

# OBJECTIVE OF THE CONTROL OF RESIDUAL STRESSES USING THE CONTOUR METHOD

## Optimisation of manufacturing processes / forming

Residual stresses are the self-balancing stresses in a piece when there are no external forces. They can significantly affect the mechanical properties of materials and structural components, particularly fatigue resistance, dimensional stability, corrosion resistance or brittle fracture. Their effect is not always beneficial thus the **measurement and analysis of residual stresses** are mandatory steps in the design of parts and structural elements to ensure **product quality**.

## Control and qualification of heavy-gauge parts

The contour method is a destructive technique relatively easy to apply compared to the high value of the results. It allows the characterisation of large thicknesses and complete mapping of the residual stresses over a section of a part or a component.

All processes affecting residual stresses:

- Casting, foundry work, forging
- Hot or cold forming
- Additive manufacturing
- Thermal treatments
- Mechanical assembly
- Welding
- Cutting
- Test part
- Finishing machining, grinding
- Coatings and surface treatments
- Mechanical surface treatments (shot peening, hammering, roller burnishing, etc.)







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#### **PRINCIPLE OF THE METHOD**

To characterise stresses over the entire section of a part, the latter is cut in half using an optimised wire cut electro-erosion process.

Under the effect of stress relief, the cutting surfaces do not remain flat. The surface deformations are measured using profilometry. This is then used to calculate the stresses on the whole section of the part via a finite element simulation inverse method.

The Bueckner superposition principle - the basis of the contour method







Initial state of stresses in the material

Deformation of the cutting plane by stress relief

Finite element stress calculation

## Advantages of the contour method



- Simplified comparison with digital simulations of forming processes
- Measurement of large thicknesses

#### **MEASUREMENT PROTOCOL**

The SONATS laboratory has provided its expertise in all stages of the method thanks to a mastered protocol and fully automated calculations as well as a network of qualified partners.



## Application example

The contour method was applied to an aluminium plate peened on two opposite sides. The results are presented as a map of the residual stresses over the entire thickness of the plate, and allow a complete analysis of the stress field.

In this specific case we observe that:

- An in-depth compression of 3 millimetres is observed on peened surface;
- There are tensile stresses at the core;
- Deeper stresses are heterogeneous;

Availability of all the measurement data allows to create an average stress profile over the entire thickness of the plate.



Examples of applications to many materials and industrial parts:

- Thick plates not stress relieved
- Aeronautical boiler making part
- Aluminium profile
- Peened pieces
- Steel plates with a weld seam
- Steel tube after forming
- Peened titanium part
- Additive manufacturing by wire deposit
- Hardened, tempered or stress relieved steel bar
- Forged steel ring
- Inconel friction welded cylinder
- Welded titanium plate and Inconel
- Additive manufacturing by melted wire deposit



#### WHO ARE WE?

The SONATS laboratory guides and assists you in the characterisation of residual stresses and materials, from the definition of your challenges to the completion of studies.

# We put our experience and databases to work for you to interpret the results. This step is essential and ensures full use of the results obtained.

Our team is specialised in metallurgy, materials and mechanics. We can provide you with the means to engage in an effective approach to quality and improvement of your products and processes.

## **Quality - Price - Deadlines**

- ASTM E837 standard
- ISO 9001 and EN 9100 qualifications
- Engineers and PhDs in Materials Science and Physical Measurements
- Our laboratory is audited and qualified by major key accounts of civil and military aerospace
- It is an active member of the French Constraints Analysis Group (GFAC)
- Verification of devices before each series of measurements
- Device monitoring (control card)
- Control of prices, short times

## Other methods of measuring residual stresses at SONATS

- Non-destructive X-ray diffraction on the surface and in depth
- Contour method
- Incremental hole method
- Access to large instruments: Synchrotron X-ray diffraction and neutron scattering

## **SONATS ACTIVITIES**

Established in 1991, SONATS is an innovative industrial company specialised in mechanical surface treatments, the main process being shot peening ultrasonically activated (STRESSONIC® Technology).

SONATS offers a complete range of products and services for understanding and improving the fatigue resistance of your metal assemblies and parts:

- Shot peening machines
- Straightening / forming equipment
- Welding peening equipment (HFMI- High Frequency Impact Treatment)
- Subcontracting of shot peening (in our workshops or on customer sites)
- Measurements and characterisation of residual stresses
- Distribution of peening and conventional sanding tools



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