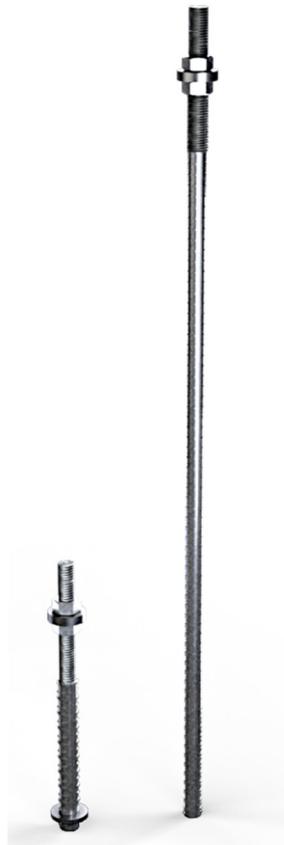


TECHNICAL MANUAL

ANCHOR BOLTS TN

Models: Short (TNC) and Long (TNL)

Version 04 (06/2025)



Contents

Contents	2
1. Introduction	3
2. System description	3
3. Dimensions and materials.....	4
3.1. Dimensions	4
3.2. Materials.....	5
4. Production	6
4.1. Environmental conditions	6
4.2. Tolerances	6
4.3. Quality Control.....	6
5. Capacities	7
6. Principles of use	9
7. Durability.....	22
8. Anchor bolt installation.....	23
8.1. Tolerances	24

1. Introduction

Anchor bolts are used to connect structural elements (mainly columns) to foundations (insulated footings, foundation slabs, pile caps, etc.) or to another concrete element (precast or in-situ wall, beam, etc.). Its main use is defined for precast concrete structures, being also suitable for fixing steel structures and machinery.

2. System description

The anchors transfer the forces generated in the structure to the foundation or other concrete element by anchoring them, either by anchoring by straight length or leg (long bolt TNL) or by concrete cone (short anchor bolt TNC). Anchor bolts are defined in two main groups:

- **TNC short version anchor:** ONLY for anchoring in concrete, DO NOT OVERLAP with reinforcing bars where the anchor is placed. Ideal for connections in foundations with reduced depths (footings, foundation slabs, wall crowning beams, etc.).

- **TNL long version anchor:** Allows anchoring of the element and, depending on conditions, OVERLAPPING with reinforcement of the area where the anchor is located. Ideal for connections such as column to column, in-situ wall columns, deep-set foundations, etc.

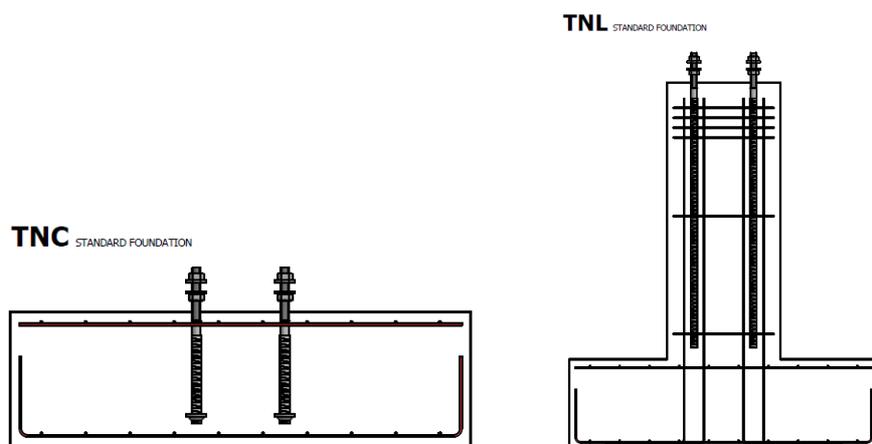
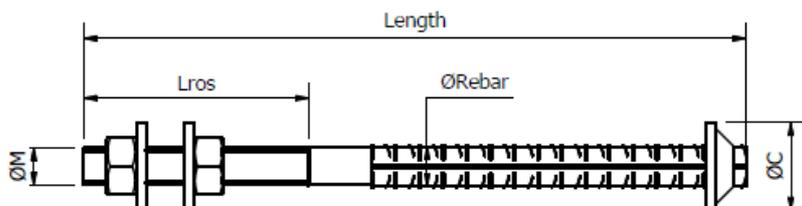


Figure 2.1 Examples of TN short and long anchor bolts

3. Dimensions and materials

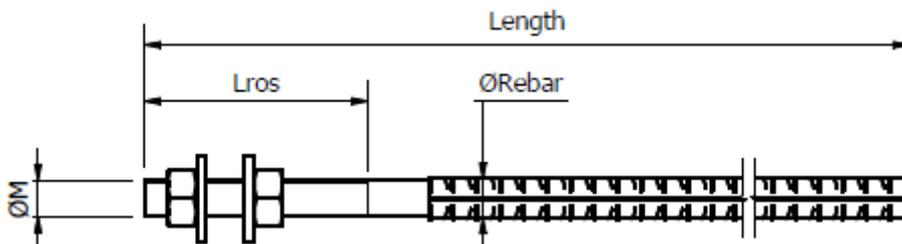
3.1. Dimensions

Short anchor bolt model: TNC



Code	Description	Lros	Length	ØM	ØRebar	ØC	Weight
TN20C	Short anchor M20	130 mm	330 mm	20 mm	20 mm	46 mm	1,11 kg
TN24C	Short anchor M24	145 mm	410 mm	24 mm	25 mm	56 mm	2,09 kg
TN30C	Short anchor M30	170 mm	520 mm	30 mm	32 mm	70 mm	4,31 kg
TN36C	Short anchor M36	180 mm	630 mm	36 mm	40 mm	90 mm	7,84 kg
TN39C	Short anchor M39	190 mm	700 mm	39 mm	40 mm	90 mm	9,26 kg

Long anchor bolt model: TNL



Code	Description	Lros	Length	ØM	ØRebar	Peso
TN20L	Long anchor M20	130 mm	1000 mm	20 mm	20 mm	2,78 kg
TN24L	Long anchor M24	145 mm	1200 mm	24 mm	25 mm	4,74 kg
TN30L	Long anchor M30	170 mm	1500 mm	30 mm	32 mm	10,25 kg
TN36L	Long anchor M36	180 mm	1700 mm	36 mm	40 mm	18,06 kg
TN39L	Long anchor M39	190 mm	2000 mm	39 mm	40 mm	21,67 kg

* Possibility of manufacturing anchor bolts upper length.
All anchors include two washers and two nuts

3.2. Materials

To produce the different elements described, the following materials are used:

- **Ribbed bar (Base material):**
 - Ribbed Bars $\varnothing 20$, $\varnothing 25$, $\varnothing 32$ and $\varnothing 40$ mm: B500B and B500SD
 - Yield strength: 500 N/mm².
 - Tensile ultimate strength: 550 N/mm².
- **Washers (all types):**
 - S275 JR (thickness less than 40 mm, according to EC-3):
 - Yield strength: 275 N/mm².
 - Tensile ultimate strength 430 N/mm².
- **Nuts (all types):**
 - Class 8 according to DIN934.

Tipo de acero		Acero soldable		Acero soldable con características especiales de ductilidad	
		B 400 S	B 500 S	B 400 SD	B 500 SD
Designación		B 400 S	B 500 S	B 400 SD	B 500 SD
Límite elástico, f_y (N/mm ²) ⁽¹⁾		≥ 400	≥ 500	≥ 400	≥ 500
Carga unitaria de rotura, f_s (N/mm ²) ⁽¹⁾		≥ 440	≥ 550	≥ 480	≥ 575
Alargamiento de rotura, $\epsilon_{u,5}$ (%)		≥ 14	≥ 12	≥ 20	≥ 16
Alargamiento total bajo carga máxima, $\epsilon_{m\acute{a}x}$ (%)	acero suministrado en barra	≥ 5,0	≥ 5,0	≥ 7,5	≥ 7,5
	acero suministrado en rollo ⁽³⁾	≥ 7,5	≥ 7,5	≥ 10,0	≥ 10,0
Relación f_s/f_y ⁽²⁾		≥ 1,08	≥ 1,08	$1,20 \leq f_s/f_y \leq 1,35$	$1,15 \leq f_s/f_y \leq 1,35$
Relación $f_y \text{ real}/f_y \text{ nominal}$		--	--	≤ 1,20	≤ 1,25

Table 4.1 Article 34 Chapter 8 of Código Estructural extract

Tipo	Espesor nominal t (mm)			
	$t \leq 40$		$40 < t \leq 80$	
	f_y	f_u	f_y	f_u
S 235	235	$360 < f_u < 510$	215	$360 < f_u < 510$
S 275	275	$430 < f_u < 580$	255	$410 < f_u < 560$
S 355	355	$490 < f_u < 680$	335	$470 < f_u < 630$
S 450	450	$550 < f_u < 720$	410	$530 < f_u < 700$

Table 4.2 Article 83 of Código Estructural extract

4. Production

The production process for the elements described above is as follows:

The ribbed bars are cut and peeled mechanically.

The threaded is made by lamination.

MAG welding by robot or by hand (for TNC short anchor bolts).

4.1. Environmental conditions

Standard anchor bolts are defined for dry and indoor conditions, surface treatment is not done (black). If other conditions are required, surface treatment, concrete cover, etc, should be checked accordingly.

In case of special requirements, please contact with NOXIFER'S technical department.

4.2. Tolerances

- Length: ± 10 mm

4.3. Quality Control

The quality control involve about materials and manufacturing method are conforming to the requirements of CE marking. NOXIFER has obtained CE marking: (Nr. 0370-CPR-1685).

5. Capacities

Anchor design bases:

- According to EN 1992-1-1:2004 (EC2)
- According to EN 1992-4:2018 (EC2)
- According to EN 1993-1-1:2005 (EC3)
- According to EN 1993-1-8:2005 (EC3)
- According to Código Estructural
- According to ETA-25/0122: TNC short anchor bolts

Anchor capacities (not differences between short or long)

	Anchor TN20	Anchor TN24	Anchor TN30	Anchor TN36	Anchor TN39
Thread	M20x2,5	M24x3	M30x3,5	M36x4	M39x4
Thread eff. section / equivalent eff. Ø	245 mm ² / 17,66 mm	352 mm ² / 21,17 mm	561 mm ² / 26,72 mm	816 mm ² / 32,23 mm	976 mm ² / 35,25 mm
Axial resistance N_{Rd} / N_{mRd} (1)	96,23 kN	138,56 kN	220,36 kN	321,03 kN	383,52 kN
Shear resistance V_{Rd} (2)	31,26 kN	45,04 kN	71,58 kN	104,12 kN	124,54 kN
Shear resistance V_{mRd}(3)	6,90 kN	10,80 kN	19,21 kN	30,91 kN	36,87 kN
Equivalence (4)	Ø16 / 201 mm ²	Ø20 / 314 mm ²	Ø25 / 491 mm ²	Ø25+Ø16 / 691mm ²	Ø32 / 804 mm ² Ø25+Ø20 / 805 mm ²
Wrench	30 mm	36 mm	46 mm	55 mm	60 mm
Joint thickness	50 mm	50 mm	50 mm	60 mm	60 mm

Table 5.1 Anchor bolt capacities

1) Maximum capacity for compression and tension in the threaded area according to EN1993-1-8: 2005.

2) Maximum shear capacity in threaded area for joint situation with filling performed, according to EN-1993-1-8: 2005; 3.6.1 Tb 3.4

3) Maximum shear capacity in threaded area for unfilled mounting situation, according to EN 1992-4:2018 7.2.2.3.2 (with lever arm). Shear values for standard joint thickness (depending on the use of NOXI column shoe, e.g. for TN30 + NOXI30; 50 mm joint)

4) Direct relation of capacities between threaded anchors and B500 ribbed bars, preliminary dimensioning.

The loads defined in the previous table are the maximums for their unique state, in reality combined cases of tension / compression with a shear state are defined, therefore, the combined situation of the actions must be checked to correctly verify the use of the anchor bolts.

Load combination:**Assembly situation (without filling the joint with mortar)**

When checking the connection in the pillar assembly phase, therefore, without filling the joint with mortar without shrinkage, the following inequality must be met:

$$\frac{N_{md}}{N_{mRd}} + \frac{V_{md}}{V_{mRd}} \leq 1$$

N_{md} = Axial design load (\pm) in bolt during assembly phase.

N_{mRd} = Axial design resistance of the anchor during assembly phase (Values from Table 5.1)

V_{md} = Shear design load on the anchor during assembly phase.

V_{mRd} = Shear design resistance of the anchor during assembly phase (Values from Table 5.1)

Final situation (with the joint filled with mortar):

In the final phase, with the joint filled with mortar, according to EC-3, the anchor bolts are checked with the following formula:

$$\frac{N_{Ed}}{1,4 \cdot N_{Rd}} + \frac{V_{Ed}}{V_{Rd}} \leq 1$$

N_{Ed} = Axial tensile design load in bolt during final phase.

N_{Rd} = Axial design resistance of the anchor during final phase (Values from Table 5.1)

V_{Ed} = Shear design load on the anchor during final phase.

V_{Rd} = Shear design resistance of the anchor during final phase (Values from Table 5.1)

For short anchors, a check load combination is also determined according to EN 1992-4-2:2018 with respect to the verification of the concrete anchors housing:

$$\left(\frac{N_{Ed}}{N_{Rd}}\right)^{1,5} + \left(\frac{V_{Ed}}{V_{Rd}}\right)^{1,5} \leq 1$$

N_{Ed} = Axial tensile design load in bolt during final phase.

N_{Rd} = Axial design resistance of the anchor during final phase (Values from Table 5.1)

V_{Ed} = Shear design load on the anchor during final phase.

V_{Rd} = Shear design resistance of the anchor during final phase (Values from Table 5.1)

6. Principles of use

Basic considerations:

The anchor bolts have been designed mainly for static loads, in the case of dynamic loads, higher safety factors must be considered for this purpose and each case must be analyzed.

To apply the maximum loads defined in the table of capacities, the separation conditions between anchors and distances to the edge of the element that houses the bolts (foundation, beam, column, etc.) must be accomplished.

Principles of design:

The connection has two phases, as has already been defined above, an initial preliminary phase without mortar in the joint (assembly phase) and the final phase with the joint filled with mortar without shrinkage (GROUT type).

In a typical connection, it is understood that there are at least four anchors, one for each corner of the column, and on this connection, there are the usual actions such as axial (either traction or compression), moment in both directions (deviated bending) and the corresponding shear.

The axial load generates a state of compression or direct traction on the anchors (for example, if we have a compression N_d with 4 anchors, each anchor will support a load of $N_d / 4$).

The moment (in each direction) will generate an axial compression and traction in each anchor according to the distance of separation between anchors (either in the x or Y direction), therefore, a moment M_x generates a state of compression and traction in the anchors in a magnitude according to the distance between the compression block center of gravity and the anchor axis (see sketch below).

The shear is applied at a distance L , which according to the EN 1992-4:2018 standard is determined as the summed distance of GROUT thickness plus eccentricities defined as half the thickness of the NOXI column sock plate or metal column base.

The resultant of the loads and their combinations generate a state of loads on the bolt that must be checked as defined in the formula on the previous page (assembly phase).

In the final phase, it is assimilated to a reinforced concrete section with a defined section (column section) and a reinforcement (anchor bolts). The check to be carried out is the same as for said concrete section, which determines a direct equivalence between the capacity of an anchor bolt and a defined ribbed bar (for example, a TN30 bolt = $\varnothing 25$ ribbed bar).

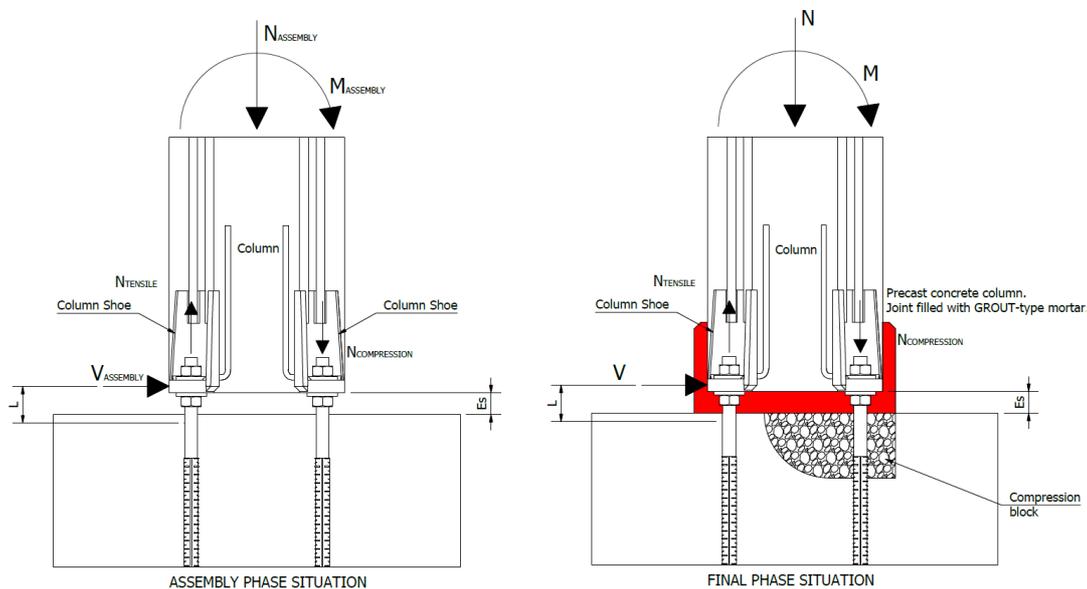


Figure 6.1 Actions on the column in assembly and final phase

Use anchors considerations:

Long anchors TNL:

Long anchors do not have a specific use restriction, the prescriptions defined in the corresponding regulations (EC-2) for anchors of ribbed bars must be followed, taking into account:

- Type of concrete.
- Bar position during concreting (good or bad adherence).
- Coating by type of environment structure.
- Arrangement of transverse reinforcement in overlap area.
- Overlap length in case to be checked.
 - Tables have been defined according to the type of long bolt for standard measurements with the corresponding limitations according to the conditions described in the EC-2 standard.
 - For each long anchor bolt, its compliance or not is determined for the cases of overlapping and parameters according to EC-2.

Usage table for long bolt TN20L.

Anchor validation according to conditions.

Total bolt length 1000 mm, outside concrete area 115 mm.

Actual anchor length inside concrete = 885 mm

% Tensile overlapping bars in relation to the total Steel section.	C25/30			C30/37			C35/45			C40/50		
	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Percentage (%)	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Ls (Position I)	YES	YES	YES									
Ls (Position II)	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES

- In case of non-compliance, a longer anchor should be used depending on the project conditions (*consult with NOXIFER technical department*).
- Verification fulfilling EN1992-1-1:2004.
- The tables are determined by the following conditions:
 - Concrete cover factor: $\alpha_2 = 0.9$.
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.9$

Usage table for long bolt TN24L.

Anchor validation according to conditions.

Total screw length 1200 mm, outside concrete area 130 mm.

Anchor real length inside concrete = 1070 mm

% Tensile overlapping bars in relation to the total Steel section.	C25/30			C30/37			C35/45			C40/50		
	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Percentage (%)	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Ls (Position I)	YES	YES	YES									
Ls (Position II)	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES

- In case of non-compliance, a longer anchor should be used depending on the project conditions (*consult with NOXIFER technical department*).
- Verification fulfilling EN1992-1-1:2004.
- The tables are determined by the following conditions:
 - Concrete cover factor: $\alpha_2 = 0.9$.
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.9$

Usage table for long bolt TN30L.

Anchor validation according to conditions.

Total bolt length 1500 mm, exterior concrete area 150 mm.

Anchor real length inside concrete = 1350 mm

% Tensile overlapping bars in relation to the total Steel section.	C25/30			C30/37			C35/45			C40/50		
	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Percentage (%)	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Ls (Position I)	YES	YES	YES									
Ls (Position II)	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES

- In case of non-compliance, a longer anchor should be used depending on the project conditions (*consult with NOXIFER technical department*).
- Verification fulfilling EN1992-1-1:2004.
- The tables are determined by the following conditions:
 - Concrete cover factor: $\alpha_2 = 0.9$.
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.9$

Usage table for long bolt TN36L.

Anchor validation according to conditions.
Total bolt length 1700 mm, exterior concrete area 170 mm.

Anchor real length inside concrete = 1530 mm

% Tensile overlapping bars in relation to the total Steel section.	C25/30			C30/37			C35/45			C40/50		
	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Percentage (%)	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Ls (Position I)	YES	YES	YES									
Ls (Position II)	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES

- In case of non-compliance, a longer anchor should be used depending on the project conditions (*consult with NOXIFER technical department*).
- Verification fulfilling EN1992-1-1:2004.
- The tables are determined by the following conditions:
 - Concrete cover factor: $\alpha_2 = 0.9$.
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.9$

Usage table for long bolt TN39L.

Anchor validation according to conditions.
Total bolt length 2000 mm, exterior concrete area 180 mm.

Anchor real length inside concrete = 1820 mm

% Tensile overlapping bars in relation to the total Steel section.	C25/30			C30/37			C35/45			C40/50		
	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Percentage (%)	33	50	>50	33	50	>50	33	50	>50	33	50	>50
Ls (Position I)	YES	YES	YES									
Ls (Position II)	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES

- In case of non-compliance, a longer anchor should be used depending on the project conditions (*consult with NOXIFER technical department*).
- Verification fulfilling EN1992-1-1:2004.
- The tables are determined by the following conditions:
 - Concrete cover factor: $\alpha_2 = 0.9$.
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.9$

TNC short anchors:

The short anchors present a geometry and operation that demands certain requirements to be considered for their correct use.

The efforts that anchor bolt can support must be transferred to the concrete where are placed in, this transfer is made through the ribbed area of the anchor (insufficient due to its short length) and the bottom head that generates the anchor cone in the concrete.

For the correct functioning of the concrete cone, geometric conditions of the area in which it is placed must be fulfilled. If any condition isn't fulfilled, it must be solved with additional reinforcement in the defined area.

The basic geometric conditions to be fulfilled are the following:

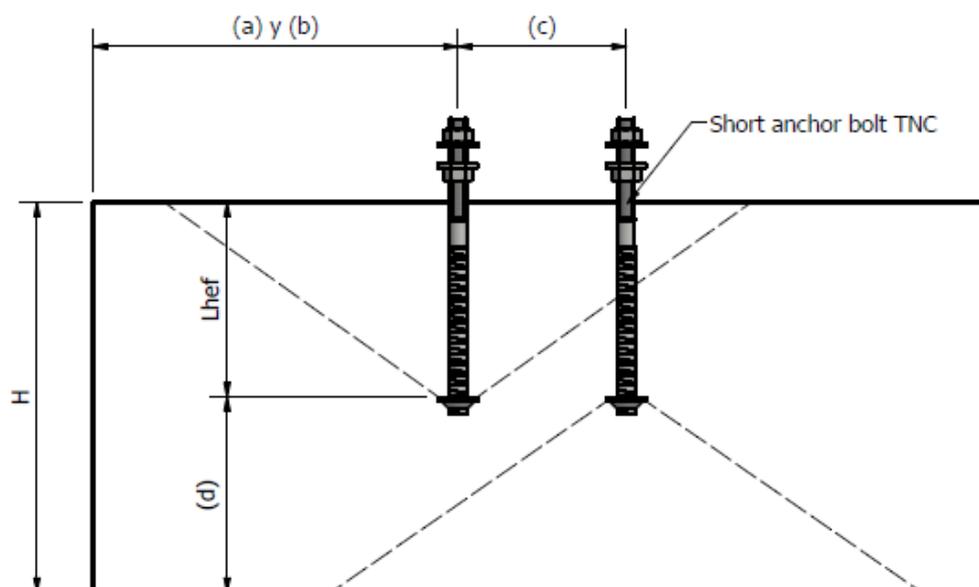


Figure 6.2 Basic geometric conditions

The verification of the minimum geometry is carried out according to article 6.7 (partially loaded areas) of the EN-1992-1-1: 2004 (EC-2) standard.

- **Foundation edge distance (a) ≥ 10 times the metric (10xM).**
 - If the distance is less, additional reinforcement is required.
 - For example, TN30C case, reference distance is $10 \times 3 = 30$ cm.
- **Unbridgeable minimum edge distance (b) ≥ 3.1 times the metric (3.1xM).**
 - This distance is to accommodate the homothetic area A_{c1} that generates the concentrated load of the bottom head.
 - For example, case TN30C, minimum distance of $3.1 \times 3 = 9.30$ cm
- **Minimum distance between bolt centers (c) ≥ 6 times the metric, (6xM).**
 - Value is defined by twice the previous minimum distance.
 - For example, TN30C case, minimum distance of $6 \times 3 = 18$ cm.
- **Lower minimum distance (d) ≥ 5 times the metric (5xM).**
 - Lower punching distance due to compression loads on the bolt. If not, additional reinforcement must be provided.
 - For example, for TN30C, measure of 150 mm = minimum shoe edge of 500 mm (counting 350 mm of L_{hef}).

Reinforcement for long anchors TNL:

In the case of long anchors, the required reinforcement will be based on the need of each case, for example, in cases the anchor long bolt TNL and its overlapping with main reinforcement of concrete element where bolts are placed.

According to EC-2 article 8.7.4, a transversal reinforcement in the overlapping zone (A_{st}) is defined for such use and it is defined:

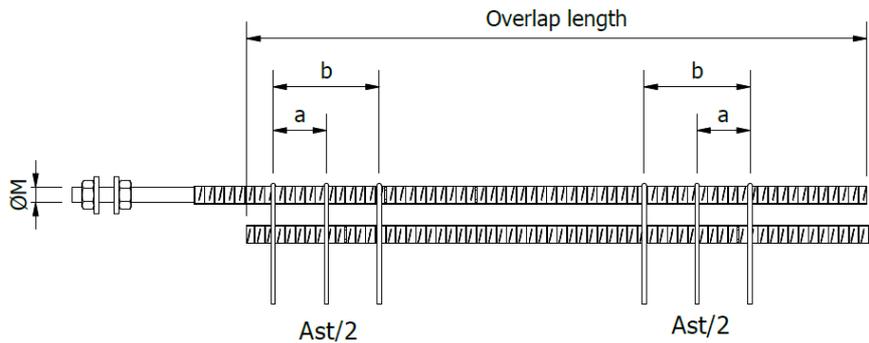


Figure 6.3 Overlapping dimensions and transverse reinforcement

Value $a \leq 150$ mm.

Value $b = \text{Overlap length} / 3$

Anchor TN20L; $A_{st} = 201 \text{ mm}^2$ (4 $\emptyset 8$) ($A_{st}/2 = 2\emptyset 8$)

Anchor TN24L; $A_{st} = 314 \text{ mm}^2$ (8 $\emptyset 8$) ($A_{st}/2 = 4\emptyset 8$)

Anchor TN30L; $A_{st} = 491 \text{ mm}^2$ (10 $\emptyset 8$) ($A_{st}/2 = 5\emptyset 8$)

Anchor TN36L; $A_{st} = 691 \text{ mm}^2$ (14 $\emptyset 8$) ($A_{st}/2 = 7\emptyset 8$)

Anchor TN39L; $A_{st} = 804 \text{ mm}^2$ (16 $\emptyset 8$) ($A_{st}/2 = 8\emptyset 8$)

This transverse reinforcement is for each overlap, if it is a column with four anchors, the stirrup will serve for the four anchors, in the case of having six anchors, stirrups must be provided to close the central anchors.

In the case of column-to-column connections or on wall pilasters, where the surface of the element that has the long anchor has a section equal to or similar to the section of the column, a transversal reinforcement derived from the forces that are transferred must be considered.

Reinforcement for short anchors TNC:

In the case of short anchors, the restrictions or considerations of use, are higher and therefore more cases where additional reinforcement will be required.

As a general recommendation, a certain reinforcement should be provided on the upper face in order to ensure a certain “anchoring” of the generated concrete cone (usually in the case of tensioned bolts) where significant efforts are generated and it is convenient to give some ductility to the concrete.

This upper reinforcement can be solved with an upper mesh, as described in the following figure, or with ribbed bars with the same capacity arranged in the area near the anchor bolt.

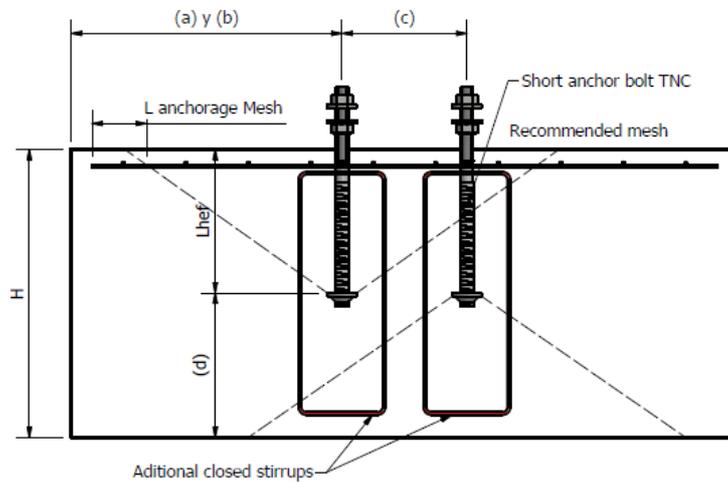


Figure 6.4 Additional reinforcement (foundation)

Upper mesh / reinforcement according to anchors:

- Anchor bolt TN20C; $A_{Mesh} = 138 \text{ mm}^2$ (two directions = mesh 25x25Ø8)
- Anchor bolt TN24C; $A_{Mesh} = 210 \text{ mm}^2$ (two directions = mesh 20x20Ø8)
- Anchor bolt TN30C; $A_{Mesh} = 330 \text{ mm}^2$ (two directions = mesh 15x15Ø8)
- Anchor bolt TN36C; $A_{Mesh} = 576 \text{ mm}^2$ (two directions = mesh 10x10Ø10)
- Anchor bolt TN39C; $A_{Mesh} = 576 \text{ mm}^2$ (two directions = mesh 10x10Ø10)

If minimum geometric requirements (side or bottom) aren't fulfilled:

Additional extra reinforcement (according to figure page before)

- Anchor TN2C; $A_{st} = 201 \text{ mm}^2$ (2 stirrups Ø8)
- Anchor TN24C; $A_{st} = 314 \text{ mm}^2$ (4 stirrups Ø8 o 2 stirrups Ø10)
- Anchor TN30C; $A_{st} = 491 \text{ mm}^2$ (4 stirrups Ø10)
- Anchor TN39C; $A_{st} = 691 \text{ mm}^2$ (4 stirrups Ø12 o 2 stirrups Ø16)
- Anchor TN39C; $A_{st} = 804 \text{ mm}^2$ (4 stirrups Ø12 o 2 stirrups Ø16)

The function of these stirrups is to "fix" the concrete cone, which, due to some limitation (mainly geometric), cannot transfer the anchoring effort to the rest of the element (foundation, etc.), therefore, this reinforcement is the one in charge of carrying out this

function. The capacity of the reinforcement must be equal to or greater than the maximum tension of the tensioned anchor.

It may be the case of arranging the short anchors in a reduced section, such as a column or beam, to generate a rigid connection beam to column, etc. In these cases, the defined minimum distance of $3.1 \times M$ (value of b) must be considered.

With this, an additional reinforcement is defined according to the figure:

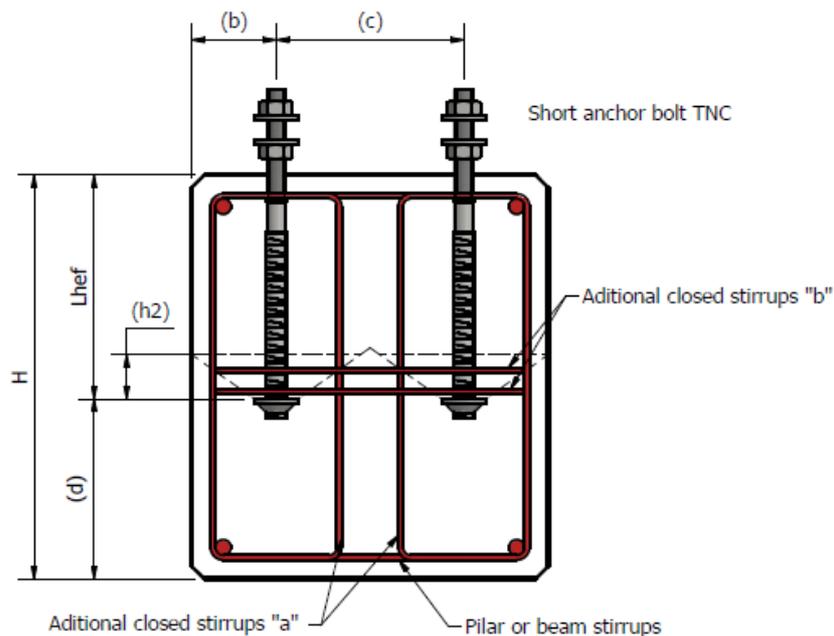


Figure 6.5 Additional reinforcement (beam)

Closed stirrups "a" are defined by the previous values.

Closed stirrups "b":

- Anchor TN20C; $A_{st} = 29 \text{ mm}^2$ (1Ø8)
- Anchor TN24C; $A_{st} = 40 \text{ mm}^2$ (1Ø8)
- Anchor TN30C; $A_{st} = 68 \text{ mm}^2$ (2Ø8)
- Anchor TN36C; $A_{st} = 120 \text{ mm}^2$ (3Ø8)
- Anchor TN39C; $A_{st} = 120 \text{ mm}^2$ (3Ø8)

Depending on the tensile load of each bolt, type of concrete (C20/25, etc.) and the anchoring conditions, the responsibility of the cone area can be variable, with which the limitations can be reduced, in such cases, consult the NOXIFER's technical department.

7. Durability

The elements embedded in the concrete are ribbed bars B500S/SD, to guarantee their adherence between both materials, and is defined by the structural Standard EC-2 (B500B and B500C respectively).

The environment defined for the structure (either in its entirety or by zones), must be assimilated for the bolted connection with the elements described, therefore, its design must be taken into account to know the requirements of each case.

For long TNL anchors, the durability condition is determined by the coating that is determined in the EC-2 standard.

For the short TNC anchors, the same criteria are defined as for the long bolt, but the requirements described above (minimum dimension of $3.1 \times M$) are more unfavorable, therefore the most demanding concrete covers are generally met.

The outer part (threaded area) must be taken into account due to the issue of durability. In most cases, the threaded connection is protected with the joint filling mortar (effective coating with mortar without shrinkage), but, depending on the case, a surface finish should be considered according to requirements (hot galvanized, stainless, etc. .)

The requirement for metallic elements is defined by the degree of corrosion according to EC-3.

8. Anchor bolt installation

For the installation of the anchor bolts, the following preliminary steps must be taken into account:

- Check that the type of anchor bolt is correct according to the plans of the Project:
 - Short or long typology.
 - Bolt capacity or bolt model (20, 24, 30, 36 or 39).
- Verify what type of bolt selected can be placed in the concrete element to be executed (foundation footing according to edge, concrete slab, pile cap or micropiles, gravitational wall, pilaster, etc.)
 - It is important that the anchor selection has been made correctly as defined in this document (distance to edges, anchor length, additional reinforcement, etc.).
- Using a placement template to:
 - Determine a fixed position of all the anchors available for a column (for example, a template for a 50x50 column, with more than four anchors, etc.).
 - Reference the position of the group of anchors with respect to some axes of the column so that the subsequent assembly of the column is carried out in the correct position according to construction drawings.
 - Prevent these anchors from moving during the concreting phase, so the template must be fixed avoiding any movement during pouring of concrete.

8.1. Tolerances

8.1.1. Geometrical measures of installation

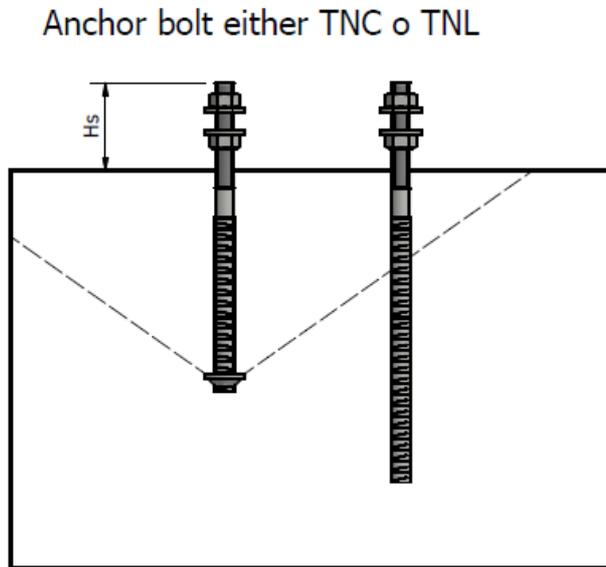


Figure 8.1 Geometric placing dimensions

Hs value according to model (for the case of connections with NOXI column shoes):

Anchor bolt TN20; Hs = 115 mm; 11.5 cm.
Anchor bolt TN24; Hs = 130 mm; 13.0 cm.
Anchor bolt TN30; Hs = 150 mm; 15.0 cm.
Anchor bolt TN36; Hs = 170 mm; 17.0 cm.
Anchor bolt TN39; Hs = 180 mm; 18.0 cm.

In the case of connection with a steel structure or fixing of machinery, the Hs dimension may vary depending on the design of the connection itself. In this case, consult the NOXIFER technical department.

8.1.2. Installation tolerances

- The tolerances are very reduced, especially in the bolt plane. The tolerance is determined by the difference between the base plate hole of NOXI column shoes or hole in the metal base plate and the diameter of the anchor bolt. For example, if the hole is 40mm, for the TN30 anchor bolt (short or long) with diameter of 30mm, the tolerance is ± 5 mm.

- The height tolerance, in reference to the previous Hs measurement, depends on the element to be connected with the anchor bolts. In the case of a steel column with a plate of a certain thickness, it will depend on that thickness, but it is preferable that the bolt is higher than low. Depending on the case, NOXIFER technical department should be consulted.

8.1.3. Installation template

- It is the most important element for the installation of the anchor bolts on site, its correct placement and possible tolerances of the system depend on this element.
- There are several types of templates, but several aspects must be considered:
 - Rigidity of the template: It must maintain its structural integrity to be able to guarantee that the weight of the bolts doesn't deform it, as well as situations in which the reinforcement of foundation or similar can "force" the "movement" of anchor bolts (interferences with reinforcement placed).
 - Allow the filling and vibrating of concrete in the area where the anchor bolts will be housed.
 - Protect the thread during concreting. If threaded zone of anchor bolt is clean, the assembling process with column (concrete or steel) will be OK.

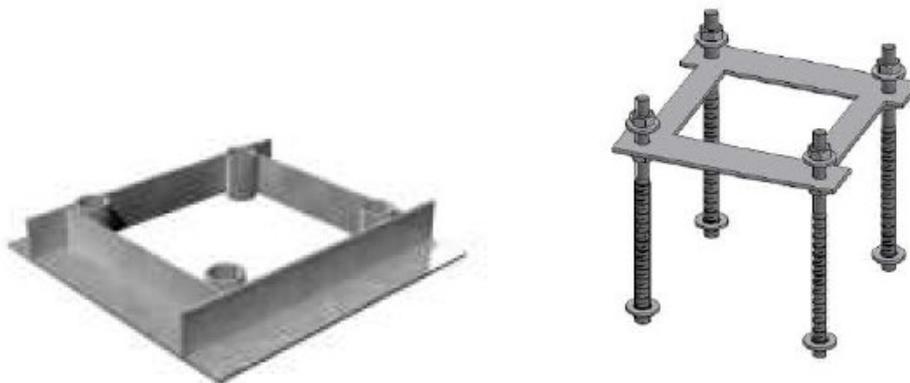
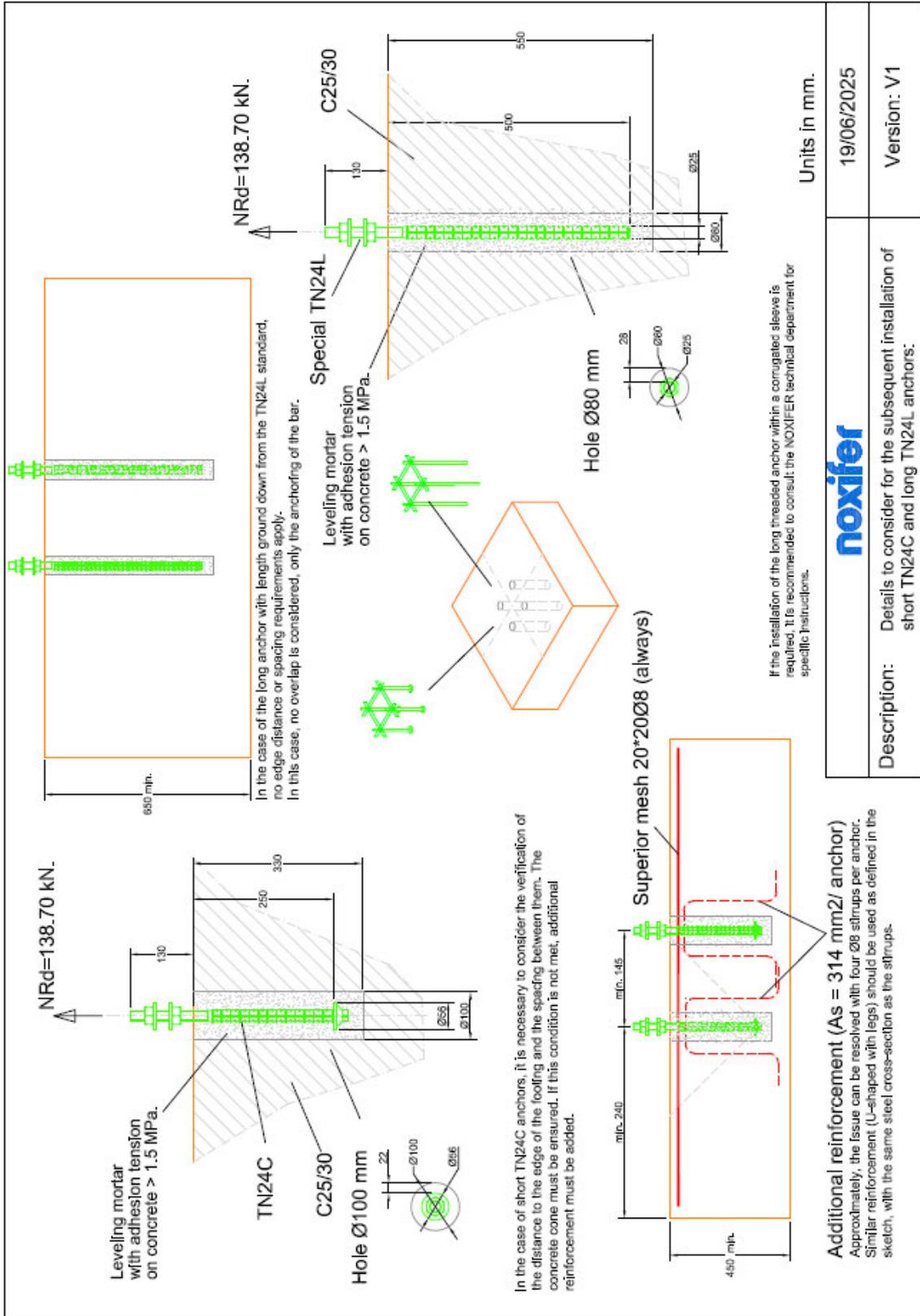


Figure 8.2 Examples of installation templates

8.1.4. Installation after casting

- In this section, several details are defined for the placement of the anchors once the concreting of the support has been carried out (foundation, beam, etc.).
- It also defines the previous options to be taken into account to leave the foundation or beam ready to be able to arrange the anchors later, for whatever circumstance (material not available on site, circulation of heavy machinery in the construction phase, etc.).
- Details are described for the five types of anchors that have been described in this manual:
 - Installation for anchor bolt TN20.
 - Installation for anchor bolt TN24.
 - Installation for anchor bolt TN30.
 - Installation for anchor bolt TN36.
 - Installation for anchor bolt TN39.

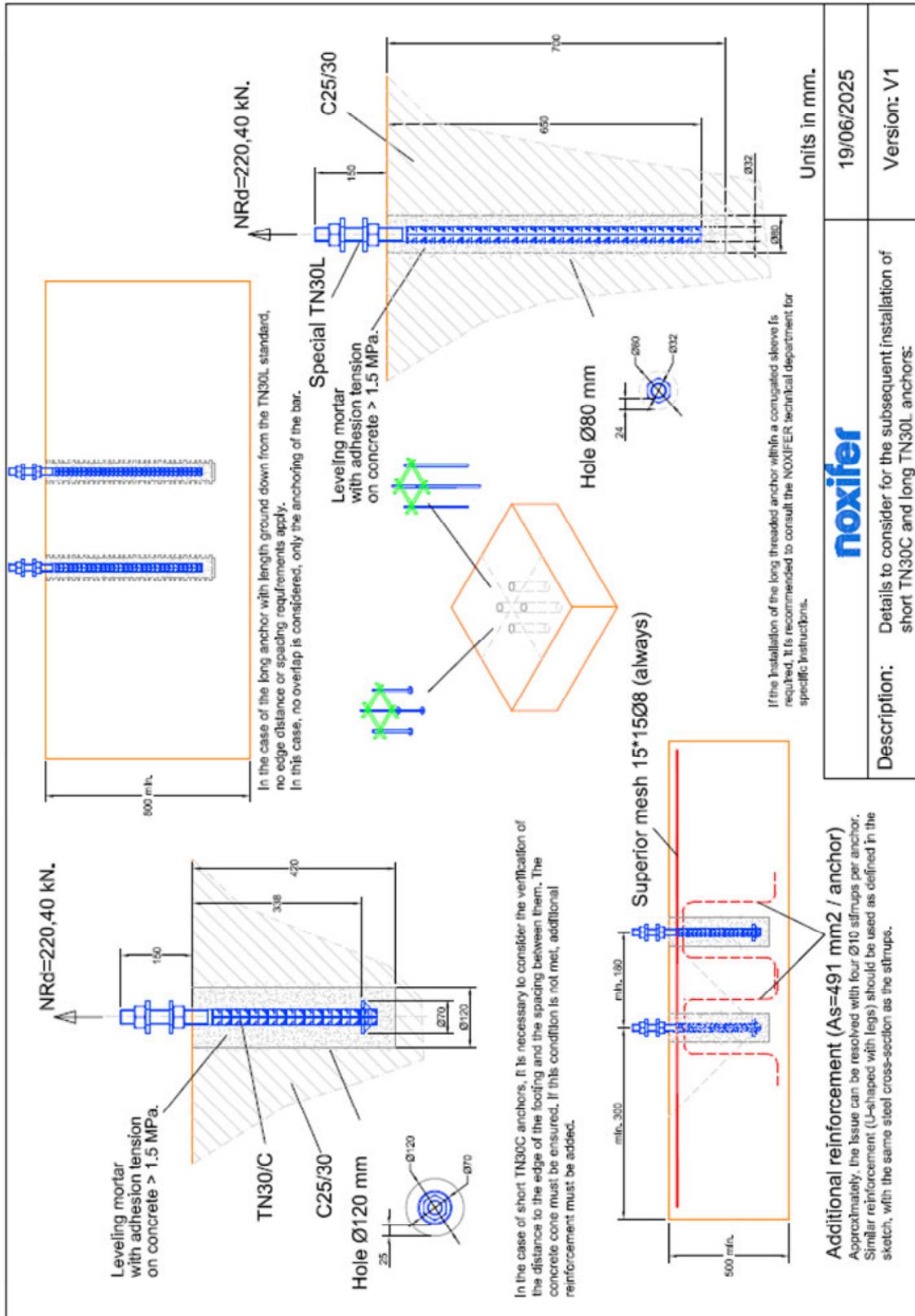


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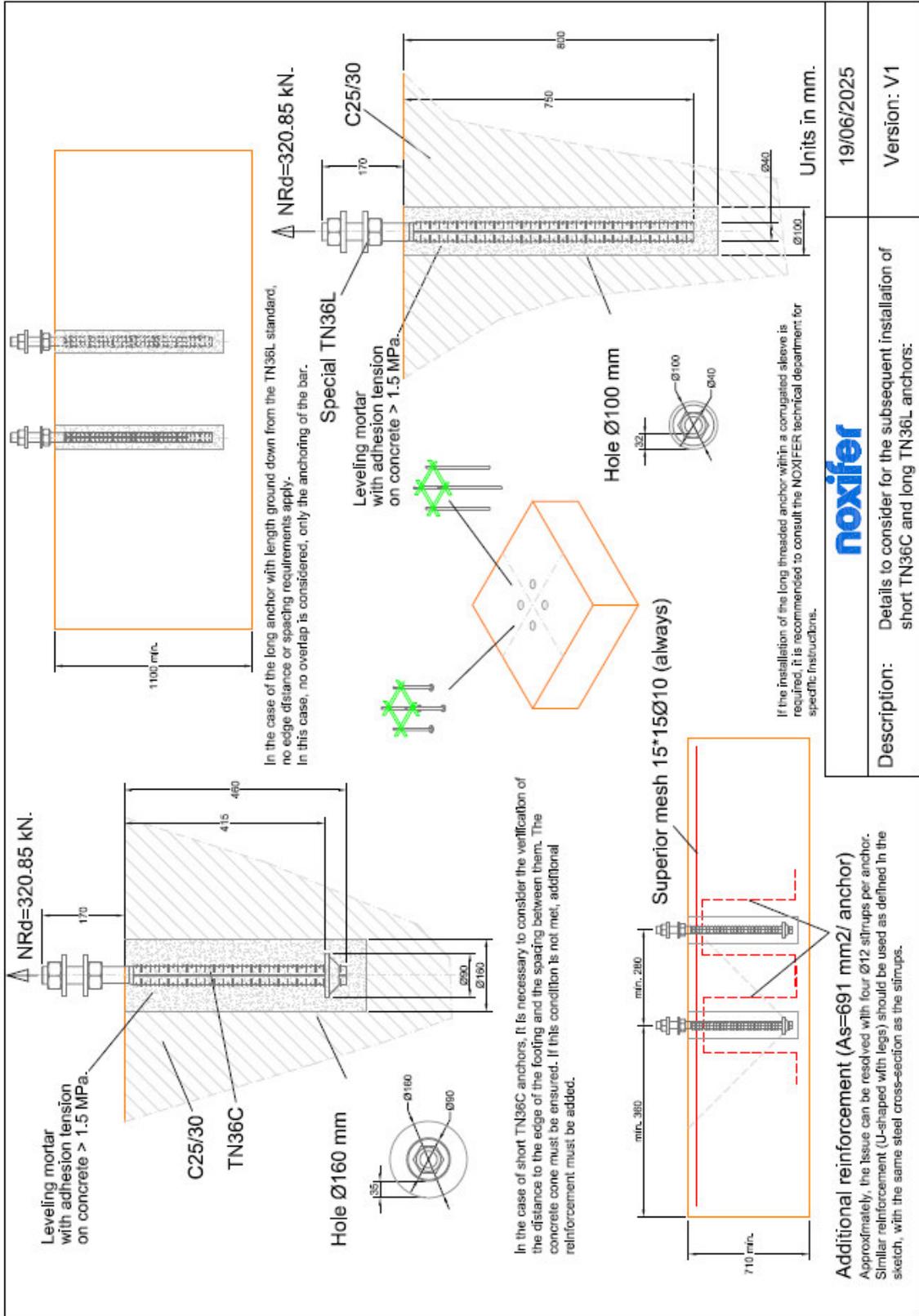
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Description: Details to consider for the subsequent installation of short TN24C and long TN24L anchors:



Units in mm.

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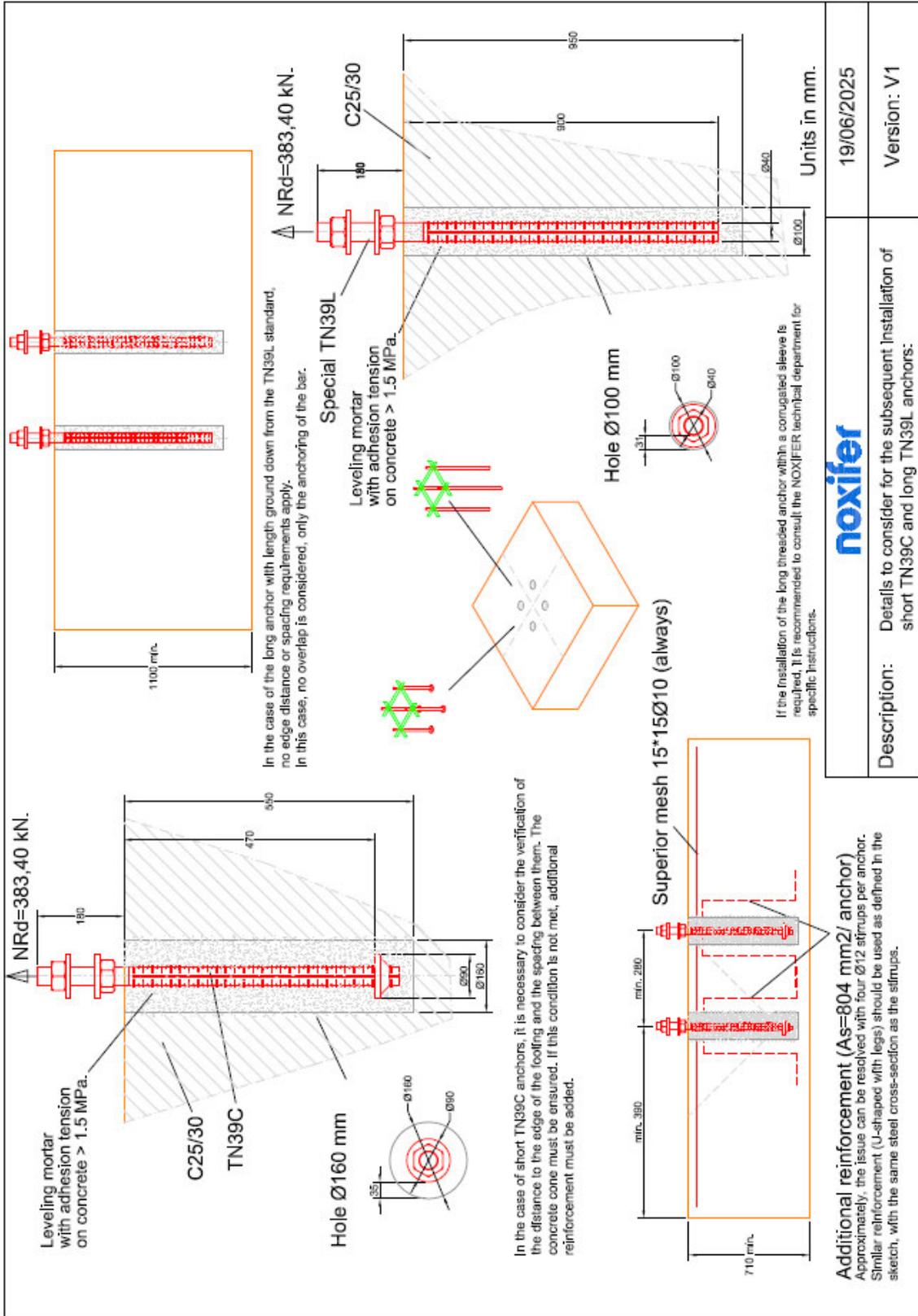


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Description: Details to consider for the subsequent installation of short TN36C and long TN36L anchors:

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Description: Details to consider for the subsequent installation of short TN39C and long TN39L anchors:

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