APPENDIX E – ***Permanent Stage FE Model results and Calculations***

Loading

LC1 Self Weight of structural elements (not shown)	
LC2 Weight of water (pool)	APP/E - 30
LC3 DL self-weight of brickwork wall	APP/E - 31
LC4 DL upper floors	APP/E - 32
LC5 LL upper floors	APP/E - 33
LC6 LL LGF level inside	APP/E - 34
LC7 LL LGF level outside	APP/E - 35
LC8 DL finishes	APP/E - 36
LC9 LL basement	APP/E - 37
LC10 LL Plant room	APP/E - 38
LC11-LC12 Uplift force / water pressure	APP/E - 39

Note: The structure as the permanent model analysis has been also assessed with the loading with the original brickwork walls. So the loading shown in appendix D.

Shear Punching Checks

400x400 mm column (worst case central column)	APP/E - 40-42
400x400 mm edge column, 30% of the column's load is inside the shear perimeter	APP/E - 43-45
350x350 mm column (worst case) 30% of the column's load is inside the shear perimeter	APP/E - 46-48

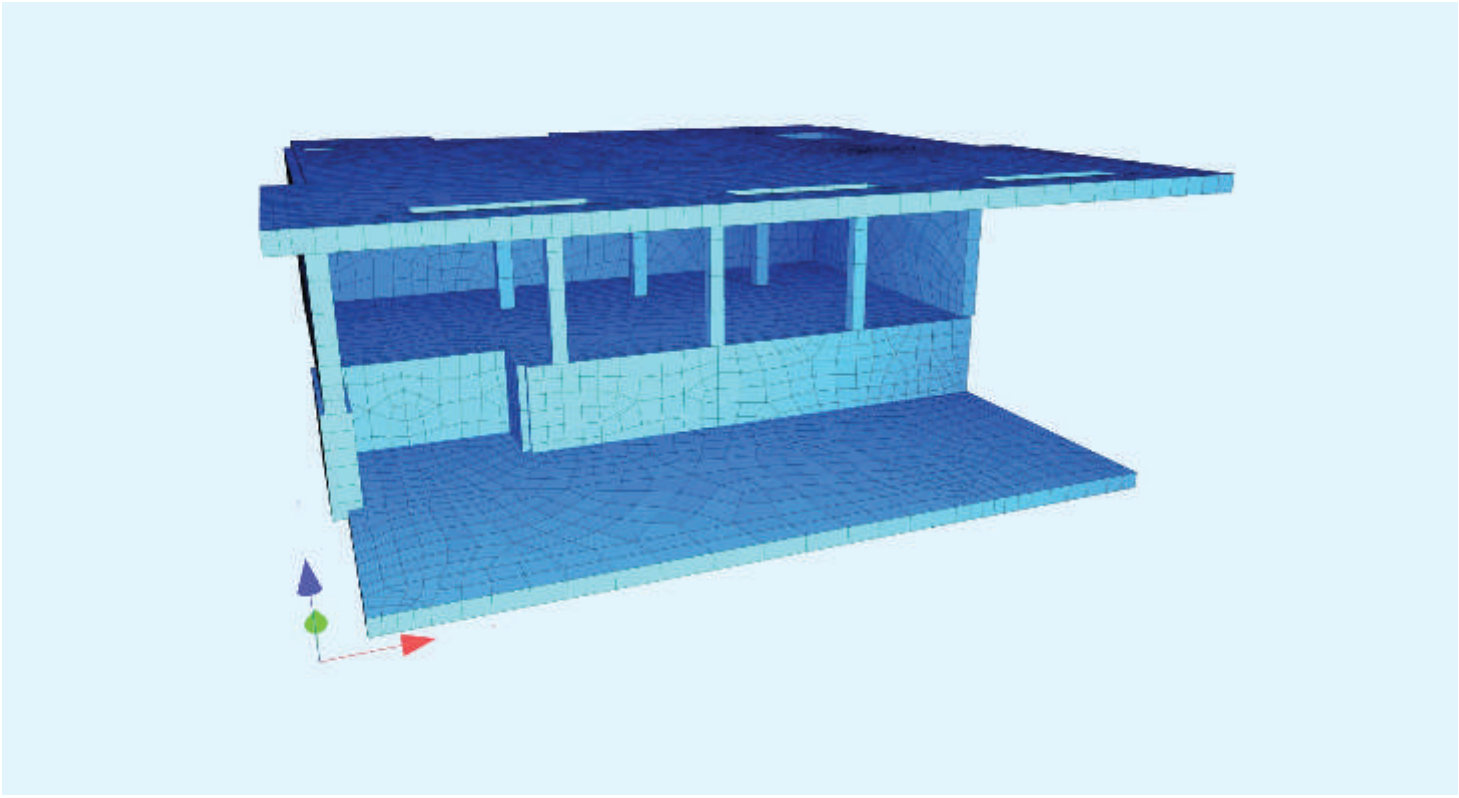
Column reinforcement calculation

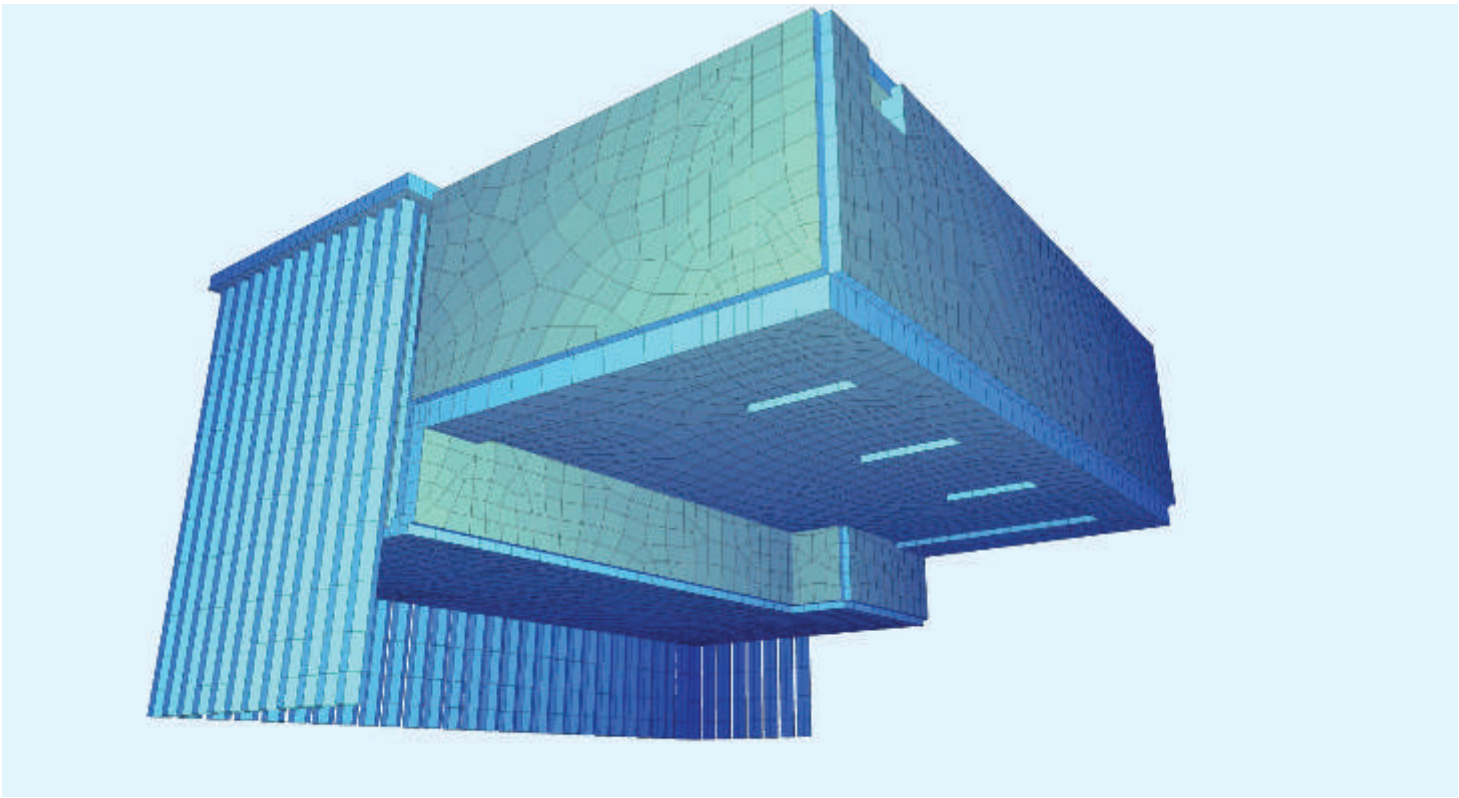
400x400 mm column (worst case)	APP/E - 49-50
350x350 mm column (worst case)	APP/E - 51-52

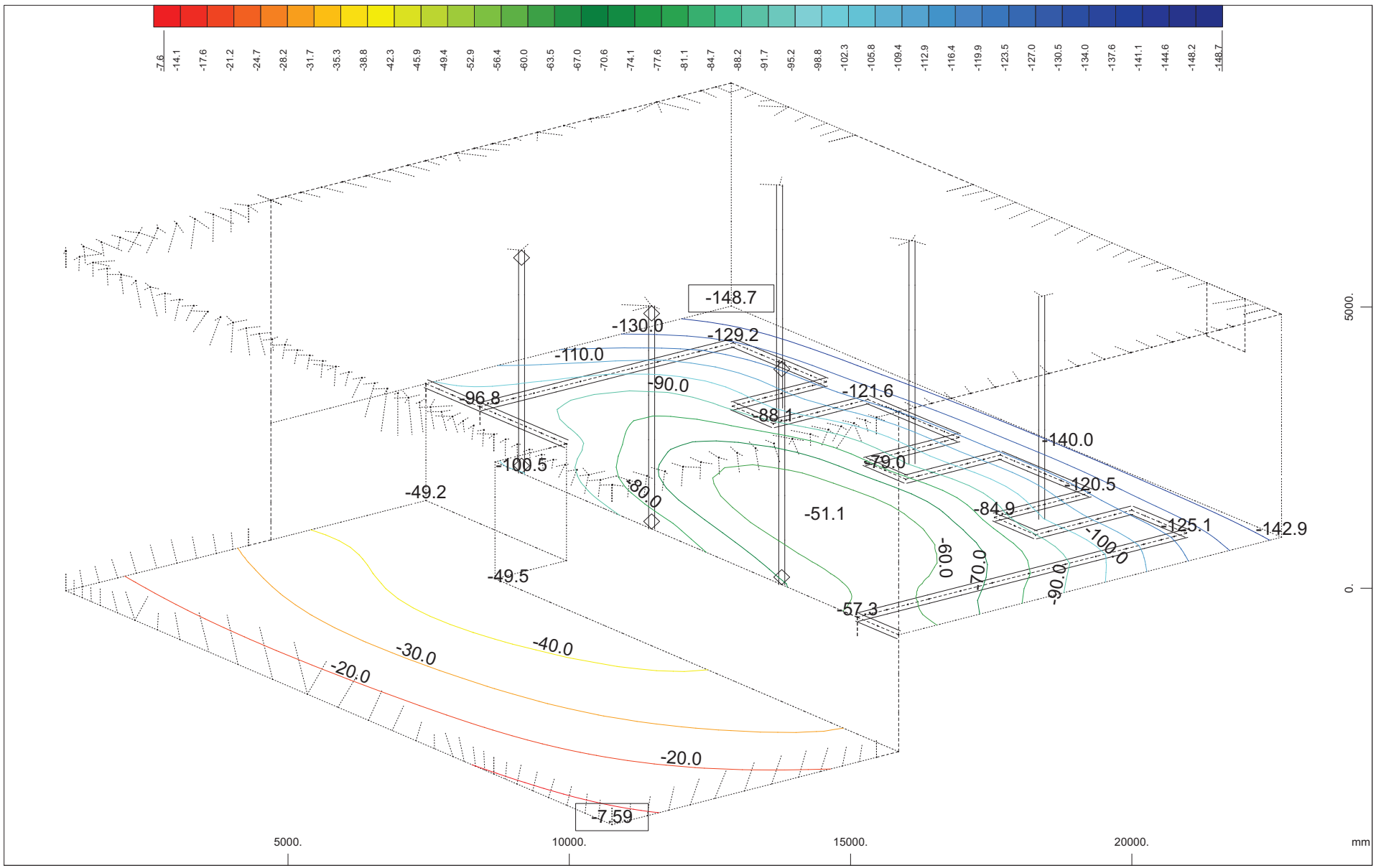
ABBEY PYNFORD

DESIGN CALCULATION SHEET

Project		Designed	**JO**	Date	**Dec 2014**	Project No:	**GA19787**
69 REDINGTON ROAD, LONDON, NW3 7RP		Checked	**MJ**	Date	**Dec 2014**	Sheet No.	**APP/E - 03**





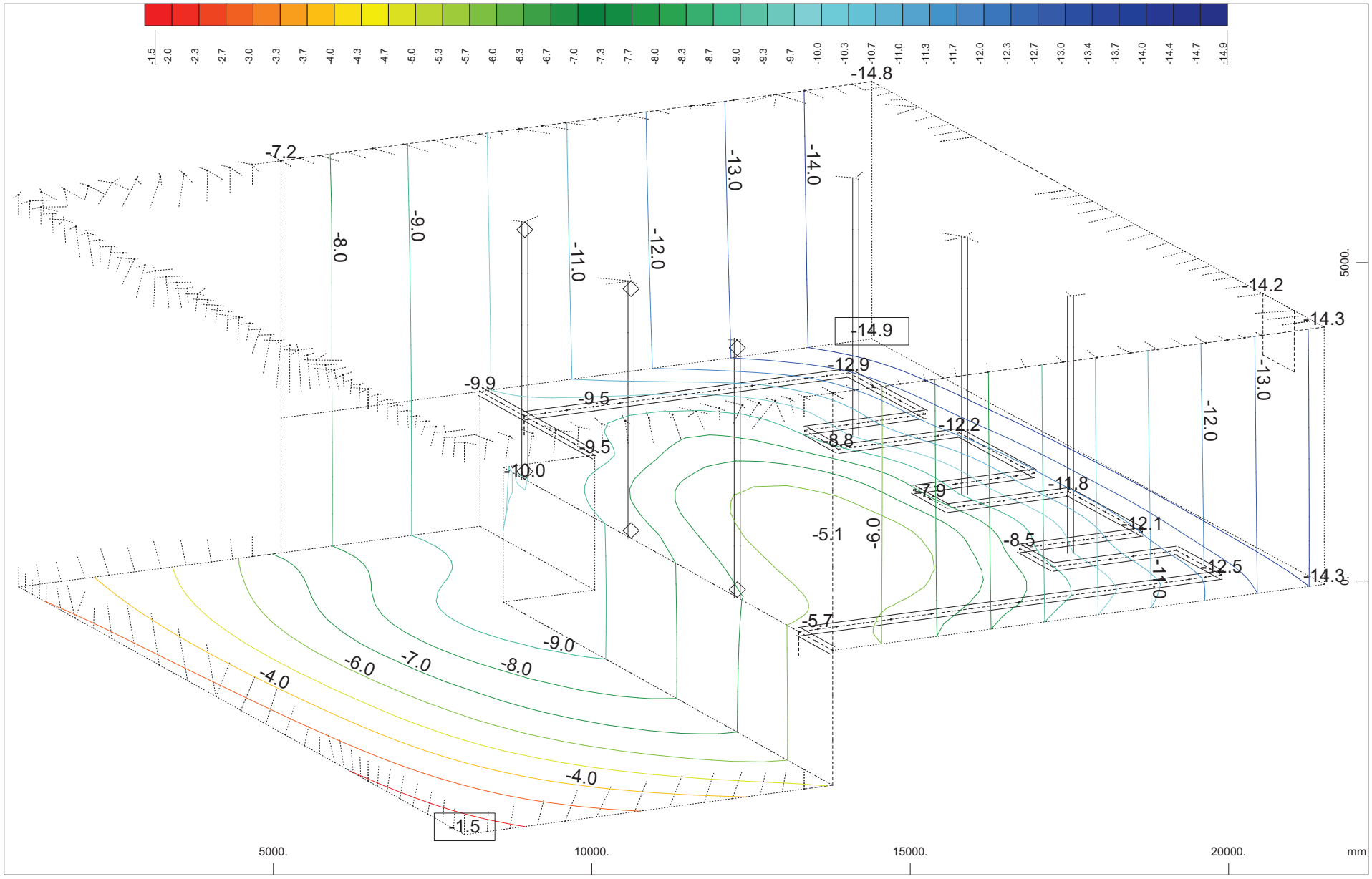


Sector of system Group 110 120 125 130 135

Bedding stress in Node , Loadcase 1118 MINR-P QUAD Bedding Stresses , from -148.7 to -7.59 step 10.0 kN/m2

M 1 : 95

X * 0.662
Y * 0.818
Z * 0.944



Z
Y
X

Sector of system Group 110 120 125 130 135

Nodal displacement in global Z in Node

, Loadcase 1176 MINR-UZ NODE Nodal Displacements , from -14.9 to -1.52 step 1.00 mm

M 1 : 85

X * 0.502
Y * 0.906
Z * 0.962

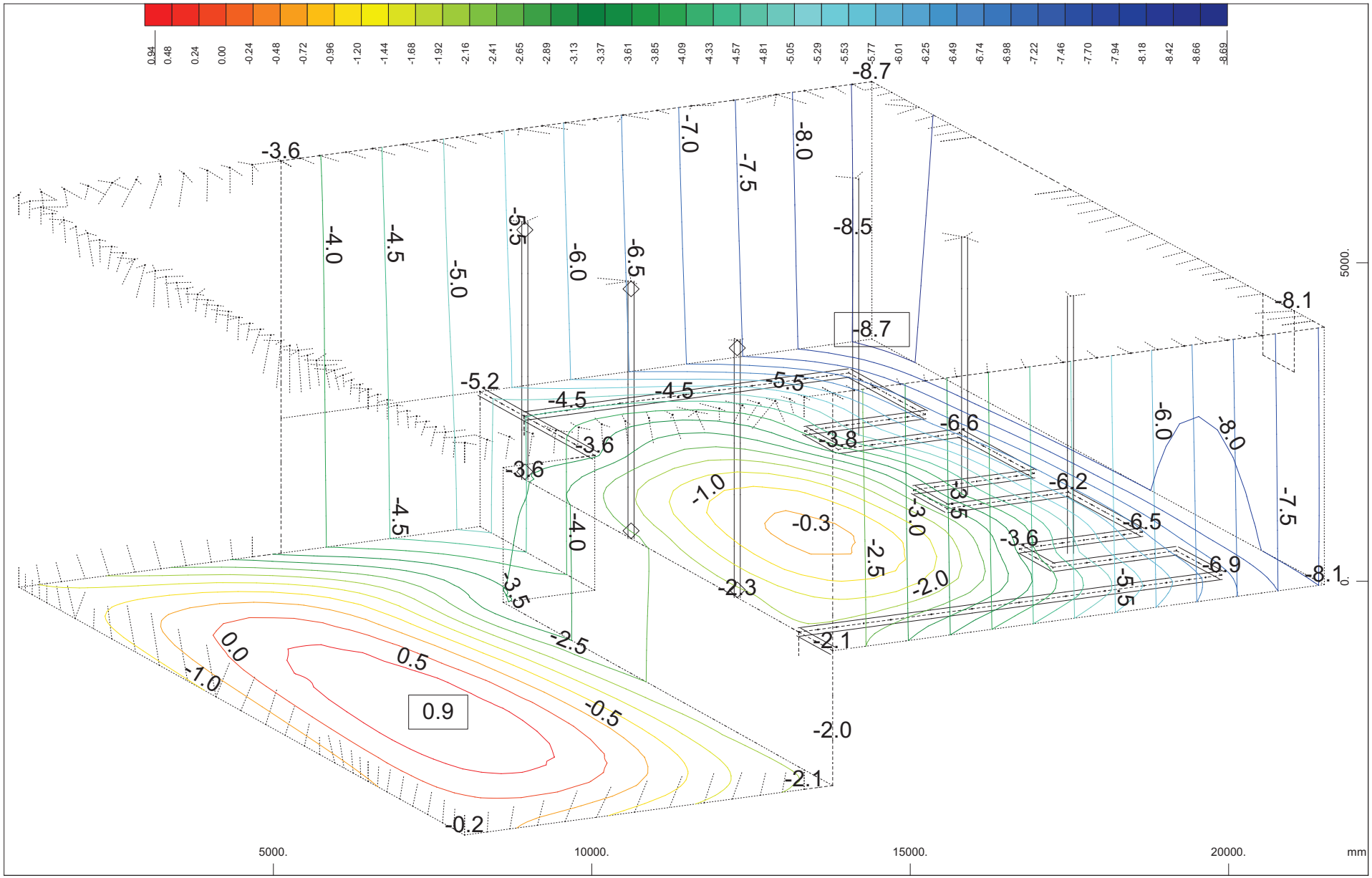
Abbey Pynford PLC Hemel Hempstead, HP2 7DX

WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP

Interactive Graphic

APP/E - 5



Z
Y
X

Sector of system Group 110 120 125 130 135

Nodal displacement in global Z in Node

, Loadcase 1175 MAXR-UZ NODE Nodal Displacements , from -8.69 to 0.935 step 0.500 mm

M 1 : 85

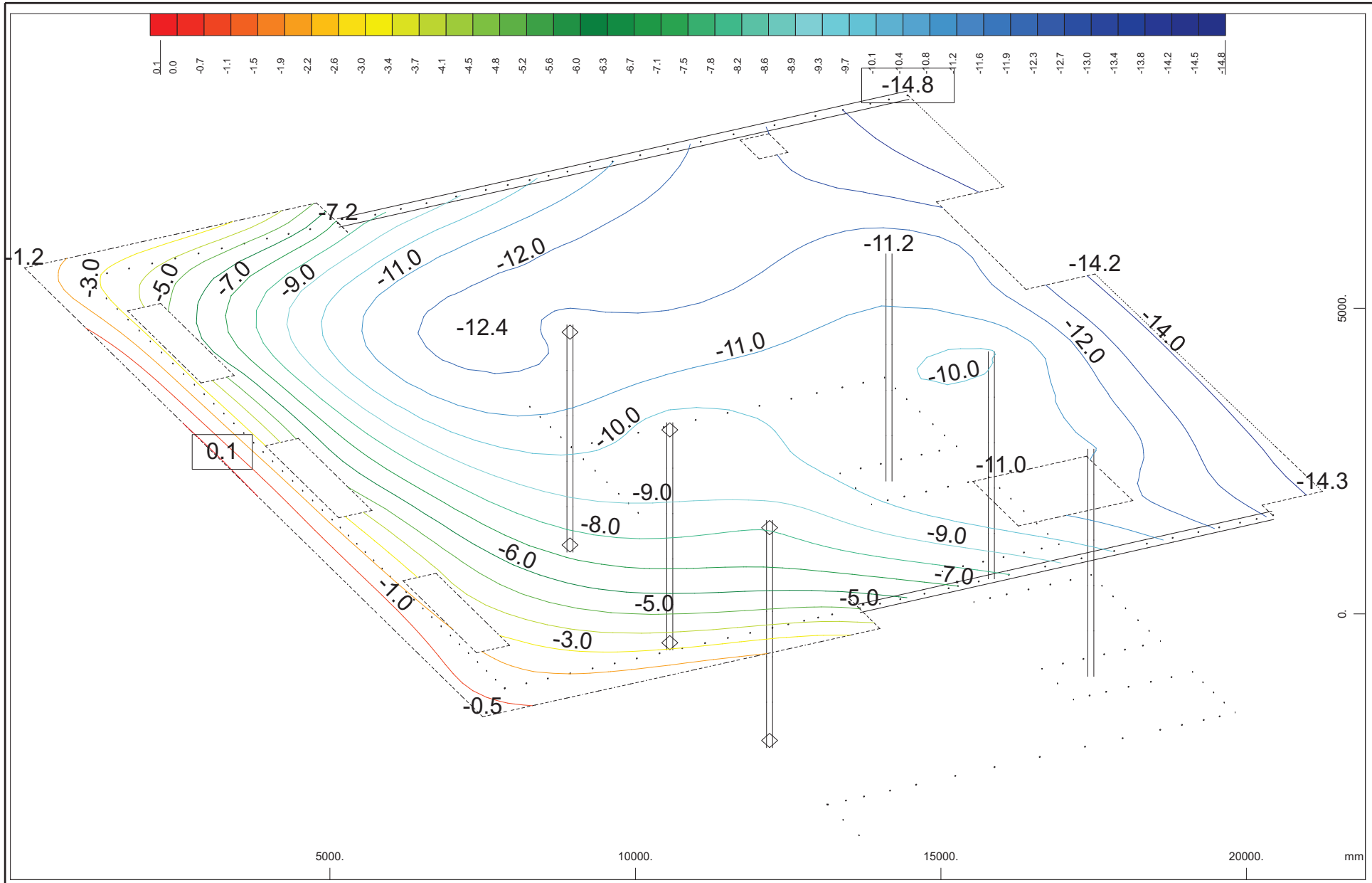
X * 0.502
Y * 0.906
Z * 0.962

Abbey Pynford PLC Hemel Hempstead, HP2 7DX

WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP

Interactive Graphic



Z
Y
X

Sector of system Group 100 130

Nodal displacement in global Z in Node

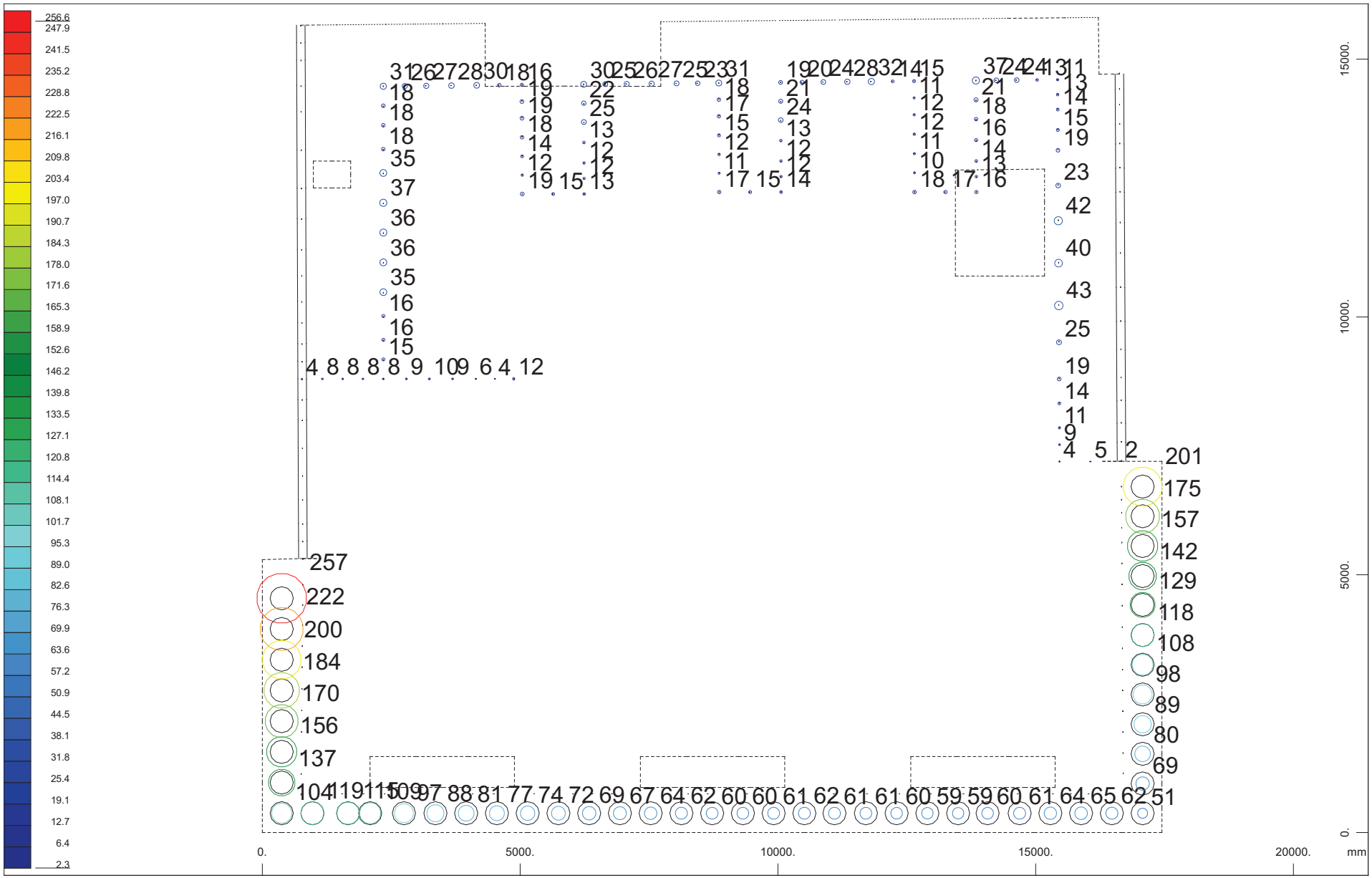
, Loadcase 1176 MINR-UZ NODE Nodal Displacements , from -14.8 to 0.0632 step 1.00 mm

M 1 : 88

X * 0.602
Y * 0.925
Z * 0.885

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Sector of system Group 100 140

Nodes , Support force in global Z, Loadcase 1155 MAXR-PZ NODE Supporting Forces i , 1 cm 3D = 200.0 kN

6687.)

(Max=256.6) (total:

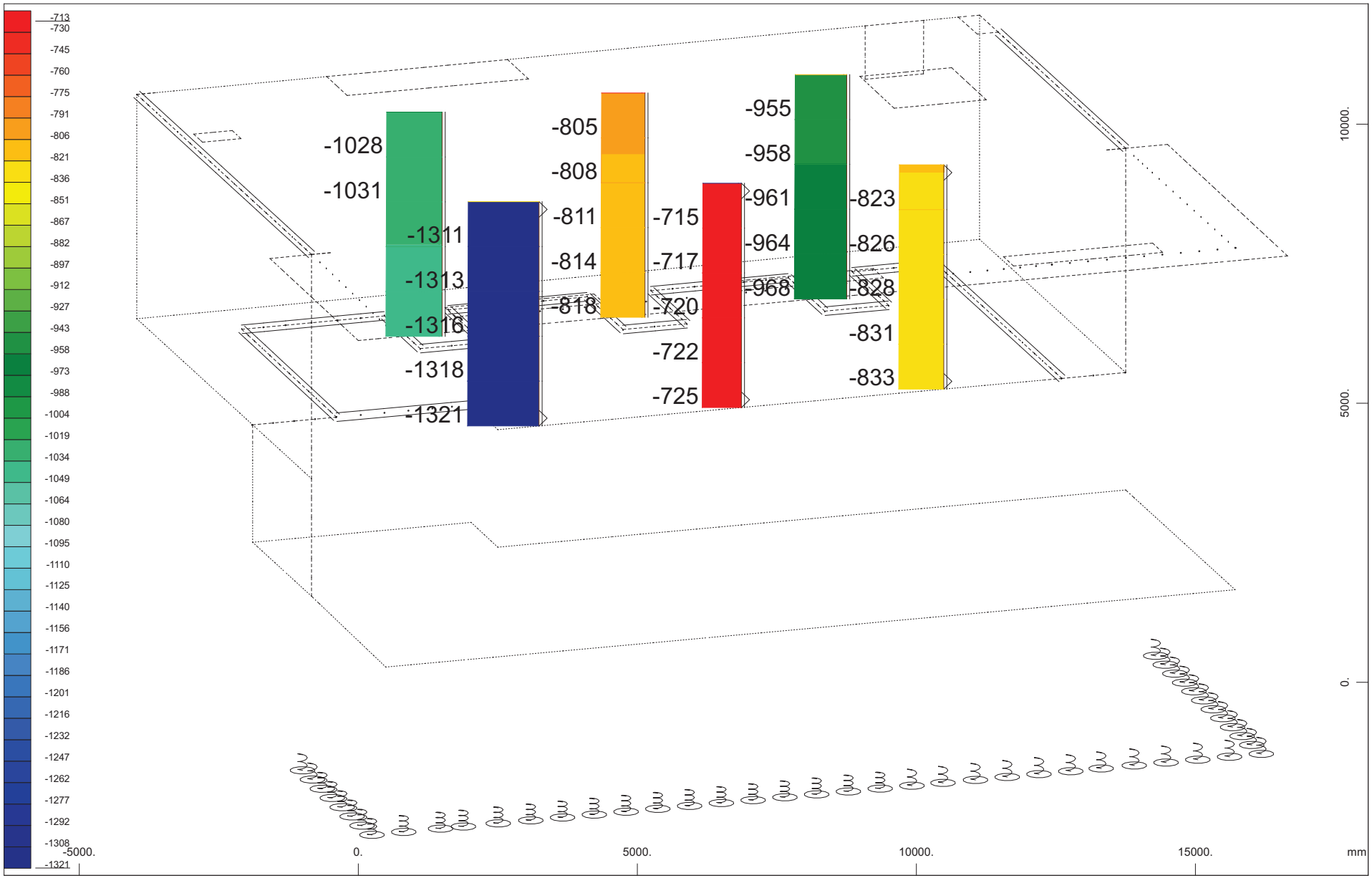
M 1 : 105

FE GA19787 TEMP

Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX

WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Z
Y X

Sector of system Group 0 100 110 120 130 135

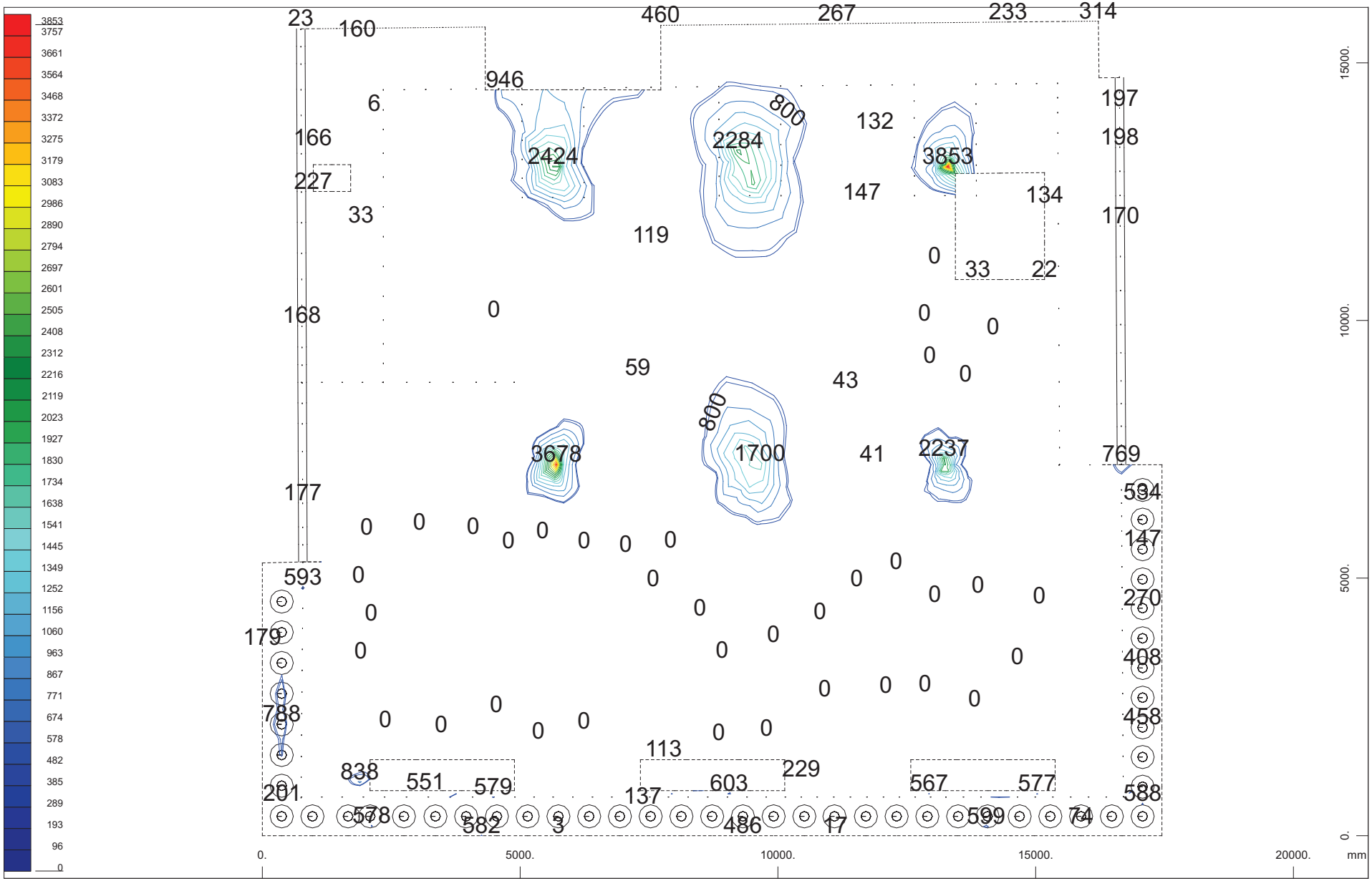
Beam Elements , Normal force Nx, Loadcase 1122 MINR-N BEAM Forces in Beam-Eleme , 1 cm 3D = 1000. kN (Min=-1321.) (Max=-712.5)

M 1 : 97

X * 0.958
Y * 0.408
Z * 0.957

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z—X

Sector of system Group 0 100

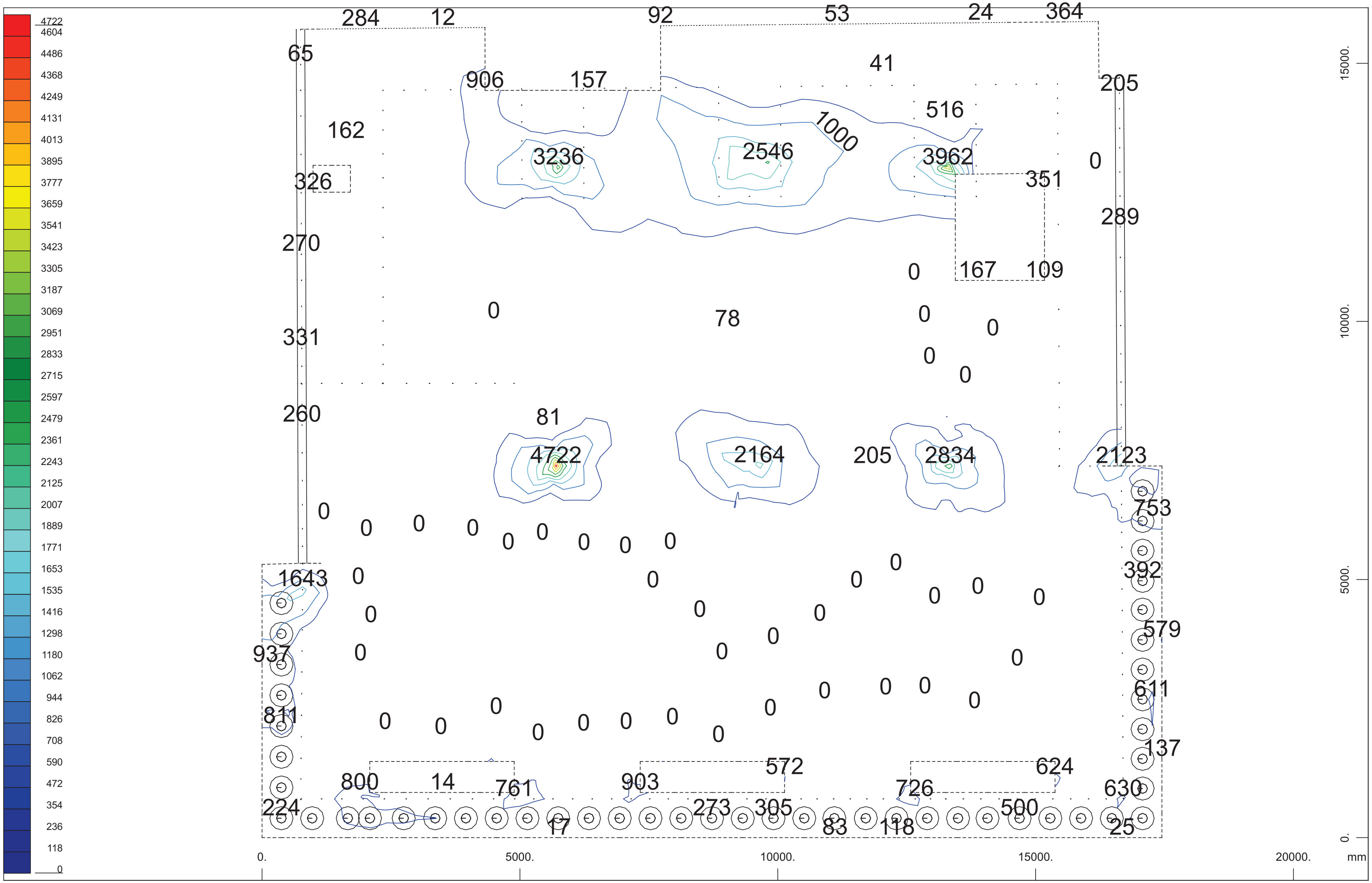
Quadrilateral Elements , upper Principal reinforcements (1st layer) in Node

⇌, Design Case 1 , from 565.0 to 3853. step 200.0 mm2/m

M 1 : 105

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z X

Sector of system Group 0 100

Quadrilateral Elements , upper Cross reinforcements (2nd layer) in Node

Design Case 1 , from 565.0 to 4722. step 500.0 mm2/m

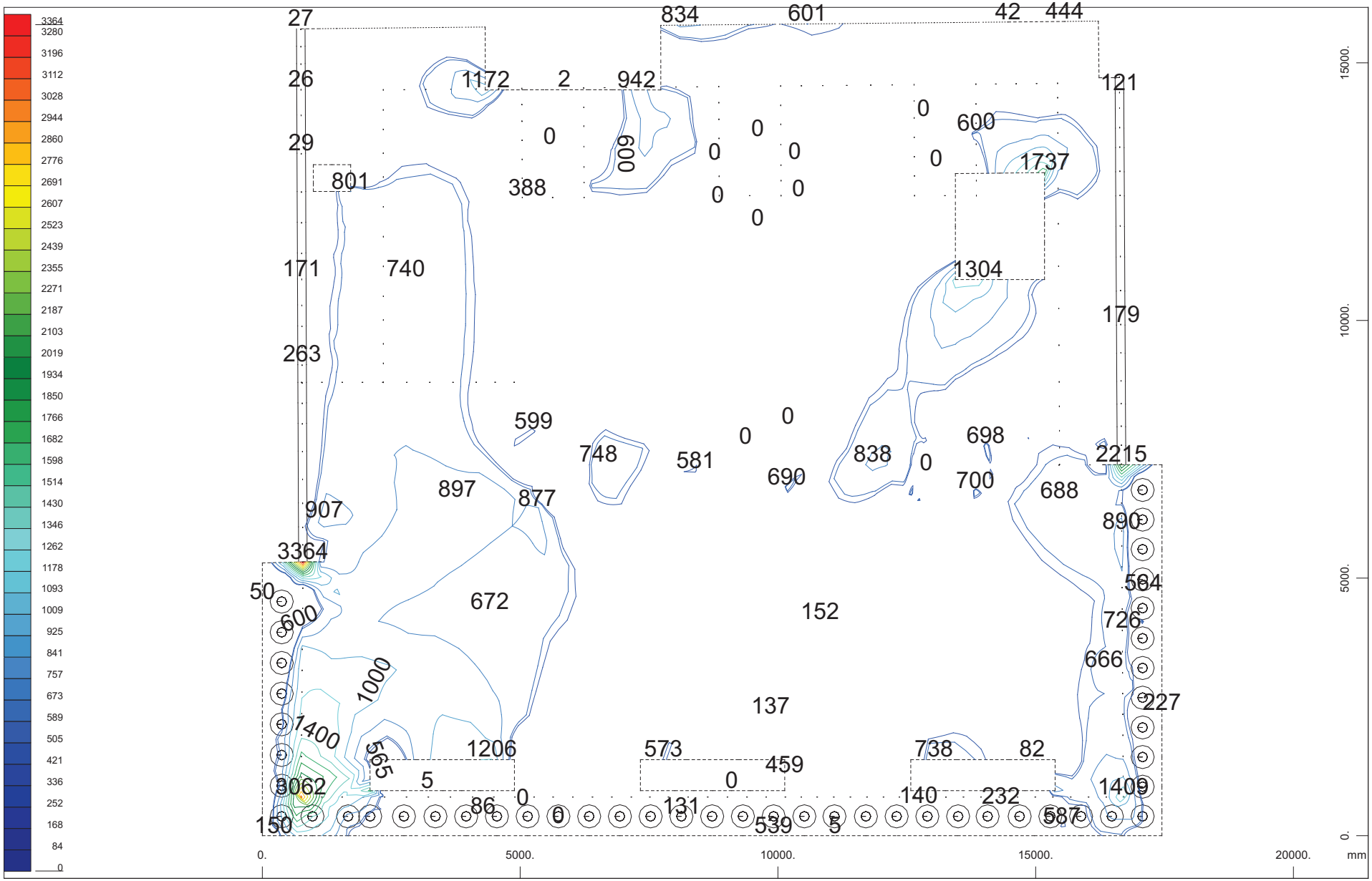
M 1 : 105

Abbey Pynford PLC Hemel Hempstead, HP2 7DX

WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP

Interactive Graphic



Y
Z—X

Sector of system Group 0 100

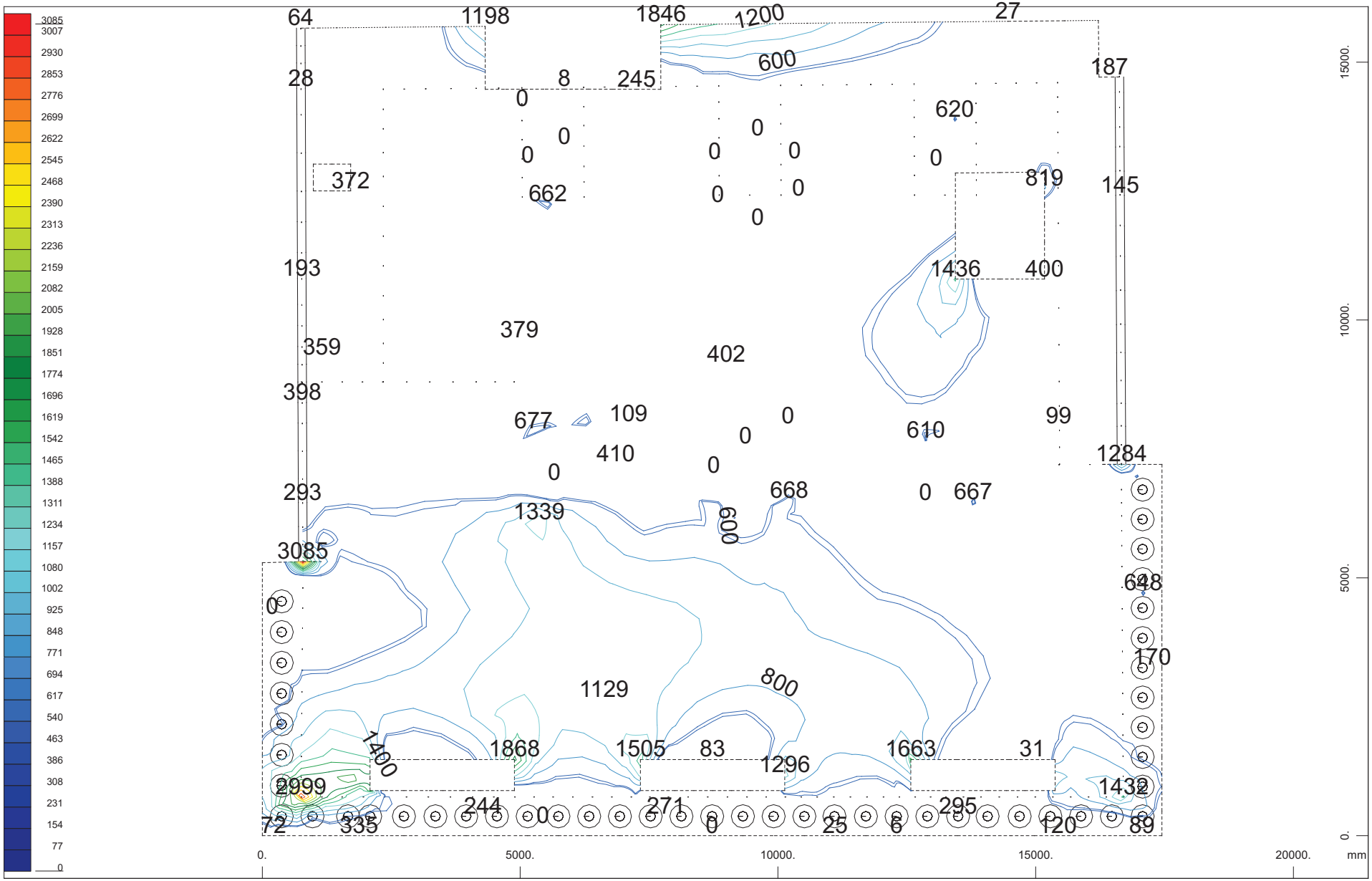
Quadrilateral Elements , lower Principal reinforcements (1st layer) in Node

⇌, Design Case 1 , from 565.0 to 3364. step 200.0 mm2/m

M 1 : 105

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z—X

Sector of system Group 0 100

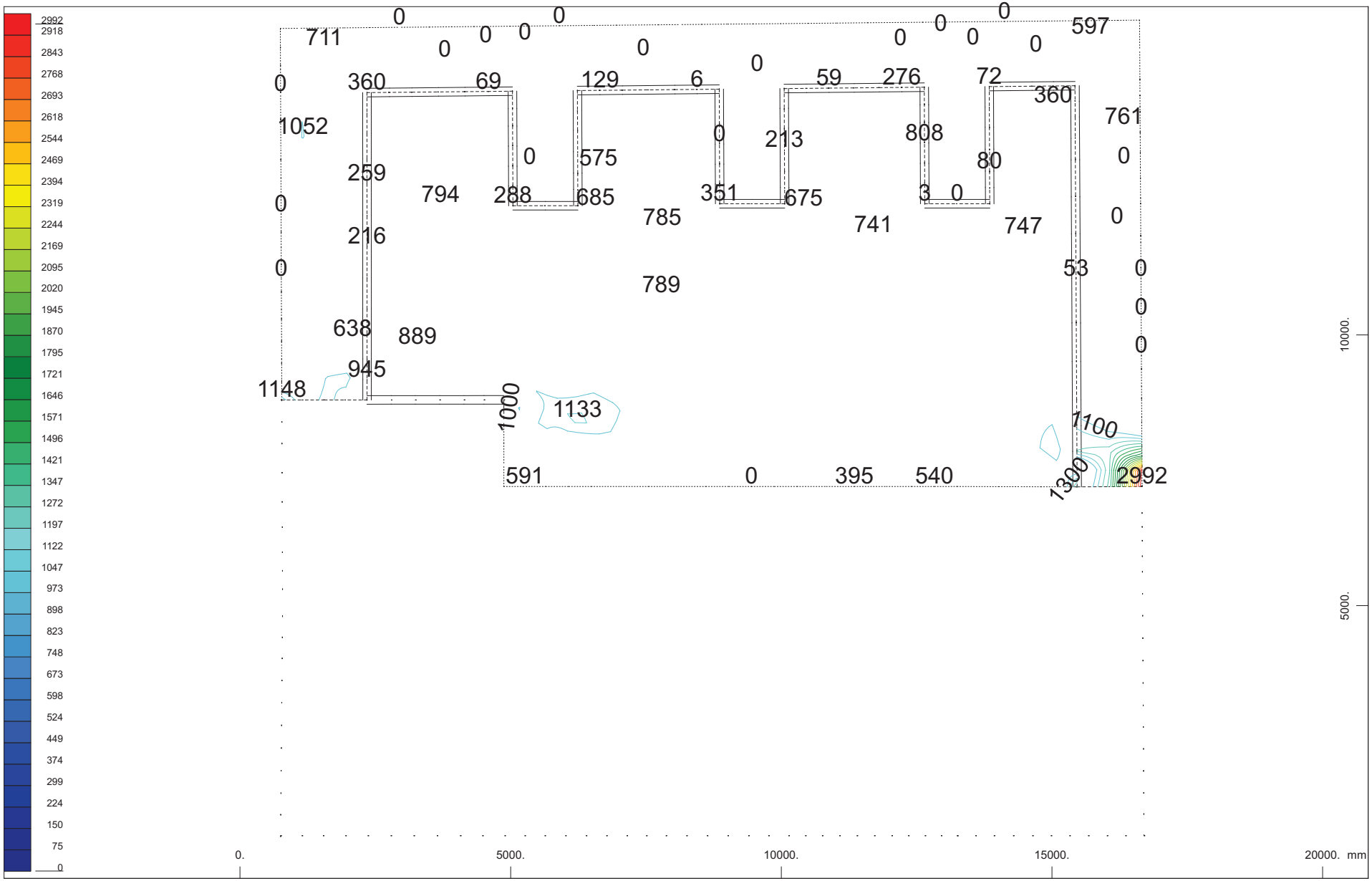
Quadrilateral Elements , lower Cross reinforcements (2nd layer) in Node

Design Case 1 , from 565.0 to 3085. step 200.0 mm2/m

M 1 : 105

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z—X

Sector of system Quadrilateral Elements Group 120

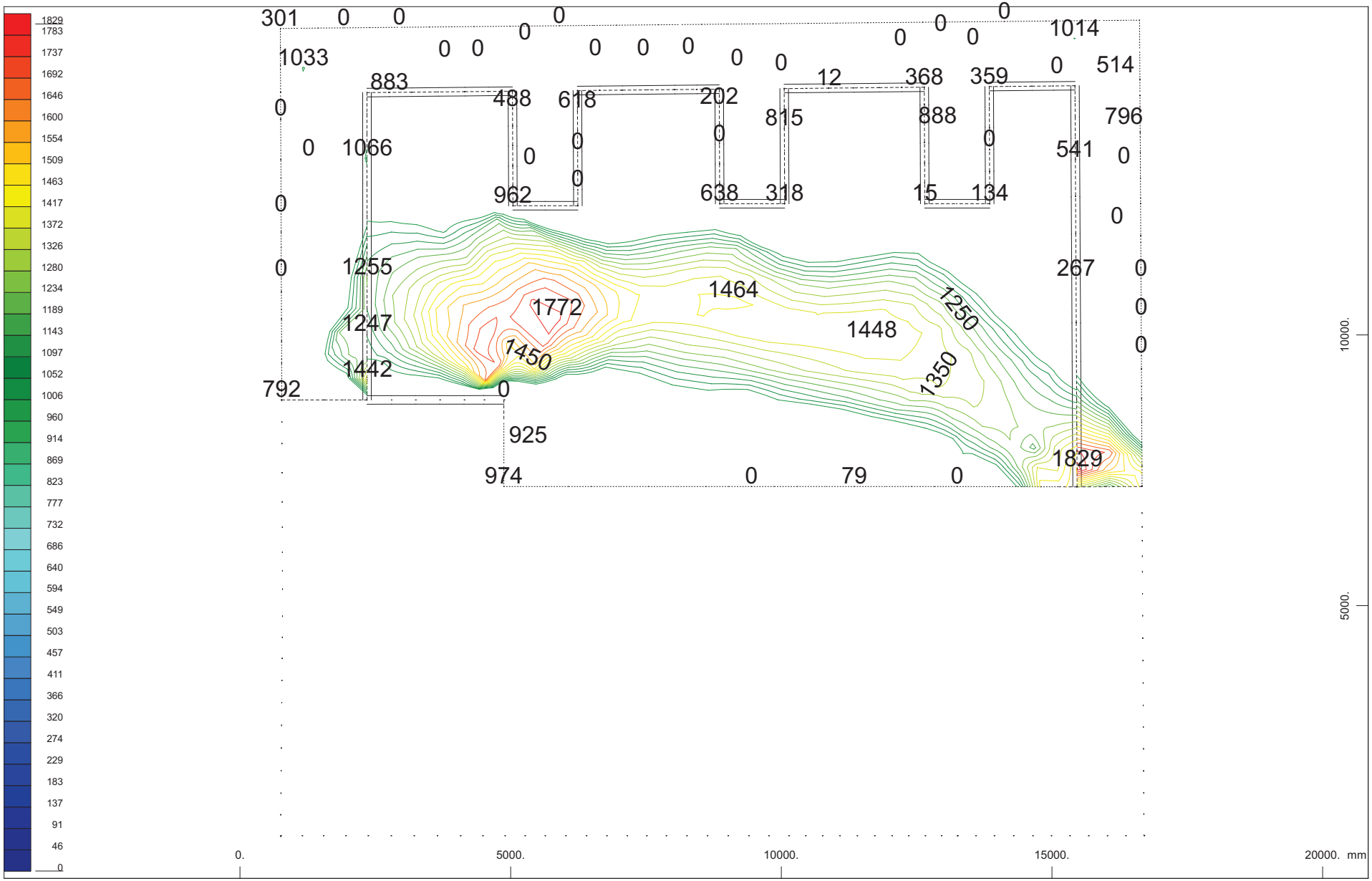
Quadrilateral Elements , upper Principal reinforcements (1st layer) in Node

, Design Case 1 , from 1000. to 2992. step 100.0 mm2/m

M 1 : 100

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z X

Sector of system Quadrilateral Elements Group 120

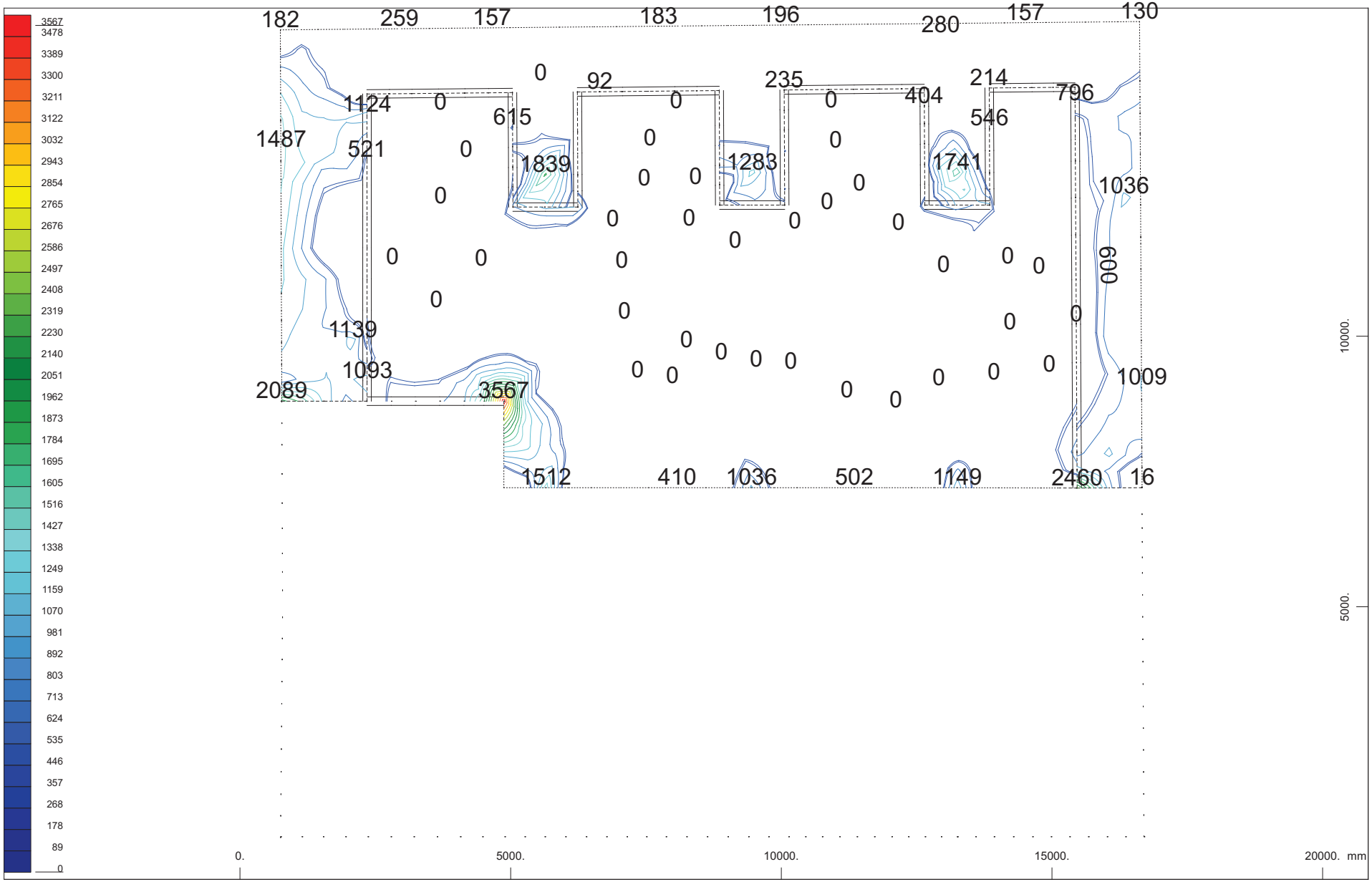
Quadrilateral Elements , upper Cross reinforcements (2nd layer) in Node

Design Case 1 , from 1000. to 1829. step 50.0 mm2/m

M 1 : 100

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z—X

Sector of system Quadrilateral Elements Group 120

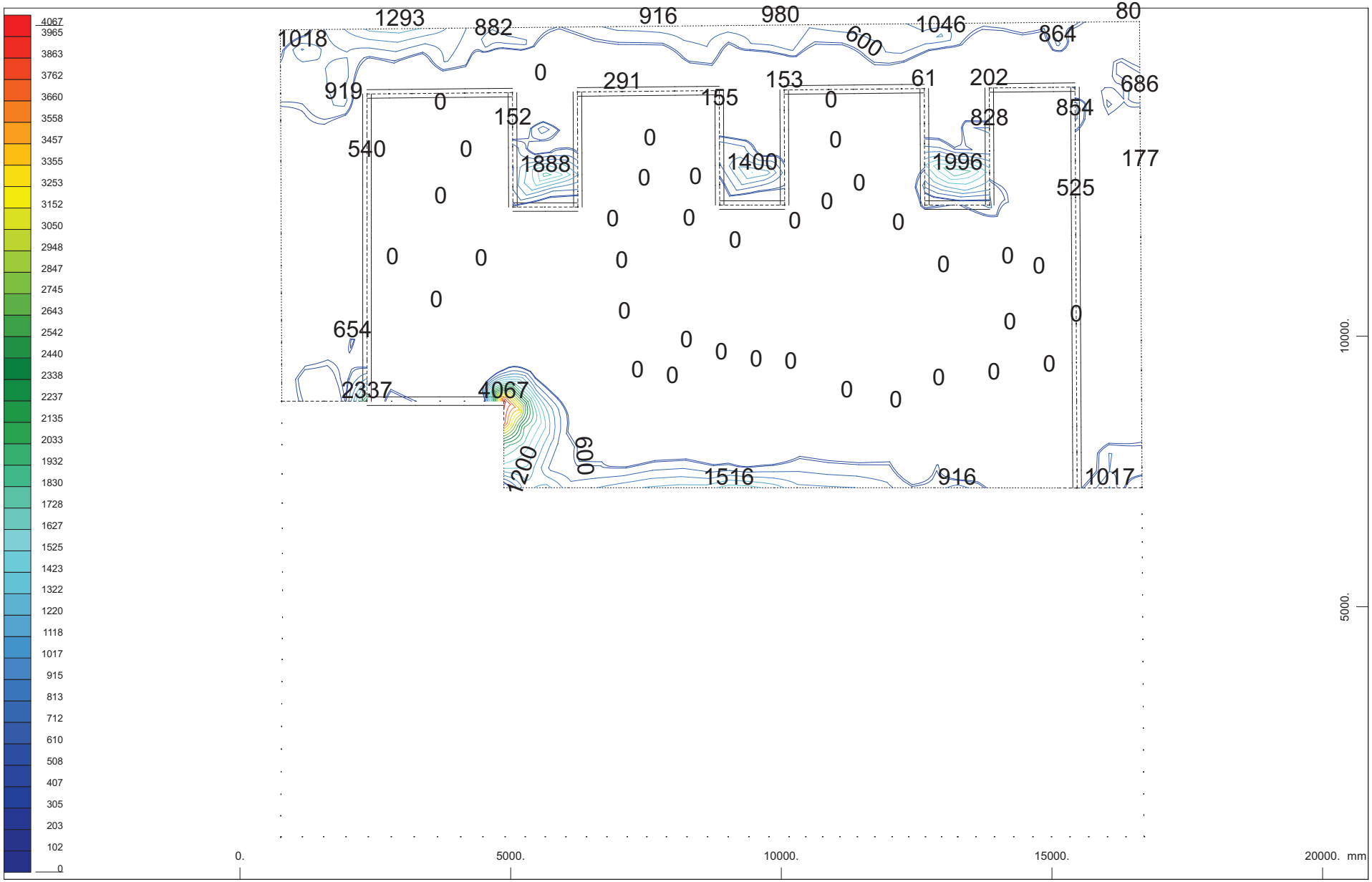
Quadrilateral Elements , lower Principal reinforcements (1st layer) in Node

⇌, Design Case 1 , from 565.0 to 3567. step 200.0 mm2/m

M 1 : 100

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z X

Sector of system Quadrilateral Elements Group 120

Quadrilateral Elements , lower Cross reinforcements (2nd layer) in Node

Design Case 1 , from 565.0 to 4067. step 200.0 mm2/m

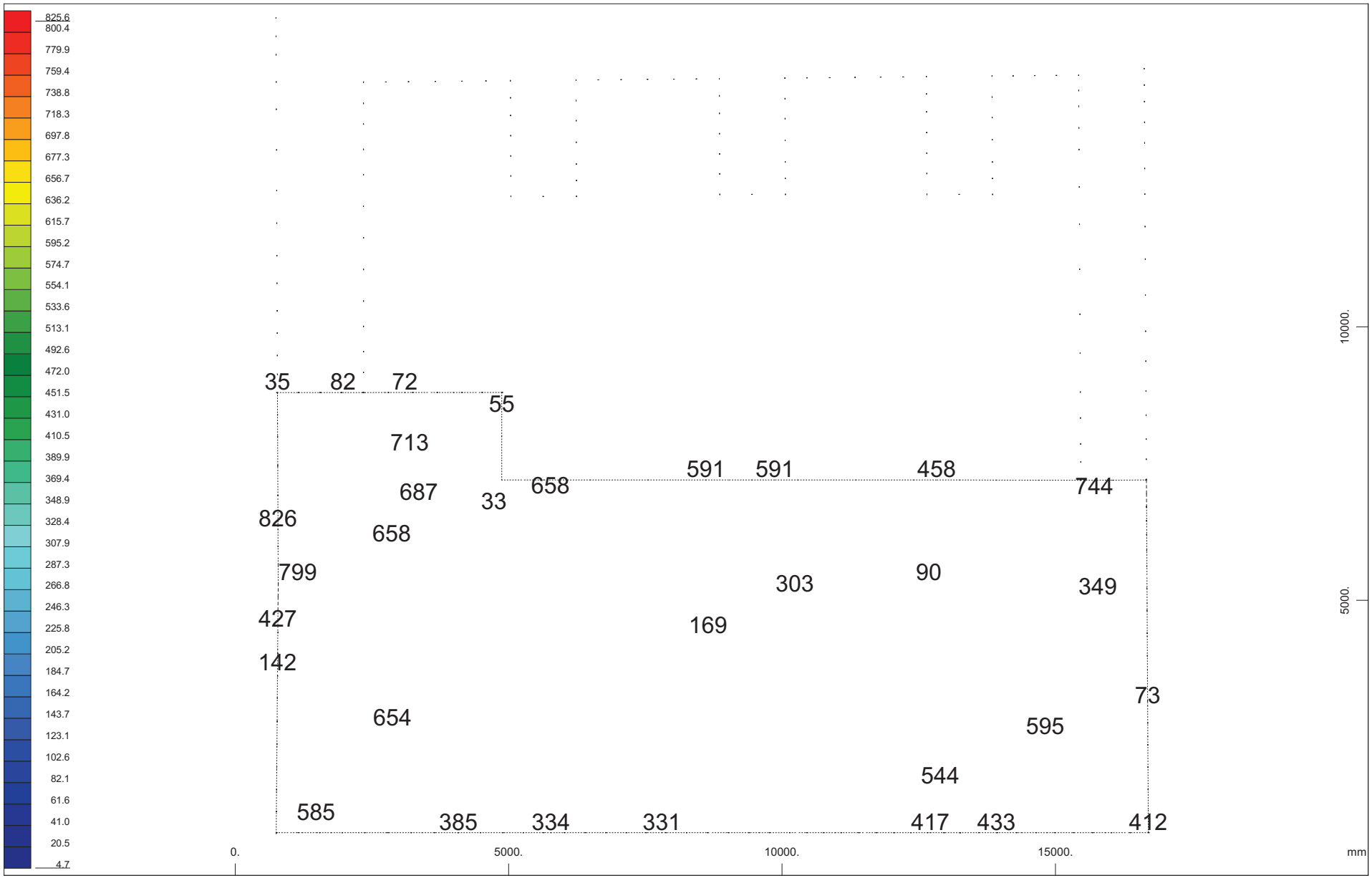
M 1 : 100

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

APP/E - 17

FE GA19787 TEMP
Interactive Graphic



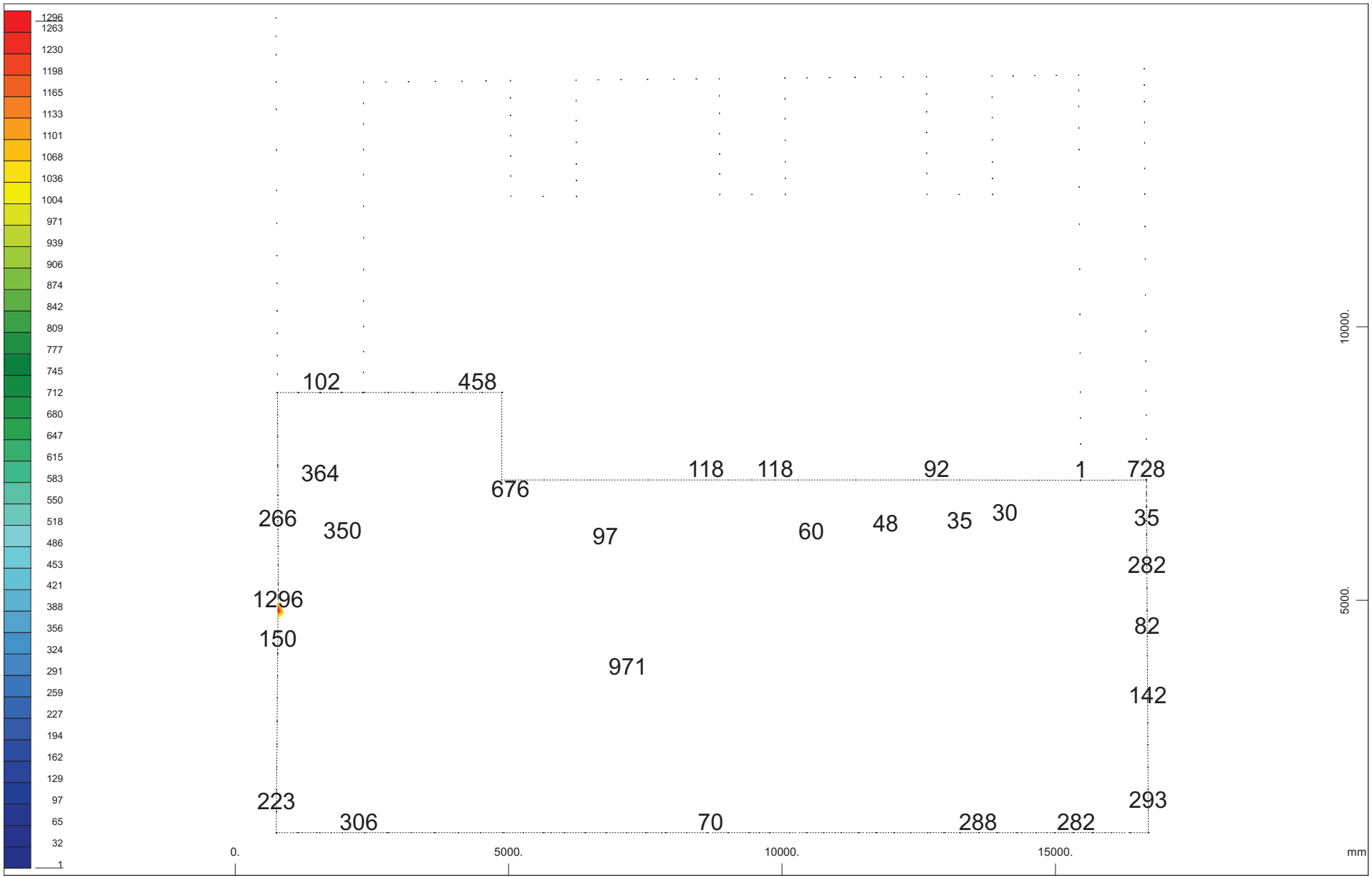
Y
Z—X

Sector of system Quadrilateral Elements Group 135

Quadrilateral Elements , upper Principal reinforcements (1st layer) in Node

, Design Case 1 , from 825.6 to 835.6 step 0.500 mm2/m

M 1 : 99



Y
Z X

Sector of system Quadrilateral Elements Group 135

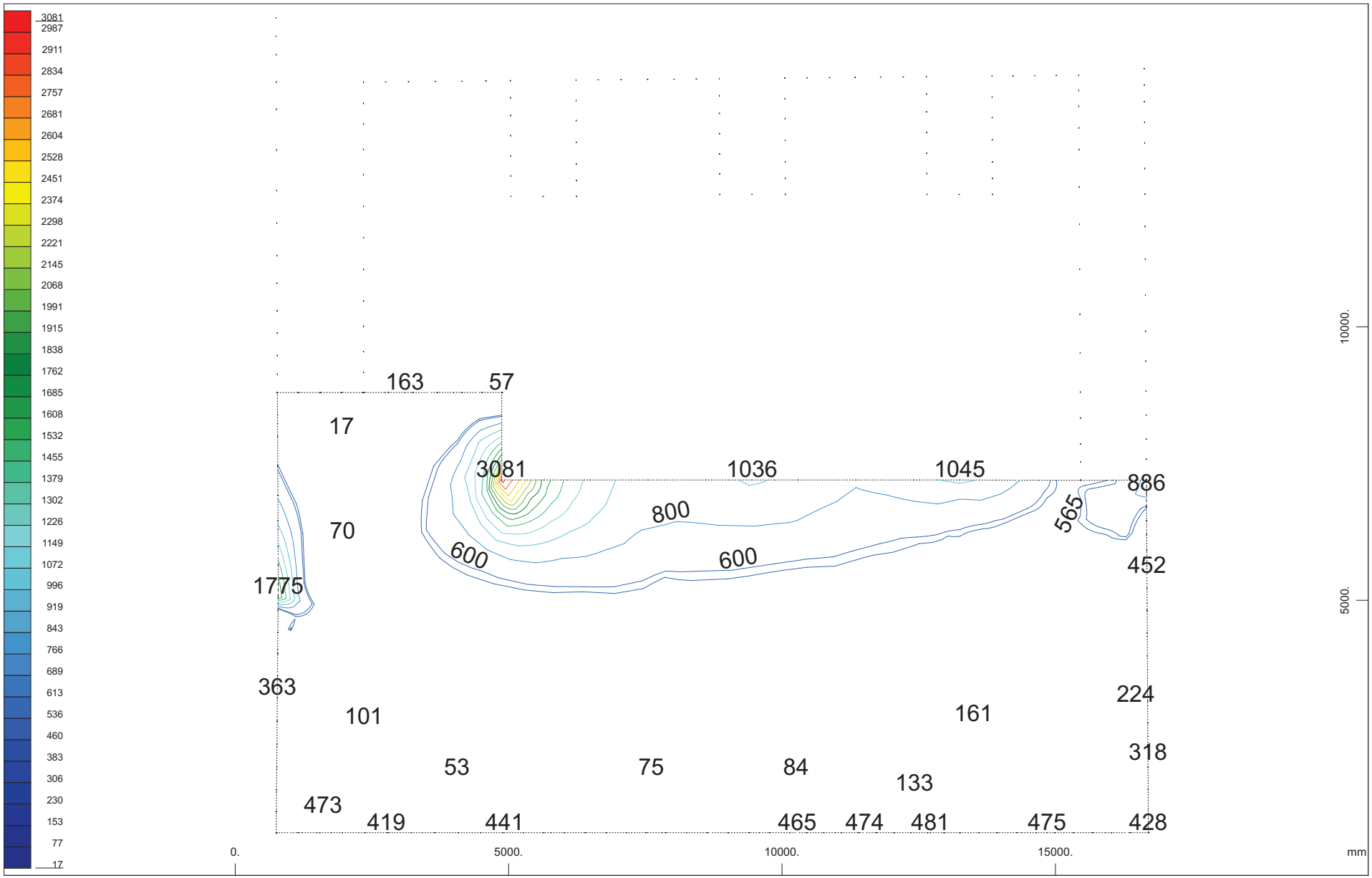
Quadrilateral Elements , upper Cross reinforcements (2nd layer) in Node

Design Case 1 , from 1000. to 1296. step 20.0 mm2/m

M 1 : 99

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z X

Sector of system Quadrilateral Elements Group 135

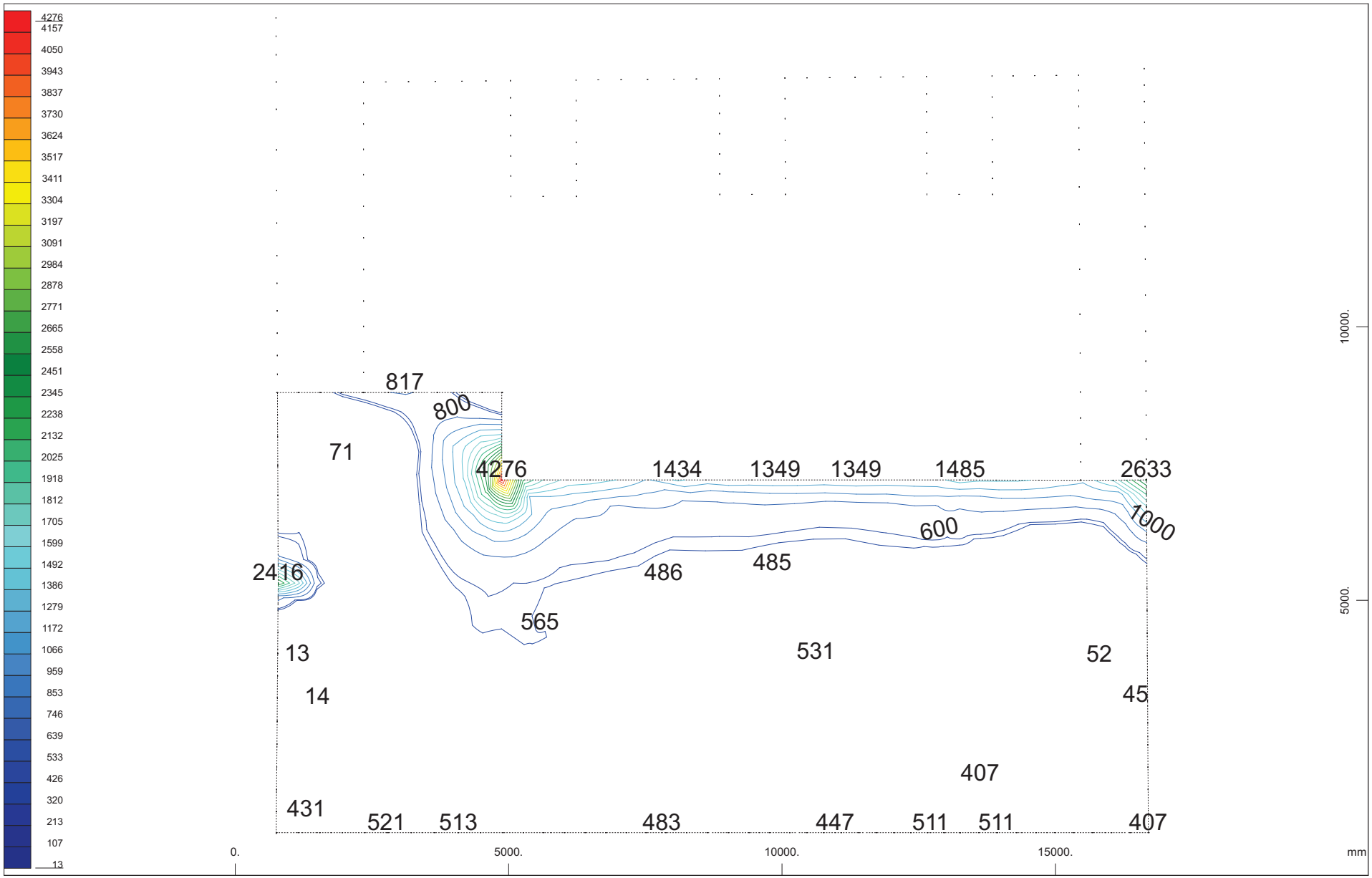
Quadrilateral Elements , lower Principal reinforcements (1st layer) in Node

, Design Case 1 , from 565.0 to 3081. step 200.0 mm2/m

M 1 : 99

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Y
Z X

Sector of system Quadrilateral Elements Group 135

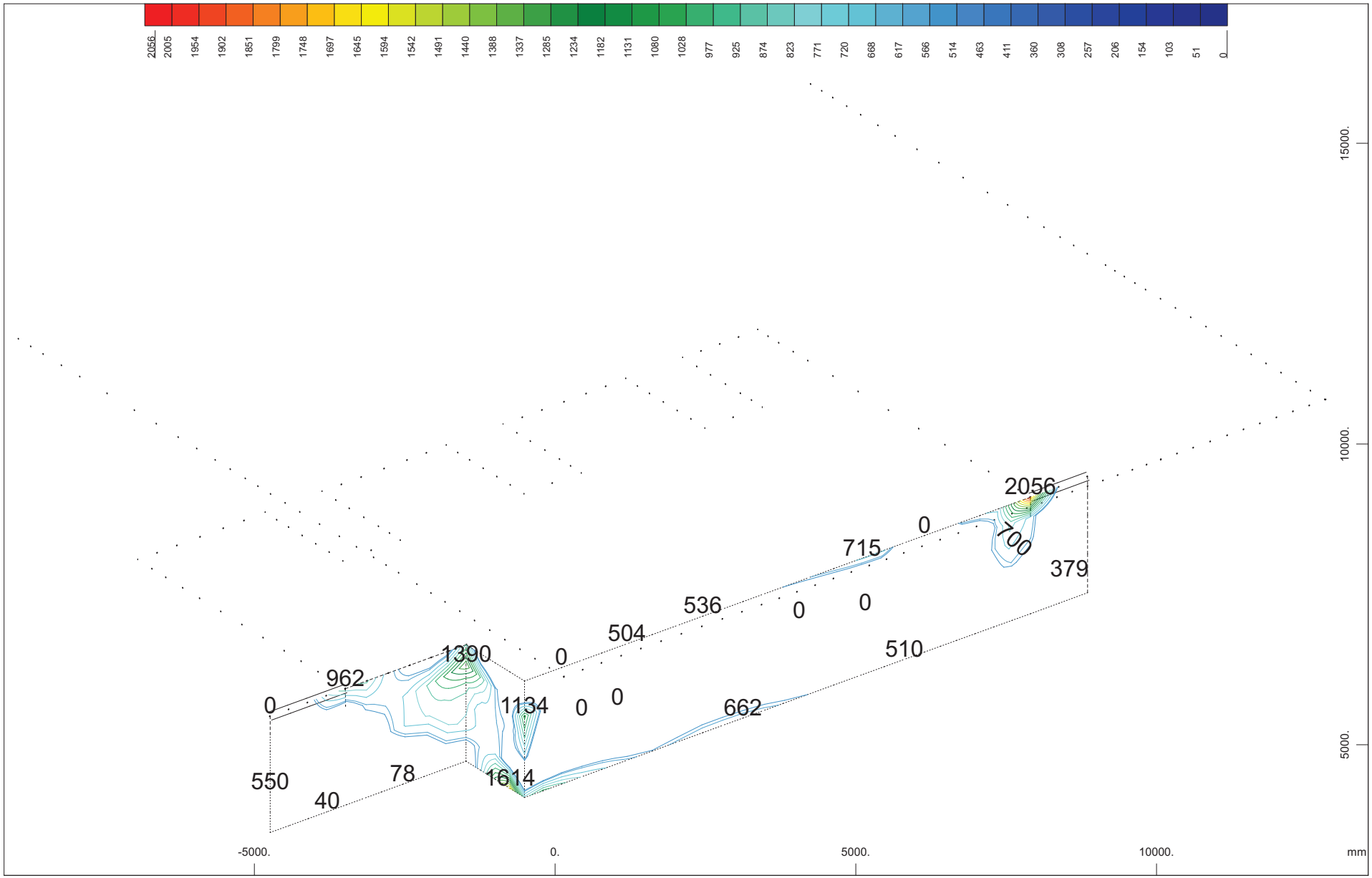
Quadrilateral Elements , lower Cross reinforcements (2nd layer) in Node

Design Case 1 , from 565.0 to 4276. step 200.0 mm2/m

M 1 : 99

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Sector of system Quadrilateral Elements Group 125

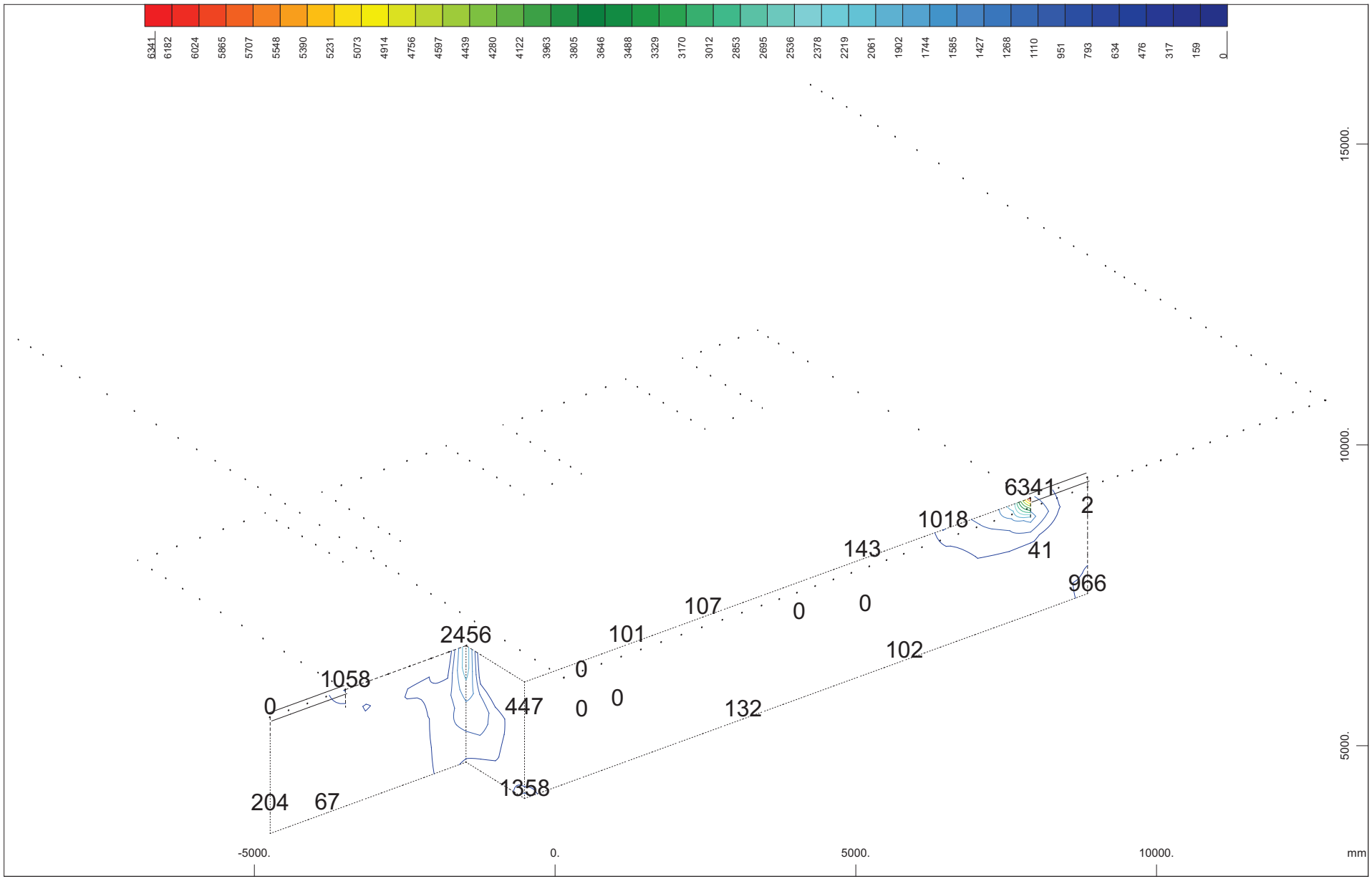
Quadrilateral Elements , upper Principal reinforcements (1st layer) in Node, Design Case 1 , from 565.0 to 2056. step 100.0 mm2/m

M 1 : 90

X * 0.845
Y * 0.715
Z * 0.880

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Sector of system Quadrilateral Elements Group 125

Quadrilateral Elements , upper Cross reinforcements (2nd layer) in Node

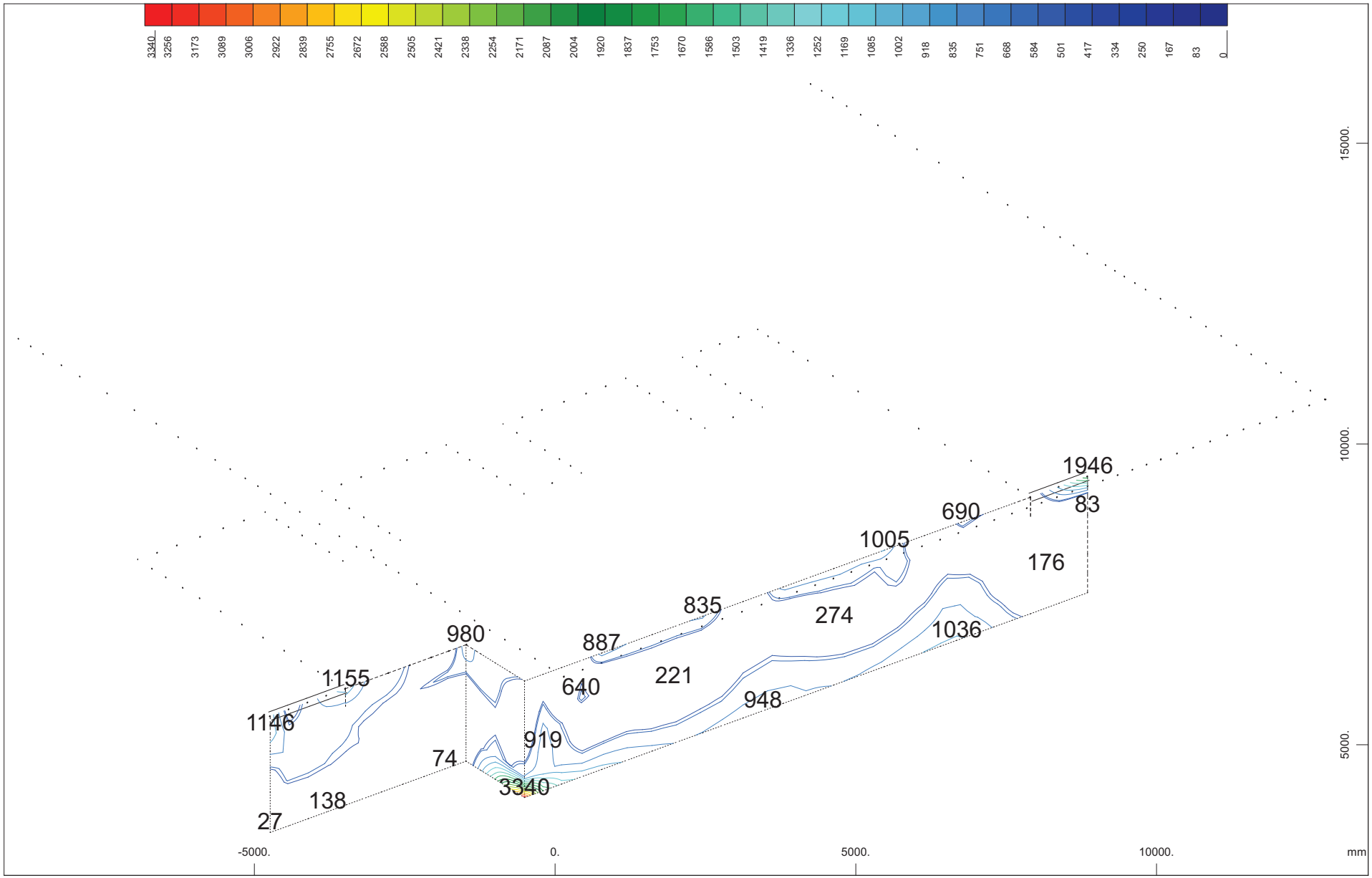
Design Case 1 , from 565.0 to 6341. step 500.0 mm2/m

M 1 : 90

X * 0.845
Y * 0.715
Z * 0.880

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

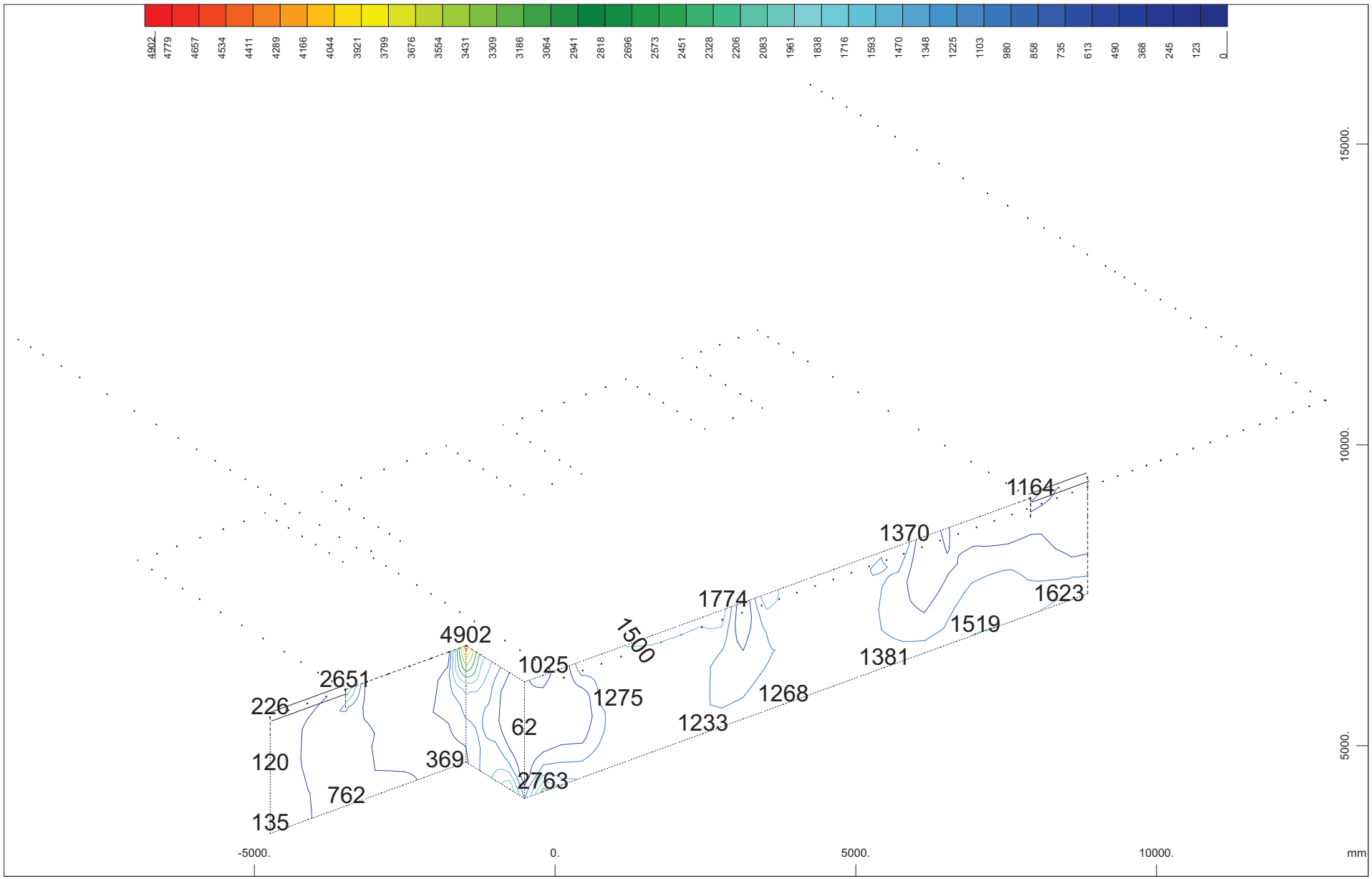


Sector of system Quadrilateral Elements Group 125

Quadrilateral Elements , lower Principal reinforcements (1st layer) in Node, Design Case 1 , from 565.0 to 3340. step 200.0 mm2/m

M 1 : 90
X * 0.845
Y * 0.715
Z * 0.880

Interactive Graphic
FE GA19787 TEMP



Sector of system Quadrilateral Elements Group 125

Quadrilateral Elements , lower Cross reinforcements (2nd layer) in Node

Design Case 1 , from 565.0 to 4902. step 500.0 mm2/m

M 1 : 90

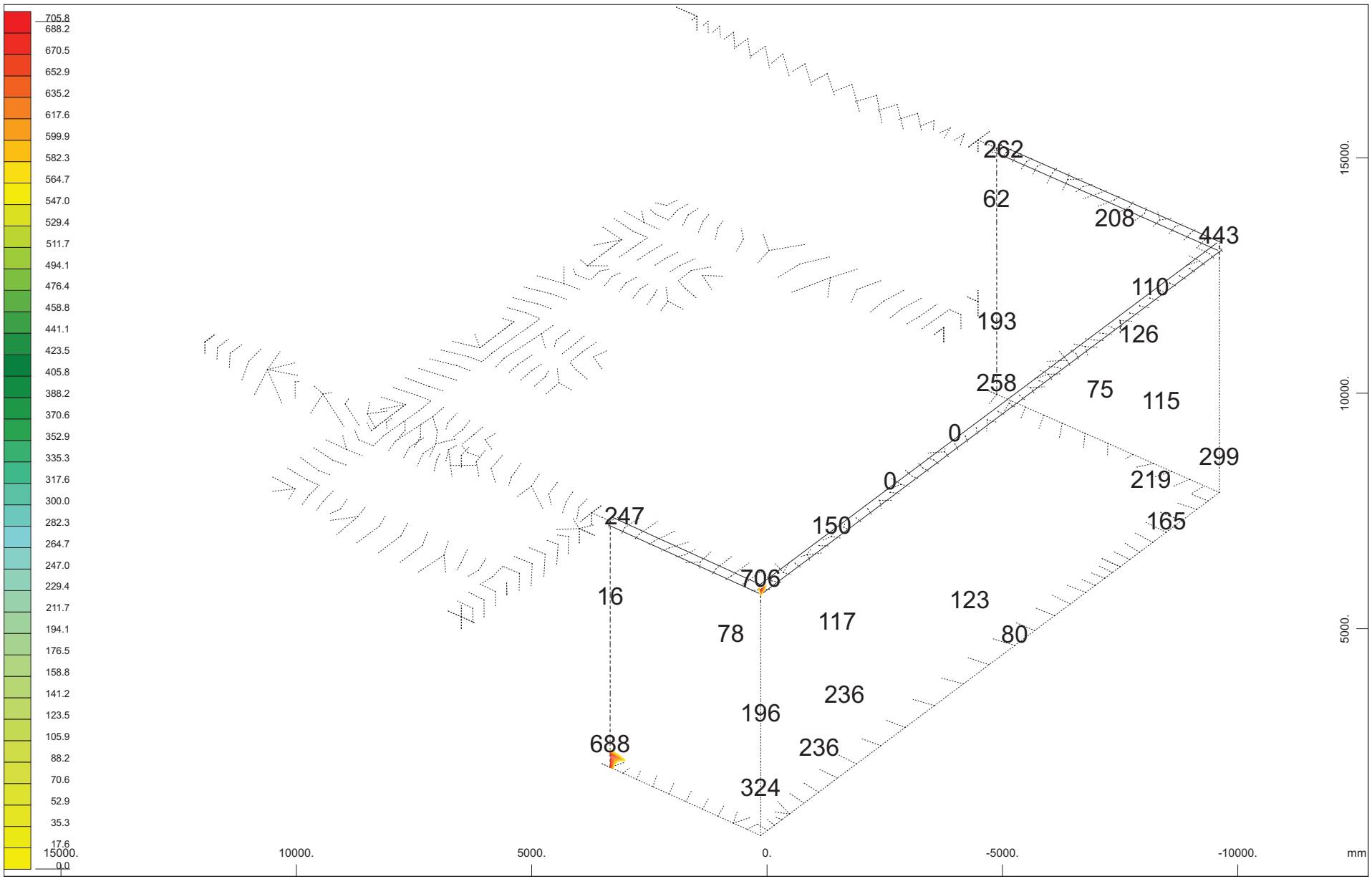
X * 0.845
Y * 0.715
Z * 0.880

Abbey Pynford PLC Hemel Hempstead, HP2 7DX

WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP

Interactive Graphic



Sector of system Quadrilateral Elements Group 150

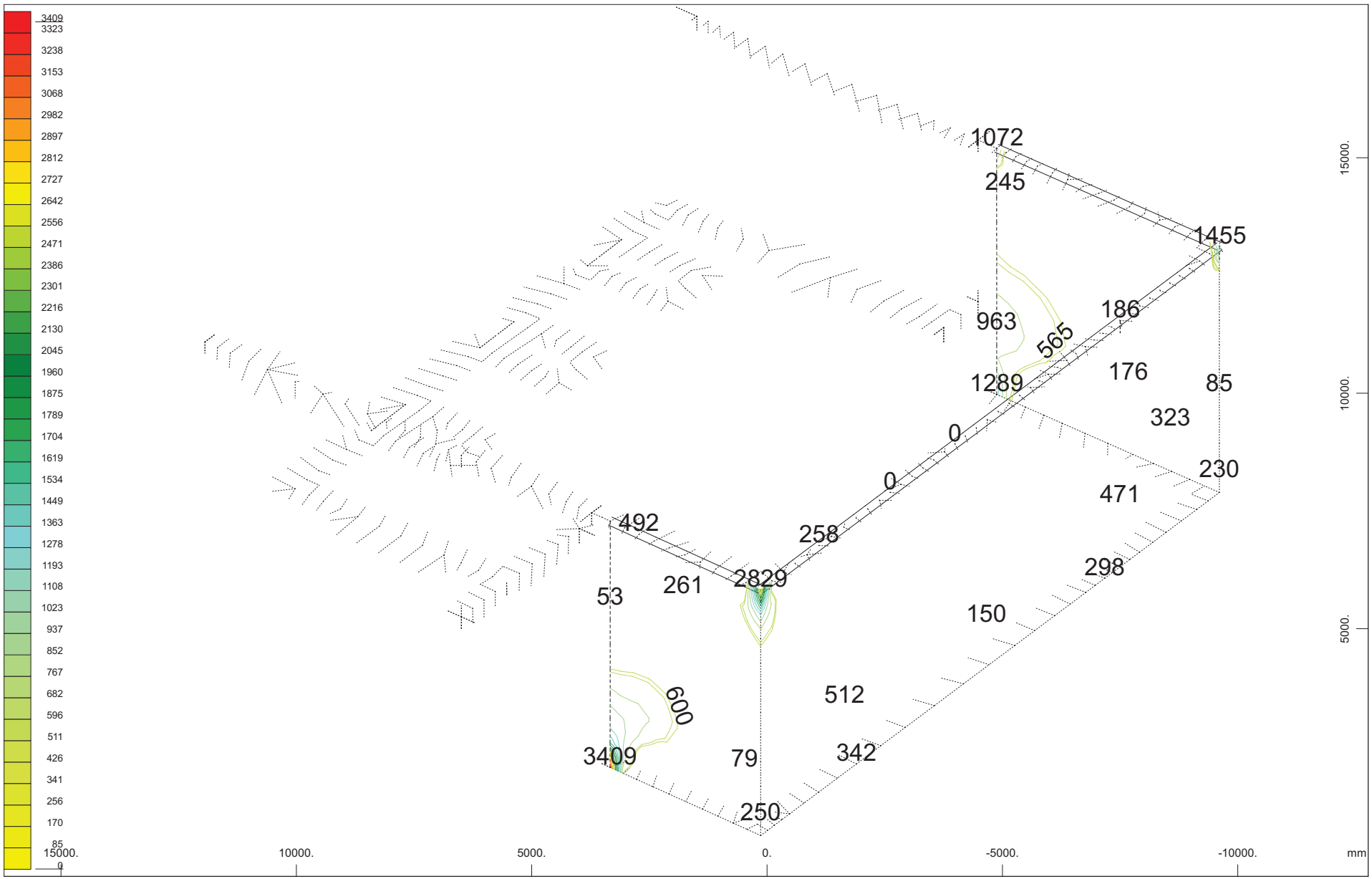
Quadrilateral Elements , upper Principal reinforcements (1st layer) in Node, Design Case 1 , from 565.0 to 705.8 step 10.0 mm2/m

M 1 : 115

X * 0.763
Y * 0.867
Z * 0.817

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Sector of system Quadrilateral Elements Group 150

Quadrilateral Elements , upper Cross reinforcements (2nd layer) in Node

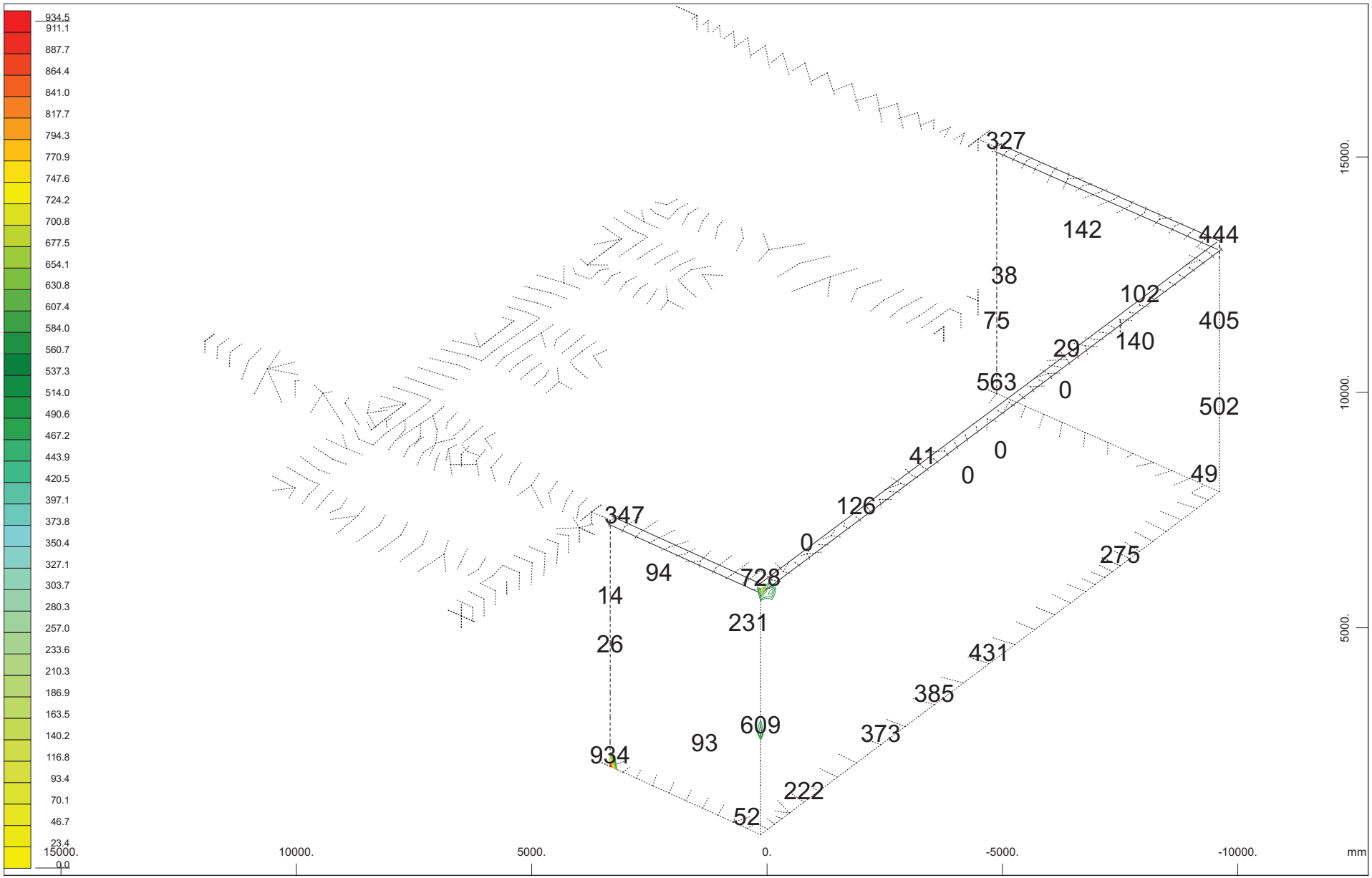
, Design Case 1 , from 565.0 to 3409. step 200.0 mm2/m

M 1 : 115

X * 0.763
Y * 0.867
Z * 0.817

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Sector of system Quadrilateral Elements Group 150

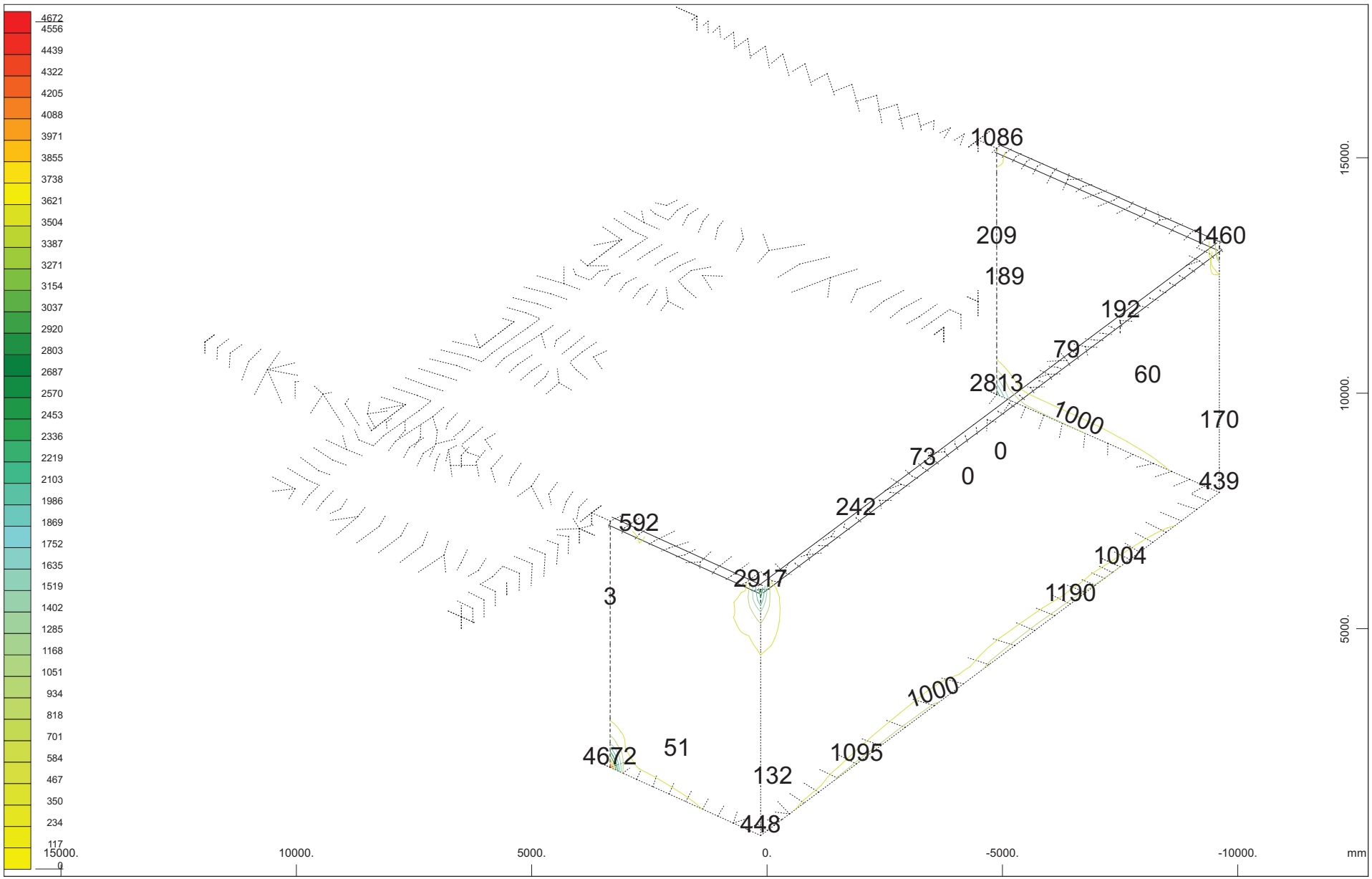
Quadrilateral Elements , lower Principal reinforcements (1st layer) in Node, Design Case 1 , from 565.0 to 934.5 step 20.0 mm2/m

M 1 : 115

X * 0.763
Y * 0.867
Z * 0.817

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP
Interactive Graphic



Sector of system Quadrilateral Elements Group 150

Quadrilateral Elements , lower Cross reinforcements (2nd layer) in Node

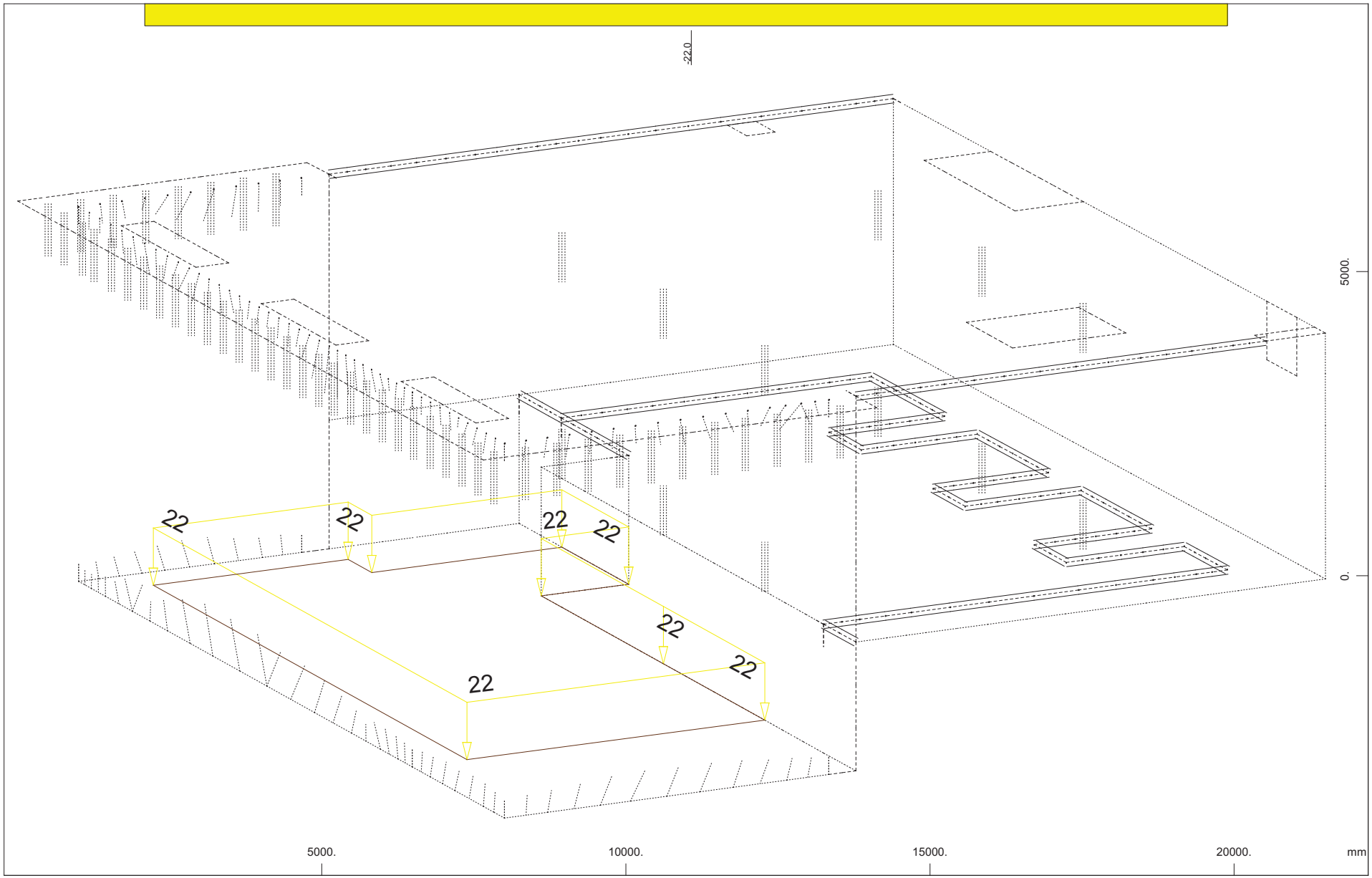
, Design Case 1 , from 565.0 to 4672. step 500.0 mm2/m

M 1 : 115

X * 0.763
Y * 0.867
Z * 0.817

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Z
Y
X

Sector of system Quadrilateral Elements Group 100 110 120 125 135

All loads, Loadcase 2 POOL WATER , (1 cm 3D = unit) Free area load (force) in global Z (Unit=20.0 kN/m2

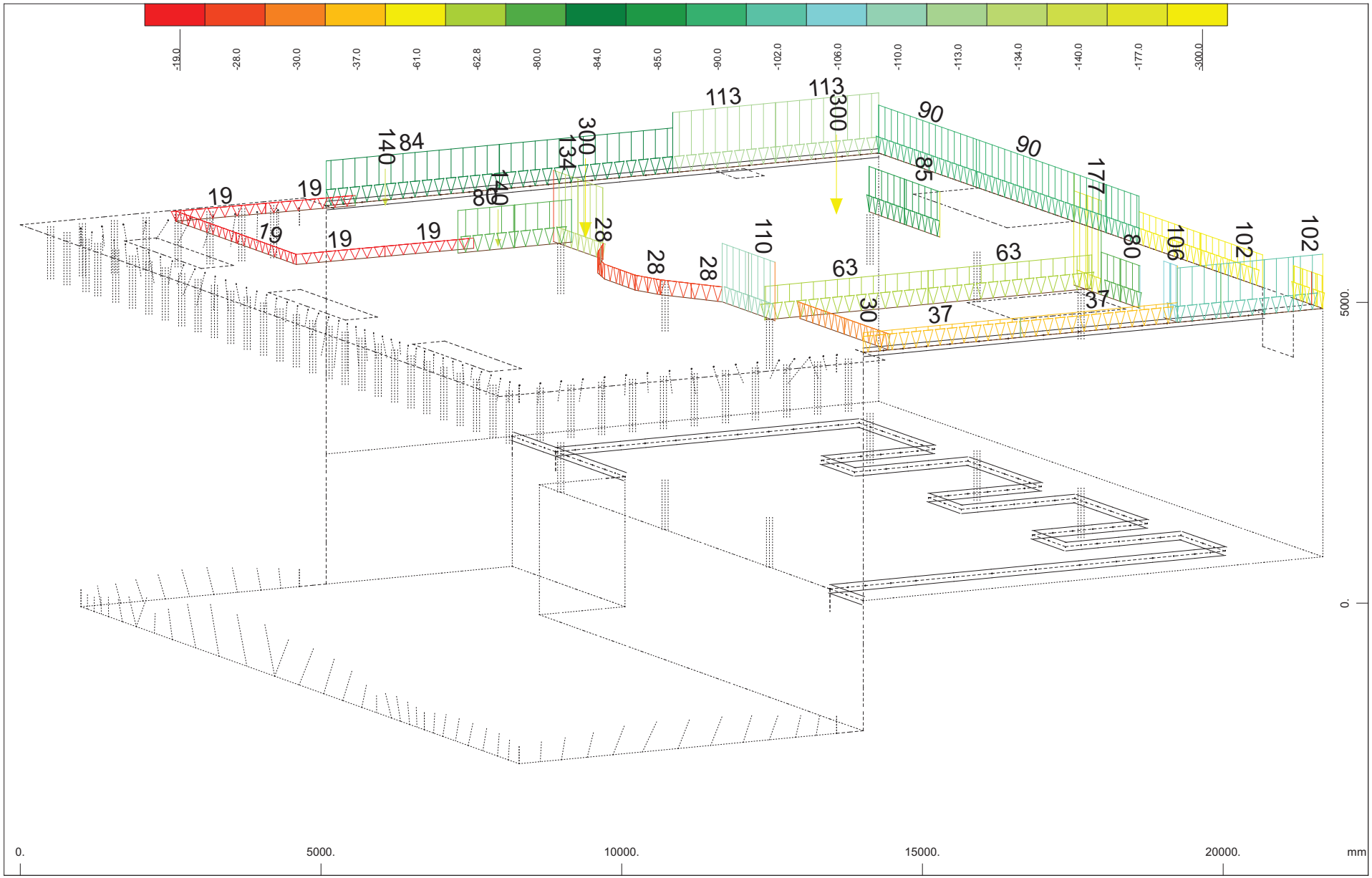
) (Min=-22.0) (Max=-22.0)

M 1 : 89

X * 0.502
Y * 0.906
Z * 0.962

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP
Interactive Graphic



Z
└ X Y

Sector of system Quadrilateral Elements Group 100 110 120 125 135

All loads, Loadcase 3 DL WALLS , (1 cm 3D = unit) Free single load (force) in global Z (Unit=200.0 kN,Min=-300.0 Max=-140.0

Free line load (force) in global Z (Unit=100.0 kN/m,Min=-177.0 Max=-19.0)

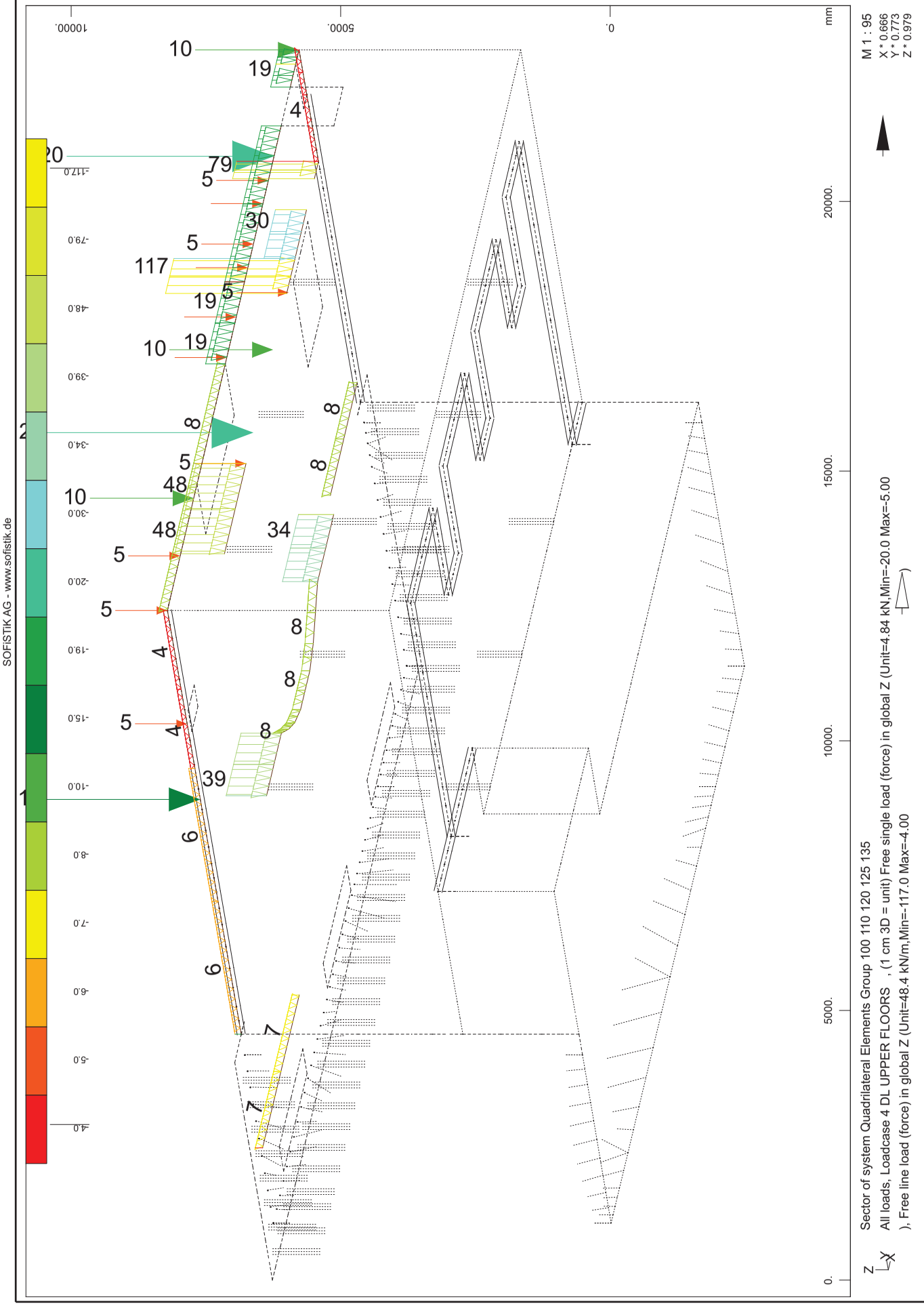
), M 1 : 90

X * 0.485
Y * 0.894
Z * 0.983

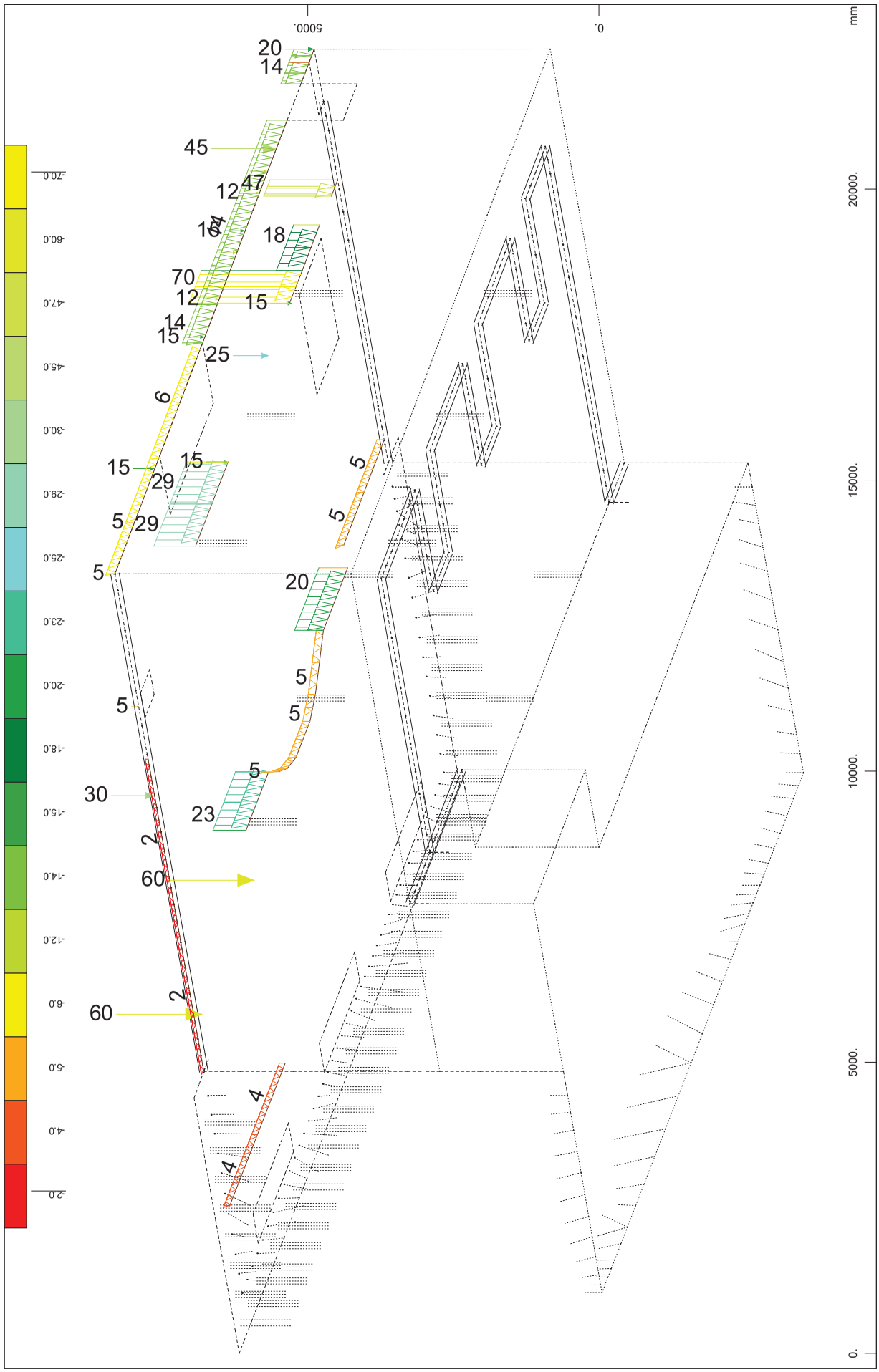
FE GA19787 TEMP
Interactive Graphic

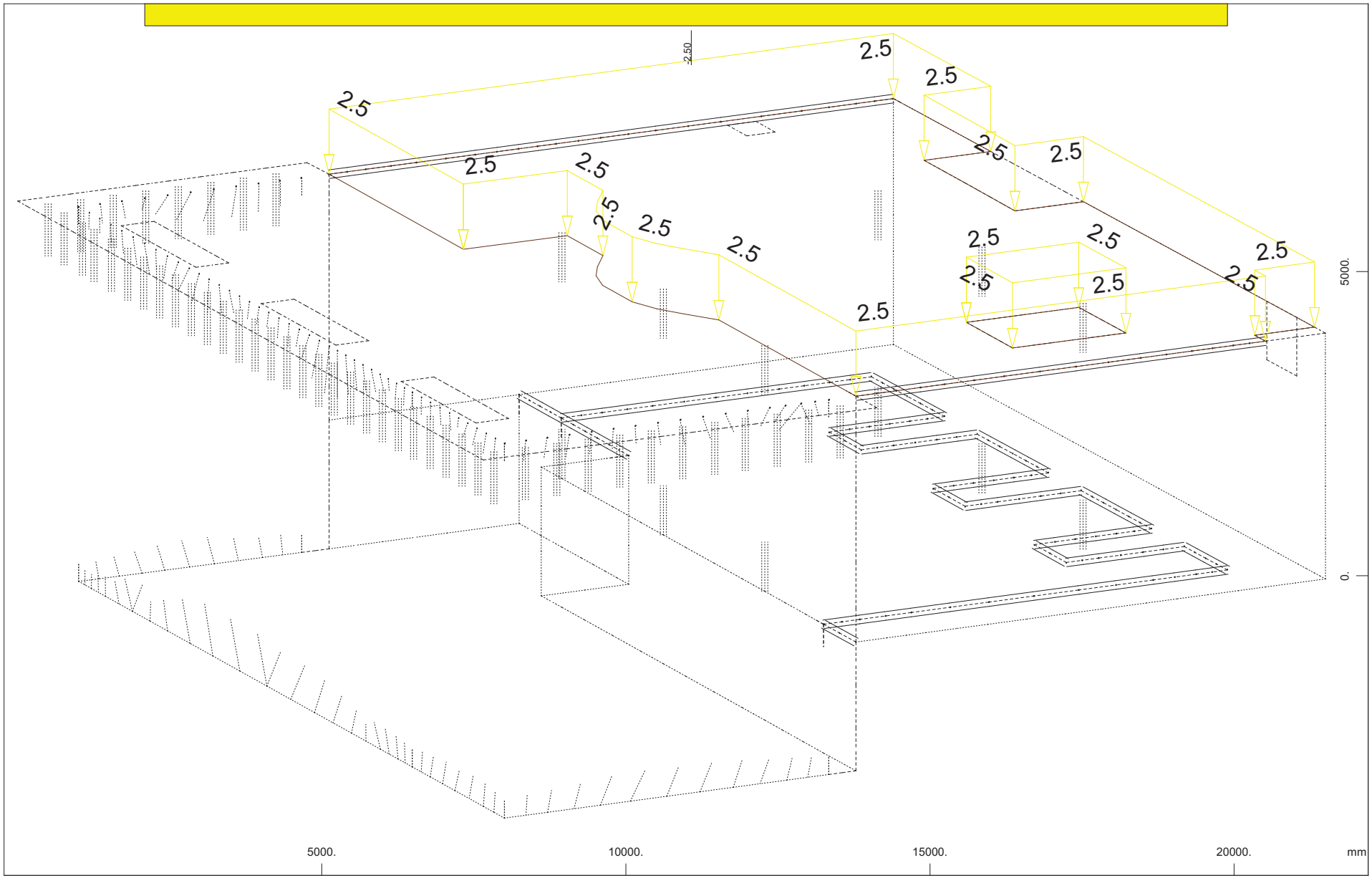
Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP
Interactive Graphic



FE GA19787 TEMP
Interactive Graphic





Z
Y
X

Sector of system Quadrilateral Elements Group 100 110 120 125 135

All loads, Loadcase 6 IMPOSED LGF INSIDE , (1 cm 3D = unit) Free area load (force) in global Z (Unit=2.00 kN/m2

(Max=-2.50)

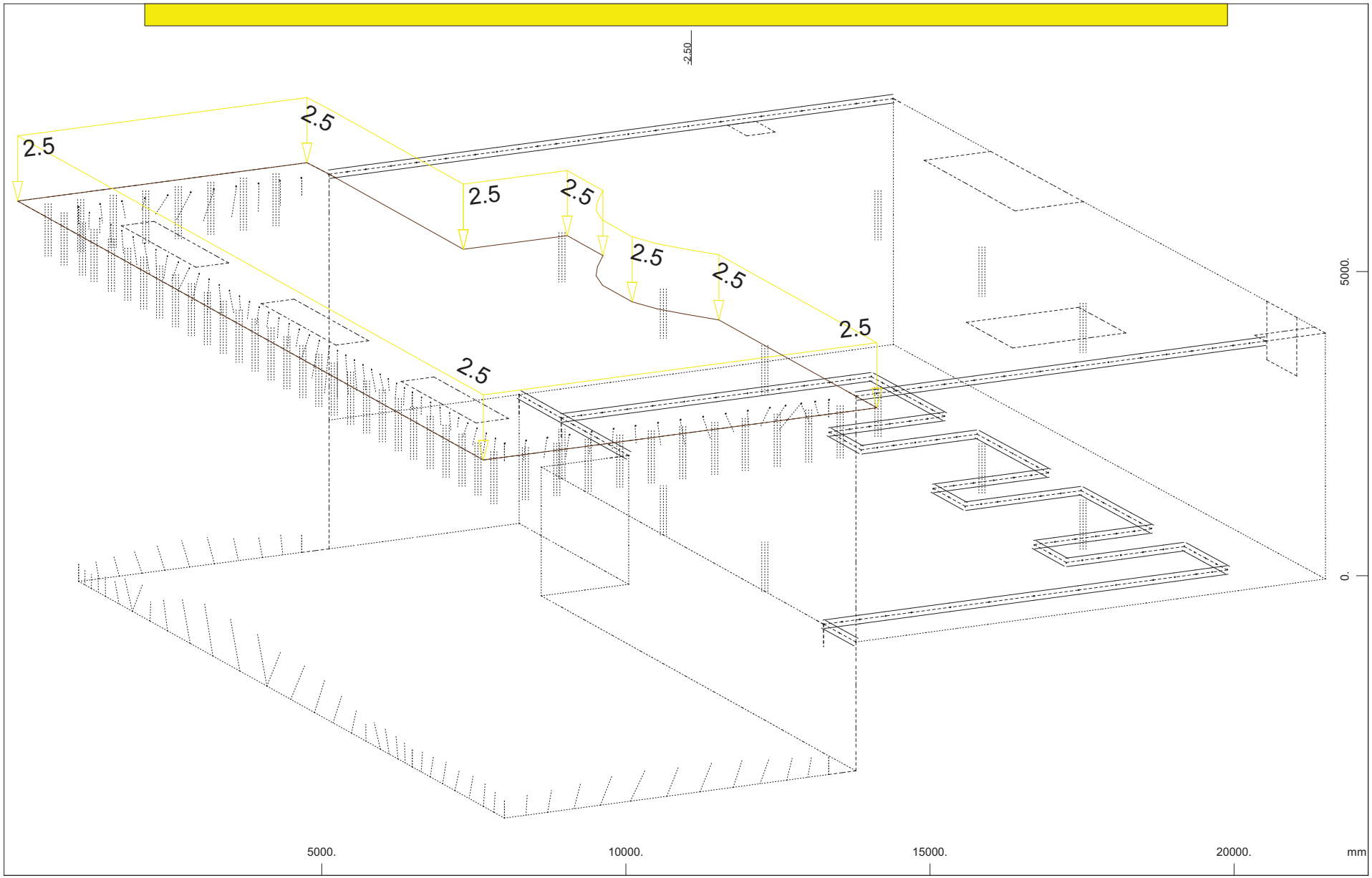
) (Min=-2.50)

M 1 : 89

X * 0.502
Y * 0.906
Z * 0.962

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)

FE GA19787 TEMP
Interactive Graphic



Z
Y
X

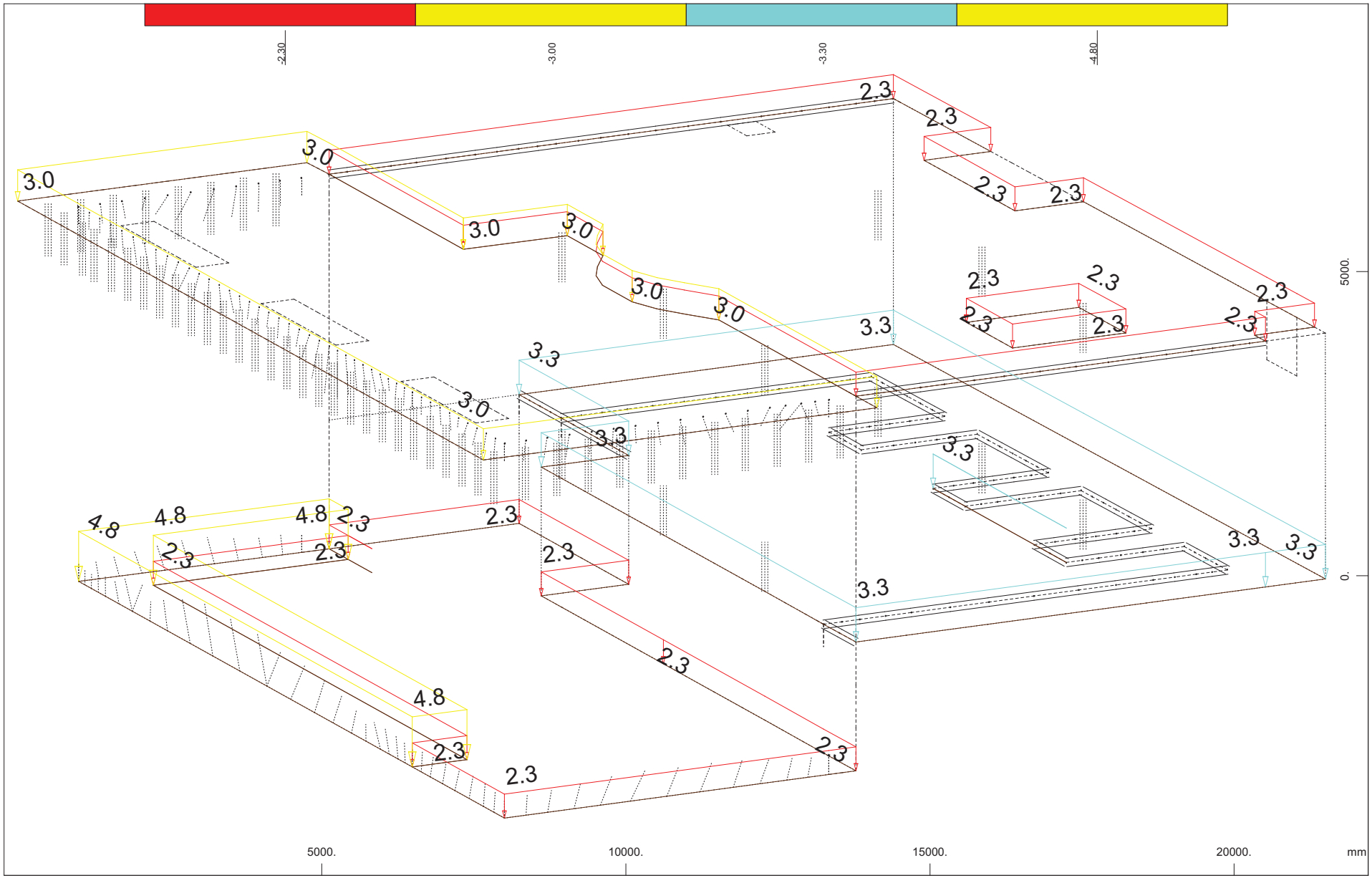
Sector of system Quadrilateral Elements Group 100 110 120 125 135
All loads, Loadcase 7 IMPOSED LGF OUTSIDE , (1 cm 3D = unit) Free area load (force) in global Z (Unit=2.00 kN/m2
(Max=-2.50)

) (Min=-2.50)

M 1 : 89
X * 0.502
Y * 0.906
Z * 0.962

FE GA19787 TEMP
Interactive Graphic

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)



Z
Y
X

Sector of system Quadrilateral Elements Group 100 110 120 125 135

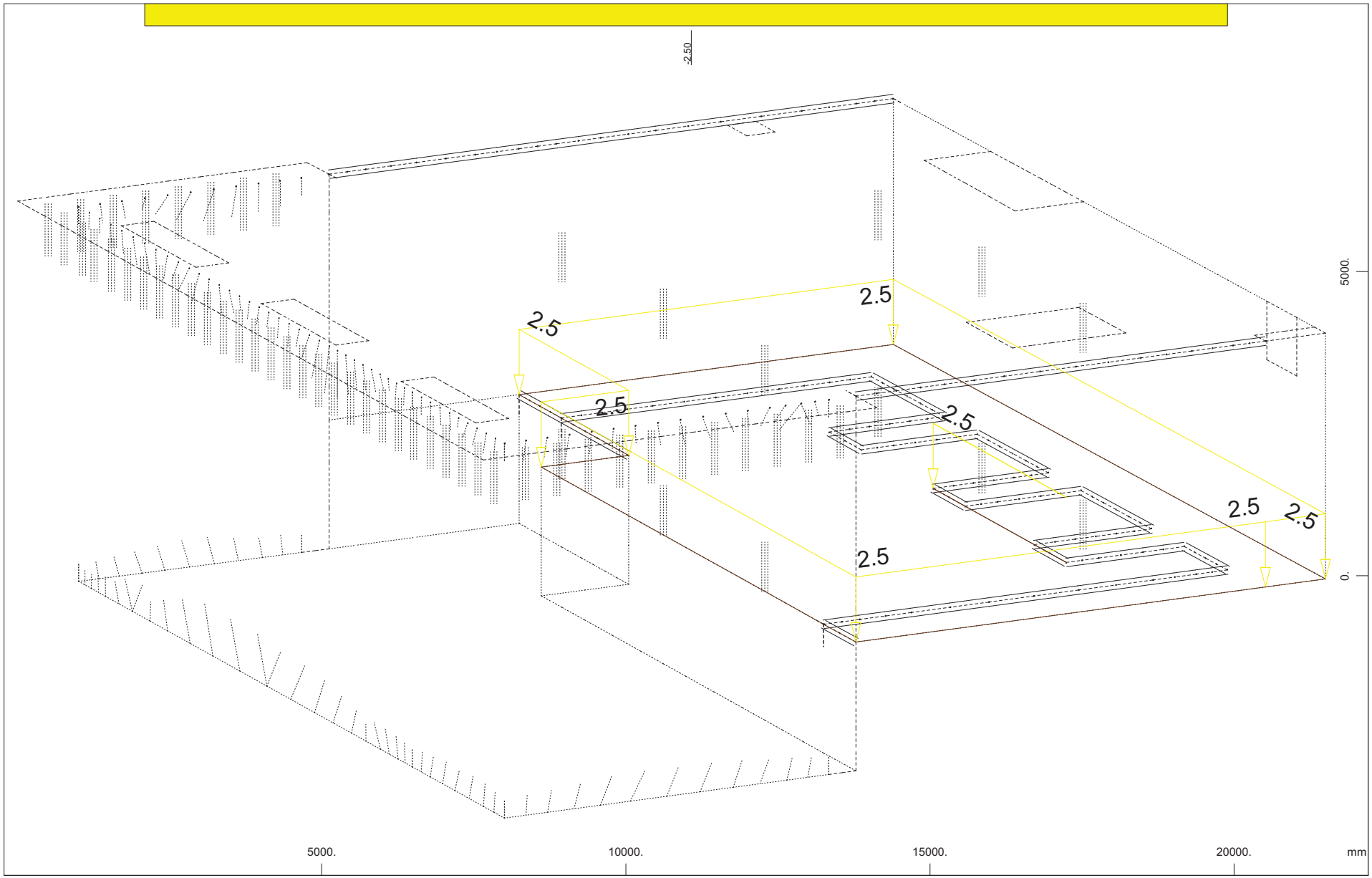
All loads, Loadcase 8 FINISHES , (1 cm 3D = unit) Free area load (force) in global Z (Unit=5.00 kN/m2

) (Min=-4.80) (Max=-2.30)

M 1 : 89

X * 0.502
Y * 0.906
Z * 0.962

FE GA19787 TEMP
Interactive Graphic

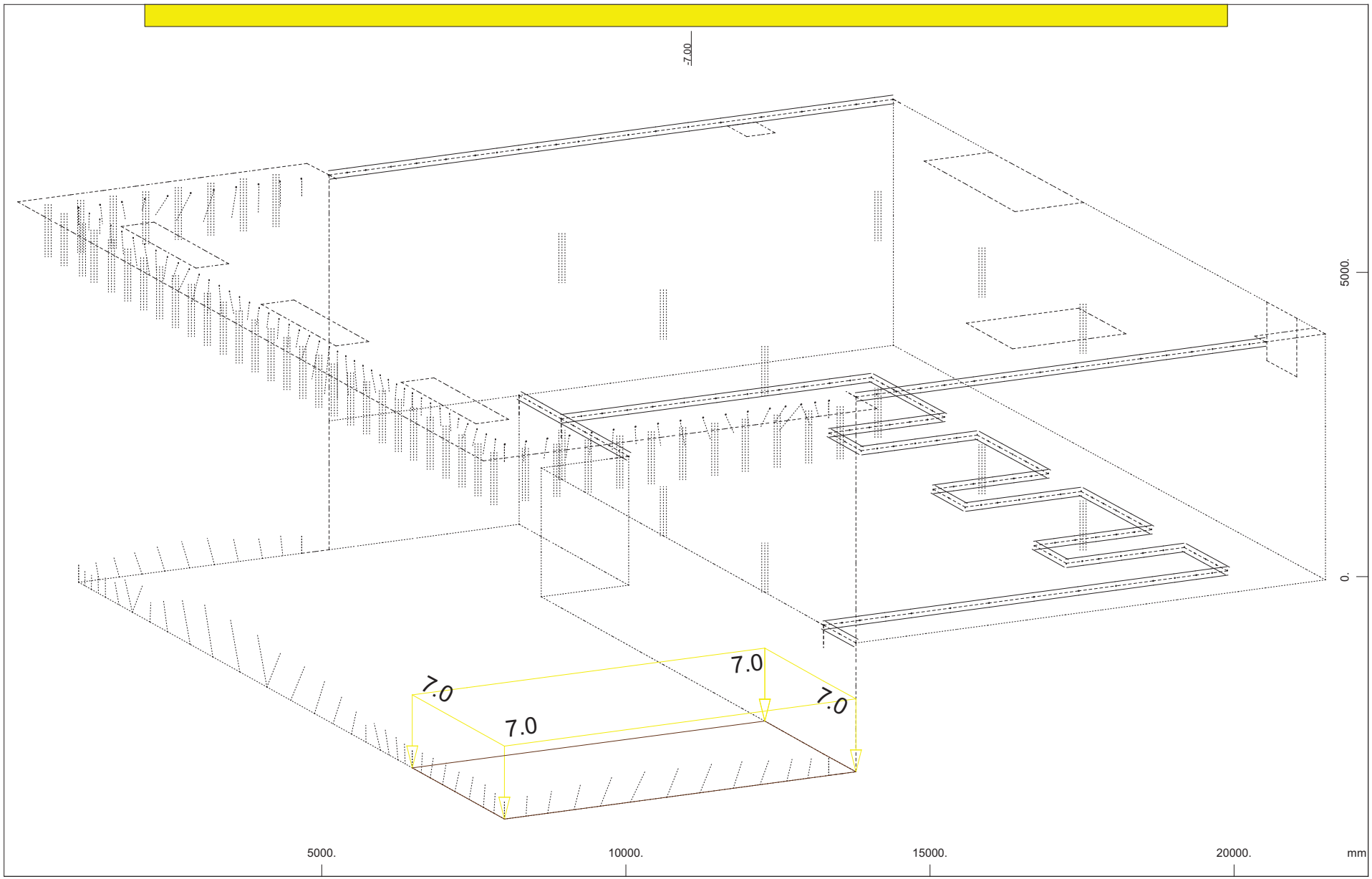


Z
Y
X

Sector of system Quadrilateral Elements Group 100 110 120 125 135
All loads, Loadcase 9 IMPOSED UPPER BASEMENT , (1 cm 3D = unit) Free area load (force) in global Z (Unit=2.00 kN/m2
(Max=-2.50)

) (Min=-2.50)

M 1 : 89
X * 0.502
Y * 0.906
Z * 0.962



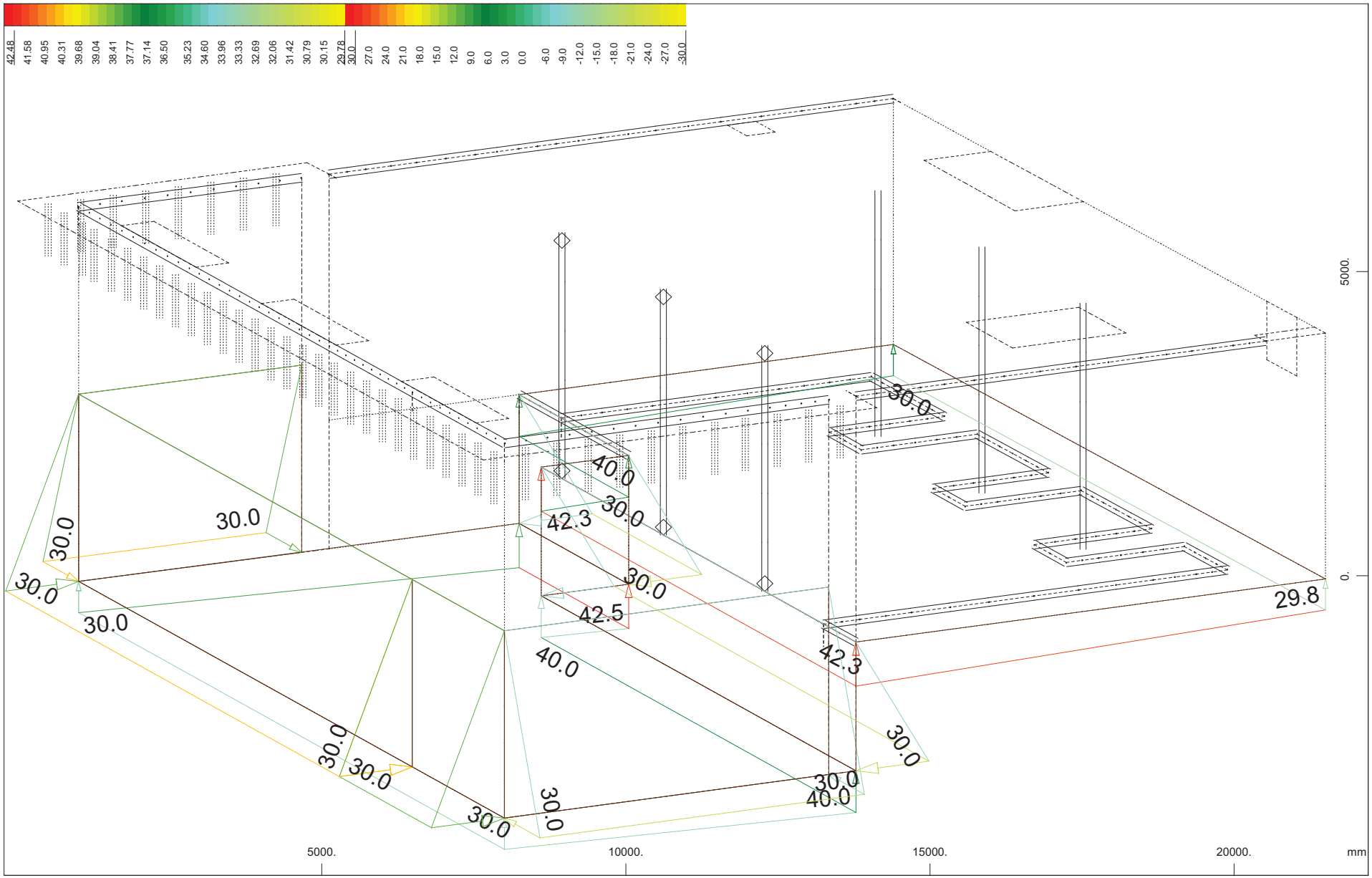
Z
Y
X

Sector of system Quadrilateral Elements Group 100 110 120 125 135
All loads, Loadcase 10 IMPOSED LOWER BASEMENT , (1 cm 3D = unit) Free area load (force) in global Z (Unit=5.00 kN/m2
(Max=-7.00)

) (Min=-7.00)

M 1 : 89
X * 0.502
Y * 0.906
Z * 0.962

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)
FE GA19787 TEMP
Interactive Graphic



Z
Y
X

Sector of system Group 100 110 120 125 130 135 150

All loads, Loadcase 11 UPLIFT FORCE , (1 cm 3D = unit) Free area load (force) in global Z (Unit=50.0 kN/m2

All loads, Loadcase 12 WATER PRESSURE , (1 cm 3D = unit) Free area load (force) in global X (Unit=20.0 kN/m2,Min=-30.0 Max=30.0

) (Max=42.5)

),

M 1 : 89

X * 0.502
Y * 0.906
Z * 0.962

Abbey Pynford PLC Hemel Hempstead, HP2 7DX
WINGRAF - GRAPHICS FOR FINITE ELEMENTS (V 16.17-27)
FE GA19787 TEMP
Interactive Graphic

Project Ref:	☒ 400mm Columns		
Project Title:	69 Redington Rd	REV	-
Block/Building:		Floor:	
Column Ref:		Sheet:	1 of 3

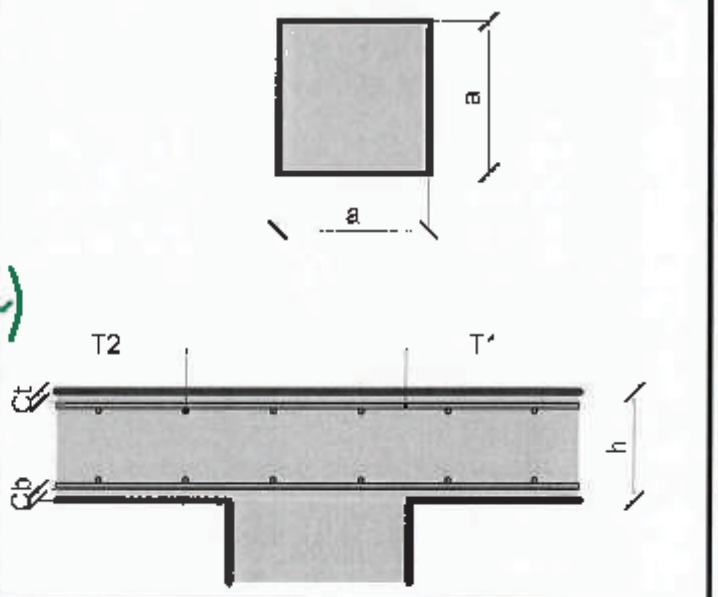
FRANK®

APP/E-40

Telephone

Design Input

Column type:	Square internal
Column size (a):	400 mm
Slab depth (h):	350 mm
Top cover (Ct):	35 mm
Bottom cover (Cb):	35 mm
T1 reinforcement:	Ø 20 = 2136.29 mm²
T2 reinforcement:	Ø 20 = 2136.29 mm²
Shear load (Vt):	1397 kN : Max. Load (factored)
fcu:	35 N/mm²
fyv:	500 N/mm²
Load factor:	1.15



Area table

Perimeter	Shearail® Ø 10 mm	Steel area provided [mm²]	Steel area required [mm²]
0.5d	8	**628.32**	557.72
U1	8 + 16 = 24	**1884.96**	1394.30
U2	16 + 24 = 40	**3141.59**	1874.44

Stud length: 280 mm
Effective depth: 295.0 mm

Project Ref:				FRANK
Project Title:		REV	-	APP/E-41
Block/Building:		Floor:		
Column Ref:		Sheet:	2 of 3	Telephone:

Results

d = 350 - 35 - 20/2 - 20/2	=	295.0 mm
Veff = 1.15 x 1397	=	1606.55 kN
u0 = 4 x 400	=	1600.0 mm
v = 1606.55 x 10 ³ / (1600.0 x 295.0)	=	3.404 N/mm ²
0.8 x 35^ ½	=	4.73 N/mm ²
3.40 < 4.73 PASS		
100 x As / (b x d) = (100 x 2136.29 / (1000 x 305.0) + 100 x 2136.29 / (1000 x 285.0)) /2	=	0.725 (Average)
(400 / d)^ ¼ = (400 / 295.0)^ ¼	=	1.08
vc = [0.79 x (0.725^ 1/3 x 1.08) / 1.25] * (35/25)^1/3	=	0.685 N/mm ²

Perimeter U1

u1 = 4 x 400 + 12.0 x 295.0	=	5140.0 mm
v = (1606.55 x 10 ³) / (5140.0 x 295.0)	=	1.060 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 5140.0 x 295.0) / (0.87 x 500)	=	1394.30 mm ²

Perimeter U2

u2 = 4 x 400 + 18.0 x 295.0	=	6910.0 mm
v = (1606.55 x 10 ³) / (6910.0 x 295.0)	=	0.788 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 6910.0 x 295.0) / (0.87 x 500)	=	1874.44 mm ²

Perimeter U3

u3 = 4 x 400 + 24.0 x 295.0	=	8680.0 mm
v = (1606.55 x 10 ³) / (8680.0 x 295.0)	=	0.627 N/mm ²

v < vc therefore no more punching shear reinforcement is required

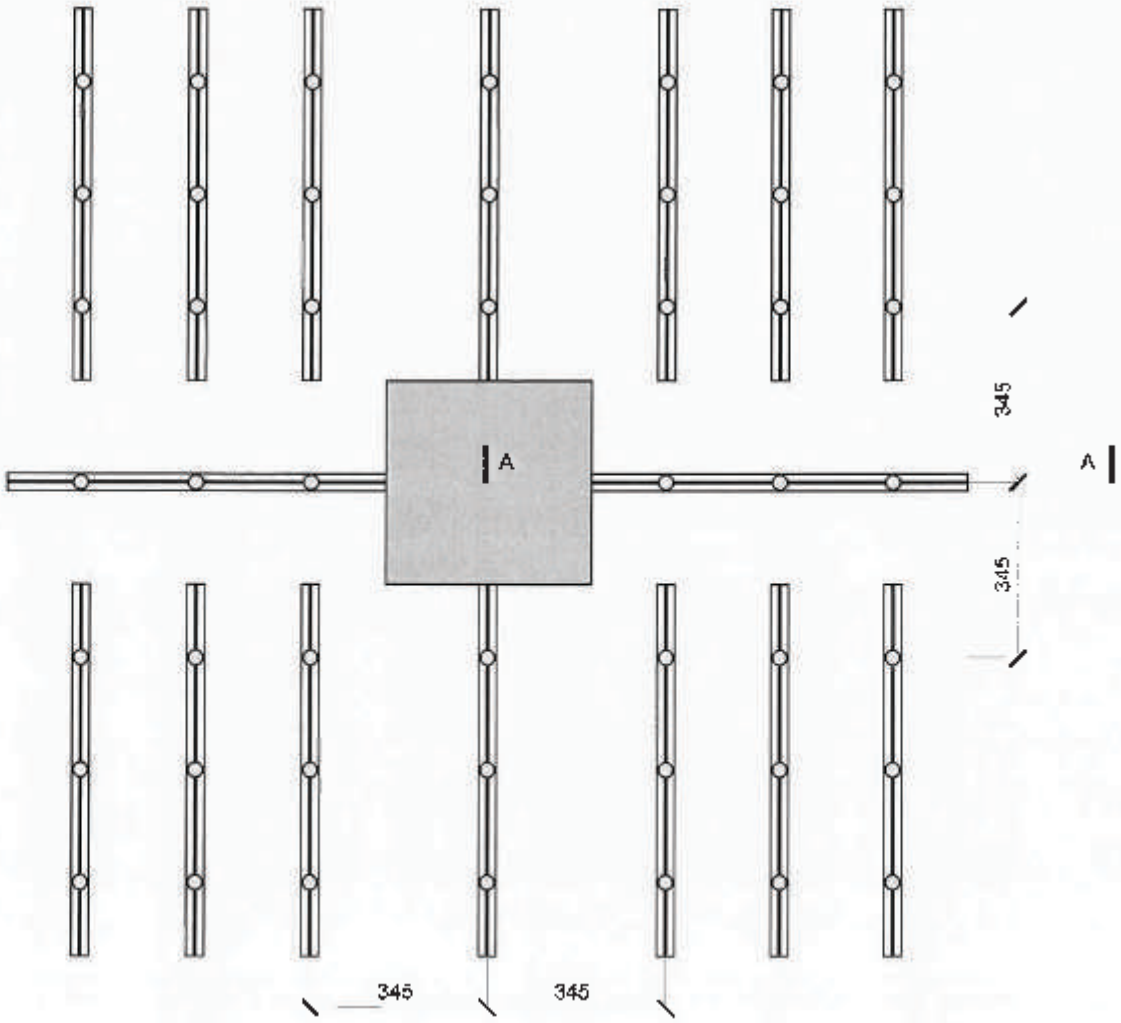
Project Ref:			
Project Title:		REV	-
Block/Building:		Floor:	
Column Ref:		Sheet:	3 of 3

FRANK

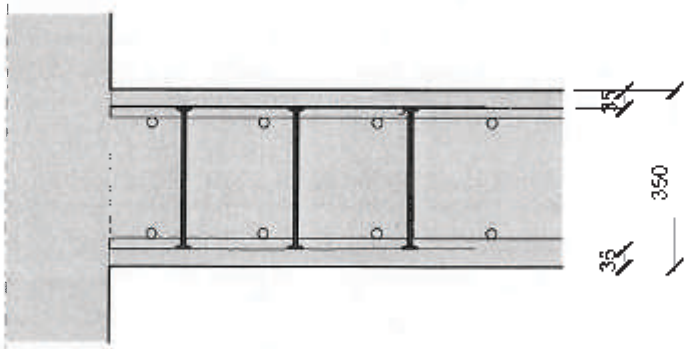
AR/E - 42

Telephone:

Layout Plan



Section A-A



Shearail® requirement

16 rails per location
Number of locations: 1
Total number of rails: 16

Rail code: ES1DE917D3CR

Project Ref:	400mm Column on EDGE			
Project Title:	69 Redington Rd			REV -
Block/Building:		Floor:		
Column Ref:		Sheet:	1 of 3	

FRANK®

APP/E - 43

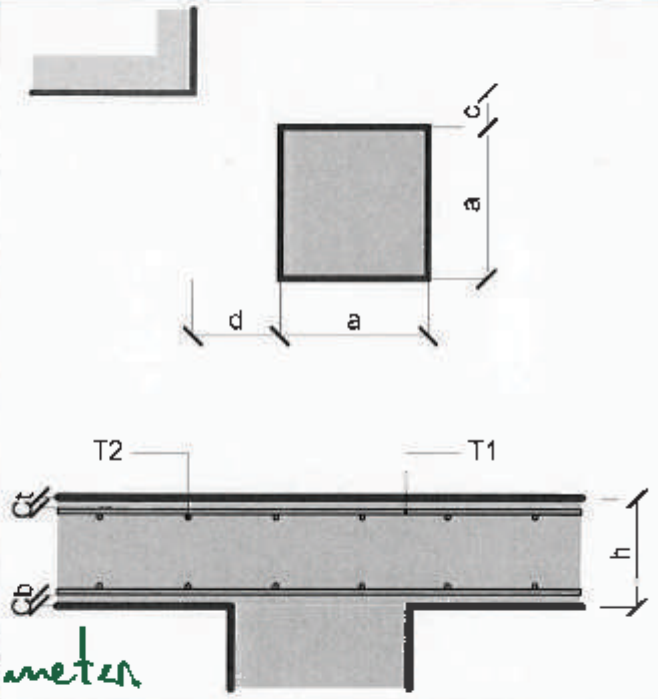
Telephone.

Design Input

Column type:	Square external corner
Column size (a):	400 mm
Offset (c):	0 mm
Offset (d):	0 mm
Slab depth (h):	350 mm
Top cover (Ct):	35 mm
Bottom cover (Cb):	35 mm
T1 reinforcement:	Ø 20 = 2136.29 mm²
T2 reinforcement:	Ø 20 = 2136.29 mm²
Shear load (Vt):	938 kN
fcu:	35 N/mm²
fyv:	500 N/mm²
Load factor:	1.25

938 = 70% of 1340 KN

min 30% of the load is inside the shear perimeter



Area table

Perimeter	Shearail® Ø 10 mm	Steel area provided [mm²]	Steel area required [mm²]
0.5d	7	**549.78**	461.69
U1	7 + 13 = 20	**1570.80**	1154.23
U2	13 + 19 = 32	**2513.27**	1514.33

Stud length: 280 mm
Effective depth: 295.0 mm

Project Ref:				FRANK® APPE-44
Project Title:			REV -	
Block/Building:		Floor:		
Column Ref:		Sheet:	2 of 3	Telephone.

Results

d = 350 - 35 - 20/2 - 20/2	=	295.0 mm
Veff = 1.25 x 938	=	1172.50 kN
u0 = (4 x 400)	=	1600.0 mm
v = 1172.50 x 10 ³ / (1600.0 x 295.0)	=	2.484 N/mm ²
0.8 x 35^ ½	=	4.73 N/mm ²
2.48 < 4.73 PASS		
100 x As / (b x d) = (100 x 2136.29 / (1000 x 305.0) + 100 x 2136.29 / (1000 x 285.0)) /2	=	0.725 (Average)
(400 / d)^ ¼ = (400 / 295.0)^ ¼	=	1.08
vc = [0.79 x (0.725^ 1/3 x 1.08) / 1.25] * (35/25)^1/3	=	0.685 N/mm ²

Perimeter U1

u1 = 4 x 400 + 0 + 0 + 9.0 x 295.0	=	4255.0 mm
v = (1172.50 x 10 ³) / (4255.0 x 295.0)	=	0.934 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 4255.0 x 295.0) / (0.87 x 500)	=	1154.23 mm ²

Perimeter U2

u2 = 4 x 400 + 0 + 0 + 13.5 x 295.0	=	5582.5 mm
v = (1172.50 x 10 ³) / (5582.5 x 295.0)	=	0.712 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 5582.5 x 295.0) / (0.87 x 500)	=	1514.33 mm ²

Perimeter U3

u3 = 4 x 400 + 0 + 0 + 18.0 x 295.0	=	6910.0 mm
v = (1172.50 x 10 ³) / (6910.0 x 295.0)	=	0.575 N/mm ²

v < vc therefore no more punching shear reinforcement is required

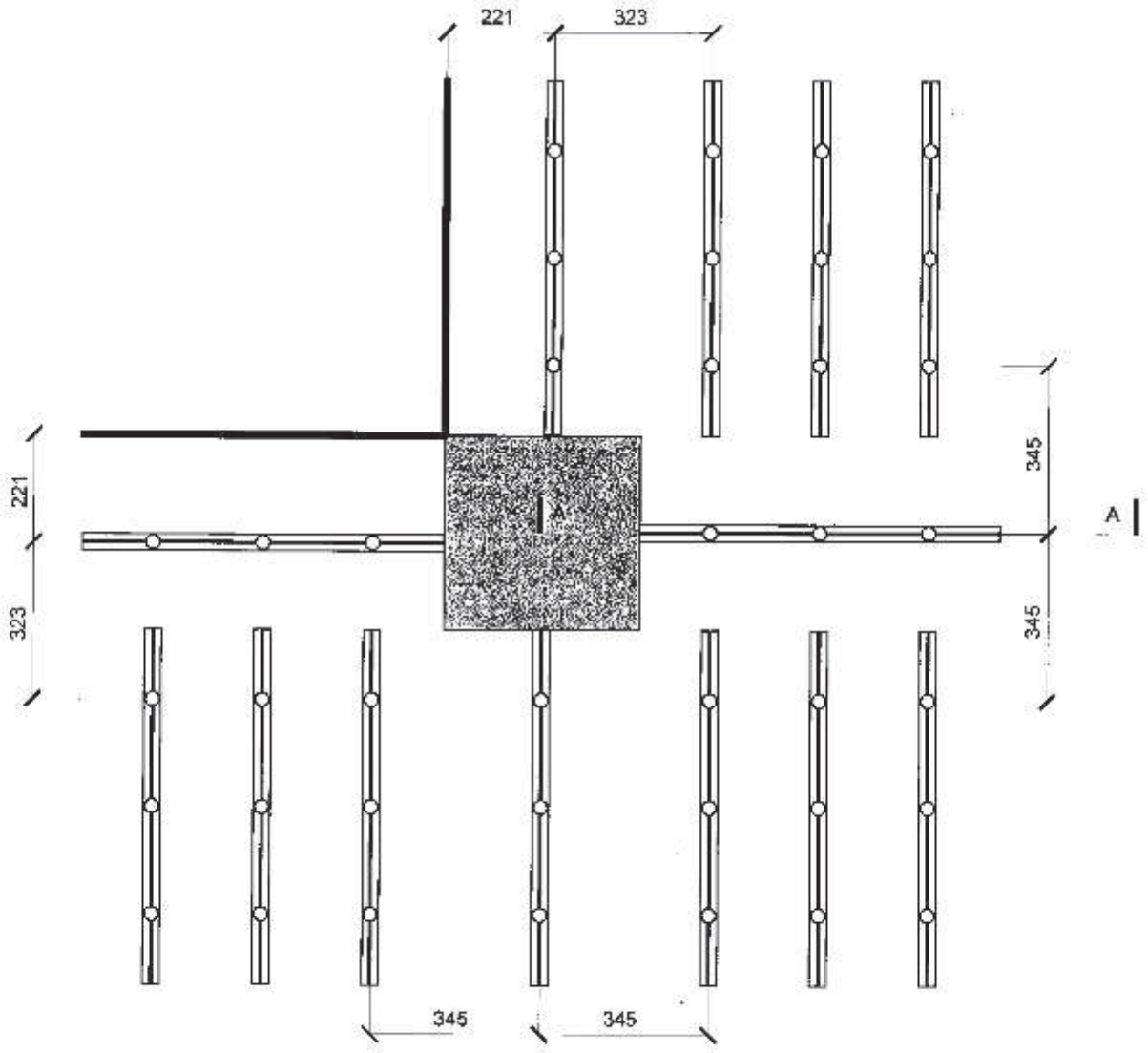
Project Ref:			
Project Title:		REV	-
Block/Building:		Floor:	
Column Ref:		Sheet:	3 of 3

FRANK

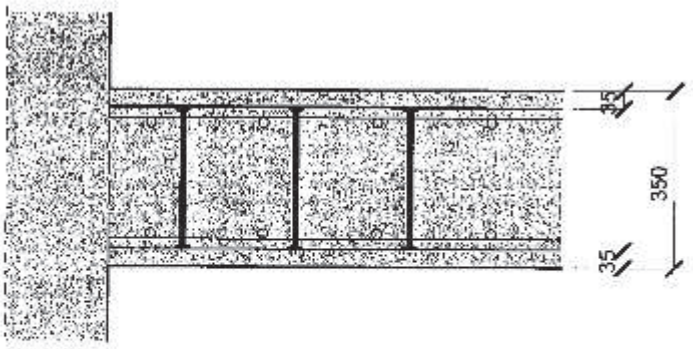
APP/E-45

Telephone:

Layout Plan



Section A-A



Shearail® requirement

13 rails per location
Number of locations: 1
Total number of rails: 13

Rail code: ES1DE917D3CR

Project Ref:	☐ 350 mm Column			
Project Title:	69 Redington Rd		REV	-
Block/Building:		Floor:		
Column Ref:		Sheet:	1 of 3	

FRANK®

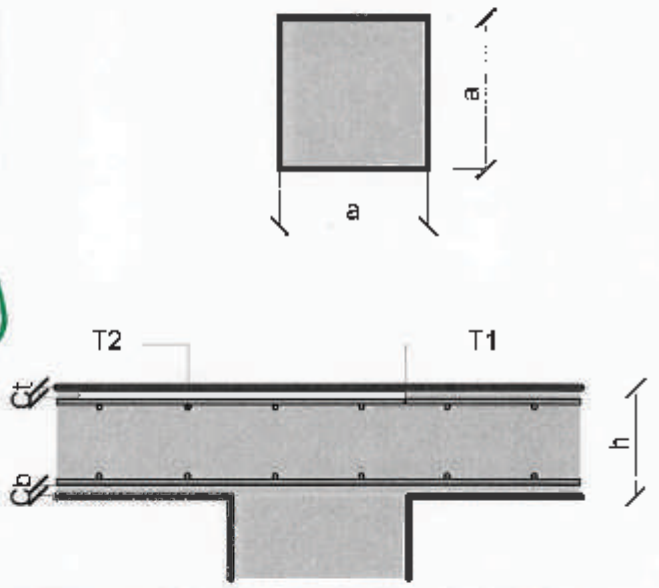
APP/E-46

Telephone

Design Input

Column type:	Square internal
Column size (a):	350 mm
Slab depth (h):	350 mm
Top cover (Ct):	35 mm
Bottom cover (Cb):	35 mm
T1 reinforcement:	Ø 20 = 2136.29 mm²
T2 reinforcement:	Ø 20 = 2136.29 mm²
Shear load (Vt):	1277 kN : Raw load (Factored)
fcu:	35 N/mm²
fyv:	500 N/mm²
Load factor:	1.15

Max. factored load is 1277 kN; but min. 30% of this load is inside the shear perimeter.



Area table

Perimeter	Shearail® Ø 10 mm	Steel area provided [mm²]	Steel area required [mm²]
0.5d	8	**628.32**	536.02
U1	8 + 16 = 24	**1884.96**	1340.05
U2	16 + 24 = 40	**3141.59**	1820.18

Stud length: 280 mm
Effective depth: 295.0 mm

Project Ref:				FRANK® APP/E-47
Project Title:		REV	-	
Block/Building:		Floor:		
Column Ref:		Sheet:	2 of 3	Telephone:

Results

d = 350 - 35 - 20/2 - 20/2	=	295.0 mm
Veff = 1.15 x 1277	=	1468.55 kN
u0 = 4 x 350	=	1400.0 mm
v = 1468.55 x 10 ³ / (1400.0 x 295.0)	=	3.556 N/mm ²
0.8 x 35^ ½	=	4.73 N/mm ²
3.56 < 4.73 PASS		
100 x As / (b x d) = (100 x 2136.29 / (1000 x 305.0) + 100 x 2136.29 / (1000 x 285.0)) /2	=	0.725 (Average)
(400 / d)^ ¼ = (400 / 295.0)^ ¼	=	1.08
vc = [0.79 x (0.725^ 1/3 x 1.08) / 1.25] * (35/25)^1/3	=	0.685 N/mm ²

Perimeter U1

u1 = 4 x 350 + 12.0 x 295.0	=	4940.0 mm
v = (1468.55 x 10 ³) / (4940.0 x 295.0)	=	1.008 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 4940.0 x 295.0) / (0.87 x 500)	=	1340.05 mm ²

Perimeter U2

u2 = 4 x 350 + 18.0 x 295.0	=	6710.0 mm
v = (1468.55 x 10 ³) / (6710.0 x 295.0)	=	0.742 N/mm ²
Asv(min) > Asv therefore minimum required steel area used		
Asv(min) = (0.4 x 6710.0 x 295.0) / (0.87 x 500)	=	1820.18 mm ²

Perimeter U3

u3 = 4 x 350 + 24.0 x 295.0	=	8480.0 mm
v = (1468.55 x 10 ³) / (8480.0 x 295.0)	=	0.587 N/mm ²

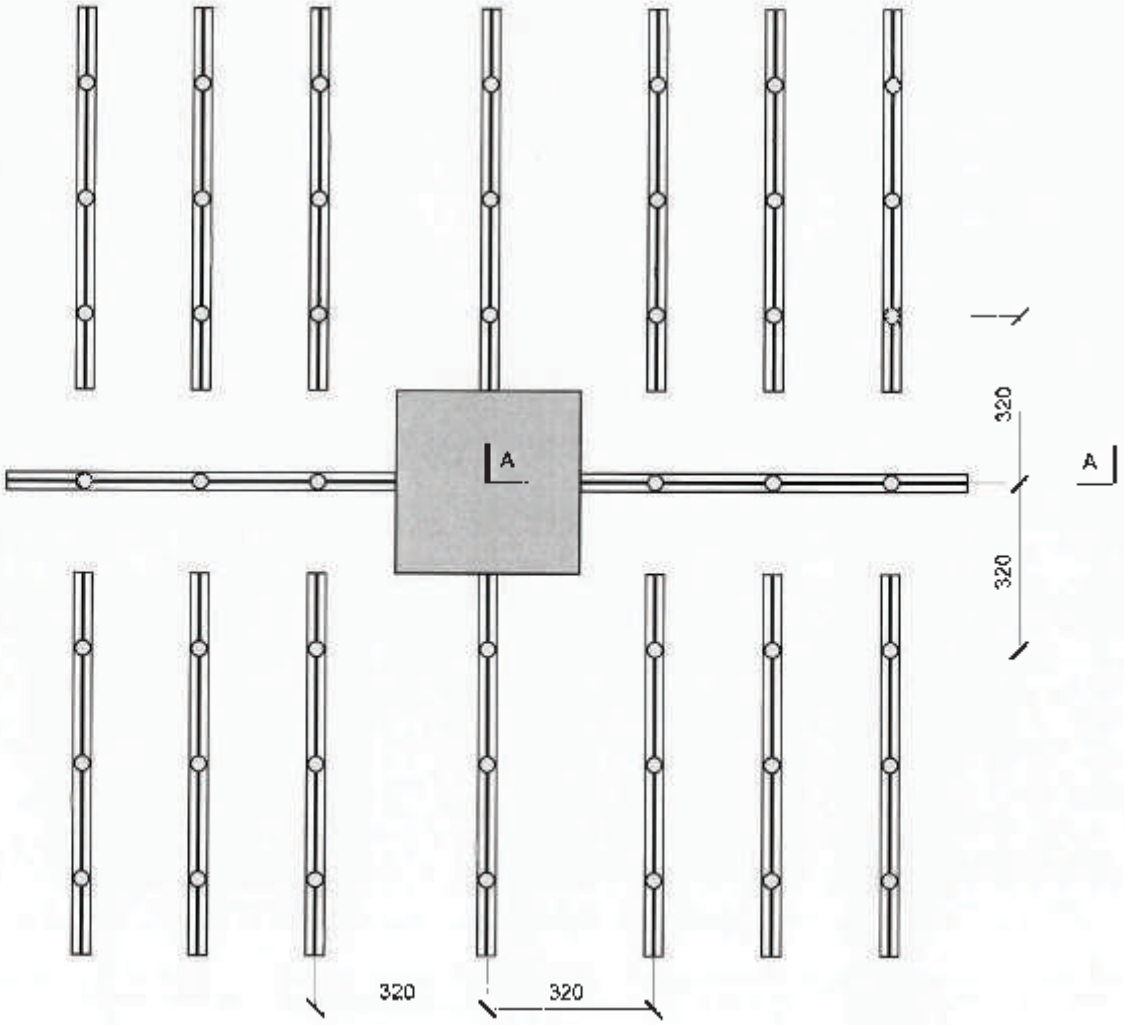
v < vc therefore no more punching shear reinforcement is required

Project Ref:				
Project Title:			REV	-
Block/Building:		Floor:		
Column Ref:		Sheet:	3 of 3	

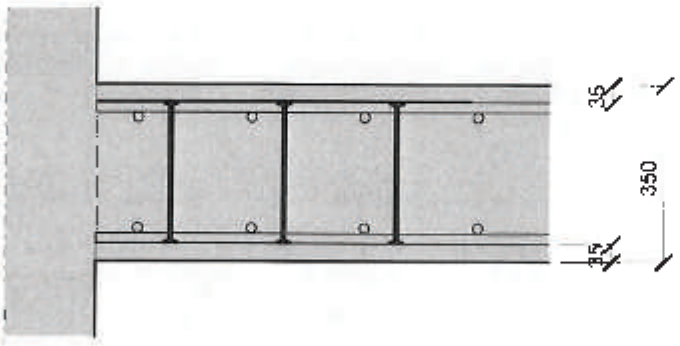
APP/E-48

Telephone:

Layout Plan



Section A-A



Shearail® requirement

16 rails per location
Number of locations: 1
Total number of rails: 16

Rail code: ES1DE917D3CR

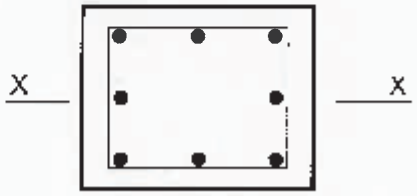
Project	69 Redington Rd		ABBEY PYNFORD
Client	SHAKIB	The Concrete Centre	
Location	LONDON		Made by: JO | Date: 09-Dec-14 | Page: APP/E-49
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005		Checked: MJ | Revision: - | Job No: GA19787
	Originated from RCC63.xls v3.1 on CD	© 2008 TCC	

MATERIALS

fcu	35	N/mm²	ym, steel	1.15	Cover to link	35	mm
fy	500	N/mm²	ym, conc	1.5	h agg	20	mm
steel class	A						

SECTION

h	400	mm
b	400	mm
with	3	#N/A
and	3	#N/A



RESTRAINTS

	Lo (mm)	Top Condition	Btm Condition	Braced ?	ß	Le (mm)	Slenderness	Status
X-AXIS	3000	2	3	Y	0.95	2850	Lex/h = 7.13	Column is
Y-AXIS	3000	2	3	Y	0.95	2850	Ley/b = 7.13	SHORT

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) M ix	TOP MOMENTS (kNm) M iy	BTM MOMENTS (kNm) M ix	BTM MOMENTS (kNm) M iy
B1	1472	110.0	110.0	0.0	0.0
B2	1472		110.0	0.0	0.0
Loadcase 3				0.0	0.0
Loadcase 4				0.0	0.0
Loadcase 5				0.0	0.0
Loadcase 6				0.0	0.0

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 400 Face	BAR CENTRES (mm) 400 Face	Nuz (kN)	Checks
H 40	6.28	10	135	135	0	Asc > 6 % (3.12.6.2)
H 32	4.02	8	141	141	5198	ok
H 25	2.45	8	145	145	4147	ok
H 20	1.57	6	149	149	3555	ok
H 16	1.01	6	151	151	3176	ok
H 12	0.57	6	153	153	2881	ok

DESIGN MOMENTS (kN

	K	X AXIS M add	X AXIS Mx	Y AXIS M add	Y AXIS My	COMBINED Axis	COMBINED M'	REBAR	max V*
B1	0.000	0.0	110.0	0.0	110.0	X	186.3	8 H 16	75.2
B2	0.000	0.0	0.0	0.0	110.0	Y	110.0	8 H 12	62.5
Loadcase 3									#DIV/0!
Loadcase 4									#DIV/0!
Loadcase 5									#DIV/0!
Loadcase 6									#DIV/0!

SEE CHARTS ON NEXT SHEET

eccentricity = 75mm applied to both axis

Project	69 Redington Rd		**ABBEY PYNFORD**
Client	SHAKIB		
Location	LONDON		

The Concrete Centre

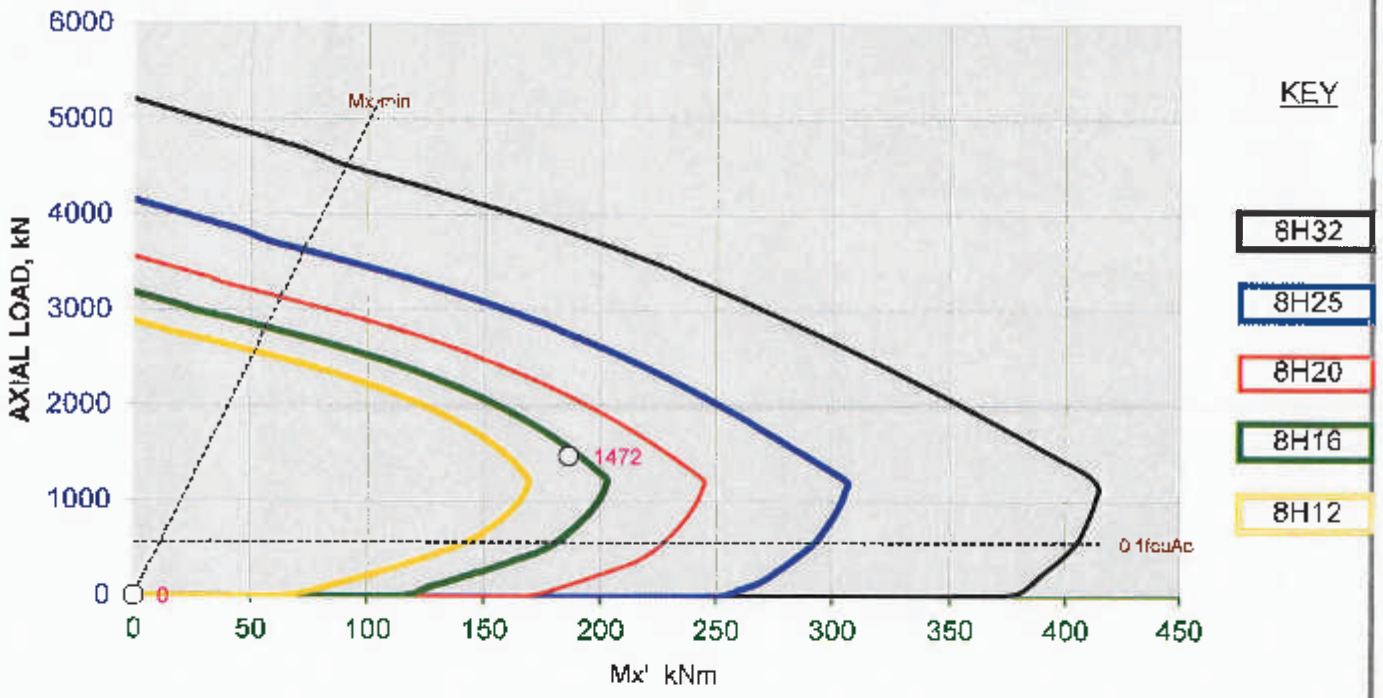
SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005

Originated from RCC53.xls v3.1 on CD

Made by	Date	Page
JO	09-Dec-14	ANE.50
Checked	**Revision**	**Job No**
MJ	-	GA19787

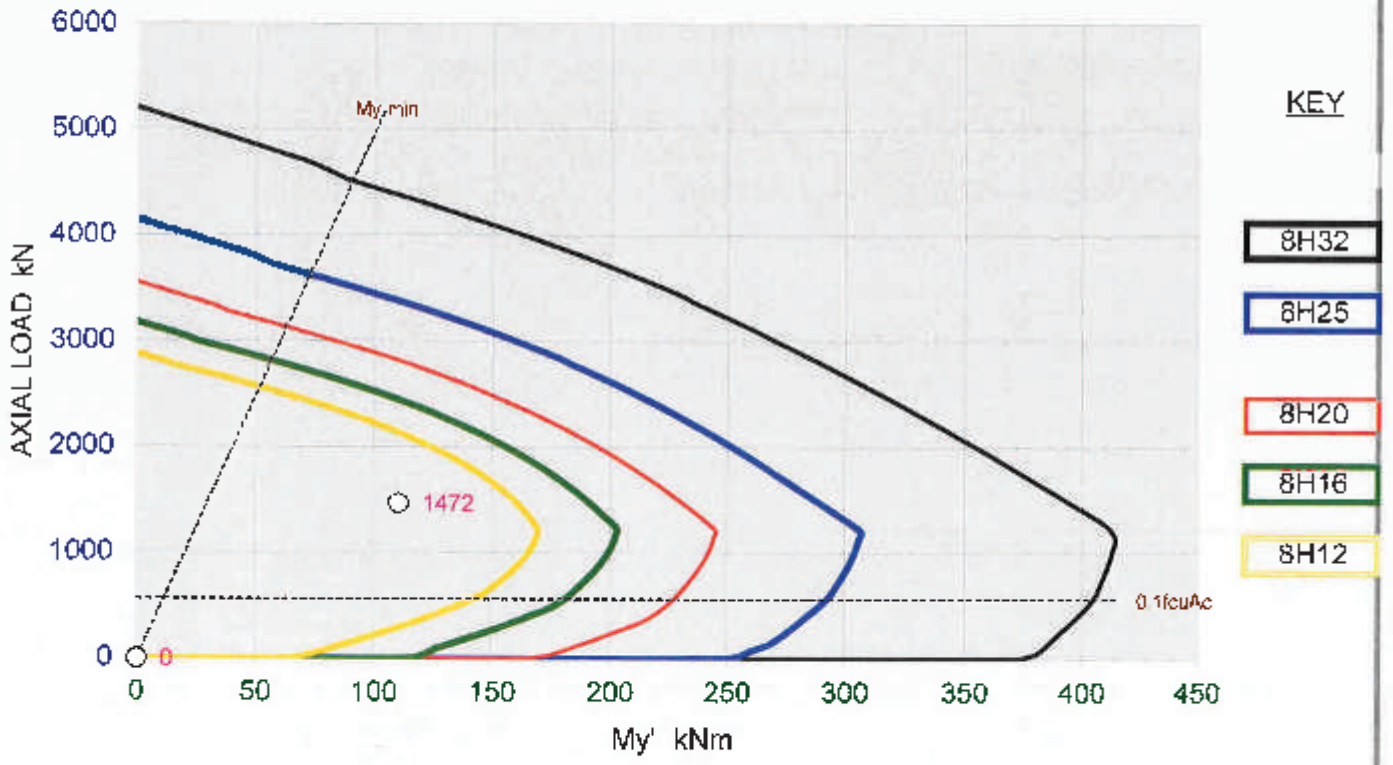
N:M interaction chart: Mx' critical

400 x 400 column (h x b), grade C35, 35 mm cover



N:M interaction chart: My' critical

400 x 400 column (h x b), moment about yy axis), Grade C35, 35 Cover



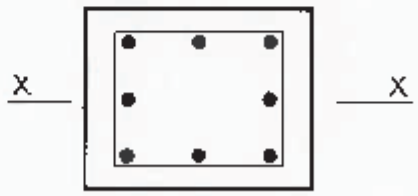
Project	69 Redington Rd		ABBEY PYNFORD		
Client	SHAKIB		Made by	Date	Page
Location	LONDON	The Concrete Centre	JO	09-Dec-14	APP/E-51
	SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005		Checked	Revision	Job No
	Originated from RCC53.xls v3.1 on CD © 2006 TCC		MJ	-	GA19787

MATERIALS

fcu	35	N/mm²	γm, steel	1.15	Cover to link	35	mm
fy	500	N/mm²	γm, conc	1.5	h agg	20	mm
steel class	A						

SECTION

h	350	mm
b	350	mm
with	3	#N/A
and	3	#N/A



RESTRAINTS

	Lo (mm)	Top Condition	Btm Condition	Braced ?	ß	Le (mm)	Slenderness	Status
X-AXIS	3000	2	3	Y	0.95	2850	Lex/h = 8.14	Column is
Y-AXIS	3000	2	3	Y	0.95	2850	Ley/b = 8.14	SHORT

LOADCASES

	AXIAL N (kN)	TOP MOMENTS (kNm) M ix	TOP MOMENTS (kNm) M iy	BTM MOMENTS (kNm) M ix	BTM MOMENTS (kNm) M iy
B1	1890	95.0	95.0	0.0	0.0
B2	1188	60.0	60.0	0.0	0.0
Loadcase 3	1188		60.0	0.0	0.0
Loadcase 4	1890		95.0	0.0	0.0
Loadcase 5				0.0	0.0
Loadcase 6				0.0	0.0

BAR ARRANGEMENTS

Bar Ø	Asc %	Link Ø	BAR CENTRES (mm) 350 Face	BAR CENTRES (mm) 350 Face	Nuz (kN)	Checks
H 40	8.21	10	110	110	0	Asc > 6 % (3.12.6.2)
H 32	5.25	8	116	116	4612	ok
H 25	3.21	8	120	120	3561	ok
H 20	2.05	6	124	124	2989	ok
H 16	1.31	6	126	126	2589	ok
H 12	0.74	6	128	128	2294	ok

DESIGN MOMENTS (kN

	K	X AXIS M add	X AXIS Mx	Y AXIS M add	Y AXIS My	COMBINED Axis	COMBINED M '	REBAR	max V *
B1	0.000	0.0	95.0	0.0	95.0	X	141.1	8 H25	85.4
B2	0.000	0.0	60.0	0.0	60.0	X	100.6	8 H12	53.3
Loadcase 3	0.000	0.0	0.0	0.0	60.0	Y	60.0	8 H12	53.6
Loadcase 4	0.000	0.0	0.0	0.0	95.0	Y	95.0	8 H20	74.6
Loadcase 5									#DIV/0!
Loadcase 6									#DIV/0!

SEE CHARTS ON NEXT SHEET

eccentricity = 50mm applied to both axis

Project	69 Redington Rd		ABBEY PYNFORD
Client	SHAKIB		
Location	LONDON		

The Concrete Centre

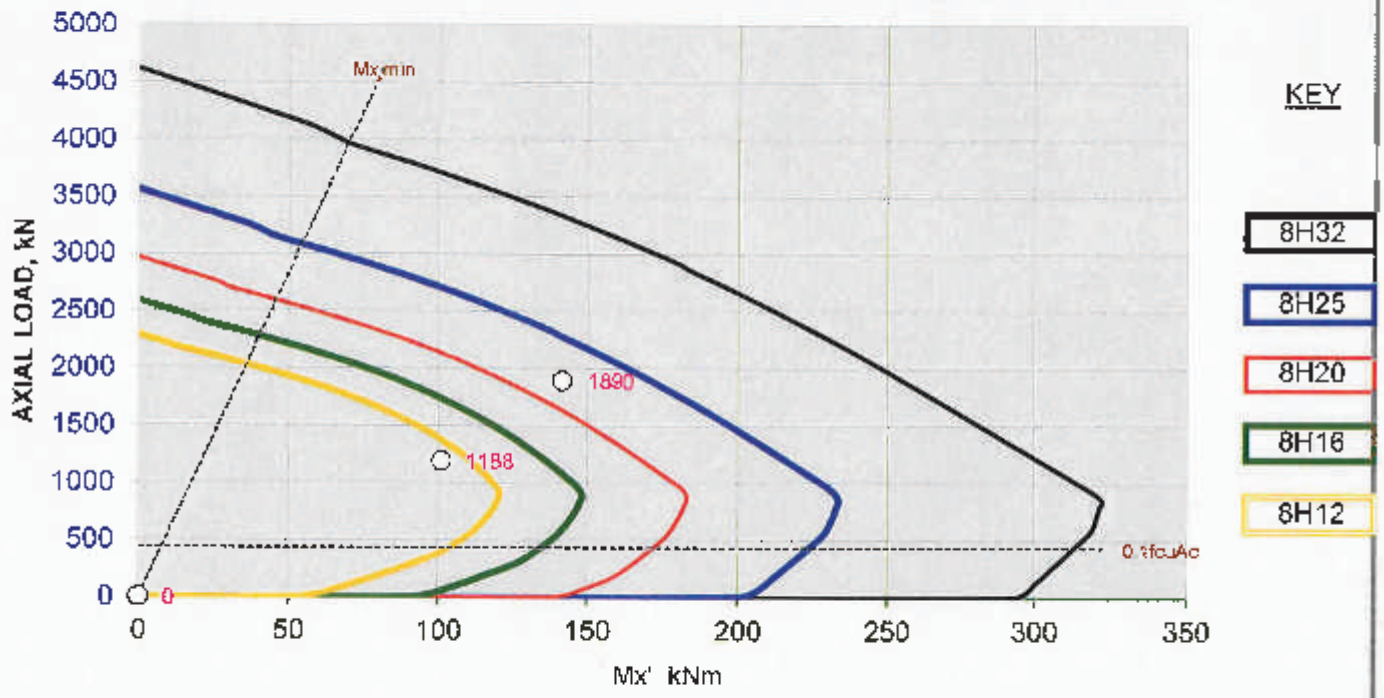
SYMMETRICALLY REINFORCED RECTANGULAR COLUMN DESIGN, BENT ABOUT TWO AXES TO BS 8110:2005

Originated from RCC53.xls v3.1 on CD

Made by	Date	Page
JO	09-Dec-14	APPE-52
Checked	Revision	Job No
MJ	-	GA19787

N:M interaction chart: Mx' critical

350 x 350 column (h x b), grade C35, 35 mm cover



N:M interaction chart: My' critical

350 x 350 column (h x b), moment about yy axis), Grade C35, 35 Cover