STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

May 2018

Log No. _____

1. State Building Code to be Amended:

- ☒ International Building Code
- ☐ ICC ANSI A117.1 Accessibility Code
- ☐ International Existing Building Code
- ☐ International Residential Code
- ☐ International Fire Code
- ☐ Uniform Plumbing Code
- ☐ International Mechanical Code
- ☐ International Fuel Gas Code
- ☐ NFPA 54 National Fuel Gas Code
- ☐ NFPA 58 Liquefied Petroleum Gas Code
- ☐ Wildland Urban Interface Code

For the Washington State Energy Code, please see specialized energy code forms

Section(s): **Washington State Building Code Amendments**

1901.2, 1905.1 and 1905.8

(e.g.: Section: R403.2)

Title: **Special Reinforced Concrete Shear Walls**

(e.g: Footings for wood foundations)

2. Proponent Name (Specific local government, organization or individual):

Proponent: Structural Engineers Association of Washington (SEAW)

Title: Earthquake Engineering Committee

Date: 8/1/2024

3. Designated Contact Person:

Name: Patrick Lindblom, PE, SE

Title: Senior Structural Engineer, HDR

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4. **Proposed Code Amendment**. Reproduce the section to be amended by underlining all added language, striking through all deleted language. Insert new sections in the appropriate place in the code in order to continue the established numbering system of the code. If more than one section is proposed for amendment or more than one page is needed for reproducing the affected section of the code, additional pages may be attached.

   Clearly state if the proposal modifies an existing amendment or if a new amendment is needed. If the proposal modifies an **existing amendment**, show the modifications to the existing amendment by underlining all added language and striking through all deleted language. If a new amendment is needed, show the modifications to the **model code** by underlining all added language and striking through all deleted language.

   Code(s) _International Building Code 2024_ **Section(s)** 1901.2, 1905.1, 1905.8

   Enforceable code language must be used.

<<Commentary related to the following provisions may be referenced in ACI 318-25.

A note on formatting:
Items with Underline are to be added to the Washington State Building Code.
Items with ~~Strikethrough~~ are to be removed from the Washington State Building Code.
Items with Underline and Highlight are text directly from ACI 318-25 to be added to the Washington State Building Code as the items being added to ACI 318-19.
Items with ~~Strikethrough and Highlight~~ are text directly from ACI 318-25 to be added to the Washington State Building Code as items being removed from ACI 318-19. >>

Amend section to read as follows:

1901.2 Plain and reinforced concrete. Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as supplemented and amended in Section 1905 of this code.

1905 ~~SEISMIC REQUIREMENTS~~ SUPPLEMENTS AND MODIFICATIONS TO ACI 318

1905.1 General. ~~In addition to the provisions of ACI 318, structural concrete shall comply with the requirements of Section 1905.~~ The text of ACI 318 shall be supplemented as indicated in Sections 1905.2 through 1905.7 and modified as indicated in Sections 1905.8 and 1905.9.

<1905.2 through 1905.7 unchanged>

1905.8 Amendments to ACI 318. The text of ACI 318 shall be permitted to be amended as indicated in Sections 1905.8.1 through 1905.8.5.

USER NOTE: The intent of the Washington State amendments to ACI 318-19 Section 18.10 (Special Structural Walls) is to permit the use of the following specific provisions, based entirely on ACI 318-25.

1905.8.1 ACI 318 Section 2.2. Amend ACI 318 Section 2.2 as follows:

E_h = effect of horizontal earthquake-induced forces.

h_n = structural height from the base to the highest level of the seismic force-resisting system of the structure, ft, where the base is the level at which the horizontal earthquake ground motions are considered to be imparted to the structure.
V_{uEh} = factored shear force from load combinations including primary load E, considering only horizontal earthquake load effect E_h.
Ω_v = overstrength factor ~~equal to the ratio of M_{pr}/M_u~~ to account for wall flexural overstrength at the wall critical section.

1905.8.2 ACI 318 Section 18.10.3. Amend ACI 318 Section 18.10.3 as follows:

18.10.3 Design forces

18.10.3.1 Design shear forces for horizontal wall segments, including coupling beams, shall be in accordance with 18.10.7.
~~The design shear force V_e shall be calculated by:~~

~~$$V_e = \Omega_v \omega_v V_u \leq 3 V_u \qquad (18.10.3.1)$$~~

~~where V_u, Ω_v, and ω_v are defined in 18.10.3.1.1, 18.10.3.1.2, and 18.10.3.1.3, respectively.~~
~~**18.10.3.1.1** V_u is the shear force obtained from code lateral load analysis with factored load combinations.~~
~~**18.10.3.1.2** Ω_v shall be in accordance with Table 18.10.3.1.2~~
~~Table 18.10.3.1.2—Overstrength factor Ω_v at critical section~~

~~Condition~~	~~Ω_v~~	
~~$h_{wcs}/l_w > 1.5$~~	~~Greater of~~	~~M_{pr}/M_u [1]~~
		~~1.5 [2]~~
~~$h_{wcs}/l_w \leq 1.5$~~	~~1.0~~	

~~[1] For the load combination producing the largest value of Ω_v.~~
~~[2] Unless a more detailed analysis demonstrated a smaller value, but not less than 1.0.~~
~~**18.10.3.1.3** For walls with $h_{wcs}/l_w < 2.0$, ω_v shall be taken as 1.0. Otherwise, ω_v shall be calculated as:~~

~~$$\omega_v = 0.9 + \frac{n_s}{10} \quad n_s \leq 6$$~~

~~$$\omega_v = 1.3 + \frac{n_s}{30} \leq 1.8 \quad n_s > 6 \qquad (18.10.3.1.3)$$~~

~~Where n_s shall not be taken less than the quantity $0.007h_{wcs}$.~~

18.10.3.2 Design shear forces for wall piers shall be in accordance with 18.10.8.

18.10.3.3 Design shear forces for parts of walls not covered by 18.10.3.1 or 18.10.3.2 shall be in accordance with the requirements of 18.10.3.3.1 through 18.10.3.3.5.

18.10.3.3.1 If the wall design actions are determined in accordance with nonlinear dynamic analysis procedures satisfying Appendix A, design shear forces shall be as determined in Appendix A.

18.10.3.3.2 If V_{uEh} is determined by linear analysis procedures of the general building code, it shall be amplified by the product $\Omega_v\omega_v$, where Ω_v and ω_v are defined in 18.10.3.3.3 through 18.10.3.3.5.

18.10.3.3.3 Ω_v and ω_v shall be in accordance with Table 18.10.3.3.3. Alternatively, it shall be permitted to calculate $\Omega_v = M_{pr}/M_u$ at the critical section for flexure, where M_{pr} is calculated for axial force that includes the effects of E and the expected gravity loads, with expected gravity loads in accordance with ASCE 7, Section 16.3.2.

Table 18.10.3.3.3 Factors Ω_v and ω_v

Condition	Ω_v	ω_v
$h_{wcs}/l_w \leq 1.0$	1.0	1.0
$1.0 < h_{wcs}/l_w < 2.0$	Linear interpolation permitted between 1.0 and 1.5	
$h_{wcs}/l_w \geq 2.0$	1.5	$0.8 + 0.09h_n^{1/3}$

18.10.3.3.4 If the general building code includes provisions to account for overstrength of the seismic-force-resisting system, it shall be permitted to take $\Omega_v\omega_v$ equal to Ω_0.

18.10.3.3.5 If $\Omega_v\omega_v = \Omega_0$, it shall be permitted to take the redundancy factor contained in the general building code equal to 1.0 for determination of V_{uEh}.

1905.8.3 ACI 318 Section 18.10.4. Amend ACI 318 Section 18.10.4 as follows:

18.10.4.1 V_n shall be calculated by

$V_n = (\alpha_c\lambda\sqrt{f'_c} + \rho_t f_{yt})A_{cv}$ (18.10.4.1)

where:

$\alpha_c = 3$ for $h_w/\ell_w \leq 1.5$
$\alpha_c = 2$ for $h_w/\ell_w \geq 2.0$

It shall be permitted to linearly interpolate the value of α_c between 3 and 2 for $1.5 < h_w/\ell_w < 2.0$. The value of f'_c used in Equation 18.10.4.1 and in 18.10.4.4 and 18.10.4.5 shall not exceed 12,000 psi.

<18.10.4.2 through 18.10.4.3 unchanged>

~~**18.10.4.6** The requirements of 21.2.4.1 shall not apply to walls or wall piers designed according to 18.10.6.2.~~

1905.8.4 ACI 318 Section 18.10.6. Amend ACI 318 Section 18.10.6 as follows:

18.10.6.4 If special boundary elements are required by 18.10.6.2 or 18.10.6.3, (a) through (k) shall be satisfied:

<18.10.6.4 (a) through (e) unchanged>

(f) ~~Transverse reinforcement shall be arranged such that the s~~Spacing h_x between laterally supported longitudinal bars around the perimeter of the boundary element shall not exceed the lesser of 14 in. and (2/3)b ~~two-thirds of the boundary element thickness~~. Lateral support shall be provided by a seismic hook of a crosstie or corner of a hoop. Unless (i) or (ii) is satisfied, ~~T~~the length of ~~a~~the hoop legs shall not exceed $2b_c$ ~~two times the boundary element thickness~~, and adjacent hoops shall overlap at least the lesser of 6 in. and (2/3)b: ~~two-thirds the boundary element thickness.~~

(i) $b \geq \sqrt{l_w c/40}$ and $\delta_u/h_{wcs} \leq 0.012$

(ii) A flange is provided within depth c with a total width at least $2b_w$ and a thickness t_f at least $b_w/2$

<18.10.6.4 (g) through (h) unchanged>

(i) For a distance above and below the critical section specified in 18.10.6.2(b), web vertical reinforcement shall have lateral support provided by the corner of a hoop or by a crosstie with seismic hooks at

each end. ~~Transverse reinforcement~~ Hoops and crossties shall have a vertical spacing not to exceed 12 in. and diameter satisfying 25.7.2.2. Alternatively, it shall be permitted to use crossties with a 90-degree hook at the other end, with the crossties alternated end for end along the length and height of the web if vertical spacing of crossties does not exceed 9 inches.

<18.10.6.4 (j) through (k) unchanged>

18.10.6.5 Where special boundary elements are not required by 18.10.6.2 or 18.10.6.3, (a) and (b) shall be satisfied:

(a) Except where V_u in the plane of the wall is less than $\lambda\sqrt{f'_c}A_{cv}$, horizontal reinforcement terminating at the edges of structural walls without boundary elements shall have a standard hook engaging the edge reinforcement or the edge reinforcement shall be enclosed in U-stirrups having the same size and spacing as, and spliced to, the horizontal reinforcement.

(b) If the maximum longitudinal reinforcement ratio at the wall boundary exceeds $400/f_y$, boundary transverse reinforcement shall satisfy 18.7.5.2(a) through (e) over the length ~~distance~~ calculated in accordance with 18.10.6.4(a). At corners where a wall web and flange intersect, boundary transverse reinforcement shall extend into the web and the flange at least 12 in. The vertical spacing of transverse reinforcement at the wall boundary shall be in accordance with Table 18.10.6.5(b).

1905.8.5 ACI 318 Section 21.2.4.1. Amend ACI 318 Section 21.2.4.1 as follows:

21.2.4.1 For any member designed to resist E, except for walls where $\Omega_v \geq 1.5$, ϕ for shear shall be 0.60 if the nominal shear strength of the member is less than the shear corresponding to the development of the nominal moment strength of the member. The nominal moment strength shall be the maximum value calculated considering factored axial loads from load combinations that include E.

5. **Briefly explain your proposed amendment, including the purpose, benefits and problems addressed.** Specifically note any impacts or benefits to business, and specify construction types, industries and services that would be affected. Finally, please note any potential impact on enforcement such as special reporting requirements or additional inspections required.

The International Building Code (IBC) 2024 edition references the American Concrete Institute (ACI) 318-19 as the Reference Standard for concrete building material. The 2019 edition of this standard introduced a number of significant changes to the seismic design of new concrete structures. Some of these changes have led to issues that are currently being revised in subsequent versions of the ACI 318 standard. Adoption of this proposal avoids drastic changes to construction practice that would only be in effect until ACI 318-25 is adopted by the Washington State Building Code Council.

The shear wall design force shear amplification in section 18.10.3 is one of these changes. The ACI 318-25 committee has approved an update to section 18.10.3 to curtail the changes made in the 318-19 edition which will reduce the design forces required for Special Reinforced Concrete Shear Walls. Additionally, changes to Section 18.10.4.1 make clear that the use of high-strength concrete is allowed for the construction of Special Reinforced Concrete Shear Walls which is unclear in the current version of the code. Lastly, Section 18.10.6 and its subsections have been modified for clarity to more correctly reflect the intent of the detailing requirements for the steel reinforcing inside Special Reinforced Concrete Shear Walls which reduces the quantity of reinforcing steel from what was described in the previous version of the code. Some of these items have already been balloted and published by the ACI 318 committee as a Code Case.

User Note: The language in this proposal is taken from the Public Comment version of ACI 318-25. As the published version of ACI 318-25 is released, the proponent plans to update the language within this proposal to match, however, it is expected that only editorial changes will be made and nothing that changes the technical content of this proposal.

6. **Specify what criteria this proposal meets.** You may select more than one.
   - ☐ The amendment is needed to address a critical life/safety need.
   - ☒ The amendment clarifies the intent or application of the code.
   - ☐ The amendment is needed to address a specific state policy or statute.
   - ☐ The amendment is needed for consistency with state or federal regulations.
   - ☐ The amendment is needed to address a unique character of the state.
   - ☐ The amendment corrects errors and omissions.

7. **Is there an economic impact:** ☒ Yes ☐ No

   If no, state reason:

   If yes, provide economic impact, costs and benefits as noted below in items a – f.

   a. ***Life Cycle Cost.*** Use the OFM Life Cycle Cost **Analysis tool** to estimate the life cycle cost of the proposal using one or more typical examples. Reference these **Instructions;** use these **Inputs.** Webinars on the tool can be found **Here** and **Here**). If the tool is used, submit a copy of the excel file with your proposal submission. If preferred, you may submit an alternate life cycle cost analysis.

   Significant reduction of materials where special reinforced concrete shear walls are used. The reduction in cost varies significantly with the building type, size, and location.

   b. ***Construction Cost.*** Provide your best estimate of the construction cost (or cost savings) of your code change proposal.

   $Varies/square foot

   (For residential projects, also provide $Click here to enter text./ dwelling unit)

   Show calculations here, and list sources for costs/savings, or attach backup data pages

   Significant reduction of construction cost due to fewer required materials where special reinforced concrete shear walls are used. The reduction in cost varies significantly with the building type, size, and location.

   c. ***Code Enforcement.*** List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

   No additional code enforcement time for additional plan review or inspections. There is an expected reduction in code enforcement time due to clarifications made to the concrete design code.

   d. ***Small Business Impact.*** Describe economic impacts to small businesses:

   Construction costs will decrease for small businesses.

   e. ***Housing Affordability.*** Describe economic impacts on housing affordability:

Construction costs will decrease for multi-family residential buildings.

f. ***Other.*** Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed:

This proposal brings forward provisions of the upcoming concrete design code ACI 318-25 which were made in response to changes in the previous code version ACI 318-19

Please send your completed proposal to: sbcc@des.wa.gov

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.