Determine Case Depth In Truck Axles-- Without Cutting!

Scope

Sonix recently completed a case study with axle manufacturer, Traxle, where case hardness depths were non-destructively measured on 24 truck axles. Depth measurements were made with the Sonix Ultrasonic Microstructural Analyzer (UMA), a device that uses ultrasonic waves to yield quantitative depth values in a few seconds without cutting, and with very high accuracy. The UMA measures case depth in induction hardened parts. Axles were inspected at both the flange root fillet and along the shaft body, taking an average measurement around the circumference. For comparison, the parts were then cut, polished and etched. Micro hardness tests were performed, measuring the case depth. The destructive tests were correlated with the ultrasonic results. The average error of the ultrasonic case depth was less than 5%.

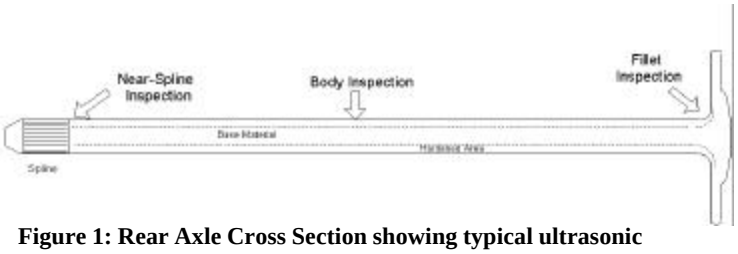


Figure 1: Rear Axle Cross Section showing typical ultrasonic inspection points to measure case depth.

Figure 2: Cut, polished and etched cross-section showing hardened outer region and soft core on a hardened axle.

Results

Figure 1 shows a cross section of the axles tested. These parts were approximately 2.0 inch diameter rear-drive truck axles. Ultrasonic measurements were taken near the center along the shaft, and 45-degrees into the flange root fillet. Figure 2 shows an axle shaft body that has been cut, polished and etched. Note that the transition from the hardened case down to the softer core is clearly visible. Figure 3a shows the averaged ultrasonic waveforms generated for three shafts at the bodies having case depths of 0.33, 0.44, and 0.51 inches. Similarly, figure 3b shows the ultrasonic waveforms recorded at the fillet areas having case depths of 0.11, 0.16, and 0.25 inches. Note in both sets of plots, that the reflection from transition zone shifts to the right as the case depth increases. The UMA measures the time between the front surface echo and the transition zone echo, then converts this to a case depth from a calibration standard. The time measurement is shown (in microseconds) on each plot.

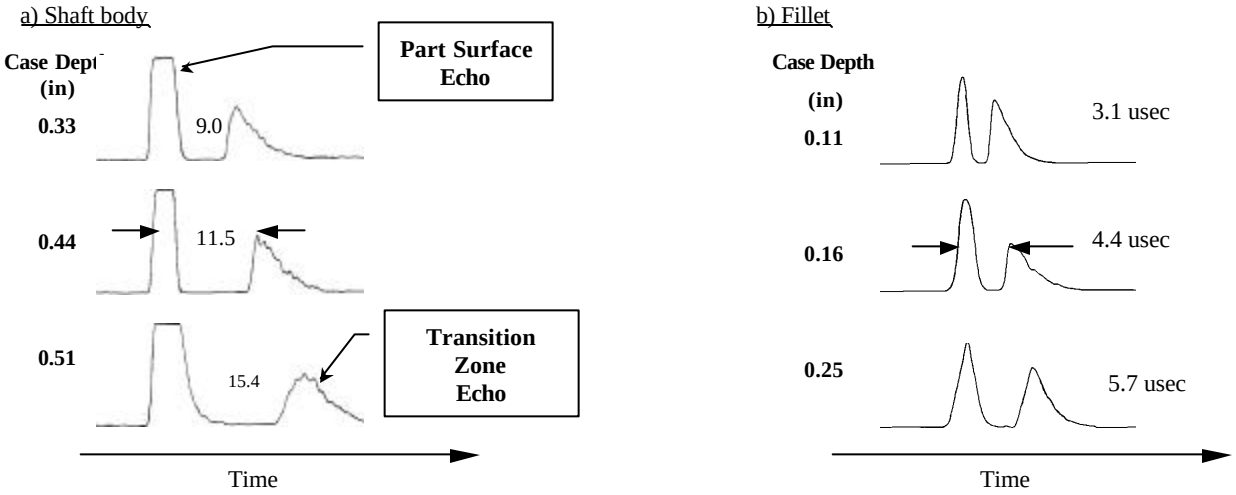


Figure 3: Ultrasonic responses from: (a) 3 shaft bodies having case depths of .33, .44, and .51 inches, and (b) three fillets having case depths of 0.11, 0.16, and 0.25 inches.

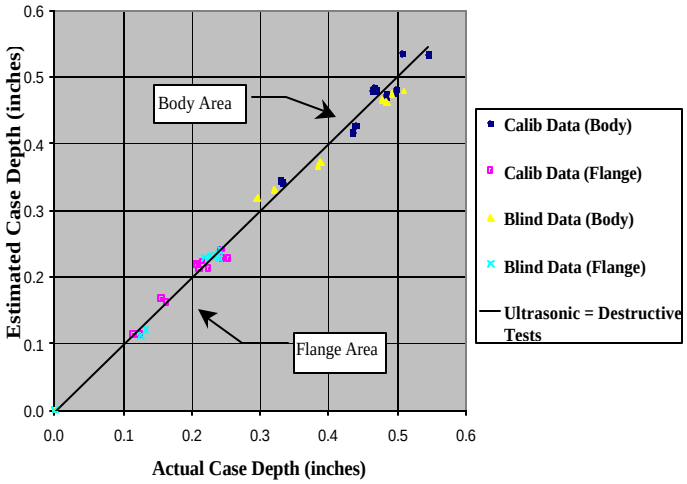
Figure 4 shows the case depth obtained ultrasonically plotted against the actual destructive case depth measurements for all 24 axles: Case depths for the shaft bodies were in the range of 0.3 - 0.55 inches. The fillets were in the range of 0.1- 0.25 inches. Note that the ultrasonic depths closely track the results obtained by cutting. Overall, the average error was less than 5%.

Advantages

The key advantage of the UMA method is that it is non-destructive: tested parts can be returned to the production line, saving significantly in scrap. Depth measurements are produced in seconds, so many more parts can be tested compared to conventional destructive methods. Process problems can be corrected sooner. The UMA provides a direct reading of case depth and is not sensitive to surface roughness, material properties, dimensional tolerances, small changes in temperature or magnetic fields. Core hardening is also easily detected.

For more information contact Sonix at 703-440-0222. See our web site at http://www.sonix.com.

Figure 4: Traxle Axles: Estimated Case Depth using Ultrasound vs Actual Case Depth (All Data)



What People Are Saying About The UMA!

Gary C. -- Chief Metallurgist --DANA Corp. Marion Forge
Application: Medium to Heavy Rear Wheel Truck Axles
Comments: Have saved 60% of destructive testing scrap by using UMA, "This device is like a dream come true"

Scott P. -- Quality Assurance Manager -- Traxle:
Application: Medium to Heavy Rear Wheel Truck Axles
Comments:"This is the most promising non-destructive technology we have seen to date…. This is the first device we have seen that actually give a quantifiable output… our confidence is high for integrating this device into our plant in the near future."

John D. -- Senior Metallurgist -- Major Automotive Axle Manufacturer
Application: Front Wheel Drive Automotive Shafts
Comments: "Have saved 25% of destructive testing scrap by using the UMA system".