APPLICATION CASE STUDY / AXLE BARS

Non-destructive case depth measurement on production axle bars

The EddySonix Eddy Current Scanner (ECS) measured effective case depth on previously unseen induction-hardened axle bars. Compared with microhardness cut checks, the root mean square error (RMSE) ranged from 0.11 to 0.18 mm across five inspection locations.



Figure 1. Examples of axle-bar geometries.

The production challenge

Effective case depth (ECD) is the distance from the surface to the point where hardness reaches the specified threshold. A microhardness cut check determines that depth on a sectioned part. A manufacturer seeking more frequent checks needs a method that can measure the same characteristic without sacrificing the part.

The validation question

How closely would ECS readings agree with cut checks on new production parts as manufacturing lots and steel heats changed?

What the operator sees

The scanner moves along the shaft and records an eddy current response. The part program uses that response to estimate effective case depth at defined inspection locations.

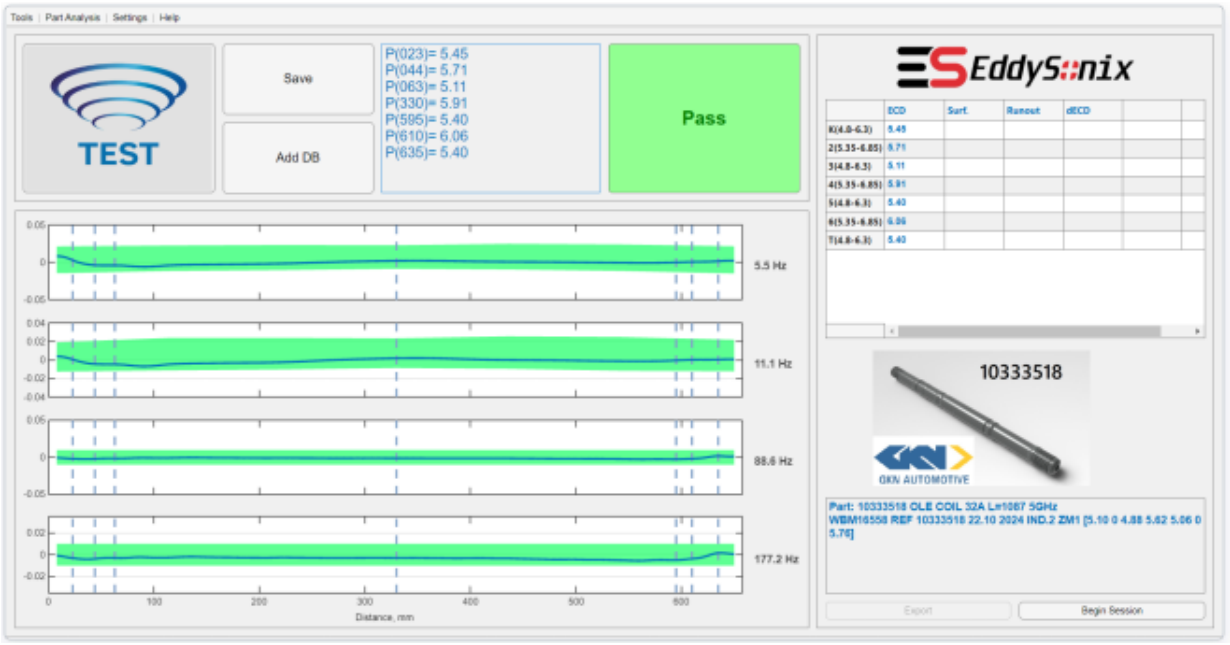


Figure 2. ECS inspection screen for GKN Automotive axle bar 10333518.

Scan traces

The traces on the left show how the eddy current response varies with axial position. The marked locations identify where the part program reports case depth.

Case depth in millimetres

For the displayed run, the app reports 5.45 mm at P(023), 5.71 mm at P(044), 5.11 mm at P(063), 5.91 mm at P(330), 5.40 mm at P(595), 6.06 mm at P(610) and 5.40 mm at P(635).

Pass or fail decision

The displayed scan received a Pass decision. The part program compares the readings with its configured limits.

Comparison with microhardness

The test used previously unseen axle bars from different production lots and steel heats. We compared each ECS reading with a destructive microhardness cut-check value from the same location on the same part.

Select production parts → Scan with ECS → Compare with cut checks

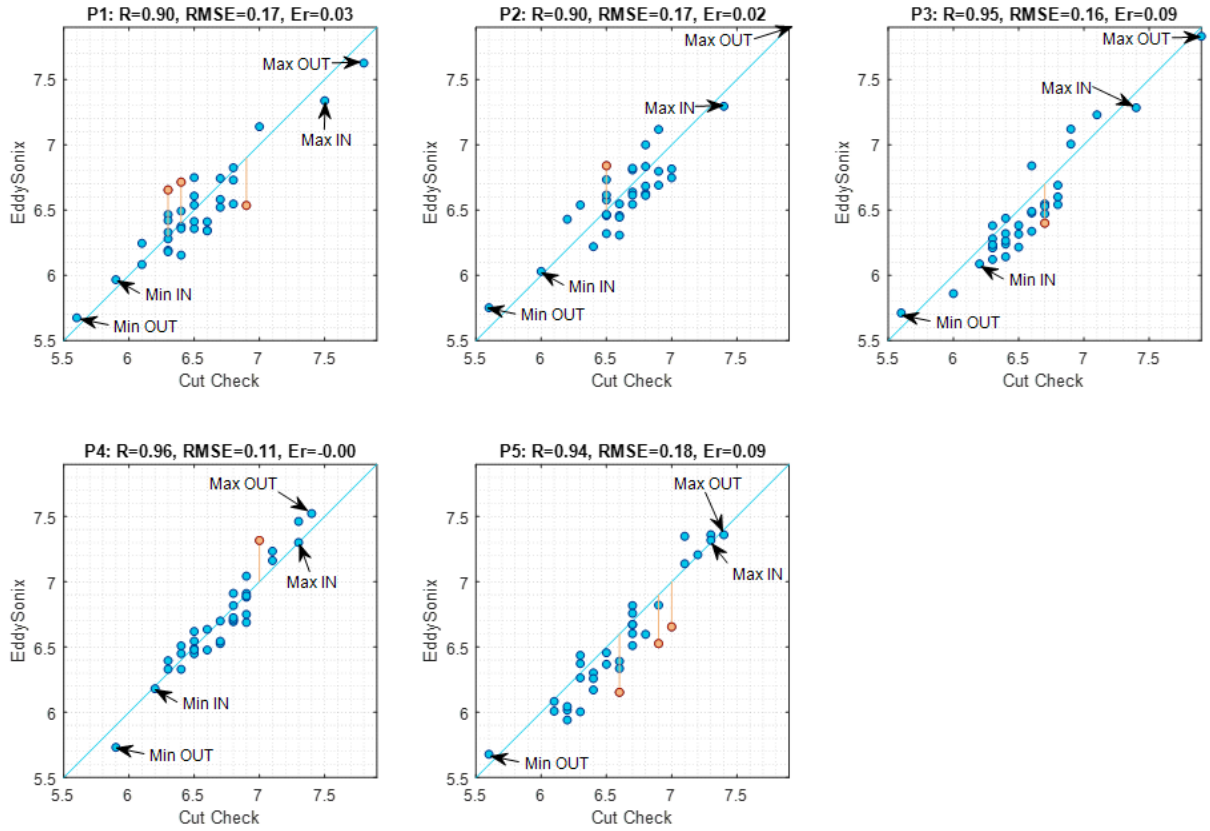


Figure 3. Paired measurements at P1 through P5. Both axes show effective case depth in millimetres.

Reading the plots

The horizontal axis shows the microhardness cut-check value. The vertical axis shows the ECS estimate. A point on the diagonal indicates equal readings. Its vertical distance from the diagonal shows the signed measurement difference.

Agreement at each inspection location

We calculated RMSE separately at each location from the paired ECS and microhardness readings. A larger difference contributes more to RMSE because the calculation squares each difference before averaging.

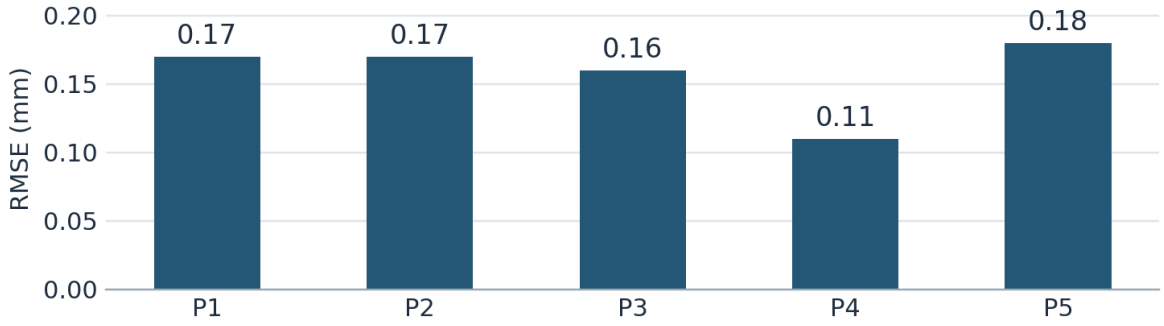


Figure 4. RMSE by inspection location.

What the study establishes

ECS produced numerical measurements that could be compared directly with destructive cut checks for the production axle bars sampled. The lowest RMSE was 0.11 mm at P4. The highest location-level RMSE was 0.18 mm at P5.

Using the results in a control plan

Evaluate agreement against the requirements at each inspection location. If the control plan relies on pass or fail decisions near a specification limit, verify those decisions on representative parts near that limit before changing the frequency of destructive checks.

Discussing a similar application

Share the part geometry, inspection locations, effective case depth limits and current cut-check method with EddySonix. These inputs define the scope of an application review.

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