



LIGHTer
International
Conference
GOTHENBURG 20-21 NOV

10

Enhancing Lightweight and Production Efficiency of Commercial Vehicles with New Generation Structural Adhesives and Modular Composite Components

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LIGHTWEIGHT TRENDS IN COMMERCIAL VEHICLES



- Introduction of **lightweight** solutions and **modular** design for large parts
- New **hybrid/mixed material** design approaches
- More **efficient production** of commercial and special vehicles
- Improved **passenger safety** and vehicle **structural integrity**

TRADITIONAL BUS BUILDING



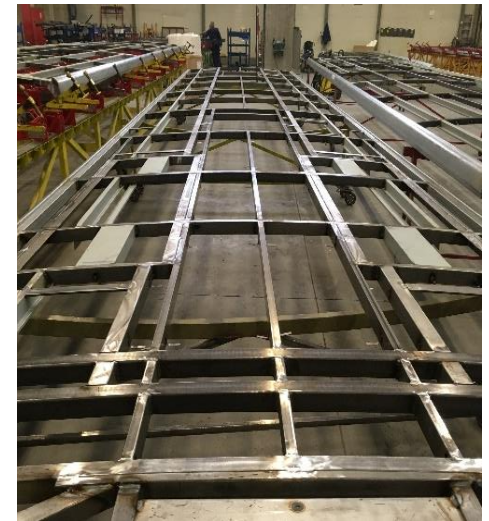
Conventional BIW design with several metal segments joined by welding or bolts



24 h production with 3 shifts and several workers on the line



Large and heavy panels that add additional weight



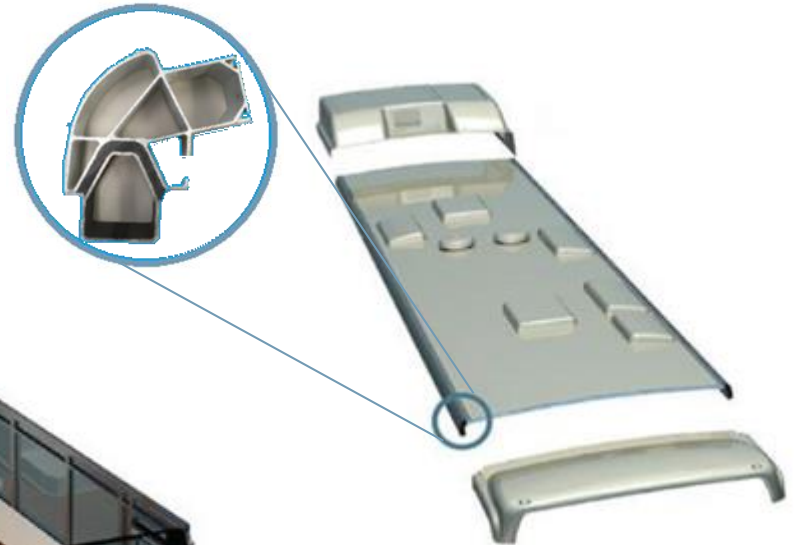
Sources: JCB, Van Hool, Ashok Leyland, Yutong

INNOVATING IN BUS BUILDING

Structurally Bonded Integral Composite Sandwich Roof for Buses and Coaches



Heavy metal roof design with separate insulation and exterior/ interior claddings



Pre-assembled sandwich module directly bonded on bus/coach walls

- New lightweight solution must show OEM approved performances
- Innovation must provide advantages both in design phase and in production

INNOVATING IN BUS BUILDING

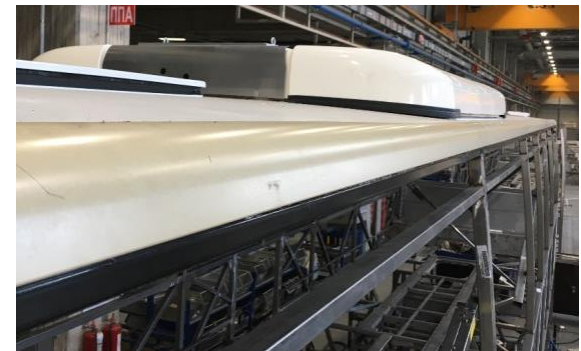
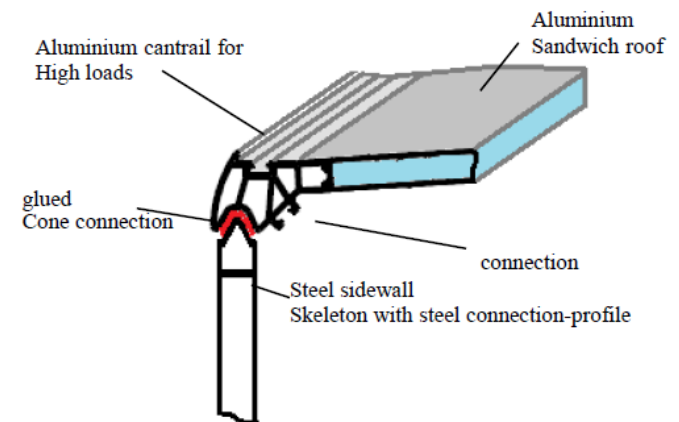
A REAL LIGHTWEIGHT EXAMPLE

Approved Engineering Performance

- Weight reduction of more than 500 Kg
- Enhanced stiffness for all load cases
- Better stress distribution (no concentration)
- Properties stability from -40 °C to 100 °C
- Additional modules and mixed material design

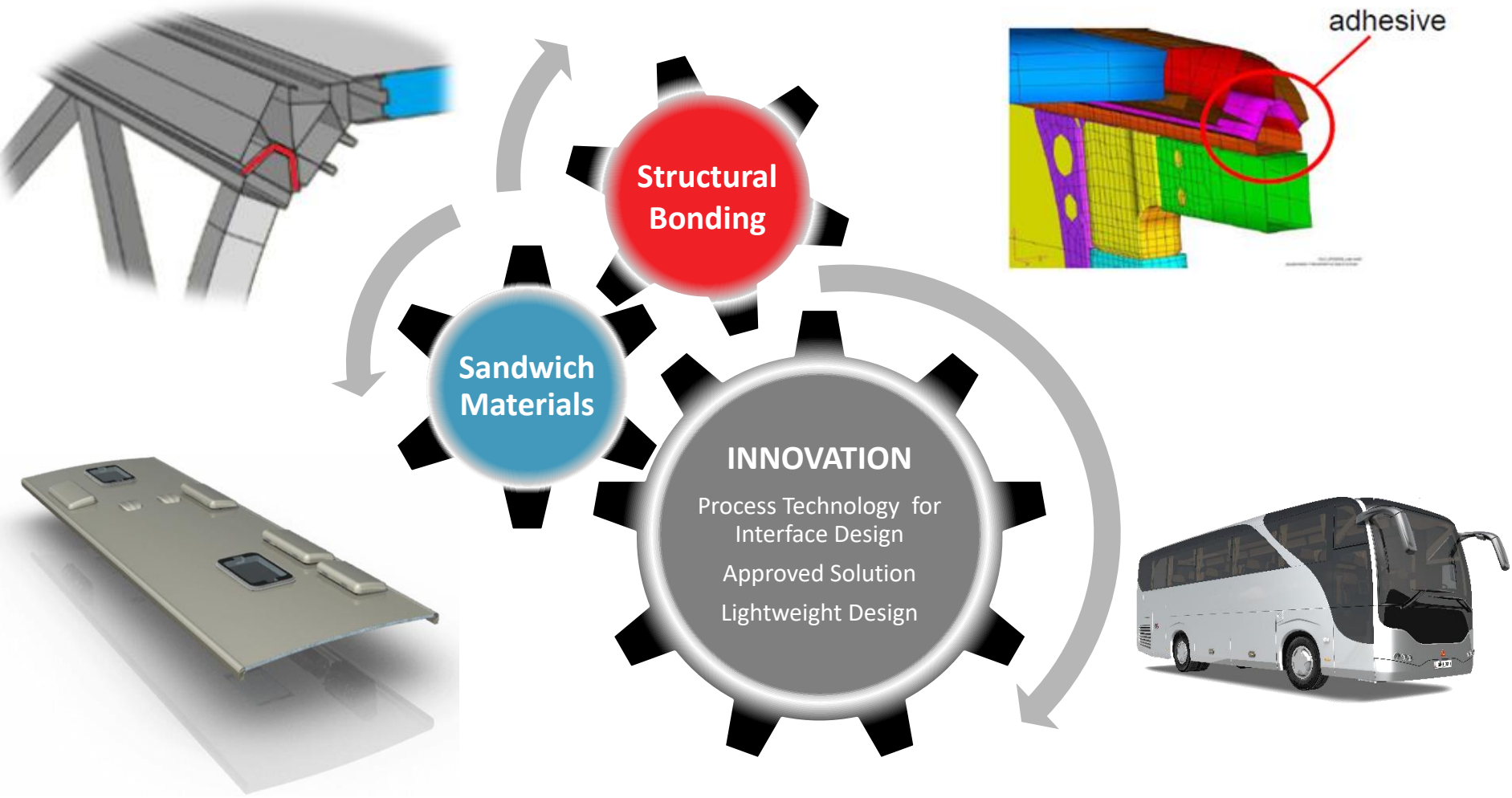
Proven Advantages in Production

- Bus roof ready in 2 hours
- Fewer workers required for assembly
- Less and faster production steps
- Easier adhesive application: compressibility, low viscosity, non-sag, no VOC and no smell
- Suitable for automatization



HOW DO WE ACHIEVE THAT?

INNOVATIVE STRUCTURAL BONDING + SANDWICH PANELS



NEW GENERATION STRUCTURAL ADHESIVES

SIKA PATENTED INNOVATIONS

SikaPower®

1C and 2C Epoxy
Adhesives

SikaForce®

2C Polyurethane
Adhesives

Sikaflex®

1C Polyurethane and STP
Adhesives

Strength, Modulus

Elongation at break



Curing by Design & Powerflex Technologies

- *Structural elasticity*
- *Stability over temperature*
- *Enhanced curing behaviour*

Strength = 10 ÷ 20 MPa
E-modulus = 20 ÷ 800 MPa
Elongation = 100 ÷ 400 %



NEW GENERATION STRUCTURAL ADHESIVES

SIKA PATENTED INNOVATIONS



CURING BY DESIGN

SNAP CURE TECHNOLOGY

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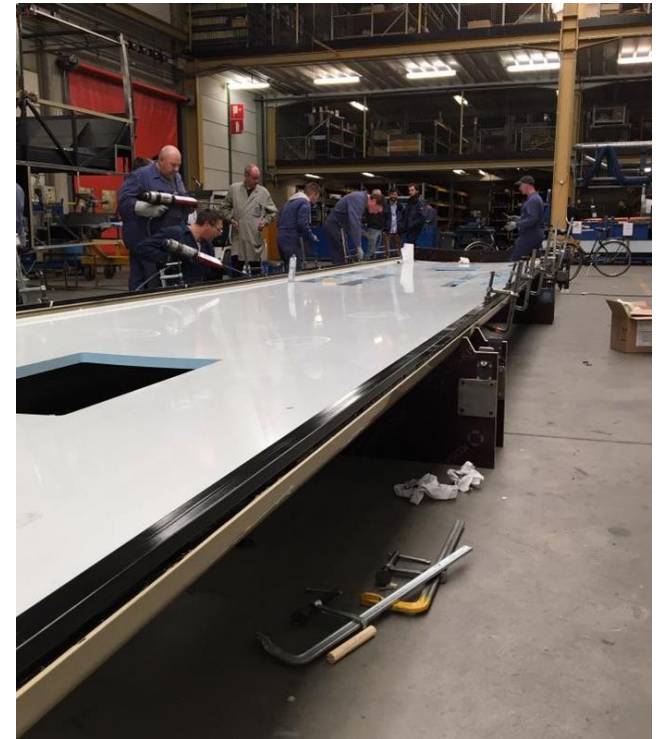


CURING BY DESIGN TECHNOLOGY

FIELD APPLICATION



- *With standard adhesive technology:*
 - Need for 6 people to apply adhesive at same time!
 - Waiting time for next assembly steps: 8-12 h

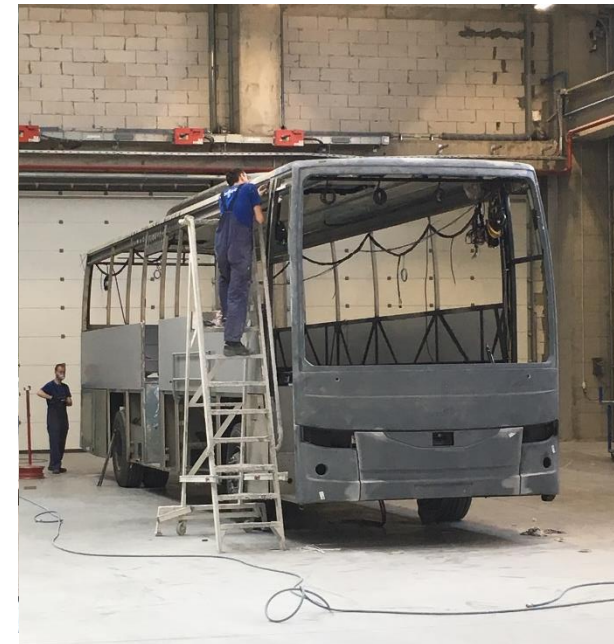
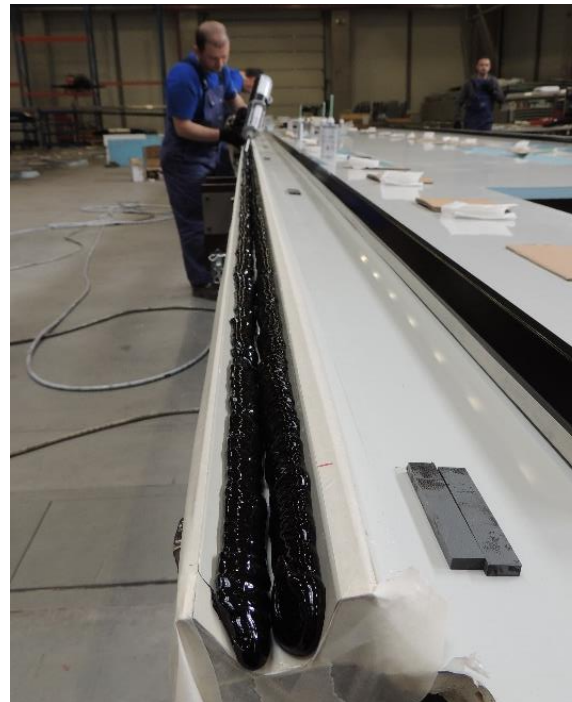


CURING BY DESIGN TECHNOLOGY

FIELD APPLICATION

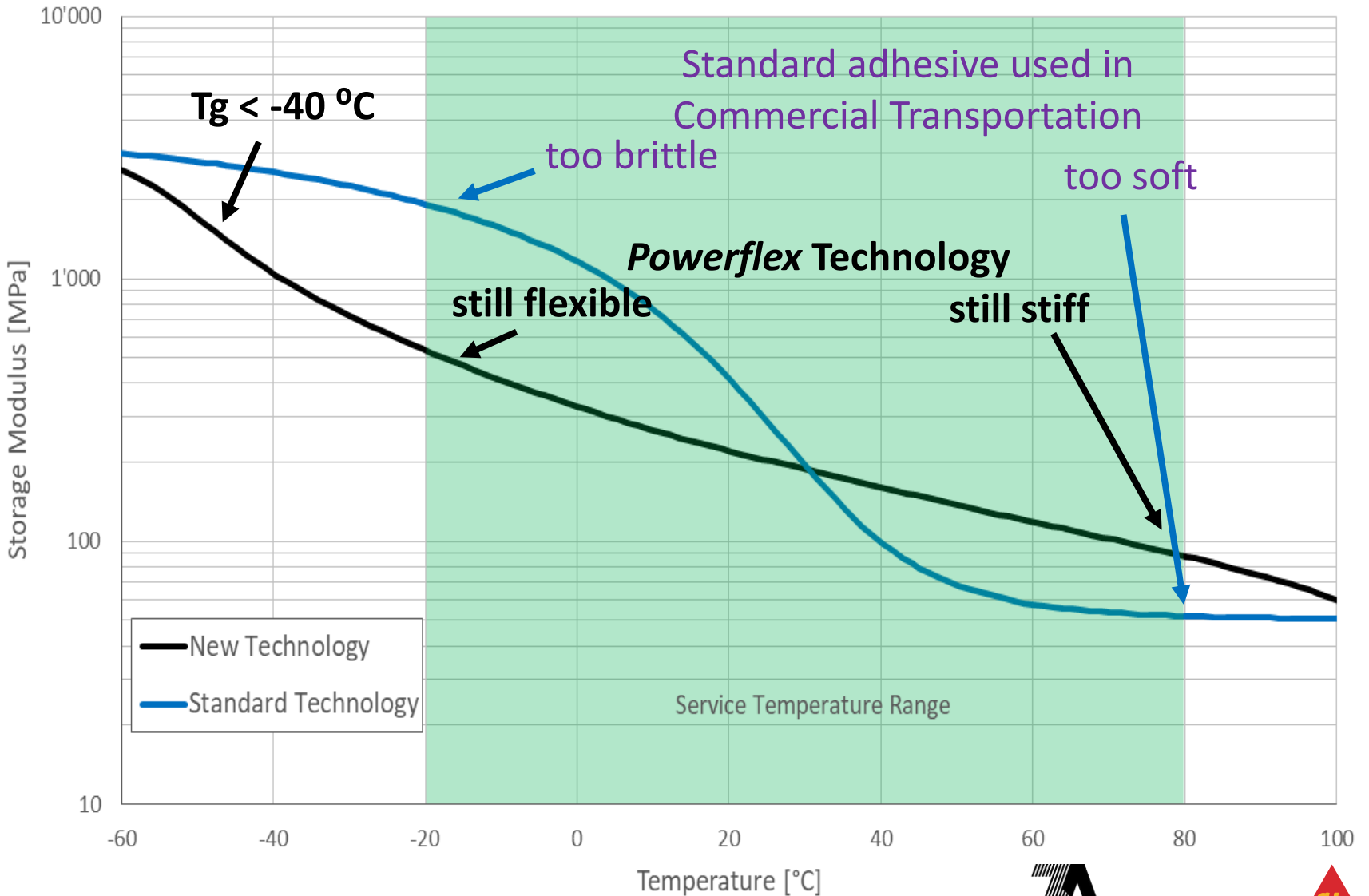


- **With *Curing by Design* technology:**
 - Only 1-2 people can complete the job using cartridges or a pumping system
 - Waiting time for next assembly steps: 2 h



POWERFLEX TECHNOLOGY

Dynamic Mechanical Analysis



2C Polyurethane Adhesives

SikaForce®

POWERFLEX TECHNOLOGY

ADVANTAGES FOR DESIGNERS AND MANUFACTURERS



Risk of substrate, coating or adhesive failure if the joint is too rigid or brittle

Risk for structural integrity if the joint is too weak to transfer loads

- New SikaForce® adhesives based on **Powerflex** technology allow designing with smaller reduction factors
- Stable properties over temperature enable more precise and reliable FEM simulations of the joints

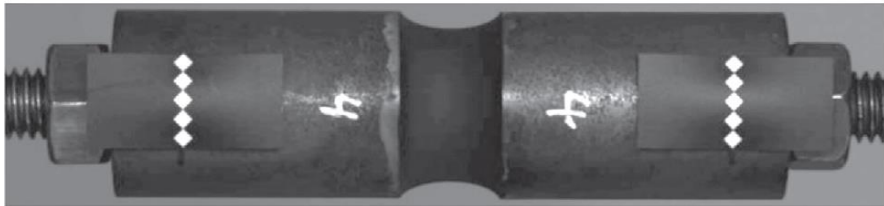
TECHNICAL SUPPORT FOR MANUFACTURERS

MATERIAL DATA AND MODELLING

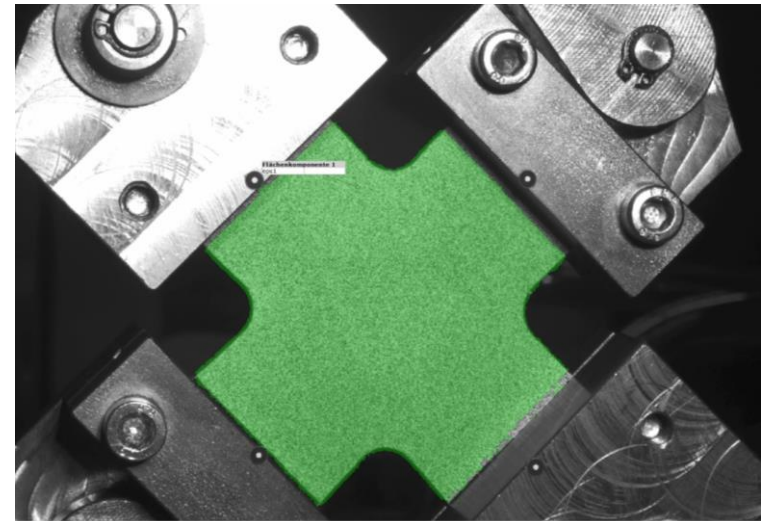
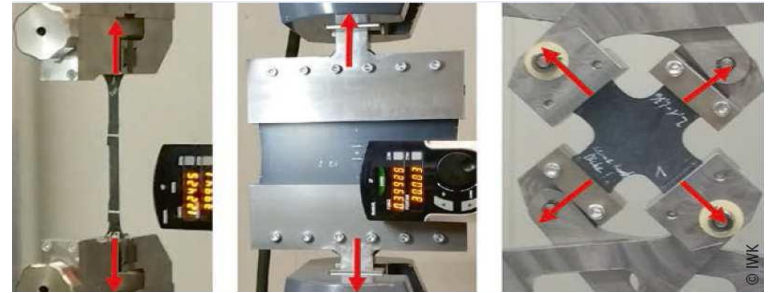
- Providing more than datasheets values to support advance material modelling
- TAST: Thick Adherent Shear Test
- Unidirectional, Planar and Biaxial tests



- BJTT: Butt Joint Tensile Test



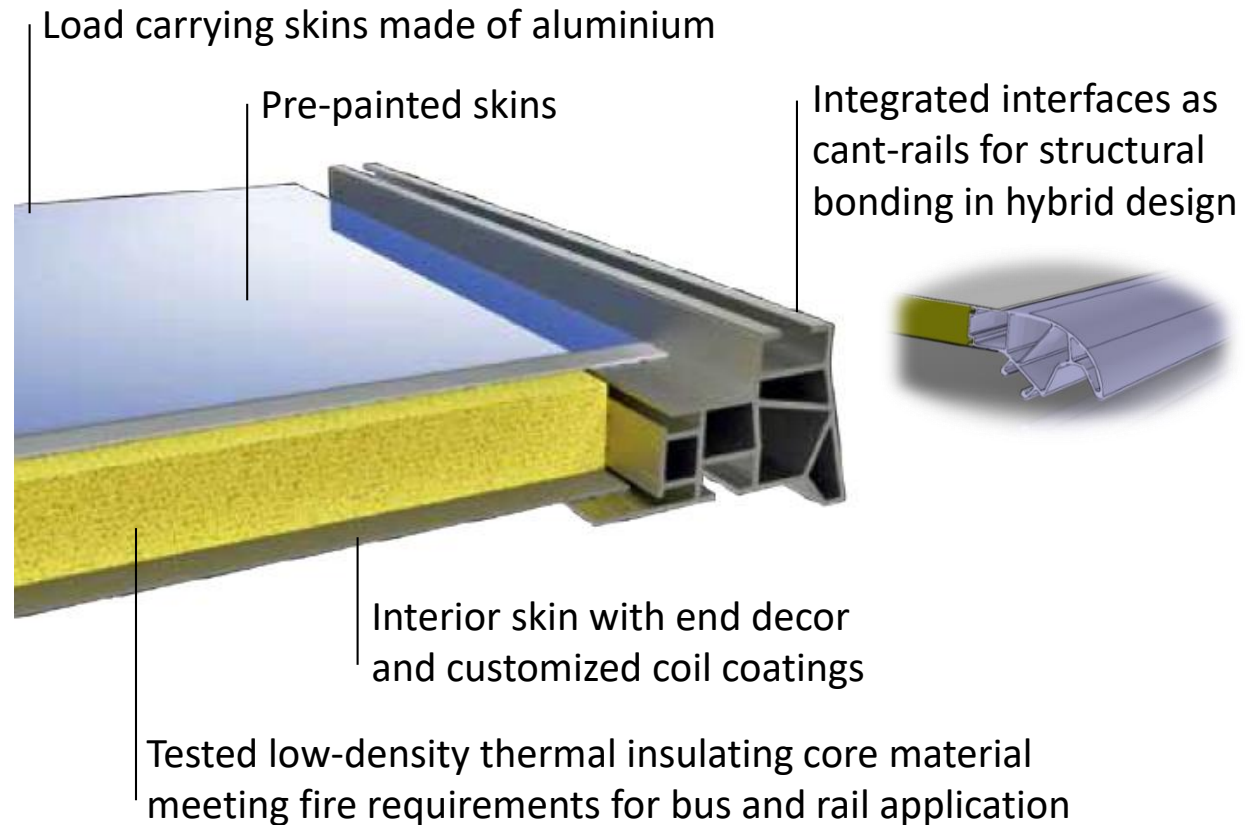
- DCB: Double cantilever



Reference: C. Amstutz, M. Bürgi, P. Jousset, *Int. J. of Adhesion and Adhesives* (2018)

INTEGRAL SANDWICH PANEL TECHNOLOGY

DESIGN OF V-NOTCHED ROOF PROFILES



- **Integral design** with freedom to accommodate additional top loads such as battery compartments, ACU climate systems, baggage compartments, etc.

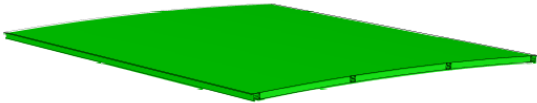
INTEGRAL SANDWICH PANEL TECHNOLOGY

STRUCTURAL, LIGHTWEIGHT, STIFF MODULAR ELEMENTS

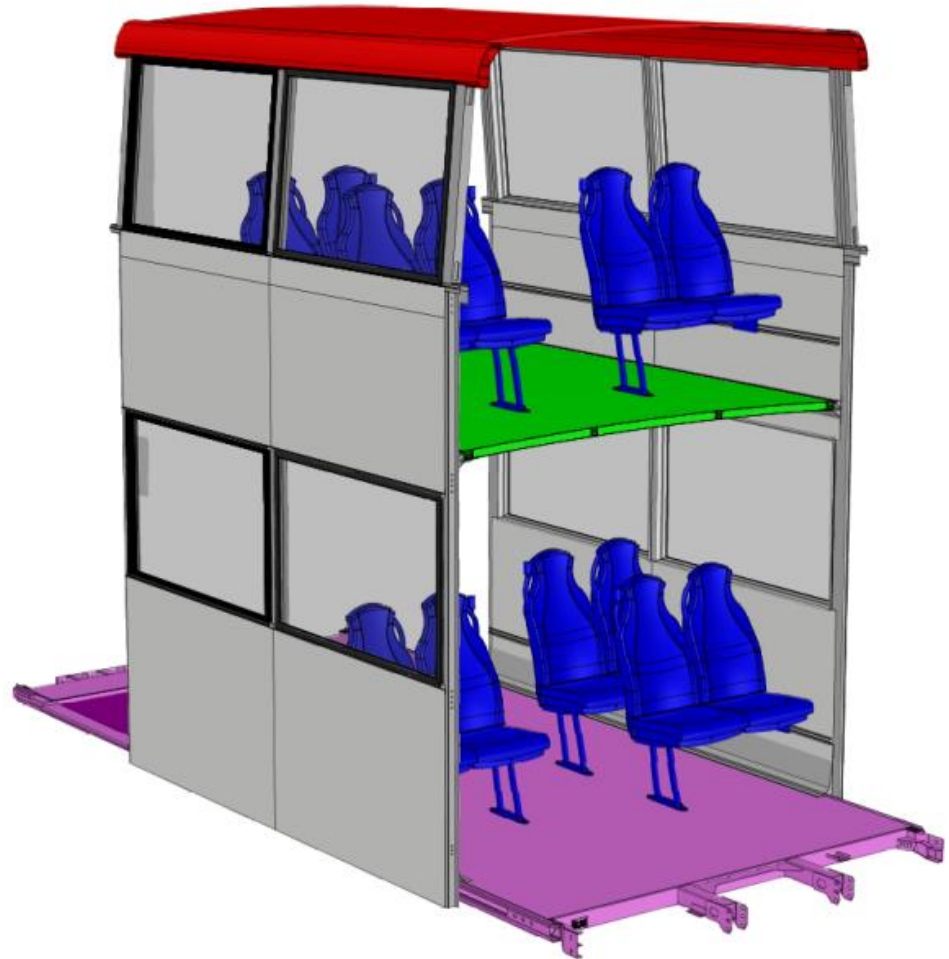
- **Integral Roofs**



- **Intermediate Floors**



- **Structural Low Floor Chassis**
(with heating option)

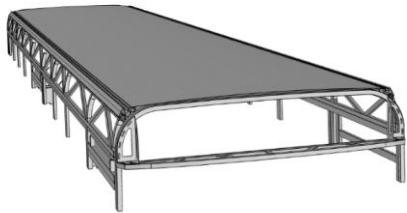


INTEGRAL SANDWICH PANEL TECHNOLOGY

WEIGHT REDUCTION EXAMPLE FOR CITY BUSES



Reduced weight thanks to design with **fewer components** and **lighter materials**

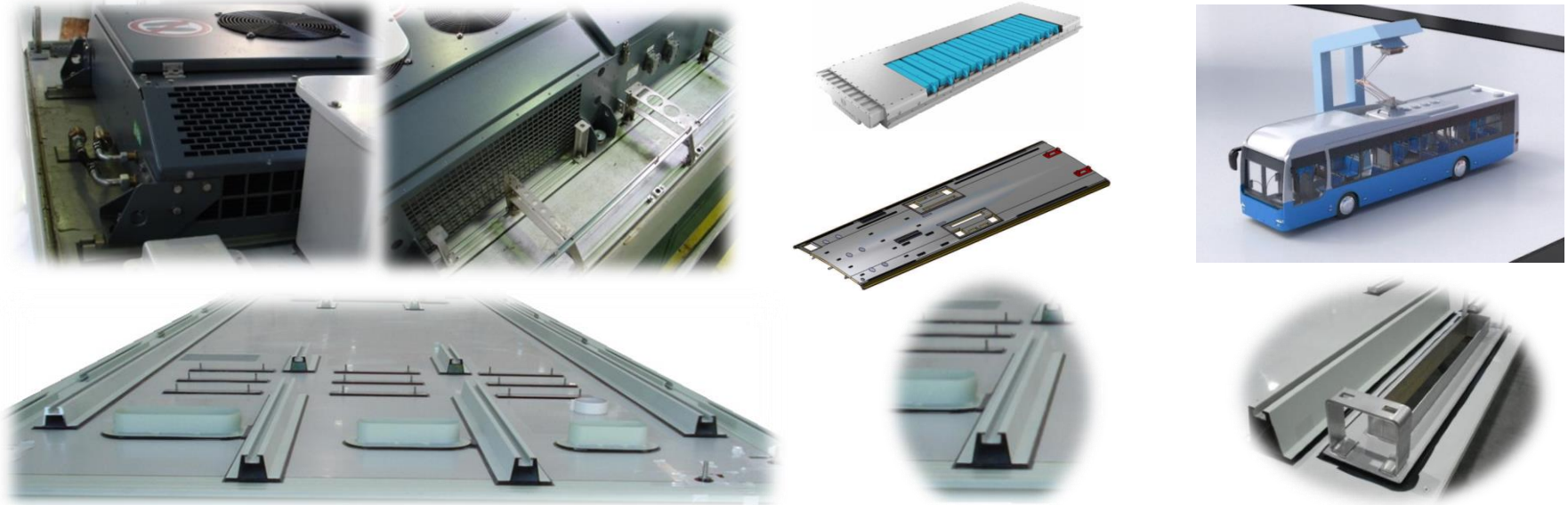


Performance of Roofs under Heavy Load (CNG, Batteries and ACU)				
12.1 m busses <i>(engine weight is not included)</i>	LOW ENTRY BUS		LOW FLOOR BUS	
High Loads Equip.				
Batteries/ Tank				
ACU				
Equipments				
Passengers				
Standing				
Sitting				
Gross mass of vehicle loads				
Tare mass & Weight reduction	6'471 kg	6'674 kg	12'975 kg	12'976 kg
	- 203 kg		- 562 kg	

INTEGRAL SANDWICH PANEL TECHNOLOGY

EXPERIENCE IN DESIGN AND PROCESS

Series production tram sandwich roof → *Development: battery & fuel cell buses*

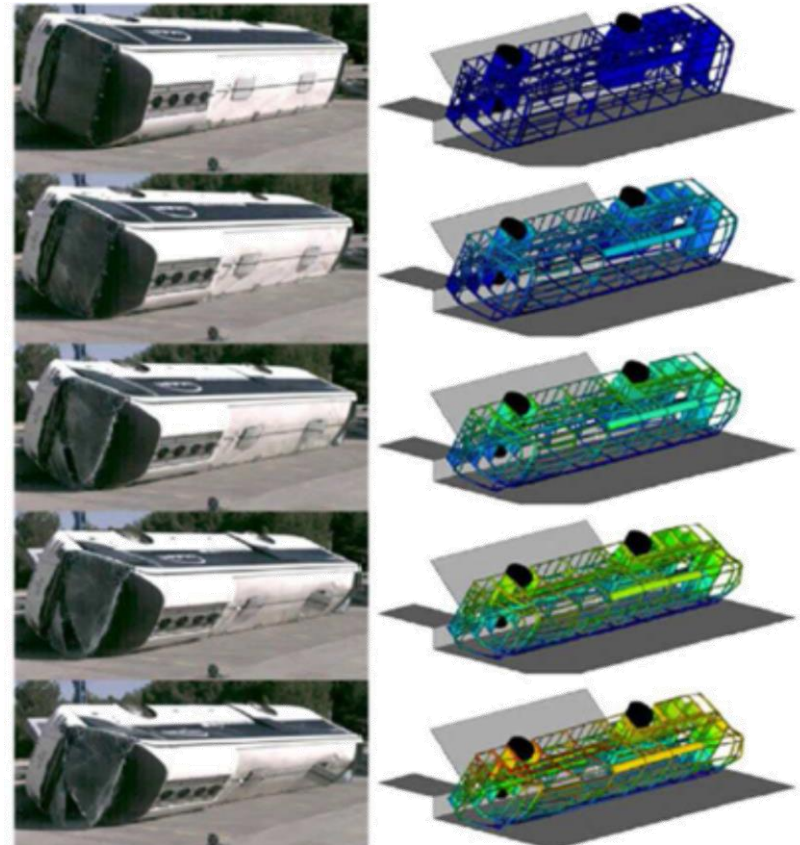
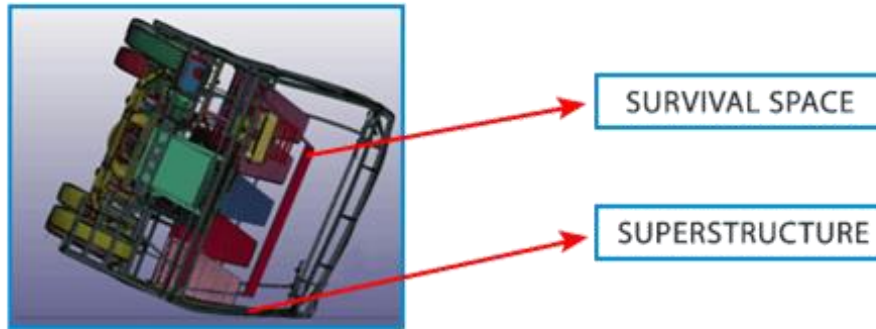


- Although lighter, the **stiffness is increased** due to better stress distribution using adhesive joints and sandwich structures
- Increased stiffness brings **better roll-over performance** and **safer vehicles**

ROLL-OVER TESTS AND SIMULATIONS

CRASHWORTHINESS OF BUS SUPERSTRUCTURE

- To show proof of structural crashworthiness (ECE R66), manufacturers can run either full-size tests or FEM simulations of whole large passenger vehicles

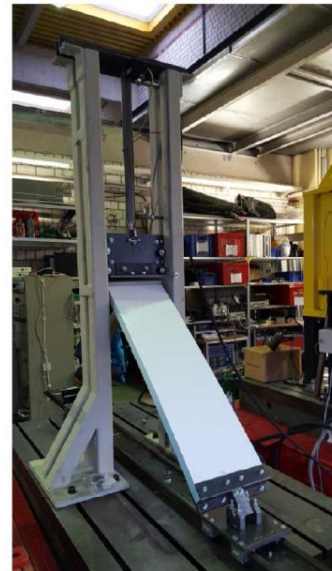
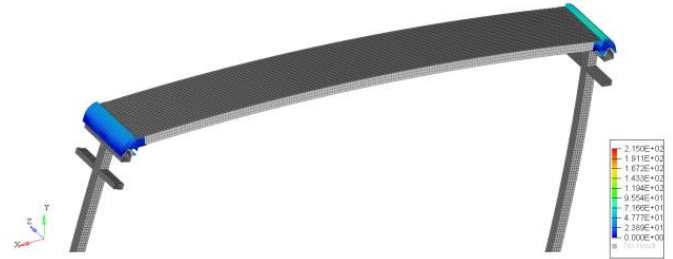
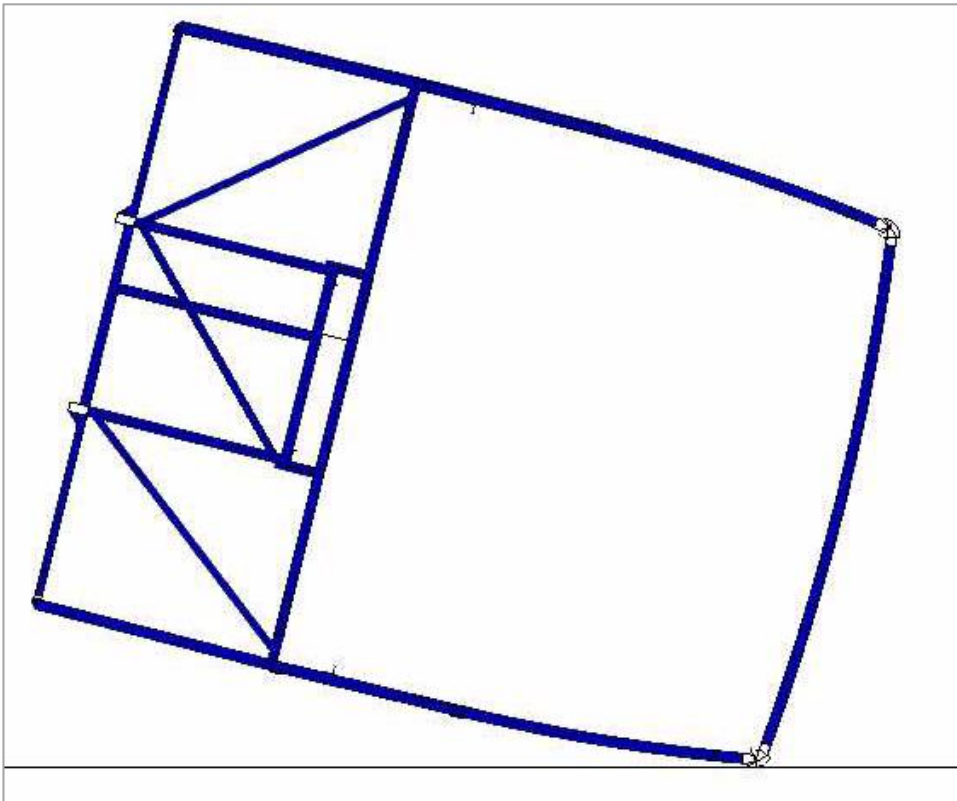


Sources: Bonluck Bus, MAN Truck & Bus AG, Advanced Structures India

ROLL-OVER TESTS AND SIMULATIONS

CRASHWORTHINESS OF BUS SUPERSTRUCTURE

- Validation: FEM simulations including non-linear material behavior for each component and adhesive
- Technical support for segment testing



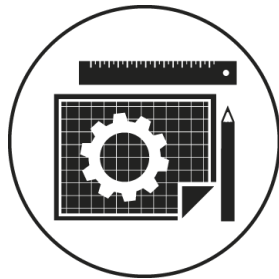
CONCLUSIONS

- Innovative **structural adhesives** and **customizable sandwich components** enables to maximize reduction of vehicle weight and structural performance
- Sika and 3A Composites developed **modular lightweight solutions** and support technological implementation at manufacturers
- Proven feasibility in production with **higher efficiency** and **fewer costs**
- Compliancy to **standards** and specific needs in **commercial transportation**



LIGHTWEIGHT

Allowing mass reduction and multi-material mix



DESIGN

Enabling modern design with new materials



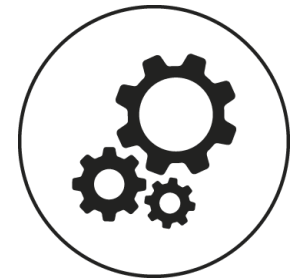
SAFETY

Meeting highest performance standards



DURABILITY

Elevating adhesive performance to the next level



PROCESS

Providing solutions for ultimate process efficiency



THANK YOU FOR YOUR ATTENTION

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BUILDING TRUST

