Stress Skin Calculator

Show: Spring Awakening TD: Duncan Jenner-Bennett

Rev. Date 11/11/2019

Results			
Panel deflection	w_Δ	=	125.7
Top skin	w_{bt}	=	108
Bottom skin	w_{bb}	=	123
Splice plate	w_p	=	143
Rolling sheer	w_s	=	106.7
Horizontal sheer	w_v	=	176.2

Color Key:	
Entry Required	Data Calculated
Material Type	Warning
Formula	Calculated Result

Material Properties

Width	3.667	ft	44	in	**Total Thickness**		**Clear distance**			**Splice Plate Width**	
Length	8	ft	96	in	4.15675	in	12.67	in		36.5	in
C (Deflection criteria) =			240								

Top Skin	1/2"	**Actual Thickness**		**Section Properties**			**Allowable Stresses**		
	Group 1	0.46875	in	A	1.947	in^2/ft	F_t,F_b	1650	psi
	Exposure 1			I	0.066	in^4/ft	F_c	1540	psi
b-distance	19	in		$I_\perp$	0.006	in^4/ft	F_s	48	psi
							E	1,800,000	psi

Bottom Skin	1/2"	**Actual Thickness**		**Section Properties**			**Allowable Stresses**		
	Group 1	0.438	in	A	2.292	in^2/ft	F_t,F_b	1650	psi
	Exposure 1			I	0.067	in^4/ft	F_c	1540	psi
b-distance	18	in		$I_\perp$	0.004	in^4/ft	F_s	48	psi
							E	1,800,000	psi

Stringers	4	**Actual Width**		**Section Properties**			**Allowable Stresses**		
	2x4	1.5	in	A	4.8750	in^2	F_v	135	
	Southern Pine #2	**Actual Height**		I_{x-x}	5.3	in^4	E	1,100,000	psi
		3.25	in						

w_Δ : Uniform load due to overall panel deflection

$E_{L\ ply}$	1,980,000	psi
$E_{L\ str}$	1,133,000	psi

C = 240

Neutral Axes	
Top	3.922375
Str	2.063
Bot	0.219

Total Thickness	
4.15675	in

G	
67,980	psi

Neutral Axis for Deflection

	A in^2 x E_L psi			=	AE_L lb x y in			=	AE_Ly inlb	
Top	7.139	x	1,980,000	=	14,135,220	x	3.922375	=	55,443,634	inlb
Str	19.50	x	1,133,000	=	22,093,500	x	2.063	=	45,578,891	inlb
Bot	8.404	x	1,980,000	=	16,639,920	x	0.219	=	3,644,142	inlb
Totals					52,868,640				104,666,667	inlb

Neutral Axis of Panel

$$\frac{\Sigma AE_Ly}{\Sigma AE_L} = \frac{104,666,667}{52,868,640} = 1.980 \text{ in from the bottom}$$

Gross Stiffness Factor, E_LI_g

	I_o in^4	+	(A in^2)	$(d\ in)^2$	=	I_g in^4	x	E_L psi	=	E_LI_g lb-in^2
Top	0.242	+	7.139	1.9426254	=	27.18	x	1,980,000	=	5.382E+07
Str	21.20	+	19.500	-0.08325044	=	21.34	x	1,133,000	=	2.417E+07
Bot	0.246	+	8.404	1.760749555	=	26.3	x	1,980,000	=	5.207E+07
Totals										1.30E+08

$$w_\Delta = \frac{1}{CL\left(\frac{7.5L^2}{E_LI_g} + \frac{0.6}{AG}\right)} = 126$$

w_{bt} & w_{bb} : Uniform load due to bending in the top and bottom skins

Neutral axis for Bending | Width = 44

Effective Width: Enter Area and I adjustments here if Eff. Width is < actual width

Eff. Width = panel width - (# of Spans)(clear distance - b-spacing)

Top Skin = 63 Bottom Skin = 60

$E_{L\ ply}$	1,980,000	psi
$E_{L\ str}$	1,133,000	psi

Neutral Axes	
Top	3.922375
Str	2.063
Bot	0.219

Total Thickness	
4.15675	in

c = 2.177

G	
67,980	psi

C = 240

Neutral Axis for Deflection

	A in^2 x E_L psi			=	AE_L lb x y in			=	AE_Ly inlb	
Top	7.139	x	1,980,000	=	14,135,220	x	3.922375	=	55,443,634	inlb
Str	19.50	x	1,133,000	=	22,093,500	x	2.063	=	45,578,891	inlb
Bot	8.404	x	1,980,000	=	16,639,920	x	0.219	=	3,644,142	inlb
Totals					52,868,640				104,666,667	inlb

Neutral Axis of Panel

$$\frac{\Sigma AE_Ly}{\Sigma AE_L} = \frac{104,666,667}{52,868,640} = 1.980 \text{ in from the bottom}$$

Gross Stiffness Factor, E_LI_g

	I_o in^4	+	(A in^2)	(d in)^2	=	I_g in^4	x	E_L psi	=	E_LI_g lb-in^2
Top	0.242	+	7.139	1.9426254	=	27.18	x	1,980,000	=	5.382E+07
Str	21.20	+	19.500	-0.0832504	=	21.34	x	1,133,000	=	2.417E+07
Bot	0.246	+	8.404	1.7607496	=	26.3	x	1,980,000	=	5.207E+07
Totals										1.30E+08

F'_c & F'_t: Allowable stress for top and bottom skins

Top

Clear distance / b-distance = 12.67 / 19 = 0.667

factor 1 = 1-((clear dist. / b-dist. - 0.5)2/3)

factor 2 = 2/3 0.667 = 0.888889

0.889

F'_c = factor(F_c) = 1369 psi

$w_{bt} = \frac{8F'_c(E_LI_n)}{48cL^2E_L} = 108$

Bottom

Clear distance / b-distance = 12.67 / 18 = 0.704

factor 1 = 1-((clear dist. / b-dist. - 0.5)2/3)

factor 2 = 2/3 0.667 = 0.864198

0.864

F't = factor(Ft) = 1426 psi

$w_{bb} = \frac{8F'_t(E_LI_n)}{48cL^2E_L} = 123$

w_p : allowable UDL due to tensile stress in splice plate

F = 1200 psi pg(557) table: 5.6.1.2

Seam 1.3125 ft

$$w_p = \frac{2F\left(\frac{\text{Total splice plate width}}{\text{Bottom skin width}}\right)(E_L I_g)}{48cX(L-X)E_L} = 143$$

Best case seam placement

w_p : allowable UDL due to tensile stress in splice plate

F = 1200 psi pg(557) table: 5.6.1.2

$$w_p = \frac{8F\left(\frac{\text{Total splice plate width}}{\text{Bottom skin width}}\right)(E_L I_g)}{48cL^2E_L} = 86$$

Worst case seam placement

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w_s : Allowable uniform load due to rolling shear

y' =	0.0405	(pg555)		$d_s = c - y'$ =	2.137
A =	3.89	Table 3.6.2		$Q_s = Ad_s$ =	8.311
c =	2.177				

t = stringer thickness (acutal width)

Allowable rolling shear capacity

$\Sigma F_s t$ = [(F_s/2)(# ext. stringers)] t + [(F_s)(# of interior stringers)t]

$\Sigma F_s t$ = 216 lb/in

$$w_s = \frac{2(E_L I_g)\Sigma F_s t}{4Q_s L E_L} = 107$$

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w_v : Allowable uniform load due to Hor. sheer stress

Q_v = (# of stringers)($Q_{stringer}$)+($E_{L\ skin}$ / $E_{L\ stringers}$)(Q_{skin})

= 32.99

A_{str} above N.A. =

= Str width (Total Thickness - NA from bottom - Top thickness)

= 1.5 x 1.708 = 2.562375667 in^2

Q_{str} = Ad = 2.189 in^3

Q_{skin}= Ad = 13.87

$$w_v = \frac{2(E_L I_g)F_v t}{4Q_v L E_{L\ str}} = 176$$