

**Stress calculations at critical point in the hub-assembly**



Below in the table are given the temperatures and strains as a function of time at the critical location (Gage 13) on the hub surface when the trunnion-hub assembly is immersed in liquid nitrogen. The strain is measured using a 45° rosette. Strain gage A is located along the radial direction and strain gage C is along the hoop direction.

**Find the radial, hoop and shear stress at location 13 as a function of time. When does the maximum hoop stress occur?**

TIME	TEMPERATURE	STRAIN - A	STRAIN - B	STRAIN - C
0:00:00	76.670	17.131	38.408	96.834
0:00:32	-51.516	111.023	119.318	218.509
0:01:05	-81.032	198.077	243.523	308.454
0:01:39	-98.935	337.131	290.239	458.710
0:02:11	-112.945	412.325	345.234	535.710
0:02:44	-124.764	329.804	361.540	602.149
0:03:17	-139.202	328.992	403.272	627.262
0:03:50	-155.587	266.971	476.784	727.091
0:04:23	-179.963	227.907	545.046	842.550
0:04:56	-213.936	188.148	554.839	962.914
0:05:29	-265.008	274.233	660.997	1120.539
0:06:02	-274.504	206.003	600.260	1095.058
0:06:35	-280.257	142.667	543.347	1058.986
0:07:08	-284.320	110.287	507.332	1025.088
0:07:41	-287.006	67.571	463.857	992.376
0:08:14	-289.867	30.592	425.405	960.724
0:08:47	-292.100	5.781	393.370	928.650
0:09:20	-293.502	-16.995	364.813	896.815
0:09:53	-294.429	-37.443	336.068	858.668
0:10:26	-295.434	-46.914	318.310	830.799
0:10:59	-296.219	-56.088	300.849	796.744
0:11:33	-296.819	-52.679	292.021	767.730
0:12:06	-297.345	-50.132	284.851	739.656

0:12:38	-297.796	-48.091	267.457	704.232
0:13:11	-298.060	-39.971	252.547	669.136
0:13:45	-298.514	-40.430	229.414	640.580
0:14:17	-298.816	-37.252	218.557	607.023
0:14:50	-299.157	-35.424	200.233	571.036
0:15:23	-299.537	-33.864	187.759	536.224
0:15:56	-299.499	-37.905	177.238	508.772
0:16:29	-299.955	-34.008	162.425	478.465
0:17:02	-300.221	-29.450	150.432	441.980
0:17:36	-300.374	-34.140	137.105	412.444
0:18:09	-300.679	-32.364	118.011	387.939
0:18:41	-300.870	-29.768	120.608	359.218
0:19:14	-301.023	-25.459	120.241	326.453
0:19:48	-301.214	-7.750	109.171	267.507
0:20:20	-301.367	5.557	95.136	228.275
0:20:53	-301.597	19.764	67.611	180.590
0:21:27	-301.904	31.639	41.712	138.493
0:22:00	-302.134	35.784	14.919	112.775
0:22:32	-302.365	33.097	-5.034	79.506
0:23:05	-302.788	33.400	-19.479	62.900
0:23:39	-302.981	32.070	-24.765	43.582
0:24:11	-302.942	32.336	-29.895	31.976
0:24:44	-303.212	35.516	-33.550	14.291
0:25:17	-303.212	27.242	-45.779	3.860
0:25:51	-303.367	30.140	-51.153	-11.587
0:26:24	-303.482	22.873	-63.095	-26.408
0:26:56	-303.598	19.204	-68.562	-39.788
0:27:30	-303.831	23.021	-67.983	-43.885
0:28:03	-303.792	15.729	-77.071	-55.491
0:28:35	-303.792	17.528	-82.826	-64.123
0:29:08	-303.831	15.466	-83.088	-69.781
0:29:42	-304.063	12.813	-88.978	-78.908
0:30:15	-304.140	12.649	-93.098	-83.747
0:30:48	-304.295	11.244	-98.818	-91.985
0:31:20	-304.140	8.332	-100.650	-98.493
0:31:54	-304.257	7.908	-101.794	-98.917
0:32:27	-304.295	2.970	-107.810	-103.134
0:33:00	-304.451	3.725	-109.572	-109.572
0:33:33	-304.412	0.749	-115.065	-112.188
0:34:06	-304.412	1.828	-116.504	-115.065
0:34:39	-304.645	0.626	-114.109	-116.986
0:35:12	-304.606	1.245	-118.165	-124.278
0:35:45	-304.684	-5.390	-125.158	-127.315
0:36:18	-304.645	-4.410	-123.819	-132.450
0:36:51	-304.956	-8.283	-126.252	-132.366

0:37:24	-304.723	-5.289	-125.777	-134.408
0:37:57	-305.034	-5.563	-126.769	-138.996
0:38:30	-305.189	-6.955	-130.678	-142.186
0:39:03	-305.228	-9.093	-130.298	-140.008
0:39:36	-305.228	-7.295	-132.816	-147.200
0:43:36	-305.345	-5.909	-131.790	-143.657
0:47:36	-305.423	-6.063	-133.382	-145.969
0:51:36	-305.423	-15.415	-139.496	-147.048
0:55:36	-305.501	-15.929	-140.729	-149.359
0:59:36	-305.618	-14.540	-139.340	-150.847
1:03:36	-305.618	-16.698	-142.576	-152.286
1:07:36	-305.696	-13.254	-139.852	-152.438
1:11:36	-305.579	-13.564	-140.163	-155.266
1:15:36	-305.618	-16.339	-139.340	-159.837
1:19:36	-305.657	-13.717	-141.394	-155.059
1:23:36	-305.735	-15.308	-142.625	-155.930
1:27:37	-305.813	-14.381	-143.496	-155.722
1:31:37	-305.813	-15.100	-143.136	-156.082
1:35:37	-305.735	-16.747	-142.265	-160.605
1:39:37	-305.852	-16.434	-143.751	-161.731
1:43:37	-305.813	-15.460	-144.215	-155.722
1:47:37	-305.891	-15.610	-146.523	-156.951
1:51:37	-305.891	-14.891	-144.725	-159.469