L_{CR}StressMap™

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Overview

L_{CR}StressMap™ identifies the method and equipment used for obtaining highly accurate travel times for L_{CR} waves used for stress measurement and material property determination in engineering materials. L_{CR} waves will typically be the earliest arrival in the wave train, thus they are easy to identify. With this characteristic, algorithms for establishing this arrival time have been developed and integrated into software used to show the travel-time variations in an area of a plate or other structure. These travel-time variations are used to calculate residual stress or the material property of interest.

Excitation and Detection of the L_{CR} Wave

The L_{CR} wave used for stress measurement is typically excited at an incident angle near to the first critical angle. This is shown in Fig 1 and a typical arrival

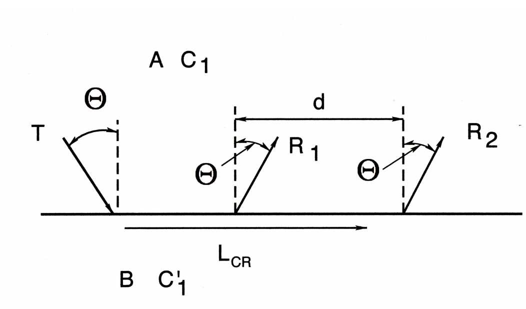

Fig .1 Excitation and Propagation of the L_{CR} Wave

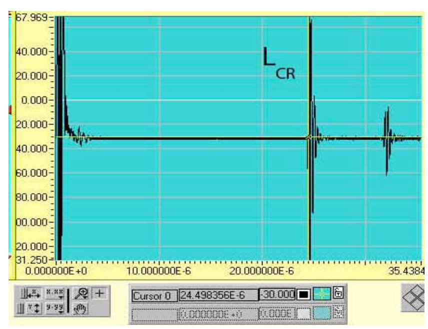

Fig 2 Typical L_{CR} arrival at probe R1

at receiver R1 is shown in Figure 2. The L_{CR} wave rises strongly out of the base line, making it easily identified. A similar arrival occurs for R2, although the amplitude is less due to the longer travel path. It is the time difference from R1 to R2 that indicates the stress-affected velocity on the material.

Automated Arrival Time Determination

The screen used for automated Time-of-Flight calculation is shown in Figure 3. Once the signal is on the screen, the sequence for calculating the travel-time begins with Record Data the red button on the right. When that is completed the Calculate Time-of-Flight is clicked and the TOF for the arrival is shown here to be 24.50955 μs. This value may be transferred to additional software to be used to develop a database and to calculate the stress fields.

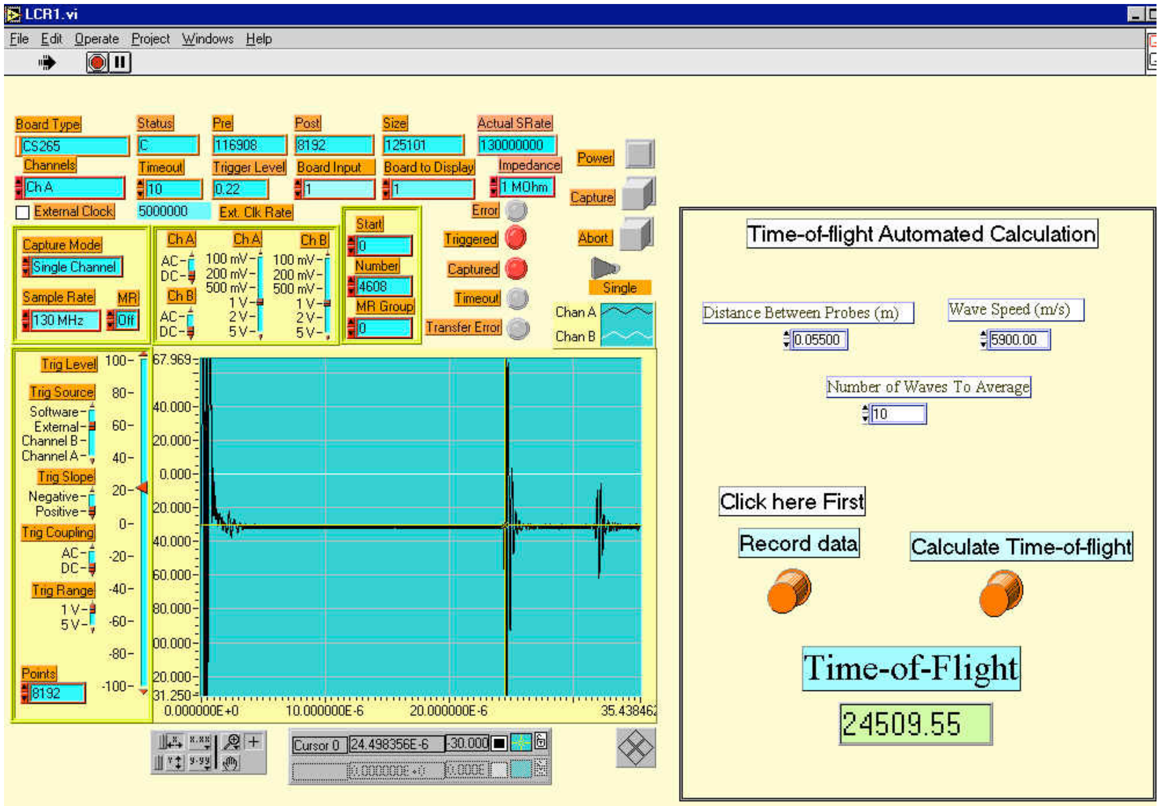

Figure 3 Typical L_{CR} arrival

L_{CR}StressMap^{TM} Screens

The application begins with entering data related to the test, as shown on Figure 4, notably the date and material as well as the elastic properties of the material, the probe characteristics and the orientation of the probe in relation to a dimension of the part. In the data processing section the method for introducing the travel-times is selected. In addition to input from a Pulser-receiver, discussed above, data may also be entered from a suitable commercial flaw detector (such as the Panametrics Epoch), or manually. If temperature data is to be inputted, that also can be done manually or automatically.

In some cases a zero stress area in the component is known, as in the case of a weld where the material away from the weld can be assumed to be unaffected by the weld stress. In the case where the item being scanned is amenable to a grid pattern, and the area to be surveyed is a complete figure or shape, it may be assumed that a full stress field can be collected and the average of all of the travel times may be used as an estimate of the zero stress travel time. Upon entering these values in the L_{CR}StressMap^{TM} data sheet, the estimated stress field may be calculated.

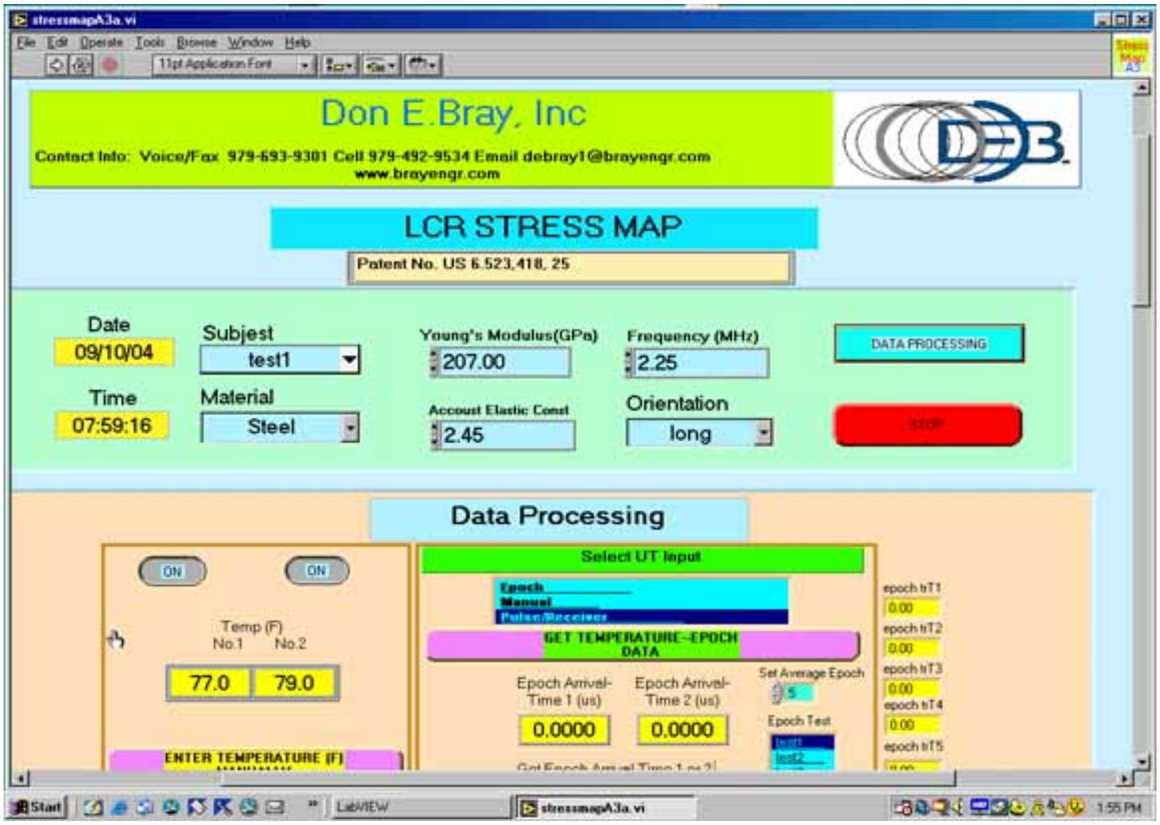

Figure 4 LCRStressMapTM Input Screens 1

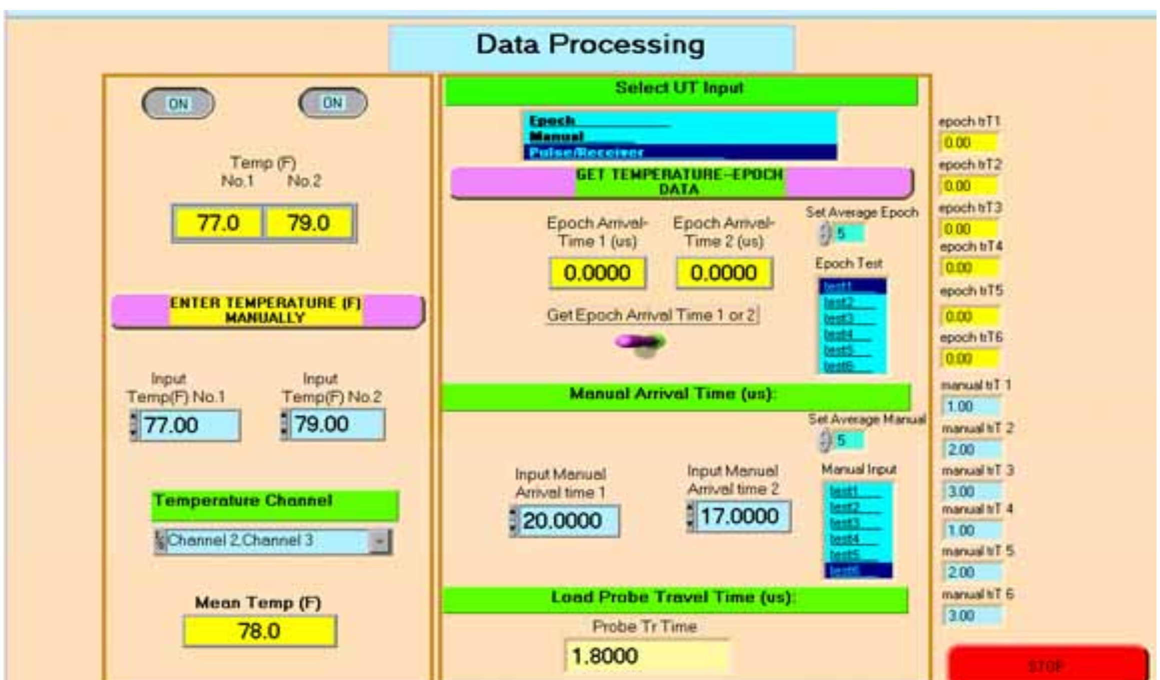

Figure 5 L_{CR}StressMap^{TM} Data Processing Screen 2

	X	Y	Travel Time	Delta T	Stress(MPa)	Stress(Ksi)
Ref Point	0.00	0.00	3.0000			
Test Point 1	0.00	0.00	1.8000	1.2000	33795.92	5069.39
Test Point 2	1.00	2.00	8.4770	0.0120	337.96	50.69
Test Point 3	3.00	4.00	8.4840	0.0050	140.82	21.12
Test Point 4	5.00	6.00	8.4516	0.0374	1053.82	158.07
Test Point 5	1.00	-1.00	10.0500	0.0500	1408.16	211.22
Test Point 6	1.00	-1.00	10.0600	0.0600	1689.80	253.47
Test Point 7	2.00	3.00	10.0700	0.0700	1971.43	295.71
Test Point 8	3.00	0.00	10.0800	0.0800	2253.06	337.96
Test Point 9	1.00	0.00	10.0900	0.0900	2534.69	380.20
Test Point 10	-1.00	0.00	10.1000	0.1000	2816.33	422.45
Test Point 11	-2.00	0.00	10.1100	0.1100	3097.96	464.69
Test Point 12	-3.00	0.00	10.1200	0.1200	3379.59	506.94
Test Point 13	-4.00	0.00	10.1300	0.1300	3661.22	549.18
Test Point 14	-4.00	0.00	10.1400	0.1400	3942.86	591.43
Test Point 15	-3.00	0.00	10.1500	0.1500	4224.49	633.67
Test Point 16	5.00	0.00	10.1600	0.1600	4506.12	675.92
Test Point 17	5.00	0.00	10.1700	0.1700	4787.76	718.16
Test Point 18	3.00	0.00	10.1800	0.1800	5069.39	760.41
Test Point 19	2.00	0.00	10.1900	0.1900	5351.02	802.65
Test Point 20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 6 Calculated Data Table for L_{CR}StressMap™

Summary

Good, accurate data are essential for obtaining quality results using the L_{CR} technique. Also, a keen understanding of the expected stress field is needed. In these cases, the automated process described above may be utilized, with various types of input.

Work continues to establish the acoustoelastic coefficients for a wider variety of materials, as well as understanding the effects of material texture on the results.

L_{CR}StressMap™ was developed using Labview 6.1 to be fully executable with Windows 98 or XP. It has not been tested with Windows Vista.