

Technical Manual

Technical changes and
errors reserved

Version 20.2.2017

RWL Double Wire Loop Box

Design according to Eurocodes
(Swedish NA)



2017
R-Group Finland OY

asiakastieto.fi

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1. Description of the system

RWL wire rope loops manufactured by R-Group Finland Oy are steel parts consisting of a high strength steel wire and a steel box. RWL wire rope loops are installed to concrete elements before casting.

When the joint between concrete wall elements is loaded, the longitudinal shear force in the joint is divided to an angled compression component and a horizontal pull component at the indented joint. RWL wire rope loop transfers the shear forces acting in the joint between concrete wall elements by the pull component of the wire rope and the compression component formed by the steel boxes and the seam.

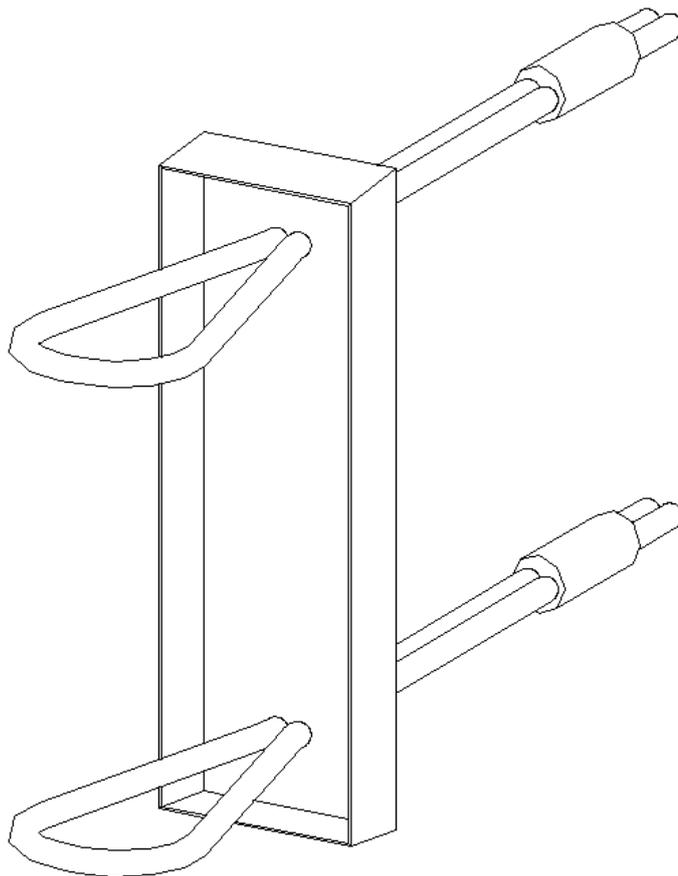


Figure 1. RWL wire rope loop

2. Dimensions and Materials

2.1 Dimensions and tolerances

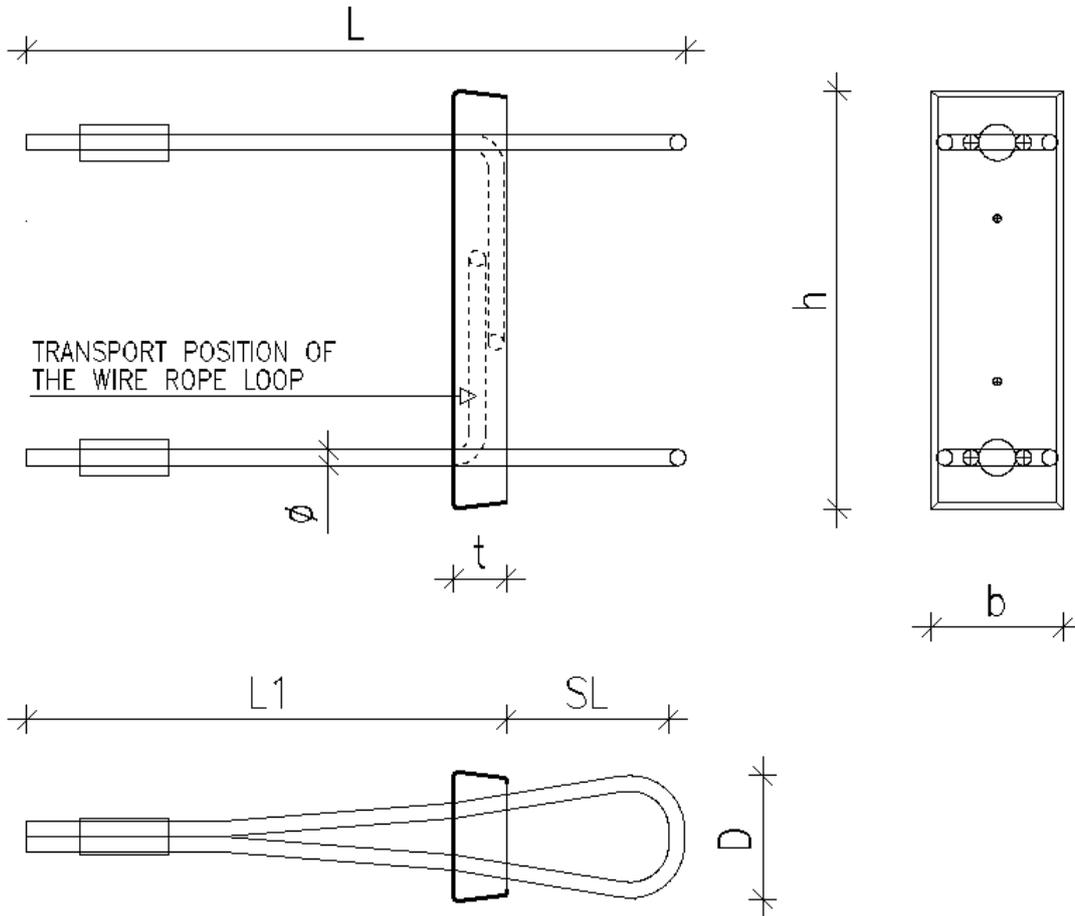


Figure 2. Dimensions of the RWL wire rope loop

Table 1. Dimensions and tolerances of the RWL wire rope loop

Wire rope loop	SL [mm] ±10	L [mm] ±20	L1 [mm] ±10	h [mm] ±2	b [mm] ±2	t [mm] ±2	Ø [mm] 1)	D [mm]
RWL THIN	80	296	210	180	50	20	6	60
RWL WIDE	100	321	215	220	80	25	6	60

1) according to EN 12385 or ISO 2408.

Thickness of the steel plate of the box is 0,5 mm.

2.2 Materials and standards

Table 2. RWL wire rope loop materials and standards

Part	Material	Standard
Steel box	1.0330	EN 10130
Wire rope	high strength steel wire rope SE-Zn	EN 12385 or ISO 2408
Compression sleeve	1.0046	EN 10025

The steel box and the wire rope are zinc coated. Zinced products are passivated with min. 1 month of storage.

3. Manufacturing

3.1 Manufacturing method

The steel box is mechanically cut and bent to shape. The open wire rope is installed to the steel box and attached by the compression sleeve to form a loop. The wire rope is bent in to the steel box and the open part of the steel box is closed by tape to protect from casting concrete.

3.2 Manufacturing markings

Product package is equipped with an R-Steel –sticker, which contains the following information: product type, product name, quantity, ISO9001 and ISO14001 quality and environment system markings, FI marking and product picture.

Products are delivered in cardboard boxes on a truck palette. Cardboard boxes are marked with FI and BY (Concrete Association of Finland) logo and the number of certified product declaration, numbers of the ISO-certificates and the product type and name.

3.3 Quality control

Quality control of the wire rope loops is done according to EN 1090-2 and the instructions according to quality and environment system of the R-Group Finland Oy (ISO9001 and ISO14001). R-Group Finland Oy has a quality control contract with Inspecta Sertifiointi Oy.

4. Resistances

4.1 Calculation principles

The longitudinal shear capacities of the RWL wire rope loops are calculated according to wire rope loop joint calculation method presented in Henrik Brøner Jørgensen, Strength of Loop Connections between Precast Concrete Elements, 2014. Capacities are calculated for static loads with the joint width presented in figure 2. The calculations do not take into account cracks or deformations in the joint.

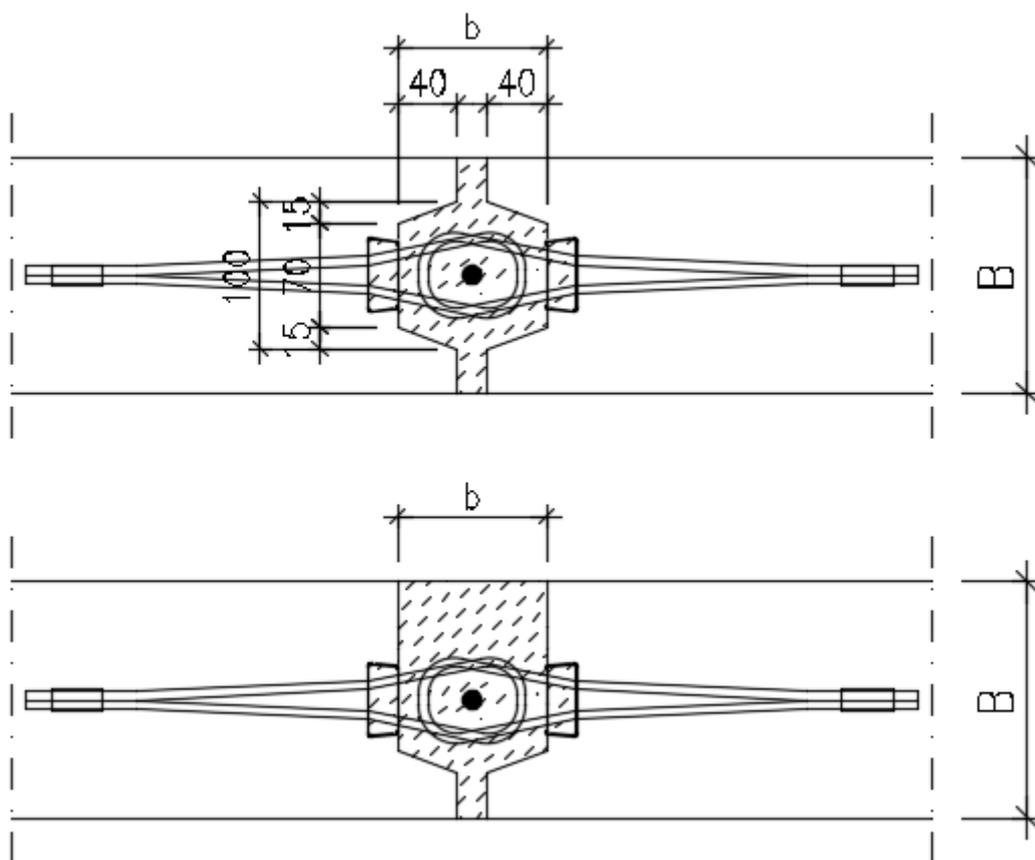


Figure 3. Indented joint type and dimensions used in calculations of longitudinal shear force

Recommended and maximum seam thicknesses for RWL wire rope loops see chapter 5.1.2.

4.2 Design values of resistance for longitudinal shear force

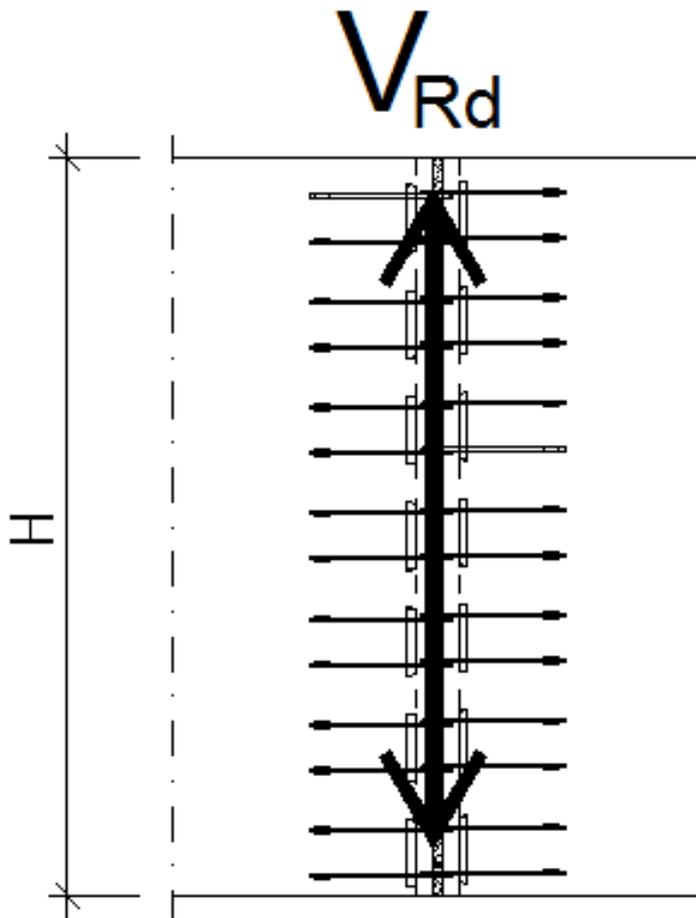


Figure 4. Direction of longitudinal shear force in joint

Design values of resistance presented in the tables are resistances in ultimate limit state. The resistance is defined by the weakest concrete in the joint (element/joint concrete). Resistances are calculated for concrete classes C25/30, C30/37 and C40/50.

Resistances are calculated for two different wall heights and for certain number of RWL wire rope loop boxes in joint. Number of wire rope loop boxes given in resistance tables is the number of wire rope loop boxes in one side of the joint. E.g. in the joint in figure 3 there is seven boxes.

Table 3. Design values of resistance for longitudinal shear force for RWL THIN wire rope loop

Number of RWL boxes [n]	V_{Rd} [kN/m]					
	Wall height H = 3 m			Wall height H = 4 m		
	C25/30	C30/37	C40/50	C25/30	C30/37	C40/50
14	-	-	-	81	91	108
13	-	-	-	77	86	101
12	-	-	-	73	80	95
11	-	-	-	68	75	89
10	85	94	110	64	70	83
9	77	87	102	58	65	76
8	69	79	93	51	60	70
7	60	70	84	45	52	63
6	51	60	75	39	45	56
5	43	50	62	-	-	-
4	34	40	50	-	-	-

Table 4. Design values of resistance for longitudinal shear force for RWL WIDE wire rope loop

Number of RWL boxes [n]	V_{Rd} [kN/m]					
	Wall height H = 3 m			Wall height H = 4 m		
	C25/30	C30/37	C40/50	C25/30	C30/37	C40/50
14	-	-	-	130	145	175
13	-	-	-	122	137	164
12	-	-	-	114	128	153
11	-	-	-	106	119	142
10	131	146	174	99	110	131
9	121	134	160	91	101	120
8	110	122	145	82	92	108
7	99	110	129	74	82	97
6	88	97	114	66	73	85
5	76	83	97	-	-	-
4	63	69	80	-	-	-

4.3 Design values of resistance for transversal shear force

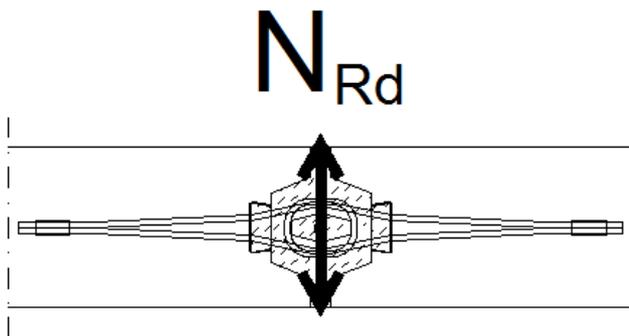


Figure 5. Direction of transversal shear force

Design values of resistance presented in the tables are resistances in ultimate limit state. The resistance is defined by the weakest concrete in the joint (element/joint concrete).

Design values for transversal shear force apply for one pair of RWL wire rope loops (one on each side of the joint). Distance between wire rope loop pairs must be according to section 5.1.1. and RWL seam dimensions according to figure 6 or 7.

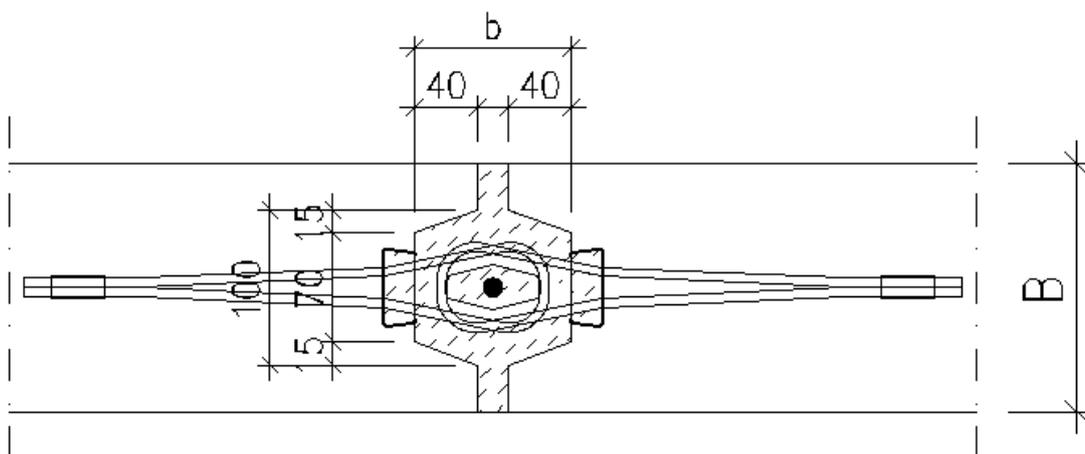


Figure 6. Indented joint dimensions used in calculations for transversal shear force resistance in table 5

Table 5. Design values of resistance for transversal shear force for RWL wire rope loop, seam type and dimensions according to figure 6

Wire rope loop	B [mm]	Design value for transversal shear force in one pair of wire rope loops N_{Rd} [kN]		
		C25/30	C30/37	C40/50
RWL THIN	≥ 120	5,4	6,1	7,4
RWL WIDE	≥ 140	6,6	7,4	9,0

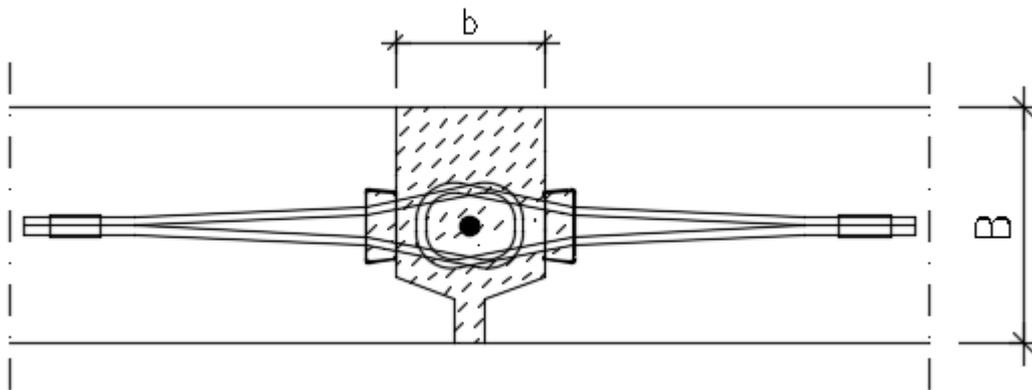


Figure 7. Indented joint dimensions used in calculations for transversal shear force resistance in table 6

Table 6. Design values of resistance for transversal shear force for RWL wire rope loop, seam type and dimensions according to figure 7

Wire rope loop	B [mm]	Design value for transversal shear force in one pair of wire rope loops N_{Rd} [kN]		
		C25/30	C30/37	C40/50
RWL THIN	≥ 120	0,9	1,2	1,4
RWL WIDE	≥ 140	1,7	2,1	2,4

4.4 Design value for tensile force

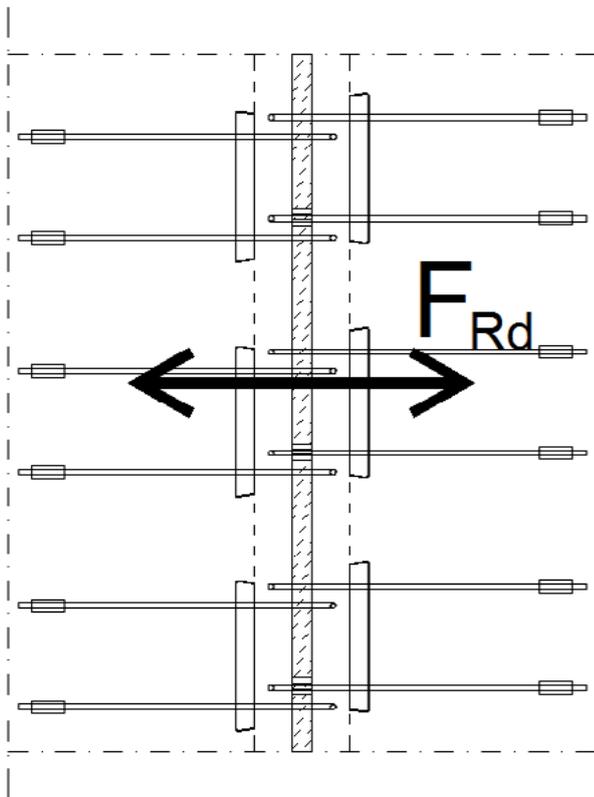


Figure 8. Direction of tensile force

Table 7. Design value for tensile force in one pair of wire rope loops

Wire rope loop	Design value for tensile force in one pair of wire rope loops F_{Rd} [kN]		
	C25/30	C30/37	C40/50
RWL THIN	13,6	14,9	16,3
RWL WIDE	13,6	14,9	16,3

Design values for transversal shear force apply for one pair of RWL wire rope loops (one on each side of the joint). Distance between wire rope loop pairs must be according to section 5.1.1.

Design values of resistance given in table 7 do not take into account cracks or deformations in RWL wire rope loop joint.

4.5 Resistances for combined forces

Resistance of RWL wire rope loop joint for combined forces may be calculated according to equation

$$\frac{V_{Ed}}{V_{Rd}} + \frac{N_{Ed}}{N_{Rd}} + \frac{F_{Ed}}{F_{Rd}} \leq 1$$

in which

V_{Ed} = design value of longitudinal shear force

V_{Rd} = design value of resistance for longitudinal shear force

N_{Ed} = design value of transversal shear force

N_{Rd} = design value of resistance for transversal shear force

F_{Ed} = design value for tensile force

F_{Rd} = design value of resistance for tensile force

5. Application

5.1 Limitations for application

Resistances presented in tables 2...5 are calculated for static loads. RWL wire rope loops are not designed to be used for lifting or as lifting loops.

Resistance of the RWL wire rope loop is defined by the weakest concrete in the joint (element/joint concrete). The resistance calculations do not take into account cracks or deformations in the joint. Resistances of the RWL wire rope loops are calculated for the joint width presented in figure 2 and it is assumed that the steel boxes and the seam are fully filled with concrete.

5.1.1 Minimum edge and center distances

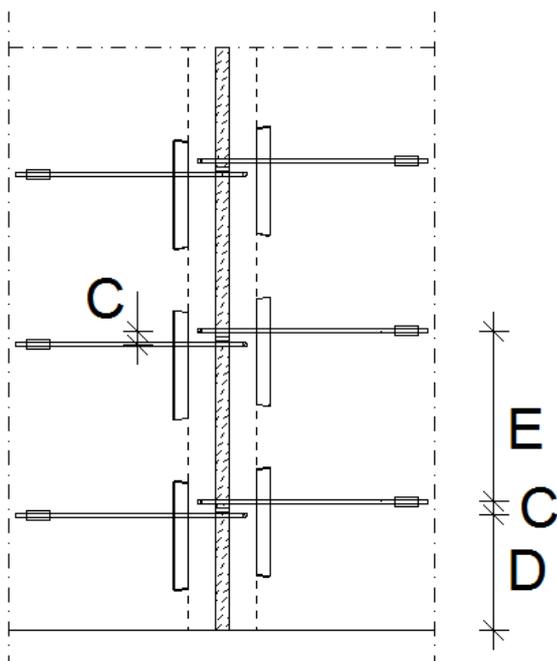


Figure 9. Distances of the RWL wire rope loops

Table 8. Minimum distances of RWL wire rope loops

Wire rope loop	center to center E_{min} [mm]	edge distance D_{min} [mm]	center to center C_{max} [mm]	minimum width B_{min} [mm]
RWL THIN	250	250	20	120
RWL WIDE	300	300	25	140

Center to center E_{min} = minimum distance between wire rope loops at the same side of the joint.

Edge distance D_{min} = the minimum distance of the wire rope loop to the upper and lower edge of the concrete element.

Center to center C_{max} = minimum distance between wire rope loops at opposite sides of the joint.

Minimum width B_{min} = minimum total wall width.

The size of the wire rope loops must be chosen according to the thickness of the joint to enable the vertical ribbed steel bar in the joint to pass through the wire rope loops on both sides of the joint.

The total wall width of the concrete wall element must be chosen taking into account the width of the indented joint (figure 2), the width of the steel box of the wire rope loop (table 1) and the required concrete cover.

5.1.2 Recommended and maximum seam thickness

Recommended and maximum seam thickness are according to table 8 and figure 7.

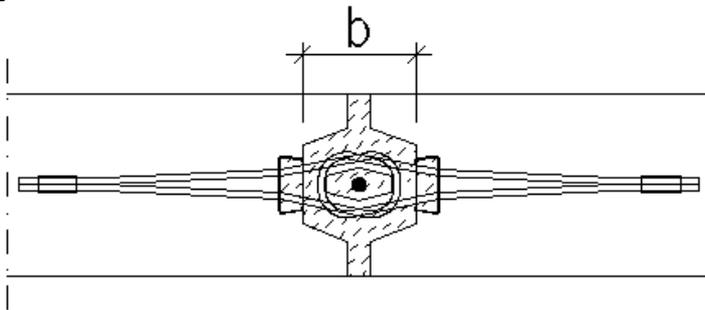


Figure 10. Seam thickness b

Table 9. Recommended and maximum thicknesses of the seam b

Wire rope loop	Recommended seam thickness b [mm]	Maximum seam thickness b [mm]
RWL THIN	90...130	130
RWL WIDE	110...160	160

Maximum values for seam thickness b must not be exceeded when using RWL wire rope loops.

5.2 Reinforcement of the concrete

5.2.1 Reinforcement of the joint

When using the RWL wire rope loops, a vertical ribbed steel bar must always be installed to the joint according to Figure 8. This ribbed steel bar is installed through the wire rope loops according to figure 8.

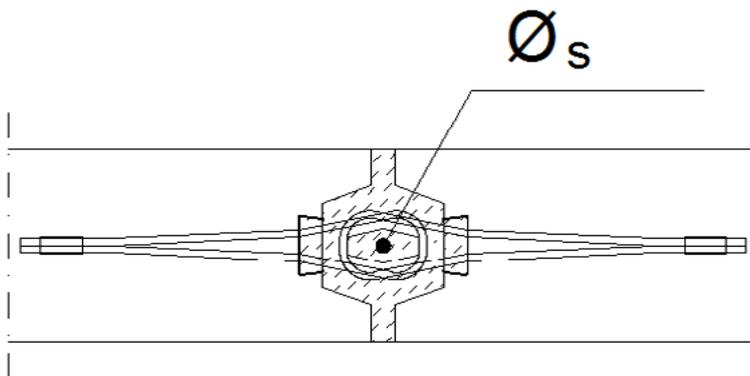


Figure 11. Ribbed steel bar in the joint

Table 10. Size of the ribbed steel bar in the joint, steel B500B (K500C-T)

Wire rope loop	Diameter of the ribbed steel bar Ø_s [mm]
RWL THIN RWL WIDE	12

5.2.2 Reinforcement of the concrete element

The wall elements must be reinforced according to the wall element design.

1) When RWL wire rope loops are used to transfer forces

When RWL wire rope loops are used to transfer forces in the joint, anchorage of the wire rope loop must be secured by overlapping the wire rope loop sufficiently with the reinforcement of the concrete element. For RWL wire rope the greatest design value for tensile force 23 kN. The anchorage of the wire rope loops must be designed for this force when using design values for resistances presented in tables 2...5.

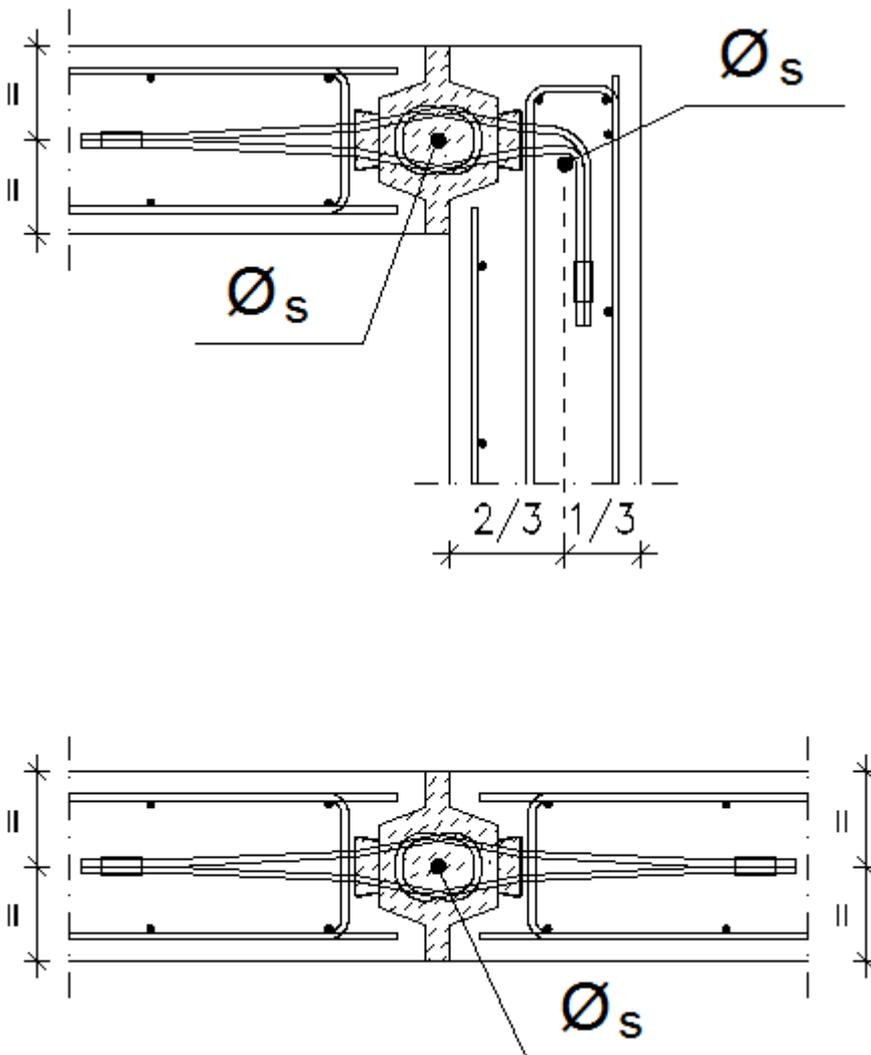


Figure 12. Example of element edge reinforcement when transferring forces

1) When RWL wire rope loops are not used to transfer forces

When RWL wire rope loops are used to limit cracking of the seam or to tie elements together without defining the required force edge reinforcement of the element may be done according to principles presented in figure 9. Edge reinforcement 2-Ø10 and additional reinforcement according to figure 9 is recommended.

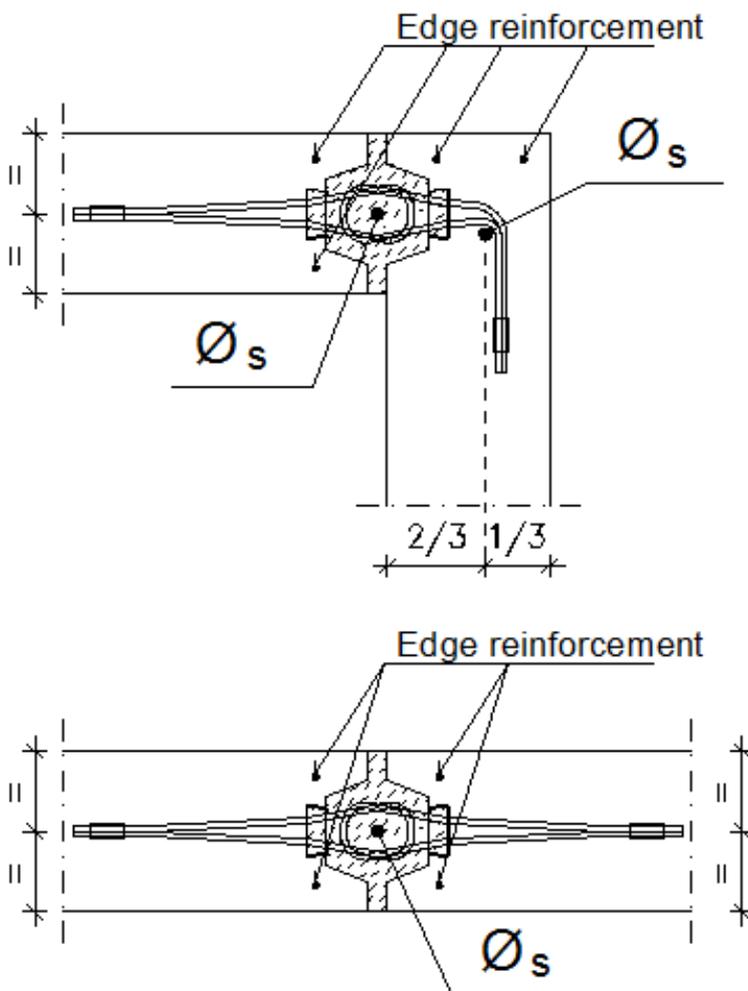


Figure 13. Example of element edge reinforcement when not transferring forces

6. Installation

6.1 Attachment to formwork

The RWL wire rope loop must be attached securely so it cannot move during casting of the concrete. At the RWL wire rope loop the concrete must be compressed carefully. The RWL wire rope loop cannot be vibrated.

The RWL wire rope loops may be fastened to formwork with nails or by magnets. The part of the wire rope which enters the concrete element is installed amidst the reinforcement. The wire rope doesn't have to be tied to the reinforcement.

7. Supervision of Installation

7.1 Installing the RWL wire rope loops

Check list before casting:

- RWL wire rope loop is in good condition
- RWL wire rope loop is according to designs and in the right place
- RWL wire rope loop is attached firmly
- the required additional reinforcement is installed

During the casting:

- RWL wire rope loop stays in the right place
- the concrete is thoroughly vibrated around the RWL wire rope loop

After the casting:

- the situation of the RWL wire rope loop is according to designs
- the tape covering the steel box is removed at the factory after the concrete is hardened.

About R-Group

R-Group is a leading provider of steel connections for precast and cast-in- situ construction around the globe.

With over three decades of our participation in huge projects, we don't compromise on quality or customer satisfaction and we create connections for a lifetime.

Our customer-oriented service, excellent and reliable network of suppliers plus our extensive product portfolio ensure that we are able to offer professional and flexible solutions for any kind of projects.

In our operations we comply with the ISO 9001 and 14001 standards

R-Group Finland Oy

Head Office:

Katajanokankatu 6B 12,
00160 Helsinki Finland
Tel : +358 (0)20 722 9420
VAT No. : FI- 2025044-5

RSTEEL[®]

 www.repo.eu
 info@repo.eu
 [linkedin/rsteel](https://www.linkedin.com/company/rsteel)

R-Group Baltic OÜ

Lõõtsa 2B
11415 TALLINN
Mob. : +372 578 396 76



OOO R-Group

18A Bolshoj pr. V.O.
199034, St.Petersburg Russia
Tel : +358 (0)20 722 9420
+372 578 396 76

R-Group Gulf FZE

PO Box 14755
Ras Al Khaymah U.A.E
Tel : +971 505119223
+91 840 894 45 78

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