

Weight Reduction of Automotive Suspension Parts using 980MPa Class Steel

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1. Introduction

The goal is to achieve CO₂ reduction while realizing the "joy of driving" and continuing to provide customers with inspiring experiences. To achieve this, the moment of inertia is reduced through "lightweighting", and vehicle responsiveness is improved by increasing the rigidity of suspension components.

The concept behind "lightweighting" reduction is the use of thinner sheets made possible by increasing material strength.

The concept behind increasing rigidity is the homogenization of stress through "improving centroid continuity," "reducing bending moment input," and "improving rigidity continuity."

We present a case study in which technology for realizing these concepts was developed and applied to the front lower control arm.

Increasing the strength of the lower control arm material gives rise to two problems.

Firstly, the reduced elongation and hole expansion ratio worsen press formability, making stretch flange forming difficult.

The second issue is that the increased amount of alloying elements leads to an increase in welding slag, which impairs paint adhesion and thus worsens the rust prevention performance.

On the other hand, realizing the concept of increased rigidity requires balancing precise control of the centroid with strict layout constraints.

2. Method

Press formability is achieved by controlling the part shape and press forming conditions to reduce the amount of strain during stretch flange forming.

Achieving both centroid control and layout optimization is realized by reducing the second moment of area, thereby improving centroid continuity and lowering the bending moment input.

3. Results

These countermeasures were applied to the Front Lower Control Arm of the MAZDA3.

Stretch flange forming was achieved by controlling flange height and ridge length and applying sequential contact punches.

We eliminated local indentations that disrupted the continuity of the centroidal path by slightly reducing the second moment of area, thereby decreasing the number of inflection points on the curve formed by the centroids from four to one. (Fig.1)

Although reducing the second moment of area causes a slight decrease in the stiffness of specific cross-sections, the lower arm's overall stiffness was significantly improved; this was achieved because stress concentrations were drastically reduced through "improved centroid continuity" and "reduced bending moment input."

In terms of rust prevention performance, the combined cycle corrosion test showed no rust formation after 30 cycles, compared to the conventional method which had a 24% rusted surface area.

4. Discussion

980 MPa-class hot-rolled steel sheet was used for the lower control arm, and the number of parts was reduced to improve rigidity continuity.

In addition, a closed-section structure offering high mass-to-rigidity efficiency was adopted, allowing the cross-section to be changed from an open type (3.2 mm thick) to a closed type with thinner material (2.0 mm thick).

This lightweight, high-rigidity Lower Control Arm achieves a 20% reduction in weight, more than triple the rigidity, and superior corrosion resistance, while meeting requirements for crash performance, high-load strength, and fatigue strength.

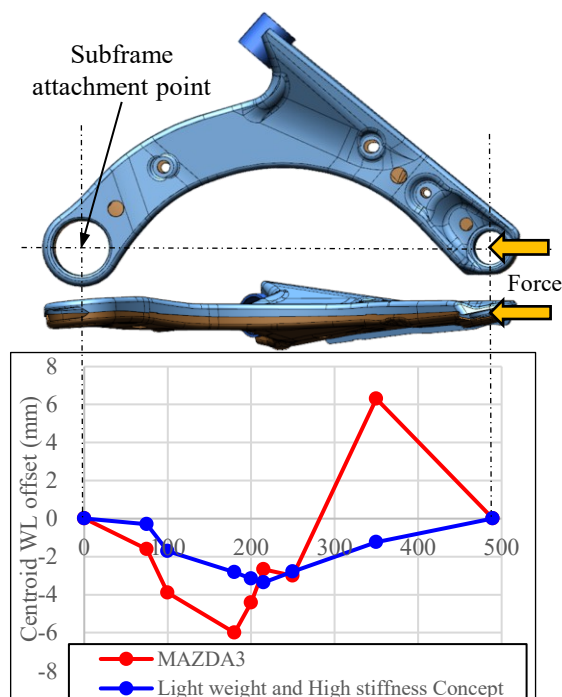


Fig.1 Continuity of Centroid