Development of Solution Technologies Contributing to Higher Functionality in Automotive Chassis

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As vehicle electrification advances, automakers face challenges such as increased vehicle weight, higher costs, and stricter crash requirements to protect high-voltage batteries. Chassis components must therefore provide greater strength, stiffness, and fatigue durability while also reducing weight, cost, and life-cycle CO_2 emissions. High-strength steel offers cost and environmental advantages over aluminum, and Nippon Steel is developing steel chassis components that achieve aluminum-equivalent weight through integrated optimization of materials, forming, and structural design.

High functionality in EV chassis requires not only stronger materials but also holistic design that considers formability, structural configuration, joining reliability, and performance evaluation. In arm and link components, higher strength often reduces ductility and hole-expansion capability, limiting curved-section height and degrading fatigue performance—especially with thinner materials. Increasing curved-section height helps reduce stress concentration. Arc-welded joints also pose challenges due to stress concentration and corrosion susceptibility, making fatigue and corrosion resistance essential.

In Case Study 1, a front lower arm was developed using 980 MPa high-formability steel (980HF) and sheet thickness compression forming method, which increased hydrostatic pressure at the flanged edge and raised the fracture limit. The curved-section forming limit improved from 17 mm to 33 mm. Structural optimization further enhanced weight efficiency, achieving an aluminum-equivalent weight of 2.2 kg and reducing LCA CO_2 emissions by 61% and cost by 65%.

In Case Study 2, the front subframe was redesigned for EV-specific load paths. GA980-class EA steel and a component-integration forming process reduced part count and weld length. Integrating cross-members and side members lowered the number of parts to 17, compared with 25 for aluminum benchmarks. CAE analysis confirmed crash energy absorption and stiffness equal to or better than aluminum. The steel subframe achieved aluminum-equivalent weight with a 90% CO_2 reduction and 76% cost reduction.

To ensure reliability in thin-walled, integrated components, the study also improved fatigue and corrosion performance of arc-welded joints. Reinforcement beads reduced weld-end stress concentration by about 20%. A low-slag solid wire and low-CO_2 shielding gas reduced paint defects and rust, while a low-slag, low-spatter wire improved corrosion resistance and productivity under low-heat-input welding.

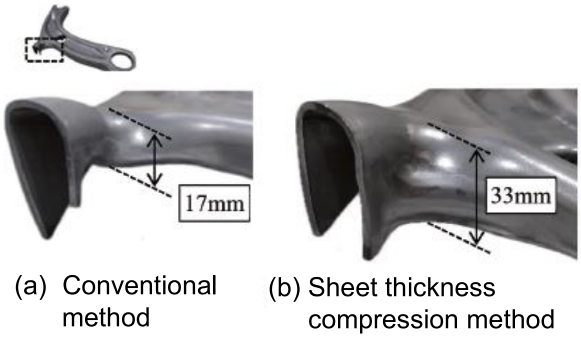

Figure. 1 Results of press forming test

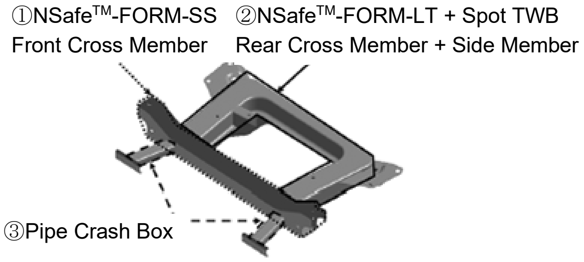

Figure. 2 Developed front subframe

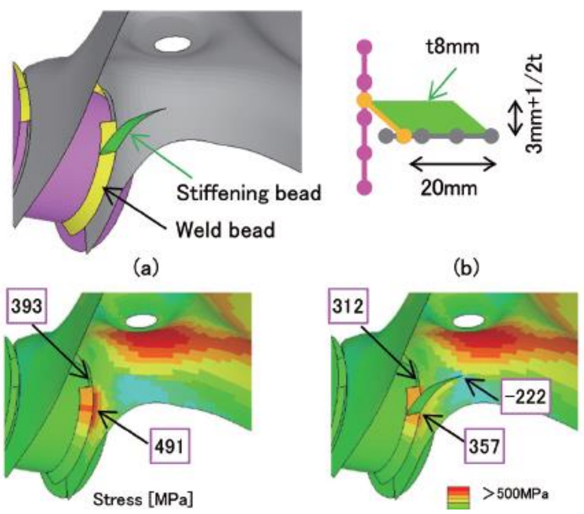

Figure. 3 CAE model around the collar and distribution of maximum principal stress

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