atelier one

PROJECT: **1578**
BRITISH MUSEUM

STRUCTURAL CALCULATIONS

CLIENT: **THE BRITISH MUSEUM**
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February 2007

CONTENTS

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INTRODUCTION

These calculations relate to the structural design of a temporary platform proposed to be constructed within the Round Reading Room at the centre of the British Museum, London. The platform is to be used for major temporary exhibitions of antiquities.

The platform is to consist of a two layers of 12.5mm thick plywood bearing on cold formed channel beams. These beams are generally arranged in a radial and circumferential pattern. Support is provided by a series of columns fixed to spreader beams placed on the existing ground floor slab. The area at the centre of the platform and immediately to the north is referred to as the 'keyhole' area. The deck is supported by a series of trusses spanning between supporting columns in this region.

Stability is provided by an arrangement of bracing members located on both radial and circumferential lines. These members have designed to withstand a notional sway loads related to the magnitude of dead and live loads applied to the deck. Two sway load conditions have been considered separately acting in two directions.

Support is provided to the platform by the existing structure which consists of a number of radial walls and arch structures spanning between the radial walls. Limitations on the applied loads within these areas have been provided in a separate report prepared by Alan Baxter & Associates. This report provides limitations on the load that can be applied to the radial walls as point loads of 30kN at a minimum spacing of 1m and point loads on the arch structures of 3kN. The maximum allowable load within the 'keyhole' area has been set as $5kN/m^2$. The structural scheme has been developed using spreader beams to apply load directly onto the radial walls and avoid applying load onto the fragile arches.

The magnitude of the live load allowance has been selected as $4kN/m^2$ in accordance with BS6399: Part 1 for the purpose of these calculations, although this has been reduced to $3kN/m^2$ in the keyhole area to avoid overloading the existing structure. However, the client has advised that access to the exhibitions will be controlled using ticket and gate keeping facilities limiting the occupancy to 400 people at any one time. Additionally, schedules of weights and the layout of exhibits have been provided by the client. These calculations also include an assessment of these loads to provide a comparison to the uniformly distributed live load allowance. This assessment indicates that the applied loads are generally substantially lower than design allowances of 3 and $4kN/m^2$.

The entire platform is to be surrounded by a fabric wall and calculations are also included for the design of this element and its supporting framing.

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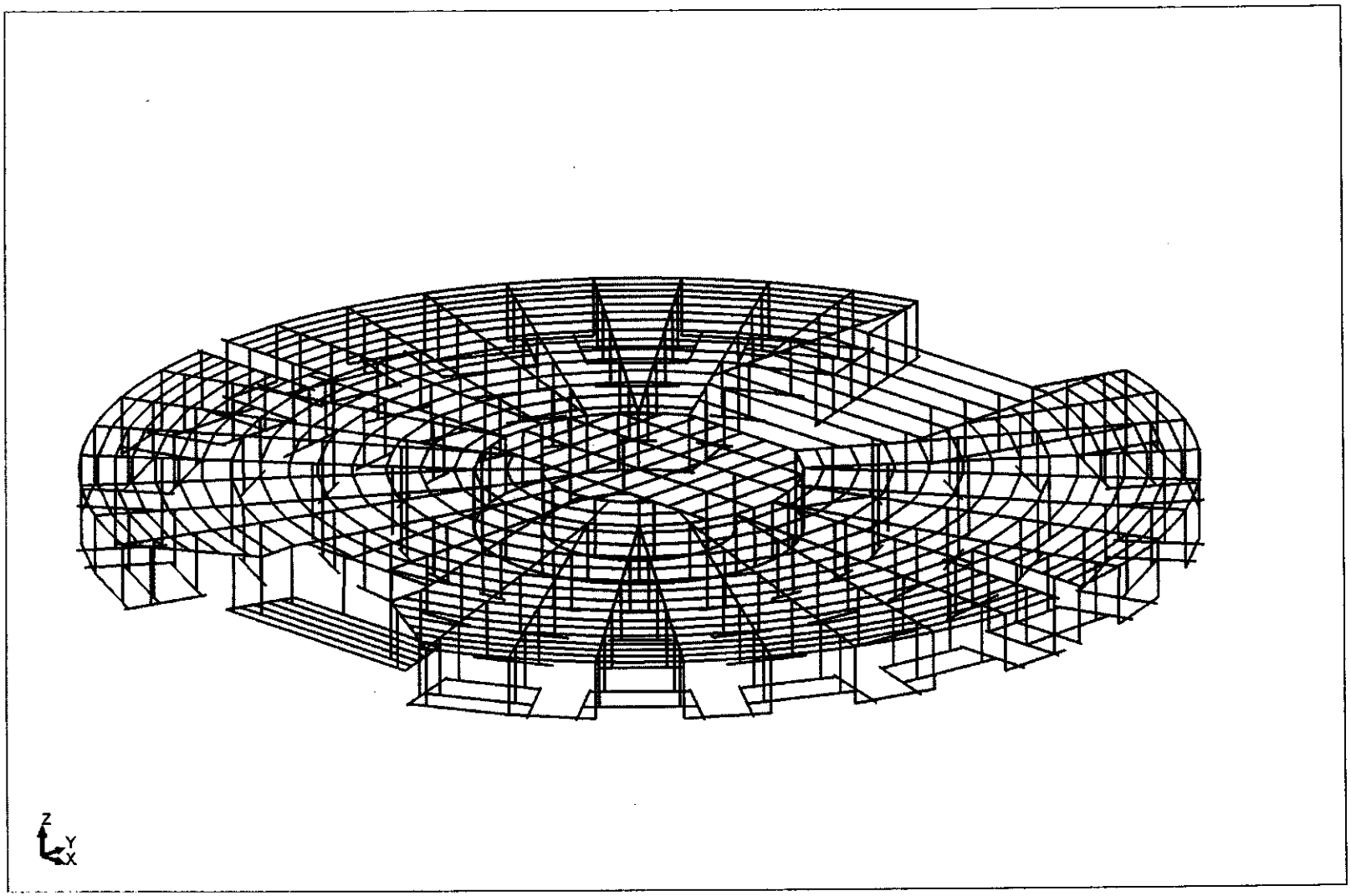
REFERENCE DOCUMENTS

BRITISH STANDARDS INSTITUTION

BS 2569:	Structural use of timber. Part 2: Code of practice for permissible stress design, material and workmanship.
BS 5950 :	Structural use of steelwork in building. Part 1: 1990 Code of practice for design in simple and continuous construction: hot rolled sections. Part 5: 1987 Code of practice for design of cold formed sections.
BS 6399 :	Loading for buildings. Part 1: 1996 Code of practice for dead and imposed loads + AMD 13669

View - Cases: 1 (Dead Load) GENERAL VIEW



1578/1/3

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Project BRITISH MUSEUM

No. 1578/2/1

Date 02/07 By LF

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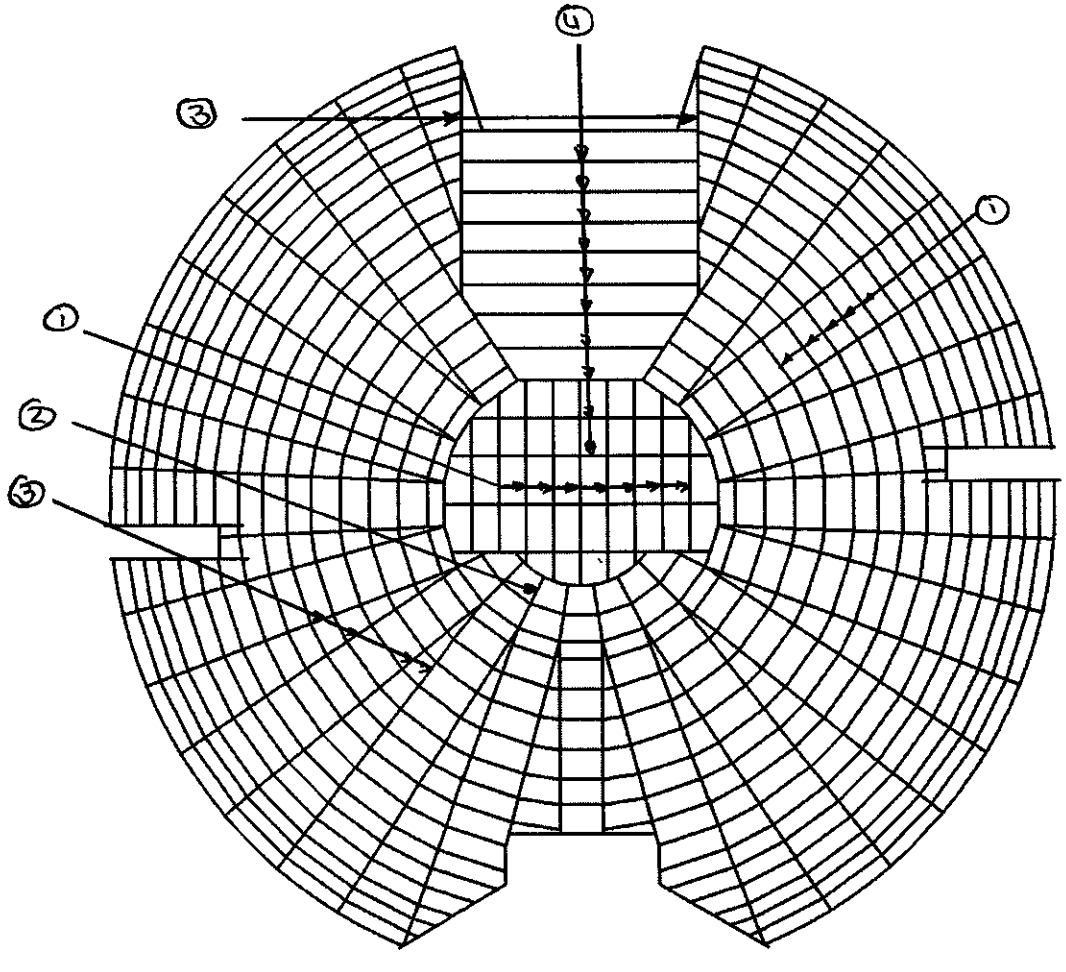
Notes

MODEL INPUT DATA

- MEMBER PROPERTIES
  - Platform Level
  - Ground Level
  - Columns
- SUPPORTS LAYOUT
- LOADING

View:2 - Cases: 1 (Dead Load)

PLATFORM BEAMS & TRUSSES



① Secondary circumferencial beams & between trusses
Cold Form PFCM 175×65×1.4

② Inner radial beams
Cold Form PFCM 175×65×2.4

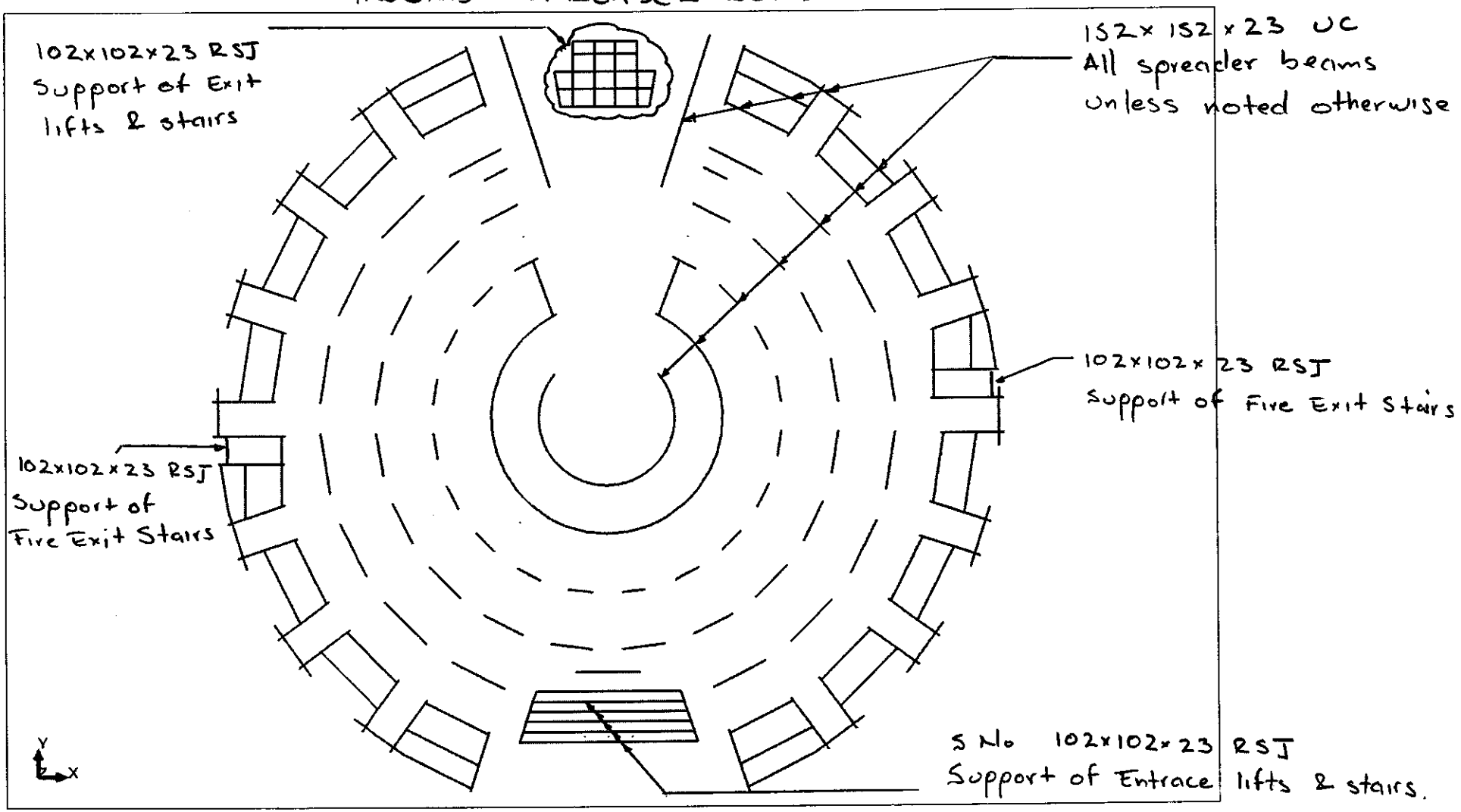
③ Radial Beams & keyhole area
Double Cold Form
DPFC 175×65×2.5
Back to Back

④ Keyhole Area including Platform Centre
Truss Type A, B, C & D

1578/2/2

View:1 - Cases: 1 (Dead Load)

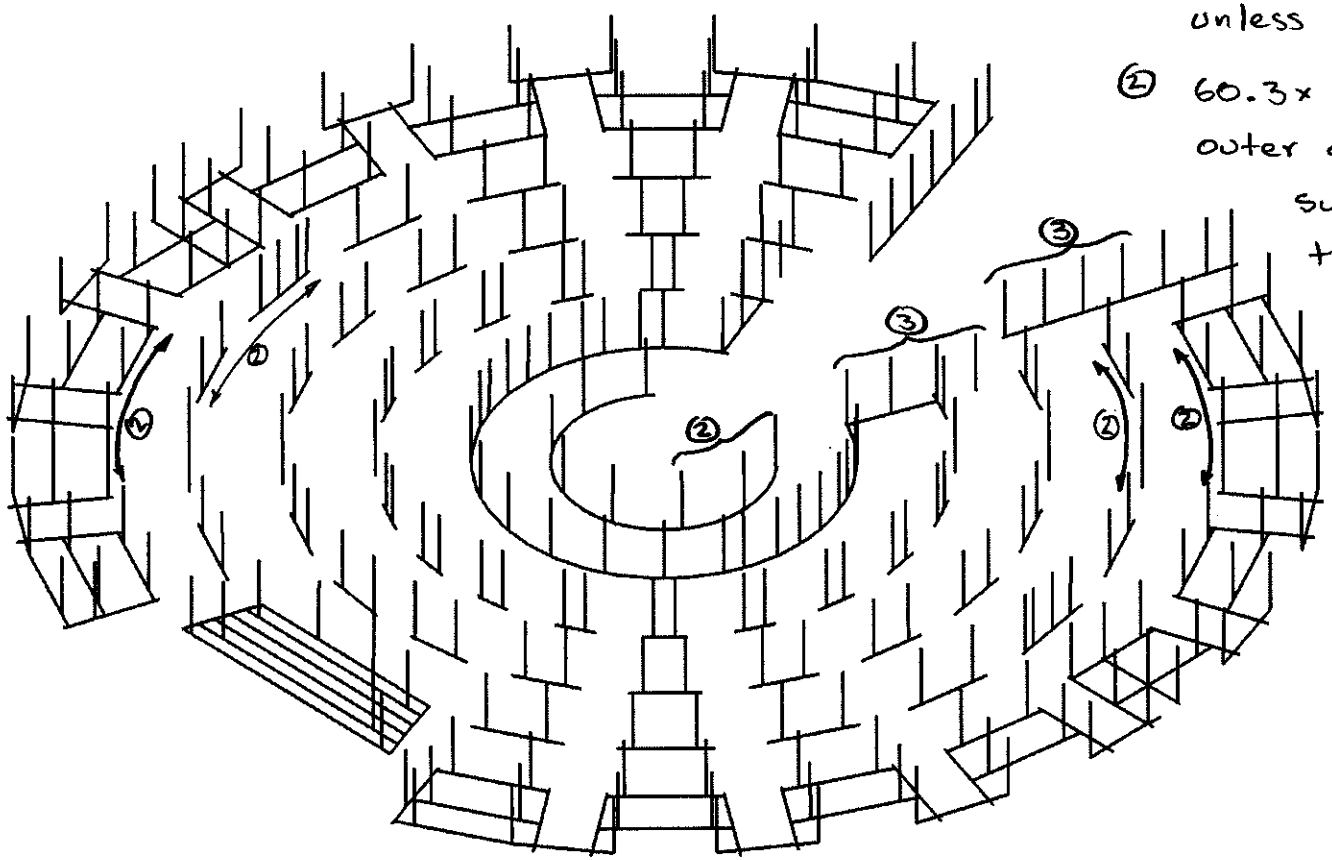
GROUND SPREADER BEAMS



1578/2/3

View:2 - Cases: 51 (1.0DL + 1.0LL)

COLUMNS



① 48.3x5 CHS – All columns unless noted otherwise

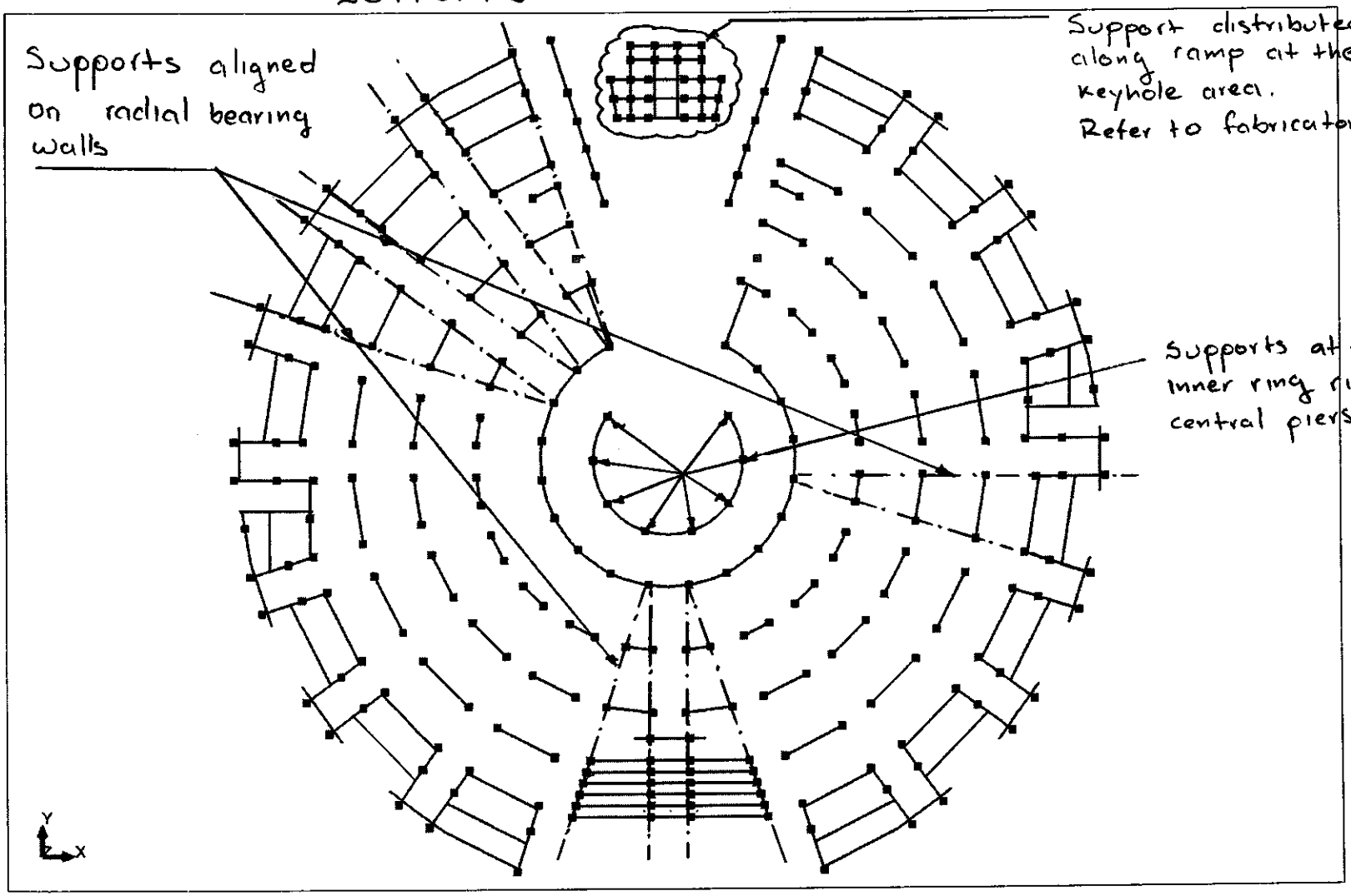
② 60.3x5 CHS – 2nd & 3rd outer column rings and support of trusses at the centre circle

③ 100x5 SHS Columns supporting Trusses at the keyhole area.

15/8/2/4

View:1 - Cases: 1 (Dead Load)

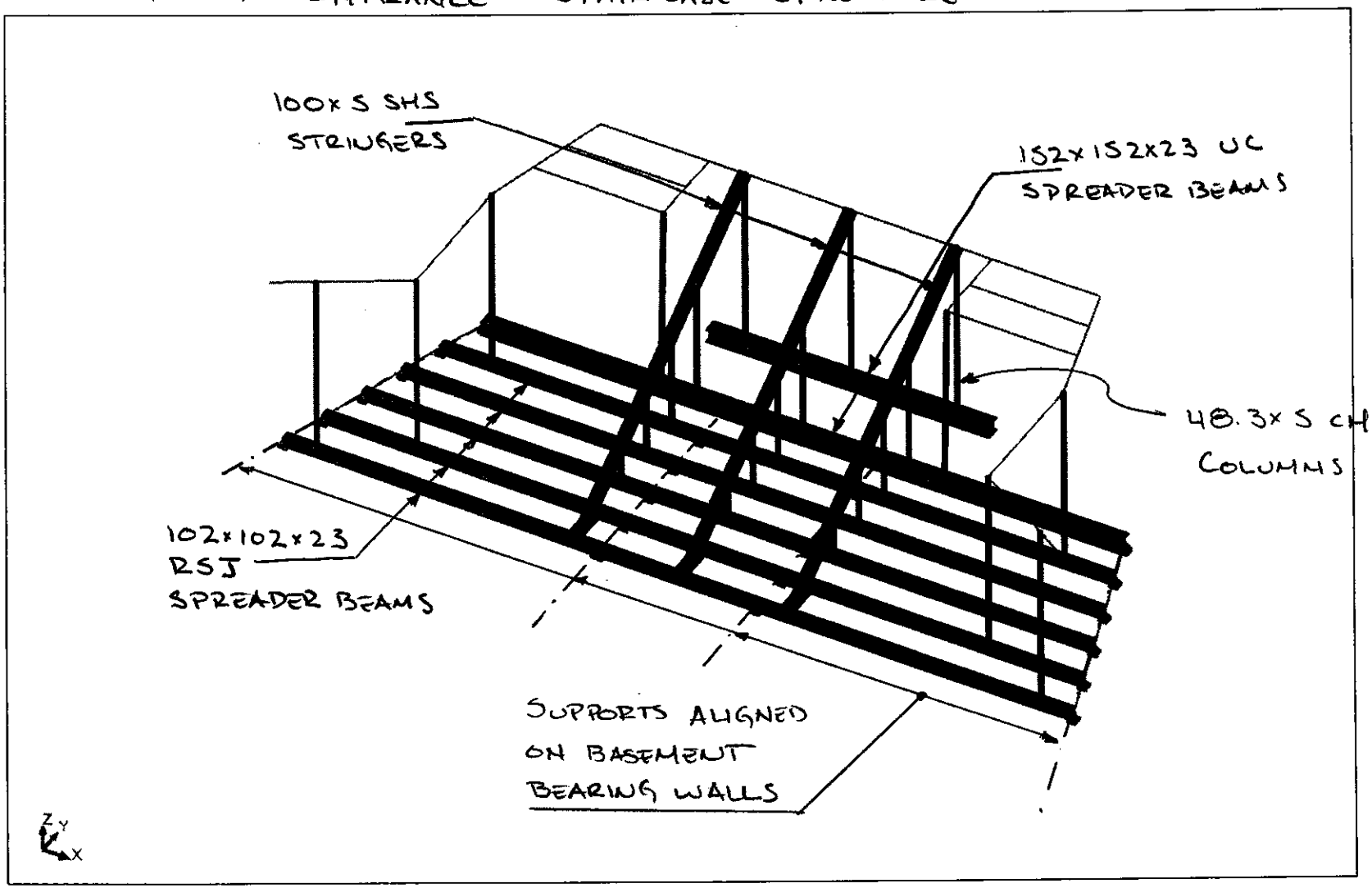
SUPPORTS



1578/2/s

View:1 - Cases: 1 (Dead Load)

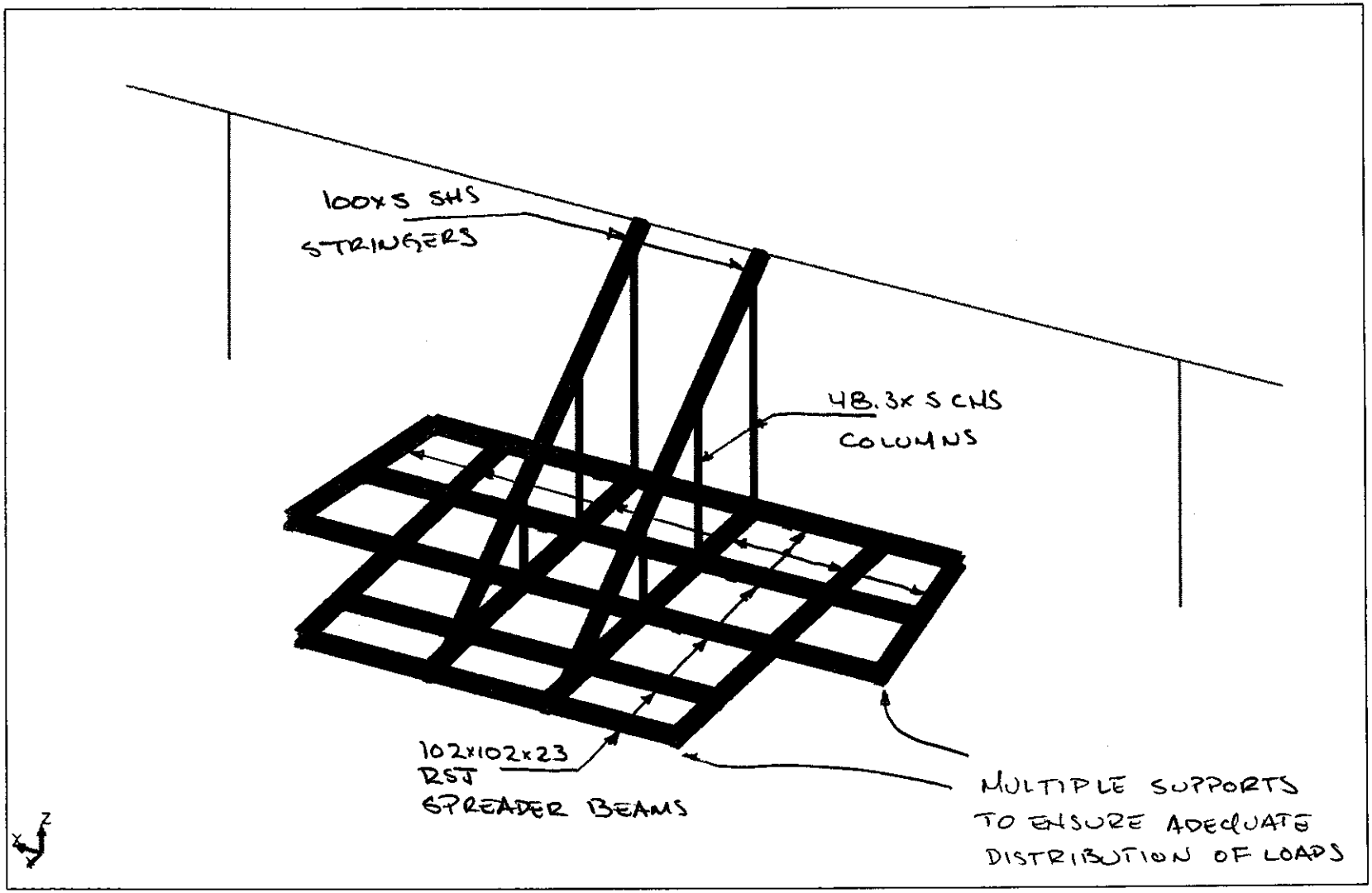
ENTRANCE - STAIR CASE STRUCTURE



15 78/2/6

View:1 - Cases: 5 (Lift& staircase)

EXIT - STAIR CASE & LIFTS' SUPPORT STRUCTURE



1578/2/7

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No 1578/2/8

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LOADING

Dead Load:

2 layers 125 mm of play	—	0.18 KN/m²
Carpet & Finishes	—	0.09 KN/m²
		0.27 KN/m²

Fabric Wall: along perimeter

- Fabric wall & handrail	—	0.4 KN/m
- Plywood wall below deck	—	0.36 KN/m
- Lighting Perimetre	—	0.23 KN/m
		0.99 KN/m

Live Load ——— 4.00 KN/m²

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No. 1578/2/9

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Notes

STAIRCASE SELF-WEIGHT 2.6m wide.

		Load per stringer.
4mm thk Plate 0.43 kN/m²	(x 1.175) entrance middle stringer.	0.51 kN/m
	(x 0.713) entrance side stringer	0.31 kN/m
Balustrade		0.5 kN/m.

LOADING

Adopt

DL	Side stringer (entrance & exit)	—	0.81 kN/m
	Middle stringer (entrance only)	—	0.51 kN/m
LL	Side stringer (4.0 x 0.713)	—	2.9 kN/m
	Middle stringer (4.0 x 1.175)	—	4.7 kN/m

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No 1578/2/10

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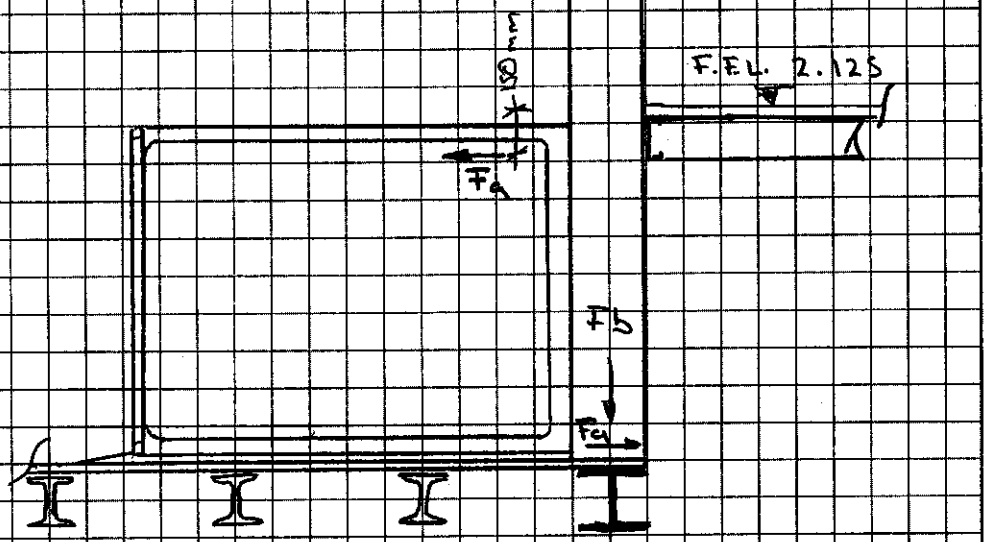
Notes

LIFT SELF-WEIGHT & LIVE LOAD

Fb = 10 KN

Fa = 5.5 KN



Fb : DL = 7.0 KN

LL = 3.0 KN

Fa : DL = 5.5 KN

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No 1578/2/11

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NOTIONAL HORIZONTAL SWAY LOAD

Platform Area = 1085 m²

Dead Load

Plywood 25 mm thk	27 kg/m²	——	293 kN
DPFC 175x65x2.4	5668 kg	——	56.7 kN
PFCH 175x65x2.4	96 kg	——	1.0 kN
PFCH 175x65x1.4	7776 kg	——	77.8 kN
TRUSS 27 kg/m	3259	——	32.6 kN
Perimeter load — L = 122 m			
↳ Fabric wall	4880	——	48.8 kN
↳ Lighting	2810	——	28.1 kN
			538 kN

Notes

L = 518.2 m

L = 16.9 m

L = 2437 m

L = 120.7 m

Live Load

4 kN/m² —— 434000 kg —— 4340 kN

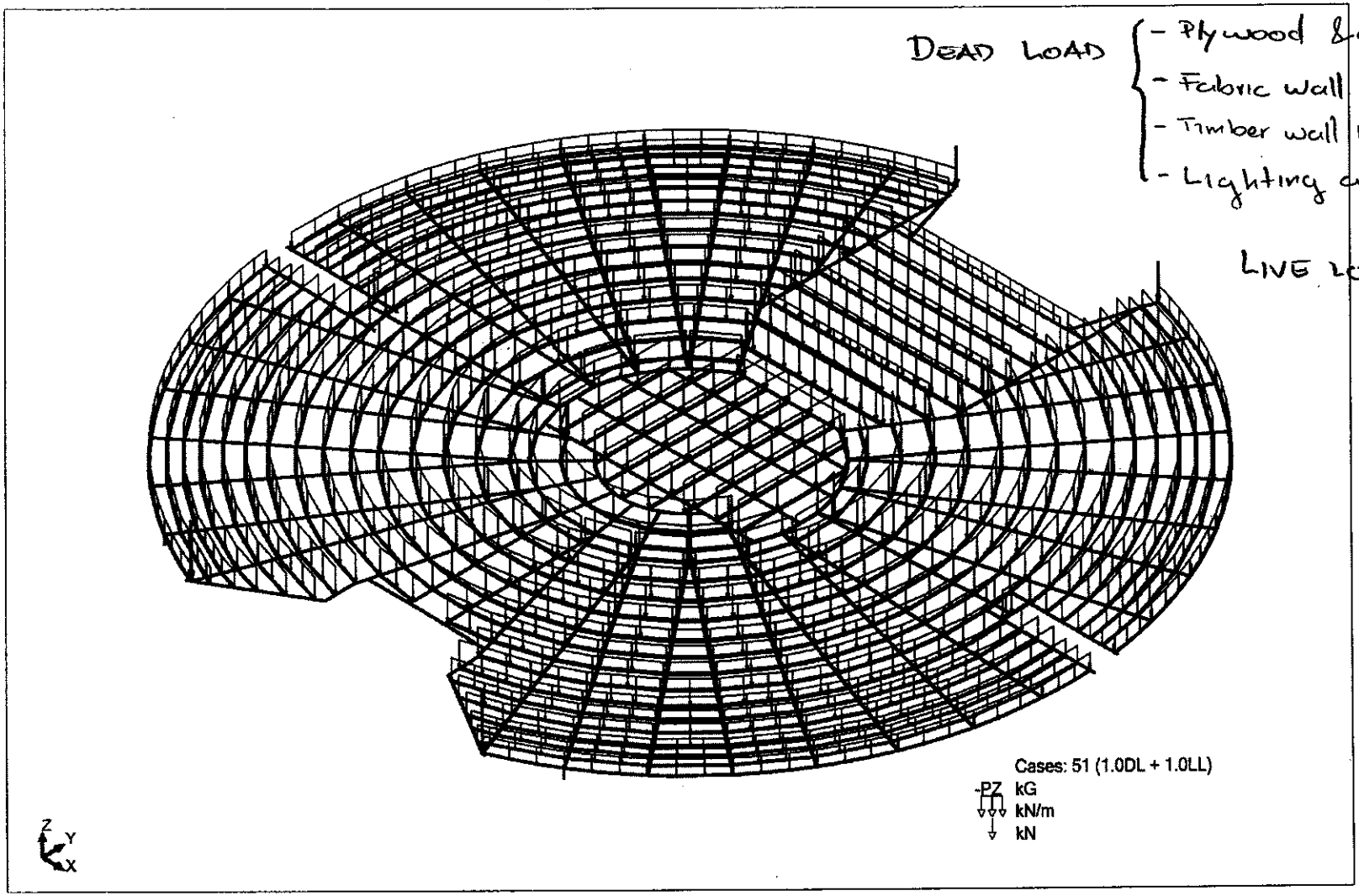
4340 kN.

Notional Load = (1.4×538)×(1.6×4340)×0.5%

= 38.5 kN

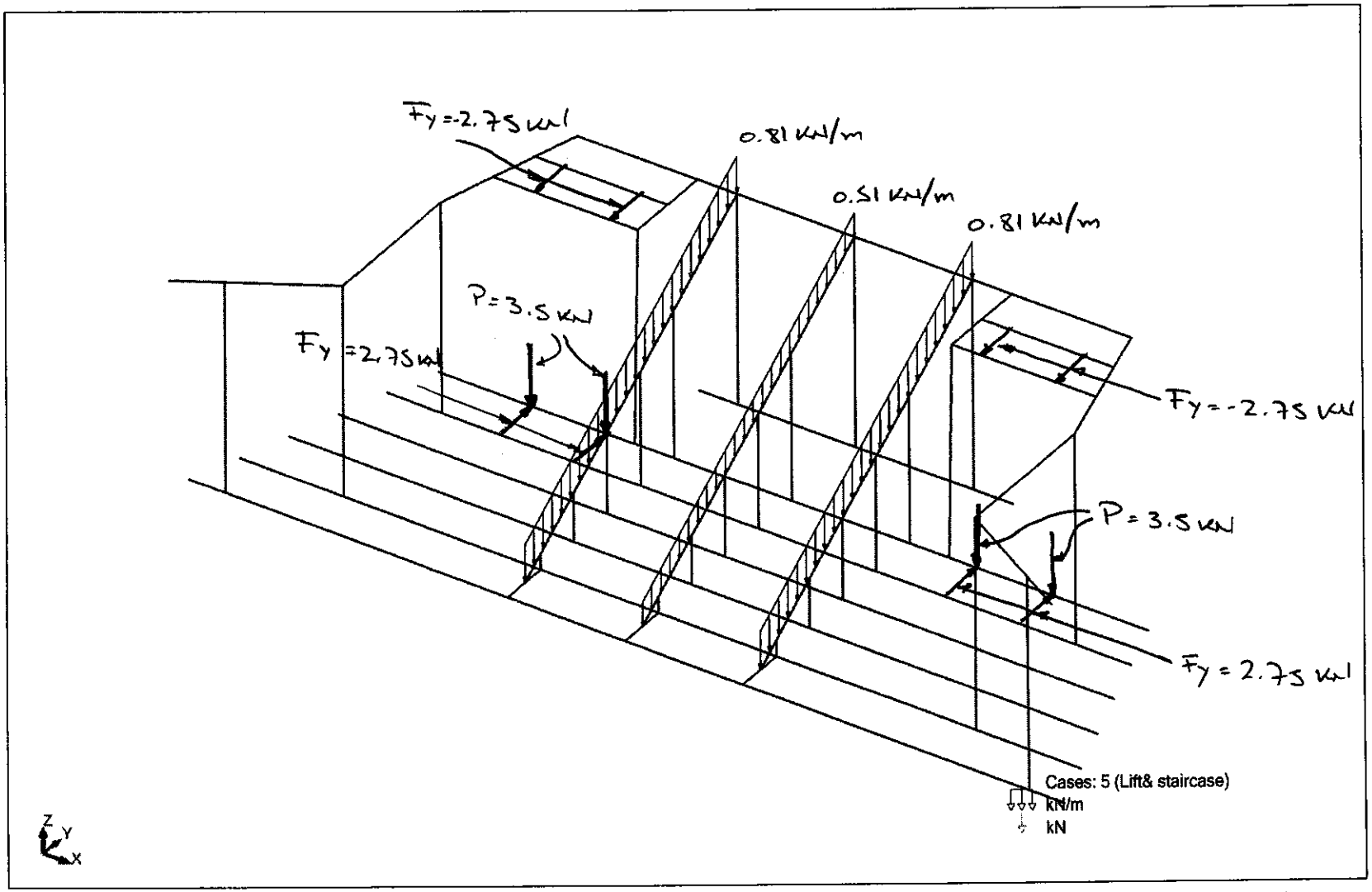
View:2 - Cases: 51 (1.0DL + 1.0LL)

LOADING



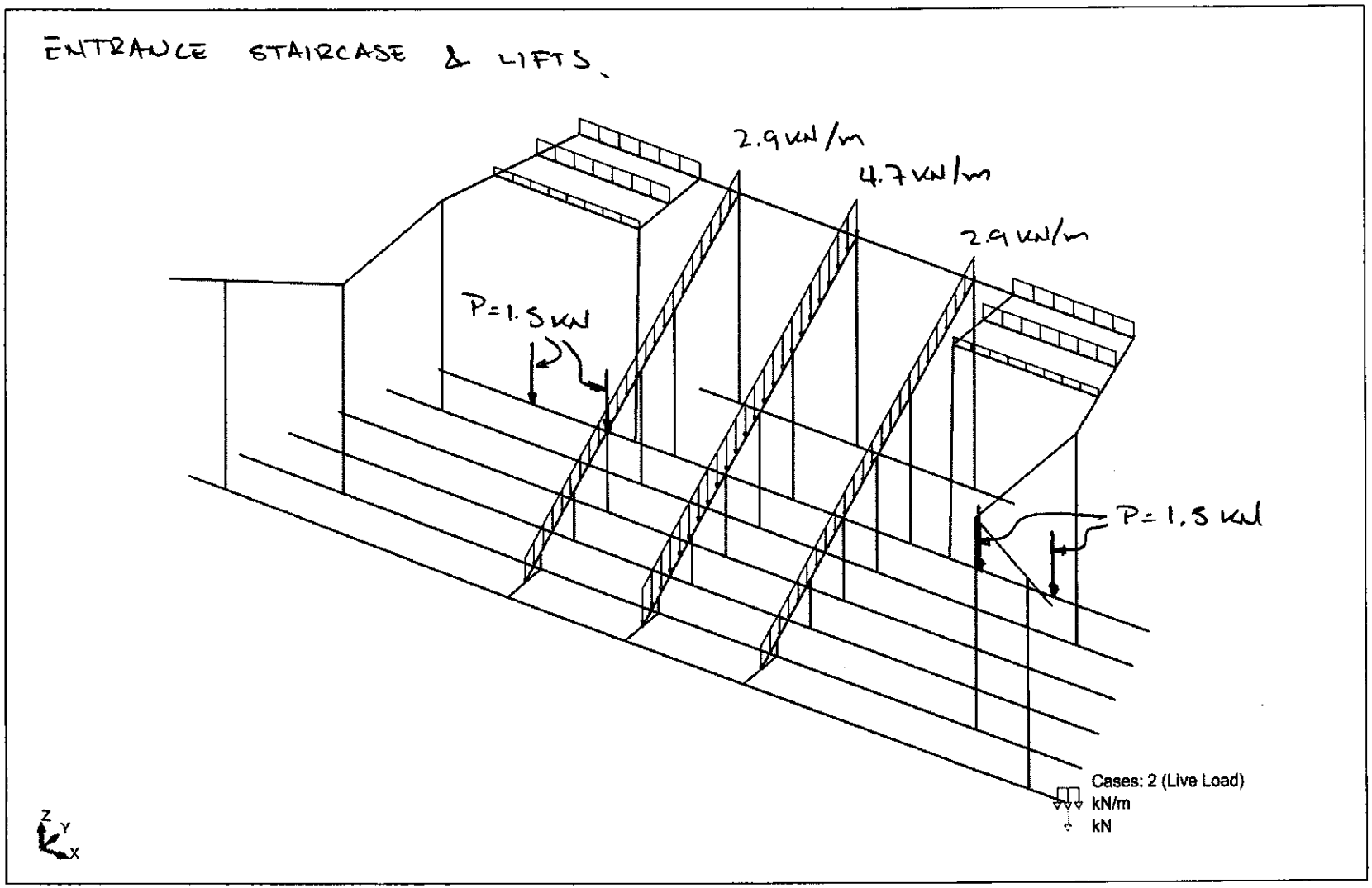
1578/2/12

View:2 - Cases: 5 (Lift& staircase) LOAD CASE 5 : DEAD LOAD STAIRCASE & LIFTS



1578/2/13

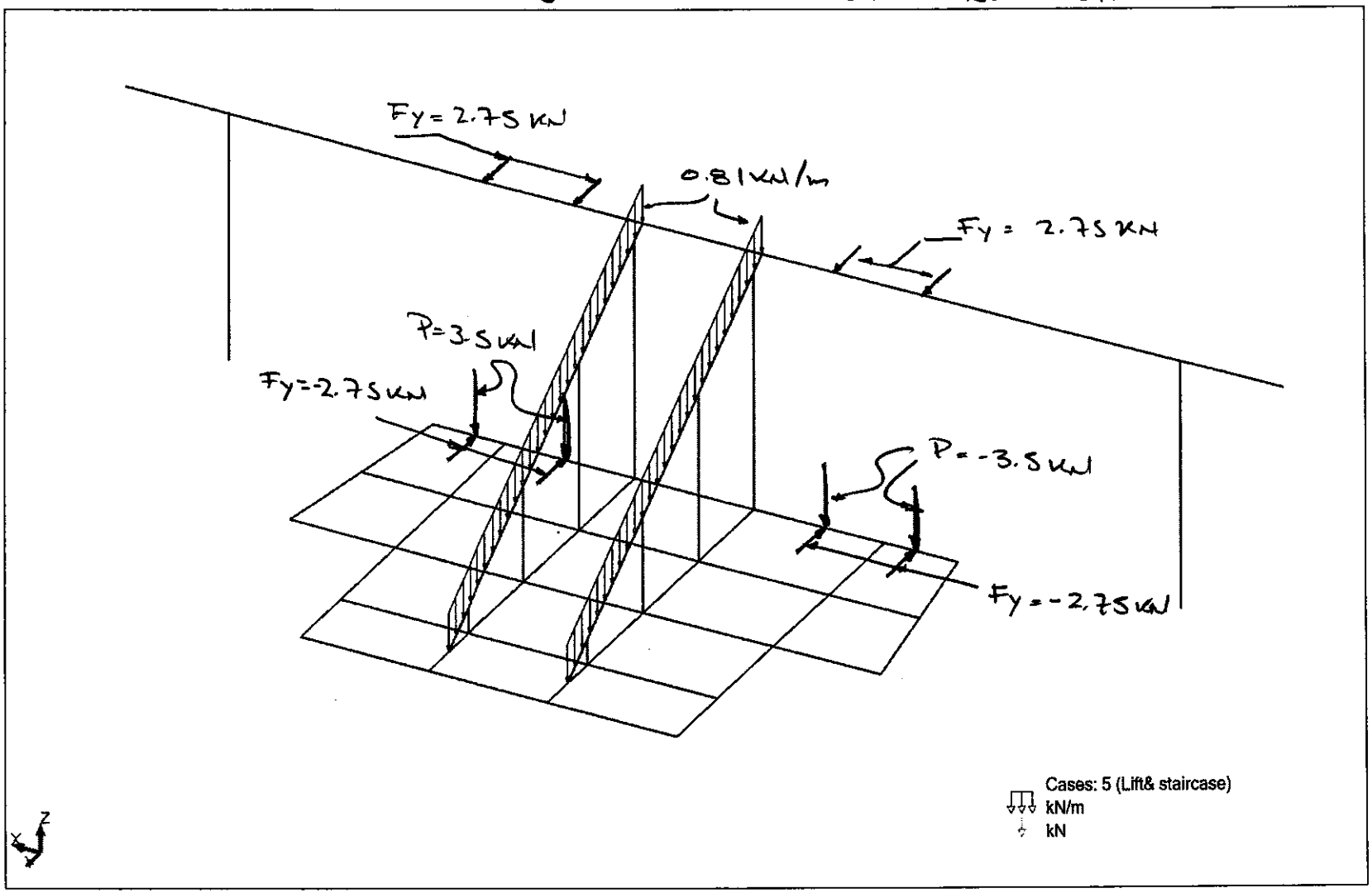
View:2 - Cases: 2 (Live Load) LOAD CASE 2 : LIVE LOAD



1578/2/14

View:1 - Cases: 5 (Lift& staircase)

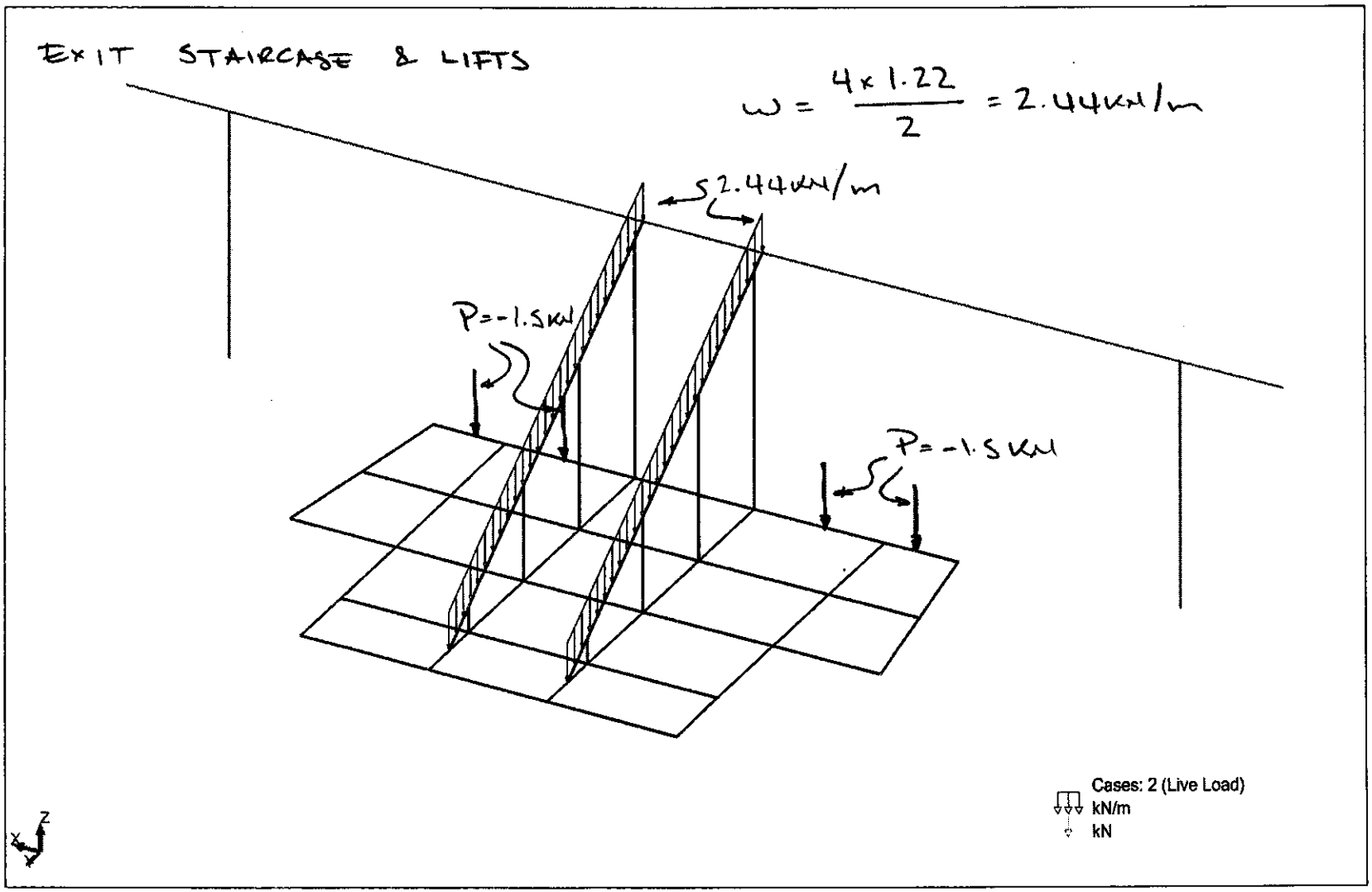
LOAD CASE 5 : DEAD LOAD STAIRCASE & LIFTS



1528/2/15

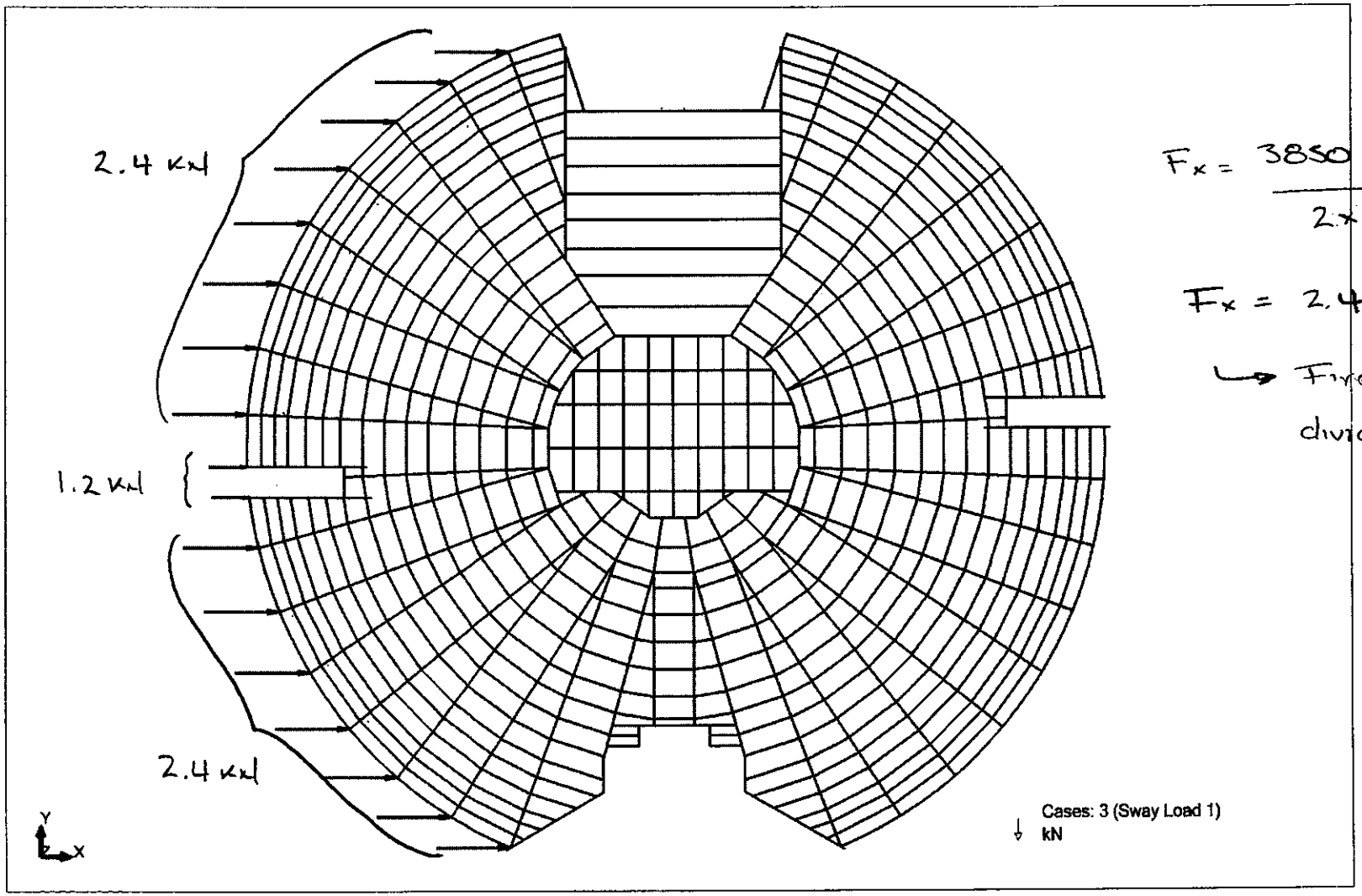
View:1 - Cases: 2 (Live Load)

LOAD CASE 2: LIVE LOAD



15780/2/16

View:1 - Cases: 3 (Sway Load 1) LOAD CASE 3: SWAY LOAD 1 — X direction. Allow - 3850 kg



$$F_x = \frac{3850 \times \frac{10}{1000}}{2 \times 8}$$

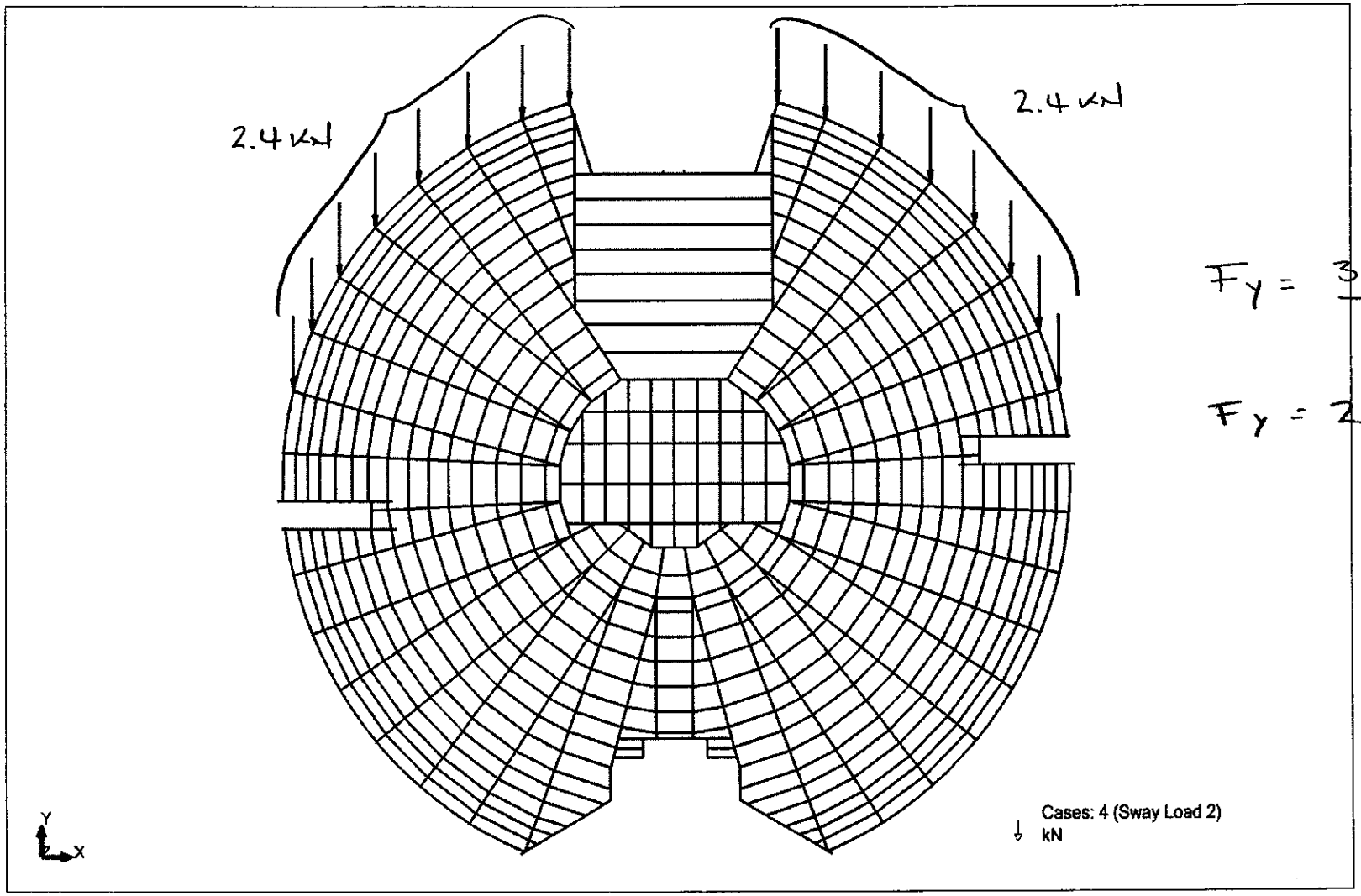
$F_x = 2.4$ kN

↳ Fire Exit Stairs divided in 2 No $F_x = 1.2$ kN

1578/2/12

View:1 - Cases: 4 (Sway Load 2)

LOAD CASE 4: SWAY LOAD 2 - Y direction Allow 3850 kg



$$F_y = \frac{3850 \times \frac{10}{1000}}{2 \times 8}$$

$$F_y = 2.4 \text{ kN}$$

1578/2/18

Load Combination - Cases: 51to67 101to104
Values
1

LOAD COMBINATIONS

- Cases: 51to67 101to104

Filtering	Combinations
Full list	51to67 101to104
Selection	51to67 101to104
Total number	21
Selected number	21

- Cases: 51to67 101to104

Combinations	Name	Analysis type	Combination nature	Case nature	Definition
51 (C)	1.0DL + 1.0LL	Linear Combination	SLS	dead	(1+2+5)*1.00
52 (C)	1.0DL + 1.0LL + 1.0Sway 1	Linear Combination	SLS	dead	(1+2+3)*1.00
53 (C)	1.0DL + 1.0LL - 1.0Sway 1	Linear Combination	SLS	dead	(1+2)*1.00+3*-1.00
54 (C)	1.0DL + 1.0LL + 1.0Sway 2	Linear Combination	SLS	dead	(1+2+4)*1.00
55 (C)	1.0DL + 1.0LL - 1.0Sway 2	Linear Combination	SLS	dead	(1+2)*1.00+4*-1.00
56 (C)	1.0DL + 1.0LL + 1.0Sway 1 + Lift	Linear Combination	SLS	dead	(1+2+3+5)*1.00
57 (C)	1.0DL + 1.0LL - 1.0Sway 1 + Lift	Linear Combination	SLS	dead	(1+2+5)*1.00+3*-1.00
58 (C)	1.0DL + 1.0LL + 1.0Sway 2 + Lift	Linear Combination	SLS	dead	(1+2+4+5)*1.00
59 (C)	1.0DL + 1.0LL - 1.0Sway 2 + Lift	Linear Combination	SLS	dead	(1+2+5)*1.00+4*-1.00
60 (C)	1.0DL + 1.0Sway 1	Linear Combination	SLS	dead	(1+3)*1.00
61 (C)	1.0DL - 1.0Sway 1	Linear Combination	SLS	dead	1*1.00+3*-1.00
62 (C)	1.0DL + 1.0Sway 2	Linear Combination	SLS	dead	(1+4)*1.00
63 (C)	1.0DL - 1.0Sway 2	Linear Combination	SLS	dead	1*1.00+4*-1.00
64 (C)	1.0DL + 1.0Sway 1 + Lift	Linear Combination	SLS	dead	(1+3+5)*1.00
65 (C)	1.0DL - 1.0Sway 1 + Lift	Linear Combination	SLS	dead	(1+5)*1.00+3*-1.00
66 (C)	1.0DL + 1.0Sway 2 + Lift	Linear Combination	SLS	dead	(1+4+5)*1.00
67 (C)	1.0DL - 1.0Sway 2 + Lift	Linear Combination	SLS	dead	(1+5)*1.00+4*-1.00
101 (C)	1.4DL	Linear Combination	ULS	dead	(1+5)*1.40
102 (C)	1.4DL + 1.6LL	Linear Combination	ULS	dead	(1+5)*1.40+2*1.60
103 (C)	1.4DL + 1.6LL + 1.0Sway 1	Linear Combination	ULS	dead	(1+5)*1.40+2*1.60+3*1.00
104 (C)	1.4DL + 1.6LL + 1.0Sway 2	Linear Combination	ULS	dead	(1+5)*1.40+2*1.60+4*1.00

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No 1578/3/1

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Notes

RESULTS:

F_x — Axial Force (+) Compression
(-) Tension

F_y — Shear Force minor axis

F_z — Shear Force major axis

M_x — Torsional Moment

M_y — Bending Moment major axis

M_z — Bending Moment minor axis

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combinations
Bar: DPFC 175x65x2.4 Back to Back.

- Cases: 1to4 51 101to104

Filtering	Bar	Case
Full list	1to81 84to87 92t	1to4 51 101to10
Selection	2001 2004to200	1to4 51 101to10
Total number	2765	9
Selected number	1153	9

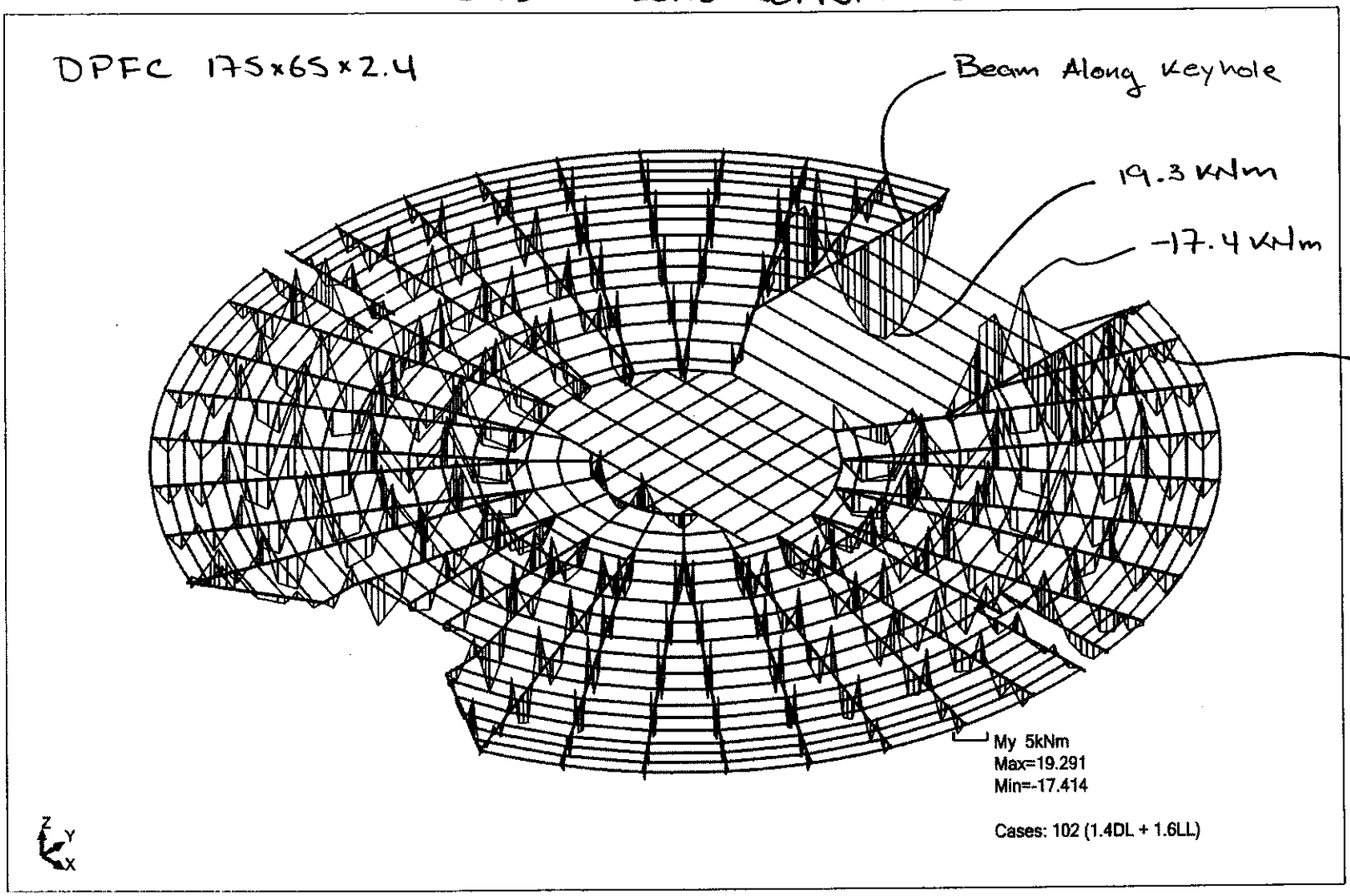
- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	4.839	2.775	2.783	0.366	1.921	0.547
Bar	2047	2344	3086	2570	2708	2324
Node	2225	2938	3334	2014	2415	2134
Case	104 (C)	102 (C)	104 (C)	104 (C)	102 (C)	103 (C)
MIN	-5.223	-2.973	-23.152	-0.369	-1.723	-0.709
Bar	2409	2317	2697	2571	3101	2566
Node	2256	2659	3326	2017	2099	2306
Case	103 (C)	102 (C)	104 (C)	103 (C)	102 (C)	103 (C)

1578/3/2

View:1 - MY, Cases: 102 (1.4DL + 1.6LL)

BMD — LOAD COMBINATION 1.4DL+1.6LL

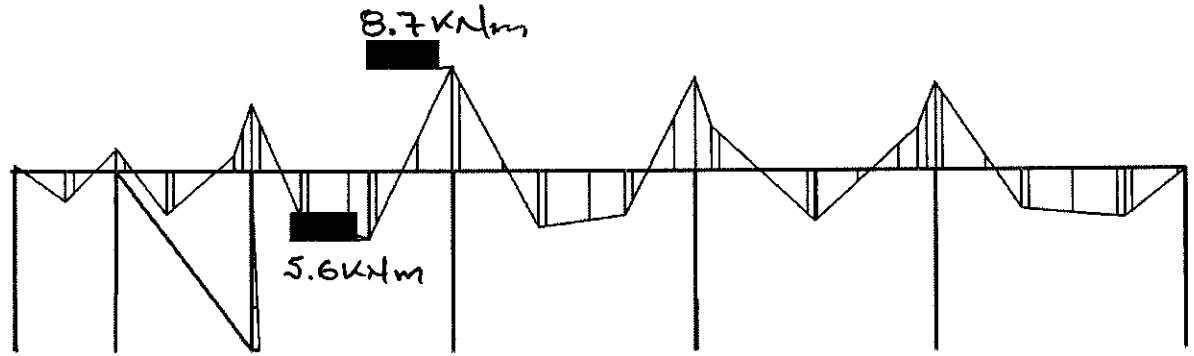


1578/3/3

View:2 - MY, Cases: 102 (1.4DL + 1.6LL)

BMD – LOAD COMBINATION 1.4DL+1.6LL

TYPICAL RADIAL BEAM DPFC 175x65x2.4



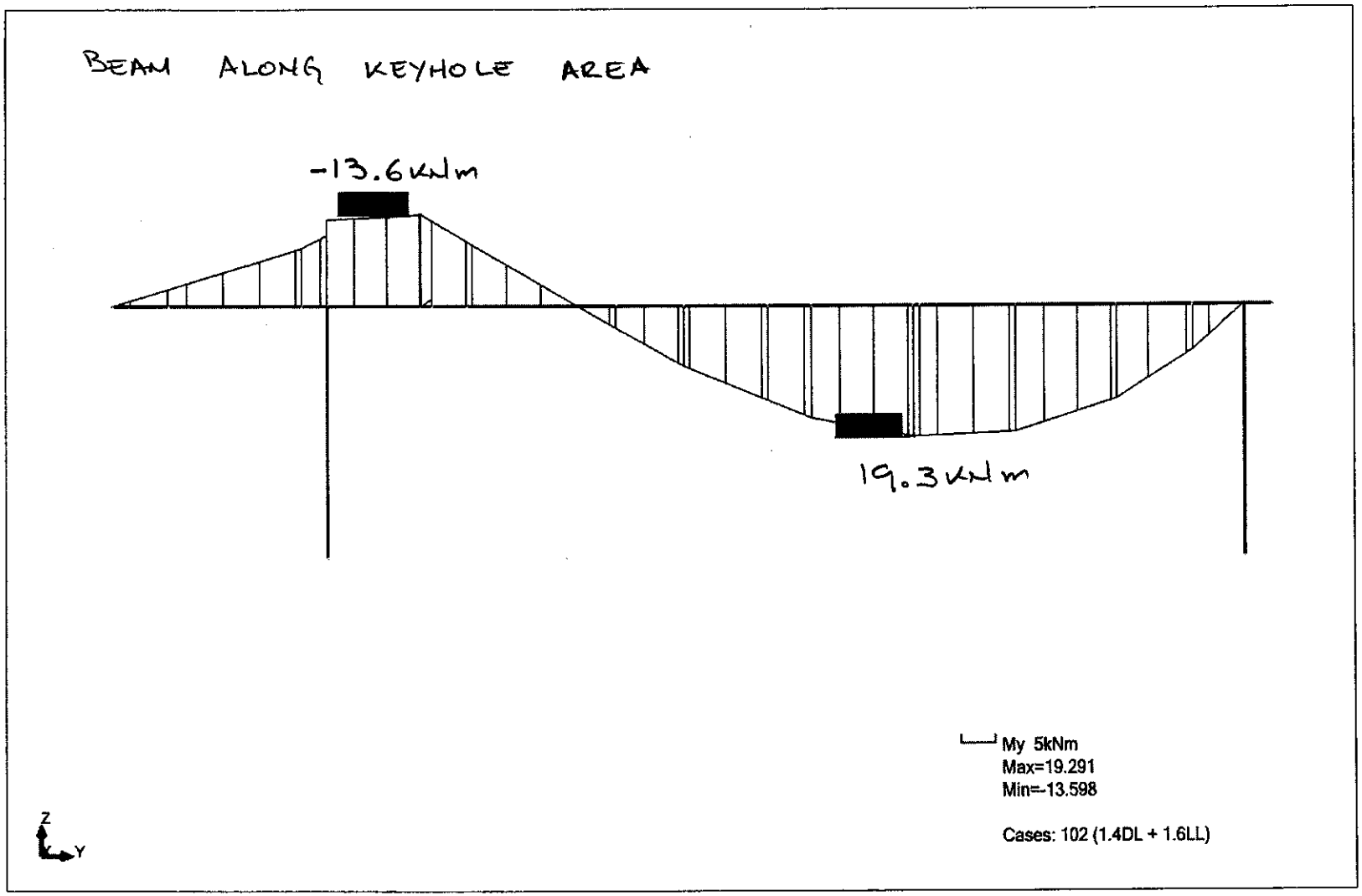
My 5kNm
Max=5.580
Min=-8.713

Cases: 102 (1.4DL + 1.6LL)

1578/3/4

View:2 - MY, Cases: 102 (1.4DL + 1.6LL)

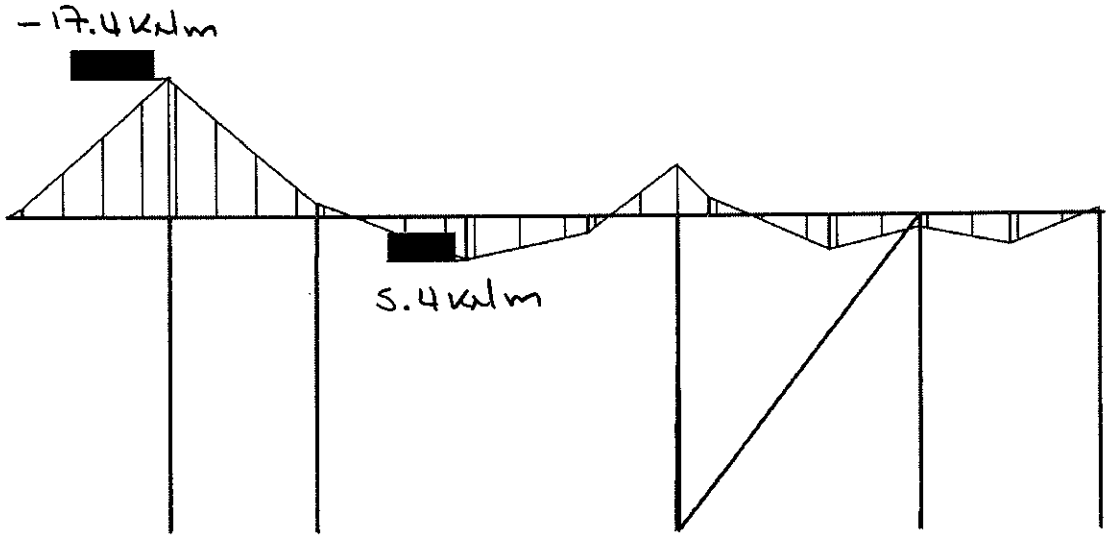
BMD — LOAD COMBINATION 1.4 DL + 1.6LL



1578/3/5

View:2 - MY, Cases: 102 (1.4DL + 1.6LL) BMD – LOAD COMBINATION 1.4DL + 1.6LL

FIRST RADIAL BEAM NEXT TO KEYHOLE AREA



My 5kNm
Max=5.386
Min=-17.414

Cases: 102 (1.4DL + 1.6LL)

Z
Y

1578/3/6

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combinations
Bar: PFCH 175x65x2.4

- Cases: 1to4 51 101to104

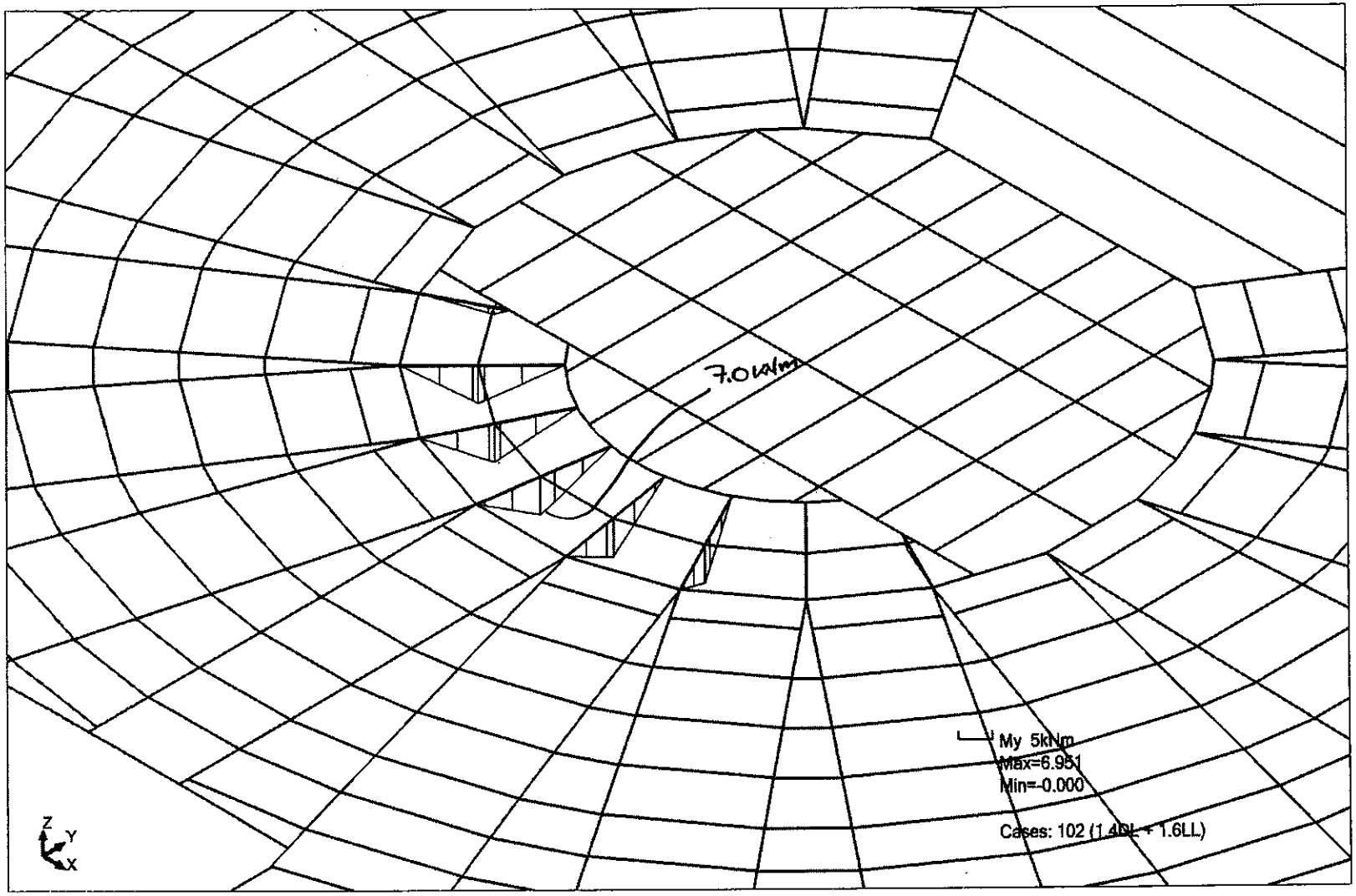
Filtering	Bar	Case
Full list	1to81 84to87 92t	1to4 51 101to10
Selection	4059 4060 4072	1to4 51 101to10
Total number	2765	9
Selected number	16	9

- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	1.570	0.149	5.922	0.000	2.954	0.036
Bar	4060	4060	4182	4655	4182	4059
Node	2341	2341	2241	2242	2345	2341
Case	3	103 (C)	102 (C)	102 (C)	102 (C)	103 (C)
MIN	-4.525	-0.032	-5.922	0.000	-2.950	-0.028
Bar	4649	4059	4656	4183	4060	4073
Node	2343	2302	2002	2345	2341	2342
Case	103 (C)	103 (C)	102 (C)	104 (C)	4	103 (C)

1578/3/4

View:1 - MY, Cases: 102 (1.4DL + 1.6LL) BMD — LOAD COMBINATION 1.4DL+1.6LL — PFCH 175x65x2.4



1578/3/B

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All load Combinations
Bar: Equivalent UB of Trusses in keyhole area.

- Cases: 1to4 51 101to104

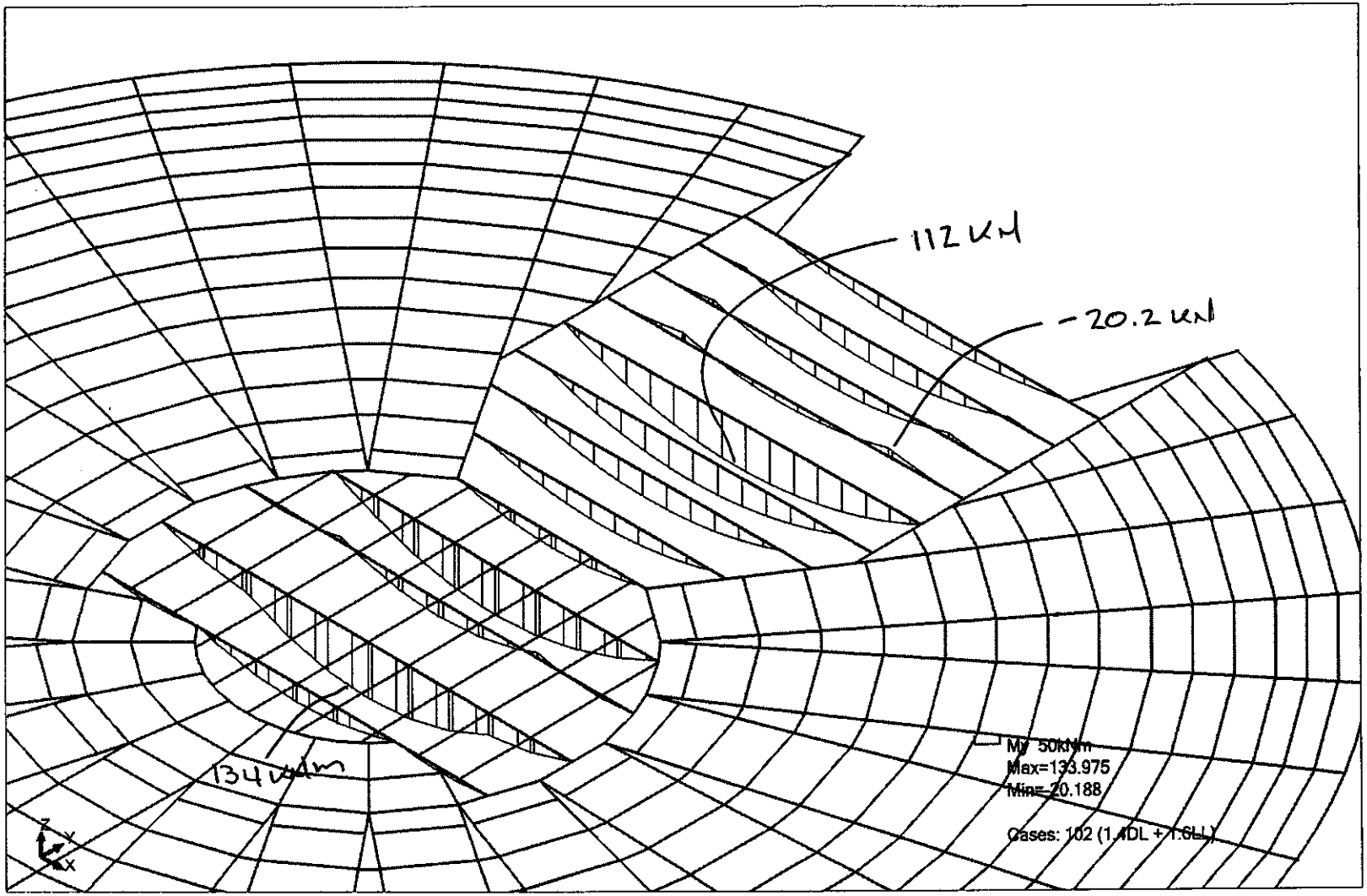
Filtering	Bar	Case
Full list	1to81 84to87 92t	1to4 51 101to10
Selection	9 19to21 23 414	1to4 51 101to10
Total number	2765	9
Selected number	69	9

- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	3.315	5.245	45.055	10.010	28.093	0.752
Bar	4235	5040	5030	4234	4151	5047
Point	2320	2106	2393	2316	2298	2428
Case	3	103 (C)	103 (C)	104 (C)	104 (C)	103 (C)
MIN	-4.428	-4.101	-28.055	-0.015	-20.468	-1.276
Bar	4235	5045	5032	5030	5028	5041
Point	2320	2431	2394	2393	2458	2427
Case	104 (C)	103 (C)	102 (C)	103 (C)	102 (C)	103 (C)

1578/3/A

View:1 - MY, Cases: 102 (1.4DL + 1.6LL) BMD – LOAD COMBINATION 1.4DL + 1.6LL — TRUSS (See Dwg 1578-135)



1578/3/D

BRACING

Forces - Cases: 51to67 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combination
Bar: 48.3x5 CHS Bracing.

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 150 151	1to5 51to67 101t
Selection	85to87 92to97 1	51to67 101to104
Total number	2842	26
Selected number	33	21

- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	11.262	0.000	0.171	0.000	0.108	0.000
Bar	6300	6307	6297	6307	6297	6300
Point	1211	1356	1292	1356	11/21	2654
Case	103 (C)	102 (C)	102 (C)	102 (C)	102 (C)	103 (C)
MIN	-14.468	-0.000	-0.171	-0.000	-0.000	-0.000
Bar	129	6300	6297	6300	6299	6307
Point	3229	1211	2784	1211	1243	2561
Case	102 (C)	103 (C)	101 (C)	104 (C)	103 (C)	102 (C)

1578/3/11

COLUMNS

GLOBAL EXTREME FORCES

Case: All Load Combinations

Bar: 48.3x5 CHS Columns - except columns under entrance & exit stairs.

Forces - Cases: 51to67 101to104
Global extremes
1

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 1001to10	1to5 51to67 101t
Selection	6004to6008 601	51to67 101to104
Total number	2842	26
Selected number	172	21

- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	39.824	0.419	0.636	0.022	0.731	0.696
Bar	6203	6144	6239	6405	6190	6144
Node	1570	1158	2257	3468	1180	1158
Case	102 (C)	104 (C)	103 (C)	103 (C)	104 (C)	104 (C)
MIN	-2.361	-0.615	-0.625	-0.025	-0.753	-1.104
Bar	6156	7	6235	6190	6239	8
Node	2657	1	1592	1180	2257	3
Case	101 (C)	104 (C)	102 (C)	104 (C)	103 (C)	104 (C)

1578/3/12

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combinations
Bar: 60.3x5 CHS Columns.

- Cases: 1to4 51 101to104

Filtering	Bar	Case
Full list	1to81 84to87 92t	1to4 51 101to10
Selection	1to6 6002 6003	1to4 51 101to10
Total number	2765	9
Selected number	84	9

- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	55.297	0.465	0.459	0.024	1.460	0.695
Bar	6	4	6228	6240	3	6045
Point	1734	2402	1004	1561	2404	1428
Case	103 (C)	103 (C)	103 (C)	103 (C)	103 (C)	104 (C)
MIN	-1.982	-0.483	-0.459	-0.025	-0.690	-0.393
Bar	6233	6046	3	6264	6173	6046
Point	1200	1431	1731	1757	1537	1431
Case	3	103 (C)	103 (C)	103 (C)	102 (C)	103 (C)

1578/3/13

Forces - Cases: 51to67 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combinations
Bar: 100 x 5 SHS Columns

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 1001to10	1to5 51to67 101t
Selection	26 27 100 106 1	51to67 101to104
Total number	2842	26
Selected number	29	21

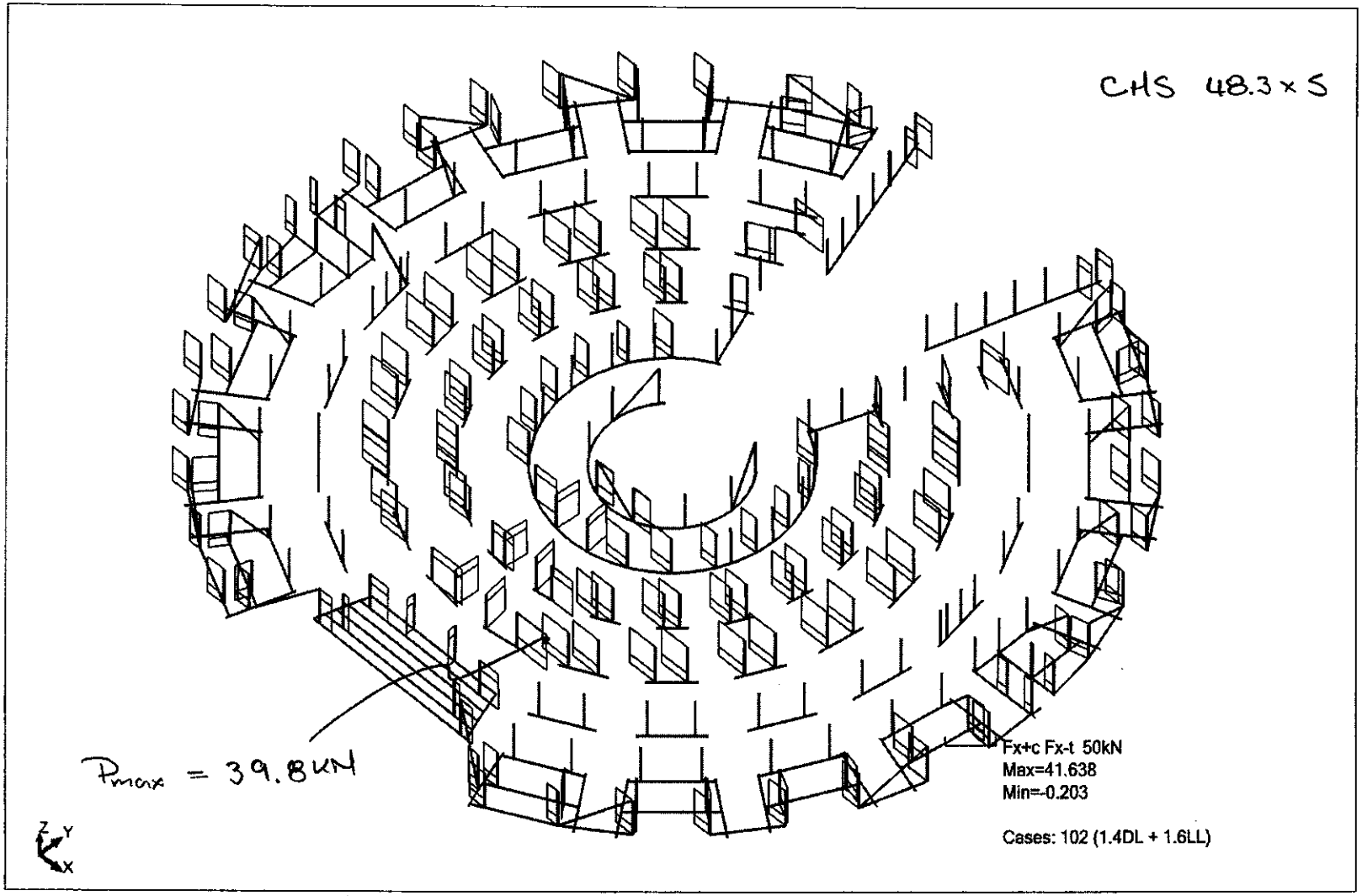
- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	49.225	6.167	33.065	1.921	2.937	7.842
Bar	6259	6197	100	6263	6259	6197
Node	3351	1553	99	3352	3351	1553
Case	103 (C)	104 (C)	54 (C)	103 (C)	103 (C)	104 (C)
MIN	-3.588	-3.047	[illegible]	[illegible]	-4.197	-5.118
Bar	6399	6401	6400	6400	6256	6197
Node	3426	3451	3425	1975	1559	2106
Case	104 (C)	104 (C)	104 (C)	103 (C)	104 (C)	103 (C)

1578/3/14

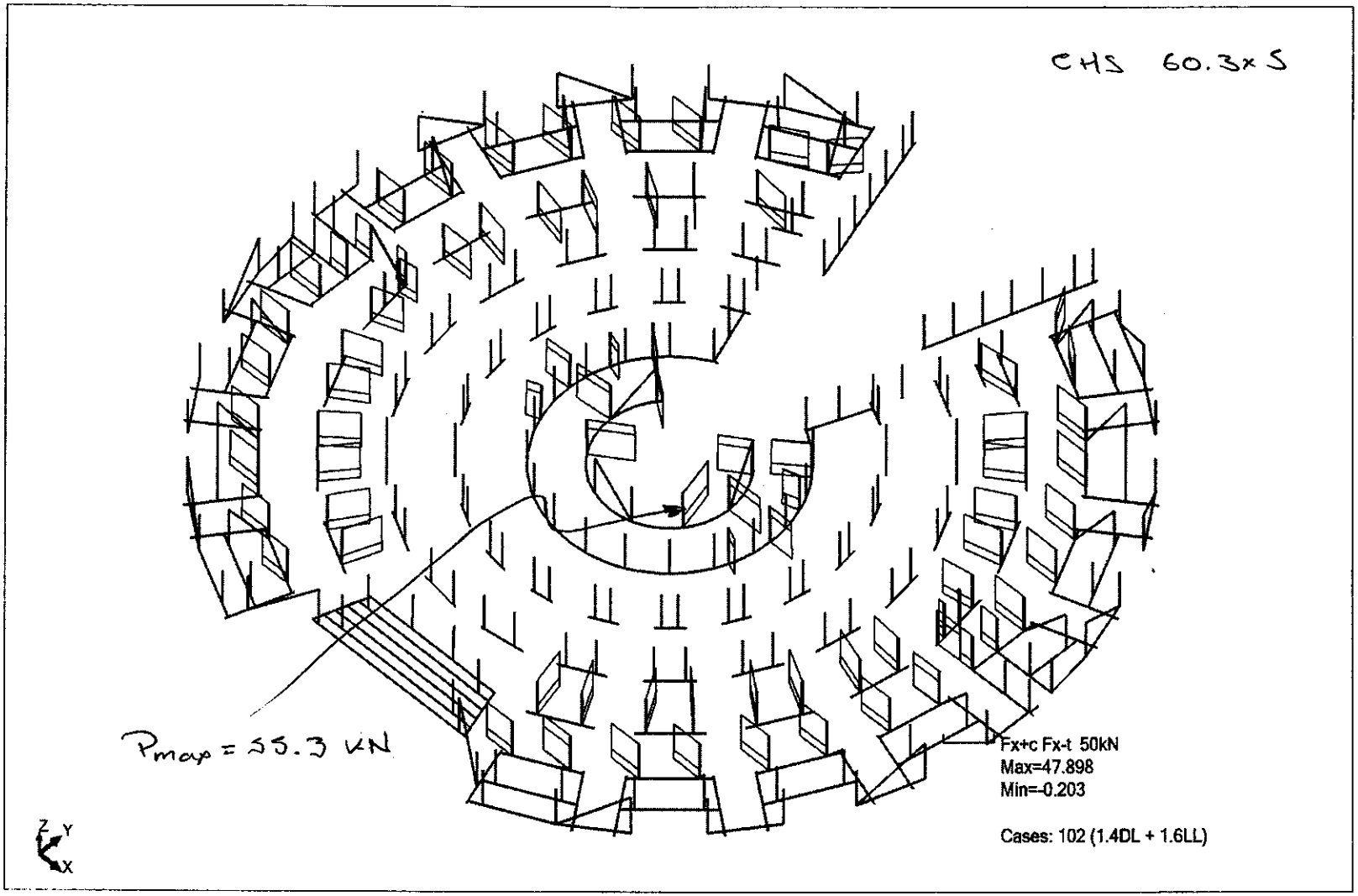
View:2 - FX, Cases: 102 (1.4DL + 1.6LL)

AXIAL FORCE DIAGRAM – LOAD COMBINATION 1.4DL + 1.6LL



1578/3/15

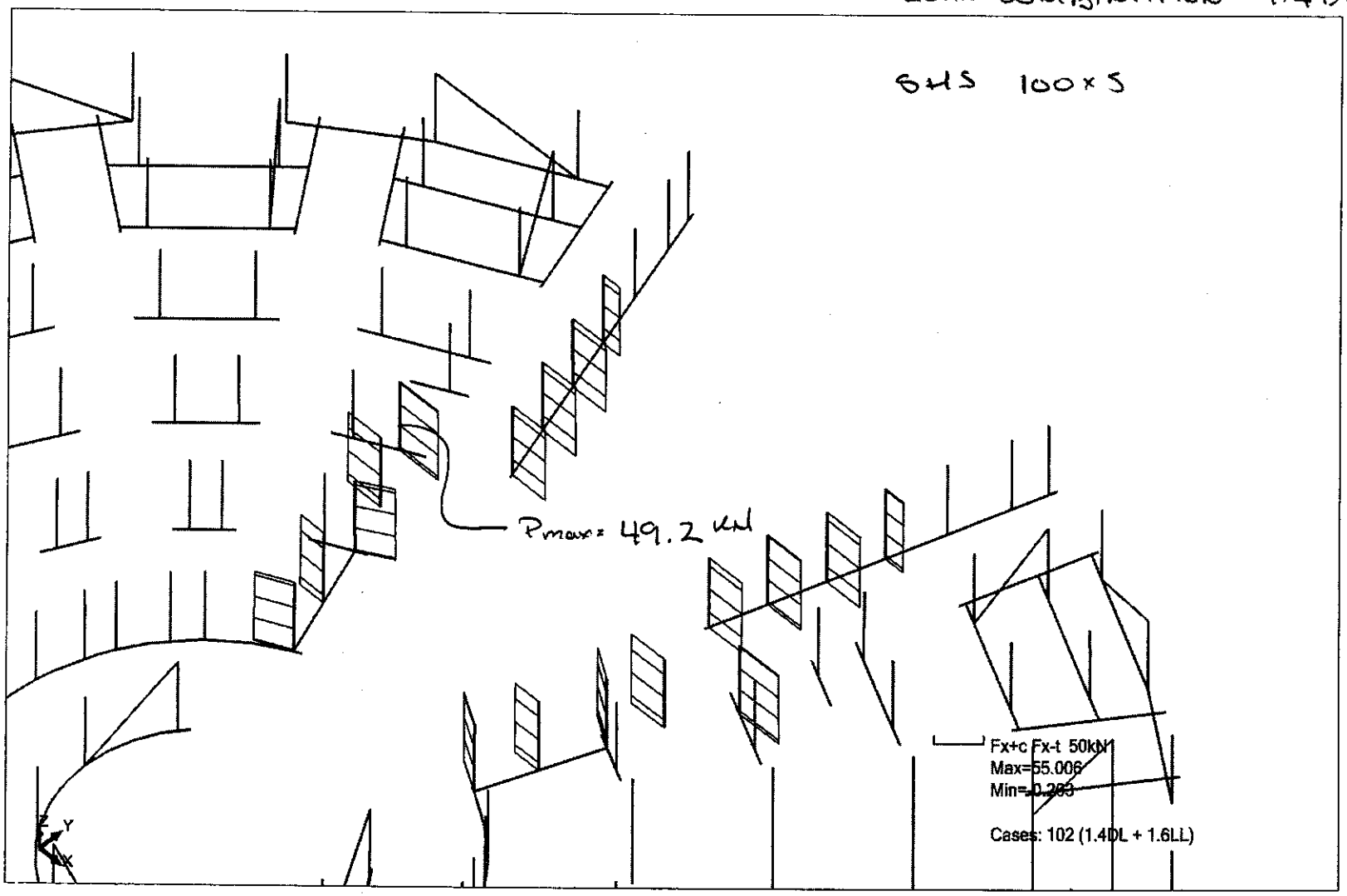
View:2 - FX, Cases: 102 (1.4DL + 1.6LL) AXIAL FORCE DIAGRAM - LOAD COMBINATION 1.4 DL+1.6LL



1578/3/16

View:2 - FX, Cases: 102 (1.4DL + 1.6LL)

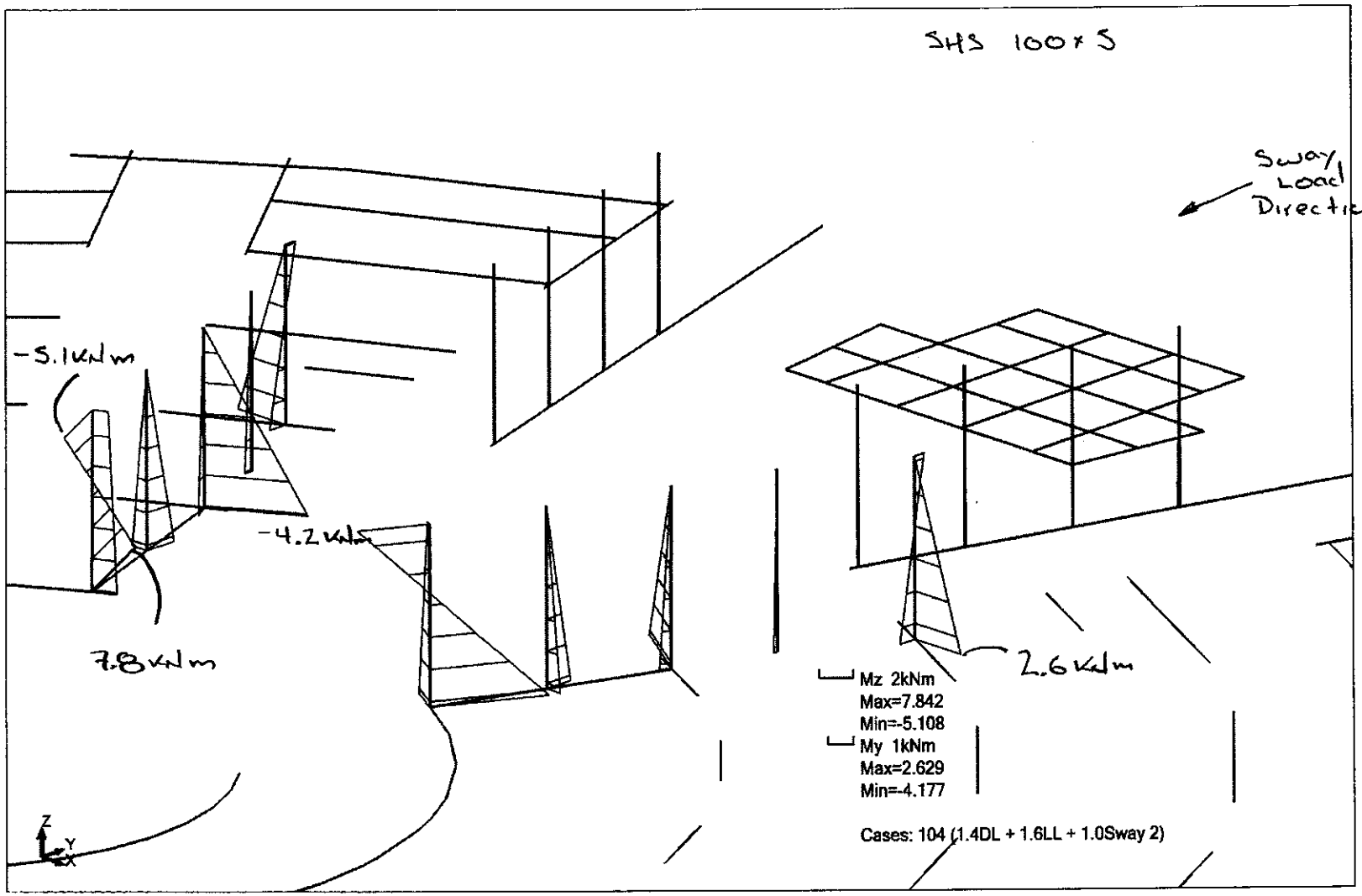
AXIAL FORCE DIAGRAM – LOAD COMBINATION 1.4DL + 1.6LL



1578/3/7

View:1 - MY,MZ, Cases: 104 (1.4DL + 1.6LL + 1.0Sway 2)

BMD - LOAD COMBINATION 1.4DL+1.6LL+1.0 Sway Load



1578/3/18

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES
Case: All Load Combinations
Bar: 152x152x23 UC Spreader Beam
Le ≤ 2300 mm

- Cases: 1to4 51 101to104

Filtering	Bar	Case
Full list	1to88 92to97 10	1to4 51 101to10
Selection	28 29 55 57 58 7	1to4 51 101to10
Total number	2766	9
Selected number	294	9

- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	7.885	3.568	46.214	0.557	26.730	0.573
Bar	1496	1178	1300	1513	1264	1248
Point	1050	1235	1162	1087	5/11	1142
Case	104 (C)	103 (C)	102 (C)	103 (C)	103 (C)	103 (C)
MIN	-7.103	-3.821	-4.190	-0.622	-16.541	-0.916
Bar	1173	1248	1264	1520	1112	1178
Point	1021	1152	1147	9/11	1015	1020
Case	103 (C)	103 (C)	103 (C)	102 (C)	103 (C)	103 (C)

1578/3/19

Forces - Cases: 1to4 51 101to104
Global extremes
1

GLOBAL EXTREME FORCES

Case: All Load Combinations

Bar: 152×152×23 UC spreader Beam

4300mm ≥ Le ≥ 2300mm

- Cases: 1to4 51 101to104

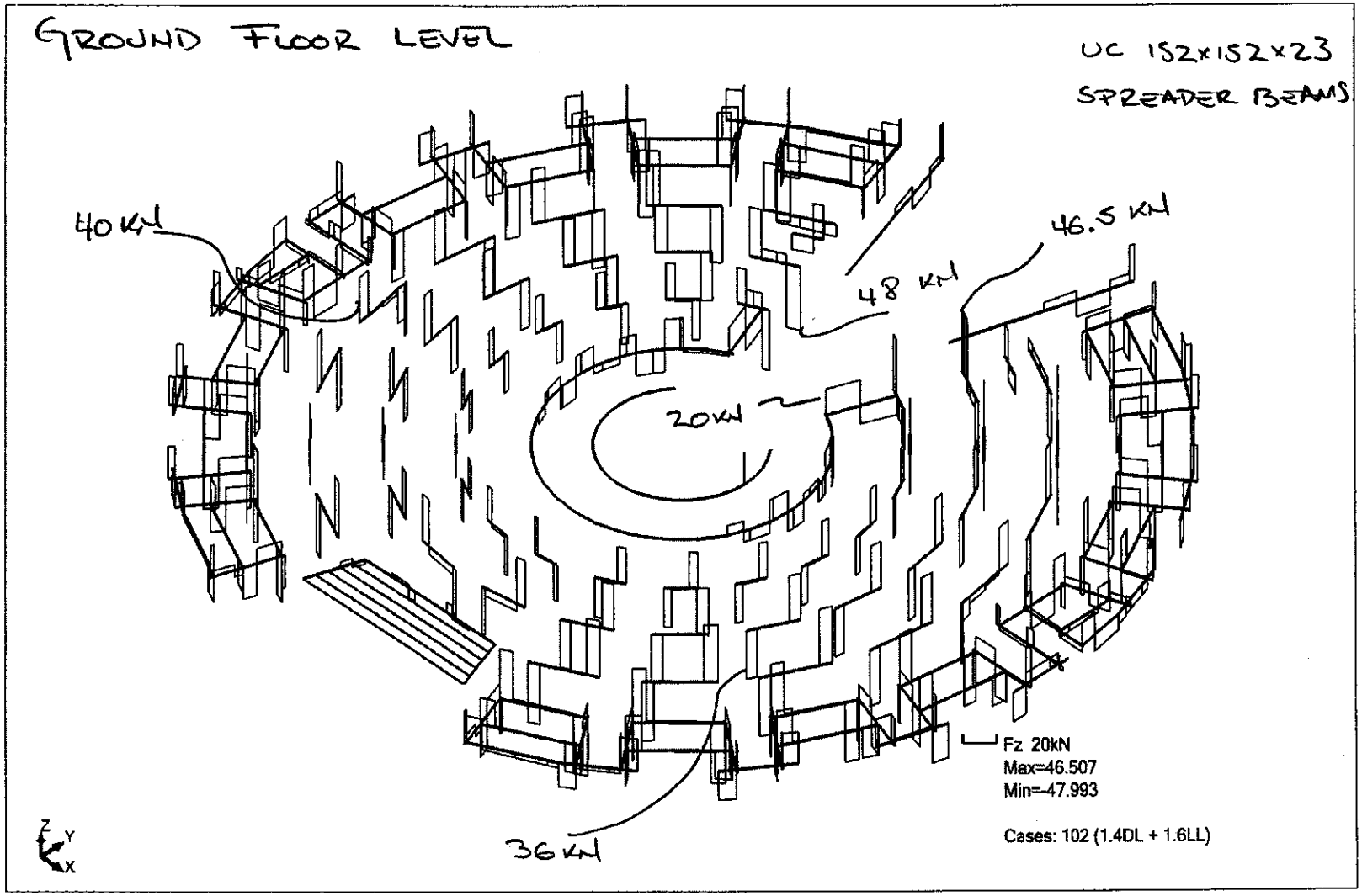
Filtering	Bar	Case
Full list	1to88 92to97 10	1to4 51 101to10
Selection	59to67 1049to10	1to4 51 101to10
Total number	2766	9
Selected number	267	9

- Cases: 1to4 51 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	3.692	4.723	44.139	0.214	23.408	0.708
Bar	1133	1141	1131	1100	1394	1141
Point	1448	1225	1241	1003	1485	1225
Case	103 (C)	103 (C)	103 (C)	103 (C)	104 (C)	103 (C)
MIN	-2.860	-4.229	-46.505	[illegible]	-8.523	-1.457
Bar	1216	1387	1426	67	64	1165
Point	1462	1306	1175	35	39	1225
Case	103 (C)	104 (C)	104 (C)	104 (C)	104 (C)	103 (C)

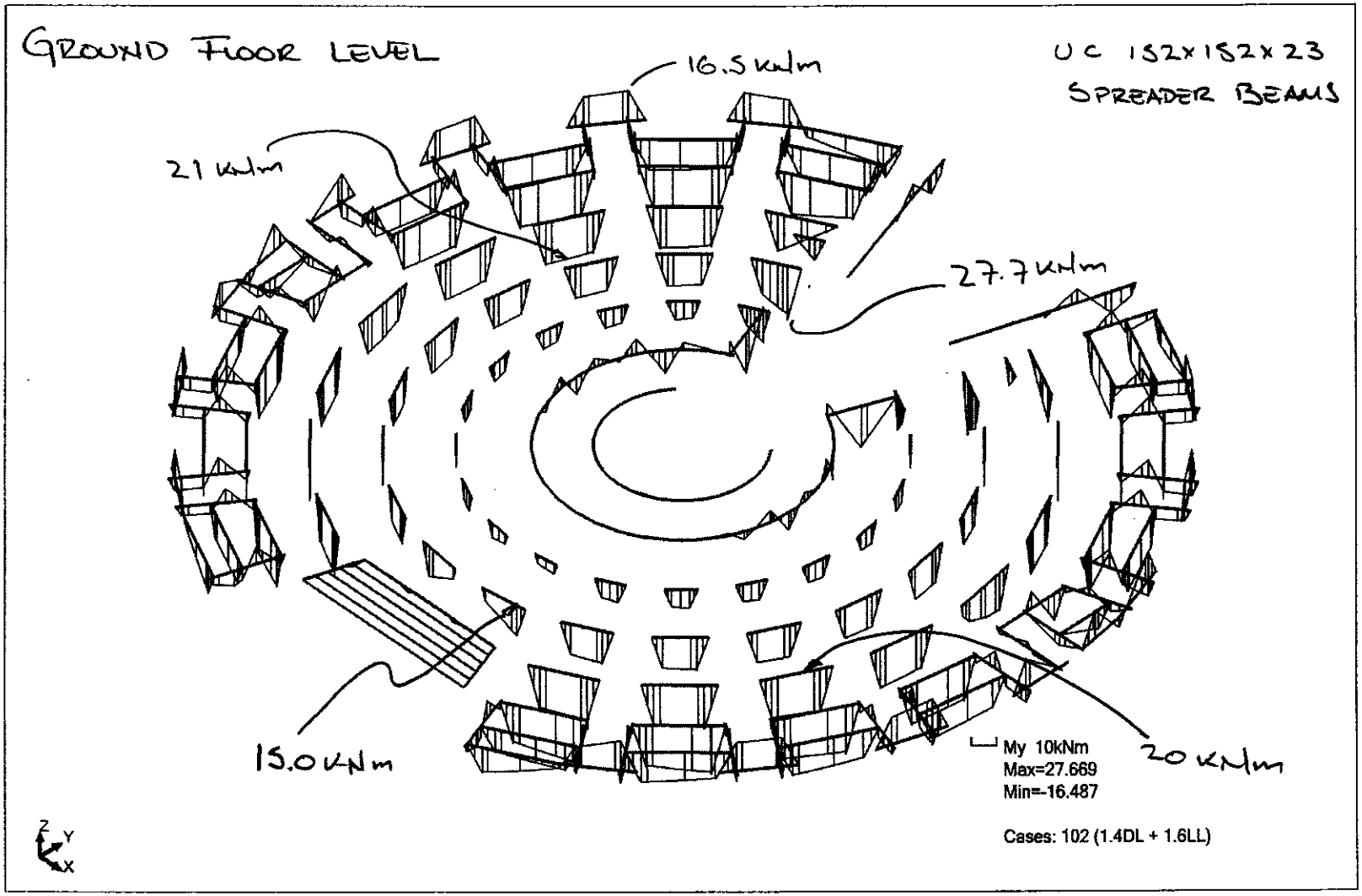
1578/3/20

View:2 - FZ, Cases: 102 (1.4DL + 1.6LL) SHEAR FORCE DIAGRAM - LOAD COMBINATION 1.4DL+1.6LL



1538/3/21

View:2 - MY, Cases: 102 (1.4DL + 1.6LL) BMD - LOAD COMBINATION 1.4DL + 1.6 LL



1578/3/22

Forces - Cases: 51to67 101to104
Global extremes
1

STAIRCASE MEMBERS

GLOBAL EXTREME FORCES

Case: All Load Combinations

Bar: 48.3x5 CHS Columns Under Entrance & Exit staircases.

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 150 151	1to5 51to67 101t
Selection	131to138 6370to	51to67 101to104
Total number	2842	26
Selected number	26	21

- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	10.052	0.154	-1.043	0.038	0.266	0.108
Bar	6395	6372	6373	6395	6393	6377
Node	3476	3427	3426	2282	3472	3457
Case	102 (C)	103 (C)	103 (C)	102 (C)	103 (C)	102 (C)
MIN	-3.895	-0.068	-1.183	-0.038	-0.243	-0.108
Bar	6370	6381	6381	6393	6370	6371
Node	3434	3451	3461	2283	3429	3433
Case	55 (C)	55 (C)	104 (C)	102 (C)	103 (C)	103 (C)

1578/3/23

Forces - Cases: 51to67 101to104
Global extremes
1

GLOBAL EXTREME FORCES

Case: All Load Combinations

Bar: 100x5 SHS STRINGERS EXIT & ENTRANCE

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 150 151	1to5 51to67 101t
Selection	100 106 140to14	51to67 101to104
Total number	2842	26
Selected number	5	21

- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	10.198	10.773	3.297	0.226	1.027	0.286
Bar	140	142	141	142	140	142
Point	13/21	20/21	1976	2282	10/21	19/21
Case	104 (C)	104 (C)	104 (C)	101 (C)	104 (C)	104 (C)
MIN	-4.078	-21.083	-4.807	-0.250	-0.869	-0.549
Bar	142	140	141	140	141	140
Point	8/21	20/21	7/21	20/21	7/21	11/21
Case	55 (C)	103 (C)	102 (C)	103 (C)	102 (C)	103 (C)

1578/3/24

Forces - Cases: 51to67 101to104
Global extremes
1

GLOBAL EXTREME FORCES
CASE: All Load Combinations
102×102×23 RSJ SPREADER BEAMS - EXIT / - ENTRANCE

- Cases: 51to67 101to104

Filtering	Bar	Case
Full list	1to147 150 151	1to5 51to67 101t
Selection	10 22 24 25 30to	51to67 101to104
Total number	2842	26
Selected number	85	21

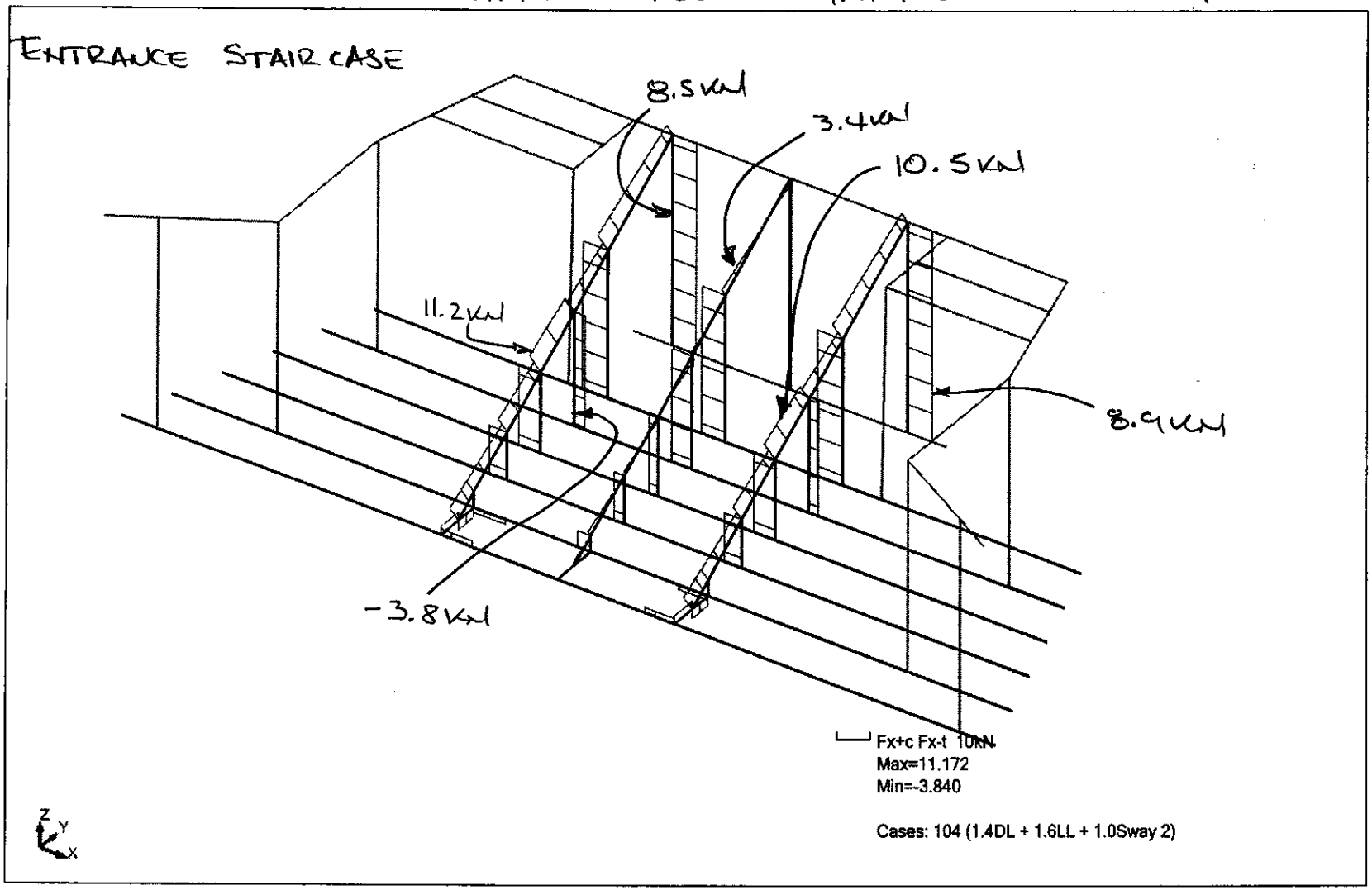
- Cases: 51to67 101to104

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	2.125	4.673	4.952	1.013	3.651	2.014
Bar	48	6324	41	6328	44	6329
Node	3377	1069	1069	1072	27	1068
Case	101 (C)	101 (C)	102 (C)	103 (C)	103 (C)	101 (C)
MIN	-2.034	-4.936	-15.240	-1.034	-3.650	-2.022
Bar	22	6329	45	6323	44	6324
Node	11	1070	1070	1071	26	1067
Case	101 (C)	101 (C)	103 (C)	102 (C)	103 (C)	101 (C)

15/8/12

View:1 - FX, Cases: 104 (1.4DL + 1.6LL + 1.0Sway 2)

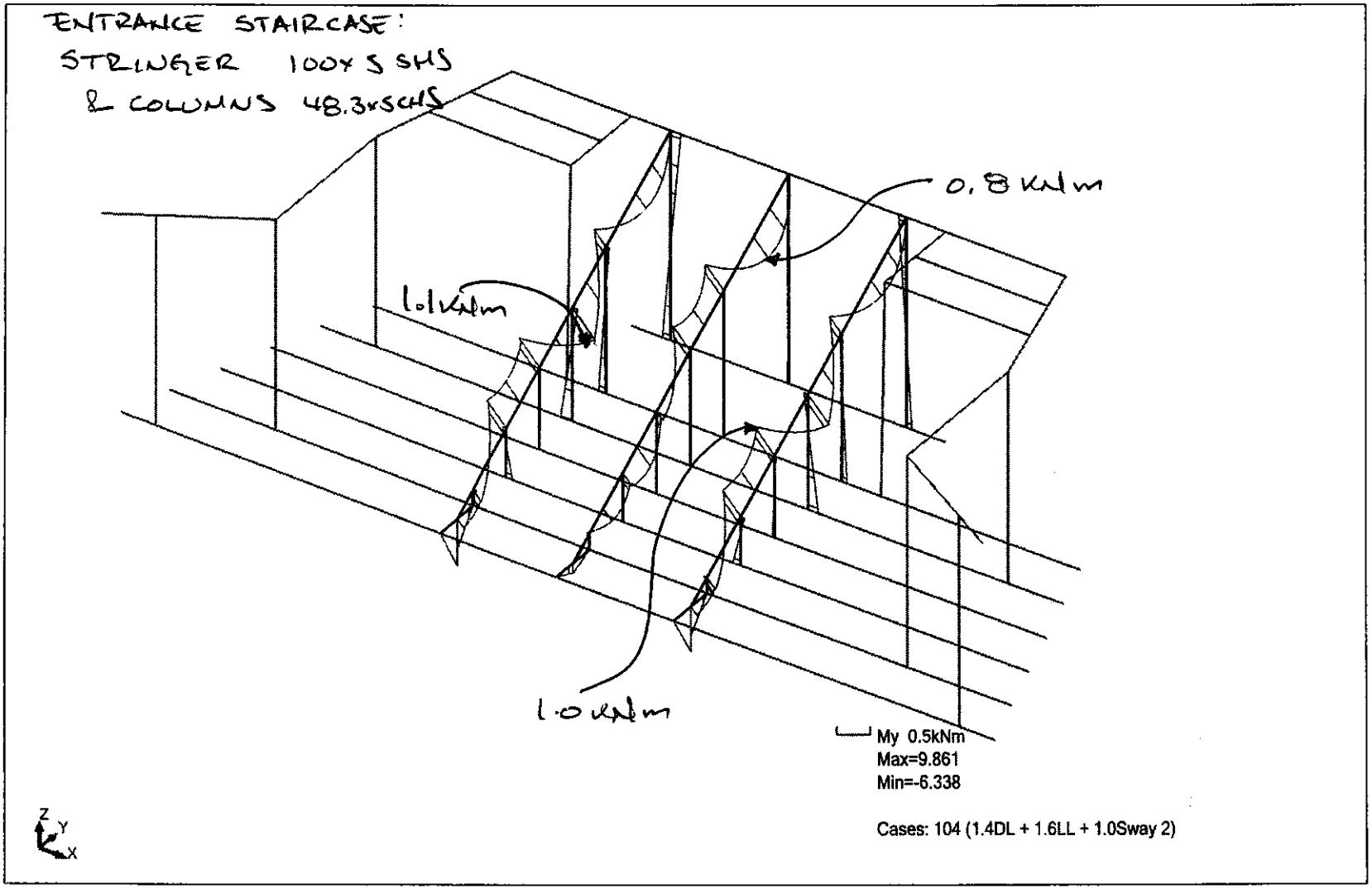
AXIAL FORCE DIAGRAM – LOAD COMB: 1.4DL+1.6LL+1.0 Sway 2



1578/3/26

View:1 - MY, Cases: 104 (1.4DL + 1.6LL + 1.0Sway 2)

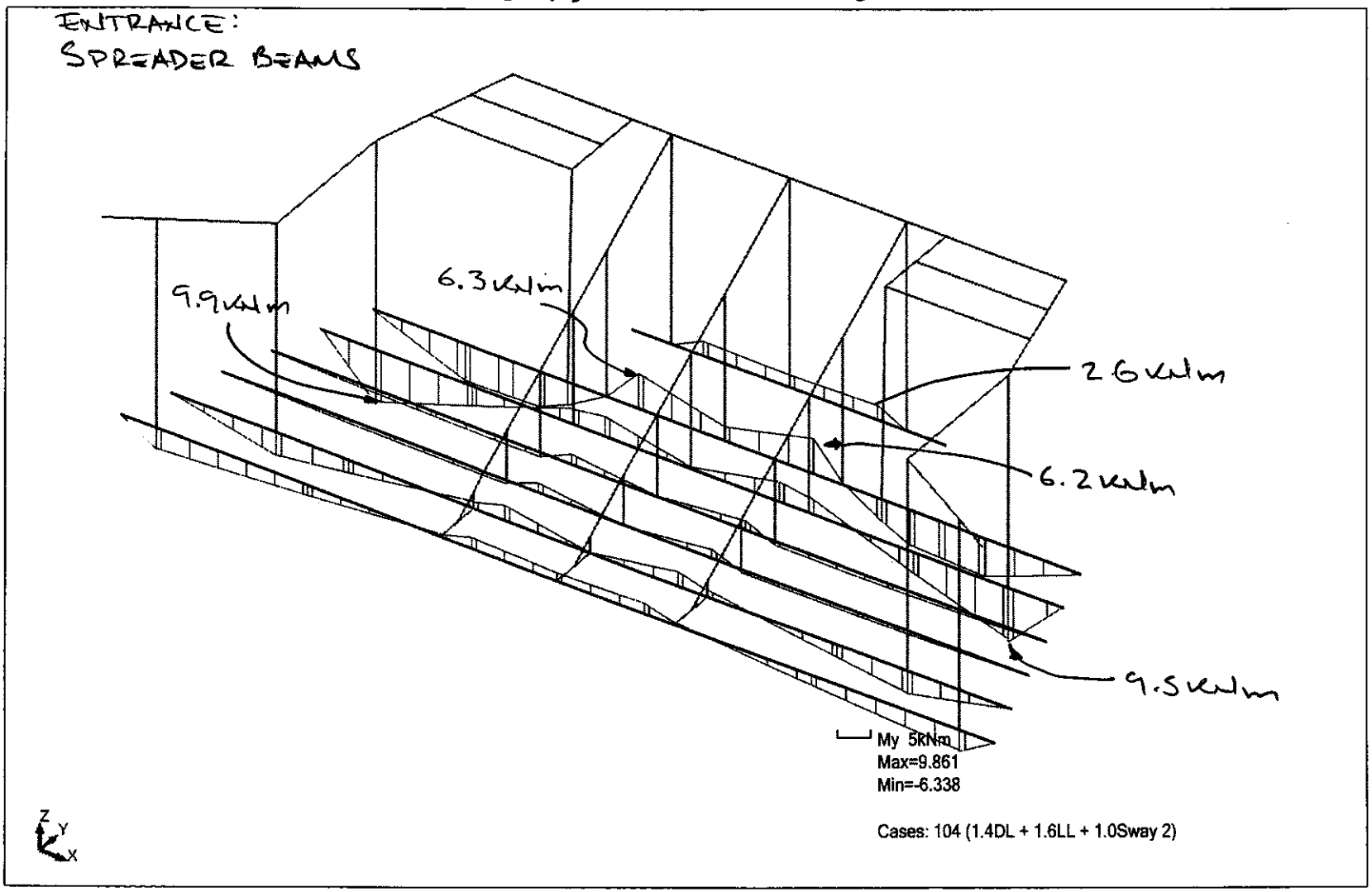
BMD - LOAD COMBINATION 1.4DL + 1.6LL + 1.0 Sway 2



1578/3/27

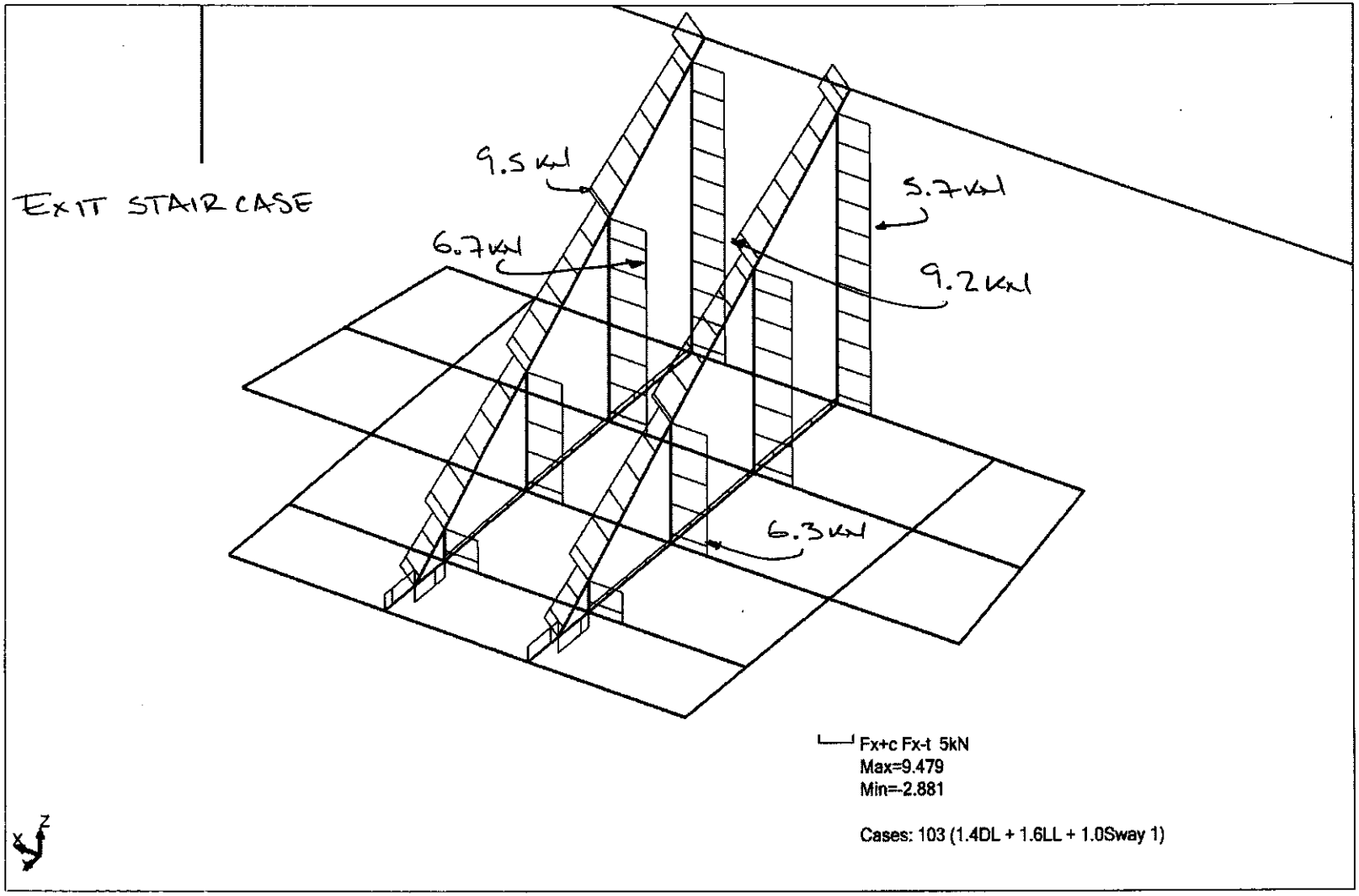
View:1 - MY, Cases: 104 (1.4DL + 1.6LL + 1.0Sway 2)

BMD - LOAD COMBINATION 1.4DL+1.6LL+1.0Sway 2



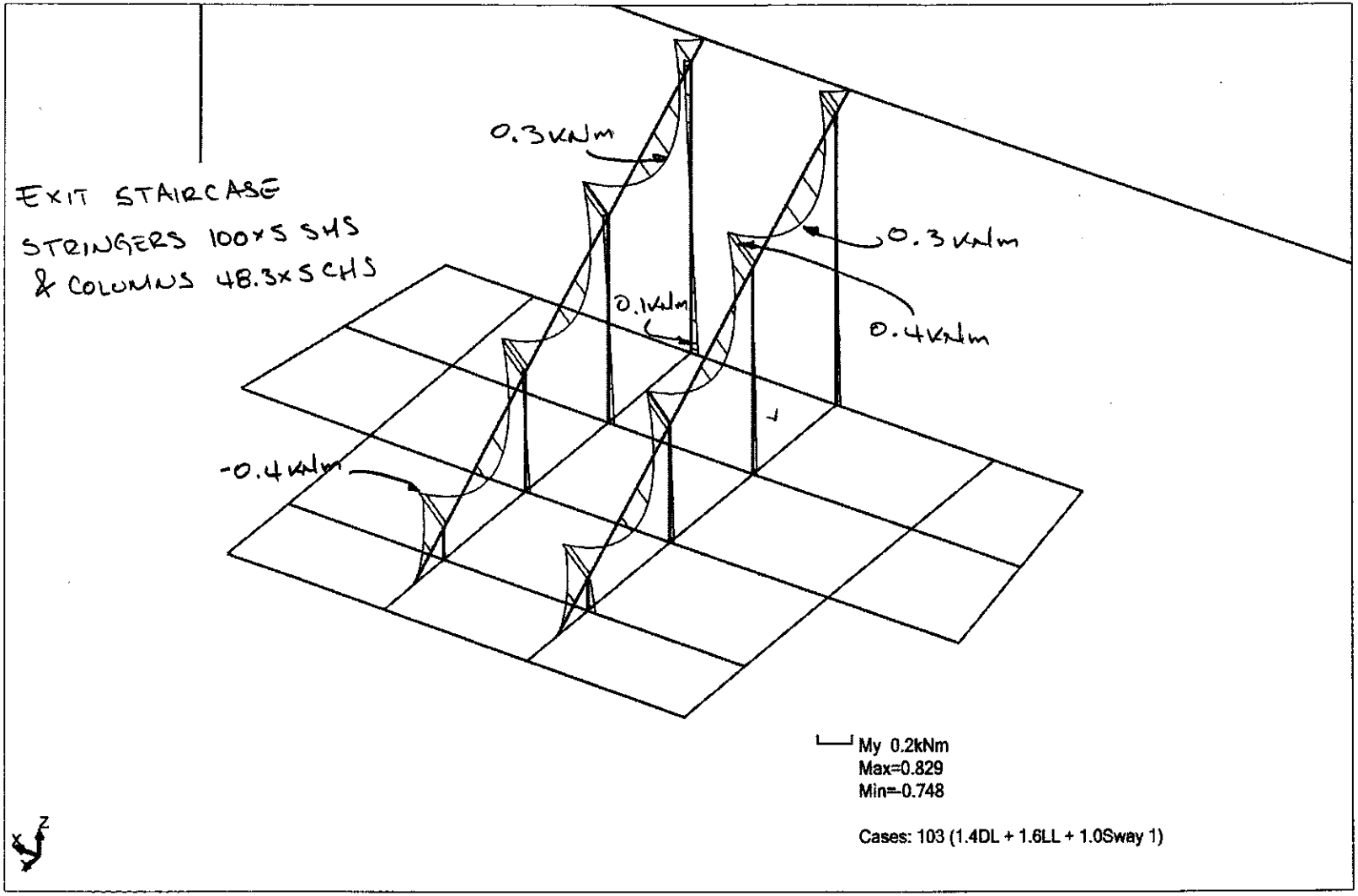
1578/3/28

View:2 - FX, Cases: 103 (1.4DL + 1.6LL + 1.0Sway 1) AXIAL DIAGRAM FORCE - LOAD COMBINATION 1.4DL+1.6LL+1.0SL



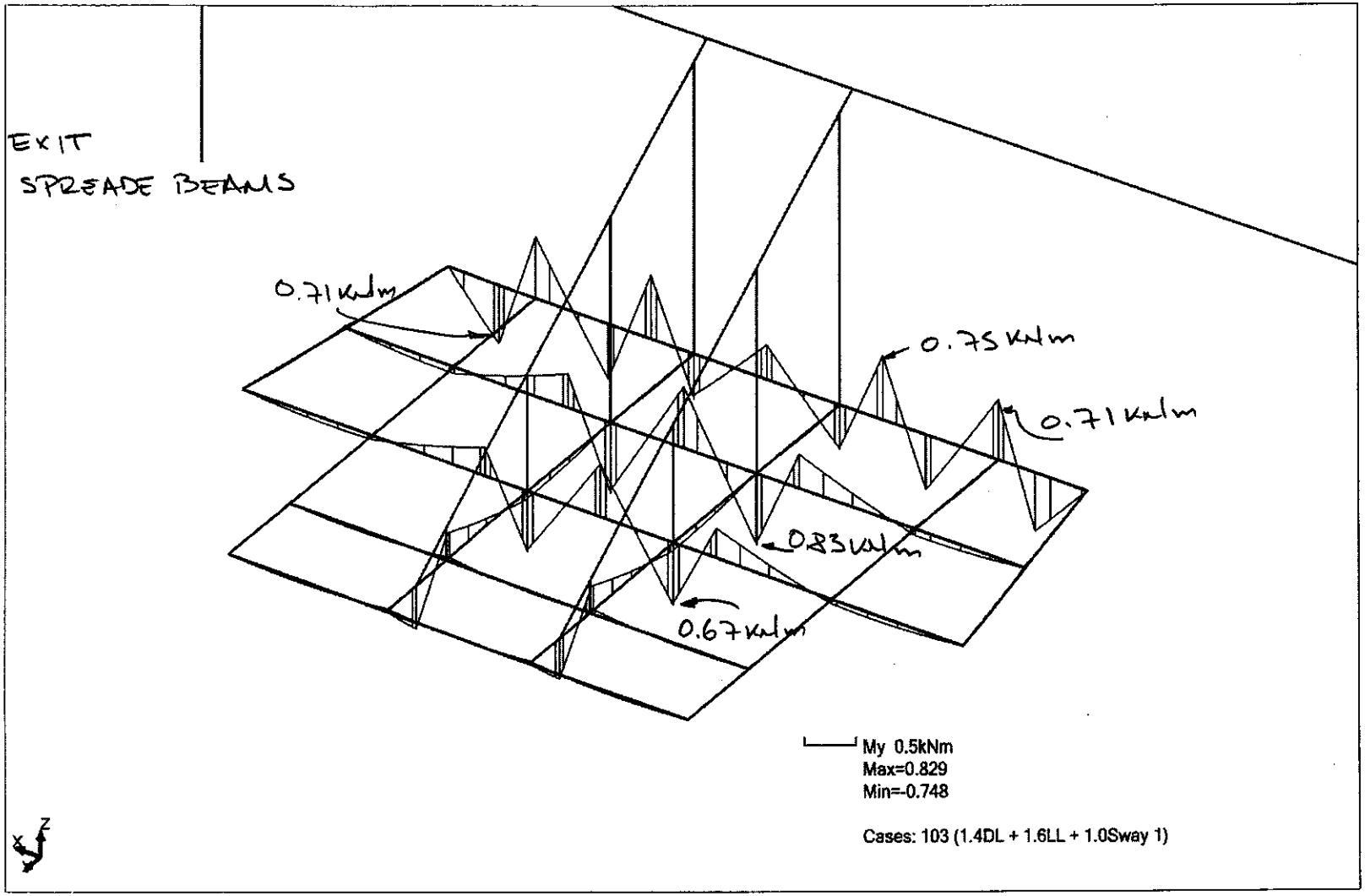
1578/3/29

View:2 - MY, Cases: 103 (1.4DL + 1.6LL + 1.0Sway 1) BMD - LOAD COMBINATION 1.4DL + 1.6LL + 1.0 Sway 1



1578/3/30

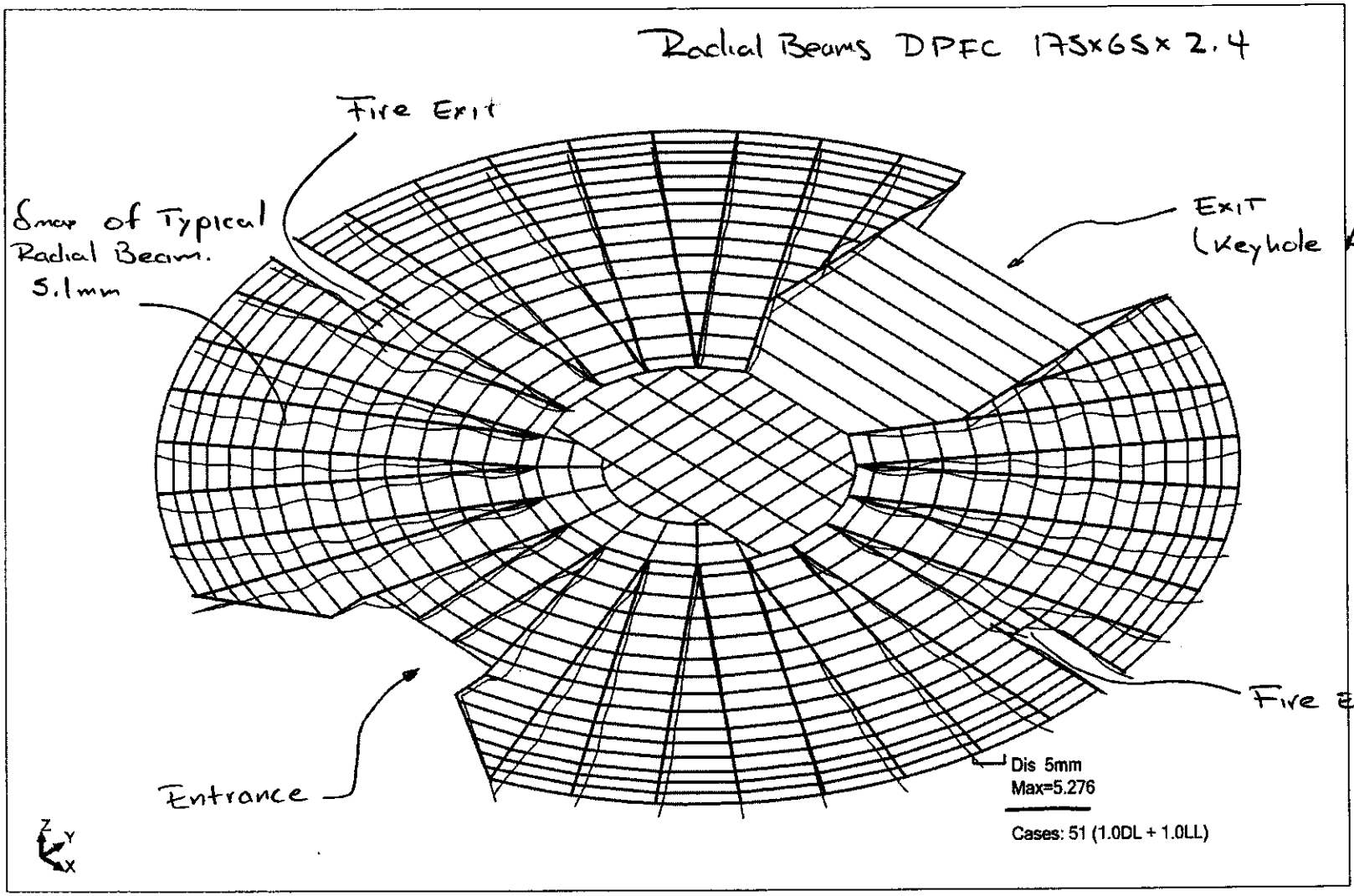
View:2 - MY, Cases: 103 (1.4DL + 1.6LL + 1.0Sway 1) BMD - LOAD COMBINATION 1.4DL+1.6LL+1.0 SWAY 1



1578/3/3

View:1 - Exact deformation(s), Cases: 51 (1.0DL + 1.0LL)

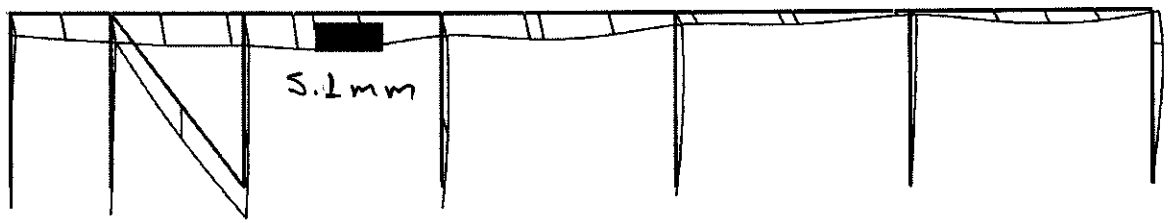
DEFLECTIONS – LOAD COMBINATION 1.0DL+1.0LL



1578/3/32

View:2 - Exact deformation(s), Cases: 51 (1.0DL + 1.0LL) DEFLECTION - LOAD COMBINATION 1.0 DL + 1.0 LL

TYPICAL RADIAL BEAM DPFC 175×65×2.4



Dis 5mm
Max=5.079

Cases: 51 (1.0DL + 1.0LL)

Z
X

1578/3/33

atelier one

Project BRITISH MUSEUM

No. 1578/4/1

Date 02/07 By LF

Checked

Notes

MEMBER CAPACITY CHECK

& DEFLECTION CHECK

atelier one

Project BRITISH MUSEUM

No 1578/4/2

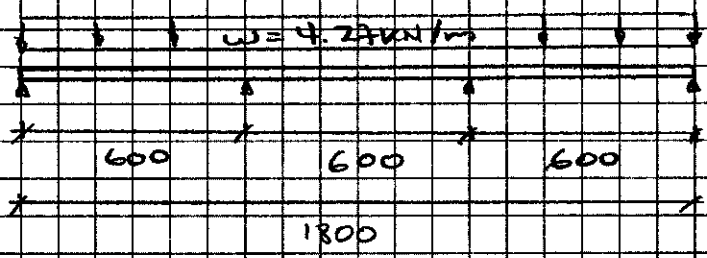
Date 02/07 By LF

Checked

Notes

TIMBER FLOOR CHECK

2 layers of ply 12.5mm thk.



Span = 600 mm

Use ply 1.8m min length to be distribute over 3 spans

Bending Check

$$M = \frac{wL^2}{10} = \frac{4.27 \times 0.6^2}{10} \quad \therefore \quad M = 0.15 \text{ kN m/m}$$

$$Z = \frac{1000 \times 12.5^2}{6}$$

$$Z = 26042 \text{ mm}^3$$

$$\sigma_{m//a} = \frac{0.15 \times 10^6}{26042} \quad \therefore \quad \sigma_{m//a} = 5.9 \text{ N/mm}^2$$

$\sigma_{m//adm} = 10.4 \text{ N/mm}^2 \geq \sigma_{m//a}$ ✓ O.K.

↳ 12.5mm Canadian Douglas fir plywood

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No 1578/4/3

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Notes

Deflection check

$w = 4.27\ KN/m^2$

$$\delta = \frac{2.1\, w L^4}{384\, E I}$$

two layers 12.5 mm

$w = 2.14\ KN/m$ per layer

$$I = \frac{1000 \times 12.5^3}{12}$$

$I = 162760\ mm^4$

$E = 5490\ N/mm^2$ Canadian Douglas fir plywood

$$\delta = \frac{2.1 \times 2.14 \times 0.6^4}{384 \times 0.893} = 0.0017$$

$\delta = 1.7\ mm$

$\delta_{adm} = 600 \times 0.003$

$\delta_{adm} = 1.8\ mm \geq \delta = 1.7\ mm$ ✓ O.K.

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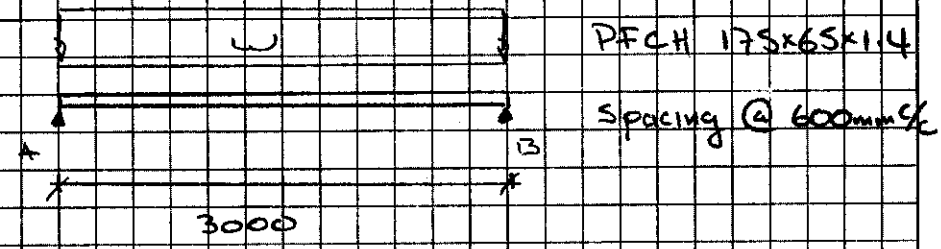
Notes

Secondary steel beam – Circumferential Beams.



w: Dead Load (inc. SW) — 0.2 KN/m

Live Load (4.0×0.6) — 2.4 KN/m

SLS — w = 2.6 KN/m

ULS — w = 4.12 KN/m

Bending Moment

$M = \frac{wL^2}{8}$

SLS => $M = \frac{2.6 \times 3.0^2}{8}$

$M = 2.93$ KNm

ULS => $M = \frac{4.12 \times 3.0^2}{8}$

$M = 4.64$ KNm

Shear Force

$R_A = R_B = \frac{w \times L}{2}$

SLS => $R_A = R_B = \frac{2.6 \times 3}{2}$

$R_A = R_B = 3.9$ KN

ULS => $R_A = R_B = \frac{4.12 \times 3}{2}$

$R_A = R_B = 6.2$ KN.

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Project BRITISH MUSEUM

No 1578/4/S

Date 02/07 By LF

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Notes

Use 175x65x1.4 PFCH Channel Section

Material Properties

$E = 205\ kN/mm^2$

$P_y = 280\ N/mm^2$

Section Properties

$t = 1.4\ mm$ $I_{xx} = 196.7\ cm^4$

$D = 175\ mm$ $r_{yy} = 20\ mm$

$I_{x1} = 159.5\ cm^4$ $Z_{xx} = 18225\ mm^3$

Moment Resistance

Compression flange fully restrained.

$M_{cx} = Z_{xx} \cdot P_y$

$M_{cx} = 18225 \times 280 / 10^6$

$M_{cx} = 5.1\ kNm > 4.64\ kNm$ ✓ O.K.

Shear Resistance

- Shear yield strength.

$P_v = 0.6 P_y = 0.6 \times 280 = 168\ N/mm^2$

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Project BRITISH MUSEUM

No. 1578/4/6

Date 02/07 By LF

Checked

Notes

* Shear buckling strength

$$q_{cr} = \left(\frac{1000t}{D}\right)^2 = \left(\frac{1000 \times 1.4}{175}\right)^2$$

$q_{cr} = 64\ N/mm^2$ — which is more critical

* Max Shear Force, $F_{v\,max} = 6.2\ kN$

Shear area $175 \times 1.4 = 245\ mm^2$

* Average Shear stress.

$$f_v = \frac{6.2 \times 10^3}{245} = 25.3\ N/mm^2 < q_{cr}$$ ✓O.K.

Connection check

$R_A = R_B = 6.2\ kN$

M12 Shear Capacity

$P_v = 31.6\ kN$ — Grade 8.8 ✓O.K.

1.4mm thk Web Bearing Cap

$p_{bs} = 0.65(280 + 360)$

$p_{bs} = 416\ N/mm^2$

$P_{bs} = d \times t \times p_{bs}$ $\therefore P_{bs} = 12 \times 1.4 \times 416/10^3$

$P_{bs} = 7.0\ kN \geq 6.2\ kN$ ✓O.K.

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No 1578/4/7

Date 02/07 By LF

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Notes

Deflection check

$$\delta_{adm} = \frac{4e}{360} = \frac{3000}{360}$$

$$\delta_{adm} = 8.3 \text{ mm}$$

$$\delta_m = \frac{5 \times wL^4}{384 EI_{av}}$$

$$I_{av} = \frac{I_{xx} + I_{xr}}{2} = \frac{196.7 + 159.5}{2}$$

$$I_{av} = 178.1 \times 10^4 \text{ mm}^4$$

$$EI_{av} = 365.1 \text{ kNm}^2$$

$$\delta_m = \frac{5 \times 2.6 \times 3^4}{384 \times 365.1} = 7.5 \times 10^{-3} \text{ m}$$

$$\delta_m = 7.5 \text{ mm} \leq \delta_{adm} = 8.3 \text{ mm}$$

√O.K.

atelier one

Project BRITISH MUSEUM

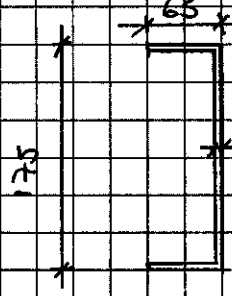
No 1578/4/8

Date 02/07 By LF

Checked

Notes

SINGLE PFCH 175x65x2.4



Material Properties

$E = 205000\ N/mm^2$

$p_y = 280\ N/mm^2$

Section Properties

$t = 2.4\ mm$ $\quad I_{xx} = 3309401\ mm^4$

$D = 175\ mm$ $\quad r_{yy} = 19.8\ mm$

$I_{xr} = 3278082\ mm^4$ $\quad Z_{xr} = 37437\ mm^3$

Bending Moment Resistance — Restrained Beam

$M_{cx} = Z_{xr} \times p_y$

$M_{cx} = 37437 \times 280 / 10^6$

$M_{cx} = 10.5\ kNm > 7.2\ kNm$ ✓ o.k.

Shear Resistance

* Shear yield Strength

$p_v = 0.6\ p_y = 0.6 \times 280 = 168\ N/mm^2$

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Project BRITISH MUSEUM

No 1578/4/9

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Notes

+ Shear buckling strength

$$q_{tcr} = \left(\frac{1000t}{D}\right)^2 = \left(\frac{1000 \times 2.4}{175}\right)^2$$

$q_{cr} = 188.1\ N/mm^2 \geq p_v = 168\ N/mm^2$ — more critical

* Max Shear Force

$F_{v,max} = 6.4\ kN$

Shear area — $A_v = 175 \times 2.4 = 420\ mm^2$

* Average Shear stress,

$$f_v = \frac{6.4 \times 10^3}{420} = 15.2\ N/mm^2 \leq p_v$$ — O.K.

Connection Check

$F_v = 6.4\ kN \leq 7.0\ kN$ Bearing Cap. — O.K.

1.4 mm thk Channel seat

Check by inspection

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Project BRITISH MUSEUM

No. 1578/4/10

Date 02/07 By LF

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Notes

Deflection Check

$L_e = 2370$ mm

$\delta_{adm} = \frac{2370}{360}$

$\delta_{adm} = 6.6$ mm

$\delta_m = 5.5$ mm $\leq \delta_{adm}$ 6.6 mm

From Results Summary
√O.K.

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Project BRITISH MUSEUM

No 1578/4/11

Date 02/07 By LF

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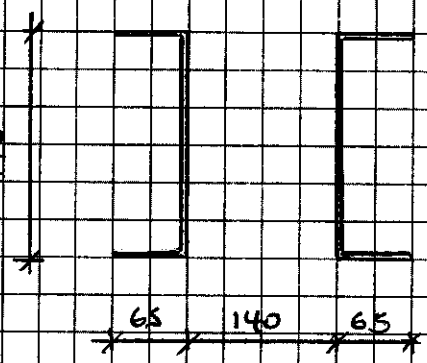
Notes

RADIAL BEAMS DOUBLE CHANNELS



DPFC 175×65×2.4

2No 175×65×2.4 PFCH

Back to Back

Material Properties

$E = 205\ kN/mm^2$

$P_y = 280\ N/mm^2$

Section Properties

$t = 2.4\ mm$ $I_{xx} = 6619802\ mm^4$

$D = 175\ mm$ $r_{yy} = 19.8\ mm$

$I_{xx} = 6556164\ mm^4$ $Z_{xx} = 74878\ mm^3$

Bending Moment Resistance

The compression flange is fully restrained over the sagging moment region but is unrestrained over the hogging moment region, that is, over

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Project BRITISH MUSEUM

No. 1578/4/R

Date 02/07 By LF

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Notes

the internal supports. Unrestrained 1.2m long.

The moment resistance of the restrained section

$M_{cx} = Z_x \times P_y$

$M_{cx} = 74878 \times 280 / 10^6$

$M_{cx} = 21.0$ kNm > 12.5 kNm
> 19.3 kNm

Ok.
(keyhole area

Buckling Resistance Moment of Unrestrained Sect.

$L_E = 1250$ mm — Effective length

$\frac{L_E}{r_y} = \frac{1250}{19.8} = 63.1$

$\lambda_{LT} = \frac{n_{uv} \frac{L_E}{r_y}}{\lambda_y}$

where $n_{uv} = 0.65$

$\lambda_y = 85$

$\lambda_{LT} = \frac{0.65 \times 63.1}{85}$

$\lambda_{LT} = 0.48$ $\therefore \frac{M_b}{M_y} = 1.0$

$M_{cx} = M_b = 21.0$ kNm

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Project BRITISH MUSEUM

No. 1578/4/13

Date 02/07 By LF

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Notes

Shear Resistance

- Shear yield stregth

$$p_v = 0.6\, p_y = 0.6 \times 280 = 168\ N/mm^2$$

- Shear buckling strength

$$q_{fcr} = \left(\frac{1000t}{D}\right)^2 = \left(\frac{1000 \times 2.4}{175}\right)^2$$

$$q_{fcr} = 188.1\ N/mm^2 \geq p_v = 168\ N/mm^2$$ — more critical

- Max Shear Force

$$F_v = 270\ kN$$

Shear area — $2 \times 175 \times 24 = 840\ mm^2$

- Average shear stress.

$$f_v = \frac{270 \times 10^3}{840} = 32.1\ N/mm^2 \leq p_v$$ ✓o.k.

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Project BRITISH MUSEUM

No 1578/4/14

Date 02/07 By LF

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Notes

Web Crushing at End Support

Check the limits of the formulae.

$\frac{D}{t} = \frac{175}{2.4} = 73 \leq 200$ ✓o.k

- Bearing length $N = 50$ mm

For $c = 0$, $N/t = 20.8$ and restrained section,

$P_w = t^2 C_7 p_y (8.8 + 1.11\sqrt{N/t})$

$C_7 = 1 + \frac{D/t}{750} = 1.1$

$P_w = 2.4^2 \cdot 1.1 \times 280 (8.8 + 1.11\sqrt{20.8}) \times 10^{-3}$

$P_w = 24.5$ kN — per channel section

$P_w = 2 \times 24.5 = 49.0$ kN $> R_{max} = 25.8$ kN ✓o.k.

Web Crushing at Internal Support

At internal support, the bearing length, N, is 50mm

For $c > 1.5D$ $N/t = 20.8$ and restrained section,

$P_w = t^2 C_5 C_c p_y (13.2 + 2.87\sqrt{N/t})$

$K = \frac{280}{228} = 1.23$

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Project BRITISH MUSEUM

No 1578/4/15

Date 02/07 By LF

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Notes

$C_s = 1.49 - 0.53\,\kappa = 0.84$

$C_6 = 0.88 + 0.12 \times (2.4/1.9) = 1.03$

$P_w = 2.4^2 \times 0.84 \times 1.03 \times 280\,(13.2 + 2.87\sqrt{20.8})$

$P_w = 36.7$ kN — per channel section

$P_w = 2 \times 36.7 = 73.4$ kN $<$ 44.3kN ✓O.K.

Combined Bending and Web Crushing at Internal Support

$$1.1\left(\frac{F_w}{P_w}\right) + \left(\frac{M_x}{M_{cx}}\right) \leq 1.5$$

$F_w = 44.3$ kN $\quad P_w = 73.4$ kN

$\frac{F_w}{P_w} \leq 1.0$ ✓O.K.

$M_x = 12.5$ kNm $\quad M_c = 21.0$ kNm

$\frac{M_x}{M_c} \leq 1.0$

$1.1\left(\frac{44.3}{73.4}\right) + \left(\frac{12.5}{21.0}\right) = 1.26 \leq 1.5$ ✓O.K.

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Project BRITISH MUSEUM

No. 1578/4/16

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Notes

Keyhole area check

$$1.1\left(\frac{F_w}{P_w}\right)+\left(\frac{M_x}{M_{cx}}\right) \leq 1.5$$

$F_w = 27.1$ kN $P_w = 73.4$ kN

$\frac{F_w}{P_w} \leq 1.0$ ✓O.K.

$M_x = 19.2$ kNm $M_c = 21.0$ kNm

$\frac{M_x}{M_c} \leq 1.0$

$1.1\left(\frac{27.1}{73.4}\right)+\left(\frac{19.2}{21.0}\right) = 1.32 \leq 1.5$

✓O.K.

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Project BRITISH MUSEUM

No 1578/4/17

Date 02/07 By LF

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Notes

Deflection Check

Radial Beams

$\delta_{max} = 7.5$ mm Load Combination 1.0DL+1.0LL

Results Summary

Relative deflection

① $\delta_m = 7.5 - \left(\frac{5.8+7.3}{2}\right)$

$\delta_m = 1.0$ mm

$L_e = 1591$

$\frac{L_e}{360} = \frac{1591}{360} = 4.4$ mm $\geq$ 1.0 mm ✓O.K.

② $\delta_m = 7.3 - 4.4 = 2.9$ mm

$L_e = 1182$

$\frac{L_e}{360} = \frac{1182}{360} = 3.3$ mm $\geq$ 2.9 mm ✓O.K.

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Project BRITISH MUSEUM

No. 1578/4/18

Date 02/07 By LF

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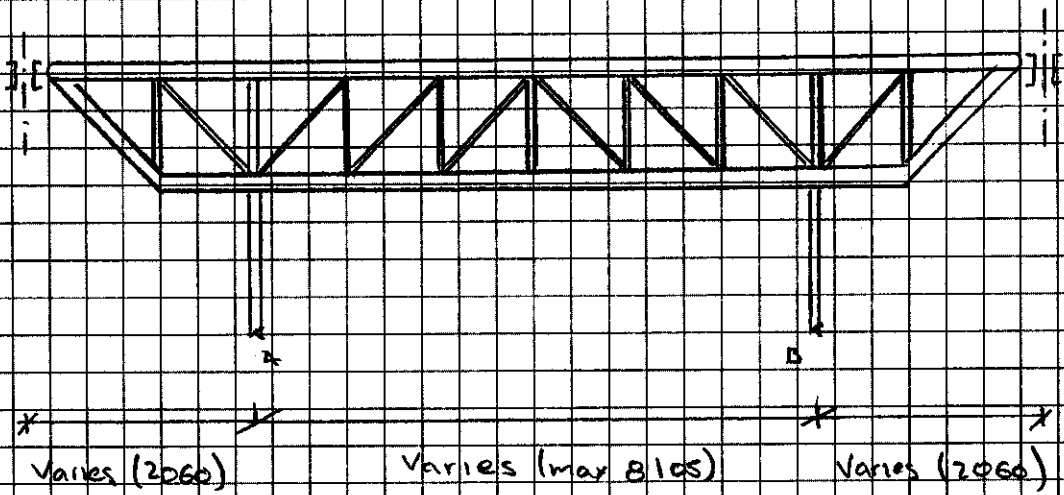
Notes

TRUSS TYPE 'A'



Beam self weight.

Section	Mass (kg/m)	length (m)	Mass (kg)
80x3.6 SHS (Chords)	8.53	20.4	174
80x3.6 SHS (Uprights)	8.53	1.0	8.5
60x40x3.2 RHS (Uprights)	4.35	5.5	23.9
60x40x3.2 RHS (diag.)	4.35	10.1	43.9
			250.3

$$w = \frac{250.3}{9.42} = 26.6 \simeq 27 \text{ kg/m}$$

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Project BRITISH MUSEUM

No 1578/4/19

Date 02/07 By LF

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Notes

Results Summary

Load

Dead Load (inc. sw) 0.67 kN/m

Live Load ——— 5.2 kN/m

SLS —— $w = 5.87$ kN/m

ULS —— $w = 9.26$ kN/m

Bending Moment

Max. Sagging moment $M_{max} = 75.1$ kNm

Max hogging moment $M_{max} = 20.2$ kNm

Shear Force

$V_{max} = 38.5$ kN

$R_A = R_B = 46.2$ kN

Material Properties

Hot rolled steel — grade S275

$E = 205$ kN/mm^2

$p_y = 275$ N/mm^2

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Project BRITISH MUSEUM

No. 1578/4/20

Date 02/07 By LF

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Notes

Moment Resistance

Sagging

$$T = C = \frac{M_{max}}{d} = \frac{751 \times 10^3}{500}$$

$T = C = 150.2$ kN.

Compression Top chord — fully restrained

Tension bottom chord

Compression capacity of top chord is equal to tension capacity

$P_T = P_c = 299$ kN $\geq$ 150.2 kN — V.O.K

Hogging

$$T = C = \frac{M_{max}}{d} = \frac{20.2 \times 10^3}{500}$$

$T = C = 40.4$ kN.

Compression bottom chord — $L_E = 5570 \times 0.7$

$L_E = 3900$ mm

$P_c = 114$ kN $\geq$ 40.4 kN — V.O.K.

Tension Top Chord $P_T = 299$ kN $\geq$ 40.4 kN — V.O.K.

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Project BRITISH MUSEUM

No. 1578/4/21

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Notes

Shear Resistance

$\theta = 53.4°$

62.9 kN at θ

37.5 kN — Reaction + loading between supports

Max Compression 60x40x3.0 RHS diagonal

$C = 62.9$ kN

$L_E = 840$ mm

$P_c = 130$ kN $\geq$ 62.9 kN ✓O.K.

80x80x3.6 SHS

$P_v = 0.6 p_y A_v$ $A_v = 0.5A = 0.5 \times 1040$

$P_v = 0.6 \times 275 \times 545 / 10^3$

$P_v = 89.9$ kN $\geq$ 46.2 kN $= R_A = R_B$ ✓O.K.

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No. 1578/4/22

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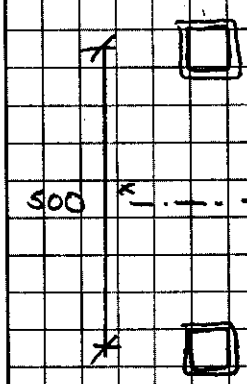
Notes

Deflection Check



$E = 205000\ N/mm^2$

$I_o = 2 \times (105 \times 10^4 + 1090 \times 250^2)$

$I_o = 13835 \times 10^4\ mm^4$

$I_{xx} = I_o / (1+F)$

where $F = k I_o / A_s L^2$

$k = 9.6$; $L = 8.1\ m$

$$\frac{1}{A_s} = \sec\vartheta \left(\frac{1}{A_D \sin^2\vartheta} + \frac{\sin\vartheta}{A_B} \right)$$

$A_D = 554\ mm^2 = A_B$ => Area of 60x40x3.0 RHS

$\vartheta = 36.6°$

$$\frac{1}{A_s} = \sec 36.6 \left(\frac{1}{554 \times \sin^2 36.6} + \frac{\sin 36.6}{554} \right)$$

$\frac{1}{A_s} = 7.66 \times 10^{-3}\ 1/mm^2$

$A_s = 130.5\ mm^2$

$F = 9.6 \times 13835 \times 10^4 / 130.5 \times 8105^2$

$F = 0.155$

$I_{xx} = 13835 \times 10^4 / (1.155)$

$I_{xx} = 11978 \times 10^4 mm^4$

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Project BRITISH MUSEUM

No. 578/4/23

Date 02/07 By LF

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Notes

$$\delta_m = \frac{5 \times 5.87 \times 8.1^4}{384 \times 24556} \times 10^3$$

$$\delta_m = 13.4 \text{ mm}$$

$$\delta_{adm} = \frac{8105}{360} = 22.5 \text{ mm} \geq 13.4 \text{mm}$$

O.K.

atelier one

Project BRITISH MUSEUM

No 1578/4/24

Date 02/07 By LF

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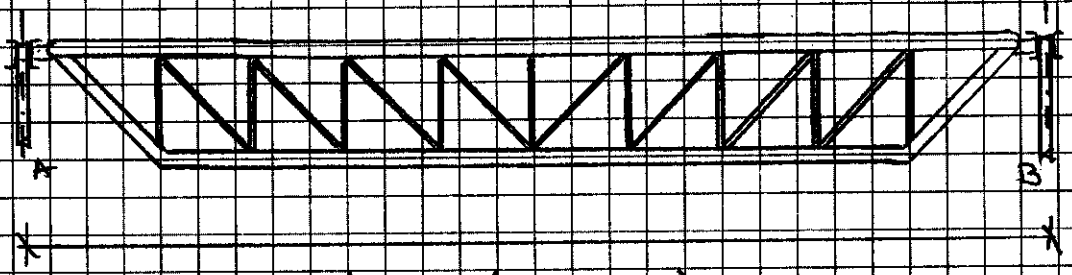
Notes

TRUSS TYPE B & C



Varies (max 9690)

Loads

Dead Load (inc Sw) 0.67 kN/m

Live Load ——— 5.2 kN/m

SLS —— $w = 5.87$ kN/m

ULS —— $w = 9.26$ kN/m

Bending Moment

$M_{max} =$ 111.6 kNm — sagging moment only

Shear Force

$V_{max} = R_A = R_B = \frac{9.26 \times 9.69}{2}$

$R_A = R_B = 44.9$ kN

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Project BRITISH MUSEUM

No 1578/4/25

Date 02/07 By LF

Checked

Notes

Moment Resistance

$$T = C = \frac{M_{max}}{d} = \frac{111.6 \times 10^3}{500}$$

$$T = C = 223.2 \text{ kN}$$

Compression Top chord – fully restrained

Tension bottom chord

Compression capacity of top chord is equal to tension capacity

$$P_T = P_C = 296 \text{ kN} \geq 223.2 \text{ kN}$$ √O.K.

Shear Resistance

Max Tension 60×40×30 RHS

$F = 44.9 / \cos 53.4$

$F = 75.3 \text{ kN} \geq 152 \text{ kN} = P_T$ √O.K.

P_C & P_T From Blue Book

Max Compression

$F = 37.4 \text{ kN} \geq 130 \text{ kN} = P_C$ √O.K.

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No. 1578/4/26

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Bearing on Web Check

PFCH 175x65x2.4

$R_A = R_B = 44.9$ kN

Use 4N M12

$P_b = t \times D \times \rho_{bs}$ | where $t = 2.4$ mm

$D = 12$ mm

$\rho_{bs} = 0.65(280+360)$

$P_b = 4 \times 2.4 \times 12 \times 416/10^3$

$\rho_{bs} = 416$ N/mm^2

$P_b = 47.9$ kN

$P_b = 47.9$ kN $\geq$ 44.9 kN $= R_A = R_B$ ✓o.k.

Deflection Check

$I_{xx} = 13835 \times 10^4$ mm^4 See truss Type A

$$\delta_m = \frac{5 \times 5.87 \times 9.62^4}{384 \times 24556}$$

$\delta_m = 26.6$ mm

$\delta_{adm} = \frac{9690}{360} = 26.9$ mm $\geq$ 26.6 mm ✓o.k.

Notes

See sketch following page.

atelier one

Project BRITISH MUSEUM

No. 1578/4/27

Date 02/07 By LF

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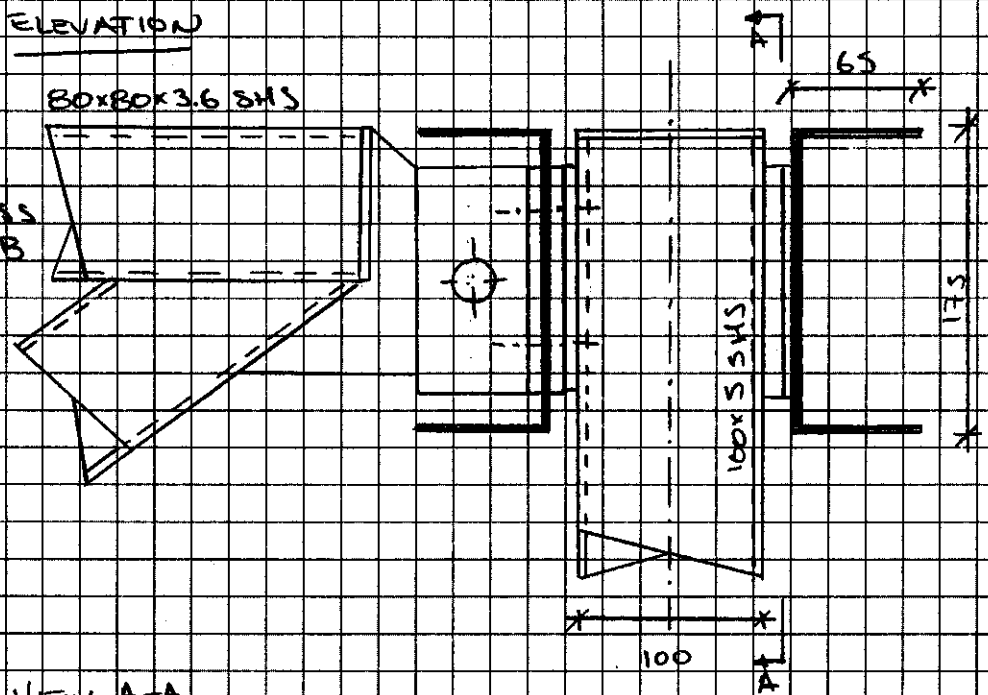
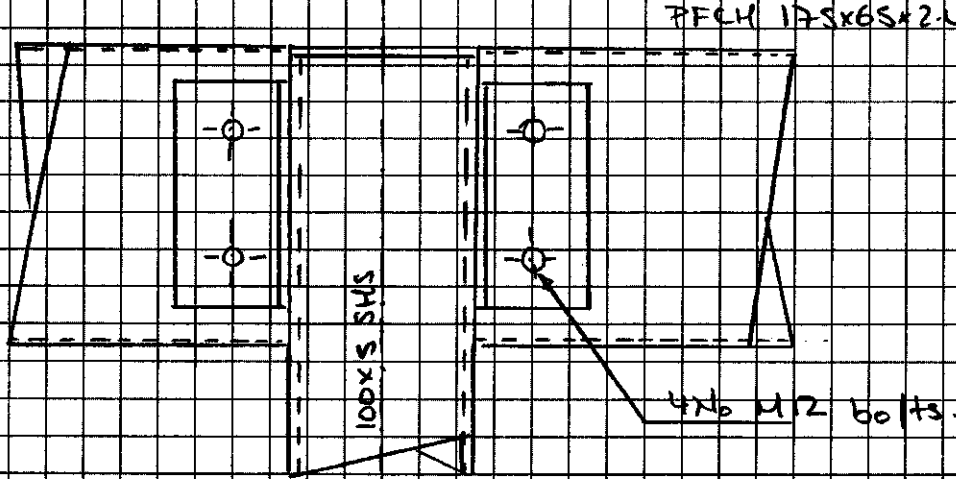
Notes

Connection Detail Truss - Channel - Column

ELEVATION



VIEW A-A



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No. 1578/4/28

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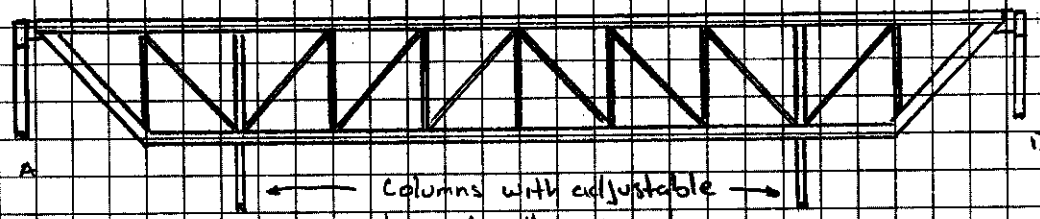
Notes

TRUSS TYPE D



500

← Columns with adjustable base to allow equal reactions →

B3 C3

Varies (Max 2640) | Varies (Max 6700) | Varies (Max 2640)

Loads

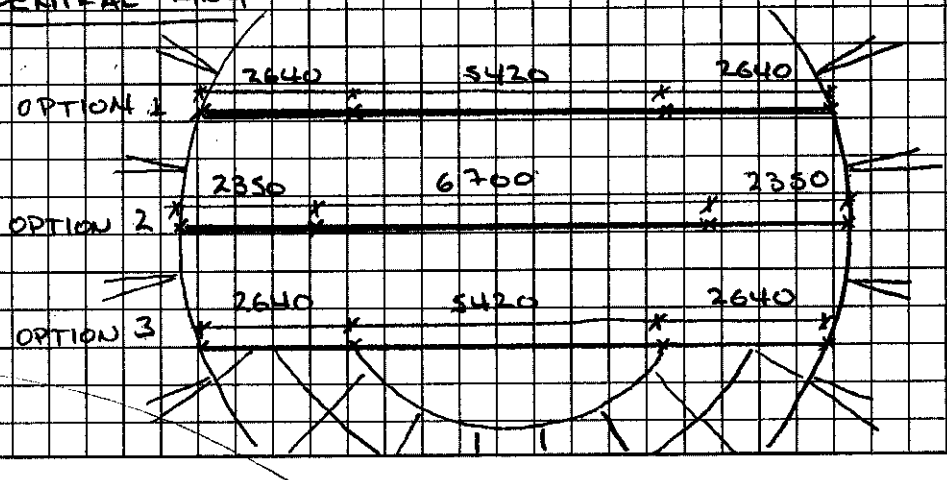
Dead Load (inc sw) — 0.91 KN/m

Live Load — 7.88 KN/m

SLS — w = 8.8 KN/m

ULS — w = 13.9 KN/m

CENTRAL RING



1762

1969

1762

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No 1578/1/29

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Notes

Adjustable Column Base

Use spring of stifness K. (kN/m) in the mid-supports to distributes reaction loads to the outer supports.

OPTION 1 ——— K = 9000 kN/m

OPTION 2 ——— K = 1300 kN/m

OPTION 3 ——— K = 6000 kN/m

Bending Moment

M_{max} = 128.3 kN m — OPTION 2 sagging moment

M_{max} = -3.7 kNm — OPTION 3 hogging moment

Shear Force

V_{max} = 39.8 kN — OPTION 2

R_{max} = 52.3 kN — OPTION 1

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No 1578/4/30

Date 02/07 By LF

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Notes

Moment Resistance

$$T = C = \frac{M_{max}}{d} = \frac{128.3 \times 10^3}{500}$$

$T = C = 257$ kN

Sagging moment
- Top chord in compression
  - ↳ fully restrained
- Bottom chord in tension

Compression capacity is equal to Tension capacity

$P_T = P_c = 299$ kN ≥ 257 kN ✓O.K.

Shear Resistance

- Max compression 60 × 40 × 3.0 RHS

$F = 39.8 / \cos 53.4$

$F = 66.8$ kN

$L_e = 840$ mm

$P_c = 130$ kN ≥ 66.8 kN ✓O.K.

- 80 × 80 × 3.6 SHS

$P_v = 89.9$ kN ≥ 52.3 kN

See Truss Type A. ✓O.K.

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Project BRITISH MUSEUM

No 1578/4/31

Date 02/07 By LF

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Notes

Deflection check

Critical deflection – OPTION 2.

* Consider mid-span and overall deflection

* Relative deflection – mid-span.

$\delta_m = 13.9$ mm

$L_e = 6700$ mm

$\delta_{adm} = \frac{6700}{360} = 18.6$ mm $\geq$ 13.9 mm ✓ O.K.

* Overall deflection

$\delta_{max} = 32.9$ mm

$L_e = 11400$ mm

$\delta_{adm} = \frac{11400}{360} = 31.7$ 1.0 mm exceeds. ✓ O.K.

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Project BRITISH MUSEUM

No 1578/4/32

Date 02/07 By LF

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Notes

BRACING CAPACITY CHECK

48.3 x 5 CHS — S355

Effective Length — 3.7m.

P_c = 19.5 kN — Compression Capacity

$M_c = M_b$ = 2.85 kNm

$P_y Z_y$ = 2.37 kNm

P_y = 241 kN — Tension Capacity

From Blue Book.

Results Summary

$F_{max\,T}$ = 14.5 kN ≤ P_y = 241 kN — √O.K.

$F_{max\,C}$ = 11.3 kN ≤ P_c = 19.5 kN — √O.K.

V_{max} = 0.11 kN

Shear Capacity

$P_v = 0.6 \times p_y \times A_v$

$P_v = 0.6 \times 355 \times 408 / 10^3$

P_v = 86.9 kN

$A_v = 0.6\,A = 0.6 \times 680$

A_v = 408 mm²

$V_{max} \leq 0.6\,P_v$ — √O.K.

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Project BRITISH MUSEUM

No. 1578/4/33

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Notes

COLUMN CAPACITY CHECK

CHS 48.3 x 5 - S355

P_{max} = 39.8 KN Max Compression Bar 6203

Nominal Bending Moment

$$M = \frac{P_{max}}{2} \times e$$

assume e = 70 mm

$$M = \frac{39.8}{2} \times 0.07$$

M = 1.39 KNm

} where only one side of beam supported is loaded

Compression Capacity

Le = 1850

P_c = 87.7 KN ≥ 41.7 KN

From Blue Book

√O.K.

Bending Capacity & Buckling

$M_c = M_b$ = 2.85 KNm

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No. 1578/4/34

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Notes

Overall Buckling Check

$$\frac{P_{max}}{P_c} + \frac{M}{M_b} \leq 1.0$$ Nominal Bending Moment

$$\frac{39.8}{87.7} + \frac{1.39}{2.85}$$

$0.454 + 0.488 = 0.94 \leq 1.0$ √O.K.

Coexistan Forces from Analysis Model

Bar 7 — Load Combination 103 : 1.4DL+1.6LL +1.0 SnowLL

$F_x = 27.4$ kN

$M_x = 1.09$ kNm — major axis

$M_y = 0.23$ kNm — minor axis

$$\frac{F_x}{P_c} + \frac{M_x}{M_b} + \frac{M_y}{p_y z_y} \leq 1.0 \qquad p_y z_y = 2.37 \text{ kNm}$$

$$\frac{25.7}{87.7} + \frac{1.09}{2.85} + \frac{0.23}{2.37}$$

$0.293 + 0.096 + 0.382 = 0.74 \leq 1.0$ √O.K.

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Project BRITISH MUSEUM

No 1578/4/35

Date 02/07 By LF

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Notes

CHS 60.3x5 — S355

P_{max} = 55.3 kN Max Compression Bar 6

M_{max} = 1.46 kNm Bar 3

Nominal Bending Moment

$M = \frac{55.3}{2} \times 0.07$

M = 1.94 kNm > M_{max} = 1.46 kNm — More critical

Compression Capacity

L_e = 1573 mm

P_c = 204 kN ≥ 55.3 kN — √o.k.

Bending & Buckling Capacity

$M_c = M_b$ = 4.73 kNm ≥ 1.94 kNm — √o.k.

atelier one

Project BRITISH MUSEUM

No. 1578/4/36

Date 02/07 By LF

Checked

Notes

Overall Buckling check

$$\frac{P}{P_c} + \frac{M}{M_b} \leq 1.0$$

Bar 6 – Coexistent Forces

$$\frac{55.3}{204} + \frac{1.94}{4.73}$$

$$0.271 + 0.410 = 0.681 \leq 1.0$$

O.K.

Non coexistent Forces

$P = 55.3$ kN

$M_y = 1.46$ kNm

$M_z = 1.07$ kNm

Results from Robot Model

$$\frac{P}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{M_{yz}} \leq 1.0$$

$$\frac{55.3}{204} + \frac{1.46}{4.73} + \frac{1.07}{3.94}$$

$$0.271 + 0.309 + 0.272 = 0.85 \leq 1.0$$

O.K

atelier one

Project BRITISH MUSEUM

No. 1578/4/37

Date 02/07 By LF

Checked

Notes

SHS 100×5 - S355

P_{max} = 49.3 kN Bar 6259

M_{major} = 7.84 kNm Bar 6197

M_{minor} = 4.18 kN Bar 6256

Nominal Bending Moment

$M = \frac{55.0}{2} \times 0.07$

M = 1.93 kNm ≤ M_{major} & M_{minor}

Compression Capacity

L_e = 1573 mm

P_c = 618 kN ≥ 49.3 kN √O.K.

Bending & Buckling Capacity

$M_c = M_b$ = 23.6 kNm ≥ 7.84 kN √O.K.

atelier one

Project BRITISH MUSEUM

No 7578/4/38

Date 02/07 By LF

Checked

Notes

Overall Buckling Check

Non coexistant Forces

$$\frac{P}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{P_y z_y} \leq 1.0$$

$$\frac{49.3}{618} + \frac{7.84}{23.6} + \frac{4.18}{19.8}$$

$$0.080 + 0.332 + 0.211 = 0.623 \leq 1.0$$

O.K.

atelier one

Project BRITISH MUSEUM

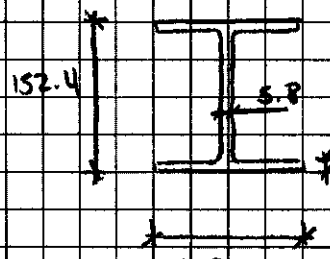
No 1578/4/39

Date 02/07 By LF

Checked

Notes

SPREADER BEAM CAPACITY CHECK



UC 152×152×23 - S275

B = 152.2 mm

D = 152.4 mm

T = 6.8 mm

t = 5.8 mm

$\frac{b}{T} = 11.2$

$\frac{d}{t} = 21.3$

A = 2920 mm²

$I_{xx} = 1250 \times 10^4$ mm⁴ $r_{xx} = 65.4$ mm

$I_{yy} = 400 \times 10^4$ mm⁴ $r_{yy} = 37.0$ mm

$S_{xx} = 182 \times 10^3$ mm³ $Z_{xx} = 164 \times 10^3$ mm³

$S_{yy} = 80.2 \times 10^3$ mm³ $Z_{yy} = 52.6 \times 10^3$ mm³

Semi-compact section

Shear Capacity

$P_v = 0.6 \times P_y \times A_v = 0.6 \times 275 \times 5.8 \times 152.4 / 10^3$

$P_v = 145.8$ kN

$F_{v\,max} = 58.7$ kN $\leq 0.6 \cdot P_v$

atelier one

Project BRITISH MUSEUM

No. 1570/4/40

Date 02/07 By L.F

Checked

Notes

Bending Capacity

$M_{cx} = p_y Z_{xx} = 275 \times 164 \times 10^3 / 10^6$

$M_{cx} = 45.1$ kNm ≥ 26.7 kNm ✓o.k.

$M_{cy} = p_y Z_{xx} = 275 \times 52.6 \times 10^3 / 10^6$

$M_{cy} = 14.5$ kNm ≥ 0.9 kNm ✓o.k.

Buckling Capacity

* Simply supported beams : $L_e = 1.0L + 2D$
* Cantilever $L_e = 3.0L$

Table 9 BS 5950

Take three effective lengths

① $L_e = 2004 + (2 \times 152.4) = 2308$ mm

Use 2300 mm — Inner 4 concentric spreader beams.

② $L_e = 4000 + (2 \times 152.4) = 4305$ mm

Use 4300 mm — Outer 3 concentric spreader beams except for cantilever beams

③ $L_e = 3.0 \times 774 = 2322$ mm

Use 2300 mm — For cantilever Beams Outer spreader ring

atelier one

Project BRITISH MUSEUM

No 1578/4/41

Date 02/07 By LF

Checked

Notes

Case ① & ⑤

$\lambda = \frac{2300}{37.0}$

$\lambda = 62$

$\lambda_{LT} = n u v \lambda$ where: $\lambda/x = 2.27$, $u = 0.9$, $n = 1.0$, $v = 0.92$

$\lambda_{LT} = 0.9 \times 1.0 \times 0.92 \times 62$

$\lambda_{LT} = 51$

$p_b = 235\ N/mm^2$

$M_b = p_b \times S_{xx} = 235 \times 182 \times 10^{-3}$

$M_b = 42.8\ kN$ $\geq 26.7\ kNm$ ✓O.K.

Case ②

$\lambda = \frac{4300}{37.0}$

$\lambda = 116$

$\lambda_{LT} = n u v \lambda$

$\lambda_{LT} = 0.9 \times 1.0 \times 0.81 \times 116$

$\lambda_{LT} = 85$

$p_b = 154\ N/mm^2$ $\therefore M_b = 28\ kNm \geq 23.4\ kNm$ ✓O.K.

$\lambda/x = 5.19$

$u = 0.9$

$n = 1.0$

$v = 0.81$

atelier one

Project BRITISH MUSEUM

No 1578/4/42

Date 02/07 By LF

Checked

Notes

Overall Buckling Check

$P_y Z_y = 14.3$ kNm

$L_e \leq 2300$ mm Non coexistant forces

$$\frac{P}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{P_y Z_y} \leq 1.0$$

$$\frac{7.9}{543} + \frac{26.7}{42.8} + \frac{0.9}{14.3}$$

$0.015 + 0.624 + 0.062 = 0.70 \leq 1.0$ J.o.k

$4300\text{mm} \geq L_e \geq 2300\text{mm}$ Non coexistant forces

$$\frac{P}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{P_y Z_y} \leq 1.0$$

$$\frac{3.6}{236} + \frac{23.4}{28.0} + \frac{1.5}{14.3}$$

$0.015 + 0.835 + 0.103 = 0.954 \leq 1.0$ J.o.k.

atelier one

Project BRITISH MUSEUM

No. 1578/4/43

Date 02/07 By LF

Checked

Notes

Deflection Check

$\delta_{max} = 9.2\,mm$ See Robot Results.

$\delta_{acdm} = \frac{Le}{360} = \frac{4000}{360}$

$\delta_{acdm} = 11.1\,mm \geq 9.2\,mm$

√O.K.

atelier one

Project BRITISH MUSEUM

No. 1578/4/44

Date 02/07 By LF

Checked

Notes

STAIRCASE MEMBERS CAPACITY CHECK

48.3x5 CHS Columns.

Overall Buckling Check - S355

$P_c = 87.7 kN$

$M_c = M_b = 2.85 kNm$

$p_y Z_y = 2.37 kNm$

} From Blue Book.

$$\frac{F_x}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{p_y Z_y} \leq 1.0$$

Non coexistant Forces - From Results Summary

$$\frac{10.1}{87.7} + \frac{0.24}{2.85} + \frac{0.11}{2.37}$$

$0.115 + 0.084 + 0.046 = 0.25 \leq 1.0$ ✓O.K.

atelier one

Project BRITISH MUSEUM

No 1578/4/45

Date 02/07 By LF

Checked

Notes

100x5 SHS STEINGERS - S355

Overall Buckling Check

P_c = 301 kN (L_e=4000mm)

$M_c = M_b$ = 23.6 kNm

P_{yZy} = 19.8 kNm

} From Blue Book

$$\frac{F_x}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{P_{yZy}} \leq 1.0$$

Non coexistant Forces - From Results Summary

$$\frac{10.2}{301} + \frac{1.03}{23.6} + \frac{0.55}{19.8}$$

0.034 + 0.044 + 0.028 = 0.105 ≤ 1.0 V.O.K.

atelier one

Project BRITISH MUSEUM

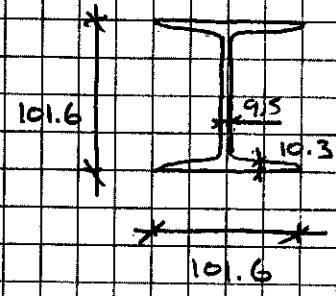
No 1578/4/46

Date 02/07 By LF

Checked

Notes

RSJ 102x102x23



$p_y = 275\ N/mm^2$

$D = 101.6\ mm = B$

$t = 9.5\ mm$; $T = 10.3$

$\frac{b}{T} = 4.93$; $\frac{d}{t} = 5.81$ Plastic.

$A = 2930\ mm^2$

$I_{xx} = 486 \times 10^4\ mm^4$ $I_{yy} = 154 \times 10^4\ mm^4$

$r_{xx} = 40.7\ mm$ $r_{xy} = 22.9\ mm$

$Z_{xx} = 95.6 \times 10^3\ mm^3$ $Z_{yy} = 30.3 \times 10^3\ mm^3$

$S_{xx} = 113 \times 10^3\ mm^3$ $S_{yy} = 50.6 \times 10^3\ mm^3$

Shear Capacity

$P_v = 0.6\ p_y\ A_v$ $A_v = tD = 965\ mm^2$

$P_v = 0.6 \times 275 \times 965 / 10^3$

$P_v = 159\ kN > 0.6\ F_{v\,max}$ ✓ O.K.

$F_{v\,max} = 18.3\ kN$

atelier one

Project BRITISH MUSEUM

No 1578/4/47

Date 02/07 By LF

Checked

Notes

Bending Capacity

$M_{cx} = S_{xx} p_y = 113 \times 10^3 \times 275 / 10^6$

$M_{cx} = 31.1$ kNm ≥ 3.6 kN ✓O.K

$M_{cy} = 1.2 \times Z_{yy} p_y = 1.2 \times 30.3 \times 10^3 \times 275 / 10^6$

$M_{cy} = 10$ kNm ≥ 2.0 kN ✓O.K.

Buckling Capacity

$L_e = 1.0L + 2D = 3524 + 2 \times 101.6 = 1946$

$L_e = 3750$

$\lambda = \frac{3750}{22.9} = 164$

$x = \frac{D}{T} = 9.9$

$\frac{\lambda}{x} = 16.5$; $v = 0.51$

$\lambda_{LT} = nuv\lambda$

$\lambda_{LT} = 0.836 \times 0.51 \times 164$; $n = 1.0$

$\lambda_{LT} = 70$; $u = 0.836$

$p_b = 188$ N/mm²

$M_b = S_{xx} p_b = 113 \times 10^3 \times 188 / 10^6$

$M_b = 21.2$ kNm ≥ 3.6 kNm ✓O.K.

atelier one

Project BRITISH MUSEUM

No 1578/4/48

Date 02/07 By LF

Checked

Notes

SPREADER BEAM UNDER STAIR & LIFTS CHECK

Overall Buckling Check

Non Coexistant Forces

$$\frac{M_y}{M_b} + \frac{M_z}{P_{yz_y}} \leq 1.0 \qquad P_{yz_y} = 8.3 \text{ kNm}$$

$$\frac{3.6}{21.2} + \frac{2.0}{8.3}$$

$$0.17 + 0.24 = 0.41 \leq 1.0$$

O.K.

atelier one

Project BRITISH MUSEUM

No 1578/S/1

Date 02/07 By LF

Checked

Notes

REACTIONS CAPACITY

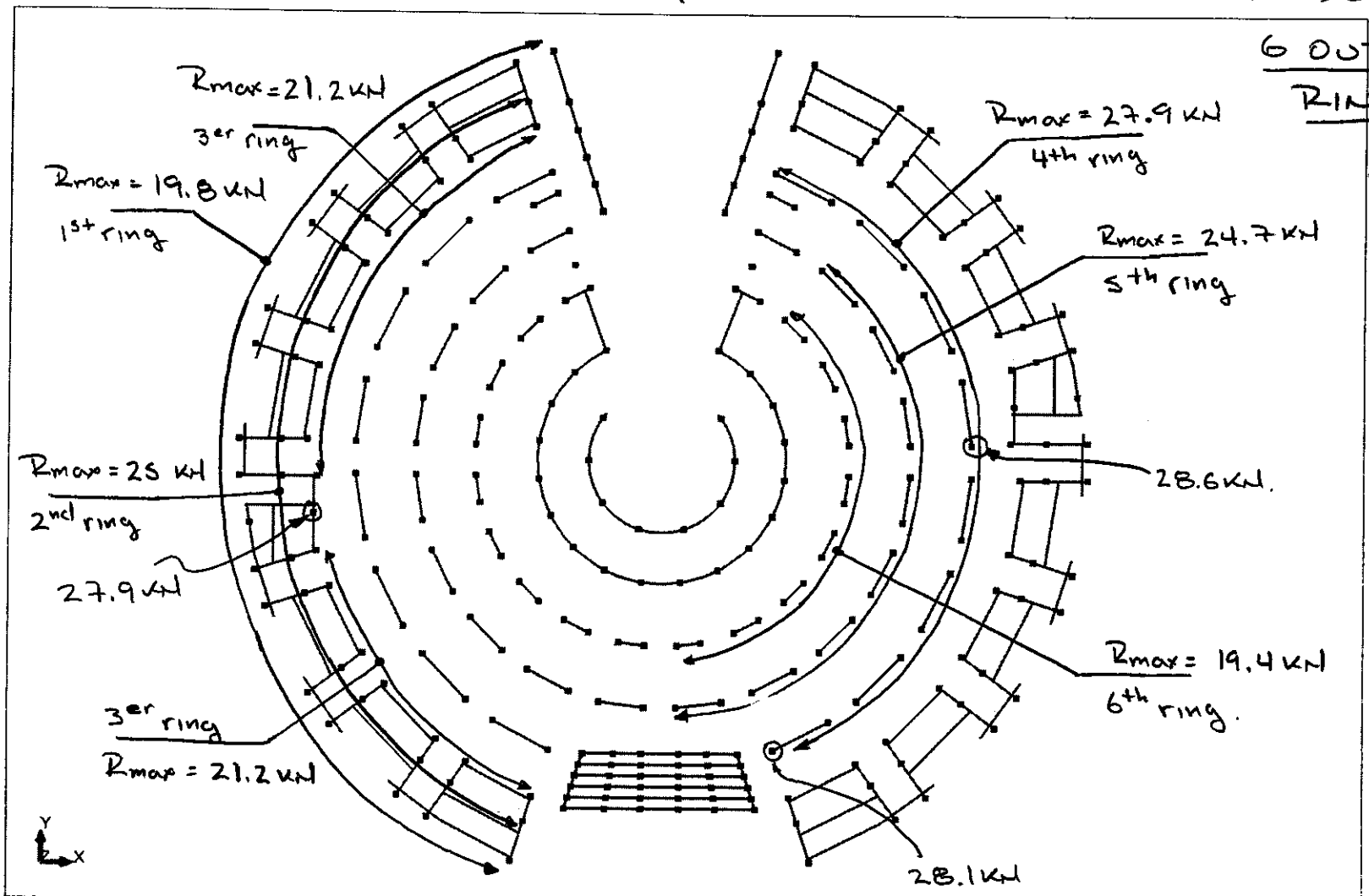
The Round Reading Room floor structure has been assessed by Alan Baxter & Associates

As a result of this investigation a list of loading constraints to the existing floor structure have been established

These constrains are explained in Alan Baxter & Associates Drawings 0699/301/20 Rev A and 0699/301/21

File: **British Museum Platform.rtd**
Project: British Museum Platform

View:2 - Cases: 1 ( ) REACTIONS DIAGRAM – LOAD COMBINATION 1.0 DL + 1.0 LL



6 OUTER SUPPORT RINGS

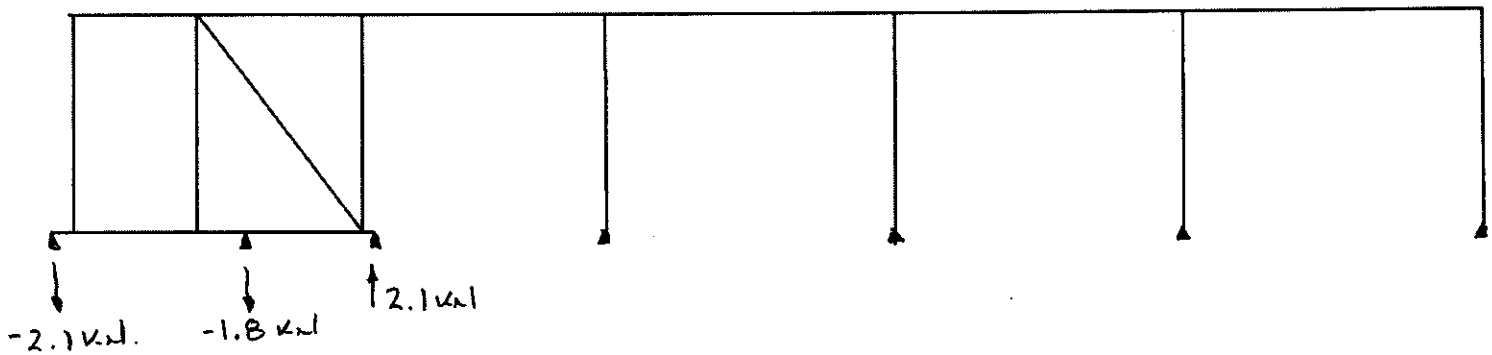
- The reactions mirror
  - left → right
  - right → left
- Outer 3rd support ring + 2.1 KN horizontal sway load.
  ↳ Rmax = 23.3 KN
- Outer 4th support ring Air handling units
  ↳ 885 kg
  + 2.2 KN
  Rmax = 30. KN.
- Rmax = 30 KN in accordance with Alan Baxter & Assoc.

1578/S/2

Dwg. 0699/301/20 A

View:2 - Cases: 3 (Sway Load 1) HORIZONTAL SWAY LOAD

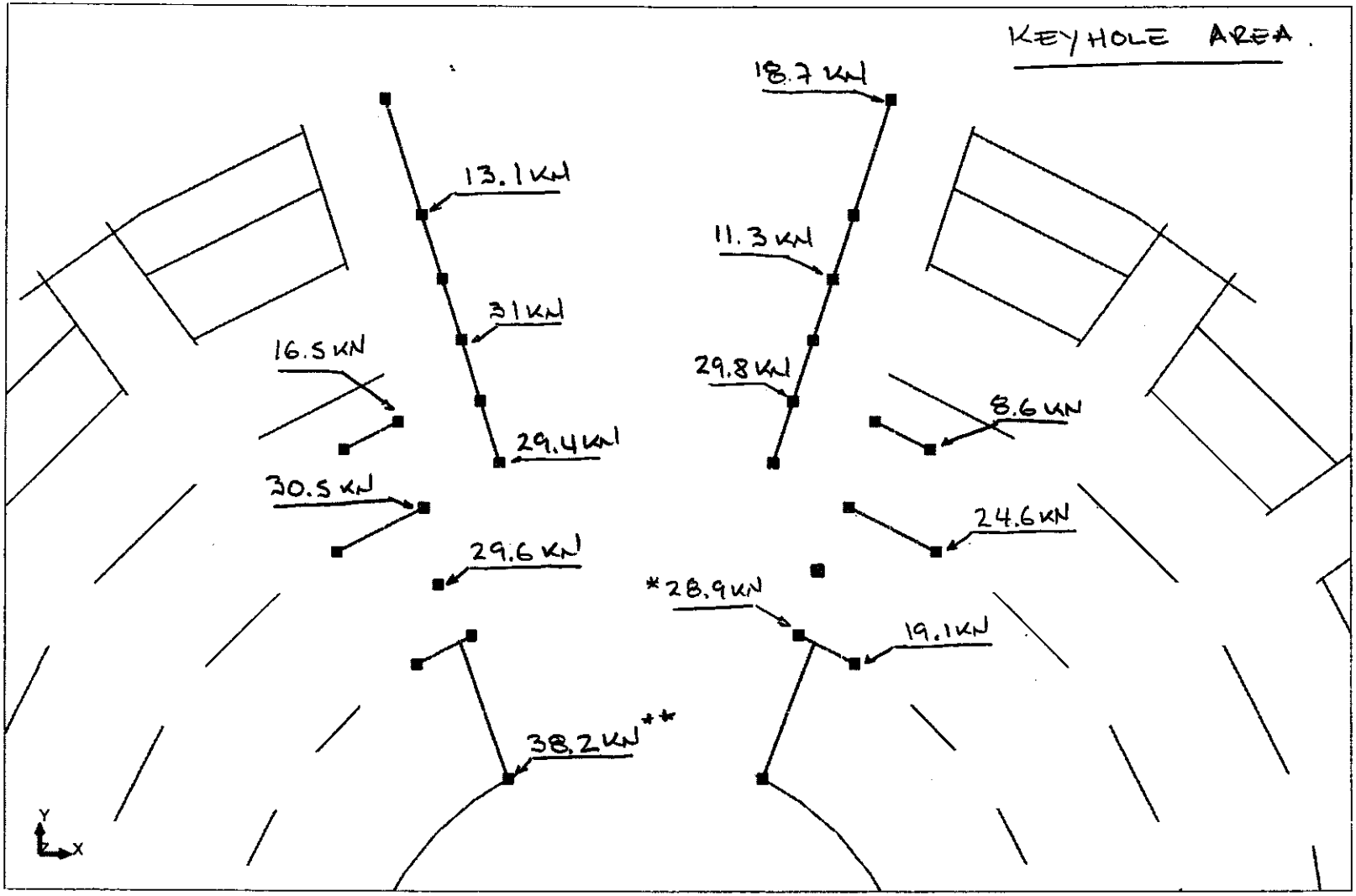
REACTIONS TYPICAL RADIAL BEAM WITH BRACING.



1578/5/3

View:2 - Cases: 51 (1.0DL + 1.0LL)

REACTIONS DIAGRAM – LOAD COMBINATION 1.0DL+1.0LL

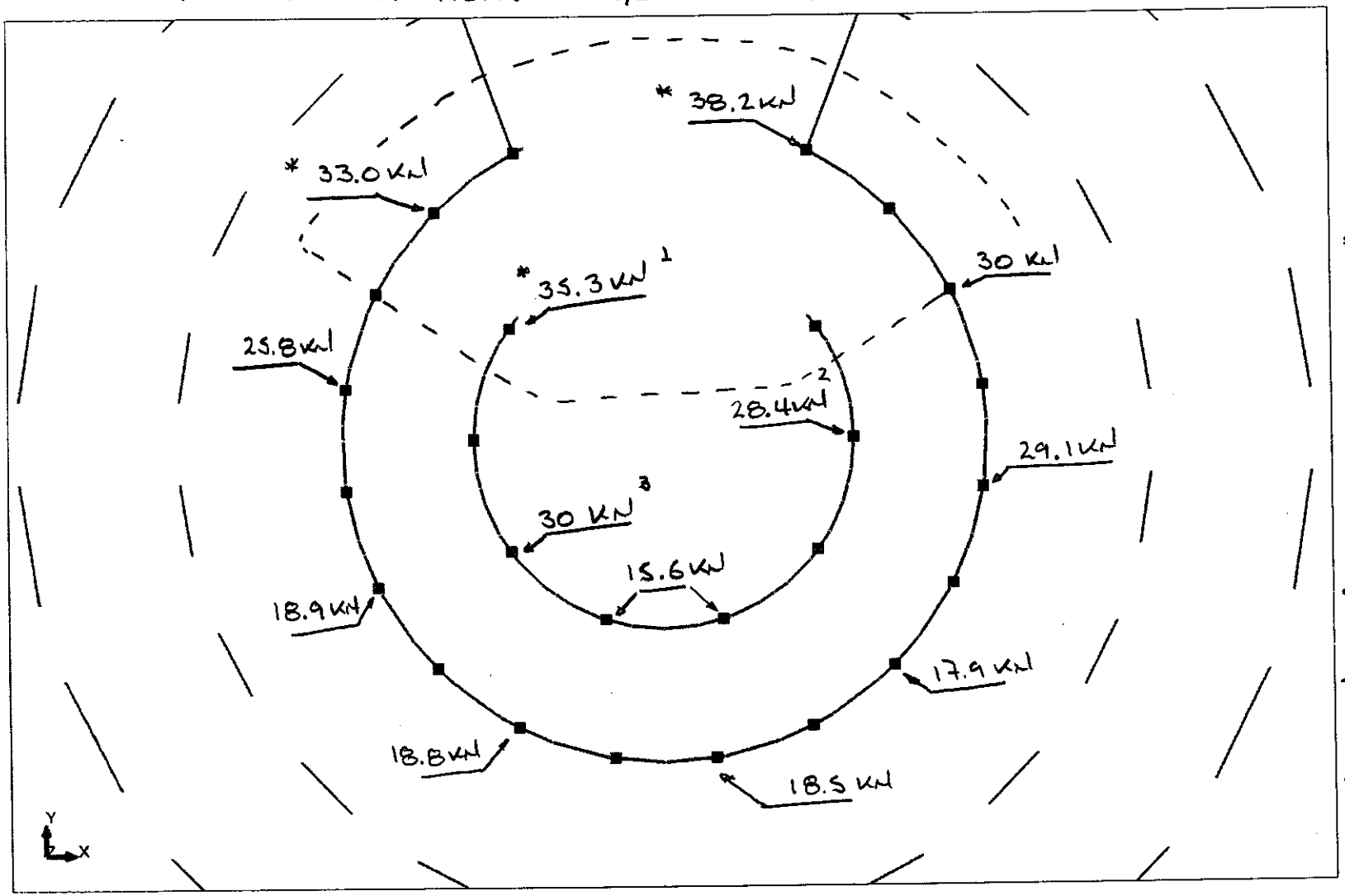


- Reactions mirror symetrically
- * Support adjusted with spring of K = 5000 KN/m
  - ↳ Reaction without spring R = 33.0 KN.
- ** Reaction exceeds the 30 KN limit.
  - ↳ Decrease Live Load allowance to 300 Kg/m^2 See Inner Circle Diagram

15/8/4

File: **British Museum Platform.rtd**
Project: British Museum Platform

View:1 - Cases: 1 (Dead Load) REACTIONS DIAGRAM – LOAD COMBINATION 1.0 DL + 1.0 LL



INNER CIRCLE

- Reactions mirror symetrically
- * Reactions exceeds the 30 KN limit.
  - ↳ Decrease Live Load allowance to 300 kg/m² within dotted line.
- Adopt spring supports to aid load distribution.

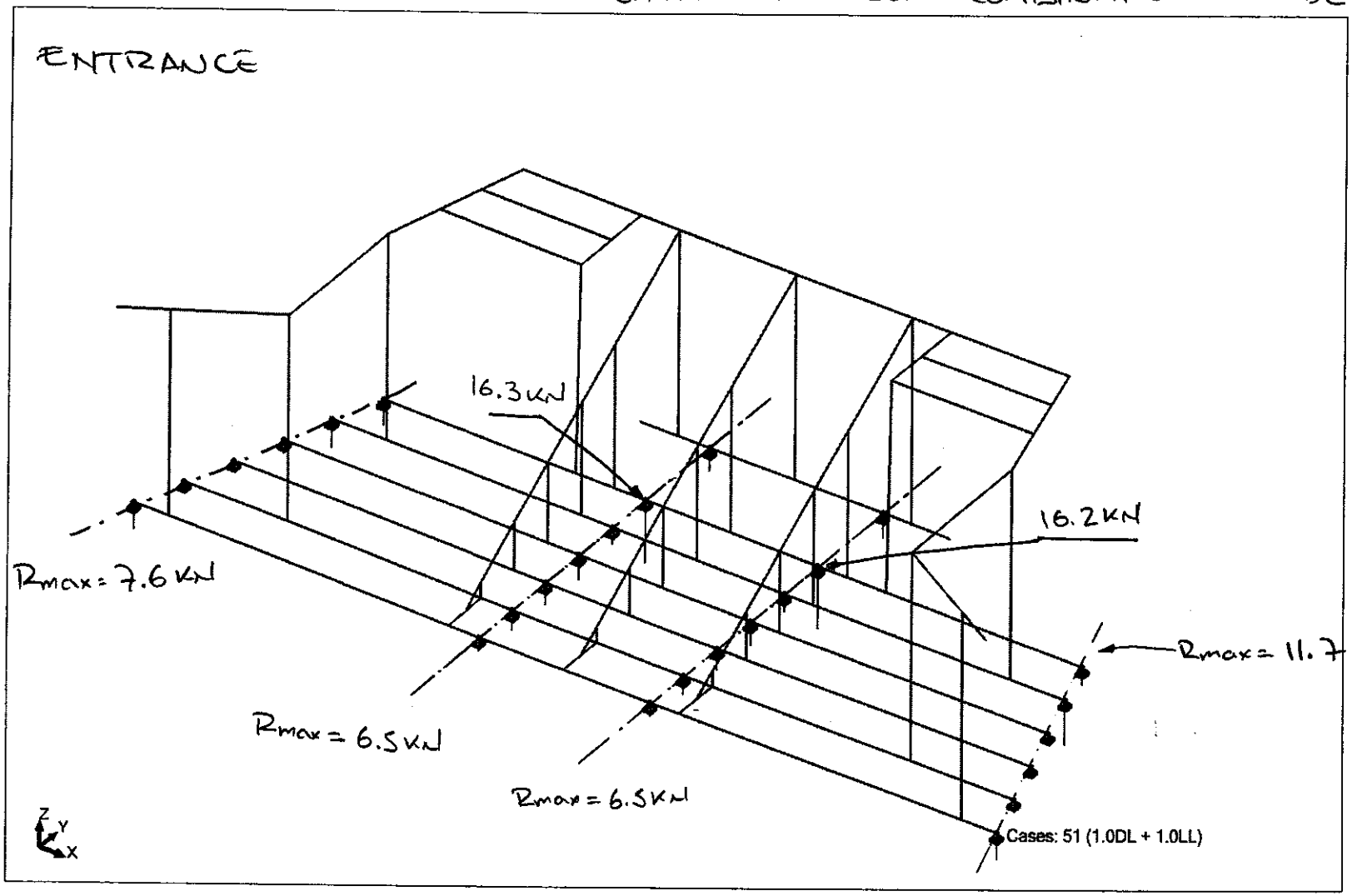
1 Spring – K = 9000 KN/m

2 Spring – K = 1300 KN/m

3 Spring – K = 6000 KN/m

1578/5/5

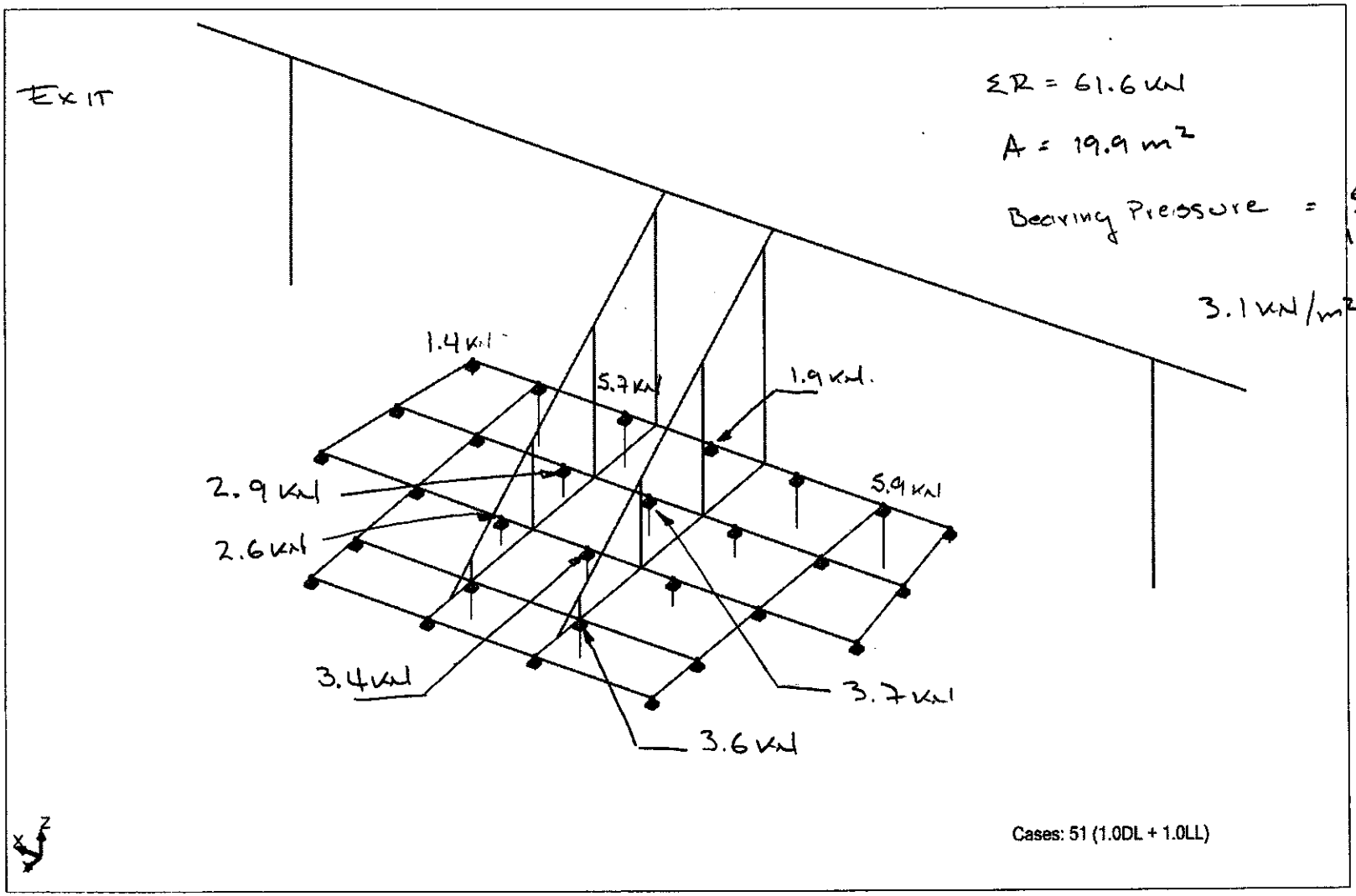
View:1 - Reaction forces(kN), Cases: 51 (1.0DL + 1.0LL) REACTIONS – LOAD COMBINATION 1.0DL+1.0LL



9/5/8451

View:2 - Reaction forces(kN), Cases: 51 (1.0DL + 1.0LL)

REACTIONS - LOAD COMBINATION 1.0 DL + 1.0 LL



15/8/51

atelier one

Project BRITISH MUSEUM

No 1578/S/18

Date 02/07 By LF

Checked

Notes

REACTIONS CHECK

LOADING CONSTRAINTS

- 30 kN point load min spacing 1 metre on Basement Bearing Walls and on the middle of central piers
- 5 kN/m² Crowd Load Keyhole Area.

Refer to Allan Baxter & Associates Report.

Reactions along platform are not greater than 30 kN with exception of dotted section at the centre of the deck.

Decrease Live Load allowance from 400 kg/m² to 300 kg/m² in this area

R_{max} = 38.4 kN → 400 kg/m²

R_{LL} = 32.5 kN (400 kg/m²)

R_{DL} = 5.9 kN.

atelier one

Project BRITISH MUSEUM

No. 1578/5/9

Date 02/07 By LF

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Notes

$R_{LL} = 32.5$ kN —— Live Load Allowance 400 kg/m²

→ Decrease L.L. to 300 kg/m²

$\therefore R_{LL} = \frac{32.5 \times 3}{4} = 24.4$ kN

$R_{LL} = 24.4$ kN

$R_{DL} = 5.9$ kN

$R_{MAX} = 30.3$ kN ≈ 30 kN

√O.K.

atelier one

Project BRITISH MUSEUM

No 1578/S/10

Date 02/07 By LF

Checked

Notes

Reactions Summary

- 1st Outer ring – bracing resisting Sway Load

  R_{max} = 19.8 kN — 1.0DL+1.0LL

  R_{max} = 4.9 kN — 1.0 Sway Load

  ∴ R_T = 24.7 kN

  $R_T \leq R_{adm}$ = 30 kN

  Including fabric wall

  O.K.

- 2nd Outer ring

  R_{max} = 25 kN

  R_T = 25 kN

  $R_T \leq R_{adm}$ = 30 kN

  O.K.

- 3rd Outer ring – bracing resisting Sway Load

  ① R_{max} = 27.9 kN — 1.0DL+1.0LL

  ② R_{max} = 21.2 kN — 1.0DL+1.0L

  R_{max} = 2.1 kN — 1.0 Sway Load

  ∴ R_T = 21.2 + 2.1 = 23.3 kN.

  R_{max} = 27.9 ≤ R_{adm} = 30 kN

  Without bracing

  With bracing

  O.K.

atelier one

Project BRITISH MUSEUM

No. 1578/S/11

Date 02/07 By LF

Checked

Notes

- 4th Outer ring — Spreader beams carrying have of Air handling units

W = 885 kg — Air handling unit weight

↳ 443 kg carried by spreader

$R = \frac{443 \times 10}{2 \times 1000}$ ∴ R = 2.2 kN

Radm = 30 − 2.2 = 27.8 kN

Rmax = 27.9 kN ≈ Radm

O.K.

- 5th Outer ring - Spreader beams carrying have of Air handling units

W = 885 kg ⇒ R = 2.2 kN as above.

Radm = 30 - 2.2 = 27.8 kN

Rmax = 24.7 kN ≤ Radm

O.K.

- 6th Outer ring

Rmax = 19.4 kN ≤ Radm

Radm = 30 kN

O.K.

atelier one

Project BRITISH MUSEUM

No. 1578/6/1

Date 02/07 By LF

Checked

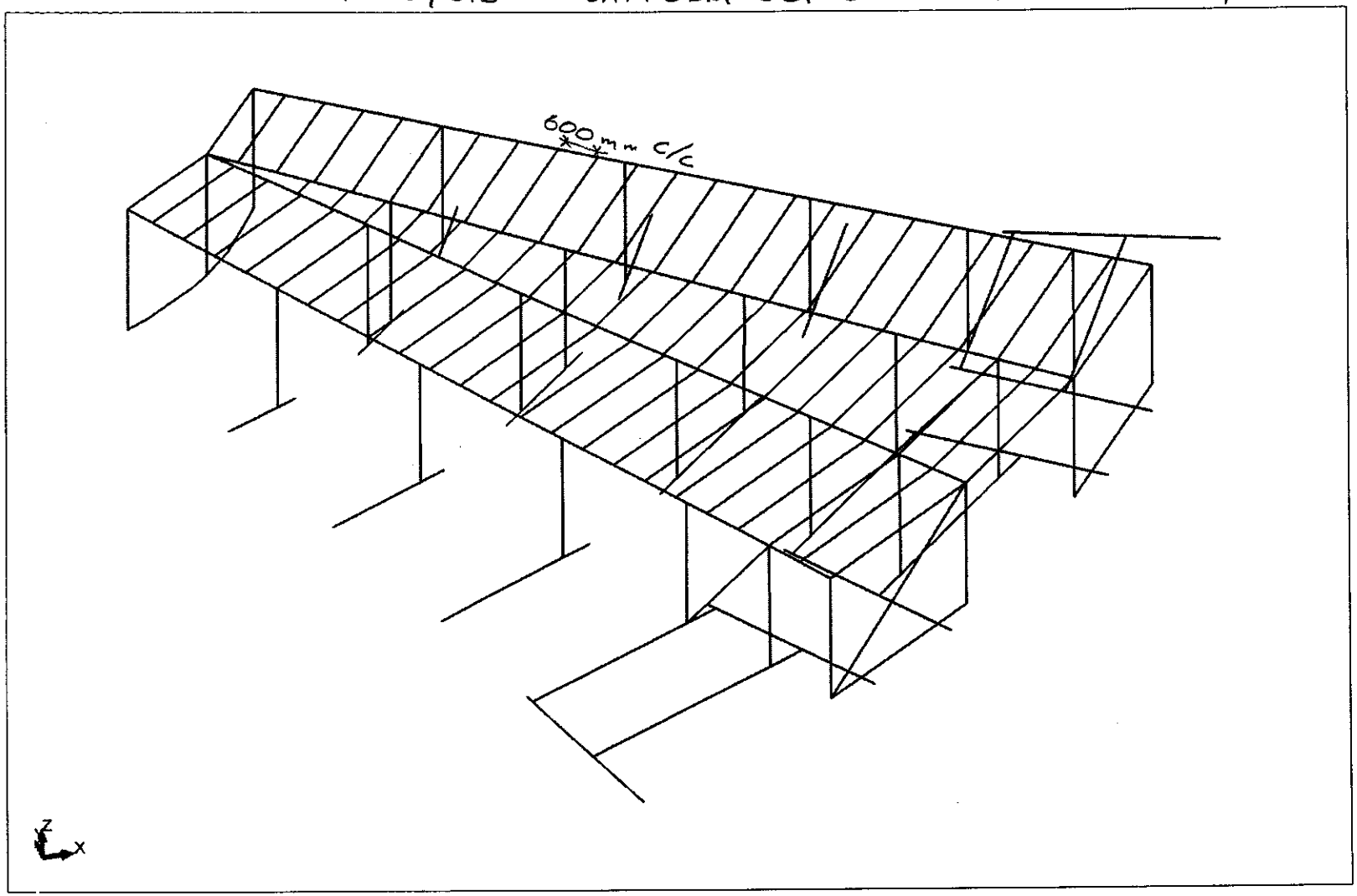
Notes

SECTIONAL MODEL - PLATFORM SLICE

Analysis model made for the platform is based with a variable secondary beams spacing, however the Fabricators have suggested an even distribution of 600 mm c/c

The Sectional Model is to compare the results of a typical bay with distribution of secondary beams according to sheetfabs drawings.

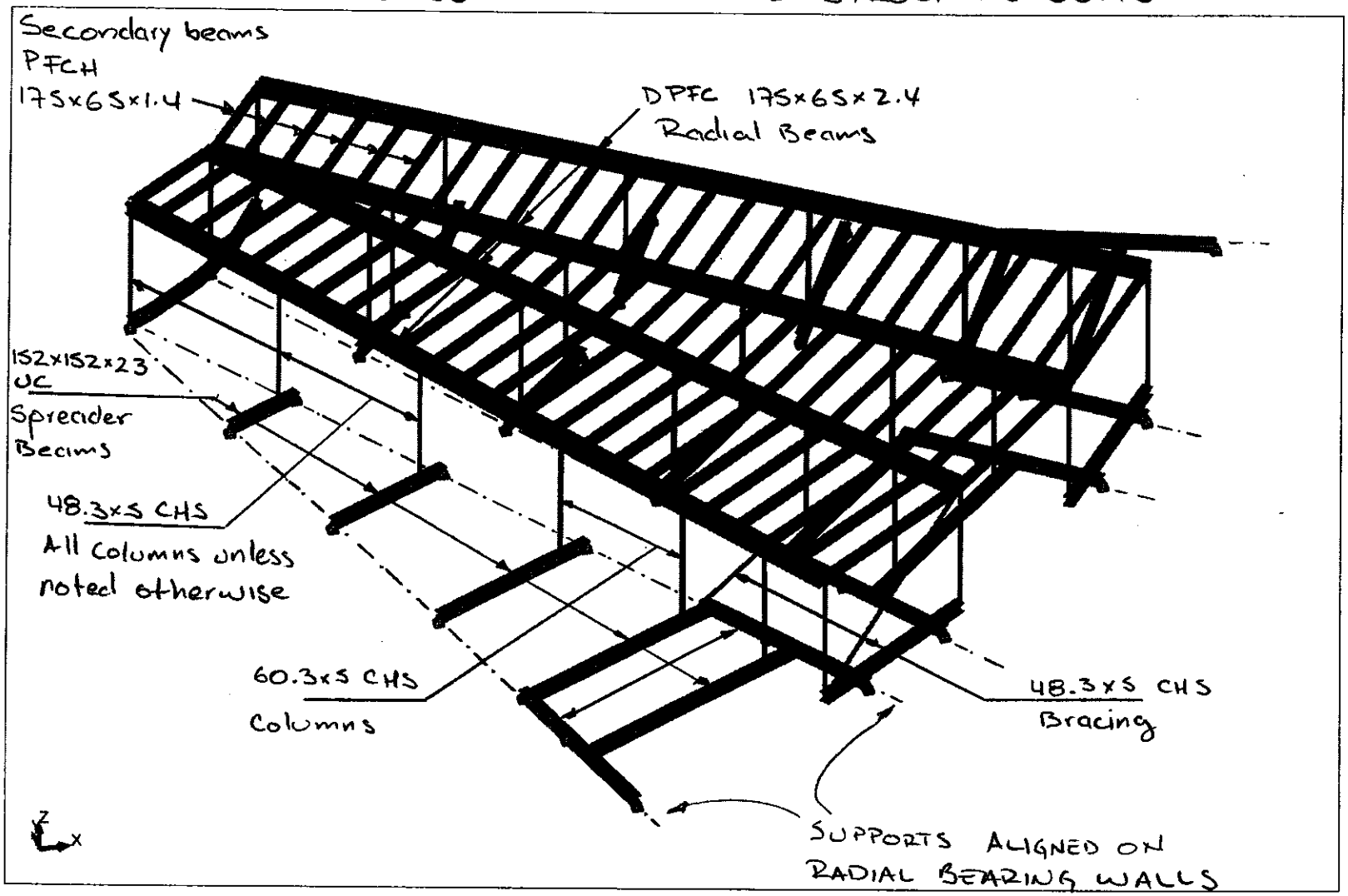
View - Cases: 1 (Dead Load) ANALYSIS - PLATFORM SLICE WITH SECONDARY BEAMS @ 600mm c/c



1578/6/2

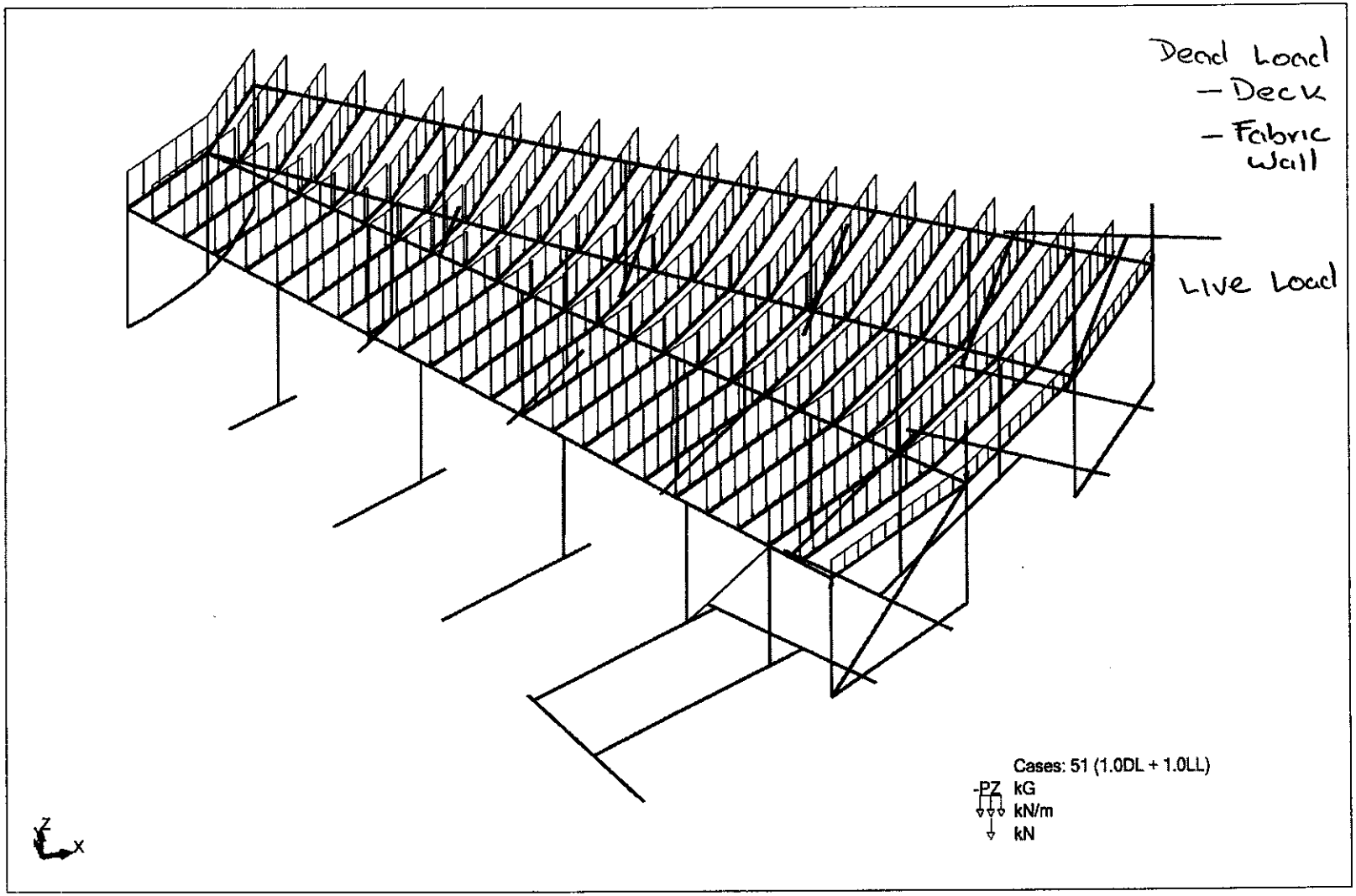
View - Cases: 1 (Dead Load)

MEMBER PROPERTIES & STRUCTURE SUPPORTS



15/8/13

View - Cases: 51 (1.0DL + 1.0LL) LOADING — DEAL & LIVE LOAD



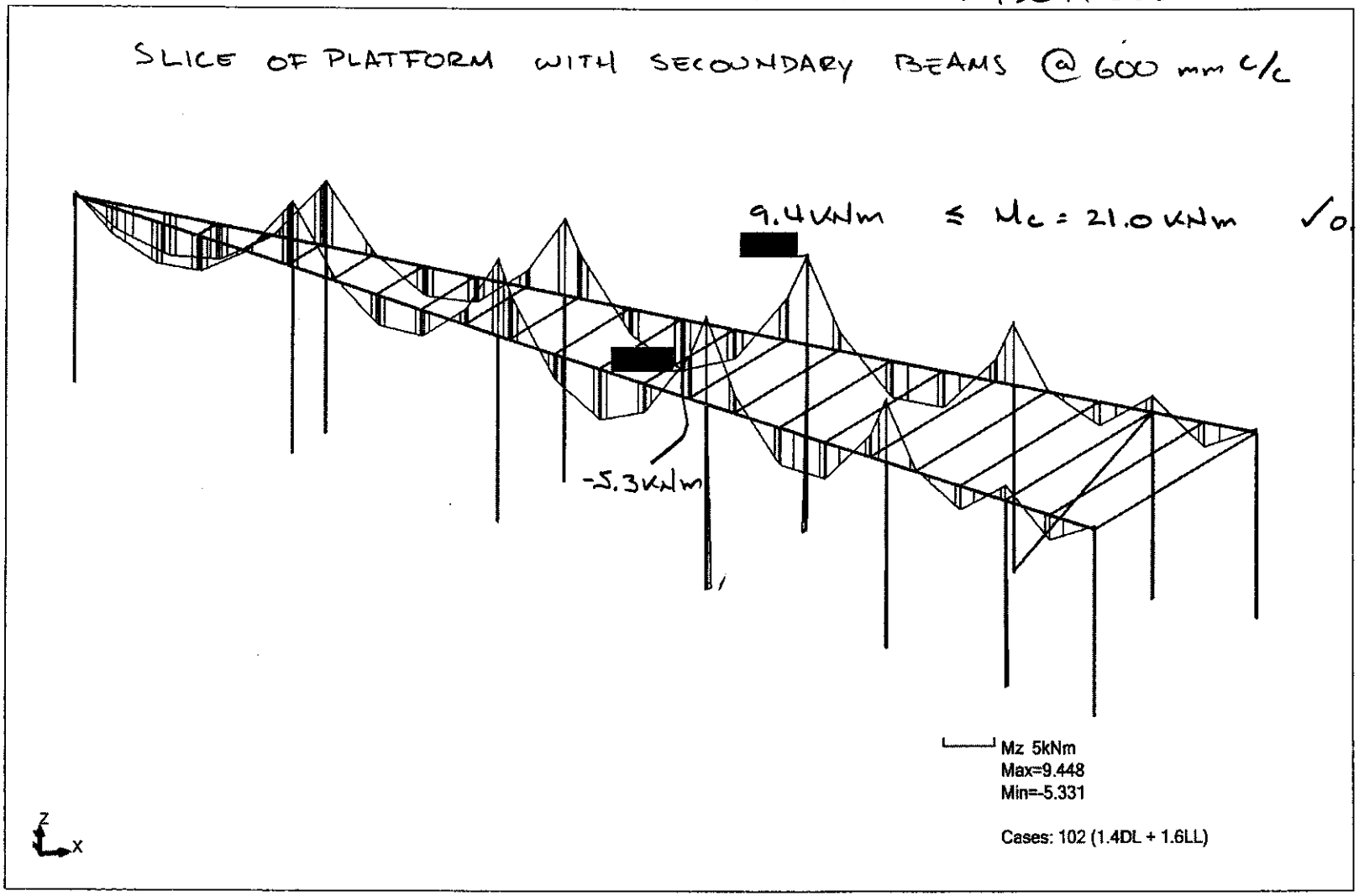
Dead Load
– Deck 27 kg/m²
– Fabric Wall 99 kg/m (along perimetre)

Live Load 400 kg/m²

15/8/4

View:2 - MZ, Cases: 102 (1.4DL + 1.6LL)

BMD – LOAD COMBINATION 1.4DL+1.6LL

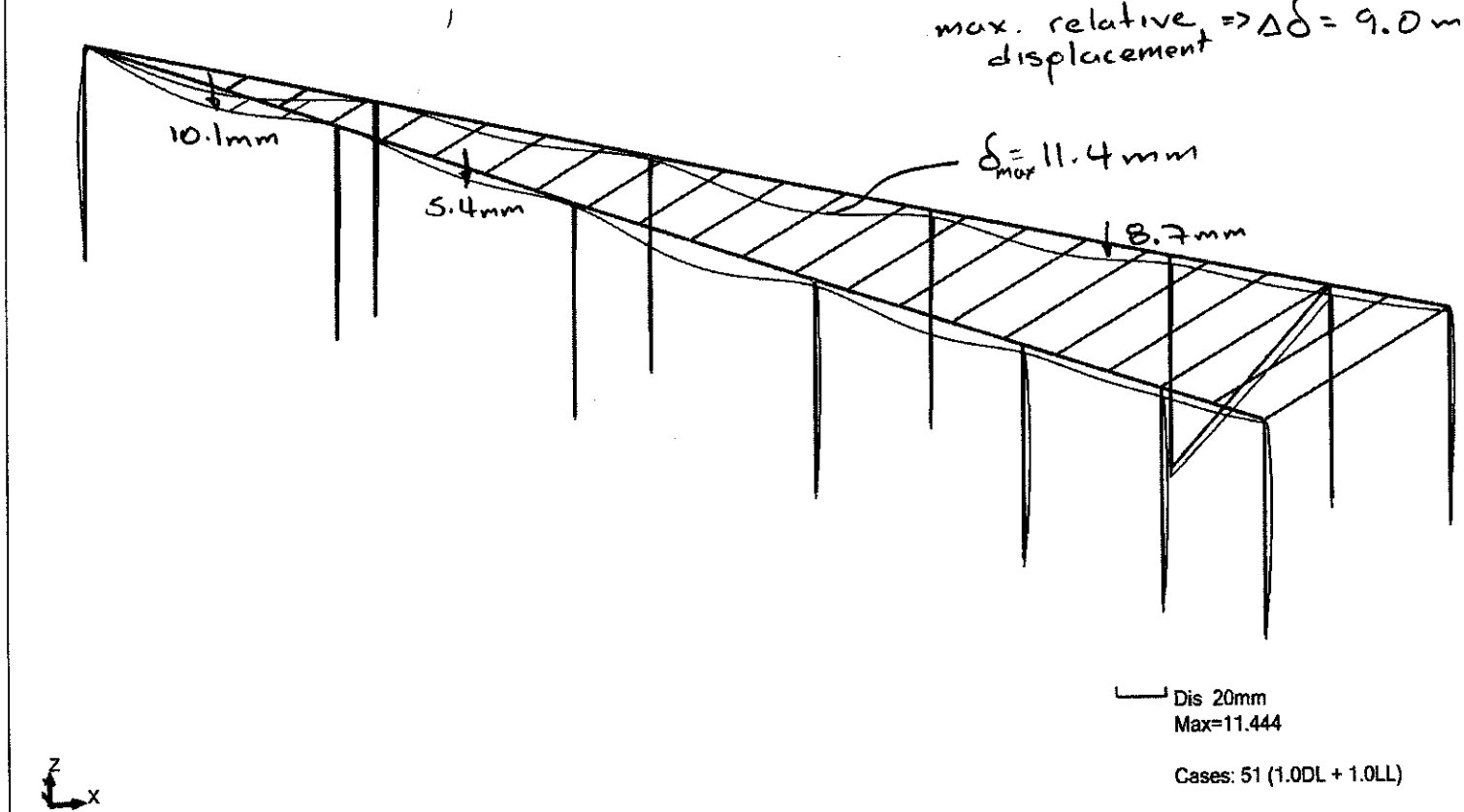


15/8/15

View:2 - Exact deformation(s), Cases: 51 (1.0DL + 1.0LL)

DEFLECTIONS — LOAD COMBINATION 1.0DL + 1.0LL

SLICE OF PLATFORM WITH SECONDARY BEAMS @ 600 mm c/c



max. relative displacement $\Rightarrow \Delta\delta = 9.0$ mm

Le = 2811

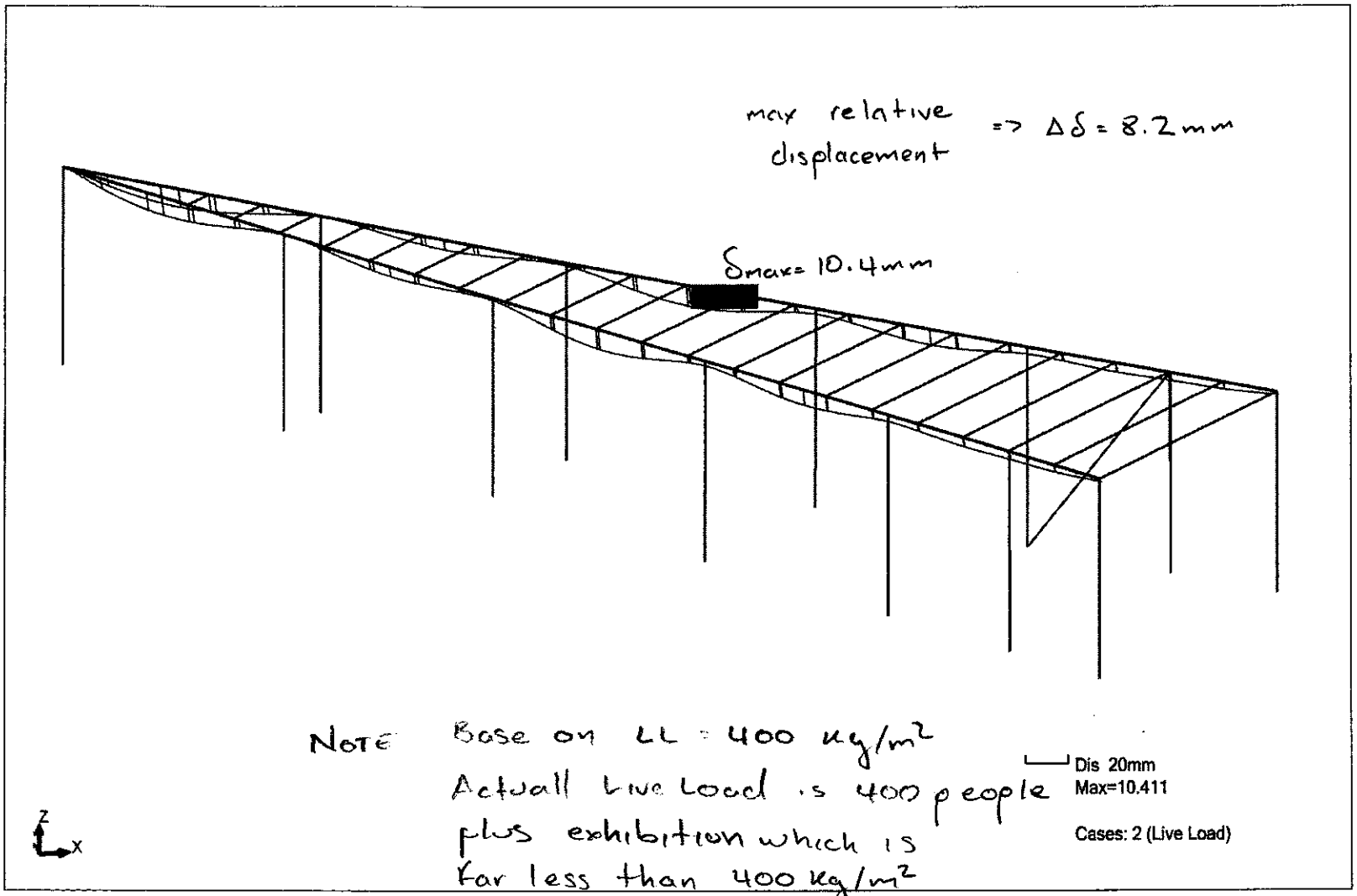
$\delta_{adm} = \frac{2811}{360}$

$\delta_{adm} = 7.8$ mm

1578/6/6

View:1 - Exact deformation(s), Cases: 2 (Live Load)

DEFLECTIONS - LOAD CASE 2: LIVE LOAD



Le = 2811

$\delta_{adm} = \frac{2811}{360}$

$\delta_{adm} = 7.8mm$

NOTE Base on LL = 400 kg/m²
Actuall Live Load is 400 people plus exhibition which is far less than 400 kg/m²

Deflection is ok by inspection.

15/8/7

atelier one

Project BRITISH MUSEUM

No. 1578/6/8

Date 02/07 By LF

Checked

Notes

Sectional Analysis Model checked in Deflection and Bending.

Therefore 600 mm c/c secondary beams spacing is permisible.

atelier one

Project BRITISH MUSEUM

No. 1578/7/1

Date 01-02-07 By VB

Checked

Notes

FABRIC WALL

ANALYSIS MODEL:

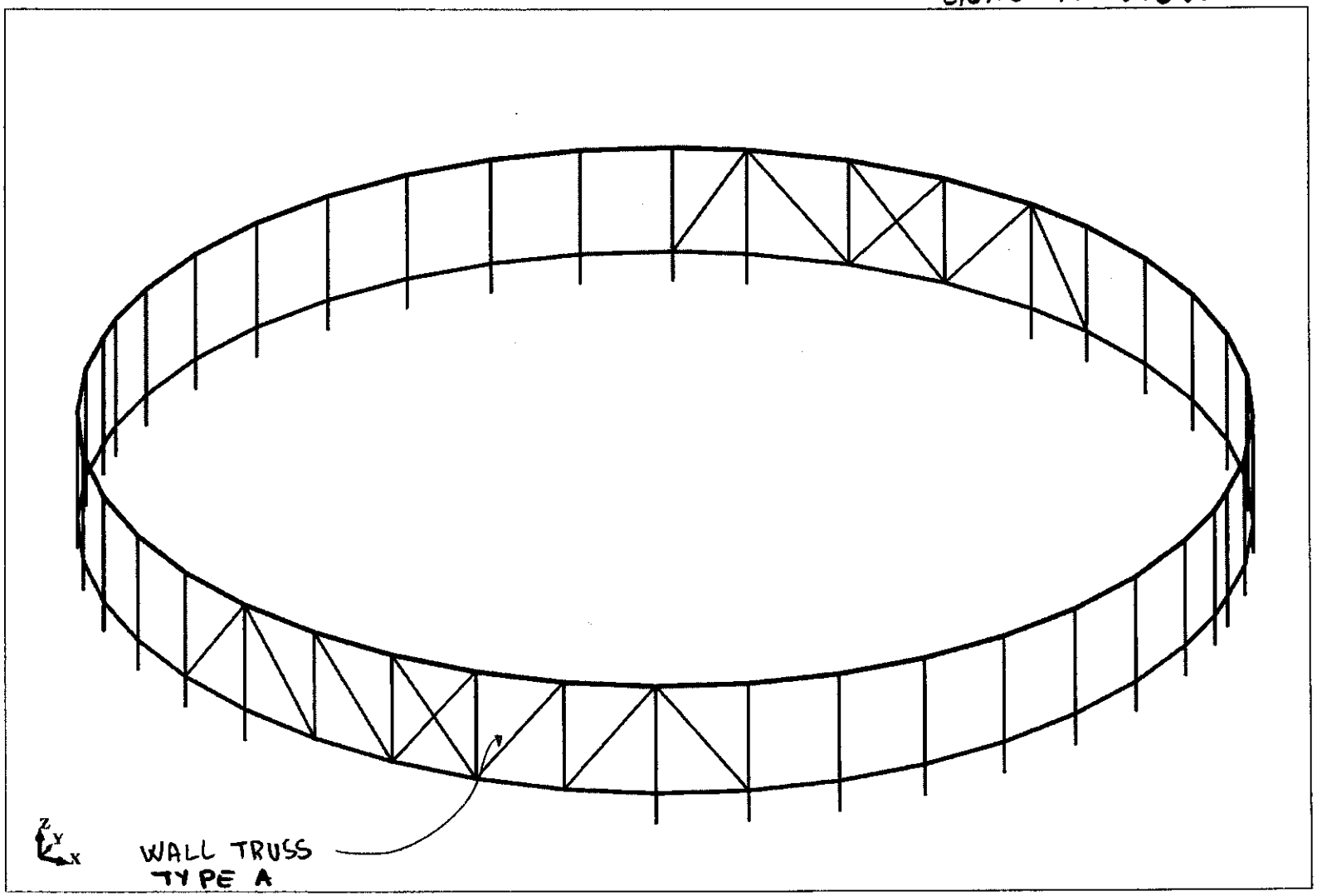
The steel structure was analysed using Robot computer program.

STRUCTURE DESCRIPTION

- The structure follow a circular geometry but in the model, we considered it faceted.
- The Fabric is carried by rails to columns to deck.
- At the access area we have two particular situations : 2 walls truss.

View - Cases: 1 (Self Weigth)

GENERAL VIEW



Columns : CHS 60.3 x 4

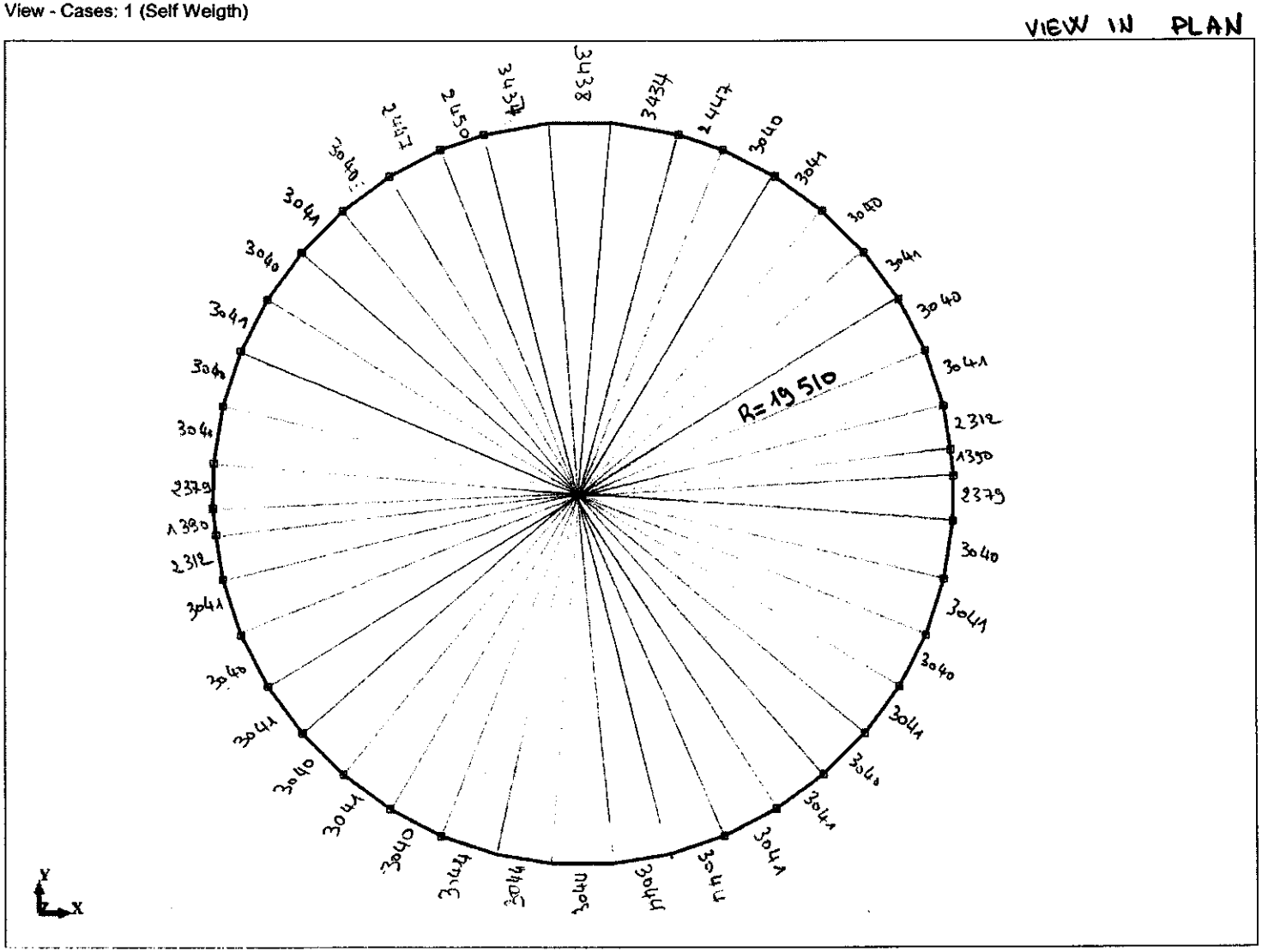
Top Rail : SHS 80 x 5

Lower Rail: SHS 60 x 5

Bracing : CHS 48.3 x 3.5

1518/4/2

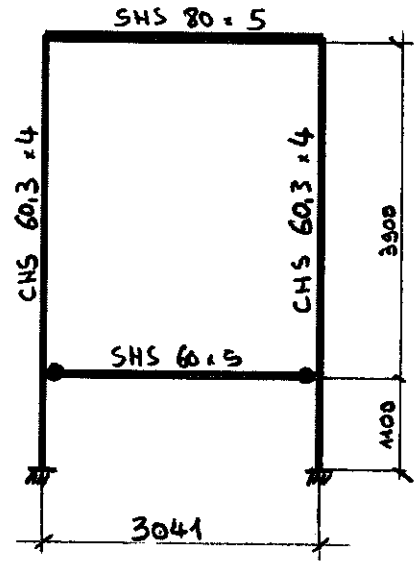
View - Cases: 1 (Self Weigth)



1578/7/3

View:3 - Cases: 1 (Self Weigth)

TYPICAL SPAN



Note:

- The Top Rail is continuous
- The Lower Rail is pinned to the columns
-

Key:

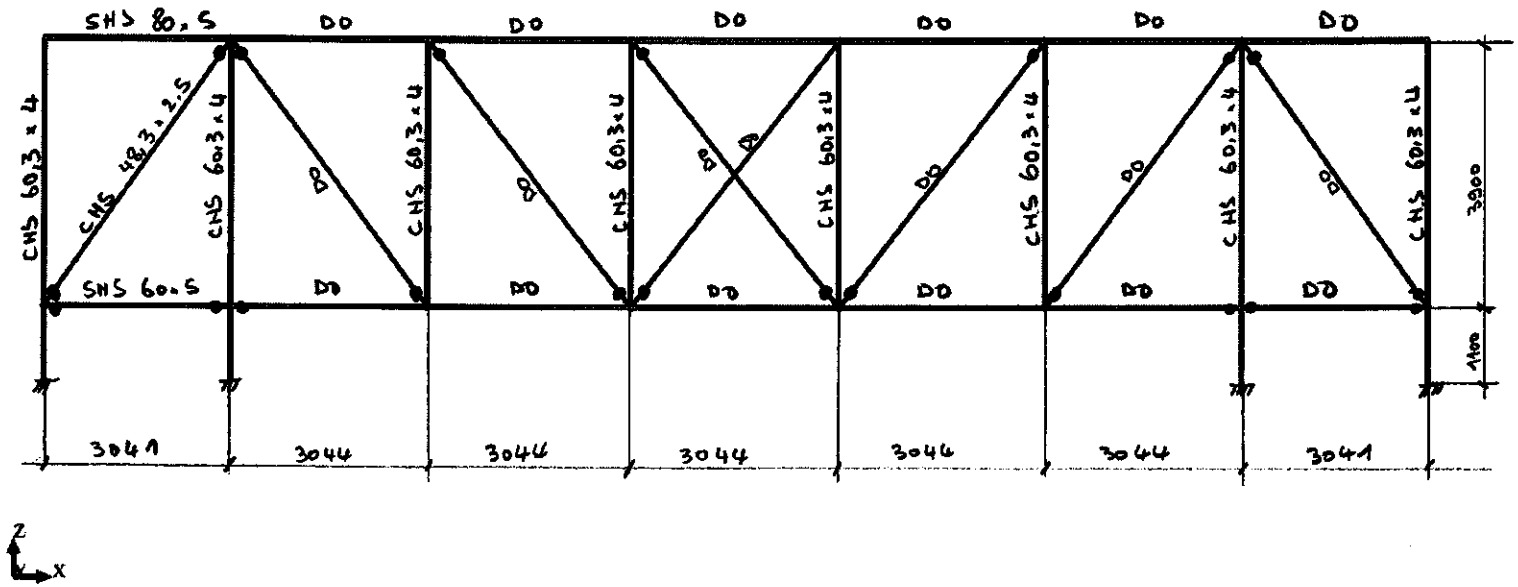
⊥ : Column fixed

/ : Pinned member

1578/4

View:2 - Cases: 1 (Self Weigth)

Wall TRUSS TYPE A



Note:

- Top Rail is continuous
- Lower Rail is continuous between the columns

Key:

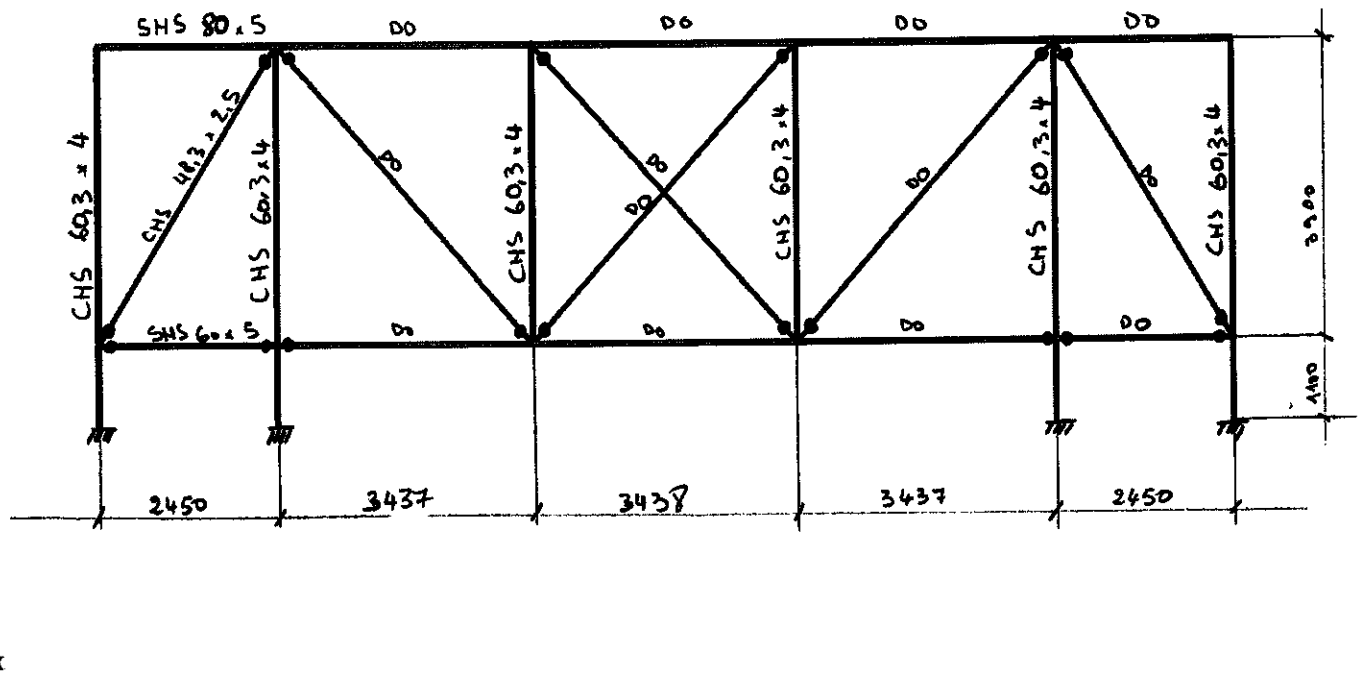
: Fixed column

: Pinned Member

1578/7/S1

View:1 - Cases: 1 (Self Weigth)

WALL TRUSS TYPE B



Note:

- Top Rail is continuous
- Low Rail is continuous between the two columns

Key:

: Fixed Column

: Pinned Member

157874/6

atelier one

Project BRITISH MUSEUM

No 1578/7/7

Date 01.02.07 By YB

Checked

Notes

ANALYSIS MODEL:

The steel structure was analysed using the Robot Computer Program.

The following pages describes the input data into each load case.

atelier one

Project BRITISH MUSEUM

No. 1578/178

Date 21-02-07 By YB

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Notes

DEAD LOAD:

- self weight of the steel work

- Fabric weight: Assume 1 kg/m² → 0,01 kN/m²
  L = 3,9 × 0,01 = 0,039 kN/m

- Pretension from the fabric:

  Assume wind applied to the fabric = 1,5 kg/m² = 0,015 kN/m²

  $$\text{Reaction} = \frac{0,015 \times 3,9}{2} = 0,03 \text{ kN}$$

  Dip = 75 mm

  $$R = \frac{L^2 + 4d^2}{8d} = \frac{3900^2 + 4 \times 75^2}{8 \times 75}$$

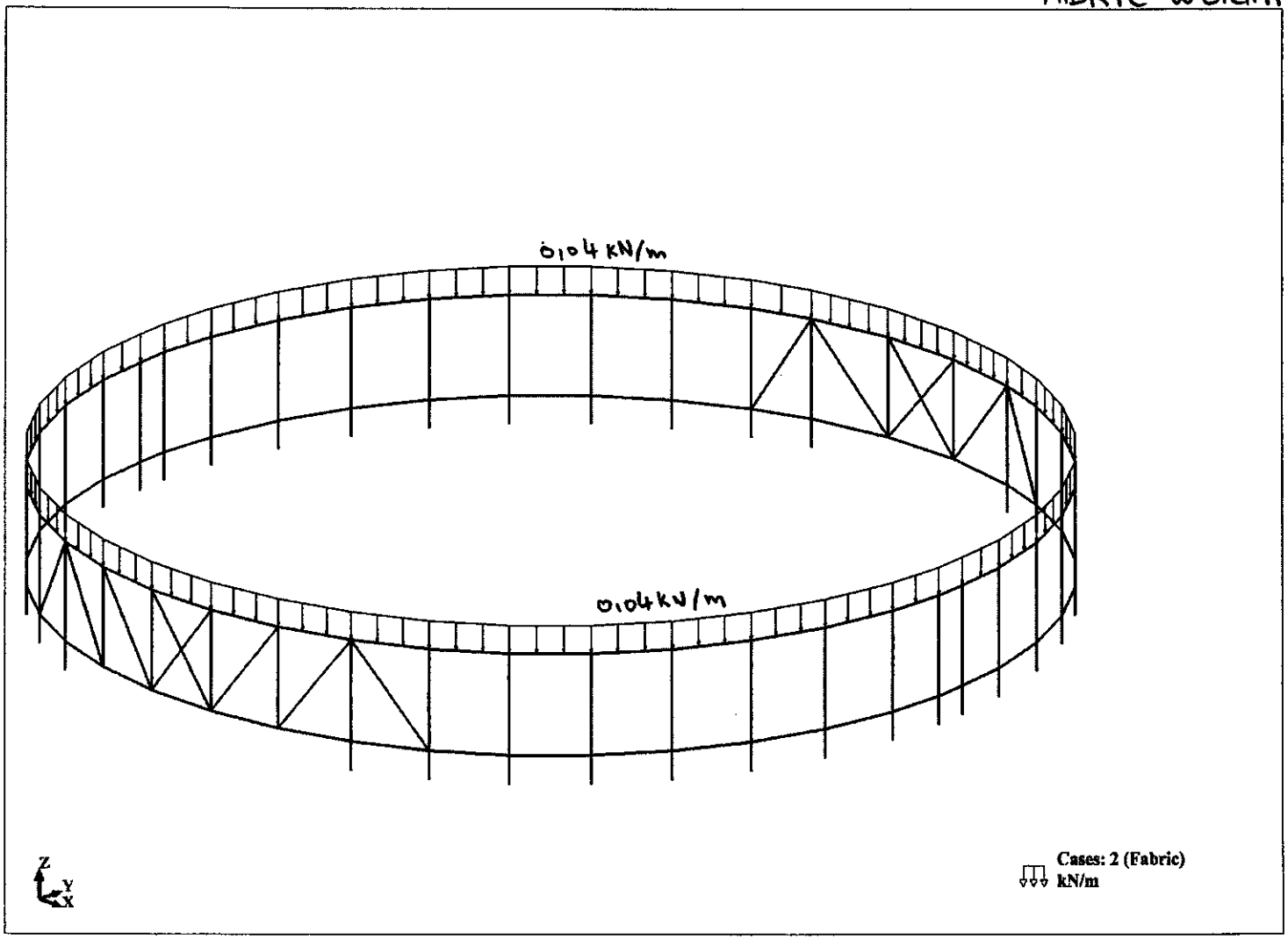
  $$= 25388 \text{ mm}$$

  Tension = 25,388 × 1,5 = 38,1 kg/m

  Tension = 0,37 kN/m

View - Cases: 2 (Fabric)

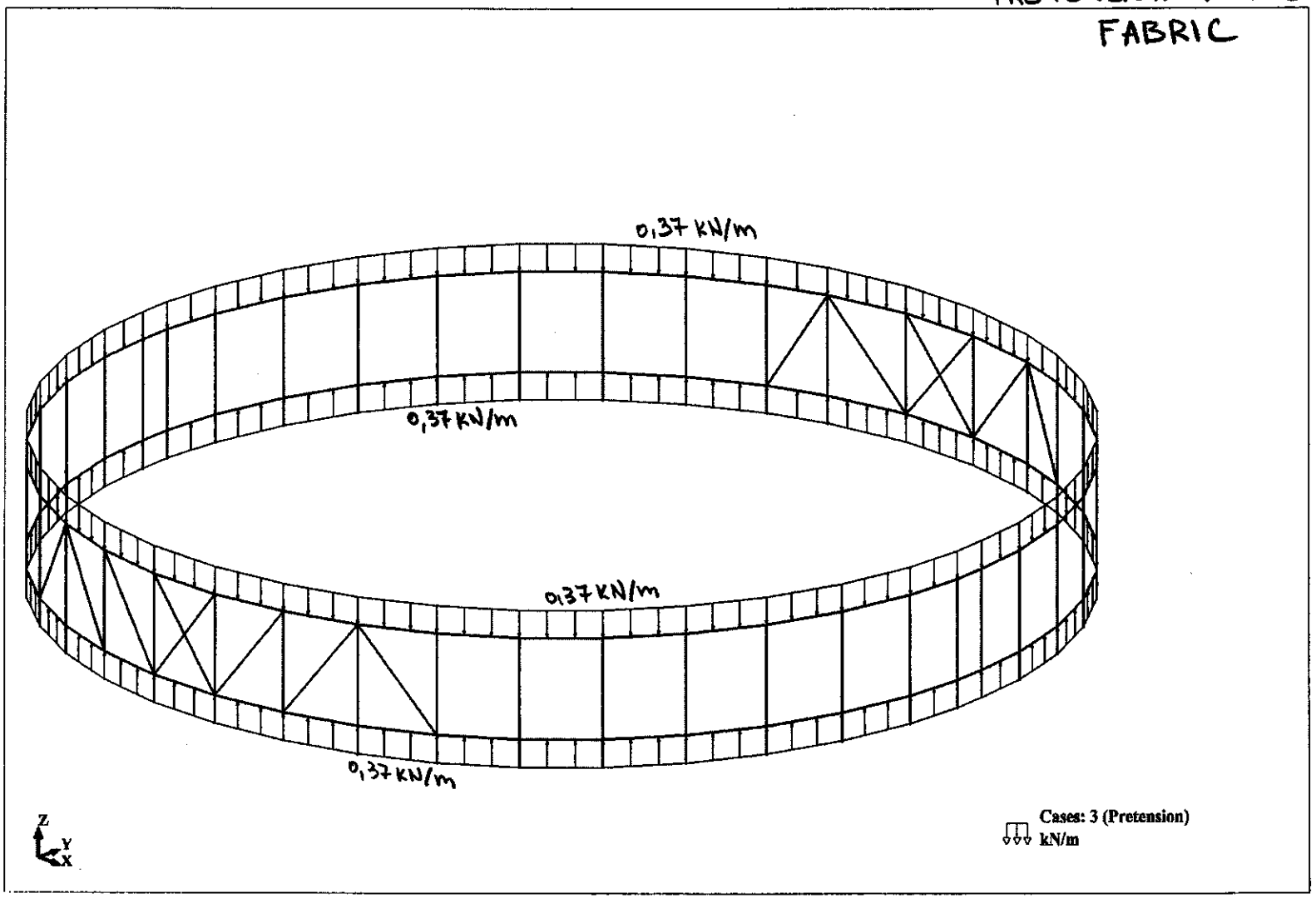
FABRIC WEIGTH



15287/9

View - Cases: 3 (Pretension)

PRETENSION OF THE FABRIC



1578/4/10

atelier one

Project BRITISH MUSEUM

No 1578/7/11

Date 01-02-07 By YB

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Notes

Live Load :

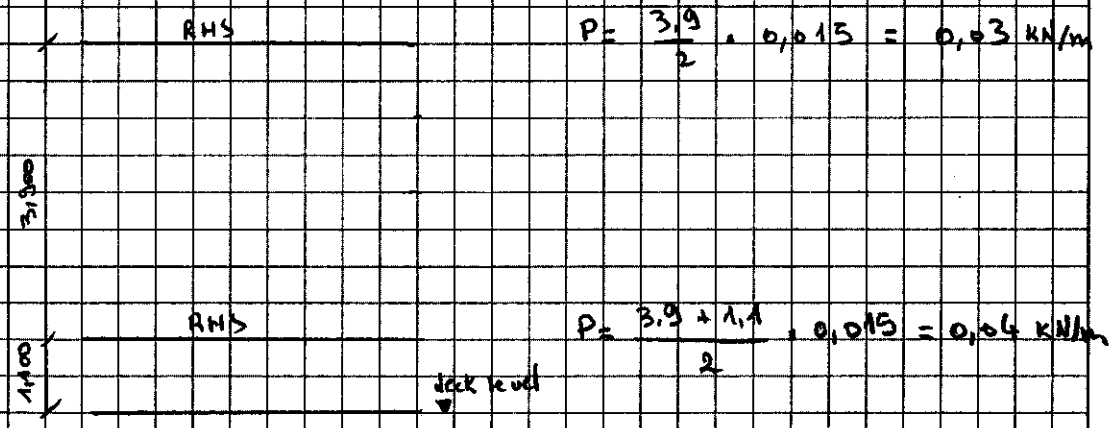
- assume 0,74 KN/m (no overcroweled area)

Applied as UDL on 2 or 3 spans

Wind Load :

Assume 1,5 kg/m^2 = 0,015 KN

The exhibition structure is indoor so the structure will not support natural wind load.



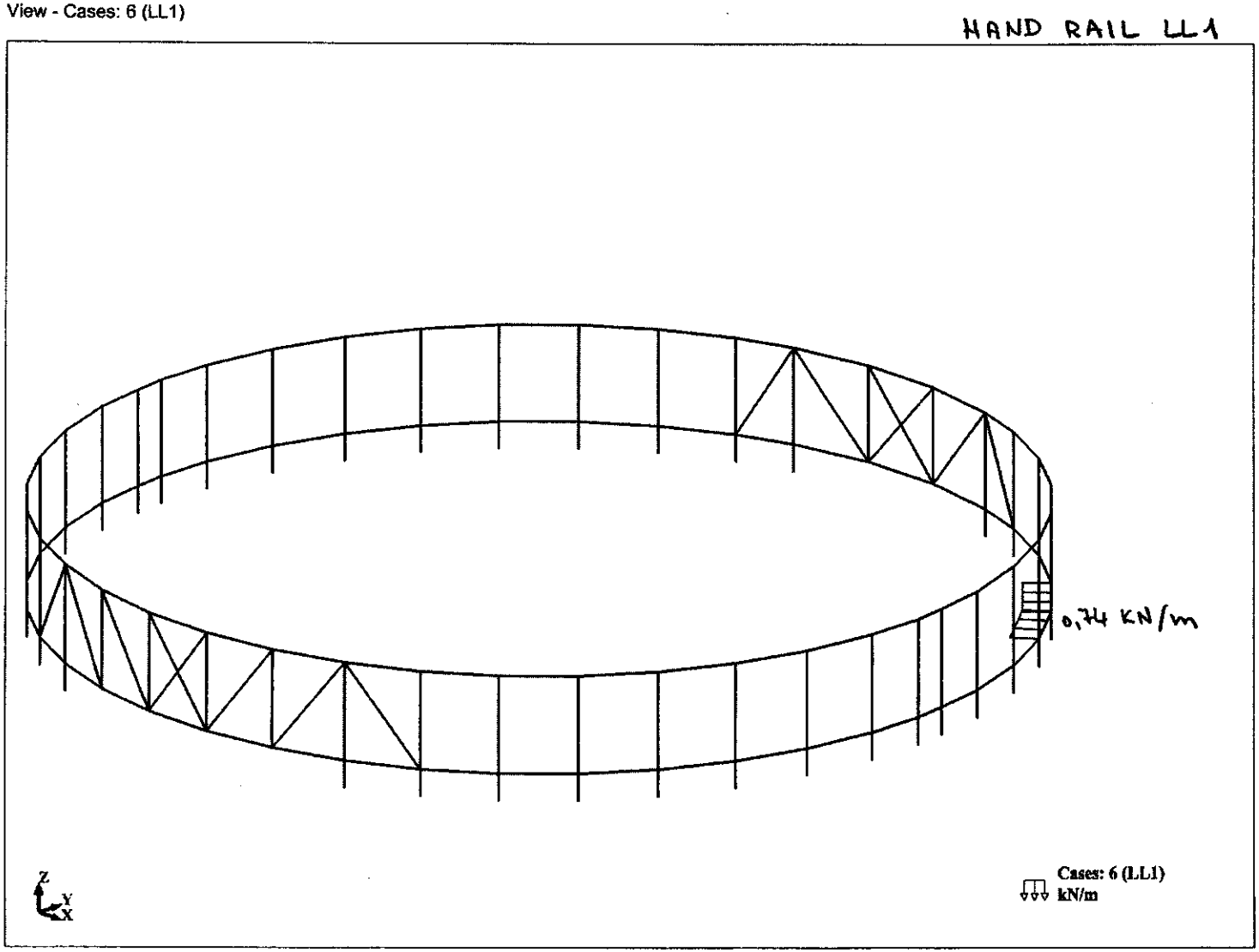
- Consider wind load from 2 directions

Assume do not act at the same time

Consider :

- Wind 1 Perpendicular to the Wall Truss
- Wind 2 Parallel to the Wall Truss

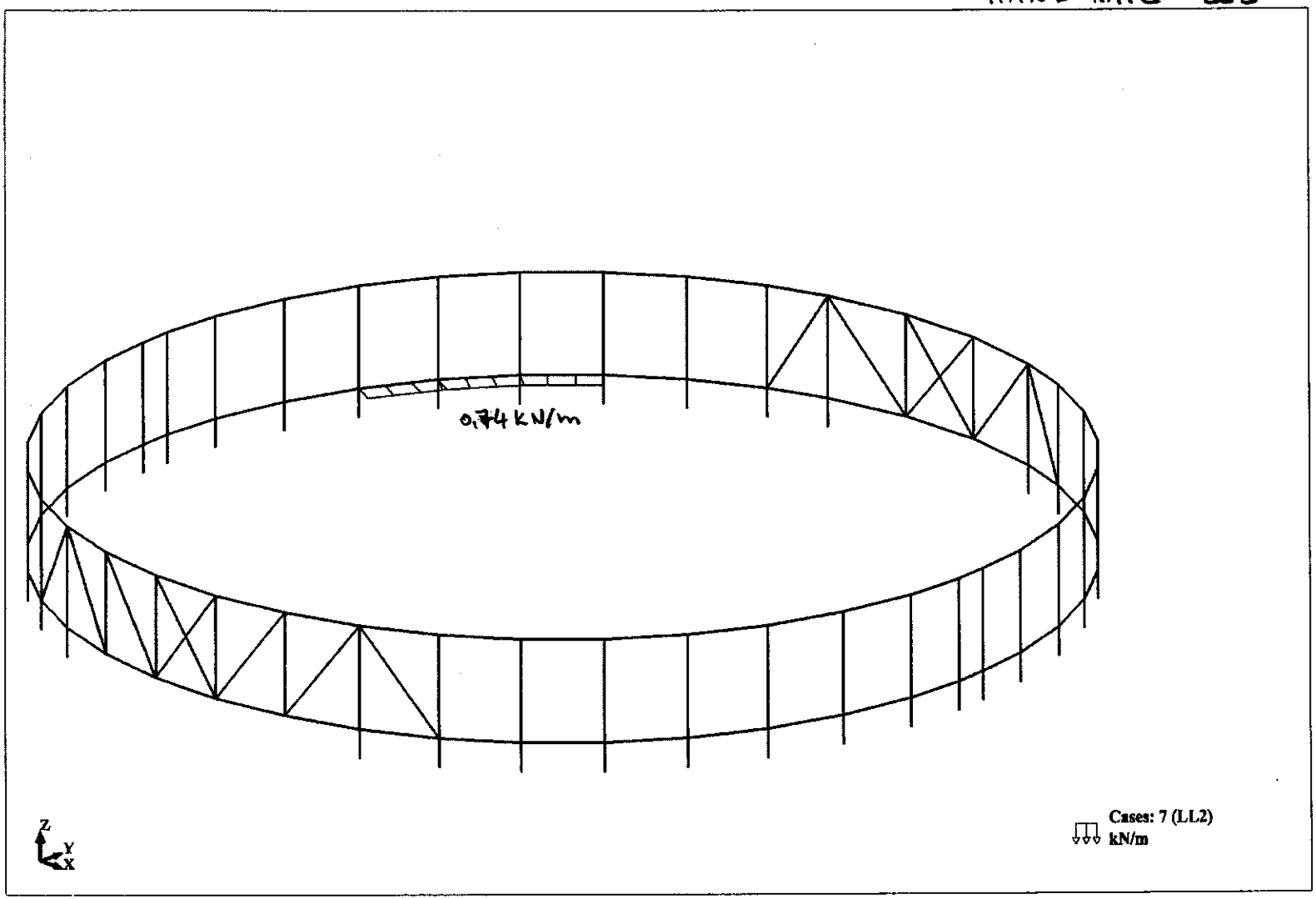
View - Cases: 6 (LL1)



21/7/2151

View - Cases: 7 (LL2)

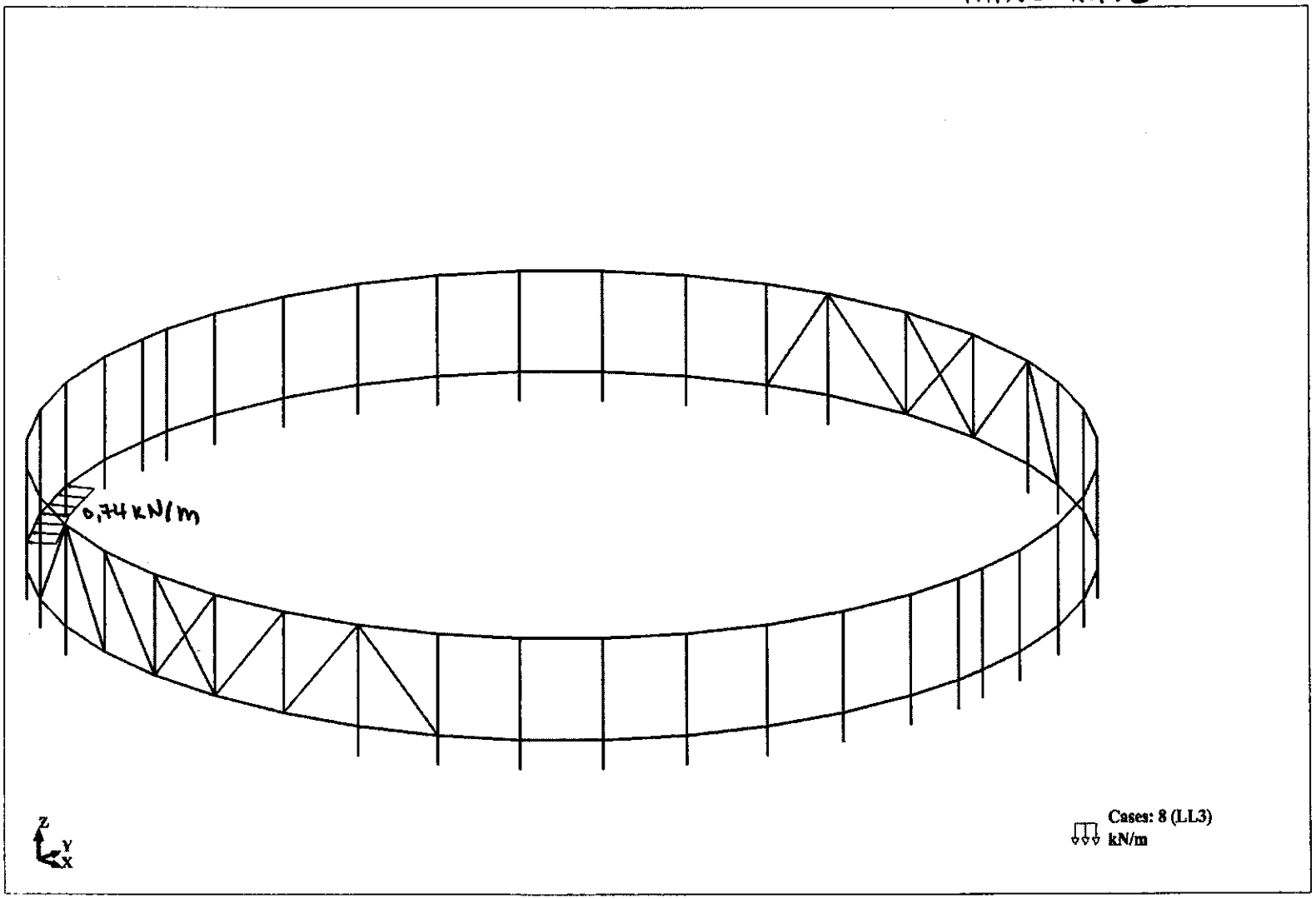
HAND RAIL LL2



15/8/13

View - Cases: 8 (LL3)

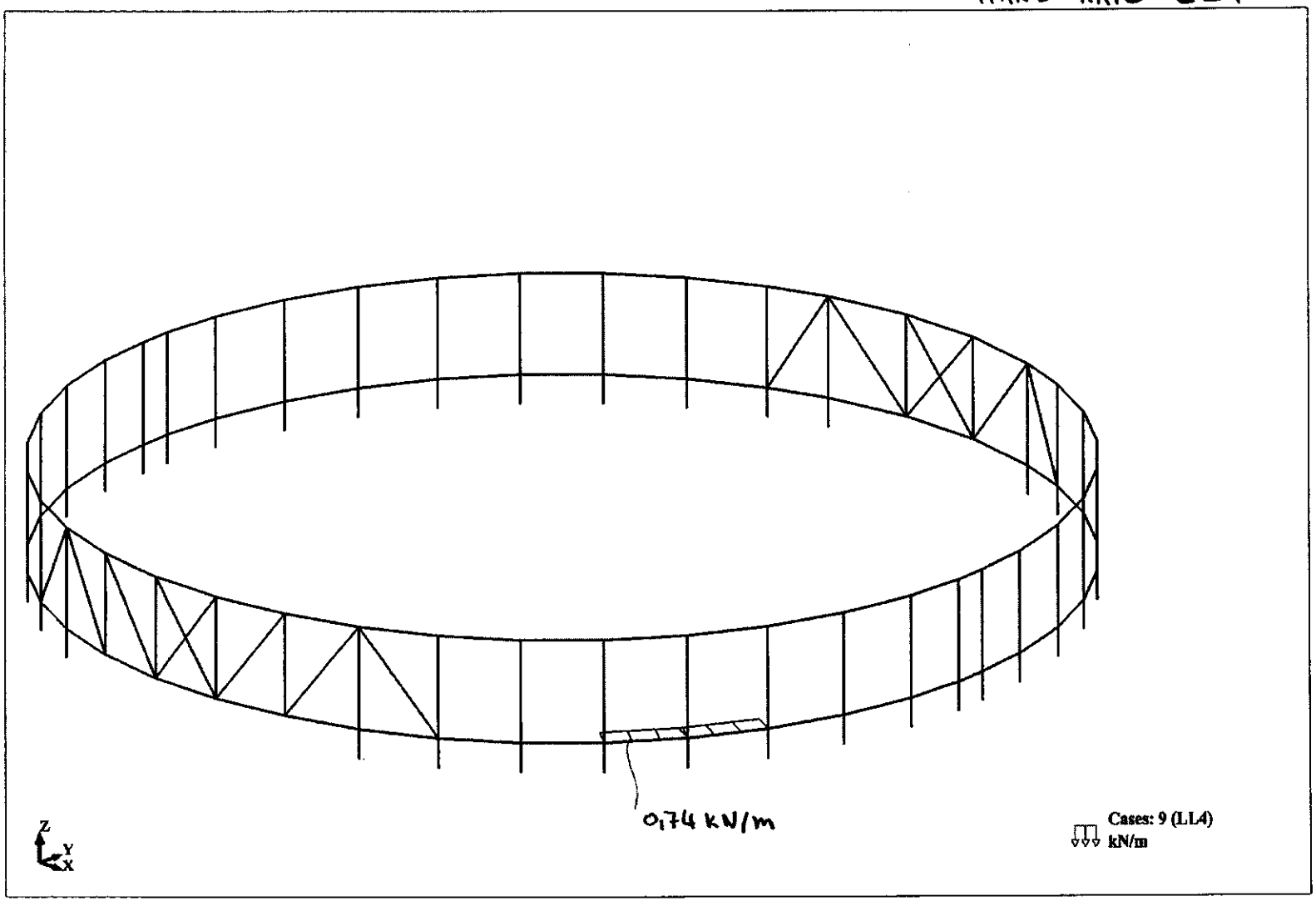
HAND RAIL LL3



15/8/14

View - Cases: 9 (LL4)

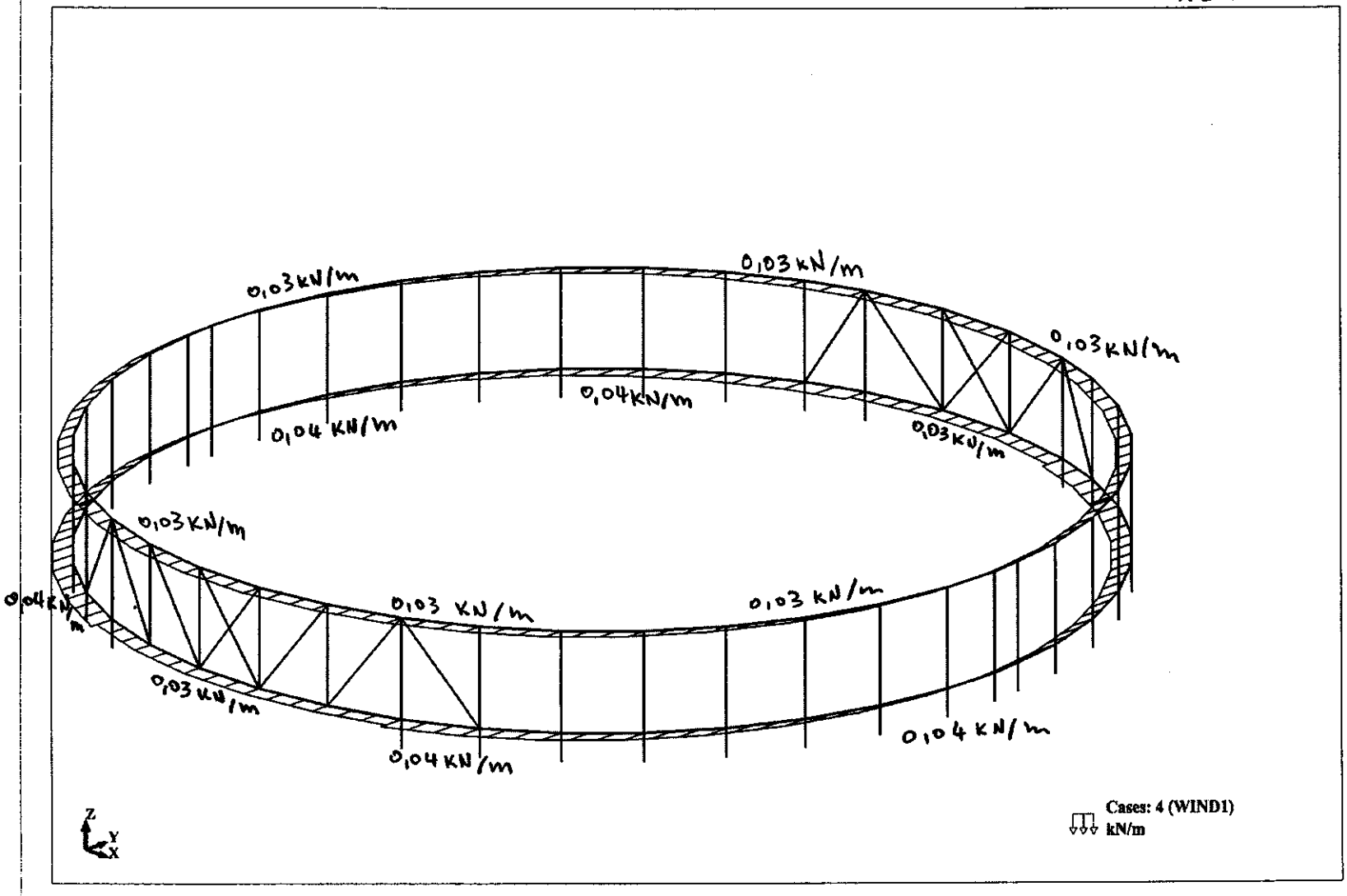
HAND RAIL LL4



1578/15

View - Cases: 4 (WIND1)

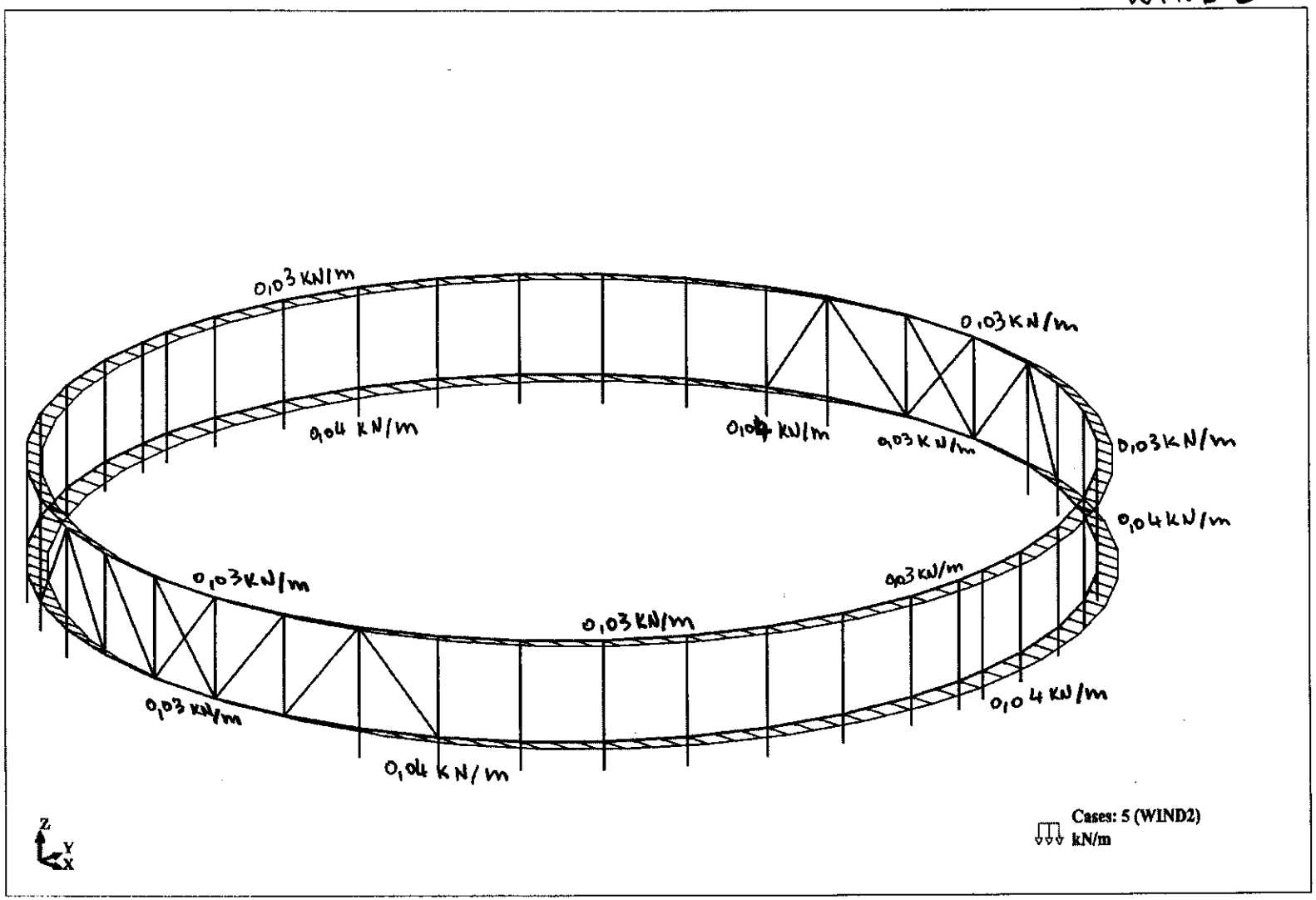
WIND 1



1S8/4/16

View - Cases: 5 (WIND2)

WIND 2



1578/17

1578/7/18

Loads:1
Info
1

Case	Case name	Nature	Analysis type
1	Self Weigth	dead	Static - Linear
2	Fabric	dead	Static - Linear
3	Pretension	dead	Static - Linear
4	WIND1	wind	Static - Linear
5	WIND2	wind	Static - Linear
6	LL1	live	Static - Linear
7	LL2	live	Static - Linear
8	LL3	live	Static - Linear
9	LL4	live	Static - Linear
50	1.0DL	dead	Linear Combination
51	1.0DL + 1.0LL1	dead	Linear Combination
52	1.0DL + 1.0LL2	dead	Linear Combination
53	1.0DL + 1.0LL3	dead	Linear Combination
54	1.0DL + 1.0LL4	dead	Linear Combination
55	1.0DL + 1.0WIND1	dead	Linear Combination
56	1.0DL + 1.0WIND2	dead	Linear Combination
61	1.0DL + 1.0LL1 + 1.0WIND1	dead	Linear Combination
62	1.0DL + 1.0LL2 + 1.0WIND1	dead	Linear Combination
63	1.0DL + 1.0LL3 + 1.0WIND1	dead	Linear Combination
64	1.0DL + 1.0LL4 + 1.0WIND1	dead	Linear Combination
65	1.0DL + 1.0LL1 + 1.0WIND2	dead	Linear Combination
66	1.0DL + 1.0LL2 + 1.0WIND2	dead	Linear Combination
67	1.0DL + 1.0LL3 + 1.0WIND2	dead	Linear Combination
68	1.0DL + 1.0LL4 + 1.0WIND2	dead	Linear Combination
101	1.4DL + 1.6LL1	dead	Linear Combination
102	1.4DL + 1.6LL2	dead	Linear Combination
103	1.4DL + 1.6LL3	dead	Linear Combination
104	1.4DL + 1.6LL4	dead	Linear Combination
105	1.0DL + 1.4WIND1	dead	Linear Combination
106	1.0DL - 1.4WIND1	dead	Linear Combination
107	1.0DL + 1.4WIND2	dead	Linear Combination
108	1.0DL - 1.4WIND2	dead	Linear Combination
111	1.4DL + 1.4WIND1	dead	Linear Combination
112	1.4DL - 1.4WIND1	dead	Linear Combination
113	1.4DL + 1.4WIND2	dead	Linear Combination
114	1.4DL - 1.4WIND2	dead	Linear Combination
121	1.2DL + 1.2LL1 + 1.2WIND1	dead	Linear Combination
122	1.2DL + 1.2LL2 + 1.2WIND1	dead	Linear Combination
123	1.2DL + 1.2LL3 + 1.2WIND1	dead	Linear Combination
124	1.2DL + 1.2LL4 + 1.2WIND1	dead	Linear Combination
125	1.2DL + 1.2LL1 + 1.2WIND2	dead	Linear Combination
126	1.2DL + 1.2LL2 + 1.2WIND2	dead	Linear Combination
127	1.2DL + 1.2LL3 + 1.2WIND2	dead	Linear Combination
128	1.2DL + 1.2LL4 + 1.2WIND2	dead	Linear Combination

atelier one

Project BRITISH MUSEUM

No 1578/7/19

Date 21-08-07 By VB

Checked

Notes

RESULTS:

- Envelopes of peak forces and moments for each member type are shown over L_D
- These are for non-coexistant conditions
  (ie) Peak F_x (comp) = 10,59 kN [LC 112 Member 1049] doesn't occur in same member or Loadcase as peak M_y = 2,35 kNm
- For checking members capacities, arrange data into coexistant conditions
  (ie) Extract all corresponding data for M_y, M_z for members and load cases where F_x occurs.
- Use this data for checking members capacities

atelier one

Project BRITISH MUSEUM

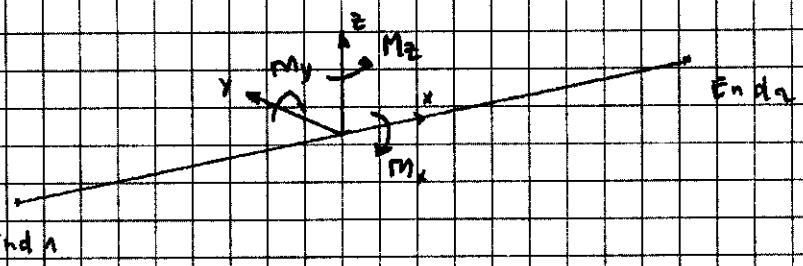
No. 1578/7/20

Date 01-02-07 By YB

Checked

Notes

Members Forces and Moments:



F_x = Axial Load (+ in Robot = compression)

F_y = Horiz Shear

F_z = Vert Shear

M_x = Torsion

M_y = Major Bending

M_z = Minor Bending.

COLUMNS

60.3x4 CHS

Forces - Cases: 50to56 61to68 101to108 111to114 121to128
Global extremes
1

- Cases: 50to56 61to68 101to108 111to114 121to128

Filtering	Bar	Case
Full list	100to141 200to2	1to9 50to56 61to
Selection	1000to1030 103	50to56 61to68 1
Total number	176	44
Selected number	78	35

- Cases: 50to56 61to68 101to108 111to114 121to128

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	10.59	1.46	2.72	0.10	2.35	1.28
Bar	1049	1012	1012	1050	1019	1012
Point	116	14	14	117	21	14
Case	112 (C)	104 (C)	104 (C)	111 (C)	103 (C)	104 (C)
MIN	-3.54	-1.87	-2.72	-0.10	-2.35	-1.72
Bar	1015	1003	1019	1072	1012	1003
Point	115	5	21	139	14	5
Case	113 (C)	101 (C)	103 (C)	111 (C)	104 (C)	121 (C)

15488/7/21

LOWER RAIL
60 x 5 SHS

Forces - Cases: 101to108 111to114 121to128
Global extremes
1

- Cases: 101to108 111to114 121to128

Filtering	Bar	Case
Full list	100to141 200to2	1to9 50to56 61to
Selection	100to141	101to108 111to1
Total number	176	44
Selected number	42	20

- Cases: 101to108 111to114 121to128

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	3.53	1.80	0.83	0.08	0.49	1.35
Bar	116	112	135	139	135	112
Point	118	113	137	139	137	5/10
Case	111 (C)	104 (C)	111 (C)	111 (C)	111 (C)	104 (C)
MIN	-3.19	-1.80	-0.83	-0.08	-0.46	-0.18
Bar	128	112	137	141	112	138
Point	129	112	138	141	6/10	139
Case	102 (C)	104 (C)	111 (C)	111 (C)	111 (C)	114 (C)

15/8/22

TOP RAIL

80x5 SHS

Forces - Cases: 101to108 111to114 121to128
Global extremes
1

- Cases: 101to108 111to114 121to128

Filtering	Bar	Case
Full list	100to141 200to2	1to9 50to56 61to
Selection	200to234 236to2	101to108 111to1
Total number	176	44
Selected number	42	20

- Cases: 101to108 111to114 121to128

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	2.40	0.28	1.30	0.28	0.48	0.68
Bar	240	216	238	239	236	240
Point	238	214	237	238	5/10	239
Case	111 (C)	111 (C)	114 (C)	111 (C)	112 (C)	111 (C)
MIN	-1.40	-0.28	-1.30	-0.28	-0.82	-0.65
Bar	233	239	236	216	205	215
Point	232	238	236	214	202	213
Case	126 (C)	111 (C)	113 (C)	111 (C)	111 (C)	112 (C)

1578/7/23

BRACING

48.3x 2.5 CHS

Forces - Cases: 101to108 111to114 121to128
Global extremes
1

- Cases: 101to108 111to114 121to128

Filtering	Bar	Case
Full list	100to141 200to2	1to9 50to56 61to
Selection	2000to2002 200	101to108 111to1
Total number	176	44
Selected number	14	20

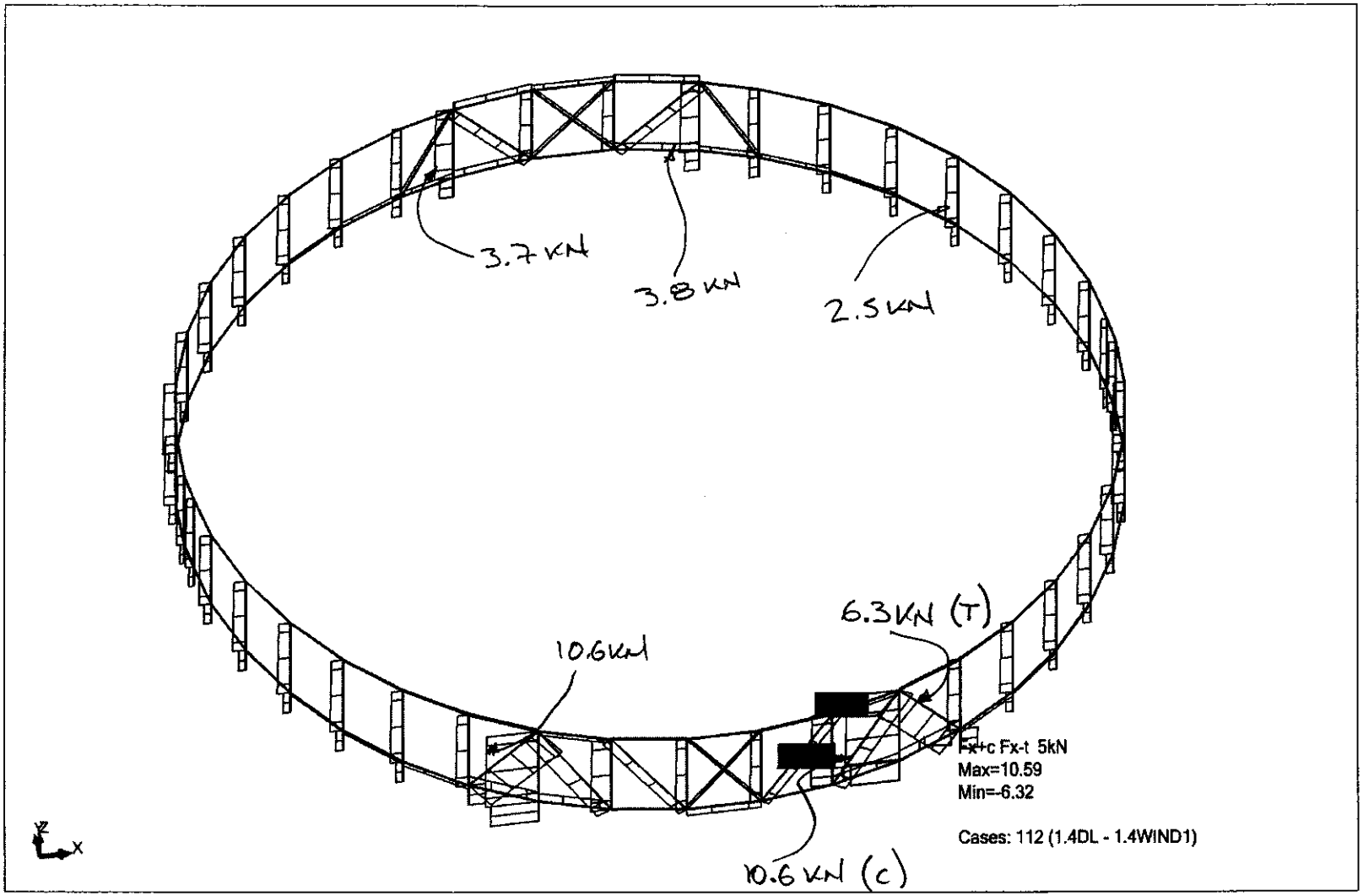
- Cases: 101to108 111to114 121to128

	FX (kN)	FY (kN)	FZ (kN)	MX (kNm)	MY (kNm)	MZ (kNm)
MAX	2.55	0.00	0.07	0.00	0.09	0.00
Bar	2015	2011	2000	2012	2001	2012
Point	134	213	138	141	5/10	214
Case	126 (C)	111 (C)	101 (C)	111 (C)	101 (C)	111 (C)
MIN	-6.32	-0.00	-0.07	-0.00	-0.00	-0.00
Bar	2011	2012	2000	2015	2014	2011
Point	213	141	236	232	119	115
Case	112 (C)	111 (C)	101 (C)	105 (C)	112 (C)	111 (C)

15/8/24

View - FX, Cases: 112 (1.4DL - 1.4WIND1)

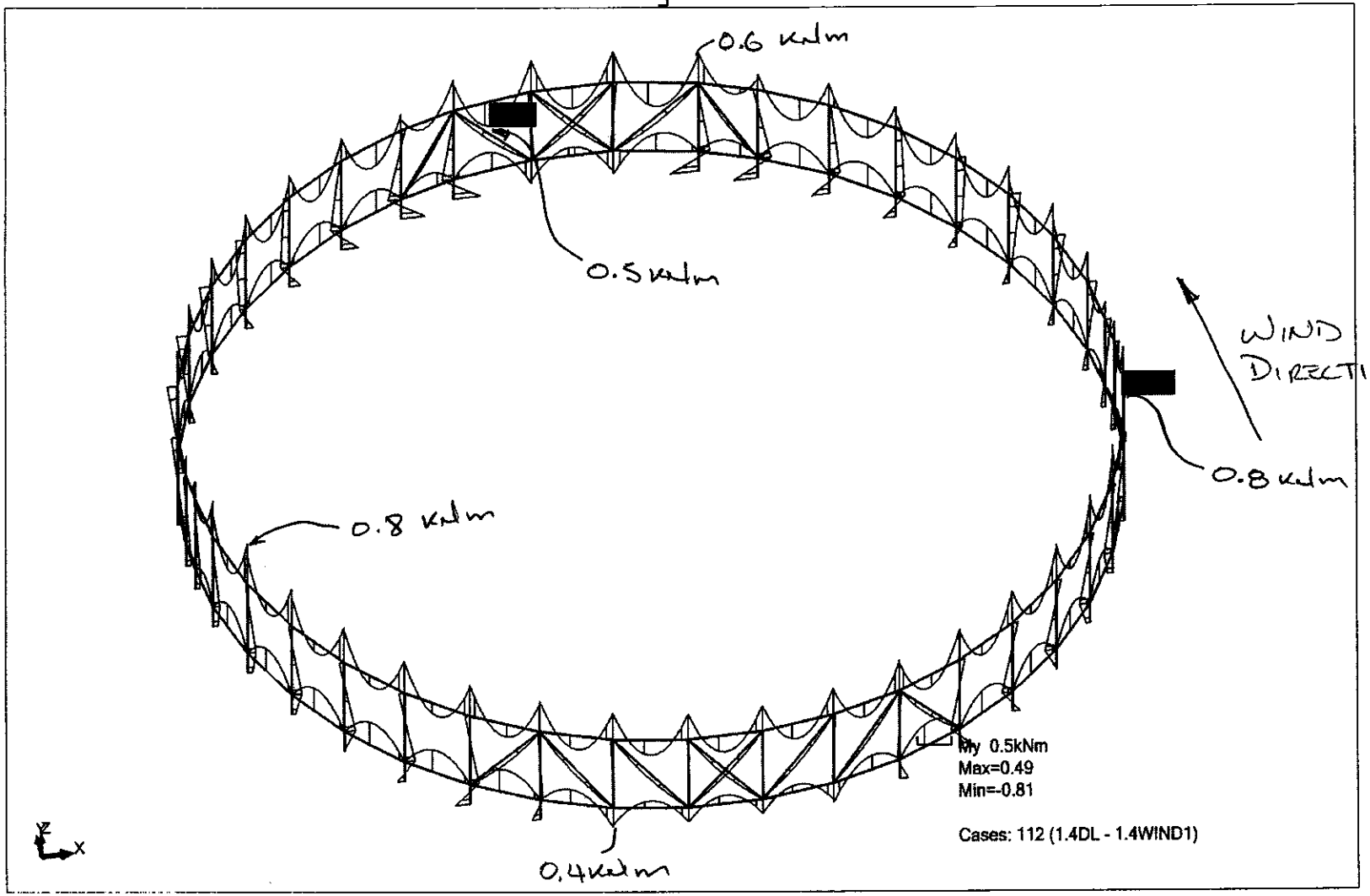
AXIAL FORCE DIAGRAM – LOAD COMBINATION 112 : 1.4DL – 1.4WL



15/8/25

View - MY, Cases: 112 (1.4DL - 1.4WIND1)

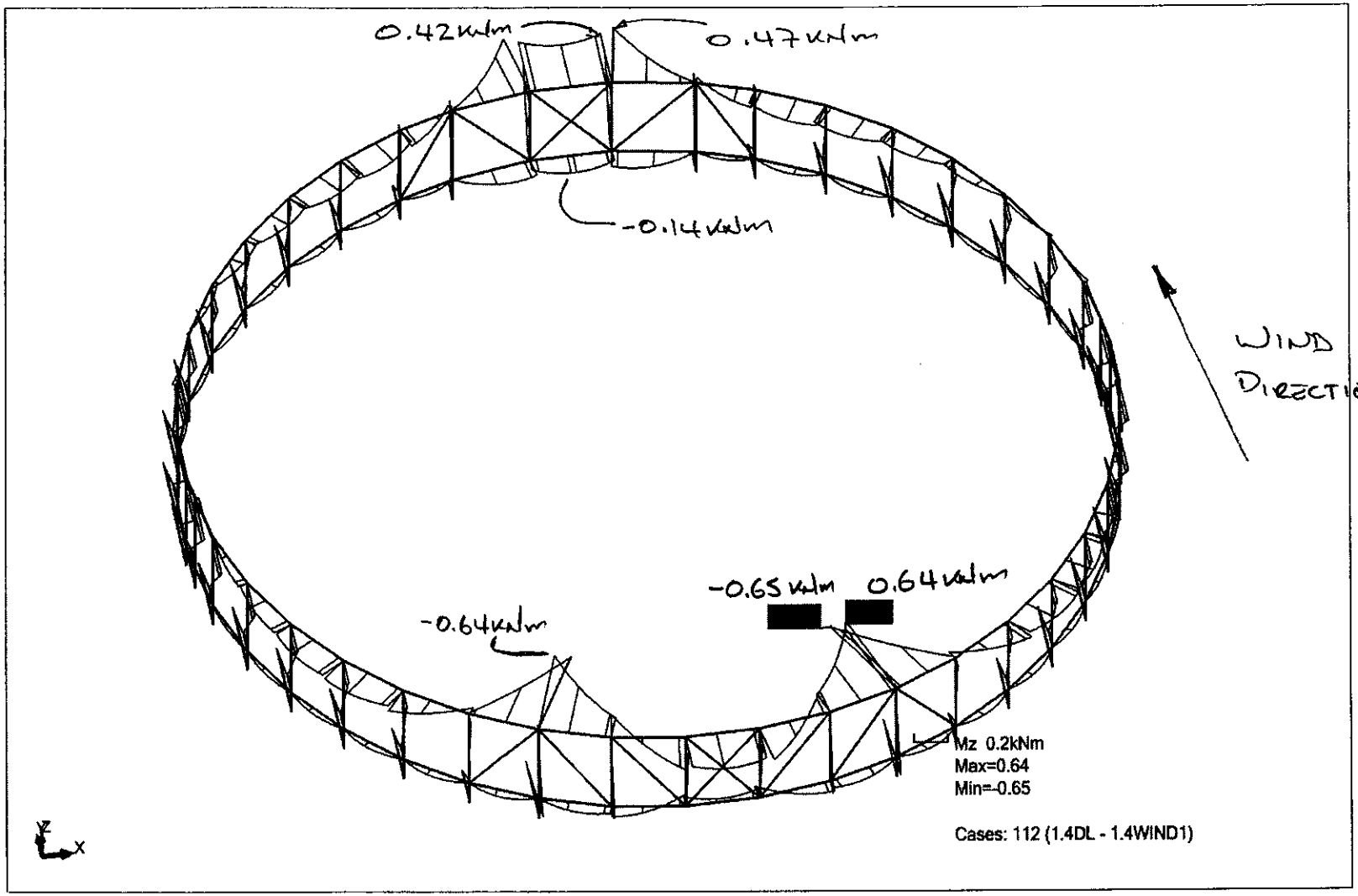
BMD - major axis - LOAD COMBINATION 112: 1.4DL - 1.4WL



1578/4/26

View - MZ, Cases: 112 (1.4DL - 1.4WIND1)

BMD - minor axis - LOAD COMBINATION 112 : 1.4DL - 1.4 WL



27/4/8151

atelier one

Project BRITISH MUSEUM

No. 1578/7/28

Date 01-02-07 By YB

Checked

Notes

OVERALL BUCKLING CAPACITY:

Check all sections using the following criteria

$$\frac{F}{P_c} + \frac{M_y}{M_b} + \frac{M_z}{P_y Z_y} < 1$$

Where:

F is the applied axial load in the member

P_c is the compression capacity

M_y is the applied moment about the major axis

M_b is the buckling resistance moment capacity

M_z is the applied moment about the minor axis

P_y is the design strength.

Z_y is the elastic section modulus about minor axis

atelier one

Project BRITISH MUSEUM

No. 1578/7/29

Date 01-02-31 By YB

Checked

Notes

Columns check:

Section: CHS 60.3 x 4

$P_y Z_y = 3,3\ kN\,m$ $M_b = 4\ kN\,m$

$L_E = L = 5m$ $P_c = 21,9\ kN$

case 1: Load 112 1.4 DL + 1.4 WIND 1

$F_x = 10,59\ kN$ $M_y = -0,04\ kN\,m$ $M_z = -0,16\ kN\,m$

$\frac{10,59}{21,9} + \frac{0,04}{4} + \frac{0,16}{3,3} = 0,543 < 1$ ok

case 2: Load 104 1.4 DL + 1.6 LL 4

$F_x = 1,36\ kN$ $M_y = -2,35\ kN\,m$ $M_z = 1,28\ kN\,m$

$\frac{1,36}{21,9} + \frac{2,35}{4} + \frac{1,28}{3,3} = 0,983 < 1$ ok

case 3: Load 121 1.2 DL + 1.2 LL 1 + 1.2 WIND 1

$F_x = 1,20\ kN$ $M_y = -1,52\ kN\,m$ $M_z = -1,72\ kN\,m$

$\frac{1,20}{21,9} + \frac{1,52}{4} + \frac{1,72}{3,3} = 0,906 < 1$ ok

atelier one

Project BRITISH MUSEUM

No. 1578 17/30

Date 01-02-07 By YB

Checked

Notes

Lower Rail :

Section SHS 60 x 5

$P_y Z_y = 4,9$ kNm $\quad M_{b,} = 5,9$ kNm

Case 1 : Load 111 : 1,4DL + 1,4 WIND 1

$F_x = 3,53$ kN $\quad M_y = +0,37$ kNm $\quad M_z = -0,05$ kNm

$L_E = L = 3,041$ m $\quad P_c = 101,7$

$\frac{3,53}{101,7} + \frac{0,37}{5,9} + \frac{0,05}{4,9} = 0,034 + 0,068 + 0,01 =$

$= 0,107 < 1$ ok

Case 2 : Load 111 : 1,4DL + 1,4 WIND 1

$F_x = 0,80$ kN $\quad M_y = 0,49$ kNm $\quad M_z = 0,03$ kNm

$L_E = L = 3,43$ $\quad P_c = 81,7$

$\frac{0,80}{81,7} + \frac{0,49}{5,9} + \frac{0,03}{4,9} = 0,010 + 0,083 + 0,006$

$= 0,099 < 1$ ok

Case 3 : Load 104 1,4 DL + 1,6 LL 4

$F_x = -1,85$ kN $\quad M_y = -0,46$ kNm $\quad M_z = 1,35$ kNm

$L_E = L = 3,041$ m $\quad P_c = 101,7$

$\frac{1,85}{1001,7} + \frac{0,46}{5,9} + \frac{1,35}{4,9} = 0,006 + 0,078 + 0,276$

$= 0,360 < 1$ ok

atelier one

Project BRITISH MUSEUM

No. 1578/7/31

Date 01-02-07 By YB

Checked

Notes

Top Rail check:

Section SHS 80x5

$P_y Z_y = 9,4$ kNm $\quad M_b = 11,5$ kNm

Case 1: Load 111 1,4DL + 1,4 WIND 1

$F_x = 2,40$ kN $\quad M_y = -0,47$ kNm $\quad M_z = 0,18$ kNm

$L_e = L = 3,038$ $\quad P_c = 237,7$ kN

$\frac{2,40}{237,7} + \frac{0,47}{11,5} + \frac{0,18}{9,4} = 0,010 + 0,041 + 0,019$

$= 0,070 < 1$ ok

Case 2: Load 111 1,4 DL + 1,4 WIND 1 $\quad L_e = L = 3,04$ $\quad P_c = 237,7$ kN

$F_x = 0,10$ kN $\quad M_y = -0,82$ kNm $\quad M_z = 0$ kNm

$\frac{0,82}{11,5} = 0,071 < 1$ ok

Case 3: Load 111 1,4 DL + 1,4 WIND 1

$F_x = 2,38$ kN $\quad M_y = -0,47$ kNm $\quad M_z = 0,68$ kNm

$L_e = L = 3,04$ $\quad P_c = 237,7$ kN

$\frac{2,38}{237,7} + \frac{0,47}{11,5} + \frac{0,68}{9,4} = 0,010 + 0,041 + 0,072$

$= 0,123 < 1$ ok

atelier one

Project BRITISH MUSEUM

No 1578/7/32

Date 01-04-07 By VB

Checked

Notes

BRACING : CHS 48,3 . 2,5

Case 1: Load 112 . 1,4 DL + 1,4 WIND 1

$F_x = -6,32$ kN $M_y = 0,00$ kNm $M_z = 0,00$ kNm

$L_e = L = 4,945$ $P_c = 99,0$ kN

$\frac{6,32}{99,0} = 0,064 < 1$ ok

Case 2: Load 126 1,2 DL + 1,2 LL2 + 1,2 WIN 1

$F_x = 2,55$ $M_y = 0,00$ kNm $M_z = 0,00$ kNm

$L_e = L = 4,604$ m → $P_c = 8,6$ kN

$\frac{2,55}{8,6} = 0,298 < 1$ ok

View:2 - Exact deformation(s), Cases: 52 (1.0DL + 1.0LL2)

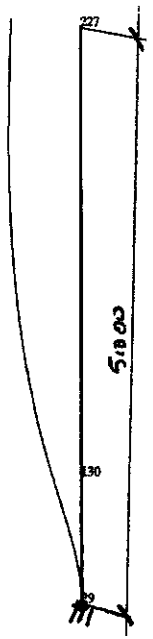
DEFLECTION

$$\delta_{max} = \sqrt{U_{x\,max}^2 + U_{y\,max}^2}$$

$$\delta_{max} = \sqrt{(18,2)^2 + (16,5)^2}$$

$$\delta_{max} = 24,56 \text{ mm}$$

$$\frac{L}{\delta_{max}} = \frac{5000}{24,56} = 203 > 180 \text{ ok}$$



Dis 10mm
Max=25.2

Cases: 52 (1.0DL + 1.0LL2)

1578/7/33

atelier one

Project BRITISH MUSEUM

No 1578/8/1

Date 02/07 By CJB

Checked

Notes

BRITISH MUSEUM

EXHIBITION LOAD ASSESSMENT

Check deck capacity & find loads under heavily loaded areas.

BRONZE CHARIOT + 4 HORSES

Exhibition Wts,

Bronze chariot = 1061kg.

Horses = 340kg each.

Assume following distribution,

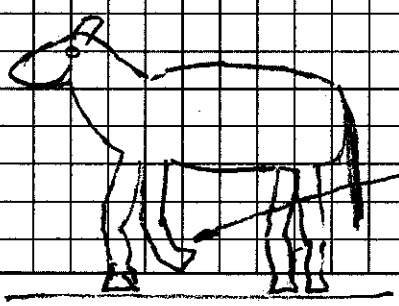
Chariot spread over 2 wheels,

Load/wheel = $\frac{1061}{2}$ = 531kg.

Horse, ½ load concentrated on one leg

Peak leg load = $\frac{340}{2}$ = 170kg

Check Horses - assume horse is walking.

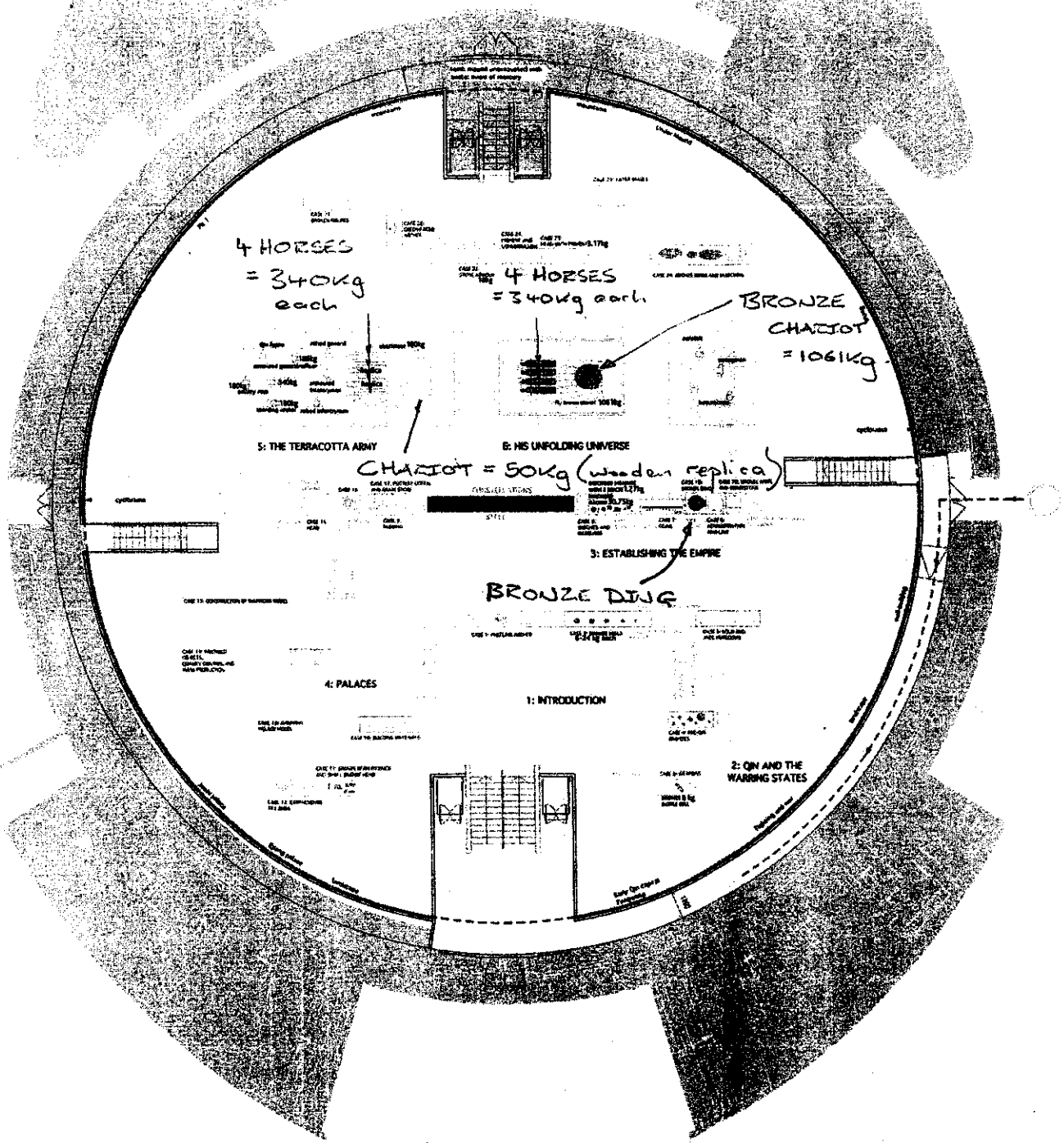


1 No. hoof making contact with ground.

NOTE:
Client confirmed all 4 No. legs on ground Meeting 19/02/07

EXHIBITION

LAYOUT: FIRST EMPEROR



EXHIBITION PLAN WITH WEIGHTS
09 FEBRUARY 2007

NOTE: HAHN LOUDA SHOWCASES
APPROX: 130 KG EACH (707 x 707 x 1500mm HIGH)

09.08.07	Draft 7		FT
31.07.07	Draft 6		FT
26.07.07	Draft 5		FT
24.07.07	Draft 4		FT/ PZ
19.07.07	Draft 3		FT
17.07.07	Draft 2		FT
12.07.07	Draft 1		FT/PZ
issue	date	description	drawn / checked

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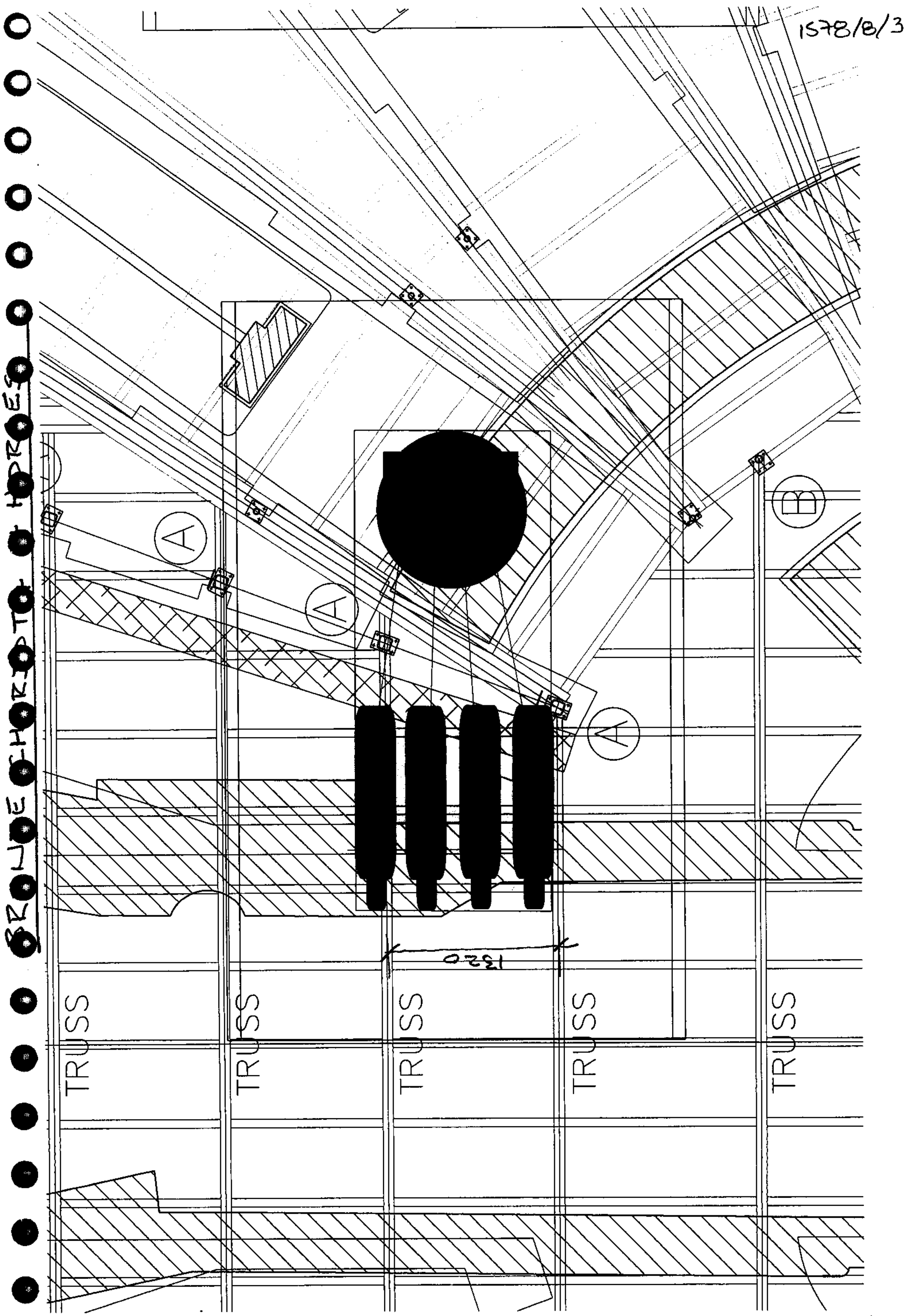
metaphor

client	The British Museum
project title	First Emperor
project address	The British Museum Great Russell Street London WC1B 3DG
drawing title	Draft plan with main circulation path
scale	1:100
paper size	A3
job number	1578/8/2
type	
revision	

1578/8/2

1578/8/3



atelier one

Project BRITISH MUSEUM

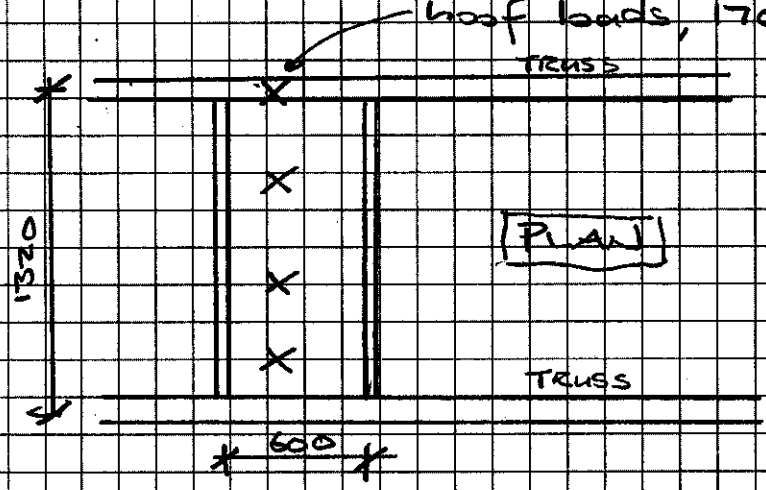
No 1579/8/4

Date 02/07 By CSB

Checked

Notes

From exhibition layout & structure overlays:-



CHECK PLY - 25mm thk

Total load = 4 x 170kg = 680kg.

$M = \frac{WL}{4}$ - assume simply supported each side - conservative

$M = \frac{6.8 \times 0.6}{4} = 1.02 kNm$

$Z = \frac{bd^2}{6} = \frac{1320 \times 25^2}{6} = 137500 mm^3$

For 25mm Canadian Douglas Fir (commonly available & also weakest)

$\sigma_{//b} = 12.2 N/mm^2$

$M_c = 137500 \times 12.2 \times 10^{-6} = 1.68 kNm$

$> 1.02 kNm$

OK.

atelier one

Project BRITISH MUSEUM

No. 1578/B/S

Date 02/07 By

Checked

Notes

Check defl^n.

$$I = \frac{bd^3}{12} = \frac{1320 \times 25^3}{12} = 1.719 \times 10^5 \text{ mm}^4$$

$E_{//,\perp} = 4745 \text{ N/mm}$

$$\delta = \frac{WL^3}{48EI} = \frac{6.8 \times 10^3 \times 600^3}{48 \times 4745 \times 1.719 \times 10^5}$$

$$= 3.75 \text{ mm}$$

allowable $= 0.003L = 0.003 \times 1320$

$= 3.96 \text{ mm}$

$> 3.75 \text{ mm}$ OK.

CHECK 175 x 65 x 1.4 PFC

Span = 1.32m

For simplicity assume all load concentrated at centre, - conservative.

$$M = \frac{WL}{4} = \frac{6.8 \times 1.32}{4} = 2.24 \text{ kNm}$$

From previous, $M_c = 4.64 \text{ kNm} > 2.24 \text{ kNm}$ OK.

$I = 196.7 \times 10^4 \text{ mm}^4$

Check Defl^n.

$$\delta = \frac{6.8 \times 10^3 \times 1320^3}{48 \times 205000 \times 196.7 \times 10^4} = 0.8 \text{ mm}$$

$$\frac{\text{span}}{\delta} = \frac{1320}{0.8} = 1650 > 360$$ OK.

atelier one

Project BRITISH MUSEUM

No. 1578/8/6

Date 02/07 By CTB

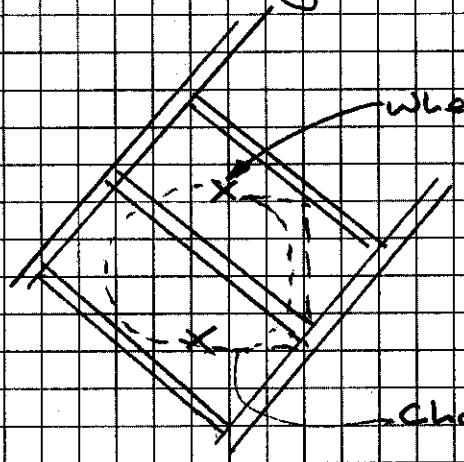
Checked

Notes

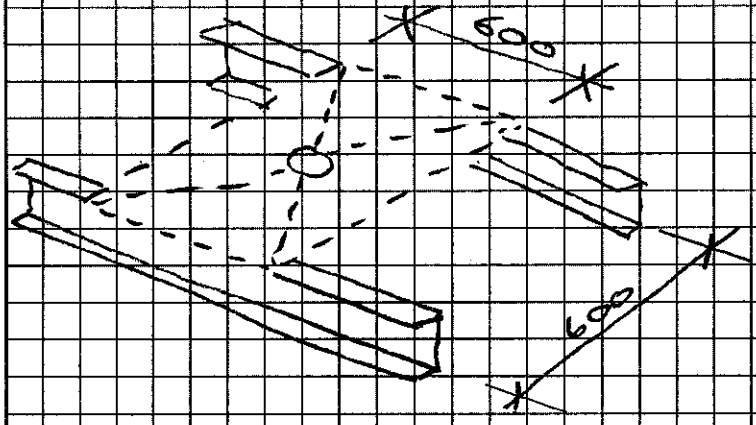
Check Chariot

Wheel load = 531Kg

From exhibition layout & structure overlay :-



Assume following load distribution



$$Z = \frac{bd^2}{6} = \frac{600 \times 25^2}{6} = 62500 mm^3$$

$$M_c = 12.2 \times 62500 = 0.763 kNm.$$

atelier one

Project BRITISH MUSEUM

No 1578/8/7

Date 02/07 By CJB

Checked

Notes

$M_{applied} = \frac{WL}{4} = \frac{5.31 \times 0.6}{4} = 0.80 kNm$.

Note: if ply is continuous over support then $M < \frac{WL}{4} \geq \frac{WL}{6}$

Check defl^n

$I = \frac{bd^3}{12} = \frac{600 \times 25^3}{12} = 781250 mm^4$

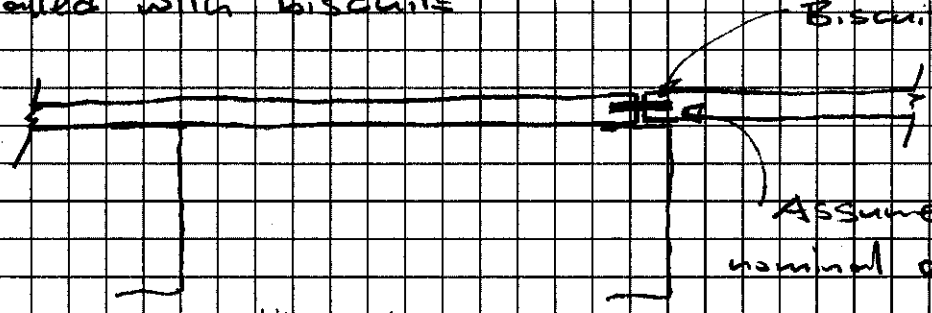
$E = 4745 kN/mm^2$

$\delta = \frac{WL^3}{48EI} = \frac{5.31 \times 600^3}{48 \times 4745 \times 781250} = 6.4 mm$.

If ply is continuous then $\delta = 1.8 mm$.

allowable $= 0.003 \times 600 = 1.8 mm$.

From telcon with contractor, ply to be installed with biscuits



- Add additional PFC's under deck.

atelier one

Project BRITISH MUSEUM

No 1578/818

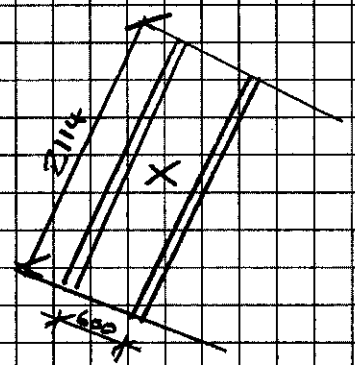
Date 02/07 By CJB

Checked

Notes

INDIVIDUAL WARRIOR

Max wt = 186kg = 1.86kN



CHECK PLY - 25mm thk.

$$M = \frac{wL}{4} = \frac{1.86 \times 0.6}{4} = 0.279 kNm$$

$$Z = \frac{bd^2}{6} = \frac{600 \times 25^2}{6} = 62500 mm^3$$

$$\sigma_{11.6} = 12.2 N/mm^2$$

$$M_c = 62500 \times 12.2 \times 10^{-6} = 0.763 kNm > 0.279 kNm$$ OK.

Check defl.

From previous, $I = 781250 mm^4$, $E = 4745 N/mm^2$

$$\delta = \frac{wL^3}{48EI} = \frac{1.86 \times 10^3 \times 600^3}{48 \times 4745 \times 781250} = 2.25 mm.$$

Allowable = $0.003 \times 600 = 1.8 mm$

atelier one

Project BRITISH MUSEUM

No. 1578/8/9

Date 02/07 By CJB

Checked

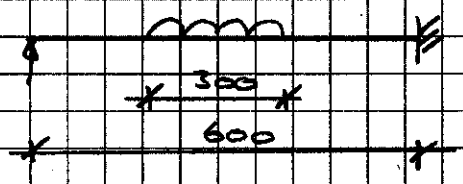
Notes

Re-check,

Min dims of warrior = 300mm wide

Check following

$\frac{1.86}{0.3} = 6.2 kN/m$



From analysis, $\delta = 0.76mm < 1.8mm$ OK.

No addl strengthening reqd.

CHECK 175×65×14PFC

Span = 2.1m.

$M = \frac{wL}{4} = \frac{1.86 \times 2.1}{4} = 0.98kNm < 4.64kNm.$

$\delta = \frac{wL^3}{48EI} = \frac{1.86 \times 10^3 \times 2100^3}{48 \times 205000 \times 196.7 \times 10^4} = 0.89mm.$

$\frac{Span}{\delta} = \frac{2100}{0.89} = 2360 > 360$ OK.

atelier one

Project BRITISH MUSEUM

No. 1578/B/10

Date 03/07 By SJB.

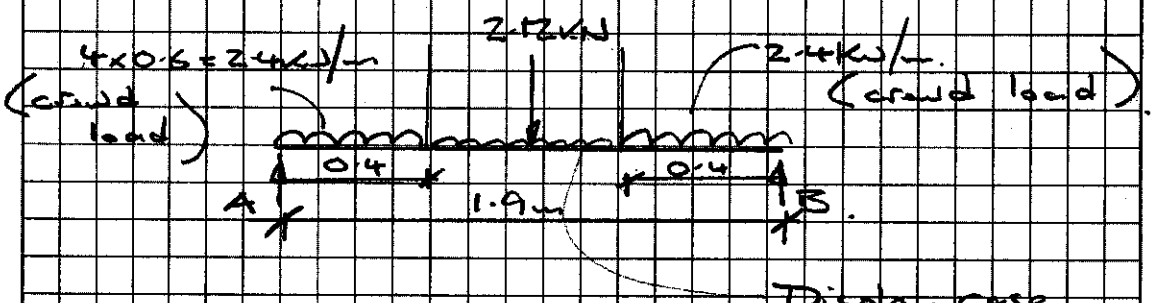
Checked

Notes

BRONZE DWG.

1 No. Bronze bell = 212kg.

Check PFC below,



$$R_A = 2.4 \times 0.4 + \frac{1.0 \times 1.1}{2} + \frac{2.12}{2} = 2.57 kN$$

⇨ midspan.

$$M = 2.57 \times 0.95 - (2.4 \times 0.4 \times 0.75) - \left(\frac{1.0 \times 0.75^2}{2}\right)$$

$$= 1.44 kNm < 4.54 kNm$$

OK.

atelier one

Project BRITISH MUSEUM

No. 1578/B/11

Date 02/07 By CJB

Checked

Notes

CHECK END LOADS

Marking plan shown over →.

Horses

Total wt = 4 × 360 = 1440 kg.

By inspection of overlay, load carried by 2 No. cols = $\frac{1440}{2}$ = 720 kg/col.

- Check Col 1

Load applied, 2 No. horses = 720 kg.

¼ Chariot = $\frac{1061}{4}$ = 265 kg.

restricted access area

= 3.5 × 0.7 + 0.75 × 4.0 = 5.45 m².

Load allowance = 75 kg/m², say.

Total load = 720 + 265 + (75 × 5.45)

= 1393 kg = 13.94 kN

< 30 kN ok.

- Check Col 2

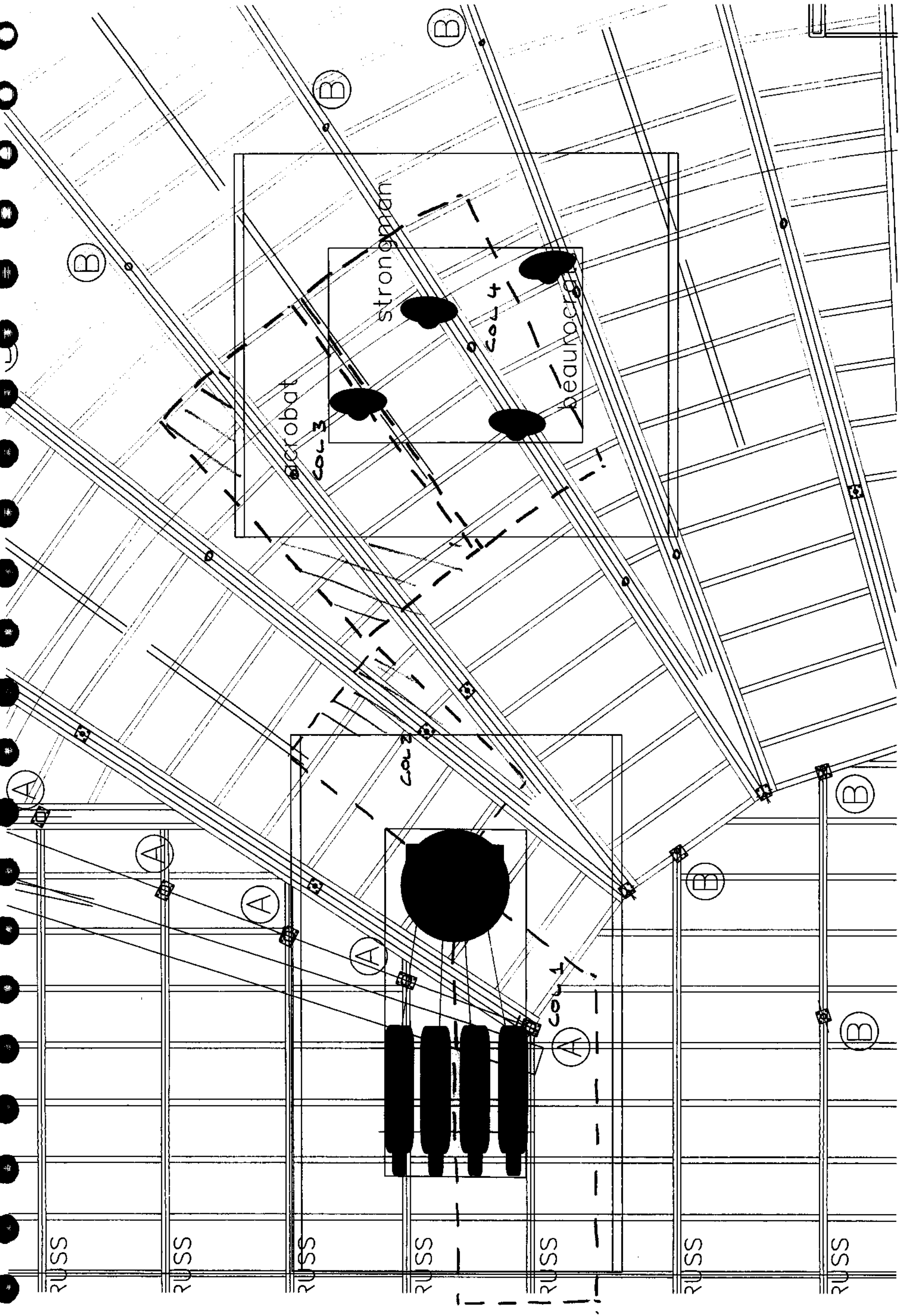
Total area = 1.5 × 2.1 = 3.15 m²

Crowd load = 1.2 × 1.3 × ½ × 400 = 312 kg.

Restricted access area = 3.15 − $\frac{(1.2 \times 1.3)}{2}$ = 2.37 m²

Load allowance = 2.37 × 75 = 178 kg.

COLUMN MAKING PLAN 1578/8/12



atelier one

Project BRITISH MUSEUM

No. 1578/B/13

Date 02/07 By CJS

Checked

Notes

$\frac{1}{4}$ Chariot = $\frac{1061}{4}$ = 265kg.

Total load = 312 + 178 + 265 = 755kg

= 7.5kN < 30kN OK.

- Check Col 3

Total area = 2 × 3.2m = 6.4m²

Crowd load area = 1.5 × 1.1 + 1.2 × 1.3

= 3.21m².

Restricted access area = 6.4 − 3.2 = 3.2m².

Crowd load = 3.2 × 400 = 1280

Restricted access load = 3.2 × 75 = 240

1 No. warrior = = 186kg

1706kg

= 17kN < 30kN OK.

- Check Col 4

Total area = 2 × 3.2 = 6.4m²

Restricted access load = 6.4 × 75 = 480kg.

2 No. warriors = 2 × 186 = 372kg

852kg

= 8.5kN < 30kN OK.

Find Loads OK under exhibition Loads