04.02_PH-SUMMER SCHOOL

THERMAL BRIDGES

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Date: 2009-07-14

CONTENT OF THIS PRESENTATION:

What are thermal bridges?

Definition

- A thermal bridge is an area of higher heat flux (increased heat transmission) in the thermal building shell. It is a weak point in the building shell.

- Heat will flow the easiest way from the higher energy level (heated space) to the lower energy level (outside) - the path with the least heat resistance (an element which has a much higher conductivity than surrounding material).

Source:

What are thermal bridges?

Effects

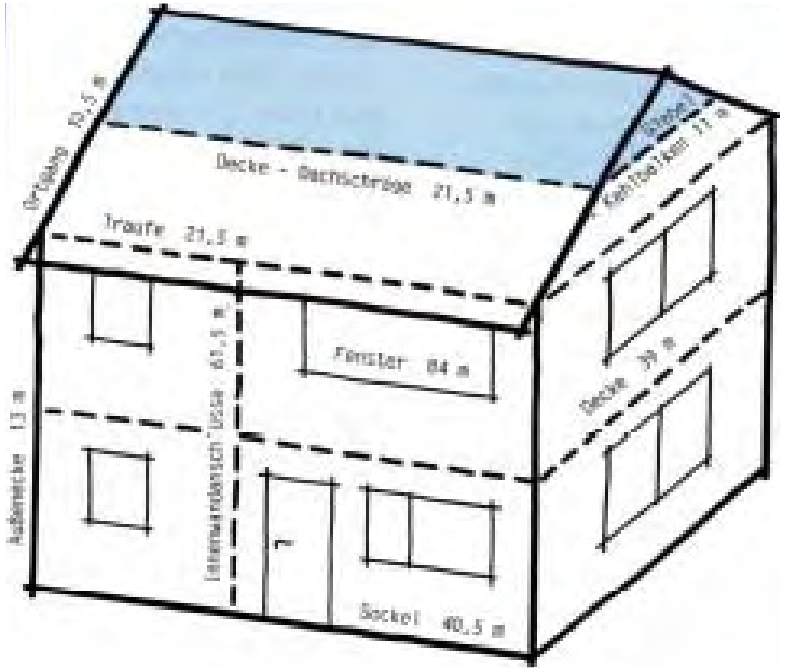
- This creates in winter temperatures that are locally lower on the inside and warmer on the outside.
- Typical effects of thermal bridges are:
  - Decreased interior surface temperatures; in the worst cases this can result in high moisture in parts of the construction
  - Significantly increased heat losses.
- This causes
  - higher energy consumption,
  - problems with moisture (condensation, danger of mould),
  - higher dust deposit due to increased relative humidity of air and materials in the area of the TB and
  - can cause structural damage due to frost.

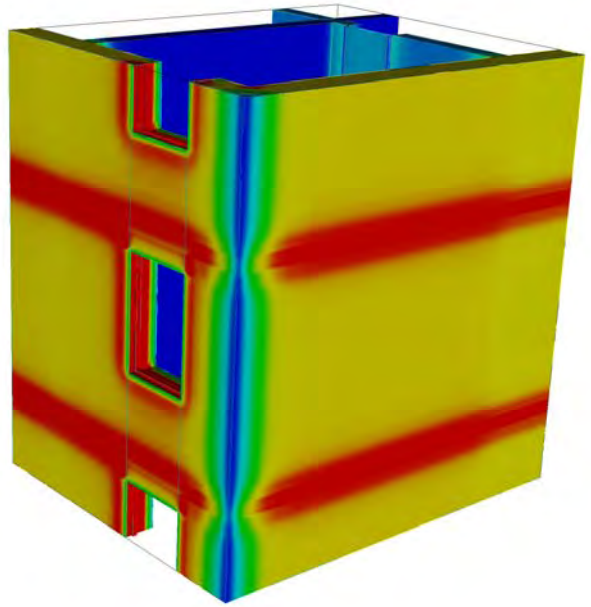
Source:

What are thermal bridges?

Thermal bridges and PH

„Typical“ thermal bridges in residential homes





Source: Die Neue Quadriga; Robert Borsch-Laaks

www.kornicki.com/antherm/images/AnTherm_Info_02.png

What are thermal bridges?

Thermal bridges and PH

- In a Passive House the heat losses of thermal bridges must be significantly reduced. The reduction is made to a degree that the losses through thermal bridges become negligible.

- If the thermal bridge coefficient (which is an indicator of the extra heat losses of a thermal bridge) is **lower than 0.01 W/(mK)**, the detail is said to be "**Thermal Bridge Free**".

Source: www.passivhaustagung.de/Passive_House_E/passive_house_avoiding_thermal_brigdes.html

What are thermal bridges?

Thermal bridges and PH

- If this PH-criterion of avoiding thermal bridges is fulfilled throughout the thermal envelope, neither the designer nor the builder has to worry about cold and humid parts in the construction - and it will be far much simpler to calculate the heat energy balance.

Source: www.passivhaustagung.de/Passive_House_E/passive_house_avoiding_thermal_brigdes.html

What are thermal bridges?

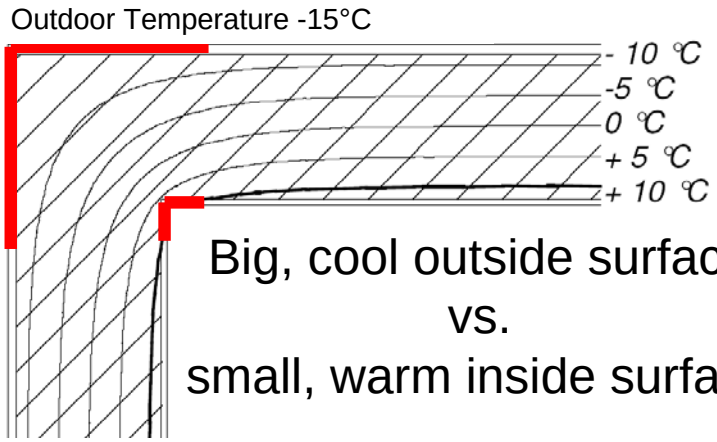
Type of thermal bridges

- Geometric Thermal Bridges
- Material based Thermal Bridges due to different material characteristics (conductivity)
- Combination of geometric and material based Thermal Bridges

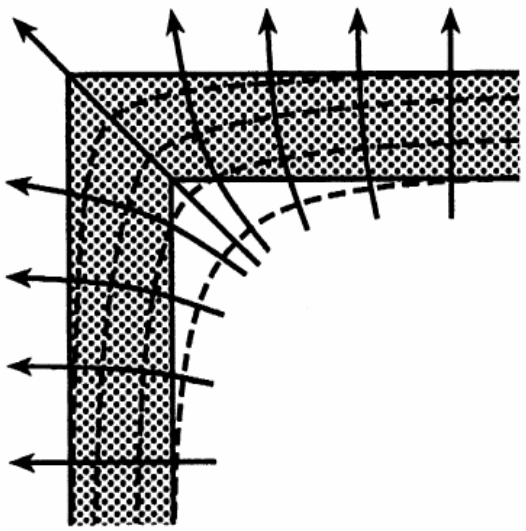
Source:

What are thermal bridges?

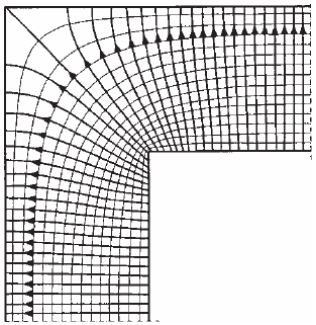
Type of thermal bridges: Geometric TB



Big, cool outside surface
vs.
small, warm inside surface



Indoor Room Temperature +20°C



Effect described with:

Isotherms = Lines with the same temperature

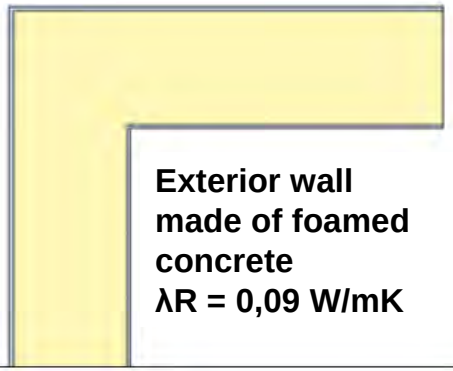
Adiabates = Lines with the same heat flux (orthogonal to isotherms)

Source:

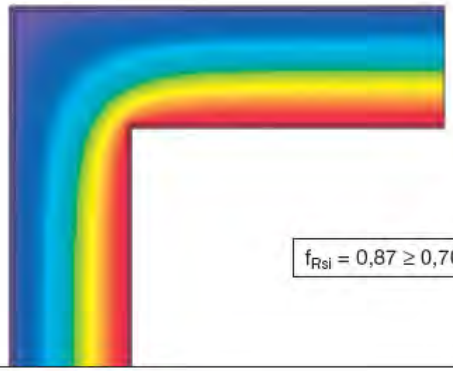
What are thermal bridges?

Type of thermal bridges: Geometric TB

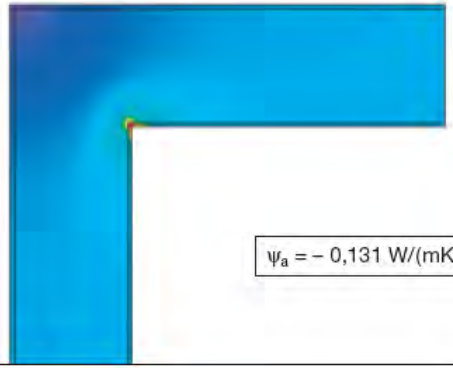
Construction



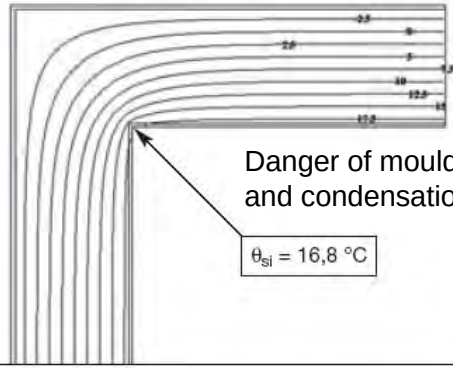
Temperatures



Heat Flux



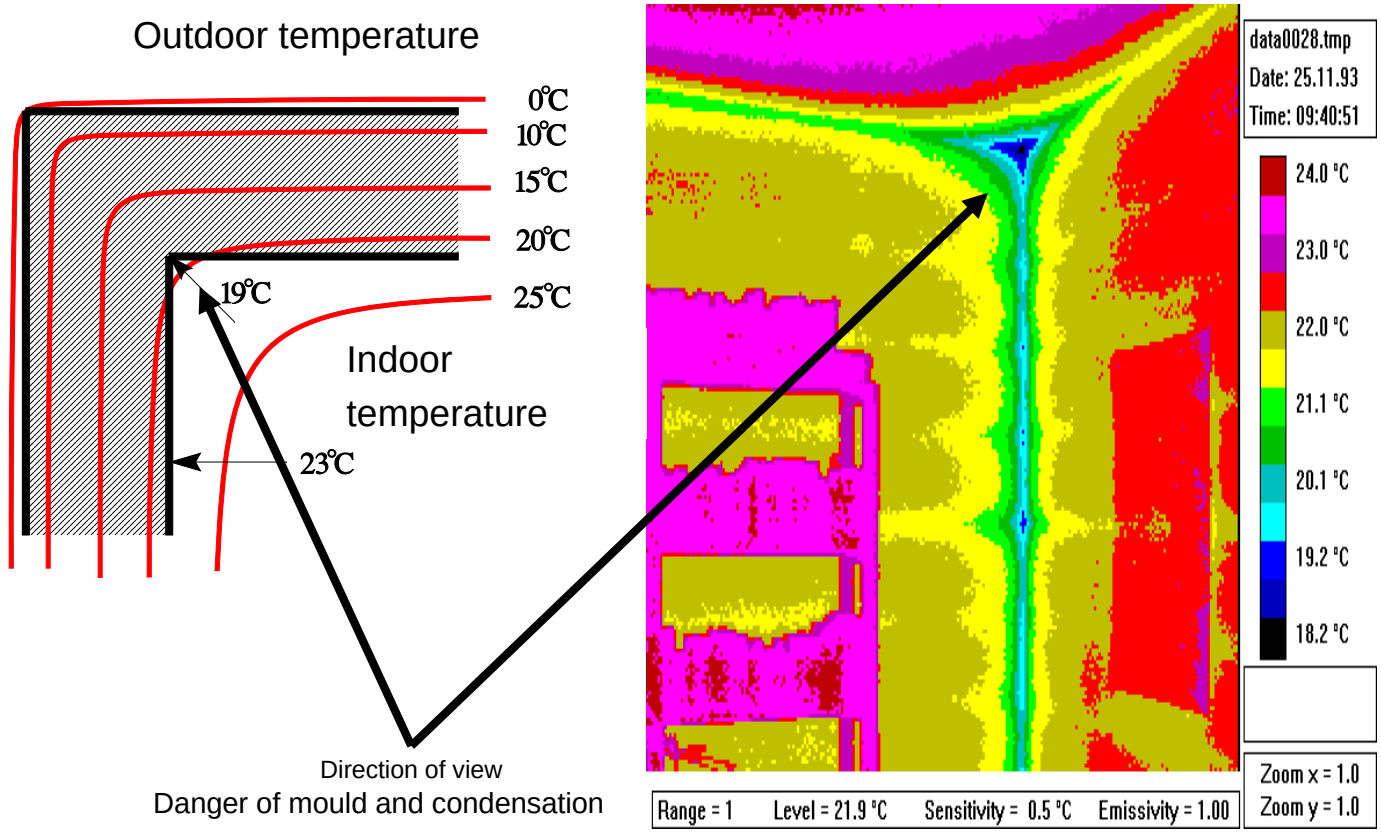
Isotherms



Source: Wärmebrückenkatalog Porenbeton

What are thermal bridges?

Type of thermal bridges: Geometric TB



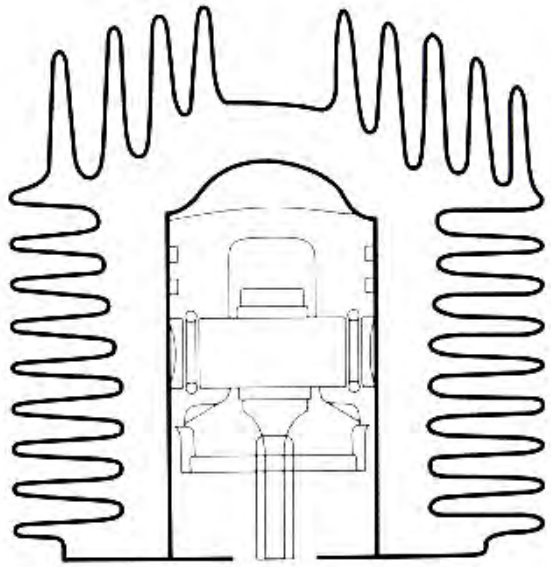
Source: Uni Siegen - MESSLAB

What are thermal bridges?

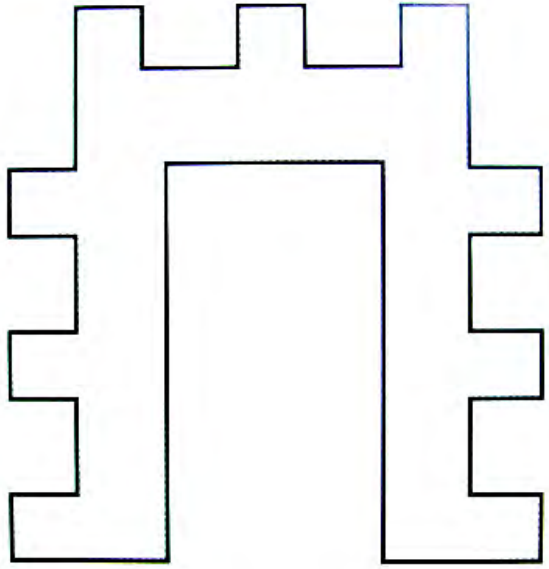
Type of thermal bridges: Geometric TB

Proportion between Surface Area and Volume + Geometric thermal bridge - Examples

„cooling fin“ of a motor generator



Ground plan of a building with many surfaces exposed to the exterior climate



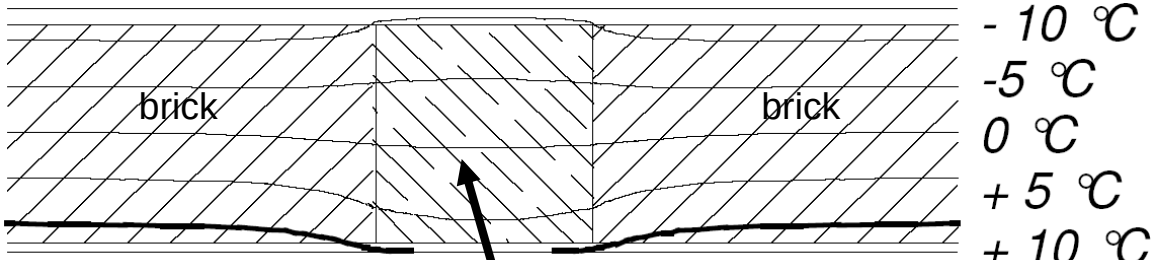
Source: Andreas Holm – Bauphysik - Feuchteschutz

What are thermal bridges?

Type of thermal bridges: Material based TB

Thermal bridges due to different conductivities

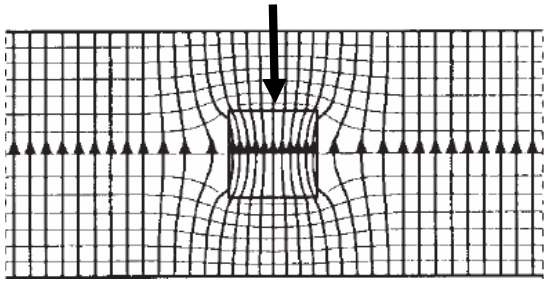
Outdoor Temperature -15°C



Room Temperature +20°C

Higher conductivity in the area of the concrete column

Materials of different heat conductivity side by side



Result:
- higher temperatures outside,
- lower temperatures inside with danger of mould and condensation

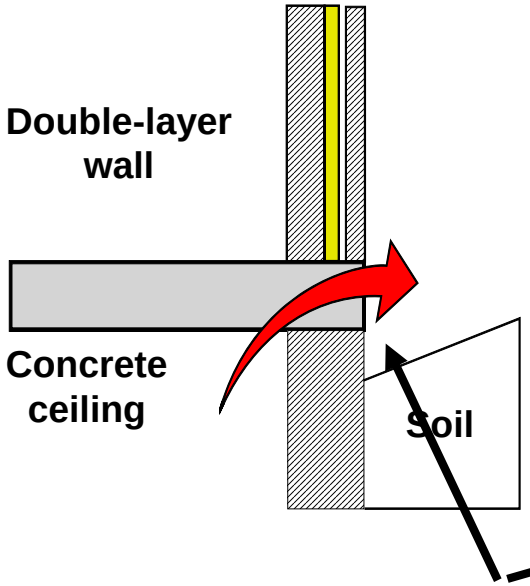
The adiabates are showing a higher heat flux across the column.

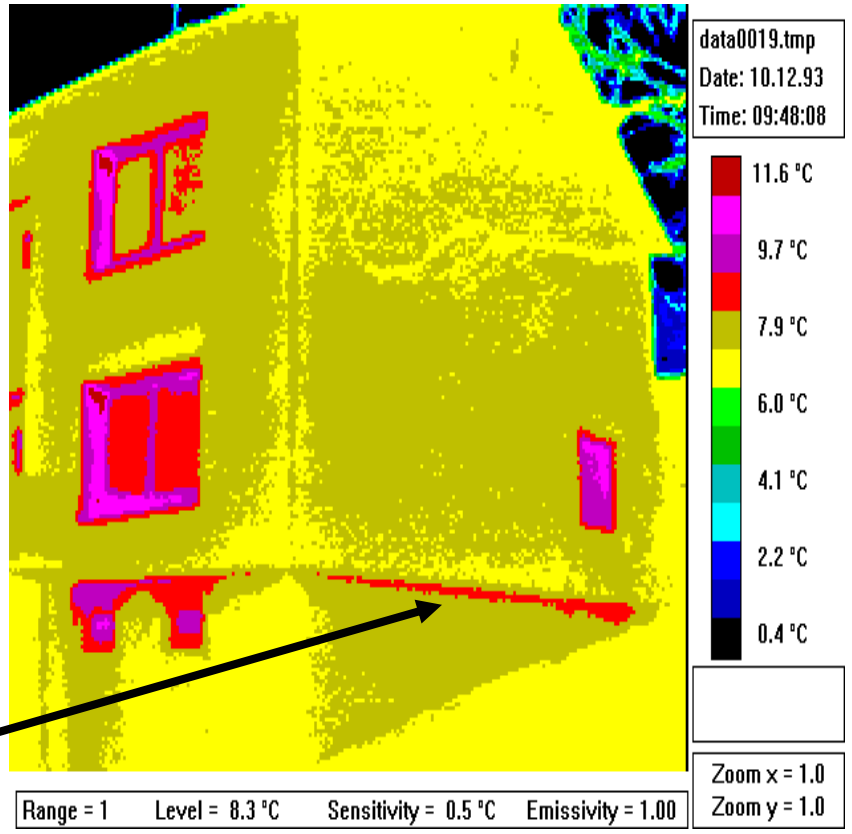
Source:

What are thermal bridges?

Type of thermal bridges: Material based TB

Joint Basement – exterior wall

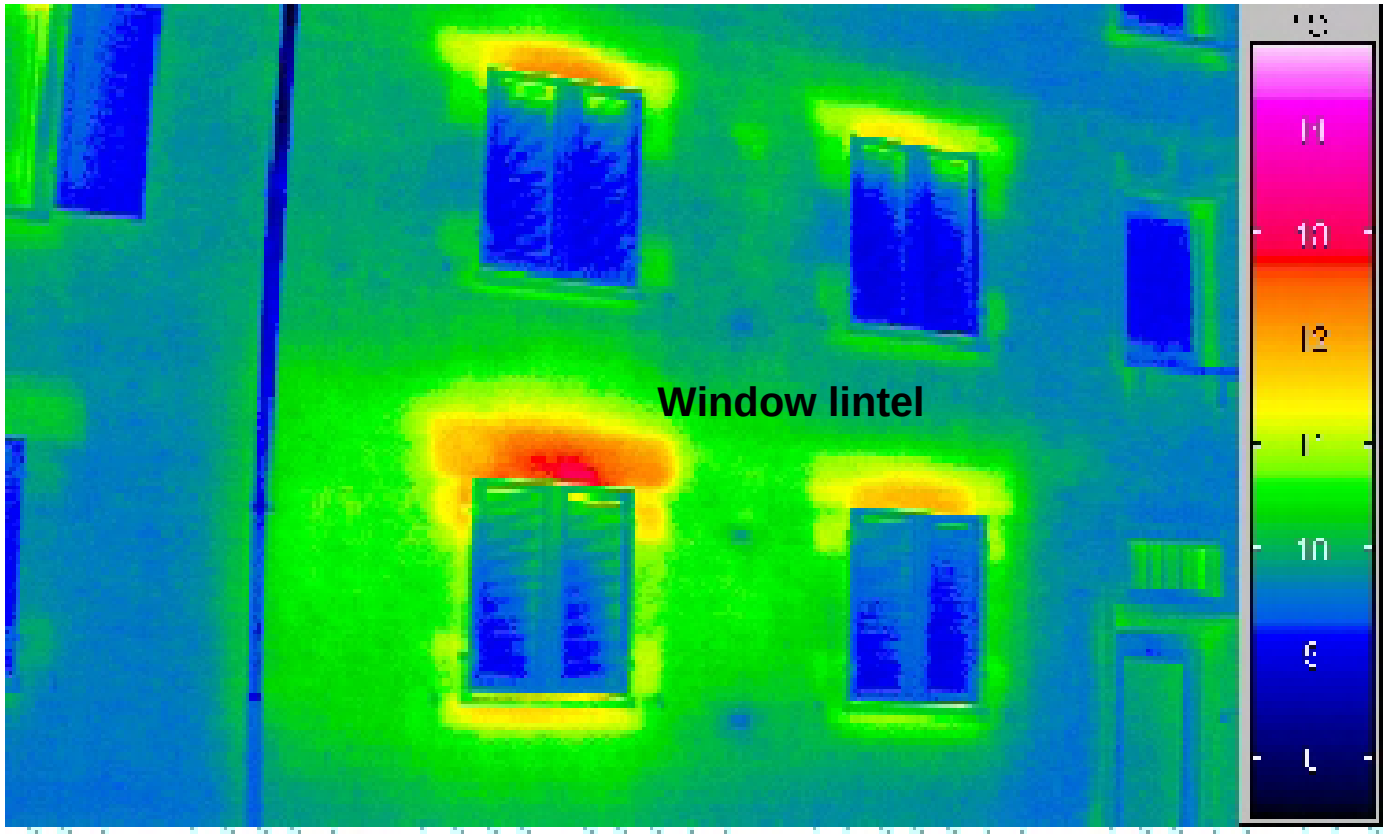




Source: Uni Siegen - MESSLAB

What are thermal bridges?

Type of thermal bridges: Material based TB

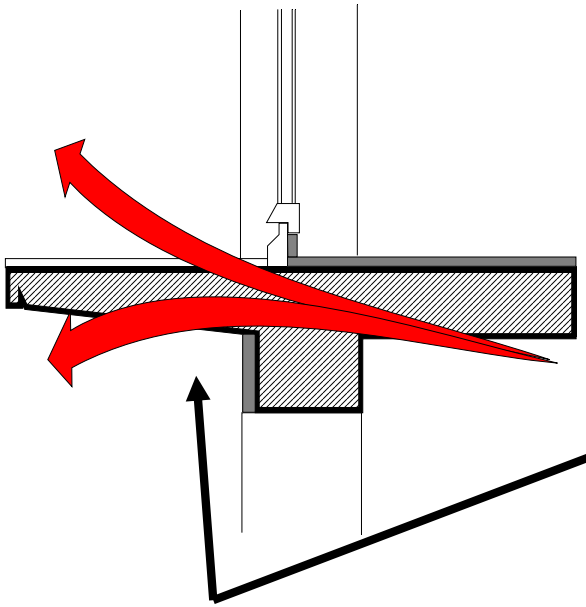


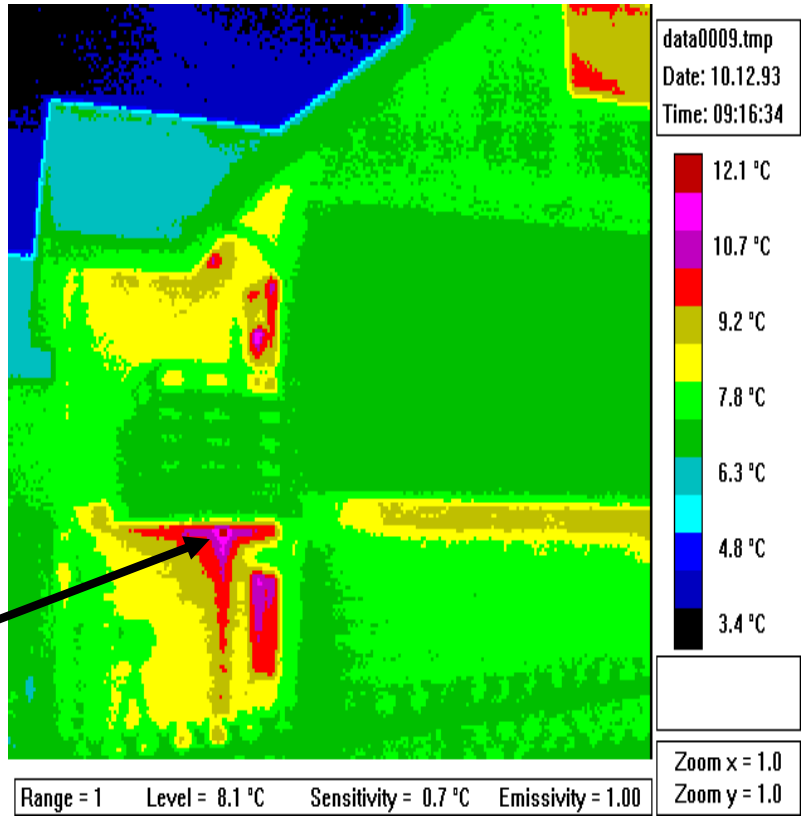
Source: www.uni-kl.de/FB-ARUBI/AG-Heinrich/index_de.htm

What are thermal bridges?

Type of thermal bridges: Combined TB (geometric + material based)

Cantilevered concrete slab of a balcony





Source: Uni Siegen - MESSLAB

How to handle thermal bridges?

Libraries of thermal bridge coefficients

The kind thermal bridge gives thermal bridge coefficient Ψ [W/(mK)].

One way is to calculate it by yourself (see 03.03)

Some scientific institutions have published libraries of thermal bridge coefficients. Their use is another way to get values for a thermal calculation.

One example is the “Swiss catalogue of building components” from “**energie**schweiz” (It is in German).

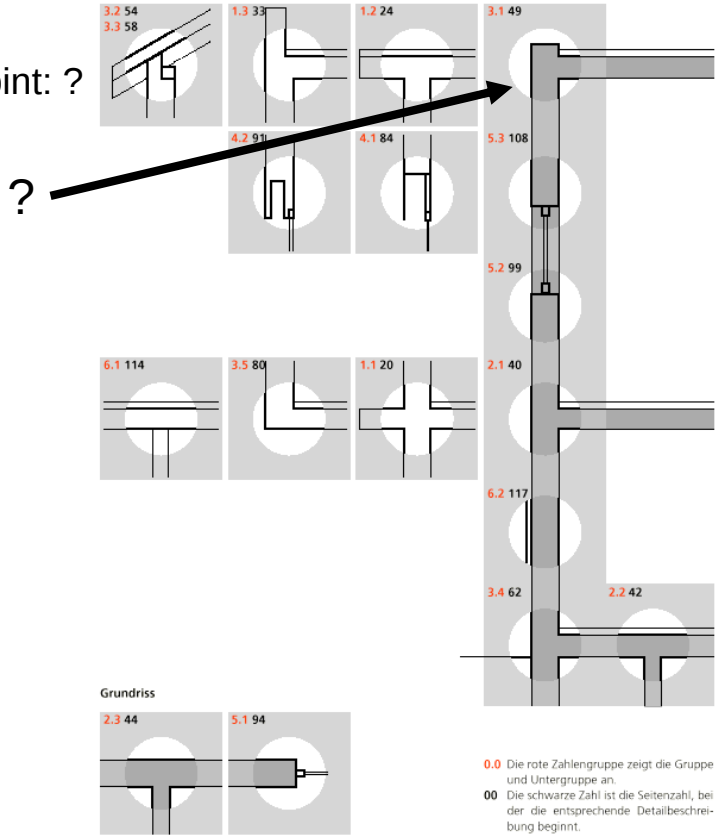
It is available: www.bfe.admin.ch > Themen > Gebäude > Planungswerkzeuge

Source:

How to handle thermal bridges?

Libraries of thermal bridge coefficients

1. Choose the construction point: ?



Source:

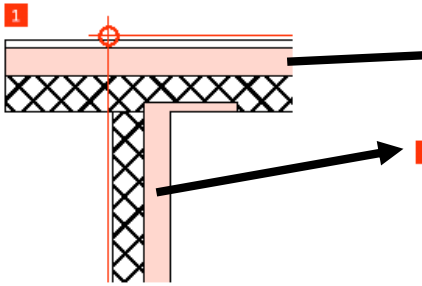
How to handle thermal bridges?

Libraries of thermal bridge coefficients

2. Choose the right thermal bridge coefficient Ψ W/(m·K) by the U-Values (U-Wert) of the bordering elements:

Ungedämmt, mit Deckendämmeinlage, Mauerwerk Stahlbeton — **1.2-I2**

1



U-Wert Wand in W/(m² · K)	*U*-Wert Dach in W/(m² · K)				*Ψ*-Wert in W/(m · K)	
	0.15	0.20 [2]	0.25	0.30	0.35	0.40
0.15	0.30	0.28	0.25	0.23	0.21	0.18
0.20	0.34	0.32	0.29	0.27	0.24	0.21
[2] 0.25	0.32	0.31 [3]	0.28	0.26	0.23	0.21
0.30	0.31	0.30	0.28	0.26	0.23	0.21
0.35	0.29	0.29	0.26	0.25	0.22	0.20
0.40	0.26	0.26	0.24	0.23	0.20	0.18

Einschränkungen	
Deckendicke	20 cm

Zuschläge	
Deckendicke 18 cm	– 0.03 W/(m · K)
[4] Deckendicke 22 cm	+ 0.03 W/(m · K)
Deckendicke 24 cm	+ 0.06 W/(m · K)

3. Take the result for calculation

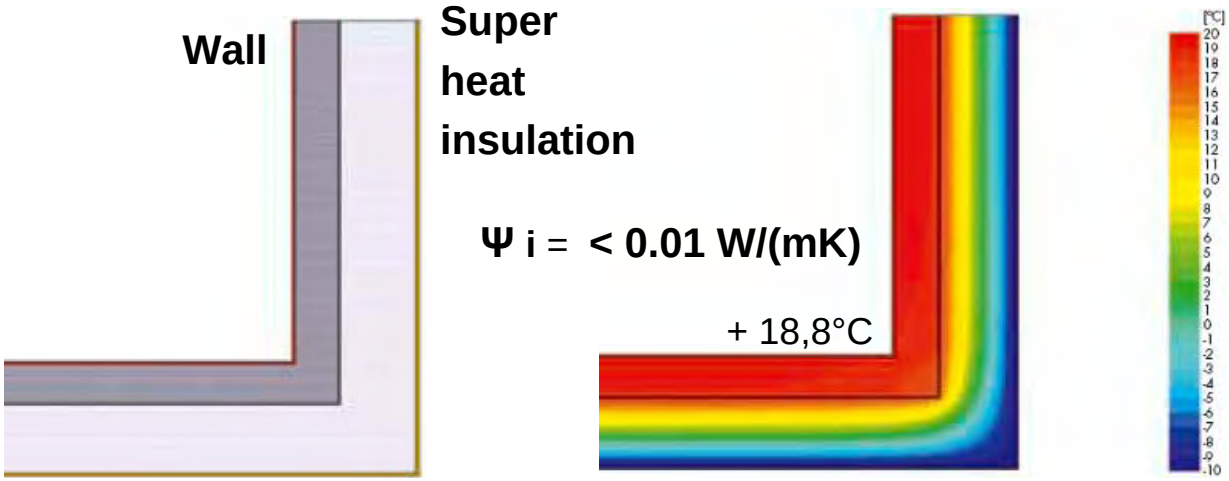
[5] $\Psi = 0.31 + 0.03 =$ **0.34 W/(m · K)**

Source:

How to handle thermal bridges?

Thermal bridge coefficients and PH

If we use for the Passive House-Standard the required high thermal quality of the building shell some types of thermal bridges are not longer relevant.



Ψa = < 0.01 W/(mK)

Geometric thermal bridges are not longer relevant !!!

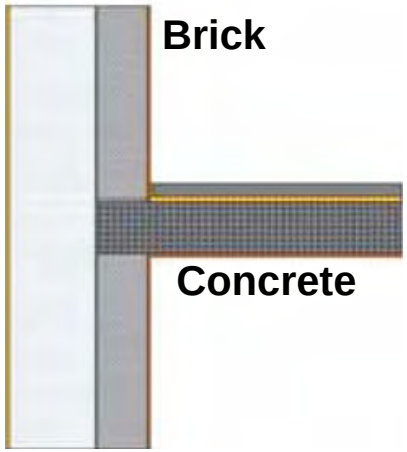
Source:

How to handle thermal bridges?

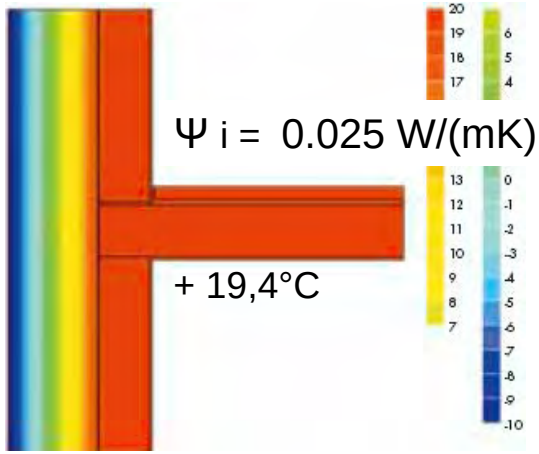
Thermal bridge coefficients and PH

If we use for the Passive House-Standard the required high thermal quality of the building shell some types of thermal bridges are not longer relevant.

super heat insulation



Ψa = < 0.01 W/(mK)



A thermal bridge like this is not longer relevant !!!

Source:

How to handle thermal bridges?

Thermal bridges and PH

Out of this, planers working in the high technically quality level “Passive House-Standard” have to look mainly to material based thermal bridges.

The strategy must be:

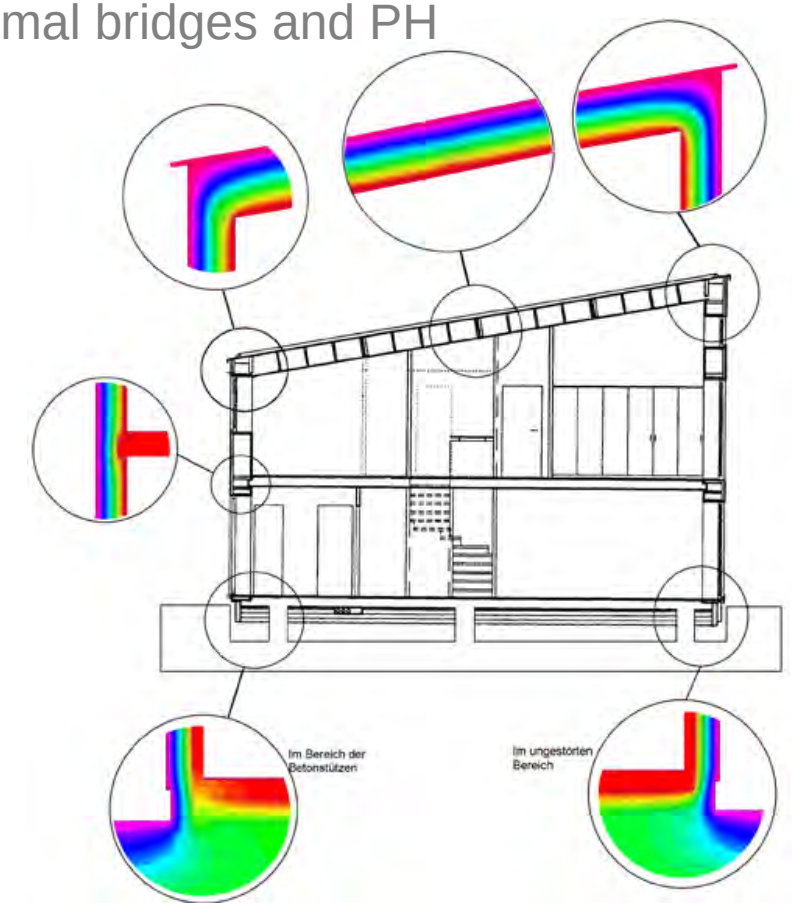
1. Avoid them as good as possible

2. Reduce the heat flux as good as possible

Source:

Thermal bridge free/reduced constructions

Thermal bridges and PH



The best way to handle thermal bridges is to avoid them.

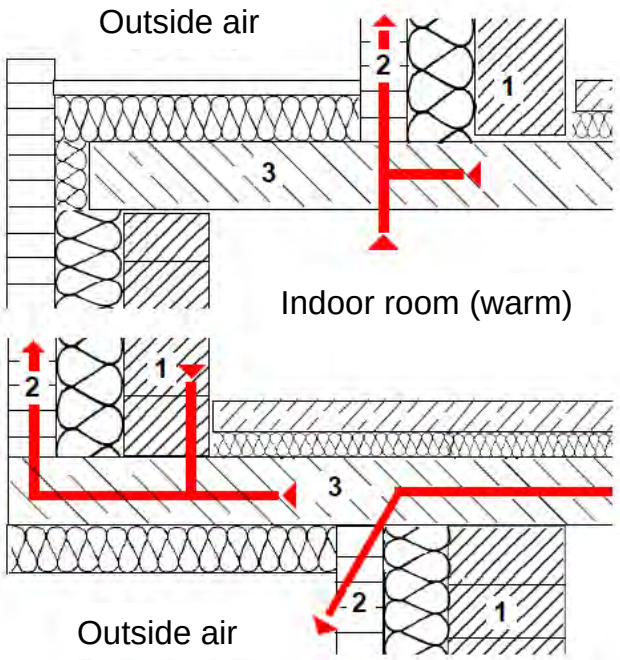
Danger of Condensation

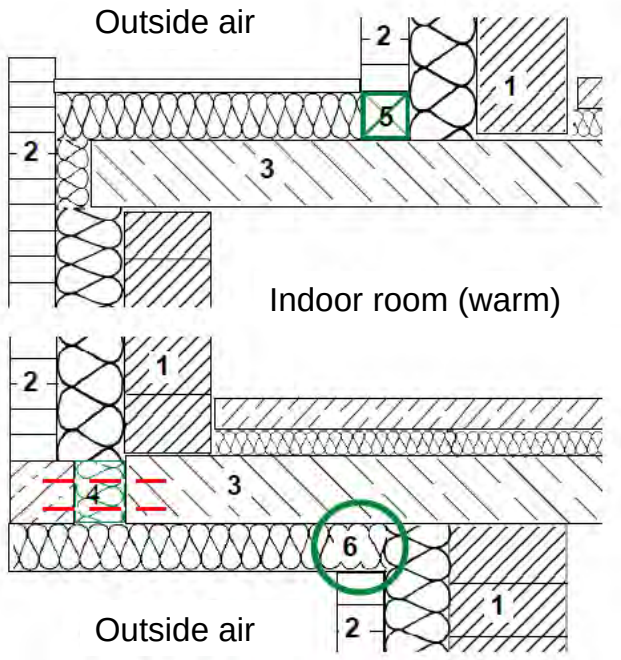
Ziel:
Die wärmebrückenfreie Gebäudehülle

Source: Wärmebrücken – Ursachen u. Auswirkungen, IWU-Darmstadt

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges





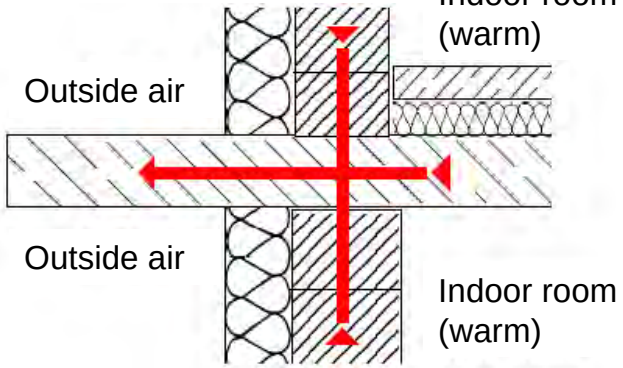
1 **Inside wall (warm)**
2 **Cladding (cold)**
3 **Cantilever slab**

4 **Thermal separated bearing**
5 **Heat flow resistant brick**
6 **Heat insulation of the slab and the wall connected**

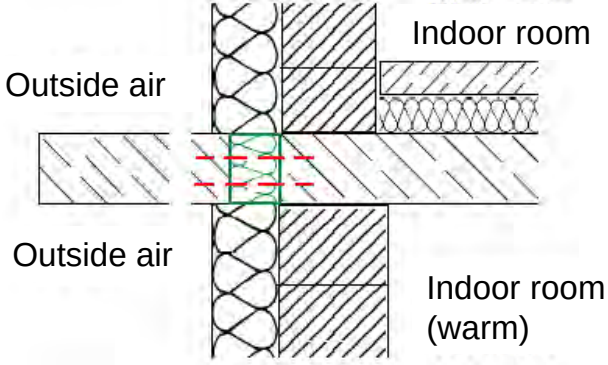
Source: www.nei-dt.de/neh-baupraxis/5__Warmebrucken/Kap504.pdf

Thermal bridge free or reduced constructions

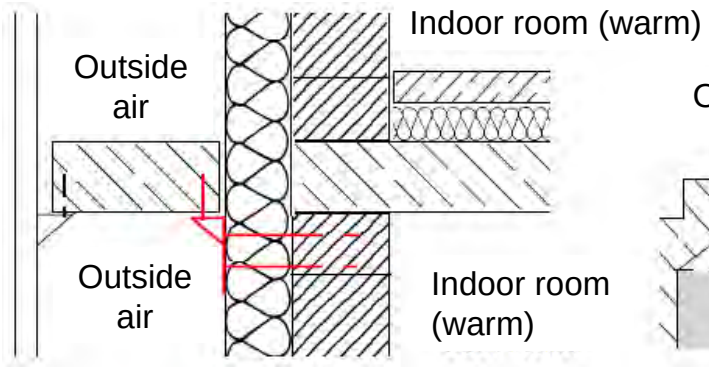
Ways to reduce Thermal Bridges



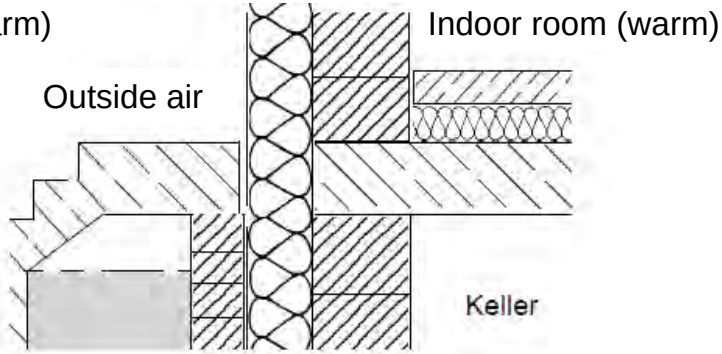
- „Isokorb“ for thermal separation



- Only bearing points (stainless steel)



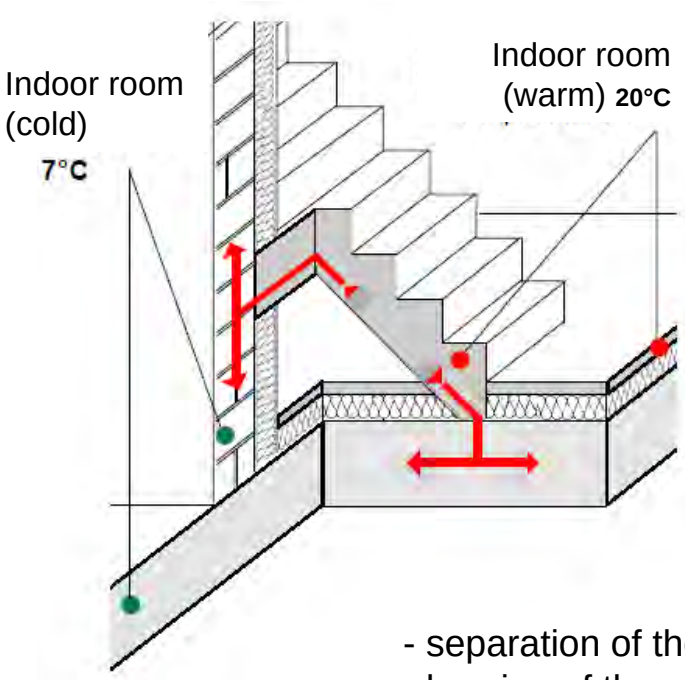
- Completely separated construction

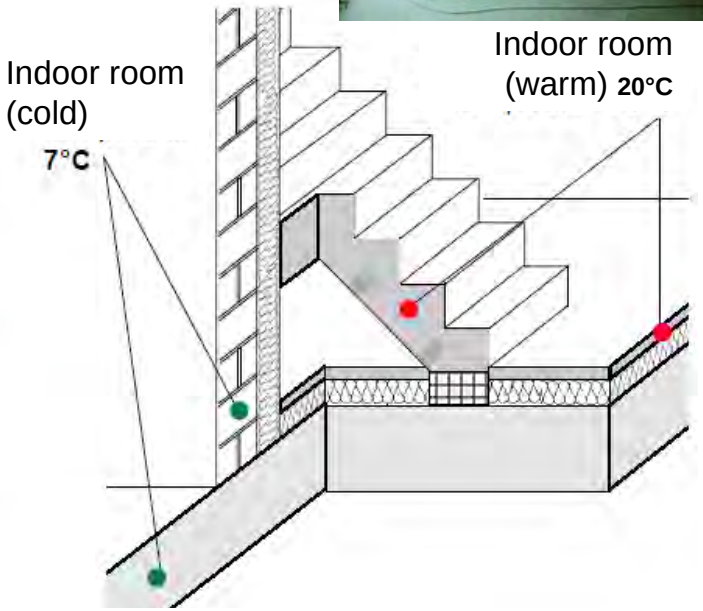


Source: www.nei-dt.de/neh-baupraxis/5__Warmebrucken/Kap504.pdf

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges



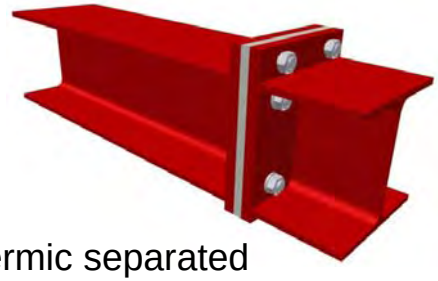


- separation of the building components + heat insulation
- bearing of the stairs on a „thermal brake“

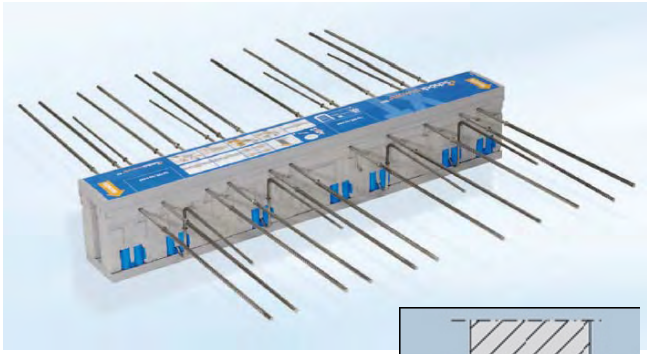
Source: www.nei-dt.de/neh-baupraxis/5__Warmebrucken/Kap503.pdf

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

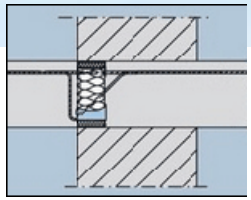


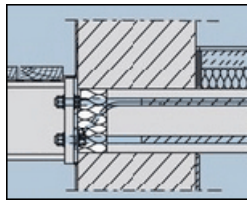
Thermic separated
end plate joints

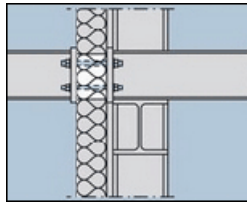


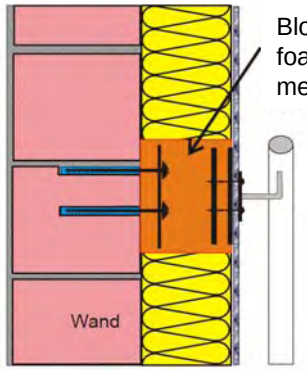
Thermal breake „Isokorb“

Schöck Bauteile AG

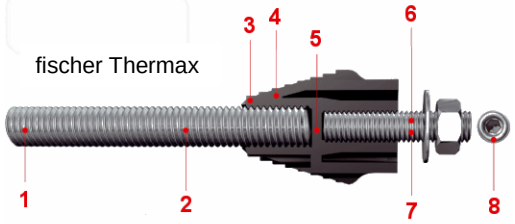








Thermal bridge
reduced fixing
on an insulated
outside wall

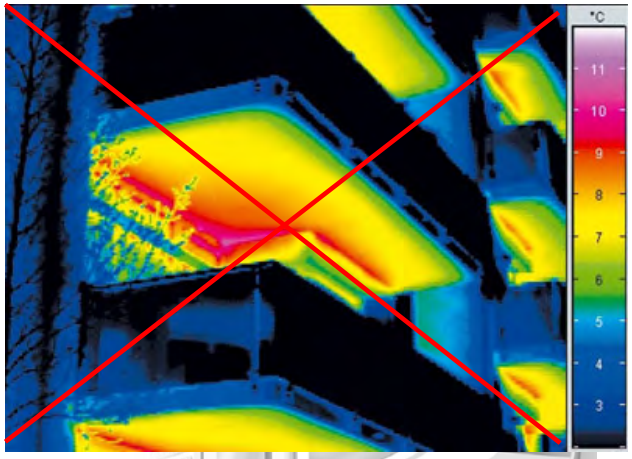


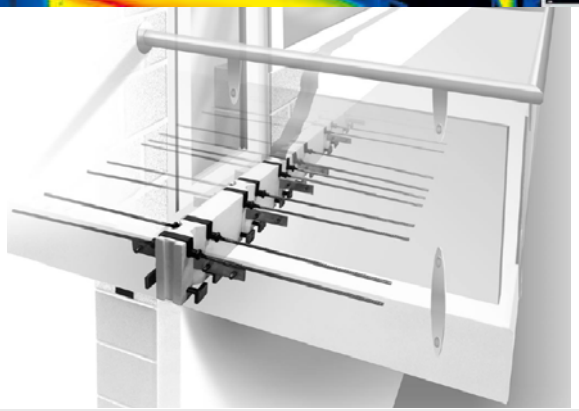
Reduced thermal
bridges of screws

Source: www.stahlbau.tu-darmstadt.de/Forschung/forschung_goepfert.html Wärmebrücken – Ursachen u. Auswirkungen, IWU-Darmstadt

Thermal bridge free or reduced constructions

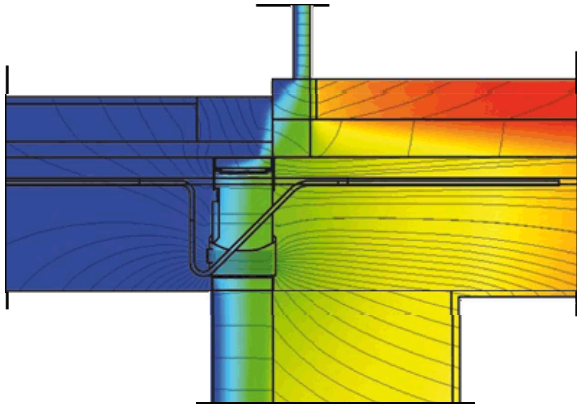
Ways to reduce Thermal Bridges

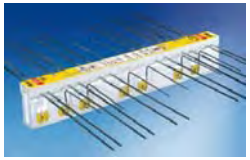


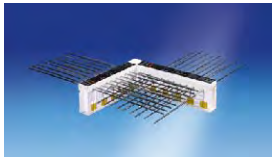


Thermal bridge reduced connection

Thermal breaks - special elements with connection of the construction plus thermal resistance





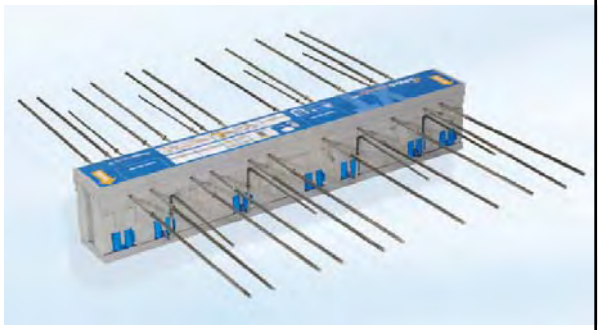


Source: Left down: Kragplattenanschlüsse aus rostfreiem Stahl, PROCEQ SA Others: Schöck Isokorb

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

This thermal break is certified by the Passive House Institute Darmstadt.



Isokorb XT - 12 cm

Reduced thermal bridge

$\Delta U_{WB} <$ **0,025 W/(m²K)**

Free of mould danger

$\theta_{i,min} >$ **17,00 °C**

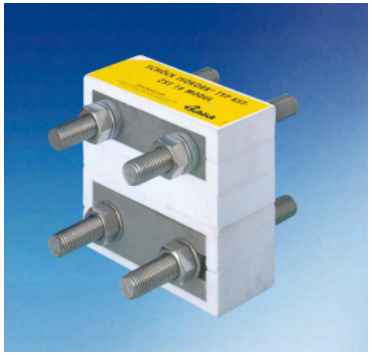
Isokorb	Minimal indoor surface temperature $\theta_{i,min}$ [°C]	Thermal bridge coefficient Ψ [W/(mK)]
QXT 10	18,92	0,10
QXT 30	18,87	0,11
KXT 50 V6	18,25	0,22
KXT 70 V8	18,05	0,25

Source: www.schoeck.de/de/neubau/schoeck-isokorb-xt-107

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

Other thermal breaks



Source: Schöck Isokorb

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

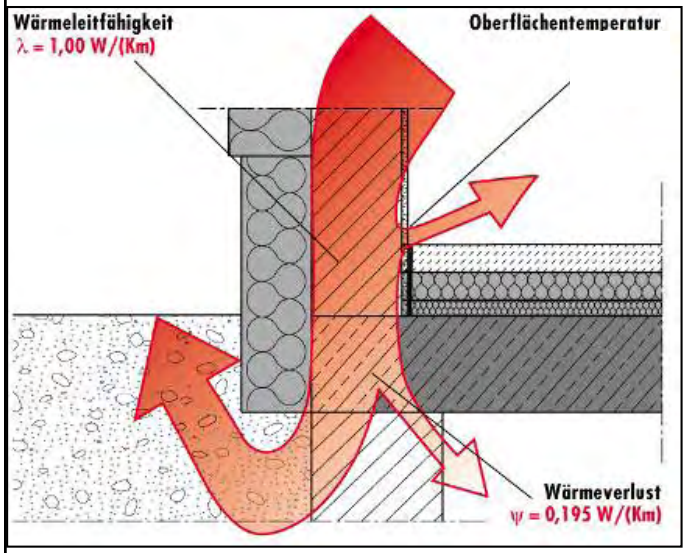
Mounting of thermal breaks

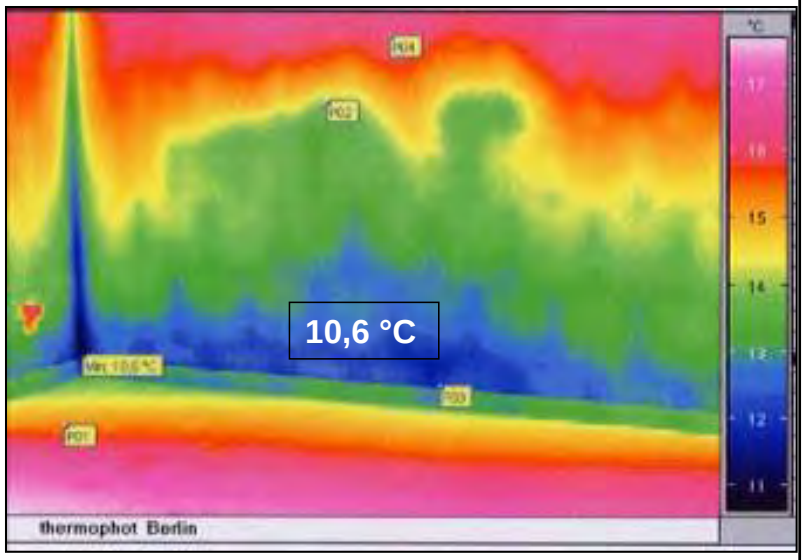
Source: www.bauingenieur24.de/sharedpics/pics_news/38_3.jpg www.energie-portal.info/cms/upload/pics-px-sanierung/Isokorb_XT_Einsatz_Schck.jpg

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

Problem: connection – outside wall / floor slab



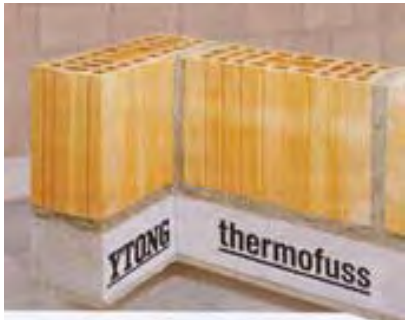


Source: Schöck Isokorb Thermophot Berlin

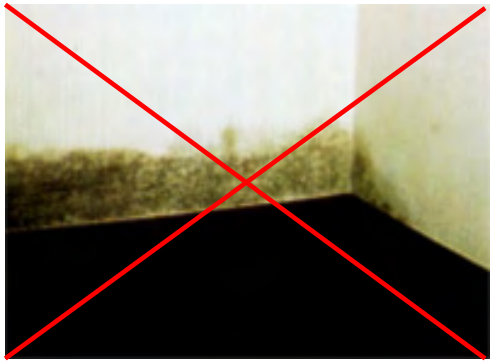
Thermal bridge free or reduced constructions

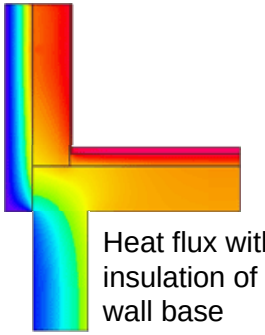
Ways to reduce Thermal Bridges – “Thermo foot”

...with foam concrete bricks

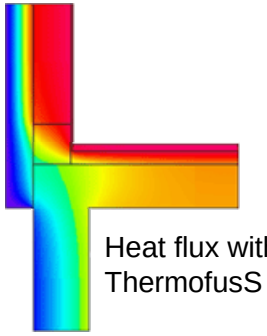


Surface temperature upgraded about 5°C at the critical spots.





Heat flux without insulation of the wall base



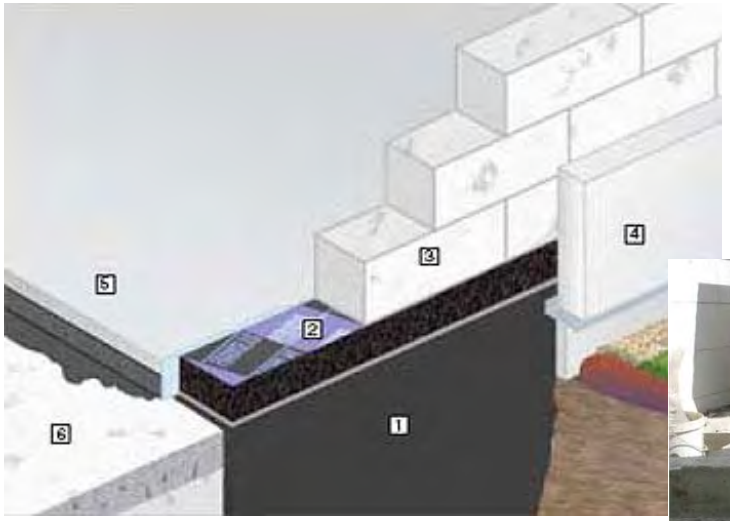
Heat flux with ThermofusS plus

Source: www.xella.ch/html/swi/ch/pb_4186

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Thermo foot”

...with foam glass bricks



FOAMGLAS®-Perinsul® SL

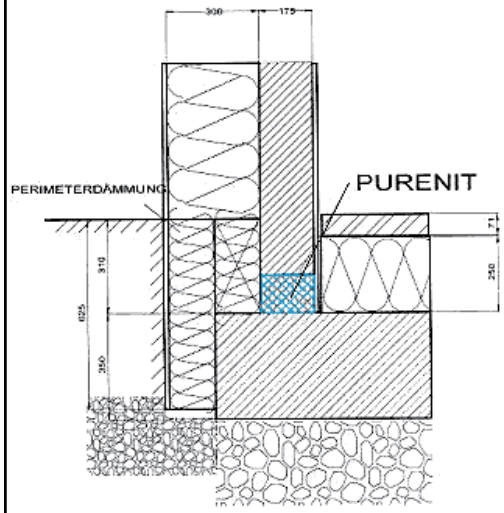
1 Sealant after DIN 18 1950 part 4
2 Perinsul® SL
3 Wall after DIN 1053 e.g. sand-lime brick, porous concrete
4 Thermal insulation composite system (ETICS)
5 Floor screed with insulation
6 Baseplate e.g. waterproof concrete

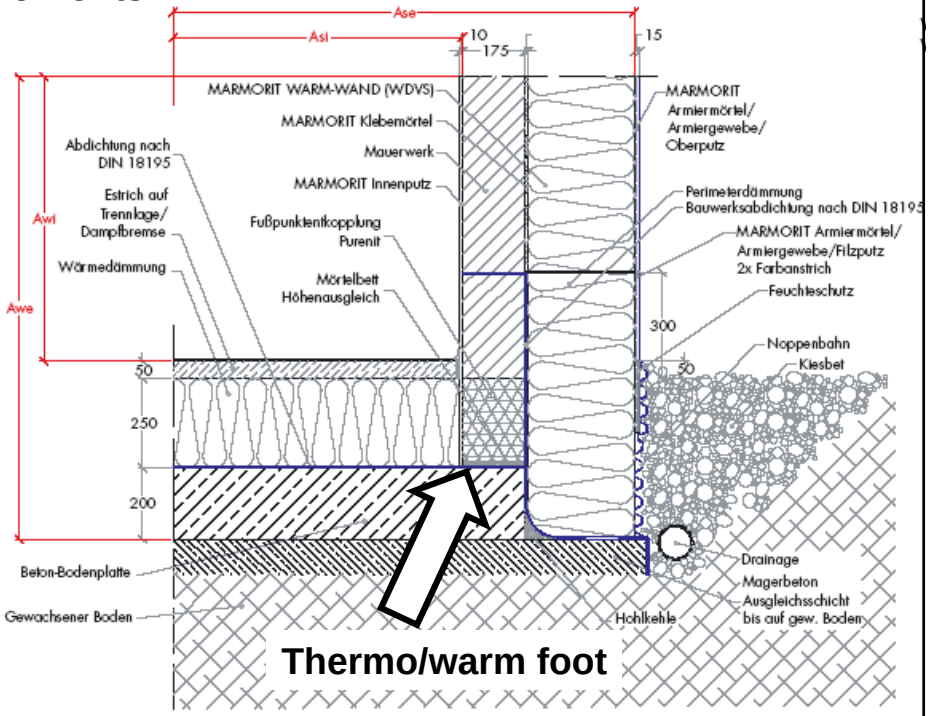
Source: www.foamglas.de/hochbau/framesets/fs_anwend6.htm

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Thermo foot”

...with hard heat insulation elements



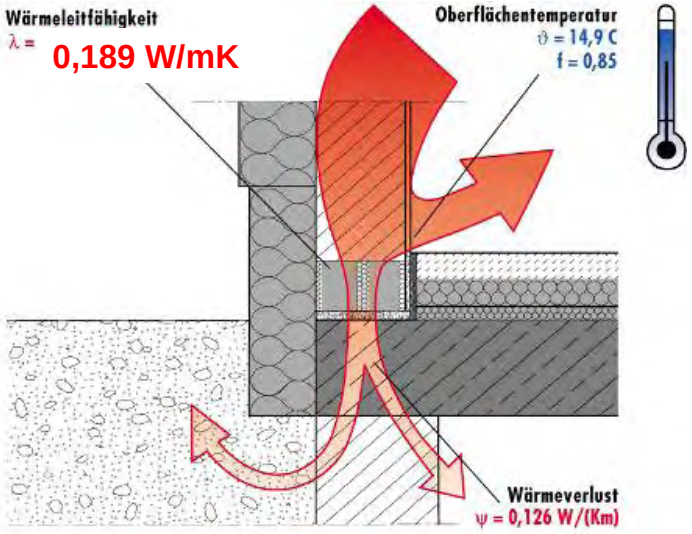


Source: www.baunetz.de/sixcms_4/sixcms/detail.php?id=57181&area_id=1170, www.marmorit.de/pages/passhaus

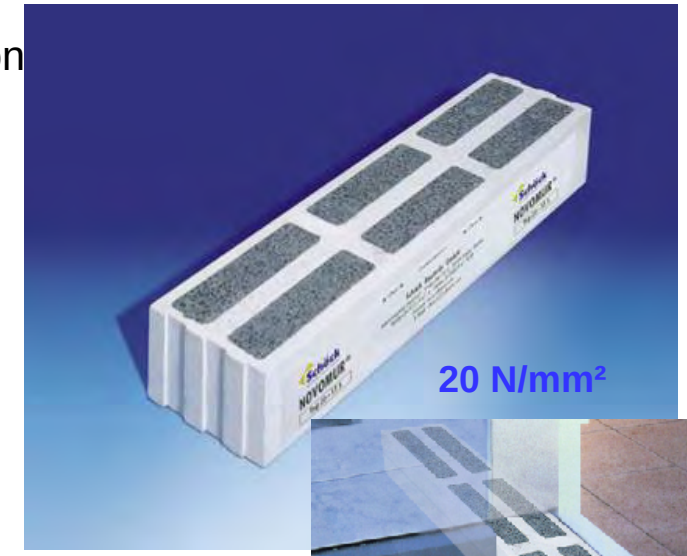
Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Thermo foot”

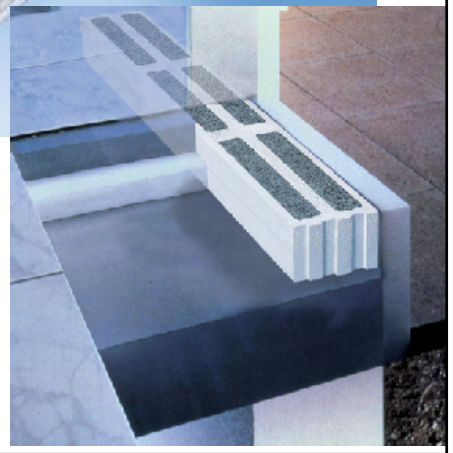
... with special elements with connection of the construction plus thermal resistance



Thermo foot



Schöck Novomur



Source: www.schoeck.de/Products,3.html

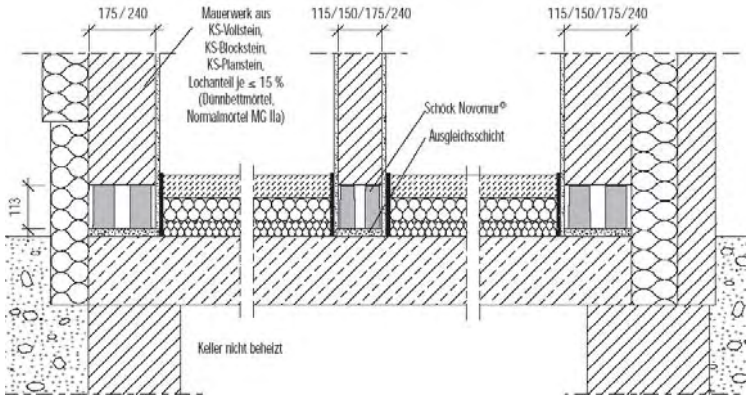
Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Thermo foot”

heat insulation outside

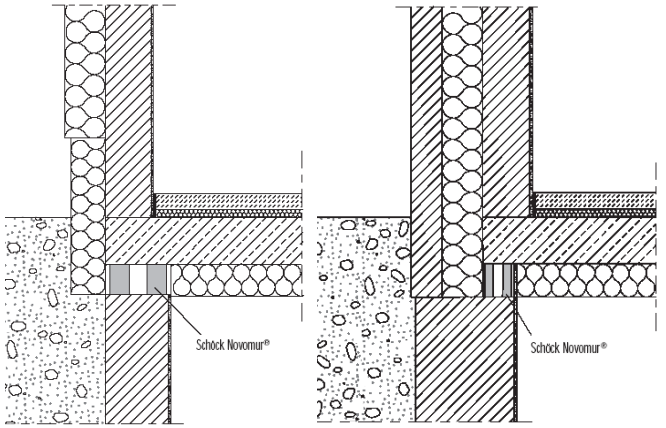
Internal wall

core insulated wall



heat insulation outside

core insulated wall



Schöck Novomur®

Thermo foot on the floor ceiling

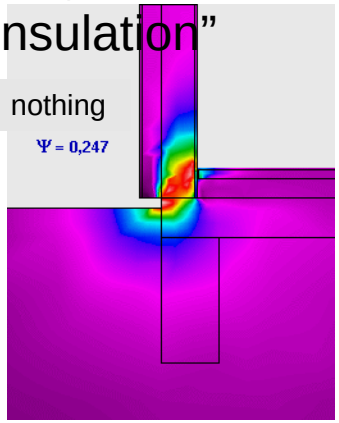
Thermo foot under the floor ceiling

Source: www.schoeck.de/upload/Files/Documents/1127283803.pdf

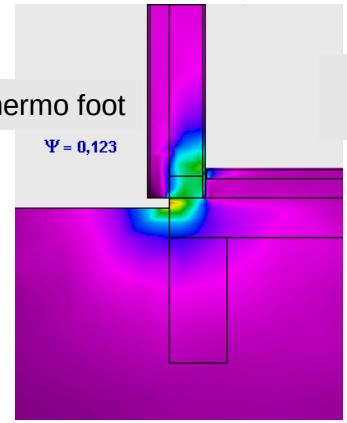
Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges - “Thermo foot + Base insulation”

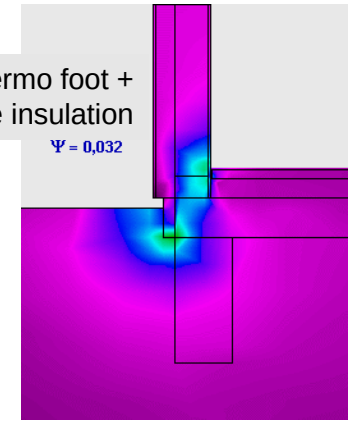
nothing



Thermo foot



Thermo foot + base insulation

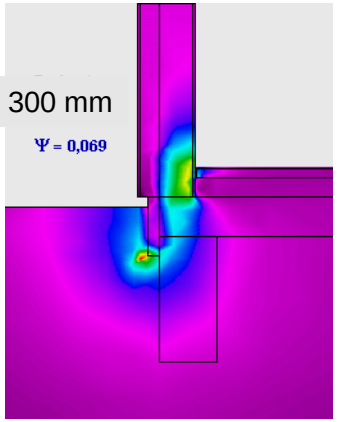


Outside wall:
ETICS 10 cm (WLG 040)
KS 17,5 cm Lamda 0,99
Thermo foot Lamda 0,33
Base insulation: 6 cm WLG 040
Floor slab:
Concrete 20 cm
Heat insulation 10 cm WLG 040
Cement screed 5 cm
Level outside = -0,20 m

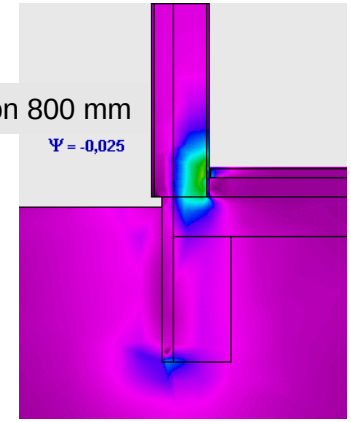
Simulation: Therm 2.1a

Psi-value calculation:
Delta T = 30K
U-value floor slab = 0,2139)

Base insulation 300 mm



Base insulation 800 mm



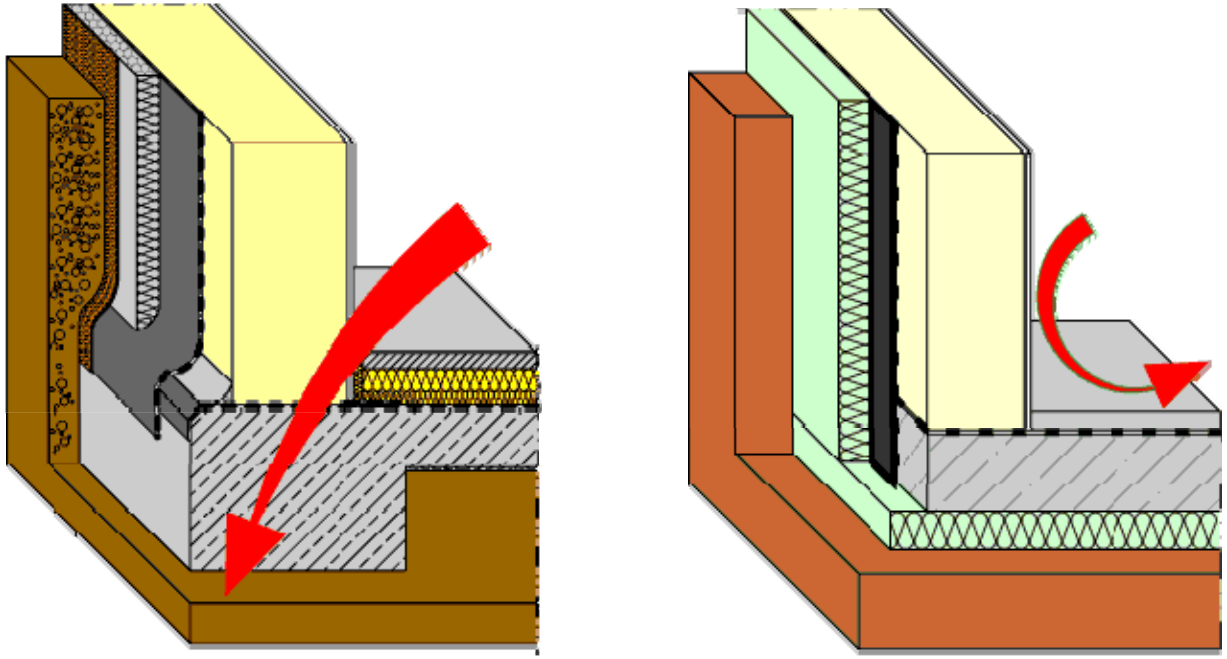
A „Thermo spoiler“ with base insulation is even a good concept for minimizing the thermal bridge.

Source: www.gamma2.de/bauphysik/kimmstein

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Base insulation”

The best concept for minimizing the thermal bridge is a **full heat insulation under floor slab**.



Source: www.prokeller.de/Planung/index-planung.html

Thermal bridge free or reduced constructions

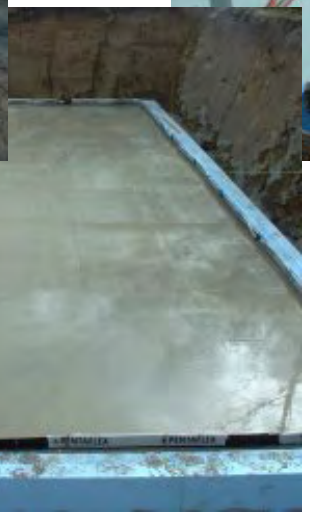
Ways to reduce Thermal Bridges – “Base insulation”

Heat insulation under
floor slab with **XPS**

Source: PH-roenn.de-Drangstedt

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Base insulation”



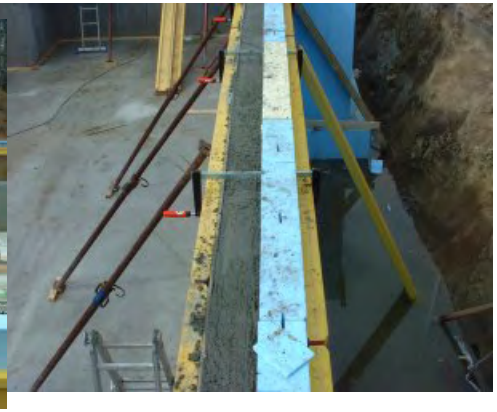
Heat insulation under floor slab with **XPS**

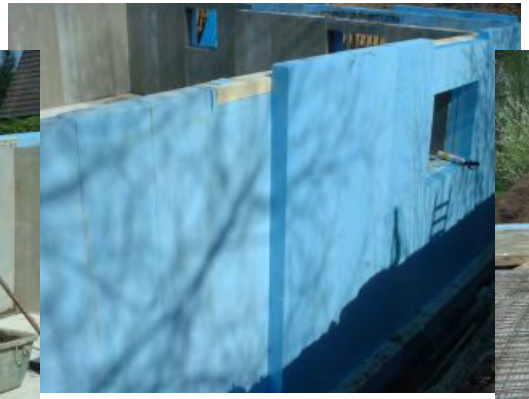
Source: www.PH-roenn.de-wohltorf

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Base insulation”



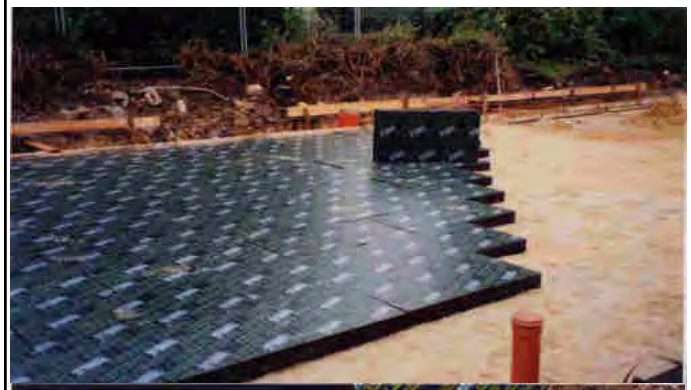




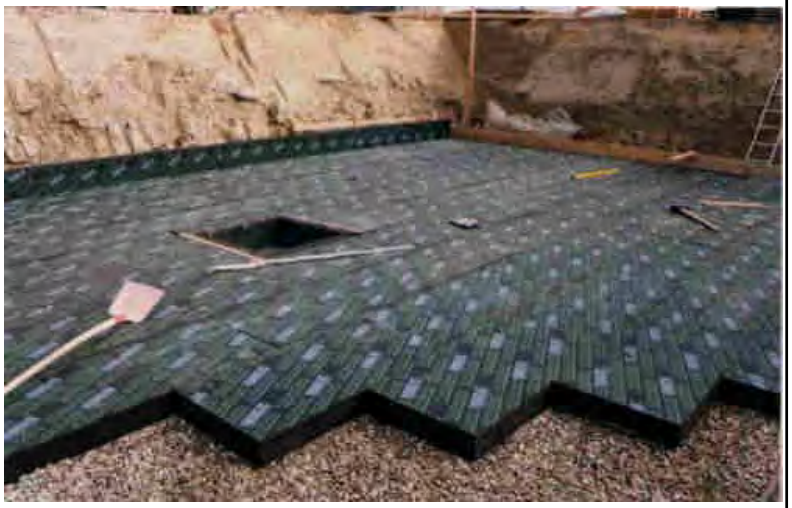

Source: www.PH-roenn.de-wohltorf

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Base insulation”



Heat insulation under
slab with **Foam glass panels**



Source: www.dimagb.de/info/bautec/perimd01.html

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges – “Base insulation”

Heat insulation under
slab with **Foam glass gravel**

Source:

Thermal bridge free or reduced constructions

Ways to reduce Thermal Bridges

A collection of “Thermal bridge free”
construction details see in
04.03_Solid constructions
and
04.04_Light weight constructions

Source: