

**NSK AND SSK WALL SHOE
(BOLTED CONNECTIONS)**

RIGHTS TO CHANGES AND ERRORS RESERVED

**TECHNICAL
MANUAL**

**EXM-BAS-DC-1003
R2 - 28.09.2022**

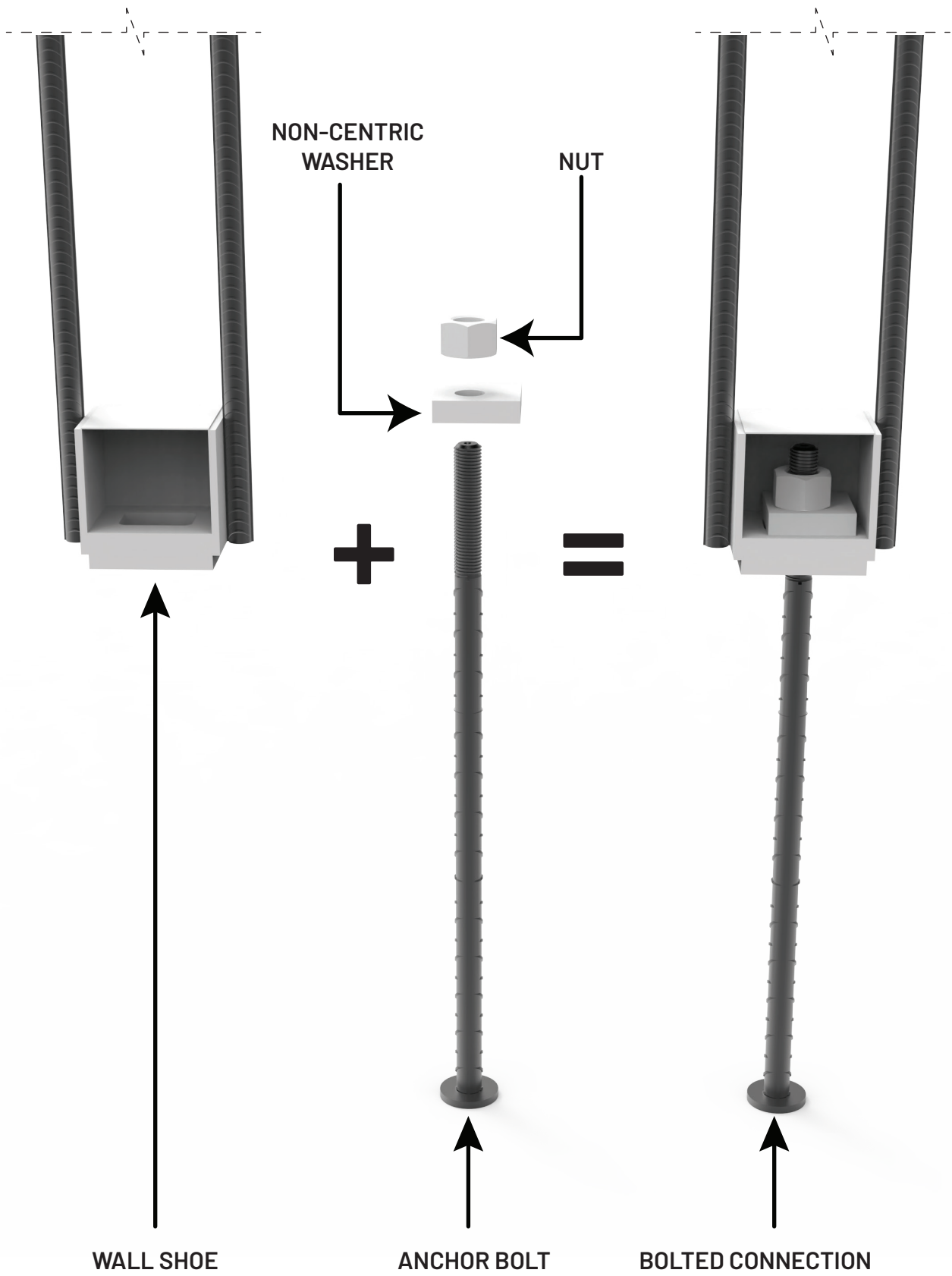


TABLE OF CONTENT

1. PRODUCT DESCRIPTION & PROPERTIES	4
1.1 Structural Behavior	6
1.2 CONDITIONS FOR USE OF NSK and SSK WALL SHOES	6
1.2.1 Exposure Conditions	6
1.2.2 Placement of Wall Shoes	7
1.2.3 Minimum Concrete Cover and Wall Thickness	7
1.3 Product Dimensions	8
1.3.1 NSK Wall Shoes	8
1.3.2 SSK Wall Shoes	9
1.4 Materials	10
1.5 Markings, Manufacturing Method & Tolerances and Quality Control	10
1.5.1 Markings	10
1.5.2 Manufacturing Method	10
1.5.3 Manufacturing Tolerances	10
1.5.4 Quality Control	10
2. RESISTANCES	11
2.1 Fire Resistances	11
3. REINFORCEMENT	11
4. INSTALLATION OF WALL SHOE	15

NSK & SSK WALL SHOES

Exmet's NSK and SSK Wall shoes are widely used to achieve tensile connection between wall and foundation or two walls. Among various other benefits, the key benefits of using Exmet's wall shoes are:

- Simple connection by bolting concrete members together
- Fast and easy erection of walls
- Immediate transfer of tensile forces once the wall is erected and bolted
- Results in reduced floor cycle

Wall to wall or wall to foundation bolted connection is achieved by casting the wall shoe in precast wall and anchor bolt in the wall or foundation below. The anchor bolt is fastened to wall shoe with the help of nut and rectangular Non-centric washer. At the time of erection, correct level of the wall can be achieved using the shims. The joint between two walls or wall and foundation as well as the cavity formed by wall shoe are grouted.

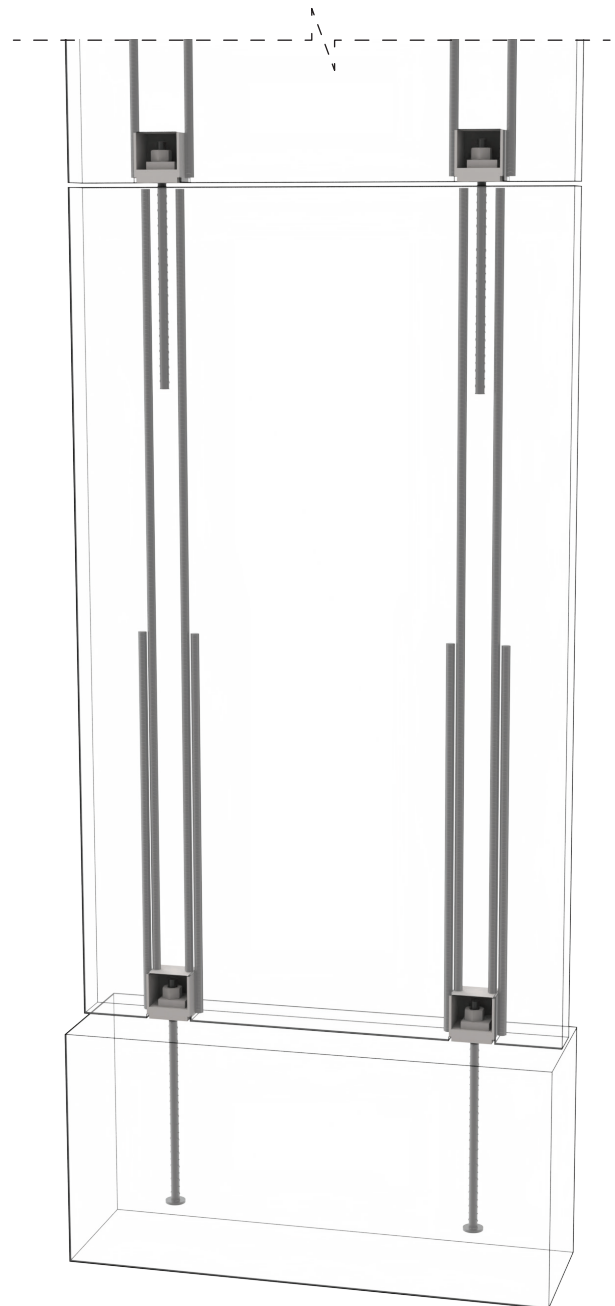


Figure 1: Wall Shoe

1. PRODUCT PROPERTIES

Exmet's Wall Shoe is constructed by welding together a thick base plate with surrounding side and top steel sheets along with two or four primary rebars. The wall shoe system consists of a Wall Shoe, an Anchor Bolt and a Non-Centric Washer. Exmet's Wall Shoes are divided into two categories: NSK – Normal Strength Wall Shoes and SSK – High Strength Wall Shoes. Each category has five different sizes for use in wide range of load conditions.



Figure 2: Normal-Capacity Wall Shoe NSK



Figure 3: High-Capacity Wall Shoe SSK

Wall Shoes are placed into the formwork together with the main and supplementary reinforcement and the anchor bolts are installed at the top of foundation or the wall below. Each connection consists of at least two separate shoes installed either on the surface of the element or symmetrically in the middle of the element. The anchor bolt passes through the rectangular hole in the wall shoe above and is fastened with the help of nut and non-centric washer. The gap between wall and foundation or Wall and Wall is filled with grout. Sufficient tolerances have been provided in the design to allow for variations at factory and on site.

Exmet's Wall Shoes can be used in 2D wall elements as well as 3D PPVC elements.

1.1 STRUCTURAL BEHAVIOUR

The resistance provided by wall shoe connection is dictated by resistance of anchor bolt used. Wall shoes are designed to safely withstand the tensile capacity of corresponding anchor bolt. Wall shoe connection can resist tensile forces between the members whereas the compressive forces are transmitted through bearing. Through vertical reinforcement, wall shoes (bottom part) transfer the tensile forces to the anchor bolt (top of the wall element).

Please refer to image below:

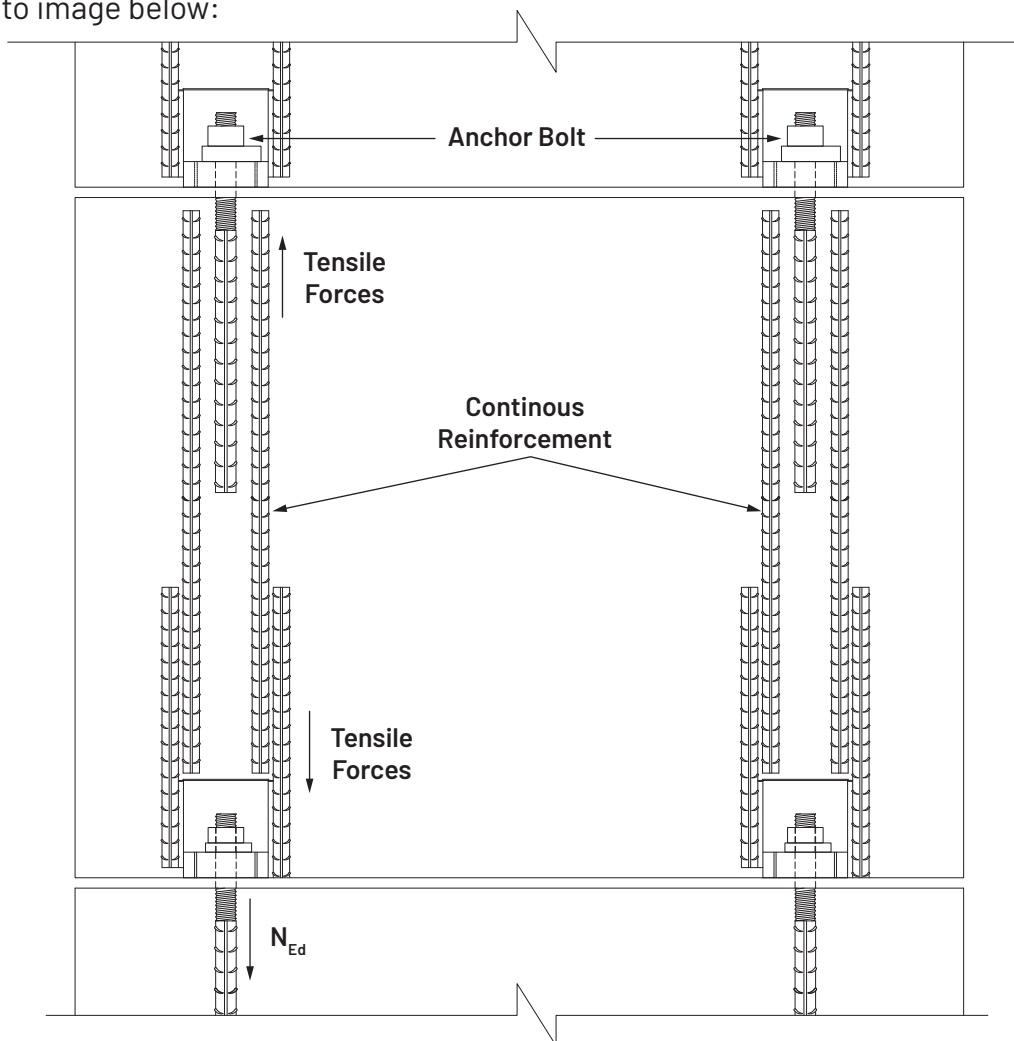


Figure 4: Structural Behaviour

1.2 CONDITIONS FOR USE OF NSK AND SSK WALL SHOES

1.2.1 Exposure Conditions

NSK and SSK Wall Shoes have been designed to withstand static loads. For use of NSK and SSK Wall Shoes under dynamic or seismic loads, kindly contact Exmet's technical team (technical@exmet.ee).

NSK and SSK Wall Shoes are uncoated by default. In case, NSK and SSK Wall Shoes are to be used in harsh conditions, appropriate surface coating or concrete cover must be provided. Exmet offers various surface coating options for NSK and SSK Wall Shoes such as electro or hot-dip galvanization. For Wall Shoes intended to be used in corrosive environment, stainless steel Wall Shoes can be provided to meet the project requirements.

1.2.2 Placement of Wall Shoes

Please refer to Figure 5, 6 and table 1, 2 for information on min concrete cover and min edge distance. Wall shoes are designed to be used in reinforced concrete wall with minimum cover and minimum edge distance as outlined in tables below. NSK and SSK Wall shoes can be used in concrete grade C25/30 and higher. In case Wall shoes have to be used in conditions other than those described in this manual, please contact Exmet's technical team (technical@exmet.ee).

1.2.3 Minimum Concrete Cover and Wall Thickness

Table 1. Minimum Concrete Cover and Wall Thickness

Wall Shoe	Concrete Cover, C_c [mm]	Wall Thickness, t_{wall} [mm]
NSK - M16	39	90
NSK - M20	37	90
NSK - M24	45	110
NSK - M30	47.5	120
NSK - M39	56.5	145
SSK - M30	52.5	130
SSK - M36	59	150
SSK - M39	42.5	190
SSK - M45	46	210
SSK - M52	43	250

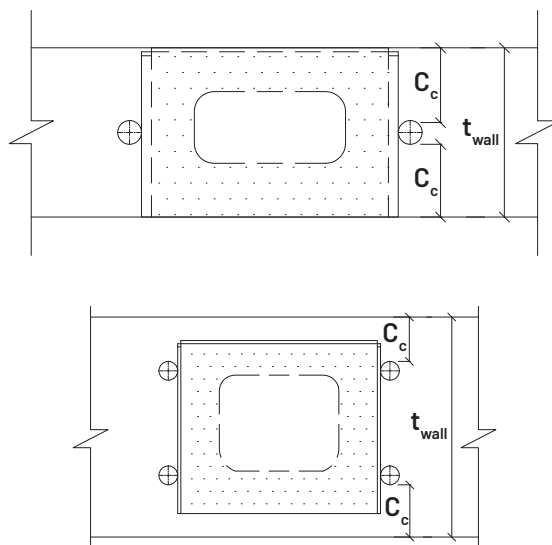


Figure 5: Minimum Concrete Cover and Wall Thickness

Table 2. Wall shoe edge distance and center-to-center distance

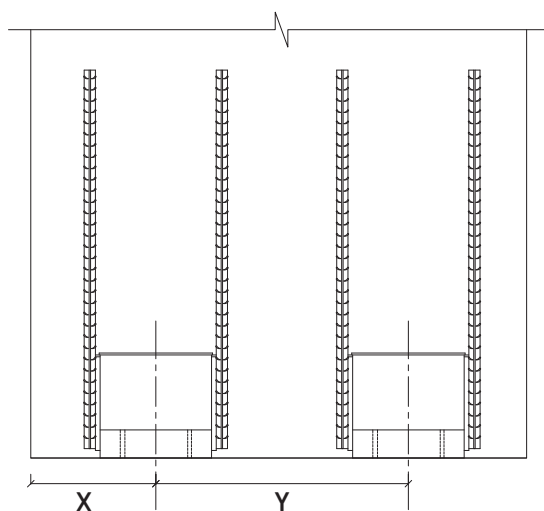


Figure 6: Wall shoe edge distance and center-to-center distance

Wall Shoe	X [mm]	Y [mm]
NSK - M16	140	220
NSK - M20	150	240
NSK - M24	160	250
NSK - M30	170	280
NSK - M39	200	320
SSK - M30	180	280
SSK - M36	200	320
SSK - M39	170	300
SSK - M45	200	320
SSK - M52	220	350

1.3 PRODUCT DIMENSIONS

Product dimension helps in selection of wall shoe to be used in the wall element, along with the specifications provided in clause 1.2.3. Following tables provide this information along with the color codes to simply the usability of products with their respective anchor bolts.

1.3.1 NSK Wall Shoes

Table 3. Normal Capacity Wall Shoe

Normal Capacity Wall Shoe	L [mm]	B [mm]	H [mm]	T [mm]	L1 [mm]	B1 [mm]	h [mm]	Colour
NSK - M16	119	80	630	30	76	36	80	Yellow
NSK - M20	124	90	800	35	80	40	90	Blue
NSK - M24	129	110	965	35	84	49	105	Grey
NSK - M30	144	120	1130	40	90	55	115	Green
NSK - M39	165	145	1600	50	99	64	140	Orange

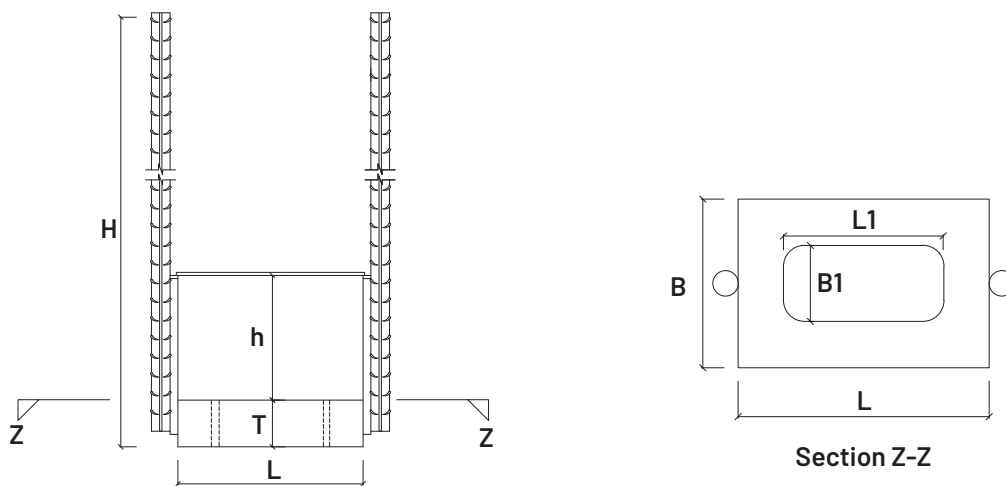


Figure 7: NSK Wall Shoe

Table 4. Non-Centric Washer (Normal Capacity Wall Shoe)

Normal Capacity Wall Shoe	X [mm]	Y [mm]	e [mm]
NSK - M16	60	60	25.0
NSK - M20	65	65	27.5
NSK - M24	80	80	30.0
NSK - M30	95	95	37.5
NSK - M39	115	115	47.5

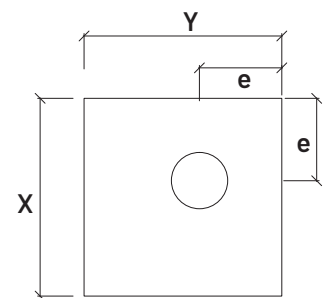


Figure 8: Non-Centric Washer

1.3.2 SSK Wall Shoes

Table 5. High Capacity Wall Shoe

High Capacity Wall Shoe	L [mm]	B [mm]	H [mm]	T [mm]	L1 [mm]	B1 [mm]	h [mm]	Colour
SSK - M30	145	130	1460	45	90	55	120	● Black
SSK - M36	164	150	1765	55	96	61	140	● Red
SSK - M39	165	150	1650	60	99	64	147	● Brown
SSK - M45	180	175	2015	70	105	75	162	● Purple
SSK - M52	210	230	2215	80	112	82	200	○ White

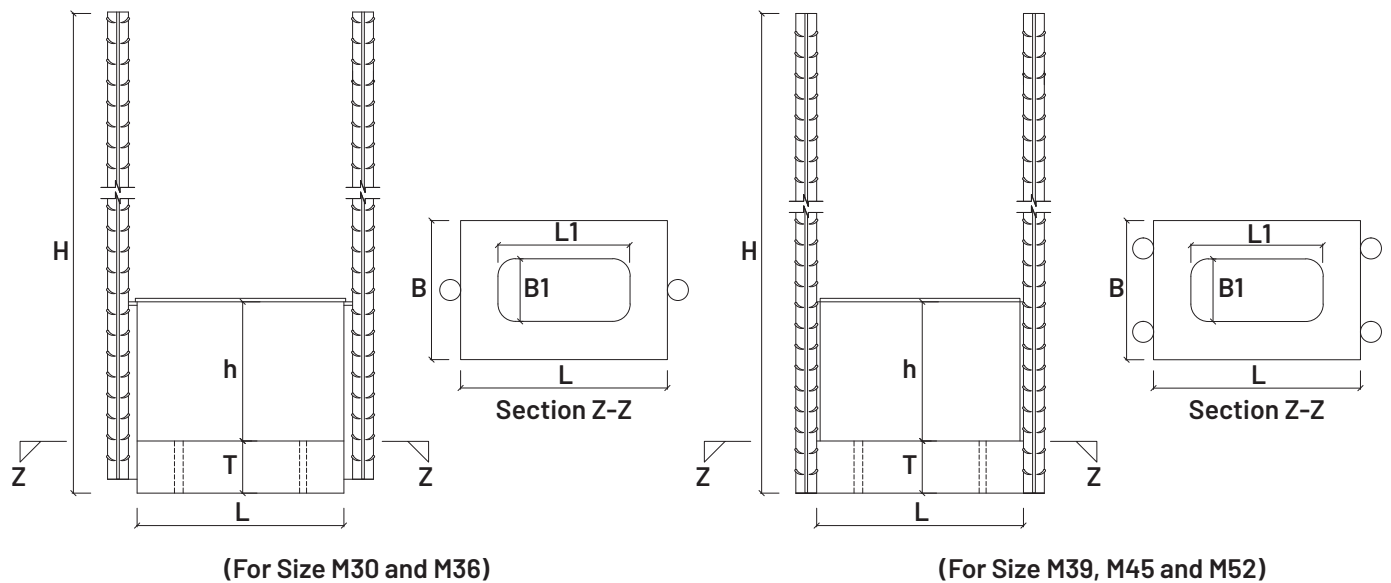


Figure 9: SSK Wall Shoe

Table 6. Non-Centric Washer (High Capacity Wall Shoe)

High Capacity Wall Shoe	X [mm]	Y [mm]	e [mm]
SSK - M30	95	95	37.5
SSK - M36	110	110	45.0
SSK - M39	115	115	47.5
SSK - M45	130	130	55.0
SSK - M52	155	155	67.5

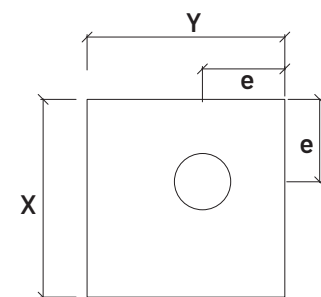


Figure 10: Non-Centric Washer

1.4 MATERIALS

Wall Shoes are manufactured with the following materials which are shown below:

Table 7: Materials

Component	Material	Standard
Ribbed Bars	B500B	SFS 1300
Bottom, Side, Top Plate	S355J2 + N	EN 10025-2

Rebars (SFS 1300/EN 10080) $f_{yk} = 500 \text{ MPa}$

$f_{uk} = 550 \text{ MPa}$

1.5 MARKINGS, MANUFACTURING METHOD & TOLERANCES AND QUALITY CONTROL

1.5.1 Markings

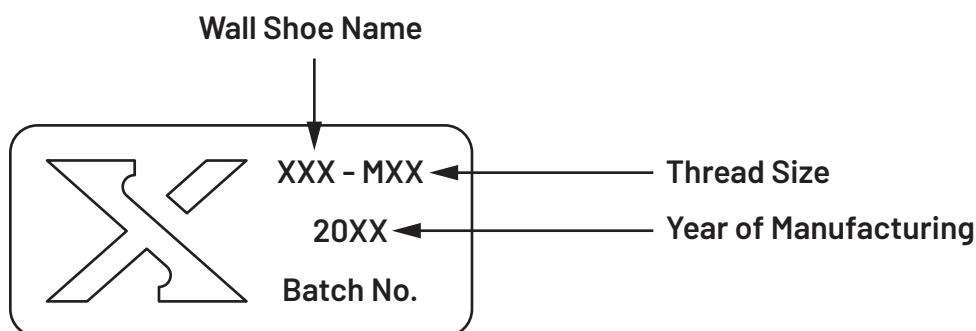


Figure 11: Marking

1.5.2 Manufacturing Method

Table 8: Manufacturing Method

Rebars	Mechanically Cut
Plates	Flame Cut, Laser or Plasma Cut
Welding (Class C)	Robot Welding or Hand Welding (MAG)

1.5.3 Manufacturing Tolerances

Table 9. Manufacturing tolerances are provided as given below:

Rebar Length	± 10
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1.5.4 Quality Control

Quality Control is in accordance with EN 1090-2.

2. RESISTANCES

The tensile resistance of the Wall shoes is calculated as per the following standards:

- EN 1992-4:2018
- EN 1992-1-1:2004
- EN 1993-1-8

Table 10. Design values for Tensile Resistances

Wall Shoe	Anchor Bolt	N_{Ed} [kN]
NSK – M16	M16	62.17
NSK – M20	M20	97.02
NSK – M24	M24	139.79
NSK – M30	M30	222.16
NSK – M39	M39	386.50
SSK – M30	M30	299.20
SSK – M36	M36	435.73
SSK – M39	M39	520.53
SSK – M45	M45	696.53
SSK – M52	M52	937.60

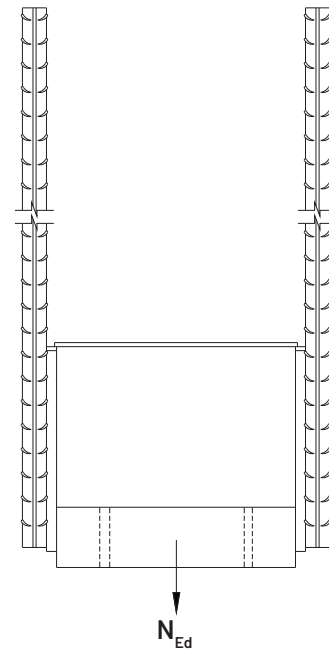


Figure 12: Tensile Resistances

2.1 Fire Resistances

The fire resistances for bolted connection are designed according to EN 1992-1-2. If the fire resistance of the connection is found insufficient, the concrete cover must be increased. The concrete cover of primary rebar of wall shoes should be at least the same as concrete cover for wall reinforcement.

3. REINFORCEMENT

Details of additional reinforcement requirement are provided from next page. The requirement is to be followed so as to ensure accurate force transfer. Continuity reinforcement also needs to be provided in the bottom and intermediate walls to ensure proper transfer of tensile forces.

Table 11. Additional Reinforcement on one side of connection (NSK/SSK)

Normal/High Capacity Wall Shoe	A [mm]	B [mm]	L_{tot} [mm]	L_1 [mm]	$L_{tot, k (mesh)}$ [mm]	$L_{tot, k (hor. bar)}$ [mm]
NSK - M16	2 - T14	2 - T6	200	100	560	670
NSK - M20	2 - T16	3 - T6	300	100	560	670
NSK - M24	2 - T20	2 - T8	300	100	670	870
NSK - M30	2 - T25	4 - T8	400	100	680	885
NSK - M39	2 - T32	4 - T10	550	150	830	1080
SSK - M30	2 - T28	4 - T10	550	150	820	1070
SSK - M36	2 - T32	5 - T10	700	150	845	1095

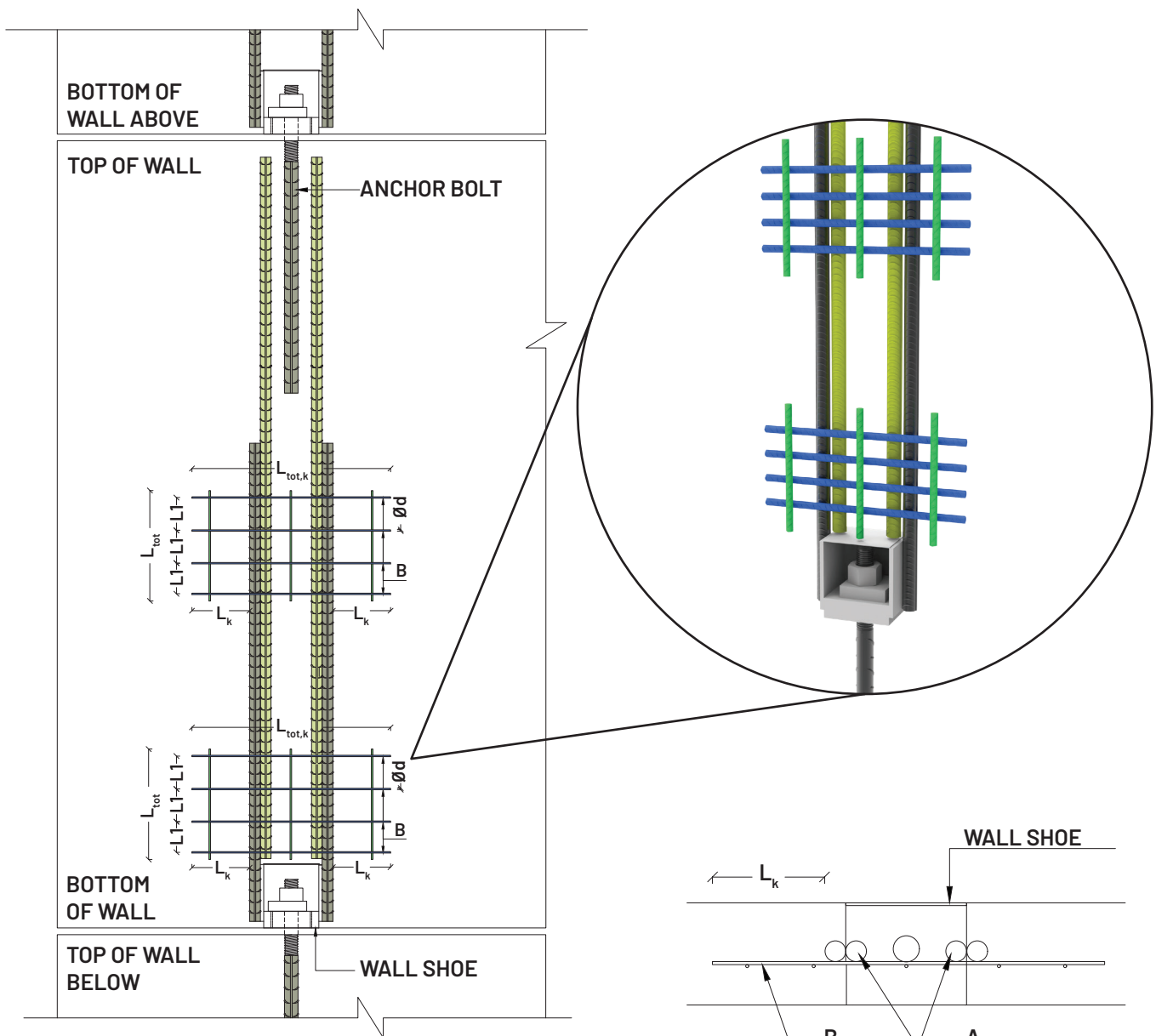


Figure 13: Additional Reinforcement on one side of connection (NSK/SSK)

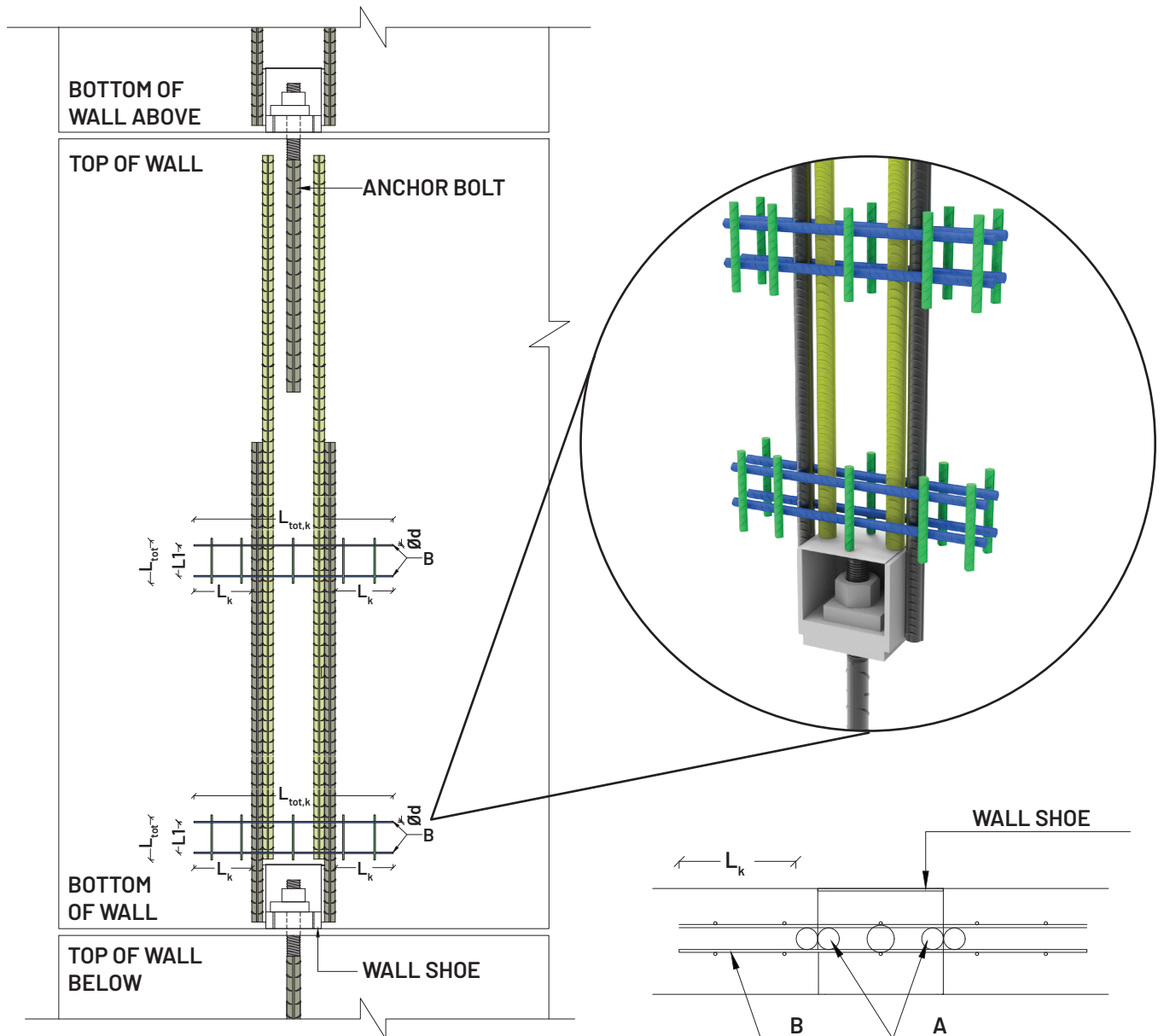


Figure 14: Additional Reinforcement on one side of connection (NSK/SSK)

Table 12. Additional Reinforcement for SSK

High Capacity Wall Shoe	A [mm]	C - Ød1 [mm]	La [mm]	Nos.
SSK - M39	4 - T25	3 - T8	100	3
SSK - M45	4 - T32	4 - T8	120	4
SSK - M52	4 - T32	4 - T8	130	4

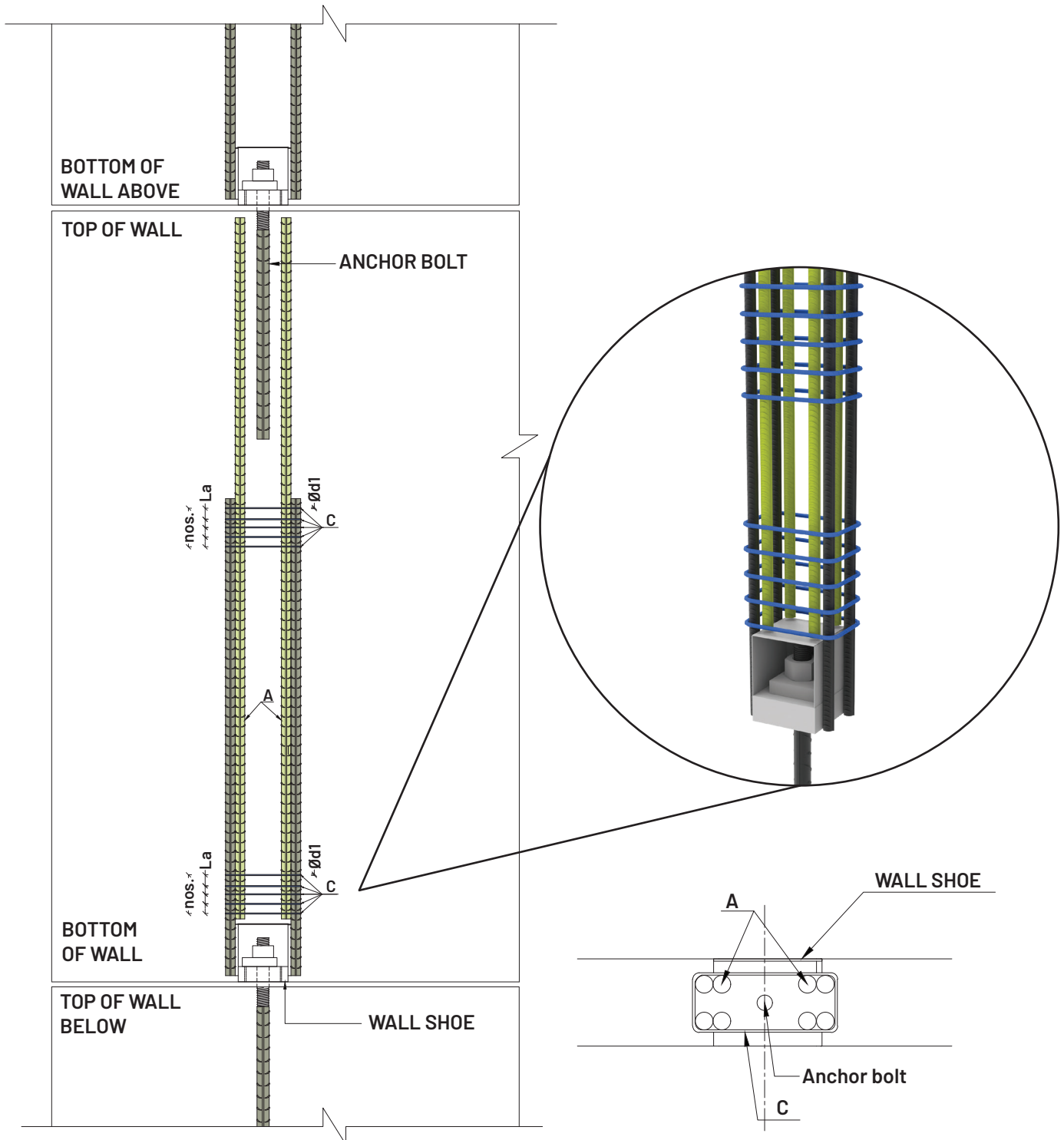


Figure 15: Additional Reinforcement for SSK

4. INSTALLATION OF WALL SHOE

Table 13. Tolerances of Wall shoe

Wall Shoe	Longitudinal Direction $T_{w,l}$ [mm]	Transverse Direction $T_{w,t}$ [mm]
NSK - M16	± 5	± 2
NSK - M20	± 5	± 2
NSK - M24	± 5	± 3
NSK - M30	± 5	± 3
NSK - M39	± 5	± 3
SSK - M30	± 5	± 3
SSK - M36	± 5	± 3
SSK - M39	± 5	± 4
SSK - M45	± 5	± 4
SSK - M52	± 5	± 4

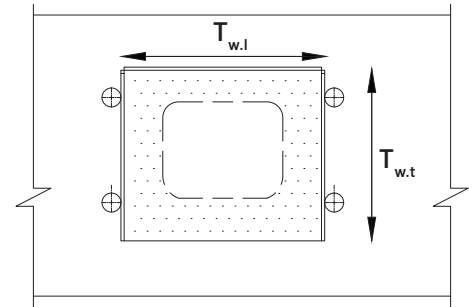


Figure 16: Tolerances of Wall shoe

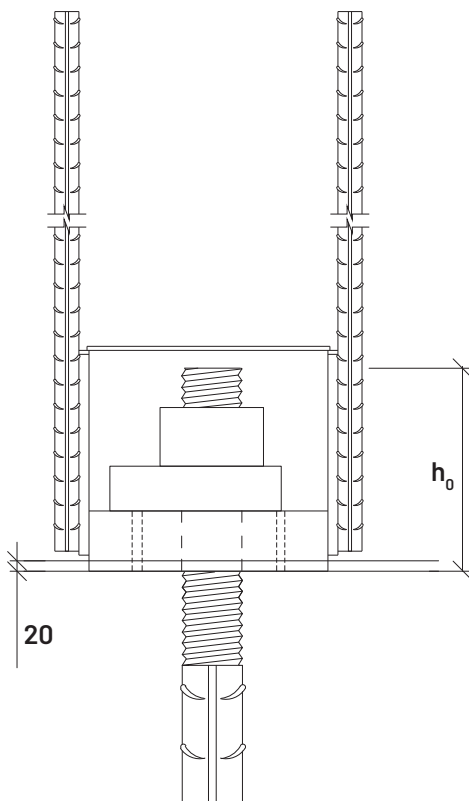


Figure 17: Bolt Height and Group Position

Table 14. Bolt Height and Group Position

Wall Shoe	h_0 [mm]	Tolerance for bolt [mm]
NSK - M16	100	± 3
NSK - M20	110	± 3
NSK - M24	115	± 3
NSK - M30	135	± 3
NSK - M39	160	± 3
SSK - M30	145	± 3
SSK - M36	165	± 4
SSK - M39	185	± 4
SSK - M45	195	± 4
SSK - M52	220	± 5



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