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LOAD ADAPTED DESIGN OF CRASH COMPONENTS FOR RAILWAY VEHICLES

THE TASK

Modern railway vehicles have to be manufactured and operated at reasonable costs. They also have to be very safe and functional. Fraunhofer IWS engineers participated in the development of a new lightweight tramcar. The specific task was to develop a new crash bumper design suitable for low cost manufacturing and capable of handling the desired application loads. In a case of a crash, the bumper should absorb the entire energy and transfer it to crash absorbers without encountering any noticeable plastic deformation. A particular design requirement was that the bumper would not climb or override the next tramcar in case of a tram versus tram crash.

For the new development the following goals were defined:
- to reduce the fabrication effort
- to reduce the materials costs
- to avoid an increase of component mass
- guaranteed crash resilience
- override protection

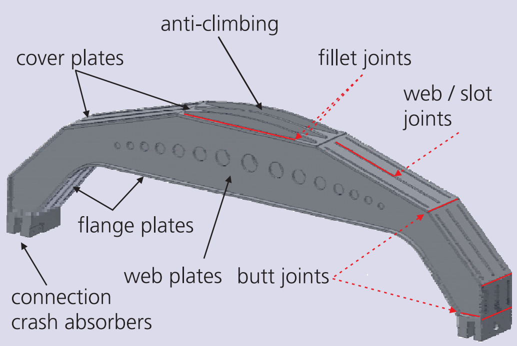
OUR SOLUTION

The Fraunhofer IWS design is based on a laser welded web / slot design made from 4-8 mm thick sheets of fine grain steel S355N (Fig. 1). The cover and flange plates have slots to insert three web-plates during assembly. Once assembled, the web-plates are laser welded from the outside. In the middle section the web-plates penetrate the coversheet and thus form the override protector. The design effort focuses on simplifying manufacturability of the individual components, which are mostly flat metal sheets. Long and externally accessible weld seams help to reduce fabrication costs. Structural stiffness is achieved by the braced box construction.

RESULTS

The dimensioning of the construction was based on the crash simulations. Frontal and frontal-side crash situations were simulated applying actual crash forces and scenarios (Fig. 3). The implicit PAM-CRASH solver code simulated the crashes for

Construction of a bumber with anti-climbing protection



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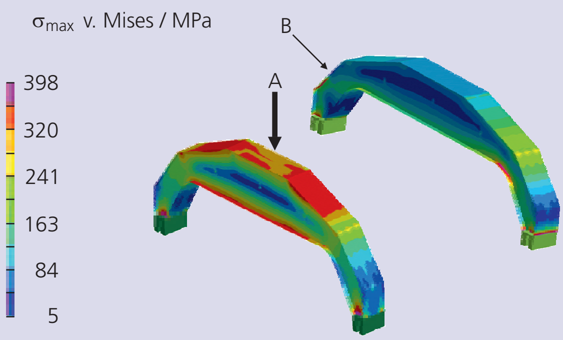
Crash simulation (v. Mises stress)



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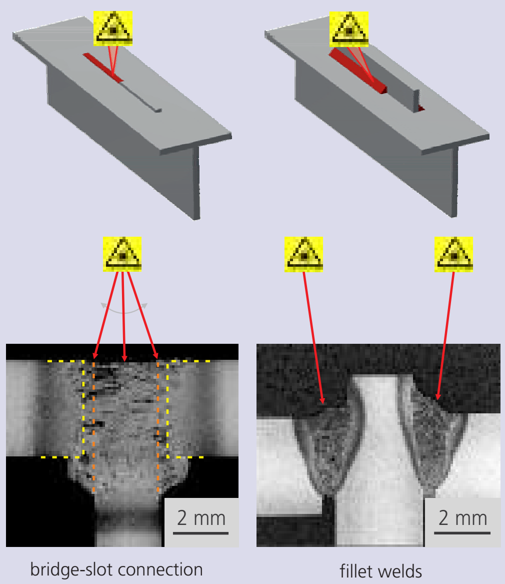
pure elastic material behavior. The calculated stress distributions and part deformations were analyzed and the component design was iteratively improved. A boundary condition during this optimization was to minimize the component mass.

The manufacturing concept aims at minimizing the effort to fabricate a part with high quality by utilizing a mechanized process flow. The individual metal sheets, the slots in the cover sheets and the feedthrough elements of the web-plates are made by laser cutting. The assembly of the box structure is done manually using spot tacking to safely position the individual parts.

Welding of web / slot joints and fillet joints (override protector)



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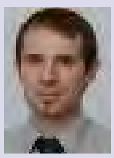
The construction is laser beam welded from outside. The web / slot joints are laser welded with a laterally deflecting beam over the whole web-plates. (Fig. 4 left). If the web-plates are especially thick (t = 8 mm) two weld seams may be applied.

Double sided fillet seams are applied in the region of the override protector (Fig. 3 right). Flange coversheets as well as the connections to the crash absorbers are welded with butt joints. Gaps of up to 1 mm may occur caused by part and assembly tolerances. In this case additional filler materials are required during welding.

The development result is a novel bumper concept for trams suitable for low cost manufacturing and able to handle the required loads. The design is based on combining sheet metal with web-plate and slot construction principles. The manufacturing costs (materials + fabrication) were reduced by more than 50 %. The new design has the same weight as the original and performs comparable in crash tests. Necessary functions were incorporated such as integrated override protection and interchangeable connectors to crash absorbers.

1 Tram design

CONTACT



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