

The logo for VEQTER, featuring the company name in a blue, sans-serif font. The letters 'V', 'E', and 'Q' are connected, as are 'T' and 'E'. The logo is enclosed in a black rectangular border.

Residual Stress Experts

Aerospace
Conventional Power Generation
Manufacturing
Maritime
Nuclear Power Generation
Oil and Gas
Rail and Transport



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.

Centre-Hole Drilling Technique

The Centre-Hole Drilling (CHD) residual stress measurement technique is a semi-invasive, mechanical strain release (MSR) technique (i.e. the strain of the component is measured during stress relief from the removal of a small amount of material) The CHD technique is one of the most widely used techniques for measuring surface residual stresses.

The CHD technique is performed by measuring the surface strains caused by the relief of residual stresses during the incremental machining of a shallow hole in a component. The principle is that the removal of the stressed material results in the surrounding material readjusting its stress state to re-attain residual stress equilibrium. The measured surface strains allow for the back calculation of the previously existing residual stresses. The formulae and calculations derived for the back calculation process are developed from a combination of experimental and Finite Element (FE) analyses.

The residual stresses calculated from the incremental strain measurements can be analysed to provide either a single set of bi-axial results averaged over the depth drilled (i.e. CHD) or a variation in bi-axial residual stresses with depth drilled (i.e. Incremental Centre-Hole Drilling or ICHD).

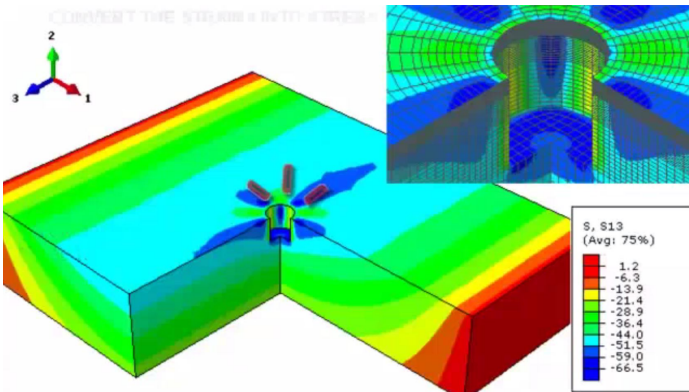
To find out how VEQTER can help you, please contact us on +44 (0) 117 992 7970 or using experts@veqter.co.uk

CHD Procedure:

The ASTM E837 standard describes the process from the attachment of the strain gauge rosette, through drilling of the hole to relieve the residual stresses, to the determination of the original residual stresses from the measured strains. The basic experimental procedure is as follows:

1. Prepare (e.g. smooth and degrease) the component surface at the measurement location.
2. Glue the CHD strain gauge rosette (SGR) to the component and attach the lead wires.
3. Align the CHD machine with the SGR.
4. Drill the central hole in a series of increments.
5. Measure the hole depth and record the strain gauge readings for each increment drilled.
6. Analyse the depth and strain gauge data to calculate the residual stress distribution.

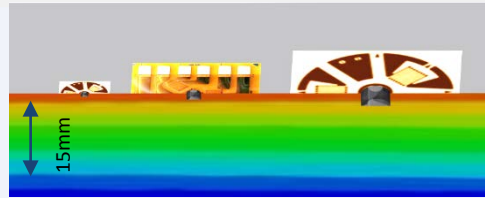
Shown below is a simulation of the technique using FE analysis illustrating the change in the stress field caused by the creation of a hole.



CHD Application:

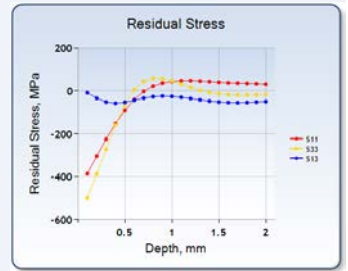
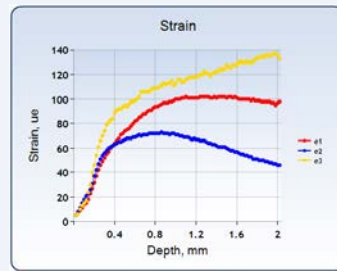
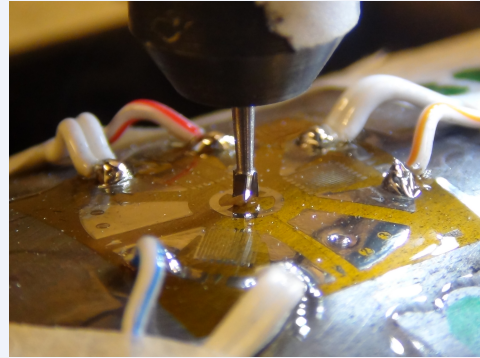
Although it is possible to measure the variation in stress with depth by incrementally deepening the hole, the practical measurement depth is limited to roughly 2/3 of the drilled diameter. The standard sizes of SGR available cater for drilled hole diameters of roughly 1.0mm, 2.0mm and 4.0mm, producing biaxial residual stress results for depths up to 0.5mm, 1.0mm and 2.0mm respectively.

SGR Size	Hole Diameter	Measurement Depth, Larger error in the first and last 20% of the measurement depth
31	Ø1mm	0.5mm
62	Ø2mm	1mm
125	Ø4mm	2mm



The different sized strain gauge rosettes attached to a bent beam

Shown below is a typical measurement using a “125” strain gauge rosette and orbital drilling a 4mm diameter hole.



Technique Specifications:

- ▲ Maximum measurement depth of 2mm.
- ▲ Semi-destructive – enabling repeated residual stress measurements at many different stages in component life;
- ▲ Laboratory or “on-site” measurements;
- ▲ Bi-axial residual stress distribution measured (e.g. σ_{xx} , σ_{yy} and σ_{xy}), including stress gradients;
- ▲ Applicable to a wide range of materials;
- ▲ Indifferent to grain structure/texture of the component material;
- ▲ Nominal accuracy: 10MPa – Aluminium, 30MPa – Steel, 15MPa – Titanium;
- ▲ Increased uncertainty when measuring residual stresses greater than roughly 80% of yield due to plastic relaxation
- ▲ Very quick and easy to apply the process, and therefore relatively cheap;
- ▲ Very good for measuring near-surface residual stresses due to surface treatments;
- ▲ Heavily reliant on good strain response curves;
- ▲ Very sensitive to non-concentricity between the SGR and drilled hole.

