



Structural Analysis & Design Software

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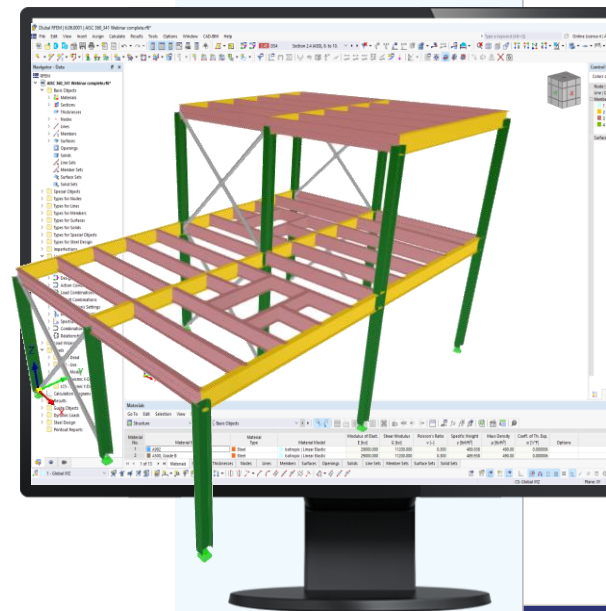
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Webinar

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



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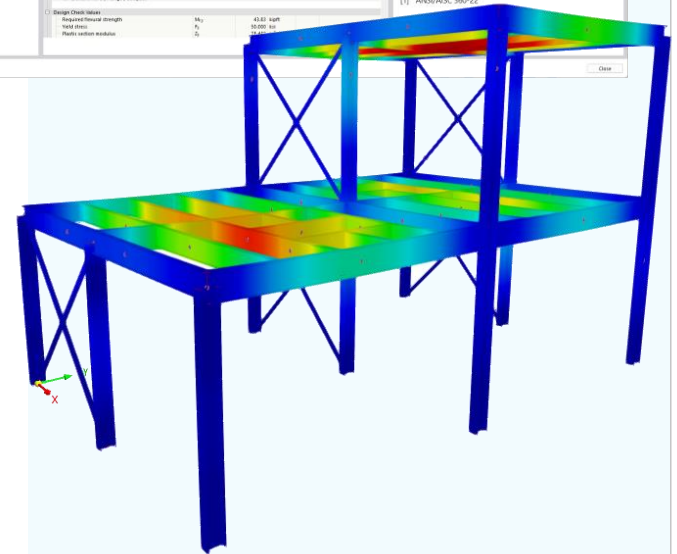
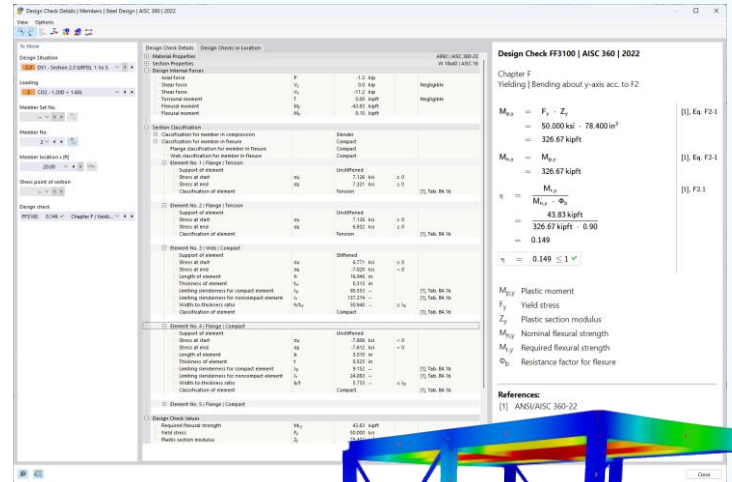
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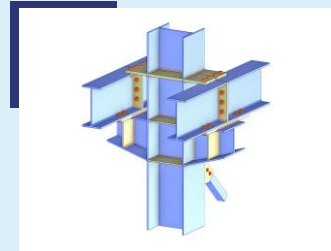
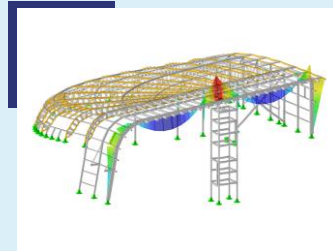
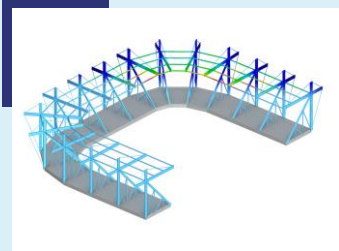


Content

- 01 Introduction RFEM 6 and Add-ons for steel design
- 02 New AISC 360-22 standard updates
- 03 New AISC 341-22 seismic member checks
- 04 Example structure input data and workflow
- 05 Detailed design results review



Steel Design in RFEM 6



RFEM 6

**Steel Design
Add-on**

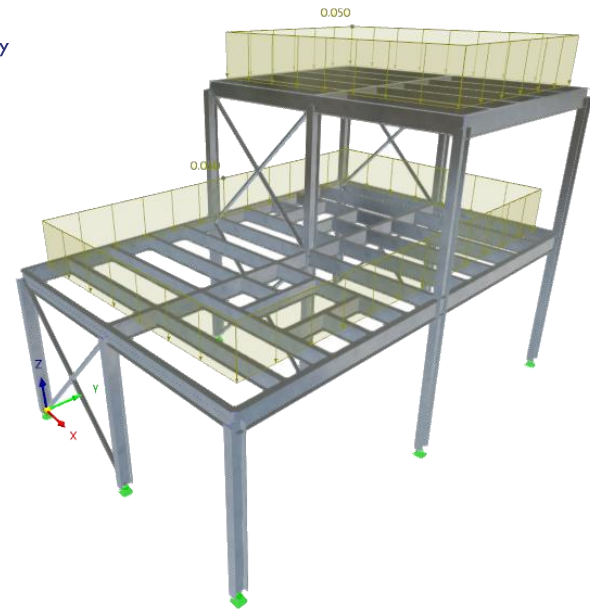
**Steel Joints
Add-on**

**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





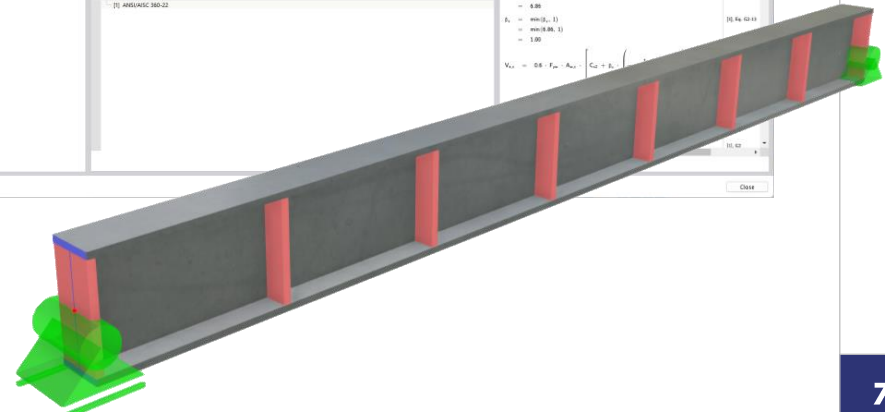
AISC 360-22 Updates (cont'd)

- 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 $a/h \leq 3$ 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

Design Check Details		Design Checks on Location	
Material Properties		430 PR Structural Shapes and Bars AISC 360-18	
Design Internal Forces		140150'S100S110M	
Load	CD1 : LC1		
Member Set No.			
Member No.			
Member location x [m]			
Stress point of section			
Design check	GG410 : 0.163	Chapter G Norm.	
Design check value	0.163	< 1	[1] G2

Design Check Values		Reference
Required shear strength	$V_r = 23.00 \text{ kN}$	
Yield stress	$F_y = 248.211 \text{ N/mm}^2$	
Yield stress of web	$F_{wy} = 248.211 \text{ N/mm}^2$	
Yield stress of end stiffener	$F_{we} = 248.211 \text{ N/mm}^2$	
Modulus of elasticity	$E = 199967.962 \text{ N/mm}^2$	
Thickness of stiffener	$t_w = 24.0 \text{ mm}$	
Width of stiffener	$b_w = 70.0 \text{ mm}$	
Height	$h = 299.0 \text{ mm}$	
Thickness	$t_w = 24.0 \text{ mm}$	
Transverse stiffener spacing	$a = 0.044 \text{ m}$	[1] Eq. G2-5
Shear area	$A_w = 4.52 \text{ cm}^2$	[1] Eq. G2-10
Web shear buckling coefficient	$k_v = 5.10$	[1] G2.3
Distance from inside face of stiffener to end of beam	$d = 24.0 \text{ mm}$	[1] G2.3
Dimension	$d_w = 0.0 \text{ mm}$	[1] Eq. G2-15
Plastic moment of section composed of flange and web	$M_{pl} = 3.12 \text{ kNm}$	[1] G2.3
Plastic moment of section composed of stiffener plus fl.	$M_{pl} = 5.13 \text{ kNm}$	[1] G2.3
Section plastic moment of top and bot.	$M_{pl} = 170.983 \text{ kNm}$	[1] Eq. G2-12
Coefficient	$\phi = 0.90$	[1] G1-W-2.196
Nominal shear strength	$V_c = 170.983 \text{ kN}$	[1] Eq. G2-12
Resistance factor for shear	$\phi = 0.90$	[1] G1-W-2.196

References	
[1] AISC/AISI 360-22	



Input Parameters in RFEM 6

Overstrength and Redundancy Factors

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

Load Cases & Combinations

Base Load Cases Actions Design Situations Action Combinations Load Combinations

Load Case Classification & Combination Wizard

Standards for Combination wizard and classification

Standard group: ASCE 7 Edition: 2022

Options

Combination wizard

Result combinations

Parentheses

Sub-results

Combination names according to action category

Generate Load Cases from Construction Stages just before calculation

Statistics

	Count
Load Cases	7
Actions	5
Design Situations	4
Action Combinations	26
Load Combinations	16
Result Combinations	0

Load Case Classification & Combination Wizard | ASCE 7 | 2022

Partial Factors

Combination Expression & Settings

Redundancy factor

ρ	1.00	--
ρ_x	1.00	--
ρ_y	1.00	--

Overstrength Factor

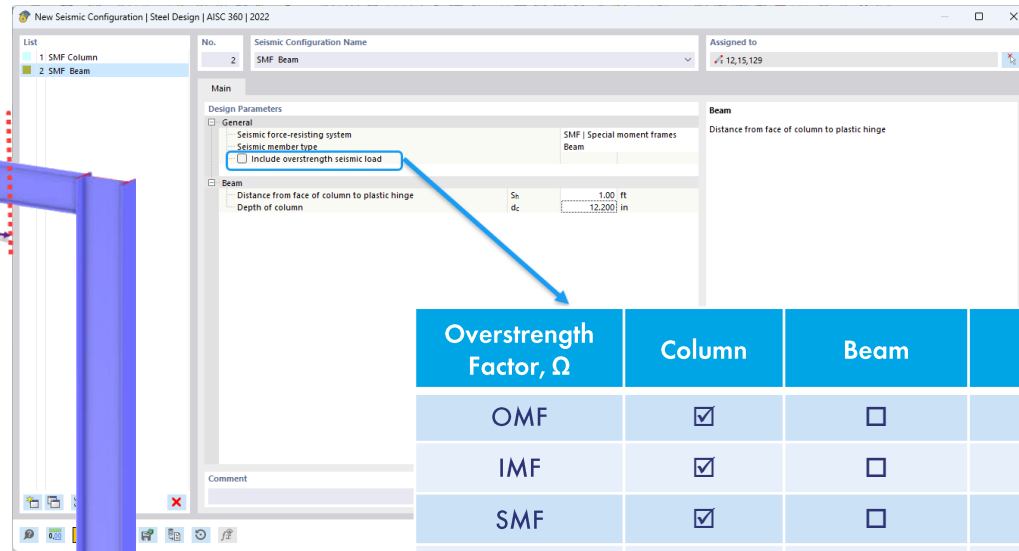
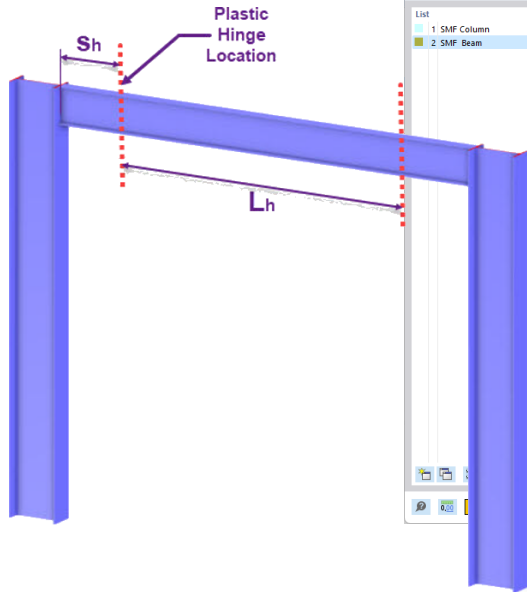
Ω	2.00	--
Ω_x	2.00	--
Ω_y	2.00	--

Orthogonal Combination Factor

Orthogonal combination factor	α	0.30	--
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Seismic Configuration Input for Steel Design

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



Overstrength Factor, Ω	Column	Beam	Brace
OMF	<input checked="" type="checkbox"/>	<input type="checkbox"/>	—
IMF	<input checked="" type="checkbox"/>	<input type="checkbox"/>	—
SMF	<input checked="" type="checkbox"/>	<input type="checkbox"/>	—
OCBF	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
SCBF	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



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)

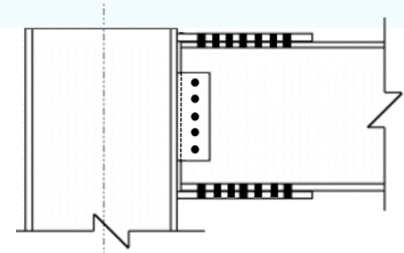
Member No.	SFRS	R_y [-]	F_y [ksi]	Z_y [in ³]	r_z [in]	Z_e [in ³]	α_s [-]	C_d [-]	h_o [in]	Required Strength		Required Strength		Required Stiffness		
										L_{br} [ft]	P_{br} [kip]	Reference	P_r [kip]	Reference	β_{br} [kip/in]	Reference
11	IMF	1.10	50.0	78.400	1.270	78.400	1.00	1.00	17.375	9.49	4.96	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

		IMF	SMF	SCBF
L_{br}	Maximum spacing of stability beam bracing	$L_b = 0.17r_y E / (R_y F_y)$	$L_b = 0.086r_y E / (R_y F_y)$	$L_b = 0.17r_y E / (R_y F_y)$
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	$\beta_{br} = 1 / \Phi (10 M_r C_d / L_{br} h_o)$	$\beta_{br} = 1 / \Phi (10 M_r C_d / L_{br} h_o)$	$\beta_{br} = 1 / \Phi (10 M_r C_d / L_{br} h_o)$



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 [in ³]	α _s [-]	Sh [ft]	L _h [ft]	C _{pr} [-]	Required Flexural Strength				Required Shear Strength							
									M _{pr} [kipft]	Reference	M _{extra} [kipft]	Reference	M _{pr} + M _{extra} [kipft]	Ω ₀ * M _y [kipft]	V _{pr} [kip]	Reference	V _g [kip]	Reference	V _{pr} + V _g [kip]	Ω 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

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 $(F_y + F_u) / (2F_y) \leq 1.2$

M_{pr} Probable maximum moment at plastic hinge

M_{extra} Extra moment due to shear force at hinge location

Ω₀M Moment demand based on the worst case of the overstrength COs

V_{pr} Shear required to produce M_{pr}

V_g Shear at plastic hinge location from gravity loads

Ω₀V Shear demand based on the worst case of the overstrength COs

OMF

$$1.1 R_y F_y Z_e$$

$$(V_{pr} + V_g) * S_h$$

$$2 M_{pr} / L_h$$

IMF/SMF

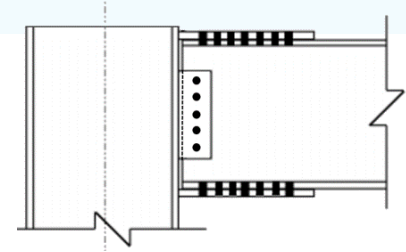
$$C_{pr} R_y F_y Z_e$$

$$(V_{pr} + V_g) * S_h$$

$$2 M_{pr} / L_h$$

Required Connection Strength (cont'd)

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 [in ³]	α _s [-]	Sh [ft]	L _h [ft]	C _{pr} [-]	Required Flexural Strength				Required Shear Strength							
									M _{pr} [kipft]	Reference	M _{extra} [kipft]	Reference	M _{pr} + M _{extra} [kipft]	Ω ₀ * M _y [kipft]	V _{pr} [kip]	Reference	V _g [kip]	Reference	V _{pr} + V _g [kip]	Ω 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

Stability Bracing by Member Moment Frame Connection by Member Brace Connection by Member



*Distance from centerline of column to plastic hinge

Required Connection Strength (cont'd)

Braced Frames - Tensile and Compressive Strength

Requirements for Brace Connection by Member

Go To Edit Selection View Settings

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		Required Connection Compressive Strength	
							$R_y * F_y * A_g / \alpha_s$ [kip]	Reference	$F_{ne} * A_g / \alpha_s$ [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

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 $R_y F_y$ [$F_{ne} = (0.658(R_y F_y / F_e)) R_y F_y$]

- $R_y F_y A_g / \alpha_s$ 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}
		$C_a = \alpha_s P_r / (R_y F_y A_g)$ $\alpha_s = 1.0$ (LRFD) and 1.5 (ASD)	$C_a = P_u / (\Phi_c P_y)$ (LRFD) $C_a = \Omega_c P_u / P_y$ (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)]	$1.1 F_{cre} A_g / \alpha_s$	$F_{ne} A_g / \alpha_s$





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\(s\) \$\Omega_o\$ in the ASCE 7 load combinations?](#)
- [FAQ 005319 | How do I include the redundancy factor\(s\) \$\rho\$ in the ASCE 7 load combinations?](#)

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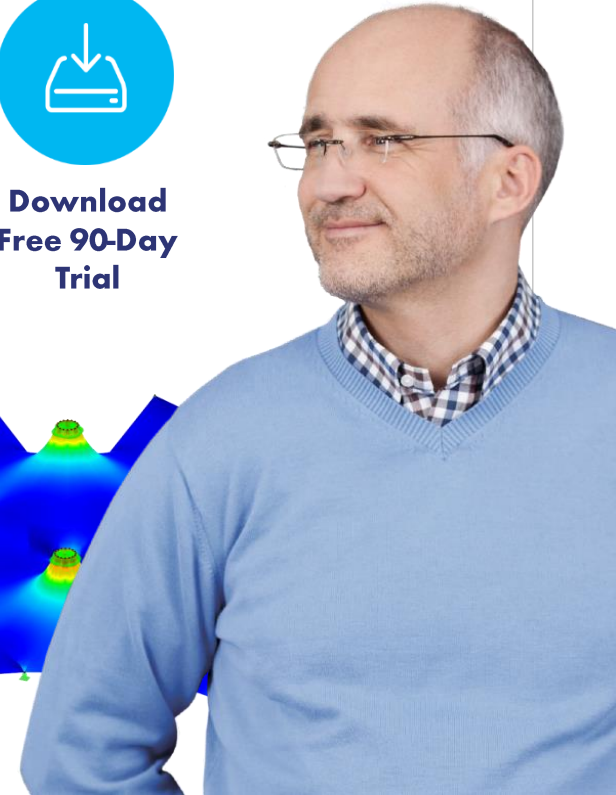
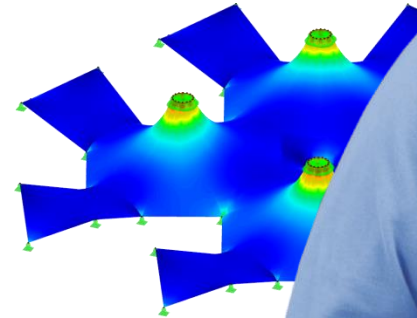
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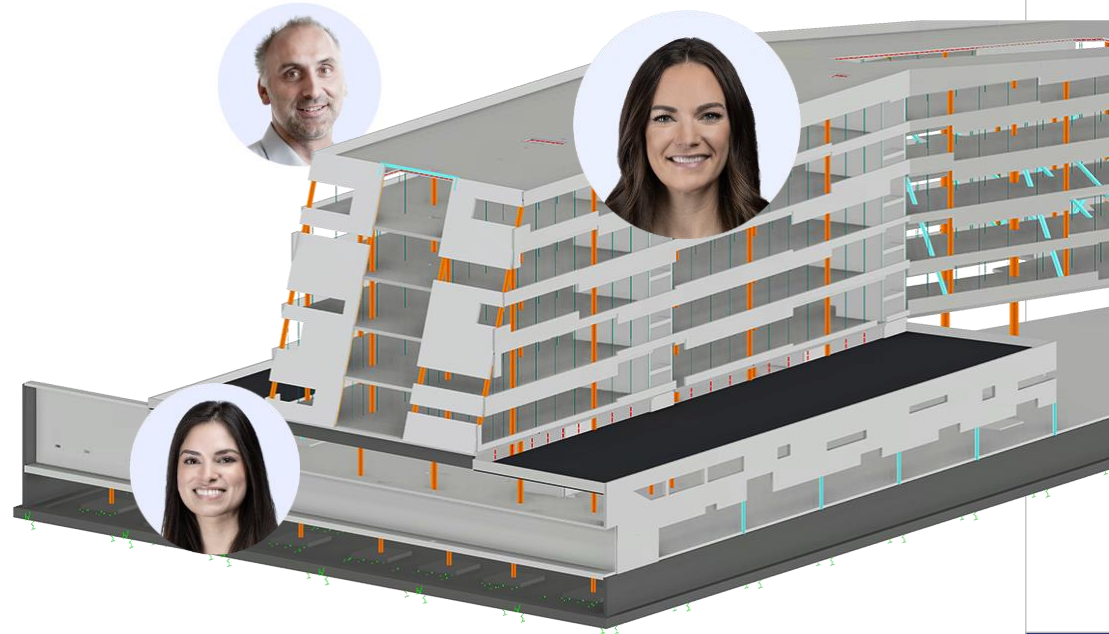
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