



INSTYTUT TECHNIKI BUDOWLANEJ
PL 00-611 WARSZAWA, ul. Filtrowa 1, www.itb.pl

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NATIONAL TECHNICAL ASSESSMENT ITB-KOT-2019/0833 1st edition

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

FORBUILD S.A. ul. Górna 2a, 26-200 Końskie

National Technical Assessment ITB-KOT-2019/0833 1st edition is a positive assessment of the performance of the following construction products for the intended use:

Bar connecting elements BINDAX

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p.p
Deputy Director for Technical
Assessment and European
Harmonization

Msc. Eng. Anna Panek

Document of the National Technical Assessment ITB-KOT-2019/0833 1st edition contains 79 pages, including 3 Annexes. The text of this document may be copied only in its entirety. Publication or dissemination in any other form of fragments of the text of the National Technical Assessment shall require a written agreement with the Building Research Institute. National Technical Assessment ITB-KOT-2019/0833 1st edition applies to products covered by the Technical Approval ITB AT-15-3793/2014.

Building Research Institute

ul. Filtrowa 1, 00-611 Warszawa

tel.: 22 825 04 71; NIP: 525 000 93 58; KRS: 0000158785

1. TECHNICAL DESCRIPTION OF THE PRODUCT

This National Technical Assessment includes BINDAX rod connecting elements manufactured by FORBUILD S.A., ul. Górna 2a, 26-200 Końskie, at the production plant in Końskie.

The National Technical Assessment includes elements:

- standard BINDAX-S, types: S, WH, H, 2H and W,
- Non-standard BINDAX-N, types: W, WH, WS, H, 2H, BK, BA, S, KO, K, KH, B and BA + H.

The BINDAX rod connecting elements are composed of longitudinal steel profiles (rails) made of perforated galvanized steel sheet.

Ribbed reinforcing bars are embedded in the profiles. Reinforcing bars on one side of the profile are bent to it and covered with a plastic tape (figure A1). The BINDAX rod connecting elements are shown in drawings A2 + A5. The dimensions of the elements are given in tables A1 ÷ A17.

Profiles (rails) of BINDAX rod connection sets are made of galvanized steel sheet in accordance with PN-EN 10346:2015 standard, with a thickness of not less than 0.4 mm, of ordinary steel, carbon with a yield strength R_e not less than 210 MPa and strength stretching of R_m not less than 270 MPa, covered with a fire-resistant layer of zinc with a thickness of not less than 6 μm .

Reinforcing bars of BINDAX rod connecting elements are made of ribbed steel bars with a diameter of 8, 10, 12, 14 or 16 mm and properties specified for reinforcing steel class B or C according to PN-EN 1992-1-1:2008 standard and given in Table C1, Annex C, placed on the market, in accordance with applicable regulations and intended use.

2. INTENDED USE OF PRODUCT

The BINDAX rod connecting elements are designed for joining reinforcing bars in the joints of monolithic elements of segmented concrete, prefabricated structures and in the connection of prefabricated elements with monolithic elements. The concrete class of joined elements should not be lower than C20/25 according to PN-EN 206+A1:2016 standard.

BINDAX elements should not be used in concrete elements subjected to the impact of dynamic loads and multiple variables.

During operation, BINDAX rod connecting elements are not exposed to the external environment. Covering the profiles with elements with a protective layer of zinc protects them against environmental aggression while they are stored before concreting and during working breaks in concreting.

Dimensioning of vertical and horizontal joints, in which BINDAX rod connecting elements were used, should be carried out in accordance with PN-EN 1992-1-1: 2008 standard (Eurocode 2).

The design shear resistance of a joint at load acting along the joint should be calculated according to the formula 6.25 given in p. 6.2.5 of PN-EN 1992-1-1: 2008 standard, in section shown in Figure C1 of this assessment. The values of c and μ coefficients, appearing in formula 6.25, characterizing the roughness of the plane of steel profile joining with concrete, should be assumed as follows: $c = 0.2$ and $\mu = 0.7$.

The design shear resistance of a joint at load transverse to the joint, when no shear reinforcement is required, should be calculated according to the point 6.2.2 of PN-EN 1992-1-1: 2008 standard.

The design shear resistance of a joint at load transverse to the joint, with shear reinforcement, should be calculated according to the point 6.2.3 of PN-EN 1992-1-1: 2008 standard.

When designing the connections of BINDAX rod elements with reinforcing bars of reinforced concrete elements, a characteristic yield limit of f_{yk} equal to 500 MPa shall be taken, and the other properties shall be appropriate for the class B or C according to PN-EN 1992-1-1: 2008 standard. Anchorage length and bending radii of rods should meet the requirements specified in PN-EN 1992-1-1: 2008 standard.

Due to the fact that the reinforcing bars in BINDAX elements are first bent and then folded back during the execution of joints, their design resistance should be reduced by 20% and assumed: $f_{yd, red} = f_{yd} \times 0.8$.

Reinforcement bars of the BINDAX connecting elements can be bent only once. They can not be bent at ambient temperatures below -15°C . Bending should be carried out in accordance with the requirements of the PN-EN 13670:2011 standard.

The assembly of the BINDAX rod connecting element in the reinforced concrete element is shown in Figure B1, Annex B.

BINDAX elements should be used in accordance with the technical design, developed taking into account Polish construction standards and regulations, the provisions of this National Technical Assessment and in accordance with the manufacturer's instructions regarding the conditions of making reinforced concrete joints using the above-mentioned connecting elements.

3. PERFORMANCE OF THE PRODUCT AND METHODS APPLIED TO THEIR ASSESSMENT

3.1. Performance of the product

3.1.1. Shape and dimensions. The shape and dimensions of BINDAX rod connecting elements should be in accordance with figures A1 ÷ A5 and tables A1 ÷ A17, Appendix A.

3.1.2. Strength properties of steel reinforced rebars in BINDAX elements after straightening. The tensile strength and yield strength of steel of rebated reinforcing bars of BINDAX elements after straightening should not be lower than 80% of the characteristic values of tensile strength and yield stress of reinforcing steel used to make BINDAX elements.

3.1.3. Coefficients characterizing the roughness of the plane of an assembly of steel profiles of BINDAX elements with concrete for calculating the load capacity in the direction along the profile. The c and μ coefficients, characterizing the surface roughness of the steel profiles of BINDAX elements with concrete, occurring in the 6.25 formula of PN-EN 1992-1-1:2008 standard, determined in the direction along the profile, should not be less than: 0.2 (c coefficient) and 0.7 (μ

3.1.4. Resistance to corrosion. Covering the profiles with elements with a 6 µm thick protective layer protects them against environmental corrosion, in the range resulting from point 2.

3.2. Methods used to evaluate performance

3.2.1. Checking of shape and dimensions. Checking the shape and dimensions of BINDAX rod connecting elements should be carried out with the use of measuring instruments that ensure the required accuracy of measurement.

3.2.2. Checking the strength properties of steel of rebated reinforcing bars of BINDAX rod connecting elements after straightening. Checking the strength properties of steel of rebated reinforcing bars of BINDAX rod connecting elements after straightening, should be performed in accordance with PN-EN ISO 6892-1:2010 standard.

3.2.3. Checking the c and μ coefficients characterizing the surface roughness of the steel profiles of BINDAX rod connecting elements with concrete. The coefficient of surface roughness of the steel profiles of BINDAX rod connecting elements with concrete should be checked on a model consisting of two disc-shaped elements made of C20/25 class concrete in accordance with PN-EN 206+A1:2016 standard, connected with a BINDAX element without reinforcing bars, in which model the bonding of both concrete elements takes place thanks to adhesion forces created between the concrete of the elements and the steel profile. The connection should be made in such a way as to preclude direct contact between the concrete of both elements. During the test, shear force generated in the connection of concrete elements should be determined when one of them is loaded with a force parallel to the connection (parallel to the steel profile). The load should be increased in a uniform manner, with the speed causing the shear stress increase in the joint, not higher than 1 MPa/min. Load measurement should be carried out using a force meter with a measurement error not exceeding 2% of the measured value. The test shall be carried out for at least three different values of the force load perpendicular to the connection (perpendicular to the steel section) causing compressive stresses normal in the plane of the fixation.

The c and μ coefficients are determined using the least squares method from the equation:

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

where:

- $V_{r,ex}$ - joint shear stress, MPa
- σ_n - normal stress compressive connection, MPa
- $f_{ct,m}$ - the average value of axial tensile strength of concrete, MPa

4. PACKAGING, TRANSPORT AND STORAGE AS WELL AS METHOD OF LABELLING THE PRODUCT

The BINDAX rod connecting elements should be delivered, stored and transported in a way that ensures their technical properties remain unchanged.

The way of marking products with a construction mark should comply with the regulation of the Minister of Infrastructure dated 11 August 2004. on the methods of declaring compliance of construction products and the method of marking them with a construction mark (Journal of Laws of 2016, item 1966, with later amendments).

The marking of a products with a construction mark should be accompanied by the following information:

- the last two digits of the year in which the construction mark was placed for the first time on a construction product,
- name and address of the registered office of the manufacturer or an identification mark allowing to clearly identify the name and address of the registered office of the manufacturer,
- the name and type designation of the construction product,
- the number and year of issuing the national technical assessment according to which the performance has been declared (ITB-KOT-2019/0833 1st edition),
- the number of the national declaration of performance,
- the level or class of the performance declared,
- the name of the certification entity that participated in the assessment and verification of constancy of performance of the construction product,
- the manufacturer's website address if the national declaration of performance is made available on it.

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

In addition, the marking of a construction product that is a hazardous mixture under 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 Regulation (EC) No. 1907/2006.

5. ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE

5.1. National system of assessment and verification of constancy of performance

In accordance with 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 2016, item 1966, as amended), system 1+ applies to the assessment and verification of constancy of performance.

5.2. Type test

The performance characteristics, evaluated in p. 3, constitute a type test of the product, until changes of raw materials, ingredients, production line or production plant occur.

5.3. Company production control

The manufacturer should have a factory production control system implemented in the production plant. All elements of the system, requirements and provisions adopted by the manufacturer should be documented in a systematic manner in the form of rules and procedures, including records from the conducted research. The factory production control should be adapted to the production technology and ensure the serial production of the declared performance of the product.

The factory production control includes the specification and checking of raw materials and components, inspection and testing in the manufacturing process and control tests (according to clause 5.4), conducted by the manufacturer in accordance with the established test plan and according to the rules and procedures set out in the factory production control documentation.

The results of production control should be systematically recorded. The records should confirm that the products meet the criteria for assessment and verification of constancy of performance. Individual products or batches of products and related production details must be fully identifiable and reproducible.

5.4. Control tests

5.4.1. Test program. The test program includes:

- a) current tests,
- b) periodic tests.

5.4.2. Current tests. Current tests include checking the shape and dimensions of the BINDAX rod connecting elements.

5.4.3. Periodic tests. Periodic tests include checking:

- a) strength properties of steel reinforced rebars after straightening,
- b) the c and M coefficients characterizing the surface roughness of the steel profiles with concrete.

5.5. Frequency of tests

Current tests should be conducted in accordance with the established test plan, but not less frequently than for each batch of products. The batch size of the products should be specified in the factory production control documentation.

Periodic tests should be carried out at least once every three years.

6. INSTRUCTION

6.1. National Technical Assessment ITB-KOT-2019/0833 1st edition is a positive assessment of the functional properties of these basic characteristics of BINDAX rod connecting elements, which, according to the intended use, resulting from the provisions of the Assessment, affect the fulfilment of basic requirements by construction facilities in which the product will be applied.

6.2. The National Technical Assessment ITB-KOT-2019/0833 1st edition is not a document authorizing to mark the construction product with a construction mark.

In accordance with the Act on construction materials of 16 April 2004 (Journal of Laws of 2016, item 1570, with later amendments) products covered by this National Technical Assessment, may be placed on the market or made available on the domestic market, if the manufacturer has assessed and verified constancy of performance, drew up a national declaration of performance in accordance with the National Technical Assessment ITB-CAT 2019/0833 1st edition and marked the products with a construction mark in accordance with applicable regulations.

6.3. The National Technical Assessment ITB-KOT-2019/0833 1st edition does not infringe powers on protection of industrial property, in particular of the Act of 30 June 2000 - Industrial property law (consolidated text: Journal of Laws of 2017, item 776). Providing these rights is one of the obligations of the beneficiaries of this National Technical Assessment of the Building Research Institute.

6.4. When issuing the National Technical Assessment, the Building Research Institute does not assume liability for contingent infringement of exclusive or acquired rights

6.5. The National Technical Assessment does not exempt the manufacturer of the products from their responsibility for their correct quality, and the contractors of construction works from the responsibility for their proper application.

6.6. 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) NK-507/A/99. Expert opinion for the technical approval of the COMAX anchoring system. Building Structures Plant of Building Research Institute, Warsaw 1999.
- 2) LW-1016/04. Test report on reinforcing bars of COMAX sets after deflection. Building Structures Plant of Building Research Institute, Warsaw 2004.
- 3) LOK-794/A/05-1. Test Report and Technical Assessment of COMAX connection sets, type H, 2H, WH, S Silesian Branch in Katowice, Building Research Institute in Warsaw, Katowice 2005.
- 4) N0/568/05. Technical opinion regarding corrosion protection of steel profiles of COMAX connecting sets. Building Permanence and Protection of the Buildings of Building Research Institute in Warsaw, Warsaw 2005.
- 5) LK00-02862/10/Z00NK. Test report on COMAX sets for joining reinforced concrete elements. Construction and Building Elements Plant of Building Research Institute, Warsaw 2010.
- 6) LK00-2305/10/Z00NK. Opinion on COMAX type sets for joining reinforced concrete elements. Construction and Building Elements Plant of Building Research Institute, Warsaw 2010.

- 7) LK00-2159/13/Z00NK. Test report on COMAX sets for joining reinforced concrete elements. Construction and Building Elements Plant of Building Research Institute, Warsaw 2013.
- 8) LM00-02159/13/Z00NK. Test report on zinc coating on steel rails of COMAX sets, type S, H and WH. Building Materials Plant of Building Research Institute, Warsaw 2013.
- 9) NK-04905R:06/PW/13. Opinion on the coefficient of roughness of the surface of the assembly profiles of COMAX type sets for joining reinforced concrete elements. Construction and Building Elements Plant of Building Research Institute, Warsaw 2014.
- 10) LZK00-03094/18/Z00NZK. Report on bar test of BINDAX connecting sets. Construction Structures, Geotechnics and Concrete Plant of Building Research Institute, Warsaw 2018.

7.2. Standards and related documents

PN-EN 10346:2015	<i>Continuously hot-dip coated steel flat products for cold forming. Technical delivery conditions</i>
PN-EN 1992-1-1:2008	<i>Eurocode 2. Designing concrete structures, Part 1-1: General rules and rules for buildings</i>
PN-EN 206+A1:2016	<i>Concrete. Part 1: Specification, performance, production and conformity</i>
PN-EN 13670:2011	<i>Execution of concrete structures</i>
PN-EN ISO 2178:1998	<i>Non-magnetic coatings on magnetic substrates. Measurement of coating thickness. Magnetic method</i>
PN-EN ISO 6892-1:2010	<i>Metallic materials. Tensile testing. Part 1: Method of test at room temperature</i>
PN-EN ISO 15630-1:2011	<i>Steel for the reinforcement and prestressing of concrete. Test methods. Part 1: Reinforcing bars, wire rod and wire</i>
AT-15-3793/2014	<i>BINDAX rod connecting elements</i>

APPENDICES

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Appendix C.	The method of determining the effective profile width of the BINDAX element and the reinforcing steel properties of ribbed bars	79

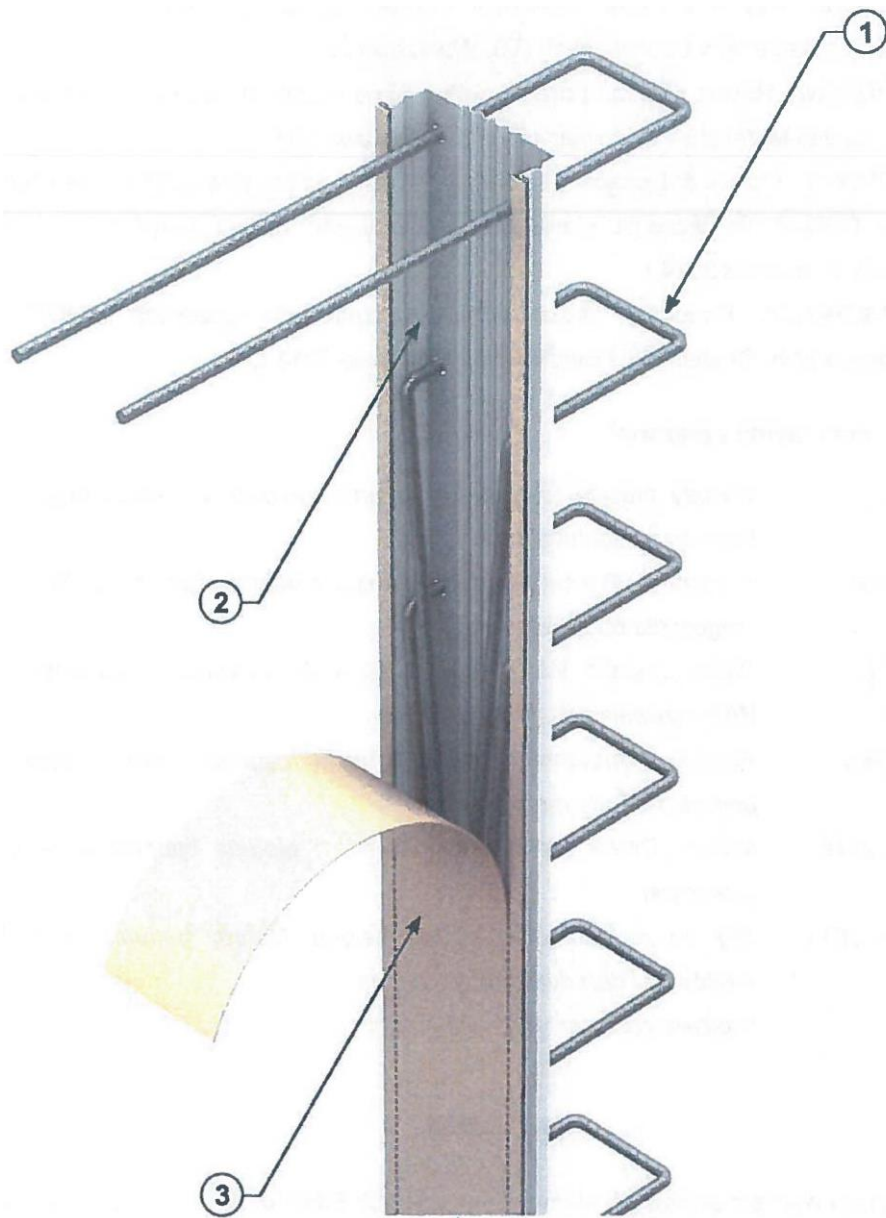
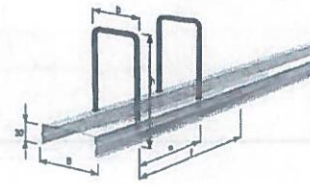
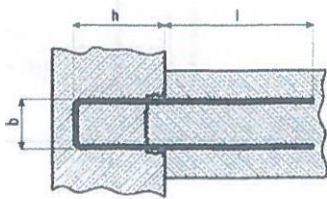
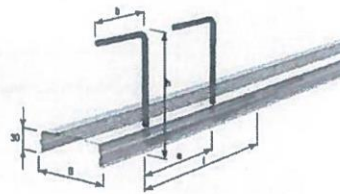
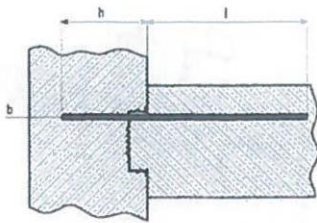


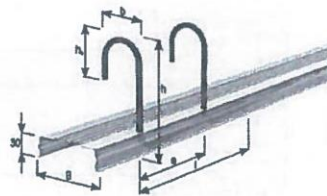
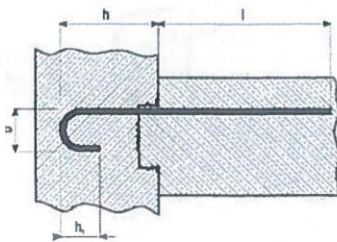
Figure A1. BINDAX rod connecting element for joining reinforced concrete elements
1. reinforcing rod. 2. profile (rail) made of galvanized sheet steel. 3. PVC tape



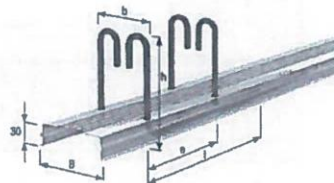
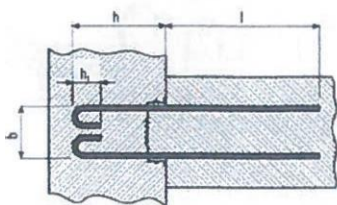
BINDAX-S element - type S



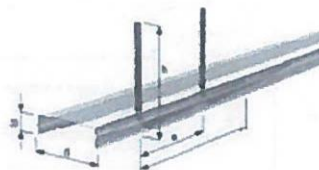
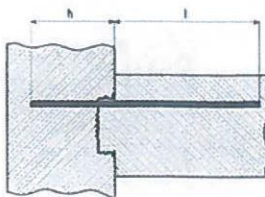
BINDAX-S element - type WH



BINDAX-S element - type H

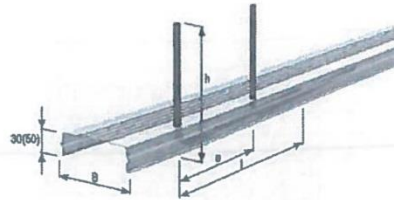
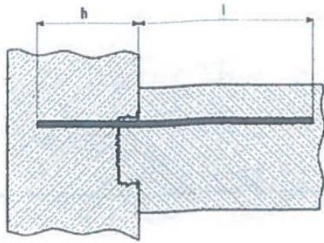


BINDAX-S element - type 2H

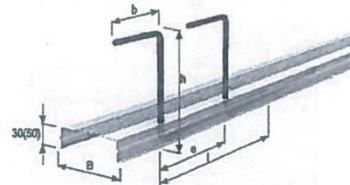
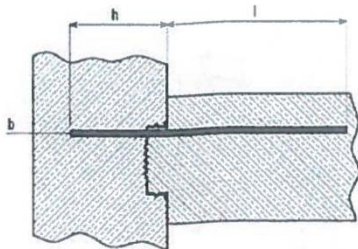


BINDAX-S element - type W

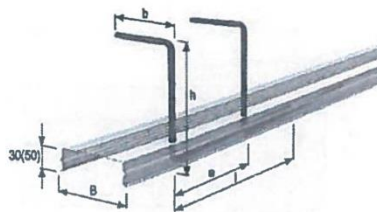
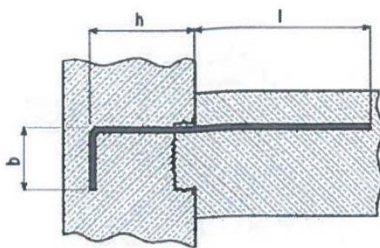
Figure A2. BINDAX-S rod connecting elements of S, WH, H, 2H and W types



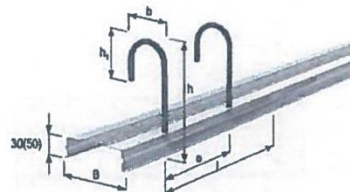
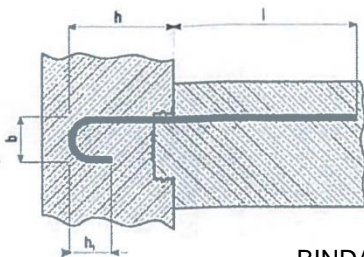
BINDAX-N element - type W



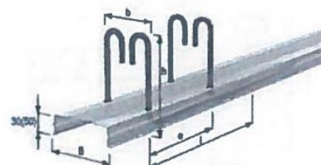
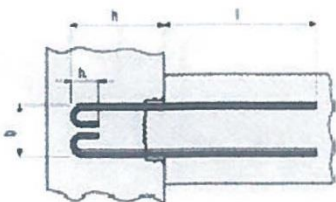
BINDAX-N element - type WH



BINDAX-N element - type WS

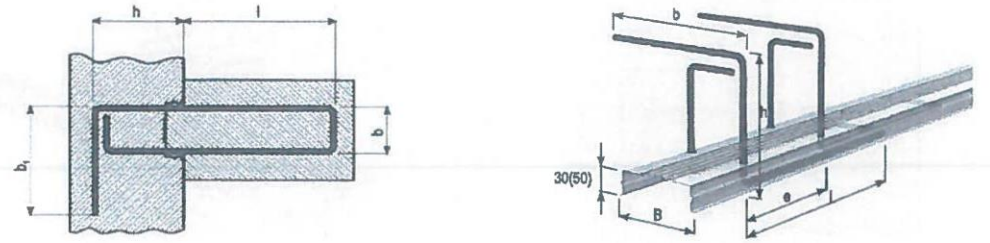


BINDAX-N element - type H

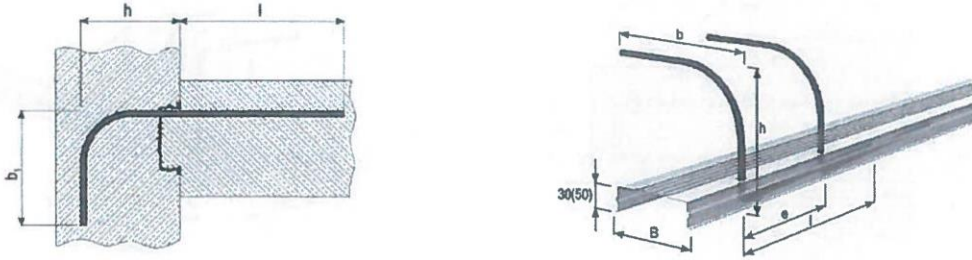


BINDAX-N element - type 2H

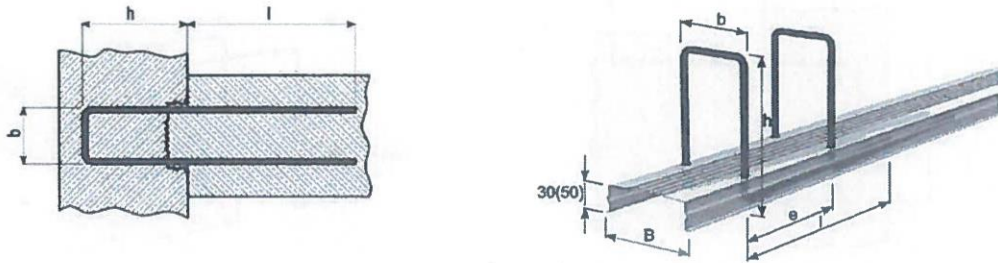
Figure A3. BINDAX-N rod connecting elements of W, WH, WS, H and 2H types



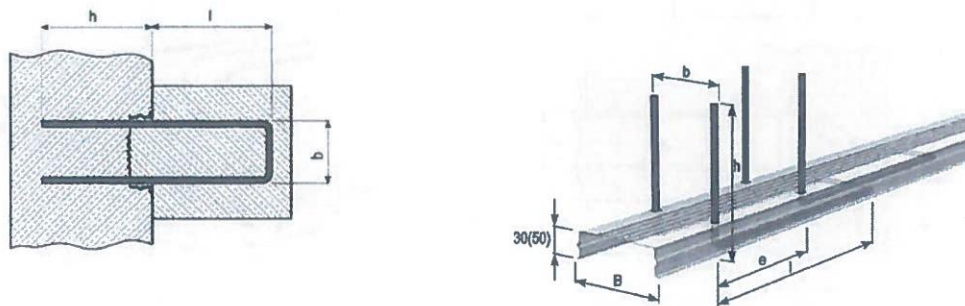
BINDAX-N element - type BK



BINDAX-N element - type BA



BINDAX-N element - type S



BINDAX-N element - type KO

Figure A4. BINDAX-N rod connecting elements of BK, BA, S and KO types

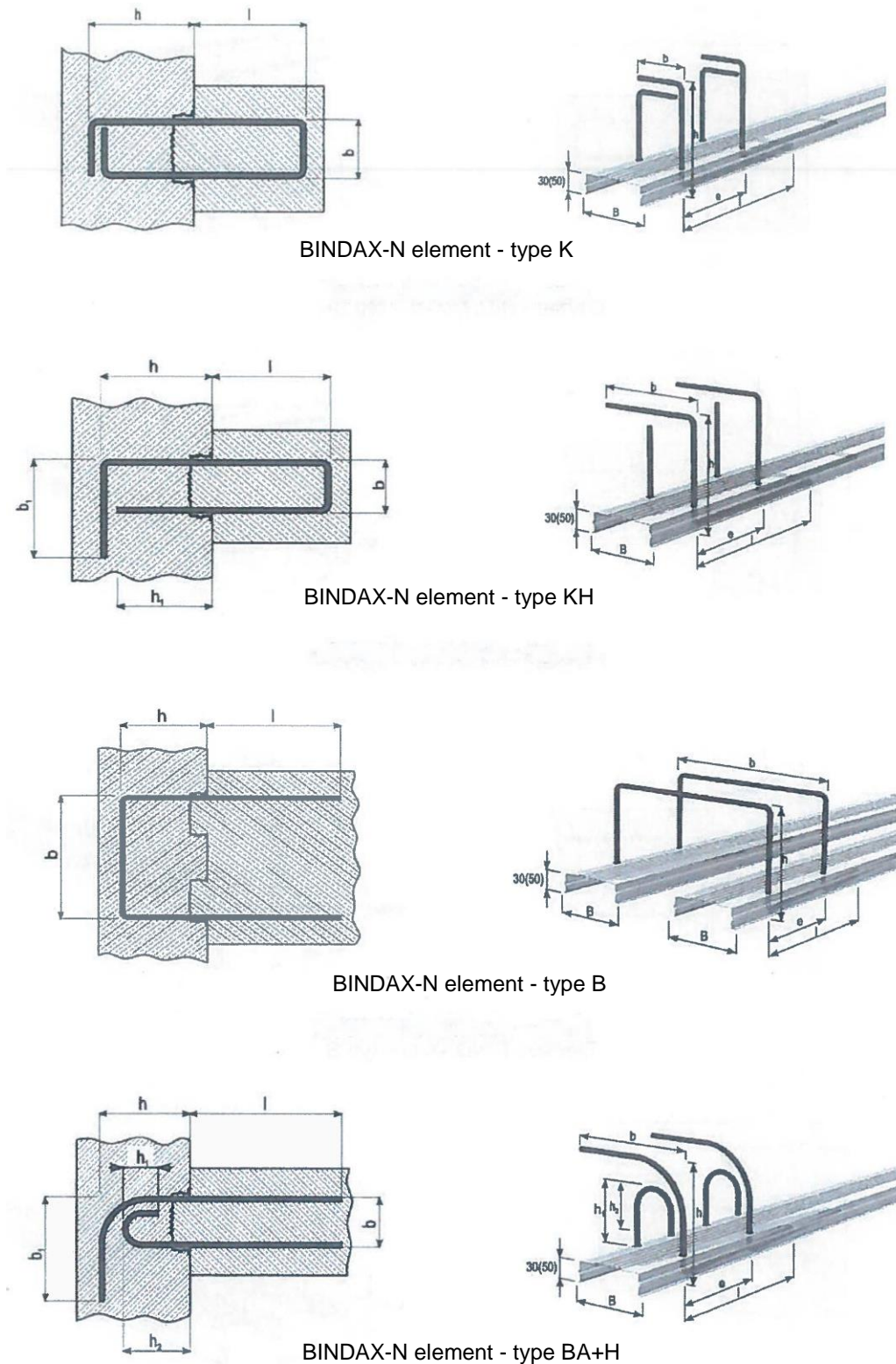
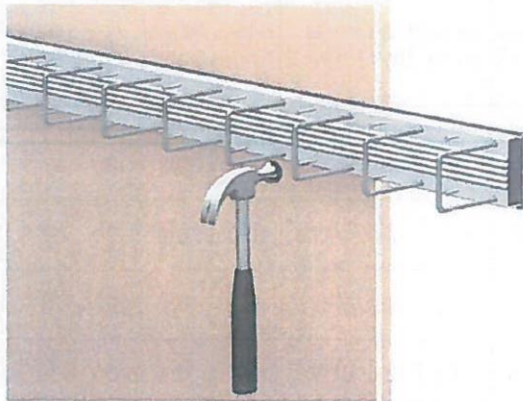
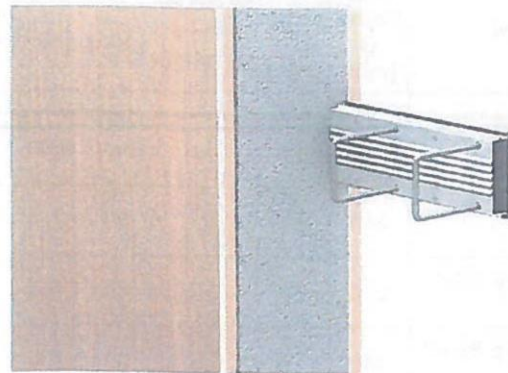


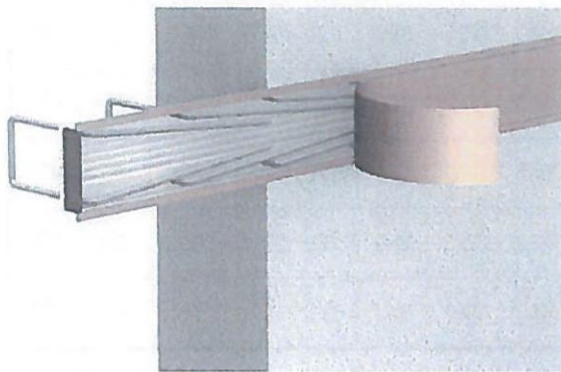
Figure A5. BINDAX-N rod connecting elements of K, KH, B and BA+H types



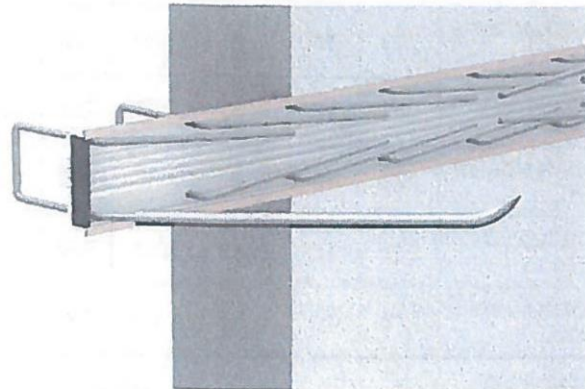
1. Mounting the formwork element



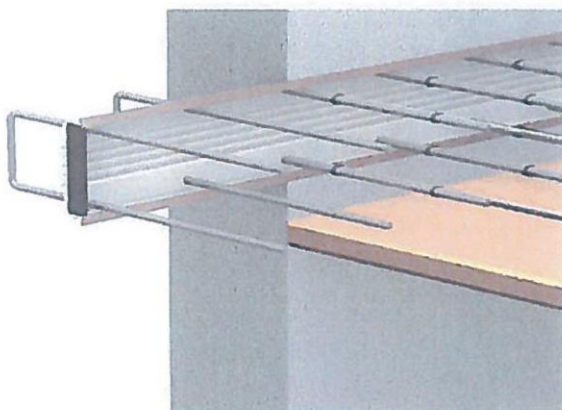
2. Concreting the first element.



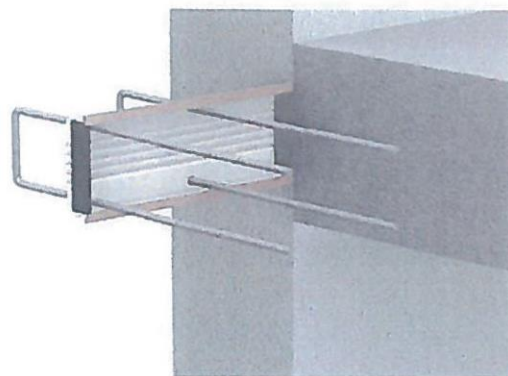
3. Disassembling the formwork from the first element. Removal of the cover tape from the element.



4. Deflection of bent element rods.



5. Connection of the bent element rods with the reinforcement of the second element.



6. Connection of two elements.

Figure B1. Installation of the BINDAX rod connecting element in the reinforced concrete element

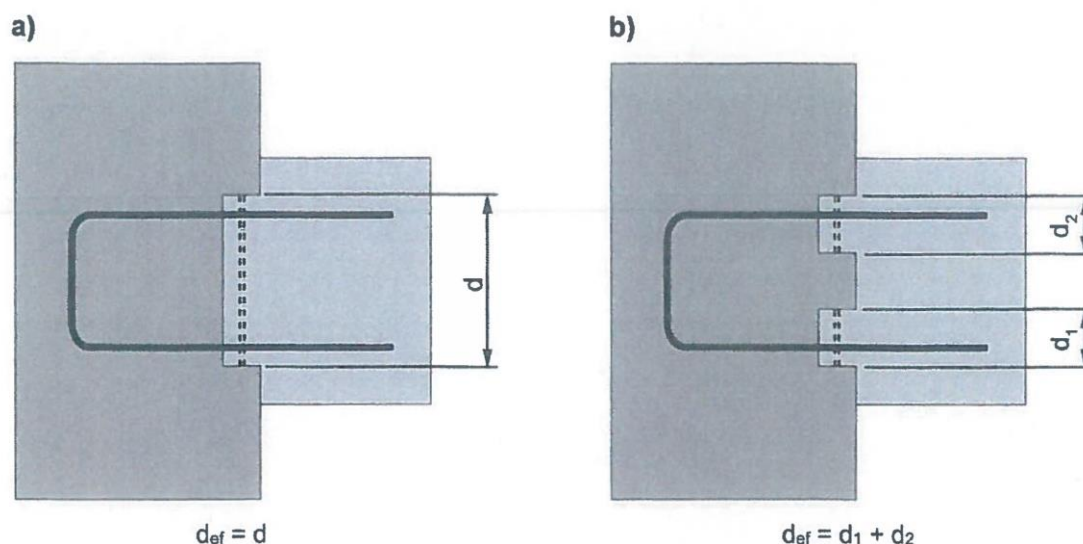


Figure C1. Illustration of how to determine the effective width of the BINDAX element profile (d_{ef})
a) connection with a single profile,
b) connection with two profiles

Table C1. Properties of reinforcing steel rods of BINDAX finned elements - ductile steel class B and C

Item	Properties	Requirements for the class of ductility		Assessment methods (unless otherwise specified in the reference document)
		B	C	
1	2	3	4	5
1	Chemical composition - content of elements [%]			according to the reference document
	- Cu	$\leq 0,80 (0,85)^{1)}$		
	- C	$\leq 0,22 (0,24)^{1)}$		
	- P	$\leq 0,050 (0,055)^{1)}$		
	- S	$\leq 0,050 (0,055)^{1)}$		
	- N	$\leq 0,012 (0,013)^{1)}$		
2	Coal equivalent C_{eq}	$\leq 0,50 (0,52)^{2)}$		according to the formula
3	Shape, dimensions and weight	according to the reference document and Eurocode 2		
4	The yield strength R_e [MPa]	≥ 500		PN-EN-ISO 6892-1:2010
5	The tensile strength R_m [MPa]	≥ 550		
6	Ratio R_m/R_e	$\geq 1,08$	1,15 + 1,35	
7	Relative elongation A_{10} [%]	≥ 10	-	
8	Relative elongation A_5 [%]	-	≥ 16	
9	Total elongation at the maximum force A_{gt} [%]	$\geq 5,0$	$\geq 8,0$	
10	Bending of samples "aged" by an angle of 20° after bending by 90° on a mandrel with a diameter of 5 · d	no cracks		PN-EN ISO 15630-1:2011
¹⁾ values without brackets refer to the requirements of the content of elements according to smelting analysis; in brackets - according to chemical analysis of the product ²⁾ $C_{eq} = c + \frac{Mn}{6} + \frac{Cr + V + Mo}{5} + \frac{Cu + Ni}{15}$				