INSTITUTE OF CONSTRUCTION TECHNOLOGY
PL00-611 WARSAW, ul. Filtrowa 1,www.itb.pl

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NATIONAL TECHNICAL ASSESSMENT ITB-KOT-2017/0331, Edition 3

This National Technical Assessment was issued in accordance with the Regulation of the Minister of Infrastructure and Construction of 17 November 2016 regarding national technical assessments (Journal of Laws of 2016, item 1968) by the Building Research Institute in Warsaw, at the request of:

EXTREA Sp. z o. o.
ul. Pawła Włodkowica 2c, 03-262 Warszawa

The National Technical Assessment ITB-KOT-2017/0331, Edition 3 is a positive assessment of the performance of the following construction products for the intended use:

ExBox reinforcement bar connecting kits

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DIRECTOR
Institute of Construction Technology

Dr. Robert Geryło, Eng.

Warsaw, 30 July 2024

National Technical Assessment documentITB-KOT-2017/0331, Edition 3, contains 18 pages, including 3 annexes. National Technical Assessment ITB-KOT-2017/0331 3 edition replaces the National Technical Assessment ITB-KOT-2017/0331, Edition 2.

Building Research Institute
ul. Filtrowa 1, 00-611 Warszawa
phone: +48 22 825 04 71; Tax ID: 525 000 93 58; National Court Register: 0000158785

1. TECHNICAL PRODUCT DESCRIPTION

This National Technical Assessment covers ExBox reinforcement bars connecting sets of the following types: S, WH, H and 2H, manufactured by EXTREA Sp. z o.o., ul. Pawła Włodkowica 2c, 03-262 Warsaw, in a production plant in Germany.

ExBox reinforcement bars connecting sets are composed of longitudinal steel sections (rails) made of perforated, galvanized steel sheets. Ribbed reinforcing bars are embedded in the sections. The reinforcing bars on one side of the rail are bent towards the rail and covered with plastic tape (Figure A1). The reinforcement bars connecting sets are shown in Figure A2. The assortment and dimensions of the sets are given in tables A1 ÷ A4.

The sections (rails) of the ExBox reinforcement bars connecting sets are made of steel sheets with a thickness of not less than 0.4 mm. They are made of standard carbon steel, with a yield strength Re of not less than 210 MPa and a tensile strength Rm of not less than 270 MPa. They are hot-dip zinc galvanised with a layer not thinner than 6 µm, in accordance with the PN-EN 10346:2015.

The reinforcement bars of the ExBox reinforcement bars connecting sets are made of ribbed steel bars with a diameter of 8, 10, 12, 14 or 16 mm and properties specified for reinforcement steel of ductility class B or C given in PN-EN 1992-1-1:2008 and in Table C1, Annex C, placed on the market in accordance with applicable regulations and intended use.

2. INTENDED PRODUCT USE

ExBox reinforcement bars connecting sets are designed to connect reinforcing bars in joints of sectional monolithic concrete components. The concrete class of the reinforcement bars connecting sets should not be lower than C20/25 according to PN-EN 206 A2:2021.

ExBox reinforcement bars connecting sets should not be used in concrete components subjected to dynamic and multi-variable loads.

During operation, ExBox reinforcement bars connecting sets must not be exposed to the external environment. Coating the rails with a layer of zinc protects them against a corrosive environment when stored before embedding in concrete and during work breaks in concrete pouring.

The dimensions of vertical and horizontal joints in which ExBox reinforcement bars connecting sets should be in accordance with PN-EN 1992-1-1:2008 (Eurocode 2).

The design shear resistance of the joint for a load acting along the joint should be calculated in accordance with formula 6.25 given in clause 6.2.5 of PN-EN 1992-1-1:2008 in the cross-section shown in Figure C1 of this National Technical Assessment. The values of factors c and µ appearing in formula 6.25, which define the roughness of the plane of connection between the steel section and the concrete, should be adopted as follows: c = 0.2 and µ = 0.7.

The design shear resistance of a joint for a load acting transversely to the joint, where shear reinforcement is not required, shall be calculated as per section 6.2.2 of PN-EN 1992-1-1:2008.

The design shear resistance of a joint with a load acting transversely to the joint and with shear reinforcement shall be calculated as per section 6.2.3 of PN-EN 1992-1-1:2008.

When designing the connections of ExBox reinforcement bars connecting sets with reinforcement bars of concrete structure components, the characteristic yield strength f_{yk} should be adopted equal to 500

MPa, and the remaining properties are for ductility class B or C according to PN-EN 1992-1-1:2008. The length of the anchorages and the bending radii of the bars should meet the requirements specified in PN-EN 1992-1-1:2008.

As the reinforcement bars in ExBox sets are first bent and then unbent during the formation of joints, their design load-bearing capacity should be reduced by 20% and the following should be assumed: $f_{yd,red} = f_{yd} \times 0.8$.

The reinforcement bars of the ExBox sets can only be bent once. Bending should be carried out in accordance with the requirements given in PN-EN 13670:2011.

The installation of ExBox reinforcement bars connecting sets in a concrete structure is shown in Figure B1.

ExBox reinforcement bars connecting sets should be used in accordance with:

- technical design developed for a specific application, Polish standards and technical and construction regulations, and in particular the Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions that buildings and their location should meet (Journal of Laws of 2022, item 1225, with later changes),
- provisions of the present National Technical Assessment,
- recommendations given in the instructions of use prepared by the manufacturer and delivered to recipients.

3. PRODUCT PERFORMANCE AND METHODS USED FOR THEIR ASSESSMENT

3.1. Product performance

3.1.1. Shape and dimensions. The shape and dimensions of ExBox reinforcement bars connecting sets are in accordance with figures A1 ÷ A2 and tables A1 ÷ A4, Annex A.

3.1.2. Strength properties of steel of bent reinforcement bars after straightening. The tensile strength and yield strength of the steel used for the production of the bent reinforcement bars of the ExBox sets after straightening must not be lower than 80% of the characteristic values of the tensile strength and yield strength of the standard reinforcement bars of ExBox sets.

3.1.3. Coefficients characterizing the roughness of the plane of connection between steel sections and concrete. Factors *c* and *μ*, characterizing the roughness of the connection surface of ExBox sets steel sections with concrete given in formula 6.25 of PN-EN 1992-1-1:2008, defined in the direction along the section, should not be less than: 0.2 (factor *c*) and 0.7 (factor *μ*).

3.2. Methods used for the performance assessment

3.2.1. Checking shape and dimensions. Checking the shape and dimensions should be performed using measuring instruments that ensure the required measurement accuracy.

3.2.2. Checking the steel strength properties of bent reinforcement bars after straightening. The verification of the strength properties of steel of the bent reinforcing bars after straightening should be performed in accordance with PN-EN ISO 6892-1:2020.

3.2.3. Checking factors *c* and *μ* cdefining the roughness of the surface of the connection between steel sections and concrete. The roughness coefficient of the steel section -concrete joint surface should be checked on a model consisting of two disc-shaped objects made of concrete class C20/25, according to PN-EN 206 A2:2021, connected by connecting bars without reinforcement bars, in which model the connection of both concrete components takes place through adhesion forces generated between the concrete of the components and the steel section. The connection should be made in such a way as to exclude direct contact of concrete of both components. During the test, the shear force generated in the connection of concrete components when one of them is loaded with a force parallel to the connection (parallel to the steel section) is determined. The load should be increased uniformly, at a rate that causes the shear stress in the joint at a rate not higher than 1 MPa/min. The load measurement should be performed using a dynamometer with a measurement error not exceeding 2% of the measured value. The test should be performed for at least three different values of load applied perpendicular to the connection (perpendicular to the steel section) causing normal compressive stresses in the plane of the connection.

Factors *c* and *μ* are determined using the least squares method from the equation:

$$v_{r,ex} = \mu\, \sigma_n + c\, f_{ct,m}$$

where:

$in_{r,ex}$ – connection shear stress, MPa

σ_n – normal compressive stress of the connection, MPa

$f_{ct,m}$ – average value of concrete axial tensile strength, MPa

4. PACKING, TRANSPORT AND STORAGE AND THE METHOD OF MARKING THE PRODUCT

ExBox reinforcement bars connecting sets should be delivered, stored and transported in a way that ensures the consistency of their technical properties.

The method of marking a product with a construction mark should comply with the Regulation of the Minister of Infrastructure and Construction of 17 November 2016 on the method of declaring the performance of construction products and the method of marking them with a construction mark (Journal of Laws of 2023, item 873).

Marking the product with the construction mark should be accompanied by the following information:

- the last two digits of the year in which the construction mark was first placed on the construction product,
- the name and address of the manufacturer's registered office or an identification mark allowing to clearly identify the name and address of the manufacturer's registered office,
- the name and designation of the construction product type,
- the number and year of issue of the national technical assessment according to which the performance was declared (ITB-KOT-2017/0331, Edition 3),
- the number of the national declaration of performance,
- the level or class of the declared performance,
- the name of the certification body that participated in the assessment and verification of the constancy of performance of the construction product,
- the manufacturer's website address, if the national declaration of performance is available on it.

Along with the national declaration of performance, a safety data sheet and/or information on hazardous substances contained in a construction product, referred to in Art. 31 or 33 of Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) and establishing a European Chemicals Agency should be delivered or made available.

In addition, the marking of a construction product, which is a hazardous mixture according to the REACH Regulation, should comply with the requirements of Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (CLP), amending and repealing Directive 67/548/EEC and 1999/45/EC and amending the Regulation (EC) No 1907/2006.

5. ASSESSMENT AND VERIFICATION OF PERFORMANCE CONSTANCY

5.1. The national system of assessment and verification of performance constancy

In accordance with the Regulation of the Minister of Infrastructure and Construction of 17 November 2016 on the methods of declaring conformity of construction products and the method of marking them with the construction mark (Journal Of Laws of 2023, item 873) the system of assessment and verification of constancy of performance no. 1 applies.

5.2. Type test

The performance assessed in Point 3, is a product-type test, until changes to raw materials, components, production line or production plant are introduced.

5.3. Factory production control

The manufacturer should have a factory production control system in place in the manufacturing plant. All elements of this system, requirements and provisions adopted by the manufacturer should be documented in a systematic manner, in the form of rules and procedures, including test records. The

factory production control should be adapted to the production technology and ensure that the declared performance of the product is maintained in series production.

The factory production control includes specification and checking of raw materials and components, control and testing in the manufacturing process as well as control tests (according to section 5.4), carried out by the manufacturer in accordance with the prescribed test plan and according to the rules and procedures specified in the documentation of the factory production control.

The results of the production control should be recorded systematically. The entries in the register should confirm that products meet the criteria of assessment and verification of constancy of performance. Individual products or product batches and related production details must be fully identifiable and traceable.

5.4. Controltests

Control tests should be conducted in accordance with the established test plan and according to the principles and procedures specified in the plant production control documentation, but not less frequently than indicated in Tables 1 and 2.

Table 1

The scope of control tests as part of the manufacturer's activities	Frequency
Shape	For each batch of products [1)]
Dimensions	For each batch of products [1)]
[1)] The size of the batch of products should be specified in the plant production control documentation.	

Table 2

Scope of control tests as part of the assessment and verification carried out by the certification body	Frequency
Shape	For each batch of products subject to assessment by the certification body [1)]
Dimensions	For each batch of products subject to assessment by the certification body [1)]
Factors c and μ that define the roughness of the connection surface of steel sections with concrete	Once every 3 years
Strength properties of steel of bent reinforcement bars after straightening	Each diameter once every 5 years
[1)]The size of the batch of products should be specified in the plant production control documentation.	

6. INSTRUCTION

6.1. The National Technical Assessment ITB-KOT-2017/0331, Edition 3, replaces the National Technical Assessment ITB-KOT-2017/0331, Edition 2.

6.2. The National Technical Assessment ITB-KOT-2017/0331, Edition 3 is, a positive assessment of the performance of the essential characteristics of ExBox reinforcement bars connecting sets which, in accordance with the intended use resulting from the provisions of the Assessment, affect the fulfilment of basic requirements by construction works in which the product will be used.

6.3. The National Technical Assessment ITB-KOT-2017/0331, Edition 3, is not a document authorizing the marking of a construction product with a construction mark.

Pursuant to the Act of 16 April 2004 on construction products (Journal of Laws of 2021, item 1213), products covered by this National Technical Assessment may be marketed or made available on the domestic market, if the manufacturer has assessed and verified the constancy of performance, he prepared a national declaration of performance in accordance with the National Technical Assessment ITB-KOT-2017/0331, Edition 3 and marked the products with a construction mark in accordance with applicable regulations.

6.4. The National Technical Assessment ITB-KOT-2017/0331, Edition 3, does not violate rights resulting from provisions on industrial property protection, in particular the Act of 30 June 2000 – Industrial Property Law (Journal of Laws of 2023, item 1170). Providing these rights is the responsibility of the users of this ITB National Technical Assessment.

6.5. By issuing the National Technical Assessment, ITB shall not be liable for any infringement of exclusive and acquired rights.

6.6. The National Technical Assessment does not release the manufacturer of products from responsibility for their proper quality, and contractors of construction works from the responsibility for their proper use.

6.7. The validity of the National Technical Assessment may be extended for subsequent periods, not longer than 5 years.

7. LIST OF DOCUMENTS USED IN THE PROCEEDINGS

7.1. Reports, test reports, assessments, classifications

1. LZK00-0311/22/Z00NZK. Test report on ExBox reinforcement bars connecting sets. Department of Building Structures, Geotechnics and Concrete of ITB, Warsaw 2022
2. NK-507/A/99. Technical evaluation for technical approval of the anchoring system. Department of Building Structures of ITB, Warsaw 1999
3. LW-1016/04. Test report on ExBox reinforcement bars connecting sets. Department of Building Structures of ITB, Warsaw 2004
4. LOK-794/A/05-1. Test report and technical evaluation of connecting sets. Building Research Institute in Warsaw, Silesian Branch in Katowice, Katowice 2005.
5. NO/568/05. Technical evaluation on anti-corrosion protection of the steel sections used in ExBox reinforcement bars connecting sets. Department of Durability and Protection of Buildings, Building Research Institute in Warsaw, Warsaw 2005.
6. LK00-02862/10/Z00NK, LK00-2159/13/Z00NK, LM00-02159/13/Z00NK, LZK00-00845/17/Z00NZK. Test reports on sets for connecting reinforced concrete components. ITB Design and Construction Components Department, Warsaw 2010-2017

7. LK00-2305/10/Z00NK, NK-04905R:06/PW/13. Evaluation of the sets for connecting reinforced concrete components. ITB Design and Construction Components Department, Warsaw 2010÷2014
8. LZK00-03366/18/Z00NZK. Test report on ExBox reinforcement bars connecting sets. Department of Building Structures and Geotechnics of ITB, Warsaw 2019

7.2. Related standards and documents

PN-EN 10346:2015	*Continuously hot-dip coated steel flat products for cold forming. Technical conditions of delivery*
PN-EN 1992-1-1:2008	*Eurocode 2. Design of concrete structures. Part 1-1: General rules and rules for buildings*
PN-EN 206:2021	*Concrete Requirements, properties, production and compliance*
PN-EN 13670:2011	*Execution of concrete structures*
PN-EN ISO 6892-1:2020	*Metals. Tensile test. Part 1: Test method at room temperature*
PN-EN ISO 15630-1:2019	*Steel for reinforcing and prestressing concrete. Test methods Part 1: Steel bars, rods and wire for concrete reinforcement*
ITB-KOT-2017/0331, Edition 2	*ExBox reinforcement bar connecting sets*

ANNEXES

Annex A:

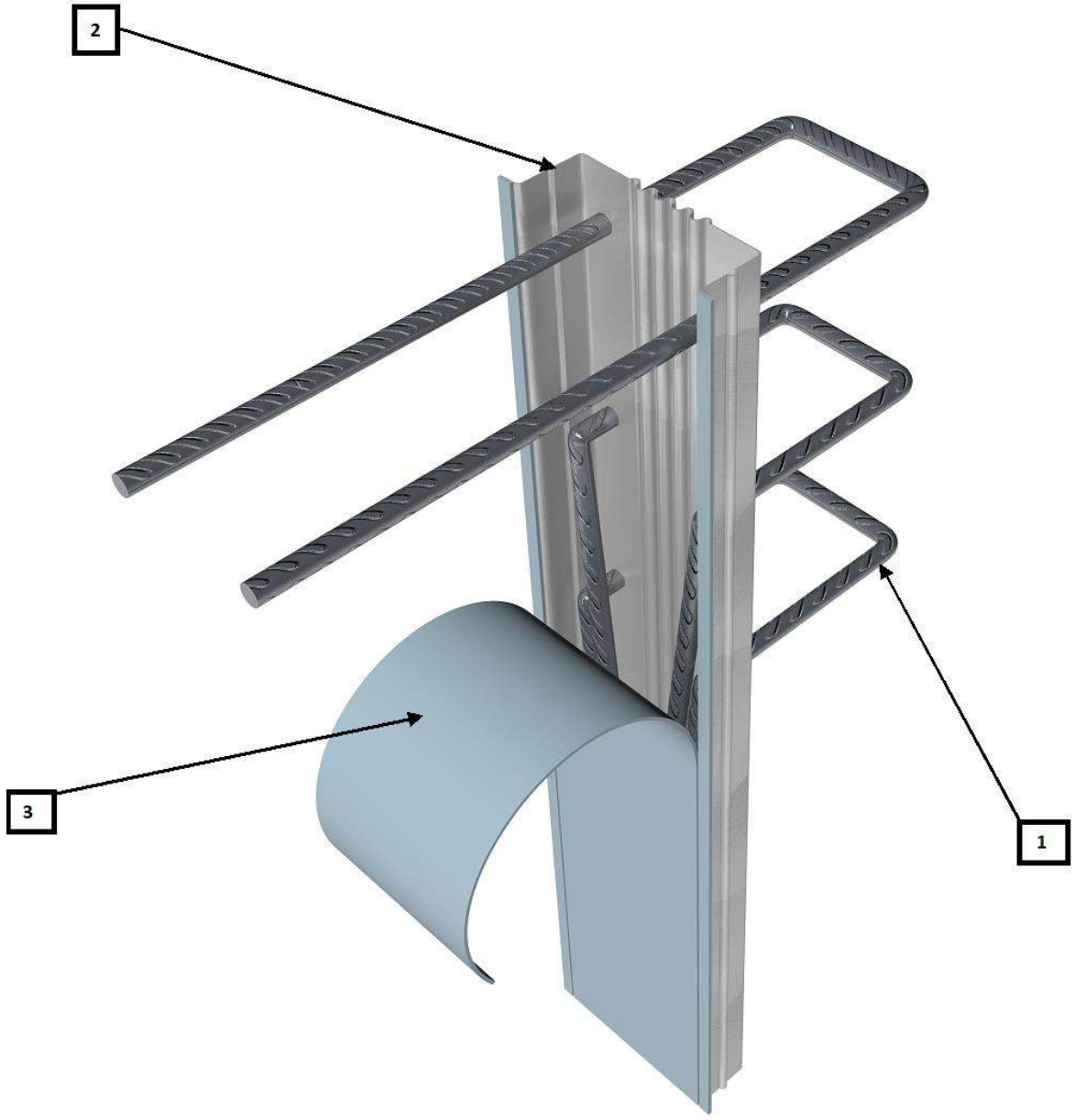
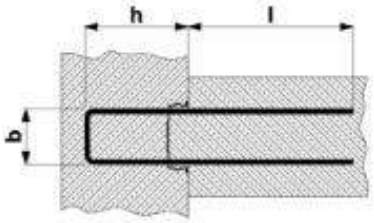
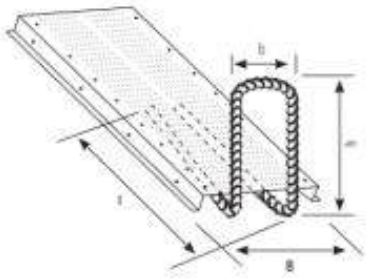
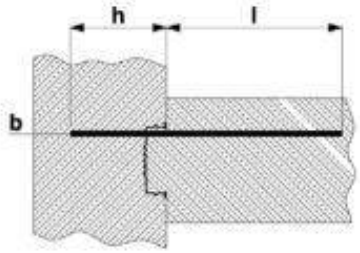


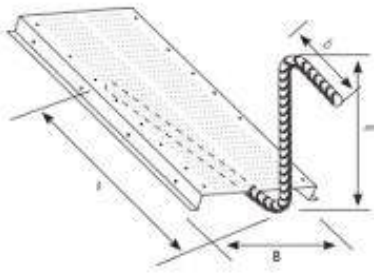
Figure A1. ExBox reinforcement bars connecting set for connecting reinforced concrete components
1 – reinforcement bar, **2** – section (rail) made of galvanized steel sheet, **3** – PVC tape



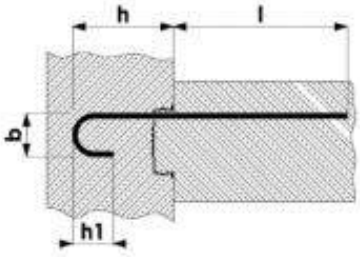


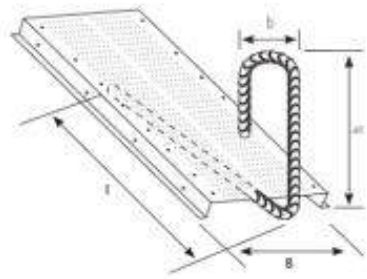
ExBox set – type S



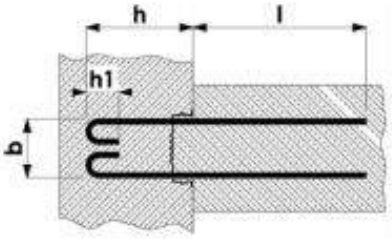


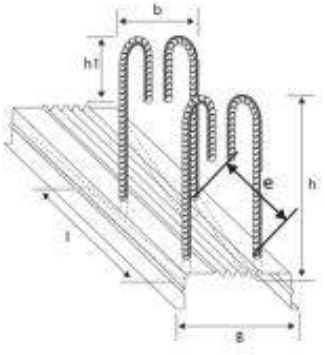
ExBox set – type WH





ExBox set – type H





ExBox set – type 2H

Figure A2. ExBox reinforcement bars connecting set type S, WH, H and 2H

Table A1. Dimensions of the ExBox reinforcement bars connecting set - type S

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*
ExBox, type S 80-8/15	80	8	150	150	60	320
ExBox, type S 80-8/20	80	8	200	150	60	320
ExBox, type S 80-8/25	80	8	250	150	60	320
ExBox, type S 80-10/15	80	10	150	150	60	290
ExBox, type S 80-10/20	80	10	200	150	60	360
ExBox, type S 80-10/25	80	10	250	150	60	390
ExBox, type S 110-8/10	110	8	100	150	90	320
ExBox, type S 110-8/15	110	8	150	150	90	320
ExBox, type S 110-8/20	110	8	200	150	90	320
ExBox, type S 110-8/25	110	8	250	150	90	320
ExBox, type S 110-8/30	110	8	300	150	90	320
ExBox, type S 110-10/10	110	10	100	150	90	390
ExBox, type S 110-10/15	110	10	150	150	90	390
ExBox, type S 110-10/20	110	10	200	150	90	390
ExBox, type S 110-10/25	110	10	250	150	90	390
ExBox, type S 110-10/30	110	10	300	150	90	390
ExBox, type S 110-12/10	110	12	100	150	90	300
ExBox, type S 110-12/15	110	12	150	150	90	330
ExBox, type S 110-12/20	110	12	200	150	90	460
ExBox, type S 110-12/25	110	12	250	150	90	460
ExBox, type S 110-12/30	110	12	300	150	90	460
ExBox, type S 140-8/10	140	8	100	150	120	320
ExBox, type S 140-8/15	140	8	150	150	120	320
ExBox, type S 140-8/20	140	8	200	150	120	320
ExBox, type S 140-8/25	140	8	250	150	120	320
ExBox, type S 140-8/30	140	8	300	150	120	320
ExBox, type S 140-10/10	140	10	100	150	120	390
ExBox, type S 140-10/15	140	10	150	150	120	390
ExBox, type S 140-10/20	140	10	200	150	120	390
ExBox, type S 140-10/25	140	10	250	150	120	390
ExBox, type S 140-10/30	140	10	300	150	120	390
ExBox, type S 140-12/10	140	12	100	150	120	400
ExBox, type S 140-12/15	140	12	150	150	120	460
ExBox, type S 140-12/20	140	12	200	150	120	460
ExBox, type S 140-12/25	140	12	250	150	120	460
ExBox, type S 140-12/30	140	12	300	150	120	460

Table A1, cont. Dimensions of the ExBox reinforcement bars connecting set - type S

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*
ExBox, type S 160-8/10	160	8	100	150	140	320
ExBox, type S 160-8/15	160	8	150	150	140	320
ExBox, type S 160-8/20	160	8	200	150	140	320
ExBox, type S 160-8/25	160	8	250	150	140	320
ExBox, type S 160-8/30	160	8	300	150	140	320
ExBox, type S 160-10/10	160	10	100	150	140	390
ExBox, type S 160-10/15	160	10	150	150	140	390
ExBox, type S 160-10/20	160	10	200	150	140	390
ExBox, type S 160-10/25	160	10	250	150	140	390
ExBox, type S 160-10/30	160	10	300	150	140	390
ExBox, type S 160-12/10	160	12	100	150	140	430
ExBox, type S 160-12/15	160	12	150	150	140	460
ExBox, type S 160-12/20	160	12	200	150	140	460
ExBox, type S 160-12/25	160	12	250	150	140	460
ExBox, type S 160-12/30	160	12	300	150	140	460
ExBox, type S 160-12/10	160	12	100	150	140	430
ExBox, type S 160-12/15	160	12	150	150	140	460
ExBox, type S 160-12/20	160	12	200	150	140	460
ExBox, type S 160-12/25	160	12	250	150	140	460
ExBox, type S 160-12/30	160	12	300	150	140	460
ExBox, type S 190-8/10	190	8	100	150	170	320
ExBox, type S 190-8/15	190	8	150	150	170	320
ExBox, type S 190-8/20	190	8	200	150	170	320
ExBox, type S 190-8/25	190	8	250	150	170	320
ExBox, type S 190-8/30	190	8	300	150	170	320
ExBox, type S 190-10/10	190	10	100	150	170	390
ExBox, type S 190-10/15	190	10	150	150	170	390
ExBox, type S 190-10/20	190	10	200	150	170	390
ExBox, type S 190-10/25	190	10	250	150	170	390
ExBox, type S 190-10/30	190	10	300	150	170	390
ExBox, type S 190-12/10	190	12	100	150	170	460
ExBox, type S 190-12/15	190	12	150	150	170	460
ExBox, type S 190-12/20	190	12	200	150	170	460
ExBox, type S 190-12/25	190	12	250	150	170	460
ExBox, type S 190-12/30	190	12	300	150	170	460

Table A1, cont. Dimensions of the ExBox reinforcement bars connecting set - type S

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*
ExBox, type S 220-8/10	220	8	100	150	200	320
ExBox, type S 220-8/15	220	8	150	150	200	320
ExBox, type S 220-8/20	220	8	200	150	200	320
ExBox, type S 220-8/25	220	8	250	150	200	320
ExBox, type S 220-8/30	220	8	300	150	200	320
ExBox, type S 220-10/10	220	10	100	150	200	390
ExBox, type S 220-10/15	220	10	150	150	200	390
ExBox, type S 220-10/20	220	10	200	150	200	390
ExBox, type S 220-10/25	220	10	250	150	200	390
ExBox, type S 220-10/30	220	10	300	150	200	390
ExBox, type S 220-12/10	220	12	100	150	200	460
ExBox, type S 220-12/15	220	12	150	150	200	460
ExBox, type S 220-12/20	220	12	200	150	200	460
ExBox, type S 220-12/25	220	12	250	150	200	460
ExBox, type S 220-12/30	220	12	300	150	200	460
ExBox, type S 220-12/30	220	12	300	150	200	460
ExBox, type S 240-8/10	240	8	100	150	220	320
ExBox, type S 240-8/15	240	8	150	150	220	320
ExBox, type S 240-8/20	240	8	200	150	220	320
ExBox, type S 240-8/25	240	8	250	150	220	320
ExBox, type S 240-8/30	240	8	300	150	220	320
ExBox, type S 240-10/10	240	10	100	150	220	390
ExBox, type S 240-10/15	240	10	150	150	220	390
ExBox, type S 240-10/20	240	10	200	150	220	390
ExBox, type S 240-10/25	240	10	250	150	220	390
ExBox, type S 240-10/30	240	10	300	150	220	390
ExBox, type S 240-12/10	240	12	100	150	220	460
ExBox, type S 240-12/15	240	12	150	150	220	460
ExBox, type S 240-12/20	240	12	200	150	220	460
ExBox, type S 240-12/25	240	12	250	150	220	460
ExBox, type S 240-12/30	240	12	300	150	220	460
ExBox, type S 240-12/30	240	12	300	150	220	460
Permissible dimensional deviations:	±5 mm	–	±15 mm	±10 mm	±10 mm	-10 +40

Table A2. Dimensions of ExBox reinforcement bars connecting sets - type WH

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*
ExBox, type WH 60-8/10	60	8	100	150	80	320
ExBox, type WH 60-8/15	60	8	150	150	80	320
ExBox, type WH 60-8/20	60	8	200	150	80	320
ExBox, type WH 60-8/25	60	8	250	150	80	320
ExBox, type WH 60-8/30	60	8	300	150	80	320
ExBox, type WH 60-10/15	60	10	150	150	80	390
ExBox, type WH 60-10/20	60	10	200	150	80	390
ExBox, type WH 60-10/25	60	10	250	150	80	390
ExBox, type WH 80-8/15	80	8	150	150	80	320
ExBox, type WH 80-8/20	80	8	200	150	80	320
ExBox, type WH 80-8/25	80	8	250	150	80	320
ExBox, type WH 80-8/30	80	8	300	150	80	320
ExBox, type WH 80-10/15	80	10	150	150	80	390
ExBox, type WH 80-10/20	80	10	200	150	80	390
ExBox, type WH 80-10/25	80	10	250	150	80	390
ExBox, type WH 80-12/10	80	12	100	150	80	390
ExBox, type WH 80-12/15	80	12	150	150	80	460
ExBox, type WH 80-12/20	80	12	200	150	80	460
ExBox, type WH 80-12/25	80	12	250	150	80	460
Permissible dimensional deviations:	±5 mm	–	±15 mm	±10 mm	±10 mm	-10 +40

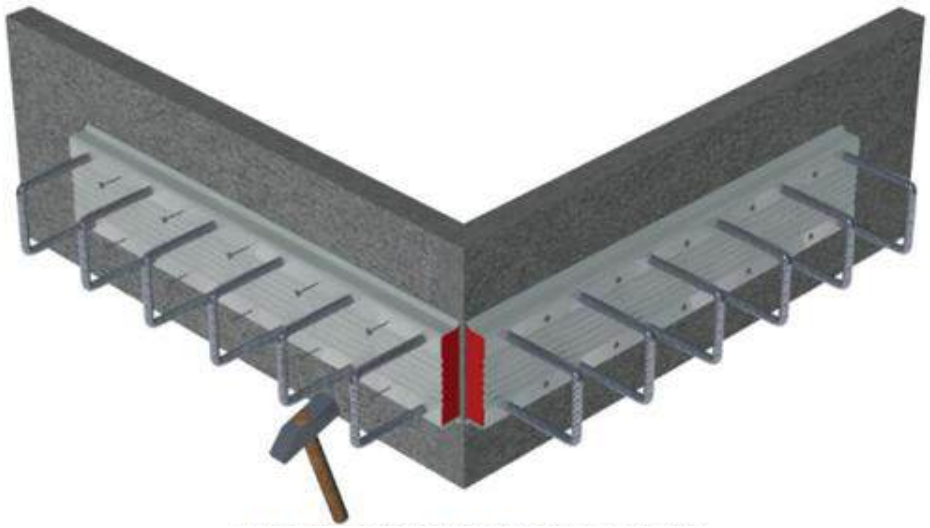
Table A3. Dimensions of ExBox reinforcement bars connecting sets - type H

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	h1 [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
ExBox, type H 60-8/10	60	8	100	150	70	60	320
ExBox, type H 60-8/15	60	8	150	150	70	60	320
ExBox, type H 60-8/20	60	8	200	150	70	60	320
ExBox, type H 60-8/25	60	8	250	150	70	60	320
ExBox, type H 60-8/30	60	8	300	150	70	60	320
ExBox, type H 60-10/10	60	10	100	150	80	60	320
ExBox, type H 60-10/15	60	10	150	150	80	60	390
ExBox, type H 60-10/20	60	10	200	150	80	60	390
ExBox, type H 60-10/25	60	10	250	150	80	60	390
ExBox, type H 60-10/30	60	10	300	150	80	60	390
ExBox, type H 80-8/10	80	8	100	150	70	60	320
ExBox, type H 80-8/15	80	8	150	150	70	60	320
ExBox, type H 80-8/20	80	8	200	150	70	60	320
ExBox, type H 80-8/25	80	8	250	150	70	60	320
ExBox, type H 80-8/30	80	8	300	150	70	60	320
ExBox, type H 80-10/10	80	10	100	150	80	60	390
ExBox, type H 80-10/15	80	10	150	150	80	60	390
ExBox, type H 80-10/20	80	10	200	150	80	60	390
ExBox, type H 80-10/20	80	10	200	150	80	60	390
ExBox, type H 80-10/25	80	10	250	150	80	60	390
ExBox, type H 80-10/30	80	10	300	150	80	60	390
ExBox, type H 80-12/10	80	12	100	150	95	80	390
ExBox, type H 80-12/15	80	12	150	150	95	80	460
ExBox, type H 80-12/20	80	12	200	150	95	80	460
ExBox, type H 80-12/25	80	12	250	150	95	80	460
ExBox, type H 80-12/30	80	12	300	150	95	80	460
Permissible dimensional deviations:	±5 mm	–	±15 mm	±10 mm	±10 mm	±10 mm	-10 +40

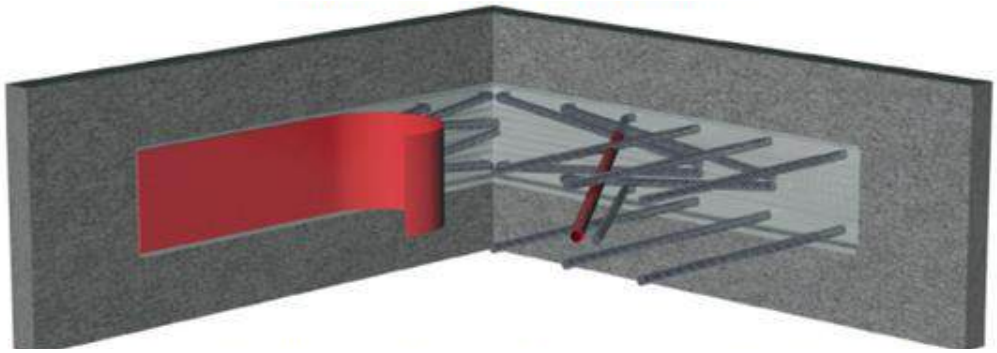
Table A4. Dimensions of ExBox reinforcement bars connecting sets - type 2H

Symbol	Rail width B [mm]	Bar diameter Ø [mm]	Spacing of bars e [mm]	h [mm]	h1 [mm]	b [mm]	l [mm]
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
ExBox, type 2H 110-12/15	110	12	150	150	95	90	430
Permissible dimensional deviations:	±5 mm	–	±15 mm	±10 mm	±10 mm	±10 mm	-10 +40

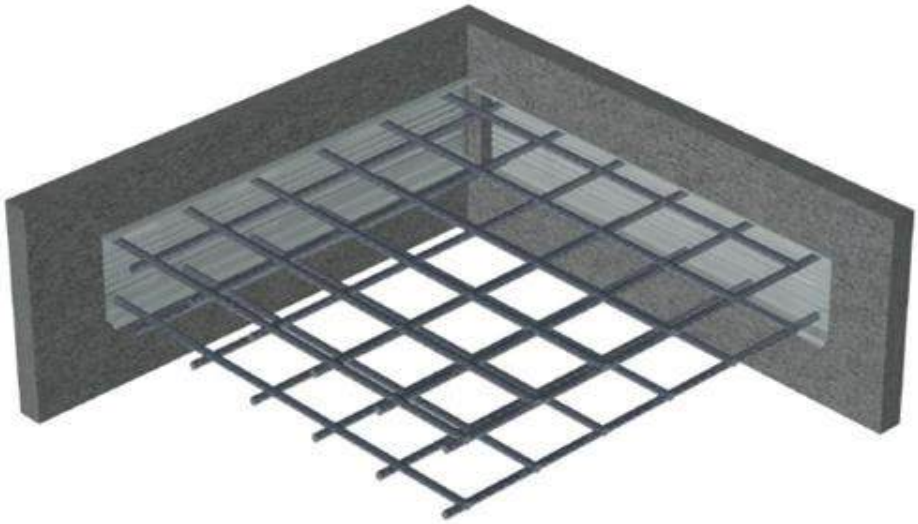
Annex B.



3. Installing the ExBox set on a formwork



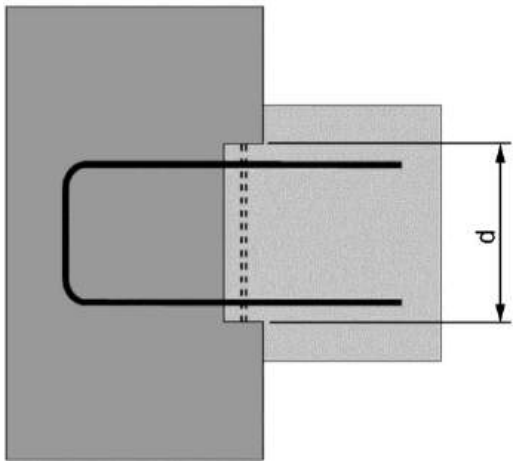
2. Stripping the plastic cover after concreting the first component



1. Cutting the bent bars of the set, fixing to the reinforcement of the concrete component in the second stage and pouring concrete

Figure B1. Appendix B. Installation of the ExBox reinforcement bars connecting set in a reinforced concrete component

Annex C.



$d_{ef} = d$

Figure C 1. Method of determining the effective section width of the ExBox set

Table C1. Properties of ribbed reinforcement bars

Item	Properties	Requirements for ductility class		Methods of evaluation (unless otherwise specified in the reference document)
		B	C	
1	*2*	*3*	*4*	*5*
1	Chemical composition – element content [%]			according to the reference document
	- Cu	≤ 0.80 (0.85) [1)]		
	- C	≤ 0.22 (0.24) [1)]		
	- P	≤ 0.050 (0.055) [1)]		
	- S	≤ 0.050 (0.055) [1)]		
	- N	≤ 0.012 (0.014) [1)]		
2	Carbon equivalent C_{eq}	≤ 0.50 (0.52) [2)]		according to the formula (1)
3	Shape, dimensions and weight	according to the reference document and Eurocode 2		
4	Yield point R_e [MPa]	≥ 500		PN-EN-ISO 6892-1:2016
5	Tensile strength R_m [MPa]	≥ 550		
6	R_m / R_e ratio	≥ 1.08	1.15 ÷ 1.35	
7	Relative elongation A_{10} [%]	≥ 10	–	
8	Unit elongation A_5 [%]	–	≥ 16	
9	Total elongation at maximum tensile force A_{gt} [%]	≥ 5.0	≥ 8.0	
10	Bending of "aged" samples by an angle of 20° after bending by an angle of 90° on a 5d diameter mandrel	no cracks		PN-EN ISO 15630-1:2019

1) The values without brackets refer to the requirements for the content of elements according to the heat analysis; in brackets - according to the chemical analysis of the product

2) $$C_{eq} = c + \frac{Mn}{6} + \frac{Cr + V + Mo}{5} + \frac{Cu + Ni}{15} \quad (1)$$