4-1 SPREAD FOOTINGS

This memo is intended to clarify the terms and design methodology used in the current LRFD BDS (AASHTO LRFD Bridge Design Specifications, with Interims and California Amendments) for spread footings, and to improve communications with Geotechnical Services (GS).

Caltrans designs foundations at bents and pier footings in accordance with the LRFD BDS. By amendments to AASHTO LRFD Bridge Design Specifications, Caltrans designs foundations at the abutments based on the Working Stress Design (WSD) methodology (Caltrans Bridge Design Specifications LFD version of April 2000, based on 1996 AASHTO with Interims and Revisions by Caltrans). The LRFD Service I Limit State load combination is used as the design load in the WSD.

Definitions

Contact Surface = Bottom of the footing, located at a specific elevation.

Footing Width (B) = Short plan dimension of the footing.

Effective Footing Width (B') = Reduced footing width for an eccentrically loaded footing.

Footing Length (L) = Long plan dimension of the footing.

Effective Footing Length (L') = Reduced footing length for an eccentrically loaded footing.

q_o = Gross Uniform Bearing Stress. This is the equivalent uniform vertical stress determined by applying the vertical load over the effective footing area. Designer must include the weight of the footing and of all overburden soil from the contact surface to finished grade, when determining the gross uniform bearing stress.

q_{max} = Gross Maximum Bearing Stress. This is the maximum applied vertical stress demand at the contact surface. Gross maximum bearing stress demand must include the weight of the footing and of all overburden soil from the contact surface to finished grade. Used for footings on rock, q_{max} is based on triangular or trapezoidal stress distribution on the footing area.

q'_o = Net Bearing Stress. This is the gross uniform bearing stress for footings on soil or the gross maximum bearing stress for footings on rock minus the initial overburden or vertical effective stress at the contact surface. The net bearing stress due to LRFD Service I load combination is used to evaluate footing settlement.

q_{pn} = Permissible Net Contact Stress. This is the net bearing stress that will result in an estimated settlement equal to the arbitrary structural threshold or permissible settlement.

q_{pg} = Permissible Gross Contact Stress. This is the permissible net contact stress plus the initial overburden or vertical effective stress at the contact surface.

q_{ult} = Ultimate Gross Bearing Capacity. This is the gross uniform bearing stress for footings on soil or the gross maximum bearing stress for footings on rock that will fail the soil or rock, respectively, in shear based on a strength criterion.

q_{all} = Allowable Gross Bearing Capacity. $q_{all} = q_{ult}/FS$, where FS = Factor of Safety against bearing failure.

q_n = Gross Nominal Bearing Resistance. Used in LRFD Strength and Extreme Event Limit States, this is considered synonymous with the Gross Ultimate Bearing Capacity defined under WSD.

q_R = Factored Gross Nominal Bearing Resistance = $\varphi_b \times q_n$ .Used in LRFD Strength and Extreme Limit States, where, φ_b = resistance factor from Section 10.5 of the LRFD BDS.

Footing design shall meet the following requirements:

- In WSD (Abutments) all designs must satisfy:
    - For Service Limit State (Settlement):
        - $q_o < q_{pg}$ for footings on soils
        - $q_{max} < q_{pg}$ for footings on rock
    - For Service Limit States (Bearing Capacity):
        - $q_o < q_{all}$ for footings on soil
        - $q_{max} < q_{all}$ for footings on rock
- In LRFD (Bents and Piers) all designs must satisfy:
    - For Service Limit State (Settlement):
        - $q'_o < q_{pn}$ for footings on soil or rock
    - For Strength and Extreme Limit States:
        - $q_o < q_R$ for footings on soil
        - $q_{max} < q_R$ for footings on rock

Communication with Geotechnical Services

Sizing spread footing is an iterative process because the allowable gross bearing capacity, the permissible contact stress and the factored nominal bearing resistance used in the design depend on the location, dimensions and depth of the footing. To facilitate design, GS will provide these parameters as a function of the effective footing width (B'), for a range of effective footing length to effective footing width ratios, (L'/B') and a given footing embedment depth specified by Structure Design(SD).

If the support location or footing embedment depth changes during the design process Geotechnical Services shall be contacted to provide an update of geotechnical design data.

To prepare foundation recommendations and reports, GS needs foundation location, geometry and load data from SD. Attachments No. 1 and 2 show examples of Foundation Design Data Sheets to be included in the request for Preliminary Foundation Report (PFR) and Foundation Report (FR), respectively.

Spread Footing Data Table

Spread Footing Data Table shall be included in the FR and on the Contract Plans in the formats shown in Attachment No. 3.

Unlike portions of the Pile Data Table, Spread Footing Data Table is not necessary for contract compliance, however its inclusion is a useful addition to the plans. With the foundation design parameters included in the table, the engineer can inspect the bearing strata, and if necessary, adjust the bottom of footing elevations. These design parameters are also a starting point for the future design of widenings and emergency supports.

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