3E.3.4 Essential Service Water Building Shear Wall on Column Line D

This critical section presents the analysis and structural design methodology and design results of the Essential Service Water Building (ESWB) Shear Wall on Column Line D (Wall D). The ESWB Wall D are shown on Figure 3B-69—Essential Service Water Building Dimensional Plan Elevation 0 m (0 ft) through Figure 3B-76—Essential Service Water Building Dimensional Section B-B.

This critical section designs ESWB Wall D, selected via the supplementary selection methodology as described in Section 3E to verify an evaluation of an "essentially complete" design. The ESWB is a safety-related, Seismic Category I structure. Specifically, this critical section designs the following portions of ESWB Wall D shown on Figure 3E.3.4-1—ESWB Wall D Design Regions (FEM) for Flexure:

- Wall D-1a, between Elevation -2 ft and Elevation 12 ft 2 in.
- Wall D-1b, between Elevation -2 ft and Elevation 12 ft 2 in.
- Wall D-2, between Elevation -2 ft and Elevation 12 ft 2 in.
- Wall D-3, between Elevation 12 ft -2 in and Elevation 18 ft 4 in.
- Wall D-4, between Elevation 18 ft -4 in and Elevation 33 ft.
- Wall D-5a, between Elevation 33 ft and Elevation 39 ft 6 in.
- Wall D-5b, between Elevation 33 ft and Elevation 39 ft 6 in.
- Wall D-6, between Elevation 33 ft and Elevation 39 ft 6 in.
- Wall D-7, between Elevation 39 ft -6 in and Elevation 61 ft 10 in.
- Wall D-8, between Elevation 61 ft -10 in and Elevation 80 ft 9 in.
- Wall D-9, between Elevation 80 ft -9 in and Elevation 114 ft.

The design of this critical section focuses on sections pertaining to the design regions of ESWB Wall D in this list. The ESWB Wall D is divided into nine subsections for flexure design, with Region 1 through Region 9 shown on Figure 3E.3.4-1. The nine subsections for horizontal shear design, Region 1 through Region 9, are shown on Figure 3E.3.4-2—ESWB Wall D Design Regions (FEM) for Horizontal Shear. The four subsections for vertical shear design, Region 1 through Region 4, are shown on Figure 3E.3.4-3—ESWB Wall D Design Regions (FEM) for Vertical Shear. These subsections facilitate an economical reinforcement design and manage analysis results more easily. Each region is scanned separately for the maximum axial force, shear, and bending moment demands.

In the design of ESWB Wall D, GTSTRUDL finite element forces averaged at the nodes are used. Averaging methodology for bending moment and axial force resultants are based on a section length of three times the thickness following ACI 349-01. Averaging the results of four or three neighboring joints satisfies this requirement for the entire wall. Section cuts that give the maximum design moment ($M_{U\text{-}YY}$ and $M_{U\text{-}XX}$), design axial force (N_{XX} and N_{YY}), and maximum eccentricity (M/N) are selected for each region and shown on Figure 3E.3.4-4—ESWB Wall D Axial Force (Tension) and Bending Moment Critical Design Cuts (FEM). For in-plane and out-of-plane shear, longer cuts covering the entire possible length and height of the wall are used. Section cuts are selected based on demand to capacity ratios considering the axial tension acting simultaneously on the cut as shown on Figure 3E.3.4-5—ESWB Wall D In-Plane and Out-of-Plane Shear Critical Design Cuts (FEM).

3E.3.4.1 Model

The global GTSTRUDL finite element model (FEM) described in Sections 3.7.2.3.2 and 3.8.4.4.4 is used in the design of ESWB Wall D. Most of the concrete plates in the superstructure of the ESWB qualify for a stress analysis with thin plates; therefore, GTSTRUDL SBHQ6 element is used to mesh the superstructure. The basemat of ESWB Wall D static model are meshed using eight-node, three-dimensional solid GTSTRUDL IPSLIM elements to accurately capture its behavior. The element size is approximately 3 ft by 3 ft at subgrade elevations and 6 ft by 6 ft at higher elevations with variations in aspect ratios to accommodate openings.

The finite element planar reference system for the GTSTRUDL finite element analysis output is provided on Figure 3E.3.4-6—GTSTRUDL Finite Element Planar Reference Frame Systems (Plate Bending) and Figure 3E.3.4-7—GTSTRUDL Finite Element Planar Reference Frame Systems (Plane Stress/Strain). The positive direction of the finite element bending moments M_{XX}, M_{YY}, and M_{XY} and out-of plane shear forces V_{XX} and V_{YY} are shown on Figure 3E.2.2-6. The positive direction of the finite element in-plane forces N_{XX}, $N_{YY,}$ and N_{XY} are the same as the positive orientation of the plane stresses S_{XX}, S_{YY}, and S_{XY} shown on Figure 3E.3.2-7.

3E.3.4.2 Load Combinations and Loads

The applicable loads applied to ESWB Wall D are described in Sections 3.8.4.3.1 and 3.8.5.3. The applicable loading combinations are described in Sections 3.8.4.3.2 and 3.8.5.3. This critical section is also designed for the soil analysis cases shown in Table 3.7.1-9.

The design of ESWB Wall D is achieved using the results obtained from the model for the load combinations which are shown in Table 3E.3.4-1—Governing Design Data for ESWB Wall D.

No additional missing loads are considered in the design of ESWB Wall D.

3E.3.4.3 Analysis and Design Methods

The methodology used for the structural analysis and design of ESWB Wall D is to determine the reinforcement configuration using forces and moments generated from the finite element GTSTRUDL model. The design of ESWB Wall D is performed using hand calculations utilizing the applicable codes, standards, and specifications described in Sections 3.8.4.2 and 3.8.5.2.

The ESWB Wall D is designed for the resultant forces and moments determined based on the applied loading and soil conditions. The data shown in Table 3E.3.4-1 are obtained by sorting results extracted from the finite element GTSTRUDL model.

Section cuts are used to determine the forces and moments throughout ESWB Wall D. Section cut locations are determined through a review of enveloping distributions of forces and moments described in Section 3E.3.4. The section cut locations are shown on Figure 3E.3.4-4 and Figure 3E.3.4-5. The sign convention describing the nomenclature for horizontal and vertical cuts applicable to this critical section is shown on Figure 3E.3.4-6 and Figure 3E.3.4-7.

Each ESWB Wall D region is first designed for flexure because of maximum out-of-plane bending moments $M_{U\text{-}YY}$ and $M_{U\text{-}XX}$. $M_{U\text{-}XX}$ is used to determine the horizontal reinforcement, while $M_{U\text{-}YY}$ is used to determine the vertical reinforcement based on the wall coordinates and surface normal. The flexural design in each direction is then checked by examining the axial force and bending moment interaction. The axial force-bending moment demand pairs (N_{XX} and $M_{U\text{-}XX}$ and N_{YY} and $M_{U\text{-}YY}$) are plotted on a beam-column capacity interaction ($N_{\text{-}M}$) diagram of the wall section, where the ultimate capacity limits for the cross section are developed for a trial reinforcement bar size and spacing selected for the inside and outside faces of the walls. A set of curves on the interaction diagrams defines the ultimate capacity boundary limits for axial tension or compression in combination with positive (hogging) or negative (sagging) moments. If there are any demand pair points that lie outside of the capacity curve boundaries, the reinforcement design is revised until the points are inside the failure surface.

In the second step, the region is designed for out-of-plane shear, in-plane shear, and shear friction in the horizontal direction. The shear design is based on section cuts through the wall in either the horizontal or vertical directions. The averaged shear demand at the nodes is summed along the cut length. The concrete shear capacity for both out-of-plane and in-plane shear is a function of the simultaneous axial load demand, and net axial tension on the cross section reduces the concrete shear capacity significantly. The horizontal cut that produces the highest shear demand to concrete

shear capacity ratio is considered the most critical section cut for the region. The shear demand and concrete capacity at this cut are used for the design of the entire region.

The required longitudinal and transverse reinforcement area to satisfy the portion of shear demand that exceeds the concrete shear capacity is calculated for the gross area of the section. The total required shear reinforcement areas will be divided by a factor of two to account for each face, and it will be added to the flexural reinforcement. The design for shear in the vertical direction is done considering the entire wall height. The vertical shear design is conducted considering four regions. Twenty-two scenarios for the vertical shear direction design are investigated by considering the horizontal reinforcement information of the nine regions, and the maximum reinforcement obtained is assigned to the entire wall (nine regions). Shear friction is checked in both directions using the reinforcement in the perpendicular direction to the friction.

The final arrangement of the wall reinforcement is performed by combining the flexure and shear reinforcement and selecting one bar size and spacing. The ESWB Wall D reinforcement is shown in Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D.

3E.3.4.4 Critical Section Design

The structural design for the critical sections provides reinforcement to resist element forces and moments for ESWB Wall D.

The governing design data for ESWB Wall D, load combinations, and joints used for averaging are shown in Table 3E.3.4-1.

The minimum required area of steel reinforcement for ESWB Wall D is shown in Table 3E.3.4-2. Table 3E.3.4-2 also shows the area of steel reinforcement provided, based on the reinforcement configuration shown on Figure 3E.3.4-8—ESWB Wall D (Elevation) – Reinforcement, Figure 3E.3.4-9—ESWB Wall D (Section A) – Reinforcement, and Figure 3E.3.4-10—ESWB Wall D (Section B) – Reinforcement. Use of reinforcement configurations, including bar size, spacing, and clear cover, different from those shown on Figure 3E.3.4-8, Figure 3E.3.4-9, and Figure 3E.3.4-10 are acceptable, provided they meet or exceed the minimum required area of steel reinforcement shown in Table 3E.3.4-2.

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 1 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-1a	5205 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	4	0	123	0	*	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	24	0	70	*	*	*
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	96	0	16	0	*	*	*
	7309 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	203	0	-4	*	*	*
	6363 - 0.9(D + H + F + Fb)+ L + E' + SET	Envelope	Horizontal - Bending & Axial	95	0	0	0	*	*	*
	7565 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-169	0	0	*	*	*
	5352 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-31	0	-166	0	*	*	*
	5002 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-24	0	-172	*	*	*
	7002 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	-94	0	-34	0	*	*	*
	5564 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-209	0	-121	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 2 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5463 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	96	0	-1	0	*	*	*
	7465 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-169	0	0	*	*	*
	7013 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	1233	7652	*	*
	7509 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1030	*	*	1696
	7013 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	2289	16901	*	*
	7051 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Out-of-plane Shear	*	*	*	2216	*	*	1112
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - In-plane Shear	*	*	3297	*	6721	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3197	*	*	594	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - In-plane Shear	*	*	3064	*	7912	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3064	*	*	1057	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 3 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-1b	5201 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	4	0	116	0	*	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	23	0	70	*	*	*
	5251 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	96	0	15	0	*	*	*
	6313 - 0.9(D + H + F + Fb)+ L + E'	Envelope	Vertical - Bending & Axial	0	336	0	47	*	*	*
	6359 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Horizontal - Bending & Axial	95	0	0	0	*	*	*
	7557 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-280	0	0	*	*	*
	5356 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-36	0	-167	0	*	*	*
	5010 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-228	0	-265	*	*	*
	7006 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	-93	0	-33	0	*	*	*
	5560 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-339	0	-205	*	*	*
	5459 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	96	0	-1	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 4 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	7457 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-280	0	0	*	*	*
	7263 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - In-plane Shear	*	*	*	1213	9853	*	*
	7501 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1076	*	*	1684
	7013 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	2289	16901	*	*
	7051 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Out-of-plane Shear	*	*	*	2216	*	*	1112
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 5 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-2	7513 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	44	0	110	0	*	*	*
	7213 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	360	0	73	*	*	*
	7001 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	106	0	87	0	*	*	*
	6513 - 0.9(D + H + F + Fb)+ L + E'	Envelope	Vertical - Bending & Axial	0	360	0	67	*	*	*
	5182 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-12	0	1	0	*	*	*
	7153 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-298	0	1	*	*	*
	5064 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-44	0	-138	0	*	*	*
	5014 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-243	0	-295	*	*	*
	5252 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-108	0	-110	0	*	*	*
	5460 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-363	0	-231	*	*	*
	5466 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-86	0	0	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 6 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	7565 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Vertical - Bending & Axial	0	-301	0	0	*	*	*
	7263 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - In-plane Shear	*	*	*	1213	9853	*	*
	7501 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1076	*	*	1684
	7013 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	2289	16901	*	*
	7051 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Out-of-plane Shear	*	*	*	2216	*	*	1112
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 7 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-3	5205 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	4	0	113	0	*	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	59	0	41	*	*	*
	5251 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	93	0	21	0	*	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	118	0	7	*	*	*
	6154 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Horizontal - Bending & Axial	-78	0	1	0	*	*	*
	6253 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Vertical - Bending & Axial	0	-119	0	1	*	*	*
	5018 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-31	0	-115	0	*	*	*
	5214 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-116	0	-193	*	*	*
	6002 - 0.9(D + H + F + Fb)+ L + E'	Envelope	Horizontal - Bending & Axial	-91	0	-27	0	*	*	*
	5056 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-120	0	-184	*	*	*
	7154 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Bending & Axial	-78	0	-1	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 8 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5057 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-104	0	0	*	*	*
	7013 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	2062	15533	*	*
	7001 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1773	*	*	563
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 9 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-4	5205 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	13	0	64	0	*	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	42	0	36	*	*	*
	5251 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	74	0	25	0	*	*	*
	7005 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	72	0	12	*	*	*
	6055 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Horizontal - Bending & Axial	65	0	0	0	*	*	*
	5561 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-75	0	0	*	*	*
	5018 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-28	0	-99	0	*	*	*
	5510 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-51	0	-171	*	*	*
	7006 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	-72	0	-66	0	*	*	*
	5252 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-76	0	-141	*	*	*
	5155 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	65	0	-1	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
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Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5253 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-76	0	0	*	*	*
	7305 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	1553	13647	*	*
	7001 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1541	*	*	1713
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
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Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-5a	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	26	0	28	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	17	0	45	*	*	*
	7501 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	48	0	18	0	*	*	*
	7001 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	26	0	39	*	*	*
	5266 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-17	0	0	0	*	*	*
	5268 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-22	0	-39	0	*	*	*
	5068 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-21	0	-117	*	*	*
	5356 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-55	0	-29	0	*	*	*
	5256 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-31	0	-94	*	*	*
	3056 - 1.4(D + F + Fb) + 1.7(L + H) + Wt+0.5(Wp)+ SET	Envelope	Horizontal - Bending & Axial	-12	0	0	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	449	887	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
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Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	211	*	*	51
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 13 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-5b	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	26	0	28	0	*	*	*
	7217 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	18	0	44	*	*	*
	7505 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	48	0	18	0	*	*	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	28	0	35	*	*	*
	5213 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	15	0	0	0	*	*	*
	5272 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-22	0	-38	0	*	*	*
	5072 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-21	0	-116	*	*	*
	5352 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-55	0	-29	0	*	*	*
	5052 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-29	0	-105	*	*	*
	3056 - 1.4(D + F + Fb) + 1.7(L + H) + (Wt)+0.5(Wp) + SET	Envelope	Horizontal - Bending & Axial	-12	0	0	0	*	*	*
	7271 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	400	1428	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 14 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	210	*	*	49
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 15 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-6	5201 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	24	0	39	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	47	0	36	*	*	*
	5275 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	69	0	-12	0	*	*	*
	5009 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	70	0	4	*	*	*
	5525 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	68	0	1	0	*	*	*
	6265 - 0.9(D + H + F + Fb)+ L + E' + SET	Envelope	Vertical - Bending & Axial	0	-69	0	1	*	*	*
	5018 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-48	0	-93	0	*	*	*
	5018 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-51	0	-167	*	*	*
	7030 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	-65	0	-28	0	*	*	*
	5260 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - Bending & Axial	0	-75	0	-160	*	*	*
	5225 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	68	0	0	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 16 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5213 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	67	0	0	*	*	*
	7071 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - In-plane Shear	*	*	*	1209	9112	*	*
	7055 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1114	*	*	1249
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 17 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-7	7021 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	67	0	62	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	35	0	44	*	*	*
	5555 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	102	0	23	0	*	*	*
	5279 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - Bending & Axial	0	154	0	-5	*	*	*
	7255 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Horizontal - Bending & Axial	73	0	0	0	*	*	*
	6279 - 0.9(D + H + F + Fb)+ L + E' + SET	Envelope	Vertical - Bending & Axial	0	121	0	0	*	*	*
	5268 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	-54	0	-149	0	*	*	*
	5202 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-93	0	-171	*	*	*
	5352 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	-111	0	-60	0	*	*	*
	7026 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	-142	0	-132	*	*	*
	6255 - 0.9(D + H + F + Fb)+ L + E' + SET	Envelope	Horizontal - Bending & Axial	74	0	-1	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 18 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5275 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - Bending & Axial	0	117	0	0	*	*	*
	7271 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - In-plane Shear	*	*	*	2202	11277	*	*
	7255 - 0.9(D + H + F + Fb)+ E'+ SET	Envelope	Horizontal - Out-of-plane Shear	*	*	*	1583	*	*	1403
	5255 - D + L + H + F + Fb + E' + SET	Envelope	Vertical - In-plane Shear	*	*	2468	*	10527	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	3086	*	*	676	*
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 19 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-8	7021 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Bending & Axial	82	0	29	0	*	*	*
	7217 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	73	0	24	*	*	*
	5555 - D + L + H + F + Fb + E' + SET	Envelope	Horizontal - Bending & Axial	86	0	17	0	*	*	*
	5355 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	77	0	14	*	*	*
	6555 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Horizontal - Bending & Axial	64	0	0	0	*	*	*
	6351 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Vertical - Bending & Axial	0	77	0	0	*	*	*
	5268 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	-76	0	-112	0	*	*	*
	5022 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-43	0	-87	*	*	*
	5506 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-86	0	-107	0	*	*	*
	5506 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-75	0	-82	*	*	*
	6551 - 0.9(D + H + F + Fb)+ L + E'+ SET	Envelope	Horizontal - Bending & Axial	64	0	-1	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 20 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5257 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	-64	0	-1	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	769	4833	*	*
	7505 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	693	*	*	612
	7251 - 0.9(D + H + F + Fb)+ E' + SET	Envelope	Vertical - In-plane Shear	*	*	1809	*	10260	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2067	*	*	1192	*
	5205 - D + L + H + F + Fb + E'	Envelope	Vertical - In-plane Shear	*	*	2043	*	9217	*	*
	7201 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Out-of-plane Shear	*	*	2354	*	*	308	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 21 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
Wall D-9	5021 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	4	0	13	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	4	0	17	*	*	*
	5325 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	14	0	8	0	*	*	*
	5305 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	137	0	6	*	*	*
	5563 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	12	0	1	0	*	*	*
	5051 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	50	0	0	*	*	*
	5202 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-7	0	-34	0	*	*	*
	5018 - D + L + H + F + Fb + E'	Envelope	Vertical - Bending & Axial	0	-12	0	-52	*	*	*
	5510 - D + L + H + F + Fb + E'	Envelope	Horizontal - Bending & Axial	-10	0	-6	0	*	*	*
	7502 - 0.9(D + H + F + Fb)+ E'	Envelope	Vertical - Bending & Axial	0	-66	0	-31	*	*	*
	5179 - D + L + H + F + Fb + E'+ SET	Envelope	Horizontal - Bending & Axial	7	0	0	0	*	*	*

Table 3E.3.4-1—Governing Design Data for ESWB Wall D
Sheet 22 of 22

Locations	LC[1]	SC[1]	Condition	Governing Design Data[3][4][6]						
				M_{U-XX}[2]	M_{U-YY}[2]	N_{XX}[5]	N_{YY}[5]	N_{XY}[5]	V_{XX}[5]	V_{YY}[5]
				k-ft/ft	k-ft/ft	k/ft or k	k/ft or k	k/ft or k	k/ft or k	k/ft or k
	5271 - D + L + H + F + Fb + E'+ SET	Envelope	Vertical - Bending & Axial	0	49	0	0	*	*	*
	7221 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - In-plane Shear	*	*	*	623	2649	*	*
	7205 - 0.9(D + H + F + Fb)+ E'	Envelope	Horizontal - Out-of-plane Shear	*	*	*	705	*	*	462
	5271 - D + L + H + F + Fb + E' +SET	Envelope	Vertical - In-plane Shear	*	*	266	*	1240	*	*
	5017 - D + L + H + F + Fb + E'	Envelope	Vertical - Out-of-plane Shear	*	*	280	*	*	88	*

Notes:

1. LC is the governing load combination, SC is the governing soil analysis case.
2. M_x is conservatively absolute summed with M_{xy} to obtain $M_{u\text{-}xx}$. The same is done for M_{xy} to obtain $M_{u\text{-}yy}$.
3. (–) indicates compression, (+) indicates tension.
4. GTSTRUDL forces and moments.
5. Units are k/ft in flexural design and k for shear design.
6. (*) indicates that reinforcing is not applicable.

Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D
Sheet 1 of 5

Locations	Type	Thickness	Condition	*[Required As-req (in^2/ ft)*	Reinforcement Pattern	Provided $A_{s\text{-}pro}$ (in^2/ft)	Reinforcement Ratio ($A_{s\text{-}pro}$/ $A_{s\text{-}req}$)
Wall D-1a & 1b	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*3.13*	2 #10s @ 9 in EF	3.38	1.08
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*3.91*	2 #10s @ 6 in EF	5.07	1.30
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*
Wall D-2	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*2.99*	2 #10s @ 9 in EF	3.38	1.13
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*4.26*	2 #10s @ 6 in EF	5.07	1.19
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*

Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D
Sheet 2 of 5

Locations	Type	Thickness	Condition	*[Required As-req (in^2/ ft)*	Reinforcement Pattern	Provided $A_{s\text{-}pro}$ (in^2/ft)	Reinforcement Ratio ($A_{s\text{-}pro}$/ $A_{s\text{-}req}$)
Wall D-3	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*2.63*	2 #10s @ 9 in EF	3.38	1.28
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*2.90*	2 #10s @ 6 in EF	5.07	1.75
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*
Wall D-4	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*2.92*	2 #10s @ 9 in EF	3.38	1.16
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*3.15*	2 #10s @ 6 in EF	5.07	1.61
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*

Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D
Sheet 3 of 5

Locations	Type	Thickness	Condition	*[Required As-req (in^2/ ft)*	Reinforcement Pattern	Provided $A_{s\text{-}pro}$ (in^2/ft)	Reinforcement Ratio ($A_{s\text{-}pro}$/ $A_{s\text{-}req}$)
Wall D-5a&5b	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*3.08*	2 #10s @ 9 in EF	3.38	1.10
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*2.96*	2 #10s @ 6 in EF	5.07	1.71
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*
Wall D-6	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*2.84*	2 #10s @ 9 in EF	3.38	1.19
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*2.96*	2 #10s @ 6 in EF	5.07	1.71
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*

Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D
Sheet 4 of 5

Locations	Type	Thickness	Condition	*[Required As-req (in^2/ ft)*	Reinforcement Pattern	Provided $A_{s\text{-}pro}$ (in^2/ft)	Reinforcement Ratio ($A_{s\text{-}pro}$/ $A_{s\text{-}req}$)
Wall D-7	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*2.61*	2 #10s @ 9 in EF	3.38	1.29
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*2.83*	2 #10s @ 6 in EF	5.07	1.79
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*
Wall D-8	Horizontal	3 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*1.90*	#10 @7 in EF	2.17	1.14
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*2.43*	#10 @ 6 in EF	2.53	1.04
	Stirrup		Out-of-plane Shear	*0.00*	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*

Table 3E.3.4-2—Reinforcement Detail for ESWB Wall D
Sheet 5 of 5

Locations	Type	Thickness	Condition	*[Required As-req (in^2/ ft)*	Reinforcement Pattern	Provided $A_{s\text{-}pro}$ (in^2/ft)	Reinforcement Ratio ($A_{s\text{-}pro}$/ $A_{s\text{-}req}$)
Wall D-9	Horizontal	2 ft	Tangential Shear, Shear Friction, Membrane, and Bending	*1.09*	#10 @12 in EF	1.27	1.16
	Vertical		Tangential Shear, Shear Friction, Membrane, and Bending	*1.87*	#10 @ 6 in EF	2.53	1.35
	Stirrup		Out-of-plane Shear	*0.00]**	#4 Cross-Ties at 18 in Vertical C. to C.(4)	0.13	*

Notes:

1. EF is each face.
2. $A_{S\text{-}req}$ is required reinforcement.
3. $A_{S\text{-}pro}$ is provided reinforcement.
4. In accordance with Section 14.3.6 of ACI 349-01, cross-ties are provided to stabilize vertical reinforcement. These cross-ties also serve as out-of-plane shear reinforcement.

Figure 3E.3.4-1—ESWB Wall D Design Regions (FEM) for Flexure

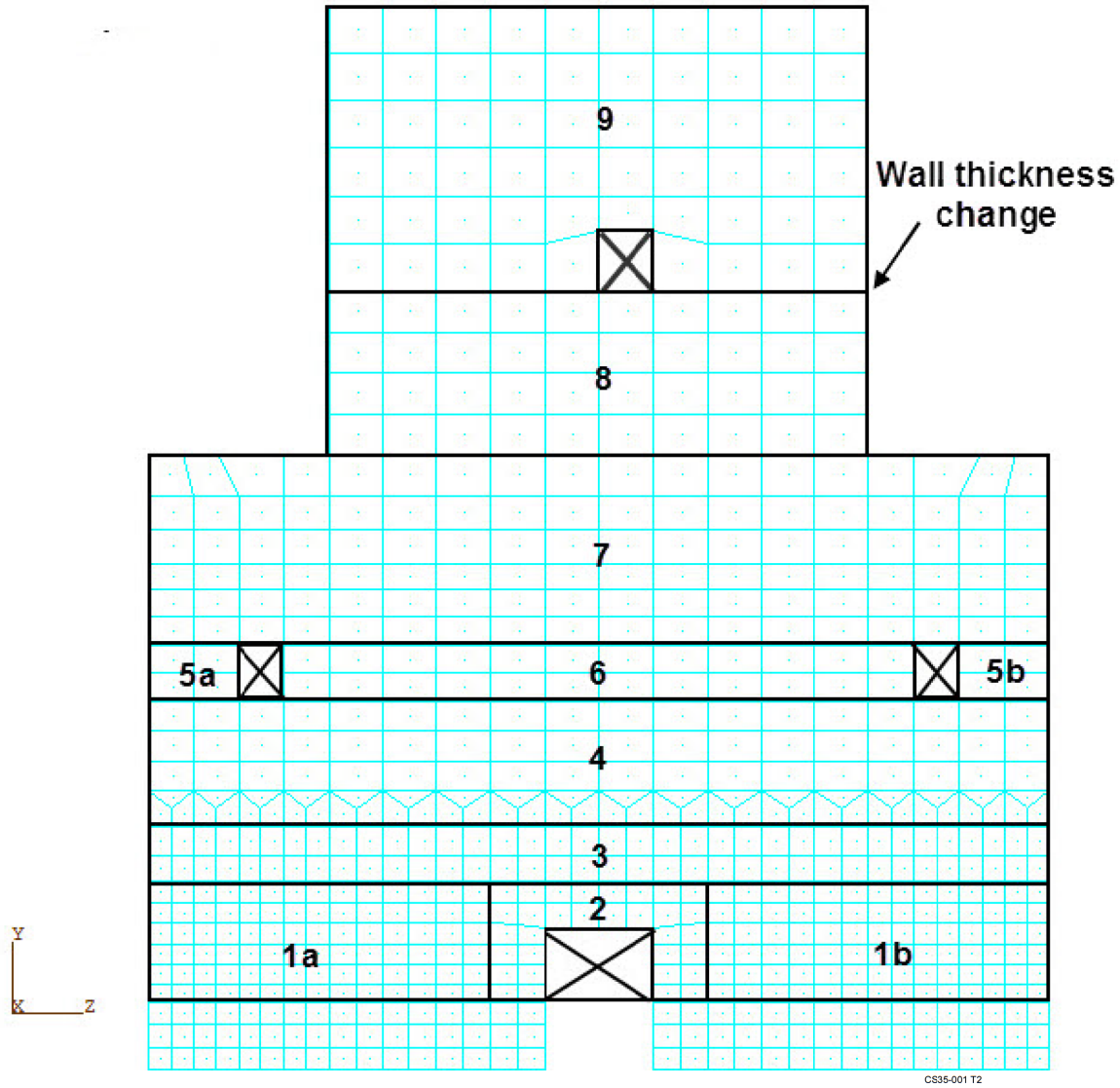


Figure 3E.3.4-2—ESWB Wall D Design Regions (FEM) for Horizontal Shear

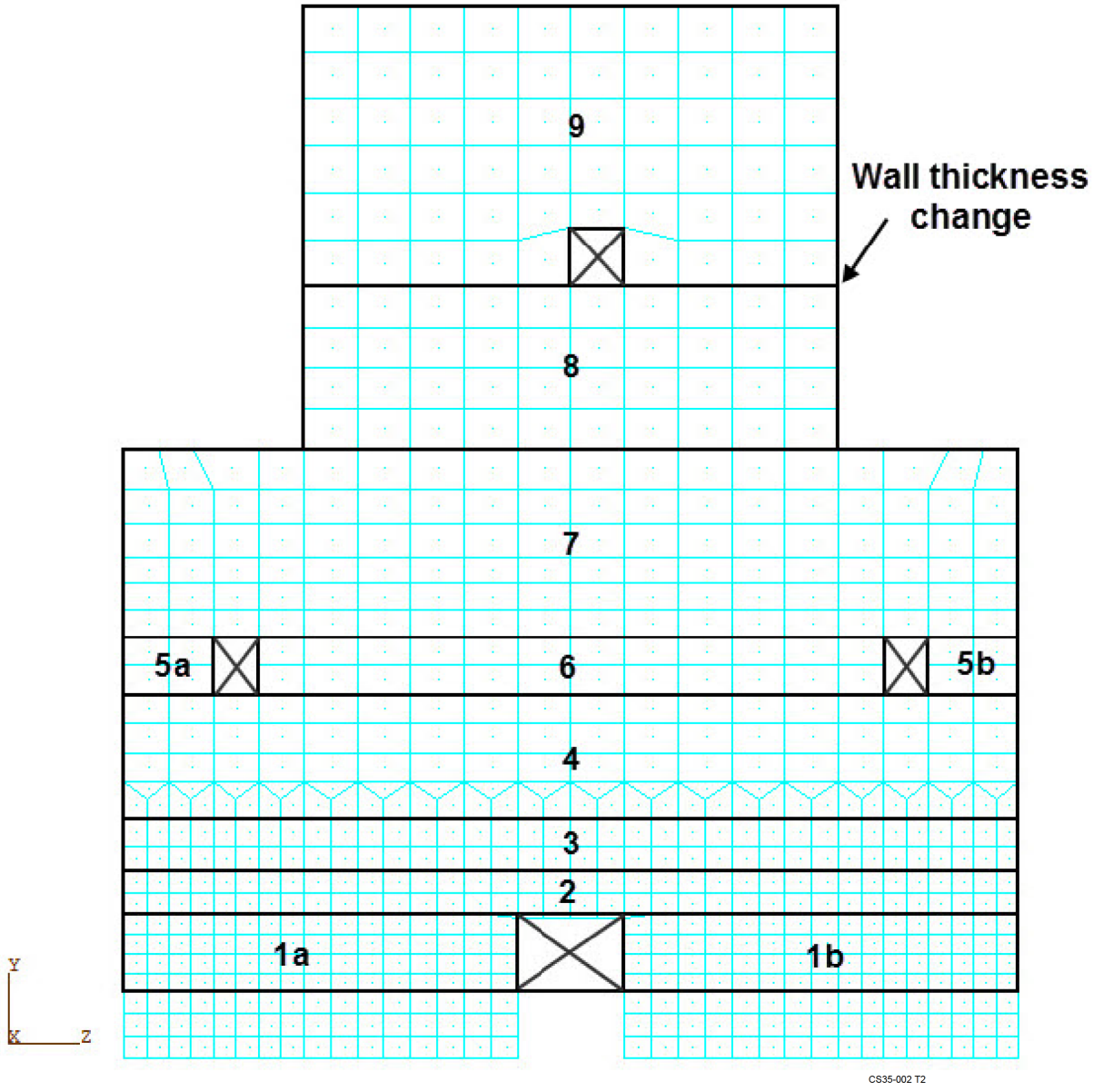


Figure 3E.3.4-3—ESWB Wall D Design Regions (FEM) for Vertical Shear

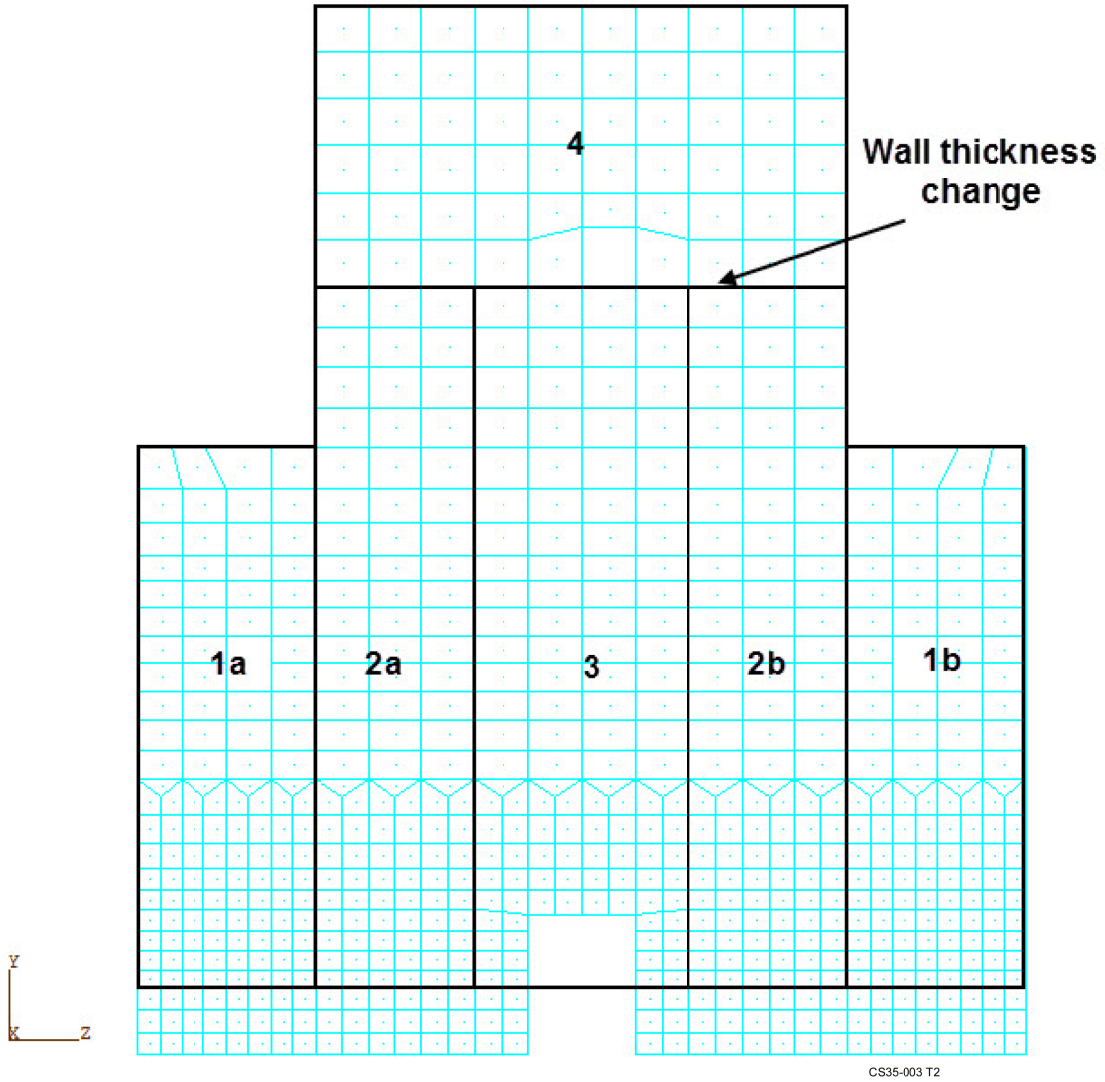


Figure 3E.3.4-4—ESWB Wall D Axial Force (Tension) and Bending Moment Critical Design Cuts (FEM)

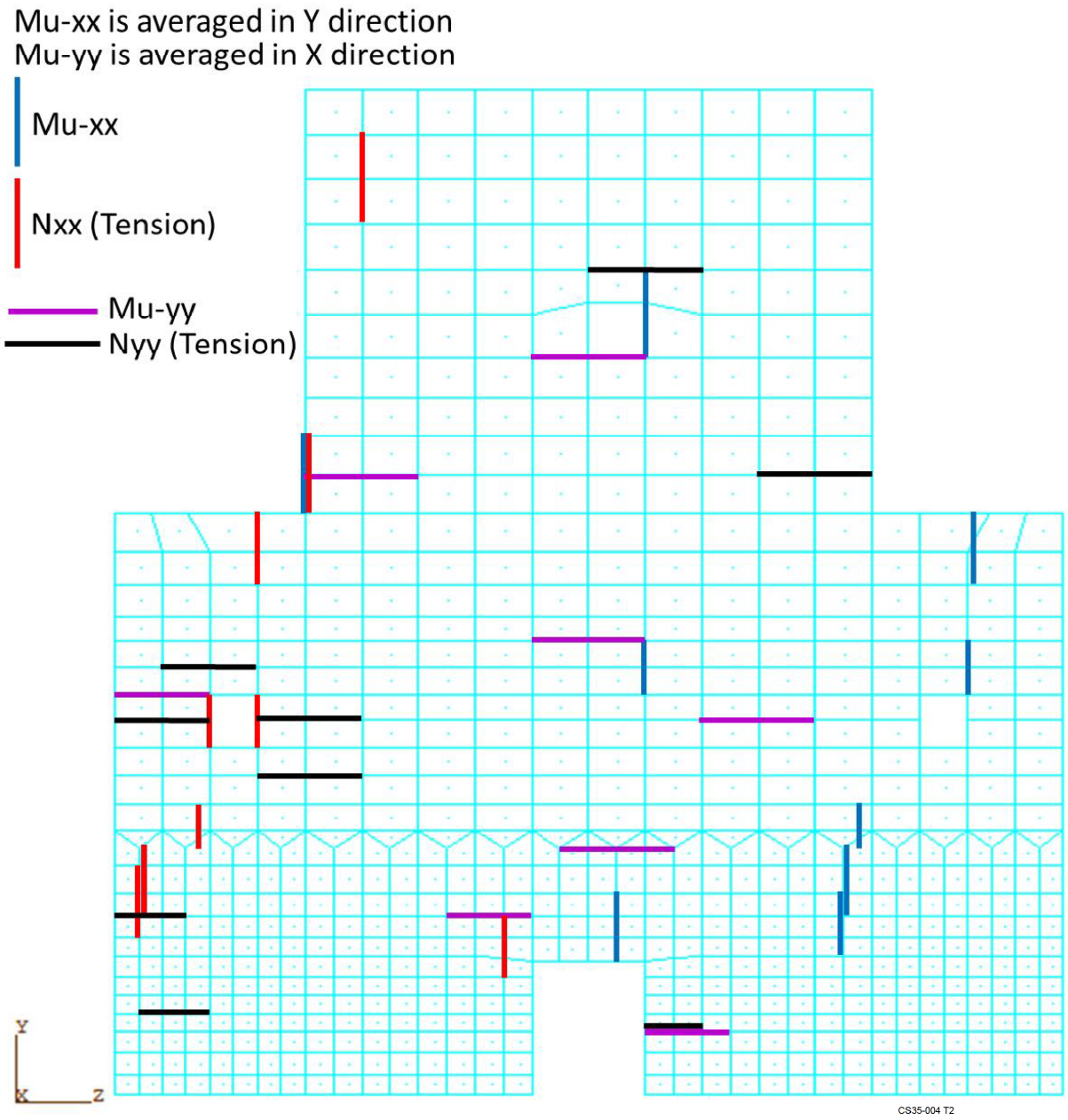


Figure 3E.3.4-5—ESWB Wall D In-Plane and Out-of-Plane Shear Critical Design Cuts (FEM)

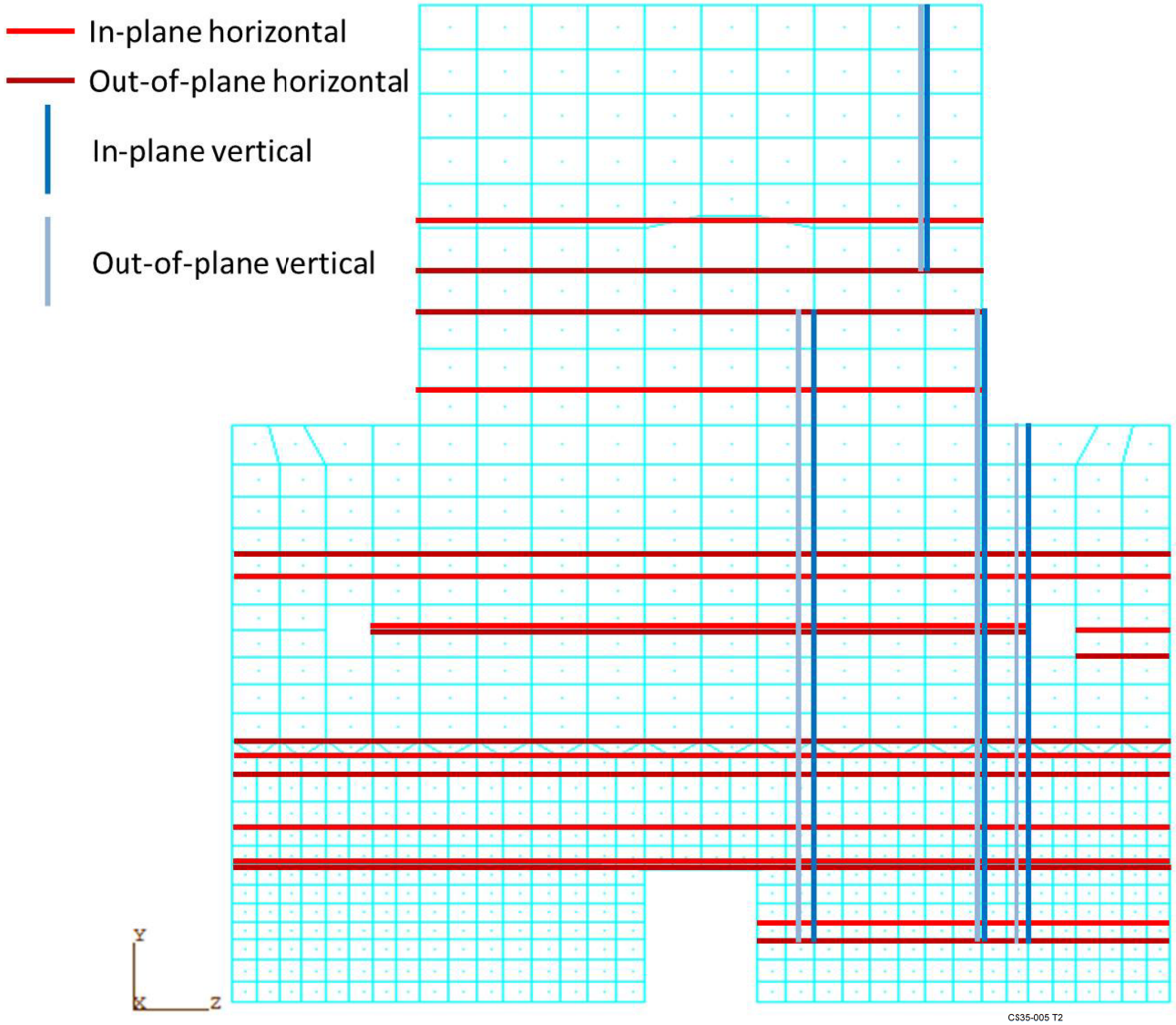


Figure 3E.3.4-6—GTSTRUDL Finite Element Planar Reference Frame Systems (Plate Bending)

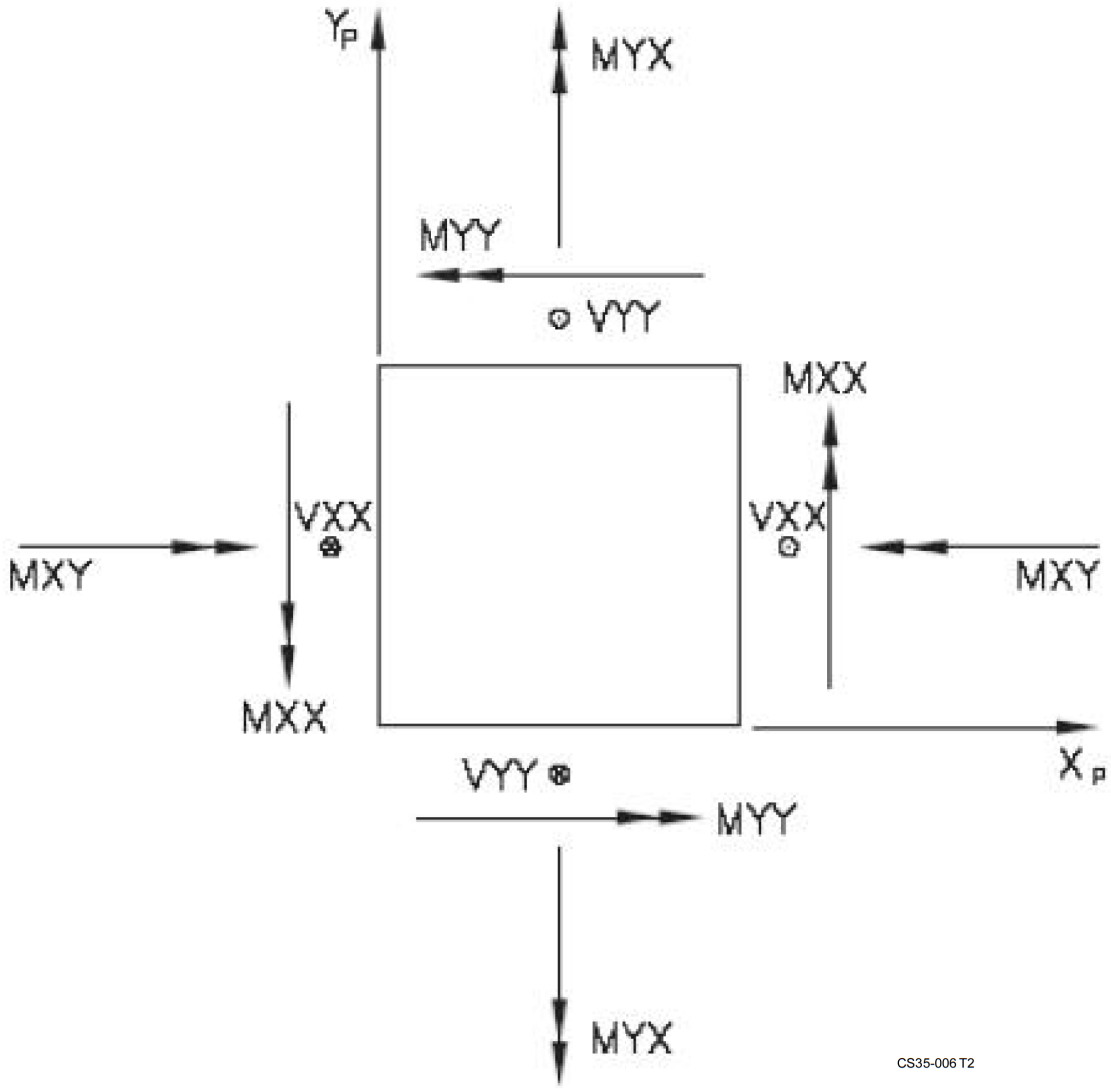


Figure 3E.3.4-7—GTSTRUDL Finite Element Planar Reference Frame Systems (Plane Stress/Strain)

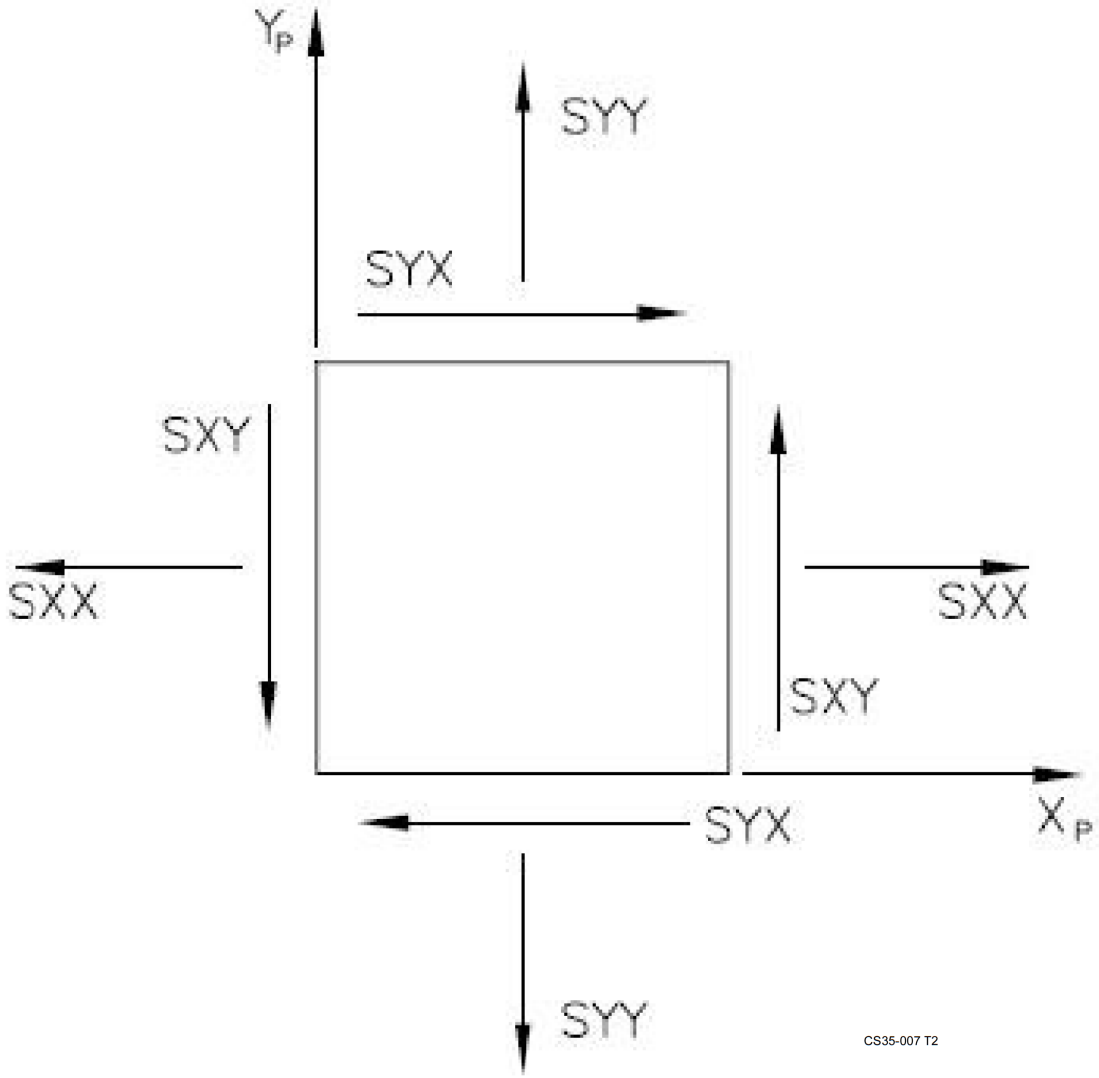


Figure 3E.3.4-8—ESWB Wall D (Elevation) – Reinforcement

Figure 3E.3.4-9—ESWB Wall D (Section A) – Reinforcement

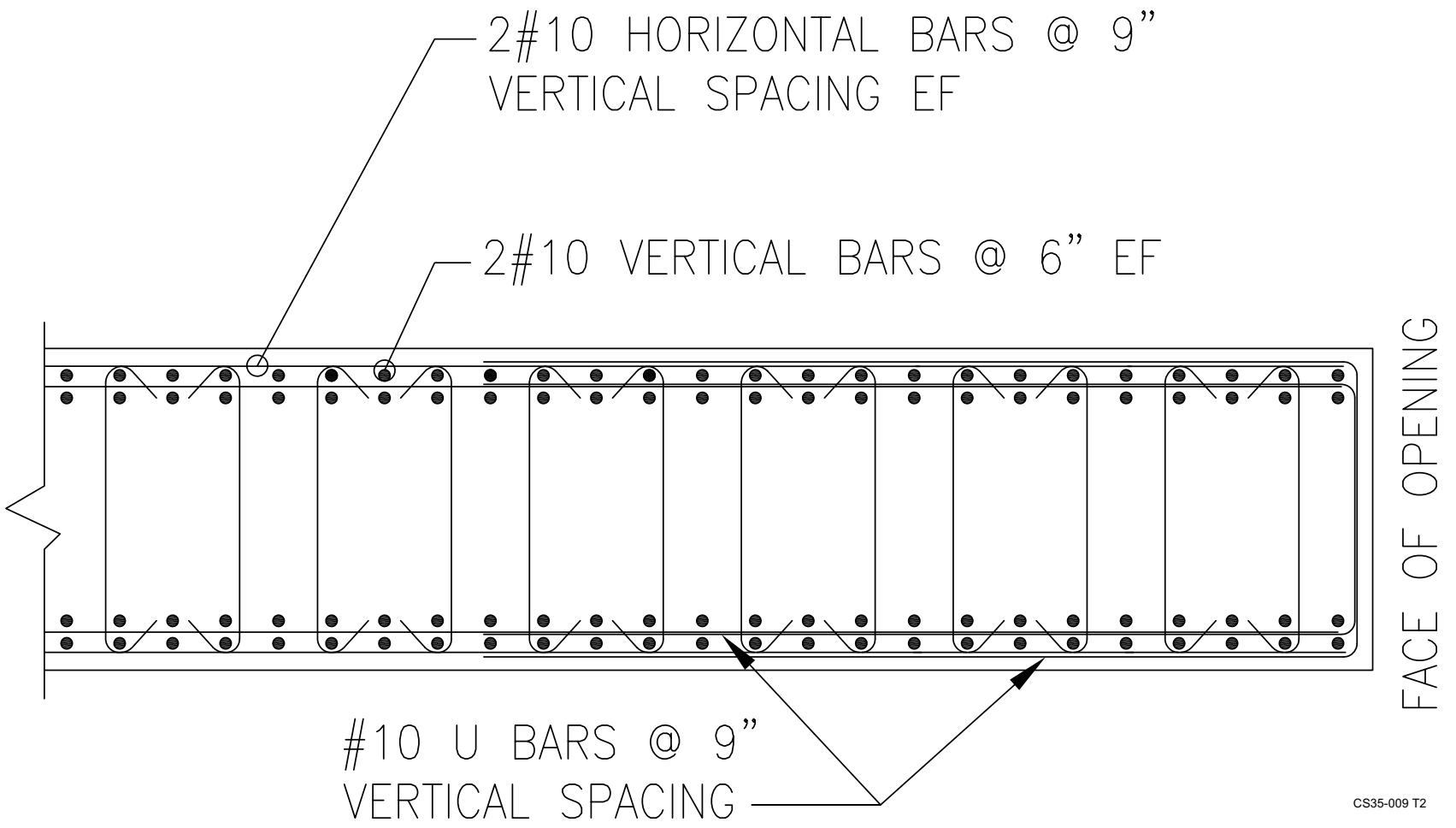
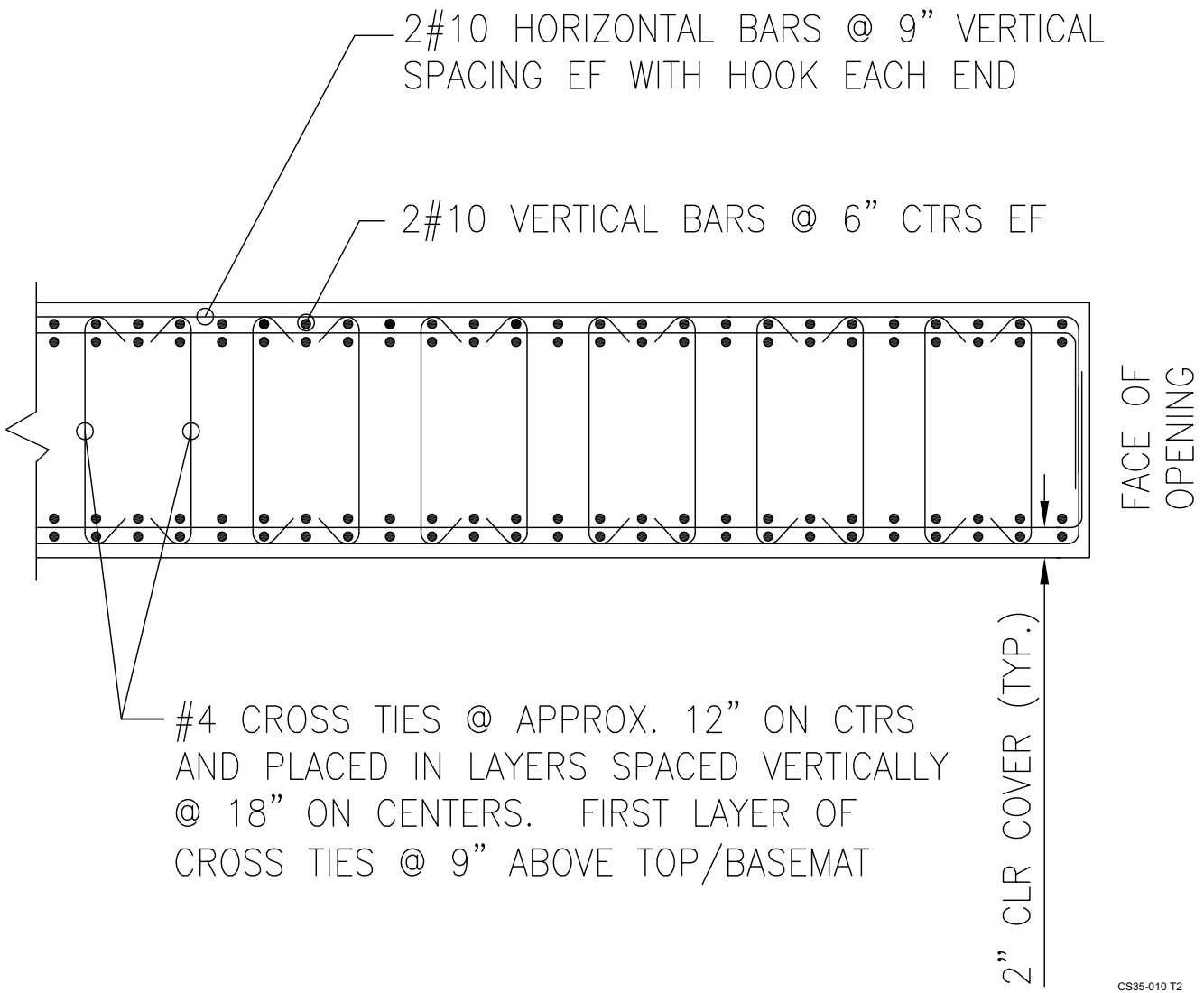


Figure 3E.3.4-10—ESWB Wall D (Section B) – Reinforcement



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