

GEOTECHNICAL EVALUATION

**WHITELAND ROAD STRUCTURE REPLACEMENTS
STRUCTURE NOS.: JOHNSON 85 AND P-004
JOHNSON COUNTY, INDIANA**

Prepared for

**STRAND ASSOCIATES, INC.
629 WASHINGTON STREET
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By

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7770 WEST NEW YORK STREET
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November 26, 2024



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Mr. Chris Bland, P.E.
Strand Associates, Inc. (Strand)
629 Washington Street
Columbus, IN 47201

Re: Geotechnical Evaluation
Whiteland Road Structure Replacements
Structure Nos. Johnson 85 and P-004
Johnson County, Indiana
Terracon Project No. CJ235021

Dear Chris:

We are pleased to submit our geotechnical evaluation for the referenced project. This report presents the results of our subsurface exploration and provides geotechnical recommendations for the proposed improvements.

The opinions and recommendations herein are based, in part, on our interpretation of the subsurface information at the exploratory locations as indicated on the attached plan (Drawing No. CJ235021.B1). This report does not reflect variations in subsurface conditions between or beyond these locations. Variations in these conditions should be expected, and fluctuation of the groundwater levels will occur with time. Other important limitations of a geotechnical report are attached.

Project Description

We understand that the Commissioners of Johnson County, with the assistance of Indianapolis MPO funds, are planning to replace an existing bridge carrying Whiteland Road over Grassy Creek (Structure No. Johnson 85) and an existing culvert carrying Whiteland Road over UNT to Grassy Creek (Structure No. P-004).

Descriptions of these elements are provided below.

Bridge Replacement (Structure No. Johnson 85)

Based on the preliminary plans provided by Strand, the new bridge is anticipated to consist of a three-span reinforced concrete slab bridge supported on deep foundation elements. The bottom of the integral end bents is planned to be established near El. 775 to 776. The interior piers are planned to have extended pile bents.

The factored pile load provided by Strand at the integral end bents and interior piers is 165 kips per pile considering five piles. The flowline of the creek is near El. 769. The scour information provided on the plans indicates a Q500 scour near El. 762 and Q100 low scour near El. 760. Lastly, spill-through slopes capped with 18-in. thick riprap are planned to be established at 2H:1V at the bridge abutments.

The project begins and ends at Sta. 14+00 and 16+00, Line “A”, respectively. Roadway improvements consisting of widening to accommodate new shoulders and reconstruction of the existing pavement are planned within the project extents. Incidental construction consisting of transition milling and overlay of the existing roadway and widening is planned to extend an additional 450 ft beyond the project limits. Based on our correspondence with Strand, we understand that Johnson County would like to use pavement sections of their choice for the proposed roadway improvements.

The earthwork (i.e., fill and cut) required to establish the embankment in the areas of widening is anticipated to be up to 5 ft. Grade changes along the centerline are nominal (i.e., less than 2 ft). Sideslopes for the embankment are planned to be established at 2H:1V or flatter.

Culvert Replacement (Structure No. P-004)

The new culvert is planned to consist of a reinforced concrete box (RCB) with a 10-ft span and a 9-ft rise. The invert is planned near El. 773. The flowline of the creek is near El. 774. Wingwalls are planned at both ends of the culvert. We understand that Type 5 structure backfill is planned to be placed behind the wingwalls. Additionally, articulated concrete blocks are planned on the upstream and downstream ends of the culvert for scour protection.

The project begins and ends between Sta. 24+10 and 24+80, Line “A”. Roadway improvements consisting of widening to accommodate new shoulders and reconstruction of the existing pavement are planned within the project extents. Incidental construction consisting of transition milling and overlay and widening is planned to extend for an additional 260 ft beyond the project limits.

For both projects, maintenance of traffic is planned to be accomplished via road closure and detour. At this time, other information such as the construction schedule is not known. If the nature, design or location of the proposed construction changes, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and the conclusions are modified or confirmed in writing.

Brief Discussion of Exploratory Program

Subsurface conditions for the proposed improvements were explored by performing two borings for the approach improvements at the proposed bridge (designated RB-1 and RB-2) to a depth of about 10 ft, two borings for the bridge (designated TB-1 and TB-2) to a depth of about 90 ft, and two borings for the culvert (designated CB-1 and CB-2) to a depth of 40 ft below the existing ground surface. Pavement cores were obtained from the roadway and culvert borings. In addition, fourteen hand auger borings (designated HA-1 through HA-14) were performed at the toe of the existing embankment and in the channel bed to determine the surficial soft soil thickness. Topsoil samples were collected from each quadrant of the existing bridge structure. Details of the drilling and sampling procedures, boring logs and respective laboratory results are provided in the attachments.

Soil descriptions on the boring logs are in general accordance with the AASHTO Soil Classification System and the INDOT Standard Specifications (ISS¹) (textural classification, e.g., clay loam, A-6[7]).

¹References the Indiana Department of Transportation (INDOT) Standard Specifications.

The boring logs represent our interpretation of the individual samples and field logs and results of the laboratory tests. The stratification lines on the boring logs represent the approximate boundary between soil types; in-situ, the transitions may be more gradual.

Discussion of Observations

Surface and Subsurface Conditions

The surface conditions at the test borings exposed approximately 6 to 10 in. of asphaltic concrete surface (HMA). An exception was observed at Boring CB-2, where Portland Cement Concrete Pavement (PCCP) was found underlying 1½ in. of HMA surface. A granular subbase, consisting of sand and gravel, approximately 5 to 7 in. thick, was observed underlying the pavement surface at roadway and culvert borings. However, no granular soil subbase was observed at the bridge borings.

The hand auger borings performed at the toe of the existing embankment exposed predominantly cohesive soils to the maximum depths explored. The moisture contents of these cohesive soils were generally in the range of 10 to 21 percent. Higher moisture contents in the range of 25 to 31 percent was observed at Borings HA-2, HA-8, HA-11, and HA-14. Refer to the attached Summary of Hand Auger Borings for additional details.

The subsurface conditions at the boring locations predominantly consisted of A-4 (clay loam) and A-6 (clay loam and clay) type cohesive soils to the maximum depths explored. Granular soils were observed below El. 715 at Boring TB-1 and below El. 718 at Boring TB-2. Granular and cohesive fill soils (sandy loam and clay loam) were observed within 3 to 9 ft of the existing ground surface of most borings and can likely be associated with the fill placed as a part of the structure and roadway construction.

The cohesive soils were generally medium stiff and better in consistency (based on q_p -value). A soft layer was observed near El. 771 at Boring RB-2. The A-4 soils had moisture contents typically in the range of 5 to 13 percent. The A-6 soils had moisture contents typically in the range of 9 to 27 percent. The consistency of the cohesive fill soils was medium stiff to stiff. Granular soils were typically observed to be medium dense to very dense below El. 718 to 715 (based on SPT N-value). However, the relative density of the granular fill soils observed at Boring CB-1 was very loose.

Atterberg limit tests indicated that the A-4 soils were of slight to medium plasticity based on plasticity indices (PI) in the range of 6 to 9 percent and with liquid limits (LL) in the range of 19 to 22 percent. The A-6 soils were of medium plasticity based on PI in the range of 14 to 21 percent and with LL in the range of 29 to 34 percent.

Unconfined compression tests performed on split-spoon samples of cohesive soils indicated undrained shear strengths in the range of 3 to 7½ kips/sq ft (ksf). The dry unit weights of these soils were observed to be in the range of 128 to 135 lbs/cu ft (pcf).

Groundwater Conditions

Groundwater was observed near a depth of 18 ft (El. 765) during drilling and near a depth of 20 to 22 ft (El. 761 to 763) at the completion of drilling at Borings CB-1 and CB-2. At Borings TB-1 and TB-2, groundwater was observed near a depth of 22 to 23 ft (El. 758 to 757) during drilling and near a depth of 22 to 25 ft (El. 758 to 755) at the completion of drilling. Groundwater was not observed at Borings RB-1 and RB-2 during drilling or after the completion of drilling. Additionally, our review of the *Soil Survey of Johnson County* indicated that the project area is prone to frequent flooding with a possible seasonal high depth of groundwater level within 1 ft of the naturally occurring ground surface. It should be recognized that groundwater levels will fluctuate due to changes in precipitation, infiltration, surface run-off, flow of the creek, and other hydrogeological factors.

Discussion and Recommendations

Based on our understanding of the planned improvements and information obtained from the exploratory locations, it is our opinion that the subsurface conditions are conducive for the support of the pavement and associated improvements provided the foundation soil is prepared in accordance with the ISS and the recommendations provided herein. In our opinion, the risks from a geotechnical perspective are associated with foundation soil preparation and improvement (where necessary) for the fill placement and new pavement components. Recommendations related to the design and construction of these elements are provided in the following sections.

Foundation Soil Preparation for Pavement and Fill

In all areas to receive new pavement components and embankment fill, we recommend all surficial soil, brush, trees, and associated roots (via grubbing per ISS), existing pavement components and wet or soft near-surface soils be removed from within the construction limits. Where root masses are removed, we recommend that the area be regraded immediately to reduce the risk of soft/loose areas developing due to loosely placed fill or ponding water. Where utilities are relocated, we recommend that the resulting excavations be backfilled with B-borrow in accordance with Section 203.09 of the ISS.

After the surficial soil and pavement materials have been removed, we anticipate that the subsurface conditions will primarily consist of cohesive soils. Once the subgrade is exposed, we recommend that the cohesive soils be proofrolled in accordance with ISS 203.26. The purpose of proofrolling is to provide a first-order evaluation of how the subgrade is anticipated to react to construction traffic and gain an additional understanding of the conditions for support of the planned improvements. In the areas of embankment widening where proofrolling may not be feasible, other means of subgrade evaluation (i.e., dynamic cone penetrometer) be used. Because otherwise relatively stiff cohesive subgrades will deteriorate when exposed to excessive moisture and repeated construction traffic, consideration be given to the timing of the removal of these surface conditions relative to the preparation of the subgrade and sequencing of other activities. We recommend that the existing pavement be used as a means of transportation for construction traffic during the construction of the bridge and placement of the embankment fill, if feasible. Where loose granular soils are exposed, we recommend that they be compacted in place via several passes of a vibratory roller prior to the application of the subgrade treatment or placement of new fill.

Based on the information obtained at the test boring locations and the results of the laboratory testing, we anticipate a majority of the cohesive foundation soils will favorably pass a proofrolling. The moisture contents of the cohesive soils were typically in the range of 10 to 21 percent. However, relatively stiff cohesive foundation soils will deteriorate when exposed to excessive moisture for extended period before the application of the subgrade treatment. As such we recommend that the contract include quantities for foundation soil improvement. We recommend the foundation soil improvement consist of removing 12 in. of the soft soils below the bottom of the subgrade treatment and replacing it with INDOT No. 8 stone encapsulated with Type 2A geotextile (918.02a). For estimating purposes, we recommend you consider up to 12 in. of undercut and replacement with crushed stone and Type 2A geotextile equal to 10 percent of the total proposed subgrade area where new pavement components are to be placed.

The subsurface conditions at the toe of the proposed embankment as observed from the test borings are anticipated to consist of medium stiff to stiff cohesive soils. The moisture contents of these soils were in the range of 10 to 23. Note that hand auger borings performed at the toe of the existing embankment indicated soft soils to a depth of about 1 to 4½ ft based on ability to advance ½-in. diameter steel rod probe. The moisture contents of these cohesive soils were generally in the range of 10 to 21 percent. Higher moisture contents in the range of 25 to 31 percent were observed at Borings HA-2, HA-8, HA-11, and HA-14. Based on these conditions, we anticipate that soft/yielding conditions will be observed at isolated locations. Where such conditions are observed, we recommend that soft soils be removed to a maximum depth of 12 in. and replaced with INDOT No. 8 stone wrapped in Type 2A geotextile (ISS 918.02a). Note that soft soils will still be present at the undercut grade; however, we anticipate that the crushed stone will bridge the conditions. For your estimating purposes, we recommend that these quantities of foundation soil improvements (i.e., 12 in. of undercut and replacement with crushed stone wrapped in Type 2A geotextile), equal to 40 percent of the area between the existing embankment toe and the proposed embankment toe along the entire length of fill planned on both side of the bridge and culvert be included in the contract. The final decision regarding the undercut depths will be made at the time of construction based on the actual observed conditions after removal of the surficial elements and field verification.

Fill Placement Considerations

Standard embankment construction practices outlined in the ISS should provide an adequate subgrade for embankment construction provided the subgrade is prepared as discussed above. In addition, we recommend that the fill used to raise grades be placed in loose lift thicknesses not exceeding 8 in. We recommend that the fill placed to raise the grades be compacted to 95 percent of the maximum density obtained in accordance with AASHTO T 99 as specified in the ISS. Based on our review of the plans, we anticipate that imported borrow may be required for embankment fill placement. The quality and source of the borrow will be evaluated in the field by others. In addition, we recommend benches be cut into any existing slopes steeper than 6H:1V before fill placement to key the new fill into the existing slope. In our opinion, benches having a minimum width of 10 ft should be cut into the slope before new fill is placed. Where 10-ft wide benches are not feasible due to shallow embankment heights, a minimum of 4-ft wide benches be cut in accordance with ISS 203.22.

Based on observations of the soil conditions, it is our opinion that the stability of the proposed sideslopes (2H:1V or flatter) is not of a concern but the performance of these slopes will be directly dependent on the foundation soil preparation and the quality of compaction achieved. Embankment slopes steeper than 3H:1V can exhibit maintenance issues as they are not accessible with conventional mowing equipment and prone to surficial sloughing. To reduce the risk of sloughing and erosion, it is important to provide adequate compaction and erosion and sloughing protection at the face of the embankment. If sloughing does occur, riprap over geotextile could be considered as a remedial measure.

Bridge Foundation Considerations (Structure No. Johnson 85)

The subsurface conditions observed at the borings performed at the bridge structure generally consist of medium stiff to hard cohesive soils up to near El. 718 to 715 which was underlain by medium dense to very dense granular soils. The dry unit weights of the cohesive soils were observed to be in the range of 128 to 135 pcf. The undrained shear strengths of these soils were observed to be in the range of 3 to 8 ksf. The SPT N-values of the cohesive soils were typically greater than 45 blows per ft (bpf) below El. 770. Interbedded granular soil seams were observed at varying depths within the predominant cohesive soils up to El. 725.

Due to the risk of driving pipe piles into the underlying hard cohesive soils and the cost associated with pre-boring to install piles to the minimum lengths required for the integral end bents and interior piers, in accordance with the Indiana Design Manual (IDM), we recommend using H-piles to support the bridge structure. Given the interbedded layers of granular soil seams observed at occasional depths, we anticipate that the H-piles will tend to “run” in these granular soil seams. This phenomenon introduces uncertainty in predicting the pile tip elevations. Additionally, wet granular soils were observed below El. 720. To reduce the risk of H-piles “running” in the underlying granular soils, we recommend that the pile tips be established no deeper than El. 730. To achieve this, we recommend that the factored design load back calculated from the driving resistances obtained near El. 730 provided in Table 2 be considered for your design purposes. The preliminary factored pile load provided by Strand considers five piles per structure. We understand that additional piles may be required to satisfy the factored design load. We understand that Strand will use the factored design load for the end bents and interior piers provided in Table 2 for design purposes and to compute the number of piles per structure.

The static analyses were performed using APile 2023 and Brown method and are provided in the attachments. The table below provides a summary of static and driving resistances and estimated pile tip elevations for HP 12x53 piles.

Table 1. Summary of Static and Driving Resistances (HP 12x53)

	Bent No. 1	Pier No. 2	Pier No. 3	Bent No. 4
Factored Design Load, Q_F (kips)	143	116	98	128
Factored Design Soil Resistance, R_R (kips)	143	116	98	128
Resistance Factor for Axial Compression, Φ_{dyn}	0.55*	0.55*	0.55*	0.55*
Downdrag Loads, DD (kips)	Negligible	Negligible	Negligible	Negligible
Nominal Soil Resistance, R_n (kips)	260	211	178	233
Downdrag Friction, R_{sdd} (kips)	Negligible	Negligible	Negligible	Negligible
Scour Zone Friction, R_{sscour} (kips)	N/A	25	28	N/A
Relaxation in Shale (kip)	N/A	N/A	N/A	N/A
Nominal Driving Resistance, R_{ndr} (kips)	260	236	206	233
Minimum Pile Tip Elevation**	El. 741	El. 752	El. 752	El. 741
Estimated Pile Tip Elevation	El. 730	El. 730	El. 730	El. 730
*Based on 701.05 (a).				
**In accordance with Indiana Design Manual Figures 408-3B and 408-3D				
For substructures with four or fewer piles, the resistance factor should be reduced by 20% in accordance with AASHTO C10.5.5.2.3 and INDOT Design Manual				

As mentioned, due to the tendency of the H-piles to “run” in the underlying wet granular soils below El. 720, we recommend that pile tips be established no deeper than near El. 730. The contractor should take care to use an appropriate fuel setting during the test piles, specifically when pile tips are near El. 730. If the recommended factored pile loads in Table 2 are found to be low, a resistance factor of 0.7 should be used with the Dynamic Pile Load Test [PDA; ISS 701.05(b)], and Terracon should be contacted for an updated pile table.

We recommend a minimum pile spacing of 3 ft in accordance with Indiana Design Manual. We recommend an indicator test pile be driven at each substructure in accordance with ISS 701.05(a) and that the first pile at each substructure be re-struck 72 hours after initial driving. We recommend the use of piles shoes in accordance with ISS 915.03.

Note that extended steel H-piles for the interior piers are required to be encased in reinforced concrete in accordance with INDOT’s Standard Drawing No. E 701-BPIL. Lastly, we recommend that Type 1A geotextile be placed below the riprap at the bridge abutments in accordance with ISS 918.02(a).

Seismic Considerations

For your consideration of seismic loads, we recommend the information provided in the table below in accordance with Section 3.10.3.1 of the AASHTO LRFD Bridge Design Specifications, 2020.

Table 2: Seismic Design Parameters

Site Class	D
Peak Ground Acceleration (PGA)	0.056
Seismic Response Parameter (S_{D1})	0.127
Seismic Zone (From Table 3.10.6-1)	1

Culvert Considerations (Structure No. P-004)

At the proposed elevation of the base of the culvert, stiff to hard A-4 loam and clay loam were observed with moisture contents in the range of 8 to 15 percent. These conditions are anticipated to be adequate for support of the culvert provided the foundation soil is prepared as discussed below.

We recommend that the base of the excavation be exposed immediately prior to the placement of the culvert (i.e., not left open for an extended period). Based on the subsurface conditions observed, we recommend that 6 in. of INDOT No. 8 crushed stone be placed below the entire plan area of the structures underlain by Type 2A (ISS 918.02a) geotextile to provide a uniform surface for the structure placement. Due to the presence of granular soil seams near the base of the excavation, dewatering effort will be challenging.

We do not anticipate yielding soil will be encountered at the base of the culvert excavation. If yielding soils are encountered, we recommend the yielding soil be undercut to a depth of 12 in. below the bottom of the bedding layer and replaced with INDOT No. 8 coarse aggregate encapsulated with Type 2A geotextile (918.02a). We recommend a quantity of this foundation soil improvement under approximately 10 percent of the total base area of the culvert be included in the contract.

The area around and above the culvert should be backfilled in accordance with ISS 715. Hand- or remote-guided vibratory compactors are recommended for compacting the bedding material and material on either side of the culvert. The first several lifts of backfill over the culvert should also be compacted with small vibratory compactors to assure proper compaction is achieved and to prevent damage to the structure from heavier, high-energy compactors. Where articulated concrete blocks are planned to be placed at the culvert ends, we recommend that Type 2A (ISS 918.02a) geotextile be placed under the concrete blocks riprap in accordance with ISS 616.

Wingwall Considerations

The foundation for the wingwalls is to be established a minimum of 4 ft below the flowline in accordance with Section 203-2.06(03) of the INDOT Design Manual. As such, we anticipate the wingwall foundations will be near El. 770. The soil conditions exposed at the wingwall foundation consist of hard cohesive soils with hand penetrometer readings greater than 4½ tsf and moisture content in the range of 8 to 15 percent. Note that 8 in. of INDOT No. 8 stone should be placed below each wall footing in accordance with ISS 714.05. We understand that Structure Backfill Type 5 will be utilized behind the wingwall. The geotechnical parameters presented in the table below may be used for the foundation design. The recommended bearing resistance provided in the following table assumes a minimum depth of 4 ft below the flowline elevation and a minimum footing width of 3 ft.

Table 3: Geotechnical Parameters for Wingwall Design

Foundation Bearing Soil Type	Clay Loam
Friction Angle between Wingwall and Backfill ¹ (deg)	20
Estimated Unit Weight of Structure Backfill, $\gamma_{\text{moist/saturated}}$ (pcf)	130
Angle of Friction between Footing and Crushed Stone (δ , deg) ²	26
Undrained Cohesion of Foundation Soil (s_u , psf) [Clay Loam]	4,500
Adhesion of Foundation Soil (C_a , psf) [Clay Loam]	4,500
Drained Internal Friction Angle of Foundation Soil (ϕ' , deg) [Clay Loam]	30
Factored Bearing Resistance (psf) ³	8,000
Resistance Factor (ϕ)	0.45
Nominal Bearing Resistance (psf) ³	17,700
<ol style="list-style-type: none"> 1. Using Structure Backfill Type 5 2. 8 in. of INDOT No. 8 stone placed below the structure footings (ISS 714.05) 3. Calculated based on undrained cohesion 4. Note - Due to the use of flowable backfill (i.e., Structure Backfill Type 5) behind the wingwalls, the critical design case for the wingwalls will be during placement of the fill. As such, we recommend the headwalls be designed considering the effects of hydrostatic pressure on the wingwalls from the use of structure backfill Type 5 in accordance with ISS 714.04(b). 	

As mentioned in the table above, the critical design case for the wingwalls will be during placement of the fill. As such, we recommend that the wingwalls be designed considering the effects of hydrostatic pressure on the wingwalls from the use of structure backfill Type 5 in accordance with ISS 714.04(b). We recommend that the backfill placement be in accordance with the standard specifications. Hand- or remote-guided vibratory compactors are recommended for compacting the bedding material (i.e., crushed stone) below the footing.

Construction Considerations

Excavations made for the project may require: 1) cut slopes adequate to prevent cave-ins/subsidence; or 2) braced excavations for safe construction operation. All excavations should conform with Occupational Safety and Health Administration (OSHA) requirements (i.e., 29 CFR Part 1926). Additionally, soil should not be stockpiled immediately adjacent to the top of the excavation. Note that the contractor will need to remove existing structure within areas of conflict with new construction, including cofferdam, in accordance with ISS 202.03(a).

As discussed, the subsurface soils observed are predominantly cohesive. However, due to the presence of granular seams near the base of the excavation, dewatering efforts will be challenging. Several high-volume sump pumps operating in pits outside of the excavation may be necessary to keep the excavations “in the dry”. Construction of the culvert is anticipated to require pumping around the tributary. Depending on the creek’s flow at the time of construction, the use of temporary earthen berms or cofferdams will likely be required. We recommend that the groundwater level be lowered a minimum of 2 ft below the planned excavation base prior to the excavation activities. The

Mr. Chris Bland, P.E.
Strand Associates, Inc.
Whiteland Road Structure Replacements– Johnson Co., IN

November 26, 2024
Page 10

scope of this evaluation was not to provide dewatering recommendations for contractors. Dewatering is a responsibility of the contractor based on their means and methods. It may be necessary for the dewatering contractor to obtain additional subsurface information to assist with the design of their dewatering plan.

Concluding Remarks

We appreciate the opportunity to provide our services to you on this project. Please contact our office if you have any questions or need further assistance with the project.

Sincerely,

TERRACON CONSULTANTS, INC.



Belayneh Desta, Ph.D., P.E.
Project Engineer

KPH



Karan B. Doshi, P.E.
Transportation Group Leader

Attachments –

- Important Information about This Geotechnical Engineering Report
- Field Methods for Exploring and Sampling Soils and Rock
- Exploratory Location Plan (Drawing No. CJ235021.B1)
- Log of Test Boring – General Notes
- Log of Test Boring (6)
- Summary of Pavement Cores
- Pavement Core Log (4)
- Grain Size Distribution Test Reports (3)
- Unconfined Compression Test (5)
- Summary of Hand Auger Borings
- Summary of Existing Topsoil Test Results
- Deep Foundation Analysis (Apile - 4, Brown Method – 4)
- Bearing Resistance Analysis

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site’s subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report’s Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals’ misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* **Confront the risk of moisture infiltration** by including building-envelope or mold specialists on the design team. **Geotechnical engineers are not building-envelope or mold specialists.**



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FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

A. Boring Procedures Between Samples

The boring is extended downward, between samples, by a hollow stem auger (AASHTO* Designation T251), continuous flight auger, driven and washed-out casing, or rotary boring with drilling mud or water.

B. Standard Penetration Test and Split-Barrel Sampling of Soils

(AASHTO* Designation: T206)

This method consists of driving a 2-in. outside diameter split-barrel sampler using a 140-lb weight falling freely through a distance of 30 in. The sampler is first seated 6 in. into the material to be sampled and then driven 12 in. The number of blows required to drive the sampler the final 12 in. is recorded on the Log of Test Boring and known as the Standard Penetration Resistance or N-value. Recovered samples are first classified as to texture by the field personnel. Later in the laboratory, the field classification is reviewed by a geotechnical engineer or a qualified person under their direction who observes each sample.

C. Thin-walled Tube Sampling of Soils

(AASHTO* Designation: T207)

This method consists of hydraulically pushing a 2-in. or 3-in. outside diameter thin wall tube into the soil, usually cohesive types. Relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings

(ASTM Designation: D1452)

This method consists of augering a hole and removing representative soil samples from the auger flight or bucket at 5-ft intervals or with each change in the substrata. Relatively disturbed samples are obtained, and its use is therefore limited to situations where it is satisfactory to determine the approximate subsurface profile.

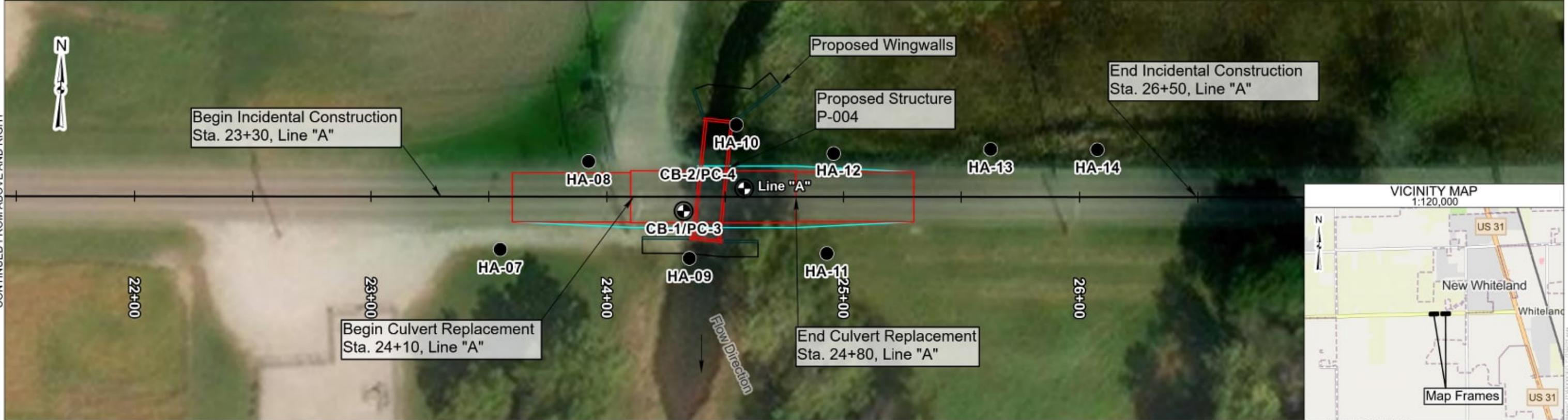
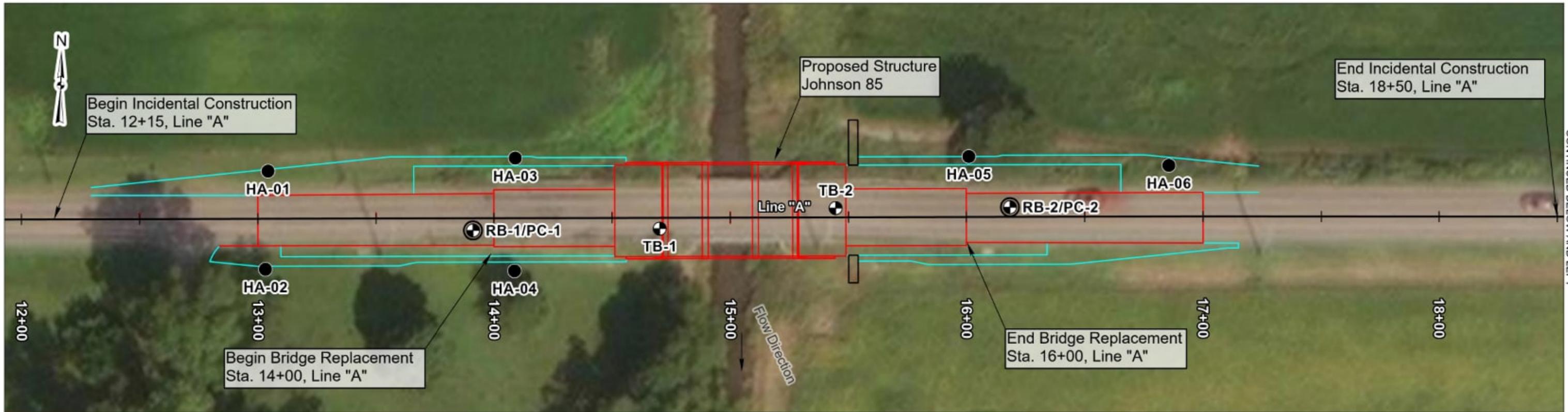
E. Diamond Core Drilling for Site Investigation

(AASHTO* Designation: T225)

This method consists of advancing a hole in rock or other hard strata by rotating downward a single tube or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings. Normally, a 3-in. outside diameter by 2-in. inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and laboratory. Cores are stored in partitioned boxes and the length of recovered material is expressed as a percentage of the actual distance penetrated.

* American Association of State Highway and Transportation Officials, Washington D.C.

** American Society for Testing and Materials



LEGEND	
	Test Boring Location and Designation
	Test Boring and Pavement Core Location and Designation
	Hand Auger Boring Location and Designation

NOTES	
1.	Base map developed using aerial imagery from Indiana Geological and Water Survey. Aerial imagery may not reflect current site conditions.
2.	Line work provided by Strand Associates, Inc.
3.	Vicinity map generated using data from Indiana Geological and Water Survey and Esri.
4.	Exploratory locations marked in the field by Terracon Consultants, Inc.
5.	Exploratory locations are approximate.

EXPLORATORY LOCATION PLAN	
PROJECT:	Whiteland Road Structure Replacements
LOCATION:	Johnson County, IN
CLIENT:	Strand Associates, Inc.
STRUCTURE NO.:	Johnson 85 & P-004
TCI PROJECT NO.:	CJ235021
SCALE:	Top frame: 1 in. = 40 ft Bottom frame: 1 in. = 40 ft

PROJECT ENG.:	BD
REVIEWED BY:	KBD
DRAWN BY:	DJR
DATE:	10/25/2024
DRAWING NO.:	CJ235021.B1



CONTINUED FROM ABOVE AND RIGHT

CONTINUED BELOW AND LEFT

LOG OF TEST BORING – GENERAL NOTES

DESCRIPTIVE CLASSIFICATION

GRAIN SIZE TERMINOLOGY

Soil Fraction	Particle Size	US Standard Sieve Size
Boulders	Larger than 75 mm	Larger than 3"
Gravel	4.76 mm to 75 mm	#10 to 75 mm
Sand: Coarse	2.00 to 4.76 mm	#40 to #10
Fine	0.075 to 0.42 mm	#200 to #40
Silt	0.002 to 0.075 mm	Smaller than #200
Clay	Smaller than 0.002 mm	Smaller than #200

GENERAL TERMINOLOGY

Physical Characteristics
 - Color, moisture, grain shape fineness, etc.
 Major Constituents
 - Clay silt, sand, gravel
 Structure
 - Laminated, varved, fibrous, stratified, cemented, fissured, etc.
 Geologic Origin
 - Glacial, alluvial, eolian, residual, etc.

RELATIVE PROPORTIONS OF COHESIONLESS SOILS

Term	Defining Range by % of Weight
Trace	1 – 10%
Little	11 – 20%
Some	21 – 35%
And	36 – 50%

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	LOI
w/ organic matter	4 – 15 %
Organic Soil (A-8)	16 – 30%
Peat (A-8)	More than 30%

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6-in. penetrations of the 2-in. split-barrel sampler. The sampler is driven with a 140-lb weight falling 30 in. and is seated to a depth of 6 in. before commencing the standard penetration test.

SYMBOLS

DRILLING AND SAMPLING

AS	– Auger Sample
BS	– Bag Sample
C	– Casing Size 2½", NW, 4", HW
COA	– Clean-Out Auger
CS	– Continuous Sampling
CW	– Clear Water
DC	– Driven Casing
DM	– Drilling Mud
FA	– Flight Auger
FT	– Fish Tail
HA	– Hand Auger
HSA	– Hollow Stem Auger
NR	– No Recovery
PMT	– Borehole Pressuremeter Test
PT	– 3" O.D. Piston Tube Sample
PTS	– Peat Sample
RB	– Rock Bit
RC	– Rock Coring
REC	– Recovery
RQD	– Rock Quality Designation
RS	– Rock Sounding
S	– Soil Sounding
SS	– 2" O.D. Split-Barrel Sample
2ST	– 2" O.D. Thin-Walled Tube Sample
3ST	– 3" O.D. Thin-Walled Tube Sample
VS	– Vane Shear Test
WPT	– Water Pressure Test

LABORATORY TESTS

q _p	– Penetrometer Reading, tsf
q _u	– Unconfined Strength, tsf
W	– Moisture Content, %
LL	– Liquid Limit, %
PL	– Plastic Limit, %
PI	– Plasticity Index
SL	– Shrinkage Limit, %
LOI	– Loss on Ignition, %
γ _d	– Dry Unit Weight, pcf
pH	– Measure of Soil Alkalinity/Acidity

WATER LEVEL MEASUREMENT

BF	– Backfilled upon Completion
NW	– No Water Encountered

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **CB-1/PC-3**
 Elevation **783**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **2**

Proj. No. --- Station **24+32** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **6 Rt. A** Temp. **83° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES								
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %		
					ASPHALTIC CONCRETE GRANULAR SUBBASE, (sand and gravel)									
SS-1	X	45	3	780	SANDY LOAM , very loose, moist, brown, with cohesive sandy loam seam near 1.5 ft, with gravelly sand seam near 5 ft (fill)									
SS-2	X	35	4	775										
SS-3	X	55	10	770		3			11.8					
SS-4	X	85	21	765		>4½		128.8	10.0	22	13	9		
SS-5	X	100	50/5	760		>4½			6.7					
SS-6	X	100	54	755		>4½			21.9	19	12	7		
SS-7	X	30	44	750		CLAY LOAM , with some gravel below 10 ft, very stiff to hard, moist, brown to gray below 10 ft, with sandy loam seam near 17 ft, A-4(2), SS-4 : SG = 2.71, SS-6 : SG = 2.73	2½		15.1					
SS-8	X	100	50/5	745			>4½			8.4				
SS-9	X	100	75	740			>4½			8.6				
SS-10	X	95	34	735			>4½			11.2				

Continued Next Page

WATER LEVEL OBSERVATIONS				GENERAL NOTES	
Depth ft	▽ While Drilling	▼ Upon Completion	▽ BF After Drilling	Start 5/20/24 End 5/20/24 Rig CME 750X	Drilling Method 3¼" I.D. HSA Remarks Backfilled with auger cuttings, bentonite chips and concrete patch at surface.
To Water	18	20			
To Cave-in		31			
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.					



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **CB-1/PC-3**
 Elevation **783**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **2** of **2**

Proj. No. --- Station **24+32** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **6 Rt. A** Temp. **83° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ g	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
SS-11	X	95	46	35	<div style="display: flex; align-items: center;"> <div style="margin-left: 10px;"> <p>CLAY LOAM, with some gravel below 10 ft, very stiff to hard, moist, brown to gray below 10 ft, with sandy loam seam near 17 ft, A-4(2), SS-4 : SG = 2.71, SS-6 : SG = 2.73</p> </div> </div>	>4½			12.0			
SS-12	X	100	75/1	745		>4½			8.5			
End of Boring at 39.9 ft												

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **CB-2/PC-4**
 Elevation **783**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **2**

Proj. No. --- Station **24+58** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **78° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
					ASPHALTIC CONCRETE PORTLAND CEMENT CONCRETE GRANULAR SUBBASE, (sand and gravel)							
SS-1	X	35	4	780								
SS-2	X	20	4	5	SANDY LOAM , stiff, moist, brown, with granular seams (fill)	1½			13.8			
SS-3	X	45	4			1½			22.6			
SS-4	X	85	17	10	CLAY LOAM , hard, moist, gray to brown below 7.5 ft, with sandy clay loam seam near 7 ft, A-6(7), SS-4 : SG = 2.72	>4½	5.03	132.2	12.9	31	15	16
SS-5	X	65	65			>4½			5.2			
SS-6	X	100	50/5	15		1½			7.5			
SS-7	X	95	50/5			>4½			8.0			
SS-8	X	90	91/1	20	LOAM , stiff to hard, moist, brown to gray below 14 ft, with gravelly sand seam near 14 ft, with sand seam near 19 ft, with cobbles near 20 ft	>4½			9.5			
SS-9	X	85	70	25		3			9.7			
SS-10	X	95	69	30		>4½			8.0			

Continued Next Page

WATER LEVEL OBSERVATIONS				GENERAL NOTES	
Depth ft	▽ While Drilling	▼ Upon Completion	▽ BF After Drilling	Start 5/20/24 End 5/20/24 Rig CME 750X	Drilling Method 3¼" I.D. HSA Remarks Backfilled with auger cuttings, bentonite chips and concrete patch at surface.
To Water	18	22	_____		
To Cave-in	_____	37	_____		
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.					



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **CB-2/PC-4**
 Elevation **783**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **2** of **2**

Proj. No. --- Station **24+58** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **78° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ g	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
SS-11	X	95	34	750 35	LOAM , stiff to hard, moist, brown to gray below 14 ft, with gravelly sand seam near 14 ft, with sand seam near 19 ft, with cobbles near 20 ft	4			9.0			
SS-12	X	95	94/0.9	745			>4½	6.97	134.6	8.0		
End of Boring at 39.9 ft												

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **RB-1/PC-1**
 Elevation **781**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **1**

Proj. No. --- Station **13+91** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **5 Rt. A** Temp. **80° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
				780	ASPHALTIC CONCRETE GRANULAR SUBBASE, (sand and gravel)							
SS-1	X	85	7		CLAY LOAM , medium stiff, moist, brown, with some gravel near 2 ft (fill)	1/2 1			21.0 10.6			
SS-2	X	95	6	5	CLAY , stiff, moist, brown and gray, A-6(11), SS-3 : SG = 2.67	2 1 1/2			14.1 20.6			
SS-3	X	100	9	775		1		100.6	19.2	37	16	21
SS-4	X	100	9			1			25.0			
				10		End of Boring at 10 ft						

WATER LEVEL OBSERVATIONS				GENERAL NOTES	
Depth ft	▽ While Drilling	▼ Upon Completion	▽ BF After Drilling	Start <u>5/22/24</u> End <u>5/22/24</u> Rig <u>CME 750X</u> Drilling Method <u>3 1/4" I.D. HSA</u> Remarks <u>Backfilled with auger cuttings, bentonite chips and concrete patch at surface.</u>	
To Water	<u>NW</u>	<u>NW</u>	_____		
To Cave-in	_____	<u>7</u>	_____		
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.					



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **RB-2/PC-2**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **1**

Proj. No. --- Station **16+18** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **80° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES							
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %	
					ASPHALTIC CONCRETE								
					GRANULAR SUBBASE, (sand and gravel)								
SS-1	X	85	5	5	SANDY LOAM , with some gravel, medium stiff, moist, brown, with clay loam seams, A-6(2), SS-2 : SG = 2.71, with sand and gravel seam near 1 ft (fill to 3 ft)	1/2			14.2				
						1				15.3			
SS-2	X	65	6	5		1			12.3	30	14	16	
				775									
SS-3	X	10	11		CLAY LOAM , soft to medium stiff, moist, brown and gray, A-6(7), SS-4 : SG = 2.73	1			24.1				
SS-4	X	85	10	10		1/4			26.7	31	15	16	
				770	End of Boring at 10 ft								

WATER LEVEL OBSERVATIONS				GENERAL NOTES	
Depth ft	▽ While Drilling	▼ Upon Completion	▽ BF After Drilling	Start <u>5/21/24</u> End <u>5/21/24</u> Rig <u>CME 750X</u> Drilling Method <u>3 1/4" I.D. HSA</u> Remarks <u>Backfilled with auger cuttings, bentonite chips and concrete patch at surface.</u>	
To Water	<u>NW</u>	<u>NW</u>	_____		
To Cave-in	_____	<u>6</u>	_____		
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.					



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-1**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **3**

Proj. No. --- Station **14+70** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **5 Rt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES							
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %	
					ASPHALTIC CONCRETE								
SS-1	X	55	5		<p>CLAY LOAM, medium stiff to stiff, moist, brown and gray, with sandy loam seam near 5 ft, (fill to 5ft), A-6(6), SS-4 : SG = 2.71</p>	1½			16.4				
						½			12.4				
SS-2	X	60	6	5 775			1½			15.1			
							1¾			10.4			
SS-3	X	85	7				1½			23.3			
SS-4	X	70	10	10 770			½		128.1	18.3	29	15	14
SS-5	X	100	56			<p>LOAM, with some gravel, very stiff to hard, moist, gray</p>	3			7.7			
SS-6	X	95	54	15 765			>4½			7.2			
SS-7	X	90	75/1			4½			11.0				
SS-8	X	85	39	20 760	SAND , dense, moist, gray								
					<p>CLAY LOAM, stiff to hard, moist, gray, with sandy loam seam near 39 ft, with silty loam seam near 40 ft, with cobbles near 54.5 ft, A-4(1), SS-14 : SG = 2.71</p>								
SS-9	X	100	27	25 755			>4½			10.2			
SS-10	X	85	50/4	30 750		>4½			10.1				

Continued Next Page

WATER LEVEL OBSERVATIONS					GENERAL NOTES	
Depth ft	▽	While Drilling	▼	Upon Completion	▽	BF After Drilling
To Water		23		22		
To Cave-in				29		
Start 5/22/24 End 5/22/24 Rig CME 750X Drilling Method 3¼" I.D. HSA Remarks Backfilled with auger cuttings, bentonite chips and concrete patch at surface.						
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.						



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-1**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **2** of **3**

Proj. No. --- Station **14+70** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **5 Rt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ g	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
SS-11	X	100	85	35 745	<p>CLAY LOAM, stiff to hard, moist, gray, with sandy loam seam near 39 ft, with silty loam seam near 40 ft, with cobbles near 54.5 ft, A-4(1), SS-14 : SG = 2.71</p> <p>CLAY, stiff to hard, moist, dark gray, with sandy clay loam seam near 65 ft, A-6</p> <p>SAND, medium dense to dense, wet, gray, with silty clay seam near 74.5 ft</p>	1¼		8.7				
SS-12	X	70	44	40 740		>4½			13.2			
SS-13	X	85	54	45 735		4			8.4			
SS-14	X	70	48	50 730		4½	3.18	130.9	10.3	19	13	6
SS-15	X	45	68	55 725		4¼			8.7			
SS-16	X	100	48	60 720		4			21.2			
SS-17	X	100	21	65 715		1			9.6			

Continued Next Page

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

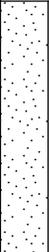


LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-1**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **3** of **3**

Proj. No. --- Station **14+70** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **5 Rt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ g	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
SS-18	X	0	42	70 710	 <p>SAND, medium dense to dense, wet, gray, with silty clay seam near 74.5 ft</p>							
SS-19	X	100	29	75 705		 <p>GRAVELLY SAND, medium dense to very dense, wet, gray, with heaving sand encountered below 75 ft</p>						
SS-20	X	100	51	80 700								
SS-21	X	100	59	85 695								
SS-22	X	100	57	90 690								
End of Boring at 90 ft												

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-2**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **1** of **3**

Proj. No. --- Station **15+45** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES												
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %						
						ASPHALTIC CONCRETE												
SS-1	X	60	4			1			18.3									
						1			18.1									
SS-2	X	65	4	5 775		CLAY LOAM , medium stiff to stiff, moist, brown (fill)	1½			18.0								
							1½			16.2								
SS-3	X	80	6				¾			18.1								
SS-4	X	85	11	10 770		CLAY , with some gravel, medium stiff, moist, brown and gray	½			21.2								
SS-5	X	95	50/4			CLAY LOAM , with some gravel, very stiff to hard, moist, gray, with sand seams near 19 ft and 20 ft, with cobbles near 29 ft, with sand seams near 39 ft and 44 ft, SS-9 : SG = 2.73, A-4(2), SS-13 : SG = 2.71	>4½			8.4								
SS-6	X	30	50/5	15 765	>4½				7.3									
SS-7	X	85	50/1			>4½			6.8									
SS-8	X	85	50	20 760		>4½			10.0									
SS-9	X	100	67	25 755		>4½	7.65	135.3	7.9	21	12	9						
SS-10	X	0	50/4	30 750														

Continued Next Page

WATER LEVEL OBSERVATIONS					GENERAL NOTES	
Depth ft	▽	While Drilling	▼	Upon Completion	▽	BF After Drilling
To Water	22	25	39	Start <u>5/21/24</u> End <u>5/21/24</u> Rig <u>CME 750X</u> Drilling Method <u>3/4" I.D. HSA</u> Remarks <u>Backfilled with auger cuttings, bentonite chips and concrete patch at surface.</u>		
To Cave-in						
The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.						



LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-2**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **2** of **3**

Proj. No. --- Station **15+45** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES							
No.	Typ	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %	
SS-11	X	95	98/0.8	35 745	<p>CLAY LOAM, with some gravel, very stiff to hard, moist, gray, with sand seams near 19 ft and 20 ft, with cobbles near 29 ft, with sand seams near 39 ft and 44 ft, SS-9 : SG = 2.73, A-4(2), SS-13 : SG = 2.71</p>	3½			7.1				
SS-12	X	85	81	40 740		4			13.3				
SS-13	X	95	50/4	45 735									
SS-14	X	100	84/1	50 730					8.6				
SS-15	X	90	52	55 725					10.7				
SS-16	X	80	61	60 720		<p>CLAY, hard, moist, dark gray, A-6(9), SS-16 : SG = 2.66</p>	>4½	6.59	128.2	12.4	34	13	21
SS-17	X	100	66	65 715			<p>SAND, medium dense to very dense, wet, gray, with heaving sand encountered below 70 ft, with sandy loam seam near 74 ft</p>						

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The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

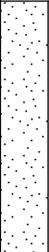


LOG OF TEST BORING

Project **Whiteland Road Structure Replacements**
 Location **Johnson Co., IN**
 Client **Strand Associates, Inc.**
 7770 West New York Street - Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

Boring No. **TB-2**
 Elevation **780**
 Datum **WGS 84**
 Proj. No. **CJ235021**
 Sheet **3** of **3**

Proj. No. --- Station **15+45** Weather **Sunny** Driller **B.N.**
 Struct. No. **Johnson 85 & P-004** Offset **4 Lt. A** Temp. **70° F** Inspector ---

SAMPLE					DESCRIPTION/CLASSIFICATION and REMARKS	SOIL PROPERTIES						
No.	Typ g	Rec %	N Value	Depth ft Elev		q _p tsf	q _u tsf	γ _d pcf	W %	LL %	PL %	PI %
SS-18	X	100	25	70 710	 <p>SAND, medium dense to very dense, wet, gray, with heaving sand encountered below 70 ft, with sandy loam seam near 74 ft</p>							
SS-19	X	100	58	75 705		 <p>GRAVELLY SAND, very dense, wet, gray, with sand and gravel seam near 79 ft</p>						
SS-20	X	100	69	80 700								
SS-21	X	100	87	85 695								
SS-22	X	100	89	90 690								
End of Boring at 90 ft												

The stratification lines represent the approximate boundary between soil/rock types and the transition may be gradual.

**Summary of Pavement Cores
Whiteland Road Structure Replacements
Terracon Project No. CJ235021
Johnson Co., IN**



Core	Latitude	Longitude	Direction	Lane	Date	Overall Thickness (in)	Overall Type	Layer 1 Thickness (in.)	Layer 1 Type	Layer 2 Thickness (in.)	Layer 2 Type	Subbase Type	Subbase Thickness (in.)
RB-1/PC-1	39.549377	-86.110668	Eastbound	Driving	5/22/24	9.0	HMA	9.0	HMA	---	---	Sand and gravel	7
RB-2/PC-2	39.549332	-86.111473	Westbound	Driving	5/21/24	10.0	HMA	10.0	HMA	---	---	Sand and gravel	7
CB-1/PC-3	39.549414	-86.107782	Eastbound	Driving	5/20/24	5.5	HMA	5.5	HMA	---	---	Sand and gravel	5
CB-2/PC-4	39.549442	-86.107692	Westbound	Driving	5/20/24	14.3	COMPOSITE	1.4	HMA	12.9	PCCP	Sand and gravel	5

Note: While the measurements of layer and overall core thicknesses are reported to the nearest tenth of an inch, an inherent variation in the pavement thickness will occur due to the size of the aggregate. Depending on the aggregate size, the variation in measurements could be 1/2 to 3/4 in.

PAVEMENT CORE LOG NO. CB-1/PC-3

PROJECT: Whiteland Road Structure Replacement

CLIENT: Strand Associates, Inc.

SITE: Johnson Co., IN

GRAPHIC LOG

DEPTH (in.)

Latitude: 39.549414° Longitude: -86.107782° Station: 24+32 Offset: 6 ft Rt. Line: "A"

Direction: Eastbound Lane: Driving

DEPTH

0.7 **HMA**, 9.5 mm surface, partially stripped, delaminated

2.0 **HMA**, 9.5 mm surface, partially stripped, delaminated

5.5 **HMA**, completely stripped, partially recovered

10.5 **Granular Subbase**, sand and gravel, not recovered

Coring Terminated at 10.5 Inches

1
2
3
4
5
6
7
8
9
10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. PAVEMENT_CORE_NO_COORDINATES_PAVEMENT_CORES.GPJ INDOT_PAVEMENT_TEMPLATE.GDT 11/8/24



Downhole photo not available



7770 W New York St
Indianapolis, IN

Coring Started: 5/20/2024

Coring Completed: 5/20/2024

Drill Rig: CORING MACHINE

Driller: B.N.

Project No.: CJ235021

PAVEMENT CORE LOG NO. CB-2/PC-4

PROJECT: Whiteland Road Structure Replacement

CLIENT: Strand Associates, Inc.

SITE: Johnson Co., IN

GRAPHIC LOG

Latitude: 39.549442° Longitude: -86.107692° Station: 24+58 Offset: 4 ft Lt. Line: "A"
 Direction: Westbound Lane: Driving

DEPTH (in.)

DEPTH

1.4 **HMA**, 9.5 mm surface

PCCP, 0.75 in. max. aggregate size

12.9

Granular Subbase, sand and gravel

17.9

Coring Terminated at 17.9 Inches

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17

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. PAVEMENT_CORE_NO_COORDINATES_PAVEMENT_CORES.GPJ INDOT_PAVEMENT_TEMPLATE.GDT 11/8/24



Downhole photo not available



7770 W New York St
Indianapolis, IN

Coring Started: 5/20/2024

Coring Completed: 5/20/2024

Drill Rig: CORING MACHINE

Driller: B.N.

Project No.: CJ235021

PAVEMENT CORE LOG NO. RB-1/PC-1

PROJECT: Whiteland Road Structure Replacement

CLIENT: Strand Associates, Inc.

SITE: Johnson Co., IN

GRAPHIC LOG

Latitude: 39.549377° Longitude: -86.110668° Station: 13+91 Offset: 5 ft Rt. Line: "A"

Direction: Eastbound Lane: Driving

DEPTH (in.)

DEPTH

1.6 **HMA**, 9.5 mm surface, delaminated

1.6 **HMA**, completely stripped, partially recovered

9.0 **Granular Subbase**, sand and gravel

16.0 **Coring Terminated at 16 Inches**

1
2
3
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10
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12
13
14
15
16

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. PAVEMENT_CORE_NO_COORDINATES_PAVEMENT_CORES.GPJ INDOT_PAVEMENT_TEMPLATE.GDT 11/8/24



7770 W New York St
Indianapolis, IN

Coring Started: 5/22/2024

Coring Completed: 5/22/2024

Drill Rig: CORING MACHINE

Driller: B.N.

Project No.: CJ235021

PAVEMENT CORE LOG NO. RB-2/PC-2

PROJECT: Whiteland Road Structure Replacement

CLIENT: Strand Associates, Inc.

SITE: Johnson Co., IN

GRAPHIC LOG

DEPTH (in.)

Latitude: 39.549332° Longitude: -86.111473° Station: 16+18 Offset: 4 ft Lt. Line: "A"

Direction: Westbound Lane: Driving

DEPTH

0.7	HMA, 9.5 mm surface	1
1.3	HMA, 9.5 mm surface	2
2.5	HMA, 12.5 mm intermediate	3
3.5	HMA, 12.5 mm intermediate, fuel odor	4
5.3	HMA, 12.5 mm intermediate, delaminated, fuel odor	5
	HMA, completely stripped, partially recovered	6
		7
		8
		9
10.0	Granular Subbase, sand and gravel, not recovered	10
		11
		12
		13
		14
		15
		16
17.0		17

Coring Terminated at 17 Inches

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. PAVEMENT_CORE_NO_COORDINATES_PAVEMENT_CORES.GPJ INDOT_PAVEMENT_TEMPLATE.GDT 11/8/24



7770 W New York St
Indianapolis, IN

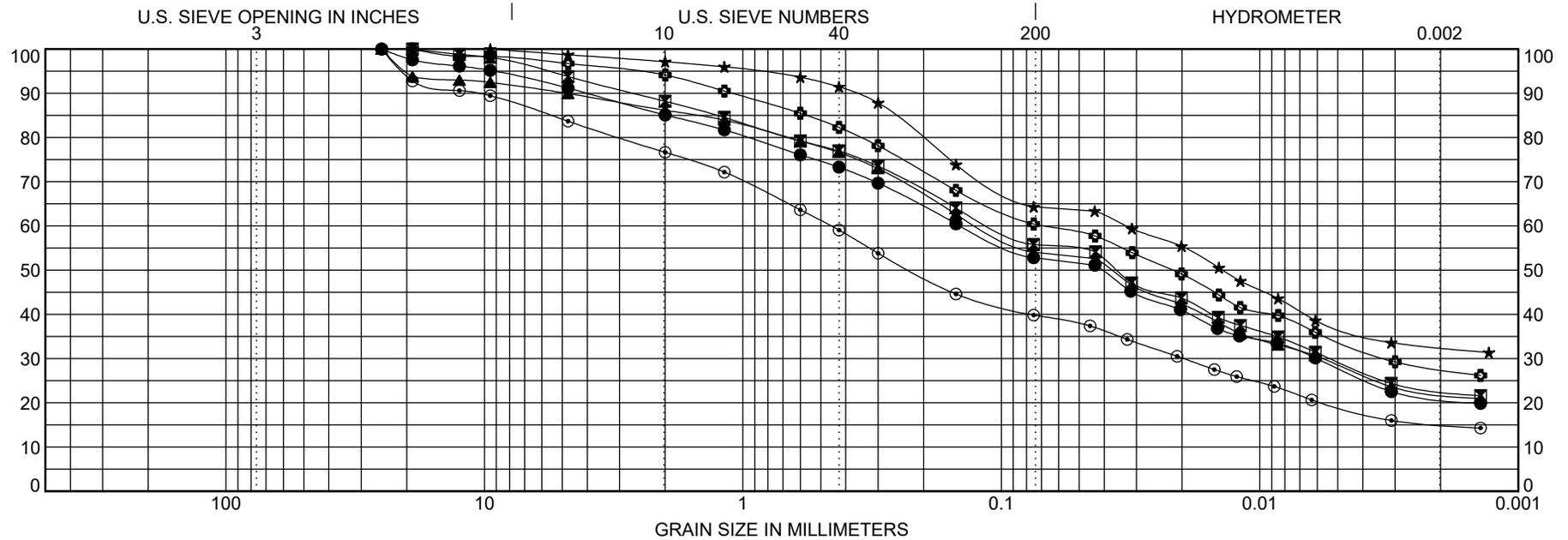
Coring Started: 5/21/2024

Coring Completed: 5/21/2024

Drill Rig: CORING MACHINE

Driller: B.N.

Project No.: CJ235021



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Lab No.	Boring	Station/Offset/Line	Sample No.	Depth ft	Classification	% Passing			% Gravel	% Sand	% Silt	% Clay	% Coll.	LL	PL	PI	Opt. Moist.	ϕ _{max} pcf	* CBR at	
						No.10	No.40	No.200											93%	97%
●	CB-1/PC-3	24+32 6 Rt. A	SS-4	8.5 - 10.0	CLAY LOAM A-4 (2)	85.1	73.3	52.8	14.9	32.3	31.7	21.1		22	13	9				
⊠	CB-1/PC-3	24+32 6 Rt. A	SS-6	13.5 - 15.0	CLAY LOAM A-4 (1)	88.2	77.0	55.8	11.8	32.4	32.9	22.8		19	12	7				
▲	CB-2/PC-4	24+58 4 Lt. A	SS-4	8.5 - 10.0	CLAY LOAM A-6 (5)	86.2	76.6	54.1	13.8	32.1	31.9	22.2		31	15	16				
★	RB-1/PC-1	13+91 5 Rt. A	SS-3	6.0 - 7.5	CLAY A-6 (11)	97.1	91.5	64.3	2.9	32.8	31.8	32.5		37	16	21				
⊙	RB-2/PC-2	16+18 4 Lt. A	SS-2	3.5 - 5.0	SANDY LOAM with some GRAVEL A-6 (2)	76.7	59.1	39.8	23.3	36.8	24.8	15.1		30	14	16				
⊕	RB-2/PC-2	16+18 4 Lt. A	SS-4	8.5 - 10.0	CLAY LOAM A-6 (7)	94.1	82.3	60.4	5.9	33.7	32.8	27.6		31	15	16				



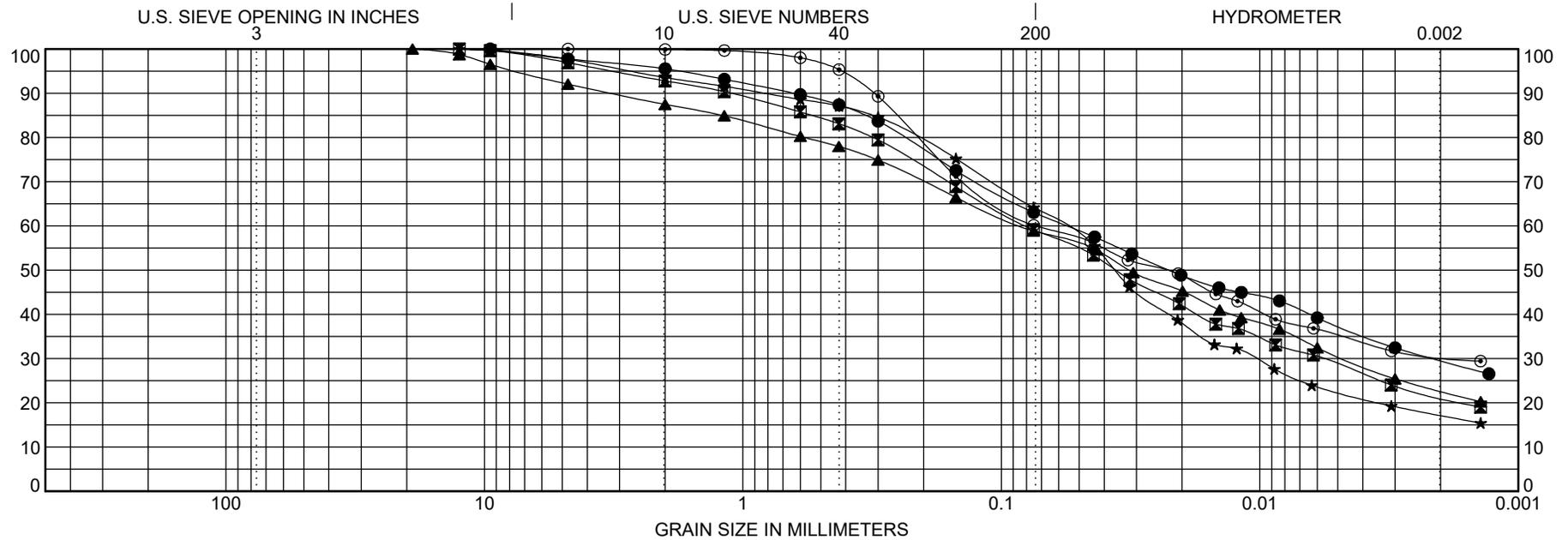
Client Project No. ---
 Structure No. Johnson 85 & P-004
 Project No. CJ235021

Project Location Whiteland Road Structure Replacements
 Johnson Co., IN
 Client Strand Associates, Inc.

SUMMARY OF CLASSIFICATION TEST RESULTS

Terracon Consultants, Inc.
 7770 West New York Street Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

* See text for recommended values.



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Lab No.	Boring	Station/Offset/Line	Sample No.	Depth ft	Classification	% Passing			% Gravel	% Sand	% Silt	% Clay	% Coll.	LL	PL	PI	Opt. Moist.	ϕ _{max} pcf	* CBR at	
						No.10	No.40	No.200											93%	97%
●	TB-1	14+70 5 Rt. A	SS-4	8.5 - 10.0	CLAY LOAM A-6 (6)	95.5	87.4	63.0	4.5	32.5	33.5	29.6		29	15	14				
⊠	TB-1	14+70 5 Rt. A	SS-14	48.5 - 50.0	CLAY LOAM A-4 (1)	92.8	83.1	59.1	7.2	33.7	37.8	21.3		19	13	6				
▲	TB-2	15+45 4 Lt. A	SS-9	23.5 - 25.0	CLAY LOAM A-4 (2)	87.5	78.0	58.8	12.5	28.6	36.2	22.7		21	12	9				
★	TB-2	15+45 4 Lt. A	SS-13	43.5 - 44.3	LOAM A-4 (0)	93.6	87.2	64.2	6.4	29.4	47.0	17.1		NP	NP	NP				
⊙	TB-2	15+45 4 Lt. A	SS-16	58.5 - 60.0	CLAY A-6 (9)	99.9	95.4	60.1	0.1	39.8	29.7	30.4		34	13	21				



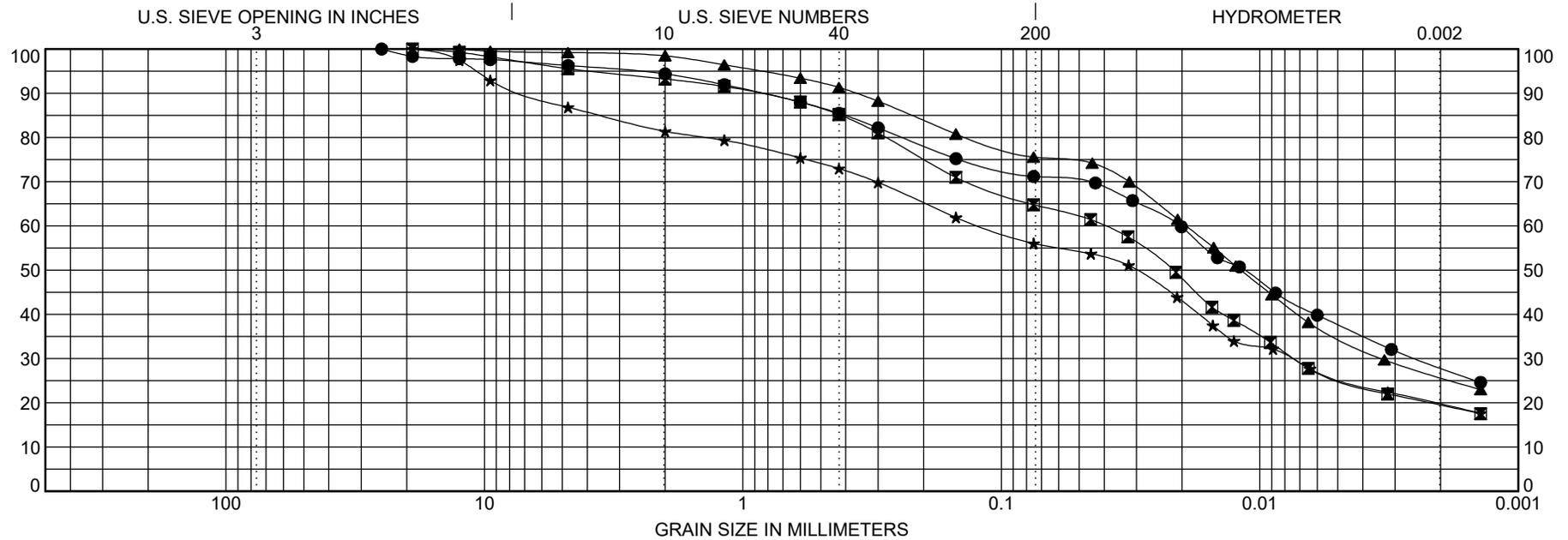
Client Project No. ---
 Structure No. Johnson 85 & P-004
 Project No. CJ235021

Project Whiteland Road Structure Replacements
 Location Johnson Co., IN
 Client Strand Associates, Inc.

SUMMARY OF CLASSIFICATION TEST RESULTS

Terracon Consultants, Inc.
 7770 West New York Street Indianapolis, Indiana 46214
 317-273-1690 / 317-273-2250 (Fax)

* See text for recommended values.



BOULDERS	GRAVEL	SAND		SILT	CLAY
		coarse	fine		

Lab No.	Boring	Station/Offset/Line	Sample No.	Depth ft	Classification	% Passing			% Gravel	% Sand	% Silt	% Clay	% Coll.	LL	PL	PI	Opt. Moist.	δ _{max} pcf	* CBR at		
						No.10	No.40	No.200											93%	97%	
●	NE		TS-1	0.0 - 1.0	CLAY LOAM with ORGANIC MATTER A-7-6 (20)	94.4	85.5	71.2	5.6	23.2	43.2	27.9		54	25	29					
☒	NW		TS-1	0.0 - 1.0	LOAM with ORGANIC MATTER A-7-5 (13)	93.2	85.2	64.8	6.8	28.5	45.3	19.4		50	30	20					
▲	SE		TS-1	0.0 - 1.0	CLAY LOAM with ORGANIC MATTER A-7-5 (27)	98.5	91.3	75.5	1.5	22.9	49.8	25.8		63	30	33					
★	SW		TS-1	0.0 - 1.0	LOAM with ORGANIC MATTER A-7-6 (12)	81.4	73.0	56.0	18.6	25.3	36.4	19.7		53	28	25					



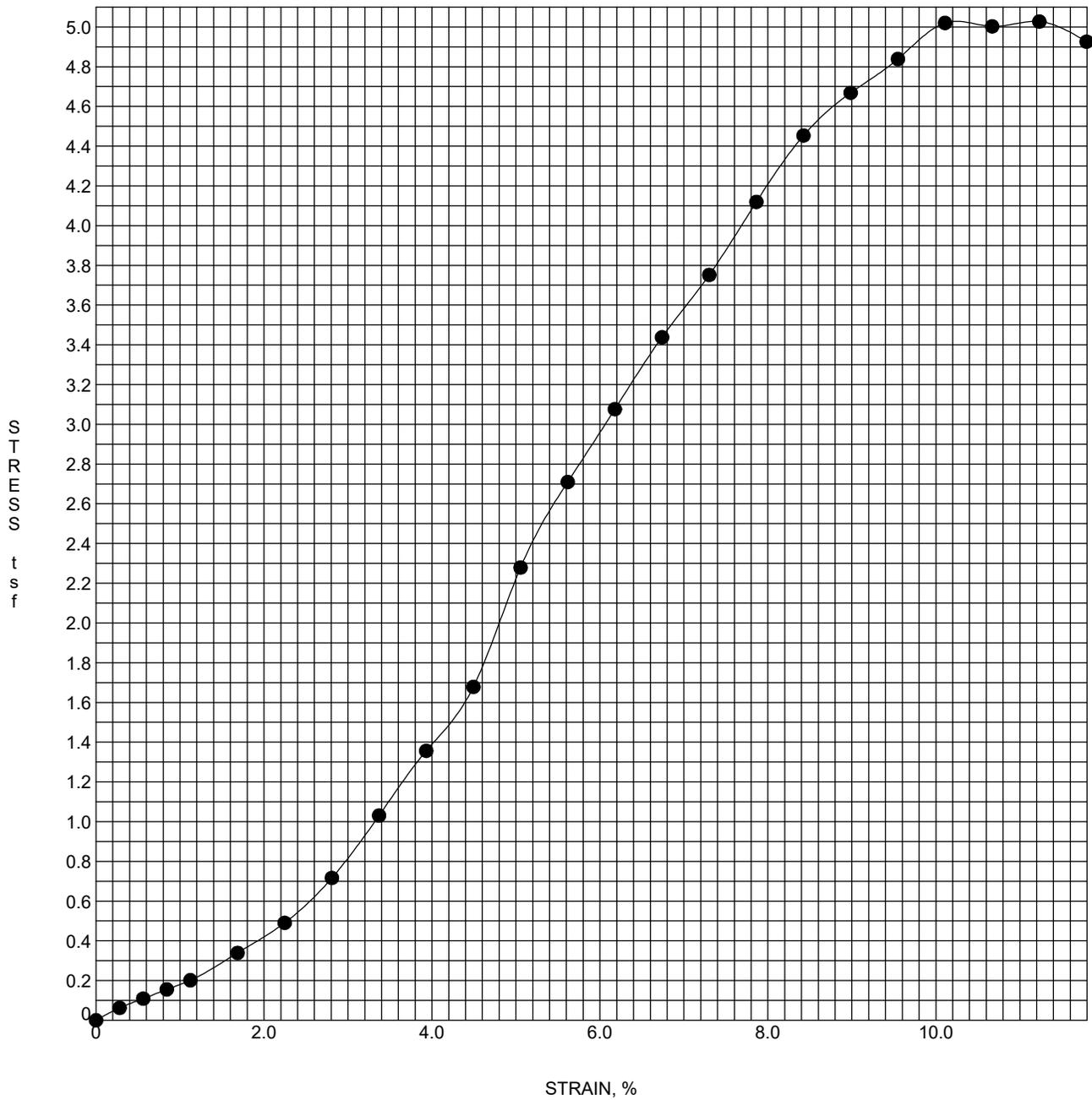
Client Project No. ---
 Structure No. ---
 Project No. CJ235021

Project Whiteland Road Structure Replacements
 Location Johnson Co., IN
 Client Strand Associates, Inc.

SUMMARY OF CLASSIFICATION TEST RESULTS

Terracon Consultants, Inc.
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Sample Identification	Station / Offset / Line	Depth, ft	Classification
● CB-2/PC-4 SS-4	24+58 4 Lt. A	8.5 - 10.0	CLAY LOAM A-6 (5)

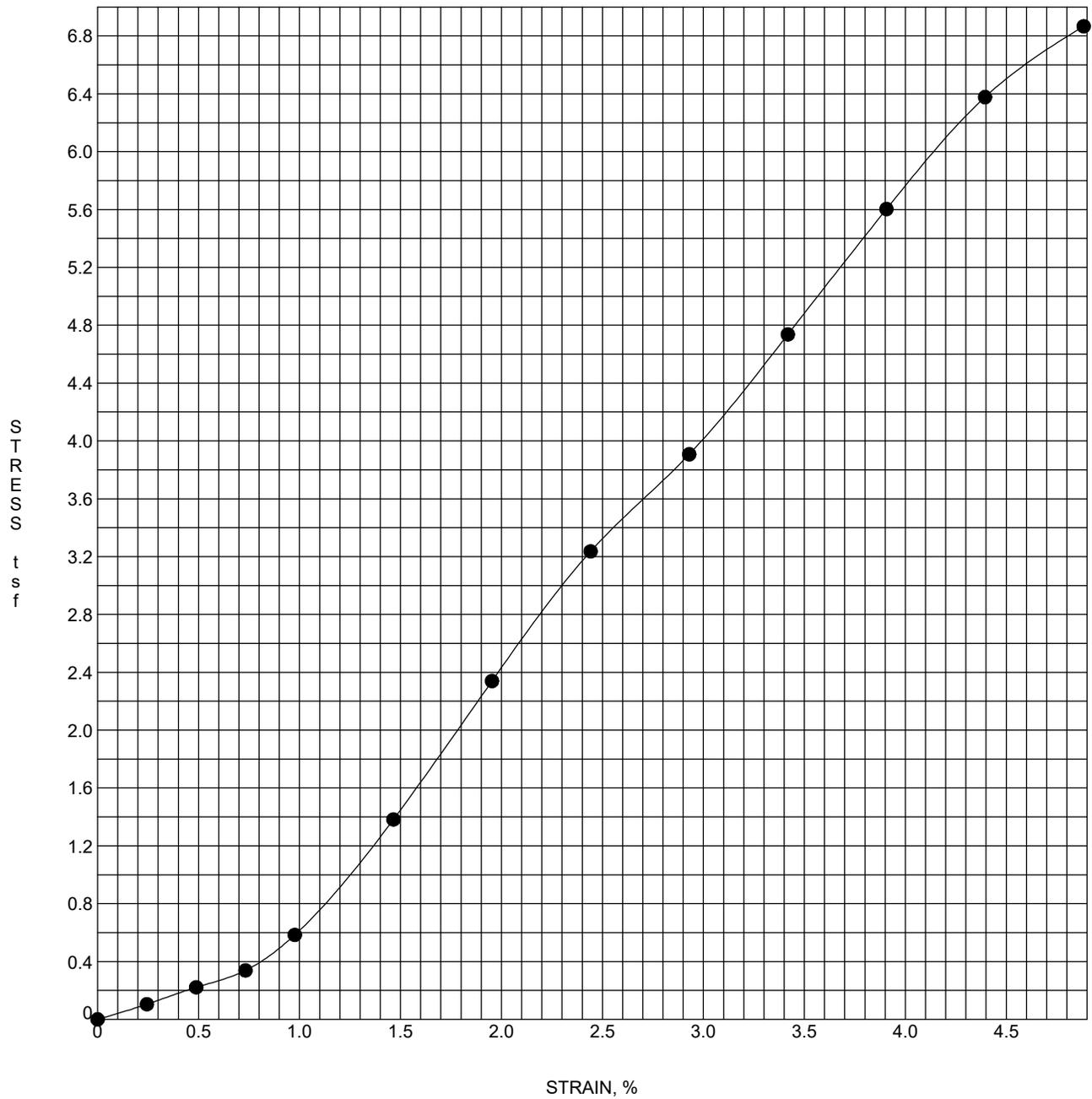
Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
	63.3	34.4	10.1	145.6	132.2	95.8	5.03	11.2	1.1



Project No. --- **Project** Whiteland Road Structure Replacements
Structure No. Johnson 85 & P-004 **Location** Johnson Co., IN
TCI Proj. No. CJ235021 **Client** Strand Associates, Inc.

UNCONFINED COMPRESSION TEST

Terracon Consultants, Inc.
 7770 West New York Street, Indianapolis, IN 46214
 317-273-1690 / 317-273-2250 (Fax)



Sample Identification	Station / Offset / Line	Depth, ft	Classification
● CB-2/PC-4 SS-12	24+58 4 Lt. A	38.5 - 39.8	LOAM

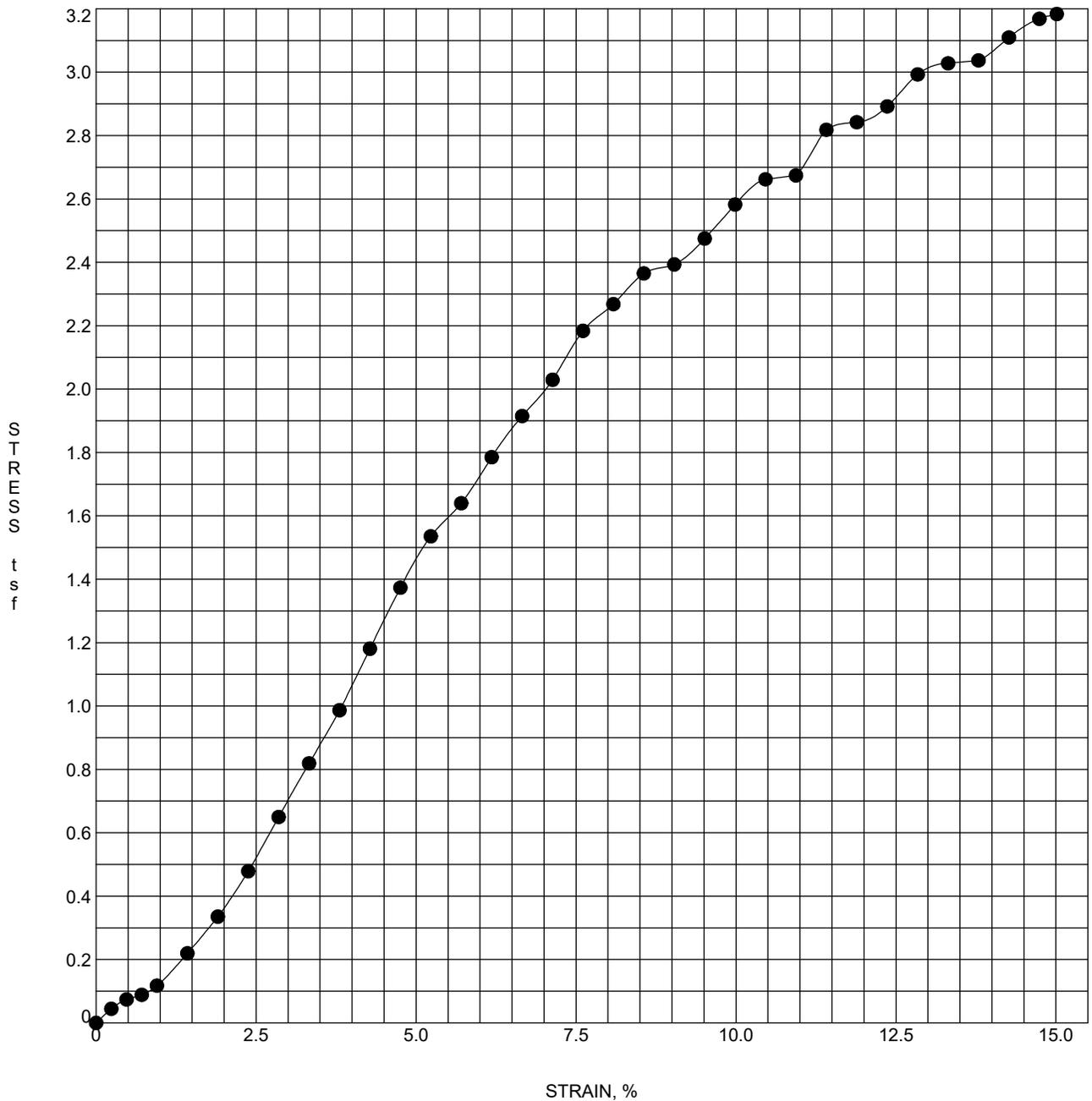
Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
	72.8	37.7	8.0	145.3	134.6	82.8	6.87	4.9	1.0



Project No. --- **Project** Whiteland Road Structure Replacements
Structure No. Johnson 85 & P-004 **Location** Johnson Co., IN
TCI Proj. No. CJ235021 **Client** Strand Associates, Inc.

UNCONFINED COMPRESSION TEST

Terracon Consultants, Inc.
 7770 West New York Street, Indianapolis, IN 46214
 317-273-1690 / 317-273-2250 (Fax)



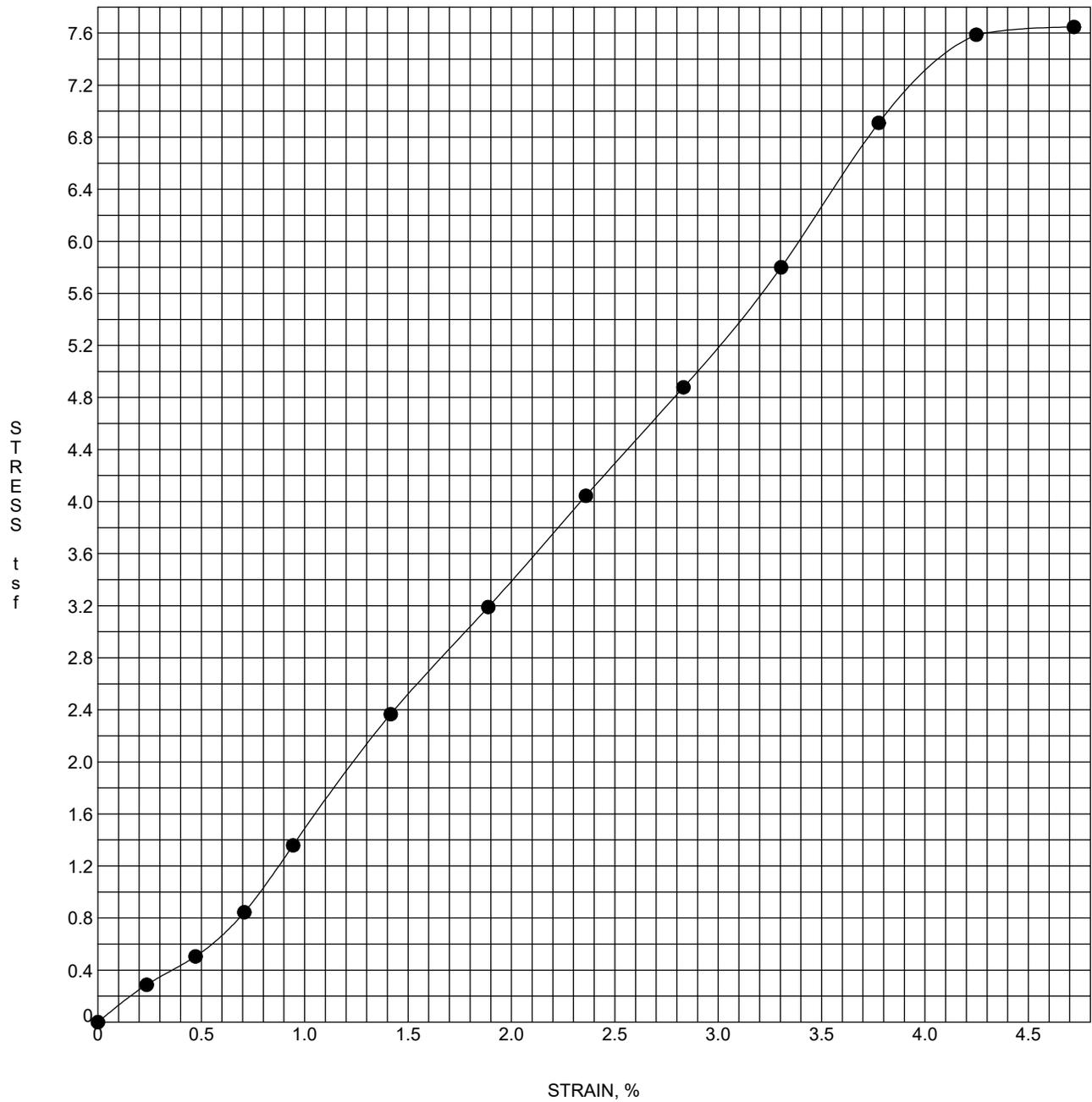
Sample Identification		Station / Offset / Line		Depth, ft		Classification			
●	TB-1 SS-14	14+70 5 Rt. A		48.5 - 50.0		CLAY LOAM A-4 (1)			
Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
	74.8	35.4	9.9	143.8	130.9	91.2	3.18	15.0	1.0



Project No. --- **Project** Whiteland Road Structure Replacements
Structure No. Johnson 85 & P-004 **Location** Johnson Co., IN
TCI Proj. No. CJ235021 **Client** Strand Associates, Inc.

UNCONFINED COMPRESSION TEST

Terracon Consultants, Inc.
 7770 West New York Street, Indianapolis, IN 46214
 317-273-1690 / 317-273-2250 (Fax)



Sample Identification	Station / Offset / Line	Depth, ft	Classification
TB-2 SS-9	15+45 4 Lt. A	23.5 - 25.0	CLAY LOAM A-4 (2)

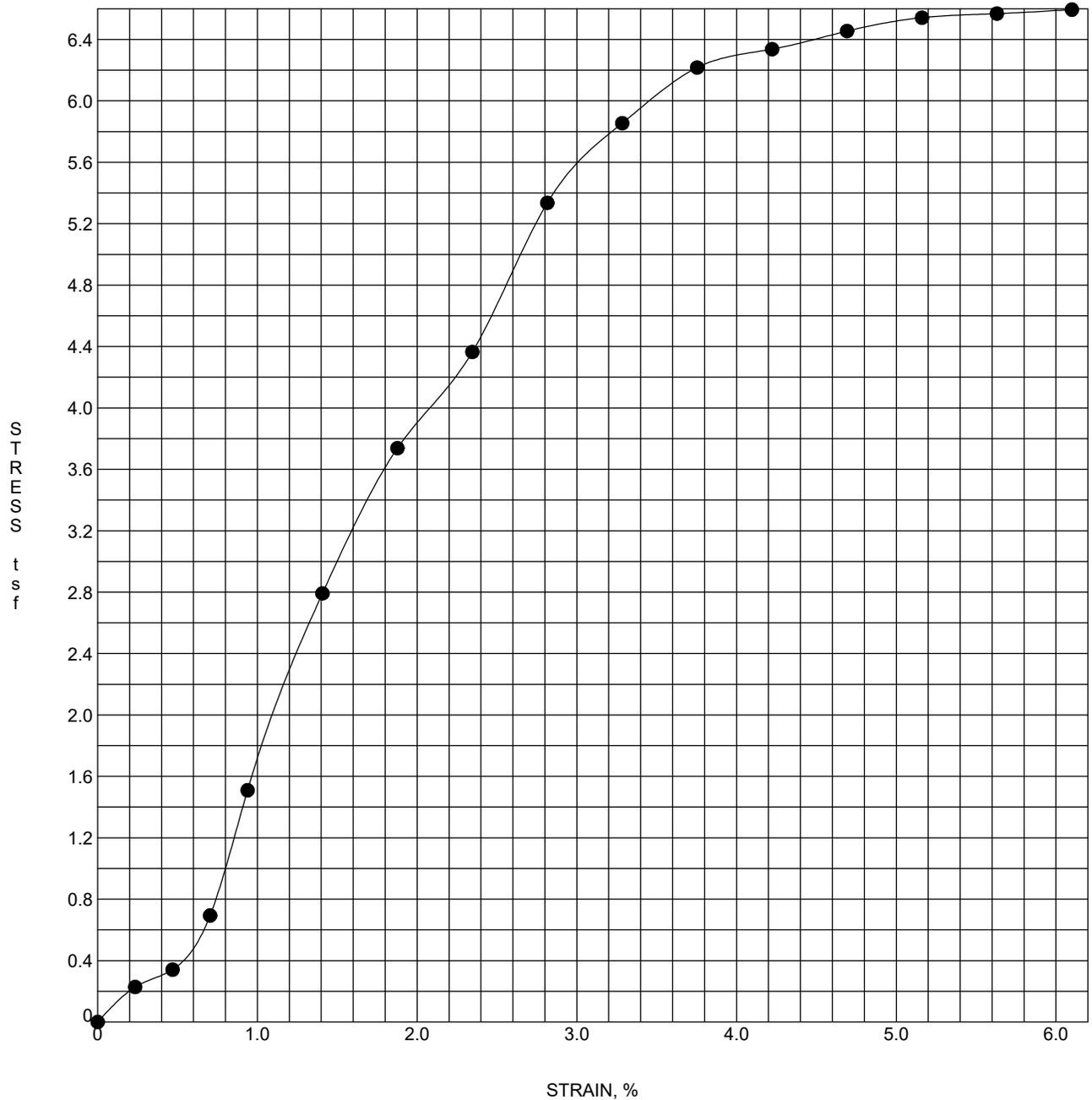
Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
	75.3	36.8	8.0	146.1	135.3	84.3	7.65	4.7	0.9



Project No. --- **Project** Whiteland Road Structure Replacements
Structure No. Johnson 85 & P-004 **Location** Johnson Co., IN
TCI Proj. No. CJ235021 **Client** Strand Associates, Inc.

UNCONFINED COMPRESSION TEST

Terracon Consultants, Inc.
 7770 West New York Street, Indianapolis, IN 46214
 317-273-1690 / 317-273-2250 (Fax)



Sample Identification		Station / Offset / Line		Depth, ft			Classification		
●	TB-2 SS-16	15+45 4 Lt. A		58.5 - 60.0			CLAY A-6 (9)		
Lab No.	Sample Ht., mm	Sample Diam., mm	Initial M.C., %	Initial Wet Den, pcf	Initial Dry Den, pcf	Sat., %	Unc. Comp. Strength, tsf	Failure Strain, %	Rate of Strain to Failure, %
	75.8	38.3	9.5	140.3	128.2	85.4	6.59	6.1	0.9



Project No. --- **Project** Whiteland Road Structure Replacements
Structure No. Johnson 85 & P-004 **Location** Johnson Co., IN
TCI Proj. No. CJ235021 **Client** Strand Associates, Inc.

UNCONFINED COMPRESSION TEST

Terracon Consultants, Inc.
 7770 West New York Street, Indianapolis, IN 46214
 317-273-1690 / 317-273-2250 (Fax)

SUMMARY OF HAND AUGER BORINGS

Project: Whiteland Road Structure Replacements
Location: Johnson County, IN
Client: Strand Associates, Inc.
Structure No.: Johnson 85 & P-004
Terracon Project No.: CJ235021

Boring No.	Station	Offset Line "A"	Approx. Ground Surface Elevation	Depth Interval (ft)	Description - All Classifications are visual
HA-01	13+04	24 ft Lt.	781	0 - ¼ ¼ - 1 1 - 4	Topsoil Silty Clay Loam, soft, moist, brown (MC = 20.1%) Clay, soft to stiff below 3 ft, moist, brown (MC = 20.9%) Hand auger refusal near 4 ft
HA-02	13+03	21 ft Rt.	781	0 - ¼ ¼ - 5	Topsoil Silty Clay Loam, soft to stiff below 4 ft, moist, brown (MC = 31.1%)
HA-03	14+09	25 ft Lt.	777	0 - ¼ ¼ - 5	Topsoil Clay Loam, soft to stiff below 4½ ft, moist, brown (MC = 21.2%)
HA-04	14+08	22 ft Rt.	777	0 - ¼ ¼ - 5	Topsoil Clay Loam, soft to stiff below 4½ ft, moist, brown (MC = 18.4%)
HA-05	16+01	28 ft Lt.	775	0 - ¼ ¼ - 2½	Topsoil Silty Clay Loam, soft to stiff below 1 ft, moist, brown, with crushed stone, with roots (MC = 10.1%) Hand auger refusal near 2½
HA-06	16+86	21 ft Lt.	775	0 - ¼ ¼ - 1	Topsoil Silty Clay Loam, stiff, moist, brown (MC = 14.4%) Hand auger refusal near 1 ft
HA-07	23+55	24 ft Rt.	781	0 - ¼ ¼ - 1	Topsoil Clay Loam, soft, moist, brown, with crushed stone, with roots (MC = 12.4%) Hand auger refusal near 1 ft
HA-08	23+92	15 ft Lt.	783	0 - ¼ ¼ - 1 1 - 5	Topsoil Silty Clay Loam, soft, moist, brown, with roots (MC = 26.9%) Silty Clay Loam, soft to stiff after 4 ft, moist, brown (MC = 19.0%)
HA-09	24+39	26 ft Rt.	774	No recovery	Creek Bottom with 3 ft of water, riprap and cut stone at the bottom
HA-10	24+55	30 ft Lt.	775	0 - ½	Sand and Gravel, Creek Bottom with 1 ft of water hand auger refusal near 6 in.

SUMMARY OF HAND AUGER BORINGS

Project: Whiteland Road Structure Replacements
Location: Johnson County, IN
Client: Strand Associates, Inc.
Structure No.: Johnson 85 & P-004
Terracon Project No.: CJ235021

Boring No.	Station	Offset Line "A"	Approx. Ground Surface Elevation	Depth Interval (ft)	Description - All Classifications are visual
HA-11	24+93	24 ft Rt.	779	0 - ¼ ¼ - 4	Topsoil Silty Clay Loam, soft to stiff below 2½ ft, moist, brown (MC = 25.2%) Hand auger refusal near 4 ft
HA-12	24+96	18 ft Lt.	780	0 - ¼ ¼ - 1 1 - 4	Topsoil Silty Clay Loam, soft, moist, brown, with roots (MC = 20.9%) Clay Loam, soft to stiff below 3 ft, moist, brown (MC = 14.3%) Hand auger refusal near 4 ft
HA-13	25+62	20 ft Lt.	779	0 - ¼ ¼ - 5	Topsoil Clay Loam, soft to stiff below 4 ft, moist, brown, wet near 4 ft (MC = 21.4%)
HA-14	26+08	20 ft Lt.	779	0 - ¼ ¼ - 5	Topsoil Clay Loam, soft to stiff below 4½ ft, moist, brown (MC = 27.5%)

Note: Consistency description based on ability to advance ½-in. diameter steel rod probe
 MC = Moisture Content

TERRACON CONSULTANTS, INC.
INDIANAPOLIS OFFICE



Summary of Existing Topsoil Test Results for Use with Plant Growth Layer

Rev 11/21

Date: 10/25/2024
 Des. No.: ---
 Project: Whiteland Road Structure Replacements
 Location: Johnson County, IN

			ANALYSIS							
REF.	LOCATION		AASHTO T 289	AASHTO T 88 and T 89	AASHTO T 267 and T 21 ³	Bray P-1 Equivalent	NCRRP 221, Chapt 7 ⁴			
Boring ¹	Sample	Tested Depth	pH	Gravel ²	Sand	Silt	Clay	Organic Content (% by Wt)	Phosphorus (ppm)	Potassium (ppm)
				(% by Weight)						
NE	TS-1	0 - 1'	7.5	5.6	23.2	43.2	27.9	8.8	54	172
NW	TS-1	0 - 1'	6.6	6.8	28.5	45.3	19.4	7.8	82	315
SE	TS-1	0 - 1'	7.7	1.5	22.9	49.8	25.8	9.6	81	192
SW	TS-1	0 - 1'	7.1	18.6	25.3	36.4	19.7	7.3	37	146
Acceptable Ranges per RSP 629-R-630 =			6.0 - 7.3	N/A	5 - 50%	30 - 80%	5 - 30%	3 - 10% ³	20 - 80	105 - 250

1 Topsoil was collected from four quadrants near the bridge structure
 2 For informational purposes only
 3 In Daviess, Gibson, Knox, Pike, Posey, and Vanderburgh Counties, AASHTO T 21 shall also be performed. Acceptable range is 4 - 10%
 4 North Central Regional Research Publication 221, Chapter 7
Note: All existing topsoil test results presented herein are for information only.

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APILE for Windows, Version 2023.10.5

Serial Number : 506768014

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.
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Bent No. 1

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Path to file locations : E:\Projects\2023\CJ235021\Working Files\Calculations-Analyses\APile HP\
Name of input data file : Bent 1 HP.ap10d
Name of output file : Bent 1 HP.ap10o
Name of plot output file : Bent 1 HP.ap10p

Time and Date of Analysis

Date: November 12, 2024 Time: 12:57:16

1

* INPUT INFORMATION *

PROJECT DESCRIPTION :

Johnson 85 - Bent 1
DESIGNER : Terracon
JOB NUMBER : CJ235021

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

AVERAGE DEPTH TO ESTIMATE TIP RESISTANCE:

- USE 1.5 DIAMETERS ABOVE AND BELOW TIP

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.20 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 80.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.60 IN.
- TIP AREA OF PILE = 15.20 IN2
- INCREMENT OF PILE LENGTH
USED IN COMPUTATION = 1.00 FT.
- PRINTING INCREMENT = 1

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICITION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
7.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
7.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
13.50	CLAY	0.80*	130.00	0.00	8.00**	4.80**
13.50	SAND	0.80*	130.00	33.00	32.00**	47.20**
16.00	SAND	0.80*	130.00	33.00	32.00**	47.20**
16.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
18.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
18.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
61.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
61.00	SAND	0.80*	70.00	33.00	32.00**	47.20**
90.00	SAND	0.80*	70.00	33.00	32.00**	47.20**

* VALUE ASSUMED BY THE PROGRAM

** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING

WERE SET TO LARGE VALUES INDICATING THAT APILE
 USES THE LIMITS SPECIFIED BY EACH SELECTED
 CRITERIA (IF ANY).

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
7.00	1.000	1.000
7.00	1.000	1.000
13.50	1.000	1.000
13.50	0.500	1.000
16.00	0.500	1.000
16.00	1.000	1.000
18.00	1.000	1.000
18.00	1.000	1.000
61.00	1.000	1.000
61.00	0.500	1.000
90.00	0.500	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.90 **
7.00	0.152 *	0.90 **
7.00	0.152 *	0.90 **
13.50	0.152 *	0.90 **
13.50	0.152 *	0.00
16.00	0.152 *	0.00
16.00	0.152 *	0.90 **
18.00	0.152 *	0.90 **
18.00	0.152 *	0.90 **
61.00	0.152 *	0.90 **
61.00	0.152 *	0.00
90.00	0.152 *	0.00

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

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* COMPUTATION RESULT *

* FED. HWY. METHOD *

ELEVATION	SKIN FRICTION	END BEARING	ULTIMATE CAPACITY
FT.	KIP	KIP	KIP
776.00	0.0	0.5	0.5
775.00	0.0	0.7	0.7
774.00	1.8	0.9	2.8
773.00	5.5	0.9	6.4
772.00	9.2	1.0	10.1
771.00	12.8	0.9	13.8
770.00	16.5	1.6	18.1
769.00	20.1	2.4	22.5
768.00	23.9	3.1	27.0
767.00	27.7	3.8	31.5
766.00	31.5	3.8	35.3
765.00	35.3	3.8	39.1
764.00	39.1	3.8	42.9
763.00	42.9	4.1	47.0
762.00	44.8	4.5	49.4
761.00	46.5	4.6	51.1
760.00	49.6	4.5	54.2

759.00	58.7	4.1	62.8
758.00	73.7	3.8	77.5
757.00	84.3	3.8	88.1
756.00	90.7	3.8	94.5
755.00	97.0	3.8	100.8
754.00	103.3	3.8	107.1
753.00	109.7	3.8	113.5
752.00	116.0	3.8	119.8
751.00	122.4	3.8	126.2
750.00	128.7	3.8	132.5
749.00	135.1	3.8	138.9
748.00	141.4	3.8	145.2
747.00	147.8	3.8	151.6
746.00	154.1	3.8	157.9
745.00	160.5	3.8	164.3
744.00	166.8	3.8	170.6
743.00	173.2	3.8	177.0
742.00	179.5	3.8	183.3
741.00	185.9	3.8	189.7
740.00	192.2	3.8	196.0
739.00	198.5	3.8	202.3
738.00	204.9	3.8	208.7
737.00	211.2	3.8	215.0
736.00	217.6	3.8	221.4
735.00	223.9	3.8	227.7
734.00	230.3	3.8	234.1
733.00	236.6	3.8	240.4
732.00	243.0	3.8	246.8
731.00	249.3	3.8	253.1
730.00	255.7	3.8	259.5
729.00	262.0	3.8	265.8
728.00	268.4	3.8	272.2
727.00	274.7	3.8	278.5
726.00	281.1	3.8	284.9
725.00	287.4	3.8	291.2
724.00	293.7	3.8	297.5
723.00	300.1	3.8	303.9
722.00	306.4	3.8	310.2
721.00	312.8	3.8	316.6

Recommended Pile Tip El. 730

720.00	319.1	3.8	322.9	Wet granular soil below El. 720
719.00	325.5	3.8	329.3	
718.00	331.8	3.8	335.6	
717.00	338.2	3.8	342.0	
716.00	344.5	4.1	348.7	
715.00	347.7	4.5	352.2	
714.00	351.4	4.9	356.3	
713.00	355.5	5.3	360.8	
712.00	359.8	5.3	365.0	
711.00	364.0	5.3	369.3	
710.00	368.4	5.3	373.6	
709.00	372.8	5.3	378.0	
708.00	377.2	5.3	382.5	
707.00	381.7	5.3	387.0	
706.00	386.2	5.3	391.5	
705.00	390.8	5.3	396.1	
704.00	395.5	5.3	400.8	
703.00	400.2	5.3	405.5	
702.00	405.0	5.3	410.2	
701.00	409.8	5.3	415.1	
700.00	414.7	5.3	419.9	
699.00	419.6	5.3	424.9	
698.00	424.6	5.3	429.8	
697.00	429.6	5.3	434.9	
696.00	434.7	5.3	439.9	

* API RP-2A (2010) *

ELEVATION	SKIN FRICTION	END BEARING	ULTIMATE CAPACITY
FT.	KIP	KIP	KIP
776.00	0.0	0.5	0.5
775.00	1.2	0.7	1.9

774.00	2.5	0.9	3.4
773.00	4.0	0.9	4.9
772.00	5.6	1.0	6.6
771.00	7.3	0.9	8.3
770.00	9.2	1.6	10.8
769.00	11.1	2.4	13.4
768.00	14.9	3.1	18.0
767.00	20.6	3.8	24.4
766.00	26.5	3.8	30.3
765.00	32.6	3.8	36.4
764.00	38.8	3.8	42.6
763.00	45.1	4.4	49.5
762.00	48.4	5.2	53.5
761.00	50.8	5.3	56.1
760.00	54.2	5.2	59.4
759.00	59.4	4.5	63.9
758.00	66.3	3.8	70.1
757.00	73.2	3.8	77.0
756.00	80.2	3.8	84.0
755.00	87.3	3.8	91.1
754.00	94.4	3.8	98.2
753.00	101.6	3.8	105.4
752.00	108.8	3.8	112.6
751.00	116.0	3.8	119.8
750.00	123.3	3.8	127.1
749.00	130.7	3.8	134.5
748.00	138.1	3.8	141.9
747.00	145.5	3.8	149.3
746.00	153.0	3.8	156.8
745.00	160.5	3.8	164.3
744.00	168.0	3.8	171.8
743.00	175.6	3.8	179.4
742.00	183.3	3.8	187.1
741.00	190.9	3.8	194.7
740.00	198.6	3.8	202.4
739.00	206.4	3.8	210.2
738.00	214.2	3.8	218.0
737.00	222.0	3.8	225.8
736.00	229.8	3.8	233.6

735.00	237.7	3.8	241.5
734.00	245.7	3.8	249.5
733.00	253.6	3.8	257.4
732.00	261.7	3.8	265.5
731.00	269.8	3.8	273.6
730.00	278.0	3.8	281.8
729.00	286.3	3.8	290.1
728.00	294.6	3.8	298.4
727.00	303.0	3.8	306.8
726.00	311.5	3.8	315.3
725.00	320.0	3.8	323.8
724.00	328.6	3.8	332.4
723.00	337.2	3.8	341.0
722.00	345.9	3.8	349.7
721.00	354.7	3.8	358.5
720.00	363.5	3.8	367.3
719.00	372.4	3.8	376.2
718.00	381.4	3.8	385.2
717.00	390.4	3.8	394.2
716.00	399.5	6.9	406.4
715.00	404.1	10.3	414.4
714.00	408.2	13.8	422.0
713.00	412.0	16.9	428.9
712.00	415.7	16.9	432.6
711.00	419.4	16.9	436.3
710.00	423.2	16.9	440.0
709.00	426.9	16.9	443.8
708.00	430.6	16.9	447.5
707.00	434.3	16.9	451.2
706.00	438.1	16.9	455.0
705.00	441.8	16.9	458.7
704.00	445.5	16.9	462.4
703.00	449.3	16.9	466.1
702.00	453.0	16.9	469.9
701.00	456.7	16.9	473.6
700.00	460.4	16.9	477.3
699.00	464.2	16.9	481.1
698.00	467.9	16.9	484.8
697.00	471.6	16.9	488.5

696.00

475.4

16.9

492.2

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APILE for Windows, Version 2023.10.5

Serial Number : 506768014

Pier No. 2

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.
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APILE Global, Global License

Path to file locations : E:\Projects\2023\CJ235021\Working Files\Calculations-Analyses\APile HP\
Name of input data file : Pier 2 HP.ap10d
Name of output file : Pier 2 HP.ap10o
Name of plot output file : Pier 2 HP.ap10p

Time and Date of Analysis

Date: November 12, 2024 Time: 13:23:15

1

* INPUT INFORMATION *

PROJECT DESCRIPTION :
Johnson 85- Pier 2
DESIGNER : Terracon
JOB NUMBER : CJ235021

METHOD FOR UNIT LOAD TRANSFERS :
- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :
- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :
- COMPRESSION

PILE TYPE :
H-Pile/Steel Pile

AVERAGE DEPTH TO ESTIMATE TIP RESISTANCE:
- USE 1.5 DIAMETERS ABOVE AND BELOW TIP

DATA FOR AXIAL STIFFNESS :
- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.20 IN2

NONCIRCULAR PILE PROPERTIES :
- TOTAL PILE LENGTH, TL = 70.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.60 IN.
- TIP AREA OF PILE = 15.20 IN2
- INCREMENT OF PILE LENGTH

USED IN COMPUTATION = 1.00 FT.
 - PRINTING INCREMENT = 1

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICITION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
6.50	CLAY	0.80*	130.00	0.00	8.00**	4.80**
6.50	SAND	0.80*	130.00	33.00	32.00**	47.20**
9.00	SAND	0.80*	130.00	33.00	32.00**	47.20**
9.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
11.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
11.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
54.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
54.00	SAND	0.80*	70.00	33.00	32.00**	47.20**
80.00	SAND	0.80*	70.00	33.00	32.00**	47.20**

* VALUE ASSUMED BY THE PROGRAM

** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00

0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO LARGE VALUES INDICATING THAT APILE USES THE LIMITS SPECIFIED BY EACH SELECTED CRITERIA (IF ANY).

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
6.50	1.000	1.000
6.50	1.000	1.000
9.00	1.000	1.000
9.00	1.000	1.000
11.00	1.000	1.000
11.00	1.000	1.000
54.00	1.000	1.000
54.00	1.000	1.000
80.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.90 **
6.50	0.152 *	0.90 **
6.50	0.152 *	0.00
9.00	0.152 *	0.00
9.00	0.152 *	0.90 **
11.00	0.152 *	0.90 **

11.00	0.152 *	0.90 **
54.00	0.152 *	0.90 **
54.00	0.152 *	0.00
80.00	0.152 *	0.00

* DEFAULT VALUE = 0.01 D

** DEFAULT VALUE = 0.9

1

 * COMPUTATION RESULT *

 * FED. HWY. METHOD *

ELEVATION	SKIN	END	ULTIMATE
FT.	FRICTION	BEARING	CAPACITY
	KIP	KIP	KIP
769.00	0.0	1.9	1.9
768.00	0.0	2.9	2.9
767.00	1.9	3.8	5.7
766.00	5.7	3.8	9.5
765.00	9.4	3.8	13.2
764.00	13.2	3.8	17.0
763.00	17.0	3.6	20.6
762.00	20.8	3.6	24.3
761.00	23.5	3.6	27.0
760.00	25.1	3.6	28.7

759.00	34.0	3.7	37.7
758.00	49.8	3.8	53.6
757.00	60.9	3.8	64.7
756.00	67.3	3.8	71.1
755.00	73.6	3.8	77.4
754.00	80.0	3.8	83.8
753.00	86.3	3.8	90.1
752.00	92.7	3.8	96.5
751.00	99.0	3.8	102.8
750.00	105.4	3.8	109.2
749.00	111.7	3.8	115.5
748.00	118.1	3.8	121.9
747.00	124.4	3.8	128.2
746.00	130.8	3.8	134.6
745.00	137.1	3.8	140.9
744.00	143.5	3.8	147.3
743.00	149.8	3.8	153.6
742.00	156.1	3.8	159.9
741.00	162.5	3.8	166.3
740.00	168.8	3.8	172.6
739.00	175.2	3.8	179.0
738.00	181.5	3.8	185.3
737.00	187.9	3.8	191.7
736.00	194.2	3.8	198.0
735.00	200.6	3.8	204.4
734.00	206.9	3.8	210.7
733.00	213.3	3.8	217.1
732.00	219.6	3.8	223.4
731.00	226.0	3.8	229.8
730.00	232.3	3.8	236.1
729.00	238.7	3.8	242.5
728.00	245.0	3.8	248.8
727.00	251.3	3.8	255.1
726.00	257.7	3.8	261.5
725.00	264.0	3.8	267.8
724.00	270.4	3.8	274.2

Recommended Pile Tip El. 730

723.00	276.7	3.8	280.5
722.00	283.1	3.8	286.9
721.00	289.4	3.8	293.2
720.00	295.8	3.8	299.6
719.00	302.1	3.8	305.9
718.00	308.5	3.8	312.3
717.00	314.8	3.8	318.6
716.00	321.2	4.1	325.3
715.00	327.5	4.5	332.0
714.00	334.1	4.9	339.1
713.00	341.1	5.3	346.4
712.00	348.1	5.3	353.4
711.00	355.3	5.3	360.6
710.00	362.6	5.3	367.9
709.00	370.0	5.3	375.3
708.00	377.5	5.3	382.7
707.00	385.1	5.3	390.3
706.00	392.8	5.3	398.0
705.00	400.6	5.3	405.9
704.00	408.5	5.3	413.8
703.00	416.5	5.3	421.8
702.00	424.7	5.3	429.9
701.00	432.9	5.3	438.2
700.00	441.2	5.3	446.5
699.00	449.7	5.3	455.0

Wet granular soil below El. 720

* API RP-2A (2010) *

ELEVATION	SKIN FRICTION	END BEARING	ULTIMATE CAPACITY
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FT.	KIP	KIP	KIP
769.00	0.0	1.9	1.9
768.00	3.4	2.9	6.3
767.00	7.1	3.8	10.9
766.00	11.3	3.8	15.1
765.00	15.9	3.8	19.7
764.00	20.8	3.8	24.6
763.00	25.9	3.7	29.6
762.00	31.3	3.6	34.9
761.00	34.9	3.6	38.6
760.00	36.8	3.7	40.5
759.00	40.8	3.8	44.6
758.00	46.8	3.8	50.6
757.00	53.0	3.8	56.8
756.00	59.2	3.8	63.0
755.00	65.6	3.8	69.4
754.00	71.9	3.8	75.7
753.00	78.4	3.8	82.2
752.00	84.9	3.8	88.7
751.00	91.5	3.8	95.3
750.00	98.1	3.8	101.9
749.00	104.8	3.8	108.6
748.00	111.5	3.8	115.3
747.00	118.3	3.8	122.1
746.00	125.2	3.8	129.0
745.00	132.1	3.8	135.9
744.00	139.1	3.8	142.9
743.00	146.1	3.8	149.9
742.00	153.2	3.8	157.0
741.00	160.3	3.8	164.1
740.00	167.4	3.8	171.2
739.00	174.6	3.8	178.4
738.00	181.9	3.8	185.7
737.00	189.2	3.8	193.0
736.00	196.5	3.8	200.3
735.00	203.9	3.8	207.7

734.00	211.4	3.8	215.2
733.00	218.8	3.8	222.6
732.00	226.3	3.8	230.1
731.00	233.9	3.8	237.7
730.00	241.5	3.8	245.3
729.00	249.1	3.8	252.9
728.00	256.8	3.8	260.6
727.00	264.5	3.8	268.3
726.00	272.2	3.8	276.0
725.00	280.0	3.8	283.8
724.00	287.8	3.8	291.6
723.00	295.7	3.8	299.5
722.00	303.6	3.8	307.4
721.00	311.5	3.8	315.3
720.00	319.5	3.8	323.3
719.00	327.6	3.8	331.4
718.00	335.7	3.8	339.5
717.00	343.9	3.8	347.7
716.00	352.1	6.5	358.6
715.00	360.5	9.5	370.0
714.00	368.4	12.6	381.0
713.00	375.8	15.5	391.3
712.00	383.3	15.7	399.0
711.00	390.7	15.9	406.7
710.00	398.2	16.2	414.4
709.00	405.6	16.4	422.1
708.00	413.1	16.6	429.7
707.00	420.6	16.8	437.3
706.00	428.0	16.9	444.9
705.00	435.5	16.9	452.4
704.00	442.9	16.9	459.8
703.00	450.4	16.9	467.3
702.00	457.8	16.9	474.7
701.00	465.3	16.9	482.2
700.00	472.8	16.9	489.7
699.00	480.2	16.9	497.1

=====

APILE for Windows, Version 2023.10.5

Serial Number : 506768014

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.
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APILE Global, Global License

Pier No. 3

Path to file locations : E:\Projects\2023\CJ235021\Working Files\Calculations-Analyses\APile HP\
Name of input data file : Pier 3 HP.ap10d
Name of output file : Pier 3 HP.ap10o
Name of plot output file : Pier 3 HP.ap10p

Time and Date of Analysis

Date: November 12, 2024 Time: 13:31:23

1

* INPUT INFORMATION *

PROJECT DESCRIPTION :

Johnson 85 - Pier 3

DESIGNER : Terracon

JOB NUMBER : CJ235021

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

AVERAGE DEPTH TO ESTIMATE TIP RESISTANCE:

- USE 1.5 DIAMETERS ABOVE AND BELOW TIP

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.20 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 70.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.60 IN.
- TIP AREA OF PILE = 15.20 IN2
- INCREMENT OF PILE LENGTH

USED IN COMPUTATION = 1.00 FT.
 - PRINTING INCREMENT = 1

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICITION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
11.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
11.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
51.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
51.00	SAND	0.80*	70.00	33.00	32.00**	47.20**
80.00	SAND	0.80*	70.00	33.00	32.00**	47.20**

* VALUE ASSUMED BY THE PROGRAM

** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
 WERE SET TO LARGE VALUES INDICATING THAT APILE
 USES THE LIMITS SPECIFIED BY EACH SELECTED
 CRITERIA (IF ANY).

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
0.00	1.000	1.000
0.00	1.000	1.000
11.00	1.000	1.000
11.00	1.000	1.000
51.00	1.000	1.000
51.00	0.500	1.000
80.00	0.500	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.90 **
0.00	0.152 *	0.90 **
0.00	0.152 *	0.90 **
11.00	0.152 *	0.90 **
11.00	0.152 *	0.90 **
51.00	0.152 *	0.90 **
51.00	0.152 *	0.00
80.00	0.152 *	0.00

* DEFAULT VALUE = 0.01 D

** DEFAULT VALUE = 0.9

* COMPUTATION RESULT *

* FED. HWY. METHOD *

ELEVATION	SKIN	END	ULTIMATE
FT.	FRICTION	BEARING	CAPACITY
	KIP	KIP	KIP
769.00	0.0	1.9	1.9
768.00	0.0	2.9	2.9
767.00	1.9	3.8	5.7
766.00	5.7	3.8	9.5
765.00	9.4	3.8	13.2
764.00	13.2	3.8	17.0
763.00	17.0	3.8	20.8
762.00	20.8	3.8	24.6
761.00	24.5	3.8	28.3
760.00	28.3	3.8	32.1
759.00	32.1	4.0	36.1
758.00	35.9	4.3	40.1
757.00	40.7	4.5	45.3
756.00	46.7	4.8	51.4
755.00	52.6	4.7	57.3
754.00	58.5	4.8	63.3
753.00	64.4	4.8	69.2
752.00	70.4	4.8	75.1

751.00	76.3	4.8	81.1
750.00	82.2	4.8	87.0
749.00	88.2	4.8	92.9
748.00	94.1	4.8	98.8
747.00	100.0	4.8	104.8
746.00	106.0	4.8	110.7
745.00	111.9	4.8	116.6
744.00	117.8	4.8	122.6
743.00	123.7	4.8	128.5
742.00	129.7	4.8	134.4
741.00	135.6	4.8	140.4
740.00	141.5	4.8	146.3
739.00	147.5	4.8	152.2
738.00	153.4	4.7	158.2
737.00	159.3	4.7	164.1
736.00	165.3	4.7	170.0
735.00	171.2	4.7	175.9
734.00	177.1	4.7	181.9
733.00	183.1	4.7	187.8
732.00	189.0	4.7	193.7
731.00	194.9	4.7	199.7
730.00	200.8	4.7	205.6
729.00	206.8	4.7	211.5
728.00	212.7	4.7	217.5
727.00	218.6	4.7	223.4
726.00	224.6	4.7	229.3
725.00	230.5	4.7	235.2
724.00	236.4	4.7	241.2
723.00	242.4	4.7	247.1
722.00	248.3	4.7	253.0
721.00	254.2	4.7	259.0
720.00	260.1	4.7	264.9
719.00	266.1	4.9	270.9
718.00	269.0	5.0	274.1
717.00	272.2	5.2	277.3
716.00	275.5	5.3	280.8

Recommended Pile Tip El. 730

Wet granular soil below El. 720

715.00	278.9	5.3	284.1
714.00	282.3	5.3	287.6
713.00	285.8	5.3	291.0
712.00	289.3	5.3	294.6
711.00	292.9	5.3	298.1
710.00	296.5	5.3	301.8
709.00	300.2	5.3	305.5
708.00	303.9	5.3	309.2
707.00	307.7	5.3	313.0
706.00	311.6	5.3	316.9
705.00	315.5	5.3	320.8
704.00	319.5	5.3	324.7
703.00	323.5	5.3	328.8
702.00	327.5	5.3	332.8
701.00	331.7	5.3	336.9
700.00	335.8	5.3	341.1
699.00	340.1	5.3	345.3

* API RP-2A (2010) *

ELEVATION	SKIN	END	ULTIMATE
FT.	FRICTION	BEARING	CAPACITY
	KIP	KIP	KIP
769.00	0.0	1.9	1.9
768.00	3.4	2.9	6.3
767.00	7.1	3.8	10.9
766.00	11.3	3.8	15.1
765.00	15.9	3.8	19.7
764.00	20.8	3.8	24.6
763.00	25.9	3.8	29.7

762.00	31.3	3.8	35.1
761.00	36.9	3.8	40.7
760.00	42.6	3.8	46.4
759.00	48.5	4.0	52.6
758.00	54.6	4.3	58.9
757.00	61.3	4.5	65.9
756.00	68.7	4.8	73.5
755.00	76.2	4.7	80.9
754.00	83.7	4.8	88.5
753.00	91.3	4.8	96.1
752.00	99.0	4.8	103.8
751.00	106.8	4.8	111.6
750.00	114.7	4.8	119.4
749.00	122.6	4.8	127.3
748.00	130.5	4.8	135.3
747.00	138.6	4.8	143.3
746.00	146.7	4.8	151.4
745.00	154.9	4.8	159.6
744.00	163.1	4.8	167.9
743.00	171.4	4.8	176.1
742.00	179.7	4.8	184.5
741.00	188.2	4.8	192.9
740.00	196.6	4.8	201.4
739.00	205.1	4.8	209.9
738.00	213.7	4.7	218.5
737.00	222.3	4.7	227.1
736.00	231.0	4.7	235.8
735.00	239.8	4.7	244.5
734.00	248.5	4.7	253.3
733.00	257.4	4.7	262.1
732.00	266.2	4.7	271.0
731.00	275.2	4.7	279.9
730.00	284.1	4.7	288.9
729.00	293.2	4.7	297.9
728.00	302.2	4.7	307.0
727.00	311.3	4.7	316.1

726.00	320.5	4.7	325.3
725.00	329.7	4.7	334.5
724.00	339.0	4.7	343.7
723.00	348.2	4.7	353.0
722.00	357.6	4.7	362.3
721.00	366.9	4.7	371.7
720.00	376.3	4.7	381.1
719.00	385.8	7.0	392.8
718.00	390.5	9.6	400.2
717.00	394.7	12.3	407.0
716.00	398.4	14.8	413.2
715.00	402.1	15.0	417.1
714.00	405.8	15.2	421.1
713.00	409.6	15.5	425.0
712.00	413.3	15.7	429.0
711.00	417.0	15.9	433.0
710.00	420.7	16.2	436.9
709.00	424.5	16.4	440.9
708.00	428.2	16.6	444.8
707.00	431.9	16.8	448.7
706.00	435.7	16.9	452.5
705.00	439.4	16.9	456.3
704.00	443.1	16.9	460.0
703.00	446.8	16.9	463.7
702.00	450.6	16.9	467.5
701.00	454.3	16.9	471.2
700.00	458.0	16.9	474.9
699.00	461.8	16.9	478.6

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APILE for Windows, Version 2023.10.5

Serial Number : 506768014

A Program for Analyzing the Axial Capacity
and Short-term Settlement of Driven Piles
under Axial Loading.
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This program is licensed to :

Bent No. 4

Terracon, Inc.
APILE Global, Global License

Path to file locations : E:\Projects\2023\CJ235021\Working Files\Calculations-Analyses\APile HP\
Name of input data file : Bent 4 HP.ap10d
Name of output file : Bent 4 HP.ap10o
Name of plot output file : Bent 4 HP.ap10p

Time and Date of Analysis

Date: November 12, 2024 Time: 13:43:52

1

* INPUT INFORMATION *

PROJECT DESCRIPTION :

Johnson 85 - Bent 4

DESIGNER : Terracon

JOB NUMBER : CJ235021

METHOD FOR UNIT LOAD TRANSFERS :

- FHWA (Federal Highway Administration)
Unfactored Unit Side Friction and Unit Side Resistance are used.

COMPUTATION METHOD(S) FOR PILE CAPACITY :

- FHWA (Federal Highway Administration)
- API RP 2A (American Petroleum Institute)

TYPE OF LOADING :

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

AVERAGE DEPTH TO ESTIMATE TIP RESISTANCE:

- USE 1.5 DIAMETERS ABOVE AND BELOW TIP

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.20 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 80.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.60 IN.
- TIP AREA OF PILE = 15.20 IN2
- INCREMENT OF PILE LENGTH

USED IN COMPUTATION = 1.00 FT.
 - PRINTING INCREMENT = 1

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICITION ANGLE DEGREES	BEARING CAPACITY FACTOR	Nq FACTOR FHWA
0.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
7.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
7.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
18.00	CLAY	0.80*	130.00	0.00	8.00**	4.80**
18.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
58.00	CLAY	0.80*	70.00	0.00	8.00**	4.80**
58.00	SAND	0.80*	70.00	33.00	32.00**	47.20**
86.00	SAND	0.80*	70.00	33.00	32.00**	47.20**

* VALUE ASSUMED BY THE PROGRAM

** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	1.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	4.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	5.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
 WERE SET TO LARGE VALUES INDICATING THAT APILE
 USES THE LIMITS SPECIFIED BY EACH SELECTED
 CRITERIA (IF ANY).

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
7.00	1.000	1.000
7.00	1.000	1.000
18.00	1.000	1.000
18.00	1.000	1.000
58.00	1.000	1.000
58.00	1.000	1.000
86.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.90 **
7.00	0.152 *	0.90 **
7.00	0.152 *	0.90 **
18.00	0.152 *	0.90 **
18.00	0.152 *	0.90 **
58.00	0.152 *	0.90 **
58.00	0.152 *	0.00
86.00	0.152 *	0.00

* DEFAULT VALUE = 0.01 D

** DEFAULT VALUE = 0.9

* COMPUTATION RESULT *

* FED. HWY. METHOD *

ELEVATION	SKIN	END	ULTIMATE
FT.	FRICTION	BEARING	CAPACITY
	KIP	KIP	KIP
776.00	0.0	0.5	0.5
775.00	0.0	0.7	0.7
774.00	1.8	0.9	2.8
773.00	5.5	0.9	6.4
772.00	9.2	1.0	10.1
771.00	12.8	0.9	13.8
770.00	16.5	1.6	18.1
769.00	20.1	2.4	22.5
768.00	23.9	3.1	27.1
767.00	27.9	3.8	31.7
766.00	31.8	3.8	35.6
765.00	35.8	3.8	39.6
764.00	39.7	3.8	43.5
763.00	43.7	3.8	47.5
762.00	47.6	3.8	51.4
761.00	51.6	3.8	55.4
760.00	55.5	3.8	59.3
759.00	59.5	4.0	63.5

758.00	63.4	4.3	67.7
757.00	68.4	4.5	72.9
756.00	74.3	4.8	79.1
755.00	80.2	4.8	85.0
754.00	86.2	4.8	90.9
753.00	92.1	4.8	96.8
752.00	98.0	4.8	102.8
751.00	104.0	4.8	108.7
750.00	109.9	4.8	114.6
749.00	115.8	4.8	120.6
748.00	121.7	4.8	126.5
747.00	127.7	4.8	132.4
746.00	133.6	4.8	138.4
745.00	139.5	4.8	144.3
744.00	145.5	4.8	150.2
743.00	151.4	4.7	156.1
742.00	157.3	4.7	162.1
741.00	163.3	4.7	168.0
740.00	169.2	4.7	173.9
739.00	175.1	4.7	179.9
738.00	181.1	4.7	185.8
737.00	187.0	4.7	191.7
736.00	192.9	4.7	197.7
735.00	198.8	4.7	203.6
734.00	204.8	4.7	209.5
733.00	210.7	4.7	215.5
732.00	216.6	4.7	221.4
731.00	222.6	4.7	227.3
730.00	228.5	4.7	233.2
729.00	234.4	4.7	239.2
728.00	240.4	4.7	245.1
727.00	246.3	4.7	251.0
726.00	252.2	4.7	257.0
725.00	258.1	4.7	262.9
724.00	264.1	4.7	268.8
723.00	270.0	4.7	274.8

Recommended Pile Tip El. 730

722.00	275.9	4.7	280.7
721.00	281.9	4.7	286.6
720.00	287.8	4.7	292.5
719.00	293.7	4.9	298.6
718.00	299.7	5.0	304.7
717.00	306.6	5.2	311.8
716.00	314.6	5.3	319.9
715.00	322.8	5.3	328.0
714.00	331.0	5.3	336.3
713.00	339.4	5.3	344.6
712.00	347.8	5.3	353.1
711.00	356.4	5.3	361.6
710.00	365.0	5.3	370.3
709.00	373.8	5.3	379.1
708.00	382.7	5.3	388.0
707.00	391.7	5.3	397.0
706.00	400.8	5.3	406.1
705.00	410.0	5.3	415.3
704.00	419.3	5.3	424.6
703.00	428.7	5.3	434.0
702.00	438.2	5.3	443.5
701.00	447.9	5.3	453.1
700.00	457.6	5.3	462.9
699.00	467.5	5.3	472.7
698.00	477.4	5.3	482.7
697.00	487.5	5.3	492.7
696.00	497.6	5.3	502.9

Wet granular soil below El. 720

* API RP-2A (2010) *

ELEVATION	SKIN	END	ULTIMATE
FT.	FRICTION	BEARING	CAPACITY
	KIP	KIP	KIP
776.00	0.0	0.5	0.5
775.00	1.2	0.7	1.9
774.00	2.5	0.9	3.4
773.00	4.0	0.9	4.9
772.00	5.6	1.0	6.6
771.00	7.3	0.9	8.3
770.00	9.2	1.6	10.8
769.00	11.1	2.4	13.4
768.00	14.9	3.1	18.0
767.00	20.6	3.8	24.4
766.00	26.5	3.8	30.3
765.00	32.6	3.8	36.4
764.00	38.8	3.8	42.6
763.00	45.1	3.8	48.9
762.00	51.6	3.8	55.4
761.00	58.2	3.8	62.0
760.00	64.8	3.8	68.6
759.00	71.6	4.0	75.7
758.00	78.5	4.3	82.8
757.00	86.1	4.5	90.6
756.00	94.4	4.8	99.2
755.00	102.8	4.8	107.5
754.00	111.2	4.8	115.9
753.00	119.6	4.8	124.4
752.00	128.2	4.8	132.9
751.00	136.7	4.8	141.5
750.00	145.4	4.8	150.1
749.00	154.0	4.8	158.8
748.00	162.8	4.8	167.5
747.00	171.5	4.8	176.3
746.00	180.4	4.8	185.1
745.00	189.3	4.8	194.0
744.00	198.2	4.8	202.9

743.00	207.2	4.7	211.9
742.00	216.2	4.7	220.9
741.00	225.3	4.7	230.0
740.00	234.4	4.7	239.1
739.00	243.5	4.7	248.3
738.00	252.7	4.7	257.5
737.00	262.0	4.7	266.7
736.00	271.3	4.7	276.0
735.00	280.6	4.7	285.3
734.00	289.9	4.7	294.7
733.00	299.4	4.7	304.1
732.00	308.8	4.7	313.6
731.00	318.3	4.7	323.1
730.00	327.8	4.7	332.6
729.00	337.4	4.7	342.2
728.00	347.0	4.7	351.8
727.00	356.7	4.7	361.4
726.00	366.3	4.7	371.1
725.00	376.1	4.7	380.8
724.00	385.8	4.7	390.6
723.00	395.6	4.7	400.4
722.00	405.4	4.7	410.2
721.00	415.3	4.7	420.0
720.00	425.2	4.7	429.9
719.00	435.1	7.6	442.8
718.00	445.2	10.8	456.0
717.00	453.9	14.0	467.9
716.00	461.4	16.9	478.3
715.00	468.8	16.9	485.7
714.00	476.3	16.9	493.2
713.00	483.8	16.9	500.6
712.00	491.2	16.9	508.1
711.00	498.7	16.9	515.6
710.00	506.1	16.9	523.0
709.00	513.6	16.9	530.5
708.00	521.0	16.9	537.9

707.00	528.5	16.9	545.4
706.00	536.0	16.9	552.8
705.00	543.4	16.9	560.3
704.00	550.9	16.9	567.8
703.00	558.3	16.9	575.2
702.00	565.8	16.9	582.7
701.00	573.2	16.9	590.1
700.00	580.7	16.9	597.6
699.00	588.2	16.9	605.0
698.00	595.6	16.9	612.5
697.00	603.1	16.9	620.0
696.00	610.5	16.9	627.4

Bearing Resistance Analysis

Project Number: CJ235021

Date: 11/13/2024

(AASHTO LRFD, 9th Edition)

Boring Numbers: CB-1, CB-2

Project Name: Whiteland Road Structure Replacements

Bearing Soil: A-4 Cohesive Soil

Location: Johnson County, Indiana

Footing Elevation: 768

N-Value: 44 to 50+ bpf

Comments:

Soil Parameters

Cohesion (C) = **4500** psf **4.500** ksf
 Friction Angle (ϕ_f) = degrees
 Unit Weight Above Footing (γ_q) = **130** pcf **0.130** kcf
 Unit Weight Below Footing (γ_f) = **130** pcf **0.130** kcf
 Groundwater Depth (D_w) = **0** ft
 Bearing Resistance Factor (ϕ_b) = **0.45**

Punching Shear:**Select**

$c^* = 0.67c$ (ksf) $c^* = 4.50$
 $\phi_f^* = \tan^{-1}(0.67 \tan \phi_f)$ $\phi_f^* = 0$

Depth Factor Applicable:**No** $32^\circ \leq \phi_f \leq 42^\circ$ No $1 \leq D_f/B \leq 8$ Yes**Footing Parameters**

Length (L) = **25** ft
 Width (B) = **3** ft
 Depth of Footing (D_f) = **4** ft

Calculations

$N_{cm} = N_c s_c$		$N_{cm} = 5.263$
		$N_c = 5.14$
$\phi_f = 0$	$s_c = 1 + \left(\frac{B}{5L}\right)$	$s_c = 1.024$
$\phi_f > 0$	$s_c = 1 + \left(\frac{B}{L}\right) \left(\frac{N_q}{N_c}\right)$	
$N_{qm} = N_q s_q d_q$		$N_{qm} = 1.000$
		$N_q = 1$
$\phi_f = 0$	$s_q = 1$	$s_q = 1.000$
$\phi_f > 0$	$s_q = 1 + \left(\frac{B}{L} \tan \phi_f\right)$	
$d_q = 1 + 2 \tan \phi_f (1 - \sin \phi_f)^2 \arctan\left(\frac{D_f}{B}\right)$		$d_q = 1.000$
$N_{ym} = N_\gamma s_\gamma$		$N_{ym} = 0.000$
		$N_\gamma = 0$
$\phi_f = 0$	$s_\gamma = 1$	$s_\gamma = 1.000$
$\phi_f > 0$	$s_\gamma = 1 - 0.4 \left(\frac{B}{L}\right)$	
$0 \leq D_w \leq D_f$	$c_{wq} = \frac{0.5 D_w}{D_f} + 0.5$	$C_{wq} = 0.50$
$D_w > D_f$	$C_{wq} = 1$	
$D_w < D_f$	$C_{w\gamma} = 0.5$	$C_{w\gamma} = 0.50$
$D_f \leq D_w \leq 1.5B + D_f$	$c_{w\gamma} = \frac{0.5(D_w - D_f)}{1.5B} + 0.5$	
$D_w > 1.5B + D_f$	$C_{w\gamma} = 1$	
$q_n = c N_{cm} + \gamma_q D_f N_{qm} C_{wq} + 0.5 \gamma_f B N_{ym} C_{w\gamma}$		$q_n = 23.95$ kcf

Results

Nominal Resistance (q_n)* **23.95 ksf** **23,945 psf**
Factored Resistance (qR)* **10.78 ksf** **10,775 psf**

*Factored Resistance is limited to 8,000 psf, and Nominal Resistance to 17,700 psf