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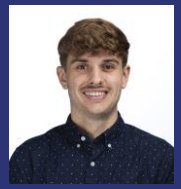
Presenter

CEO – USA Office



Alex Bacon, EIT
Moderator

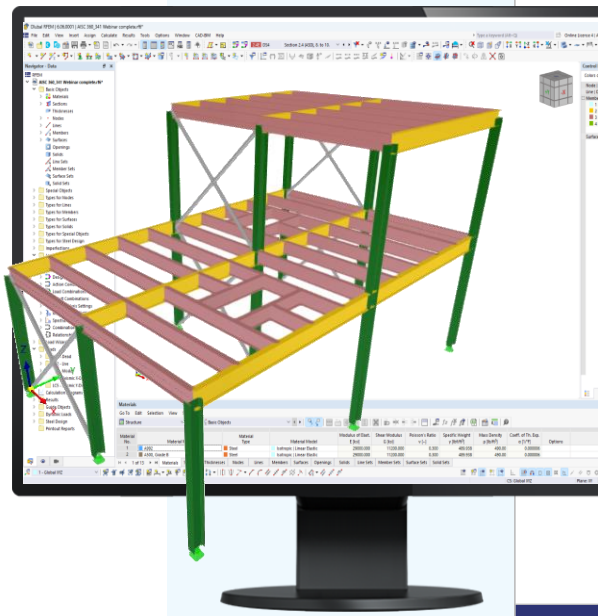
Technical Support Engineer

Cisca Tjoa, PE
Moderator

Technical Support Engineer

Webinar

AISC 360/ 341-22 Steel Member Design in RFEM 6



Questions During the Presentation

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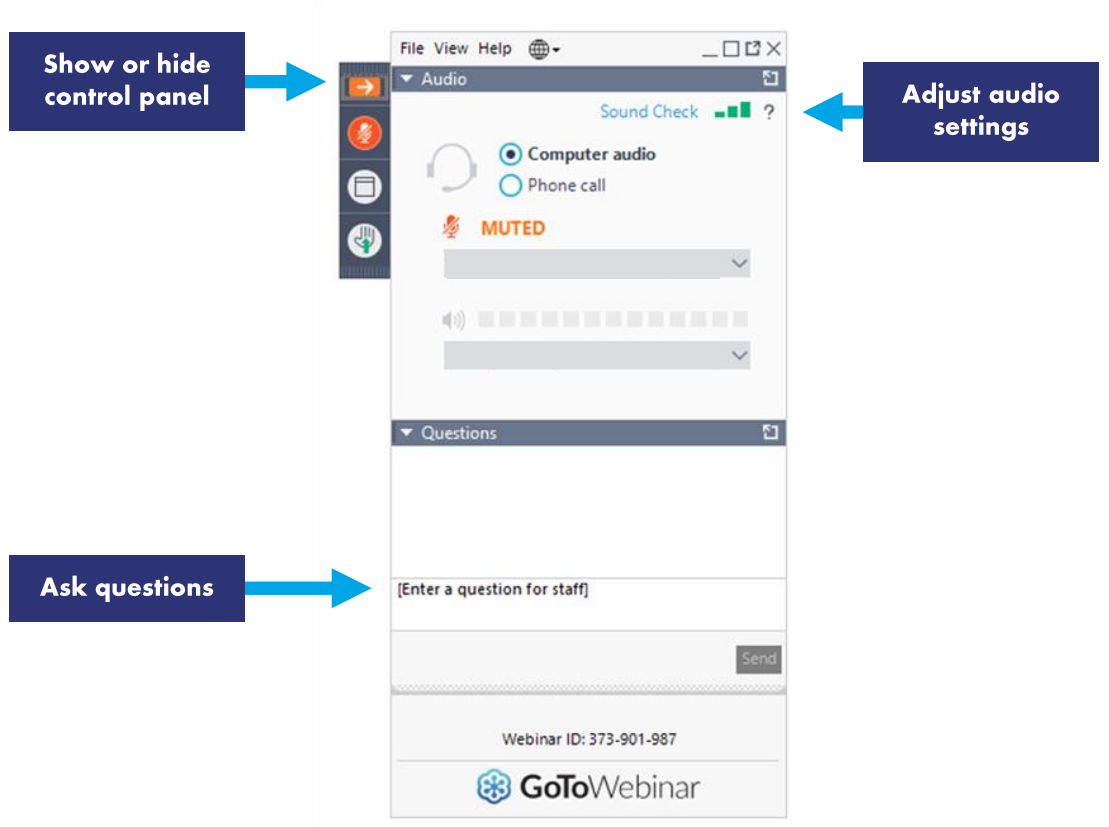
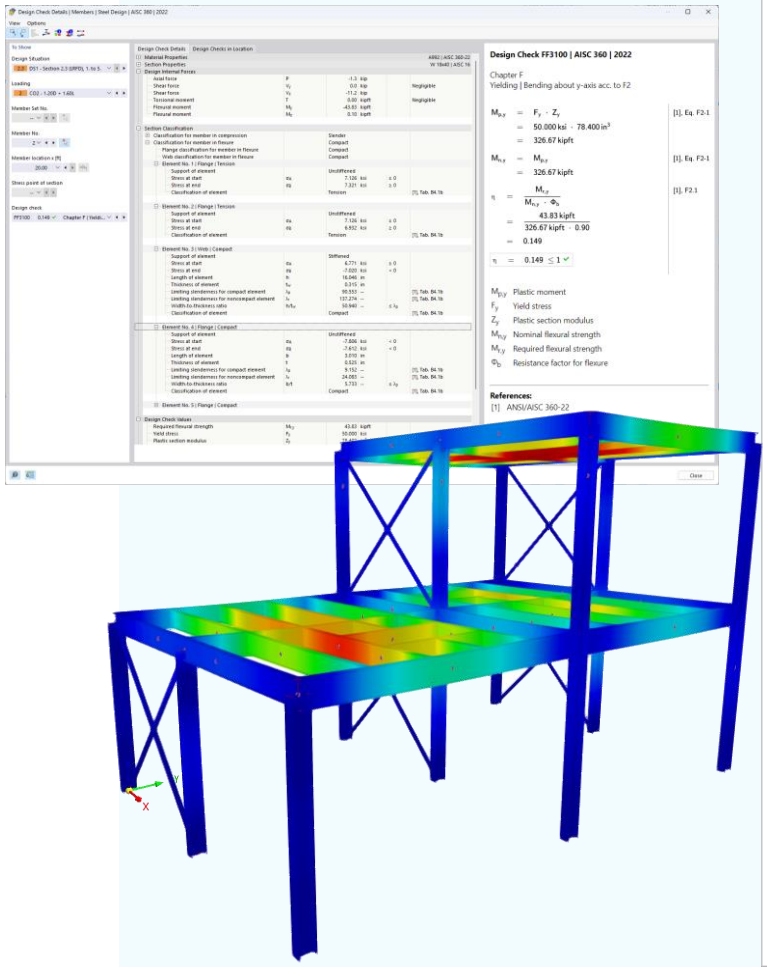


Content



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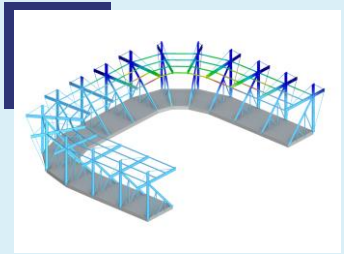
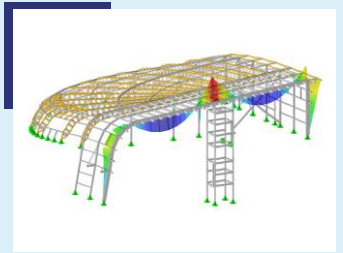
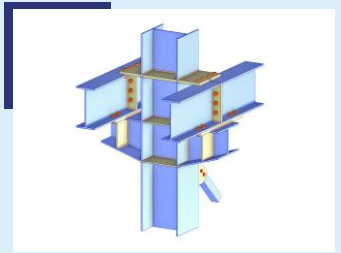
Steel Design in RFEM 6



RFEM 6



Steel Design Add-on



Steel Joints Add-on

Additional Add-ons

Structure Stability

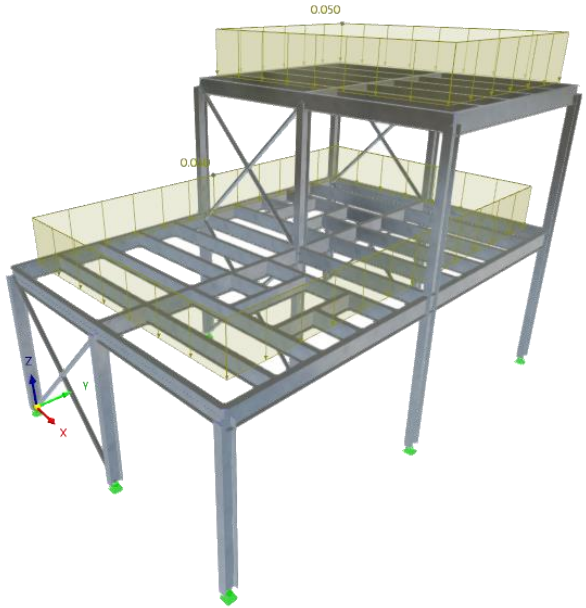
Nonlinear Material Behavior

Construction Stage Analysis

etc.

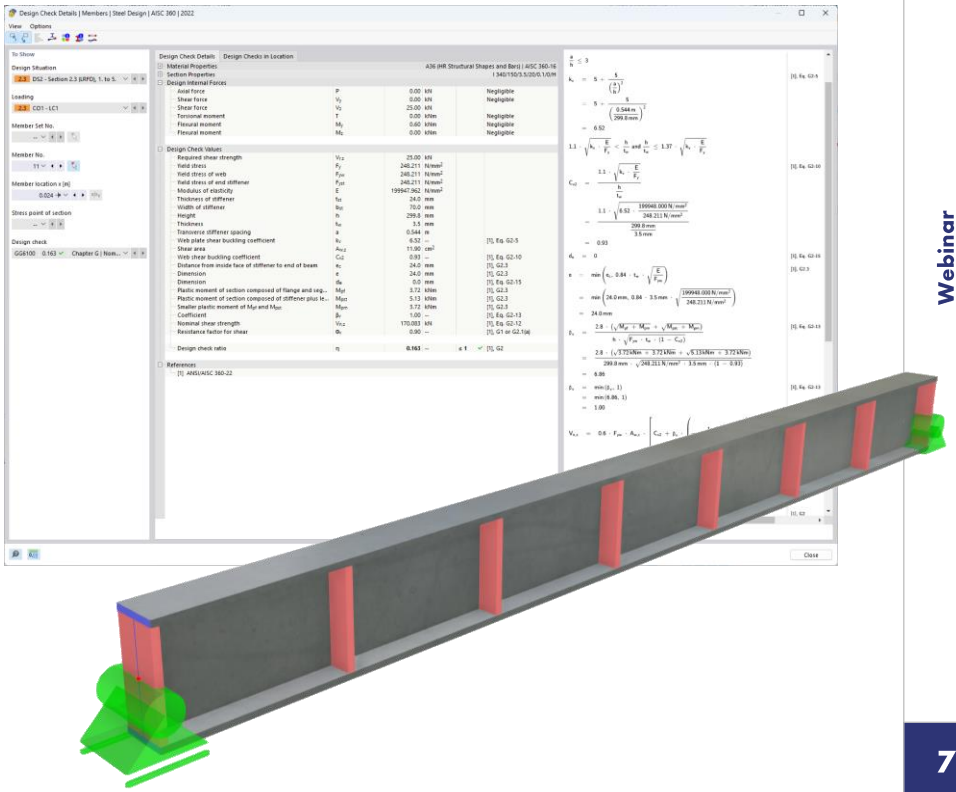
AISC 360-22 Updates

- Sect. C2.3(b) – Adjustments to Stiffness
  - "Stiffness Adjustment Parameter" (τ_b) – Eqn. C2-2b
  - P_{ns} – compressive strength for slender-elements, $P_{ns} = F_y A_e$, A_e from E7 with $F_n = F_y$
- Ch. E – Members for Compression
  - "Critical Stress" (F_{cr}) variable revised to "Nominal Stress" (F_n)
- F6.2 I-Shaped Members and Channels Bent about their Minor Axis | Flange Local Buckling
  - Slender Flanges – Eqn. F6-4 Critical Stress (F_{cr}) 0.70 multiplier modification
- F7.2 Square and Rectangular HSS and Box Sections
  - Flange Local Buckling - Eqn. F7-2 format revision only
  - Web Local Buckling - Eqn. F7-6 format revision only



AISC 360-22 Updates (cont'd)

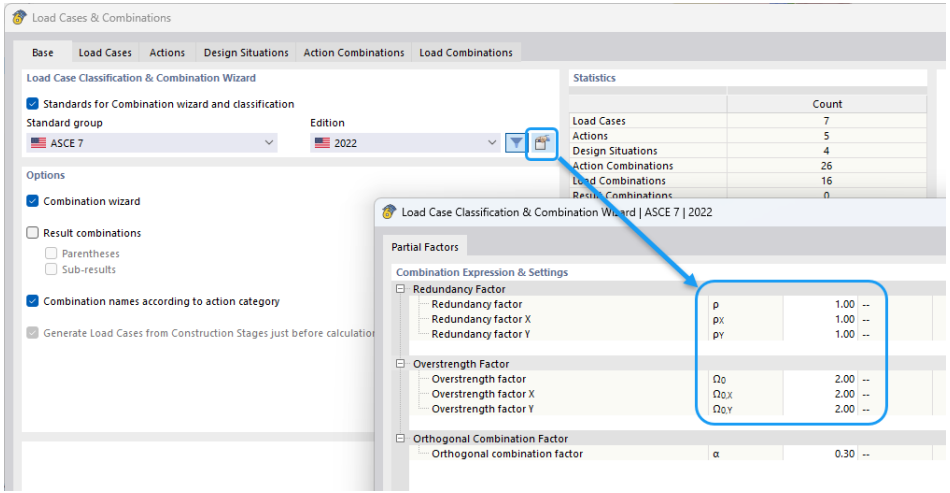
- F11.1 Rectangular Bars and Rounds | Yielding
  - Eqn. F11-1 applies to rectangular bars
  - Eqn. F11-2 applies to round bars
- G2.3 I-Shaped Members and Channels | Shear Strength of End Web Panels with a/h ≤ 3 Considering Tension Field Action
  - New! Nominal shear strength for end web panels including the effects of tension field action for I-sections w/ equal and unequal web flanges
- H3.2 HSS Subjected to Combined Torsion, Shear, Flexure and Axial Force
  - Eqn. H3-6 - Shear ratio, V_r/V_c, now taken as the larger value for the major- or minor-axis



Input Parameters in RFEM 6

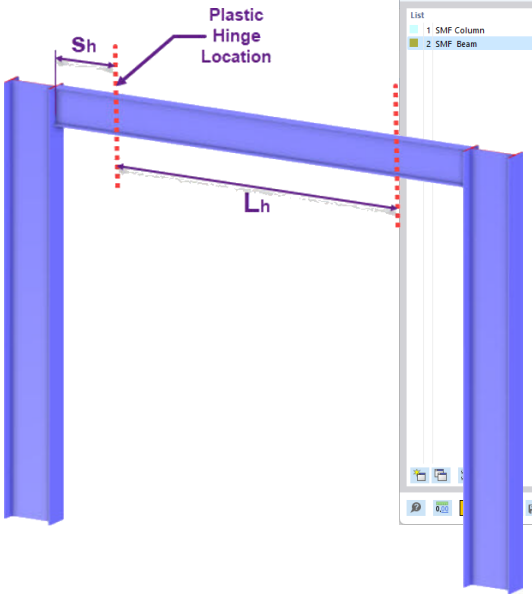
Overstrength and Redundancy Factors

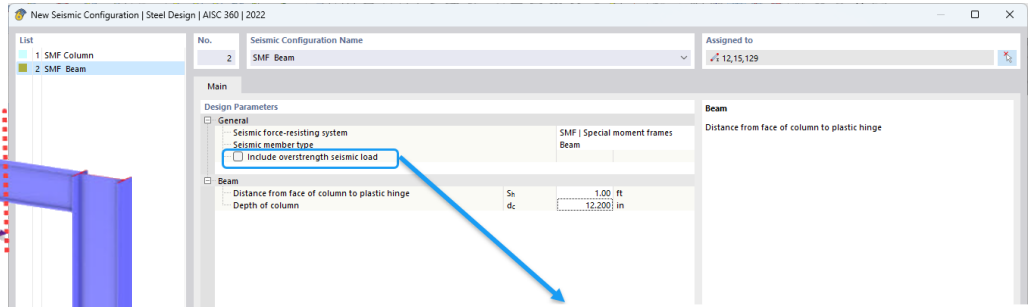
- **Overstrength, Ω**
  - Amplification factor applied to the forces in certain elements that must remain elastic
  - Ω = 3 (moment), 2 (braced) [ASCE 7-22 Table 12.2-1]
- **Redundancy, ρ**
  - A penalty factor for less redundant structures
  - ρ = 1.0 or 1.3 [ASCE 7-22 Sect. 12.3.4]
  - For members without overstrength, Ω



Seismic Configuration Input for Steel Design

Overstrength Requirements (AISC 341-22 Sect. D1.4a & F1.5c)





Overstrength Factor, Ω	Column	Beam	Brace
OMF	☑	☐	—
IMF	☑	☐	—
SMF	☑	☐	—
OCBF	☑	☑	☐
SCBF	☑	☐	☐

Webinar

AISC 341-22 Member Design Checks

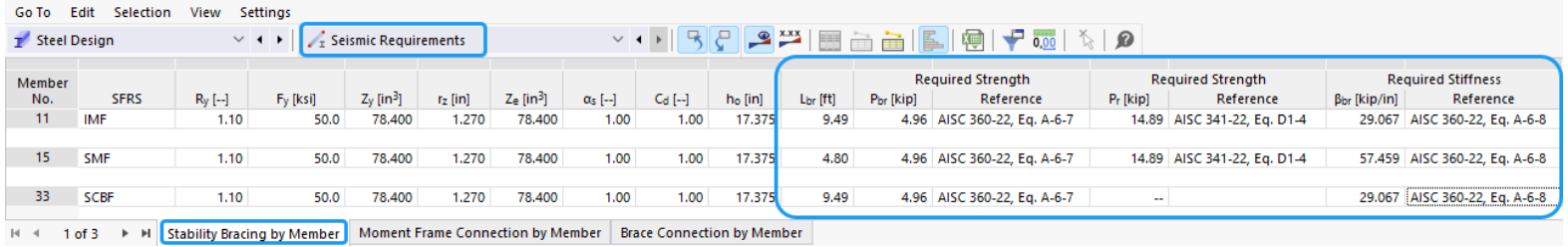
- Member ductility requirements (AISC 341-22 Table D1.1)
- Slenderness ratio checks for SMF column, OCBF and SCBF braces
- Stability bracing of beams (*Seismic Requirements* output – next slide)

AISC Seismic Design Manual
Table 1-2
Summary of Member Ductility Requirements

System Type	Highly Ductile λ_{hd}	Moderately Ductile λ_{md}	No Ductility Requirements per AISC *Seismic Provisions*	AISC *Seismic Provisions* Section Reference
Ordinary Moment Frame (OMF)			•	E1.5a
Intermediate Moment Frame (IMF)				
Beams		•		E2.5a
Columns		•		E2.5a
Special Moment Frame (SMF)				
Beams	•			E3.5a
Columns	•			E3.5a
Ordinary Concentrically Braced Frames (OCBF)				
Diagonal Braces		•		F1.5a
Special Concentrically Braced Frames (SCBF)				
Diagonal Braces	•			F2.5a
Beams	•			F2.5a
Columns	•			F2.5a

AISC 341-22 Member Design Checks (cont'd)

Stability Bracing of Beams (Sec D1.2a & F2.4)



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Steel Design | Seismic Requirements

Member No.	SFRS	R_y [--]	F_y [ksi]	Z_y [in^3]	r_z [in]	Z_e [in^3]	α_s [--]	C_d [--]	h_o [in]	L_{br} [ft]	Required Strength P_{br} [kip]	Reference	Required Strength P_r [kip]	Reference	Required Stiffness β_{br} [kip/in]	Reference
11	IMF	1.10	50.0	78.400	1.270	78.400	1.00	1.00	17.375	9.49	4.96	AISC 360-22, Eq. A-6-7	14.89	AISC 341-22, Eq. D1-4	29.067	AISC 360-22, Eq. A-6-8
15	SMF	1.10	50.0	78.400	1.270	78.400	1.00	1.00	17.375	4.80	4.96	AISC 360-22, Eq. A-6-7	14.89	AISC 341-22, Eq. D1-4	57.459	AISC 360-22, Eq. A-6-8
33	SCBF	1.10	50.0	78.400	1.270	78.400	1.00	1.00	17.375	9.49	4.96	AISC 360-22, Eq. A-6-7	--		29.067	AISC 360-22, Eq. A-6-8

1 of 3 | Stability Bracing by Member | Moment Frame Connection by Member | Brace Connection by Member

		IMF	SMF	SCBF
L_{br}	Maximum spacing of stability beam bracing	$L_b = 0.17 r_y E/(R_y F_y)$	$L_b = 0.086 r_y E/(R_y F_y)$	$L_b = 0.17 r_y E/(R_y F_y)$
P_{br}	Required strength of stability beam bracing	$P_{br} = 0.02\ (M_r C_d/h_o)$	$P_{br} = 0.02\ (M_r C_d/h_o)$	$P_{br} = 0.02\ (M_r C_d/h_o)$
P_r	Required strength of stability beam bracing at plastic hinge	$P_r = 0.06 R_y F_y Z/(\alpha_s h_o)$	$P_r = 0.06 R_y F_y Z/(\alpha_s h_o)$	
β_{br}	Required stiffness of stability beam bracing	$\beta_{br} = 1/\Phi\ (10 M_r C_d/L_{br} h_o)$	$\beta_{br} = 1/\Phi\ (10 M_r C_d/L_{br} h_o)$	$\beta_{br} = 1/\Phi\ (10 M_r C_d/L_{br} h_o)$

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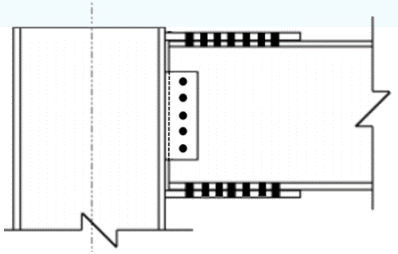
Required Connection Strength

Moment Frames - Flexural and Shear Strength



Requirements for Beam-to-Column Connection by Member

Go To | Edit | Selection | View | Settings

Steel Design | Seismic Requirements

Member No.	SFRS	R_y [--]	F_y [ksi]	Z_e [in³]	α_s [--]	S_h [ft]	L_h [ft]	C_{pr} [--]	Required Flexural Strength: M_{pr} [kipft]	Reference	M_{extra} [kipft]	Reference	$M_{pr} + M_{extra}$ [kipft]	$\Omega_0 * M_y$ [kipft]	Required Shear Strength: V_{pr} [kip]	Reference	V_g [kip]	Reference	$V_{pr} + V_g$ [kip]	$\Omega_0 * V_z$ [kip]
5	OMF	1.10	50.0	78.400	1.00	1.00	26.98	--	395.27	AISC 341-22, E1.6b.(a)	40.49	AISC 358-22	435.76	94.32	29.30	AISC 341-22, Eq. E...	11.20	AISC 358-22	40.49	11.02
11	IMF	1.10	50.0	78.400	1.00	1.00	26.98	1.15	413.23	AISC 358-22, Eq. 2.4-1	52.34	AISC 358-22	465.57	150.54	30.63	AISC 341-22, Eq. E...	21.71	AISC 358-22	52.34	18.98
15	SMF	1.10	50.0	78.400	1.00	1.00	26.98	1.15	413.23	AISC 358-22, Eq. 2.4-1	41.82	AISC 358-22	455.06	76.32	30.63	AISC 341-22, Eq. E...	11.20	AISC 358-22	41.82	9.78

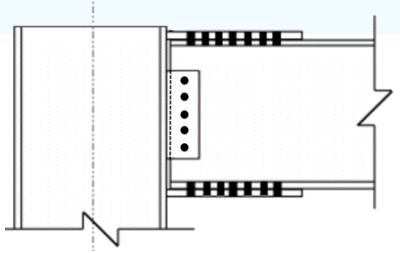
2 of 3 | Stability Bracing by Member | Moment Frame Connection by Member | Brace Connection by Member

C_{pr}	Factor to account for peak connection strength (strain hardening) per AISC 358	$(F_y+F_u)/(2F_y) \leq 1.2$

		OMF	IMF/SMF
M_{pr}	Probable maximum moment at plastic hinge	$1.1R_yF_yZ_e$	$C_{pr}R_yF_yZ_e$
M_{extra}	Extra moment due to shear force at hinge location	$(V_{pr}+V_g)*S_h$	$(V_{pr}+V_g)*S_h$
$\Omega_0 M$	Moment demand based on the worst case of the overstrength COs		
V_{pr}	Shear required to produce M_{pr}	$2M_{pr}/L_h$	$2M_{pr}/L_h$
V_g	Shear at plastic hinge location from gravity loads		
$\Omega_0 V$	Shear demand based on the worst case of the overstrength COs		

Required Connection Strength (cont'd)

Moment Frames - Flexural and Shear Strength



Requirements for Beam-to-Column Connection by Member

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Steel Design | Seismic Requirements

Member No.	SFRS	R_y [--]	F_y [ksi]	Z_e [in^3]	α_s [--]	S_h [ft]	L_h [ft]	C_{pr} [--]	Required Flexural Strength: M_{pr} [kipft]	Reference	M_{extra} [kipft]	Reference	$M_{pr} + M_{extra}$ [kipft]	$\Omega_0 * M_y$ [kipft]	Required Shear Strength: V_{pr} [kip]	Reference	V_g [kip]	Reference	$V_{pr} + V_g$ [kip]	$\Omega_0 * V_E$ [kip]
5	OMF	1.10	50.0	78.400	1.00	1.00	26.98	--	395.27	AISC 341-22, E1.6b.(a)	40.49	AISC 358-22	435.76	94.32	29.30	AISC 341-22, Eq. E...	11.20	AISC 358-22	40.49	11.02
11	IMF	1.10	50.0	78.400	1.00	1.00	26.98	1.15	413.23	AISC 358-22, Eq. 2.4-1	52.34	AISC 358-22	465.57	150.54	30.63	AISC 341-22, Eq. E...	21.71	AISC 358-22	52.34	18.98
15	SMF	1.10	50.0	78.400	1.00	1.00	26.98	1.15	413.23	AISC 358-22, Eq. 2.4-1	41.82	AISC 358-22	455.06	76.32	30.63	AISC 341-22, Eq. E...	11.20	AISC 358-22	41.82	9.78

2 of 3 | Stability Bracing by Member | Moment Frame Connection by Member | Brace Connection by Member

*Distance from centerline of column to plastic hinge

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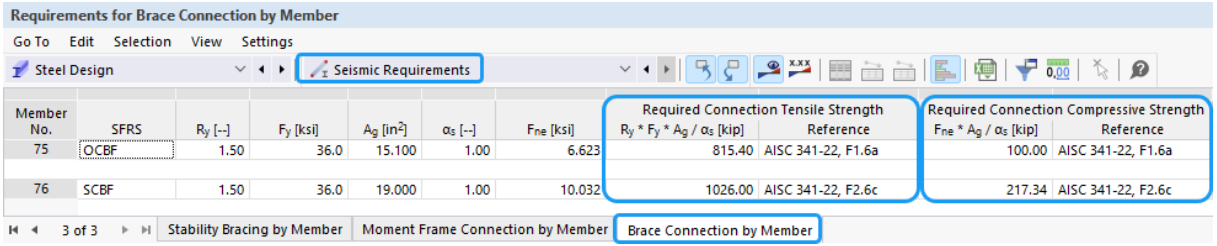
Required Connection Strength (cont'd)

Braced Frames - Tensile and Compressive Strength



Requirements for Brace Connection by Member

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Steel Design | Seismic Requirements

Member No.	SFRS	R_y [--]	F_y [ksi]	A_g [in^2]	α_s [--]	F_{ne} [ksi]	Required Connection Tensile Strength $R_y * F_y * A_g / \alpha_s$ [kip]	Reference	Required Connection Compressive Strength $F_{ne} * A_g / \alpha_s$ [kip]	Reference
75	OCBF	1.50	36.0	15.100	1.00	6.623	815.40	AISC 341-22, F1.6a	100.00	AISC 341-22, F1.6a
76	SCBF	1.50	36.0	19.000	1.00	10.032	1026.00	AISC 341-22, F2.6c	217.34	AISC 341-22, F2.6c

3 of 3 | Stability Bracing by Member | Moment Frame Connection by Member | Brace Connection by Member

R_y	Ratio of expected yield stress to the specified minimum yield stress
F_y	Specified minimum yield stress
A_g	Gross area of brace
α_s	LRFD-ASD force level adjustment factor = 1.0 for LRFD and 1.5 for ASD
F_{ne}	Flexural buckling nominal stress using R_yF_y [Fne = (0.658(RyFy/Fe)) RyFy]

$R_yF_yA_g/\alpha_s$	Expected brace strength in tension
$F_{ne}A_g/\alpha_s$	Expected brace strength in compression for **OCBF**
$1.14\ F_{ne}A_g/\alpha_s$	Expected brace strength in compression for **SCBF**

*Note: The capacity-limited design of columns and beams for SCBF based on the expected brace strength is currently not implemented in RFEM. This capability will be added in the future.

AISC 341 Updates

AISC 341 Updates in RFEM 6		2016	2022
Ductility Requirements Width-to-Thickness Ratios [Table D1.1]		Table D1.1 One Table	Two Tables: Table D1.1a - Diagonal Braces Table D1.1b - All Other Members
		More Conservative λ_{hd} and λ_{md}	Less Conservative λ_{hd} and λ_{md}
		$C_a = \alpha_s P_r/(R_y F_y A_g)$ α_s = 1.0 (LRFD) and 1.5 (ASD)	$C_a = P_u/(\Phi_c P_y)$ (LRFD) $C_a = \Omega_c P_a/P_y$ (ASD) $P_y = R_y F_y A_g$
Stability Bracing of Beams (max spacing)	IMF & SCBF [D1.2a.1.(c)]	$L_b = 0.19 r_y E/(R_y F_y)$	$L_b = 0.17 r_y E/(R_y F_y)$
	SMF [D1.2b]	$L_b = 0.095 r_y E/(R_y F_y)$	$L_b = 0.086 r_y E/(R_y F_y)$
OCBF Brace Connection Compressive Strength	1.1 Factor Removed [F1.6a.(c)]	$1.1 F_{cre} A_g/\alpha_s$	$F_{ne} A_g/\alpha_s$

Webinar

AISC 341 Knowledge Base Articles & FAQs

- KB 001761 | AISC 341 Seismic Design in RFEM 6
- KB 001767 | AISC 341-16 Moment Frame Member Design in RFEM 6
- KB 001875 | AISC 341-22 Moment Frame Member Design in RFEM 6
- KB 001768 | AISC 341-16 Moment Frame Connection Strength in RFEM 6
- KB 001775 | AISC 341 Braced Frame Design in RFEM 6

- FAQ 005324 | Which limit state types are applicable for the AISC 341 seismic design?
- FAQ 005320 | How do I include the overstrength factor(s) Ωo in the ASCE 7 load combinations?
- FAQ 005319 | How do I include the redundancy factor(s) ρ in the ASCE 7 load combinations?

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