PENNDOT e-Notification

Bureau of Design
Bridge Quality Assurance Division

PENNDOT

ABLRFD

No. 001
January 16, 2003

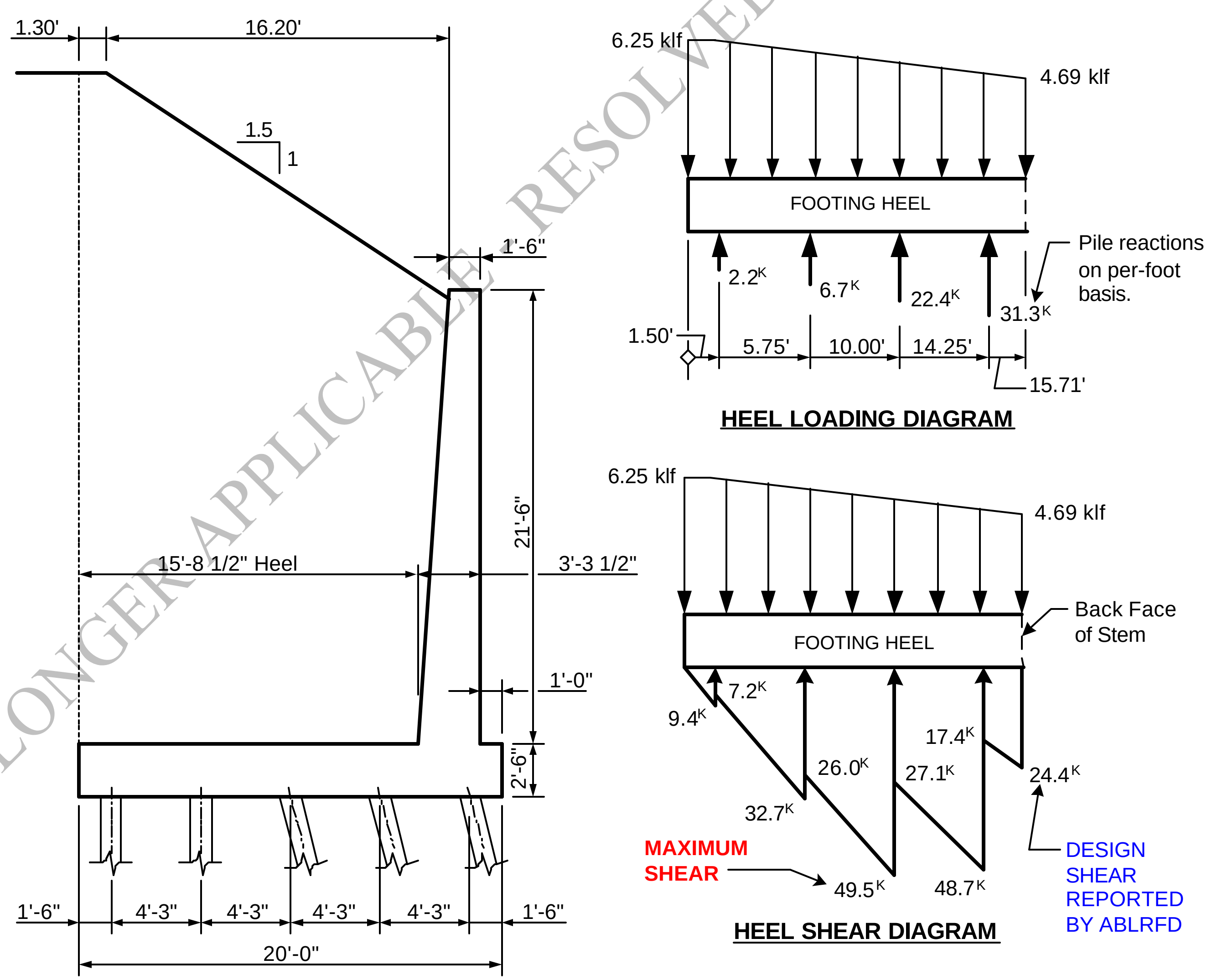
Potential for Program Not Detecting Maximum Design Shear in Footing Heel.

NO LONGER APPLICABLE - RESOLVED BY ABLRFD v1.4.0.3

A problem with the ABLRFD program possibly failing to detect the maximum design shear in the heel portion of the footing has been recently identified.

Currently, the program assumes the critical shear location is the back face of the stem or an effective depth distance away from the stem depending on the sign of the moment on the heel (refer to Figure 3.5.1-1 on p. 3-59 of the user's manual.) These assumed locations might be incorrect particularly for pile-supported footings under certain loading and geometric conditions, and for spread footings with relatively high bearing resistances. Furthermore, the situation tends to be more critical for footings with small toes.

Consider the following retaining wall example:



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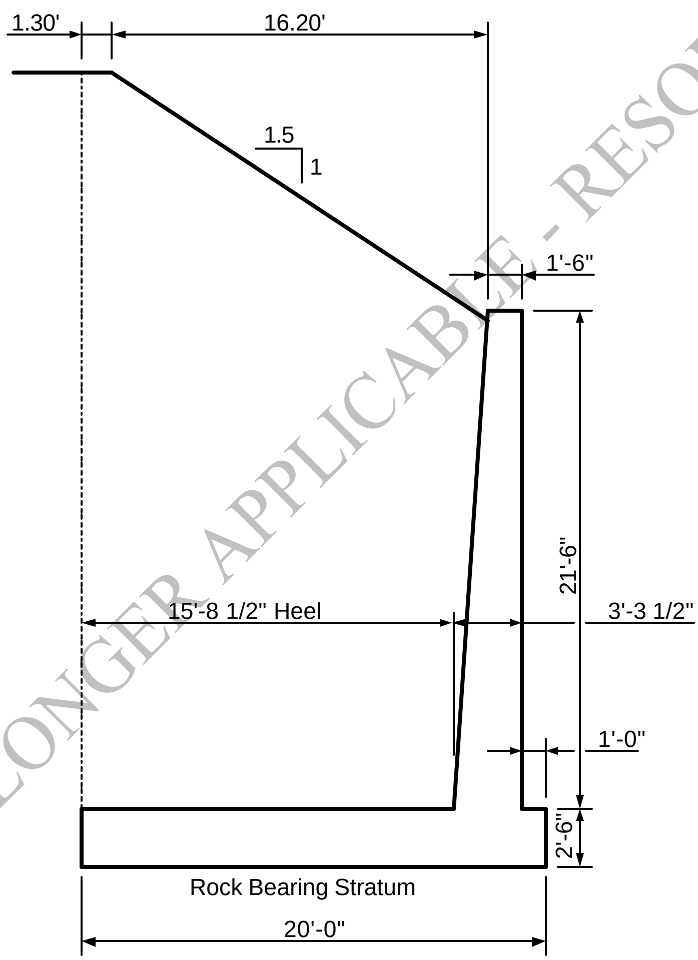
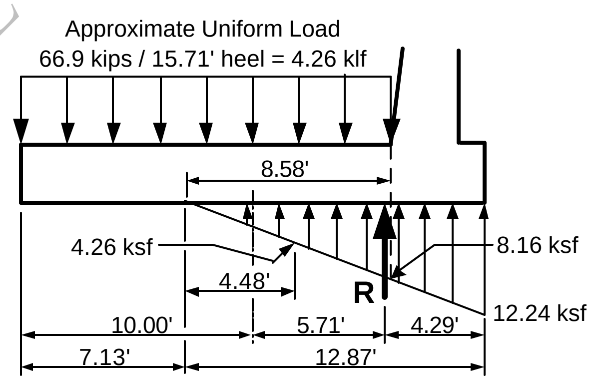
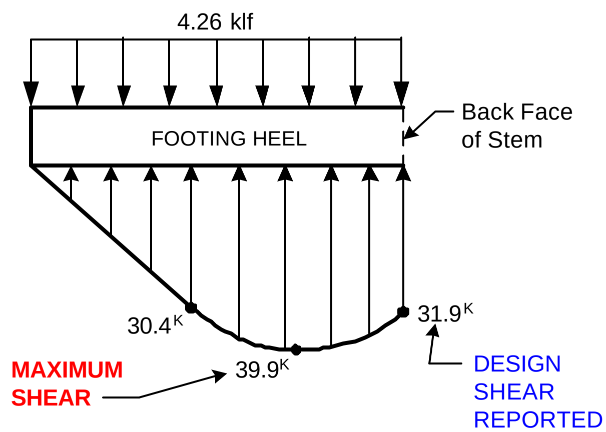
In the above example, since negative moment is induced in the heel (tension on the top of the footing), the ABLRFD program automatically assumes the critical shear location is at the back face of the stem. However, as can be seen from the shear diagram, the maximum shear actually occurs at an intermediate point at a pile location. (In the above example, the pile reactions were assumed to be concentrated loads. In reality, the physical dimension of the pile/caisson could be considered.) In this example, which was taken from an actual project currently under design, the maximum design shear is approximately **two times** the value reported by the ABLRFD program!

A similar situation could occur if this footing were supported on a spread footing. If the bearing pressure at any point along the heel exceeds the downward vertical load intensity, the maximum shear will not occur at the back face of the stem. See the example below.





HEEL LOADING DIAGRAM



HEEL SHEAR DIAGRAM

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Therefore, effective immediately, designers are required to perform hand computations to determine if the ABLRFD program is failing to detect the maximum design shear in footings and to make appropriate modifications. This condition affects the heel only — not the toe.

Below is a suggested method for performing the necessary check of the program as an interim measure. This method utilizes intermediate results already available from the standard ABLRFD output:

1) From the 'Footing' table of the 'Factored Forces' report, find the heel shear force for the "STR-I Maximum Final" limit state. This shear force does not reflect the upward reactions from the piles or soil/rock bearing stratum.

2) Divide the maximum heel shear force from Step 1 by the length of the heel to arrive at the average vertical load intensity acting on top of the heel (also includes weight of footing.)

3) *For a pile-supported footing* find the pile reactions corresponding to the limit state in Step 1 from the 'Pile Axial Loads / Pile Axial Resistance' table of the 'Footing Stability' report. Adjust the pile forces to be on a per foot basis (i.e., divide the pile force by the pile spacing on row-by-row basis) and to account for batter effects (the pile force reported acts along the slope axis of a battered pile.)

   For a spread footing, determine the bearing pressure distribution from the 'Spread Footing — Bearing Resistance' table of the 'Footing Stability' report. Use the resultant eccentricity value to compute the distribution length. Note that for spread footings on soil, the bearing resistance is based on an equivalent ***uniform*** pressure distribution, while for spread footings on rock, the bearing resistance is based on a ***linear*** pressure distribution.

4) Develop a shear diagram for the heel of the footing and determine the maximum design value.

5) Repeat Steps 1 – 4 for the "STR-I Minimum Final" limit state.

6) If the maximum design shear determined in the steps above is greater than the heel design shear value shown in the 'Footing' table of the 'Shear Results' report, adjust the shear performance ratio accordingly. If necessary, increase the footing thickness and re-run the program. In a design run, the minimum footing thickness could be increased so as to ensure adequate shear capacity.

Direct any questions concerning the above issue to:

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