A Method of Evaluating the Joint Effectiveness on Contribution to Global Vehicle Performance

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Overview

• Joint locations
• Introduction to stiffness contribution ratio
• Introduction to joint effectiveness factor
• Application of achieving weight savings while not affecting the joint effectiveness
• Application of improving global stiffness with minimal weight increase
• Summary of total contribution of adding and removing parts
The Need to Increase BIW Stiffness

• Advancements in steel technologies at AK Steel, along with Ford Motor Company’s BIW optimization techniques, dramatically reduce the steel mass used to meet crash requirements.

• Smarter design of the BIW is necessary to increase the body stiffness & joint efficiency.

• Current AK Steel AHSS products, along with soon to be launched Next Generation and 3rd Generation AHSS products, will assist Ford Motor Company in continuing to lead the way for the lightest, most capable vehicles on the road.

• Ford Motor company designs are open to all materials in order to achieve light weight designs.

• We choose the right material for the right application and right part.
K = \frac{(F \times L)}{\left(\text{ATAN}(\text{abs}(Uz_l) + \text{abs}(Uz_r))/L\right)} \quad \text{KN-m} / \text{rad}
Joint Locations – on a Unibody Model

A-pillar hinge
A-pillar Roof
B-pillar Roof
C-pillar Roof

A-pillar Rocker
B-pillar Rocker
C-pillar Rocker
The stiffness contribution ratio: \( \frac{K_b - K_o}{K_b} \times 100\% \)
Joint Effectiveness Factors – Baseline

The joint effectiveness factor: $\frac{K_b}{K_r}$
Case 1: Local Reinf @ A-Pillar Rocker Joint Removal

Removing Local reinf
On both left and right sides

0.6 mm gauge
Case 1: Local Reinf @ A-pillar Rocker Joint Removal

0.95% reduction
Case 2: Local Reinf @ B-pillar Rocker Joint-Removal

Removing Local reinf
On both left and right sides

1.1mm gauge
Caser 2 Reinf @ B-Pillar Rocker Joint-Removal

Joint Effectiveness Factor (%) (global)

Young's Modulus Factor (*E) @ local joints

not affected
Case 3: Local Reinf @ B-Pillar Rocker Joint-Adding

Added Local reinf
On both left and right sides

1.2 mm gauge
Case 3: Local Reinf @ B-Pillar Rocker Joint-Adding

1.03% increase
Local reinf removed
On both left and right sides

Local reinf-3 adding
On both left and right sides

The global torsion rigidity of this vehicle is improved by 1.11%,
Added stiffness-mass efficiency ratio: 20
Conclusion

- This joint effectiveness method is valuable in improving the global stiffness performance & minimizing the added weight by reinforcing local joints.

- While offering high strength, better formability and crash safety for future vehicles using AK steel new material grades, the stiffness performance will not be compromised.

- The global torsion rigidity of this vehicle is improved with minimal mass increase & added stiffness-mass ratio 20