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VEQTER

Residual Stress Experts

VEQTER is an engineering company providing excellence in the measurement, analysis and management of residual stresses. We are world leaders in our field and offer expertise on any aspect related to residual stresses in engineering components and structures.

Slitting Technique

The Slitting or Crack Compliance technique is a destructive, mechanical strain release (MSR) technique that can accurately measure both near surface and through thickness residual stresses.

The technique involves cutting a slit across a component, typically using wire-EDM, and measuring the surface strains with strain gauges located underneath or next to the slit. During the procedure the slit depth is increased incrementally to predetermined depths and the strain at each depth increment is recorded. The surface strain relaxations are related to the stresses throughout the specimen thickness using numerically determined influence coefficients. Typically the underneath (or back) strain gauge is most important and is used for the calculation of through thickness residual stresses, however the top strain gauge also gives further information about the top surface stresses during the first few EDM increments.

To find out how VEQTER can help you please contact us on +44 (0) 117 992 7970 or using experts@veqter.co.uk

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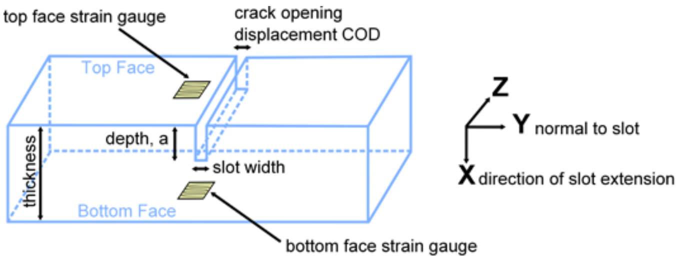
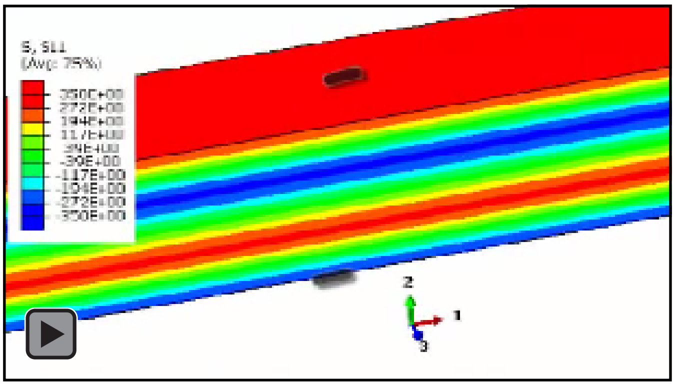


Schematic of the Slitting technique.

Analysis of the strain data from the Slitting process is carried out using elastic inverse solutions. The most commonly seen analysis is the polynomial series expansion method which is performed by assuming a polynomial expansion for the unknown residual stress profile and finding the 'compliance coefficients' that relate the stress at each slit depth to the given strain relaxation. Another common method for the analysis is the 'integral' or 'pulse' method which is a more popular solution for rapidly changing stress fields where applying a least squares fit to the strain data is not considered accurate.

The Slitting technique is good for measuring uniaxial residual stress profiles in specimens with prismatic cross sections, where the stress profile only varies in one direction (i.e. in the direction of incremental cutting), and moment and stress distributions across the measurement section are balanced.

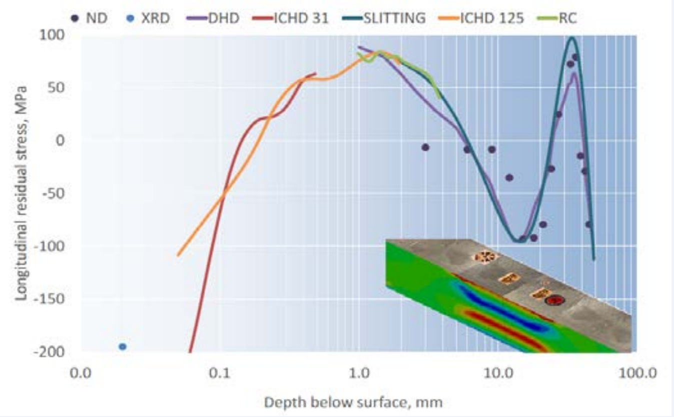


Finite element simulation of the Slitting technique.

Slitting Procedure:

The basic experimental procedure is as follows:

1. Prepare (e.g. smooth and degrease) the component surface at the strain gauge locations.
2. Glue the uniaxial strain gauges to the front and back of the specimen and attach the lead wires.
3. Waterproof/encapsulate the strain gauges to ensure they are not damaged by the EDM fluid or agitated by fluid flow (not necessary for mechanical cutting).
4. Align and fix the specimen relative to the EDM wire or mechanical cutter so that the back strain gauge is directly underneath the cut.
5. Perform a series of slitting increments up to 90% of the specimen thickness and record the strain gauge readings after each increment.
6. After the experiment is complete make further measurements to check slit depth, thickness and alignment to strain gauge, and make adjustments to the analysis procedure where appropriate.
7. Analyse the strain gauge data to calculate the residual stress distribution.



Example results for a 50mm thick 4-point plastically bent beam.

Technique Specifications:

- Depth of measurement only limited by the size of slitting machine used, >100mm depth is possible;
- Very good for measuring residual stress gradients;
- Applicable to a wide range of materials, both metallic and non-metallic;
- Nominal accuracy: 10MPa – Aluminium, 30MPa – Steel, 15MPa – Titanium;
- Very price competitive with respect to the depth of measurements made;
- Destructive;
- Laboratory based measurements;
- Uni-axial residual stress measurements;
- Increased uncertainty in surface residual stress measurements, Increased uncertainty in the measurement of high magnitude residual stresses;
- Difficult to apply to complex shaped components and stress fields;