Laser beam welded patchwork structures - innovative solutions for automotive body making

Task

Metal parts in automotive manufacturing are required to constantly increase their mechanical strength and stiffness and simultaneously reduce their weight. This trend inevitably leads to new material and design concepts trying to adapt the utilization of materials to the realistic loading conditions.

The patchwork concept offers a novel approach to locally optimize parts. The principle is based on minimizing the metal sheet thickness wherever possible, while reinforcing the basic blank with additional smaller patch sheets to accommodate for higher local mechanical loads. As opposed to other known processes here, the joining occurs when the sheets are still flat. The forming process is applied after the sheets have been welded into a patch compound. The development goal is to optimize the manufacturing process as well as the load bearing capacity of the parts as a function of the shape of the patch sheet as well as the formability of the patch compound.

Solution

In collaboration with Fraunhofer IWU, basic investigations were performed to analyze the process steps design, laser beam welding and hydro forming. FE analysis and verifying experimentation was employed to identify patch geometries and patch edge formation to avoid catastrophic material failures during the forming process (Fig. 1).

The laser remote welding technology is an effective method to adapt the patch shape and seam contours to the expected loads. The high strength seam guarantees the safe transfer of the forming forces and a flawless part function. In the case of high strength sheet metals it is possible to significantly improve the ductility of the seam by using an integrated heat treatment process. This makes it possible to optimize the seam properties for forming processes.

Results

We analyzed the manufacturing process steps of design, laser beam welding and hydro forming and showed created necessary conditions to benefit from the advantages of the laser patchwork technology. These are in particular:

- saving of process steps (forming of individual sheets, joining of curved sheets),
- reduced requirements for blank tailoring and positioning,
- manufacturability of structures with high load bearing capacity at minimized weight.

Fig. 1: Formed model part with optimized patch and welding seam contour

Fig. 2: Demonstrator: engine hood with edge relaxed patch

Demonstrators were designed according to load specification, laser welded at high quality and successfully formed. As an example we manufactured a model engine hood with a patch to reinforce the lock area (Fig. 2).

Contact

Dipl.-Ing. Axel Jahn
phone:
+49 (0) 351-2583-237
axel.jahn@iws.fraunhofer.de