# Approval In Principle: Poole Park Sluice FRP Bridge

Document no.: POOLE-REP-01

Revision: P02

| Revision | Date | Author | Checked by | Approved by | Revision Details: |
|---|---|---|---|---|---|
| P01 | 17/08/18 | M. Amaduddin | L. Canning | L. Canning | First draft for information |
| P02 | 21/08/18 | M. Amaduddin | L. Canning | L. Canning | Updated for CTS comments |

# Contents

# 1 Purpose

1.1.1 This Approval in Principle (AIP) submission provides details of the works required to construct Poole Park Sluice FRP Bridge.

## 1.2 Type of Highway

1.2.1 Pedestrian bridge

## 1.3 Permitted traffic speed

1.3.1 Over N/A (pedestrian bridge)

1.3.2 Under N/A (watercourse)

## 1.4 Existing restrictions

1.4.1 None.

# 2 Site details

## 2.1 Obstacle supported

2.1.1 Footpath and maintenance vehicle access route.

## 2.2 Obstacle spanning

2.2.1 Poole Park watercourse.

# 3 Proposed Structure

## 3.1 Description of the structure and design working life

### Proposed Superstructure:

3.1.1 The proposed FRP structure replaces the existing bridge at this location. The single span structure comprises bonded pultruded GFRP (glass fibre reinforced polymer) components and bonded CFRP (carbon fibre reinforced polymer) components, manufactured by Fiberline.

3.1.2 The bridge has a width of approximately 4.3m (minimum clear width between parapets of 3.9m) and total length varying from approximately 5.1m to 6.1m (due to skewed ends).

### Proposed Substructure:

3.1.3 N/A. New mass concrete cill beams by others.

### Design Working Life:

3.1.4 The design working life of the structure is Design Working Life Category 4 (50-120 years design working life) in accordance with BS EN 1990:2002 and BD 100/16.

3.1.5 The design working life of the bearings is Design Working Life Category 2 (replaceable structural parts, up to 50 years design working life) in accordance with BS EN 1990:2002 and BD 100/16.

## 3.2 Structural Type

3.2.1 The proposed structure is a single span simply supported structure comprising a shallow GFRP deck stiffened with GFRP/CFRP beams.

3.2.2 The proposed structure is shown on Drawing POOLE-DRG-01.

## 3.3 Foundation Type

3.3.1 The foundation comprises brick abutment based on Drawing 70044480-SBR-DR-CB-0001.

## 3.4 Span arrangements

3.4.1 The proposed bridge is a single span structure with an effective span varying from 5.085m to 6.095m due to skewed ends.

## 3.5 Articulation Arrangements

3.5.1 The bridge is simply supported and bears onto plain elastomeric bearings.

3.5.2 Longitudinal restraint is assumed to be provided by the approach reinforced concrete slabs (by others). Lateral restraint provided by friction at bearings. No vertical restraint required.

3.5.3 Bearings are assumed to be bonded to the FRP deck prior to lifting into final position to minimise the need for working over/near water.

## 3.6 Classes and Levels

### Consequence Class

3.6.1 Overall Consequence Class CC2 in accordance with BS EN 1990:2002 Annex B3, Section B3, Clause B3.

### Reliability Class

3.6.2 Overall Reliability Class RC2 in accordance with BS EN 1990:2002 Annexe B, Section B3, Clause B3.2.

### Inspection Level

3.6.3 Overall Inspection Level IL2 in accordance with BS EN 1990:2002 Annex B Section B5.

## 3.7 Road restraint systems requirements

3.7.1 Pedestrian parapet (by others) to be designed for PD CEN-TR-16949:2016 Class C pedestrian loads.

## 3.8 Proposed arrangement for future maintenance and inspection

### Traffic management

3.8.1 Partial or temporary full closure for maintenance (e.g. surfacing replacement or repairs).

### Arrangements for future maintenance and inspection of the structure

3.8.2 The topside of the structure can be inspected without full closure via foot access.

3.8.3 The soffit of the structure can be inspected without closure via dinghy access in the watercourse.

3.8.4 Repairs to parapets, surfacing, and FRP components can be undertaken during partial or full closure of the bridge. Bearing replacement can be undertaken by jacking of the structure at the edge FRP beams at the front of the cill beam and would require full closure of the bridge.

## 3.9 Environment and Sustainability:

3.9.1 Lightweight and durable FRP components proposed that allow quick installation and minimise maintenance to structural components, minimising whole life cost and reducing risk to environment from construction work.

## 3.10 Durability. Materials and Finishes

3.10.1 FRP is resistant to corrosion, weathering and freeze thaw effects.

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| GFRP components: | GFRP components comprise E-glass fibres in isophthalic polyester resin. See ETA certificate in Appendix D for GFRP component mechanical properties, also in accordance with E23 grade to BS EN 13706. |
| | GFRP density of 1800kg/$m^3$. |
| | CTE (pultrusion direction) 10 x $10^{-6}$/ºC. |
| | CTE (perpendicular direction) 20 x $10^{-6}$/ºC. |
| CFRP plate: | CFRP plates comprise standard modulus carbon fibres in vinylester resin. CFRP density of 1500kg/$m^3$. |
| | Tensile strength 1600 MPa in pultrusion direction. |
| | Tensile elastic modulus 130 GPa in pultrusion direction. |
| | CTE (pultrusion direction) 0 x $10^{-6}$/ºC. |

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| Structural adhesive: | Adhesive comprises two-part structural epoxy adhesive or polyurethane adhesive.<br>Adhesive density of 2000kg/m$^3$.<br>Tensile strength 20 MPa. |
| Bolts: | Bolts to be Grade 8.8 and galvanised. |
| Parapets: | By others. |
| Concrete: | Cill beams and approach slabs by others. |
| Surfacing: | Anti-slip surfacing assumed to be epoxy/grit system, to be confirmed at detailed design based on required specification and manufacturers recommendations. |

## 3.11 Risks and Hazards considered for design, execution, maintenance and demolition. Consultation with and / or agreement from CDM co-ordinator

3.11.1 Primary risks include handling and control of resins, control of dust, and FRP cutting, during FRP deck fabrication, and lifting of the fabricated structure onto bearings.

## 3.12 Estimated cost of proposed structure, together with other structural forms considered (including where appropriate proprietary manufactured structure), and the reason for their rejection (including comparative whole life costs with dates of estimates)

3.12.1 The estimated cost of the proposed works (including parapets, cill beams and approach slabs) to be confirmed by others.

## 3.13 Proposed arrangements for construction

3.13.1 The FRP bridge is proposed to be fabricated in two parts and then delivered to site and joined with a bolted site joint (together with attachment of parapets, by others) prior to installation by small crane. It is assumed that the cill beams (by others) will be adequately cured prior to installation of the FRP bridge, and that the concrete approach slabs will be placed after installation of FRP bridge to allow for construction tolerance.

3.13.2 All other construction arrangements are by others.

### Traffic management

3.13.3 N/A (by others).

### Service diversions

3.13.4 N/A (by others).

### Interface with existing structures

3.13.5 Cill beams (by others) are located on existing brickwork abutments.

# 4 Design Criteria

## 4.1 Actions

4.1.1 All actions in accordance with BS EN 1990:2002 and associated National Annex.

### Permanent Actions

4.1.2 Permanent actions will be based on density values stated in Section 3.10. Nominal parapet load of 0.5 kN/m assumed. Pre-cambering of the FRP deck is not proposed, curved edge fascia plate proposed as permanent sag is negligible. Drainage of FRP bridge provided by 1:150 (

### Snow, Wind and Thermal Actions

4.1.3 Snow loading will not be considered. It is considered that accumulation of snow will effectively reduce any pedestrian loads by an amount greater than the snow loads. This is outlined in the UK National Annex to BS EN 1991-1-3.

4.1.4 Wind loading will be in accordance with BS EN 1991-1-4:2005 as modified by UK National Annex to BS EN 1991-1-4:2005.

4.1.5 Thermal loads will be considered in accordance with BS EN 1991-1-5 clause 6.1.4.2 and NA (Approach 2). Thermal actions on FRP deck assumed to be the same as those for steel bridges.

### Actions relating to normal traffic under AW regulations C&U regulations

4.1.6 None.

### Actions relating to General order traffic under STGO regulations

4.1.7 None.

### Footway variable actions

4.1.8 5.0 kN/m$^2$ (unfactored characteristic) uniformly distributed crowd loading including dynamic amplification (Load model 4) in accordance with BS EN 1991-2:2003 (4.3.5) and NA to BS EN 1991-2:2003 (NA 2.36). Load due to service vehicles in accordance with Figure 5.2 of BS EN 1991-2:2003 but with $Q_{sv1}$ of 35kN and $Q_{sv2}$ of 17.5kN as stated in WSP FRP Specification document (reference 70044480-0003).

4.1.9 FRP deck to be designed for PD CEN-TR-16949:2016 Class E pedestrian parapet loads (unfactored characteristic load of 1.6kN/m applied vertically or horizontally to top rail).

### Actions relating to special order traffic, provision for exceptional abnormal indivisible loads including location of vehicle track on deck cross section

4.1.10 Not Applicable.

### Accidental actions

4.1.11 Accidental vehicle loading will be considered in accordance with the requirements of BS EN 1991-1-2:2003 Clause 5.6.3 and associated NA.

### Actions During Construction

4.1.12 Consideration will be given to the construction sequence when determining temporary actions (such as lifting by crane).

### Any special action not covered above

4.1.13 None.

## 4.2 Heavy or high load route requirements and arrangements being made to preserve the route, including any provision for future heavier loads or future widening.

4.2.1 None.

## 4.3 Minimum Headroom provided

4.3.1 Minimum FRP bridge soffit level of 1.230m over watercourse as per Drawing 70044480-SBR-DR-CB-0004.

## 4.4 Authorities consulted and any special conditions required.

4.4.1 None.

## 4.5 Standards and documents listed in the Technical Approval Schedule

4.5.1 See Appendix A – Technical Approval Schedule.

## 4.6 Proposed Departures relating to departures from standards given in 4.5

4.6.1 None.

## 4.7 Proposed departures relating to methods for dealing with aspects not covered by the standards in 4.5

4.7.1 Design of the FRP deck shall be based on the following:

Ultimate Limit State – Stresses due to load effects to be checked against the factored FRP strength. Partial material factor on FRP strength stated in Section 3.10 shall be 1.5, the minimum allowed in the Eurocomp Design Code and Handbook and noting that test evidence exists for the FRP deck components.

Serviceability Limit State – Pedestrian comfort shall be checked by limiting the vertical natural frequency of the FRP bridge to above 5 Hz, and the transverse/torsional natural frequency to above 2.5 Hz. Partial material factor on elastic moduli for GFRP shall be 1.3, the minimum allowed in the Eurocomp Design Code and Handbook and noting that test evidence exists for the FRP deck components. Partial material factor on elastic modulus of CFRP plate shall be 1.0 due to high durability (vinylester resin cf. polyester resin for GFRP components) and minimum variability in properties (uni-directional fibres).

# 5 Structural Analysis

## 5.1 Methods of analysis proposed for superstructure, substructure and foundations

5.1.1 Load effects in the FRP deck shall be determined using a 3D finite element analysis of the FRP superstructure using shell elements, taking account of the orthotropy of the FRP materials.

Through-thickness load effects shall be calculated by hand based on consideration of the stresses from the 3D finite element analysis.

Bond load effects and strength shall be calculated by hand based on consideration of the stresses from the 3D finite element analysis, and using CIRIA Report C595 assuming that FRP can theoretically be assumed to act as steel with a lower elastic modulus. Previous test evidence may also be used to confirm bond adequacy.

Buckling capacity to be calculated using linear elastic buckling analysis of 3D FE model, calculated by hand in accordance with Eurocomp Design Code and Handbook, or based on previous test evidence.

## 5.2 Description and diagram of idealised structure to be used for analysis

5.2.1 See diagram in Appendix C.

## 5.3 Assumptions intended for calculations of structural element stiffness

5.3.1 Gross section properties of the FRP components shall be used, additional stiffness from any surfacing and fill to be ignored. The effects of any additional stiffening from the parapet (by others) shall be considered.

## 5.4 Proposed range of soil parameters to be used in the design of earth retaining elements/

5.4.1 N/A.

# 6 Geotechnical Conditions

## 6.1 Acceptance of recommendations of the Geotechnical Design Report to be used in the design and reasons for any proposed changes

6.1.1 N/A.

## 6.2 Summary of design for highway structure in geotechnical design report

6.2.1 N/A.

## 6.3 Differential settlement to be allowed for the design of the structure

6.3.1 N/A (simply supported FRP bridge and cill beam design by others).

## 6.4 If the Geotechnical Design Report is not yet available, state when the results are expected and list the source of information used to justify the preliminary choice of foundations

6.4.1 N/A.

# 7 Check

## 7.1 Proposed Category and Design Supervision Level

7.1.1 Category 1 (Design Supervision Level 2) in accordance with BD2/12. Also considered acceptable as FRP components are in accordance with BS EN 13706 with ETA document, and small scale of structure.

## 7.2 If Category 3, name of proposed Independent Checker

7.2.1 N/A.

## 7.3 Erection proposals or temporary works for which Types S and P proposals will be required, listing structural parts of the permanent structure affected with reasons

7.3.1 N/A.

# 8 Drawings and Documents

## 8.1 List of drawings (including numbers) and document accompanying the submission

| | |
|---|---|
| Appendix A | Technical Approval Schedule (TAS) |
| Appendix B | FRP Deck General Arrangement and Details |
| Appendix C | Diagram of Idealised Structure |
| Appendix D | ETA Document For GFRP Components |

# 9 THE ABOVE IS SUBMITTED FOR ACCEPTANCE

| | |
|---|---|
| Signed | ..... |
| Name | Lee Canning |
| Position Held | Design Team Leader |
| Engineering Qualifications | MEng PhD |
| Name of Organisation | Jacobs |
| Date | 17/08/18..... |

# 10 THE ABOVE IS REJECTED/AGREED SUBJECT TO THE AMENDMENTS AND CONDITIONS SHOWN BELOW

Signed ……

Name

Position Held

Engineering Qualifications

TAA

Date ……

# Appendix A Technical Approval Schedule (TAS)

# Schedule of Documents Relating to Design of Highway Bridges and Structures

**Eurocodes and associated UK National Annexes**

| Eurocode part | Title | Amendment / Corrigenda | |
|---|---|---|---|
| **Eurocode 0** | **Basis of structural design** | | |
| BS EN 1990:2002 +A1:2005 | Eurocode 0: Basis of structural design | +A1:2005 Incorporating corrigenda December 2008 and April 2010 | See BD100 Annex A for additional guidance. |
| NA to BS EN 1990:2002 + A1:2005 | UK National Annex to Eurocode 0 Basis of structural design | National Amendment No.1 | See BD100 Annex A for additional guidance. |
| **Eurocode 1** | **Actions on structures** | | |
| BS EN 1991-1-1:2002 | Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings | Corrigenda December 2004 and March 2009 | |
| NA to BS EN 1991-1-1:2002 | UK National Annex to Eurocode 1: Actions on structures. General Actions. Densities, self-weight, imposed load for buildings | - | |
| ~~BS EN 1991-1-3:2003 +A1:2015~~ | ~~Eurocode 1: Actions on structures. General Actions. Snow loads~~ | ~~+A1:2015 Incorporating corrigenda December 2004 and March 2009~~ | |
| ~~NA to BS EN 1991-1-3:2003+A1:2015~~ | ~~UK National Annex to Eurocode 1: Actions on structures. General Actions. Snow loads~~ | ~~+A1:2015 Incorporating corrigendum No.1~~ | |
| BS EN 1991-1-4:2005 +A1:2010 | Eurocode 1: Actions on structures. General Actions. Wind actions | +A1:2010 Corrigenda July 2009 and January 2010 | |
| NA to BS EN 1991-1-4:2005 + A1:2010 | UK National Annex to Eurocode 1: Actions on structures. General Actions. Wind actions | National Amendment No.1 | |
| BS EN 1991-1-5:2003 | Eurocode 1: Actions on structures. General Actions. Thermal actions | Corrigenda December 2004 and March 2009 | |
| NA to BS EN 1991-1-5:2003 | UK National Annex to Eurocode 1: Actions on structures. General Actions. Thermal actions | - | |
| BS EN 1991-1-6:2005 | Eurocode 1: Actions on structures. General Actions. Actions during execution | Corrigenda July 2008, November 2012 and February 2013 | |
| NA to BS EN 1991-1-6:2005 | UK National Annex to Eurocode 1: Actions on structures. General Actions. Actions during execution | - | |
| BS EN 1991-1-7:2006 +A1:2014 | Eurocode 1: Actions on structures. General Actions. Accidental actions | +A1: 2014 Corrigendum February 2010 | |
| NA+A1 to BS EN 1991-1-7:2006+A1:2014 | UK National Annex to Eurocode 1: Actions on structures. Part 1- | +A1:2014 Incorporating | See BD100 for additional guidance. |

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| | 7 : Accidental actions | corrigenda August 2014 and November 2015 | |
| BS EN 1991-2:2003 | Eurocode 1: Actions on structures. Traffic loads on bridges | Corrigenda December 2004 and February 2010 | See BD100 Annex A for additional guidance. |
| NA to BS EN 1991-2:2003 | UK National Annex to Eurocode 1: Actions on structures. Traffic loads on bridges | Corrigendum No.1 | See BD100 Annex A for additional guidance. |
| **Eurocode 2** | **Design of concrete structures** | | |
| ~~BS EN 1992-1-1:2004 + A1:2014~~ | ~~Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings~~ | ~~Incorporating corrigendum January 2008, November 2010 and January 2014~~ | |
| ~~NA + A2:2014 to BS EN 1992-1-1:2004 + A1:2014~~ | ~~UK National Annex to Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings~~ | | |
| ~~BS EN 1992-2:2005~~ | ~~Eurocode 2: Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules~~ | ~~Corrigendum July 2008~~ | |
| ~~NA to BS EN 1992-2:2005~~ | ~~UK National Annex to Eurocode 2: Design of concrete structure – Part 2: Concrete bridges – Design and detailing rules~~ | ~~-~~ | |
| ~~BS EN 1992-3:2006~~ | ~~Eurocode 2: Design of concrete structures – Part 3: Liquid retaining and containment structures~~ | ~~-~~ | |
| ~~NA to BS EN 1992-3:2006~~ | ~~UK National Annex to Eurocode 2: Design of concrete structure – Part 3: Liquid retaining and containment structures~~ | ~~-~~ | |
| **Eurocode 3** | **Design of steel structures** | | |
| BS EN 1993-1-1:2005 + A1:2014 | Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings | Corrigenda February 2006 and April 2009 | |
| NA + A1:2014 to BS EN 1993-1-1:2005 + A1:2014 | UK National Annex to Eurocode 3: Design of steel structures – Part 1-1 General rules and rules for buildings | - | |
| ~~BS EN 1993-1-3:2006~~ | ~~Eurocode 3: Design of steel structures – Part 1-3 General rules – Supplementary rules for cold-formed members and sheeting~~ | ~~Corrigendum November 2009~~ | |
| ~~NA to BS EN 1993-1-3:2006~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-3 Supplementary rules for cold-formed members and sheeting~~ | ~~-~~ | |
| ~~BS EN 1993-1-4:2006~~ | ~~Eurocode 3: Design of steel structures – Part 1-4 General rules – Supplementary rules for stainless steels~~ | ~~-~~ | |
| ~~NA to BS EN 1993-1-4:2006~~ | ~~UK National Annex to Eurocode 3: Design of steel structures –~~ | - | |

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| | ~~Part 1-4 Supplementary rules for stainless steels~~ | | |
| ~~BS EN 1993-1-5:2006+A1:2017~~ | ~~Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements~~ | ~~Corrigendum April 2009, +A1:2017 Amendment No. 1~~ | |
| ~~NA to BS EN 1993-1-5:2006~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-5 Plated structural elements~~ | ~~-~~ | |
| ~~BS EN 1993-1-6:2007~~ | ~~Eurocode 3: Design of steel structures – Part 1-6 Strength and stability of shell structures~~ | ~~+ A1:2017 Amendment No. 1~~ | |
| ~~BS EN 1993-1-7:2007~~ | ~~Eurocode 3: Design of steel structures – Part 1-7 Plated structures subject to out of plane loading~~ | ~~Corrigendum April 2009~~ | |
| BS EN 1993-1-8:2005 | Eurocode 3: Design of steel structures – Part 1-8 Design of joints | Corrigenda December 2005, September 2006, July 2009 and August 2010 | |
| NA to BS EN 1993-1-8:2005 | UK National Annex to Eurocode 3: Design of steel structures – Part 1-8 Design of joints | - | |
| ~~BS EN 1993-1-9:2005~~ | ~~Eurocode 3: Design of steel structures – Part 1-9 Fatigue~~ | ~~Corrigenda December 2005, September 2006 and April 2009~~ | |
| ~~NA to BS EN 1993-1-9:2005~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-9 Fatigue~~ | ~~-~~ | |
| ~~BS EN 1993-1-10:2005~~ | ~~Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through-thickness properties~~ | ~~Corrigenda December 2005, September 2006 and March 2009~~ | |
| ~~NA to BS EN 1993-1-10:2005~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-10 Material toughness and through thickness properties~~ | ~~-~~ | |
| ~~BS EN 1993-1-11:2006~~ | ~~Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components~~ | ~~Corrigendum April 2009~~ | |
| ~~NA to BS EN 1993-1-11:2006~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-11 Design of structures with tension components~~ | ~~-~~ | |
| ~~BS EN 1993-1-12:2007~~ | ~~Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700~~ | ~~Corrigendum April 2009~~ | |
| ~~NA to BS EN 1993-1-12:2007~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 1-12 Additional rules for the extension of EN 1993 up to steel grades S 700~~ | ~~-~~ | |
| BS EN 1993-2:2006 | Eurocode 3: Design of steel structures – Part 2 Steel bridges | Corrigendum July 2009 | |
| NA + A1:2012 to BS EN | UK National Annex to Eurocode | + A1:2012 | |

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| 1993-2:2006 | 3: Design of steel structures – Part 2 Steel bridges | | |
| ~~BS EN 1993-5:2007~~ | ~~Eurocode 3: Design of steel structures – Part 5 Piling~~ | ~~Corrigendum May 2009~~ | |
| ~~NA + A1:2012 to BS EN 1993-5:2007~~ | ~~UK National Annex to Eurocode 3: Design of steel structures – Part 5 Piling~~ | ~~+ A1:2012~~ | |
| **Eurocode 4** | **Design of composite steel and concrete structures** | | |
| ~~BS EN 1994-1-1:2004~~ | ~~Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings~~ | ~~Corrigendum April 2009~~ | |
| ~~NA to BS EN 1994-1-1:2004~~ | ~~UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 1-1 General rules and rules for buildings~~ | ~~-~~ | |
| ~~BS EN 1994-2:2005~~ | ~~Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges~~ | ~~Corrigendum July 2008~~ | |
| ~~NA to BS EN 1994-2:2005~~ | ~~UK National Annex to Eurocode 4: Design of composite steel and concrete structures – Part 2 General rules and rules for bridges~~ | ~~-~~ | |
| **Eurocode 5** | **Design of timber structures** | | |
| ~~BS EN 1995-1-1:2004 + A2:2014~~ | ~~Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings~~ | ~~+ A2:2014 Incorporating corrigendum June 2006~~ | |
| ~~NA to BS EN 1995-1-1:2004 + A1:2008~~ | ~~UK National Annex to Eurocode 5: Design of timber structures – Part 1-1 General – common rules and rules for buildings~~ | ~~+ A1:2008 Incorporating National Amendment No. 2~~ | |
| ~~BS EN 1995-2:2004~~ | ~~Eurocode 5: Design of timber structures – Part 2 Bridges~~ | ~~-~~ | |
| ~~NA to BS EN 1995-2:2004~~ | ~~UK National Annex to Eurocode 5: Design of timber structures – Part 2 Bridges~~ | ~~-~~ | |
| **Eurocode 6** | **Design of masonry structures** | | |
| ~~BS EN 1996-1-1:2005~~ | ~~Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures~~ | ~~Corrigenda February 2006 and July 2009~~ | |
| ~~NA to BS EN 1996-1-1:2005 +A1:2012~~ | ~~UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1 General rules for reinforced and unreinforced masonry structures~~ | ~~Corrigendum October 2015~~ | |
| ~~BS EN 1996-2:2006~~ | ~~Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry~~ | ~~Corrigendum September 2009~~ | |
| ~~NA to BS EN 1996-2:2006~~ | ~~UK National Annex to Eurocode 6: Design of masonry structures – Part 2 Design considerations, selection of materials and execution of masonry~~ | ~~Corrigendum No.1~~ | |

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| ~~BS EN 1996-3:2006~~ | ~~Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures~~ | ~~Corrigendum October 2009~~ | |
| ~~NA +A1:2014 to BS EN 1996-3:2006~~ | ~~UK National Annex to Eurocode 6: Design of masonry structures – Part 3 Simplified calculation methods for unreinforced masonry structures~~ | ~~+A1:2014~~ | |
| **Eurocode 7** | **Geotechnical design** | | |
| ~~BS EN 1997-1:2004+A1:2013~~ | ~~Eurocode 7: Geotechnical design – Part 1 General rules~~ | ~~+A1:2013 Corrigendum February 2009~~ | |
| ~~NA+A1 to BS EN 1997-1:2004+A1:2013~~ | ~~UK National Annex to Eurocode 7: Geotechnical design – Part 1 General rules~~ | ~~+A1:2013 Incorporating Corrigendum No.1~~ | |
| ~~BS EN 1997-2:2007~~ | ~~Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing~~ | ~~Corrigendum June 2010~~ | |
| ~~NA to BS EN 1997-2:2007~~ | ~~UK National Annex to Eurocode 7: Geotechnical design – Part 2 Ground investigation and testing~~ | ~~-~~ | |
| **Eurocode 8** | **Design of structures for earthquake resistance** | | |
| ~~BS EN 1998-1:2004 + A1:2013~~ | ~~Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings~~ | ~~Corrigendum June 2009, January 2011 and March 2013~~ | |
| ~~NA to BS EN 1998-1:2004~~ | ~~UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 1 General rules, seismic actions and rules for buildings~~ | ~~-~~ | |
| ~~BS EN 1998-2:2005+A2:2011~~ | ~~Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges~~ | ~~Corrigenda February 2010 and February 2012~~ | |
| ~~NA to BS EN 1998-2:2005~~ | ~~UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 2 Bridges~~ | ~~-~~ | |
| ~~BS EN 1998-5:2004~~ | ~~Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects~~ | ~~-~~ | |
| ~~NA to BS EN 1998-5:2004~~ | ~~UK National Annex to Eurocode 8: Design of structures for earthquake resistance – Part 5 Foundations, retaining structures and geotechnical aspects~~ | ~~-~~ | |
| **Eurocode 9** | **Design of aluminium structures** | | |
| ~~BS EN 1999-1-1:2007 + A2:2013~~ | ~~Eurocode 9: Design of aluminium structures - Part 1-1 General structural rules~~ | ~~+ A2:2013 Incorporating corrigendum March 2014~~ | |
| ~~NA to BS EN 1999-1-1:2007 + A1:2009~~ | ~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-1 General structural rules~~ | ~~National Amendment No.1 Corrigendum No.1~~ | |

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| ~~BS EN 1999-1-3:2007 + A1:2011~~ | ~~Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue~~ | ~~+ A1:2011~~ | |
| ~~NA to BS EN 1999-1-3:2007 + A1:2011~~ | ~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-3 Structures susceptible to fatigue~~ | ~~+ A1:2011~~ | |
| ~~BS EN 1999-1-4:2007 +A1:2011~~ | ~~Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting~~ | ~~+ A1:2011 Corrigendum November 2009~~ | |
| ~~NA to BS EN 1999-1-4:2007~~ | ~~UK National Annex to Eurocode 9: Design of aluminium structures – Part 1-4 Cold formed structural sheeting~~ | ~~-~~ | |

**Bsi Published Documents**

***For guidance only unless clauses are otherwise specified in BD 100/16 Annex B.***

| | | |
|---|---|---|
| PD 6688-1-1:2011 | Recommendations for the design of structures to BS EN 1991-1-1 | See BD100 Annex B for additional guidance. |
| PD 6688-1-4:2015 | Background paper to the UK National Annex to BS EN 1991-1-4 | See BD100 Annex B for additional guidance. |
| PD 6688-1-7:2009 +A1:2014 | Recommendations for the design of structures to BS EN 1991-1-7 | See BD100 clause 2.17 and Annex B for additional guidance. |
| PD 6688-2:2011 | Recommendations for the design of structures to BS EN 1991-2 | See BD100 Annex B for additional guidance. |
| ~~PD 6687-1:2010~~ | ~~Background paper to the UK National Annexes to BS EN 1992-1 and BS EN 1992-3~~ | ~~See BD100 clauses 2.15, 2.16 and Annex B for additional guidance.~~ |
| ~~PD 6687-2:2008~~ | ~~Recommendations for the design of structures to BS EN 1992 2:2005~~ | ~~See BD100 clause 2.16 and Annex B for additional guidance.~~ |
| ~~PD 6695-1-9:2008~~ | ~~Recommendations for the design of structures to BS EN 1993-1-9~~ | ~~See BD100 Annex B for additional guidance.~~ |
| ~~PD 6695-1-10:2009~~ | ~~Recommendations for the design of structures to BS EN 1993-1-10~~ | ~~See BD100 Annex B for additional guidance.~~ |
| ~~PD 6695-2:2008 + A1:2012 Incorporating Corrigendum No.1~~ | ~~Recommendation for the design of bridges to BS EN 1993~~ | ~~See BD100 Annex B for additional guidance.~~ |
| ~~PD 6696-2:2007 + A1:2012~~ | ~~Background paper to BS EN 1994-2 and the UK National Annex to BS EN 1994-2~~ | ~~See BD100 Annex B for additional guidance.~~ |
| ~~PD 6694-1:2011~~ | ~~Recommendations for the design of structures subject to traffic loading to BS EN 1997-1~~ | ~~See BD100 Annex B for additional guidance.~~ |
| ~~PD 6698:2009~~ | ~~Recommendations for the design of structures for earthquake resistance to BS EN 1998~~ | ~~See BD100 Annex A for additional guidance.~~ |
| PD 6703:2009 | Structural bearings – Guidance on the use of structural bearings | |
| ~~PD 6705-2:2010 + A1:2013~~ | ~~Recommendations for the execution of steel bridges to BS EN 1090-2~~ | ~~Amended 30 April 2013~~ |
| ~~PD 6705-3:2009~~ | ~~Recommendations on the execution of aluminium structures to BS EN 1090-3~~ | |
| ~~PD 6702-1:2009~~ | ~~Structural use of aluminium. Recommendations for the design of aluminium structures to BS EN 1999~~ | |

**Execution Standards referenced in British Standards or Eurocodes**

| | | |
|---|---|---|
| ~~BS EN 1090-1:2009+A1:2011~~ | ~~Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components~~ | |
| ~~BS EN 1090-2:2018~~ | ~~Execution of steel structures and aluminium structures. Technical requirements for the execution of steel structures~~ | ~~Supersedes BS EN 1090-2:2008+A1:2011~~ |
| ~~BS EN 1090-3:2008~~ | ~~Execution of steel structures and aluminium structures – Part 3: Technical requirements for aluminium structures~~ | |
| ~~BS EN 13670:2009 Incorporating corrigenda October 2015 and November 2015~~ | ~~Execution of concrete structures~~ | |

**Product Standards referenced in British Standards or Eurocodes**

| | | |
|---|---|---|
| ~~BS EN 206:2013~~ | ~~Concrete – Specification, performance, production and conformity~~ | ~~Corrigendum May 2014~~ |
| ~~BS EN 1317-1:2010~~ | ~~Road Restraint Systems – Part 1 – Terminology and general criteria for test methods~~ | |
| ~~BS EN 1317-2:2010~~ | ~~Road Restraint Systems – Part 2 – Performance classes, impact test acceptance criteria and test methods for safety barriers.~~ | |
| ~~BS EN 1317-3:2010~~ | ~~Road Restraint Systems – Part 3 – Performance classes, impact test acceptance criteria and test methods for crash cushions.~~ | |
| ~~DD ENV 1317-4:2002~~ | ~~Road Restraint Systems – Part 4 – Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers.~~ | ~~*Draft BS EN 1317-4 for public comment published in June 2012*~~ |
| ~~BS EN 1317-5:2007+A2:2012~~ | ~~Road Restraint Systems – Part 5 - Product requirements and evaluation of conformity for vehicle restraint systems~~ | ~~Incorporating corrigendum August 2012~~ ~~*Draft prEN 1317-5 for public comment published in December 2013*~~ |
| PD CEN/TR 16949:2016 | Road Restraint System – Pedestrian restraint system - Pedestrian parapets | *Bsi Published Document / CEN Technical Report published in July 2016*<br><br>*(This document should temporarily not be used. The requirements of BS 7818:2015 apply.)* |
| ~~Draft prEN 1317-7~~ | ~~Road restraint systems - Part 7: Performance classes, impact test acceptance criteria and test methods for terminals of safety barriers~~ | ~~*Draft prEN 1317-7 for public comment published in June 2012*~~ |
| ~~PD CEN/TS 1317-8:2012~~ | ~~Road restraint systems - Part 8: Motorcycle~~ | ~~*Bsi Published*~~ |

| | | |
|---|---|---|
| | ~~road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers~~ | ~~*Document / CEN Technical Specification published in May 2012*~~ |
| BS EN 1337-1:2000 | Structural bearings – Part 1: General Design Rules | |
| ~~BS EN 1337-2:2004~~ | ~~Structural bearings – Part 2: Sliding elements~~ | |
| BS EN 1337-3:2005 | Structural bearings – Part 3: Elastomeric bearings | |
| ~~BS EN 1337-4:2004~~ | ~~Structural bearings – Part 4: Roller bearings~~ | |
| ~~BS EN 1337-5:2005~~ | ~~Structural bearings – Part 5: Pot bearings~~ | |
| ~~BS EN 1337-6:2004~~ | ~~Structural bearings – Part 6: Rocker bearings~~ | |
| ~~BS EN 1337-7:2004~~ | ~~Structural bearings – Part 7: Spherical and cylindrical PTFE bearings~~ | |
| ~~BS EN 1337-8:2007~~ | ~~Structural bearings – Part 8: Guide bearings and restraint bearings~~ | |
| BS EN 1337-9:1998 | Structural bearings – Part 9: Protection | |
| BS EN 1337-10:2003 | Structural bearings – Part 10: Inspection and maintenance | |
| BS EN 1337-11:1998 | Structural bearings – Part 11: Transport, Storage and Installation. | |
| ~~BS EN 1794-1:2018~~ | ~~Road traffic noise reducing devices – Non-acoustic performance Part 1: Mechanical performance and requirements~~ | ~~Supersedes previous version BS EN 1794-1:2011~~ |
| ~~BS EN 1794-2:2011~~ | ~~Road traffic noise reducing devices – Non-acoustic performance Part 2: General safety and environmental requirements~~ | |
| ~~BS EN 10025-1:2004~~ | ~~Hot rolled products of structural steels Part 1: General technical delivery conditions.~~ | |
| ~~BS EN 10025-2:2004~~ | ~~Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels.~~ | |
| ~~BS EN 10025-3:2004~~ | ~~Hot rolled products of structural steels Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels.~~ | |
| ~~BS EN 10025-4:2004~~ | ~~Hot rolled products of structural steels Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels.~~ | |
| ~~BS EN 10025-5:2004~~ | ~~Hot rolled products of structural steels – Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance~~ | |
| ~~BS EN 10025-6:2004+A1:2009~~ | ~~Hot rolled products of structural steels – Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition.~~ | |
| ~~BS EN 10080:2005~~ | ~~Steel for the reinforcement of concrete – Weldable reinforcing steel - General~~ | |
| ~~BS EN 10210-1:2006~~ | ~~Hot finished structural hollow sections of non-alloy and fine grain steels – Part 1: Technical delivery conditions~~ | |
| ~~BS EN 10210-2:2006~~ | ~~Hot finished structural hollow sections of non-alloy and fine grain steels – Part 2: Tolerances, dimensions and sectional properties~~ | ~~*Incorporating corrigendum no.1*~~ |

| | | |
|---|---|---|
| ~~BS EN 10248-1:1996~~ | ~~Hot rolled sheet piling of non alloy steels. Technical delivery conditions~~ | |
| ~~BS EN 10248-2:1996~~ | ~~Hot rolled sheet piling of non alloy steels. Tolerances on shape and dimensions~~ | |
| ~~BS EN 12063:1999~~ | ~~Execution of special geotechnical work. Sheet pile walls.~~ | |
| ~~BS EN 15050:2007 + A1:2012~~ | ~~Precast concrete products – Bridge elements~~ | ~~See BD100 clause 2.18 for additional guidance.~~ |

**British Standards**

| | | |
|---|---|---|
| ~~BS 4449:2005+A3:2016~~ | ~~Steel for the reinforcement of concrete~~ | ~~No longer covers plain round bar. (See BS4482 up to 12mm dia, see BS EN 10025-1 for larger sizes and dowels. See BS EN 13877-3 for dowel bars in concrete pavements.)~~ |
| ~~BS 5896:2012~~ | ~~Specification for high tensile steel wire and strand for the prestressing of concrete~~ | |
| BS 7818:1995 | Specification for pedestrian restraint systems in metal | Currently the requirements of BS 7818:2015 are to be used instead of PD CEN/TR 16949:2016 |
| ~~BS 8002:2015~~ | ~~Code of practice for earth retaining structures~~ | |
| ~~BS 8004:2015~~ | ~~Code of practice for foundations~~ | |
| ~~BS 8006-1:2010+A1:2016~~ | ~~Code of practice for strengthened/reinforced soils and other fills~~ | |
| ~~BS 8500-1:2015+A1:2016~~ | ~~Concrete – Complementary British Standard to BS EN 206 : Method of specifying and guidance for the specifier.~~ | ~~Incorporating Corrigendum No.1~~ |
| ~~BS 8500-2:2015+A1:2016~~ | ~~Concrete – Complementary British Standard to BS EN 206 : Specification for constituent materials and concrete.~~ | |
| ~~BS 8666:2005~~ | ~~Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete~~ | ~~Incorporating Amendment No.1~~ |

**The Manual Contract Document for Highway Works (MCHW)**

| | | |
|---|---|---|
| ~~MCHW Volume 1: May 2017~~ | ~~Specification for Highway Works~~ | ~~*Specification compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published.*~~ |
| ~~MCHW Volume 2: May 2017~~ | ~~Notes for guidance on the Specification for Highway Works~~ | ~~*Notes for guidance compliant with the execution standards must be used. A Departure is necessary for the parts where a compliant revision has not been published.*~~ |
| ~~MCHW Volume 3: February 2017~~ | ~~Highway Construction Details~~ | |

**The Design Manual for Roads and Bridges (DMRB)**

| | | |
|---|---|---|
| BD 2/12 | Technical Approval of Highway Structures | |
| ~~BD 7/01~~ | ~~Weathering steel for highway structures~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 10/97~~ | ~~Design of highway structures in areas of mining subsidence~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 12/01~~ | ~~Design of corrugated steel buried structures with spans greater than 0.9 metres and up to 8.0 metres~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| BD 29/17 | Design criteria for footbridges | |
| ~~BD 33/94~~ | ~~Expansion joints for use in highway bridge decks~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 35/14~~ | ~~Quality assurance scheme for paints and similar protective coatings~~ | |
| ~~BD 36/92~~ | ~~Evaluation of maintenance costs in comparing alternative designs for highway structures~~ | |
| ~~BD 43/03~~ | ~~The impregnation of reinforced and prestressed concrete highway structures using hydrophobic pore-lining impregnants~~ | |
| ~~BD 45/93~~ | ~~Identification markings of highway structures~~ | |
| ~~BD 47/99~~ | ~~Waterproofing and surfacing of concrete bridge decks~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 51/14~~ | ~~Portal and cantilever signs/signal gantries~~ | |
| ~~BD 57/01~~ | ~~Design for durability~~ | ~~*Not to be used. See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 62/07~~ | ~~As built, operational and maintenance records for highway structures~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BD 65/14~~ | ~~Design criteria for collision protection beams~~ | |
| ~~BD 67/96~~ | ~~Enclosure of bridges~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~**BD 68/97**~~ | ~~**Crib retaining walls**~~ | **Withdrawn** |
| ~~BD 78/99~~ | ~~Design of road tunnels~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~**BD 82/00**~~ | ~~**Design of buried rigid pipes**~~ | **Withdrawn** |
| ~~BD 90/05~~ | ~~Design of FRP bridges and highway structures~~ | |
| ~~BD 94/17~~ | ~~Design of minor structures~~ | |
| BD 100/16 | The use of Eurocodes for the design of highway structures | |
| ~~BA 26/94~~ | ~~Expansion joints for use in highway bridge decks~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 28/92~~ | ~~Evaluation of maintenance costs in comparing alternative designs for highway structures~~ | |
| ~~BA 36/90~~ | ~~The use of permanent formwork~~ | ~~*Not to be used. See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 41/98~~ | ~~The design and appearance of bridges~~ | |
| ~~BA 42/96~~ | ~~The design of integral bridges~~ | ~~*Not to be used. See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 47/99~~ | ~~Waterproofing and surfacing of concrete bridge decks~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 57/01~~ | ~~Design for durability~~ | ~~*Not to be used. See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 59/94~~ | ~~Design of highway bridges for hydraulic action.~~ | ~~*Not to be used. See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 67/96~~ | ~~Enclosure of bridges~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~BA 68/97~~ | ~~Crib retaining walls~~ | |
| ~~BA 82/00~~ | ~~Formation of continuity joints in bridge decks~~ | |

| | | |
|---|---|---|
| ~~BA 85/04~~ | ~~Coatings for concrete highway structures & ancillary structures~~ | |
| ~~BA 92/07~~ | ~~Use of recycled concrete aggregates in structural concrete~~ | |
| ~~TD 19/06~~ | ~~Requirement for road restraint systems~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~TD 27/05~~ | ~~Cross-sections and headrooms~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~ |
| ~~HD 22/08~~ | ~~Managing geotechnical risk~~ | |
| ~~HA 66/95~~ | ~~Environmental barriers~~ | ~~*See IAN 124/11 Annex C for additional guidance.*~~<br>~~*Work on update being undertaken.*~~ |
| ~~GD 01/15~~ | ~~Introduction to the Design Manual for Roads and Bridges~~ | |
| ~~GD 02/16~~ | ~~Quality Management Systems for Highway Design~~ | |
| ~~GD 04/12~~ | ~~Standard for Safety Risk Assessment on the Strategic Road Network~~ | |

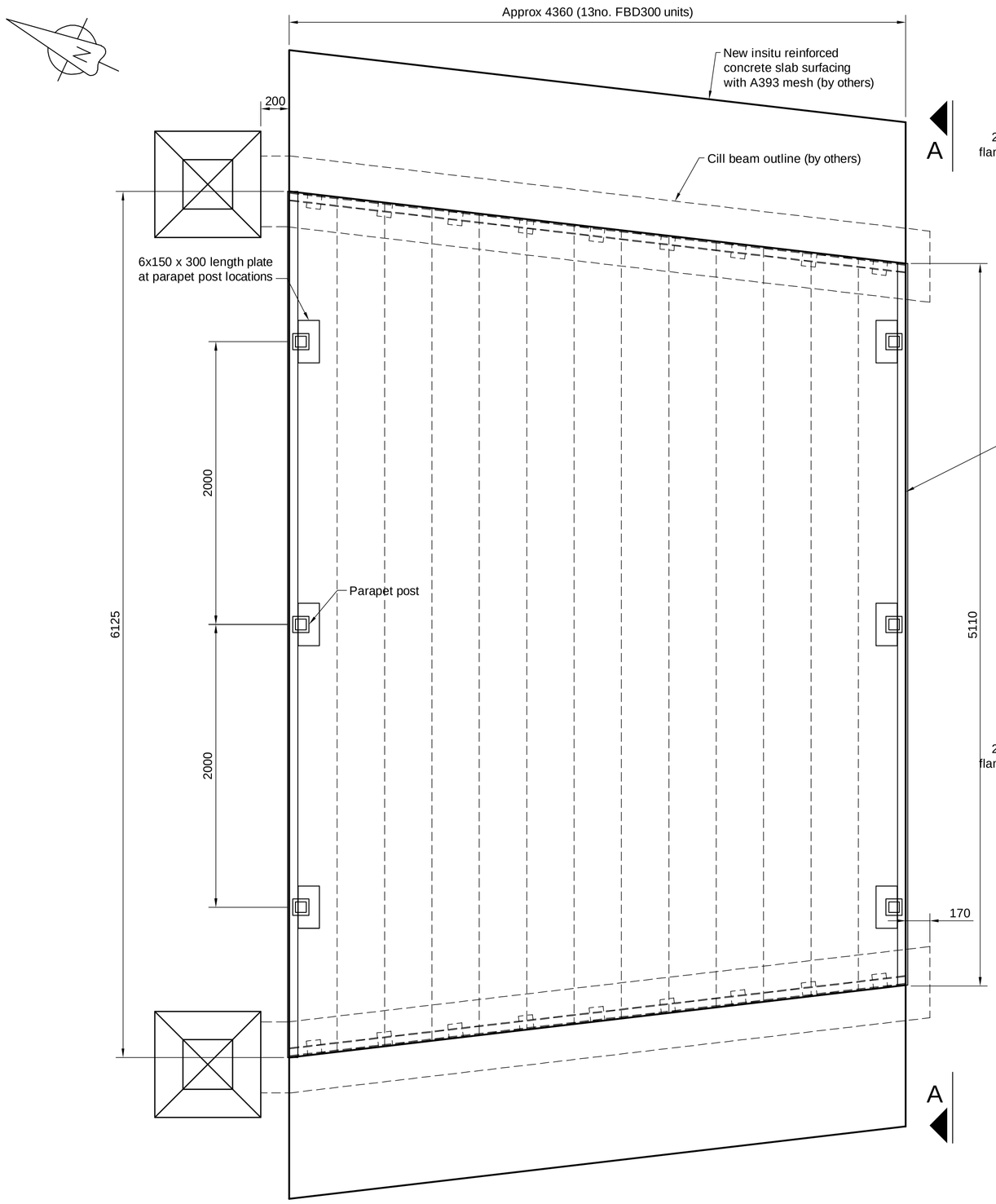
**Interim Advice Notes**

| | |
|---|---|
| ~~IAN 69/15~~ | ~~Designing for maintenance~~ |
| ~~IAN 83/06~~ | ~~Principal and General Inspection of Sign/Signal Gantries, and Gantries with low handrails or open mesh flooring~~ |
| ~~IAN 96/07r1~~ | ~~Guidance on implementing results of research on bridge deck waterproofing.~~ |
| ~~IAN 97/07~~ | ~~Assessment and upgrading of existing parapets~~ |
| ~~IAN 104/15~~ | ~~The anchorage of reinforcement and fixings in hardened concrete.~~ |
| ~~IAN 105/08~~ | ~~Implementation of construction (design and management) 2007 and the withdrawal of SD 10 and SD 11~~ |
| ~~IAN 117/08r2~~ | ~~Certification of combined kerb and drainage products~~ |
| IAN 124/11 Annex C | Use of Eurocodes for the design of highway structures |
| ~~IAN 127/10r1~~ | ~~The use of foamed concrete~~ |
| ~~IAN 131/11~~ | ~~Deflection of Permanent Formwork~~ |
| ~~IAN 136/10~~ | ~~Structural safety reporting~~ |
| ~~IAN 149/17~~ | ~~Existing Motorway Minimum Requirements~~ |
| ~~IAN 161/15~~ | ~~Smart Motorways~~ |
| ~~IAN 177/13~~ | ~~Introduction of the Construction Products Regulation (EU) 305/2011~~ |
| ~~IAN 184/16~~ | ~~Highways Agency Data & CAD Standard~~ |
| ~~IAN 186/15~~ | ~~In-situ concrete barriers based on proprietary designs commercialised as products~~ |
| ~~IAN 193/16~~ | ~~Requirements for the provision of access arrangements on gantries~~ |

**Miscellaneous**

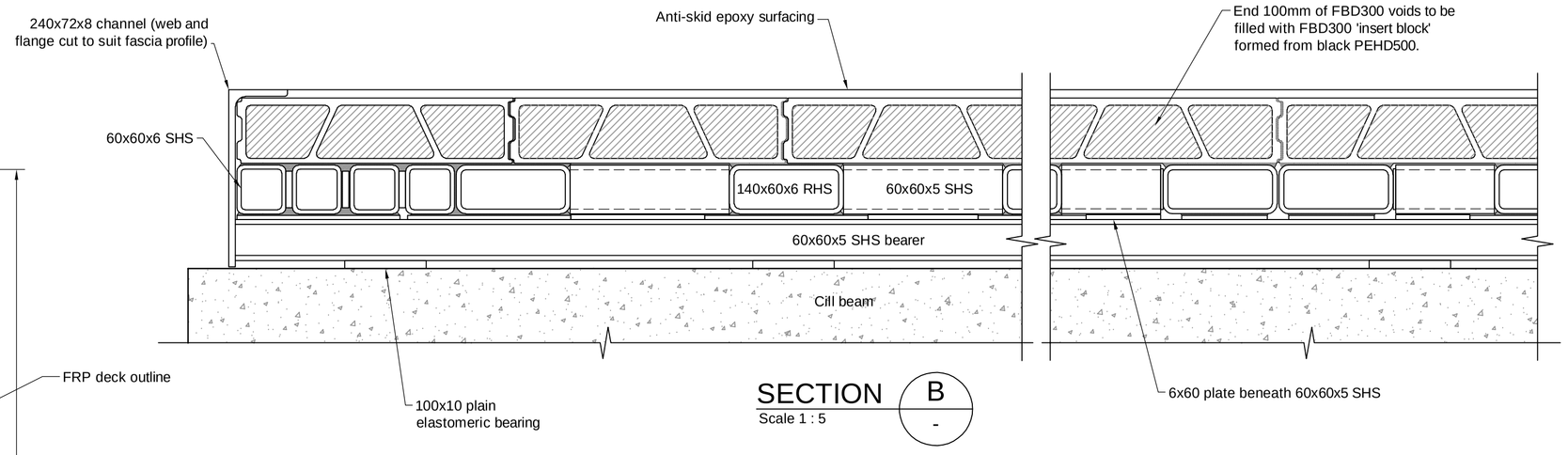
| | | |
|---|---|---|
| ~~CHE Memorandum 227/08~~ | ~~The Impregnation of Reinforced and Prestressed Concrete Highway Structures using Hydrophobic Pore Lining Impregnants~~ | ~~CHE memoranda are internal Highways England documents and not available to external organisations. This CHE memorandum is included as a useful reference for the Technical Approval Authority.~~ |
| CIRIA C543 | Bridge Detailing Guide | |
| ~~CIRIA C660~~ | ~~Early-age Thermal Crack Control in Concrete~~ | |
| CIRIA C686 | Safe Access for Maintenance and Repair | |
| ~~CIRIA C760~~ | ~~Guidance on embedded retaining wall design~~ | |
| CIRIA C595 | Strengthening Metallic Structures Using Externally Bonded Fibre Reinforced Polymers | |
| EuroComp | Structural Design of Polymer Composites | |

# Appendix B FRP Deck General Arrangement and Details



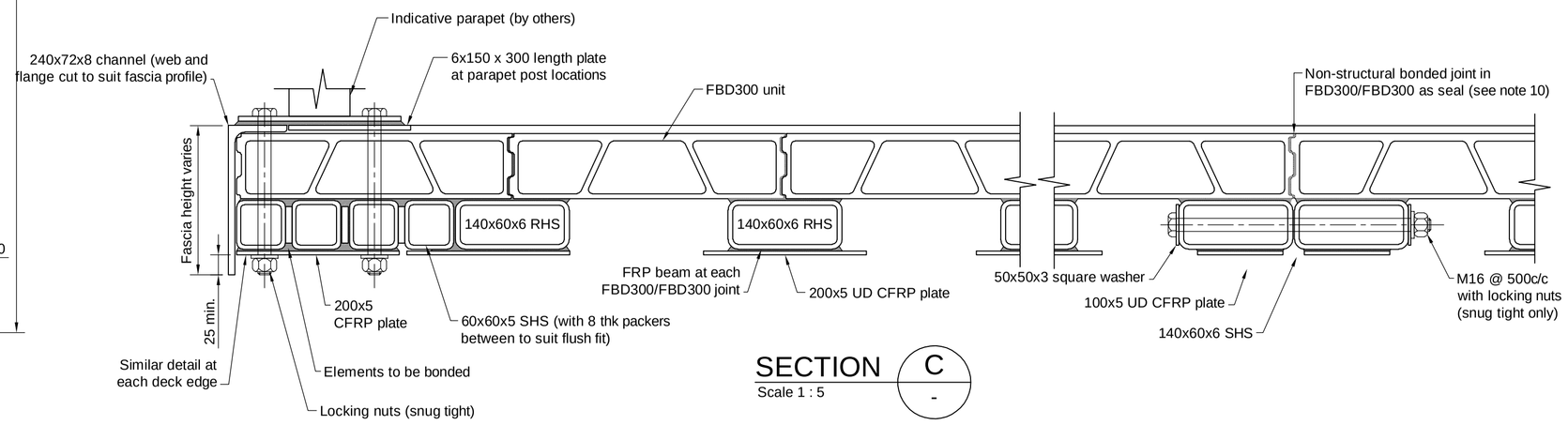

PLAN ON FRP DECK OUTLINE

(Scale 1:25)



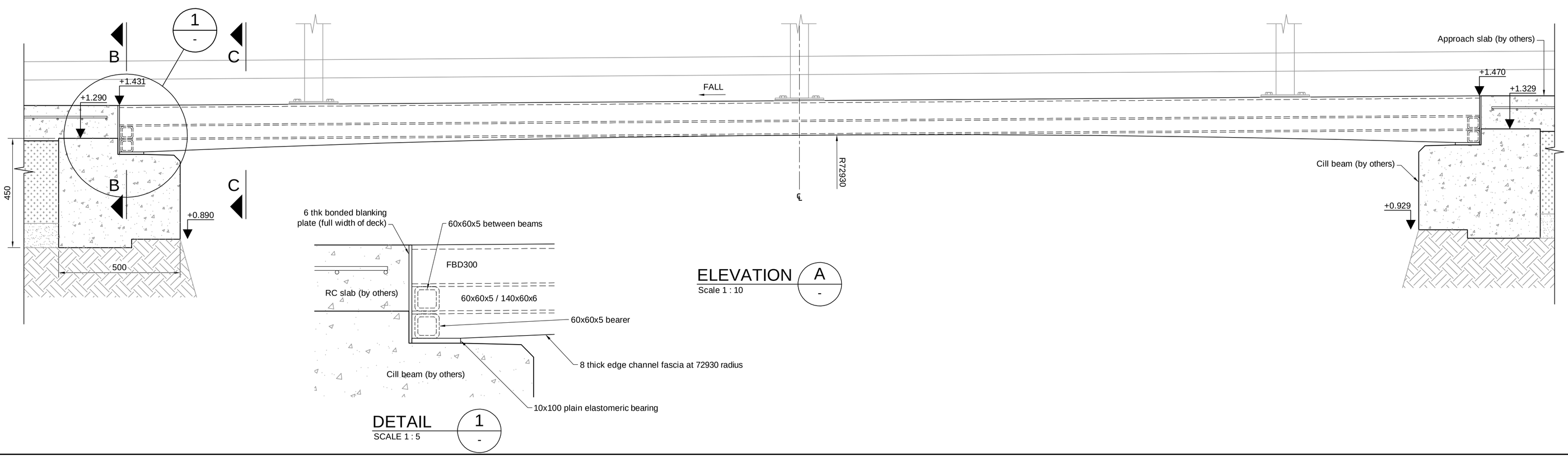

SECTION B

Scale 1 : 5




SECTION C

Scale 1 : 5




ELEVATION A

Scale 1 : 10

DETAIL 1

SCALE 1 : 5

## Notes:

1. Do not scale from this drawing.
2. All dimensions are shown in millimetres. All levels are shown in metres.
3. Deck length and skew as per WSP drawing 70044480-SBR-DR-SB-0004_T02 (04/04/18).
4. Deck width is based on 13No. FBD300 units.
5. All GFRP materials to be E23 to BS EN 13706 provided by Fibreline.
6. CFRP plate to have minimum elastic modulus 130GPa, provided by Fibreline.
7. All steel bolts, nuts and washers to be Grade 8.8 and galvanised to EN ISO 1461.
8. Bonding adhesive to be two-part structural epoxy or polyurethane with elastic modulus of between 1-10GPa, minimum tensile strength 25MPa.
9. All structural bonding work and FRP cutting in accordance with FRP materials and workmanship specification. All FRP components to be bonded U.N.O.
10. FRP deck assumed to be fabricated in two parts, with parapets and central FRP deck bolted joint completed prior to installation of bearings.

| Rev | Rev. Date | Purpose of revision | Drawn | Checkd | Rev'd | Apprv'd |
|---|---|---|---|---|---|---|
| P01 | 17.08.18 | For information | CS | MA | LC | LC |

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www.jacobs.com

Client: CTS BRIDGES LTD

Project: POOLE PARK SLUICE BRIDGE FRP DECK

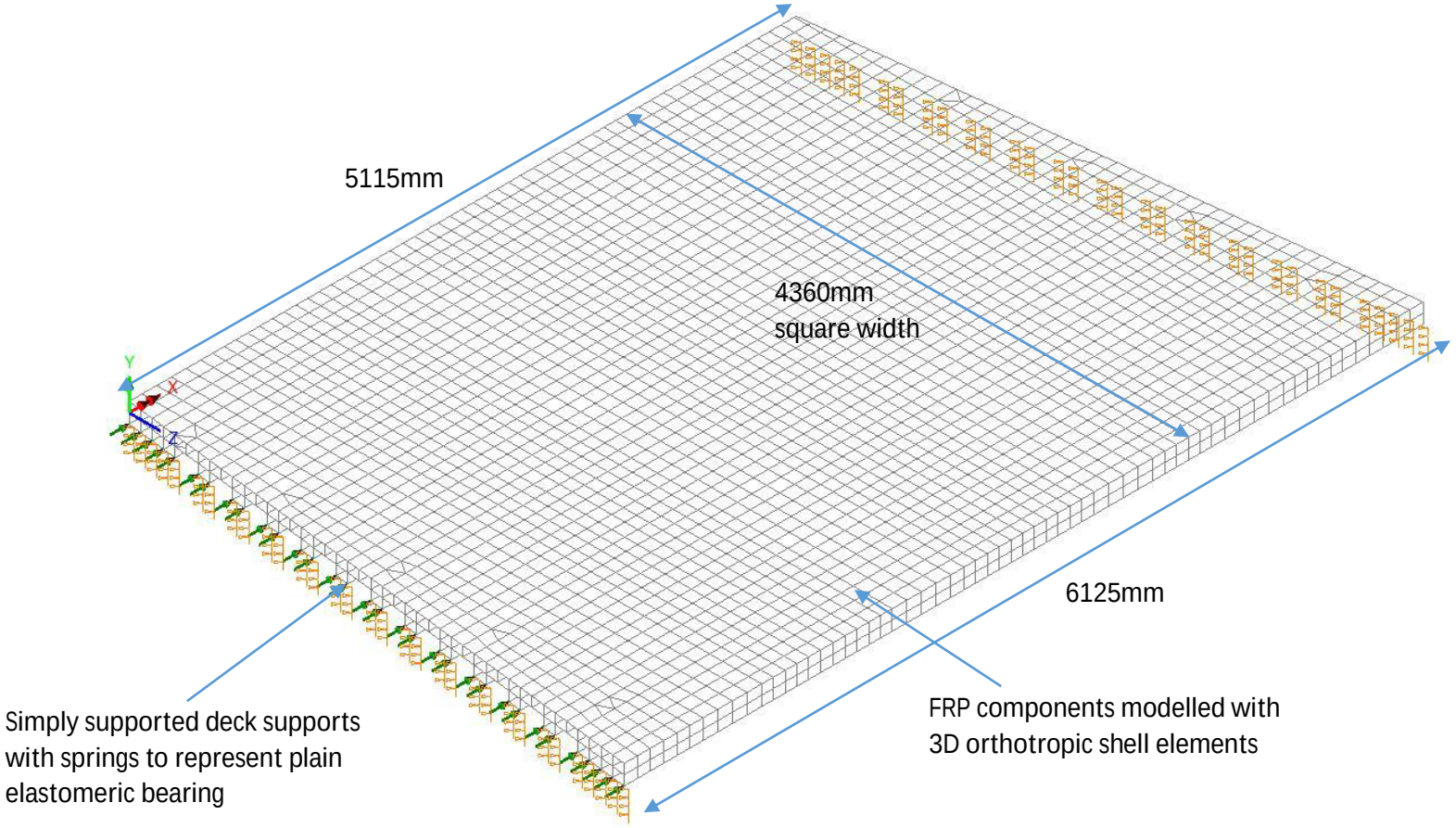
Drawing title: GENERAL ARRANGEMENT AND DETAILS

Drawing status: FOR INFORMATION

| | | |
|---|---|---|
| Scale | AS SHOWN @ A1 | DO NOT SCALE |
| Jacobs No. | TBC | Rev P01 |
| Client no. | N/A | |

Drawing number: POOLE-DRG-01

# Appendix C Diagram of Idealised Structure


5115mm
4360mm
square width
6125mm
Simply supported deck supports with springs to represent plain elastomeric bearing
FRP components modelled with 3D orthotropic shell elements

# Appendix D ETA Document For GFRP Components

ETA-Danmark A/S
Göteborg Plads 1
DK-2150 Nordhavn
Tel. +45 72 24 59 00
Fax +45 72 24 59 04
Internet www.etadanmark.dk

Authorised and notified according to Article 29 of the Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011



# European Technical Assessment ETA-16/0901 of 02/06/2017

I General Part

**Technical Assessment Body issuing the ETA and designated according to Article 29 of the Regulation (EU) No 305/2011:** ETA-Danmark A/S

| | |
|---|---|
| **Trade name of the construction product:** | Fiberline Structural profiles |
| **Product family to which the above construction product belongs:** | Structural sections made from fibre reinforced polymers (FRP/Glassfiber Composites) |
| **Manufacturer:** | Fiberline Composites A/S<br>Barmstedt Allé 5<br>DK-5500 Middelfart<br>Phone +45 70 13 77 13<br>Fax +45 70 13 77 14<br>Internet www.fiberline.com |
| **Manufacturing plant:** | Fiberline Composites A/S<br>Barmstedt Allé 5<br>DK-5500 Middelfar |
| **This European Technical Assessment contains:** | 22 pages including 17 annexes which form an integral part of the document |
| **This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:** | EAD 260001-00-03.03 for Structural sections made from fibre reinforced polymers (FRP/Glassfiber Composites) of April 2016 |
| **This ETA replaces** | - |

# II SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

## 1 Technical description of product and intended use

**Technical description of the product**
Fiberline structural profiles are made from fibre reinforced polymers (FRP/Glassfiber Composites). The profiles are made as closed web based elements or as open elements.

The range of products spans from shapes that are equivalent to steel sections for construction such as square tube- I-, and U-sections to profile shapes for use as deck elements. The structural sections are engineered according to the requirements of EN13706 parts 1 to 3.

The sections are made with unidirectional reinforcement in several layers

The product description corresponds to the drawings given in the Annex A1 to A2.

The characteristic material values, dimensions and tolerances of the elements and decks not indicated in Annexes shall correspond to the respective values laid down in the technical documentation[1] of this European Technical Assessment.

## 2 Specification of the intended use in accordance with the applicable EAD

The Fiberline structural profiles are intended to be used as a structural element (beams, columns and decks) where the load bearing characteristic is the major criterion of design and where the product is part of a load bearing system.

The performance of the structural profiles and deck profiles are given on the basis of short term loads, at room temperature and without any environmental influences.

Properties of composites, as any other material, change in elevated temperatures, over time and depending on the environment. Testing is recommended in unusual exposures and extra attention shall be shown in the design when elements are subject to torsional loads, in risk of lateral-torsional buckling, fatigue loads and or long term exposure – experimental proof can be required.

Within a roof construction, the deck element will not contribute to the water tightness, but will receive a suitable waterproofing or roof covering. The waterproofing and roof covering are not covered by this ETA.

The provisions made in this European Technical Assessment are based on an assumed intended working life of the profiles of 50 years

The indications given on the working life cannot be interpreted as a guarantee given by the producer or Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

1 The technical documentation of this European Technical Assessment is deposited at ETA-Danmark and, as far as relevant for the tasks of the Notified bodies involved in the attestation of conformity procedure, is handed over to the notified bodies.

# 3 Performance of the product and references to the methods used for its assessment

## 3.1 Characteristics of product

**Mechanical resistance and stability (BWR 1):**
The essential characteristics are detailed in the Annex from B1 to BX.

**Safety in case of fire (BWR 2):**
No performance is assessed for reaction to fire.

No performance is assessed for resistance to fire.

**Hygiene, health and the environment (BWR3):**
The product does not contain/release dangerous substances specified in TR 034, dated March 2012.

Regarding the dangerous substances contained in this European Technical Assessment, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Regulation, these requirements need also to be complied with, when and where they apply.

**Safety in use (BWR4):**
For basic requirement Safety in use the same criteria are valid for Basic Requirement Mechanical resistance and stability (BR1), including geometry and tolerances.

Impact resistance: At fall height 2,12 m with a 2.88 kg falling mass corresponding to a fall height of 1 kg of 6.49 mm and a total impact energy of 6.11 J, the sample shows no signs of damage.

**Sustainable use of natural resources (BWR7)**
No performance Assessed

Other Basic Requirements are not relevant.

## 3.2 Methods of assessment

The assessment of fitness of the profiles for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Basic Requirements 1 and 4 has been made in accordance with the EAD 260001-00-03.03 for Structural sections made from fibre reinforced polymers (FRP/Glassfiber Composites) of April 2016

# 4 Attestation and verification of constancy of performance (AVCP)

## 4.1 AVCP system

According to the decision 97/597/EC of the European Commission, the system(s) of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) is 1+.

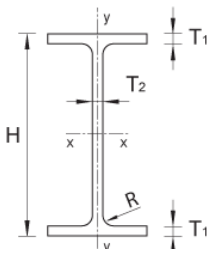
# 5 Technical details necessary for the implementation of the AVCP system, as foreseen in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at ETA-Danmark prior to CE marking.

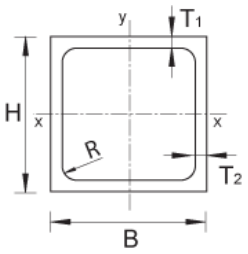
Issued in Copenhagen on 2017-06-02 by

Thomas Bruun
Manager, ETA-Danmark

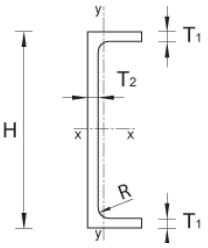
**Cross sections, structural profiles:**



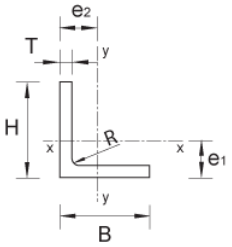

I-section



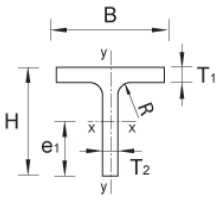

Square hollow section (SHS)



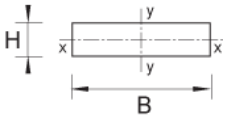

U-section



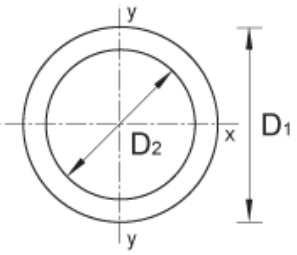

Angle section



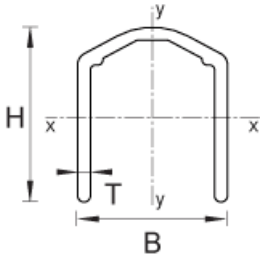

T-section




Flat sheets/plates

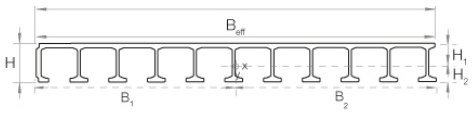



Circular hollow sections (CHS)

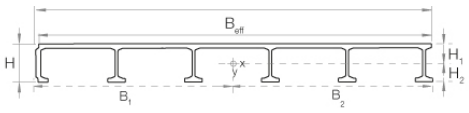



Handrail sections

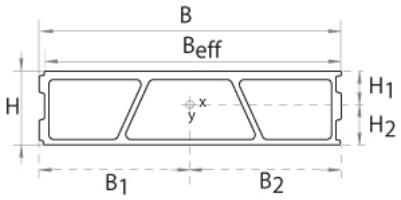
**Cross sections, Deck profiles:**



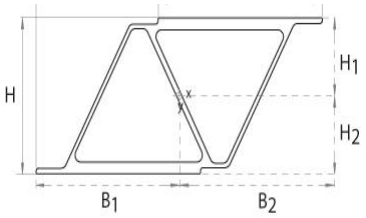

Plank HD




Plank MD




FBD300



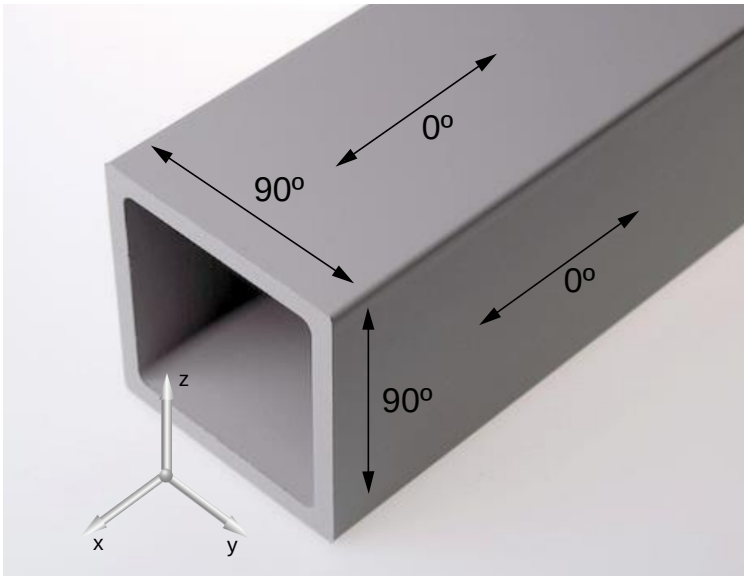

FBD450/600

| | |
|---|---|
| **Fiberline Structural profiles and deck elements** | **Annex A1** of European Technical Assessment ETA-16/0901 |
| Element and decks | |

**Expression of performance**

The following tables indicate the short term characteristics for the profile and deck elements

The below figure provides the main directions for which the characteristics are determined. The index 0° symbolizes the axial direction of the profiles and corresponds to the pull direction in the pultrusion process. This direction is normally used for deflecting beam or columns. The index 90° symbolizes the transverse direction.



**Material data for structural profiles – Characteristic values**

**Strength**

| Material Properties | Unit | Characteristic value |
|---|---|---|
| Tensile strength, axial, $f_{tx}$ | N/mm² | 240 |
| Tensile strength, transverse $f_{ty}$ for<br>- Resin "P2600" or "P2607" | N/mm² | 50 |
| - Resin "P4506" | | 35 |
| Compression strength, axial, $f_{cx}$ | N/mm² | 240 |
| Compression strength, transverse, $f_{cy}$ | N/mm² | 90 |
| Pin bearing strength, axial, $f_{px}$ | N/mm² | 200 |
| Pin bearing strength, transverse, $f_{py}$ | N/mm² | 120 |
| Flexural strength, axial, $f_{fx}$ | N/mm² | 240 |
| Flexural strength, transverse, $f_{fy}$ | N/mm² | 60 |
| Interlaminar Shear strength, $\tau_m$ | N/mm² | 20 |
| In-plane Shear strength, $f_{\tau xy}$ | N/mm² | 40 |
| Shear strength perpendicular to the plane, $f_{\perp II}$<br>(Punching shear) | N/mm² | 50 |
| Shear strength in plane, $f_{\tau xy,torsion}$<br>(torsion of rectangular hollow sections) | N/mm² | 40 |

**Stiffness and Poisson's ratio**

| Material Properties | Unit | Characteristic value |
|---|---|---|
| Full section modulus, $E_{eff}$ | N/mm² | 24.000 |
| Tensile modulus, axial, $E_{tx}$ | N/mm² | 24.000 |
| Tensile modulus, transverse, $E_{ty}$ | N/mm² | 7.000 |
| Compression modulus, axial, $E_{cx}$ | N/mm² | 24.000 |
| Compression modulus, transverse, $E_{cy}$ | N/mm² | 10.000 |
| Poisson's ratio, $\nu_{yx}$ | - | 0,23 |
| Poisson's ratio, $\nu_{xy}$ | - | 0,07 |
| In-plane shear modulus, $G_{xy}$ and $G_{yz}$ | N/mm² | 3.000 |

**Strain**

| Material Properties | Unit | Characteristic value |
|---|---|---|
| Tensile failure strain, axial, $\varepsilon_{tx}$ | % | 0,90 |
| Tensile failure strain, transverse, $\varepsilon_{ty}$ | % | 0,60 |
| Compression failure strain, axial, $\varepsilon_{cx}$ | % | 0,90 |
| Compression failure strain, transverse, $\varepsilon_{cy}$ | % | 0,70 |

**Other Properties**

| Material Properties | Unit | Characteristic value |
|---|---|---|
| Thermal expansion, axial | $K^{-1}$ | $10 \cdot 10^{-6}$ |
| Thermal expansion, transverse | $K^{-1}$ | $17 \cdot 10^{-6}$ |
| Fibre content by weight | % | 68% ± 5% |
| Degree of cure- Differentia scanning calorimety (DSC) | % | <6% |
| Creep (after 24 hours) | % | <6% |

**Material data for MD Plank – Characteristic values**

| Material Properties | Unit | Characteristic value |
|---|---|---|
| Full section modulus, $E_{eff}$ | N/mm² | 23000 |
| Tensile strength, axial, $f_{tx}$ | N/mm² | 240 |
| Tensile strength, transverse $f_{ty}$ for<br>- Resin "P2600" or "P2607" | N/mm² | 50 |
| - Resin "P4506" | N/mm² | 35 |
| Compression strength, axial, $f_{cx}$ | N/mm² | 240 |
| Compression strength, transverse, $f_{cy}$ | N/mm² | 90 |
| Flexural strength, axial, $f_{fx}$ | N/mm² | 240 |
| Flexural strength, transverse, $f_{fy}$ | N/mm² | 60 |
| Shear strength, $\tau_c$ | N/mm² | 60 |

**Material data for HD Plank – Characteristic resistance values for one plank**

| Classification | Unit | Characteristic value |
|---|---|---|
| Bending moment, between supports, $M_{R,k}$ | kN·m | 11,7 |
| Bending moment, at the support, $M_{R,k}$ | kN·m | 14,0 |
| Vertical reaction, at the support, $V_{R,k}$ | kN | 68,61 |
| Upward vertical force at suports, $R_k$ | kN | 3,53 |
| Horizontal load, axial, $R_k$ | kN | 0,736 |
| Horizontal load, transverse, $R_k$ | kN | 0,404 |
| Stiffness, EI | N·mm² | $2{,}189 \cdot 10^{10}$ |

**Material data for FBD300**

**Characteristic values for strength and average values for stiffness - local analyses – flanges**

| **Material Properties** | **Unit** | **Average values** |
|---|---|---|
| | | Flanges |
| Tensile modulus, axial, $E_{tx}$ | N/mm² | 27.000 |
| Tensile modulus, transverse, $E_{ty}$ | N/mm² | 14.000 |
| Compression modulus, axial, $E_{cx}$ | N/mm² | 27.000 |
| Compression modulus, transverse, $E_{cy}$ | N/mm² | 14.000 |
| In-plane shear modulus G | N/mm² | 3.000 |
| **Material Properties** | **Unit** | **5% Characteristic value** |
| | | Flanges |
| Tensile strength, axial, $f_{tx}$ | N/mm² | 350 |
| Tensile strength, transverse $f_{ty}$ | N/mm² | 100 |
| Compression strength, axial, $f_{cx}$ | N/mm² | 205 |
| Compression strength, transverse, $f_{cy}$ | N/mm² | 100 |
| Flexural strength, axial, $f_{fx}$ | N/mm² | 300 |
| Flexural strength, transverse, $f_{fy}$ | N/mm² | 100 |
| Interlaminar shear strength, axial, $t_m$ | N/mm² | 20 |

**Characteristic values for strength and average values for stiffness - local analyses – webs**

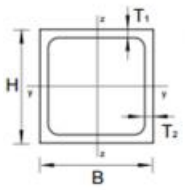
| **Material Properties** | **Unit** | **Average values** |
|---|---|---|
| | | Webs |
| Tensile modulus, axial, $E_{tx}$ | N/mm² | 20.000 |
| Tensile modulus, transverse, $E_{ty}$ | N/mm² | 18.000 |
| Compression modulus, axial, $E_{cx}$ | N/mm² | 15.000 |
| Compression modulus, transverse, $E_{cy}$ | N/mm² | 18.000 |
| In-plane shear modulus G | N/mm² | 3.000 |
| **Material Properties** | **Unit** | **5% Characteristic value** |
| | | Webs |
| Tensile strength, axial, $f_{tx}$ | N/mm² | 350 |
| Tensile strength, transverse $f_{ty}$ | N/mm² | 68 |
| Compression strength, axial, $f_{cx}$ | N/mm² | 200 |
| Compression strength, transverse, $f_{cy}$ | N/mm² | 80 |
| In-plane shear strength, $t_m$ | N/mm² | 61 |

**Characteristic, average values* or typical** values for the local analyses**

| Material Properties | Unit | Value | | |
|---|---|---|---|---|
| | | Flanges | Inner web | Outer web |
| Elastic modulus, axial, $E_{tx}$ | N/mm² | 24.100 | 15.000 | 18.400 |
| Elastic modulus, transverse, $E_{ty}$ | N/mm² | 17.800 | 25.500 | 22.00 |
| Shear modulus, G | N/mm² | 3.700 | 1.900 | 3.800 |
| Tensile strength, axial, $f_{tx}$ | N/mm² | 250 | 213 | 372 |
| Tensile strength, transverse $f_{ty}$ | N/mm² | 175 | 195 | 128 |
| Compression strength, axial, $f_{cx}$ | N/mm² | 330** | 230** | 405** |
| Compression strength, transverse, $f_{cy}$ | N/mm² | 180** | 230** | 135** |
| In-plane shear strength, $t_m$ | N/mm² | 25 | 25 | 40 |
| Interlaminate, $t_{~~am~~}$ | N/mm² | 25** | 25** | 25** |
| Pin bearing strength, $f_p$ | N/mm² | 70** | 70** | 70** |
| Poisson's ratio | - | 0,20* | 0,20* | 0,20* |

**Overview of structural profiles**

**Square tubes**




| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ mm² | x $10^6$ mm⁴ | x $10^3$ MPa |
| 50 | 50 | 5 | | 1.630 | 0,90 | 0,31 | 24 |
| 60 | 60 | 5 | | 2.000 | 1,11 | 0,57 | 24 |
| 75 | 75 | 6 | | 2.999 | 1,67 | 1,33 | 24 |
| 75 | 75 | 8 | | 3.870 | 2,15 | 1,63 | 24 |
| 80 | 60 | 5 | | 2.360 | 1,31 | 1,15 | 24 |
| 100 | 60 | 8 | | 4.180 | 2,31 | 2,84 | 24 |
| 100 | 100 | 6 | | 4.090 | 2,27 | 3,36 | 24 |
| 100 | 100 | 8 | | 5.320 | 2,96 | 4,21 | 24 |
| 114 | 114 | 6 | | 4.684 | 2,60 | 5,08 | 24 |
| 114 | 114 | 8 | | 6.124 | 3,40 | 6,41 | 24 |
| 114 | 114 | 10 | | 7.506 | 4,17 | 7,59 | 24 |
| 120 | 60 | 5 | | 3.060 | 1,70 | 3,09 | 24 |
| 120 | 120 | 6 | | 4.940 | 2,75 | 5,98 | 24 |
| 120 | 120 | 8 | | 6.480 | 3,60 | 7,57 | 24 |
| 132 | 132 | 7 | | 6,370 | 3,54 | 9,26 | 24 |
| 132 | 132 | 9,5 | | 8.690 | 4,73 | 11,95 | 24 |
| 140 | 60 | 6 | 5 | 3.650 | 2,00 | 5,08 | 24 |
| 160 | 160 | 8 | | 8.850 | 4,92 | 19,10 | 24 |
| 200 | 200 | 10 | | 13.840 | 7,69 | 46,50 | 24 |
| 240 | 240 | 12 | | 20.000 | 11,00 | 96,40 | 24 |

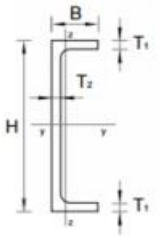
**I-profiles**


| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^6$ $mm^4$ | x $10^3$ MPa |
| 120 | 60 | 6 | | 2.550 | 1,42 | 3,10 | 24 |
| 160 | 80 | 8 | | 4.480 | 2,49 | 9,66 | 24 |
| 200 | 100 | 10 | | 6.990 | 3,89 | 23,60 | 24 |
| 240 | 120 | 12 | | 10.100 | 5,60 | 48,90 | 24 |
| 300 | 150 | 15 | | 15.700 | 8,74 | 119,41 | 24 |
| 360 | 180 | 18 | | 22.700 | 12,60 | 247,61 | 24 |

**Flat profiles**

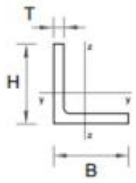

| B | T | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|
| mm | mm | g/m | x $10^3$ $mm^2$ | x $10^3$ $mm^4$ | x $10^3$ MPa |
| 30 | 6 | 320 | 0,18 | 0,54 | 17 |
| 50 | 6 | 540 | 0,30 | 0,90 | 17 |
| 100 | 6 | 1.080 | 0,60 | 1,80 | 17 |
| 100 | 8 | 1.444 | 0,80 | 4,30 | 17 |
| 100 | 10 | 1.800 | 1,00 | 8,30 | 17 |
| 500 | 10 | 9.000 | 5,00 | 41,70 | 17 |

**U-profiles**



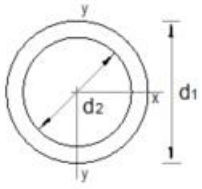

| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0^\circ}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ mm² | x $10^6$ mm⁴ | x $10^3$ MPa |
| 70 | 30 | 5 | | 1.08 | 0,60 | 0,40 | 24 |
| 85 | 31 | 5 | | 1.23 | 0,68 | 0,66 | 24 |
| 100 | 30 | 6 | | 1.611 | 0,90 | 1,15 | 24 |
| 100 | 50 | 6 | | 2.043 | 1,14 | 1,68 | 24 |
| 114 | 41 | 6 | | 2.000 | 1,11 | 1,98 | 24 |
| 120 | 50 | 6 | | 2.290 | 1,27 | 2,65 | 24 |
| 140 | 40 | 5 | | 1.910 | 1,06 | 2,78 | 24 |
| 150 | 40 | 6 | | 2.394 | 1,33 | 3,90 | 24 |
| 160 | 48 | 8 | | 3.510 | 1,95 | 6,57 | 28 |
| 200 | 60 | 10 | | 5.480 | 3,04 | 16,00 | 28 |
| 240 | 72 | 8 | | 5.350 | 2,97 | 23,30 | 28 |
| 240 | 72 | 12 | | 7.890 | 4,38 | 33,20 | 28 |
| 300 | 90 | 15 | | 12.300 | 6,85 | 81,20 | 28 |
| 360 | 108 | 18 | | 17.800 | 9,86 | 168,00 | 28 |

**Angle sections**



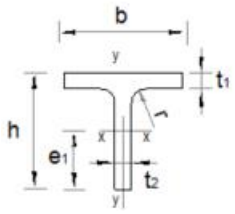

| H | B | T | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^6$ $mm^4$ | x $10^3$ MPa |
| 50 | 50 | 6 | 1.026 | 0,57 | 0,13 | 24 |
| 50 | 50 | 8 | 1.350 | 0,75 | 0,17 | 24 |
| 75 | 75 | 6 | 1.555 | 0,87 | 0,47 | 24 |
| 75 | 75 | 8 | 2.045 | 1,15 | 0,60 | 24 |
| 80 | 80 | 8 | 2.189 | 1,23 | 0,74 | 24 |
| 100 | 100 | 8 | 2.765 | 1,55 | 1,49 | 24 |
| 100 | 100 | 10 | 3.420 | 1,91 | 1,80 | 24 |
| 100 | 100 | 12 | 4.061 | 2,27 | 2,10 | 24 |
| 150 | 100 | 8 | 3.500 | 1,95 | 4,57 | 24 |
| 150 | 100 | 10 | 4.320 | 2,41 | 5,59 | 24 |
| 150 | 100 | 12 | 5.141 | 2,87 | 6,57 | 24 |
| 150 | 150 | 8 | 4.205 | 2,35 | 5,21 | 24 |
| 150 | 150 | 10 | 5.220 | 2,94 | 6,38 | 24 |
| 150 | 150 | 12 | 6.221 | 3,47 | 7,51 | 24 |

**Tubes**



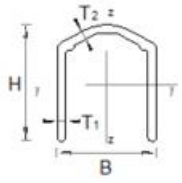

| $D_1$ | $D_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|
| mm | mm | g/m | x $10^3$ $mm^2$ | x $10^3$ $mm^4$ | x $10^3$ MPa |
| 75 | 65 | 1.979 | 1.100 | 680 | 23 |
| 90 | 80,2 | 2.400 | 1.340 | 1.210 | 23 |

**T-profiles**

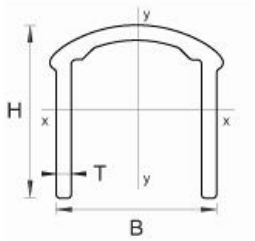


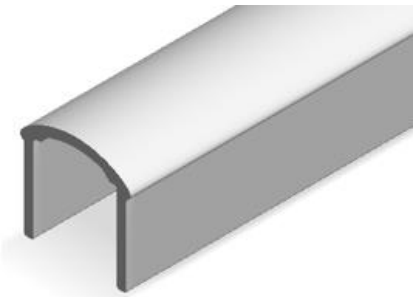

| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^3$ $mm^4$ | x $10^3$ MPa |
| 60 | 60 | 6 | 6 | 1.979 | 0,7 | 0,23 | 23 |
| 72 | 90 | 11 | 10 | 2.400 | 1,62 | 1,28 | 23 |

**Handrail**

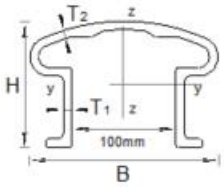


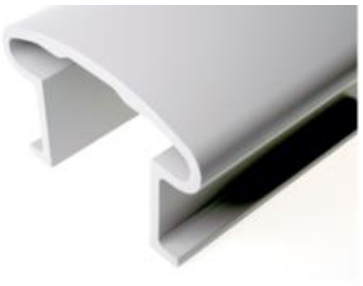

| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^6$ $mm^4$ | x $10^3$ MPa |
| 70 | 60 | 5 | 5 | 1.550 | 0,86 | 0,38 | 24 |



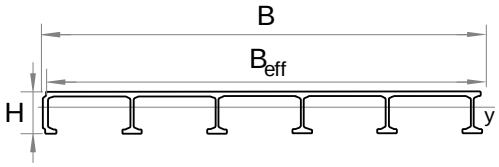
| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^6$ $mm^4$ | x $10^3$ MPa |
| 80 | 80 | 7 | 7 | 2.67 | 1,49 | 0,873 | 24 |



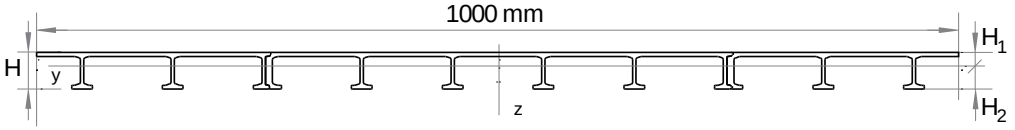
| H | B | $T_1$ | $T_2$ | Weight | A | $I_{yy}$ | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | mm | g/m | x $10^3$ $mm^2$ | x $10^6$ $mm^4$ | x $10^3$ MPa |
| 120 | 180 | 8 | 8 | 6.780 | 3,77 | 5,55 | 24 |

**Overview of MD Plank**




Single profile

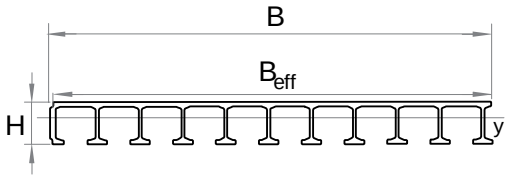
| H | B | $B_{eff}$ | A | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 40 | 505 | 500 | 3.650 | 0,7 | 6.570 | 20,5 |




One meter of profile

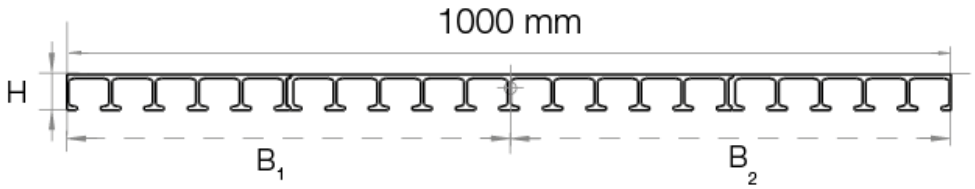
| H | $H_1$ | $H_2$ | A | $A_{s,z}$ | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $mm^2/m$ | $x10^6$ $mm^4/m$ | g/m | $x10^3$ MPa |
| 40 | 11,5 | 28,5 | 7.300 | 2.020 | 1,39 | 13.140 | 20,5 |

**Overview of HD Plank**




Single profile

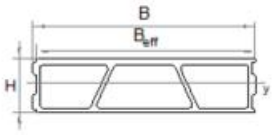
| H | B | $B_{eff}$ | A | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 40 | 505 | 500 | 4.783 | 1,07 | 8.530 | 20,5 |




One meter of profile

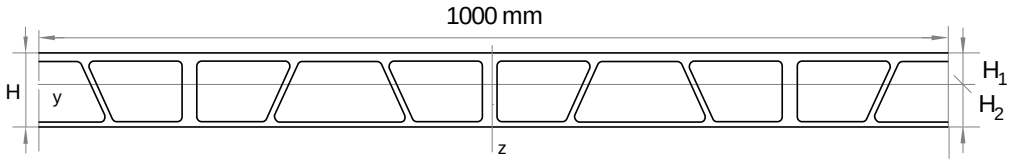
| H | $H_1$ | $H_2$ | A | $A_{s,z}$ | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $mm^2/m$ | $x10^6$ $mm^4/m$ | g/m | $x10^3$ MPa |
| 40 | 15,2 | 24,8 | 9.566 | 3.419 | 2,14 | 17.060 | 20,5 |

**Overview of FBD300**




Single profile

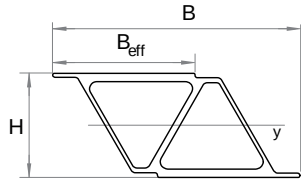
| H | B | $B_{eff}$ | A | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 80 | 339 | 333 | 7.118 | 7,22 | 14.050 | 27 |

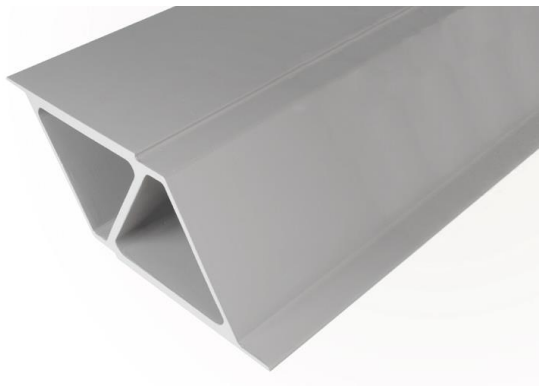



One meter of profile

| H | $H_1$ | $H_2$ | A | $A_{s,z}$ | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $mm^2/m$ | $x10^6$ $mm^4/m$ | g/m | $x10^3$ MPa |
| 80 | 35,9 | 44,1 | 21.480 | 7.315 | 21,7 | 42.120 | 27 |

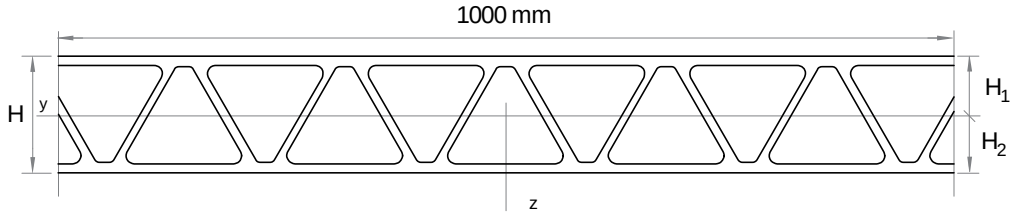
**Overview of FBD450**



Single prifile

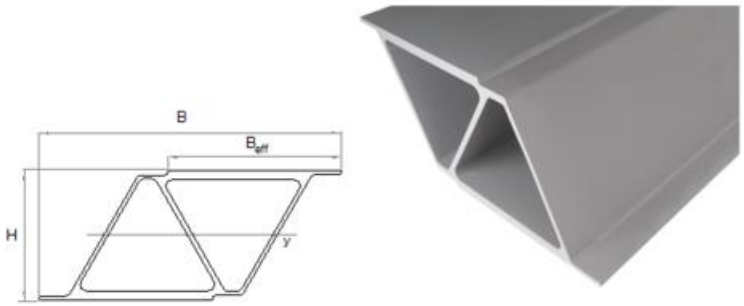
| H | B | $B_{eff}$ | A | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 225 | 521 | 299 | 15.644 | 125,4 | 29.900 | 20 |




One meter of profile

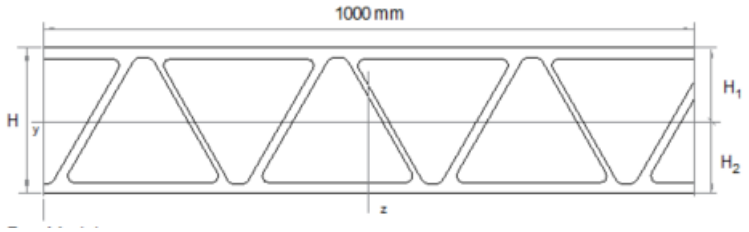
| H | $H_1$ | $H_2$ | A | $A_{s,z}$ | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $mm^2/m$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 225 | 114 | 111 | 54.252 | 19.625 | 409,8 | 103.690 | 20 |

**Overview of FBD600**




Single prifile

| H | B | $B_{eff}$ | A | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 225 | 521 | 299 | 15.644 | 125,4 | 29.900 | 20 |




One meter of profile

| H | $H_1$ | $H_2$ | A | $A_{s,z}$ | $I_{yy}$ | Weight | $E_{0°}$ |
|---|---|---|---|---|---|---|---|
| mm | mm | mm | $mm^2$ | $mm^2/m$ | $x10^6$ $mm^4$ | g/m | $x10^3$ MPa |
| 225 | 114 | 111 | 54.252 | 19.625 | 409,8 | 103.690 | 20 |