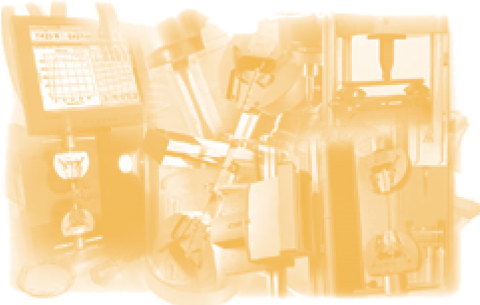

Tensile Testing of Stainless Steel Tubing with the AVE

Application Report

Introduction

Stainless steel tubing (or any other variety of rigid metallic tubing) can be difficult to test in tension for two reasons. Standard methods of gripping will cause the tubing to collapse and lead to pre-mature failure of the specimen. Strain measurement is also usually not possible with traditional clip-on extensometers because the knife-edges lead to high stress concentrations and consequently failure of the thin specimen wall. The purpose of this testing was to recommend a gripping solution and evaluate the use of the Advanced Video Extensometer (AVE) for accurate, non-contacting strain measurement.

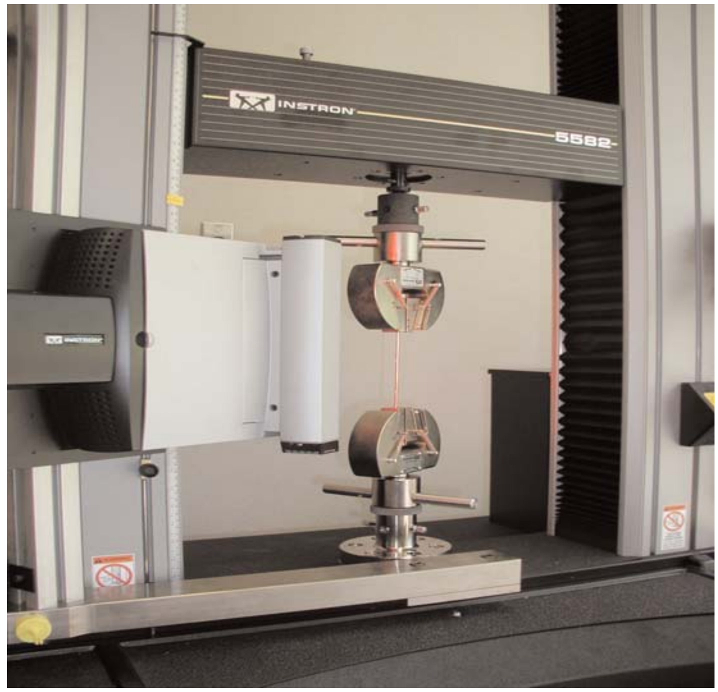

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Figure 1:
Configuration for testing stainless steel tubing specimens in tension.

Test Configuration and Specimen Preparation

Frame: 5582
Grips: 30 kN wedge grips with V-faces
Extensometry: AVE with 200 mm Field of View (FOV) lens
Software: Bluehill®
Gauge length: 2.0 in
Test speed: 0.1 in/min up to the yield point and 0.5 in/min from yield to failure

Solid mandrels that matched the inner diameter of the specimens were inserted into the gripped ends to encourage failure within the gauge area. A white paint pen was used to mark the specimen gauge area for strain measurement with the AVE. The complete test configuration is shown in Figures 1 and 2. The AVE set-up window shown in Figure 3 demonstrates the relationship between the marks on the specimen and the marks captured by the AVE before the start of a test.

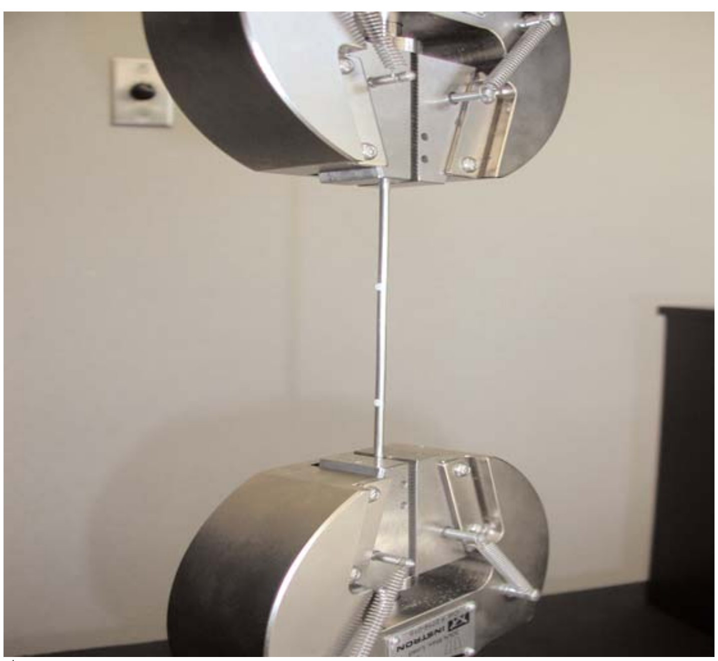

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Figure 2:
Close-up of the grips and the marking technique recommended for strain measurement with the AVE.

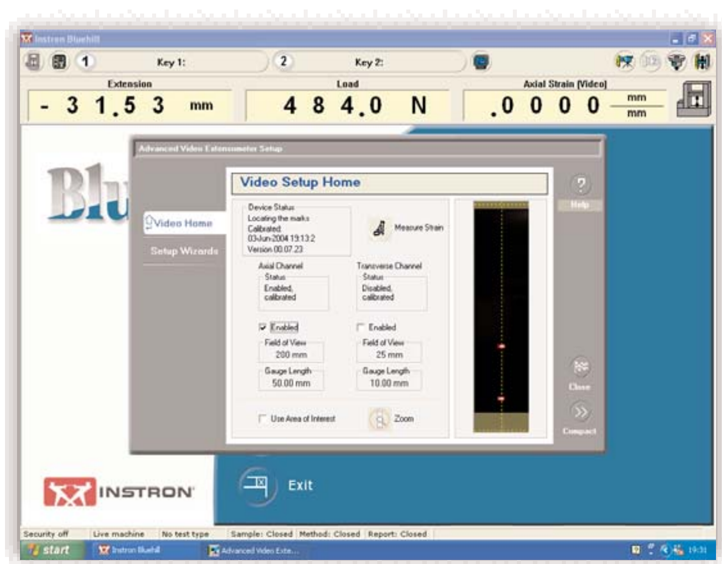

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Figure 3:
The software easily interprets the gage length marked on the specimen.

Results

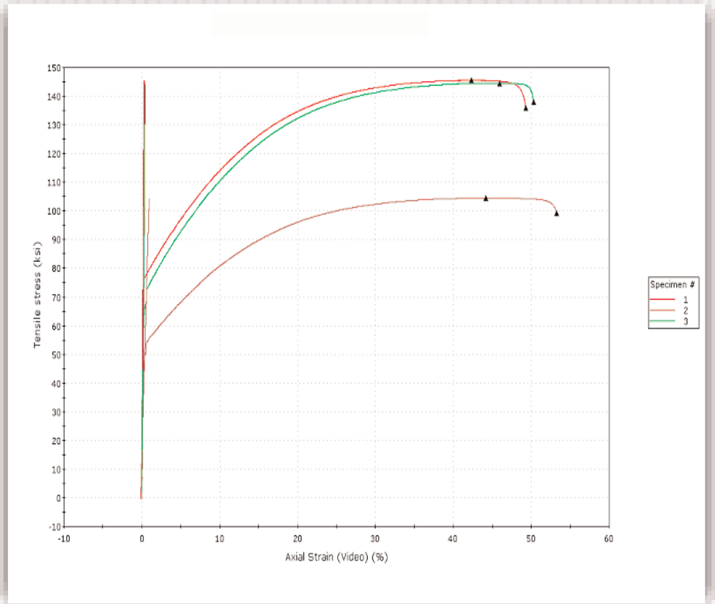

Figure 4:
Stress vs. strain data for three stainless steel tubing specimens testing in tension.

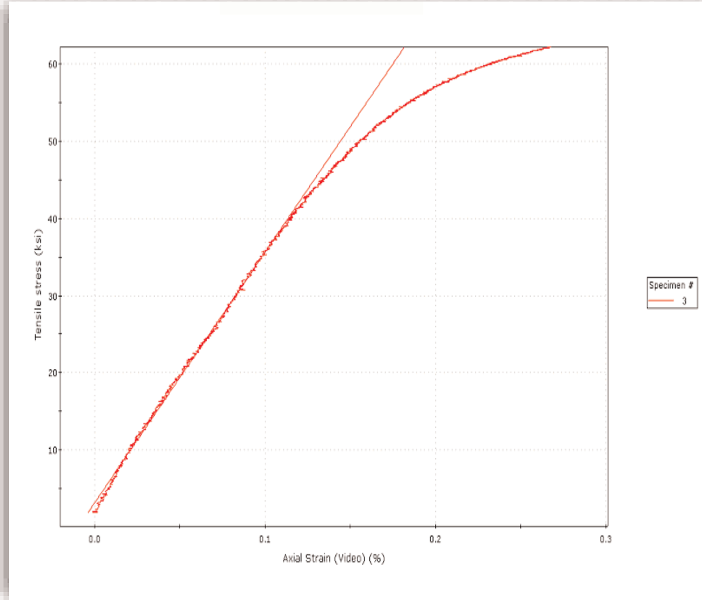

Figure 5:
Close-up of the linear region of specimen #3.

Specimen	Max Load (lbf)	Strain at Max Load (%)	Tensile Strength (ksi)	Load at Break (lbf)	Ultimate Strength (ksi)	Stress at break (%)	Stress at 2% Strain (ksi)	Modulus (ksi)
1	267.388	42.293	145.491	249.592	135.808	49.277	84.56	57819.67
2	267.793	44.154	104.526	254.161	99.205	53.246	59.048	19248.216
3	265.618	45.984	144.528	253.562	137.968	50.311	79.603	32509.503
Mean	266.933	44.144	131.515	252.438	124.327	50.945	74.403	36525.796
S.D	1.157	1.846	23.378	2.483	21.783	2.059	13.527	19596.868

Table 1:
Results of three specimens tested in tension.

Conclusions

These results show that the gripping and marking techniques were able to accurately measure tensile load and axial strain through failure in each specimen. For this particular customer, as a result of ease of use of the product and the simple specimen marking technique, an increase in productivity and improvement in results accuracy has been reported.

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