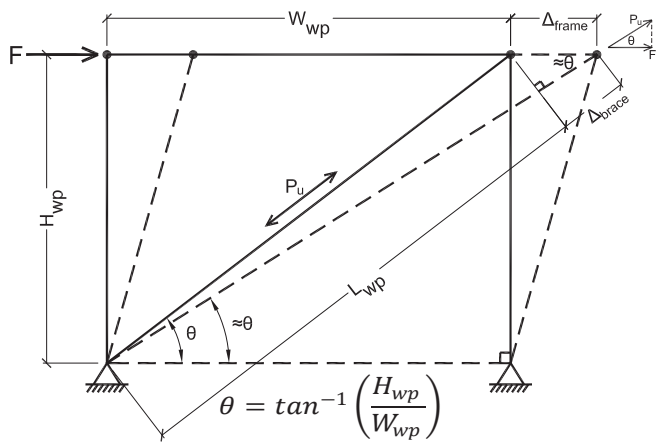


## BRACE STIFFNESS CALCULATIONS



### EQ# Brace Force

$$1 \quad P_u = F / \cos\theta = F \left( \frac{L_{wp}}{W_{wp}} \right)$$

### Brace Elongation & Stiffness (Elastic)

$$2 \quad \Delta_{brace} = \frac{P_u L_{wp}}{KF A_{sc} E} = \frac{P_u}{K_{eff}} \Rightarrow$$

$$3 \quad K_{eff} = P_u / \Delta_{brace} \Rightarrow K_{eff} = \frac{KF A_{sc} E}{L_{wp}}$$

### Frame Deflection (Elastic)

$$\Delta_{frame} = \frac{\Delta_{brace}}{\cos\theta} \Rightarrow \Delta_{frame} = \frac{P_u}{K_{eff} \cos\theta} \Rightarrow$$

$$4 \quad \Delta_{frame} = \frac{F}{K_{eff} \cos^2\theta} \Rightarrow \Delta_{frame} = \frac{F L_{wp}}{KF A_{sc} E \cos^2\theta}$$

### Alternate Forms (Elastic)

$$\Delta_{frame} = \frac{2\Phi(F_y/E) H_{wp}}{KF \sin 2\theta}$$

$$\text{Story Drift} = \frac{\Delta_{frame}}{H_{wp}} = \frac{2\Phi(F_y/E)}{KF \sin 2\theta}$$

For LRFD design, use  $\Phi = 0.9$  in addition to any factor of safety resulting from the ratio of the required  $A_{sc}$  to the provided  $A_{sc}$ .

### Frame Stiffness

The effective horizontal stiffness can be summarized by the following statement:

$$\Delta_{frame} = F / K_{frame} \Rightarrow$$

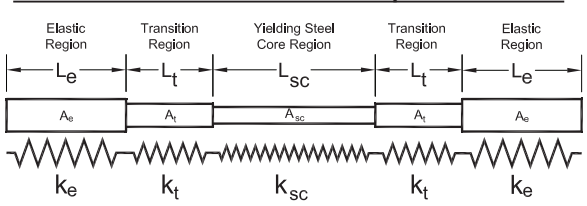
$$K_{frame} = F / \Delta_{frame} \Rightarrow$$

$$K_{frame} = K_{eff} \cos^2\theta$$

**For design assistance please contact CoreBrace:**

5789 West Wells Park Road  
West Jordan, UT 84081  
801.280.0701  
www.corebrace.com

### Stiffness Determination of a Composite Element



$$K_{sc\_wp} = \frac{A_{sc} E}{L_{wp}} \quad \text{Axial stiffness of yielding core projected from workpoint to workpoint}$$

$$K_{eff} = \frac{1}{\sum_{i=0}^n \frac{1}{K_i}} \quad \text{BRB Effective (Actual) stiffness of composite element}$$

$$KF = \frac{K_{eff}}{K_{sc\_wp}} \quad \text{Axial Stiffness Adjustment Factor supplied by CoreBrace}$$

$$K_{eff} = \frac{KF A_{sc} E}{L_{wp}} \quad \text{Effective stiffness of BRB for use in deflection analysis}$$

### Rigid Assumption

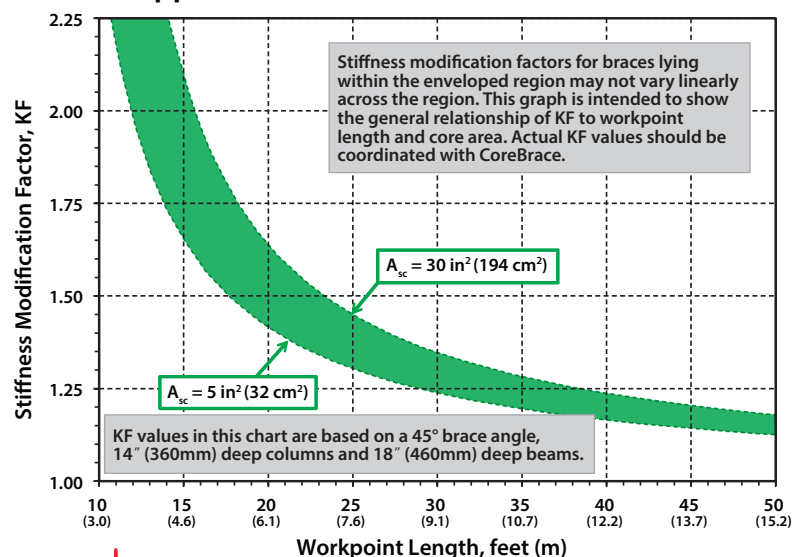
If  $K_e$  and  $k_t$  are assumed rigid, the above equation for  $KF$  simplifies to:

$$KF \approx \frac{L_{wp}}{L_{sc}} = \frac{1}{0.6} = 1.67 \Rightarrow$$

$$K_{eff} \approx 1.67 K_{sc\_wp}$$

This assumption can result in significant error as the ratio of  $L_{wp}/L_{sc}$  increases and can underestimate elastic deformations. However, since the elastic deformations of non-yielding regions calculated with non-rigid assumptions are amplified by  $C_d$  to calculate their inelastic deformations (which over-predicts these deformations), the rigid assumption may more accurately predict the total inelastic deformations of the element.

### Approximate Stiffness Modification Factor

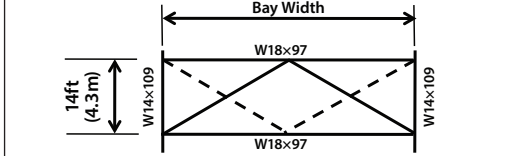
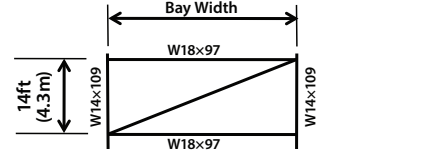


## APPROXIMATE STIFFNESS MODIFICATION FACTORS, KF<sup>1,2,7</sup>

Sizes shown are representative of typical BRB sizes. Information on intermediate and larger sizes is available upon request.

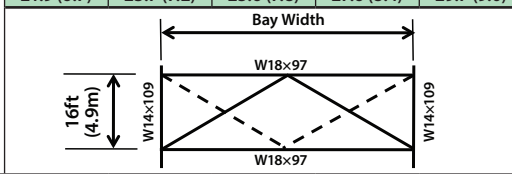
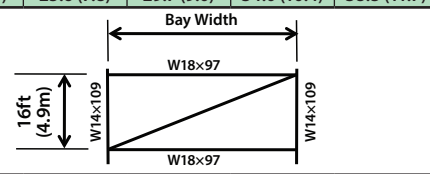
F <sub>yc</sub> = 38 ksi (262 MPa)	A <sub>sc</sub> <sup>3</sup>		Bay Width, ft (m)									
	in <sup>2</sup> (cm <sup>2</sup> )	P <sub>y,axial</sub> <sup>4</sup> kip (kN)	15 (4.6)	20 (6.1)	25 (7.6)	30 (9.1)	35 (10.7)	30 (9.1)	35 (10.7)	40 (12.2)	45 (13.7)	50 (15.2)
2.0 (13)	68 (306)	1.38	1.35	1.32	1.31	1.29	1.38	1.36	1.35	1.33	1.32	
3.0 (19)	103 (448)	1.39	1.35	1.33	1.31	1.30	1.39	1.37	1.35	1.34	1.33	
4.0 (26)	137 (613)	1.37	1.34	1.32	1.30	1.29	1.37	1.35	1.34	1.33	1.32	
5.0 (32)	171 (754)	1.39	1.36	1.33	1.32	1.30	1.39	1.37	1.36	1.34	1.33	
6.0 (39)	205 (919)	1.43	1.40	1.37	1.35	1.33	1.43	1.41	1.40	1.38	1.37	
7.0 (45)	239 (1060)	1.41	1.38	1.35	1.33	1.32	1.41	1.40	1.38	1.37	1.35	
8.0 (52)	274 (1225)	1.44	1.40	1.38	1.35	1.34	1.44	1.42	1.40	1.39	1.38	
9.0 (58)	308 (1367)	1.43	1.39	1.36	1.34	1.33	1.43	1.41	1.39	1.38	1.36	
10.0 (65)	342 (1532)	1.45	1.41	1.38	1.36	1.34	1.45	1.43	1.41	1.39	1.38	
11.0 (71)	376 (1673)	1.51	1.46	1.43	1.40	1.38	1.51	1.49	1.46	1.44	1.43	
12.0 (77)	410 (1814)	1.47	1.43	1.40	1.37	1.35	1.47	1.45	1.43	1.41	1.40	
14.0 (90)	479 (2121)	1.45	1.41	1.38	1.36	1.34	1.45	1.43	1.41	1.39	1.38	
16.0 (103)	547 (2427)	1.51	1.46	1.43	1.40	1.38	1.51	1.49	1.46	1.44	1.43	
18.0 (116)	616 (2733)	1.52	1.47	1.44	1.41	1.39	1.52	1.50	1.47	1.45	1.44	
20.0 (129)	684 (3040)	1.58	1.52	1.47	1.44	1.42	1.58	1.55	1.52	1.49	1.47	
22.0 (142)	752 (3346)	1.56	1.50	1.46	1.43	1.41	1.56	1.53	1.50	1.48	1.46	
24.0 (155)	821 (3652)	1.54	1.49	1.45	1.42	1.40	1.54	1.52	1.49	1.47	1.45	
26.0 (168)	889 (3959)	1.61	1.55	1.50	1.47	1.44	1.61	1.58	1.55	1.52	1.50	
28.0 (181)	958 (4265)	1.63	1.56	1.51	1.48	1.45	1.63	1.59	1.56	1.53	1.51	
30.0 (194)	1026 (4571)	1.64	1.57	1.52	1.48	1.45	1.64	1.60	1.57	1.54	1.52	
Workpoint Length, ft (m)		20.5 (6.3)	24.4 (7.4)	28.7 (8.7)	33.1 (10.1)	37.7 (11.5)	20.5 (6.3)	22.4 (6.8)	24.4 (7.4)	26.5 (8.1)	28.7 (8.7)	

STORY HEIGHT: 14ft (4.3m)



F <sub>yc</sub> = 38 ksi (262 MPa)	A <sub>sc</sub> <sup>3</sup>		Bay Width, ft (m)									
	in <sup>2</sup> (cm <sup>2</sup> )	P <sub>y,axial</sub> <sup>4</sup> kip (kN)	15 (4.6)	20 (6.1)	25 (7.6)	30 (9.1)	35 (10.7)	30 (9.1)	35 (10.7)	40 (12.2)	45 (13.7)	50 (15.2)
2.0 (13)	68 (306)	1.33	1.30	1.28	1.27	1.26	1.33	1.31	1.30	1.29	1.28	
3.0 (19)	103 (448)	1.33	1.31	1.29	1.27	1.26	1.32	1.31	1.30	1.29	1.28	
4.0 (26)	137 (613)	1.32	1.30	1.28	1.26	1.25	1.32	1.31	1.30	1.29	1.28	
5.0 (32)	171 (754)	1.33	1.31	1.29	1.28	1.27	1.33	1.32	1.31	1.30	1.29	
6.0 (39)	205 (919)	1.37	1.34	1.32	1.30	1.29	1.37	1.36	1.34	1.33	1.32	
7.0 (45)	239 (1060)	1.36	1.33	1.31	1.29	1.28	1.36	1.34	1.33	1.32	1.31	
8.0 (52)	274 (1225)	1.38	1.35	1.33	1.31	1.30	1.38	1.36	1.35	1.34	1.33	
9.0 (58)	308 (1367)	1.37	1.34	1.32	1.30	1.29	1.37	1.35	1.34	1.33	1.32	
10.0 (65)	342 (1532)	1.38	1.35	1.33	1.31	1.30	1.38	1.37	1.35	1.34	1.33	
11.0 (71)	376 (1673)	1.44	1.40	1.37	1.35	1.33	1.44	1.42	1.40	1.39	1.37	
12.0 (77)	410 (1814)	1.40	1.37	1.34	1.33	1.31	1.40	1.39	1.37	1.36	1.34	
14.0 (90)	479 (2121)	1.38	1.35	1.33	1.31	1.30	1.38	1.37	1.35	1.34	1.33	
16.0 (103)	547 (2427)	1.44	1.40	1.37	1.35	1.33	1.44	1.42	1.40	1.38	1.37	
18.0 (116)	616 (2733)	1.45	1.41	1.38	1.36	1.34	1.45	1.43	1.41	1.39	1.38	
20.0 (129)	684 (3040)	1.49	1.45	1.41	1.39	1.36	1.49	1.47	1.45	1.43	1.41	
22.0 (142)	752 (3346)	1.48	1.43	1.40	1.38	1.36	1.48	1.45	1.43	1.42	1.40	
24.0 (155)	821 (3652)	1.46	1.42	1.39	1.37	1.35	1.46	1.44	1.42	1.41	1.39	
26.0 (168)	889 (3959)	1.52	1.47	1.43	1.41	1.38	1.52	1.49	1.47	1.45	1.43	
28.0 (181)	958 (4265)	1.53	1.48	1.44	1.41	1.39	1.53	1.51	1.48	1.46	1.44	
30.0 (194)	1026 (4571)	1.54	1.49	1.45	1.42	1.40	1.54	1.51	1.49	1.47	1.45	
Workpoint Length, ft (m)		21.9 (6.7)	25.6 (7.8)	29.7 (9.0)	34.0 (10.4)	38.5 (11.7)	21.9 (6.7)	23.7 (7.2)	25.6 (7.8)	27.6 (8.4)	29.7 (9.0)	

STORY HEIGHT: 16ft (4.9m)



## APPROXIMATE STIFFNESS MODIFICATION FACTORS, KF<sup>1,2,7</sup> (CONT'D)

Sizes shown are representative of typical BRB sizes. Information on intermediate and larger sizes is available upon request.

F <sub>yc</sub> = 38 ksi (262 MPa)	A <sub>sc</sub> <sup>3</sup>		Bay Width, ft (m)									
	in <sup>2</sup> (cm <sup>2</sup> )	P <sub>y,axial</sub> <sup>4</sup> kip (kN)	15 (4.6)	20 (6.1)	25 (7.6)	30 (9.1)	35 (10.7)	30 (9.1)	35 (10.7)	40 (12.2)	45 (13.7)	50 (15.2)
2.0 (13)	68 (306)	1.30	1.27	1.25	1.24	1.23	1.30	1.28	1.27	1.26	1.25	
3.0 (19)	103 (448)	1.30	1.27	1.26	1.24	1.23	1.29	1.27	1.26	1.25	1.24	
4.0 (26)	137 (613)	1.29	1.26	1.25	1.24	1.23	1.29	1.27	1.26	1.25	1.24	
5.0 (32)	171 (754)	1.31	1.28	1.26	1.25	1.24	1.31	1.28	1.26	1.25	1.24	
6.0 (39)	205 (919)	1.30	1.30	1.29	1.27	1.26	1.30	1.30	1.29	1.27	1.26	
7.0 (45)	239 (1060)	1.33	1.29	1.27	1.26	1.25	1.33	1.30	1.29	1.28	1.27	
8.0 (52)	274 (1225)	1.35	1.31	1.29	1.28	1.26	1.35	1.32	1.31	1.30	1.29	
9.0 (58)	308 (1367)	1.33	1.30	1.28	1.27	1.26	1.33	1.31	1.30	1.29	1.28	
10.0 (65)	342 (1532)	1.35	1.31	1.29	1.28	1.26	1.35	1.32	1.31	1.30	1.29	
11.0 (71)	376 (1673)	1.40	1.35	1.33	1.31	1.29	1.40	1.37	1.35	1.34	1.33	
12.0 (77)	410 (1814)	1.37	1.33	1.31	1.29	1.28	1.37	1.34	1.33	1.32	1.31	
14.0 (90)	479 (2121)	1.35	1.31	1.29	1.28	1.27	1.35	1.32	1.31	1.30	1.29	
16.0 (103)	547 (2427)	1.40	1.35	1.33	1.31	1.30	1.40	1.37	1.35	1.34	1.33	
18.0 (116)	616 (2733)	1.41	1.36	1.34	1.32	1.30	1.41	1.38	1.36	1.35	1.34	
20.0 (129)	684 (3040)	1.45	1.39	1.37	1.34	1.32	1.45	1.41	1.39	1.38	1.37	
22.0 (142)	752 (3346)	1.44	1.38	1.35	1.33	1.32	1.44	1.40	1.38	1.37	1.35	
24.0 (155)												

