SLABS ON GROUND SOFTWARE MANUAL
SikaFiber®

FEBRUARY 2020 / V0 / SIKA SERVICES AG / DAVID TAYLOR

CLASSIFICATION (EXTERNAL)

BUILDING TRUST

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1   SCOPE

The SikaFiber® software is a desktop tool for calculating the dosage of fiber required for a reinforced industrial concrete ground slab ("The Product Proposal"). This manual describes the method of downloading, registering and navigating the SikaFiber® software.

The User has the option of calculating the dosage of fiber follows according to one of two globally recognised guidelines, referred to as 'Standards'

- **The UK Concrete Society Technical Report 34 - Concrete Industrial Ground Floors (<u>4th Edition</u>, printed March 2016)** ISBN: 978-1-904482-77-2

- **American Concrete Institute 360R-10 - A Guide to Design of Slabs-on-Ground (Ninth print, March 2016, errata June 23rd 2016)** ISBN: 0870313711 / 9780870313714

Reference is also made to ACI 544 4R-18 Guide to Design with Fiber-Reinforced Concrete.

IT IS STRONGLY RECOMMENDED TO HAVE A COPY OF THE RELEVANT STANDARD FOR USE WITH THE SOFTWARE

2   DEVELOPMENT

The software has been developed by CYPE Ingenieros S:A, a specialist company that develops and distributes technical software for Architecture, Engineering and Construction professionals.

The software is maintained and will be periodically updated.

3   GETTING STARTED

3.1   LANGUAGE AND END-USER LICENSE AGREEMENT

On opening the software, a window will appear with language options and the end -user license agreement.

Language options are displayed at the bottom of the screen. Select from the available options. If your language is not there, and you cannot use what is available, contact your local Sika Technical Department.

The software is licensed and not sold. It is important to read the "end-user licence agreement" carefully and click "accept" to continue. Otherwise, click "cancel" to exit.
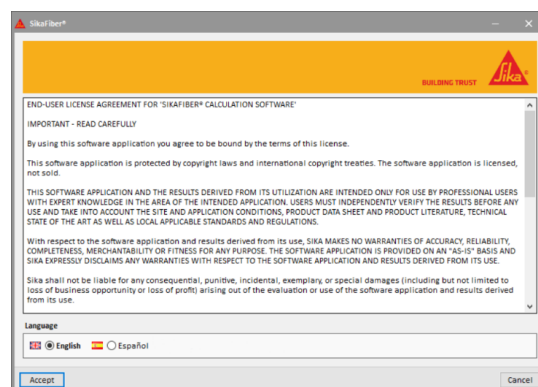
3.2   PRIVACY POLICY

Sika provides a Privacy Notice for our business partners (and Clients). This is also regulated by the EU for EEA citizens (regulation EU 2016/679 – GDPR). The Privacy Note and Privacy Email is downloadable from the software. Further information can be found on the Sika website, https://gdpr.sika.com/

3.3   DOWNLOADING THE FILE

The software can be download from the Sika group web site www.sika.com/sikafiber-software or from your local Sika country web site. Install only the file "**Install SikaFiber.exe**". You need to have the computer's administrator rights to install the software. If you do not have administrator rights, contact your IT department for assistance.

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3.4   USERS

The software is intended of professionals with expert knowledge in the area of application. The term "User" is used to define the professional in this manual.

3.5   REGISTRATION

The SikaFiber® software is free to use for 15 days. Activate the software by selecting the online activation. This requires an active internet connection.   Complete the form which requires some basic information about you your company and contact details. Read the privacy note and "accept" to continue or "cancel" to exit.

Shortly afterwards you will receive a verification email. Follow the instructions and when completed the software will be ready to use by clicking the access button. If you have any difficulties, please contact your local Sika Technical Department.

The registration is restricted to one user and on one device. Should you change your device, you will be asked to register again.

If the software is not registered within 15 days, the User will no longer be able to access the software until the registration process is complete.
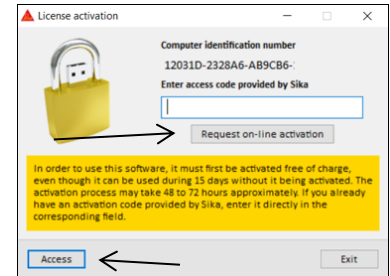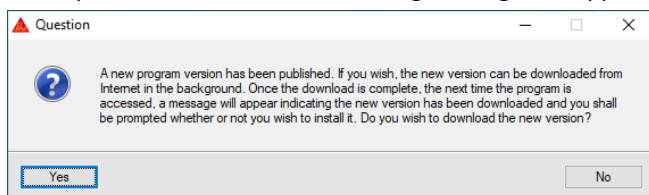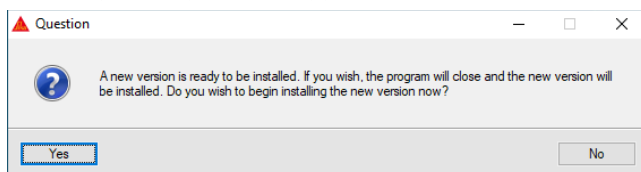

3.6   UPDATES

The software may be periodically updated. SikaFiber® Software updates could be due, and limited to:

- As a result of a Windows update or new version
- New language addition
- New SikaFiber® products, updated properties
- Server maintenance
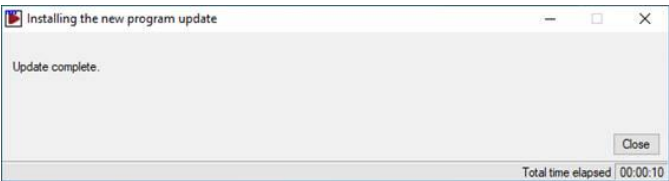- Improvements

If an update is available, the following message will appear

Click "Yes" to install the update and close the SikaFiber® software. Wait a few minutes, open the software again and the following message should appear.

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When the update is installed the following message will appear.

If there is a problem check with your IT department there are update permissions available, or if administration rights are required. If this does not solve the issue contact your local Sika Technical Department.

4   FEATURES

4.1   MAIN INTERFACE

The user interface consists of FIVE main parts

1.   Options menu

2.   Navigation bar

3.   User input

4.   Graphic representation

5.   Secondary navigation

4.1.1   OPTIONS MENU

The options menu is opened by clicking on the Sika logo in the top left-hand corner, and will display the following options

New	Create a new project
File	Displays the file manager to see where the projects are listed and saved
Save	Save a project
Save As	Save a project to a folder location
Recent files	Displays recently created files
Exit	Closes the software

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4.1.2 NAVIGATION BAR

The navigation bar has **five** main steps to guide you through the calculation process. When displayed, it is possible to navigate forward or back.

1. **Project information** (Section 6 of this manual)
2. **Loading** (Section 7 of this manual)
3. **Check and design** (Section 8 of this manual)
4. **Results** (Section 9 of this manual)
5. **Printout** (Section 10 of this manual)

It is not possible to continue to a next step until the previous step is completed. An error message will be displayed in the bottom left corner of the window to indicate the reason.

→ On starting a calculation, the project information and loadings will be displayed.

→ The check and design and results will only be displayed when loads have been correctly added.

→ The printout will be displayed only when the slab passes the checks.

TR34 navigation bar

ACI 360 navigation bar

4.1.3 USER INPUT

The User is required to add the parameters required for the calculation and is responsible for ensuring the values are correct.
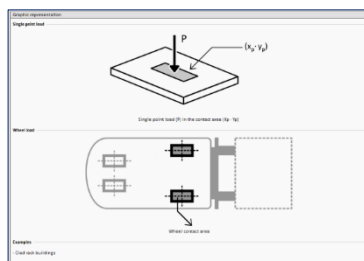
4.1.4 GRAPHIC REPRESENTATIONS

Graphics are an aid to the user input requirements. They are there to illustrate the parameters required for the input.

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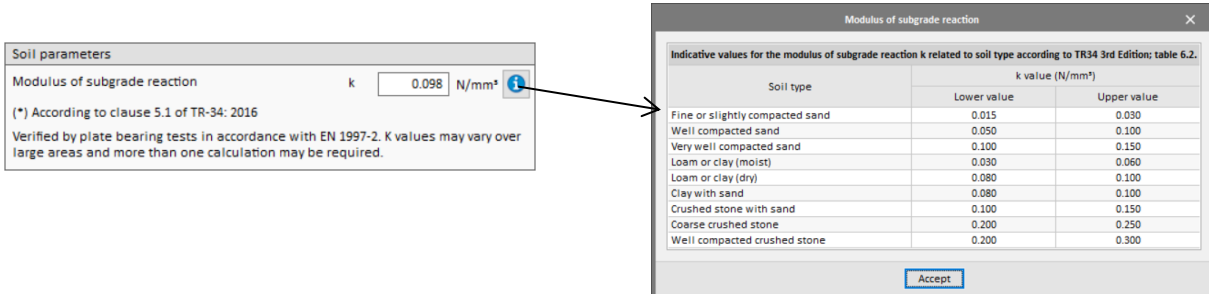
4.1.5 SECONDARY NAVIGATION

The secondary navigation bar allows the User to move forwards and backwards between the calculation steps.


4.2 ADDITIONAL FEATURES

4.2.1 INFORMATION ICONS

Information symbols open a window to give the User additional guidance about the parameter. They may contain some indicative values or refer to relevant clauses in the Standards.

Soil parameters			
Modulus of subgrade reaction	k	0.098	N/mm³

(*) According to clause 5.1 of TR-34: 2016

Verified by plate bearing tests in accordance with EN 1997-2. K values may vary over large areas and more than one calculation may be required.

Modulus of subgrade reaction

Indicative values for the modulus of subgrade reaction k related to soil type according to TR34 3rd Edition; table 6.2.

Soil type	k value (N/mm³)	
	Lower value	Upper value
Fine or slightly compacted sand	0.015	0.030
Well compacted sand	0.050	0.100
Very well compacted sand	0.100	0.150
Loam or clay (moist)	0.030	0.060
Loam or clay (dry)	0.080	0.100
Clay with sand	0.080	0.100
Crushed stone with sand	0.100	0.150
Coarse crushed stone	0.200	0.250
Well compacted crushed stone	0.200	0.300

4.2.2 ERROR MESSAGES

Error messages are displayed in the bottom left corner of the window.

For example, if the check and design or the printout step is not displayed the reason will be shown here.

❌ Point loads There are loads defined with no valid values. All values must be greater than 0.
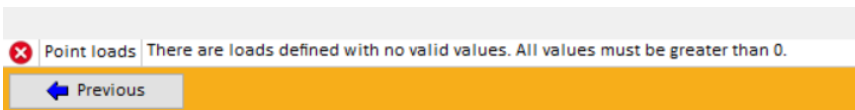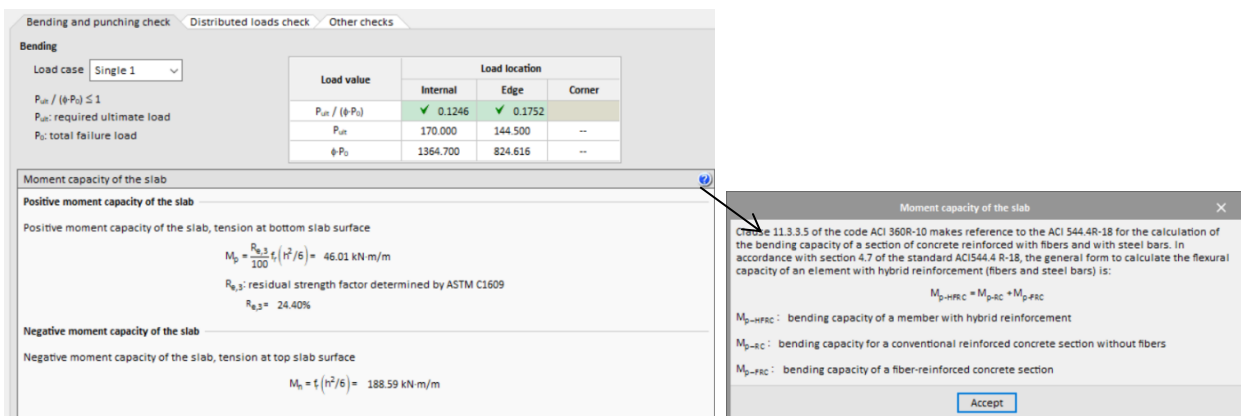
4.2.3 CALCULATION FILES

The calculation files are stored automatically on the User's hard drive, in 'my documents'. A file called Sika Fiber is automatically created during the installation process. Calculation files are created in .skf$ and .skfb format.

Worked example.skf$	05.03.2020 14:29	SKF$ File	2 KB
Worked example.skfb	05.03.2020 14:33	SKFB File	2 KB

Should the software be updated after the file is created, the calculation shall continue to contain and use the original parameters at the time of creation.

4.2.4 FORMULAS

Formulas used in the calculations will be displayed in the results section and on the printout. Clicking on the information icon will give some more additional information about the calculation.


Bending

Load case: Single 1

$P_{ult} / (\phi \cdot P_0) \leq 1$
P_{ult}: required ultimate load
P_0: total failure load

Load value	Load location		
	Internal	Edge	Corner
$P_{ult} / (\phi \cdot P_0)$	✓ 0.1246	✓ 0.1752	
P_{ult}	170.000	144.500	--
$\phi \cdot P_0$	1364.700	824.616	--

Moment capacity of the slab

Positive moment capacity of the slab

Positive moment capacity of the slab, tension at bottom slab surface

$$M_p = \frac{R_{e,3}}{100} f_t \left(h^2/6 \right) = 46.01 \text{ kN·m/m}$$

$R_{e,3}$: residual strength factor determined by ASTM C1609

$$R_{e,3} = 24.40\%$$

Negative moment capacity of the slab

Negative moment capacity of the slab, tension at top slab surface

$$M_n = f_t \left(h^2/6 \right) = 188.59 \text{ kN·m/m}$$

Moment capacity of the slab

Clause 11.3.3.5 of the code ACI 360R-10 makes reference to the ACI 544.4R-18 for the calculation of the bending capacity of a section of concrete reinforced with fibers and with steel bars. In accordance with section 4.7 of the standard ACI544.4 R-18, the general form to calculate the flexural capacity of an element with hybrid reinforcement (fibers and steel bars) is:

$$M_{p-HFRC} = M_{p-RC} + M_{p-FRC}$$

M_{p-HFRC}: bending capacity of a member with hybrid reinforcement

M_{p-RC}: bending capacity for a conventional reinforced concrete section without fibers

M_{p-FRC}: bending capacity of a fiber-reinforced concrete section

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5 STARTING A PROJECT

5.1 PROJECT PARAMETERS

The project parameters window is displayed automatically for the first calculation. In subsequent calculations the last project will automatically be displayed.

To open a new project, open the options menu in the top left corner (Sika logo) and select new. You will be prompted to add a file name and define the file location.

There are three options in the project parameters. Once accepted for the calculation it is not possible to change this selection. In this event the User must start a new project.
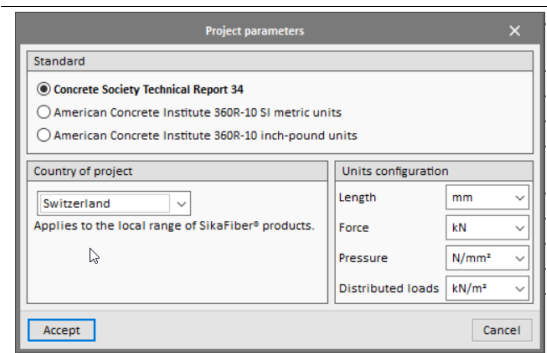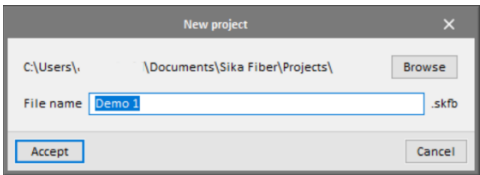
Standard	Select from the TR34 (metric) or ACI 360R-10 (metric or imperial)
Country of Project	It is possible to be a User in country A designing a project in country B. This is relevant to the available local range of SikaFiber® products
Units	Select your preferred units for calculation parameters

6 PROJECT INFORMATION

Project information window
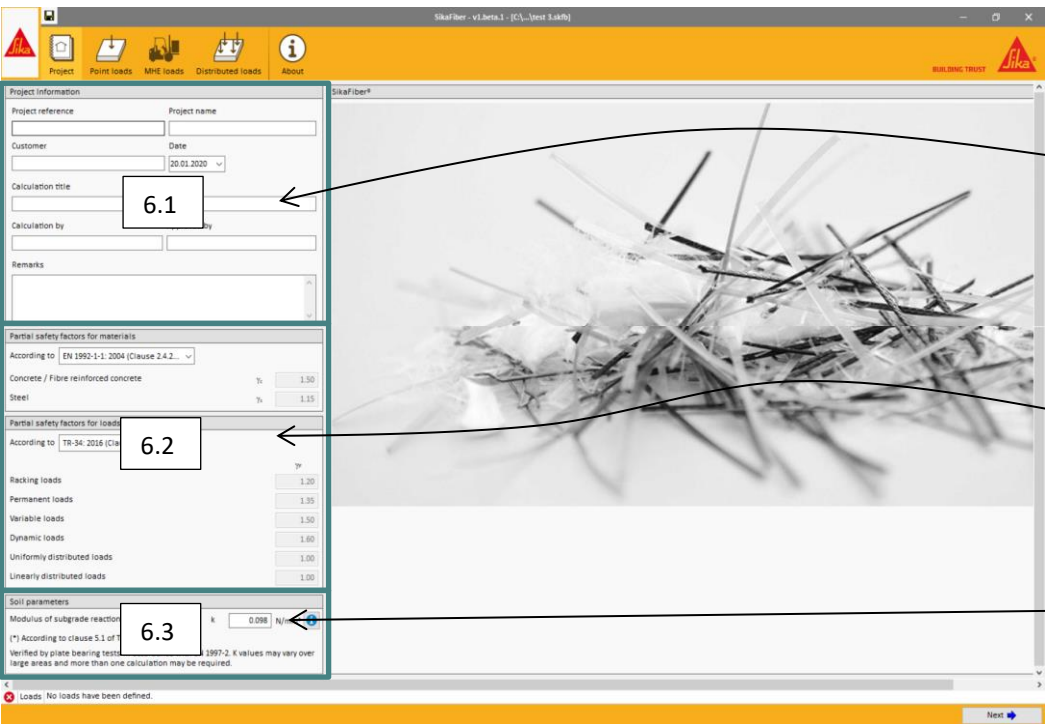
Project information

Safety factors

Soil parameters

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6.1 PROJECT INFORMATION

The User has the option to define information about the project, the location, date of calculation, or can add some additional remarks for future reference. Filling out the project information fields is not compulsory to continue to the next steps.

Project reference	An abbreviation for the project
Project name	Given name of the project and location
Customer	Name of the User's Client or Customer, for whom the calculation is produced
Calculation title	Specific part of the project the calculation has been made
Calculation by	The User's name or initials
Approved by	Name or initials of the person checking the calculations e.g. internal company or for purposes of a signing-off the calculation
Remarks	Additional information about the project e.g. references to drawings, specifications, geological report, special instructions/requirements or at the end of the calculation specific instructions resulting from the calculation etc.

6.2 PARTIAL SAFETY FACTORS

The displayed partial safety factors are defaulted to the recommendations contained in TR34 / EN 1992-1-1 or ACI360R-10 or can be user defined.

To change the safety factors, click on the drop-down menu and select User.
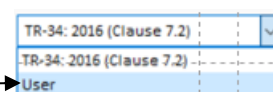
6.3 SOIL PARAMETERS

Both TR34 and ACI360R-10 specify the structural integrity of the layers below the ground slab in terms of the "modulus of subgrade reaction, k".

This value shall be provided by the Geotechnical Engineer based on conclusions from the ground investigation and loadings provided by the Structural Engineer.

The software limits the minimum and maximum values which can be inserted.

STANDARD	CLAUSE	MINIMUM	MAXIMUM	UNIT
TR34	5.1	0.015	0.300	N/mm^3
ACI 360R-10	Chapter 4	0.015	0.300	N/mm^3
ACI 360R-10	Chapter 4	55.24	1104.81	PCI
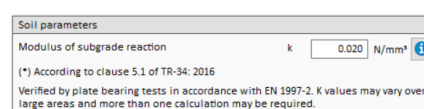
7 LOADINGS

There are three main loading types identified by the Standards

1. Point loads

2. Material Handling Equipment (MHE)

3. Distributed loads

The TR34 and ACI 360R-10 consider acting loads differently, therefore there is a difference on how the data is input into the software.

If loads are not adequately input an error message will appear and it is not possible to continue to the check and design

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7.1 LOAD COMBINATIONS

The Standards consider forces as individual loads acting on the slab, with the one exception in TR34 where it considers a combined column/upright load in combination with the MHE load.
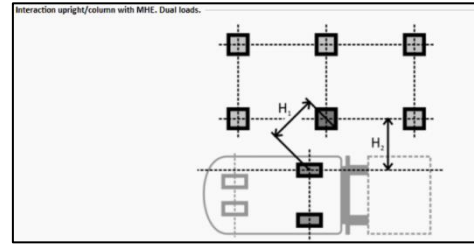
7.2 LOAD SUMMARY

TR34 loadings (refer to section 4 of Standard)

STANDARD	LOAD	DESCRIPTION	LOAD TYPE	INPUT	
TR34	Point loads	Automatic load generation	Stoarge racking	Simple Back to back	
			Mezzanine	Permanent Variable loads	
		Manual load input	Single point loads	Racking Permanent Dynamic Variable	Internal Edge Corner
			Dual point loads		
			Quadruple point loads		
	Material Handling Equipment	Materials Handling Equipment	Wheel load	Contact Pressure Contact Area	
		Interaction with column	Wheel load	Contact Pressure Contact Area	
			Column load		
	Distributed Loads	Uniformly Distributed loads	Unknown		
			Specific		
		Linerarly distributed loads	Line load	Edge distance	

ACI 360R-10 loadings (refer to Section 11.3.3.3 of Standard)

STANDARD	DESCRIPTION	TYPE	LOADING	INPUT
ACI 360R-10	Point loads	Single point loads	Racking Moving wheel load Other	Internal Edge Corner
			Wheel data	Contact Pressure Contact Area
		Materials Handling Equipment	Wheel data	Contact Pressure Contact Area
	Distributed Loads	Uniformly Distributed loads	Unknown	
			Known	
		Linerarly distributed loads	Line load	Edge Distance

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7.3   BASIC LOAD FUNCTIONS

Loads can be added, copied or deleted using the icons

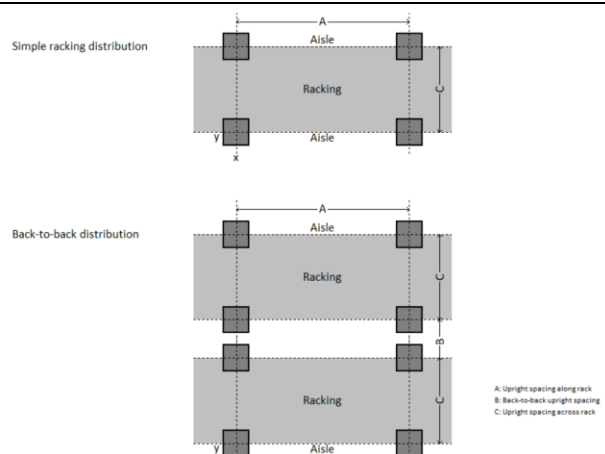|	
⊞	Add a load
▢	Copy a load
▨	Delete load

7.4   TR34 LOADING

7.4.1   AUTOMATIC POINT LOAD GENERATION

The User is required to input

→ The total upright load
→ Dimensions of the baseplates x and y
→ Dimensions A and B
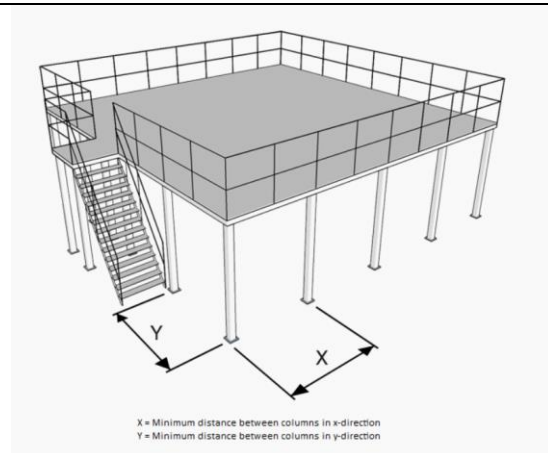→ Check the box if there is a back to back arrangement and add dimension C

Storage racking

Name	Upright load (kN)	Plate dimensions		Back-to-back distribution	A (mm)	B (mm)	C (mm)
		x (mm)	y (mm)				
Racking 1	0.000	0	0	☐	0	--	0

A: Upright spacing along rack
B: Back-to-back upright spacing
C: Upright spacing across rack

The User is required to input

→ The column permanent load
→ The column variable load
→ Dimensions of the baseplate
→ Spacing of the columns

Mezzanine

Name	Column load		Plate dimensions		X (mm)	Y (mm)
	Permanent (kN)	Variable (kN)	x (mm)	y (mm)		
Mezzanine 1	0.000	0.000	0	0	0	0
Mezzanine 2	0.000	0.000	0	0	0	0

X = Minimum distance between columns in x-direction
Y = Minimum distance between columns in y-direction

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7.4.2   MANUAL POINT LOAD

The User is required to input

→   The total single load, the total of two dual loads or the total of a four-point load
→   Select if the load is a racking, permanent, dynamic or other load from the drop-down menu
→   The contact dimensions x and y
→   Check at least one or more of the boxes, if the load is acting at an internal, edge or corner location

INTERNAL, EDGE OR CORNER POSITIONS

Single point loads can act at internal edge or corner positions.

The Standard does not contemplate the possibility of considering a dual load in a corner because only one of the two loads will be in the corner. The same applies to quadruple loads by an edge or in a corner. Only two of the four loads are next to an edge or one of the four loads is in the corner. In these situations, the User shall assess how best to simulate the load arrangements.

Possible load positions are illustrated in the diagram.

TR34 section 7.7 defines internal, edge and corner loads in terms of load locations.
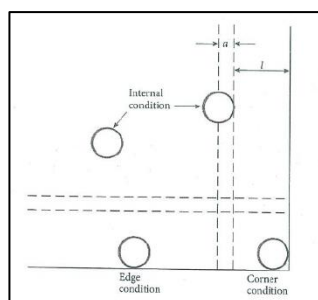
Internal – the centre of the load is located more than (a + l) from an edge (i.e. a free edge or a joint)

Edge – the centre of the load is located immediately adjacent to a free edge or joint more than (a + l) from a corner (i.e. a free corner, the intersection of a free edge and a joint, or the intersection of two joints)

Corner – the centre of the load is located a from each of the two edges or joints forming a corner

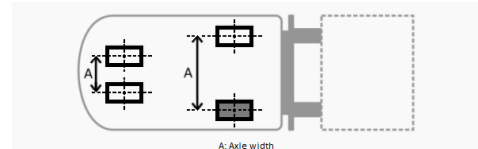Where;   a = equivalent radius of contact area of the load

l = radius of relative stiffness (refer to section 9.1.3 of this manual)

7.4.3   MATERIAL HANDLING EQUIPMENT

The User is required to input

→   The load value for a single wheel
→   Select from the drop-down menu the option to a contact area of contact pressure
→   Add the contact area or contact pressure value
→   Dimension A between wheels (TR34 only)

Materials Handling Equipment (MHE)					
Name	Wheel load (kN)	Wheel data	Contact area (mm²)	Contact pressure (kN/m²)	A (mm)
MHE 1	140.000	Contact pressure	--	690.0	1400
MHE 2	0.000	Contact area	--	--	0
MHE 3	0.000	Contact pressure	--	--	0

A: Axle width

The 'MHE' option allows the user to enter axle loads as dual loads, with multiple load cases. A case of MHE load that does not conform to these conditions can be simulated with the tools of the tab 'Manual introduction of loads'.

NOTE: TR34 checks this as a single wheel load and another check as a dual load (to simulate the axle at a distance A). To simulate a front and rear axle, a separate load case must be generated

The User is required to input

→   The load value for a single wheel
→   Select from the drop-down menu the option to a contact area of contact pressure
→   Add the contact area or contact pressure
→   The total upright load
→   Dimensions of the baseplates x and y
→   Distance between the column and wheel loading H_1 and H_2

Interaction upright/column with MHE. Dual loads.

H_1=   Distance of truck wheel from rack upright/column when the wheel load is at its maximum value
H_2=   Distance of truck wheel from rack upright/column when the truck is in motion

Interaction upright/column with MHE. Dual loads.							Plate dimensions			
Name	Wheel load (kN)	β(*)	Wheel data	Contact area (mm²)	Contact pressure (kN/m²)	Upright / column load (kN)	x (mm)	y (mm)	H1 (mm)	H2 (mm)
Interaction 1	120.000	1.00	Contact pressure	--	500.0	40.000	100	100	1000	1200
Interaction 2	0.000	1.00	Contact area / Contact pressure	--	--	0.000	0	0	0	0

(*) Multiplies the wheel load to consider the maximum load situation.
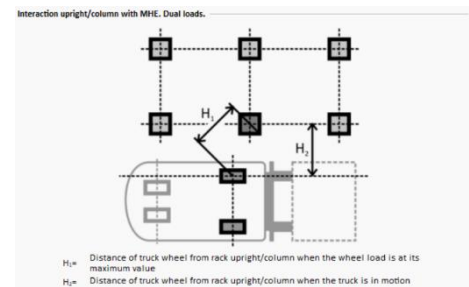
7.4.4   UNIFORMLY DISTRIBUTED LOADS

The User is required to input

→   Select type of UDL from the drop-down menu specific or unknown
→   Add the load value
→   For known arrangements add the L, A and B dimensions

| Uniformly distributed loads					
Name	Type (*)	Load (q) (kN/m²)	L (mm)	A (mm)	B (mm)
Uniform load 1	Unknown	0.0	--	--	--
Uniform load 2	Specific / Unknown	0.0	--	--	--

(*) Type of uniformly distributed load

Specific distribution of loads
If the position of the loading is well defined.

Unknown distribution of loads
For the general case where the slab will be subjected to a random pattern of uniformly distributed loading.
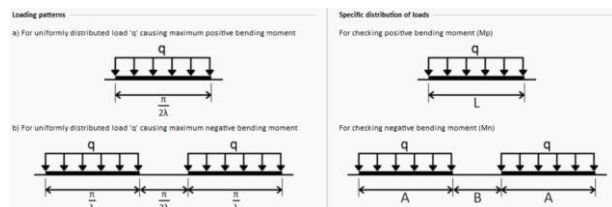

NOTE: Section 7.12 of TR34 states either the arrangement of distributed load is known or unknown. When the load arrangement is specific the actual positive and negative slab moments can be calculated. If the load arrangement is unknown the software will determine the worst case positive and negative moment, depending on the slab thickness and concrete class.

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The User is required to input

→ The line load value
→ Distance away from an edge

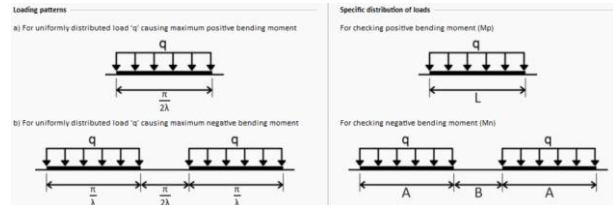| Linearly distributed loads		
⊞ 🗋 🗷		
Name	Load (q) (kN/m)	Distance 'd' from the edge (mm)
Linear load 1	0.00	0
Linear load 2	0.00	0
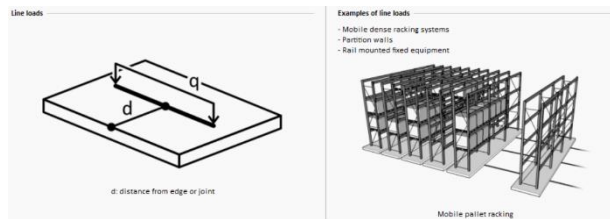
7.5 ACI 360R-10 INPUT LOADING

7.5.1 SINGLE POINT LOAD

The User is required to input

→ The total single load
→ Select if the load is a racking, moving wheel load or other from the drop-down menu
→ The contact dimensions x and y
→ Check at least one or more of the boxes, if the load is acting at an internal, edge or corner location

Single point loads							
⊞ 🗋 🗷							
Name	Load (kN)	Type	Contact area dimensions		i(*)	e(*)	c(*)
			Xp (mm)	Yp (mm)			
Single 1	0.000		0	0	☑	☐	☐
Single 2	0.000	Racking / Moving wheel load / Other load	0	0	☑	☐	☐
(*) Possible load location: (i) in...location; (c) corner location							

Single point load (P) in the contact area (Xp · Yp)
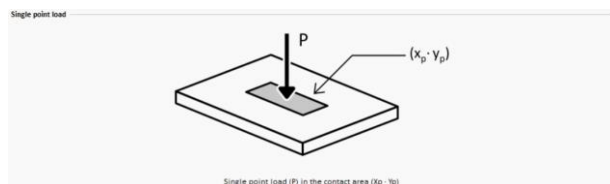
7.5.2 MATERIAL HANDLING EQUIPMENT

The User is required to input

→ The load value for a single wheel

NOTE: ACI360R-10 only considers a single wheel load does not consider an axle

→ Select from the drop-down menu the option to a contact area of contact pressure
→ Add the contact area or contact pressure value

Materials Handling Equipment (MHE)				
⊞ 🗋 🗷				
Name	Wheel load (kN)	Wheel data	Contact area (mm²)	Contact pressure (N/mm²)
MHE 1	0.000		--	--
MHE 2	0.000	Contact area / Contact pressure	--	--
MHE 3	0.000		--	--
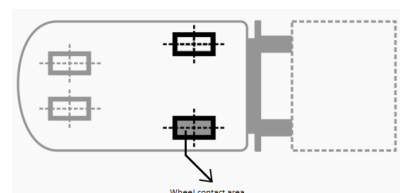
Wheel contact area

7.5.3 UNIFORMLY DISTRIBUTED LOADS

The User is required to input

→ Select type of UDL from the drop-down menu specific or unknown
→ Add the load value

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NOTE: Section 7.12 of TR34 states either the arrangement of distributed load is known or unknown. When the load arrangement is specific the actual positive and negative slab moments can be calculated. If the load arrangement is unknown the software will determine the worst case positive and negative moment, depending on the slab thickness and concrete class.

→ For known arrangements add the L, A and B dimensions

The User is required to input

→ The line load value
→ Distance away from an edge

7.5.4   WHEEL LOADS

The load value is for one wheel and the value of the area or pressure is for one wheel.

The program checks a wheel as a single load with the defined "wheel load" e.g. 60 kN. TR34 also makes a check considering a dual load, to simulate the axle, with 2 times "wheel load" i.e. 120kN and a distance between loads of "A". The report shows only the development of the most unfavourable load case. In this case it is the dual load at the edge, but the two calculations are performed, as it can be seen in the table of checks.

Bending ultimate limit state					
Load name	Load case	Type	Internal	Edge	Corner
Single 1		Single point load	✔ 0.2530		
MHE 1	MHE 1-1	Single point load	✔ 0.3440	✔ 0.7667	✔ 0.6507
	MHE 1-2	Dual point load	✔ 0.4222	✔ 0.9410	L.C.N.P.

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8   CHECK AND DESIGN

8.1   LAYOUT

The layout of the check and design is split into different parts.

A	Concrete	Displays the selected concrete class and Poisson's ratio
B	Fibers	Displays the selected SikaFiber® type and adjust the dosage
C	Slab	Displays data about the slab thickness and joints
D	Reinforcement	Displays additional reinforcement, if required
E	Design Wizard	This function calculates an optimum fiber dosage and slab thickness
F	Checking Summary	Indicates a pass or fail status for bending, punching and load checks. Indicates the usage coefficient, and a pass or fail for each of the loads.
G	Strength values	Displays the calculated strength values

8.1.1   CONCRETE

The concrete class can be changed by selecting another grade in the drop-down menu. In some cases, the fiber dosage and concrete class is fixed, in others this is optional.

For TR34, the concrete class is limited between C20/25 to C40/50 [25 MPa to 50 MPa when tested with 150 x 150 x150 cubes]

The Poisson's ratio can be changed between values of 0.1 to 0.5.

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8.1.2 FIBER

The country defined at the start in the 'Project Parameters' will display the available SikaFiber® in the country from the drop-down menu.

The available dosage range for the specific SikaFiber® is displayed by hovering the cursor over the value.

The fiber dosage value can be locked or un-locked in the calculation by clicking on the padlock symbol.
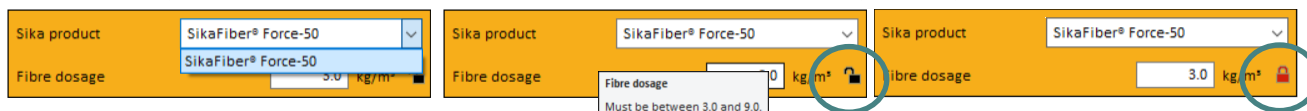

8.1.3 SLAB THICKNESS

The slab thickness is defined by the User. It is restricted to a maximum value and a recommended minimum value from the Standard.

The slab thickness can be locked or un-locked in the calculation by clicking on the padlock symbol.

STANDARD	SECTION	MINIMUM	MAXIMUM	UNIT
TR34	7.1	150	600	mm
ACI 360R-10	Appendix 1	120	600	mm
ACI 360R-10	Appendix 1	5	23	inches
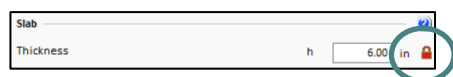
8.1.4 JOINTLESS SLAB

The software has the option to turn off the joint spacing check option.

Selecting "jointless" does not mean the software allows the specification of no joints!

If jointless is selected, the panel dimensions (TR34) or recommended joint spacing (ACI360R-10) will not be an option. The joint spacing will be reduced to a light grey text and the dimensional check will therefore not be done. In the "other checks" tab, a warning yellow triangle will appear to indicate the check is not requested.

When designing a jointless slab consider edge and corner cases only occur on the periphery of the slab. This needs to be taken into consideration when specifying the load transfer at a joint.

8.1.5 JOINT SPACING

The software gives limited guidance on joint spacing. In the case of "jointed long area" slabs and "long strip" slabs, with the formed joints and the sawn joints, the floor becomes a set of smaller panels. The dimension of these panels is checked in the program. The many factors and construction methods which need to be taken into consideration requires each slab to be considered on a project by project basis. The software does not design project specific joints or the spacing. It only gives spacing guidance according to the Standards.

The User shall refer to the relevant parts of the Standards are TR34 section 11 and chapter 6 of ACI360R-10.

TR34	Clause 11.1.1 large area construction sawn restrained-movement joints the slab is typically cut into 6m bays. The User can add the size of the bay and the software will make some checks in accordingly which can be viewed in the results

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ACI 360R-10	For slabs reinforced only for limiting crack widths the software will suggest a joint spacing based on figure 6.6 of the Standard. The User must decide if the concrete is of low, typical or high shrinkage concrete.	

8.1.6   LOAD TRANSFER
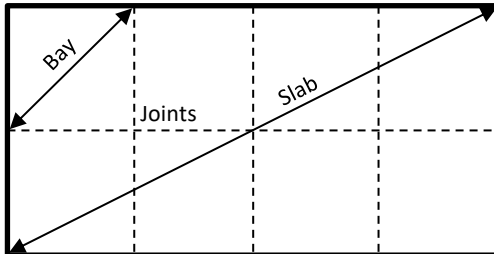
A typical slab consists of bays divided up by joints. The joint layout is planned based on project specific factors such as building geometry, equipment layout, joint width etc.

Free edges at periphery of building do not tend to transfer shear. However, internal joints can transfer load across a joint, depending on the joint type and according to how it is designed.

The default value for the percentage of load transfer at the edge and corner is zero. The User, depending on the type of joint in consideration can edit that value between 0 to 50%.

The entered value will be the load transfer throughout the calculation. If there are different types of joints, and load transfer, a new calculation is required for the different load case.

When checking a load at the edge or at the corner, part of the load can be transferred through the joint, and therefore, the required load at the edge or corner slab will be less than the specified value. In the case of the internal load this transfer to the joint does not occur.

If a transfer percentage is specified, for example 20%, the load-transfer capacity will be available across the joint. It would be expected that this will be capable of supporting 20% of the load and this information must be conveyed to the responsible joint designer. This reduces the required load capacity to $P \cdot (1 - 0.20) = P \cdot 0.8$. and can be seen in the report.

Single point load
Edge location

$P_d / P_u \leq 1.0$
P_d: required ultimate load

$P_d = \sum \gamma_{Fi} \cdot P_i \cdot (1 - \alpha / 100)$

γ_f: Partial safety factor for load
P: Point load
α: Load transfer at the edge

P_d / P_u : 0.5627 ✓	
P_d : 57.600 kN	
γ_f : 1.20	
P : 60.000 kN	
α : 20.0 %	

Single point load
Internal location

$P_d / P_u \leq 1.0$
P_d: required ultimate load

$P_d = \sum \gamma_{Fi} \cdot P_i$

γ_f: Partial safety factor for load
P: Point load

P_d / P_u : 0.2530 ✓	
P_d : 72.000 kN	
γ_f : 1.20	
P : 60.000 kN	

8.1.7   ADDITIONAL REINFORCEMENT

The SikaFiber® software offers the possibility of adding some reinforcement in addition to the fibers. The maximum amount of reinforcement is limited. The ratio is dependent on the bar spacing and slab thickness as shown in the example below.

STANDARD	MINIMUM	MAXIMUM
Bending	0	Ø6 @ 200 mm
Punching	0	Ø7 @ 200 mm (x and y)

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The maximum limit ratio will automatically change depending on the thickness of the slab.

Calculating the reinforcement ratio

ρ (%) is defined as reinforcement ratio for bending (1-direction)

ρ (%) = (As / b.d) x 100
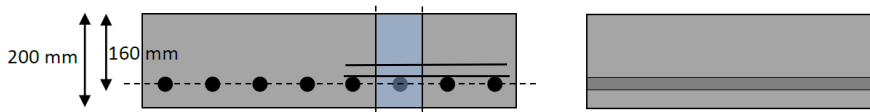
Calculation example:

reinforcement H6 at 200mm

d = h – cover to bar centre = 200 – 40 = 160mm

As = $(\pi \cdot 6^2/4)$ = 28.3 mm^2

ρ = 28.3/ (200·160) = 0.00088

ρ (%) = 0.088

Calculating the punching ratio (2-direction)

ρ1 (%) is defined as reinforcement ratio for punching

ρ1 = $(\rho x \cdot \rho y)^{0.5}$

ρx = Asx / b.d

ρy = Asy / b.d

Calculation example:

reinforcement mesh H7 at 200mm in X and 200 in Y

As = $(\pi \cdot 7^2/4)$ = 38.5 mm^2

ρx = 38.5/(200·153) = 0.00126

ρy = 38.5/(200·160) = 0.00120

ρ1 = $(0.00126 \cdot 0.00120)^{0.5}$ = 0.00123

P1 (%) = 0.123

8.1.8   DESIGN WIZARD

Pressing the design wizard searches the optimum dosage amount and a slab thickness. It will also work if one of either the dosage or thickness is locked, but not if both are locked.

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8.1.9 CHECKING SUMMARY

The individual checks for each load case are summarised.

The slab capacity is defined as the required ultimate load (Pd) / total failure load (Pu) which must be less than 1. Values with a Pd/Pu < 1 are indicated green, values > 1 are indicated red.

For each checking type the more unfavourable ratio, highest value, is displayed.

Checking summary

Checking type	More unfavourable ratio	
⦿ Bending ultimate limit state	$P_d / P_u = 2.7116$	✗
○ Punching ultimate limit state	$P_d / P_u = 1.3810$	✗
○ Uniformly and linearly distributed loads checking	$q_d / q_u = 1.0504$	✗
○ Other verifications		✓

Bending ultimate limit state

Load name	Load case	Type	Internal	Edge	Corner
Racking 1	Racking 1-1	Single point load	✓ 0.3380	✓ 0.8008	✗ 1.9743
	Racking 1-2	Dual point load	✓ 0.4627	✗ 1.0960	L.C.N.P.
	Racking 1-3	Dual point load	✓ 0.5494	✗ 1.3014	L.C.N.P.
	Racking 1-4	Dual point load	✓ 0.5860	✗ 1.3882	L.C.N.P.
	Racking 1-5	Quadruple point load	✓ 0.7992	L.C.N.P.	L.C.N.P.
MHE 1	MHE 1-1	Single point load	✓ 0.5576	✗ 1.2116	✗ 2.7116
	MHE 1-2	Dual point load	✓ 0.9173	✗ 1.9932	L.C.N.P.

Selecting a different 'checking type' will change to another view of the summary.

Checking summary

Checking type	More unfavourable ratio	
○ Bending ultimate limit state	$P_d / P_u = 2.7116$	✗
⦿ Punching ultimate limit state	$P_d / P_u = 1.3810$	✗
○ Uniformly and linearly distributed loads checking	$q_d / q_u = 1.0504$	✗
○ Other verifications		✓

Punching ultimate limit state

Load name	Load case	Type	Shear at the face of the loaded area			Shear on the critical perimeter		
			Internal	Edge	Corner	Internal	Edge	Corner
Racking 1	Racking 1-1	Single point load	✓ 0.2389	✓ 0.3186	✓ 0.4778	✓ 0.4562	✓ 0.7861	✗ 1.3810
	Racking 1-2	Dual point load	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.
	Racking 1-3	Dual point load	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.
	Racking 1-4	Dual point load	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.
	Racking 1-5	Quadruple point load	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.	L.C.N.P.

8.1.10 WARNING SYMBOLS

$$\frac{M_{un}}{M_{up} + M_{un}} = 0.4870 \; \triangle$$

Warning symbols are an advice. Refer to the Standard for further details.

8.1.11 USAGE COEFFICIENTS

Within the green and red box are displayed a '**usage coefficient**'. This is determined from:

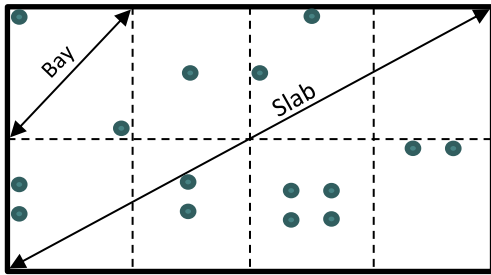Usage Coefficient = Ultimate load / slab capacity

If a red cross and value of 1.7987 is displayed, it means the slab capacity is exceeded by 79.9 %

If a green tick and value of 0.6212 is displayed, it means there is 37.9 % capacity remaining.

Edge	Corner
✓ 0.6212	✗ 1.7987

8.1.12 LCNP

A **LCNP** denotes where the Load Cases are Not Possible.

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Single loads are possible in corners, edges and at internal bay locations.

The Standard does not contemplate the possibility of considering a dual load in a corner because only one of the two loads will be in the corner. The same applies to quadruple loads by an edge or in a corner. Only two of the four loads are next to an edge or one of the four loads is in the corner. In these situations, the User shall assess how best to simulate the load arrangement according to the requirements.

Possible load positions are illustrated in the diagram.

If the check does not pass there are several options to the User. The solution could be, and not limited to.

I. Increase slab thickness (locally or generally)
II. Increase concrete grade
III. Change fiber dosage
IV. Reduce the load
V. Move the load away from the affected edge or corner
VI. Change the joint load transfer (designed joint)
VII. A combination of the above

STRENGTH VALUES

Flexural tensile strength $f_{ctd,fl} = f_{ctm} \cdot (1.6 - h / 1000) / \gamma_c = 3.27$ MPa

Residual flexural strength $f_{r1} = 1.54$ MPa $\quad f_{r2} = 1.73$ MPa
$f_{r3} = 1.80$ MPa $\quad f_{r4} = 1.79$ MPa

The flexural tensile and residual strength used in the calculation are summarised. These values come from testing and relate to the concrete grade and fiber dosage.

9 RESULTS

The results window displays for each load case the required ultimate load (Pd) and total failure load (Pu). The load case can be changed by selecting the pull-down menu.

tabs to change checks

Radius of relative stiffness

Pull down menu to change load case

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9.1 SLAB CAPACITY CHECK

The results display the Pd and Pu values.

The Pd value is defined as the input load multiplied by the relevant factor of safety.

Load value	Load location		
	Internal	Edge	Corner
P_d / P_u	✔ 0.1646	✔ 0.4090	✔ 0.9208
P_d	120.000	120.000	102.000
P_u	729.143	293.373	110.773

The printout will display how the calculations were derived for only <u>one</u> of the load locations. The load calculation selected for the printout is the check with least remaining slab capacity.

9.2 RADIUS OF RELATIVE STIFFNESS

The program calculates the "radius of relative stiffness" and the "equivalent radius of contact area" to perform the checking calculations, as can be seen in the report.

In addition, in the "Results" screen, the program provides the "radius of relative stiffness" as informative data and draws the corresponding bands on the panel of dimensions given by the User.
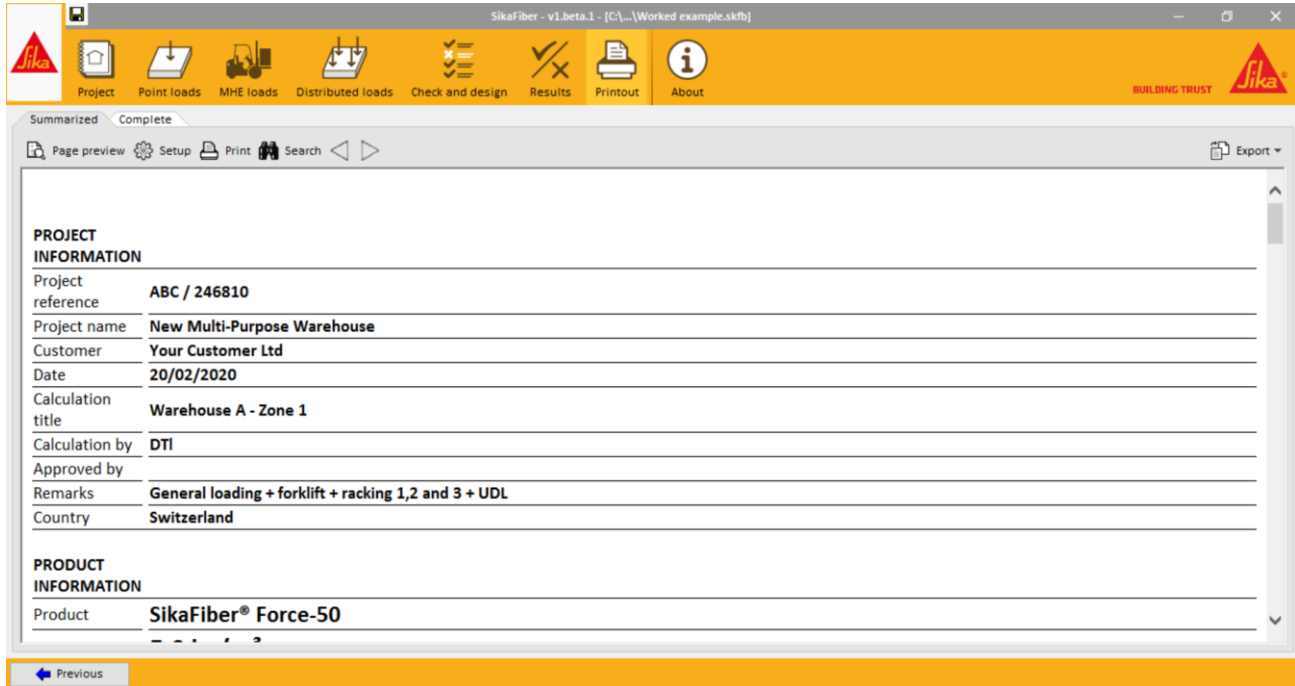

This is information for the user, since there are loads that are automatically calculated at the three positions: interior, edge and corner, but there are other loads whose position will be dictated by the user.

The program does not analyse if the load is at a distance from the edge less than "l" or greater than "(a + l)", it only provides the data of "a" and "l".

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10 PRINTOUT

The main features of the printout are:

- Optional summarised or complete report
- Printer setup
- Search function
- Export to different formats

10.1 SUMMARISED REPORT

The summarised report contains:

- Project information
- Product proposal
- Design summary
- Loading summary
- Design data
- Result summary

10.2 COMPLETE REPORT

In addition, the complete report contains:

- Slab capacity calculations
- Bending checks
- Punching checks
- Line load checks
- Uniform distributed load checks
- Other verifications

Only the complete development of the most unfavorable check of each group of checks is shown in the printout. This is to keep the report within a reasonable number of pages.

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In order to see a specific check, enter loads in a separate project and use the manual load input tool to place them only in the desired position.

10.3 PRINTER SETUP

Set up to a printer using the configure option, paper size and to set up the margins
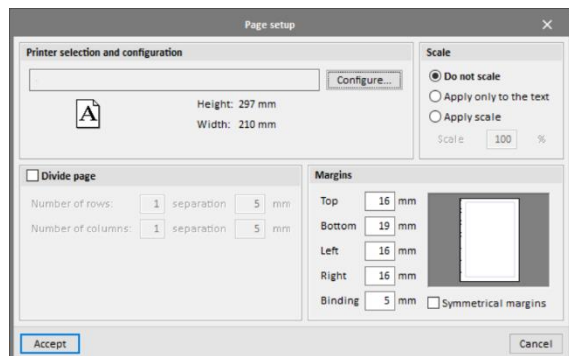
10.4 SEARCH FUNCTION

Use the search function to find quickly a formula, phrase or word in the calculation.

10.5 EXPORTING TO DIFFERENT FORMATS

The calculation printout can be exported into different formats by selecting the format icon in the top right corner.

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