FAST FORM SYSTEMS LTD

Fast Form Capping Beam System

Structural Stress Design

Fast Form Type C brackets to be used to form an access platform

Fast Form Systems Ltd
Unit 1 Topcat Industrial Estates
Estate Road 8
DN31 2TG
Grimsby

Fast-Form™ systems

'Formwork, shuttering, handrail and access hire'

SAFER / GREENER / MORE EFFICIENT & SUSTAINABLE

CONTENTS:

Calculations report prepared by:

Tomasz Fras (M.Eng)

1. INTRODUCTION:

This report contains the loading calculations and structural analysis of Fast Form Bracket System® designed to be used as a walkway platform.

The basic geometrical requirements including plans and arrangements are defined based on the drawings of Fast Form Bracket System® provided by Fast Form Systems Ltd.

The Fast Form Bracket System® consists of Fast Form Brackets® sizes C fixed to reinforced concrete structure with FBS II 14x100mm concrete bolts.

The structural analysis is conducted with the use of Graitec® Advance Design 2016 structural analysis software which calculates stresses and internal forces of the structure using Finite Element method. The loading combinations and design rules are defined by The Eurocodes.

The results of structural analysis have showed that the Fast Form Bracket System® and all of its components and connection joints are designed to withstand the load acting on the structure during operation time.

2. DESIGN CODES AND REGULATIONS:

BS EN 1990:2002+A1:2005: “Eurocode. Basis of structural design.”

BS EN 1991-1-1:2002: “Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings.”

BS EN 1991-1-4:2005+A1:2010: “Eurocode 1. Actions on structures. General actions. Wind actions.”

BS EN 1993-1-1:2005+A1:2014: “Eurocode 3. Design of steel structures. General rules and rules for buildings.”

BS EN 1993-1-8:2005: “Eurocode 3. Design of steel structures. Design of joints.”

BS 5975:2008+A1:2011: “Code of practice for temporary works procedures and the permissible stress design of falsework.”

Construction (Design and Management) Regulations 2015

3. MATERIALS AND CROSS-SECTIONS:

3.1 STEEL:

The Fast Form Brackets® are made of 5mm thick steel grade S275 with Z275 coating. The steel properties are as follows:

$f_y = 275\ MPa$ $f_u = 430\ MPa$ for thickness less than or equal to 40mm

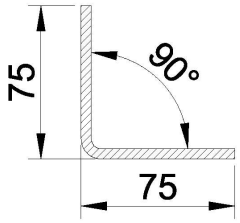
$E = 210\ GPa$

The Fast Form Brackets® horizontal and vertical members are made of L-shaped 75mm x 75mm sections.

Cross section properties:

Area:
$A = 725\ mm^2$

Area moments of inertia:
$I_y = 398278\ mm^4$ $I_z = 398278\ mm^4$ $I_t = 5833\ mm^4$

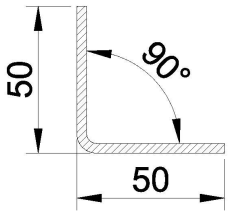


The Fast Form Brackets® diagonal members are made of L-shaped 50mm x 50mm sections.

Cross section properties:

Area:
$A = 475mm^2$

Area moments of inertia:
$I_y = 112503mm^4$ $I_z = 112503mm^4$ $I_t = 3750mm^4$



4. LOADS:

4.1 SELF-WEIGHT:

The self-weight of all the components of the formwork is considered in the calculations of Advance Design 2016. The coefficient used for the calculations for self-weight $\gamma = 1.35$.

4.2 TECHNOLOGICAL LOAD ON PLATFORMS:

Load on the platforms assumed as $Q_k = 0.75 \frac{kN}{m^2}$.

The coefficient used for the calculations for technological load $\gamma = 1.50$.

4.3 Wind Load:

Wind characteristics:

Wind characteristics	
Direction	other
Wind region	23 m/s
Fundamental value of the basic wind velocity	23.0 m/s
Altitude	15000mm
Directional factor	X+:1.00 X-:1.00 Y+:1.00 Y-:1.00
Season factor	1.00
Terrain category	Urban area
Orography factor	1.00
Orography type	Non significant
Basic velocity pressure	0.0000004 kN/mm²
Roughness Factor	1.31
Roughness correction factor	0.97
Turbulence intensity	0.12
Turbulence correction factor	1.11
Exposure factor	3.21
Exposure correction factor	1.00

WIND Uplift check:

wind force applied to falsework

$$F_{uplift} = c_s c_d * c_f * q_p(z) * A_{Ref} * \eta$$

F_uplift	=	51606.36	N	windforce on structure in N
c_s	=	1		size factor — 1.0 for formwork
c_d	=	1		dynamic factor — 1.0 for formwork
c_f	=	2.2		force coefficient — from Table 7.6 of BS EN 1991-1-4 -worst case (2.2)
$q_p(z)$	=	390.96	N/m²	peak velocity pressure in N/m²

$$q_p = c_{prob}^2 * 0.613 * C_{ef} * S_{wind}^2$$

c_{prob}	=	0.83		probability factor for formwork for 2 year return period
C_{ef}	=	1.07		combined exposure factor
S_{wind}	=	29.4147		wind factor

$$S_{wind} = T_{wind} * v_{b,map}(1 + \frac{A_{alt}}{1000})$$

T_{wind}	=	1.26		topographical factor
A_{alt}	=	15	m	altitude of the site (in m above sea level)
$v_{b,map}$	=	23	m/s	fundamental basic wind velocity of the site (in m/s)
A_{Ref}	=	60	m^2	reference area on which the wind acts in m^2
η	=	1		shielding factor, generaly 1.0 for formwork

Customer to provide adequate fixings that can resist 1.07kN/m² of uplift force.

4.4 LOAD CASES (COMBINATIONS):

The calculations are made for a set of combinations generated by the Advance Design 2016 software according to BS EN 1990:2002+A1:2005: “Eurocode. Basics of structural design.” Design checks are done against the most unfavourable set of actions.

Description of combinations:

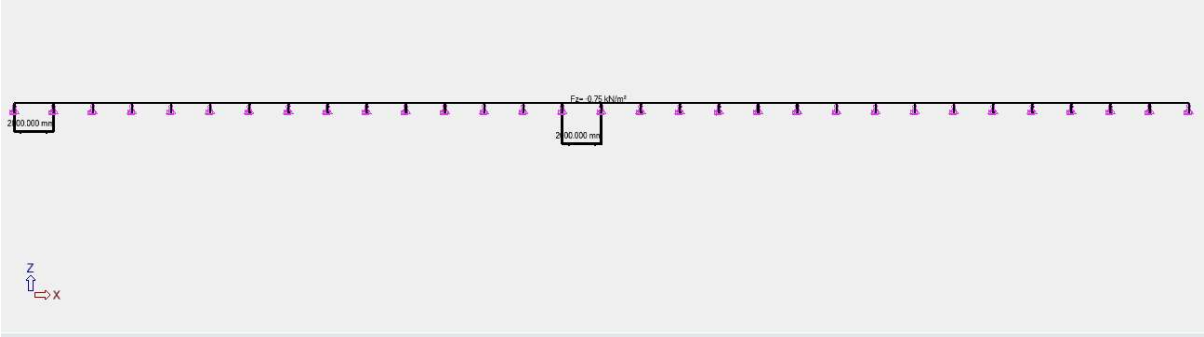
[1 G] – Self Weight of members.
[2 Q] – Technological Load on Platforms.

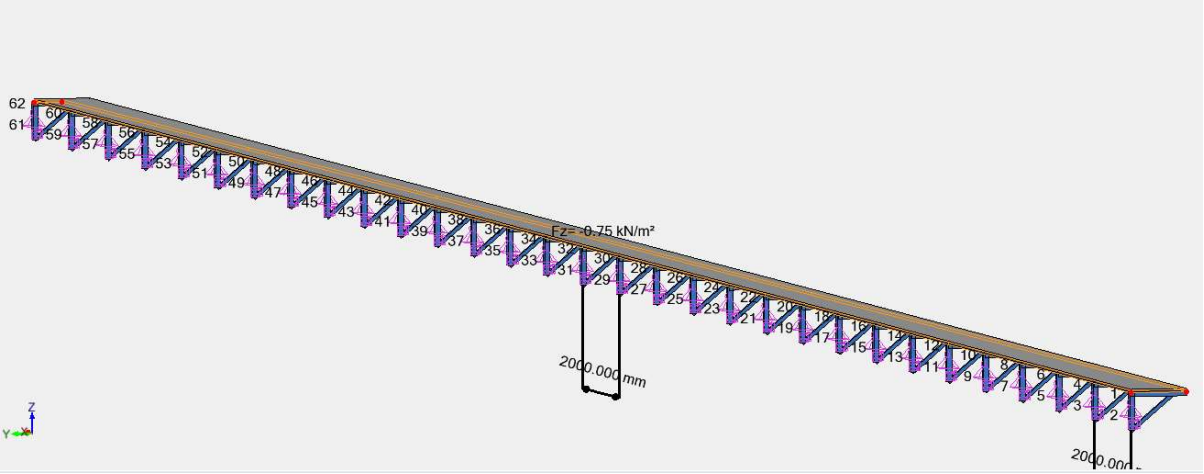
Description of combinations

Description of combinations			
No.	Name	Details	Code
101	1.35x[1 G]	1.35*1	ECULSSTR
102	1.35x[1 G]+1.5x[2 Q]	1.35*1 + 1.50*2	ECULSSTR
103	1x[1 G]	1.00*1	ECSLSC
104	1x[1 G]+1x[2 Q]	1.00*1 + 1.00*2	ECSLSC
105	1x[1 G]	1.00*1	ECSLSQ
106	1x[1 G]+0.3x[2 Q]	1.00*1 + 0.30*2	ECSLSQ

5. DESIGN MODEL:

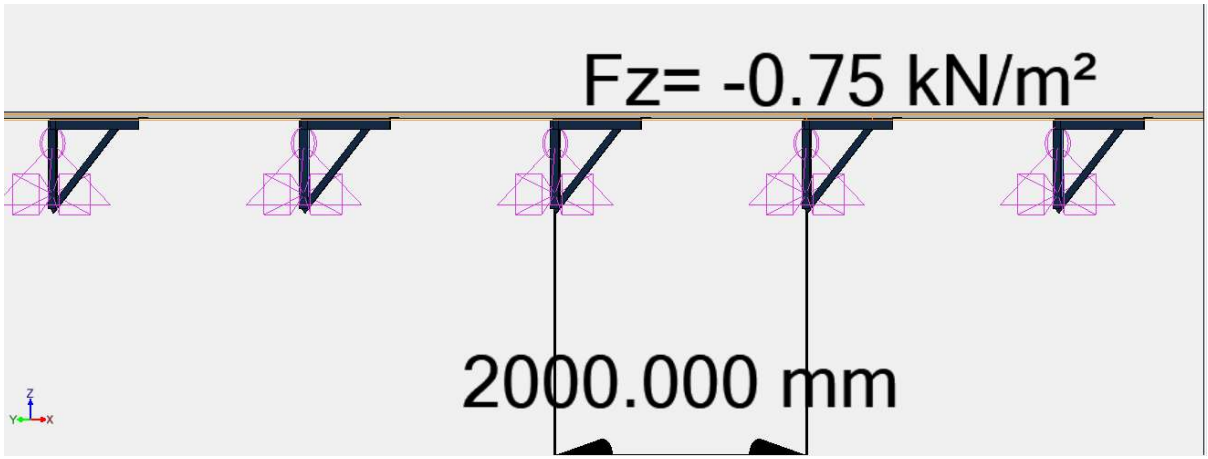
5.1 BASIC MODEL VIEWS:





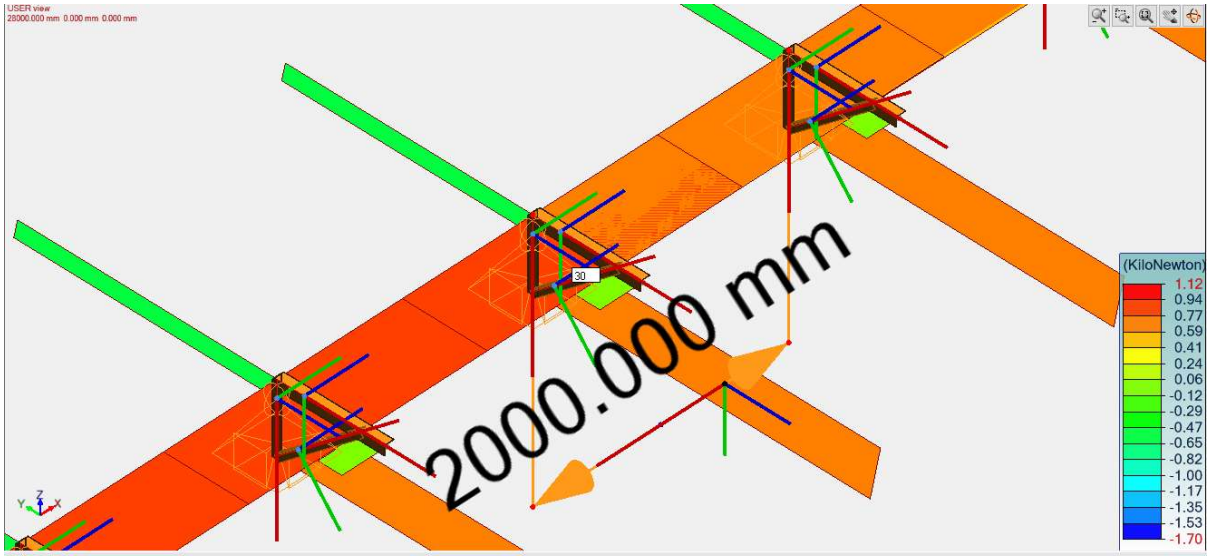
5.2 LOADS:

Units for area loads are $\frac{kN}{m^2}$.

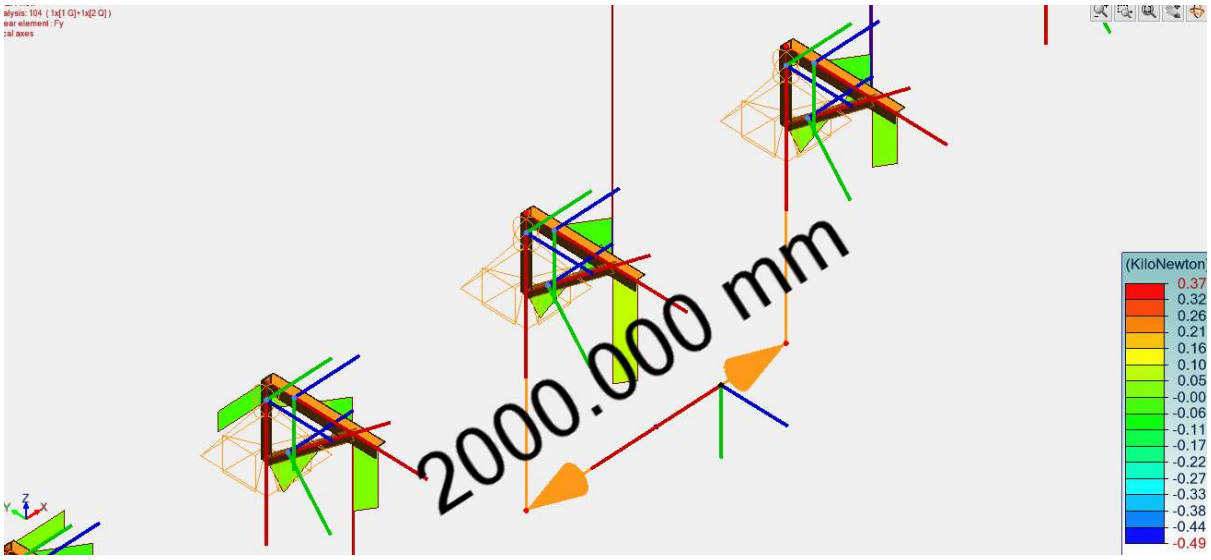


5.3 Internal forces:

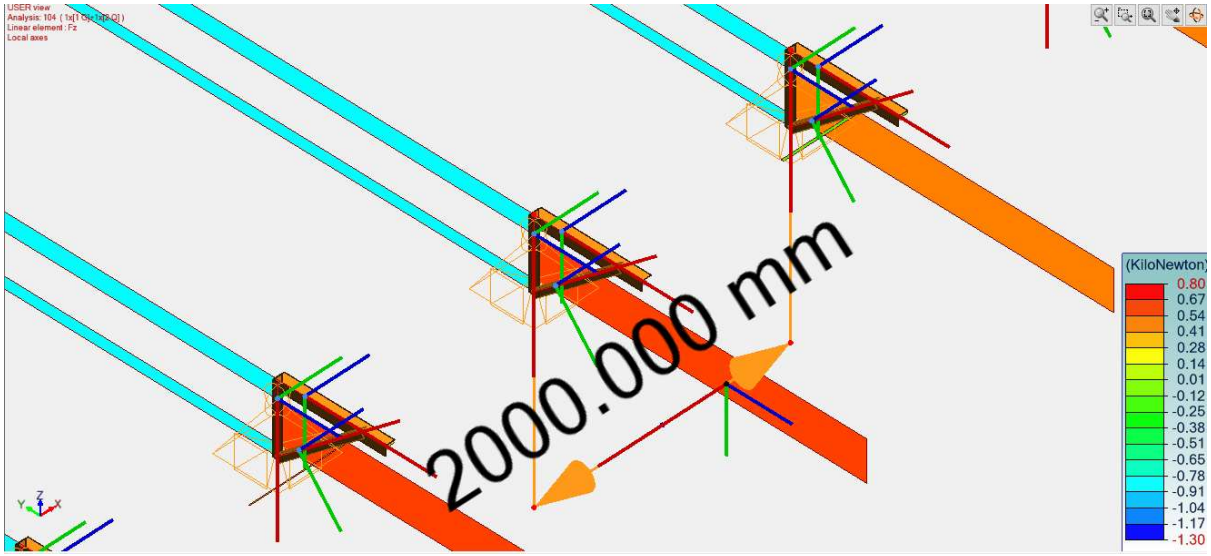
Shear force (x) a long axis x:



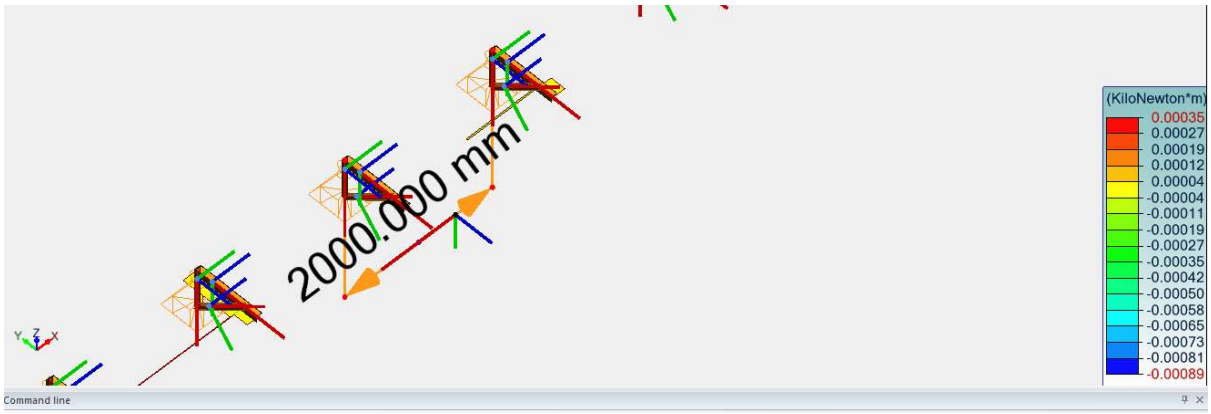
Shear force (y) a long axis y:



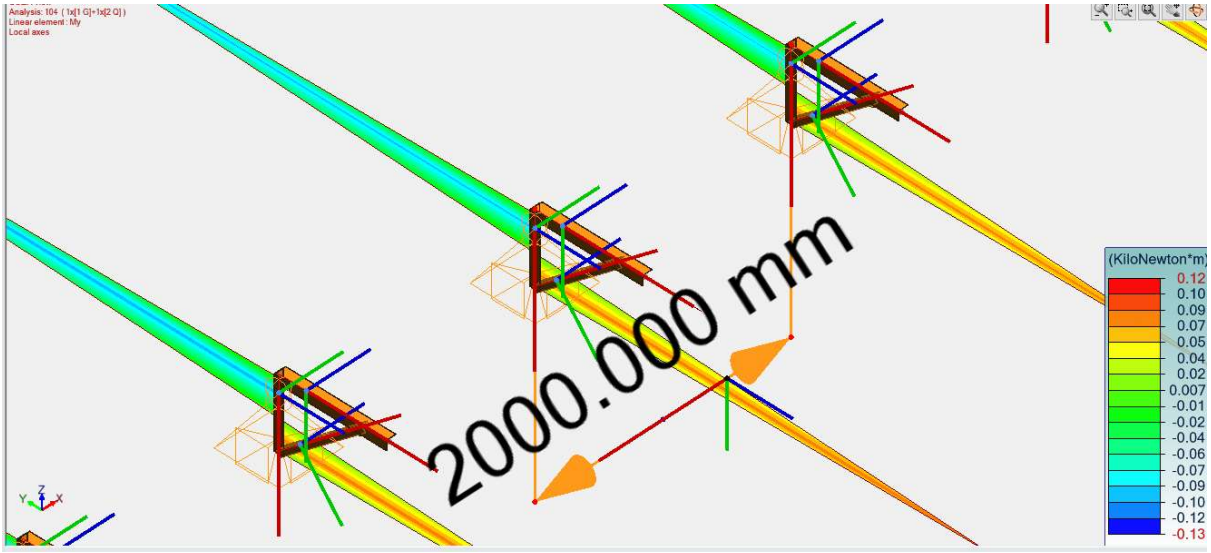
Shear force (z) a long axis z:



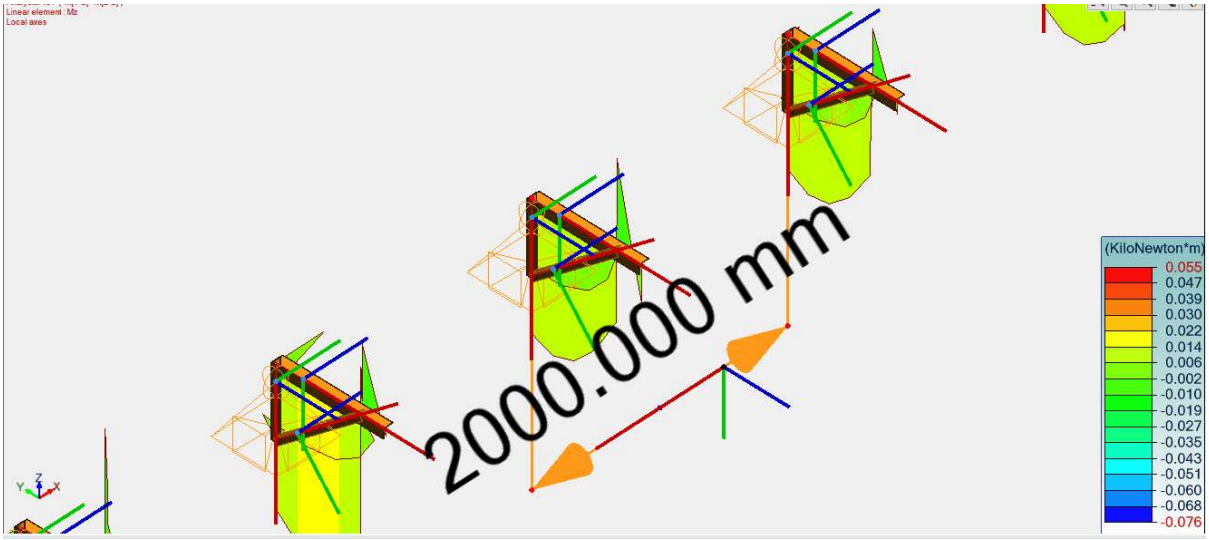
Moment (x) about axis x:



My bending moment about axis y:



Mz bending moment about axis z:



6.0 DESIGN CHECKS:

The Advance Design 2016 software steel shapes design settings are:

- Dimensioning performed according to EC3 (UK NA).
- The calculation was performed in combined bending.
- The calculation was performed by elements.
- The sorting of shape sheets is made with the of work ratio criterion.

The buckling lengths are calculated by η1- η2 method.

6.1. SUPPORT BRACKET 'C':

Vertical member fixed to reinforced concrete structure:

Shape sheet - Linear element No. 5 Linear	
1) Cross section	
Shape	L75*5
Dimensions(mm)	h = 75 t = 5 r = 0 r1 = 0
Cross sections(mm2)	Area = 725 Avy = 312 Avz = 312
Inertia(mm4)	It = 5833.33 Iy = 398278 Iz = 398278
Inertia(mm6)	Iw = 0
Modules(mm3)	Welyinf = 19330.6 Welysup = 7321.74 Welzinf = 19330.6 Welzsup = 7321.74
Material	S275 E = 210000 MPa Nu = 0.3 G = 80800 MPa
Grade	fy = 275.0 MPa fu = 430.0 MPa
2) Section classification	
Class	Cross section : Class 3
3) Deflections	
1st criterion	Case no 104 : 1x[1 G]+1x[2 Q] L/10000 < L/500 (2 %)
4) Cross sections strength	
Tension Compression (6.2.3)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.2 Fx < Npl : 1.64 < 199.38 kN (1 %)
Shear in y direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.1 Fy < Vply : 0.36 < 49.62 kN (1 %)
Shear in z direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.3 Fz < Vplz : 1.92 < 49.62 kN (4 %)
Bending /yy (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.1 MyEd < MyRk : 0.19 < 2.01 kN*m (10 %)
Bending /zz (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.1 MzEd < MzRk : 0.03 < 2.01 kN*m (2 %)
Oblique bending (6.2.9.2)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.1

Shape sheet - Linear element No. 5 Linear	
	$\frac{S_{x,Ed}}{\frac{f_y}{\gamma_{M0}}} < 1$ (6.42) : 0.11050 < 1 (11 %)
Torsion (6.2.7)	Case no -, Mesh No. -, $Mx < Wt \bullet \frac{\frac{Fy}{\sqrt{3}}}{\gamma_{M0}}$: not done (-)
5) Elements stability	
Unfavorable case	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 5.2 0/4
Buckling /yy (6.3.1)	Lfz = 1091.485 mm λ_y = 0.536 Curve b α_y = 0.34 Φ_y = 0.70 χ_y = 1.000 Ncry = 692.90 kN
Buckling /zz (6.3.1)	Lfy = 540.000 mm λ_z = 0.265 Curve b α_z = 0.34 Φ_z = 0.55 χ_z = 1.000 Ncrz = 2830.85 kN
Lateral-torsional buckling (6.3.2.1)	not done (-)
Auxiliary terms (Annex A)	C_{my0} = 1.00 (| δ_x | = 0 mm at x = 140.000 mm) C_{mz0} = 1.00 (| δ_x | = 0 mm at x = 217.500 mm) NcrT = 0.00 kN λ_{max} = 0.54 λ_0 = 0.00 $\lambda_{0limite}$ = ∞ C_{my} = 1.00 C_{mz} = 1.00 C_{mLT} = 1.00 a_{LT} = 0.99 ε_y = 1.00 m_{uy} = 1.00 m_{uz} = 1.00 w_y = 1.50 w_z = 1.50 n_{pl} = 0.00
Interaction coefficients (Annex A)	kyy = 1.00 kyz = 1.00 kzy = 1.00 kzz = 1.00
Verification (6.61)	$\frac{N_{Ed}}{\chi_y \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{yy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{yz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \le 1.00$ 0.01 + 0.10 + 0.01 = 0.11 < 1.00 (11%)
Verification (6.62)	$\frac{N_{Ed}}{\chi_z \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{zy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{zz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \le 1.00$ 0.01 + 0.10 + 0.01 = 0.11 < 1.00 (11%)

Horizontal member supporting steel tubes and scaffold boards:

Shape sheet - Linear element No. 6 Linear	
1) Cross section	
Shape	L75*5
Dimensions(mm)	h = 75 t = 5 r = 0 r1 = 0
Cross sections(mm2)	Area = 725 Avy = 312 Avz = 312
Inertia(mm4)	It = 5833.33 Iy = 398278 Iz = 398278
Inertia(mm6)	Iw = 0
Modules(mm3)	Welyinf = 19330.6 Welysup = 7321.74 Welzinf = 19330.6 Welzsup = 7321.74
Material	S275 E = 210000 MPa Nu = 0.3 G = 80800 MPa
Grade	fy = 275.0 MPa fu = 430.0 MPa

Shape sheet - Linear element No. 6 Linear	
2) Section classification	
Class	Cross section : Class 3
3) Deflections	
1st criterion	Case no 104 : 1x[1 G]+1x[2 Q] L/7562 < L/500 (7 %)
4) Cross sections strength	
Tension Compression (6.2.3)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.1 Fx < Npl : 1.47 < 199.38 kN (1 %)
Shear in y direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.2 Fy < Vply : 0.19 < 49.62 kN (0 %)
Shear in z direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.3 Fz < Vplz : 0.16 < 49.62 kN (0 %)
Bending /yy (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.2 MyEd < MyRk : 0.004 < 2.01 kN*m (0 %)
Bending /zz (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.2 MzEd < MzRk : 0.03 < 2.01 kN*m (2 %)
Oblique bending (6.2.9.2)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.1 $\frac{S_{x,Ed}}{\frac{f_y}{\gamma_{M0}}} < 1$ (6.42) : 0.01860 < 1 (2 %)
Torsion (6.2.7)	Case no -, Mesh No. -, $Mx < Wt \bullet \frac{\frac{Fy}{\sqrt{3}}}{\gamma_{M0}}$: not done (-)
5) Elements stability	
Unfavorable case	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 6.2 0/4
Buckling /yy (6.3.1)	Lfz = 8342.694 mm λ_y = 4.100 Curve b α_y = 0.34 Φ_y = 9.57 χ_y = 0.055 Ncry = 11.86 kN
Buckling /zz (6.3.1)	Lfy = 1735.245 mm λ_z = 0.853 Curve b α_z = 0.34 Φ_z = 0.97 χ_z = 0.691 Ncrz = 274.15 kN
Lateral-torsional buckling (6.3.2.1)	not done (-)
Auxiliary terms (Annex A)	C_{my0} = 1.00 C_{mz0} = 1.00 ($\lvert \delta_x \rvert$ = 0 mm at x = 325.000 mm) NcrT = 0.00 kN λ_{max} = 4.10 λ_0 = 0.00 $\lambda_{0limite}$ = ∞ C_{my} = 1.00 C_{mz} = 1.00 C_{mLT} = 1.00 a_{LT} = 0.99 ε_y = 0.35 m_{uy} = 0.97 m_{uz} = 1.00 w_y = 1.50 w_z = 1.50 n_{pl} = 0.00
Interaction coefficients (Annex A)	kyy = 1.00 kyz = 0.97 kzy = 1.04 kzz = 1.00
Verification (6.61)	$\frac{N_{Ed}}{\chi_y \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{yy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{yz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \leq 1.00$ 0.04 + 0.00 + 0.02 = 0.06 < 1.00 (6%)

Shape sheet - Linear element No. 6 Linear	
Verification (6.62)	$\frac{N_{Ed}}{\chi_z \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{zy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{zz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \leq 1.00$ 0.00 + 0.00 + 0.02 = 0.02 < 1.00 (2%)

Diagonal member check:

Shape sheet - Linear element No. 4 Linear	
1) Cross section	
Shape	L50*5
Dimensions(mm)	h = 50 t = 5 r = 0 r1 = 0
Cross sections(mm2)	Area = 475 Avy = 208 Avz = 208
Inertia(mm4)	It = 3750 Iy = 112503 Iz = 112503
Inertia(mm6)	Iw = 0
Modules(mm3)	Welyinf = 7844.23 Welysup = 3155.06 Welzinf = 7844.23 Welzsup = 3155.06
Material	S275 E = 210000 MPa Nu = 0.3 G = 80800 MPa
Grade	fy = 275.0 MPa fu = 430.0 MPa
2) Section classification	
Class	Cross section : Class 3
3) Deflections	
1st criterion	Case no 104 : 1x[1 G]+1x[2 Q] L/9977 < L/500 (5 %)
4) Cross sections strength	
Tension Compression (6.2.4)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 Fx < Npl : 2.51 < 130.63 kN (2 %)
Shear in y direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 Fy < Vply : 0.02 < 33.08 kN (0 %)
Shear in z direction (6.2.6)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 Fz < Vplz : 0.01 < 33.08 kN (0 %)
Bending /yy (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 MyEd < MyRk : 0.008 < 0.87 kN*m (1 %)
Bending /zz (6.2.5)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 MzEd < MzRk : 0.004 < 0.87 kN*m (0 %)
Oblique bending (6.2.9.2)	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 $\frac{S_{x,Ed}}{\frac{f_y}{\gamma_{M0}}}$ < 1 (6.42) : 0.02292 < 1 (2 %)
Torsion (6.2.7)	Case no -, Mesh No. -, $Mx < Wt \bullet \frac{\frac{Fy}{\sqrt{3}}}{\gamma_{M0}}$: not done (-)

Shape sheet - Linear element No. 4 Linear	
5) Elements stability	
Unfavorable case	Case no 102 : 1.35x[1 G]+1.5x[2 Q], Mesh No. 4.1 3/4
Buckling /yy (6.3.1)	Lfz = 2181.894 mm λ_y = 1.633 Curve b α_y = 0.34 Φ_y = 2.08 χ_y = 0.298 Ncry = 48.98 kN
Buckling /zz (6.3.1)	Lfy = 1010.592 mm λ_z = 0.756 Curve b α_z = 0.34 Φ_z = 0.88 χ_z = 0.751 Ncrz = 228.31 kN
Lateral-torsional buckling (6.3.2.1)	not done (-)
Auxiliary terms (Annex A)	C_{my0} = 0.78 C_{mz0} = 1.00 ($\lvert \delta_x \rvert$ = 0 mm at x = 422.522 mm) NcrT = 0.00 kN λ_{max} = 1.63 λ_0 = 0.00 $\lambda_{0limite}$ = ∞ C_{my} = 0.78 C_{mz} = 1.00 C_{mLT} = 1.00 a_{LT} = 0.97 ε_y = 0.14 m_{uy} = 0.96 m_{uz} = 1.00 w_y = 1.50 w_z = 1.50 n_{pl} = 0.02
Interaction coefficients (Annex A)	kyy = 0.79 kyz = 0.97 kzy = 0.82 kzz = 1.01
Verification (6.61)	$\frac{N_{Ed}}{\chi_y \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{yy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{yz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \le 1.00$ 0.06 + 0.01 + 0.00 = 0.07 < 1.00 (7%)
Verification (6.62)	$\frac{N_{Ed}}{\chi_z \bullet \frac{N_{Rk}}{\gamma_{M1}}} + k_{zy} \bullet \frac{M_{y,Ed} + \Delta M_{y,Ed}}{\chi_{LT} \bullet \frac{M_{y,Rk}}{\gamma_{M1}}} + k_{zz} \bullet \frac{M_{z,Ed} + \Delta M_{z,Ed}}{\frac{M_{z,Rk}}{\gamma_{M1}}} \le 1.00$ 0.03 + 0.01 + 0.00 = 0.03 < 1.00 (3%)

6.4. Concrete bolts check:

Bolts used are FBS II 14x100 35/15/- US

Concrete screw ULTRACUT FBS II 8-14

fischer innovative solutions

High performance steel anchors

LOADS

Concrete screw ULTRACUT FBS II

Highest permissible loads for a single anchor[1] in concrete C20/25[4]

For the design the complete assessment ETA-15/0352 has to be considered.

				Cracked concrete				Non-cracked concrete			
Type	Embedment depth h_{nom} [mm]	Min. member thickness h_{min} [mm]	Installation torque $T_{inst,max}$[5] [Nm]	Permissible tensile load N_{perm}[2] [kN]	Permissible shear load V_{perm}[2] [kN]	Min. spacing s_{min}[2] [mm]	Min. edge distance c_{min}[2] [mm]	Permissible tensile load N_{perm}[2] [kN]	Permissible shear load V_{perm}[2] [kN]	Min. spacing s_{min}[2] [mm]	Min. edge distance c_{min}[2] [mm]
FBS II 8	50	100	≤ 600	2,9	4,2	35	35	5,9	5,9	35	35
	65	120		5,7	9,0	35	35	9,0	9,0	35	35
FBS II 10	55	100	≤ 650	4,3	4,8	40	40	6,8	6,8	40	40
	65	120		5,7	12,5	40	40	8,8	14,0	40	40
	85	140		9,6	16,6	40	40	13,5	16,6	40	40
FBS II 12	60	110		5,5	11,0	50	50	7,7	15,2	50	50
	75	130		8,0	15,2	50	50	11,2	15,2	50	50
	100	150		12,5	20,3	50	50	17,5	20,3	50	50
FBS II 14	65	120		6,1	12,1	60	60	8,5	17,0	60	60
	85	140		9,4	18,8	60	60	13,2	22,1	60	60
	115	180		15,4	29,4	60	60	21,6	29,4	60	60

1) The partial safety factors for material resistance as regulated in the assessment as well as a partial safety factor for load actions of γ_L = 1,4 are considered. As an single anchor counts e.g. an anchor with a spacing $s \geq 3 \times h_{ef}$ and an edge distance $c \geq 1,5 \times h_{ef}$.

2) Minimum possible axial spacings resp. edge distance while reducing the permissible load.

3) For combinations of tensile loads, shear loads, bending moments as well as reduced edge distances or spacings (anchor groups) see assessment.

4) For higher concrete strength classes up to C50/60 higher permissible loads may be possible.

5) Maximum allowable torque moment for installation with any tangential impact screw driver.

LOADS

Concrete screw ULTRACUT FBS II

Highest recommended loads [1) 2)] for each fixing point [4) 5) 6) 7)] in solid brick masonry.

Base material	Compressive strength class [N/mm²]	Type		FBS II 8	FBS II 10
		h_{nom}	[mm]	65	85
Solid clay brick (EN771-1), 240x113x115 mm	≥ 12	F_{empf} [3)]	[kN]	1,1	1,4
	≥ 20	F_{empf} [3), 8)]	[kN]	1,6	1,6
Solid sand-lime brick (EN771-2), ≥ 240x71x115 mm	≥ 12	F_{empf} [3), 8)]	[kN]	1,2	1,2
	≥ 20	F_{empf} [3), 8)]	[kN]	1,2	1,2
Aerated concrete (EN771-4), ≥ 499x100x100 mm	≥ 6	F_{empf} [3)]	[kN]	0,7	0,9
Minimum spacing within anchor groups of 2 or 4 anchors		s_{min}	[mm]	80	
Minimum distance to the horizontal joint		$c_{min,v}$	[mm]	20	
Minimum distance to the vertical joint		$c_{min,h}$	[mm]	40	
Minimum distance to the free edge		$c_{min,free}$	[mm]	200	

1) An appropriate safety factor is considered.

2) The given loads apply to the given brick measures. For bigger sizes higher recommended loads may be possible. In this case please contact our technical department for further advice.

3) Valid for tensile load, shear load and oblique load under any angle.

4) On - site screw testing is recommended to validate technical data. If the joints are not visible 100% anchor testing is recommended due to the screws are only working in the bricks and not in the mortar joints.

5) The given data are valid for multiple fixings of non-structural applications.

6) A fixing point can be a single anchor, 2 anchors or 4 anchors with a minimum spacing s_{min}. Anchor groups of 4 anchors are arranged in rectangular disposition.

7) The fixing points have to be arranged in this way that there will be always maximum one fixing point arranged in one brick.

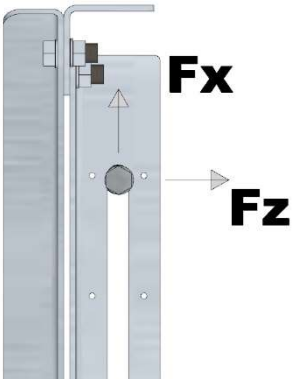
8) Brick pull-out is decisive

Forces acting on the bolts:

Point supports

Reactions on point supports by load case (global coordinate system)							
Load case	No	FX(kN)	FY(kN)	FZ(kN)	MX(kN*m)	MY(kN*m)	MZ(kN*m)
102	1(R)	0.37	1.52	1.16	0.00	0.00	0.00
	2(R)	0.23	-1.48	0.00	0.00	0.00	0.00
	3(R)	0.05	-3.10	0.00	0.00	0.00	0.00
	4(R)	-0.43	2.97	2.38	0.00	0.00	0.00
	5(R)	0.03	-2.95	0.00	0.00	0.00	0.00
	6(R)	-0.06	3.02	2.26	0.00	0.00	0.00
	7(R)	0.01	-2.86	0.00	0.00	0.00	0.00
	8(R)	-0.06	2.88	2.24	0.00	0.00	0.00
	9(R)	0.01	-2.76	0.00	0.00	0.00	0.00
	10(R)	-0.05	2.76	2.21	0.00	0.00	0.00
	11(R)	0.01	-2.68	0.00	0.00	0.00	0.00
	12(R)	-0.04	2.68	2.17	0.00	0.00	0.00
	13(R)	0.00	-2.60	0.00	0.00	0.00	0.00
	14(R)	-0.03	2.60	2.14	0.00	0.00	0.00
	15(R)	0.00	-2.53	0.00	0.00	0.00	0.00
	16(R)	-0.03	2.53	2.11	0.00	0.00	0.00
	17(R)	0.00	-2.45	0.00	0.00	0.00	0.00
	18(R)	-0.01	2.44	2.08	0.00	0.00	0.00
	19(R)	0.00	-2.38	0.00	0.00	0.00	0.00
	20(R)	-0.01	2.38	2.05	0.00	0.00	0.00
	21(R)	0.00	-2.30	0.00	0.00	0.00	0.00
	22(R)	0.01	2.29	2.02	0.00	0.00	0.00
	23(R)	0.00	-2.25	0.00	0.00	0.00	0.00
	24(R)	0.01	2.26	1.98	0.00	0.00	0.00
	25(R)	0.00	-2.20	0.00	0.00	0.00	0.00
	26(R)	0.05	2.19	1.95	0.00	0.00	0.00
	27(R)	0.00	-2.07	0.00	0.00	0.00	0.00
	28(R)	-0.04	2.08	1.93	0.00	0.00	0.00
	29(R)	0.00	-2.04	0.00	0.00	0.00	0.00
	30(R)	0.01	2.05	1.88	0.00	0.00	0.00
	31(R)	0.00	-1.97	0.00	0.00	0.00	0.00
	32(R)	0.00	1.96	1.86	0.00	0.00	0.00
	33(R)	0.00	-1.91	0.00	0.00	0.00	0.00
	34(R)	0.00	1.90	1.83	0.00	0.00	0.00
	35(R)	0.00	-1.85	0.00	0.00	0.00	0.00
	36(R)	0.00	1.84	1.80	0.00	0.00	0.00
	37(R)	-0.01	-1.78	0.00	0.00	0.00	0.00
	38(R)	0.01	1.78	1.76	0.00	0.00	0.00
	39(R)	-0.01	-1.73	0.00	0.00	0.00	0.00
	40(R)	0.01	1.73	1.73	0.00	0.00	0.00
	41(R)	-0.01	-1.67	0.00	0.00	0.00	0.00
	42(R)	0.01	1.67	1.70	0.00	0.00	0.00
	43(R)	-0.01	-1.61	0.00	0.00	0.00	0.00
	44(R)	0.01	1.61	1.67	0.00	0.00	0.00
	45(R)	-0.01	-1.56	0.00	0.00	0.00	0.00
	46(R)	0.02	1.56	1.64	0.00	0.00	0.00
	47(R)	-0.01	-1.50	0.00	0.00	0.00	0.00
	48(R)	0.02	1.50	1.61	0.00	0.00	0.00
	49(R)	-0.01	-1.45	0.00	0.00	0.00	0.00
	50(R)	0.03	1.45	1.58	0.00	0.00	0.00
	51(R)	-0.02	-1.40	0.00	0.00	0.00	0.00
	52(R)	0.04	1.40	1.54	0.00	0.00	0.00
	53(R)	-0.02	-1.35	0.00	0.00	0.00	0.00
	54(R)	0.05	1.35	1.51	0.00	0.00	0.00
	55(R)	-0.02	-1.31	0.00	0.00	0.00	0.00
	56(R)	0.07	1.31	1.48	0.00	0.00	0.00
	57(R)	-0.03	-1.27	0.00	0.00	0.00	0.00
	58(R)	0.08	1.30	1.45	0.00	0.00	0.00
	59(R)	-0.05	-1.26	0.00	0.00	0.00	0.00
	60(R)	0.25	1.23	1.45	0.00	0.00	0.00
	61(R)	-0.13	-0.60	0.00	0.00	0.00	0.00
	62(R)	-0.28	0.60	0.74	0.00	0.00	0.00

The maximum forces acting on the bolts are:



Shear:

$F_x = 0.43\ kN$ $F_z = 2.38\ kN$

Tension:

$F_y = 2.97\ kN$

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Design Office
Fast Form Systems
Tomasz Fras
Unit 1 Omega Business Park,
Estate Road 6,
Grimsby,
North East Lincolnshire,
DN31 2TG
Phone: 01472 488230
info@fastformsystems.com

fischer fixings UK Ltd

Whitely Road; Hithercroft Industrial Estate
Wallingford; Oxfordshire; OX10 9AT
Phone: 44-(0)-1491 827900
Fax: 44-(0)- 1491 827953
technical@fischer.co.uk
www.fischer.co.uk

Design Specifications

Anchor

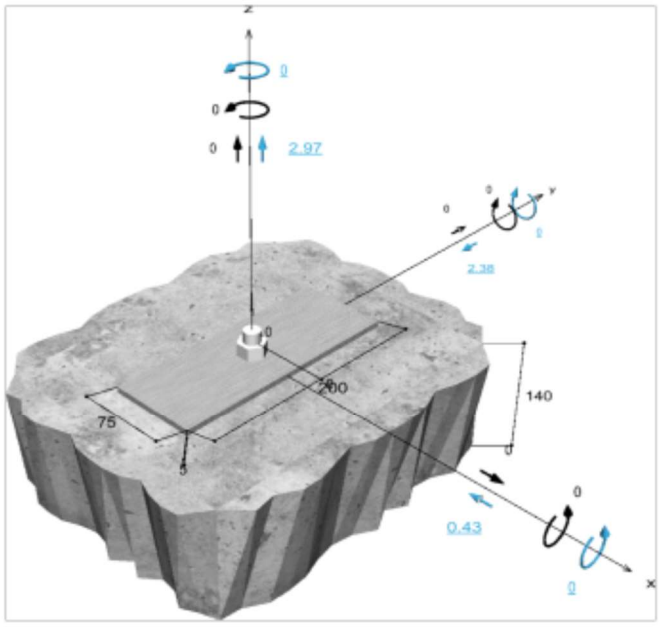
Anchor system	fischer Concrete screw ULTRACUT FBS II
Anchor	Concrete screw with hexagon head and washer FBS II 14x95 30/10/- US, zinc plated steel
Anchorage depth	67 mm
Design Data	Anchor design in Concrete according European Technical Assessment ETA-15/0352, Option 1, Issued 30/10/2018

Geometry / Loads / Scale units

mm, kN, kNm

Permanent actions: G = black, γ = 1.35

Variable actions: Q = blue, γ = 1.5



Not drawn to scale

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Input data

Design method	ETAG 001, Annex C, Method A
Base material	Normal weight concrete, C20/25, EN 206
Concrete condition	Cracked, dry hole
Reinforcement	No or standard reinforcement. No edge reinforcement. With reinforcement against splitting
Drilling method	hammer drilling
Installation type	Push-through installation
Annular gap	Annular gap not filled
Type of loading	Static or quasi-static
Base plate location	Base plate flush installed on base material
Base plate geometry	75 mm x 200 mm x 5 mm
Profile type	None

Actions

Action	Dead Load	Live Load	Action	Case 1 $1.35 \cdot G + 1.5 \cdot Q$	Case 2 $1 \cdot G + 1.5 \cdot Q$
N_{Sk} kN	0.00	2.97	N_{Sd} kN	**4.46**	4.46
$V_{Sk,x}$ kN	0.00	-0.43	$V_{Sd,x}$ kN	**-0.65**	-0.65
$V_{Sk,y}$ kN	0.00	-2.38	$V_{Sd,y}$ kN	**-3.57**	-3.57
$M_{Sk,x}$ kNm	0.00	0.00	$M_{Sd,x}$ kNm	**0.00**	0.00
$M_{Sk,y}$ kNm	0.00	0.00	$M_{Sd,y}$ kNm	**0.00**	0.00
$M_{T,Sk}$ kNm	0.00	0.00	$M_{T,Sd}$ kNm	**0.00**	0.00

Decisive case 1

Resulting anchor forces for load case 1

Anchor no.	Tensile action kN	Shear Action kN	Shear Action x kN	Shear Action y kN
1	4.46	3.63	-0.65	-3.57

max. concrete compressive strain :	0.00 ‰
max. concrete compressive stress :	0.0 N/mm²
Resulting tensile actions :	4.46 kN , X/Y position (0 / 0)
Resulting compression actions :	0.00 kN , X/Y position (0 / 0)

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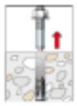
Resistance to tension loads

Proof	Action kN	Capacity kN	Utilisation β_N %
Steel failure *	4.46	73.57	6.1
Concrete cone failure	4.46	13.16	33.8

* Most unfavourable anchor

Steel failure

$$N_{Sd} \leq \frac{N_{Rk,s}}{\gamma_{Ms}} \quad (N_{Rd,s})$$



$N_{Rk,s}$ kN	γ_{Ms}	$N_{Rd,s}$ kN	N_{Sd} kN	$\beta_{N,s}$ %
103.00	1.40	73.57	4.46	6.1

Anchor no.	$\beta_{N,s}$ %	Group N°	Decisive Beta
1	6.1	1	$\beta_{N,s;1}$

Concrete cone failure

$$N_{Sd} \leq \frac{N_{Rk,c}}{\gamma_{Mc}} \quad (N_{Rd,c})$$

$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot \Psi_{ec,N} \qquad \text{Eq. (5.2)}$$

$$N_{Rk,c} = 19.74kN \cdot \frac{40{,}401mm^2}{40{,}401mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 = 19.74kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck,cube}} \cdot h_{ef}^{1.5} = 7.2 \cdot \sqrt{25.0N/mm^2} \cdot \left(67mm\right)^{1.5} = 19.74kN \qquad \text{Eq. (5.2a)}$$

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{101mm}\right) = 1.000 \leq 1 \qquad \text{Eq. (5.2c)}$$

$$\Psi_{re,N} = 1.000 \qquad \text{Eq. (5.2d)}$$

$$\Psi_{ec,N} = \frac{1}{1 + \frac{2e_N}{s_{cr,N}}} \Rightarrow \Psi_{ec,Nz} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1 \qquad \text{Eq. (5.2e)}$$

$$\Psi_{ec,Nz} = \frac{1}{1 + \frac{2 \cdot 0mm}{201mm}} = 1.000 \leq 1 \qquad \Psi_{ec,Ny} = \frac{1}{1 + \frac{2 \cdot 0mm}{201mm}} = 1.000 \leq 1$$

$N_{Rk,c}$ kN	γ_{Mc}	$N_{Rd,c}$ kN	N_{Sd} kN	$\beta_{N,c}$ %
19.74	1.50	13.16	4.46	33.8

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Anchor no.	$\beta_{N,c}$ %	Group N°	Decisive Beta
1	33.8	1	$\beta_{N,c;1}$

Resistance to shear loads

Proof	Action kN	Capacity kN	Utilisation β_V %
Steel failure without lever arm *	3.63	31.00	11.7
Concrete pry-out failure	3.63	26.32	**13.8**

* Most unfavourable anchor

Steel failure without lever arm

$$V_{Sd} \leq \frac{V_{Rk,s}}{\gamma_{Ms}} \quad (V_{Rd,s})$$

$V_{Rk,s}$ kN	γ_{Ms}	$V_{Rd,s}$ kN	V_{Sd} kN	β_{Vs} %
46.50	1.50	31.00	3.63	11.7

Anchor no.	β_{Vs} %	Group N°	Decisive Beta
1	11.7	1	$\beta_{Vs;1}$

Concrete pry-out failure

$$V_{Sd} \leq \frac{V_{Rk,cp}}{\gamma_{Mcp}} \quad (V_{Rd,cp})$$

$$V_{Rk,cp} = k \cdot N_{Rk,c} = 2 \cdot 19.74kN = 39.49kN$$ Eq. (5.6)

$$N_{Rk,c} = N^0_{Rk,c} \cdot \frac{A_{c,N}}{A^0_{c,N}} \cdot \Psi_{s,N} \cdot \Psi_{re,N} \cdot \Psi_{ec,N}$$ Eq. (5.2)

$$N_{Rk,c} = 19.74kN \cdot \frac{40{,}401mm^2}{40{,}401mm^2} \cdot 1.000 \cdot 1.000 \cdot 1.000 = 19.74kN$$

$$N^0_{Rk,c} = k_1 \cdot \sqrt{f_{ck,cube}} \cdot h_{ef}^{1.5} = 7.2 \cdot \sqrt{25.0N/mm^2} \cdot \left(67mm\right)^{1.5} = 19.74kN$$ Eq. (5.2a)

$$\Psi_{s,N} = min\left(1;\ 0.7 + 0.3 \cdot \frac{c}{c_{cr,N}}\right) = min\left(1;\ 0.7 + 0.3 \cdot \frac{\infty}{101mm}\right) = 1.000 \leq 1$$ Eq. (5.2c)

$$\Psi_{re,N} = 1.000$$ Eq. (5.2d)

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$$\Psi_{ec,N} = \frac{1}{1+\frac{2e_N}{s_{cr,N}}} \Rightarrow \Psi_{ec,Nz} \cdot \Psi_{ec,Ny} = 1.000 \cdot 1.000 = 1.000 \leq 1$$ Eq. (5.2e)

$V_{Rk,cp}$ kN	γ_{Mc}	$V_{Rd,cp}$ kN	V_{Sd} kN	$\beta_{V,cp}$ %
39.49	1.50	26.32	3.63	13.8

Anchor no.	$\beta_{V,cp}$ %	Group N°	Decisive Beta
1	13.8	1	$\beta_{V,cp;1}$

Utilization of tension and shear loads

Tension loads	Utilisation βN %	Shear Loads	Utilisation βV %
Steel failure *	6.1	Steel failure without lever arm *	11.7
Concrete cone failure	33.8	Concrete pry-out failure	13.8

* Most unfavourable anchor

Resistance to combined tensile and shear loads

$$\beta_N = \beta_{N,c1} = 0.34 \leq 1$$ Eq. (5.8a)
$$\beta_V = \beta_{V,cp;1} = 0.14 \leq 1$$ Eq. (5.8b)
$$\beta_N^{1.5} + \beta_V^{1.5} = \beta_{N,c1}^{1.5} + \beta_{V,cp1}^{1.5} = 0.25 \leq 1$$ Eq. (5.9)

Proof successful

Information concerning the anchor plate

Base plate details

Plate thickness specified by user without proof — t = 5 mm

Profile type — None

Technical remarks

All data and information in the software is based on fischer products and common engineering knowledge. Please check all the proof results against local valid standards and approvals.
As fischer is not the design office, the attached is no guarantee for incorrect input or assumptions. Any recommendations have to be approved by the building-authority or project engineer. Results are valid only for anchor system calculated in the attached. If any part of the system is changed, it will invalidate this report and new calculations would be required. The calculation was done under the assumption that a sufficient splitting reinforcement is available. In this case the spliiting failure can be omitted.
The transmission of the anchor loads to the supports of the concrete member shall be shown for the ultimate limit state and the serviceability limit state; for this purpose, the normal verifications shall be carried out under due consideration of the actions introduced by the anchors. For these verifications the additional provisions given in the current design method shall be taken into account.
As a pre-condition the anchor plate is assumed to be flat when subjected to the actions. Therefore, the plate must be sufficiently stiff. The C-Fix anchor plate design is based on a proof of stresses and does not allow a statement about the stiffness of the plate. The proof of the necessary stiffness is not carried out by C-Fix.

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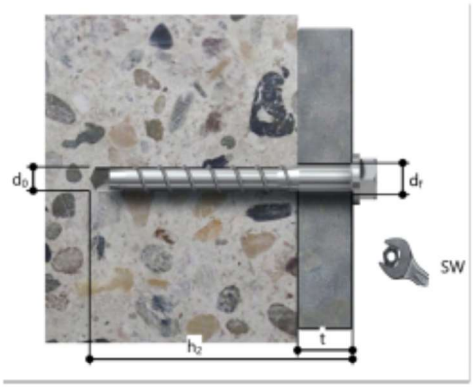
Installation data

Anchor

Anchor system	**fischer Concrete screw ULTRACUT FBS II**	
Anchor	Concrete screw with hexagon head and washer FBS II 14x95 30/10/- US, zinc plated steel	Art.-No. 536875
Accessories	Blow-out pump ABG big Hammer drill bit SDS Plus IV 14/150/210 Erection of the drillhole by hammer drilling with or without suction cleaning	Art.-No. 89300 Art.-No. 504153

Installation details

Thread diameter	-
Drill hole diameter	d_0 = 14 mm
Drill hole depth	h_2 = 105 mm
Anchorage depth	h_{ef} = 67 mm
Drilling method	hammer drilling
Drill hole cleaning	only blow out by hand
Installation type	Push-through installation
Annular gap	Annular gap not filled
Maximum torque	-
Socket size	21 mm
Base plate thickness	t = 5 mm
Total fixing thickness	t_{fix} = 5 mm
Tfix,max	$t_{fix,\,max}$ = 10 mm

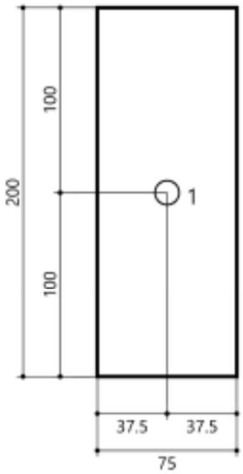


Base plate details

Base plate material	Not available
Base plate thickness	t = 5 mm
Clearance hole in base plate	d_f=18 mm

Attachment

Profile type	None



Anchor coordinates

Anchor no.	x mm	y mm
1	0	0