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This paper presents representative examples of recent research and development in connection with forming and joining technologies for automotive steel products at JFE Steel. To contribute to diversifcation of automobile manufacturing and shortening of the development period by automakers and create a joint development system for automotive parts, JFE Steel has developed forming, crashworthiness, and durability prediction technologies, centering on the fnite element method (FEM), and implemented a system which enables material proposal/supply from the design stage. The accuracy of these prediction technologies supports material and part evaluation technologies and ensures the reliability of solutions.

1. Introduction

The ULSAB (Ultra Light Steel Auto Body) Project began in Apr. 1994 with the joint sponsorship of 32 steel makers ¡ s

make it possible to supply customers with the optimum materials for their intended applications. This chapter presents an outline of a large-scale press machine, which is capable of evaluating the press formability of high tensile strength and coated steel sheets at the actual-machine level, and a dynamic testing machine, which is capable of investigating the dynamic properties that govern crashworthiness at the test part level.

(1) 1 200 t Experimental Press Machine

This device, which was installed at JFE Steel, makes it possible to measure changes in the blank holding force, stroke, forming load, and other parameters of the forming process in the single-action mechanical press machines used in mass production by automakers. The press capacity of this device is 1 200 t, and the maximum blank holding force is 300 t. Using model dies for the front fender, door outer, center pillar outer, lower arm, and similar parts, it is possible to research the forming behavior of actual parts and evaluate the formability of actual parts made from newly developed materials. Because the press is equipped with an internal NC die cushion device, it is also possible to control the blank holding force during the forming process. The press machine and examples of formed parts are shown in **Photo 1**.

(2) Dynamic Impact Deformation Testing Machine

JFE Steel has also installed an impact deformation testing machine with a 50 t dynamic load, which makes it possible to study the absorbed energy and deformation behavior of auto parts in collisions. It is possible to investigate the crushing properties of parts up to 500 mm h × 300 mm w × 300 mm h and the impact bending properties of parts up to 1 200 mm l × 200 mm w at varying speeds from 0.1 m/s to 14 m/s. As features of the device, because the speed can be held constant during the test process, systematic investigation of the effects of material strength and thickness on the impact properties of materials with strain rate dependency is possible. The testing machine is equipped with a high-speed video camera, enabling detailed study of the relationship between load-displacement behavior and the deformation behavior of parts, and a device which enables study of deformation characteristics under low temperature environments, making it possible to propose proper high tensile strength materials considering low

is applied only on the die side. **Figure 7** shows the available forming range at a drawing ratio of 2.0. Use of the HPLL forming method remarkably expands the available forming range, and is equivalent to an increase of more than 0.4 in the *r*-value of the material. The following presents an example of a study of application to forming of the front door inner.

Figure 8 shows the tool shape and high pressure liquid lubrication supply positions. **Table 1** shows the effect of the high pressure liquid lubricant in sections A and B in the figure. Effectiveness was confirmed in both parts, even though different forming modes are used. Moreover, in section B, which is a reduced flange forming section, a flange wrinkle suppression effect was apparent, as shown in **Fig. 9**. In the forming described above, a commercially-available compact high-pressure pump (maximum hydraulic pressure: 53.9 MPa, discharge rate: 1.9 *l*/min) was used to supply the liquid