Resource-efficient steel structures: Evaluating weld seams under multi-axial load

About this project

RESSiS

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

Markets:

Material: Steel

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

About this project

Context

In steel and heavy machinery construction, companies need to reduce material usage and CO# emissions. At the same time, welded structures must be able to bear high loads. High-strength fine-grain structural steels are suitable for this. Their fine microstructure enables thinner sheets and lighter assemblies.

However, the weld seam often limits the load-bearing capacity and service life. Notches occur at seam transitions, and high residual tensile stresses from welding also have an effect. Both shorten the service life under changing loads. Complete heat treatment after welding is usually too costly for large components. Residual stresses therefore remain in the component.

In addition, many structures are not only loaded in one direction. With multi-axial loads and alternating load paths, common assessment methods estimate the service life inaccurately in some cases. For very high-strength steel grades, there is also a lack of resilient design details and assessment principles. This is where the RESSiS project comes in.

Purpose

The researchers are making highly stressed welded constructions lighter. To do this, they are increasing the permissible load level and extending the service life of weld seams made from high-strength steels.

The team is investigating how preheating, mechanical post-treatment and selected filler materials change the residual stress state and influence fatigue strength. To do this, it uses filler materials with a low transformation temperature and deliberately lower-strength filler materials and adapts them to the seam geometry.

The partners are developing a testing and evaluation concept for uniaxial and multiaxial fatigue, even with changing load paths. The result is a practical method that combines test data and simulations. On this basis, the team derives notch classes and prepares them for use in regulations. Notch classes categorise typical weld seam shapes according to their fatigue strength.

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

About this project

Procedure

Firstly, the team sets up welding processes for high-strength steels and defines robust parameter ranges. The partners then produce test specimens and large-scale mock-ups with defined seam geometries. Adapted transition details distribute the load more evenly and reduce critical stress peaks at the weld seams.

The team then analyses the seam quality, microstructure and residual stresses and measures the fatigue strength under uniaxial and multiaxial loads. At the same time, it sets up digital twins of selected welding processes, calculates temperature fields, microstructure development and residual stresses and compares the results with measurement data.

Finally, the team summarises the results, evaluates them using service life models and derives a practical evaluation method. It then translates the findings into notch classes and draws up design guidelines. The team tests the practical transfer using a prototype storage and retrieval machine.

Funding duration:

Funding sign: 03LB2059 **Funding amount:** EUR 2.5 million

Final report

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB2059A - RESSiS in the federal funding catalogue

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

Project coordination

Contact:

Mr Dr.-Ing. Martin Werz

+49 0711 68562597

martin.werz@mpa.uni-stuttgart.de

Organisation:

Materials Testing Institute University of Stuttgart

Pfaffenwaldring 4d
70569 Stuttgart
Baden-Wï¿½rttemberg
Germany

www.mpa.uni-stuttgart.de

English (EN){{ Projektpartner }}

Lightweighting classification

	Realisation
Offer	
Products Materials	✓
Services & consulting	

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

Lightweighting classification

	Realisation
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration	
Measuring and testing technology Materials analysis	✓
Modelling and simulation Optimisation, Processes	✓
Plant construction & automation Automation technology	✓
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology	
Forming Forging	✓
Joining Welding	✓
Material property alteration Mechanical treatment	✓
Primary forming	
Processing and separating	
Textile technology	

Resource-efficient steel structures: Evaluating weld seams under multi-axial load

Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites	
Fibres	
Functional materials	
Metals Steel	✓
Plastics	
Structural ceramics	
(Technical) textiles	