Laser Weldability of High Strength Steel Sheets in Fabrication of Tailor Welded Blanks

the conventional parts manufacturing process, two or more stamped parts are spot welded together to form a part. In the TWB stamping process, sheets are first welded together, and then integrally stamped into a part; in this way, the numbers of parts, welding steps, and press dies are reduced, and costs are reduced accordingly.

In recent years, demand is rising for lighter, stiffer automobile bodies to meet stricter environmental and safety regulations. Accordingly, the purpose of using TWBs is changing. In addition to the use of high strength steel sheets having the strength exceeding 590 MPa, a differential thickness TWB that has a thickness ratio as high as three has begun to be used.

At present, ISO and North American ASP (Auto-Steel Partnership) specify the TWB quality standards. These standards are for TWBs that use mild steel sheets and have

quality standards for differential thickness TWB high strength steel sheets.

This report presents the conditions required at TWBs composed of high strength steel sheets thickness ratios. Further, from the viewpoint o properties, basic characteristics such as mechanic operties and press formability of TWBs tensile strength of 590 MPa or more were clarifie

2. Butt welding technology

Since material sheets joined by welding are stamped and used as automotive panels and parts, welds must satisfy the following requirements[2].

(1) The weld has a uniform configuration as close to the base metal as possible.

(2) The weld strength exceeds that of the base metal.

(3) The press formability is close to that of the base metal.

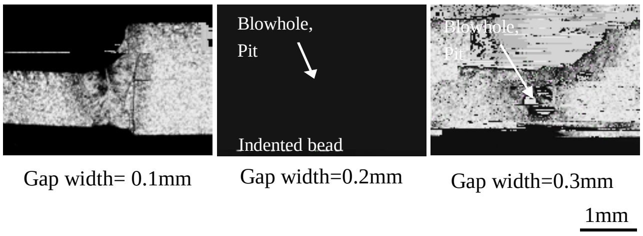

Table 2 Laser welding conditions

Welding was performed by irradiating the steel sheets with a CO_2 laser concentrated to about 0.6 mm by a ZnSe lens with a focal length of 254 mm. The CO_2 laser output and welding speed were set constant at 3 kW (working point output) and 4 m/min, respectively. Differential thickness butt-welded samples with thickness ratios of 1.0, 2.0 and 2.9 were fabricated with different gap widths of 0.1 to 0.4 mm between two sheets.

The quality of the welds was evaluated as follows. The

3. Laser weldability of high strength steel sheets

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elongation of welded joints decreases. The elongation of welded joints further decreases in the 980 MPa class material.

the heat-affected zone under either the standard condition or comparative condition, none of their test pieces fractured at the heat-affected zone.

Photo 2 Erichsen stretch test results of high strength TWB

4. Conclusions

With regard to mild steel sheets and high strength steel sheets, conditions required at welds of differential thickness joints (thickness ratio up to three) and basic characteristics such as mechanical and fatigue properties and press formability of welded joints were clarified. The main conclusions obtained are as follows:

(1) Conditions required at welds

The weld thickness ratio T_w/T_1 must be kept at 0.8 or higher regardless of material properties and sheet thickness ratios, where T_w is the thickness of the weld, and T_1 is the thickness of the thinner base metal.

(2) Laser weldability of high strength steel sheets

The hardness of laser welds is estimated accurately by the carbon equivalent formula for laser welding.

$$Ceq\ (laser) = C + Si/50 + (Mn + Cr)/25 + P/2$$

The elongation of welded joints under perpendicular tension becomes lower than that of the base metal because the deformation is restrained by the increased hardness of welds. When the weld heat input is high and thus the heat-affected zone is softened, strain concentrates in the softened zone, and the elongation significantly decreases.

The strength of welded joints under parallel tension becomes higher than that of the base metal, but the elongation thereof becomes lower because the weld is harder than the base metal. The elongation of 1 Tf0e5Ti-n-n siation is restrained by the incT((T.2(and 14.7(welsys2(th)y)2Tw[tt8(e 9h)-a th)