DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

LOAD RESISTANCE FACTOR DESIGN (LRFD)
FOR BRIDGE FOUNDATION INVESTIGATION

TEMPLATE GUIDELINES

The below numbering of sections corresponds to the template under section 9.2.1.

1.0 Foundation Recommendations

Choose an appropriate foundation type based on previous engineering experience and the guidelines in Chapter 3. Make specific considerations for possible drivability, down drag, and any other specific limitations base on LRFD Specifications. This section functions exactly like the existing NON-LRFD template.

1.1 Pile Properties

Nominal Compression and Tension Stresses:
Nominal Compression/Tension Stresses are given to check for Drivability. See LRFD 10.7.8 for more information. The compression stresses and tension stresses values have been provided by the Office of Bridge Design in a letter dated December 9, 2013.

Factored Structural Resistance:
Factored Structural Resistance of a pile refers to the Nominal Compressive Resistance of a pile that has been factored for the Structural Limit State. The factored structural resistances have been provided by the Office of Bridge Design in a letter dated December 9, 2013.

H-Piles:
List the appropriate size and strength of steel for the pile(s) being used. 50 ksi steel loads are only allowed on piles that are fully embedded in the ground and not subject to severe corrosive environments.

Prestressed Concrete (PSC) Piles:
List the appropriate size of the pile(s) used. If a pile will be used that does not conform to the existing GDOT Standard for PSC piles (GSE 3215) Square Prestressed Concrete Piles then all pile properties will need to be approved by the Bridge Office before use. Also the approved pile design will need to be attached to the report. Tension stresses should be controlled based on the severe environment for any bridges over waterways located fully or partially in the following coastal counties: Chatham, Bryan, Liberty, McIntosh, Glynn, and Camden.

Metal Shell (MS) Piles:
List the appropriate size of Metal Shell piles including diameter and wall thickness. All piles specified should be Grade 3 (45 ksi) in accordance with ASTM A252 Standard Specifications for Welded and Seamless Steel Pipe Piles. Minimum wall thickness shall be in accordance with GDOT Standard Specifications Section 520.3.05.M.

1.2 Design Loads

All of the following design loads should be provided by the Bridge Designer. The loads can be per each bent or reduced to a range of bents to aid in reduction of excessive analysis. Foundation unit is defined as an axial load per column at ground line for drilled shafts, axial load per pile for pile bents/footings, and bearing pressure for spread footings

Maximum Factored Strength Limit Load:
This is the maximum factored load for the Strength Limit State per the above mentioned foundation unit.

Maximum Factored Service Limit Load:
This is the maximum factored load for the Service Limit State per the above mentioned foundation unit.

Factored Extreme Event I Limit State Load:
This is the factored load for the Extreme Event I Limit State per the above mentioned foundation unit.

2.0 Foundation Loads

List the appropriate information in the following sections based on the foundations recommend.

2.1 Pile Foundation Loads

List the appropriate pile types, pile sizes, down drag, scour, and driving resistances per bent. This information can be listed per bent or range of bents to reduce excessive analysis.

Down Drag:
If down drag is applicable use the appropriate load factor perLRFD 3.4.1-2 and load based per pile size and bent. See LRFD 10.7.3.7 for guidance on calculation of down drag loads.

Scour:
If scour is applicable list the load per pile size and bent. See LRFD 10.7.3.6 for guidance on calculation of scour loads.

Driving Resistance:
List the driving resistance per LRFD 10.7.7. The driving resistance (nominal resistance) should be limited to the maximum factored structural resistance of an H-pile driven to hard rock per LRFD 10.7.3.2.3.

$$R_{ndr} = \frac{\Sigma \gamma_i Q_i}{\varphi_{dyn}} + \frac{\gamma_p DD}{\varphi_{dyn}} + R_{Sdd} + R_{Sscour}$$

Rndr = nominal pile driving resistance required (kips)

$\Sigma\gamma_i Q_i$ = factored load per pile (kips)

φ_{dyn} = resistance factor

γ_p = load factor for downdrag

DD = downdrag load per pile (kips)

RSdd = skin friction which must be overcome during driving through downdrag zone (kips)

RSscour = skin friction which must be overcome during driving through scour zone (kips)

2.2 Spread Footing Foundation Loads

List the appropriate nominal bearing resistance, factored bearing resistance, gross footing size and effective footing size per bent. This information can be listed per bent or in a range of bents to reduce extraneous information.

Nominal Bearing Resistance:
List the Nominal Resistance in accordance with LRFD 10.6 controlling for a maximum settlement of 1 inch at the Service Limit State.

Factored Bearing Resistance:
List the appropriate factored resistance per LRFD 10.6.3.

Gross footing Size:
List the gross footing size of the foundation to be built on construction.

Effective footing Size:
List the minimum effective size of a footing for the above listed factored resistance based on the maximum factored foundation load or based on settlement criteria. The effective footing size is the size of a footing that has been reduced for eccentricity.

2.3 Drilled Shaft Foundation Loads

List the appropriate size, nominal resistance, factored resistance and minimum shaft diameter.

Down Drag:
If down drag is applicable use the appropriate load factor per LRFD 3.4.1-2. See LRFD 10.8.1.6.2 for guidance on calculation of down drag loads.

Nominal Resistance:
List the appropriate nominal resistance for either side friction or end bearing, not both, per LRFD 10.8.3 controlling for 1 inch of settlement per LRFD 10.8.2.

Factored Resistance:
List the appropriate factored resistance based on LRFD 10.8.3.

Factored Axial Resistance:
List the factored axial resistance based on the size of the shaft.

3.0 Foundation Elevations

List all applicable foundation elevations.

Bottom of Drilled Shaft:
List all elevations with "or below".

Bottom of Spread Footing:
List all elevations with "or below" unless there is some limiting depth factor based on settlement or other criteria.

Minimum Tips:
Use the same criteria as in Chapter 3.

Estimated Tips:
Estimated tips are set based on Driving Resistance and static analysis. See LRFD 10.7.3.3 for guidance; however let previous pile driving experience and engineering judgment guide.

4.0 General Notes

No notes provided are specific to LRFD, use guidance from Chapter 3.

4.1 Pile Foundation Notes

Nominal Bearing Resistance of Single Pile:
List the appropriate resistance determination method and resistance factor for the analysis method chosen from table LRFD 10.5.5.2.3-1.

Down Drag:
List the appropriate load factor per LRFD 3.4.1-2.

Piles Driven to Hard Rock:
The nominal driving resistance should be limited to the factored structural resistance for all piles driven to hard rock per LRFD 10.7.3.2.3.

Drivability:
Provide the GRLWEAP Drivability and Bearing Resistance analyses in an appendix to the report. You may list your maximum compression and tension values here that you obtained in your analyses as a summary. The bearing resistance analysis is used to verify the hammer has the proper capacity and hammer sets for varying driving resistances required for drivability analysis. A valid analysis is defined as having the required hammer having a hammer set greater than 3 blows per inch and less than 10 blows per inch at the required driving resistance for that pile. It is preferred to have one hammer that is valid for the whole bridge. However, this is not always possible if there is a wide range of driving resistances and varying pile sizes on a project. If one hammer cannot be used for the whole project multiple analyses with different hammers should be provided.

4.2 Spread Footing Foundation Notes

Bearing Resistance of Spread footings at the Strength Limit State:
List the appropriate method/soil/condition and resistance factor for the analysis method chosen from table LRFD 10.5.5.2.3-1.

4.3 Drilled Shaft Notes

Nominal Axial Compressive Resistance of Single Drilled Shafts:

List the appropriate soil condition/method with the resistance factor for the analysis method chosen from table LRFD 10.5.5.2.4-1.

Down Drag:
List the appropriate load factor per LRFD 3.4.1-2.

5.0 QA QC

List the names of the person(s) who generated the report and their reviewer.