

Homework Assignment 4: Residual Strain Measurements Based on the Hole Drilling Method

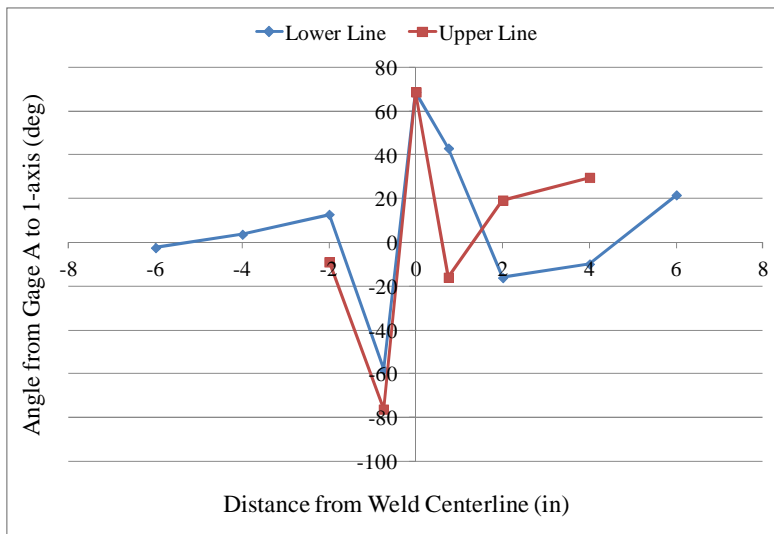
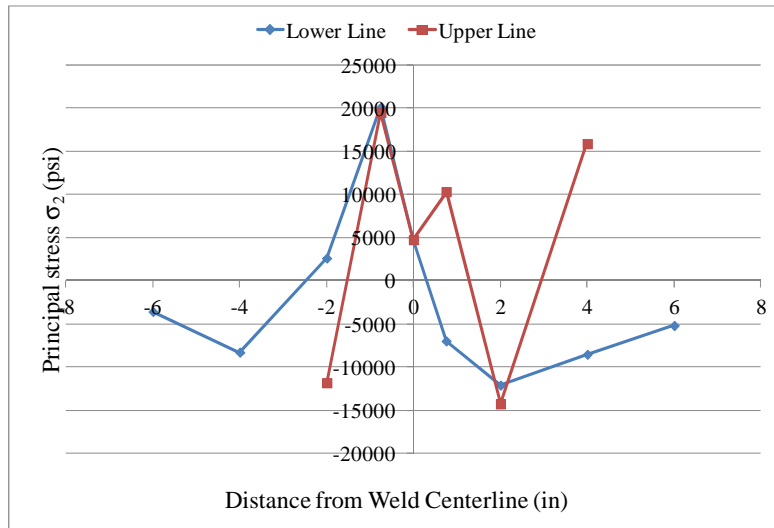
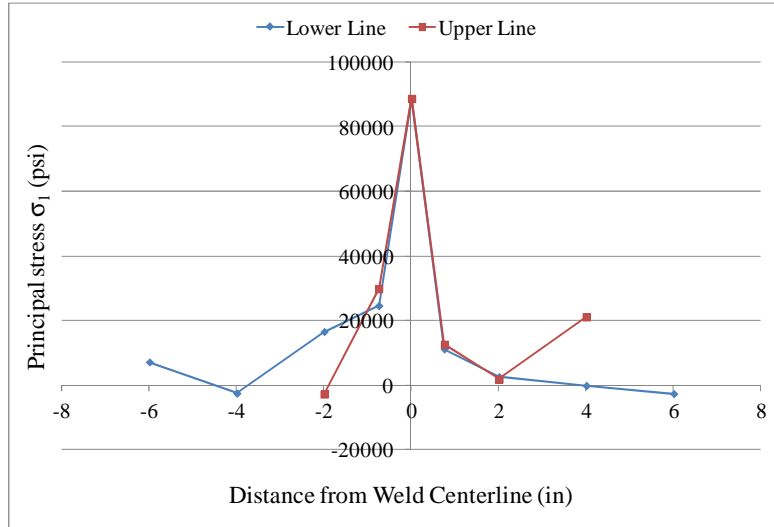
Overall comments: This assignment did not work out too well. I expected that the maximum residual stresses would occur at/near the weldline, which is what was found. However, I also expected a symmetry about the weldline to exist; in contrast, measurements and calculated results show a very modest symmetry (at best!). Many calculations lead to unreasonably high residual stress levels, particularly for the blind hole calculations in part (b).

I do not have much personal experience with the hole drilling method. I do not know if the inconsistent results we obtained are due to our lack of experience and/or the random nature of the welding process, or if the high levels of scatter are typical of the hole drilling method. Prof. Kim, Mahdi Ashrafi, and I plan additional measurements in the coming weeks. These additional experiences will provide us with a better feel for the level of accuracy and consistency that can be achieved with this technique.

- a. Calculate principal residual stresses and orientation of principal coordinate system at all available rosette positions, based on through-hole measurement. Report results both in tabular form and as a plot.

Data and calculated principal residual stress and orientations, based on through-hole measurements

Rosette Label	Location w/r/t Plate centerline (in)	hole diameter (in)	Hole radius (in)	C_1	C_2	Strain Measurements			Principal stresses		Angle calculated using Eq 8.55	is $\epsilon_C > \epsilon_A$?	Angle to 1-axis (degs)
						$\epsilon_1 = \epsilon_A$	$\epsilon_2 = \epsilon_B$	$\epsilon_3 = \epsilon_C$	σ_1	σ_2	θ (degs)		
U3	-2	0.0805	0.04025	-0.00352	-0.00928	-28	77	131	-2818	-11818	-8.891944221	yes	-8.892
U4	-0.75	0.075	0.0375	-0.00305	-0.00824	-75	-111	-226	29806	19470	13.80880556	no	-76.2
C	0	0.076	0.038	-0.00314	-0.00843	228	-772	-814	88687	4739	-21.29749537	no	68.7
U5	0.75	0.075	0.0375	-0.00305	-0.00824	-86	-60	-54	12604	10315	-16.0026916	yes	-16
U6	2	0.078	0.039	-0.0033	-0.00881	-70	-47	152	1838	-14249	19.20356365	yes	19.2
U7	4	0.075	0.0375	-0.00305	-0.00824	-135	-150	-91	21110	15888	29.63225615	yes	29.63
L1	-6	0.072	0.036	-0.00281	-0.00769	-92	-3	72	7128	-3575	-2.439636892	yes	-2.44
L2	-4	0.075	0.0375	-0.00305	-0.00824	-14	27	80	-2529	-8276	3.637502479	yes	3.63
L3	-2	0.075	0.0375	-0.00305	-0.00824	-162	-108	45	16535	2619	12.77998259	yes	12.8
L4	-0.75	0.0785	0.03925	-0.00335	-0.0089	-132	-114	-167	24565	20117	31.87932517	no	-58.12
C	0	0.076	0.038	-0.00314	-0.00843	228	-772	-814	88687	4739	-21.29749537	no	68.7
L5	0.75	0.0785	0.03925	-0.00335	-0.0089	-25	-175	-3	11159	-6975	43.04572785	yes	43
L6	2	0.08	0.04	-0.00347	-0.00918	-81	105	147	2594	-12091	-16.13782216	yes	-16.14
L7	4	0.0735	0.03675	-0.00293	-0.00797	-37	48	88	-177	-8516	-9.899438177	yes	-9.88
L8	6	0.078	0.039	-0.0033	-0.00881	10	11	42	-2690	-5181	21.57619487	yes	21.6



- b. Calculate residual stresses through the thickness of the plate, using the blind-hole method and data collected using the center rosette (only). Report results both in tabular form and as a plot

Through-Thickness Stresses (Center Rosette Only)

$$D_m = 0.202 \text{ in, } D = 0.076 \text{ in, so } D/D_m = 0.3762$$

Hole Depth, h (in)	h/D _m	Interpolated from Tbl 8.2				ε ₁ (μ ϵ)	ε ₂ (μ ϵ)	ε ₃ (μ ϵ)	σ ₁	σ ₂
		\bar{C}_1	\bar{C}_2	\bar{C}_1	\bar{C}_2					
0.005	0.025	-0.018144	-0.032716	-0.00040198	-0.00056407	46	-263	-410	440855.4564	11899.50348
0.01	0.050	-0.042812	-0.078004	-0.00094851	-0.0013449	93	-318	-521	233315.2505	-7697.573966
0.015	0.074	-0.06948	-0.128816	-0.00153934	-0.00222097	162	-381	-664	179003.3015	-15946.5531
0.02	0.099	-0.094148	-0.18382	-0.00208587	-0.00316931	211	-431	-772	148332.5501	-13855.97721
0.025	0.124	-0.115768	-0.225344	-0.00256486	-0.00388524	261	-477	-860	134047.7457	-17277.2397
0.03	0.149	-0.132864	-0.26606	-0.00294362	-0.00458724	301	-508	-921	122663.5022	-17351.16852
0.035	0.173	-0.146912	-0.301204	-0.00325486	-0.00519317	357	-618	-1026	123340.5451	-20571.16976
0.04	0.198	-0.156484	-0.330348	-0.00346693	-0.00569566	372	-643	-1055	117249.0966	-18746.96362
0.045	0.223	-0.164008	-0.35392	-0.00363363	-0.00610207	391	-651	-1065	111336.4796	-18591.64433
0.05	0.248	-0.168532	-0.373016	-0.00373386	-0.00643131	396	-656	-1075	107713.119	-16788.33668
0.075	0.371	-0.17096	-0.41816	-0.00378765	-0.00720966	396	-655	-1028	96403.99008	-12974.91299
0.1	0.495	-0.163008	-0.427732	-0.00361147	-0.00737469	373	-655	-994	94882.41979	-8906.357314

