



## Standard pile head details

Design and detailing

National Technical Approval  
Z-34.14-209

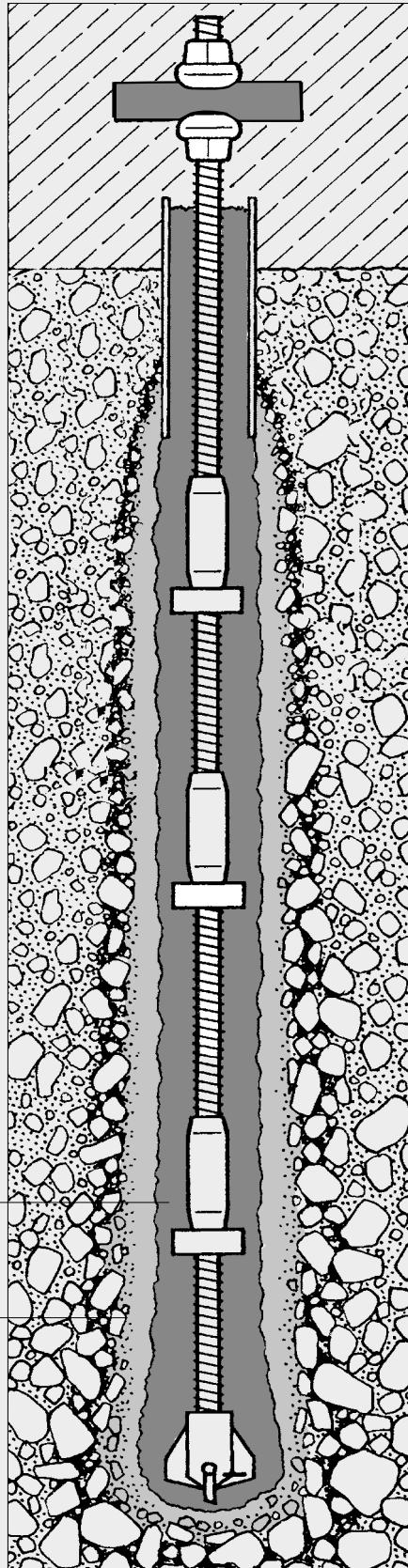
# TITAN micropiles – standard pile head details

In Germany, TITAN micropiles to EN 14199 (+ DIN SPEC 18539) are covered by National Technical Approval Z-34.14-209 issued by the German Institute of Building Technology (DIBt).

The TITAN micropile consists of a ribbed steel tube and a grout body made from a cement suspension. The system is permanently interlocked with the surrounding soil and is suitable for tensile, compressive and cyclic loads in permanent and temporary applications.

TITAN micropiles are installed...

- as tension and compression piles for foundations and underpinning,
- as tension piles for tying back retaining structures,
- to stabilise slopes, embankments and rock, and
- in tunnelling.



## The pile head – a critical interface

The pile head is the point where the pile is connected to the structure. This is generally a critical interface between two different types of engineering (structural and geotechnical). The design and detailing of the pile head calls for knowledge of soil mechanics, the structural analysis of reinforced concrete and steel and corrosion protection. For simplicity, this brochure presents a collection of standardised pile head details (some verified) that have proved suitable for TITAN micropiles, plus a number of special solutions.

## Pile head details

- Temporary excavation shoring
- Permanent anchorages for sheet pile walls
- Anchorages for bored cast-in-place pile walls
- Pile heads in plain and reinforced concrete
- Pile head details for inclined tension loads
- Tying back geotextile nets, wire meshes and gabion walls
- Rock stabilisation without nets

## **Sheet pile sections**

U sections	Width: 600 - 750 mm $W_x$ : 600 - 3200 $\text{cm}^3/\text{m}$
Z sections	Width: 580 - 700 mm $W_x$ : 1200 - 5015 $\text{cm}^3/\text{m}$
Bearing/sheet pile combinations	Width: 1790 - 2350 mm $W_x$ : up to 30000 $\text{cm}^3/\text{m}$

## Allocation of sheet pile wall stiffnesses to micropiles

Elastic section modulus W of sheet pile wall

W <	900 cm <sup>3</sup> /m	TITAN 30/11 to TITAN 40/16
W <	1500 cm <sup>3</sup> /m	TITAN 52/26
W <	2000 cm <sup>3</sup> /m	TITAN 73/53 to TITAN 73/35
W >	2000 cm <sup>3</sup> /m	TITAN 103/78 to TITAN 103/51

Information according to test report No. 306043 (Ingenieurberatung Bröqqelhof GmbH, Oldenburg)

Z section tied back off-centre without having to flame-cut the interlock, with HD-PE tube, pile head connection type 3 (see page 5).



An HD-PE or steel tube to suit the structural requirements protects the hollow bar against damage and corrosion when backfilling behind the sheet pile wall.

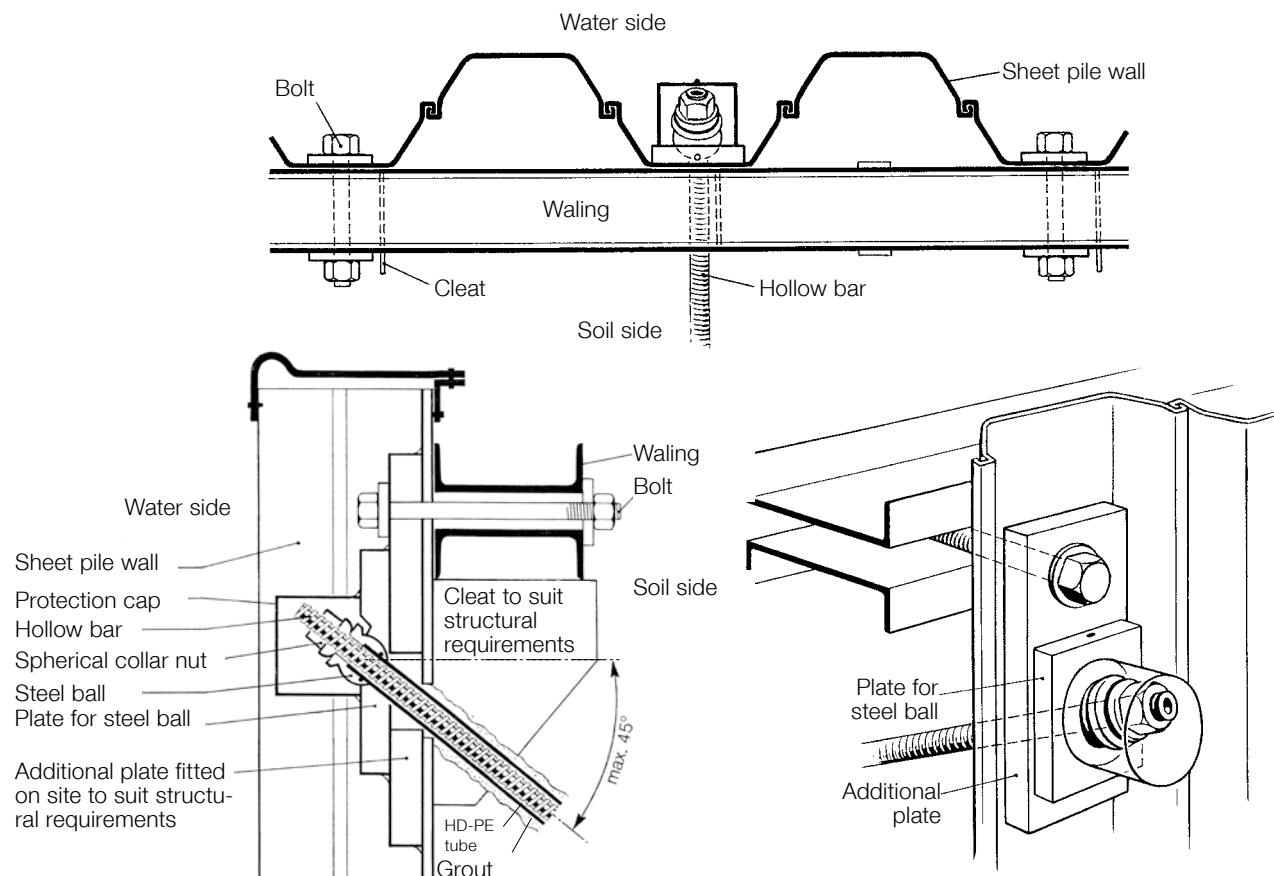


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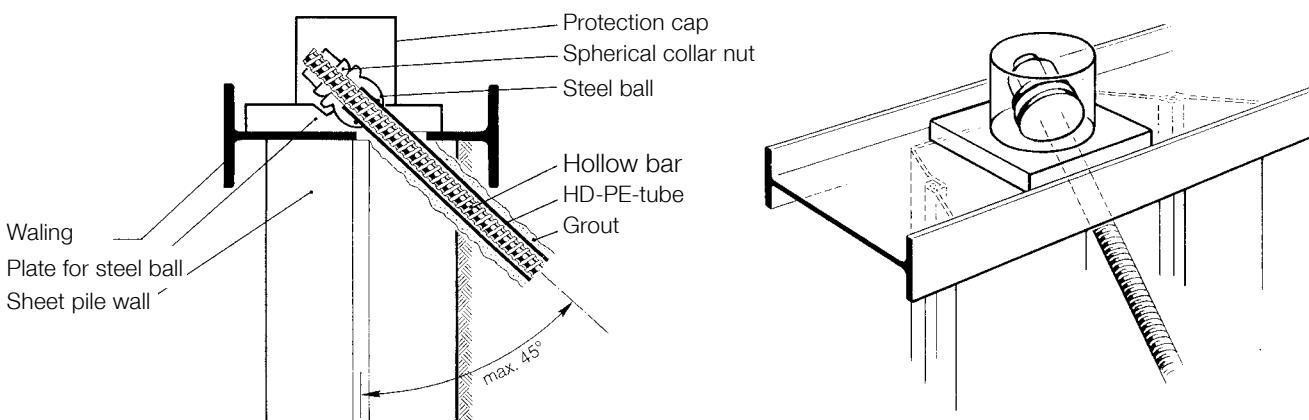
# Anchorage for sheet pile walls

## Pile head connection types 1 and 2

### Type 1 Waling on soil side



### Type 2 Waling along top of sheet pile wall



- Despite the different pile sizes, pile head details covered by a protection cap appear identical across an entire project.
- It is important to check how far a protection cap projects so that there is enough space for hands and feet around vertical ladders.

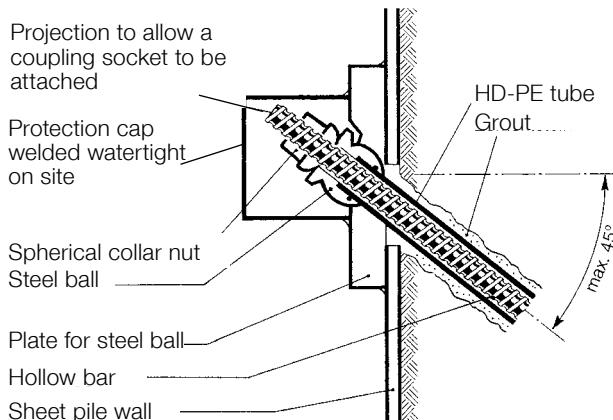
## Anchorage for sheet pile walls

### Pile head connection type 3

**Type 3** Pile head direct on sheet pile wall

#### Sheet pile wall

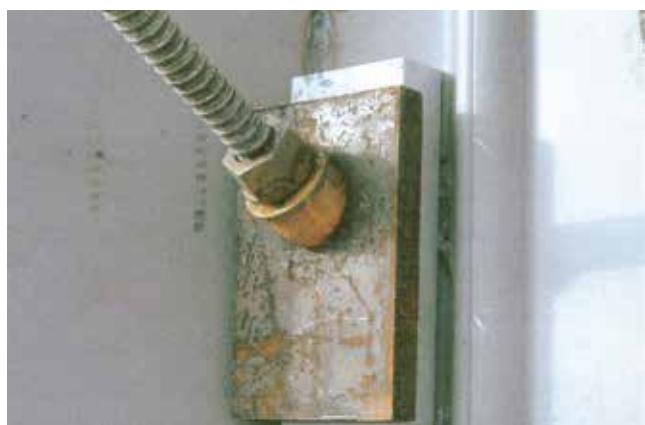
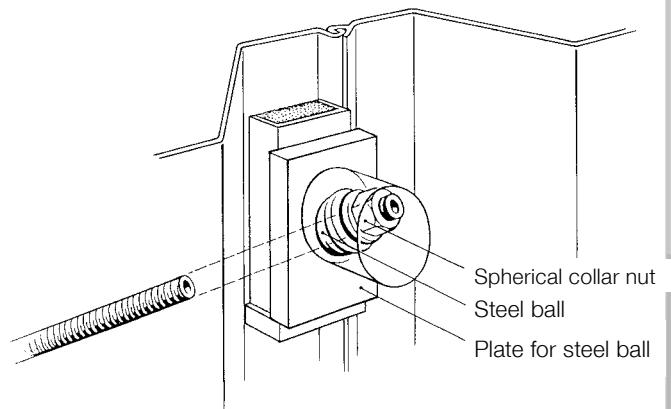
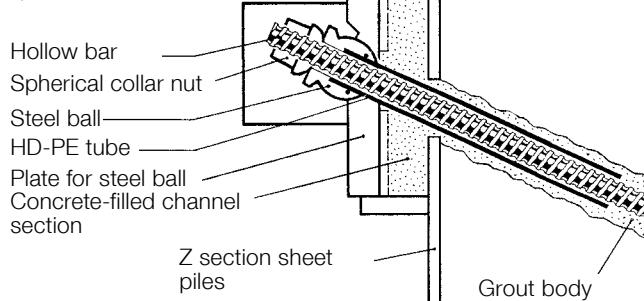
with Steel ball, Plate for steel ball and Protection cap (no additional plate)



Pile head detail with protection cap

#### Pile head detail

for Z section sheet piles, eccentric, with washer plate with spherical recess



#### Double pile connection in trough without waling

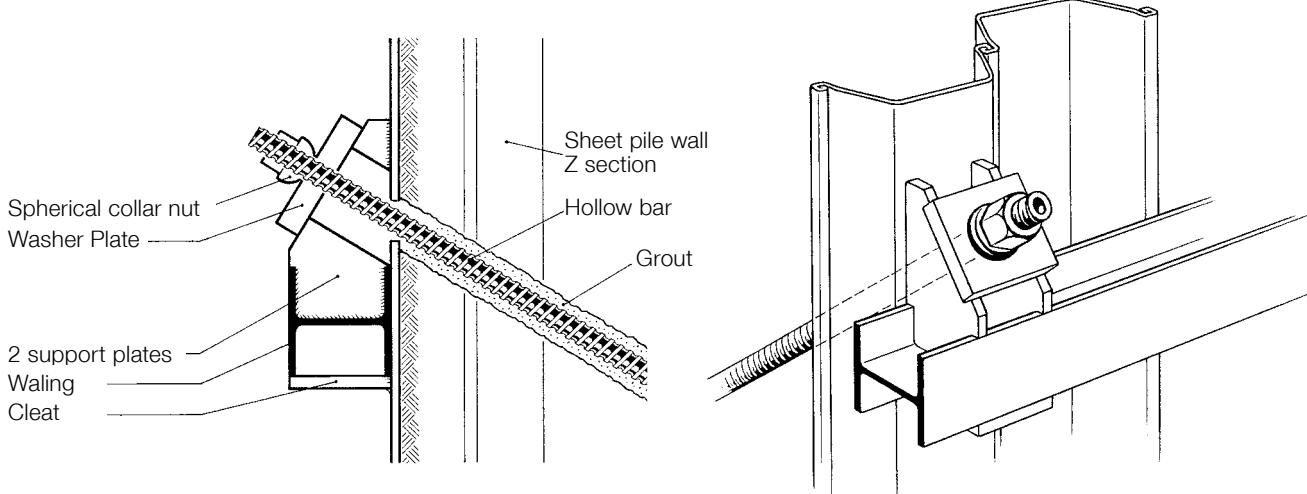
Where anchor forces are low, it can be more economical to tie back every double pile individually without including a waling. This special case is permitted by DIN 4124:2012, "Excavations and trenches", section 8.6.4.

When checking the "failure of anchor" load case, the sheet pile interlock must be able to transfer sufficient tension.

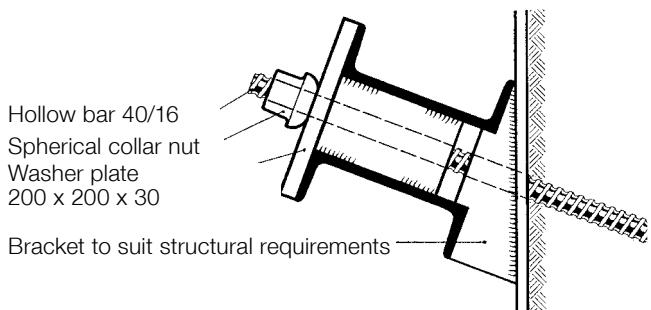
# Anchorage for sheet pile walls

## Pile head connection types 4 and 5

Type 4 Waling on air side

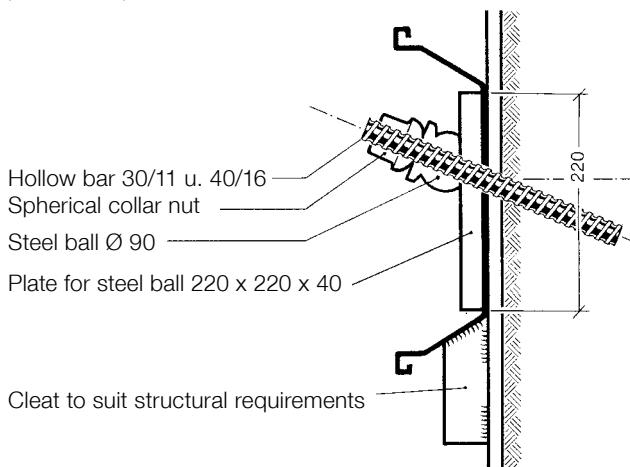


Inclined twin channel waling

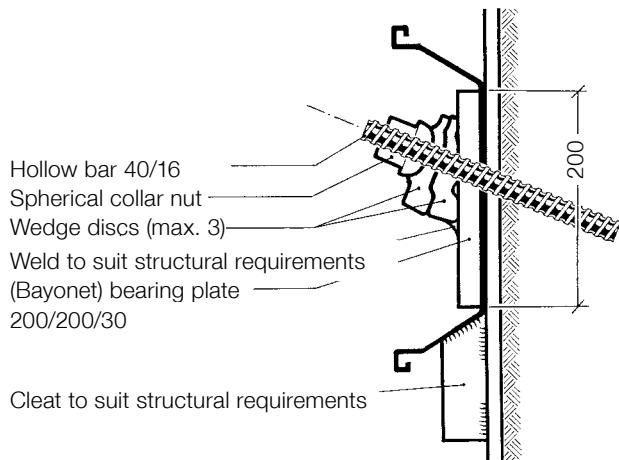


Type 5 Trench sheet as waling

with spherical collar nut + washer plate with spherical recess



with wedge discs + bearing plate



Verified connection

## Standardised ball fitting head detail for TITAN micro-piles

One of the many applications for TITAN micropiles is tying back sheet pile walls. In order to obtain a standard solution for the connection between the micropile and the sheet pile wall, calculations were carried out for various sheet pile flange widths and thicknesses, with and without an additional plate. It was therefore possible to prepare universally applicable design charts for any type of pile which are not linked to any particular sheet pile sections.

The first step in the design is to determine the tensile force  $F_{d,pile}$  (design value) acting on the micropile. Using the horizontal component  $F_{d,h}$  of the calculated design load and the actual sheet pile flange width  $b_{flange}$  and thickness  $t_{flange}$ , it is possible to determine the required sheet pile flange thick-

ness using the charts.

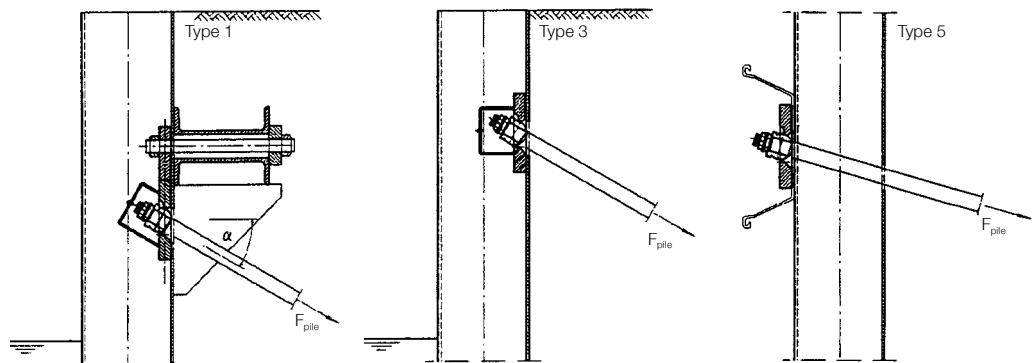
If the required sheet pile flange thickness is greater than the actual thickness, the required thickness can be achieved by attaching an additional plate (see design example).

### Standards, directives

DIN 18800	Steel structures
EAU 2012	Recommendations of the Committee for Waterfront Structures
EN 1993-5	Eurocode 3: Design of steel structures – Part 5: Piling; German version
EN 14199	EN 1993-5:2007 + AC:2009 Execution of special geotechnical works – Micropiles

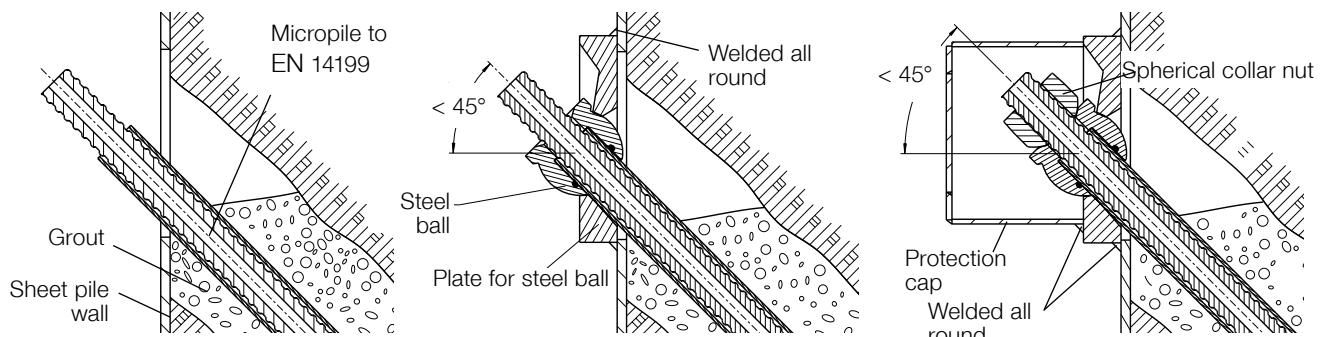
### Types of connection

In principle, the following calculations can be used for these three types of connection:



### Anchor pile head detail with steel ball + plate for steel ball – example

Compensates for angles of up to 45°. Sealing the critical backfilling area behind the sheet piling.



#### Step 1

After installing the pile, cut the HD-PE tube to the right length and slip this over the hollow bar. Insert the tube into the cement grout body.

#### Step 2

Mount the steel ball and plate for steel ball. Weld the plate to the sheet piling all round. Fill the gap between hollow bar, tube and steel ball with a corrosion protection compound (e.g. Denso-Fill).

#### Step 3

Screw on the spherical collar nut and complete the pile head detail by adding a protection cap welded on airtight on all sides.

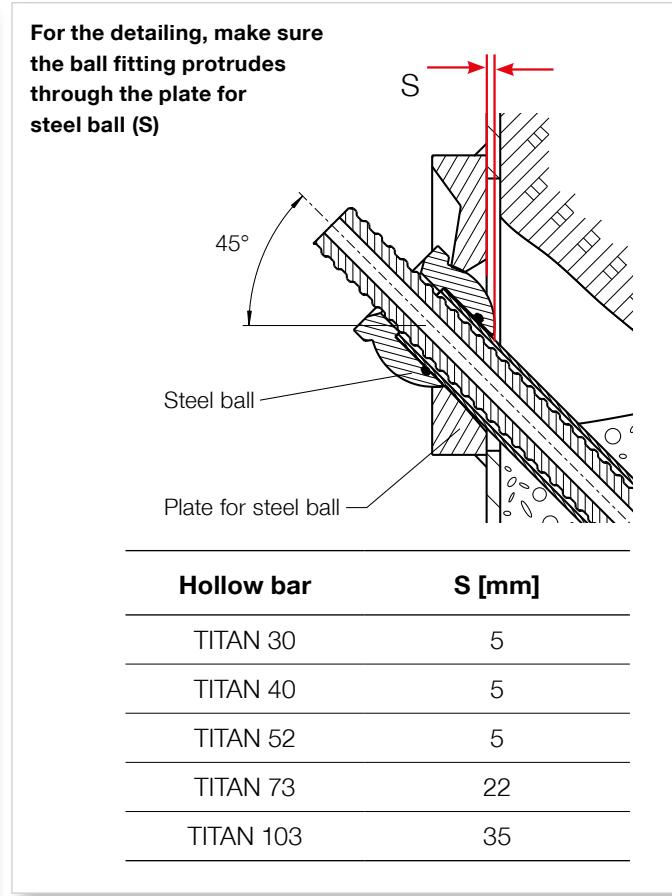
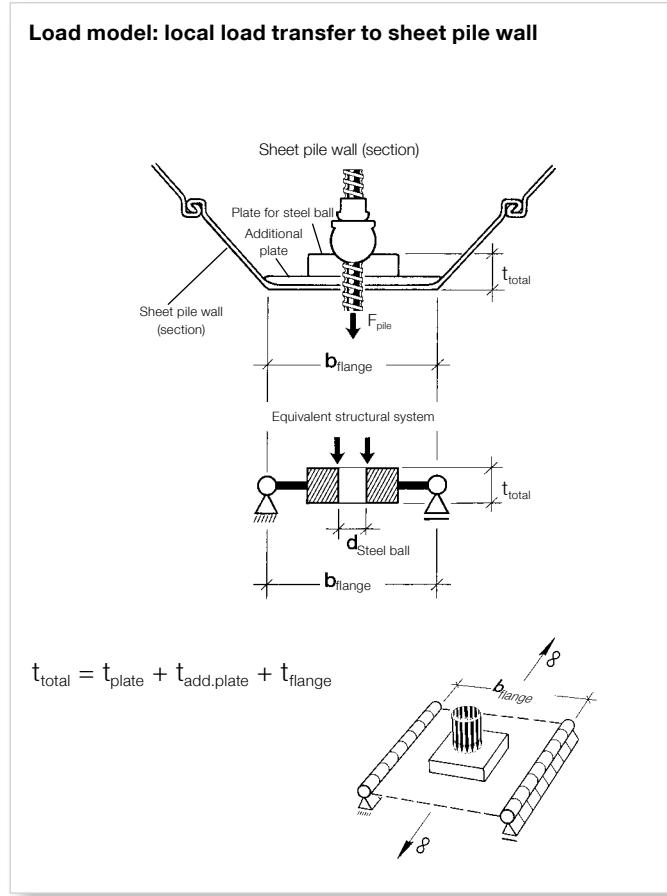
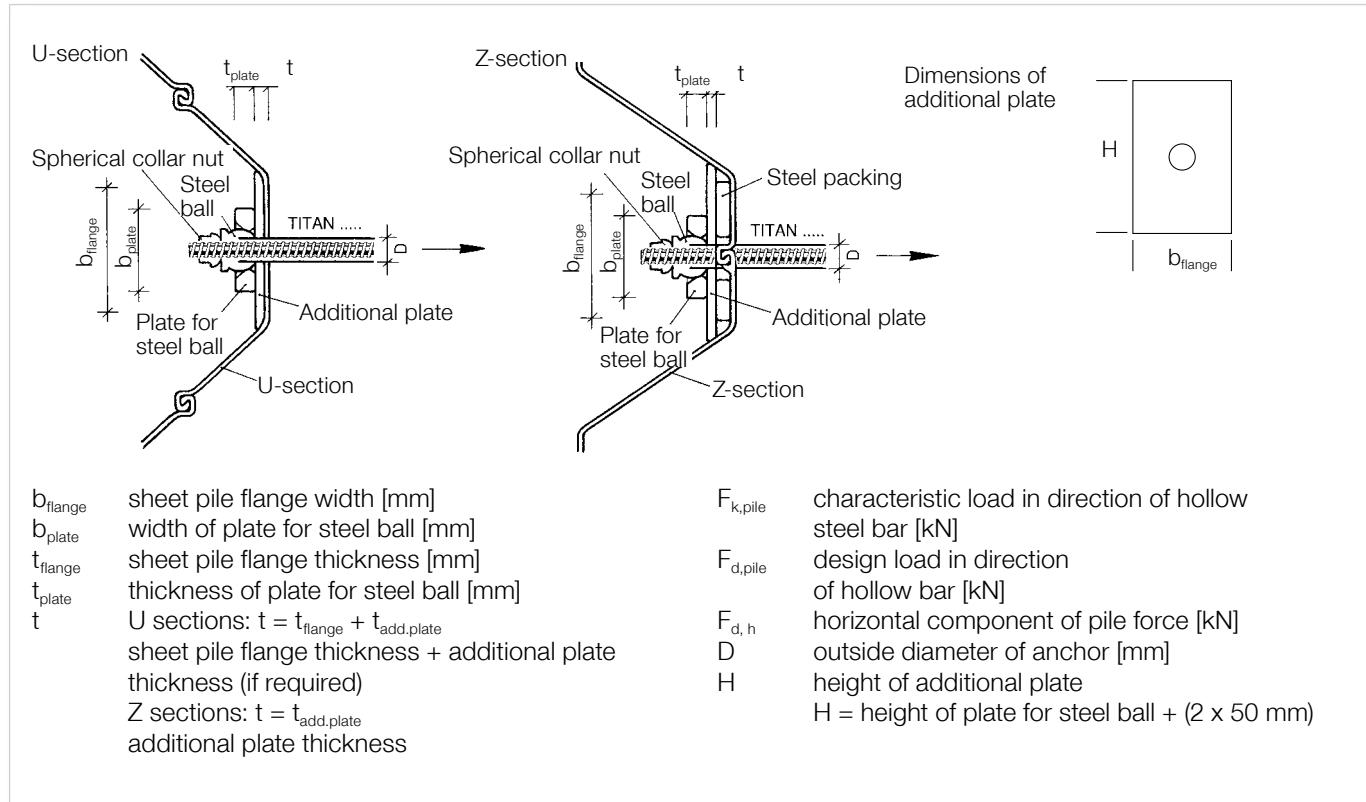
Note: The installation sequence can vary depending on type of pile and site conditions.

# Anchorage for sheet pile walls

## Definitions and load model

The sheet pile flange thickness required to carry the actual design loads can be read off directly from the charts on the following pages.

The charts are not dependent on type of sheet pile wall or rake of pile.

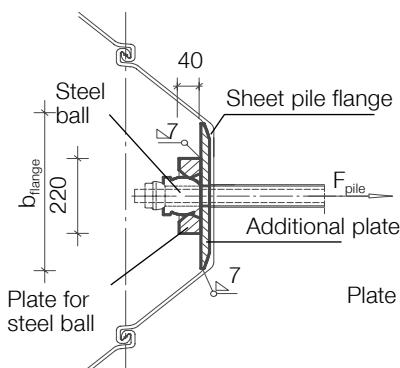


# Anchorage for sheet pile walls

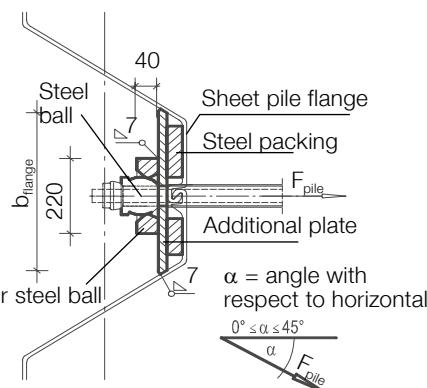
Example with micropile TITAN 40/16

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add.plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add.plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate + (2 x 50 mm)

7 mm weld all round

Sheet pile trough completely filled

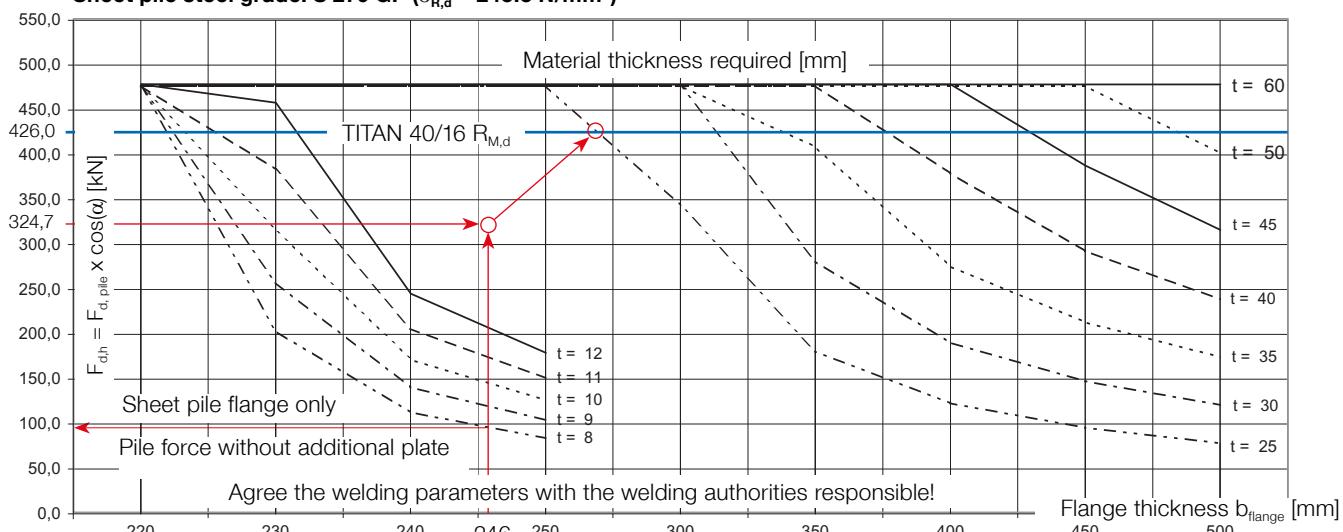
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

220 x 220 x 40 mm

7 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



## Design example

### Given values

Sheet pile section	= L602 (Larssen)
$t_{\text{flange}}$	= 8.20 mm
$b_{\text{flange}}$	= 246 mm
Steel grade	S 270 GP
Micropile	= TITAN 40/16
Pile rake $\alpha$	= 30°

Internal forces (design values)

$$F_{d,pile} = \gamma_F \times F_{k,pile} = 375 \text{ kN}$$

$$F_{d,h} = F_{d,pile} \times \cos(\alpha) = 324.7 \text{ kN}$$

### Design

from chart 40/16 (see above):

with

$$b_{\text{flange}} = 246 \text{ mm}$$

$$F_{d,h} = 324.7 \text{ kN}$$

→ required:  $t = 25 \text{ mm}$  (next higher line)

For U section:

$$t_{\text{add.plate}} = t - t_{\text{flange}} = 16.8 \text{ mm}$$

Selected:

additional plate with  $t_{\text{add.plate}} = 18 \text{ mm}$ , S 355 JO

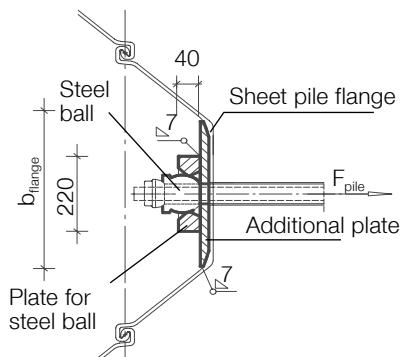
where  $\gamma_F$  = partial safety factor for actions

# Anchorage for sheet pile walls

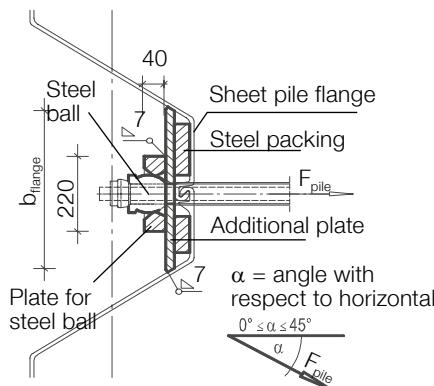
TITAN 30/11 micropile

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height H = height of end plate + (2 x 50 mm)  
7 mm weld all round

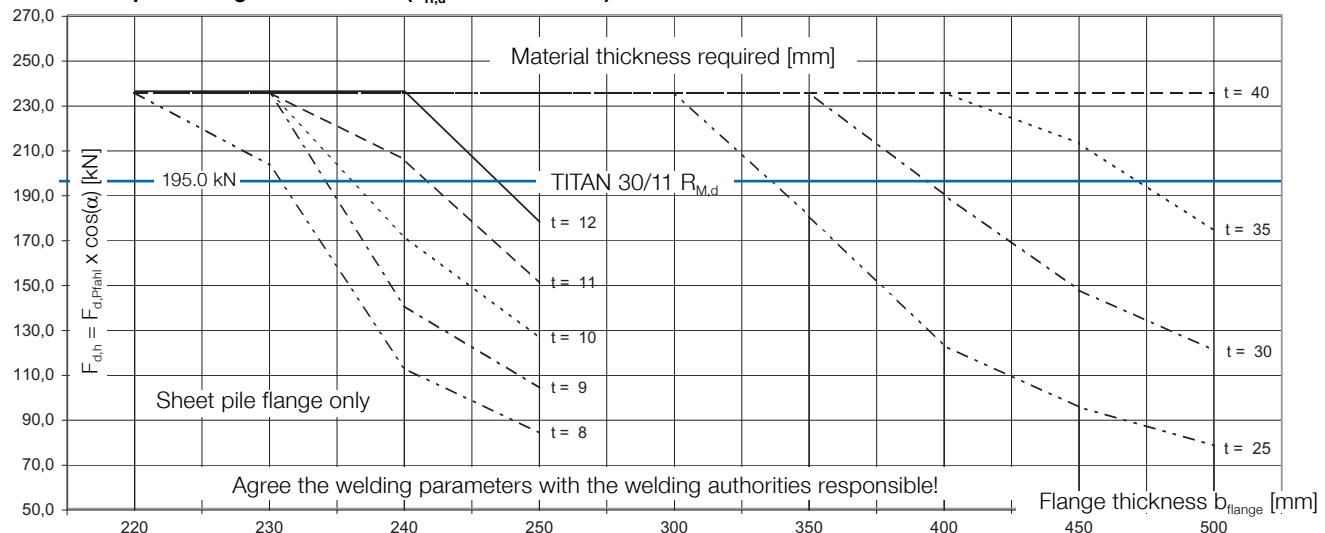
Sheet pile trough completely filled  
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

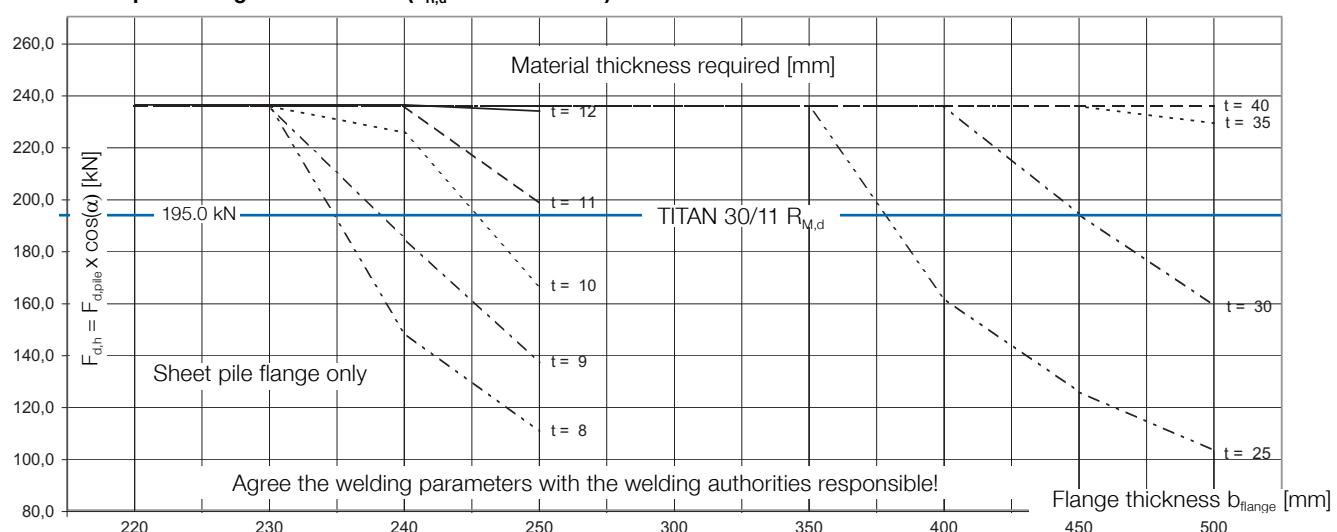
220 x 220 x 40 mm

7 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**



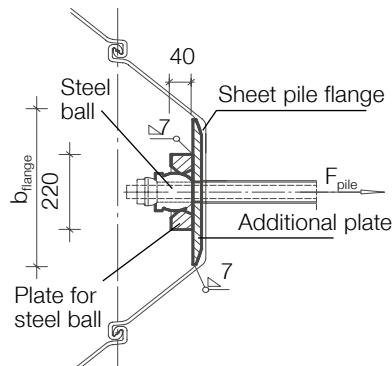
# Anchorage for sheet pile walls

TITAN 40/20 micropile

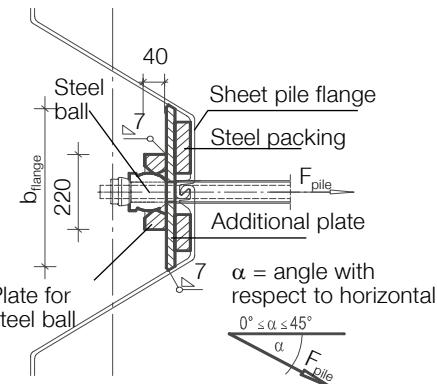
**ISCHEBECK**  
**TITAN**

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate + (2 x 50 mm)  
7 mm weld all round

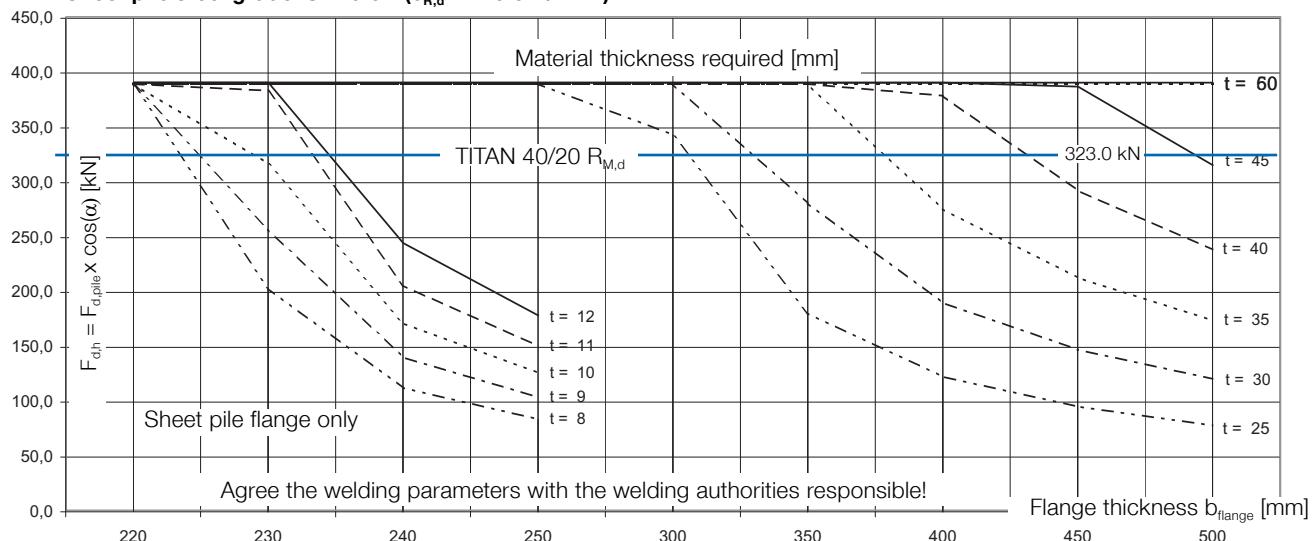
Sheet pile trough completely filled  
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

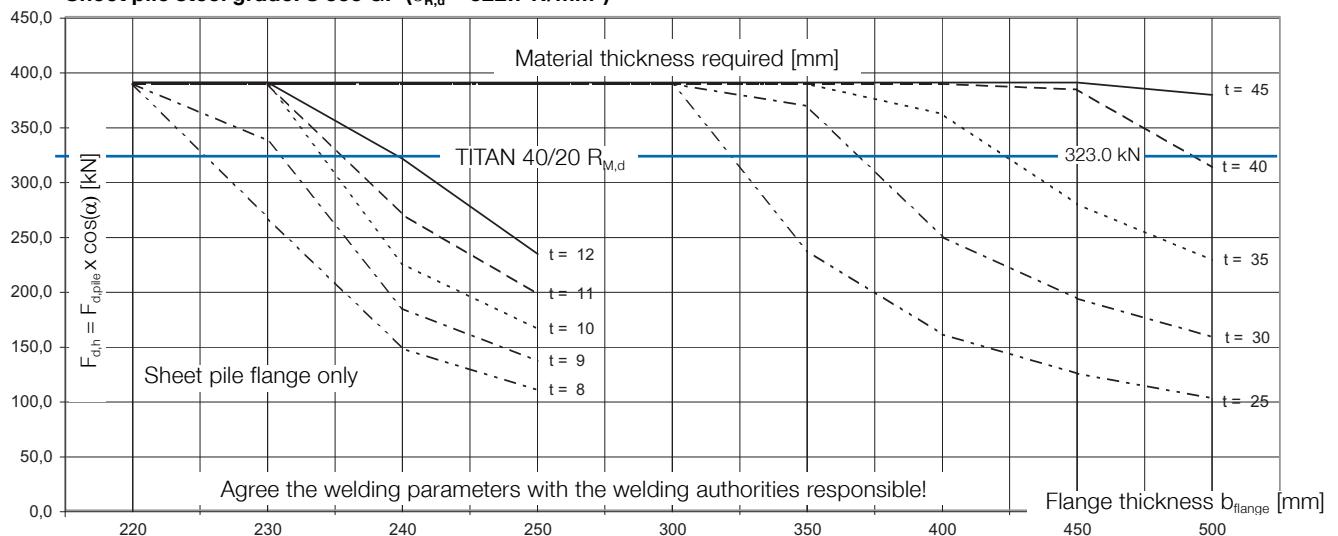
220 x 220 x 40 mm

7 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**

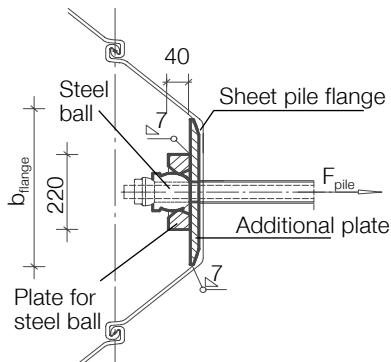


# Anchorage for sheet pile walls

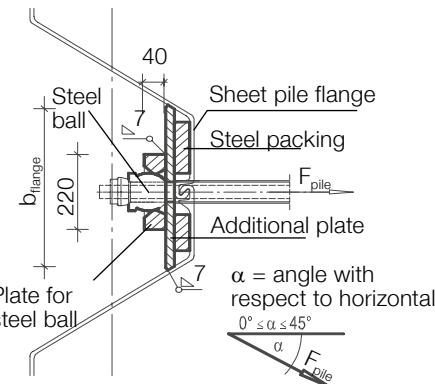
## TITAN 40/16 micropile

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$$t_{\text{add,plate}} = t - t_{\text{flange}} \text{ [mm]} \quad (\text{U sections})$$

$$t_{\text{add,plate}} = t \text{ [mm]} \quad (\text{Z sections})$$

Height  $H$  = height of end plate +  $(2 \times 50 \text{ mm})$   
7 mm weld all round

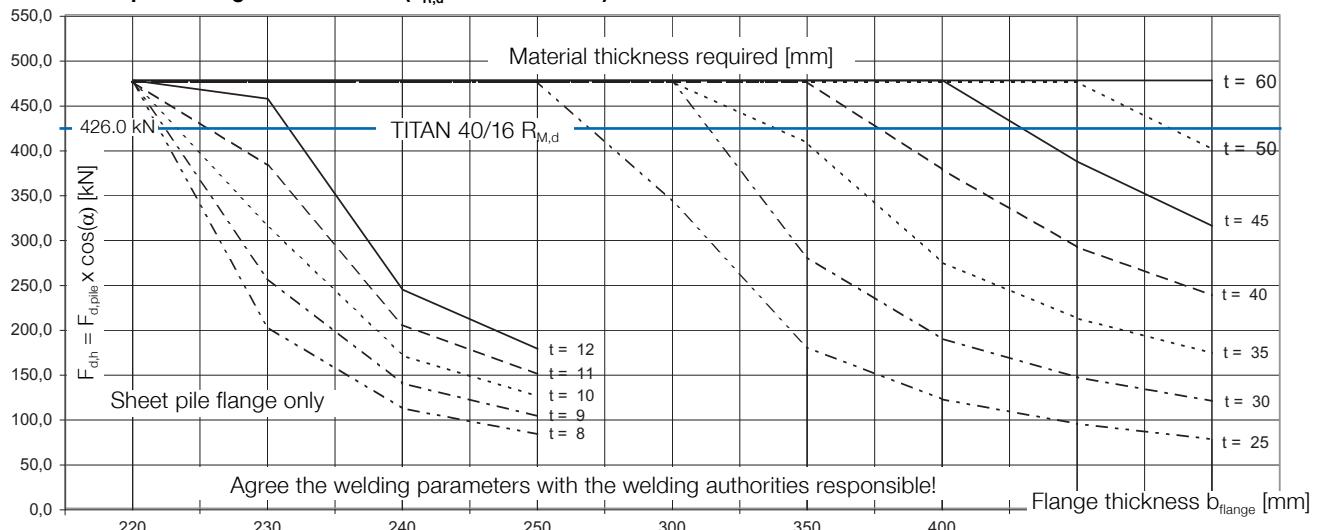
Sheet pile trough completely filled  
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

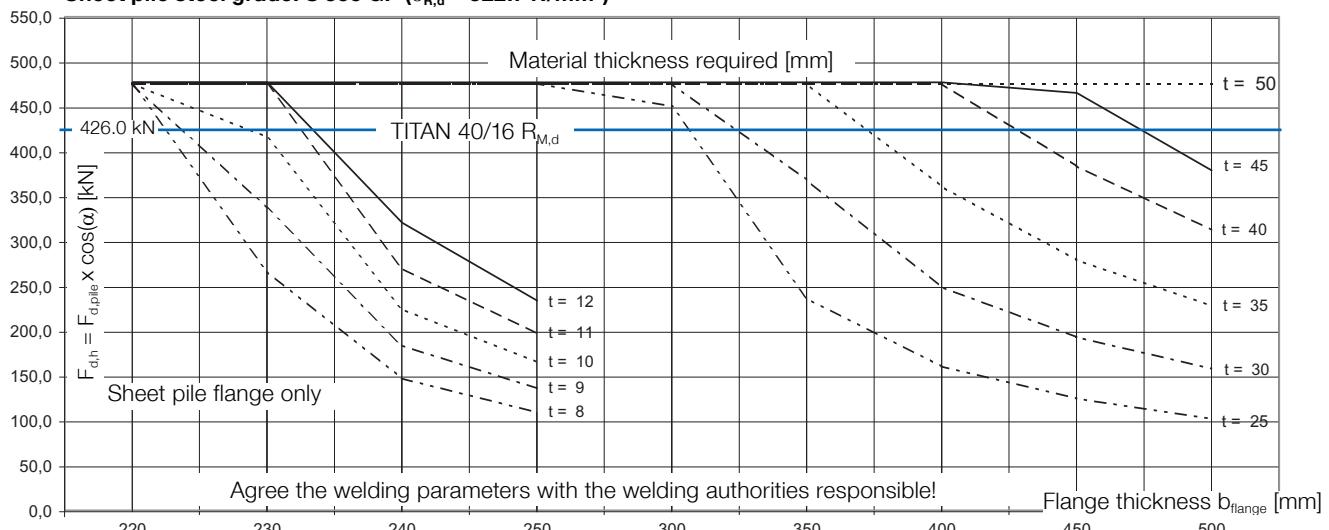
220 x 220 x 40 mm

7 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**



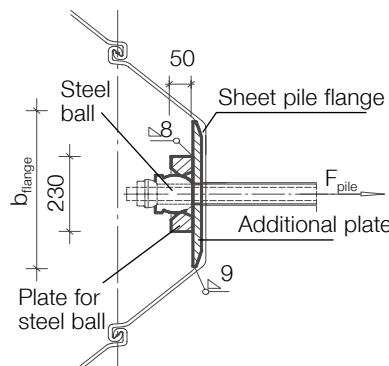
# Anchorage for sheet pile wall

TITAN 52/26 micropile

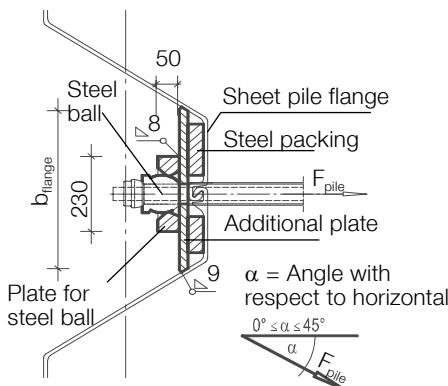
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**TITAN**

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate + (2 x 50 mm)  
9 mm weld all round

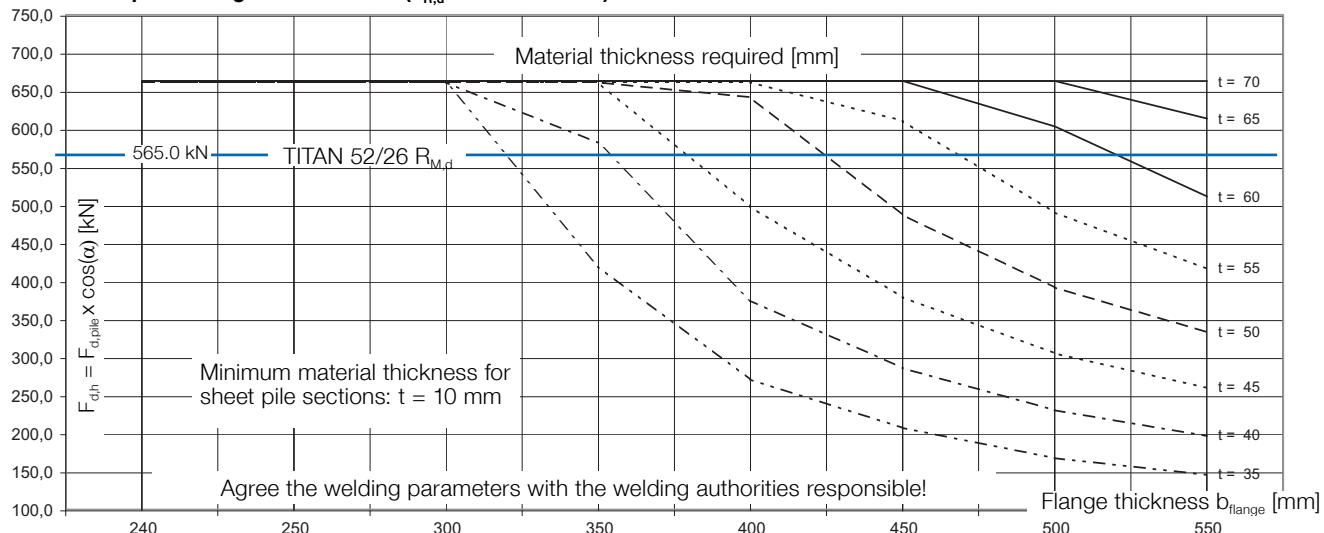
Sheet pile trough completely filled  
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

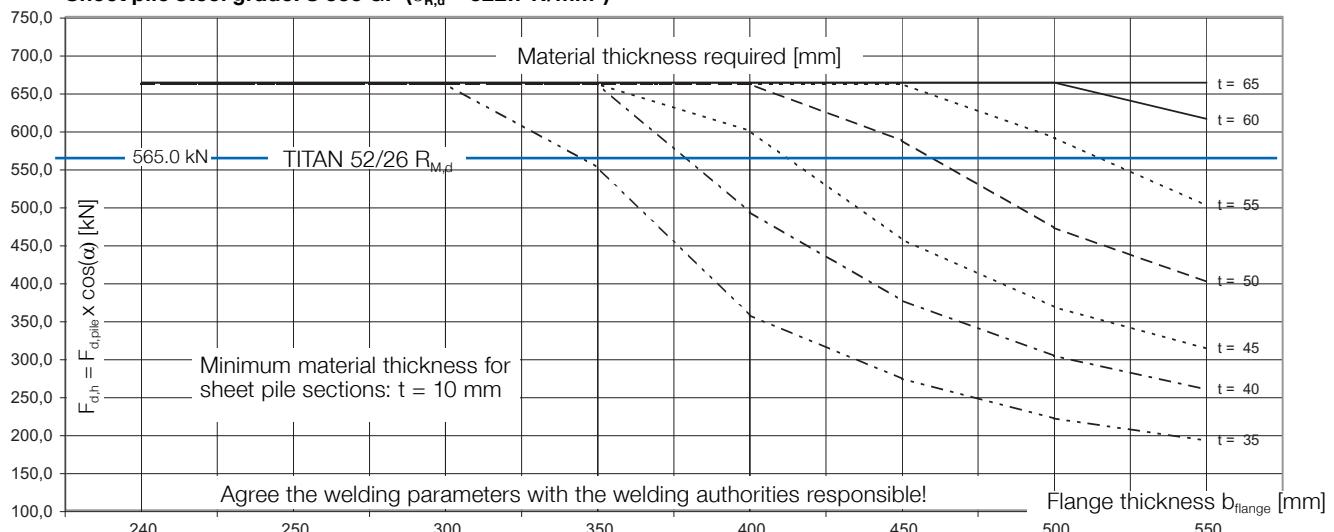
230 x 230 x 50 mm

8 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**

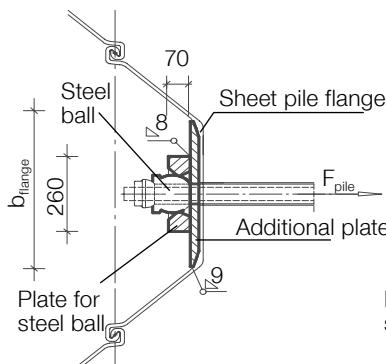


# Anchorage for sheet pile walls

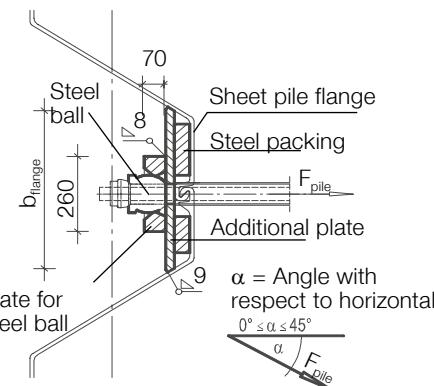
TITAN 73/53 micropile

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate +  $(2 \times 50 \text{ mm})$   
9 mm weld all round

Sheet pile trough completely filled

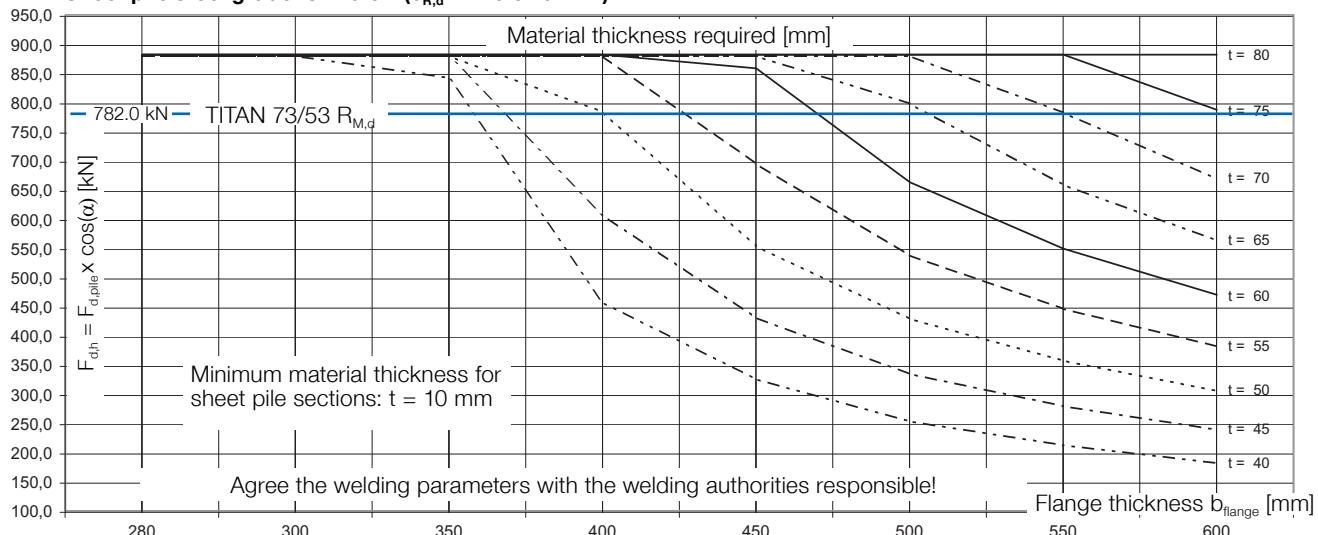
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

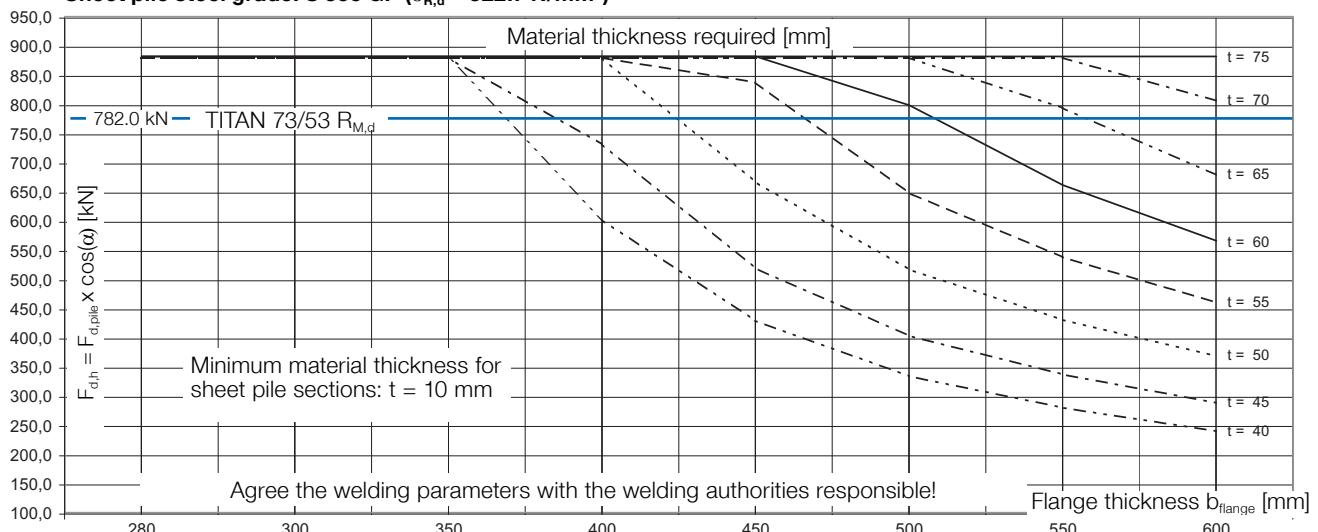
260 x 325 x 70 mm

8 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**



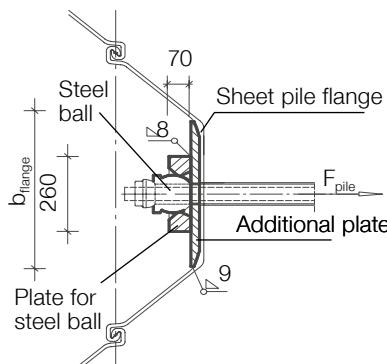
# Anchorage for sheet pile walls

TITAN 73/45 micropile

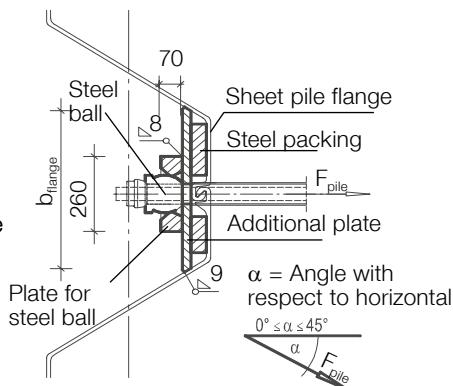
**ISCHEBECK**  
**TITAN**

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate + (2 x 50 mm)

9 mm weld all round

Sheet pile trough completely filled

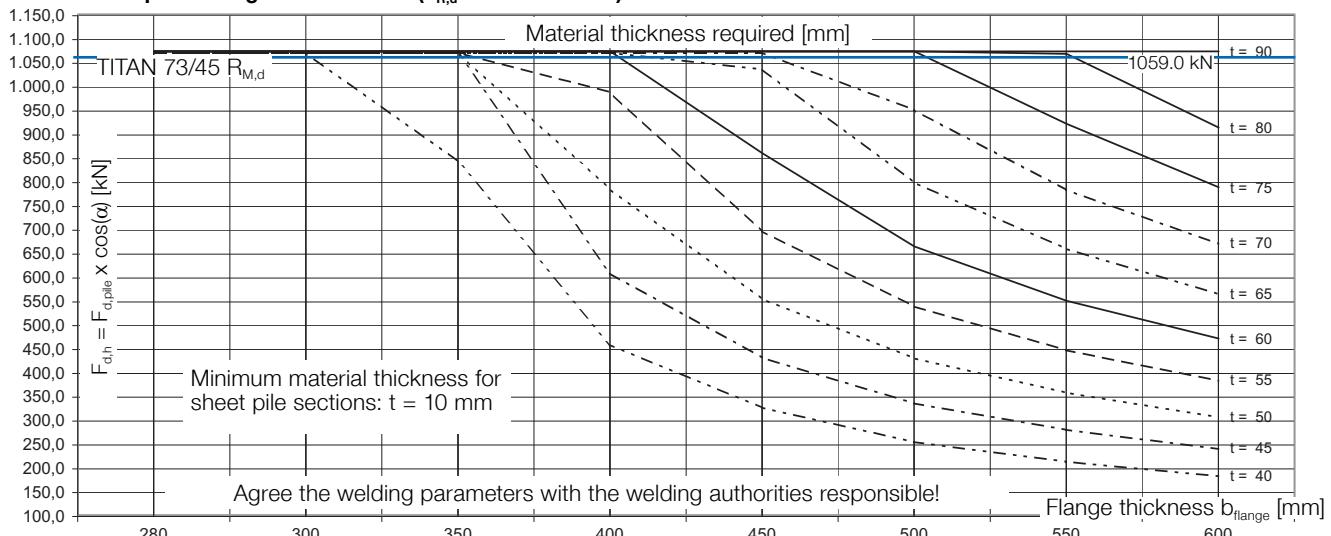
Steel packing for Z sections chosen to suit requirements

**Plate for steel ball:** S 355 JR

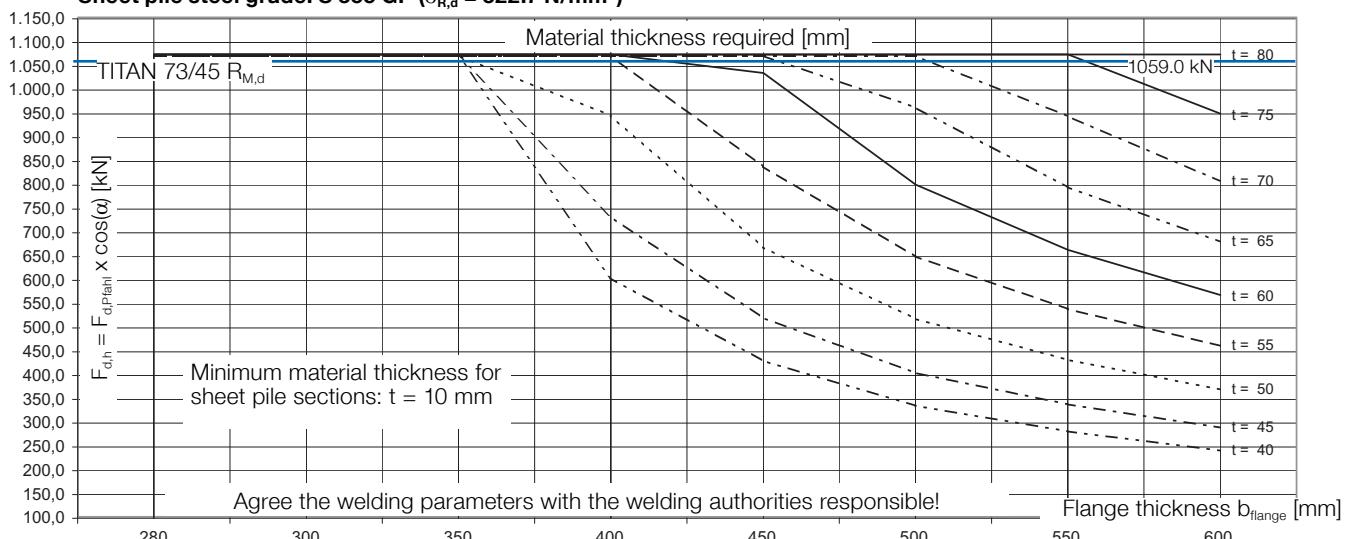
260 x 325 x 70 mm

8 mm weld all round

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**

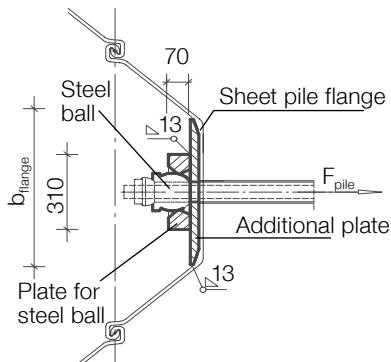


# Anchorage for sheet pile walls

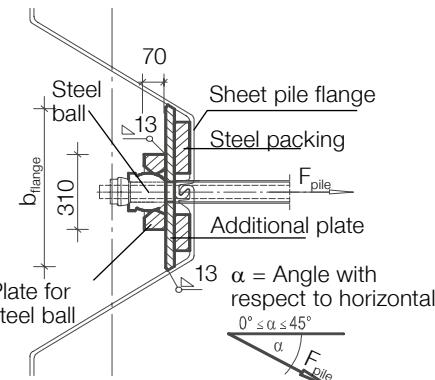
TITAN 103/78 micropile

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$$t_{\text{add,plate}} = t - t_{\text{flange}} \text{ [mm]} \text{ (U sections)}$$

$$t_{\text{add,plate}} = t \text{ [mm]} \text{ (Z sections)}$$

Height  $H$  = height of end plate +  $(2 \times 50 \text{ mm})$

13 mm weld all round

$$a_w = 12 \text{ mm} \text{ is possible for } F_{R,d} < 1080 \text{ kN}$$

Fill sheet pile trough completely

Steel packing for Z sections chosen to suit requirements

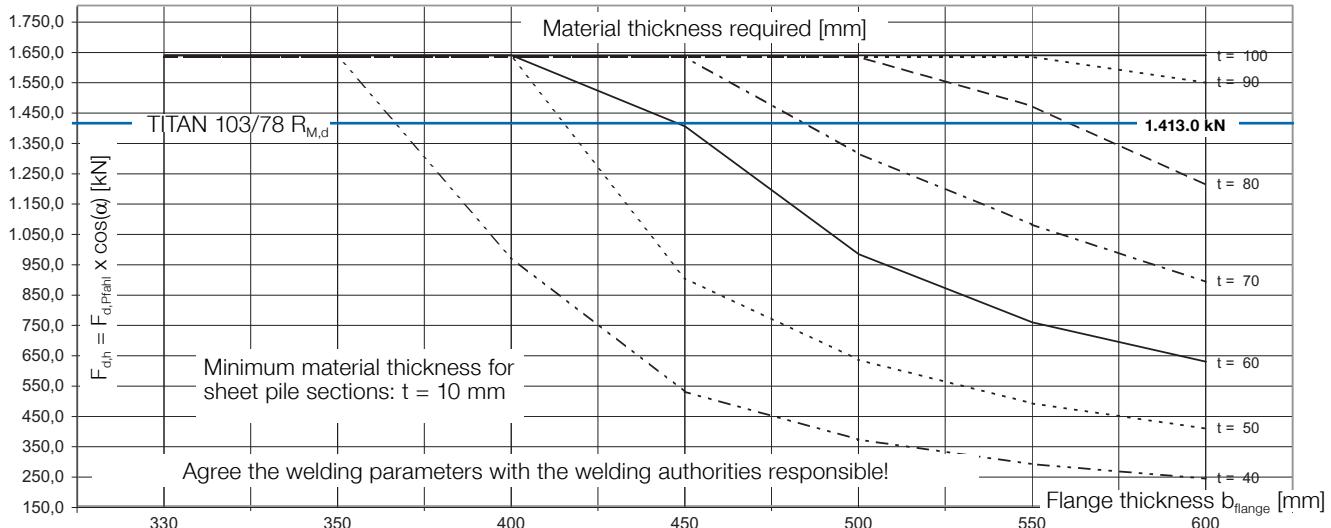
**Plate for steel ball:** S 355 JR

$$310 \times 400 \times 70 \text{ mm}$$

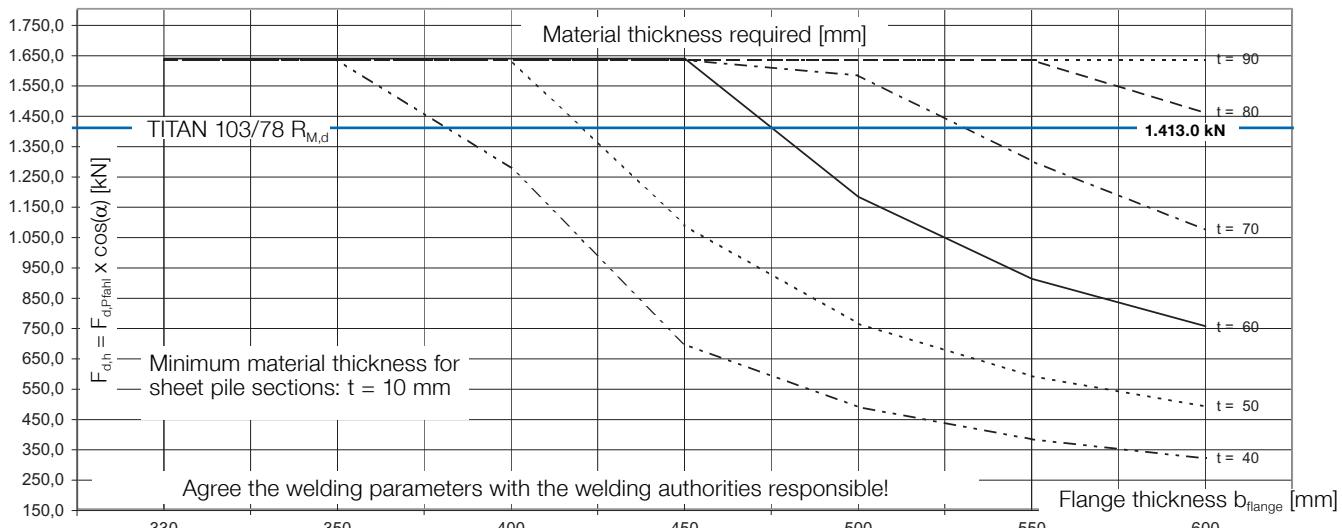
13 mm weld all round

$$a_w = 10 \text{ mm} \text{ is possible for } F_{R,d} < 1080 \text{ kN}$$

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5 \text{ N/mm}^2$ )**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7 \text{ N/mm}^2$ )**



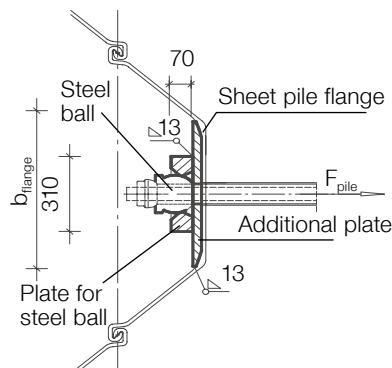
# Anchorage for sheet pile walls

TITAN 103/51 micropile

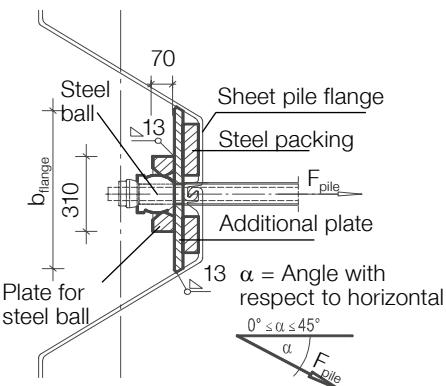
**ISCHEBECK**  
**TITAN**

Load-carrying capacity of pile connection depending on material thickness  $t$  and flange width  $b_{\text{flange}}$  of sheet piles

U section



Z section



**Additional plate:** S 355 JO

$t_{\text{add,plate}} = t - t_{\text{flange}}$  [mm] (U sections)

$t_{\text{add,plate}} = t$  [mm] (Z sections)

Height  $H$  = height of end plate + (2 x 50 mm)  
13 mm weld all round

$a_w = 12$  mm is possible for  $F_{R,d} < 1080$  kN

Fill sheet pile trough completely

Steel packing for Z sections chosen to suit requirements

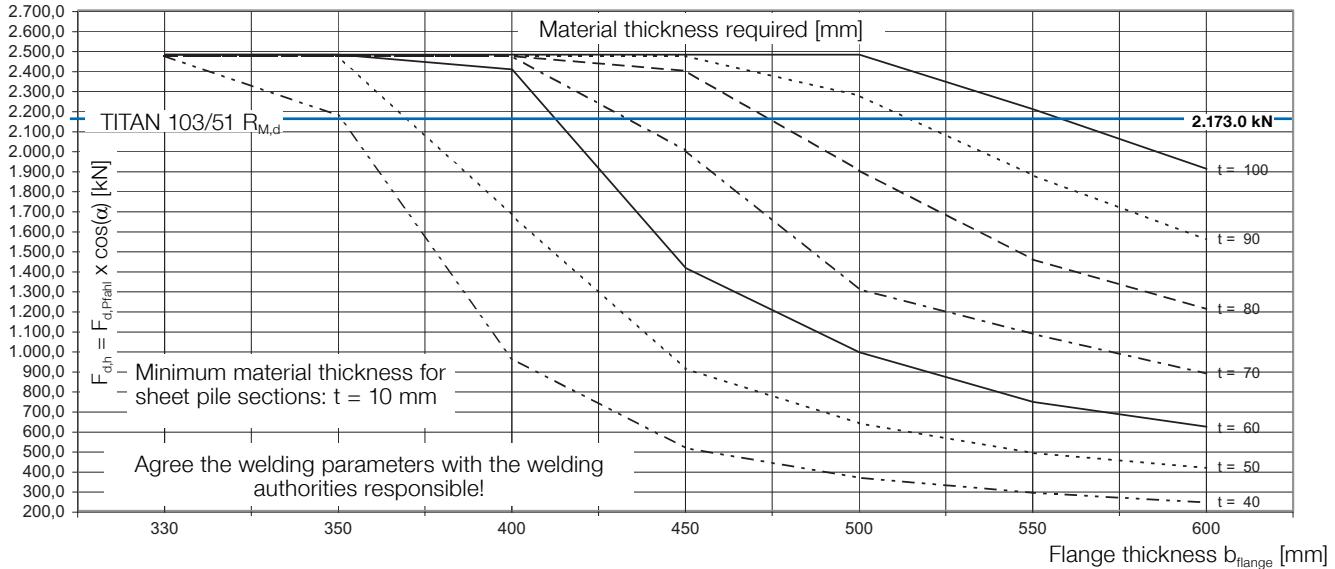
**Plate for steel ball:** S 355 JR

310 x 400 x 70 mm

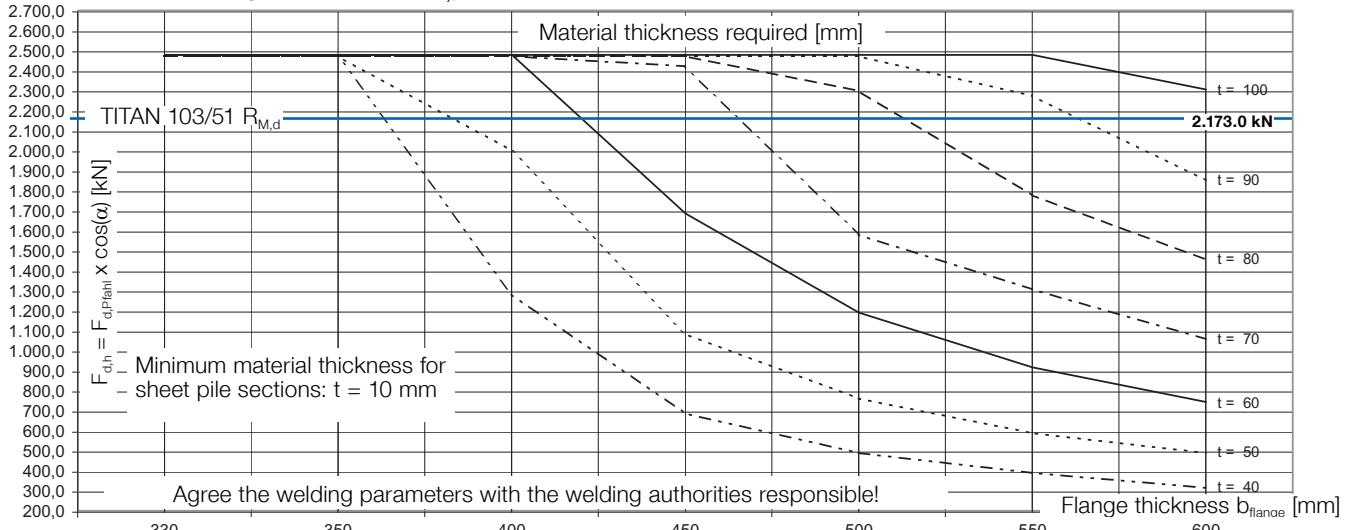
13 mm weld all round

$a_w = 10$  mm is possible for  $F_{R,d} < 1080$  kN.

**Sheet pile steel grade: S 270 GP ( $\sigma_{R,d} = 245.5$  N/mm<sup>2</sup>)**



**Sheet pile steel grade: S 355 GP ( $\sigma_{R,d} = 322.7$  N/mm<sup>2</sup>)**



# Pile head anchored in concrete

## Checking local bearing pressure and punching

### Design charts based on standard calculation

Where pile heads are anchored in concrete (local load transfer), it is necessary to check that the relevant pile forces are transferred to the foundations. This work includes checking the local bearing pressure according to the relevant codes of practice (e.g. EN 1992-1-1 in conjunction with EN 1992-1-1/NA).

The dimensions of washer plates and the bearing pressure on the concrete under washer plates have been verified for concrete with a cylinder compressive strength  $f_{ck} > 20 \text{ N/mm}^2$  within the scope of the approval procedure.

As this situation occurs frequently, these analyses have been carried out for TITAN micropiles in a standard calculation (SIGMA KARLSRUHE GmbH).

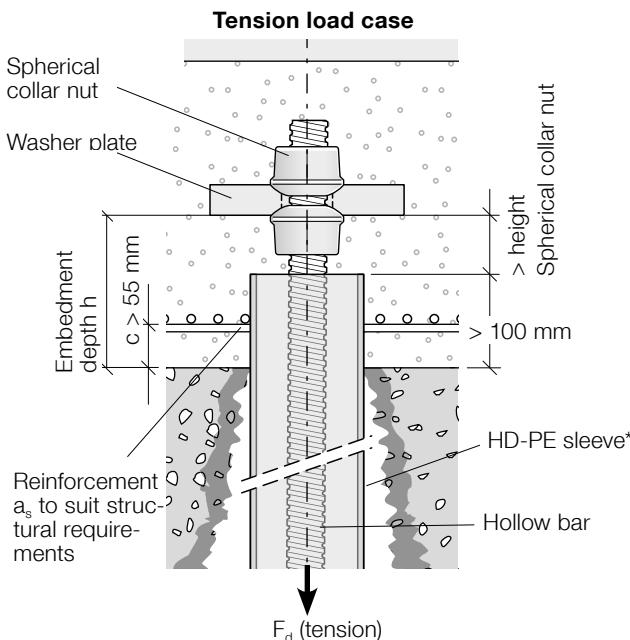
The design load  $F_d$  is already known from micropile designs to EN 1997-1:2009-09 and EN 1997-1/NA:2010-12 / EN 14199:2012-01.

The embedment depth  $h$  required for each TITAN micropile can be read off the following charts depending on the design load  $F_d$ , the concrete strength  $f_{ck}$  selected, the amount of reinforcement  $a_s$  and the local bearing pressure. The partial safety factor  $\gamma_M = 1.15$  on the resistance side has been taken into account in the standard calculation and the charts.

The minimum embedment depth depends on the system dimensions (minimum embedment length of sleeve and height of spherical collar nut).

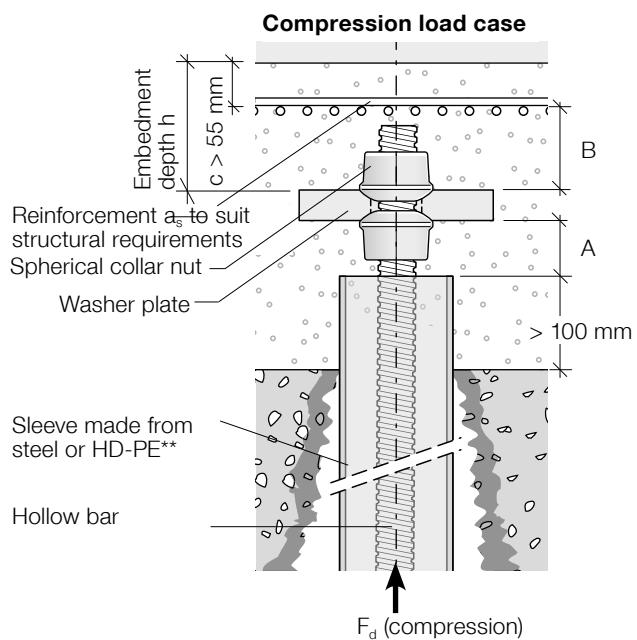
The sleeve prevents through-cracks in the grout body around the soil-structure interface which can be caused by movement of the subsoil relative to the structure in the case of fluctuating loads. Protection against corrosion is still guaranteed. The force transfer within the structure must be checked by others.

### Anchorage of pile head in reinforced concrete slab for tension and compression load cases:



In the **tension load case** the loaded side of the reinforced concrete slab lies below the washer plate, and so the average near-surface reinforcement  $a_s$  must be positioned at the bottom.

\* see National Technical Approval Z-34.14-209 (Annex 4)



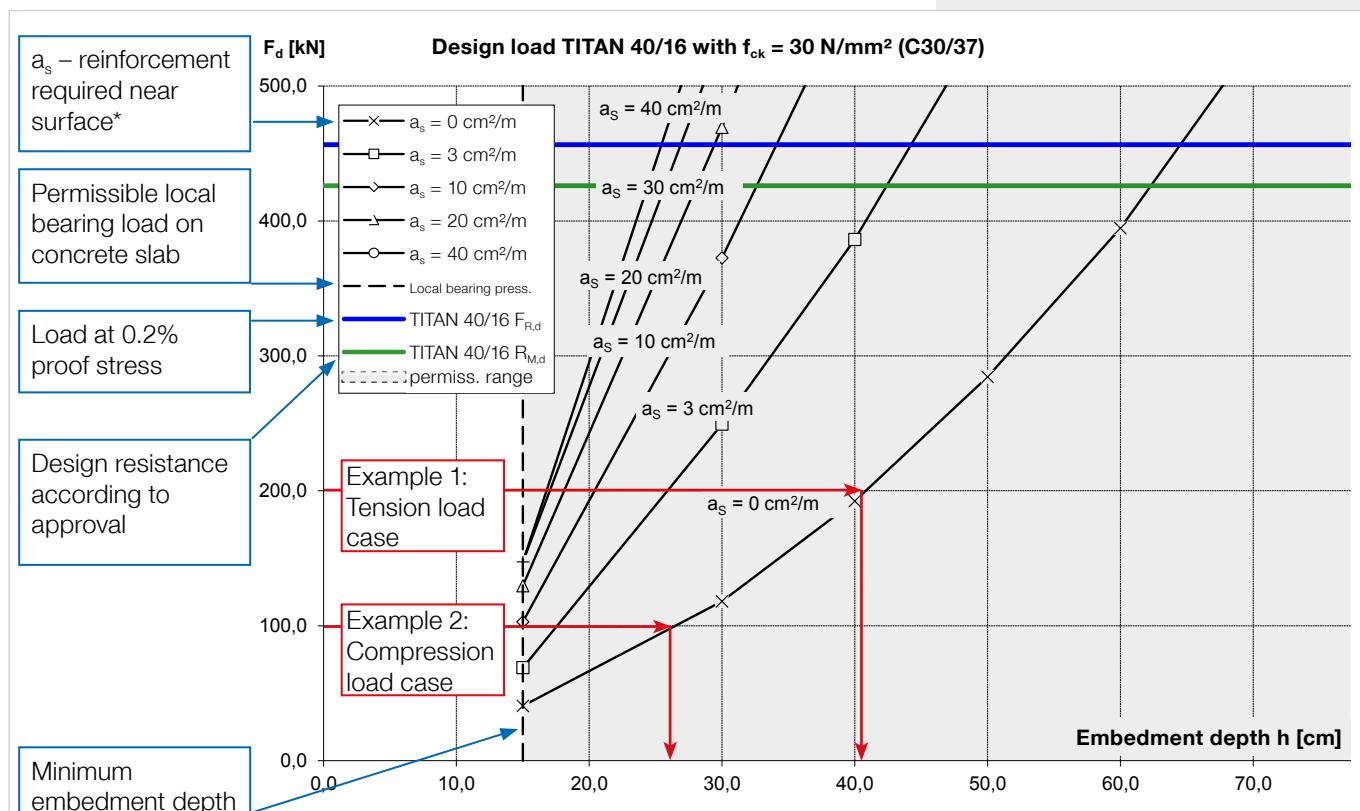
In the **compression load case** the loaded side of the reinforced concrete slab lies above the washer plate, and so the average near-surface reinforcement  $a_s$  must be positioned at the top.

\*\* If an HD-PE tube is used instead of a steel tube, additional reinforcement top and bottom is required according to National Technical Approval Z-34.14-209 (Annex 5).

# Pile head anchored in concrete

## Design example and load model

The charts on the following pages specify the embedment depth  $h$  required depending on the average near-surface reinforcement selected  $a_s$  and the design load  $F_d$ . The charts have been compiled for a continuous ground slab taking into account the loading eccentricity for interior columns ( $\beta = 1.1$ ) according to EN 1992-1-1:2011-01 (section 6.4).



### Design example:

Required: embedment depth  $h$

Given: TITAN 40/16 micropile:

- $R_{M,d} = 426 \text{ kN}$
- (with  $R_{M,k} = 490 \text{ kN}$ ;  $\gamma_M = 1.15$ )
- C 30/37 concrete (plain)
- design load 200 kN

Example 1:  
Embedment depth

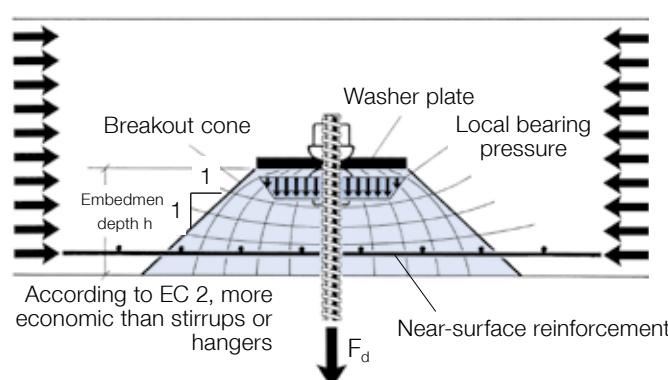
Tension Load case  $F_d = 200 \text{ kN}$   
 $h_u = 40.5 \text{ cm}$  (read off chart)

Example 2:

Compression load case  
 $F_d = 100 \text{ kN}$   
 $h_u = 26.0 \text{ cm}$  (read off chart)

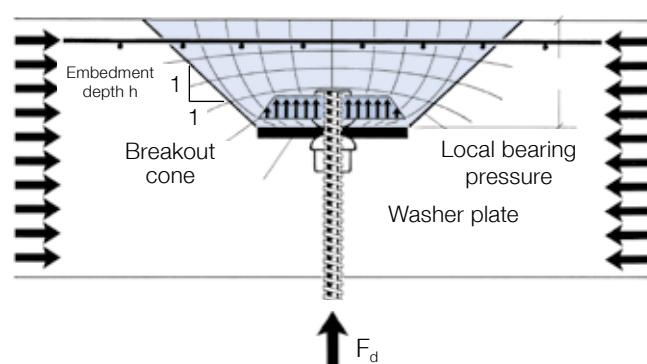
### Local load transfer into reinforced concrete slab (tension load case)

Checking local bearing pressure and punching



### Local load transfer into reinforced concrete slab (compression load case)

Checking local bearing pressure and punching



### Note:

Splitting tensile forces occur beneath point loads. The reinforcement should be designed for the splitting tensile forces and distributed evenly or curtailed as required. Source: DAFStb doc. No. 240

# Pile head anchored in concrete

Design charts for TITAN 30/11 with 100 x 100 x 20 washer plate

## Hollow bar parameters

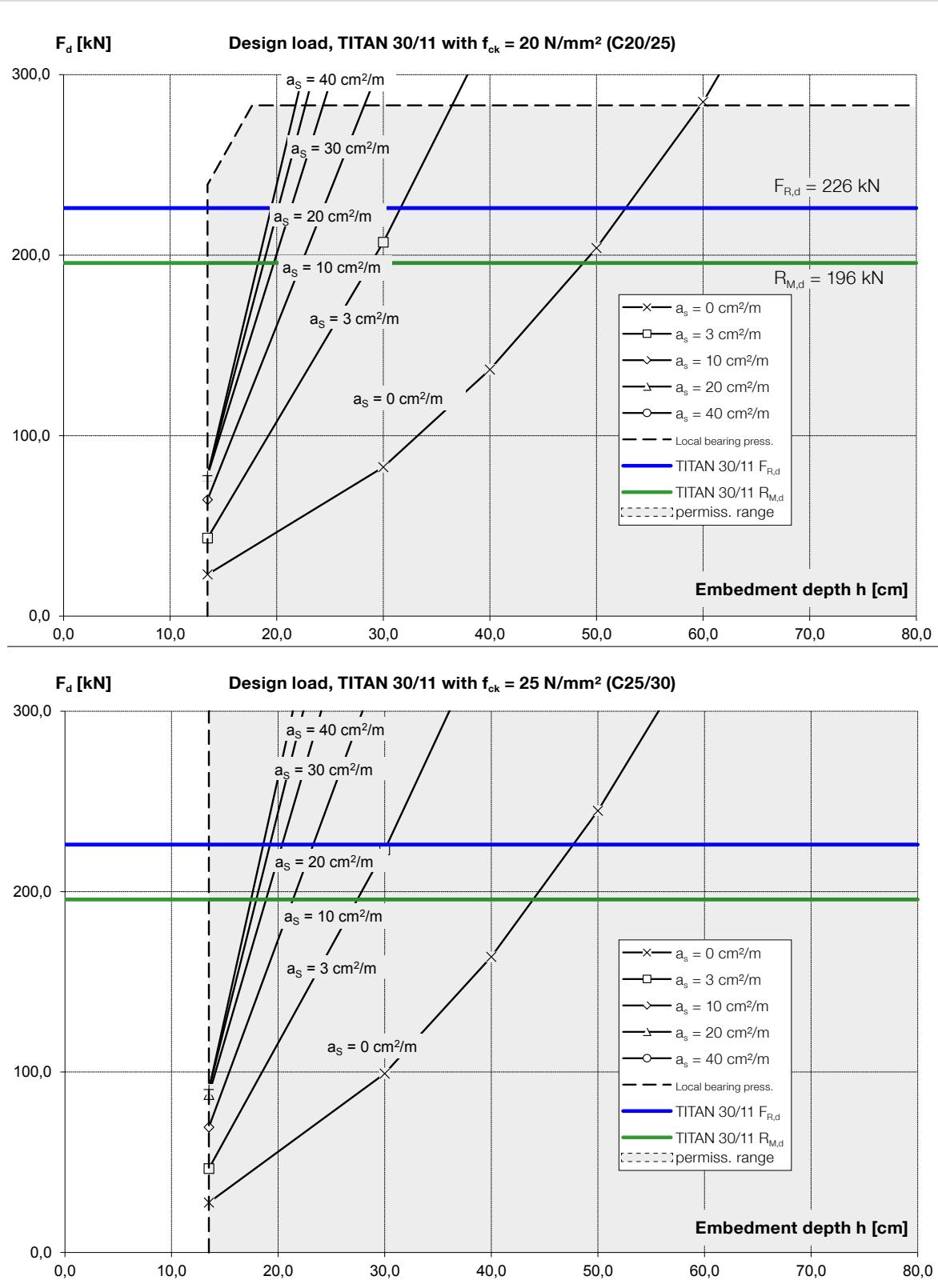
Design resistance according to National Technical Approval:  $R_{M,d} = 196 \text{ kN}$  (with  $R_{M,k} = 225 \text{ kN}$  and  $\gamma_M = 1.15$ )

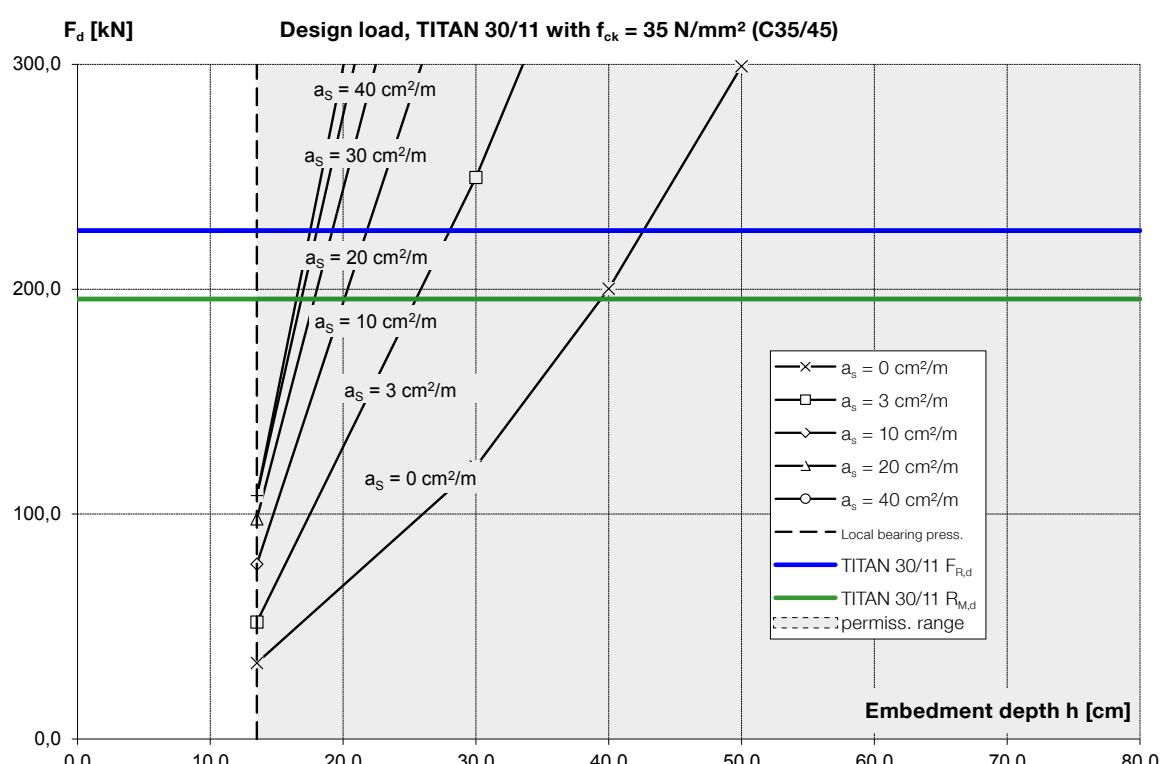
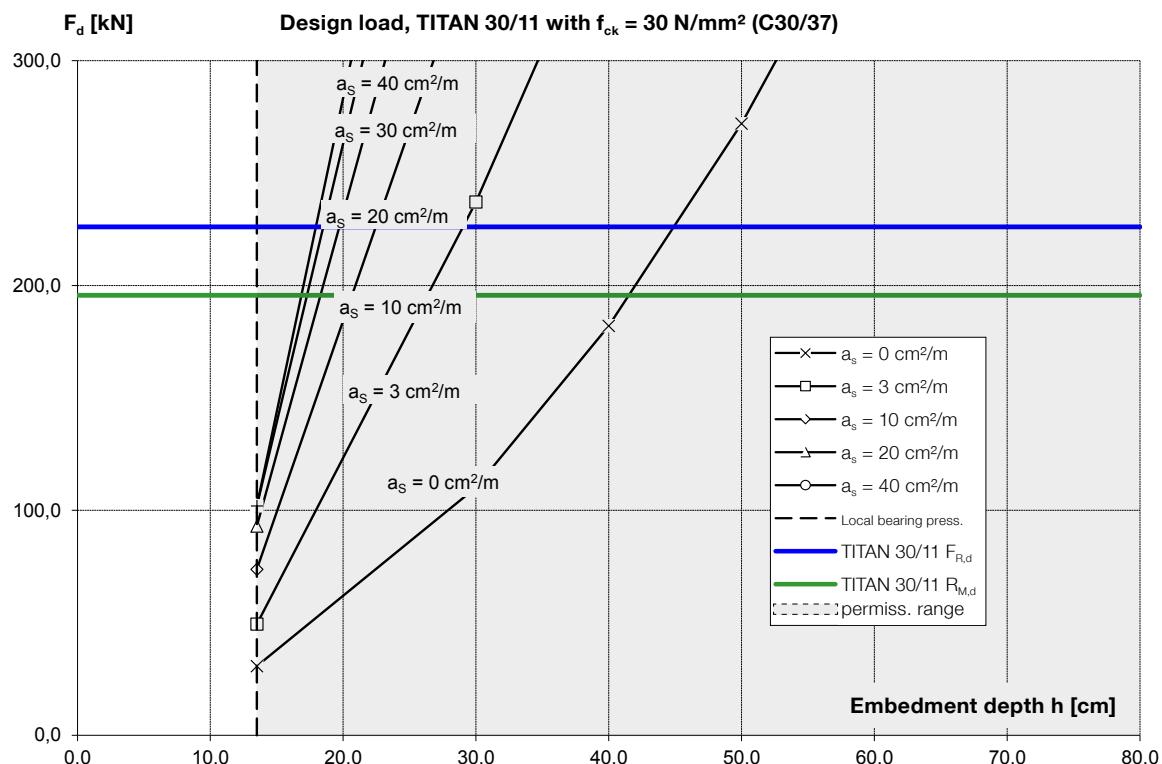
Load at 0.2% proof stress:  $F_{R,d} = 226 \text{ kN}$  (with  $F_{R,k} = 260 \text{ kN}$  and  $\gamma_M = 1.15$ )

Min. embedment depth  $h$

Tension:  $h = 13.5 \text{ cm}$

Compression:  $h = 14 \text{ cm}$  ( $A = 10 \text{ cm}$ ,  $B = 7.9 \text{ cm}$ )





# Pile head anchored in concrete

## Design charts for TITAN 40/20 with 115 x 115 x 20 washer plate

### Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

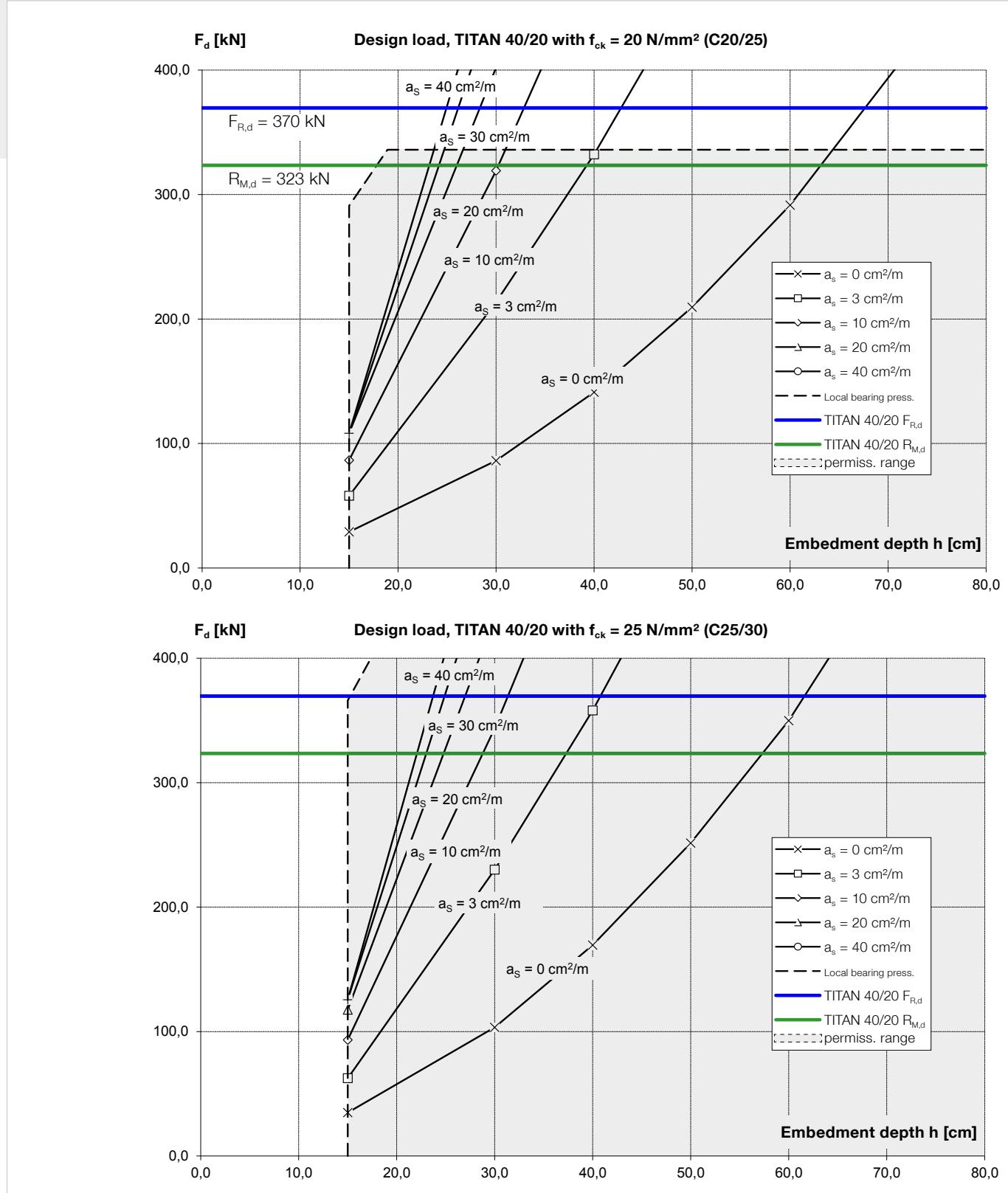
Min. embedment depth h

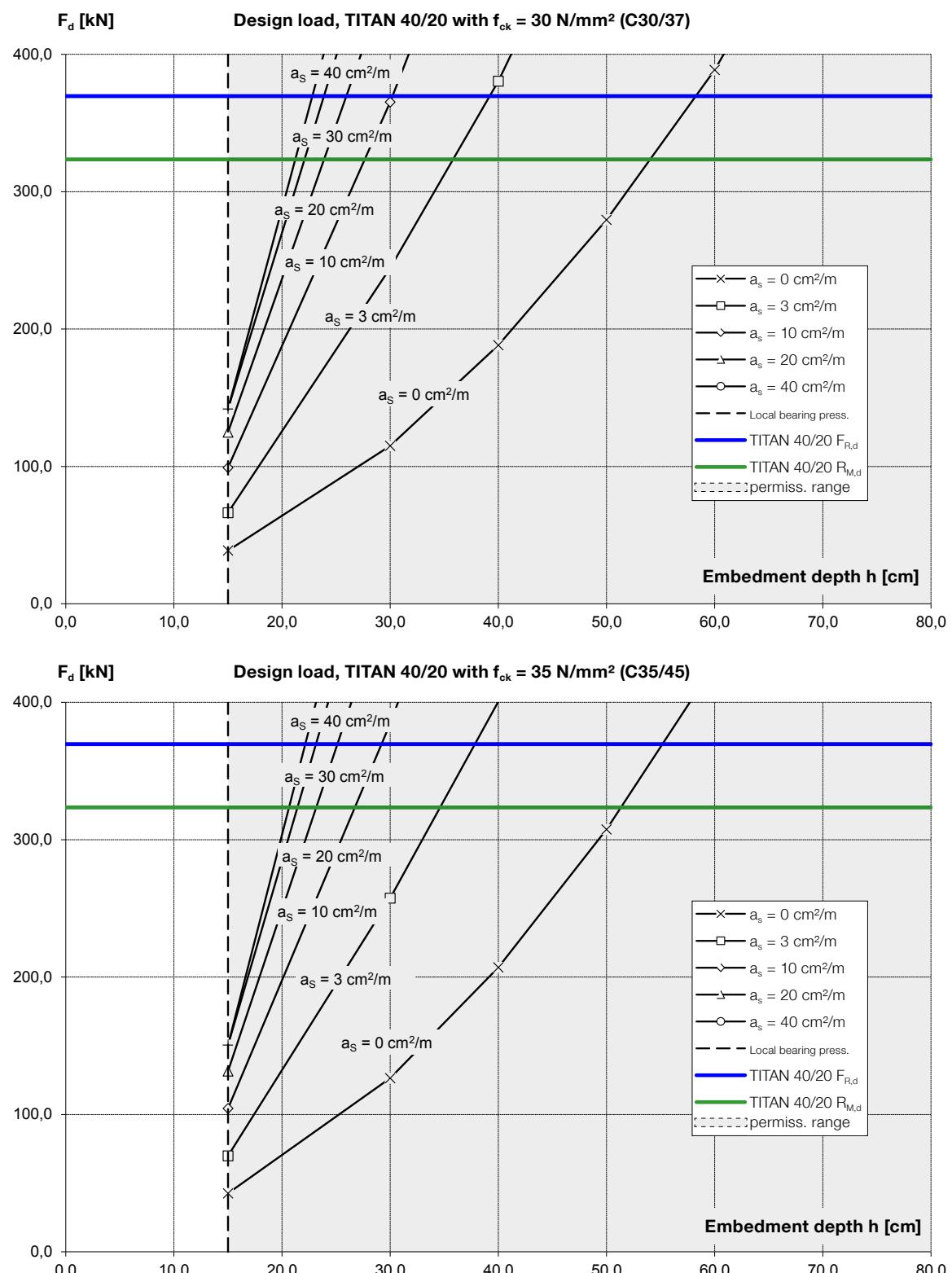
$R_{M,d} = 323 \text{ kN}$  (with  $R_{M,k} = 372 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 370 \text{ kN}$  (with  $F_{R,k} = 425 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 15 \text{ cm}$

Compression:  $h = 17 \text{ cm}$  ( $A = 10 \text{ cm}$ ,  $B = 10.5 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 40/16 with 125 x 125 x 24 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

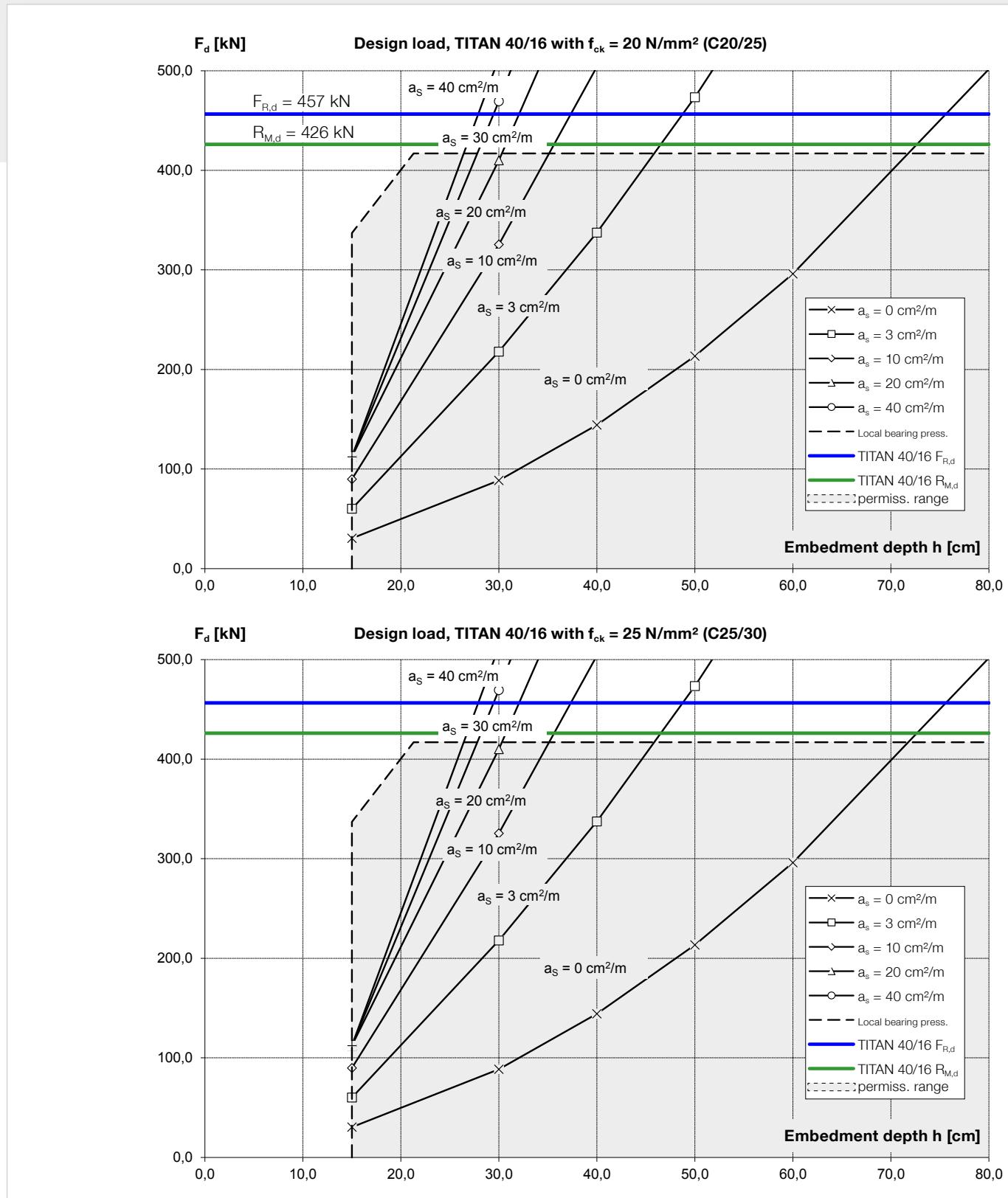
Min. embedment depth h

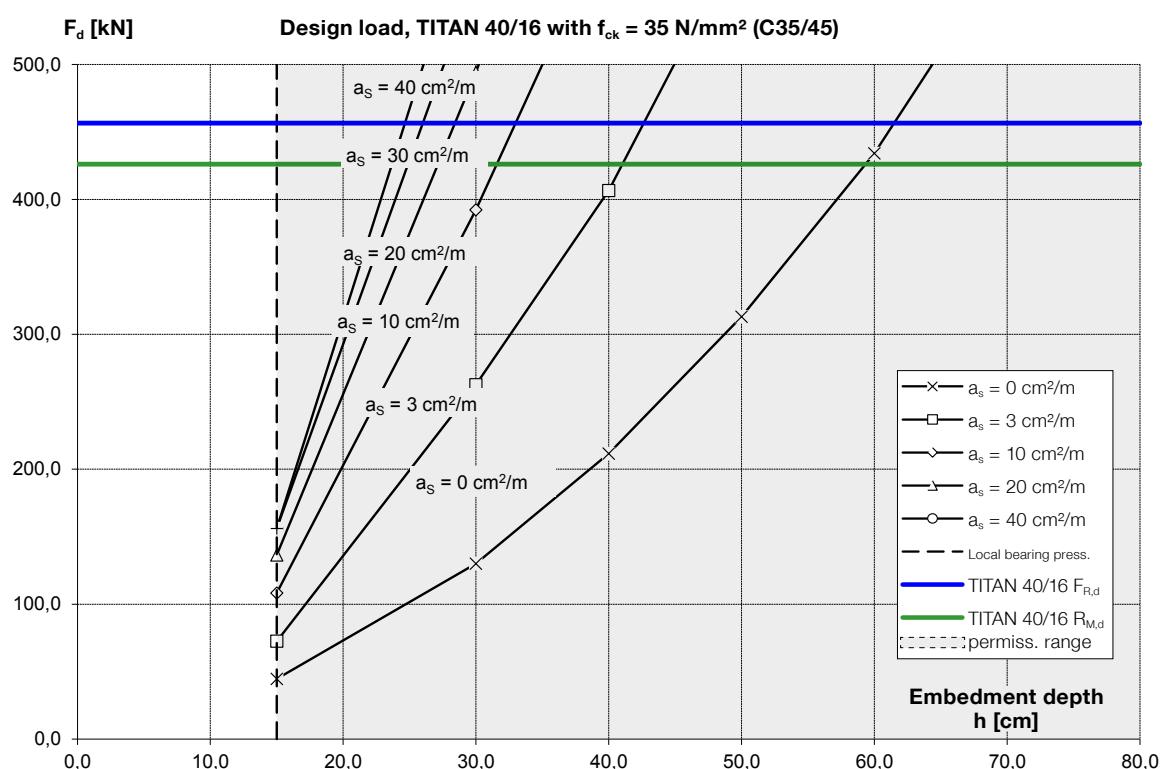
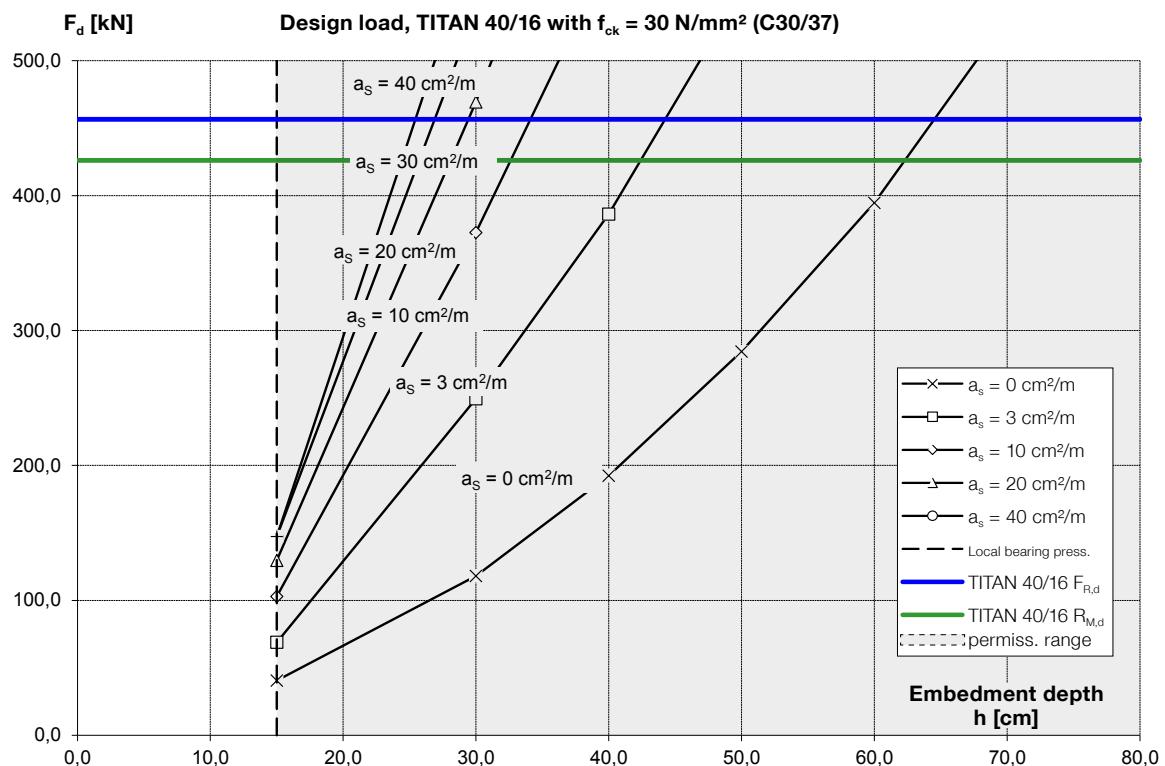
$R_{M,d} = 426 \text{ kN}$  (with  $R_{M,k} = 490 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 457 \text{ kN}$  (with  $F_{R,k} = 525 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 15 \text{ cm}$

Compression:  $h = 17 \text{ cm}$  ( $A = 10 \text{ cm}$ ,  $B = 10.5 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 52/26 with 145 x 145 x 28 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

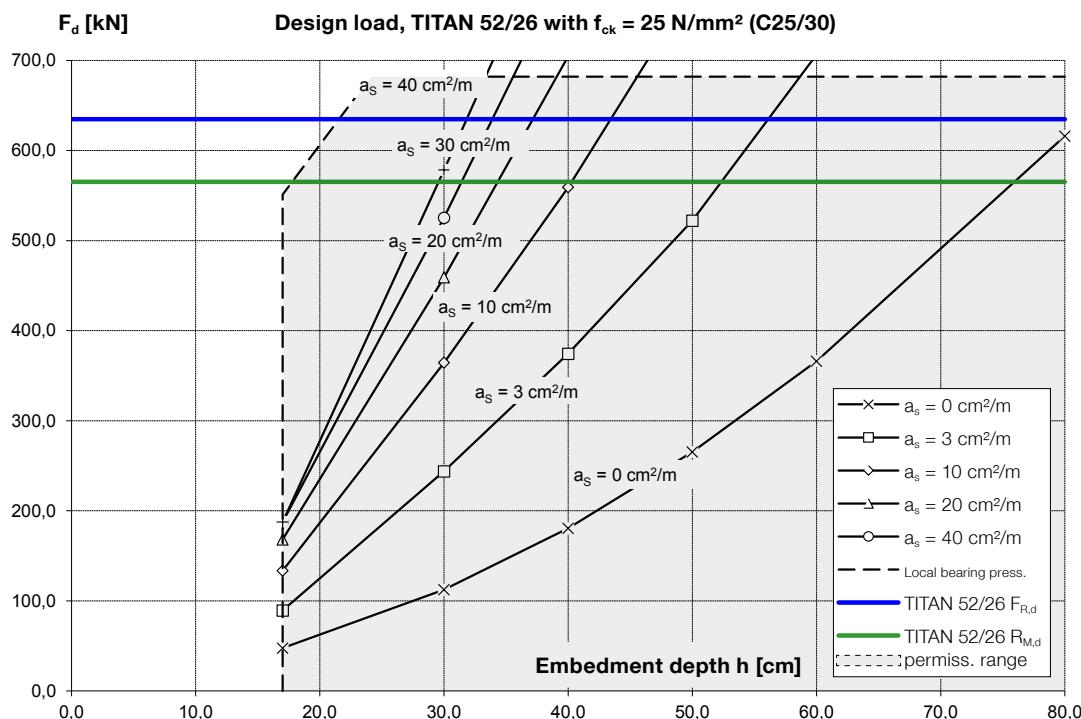
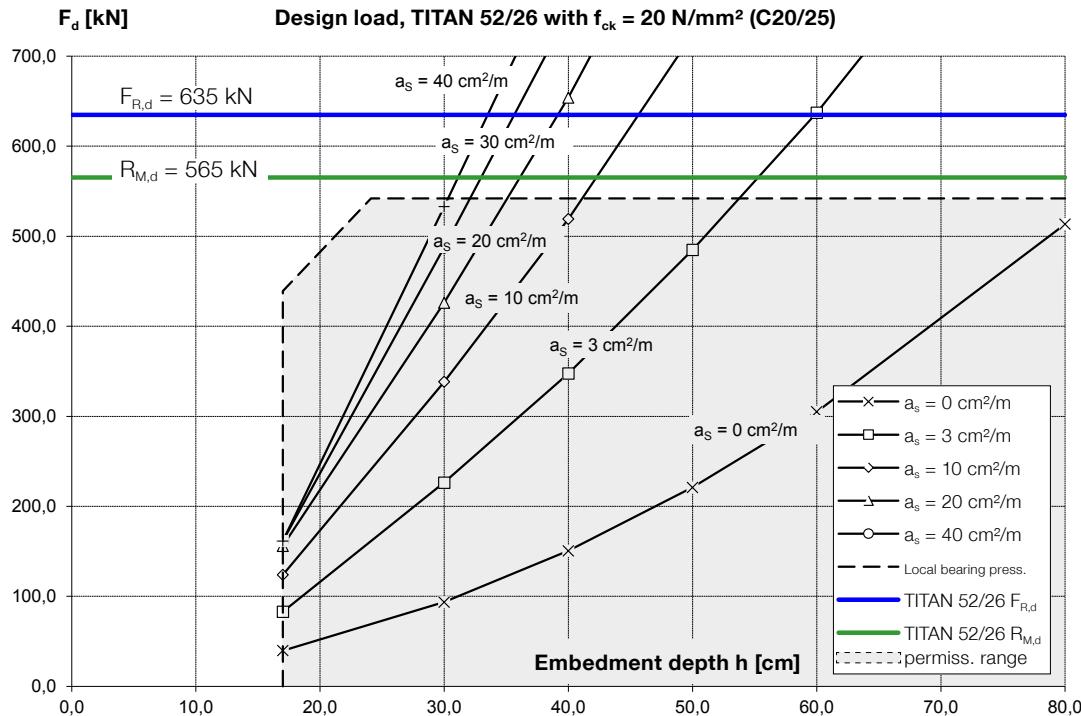
Min. embedment depth h

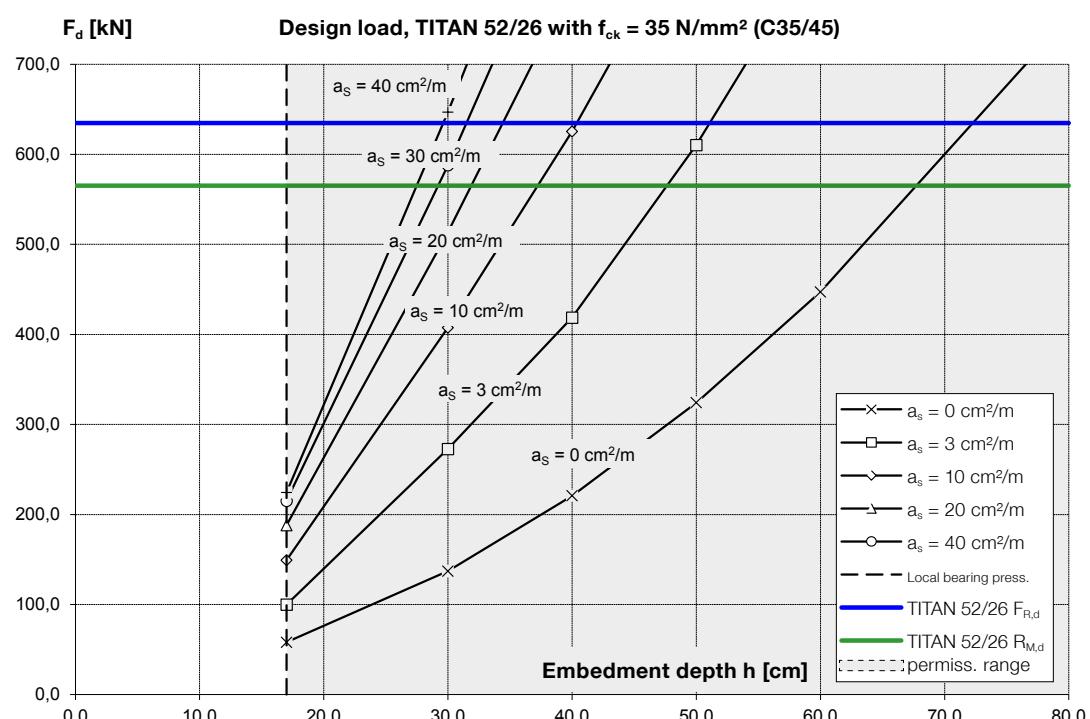
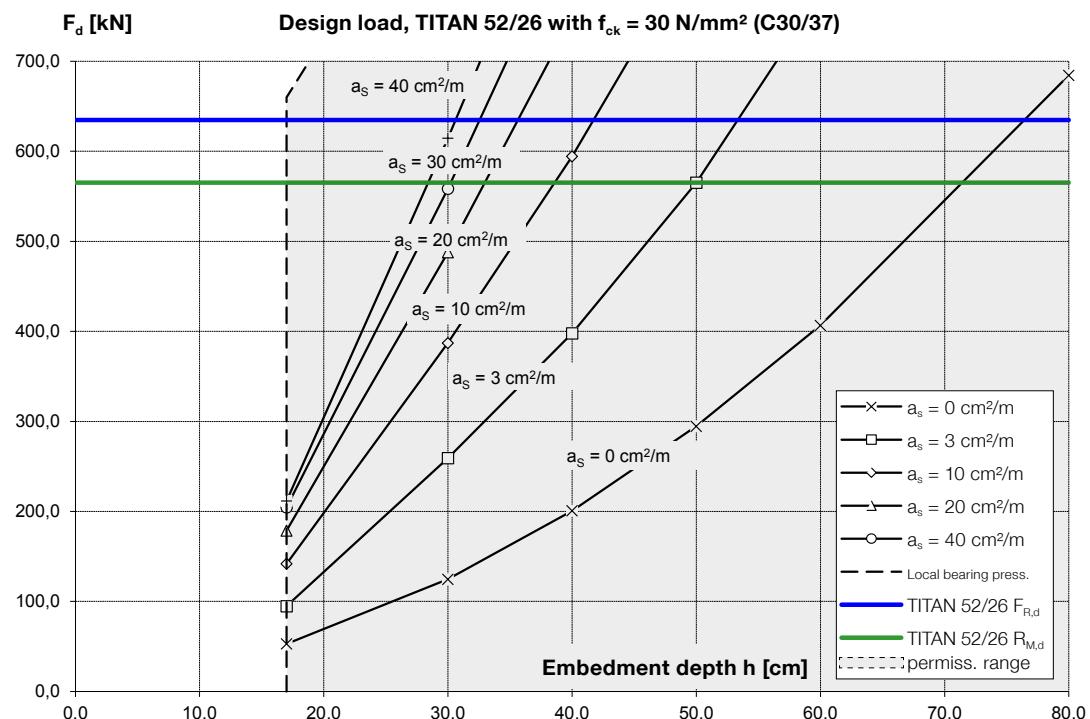
$R_{M,d} = 565 \text{ kN}$  (with  $R_{M,k} = 650 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 635 \text{ kN}$  (with  $F_{R,k} = 730 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 17 \text{ cm}$

Compression:  $h = 20 \text{ cm}$  ( $A = 12.5 \text{ cm}$ ,  $B = 13 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 73/56 with 175 x 175 x 35 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

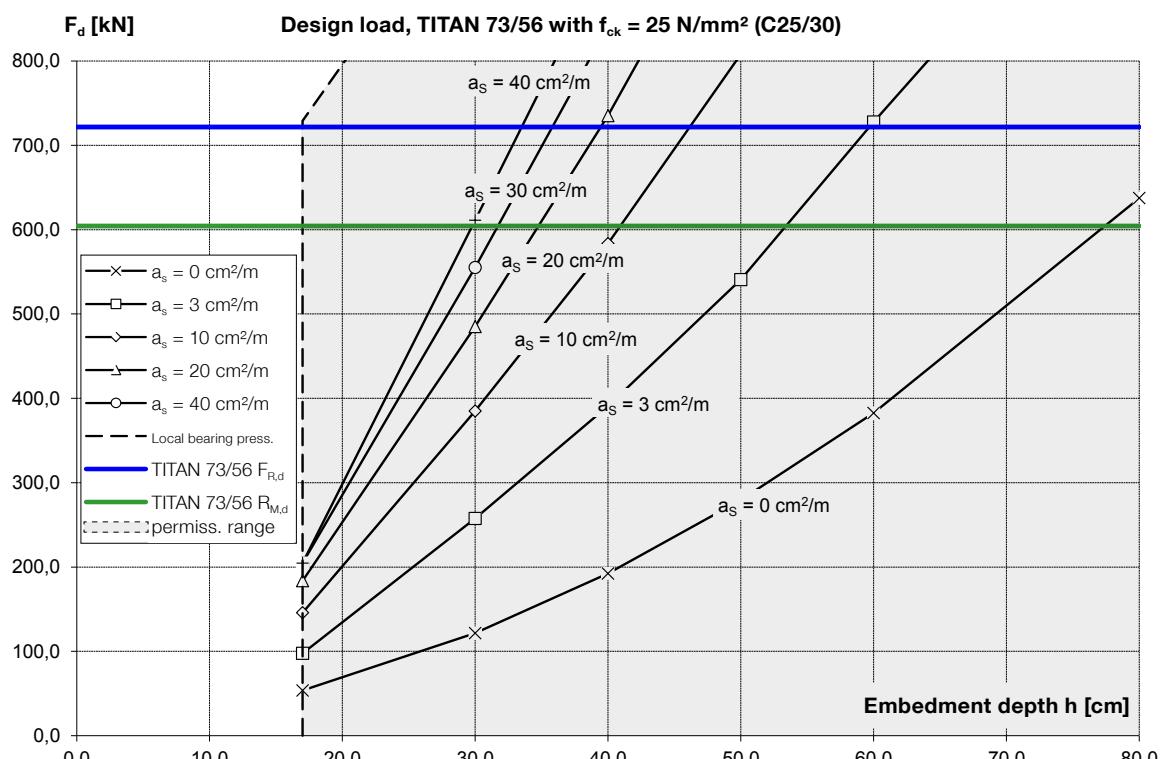
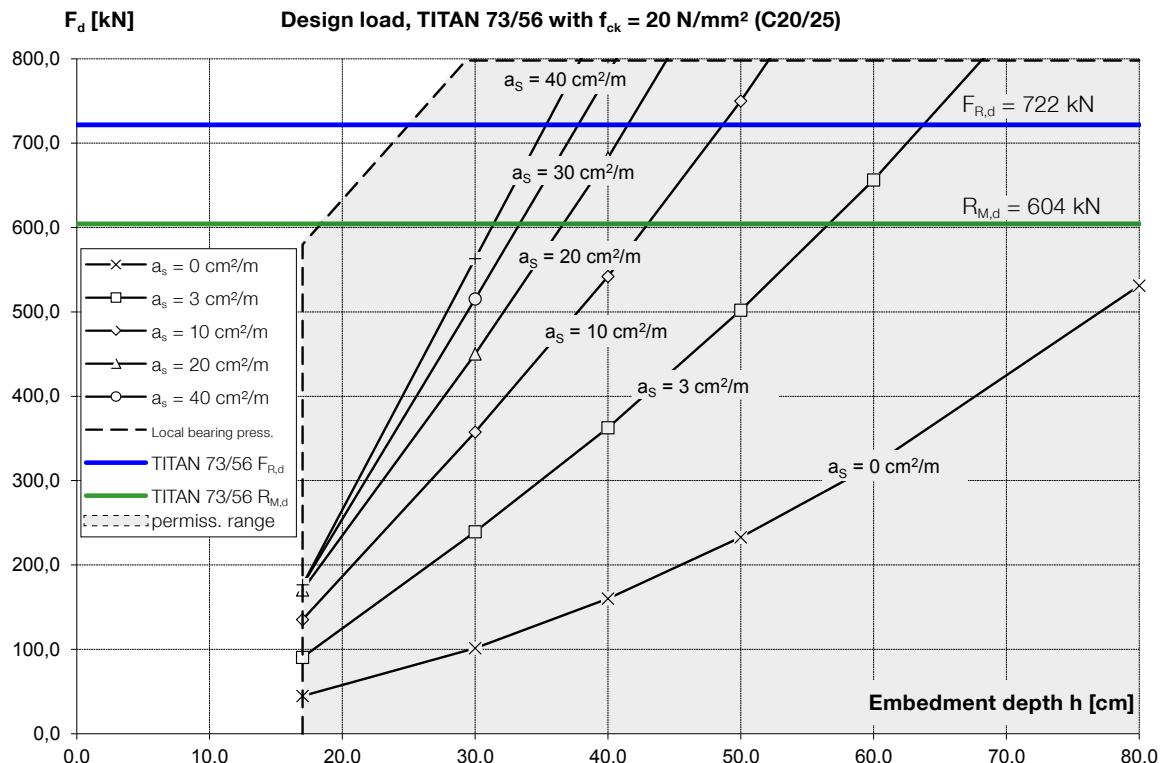
Min. embedment depth h

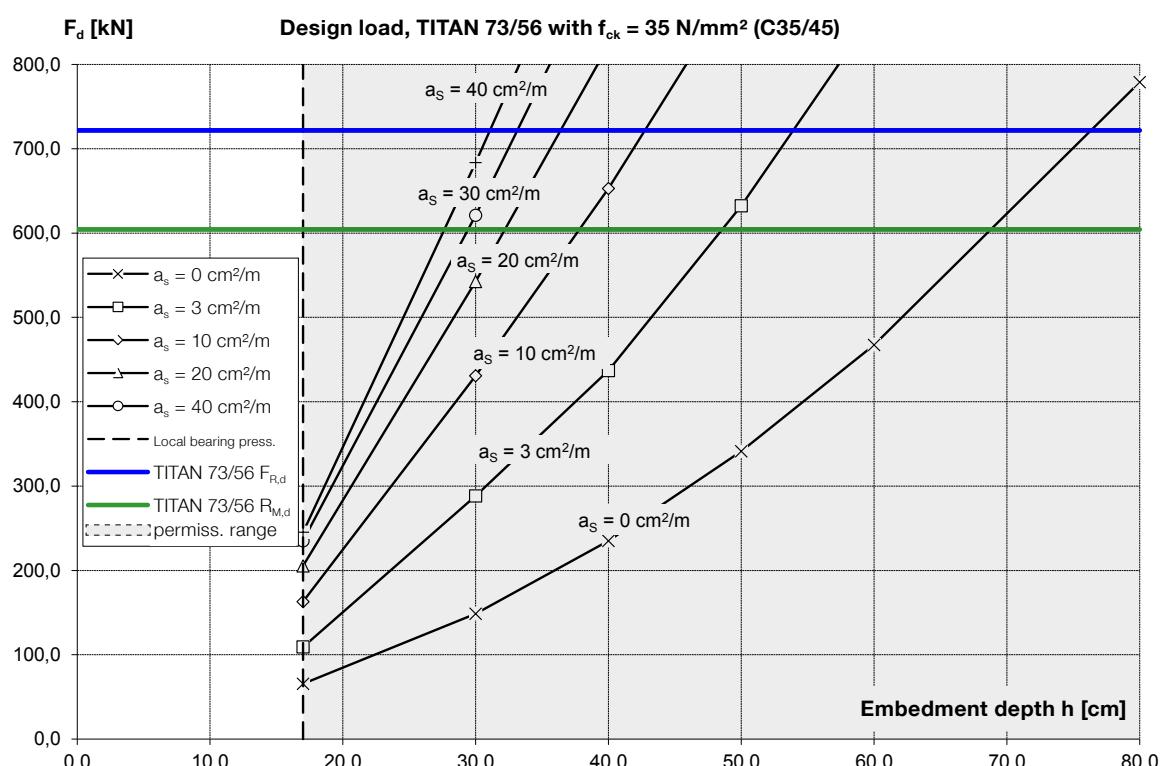
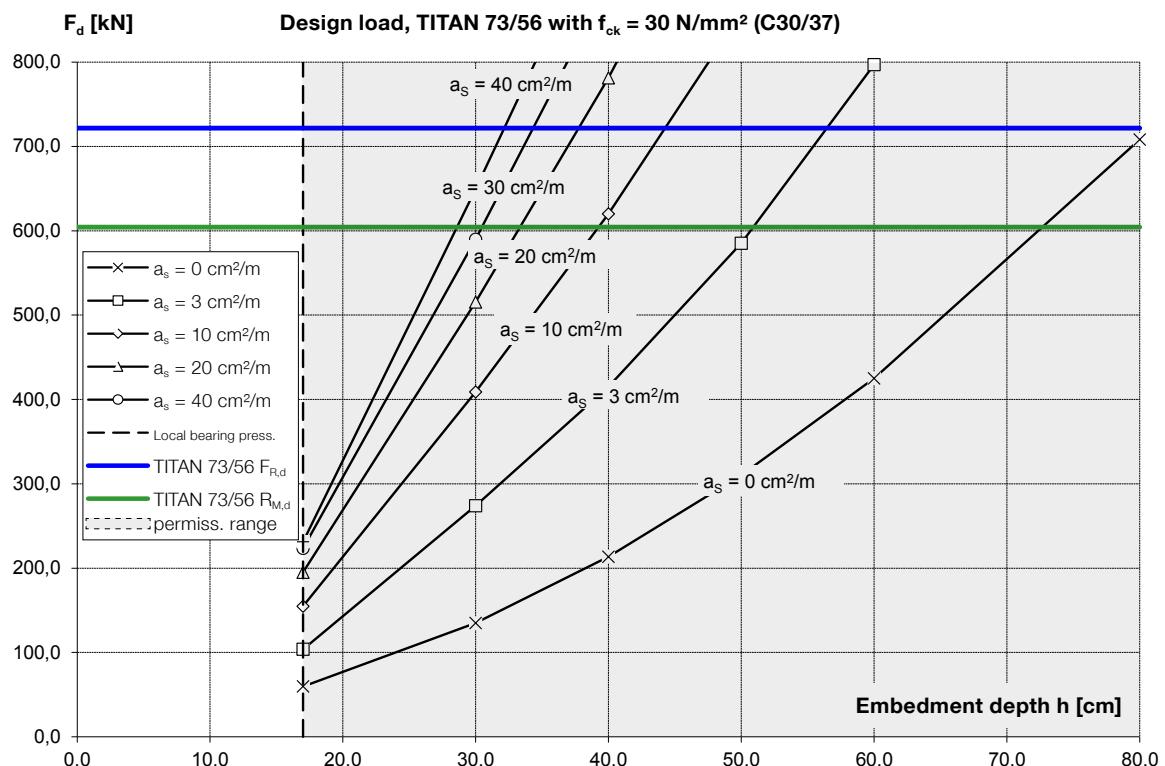
$R_{M,d} = 604 \text{ kN}$  (with  $R_{M,k} = 695 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 722 \text{ kN}$  (with  $F_{R,k} = 830 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 17 \text{ cm}$

Compression:  $h = 25 \text{ cm}$  ( $A = 14 \text{ cm}$ ,  $B = 18.2 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 73/53 with 175 x 175 x 35 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

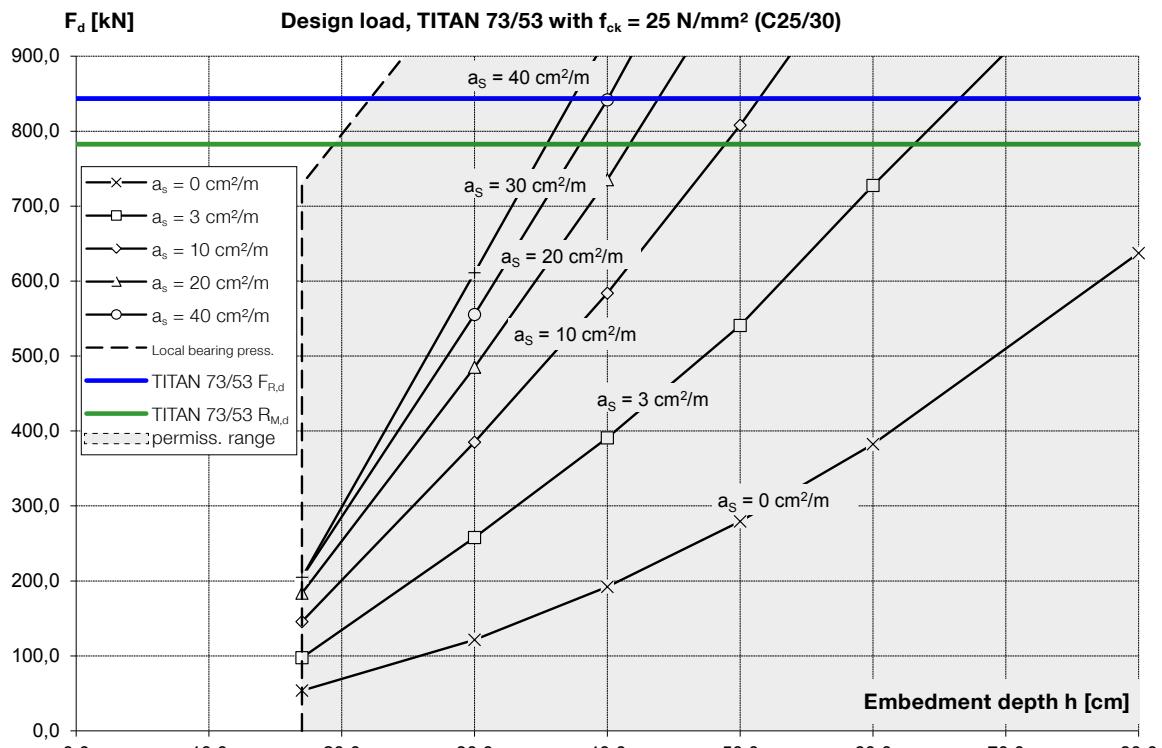
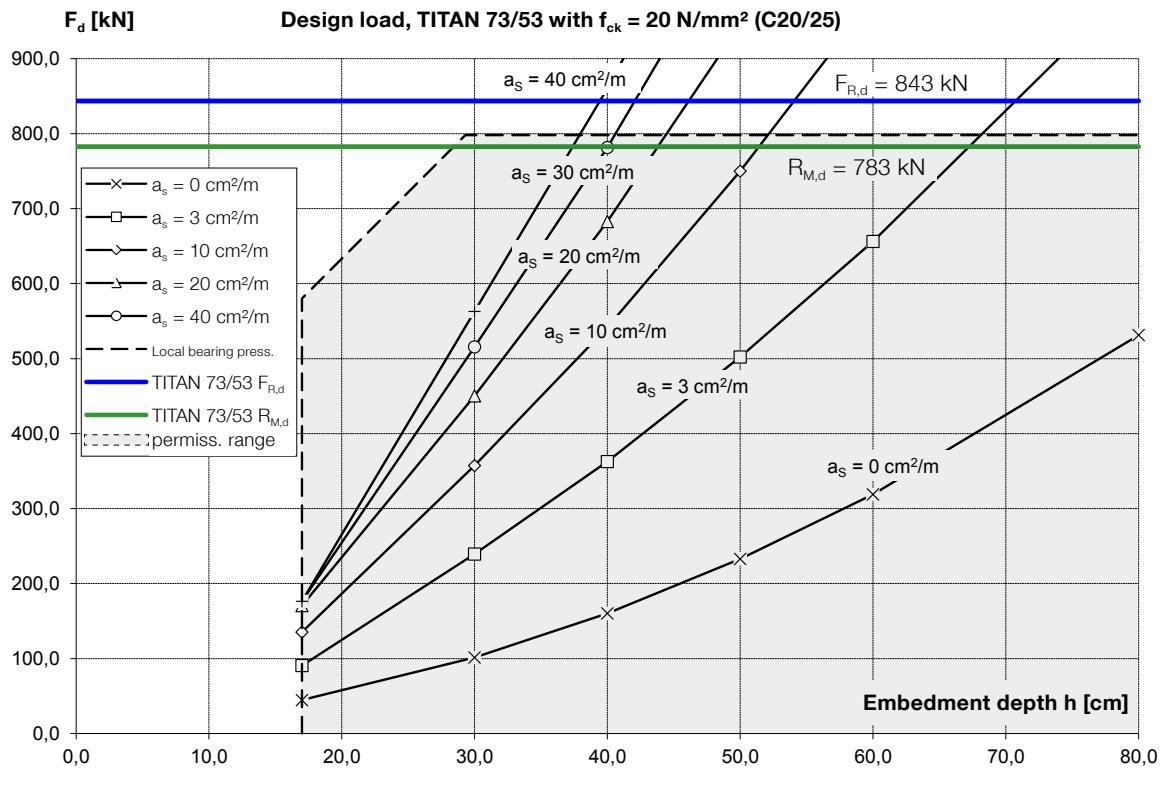
Min. embedment depth h

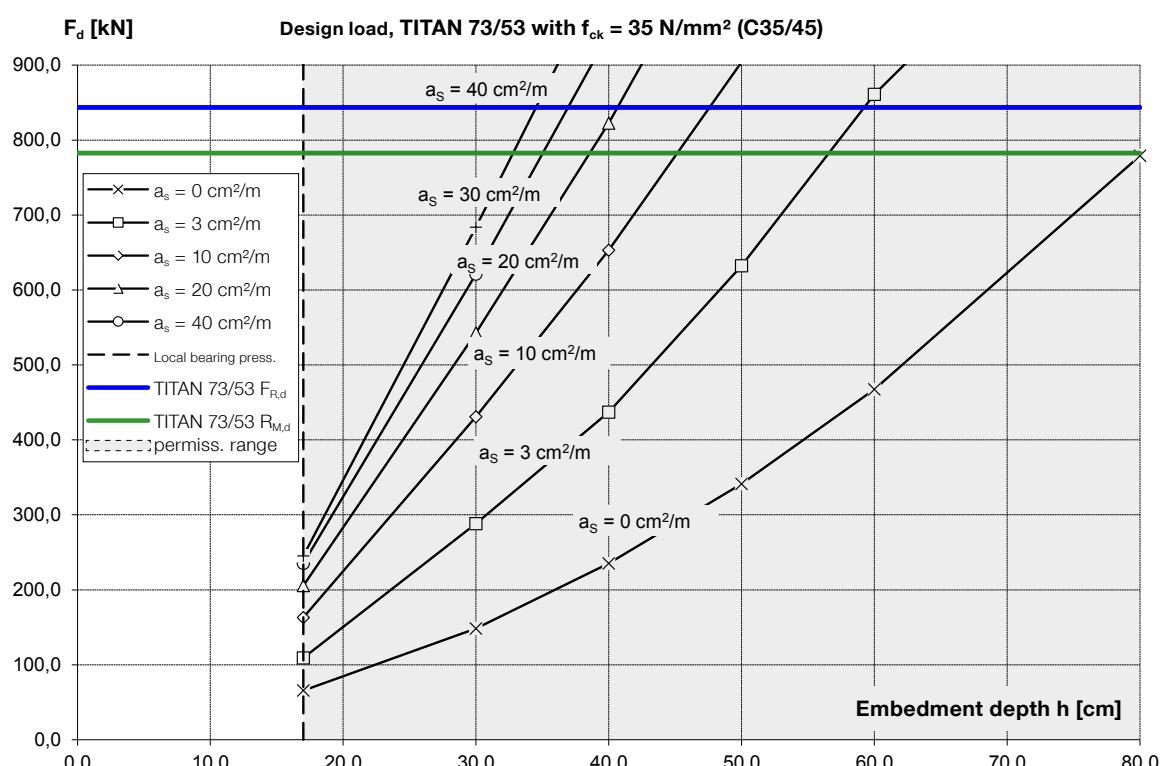
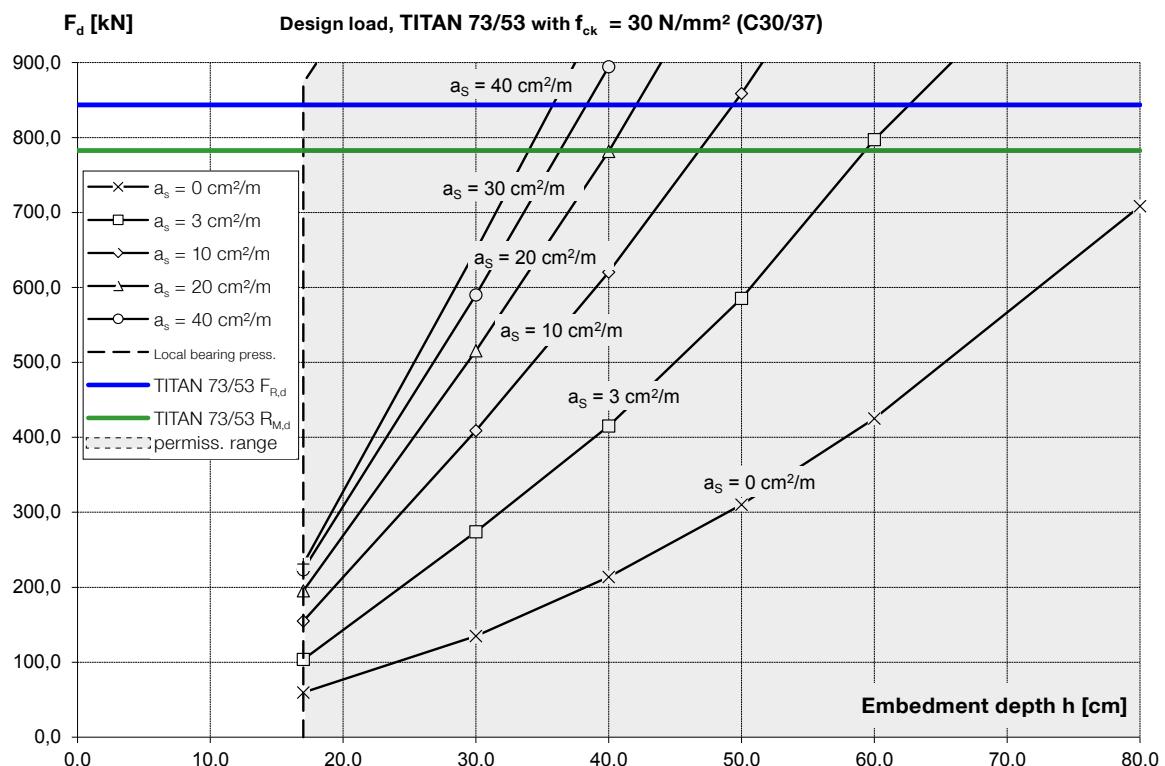
$R_{M,d} = 783 \text{ kN}$  (with  $R_{M,k} = 900 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 843 \text{ kN}$  (with  $F_{R,k} = 970 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 17 \text{ cm}$

Compression:  $h = 25 \text{ cm}$  ( $A = 14 \text{ cm}$ ,  $B = 18.2 \text{ cm}$ )





# Pile head anchored in concrete

## Design charts for TITAN 73/45 with 210 x 210 x 50 washer plate

### Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

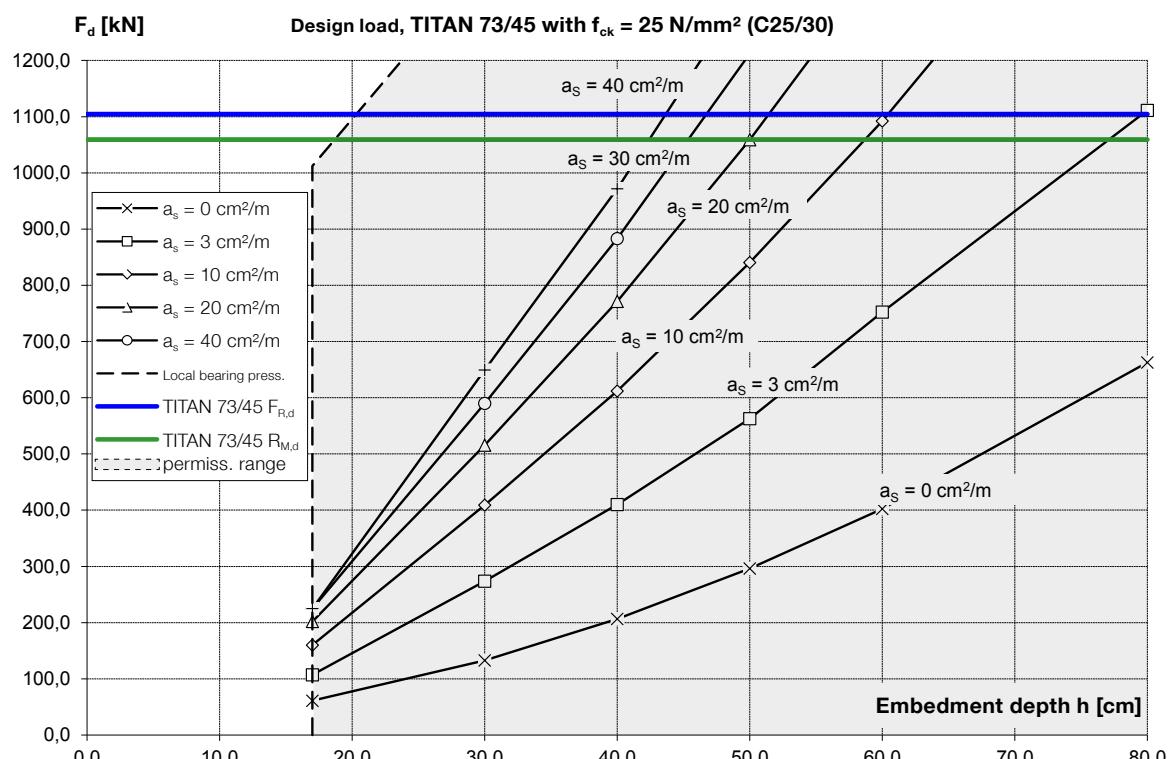
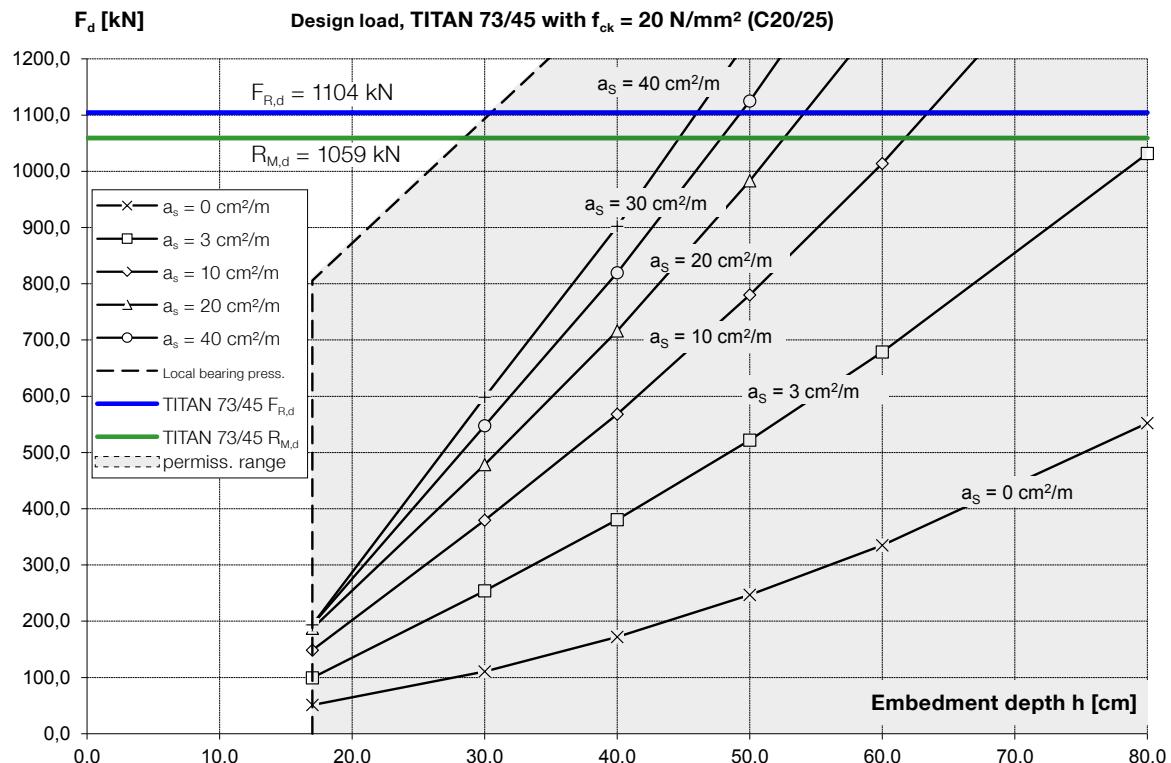
Min. embedment depth h

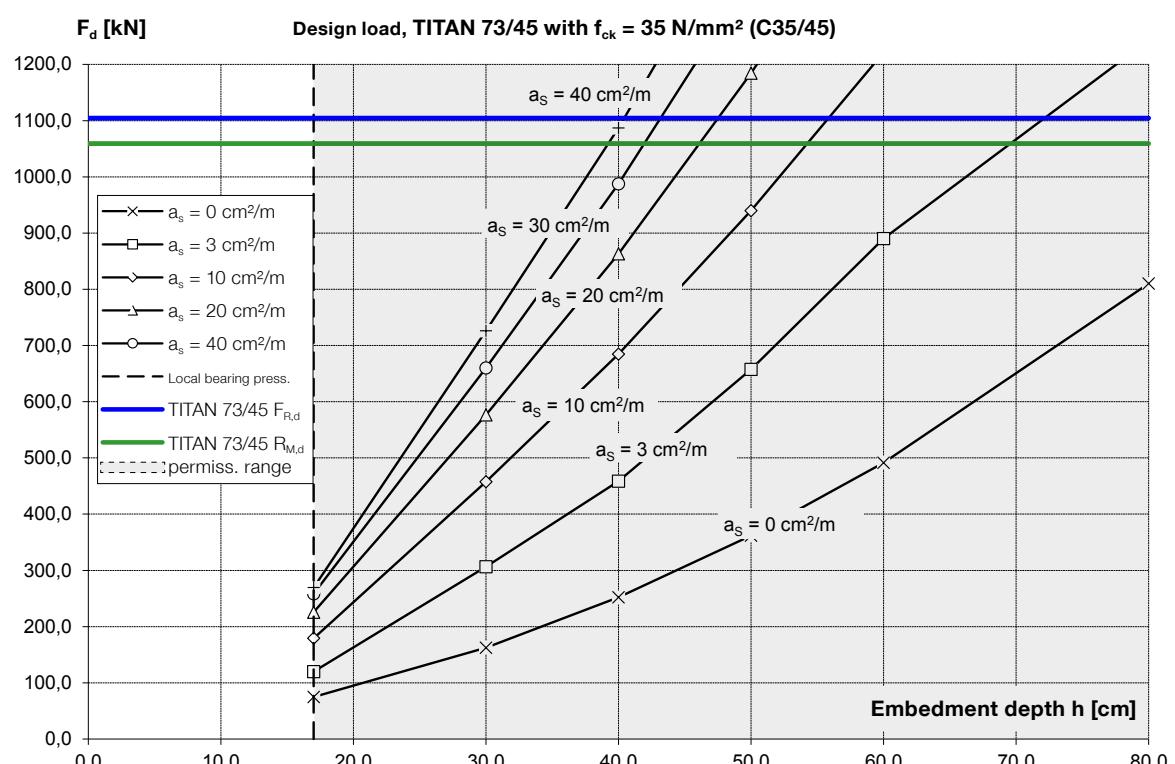
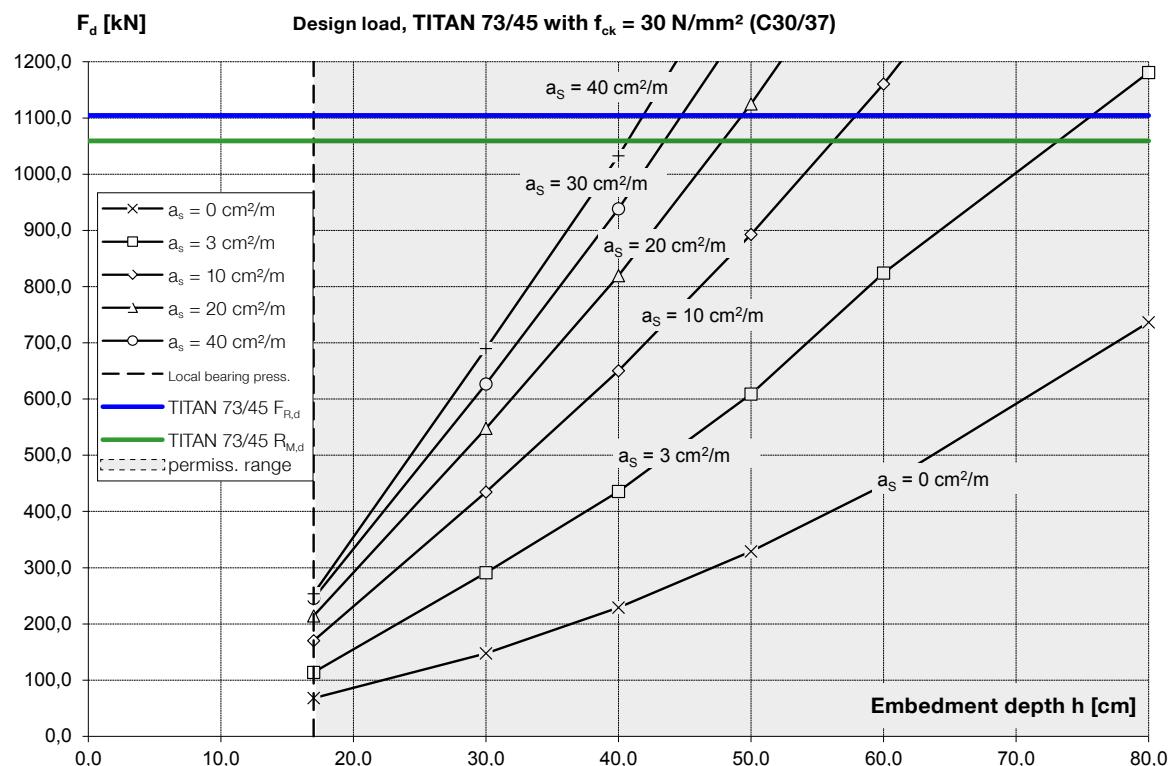
$R_{M,q} = 1059 \text{ kN}$  (with  $R_{M,k} = 1218 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 1104 \text{ kN}$  (with  $F_{R,k} = 1270 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 17 \text{ cm}$

Compression:  $h = 25 \text{ cm}$  ( $A = 14 \text{ cm}$ ,  $B = 18.2 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 73/35 with 210 x 210 x 50 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

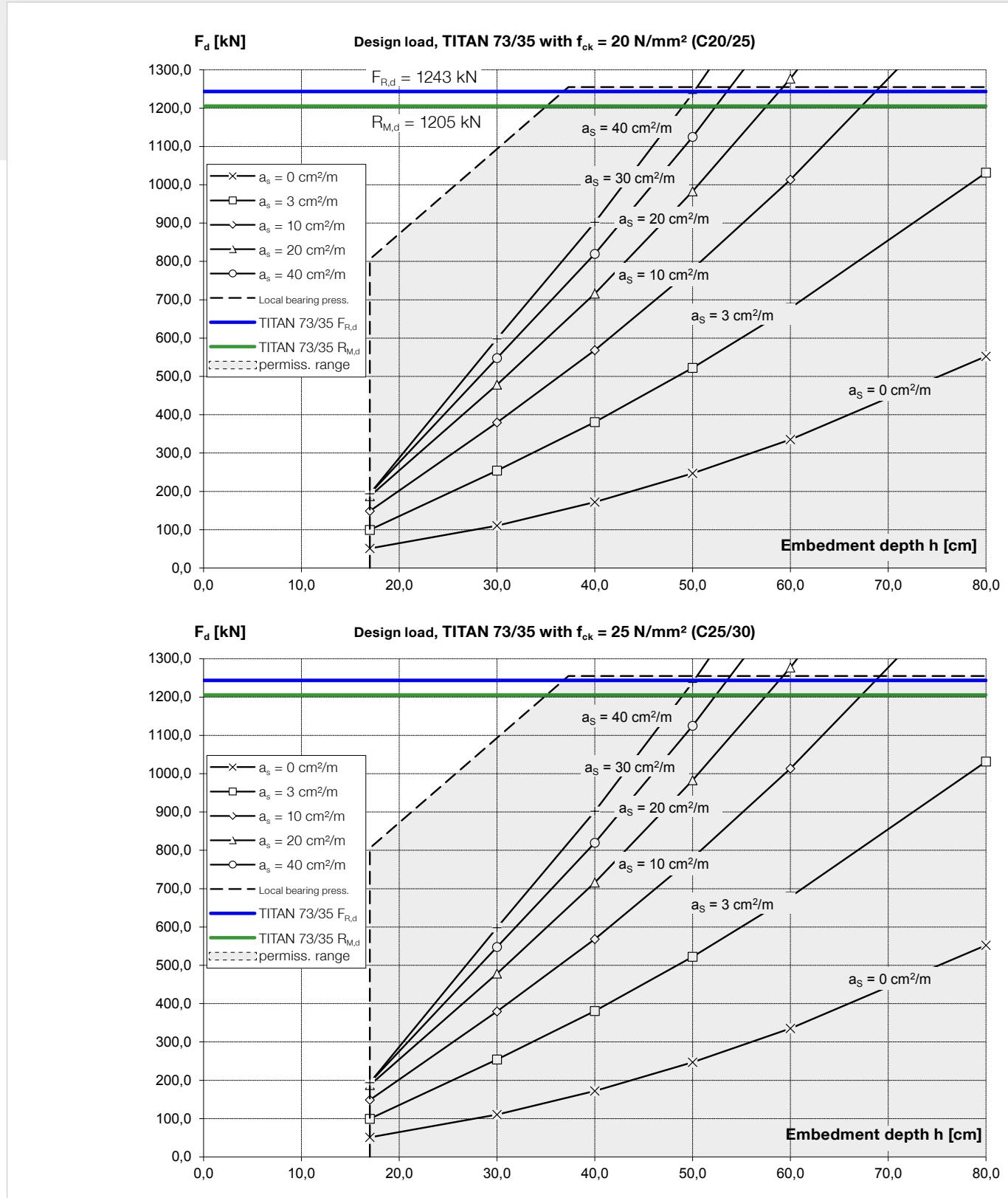
Min. embedment depth h

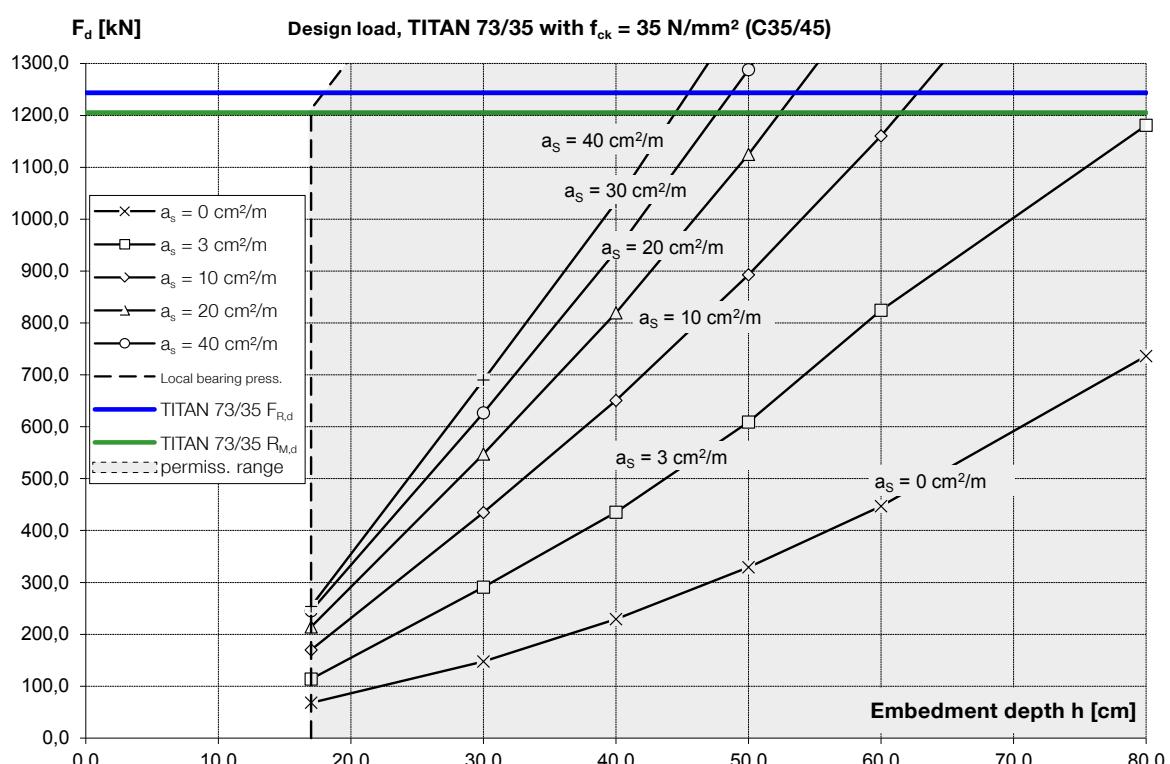
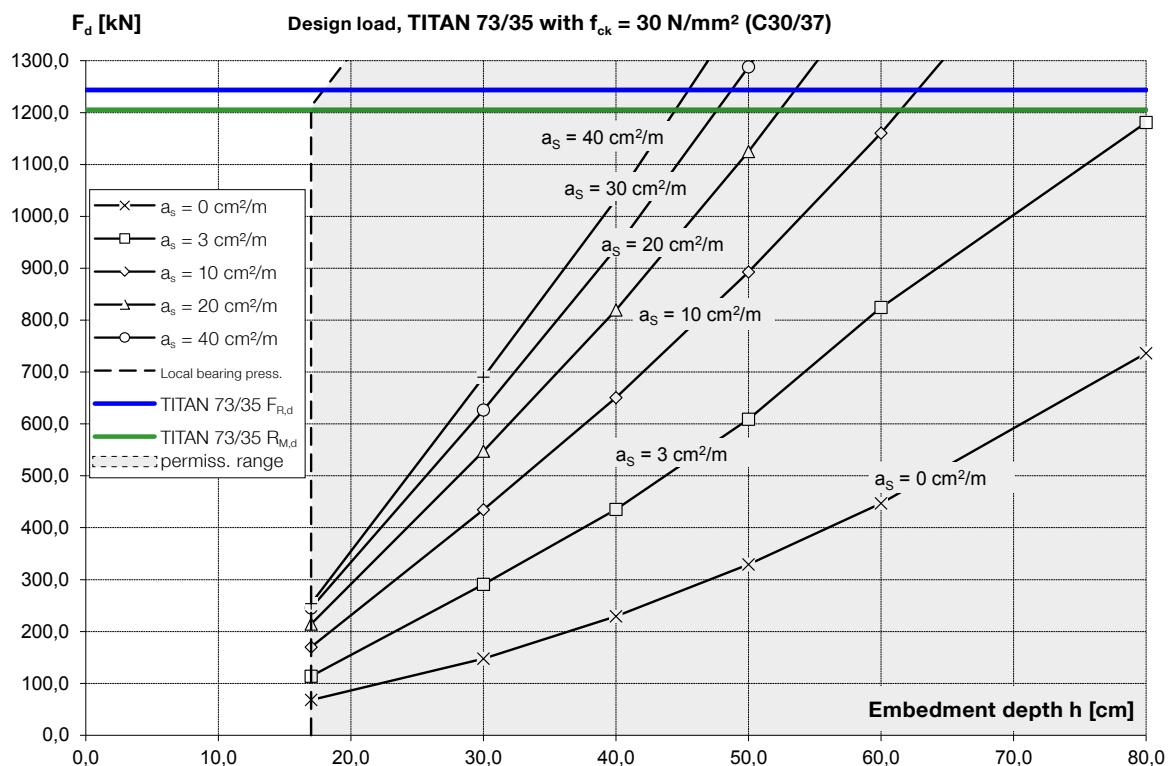
$R_{M,d} = 1205 \text{ kN}$  (with  $R_{M,k} = 1386 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 1243 \text{ kN}$  (with  $F_{R,k} = 1430 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 17 \text{ cm}$

Compression:  $h = 25 \text{ cm}$  ( $A = 14 \text{ cm}$ ,  $B = 18.2 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 103/78 with 240 x 240 x 50 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

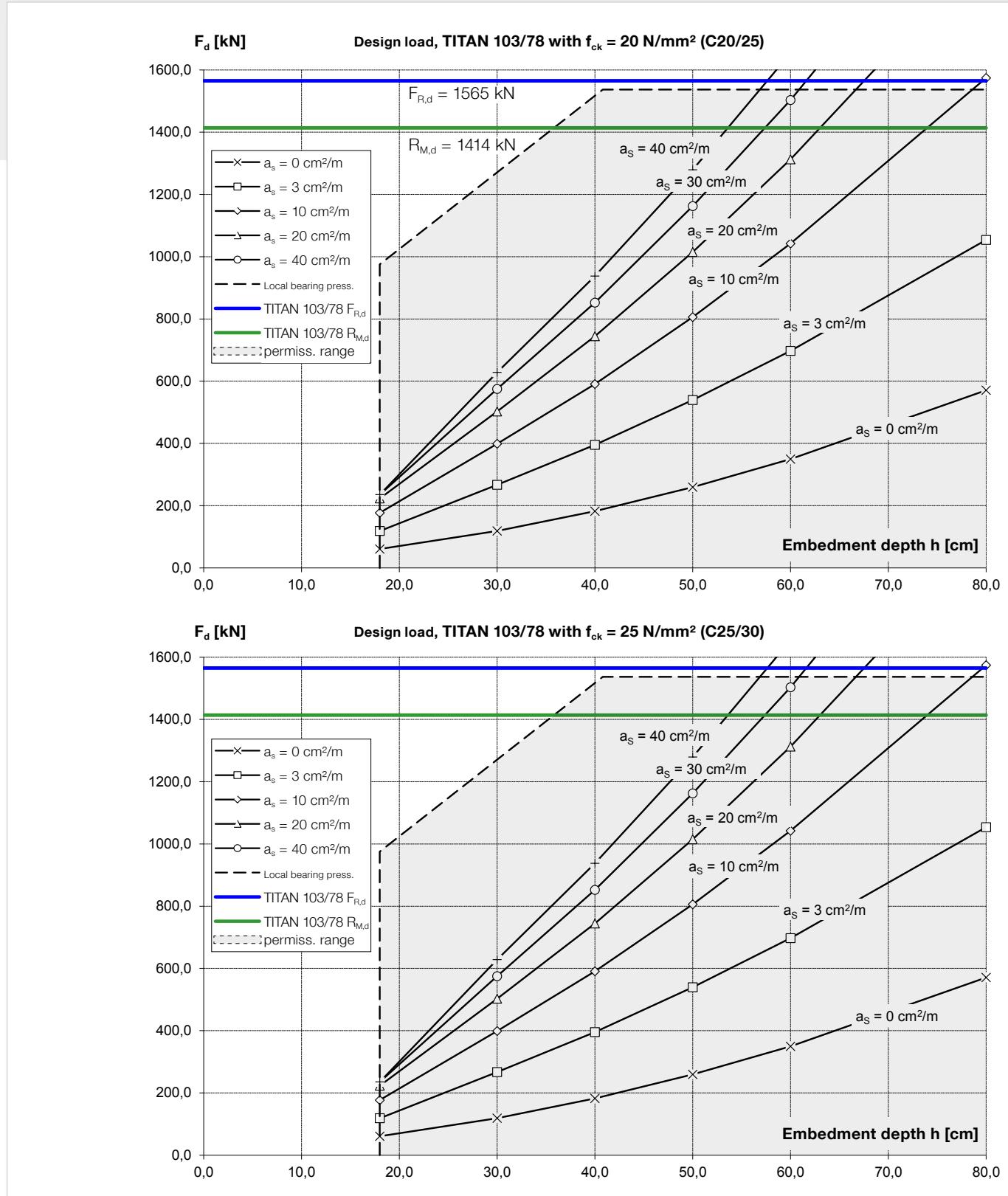
Min. embedment depth h

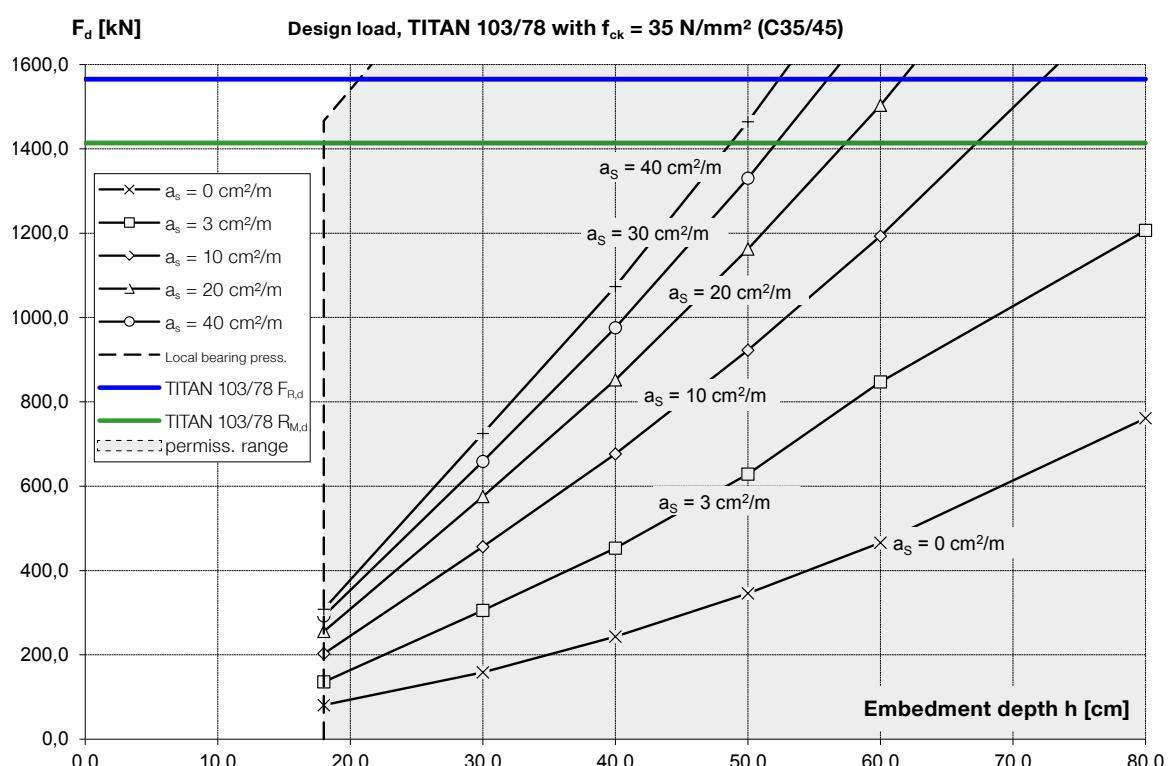
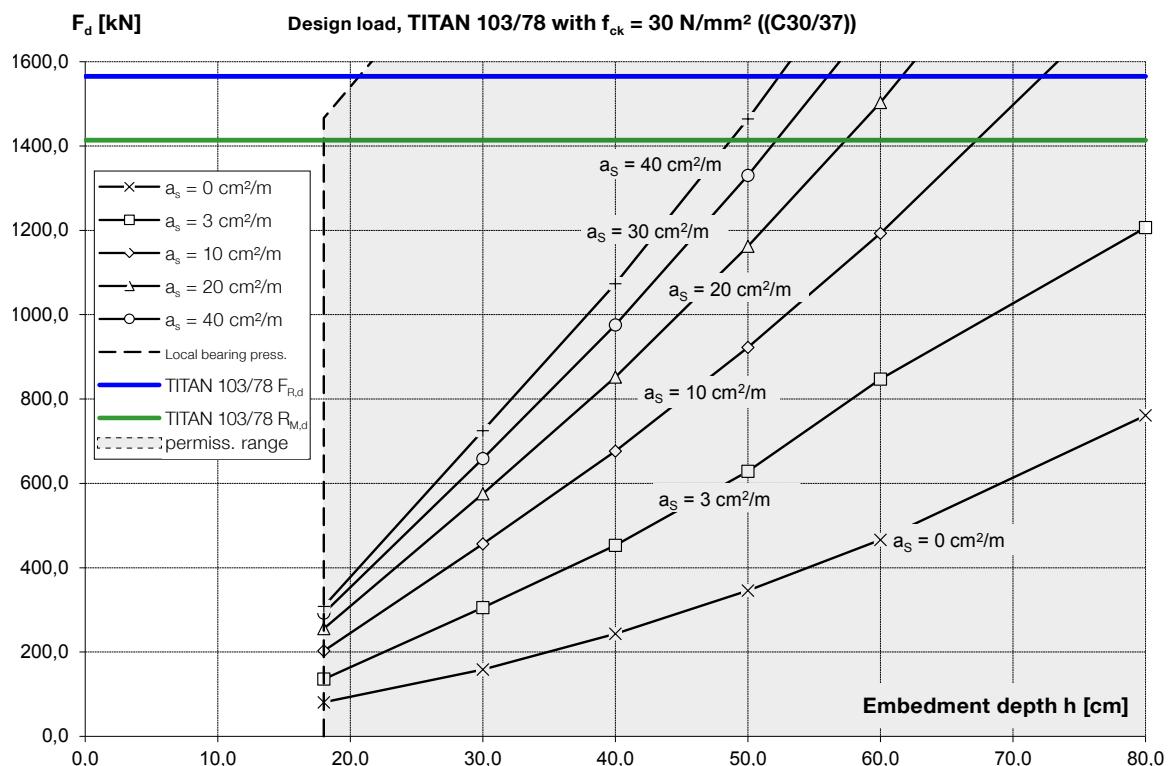
$R_{M,d} = 1414 \text{ kN}$  (with  $R_{M,k} = 1626 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 1565 \text{ kN}$  (with  $F_{R,k} = 1800 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 18 \text{ cm}$

Compression:  $h = 33 \text{ cm}$  ( $A = 17 \text{ cm}$ ,  $B = 26.1 \text{ cm}$ )





# Pile head anchored in concrete

Design charts for TITAN 103/51 with 285 x 285 x 70 washer plate

## Hollow bar parameters

Design resistance according to National Technical Approval:

Load at 0.2% proof stress:

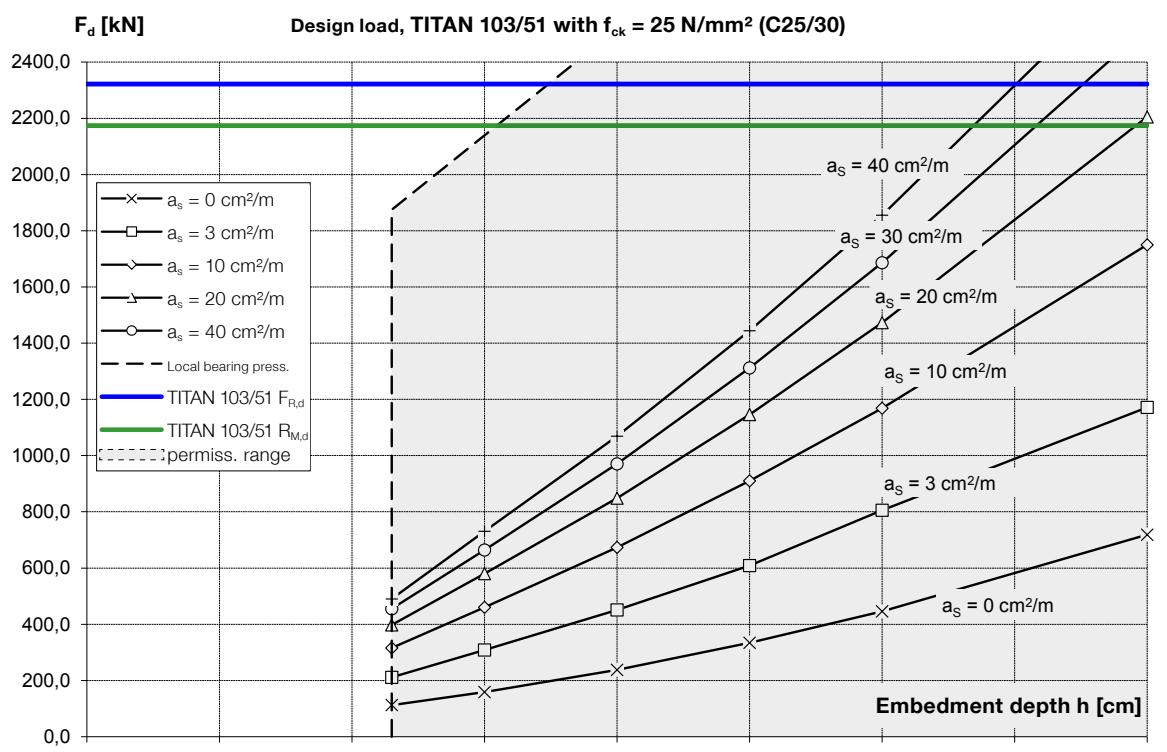
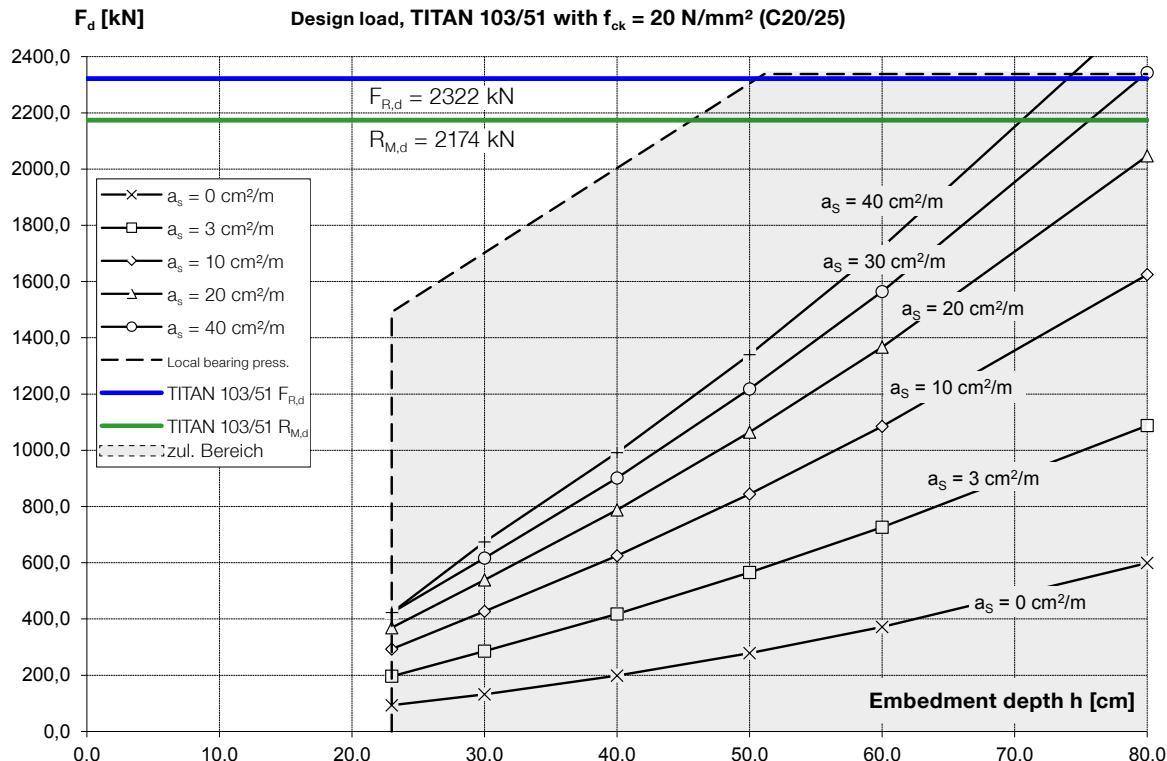
Min. embedment depth h

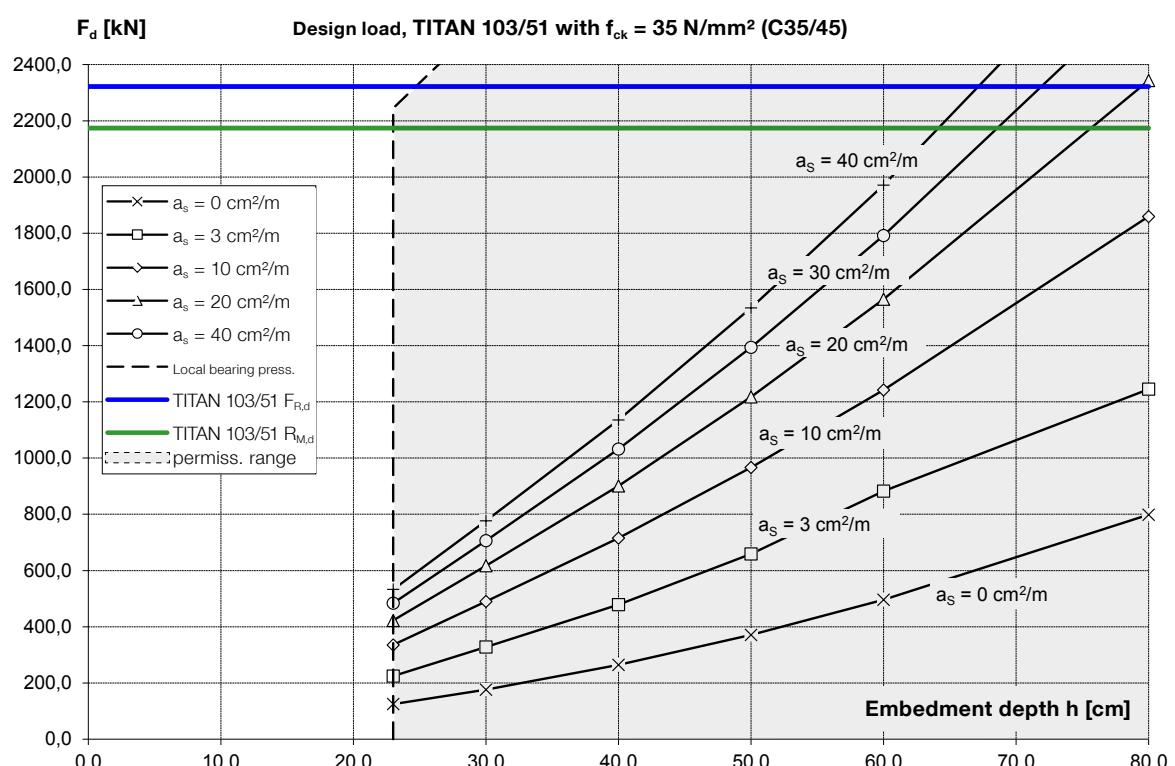
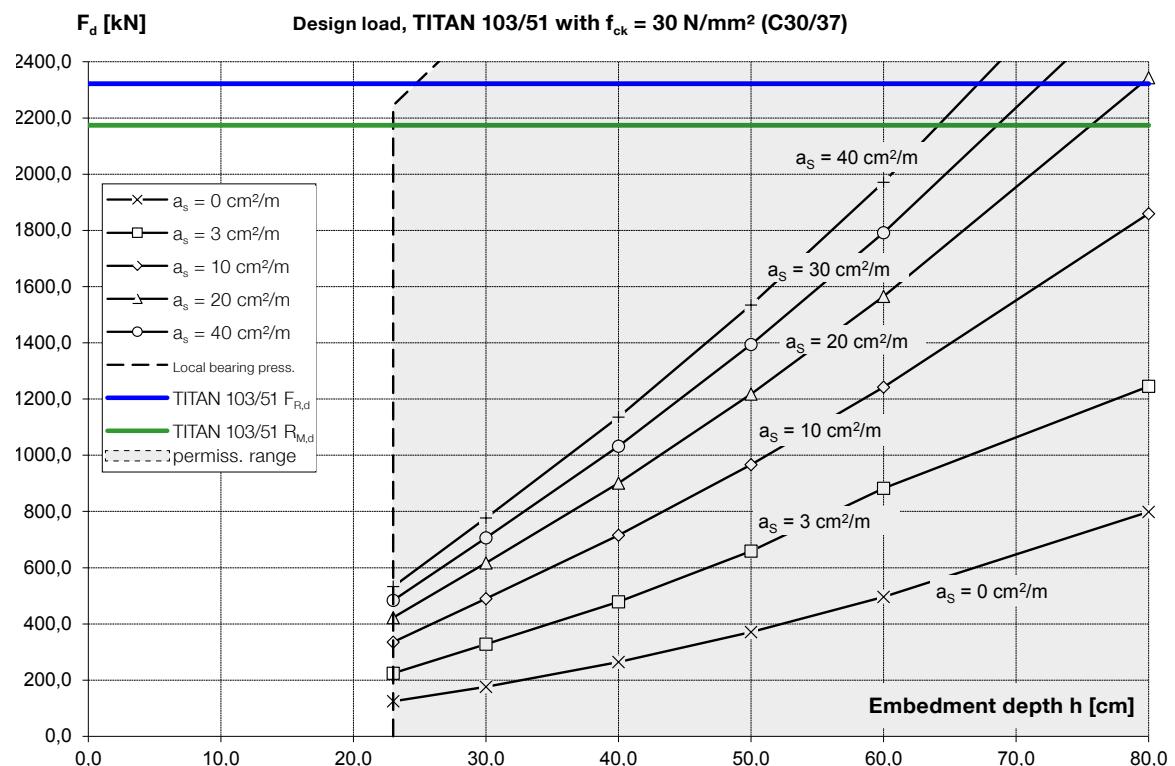
$R_{M,d} = 2174 \text{ kN}$  (with  $R_{M,k} = 2500 \text{ kN}$  and  $\gamma_M = 1.15$ )

$F_{R,d} = 2322 \text{ kN}$  (with  $F_{R,k} = 2670 \text{ kN}$  and  $\gamma_M = 1.15$ )

Tension:  $h = 23 \text{ cm}$

Compression:  $h = 33 \text{ cm}$  ( $A = 22.5 \text{ cm}$ ,  $B = 26.1 \text{ cm}$ )





## Examples of applications

### Foundation – pile head anchored in concrete



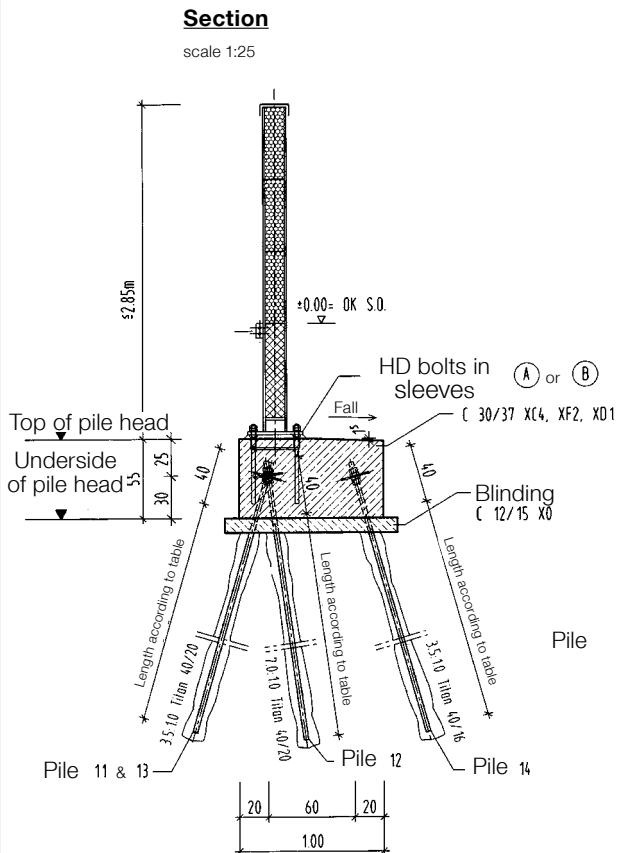
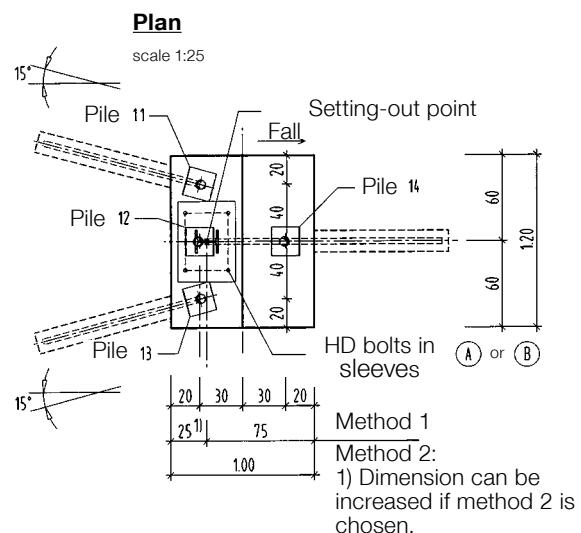
Fig. top  
Micropiles installed with sleeves

Fig. centre  
Micropiles fitted with washer plates and spherical collar nuts

Fig. bottom  
Reinforcement in place

### Foundation with TITAN micropiles

(noise barrier)



## Examples of applications

### Anchoring a timber wedge clamp wall



Timber wedge clamp wall anchored through waling

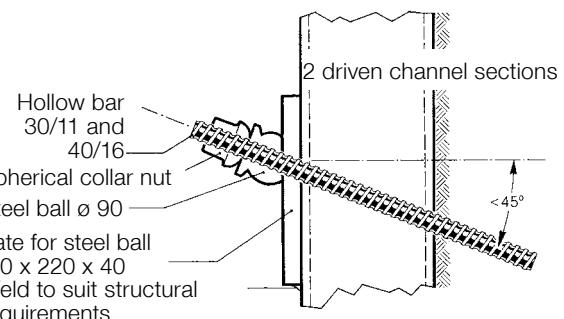


Construction project at the Heinrich Schütz Residence in Dresden



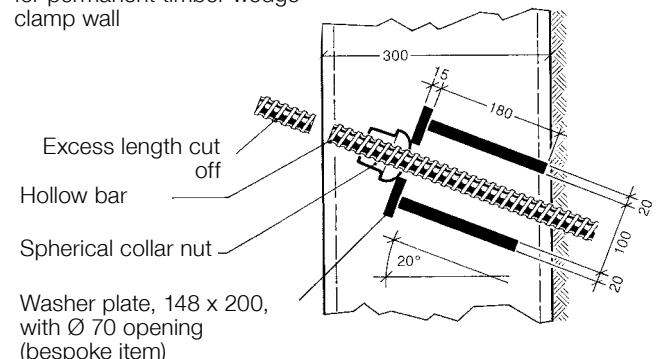
Excavation shoring anchored with TITAN 40/16 and TITAN 52/26 without walings

#### Timber wedge clamp wall for excavation shoring



#### Pile head concealed between twin-channel waling

for permanent timber wedge  
clamp wall



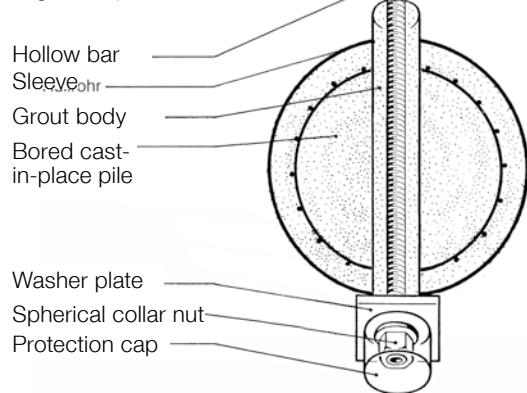
Are you familiar with our timber wedge clamp? If not, simply request the brochure on excavation shoring with timber wedge clamp walls.

## Examples of applications

### Anchoring a bored cast-in-place pile wall

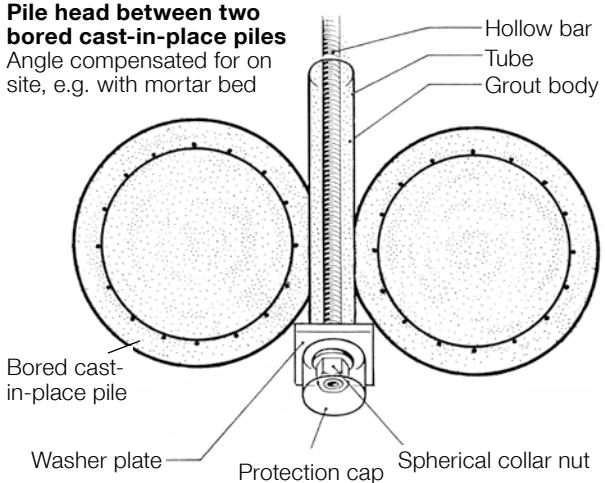
#### Pile head on bored cast-in-place pile

Angle compensated for on site



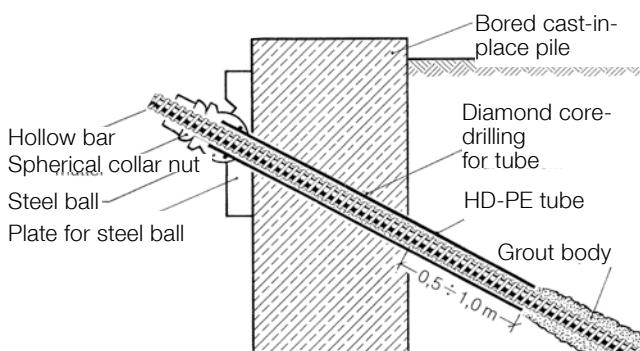
#### Pile head between two bored cast-in-place piles

Angle compensated for on site, e.g. with mortar bed



#### Pile head on bored cast-in-place pile

Angle compensation by system



#### Anchoring a bored cast-in-place pile wall – use of a sleeve

When anchoring a bored cast-in-place pile wall, the pile head detail requires the inclusion of a smooth HD-PE tube. Operations:

1. Core-drill through the concrete pile for the tube.
2. Insert the tube.
3. Drill, insert and grout the micropile through the tube.

The aim of the tube is to prevent the grout body being supported directly on the bored cast-in-place pile wall.

#### Anchoring a bored cast-in-place pile wall with

TITAN 40/16

Vnukovo subway station in Moscow



#### Anchoring a bored cast-in-place pile wall without walings

Building site in Beringen, Belgium



## Examples of applications

### Embankment stabilisation and nailing



After installing the hollow bars, the surface was secured with wire mesh held in place on the slope with spherical collar nuts and domed claw washer plates.



Hot-dip galvanised **TITAN domed claw washer plate**

- For fixing hexagonal, double-twist hexagonal wire mesh
- 5° angle compensation with spherical collar nut (hot-dip galvanised)



**Claw washer plate (part of netting supplier's system)**

- For high-strength wire mesh
- 5° angle compensation with hot-dip galvanised TITAN spherical collar nut



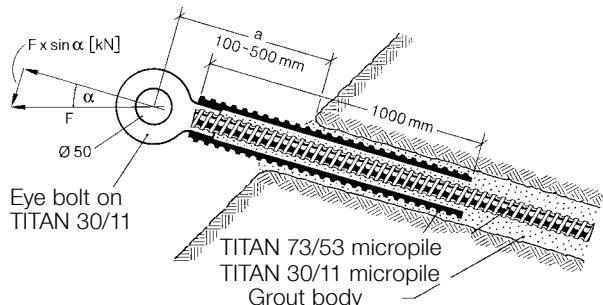
An unstable embankment more than 20 m high stabilised with soil nailing and secured with high-strength wire mesh.

## Examples of applications

### Embankment stabilisation and nailing

#### Pile head detail for inclined tension load

e.g. TITAN 30/11 micropile



$F \times \sin \alpha$  = inclined tension [kN]

$a$  [m] = projection of anchor eye fitting above ground  
(fixity)

$M_{Rd}$  = bending moment capacity of TITAN 73/53

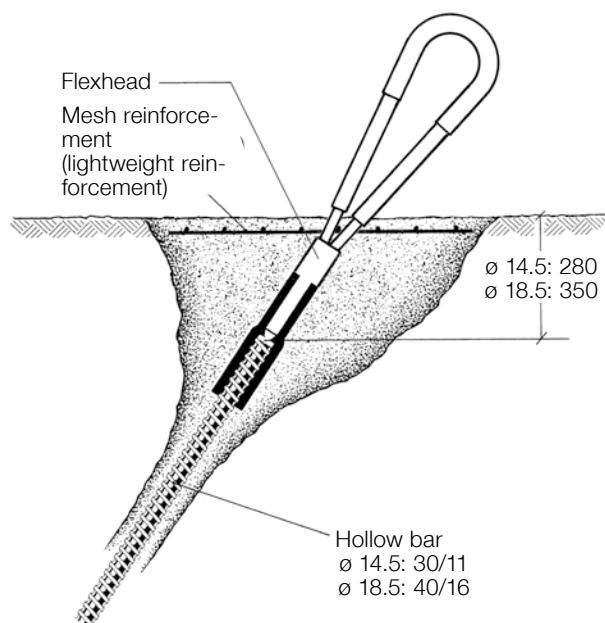
$M_{Ed}$  = actual bending moment (design value)

$$M_{Ed} = g_r \times F_k \times \sin \alpha \times a \leq M_{Rd}$$



Pile head detail with hot-dip galvanised **eye fitting** for holding wire ropes

#### Pile head detail with Flexhead (not part of ISCHEBECK range of products)



In the case of an overload, the hollow bar remains undamaged and the Flexhead is replaced.



**Flexhead** for fixing wire ropes

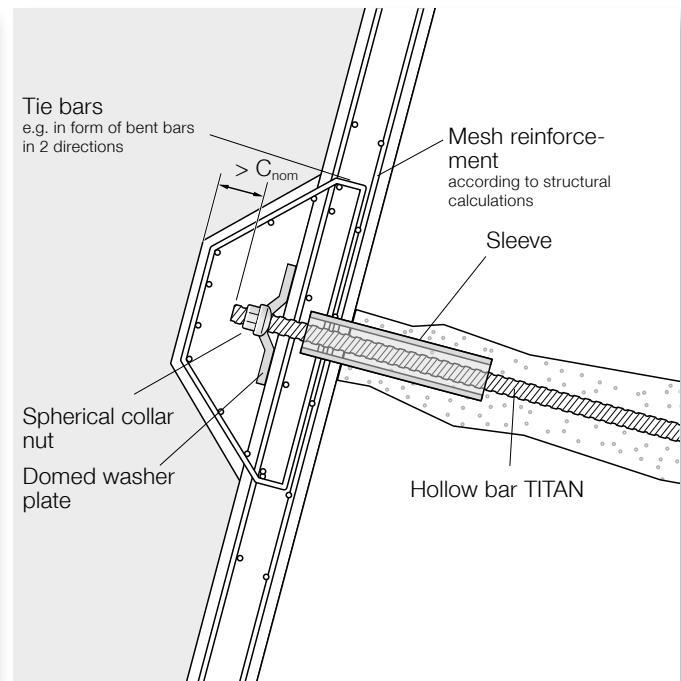
## Examples of applications

### Embankment stabilisation and nailing



#### Nailing with shotcrete facing

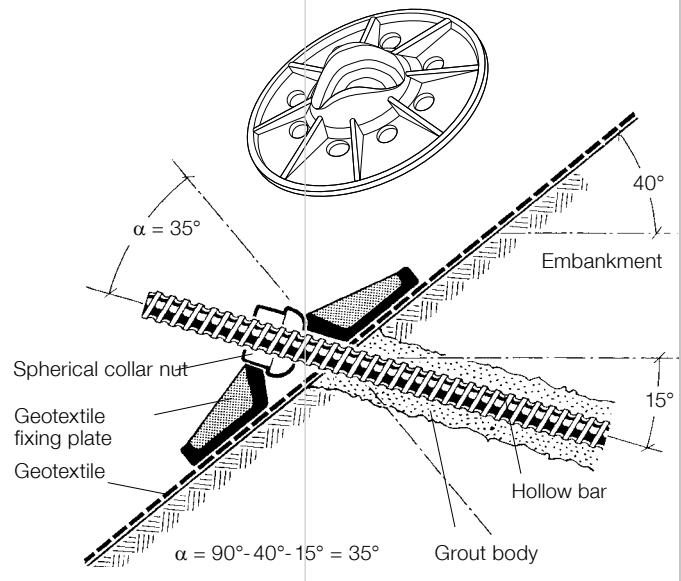
- Washer plate embedded in shotcrete
- 5° angle compensation with spherical collar nut



#### Large load distribution plate

The TITAN geotextile fixing plate is ideal for use with geotextiles and rubble stone walls:

- **Rounded edges** = much less risk of damage to geotextiles or plastic sheeting
- **285 mm diameter** = low bearing pressures (ideal for thin stone walls, for instance)
- **Integrated angle adaptor** = for differences in angles of up to 36° in all directions between pile axis and abutment
- **Galvanised** = permanent corrosion protection if left exposed

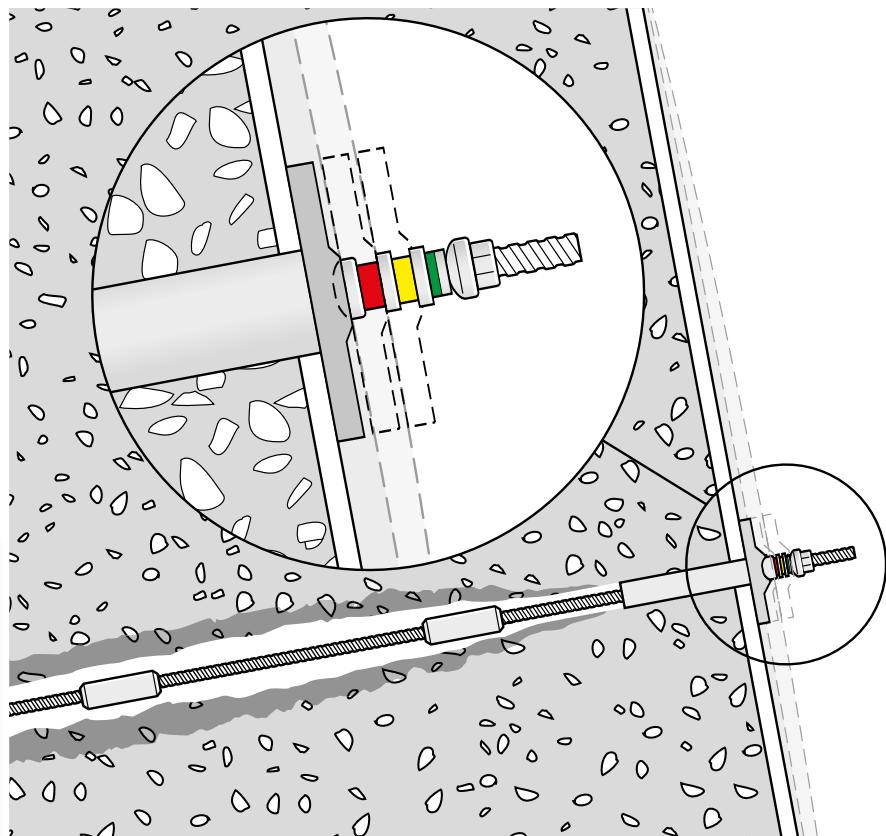


## Fast identification of load increases

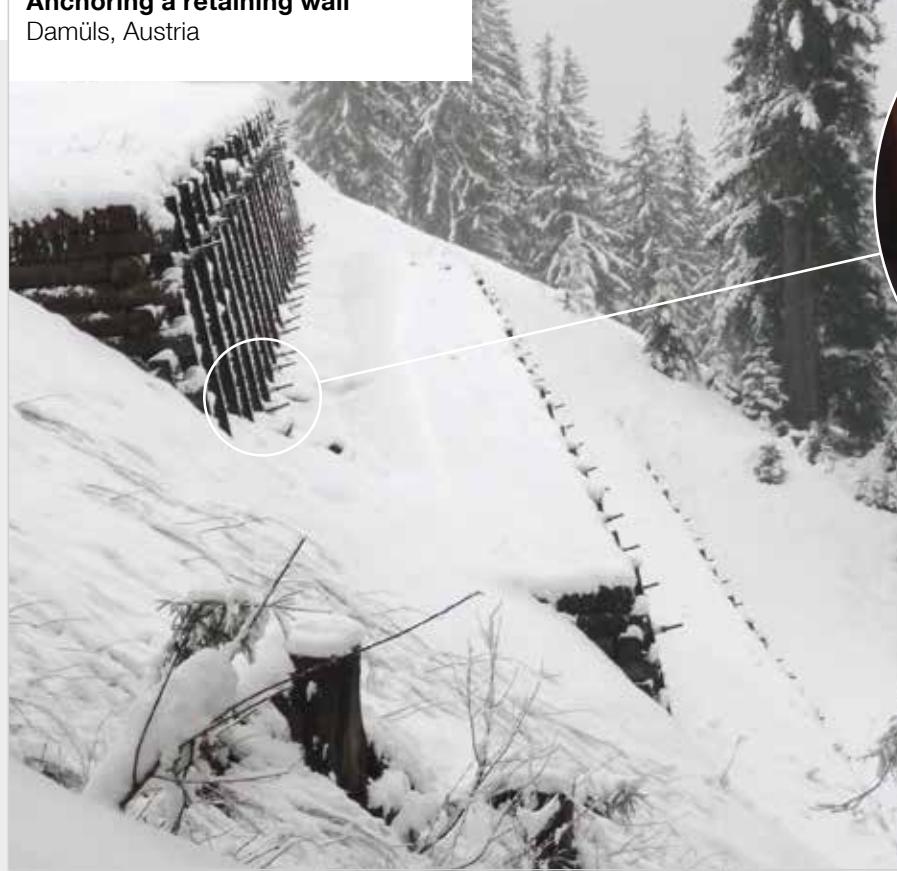
German Mining  
Inspectorate (LOBA)  
approval 18.24.6-28-4

The **load stage indicator (LSI)** is fitted to identify load increases and the associated deformations at an early stage. The LSI reveals load increases visually in three stages without the need for elaborate geodetic surveys.

- Three load stages  
70 kN - 160 kN - 180 kN (TITAN 30/11)  
200 kN - 300 kN - 400 kN (TITAN 40/16)
- Up to 30 mm deformation
- Can be checked visually at any time
- German Mining Inspectorate (LOBA) approval 18.24.6-28-4 (for TITAN 30/11)



**Anchoring a retaining wall**  
Damüls, Austria



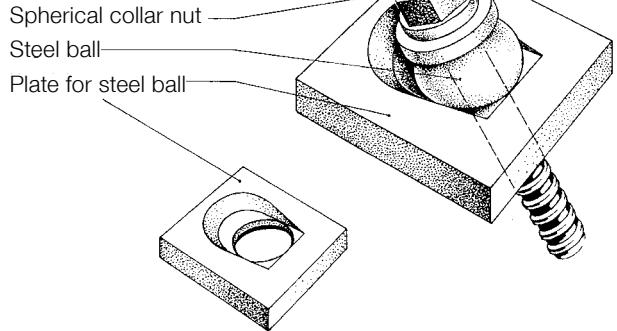
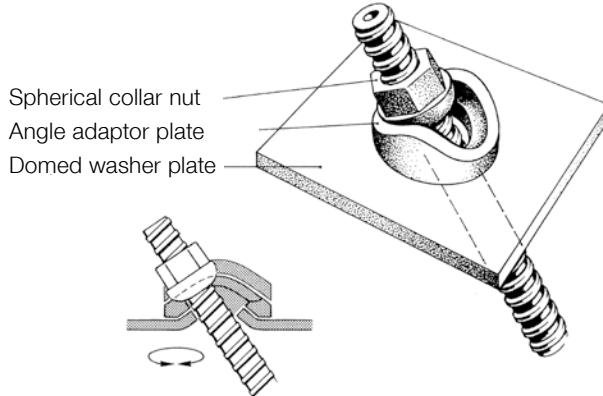
Simple visual inspection of deformations without geodetic surveys

**Steel ball with wafer plate for steel ball and O-ring**

Seal for HD-PE tube to protect the micropile against corrosion in the critical backfilling area behind the sheet pile wall. The HD-PE tube is inserted into the cement grout body.

**Easily centred pile head**

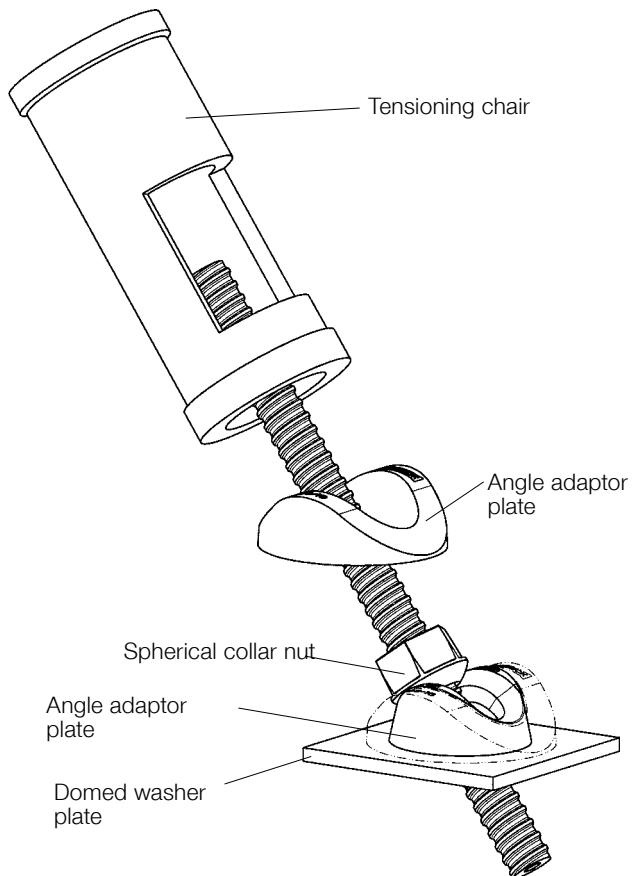
with spherical collar nut, steel ball with wafer plate for steel ball


**Self-centring angle adaptor plate** for domed washer plates


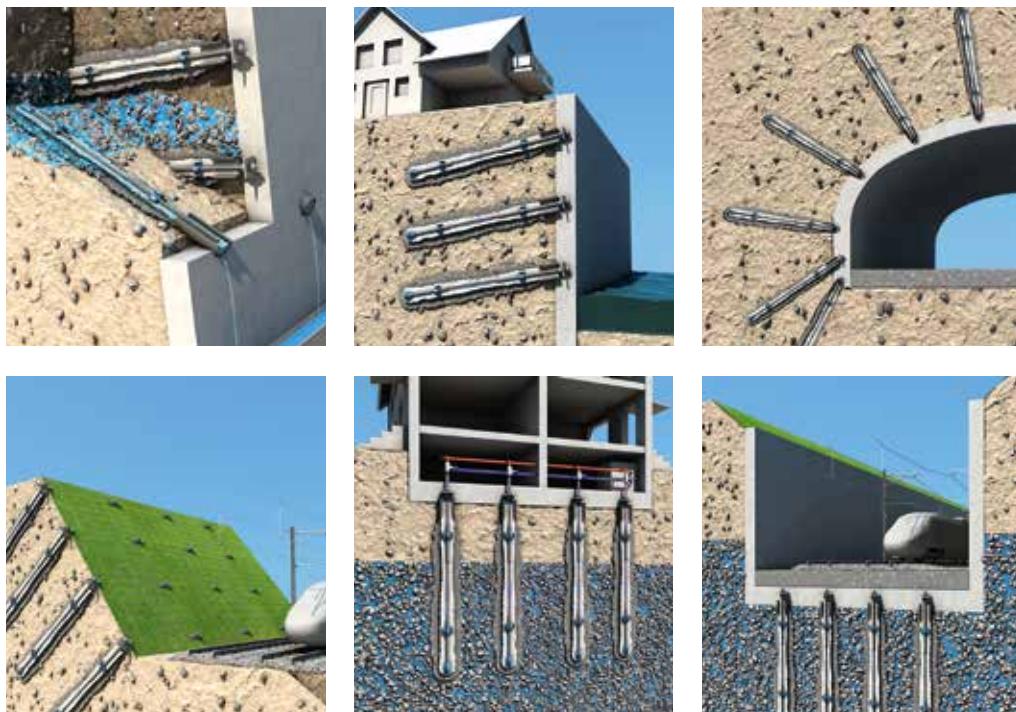
- For use together with domed washer plate
- Angle adaptor plate for angles of up to  $\pm 36^\circ$
- Self-centring, no additional on-site welding required



Differences in angle of up to  $+36^\circ$  between nail and terrain can be compensated for by fitting a self-centring TITAN angle adaptor plate (shown here with domed claw plate).

**Angle adaptor plate** for mounting on compensating washer as bearing for tensioning chair


TITAN micropiles are ideal for many applications, e.g. foundations, underpinning, soil nailing, anchoring retaining structures, tunnelling, etc.



Please refer to our TITAN micropile brochure for general information and analyses. Information on other potential applications can be found in our brochures on **slope stabilisation and nailing, foundations and underpinning, anchorages and tunnelling**:



The photos reproduced in this brochure represent momentary snapshots of work on building sites. It is therefore possible that certain facts and circumstances do not fully correspond to the technical (safety) requirements.

#### Falsework and Formwork systems



#### Trench lining systems



#### Geotechnical



Certified Management-System to DIN EN ISO 9001:2015

