APPENDIX B

Design Parameters for Round Reading Room Platform

February 2007

PROJECT
British Museum Round Reading Room

CLIENT
The British Museum

ARCHITECT
Purcell Miller Tritton

ENGINEER
Atelier One
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London
W1T 4SB

atelier one

1.0 Introduction

The First Emperor exhibition will display the terracotta warriors in a raised stage in the British Museum Reading Room. The stage will be elevated above the existing furniture, causing minimum interference to the Reading Room.

This report will assess the feasibility of building a flat raised floor with perimeter wall and overhead lighting in the British Museum Reading Room. Particular attention has been paid to ensuring that the existing structure is not compromised in any way.

The proposed exhibition is described in figure 1.0.1, and the following attached drawings.

1578_100_GA PLAN

1578_101_GA SECTION

1578_113_TYPICAL CORRIDOR

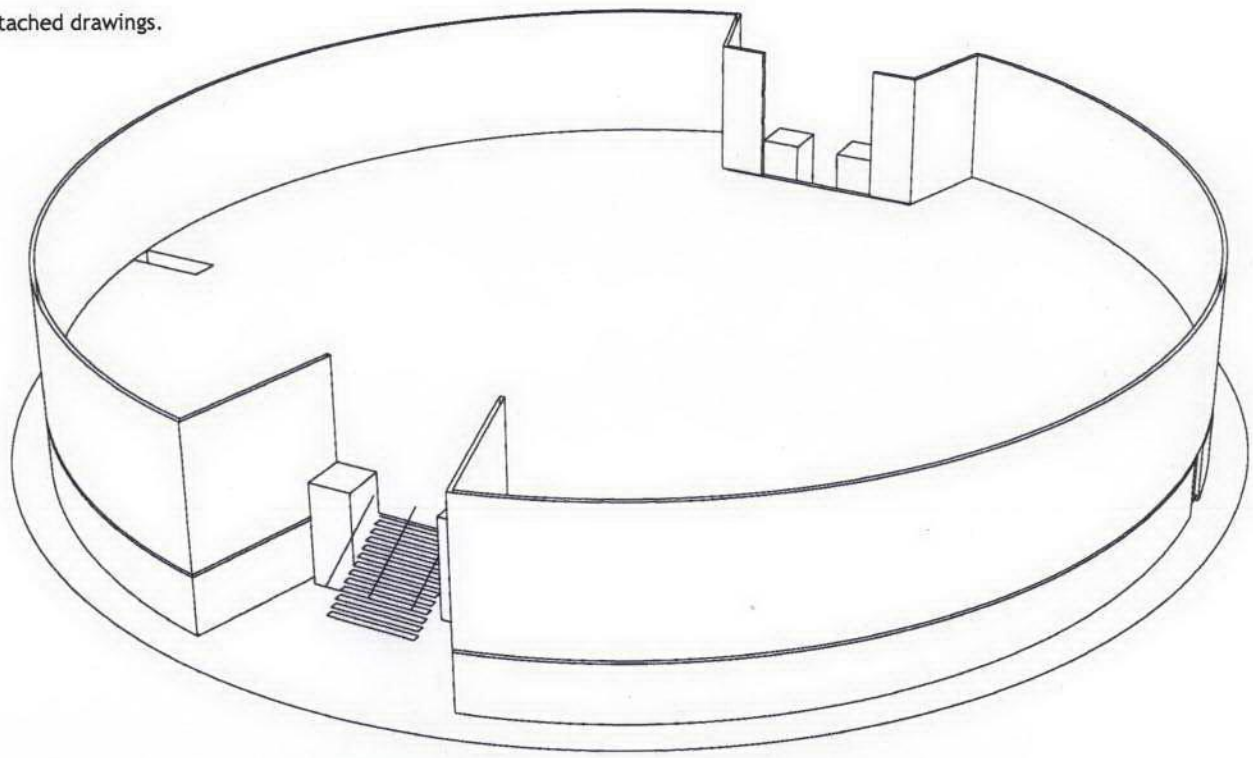
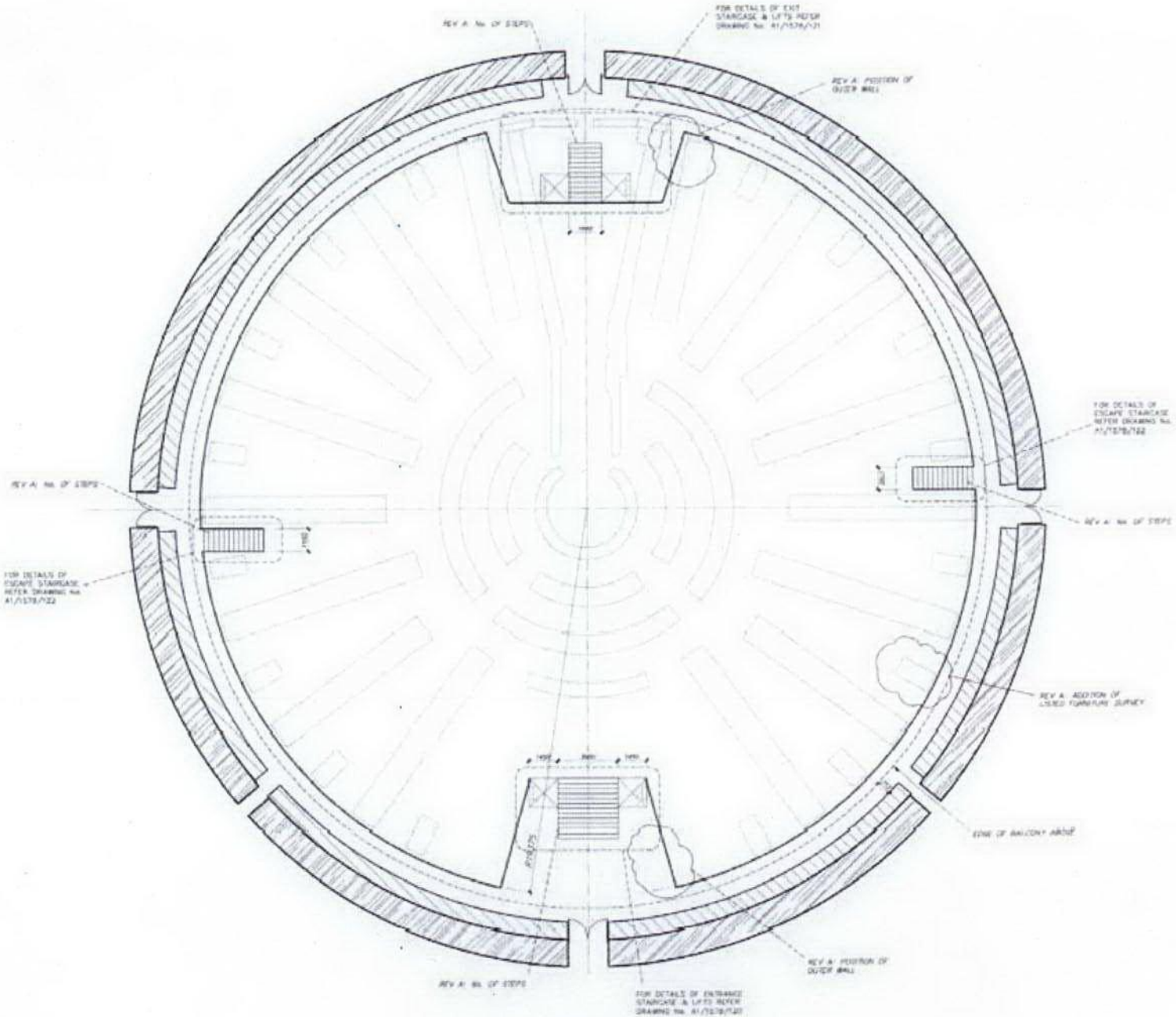


Figure 1.0.1
Proposed exhibition



GA DECK PLAN

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5. This drawing to be read in conjunction with architectural and various engineer's drawings and associated others' drawings.

PRELIMINARY

'B' X/X/06 - DWG No. CHANGED FROM 1578/121 TO 1578/100

'A' 06/10/06 - GENERAL REVISIONS

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PMT

BRITISH MUSEUM

GA
DECK PLAN

SEPT 2006 1:100 @ A1

A1/1578/100 B

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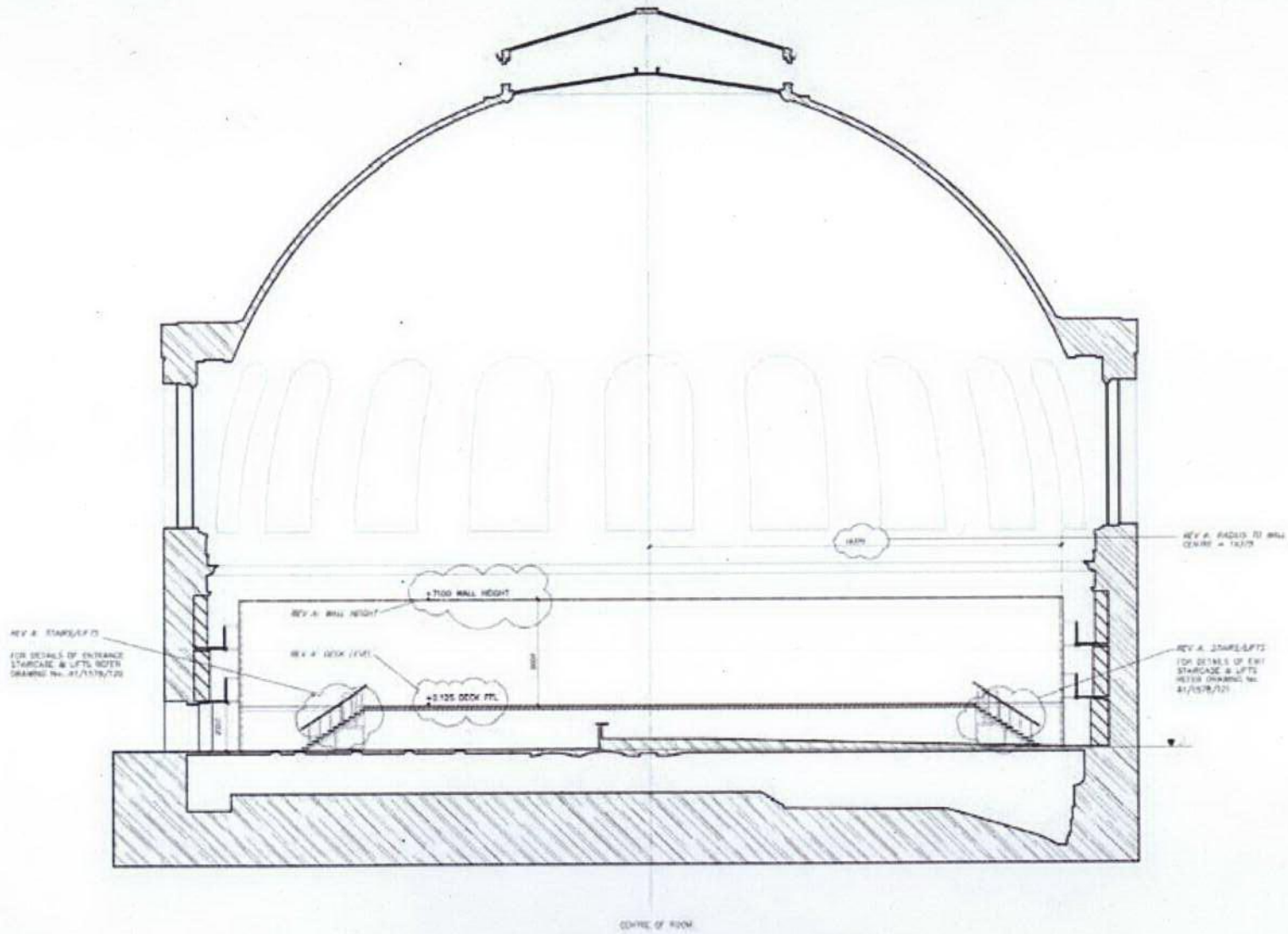

GA SECTION

PRELIMINARY

'B' - X/X/04 - DRC No. CHANGES FROM 1578/100 TO 1578/101

'A' - 06/10/04 - GENERAL REVISIONS

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GA SECTION

SEPT 2004 1:100 @ A1

A1/1578/101 B

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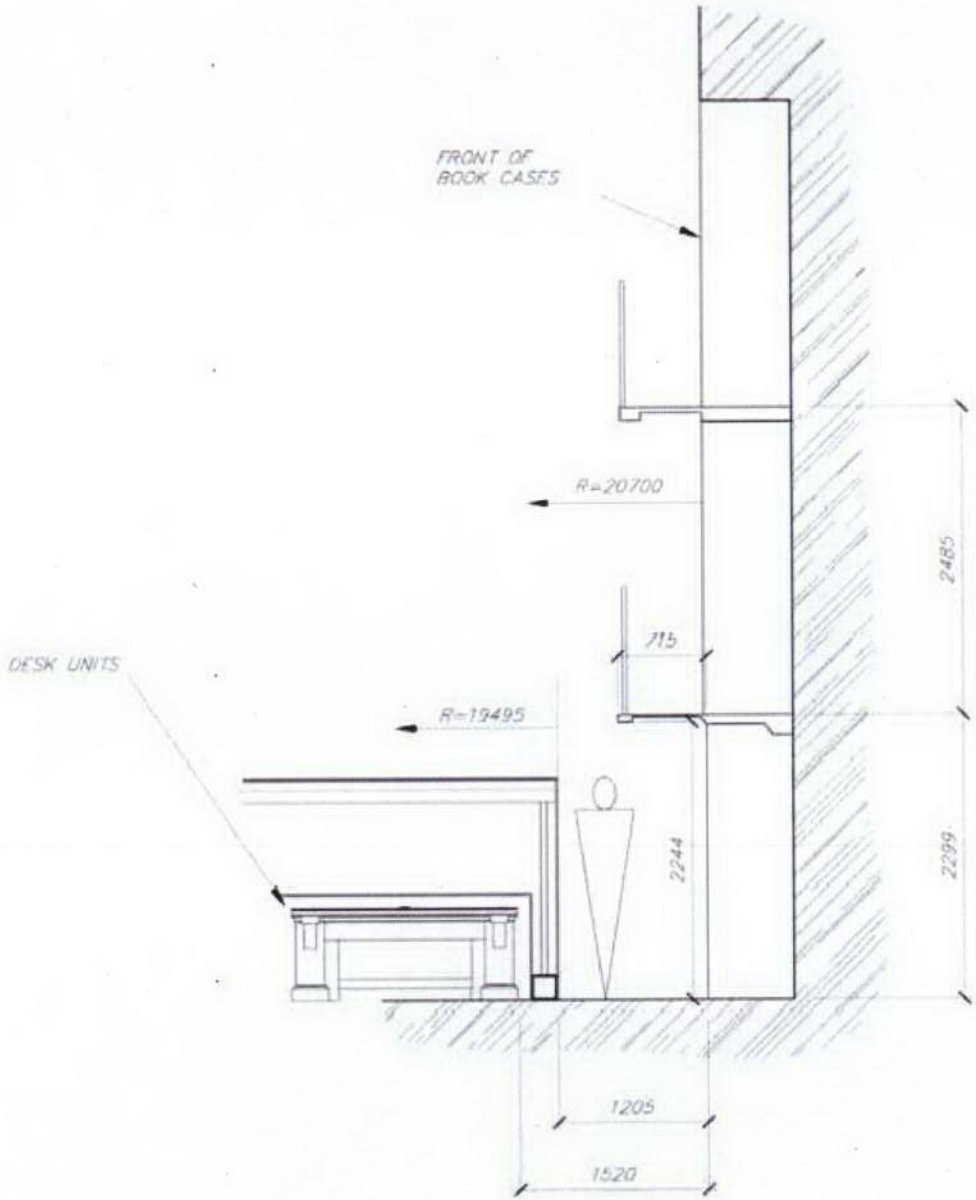

PREMLININARY

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BRITISH MUSEUM

BRITISH MUSEUM

TYPICAL CORRIDOR

SEPTEMBER 2006 NOT TO SCALE

A1/1578/113

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2.0 Existing Building

2.1 Description of existing building

The existing Reading Room is formed from an enclosure approximately 42m in diameter.

The ground floor is supported on a series of radial walls at basement level. These sleeper walls then support brick vaults/ arches which taper towards the centre of the space.

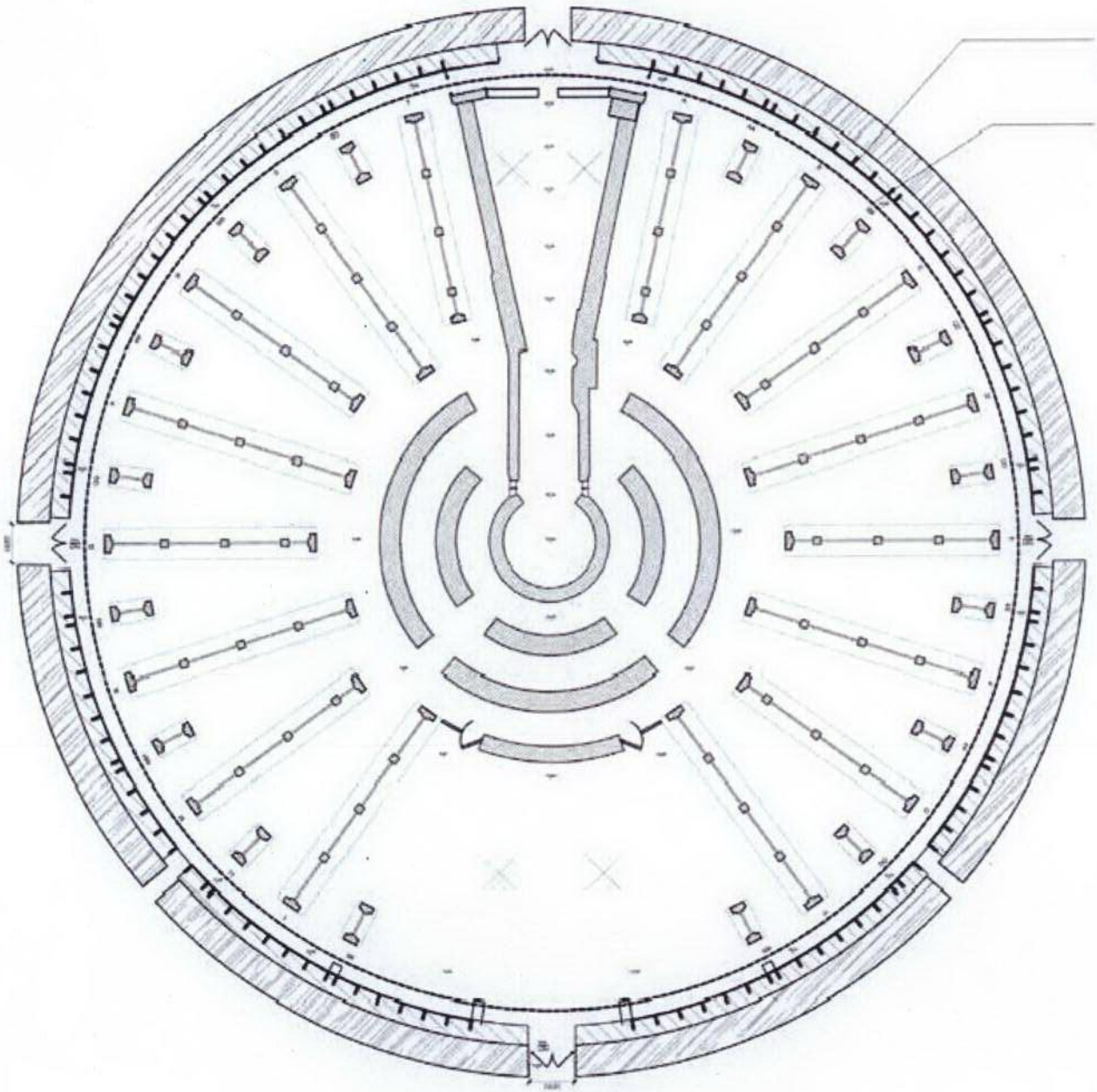
The Reading Room floor above the arches consists mainly of mass concrete (Portland cement) with a screed finish. However, underneath the raised podium and ramp the mass concrete does not exist and stone pavers span between the extended sleeper walls. The desks within the Reading Room are also arranged radially and align with the basement structure. The alignment was designed for load carrying but also to aid the services/ environmental strategy. The air conditioning supplied from the basement is distributed up through the floors and from the desks.

The basic arrangement of ground, basement and relationship to the furniture/desks are as shown in the following drawings.

2.2 Drawings of existing building

The basic arrangement of ground floor, basement and relationship to furniture/desks.

1578_001_GROUND FLOOR LAYOUT
1578_002_BASEMENT LAYOUT
1578_003_GROUND BASEMENT OVERLAY
1578_004_TYPICAL SECTION
1578_211_LISTED FURNITURE
1578_011_CUTAWAY ISOMETRIC GROUND
1578_012_CUTAWAY ISOMETRIC BASEMENT



EXISTING GROUND LAYOUT

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EXISTING LAYOUT
GROUND FLOOR

A1/1578/001 A

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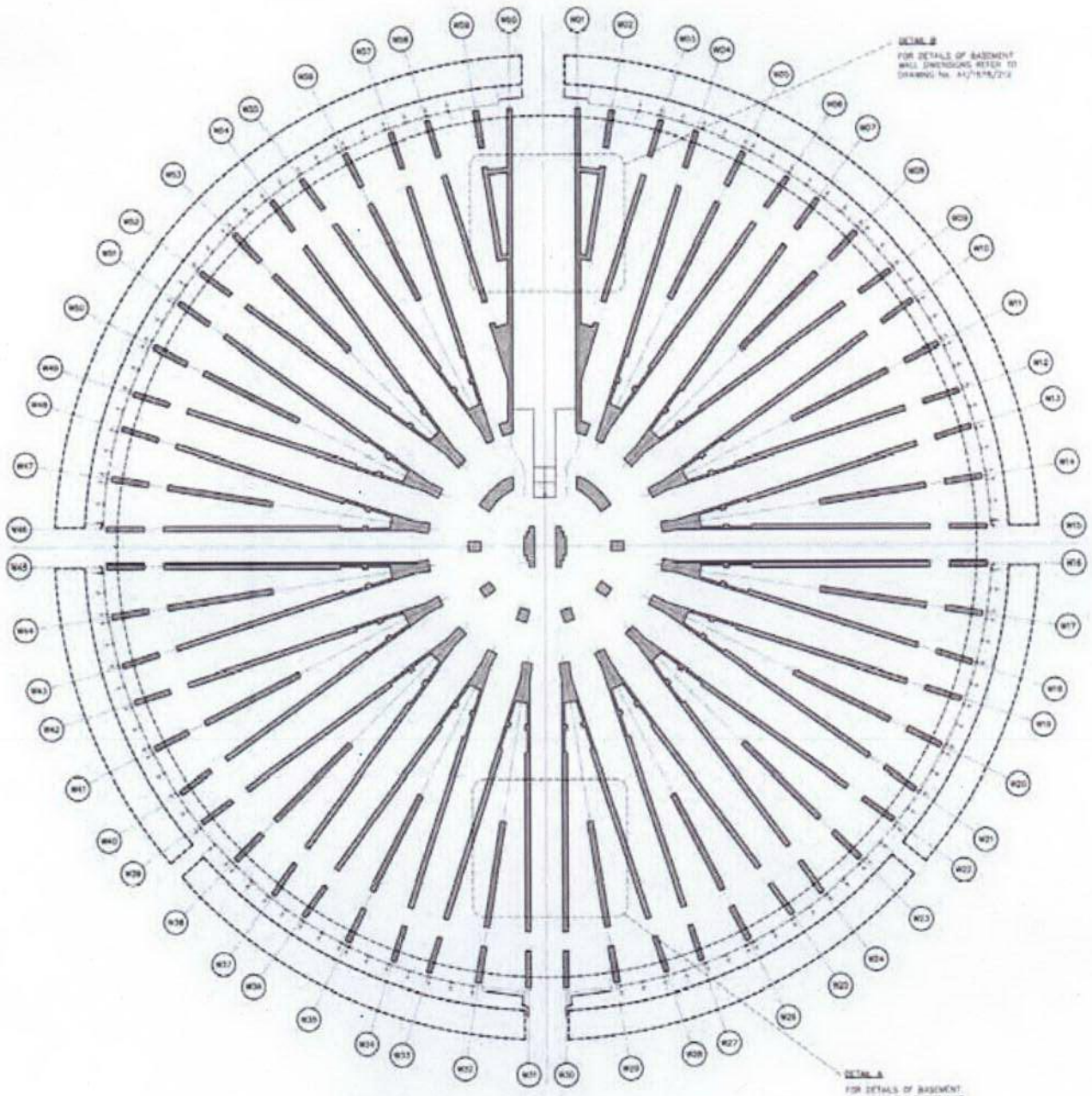

EXISTING BASEMENT LAYOUT

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A

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EXISTING LAYOUT
BASEMENT FLOOR

A1/1578/002 A

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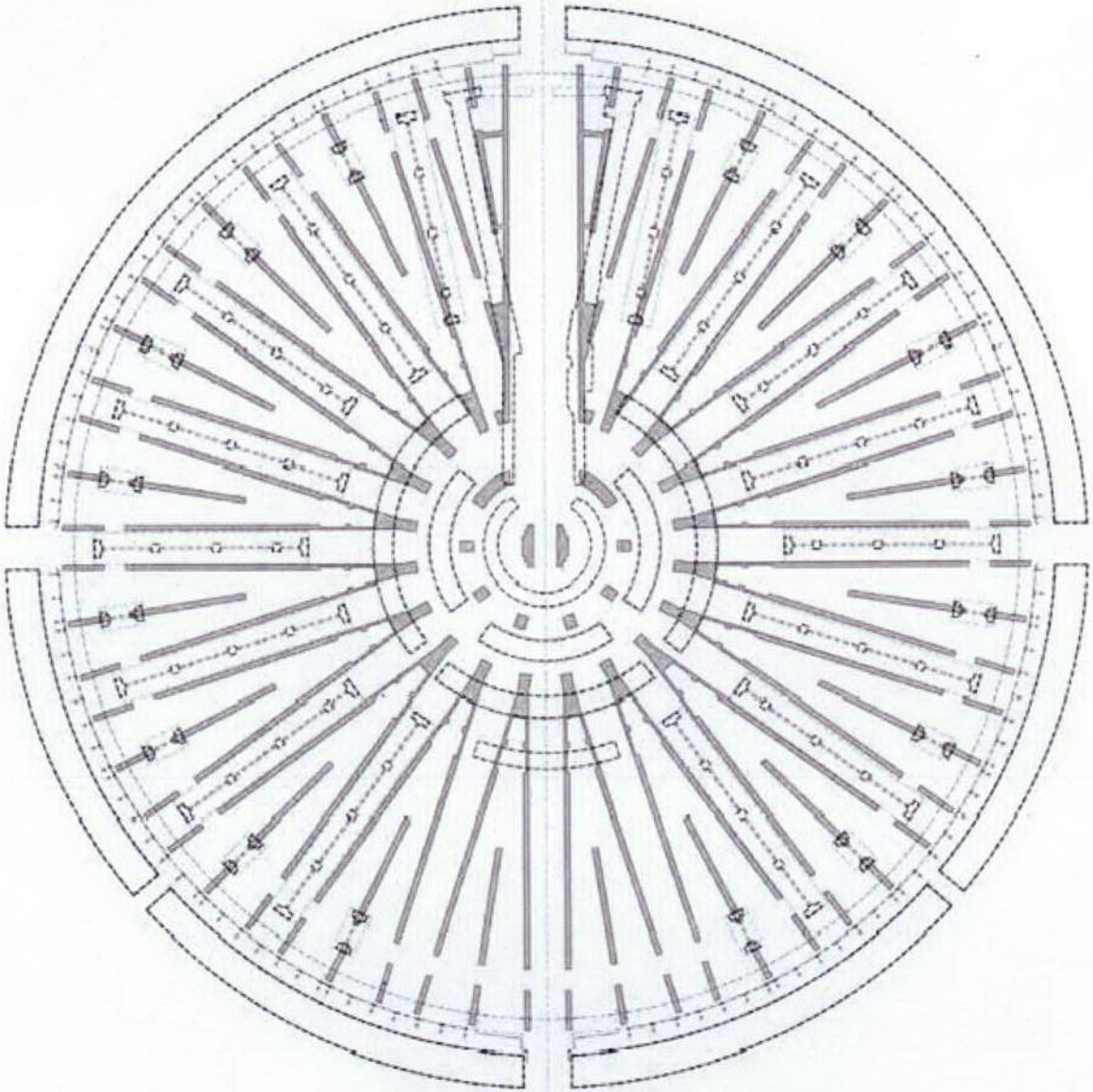

EXISTING GROUND/BASEMENT OVERLAY

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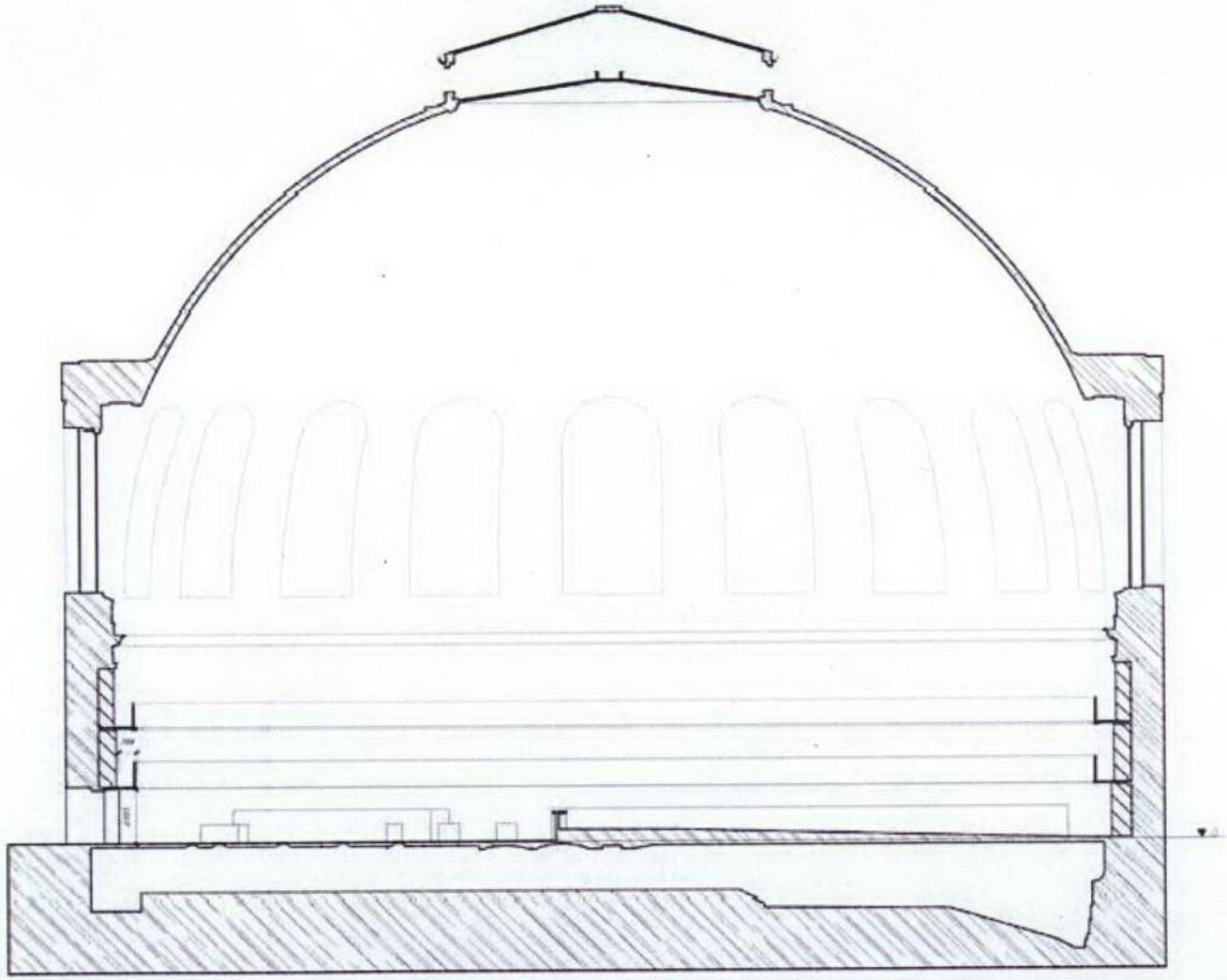
BASEMENT/GROUND OVERLAY

A1/1578/003 A



EXISTING GROUND LAYOUT

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EXISTING LAYOUT SECTION

SEPTEMBER 2006 1:100 @ A1

A1/1578/004

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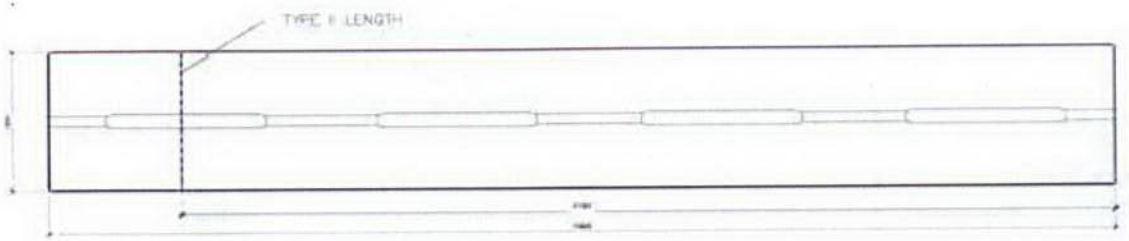
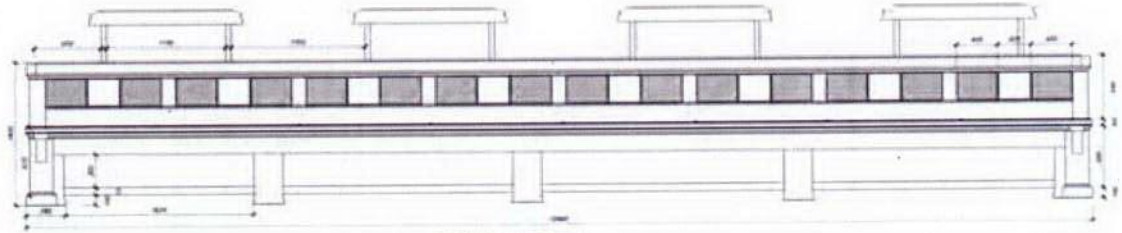
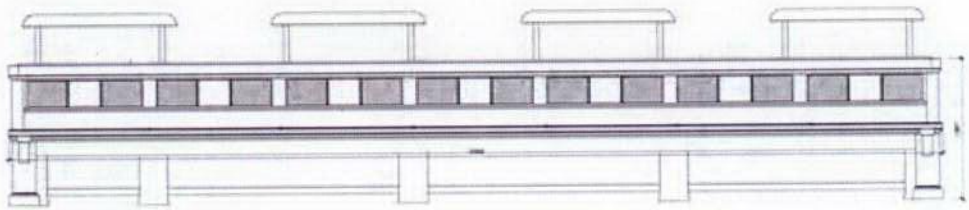




DESK TYPE I



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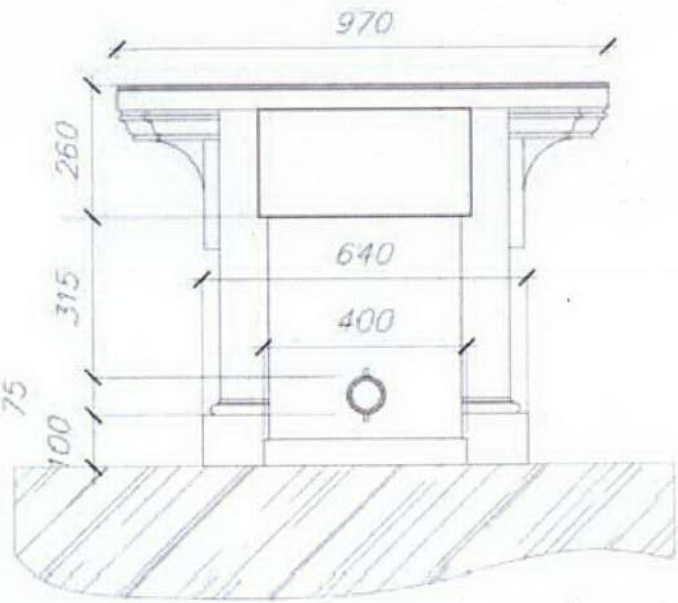
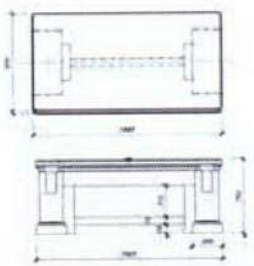


DETAIL A DESK TYPE III

DETAIL A



DESK TYPE III

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EXISTING LAYOUT
LISTED FURNITURE

SEPT 2006 1:20

AC

A1/1578/211

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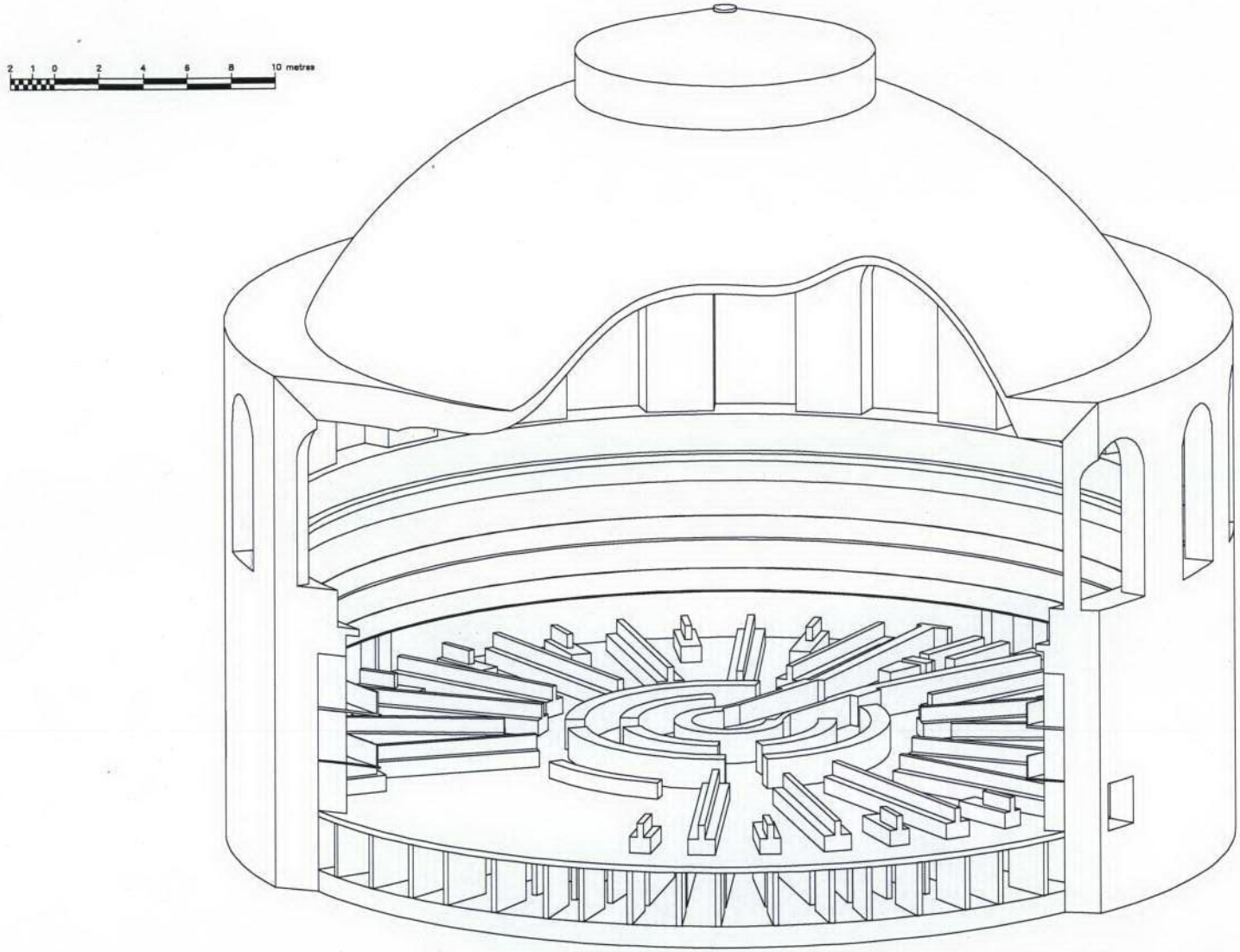

CUTAWAY ISOMETRIC OF EXISTING

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5. This drawing to be read in conjuction with architectural and service engineer's drawings and associated atelier one drawings.

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Client BRITISH MUSEUM

Architect

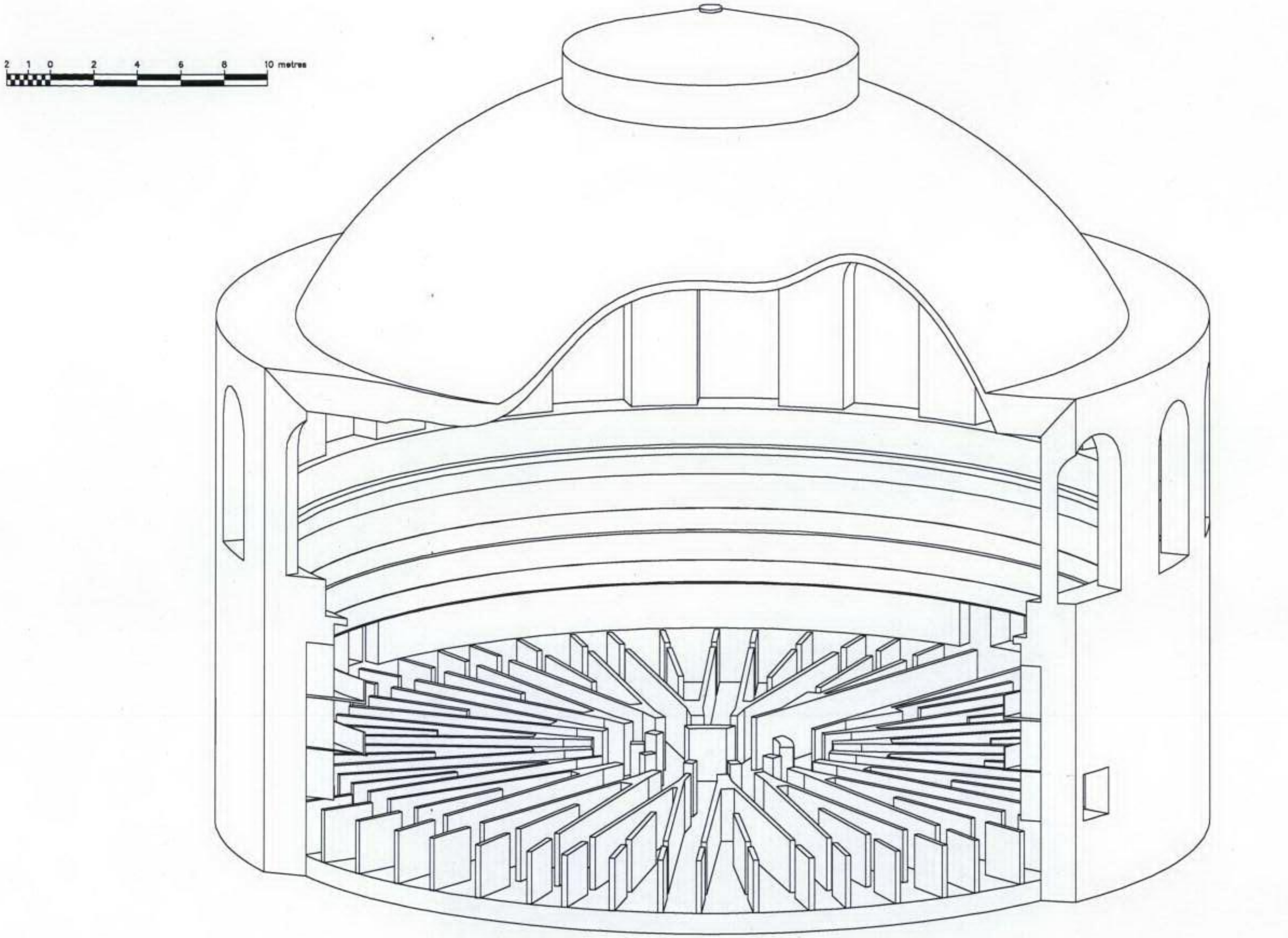
Project BRITISH MUSEUM

Title EXISTING LAYOUT CUTAWAY ISOMETRIC

Date APRIL 2006 Scale 1:100 @ A1

Drawn by R.A.B. Checked Rev

Drawing No A1/1578/011



CUTAWAY ISOMETRIC OF EXISTING
(GROUND FLOOR OMITTED)

Notes
1. This drawing must not be used for construction or installation purposes unless expressly stated.
2. Do not scale off this drawing. Always work to noted dimensions.
3. All dimensions must be verified on site before completing shop drawings and setting out the work.
4. This drawing to be read in conjunction with the technical specification and associated schedules prepared by atelier one.
5. This drawing to be read in conjunction with architectural and service engineer's drawings and associated atelier one drawings.

Rev Date Revision

atelier one

Client: BRITISH MUSEUM
Architect:
Project: BRITISH MUSEUM
Title: EXISTING LAYOUT CUTAWAY ISOMETRIC
Date: APRIL 2006 Scale: 1:100 @ A1
Drawn by: R.A.B. Checked:
Drawing No: A1/ 1578/012 Rev

2.3 Study of building capacity by Alan Baxter Associates

A study of the existing building has been carried out by Alan Baxter and Associates to ascertain the issues involved with general loading allowance in the building. The study details the basement and ground floor structure and the presumed load capacity based on historical research.

Based on consideration of this structure, and historical floor loads in the Reading Room, Alan Baxter and Associates suggest that the floor should not undergo a distributed load of any more than 6kN/m² anywhere. Owing to the shallowness of the arched vaulting, point loads can cause great instability. This considered, no point loads greater than **3kN** should be allowed on anywhere without a load bearing wall underneath. During design development this point must be considered very carefully because there maybe conditions when this load might be exceeded. High point loads can be taken down onto the load bearing walls. A limit of **30kN** is suggested for any point loads on load bearing walls. The tables cannot be removed as they are grade 1 listed; only the light element on the top can be disconnected.

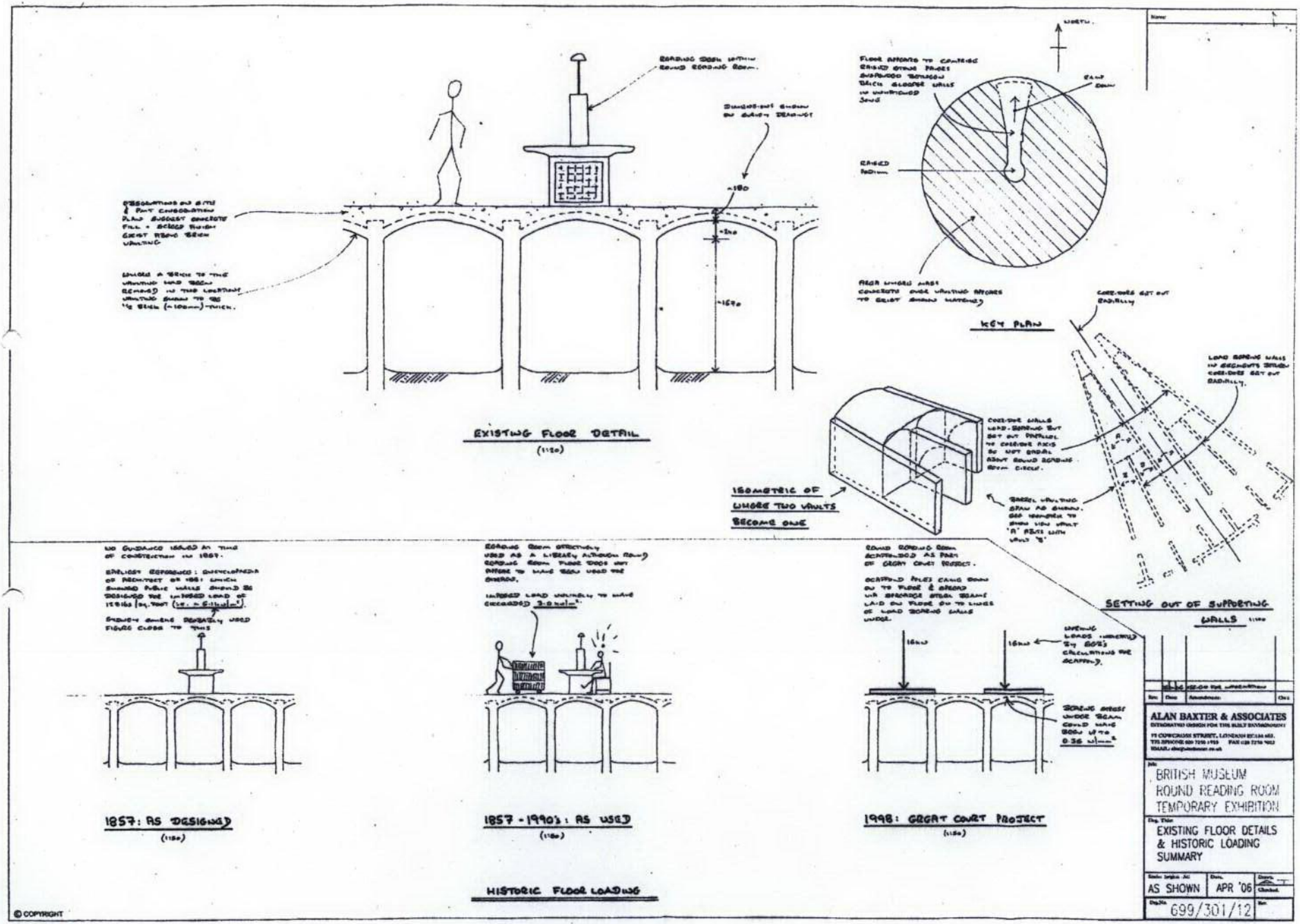


Figure 2.3.1
Existing floor details and historic loading summary.

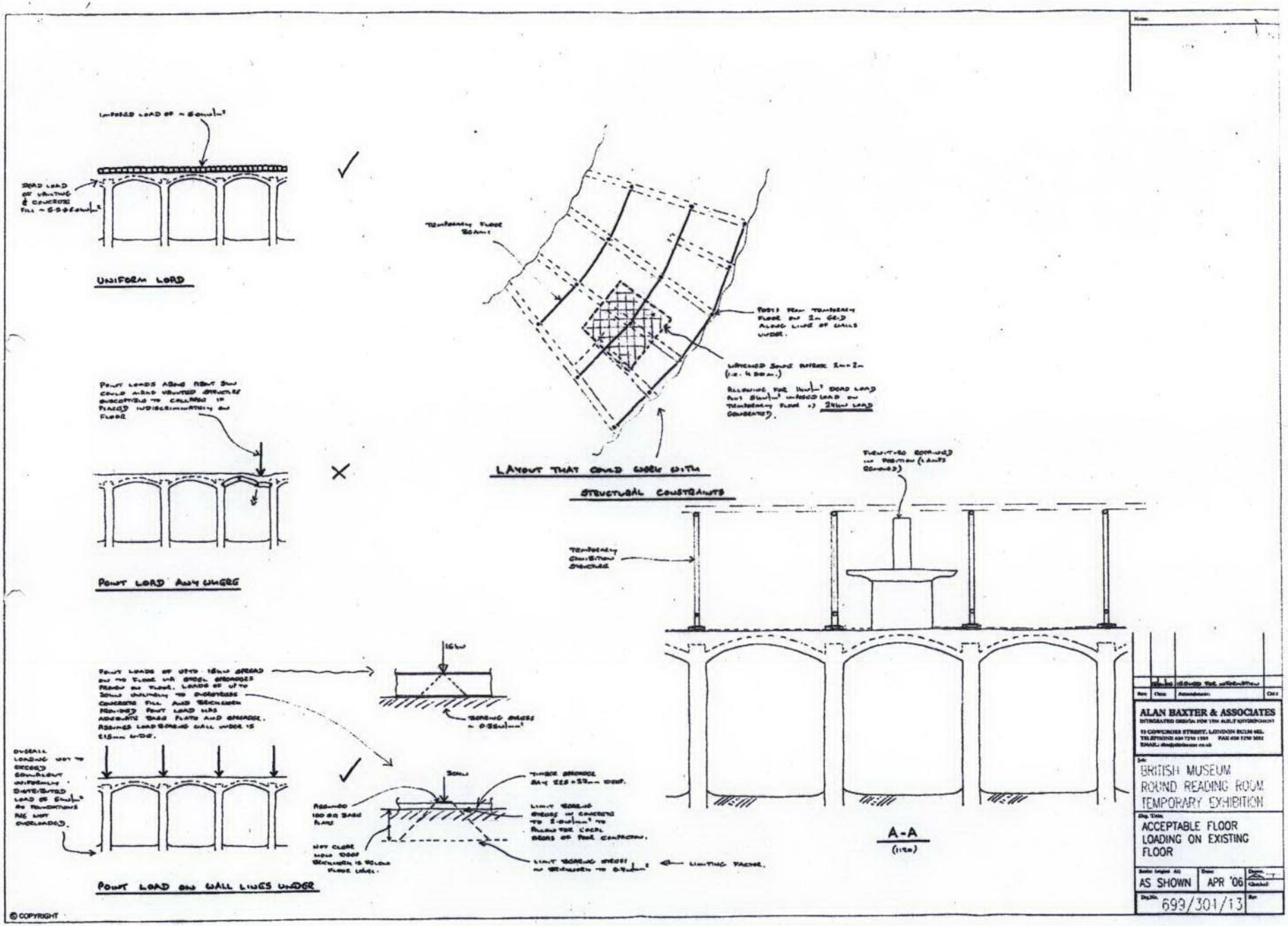


Figure 2.3.2
Acceptable floor loading on existing floor.

2.4 Specific loading restrictions

The restrictions placed on the loading of the keyhole ramp area are illustrated in the referenced drawing overleaf.

Further information is required before committing to construction around the keyhole

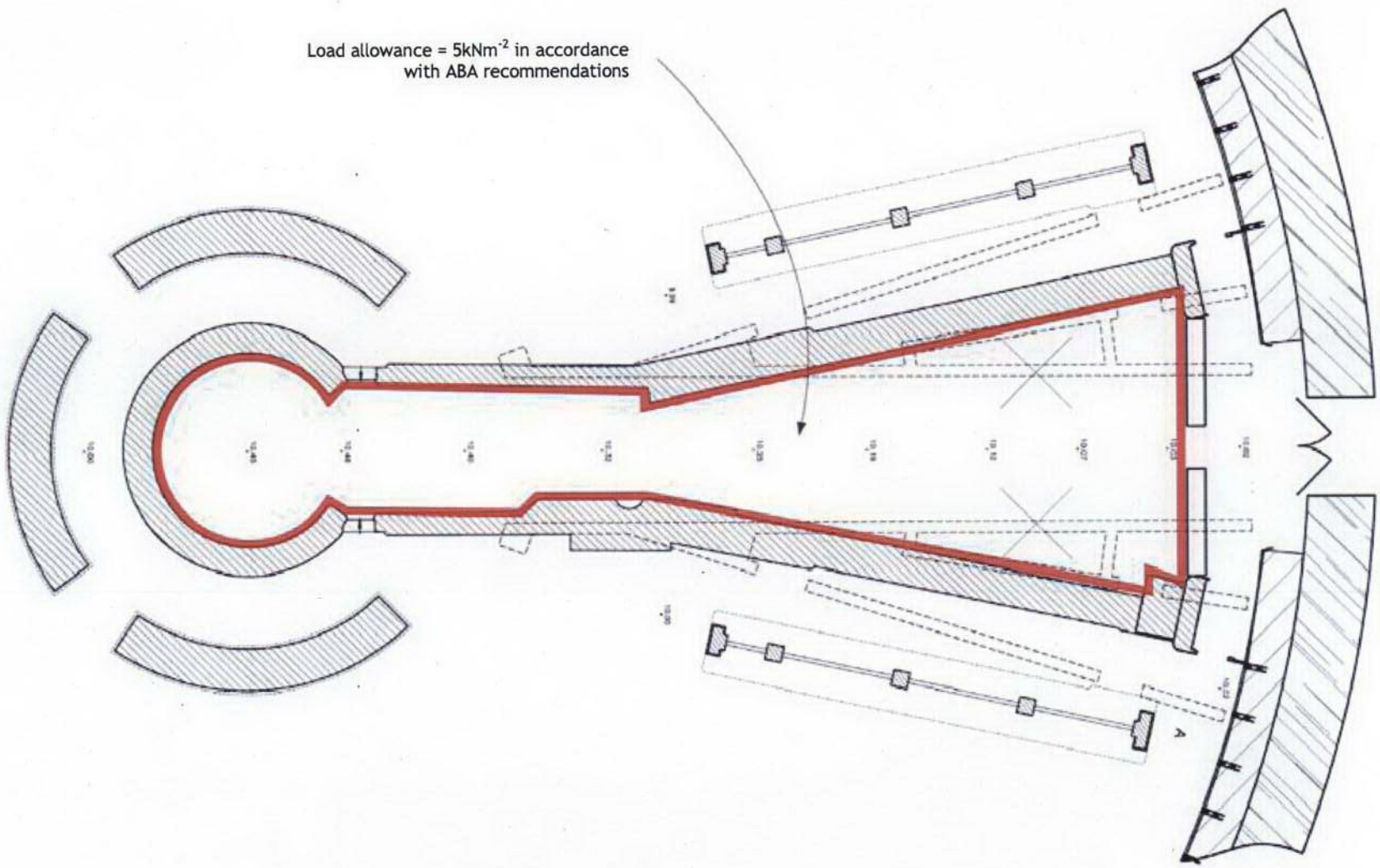


Figure 2.5.1
Keyhole loading restrictions

2.5 General considerations for the exhibition

Many of the load bearing walls are too close to the existing tables to allow a direct load path. In this case sections will be used to transfer the load onto the walls underneath the tables.

It is of paramount importance that the Reading Room remains unharmed from this exhibition. Thus, all of the fixed tables will be protected by means of plywood boxing and the floor will be covered in a 25mm plywood protective layer.

The access to the Reading Room is through double doors measuring a minimum 1630mm and maximum 1930mm in width. The structural parts must be able to be taken through these doors and assembled. The defined limit of load is to be confirmed.

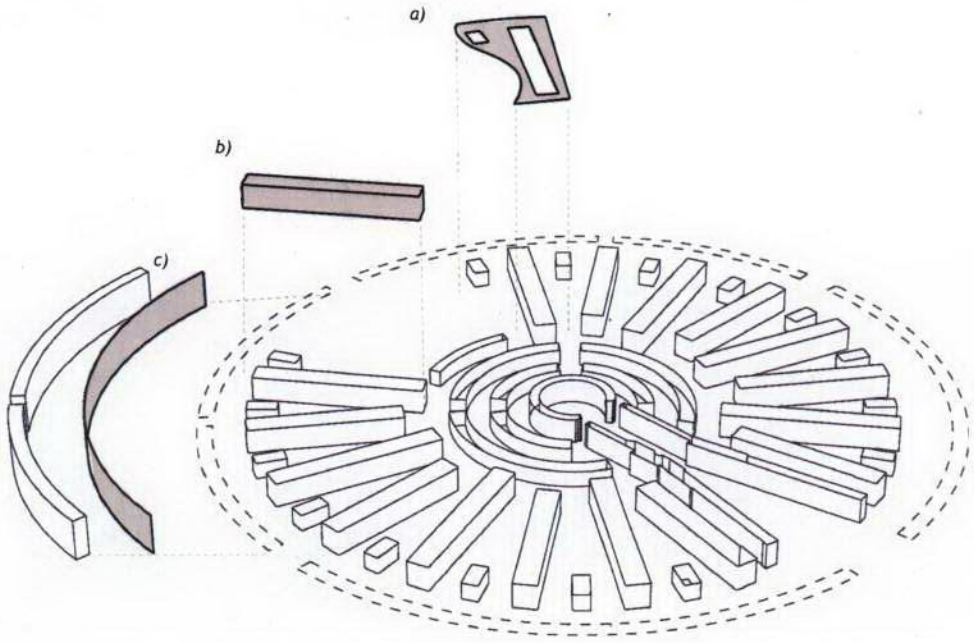


Figure 2.5.2
Indicative Isometric view showing protected areas

a) plywood protection for entire floor
b) plywood boxes for all listed furniture
c) plywood facing on ¼ of perimeter bookcases as shown

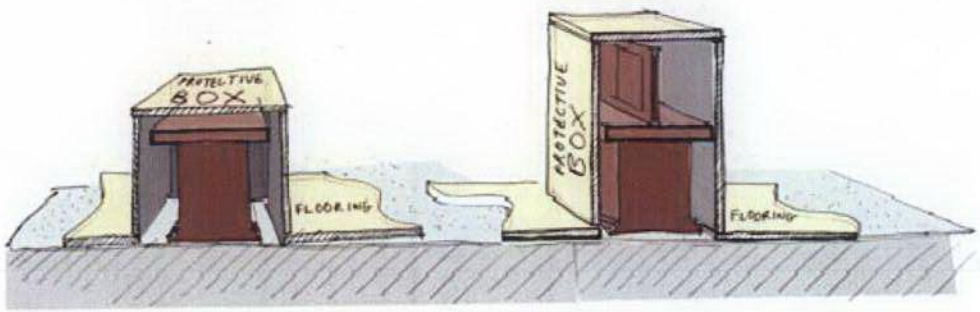


Figure 2.5.3
Strategy for protection of boxes

3.0 Structural Key

To utilise the capacity of the ground floor and substructure the proposed super structure has to place loads over as much of the existing supporting structure as equally as possible. The principle therefore is to create a transfer structure at floor level which distributes the load of the exhibition, exhibition deck and public into the radial walls beneath.

Certain key criteria have to be considered in configuring the structure.

1. No significant point loads are permissible away from sleeper walls.
2. Any loading should sit over areas as close to the existing basement sleeper walls as possible: refer to Alan Baxter report.
3. **No** support should be taken at mid span of the barrel arches as this could lead to instability.

The following diagrams endeavour to in corporate a structure for the exhibition deck within the existing desks/furniture and then transfer loads directly to the basement sleeper walls.

In an attempt to utilise as much of the capacity of the building as possible the distribution steel transfers loads to **all** radial walls. This is then combined with a deck structural grid, different from that of the structural walls but rationalised to keep costs of the proposed structure to a minimum.

The maximum allowable load as currently specified is 6kN/m². Considering the layout of the walls, this equates to 12kN/m run of the wall (i.e. 6kN/m² x 2m).

See right for the distribution principle.

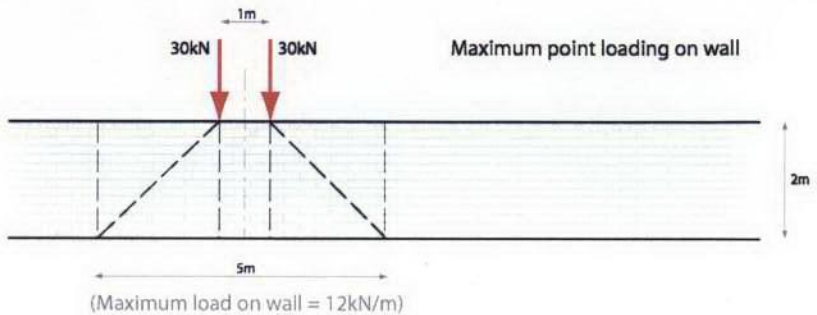


Figure 3.0.1a
Maximum load on wall

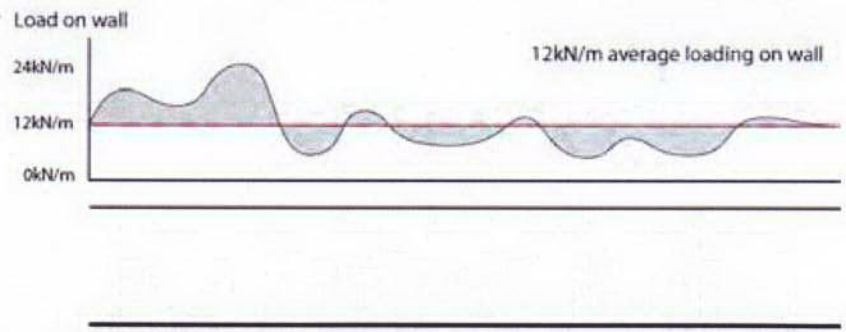


Figure 3.0.1b
Variable point loads permissible within 6kN/m² limitation.

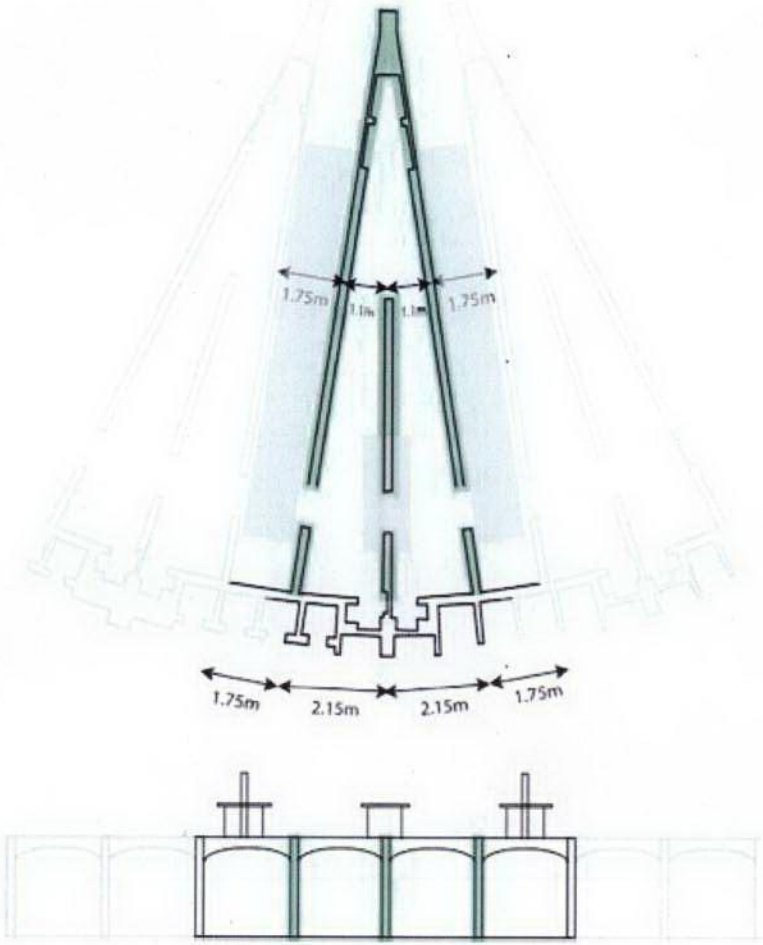


Figure 3.0.2
Typical radial bay substructure

To load all basement walls whilst maintaining desk locations it is necessary to utilise distribution steel at ground level.

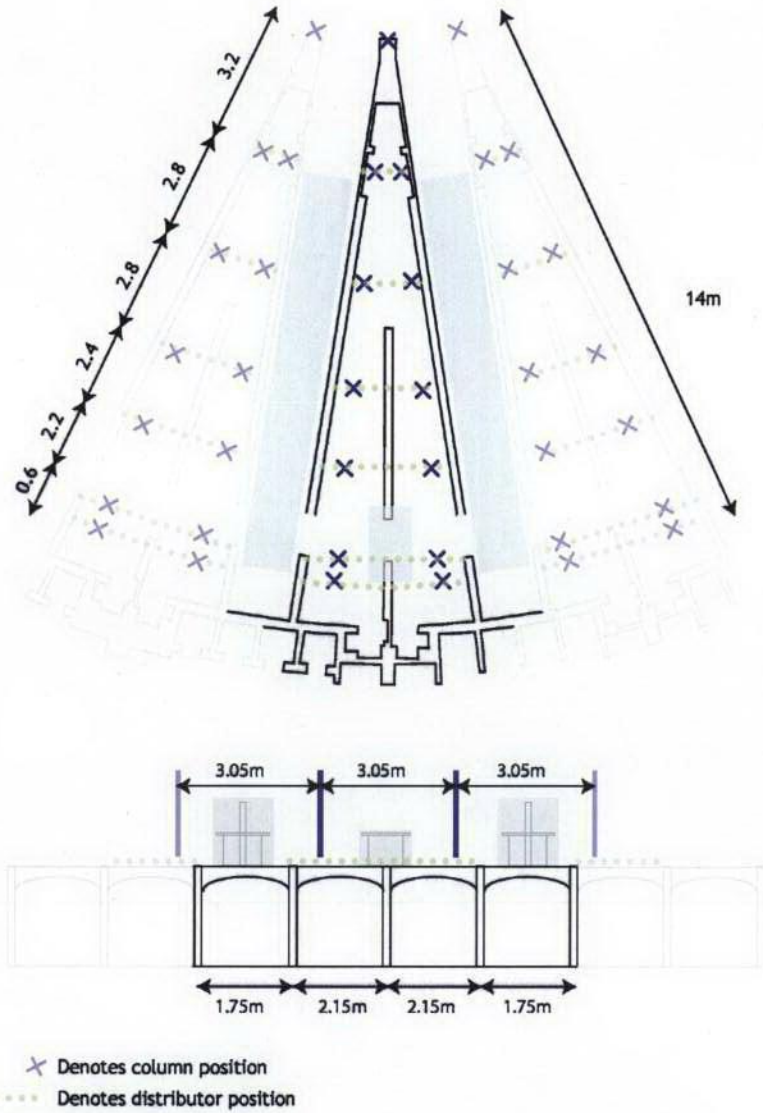


Figure 3.0.3
Column layout

The columns positions are staggered in order that each column maintains an approximately equal area over which its load can be considered to be distributed.

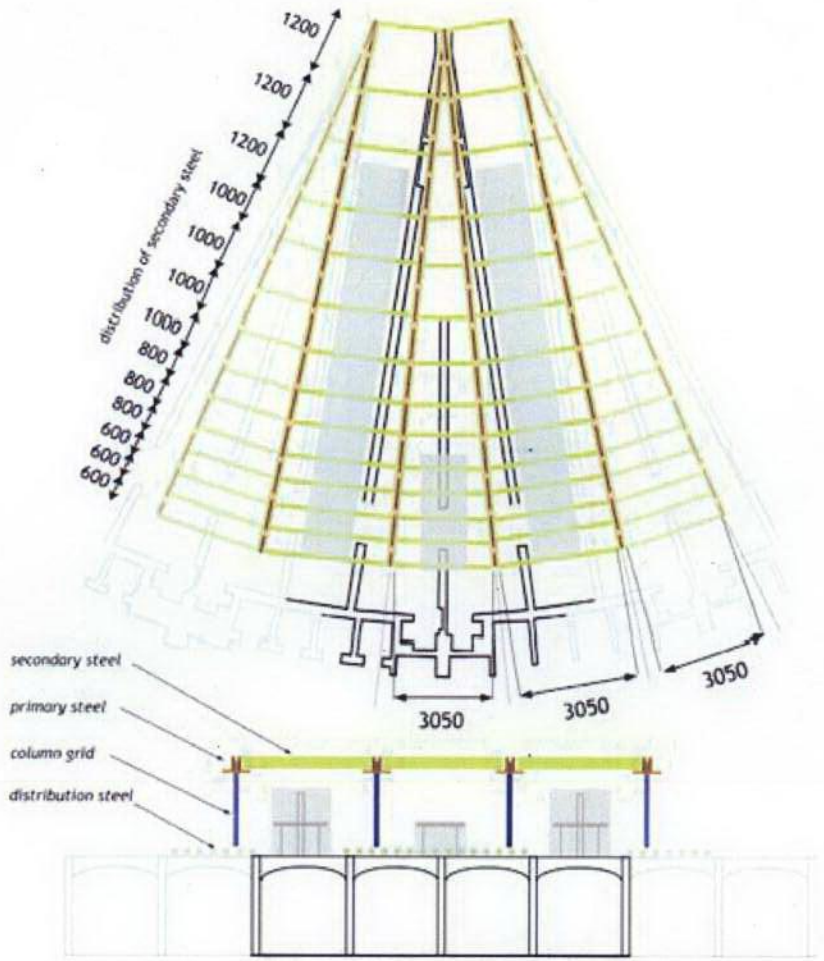


Figure 3.0.4.
Structural section

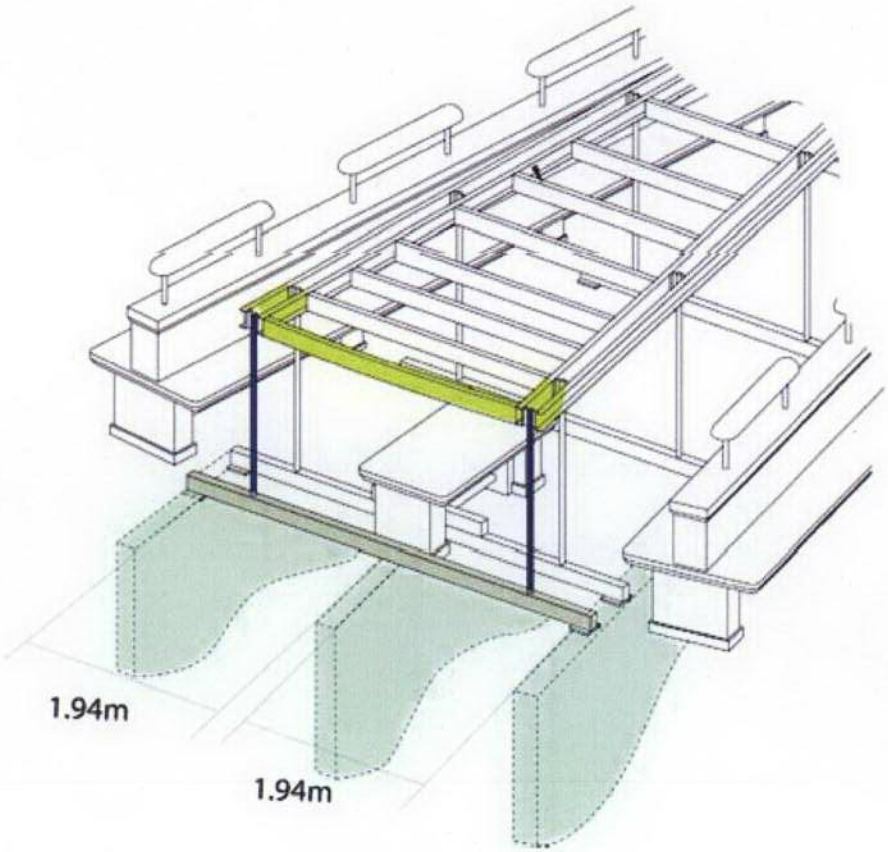


Figure 3.0.5.
Structural principle

The distribution steel then allows a uniform radial spacing of the primary steel above.

4.0 Proposed structure

Please refer to the following drawings which describe the proposed exhibition structure.

1578_102_DECK STEELWORK LAYOUT
1578_103_SPREADER BEAM LAYOUT
1578_104_TYPICAL BAY LAYOUT
1578_105_TYPICAL FLOOR PANEL DETAILS
1578_106_DECK LEVEL WALL LAYOUT
1578_107_TYPICAL WALL PANELS-STUDWORK
1578_120_ENTRANCE STAIRCASE AND LIFTS
1578_121_EXIT STAIRS AND LIFTS
1578_122_ESCAPE STAIRS AND TYPICAL TREAD DETAIL
1578_123_ISOMETRIC VIEW
1578_124_ISOMETRIC VIEW ON DECK STRUCTURE
1578_125_CONSTRUCTION SEQUENCE - SHEET 1
1578_126_CONSTRUCTION SEQUENCE - SHEET 2
1578_127_KEYHOLE STRUCTURE
1578_128_STRUCTURE AT ENTRANCE AND EXIT STAIRS
1578_129_LIGHTING MASTS
1578_130_CROSS SECTIONS A-A TO C-C
1578_214_GA LIGHTING OPTIONS
1578_131_DECK LEVEL WALL LAYOUT
1578_132_FABRIC WALL TYPICAL PANEL
1578_133_FABRIC WALL STAIRCASE ZONES
1578_134_FABRIC WALL ISOMETRIC VIEWS
1578_135_KEYHOLE TRUSSES

5.0 Overall loading assessment

The loading is broken down as shown:

Please refer to calculations for loading assessment of these areas

- Overhead lighting and support
- Deck level perimeter wall and handrail
- Deck, superstructure and ground level perimeter wall
- Staircases and lifts
- Services and plant at ground level

5.1 Furniture protection

5.2 Exhibition loads

5.3 Installation loads

5.4 Self weight

5.5 Imposed loads

5.6 Loading summary

The loads will be distributed by the grid as described on the previous pages.

The floor area of the exhibition is a circle of diameter 19.48m. This figure is the maximum floor available which provides clear access for disabled uses in the entrance corridor.

The columns are equally spaced at 3.05m at the perimeter edge.

5.1 Floor and furniture protection

The desks will be protected with plywood boxes. Each long table plywood box weighs approximately **475kg**.

The floor will be covered by 25mm ply, a loading of **15 kg/m²**.

5.2 Exhibition Loads

Notes on Exhibition Design

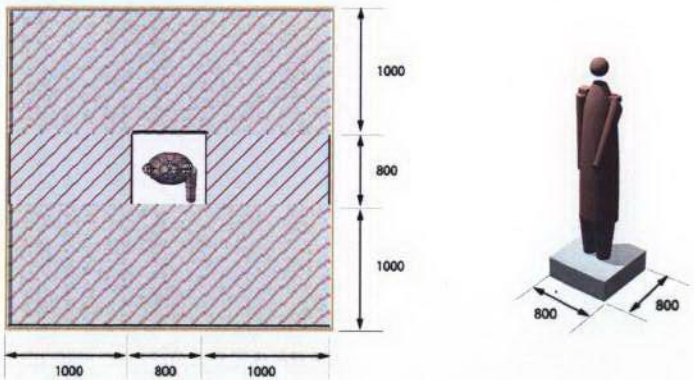
Exhibition design in accordance with Metaphor design, See figure 5.2.4 - Draft plan with main circulation path.

The heaviest object in the exhibition will weigh **1061kg**

The exhibition must be arranged so that the applied load does not exceed **4kNm^{-2}**
Each heavy exhibit must therefore be surrounded by an unloaded exclusion zone so that the net applied load is less than 4kNm^{-2}. The following calculations illustrate the derivation of required areas.

Object Display

Figure 5.2.1 Single object display



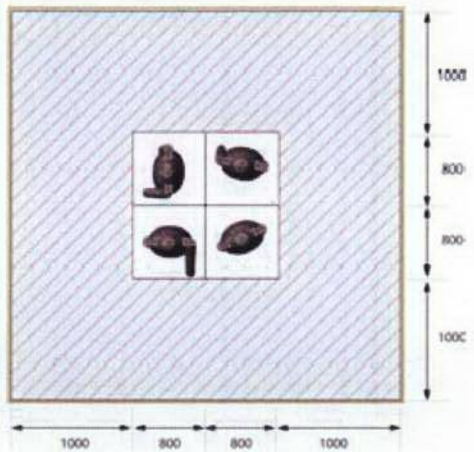
Ex-case/ open display

Maximum weight		*= 1061kg*
Assumed base weight		*= 100kg*
Total load		*= 1161kg*
Total area (including exclusion zone)	*= 2.8m x 2.8m*	*= 7.84m²*
Average load per m²	= 1161 / 7.84	**= 148 kgm⁻²**

-This value is less than 400kgm⁻² and is therefore acceptable

Multiple Object Display

Figure 5.2.2 Multiple object display



Ex-case/ open display

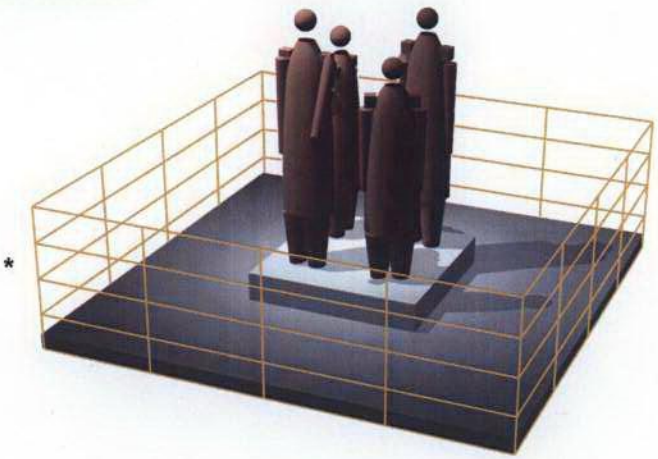
Maximum weight	*= 4 x 1061kg*	*= 4244kg*
Assumed base weight		*= 400kg*
Total load		*= 4624kg**
Total area (including exclusion zone)	*= 3.6m x 3.6m*	*= 12.96m²*
Average load per m²	= 4624 / 12.96	**= 357 kgm⁻²**

-This value is less than 400kgm⁻² and is therefore acceptable

*Load Distribution

NB This total load of exhibits (4644kg) must be distributed over 13m² to work within limits.

Figure 5.2.3 Load distribution



* *Public exclusion zone*

Additional structure may be required to distribute load.

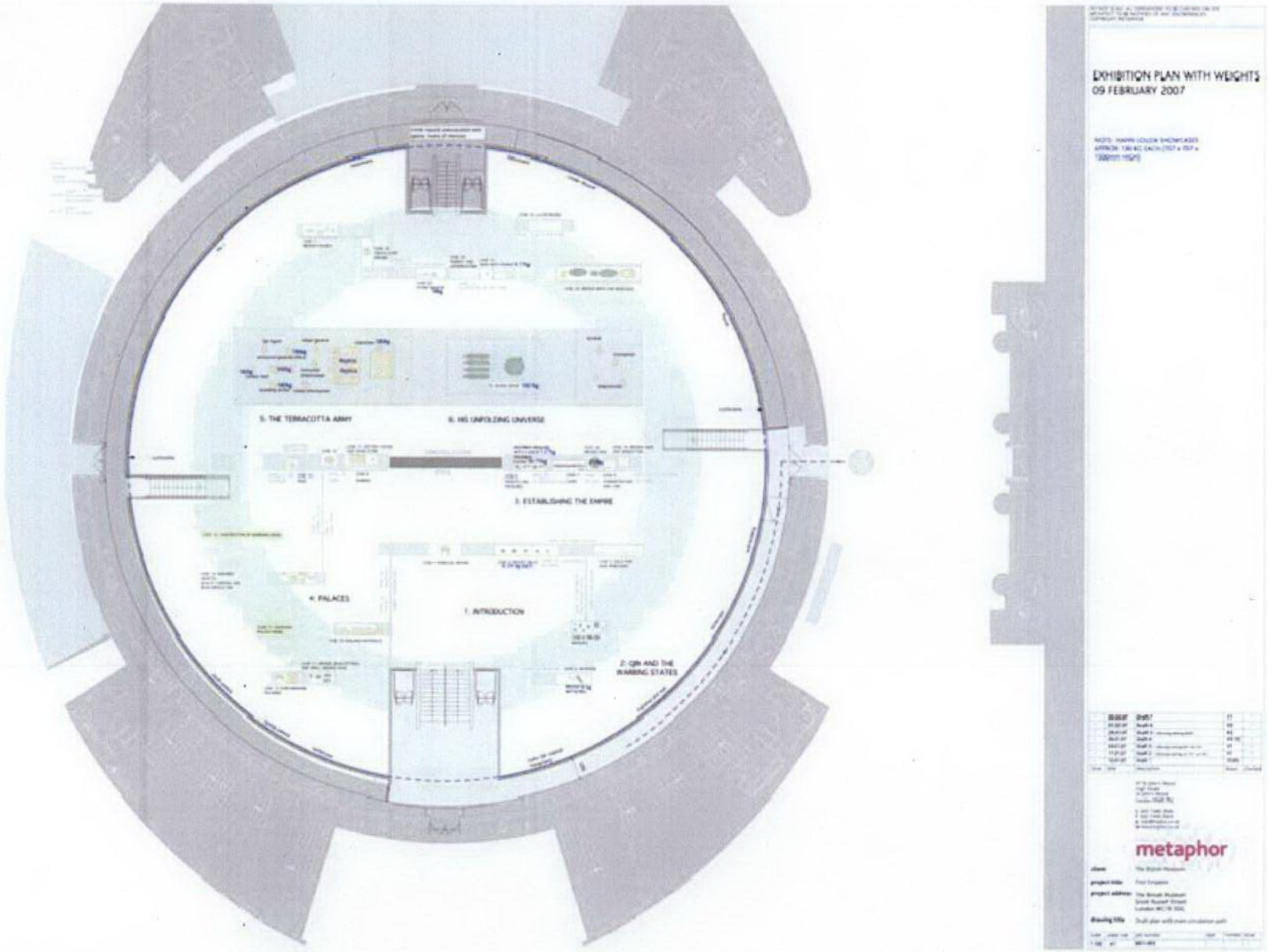


Figure 5.2.4: Draft plan with main circulation path

Technical Details		RWE120
Rated capacity	kg	1200
Load centre	mm	600
Max. axle load drive wheel, with rated load		
mast rear, tilt down/up	kg	880/910
mast forward, tilt down/up	kg	210/230
Max. axle load drive wheel, without rated load		
mast rear, tilt down/up	kg	700/720
mast forward, tilt down/up	kg	765/780
Max. axle load support arm wheels, without rated load		
mast rear, tilt down/up	kg	830/820
mast forward, tilt down/up	kg	1330/1325
Mast tilt forward/backward	°	1.3/1.6
Travel speed, without/with rated load	km/h	6/5
Lift speed, without/with rated load	m/s	0.24/0.15 [1]
Lowering speed, without/with rated load	m/s	0.40/0.50 [1]
Gradient, without/with rated load	%	10/8
Service-/parking brake		2 stage electromagnetic brake
Drive motor/intermittent rating	kW/%	1.4/60
Lift motor/intermittent rating	kW/%	3.1/20
Steering system		steering arm
Speed control		transistor, stepless
Steering arc	°	180

Dimensions, mm		RWE120
x	Back of fork to wheel centre	640 [2]
	Support arm wheels, Vulkollan	Ø 140x60
	Drive wheel, Vulkollan	Ø 215
h_7	Platform height	230
l_{24}	Platform length	530
h_{14}	Height of handle in neutral pos., without/with platform	1525/1295
h_8	Height of support arm	150
h_{13}	Height of lowered fork	40
l_2	Truck length incl. fork face, without/with platform up/down	1025/1190/1555 [3]
l_7	Truck length excl. fork	1748 [3]
b_1	Chassis, width	850
b_2	Width across support arms, min./max.	900/1085
s	Fork thickness	40
e	Fork width	100
l	Fork length	1150
b_5	Width across fork, min./max.	250—620/250—773
b_4	Width between support arms, min./max.	665/850
l_4	Reach movement	810
m_1	Floor clearance under mast	45 [4]
A_{st}	Aisle width, without/platform up/down	2570/2735/3090 [5]
W_a	Turning radius, without/with platform up/down	1680/1848/2200 [5]

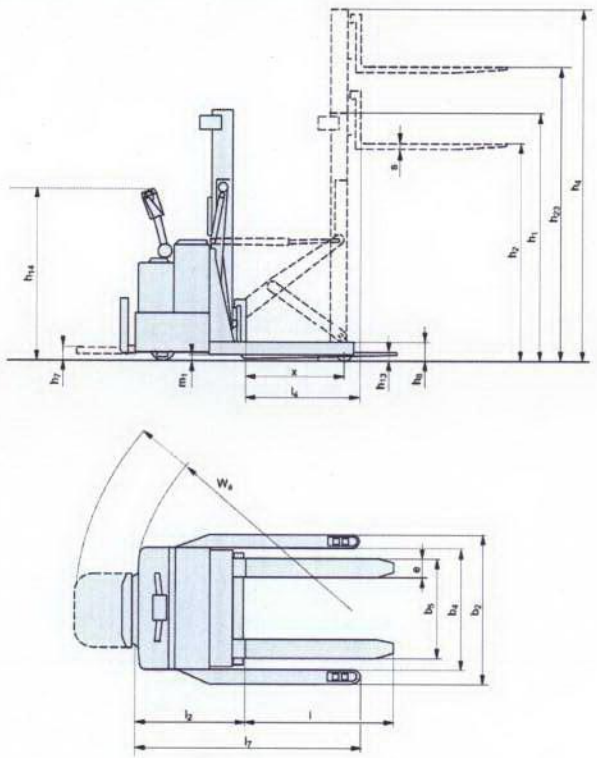
Mast, mm			Duplex Tele			Duplex Hi-Lo					Triplex Hi-Lo				
h_{23}	Total lift height	mm	2400	2800	3350	2400	2900	3350	3750	4150	3600	3750	4150	4500	4800
h_1	Height of mast, min.	mm	1737	1937	2212	1737	1987	2212	2422	2622	1765	1830	1948	2065	2165
h_4	Height of mast, max.	mm	2917	3317	3867	2917	3417	3867	4277	4677	4120	4270	4670	5021	5321
Weight without battery [6]		kg	1222	1242	1272	1222	1247	1272	1292	1312	1377	1392	1407	1437	1447
Battery (5h discharge), min./max.		V/Ah	276—300												
Battery weight, min./max.		kg	249—300												

1) Based on Triplex mast
2) Based on Triplex mast; Duplex mast +20 mm
3) Based on Triplex mast; Duplex mast -20 mm
4) 15 mm under studs
5) Mast rear
6) b_5 1085 mm = +50 kg
For sideshift = +100 kg

Figure 5.3.1 Specification for model RWE 120

5.3 Installation loads

The proposed forklift weighs **1455kg (+300kg** with battery)



The point load is too great for platform. The forklift is therefore not permitted at platform level.

Truck performance and dimensions are nominal and subject to tolerances.
BT Products AB products and specifications are subject to change without notice.
All data is based on VDI 2198.

Figure 5.3.2 Drawings for model RWE 120

5.4 Elemental self weight

The following is a preliminary assessment, for detailed assessment refer to the calculations.

Typical section

Column Point Loads:
Load = Deck load + deck level perimeter load + column self weight

Column	Point Load
A	30 + 96 +10 = 136kg
B	131 + 96 + 10 = 237kg
C	198 + 10 = 207kg
D	190 + 10 = 200kg
E	167 + 82 + 10 = 259kg
F	133 + 10 = 142kg
G	60 + 10 = 70kg

Point Loads onto walls:
Load = column point load + ground level perimeter load + distributor self weight

Wall	Point Load
A1	91 + 110 + 29 = 230kg
A2	91 + 110 + 29 = 230kg
B1	158 + 27 = 185kg
B2	158 + 27 = 185kg
C1	138 + 23 = 161kg
C2	138 + 23 = 161kg
D1	133 + 18 = 151kg
D2	133 + 18 = 151kg
E1	259 + 19 = 278kg
F1	142 + 12 = 154kg
G	70kg

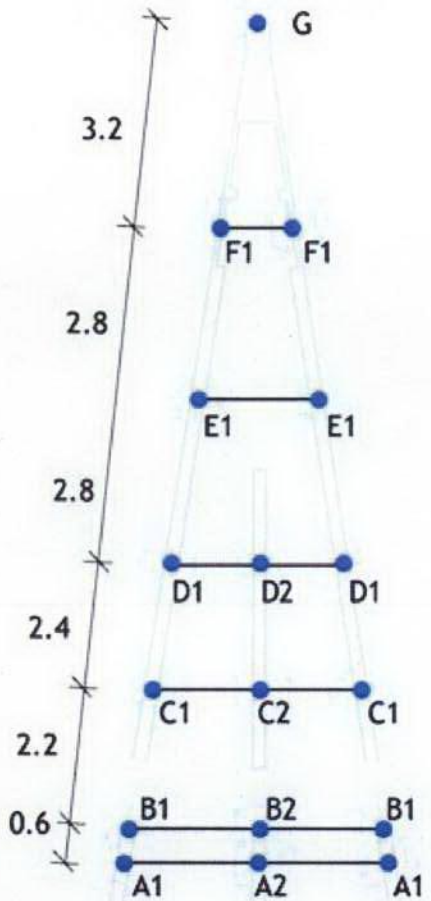


Figure 5.4.1 Point loads onto walls

Equivalent distribution at walls:
Load = wall point loads / floor area supported by wall

Wall	Equivalent Distributed Load
A1	230 / 1.2 = 192 kg/m²
A2	230 / 1.31 = 176 kg/m²
B1	185 / 2.63 = 70 kg/m²
B2	185 / 2.81 = 66 kg/m²
C1	161 / 3.97 = 41 kg/m²
C2	161 / 3.91 = 41 kg/m²
D1	151 / 4.00 = 38 kg/m²
D2	151 / 3.46 = 44 kg/m²
E1	278 / 5.05 = 55 kg/m²
F1	154 / 5.42 = 28 kg/m²
G	70 / 3.44 = 20 kg/m²

Load distribution:
Load = distribution of point loads + load of plywood floor

Wall	Equivalent Distributed Load
A1	192 + 15 = **207 kg/m²**
A2	176 + 15 = **191 kg/m²**
B1	70 + 15 = **85 kg/m²**
B2	66 + 15 = **81 kg/m²**
C1	41 + 15 = **56 kg/m²**
C2	41 + 15 = **56 kg/m²**
D1	38 + 15 = **53 kg/m²**
D2	44 + 15 = **59 kg/m²**
E1	55 + 15 = **70 kg/m²**
F1	28 + 15 = **43 kg/m²**
G	20 + 15 = **35 kg/m²**

Inner Area

Column Point Loads:
Load = Deck load + perimeter load

Eight columns are evenly distributed radially:
Load = 33 x 60.14 / 8 + 348 = **596 kg**

The area of the inner section is 60.14m²

The distribution for each column is 770 / (60.14 / 8) = **79 kg/m²**

5.5 Imposed loads

The study of the existing building carried out by Alan Baxter and Associates has suggested that a 6 kN/m² distributed load is allowable on the Reading Room floor. This has previously been allocated in the ratio 5 kN/m² imposed load and 1kN/m² dead load. Table 1 from BS 6399/1 show that the imposed loading requirement on "museum floors and art galleries for exhibition purposes" is in fact 4kN/m². This considered, the loading can be separated into 4 kN/m² for imposed load and 2 kN/m² for dead load.

The imposed loading for staircases is 7.5 kN/m²

Table 1 — Minimum imposed floor loads *(continued)*

Type of activity/occupancy for part of the building or structure	Examples of specific use		Uniformly distributed load kN/m²	Concentrated load kN
C Areas where people may congregate	Public, institutional and communal dining rooms and lounges, cafes and restaurants (See note 2)		2.0	2.7
C1 Areas with tables	Reading rooms with no book storage		2.5	4.5
	Classrooms		3.0	2.7
C2 Areas with fixed seats	Assembly areas with fixed seating (See note 3)		4.0	3.6
	Places of worship		3.0	2.7
C3 Areas without obstacles for moving people	Corridors, hallways, aisles, stairs, landings etc. in institutional type buildings (not subject to crowds or wheeled vehicles), hostels, guest houses, residential clubs, and communal areas in blocks of flats not covered by note 1. (For communal areas in blocks of flats covered by note 1, see A)	Corridors, hallways, aisles etc. (foot traffic only)	3.0	4.5
		Stairs and landings (foot traffic only)	3.0	4.0
	Corridors, hallways, aisles, stairs, landings, etc. in all other buildings including hotels and motels and institutional buildings	Corridors, hallways, aisles, etc. (foot traffic only)	4.0	4.5
		Corridors, hallways, aisles etc. subject to wheeled vehicles, trolleys etc.	5.0	4.5
		Stairs and landings (foot traffic only)	4.0	4.0
	Light duty walkways — (access suitable for one person, walkway width approximately 600 mm)		3.0	2.0
	General duty walkways — (regular two-way pedestrian traffic)		5.0	3.6
	Heavy duty walkways — (high density pedestrian traffic including escape routes)		7.5	4.5
	Museum floors and art galleries for exhibition purposes		4.0	4.5
	Balconies (except as specified in A)		Same as rooms to which they give access but with a minimum of 4.0	1.5/m run concentrated at the outer edge
	Fly galleries		4.5 kN/m run distributed uniformly over width	—
C4 Areas with possible physical activities (See clause 5, Note 1, Note 2 and Note 3)	Dance halls and studios, gymnasia, stages		5.0	3.6
	Drill halls and drill rooms		5.0	9.0
C5 Areas susceptible to overcrowding (See clause 5, Note 1, Note 2 and Note 3)	Assembly areas without fixed seating, concert halls, bars and places of worship (See Note 4)		5.0	3.6
	Stages in public assembly areas		7.5	4.5
D Shopping areas	Shop floors for the sale and display of merchandise		4.0	3.6

Figure 5.5.1
Table 1 from BS 639911: Minimum imposed floor loads