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Replace Article 11.6.5 of the Table of Contents with the following:

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11.3—NOTATION

Replace the notations with the following:

B = wall base width (ft); semi-gravity wall heel length (ft) (11.10.2) (A11.3.1)
b = gross width of the strip, sheet, or grid reinforcement; width of bin module (ft) (11.10.6.4.1) (11.11.5.1)
D_{min} = distance between the back of MSE facing elements and any concrete footing element (ft) (11.10.11)
H = height of wall (ft); vertical distance between ground surface and top of heel at the stem (ft) (11.6.5.1) (A11.3.1)
H_{max} = maximum clear distance between superstructure soffit and finished grade in front of the MSE facing (ft) (11.10.11)

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11.5.1—General

Replace the 2nd paragraph with the following:

Abutments, piers and retaining walls shall be designed to withstand lateral earth and water pressures, including any live and dead load surcharge, the self weight of the wall, temperature and shrinkage effects, and earthquake loads (if applicable) in accordance with the general principles specified in this Section.

11.5.2—Eccentricity Limits

Add a new paragraph after the 2nd paragraph:

When abutments and piers are supported on shallow foundations, the location of the resultant of the reaction forces shall be in compliance with the provisions of Article 10.5.2.2.

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Add a new paragraph after the last paragraph:

The eccentricity check for bridge shallow foundations, including abutments, is conducted under Service-I Combination as stated in Section 10.

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11.5.6—Load Combinations and Load Factors

Replace the 1st paragraph with the following:

Piers and retaining structures and their foundations and other supporting elements shall be proportioned for all applicable load combinations specified in Article 3.4.1. Abutments and their foundations shall be proportioned for all applicable load combinations specified in Article 3.4.5.

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11.5.7—Resistance Factors – Service and Strength

Replace Table 11.5.7-1 with the following:

Table 11.5.7-1—Resistance Factors for Permanent Retaining Walls

Wall-Type and Condition		Resistance Factor
Nongravity Cantilevered and Anchored Walls		
Axial compressive resistance of vertical elements		Article 10.5 applies
Passive resistance of vertical elements		1.00
Pullout resistance of anchors (1)	• Cohesionless (granular) soils • Cohesive soils • Rock	0.65 (1) 0.70 (1) 0.50 (1)
Pullout resistance of anchors (2)	• Where proof tests are conducted	1.0 (2)
Tensile resistance of anchor tendon	• Mild steel (e.g., ASTM A 615 bars) • High strength steel (e.g., ASTM A 722 bars) • High strength steel strands (e.g., ASTM A 416)	0.90 (3) 0.80 (3) 0.75 (3)
Flexural capacity of vertical elements		0.90
Mechanically Stabilized Earth Walls, Gravity Walls, and Semigravity Walls		
Bearing resistance	• Gravity and semi-gravity walls • MSE walls	0.55 0.65
Sliding	• Friction • Passive resistance	1.00 0.50
Tensile resistance of metallic reinforcement and connectors	Strip reinforcements (4) • Static loading Grid reinforcements (4) (5) • Static loading	 0.90 0.80
Tensile resistance of geosynthetic reinforcement and connectors	• Static loading	0.90
Pullout resistance of tensile reinforcement	• Static loading	0.90
Prefabricated Modular Walls		
Bearing		Article 10.5 applies
Sliding		Article 10.5 applies
Passive resistance		Article 10.5 applies

Continued on next page

Table 11.5.7-1 (Continued)—Resistance Factors for Permanent Retaining Walls

(1) Apply to presumptive ultimate unit bond stresses for preliminary design only in Article C11.9.4.2.

(2) Apply where proof test(s) are conducted on every production anchor to a load of 1.0 or greater times the factored load on the anchor.

(3) Apply to maximum proof test load for the anchor. For mild steel apply resistance factor to F_y. For high-strength steel apply the resistance factor to guaranteed ultimate tensile strength.

(4) Apply to gross cross-section less sacrificial area. For sections with holes, reduce gross area in accordance with Article 6.8.3 and apply to net section less sacrificial area.

(5) Applies to grid reinforcements connected to a rigid facing element, e.g., a concrete panel or block. For grid reinforcements connected to a flexible facing mat or which are continuous with the facing mat, use the resistance factor for strip reinforcements.

11.6.1.2—Loading

Replace the 2nd paragraph with the following:

The provisions of Articles 3.11.5 and 11.5.5 shall apply. For stability computations, the earth loads shall be multiplied by the maximum and/or minimum load factors given in Table 3.4.1-2, as appropriate. Abutments and their foundations shall be proportioned for all applicable load combinations specified in Article 3.4.5.

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11.6.1.5.2—Wingwalls

Replace the article with the following:

Reinforcing bars or suitable rolled sections shall be spaced across the junction between wingwalls and abutments to tie them together. Such bars shall extend into the concrete and/or masonry on each side of the joint far enough to develop the strength of the bar as specified for bar reinforcement, and shall vary in length so as to avoid planes of weakness in the concrete at their ends. If bars are not used, an expansion joint shall be provided and the wingwall shall be keyed into the body of the abutment.

Replace the article and title for Article 11.6.1.6 with the following:

11.6.1.6—Expansion and Weakened Plane Joints

Weakened plane joints shall be provided at intervals not exceeding 24.0 ft and expansion joints at intervals not exceeding 96.0 ft for conventional retaining walls. All joints shall be filled with approved filling material to ensure the function of the joint.

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11.6.3.3—Eccentricity Limits

Replace the article with the following:

For shallow foundations of retaining walls on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds of the base width.

The eccentricity check for bridge shallow foundations, including abutments, is conducted under Service-I Combination as stated in Section 10.

For shallow foundations of retaining walls on rock, the location of the resultant of the reaction forces shall be within the middle nine-tenths of the base width.

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Replace the article title for 11.6.5 with the following:

11.6.5—Seismic Design for Conventional Retaining Walls

Add a new commentary as follows:

C11.6.5

Abutments founded in Class S1 soil (as defined in SDC 6.1.2) have been exempted from Extreme Event (Seismic) design considering the following facts:

- Post seismic observations have not shown any catastrophic damage to abutments that resulted in collapse, provided that enough seat width has been provided for superstructure movements.
- For non-integral type abutments, excessive movement of the abutment towards the bridge is prevented by contact of the back wall to the superstructure.
- Components of the abutments, such as shear keys and the backwall, are designed to break without causing any failure in the foundation system.
- Overall (slope) stability check is performed by the geotechnical professional.

Abutments in Class S2 soil (as defined in SDC 6.1.3) require special analysis.

11.6.5.1—General

Replace the 1st sentence of the 1st paragraph with the following:

Rigid gravity and semigravity retaining walls shall be designed to meet overall stability, external stability, and internal stability requirements during seismic loading.

Delete the 3rd paragraph.

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Replace the article and title for Article 11.6.5.4 with the following:

11.6.5.4—Calculation of Seismic Earth Pressure for Nonyielding Walls

For walls that are considered nonyielding, the value k_h used to calculate seismic earth pressure shall be increased to 1.0k_{h0}, unless the Owner approves the use of more sophisticated numerical analysis techniques to determine the seismically induced earth pressure acting on the wall to yield in response to lateral loading. In this case, k_h should not be corrected for wall displacement, since displacement is assumed to be zero. However, k_h should be corrected for wave scattering effects as specified in Article 11.6.5.2.2.

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11.9.5.1—Anchors

C11.9.5.1

Add the following after the 2nd paragraph:

In addition to the Hinge Method shown in Figures C11.9.5.1-1 and C11.9.5.1-2, the Modified Hinge Method may be used as illustrated in Figure C11.5.9.1-3 a) for one-level anchor and C11.9.5.1-3 b) for multilevel anchors. The Modified Hinge Method eliminates the reaction *"R"* at the base of the excavation by applying earth pressures to the vertical wall element below the base of excavation. The pressure on the vertical wall element in Figure C11.9.5.1-3 is shown schematically and for illustrative purposes only. The actual active and passive pressure diagrams on the vertical wall element will depend on soil parameters unique to the wall system and on appropriate earth pressure theories.

The procedure to analyze a one-level wall in Figure C11.9.5.1-3a) is as follows:

- i) Take moments about the anchor to calculate the embedment depth of the vertical wall element, *CD*;
- ii) Set summation of forces equal to zero in the horizontal direction to calculate anchor load T_1;
- iii) Calculate Maximum Bending Moment (M_{MAX}) and Maximum Shear Force (V_{MAX}) in the wall element.

The procedure to analyze a multilevel wall in Figure C11.9.5.1-3b is,

i) Calculate T_{NU} in the lowest anchor following the procedure given for the Hinge Method, using the loads in the anchors above the lowest anchor;
ii) Calculate M_{MAX} and V_{MAX} in the wall element *ACD*;
iii) Calculate the embedment depth of the vertical wall element, *EL*, by taking moments about the lowest anchor;
iv) Set summation of forces equal to zero in the horizontal direction for *DEL* to calculate the lowest anchor load (T_{nL});
v) The total load in the lowest anchor, T_n, is $T_{nU} + T_{nL}$;
vi) Calculate M_{MAX} and V_{MAX} in the wall element, *DEL*;
vii) Design the pile with the controlling M_{MAX} and V_{MAX} from *ACD* and *DEL*.

Add the following figure after Figure C11.9.5.1-2:

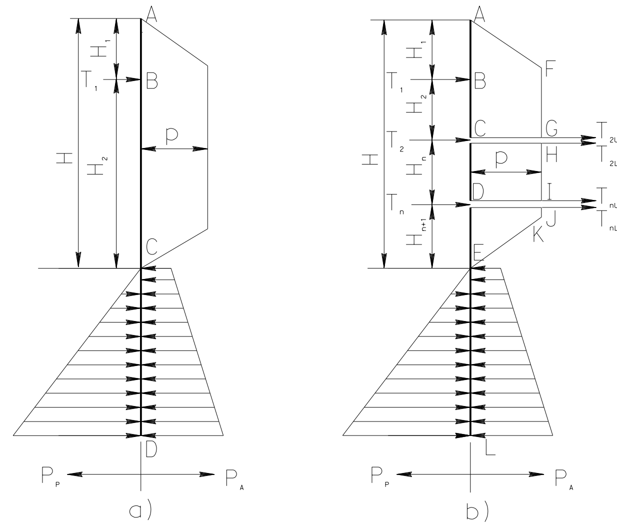

Figure C11.9.5.1-3—Calculation of Anchor Loads and Pile Embedment Depth for a) One-Level Wall and b) Multilevel Wall

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11.10.2.2—Minimum Front Face Embedment

Replace the 2nd bullet of the 2nd paragraph with the following:

- 10% of the design height, and not less than 2.0 ft

Replace the 5th paragraph with the following:

A minimum horizontal bench width of 0.1*H* but not less than 4.0 ft shall be provided in front of walls founded on slopes. The bench may be formed or the slope continued above that level as shown in Figure 11.10.2-1.

C11.10.2.2

Delete Table C11.10.2.2-1

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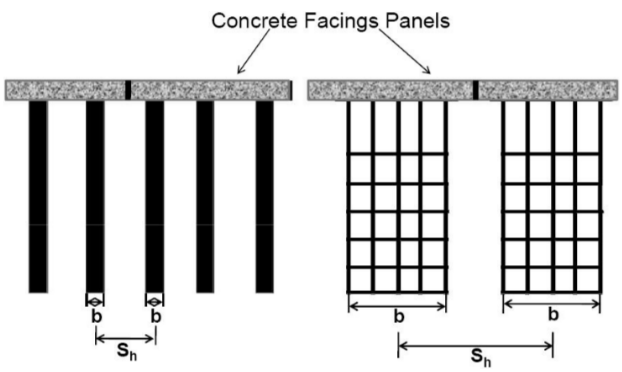
11.10.6.4.1—General

Replace the definition of *b* within Figure 11.10.6.4.1-1 with the following:

b = the gross width of the strip, sheet, or grid reinforcement (if reinforcement is continuous, count the number of bars for reinforcement width of 1 unit of measure).

Add a new figure after Figure 11.10.6.4.1-1 as follows:



b = the gross width of the strip, sheet, or grid reinforcement.

Figure 11.10.6.4.1-1a—Reinforcement Width *b*

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11.10.6.4.2a— Steel Reinforcements

Add a new paragraph before the 4th paragraph:

When soil backfill conforms to the following criteria:

- pH = 5.5 to 10
- Resistivity ≥2000 ohm-cm
- Chlorides <250 ppm
- Sulfates <500 ppm
- Organic Content ≤1 percent
- Does not contain slag aggregate or recycled materials

the sacrificial thicknesses shall be computed for each exposed surface as follows:

- Loss of galvanizing over 10 years (using 2 oz/ ft^2)
- Loss of carbon steel = 1.1 mil/yr. after zinc depletion

C11.10.6.4.2a

Add a new paragraph after the 4th paragraph:

Considerable data from numerous MSE in California has been gathered for a national research project to develop the resistance and load factors for corrosion in actual field conditions. As a result, the equations, design parameters and construction specifications are under review. This section continues current practice in conjunction with the more aggressive soils permitted in current Caltrans construction specifications, until that review is complete.

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11.10.11—MSE Abutments

Replace the 6th paragraph with the following:

The minimum thickness of compacted backfill between the concrete footing elements and the soil reinforcement shall be 6 inches. The minimum distance, D_{min}, between the back of the MSE facing elements and any element of the concrete footing shall be as follows:

$$D_{min} = 8 - 0.3(20 - H_{max}) \geq 5 \text{ ft} \qquad (11.10.11\text{-}3)$$

where H_{max} is ≤ 30 ft

Replace the 9th paragraph with the following:

In pile or drilled shaft supported abutments, the horizontal forces transmitted to the deep foundation elements shall be resisted by the lateral capacity of the deep foundation elements by provision of additional reinforcements to tie the drilled shaft or pile cap into the soil mass, or by batter piles. Lateral loads transmitted from the deep foundation elements to the reinforced backfill may be determined using a P-Y lateral load analysis technique. The facing shall be isolated from horizontal loads associated with lateral pile or drilled shaft deflections. A minimum clear distance of 5.0 ft shall be provided between the facing and all deep foundation elements. Piles or drilled shafts shall be specified to be placed prior to wall construction and cased through the fill if necessary.

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A11.3.1—Mononobe-Okabe Method

Replace Figure A11.3.1-1 with the following:

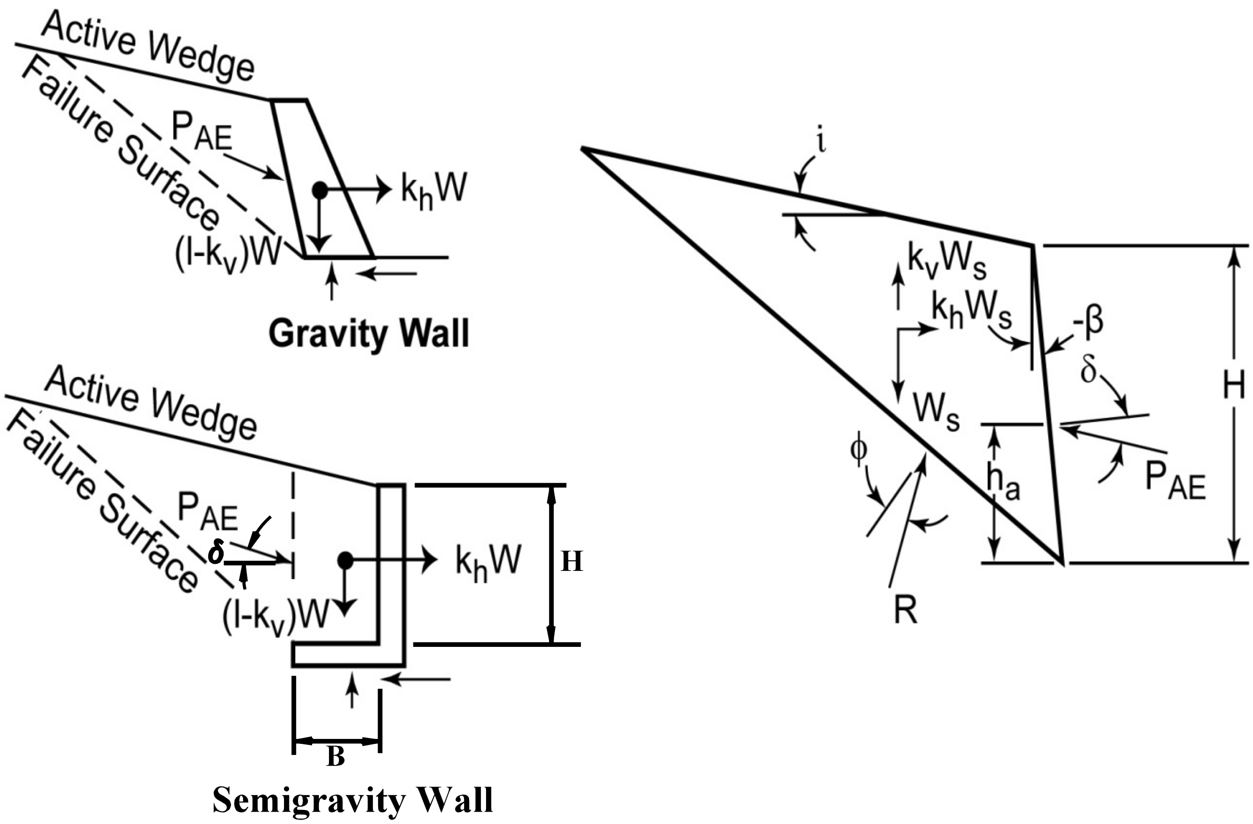

Figure A11.3.1-1—Mononobe-Okabe Method Force Diagrams

Add the following before the second to last paragraph:

Modified from a study by Iskander, *et al* (2013), when retaining cohesionless soil, the angle of P_{AE} on the vertical plane through the end of the heel of a semigravity wall, δ, in Figure A11.3.1-1 may be determined as,

$$\delta = \tan^{-1}\left\{\frac{\sin(2\theta_{Mo}) + m_\alpha \sin(2i)}{2\,[\sin^2\theta_{Mo} - m_\alpha \cos^2 i\,]}\right\}\ \text{(degrees)} \qquad \text{(A11.3.1-2)}$$

where

$$m_\alpha = \frac{\cos(i+\theta_{Mo}) - \sqrt{\cos^2(i+\theta_{Mo}) - \cos^2\phi_f}}{\cos(i+\theta_{Mo}) + \sqrt{\cos^2(i+\theta_{Mo}) - \cos^2\phi_f}} \qquad \text{(A11.3.1-3)}$$

δ used with equation (A11.3.1-2) is measured from horizontal. Modified from a study by Kloukinas, *et al* (2011), the heel of the semigravity wall must be long enough for δ in Equation A11.3.1-2 to be valid and the ratio of heel length, *B*, over stem height, *H*, must satisfy the following relation,

$$\frac{B}{H} \geq \tan\left(45° - \frac{\phi_f}{2} - \frac{\Delta_{1e} - i}{2} - \frac{\theta_{Mo}}{2}\right) \qquad \text{(A11.3.1-4)}$$

where

$$\Delta_{1e} = \sin^{-1}\left\{\frac{\sin(i + \theta_{Mo})}{\sin\phi_f}\right\} \text{(degrees)} \qquad \text{(A11.3.1-5)}$$

Equation A11.3.1-2 should not be used to predict δ, for any other types of earth retaining systems, including, but not limited to, gravity walls, MSEs, non-gravity walls, crib walls or gabion systems.