



**Axel Reinsch**

CEO / Owner



**Fabian Nowacki**

Leiter Engineering

**calcbond**

the ecosystem for adhesive joint design



# Über uns



## Axel Reinsch

**CEO/Inhaber**, est. 2010  
(GmbH seit 2013)

**Career:**

Airbus, Design-Team  
Motor- und Segelrennsport  
(Alinghi, BMW-Sauber,  
Carbo-Link)

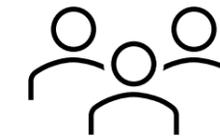


## Fabian Nowacki

Leiter Engineering  
M.Sc. Flugzeugbau

**Career:**

7 Jahre bei *ar engineers*  
*calcbond* Entwicklungsleiter



Das Team besteht aus hochqualifizierten Ingenieuren mit unterschiedlichen Hintergründen und internationaler Erfahrung.

**Skills:**

- Composites
- Strukturen
- Simulation
- Automation
- Klebtechnik
- Materialmodellierung
- Softwareentwicklung

## Unsere Kompetenzfelder

**Composites**

**FEA**

**Software**

**Produktion**

**F&E**

## Hauptindustrien

### Maritime

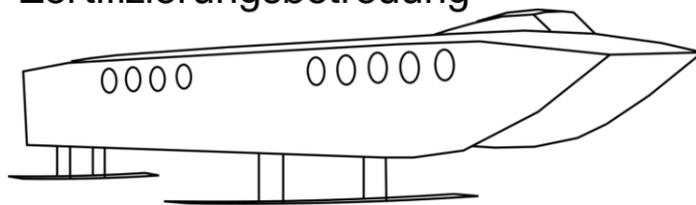
Leichtbau & Composite Engineering

Gewichts- & Kostenoptimierung

Klebtechnische Beratung

Fertigungsbetreuung

Zertifizierungsbetreuung



### Transportation / Automotive

Leichtbau & Composite Engineering

High-End Simulation (Crash & Impact)

Laminat- & Topologieoptimierung

Formbau & Fertigungsunterlagen

Klebtechnische Beratung



### Wind Energy

Leichtbau & Composite Engineering

Fertigungsüberwachung

Rotorblattinspektion



## F&E-Projekte

### Innovative Füge-technologie

- 2020 – 2023
- Multiskalensimulation
- Schiffbauliche strukturelle Anwendung
- Beschleunigung der Zertifizierung

### Klebtechnik / Composites

- 2020 – 2023
- Verklebte GFK-Strukturen
- Lebensdauerberechnung
- Ermüdungsversuche & Simulation



Emissionsfreie Elektromobilität für maritime urbane Transporte

### Adaptive Foil-technologie

- 2021 – 2024
- Hydrofoil design
- Fluid-Struktur-Interaktion
- Structural Health Monitoring – SHM

Supported by:

Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

Supported by:

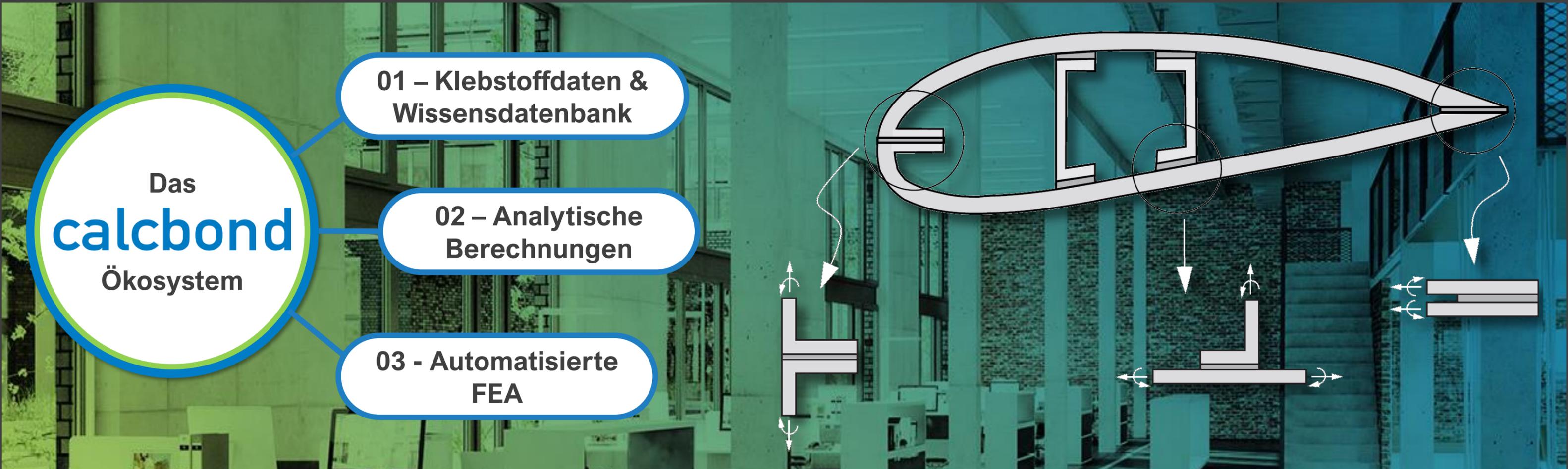
Zentrales Innovationsprogramm Mittelstand

on the basis of a decision by the German Bundestag

SPONSORED BY THE

Federal Ministry of Education and Research

Regionale unternehmerische Bündnisse für Innovation



## Workflow

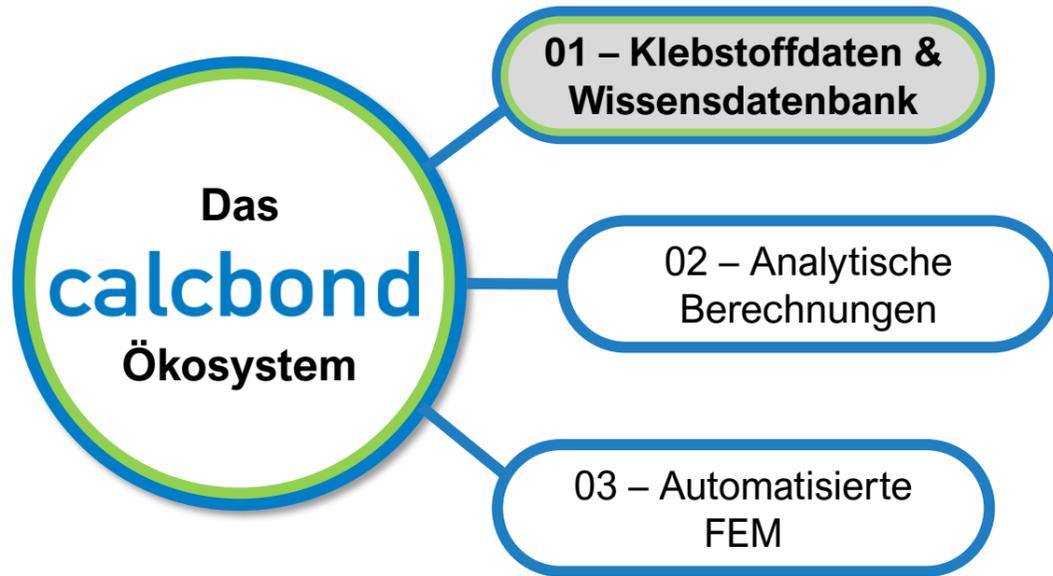


UNSERE  
MISSION

Anwendung der Klebtechnik vereinfachen  
– verlässliche Lösungen zur Auslegung  
von Klebungen bieten

**calcbond**  
the ecosystem for adhesive joint design

# calcbond – Materialdatenbank für Klebstoffe



## Ihr Vorteil

Einfacher Zugang zu wichtigen Klebstoffdaten

Prüfen & Vergleichen von Klebstoffen

**\*Extra:**  
Klebstoff direkt für Berechnung auswählen

### Adhesive Material Cards

Name	Type	Application temp.*	Open time	Tensile Modulus at 23°C [MPa]	Tensile Strength at 23°C [MPa]	Selected (max. 5)
SikaPower®-880	Two-Component Epoxy	15 - 30°C	45 minutes	2220	22	<input type="checkbox"/>
SikaPower®-492 G <small>*Max. temperature range for processing the adhesive during bonding.</small>	1-Component Epoxy	50 - 60°C	N/A	2190	29	<input checked="" type="checkbox"/>

#### SikaPower®-1277

Versatile and fast curing adhesive for high-performance bonds between multiple materials  
Manufacturer: Sika

[Submit to Joint Calculation](#)

#### Tensile Test (ISO 527-2)

Please note: The shown tensile test curve represents typical average mechanical behaviour of the cured bulk adhesive at 23 °C. Be aware that each batch underlies certain statistical variations.

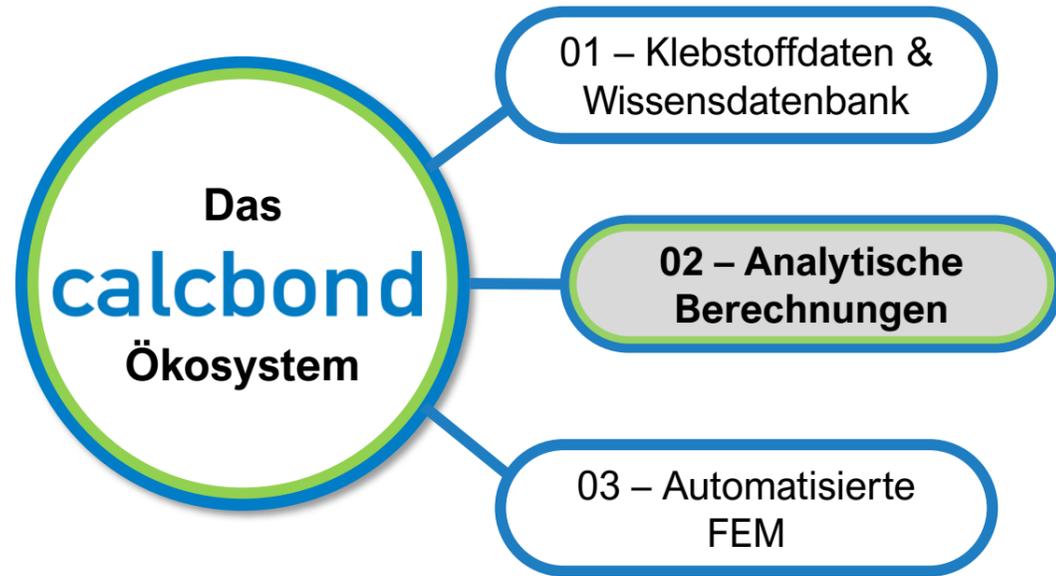
Name	Value	Units
Tensile modulus <sup>12</sup>	1940	MPa
Tensile strength <sup>1</sup>	28	MPa
Poisson's ratio	0.39	
Shear modulus (calculated)	698	MPa
Shear strength (calculated)	16.2	MPa

Name	Value	Units
Tensile Strength	28	MPa
Tensile Modulus	1940	MPa
Elongation at break	7.4	%

Areas of Application: SikaPower®-1277 is suitable for structural bonding applications in transportation and general industry. It can also be used for repair applications in combination with spot welding, riveting or stitching. The product is applied as contact adhesive (2-side application), in case of single bond.

# calcbond – Analytische Berechnungen



## Ihr Vorteil

Vereinfachte Standard-Klebfälle  
 Ergebnisse in Sekundenschnelle  
 Parameterstudien mit  
 minimalem Aufwand

Choose your loadcase scenario:

**Manual (most general SLJ)** ⓘ

Any rectangular bonded joint, manual calculation of section loads. One face fixed.

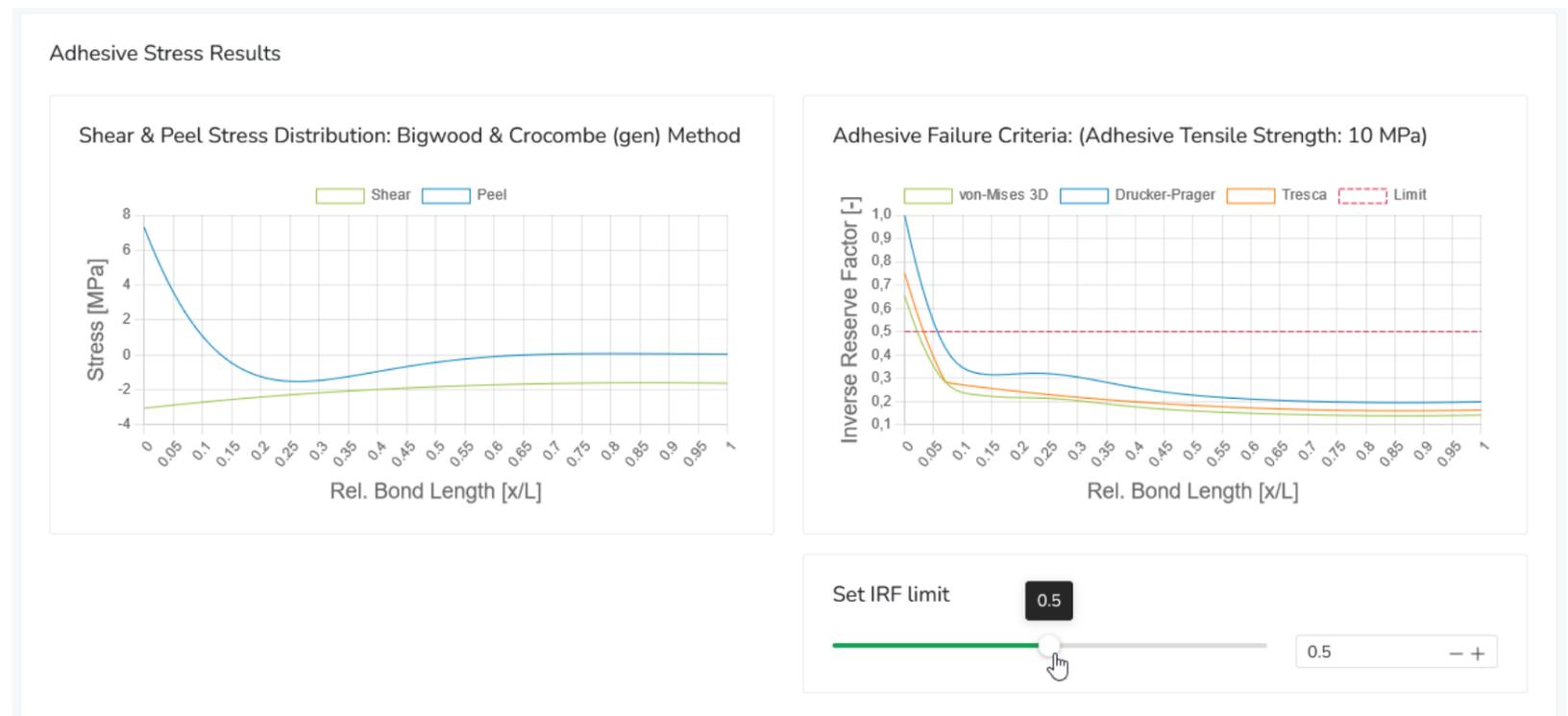
**Manual Single Lap (rectangle)** ⓘ

Any rectangular bonded joint, manual calculation of section loads.

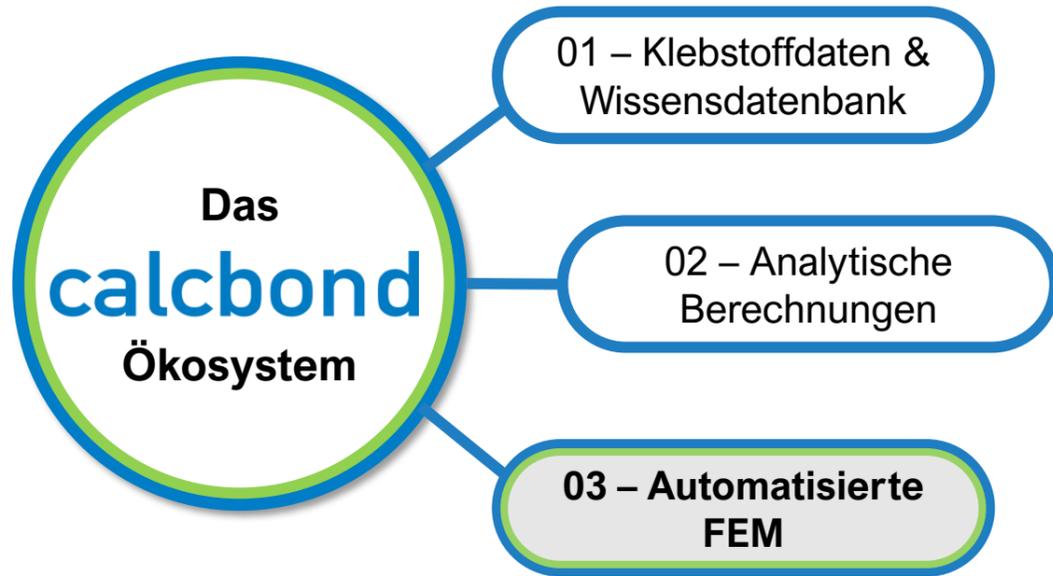
**Double-L-Bracket** ⓘ

A rectangular base plate with a lever on whose end you can introduce a load. All relevant dimensions are free to choose for the calculation.

**Boost your decision making for your standard bonding applications**



# calcbond – Automatisierte FEM-Berechnungen



## Ihr Vorteil

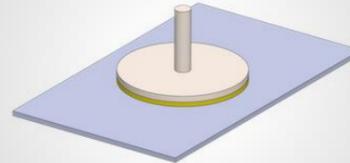
- Berechnung konkreter Use Cases
- Festigkeits- & Verformungsanalyse über 3D-FEM
- Automatisierte Dokumentation

### AutoFEA

Choose your adhesive bonding use case for finite element analysis:

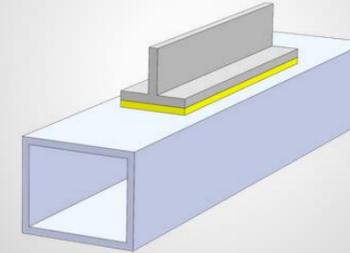
#### Bonded Stud

Calculate a bonded stud on a rectangular plate. Change the studs and the plates geometry, choose the plates fixation and define the loads the stud is subjected to.



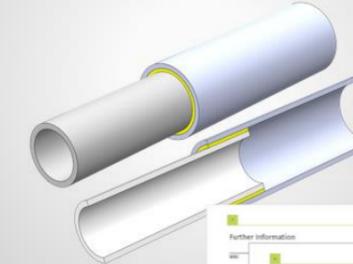
#### Beam on Beam

Calculate two bonded beams. One is a rectangular profile, the other a T-Profile. Change the profiles dimensions freely and position them how you like to match your usecase.



#### Bonded Tubes

Calculate two overlapping, bonded tubes. Decide, which one of them to fixate and apply loads to the other. Choose dimensions to depict your usecase.



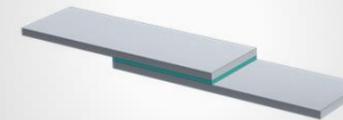
#### Glazing

Calculate bonded glass panes in rail structures. Define and calculate rectangular or trapezoidal window panes with sharp or rounded corners. The structure can be planar or curved about the vertical and/or horizontal axis.



#### Single-Lap-Joint

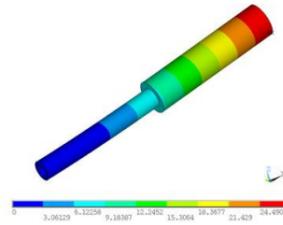
Calculate single lap joints. Define and calculate single lap joints.



Please choose one of the above usecases. If you cannot find anything matching your requirements, we would love to learn about your needs to implement more use cases. T: calcbond@ar-engineers.de

#### FEA - Visualization

Total deformation [mm]  
Bonded Assembly



Von Mises Stress [MPa]  
Adhesive Layer



Von Mises Strain [mm/mm]  
Adhesive Layer



## Transportation Use Case – Scheibenklebung



**Geometrie:**  
Rechteckig, abgerundete Ecken

**Belastung:**  
3kPa Druck + Eigengewicht

**Material:**  
Aluminium / Glas / Sikaflex-268

- Fragen:**
- Ist die Klebverbindung ausreichend dimensioniert?
  - Welche Reserven hat das Bauteil gegen Versagen?
  - Kann ich den Klebstoff verwenden?

# calcbond

the ecosystem for adhesive joint design

### Glazing

Calculate bonded glass panes in rail structures.

Define and calculate rectangular or trapezoidal window panes with sharp or rounded corners. The structure can be planar or curved about the vertical and/or horizontal axis.



## Wie löse ich meinen Use Case?

# calcbond

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# Materialkarten prüfen – richtiges Produkt finden

**calcbond** 1.9.6

- Analytical Toolbox
- AutoFEA
- Material Cards**
- Saved Calculations
- FAQ
- Wiki
- User Manual
- User Portal
- Feedback
- Changelog
- Imprint
- Terms & Conditions
- Privacy Notice
- Service Description
- Customer Information

### Adhesive Material Cards

Sika   Kisling   Huntsman

Name	Type	Application temp.*	Open time
SikaPower®-880	Two-Component Epoxy	15 - 30°C	45 minutes
SikaPower®-492 G	1-Component Epoxy	50 - 60°C	N/A
SikaPower®-498/3	1-Component Epoxy	50 - 60°C	N/A

SikaForce®-840 L07   SikaFast®-555   **Sikaflex®-268**

## Sikaflex®-268

Assembly & glazing adhesive and sealant for rail applications with acceleration option  
 Manufacturer: Sika

[Submit to Joint Calculation](#)

Name

SikaForce®-840 L07   SikaFast®-555   SikaForce®-840 L07

### SikaForce®-840 L07

Structural elastic 2-component polyurethane adhesive  
 Manufacturer: Sika

[Submit to Joint Calculation](#)

#### Basic Properties

SikaForce®-840 L07 is a flexible, structural two-component polyurethane adhesive, which cures at room temperature. It is designed for bonding composite or coated metal components with stable properties over large temperature span. The adhesive is characterized by fast curing and strength build-up. While uncured, it has very good non-sag and compressibility behavior.

If not stated otherwise, the values shown here were obtained at 23°C and 50% rel. humidity.

Name	Value	Units
Tensile modulus <sup>12</sup>	370	MPa
Tensile strength <sup>1</sup>	19	MPa
Poisson's ratio	0.41	
Shear modulus (calculated)	131	MPa
Shear strength (calculated)	11	MPa
Coefficient of thermal expansion	139	ppm/K
Glass transition temperature (cured at 23°C)	-46	°C

#### Tensile Test (ISO 527-2)

Please note: The shown tensile test curve represents typical average mechanical behaviour of the cured bulk adhesive at 23 °C. Be aware that each batch underlies certain statistical variations.

#### Mechanical properties table

Name	Value	Units
Tensile Strength	19	MPa
Tensile Modulus	370	MPa
Elongation at break	90	%

Areas of Application: SikaForce®-840 L07 is suitable for structural elastic bonding of composites (e.g., CFRP, GFRP) or coated metals in transportation and general industry. This product is suitable for experienced professional users only. Tests with actual substrates and conditions have to be performed to ensure adhesion and material compatibility. Cure Mechanism: SikaForce®-840 L07 cures by chemical reaction of the two components at room temperature. Higher temperatures accelerate the cure rate and decrease the open time. High humidity reduces the open time as well. In big bead applications, the generated exothermic heat of

-40 °C  
-20 °C  
0 °C  
**23 °C**  
40 °C  
60 °C  
80 °C  
100 °C

[View data for selected products](#)

# AutoFEA öffnen – Anwendungsfall auswählen

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Analytical Toolbox

**AutoFEA**

Material Cards

Saved Calculations

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FAQ

Wiki

User Manual

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User Portal

Feedback

Changelog

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Imprint

Terms & Conditions

Privacy Notice

Service Description

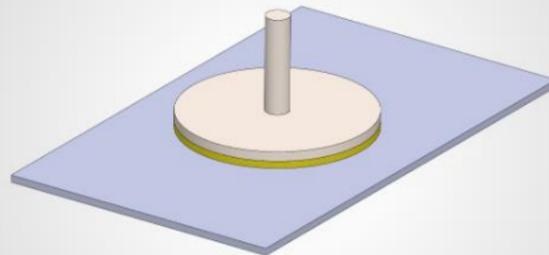
Customer Information

## AutoFEA

Choose your adhesive bonding use case for finite element analysis:

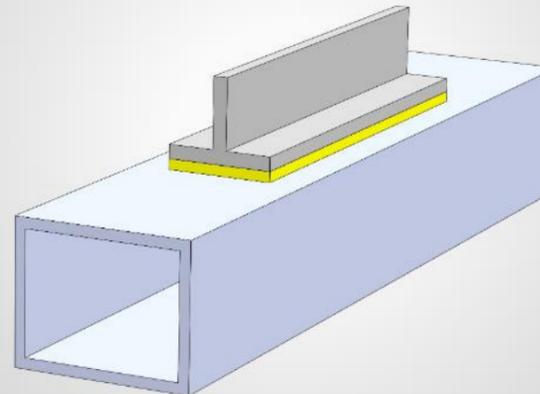
### Bonded Stud

Calculate a bonded stud on a rectangular plate. Change the studs and the plates geometry, choose the plates fixation and define the loads the stud is subjected to.



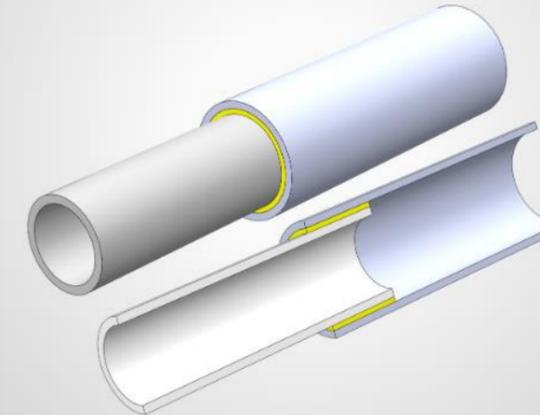
### Beam on Beam

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### Bonded Tubes

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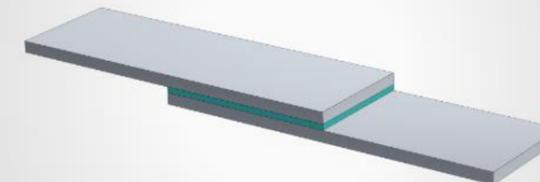
### Glazing

Calculate bonded glass panes in rail structures. Define and calculate rectangular or trapezoidal window panes with sharp or rounded corners. The structure can be planar or curved about the vertical and/or horizontal axis.



### Single-Lap-Joint

Calculate single lap joints. Define and calculate single lap joints



# Design-Parameter eingeben...

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- Analytical Toolbox
- AutoFEA
- Material Cards
- Saved Calculations

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- FAQ
- Wiki
- User Manual

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- User Portal
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- Changelog

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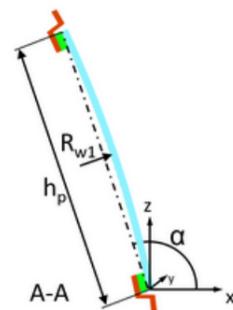
## Glazing - Rail Geometry Parameters

### Window Pane

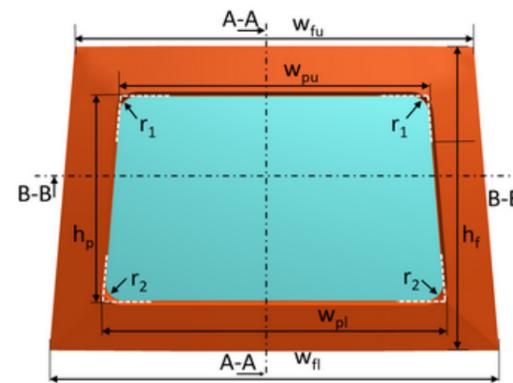
- Sharp corners (no edge radii)
- Radius  $r_1$  [mm]
- Radius  $r_2$  [mm]
- Projected Pane Width  $w_{pu}$  [mm]
- Projected Pane Width  $w_{pl}$  [mm]
- Projected Pane Height  $h_p$  [mm]

### Section Cut A-A

- Curvature in A-A
- Curvature radius  $R_{w1}$  [mm]
- Angle  $\alpha$  [°]



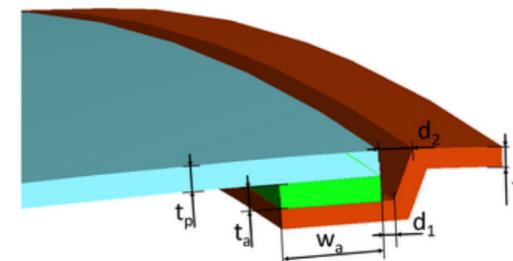
### Front View



### Frame

- Projected Frame Width  $w_{fu}$  [mm]
- Projected Frame Width  $w_{fl}$  [mm]
- Projected Frame Height  $h_f$  [mm]
- Flange clearance  $d_1$  [mm]
- Gap Width  $d_2$  [mm]

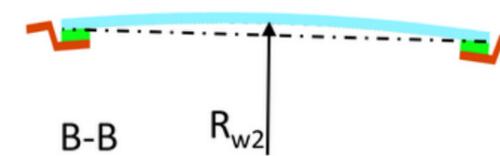
### Bonding zone details



- Pane Thickness  $t_p$  [mm]
- Frame thickness  $t_f$  [mm]
- Adhesive thickness  $t_a$  [mm]
- Adhesive width  $w_a$  [mm]

### Section Cut B-B

- Curvature in B-B
- Curvature radius  $R_{w2}$  [mm]



## ...und Materialien auswählen



### Pane Material

Adherend Selector **Toughened Safety C** ▾

Young's Modulus [MPa]:

Poisson Ratio [-]:

Density [g/cm<sup>3</sup>]:

Yield Strength [MPa]:

Thermal Expansion Coefficient [ppm/K]:

### Adhesive Material

Adhesive Selection **Sikaflex®-268** ▾

Young's Modulus [MPa]:

Poisson Ratio [-]:

Tensile Strength [MPa]:

Compressive Strength [MPa]:

Thermal Expansion Coefficient [ppm/K]:

### Frame Material

Adherend Selector **Aluminium 3.3211** ( ▾

Young's Modulus [MPa]:

Poisson Ratio [-]:

Density [g/cm<sup>3</sup>]:

Yield Strength [MPa]:

Thermal Expansion Coefficient [ppm/K]:

# Lasten & Randbedingungen eingeben



## Support

The displacement of the faces of the frame are fixed.  
All rotations are kept free.



## Forces

Pressure is evenly distributed on the entire structure (window pane and frame). To simulate an increased cabin pressure use a negative value for "P".

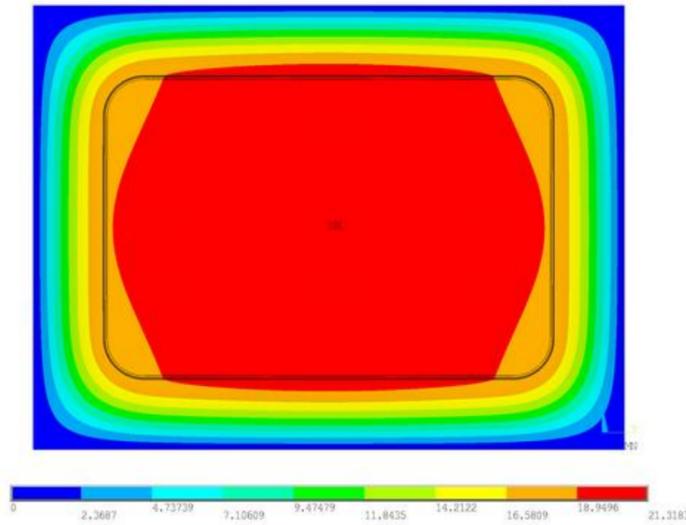
Pressure P [kPa]	<input type="text" value="3"/>
Acceleration x-direction [m/s <sup>2</sup> ]	<input type="text" value="0"/>
Acceleration y-direction [m/s <sup>2</sup> ]	<input type="text" value="0"/>
Acceleration z-direction [m/s <sup>2</sup> ]	<input type="text" value="9.81"/>



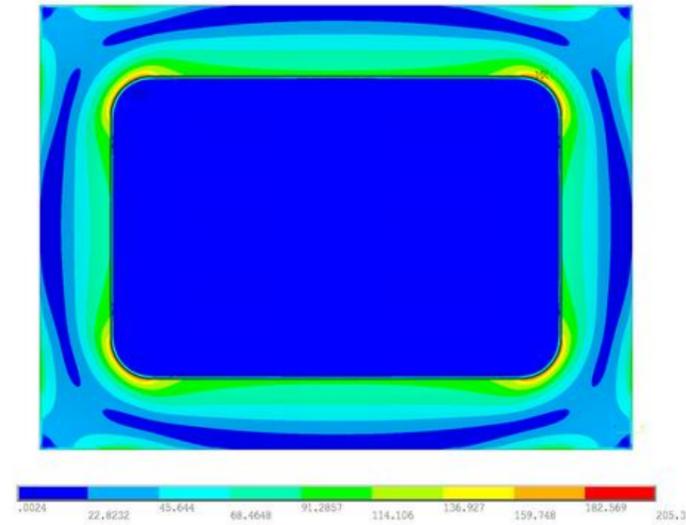
# Berechnung abschicken – Ergebnisse erhalten & auswerten

## FEA - Visualization

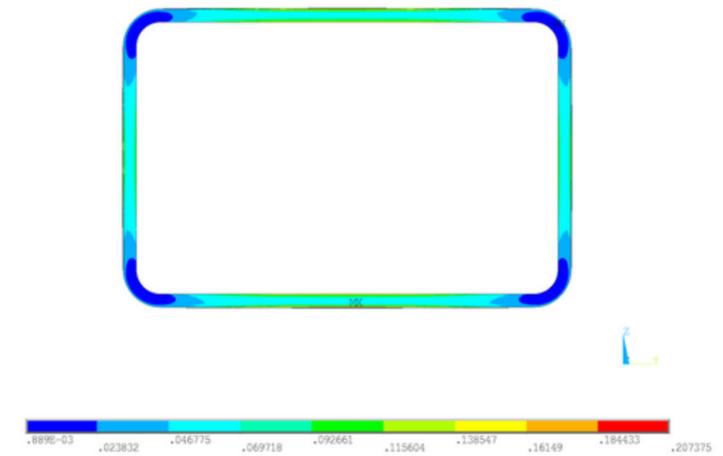
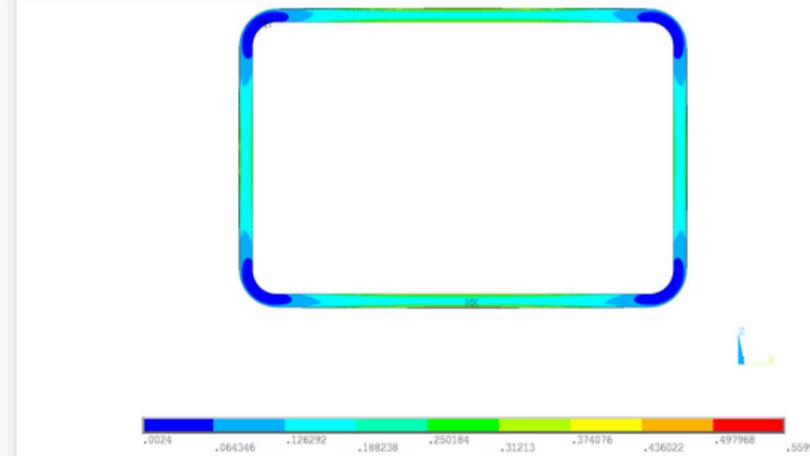
Total deformation [mm]  
Bonded Assembly



von-Mises Stresses [MPa]  
Bonded Assembly



Equivalent Elastic Strain [mm/mm]  
Adhesive Front View

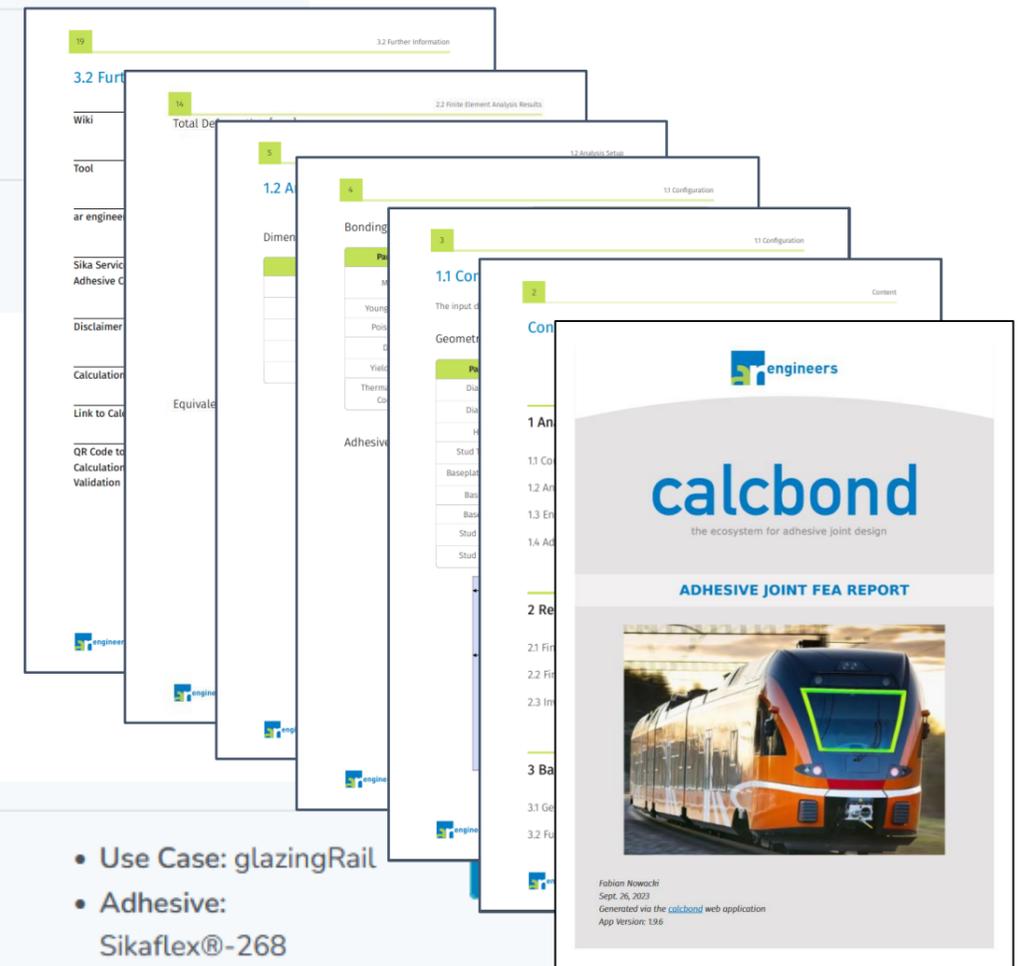


# Berechnung speichern & verwalten

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- Analytical Toolbox
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Analytical Calculations		FEA Calculations				
Title	Project	Date	PDF Report	Properties	Actions / Status ?	
Beispielrechnung	an VTR gesendet	2023-08-04 11:15:02	<a href="#">Download PDF</a>	<ul style="list-style-type: none"> <li>Use Case: bondedStud</li> <li>Adhesive: SikaPower®-880</li> </ul>	<a href="#">Transfer</a> <a href="#">Delete</a>	
Stud-Bsp-A&R-kleine Base	Schulung	2023-09-07 08:07:40	<a href="#">Download PDF</a>	<ul style="list-style-type: none"> <li>Use Case: bondedStud</li> <li>Adhesive: SikaPower®-880</li> </ul>		
Stud-Bsp-A&R-kleine Base	Schulung	2023-09-07 08:16:23	<a href="#">Download PDF</a>	<ul style="list-style-type: none"> <li>Use Case: bondedStud</li> <li>Adhesive: SikaPower®-880</li> </ul>		

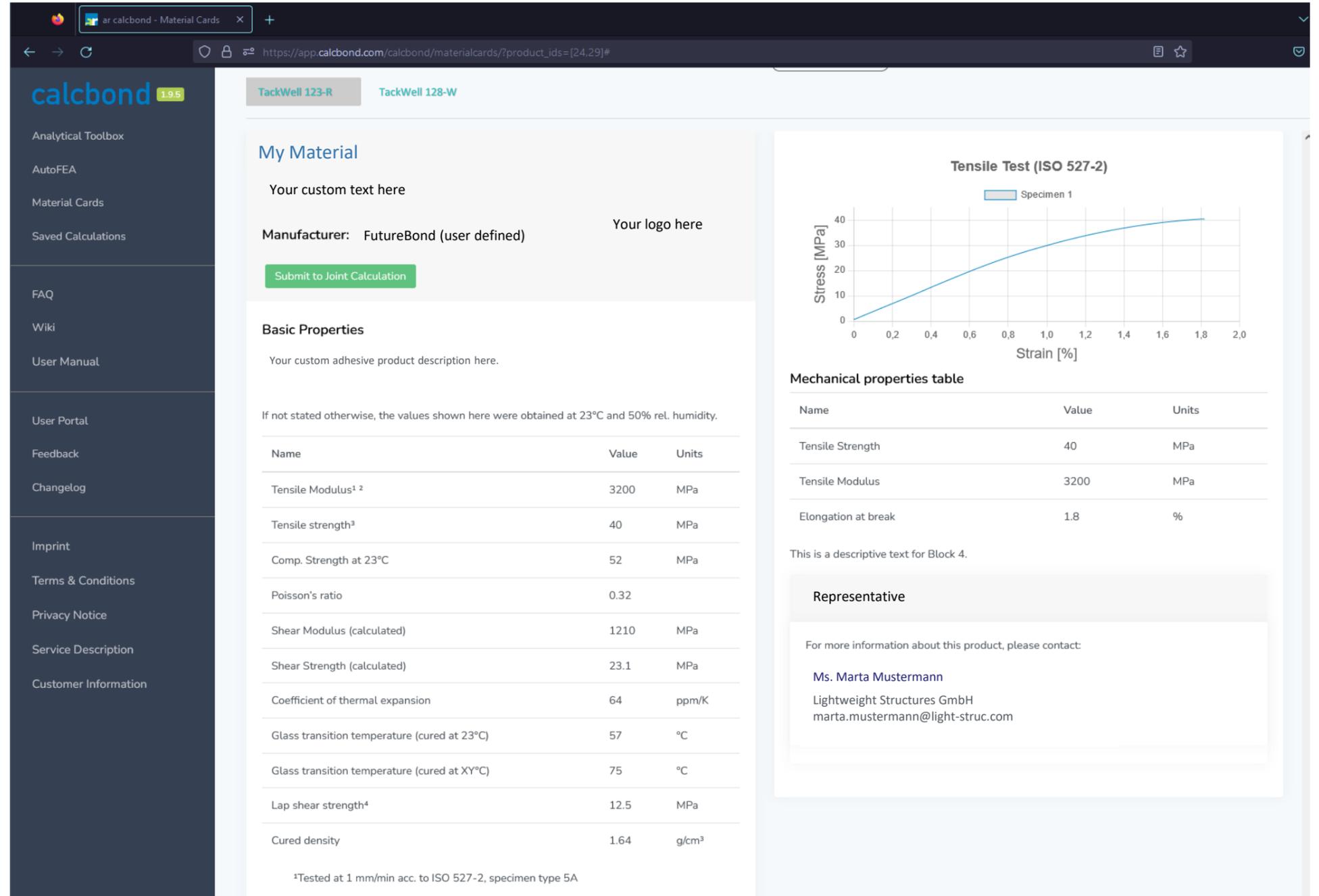


Sika Technologietage Transportation	Fensterscheibe_Zug_1	2023-09-26 11:34:43	<a href="#">Download PDF</a>	<ul style="list-style-type: none"> <li>Use Case: glazingRail</li> <li>Adhesive: Sikaflex®-268</li> </ul>
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## Ausblick – was kommt bald?

### Nutzerspezifische Materialkarten

- ✓ Erstellen und speichern Sie Ihre eigenen Testdaten
- ✓ Verwalten Sie Ihre Materialien in Ihrem persönlichen Konto
- ✓ Teilen Sie Ihre Materialkarten innerhalb Ihrer Organisation oder mit externen Partnern → stets bei voller Kontrolle



The screenshot shows the CalcBond web application interface. The left sidebar contains navigation links: Analytical Toolbox, AutoFEA, Material Cards, Saved Calculations, FAQ, Wiki, User Manual, User Portal, Feedback, Changelog, Imprint, Terms & Conditions, Privacy Notice, Service Description, and Customer Information. The main content area displays a material card for 'TackWell 123-R' and 'TackWell 128-W'. The card includes a 'My Material' section with a 'Submit to Joint Calculation' button, a 'Basic Properties' table, a 'Tensile Test (ISO 527-2)' graph, and a 'Mechanical properties table'.

**Basic Properties Table:**

Name	Value	Units
Tensile Modulus <sup>1 2</sup>	3200	MPa
Tensile strength <sup>3</sup>	40	MPa
Comp. Strength at 23°C	52	MPa
Poisson's ratio	0.32	
Shear Modulus (calculated)	1210	MPa
Shear Strength (calculated)	23.1	MPa
Coefficient of thermal expansion	64	ppm/K
Glass transition temperature (cured at 23°C)	57	°C
Glass transition temperature (cured at XY°C)	75	°C
Lap shear strength <sup>4</sup>	12.5	MPa
Cured density	1.64	g/cm <sup>3</sup>

<sup>4</sup>Tested at 1 mm/min acc. to ISO 527-2, specimen type 5A

**Tensile Test (ISO 527-2) Graph:**

The graph shows Stress [MPa] on the y-axis (0 to 40) and Strain [%] on the x-axis (0 to 2.0). A single data series for 'Specimen 1' shows a non-linear stress-strain curve starting at (0,0) and ending at approximately (1.8, 40).

**Mechanical properties table:**

Name	Value	Units
Tensile Strength	40	MPa
Tensile Modulus	3200	MPa
Elongation at break	1.8	%

**Representative:**

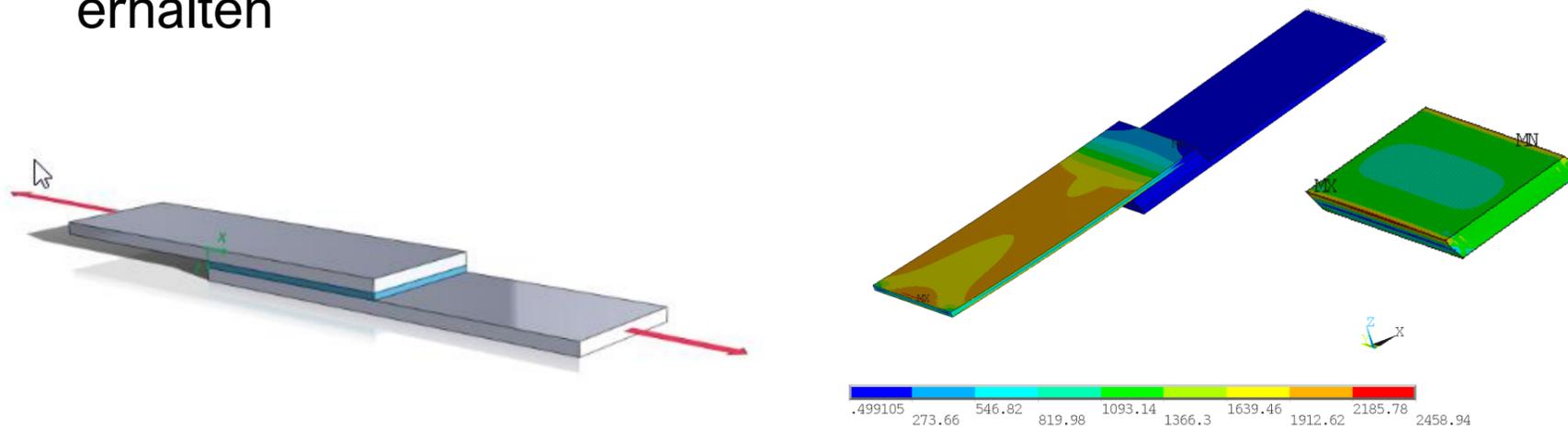
For more information about this product, please contact:

**Ms. Marta Mustermann**  
 Lightweight Structures GmbH  
 marta.mustermann@light-struc.com

## Ausblick – was kommt bald?

### 3D Design Space Explorer

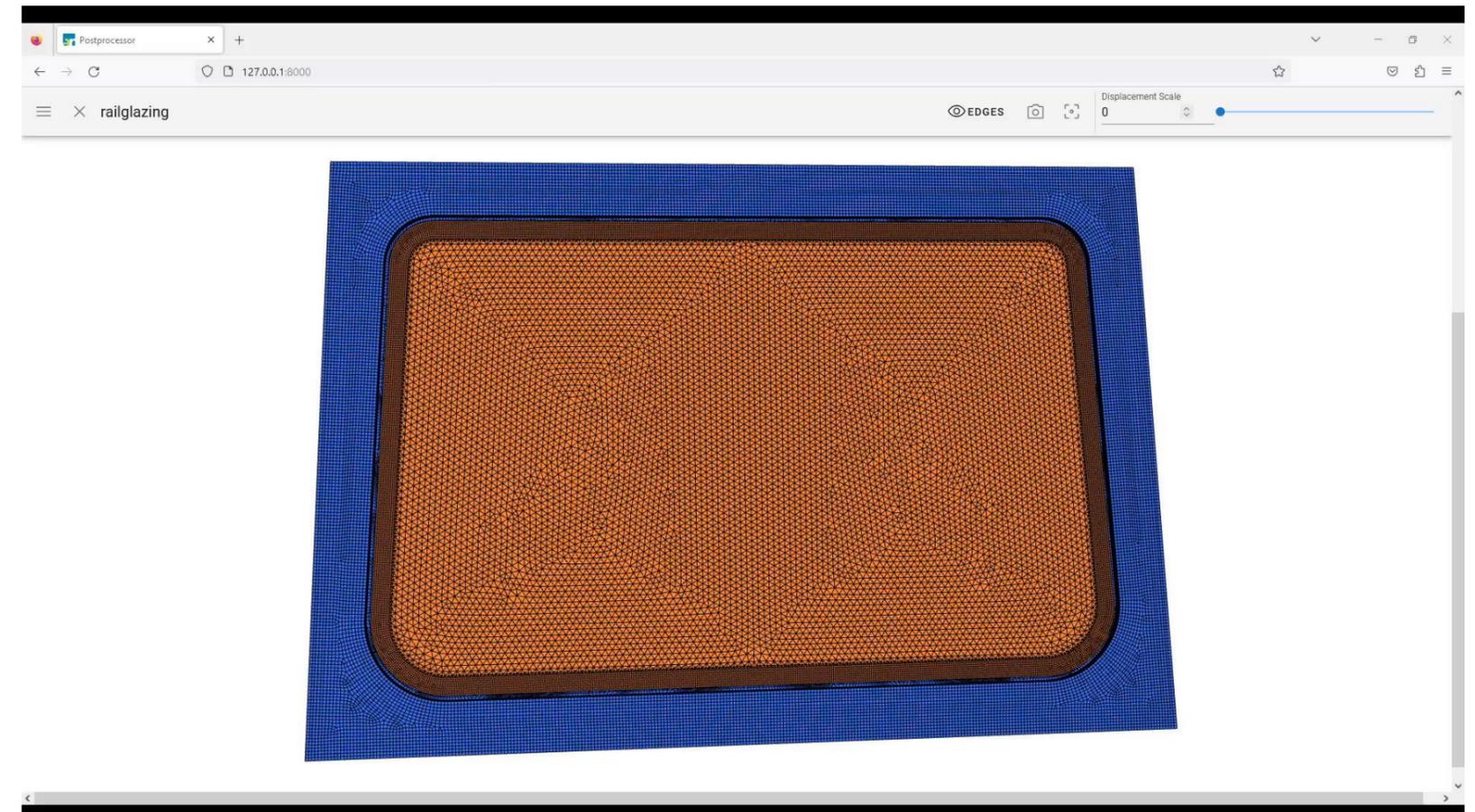
- ✓ Über die klassische FEM hinaus → Untersuchen Sie Ihre Klebverbindung mit auf maschinellem Lernen basierenden Simulationstechniken
- ✓ Erhalten Sie Berechnungsergebnisse mit hoher Reaktionsfähigkeit während des Entwurfsprozesses
- ✓ Untersuchen Sie eine große Anzahl von Klebungsvarianten - schneller als je zuvor
- ✓ Steigern Sie die Effizienz, um die optimale Klebverbindung zu erhalten



## Ausblick – was kommt bald?

### Interaktives 3D-Ergebnisinterface

- ✓ Betrachten Sie Ihr spezielles Berechnungsmodell in 3D innerhalb von calcbond
- ✓ Bewegen, drehen und zoomen Sie in das Modell, um interessante Bereiche zu überprüfen
- ✓ Rendering der Ergebnisse nach Ihren Bedürfnissen (Verformung, Dehnungen, Spannungen, benutzerdefinierte Ergebnisse)
- ✓ Einrichten und Speichern von benutzerdefinierten Ergebnisansichten für Ihren calcbond-Bericht



## calcbond – Einfaches, flexibles Abo-Modell

Feature	Free	Pro
Subscription Fee per Month	0€	250€ excl. VAT
Analytical Stress Calculation for Single-Lap Joints	yes	yes
Tabular and Graphical Adhesive Stress Results from Analytical Calculations	yes	yes
Material Cards & Project Database	limited*	Full
Number of Analytical Calculations Included	unlimited	unlimited
Design Exploration Runs included	none	unlimited
PDF Reports for Analytical Calculations	none	unlimited
Automated FEA for Practical Use Cases	no	yes
Included FEA Requests per Month	0	5
Calculation Reports Included	no	yes
User Defined Material Cards	no	yes

Melden Sie sich zum Free Trial an!

**30-day Free Trial**



\*keine Bezahlinformationen erforderlich.

**Promo Code: SikaTransportation23**

### Herbst- angebot

Buchen Sie 1 Jahr Pro-Lizenz und erhalten Sie 10 extra AutoFEA tokens!

~~3.500€~~ → **3.000€**

calcbond-Schulung:  
6h Session zu 850 € pro Person bei ar engineers in Hamburg



# calcbond

the ecosystem for adhesive joint design

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