European Technical Assessment

valid for

MPR-Support channels

This document is for informational use only and does not underly the actualization process. This document can not be used for advertising or other purposes unless otherwise approved by MÜPRO in advance.
All rights reserved. Subject to change.

Centre Scientifique et Technique du Bâtiment
84 avenue Jean Jaurès
CHAMPS-SUR-MARNE
F-77447 Marne-la-Vallée Cedex 2
Tél. : (33) 01 64 68 82 82
Fax : (33) 01 60 05 70 37

Designated according to Article 29 of Regulation (EU) No 305/2011

Member of EOTA
www.eota.eu

European Technical Assessment

ETA-25/0296 of 28/04/2025

English translation prepared by CSTB - Original version in French language

General Part

Technical Assessment Body issuing the European Technical Assessment: Centre Scientifique et Technique du Bâtiment (CSTB)	
Trade name of the construction product:	MÜPRO channels
Product family to which the construction product belongs:	Products for installation systems for supporting technical building equipment
Manufacturer:	MÜPRO Services GmbH Borsigstrasse 14 65205 Wiesbaden Germany
Manufacturing plants:	UBB Umformtechnik GmbH Im Grund 1 91593 Burgbernheim Germany
This European Technical Assessment contains:	45 pages including 44 pages of annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of:	European Assessment Document (EAD) 280016-00-0602 version June 2020
This version replaces:	-

The European Technical Assessment is issued by the Technical Assessment Body in its official language. Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and shall be identified as such. Communication of this European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may only be made with the written consent of the issuing Technical Assessment Body. Any partial reproduction shall be identified as such. This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No 305/2011.

Specific Part

1 Technical description of the product

This European Technical Assessment covers MÜPRO channels described in Table A1 through Table A5.

The MÜPRO channels MPR 41/21/1.5, MPR 41/21/2.0, MPR 41/41/2.0, MPR 41/41/2.5 and MPR 41/62/2.5 are made of thin-walled steel in C-shape. Recesses in the form of oblong and round holes allow the use of fasteners and fixtures.

The MÜPRO channels MPR 41/42/2.0 H, MPR 41/82/2.0 H, MPR 41/82/2.5 H and MPR 41/124/2.5 H consist of two profiles of equal type which are connected in the area of the back of the channels in a shape-fitting and force-fitting way. Recesses in the form of oblong and round holes allow the use of fasteners and fixtures.

The MÜPRO channels can be cut along the entire length following the manufacturers instructions without compromising the declared performances.

The drawings, dimensions and materials of the MÜPRO installation channels are given in Annex A.

2 Specification of the intended use

The performances given in clause 3 are only valid if MÜPRO channels are in compliance with the specifications and conditions given in Annex B.

The provisions made in this European Technical Assessment are based on an assumed working life of the MÜPRO channels of 50 years when installed in the works (provided that the installation systems products are subject to appropriate installation). The indications given on the working life cannot be interpreted as a guarantee given by the producer or Technical 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.

In accordance with the European Assessment Document EAD 280016-00-0602, the product is intended to be used in:

a) installations for the support of sprinkler kits,

b) installations for the support of technical building equipment in general,

c) installations for the support of pipes for the transportation of water not intended for human consumption,

d) installations for the support of pipes for the transport of gas/fuel intended for the supply of building heating / cooling systems.

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

3.1 Safety in case of fire (BWR 2)

No.	Essential characteristic	Performance
1	Reaction to fire	Class A1
2	Pull-through resistance of channel back holes under fire exposure	No Performance Assessed
3	Bending characteristics under fire exposure	No Performance Assessed

3.2 Safety and accessibility in use (BWR 4)

No.	Essential characteristic	Performance
4	Shape	See Annex A
5	Dimensions	See Annex A
6	Material and cross-section characteristics	See Annex A and B
7	Characteristic pull-through resistance of channel back holes at ambient temperatures	No Performance Assessed

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with the European Assessment Document EAD 280016-00-0602, the following legal bases apply:

- In case of intended use a) specified in Section 2:
  Commission Decision N° 96/577/EC as amended by Commission Decision 2002/592/EC:
  The system is 1

- In case of intended use b) specified in Section 2:
  Commission Decision N° 97/161/EC de la Commission:
  The system is 2+

- In case of intended use d) specified in Section 2:
  Commission Decision N° 1999/472/EC as amended by Commission Decision 2001/596/EC:
  The system is 3

- In case of intended use c) specified in Section 2:
  Commission Decision N° 1999/472/EC as amended by Commission Decision 2001/596/EC:
  The system is 4

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

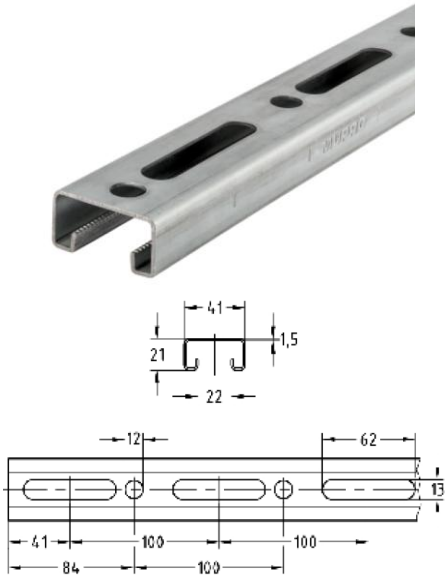
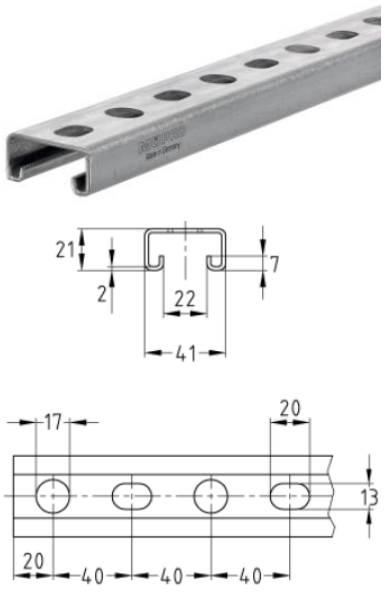
The technical details necessary for the implementation of the system for the assessment and verification of constancy of performance are laid down in the control plan (confidential part of this European Technical Assessment) deposited at Centre Scientifique et Technique du Bâtiment.

The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of supporting systems for issuing the certificate of conformity CE based on the control plan.

The original French version is signed by

Loïc PAYET
Responsable de la division Structure, Maçonnerie et Partition

Table A1: Dimensions and materials of MÜPRO MPR 41/21/1.5 and MPR 41/21/2.0 channels

Illustration (Dimensions in mm and inch)	Designation	Item number	Length [mm]	Materials and coatings
	MÜPRO channel MPR 41/21/1.5	175787	3 000	S250GD + Z275NA According to EN 10346
		175788	6 000	
	MÜPRO channel MPR 41/21/2.0	150930 150931 150932	2 000 3 040 6 000	S250GD + Z275NA According to EN 10346
		154173 154174 154175	2 000 3 040 6 000	S235JR, hot-dip galvanized According to EN 10025-2
		154393 154394 154395	2 000 3 040 6 000	V4A (1.4404) According to EN 10088-2

MÜPRO channels

Product description
Shape, dimensions, material and coating

Annex A1

Table A2: Dimensions and materials of MÜPRO MPR 41/41/2.0 and MPR 41/41/2.5 channels

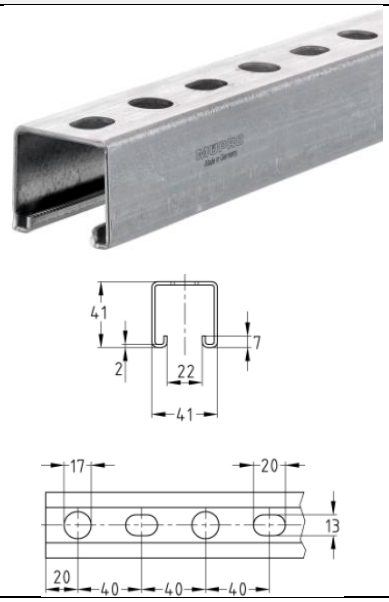
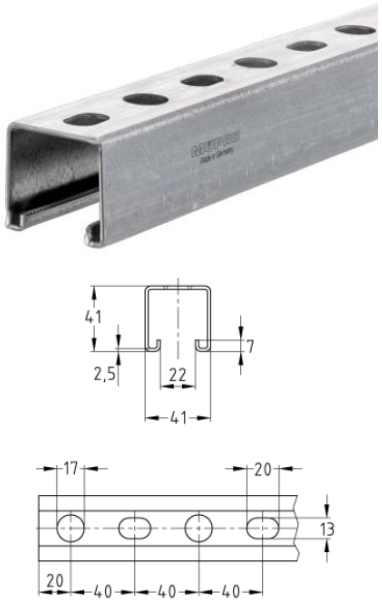
Illustration (Dimensions in mm and inch)	Designation	Item number	Length [mm]	Materials and coatings
	MÜPRO channel MPR 41/41/2.0	150933 150934 150935	2 000 3 040 6 000	S250GD + Z275NA According to EN 10346
		154176 154177 154178	2 000 3 040 6 000	S235JR, hot-dip galvanized According to EN 10025-2
		154396 154397	2 000 6 000	V4A (1.4404) According to EN 10088-2
	MÜPRO channel MPR 41/41/2.5	150864 150937 150938	2 000 3 040 6 000	S250GD + Z275NA According to EN 10346
		154179 154180 154181	2 000 3 040 6 000	S235JR, hot-dip galvanized According to EN 10025-2

Table A3: Dimensions and materials of MÜPRO MPR 41/62/2.5 and MPR 41/42/2.0 H channels

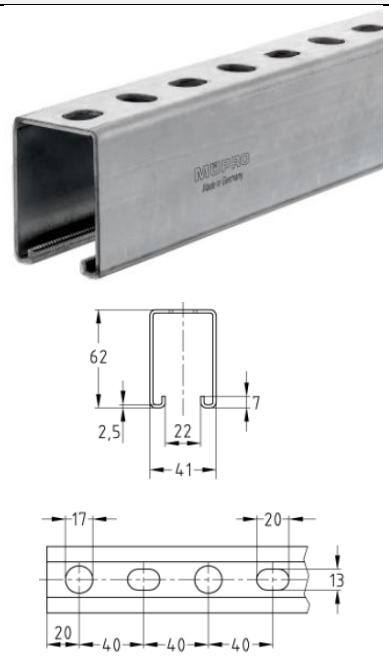
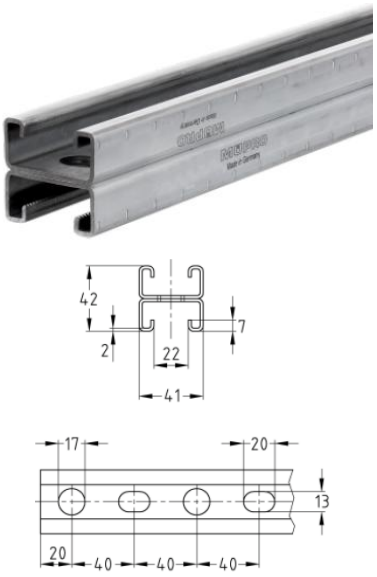
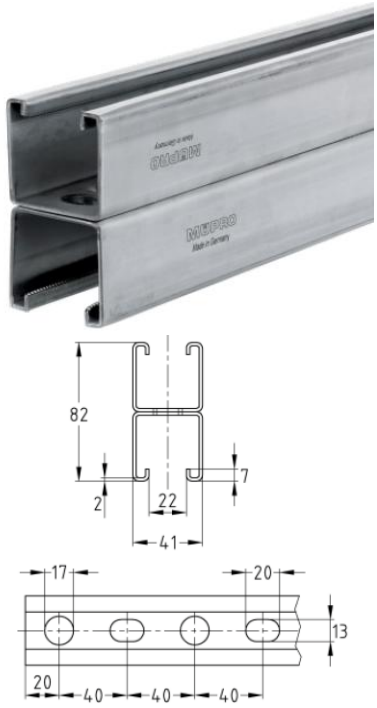
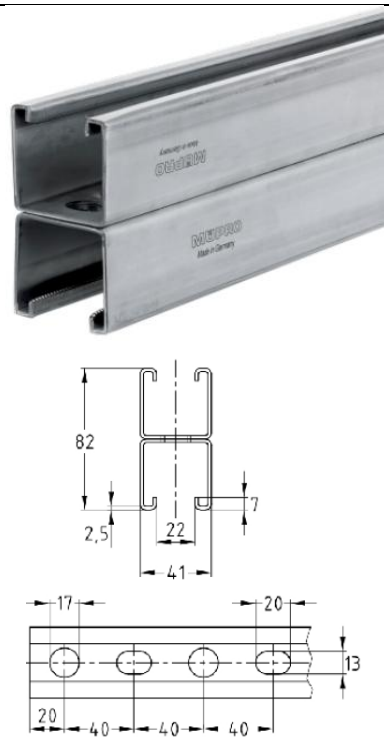
Illustration (Dimensions in mm and inch)	Designation	Item number	Length [mm]	Materials and coatings
	MÜPRO channel MPR 41/62/2.5	150936 150978 150979	2 000 3 040 6 000	S250GD + Z275NA According to EN 10346
		154182 154183 154184	2 000 3 040 6 000	S235JR, hot-dip galvanized According to EN 10025-2
		154404	6 000	V4A (1.4404) According to EN 10088-2
	MÜPRO channel MPR 41/42/2.0 H	150968	6 640	S250GD + Z275NA According to EN 10346
		154185	6 640	S235JR, hot-dip galvanized According to EN 10025-2

Table A4: Dimensions and materials of MÜPRO MPR MPR 41/82/2.0 H and MPR 41/82/2.5 H channels

Illustration (Dimensions in mm and inch)	Designation	Item number	Length [mm]	Materials and coatings
	MÜPRO channel MPR 41/82/2.0 H	150969	6 640	S250GD + Z275NA According to EN 10346
		154186	6 640	S235JR, hot-dip galvanized According to EN 10025-2
		154406	6 000	V4A (1.4404) According to EN 10088-2
	MÜPRO channel MPR 41/82/2.5 H	177352	6 000	S250GD + Z275NA According to EN 10346

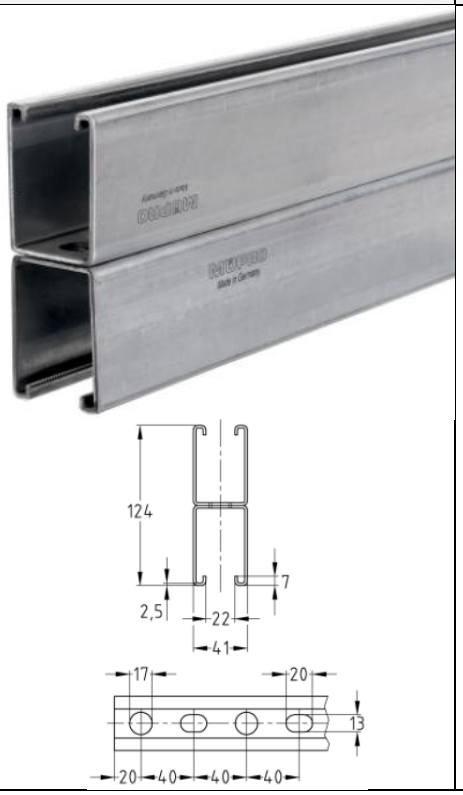
Double channels consist of two MPR 41/41/2.5 channels single profiles which are connected in the back of the channels in a shape-fitting and force-fitting way as a kind of clinched or welded connection.

MÜPRO channels

Product description
Shape, dimensions, material and coating

Annex A4

Table A5: Dimensions and materials of MÜPRO MPR 41/124/2.5 H channels

Illustration (Dimensions in mm and inch)	Designation	Item number	Length [mm]	Materials and coatings
	MÜPRO channel MPR 41/124/2.5 H	151050	6 640	S250GD + Z275NA According to EN 10346
		154187	6 640	S235JR, hot-dip galvanized According to EN 10025-2
		154407	6 000	V4A (1.4404) According to EN 10088-2

Double channels consist of two MPR 41/62/2.5 channels single profiles which are connected in the back of the channels in a shape-fitting and force-fitting way as a kind of clinched or welded connection.

Specifications of intended use

- MÜPRO MPR channels are used to transfer building services components loads such as ducts and equipment for water, heating, cooling, ventilation, electrical and other systems. MÜPRO MPR channels are performing this loadbearing function under conditions described in Section 2 of this European Technical Assessment.
- MÜPRO MPR channels (regardless of length and coating) in the scope of this European Technical Assessment are used for applications at ambient temperature.

Table B1: Properties of the cross section of Müpro channels MPR 41/21/1.5, perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	131,28	mm^2	
	A_{geom}	131,28	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	39,22	mm^2	
	A_z	42,59	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	11,13	mm	
Moments of inertia	I_y	7776,64	mm^4	about centroidal axes y
	I_z	35532,19	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	43308,83	mm^4	
	$I_{p,M}$	104828,94	mm^4	about shear center M
Radii of gyration	i_y	7,70	mm	relative to centroid C
	i_z	16,45	mm	
Polar radii of gyration	i_p	18,16	mm	
	$i_{p,M}$	28,26	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,01	mm	
Cross-section weight	G	1,03	kg/m	
Cross-section perimeter	U	181,02	mm	incl. inner side of cells
Torsional constant	I_t	87,34	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	26165,15	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,78	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	21,65	mm	
Warping constants	$I_{\omega,S}$	2,181E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,157E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	787,95	mm^3	in distance 9.87 mm
	$W_{y,min}$	-698,67	mm^3	in distance -11.13 mm
	$W_{z,max}$	1733,28	mm^3	in distance 20.50 mm
	$W_{z,min}$	-1733,28	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	14435,36	mm^4	in node 40
	$W_{\omega,M,min}$	-14449,92	mm^4	in node 28
Torsional section modulus	W_t	58,22	mm^3	
Stability parameters	r_u	-2,88	mm	
	$r_{M,v}$	-46,17	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B2: Properties of the cross section of Müpro channels MPR 41/21/1.5, perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	129,78	mm^2	
	A_{geom}	129,78	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	39,19	mm^2	
	A_z	42,88	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	11,03	mm	
Moments of inertia	I_y	7650,17	mm^4	about centroidal axes y
	I_z	35473,56	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	43123,73	mm^4	
	$I_{p,M}$	104651,83	mm^4	about shear center M
Radii of gyration	i_y	7,68	mm	relative to centroid C
	i_z	16,53	mm	
Polar radii of gyration	i_p	18,23	mm	
	$i_{p,M}$	28,40	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,01	mm	
Cross-section weight	G	1,02	kg/m	
Cross-section perimeter	U	179,02	mm	incl. inner side of cells
Torsional constant	I_t	87,34	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	26174,55	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,80	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	21,77	mm	
Warping constants	$I_{\omega,S}$	2,197E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,148E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	766,94	mm^3	in distance 9.97 mm
	$W_{y,min}$	-693,89	mm^3	in distance -11.03 mm
	$W_{z,max}$	1730,42	mm^3	in distance 20.50 mm
	$W_{z,min}$	-1730,42	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	14419,31	mm^4	in node 40
	$W_{\omega,M,min}$	-14434,05	mm^4	in node 28
Torsional section modulus	W_t	58,22	mm^3	
Stability parameters	r_u	-2,34	mm	
	$r_{M,v}$	-45,89	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B3: Properties of the cross section of Müpro channels MPR 41/21/1.5, non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	149,28	mm^2	
	A_{geom}	149,28	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	39,33	mm^2	
	A_z	39,06	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	12,23	mm	
Moments of inertia	I_y	9096,32	mm^4	about centroidal axes y
	I_z	35748,19	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	44844,51	mm^4	
	$I_{p,M}$	107407,44	mm^4	about shear center M
Radii of gyration	i_y	7,81	mm	relative to centroid C
	i_z	15,47	mm	
Polar radii of gyration	i_p	17,33	mm	
	$i_{p,M}$	26,82	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,95	mm	
Cross-section weight	G	1,17	kg/m	
Cross-section perimeter	U	202,02	mm	incl. inner side of cells
Torsional constant	I_t	88,40	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	26122,70	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,70	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	20,47	mm	
Warping constants	$I_{\omega,S}$	2,018E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,191E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	1037,33	mm^3	in distance 8.77 mm
	$W_{y,min}$	-743,71	mm^3	in distance -12.23 mm
	$W_{z,max}$	1743,81	mm^3	in distance 20.50 mm
	$W_{z,min}$	-1743,81	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	14494,55	mm^4	in node 37
	$W_{\omega,M,min}$	-14507,29	mm^4	in node 25
Torsional section modulus	W_t	58,93	mm^3	
Stability parameters	r_u	-8,39	mm	
	$r_{M,v}$	-49,33	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B4: Properties of the cross section of Müpro channels MPR 41/21/1.5, averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	136,02	mm^2	
	A_{geom}	136,02	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	24,10	mm^2	
	A_z	41,50	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	11,45	mm	
Moments of inertia	I_y	8156,93	mm^4	about centroidal axes y
	I_z	35561,44	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	43718,37	mm^4	
	$I_{p,M}$	105541,42	mm^4	about shear center M
Radii of gyration	i_y	7,74	mm	relative to centroid C
	i_z	16,17	mm	
Polar radii of gyration	i_p	17,93	mm	
	$i_{p,M}$	27,86	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,99	mm	
Cross-section weight	G	1,07	kg/m	
Cross-section perimeter	U	204,06	mm	incl. inner side of cells
Torsional constant	I_t	74,25	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	25909,94	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,77	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	21,32	mm	
Warping constants	$I_{\omega,S}$	2,133E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,162E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	854,01	mm^3	in distance 9.55 mm
	$W_{y,min}$	-712,48	mm^3	in distance -11.45 mm
	$W_{z,max}$	1734,70	mm^3	in distance 20.50 mm
	$W_{z,min}$	-1734,70	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	14443,60	mm^4	in node 39
	$W_{\omega,M,min}$	-14457,64	mm^4	in node 27
Torsional section modulus	W_t	49,50	mm^3	
Stability parameters	r_u	-4,61	mm	
	$r_{M,v}$	-47,25	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B5: Properties of the cross section of Müpro channels MPR 41/21/2.0, perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	160,32	mm^2	
	A_{geom}	160,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	51,97	mm^2	
	A_z	57,42	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	10,64	mm	
Moments of inertia	I_y	8783,35	mm^4	about centroidal axes y
	I_z	44901,68	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	53685,03	mm^4	
	$I_{p,M}$	128104,27	mm^4	about shear center M
Radii of gyration	i_y	7,40	mm	relative to centroid C
	i_z	16,74	mm	
Polar radii of gyration	i_p	18,30	mm	
	$i_{p,M}$	28,27	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,76	mm	
Cross-section weight	G	1,26	kg/m	
Cross-section perimeter	U	168,31	mm	incl. inner side of cells
Torsional constant	I_t	196,26	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	32712,83	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,19	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	21,54	mm	
Warping constants	$I_{\omega,S}$	2,671E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,856E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	848,08	mm^3	in distance 10.36 mm
	$W_{y,min}$	-825,25	mm^3	in distance -10.64 mm
	$W_{z,max}$	2190,33	mm^3	in distance 20.50 mm
	$W_{z,min}$	-2190,33	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	17539,77	mm^4	in node 41
	$W_{\omega,M,min}$	-17558,05	mm^4	in node 29
Torsional section modulus	W_t	98,13	mm^3	
Stability parameters	r_u	-0,46	mm	
	$r_{M,v}$	-43,55	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B6: Properties of the cross section of Müpro channels MPR 41/21/2.0, perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	168,32	mm^2	
	A_{geom}	168,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	52,22	mm^2	
	A_z	55,94	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	11,09	mm	
Moments of inertia	I_y	9453,09	mm^4	about centroidal axes y
	I_z	45354,35	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	54807,43	mm^4	
	$I_{p,M}$	128886,01	mm^4	about shear center M
Radii of gyration	i_y	7,49	mm	relative to centroid C
	i_z	16,41	mm	
Polar radii of gyration	i_p	18,04	mm	
	$i_{p,M}$	27,67	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,78	mm	
Cross-section weight	G	1,32	kg/m	
Cross-section perimeter	U	176,31	mm	incl. inner side of cells
Torsional constant	I_t	196,26	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	32651,89	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,07	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	20,98	mm	
Warping constants	$I_{\omega,S}$	2,590E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,922E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	953,73	mm^3	in distance 9.91 mm
	$W_{y,min}$	-852,53	mm^3	in distance -11.09 mm
	$W_{z,max}$	2212,41	mm^3	in distance 20.50 mm
	$W_{z,min}$	-2212,41	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	17662,60	mm^4	in node 39
	$W_{\omega,M,min}$	-17679,88	mm^4	in node 27
Torsional section modulus	W_t	98,13	mm^3	
Stability parameters	r_u	-2,75	mm	
	$r_{M,v}$	-44,71	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B7: Properties of the cross section of Müpro channels MPR 41/21/2.0, non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	194,32	mm^2	
	A_{geom}	194,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	52,40	mm^2	
	A_z	50,80	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	12,28	mm	
Moments of inertia	I_y	11250,15	mm^4	about centroidal axes y
	I_z	45720,51	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	56970,66	mm^4	
	$I_{p,M}$	132304,96	mm^4	about shear center M
Radii of gyration	i_y	7,61	mm	relative to centroid C
	i_z	15,34	mm	
Polar radii of gyration	i_p	17,12	mm	
	$i_{p,M}$	26,09	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,72	mm	
Cross-section weight	G	1,53	kg/m	
Cross-section perimeter	U	198,31	mm	incl. inner side of cells
Torsional constant	I_t	199,62	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	32577,93	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	31,97	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	19,69	mm	
Warping constants	$I_{\omega,S}$	2,371E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,975E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	1290,38	mm^3	in distance 8.70 mm
	$W_{y,min}$	-916,02	mm^3	in distance -12.30 mm
	$W_{z,max}$	2230,27	mm^3	in distance 20.50 mm
	$W_{z,min}$	-2230,27	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	17759,81	mm^4	in node 36
	$W_{\omega,M,min}$	-17774,69	mm^4	in node 24
Torsional section modulus	W_t	99,81	mm^3	
Stability parameters	r_u	-8,83	mm	
	$r_{M,v}$	-48,21	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B8: Properties of the cross section of Müpro channels MPR 41/21/2.0, averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	183,10	mm^2	
	A_{geom}	183,10	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	43,86	mm^2	
	A_z	52,46	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	11,81	mm	
Moments of inertia	I_y	10532,80	mm^4	about centroidal axes y
	I_z	45450,30	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	55983,10	mm^4	
	$I_{p,M}$	130945,54	mm^4	about shear center M
Radii of gyration	i_y	7,58	mm	relative to centroid C
	i_z	15,76	mm	
Polar radii of gyration	i_p	17,49	mm	
	$i_{p,M}$	26,74	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	6,73	mm	
Cross-section weight	G	1,44	kg/m	
Cross-section perimeter	U	199,63	mm	incl. inner side of cells
Torsional constant	I_t	167,92	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	32546,82	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	32,04	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	20,23	mm	
Warping constants	$I_{\omega,S}$	2,456E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	5,936E+06	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	1145,89	mm^3	in distance 9.19 mm
	$W_{y,min}$	-891,99	mm^3	in distance -11.81 mm
	$W_{z,max}$	2217,09	mm^3	in distance 20.50 mm
	$W_{z,min}$	-2217,09	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	17689,06	mm^4	in node 37
	$W_{\omega,M,min}$	-17704,92	mm^4	in node 25
Torsional section modulus	W_t	83,96	mm^3	
Stability parameters	r_u	-6,66	mm	
	$r_{M,v}$	-47,13	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B9: Properties of the cross section of Müpro channels MPR 41/41/2.0, perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	240,32	mm^2	
	A_{geom}	240,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	44,26	mm^2	
	A_z	136,15	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	20,39	mm	
Moments of inertia	I_y	49227,59	mm^4	about centroidal axes y
	I_z	75348,35	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	124575,94	mm^4	
	$I_{p,M}$	560274,16	mm^4	about shear center M
Radii of gyration	i_y	14,31	mm	relative to centroid C
	i_z	17,71	mm	
Polar radii of gyration	i_p	22,77	mm	
	$i_{p,M}$	48,28	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,41	mm	
Cross-section weight	G	1,89	kg/m	
Cross-section perimeter	U	248,31	mm	incl. inner side of cells
Torsional constant	I_t	302,92	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	78591,10	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,97	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	42,58	mm	
Warping constants	$I_{\omega,S}$	1,675E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,078E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2388,89	mm^3	in distance 20.61 mm
	$W_{y,min}$	-2413,94	mm^3	in distance -20.39 mm
	$W_{z,max}$	3675,53	mm^3	in distance 20.50 mm
	$W_{z,min}$	-3675,53	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	41486,76	mm^4	in node 43
	$W_{\omega,M,min}$	-41511,21	mm^4	in node 31
Torsional section modulus	W_t	151,46	mm^3	
Stability parameters	r_u	0,76	mm	
	$r_{M,v}$	-84,39	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B10: Properties of the cross section of Müpro channels MPR 41/41/2.0, perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	248,32	mm^2	
	A_{geom}	248,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	44,46	mm^2	
	A_z	135,16	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,03	mm	
Moments of inertia	I_y	52206,58	mm^4	about centroidal axes y
	I_z	75801,01	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	128007,59	mm^4	
	$I_{p,M}$	562100,73	mm^4	about shear center M
Radii of gyration	i_y	14,50	mm	relative to centroid C
	i_z	17,47	mm	
Polar radii of gyration	i_p	22,70	mm	
	$i_{p,M}$	47,58	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,43	mm	
Cross-section weight	G	1,95	kg/m	
Cross-section perimeter	U	256,31	mm	incl. inner side of cells
Torsional constant	I_t	302,92	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	78504,84	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,84	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	41,81	mm	
Warping constants	$I_{\omega,S}$	1,636E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,102E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2613,61	mm^3	in distance 19.97 mm
	$W_{y,min}$	-2483,06	mm^3	in distance -21.03 mm
	$W_{z,max}$	3697,61	mm^3	in distance 20.50 mm
	$W_{z,min}$	-3697,61	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	41715,30	mm^4	in node 38
	$W_{\omega,M,min}$	-41738,90	mm^4	in node 26
Torsional section modulus	W_t	151,46	mm^3	
Stability parameters	r_u	-0,77	mm	
	$r_{M,v}$	-84,39	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B11: Properties of the cross section of Müpro channels MPR 41/41/2.0, perforated area, non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	274,32	mm^2	
	A_{geom}	274,32	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	44,62	mm^2	
	A_z	129,72	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	22,82	mm	
Moments of inertia	I_y	60688,80	mm^4	about centroidal axes y
	I_z	76167,18	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	136855,98	mm^4	
	$I_{p,M}$	573636,69	mm^4	about shear center M
Radii of gyration	i_y	14,87	mm	relative to centroid C
	i_z	16,66	mm	
Polar radii of gyration	i_p	22,34	mm	
	$i_{p,M}$	45,73	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,38	mm	
Cross-section weight	G	2,15	kg/m	
Cross-section perimeter	U	278,31	mm	incl. inner side of cells
Torsional constant	I_t	306,28	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	78421,05	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,73	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	39,90	mm	
Warping constants	$I_{\omega,S}$	1,526E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,121E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	3339,02	mm^3	in distance 18.18 mm
	$W_{y,min}$	-2658,95	mm^3	in distance -22.82 mm
	$W_{z,max}$	3715,47	mm^3	in distance 20.50 mm
	$W_{z,min}$	-3715,47	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	41898,91	mm^4	in node 36
	$W_{\omega,M,min}$	-41920,23	mm^4	in node 24
Torsional section modulus	W_t	153,14	mm^3	
Stability parameters	r_u	-5,30	mm	
	$r_{M,v}$	-85,10	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B12: Properties of the cross section of Müpro channels MPR 41/41/2.0, perforated area, averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	263,10	mm^2	
	A_{geom}	263,10	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	38,83	mm^2	
	A_z	131,81	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	22,09	mm	
Moments of inertia	I_y	57229,73	mm^4	about centroidal axes y
	I_z	75896,96	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	133126,69	mm^4	
	$I_{p,M}$	569291,22	mm^4	about shear center M
Radii of gyration	i_y	14,75	mm	relative to centroid C
	i_z	16,98	mm	
Polar radii of gyration	i_p	22,49	mm	
	$i_{p,M}$	46,52	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,39	mm	
Cross-section weight	G	2,07	kg/m	
Cross-section perimeter	U	279,63	mm	incl. inner side of cells
Torsional constant	I_t	274,58	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	78348,31	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,81	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	40,72	mm	
Warping constants	$I_{\omega,S}$	1,570E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,107E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	3026,68	mm^3	in distance 18.91 mm
	$W_{y,min}$	-2590,57	mm^3	in distance -22.09 mm
	$W_{z,max}$	3702,29	mm^3	in distance 20.50 mm
	$W_{z,min}$	-3702,29	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	41764,32	mm^4	in node 39
	$W_{\omega,M,min}$	-41786,58	mm^4	in node 27
Torsional section modulus	W_t	137,29	mm^3	
Stability parameters	r_u	-3,52	mm	
	$r_{M,v}$	-84,95	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B13: Properties of the cross section of Müpro channels MPR 41/41/2.5, perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	294,51	mm^2	
	A_{geom}	294,51	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	54,98	mm^2	
	A_z	168,69	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	20,50	mm	
Moments of inertia	I_y	58672,28	mm^4	about centroidal axes y
	I_z	90855,46	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	149527,74	mm^4	
	$I_{p,M}$	661360,94	mm^4	about shear center M
Radii of gyration	i_y	14,11	mm	relative to centroid C
	i_z	17,56	mm	
Polar radii of gyration	i_p	22,53	mm	
	$i_{p,M}$	47,39	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,19	mm	
Cross-section weight	G	2,31	kg/m	
Cross-section perimeter	U	245,49	mm	incl. inner side of cells
Torsional constant	I_t	581,57	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	92350,95	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,19	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	41,69	mm	
Warping constants	$I_{\omega,S}$	1,923E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,421E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2861,86	mm^3	in distance 20.50 mm
	$W_{y,min}$	-2862,27	mm^3	in distance -20.50 mm
	$W_{z,max}$	4431,97	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4431,97	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	48581,49	mm^4	in node 42
	$W_{\omega,M,min}$	-48608,53	mm^4	in node 30
Torsional section modulus	W_t	232,63	mm^3	
Stability parameters	r_u	0,47	mm	
	$r_{M,v}$	-82,91	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B14: Properties of the cross section of Müpro channels MPR 41/41/2.5, perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	304,51	mm^2	
	A_{geom}	304,51	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	55,24	mm^2	
	A_z	167,40	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,13	mm	
Moments of inertia	I_y	62261,90	mm^4	about centroidal axes y
	I_z	91421,29	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	153683,20	mm^4	
	$I_{p,M}$	663510,83	mm^4	about shear center M
Radii of gyration	i_y	14,30	mm	relative to centroid C
	i_z	17,33	mm	
Polar radii of gyration	i_p	22,47	mm	
	$i_{p,M}$	46,68	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,21	mm	
Cross-section weight	G	2,39	kg/m	
Cross-section perimeter	U	253,49	mm	incl. inner side of cells
Torsional constant	I_t	581,57	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	92249,79	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,05	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	40,92	mm	
Warping constants	$I_{\omega,S}$	1,877E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,450E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	3133,63	mm^3	in distance 19.87 mm
	$W_{y,min}$	-2946,46	mm^3	in distance -21.13 mm
	$W_{z,max}$	4459,58	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4459,58	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	48867,65	mm^4	in node 40
	$W_{\omega,M,min}$	-48893,74	mm^4	in node 28
Torsional section modulus	W_t	232,63	mm^3	
Stability parameters	r_u	-1,06	mm	
	$r_{M,v}$	-82,90	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B15: Properties of the cross section of Müpro channels MPR 41/41/2.5, non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	337,01	mm^2	
	A_{geom}	337,01	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	55,45	mm^2	
	A_z	160,43	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	22,93	mm	
Moments of inertia	I_y	72458,46	mm^4	about centroidal axes y
	I_z	91879,00	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	164337,46	mm^4	
	$I_{p,M}$	677255,43	mm^4	about shear center M
Radii of gyration	i_y	14,66	mm	relative to centroid C
	i_z	16,51	mm	
Polar radii of gyration	i_p	22,08	mm	
	$i_{p,M}$	44,83	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,16	mm	
Cross-section weight	G	2,65	kg/m	
Cross-section perimeter	U	274,49	mm	incl. inner side of cells
Torsional constant	I_t	589,77	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	92155,83	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	61,94	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	39,01	mm	
Warping constants	$I_{\omega,S}$	1,747E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,473E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	4009,30	mm^3	in distance 18.07 mm
	$W_{y,min}$	-3160,35	mm^3	in distance -22.93 mm
	$W_{z,max}$	4481,90	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4481,90	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	49097,77	mm^4	in node 38
	$W_{\omega,M,min}$	-49121,29	mm^4	in node 26
Torsional section modulus	W_t	235,91	mm^3	
Stability parameters	r_u	-5,59	mm	
	$r_{M,v}$	-83,61	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B16: Properties of the cross section of Müpro channels MPR 41/41/2.5, averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	322,90	mm^2	
	A_{geom}	322,90	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	48,12	mm^2	
	A_z	163,09	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	22,19	mm	
Moments of inertia	I_y	68275,21	mm^4	about centroidal axes y
	I_z	91539,19	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	159814,40	mm^4	
	$I_{p,M}$	672055,17	mm^4	about shear center M
Radii of gyration	i_y	14,54	mm	relative to centroid C
	i_z	16,84	mm	
Polar radii of gyration	i_p	22,25	mm	
	$i_{p,M}$	45,62	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,17	mm	
Cross-section weight	G	2,53	kg/m	
Cross-section perimeter	U	276,15	mm	incl. inner side of cells
Torsional constant	I_t	527,62	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	92108,61	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,02	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	39,83	mm	
Warping constants	$I_{\omega,S}$	1,799E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	3,456E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	3630,10	mm^3	in distance 18.81 mm
	$W_{y,min}$	-3076,58	mm^3	in distance -22.19 mm
	$W_{z,max}$	4465,33	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4465,33	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	48928,27	mm^4	in node 42
	$W_{\omega,M,min}$	-48952,85	mm^4	in node 30
Torsional section modulus	W_t	211,05	mm^3	
Stability parameters	r_u	-3,80	mm	
	$r_{M,v}$	-83,46	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B17: Properties of the cross section of Müpro channels MPR 41/62/2.5, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	399,51	mm^2	
	A_{geom}	399,51	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	46,25	mm^2	
	A_z	269,34	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	30,89	mm	
Moments of inertia	I_y	173330,48	mm^4	about centroidal axes y
	I_z	129819,21	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	303149,70	mm^4	
	$I_{p,M}$	1,894E+06	mm^4	about shear center M
Radii of gyration	i_y	20,83	mm	relative to centroid C
	i_z	18,03	mm	
Polar radii of gyration	i_p	27,55	mm	
	$i_{p,M}$	68,85	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,10	mm	
Cross-section weight	G	3,14	kg/m	
Cross-section perimeter	U	329,49	mm	incl. inner side of cells
Torsional constant	I_t	800,32	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	143682,79	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	93,99	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	63,10	mm	
Warping constants	$I_{\omega,S}$	6,129E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	9,540E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	5571,64	mm^3	in distance 31.11 mm
	$W_{y,min}$	-5611,11	mm^3	in distance -30.89 mm
	$W_{z,max}$	6332,64	mm^3	in distance 20.50 mm
	$W_{z,min}$	-6332,64	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	85117,90	mm^4	in node 40
	$W_{\omega,M,min}$	-85150,41	mm^4	in node 28
Torsional section modulus	W_t	320,13	mm^3	
Stability parameters	r_u	0,67	mm	
	$r_{M,v}$	-125,52	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B18: Properties of the cross section of Müpro channels MPR 41/62/2.5, Perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	409,51	mm^2	
	A_{geom}	409,51	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	46,45	mm^2	
	A_z	269,05	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	31,62	mm	
Moments of inertia	I_y	182033,75	mm^4	about centroidal axes y
	I_z	130385,05	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	312418,79	mm^4	
	$I_{p,M}$	1,898E+06	mm^4	about shear center M
Radii of gyration	i_y	21,08	mm	relative to centroid C
	i_z	17,84	mm	
Polar radii of gyration	i_p	27,62	mm	
	$i_{p,M}$	68,08	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,11	mm	
Cross-section weight	G	3,21	kg/m	
Cross-section perimeter	U	337,49	mm	incl. inner side of cells
Torsional constant	I_t	800,32	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	143591,82	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	93,85	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	62,23	mm	
Warping constants	$I_{\omega,S}$	6,015E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	9,602E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	5991,89	mm^3	in distance 30.38 mm
	$W_{y,min}$	-5756,92	mm^3	in distance -31.62 mm
	$W_{z,max}$	6360,25	mm^3	in distance 20.50 mm
	$W_{z,min}$	-6360,25	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	85541,55	mm^4	in node 40
	$W_{\omega,M,min}$	-85573,24	mm^4	in node 28
Torsional section modulus	W_t	320,13	mm^3	
Stability parameters	r_u	-0,51	mm	
	$r_{M,v}$	-124,96	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B19: Properties of the cross section of Müpro channels MPR 41/62/2.5, Non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	442,01	mm^2	
	A_{geom}	442,01	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	46,61	mm^2	
	A_z	264,05	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	33,76	mm	
Moments of inertia	I_y	207600,37	mm^4	about centroidal axes y
	I_z	130842,75	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	338443,12	mm^4	
	$I_{p,M}$	1,928E+06	mm^4	about shear center M
Radii of gyration	i_y	21,67	mm	relative to centroid C
	i_z	17,21	mm	
Polar radii of gyration	i_p	27,67	mm	
	$i_{p,M}$	66,05	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,08	mm	
Cross-section weight	G	3,47	kg/m	
Cross-section perimeter	U	358,49	mm	incl. inner side of cells
Torsional constant	I_t	808,52	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	143522,71	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	93,73	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	59,97	mm	
Warping constants	$I_{\omega,S}$	5,677E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	9,652E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	7351,96	mm^3	in distance 28.24 mm
	$W_{y,min}$	-6148,83	mm^3	in distance -33.76 mm
	$W_{z,max}$	6382,57	mm^3	in distance 20.50 mm
	$W_{z,min}$	-6382,57	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	85883,25	mm^4	in node 38
	$W_{\omega,M,min}$	-85912,59	mm^4	in node 26
Torsional section modulus	W_t	323,41	mm^3	
Stability parameters	r_u	-4,31	mm	
	$r_{M,v}$	-124,25	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B20: Properties of the cross section of Müpro channels MPR 41/62/2.5, Averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	427,90	mm^2	
	A_{geom}	427,90	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	41,53	mm^2	
	A_z	266,24	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	32,87	mm	
Moments of inertia	I_y	196969,22	mm^4	about centroidal axes y
	I_z	130502,94	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	327472,16	mm^4	
	$I_{p,M}$	1,917E+06	mm^4	about shear center M
Radii of gyration	i_y	21,45	mm	relative to centroid C
	i_z	17,46	mm	
Polar radii of gyration	i_p	27,66	mm	
	$i_{p,M}$	66,93	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	7,08	mm	
Cross-section weight	G	3,36	kg/m	
Cross-section perimeter	U	360,15	mm	incl. inner side of cells
Torsional constant	I_t	746,37	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	143465,26	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	93,82	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	60,94	mm	
Warping constants	$I_{\omega,S}$	5,815E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	9,615E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	6762,28	mm^3	in distance 29.13 mm
	$W_{y,min}$	-5991,94	mm^3	in distance -32.87 mm
	$W_{z,max}$	6366,00	mm^3	in distance 20.50 mm
	$W_{z,min}$	-6366,00	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	85631,07	mm^4	in node 40
	$W_{\omega,M,min}$	-85661,39	mm^4	in node 28
Torsional section modulus	W_t	298,55	mm^3	
Stability parameters	r_u	-2,74	mm	
	$r_{M,v}$	-124,63	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B21: Properties of the cross section of Müpro channels MPR 41/42/2.0 H, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	320,65	mm^2	
	A_{geom}	320,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	103,94	mm^2	
	A_z	122,77	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,00	mm	
Moments of inertia	I_y	51931,06	mm^4	about centroidal axes y
	I_z	89803,35	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	141734,42	mm^4	
	$I_{p,M}$	141734,42	mm^4	about shear center M
Radii of gyration	i_y	12,73	mm	relative to centroid C
	i_z	16,74	mm	
Polar radii of gyration	i_p	21,02	mm	
	$i_{p,M}$	21,02	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	13,88	mm	
Cross-section weight	G	2,52	kg/m	
Cross-section perimeter	U	302,62	mm	incl. inner side of cells
Torsional constant	I_t	916,96	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	64783,04	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	21,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	2,732E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	2,732E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2472,91	mm^3	in distance 21.00 mm
	$W_{y,min}$	-2472,91	mm^3	in distance -21.00 mm
	$W_{z,max}$	4380,65	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4380,65	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	54240,20	mm^4	in node 63
	$W_{\omega,M,min}$	-54242,93	mm^4	in node 51
Torsional section modulus	W_t	272,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B22: Properties of the cross section of Müpro channels MPR 41/42/2.0 H, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	336,65	mm^2	
	A_{geom}	336,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	104,43	mm^2	
	A_z	122,78	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,00	mm	
Moments of inertia	I_y	51952,39	mm^4	about centroidal axes y
	I_z	90708,69	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	142661,08	mm^4	
	$I_{p,M}$	142661,08	mm^4	about shear center M
Radii of gyration	i_y	12,42	mm	relative to centroid C
	i_z	16,41	mm	
Polar radii of gyration	i_p	20,59	mm	
	$i_{p,M}$	20,59	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	13,84	mm	
Cross-section weight	G	2,64	kg/m	
Cross-section perimeter	U	310,62	mm	incl. inner side of cells
Torsional constant	I_t	916,96	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	64781,66	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	21,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	2,733E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	2,733E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2473,92	mm^3	in distance 21.00 mm
	$W_{y,min}$	-2473,92	mm^3	in distance -21.00 mm
	$W_{z,max}$	4424,81	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4424,81	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	54241,68	mm^4	in node 61
	$W_{\omega,M,min}$	-54244,28	mm^4	in node 85
Torsional section modulus	W_t	272,00	mm^3	
Stability parameters	r_u	-2,75	mm	
	$r_{M,v}$	-44,71	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B23: Properties of the cross section of Müpro channels MPR 41/42/2.0 H, non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	388,65	mm^2	
	A_{geom}	388,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	104,80	mm^2	
	A_z	122,81	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,00	mm	
Moments of inertia	I_y	52021,72	mm^4	about centroidal axes y
	I_z	91441,02	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	143462,74	mm^4	
	$I_{p,M}$	143462,74	mm^4	about shear center M
Radii of gyration	i_y	11,57	mm	relative to centroid C
	i_z	15,34	mm	
Polar radii of gyration	i_p	19,21	mm	
	$i_{p,M}$	19,21	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	13,80	mm	
Cross-section weight	G	3,05	kg/m	
Cross-section perimeter	U	328,62	mm	incl. inner side of cells
Torsional constant	I_t	923,68	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	64780,47	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	21,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	2,733E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	2,733E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2477,23	mm^3	in distance 21.00 mm
	$W_{y,min}$	-2477,23	mm^3	in distance -21.00 mm
	$W_{z,max}$	4460,54	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4460,54	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	54243,00	mm^4	in node 57
	$W_{\omega,M,min}$	-54245,25	mm^4	in node 81
Torsional section modulus	W_t	272,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B24: Properties of the cross section of Müpro channels MPR 41/42/2.0 H, Averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	366,21	mm^2	
	A_{geom}	366,21	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	87,71	mm^2	
	A_z	122,76	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	21,00	mm	
Moments of inertia	I_y	51983,44	mm^4	about centroidal axes y
	I_z	90900,59	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	142884,03	mm^4	
	$I_{p,M}$	142884,03	mm^4	about shear center M
Radii of gyration	i_y	11,91	mm	relative to centroid C
	i_z	15,76	mm	
Polar radii of gyration	i_p	19,75	mm	
	$i_{p,M}$	19,75	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	13,84	mm	
Cross-section weight	G	2,87	kg/m	
Cross-section perimeter	U	365,26	mm	incl. inner side of cells
Torsional constant	I_t	763,33	mm^4	calculated analytically
Secondary torsional constant	$I_{t,s}$	64858,03	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	21,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	2,738E+07	mm^6	relative to centroid C
	$I_{\omega,M}$	2,738E+07	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	2475,40	mm^3	in distance 21.00 mm
	$W_{y,min}$	-2475,40	mm^3	in distance -21.00 mm
	$W_{z,max}$	4434,18	mm^3	in distance 20.50 mm
	$W_{z,min}$	-4434,18	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	54313,00	mm^4	in node 63
	$W_{\omega,M,min}$	-54315,45	mm^4	in node 87
Torsional section modulus	W_t	182,24	mm^3	
Stability parameters	r_u	-6,66	mm	
	$r_{M,v}$	-47,13	mm	
Reduction factor	λ_M	0,00	1/mm	

Table B25: Properties of the cross section of Müpro channels MPR 41/82/2.0 H, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	480,65	mm^2	
	A_{geom}	480,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	88,51	mm^2	
	A_z	272,10	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	41,00	mm	
Moments of inertia	I_y	302445,57	mm^4	about centroidal axes y
	I_z	150696,69	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	453142,26	mm^4	
	$I_{p,M}$	453142,26	mm^4	about shear center M
Radii of gyration	i_y	25,08	mm	relative to centroid C
	i_z	17,71	mm	
Polar radii of gyration	i_p	30,70	mm	
	$i_{p,M}$	30,70	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,04	mm	
Cross-section weight	G	3,77	kg/m	
Cross-section perimeter	U	462,62	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	462,62		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	1130,29	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	616,51		
Torsional constant, Bredt portion.	J_{Bredt}	513,78		
Secondary torsional constant	$I_{t,s}$	136202,24	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,474E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,474E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	7376,72	mm^3	in distance 41.00 mm
	$W_{y,min}$	-7376,72	mm^3	in distance -41.00 mm
	$W_{z,max}$	7351,06	mm^3	in distance 20.50 mm
	$W_{z,min}$	-7351,06	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	141870,08	mm^4	in node 70
	$W_{\omega,M,min}$	-1,419E+05	mm^4	in node 58
Torsional section modulus	W_t	272,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B26: Properties of the cross section of Müpro channels MPR 41/82/2.0 H, Perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	496,65	mm^2	
	A_{geom}	496,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	88,92	mm^2	
	A_z	272,11	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	41,00	mm	
Moments of inertia	I_y	302466,90	mm^4	about centroidal axes y
	I_z	151602,03	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	454068,93	mm^4	
	$I_{p,M}$	454068,93	mm^4	about shear center M
Radii of gyration	i_y	24,68	mm	relative to centroid C
	i_z	17,47	mm	
Polar radii of gyration	i_p	30,24	mm	
	$i_{p,M}$	30,24	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,02	mm	
Cross-section weight	G	3,90	kg/m	
Cross-section perimeter	U	470,62	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	470,62		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	1130,29	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	616,51		
Torsional constant, Bredt portion.	J_{Bredt}	513,78		
Secondary torsional constant	$I_{t,s}$	136201,54	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,474E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,474E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	7377,24	mm^3	in distance 41.00 mm
	$W_{y,min}$	-7377,24	mm^3	in distance -41.00 mm
	$W_{z,max}$	7395,22	mm^3	in distance 20.50 mm
	$W_{z,min}$	-7395,22	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	141870,81	mm^4	in node 60
	$W_{\omega,M,min}$	-1,419E+05	mm^4	in node 48
Torsional section modulus	W_t	272,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B27: Properties of the cross section of Müpro channels MPR 41/82/2.0 H, Non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	548,65	mm^2	
	A_{geom}	548,65	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	89,24	mm^2	
	A_z	272,12	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	41,00	mm	
Moments of inertia	I_y	302536,24	mm^4	about centroidal axes y
	I_z	152334,36	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	454870,59	mm^4	
	$I_{p,M}$	454870,59	mm^4	about shear center M
Radii of gyration	i_y	23,48	mm	relative to centroid C
	i_z	16,66	mm	
Polar radii of gyration	i_p	28,79	mm	
	$i_{p,M}$	28,79	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,00	mm	
Cross-section weight	G	4,31	kg/m	
Cross-section perimeter	U	488,62	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	488,62		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	1137,01	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	623,23		
Torsional constant, Bredt portion.	J_{Bredt}	513,78		
Secondary torsional constant	$I_{t,s}$	136200,95	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,474E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,474E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	7378,93	mm^3	in distance 41.00 mm
	$W_{y,min}$	-7378,93	mm^3	in distance -41.00 mm
	$W_{z,max}$	7430,94	mm^3	in distance 20.50 mm
	$W_{z,min}$	-7430,94	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	141871,47	mm^4	in node 56
	$W_{\omega,M,min}$	-1,419E+05	mm^4	in node 44
Torsional section modulus	W_t	272,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B28: Properties of the cross section of Müpro channels MPR 41/82/2.0 H, Averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	526,21	mm^2	
	A_{geom}	526,21	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	77,66	mm^2	
	A_z	272,10	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	41,00	mm	
Moments of inertia	I_y	302498,02	mm^4	about centroidal axes y
	I_z	151793,93	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	454291,95	mm^4	
	$I_{p,M}$	454291,95	mm^4	about shear center M
Radii of gyration	i_y	23,98	mm	relative to centroid C
	i_z	16,98	mm	
Polar radii of gyration	i_p	29,38	mm	
	$i_{p,M}$	29,38	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,03	mm	
Cross-section weight	G	4,13	kg/m	
Cross-section perimeter	U	525,26	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	489,94		
Cross-section inner perimeter	U_i	35,32		
Torsional constant	J	976,66	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	559,83		
Torsional constant, Bredt portion.	J_{Bredt}	416,83		
Secondary torsional constant	$I_{t,s}$	136278,41	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,476E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,476E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	7378,00	mm^3	in distance 41.00 mm
	$W_{y,min}$	-7378,00	mm^3	in distance -41.00 mm
	$W_{z,max}$	7404,58	mm^3	in distance 20.50 mm
	$W_{z,min}$	-7404,58	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	141969,27	mm^4	in node 62
	$W_{\omega,M,min}$	-1,420E+05	mm^4	in node 50
Torsional section modulus	W_t	182,24	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B29: Properties of the cross section of Müpro channels MPR 41/82/2.5 H, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	589,03	mm^2	
	A_{geom}	589,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	109,97	mm^2	
	A_z	340,00	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	41,00	mm	
Moments of inertia	I_y	364791,97	mm^4	about centroidal axes y
	I_z	181710,92	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	546502,89	mm^4	
	$I_{p,M}$	546502,89	mm^4	about shear center M
Radii of gyration	i_y	24,89	mm	relative to centroid C
	i_z	17,56	mm	
Polar radii of gyration	i_p	30,46	mm	
	$i_{p,M}$	30,46	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	17,59	mm	
Cross-section weight	G	4,62	kg/m	
Cross-section perimeter	U	456,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	456,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2178,91	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1189,18		
Torsional constant, Bredt portion.	J_{Bredt}	989,73		
Secondary torsional constant	$I_{t,s}$	161880,90	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,691E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,691E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	8897,36	mm^3	in distance 41.00 mm
	$W_{y,min}$	-8897,36	mm^3	in distance -41.00 mm
	$W_{z,max}$	8863,95	mm^3	in distance 20.50 mm
	$W_{z,min}$	-8863,95	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	168325,35	mm^4	in node 78
	$W_{\omega,M,min}$	-1,683E+05	mm^4	in node 90
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B30: Properties of the cross section of Müpro channels MPR 41/82/2.5 H, Perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	609,03	mm^2	
	A_{geom}	609,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	110,49	mm^2	
	A_z	340,01	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	41,00	mm	
Moments of inertia	I_y	364833,54	mm^4	about centroidal axes y
	I_z	182842,59	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	547676,13	mm^4	
	$I_{p,M}$	547676,13	mm^4	about shear center M
Radii of gyration	i_y	24,48	mm	relative to centroid C
	i_z	17,33	mm	
Polar radii of gyration	i_p	29,99	mm	
	$i_{p,M}$	29,99	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	17,57	mm	
Cross-section weight	G	4,78	kg/m	
Cross-section perimeter	U	464,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	464,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2178,90	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1189,17		
Torsional constant, Bredt portion.	J_{Bredt}	989,72		
Secondary torsional constant	$I_{t,s}$	161879,53	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,691E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,691E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	8898,38	mm^3	in distance 41.00 mm
	$W_{y,min}$	-8898,38	mm^3	in distance -41.00 mm
	$W_{z,max}$	8919,15	mm^3	in distance 20.50 mm
	$W_{z,min}$	-8919,15	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	168326,70	mm^4	in node 76
	$W_{\omega,M,min}$	-1,683E+05	mm^4	in node 88
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B31: Properties of the cross section of Müpro channels MPR 41/82/2.5 H, Non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	674,03	mm^2	
	A_{geom}	674,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	110,90	mm^2	
	A_z	340,03	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	41,00	mm	
Moments of inertia	I_y	364968,96	mm^4	about centroidal axes y
	I_z	183758,00	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	548726,97	mm^4	
	$I_{p,M}$	548726,97	mm^4	about shear center M
Radii of gyration	i_y	23,27	mm	relative to centroid C
	i_z	16,51	mm	
Polar radii of gyration	i_p	28,53	mm	
	$i_{p,M}$	28,53	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	17,56	mm	
Cross-section weight	G	5,29	kg/m	
Cross-section perimeter	U	480,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	480,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2195,30	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1205,58		
Torsional constant, Bredt portion.	J_{Bredt}	989,72		
Secondary torsional constant	$I_{t,s}$	161878,41	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,691E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,691E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	8901,68	mm^3	in distance 41.00 mm
	$W_{y,min}$	-8901,68	mm^3	in distance -41.00 mm
	$W_{z,max}$	8963,81	mm^3	in distance 20.50 mm
	$W_{z,min}$	-8963,80	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	168327,91	mm^4	in node 68
	$W_{\omega,M,min}$	-1,683E+05	mm^4	in node 84
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B32: Properties of the cross section of Müpro channels MPR 41/82/2.5 H, Averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	645,81	mm^2	
	A_{geom}	645,81	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	96,23	mm^2	
	A_z	339,99	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	41,00	mm	
Moments of inertia	I_y	364893,88	mm^4	about centroidal axes y
	I_z	183078,37	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	547972,26	mm^4	
	$I_{p,M}$	547972,26	mm^4	about shear center M
Radii of gyration	i_y	23,77	mm	relative to centroid C
	i_z	16,84	mm	
Polar radii of gyration	i_p	29,13	mm	
	$i_{p,M}$	29,13	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	17,58	mm	
Cross-section weight	G	5,07	kg/m	
Cross-section perimeter	U	518,31	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	482,65		
Cross-section inner perimeter	U_i	35,66		
Torsional constant	J	1884,96	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1081,28		
Torsional constant, Bredt portion.	J_{Bredt}	803,69		
Secondary torsional constant	$I_{t,s}$	162026,91	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	41,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	1,694E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	1,694E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	8899,85	mm^3	in distance 41.00 mm
	$W_{y,min}$	-8899,85	mm^3	in distance -41.00 mm
	$W_{z,max}$	8930,65	mm^3	in distance 20.50 mm
	$W_{z,min}$	-8930,65	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	168513,19	mm^4	in node 79
	$W_{\omega,M,min}$	-1,685E+05	mm^4	in node 90
Torsional section modulus	W_t	283,90	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B33: Properties of the cross section of Müpro channels MPR 41/124/2.5 H, Perforated area, round hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	799,03	mm^2	
	A_{geom}	799,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	92,50	mm^2	
	A_z	528,27	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	62,00	mm	
Moments of inertia	I_y	1,120E+06	mm^4	about centroidal axes y
	I_z	259638,43	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	1,379E+06	mm^4	
	$I_{p,M}$	1,379E+06	mm^4	about shear center M
Radii of gyration	i_y	37,43	mm	relative to centroid C
	i_z	18,03	mm	
Polar radii of gyration	i_p	41,55	mm	
	$i_{p,M}$	41,55	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,97	mm	
Cross-section weight	G	6,27	kg/m	
Cross-section perimeter	U	624,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	624,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2616,40	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1626,68		
Torsional constant, Bredt portion.	J_{Bredt}	989,72		
Secondary torsional constant	$I_{t,s}$	241187,79	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	4,962E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	4,962E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	18059,12	mm^3	in distance 62.00 mm
	$W_{y,min}$	-18059,12	mm^3	in distance -62.00 mm
	$W_{z,max}$	12665,29	mm^3	in distance 20.50 mm
	$W_{z,min}$	-12665,29	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	319229,22	mm^4	in node 76
	$W_{\omega,M,min}$	-3,192E+05	mm^4	in node 88
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B34: Properties of the cross section of Müpro channels MPR 41/124/2.5 H, Perforated area, oblong hole

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	819,03	mm^2	
	A_{geom}	819,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	92,90	mm^2	
	A_z	528,27	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	62,00	mm	
Moments of inertia	I_y	1,120E+06	mm^4	about centroidal axes y
	I_z	260770,10	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	1,380E+06	mm^4	
	$I_{p,M}$	1,380E+06	mm^4	about shear center M
Radii of gyration	i_y	36,97	mm	relative to centroid C
	i_z	17,84	mm	
Polar radii of gyration	i_p	41,05	mm	
	$i_{p,M}$	41,05	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,96	mm	
Cross-section weight	G	6,43	kg/m	
Cross-section perimeter	U	632,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	632,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2616,40	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1626,67		
Torsional constant, Bredt portion.	J_{Bredt}	989,72		
Secondary torsional constant	$I_{t,s}$	241187,06	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	4,962E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	4,962E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	18059,79	mm^3	in distance 62.00 mm
	$W_{y,min}$	-18059,79	mm^3	in distance -62.00 mm
	$W_{z,max}$	12720,49	mm^3	in distance 20.50 mm
	$W_{z,min}$	-12720,49	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	319230,10	mm^4	in node 76
	$W_{\omega,M,min}$	-3,192E+05	mm^4	in node 88
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B35: Properties of the cross section of Müpro channels MPR 41/124/2.5 H, Non-perforated area

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	884,03	mm^2	
	A_{geom}	884,03	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	93,21	mm^2	
	A_z	528,28	mm^2	
Centroid position	$y_{S,0}$	20,50	mm	relative to zero point
	$z_{S,0}$	62,00	mm	
Moments of inertia	I_y	1,120E+06	mm^4	about centroidal axes y
	I_z	261685,51	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	1,382E+06	mm^4	
	$I_{p,M}$	1,382E+06	mm^4	about shear center M
Radii of gyration	i_y	35,59	mm	relative to centroid C
	i_z	17,21	mm	
Polar radii of gyration	i_p	39,53	mm	
	$i_{p,M}$	39,53	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,95	mm	
Cross-section weight	G	6,94	kg/m	
Cross-section perimeter	U	648,99	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	648,99		
Cross-section inner perimeter	U_i	0,00		
Torsional constant	J	2632,80	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1643,08		
Torsional constant, Bredt portion.	J_{Bredt}	989,72		
Secondary torsional constant	$I_{t,s}$	241186,46	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	4,962E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	4,962E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	18061,97	mm^3	in distance 62.00 mm
	$W_{y,min}$	-18061,97	mm^3	in distance -62.00 mm
	$W_{z,max}$	12765,15	mm^3	in distance 20.50 mm
	$W_{z,min}$	-12765,15	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	319230,89	mm^4	in node 69
	$W_{\omega,M,min}$	-3,192E+05	mm^4	in node 85
Torsional section modulus	W_t	425,00	mm^3	
Reduction factor	λ_M	0,00	1/mm	

Table B36: Properties of the cross section of Müpro channels MPR 41/124/2.5 H, Averaged cross-section

Description	Symbol	Value	Unit	Comment
Cross-sectional area	A	855,81	mm^2	
	A_{geom}	855,81	mm^2	geometric cross-sectional area (not ideal)
Shear areas	A_y	83,06	mm^2	
	A_z	528,26	mm^2	
Centroid position	$y_{s,0}$	20,50	mm	relative to zero point
	$z_{s,0}$	62,00	mm	
Moments of inertia	I_y	1,120E+06	mm^4	about centroidal axes y
	I_z	261005,88	mm^4	
Inclination of principal axes	α	0,00	°	clockwise
Polar moments of inertia	I_p	1,381E+06	mm^4	
	$I_{p,M}$	1,381E+06	mm^4	about shear center M
Radii of gyration	i_y	36,17	mm	relative to centroid C
	i_z	17,46	mm	
Polar radii of gyration	i_p	40,17	mm	
	$i_{p,M}$	40,17	mm	about shear center M
Warping radius of gyration	$i_{\omega,M}$	18,97	mm	
Cross-section weight	G	6,72	kg/m	
Cross-section perimeter	U	686,31	mm	incl. inner side of cells
Cross-section outer perimeter	U_o	650,65		
Cross-section inner perimeter	U_i	35,66		
Torsional constant	J	2322,46	mm^4	calculated analytically
Torsional constant St. Ven.	$J_{St.Ven.}$	1518,78		
Torsional constant, Bredt portion.	J_{Bredt}	803,69		
Secondary torsional constant	$I_{t,s}$	241335,40	mm^4	
Location of the shear center	$y_{M,0}$	20,50	mm	relative to zero point
	$z_{M,0}$	62,00	mm	
	y_M	0,00	mm	relative to centroid C
	z_M	0,00	mm	
Warping constants	$I_{\omega,S}$	4,968E+08	mm^6	relative to centroid C
	$I_{\omega,M}$	4,968E+08	mm^6	about shear center M
Auxiliary value for warp rotation	$r_{\omega,M}$	0,000		
Section moduli	$W_{y,max}$	18060,76	mm^3	in distance 62.00 mm
	$W_{y,min}$	-18060,76	mm^3	in distance -62.00 mm
	$W_{z,max}$	12731,99	mm^3	in distance 20.50 mm
	$W_{z,min}$	-12731,99	mm^3	in distance -20.50 mm
Warping section moduli	$W_{\omega,M,max}$	319477,47	mm^4	in node 76
	$W_{\omega,M,min}$	-3,195E+05	mm^4	in node 88
Torsional section modulus	W_t	283,90	mm^3	
Reduction factor	λ_M	0,00	1/mm	