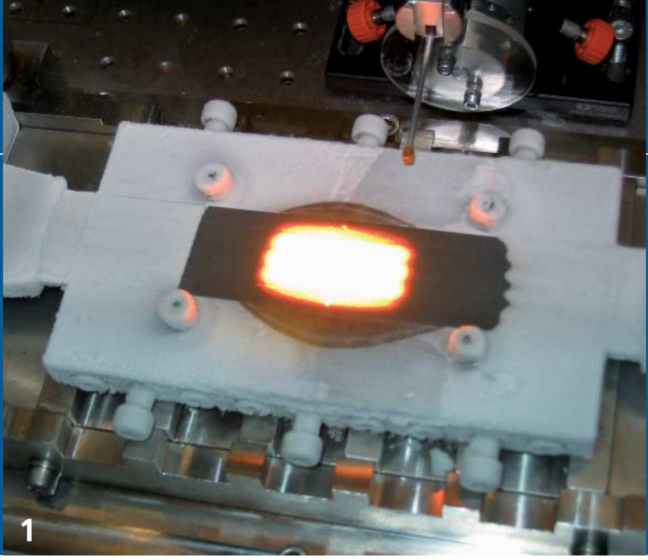
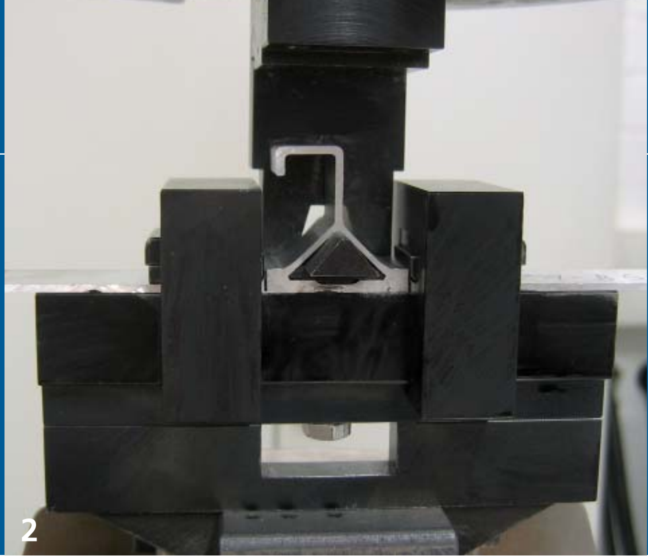








# NEW TESTING METHODS FOR JOINED AND SURFACE REFINED PARTS

**THE TASK**

Over recent years joining and localized hardening processes have been established in modern manufacturing lines. For quality assurance this state of affairs requires the simultaneous development of techniques and testing processes to evaluate the performance of the treated zones under realistic mechanical loading and tribological wear conditions.

Standard material testing techniques are typically not useful to predict the wear and stability performance of surface treated parts and welded constructions and testing with actual parts is much too complicated. Consequently Fraunhofer IWS engineers focused on the development of special testing techniques and on the adaptation of existing tests to special geometries and application conditions. Here we introduce some current examples, which are of relevance to various industry sectors.

**APPLICATION EXAMPLES**

Stiffened skin sheets of aircraft fuselage structures tend to dent in and out on both sides of the stringer under shear and compressive loading. The question was how this particular loading profile affects the structural integrity of the welds. Furthermore, how can the loading profile be simulated in an appropriate experiment and is it possible to even increase the structural strength using optimized dimensioning and welding processes. To address these questions we derived the task to develop a mechanical testing procedure that uses small samples compared to actual fuselage structures and simulates a realistic loading profile of weld seams all the way to failure.

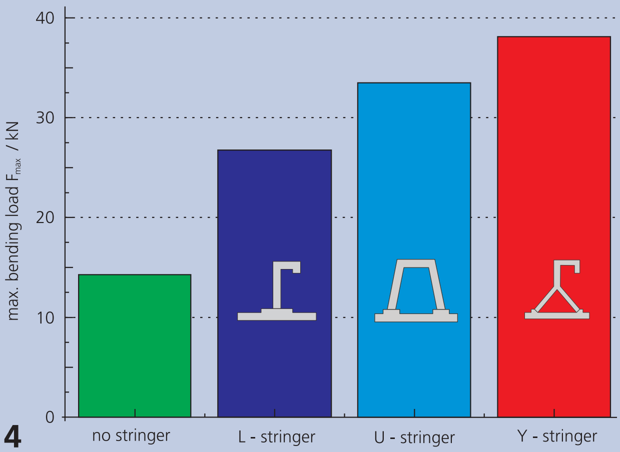
First calculations were performed to understand the deformation behavior (denting modes) of stiffened skin sheets under compressive loading. The output was used to design and build a ten-point bending rig, which can deform simple components and yield qualitatively similar results if compared to actual parts (Fig. 3).

A quantitative analysis of the mechanical loading capacity is possible if the experiments are performed with stiffeners of equal cross sectional area but varying geometry that are welded onto strip samples. Fig. 4 clearly shows the maximal loading capacity advantage of closed structure stiffeners (Y- and U stringers) over conventional stringers (L-stringers). In addition we developed a testing rig to quantify the weld seam strength of the stringer geometries using a so-called head pull test (Fig. 2).

3



*Maximal bending load in a ten-point bending experiment for various stringer geometries*




4

Further development efforts in the area of mechanical and tribological surface testing techniques include, for example, processes for the precise and reproducible hardness measurement on curved surfaces, the partially automated measurement and plotting of two-dimensional hardening profiles, thermoshock testing methods for coatings and joined structures, and methods to analyze crack propagation in wear protective coatings in different environments. An additional topic is the characterization of the thermoshock / thermocycling resistance of coatings and joined structures (Fig. 1).

Another typical example is the further development of a testing technique to predict the fatigue behavior of new and already worn hardened surfaces. The problem was to introduce defined notches into the already hardened and thus brittle surfaces without causing cracking. For this reason and due to the limited thickness of the hardened layer the traditional methods of sawing or eroding to create starter notches were not useful. However, a suitable approach was to introduce Vickers impressions with varying loads and to apply four point bending testing to the samples.

This method proved useful to provide reliable results for the cracking sensitivity, long-term vibration strength and notching sensitivity of laser gas nitrided titanium samples. It was also possible to derive conclusions as to how the fatigue behavior of equally gas nitrided parts would change with wear for example in turbine blade applications.

1 *Thermocycling test of coated test structures for jet engine components*

2 *Head pull test for closed structures (opened rig)*

3 *Ten-point bending rig in action*

**CONTACT**

*Dr. Johannes Rödel*
*phone +49 351 83391-3384*
*johannes.roedel@iws.fraunhofer.de*