

# online-application calcbond

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## Service description

calcbond is a powerful tool that enables the user to perform complex analytical and numerical calculations for bonded joints in a short period of time.

Under the Pro Plan subscription calcbond provides four main features:

- Adhesive Joint App, which is an analytical calculation toolbox for single overlapped bonded joints
- FEA Toolbox, which is a numerical calculation toolbox for predefined 3D bonded joints
- Material Cards, which are data sets containing characteristic values for selected adhesives from different manufacturers
- “My Calculations” function, which is an option to save certain input values and calculation results from the Adhesive Joint App and the FEA Toolbox

For free users and free-trial users only a limited range of features is available, and a commercial use of calculation results is not permitted (for more details see I.). These free subscriptions allow users to test calcbond before signing up for the paid Pro Plan.

This service description for calcbond is structured as follows:

Under I. the different calcbond subscriptions (Free, Free-Trial and Pro) are described in detail, especially with regard to available features, contract terms and pricing. The calcbond service, its functionality and its technical availability are described in general terms under II. Subsequently, under III. to VI., the four main features of calcbond are explained in-depth.

### Content

I. General Information about the different subscription plans .....	2
II. General description of the calcbond service, its functioning and its technical availability .....	4
III. Specific functional description of the "Adhesive Joint App" (analytical toolbox) .....	5
IV. Specific functional description of the "FEA Toolbox" (numerical toolbox) .....	7
V. Specific functional description of the "Material Cards" .....	9
VI. Specific functional description of "My Calculations" .....	11

## I. General Information about the different subscription plans

calcbond is available in three subscription versions (Free, Free-Trial and Pro). The features available for a user depend on his subscription.

Subscription overview and feature availability:

Feature	Free	Trial	Pro
Adhesive Joint App	✓	✓	✓
Analytical Stress Calculation for Single-Lap Joints	✓	✓	✓
Tabular and graphical stress results for adhesive layer from analytical calculations	✓	✓	✓
Number of analytical calculations included	Unlimited	Unlimited	Unlimited
Analytical Design Exploration	-	Unlimited	Unlimited
Calculation reports for Adhesive Joint App (Comprehensive results in PDF-Report)	-	✓	✓
<b>FEA Toolbox</b>	-	✓	✓
Automated FEA for available joint designs	-	✓	✓
Included FEA requests per month	-	5	5
Additional FEA requests	-	-	against surcharge
Calculation reports for FEA Toolbox (Comprehensive results in PDF-Report)	-	✓	✓
<b>Material Cards</b>	-	✓	✓
Material Data & Project Database	-	✓	✓
<b>My Calculations</b>	-	✓	✓
Save performed calculations in calcbond	-	✓	✓
Create calculation reports from saved calculations	-	✓	✓
Permitted use of calculation results	internal testing purposes only		internal and commercial use
Contract Term	until termination	30 days	until termination
Price (excl. tax)	free		250 € / month

### Pro Plan

The Pro Plan unlocks the full range of functions and costs 250 euros net per month. It gives access to the Adhesive Joint App, the FEA Toolbox, the Material Cards and the My Calculations feature. Under the Pro Plan, an unlimited number of calculations can be performed with the Adhesive Joint App. The number of calculations with the FEA Toolbox is limited to 5 per month due to the high computing effort, with unused FEA calculations expiring at the end of the billing month. Additional calculations can always be purchased for an extra fee. Such additional calculations do not expire

at the end of the billing month, but only if they remain unused for a whole billing year or if you downgrade from the Pro Plan to a free subscription.

Under the Pro Plan calculation results may be used not only for internal test purposes but also for commercial purposes, whereby the instructions described under point II. must always be observed.

The Pro Plan runs for an indefinite period and can be terminated at any time, with termination taking effect at the end of the billing month. In the event of termination of the Pro Plan, the account will be downgraded to the Free subscription or completely deleted at the user's discretion. In both cases, saved calculations and calculation results in calcbond will be irrevocably deleted. Subscribers to the Pro Plan are referred to as "Fee-based Users" in the calcbond Terms and Conditions.

#### Free-Trial subscription

The Free-Trial subscription is approximated to the Pro Plan to allow users to test the main features of calcbond for free for a limited time. Under the Free-Trial subscription, however, the calculation results may only be used for internal testing purposes, but never for commercial purposes. Commercial use always requires an upgrade to the paid Pro Plan.

The Free-Trial subscription runs once for 30 days from registration or until the time of upgrading to the Pro Plan. Only new users who have never used calcbond before get access to the Free-Trial subscription. Employees of companies or corporate groups whose other employees have previously used calcbond will not be granted access to the Free-Trial subscription. After the 30 days, the account will be downgraded to the Free subscription automatically.

#### Free subscription

The Free subscription is a basic version for testing calcbond without any charge. The functions are very limited. In particular, the FEA Toolbox, the Material Cards, the My Calculations feature, Analytical Design Explorations and PDF reports are not available. Calculation results cannot be saved and may only be used for internal testing purposes, never for commercial purposes. The Free subscription runs for an indefinite period of time and can be terminated at any time, with termination taking effect at the end of the contract month.

#### Licence

Under all subscriptions, the registered user receives a single-user licence, i.e. only the registered person may use calcbond. If additional persons / employees are to be given access to calcbond,

additional accounts with suitable subscriptions must be created for each of them. For special conditions and quantity discounts, please contact ar engineers at any time.

## **II. General description of the calcbond service, its functioning and its technical availability**

calcbond allows the user to perform complex computer-aided calculations for adhesive joints (Adhesive Joint App and FEA Toolbox).

To do this, the user must enter the required data and select one of the calculation methods offered. calcbond carries out the computerized calculation and produces a correct result. The available forms of result display (e.g. reports, graphical display) depend on the calculation method and the subscription.

ar engineers carries out the calculation in accordance with accepted engineering practice for purely computer-based model calculation. The calculations are carried out within a reasonable period of time. Often the results will be available within a few minutes. More complex calculations (esp. FEA calculations) may take more time but should normally be completed within a maximum of 48 hours.

The user selects, checks and verifies the input data, selects the calculation method, interprets the results and decides on the further use of the results. calcbond is a great tool to perform analytical and numerical calculations for the user. However, due to the high degree of automation, calcbond is not suitable for checking and verifying the input data or for relieving the user of the interpretation of the results. calcbond calculates according to standardised, recognised models and simulations, but does not advise on data selection, interpretation of results or other engineering issues in the context of analytical or numerical calculations. In particular, a computerized calculation like calcbond cannot replace the comprehensive and proper testing, examination and vetting of objects with regard to their suitability for a specific intended use.

The user must decide for himself which data he enters, what reliability and significance he attaches to the results obtained on the basis of the selected procedure and the entered data, and what he uses the results for. In view of the very low price, ar engineers does not verify the data entered into calcbond by the user, nor does it analyse whether the calculation results are suitable for a specific production, application or other goals with regard to the object examined. Such consulting and testing services must be ordered separately from ar engineers, i.e. outside the calcbond subscriptions and for a separate fee.

It should be noted that - as is inevitable in engineering - calcbond calculates on the basis of numerical or analytical simulations. The models used for this are necessarily based on

simplifications and assumptions and never correspond completely with reality, even with the greatest possible care. Therefore, the user must consider that there may be deviations between the calculation results and the actual properties of an examined object in reality. This also applies with regard to the material data in the Material Cards (see V). ar engineers has received this data from material manufacturers or has taken it from public sources. ar engineers has not checked or verified the correctness and accuracy of the material data.

After all, calcbond is a valuable calculation tool for technical professionals. Its effective use requires a certain technical expertise on the part of the user. Without a solid idea of the required data quality, the calculation basis and the model- and simulation-inherent limits, a successful use of calcbond is hardly possible. ar engineers therefore strongly recommends that only sufficiently qualified engineers use calcbond and that further expert advice is sought in case of problems or remaining doubts.

ar engineers ensures a technical availability of the calcbond platform of 98,5 % on a monthly average. The router output of the server on which calcbond is provided to the user is decisive for the measurement of the technical availability. The calculation of the availability does not include certain downtimes for which ar engineers is not responsible or which are considered scheduled maintenance works (see in detail § 6 para. 3 and 4 of the calcbond Terms and conditions).

### **III. Specific functional description of the "Adhesive Joint App" (analytical toolbox)**

The "Adhesive Joint App" has the following functions:

#### **(1) Load case configurations / adhesive joints**

- Selection of different load case configurations:
  - a) most general single lap joint (SLJ)
  - b) manual SLJ,
  - c) double-L-bracket

#### **(2) Selection of material, geometry data and loads**

- Provision of generally known isotropic calculation parameters for common metallic construction materials, as well as plastics for use as joining part materials
- Possibility to enter user-defined isotropic material parameters (Young's modulus and Poisson's ratio) for use as joining part materials
- Possibility to calculate user-defined laminate parameters from predefined, generally known single-layer parameters for use as joining part materials. For this purpose, the Classical

Laminate Theory (CLT) is used and a symmetrical balanced laminate is automatically created. The resulting global laminate stiffnesses are provided:  $E_x$ ,  $E_y$ ,  $G_{xy}$ ,  $\nu_{xy}$ ,  $\nu_{yx}$ .

- Possibility to select provided adhesive characteristics from the material cards
- Possibility to enter user-defined adhesive properties (Young's modulus, Poisson's ratio, allowable tensile stress, allowable compressive stress, adhesive layer thickness)
- Adjustment of geometric dimensions of the adhesive layer and bonded parts
- Definition of the cutting loads on the bonded parts corresponding to the load case

### **(3) Calculation**

- Unlimited calculation of the bonded joint using the Bigwood & Crocombe (general elastic) analytical method.
- Analytical calculation of the shear stress profile ( $\tau_{xz}$ ) of the  $xz$ -plane in the mid-plane of the adhesive layer along the global  $x$ -axis.
- Analytical calculation of the peel stress profile ( $\sigma_z$ ) in the mid-plane of the adhesive layer along the global  $x$ -axis
- Analytical calculation of different failure criteria in the mid-plane of the adhesive layer along the global  $x$ -axis based on continuum mechanics and strength hypotheses for isotropic materials

### **(4) Presentation of results and report**

- Representation of the shear stress curve ( $\tau_{xz}$ ) of the  $xz$ -plane in the center plane of the adhesive layer along the global  $x$ -axis over the relative adhesive layer length by means of a line diagram
- Representation of the peel stress curve ( $\sigma_z$ ) in the center plane of the adhesive layer along the global  $x$ -axis over the relative adhesive layer length by a line diagram
- Representation of the failure criteria as inverse reserve factors along the global  $x$ -axis as a table and bar chart
- Representation of the failure criteria as inverse reserve factors along the global  $x$ -axis over the relative adhesive layer length by a line diagram
- Determination of the limiting inverse reserve factor and representation in line diagram of the failure criteria
- Analytical Design Exploration is only available under the Free-Trial subscription and the Pro Plan.
- Generate comprehensive PDF-reports to document and visualize the results (only in Free-Trial subscription and Pro Plan).

#### **(5) Save calculation**

- Time-limited provision of the calculation results online in the user profile directly after the calculation. If the user leaves the analytical toolbox, the calculation is repeated or the user logs off from the platform, the results will expire if they have not been saved to the user database.
- Saving of calculations is possible under the Free-Trial subscription and the Pro Plan. Saved calculations and calculation results in calcbond will be deleted irrevocably upon downgrading to the Free subscription.

#### **Delimitations:**

- No calculation of stresses in y-direction
- Simplifications compared to the standard models are made by the user alone. If any help is given in the tool, these are only suggestions.
- The result output is standardized. User cannot influence the result scope.
- Calculation reporting is standardized. Users cannot influence the selection of content.
- The examination of the data, as well as the interpretation of the results and the associated decisions are the responsibility of the user (see details under II.).
- Use of calculation results for commercial purposes is only permitted under the Pro Plan. Free- and Free-Trial subscriptions only allow a use für internal testing purposes.

## **IV. Specific functional description of the "FEA Toolbox" (numerical toolbox)**

The "FEA Toolbox" is only available under the Free-Trial subscription and the Pro Plan and has the following functions:

#### **(1) Use cases - predefined adhesive joints**

- Selection of three load case configurations:
  - Bonded Stud
  - Beam on Beam
  - Bonded Tubes
  - Glazing
  - Single Lap Joint

#### **(2) Selection of material, geometry data and loads**

- Provision of generally known isotropic material parameters for common metallic construction materials as well as plastics for use as joining part materials
- Possibility to enter user-defined isotropic material properties (Young's modulus and Poisson's ratio) for use as joining part materials
- Possibility to select available adhesive properties from the material cards
- Possibility to enter user-defined adhesive properties (Young's modulus, Poisson's ratio, permissible tensile stress, permissible compressive stress, adhesive layer thickness)
- Adjustment of geometric dimensions of the adhesive layer and bonded parts
- Determination of the external loads on the bonded parts corresponding to the load case
  - Forces, moments, temperatures
- Determination of the boundary conditions on the parts to be joined corresponding to the load case
  - Clamping of the basic geometry

### **(3) Calculation**

- Numerical, linear-static calculation of deformations, stresses, and strains for the joined parts, as well as the adhesive layer, using linear-elastic material models.
- The number of included FEA calculations is limited to 5 per billing month, with unused included FEA calculations expiring at the end of the billing month. Additional calculations can be purchased for an additional fee (see I.).

### **(4) Presentation of results and report**

- Representation of the deformations, stresses and strains of the joined parts, as well as the adhesive layer in tabular form and by means of 3D plots
- Indication of the reserve factor due to cohesive failure based on numerical FEM (Finite Element Method) calculations.
- Generate comprehensive PDF-reports to document and visualize the results.

### **(5) Save calculation**

- Time-limited provision of the calculation results directly after the calculation online directly under the calculation input. If the calculation is repeated, the user navigates to other areas of the platform or logs off from the platform, the results will be lost if they have not been saved to the user database.

- Saving of calculations is possible. Saved calculations and calculation results in calcbond will be deleted irrevocably upon downgrading to the Free subscription.

#### **Delimitations:**

- Only the calculation results are provided to the user in the form of representations of the stress and deformation plots on the geometry. The maximum deformations and stresses are presented in the form of tables. The FEM models used are not provided.
- The output of results is standardized. Users cannot influence the scope of results.
- Calculation reporting is standardized. Users cannot influence the selection of content.
- The examination of the data, as well as the interpretation of the results and the associated decisions are the responsibility of the user (see details under II.).
- Use of calculation results for commercial purposes is only permitted under the Pro Plan. The Free-Trial subscription only allows a use für internal testing purposes.

## **V. Specific functional description of the “Material Cards”**

The calcbond "Material Cards" offer material data for on adhesives from different manufacturers which can be used for the numerical and analytical calculations at the user’s discretion. The Material Cards are only available under Free-Trial subscriptions and Pro Plans.

an engineers has received the material data from material manufacturers or has taken it from public sources. an engineers has not checked or verified the correctness and accuracy of the material data. The Material data always depends on various parameters, such as air humidity. The user has to check and verify the predefined material data with regard to their correctness and suitability for the calculations planned and executed by him. If the user does not want or is not able to check and verify the predefined material data, the user himself shall enter checked and verified material data as a calculation basis.

The Material Cards feature has the following functions:

- Different products can be selected, and the properties can be displayed in detail.
- By selecting multiple products, up to five adhesives can be arranged on tabs next to each other to display them in detail
- A selected material data set of an adhesive can be used for a calculation. For this process, the database offers the functionality to transfer the corresponding adhesive data directly into the calculation process.
- The following adhesive manufacturers are currently available on calcbond:
  1. Huntsman, with the material names (products):
    - a. Araldite 2011

- b. Araldite 2012
  - c. Aradite 2014-2
  - d. Araldite 2015-1
  - e. Araldite 2019
  - f. Araldite 2051
  - g. Araldite 2053-15
  - h. Araldite 2031-1
  - i. Araldite 2023-10
  - j. Araldite 2080-15
2. Sika, with the material names (products):
- a. SikaFast-555
  - b. SikaFlex-268
  - c. SikaForce-803 L45
  - d. SikaForce-840 L07
  - e. SikaPower-492 G
  - f. SikaPower-498/3
  - g. SikaPower-880
  - h. SikaPower-1200
  - i. SikaPower-1277
3. Kisling, with the material names (products):
- a. 7490

### **Delimitations:**

- A direct product comparison is not possible
- All contents listed in the "Material Cards", i.e. information and characteristic values, are provided by the respective material manufacturers or have been taken from public sources and have not been checked or verified by an engineers.
- It is possible that different manufacturers and/or different materials have different characteristic values or information available. Accordingly, quite different material data can exist. It is up to the user to check which data is suitable for his purposes and whether the respective data is correct. Missing information can be requested directly from the manufacturers at any time.
- The examination of the data, as well as the interpretation of the results and the associated decisions are the responsibility of the user (see details under II.).

## VI. Specific functional description of “My Calculations“

In the My Calculations feature calculations and calculation results can be stored and reviewed. The My Calculation feature is only available under the Free-Trial subscription and the Pro Plan.

- Performed calculations can be saved with the "Save Calculation" function under "My Calculations".
- Calculation reports can be created from saved calculations.

### **Delimitations:**

- A model download is not available.
- The calculation models themselves are not saved, only the input values and results.
- Saved calculations and calculation results in calcbond will be deleted irrevocably upon downgrading to the Free subscription or upon terminating the Account altogether.
- The examination of the data, as well as the interpretation of the results and the associated decisions are the responsibility of the user (see details under II.).

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