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EVL

Single Wire Loop Box

TECHNICAL MANUAL

EN / WLB / DC- 001

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ENDURA

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1. INTRODUCTION

EVL wire loops are primarily used in thin precast concrete elements to easily and effectively form joints with other concrete elements. The joints with EVL wire loops are designed to transfer shear forces.

1.1. Product description

EVL wire Loops are composed of a steel box, a single wire rope per box and an anchorage sleeve.

Figure: 1

EVL wire loops are designed primarily to transfer vertical shear forces between precast concrete walls. Recesses are formed in the wall joint and act as a shear key. The connection includes overlapping wire loops that create a restraint for the grout; after the concrete has been hardened, they transfer tensile forces from one wire loop to another. The tensile forces are transferred from the wire loop to the wall (element) through the anchoring sleeve, which is attached at the end of the wire rope. Collectively, they establish an optimal mechanism for transferring vertical shear forces among concrete elements.

1.2. Materials

The following materials are used in the product are as below table 1.

Table 1. Materials used in EVL wire loops

Part	Material	Description
Steel box	Galvanized steel plate 0.5....0.7 mm	SFS-EN 10130 1.0330
Wire loop	Steel wire Ø6 6x19 IWRC Steel wire Ø6 6x19 IWRC	SFS-EN 12385 (1770 MPa)
Anchorage sleeve	Steel compression sleeve Ø12-L28 or Ø18-L40	SFS-EN 10025, 10046
Protective tape	Duct tape	

EVL wire loops are zinc coated. Zinc-coated products undergo passivation with a minimum storage duration of 1.5 months. The EVL wire loop box is designed using steel with a minimum yield strength of 235 MPa.

1.3. Storage Environment

Wire loop boxes shall be stored in dry, covered conditions at all times. Galvanised steel products shall be stored undercover to prevent unnecessary exposure to moisture in any form. Under no circumstances shall wire loop boxes be left in open outdoor conditions without overhead weather protection. Where a fully enclosed indoor storage facility is not available on site, the minimum acceptable provision is a covered shelter that gives complete protection from rainfall; nevertheless, a sealed, dry internal storage space remains the preferred and recommended arrangement.

1.4. Product geometry

The dimensions and tolerances of EVL wire loops are given in table 2.

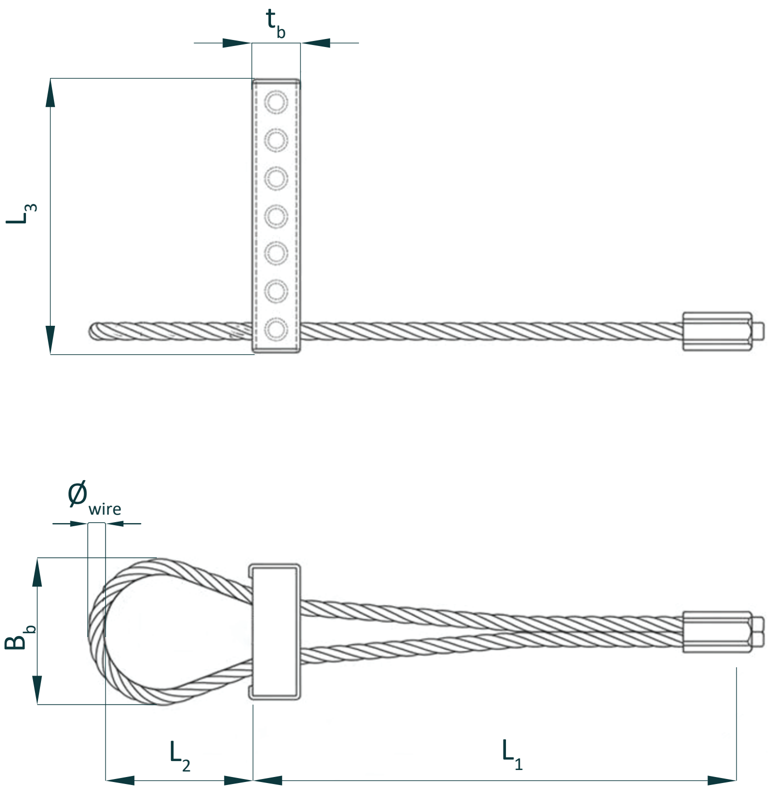


Figure: 2

Table 2. Dimensions and allowable tolerances of EVL wire loops

EVL wire loop	L_1 [mm]	L_2 [mm]	L_3 [mm]	B_b [mm]	t_b [mm]	$\varnothing_{wire}$ [mm]
EVL-60	190	60	160	55	20	6
EVL-80	190	80	160	55	20	6
EVL-100	190	100	160	55	20	6
EVL-120	190	120	160	55	20	6
EVL-140	350	140	200	75	30	9
Tolerances	±2	±2	±2	±2	±2	-

Thickness of the steel plate box: 0.5mm...0.7mm

2. MANUFACTURING

2.1. Manufacturing Method

The steel sheet box is formed by precision cutting and sequential press-bending operations. A single wire rope is fitted through the box and swaged into a compression sleeve to form the loop. The loop is folded flush within the box and the open face sealed with protective tape prior to despatch, preventing concrete ingress during casting of the precast element.

2.2. Manufacturing Markings

Product package is equipped with an ENDURA – sticker, which contains the following information: Product type, product name, quantity and product picture. Products are delivered in plywood boxes on a truck pallet.

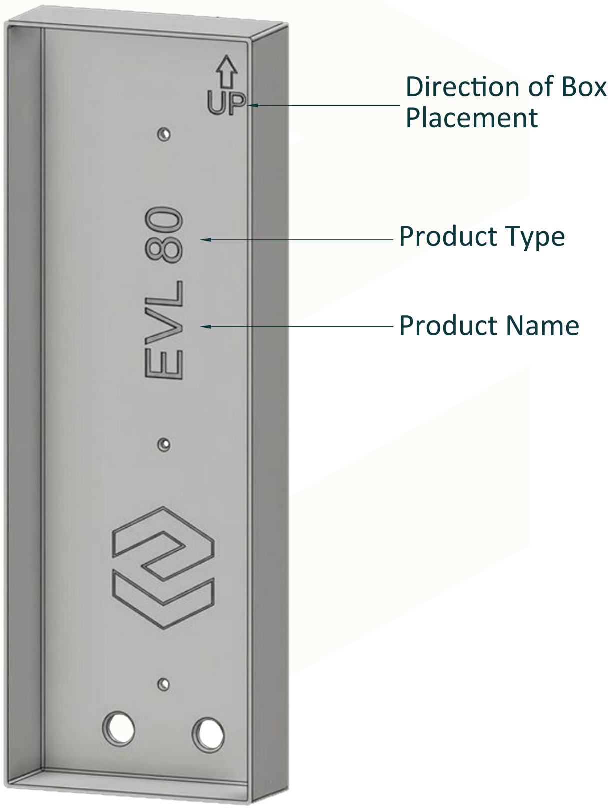


Figure: 3

The product’s marking is embossed directly onto the box during the production process.

2.3. Quality Control

Quality control procedures for EVL wire loop boxes are executed in accordance with EN 1090-2, covering material verification, dimensional inspection, and wire rope swage integrity across all stages of manufacture. Incoming materials are checked against mill certificates for conformity. Batch traceability records linking material certificates, production date, and inspection results are maintained for each production run.

3. TECHNICAL INFORMATION

3.1. Structural Behavior

The wire loop box is a non-alloy steel sheet component that is permanently cast into the edge face of a precast concrete wall element and serves as the primary structural interface between the wall panel and the grouted connection joint. The system consists of a high-strength steel wire rope loop housed within a steel box, providing a durable and reliable connection solution. These loops are designed to transfer tensile forces effectively, ensuring reliable anchorage within precast concrete elements. The joint recess shall be filled with high-strength, non-shrink grout after installation. The connection shall be considered load-bearing only after the grout has achieved the specified design strength.

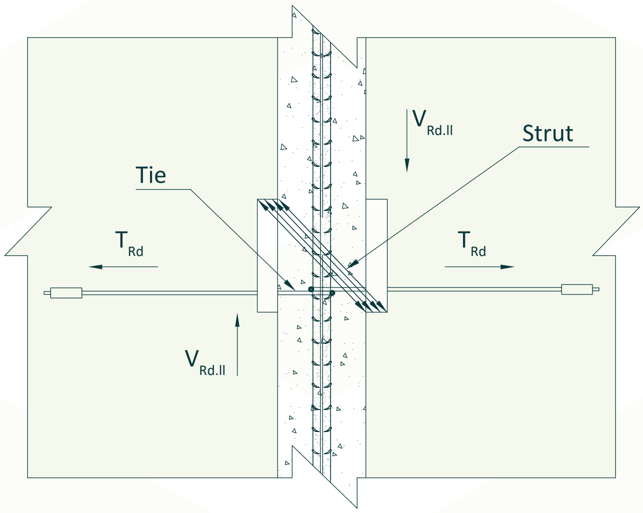


Figure 4: Vertical Shear Load Transfer

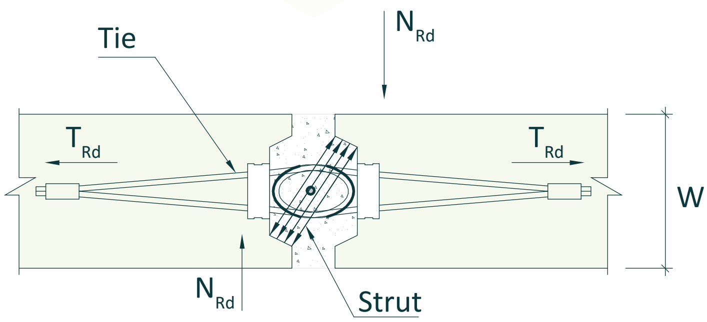


Figure 5: Transverse Shear Load Transfer

3.2. Geometric requirements for concrete elements

The geometric requirements for concrete elements are given in Table 3.

Table 3. Geometric requirements for concrete elements (see also Figure 1 for the definition of symbols used in the table)

EVL wire loop	Geometric horizontal requirements			Geometric vertical requirements		
	W [mm]	b [mm]	Overlap [mm]	t1 [mm]	b1 [mm]	S [mm]
EVL-60	≥ 100	80	40	≥ 150	≥ 150	≥ 250 / ≤ 800
EVL-80	≥ 100	100	60	≥ 150	≥ 150	≥ 250 / ≤ 800
EVL-100	≥ 100	120	80	≥ 150	≥ 150	≥ 250 / ≤ 800
EVL-120	≥ 100	140	100	≥ 150	≥ 150	≥ 250 / ≤ 800
EVL-140	≥ 150	160	120	≥ 250	≥ 250	≥ 350 / ≤ 800

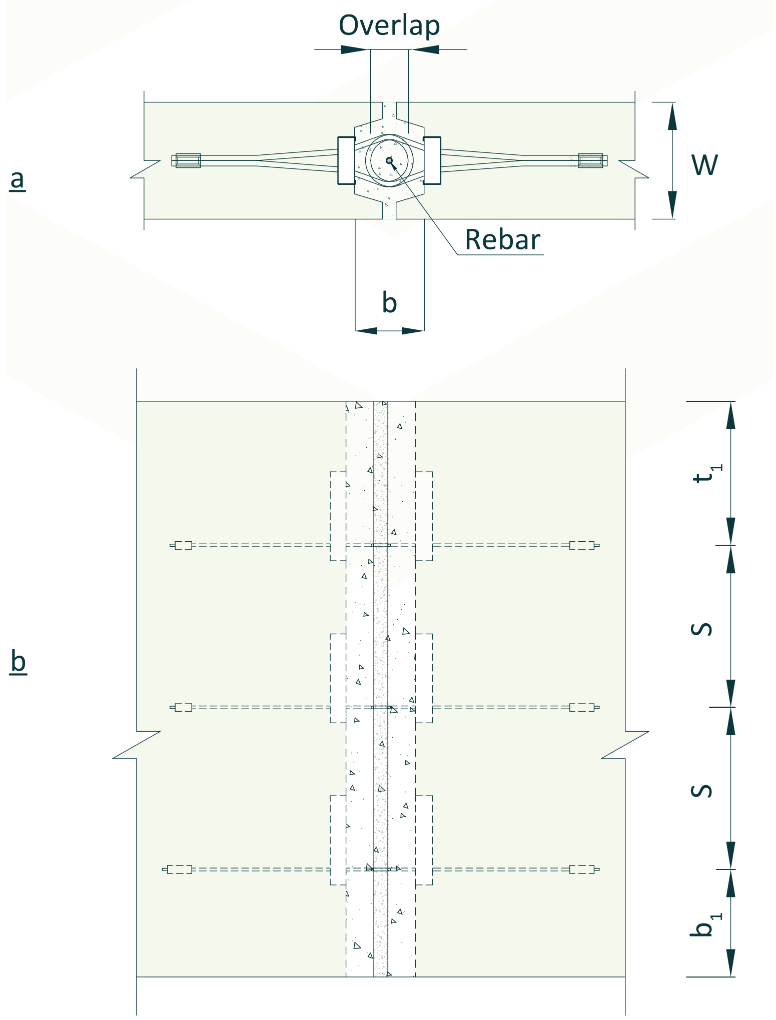


Figure- 6

Figure 6. Symbols used to represent geometric specifications for concrete elements using EVL wire loops. Symbols representing both horizontal and vertical requirements are depicted in (a) and (b) respectively.

Note that: Vertically, the loops are usually fitted without any offset, so that the one wire loop to another wire loop (vertical centre-to-centre) maximum 20 mm (see Figure 4).

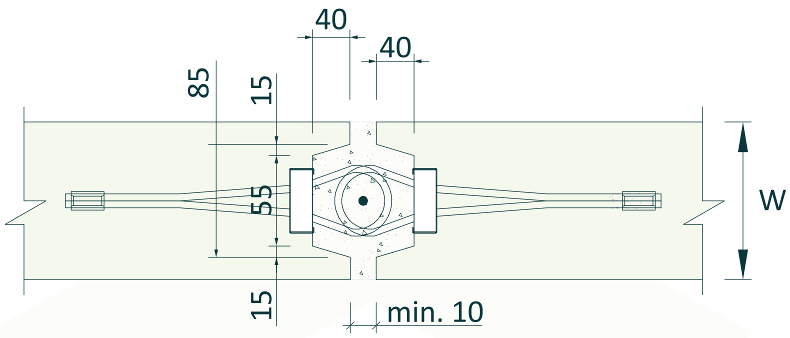


Figure - 7: Minimum dimensions of the joint for EVL

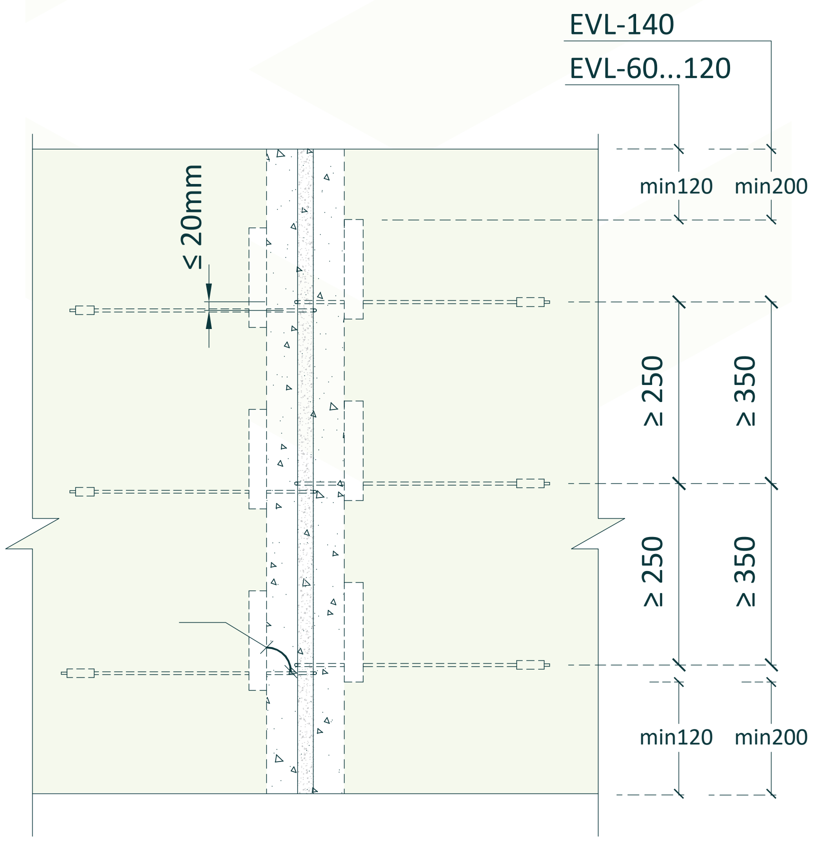


Figure 8. Minimum spacing of the joint for EVL

3.3. Environmental conditions

EVL wire loops are suitable for interior and exterior applications. Concrete cover over the wire loop and steel box shall comply with EN 1992-1-1 §4.4.1 for the applicable exposure class. The galvanized surface treatment of the box and wire rope provides corrosion resistance appropriate for standard building environments.

3.4. Load bearing properties

EVL wire loops transfer static loads, and their capacities are calculated as per the Eurocode. In the final condition, after the joint has been grouted, it must reach the required design strength (non-shrink grout must be used in joint).
EVL wire loop boxes are structural connection devices only. They must not be used to lift, handle, or relocate precast panels under any circumstances.

3.5. Temporary Condition

Prior to joint grouting, EVL wire loops carry no structural load and must not be relied upon for panel stability. Independent temporary bracing shall be provided and maintained throughout the erection stage to secure each panel in position. Load transfer through the EVL connection commences only after the joint grout has achieved the specified characteristic compressive strength.

3.6. Final Condition

In the final condition, once the joint grout has reached the required design strength, the EVL connection is fully load-bearing. Force transfer across the joint is governed by a strut-and-tie mechanism: tensile forces are carried by the interlocking wire loops and lacing bar, while compressive struts form within the grouted recess between the shear keys of the opposing panel faces.

3.7. Fire-resistance

The wall must satisfy the specific minimum thickness requirements according to EN 1992-1-2 such that the temperature in EVL wire loops would not exceed 350 °C.

4. RESISTANCES

4.1. Design values of resistance for transverse shear force

The design capacities are given below are for ultimate limit state design, specified at the weakest joint in the section. The transverse capacities for shear-keyed joints apply to one pair of wire loop boxes, while for smooth joints, they are specified per meter length of the joint. EVL wire loops shall be embedded in reinforced concrete wall or column elements cast with minimum concrete strength class C25/30 or will be higher.

4.1.1. Transverse Shear Resistance with the Indented Joint

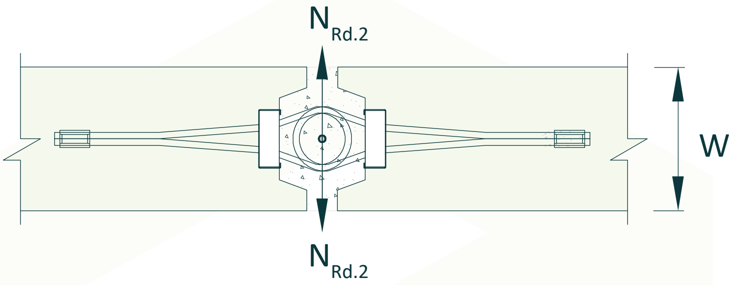


Figure 9: Shear resistance with indentation

Table 4: Design value of Transverse Shear Resistances with intended for one pair of EVL wire loop :

Min. Wall thickness (mm)	Transverse Shear resistance of joint with EVL-60...120, [KN]						Transverse Shear resistance of joint with EVL-140, [KN]					
	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
120	13.6	14.9	16.1	17.2	18.3	19.3	-	-	-	-	-	-
≥ 140	18.6	20.3	22.0	23.5	24.9	26.3	-	-	-	-	-	-
150	-	-	-	-	-	-	16.1	17.6	19.0	20.3	21.6	22.8
≥ 160							18.6	20.3	22.0	23.5	24.9	26.3

4.1.2. Transverse Shear Resistance with Smooth joint

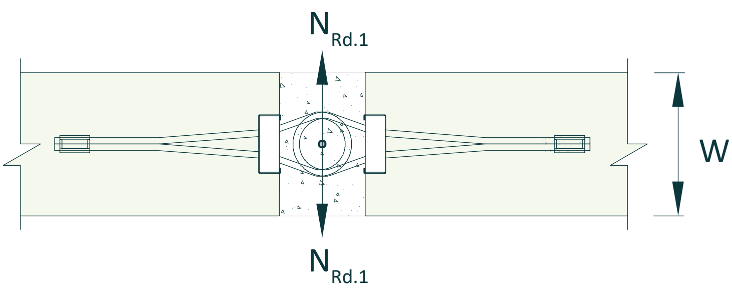


Figure 10: Shear Resistance with Smooth Joint

Table 5: Design value of Transverse Shear Resistances with smooth for one pair of EVL wire loop :

Min. Wall thickness (mm)	Transverse Shear resistance of joint with EVL-60...120, [KN]						Transverse Shear resistance of joint with EVL-140, [KN]					
	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
120	2.6	2.8	3.0	3.3	3.5	3.6	-	-	-	-	-	-
150	-	-	-	-	-	-	3.7	4.1	4.4	4.7	5.0	5.3

ΣNRD = ηEVL x NRD {kN/m}

ηEVL = number of EVL wire loops per meter.

Example = if we are using EVL - 60, center-to-center spacing is 300 mm, concrete is C35/45

ΣNRD = 1200mm / 300mm x 3.0 kN = 4 x 3.00 kN = 12.00 kN.

4.2. Parallel shear resistance

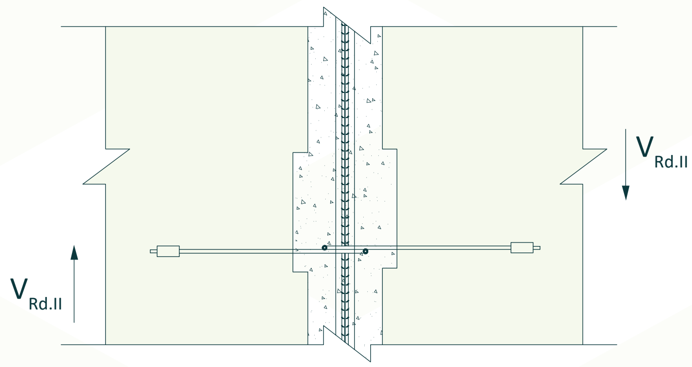


Figure 11. Depiction of parallel shear

The design value of parallel shear resistance VRd,s for EVL wire loops is determined based on the specified concrete strength classes. Ensure that the actual applied shear force does not exceed the calculated design resistance provided in the table. Design values for the parallel shear resistances for the final design stage given in Table 4, and for the accidental design resistance with sudden load redistribution, as in Table 5

Note: Each joint should have a one pair of EVL wire loops.

Table 6. Design value of Parallel shear resistances of one pair of EVL wire loops

Shear resistance of joint with EVL-60...120, [KN]						Shear resistance of joint with EVL-140, [KN]					
C25/30	C30/37	C35/45	C40/50	C45/55	C50/60	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
13.5	15.8	18.2	20.5	22.7	25.0	30.1	35.3	40.3	45.0	49.4	53.6

ΣVRD.II = ηEVL x VRD.II {kN}

ηEVL = number of EVL wire loops per meter.

Example = if we are using EVL - 60, center-to-center spacing is 300 mm, concrete is C35/45

ΣVRD.II = 1200mm / 300mm x 18.2 kN = 4 x 18.2 kN = 72.8 kN.

4.3. Tensile Shear Resistance

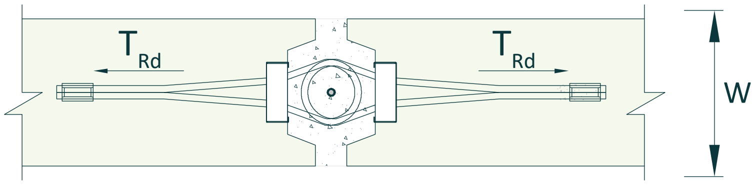


Figure 12

Table 7. Tensile shear resistances for the final design stage

Tensile Shear resistance of joint with EVL-60...120, [KN]						Tensile Shear resistance of joint with EVL-140, [KN					
C25/30	C30/37	C35/45	C40/50	C45/55	C50/60	C25/30	C30/37	C35/45	C40/50	C45/55	C50/60
9.48	11.18	12.78	14.45	16.08	17.68	22.2	26.2	30.1	34.0	37.8	41.7

ΣTRD = ηEVL x TRD {kN}
ηEVL = number of EVL wire loops per meter.
Example = we are using EVL - 60, center-to-center spacing is 300 mm; concrete is C35/45
ΣTRD = 1200mm / 300mm x 12.78 kN = 4 x 12.78 kN = 51.12 kN

4.4. Combined Forces

When EVL wire loops are subjected to simultaneous shear and tensile loading, the combined utilisation must satisfy the following interaction condition at ultimate limit state.
For the verification of combined parallel shear and tensile forces, the following interaction equation should be applied:

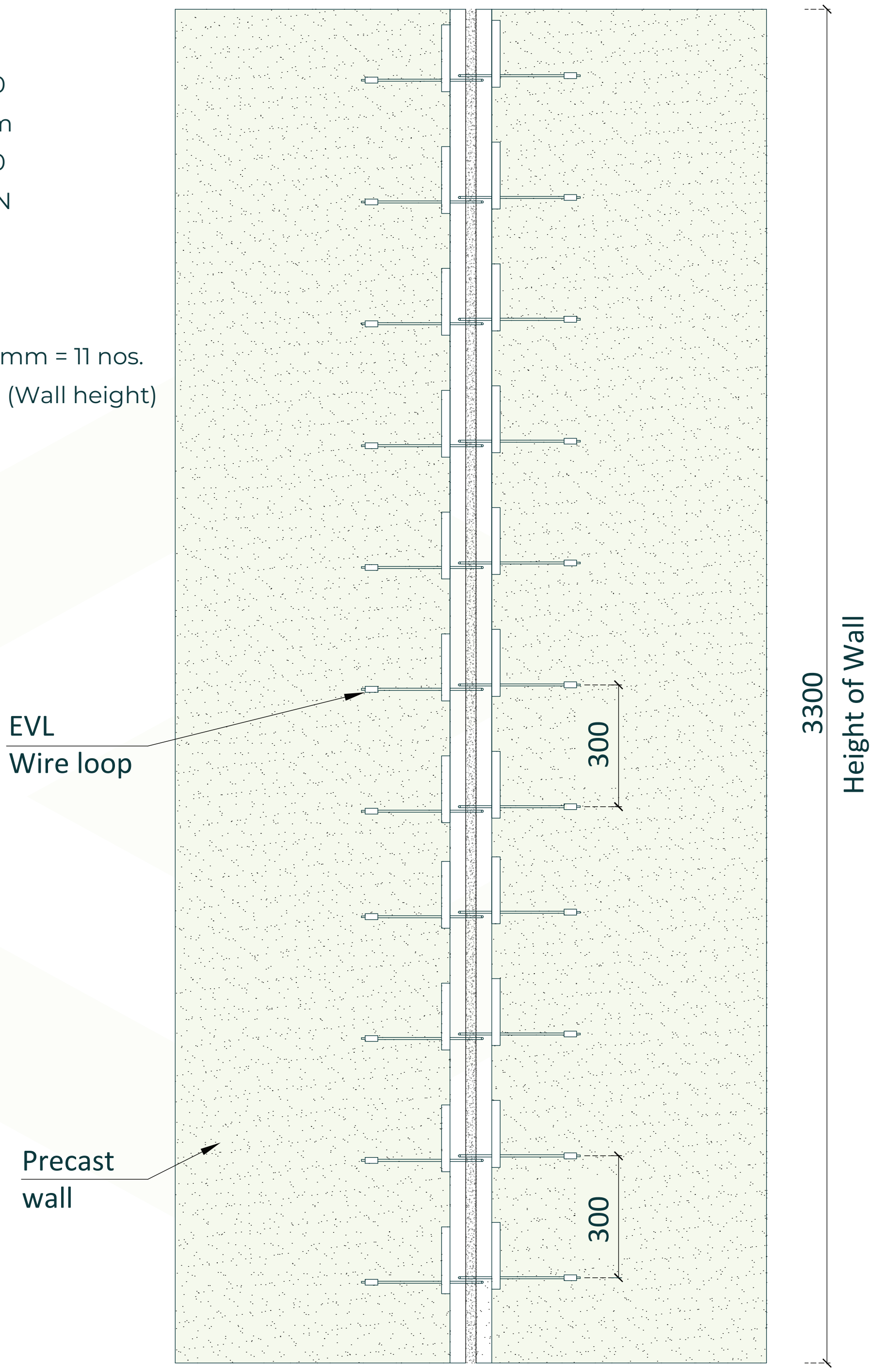
$$\frac{V_{ED.II}}{V_{RD.II}} + \frac{N_{ED}}{N_{RD}} + \frac{T_{ED}}{T_{RD}}$$

Where:
$V_{ED.II}$ = Parallel shear force
N_{ED} = Transverse shear force
T_{ED} = Tensile shear force
N_{RD} = Parallel resistance for shear force
V_{RD} = Transverse resistance for shear force
T_{RD} = Tensile resistance for shear force

Design Example

Concrete Grade = C25/30
Thickness of wall = 120mm
Concrete Grout = C25/30
Parallel shear load VRD.II = 58.5 kN

$\Sigma V_{RD.II} = \eta_{EVL} \times V_{RD.II}$ {kN}
η_{EVL} = number of EVL wire loops
Nos. of Wire Loop = 3300mm / 300mm = 11 nos.
Use 11 nos. of wire loop in 3300mm (Wall height)
$\Sigma V_{RD.II} = \eta_{EVL} \times V_{RD.II}$ {kN}
$\Sigma V_{RD.II}$ =11 x 13.5 kN = 148.5 kN
$V_{Ed.II} / \Sigma V_{RD.II}$ = 58.5/148.5 = 0.39<1.0



4.5. Additional reinforcement

Concrete elements that use EVL wire loops must be suitably designed to endure a variety of loading conditions and be able to transfer the required loads to the EVL wire loops.
To take the maximum load-bearing capacity of EVL wire loops, reinforcement as per Figure 13 must be followed in the concrete element (this does not have to be additional reinforcement). The supplementary reinforcement shown in the diagrams is intended to prevent premature concrete splitting and to ensure effective anchorage of the wire loops under service and ultimate limit states.
Note that reinforcement in the shape of U-stirrups is provided as close to the loop box as possible and is properly anchored in the concrete.

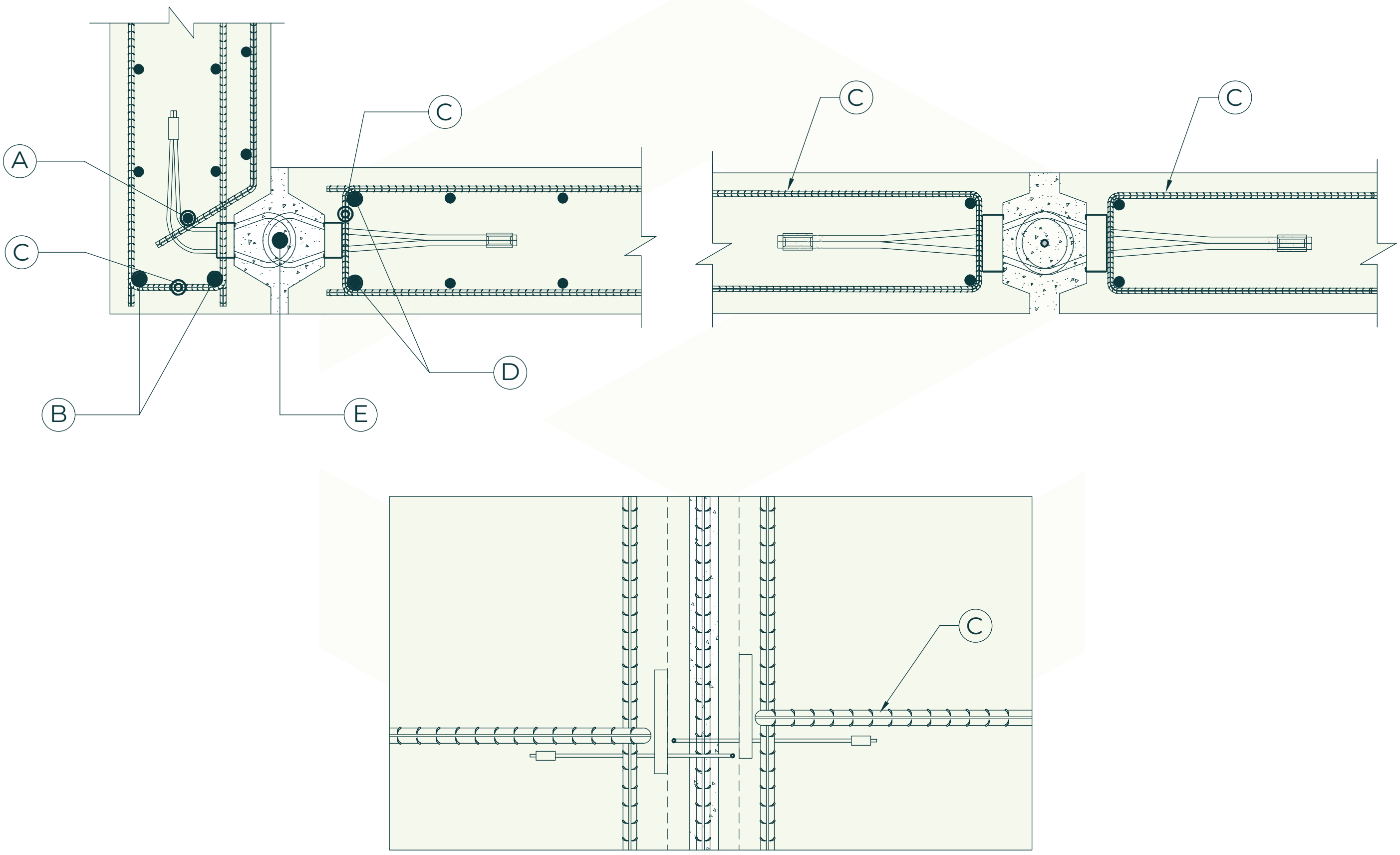


Figure 13. Required reinforcement to utilize the maximum load-bearing capacity of EVL wire loops.

Table 8: Additional reinforcement

EVL wire loop	Rebars, if wire is bent A (mm)	Rebars at edges B (mm)	U-shaped Rebars near EVL wire loop C (mm)	Rebars at edges D (mm)	Lacer Rebar E (mm)
EVL-60.....120	Ø 10	Ø 10	Ø 8	Ø 10	Ø 12
EVL-140	Ø 12	Ø 12	Ø 10	Ø 12	Ø 16

6. INSTALLATION

6.1. INSTALLATION REQUIREMENTS AND TOLERANCES

EVL wire loops shall be positioned within the formwork as per the production drawings provided by the designer. Wire loops can be attached by magnet or nails through the hole in boxes. Installation tolerances of wire loops shall satisfy the requirements as per figure 6. The reinforcement shall satisfy the requirements as per clause 3.4 figure 3.

At the erection stage, until the joint is filled with concrete, the wire loop cannot take any load. Independent temporary bracing shall be provided to secure elements throughout the erection stage.

Before grouting, verify that each EVL wire loop is fully extended perpendicular to the box face. Where pairs of boxes face one another across the joint, the vertical centre-to-centre misalignment between opposing loops shall not exceed 20 mm. The lacing bar shall be inserted through all overlapping loops prior to joint grouting.

6.2. Grouting Procedure

Prior to grouting, ensure that the precast elements are correctly aligned, adequately supported, and that all wire loops are fully interlocked in accordance with the approved installation drawings. The joint cavity shall be free from loose particles, dirt, oil, standing water, and other contaminants that may impair grout performance.

A high-strength, non-shrink structural grout shall be mixed and placed in accordance with the grout manufacturer's instructions. Grout shall be introduced in a manner that ensures complete filling of the joint and full encapsulation of the wire loops and any associated reinforcement. Measures shall be taken to prevent air entrapment and the formation of voids within the connection zone.

The connection shall not be subjected to design loads until the grout has achieved the specified minimum design strength. Temporary supports and bracing shall remain in place until the grout has adequately cured and the connection is capable of carrying the intended loads.

6.3. Damaged or Misaligned Loops

Wire loops shall be inspected prior to installation and grouting. Loops exhibiting excessive deformation, visible damage, corrosion, broken strands, or other conditions that may affect their performance shall not be used without approval from the project designer or responsible engineer.

Minor misalignment that does not adversely affect loop engagement or grout cover may be corrected using approved installation methods. Loops shall not be cut, welded, heated, or mechanically altered unless specifically permitted by the manufacturer.

Where loops cannot be properly engaged or where damage is identified after installation, the connection shall be assessed by the project engineer. Any remedial measures shall be supported by project-specific calculations and documented repair procedures before the connection is placed into service.

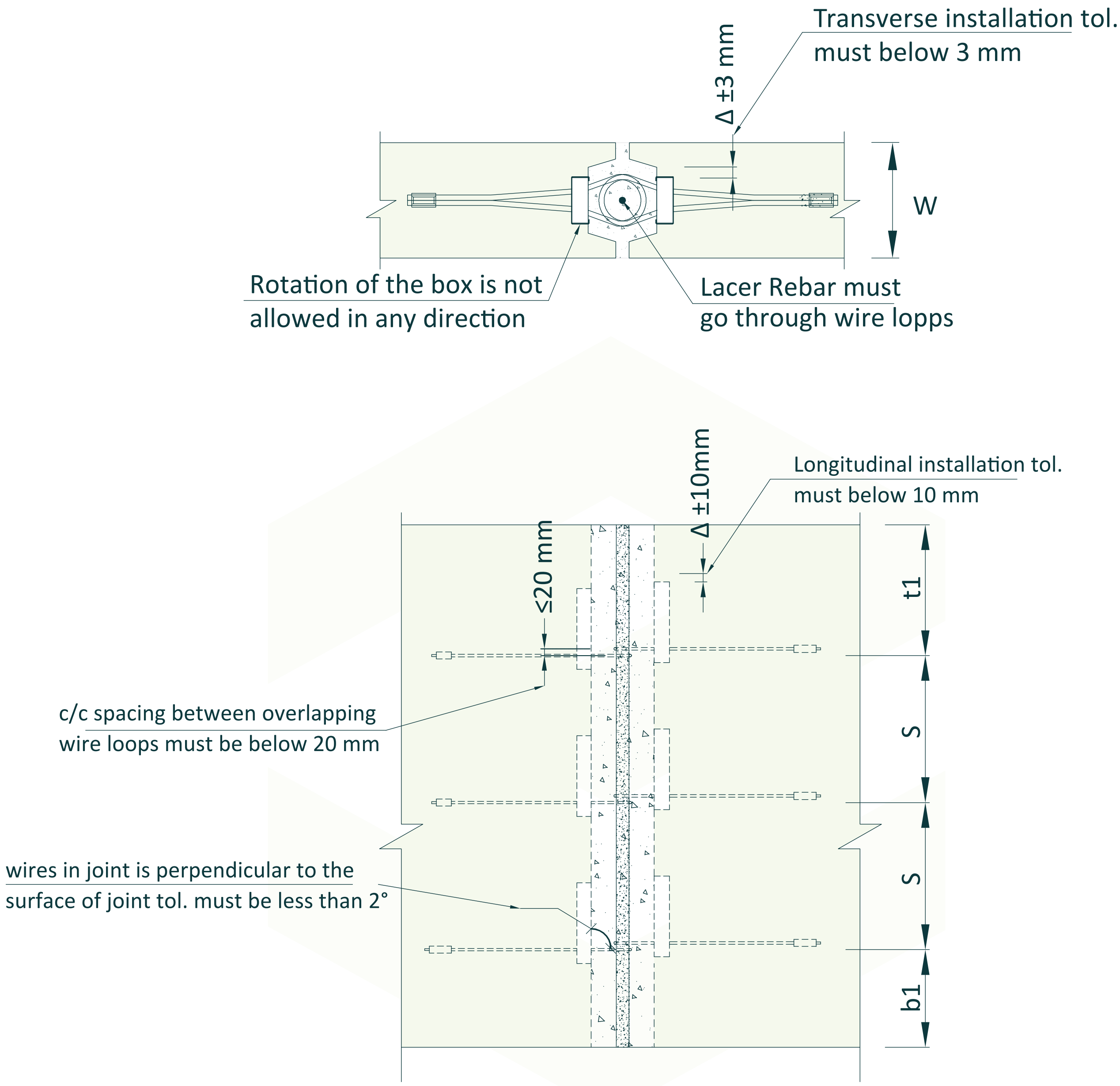


Figure 15. Installation requirements and tolerances for EVL wire loops

7. SUPERVISION OF INSTALLATION

Pre-casting inspection:

- Verify that each EVL wire loop and box is undamaged, free from rust, and free from wire breakage.
- Confirm EVL wire loop type, size, and spacing match the production drawings.
- Confirm that U-stirrups and supplementary reinforcement are positioned per clause 4.5 and Figure 3.
- Confirm that non-shrink, free-flow cementitious grout of the specified strength class is available on site.

Post-Grouting Inspection:

- The joint cavity has been completely filled with grout and no visible voids are present.
- Grout leakage, honeycombing, or significant surface defects are not evident.
- All wire loops and associated reinforcement are fully embedded within the grouted connection zone.
- The grout surface is properly finished and protected in accordance with the project requirements.
- Temporary supports and bracing remain in place until the specified grout strength has been achieved.
- The required grout curing period has been completed.
- Test reports or other verification records confirming that the grout has attained the specified design strength.

Casting:

- Confirm that each EVL wire loop remains correctly positioned and fully extended throughout the casting operation.
- Ensure concrete is properly compacted around the EVL wire loop box; do not vibrate the box directly.

After Casting:

- Record the final position of each EVL wire loop against the production drawing tolerances.
- After the concrete has reached sufficient strength and the formwork is stripped, remove the protective tape and fold the wire loop out to its operating position.

8. LIMITATIONS

A wire loop embedded in a precast wall alone cannot form a connection between two panels. It requires a lacing bar inserted through the overlapping loops of adjacent panels to transfer forces from one panel to the other.

EVL wire loops are designed exclusively for in-plane shear force transfer between adjacent precast panels. They are not capable of resisting out-of-plane bending moments at the joint interface. Compared to welded plate or bolted connection systems, wire loop connections offer moderate tensile and shear capacity and require precise panel alignment during both casting and erection. For structures where dynamic, fatigue, or seismic loading governs the connection design, specialist verification is required - contact Endura engineering support before proceeding.

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