

USER MANUAL

NOXI COLUMN SHOE

Models: NOXI20, NOXI24, NOXI30, NOXI36, NOXI39.

Version 01 (05/2025)



Contents

1. Introduction.....	3
2. System description	3
3. Dimensions and materials.....	4
3.1. NOXI Column Shoes dimensions	4
3.2. Materials.....	6
4. Production	6
4.1. Surface finishing.....	7
4.2. Tolerances	7
4.3. Quality control	7
5. Capacities.....	8
6. Principles of use	12
6.1. Basic considerations.....	12
6.2. Design principles	12
6.3. Usage conditions for Column Shoes.....	14
6.4. Additional reinforcement	21
7. Durability.....	38
8. Fire resistance	40
9. NOXI Column Shoe placement.....	41
9.1. Considerations	43
9.1.1. Geometric measurements of installation	43
9.1.2. Installation tolerances	45
9.1.3. Wrench for tightening the bolts inside the NOXI Column Shoe:.....	51



1. Introduction

NOXI Column Shoes are designed to transfer the forces applied on the column (usually precast concrete) to the foundation or another element using TN Anchor Bolts. These column shoes are embedded in the concrete column as described in this document.

2. System description

The Column Shoes define a geometry in which an open box can be distinguished at the base (area where the Anchor Bolt will be located) and, welded to this metal box, steel rebars by means of which the column shoes are anchored in the concrete.

The complete connection of TN Anchor bolt and the NOXI Column Shoes is defined as a rigid connection that can transfer tension loads (compression and/or traction), bending moments (torque or concrete section with compression block and traction = reinforcement, and horizontal forces such as the shears that are generated).

The connection has two phases in which the performance is somewhat different. The first phase in which the filling mortar has not been arranged and the final phase with the mortar already hardened.

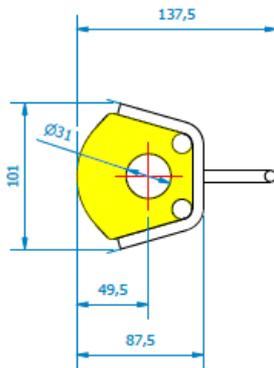
The total connection is defined with the two main elements, the TN Anchor Bolt and the NOXI Column Shoe.



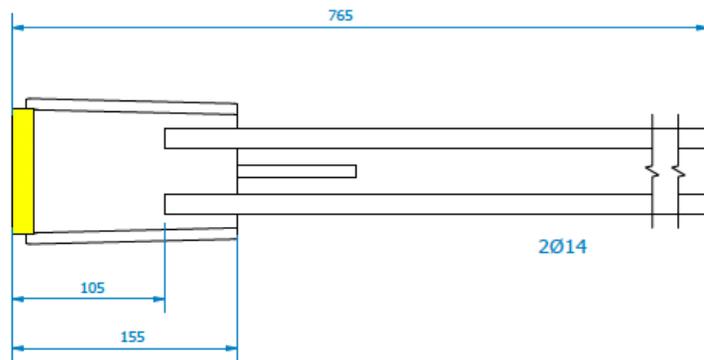
Figure 2.1 Examples of use: Case of connection to foundation and connection between columns

3. Dimensions and materials

3.1. NOXI Column Shoes dimensions

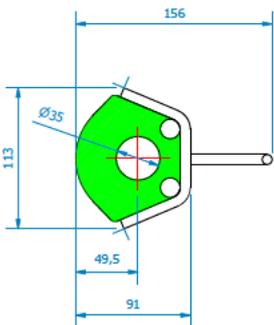


NOXI20 Column Shoe

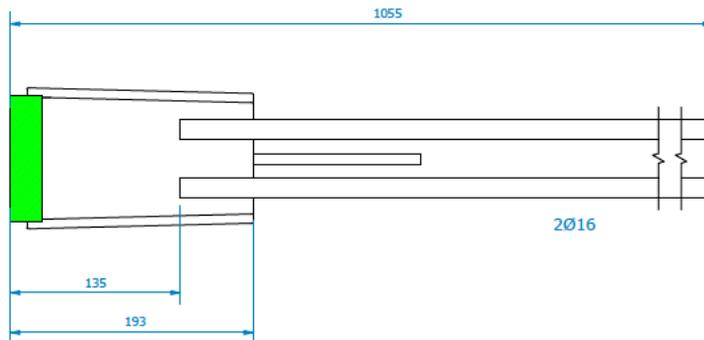


Associated Anchor Bolt: TN20C / TN20L

Weight: 3,74 kg

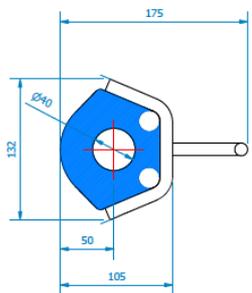


NOXI24 Column Shoe

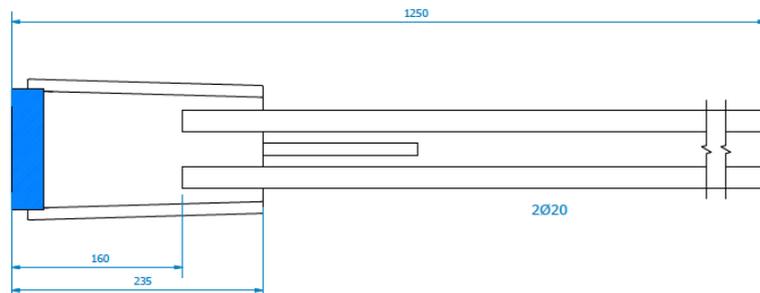


Associated Anchor Bolt: TN24C / TN24L

Weight: 5,92 kg

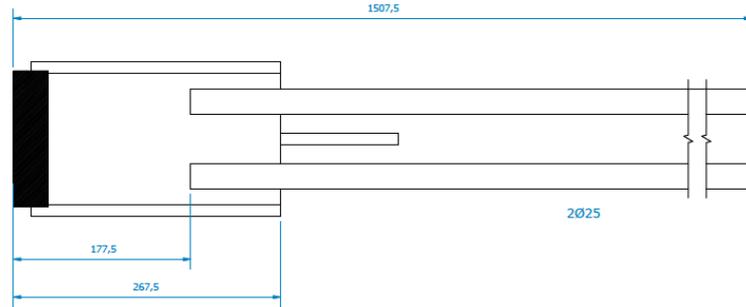
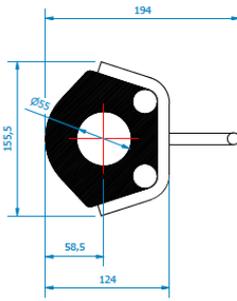


NOXI30 Column Shoe



Associated Anchor Bolt: TN30C / TN30L

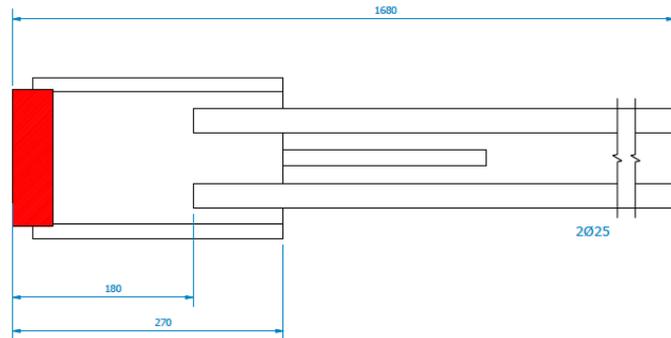
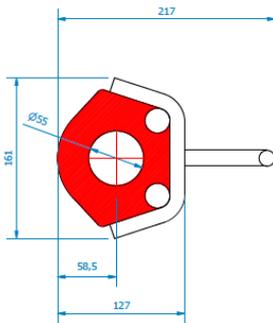
Weight: 11,02 kg



NOXI36 Column Shoe

Associated Anchor Bolt: TN36C / TN36L

Weight: 18,78 kg



NOXI39 Column Shoe

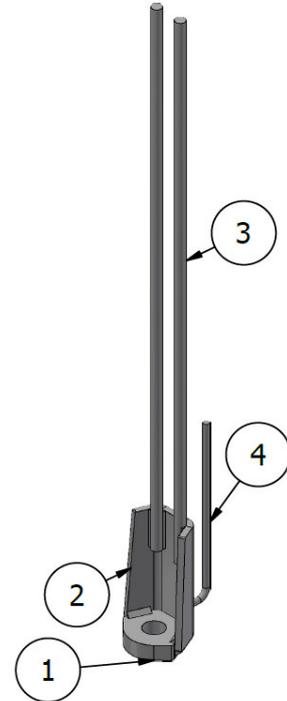
Associated Anchor Bolt: TN39C / TN39L

Weight: 22,44 kg

3.2. Materials

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

- **Base plate (reference nº1):**
 - S355J2 (th. ≤ 40 mm, according to EC-3):
 - Yield strength: 355 N/mm².
 - Ultimate tensile strength: 490 N/mm².
- **Bended plate (reference nº2):**
 - S355J2 (th. ≤ 40 mm, according to EC-3):
 - Yield strength: 355 N/mm².
 - Ultimate tensile strength: 490 N/mm².
- **Rebar (references nº3 and 4):**
 - Rebars B500SD.
 - Ø8, Ø12, Ø14, Ø16, Ø20 or Ø25mm.
 - Yield strength: 500 N/mm².
 - Ultimate tensile strength: 575 N/mm².



4. Production

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

- Following the standards defined in EN 1090-1 and EN 1090-2.
- Rebars are mechanically cut.
- Plates are mechanically cut and bended.
- MAG welding by robot or manually.

4.1. Surface finishing

The Column Shoes are delivered as standard, in black without any treatment.

There is the option of making a hot-dip galvanized finishing according to the customer's needs. *CONSULT WITH TECHNICAL DEPARTMENT.*

4.2. Tolerances

- Length: ± 10 mm.
- Diameter of the hole in the base plate: ± 2 mm.
- Position of the hole in the base plate: ± 2 mm.
- Position of the rebars: ± 2 mm.
- Dimensions of the plates: 0-3 mm.

4.3. Quality control

Quality control in production is governed by the standard defined in the available CE marking (Nr. 0370-CPR-1685).

5. Capacities

ANCHOR DESIGN BASES

- According to EN 1992-1-1:2004 (EC2)
- According to EN 1993-1-1:2005 (EC3)
- According to EN 1993-1-8:2005 (EC3)
- According to Código Estructural
- According to TR068:2020-03: Design of structural connections with column shoes
- According to ETA-25/0259: ETA NOXI Certificate

NOXI Column Shoes capacities by analogy with TN Anchor Bolt .

	NOXI20	NOXI24	NOXI30	NOXI36	NOXI39
Associated Anchor Bolt	TN20 (C and L)	TN24 (C and L)	TN30 (C and L)	TN36 (C and L)	TN39 (C and L)
Rebars of the Column Shoe	2Ø14 / 308 mm ²	2Ø16 / 401 mm ²	2Ø20 / 628 mm ²	2Ø25 / 982 mm ²	2Ø25 / 982 mm ²
Axial load N_{Rd} / N_{mRd} (1)	96,23 kN	138,56 kN	220,36 kN	321,03 kN	383,52 kN
Shear load V_{Rd} (2)	31,26 kN	45,04 kN	71,58 kN	104,12 kN	124,54 kN
Shear load 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 Capacities of Column Shoes and Anchor Bolts

- 1) Maximum capacity of the threaded zone in compression and traction according to EN1993-1-8:2005.
- 2) Maximum shear capacity in the threaded zone for joint condition with grout mortar applied, according to EN1993-1-8:2005;3.6.1 Tb 3.4)
- 3) Maximum shear capacity in the threaded zone for installation without grout mortar , according to EN 1992-4:2018 Clause 7.2.2.3.2 (with mechanical arm). Shear values referred to standard joint thickness (based on typical use of NOXI Column Shoes, e.g. for TN30 + NOXI; 50 mm joint)
- 4) Direct relation of capacities between threaded anchors and B500 rebar. Predimensioned.

The capacities of the Column Shoes have been adjusted to those defined by the capacities of the TN Anchor Bolts associated with each model (either in its short or long version). In fact, the Anchor Bolt is what truly defines the capacity of the connection, as well as its verification (both in the initial phase during assembling and in the final phase with a fully grouted joint).

The Anchor Bolt is defined as the weak part of the connection, as long as the connection conditions with reinforcement and concrete column are met.

Regarding the Column Shoe, this element must be capable of transferring the column loads (shear, moment, and axial forces) to the Anchor Bolts during the assembly phase without mortar, and to both the bolts and the concrete once the GROUT has been placed and has hardened.

The constraints related to the Column Shoe involve the “connection” of the element to the concrete column and its reinforcement. Therefore, it is essential to ensure the proper overlap of the Column Shoe bars with the main reinforcement of the column, to provide the recommended additional reinforcement, and to achieve the most homogeneous filling of the area possible (bar spacing, concrete cover, etc.).

Considerations for shear verification in the final phase:

In general terms, **ONLY CONSIDER COMPRESSED TN ANCHOR BOLTS/NOXI COLUMN SHOES FOR SHEAR CAPACITY**, as defined in the following sketch.

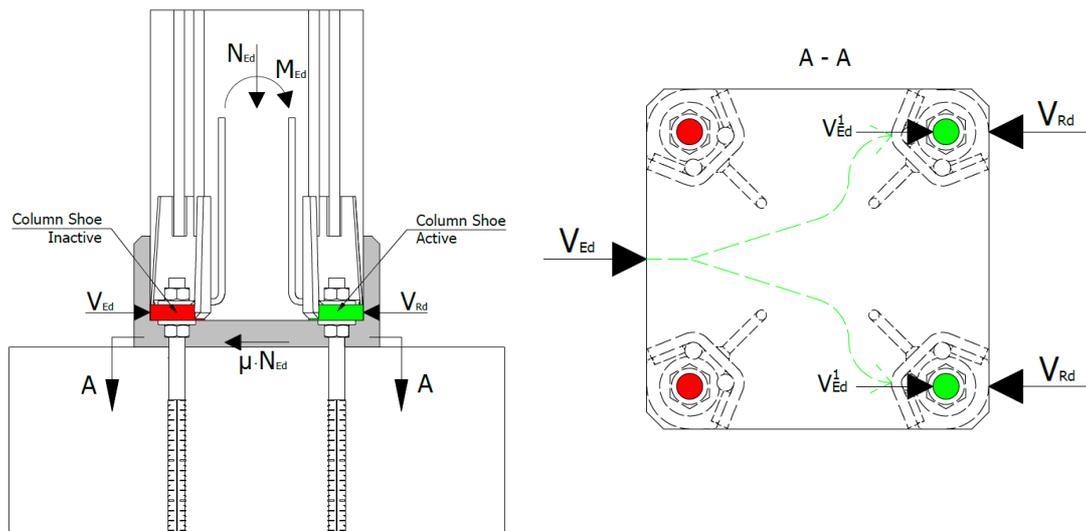


Figure 5.1 Shear force distribution on Column Shoe according to TR068

The design shear value for a Column Shoe located on the active side (V_{Ed}^1) is calculated as follows:

$$V_{Ed}^1 = \frac{V_{Ed} - \mu * N_{Ed}}{n}$$

V_{Ed} = Total design shear load (design load).

μ = Friction coefficient between the Column Shoe and the grout mortar (=0,20 according to EN 1993-1-8 Section 6.2.2 (6), for a mortar joint made with sand and cement).

N_{Ed} = Total design axial compressive load.

n = Number of compressed Column Shoes resisting the shear load (see Figure 5.1).

The resistance capacity of the Column Shoes subjected to shear must satisfy the following expression:

$$V_{Rd} \geq V_{Ed}^1$$

Load combinations:

Assembly situation (without filling the joint with mortar)

When the connection is checked in the assembly phase of the column, therefore without filling the joint with the shrinkage less mortar, the following inequality must be met:

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

N_{md} = Design axial load (\pm) on bolt during the assembly phase.

N_{mRd} = Design axial resistance of the bolt during the assembly phase (Values from Table 5.1)

V_{md} = Design shear load on bolt during assembly phase.

V_{mRd} = Design shear resistance of the bolt during assembly phase (Values from Table 5.1)

6. Principles of use

6.1. Basic considerations

NOXI Column Shoes 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 analysed on a case-by-case.

In order to apply the maximum loads defined in the chart of capacities, the correct conditions must be met in which the Column Shoe is well assembled with the column reinforcement and correctly filled with concrete in the area of these.

6.2. Design principles

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

In a typical connection, it is understood that there are at least four Column Shoes, 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 (deflected bending) and the corresponding shears.

The axial load generates a state of direct compression or traction on the Column Shoes (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 Column Shoe 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 anchors $N(m) = M/ex$, where e_x is the distance between anchors in the direction of moment M_x .

The shear is applied at a distance L , which according to the EN 1992-1-4 standard is determined as the sum distance of GROUT thickness plus eccentricities defined as half the thickness of the NOXI Column Shoe plate.

The resulting loads and their combinations generate a state of loads on the bolt that must be checked as defined in the user manual for TNC and TNL Anchor Bolts.

In the final phase, it is assimilated to a reinforced concrete section with a defined section (column section) and reinforcement (anchor bolts). The check to be carried out is the same as for this section of concrete, which determines a direct equivalence between the capacity of a column shoe and the defined reinforcement.

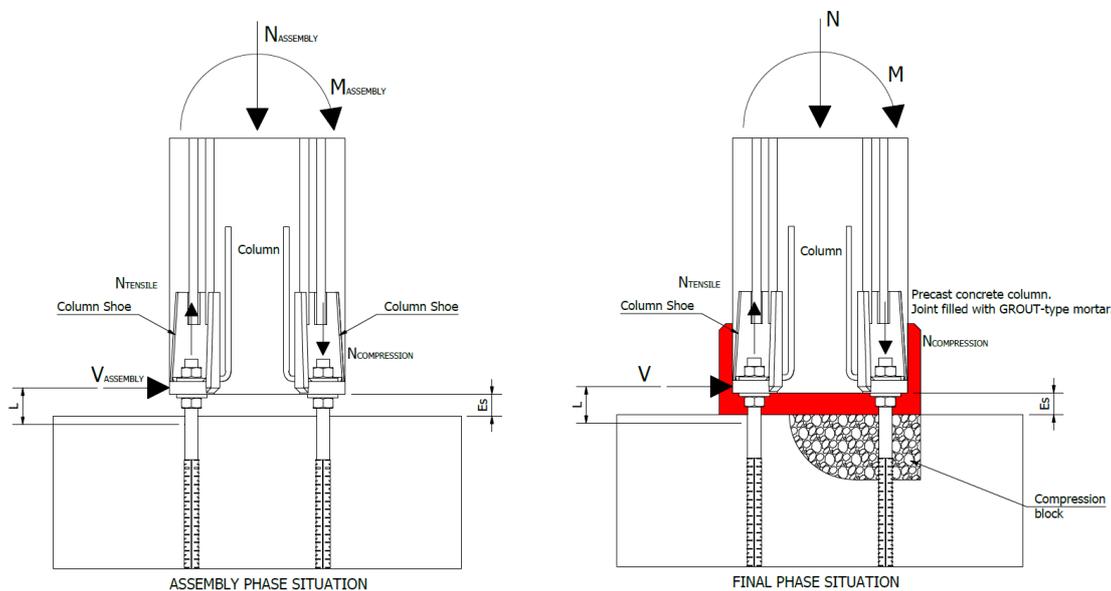


Figure 6.1 Actions on the column in assembly and final phase

For the defined connection, it is important to take into account the following considerations, which are of vital importance:

- Attach the lower nut and washer, as well as the upper washer and nut. It is important that they are positioned correctly since through these elements the forces of the NOXI Column Shoe will be transferred to the TN Anchor Bolt, without these basic elements, the connection could fail completely with what it represents.

- GROUT type non-shrinkage filler mortar. The infill has several functions, both structural and durability. The main function is to transfer the compressive stresses that are generated due to the loads of the column. Without this filling and with a significant retraction, it could not be considered a connection in the final phase and would be partially temporary, so that the connection could fail or present some anomaly (collapse or excessive displacement of the column, as well as its collapse in extreme cases).
 - Based on the consideration defined by EC3 (EN1993-1-8 chapter 6.2.2.), such mortar filler contributes a frictional state to partially support the shear loads of the connection, together with the compressed Anchor Bolts.
 - Self-locking function on the lower nut (this will always be the case) and the upper nut (if the mortar covers the nut). It must be considered that the connection will withstand bending moments in both directions and therefore a situation of untightening may occur in the useful life of the connection.
 - Durability-wise, this mortar serves the purpose of coating metallic elements that cannot be exposed to the environment (and in some cases, may be more prone to significant degradation due to corrosion).

6.3. Usage conditions for Column Shoes

The conditions of use reflected in this manual are valid for the five types of NOXI Column Shoes described. In each case, specific details for each NOXI model will be defined if necessary.

Based on the definition of the geometries and capacities of NOXI Column Shoes, usage considerations are determined in conjunction with TN Anchor Bolts (*see Anchor Bolt user manual*).

In accordance with the requirements of the relevant standards (Código Estructural and/or EC-2), regarding the anchorage of Column Shoes in the precast concrete column, the **following must be defined**:

- **Concrete type (of the precast column).**
- Bar position during pouring (good or poor adherence).
 - Typically, the Column Shoe is in a horizontal position during its pouring, so, depending on the filling stages, it can be considered a situation in position II.
- Concrete cover according to the structural environment type.
 - The concrete cover of the column stirrup must be taken into consideration, as for stirrup coatings exceeding 30 mm, the column shoe must be displaced from its generic position (50 mm in models NOXI20, NOXI24 and NOXI30; 60 mm for models NOXI36 and NOXI39).
- Disposition of transverse reinforcement in the overlap zone.
- Overlap length in the case that needs to be checked.
 - Depending on the specific case considered and the defined conditions for anchoring and overlap, the length of the bars in the Column Shoe must be analysed.
 - The following parameters have been considered for the NOXI elements described in this manual to meet the overlap requirements:
 - For each long Anchor Bolt, compliance or non-compliance is determined for overlap cases and parameters according to the article 49.5 of the Código Estructural.
 - **The overlap requirements for the earthquake situation are not considered in the following tables.**

**Usage chart for NOXI20 Column Shoe.
Anchoring conditions in precast column.**

Length of overlap zone with main column reinforcement ($\varnothing 16$) = 610 mm.

%Overlapping bars in traction with respect 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	YES	YES	YES	YES	YES	YES	YES

- **The table is determined under the following conditions:**
 - **Simplified method according to Código Estructural**
 - Coating factor: $\alpha_2 = 0.794$ (coating. stirrup 30 mm; bar $\varnothing 16$).
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.882$
 - According to additional reinforcement in this manual.
 - Welded transverse reinforcement factor: $\alpha_4 = 0.7$ (stirrups welded to the main reinforcement bars of the column, not to the NOXI Column Shoes bars).
 - Value $\alpha_5 = 1$
 - Product $\alpha_2 * \alpha_3 * \alpha_5 \geq 0.7$.

**In case of non-compliance, a Column Shoe with longer rebar should be used based on project conditions
(Consult with NOXIFER's technical department).**

**Usage chart for NOXI24 Column Shoe.
Anchoring conditions in precast column.**

Length of overlap zone with main column reinforcement ($\varnothing 20$) = 862 mm.

%Overlapping bars in tension with respect 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

- **The table is determined under the following conditions:**
 - **Simplified method according to Código Estructural**
 - Coating factor: $\alpha_2 = 0.865$ (coating: stirrup 30 mm; bar $\varnothing 20$).
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.849$
 - According to additional reinforcement in this manual.
 - Welded transverse reinforcement factor: $\alpha_4 = 0.7$ (stirrups welded to the main reinforcement bars of the column, not to the NOXI Column Shoes bars).
 - Value $\alpha_5 = 1$
 - Product $\alpha_2 * \alpha_3 * \alpha_5 \geq 0.7$.

**In case of non-compliance, a Column Shoe with longer rebar should be used based on project conditions
(Consult with NOXIFER's technical department).**

**Usage chart for NOXI30 Column Shoe.
Anchoring conditions in precast column.**

Length of overlap zone with main column reinforcement ($\varnothing 25$) = 1015 mm.

%Overlapping bars in tension with respect 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	NO	NO	YES	YES	YES	YES	YES	YES

- **The table is determined under the following conditions:**
 - **Simplified method according to Código Estructural**
 - Coating factor: $\alpha_2 = 0.922$ (coating: stirrup 30 mm; bar $\varnothing 25$).
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.892$
 - According to additional reinforcement in this manual.
 - Welded transverse reinforcement factor: $\alpha_4 = 0.7$ (stirrups welded to the main reinforcement bars of the column, not to the NOXI Column Shoes bars).
 - Value $\alpha_5 = 1$
 - Product $\alpha_2 * \alpha_3 * \alpha_5 \geq 0.7$.

**In case of non-compliance, a Column Shoe with longer rebar should be used based on project conditions
(Consult with NOXIFER's technical department).**

**Usage chart for NOXI36 Column Shoe.
 Anchoring conditions in precast column.**

Length of overlap zone with main column reinforcement ($\varnothing 25 + \varnothing 16$) = 1240 mm.

%Overlapping bars in tension with respect 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	YES	YES	YES	YES	YES	YES	YES

- **The table is determined under the following conditions:**
 - **Simplified method according to Código Estructural**
 - Coating factor: $\alpha 2 = 0.989$ (coating: stirrup 30 mm; bar $\varnothing 25$).
 - Non-welded transverse reinforcement factor: $\alpha 3 = 0.897$
 - According to additional reinforcement in this manual.
 - Welded transverse reinforcement factor: $\alpha 4 = 0.7$ (stirrups welded to the main reinforcement bars of the column, not to the NOXI Column Shoes bars).
 - Value $\alpha 5 = 1$
 - Product $\alpha 2 * \alpha 3 * \alpha 5 \geq 0.7$.

**In case of non-compliance, a Column Shoe with longer rebar should be used based on project conditions
 (Consult with NOXIFER's technical department).**

**Usage chart for NOXI39 Column Shoe.
Anchoring conditions in precast column.
Length of overlap zone with main column reinforcement
(Ø32 or Ø25+Ø20) = 1410 mm.**

%Overlapping bars in tension with respect 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 (Posición I)	YES	YES	YES									
Ls (Posición II)	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES

- **The table is determined under the following conditions:**
 - **Simplified method according to Código Estructural**
 - Coating factor: $\alpha_2 = 0.972$ (coating. stirrup 30 mm; bar Ø25).
 - Non-welded transverse reinforcement factor: $\alpha_3 = 0.859$
 - According to additional reinforcement in this manual.
 - Welded transverse reinforcement factor: $\alpha_4 = 0.7$ (stirrups welded to the main reinforcement bars of the column, not to the NOXI Column Shoes bars).
 - Value $\alpha_5 = 1$
 - Product $\alpha_2^* \alpha_3^* \alpha_5 \geq 0.7$.

**In case of non-compliance, a Column Shoe with longer rebar should be used
based on project conditions
(Consult with NOXIFER's technical department).**

6.4. Additional reinforcement

In the case of the NOXI Column Shoe, certain additional reinforcement is required. Part of this reinforcement is recommended by the Código Estructural and, by analogy, by EN 1992-1-1 (EC-2), and another part is due to the eccentricity defined between the axis of the hole in the lower plate (where the Anchor Bolt is placed) and the center of gravity of the bars welded to the vertical plates of the element (Column Shoe).

This reinforcement has the functions of improving the anchoring in the overlap area between the main bar of the column reinforcement and the NOXI Column Shoe rebars.

The additional reinforcement in the overlap zone between the column's main reinforcement and the rebars of the Column Shoe is defined in the sketches on the following pages, according to the type of Column Shoe and combinations. This reinforcement is considered in the α factors defined in the previous tables regarding anchorage and overlap lengths for NOXI Column Shoe types. It is important to follow the definitions shown in the corresponding sketches of this document.

This manual defines basic combinations for each typology, although more combinations may exist, including hybrid configurations combining different types of NOXI Column Shoes—for example, a column with 4 NOXI30 Column Shoes and 4 NOXI24 Column Shoes. In such cases, which are not described in this document, **PLEASE CONTACT THE NOXIFER TECHNICAL DEPARTMENT.**

Starting from a minimum reinforcement in the overlap area according to standards.

According to EC-2 Article 8.7.4, a cross-sectional reinforcement in the overlap zone (A_{st}) is defined for this use and the following is defined:

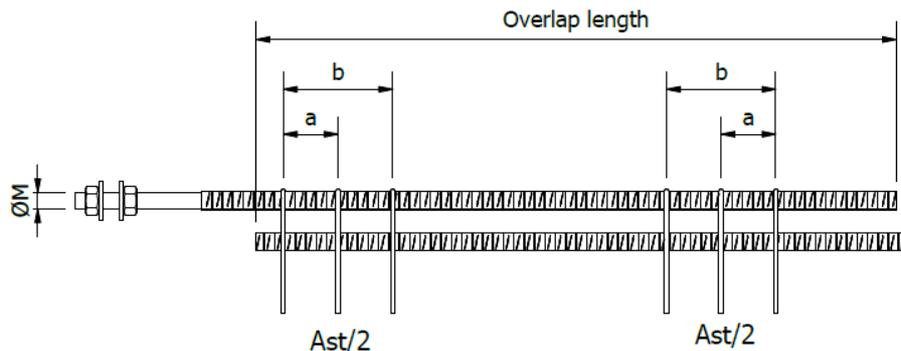


Figure 6.2 Overlap length and dimensions for the transverse reinforcement

Value of $a \leq 150$ mm.

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

Principal bar of the column reinforcement $\varnothing 16$; $A_{st} = 201 \text{ mm}^2$ ($4\varnothing 8$) ($A_{st}/2 = 2\varnothing 8$)

Value of $b = 610/3 = 204$ mm.

Principal bar of the column reinforcement $\varnothing 20$; $A_{st} = 314 \text{ mm}^2$ ($8\varnothing 8$) ($A_{st}/2 = 4\varnothing 8$)

Value of $b = 862/3 = 287$ mm.

Principal bar of the column reinforcement $\varnothing 25$; $A_{st} = 491 \text{ mm}^2$ ($10\varnothing 8$) ($A_{st}/2 = 5\varnothing 8$)

Value of $b = 1015/3 = 338$ mm.

Principal bar of the column reinforcement ($\varnothing 25 + \varnothing 16$); $A_{st} = 692 \text{ mm}^2$ ($9\varnothing 10$) ($A_{st}/2 = 5\varnothing 10$)

Value of $b = 1240/3 = 415$ mm.

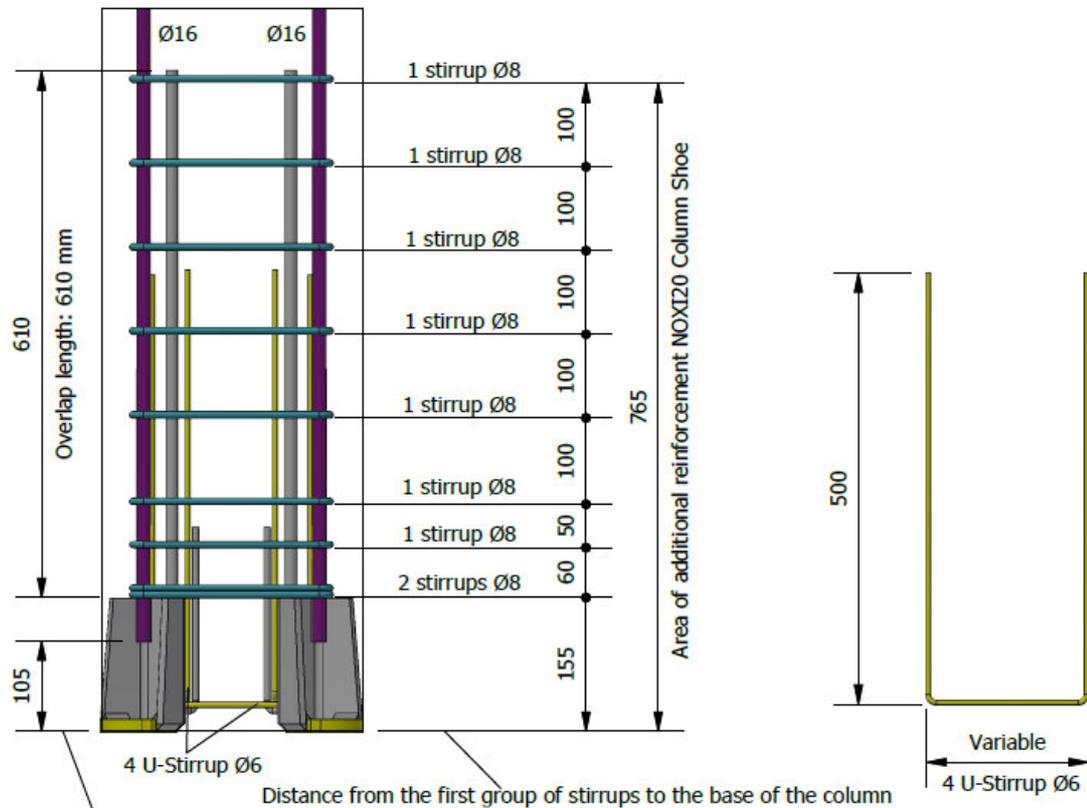
Principal bar of the column reinforcement $\varnothing 32$ ($\varnothing 25 + \varnothing 20$); $A_{st} = 804 \text{ mm}^2$ ($10\varnothing 10$) ($A_{st}/2 = 5\varnothing 10$)

Value of $b = 1410/3 = 470$ mm.

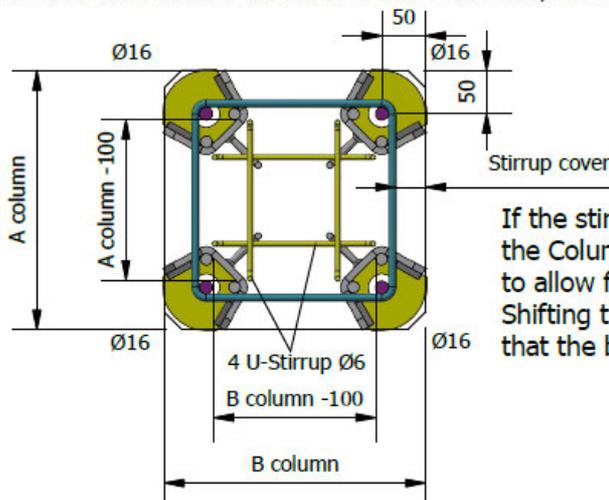
In the case of the bar of 32 and group of bars of $\varnothing 20 + 25$, it is recommended to solve it with stirrups of diameter 10, and it can be studied with stirrups of diameter 8.

For the definition of the additional reinforcement for the column shoe, a general sketch has been made that defines its position:

Additional reinforcement for columns with 4 NOXI20



The reinforcement bars of the column should be about 10,5 cm from the base of the column

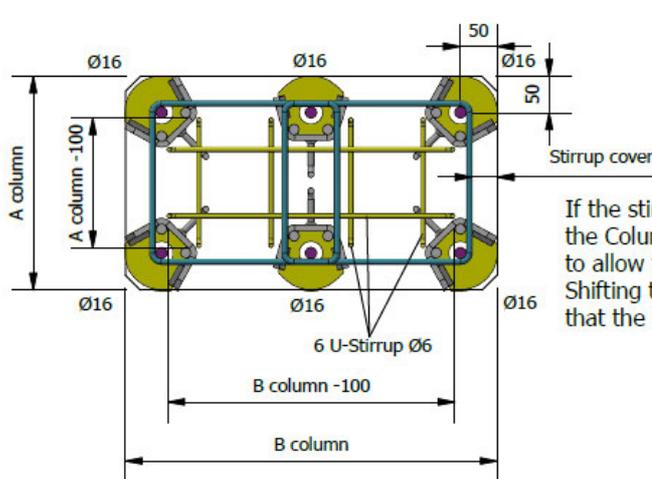
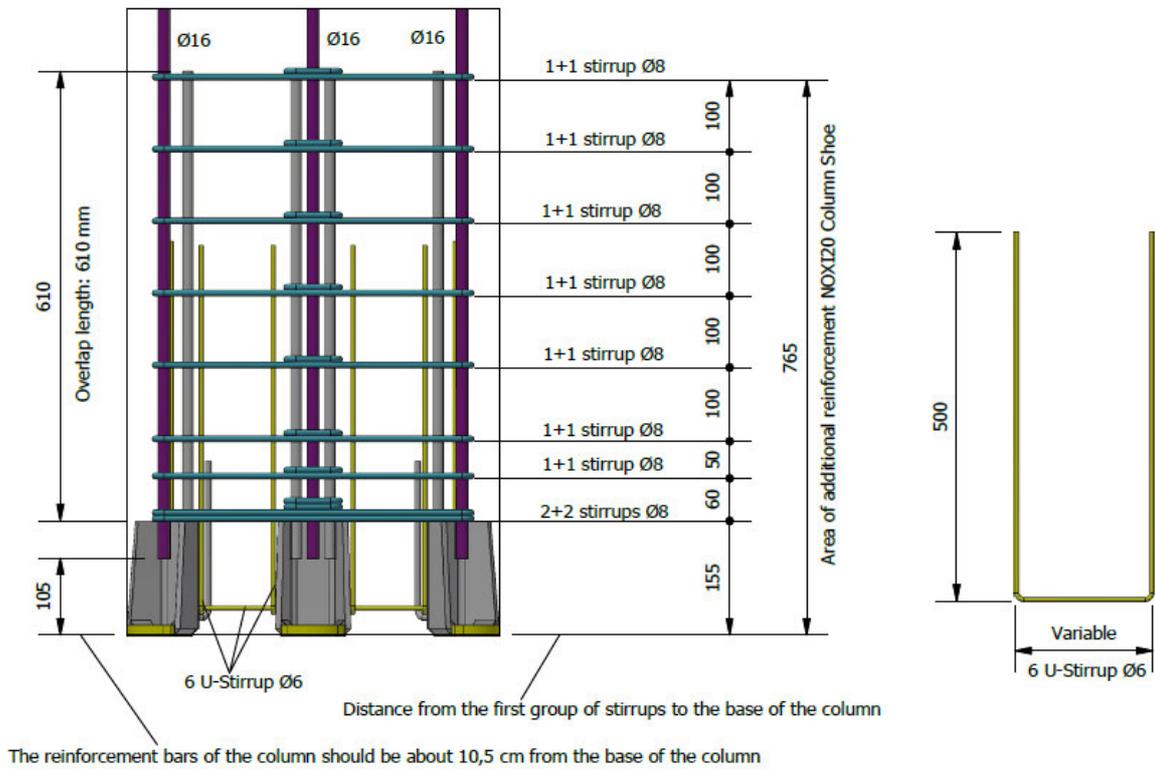


Reinforcing bar of the column: Ø16
Column Shoe: NOXI20

Dimensions in [mm]

If the stirrup cover exceeds 30mm,
the Column Shoe must be shifted inward
to allow for placement.
Shifting the Column Shoe also means
that the bolt must be adjusted to the new position.

Additional reinforcement for columns with 6 NOXI20

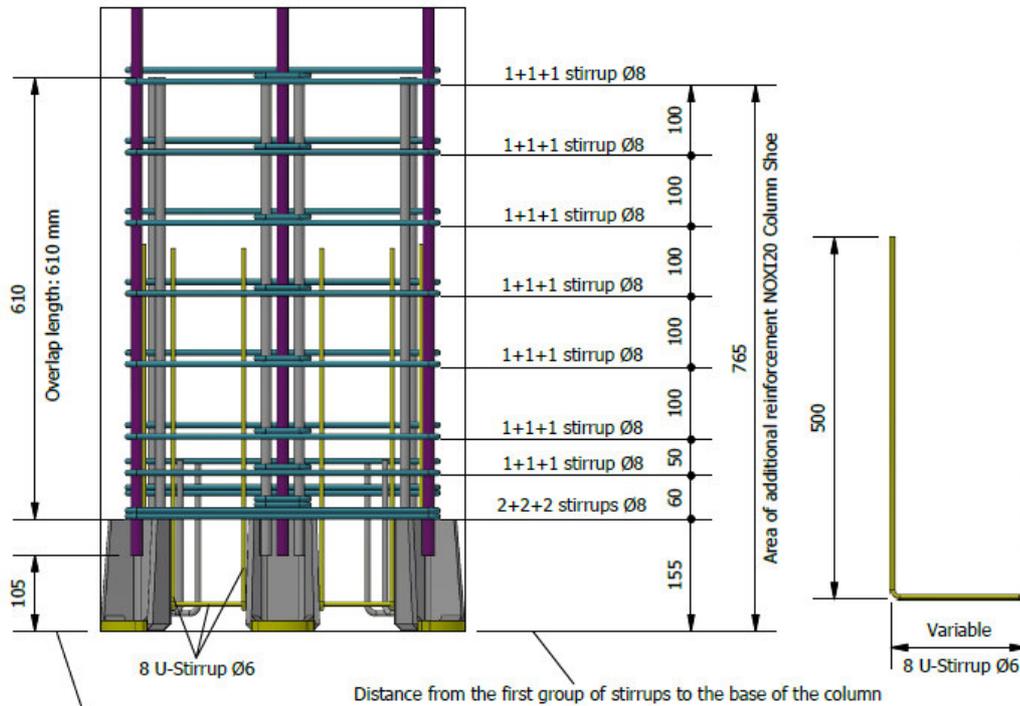


Reinforcing bar of the column: Ø16
Column Shoe: NOXI20

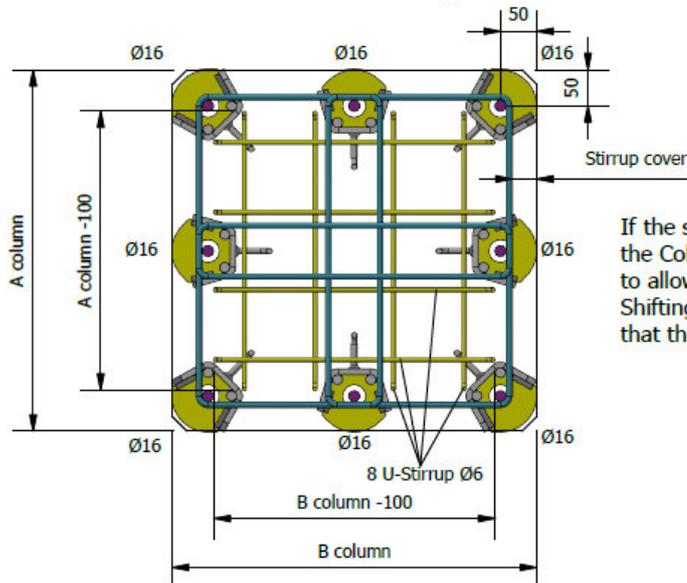
Dimensions in [mm]

If the stirrup cover exceeds 30mm,
the Column Shoe must be shifted inward
to allow for placement.
Shifting the Column Shoe also means
that the bolt must be adjusted to the new position.

Additional reinforcement for columns with 8 NOXI20



The reinforcement bars of the column should be about 10,5 cm from the base of the column

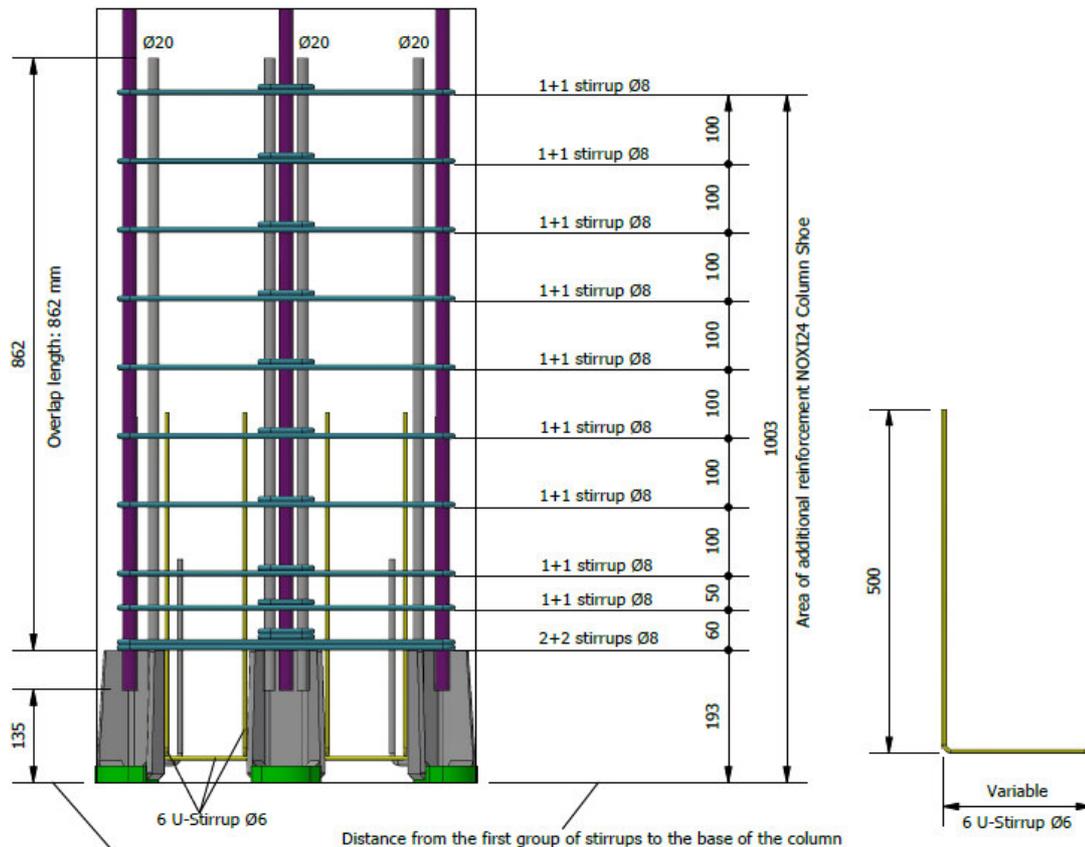


Reinforcing bar of the column: Ø16
Column Shoe: NOXI20

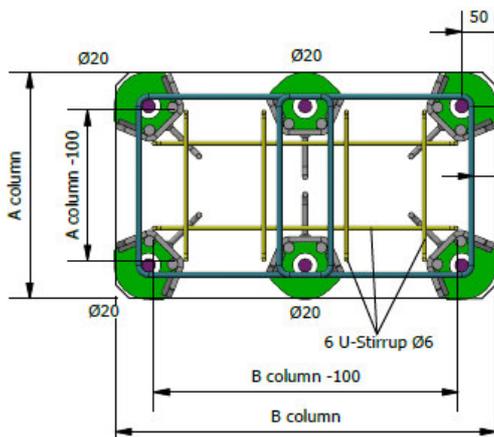
Dimensions in [mm]

If the stirrup cover exceeds 30mm,
the Column Shoe must be shifted inward
to allow for placement.
Shifting the Column Shoe also means
that the bolt must be adjusted to the new position.

Additional reinforcement for columns with 6 NOXI24



The reinforcing bars of the column should be about 13,5 cm from the base of the column

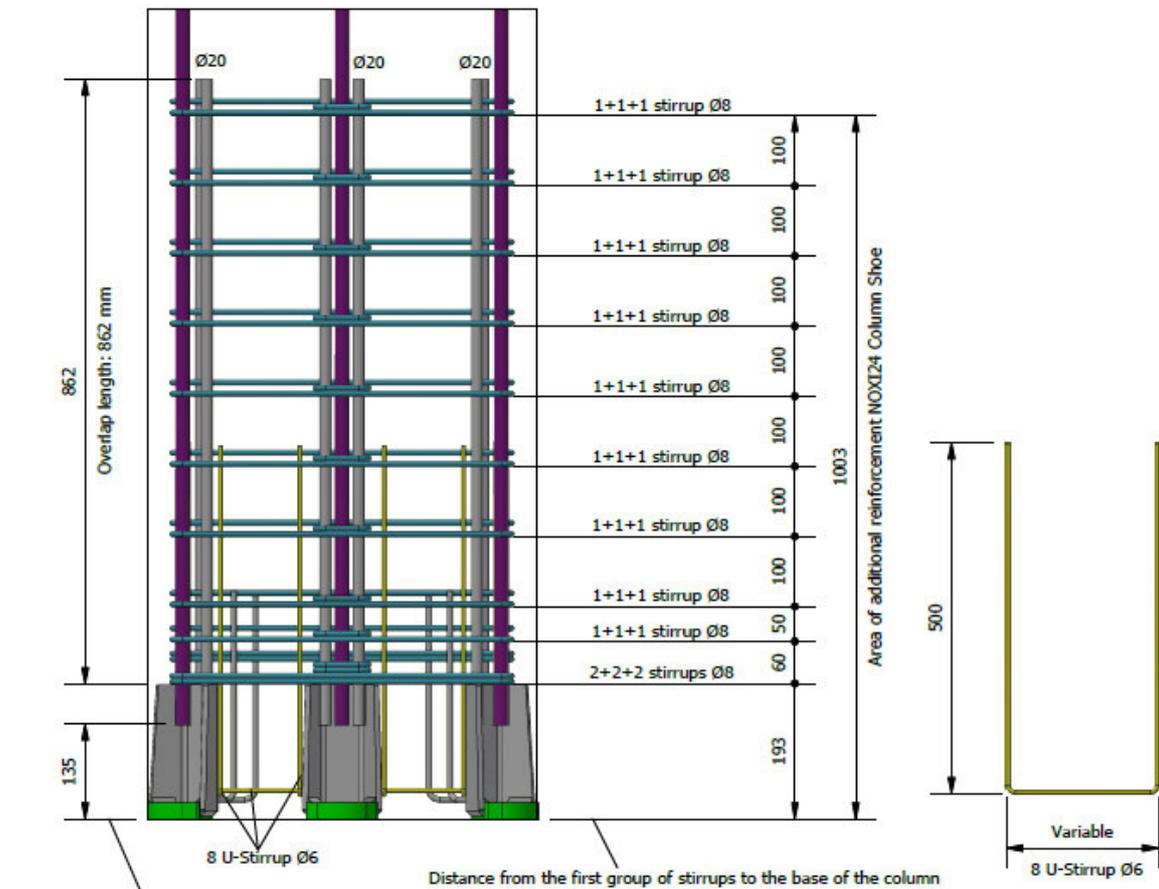


Reinforcing bar of the column: Ø20
Column Shoe: NOXI24

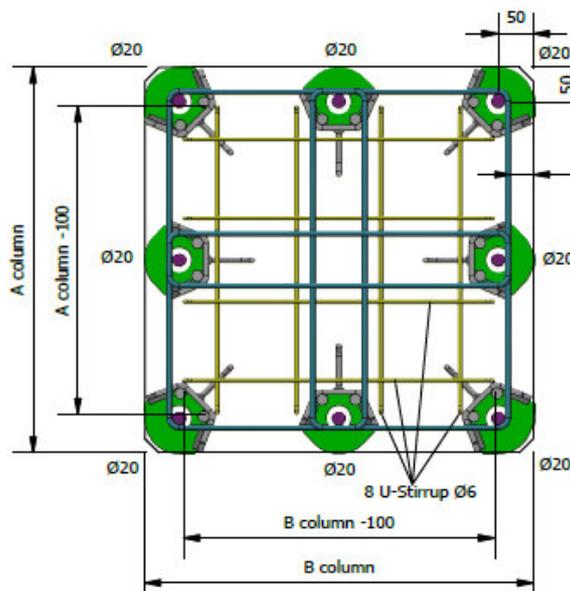
Dimensions in [mm]

If the stirrup cover exceeds 30mm, the Column Shoe must be shifted inward to allow for placement. Shifting the Column Shoe also means that the bolt must be adjusted to the new position.

Additional reinforcement for columns with 8 NOXI24

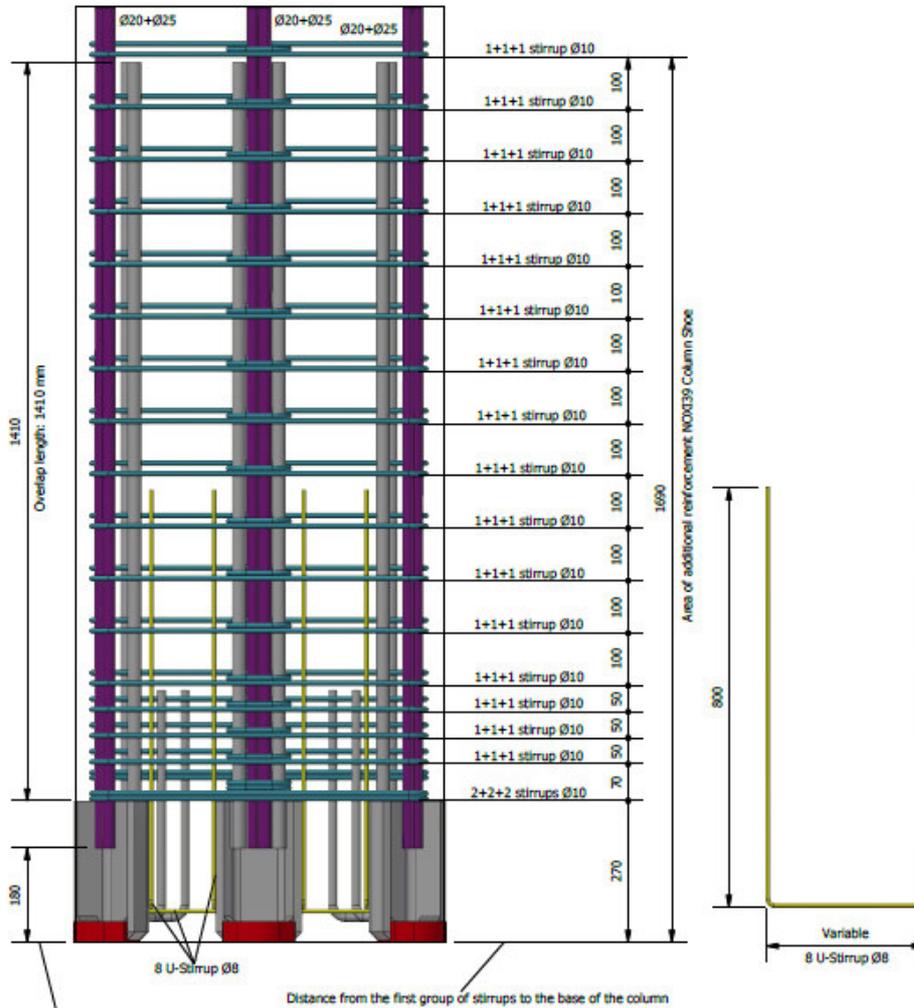


The reinforcement bars of the column should be about 13,5 cm from the base of the column

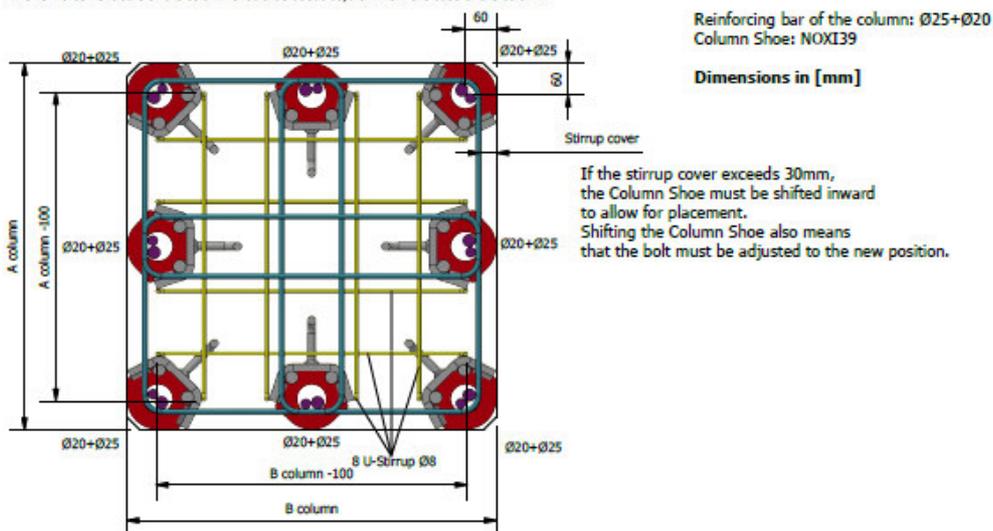


If the stirrup cover exceeds 30mm, the Column Shoe must be shifted inward to allow for placement. Shifting the Column Shoe also means that the bolt must be adjusted to the new position.

Additional reinforcement for columns with 8 NOXI39



The reinforcement bars of the column should be about 18,0 cm from the base of the column



7. Durability

Column Shoes are elements embedded in concrete.

The rebars of the Column Shoe are B500SD type, to guarantee their adhesion between both materials, as defined by the Código Estructural and EC-2 standard.

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

One of the considerations for this purpose is the **CONCRETE COVER of the main reinforcement of the column**, depending on the requirements of the environment (and also fire), the position of the Column Shoe must be modified in order to have space available to place the Column Shoe itself, this defines a greater capacity of durability because it always has a greater cover than the reinforcement of the Column Shoe.

IF A GREATER CONCRETE COVER THAN 30 mm IS REQUIRED, THE COLUMN SHOE MUST BE MOVED INWARDS (as well as the corresponding TN Anchor Bolt).

The minimum concrete cover according to exposure class is defined in Article 44 of the Código Estructural and also in accordance with EN 1992-1-1 (EC-2), Chapter 4. Additionally, the requirements for metallic elements are determined based on the corrosion level, as specified in Article 80 of the Código Estructural.

The point to consider for durability is the base plate of the Column Shoe.

Under normal conditions, the coating of the base plate is a function of the GROUT type filler mortar coating that is made on the joint itself. If the mortar has the characteristics of GROUT and such a cover is defined, it can be equated to the coating conditions of the column reinforcement. It can also be considered to apply a protection such as HOTDIP GALVANIZED in the area of the column shoe plates to improve its durability (depending on the project).

One of the important aspects is to design, as far as possible, that the joint is inserted into the own or adjacent structure (such as pavement to be placed later, compression layer of forged in situ or prefabricated, etc.), in this way the base plate is protected against the environment and fire resistance.

8. Fire resistance

Based on the equivalent mechanical cover requirements and the tables in Annex 20 of the Código Estructural, the fire resistance of the connection can be estimated.

In any case, the position of the connection and its exposure must be defined in order to determine a higher degree of coverage required to achieve the necessary resistance.

It is estimated that, without any protection, the fire resistance of the connection is approximately 60 minutes. For greater resistance, the Column Shoe must be covered, typically using GROUT.

In ETA certificate 25/0259 for NOXI Column Shoe, Annex C1 includes the following table:

Basic Works Requirement 2: Safety in case of fire

Table C2: Resistance to fire-steel temperature as a function of the duration of fire exposure - $T_{cr}(t_i)$ [°C]

Time t_i (min)	NOXI20 Minimum column size 300x300	NOXI24 Minimum column size 300x300	NOXI30 Minimum column size 300x300	NOXI36 Minimum column size 400x400	NOXI39 Minimum column size 400x400
Steel temperature as a function of the duration of fire exposure - $T_{cr}(t_i)$ [°C]					
15	121	109	121	87	109
30	217	194	212	151	186
45	328	287	327	229	269
60	430	380	419	294	342
90	583	528	570	399	462
120	684	633	681	488	556
180	826	778	832	625	697

In this table, based on the corresponding tests, the steel temperature is determined for the connection with the defined minimum section and with the standard position of the Column Shoe (corner position). If the steel temperature is less than or equal to 400°C, the steel—and therefore the connection—does not suffer any loss of capacity.

For further information, **PLEASE CONTACT THE NOXIFER TECHNICAL DEPARTMENT.**

9. NOXI Column Shoe placement

For the placement of the Column Shoes, the following preliminary steps must be considered:

- Check that the type of Column Shoe is the correct according to the plans of the project management.
 - Column Shoe model.
 - Correspondence with TN bolt to be arranged (NOXI30=TN30)
- Verify the type of Column Shoe selected that can be placed on the precast concrete column to be produced (column dimensions = possibility to place X Column Shoes, stirrup cover = potential displacement of the Column Shoe, and bolt for geometric availability.)
 - It is important to ensure that the selection of the Column Shoe has been done correctly as defined in this document (equivalence with column reinforcement = capacity, position in the section, etc.)
- Using a placement template:
 - Determine a fixed position for all Column Shoes arranged in a section (e.g., using a template = final mould tape for a 50x50 column, with more than four anchor points, etc.).
 - Reference the position of the group of Column Shoes with respect to the column axes so that the subsequent assembly of the column is carried out in the correct position according to construction plans.
 - Prevent the movement of these Column Shoes during the prefabricated column casting phase, so they must be securely fixed to the mould template (using installation boxes as described in the following sketch).

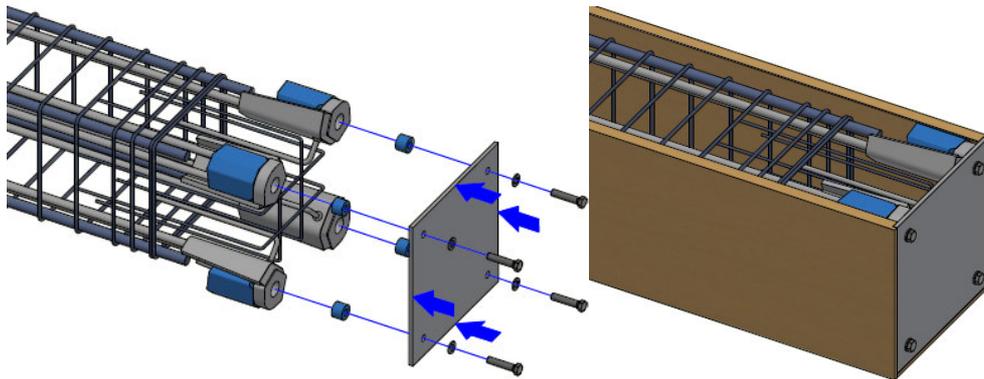


Figure 9.1 Installation boxes for securing to mould template (central and corner)

The boxes also serve the purpose of leaving an area without concrete for the subsequent assembly of the column on-site.

The attachment bolts for the installation boxes are M16, therefore, the hole in the mould template should be 17 mm.

9.1. Considerations

9.1.1. Geometric measurements of installation

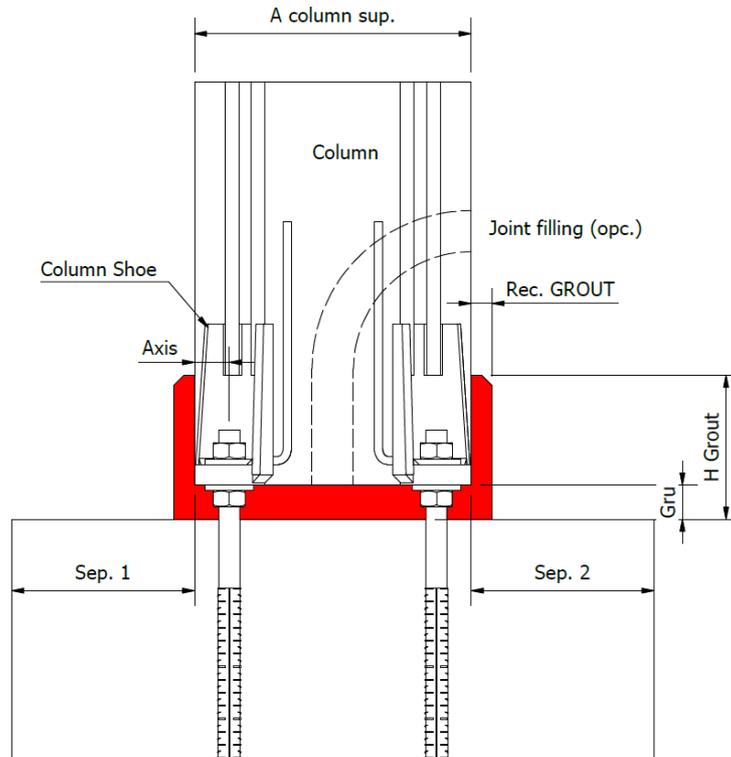


Figure 9.2 Dimensions to be respected during installation

NOXI20 Column Shoe; Axis = 50 mm; Gru = 50 mm; H Grout = 160 mm.

NOXI24 Column Shoe; Axis = 50 mm; Gru = 50 mm; H Grout = 175 mm.

NOXI30 Column Shoe; Axis = 50 mm; Gru = 50 mm; H Grout = 206 mm.

NOXI36 Column Shoe; Axis = 60 mm; Gru = 60 mm; H Grout = 250 mm.

NOXI39 Column Shoe; Axis = 60 mm; Gru = 60 mm; H Grout = 250 mm.

The GROUT cover can be variable, as it is considered as protection or durability of the lower area of the column shoe, it is defined that a minimum value can be 25/30 mm of lateral thickness. This value can be increased as necessary or by the geometry available on site of the formwork boxes.

If the recommended GROUT value is 25/30 mm, the use of an inner filling tube, as shown in the sketch, may be advisable. This is an optional solution but may be necessary in certain cases.

One aspect to mention is that it is assumed by default that the filling mortar type GROUT has a capacity equal to or greater than the type of concrete used in the prefabricated pillar (if the pillar is C40/50, f_{ck} GROUT \geq 40 MPa). **Otherwise, the section must be verified with the value of the concrete of lower capacity.**

The defined values for Sep. 1 and Sep. 2 determine the separation of any face of the column from the edge or end of the element containing the TN bolts. It is specified that based on geometry, the value of Sep. 1 and/or Sep. 2 should not be less than 150/200 mm for several reasons:

- Distance from the bolt to the concrete edge of the lower element (which could be a shoe, foundation, in-situ wall, precast column, in-situ pilaster, etc.). This distance is conditioned in short TNC Anchors by the concrete cone and by coverings in long TNL anchors).
 - In the case of column-column connection (according to Figure 9.2), it is necessary to shift the anchors and Column Shoes to avoid interference with reinforcement due to minimum coatings. This situation occurs when one face is aligned with the lower cement face (value of A = value of B). The "Axis" value is greater than the one defined on the previous page.
- Type of concrete for the lower element. If it is standard foundation concrete (such as C25/30), the lower element must have a larger section than the precast column to assimilate the same capacity of the compression block generated in the connection.
 - Comparable to a concentrated load on solid concrete blocks as defined in the Código Estructural, applied over an area homothetic to the section of the precast column.

9.1.2. Installation tolerances

- a) Tolerances are very tight, especially in the bolts plane. Tolerance is determined by the difference between the hole in the Column Shoe or the plate hole of the metal column and the diameter of the Anchor Bolt. For example, if the hole is 40 mm, for the TN30 Bolt (short or long) with a metric diameter of 30 mm, the tolerance is ± 5 mm.
- i. NOXI20 Column Shoe; \varnothing hole = 31 mm. TN20 Anchor Bolt = 20 mm
Tolerance: $\pm 5,5$ mm.
 - ii. NOXI24 Column Shoe; \varnothing hole = 35 mm. TN24 Anchor Bolt = 24 mm
Tolerance: $\pm 5,5$ mm.
 - iii. NOXI30 Column Shoe; \varnothing hole = 40 mm. TN30 Anchor Bolt = 30 mm
Tolerance: ± 5 mm.
 - iv. NOXI36 Column Shoe; \varnothing hole = 55 mm. TN36 Anchor Bolt = 36 mm
Tolerance: $\pm 9,5$ mm.
 - v. NOXI39 Column Shoe; \varnothing hole = 55 mm. TN39 Anchor Bolt = 39 mm
Tolerance: ± 8 mm.
- b) Height tolerance depends on the dimension at which the bolt protrudes from the concrete level of the lower element. Based on the standard values for the use of TN Anchors:
- i. TN20 = 115 mm.
 - ii. TN24 = 130 mm.
 - iii. TN30 = 150 mm.
 - iv. TN36 = 170 mm
 - v. TN39 = 180 mm.

Based on these values, a potential height tolerance for the connection is determined, not so much for the Column Shoe, which will always follow the final level of the Column Shoe (mould template), but assembly may require adjustment. It is better to have the bolt slightly higher than lower, as there is more margin inside the column box than at the bottom joint.

The corresponding sketches of the placement tolerances with NOXIFER Anchor Bolts (TN), as described in section 5 of this manual, are attached. Assembly tolerances are defined for all models of NOXI column shoes.

LOW ANCHOR BOLT

Solution:
If the anchor bolt is placed below 120mm, there are different possibilities:
- If it is placed between 120 and 105mm, the joint between the column and the concrete can be adjusted below the 50mm.
- If it is placed below the 105mm, a DIN6334 nut must be used along with a threaded bar.

Height tolerances:
Maintaining the lower joint of 50 mm, the anchor bolt has a tolerance of -30 to +15 mm, therefore, the variation of the level where the anchor protrudes from the concrete level can be from: $150-30 = 120$ mm to $150 + 15 = 165$ mm.

HIGH ANCHOR BOLT.

Solution:
If the anchor bolt is higher than 165 mm, there are several options:
- If it is between 165 and 188 mm, the upper part must be cut, leaving the defined 150 mm.
- If it is higher than 188 mm, consult with NOXIFER's technical department, as the anchorage area in the foundation must be verified for short anchors.
For long anchors, the solution options must be verified, including whether the precast column has already been manufactured, etc.
In short, if the anchor is higher than 188/200 mm, the solution can be complex.

Anchor bolt TN30C:
Same for long anchor bolt, TN30L.

Wrench: Closed 46.
Nut TN30C, M30 C8.

Washer TN30C, S275JR.

Ø anchor threaded part: 30 mm.
Ø hole column shoe NOX130: 40 mm.
Tolerance: ± 5 mm (x & y axis).

Column shoe NOX130

Threaded bar M30 8.8

Nut DIN6334 M30

Dimensions in mm.

26/05/2025

Version: V0

LOW ANCHOR BOLT

Solution:
If the anchor bolt is placed below 145mm, there are different possibilities:
- If it is placed between 145 and 130mm, the joint between the column and the concrete can be adjusted below the 60mm.
- If it is placed below the 130mm, a threaded coupler must be used along with a threaded bar.

HIGH ANCHOR BOLT.

Solution:
If the anchor bolt is higher than 195 mm, consult with NOXIFER's technical department, as the anchorage area in the foundation for short anchor bolts must be verified and the best possible solution must be determined.
(The solution options must be verified, including whether the precast column has already been manufactured, etc.)
In short, if the anchor is higher than 195 mm, the solution may be complex.

Anchor bolt TN36C.
Same for long anchor bolt, TN36L.

Wrench: Closed 55.
Nut: TN36, M36 C8.

Washer TN36, S275JR.

Threaded coupler S355J2 M36

Ø anchor threaded part: 36 mm.
Ø hole column shoe NOXI36: 55 mm.
Tolerance: ± 9 mm (x & y axis).

Description: Assembly tolerances for NOXI36 column shoe with short anchor bolt TN36C and long anchor bolt TN36L.

Dimensions in mm.

26/05/2025

Version: V0

LOW ANCHOR BOLT

Solution:
If the anchor bolt is placed below 150mm, there are different possibilities:
- If it is placed between 150 and 135mm, the joint between the column and the concrete can be adjusted below the 60mm.
- If it is placed below the 135mm, a threaded coupler must be used along with a threaded bar.

HIGH ANCHOR BOLT

Solution:
If the screw is higher than 200 mm, consult with NOXIFER's technical department, as the anchorage area in the foundation for short anchor bolts must be verified and the best possible solution must be determined. (The solution options must be verified, including whether the precast column has already been manufactured, etc.)
In short, if the anchor is higher than 200 mm, the solution may be complex.

Height tolerances:
Maintaining the lower joint of 60 mm, the anchor bolt has a tolerance of -30 to +20 mm, therefore, the variation of the level where the anchor protrudes from the concrete level can be from 180-30 = 150 mm to 180 + 20 = 200 mm.

Column shoe NOXI39

Anchor bolt TN39C.
Same for long anchor bolt, TN39L.

Wrench: Closed 60.
Nut: TN39, M39 CB.
Washer: TN39, S275JR.

Anchor threaded part: 39 mm.
Ø hole column shoe NOXI39: 55 mm.
Tolerance: +- 8 mm (x & y axis).

Threaded coupler S355J2 M39

Threaded bar M39 8.8

Dimensions in mm.

noxiFER

Description: Assembly tolerances for NOXI39 column shoe with short anchor bolt TN39C and long anchor bolt TN39L.

26/05/2025

Version: V0

9.1.3. Wrench for tightening the bolts inside the NOXI Column Shoe:

Based on the available space inside the Column Shoe box, where the TN Anchor Bolt will be placed through the hole in the base plate, **it is recommended that the tightening wrench be of the BOX-END WRENCH or in cases where the column is close to existing structures, a STRIKING BOX-END WRENCH is recommended.**

Remember that no specific torque is required.



Figure 9.3 Box-end wrench

**For NOXI20 Column Shoe = TN20 Bolt → 30 wrench.
For NOXI24 Column Shoe = TN24 Bolt → 36 wrench.
For NOXI30 Column Shoe = TN30 Bolt → 46 wrench.
For NOXI36 Column Shoe = TN36 Bolt → 55 wrench.
For NOXI39 Column Shoe = TN39 Bolt → 60 wrench.**

At the bottom of the Column Shoe, the wrench of the same type but open must be used to access the nut.



Figure 9.4 Open-end wrench