix E.
- The posted speed for Fairground Road was determined to be 55 mph, with a design speed of 60 mph. Based on Figure 600-1 of the ODOT L&D Manual, Volume 1, this design speed for a rural, minor collector yields a preferred horizontal clearance of 30'-0" from the edge of pavement. Therefore, the proposed horizontal clearance for Fairground Road was determined to be 30'-0" from the edge of the future 12'-0" travel lane dimension; the existing edge of pavement to edge of pavement width is approximately 21'-0". Span lengths for all alternatives shall meet this requirement.

3. Design Criteria

All proposed structure types are in accordance with the most current version of the Ohio Department of Transportation Bridge Design Manual and the 2002 AASHTO Standard Specifications for Highway Bridges, 17th edition.

4. Bridge Transverse Section and Alignment

At the proposed bridge location, Ramp C follows a 1°00'00" horizontal curve (5729.58-foot radius) to the right. The proposed section consists of one 16-foot lane, a 6-foot left shoulder, and an 8-foot right shoulder. With two 1'-6" wide single slope deflector parapets, the out-to-out deck width is a constant 33'-0" for all alternatives. The Ramp C bridge will be superelevated, with a constant superelevation rate of 2.9 percent across the entire length of the proposed structure.

The proposed Ramp C vertical alignment over Fairground Road consists of a 250-foot sag vertical curve over the entire length of the proposed bridge structure.

The existing Fairground Road will remain on the existing horizontal alignment and vertical grade under the bridge, and will not be constructed as part of the project except as required for restoration after construction of the new bridge.

5. Proposed Maintenance of Traffic Solution

The proposed Ramp C alignment will carry traffic exiting westbound SR-823 onto northbound US-23. Because the Ramp C alignment is new construction, maintenance of traffic during construction of the Ramp C bridge over Fairground Road will be limited. With the exception of limited Fairground Road closure for superstructure beam setting, as well as traffic safety precautions throughout bridge construction, no additional maintenance of traffic solutions will need to be investigated.

6. Evaluation of Structure Alternatives

Common Considerations

Construction costs for each alternative have been developed for an identical length of improvement, equal to the length of the longest alternative. Estimated construction costs for each alternative include all proposed structures and wall work between these limits. The vertical profile of Ramp C is controlled by the crossing over the Norfolk Southern Railway to the west of the proposed structure over Fairground Road. As a result, vertical clearance over Fairground Road greatly exceeds the 15'-0" minimum for a rural, minor collector, and no additional costs associated with profile adjustments are necessary. Other construction costs not included in the cost estimate include provisions for the reconstruction of Fairground Road (if required due to construction impacts) and maintenance of traffic cost differentials.

The existing Fairground Road section is an uncurbed roadway, with an edge of pavement to edge of pavement width of approximately 21'-0" and a posted speed of 55 mph. Discussions between Scioto County and ODOT District 9 determined that there are no future plans to widen Fairground Road, but it is desired that the proposed structure allow for a future 24'-0" pavement width. Therefore, substructures along Fairground Road for alternatives consisting of spill-through slopes are located outside the minimum preferred horizontal clear zone width of 30'-0". Substructures consisting of abutments behind MSE or CIP walls are also located outside the minimum preferred horizontal clear zone width of 30'-0" to the face of MSE/CIP wall.

Alternative 1

Alternative 1 consists of a 106'-10" single-span bridge with rear and forward semi-integral stub abutments on steel H-piles behind MSE abutment breastwalls constructed outside the minimum preferred Fairground Road lateral clearance. Both abutment faces are straight and parallel to the existing Fairground Road centerline. The superstructure will consist of four 54"-deep AASHTO Type 4 prestressed concrete beams spaced at 9'-0" on center.

The initial bridge construction cost for Alternative 1 is estimated to be $568,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $227,000, resulting in a total estimated bridge ownership cost of $795,000 in year 2006 dollars.

The wall improvement strategy for this alternative is to preload this location in three stages, prior to constructing conventional MSE abutment walls. Geotextile fabric walls will be used to prevent the surcharge embankment from encroaching upon Fairground Road and its

open drainage system. For additional information on this wall improvement alternative, please refer to the separate Wall Type Study submittal.

To determine the total bridge/wall system cost of Alternative 1, the other proposed bridges along Fairground Road (Ramp B over Fairground Road and SR 823 over Fairground Road) need to be considered – please refer to the separate Structure Type Studies for these structures. In addition, refer to the Alternative vs. Cost Matrix in Appendix F, which shows that the total bridge/wall system cost of Alternative 1 is estimated to be $4,919,000 in year 2006 dollars.

Alternative 2

Alternative 2 consists of a 106'-10" single-span bridge with rear and forward semi-integral stub abutments behind MSE abutment breastwalls constructed outside the minimum preferred Fairground Road lateral clearance. Both abutment faces are straight and parallel to the existing Fairground Road centerline. While it is possible to construct an MSE retaining wall with semi-integral stub abutments on steel H-piles, both the rear and the forward abutments are assumed to be founded on spread footings for this analysis due to the soil-mixed nature of the subsurface condition below the MSE Wall. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. For Alternative 2, the superstructure will consist of four tangent 54"-deep AASHTO Type 4 prestressed concrete beams spaced at 9'-0" on center.

The initial bridge construction cost for Alternative 2 is estimated to be $517,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $227,000, resulting in a total estimated bridge ownership cost of $744,000 in year 2006 dollars.

The wall improvement strategy for this alternative is to utilize deep soil mixing, prior to constructing conventional MSE abutment walls. For additional information on this wall improvement alternative, please refer to the separate Wall Type Study submittal.

To determine the total bridge/wall system cost of Alternative 2, the other proposed bridges along Fairground Road (Ramp B over Fairground Road and SR 823 over Fairground Road) need to be considered – please refer to the separate Structure Type Studies for these structures. In addition, refer to the Alternative vs. Cost Matrix in Appendix F, which shows that the total bridge/wall system cost of Alternative 2 is estimated to be $4,941,000 in year 2006 dollars.

Alternative 3

Alternative 3 consists of a 67'-1", 95'-10", 67'-1" three span bridge with rear and forward abutments on steel H-piles behind 2:1 spill-through slopes constructed outside the minimum preferred Fairground Road lateral clearance. The rear and forward abutment breastwalls will be straight and parallel to the existing Fairground Road centerline. For Alternative 3, the superstructure will consist of four 54"-deep AASHTO Type 4 prestressed concrete beams spaced at 9'-0" on center. For cost comparison purposes, the piers are also assumed to be founded on steel H-piles. However, according to preliminary boring logs, the piles at Pier 1 and Pier 2 may be less than 10', which is not acceptable. Additional

borings may be obtained to locate bedrock at this location if this alternative is selected. As a result, Pier 1 and Pier 2 may be required to be on either drilled shafts or a spread footing on rock.

The initial bridge construction cost for Alternative 3 is estimated to be $962,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $455,000, resulting in a total estimated bridge ownership cost of $1,417,000 in year 2006 dollars.

The wall improvement strategy for this alternative is to not use a wall, but rather construct the proposed abutments on 2:1 stage-constructed embankment. For additional information on this wall improvement alternative, please refer to the separate Wall Type Study submittal.

To determine the total bridge/wall system cost of Alternative 3, the other proposed bridges along Fairground Road (Ramp B over Fairground Road and SR 823 over Fairground Road) need to be considered – please refer to the separate Structure Type Studies for these structures. In addition, refer to the Alternative vs. Cost Matrix in Appendix F, which shows that the total bridge/wall system cost of Alternative 3 is estimated to be $6,220,000 in year 2006 dollars.

Alternative 4

Alternative 4 consists of a 178'-11" single span bridge with rear and forward abutments on steel H-piles behind 2:1 spill-through slopes constructed outside the minimum preferred Fairground Road lateral clearance. The rear and forward abutment breastwalls will be straight and parallel to the existing Fairground Road centerline. For Alternative 4, the superstructure will consist of four 72" Grade 50 weathering steel plate girders, spaced at 9'-0" on center.

The initial bridge construction cost for Alternative 4 is estimated to be $1,204,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $661,000, resulting in a total estimated bridge ownership cost of $1,865,000 in year 2006 dollars.

The wall improvement strategy for this alternative is to not use a wall, but rather construct the proposed abutments on 2:1 stage-constructed embankment. For additional information on this wall improvement alternative, please refer to the separate Wall Type Study submittal.

To determine the total bridge/wall system cost of Alternative 4, the other proposed bridges along Fairground Road (Ramp B over Fairground Road and SR 823 over Fairground Road) need to be considered – please refer to the separate Structure Type Studies for these structures. In addition, refer to the Alternative vs. Cost Matrix in Appendix F, which shows that the total bridge/wall system cost of Alternative 4 is estimated to be $7,744,000 in year 2006 dollars.

Alternative 5

Alternative 5 consists of a 95'-10" single-span bridge with rear and forward full height cast-in-place (CIP) abutments on steel H-piles constructed outside the minimum preferred

Fairground Road lateral clearance. Both abutment faces are straight and parallel to the existing Fairground Road centerline. The superstructure will consist of four 54"-deep AASHTO Type 4 prestressed concrete beams spaced at 9'-0" on center. For cost comparison purposes, the rear and forward abutments are assumed to be founded on steel H-piles. However, according to preliminary boring logs, the piles at the both abutments may be less than 10', which is not acceptable. Additional borings may be obtained to locate bedrock at this location if this alternative is selected. As a result, the full height CIP rear and forward abutments may be required to be on either drilled shafts or a spread footing on rock.

The initial bridge construction cost for Alternative 5 is estimated to be $778,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $205,000, resulting in a total estimated bridge ownership cost of $983,000 in year 2006 dollars.

The wall improvement strategy for this alternative is to preload this location in three stages, prior to constructing the full-height CIP abutment walls. Geotextile fabric walls will be used to prevent the surcharge embankment from encroaching upon Fairground Road and its open drainage system. For additional information on this wall improvement alternative, please refer to the separate Wall Type Study submittal.

To determine the total bridge/wall system cost of Alternative 5, the other proposed bridges along Fairground Road (Ramp B over Fairground Road and SR 823 over Fairground Road) need to be considered – please refer to the separate Structure Type Studies for these structures. In addition, refer to the Alternative vs. Cost Matrix in Appendix F, which shows that the total bridge/wall system cost of Alternative 5 is estimated to be $5,495,000 in year 2006 dollars.

7. Recommended Alternative

Five (5) structural solutions for the construction of the proposed Ramp C bridge over Fairground Road have been evaluated in this revised Structure Type Study. All alternatives provide comparable operational characteristics and meet minimum horizontal clearance requirements. Due to the fact that the proposed Ramp C grade separation structure over the Norfolk Southern Railway west of Fairground Road controls the vertical profile for vertical clearance, no differential costs associated with profile adjustments have been considered in the aforementioned alternatives.

Based on estimated total ownership costs for the three Fairground Road bridges, the single-span bridge of Alternative 2 is the most cost-effective structure. However, when including the wall improvement costs and the additional roadway embankment costs associated with the shorter bridge lengths per the separate Wall Type Study submittal, Alternative 1 becomes the most economical solution by $22,000 in relation to Alternative 2. Qualitatively, there are two distinct differences between Alternative 1 and Alternative 2: *construction time and construction risk.* The staged construction nature of Alternative 1 will add additional construction time to the schedule, due to the need to consolidate the existing subsurface in stages prior to construction of the permanent MSE Walls; quantitatively speaking, the additional construction time is dependent upon the use of wick drains, and if used, to what extent. In addition, per geotechnical consultant, DLZ, the relatively poor subsurface conditions increase the risk of detrimental differential settlement when constructing the

MSE walls using staged construction. Soil mixing ground improvement, as used in Alternative 2, would lower construction risk and future maintenance problems associated with MSE wall construction. As a result, based on low estimated total ownership costs and lower qualitative costs in construction time and construction risk, **CH2M HILL recommends that the single-span bridge of ALTERNATIVE 2, using MSE walls and prestressed concrete I-beams, be constructed for the Ramp C bridge over Fairground Road.**

8. Subsurface Conditions and Foundation Recommendation

Subsurface investigations for the SCI-823-0.00 project will be conducted in two or possibly three phases. The first mobilization is complete, and included all of the proposed pavement and embankment borings, and a limited number of bridge borings. The second mobilization will include the remaining bridge borings (if necessary), and the majority of the proposed MSE retaining wall borings. If required, a third mobilization will target specific boring locations or in-situ testing recommended in the bridge and retaining wall Preliminary Design Report submissions.

Two borings at the Ramp C bridge over Fairground Road were taken during the first mobilization. Based on these initial borings, geotechnical consultant, DLZ, has made preliminary foundation recommendations for the Ramp C structure. Copies of the preliminary report are included with this submission.

The recommended alternative, Alternative 2, consists of semi-integral abutments supported behind MSE retaining walls for the single-span bridge. Both abutments are assumed to be supported on spread footings resting directly on the MSE select granular fill to avoid conflicts with the MSE reinforcing straps. If pile foundations are required and used, the piles are envisioned to be HP 12x53 H-pile sections driven to bedrock refusal. The pile spacing is assumed to be 7'-6" to allow for convenient staggering of the piles between MSE reinforcing in 5'-0" standard square wall panels. An alternative to driven H-piles would be the use of drilled shafts socketed into bedrock.

Final foundation size, capacity, and possible pile length recommendations will be made upon completion of the remaining bridge and retaining wall borings, and will be included with the bridge Preliminary Design Report submission.

APPENDIX A

SCI-823-0.00
Ramp C Over Fairground Road
STRUCTURE TYPE STUDY

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[Structure Cost Comparison.xls]Substructure
By: DGS Date: 3/15/2007
Checked: SKT Date: 3/21/2007

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Approach Roadway Length (Note 2)	Approach Roadway Cost (Notes 3 & 4)	Structure Incidental Cost (16%) (Note 5)	Structure Contingency Cost (20%)	Roadway Incidental & Contingency Cost (30%) (Note 6)	Total Initial Construction Cost (Note 1)	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	1	106.83	106.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	**$254,000**	**$116,000**	123.2	**$41,000**	**$59,000**	**$86,000**	**$12,000**	**$568,000**	**$227,000**	**$795,000**
2	1	106.83	106.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	**$254,000**	**$80,000**	123.2	**$41,000**	**$53,000**	**$77,000**	**$12,000**	**$517,000**	**$227,000**	**$744,000**
3	3	67.08 - 95.83 - 67.08	230.00	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	**$487,000**	**$204,000**	0.0	**$0**	**$111,000**	**$160,000**	**$0**	**$962,000**	**$455,000**	**$1,417,000**
4	1	178.92	178.92	4 ~ Steel Plate Girders	72" Steel Plate Girder	**$713,000**	**$136,000**	51.1	**$17,000**	**$136,000**	**$197,000**	**$5,000**	**$1,204,000**	**$661,000**	**$1,865,000**
5	1	95.83	95.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	**$233,000**	**$285,000**	134.2	**$44,000**	**$83,000**	**$120,000**	**$13,000**	**$778,000**	**$205,000**	**$983,000**

NOTES:

1. The total initial construction costs do not include ground improvement costs. See Wall Type Study for those costs.
2. Approach roadway length equals the difference between the maximum bridge length and the bridge length for the alternative being considered.
3. Use 2006 pavement cost = $46.00 /sq. yd.

   Pavement Widths:

Alternative	Average Rear Approach		Average Fwd. Approach		Combined Average	
Alt. 1	33.00	ft.	33.00	ft.	33.00	ft.
Alt. 2	33.00	ft.	33.00	ft.	33.00	ft.
Alt. 3	33.00	ft.	33.00	ft.	33.00	ft.
Alt. 4	33.00	ft.	33.00	ft.	33.00	ft.
Alt. 5	33.00	ft.	33.00	ft.	33.00	ft.

4. Use 2006 Concrete Barrier, Single Slope Median, Type B1 cost = $64.00 /ft.
   Use 2006 Concrete Barrier, Single Slope, Type D cost = $81.00 /ft.
5. Structure incidental cost allowance includes provision for structure excavation, porous backfill & drainage pipe, sealing of concrete surfaces, structural steel painting, bearings, (minor) temporary shoring, crushed aggregate slope protection, pile driving equipment mobilization, shear connectors, settlement platforms, expansion joints, joint sealers, and joint fillers costs.
6. Roadway incidental cost allowance includes provision for drainage, maintenance of traffic, and traffic control costs.
7. No profile adjustment costs associated with raising the SCI-823 profiles have been considered, since all alternatives satisfy the minimum required vertical clearance of 15'-0" for steel structures and 15'-0" for concrete structures.

Alternative	Vertical Clearance Provided (ft.)		Profile Adjustment Required (ft.)	
Alt. 1	20.53	ft.	0.00	ft.
Alt. 2	20.53	ft.	0.00	ft.
Alt. 3	20.53	ft.	0.00	ft.
Alt. 4	18.79	ft.	0.00	ft.
Alt. 5	20.53	ft.	0.00	ft.

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SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Area (sq. ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Framing Alternative	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Prestressed Beam Cost	Initial Superstructure Cost
1	1	106.83	106.83	108.83	3,600	138	$67,800	$31,900	$45,300	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	0.0	$0	$108,600	**$254,000**
2	1	106.83	106.83	108.83	3,600	138	$67,800	$31,900	$45,300	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	0.0	$0	$108,600	**$254,000**
3	3	67.08 - 95.83 - 67.08	230.00	232.00	7,700	294	$144,400	$67,900	$45,300	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	0.0	$0	$229,200	**$487,000**
4	1	178.92	178.92	180.92	6,000	229	$112,600	$53,000	$45,300	4 ~ Steel Plate Girders	72" Steel Plate Girder	390000.0	$502,300	$0	**$713,000**
5	1	95.83	95.83	97.83	3,200	124	$60,900	$28,600	$45,300	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	0.0	$0	$98,300	**$233,000**

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	2	4.26	8.52
Median	0	9.29	0.00

Slab:

	T (ft.)	Ave. W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Alt. 1	0.71	33.00	23.4	2.3	34.2
Alt. 2	0.71	33.00	23.4	2.3	34.2
Alt. 3	0.71	33.00	23.4	2.3	34.2
Alt. 4	0.71	33.00	23.4	2.3	34.2
Alt. 5	0.71	33.00	23.4	2.3	34.2

Note: Deck width measured as average width.
10% of deck area allowed for haunches and overhangs

QC/QA Concrete, Class QSC2
Unit Cost ($/cu. yd):

	Year 2005	Annual Escalation	Year 2006
Deck	$512.91	3.0%	$528.00
Parapets	$370.36	3.0%	$381.00
Weighted Average (Alt. 1 - Alt. 5) =			$491.00

Based on parapet and slab percentages of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):

Assume 285 lbs of reinforcing steel per cubic yard of deck concrete for concrete or steel girder bridges

	Year 2005	Annual Escalation	Year 2006
Deck Reinforcing	$0.79	3.0%	$0.81

Prestressed Concrete Beams
Unit Costs:

	Year 2005		Annual Escalation	Year 2006		No. Required
Alt. 1						
AASHTO Type 4 Beams						
Type 4 I-Beams (54")	$220	lf	6.0%	$233	lf	428
Intermediate Diaphragms	$920	ea.	6.0%	$975	ea.	9
Alt. 2						
AASHTO Type 4 Beams						
Type 4 I-Beams (54")	$220	lf	6.0%	$233	lf	428
Intermediate Diaphragms	$920	ea.	6.0%	$975	ea.	9
Alt. 3						
AASHTO Type 4 Beams						
Type 4 I-Beams (54")	$220	lf	6.0%	$233	lf	920
Intermediate Diaphragms	$920	ea.	6.0%	$975	ea.	15
Alt. 5						
AASHTO Type 4 Beams						
Type 4 I-Beams (54")	$220	lf	6.0%	$233	lf	384
Intermediate Diaphragms	$920	ea.	6.0%	$975	ea.	9

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2006
Rolled Beams - Grade 50 (level 2)	n/a	$0.95	12.0%	$1.06
Plate Girders - Grade 50 (level 4)	n/a	$1.15	12.0%	$1.29
Hybrid Plate Girders - Grade 50/70W	1.10	$1.27	12.0%	$1.42

Note - all structural steel weight will be estimated at 65 pounds per each square foot of bridge deck area for long span tangent girders.
45 pounds per each square foot of bridge deck area for short span tangent girders.

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):

Alt. 1 - 5
Length = 30 ft. Width = 33.00 ft
Area = 110 sq. yd.

	Year 2005	Annual Escalation	Year 2006
Approach Slabs	$199.78	3.0%	$206.00

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Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[Structure Cost Comparison.xls]Substructure
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SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	Initial Substructure Cost
1	1	106.83	4 – P.S. Concrete I-Beams	AASHTO Type 4	$0	$0	$67,700	$12,500	$35,900	**$116,000**
2	1	106.83	4 – P.S. Concrete I-Beams	AASHTO Type 4	$0	$0	$67,700	$12,500	$0	**$80,000**
3	3	67.08 - 95.83 - 67.08	4 – P.S. Concrete I-Beams	AASHTO Type 4	$55,500	$11,900	$73,400	$13,600	$49,700	**$204,000**
4	1	178.92	4 – Steel Plate Girders	72" Steel Plate Girder	$0	$0	$84,300	$15,600	$35,900	**$136,000**
5	1	95.83	4 – P.S. Concrete I-Beams	AASHTO Type 4	$0	$0	$222,800	$28,300	$33,400	**$285,000**

Pier QC/QA Concrete, Class QSC1 Cost:

Alt 3; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	21.5	$555.68	3.0%	$572.00	$12,300
Columns	15.2	$555.68	3.0%	$572.00	$8,690
Footings	21.3	$300.31	3.0%	$309.00	$6,580
Total Pier Cost					$27,600 Each Pier

Alt 3; Pier 2

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	21.5	$555.68	3.0%	$572.00	$12,300
Columns	15.8	$555.68	3.0%	$572.00	$9,040
Footings	21.3	$300.31	3.0%	$309.00	$6,580
Total Pier Cost					$27,900 Each Pier

Pile Foundation Unit Cost ($/ft.): HP Steel Piles, Furnished & Driven

Pier Piles:

	Number Pier 1	Number Pier 2	Top Elevation Pier 1	Top Elevation Pier 2	Bottom Elevation Pier 1	Bottom Elevation Pier 2	Length Per Pier 1 Pile	Length Per Pier 2 Pile	Total Pile Length	Total Cost	Pile Size
Alt. 1	0	0	0.0	0.0	0.0	0.0	0	0	0	$0	
Alt. 2	0	0	0.0	0.0	0.0	0.0	0	0	0	$0	
Alt. 3	12	12	562.9	560.0	551.9	542.8	20	20	480	$14,200	HP10 x 42
Alt. 4	0	0	0.0	0.0	0.0	0.0	0	0	0	$0	
Alt. 5	0	0	0.0	0.0	0.0	0.0	0	0	0	$0	

Abutment Piles:

	Number Rear	Number Forward	Top Elevation Rear	Top Elevation Forward	Bottom Elevation Rear	Bottom Elevation Fwd.	Length Per Rear Pile	Length Per Forward Pile	Total Pile Length	Total Cost	
Alt. 1	14	16	583.5	582.5	551.9	542.8	40	40	1,200	$35,900	HP12 x 53
Alt. 2	0	0	0.0	0.0	0.0	0.0	0	0	0	$0	
Alt. 3	14	16	585.1	580.2	551.9	542.8	40	40	1,200	$35,500	HP10 x 42
Alt. 4	14	16	582.9	579.2	551.9	542.8	40	40	1,200	$35,900	HP12 x 53
Alt. 5	23	23	562.9	560.9	551.9	542.8	20	20	920	$33,400	HP14 x 73

HP10 x 42 Steel Piles, Furnished & Driven	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$17.50	6.0%	$18.60
Driven	$10.69	3.0%	$11.00
Total			$29.60

HP12 x 53 Steel Piles, Furnished & Driven	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$19.02	6.0%	$20.20
Driven	$9.38	3.0%	$9.70
Total			$29.90

HP14 x 73 Steel Piles, Furnished & Driven	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$27.30	6.0%	$28.90
Driven	$7.19	3.0%	$7.40
Total			$36.30

Abutment QC/QA Concrete, Class QSC1 Cost:

Alt. 1 & 2

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment					
Rear	56.2	$384.26	3.0%	$396.00	$22,300
Fwd	56.2	$384.26	3.0%	$396.00	$22,300
Wingwalls					
Rear	28.6	$384.26	3.0%	$396.00	$11,300
Fwd	29.9	$384.26	3.0%	$396.00	$11,800

Alt. 3

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment					
Rear	60.3	$384.26	3.0%	$396.00	$23,900
Fwd	60.3	$384.26	3.0%	$396.00	$23,900
Wingwalls					
Rear	28.9	$384.26	3.0%	$396.00	$11,400
Fwd	35.8	$384.26	3.0%	$396.00	$14,200

Alt. 4

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment					
Rear	68.2	$384.26	3.0%	$396.00	$27,000
Fwd	68.2	$384.26	3.0%	$396.00	$27,000
Wingwalls					
Rear	34.7	$384.26	3.0%	$396.00	$13,700
Fwd	41.9	$384.26	3.0%	$396.00	$16,600

Alt. 5

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment					
Rear	193.0	$560.20	3.0%	$577.00	$111,400
Fwd	193.0	$560.20	3.0%	$577.00	$111,400
Wingwalls					
Rear	0.0	$384.26	3.0%	$396.00	$0
Fwd	0.0	$384.26	3.0%	$396.00	$0

Reinforcing Steel Unit Cost ($/lb):

Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

	Year 2005	Annual Escalation	Year 2006
Pier	$0.79	3.0%	$0.81
Abutment	$0.79	3.0%	$0.81

SCI-823-0.00
Ramp C Over Fairground Road
STRUCTURE TYPE STUDY

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[Structure Cost Comparison.xls]Substructure
By: DGS Date: 3/15/2007
Checked: SKT Date: 3/21/2007

LIFE CYCLE MAINTENANCE COST

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Structural Steel Painting (5) Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Superstructure Sealing (5) Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Approach Pavement Resurfacing (7) Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost
1	1	106.83	4 ~ P.S. Concrete I-Beams	$0	0	$0	$6,900	4	$27,600	$2,000	7	$14,000
2	1	106.83	4 ~ P.S. Concrete I-Beams	$0	0	$0	$6,900	4	$27,600	$2,000	7	$14,000
3	3	67.08 - 95.83 - 67.08	4 ~ P.S. Concrete I-Beams	$0	0	$0	$14,700	4	$58,800	$0	7	$0
4	1	178.92	4 ~ Steel Plate Girders	$173,000	2	$346,000	$0	0	$0	$800	7	$5,600
5	1	95.83	4 ~ P.S. Concrete I-Beams	$0	0	$0	$6,100	4	$24,400	$2,100	7	$14,700

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Bridge Deck Overlay (5) Deck Demo & Chipping	Deck Overlay	Deck Joint Gland (2)	Number of Maintenance Cycles	Total Life Cycle Cost	Bridge Redecking (5) Deck Concrete Cost (3)	Deck Reinforcing Cost (3)	Deck Joint Cost (2)	Deck Removal Cost	Number of Maintenance Cycles	Total Life Cycle Cost	Superstructure Life Cycle Maintenance Cost (1)	Total Initial Construction Cost	Total Relative Ownership Cost
1	1	106.83	4 ~ P.S. Concrete I-Beams	$11,600	$13,400	$0	2	$50,000	$67,800	$31,900	$0	$36,000	1	$135,700	**$227,000**	**$568,000**	**$795,000**
2	1	106.83	4 ~ P.S. Concrete I-Beams	$11,600	$13,400	$0	2	$50,000	$67,800	$31,900	$0	$36,000	1	$135,700	**$227,000**	**$517,000**	**$744,000**
3	3	67.08 - 95.83 - 67.08	4 ~ P.S. Concrete I-Beams	$24,700	$28,700	$0	2	$106,800	$144,400	$67,900	$0	$77,000	1	$289,300	**$455,000**	**$962,000**	**$1,417,000**
4	1	178.92	4 ~ Steel Plate Girders	$19,300	$22,400	$0	2	$83,400	$112,600	$53,000	$0	$60,000	1	$225,600	**$661,000**	**$1,204,000**	**$1,865,000**
5	1	95.83	4 ~ P.S. Concrete I-Beams	$10,300	$11,900	$0	2	$44,400	$60,900	$28,600	$0	$32,000	1	$121,500	**$205,000**	**$778,000**	**$983,000**

Structural Steel Painting:

Structural Steel Area:

	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (in.)	Nominal Exposed Girder Area (sq. ft.)	Secondary Member Allowance	Total Exposed Steel Area (sq. ft.)
Alt. 4	72	4	178.9	16.00	11,451	20%	13,700

Painting Cost per sq. ft.:

	Year 2005	Annual Escalation	Year 2006
Prep.	$6.88	3.0%	$7.09
Prime	$1.62	3.0%	$1.67
Intermed.	$1.89	3.0%	$1.95
Finish	$1.86	3.0%	$1.92
Total			$12.63

Superstructure Sealing:

PS Concrete I-Beam Area:
54" AASHTO Type 4

	H	V	Diag.	No.	Total
Bot. Flange	26			1	26.00
		8		2	16.00
Lower Fillets	9	9	12.73	2	25.46
Web		23		2	46.00
Upper Fillets	6	6	8.49	2	16.97
Top Flange		8		2	16.00
Total Exposed Perimeter					146.43 in.

PS Concrete Area:

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1	4	106.83	5,214	10%	640
Alt. 2	4	106.83	5,214	10%	640
Alt. 3	4	230.00	11,226	10%	1,370
Alt. 5	4	95.83	4,678	10%	570

Sealing Cost per sq. yd.:

	Year 2005	Annual Escalation	Year 2006
Epoxy-Urethane Sealer	$10.44	3.0%	$10.75

Bridge Redecking:

Bridge Deck Joint Cost per foot:

	Year 2005	Annual Escalation	Year 2006
Structural Expansion Joint Including Elastomeric Strip Seal	$305.46	3.0%	$314.62

	Bridge Width (ft.)	No. Joints
Alt. 1	33.00	0
Alt. 2	33.00	0
Alt. 3	33.00	0
Alt. 4	33.00	0
Alt. 5	33.00	0

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2006	Deck Removal Cost
Alt. 1	3,600	$10.00	$36,000
Alt. 2	3,600	$10.00	$36,000
Alt. 3	7,700	$10.00	$77,000
Alt. 4	6,000	$10.00	$60,000
Alt. 5	3,200	$10.00	$32,000

Bridge Deck Overlay (Item 848):

Bridge Deck MSC Overlay Cost per sq. yd.:

	Year 2005	Annual Escalation	Year 2006
Micro Silica Modified Concrete Overlay Using Hydrodemolition (1.25" thick)	$29.57	3.0%	$30.46
Surface Preparation Using Hydrodemolition	$25.93	3.0%	$26.71
Hand Chipping (10% of deck area)	$85.66	3.0%	$88.23

Bridge Deck MSC Overlay Cost per cu. yd.:

Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only	$145.00	3.0%	$149.35

	Deck Area (3) (sq. ft.)	Deck Area (sq. yd.)	Hand Chipping (sq. yd.)	Variable Thickness Repair (cu. yd.)
Alt. 1	3,600	400	10	8
Alt. 2	3,600	400	10	8
Alt. 3	7,700	856	21	18
Alt. 4	6,000	667	17	14
Alt. 5	3,200	356	9	7

Assume 25% of deck area requires removal to depth of 4.5" (3.00" additional removal).

Bridge Deck Joint Gland Replacement Cost per foot:

	Year 2005	Annual Escalation	Year 2006
Elastomeric Strip Seal Gland	$76.37	3.0%	$78.66

Assume gland replacement cost equals 25% of original deck joint construction cost.

NOTES:

1. Life cycle maintenance costs assume a 75 -year structure life, and are expressed in present value (2006) dollars.
2. Bridges with straight girders are assumed to have semi-integral abutments, therefore strip seal deck joints are only included for curved girder bridges.
3. See Superstructure Cost sheet.
4. See Alternative Cost Summary sheet.
5. Assume bridge deck overlay at Year 20 & Year 60 and bridge deck replacement at Year 40.
   Assume steel superstructures are painted at Year 25, then on a 25-year recurrence interval.
   Assume concrete superstructures are sealed on a 15-year interval.
   Assume complete bridge replacement at Year 75.
6. Life cycle maintenance cost differences are assumed to be predominately a function of superstructure maintenance costs. Consequently, substructure lifecycle maintenance costs are not included in this analysis.
7. Assume approach pavement resurfacing on a 10-year recurrence interval.

Approach Pavement Resurfacing:

Resurfacing Units Costs:

	Year 2005	Annual Escalation	Year 2006
Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254)	$0.95	3.0%	$0.98
Asphalt Concrete Surface Course, per cu. yd.	$78.03	3.0%	$80.37

Asphalt Resurfacing Costs:

	Approach Roadway Length (ft.) (4)	Approach Roadway Width (ft.)	Resurfacing Area (sq. yd.)	Wearing Course Thickness (in.)	Wearing Course Volume (cu. yd.)
Alt. 1	123.2	33.0	452	1.50	18.8
Alt. 2	123.2	33.0	452	1.50	18.8
Alt. 3	0.0	33.0	0	1.50	0.0
Alt. 4	51.1	33.0	187	1.50	7.8
Alt. 5	134.2	33.0	492	1.50	20.5

SCI-823-0.00

Ramp C Over Fairground Road

STRUCTURE TYPE STUDY

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[Structure Cost Comparison.xls]Substructure

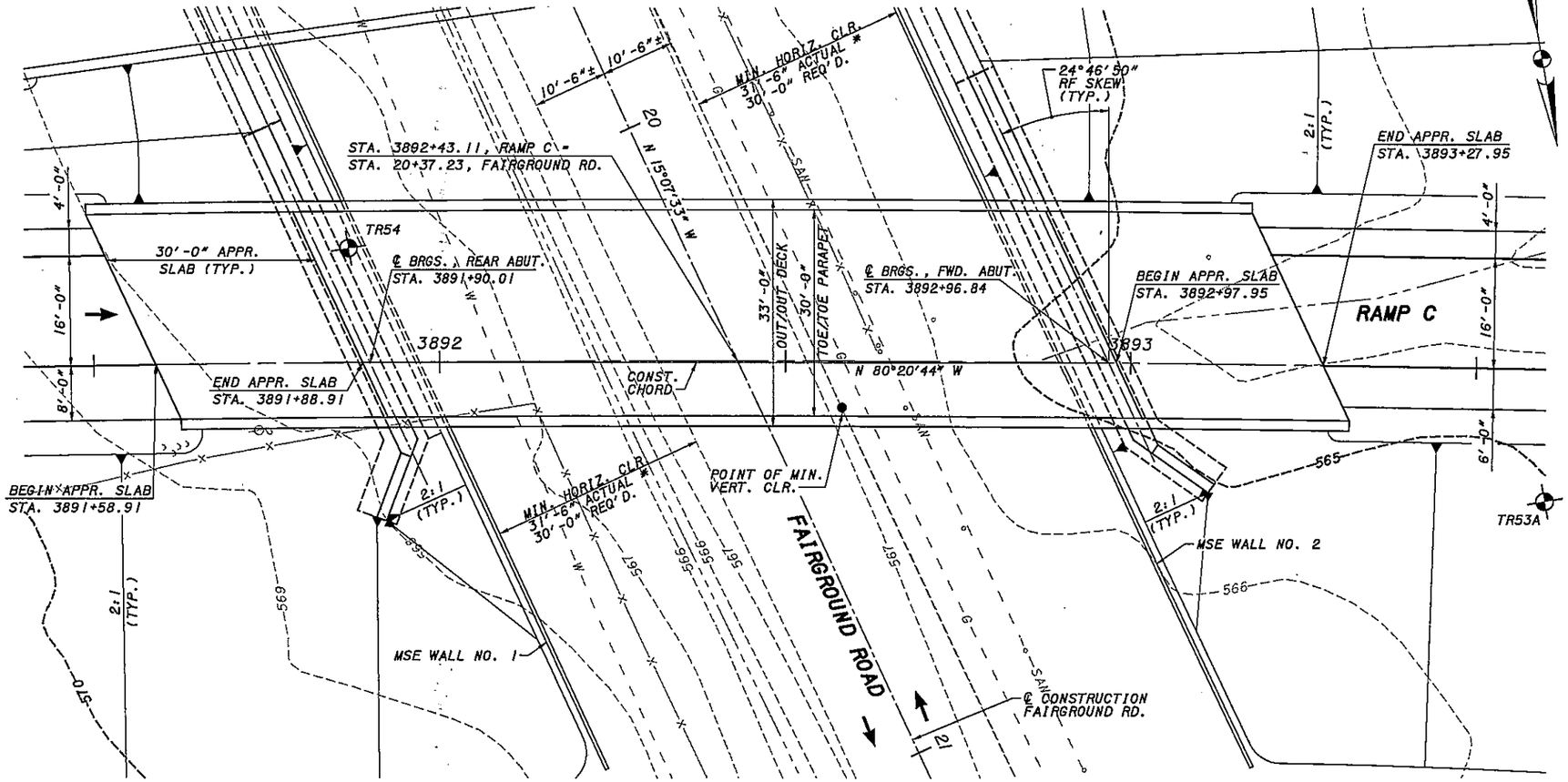
By: DGS Date: 3/15/2007

Checked: SKT Date: 3/21/2007

COST COMPARISON SUMMARY

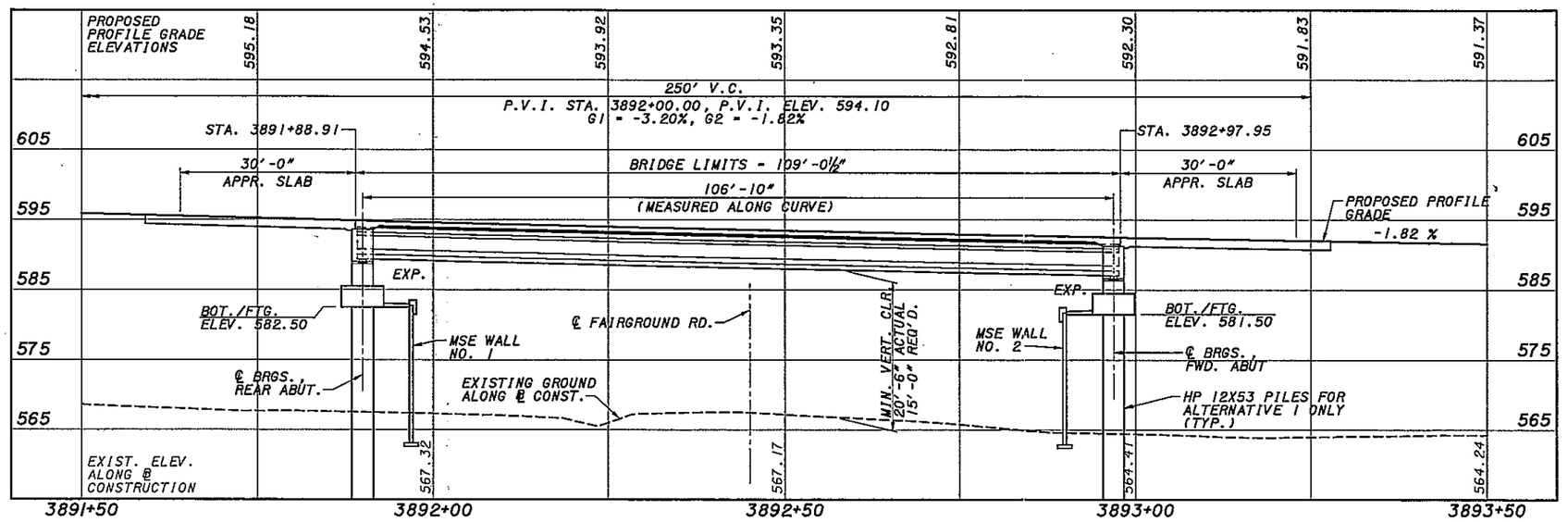
Alternative No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Proposed Stringer Section	Total Initial Superstructure Cost	Total Initial Substructure Cost	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	1	106.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	$254,000	$116,000	$568,000	$227,000	**$795,000**
2	1	106.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	$254,000	$80,000	$517,000	$227,000	**$744,000**
3	3	67.08 - 95.83 - 67.08	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	$487,000	$204,000	$962,000	$455,000	**$1,417,000**
4	1	178.92	4 ~ Steel Plate Girders	72" Steel Plate Girder	$713,000	$136,000	$1,204,000	$661,000	**$1,865,000**
5	1	95.83	4 ~ P.S. Concrete I-Beams	AASHTO Type 4	$233,000	$285,000	$778,000	$205,000	**$983,000**

APPENDIX B



PLAN

* 31'-6" PROVIDED TO PERMIT FUTURE 12'-0" LANE



PROFILE ALONG ℄ CONSTRUCTION, RAMP C

BENCHMARKS

CURVE DATA - RAMP C

P.I. Sta = 3889+21.16
Δ = 9° 37' 49" (RT)
Dc = 1° 00' 00"
R = 5,729.58'
T = 482.65'
L = 963.03'
E = 20.29'

TRAFFIC DATA

CURRENT ADT (2010) - 6200
DESIGN ADT (2030) - 9400
DESIGN ADTT - 1320

LEGEND

INDICATES BORING LOCATION

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

POWER AND TELEPHONE LINES TO BE RELOCATED

PROPOSED STRUCTURE

TYPE: SINGLE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK AND SEMI-INTEGRAL ABUTMENTS ON MSE WALLS

LENGTH OF SPAN: 106'-10" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 24°46'50" RIGHT FORWARD, MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS = 5729.58')

SUPERELEVATION: 0.029 FT/FT

LATITUDE: N 38°53'33"

LONGITUDE: W 82°59'52"

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

SCIOTO COUNTY
STA. 3891+88.91 TO STA. 3892+97.95

SITE PLAN
BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 1 & 2

SCI-823-0.00
PID 19415

1 / 3

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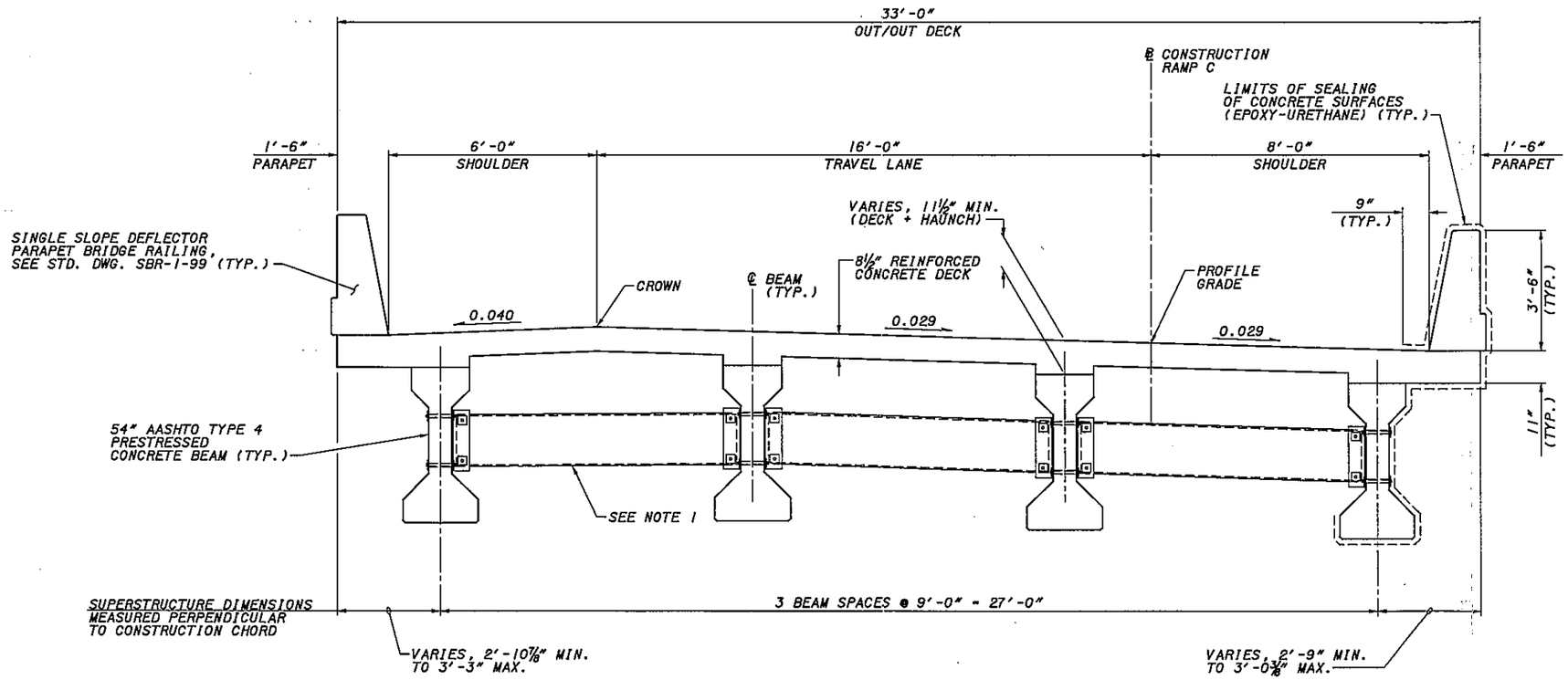

TYPICAL TRANSVERSE SECTION

NOTES:

1. INTERMEDIATE DIAPHRAGMS MAY BE CAST-IN-PLACE CONCRETE OR GALVANIZED STEEL. FOR DETAILS OF BOTH DIAPHRAGM TYPES, SEE STANDARD CONSTRUCTION DRAWING PSID-1-99.

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

TYPICAL TRANSVERSE SECTION
BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 1 & 2

SCI-823-0.00
PID 19415

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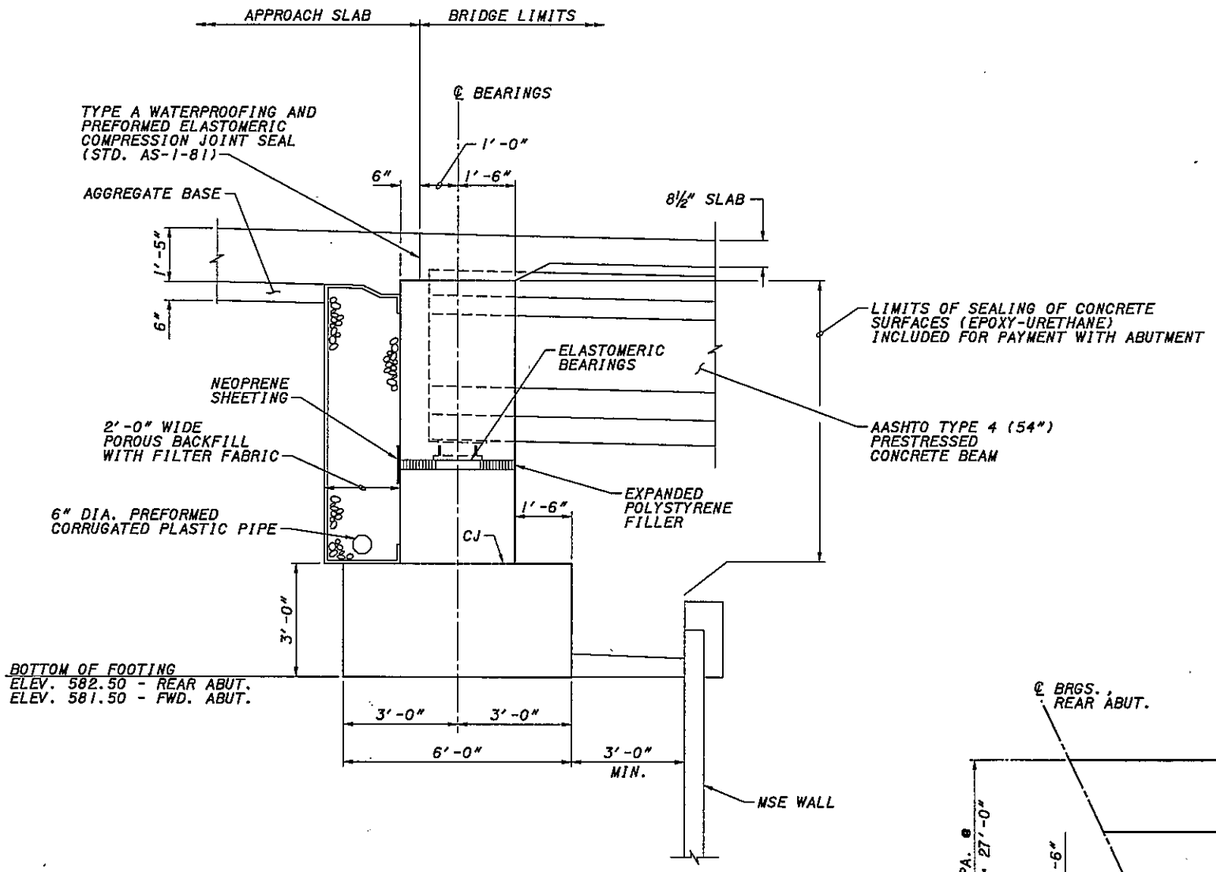
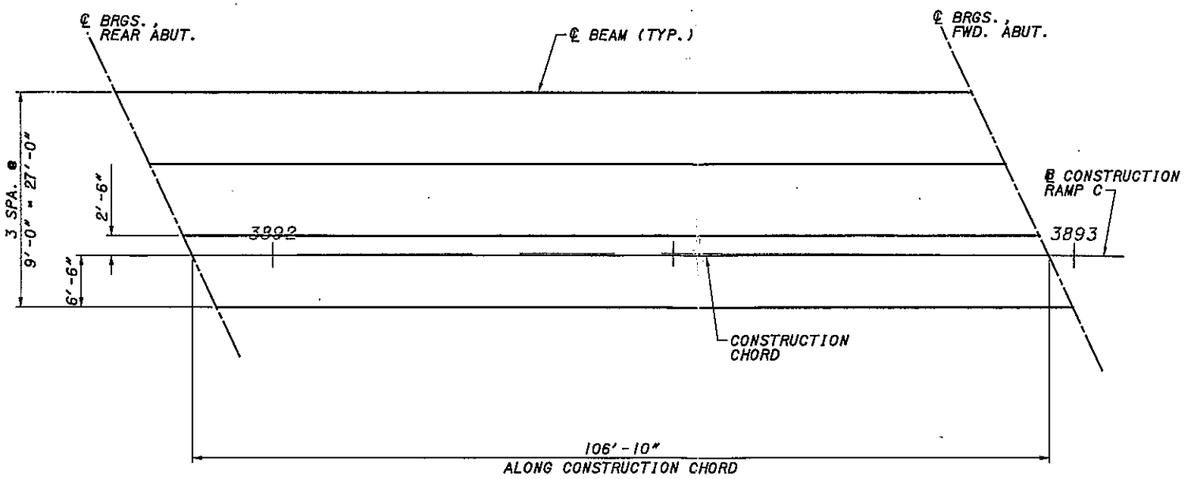


REAR AND FORWARD ABUTMENT SECTION



FRAMING PLAN

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DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

ABUTMENT SECTION AND FRAMING PLAN
BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 1 & 2

SCI-823-0.00
PID 19415

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APPENDIX C

SCI-823-0.00
RAMP C OVER FAIRGROUND ROAD
VERTICAL CLEARANCES

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[RampC_Vert_Clr.xls]Alternative 1
By: DGS Date: 3/14/2007
Checked: SKT Date: 3/22/2007

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 1 - AASHTO Type 4 Concrete I-Beams

PROFILE DATA - Fairground Road

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.44
2	Centerline	n/a	567.21
3	E/Pavement SB	n/a	566.98

PROFILE DATA - RAMP C

Linear:
PVT Sta. 3890+33.96 PVC Sta. 3890+75.00
PVT Elev. 599.42 PVC Elev. 598.10
g -3.22%

Vertical Curve:
PVC Sta. 3890+75.00 PVI Sta. 3892+00.00 PVT Sta. 3893+25.00
PVC Elev. 598.10 PVI Elev. 594.10 PVT Elev. 591.83
g1 -3.20%
g2 -1.82%
LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3884+53.90	-4.0%	2.9%	-2.9%
3893+54.18	-4.0%	2.9%	-2.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA BEAM	3892+34.84	6.74	593.69	-4.0%	2.9%	-2.9%	593.50
2	RT. FASCIA BEAM	3892+46.23	6.75	593.43	-4.0%	2.9%	-2.9%	593.24
3	RT. FASCIA BEAM	3892+58.18	6.73	593.17	-4.0%	2.9%	-2.9%	592.97

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 3 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
2	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
3	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in

VERTICAL CLEARANCE - RAMP C OVER FAIRGROUND RD.

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA BEAM	593.50	65.50	588.04	567.44	**20.60**	OK
2	RT. FASCIA BEAM	593.24	65.50	587.78	567.21	**20.57**	OK
3	RT. FASCIA BEAM	592.97	65.50	587.51	566.98	**20.53**	OK

SCI-823-0.00
RAMP C OVER FAIRGROUND ROAD
VERTICAL CLEARANCES

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[RampC_Vert_Clr.xls]Alternative 1
By: DGS Date: 3/14/2007
Checked: SKT Date: 3/22/2007

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 2 - AASHTO Type 4 Concrete I-Beams

PROFILE DATA - Fairground Road

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.44
2	Centerline	n/a	567.21
3	E/Pavement SB	n/a	566.98

PROFILE DATA - RAMP C

Linear:
PVT Sta. 3890+33.96 PVC Sta. 3890+75.00
PVT Elev. 599.42 PVC Elev. 598.10
g -3.22%

Vertical Curve:
PVC Sta. 3890+75.00 PVI Sta. 3892+00.00 PVT Sta. 3893+25.00
PVC Elev. 598.10 PVI Elev. 594.10 PVT Elev. 591.83
g1 -3.20%
g2 -1.82%
LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3884+53.90	-4.0%	2.9%	-2.9%
3893+54.18	-4.0%	2.9%	-2.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA BEAM	3892+34.84	6.74	593.69	-4.0%	2.9%	-2.9%	593.50
2	RT. FASCIA BEAM	3892+46.23	6.75	593.43	-4.0%	2.9%	-2.9%	593.24
3	RT. FASCIA BEAM	3892+58.18	6.73	593.17	-4.0%	2.9%	-2.9%	592.97

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 3 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
2	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
3	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in

VERTICAL CLEARANCE - RAMP C OVER FAIRGROUND RD.

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA BEAM	593.50	65.50	588.04	567.44	**20.60**	OK
2	RT. FASCIA BEAM	593.24	65.50	587.78	567.21	**20.57**	OK
3	RT. FASCIA BEAM	592.97	65.50	587.51	566.98	**20.53**	OK

SCI-823-0.00
RAMP C OVER FAIRGROUND ROAD
VERTICAL CLEARANCES

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[RampC_Vert_Clr.xls]Alternative 1
By: DGS Date: 3/14/2007
Checked: SKT Date: 3/22/2007

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 3 - AASHTO Type 4 Concrete I-Beams

PROFILE DATA - Fairground Road

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.44
2	Centerline	n/a	567.21
3	E/Pavement SB	n/a	566.98

PROFILE DATA - RAMP C

Linear: PVT Sta. 3890+33.96, PVC Sta. 3890+75.00
PVT Elev. 599.42, PVC Elev. 598.10
g -3.22%

Vertical Curve: PVC Sta. 3890+75.00, PVI Sta. 3892+00.00, PVT Sta. 3893+25.00
PVC Elev. 598.10, PVI Elev. 594.10, PVT Elev. 591.83
g1 -3.20%
g2 -1.82%
LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3884+53.90	-4.0%	2.9%	-2.9%
3893+54.18	-4.0%	2.9%	-2.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA BEAM	3892+34.84	6.74	593.69	-4.0%	2.9%	-2.9%	593.50
2	RT. FASCIA BEAM	3892+46.23	6.75	593.43	-4.0%	2.9%	-2.9%	593.24
3	RT. FASCIA BEAM	3892+58.18	6.73	593.17	-4.0%	2.9%	-2.9%	592.97

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 3 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
2	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
3	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in

VERTICAL CLEARANCE - RAMP C OVER FAIRGROUND RD.

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA BEAM	593.50	65.50	588.04	567.44	**20.60**	OK
2	RT. FASCIA BEAM	593.24	65.50	587.78	567.21	**20.57**	OK
3	RT. FASCIA BEAM	592.97	65.50	587.51	566.98	**20.53**	OK

SCI-823-0.00
RAMP C OVER FAIRGROUND ROAD
VERTICAL CLEARANCES

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[RampC_Vert_Clr.xls]Alternative 1
By: DGS Date: 3/14/2007
Checked: SKT Date: 3/22/2007

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 4 - 72" Steel Plate Girder

PROFILE DATA - Fairground Road

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION		FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement	NB	n/a	567.44
2	Centerline		n/a	567.21
3	E/Pavement	SB	n/a	566.98

PROFILE DATA - RAMP C

Linear:
PVT Sta. 3890+33.96 PVC Sta. 3890+75.00
PVT Elev. 599.42 PVC Elev. 598.10
g -3.22%

Vertical Curve:
PVC Sta. 3890+75.00 PVI Sta. 3892+00.00 PVT Sta. 3893+25.00
PVC Elev. 598.10 PVI Elev. 594.10 PVT Elev. 591.83
g1 -3.20%
g2 -1.82%
LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3884+53.90	-4.0%	2.9%	-2.9%
3893+54.18	-4.0%	2.9%	-2.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3892+34.82	6.70	593.69	-4.0%	2.9%	-2.9%	593.50
2	RT. FASCIA GIRDER	3892+46.41	6.69	593.43	-4.0%	2.9%	-2.9%	593.23
3	RT. FASCIA GIRDER	3892+58.15	6.67	593.17	-4.0%	2.9%	-2.9%	592.97

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 4 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	72" STEEL PLATE GIRDER	8.50	2.00	2.0	72	2.0	-	86.50 in
2	72" STEEL PLATE GIRDER	8.50	2.00	2.0	72	2.0	-	86.50 in
3	72" STEEL PLATE GIRDER	8.50	2.00	2.0	72	2.0	-	86.50 in

VERTICAL CLEARANCE - RAMP C OVER FAIRGROUND RD.

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA GIRDER	593.50	86.50	586.29	567.44	**18.85**	OK
2	RT. FASCIA GIRDER	593.23	86.50	586.03	567.21	**18.82**	OK
3	RT. FASCIA GIRDER	592.97	86.50	585.77	566.98	**18.79**	OK

SCI-823-0.00
RAMP C OVER FAIRGROUND ROAD
VERTICAL CLEARANCES

Filename: P:\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1595C Ramp C over Fairground\[RampC_Vert_Clr.xls]Alternative 1
By: DGS Date: 3/14/2007
Checked: SKT Date: 3/22/2007

LEGEND:
User Input - Not Critical
User Input - Critical to Output

Alternative 5 - AASHTO Type 4 Concrete I-Beams

PROFILE DATA - Fairground Road

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.44
2	Centerline	n/a	567.21
3	E/Pavement SB	n/a	566.98

PROFILE DATA - RAMP C

Linear: PVT Sta. 3890+33.96; PVC Sta. 3890+75.00
PVT Elev. 599.42; PVC Elev. 598.10
g -3.22%

Vertical Curve: PVC Sta. 3890+75.00; PVI Sta. 3892+00.00; PVT Sta. 3893+25.00
PVC Elev. 598.10; PVI Elev. 594.10; PVT Elev. 591.83
g1 -3.20%
g2 -1.82%
LVC 250

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3884+53.90	-4.0%	2.9%	-2.9%
3893+54.18	-4.0%	2.9%	-2.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA BEAM	3892+34.84	6.74	593.69	-4.0%	2.9%	-2.9%	593.50
2	RT. FASCIA BEAM	3892+46.23	6.75	593.43	-4.0%	2.9%	-2.9%	593.24
3	RT. FASCIA BEAM	3892+58.18	6.73	593.17	-4.0%	2.9%	-2.9%	592.97

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

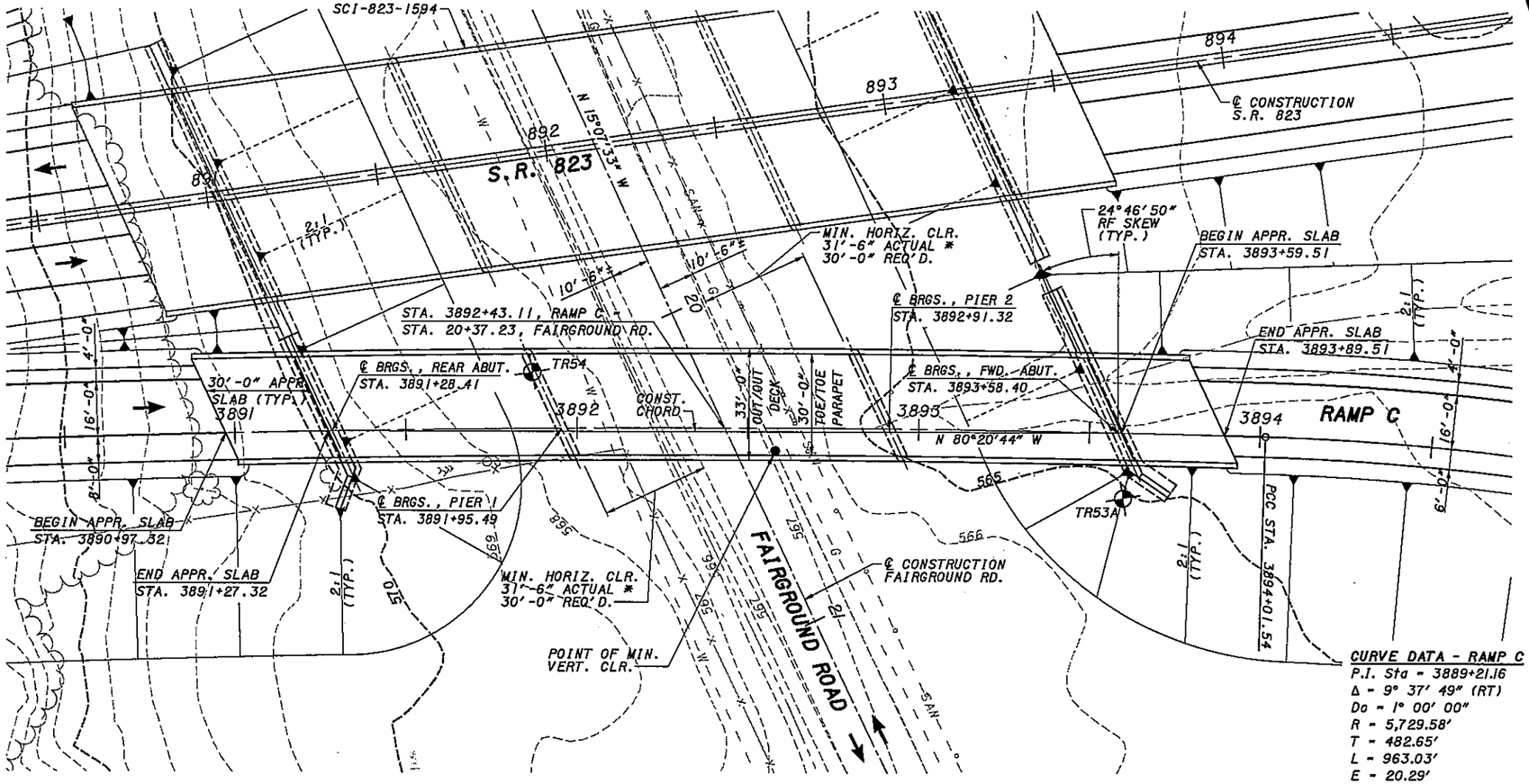
STRUCTURE DEPTH Haunch + Max. Top Flange = 3 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
2	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in
3	AASHTO TYPE 4	8.50	3.00	0.0	54	0.0	-	65.50 in

VERTICAL CLEARANCE - RAMP C OVER FAIRGROUND RD.

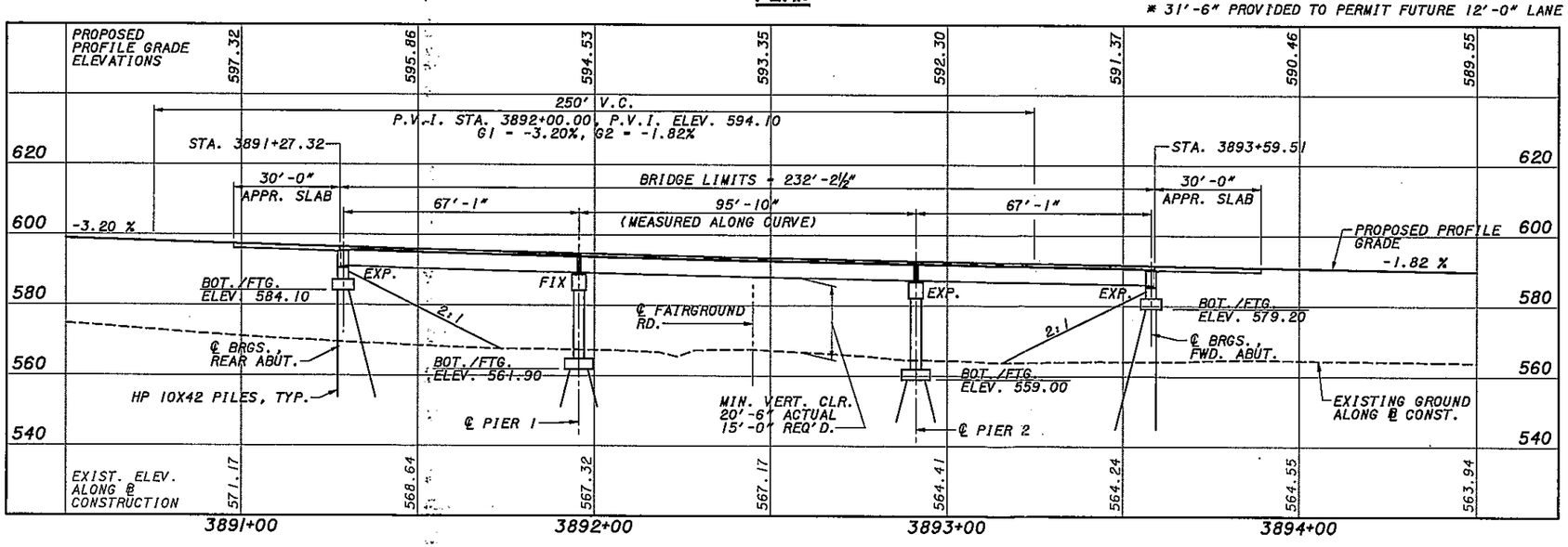
POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA BEAM	593.50	65.50	588.04	567.44	**20.60**	OK
2	RT. FASCIA BEAM	593.24	65.50	587.78	567.21	**20.57**	OK
3	RT. FASCIA BEAM	592.97	65.50	587.51	566.98	**20.53**	OK

APPENDIX D



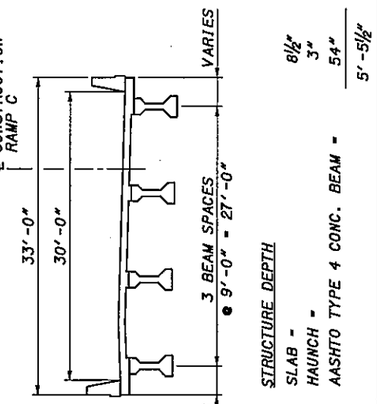
PLAN

* 31'-6" PROVIDED TO PERMIT FUTURE 12'-0" LANE



PROFILE ALONG ℄ CONSTRUCTION, RAMP C

SUPERSTRUCTURE DATA



STRUCTURE DEPTH	
SLAB -	8½"
HAUNCH -	3"
AASHTO TYPE 4 CONC. BEAM -	54"
	5'-5½"

N.T.S.

CURVE DATA - RAMP C

P.I. Sta = 3889+21.16
Δ = 9° 37' 49" (RT)
Do = 1° 00' 00"
R = 5,729.58'
T = 482.65'
L = 963.03'
E = 20.29'

LEGEND

INDICATES BORING LOCATION

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

POWER AND TELEPHONE LINES TO BE RELOCATED

PROPOSED STRUCTURE

TYPE: THREE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK AND SEMI-INTEGRAL ABUTMENTS BEHIND 2:1 SLOPES

LENGTH OF SPANS: 67'-1" - 95'-10" - 67'-1" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 24°46'50" RIGHT FORWARD, MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS - 5729.58')

SUPERELEVATION: 0.029 FT/FT

LATITUDE: N 38°53'33"

LONGITUDE: W 82°59'52"

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 180
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

SCIOTO COUNTY
STA. 3891+27.32
TO STA. 3893+59.51

SITE PLAN

BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 3

SCI-823-0.00
PID 19415

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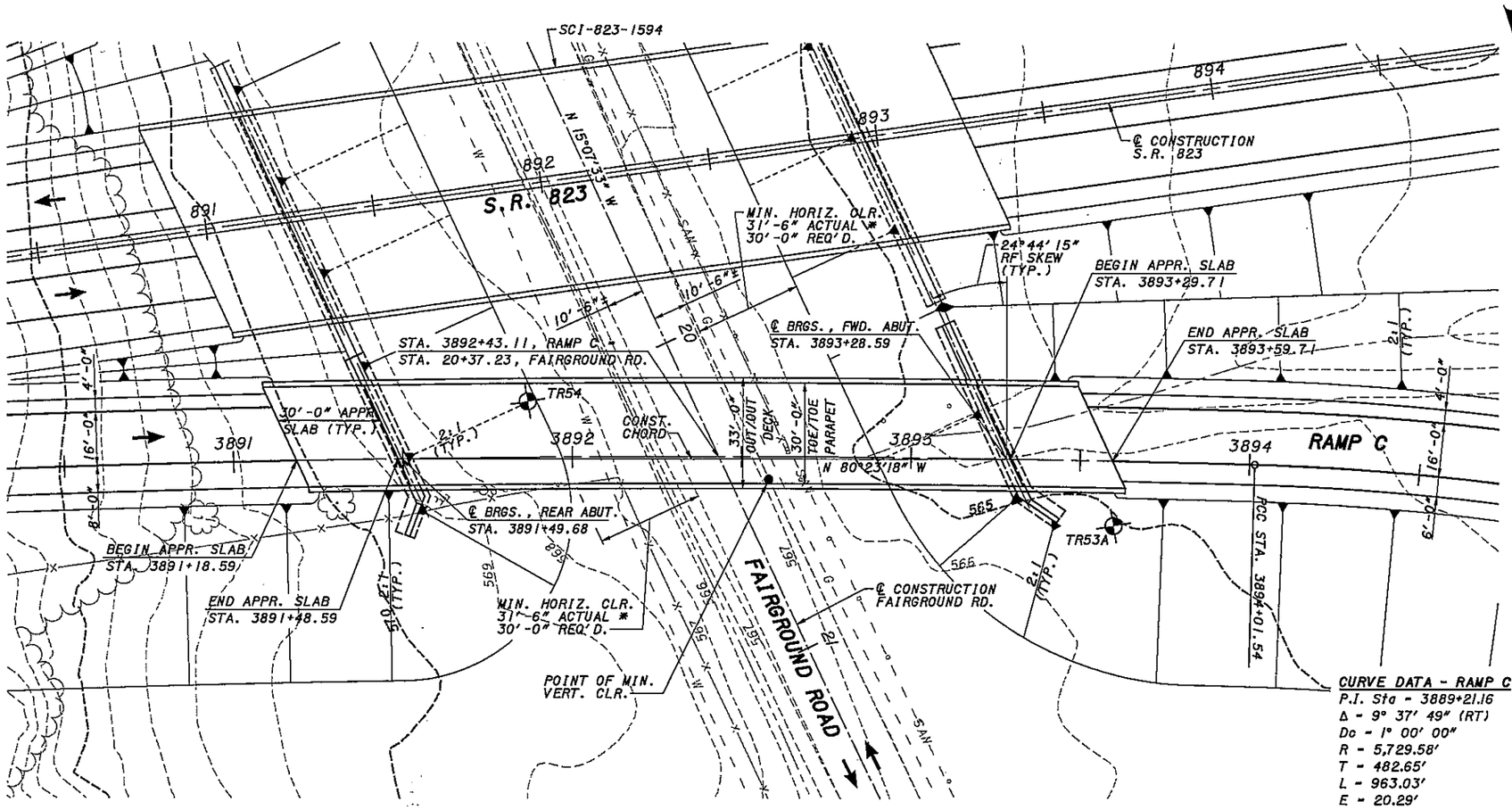
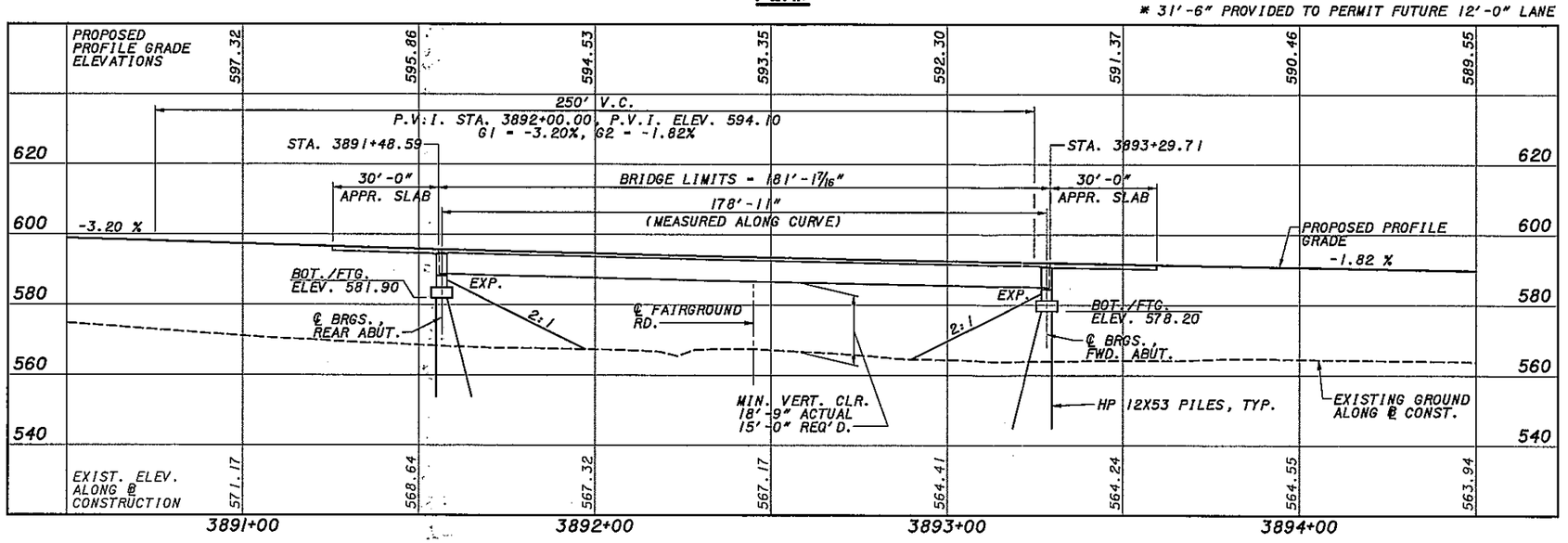


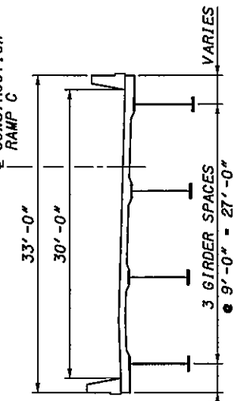
PLAN

* 31'-6" PROVIDED TO PERMIT FUTURE 12'-0" LANE



PROFILE ALONG ℄ CONSTRUCTION, RAMP C

SUPERSTRUCTURE DATA



STRUCTURE DEPTH	
SLAB -	8½"
HAUNCH -	2"
72" PLATE GIRDER -	76"
	7'-2½"

N.T.S.

LEGEND

⊕ INDICATES BORING LOCATION

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

POWER AND TELEPHONE LINES TO BE RELOCATED

PROPOSED STRUCTURE

TYPE: SINGLE SPAN COMPOSITE STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK AND SEMI-INTEGRAL ABUTMENTS BEHIND 2:1 SLOPES

LENGTH OF SPAN: 178'-11" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 24°44'15" RIGHT FORWARD, MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS = 5729.58')

SUPERELEVATION: 0.029 FT/FT

LATITUDE: N 38°53'33"

LONGITUDE: W 82°59'52"

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 190
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

SCIOTO COUNTY
STA. 3891+48.59
TO STA. 3893+29.71

SITE PLAN

BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 4

SCI-823-0.00
PID 19415

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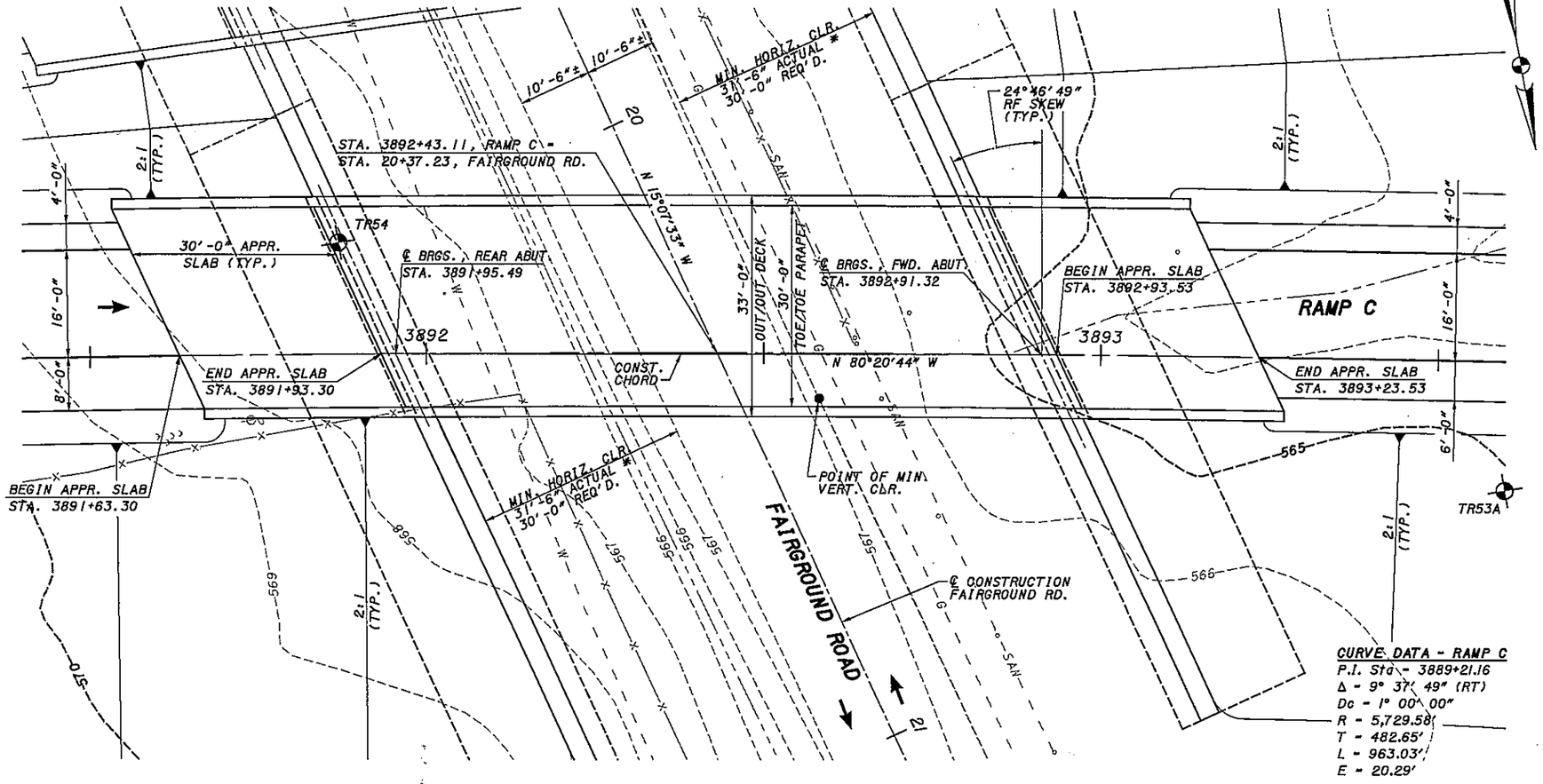
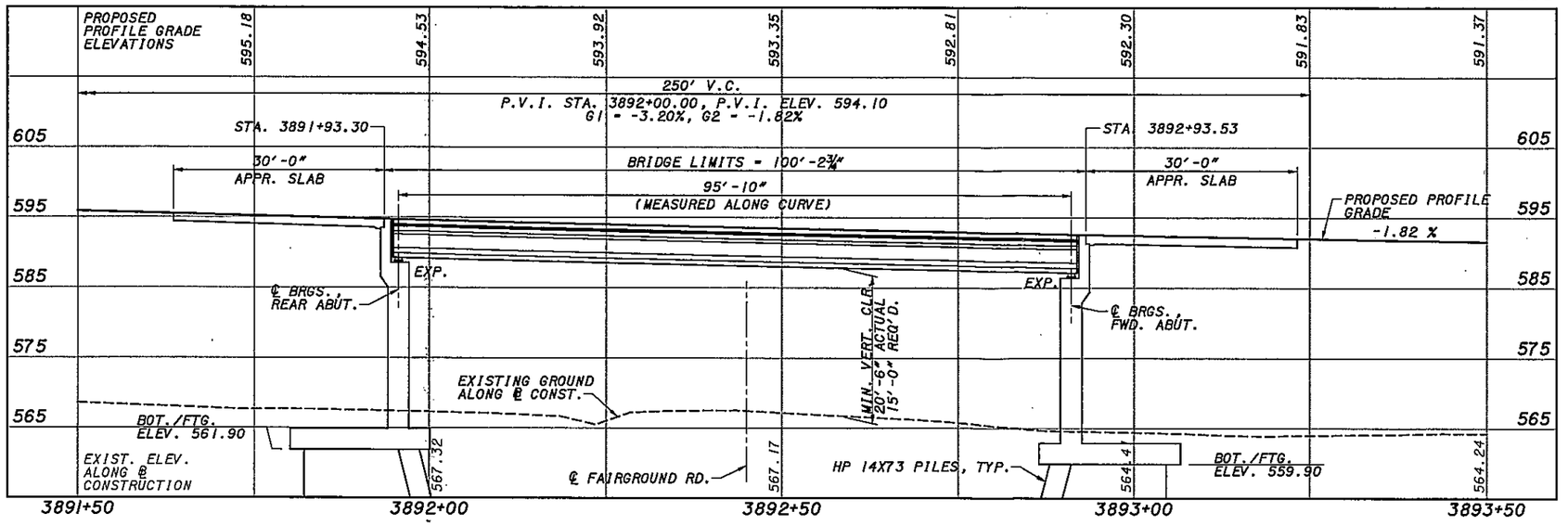


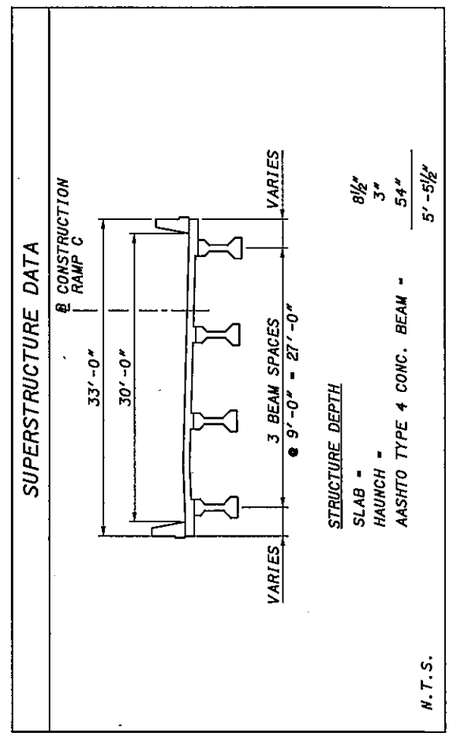
PLAN

* 31'-6" PROVIDED TO PERMIT FUTURE 12'-0" LANE



PROFILE ALONG ℄ CONSTRUCTION, RAMP C

SUPERSTRUCTURE DATA



N.T.S.

CURVE DATA - RAMP C

P.I. Sta. = 3889+21.16
Δ = 9° 37' 49" (RT)
Dc = 1° 00' 00"
R = 5,729.58'
T = 482.65'
L = 963.03'
E = 20.29'

LEGEND

⌖ INDICATES BORING LOCATION

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

POWER AND TELEPHONE LINES TO BE RELOCATED

PROPOSED STRUCTURE

TYPE: SINGLE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK AND FULL HEIGHT CIP ABUTMENTS

LENGTH OF SPAN: 95'-10" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 24°46'49" RIGHT FORWARD, MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS = 5729.58')

SUPERELEVATION: 0.029 FT/FT

LATITUDE: N 38°53'33"

LONGITUDE: W 82°59'52"

DESIGN AGENCY
CH2MHILL
5775 Perimeter Drive, Suite 180
Dublin, Ohio 43017

DESIGNED	DRAWN	REVIEWED	DATE
DGS	JBA	SCJ	03/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
SKT			

SCIOTO COUNTY
STA. 3891+93.30
TO STA. 3892+93.53

SITE PLAN

BRIDGE NO. SCI-823-1595
RAMP C OVER FAIRGROUND ROAD - ALT. 5

SCI-823-0.00
PID 19415

- | -

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APPENDIX E

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

March 29, 2007

Mr. Rob Miller, AICP
Project Manager
CH2M Hill
5775 Perimeter Drive Suite 190
Dublin, Ohio 43017

Re: **SR 823 and US 23 Interchange – Fairgrounds Road Structures**
Preliminary Retaining Wall and Bridge Foundation Recommendations
Project SCI-823-0.00
DLZ Job No.: 0121-3070.03

Dear Mr. Miller:

This letter reports additional preliminary recommendations for the proposed retaining walls and bridge foundations at the SR 823 and Fairgrounds Road site. This document is an addendum to our report of Preliminary Subsurface Exploration and MSE retaining wall and Embankment Evaluations, dated October 4, 2006. Additionally, this document presents alternative wall types and ground improvement techniques that could be employed at this site. This document presents options for walls 1 and 2, adjacent to Fairgrounds Road only. Recommendations for other retaining walls at the interchange will be presented in separate documents.

It is anticipated that three proposed bridges will span existing Fairgrounds Road. It is understood that one structure each will be required for Ramp B, Ramp C, and Mainline SR 823.

The findings and recommendations presented in this document should be considered preliminary. After the structure and wall configurations have been finalized, additional borings will be necessary to finalize the structure and retaining wall recommendations.

Preliminary Abutment Retaining Wall Recommendations – Fairgrounds Road Structures

As outlined in the October 4, 2006 report, DLZ recommended that MSE walls, built using staged construction and wick drains, were the most economical solution for the walls at the proposed interchange. However, as stated in the report, the subsurface conditions at the site are marginal for MSE walls and there is a significant risk of detrimental settlement occurring over time. In addition, it is anticipated that the final wall borings may reveal subsurface conditions that are poorer than those encountered by the preliminary borings, resulting in excessive settlements that may preclude MSE walls from being used.

Representatives of CH2M Hill expressed concern about the shear strength selection of the foundation soils of this site. At the request of CH2M Hill, DLZ has elected to assume more conservative values to carry out the preliminary analyses and to develop design parameters. The assumed values were based upon soil conditions encountered in boring B-1133. It should be noted that an extensive testing program (including in-situ testing) will be executed for "approved" structure and wall configurations to more accurately determine the appropriate shear strengths for use in analyses and design.

Consequently, we have re-evaluated the subsurface conditions and have analyzed an MSE wall using the conditions encountered by boring B-1133. The revised analyses indicate that MSE walls could be built in approximately ten-foot stages while maintaining adequate undrained bearing capacity. Additionally, primary consolidation is estimated to be approximately 9 inches (at the wall face). Differential settlement is estimated to be greater than 1.0 percent, which is typically considered to be the maximum allowable differential settlement. In addition to primary consolidation, secondary compression settlement was evaluated, and was found to be less than 1 inch over 75 years (service life). Consequently, secondary compression settlement is not considered to be of significant concern at this site. The results of bearing capacity, MSE stability (sliding and overturning), and settlement calculations are attached. Also, the results of MSE and embankment global stability results are attached.

Based upon the risk associated with using conventional MSE walls at this site, even with staged construction, we offer the following preliminary alternative recommendations for the proposed abutment retaining walls at the Fairgrounds Road site.

Option 1
Preload with Temporary Geotextile/Fabric-faced Wall and Build Conventional MSE Wall

As stated previously, primary consolidation has been estimated to be approximately 9 inches at the proposed wall face. A preloading (surcharge) embankment could be constructed at the Fairgrounds Road site to consolidate any soft and compressible foundation soils. Fabric-faced walls may be built with vertical or nearly vertical slopes (1H:20V batter) to allow preloading of soils near the existing road. Preliminary analyses indicate that the surcharge load must be constructed in 10-foot stages to maintain

adequate undrained bearing capacity. It is recommended that settlement plates and piezometers be installed to monitor consolidation and pore pressures in clay layers.

Based on the preliminary results of consolidation tests at the site, the time to 90 percent consolidation (without wick drains) has been estimated to be approximately 110 days. This duration can be shortened through the use of wick drains. Wick drain spacing and resulting consolidation times (90 percent consolidation) are presented in the table below.

Time Rate of Consolidation Estimates Walls 1 and 2

Wall Locations	t_{90} Without Wick Drains (days)	Spacing (ft)	t_{90} With Wick Drains (days)
SR-823 over Fairground Rd	110	5.0	30
		7.0	45
		9.0	60

Wick drain treatment areas should extend 10 feet beyond the limits of the retaining walls, and be advanced to the top of rock.

The surcharge embankment should remain in place until at least 90 percent of primary consolidation has occurred. Once the surcharge embankment has been removed, construction of the MSE wall may commence. The MSE walls should also be constructed in 10-foot stages to maintain adequate undrained stability. When the surcharge embankment is removed, it is anticipated that the foundation soils will rebound slightly before they consolidate again under the weight of the new MSE wall and fill. Settlement calculations using the recompression index for the fine-grained foundation soils indicate that the primary consolidation beneath the new MSE wall will be approximately 2 inches with differential settlement being approximately 0.4 percent.

Fill material should be selected that can be used for both the surcharge embankment and the conventional MSE wall backfill. Also, consideration must be given to the degradation of the geotextile fabric when exposed to UV light. The selected fabric must be able to withstand the planned exposure to UV light during the service of the temporary surcharge walls. If degradation due to UV exposure is of significant concern, a temporary cover such as shotcrete or a UV resistant fabric cover (exposed face only) should be considered.

Option 2
Deep Soil Mixing (Grouting) with Conventional MSE Retaining Walls

Soil mixing may also be considered to strengthen the foundation soils. The deep soil mixing would create a concrete/soil mass, which would provide suitable bearing for conventional MSE retaining walls. The treatment area should extend approximately 10 feet beyond the limits of the retaining wall fill, and the soil mixing should extend to the top of bedrock. After the soil is treated, the MSE wall can be constructed with negligible settlement. For preliminary cost estimating purposes, 80 percent replacement (mixing) should be assumed in the areas to be treated.

Option 3
Preload with Temporary Geotextile/Fabric-faced Wall and Build Pile-Supported, Reinforced Concrete Retaining Walls

Pile-supported walls could be considered for these locations. If the piles are driven to bedrock, the settlement of the walls founded on piles would be negligible. However, the embankments behind the walls would settle, resulting in potential distortion of the new retaining wall and differential settlement between the wall and the embankment fill. Consequently, to reduce this differential settlement, it is recommended that the foundation soils be surcharged and allowed to consolidate prior to constructing the walls. Fabric-faced walls may be used to surcharge the soils near the existing road. These walls should be built according to the recommendations outlined in Option 1 on page 2.

If Option 3 is used, piles should not be driven and construction on the wall should not begin until at least 90 percent consolidation has been achieved. Piles to support the walls should be driven to refusal on bedrock. Estimated pile tip elevations for the structures are provided on page 6.

The surcharge embankment may be removed prior to constructing the pile-supported retaining wall. Alternatively, consideration could be given to leaving the surcharge embankment in place. This may not be feasible due to the dimensions of the proposed retaining wall and the space required for construction. If left in place, the void space between the surcharge embankment and the reinforced concrete retaining wall should be filled with suitable material and compacted. If there is not sufficient space to properly

compact a granular fill material, a flowable-fill material, such as a low-strength concrete, could be considered.

Other Options

Other ground improvement techniques such as controlled modulus columns (CMC) could be considered to stabilize the foundation soils prior to construction of the walls and embankments at the interchange. However, it is understood that ODOT personnel do not want to explore this technique at this time.

The use of vibro-compaction has been considered to improve soils at this site. Although vibro-compaction could improve shear strengths in granular layers, several concerns still exist that may preclude the use of this technique at this site. Some concerns are the potential settlement of nearby railroad tracks and the low undrained shear strength of clay (fine-grained) layers across the site. The fine-grained soils would not realize an appreciable increase in undrained shear strengths using this technique. Consequently, this technique is not recommended.

Preliminary Bridge Foundation Recommendations

In the area of the proposed structures, borings generally encountered bedrock at depths ranging from 13 to 21 feet below the ground surface. Bedrock encountered in the borings generally consisted of soft to medium hard Shale, which was highly to moderately weathered and moderately fractured.

It is recommended that driven H-piles be used to support the proposed structure. Pile tip elevations have been estimated for HP 12x53, 70-ton piles driven to refusal on bedrock. Other H-piles could also be considered to support the bridge abutments. For preliminary purposes, the pile tip elevations provided for the HP 12x53 piles are also considered to be representative of HP 10x42 and HP 14x73 piles. It is anticipated that the piles will penetrate one to two feet into the bedrock. Because of the tendency of some shales to relax, it is recommended that the contractor restrike the piles 24 hours after installation to ensure the allowable bearing capacity of the pile is met.

Typically, a minimum of 15 feet of embedment is required for bearing piles. The overburden thickness on this site ranges from approximately 13 to 21 feet. It is anticipated that some piles

will not achieve the required 15 feet of embedment. If this is of concern, the piles could be pre-bored and socketed five-feet into competent bedrock. Alternatively, drilled shafts could be considered for support of the abutments.

If lateral loading or uplift is a concern, consideration could be given to using drilled shafts to support the abutments. If significant uplift or lateral loading of the structure foundation is anticipated, DLZ should be notified so that we may revise our recommendations as necessary.

A table summarizing the site conditions and foundation recommendations (assumes single-span structures) is presented below.

Summary of Foundation Recommendations, HP-12x53, 70 ton Driven Piles*

Structure	Element	Boring Number	Existing Ground Surface Elevation (Feet)	Estimated Pile Tip Elevation (Feet)
Mainline (Westbound) over Fairgrounds Road	Rear Abutment	B-1146	567.7	551.7
	Forward Abutment	B-1144	565.2	542.2
Mainline (Eastbound) over Fairgrounds Road	Rear Abutment	B-1145	567.3	551.3
	Forward Abutment	TR-55A	565.4	544.4
Ramp B over Fairgrounds Road	East Abutment	TR-58	567.1	550.6
	West Abutment	B-1113	566.8	545.8
Ramp C over Fairgrounds Road	East Abutment	TR-54	566.9	550.4
	West Abutment	B-1116	565.8	544.8

** Cited pile tip elevations are considered representative of all H-piles being considered.*

Closing

We appreciate having the opportunity to be of service to you on this project. Please do not hesitate to call if you have any questions concerning our report.

Sincerely,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

Dorothy A. Adams, P.E. (SJR)
Dorothy A. Adams, P.E.
Senior Geotechnical Engineer

Attachments: MSE Wall Stability Calculations
Settlement Calculations
Results of Laboratory Testing

cc: File

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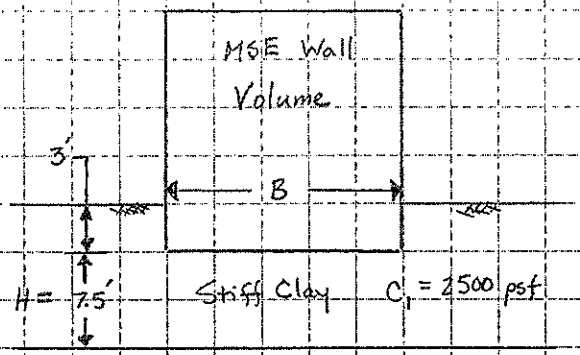
PLANNERS • SURVEYORS

CLIENT CH2M Hill / ODOT D-9 PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass SHEET NO. 1 OF 17
SUBJECT Undrained Bearing Capacity COMP. BY SJK DATE 3-25-07
Multi-Layered Analysis CHECKED BY GWT DATE 3-26-07

* Multi-layered bearing capacity Reference: [AASHTO, Standard Spec. for Highway Bridges, 17th Ed.]



* Assume B = 30', L = 219' (Wall 1)
* Assume 3' Embedment of MSE Wall
* Assumes C_2 = 300 psf (conservative)

$q_{ULT} = C_1 N_m + q$ [4.4.7.1.1.7-1]

$N_m = \left(\frac{1}{\beta_m} + K \cdot S_c \cdot N_c\right) \leq S_c \cdot N_c$ [4.4.7.1.1.7-2]

β_m = Punching Index $\beta_m = BL / [2(B+L)H] = (30)(219) / [2(30+219)(7.5)] = 1.76$

$K = C_2/C_1 = 300/2500 = 0.12$

S_c = Shape Factor $S_c = 1 + \left(\frac{B}{L}\right)\left(\frac{N_q}{N_c}\right)$ for other than continuous footings ($L < 5B$)

Since $L = 219' > 5B = 150$ → We may assume continuous footings
∴ $S_c = 1.0$

For Undrained Case $\phi = 0 \rightarrow N_c = 5.14$

$N_m = \left(\frac{1}{1.76}\right) + (0.12)(5.14) = 1.18$

$q_{ULT} = C_1 \cdot N_m + q = (2500\ psf)(1.18) + (3')(120\ pcf) = 3310\ psf$

$q_{allow} = \frac{q_{ULT}}{F.S.} = \frac{3310\ psf}{2.5} = 1324\ psf$

DLZ

SUBJECT

Client	CH2M Hill	JOB NUMBER	0121-3070.03
Project	SCI-823 Portsmouth Bypass	SHEET NO.	2 OF 17
Item	MSE Wall Stability	COMP. BY	SJK DATE 3-23-07
Fairgrounds Road Walls 1 & 2		CHECKED BY	DAA DATE 3-28-07

Based upon strengths from boring B-1133

STABILITY OF MSE WALL *(Using Pile Supported Abutments)*

Assumptions:

1 Estimated height of embankment; H=32'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglected in resisting forces
5

Wall Properties

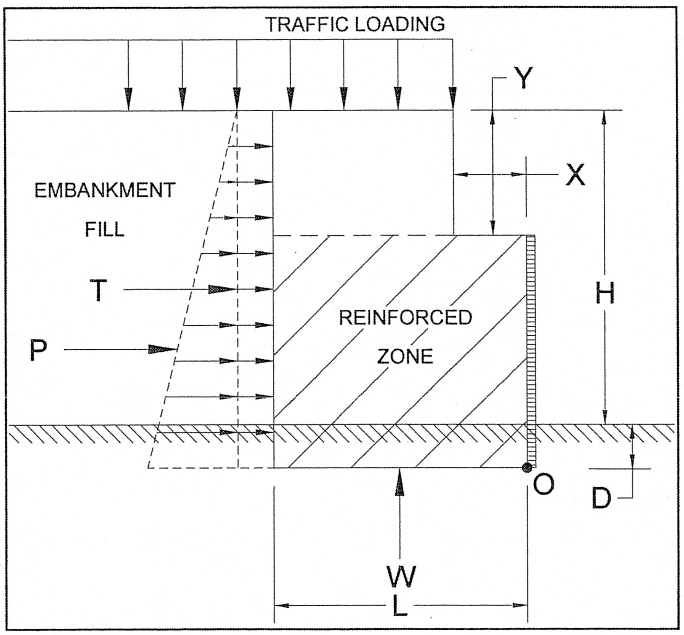
H+D	= 35	feet	
γ_{mse}	= 120	pcf	
L	= 31.5	feet	
L factor	= 0.90		Length factor-range (0.7 - 1.0)
ϕ	= 30	deg	Friction Angle of Embankment Fill

Foundational Soil Properties

c	= 2500	psf	Cohesion
ϕ'	= 29	deg	Friction angle
ω_T	= 240	psf	Traffic loading

RESISTANCE AGAINST SLIDING ALONG BASE

Dimensions X= 8.5 ft, Y= 10.0 ft



Thrust: $P_a = K_a\left[\frac{1}{2}\gamma H^2 + \omega_T H\right]$

where; $K_a = \tan^2(45 - \frac{\phi}{2})$ K_a = 0.33

P_a = 27,027 lbs per foot of wall

Resistance: $P_r = W(\mu)$ (Drained)

where; $\mu = \left(\frac{2}{3}\right)\tan(\phi)$ μ = 0.37

P_r = 45,177 lbs per foot of wall

USE THIS VALUE

$P_r = L(c)$ (Undrained)

P_r = 78,750 lbs per foot of wall

Use Drained Value

$FS = \frac{P_r}{P_a}$ Calculated FS = **1.67** Required FS = 1.50 Resistance Against Sliding is **OK**

RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).
* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 2,040,375 lb-ft

$\Sigma M_{resisting} = (L - X)Y\gamma\left(X + \left(\frac{L - X}{2}\right)\right) + L(H - Y)\gamma\left(\frac{L}{2}\right)$

$\Sigma M_{overturning}$ = 331,485 lb-ft

$\Sigma M_{overturning} = K_a\left[\frac{1}{2}\gamma H^2\left(\frac{H}{3}\right) + \omega_T H\left(\frac{H}{2}\right)\right]$

$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturning}}$ Calculated FS = **6.16** Required FS = 2.00 Resistance Against Overturning is **OK**

DLZ

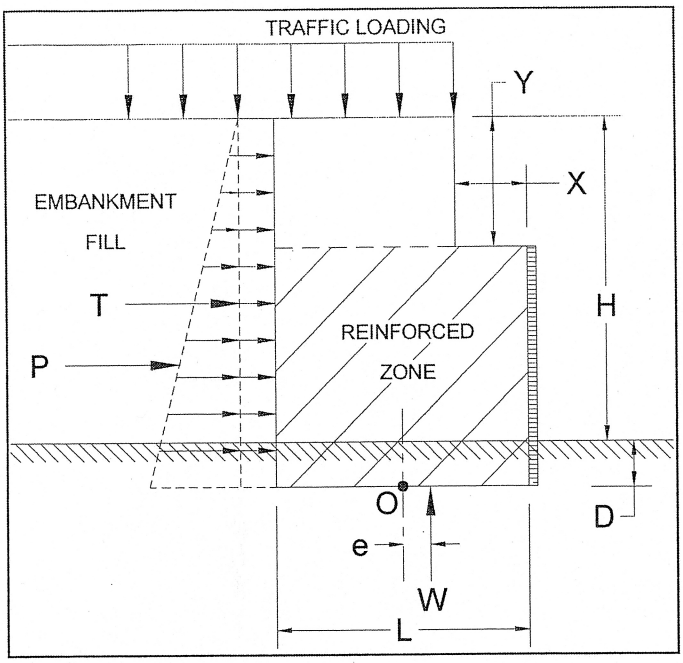
SUBJECT

Client	CH2M Hill
Project	SCI-823 Portsmouth Bypass
Item	Fairgrounds Road Walls 1 & 2
Based upon strengths from boring B-1133	

JOB NUMBER 0121-3070.03
SHEET NO. 3 OF 17
COMP. BY SJK DATE 3-23-07
CHECKED BY DAA DATE 3-28-07

BEARING CAPACITY OF A MSE WALL *(Using Pile Supported Abutments)*

Ref: {AASHTO; STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17th Edition, 2002}



Soil Properties

γ_{EMB}	= 120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	= 30	deg.	Friction ang.	Embankment fill
γ_{FDN}	= 120	pcf	Unit weight	Foundation soil
c	= 300	psf	Cohesion	Foundation soil
ϕ	= 0	deg.	Friction ang.	Foundation soil
c'	= 0	psf	Cohesion	Foundation soil
ϕ'	= 29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ωt	= 240	psf	traffic loading
L=B	= 31.5	ft	length of mse block
L factor	= 0.9		Length factor-range (0.7 - 1.0)
D	= 3	ft	embedment depth
Dw	= 0	ft	groundwater depth
H+D	= 35	ft	
H	= 32	ft	height of wall
Ka	= 0.33		
⌜ Pa	= 11.667	ft	moment arm
⌜ Wt	= 17.5	ft	moment arm
B'	= 28.52	ft	
γ'	= 57.6	pcf	
W_t	= 5,520	lb/ft of wall	X = 8.5 ft
W_{mseA}	= 94,500	lb/ft of wall	Y = 10.0 ft
W_{mseB}	= 27,600	lb/ft of wall	

Effective Bearing Pressure

$$\sigma_v = \frac{W_t + W_{MSE}}{L - 2e}$$

σ_v = 4,475 psf

Ultimate undrained bearing capacity, q_{ult}

$$q_{ULT} = cN_c + \sigma_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

q_{ULT} = 1,715 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 686 psf

Factor of Safety = * 0.38 **No Good**

*See multi-layered bearing Capacity Analysis

Ultimate drained bearing capacity, q_{ult}

$$q_{ULT} = c' N_c + \sigma_D N_q + \frac{1}{2}\gamma B N_\gamma$$

q_{ULT} = 18,726 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

q_{ALL} = 7,490 psf

Factor of Safety = **4.18** **OK**

Bearing Capacity Factors for Equations

Undrained		Drained	
N_c	5.14	N_c	27.86
N_q	1.00	N_q	16.44
N_γ	0.00	N_γ	19.34

Eccentricity of Resultant Force

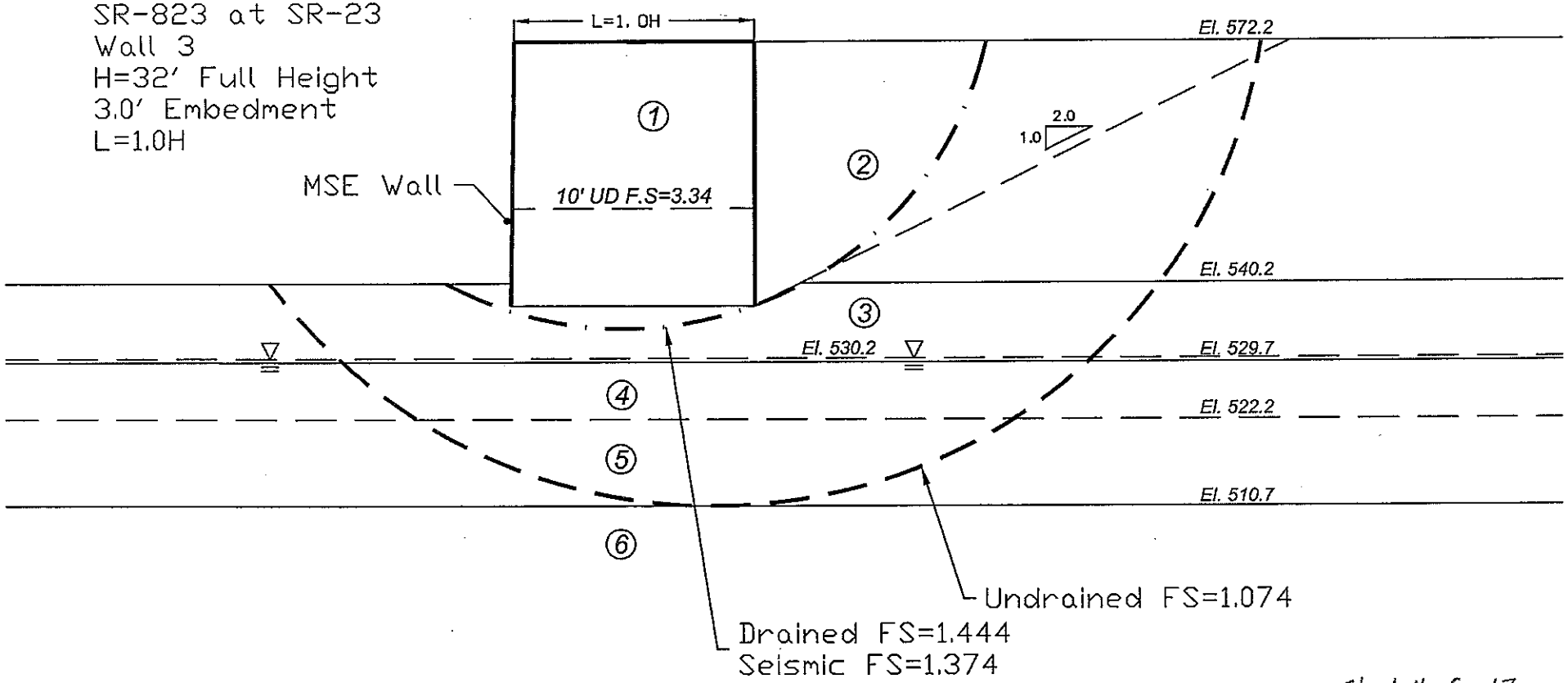
e = 1.49 ft

Kern

e < L/6 = 5.25 ft

Material	Consistency	Soil Type	Undrained C (psf)	Undrained ϕ (deg)	Drained C′ (psf)	Drained ϕ′ (deg)	γ (pcf)
Material 1	Lightweight	MSE Fill	10000	40	10000	40	30
Material 2	Compacted	Emb. Fill	0	30	0	30	120
Material 3	Very Stiff	Silt and Clay	2500	0	0	29	125
Material 4	Soft	Sandy Silt	300	0	0	29	120
Material 5	Soft	Silty Clay	300	0	0	29	125
Material 6		Bedrock	10000	45	10000	45	145

Stability Analysis
SR-823 at SR-23
Wall 3
H=32′ Full Height
3.0′ Embedment
L=1.0H



Undrained, Drained and Seismic Analyses
Based on Boring B-1133

MSE GLOBAL STABILITY ANALYSIS

SCI-823-0.00

PROJECT NO. 0121-3070.03	CALC: SJR	DATE 2/19/07

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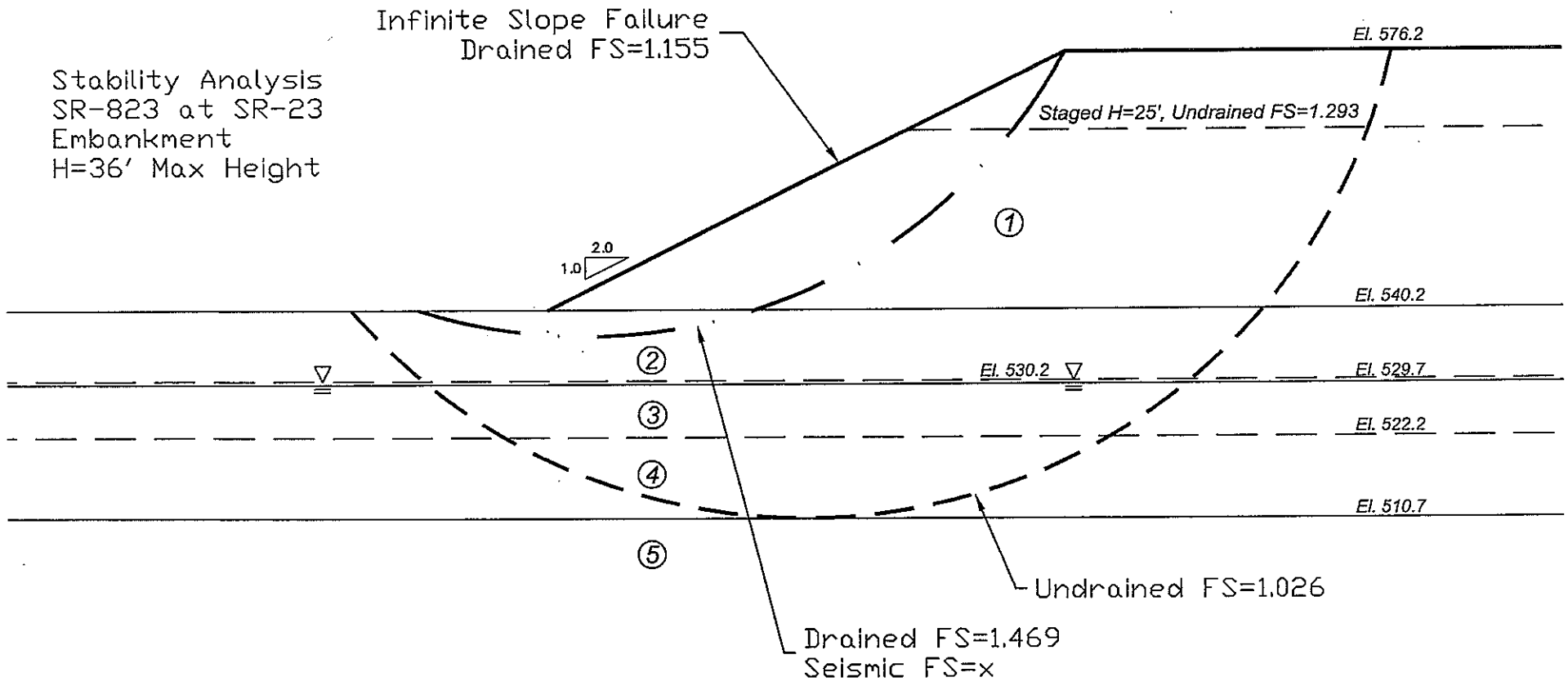
			Undrained		Drained		
Material	Consistency	Soil Type	C (psf)	ϕ (deg)	C' (psf)	ϕ' (deg)	γ (pcf)
Material 1	Compacted	Emb. Fill	0	30	0	30	120
Material 2	Very Stiff	Silt and Clay	2500	0	0	29	125
Material 3	Soft	Sandy Silt	300	0	0	29	120
Material 4	Soft	Silty Clay	300	0	0	29	125
Material 5		Bedrock	10000	45	10000	45	145



US-23 Interchange

Based on Boring B-1133
Embankment Stability & Staged Const.

EMBANKMENT GLOBAL STABILITY ANALYSIS

SCI-823-0.00

PROJECT NO. 0121-3070.03	CALC: SJR	DATE 2/19/07

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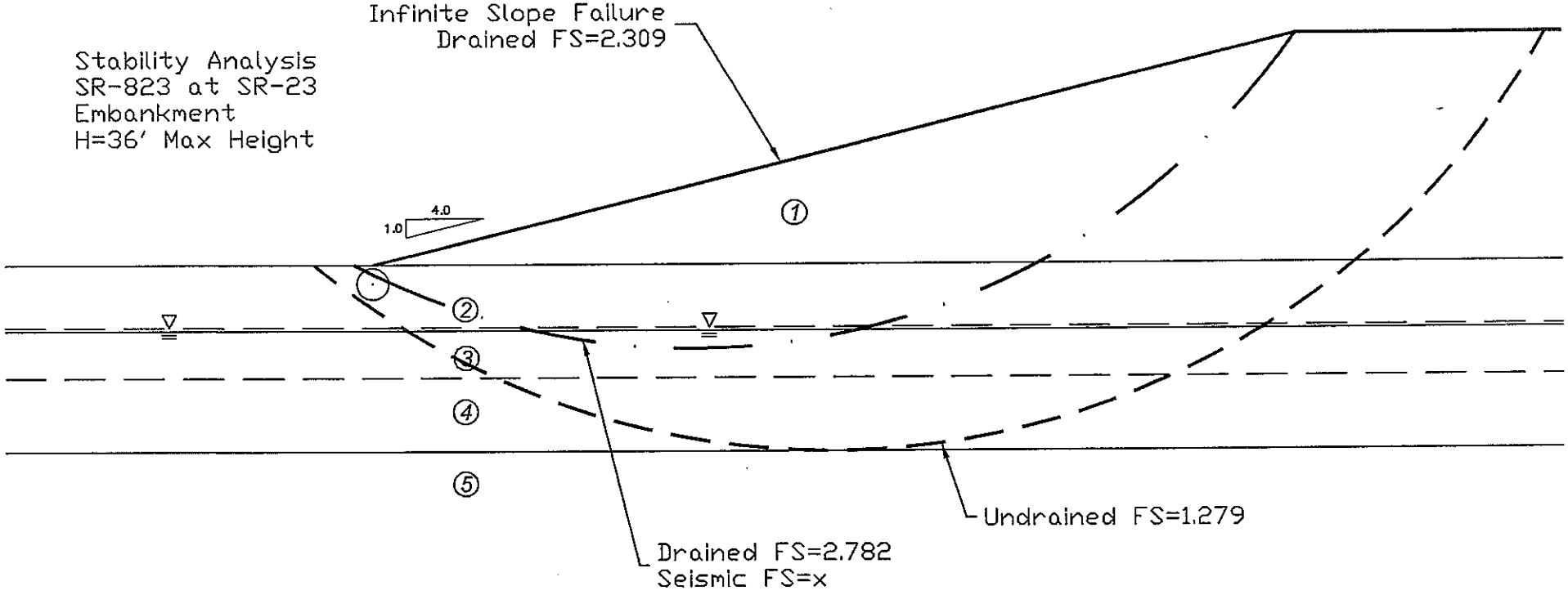
Material	Consistency	Soil Type	Undrained C (psf)	Undrained ϕ (deg)	Drained C' (psf)	Drained ϕ' (deg)	γ (pcf)
Material 1	Compacted	Emb. Fill	0	30	0	30	120
Material 2	Very Stiff	Silt and Clay	2500	0	0	29	125
Material 3	Soft	Sandy Silt	300	0	0	29	120
Material 4	Soft	Silty Clay	300	0	0	29	125
Material 5		Bedrock	10000	45	10000	45	145

Stability Analysis
SR-823 at SR-23
Embankment
H=36' Max Height



Sheet 6 of 17

US-23 Interchange
Based on Boring B-1133
Embankment Stability & Staged Const.

EMBANKMENT GLOBAL STABILITY ANALYSIS

SCI-823-0.00

PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 2/19/07

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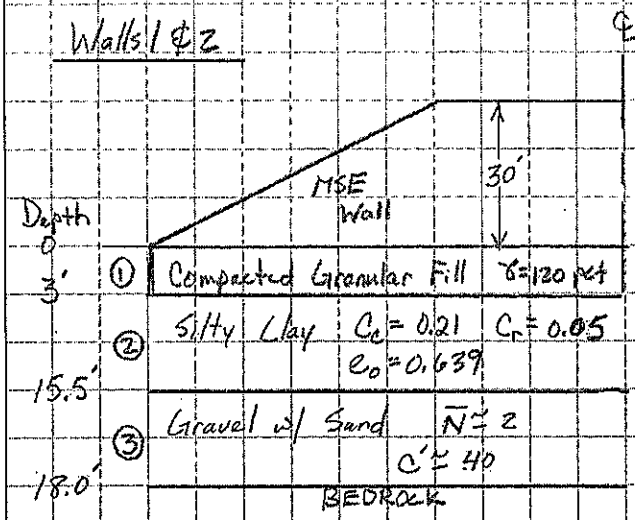
CLIENT CH2 M Hill / ODOT D-9 | PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass | SHEET NO. 7 OF 17
SUBJECT US-23 Interchange | COMP. BY SJR DATE 2-28-07
Settlement of Wall at Fairgrounds Rd | CHECKED BY DAA DATE 3-1-07

Walls 1 & 2



Walls 1 & 2 * Assume H = 30'
Soil Profile based upon B-1113

Assume Incompressible
Consolidation Parameters Taken from tests on similar soils found in B-1108A. - See attached
Ref [FHWA NHI-00-045] See Calculation Below

Layer 2
From Consolidation Tests, assume that soils are normally consolidated.

Layer 3
[Ref: FHWA NHI-00-045]
$N \cong N' \cong 2$ blows/ft. $\rightarrow$ $C' \cong 40$

*The Computer program EMBANK requires inputs for C_c, C_r, and e_o. To evaluate the settlement of granular layers we must calculate equivalent consolidation parameters from C'.

$$\frac{1}{C'} = \frac{C_c}{1+e_o}$$ Say $e_o = 1$ in this case.

$$\frac{1}{C'} = \frac{C_c}{1+e_o} \rightarrow C' = \frac{2.0}{C_c} \rightarrow \boxed{C_c = C_r = \frac{2}{C'}}$$

When $C' = 40 \rightarrow C_r = C_c = 0.05$ & $e_o = 1.0$

US-23 Walls 1 and 2 Initial Consolidation

ÚÄÄÄÄÄ ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration ÄÄÄÄÄ¿
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name	: SCI-823	Client	: CH2M Hill
File Name	: 23-12	Project Manager	: P Nix
Date	: 2/28/10	Computed by	: SJR

Settlement for X-Direction

Embank. slope, x direc. =	60.00 (ft)	Height of fill H =	30.00 (ft)
y direc. =	60.00 (ft)	Unit weight of fill =	120.00 (pcf)
Embankment top width =	120.00 (ft)	p load/unit area =	3600.00 (psf)
Embankment bottom width =	240.00 (ft)	Foundation Elev. =	563.20 (ft)
Ground Surface Elev. =	566.80 (ft)		
Water table Elev. =	556.80 (ft)	Unit weight of Wat. =	62.40 (pcf)

N§.	LAYER TYPE	THICK. (ft)	COEFFICIENT COMP.	RECOMP.	SWELL.	UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
1	INCOMP.	3.0	-----	-----	-----	120.00	----	----
2	COMP.	12.5	0.210	0.050	0.000	120.00	2.65	0.64
3	COMP.	2.5	0.050	0.050	0.000	120.00	2.65	1.00

N§.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES INITIAL (psf)	MAX.PAST PRESS. (psf)
1	INCOMP.			
2	5.65	560.38	771.00	771.00
3	6.25	554.42	1336.80	1336.80
4	2.50	550.05	1588.80	1588.80

Layer	X = Stress (psf)	0.00 Sett. (in.)	X = Stress (psf)	12.00 Sett. (in.)	X = Stress (psf)	24.00 Sett. (in.)	X = Stress (psf)	36.00 Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	16.58	0.08	374.97	1.49	745.97	2.55	1113.94	3.37
3	80.49	0.24	374.74	1.03	730.00	1.82	1088.95	2.49
4	122.11	0.02	389.67	0.07	730.70	0.12	1081.51	0.17
		0.35		2.60		4.49		6.02

Layer	X = Stress (psf)	48.00 Sett. (in.)	X = Stress (psf)	60.00 Sett. (in.)	X = Stress (psf)	72.00 Sett. (in.)	X = Stress (psf)	84.00 Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	1478.45	4.04	1824.35	4.58	1840.10	4.60	1840.43	4.60
3	1442.18	3.05	1733.20	3.47	1802.29	3.56	1809.80	3.57
4	1421.25	0.21	1686.95	0.24	1780.00	0.24	1798.66	0.25
		7.30		8.28		8.40		8.42

δ_{max}

US-23 Walls 1 and 2 Initial Consolidation

Layer	X = 96.00 Stress (psf)	Sett. (in.)	X = 108.00 Stress (psf)	Sett. (in.)	X = 120.00 Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.			
2	1840.49	4.60	1840.51	4.60	1840.52	4.60
3	1811.50	3.57	1812.04	3.57	1812.18	3.57
4	1803.68	0.25	1805.38	0.25	1805.81	0.25
		8.42		8.42		8.42

ÀÄÄÄÄÄ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu ÄÄÄÄÄÙ

US-23 Walls 1 and 2 Consolidation after Surcharge

Sheet 10 of 17

ÚÄÄÄÄÄ ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration ÄÄÄÄÄ¿
INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name	: SCI-823	Client	: CH2M Hill
File Name	: 23-12	Project Manager	: P Nix
Date	: 2/28/10	Computed by	: SJR

Settlement for X-Direction

Embank. slope, x direc. =	60.00 (ft)	Height of fill H =	30.00 (ft)
y direc. =	60.00 (ft)	Unit weight of fill =	120.00 (pcf)
Embankment top width =	120.00 (ft)	p load/unit area =	3600.00 (psf)
Embankment bottom width =	240.00 (ft)	Foundation Elev. =	563.20 (ft)
Ground Surface Elev. =	566.80 (ft)		
Water table Elev. =	556.80 (ft)	Unit weight of Wat. =	62.40 (pcf)

N§.	LAYER TYPE	THICK. (ft)	COEFFICIENT COMP.	RECOMP.	SWELL.	UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
1	INCOMP.	3.0	-----	-----	-----	120.00	----	----
2	COMP.	12.5	0.210	0.050	0.000	120.00	2.65	0.64
3	COMP.	2.5	0.050	0.050	0.000	120.00	2.65	1.00

N§.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES INITIAL (psf)	MAX.PAST PRESS. (psf)
1	INCOMP.			
2	5.65	560.38	771.00	4713.89
3	6.25	554.42	1336.80	5375.00
4	2.50	550.05	1588.80	5861.11

Layer	X = Stress (psf)	0.00 Sett. (in.)	X = Stress (psf)	12.00 Sett. (in.)	X = Stress (psf)	24.00 Sett. (in.)	X = Stress (psf)	36.00 Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	16.58	0.02	374.97	0.36	745.97	0.61	1113.94	0.80
3	80.49	0.06	374.74	0.25	730.00	0.43	1088.95	0.59
4	122.11	0.02	389.67	0.07	730.70	0.12	1081.51	0.17
		0.10		0.67		1.16		1.56

Layer	X = Stress (psf)	48.00 Sett. (in.)	X = Stress (psf)	60.00 Sett. (in.)	X = Stress (psf)	72.00 Sett. (in.)	X = Stress (psf)	84.00 Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	1478.45	0.96	1824.35	1.09	1840.10	1.10	1840.43	1.10
3	1442.18	0.73	1733.20	0.83	1802.29	0.85	1809.80	0.85
4	1421.25	0.21	1686.95	0.24	1780.00	0.24	1798.66	0.25
		1.90		2.15		2.19		2.19

δ_{max}

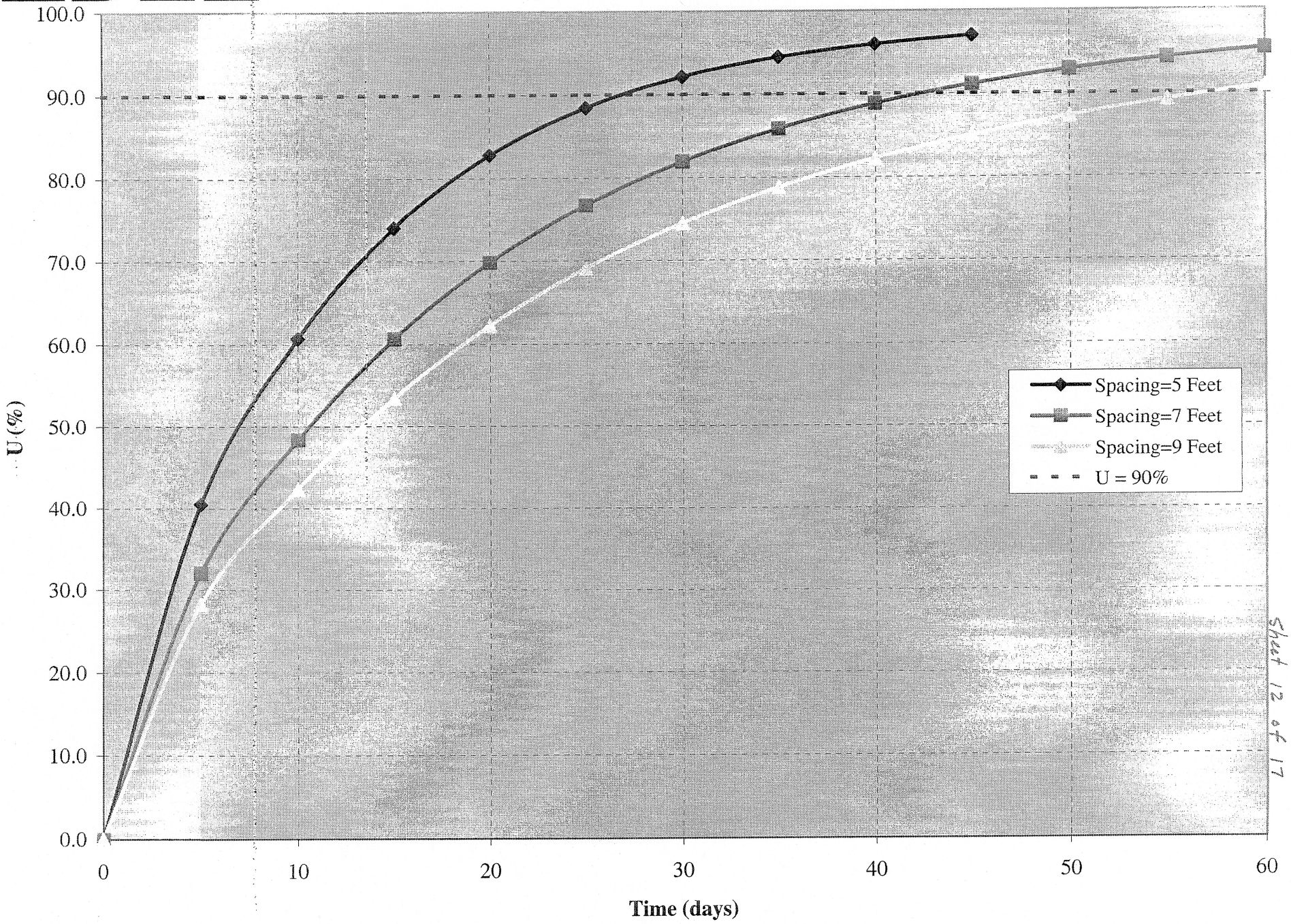
US-23 Walls 1 and 2 Consolidation after Surcharge

Layer	X = 96.00 Stress (psf)	Sett. (in.)	X = 108.00 Stress (psf)	Sett. (in.)	X = 120.00 Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.			
2	1840.49	1.10	1840.51	1.10	1840.52	1.10
3	1811.50	0.85	1812.04	0.85	1812.18	0.85
4	1803.68	0.25	1805.38	0.25	1805.81	0.25
		2.19		2.19		2.19

ÀÄÄÄÄÄ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu ÄÄÄÄÄÙ

DLZ

Percent Consolidation vs Time
US-23 Interchange, Fairgrounds Road, Walls 1 &2



Sheet 12 of 17

DLZ

Time Rate of Consolication of Foundation Soils with Wick Drians
Fairgrounds Road Walls 1 & 2
Reference: FHWA-RD-86-168

Wick Drain Spacing 5.0 feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	5.25	0.30	6.25	8.4
5	0.0544	0.0384	0.25	0.20	40.5	3.4				
10	0.1088	0.0768	0.44	0.30	60.7	5.1				
15	0.1633	0.1152	0.58	0.39	74.0	6.2				
20	0.2177	0.1536	0.68	0.46	82.8	7.0				
25	0.2721	0.1920	0.76	0.52	88.5	7.4				
30	0.3265	0.2304	0.82	0.57	92.1	7.7				
35	0.3810	0.2688	0.86	0.61	94.4	7.9				
40	0.4354	0.3072	0.89	0.64	96.0	8.1				
45	0.4898	0.3456	0.91	0.67	97.0	8.1				

DLZ

Time Rate of Consolication of Foundation Soils with Wick Drians
Fairgrounds Road Walls 1 & 2
Reference: FHWA-RD-86-168

Wick Drain Spacing **7.0** feet Use $\eta = 10$

t (days)	T_R	T_V	U_R	U_V	U_C	δ(inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	7.35	**0.30**	**6.25**	**39**
5	0.0278	0.0384	0.15	0.20	32.0	12.5				
10	0.0555	0.0768	0.26	0.30	48.4	18.9				
15	0.0833	0.1152	0.36	0.39	60.6	23.6				
20	0.1111	0.1536	0.44	0.46	69.8	27.2				
25	0.1388	0.1920	0.52	0.52	76.8	29.9				
30	0.1666	0.2304	0.58	0.57	81.9	32.0				
35	0.1944	0.2688	0.64	0.61	85.9	33.5				
40	0.2221	0.3072	0.69	0.64	88.8	34.6				
45	0.2499	0.3456	0.73	0.67	91.1	35.5				
50	0.2777	0.3840	0.77	0.69	92.9	36.2				
55	0.3054	0.4224	0.80	0.72	94.2	36.7				
60	0.3332	0.4608	0.82	0.73	95.3	37.2				
65	0.3610	0.4992	0.84	0.75	96.2	37.5				
70	0.3887	0.5376	0.86	0.77	96.9	37.8				
75	0.4165	0.5760	0.88	0.79	97.4	38.0				
80	0.4443	0.6144	0.89	0.80	97.9	38.2				
85	0.4720	0.6528	0.90	0.82	98.3	38.3				
90	0.4998	0.6912	0.91	0.84	98.6	38.4				

DLZ

Time Rate of Consolication of Foundation Soils with Wick Drians
Fairgrounds Road Walls 1 & 2
Reference: FHWA-RD-86-168

Wick Drain Spacing **9.0** feet Use $\eta = 10$

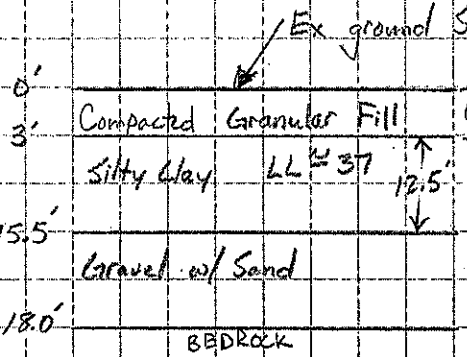
t (days)	T_R	T_V	U_R	U_V	U_C	δ (inches)	d_e	c_v	H_v	δ_{max}
0	0.0000	0.0000	0.00	0.00	0.0	0.0	9.45	0.30	6.25	39
5	0.0168	0.0384	0.10	0.20	28.2	11.0				
10	0.0336	0.0768	0.17	0.30	42.4	16.5				
15	0.0504	0.1152	0.24	0.39	53.5	20.9				
20	0.0672	0.1536	0.30	0.46	62.2	24.3				
25	0.0840	0.1920	0.36	0.52	69.1	27.0				
30	0.1008	0.2304	0.41	0.57	74.5	29.1				
35	0.1176	0.2688	0.46	0.61	78.8	30.7				
40	0.1344	0.3072	0.51	0.64	82.3	32.1				
45	0.1512	0.3456	0.55	0.67	85.0	33.2				
50	0.1680	0.3840	0.59	0.69	87.3	34.1				
55	0.1848	0.4224	0.62	0.72	89.2	34.8				
60	0.2016	0.4608	0.65	0.73	90.8	35.4				
65	0.2184	0.4992	0.68	0.75	92.1	35.9				
70	0.2352	0.5376	0.71	0.77	93.3	36.4				
75	0.2520	0.5760	0.73	0.79	94.3	36.8				
80	0.2687	0.6144	0.76	0.80	95.2	37.1				
85	0.2855	0.6528	0.78	0.82	96.0	37.4				
90	0.3023	0.6912	0.79	0.84	96.7	37.7				
95	0.3191	0.7296	0.81	0.86	97.3	37.9				
100	0.3359	0.7680	0.83	0.87	97.7	38.1				
105	0.3527	0.8064	0.84	0.89	98.1	38.3				
110	0.3695	0.8448	0.85	0.90	98.5	38.4				
115	0.3863	0.8832	0.86	0.91	98.7	38.5				
120	0.4031	0.9216	0.87	0.91	98.8	38.5				
125	0.4199	0.9600	0.88	0.91	98.9	38.6				
130	0.4367	0.9984	0.89	0.90	98.9	38.6				
135	0.4535	1.0368	0.89	0.88	98.8	38.5				
140	0.4703	1.0752	0.90	0.85	98.6	38.4				

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

CLIENT CHZM Hill / ODOT D-9 | PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass | SHEET NO. 16 OF 17
SUBJECT US-23 Interchange | COMP. BY SJR DATE 2-28-07
Settlement of Wall at Fairgrounds Rd. | CHECKED BY DAA DATE 3-1-07

Walls 1 & 2

*Soil Profile based upon boring B-1113



{Estimated as per FHWA based on LL}
Ref: FHWA HI-97-021, Also NAVFAC

Time-Rate of Consolidation

* Assume Double Drainage

$H_v = 12.5'/2 = 6.25'$

for $U = 90\% \rightarrow T_v = 0.848$

$$t_{90} = \frac{T \cdot H_v^2}{C_v}$$

$$t_{90} = \frac{(0.848)(6.25')^2}{0.3\ ft^2/day} = 110.4 \text{ days} \cong \boxed{110 \text{ days}}$$

Differential Settlement

Prior to Surcharge: $DS = \dfrac{(2.60'' - 0.35'')\left(\frac{1ft}{12''}\right)}{12'}$

$\delta_{max} = 8.4''$

$DS = 0.016 = 1.6\% > 1.0\%$

After Surcharge: $DS = \dfrac{(0.67'' - 0.10'')\left(\frac{1ft}{12''}\right)}{12'}$

$\delta_{max} \cong 2.2''$

$DS = 0.004 = 0.4\% < 1.0\%$

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CLIENT CHZ M Hill / ODOT D-9 PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass SHEET NO. 17 OF 17
SUBJECT US-23 Interchange COMP. BY SJK DATE 3-26-0
Settlement of Walls at Fairgrounds Rd. CHECKED BY DAA DATE 3-26-0

Walls 1 & 2 – Secondary Compression Settlement

C_α > Secondary compression index measured from consolidation testing.

From boring B-1108A, Sample P3

$C_\alpha \simeq 0.003$ $\quad e_p \simeq 0.56$

t = 75 years (Service Life) = 27,394 days

$t_p = t_{95} = \frac{(1.13)(6.25)^2}{0.3\ ft^2/day} = 147$ days $\quad H = 12.5'$

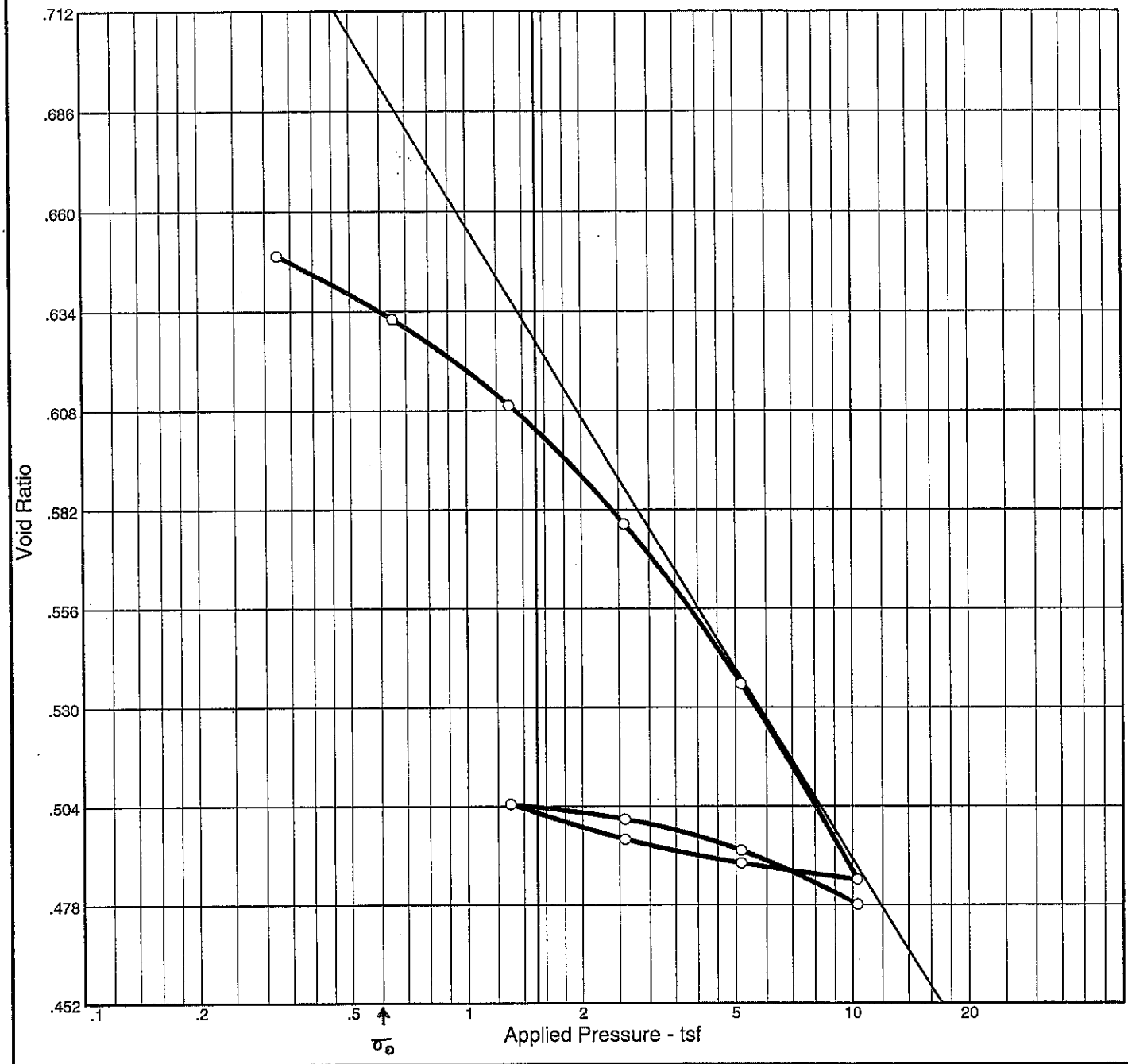
$$\delta_s = \frac{C_\alpha}{1+e_p} \cdot H \cdot \log\left(\frac{t}{t_p}\right)$$

$$\delta_s = \frac{0.003}{1+0.56}(12.5) \cdot \log\left(\frac{27,394}{147}\right) = 0.055\ ft$$

$\delta_s = 0.055\ ft = 0.7$ inches

* Secondary Compression at this site will be negligible

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
95.5 %	23.0 %	101.0	36	15	2.65	CL	A-6(15)	0.639

MATERIAL DESCRIPTION

Lean clay, Silt and Clay (A-6a)
Specific Gravity= 2.65

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-1108A **Sample No.:** P1 **Elev./Depth:** 10.0

DLZ

Remarks:

NC

$C_c = 0.17$

$C_r = 0.03$

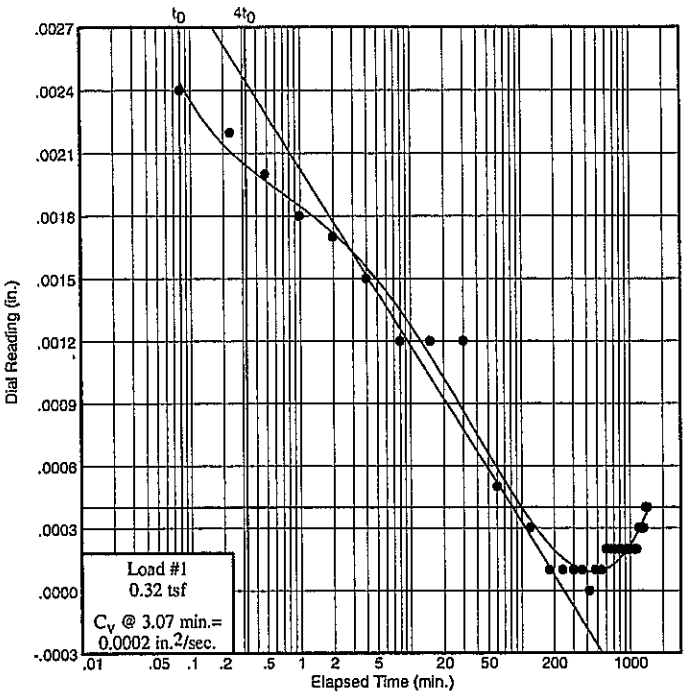
$C_\alpha \simeq 0.003$

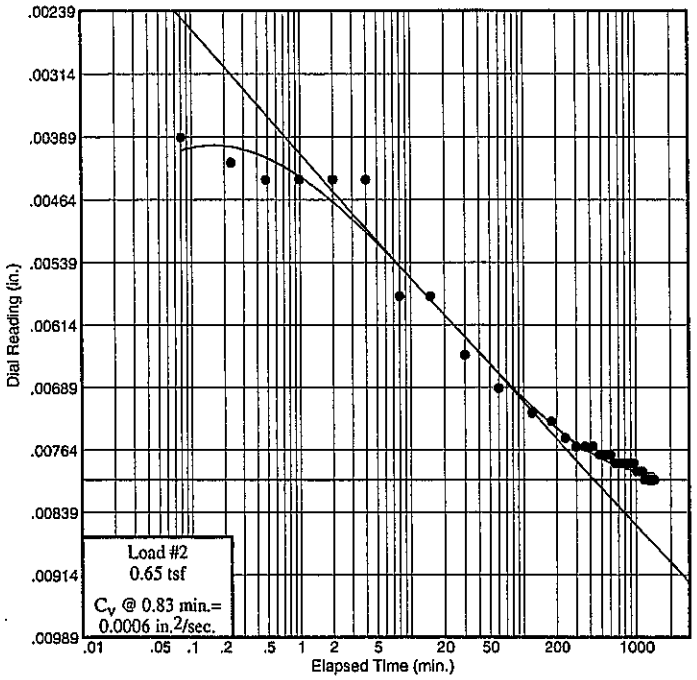
Figure

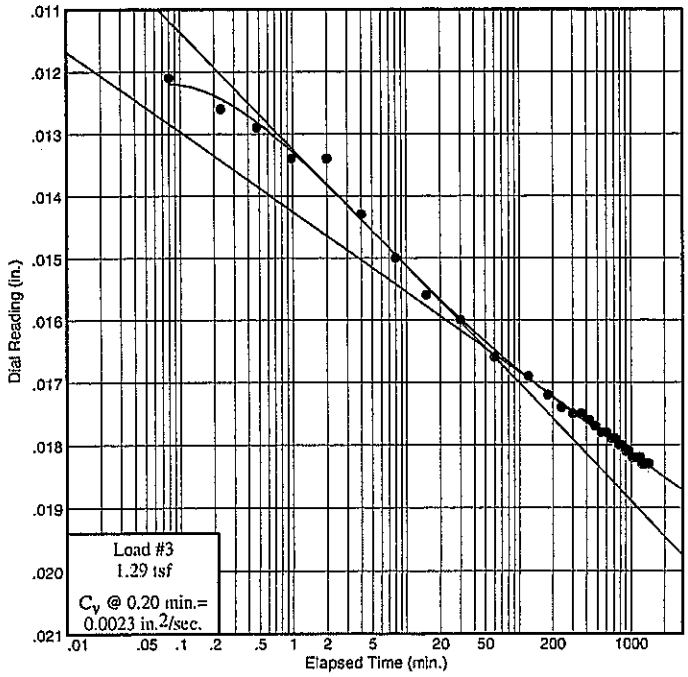
Dial Reading vs. Time

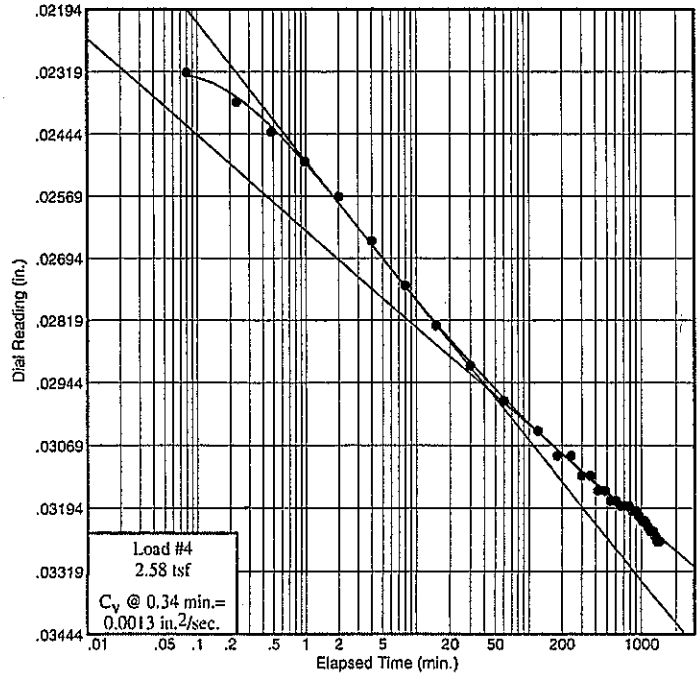
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-1108A Sample No.: P1 Elev./Depth: 10.0









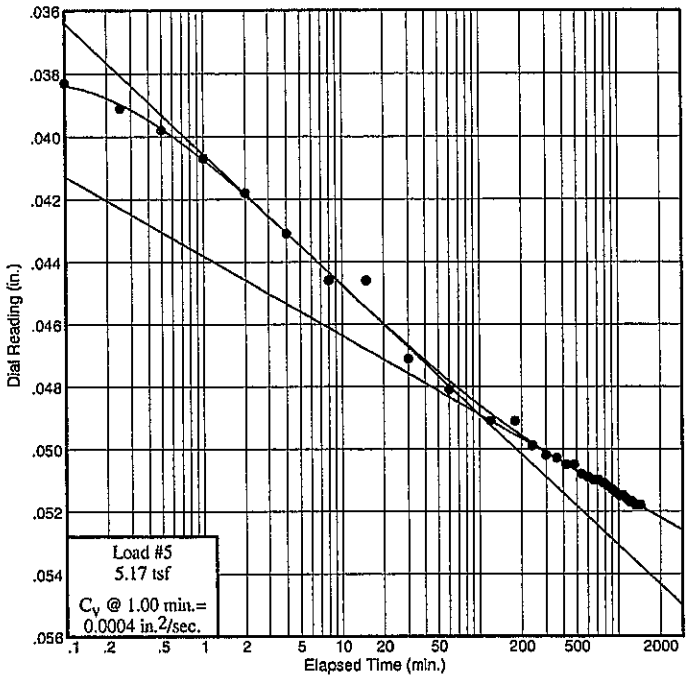
DLZ

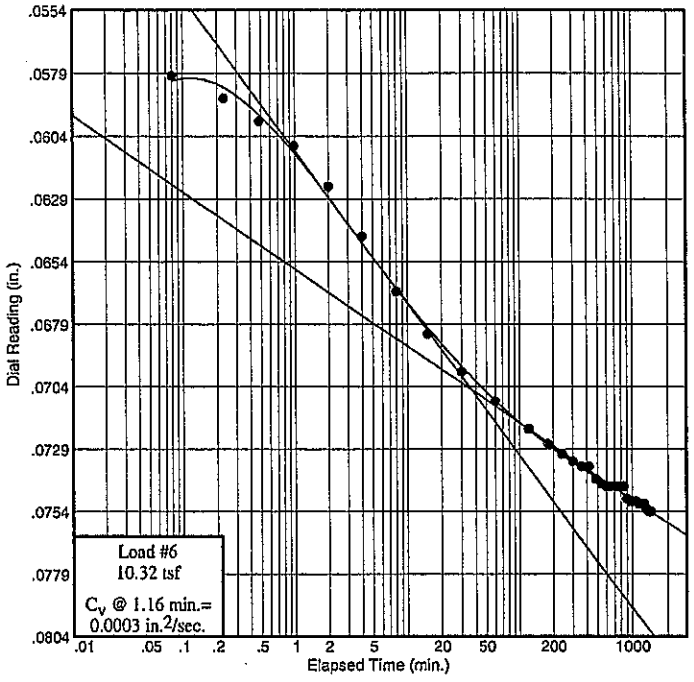
Figure

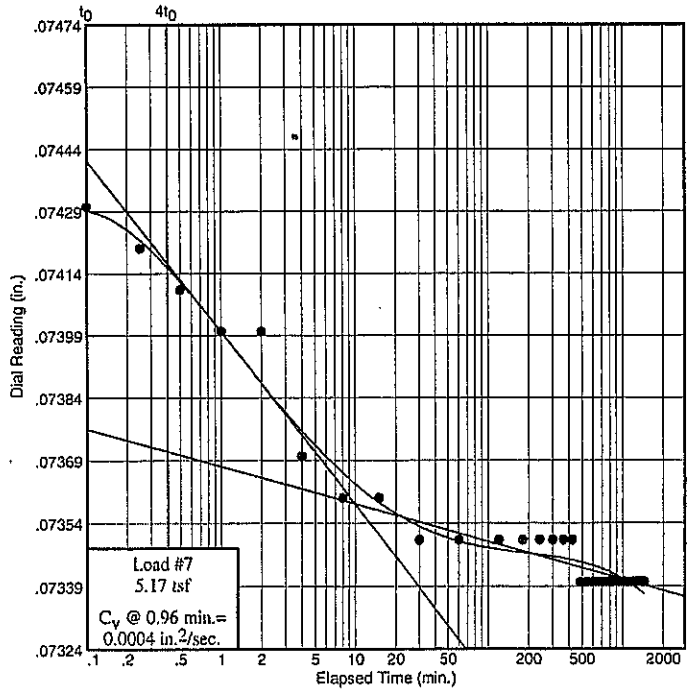
Dial Reading vs. Time

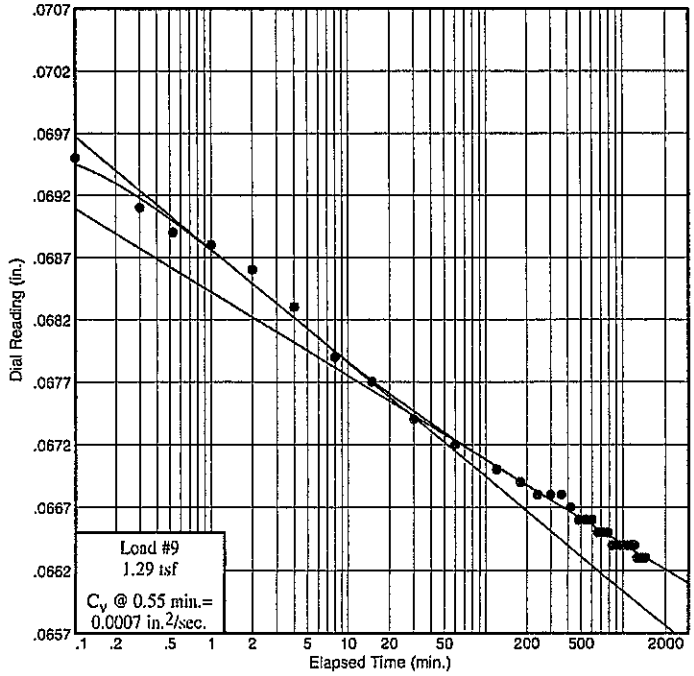
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-1108A Sample No.: P1 Elev./Depth: 10.0









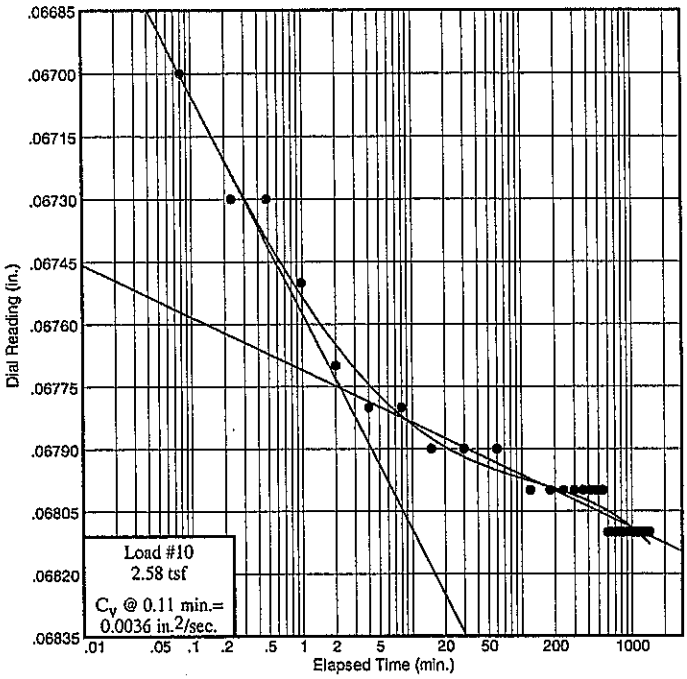
DLZ

Figure

Dial Reading vs. Time

Project No.: 0121-3070.03
Project: SCI-823-0.00

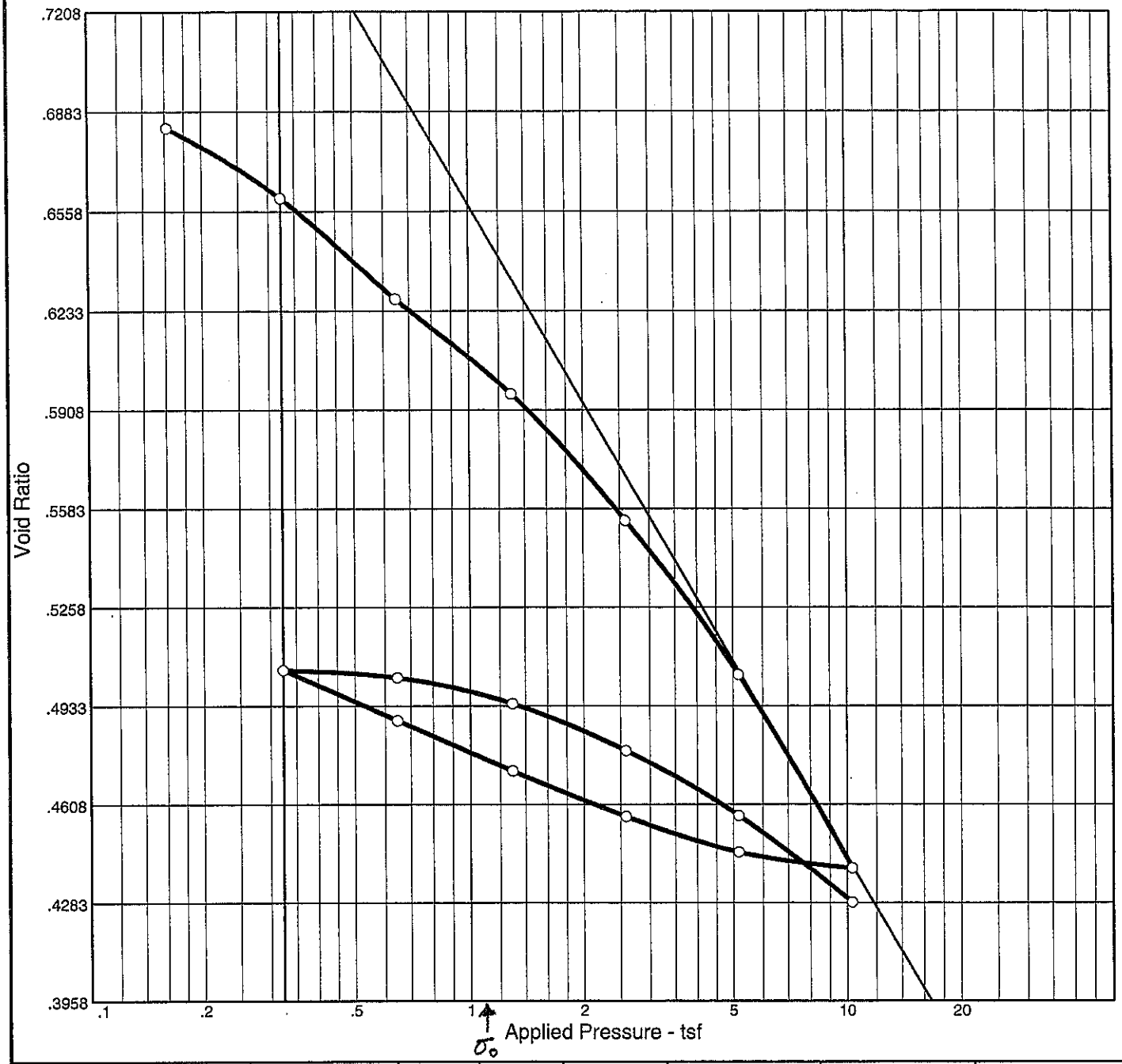
Source: B-1108A Sample No.: P1 Elev./Depth: 10.0



DLZ

Figure

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
		95.0	38	19		CL	A-6(17)	

MATERIAL DESCRIPTION

Lean clay — Silty Clay (A-6b)

Project No. 0121- **Client:** TranSystems, Inc.

Project: SCI-823-0.00

Source: B-1108A **Sample No.:** P3 **Elev./Depth:** 18.0

DLZ

Remarks:

NC

$C_c = 0.21$

$C_r = 0.05$

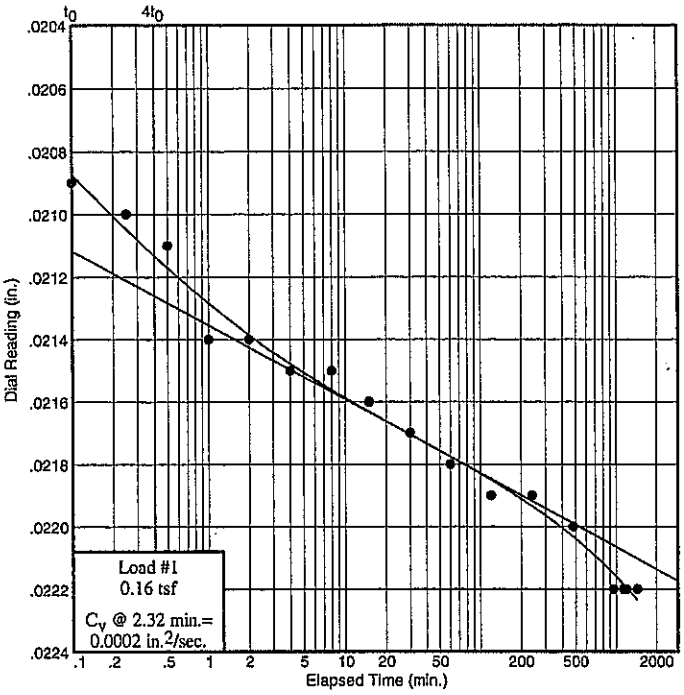
$C_\alpha = 0.003$

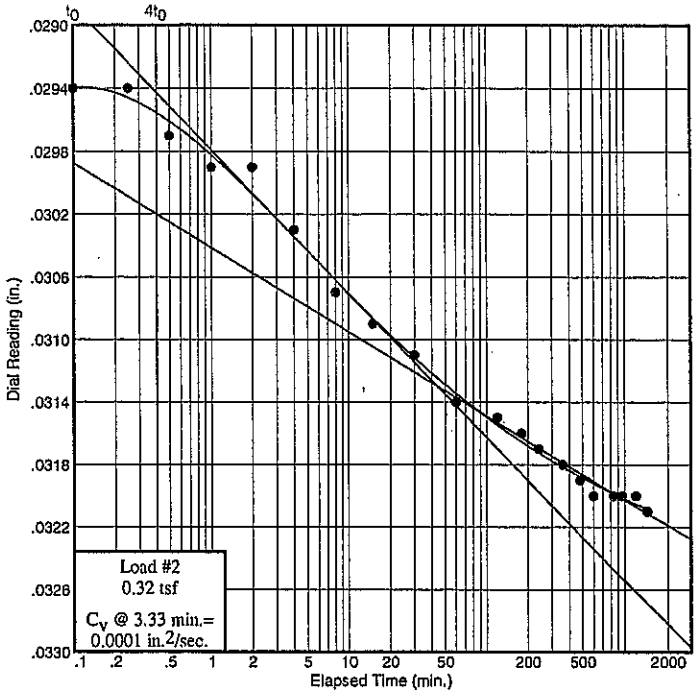
Figure

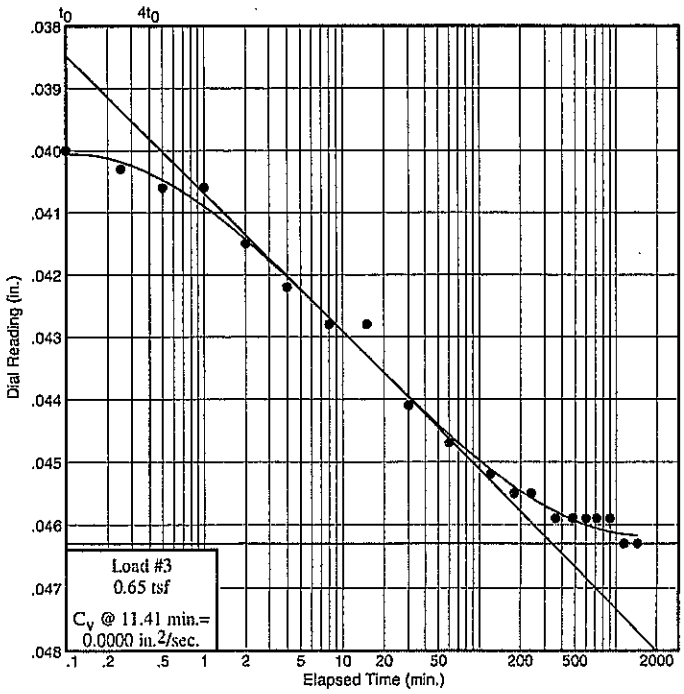
Dial Reading vs. Time

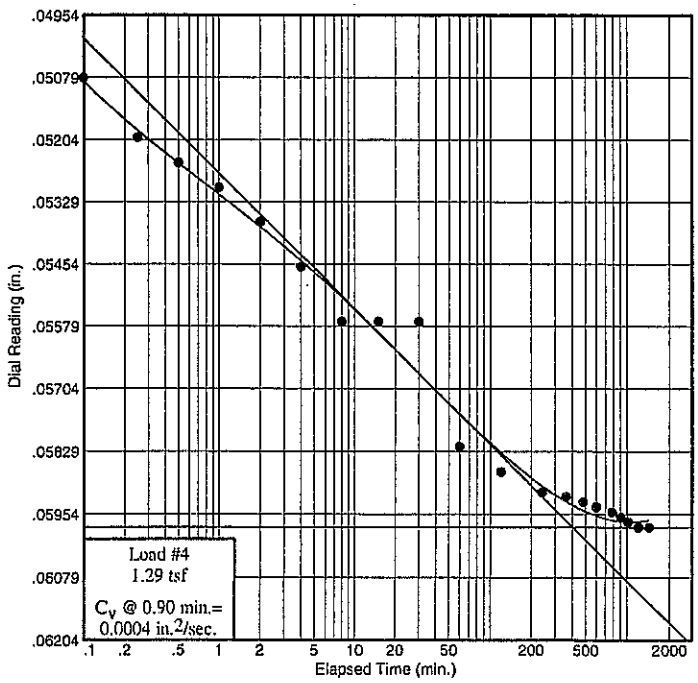
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-1108A Sample No.: P3 Elev./Depth: 18.0









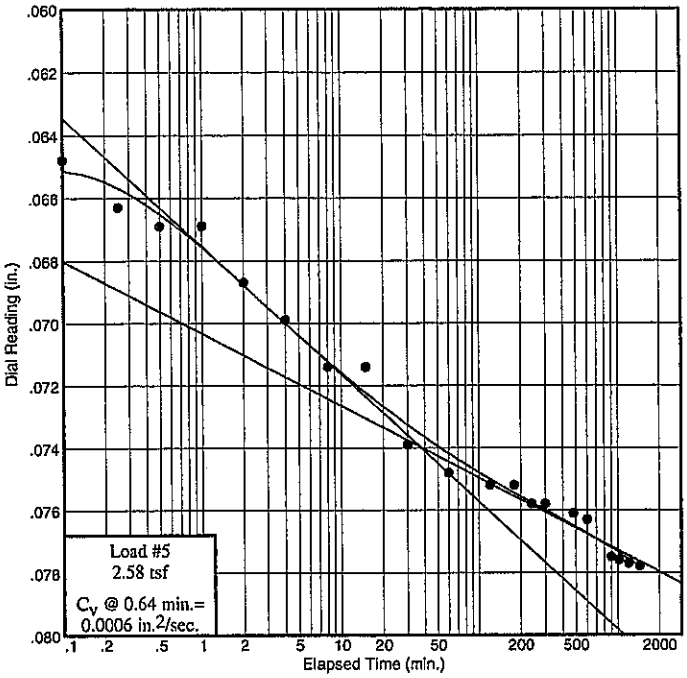
DLZ

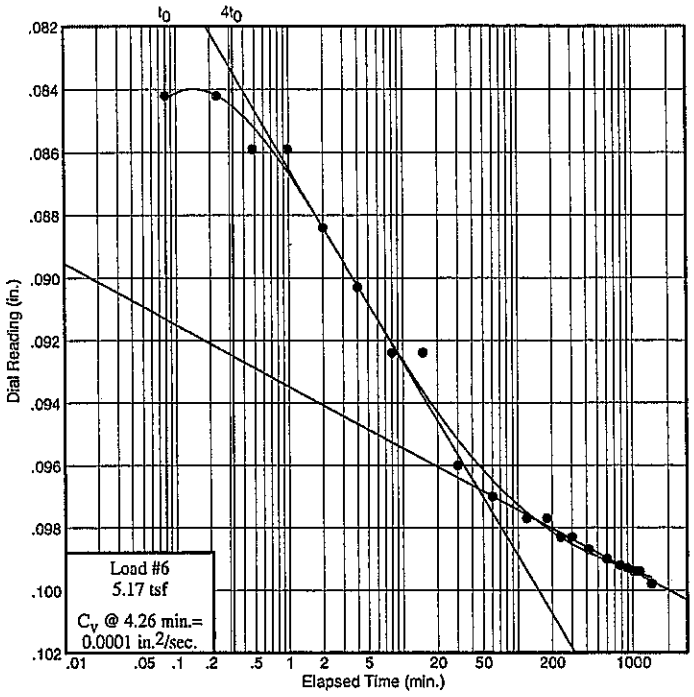
Figure

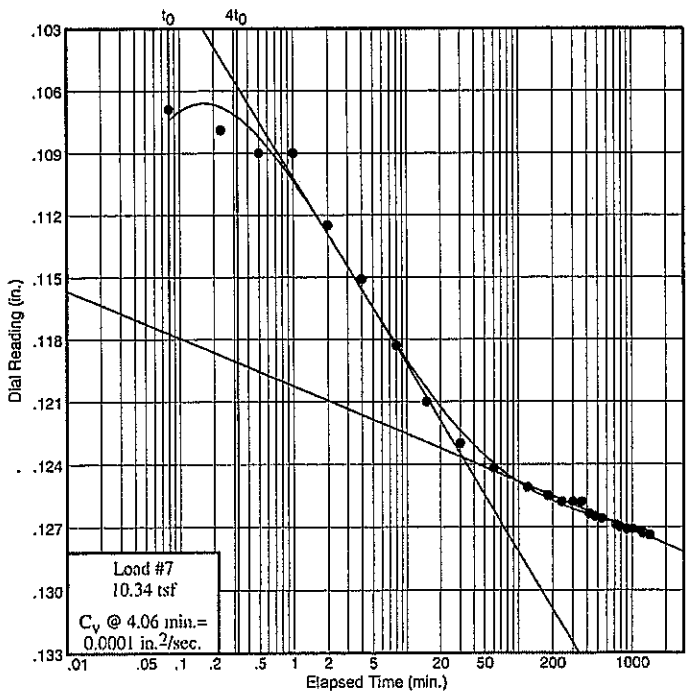
Dial Reading vs. Time

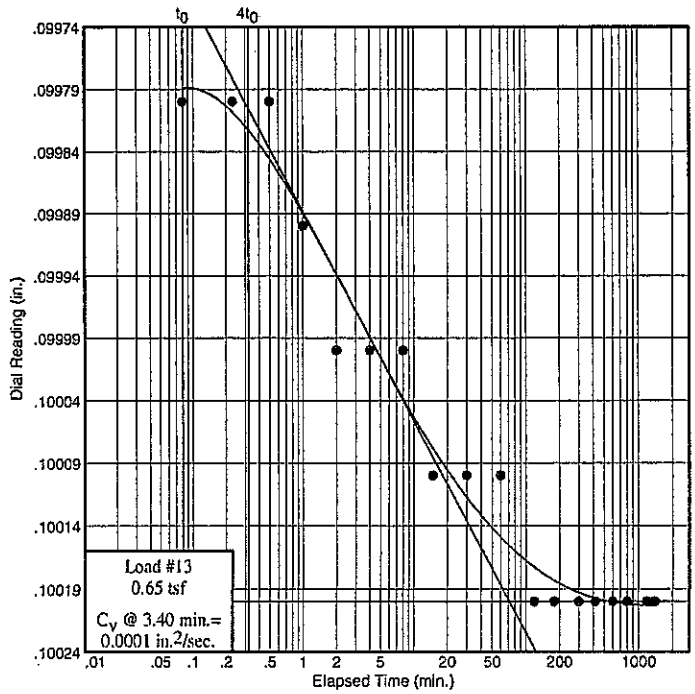
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-1108A Sample No.: P3 Elev./Depth: 18.0









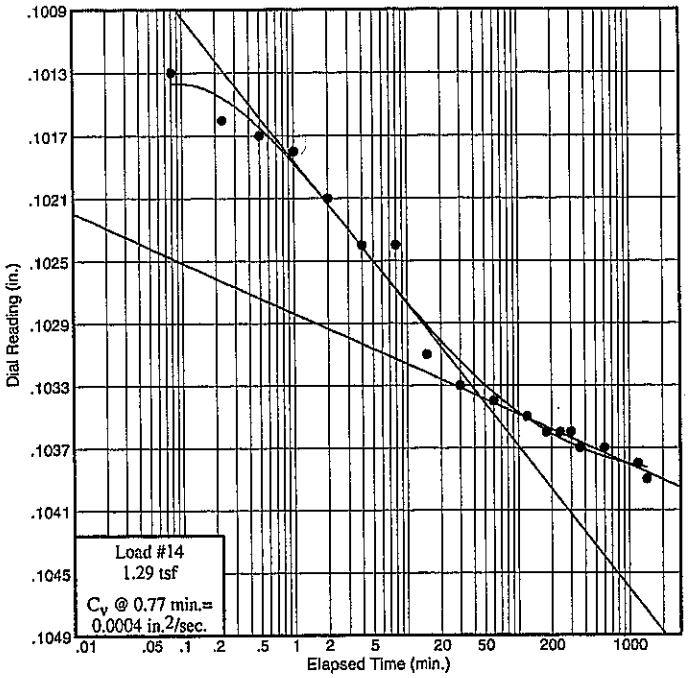
DLZ

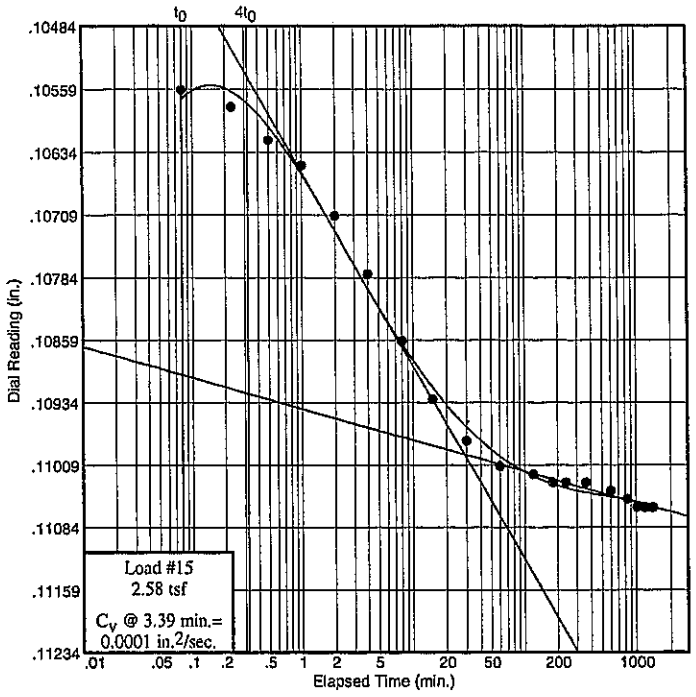
Figure

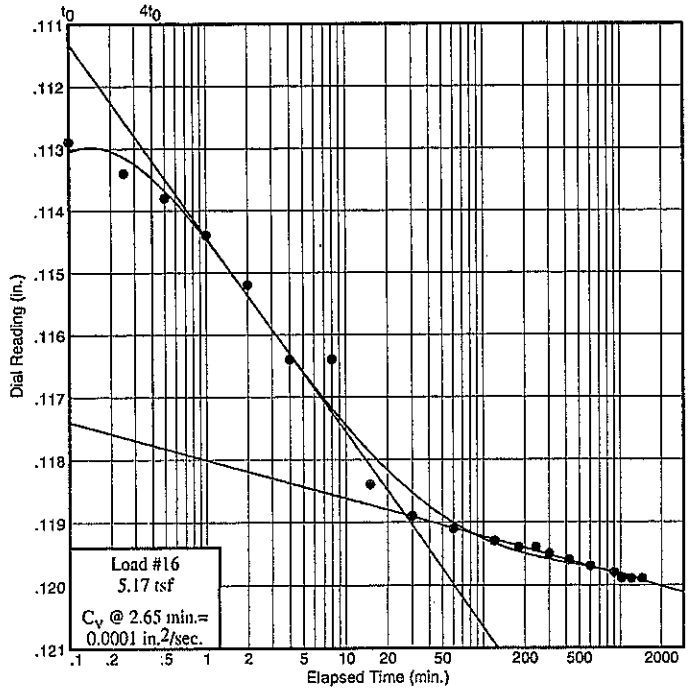
Dial Reading vs. Time

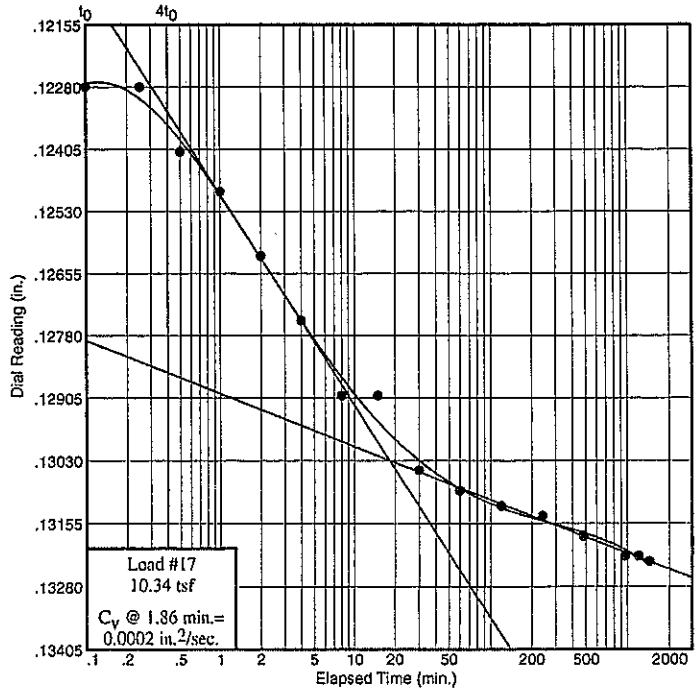
Project No.: 0121-3070.03
Project: SCI-823-0.00

Source: B-1108A Sample No.: P3 Elev./Depth: 18.0





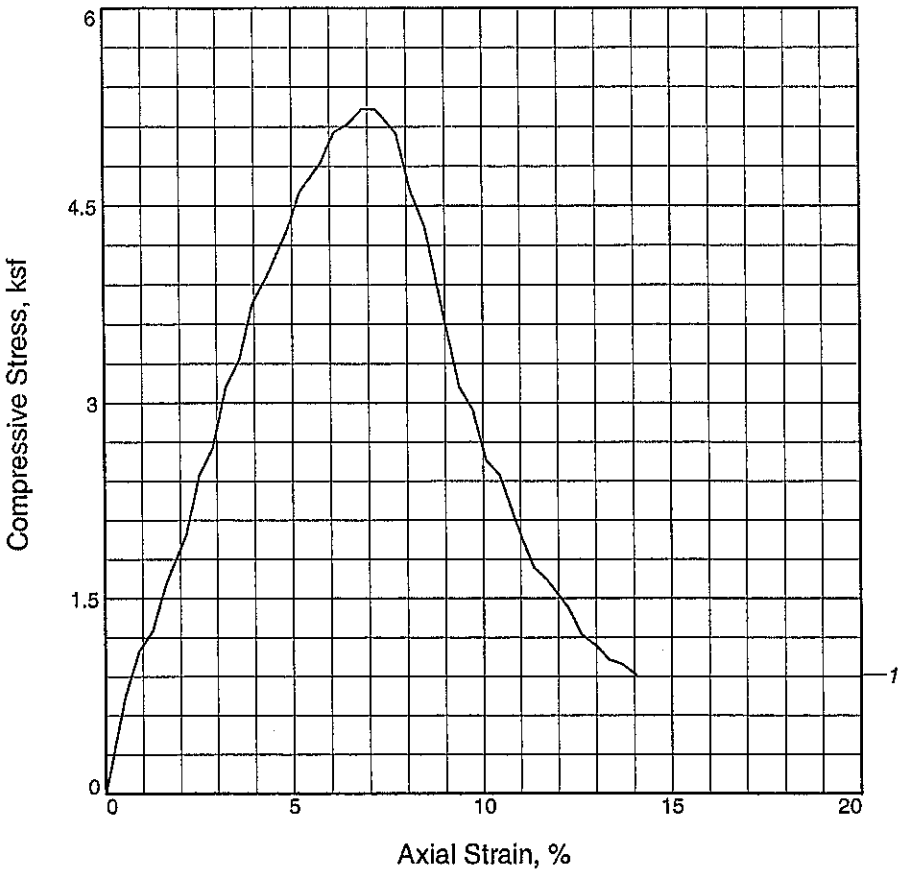




DLZ

Figure

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, ksf	5.24			
Undrained shear strength, ksf	2.62			
Failure strain,	6.8			
Strain rate, in./min.	0.06			
Water content, %	22.4			
Wet density, pcf	126.5			
Dry density, pcf	103.4			
Saturation, %	93.1			
Void ratio	0.6602			
Specimen diameter, in.	2.83			
Specimen height, in.	5.55			
Height/diameter ratio	1.96			

Description: Moisture Content = 22.4%

LL = 36	**PL** = 21	**PI** = 15	**Assumed GS=** 2.75	**Type:** 3" Press Tubes

Project No.: 0121-3070.03

Date: 08/16/06

Remarks:

Figure _____

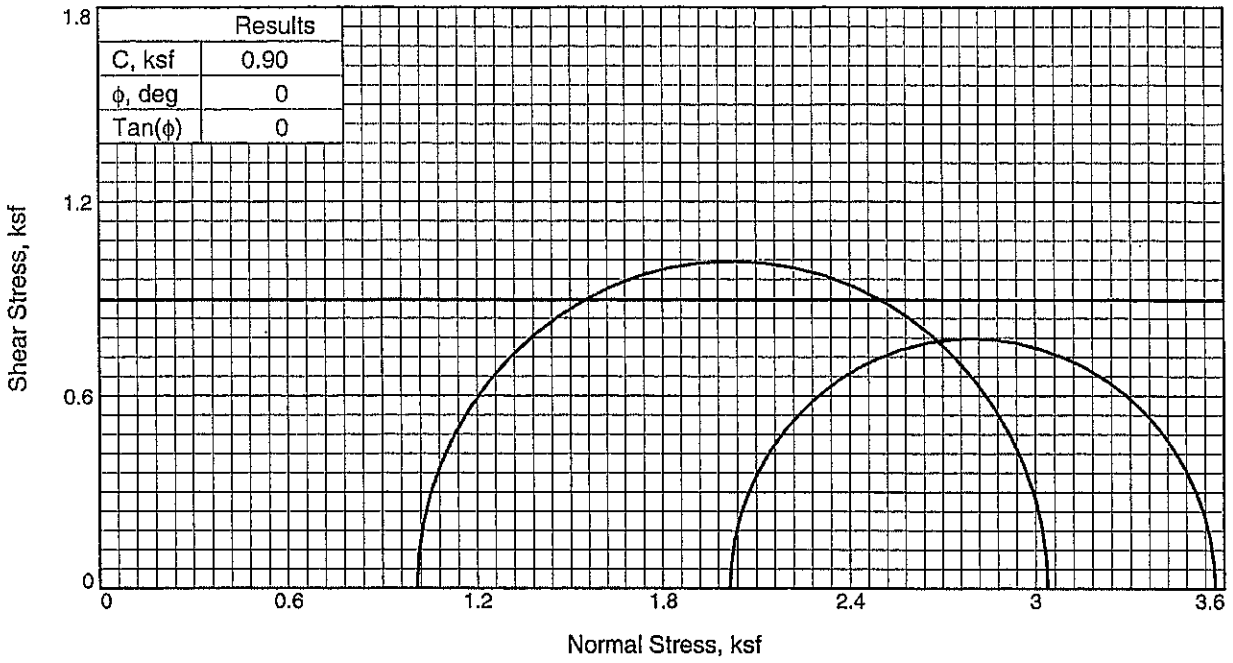
Client: TranSystems, Inc.

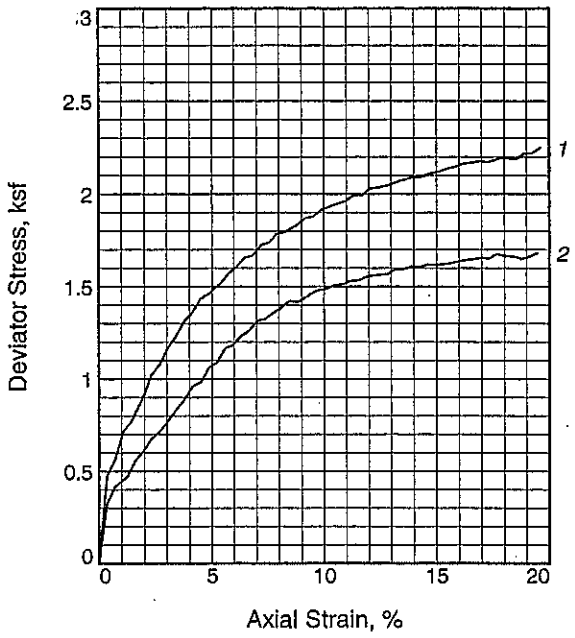
Project: SCI-823-0.00

Source of Sample: B-1108A **Depth:** 10.0

Sample Number: P1

DLZ





Sample No.		1	2
Initial	Water Content,	30.2	32.6
	Dry Density, pcf	95.2	89.5
	Saturation,	103.3	97.8
	Void Ratio	0.8041	0.9172
	Diameter, in.	2.83	2.84
	Height, in.	5.56	5.54
At Test	Water Content,	27.0	31.8
	Dry Density, pcf	95.2	89.5
	Saturation,	92.2	95.2
	Void Ratio	0.8041	0.9172
	Diameter, in.	2.83	2.84
	Height, in.	5.56	5.54
Strain rate, in./min.		0.06	0.06
Back Pressure, ksf		0.00	0.00
Cell Pressure, ksf		1.01	2.02
Fail. Stress, ksf		2.03	1.55
Ult. Stress, ksf		2.03	1.55
σ_1 Failure, ksf		3.04	3.57
σ_3 Failure, ksf		1.01	2.02

Type of Test:
Unconsolidated Undrained
Sample Type: 3" Press Tube
Description: Lean clay with sand

LL= 38 **PL=** 19 **PI=** 19
Assumed Specific Gravity= 2.75
Remarks:

Client: TranSystems, Inc.

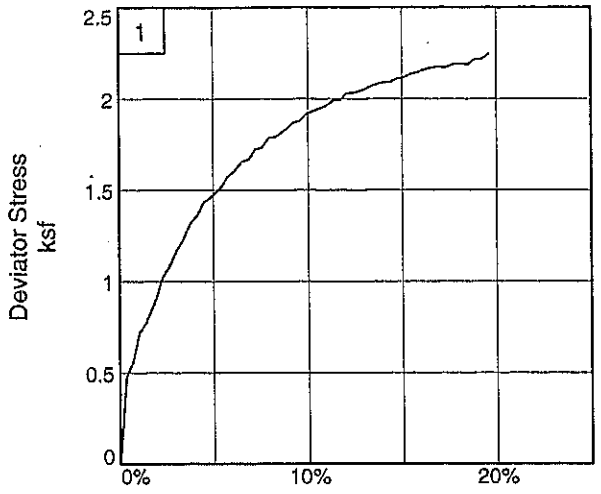
Project: SCI-823-0.00

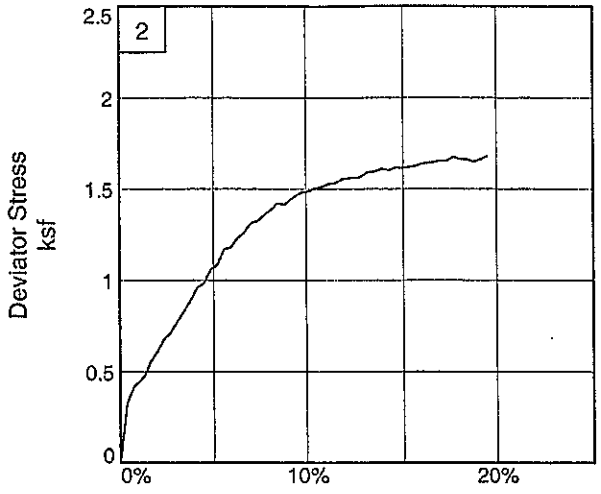
Source of Sample: B-1108A **Depth:** 14.0
Sample Number: P2

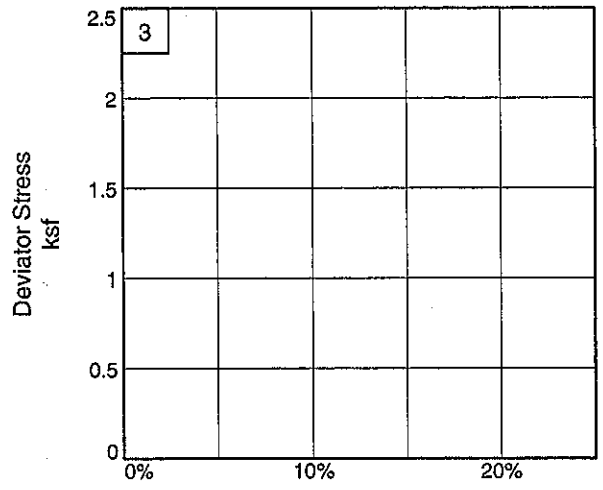
Proj. No.: 0121-3070.03 **Date:** 08/16/06

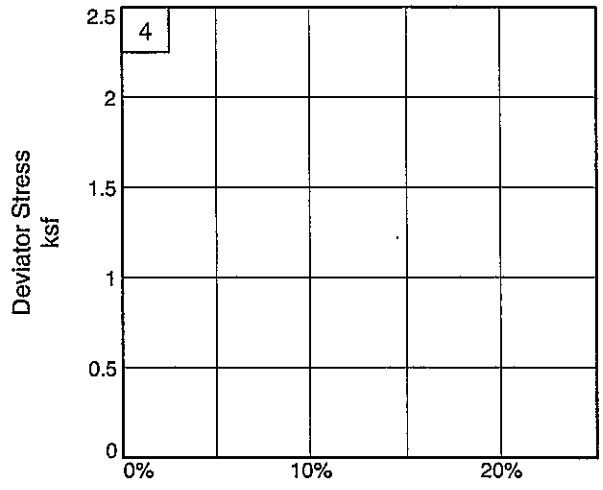
DLZ

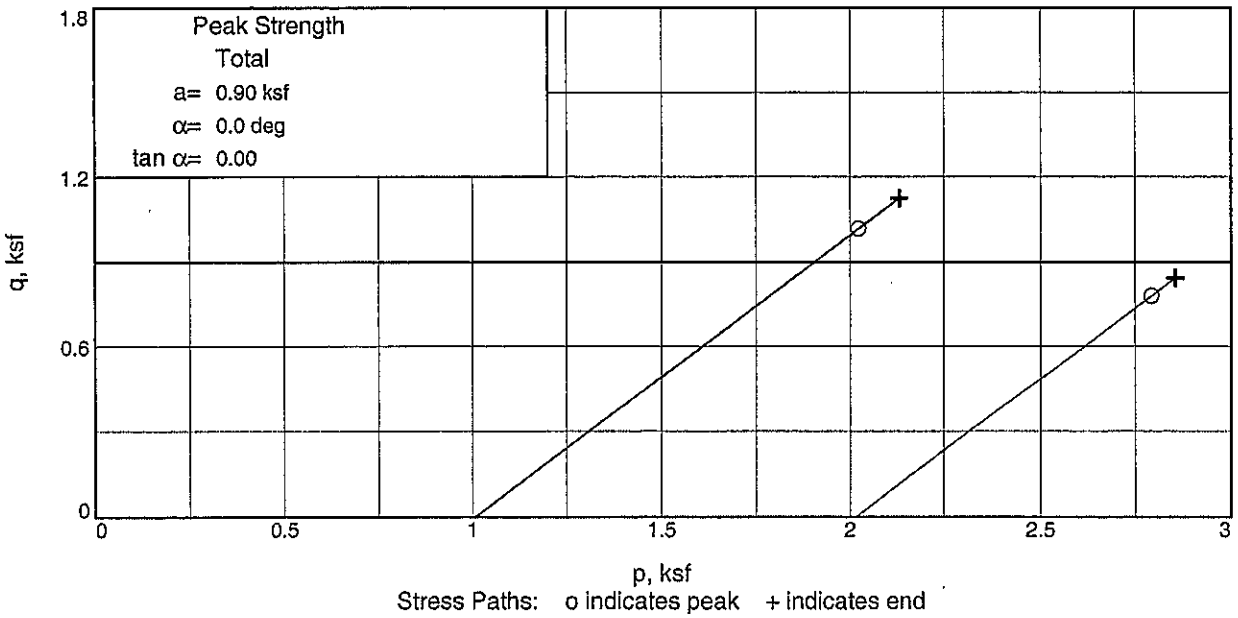
Figure _____











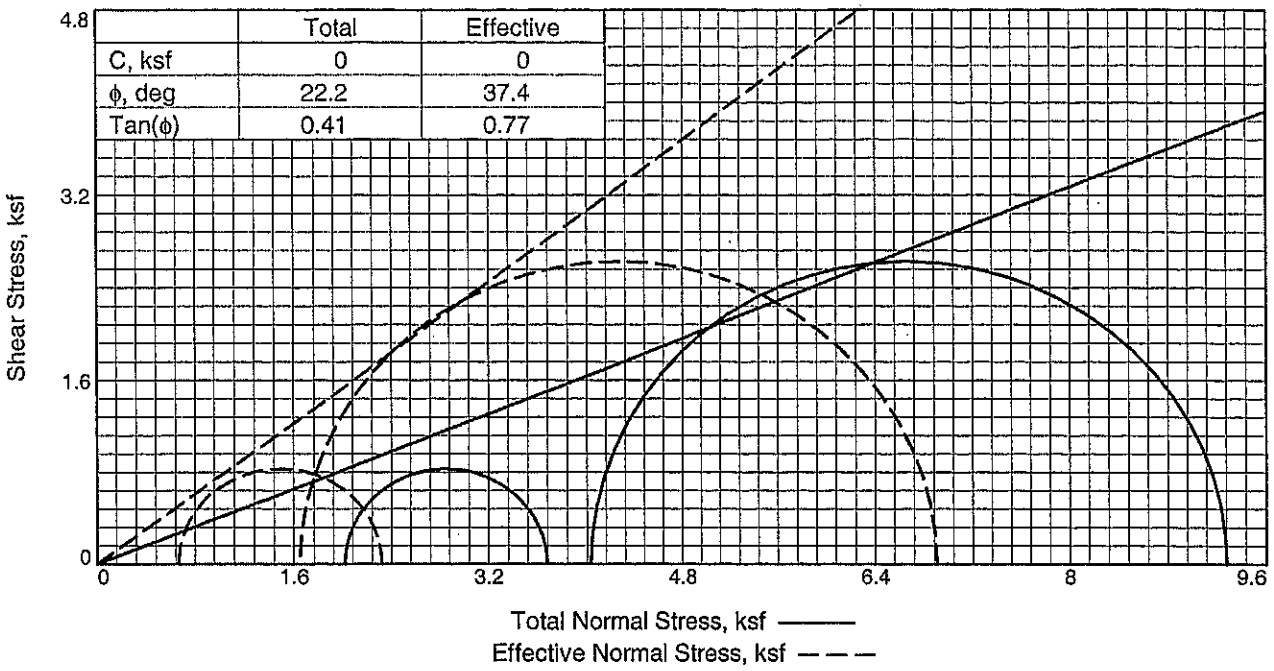
Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-1108A
Project No.: 0121-3070.03

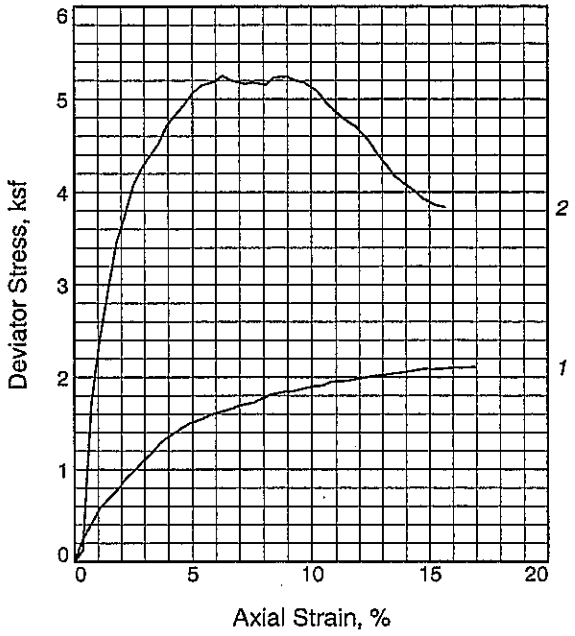
Depth: 14.0
Figure _____

Sample Number: P2

DLZ, INC.

	Total	Effective
C, ksf	0	0
ϕ, deg	22.2	37.4
Tan(ϕ)	0.41	0.77





Sample No.		1	2
Initial	Water Content,	28.4	29.1
	Dry Density, pcf	95.8	95.6
	Saturation,	98.7	100.4
	Void Ratio	0.7914	0.7964
	Diameter, in.	2.84	2.83
	Height, in.	5.56	5.56
At Test	Water Content,	26.3	25.7
	Dry Density, pcf	99.7	100.6
	Saturation,	100.0	100.0
	Void Ratio	0.7223	0.7068
	Diameter, in.	2.79	2.76
	Height, in.	5.56	5.56
Strain rate, in./min.		0.06	0.06
Back Pressure, ksf		8.06	8.06
Cell Pressure, ksf		10.08	12.10
Fail. Stress, ksf		1.66	5.25
Total Pore Pr., ksf		9.42	10.45
Ult. Stress, ksf		1.66	5.25
Total Pore Pr., ksf		9.42	10.45
$\bar{\sigma}_1$ Failure, ksf		2.32	6.90
$\bar{\sigma}_3$ Failure, ksf		0.66	1.65

Type of Test:
CU with Pore Pressures
Sample Type: 3" Press TUbe
Description: Lean clay

LL= 38 **PL=** 19 **PI=** 19
Assumed Specific Gravity= 2.75
Remarks:

Figure _____

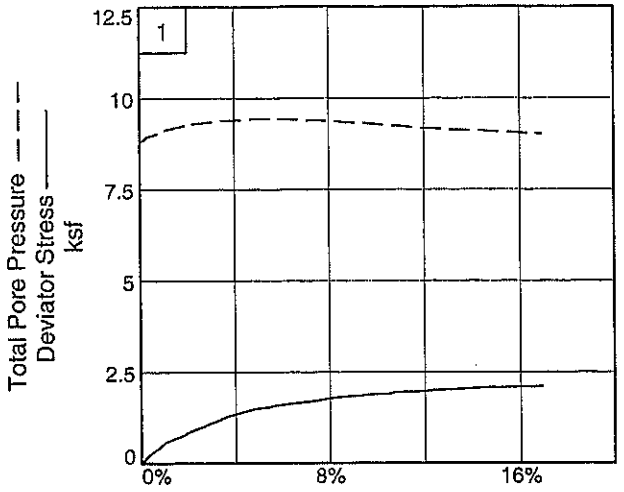
Client: TranSystems, Inc.

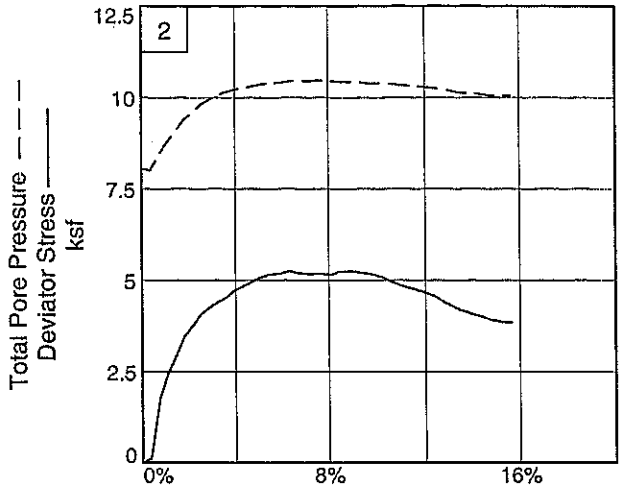
Project: SCI-823-0.00

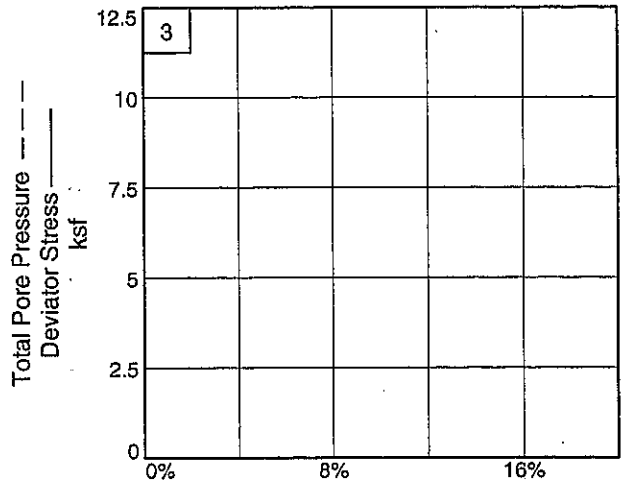
Source of Sample: B-1108A **Depth:** 18.0
Sample Number: P3

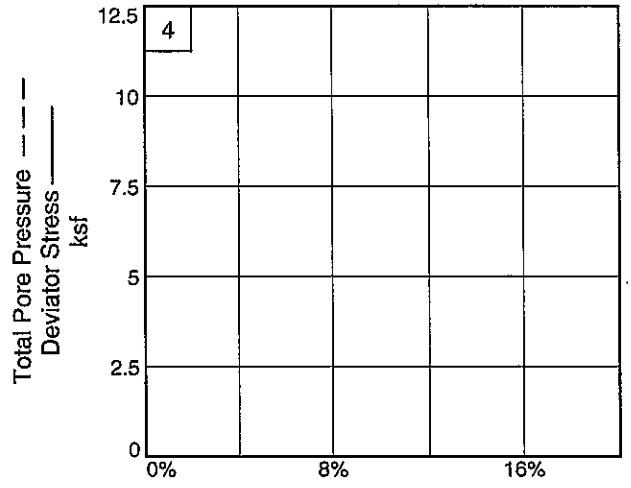
Proj. No.: 0121-3070.03 **Date:** 08/16/06

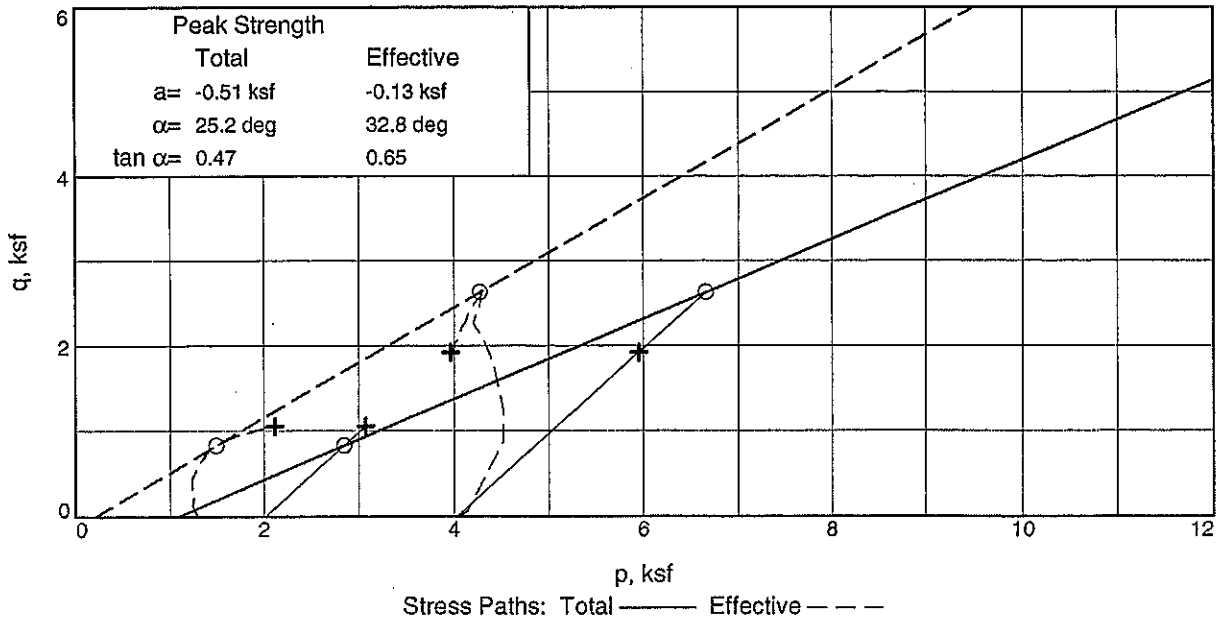
DLZ







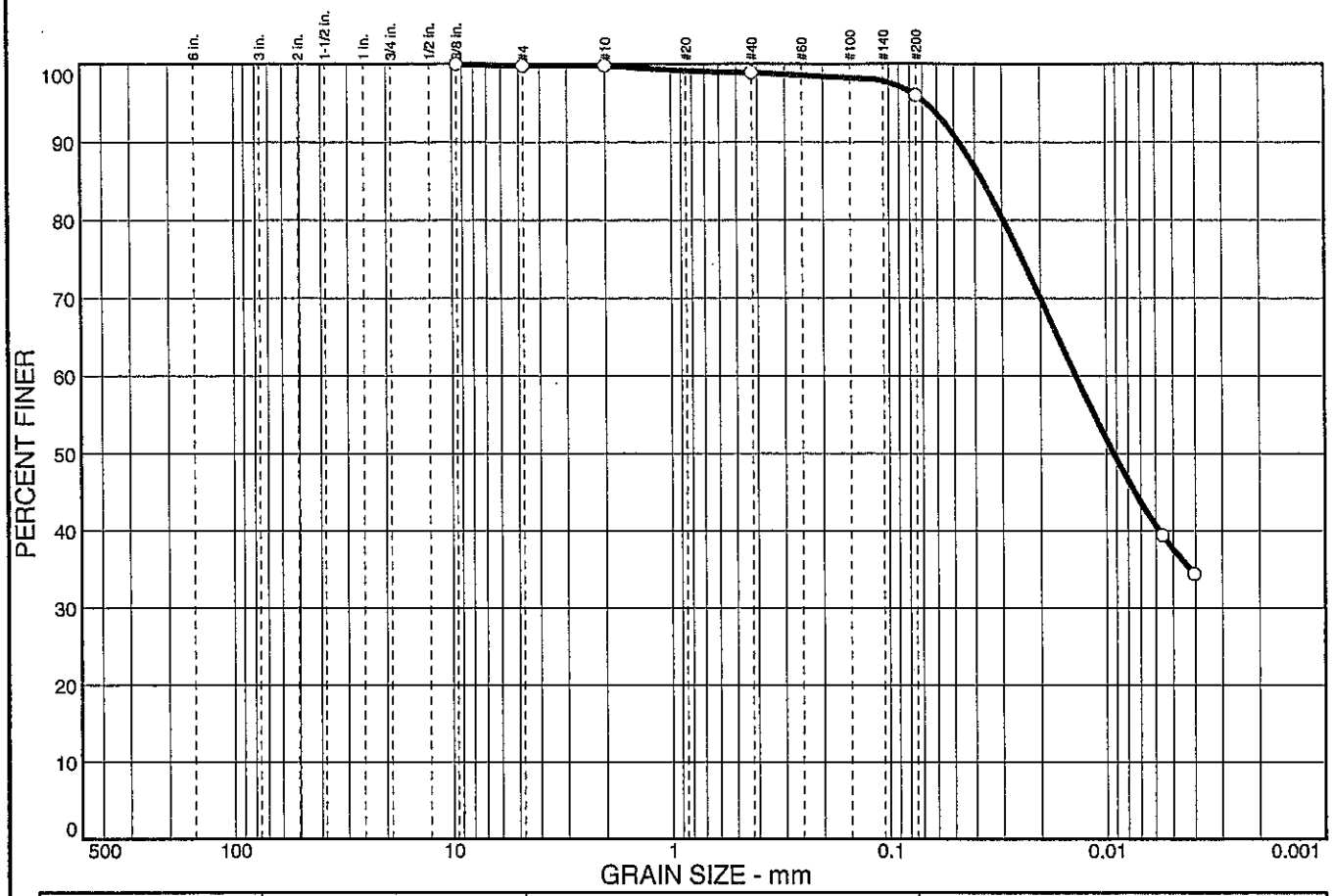




Client: TranSystems, Inc.
Project: SCI-823-0.00
Source of Sample: B-1108A
Depth: 18.0
Sample Number: P3
Project No.: 0121-3070.03
Figure _____

DLZ, INC.

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.2	0.0	0.9	2.9	58.5	37.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	99.8		
#10	99.8		
#40	98.9		
#200	96.0		

* (no specification provided)

Soil Description

Lean clay,
Specific Gravity= 2.65

Atterberg Limits

PL= 21 LL= 36 PI= 15

Coefficients

D_{85}= 0.0370 D_{60}= 0.0138 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

Moisture Content = 14.5%

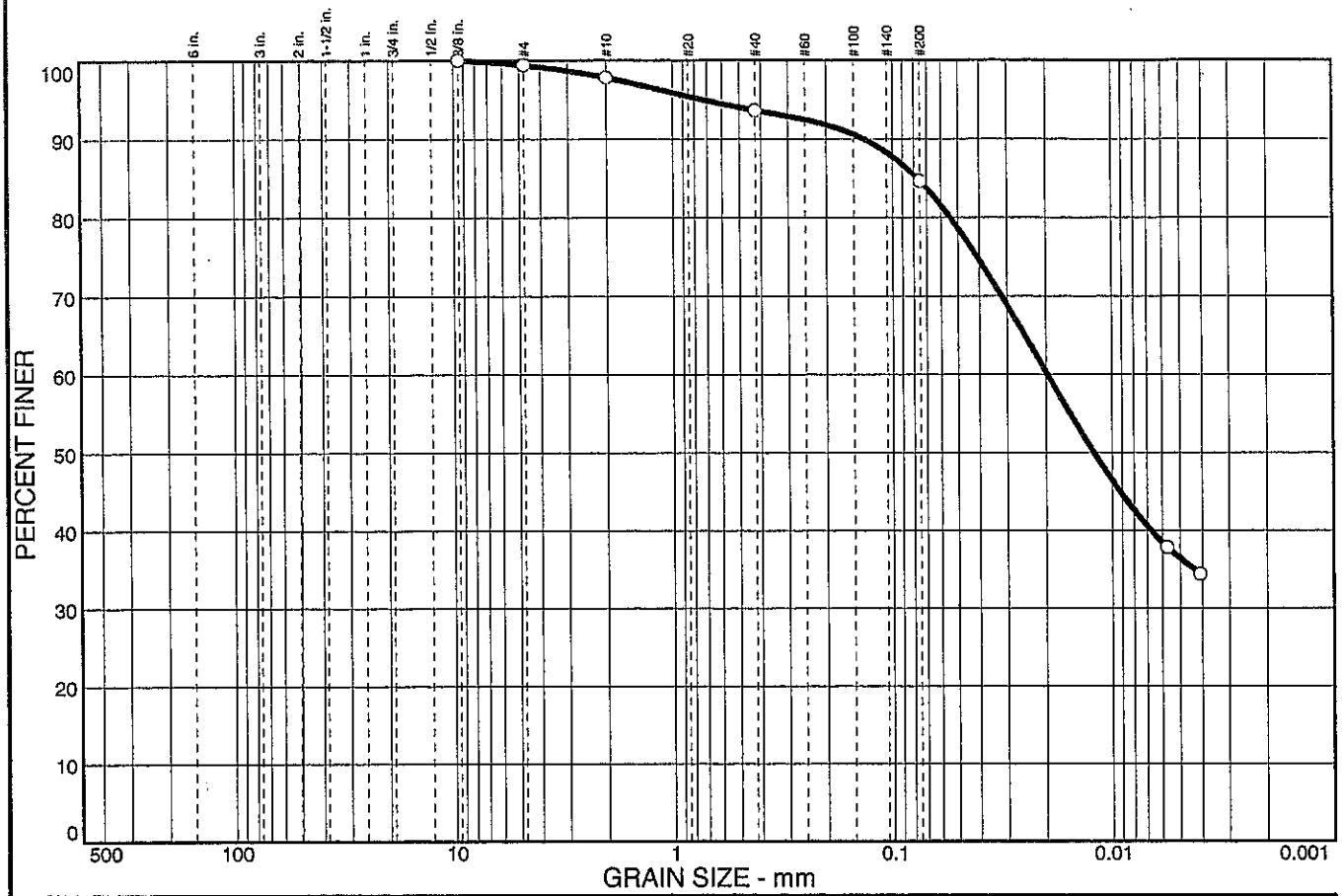
Sample No.: P1 **Source of Sample:** B-1108A **Date:** 08/16/06
Location: **Elev./Depth:** 10.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00

Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.6	1.6	4.2	9.0	48.2	36.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	99.4		
#10	97.8		
#40	93.6		
#200	84.6		

* (no specification provided)

Soil Description

Lean clay with sand

Atterberg Limits

PL= 19 LL= 38 PI= 19

Coefficients

D_{85}= 0.0775 D_{60}= 0.0198 D_{50}= 0.0121
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(16)

Remarks

Moisture Content = 19.8%

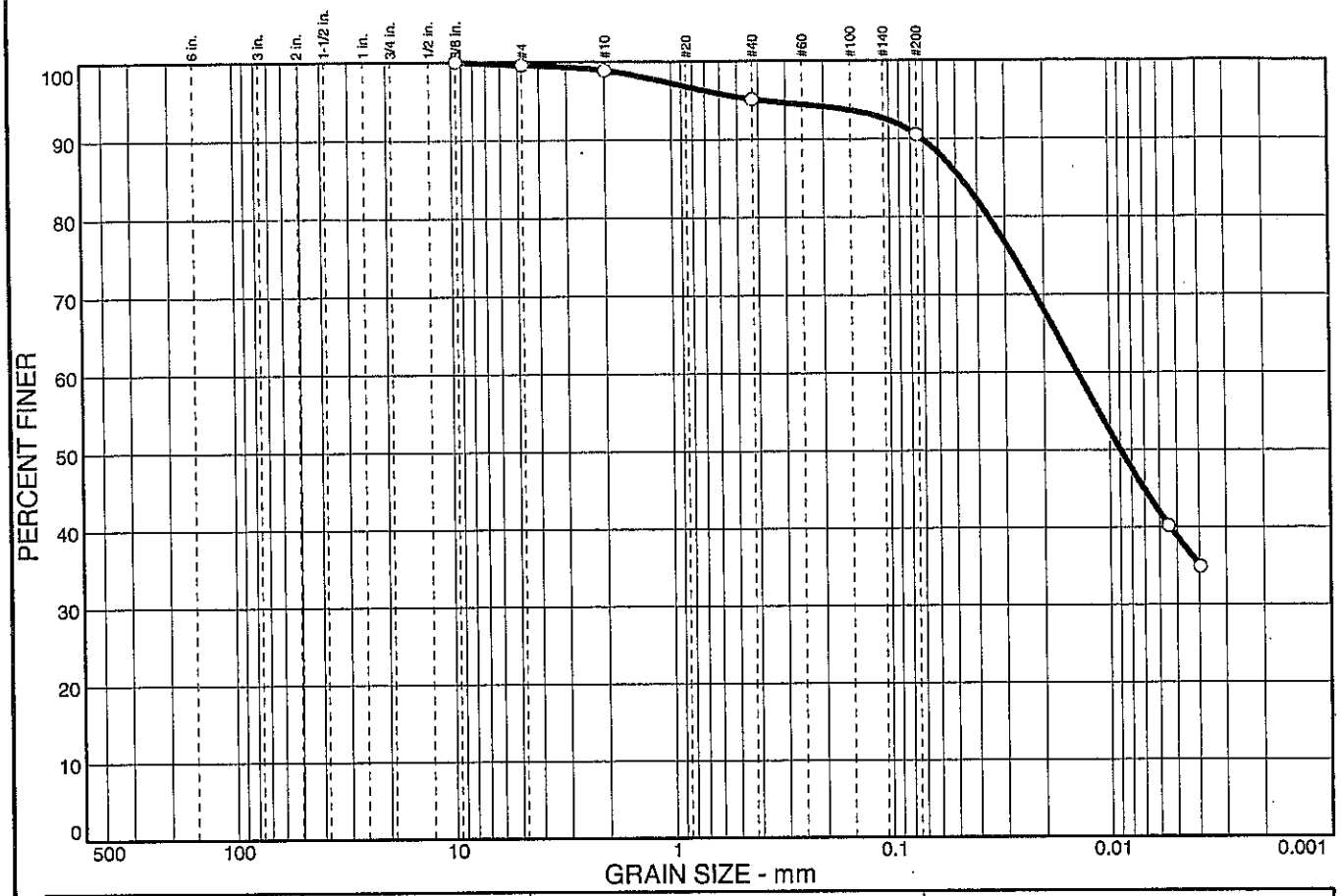
Sample No.: P2 **Source of Sample:** B-1108A **Date:** 08/16/06
Location: **Elev./Depth:** 14.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00

Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.4	0.7	3.8	4.6	51.8	38.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	99.6		
#10	98.9		
#40	95.1		
#200	90.5		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 19 LL= 38 PI= 19

Coefficients

D_{85}= 0.0479 D_{60}= 0.0141 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(17)

Remarks

Moisture Content = 24.0%

Sample No.: P3 **Source of Sample:** B-1108A **Date:** 08/16/06
Location: **Elev./Depth:** 18.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00

Project No: 0121-3070.03 **Figure**

APPENDIX F

ALTERNATIVE VS. COST MATRIX

		Alternative 1 Single Span Bridges behind MSE Walls with Surcharging	Alternative 2 Single Span Bridges behind MSE Walls with Deep Soil Mixing	Alternative 3 Three Span Bridges behind Spill-Through Slopes	Alternative 4 Single Span Bridges behind Spill-Through Slopes	Alternative 5 Single Span Bridges with Pile Supported CIP Walls
Bridges	Ramp B over Fairgrounds Road	$756,000	$697,000	$1,829,000	$1,902,000	$941,000
	823 over Fairgrounds Road	$1,437,000	$1,379,000	$2,632,000	$3,486,000	$1,872,000
	Ramp C over Fairgrounds Road	$795,000	$744,000	$1,417,000	$1,865,000	$983,000
	Total Cost of Three Bridges	**$2,988,000**	**$2,820,000**	**$5,878,000**	**$7,253,000**	**$3,796,000**
Retaining Walls	MSE Wall 1 (East Side of Fairgrounds)	$780,000	$676,000	$0	$0	$0
	MSE Wall 2 (West Side of Fairgrounds)	$923,000	$1,107,000	$0	$0	$0
	CIP Wall 1 (East Side of Fairgrounds)	$0	$0	$0	$0	$587,000
	CIP Wall 2 (West Side of Fairgrounds)	$0	$0	$0	$0	$737,000
	Total Cost of Retaining Walls	**$1,703,000**	**$1,783,000**	**$0**	**$0**	**$1,324,000**
Non-Ret. Wall Embank.	Embankment at East Side of Fairgrounds	$95,000	$144,000	$150,000	$205,000	$160,000
	Embankment at West Side of Fairgrounds	$133,000	$194,000	$192,000	$286,000	$215,000
	Total Cost of Non-Ret. Wall Embankment	**$228,000**	**$338,000**	**$342,000**	**$491,000**	**$375,000**
TOTAL COST OF ALTERNATIVE		**$4,919,000**	**$4,941,000**	**$6,220,000**	**$7,744,000**	**$5,495,000**

APPENDIX G

inter-office communication

to: Harry A. Fry, District 9 Deputy Director **date:** Sept. 1, 2005

from: Timothy J. Keller, Administrator, Office of Structural Engineering **by:** Ananda Dharma, P.E.

subject: SCI-823-0.00; PID 19415; Bridge No. SCI-823-1595; Ramp C over Fairground Road; Structure Type Study Review

Attn.: Thomas M. Barnitz, District 9 Production Administrator

We have briefly reviewed Structure Type Study submission from CH2MHill for the proposed bridge along Ramp B over Fairground Road. Our comments are shown below.

General Comments

1. The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office. The determination of utilizing a spread footing abutment placed directly on the reinforced soil mass can only be made after the above mentioned analysis have been performed as a minimum. Please refer to Section 204.6 of the 2004 Ohio Bridge Design Manual for additional design guidelines on MSE walls and L&D Manual, Volume 3, Section 1403.5.3 for submittal requirements.

2. Assuming the MSE wall supported abutments can be utilized at the proposed location, we agree that the proposed structure should consist of a single span composite prestressed concrete I-beams with reinforced concrete deck and semi-integral abutments supported on MSE walls.

3. Soil boring TR53A seems to be missing. Please include all the soil borings in the next submittal.

4. The profile grade for the entire project needs to be reevaluated one more time in order to minimize the difference between the amounts of cut and fill. We feel that the 22'-2" proposed vertical clearance shown on the Site Plan can be further reduced. Please verify the minimum required vertical clearance for the proposed structure. Refer to L&D Manual, Volume 1, Fig. 302-1E.

5. We could not verify the 10'-0" minimum required horizontal clearance. Please refer to L&D Manual, Volume 1, Fig. 600-1.

6. The existing lane widths for Fairground Road are shown as 2-lanes @ 10'-6" per lane. Fairground Road might experience an increase in traffic at some point in time upon completion of this project. Is there a plan for future widening for Fairground Road or was this even considered? This will affect the proposed bridge limit.

7. Limits for Southwest and Southeast wingwalls are not clearly shown in the plan view. Also, please investigate if the 45-degree wingwalls can be utilized at SW and SE wingwalls.

8. The outcome of the recommendation remains the same even though we revised the Alternative Cost Summary to reflect the most recent costs. The cost of structural steel and prestressed concrete beams have fluctuated and the following costs are the most recent available. For future submittals, the Design Consultant should use the following costs until further notice:

Structural Steel: Grade 50 Rolled Beams: $0.90 - $1.00 per pound
Grade 50 Plate Girders: $1.00 - $1.15 per pound (Level 4)
$1.15 - $1.30 per pound (Level 5)
For Grade 70, add $0.10 - $0.15 per pound

Prestressed Concrete I-Beams: AASHTO Type 2: $150 - $170/LF
AASHTO Type 3: $175 - $200/LF
AASHTO Type 4 (54"): $215 - $225/LF
AASHTO Type 4 (60"): $240 - $255/LF
AASHTO Type 4 (66"): $265 - $280/LF
AASHTO Type 4 (72"): $295 - $310/LF

Paint: $12/SF
MSE Walls: $45 - $50/SF

9. Provide Project Identification Number (**PID**) below the County-Route-Section in the Title Block as per Section 102.5 of the 2004 Ohio Bridge Design Manual (BDM).

10. Include the Structure File Number in the Title block. Structure File Number can be obtained by contacting Ms. Kathy J. Keller, Office of Structural Engineering, Bridge Inventory section (Phone: 614-752-9973) prior to Stage 1 (Preliminary Design) submission.

Please provide our office with the disposition of comments in writing and a revised Site Plan prior to Preliminary Design submission.

Nothing in these comments is to be construed as authorizing extra work for which additional compensation may be claimed. If you have reason to believe that these comments require work outside the limits of your Scope of Services, please contact this office before proceeding.

Should you have any questions concerning our review comments for the above referenced project, please contact our office.

TJK:JS:ad

c: David A. Norris, ODOT District 9
Douglas A. Buskirk, ODOT District 9
Lawrence A. Wills, ODOT District 9
Timothy J. Keller, Office of Structural Engineering
Jawdat Siddiqi, Office of Structural Engineering
file

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: SKT DATE: 3/20/2007

Bridge SCI-823-0.00: Ramp C over Fairgrounds Road

PROJECT: SCI-823-0.00: Portsmouth Bypass PROJ. NO: 319861.08.05

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

Reference Page/Sheet No.	Review Comment	Designer Response
	ODOT Comments	
General	1. The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure Type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office. The determination of utilizing a spread footing abutment placed directly on the reinforced soil mass can only be made after the above mentioned analysis have been preformed as a minimum. Please refer to Section 204.6 of the 2004 Ohio Bridge Design Manual for additional design guidelines on MSE walls and L&D Manual, Volume 3, Section 1403.5.3 for submittal requirements.	On October 4, 2006, DLZ submitted an updated "Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23 / SR 823 Interchange" report, in response to ODOT concerns with the existing subsurface soil conditions at the site. It was noted in the report that due to the large amount of differential settlement at this location, other alternative wall types will need to be developed for further consideration. Subsequent technical memorandums by DLZ provided various ground improvement techniques/wall types for study. By studying different wall types/ground improvement techniques with various bridge types and layouts, the most economical wall/bridge system was found to be a single span bridge behind MSE Walls with surcharging. For information on the recommended MSE Walls with surcharging, please see separate Wall Type Study submittal.
General	2. Assuming the MSE wall supported abutments can be utilized at the proposed location, we agree that the proposed structure should consist of a single span composite prestressed concrete I-beams with reinforced concrete deck and semi-integral abutments supported on MSE walls.	Will comply.

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: SKT DATE: 3/20/2007

Bridge SCI-823-0.00: Ramp C over Fairgrounds Road

PROJECT: **SCI-823-0.00: Portsmouth Bypass** PROJ. NO: 319861.08.05

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

Site Plan (1/3)	3. Soil boring TR53A seems to be missing. Please include all the soil borings in the next submittal.	Will comply.
Site Plan (1/3)	4. The profile grade for the entire project needs to be reevaluated one more time in order to minimize the difference between the amounts of cut and fill. We feel that the 22'-2" proposed vertical clearance shown on the Site Plan can be further reduced. Please verify the minimum required vertical clearance for the proposed structure. Refer to L&D Manual, Volume 1, Fig. 302-1E.	Will comply. Per the L&D Manual, the preferred vertical clearance for Fairgrounds Road is 15'-0". In this re-submittal package, we are proposing a structure with minimum vertical clearance of 20'-6". The profile grade is being driven by the Ramp C over Norfolk Southern bridge to the west, specifically with the addition of two new rail lines per District direction in March 2006. The re-submittal of the Ramp C over Norfolk Southern bridge will be provided at a later date.
Site Plan (1/3)	5. We could not verify the 10'-0" minimum required horizontal clearance. Please refer to the L&D Manual, Volume 1, Fig. 600-1.	Will comply. The minimum required for an MSE outside the clear zone is 30'-0"; the span has been adjusted to meet this minimum horizontal clearance.
Site Plan (1/3)	6. The existing land widths for Fairground Road are shown as 2-lanes @ 10'-6" per lane. Fairground Road might experience an increase in traffic at some point in time upon completion of this project. Is there a plan for future widening for Fairground Road or was this even considered? This will affect the proposed bridge limit.	The District spoke to the Scioto County Engineer regarding this. Per communication dated September 1, 2005, there are no plans to widen Fairgrounds Road in the future, but allow for 24' pavement.
Site Plan (1/3)	7. Limits for the Southwest and Southeast wingwalls are not clearly shown in the plan view. Also, please investigate if the 45-degree wingwalls can be utilized at SW and SE wingwalls.	Will comply. However, from an aesthetic viewpoint, having the Southwest and Southeast wingwalls of this bridge mate with the Northwest and Northeast wingwalls of the SR 823 over Fairgrounds Road bridge would be visually superior.

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: SKT DATE: 3/20/2007

Bridge SCI-823-0.00: Ramp C over Fairgrounds Road

PROJECT: **SCI-823-0.00: Portsmouth Bypass** PROJ. NO: 319861.08.05

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

General	8. The outcome of the recommendation remains the same even though we revised the Alternative Cost Summary to reflect the most recent costs. The cost of structural steel and prestressed concrete beams have fluctuated and the following costs are the most recent available. For future submittals, the Design Consultant should use the following costs until further notice: Structural Steel: Grade 50 Rolled Beams: \$0.90 - \$1.00 per pound; Grade 50 Plate Girders: \$1.00 - \$1.15 per pound (Level 4) and \$1.15 - \$1.30 per pound (Level 5); For Grade 70, add \$0.10 - \$0.15 per pound Prestressed Concrete I-Beams: AASHTO Type 2: \$150-\$170/LF AASHTO Type 3: \$175-\$200/LF AASHTO Type 4 (54"): \$215-\$225/LF AASHTO Type 4 (60"): \$240-\$255/LF AASHTO Type 4 (66"): \$265-\$280/LF AASHTO Type 4 (72"): \$295-\$310/LF Paint: \$12/SF MSE Walls: \$45-\$50/SF	Will comply. In September 2006, we contacted the ODOT Office of Estimating regarding another ODOT project for pricing information. We received new pricing information for several structural items in 2006 dollars, which will be used on this Structure Type Study re-submittal.
General	9. Provide Project Identification Number (PID) below the County-Route-Section in the Title Block as per Section 102.5 of the 2004 Ohio Bridge Design Manual (BDM).	Will comply.
General	10. Include the Structure File Number in the Title block. Structure File Number can be obtained by contacting Ms. Kathy J. Keller, office of Structural Engineering, Bridge Inventory section (Phone: 614-752-9973) prior to Stage 1 (Preliminary Design) submission.	Will comply. Ms. Keller will be contacted after approval of this Structure Type Study re-submittal.