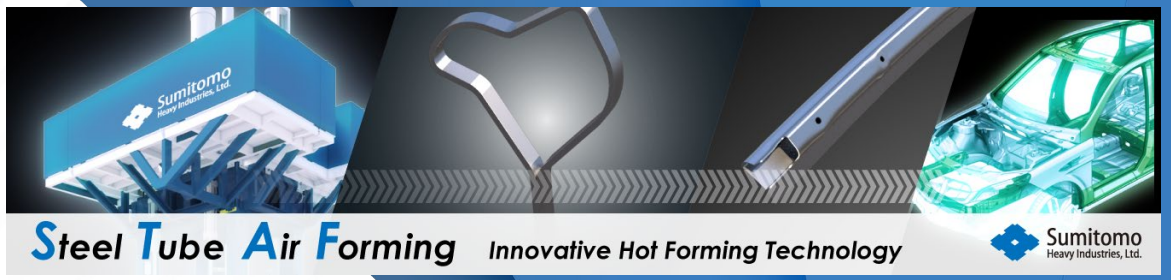
GREAT DESIGNS IN STEEL



MAXIMIZING LIGHT-WEIGHTING IN STEEL AUTOMOTIVE BODIES AND FRAMES WITH STEEL TUBE AIR FORMING (STAF) PROCESS

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Sumitomo Heavy Industries, USA Inc.

Specialist of Sales engineering

2023

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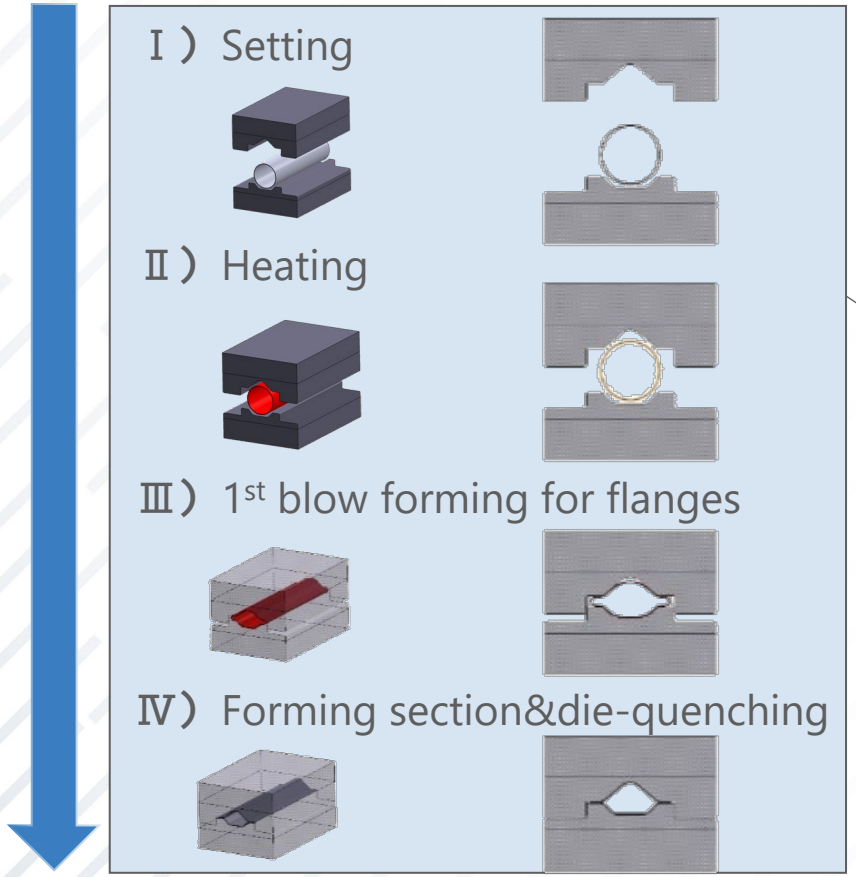
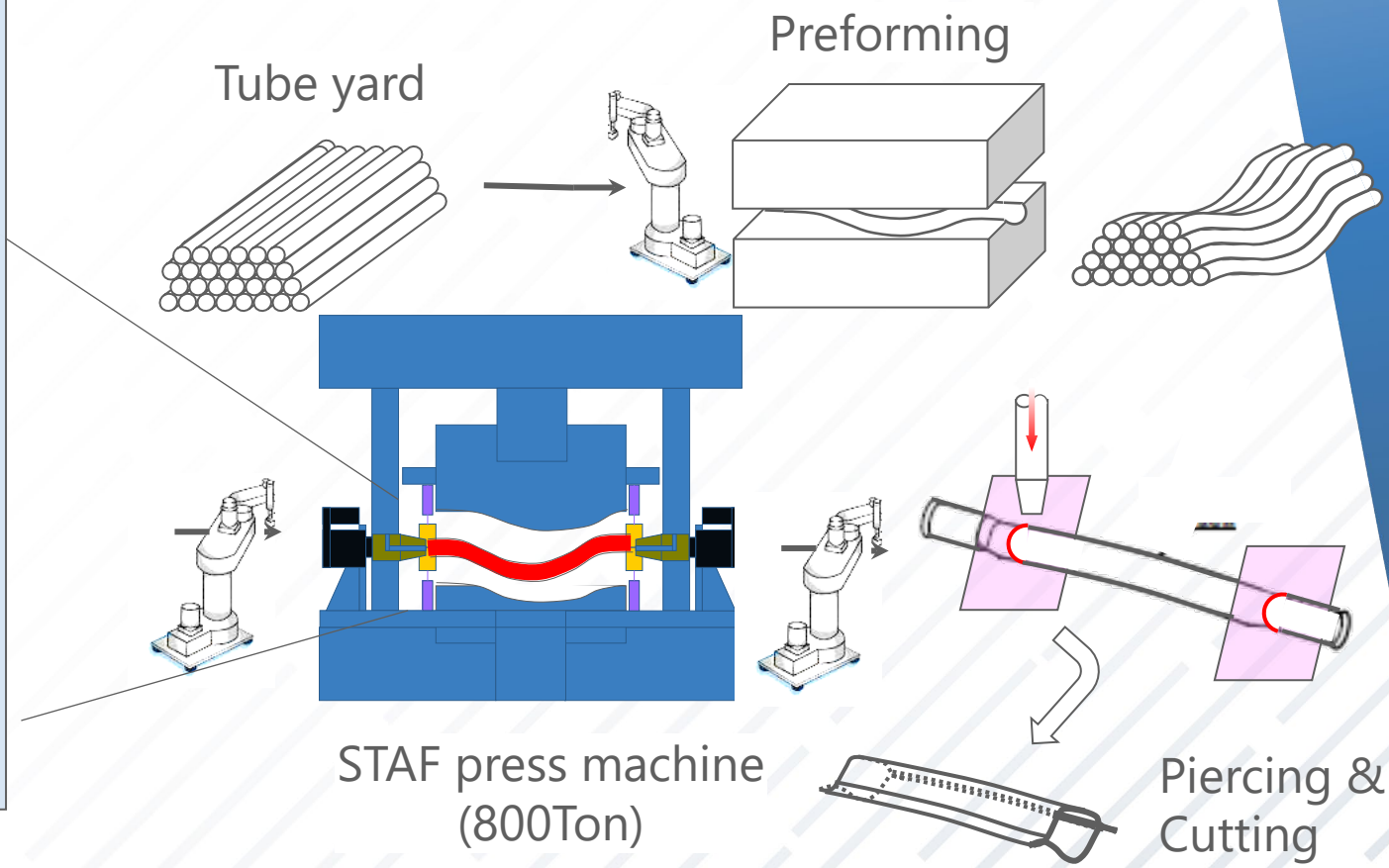
1. INTRODUCTION

- Form high strength and high rigidity auto parts in one-pack.
- Form flanges, drastically the assembly processes are reduced.





1. INTRODUCTION

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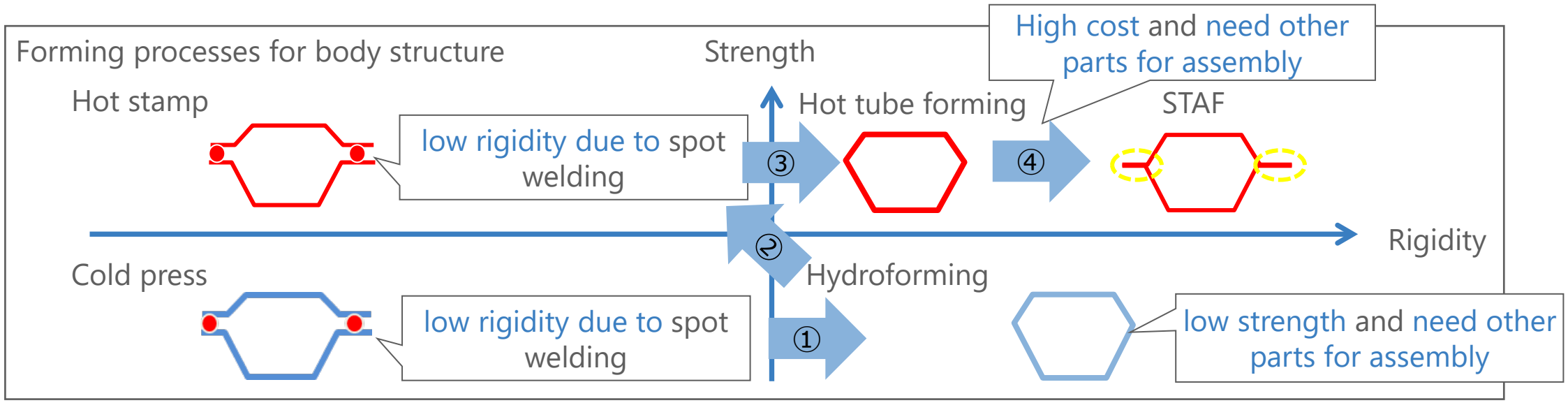
2. POSITIONING OF STAF



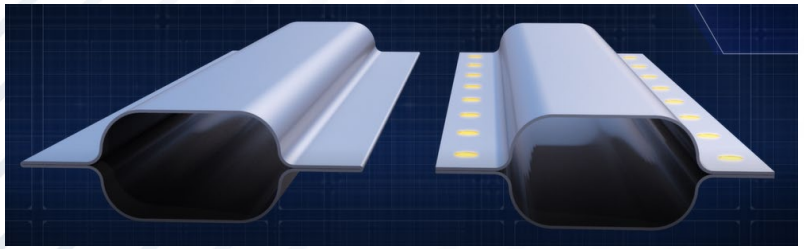
Invented Developed Promoted Adopted To be conventional

Flow of development		1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020s	2030s
Forming processes	Cold press	Improved material yield, elongation and tension performance									
	Hydroforming	★									
	Hot stamping				★						
	Hot tube forming							★			
	STAF								★		

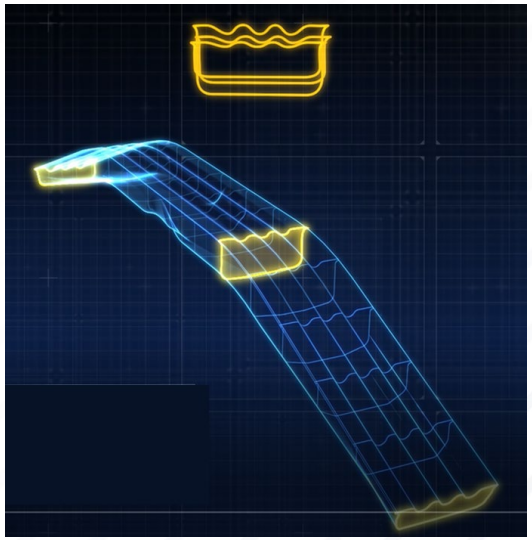
3. STAF'S BENEFITS

① Drastically weight reduction
② Adjustability
Performance can be controlled by flanges and varying profile
③ Simplification
STAF can integrate surrounding components into a STAF part.
Equipment for STAF is compact and well optimized

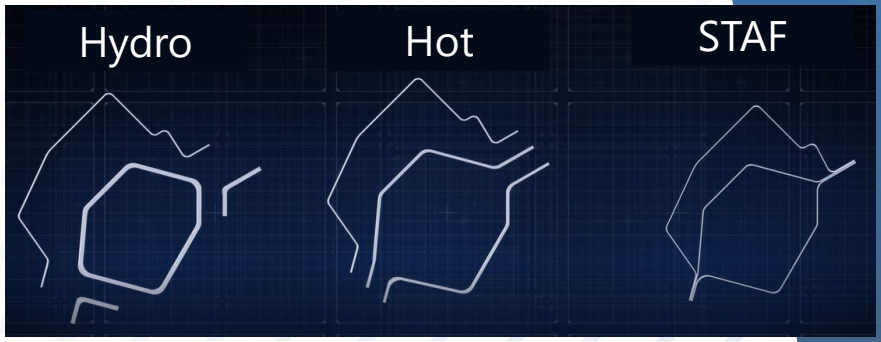
① Drastically weight reduction



② Adjustability



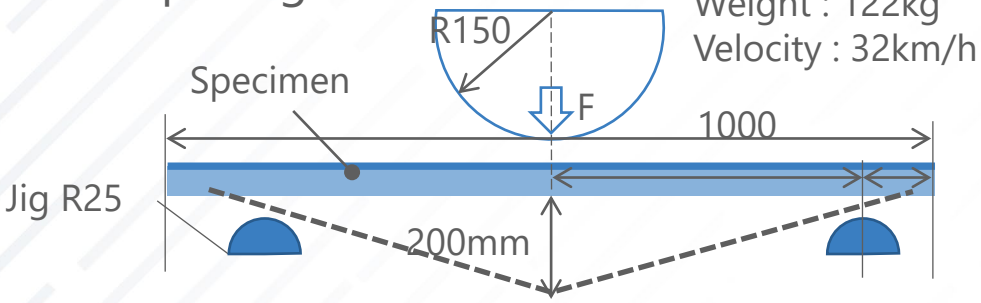
③ Simplification



3. STAF'S BENEFITS

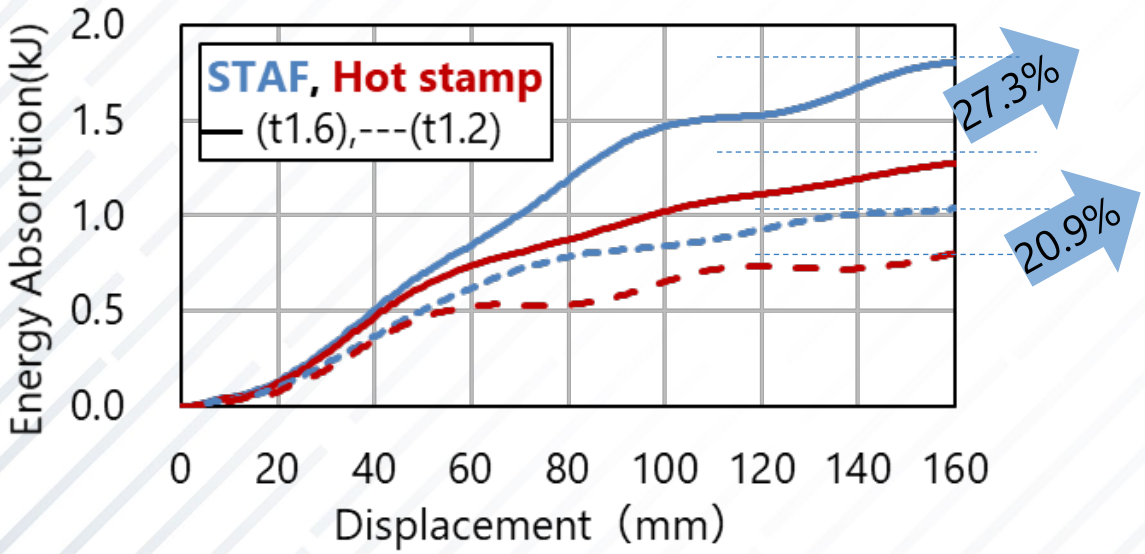
① Drastically weight reduction; Improved basic performance

■ Drop weight test

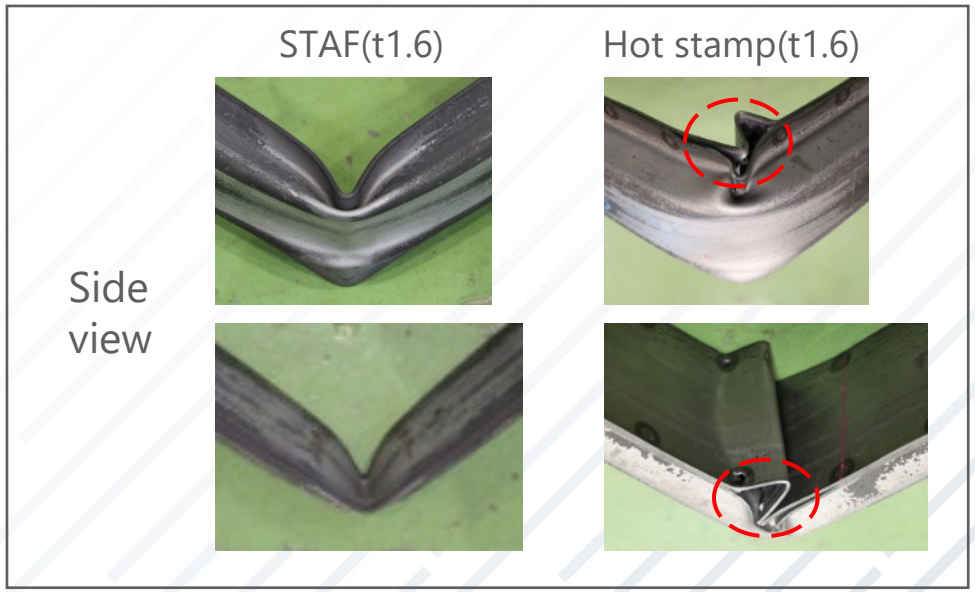


■ Specimen's Cross section

■ Test result



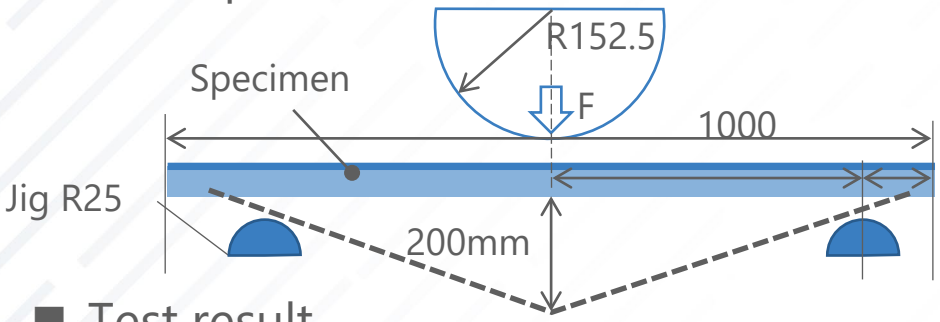
■ After collision



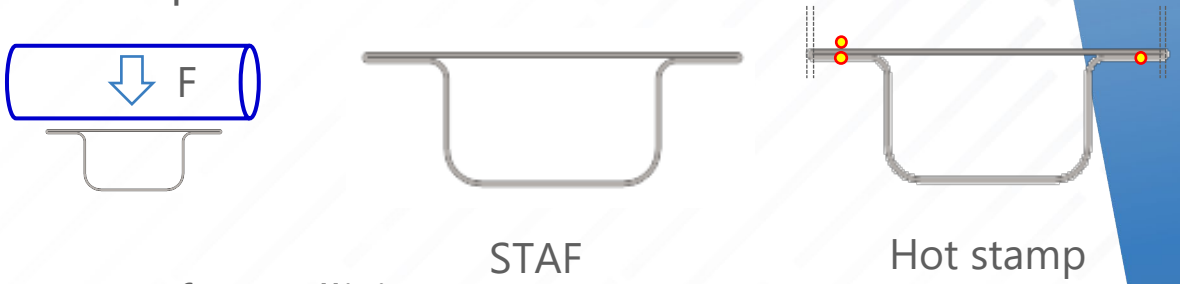
3. STAF'S BENEFITS

① Drastically weight reduction; Improved basic performance

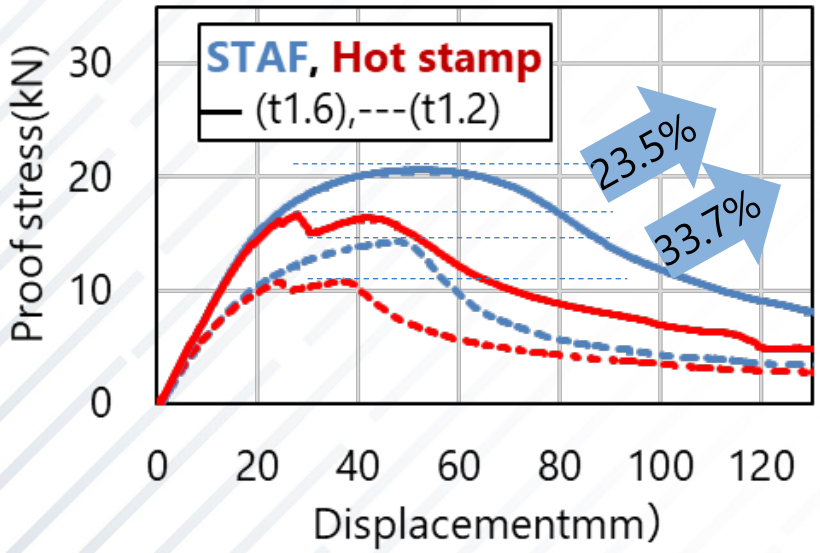
■ Three-point bend



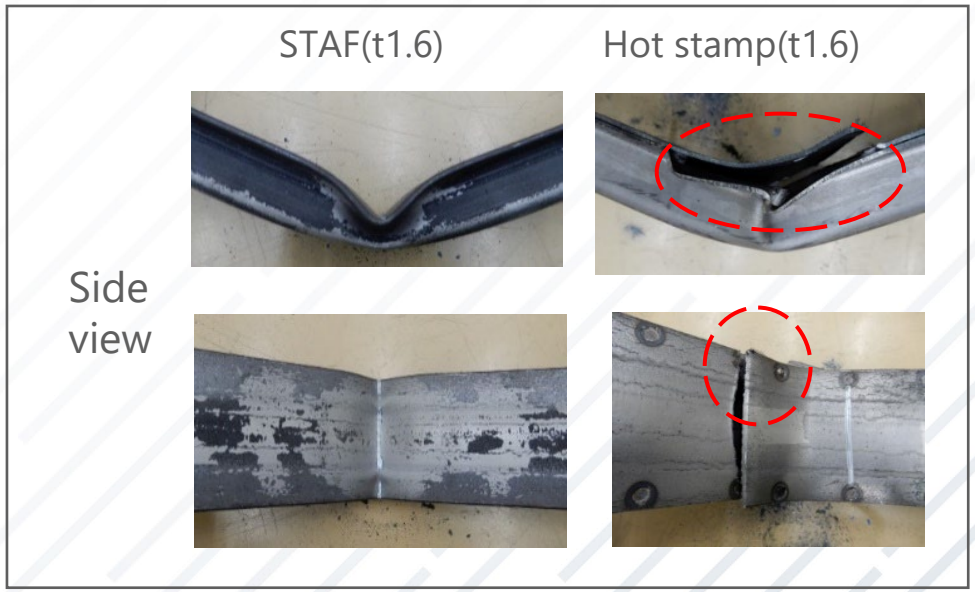
■ Specimen's cross section



■ Test result

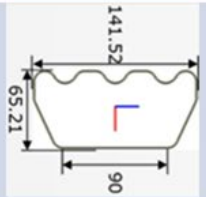
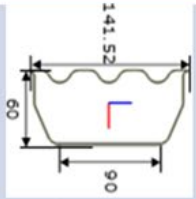
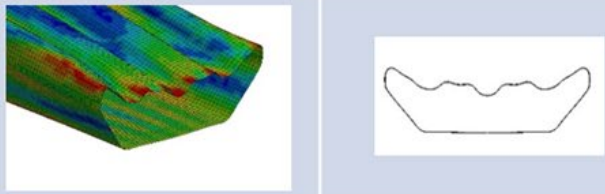
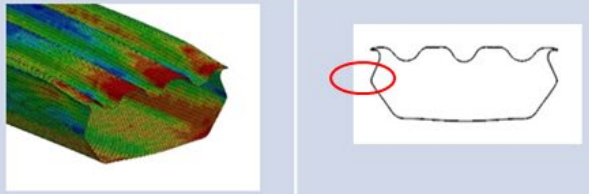
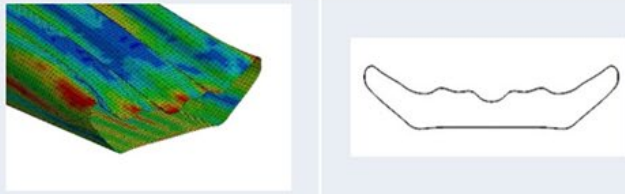
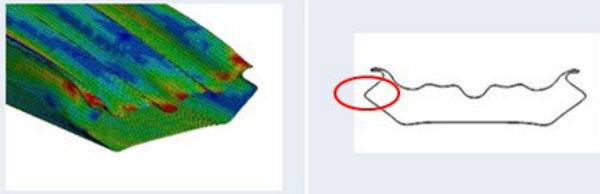


■ After collision

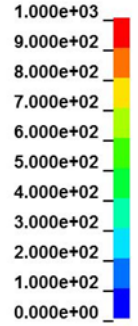


3. STAF'S BENEFITS

② Adjustability Performance can be controlled by flanges and varying profile

Models	No Flanged model	Minimum Flanged model
Criteria Cross-section		
Stroke 20mm		
Stroke 40mm		
Stroke 60mm		

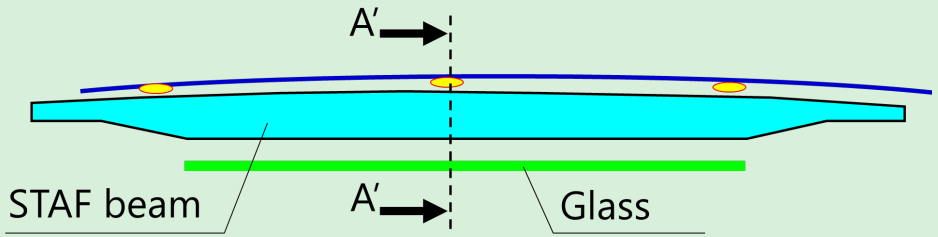
Beam profile

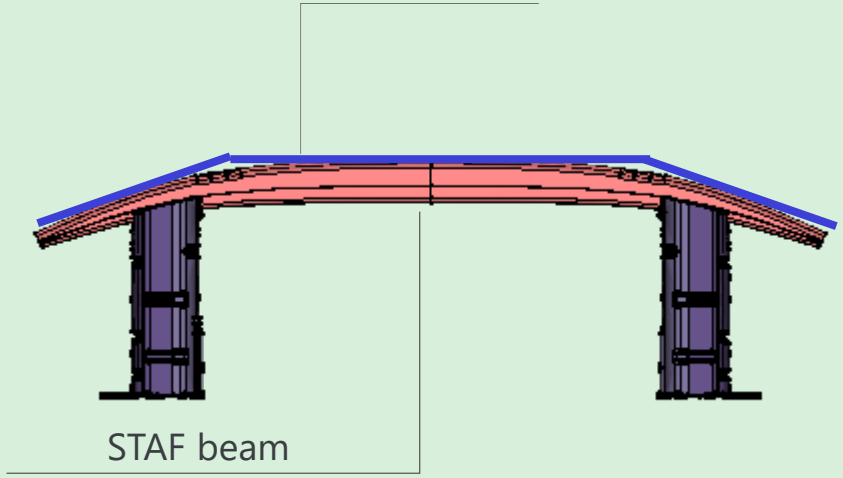


3. STAF'S BENEFITS

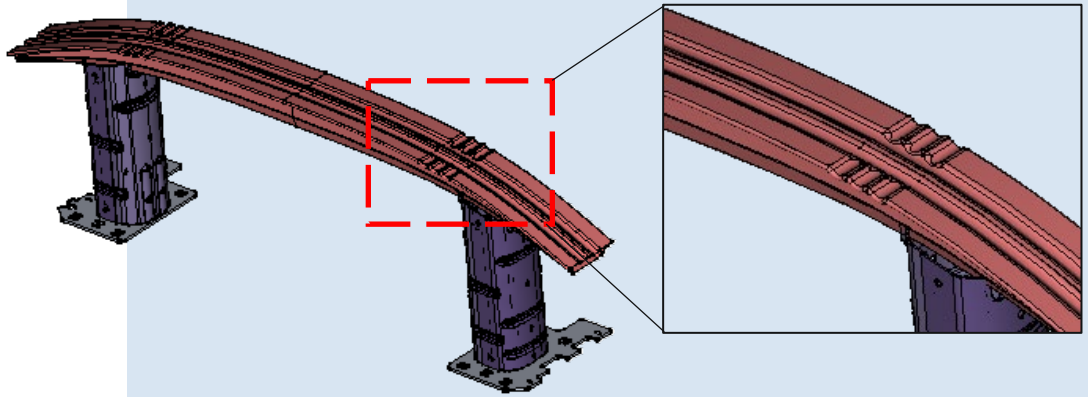
② Adjustability Performance can be controlled by flanges and varying profile

Design adjustment



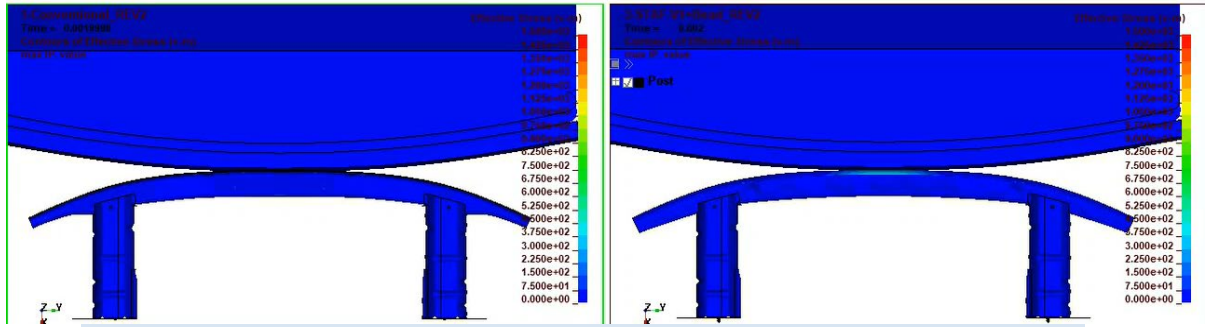


Performance adjustment



Conventional
Buckled in the center

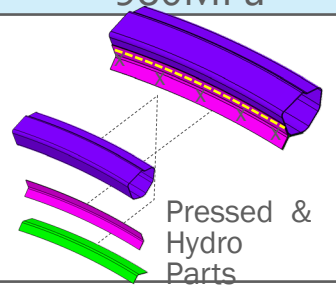
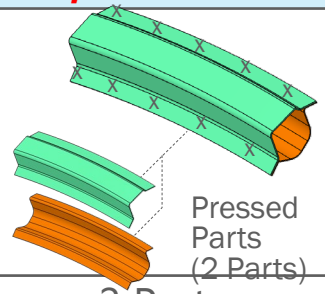
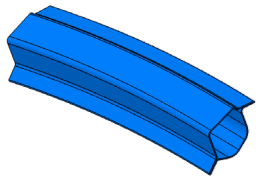
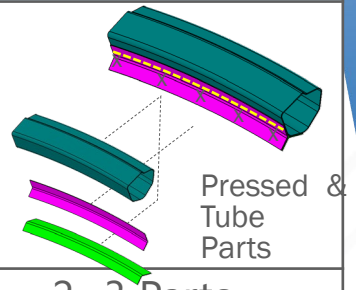
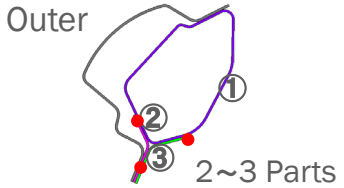
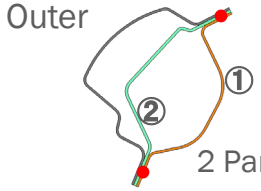
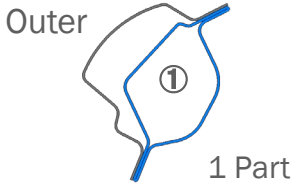
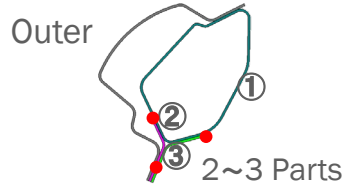
STAF with beads attached
Stress dispersed



3. STAF'S BENEFITS

GDIS

③ Simplification (Integration and optimized equipment)

	Hydroforming	Hot stamping	STAF	Hot gas forming
Strength	~980MPa	**1,500MPa~**	**1,500MPa~**	**1,500MPa~**
Parts construction				
Cross section image	2~3 Parts 	2 Parts 	1 Part 	2~3 Parts 
Process	5 processes ➢ Preforming ➢ Hydroforming (3000Ton~) ➢ Laser cutting ➢ Press forming ➢ Welding(ass'y)	5 processes ➢ Blanking ➢ Heating furnace ➢ Hot stamping (2 Sheets &2 Dies) ➢ Laser cutting ➢ Welding(ass'y)	3 processes ➢ Preforming ➢ STAF form (800Ton~) ➢ Laser cutting	6 process ➢ Preforming ➢ Heating furnace ➢ Gas forming ➢ Laser cutting ➢ Press forming ➢ Welding(ass'y)

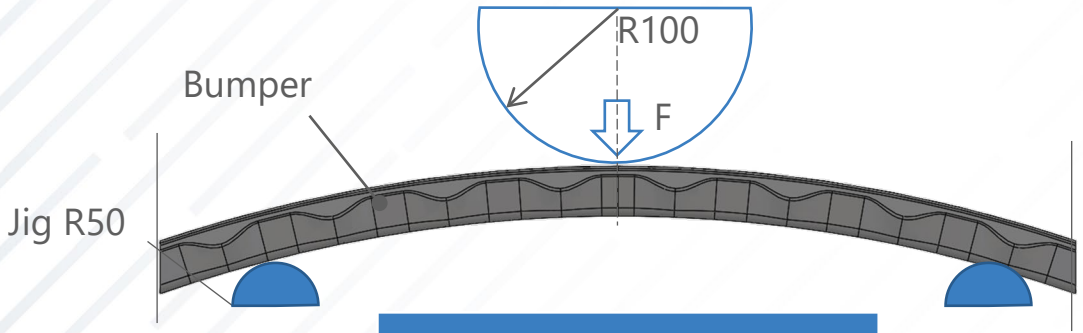
CONTENTS

CASE STUDY. Ⅰ FOR BUMPER BEAM VERIFICATION OF STAF'S BENEFITS

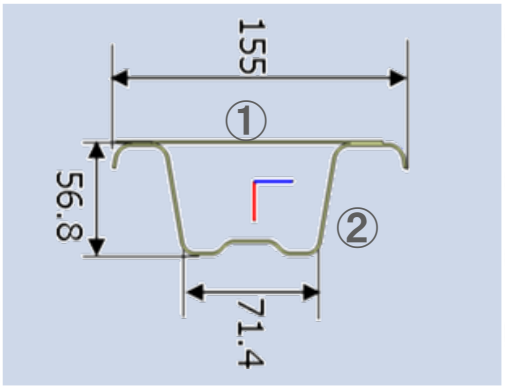
4. CASE STUDY

- We replaced a conventional bumper with STAF. STAF is designed under the same layout of conventional. We tested this evaluation with several strength evaluation, for this page introduce the basic performance.

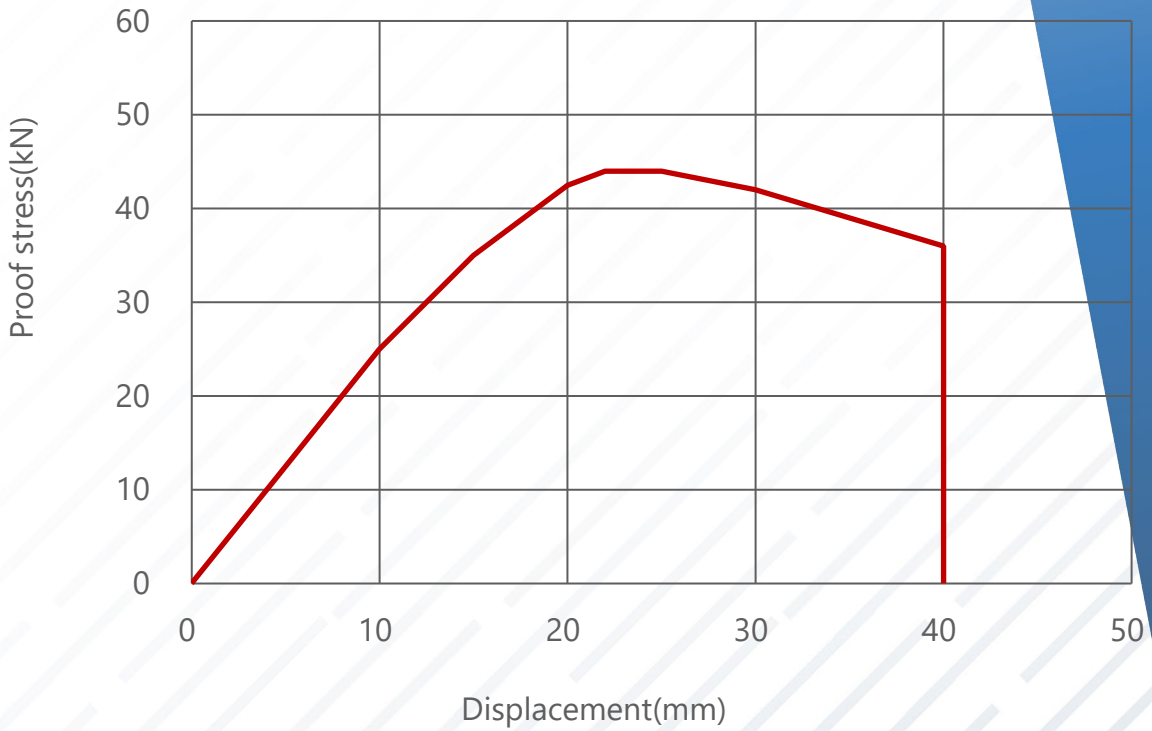
■ Evaluation (three-point bend)



Market model

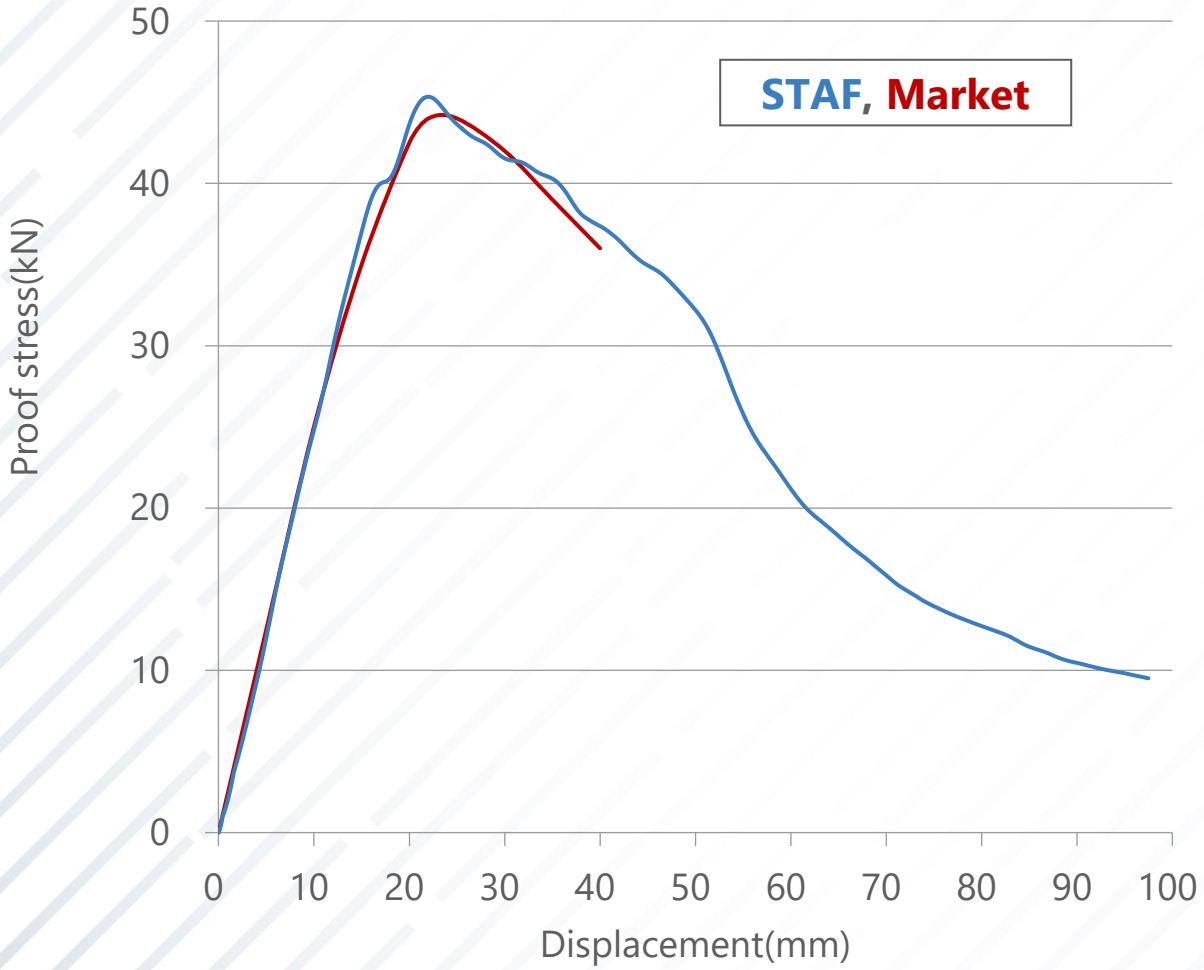


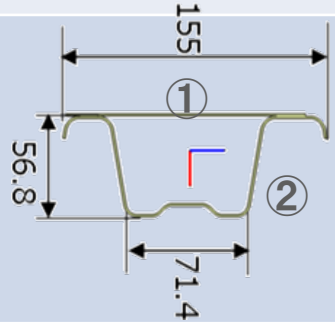
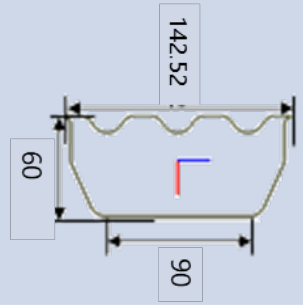
①590MPa,t1.25
②1800MPa,t1.6



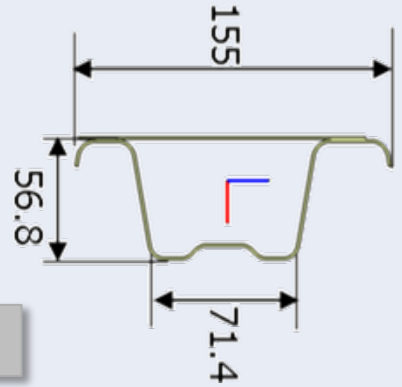
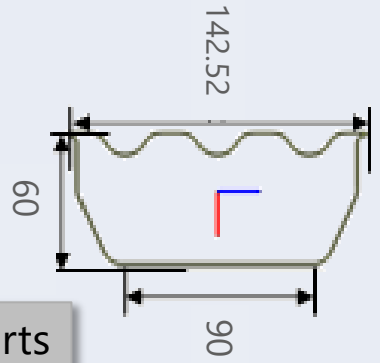
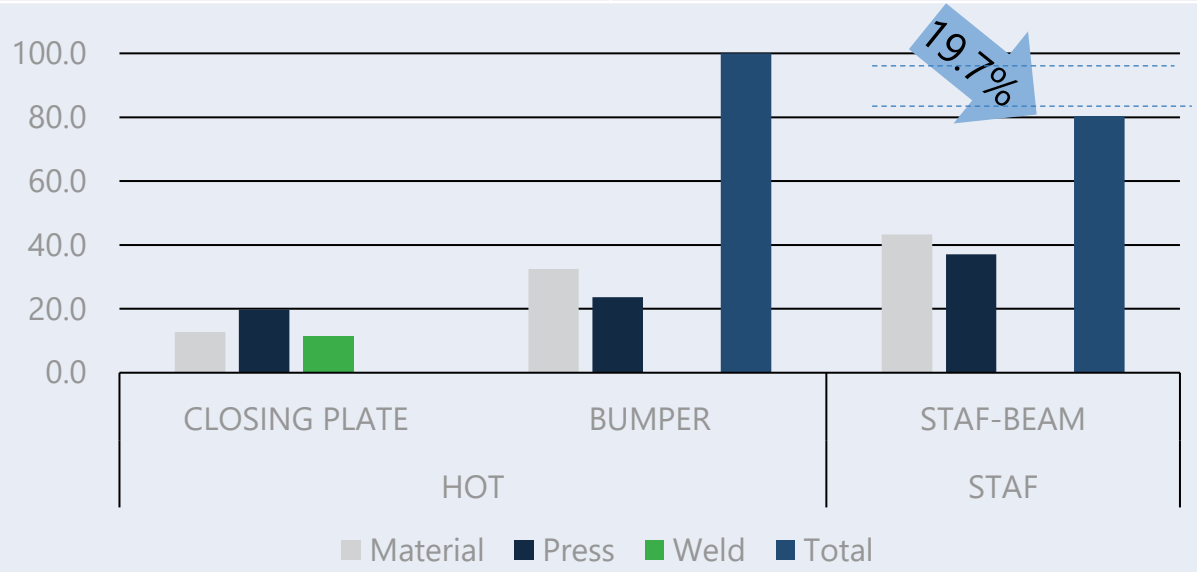
4. CASE STUDY

■ Test result (three-point bend)



Model	Market model	STAF model
Pipe diameter(㎜)	–	φ114.3
Thickness(㎜)	①590MPa,t1.25 ②1800MPa,t1.6	1500MPa,t1.2
Cross section		
Weight(kg)	5.15	3.72 (◎－27.7%)

4. CASE STUDY

Cost Comparison	Market model	STAF
Bumper section	 2Parts	 1Parts
Manufacturing Cost (SHI's estimation		
%	100%	80. 3%

These cost numbers are calculated based on SHI's standard, not guaranteed.

4. CASE STUDY

■ Summary

STAF applicability to Bumper beam

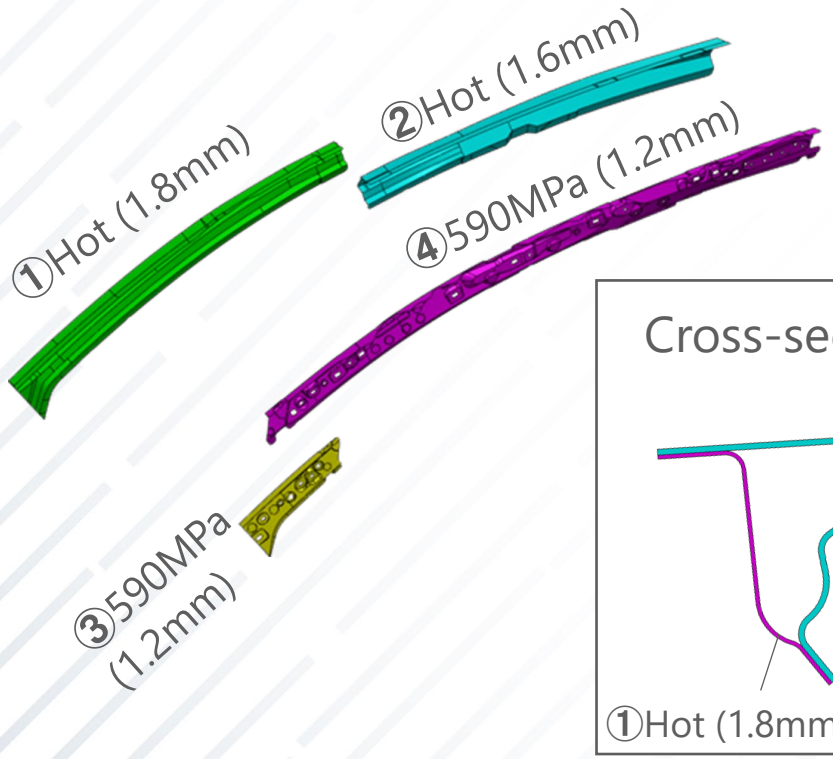
1. In this test condition(3point bending), it is possible to reduce **the weight by 27.7%**, compared with conventional bumper of hot stamped.(Apple to Apple same layout design comparison)
2. By reducing the number of parts, production efficiency and the number of dies, manufacturing cost will be reduced **by 19.65%.**
3. Structure that cannot be manufactured by other forming process

CASE STUDY. Ⅱ FOR A PILLAR VERIFICATION OF STAF'S BENEFITS

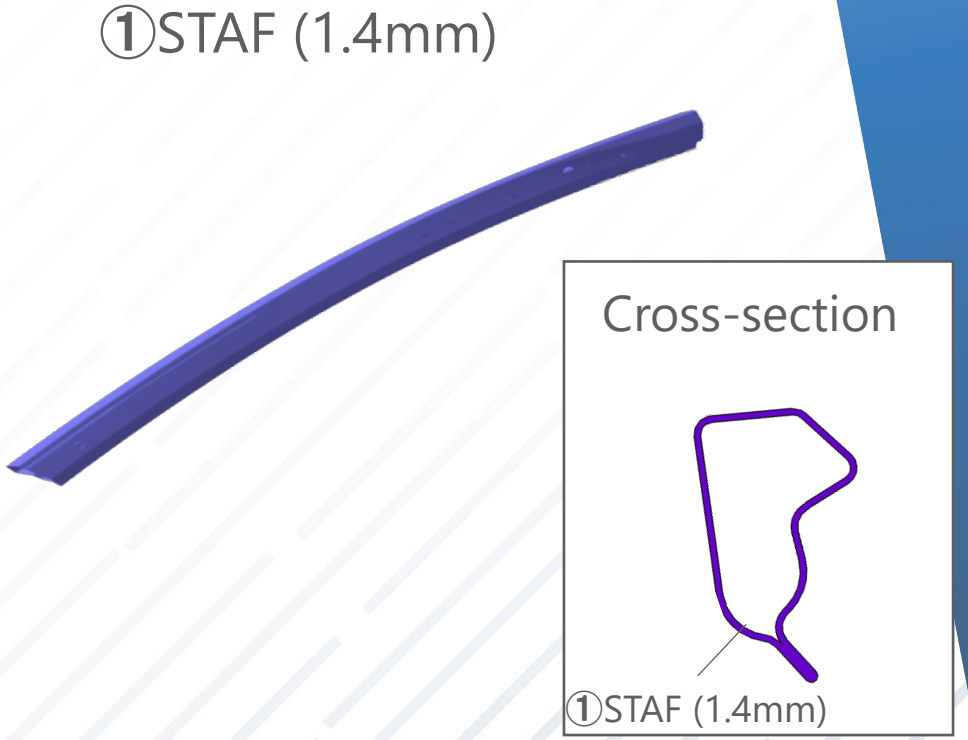
4. CASE STUDY

- We replaced a conventional A-pillar in the market with STAF process. The conventional model is composed of four reinf., each of which is spot welded together. With STAF, those parts can be integrated into a single part at once.

Market model

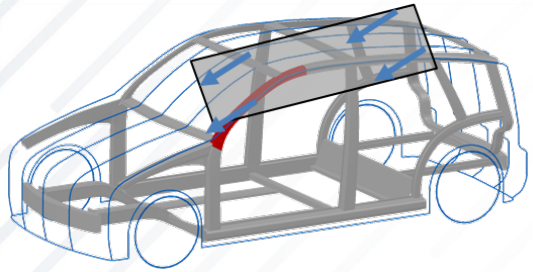


STAF

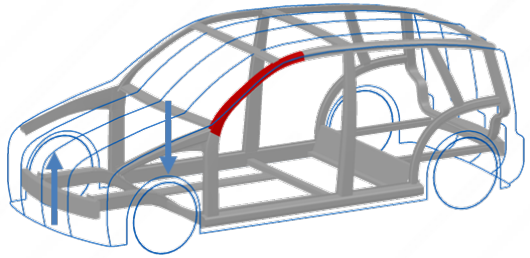


4. CASE STUDY

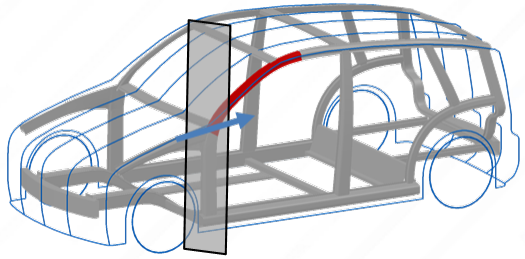
■ Evaluation We have studied various requirements of A pillar as below.
In order to prove the basic performance of STAF, I will explain the performance with Full Frontal Crush.



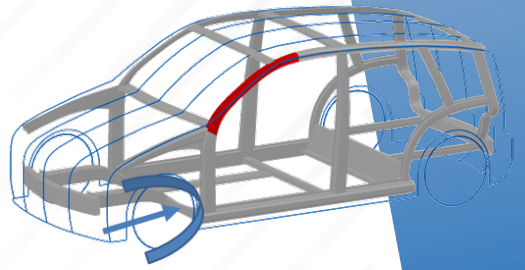
FMVSS216:Roof crush



Body torsion performance



Frontal crush



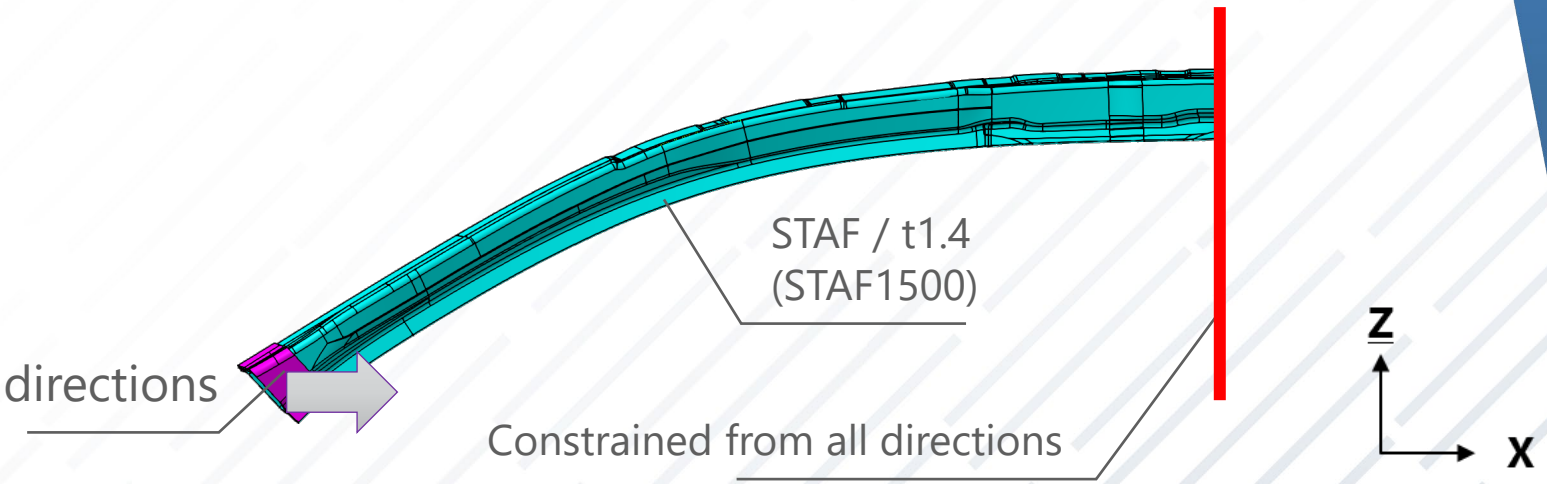
Small overlap frontal crush

■ Full-Frontal crush test(CAE)

Solver：LS-DYNA

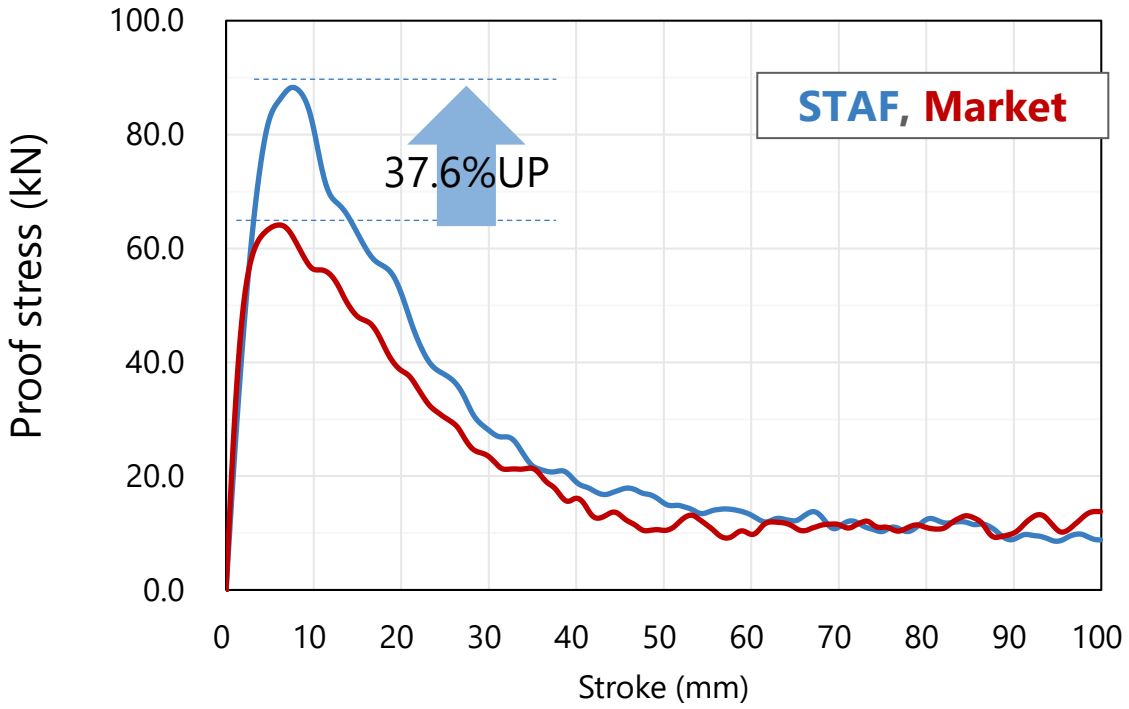
Methods：Forcibly the contact area is moved at 0.5 mm / sec to evaluate the load and energy absorption.

*The contact area is set as the rigid.

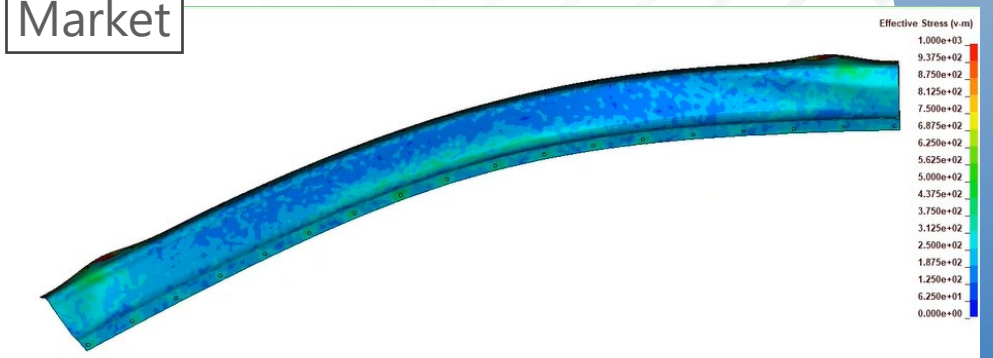


4. CASE STUDY

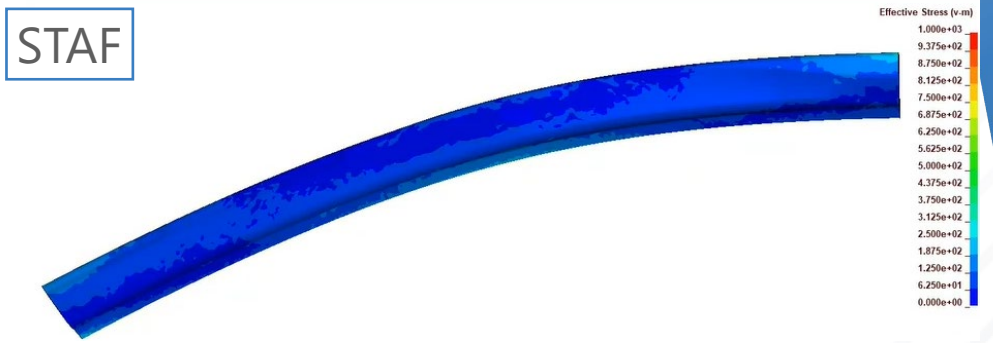
■ Test Result



Market



STAF



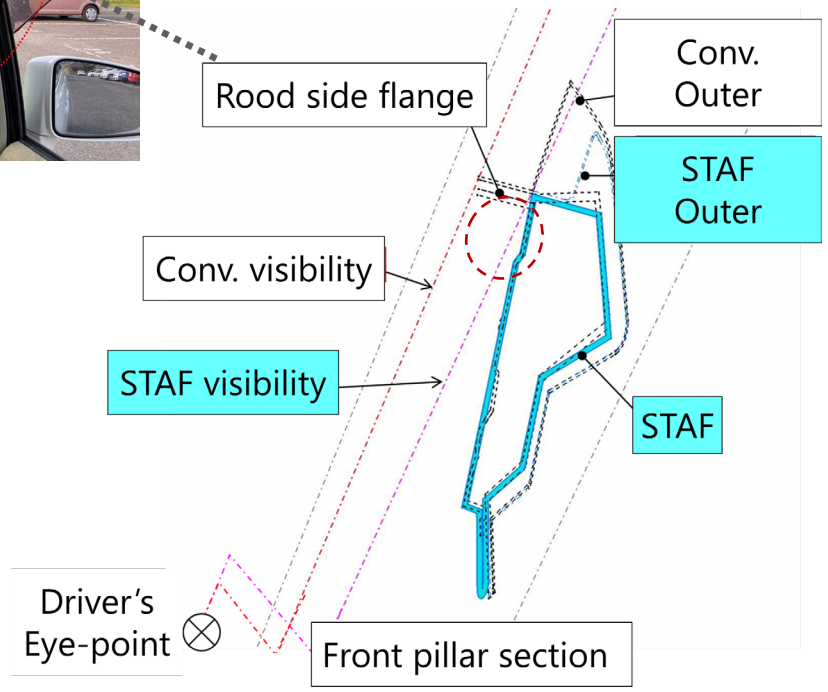
	STAF		Market model
Parts count	1 part	Reduce 3 parts	4 parts
Weight	3.8kg	31% Weight reduction	5.5kg

4. CASE STUDY

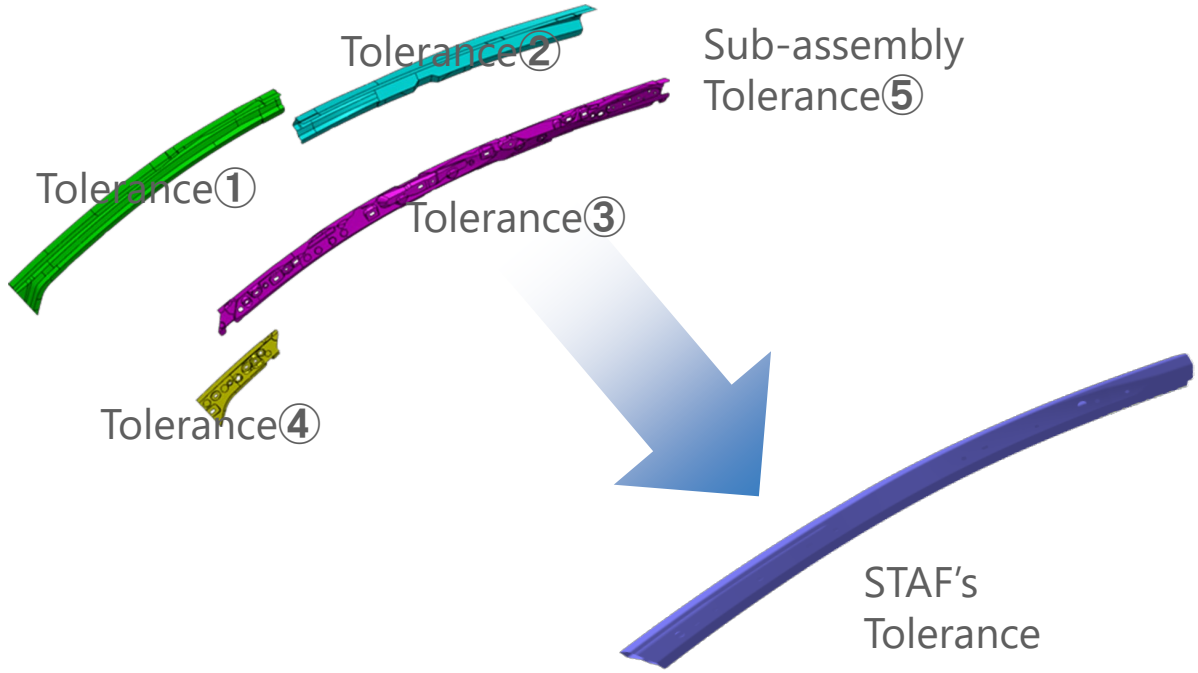
■Additional features for A pillars

①Improvement of visibility

The pate used for a flange also can be replaced for enlarging the section size, so the weight can be further reduced.



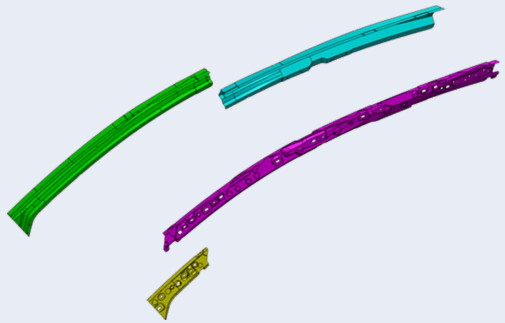
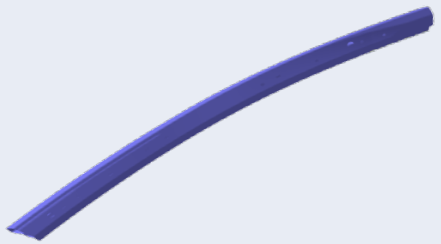
②Improvement of assembly accuracy

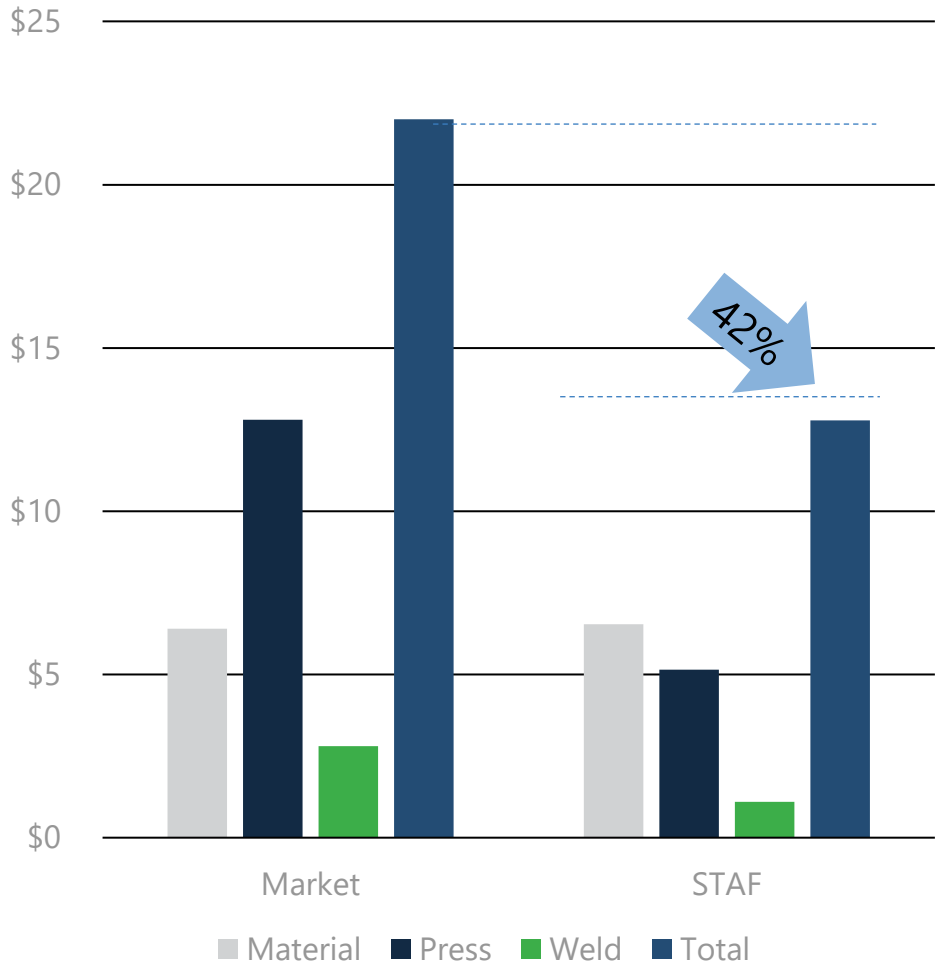


A-pillars processed by conventional forming processes requires some parts for sub-assembly.
ASSY accuracy will be deteriorated for each part.
Additionally, if laser or MIG weld joining are used, the total accuracy will be worse.

4. CASE STUDY

■Cost comparison

Cost Comparison	Market model	STAF
		
Parts count	4	1
Die count	4	1
%	１００%	５８%



4. CASE STUDY

■ Summary

STAF applicability to A-pillar test

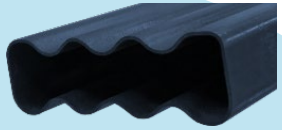
1. In this test condition(Front crush test), it is possible to reduce **the weight by 31%**, compared with conventional A pillar of hot stamped.(Apple to Apple same profile comparison)
2. By reducing the number of parts, production efficiency and the number of dies, manufacturing cost will be reduced **by 42%.**
3. Structure that cannot be manufactured by other forming process

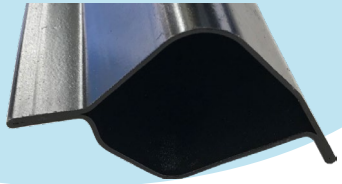
5. APPLICATION FOR STAF

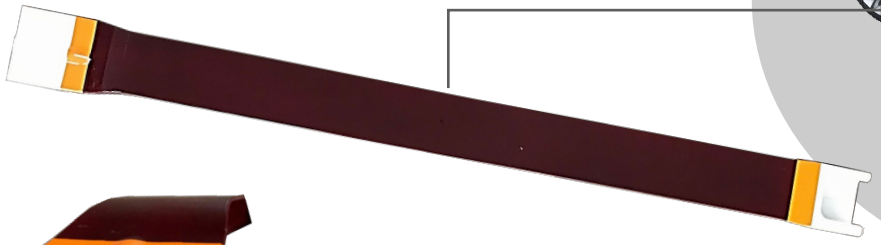
The parts below are just examples of the prototype parts that we are studying with our customers(OEMs and Tier1 suppliers). We have verified that compared with conventional body frame parts, STAF's unique high-strength tubular flanged components can make joining easier, performance higher, manufacturing cost lower.

Red: Body frame parts to which STAF is applicable

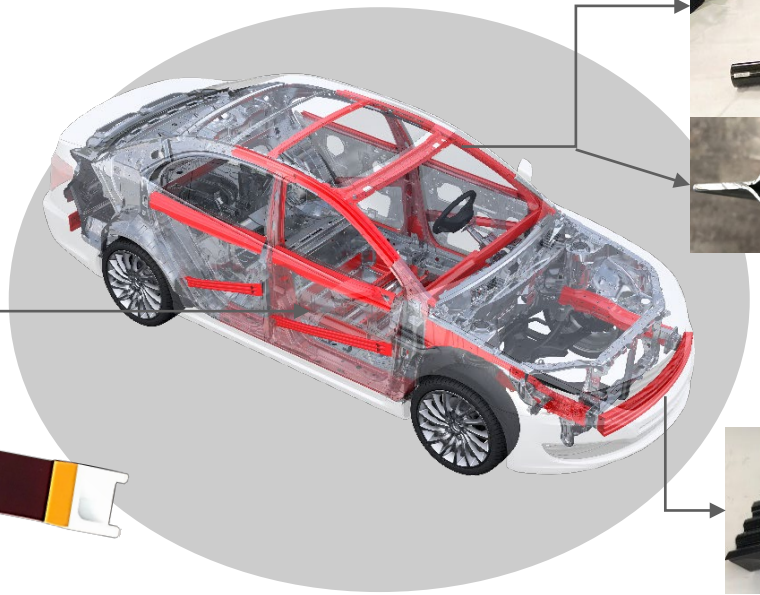
Various sections



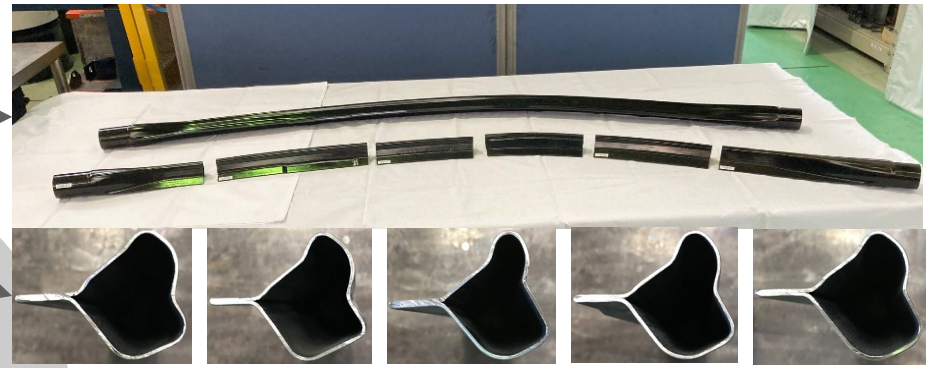




Door beam



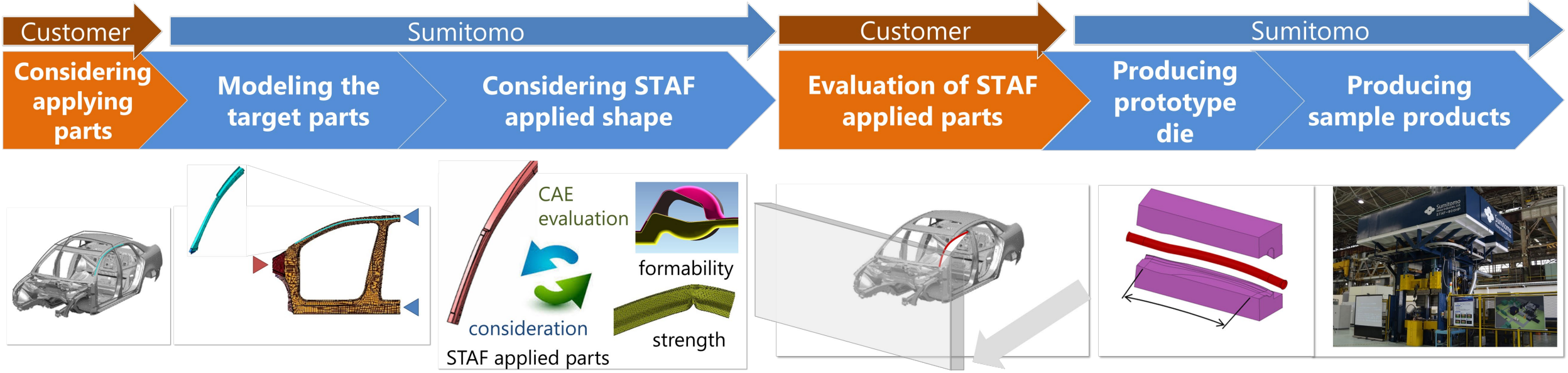
Front pillar



Bumper reinf.

5. APPLICATION FOR STAF

■CAE × Design support & Engineering support

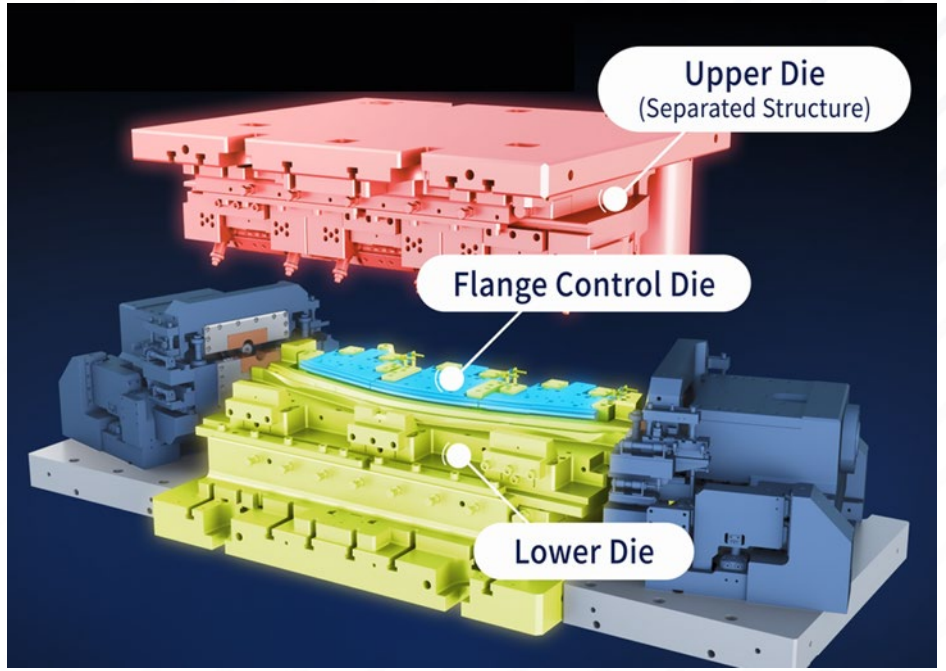


Through these activities, Sumitomo can provide the technical know-how in the feasibility and strength confirmation CAE that have already been verified, and the confirmation results such as the weldability, formability and corrosion protection of STAF product, etc., The adoption of STAF by OEMs and Tier1 suppliers can be strongly promoted.

5. APPLICATION FOR STAF

■Specificaitions

Full-automatic line STAF manufacturing equipment



Specifications		Formable product shape	
Capacity (tf)	800	Maximum tube diameter (mm)	φ150
Stroke (mm)	100 (loading)/600 (approach)	Minimum tube diameter (mm)	φ50
Daylight (mm)	1740	Full length (mm)	1600~1850
Bed size (mm)	L1900×W1600	Material length (mm)	750～1930
Installation area (mm)	L4950×W4800 ×H7500	Thickness (mm)	t1.0～2.3
Weight (t)	85	Minimum allowable bending angle (°)	120～180
Electric current (kA)	18	Cycle time	Apprx. 2spm
Capacity of high pressure air (NL/m)	8770	Production capacity(units per year per line)	Apprx.180,000~300,000

＊These values are subject to change as conditions and specifications change.

FOR MORE INFORMATION

Thank you all for listening!
If you are interested in STAF and like to hear more details, please feel free to contact us at:

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