



Analysis with Bulk Residual Stress

Many manufacturing or metal forming processes (such as cold working of holes) can induce residual stress throughout the volume of material. These bulk residual stresses (BRS) can significantly influence fatigue life, structural stability, failure loads, and distortion after machining. StressCheck allows such **stresses**, or the corresponding **eigenstrains**, to be included in linear analyses with industry-leading solution quality assurance procedures.

Introduce Residual Stresses Caused by Manufacturing and Metal Forming

- Cold working
- Welding
- Forging
- Heat treatments

Distortion and Redistribution of Residual Stress

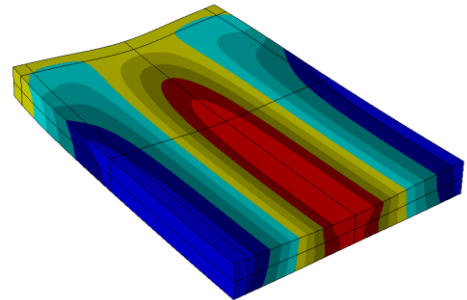
As material is removed in the metal forming process, any residual stresses present in the stock material must redistribute to maintain static equilibrium. The redistribution is accompanied by distortion as stored energy is released. For a given initial residual stress state, StressCheck can solve both for:

- **Distortion** caused by machining material with residual stress.
- The resulting **redistributed residual stress** after a change in shape, for example, after material removal or after the insertion of a crack.

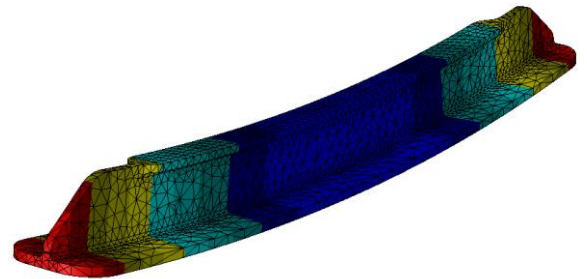
Fatigue and Fracture

It is well known that residual stresses can have a significant impact in the fatigue life of parts, but reliable numerical analyses techniques are difficult to find¹ – **StressCheck brings predictability and reliability to computed data**, reducing analysis errors and modeling uncertainty.

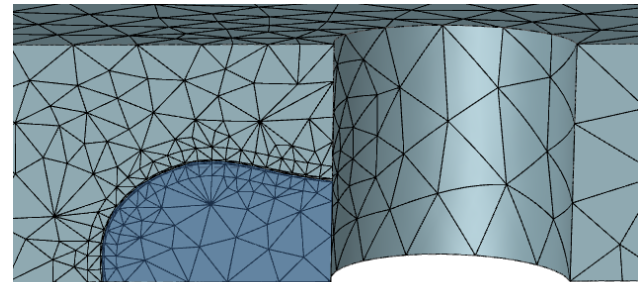
- Simulate cold working and other overload events to predict residual stresses.
- Compute fracture mechanics parameters J_I , J_{II} , J_{III} , K_I , K_{II} , or K_{III} using simulated or imported residual stress field.



Residual stresses from a friction stir weld



Distortion predicted from surface treatments



Crack growing at a cold-worked hole

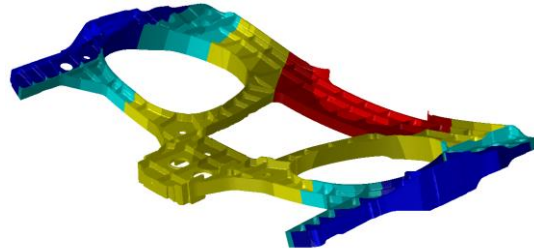
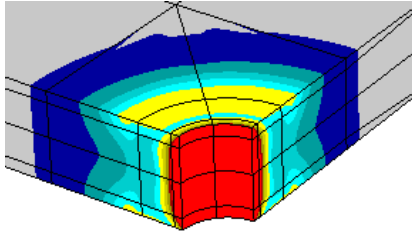
¹Szabó B., Actis, A. "Simulation governance: Technical requirements for mechanical design". Comput. Meth. Appl. Eng. Vol 249-252 (2012) 158-168.



StressCheck provides a framework for the most reliable numerical simulation results in the industry, designed from the ground up to support Verification and Validation. You can always verify solution quality – essential when tackling the uncertainties involved in residual stress analysis. Reduce your analysis errors and model uncertainty with StressCheck’s Bulk Residual Stress (BRS) analysis module!

Introduction of Residual Stress from Manufacturing or Metal Forming

Residual stresses can be computed in StressCheck, imported from a simulation in another analysis tool, or specified with spatial formulae.



$$\{\sigma_{RS}\} = \begin{Bmatrix} \sigma_x(x, y, z) \\ \sigma_y(x, y, z) \\ \vdots \\ \tau_{zx}(x, y, z) \end{Bmatrix}$$

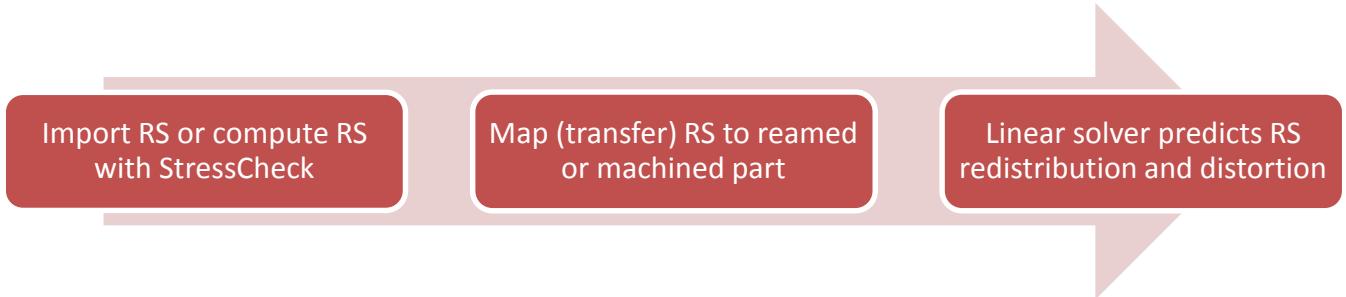
Use the Incremental Plasticity solver to simulate overload events or cold working processes to predict the formation of residual stress.

Import residual stress from time-dependent LS-Dyna simulations of metal forming processes.

Specify the residual stress tensor as spatial formulae.

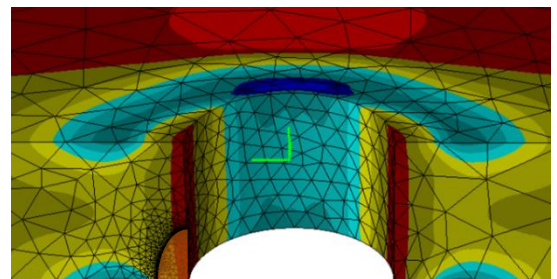
Distortion and Redistribution: Mapping Residual Stress for Material Removal

StressCheck’s Stress Mapping feature makes it possible to simulate reaming of cold worked holes, machining of parts from forgings, extrusions, and other heat-treated materials with locked-in residual stress (RS), and more!



Fracture Parameters

No other tool can provide the same flexibility and reliability of StressCheck for computing fracture mechanics parameters with complex geometries. If the full residual stress tensor is known the J-integral can be used to calculate J_I , J_{II} , and J_{III} and if desired, convert them to stress intensity factors K_I , K_{II} , and K_{III} for the three separate fracture modes in a residual stress field.



Corner crack defined by a spline in a residual stress field.

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