2021 Geotechnical Conference
Geotechnical Design & Consultant Agreements

Min Sang Lee, P.E.
Mir Zaheer, P.E.
Division of Geotechnical Engineering
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2020 OCC, Cost Estimate Submittal Format

- Appendix A includes definition of each item in Appendix D.
- The CONSULTANT will be paid for the hourly rate services described in Appendix "A" Items 1d., 1e, 36 d., 65 through 73, 76, 78, 80 and, 83 thru 87 and 102 on an hourly rate basis. (described in Section 3, Appendix D)
- For the services of Item Nos. ~~15, 16.a.ii, 32, 35, and 37~~ 36, the Geotechnical CONSULTANT needs to obtain at least three (3) cost estimates before selecting the lowest bidder to perform the work.
- Classification of employment and Base hourly rate are as shown in Section 3, Appendix D.
- 2020 OCC Cost Estimate Submittal Format.xlsx

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Project Team Hours – Cost Estimates Table

Item numbers

Tasks (based on App. A)

Employment Classification

		PROJECT TEAM HOURS										
			Engineering Staff			Non-Engineering Staff			Geophysicist			CADD	Admin Staff
	Appendix "A"	Designation/Classification											
	Items	Tasks/Base Hourly Rate ($)											
Geotechnical Field	1d	Marking test borings and pavement core locations (Boring/coring layout)											
		Field checks, coordinationg the field work with utilities and sub contractors											
		Obtaining required permits											
	1e	Coordination with Property owners											
		Crop damage											
Traffic Control	36d	Coordinating field work with Traffic control sub-contractor											
Geotechnical Report, Final Check Print and Foundation Review	65	Review of Historical Documents & Current Plans											
		Prepare Exploratory Program, Review and Concurrence with INDOT											
		Assign Laboratory Tests											
		Prepare gINT boring Logs											
		Review Boring Logs and Lab test data (QC/QA)											
		Prepare Roadway subsurface Profiles											
		Prepare Bridge subsurface profiles											
		Preparation of geotechnical recommendations, report, appendices and concurrance with INDOT.											
		a. Without Soil Subgrade Investigations.											
		b. With Soil Subgrade Recommendations.											
		c. Soil Subgrade Recommendations (ONLY).											
		d. Soil Profile Drawing											
		e. Development of Uniques Special Provisions.											
		Foundation review											
		Final Check Prints											
	66	Geotechnical Data Report & Technical memoranda for DB, DBBV & PPP projects											
	67	Settlement Analysis And Recomendations For Embankment											

Project Team Hours – Cost Estimates Table

		PROJECT TEAM HOURS
	Appendix "A"	Designation/Classification
	Items	Tasks/Base Hourly Rate ($)
Geotechnical Field	1d	Marking test borings and pavement core locations (Boring/coring layout)
		Field checks, coordinationg the field work with utilities and sub contractors
		Obtaining required permits
	1e	Coordination with Property owners
		Crop damage
		sub-contractor
		Plans
		Concurrence with INDOT
		QA)
		s, report, appendices and concurrance with

d. FIELD COORDINATION

This work shall consist of marking test borings and pavement core locations in the field, required field checks, coordinating the field work with utilities and subcontractors, obtaining required permits other than railroad permits. Tasks for this item will be paid in accordance with the hourly rate schedule included in Section 3 of Appendix D and as defined in Section 4 of Appendix D for non-salary costs.

Project Team Hours – Cost Estimates Table

- Item 65, Geotechnical Report

Geotechnical Report, Final Check Print and Foundation Review	**65**	Review of Historical Documents & Current Plans	
		Prepare Exploratory Program, Review and Concurrence with INDOT	
		Assign Laboratory Tests	
		Prepare gINT boring Logs	
		Review Boring Logs and Lab test data (QC/QA)	
		Prepare Roadway subsurface Profiles	
		Prepare Bridge subsurface profiles	
		Preparation of geotechnical recommendations, report, appendices and concurrance with INDOT.	
		a. Without Soil Subgrade Investigations.	
		b. With Soil Subgrade Recommendations.	
		c. Soil Subgrade Recommendations (ONLY).	
		d. Soil Profile Drawing	
		e. Development of Uniques Special Provisions.	
		Foundation review	
		Final Check Prints	
	66	Geotechnical Data Report & Technical memoranda for DB, DBBV & PPP projects	

Project Team Hours – Cost Estimates Table

- Items 67 through 73, Geotechnical Analysis

Geotechnical Analysis	**67**	Settlement Analysis And Recomendations For Embankment		
		a. Proposed Embankment		
		b. Proposed and Existing Embankment.		
	68	Ground Modification Design		
	69	Slope Stability Analysis		
	70	Bridge Foundation Analysis And Recommendations		
		a. Spread foundation		
		b. Deep foundation		
		c. Settlement analysis for bridge pier foundation (i, ii, iii)		
		d. Foundation on Bedrock		
	71	Retaining Structure Analysis And Recommendations		
		a. Conventional Retaining Structure		
		i. Spread Foundation		
		ii. Deep Foundation		
		iii. Settlement Analysis For Retaining Wall Foundations		
		b. Pile Retaining Structure Analysis And Recommendations		
		i. Free Standing Structure		
		ii. Retaining Structure With Tie-Back System		
		c. Drilled-In-Pier Retaining Structure Analysis		
		i. Free-Standing Structure		
		ii. Retaining Structure With Tie-Back System		
		d. Soil Nailing Wall		
	72	Seepage Analysis		
	73	Deep Dynamic Compaction Analysis		

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- For other items
  - Construction Inspection & Monitoring (items 76, 78, 80, and 83)
  - Foundation Evaluation by Non-Destructive Methods (item 84)
  - Geophysical Investigations (item 85)
  - Geotechnical Project Management (For Lead Geotechnical Consultant Only), (items 86 and 87)
  - Pavement Investigation (item 102)

- Cost Estimate shall be submitted to Geotechnical Project Engineer for review, negotiation and approval.
- We will not pay more than approved Manhour cost estimate, unless there is a change in project scope.
- On Call Contracts are not Time and Materials Contracts.

Geotechnical Design Updates
&
Upcoming Changes

"Geotechnical design is not complete until construction is successfully completed"

Geotechnical Consultants Role:

The role and responsibility of engineers if they are performing geotechnical investigations and developing Geotechnical Recommendations is to:

- Review and understand the scope of the project and the geotechnical needs.
- Perform the investigation and analyses consistent with owner requirements and/or industry standards (e.g., AASHTO, FHWA, GDM, IDM, etc.).
- Develop recommendations, and designs and specifications necessary to implement recommendations.
- Verify that recommendations, designs and specifications, have been properly included in the plans and contracts.
- Perform and document QC and QA reviews of the Geotech Reports

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Driven Piles Design For Downdrag - AASHTO

AASHTO: 10.7.1.6.2 & 10.7.3.7

- Where piles are driven to end bearing on a dense stratum or rock and the design of the pile is structurally controlled, downdrag shall be considered at the strength and extreme limit states.
- For friction piles that can experience settlement at the pile tip, downdrag shall be considered at the service, strength and extreme limit states.
- Estimate pile and pile group settlement according to Article 10.7.2.
- The nominal pile resistance available to support structure loads plus downdrag shall be estimated by considering only the positive side and tip resistance below the lowest layer contributing to downdrag computed as specified in Article 3.11.8.
- The AASHTO approach has generally been conservative in practice as there have been relatively few transportation structures where drag forces have been problematic and corrective action required.

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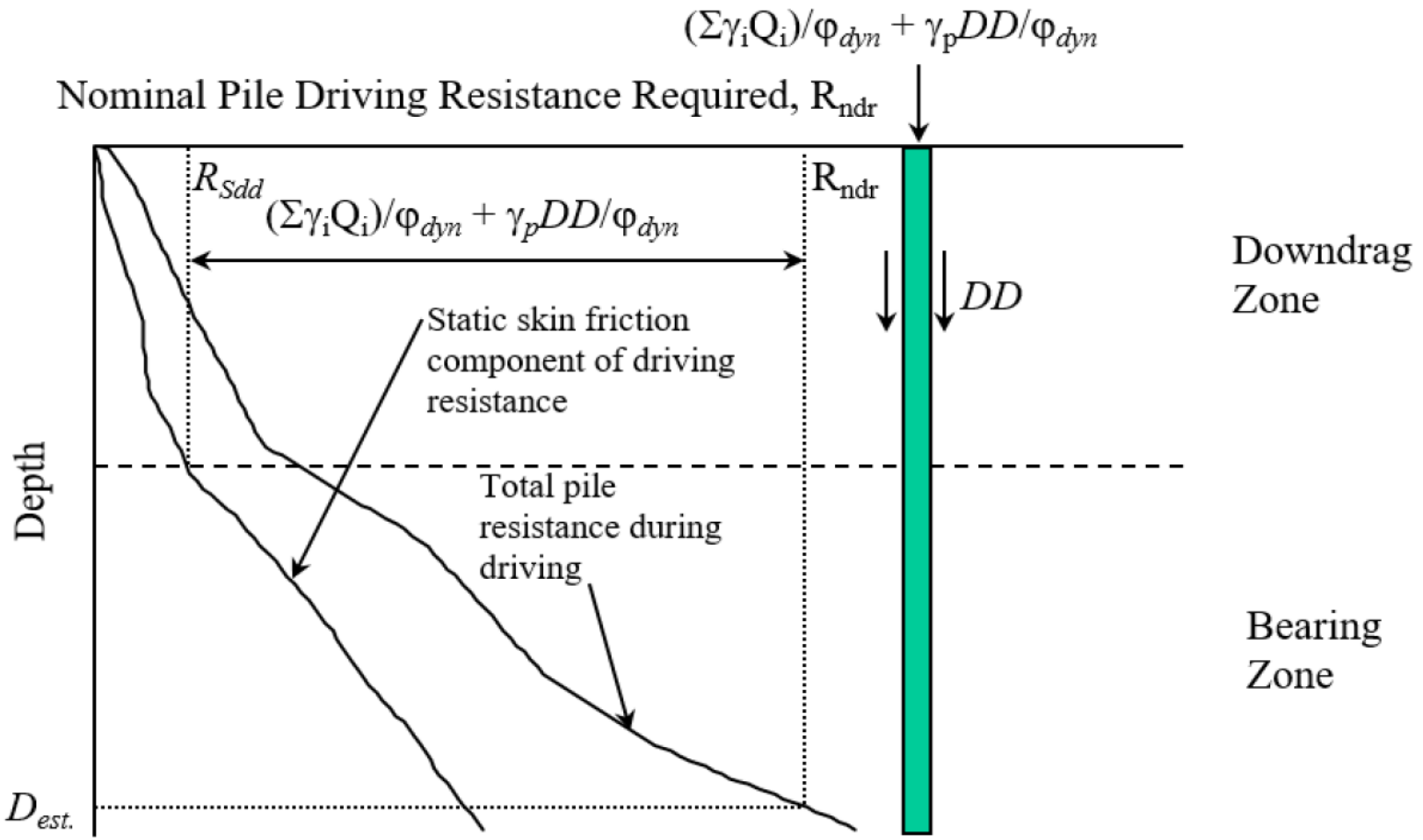
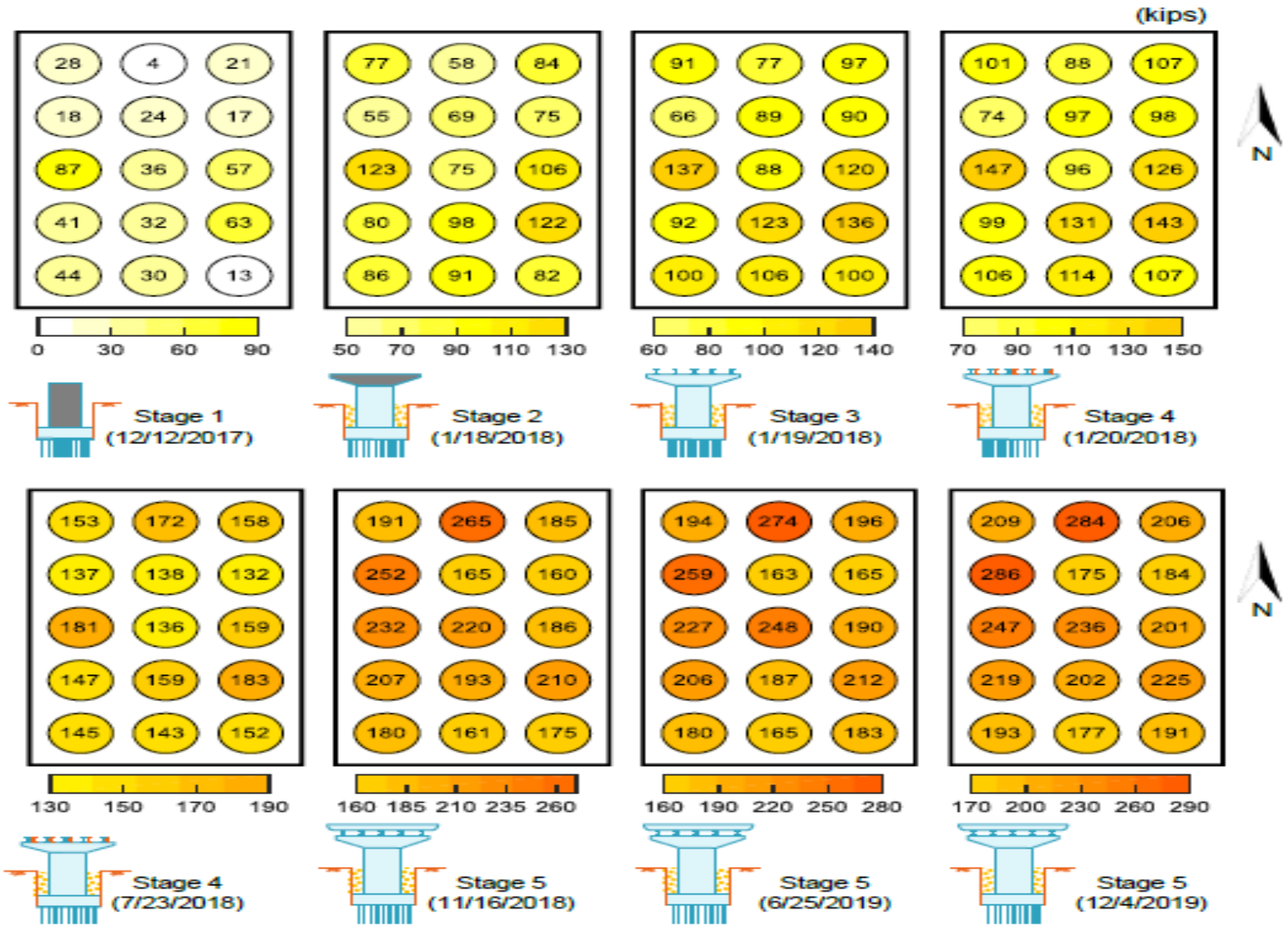
AASHTO 10.7.3.7 Downdrag Concept



SPR-4165 Research Output



Distribution of Dead Loads among piles at various construction Stages

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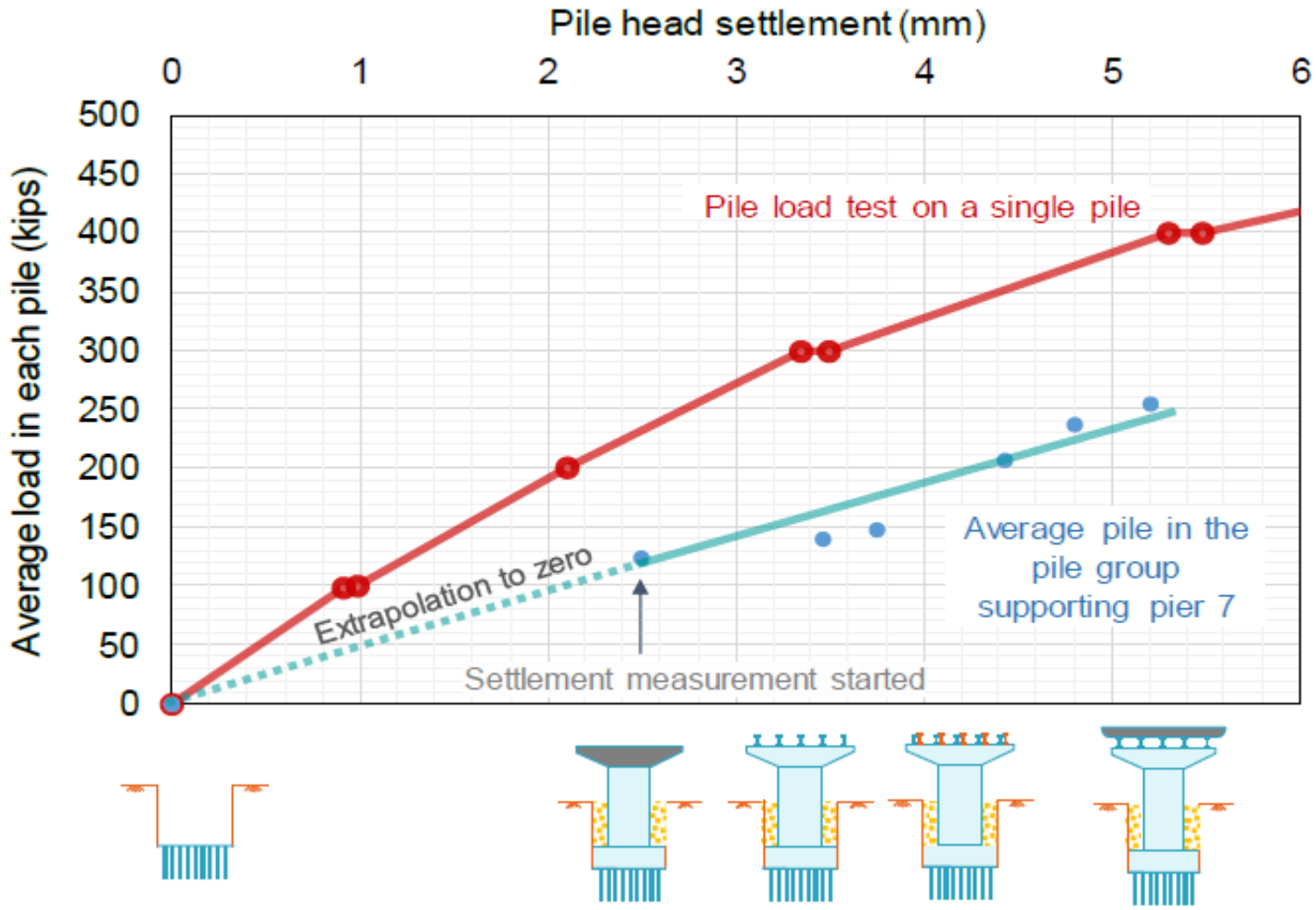
SPR – 4165 Research Output



Load Settlement Curve of the Static Load Test Pile Versus average of production piles in a 3x5 Pile Group under Pier 7 of Sagamore Parkway Bridge (US 52) Over Wabash River.

Driven Piles Design For Downdrag - FHWA

U.S. Department of Transportation
Federal Highway Administration

Publication No. FHWA-NHI-16-009
FHWA GEC 012 – Volume I
September 2016

NHI Courses No. 132021 and 132022

Design and Construction of Driven Pile Foundations – Volume I

Developed following:
AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014, with 2015 Interim.
and
AASHTO LRFD Bridge Construction Specifications, 3rd Edition, 2010, with '11, '12, '13, '14, and '15 Interims.

NHI
NATIONAL HIGHWAY INSTITUTE

Neutral Plane Method for Drag Force of Deep Foundations and the AASHTO LRFD Bridge Design Specifications

Timothy C. Siegel, P.E., G.E., D.GE
Dan Brown and Associates, PC, Knoxville, Tennessee USA

Rich Lamb, P.E.
Minnesota Department of Transportation, Maplewood, Minnesota USA

Derrick Dasenbrock
Minnesota Department of Transportation, Maplewood, Minnesota USA

Paul J. Axtell, P.E., D.GE
Dan Brown and Associates, PC, Overland Park, Kansas USA

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Report 393

Design and Construction Guidelines for Downdrag on Uncoated and Bitumen-Coated Piles

JEAN-LOUIS BRIAUD
and
LARRY TUCKER
Texas A&M University
College Station, TX

Subject Areas
Bridges, Other Structures, Hydraulics and Hydrology
Soils, Geology and Foundations

Research Sponsored by the American Association of State Highway and Transportation Officials in Cooperation with the Federal Highway Administration

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS
Washington, D.C. 1997

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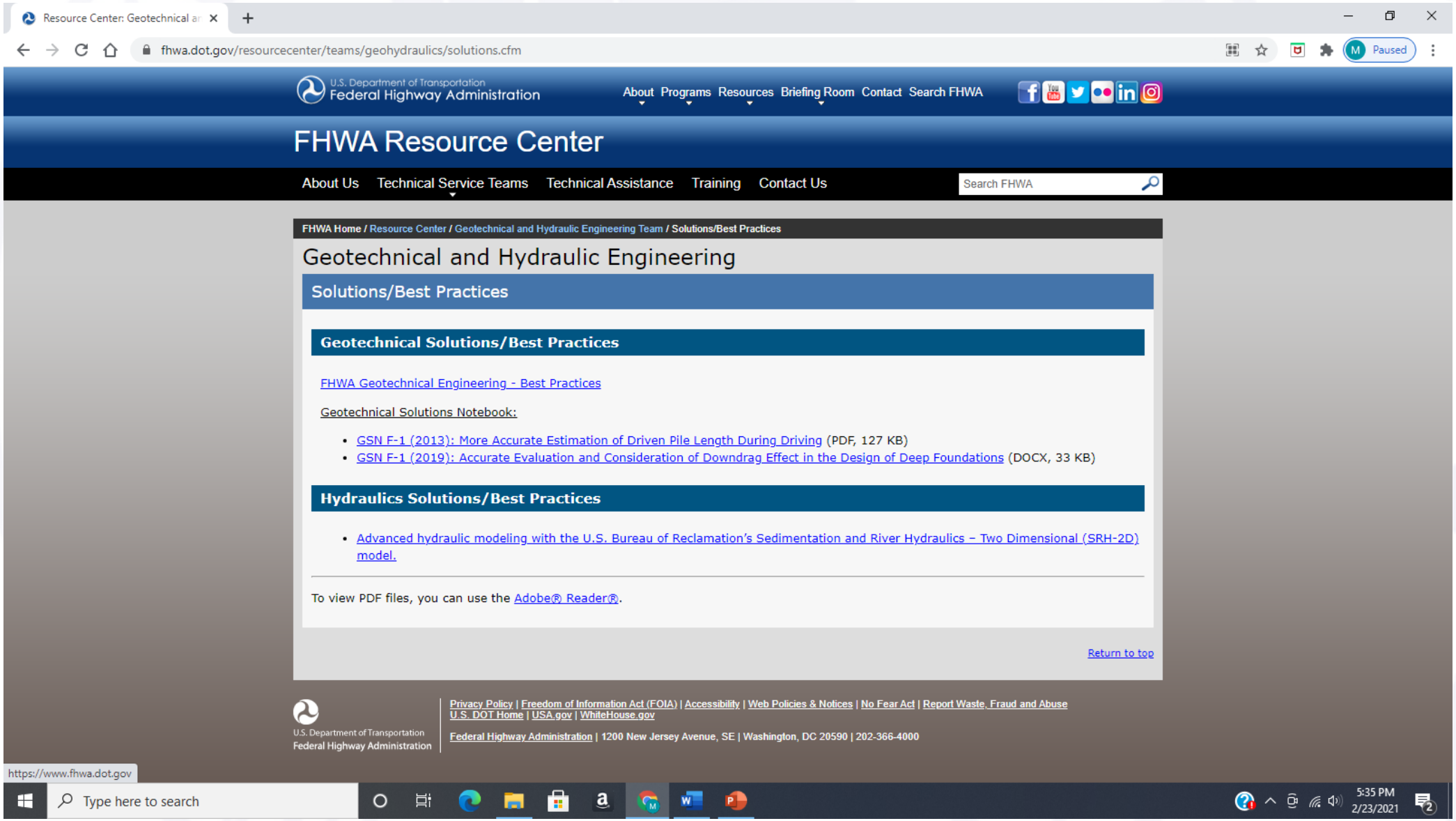
https://www.fhwa.dot.gov/resourcecenter/teams/geohydraulics/solutions.cfm



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Driven Piles Design For Downdrag - FHWA

FHWA GEC 12-Design and Construction of Driven Pile Foundations Vol's I, II & III

7.2.10: Downdrag: Design procedure that addresses the effects of downdrag in the geotechnical service limit state and in the pile structural strength limit state is preferred to the current AASHTO geotechnical strength limit state approach.

7.3.4 Recommended Procedure for Vertical Deformation Analysis

7.3.5.7 Group Settlement Using the Neutral Plane Method (*Mentioned in AASHTO 3.11.8*)

The NP is the location where the direction of the side resistance reverses from negative to positive. It is also the location of the maximum force in the pile and where there is no relative movement between the pile and surrounding soil.

- It occurs at the depth where the unfactored permanent load plus the load from negative shaft resistance is equal to the positive shaft resistance plus the toe resistance.
- Above the NP, the settlement of the soil is greater than the settlement of the pile. Any shaft resistance above the NP is negative shaft resistance, since by definition the soil settlement is greater than the pile settlement. Therefore, the soil settlement transfers load to the pile.

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Driven Piles Design For Downdrag - FHWA

- Below the NP, the settlement of the soil is less than the settlement of the pile and load is transferred from the pile to the soil. Accordingly, pile settlement equals soil settlement at the NP. Therefore, pile settlement is controlled by the soil compressibility below the NP.

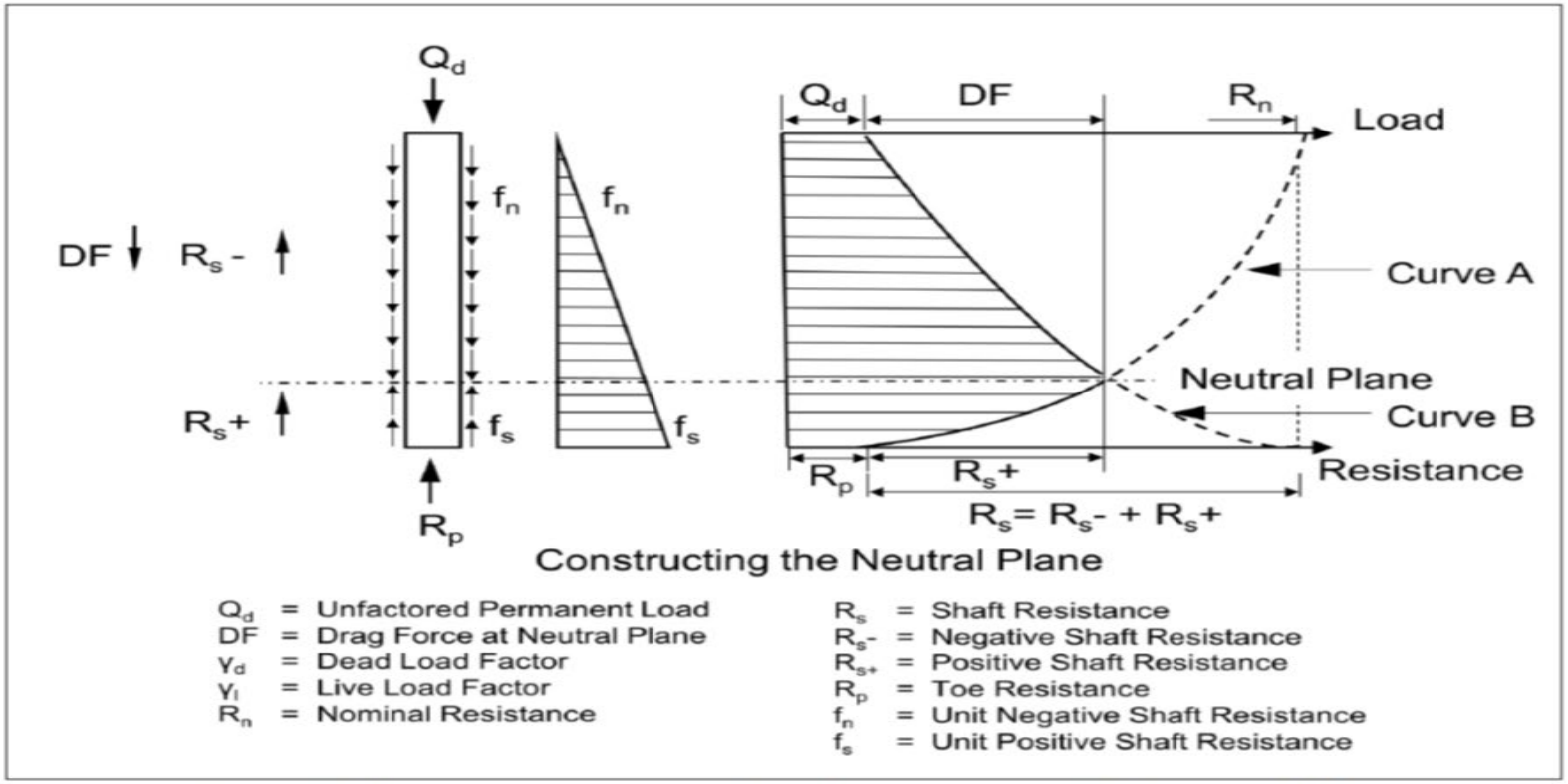

Figure 7-49 Neutral plane (after Goudrealt and Fellenius 1994).

Driven Piles Design For Downdrag – FHWA

7.3.6 Settlement Due to Downdrag7.2.10: Downdrag: The design approach for downdrag specified by AASHTO treats drag force as an additional load to be resisted in a geotechnical strength limit state analysis. However, drag force does not affect geotechnical strength. As the pile head axial compression load approaches the nominal geotechnical resistance, all shaft resistance is positive or acting upward, hence no drag force exists.

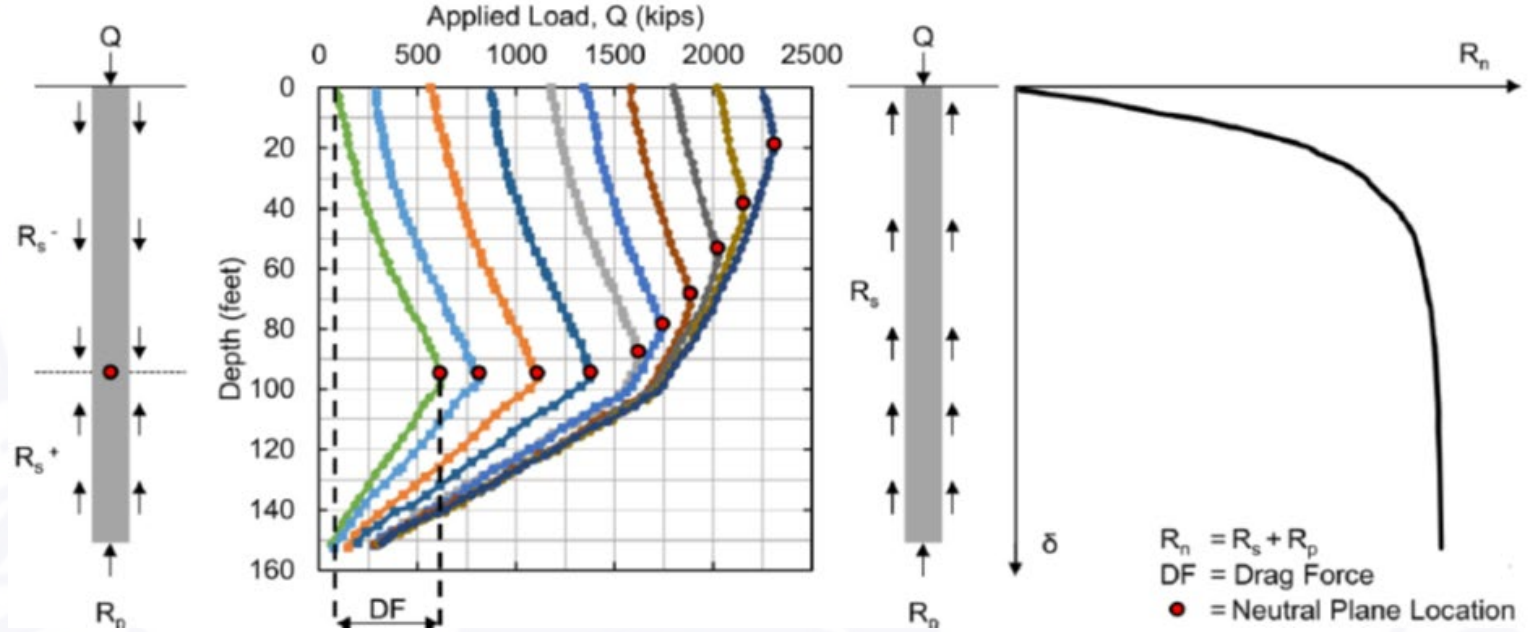

Figure 7-51 Change in neutral plane, negative shaft resistance, and drag force during transition to geotechnical strength limit (after MnDOT Geotechnical Manual).

Driven Piles Design For Downdrag – FHWA

Figure 7-51 illustrates the changes that occur as the pile approaches the geotechnical strength limit state. Note that the location of the neutral plane moves up the pile toward the ground surface. This results in a reduction in the magnitude of the negative shaft resistance as well as the drag force in the pile. At the geotechnical strength limit state, geotechnical failure, all shaft resistance is positive as the entire pile is moving downward relative to the soil during plunging failure. Hence, drag force does not alter the geotechnical strength limit state.

7.3.6.1 Recommended Approach for Downdrag

Siegel et al. (2013) proposed a downdrag design approach using the neutral plane method within the LRFD framework. This approach is the FHWA recommended design method for downdrag. It does not treat the drag force as an additional load that must be supported. Rather, drag force is a settlement consideration in the geotechnical service limit state and is a structural consideration in the pile structural limit state. The approach recognizes that drag force develops on all piles, regardless of soil and loading conditions.

Driven Piles Design For Downdrag – FHWA

The information necessary to implement the downdrag analysis procedure includes:

- Unfactored structural loads to determine the permanent load.
- Defined subsurface stratigraphy with appropriate parameters for all layers.
- Soil behavior models to characterize load-deformation response, (instrumented load tests, or t-z and q-z models).
- Information on fill placement including amount, lateral extent, and timeline.

In the recommended approach, all loads and resistances should be unfactored.

Step by Step Procedure For Downdrag Analyses

The FHWA GEC -012 Manual gives 7 steps to get this done.

A Brief Comparison of both DD Methods

Current Approach	Recommended Neutral Plane Approach
Applies to deep foundations under certain conditions	Applies to all deep foundations
Applies DD/Drag Force as Top Load	Drag Force/DD is an internal force associated with static equilibrium of pile-soil system
Includes DD at geotechnical strength limit state	Excludes Drag Force/DD at geotechnical strength limit state
Includes DD for settlement	Excludes DD for settlement because settlement is a function of Neutral Plane.
Includes DD at structural strength limit state.	Includes DD at structural strength limit state.
DD Load Factor $\gamma_P = 1.4$	DD Load Factor $\gamma_P = 1.1$

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What is Upcoming/Resources

CPT BASED DESIGN OF FOUNDATIONS:

- Under Final Stage of Development by Purdue - JTRP Research SPR-4108

Revisions to INDIANA DESIGN MANUAL:

- Chapter 408
- Foundation Review Forms
- Downdrag/Settlement Calculation Method

Revisions to Geotechnical Design Manual:

Construction Projects of Interest: I-69 Contract R-33493

- Geofoam Embankment
- Ground Modifications – Wick Drains & Rigid Inclusions
- Static Load Test

Research Projects:

- SPR-4165: Verification of Bridge Foundation Design Assumptions and Calculations.

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Guidance for Pavement Design Projects

Pavement Scope based on IDM 602	Full Geotechnical Report	Geotech Pavement Design Parameter Report	Pavement Cores
New Alignment	X		
Pavement Reconstruction	X		X (shoulder for MOT)
HMA Overlay, Minor Structural or HMA Overlay, Structural	X		X
PCCP Rubblization and HMA Overlay	X		X
PCCP Cracking and Seating and HMA Overlay	X		X
Unbonded PCCP Overlay over Old PCCP	X		X
Thin PCCP Overlay Bonded to Old Pavement	X		X
Full Depth Pavement Reclamation	X		X
Cold Central Plant Recycling	X		X
HMA Overlay, Preventative Maintenance		X	X
In-Place Recycling (CIR)		X	X
Crack Sealing and Filling			
Fog Sealing			
Seal Coat/Chip Seal			
Microsurfacing		X	X
Ultrathin Bonded Wearing Course		X	X
Concrete Pavement Restoration (CPR)		X	X
Concrete Pavement Preservation (CPP)		X	X

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Questions