

## recostal®-Keyboard

Isolation joint units for industrial floor slabs



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## Introduction

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Since the 1980s, DYWIDAG-Systems International GmbH (DSI) with its business segments contec® and recostal® has developed into a leading manufacturer of formwork and waterproofing systems.

Today, recostal® permanent formwork systems and contec® waterproofing systems are well established brands on the German market and on major export markets.

recostal® Keyboard units are designed as formwork for the installation of contraction joints in industrial ground floor slabs. Rather than subsequently saw cuttings joints, a controlled crack appears along the unit.

The trapezoidal profile provides a keyed profile between the slabs. Deflection of the individual floor slabs can thus be avoided.

In order to increase the capacity to withstand shear forces, the Keyboard units can be equipped with additional dowel bars. The height can be adjusted with set-screws incorporated in the formbraces. There is a wide variety of systems available for the top of the recostal® Keyboard units to allow for various applications.



## Design of joints in industrial ground floor slabs

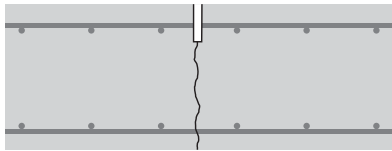
Occurring erratic shrinkage during the installation of industrial ground floor slabs leads to the formation of cracks, a process that has to be taken into account. A common method is to saw cut joints. The 5 to 7 cm deep sawn joints weaken

the surface of the plane and induce a planned crack. Typically the concrete should crack along this joint during shrinkage.

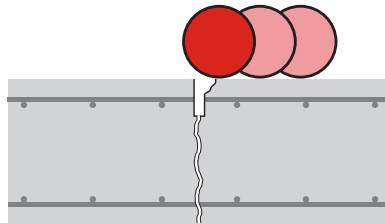
### Risks of saw cut joints

Subsequent saw cutting causes uncontrolled crack patterns which make the planned transfer of shear forces impossible. The undefined shear force, when exposed to loads generated by shrinking slabs and forklift trucks, leads to spalling.

Industrial ground floor slabs with constant forklift loading are especially susceptible to damage. Subsequent remedial action is costly and entails extensive technical refurbishing operations.



Saw cut joint with early stages of crack formation.



Initial spalling and crack formation.



Refurbished saw cut joint with supplementary dowel bars.

### Keyboard units provide the safe solution

Rather than saw cutting joints, keyboard units are installed in order forklift trucks are transferred effectively even if the joint opens. The load bearing capacity of the keyboard units was verified by tests carried out by the MFPA Leipzig.

Depending on the distance of the joint and the joint opening, spalling of edges is prevented by angled plastic cap strips or edge protection profiles made from sharp-edged flat steel.

### According to the DBV- Bulletin "Industrial floor slabs"

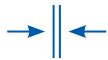
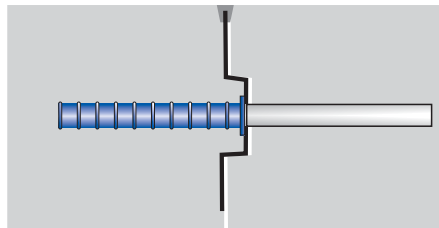
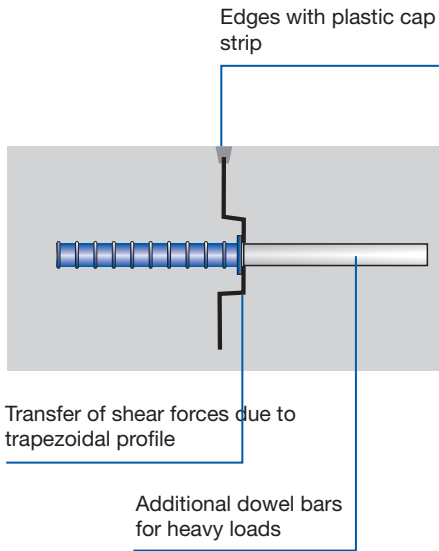
In the case of constructions with contraction joints, the planner has to point out to the contractor that damage to the joint is likely to occur when subjected to dynamic loads and that the appearance of cracks outside the joint can not be ruled out.





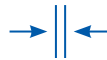
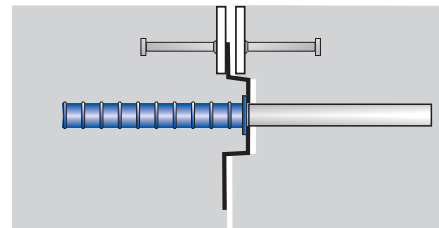
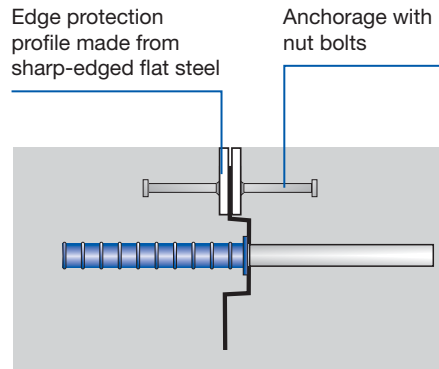
# Isolation joint units for industrial floor slabs

## recostal®-Keyboard XL for small joint expansions



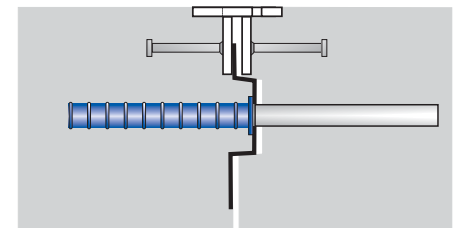
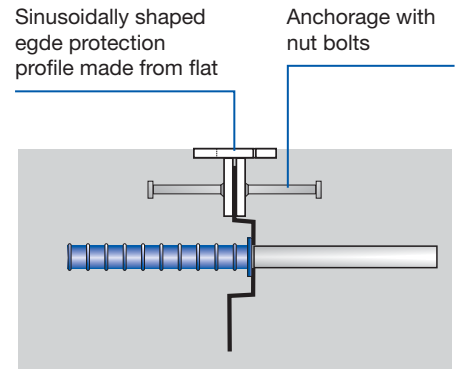
Joint expansion less than 3 mm

## recostal®-Keyboard XLV/XLW for larger joint expansions



Joint expansion up to 12 mm

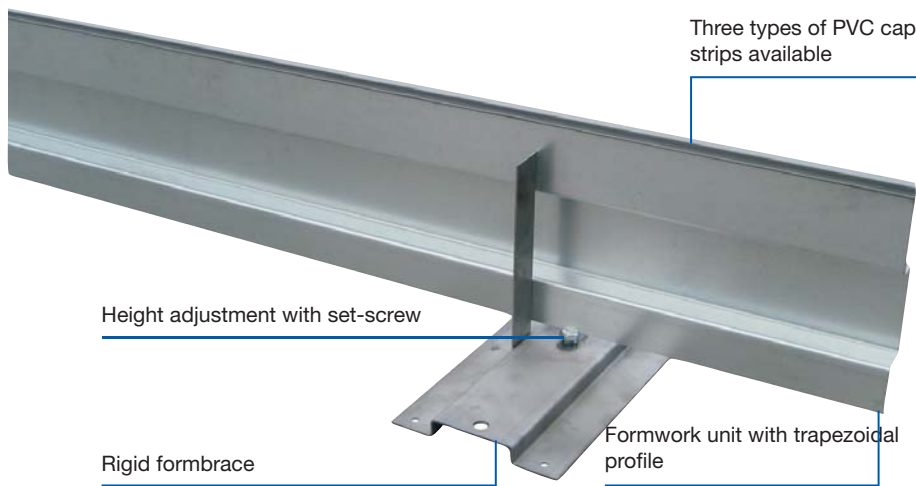
## recostal®-Keyboard XLS to reduce vibration



Joint expansion up to 12 mm



# recostal®-Keyboard XL



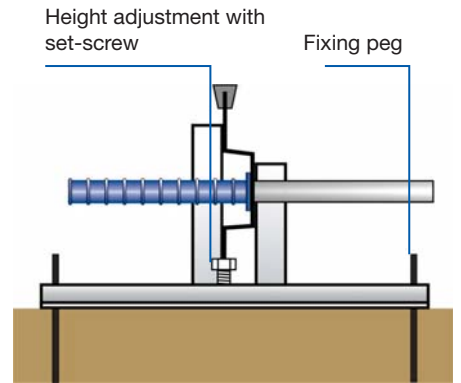
## List of parts recostal®-Keyboard XL

	Keyboard type	Formbrace type	Unit height	Slab height <sup>1)</sup>
<p>Unit length L = 3.0 m</p>	XL 150	KBS 150	120	150
	XL 180	KBS 180	145	180
	XL 200	KBS 200	165	200
	XL 250	KBS 250	215	250
	XL 300	KBS 300	265	300

1) Other heights available on request

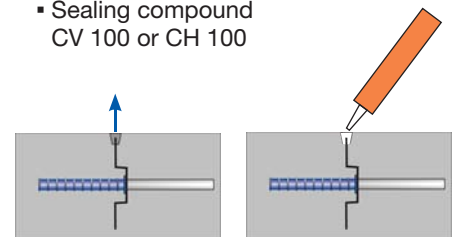
## Accessories Keyboard XL

	Item
	PVC cap strip type 75E, removable, width 7.5 mm, colour: grey, 24 m/roll
	PVC cap strip type 120E, removable, width 12 mm, colour: grey, 6 m/roll
	PVC cap strip type 95P, permanent, width 9.5 mm, colour: grey, 24 m/roll, UV-stabilised
	Contaseal Joint Sealing Compound CH 100 highly elastic with strong bond, 600 ml tube
	Contaseal Joint Sealing Compound CV 100 highly elastic with strong bond, 4 kg can



recostal®-Keyboard XL units induce the appearance of planned cracks along the joint. The top of the unit consists of a plastic cap strip which can be installed either as a permanent or a removable strip. If the cap strip is removed, the joint can be sealed with an elastic sealing compound.

- Recommendation:
  - Sealing compound CV 100 or CH 100



## Dowel bars for Keyboard XL and XLV

	Item
	Dowel sleeve, PVC, for dowel bars Ø 16 mm, L = 300 mm for dowel bars up to L = 600 mm, can be shortened to any length
	Dowel sleeve, PVC, for dowel bars Ø 20 mm, L = 300 mm for dowel bars up to L = 600 mm, can be shortened to any length
	Dowel bar Ø 16, L = 300/400/500/600 mm, galvanized
	Dowel bar Ø 20, L = 300/400/500/600 mm, galvanized

Centres to specification



Lap joint



Stable installation with formbrace

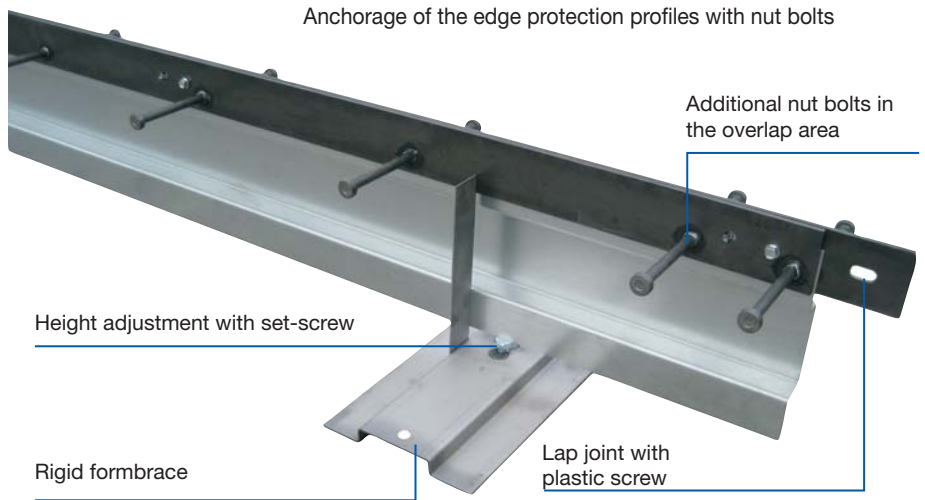
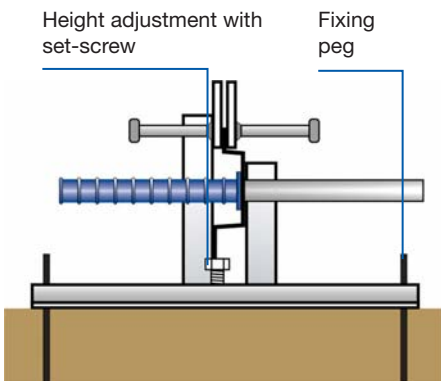


Cap strip



Height adjustment with set-screw

# recostal®-Keyboard XLV/XLW



## List of parts Keyboard XLV

	Keyboard type	Formbrace type	Unit height	Slab height <sup>1)</sup>
 Unit length L = 3.0 m	XLV 150	KBS 150	120	150
	XLV 180	KBS 180	145	180
	XLV 200	KBS 200	165	200
	XLV 250	KBS 250	215	250
	XLV 300	KBS 300	265	300

1) Other heights available on request

recostal® Keyboard XLV/XLW units induce the appearance of planned cracks along the joint. The top of the units consists of edge protection profiles which protect the concrete edges from spalling. There is a choice between type XLV and type XLW, depending on the respective requirement for edge protection.

Standard edge protection profiles are black steel. On request edge protection profiles are also available galvanized or made from non-corroding steel.

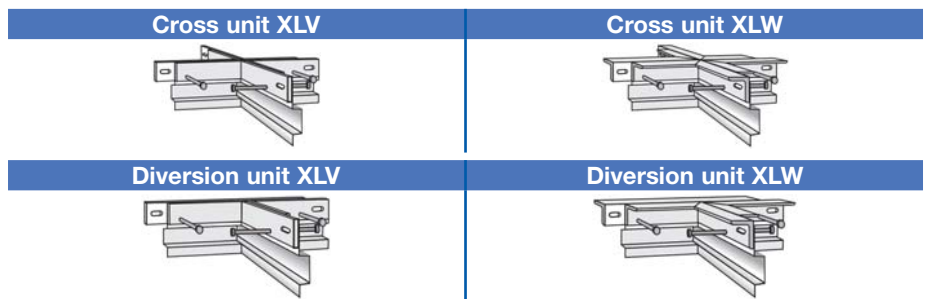
Intermediate sizes and fixed lengths are available on request.

## List of parts Keyboard XLW

	Keyboard type	Formbrace type	Unit height	Slab height <sup>1)</sup>
 Unit length L = 3.0 m	XLW 150	KBS 150	120	150
	XLW 180	KBS 180	145	180
	XLW 200	KBS 200	165	200
	XLW 250	KBS 250	215	250
	XLW 300	KBS 300	265	300

1) Other heights available on request

## recostal®-Keyboard preshaped parts



Lap joint



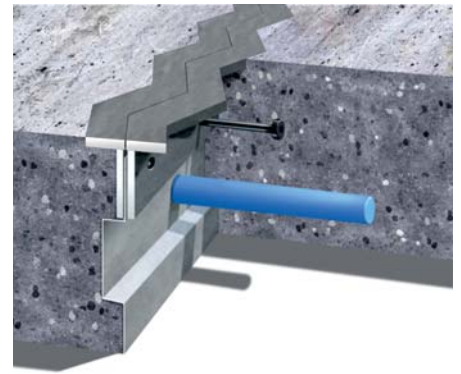
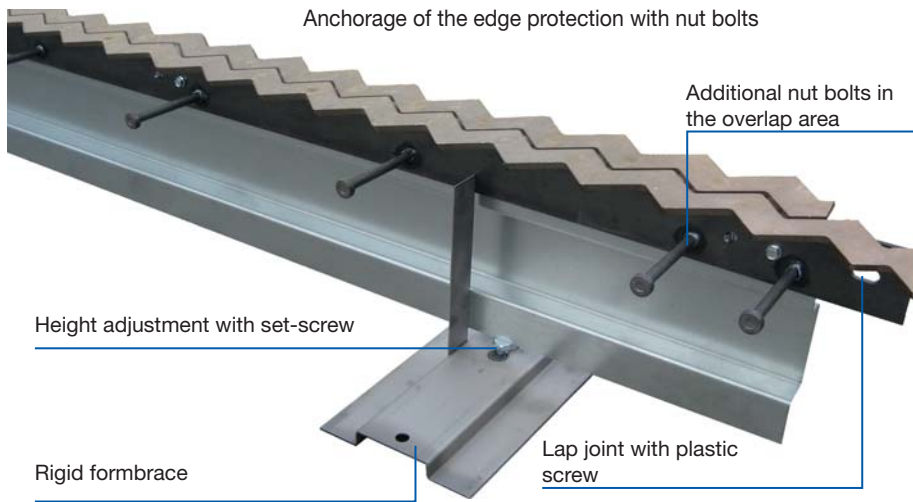
Lap joint with plastic screw



Height adjustment with set-screw



# recostal®-Keyboard XLS



## List of parts Keyboard XLS

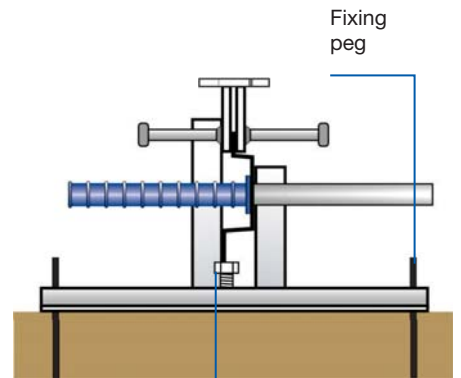
	Keyboard type	Formbrace type	Unit height	Slab height <sup>1)</sup>
<p>Unit length L = 3.0 m</p>	XLS 150	KBS 150	120	150
	XLS 180	KBS 180	145	180
	XLS 200	KBS 200	165	200
	XLS 250	KBS 250	215	250
	XLS 300	KBS 300	265	300

1) Other heights available on request

recostal®-Keyboard XLS units induce the controlled formation of cracks along the joint. In addition to providing edge protection, vibration and shock-free passage over the joint is guaranteed. The sinusoidally shaped edge protection overlaps far enough to allow constant contact between the wheel and the track. Thus noise emissions, whole-body vibration and tyre wear are considerably reduced.

Joint expansions of up to 12 mm are possible without having to take further measures. In the case of heavier shear force loads, recostal®-Keyboard XLS can be fitted with additional dowel bars. The load capacities have been tested by the MFPA Leipzig.

The edge protection profiles are typically made of black steel. On request, however, galvanized or non-corrosive edge protection profiles are also available. Preshaped parts like diversion or cross units are designed to fit perfectly. Positioning for the whole project can be included. Intermediate sizes and fixed lengths are also available on request.



Height adjustment with set-screw



Opening to accommodate dowel sleeve



Joint after concreting



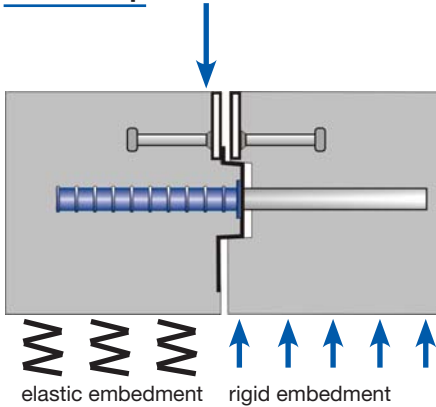
Joint expansion after shrinkage



Attachment of the dowel sleeve

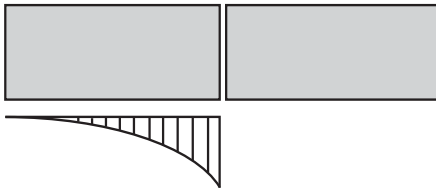
## Load bearing behaviour

### Test set-up

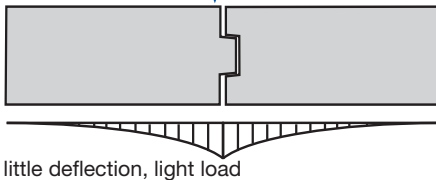


### Differences in the load bearing behaviour

Load bearing behaviour of an open joint without trapezoidal profile



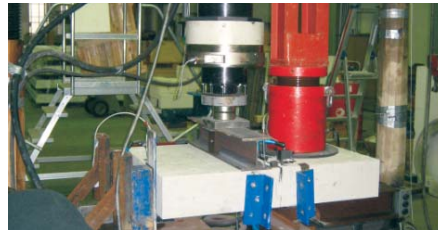
Load bearing behaviour of an open joint with trapezoidal profile



### Testing of the load bearing capacity by the MFPA-Leipzig

Industrial ground floor slabs in standard applications are not regarded as structural elements in terms of the DIN EN 1992-1-1 and the DIN 1055-100. There is no Standard covering the design of concrete floor slabs for production halls and warehousing but the guidelines of the DIN EN 1992-1-1 and the DIN 1055-100 are highly recommendable for the construction of these industrial floor slabs. For additional guidance regarding the design of the joints, a series of laboratory tests was carried out by the

MFPA-Leipzig to determine the bearing capacity of the Keyboard units. 15 - 25 cm high slabs with varying joint openings of up to 12 mm were tested. The effect of applied loads in the case of Keyboard units with additional dowel bars was also examined. Table 1 shows the results from the load tests taking into account added safety factors.



### Load bearing behaviour of the Keyboard units

The specific trapezoidal profile of the Keyboard units and the option of including additional dowel bars allow for the transfer of shear forces across the adjacent slab. This results in a reduction of slab deformation and deflection and therefore reduces the bending stress applied to the concrete slab. Thus a much more economic design and construction of the floor slab in the particularly critical area around the slab edges is ensured. Due to the trapezoidal profile or dowel bars, the shear force

to be transferred across the joint may, according to Lohmeyer/Ebeling\*), be reduced by multiplying by the load factor = 0.60 (0.55). This validated by example FEM-calculations.

\*) Lohmeyer/Ebeling, Concrete Floors for Production Halls and Warehouses, issue 2008.

### Bearing capacity of Keyboard units

Rated bearing capacity	10 kN	15 kN	25 kN	40 kN	60 kN
Wheel load	$Q_k = 13 \text{ kN}$	$Q_k = 20 \text{ kN}$	$Q_k = 32 \text{ kN}$	$Q_k = 45 \text{ kN}$	$Q_k = 70 \text{ kN}$
Slab height 15 cm	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard with dowel bars $\varnothing 20 \text{ mm}$ , $s = 40 \text{ cm}$		
Slab height 20 cm	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard with dowel bars $\varnothing 20 \text{ mm}$ , $s = 40 \text{ cm}$	
Slab height 25 cm	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard with dowel bars $\varnothing 20 \text{ mm}$ , $s = 40 \text{ cm}$
Slab height 30 cm	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard without dowel bars	Keyboard with dowel bars $\varnothing 20 \text{ mm}$ , $s = 40 \text{ cm}$

Based on: forklift truck loading according to DIN 1055-3, concrete C25/30 (structurally reinforced), material  $\gamma = 1.5$ , load  $\gamma_q = 1.6$   
Joint expansion  $v = 12 \text{ mm}$  (in the case of smaller joint expansions heavier loads might be possible).

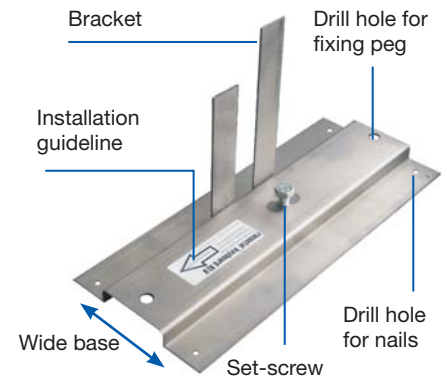


## Installation

### Fast installation with Keyboard formbraces

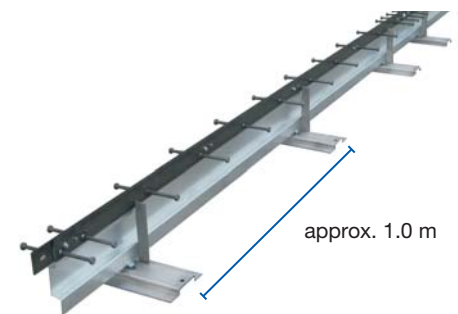
The installation with Keyboard formbraces has many advantages.

- Wide base
  - When inserting the Keyboard units, the wide formbrace makes handling very easy as it provides a stable footing.
- Stable against concrete pressure
  - Due to the design of the dimensions, the formbraces only need to be prevented from moving sideways. They are placed at a distance of approx. 1.0 m.
- Easy and exact height adjustment
  - The adjustment in height is exact to the millimeter with set-screws type M12.



### Keyboard installation

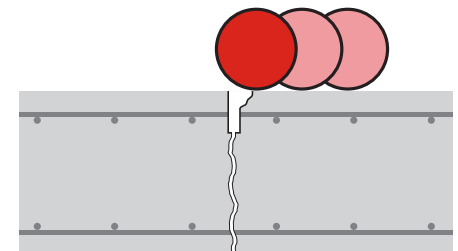
- Place one Keyboard formbrace approx. every metre in line with the joint. Please note sticker pointing out direction.
- Insert Keyboard unit into the formbrace and connect lap joints with the included plastic screws.
- Align Keyboard units in a straight line and exact direction.
- Fix Keyboard formbraces with fixing pegs or, in the case of an existing blinding layer, with nail gun to prevent them from moving sideways.
- Exact height adjustment of the Keyboard units with set-screws.



### What to do in cases of spalling

Constant load applied by the passage of handlift and forklift trucks can cause extensive spalling of saw cut joints over time. Once shrinkage is completed, refurbishing of the joints is inevitable. In order to avoid further damage, the affected joint areas need to be sealed and stabilised permanently with epoxy resin. HYPOFLEX XF is a flexible 2-part epoxy resin fine mortar that has been proven reliable for repairing damaged

joints. In order to ensure proper bond to the edges, the surfaces of the joint are treated with HYPOFLEX P primer prior to the application of the epoxy mortar.



Spalling caused by the passage of handlift truck traffic once the joint opened.



### List of parts - joint refurbishing

	HYPOFLEX XF	flexible, 2-part epoxy resin fine mortar	A+B component	10,00 kg
	HYPOFLEX P	Primer to pretreat joint edges	A+B component	1,44 kg

## Specification

### 1.01

**Isolation joint unit with trapezoidal profile designed to install control joints in industrial floor slabs** including permanent/removable PVC cap strips and formbraces with height adjustment to be supplied and installed according to the manufacturer's installation guidelines.

Concrete slab: d = ..... cm

Cap strip: Type 75E  Type 120E  Type 95P

Manufacturer: **DYWIDAG-Systems International GmbH**

Make: **recostal-KeyBoard XL** with formbrace type KBS

Quantity/unit ..... m Price per m ..... €/m Total ..... €

### 2.01

**Isolation joint unit with trapezoidal profile and flat steel edge protection 60 x 5 mm (black<sup>1)</sup>) designed to install control joints in industrial floor slabs** including anchorage with nut bolts and formbraces with height adjustment to be supplied and installed according to the manufacturer's installation guidelines.

Concrete slab: d = ..... cm

Manufacturer: **DYWIDAG-Systems International GmbH**

Make: **recostal-KeyBoard XLV** with formbrace type KBS

Quantity/unit ..... m Price per m ..... €/m Total ..... €

1) Alternatively the specification can be for galvanized or non-corrosive steel.

### 3.01

**Isolation joint unit with trapezoidal profile and angled steel edge protection 30 x 60 x 5 mm (black<sup>1)</sup>) designed to install control joints in industrial floor slabs** including anchorage with nut bolts and formbraces with height adjustment to be supplied and installed according to the manufacturer's installation guidelines.

Concrete slab: d = ..... cm

Manufacturer: **DYWIDAG-Systems International GmbH**

Make: **recostal-KeyBoard XLW** with formbrace type KBS

Quantity/unit ..... m Price per m ..... €/m Total ..... €

1) Alternatively the specification can be for galvanized or non-corrosive steel.

### 4.01

**Isolation joint unit with trapezoidal profile and sinusoidally shaped edge protection (black<sup>1)</sup>) designed to install control joints in industrial floor slabs for vibration and shock-free passage** including anchorage with nut bolts and formbraces with height adjustment to be supplied and installed according to the manufacturer's installation guidelines.

Concrete slab: d = ..... cm

Manufacturer: **DYWIDAG-Systems International GmbH**

Make: **recostal-KeyBoard XLS** with formbrace type KBS

Quantity/unit ..... m Price per m ..... €/m Total ..... €

1) Alternatively the specification can be for galvanized or non-corrosive steel.









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