

BASIS OF DESIGN

DESIGN DATA ONLY - DO NOT INCLUDE THIS SHEET IN WALL PLANS

DESIGNED IN ACCORDANCE WITH THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, FIFTH EDITION (WITH 2010 INTERIMS) AND MnDOT LRFD BRIDGE DESIGN MANUAL. REFERENCES TO ARTICLES ARE TO THE AASHTO LRFD SPECIFICATIONS.

LOAD MODIFIERS η_D, η_E, η_I 1.0

LOAD COMBINATIONS

LOAD COMBINATION	APPLICATION	γ_{DC}	γ_{EV}	γ_{LS}	γ_{EH} Active	γ_{EH} At Rest	γ_{WS}	γ_{CT}
Strength Ia	Min V/Max H	0.90	1.00	1.75	1.50	1.35	---	---
Strength Ib	Max V/Max H	1.25	1.35	1.75	1.50	1.35	---	---
Strength Ic 1	Max V/Min H	1.25	1.35	1.75	0.90	0.90	---	---
Strength Id 1	Max V/Min H without LS	1.25	1.35	---	0.90	0.90	---	---
Strength III 2	Max V/Max H (construction case)	1.25	1.35	---	1.50	1.35	1.40	---
Strength V 2	Max V/Max H (construction case)	1.25	1.35	1.35	1.50	1.35	0.40	---
Extreme Iia	Min V/Max H (collision case)	0.90	1.00	---	---	---	---	1.00
Extreme Iib	Max V/Max H (collision case)	1.25	1.35	---	---	---	---	1.00
Service I	Service	1.00	1.00	1.00	1.00	1.00	0.30	---

AN ACTIVE EARTH PRESSURE CONDITION WAS ASSUMED FOR THE GEOTECHNICAL FAILURE MODES (SLIDING, OVERTURNING AND BEARING) AS WELL AS FOR THE STRUCTURAL DESIGN OF THE SPREAD FOOTINGS. AN AT REST PRESSURE CONDITION WAS ASSUMED FOR THE STRUCTURAL DESIGN OF THE STEM.

LOAD CASES (REFER TO STANDARD SHEET 5-297.620 FOR SKETCHES)

LEVEL FILL.....ASSUMES 1(V) : 6(H)
 LIVE LOAD (LL).....0.240 KSF LL SURCHARGE
 SLOPED FILL 1(V) : 2(H).....ASSUMES 1(V) : 2(H) SLOPE

THE STANDARDS WERE DESIGNED USING AN NCHRP REPORT 350 TEST LEVEL 4 (TL- 4) HORIZONTAL VEHICLE COLLISION FORCE (CT). FOR THE FOOTING DESIGN, FORCE WAS ASSUMED TO ACT OVER THE ENTIRE FOOTING/PANEL LENGTH (30 ft. 6 in.). FOR THE STEM DESIGN, LOAD WAS DISTRIBUTED USING A FINITE ELEMENT MODEL AND WAS NOT FOUND TO CONTROL THE DESIGN. IF A MASH TL-4 BARRIER OR ANY TL-5 BARRIER IS USED, A CUSTOM DESIGN IS REQUIRED.

GEOTECHNICAL DESIGN ASSUMPTIONS :

THE STANDARDS WERE DESIGNED ASSUMING HYDROSTATIC PRESSURE FROM GROUNDWATER BEHIND THE WALL IS NOT PRESENT. IF HYDROSTATIC PRESSURE BEHIND THE WALL IS ANTICIPATED, A GEOTECHNICAL AND STRUCTURAL REVIEW IS REQUIRED, AND A CUSTOM DESIGN IS REQUIRED.

SOIL UNIT WEIGHT 0.120 kcf
 FRICTION ANGLE, ϕ (RETAINED SOIL) 35 deg
 FRICTION ANGLE, ϕ (FOUNDATION SOIL BELOW FOOTING)
 ALL SPREAD FOOTING CASES EXCEPT SLOPED FILL ≥ 21 FT 32 deg 3
 SPREAD FOOTING WITH SLOPED FILL ≥ 21 FT 35 deg 3
 FRICTION ANGLE BETWEEN SOIL AND WALL 0.67 X ϕ

LATERAL EARTH PRESSURE COEFFICIENTS :

LOAD CASE	ACTIVE, k_a	AT REST, k_o	PASSIVE, k_p
LEVEL FILL AND LL SURCHARGE CASE	0.27	0.50	3.40
1(V) : 2(H) SLOPED FILL CASE	0.38	0.62	< 21 FT ($\phi = 32^\circ$) = 3.40 ≥ 21 FT ($\phi = 35^\circ$) = 4.24

ACTIVE, k_a LRFD 3.11.5.3 (COULOMB)
 AT REST, k_o LEVEL FILL AND LL SURCHARGE CASE- ASSUME 1(V) : 6(H)
 AT REST, k_o 1(V) : 2(H) SLOPED FILL CASE DANISH CODE (1978)

$$k_o = (1 - \sin(\phi)) \times (1 + \sin(\beta))$$

β = BACKSLOPE ANGLE

PASSIVE, k_pLRFD 3.11.5.3 (COULOMB)

SPREAD FOOTINGS
SLIDING

	RESISTANCE FACTOR ϕ	COEFFICIENT OF FRICTION	METHODOLOGY
SOIL ON SOIL	0.9	ALL CASES EXCEPT 1(V) : 2(H) SLOPED FILL ≥ 21 FT = 0.62	LRFD 10.6.3.4 $= \tan(\phi)$
CIP CONCRETE ON SAND	0.8	1(V) : 2(H) SLOPED FILL ≥ 21 FT = 0.7	
PASSIVE	0.5	---	TRAPEZOIDAL DISTRIBUTION (USED IN FRONT OF SHEAR KEY ONLY)

GEOTECHNICAL DESIGN ASSUMPTIONS (CONTINUED) :

BEARING

APPLIED BEARING PRESSURE DISTRIBUTION (SPREAD FOOTING ON SOIL) LRFD 11.6.3.2, FIG. 11.6.3.2-1 (MEYERHOFF)
 APPLIED BEARING PRESSURE DISTRIBUTION (SPREAD FOOTING ON ROCK) LRFD 11.6.3.2, FIG. 11.6.3.2-2
 ECCENTRICITY (SPREAD FOOTING) $e \leq B/4$, LRFD 11.6.3.3
 SETTLEMENT (ASSUMED MAXIMUM) 1 in.

PILE FOOTINGS

ASSUMED MAXIMUM FACTORED GEOTECHNICAL AXIAL RESISTANCE OF PILE..... 100 tons PER PILE
 ASSUMED MAXIMUM GEOTECHNICAL LATERAL RESISTANCE OF PILE 24 kips PER PILE 4 5
 DRAG LOAD (DOWNDRAG) IS NOT INCLUDED IN STANDARDS. INCREASE AXIAL RESISTANCE FOR DOWNDRAG AS NEEDED.
 THE FOOTINGS WERE SIZED SUCH THAT UPLIFT IS NOT PRESENT.

STRUCTURAL DESIGN ASSUMPTIONS :

REINFORCEMENT YIELD STRESS.....60 ksi 6
 CONCRETE COMPRESSIVE STRENGTH 4 ksi
 RESISTANCE FACTOR REINFORCED CONCRETE STRENGTH LIMIT STATE 0.9
 RESISTANCE FACTOR REINFORCED CONCRETE EXTREME EVENT LIMIT STATE .. 1.0
 FLEXURE LRFD 5.7.3.2
 MINIMUM REINFORCEMENT LRFD 5.7.3.3.2
 SHEAR (ONE WAY) LRFD 5.8.3.4.1 and 5.8.3.4.2
 SHEAR CRITICAL SECTION (TWO WAY) LRFD 5.13.3.6.1
 CRACK CONTROL (STEM DESIGN ONLY) LRFD 5.7.3.4
 SHRINKAGE AND TEMPERATURE CLASS 2 EXPOSURE CONDITIONS
 MAXIMUM BAR SIZE LRFD 5.10.8
 *9 (FOOTING)
 *11 (STEM)

BAR LAPS : CLASS "C" LAPS AT ALL LOCATIONS
 BAR TRANSITION AT LAPS SHALL NOT VARY BY MORE THAN 2 BAR SIZES.
 MAXIMUM HEIGHT DOWEL EXTENDS ABOVE TOP OF FOOTING 11 ft.

STRUCTURAL DESIGN ASSUMPTIONS (CONTINUED) :

GEOMETRY:

SPREAD FOOTINGS

MINIMUM FOOTING THICKNESS (c) 1 ft. 5 in.
 MINIMUM FOOTING TOE WIDTH (b) 9 in.
 MINIMUM HEEL WIDTH 9 in.
 MINIMUM FOOTING WIDTH (d) 3 ft. 3 in.
 b, c, d DIMENSION - REFER TO STANDARD PLAN SHEET FIG. 5-297.630 (1 OF 2), 5-297.631 (1 OF 2) AND 5-297.632 (1 OF 2).

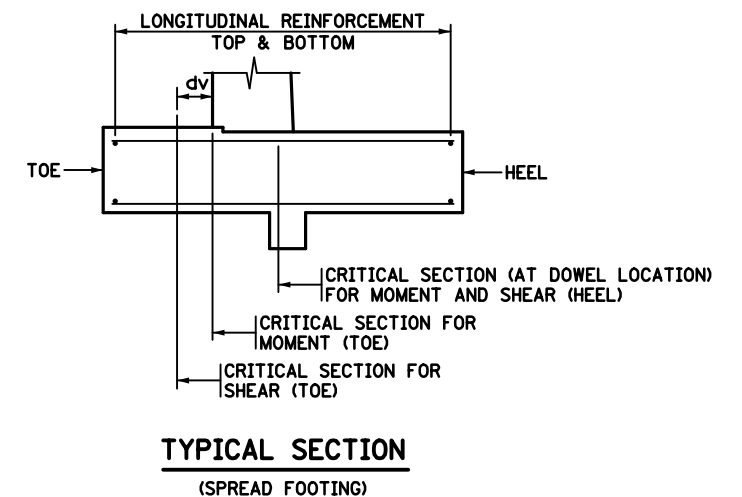
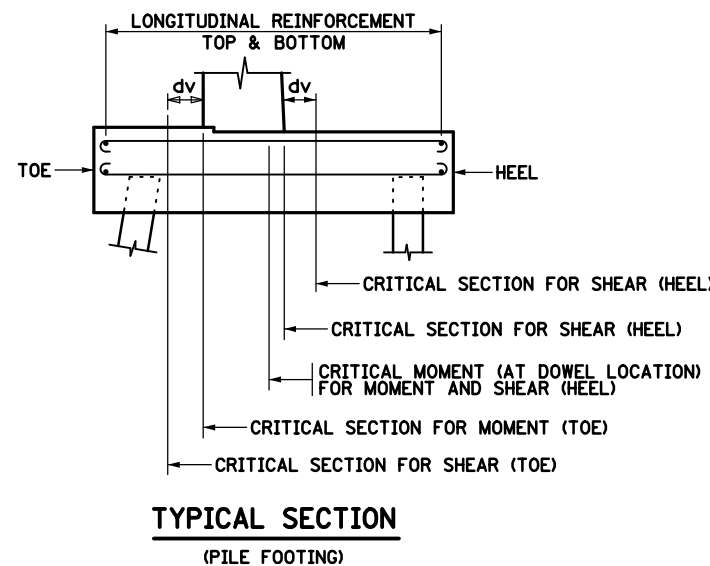
PILE FOOTINGS

MINIMUM HORIZONTAL CONCRETE COVER 9 in.
 MINIMUM CAP THICKNESS 2 ft.
 DISTANCE FROM TOE TO CENTER OF FRONT ROW OF PILES 1ft. 6 in.
 DISTANCE FROM HEEL TO CENTER OF BACK ROW OF PILES
 2 ROWS OF PILES 1 ft. 6 in.
 MORE THAN 2 ROWS OF PILES 2 ft.
 MINIMUM CENTER-TO-CENTER PILE SPACING 3 ft.
 MAXIMUM CENTER-TO-CENTER PILE SPACING 12 ft.
 MINIMUM PILE EMBEDMENT IN CAP 1 ft.
 MINIMUM CAP WIDTH 6 ft.

ALL PILES TO BE BATTERED 4(V):1(H) EXCEPT BACK ROW WHICH IS TO BE DRIVEN VERTICAL.

NOTES:

- 1 USED FOR PILE FOOTING DESIGN ONLY TO MAXIMIZE LOAD ON BACK ROW OF PILES
- 2 USED FOR STEM DESIGN ONLY WITH WIND LOAD FROM ARTICLE 3.8
- 3 THE FOUNDATION SOILS MUST MEET THE LISTED ASSUMPTIONS. IF THEY DO NOT MEET THE LISTED ASSUMPTIONS A SUBCUT OR DEEP FOUNDATION MAY BE NEEDED.
- 4 ASSUMES THAT THE INSITU SOIL CONDITIONS MEET OR EXCEED THE PARAMETERS LISTED IN MnDOT LRFD BRIDGE DESIGN MANUAL ARTICLE 10.2 FOR THE DEVELOPMENT OF MnDOT LRFD BRIDGE DESIGN MANUAL TABLE 10.2.1. IF THE SOIL CONDITION DOESN'T MEET OR EXCEED TABLE 10.2.1, THE LATERAL PILE RESISTANCE SHOULD BE CALCULATED PER THE INSITU SOIL PARAMETERS.
- 5 THE SOIL IN FRONT OF THE FIRST ROW OF PILE SHALL BE HORIZONTAL TO A DISTANCE OF 8 PILE DIAMETERS FROM THE FIRST ROW OF PILE.
- 6 ALL REINFORCEMENT BARS EXCEPT THOSE THAT ARE ENTIRELY EMBEDDED IN FOOTINGS ARE EPOXY COATED.



LEAD EXPERT OFFICE
 NANCY DAUBENBERGER
 STATE BRIDGE ENGINEER



CAST IN PLACE CONCRETE RETAINING WALL
 BASIS OF DESIGN (DO NOT INCLUDE IN PLAN)

APPROVED: 08-27-2014
 REVISED:

CHRISTOPHER ROY
 STATE DESIGN ENGINEER

STANDARD PLAN
 5-297.639

1 OF 1

STANDARD PLAN

STATE PROJ. NO.

SHEET NO.

TRUNK HWY.

TOTAL SHEETS