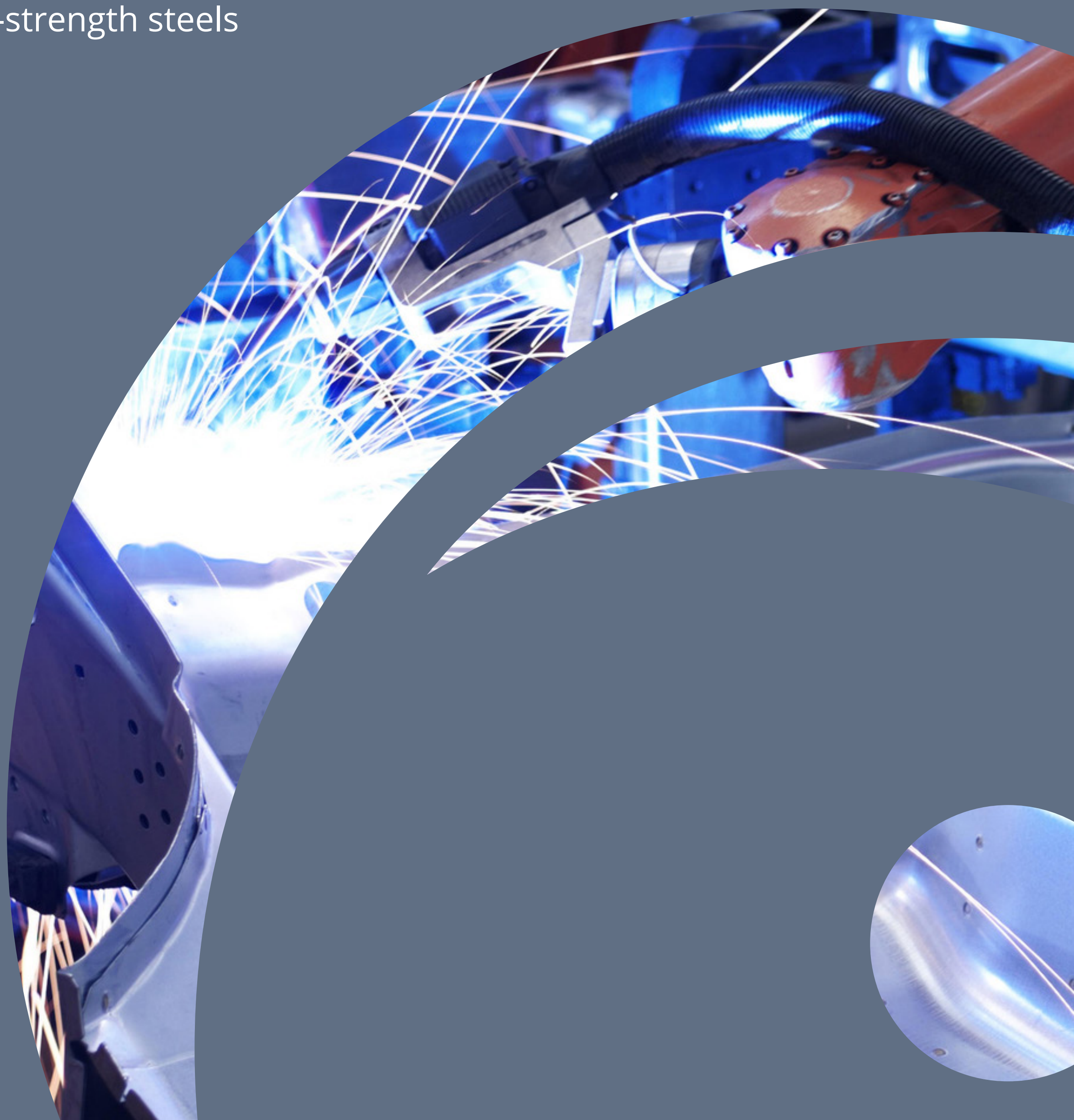
WorldAutoSteel

Reducing Complexity & Cost through Parts Consolidation

A front body structure study using advanced high-strength steels



Introduction

This study forms part of WorldAutoSteel's broader commitment to leading the automotive industry through independent, engineering led evidence that addresses real-world OEM challenges around complexity, manufacturability and cost.

Faced with growing pressure to deliver more efficient and cost-effective manufacturing processes, global vehicle manufacturers are increasingly seeking engineering solutions without compromising performance or safety.

These challenges are especially relevant to future vehicle design, particularly battery electric vehicle (BEV) platforms, which incorporate a wide range of structural components. As a result, parts consolidation has emerged as a critical strategy for reducing vehicle complexity and cost.

To address these challenges, WorldAutoSteel commissioned Ricardo Engineering to conduct a study demonstrating the potential of advanced high-strength steels (AHSS) in enabling parts consolidation, using the Steel E-Motive concept as the baseline reference vehicle.

The study's objective was twofold:

- Demonstrate steel's ability to achieve parts consolidation in a front body structure
- Highlight the applicability of these solutions for real-world use in current and future vehicle platforms

The results demonstrate a credible pathway for manufacturers to rethink how vehicles are designed and manufactured. Specifically, this included: a 34% reduction in part count, 8% weight savings, 10% reduction in piece cost and the potential for up to $21 million in overall manufacturing investment savings.

Key Results

BIW structure front structure part consolidation study

Number of parts deleted in front structure
13
(34% reduction)

Front body structure weight reduction
8%

Manufacturing investment cost reduction (front structure)
$21M

Front body structure piece cost reduction
10%

Structural performance
Comparable to baseline Steel E-Motive design

New Concept Development Process

The engineering study focused on translating the conceptual design into a practical, manufacturable solution. To support this effort, the team utilised 3D CAD modelling and stamping simulation tools to assess both design integrity and manufacturing feasibility.

The Steel E-Motive concept final design enabled further adaption of this virtual vehicle to provide a more sophisticated approach to solving current challenges in the automotive industry. This allowed the engineering team to focus on translating the conceptual design into an advanced, practical, manufacturing solution.

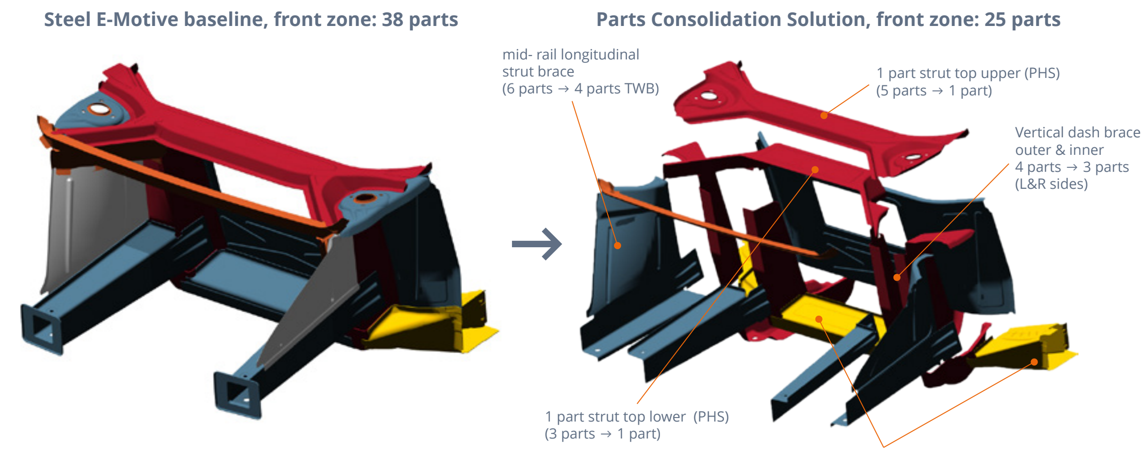
In parallel, a comprehensive cost analysis was conducted to quantify potential reductions in capital equipment, tooling, material usage, and facility-related expenses relative to the baseline Steel E-Motive design.

Front Body Structure Assembly Results

The final concept design resulted in a 34% part reduction in the front structure stampings, achieved by the development of five new subassembly designs within the front structure. These subassemblies combined multiple existing stamped parts ranging between two and six into single stampings.

Using comparable AHSS strength and gauges, the new front structure design is expected to achieve the same structural performance for crash, stiffness, strength and durability as the Steel E-Motive baseline reference.

An **8% weight savings** was achieved for the new front body structure design.



SEM1 38 parts
28 SEM parts deleted → 15 new consolidated parts
10 SEM parts carry over to Parts Consolidation Solution
= 25 Parts Consolidation Solution

Figure 1: comparison of baseline design Steel E-Motive front body structure (L) and part consolidation study (R).

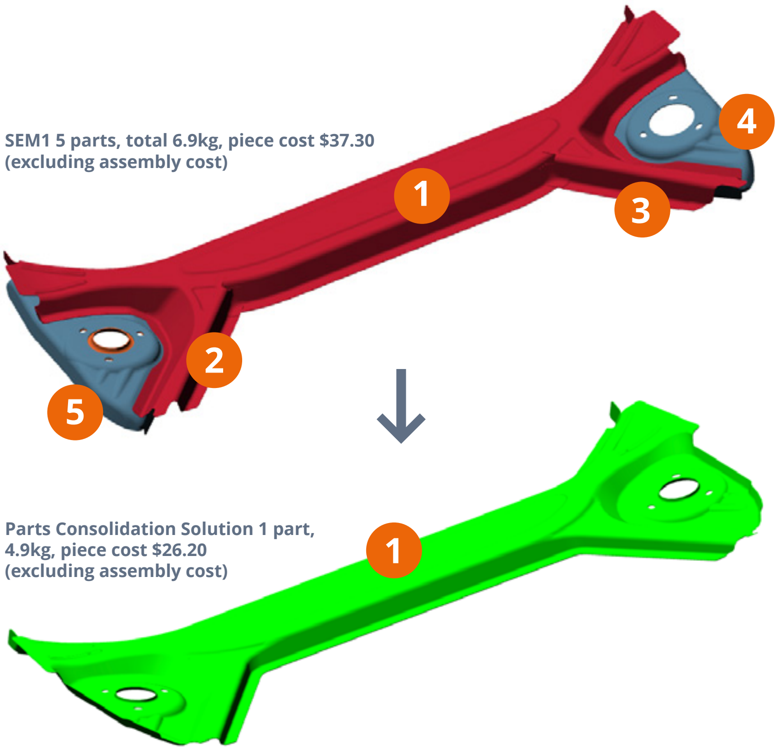
Subassembly Results

Figure 2 illustrates the strut brace sub-assembly concept and the application of AHSS grades. Here, ultra-high-strength steel (UHSS) is utilised to provide enhanced performance under front crash load conditions.

The Steel E-Motive baseline configuration consists of five individual stamped components, including cold-stamped Dual Phase steel for the strut top elements (parts 4 and 5), combined with hot-stamped press hardened steel (PHS) components. Steel E-Motive's strut top assembly also requires four separate spot-welding processes.

In contrast, the integrated, hot-stamped single-part design eliminates all four of these welding steps, delivering an approximate **30% mass reduction** relative to the baseline subassembly. This improvement was driven by the removal of overlapping weld flanges, inherent in the baseline multi-part design.

The reduction in material usage, combined with simplified manufacturing, results in an estimated **20%, or $11 per piece cost reduction,** while associated manufacturing investment cost savings for this subassembly are estimated at **$4.6M.**



Part	AHSS Grade	Gauge thickness
1	PHS1900	1.0mm
2	PHS1500	0.8mm
3	PHS1500	0.8mm
4	DP1180	2.0mm
5	DP1180	2.0mm

Part	AHSS Grade	Gauge thickness
1	PHS1900	1.2mm

Figure 2: Front Strut Top Comparison: Baseline Steel E-Motive Design vs. Part Consolidation Concept.

Parts Consolidation

Engineering Considerations and Solutions

The consolidation of multiple body structure parts into a reduced number of larger stampings poses a number of engineering challenges.

1. Part designs must conform to geometrical requirements for welding, package space and interfaces to adjoining systems and components. In order to maintain the overall structural performance, part material strengths (and grade) should be maintained in specific locations. These design requirements can lead to significant challenges for achieving part stamping manufacture feasibility.
2. Excessive thinning, splitting and tearing of parts can occur where stampings are required to achieve complex geometries.

The stamping feasibilty challenges can be overcome by employing a combination of design, material selection and manufacturing engineering approaches:

- The latest advanced AHSS, such as 3rd generation and hot stamped grades, enable Ultimate Tensile Strengths (UTS) > 1200MPa and high formability. Tailor Welded Blanks (TWB) enable multiple grades and gauge thickness steels to be applied within a single stamped part. Material properties can be locally tailored to the specific strength and formability requirements within a single part.
- Considerate design and optimisation of the part geometry, promoting material flow during the stamping process. Where material grades with lower formability are applied, geometry features such as radii and draw depth require optimisation. Specific additional features such as drawbeads can be added to the design to facilitate material flow during stamping.
- Optimisation and control of the parameters during the stamping process such as the blank clamping binder force, the stamping force and speed and die parameters such as lubrication/friction. For hot stamping, further parameters can be varied, such as blank heating temperature and cooling rates.
- 3D stamping simulations were also extensively used to evaluate part formability and support iterative optimisation of the single-piece concepts. An example of the strut cross member hot stamping simulation output is shown in Figure 3.

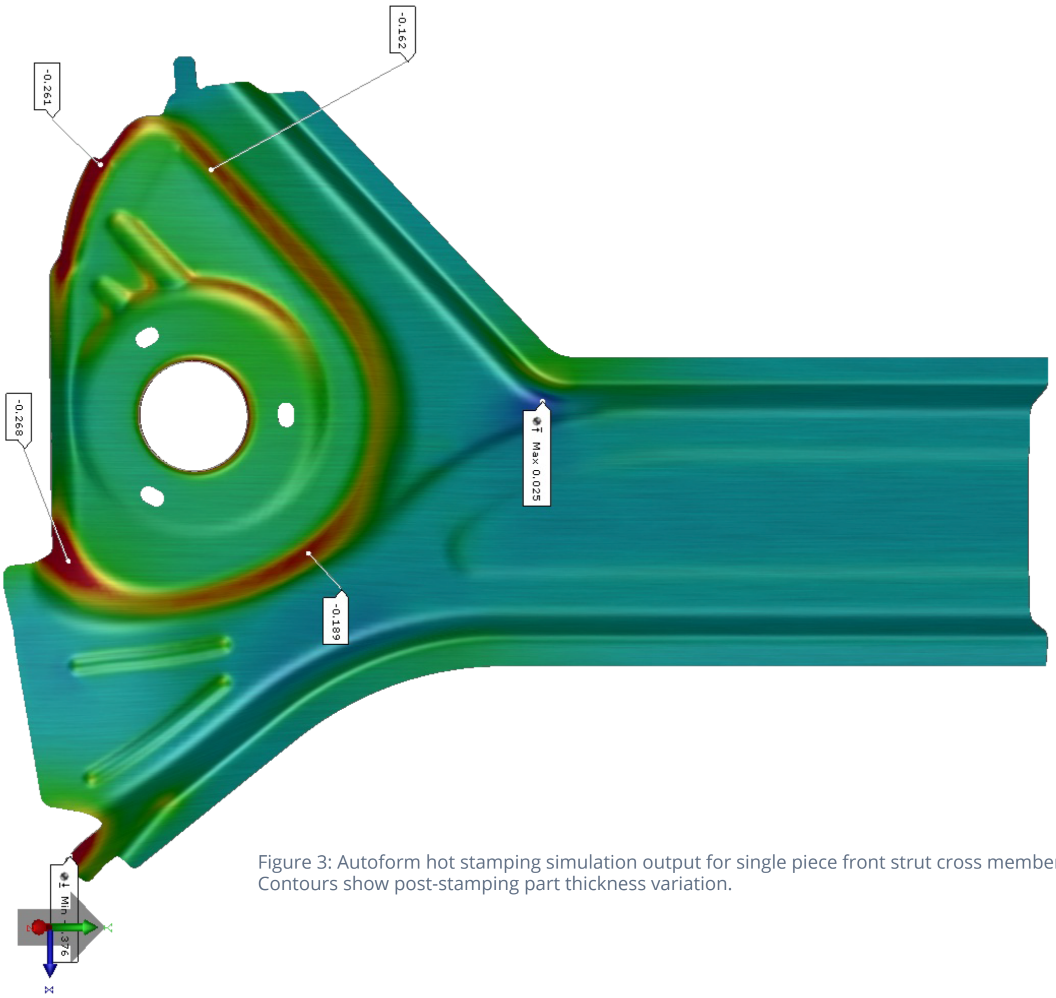


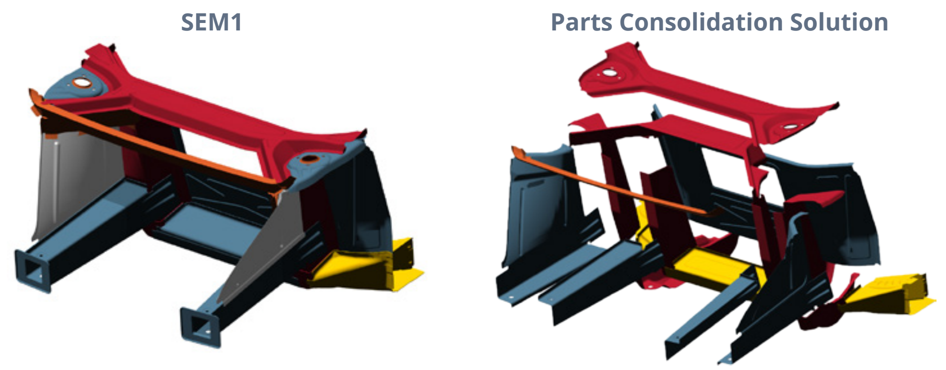
Figure 3: Autoform hot stamping simulation output for single piece front strut cross member. Contours show post-stamping part thickness variation.

Parts Consolidation
Offers Significant Manufacturing Cost Savings

The manufacturing cost savings for front structure parts consolidation are compelling. The cost modelling study estimated a potential savings of $21M, achieved through simplified tooling and reduced factory floor space. Figure 4 illustrates this in greater detail.

Using a similar parts consolidation ratio, scaling these estimated savings for the front structure to the complete body structure including closures could result in manufacturing cost reductions of **up to $112M.**

Figure 5 shows the breakdown and contribution of the five part consolidation subassemblies. This data excludes assembly costs contributions for the structure.



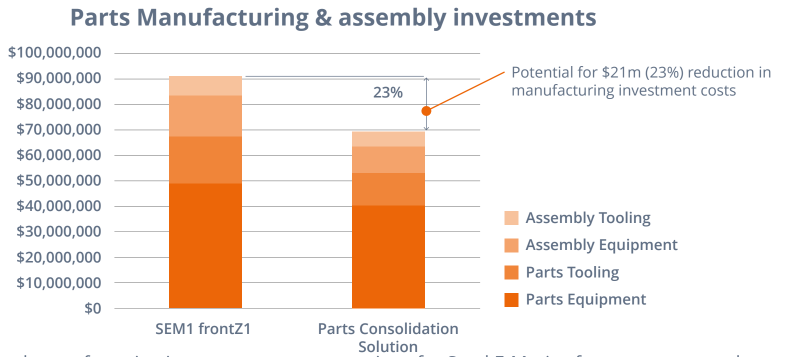


Figure 4: total manufacturing investment cost comparison for Steel E-Motive front structure and parts consolidation design.

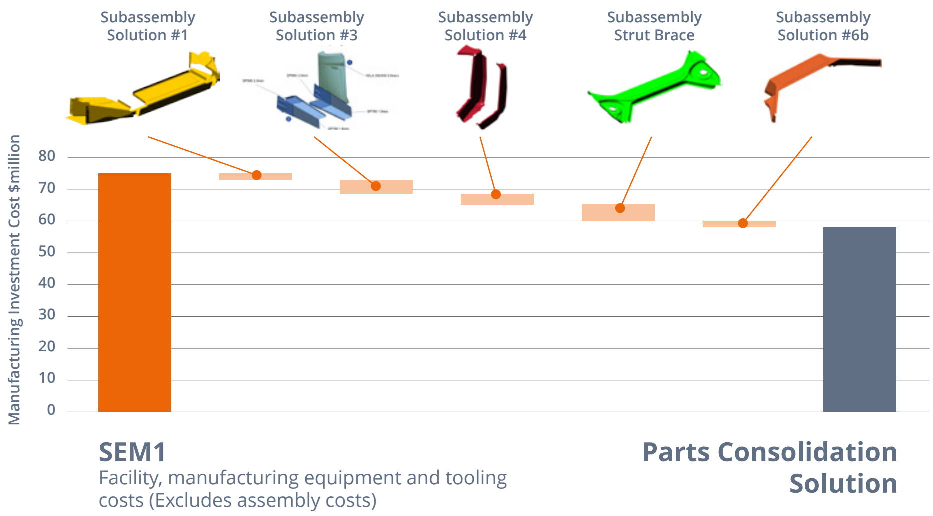


Figure 5: manufacturing cost and contribution of the five-part consolidation subassemblies.

Application Potential

A sample of current OEM BEV platforms were reviewed and compared against the WorldAutoSteel parts consolidation concepts. Each comparison was assessed using the following criteria:

- Directly applicable - the geometries and application/location are common and the part consolidation concept has very high application potential to the reference vehicle platform
- Indirect application - the geometries differ, but the part consolidation concept could be applied to the reference platform with some adaptation.

None of the part consolidation concepts were evaluated as having limited application, indicating strong potential for practical implementation across future BEV platforms. This reinforces the relevance of the findings not only as a technical concept, but as a practical input to near and midterm vehicle platform decisions.

Figure 6 summarises the potential applicability of the redesigned strut bar for OEM applications*.

OEM	Platform	Subassembly Strut Brace
STELLANTIS	STLA small, med, large	
VOLKSWAGEN GROUP	MEB, MEB+	
VOLKSWAGEN GROUP	PPE	
TOYOTA	e-TNGA	
RENAULT NISSAN MITSUBISHI	CMF-B EV / AmpR Small	
BYD	E-platform 3.0	
GEELY	SEA	
gm	BEV3.0	

Direct application potential   Indirect application potential

Figure 6: Part consolidation concept application and potential study.

* The OEMs listed here are intended to be illustrative and not an exhaustive list

Conclusion

WorldAutoSteel's study directly addresses the most pressing challenges faced by vehicle manufacturers today, notably reducing complexity and cost without compromising safety or performance. It provides clear evidence that parts consolidation, enabled by AHSS, offers a viable and scalable pathway to achieving these objectives.

This study shows that significant reductions in manufacturing and piece cost can be achieved through the adoption of a parts consolidation strategy using AHSS for high-volume stamped and fabricated body structures. Minor adjustments to material grade and strength enabled a reduction in the total number of stamped parts, which also helped streamline the assembly process, requiring fewer machines, tools and less overall factory space.

The parts consolidation process pushes the boundaries of steel stamping processes and metallurgy. In this study, engineering challenges are overcome through the application of:

- Advanced hot stamping materials and processes;
- Stamping relief geometrical features and stamping simulation tools;
- Material models and calculation processes.

Together, these innovations provide robust solutions for high-performance components that maintain their structural performance, further demonstrating steel's potential for high-performance engineering solutions designed for future mobility. By applying the lessons learnt in this study, WorldAutoSteel believes OEMs could transform the way vehicles are built.

For more information on this study, contact us at steel@worldautosteel.org.

[1] Steel – The Sustainable Option for Future Mobility - WorldAutoSteel: https://www.worldautosteel.org/steel-e-motive-a-sustainable-solution-for-future-mobility/

[2] What Type of Steel Is Used in the Automotive Industry? Automotive Steel Grades Explained: https://www.jswonemsme.com/blogs/blogs-articles/what-type-of-steel-is-used-in-the-automotive-industry

WorldAutoSteel Expert Insight:

While steel is widely acknowledged as the most sustainable, low emission and circular solution for next generation mobility[1], the conceptual and financial arguments made in this study are compelling.

Ricardo has analysed that reducing the number of parts by 13 enables a weight reduction of 8%, resulting in an estimated cost savings of $21M.

These results demonstrate that steel delivers the most sustainable, safe and scalable path for next generation mobility. Technically challenging studies such as this demonstrate the potential of AHSS to address the automotive sector's most pressing concerns. Steel, the most trusted structural material[2], provides an answer in addressing challenges around parts consolidation and assembly line efficiencies. Ricardo's study for WorldAutoSteel demonstrates ever greater potential for it to enable high performance engineering solutions for future mobility.

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