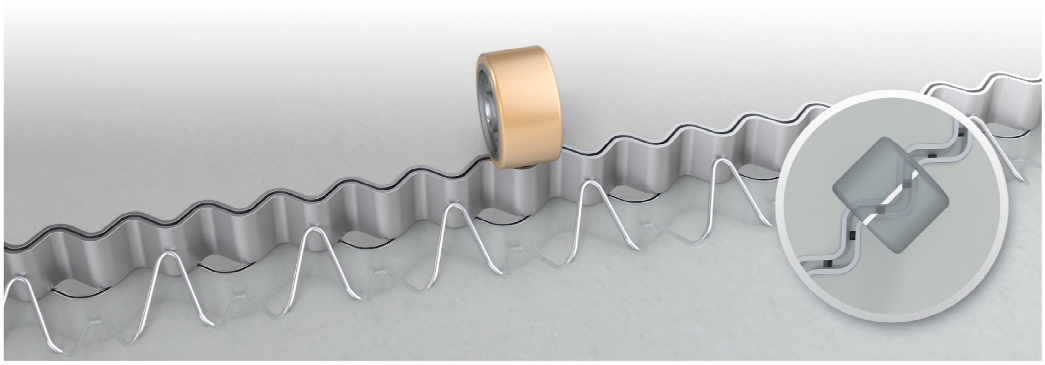
INTERNATIONAL JOINT TECH ENGINEERING

Joints in industrial floors

From saw cut joints to jointing systems with proven design



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INTERNATIONAL JOINT TECH ENGINEERING

Joints in industrial floors

Overview

- Review / history of joints
- Development of Sinus Slide® joints
- Development of Cosinus Slide® joints
- Why a design is now possible
- Determination of material resistance (laboratory tests / simulations)
- Loading actions at joints - load distribution and transfer

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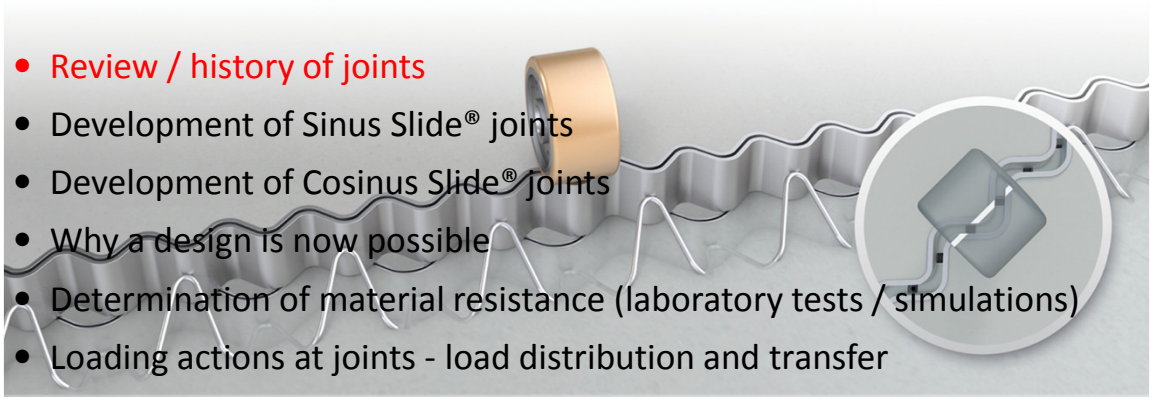
INTERNATIONAL JOINT TECH ENGINEERING

Joints in industrial floors

Overview



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INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

facts:

- Joints in concrete construction are nearly not to avoid
- Each joint in a concrete construction is a possible point of failure
- Joints a generally a weak point in terms of design
- Joints are limiting the use of a construction
- Joints usually require an intensive maintenance during the lifetime of the whole construction

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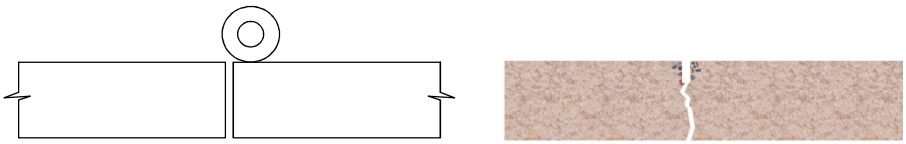
Review / history of joints

Flooring technology before 1980:
Shrinkage stresses compensated by saw cut joints



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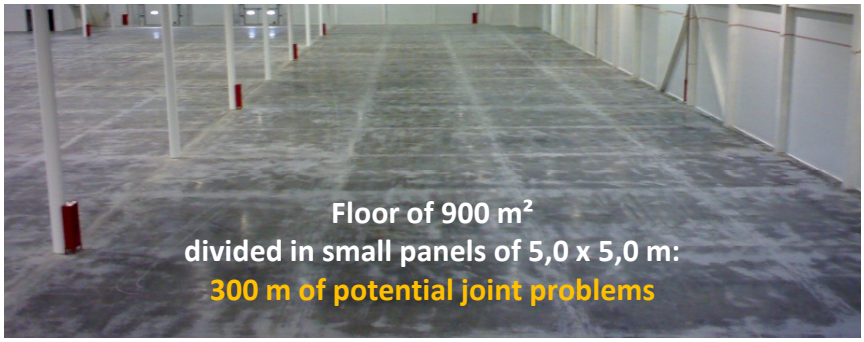

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Review / history of joints

Flooring technology before 1980:
Shrinkage stresses compensated by saw cut joints

The problems can be various …

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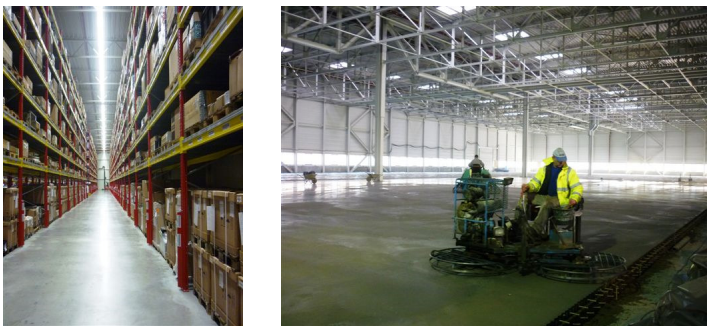
INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

Flooring technology since 1980:
Jointless floors are constructed
Potential joint problems reduced by about 80%



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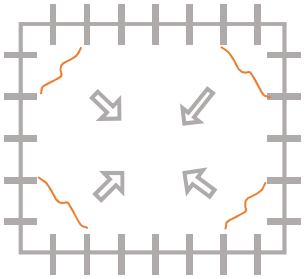
INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

Flooring technology since 1980:
Jointless floors are constructed

At the beginning with simple dowel systems
Disadvantage: No movements possible parallel to the joint



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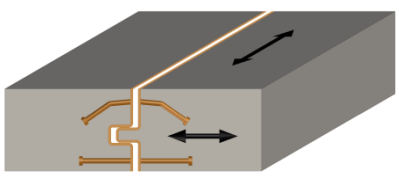
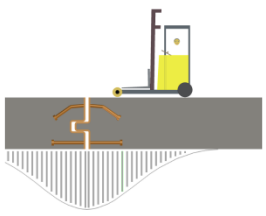
INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

Flooring technology since 1980:
Jointless floors are constructed

Later on with „Delta“ or „Omega“ – advantage:
Free horizontal movement to reduce shrinkage stresses with a proportional load transmission





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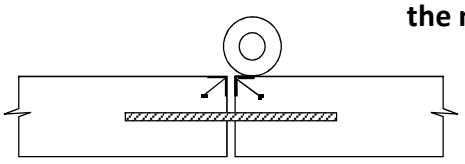
Review / history of joints

Between 1985 and 2006 various joint system have been introduced in the market:



Double corner with dowels

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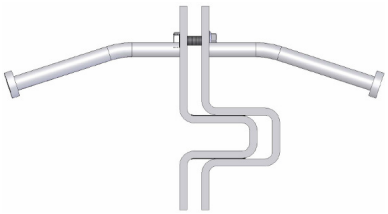
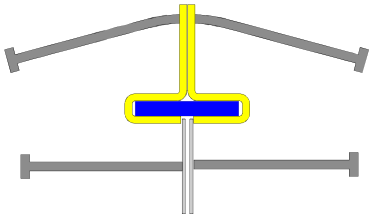
INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

Between 1985 and 2006 various joint system have been introduced in the market:

Joints with continuous load transfer system





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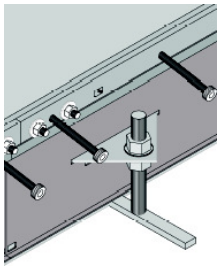
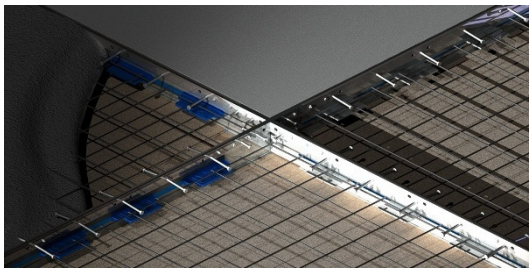
INTERNATIONAL JOINT TECH ENGINEERING

Review / history of joints

Between 1985 and 2006 various joint system have been introduced in the market:

Joints with discontinuous load transfer system





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Review / history of joints

Between 1985 and 2006 various joint system have been introduced in the market:

BUT ALL HAVE THE SAME WEAK POINT:
THE OPENING GAP OF THE JOINT!

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INTERNATIONAL JOINT TECH ENGINEERING

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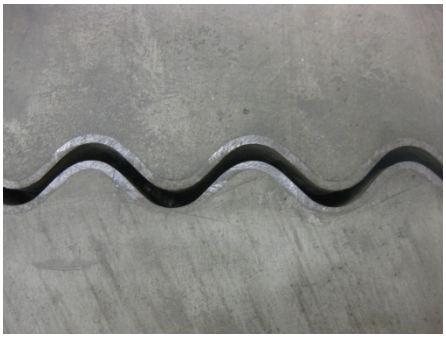
Development of Sinus Slide® joints

Idea: eliminate weak point „OPENING GAP OF JOINT“:



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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

Idea: eliminate weak point „OPENING GAP OF JOINT“:

Sinus Slide® joints have eliminated the cause of damage and are therefore considered a revolutionary innovative solutions in the industrial floor technology.

The Sinus Slide® joints allow shock- and vibration-free crossing - as if there would be no gap in the floor.

The joint is still visible but the floor panel is felt in the operation and serviceability completely joint free.

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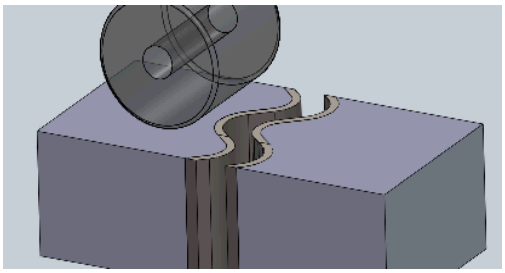
INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

Idea: eliminate weak point „OPENING GAP OF JOINT“:

With a Sinus Slide® joint the wheels of the forklift truck remain permanently in contact with the concrete by the sinusoidal concrete joint edges.



The permanent contact between the wheel and the concrete floor creates a sliding and noiseless crossing, so that users experience a feeling of a jointfree floor.

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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

Idea: eliminate weak point „OPENING GAP OF JOINT“:

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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

INITIAL SITUATION: WHOLE BODY VIBRATIONS

Problem: Through work on/with forklift trucks operators are exposed to whole-body vibration.

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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

INITIAL SITUATION: WHOLE BODY VIBRATIONS

Problem: Through work on/wi…are exposed to whole-body vibration.

Legal Terms: EU Directive 2…limits for exposure of drivers.

Consequence: operators/…d to carry out a risk assessment.

Solution: Simple constru…bots when driving over floor joints and provides legal certainty.

Result: A jointless floor, joint free in its sensation

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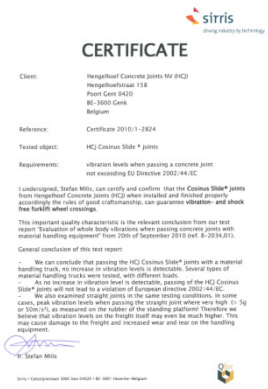
INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

scientifically proven:


sirris

CERTIFICATE

Client: Hengelhoof Concrete Joints NV (HCJ)
Hengelhoefstraat 158
Poort Gent 0420
BE-3600 Genk
Belgium

Reference: Certificate 2010/1-2824

Tested object: HCJ Cosinus Slide ® joints

Requirements: vibration levels when passing a concrete joint not exceeding EU Directive 2002/44/EC

I undersigned, Stefan Mills, can certify and confirm that the **Cosinus Slide® joints** from Hengelhoof Concrete Joints (HCJ) when installed and finished properly accordingly the rules of good craftsmanship, can guarantee **vibration- and shock free forklift wheel crossings.**

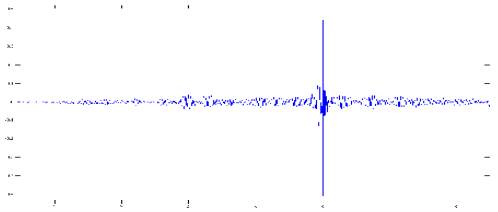
This important quality characteristic is the relevant conclusion from our test report "Evaluation of whole body vibrations when passing concrete joints with material handling equipment" from 20th of September 2010 (ref. 8-2034.01).

General conclusion of this test report:

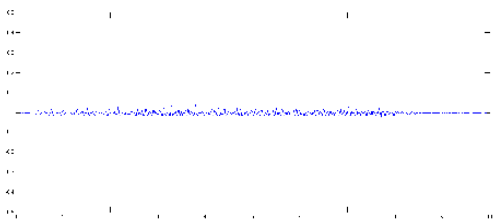
- We can conclude that passing the HCJ Cosinus Slide® joints with a material handling truck, no increase in vibration levels is detectable. Several types of material handling trucks were tested, with different loads.
- As no increase in vibration level is detectable, passing of the HCJ Cosinus Slide® joints will not lead to a violation of European directive 2002/44/EC.
- We also examined straight joints in the same testing conditions. In some cases, peak vibration levels when passing the straight joint where very high (> 5g or 50m/s²), as measured on the rubber of the standing platform! Therefore we believe that vibration levels on the freight itself may even be much higher. This may cause damage to the freight and increased wear and tear on the handling equipment.

Ir. Stefan Mills

Forklift crossing a linear joint



Forklift crossing a Sinus Slide® Joint



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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

Ecological and economic benefits of the sinusoidal form:

Facts related to wear and costs:

Fact 1: In average 66% of all damages of forklift trucks affect electric and wheels (source: InnoRad)

Fact 2: A major cause of failure of electric and wheels are shocks and vibrations (source : InnoRad)

Fact 3: Joint profiles in industrial floors are crossed 140 times per day on average (source : InnoRad)

Fact 4: Only by changing damaged wheels in Europe costs arise amounting to € 550 million per year. The average cost per forklift and year is € 755. The Europe-wide quantity of waste is nearly 17,000 tons per year (source: Linde)

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INTERNATIONAL JOINT TECH ENGINEERING

Development of Sinus Slide® joints

Ecological and economic benefits of the sinusoidal form:

By using Sinus Slide® Joints: minimize consequential costs and waste, both in floor as well as forklift trucks.
Savings between 25 and 50% depending on the forklift type, joint opening, operation time, speed, etc ..

Example: Logistic company operates at a site 50 forklift trucks
Average costs for wheel change € 755 x 50 = € 37,750 / year
Savings 25 - 50%: about 9,400-18,800 € / year
The investment costs pay off very quickly.

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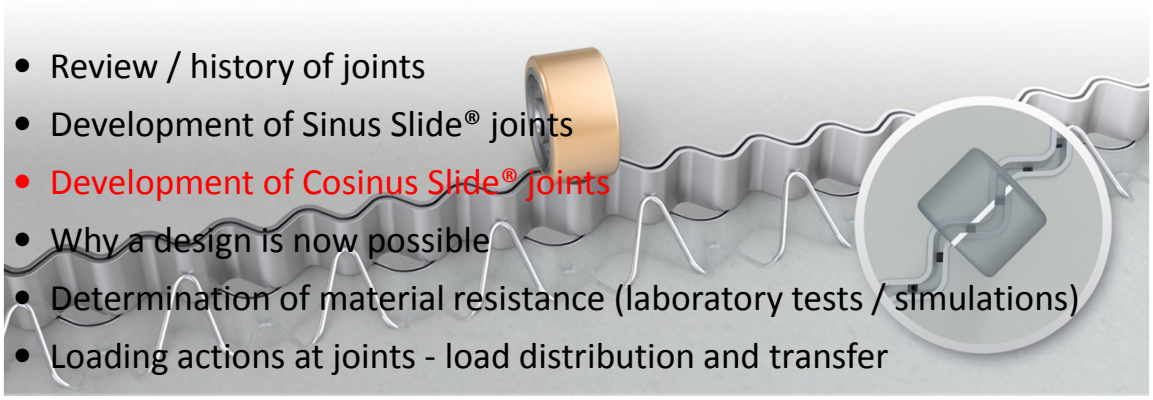
INTERNATIONAL JOINT TECH ENGINEERING

Joints in industrial floors

Overview



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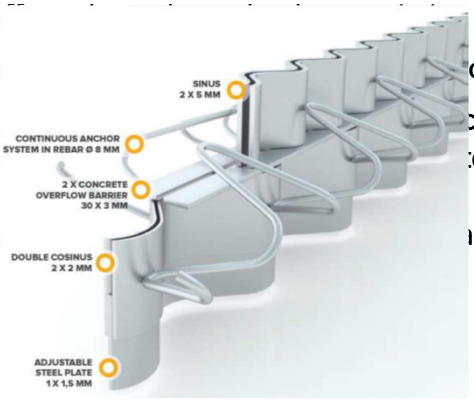
Development of Cosinus Slide® joints

INITIAL SITUATION:

- Existing systems often c
- Bearing capacity always onal component (dowel)
- Load transfer from the ctually
  - partially only sing ely in the center of the concrete section
  - depending on the anisms



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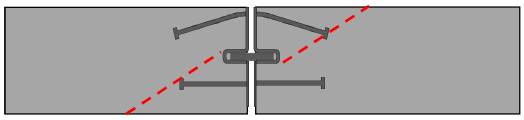
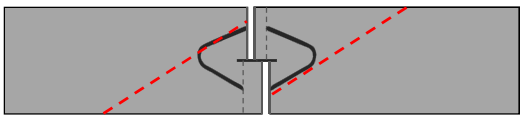
Development of Cosinus Slide® joints

- Existing systems often offer only moderate load transmission

Delta or dowels +/- 0,5 x h



COSINUS +/- 0,8 x h



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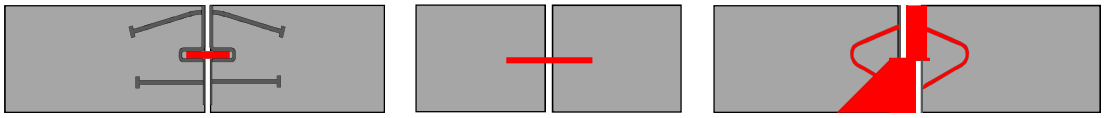
Development of Cosinus Slide® joints

- Bearing capacity always has be achieved through an additional component (dowel)

Delta **dowels or plates** **COSINUS**



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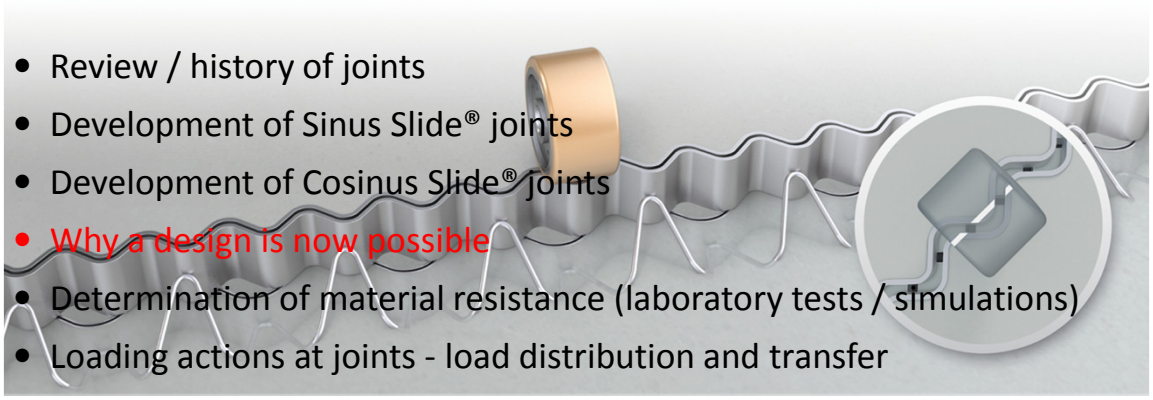
Joints in industrial floors

Overview



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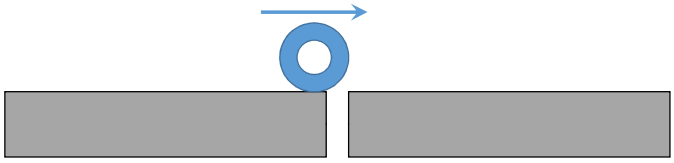
INTERNATIONAL JOINT TECH ENGINEERING

Why a design is now possible?

What happens when a dynamic load hitting a linear joint profile?



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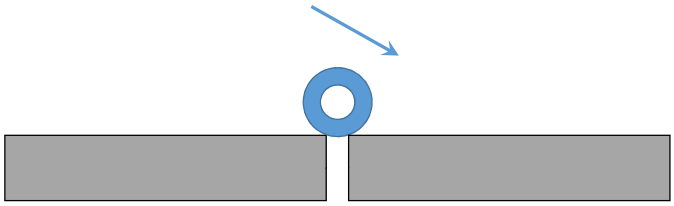

Sink in of the wheel into the open gap

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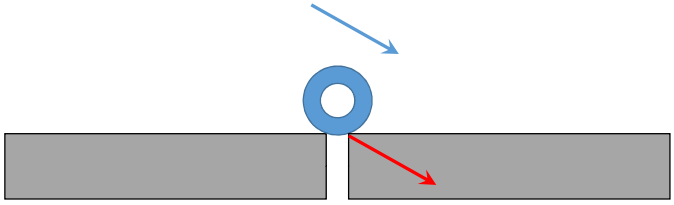

Impact of the load on the joint edge

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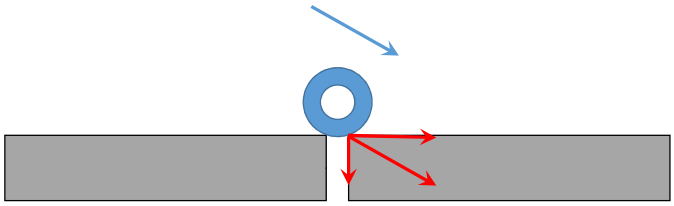

Distribution of the load in vertical and horizontal proportion in function of the sinking depth

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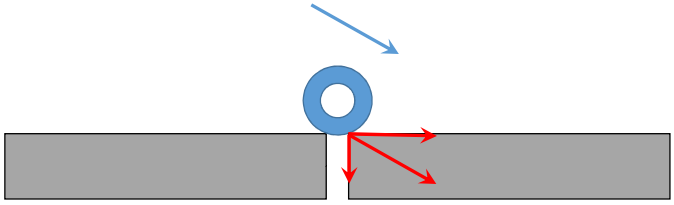

Neither the horizontal nor the vertical part of the load can be accurately determined, as there are too many variables!

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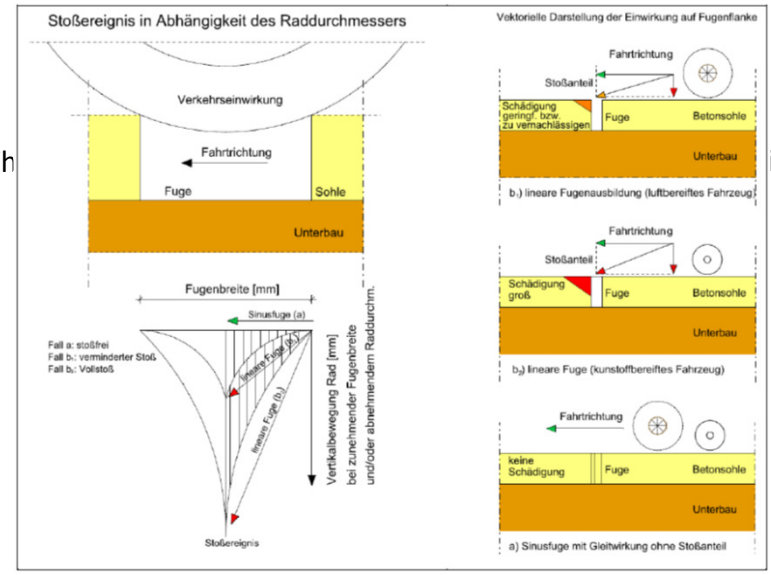
Wh ile?



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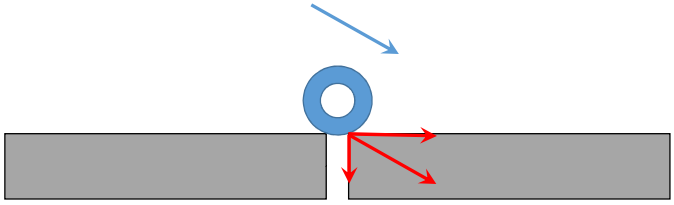

Even if the action/impact would be determined, what about a corresponding resistance???

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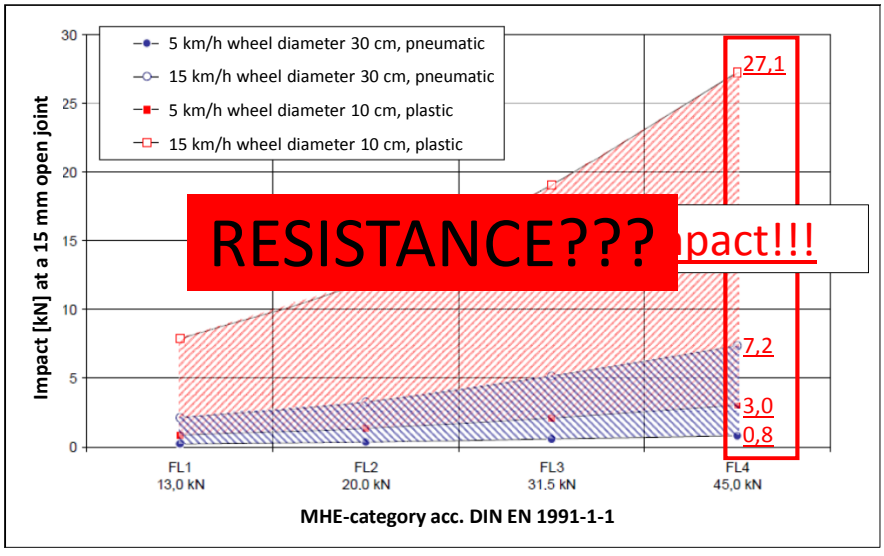

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INTERNATIONAL JOINT TECH ENGINEERING

Why a design is now possible?

What happens when a dynamic load hitting a linear joint profile?

RESISTANCE???

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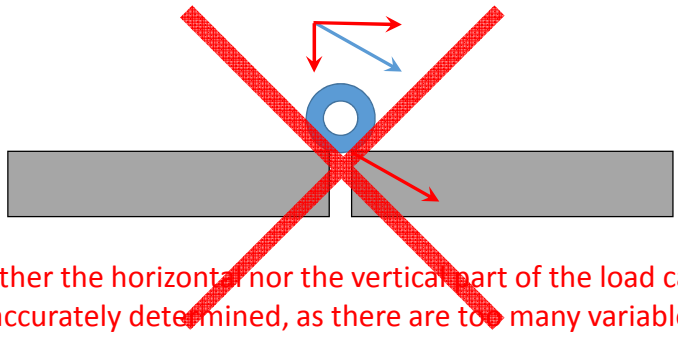
Why a design is now possible?

With a sinusoidal surface of the joint profile the wheel remains in permanent contact with the floor, means that no impact is possible!



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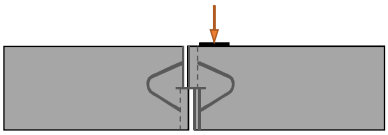
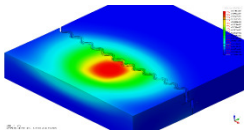
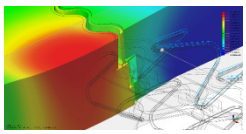
Determination of material resistance (laboratory tests / simulations)







By sinusoidal formation of the surface and the load introduction and transmission is positively influenced.

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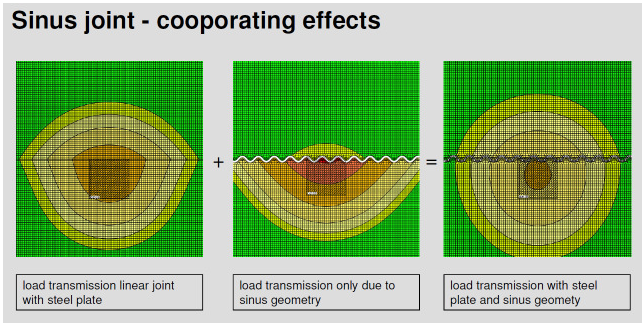
Determination of material resistance (laboratory tests / simulations)



By sinusoidal formation of the surface and the load introduction and transmission is positively influenced.

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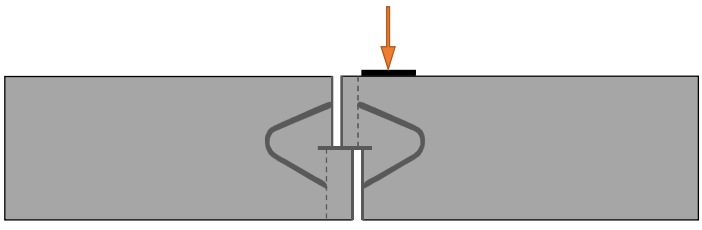
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



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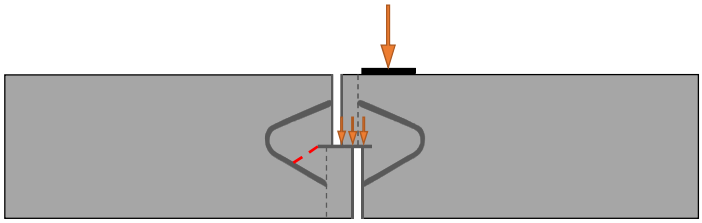
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



Loading and load transfer to opposite side.

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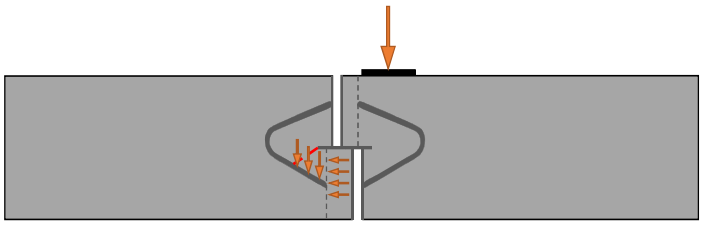
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



Load transfer into 3D stirrups

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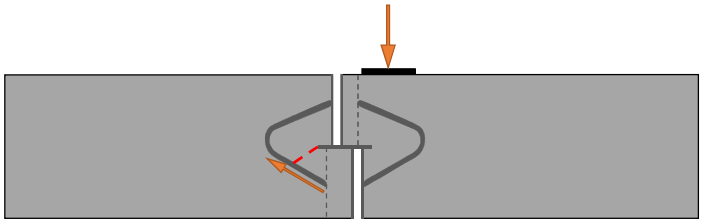
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



Load transmission through stirrups

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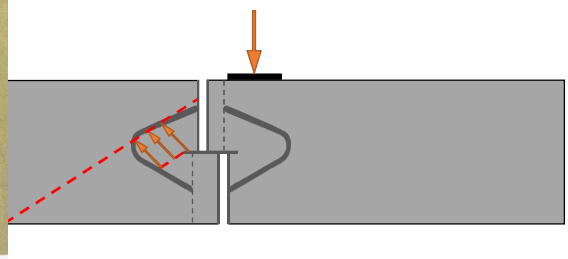
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



Displacement of the shear section by deviated load through stirrups

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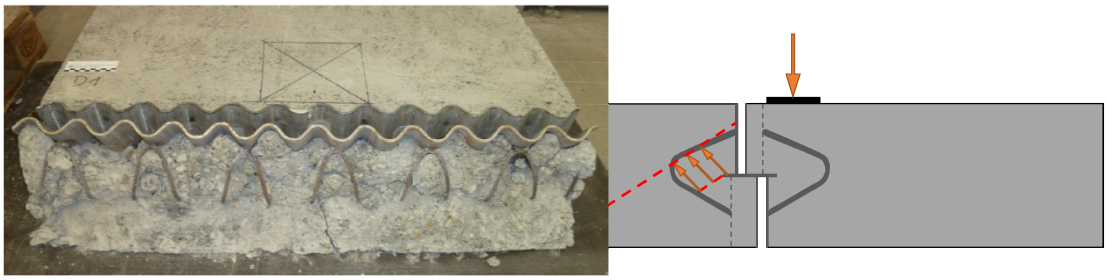
Determination of material resistance (laboratory tests / simulations)

HCJ Cosinus Slide® Joint - working principles



Through the sinus-cosinus form and its opposite arrangement, the applied forces can be distributed very evenly over the profile length.

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Determination of material resistance (laboratory tests / simulations)

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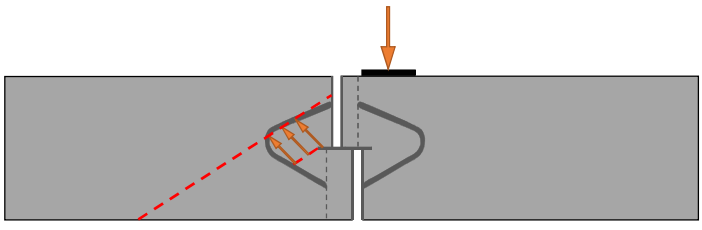

Compared to traditional types of profiles that ensure load transmission dowels (round, square, plate dowels) or by Omega or Delta form, it is possible to increase the capacity from about 0.5 to about 0.85 x h

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Determination of material resistance (laboratory tests / simulations)

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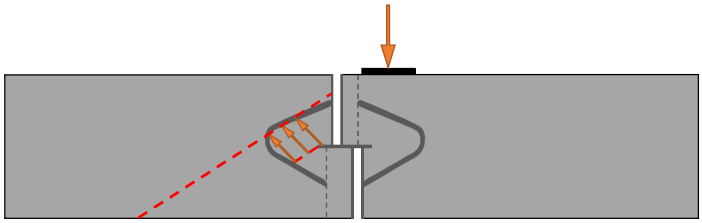

Through this capacity increase, load cases at joints are significantly less critical. Depending on the type and position of load cases, the utilization ratio of cases at the edge can be reduced to the same level of comparable load cases at center.

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Joints in industrial floors

Overview

- Review / history of joints
- Development of Sinus Slide® joints
- Development of Cosinus Slide® joints
- Why a design is now possible
- Determination of material resistance (laboratory tests / simulations)
- Loading actions at joints - load distribution and transfer

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Loading actions at joints - load distribution and transfer

Load transfer at Cosinus Slide® Joint

- Design of the floor (eg by steel fiber manufacturer) is based on an assumption of the shear transmission at the joint (usually betw. 30 & 50 %)
- Until now a check of this assumption was not possible:
  - Impact effect of vehicles not defined (many unknown parameters)
  - Designer has mostly no information about the bearing capacity of the joint
  - Real percentage of load to be transferred is not exactly known
- How loads are distributed along the joint?

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Loading actions at joints - load distribution and transfer

Load transfer at Cosinus Slide® Joint

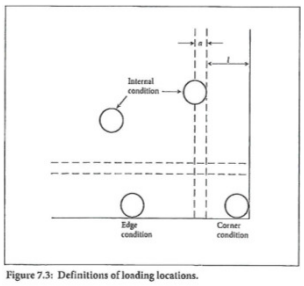

Figure 7.3: Definitions of loading locations.

Technical Report 34 (TR34),
The Concrete Society
Definition of loading locations

What loads have to be considered for a design check at the joint profile?

According Westergaard influence defined by radius of stiffness
f (modulus concrete, thickness, soil characteristics, Poisson's ratio)

$$l = [(E_{cm}\, h^3 \times 10^6) / (12\,(1 - \nu^2)\, k)]^{0.25}$$

All loads within this distance, have an impact on the joints!

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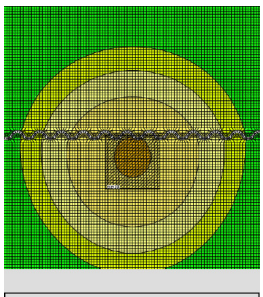
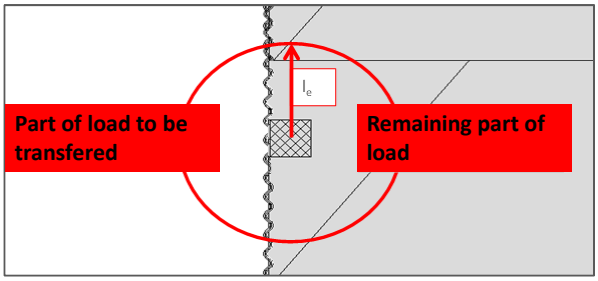
Loading actions at joints - load distribution and transfer

Load transfer at Cosinus Slide® Joint



load transmission with steel plate and sinus geomety



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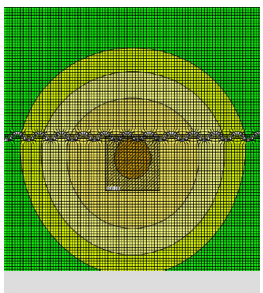
Loading actions at joints - load distribution and transfer

Load transfer at Cosinus Slide® Joint



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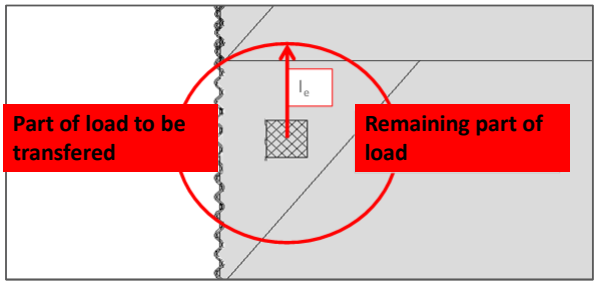

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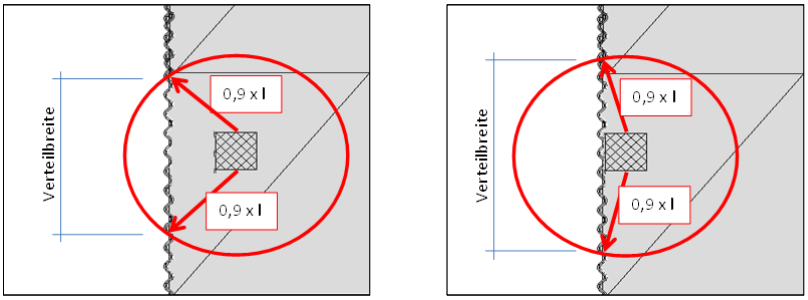
Loading actions at joints - load distribution and transfer

Load distribution at Cosinus Slide® Joint

Acc. Technical Report 34 (TR34): **load distribution up to 1,8 x l bothsides of load, but decreasing**
Simplification: 0,9 x l with full loading



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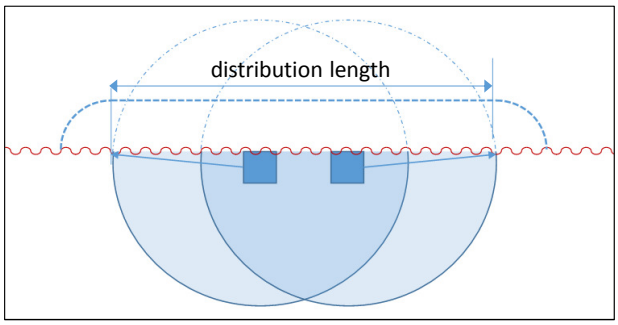
Loading actions at joints - load distribution and transfer

Load distribution at Cosinus Slide® Joint

Development of the model – side by side loads:



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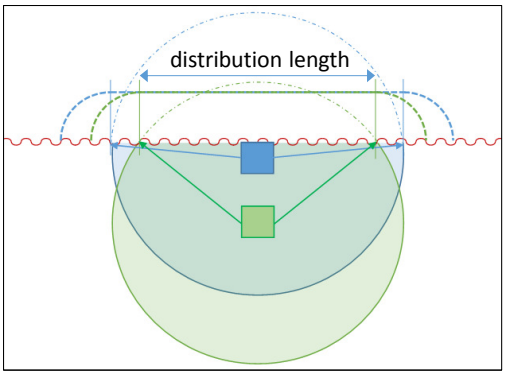
Loading actions at joints - load distribution and transfer

Load distribution at Cosinus Slide® Joint

Development of the model – loads standing behind one another :



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Resume

- With sinusoidal form at surface:
  - Prevent damage of floor slab
  - Minimize damage to vehicles
  - Reduce workplace accidents
  - Comply with health and safety regulations
- With Cosinus Slide® Joint:
  - cost savings
  - Static analysis
  - Optimization potential for the entire construction

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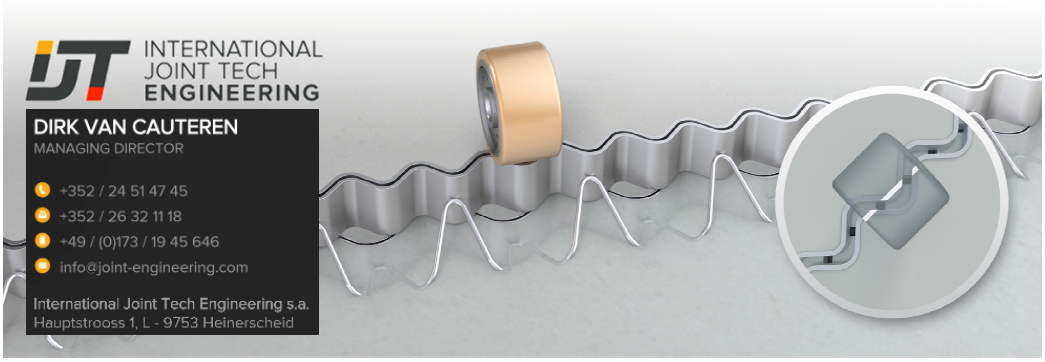
Joints in industrial floors

Thank you for your attention



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