

Shear load connectors



Fondazione
Ordine degli Ingegneri
Provincia di Roma

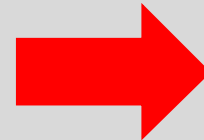
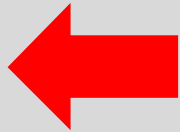
24 Marzo 2026

Imagine. Model. Make.

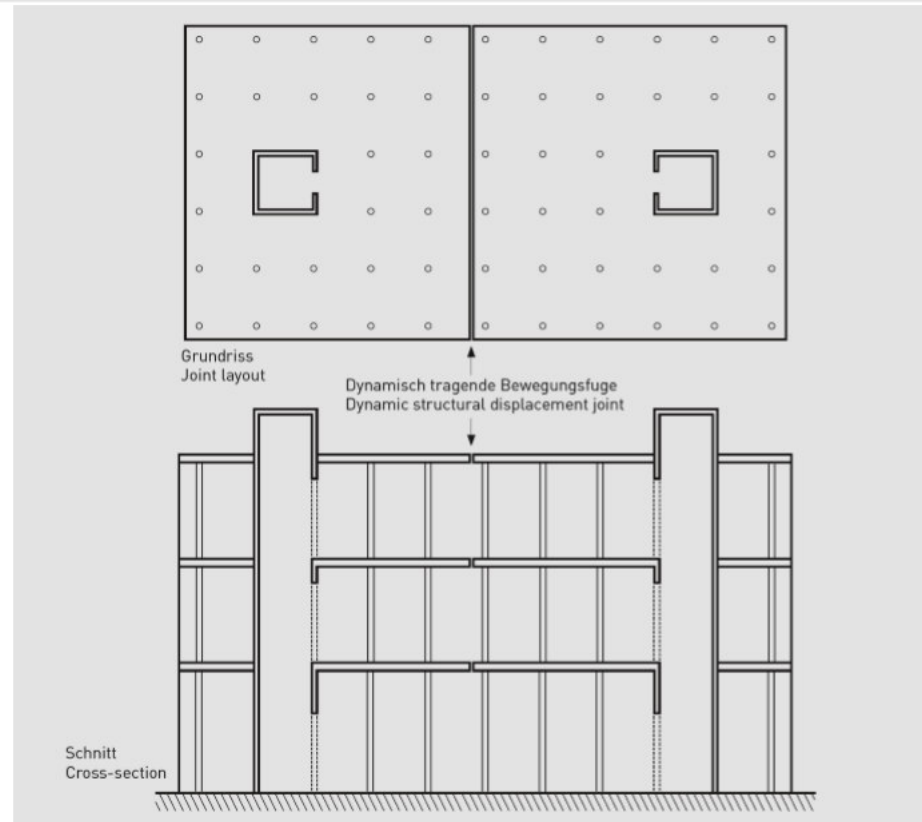
Shear load connectors



- Movement joints – Shear connectors
- CRET Shear load connectors
- Seismic testing for Shear load connectors
- Shear load connectors in PT structures
- Lockable dowel against pour strips
- Case studys PT



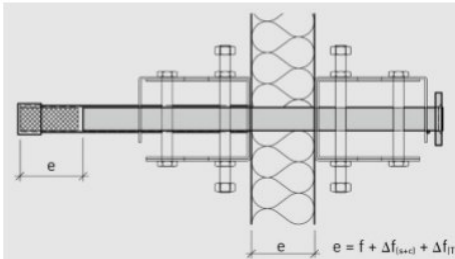
movement could generate cracks



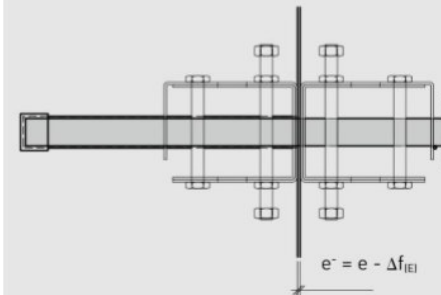
Structural displacement joints with CRET Seismic connectors subjected to earthquakes

Joint response

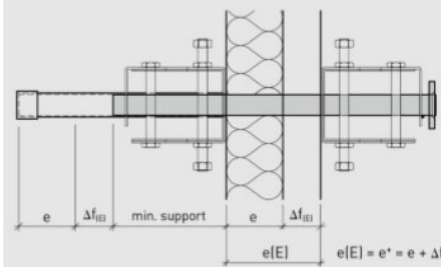
Normal load case
Joint gap e



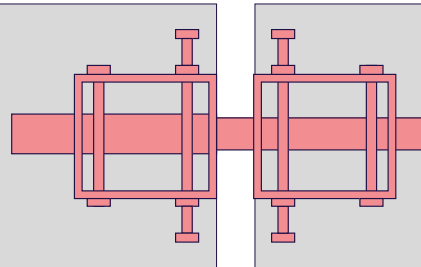
Earthquake load case
Minimal joint gap $e-(E)$



Earthquake load case
Maximum joint gap $e+(E)$



- e Design factor of the joint gap Normal [mm]
- f Nominal joint gap [mm]
- $e(E)$ Design factor of the joint gap Earthquake
- $\Delta f_{(T)}$ Temperature
- $\Delta f_{(s+c)}$ Shrinkage and creep
- $\Delta f_{(E)}$ Earthquake

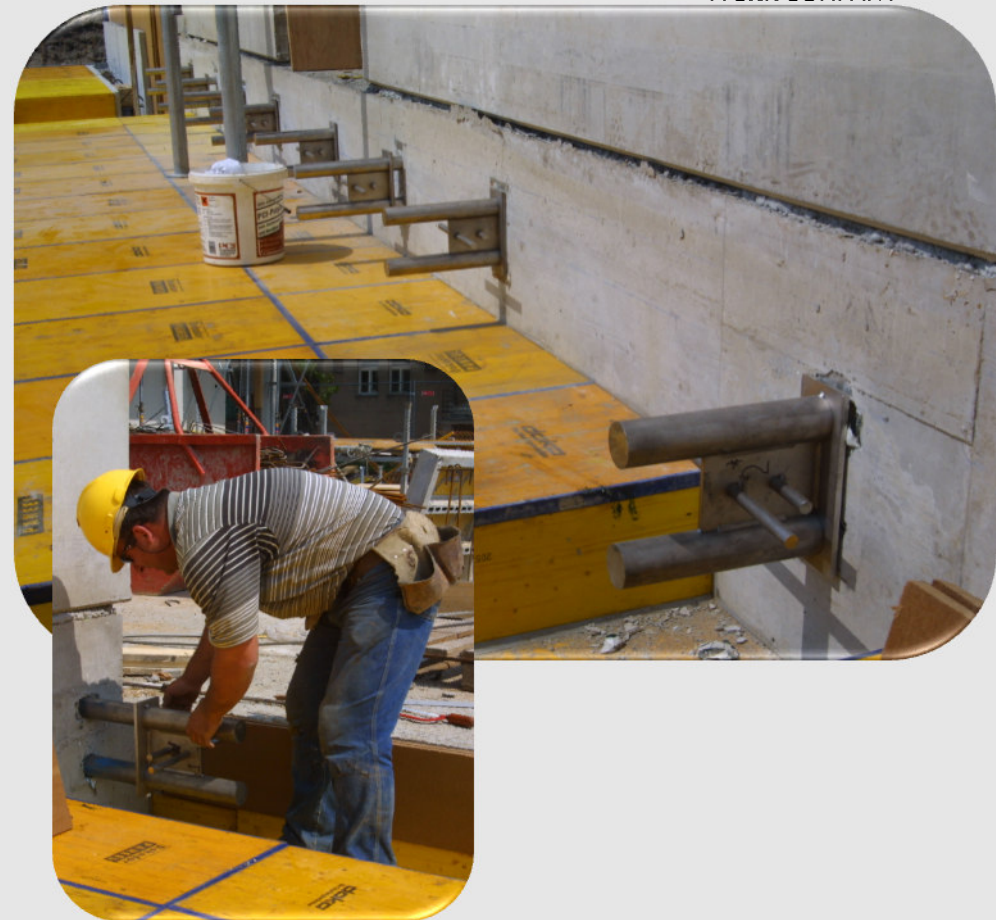


Compact and simple

Controls movement
and limits cracks

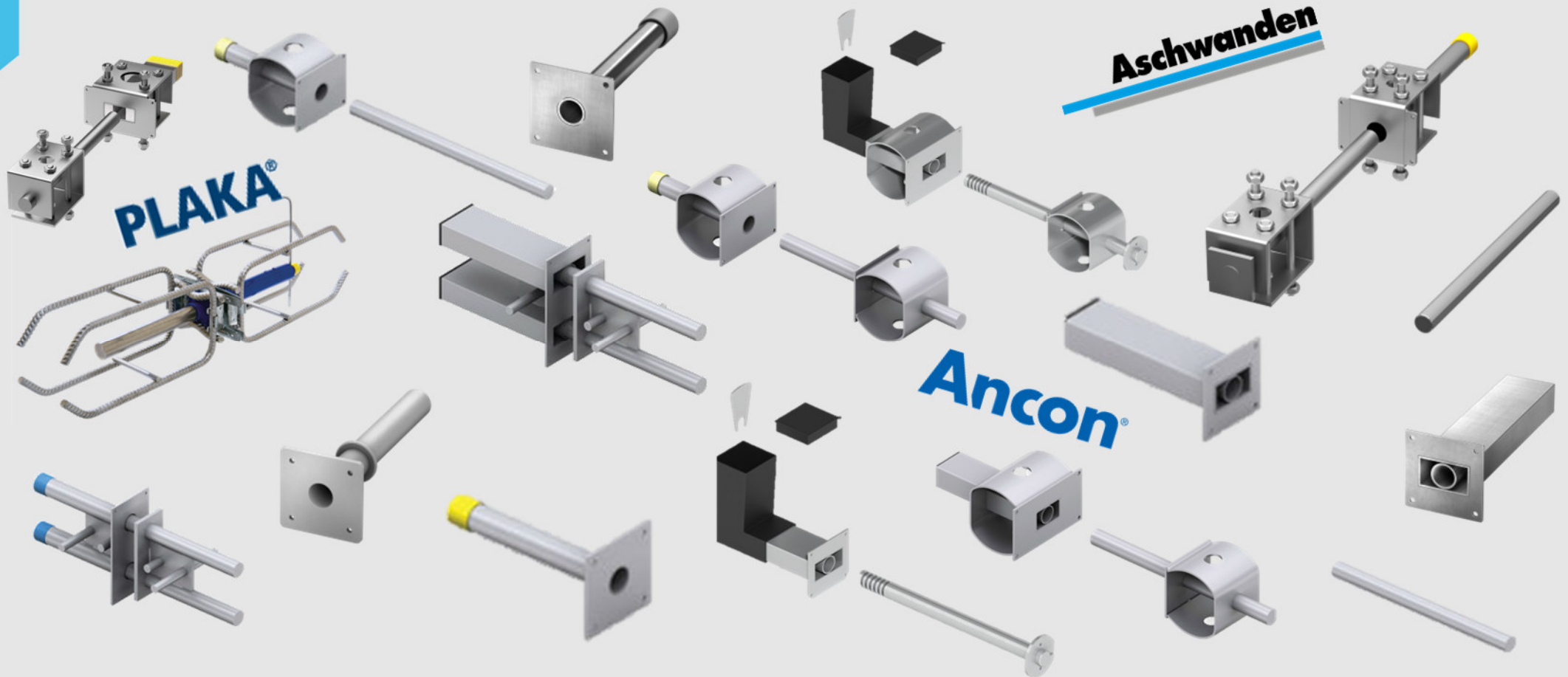
Movement joints

- Main application for Shear load connectors
- Required in large structures
- Shopping malls, Hospitals, Offices, Apartment houses
- There are different solutions available to handle movement joints in large structures.
- What is the benefit of shear load connectors?
- To increase space and simplify the building structure



Various types of shear load connectors within Leviat

Leviat
A CRH COMPANY

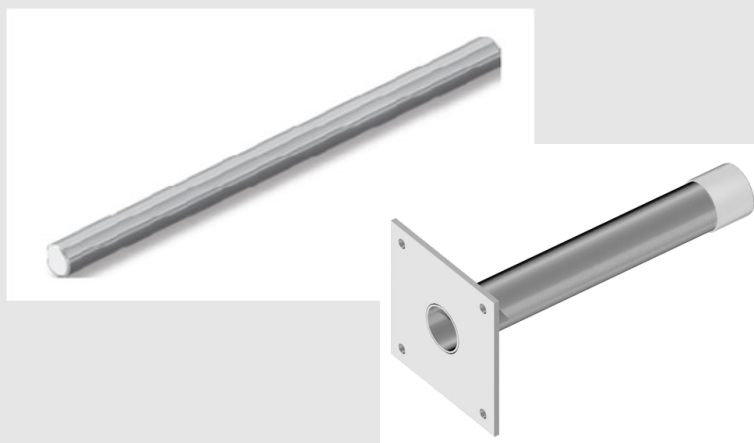




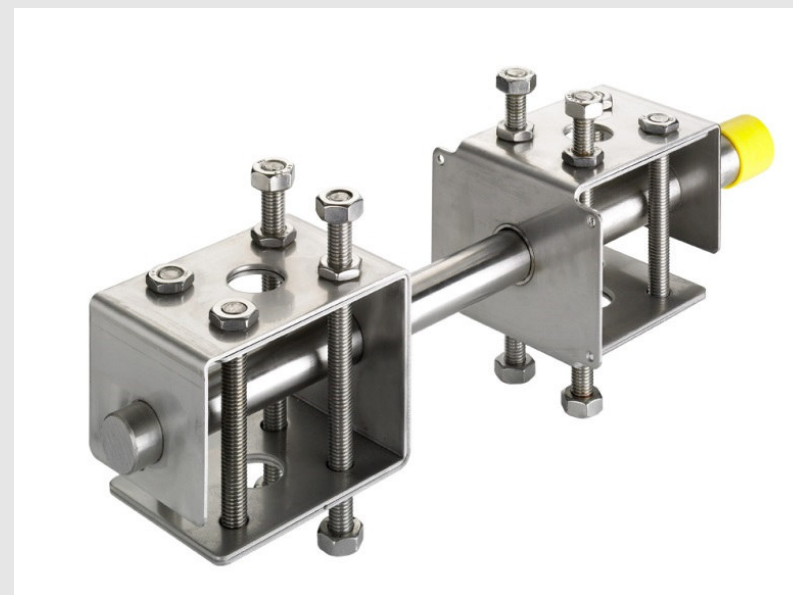
Product overview

CRET Shear dowels





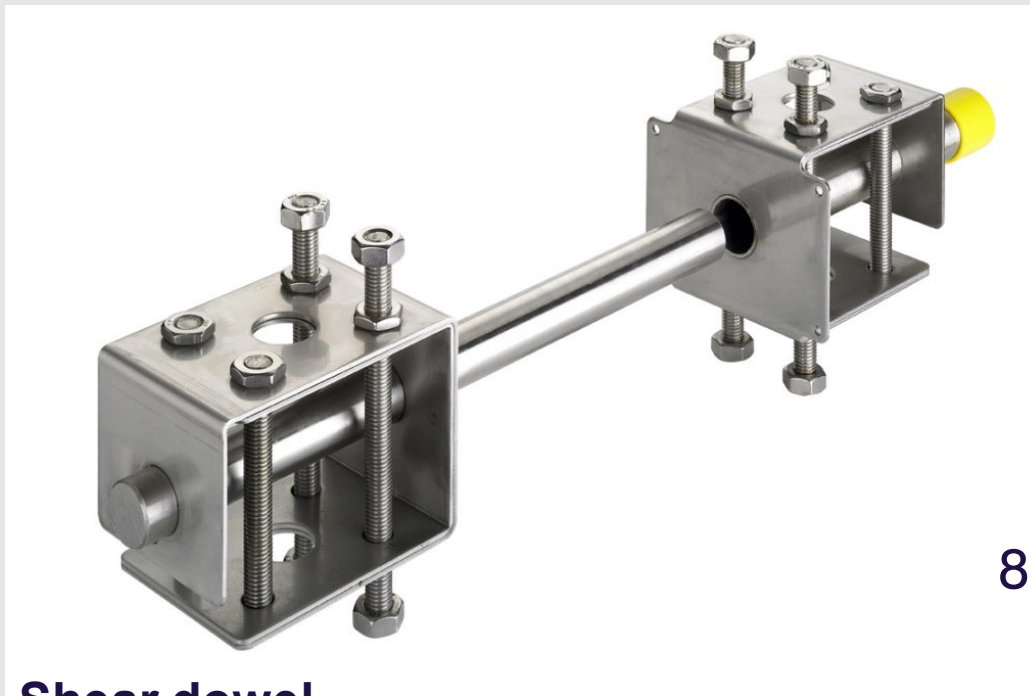
Single dowels
Stainless steel
shear dowel



CRET100 serie
Heavy duty stainless steel
shear dowel system

CRET

Sleeve

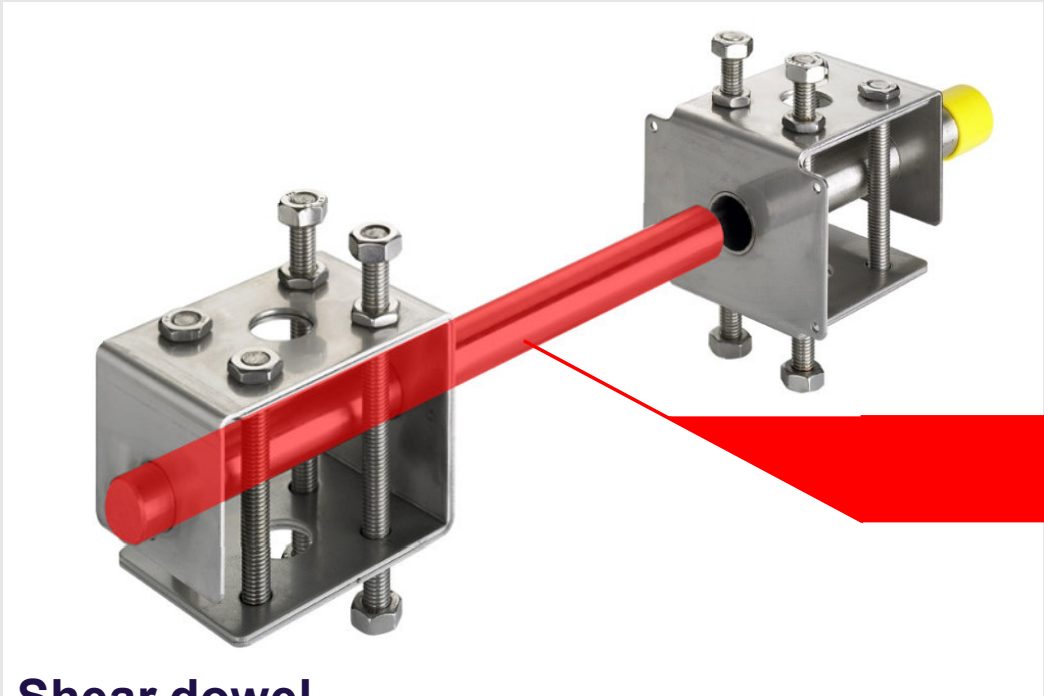


8 different sizes

Shear dowel

CRET

Sleeve

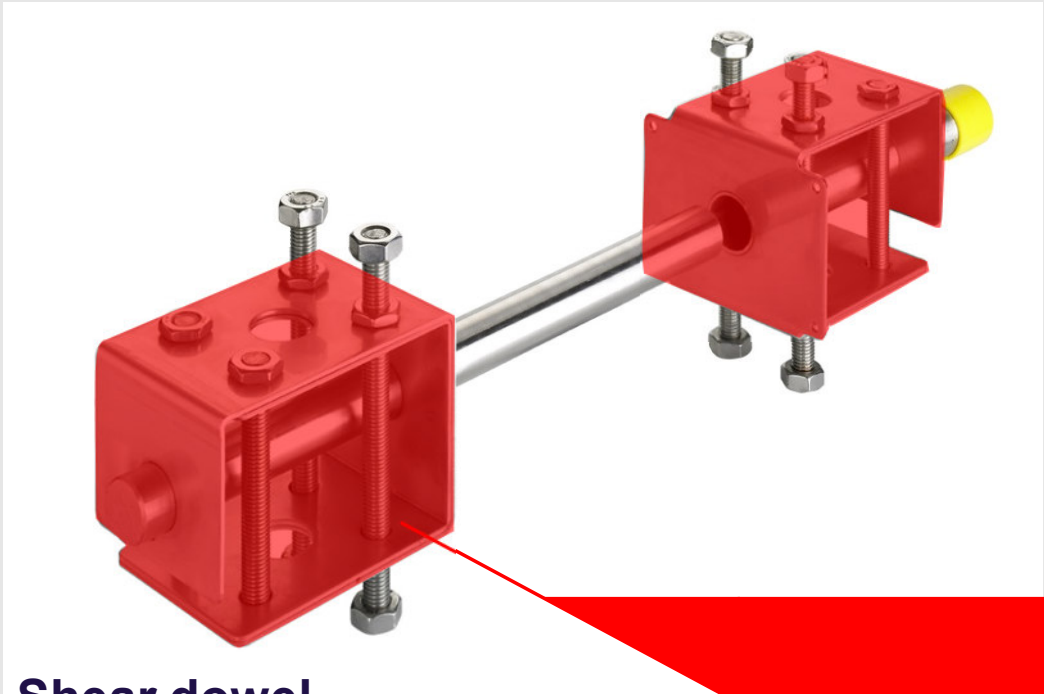


Dowel

Shear dowel

CRET

Sleeve

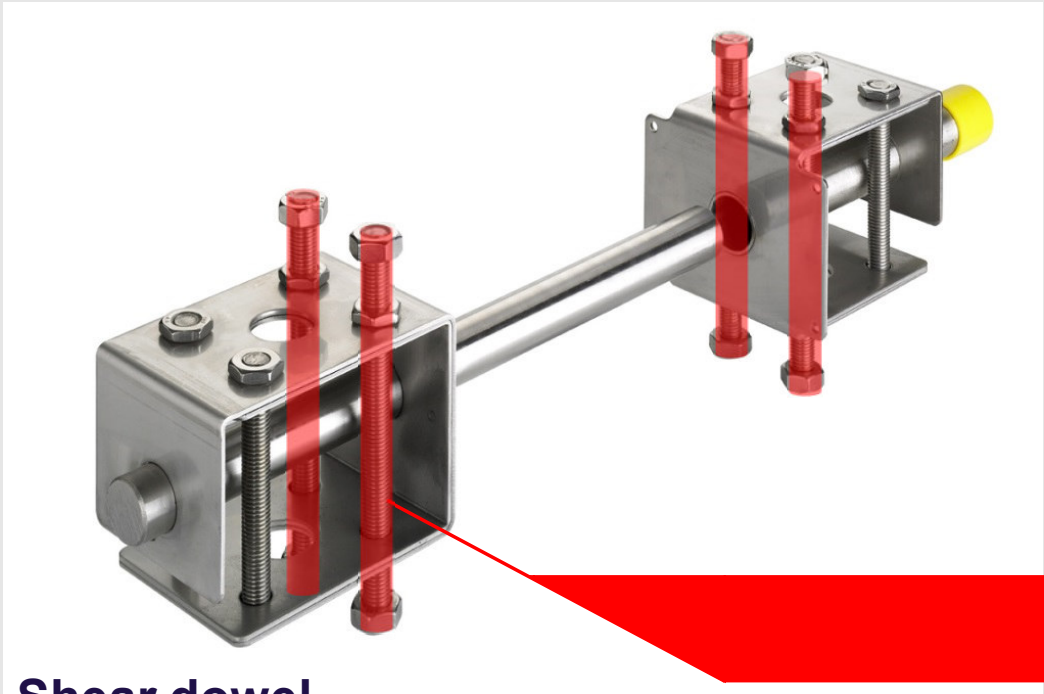


Shear dowel

Supporting case

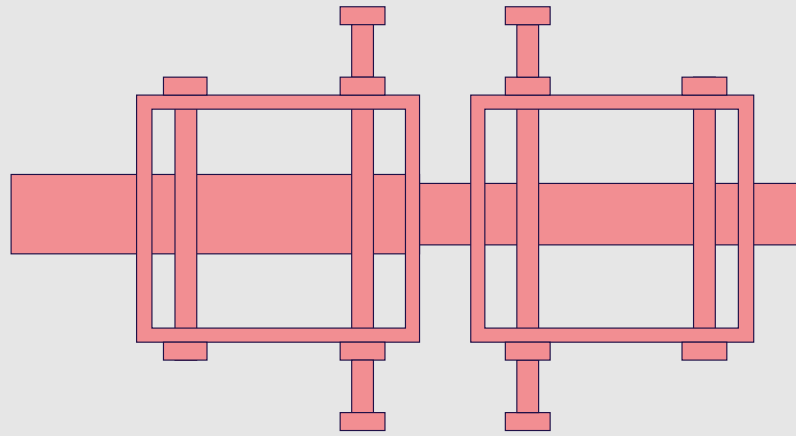
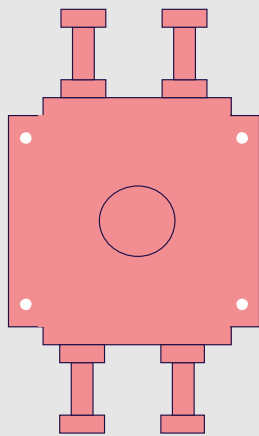
CRET

Sleeve



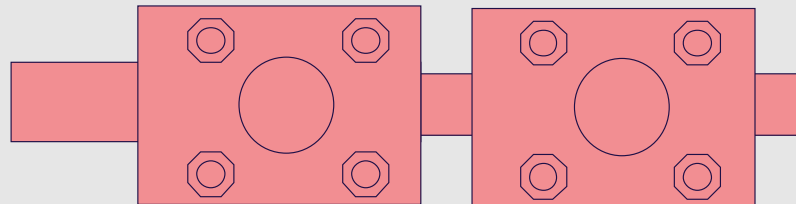
Shear dowel

Vertical anchorage rods



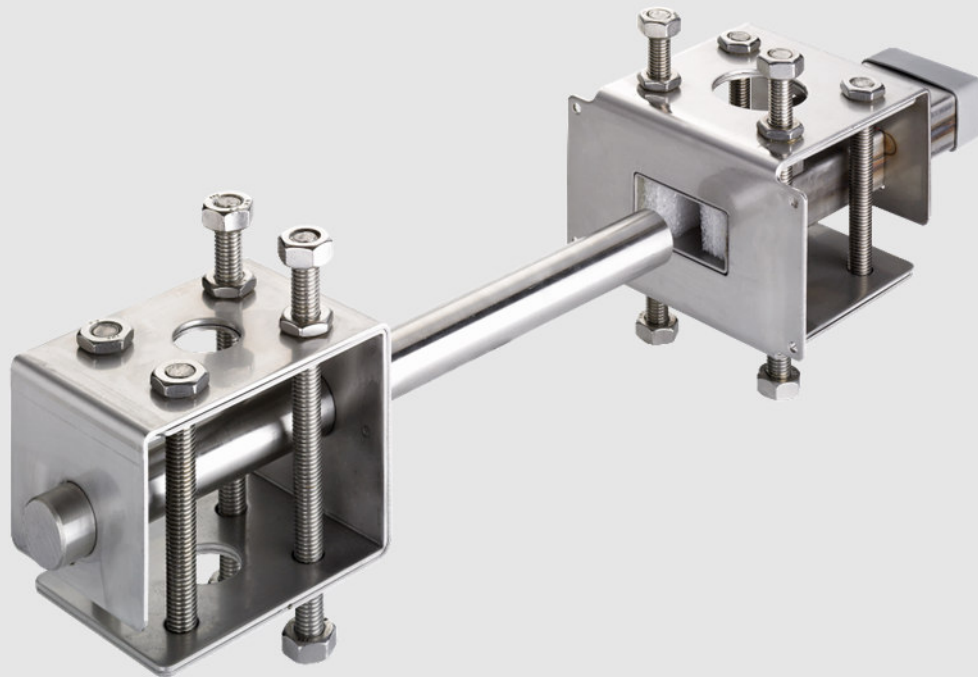
**Axial
movement**

CRET



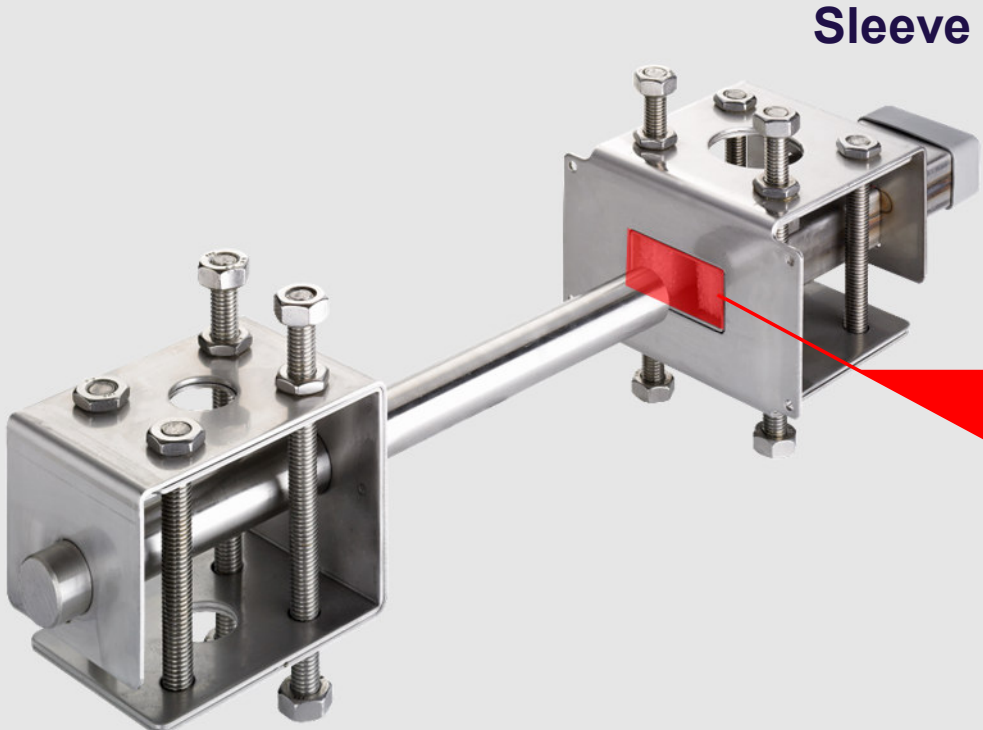
CRET V

Sleeve



Shear dowel

CRET V

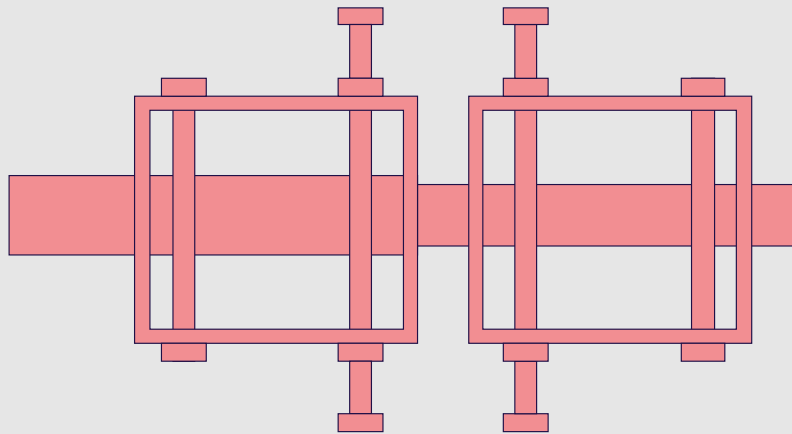
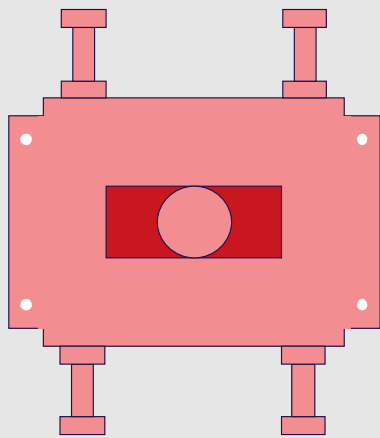


Sleeve

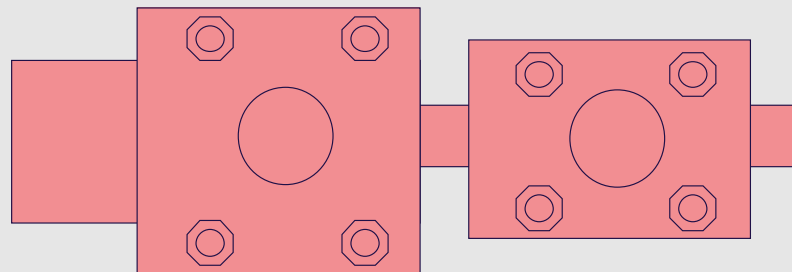
Slot

Shear dowel

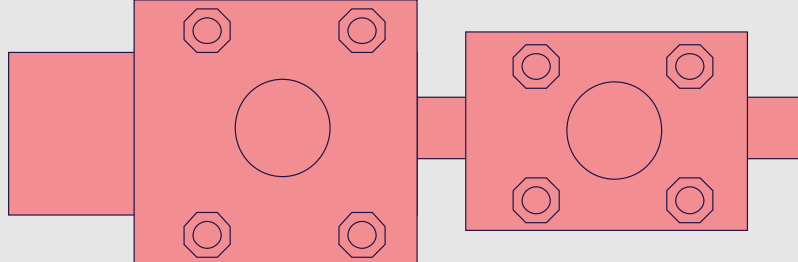
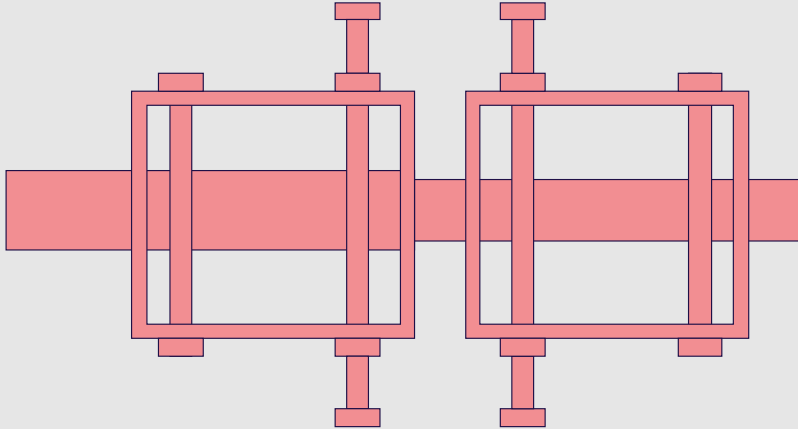
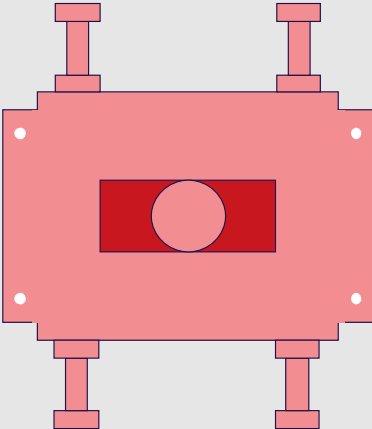
CRET V



**Axial
movement**

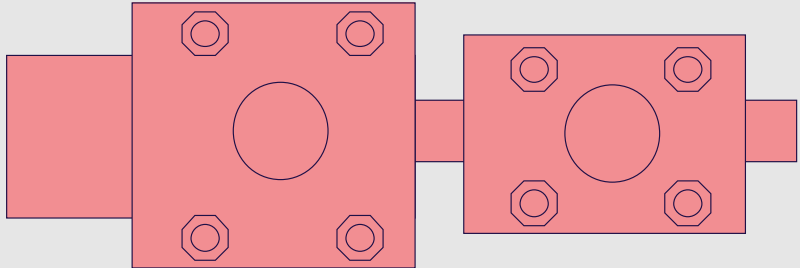
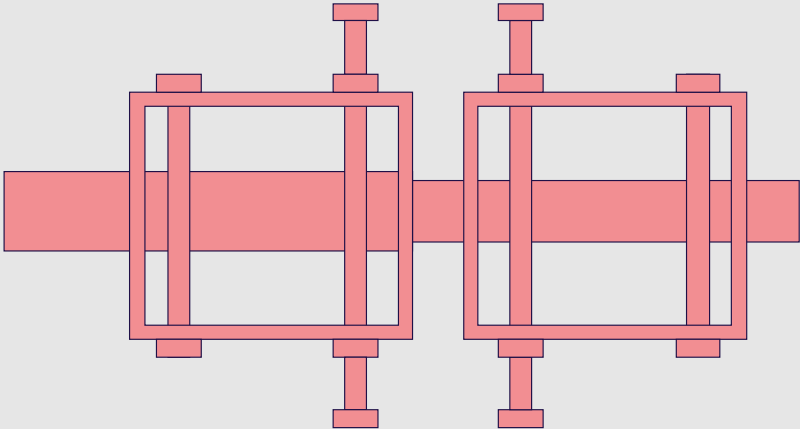
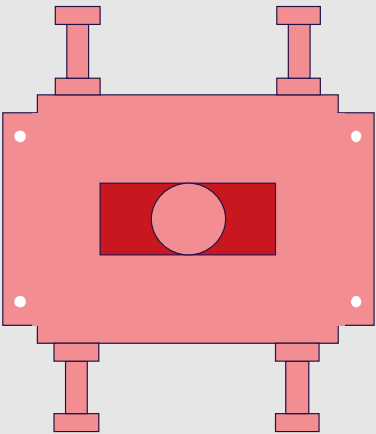


CRET V



**Axial
movement
+
lateral
movement**

CRET V



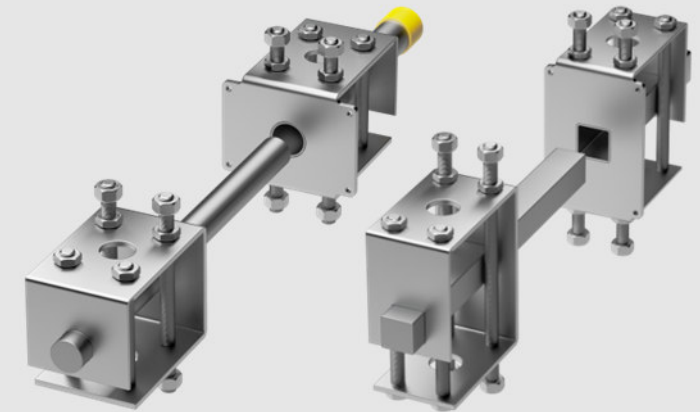
**Axial
movement
+
lateral
movement**

Aschwanden CRET Shear Load Connectors



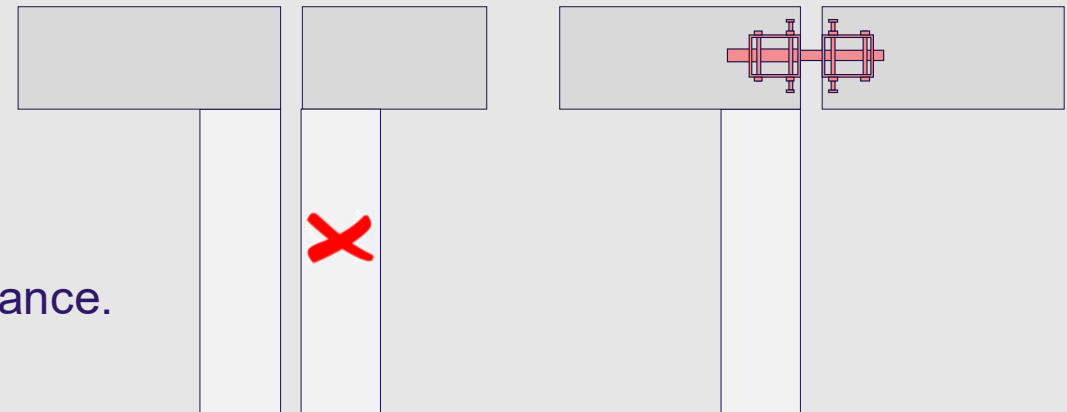
Product description

CRET Shear connectors are used to transfer shear loads across movement joints and enable expansions and/or contractions of enclosed concrete structures.



Key features & benefits

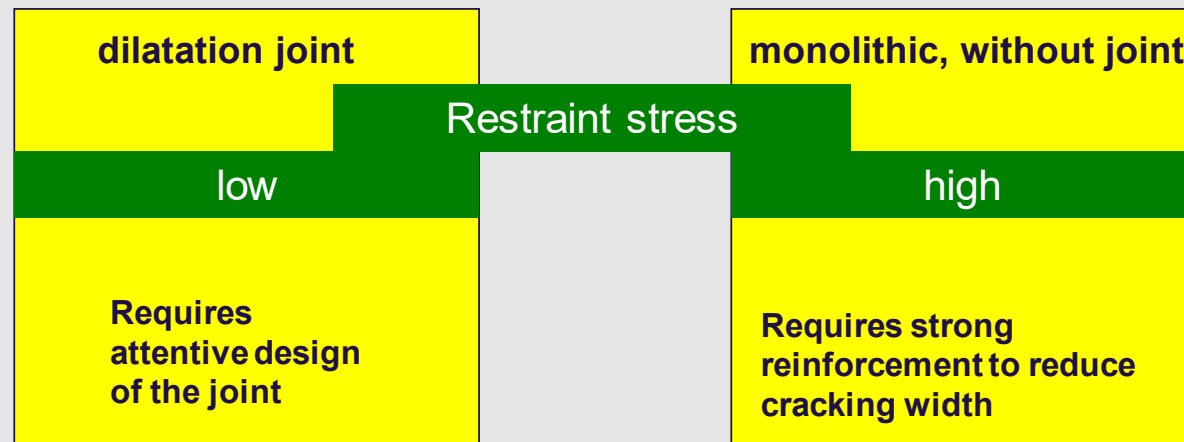
- Simple and easy installation.
- Increases space in the habitat.
- Reduces construction time.
- High load transfer and high corrosion resistance.
- Design software and BIM models available.



4. Structural calculations

Designing joints

- The effects of shrinkage, temperature changes, creep (pre-tension) have to be regarded in the design of a construction



4. Structural calculations

Joint layout & determining internal forces

Method:

- Determination of gap and movement
- Determination of internal forces through FE-software
- Design of a feasible dowel layout in the joint
- Selection of shear dowels
- Design of layout for additional on-site reinforcement
- Design of longitudinal reinforcement for joint

4. Structural calculations

Design of the joint width f

Method:

$$f = f_0 + \Delta L_{(Shrinkage)} + \Delta L_{(Temperature)}$$

f_0 ...planned joint width

$$\Delta L_{(Shrinkage)} = L \cdot \varepsilon_{cs} \quad \dots \text{Expansion due to shrinkage}$$

$$\text{with } \varepsilon_{cs} = \varepsilon_{cd} + \varepsilon_{ca} \quad [\text{acc. EN1992-1-1: 2008, 3.1.4(6)}]$$

$$\Delta L_{(Temperature)} = \alpha_t \cdot \Delta T \cdot L \quad \dots \text{Expansion due to temperature changes}$$

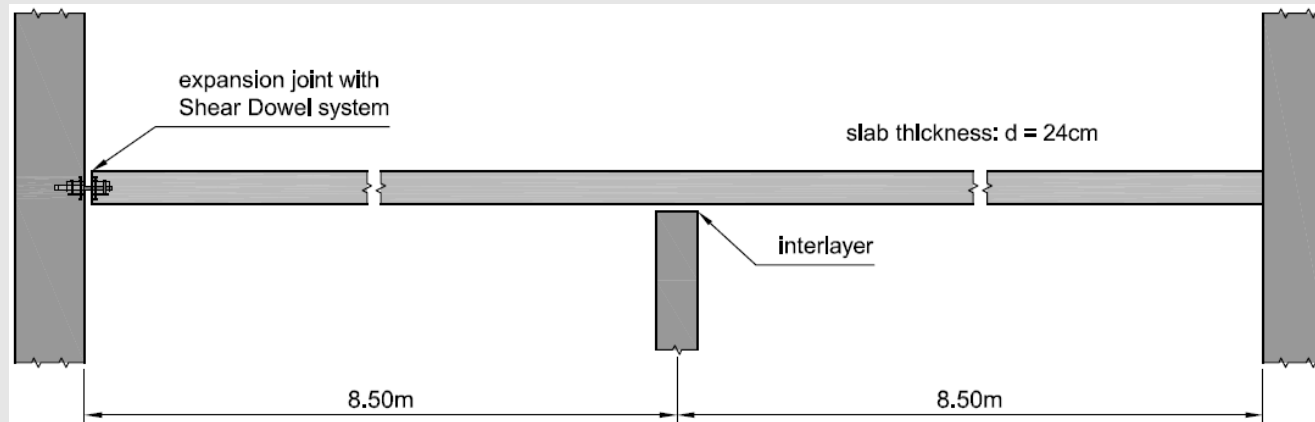
$\Delta L_{(Creep)}$ only in case of post – tensioning

- Note: If necessary, insufficient building quality has to be taken into account by an additional safety supplement.

4. Structural calculations

Design of the joint width f

Example:



- Closed warehouse
- Construction during summer time
- Concrete C 25/30
- Cement 32,5 R

4. Structural calculations

Determination of joint width f

Example:

- Initial joint width

$$f_{t=0} = 20 \text{ mm}$$

- Movement due to shrinkage

$$\Delta f_{sh} = l * e_{cs,\infty} = 17000 * -0,60 * 10^{-3} = 10,2 \text{ mm}$$

- Movement due to temperature, $\Delta T = 20K$

$$\Delta f_{tem} = l * \Delta T * \alpha_t = 17000 * 20 * 10^{-5} = 3,4 \text{ mm}$$

- Design value of the joint width

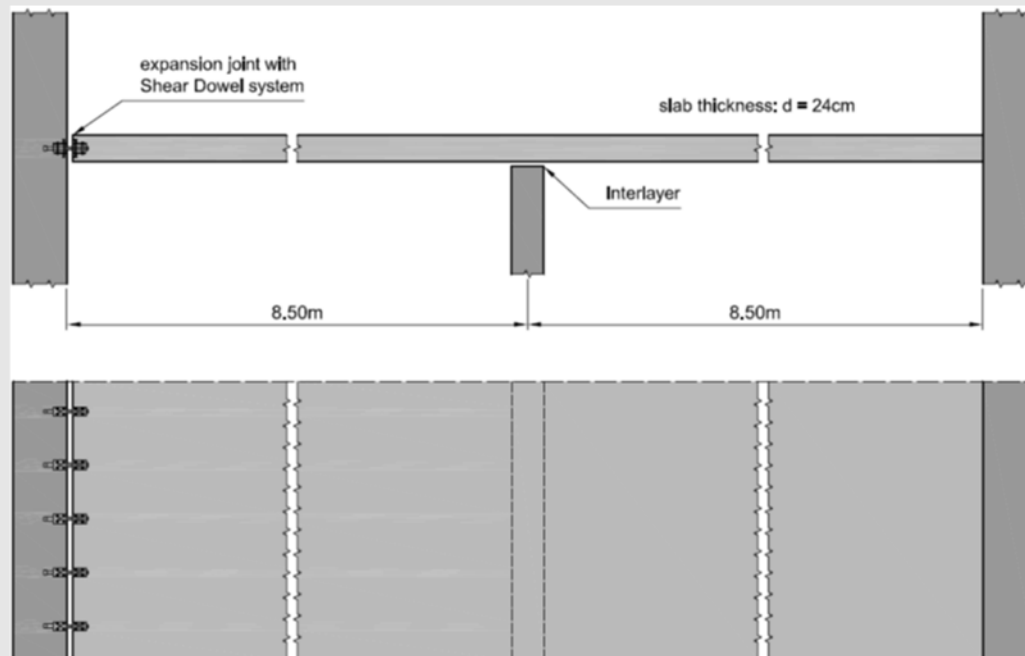
$$f = f_{t=0} + \Delta f_{sch} + \Delta f_{tem} = 20 + 10 + 3 = 33 \text{ mm} \sim 40 \text{ mm}$$

4. Structural calculations

Loading and dowel arrangement

Method:

- Determination of loading in the joint

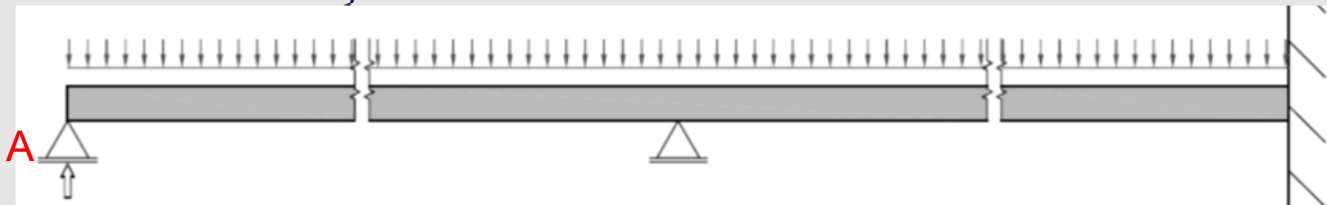


4. Structural calculations

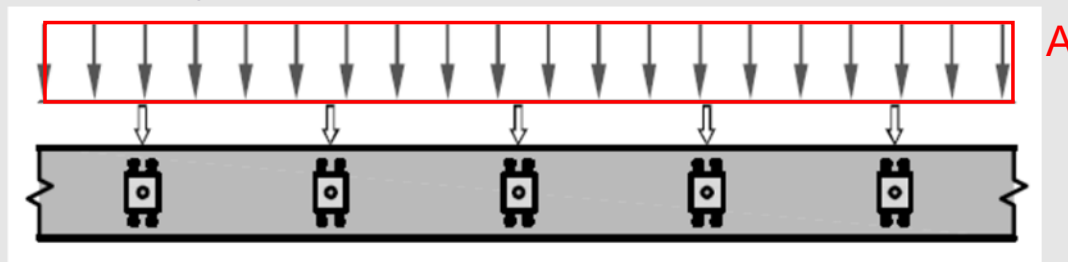
Loading and dowel arrangement

Method:

- Determination of loading in the joint
 - Structural system



- Loading within the connection

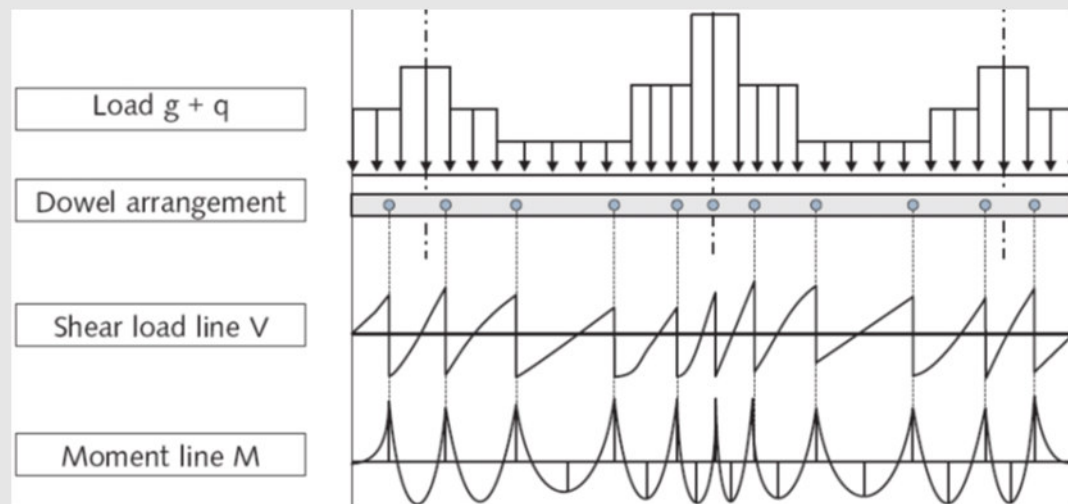


4. Structural calculations

Loading and dowel arrangement

Method:

- Design of feasible dowel layout in the joint
- Calculation of shear forces (bearing forces) and moments by applying the structural model of a continuous beam



4. Structural calculations

Joint layout & determination of internal forces

Method:

- Selection of shear dowels from load tables in the catalog
- Design and layout of suspension reinforcement
- Design of longitudinal reinforcement by applying the structural model of a continuous beam (bending design)

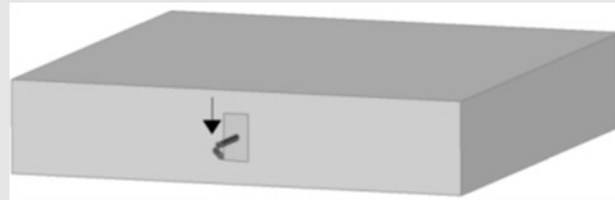
shear dowel	Component thickness [mm]	C20/25				
		Joint width [mm]				
		20	30	40	50	60
HSD CRET-122	180	58.8	58.8	58.8	47.9	39.9
	200	65.6	65.6	59.9	47.9	39.9
	220	72.5	72.5	59.9	47.9	39.9
	240	79.3	79.3	59.9	47.9	39.9
	250	82.7	79.4	59.9	47.9	39.9
	260	86.1	79.4	59.9	47.9	39.9
	≥ 280	92.9	79.4	59.9	47.9	39.9

Number of stirrups Asx (fyk= 500 Mpa)			
h [mm]	CRET-122(V)		
	10	12	16
180	6	4	-
200	6	4	2
220	6	4	2
240	6	4	2
250	6	4	2

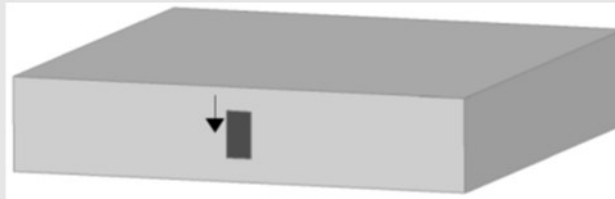
4. Structural calculations

Failure modes

- Steel failure of the dowel

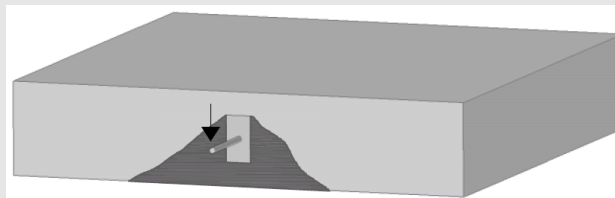


- Failure of the steel box



- Failure of the concrete compression struts

- Concrete edge failure



4. Structural calculations

Verifications

$$V_{Ed} \leq \text{Min}(V_{Rd,1}; V_{Rd,2}; V_{Rd,max}) \leq V_{Rd,s}$$

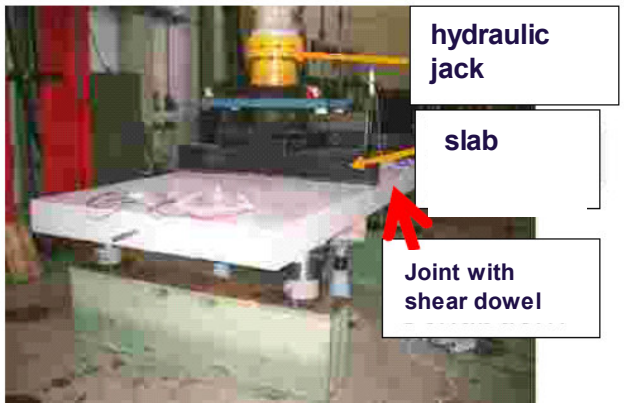
- $V_{Rd,1}$ – Design resistance of the steel dowel
EN 1993-1-1
- $V_{Rd,2}$ – Design resistance of the steel box + threaded bars
EN 1993-1-1 + EN 1994-1-1
- $V_{Rd,max}$ – Compression resistance of the concrete struts
EN 1992-1-1
- $V_{Rd,s}$ - Limitation of the force in additional slab edge reinforcement
EN 1992-1-1

3. Design



Tests

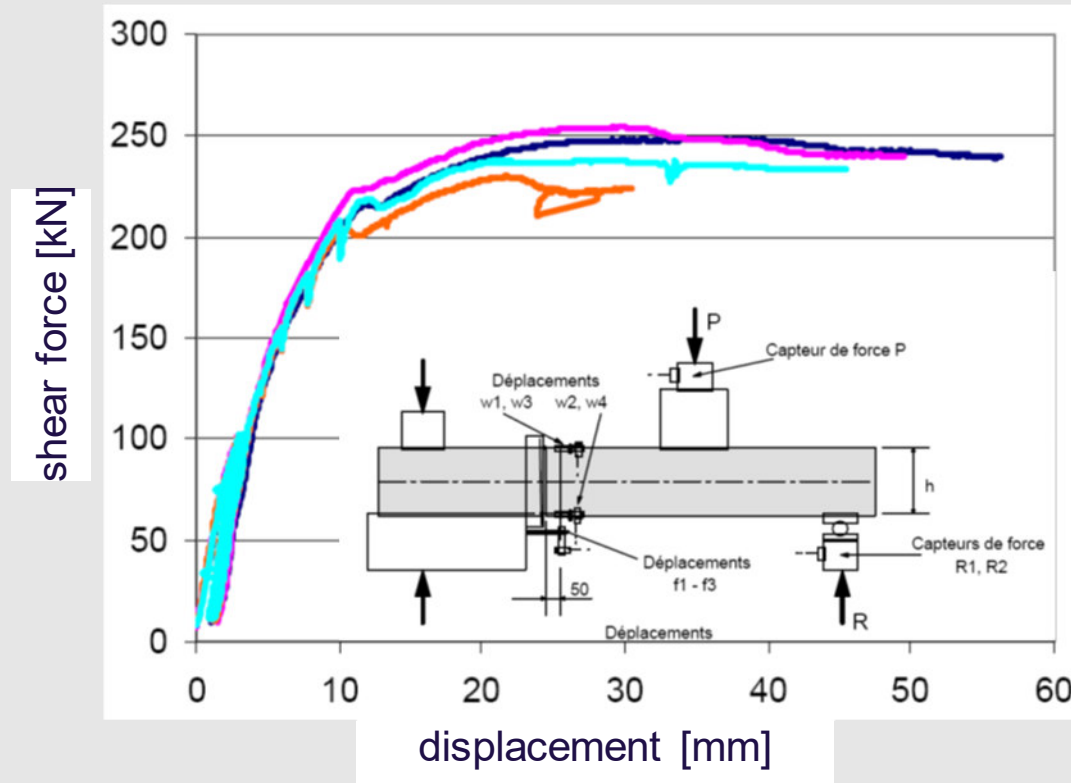
- Tests were carried out to determine the location of the punching cone at the concrete edge and the effects of the reinforcement



3. Design



Tests



4. Structural calculations



Leviat
A CRH COMPANY

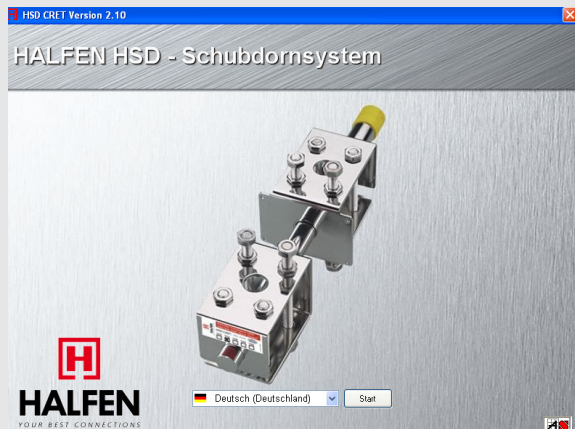
Tests – observed failure

- Failure due to concrete edge failure in all tests



4. Structural calculations

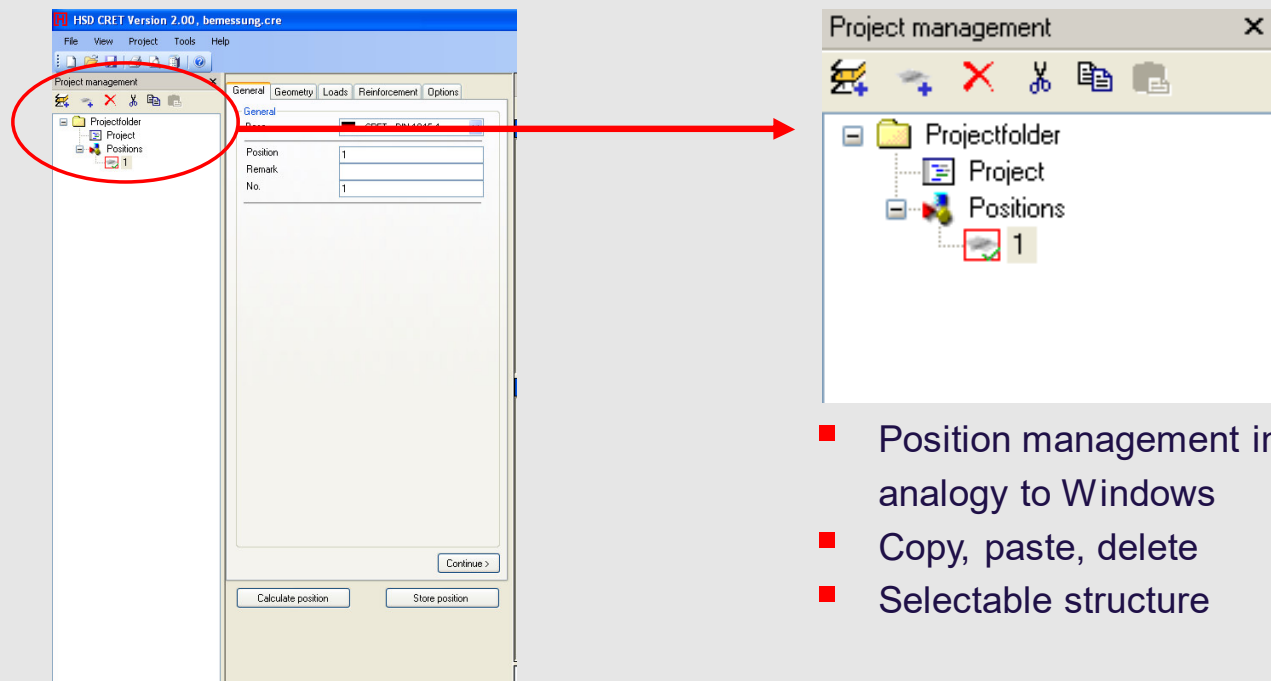
Software – HSD-CRET



- current version: HSD-CRET 2.20
- Intuitive handling
- 14 different connection types
- Offsets can be incorporated
- Manual adjustment possible
- Optimisation options

4. Structural calculations

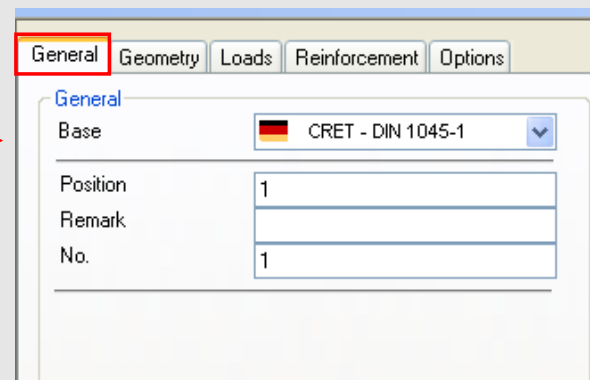
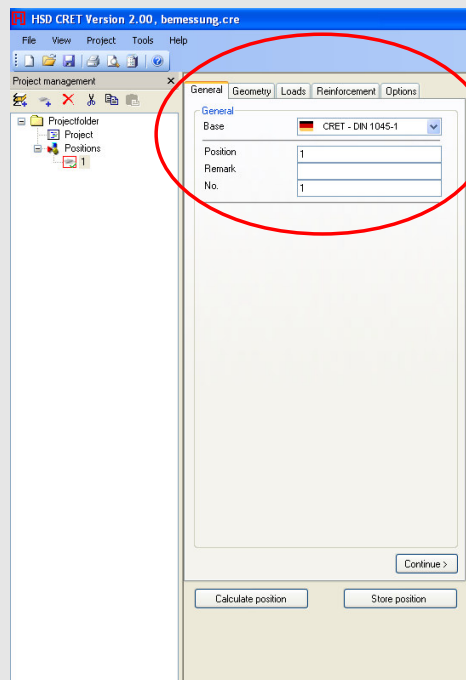
Software - HSD-CRET



- Position management in analogy to Windows
- Copy, paste, delete
- Selectable structure

4. Structural calculations

Software – HSD-CRET



- Selection of analysis basis
- Position titles
- Specification of position quantities

4. Structural calculations

Software – HSD-CRET

General **Geometry** Loads Reinforcement Options

Component and joint

Bearing component Slab **Carrying component** Slab

Geometry

200 Length L [cm] 200
20 Depth D [cm] 20
20 Height H [cm] 20

Concrete

C20/25 C20/25

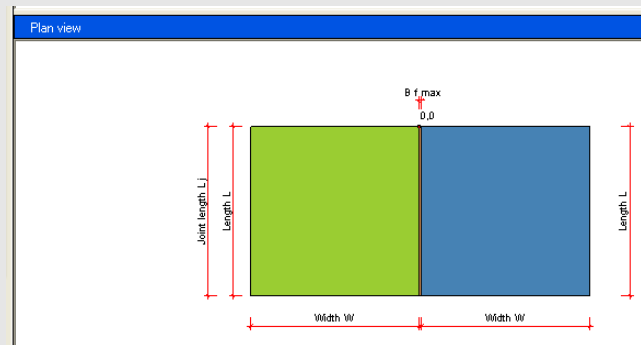
Concrete cover

Concrete cover equal 2.5

2.5 Top c_{nom} [cm] 2.5
2.5 Bottom c_{nom} [cm] 2.5

Joint

max. Width W_{max} [cm] 3
Length disalignment V_x [cm] 0
Height disalignment V_y [cm] 0
Joint length L_f [cm] 200
Fire Resistance F120



- Specification of structural members and geometries
- Definition of material grades
- Selection of joint geometry and fire rating
- Graphical display

4. Structural calculations

Software – HSD-CRET

General | Geometry | Loads | **Reinforcement** | Options

Loads

Line loads ∇E_d

Load start (cm) ab 0	Length (cm) ab 0	left side (kN/m)	right side (kN/m)
0	200	20	20

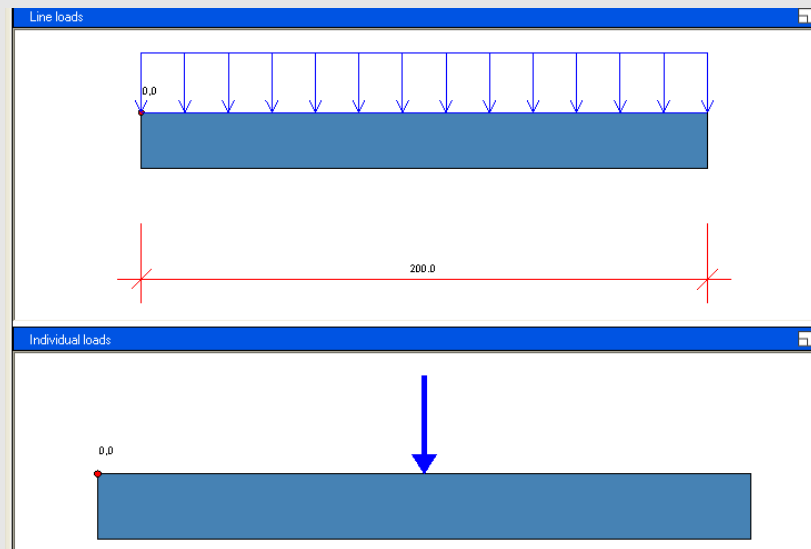
Add Delete

Individual loads ∇E_d

Point of load application (cm) from zero	Individual load (kN)
100	30

L Add IL delete

- Specification of line and point loads
- Supported by graphic display



4. Structural calculations

Software – HSD-CRET

General Geometry Loads **Reinforcement** Options

Reinforcement specification

Reinforcement specification for all Dowels

Ø 8

Specify reinforcement Specify reinforcement

Bearing component **Carrying component**

Hanger reinforcement Asx,1

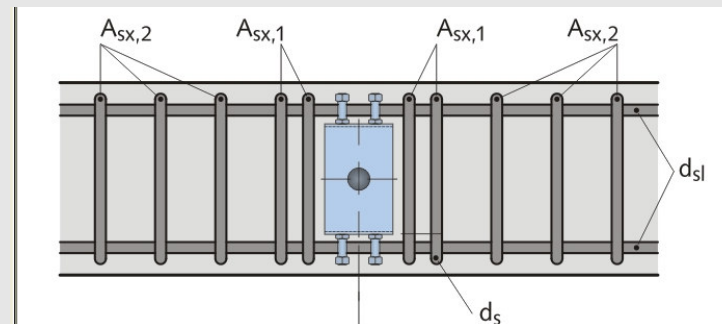
No.	Ø	No.	Ø
2	8	2	8

Transverse reinforcement Asy

No.	Ø	No.	Ø
2	8	2	8

Additional stirrups Asx,2

No.	Ø	No.	Ø
2	8	2	8



- Automatic and manual determination of on-site reinforcement
- Manual selection of reinforcing members
- Supported by graphic display

4. Structural calculations

Software – HSD-CRET

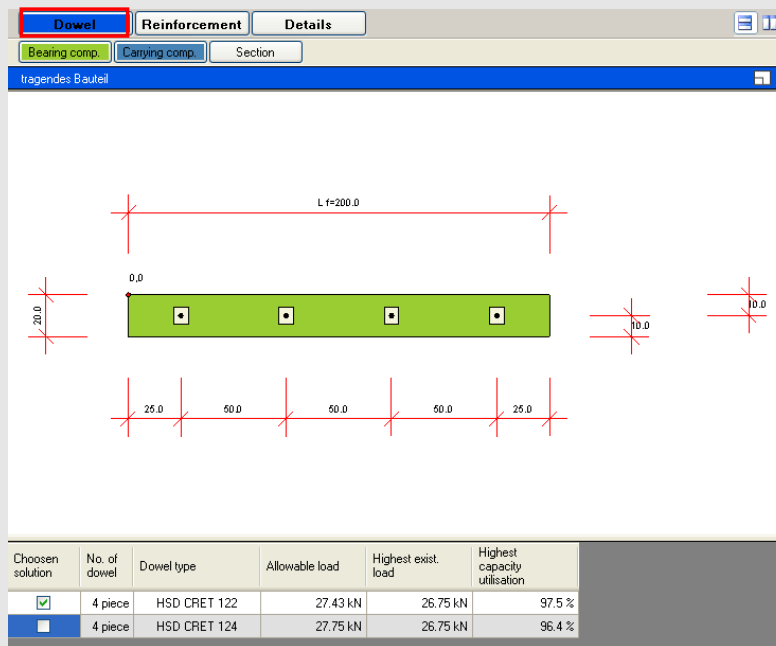
The screenshot shows the 'Options' tab in the HSD-CRET software. The interface is divided into several sections:

- Options for the Calculation**
 - Automatic**
 - Automatically order of the Dowels
 - Type of Dowel: auto (dropdown)
 - Arrangement: continuous (dropdown)
 - Areas for lateral moveable V-types**
 - V-type left Area length [cm]: 0
 - V-type right Area length [cm]: 0
 - V-type completely
 - Policies of the user**
 - Dowels [No.]: 0
 - Edge distance [cm]: 0
 - Intermediate distance [cm]: 0
 - Manual**
 - Manuell order of the dowels - proof only

- Specification of dowel layout
- Definition of moveability
- Manual options regarding dowel quantities and distances

4. Structural calculations

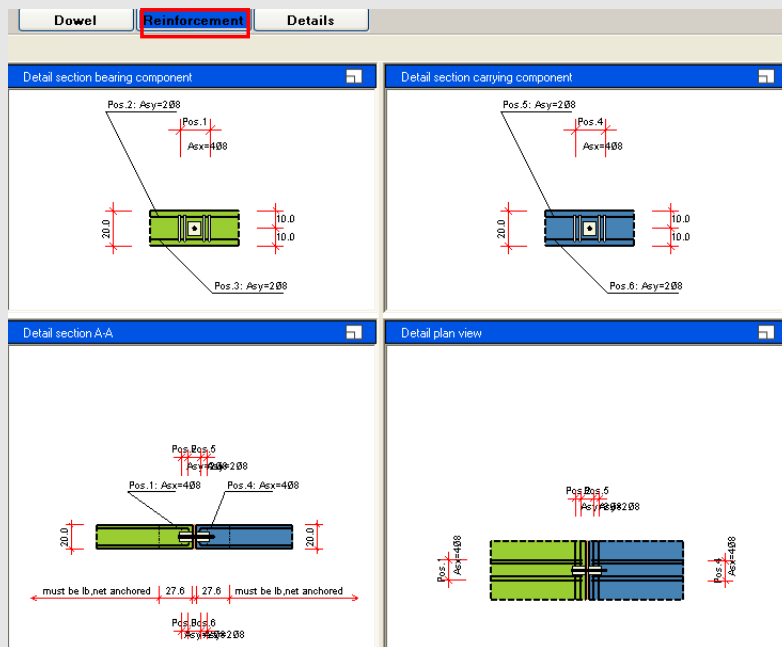
Software – HSD-CRET



- Numerical and graphical output of dowel forces, quantities and dowel distances

4. Structural calculations

Software – HSD-CRET



- Graphic output of required on-site reinforcement

4. Structural calculations

Software – HSD-CRET

HALFEN-DEHA
PART LIST GENERATOR

Development: []
Proj. No.: []
Side: 1

HALFEN - shear dowel system HSD (Appr. - Norm. Z-1.5-T-255) - DIN 1045-1
HALFEN - DEHA design program HSD, version 2.00

Design:
 Crispness : bearing comp.: Slab carrying comp.: Slab
 Arrangement : Uniform distribution
 Dowel distance : automatic, 50.0 cm

Receiving component:
 L=2000
 0.0
 20.0 50.0 50.0 50.0 20.0

Carrying component:
 L=2000
 0.0
 20.0 50.0 50.0 50.0 20.0

Fire resistance : F120 with HALFEN fire protection pad

Dimensions of the concrete:	Component 1 (Receiving)	Component 2 (Carrying)
Height	20.0 cm	20.0 cm
Length (in joint)	200.0 cm	200.0 cm
Depth	200.0 cm	200.0 cm

Concrete cover:	Component 1 (Receiving)	Component 2 (Carrying)
Top	2.5 cm	2.5 cm
Bottom	2.5 cm	2.5 cm
Concrete Quality	C20/25	C20/25

Dimensions of the bolts:
 Width b : 3 cm
 Length l : 200.0 cm
 Height h : 20.0 cm
 Height displacement : 0.0 cm
 Length displacement : 0.0 cm

© HALFEN GmbH, Leisnig, Germany
Date: 30/04/2009

HALFEN-DEHA
PART LIST GENERATOR

Development: []
Proj. No.: []
Side: 1

Completion of the material schedule

Completion by position:

Position	Number of units	Construction element	Order Number of parts, which is
1	4	HSD-CRET 122	730.010-00001
1	4	HSD-F-CRET 122-20	730.320-00001

Sum of the elements of the selected positions:

Position	Number of units	Construction element	Order No.
1	4	HSD-CRET 122	730.010-00001
2	4	HSD-F-CRET 122-20	730.320-00001

- Output of structural analysis
- Output of partlists

Approvals

Existing approvals:

- Germany
- Poland
- France (expired in 2021)

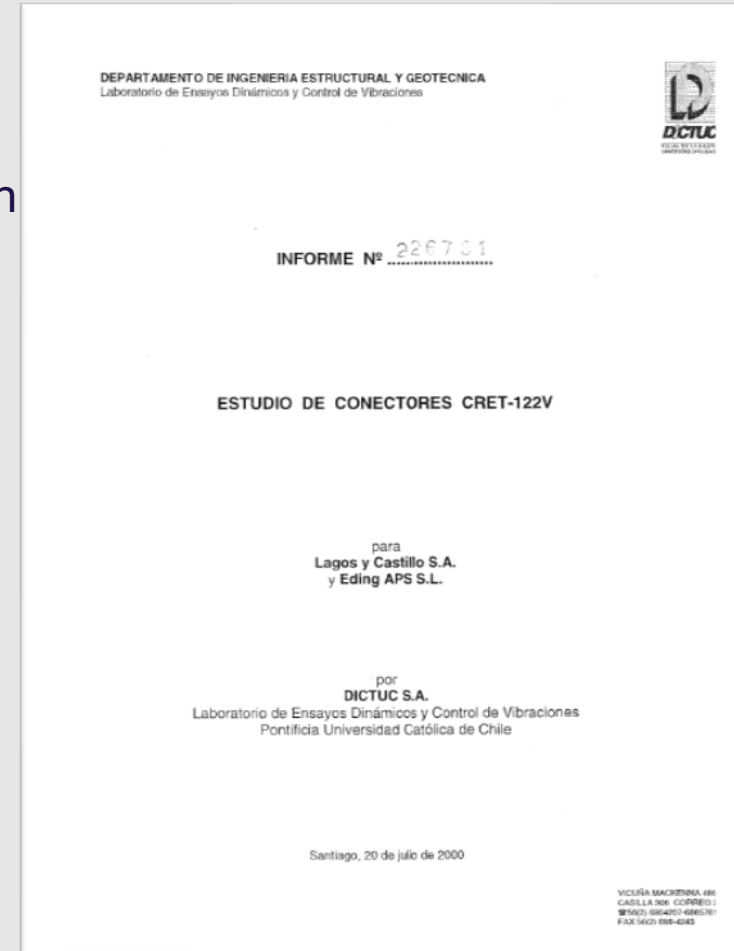
- ETA – 23/0065 (not all the type covered)
Seismic applications are not covered

Others :

- ICC Evaluation

Seismic investigation of CRET

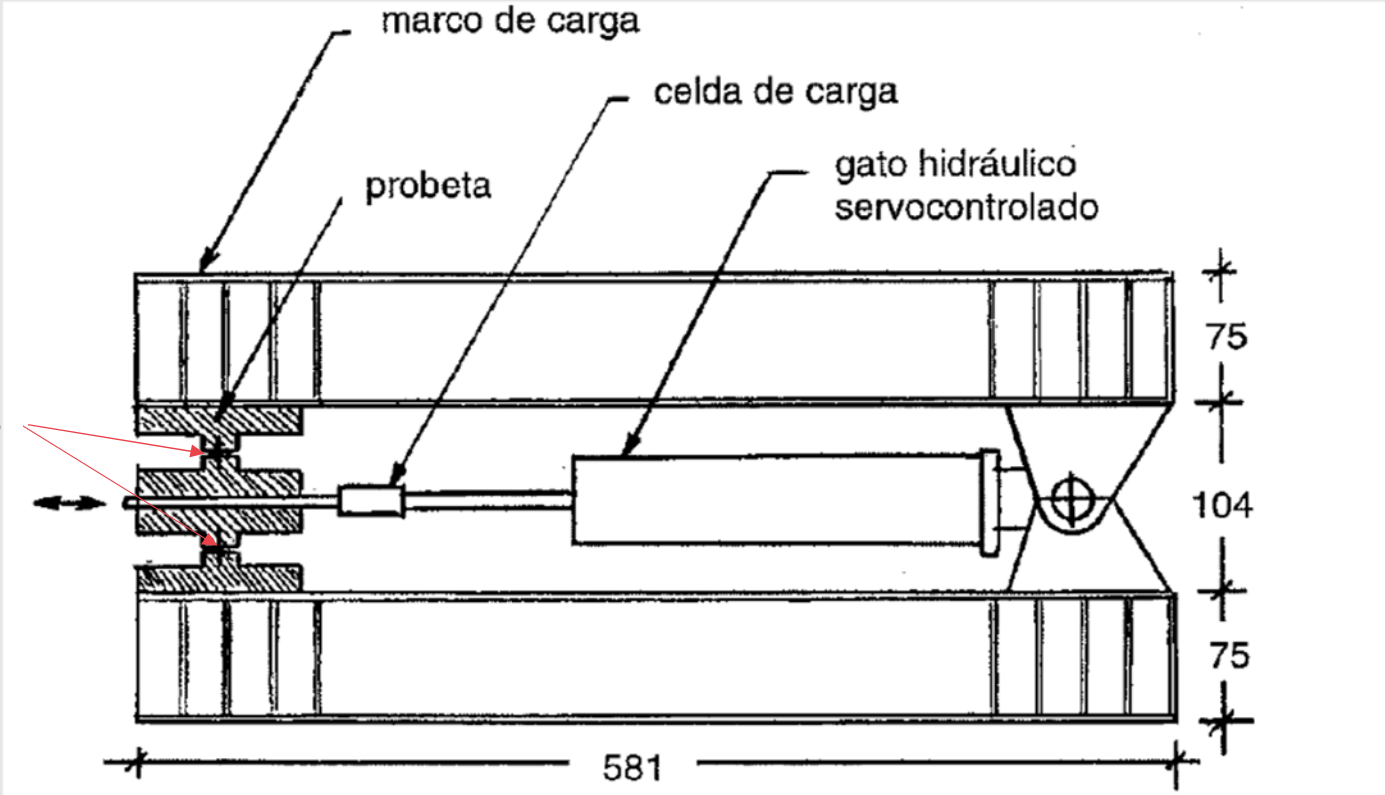
- When Cret Seismic is in scope people always ask for approvals. However, this is a very much region related topic we are not able cover with approvals.
- Investigation of CRET-122V
- Pontificia Universidad Católica de Chile in Juli 2000



Seismic investigation of CRET

Test set-up

CRET Connectors



Seismic investigation of CRET

Sine curve

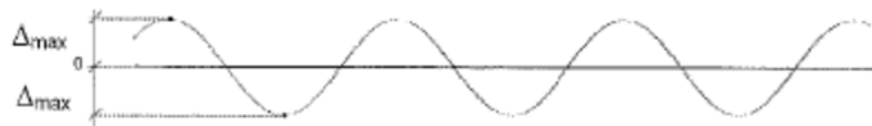
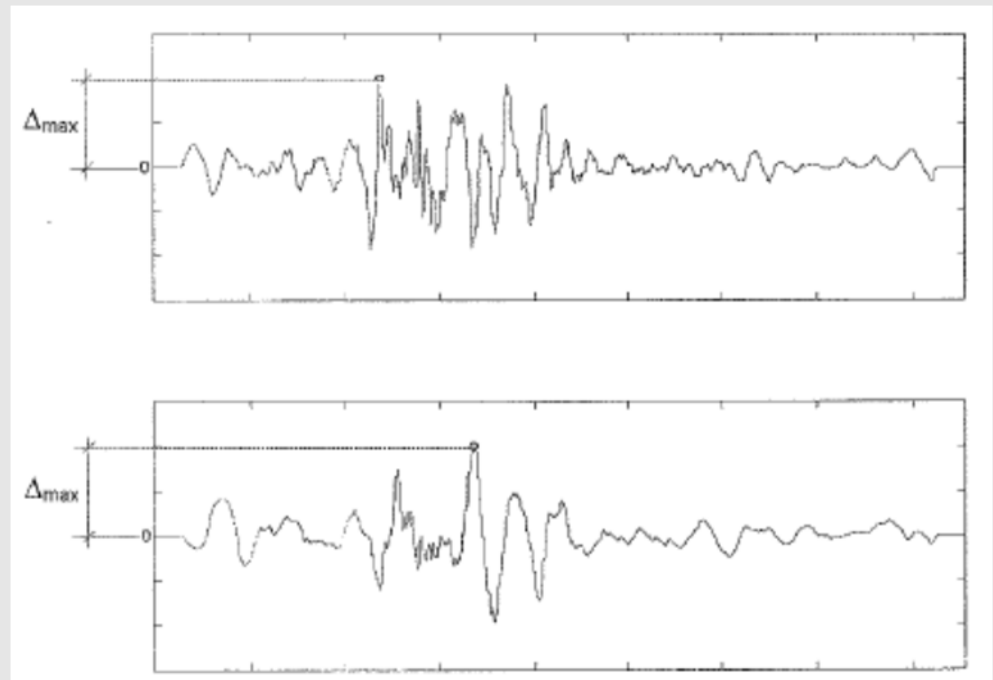


Figura 9. Historia de desplazamiento cíclico

Acc. earthquake measurements (Melipilla 1985)



Chorus Life Bergamo Italy

Leviat
A CRH COMPANY



Project details:

- It is a large replicable smart district project
- 4 squares
- City arena of up to 6.500 seats
- Wellness concept with over 4.000m²
- Large car park with over 1.000 parking spaces
- Residential complex of 74 residences
- Hotel with 107 rooms available.

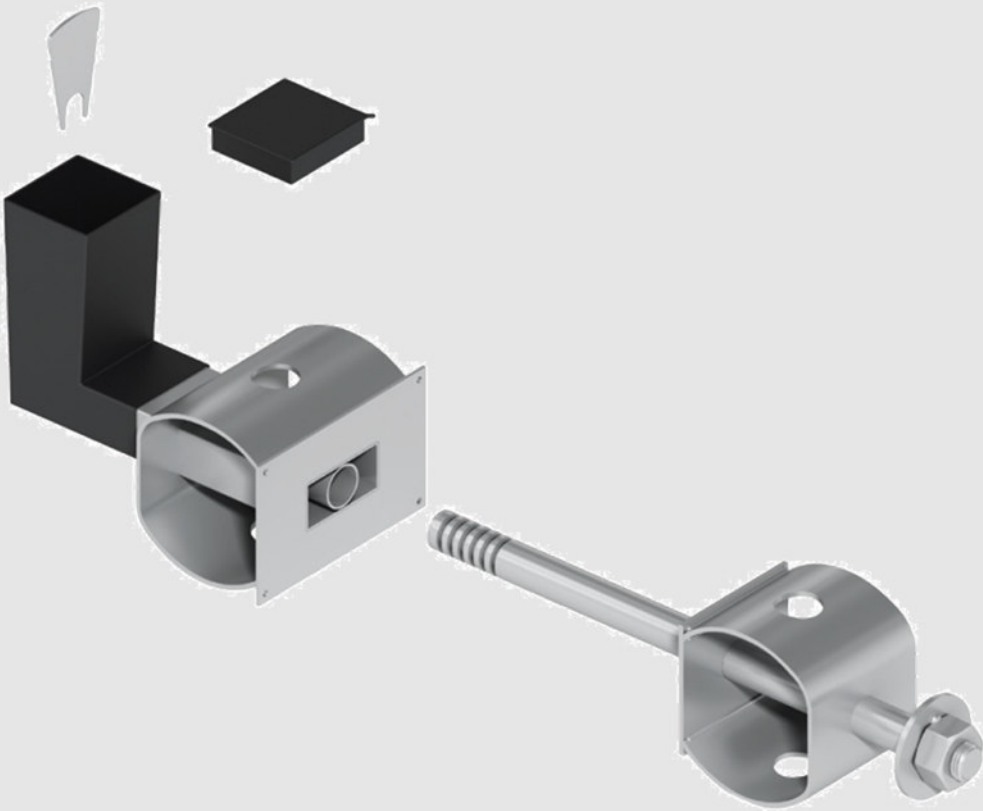
Chorus Life Bergamo Italy – Some images from site



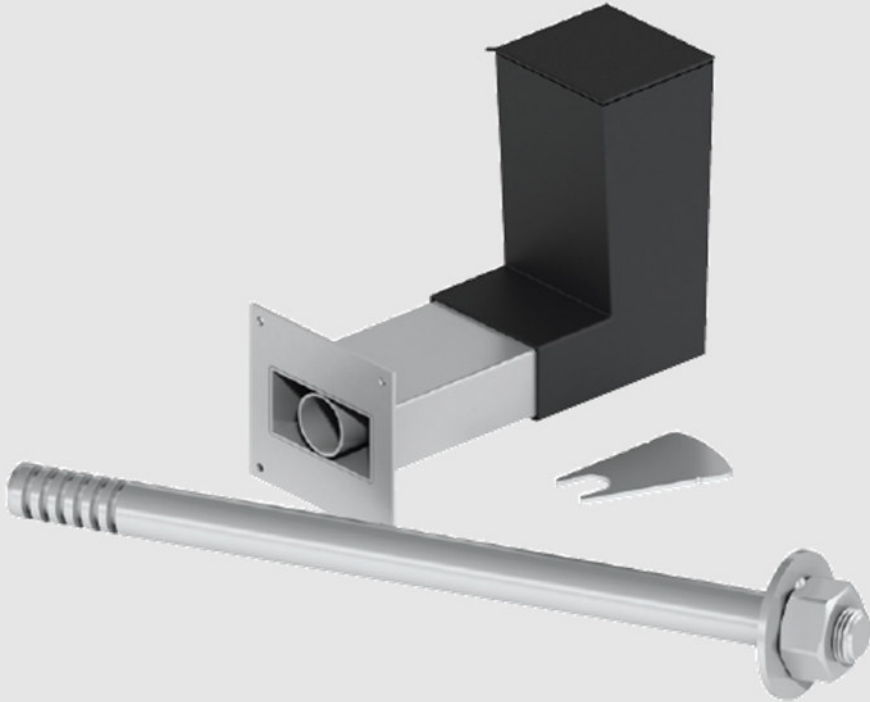
Part 2

Shear Load Connectors in PT structures

Lockable Dowels



HLDQ-L30



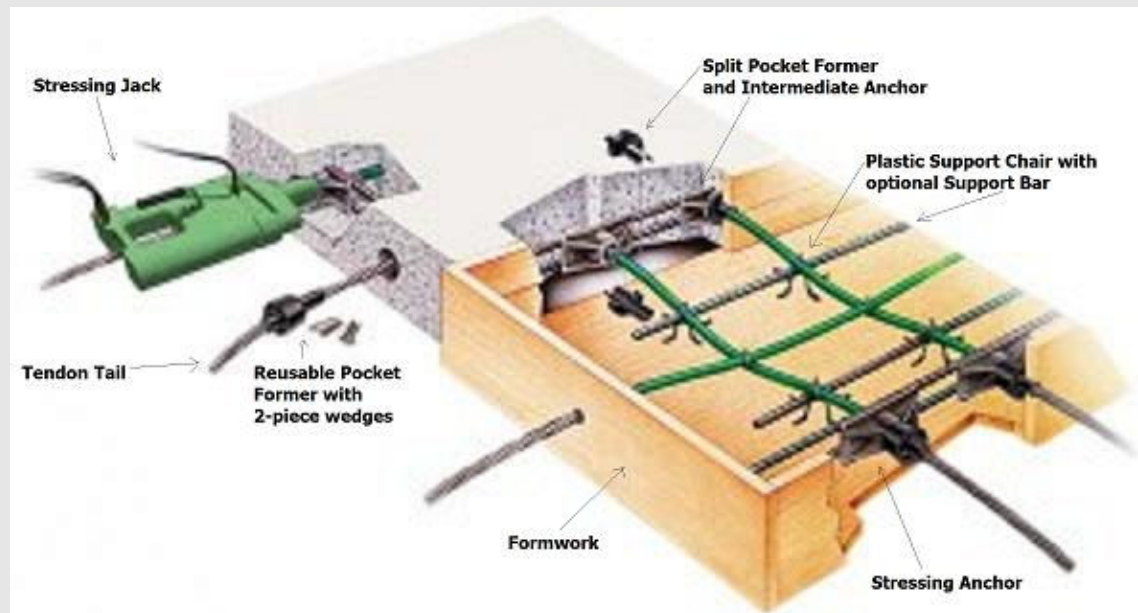
ESDQ-L20

Project

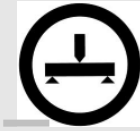


Post tensioning - Construction method

- Cables are put into the concrete without tension
- the concrete slab has hardened, the tendons are stretched and the elongation applies force to compress the concrete.



Project



Concrete building methods

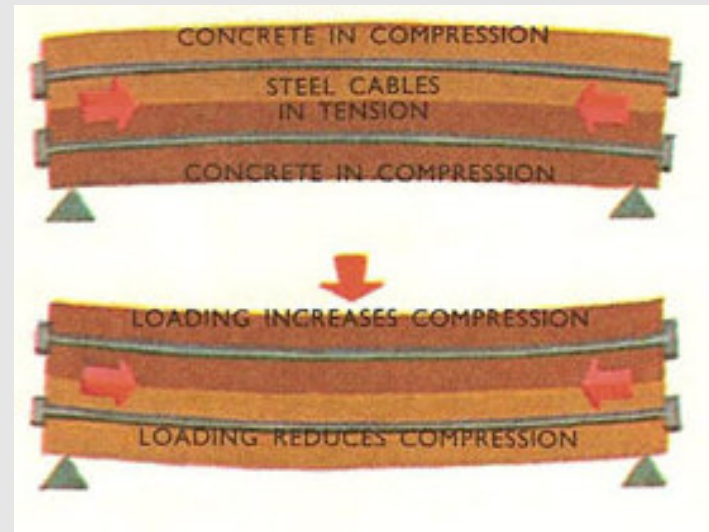
Unreinforced concrete



Reinforced concrete



Post-tensioned concrete

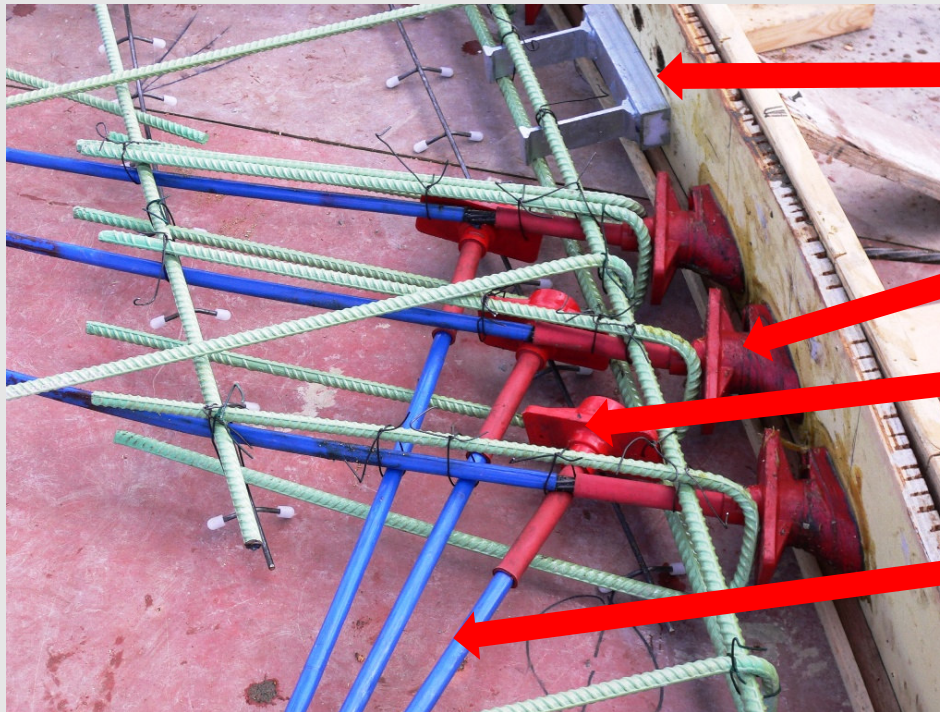


Project

Concrete building methods



Leviat
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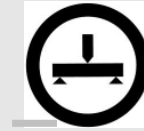
**HALFEN
anchor
channel!**

Live end

Dead end

**Post-tensioning
cable**

Project

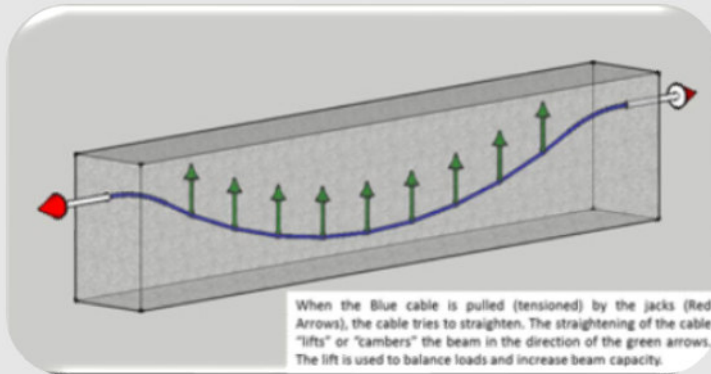


Leviat
A CRH COMPANY

Why post-tensioning?

- The Post-tensioning technology uses the steel in tension and the concrete in compression – this is what they are strong in!
- Slab thickness can be scaled down
 - Less material → Saves cost!
 - Less weight → Big advantage for high risers and in seismic areas!
- Wing span of slabs can be increased against “normal” reinforced constructions.
- Flat soffits
- Reduction in storey height and overall weight

Shear load connectors at post tensioning sabs

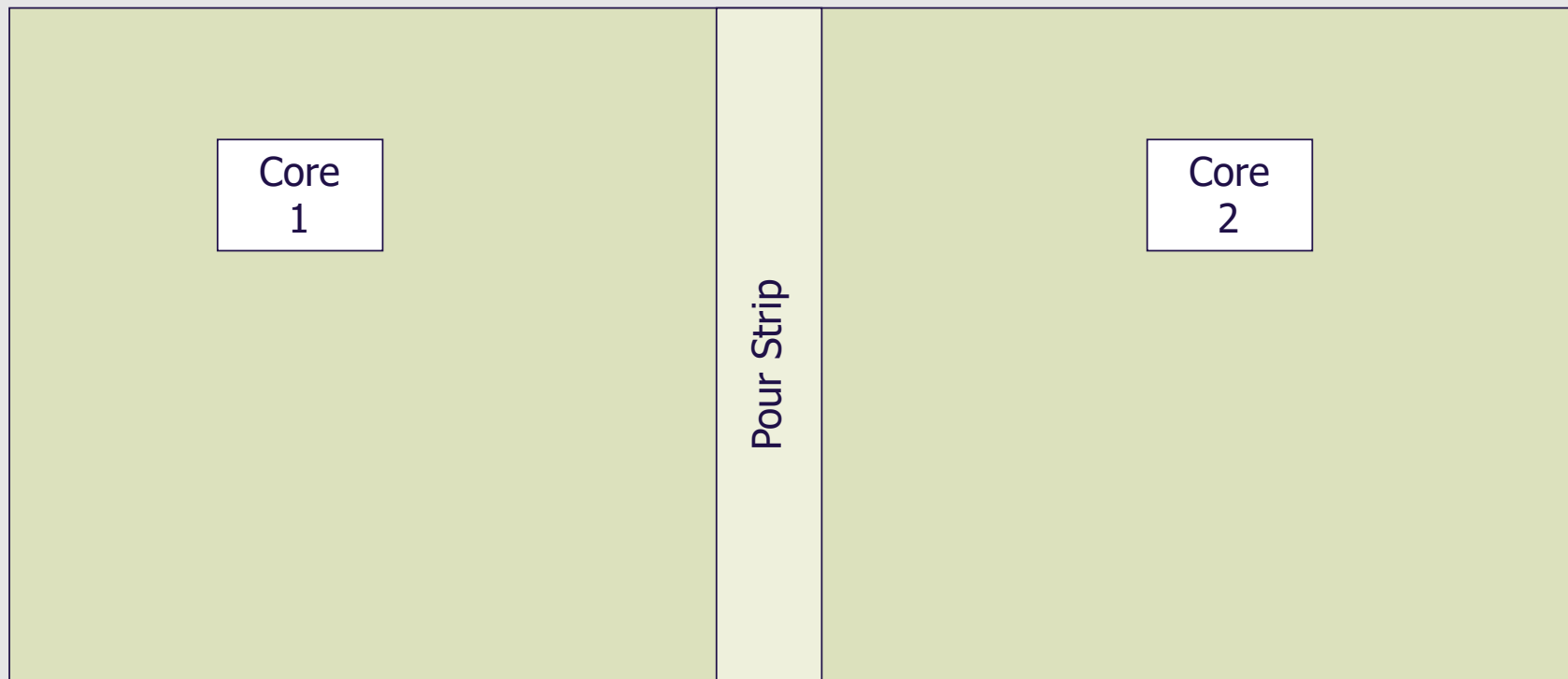


- Tensions and movement of concrete due to shrinkage and creeping.
- How ca we avoid this?



Temporary Movement Joints

Where a building has large areas and/or two rigid cores or more, a temporary movement joint is required to allow for concrete contraction



Problems with Pour Strips

Left open for 14 – 90 days

Slab propping required

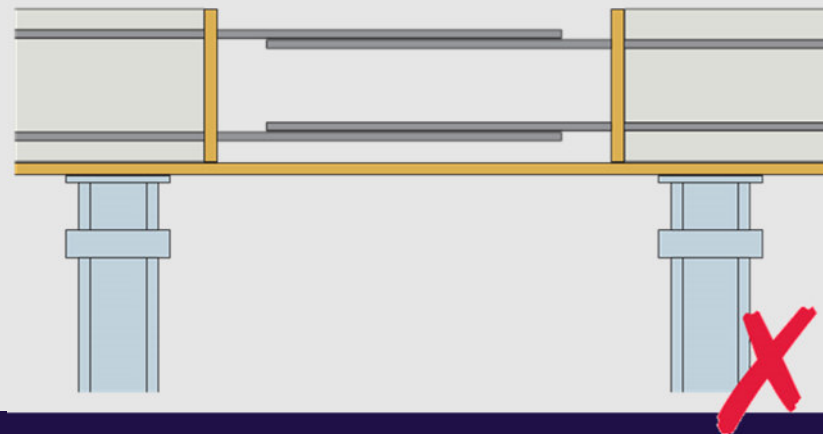
Trip hazard

Restricted site access

Delays follow-on trades

Wet trade must return to fill strip

Unightly soffit face



Leviat
A CRH COMPANY

Traditional Solutions to Temporary Movement Joints

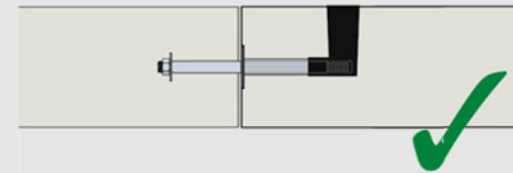
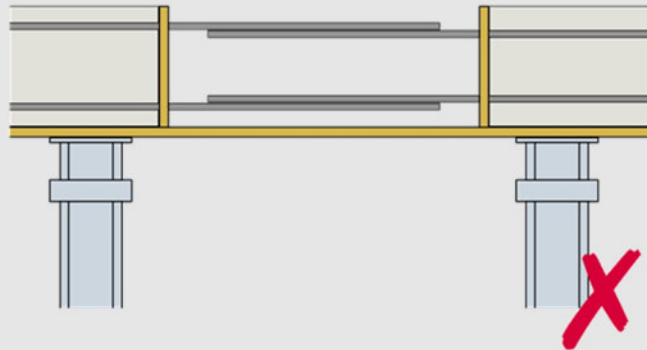
Site-assembled system of rebar / duct / tubes / grout

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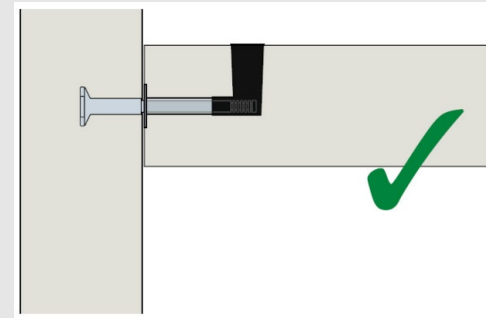
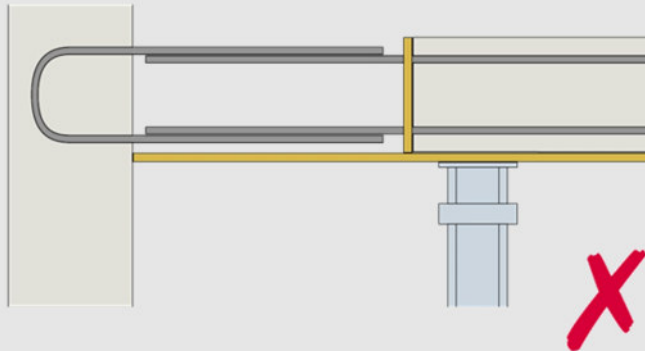
Lockable Dowel for temporary movement joints

Slab to slab:



- Shorter propping times
- Increased safety on site
- Shorter construction times

Slab to wall



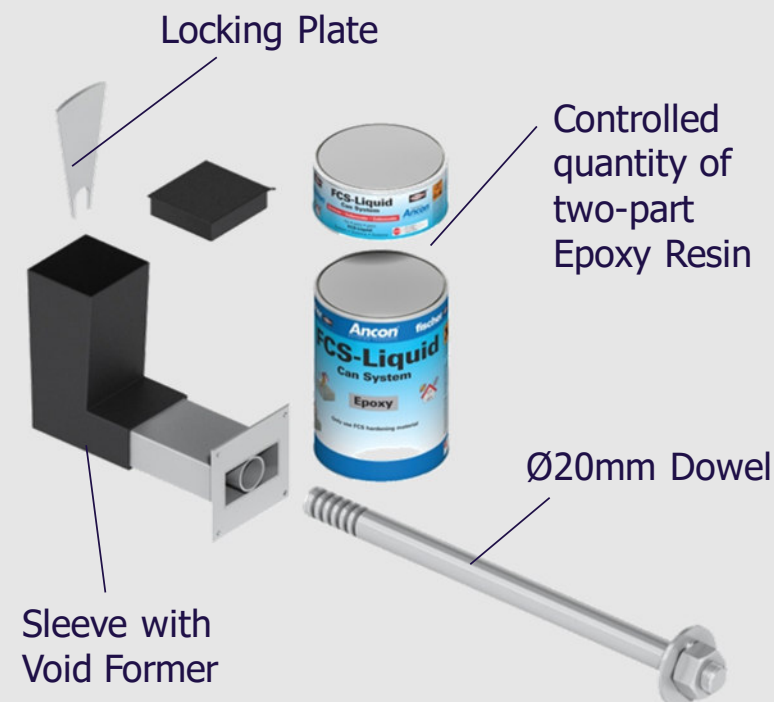
ANCON Lockable Dowel for temporary movement joints

Product description

Lockable Dowels are stainless steel shear load connectors designed to be used in temporary movement joints of concrete constructions, most commonly found in post-tensioned concrete slabs.

Key features & benefits

- Allows initial shrinkage of the concrete to take place and eventually gets locked after predefined time.
- Reduces propping time (site access gets easier)
- Increases safety on site (no pour strips)
- Reduces construction time



Lockable Dowel



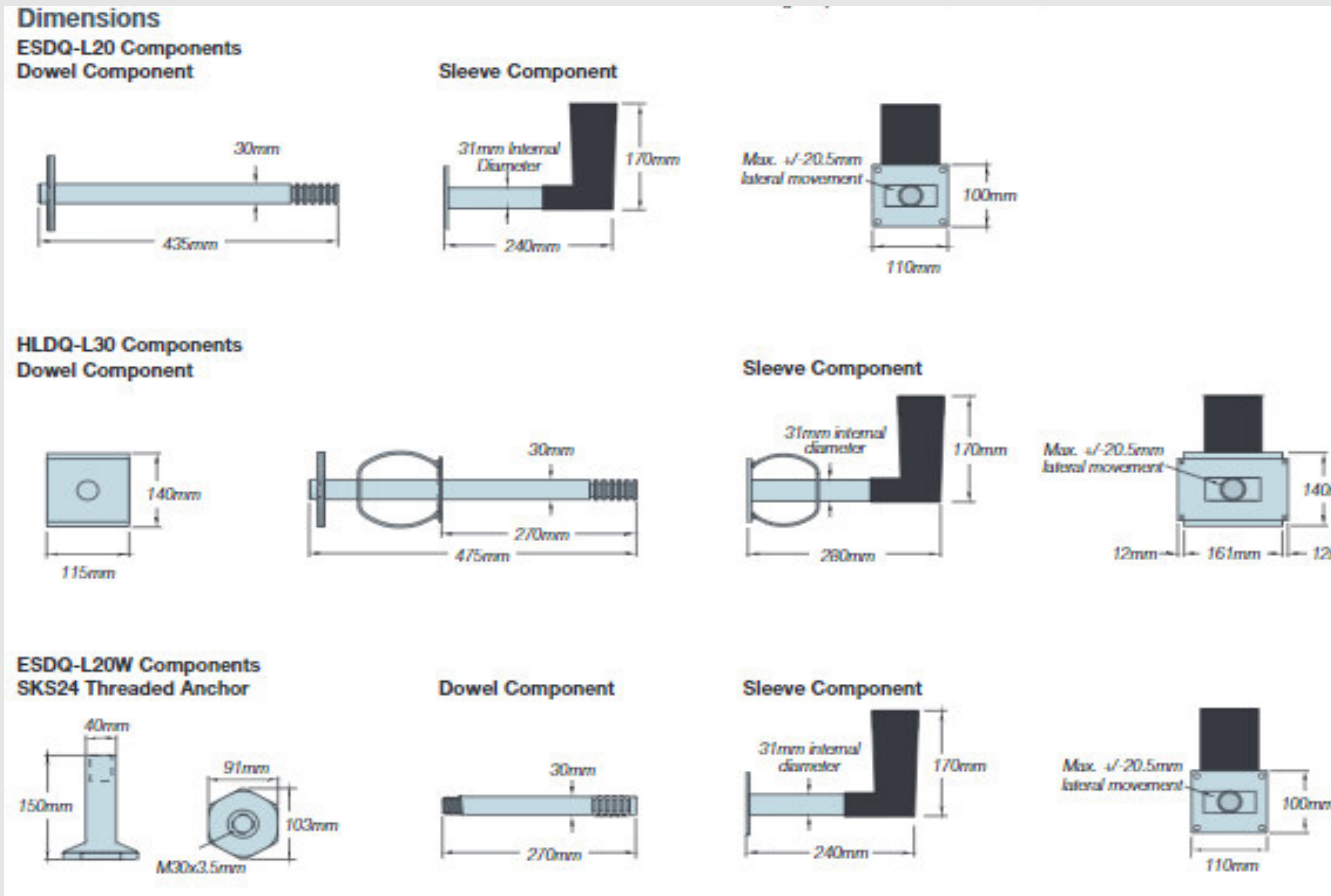
Leviat
A CRH COMPANY



Product Range - Dimensions



Leviat
A CRH COMPANY



Technical Information

HSD-LD / ESDQ-L20 Lockable Dowels – Load capacities



Leviat
A CRH COMPANY

ESDQ-L20 Lockable Dowels (slab-to-slab)

Slab Thickness (mm)	Tension along line of dowel (kN)	Vertical Design Resistance (kN) for Various Design Joint Widths (mm) in C30/37 Concrete							
		5	10	15	20	25	30	35	40
160	45	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
180	65	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
200	80	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
220	100	53.6	53.6	53.6	53.6	53.6	53.6	53.6	52.7
240	100	62.2	62.2	62.2	62.2	60.6	57.8	55.2	52.7
260 and above	100	71.4	69.9	66.6	63.5	60.6	57.8	55.2	52.7

ESDQ-L20W Lockable Dowels (slab-to-wall)

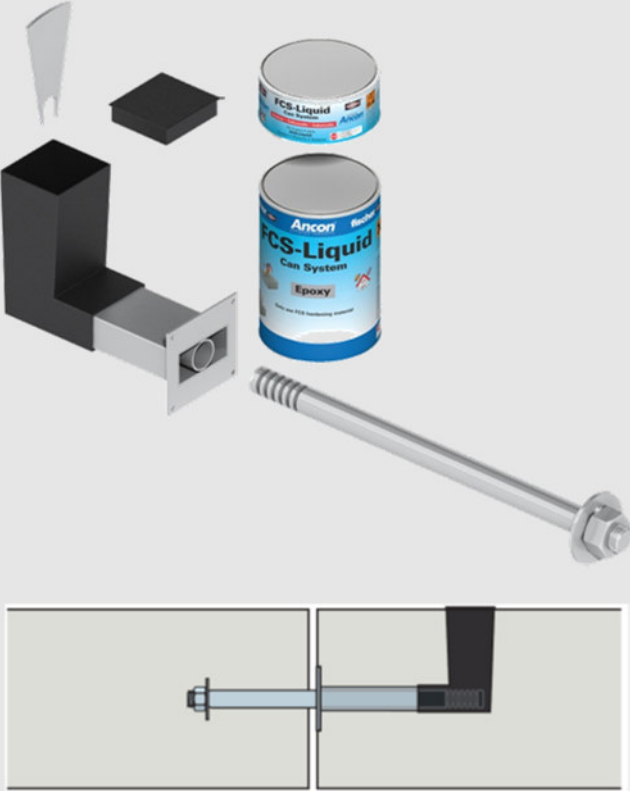
Slab Thickness (mm)	Tension along line of dowel (kN)	Vertical Design Resistance (kN) for Various Design Joint Widths (mm) in C30/37 Concrete							
		5	10	15	20	25	30	35	40
160	45	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
180	65	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
200	80	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
220	80	53.6	53.6	53.6	53.6	53.6	53.6	53.6	52.7
240	80	62.2	62.2	62.2	62.2	60.6	57.8	55.2	52.7
260 and above	80	71.4	69.9	66.6	63.5	60.6	57.8	55.2	52.7

All loads in the table are design load capacities (LRFD) and have to be compared to factored loads.

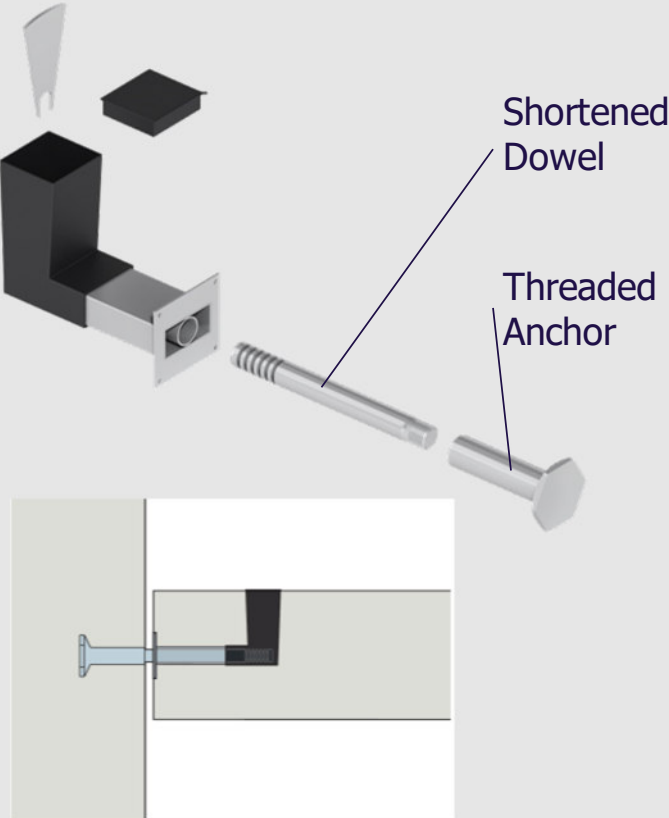
Lockable Dowels covers slab to slab and slab to wall



Slab-to-Slab Joints



Slab-to-Wall Joints

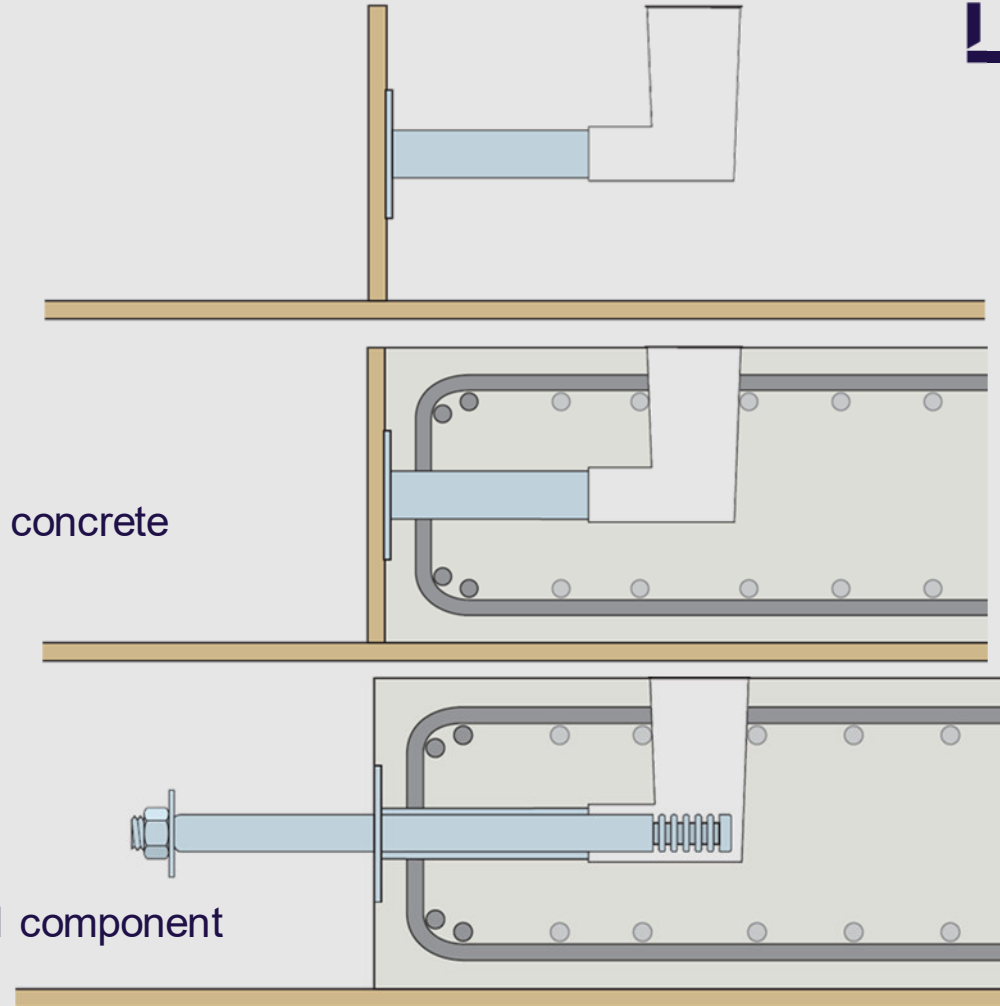


Slab-to-Slab Installation

1. Nail the sleeve to the formwork

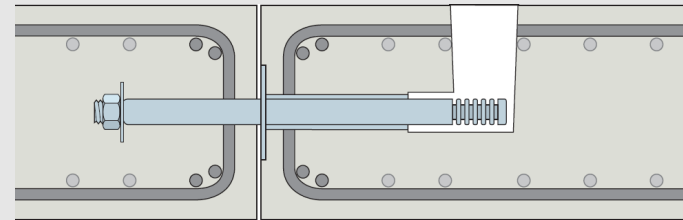
2. Fix the local reinforcement and pour the concrete

3. Strike the formwork and insert the dowel component

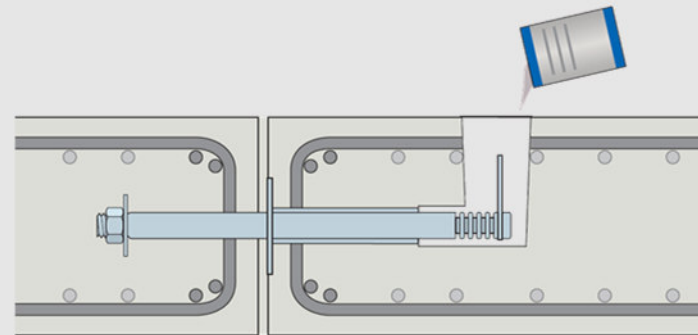


Slab-to-Slab Installation

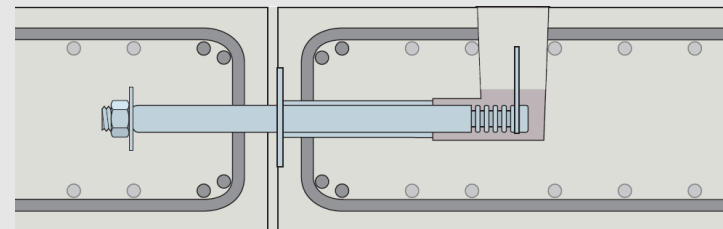
4. Fix the local reinforcement and pour the concrete. Remove formwork when concrete has cured



5. Fill the joint when movement has stabilised (after a predetermined time period). Fit the Locking Plate on the dowel. Mix then pour the resin.



6. After 24 hours, top with cementitious material



Summary Lockable Dowel



- Money and time savings on the construction site
 - Formwork does not need to be drilled at the joint (time and money savings)
 - Formwork is earlier available – less formwork needed
 - Less propping needed
 - No pouring of the strips with a wheel barrel necessary (time savings + health and safety)
 - Easy installation of the product with the nailing plates
- Work Safety
 - No trip hazards from reinforcement in pour strip
 - Better site access

Footscary Hospital Melbourne

Products supplied:

Lockable dowel, Lockable Pin and DSD

Leviat
A CRH COMPANY



Footscary Hospital Melbourne

Pictures from site:



Leviat
A CRH COMPANY

Leviat.com

Imagine. Model. Make.

Footscary Hospital Melbourne

Pictures from site:

Leviat
A CRH COMPANY



Royal Children's Hospital, Melbourne, Australia

5,000 Lockable Dowels installed

Leviat
A CRH COMPANY

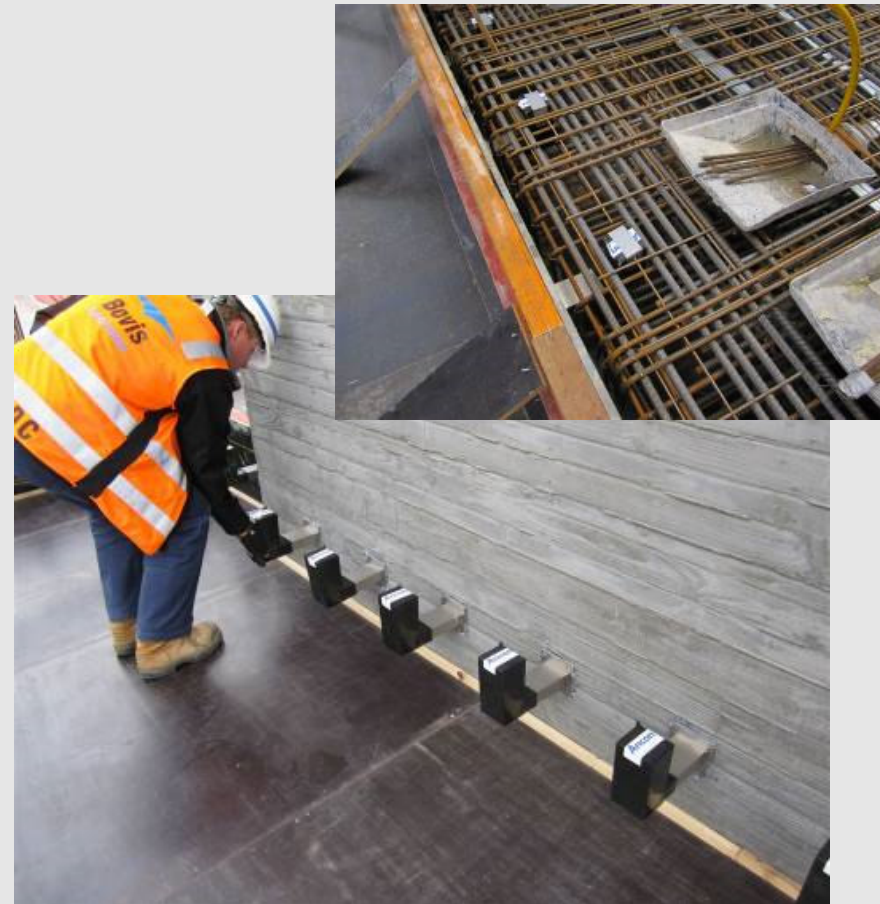




Supreme Courts, Brisbane, Australia

2,500 Lockable Dowels installed

Leviat
A CRH COMPANY



Project

Oman through the ages Museum

Leviat
A CRH COMPANY



- ~ 500 Lockable dowels supplied
- Specified by an Australian Engineer



University of Suffolk, Ipswich, UK

200 Lockable Dowels installed

Leviat
A CRH COMPANY



Project

The standard at East Library

- Five story building with 99 apartments, 16,000 Square-foot space for Milwaukee Library, retail store and underground parking garage – finished in summer 2014



Leviat
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- 320 feet long
- Pour strips specified
- 90 days holding period





Shear load connectors

Imagine. Model. Make.