

2.10-2 / Load & Stress Analysis

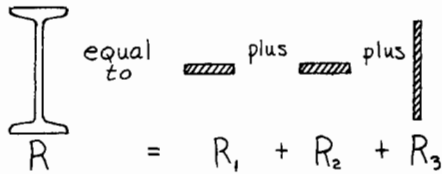


FIGURE 1

equal to the sum of the torsional resistances of the two flanges and web (Fig. 1).

Figure 2 shows the results of twisting an I beam made of three equal plates. Calculated values of twist by using the conventional polar moment of inertia (J) and the torsional resistance (R) are compared with the actual results. This shows greater accuracy by using torsional resistance (R).

This means that the torsional resistance of a flat



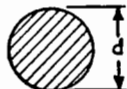
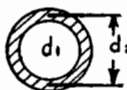

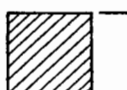
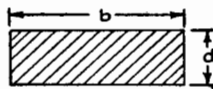


Angle of twist		
all loadings identical	$t = .055$ 	$t = .055$ 
Conventional method J	$.065^\circ$	$.007^\circ$
polar moment of Inertia		
Method using R	21.8°	7.3°
Torsional Resistance		
Actual Twist	22°	9.5°

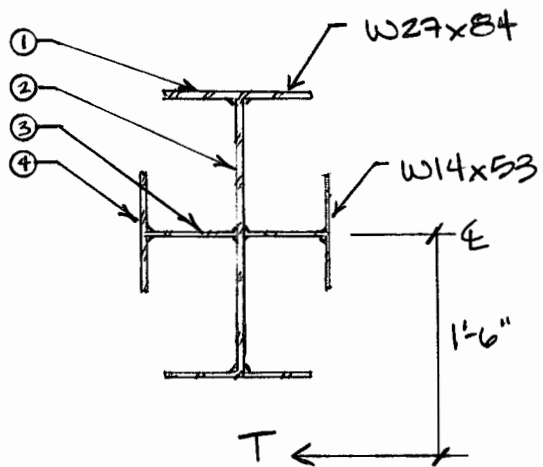
FIGURE 2

TABLE 1—Torsional Properties of Various Sections

Section	Shear Stress	(for steel) R-torsional Resistance																																				
	$\tau = \frac{16 T}{\pi d^3}$	$R = .0982 d^4$																																				
	$\tau = \frac{16 T d_2}{\pi (d_2^4 - d_1^4)}$	$R = .0982 (d_2^4 - d_1^4)$																																				
	$\tau = \frac{3 T}{\pi d t^2}$	$R = 1.0472 t^3 d$																																				
	$\tau = \frac{4.8 T}{d^3}$	$R = .1406 d^4$																																				
<div> for solid rectangular sections</div> <table><tr><td>$\frac{b}{d}$</td><td>1.00</td><td>1.50</td><td>1.75</td><td>2.00</td><td>2.50</td><td>3.00</td><td>4.00</td><td>6</td><td>8</td><td>10</td><td>∞</td></tr><tr><td>α</td><td>.208</td><td>.231</td><td>.239</td><td>.246</td><td>.258</td><td>.267</td><td>.282</td><td>.299</td><td>.307</td><td>.313</td><td>.333</td></tr><tr><td>β</td><td>.141</td><td>.196</td><td>.214</td><td>.229</td><td>.249</td><td>.263</td><td>.281</td><td>.299</td><td>.307</td><td>.313</td><td>.333</td></tr></table>	$\frac{b}{d}$	1.00	1.50	1.75	2.00	2.50	3.00	4.00	6	8	10	∞	α	.208	.231	.239	.246	.258	.267	.282	.299	.307	.313	.333	β	.141	.196	.214	.229	.249	.263	.281	.299	.307	.313	.333	$\tau = \frac{T}{\alpha b d^2}$	$R = \beta b d^3$
$\frac{b}{d}$	1.00	1.50	1.75	2.00	2.50	3.00	4.00	6	8	10	∞																											
α	.208	.231	.239	.246	.258	.267	.282	.299	.307	.313	.333																											
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<u>Use this</u> <u>for diagonal</u> <u>bracing</u>	 single brace	$R = 3.54 I$																																				
	 double brace	$R = 10.6 I$																																				

TORSIONAL CHECK OF COMPOSITE COLUMN

(ref: DESIGN OF WELDED STRUCTURES, OMER W. BLODGETT Pg. 2.10)



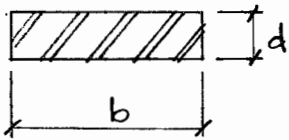
- COLUMN PROPERTIES

W27x84: $b_f = 10 \text{ in}$
 $t_f = 0.64 \text{ in}$
 $d_w = 26.7 \text{ in}$
 $t_w = 0.46 \text{ in}$

W14x53: $b_f = 8.06 \text{ in}$
 $t_f = 0.66 \text{ in}$
 $d_w = 13.9 \text{ in}$
 $t_w = 0.37 \text{ in}$

- DETERMINE TORSIONAL RESISTANCE, R:

$$R = \beta b d^3$$



$$R_1 \Rightarrow \frac{b_f}{t_f} = \frac{10 \text{ in}}{0.64 \text{ in}} = 15.625 \therefore \beta_1 = .34, R_1 = 0.891 \text{ in}^4$$

$$R_2 \Rightarrow \frac{d_w - t_f}{t_w} = \frac{26.7 \text{ in} - 0.64 \text{ in}}{0.46 \text{ in}} = 56.6 \therefore \beta_2 = .34, R_2 = 0.862$$

$$R_3 \Rightarrow \frac{d_w - t_f}{t_w} = \frac{13.9 \text{ in} - 0.66 \text{ in}}{0.37 \text{ in}} = 35.8 \therefore \beta_3 = .34, R_3 = 0.23 \text{ in}^4$$

$$R_4 \Rightarrow \frac{b_f}{t_f} = \frac{8.06 \text{ in}}{0.66 \text{ in}} = 12.2 \therefore \beta_4 = .34, R_4 = 0.79 \text{ in}^4$$

$$\underline{\underline{\sum R = 4.45 \text{ in}^4}}$$

- TORQUE :

$$T = 20 (4.66 \text{ k})(1'-6") = 3(4.66 \text{ k})(1'-6") = \underline{\underline{21 \text{ k} \cdot \text{ft}}}$$

- SHEAR STRESS:

$$\tau = \frac{T_c}{\sum R} = \frac{21 \text{ k} \cdot \text{ft} \left(\frac{12 \text{ in}}{1 \text{ ft}} \right) (13.4 \text{ in})}{4.45 \text{ in}^4} = 758 \text{ ksi} \quad \underline{\underline{NG!}}$$