DD Porter /Siemens

UCLH, BIRKBECK UNIVERSITY - MRI

Structural Design Philosophy

UCL-WSP-ZZ-ZZ-RP-S- 0001
JANUARY 2018

CONFIDENTIAL

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TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70038590
OUR REF. NO. UCL-WSP-ZZ-ZZ-RP-S- 0001

DATE: JANUARY 2018

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QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	INFORMATION			
Date	22nd January 2018			
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Authorised by	Mark Bundy			
Signature	MRB			
Project number	70038590			
Report number	UCL-WSP-ZZ-ZZ-RP-S-0001			
File reference				

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1 INTRODUCTION

1.1 This document summarizes the design basis and the structural concept for the proposed installation of a new 3T MRI Scanner at 26 Bedford Way as part of University College London, Birkbeck University (Figure 1).

1.2 The design base document sets out WSP's understanding of the requirements of the clients' brief. This will ensure a consistent interpretation across the disciplines within the design team, and that all parameters affecting the structure are agreed and accounted for in the design.

Figure 1 - Location of Birkbeck UCL Centre within Bedford Way (indicated by hatched area)

2 SYNOPSIS

2.1 The new MRI Suite is to be located at ground level in the Birkbeck-UCL Centre for Neuroimaging. This is located to the north end of the Bedford Way complex, Bloomsbury, London (a grade II listed building).

2.2 Rooms B21 and B23 have been identified as an appropriate location for the 3T scanner. As shown in Figure 2 these are accessible from the rear of the building and as such two existing piers/columns will need to be removed in order to facilitate the installation.

Figure 2 - Rooms B21 & B23 as Viewed from Rear of Bedford Way

2.3 The following structural works will need to be carried out as part of the scheme:

- A new RC slab (with stainless steel bars) to support the MRI scanner, this will in turn be supported on RC stub columns to facilitate existing service ducts below ground level.
- A new internal steel frame to support required shielding.
- Additional steelwork for the delivery opening to support existing structural columns to be removed between Lower Ground Floor and Basement levels.

2.4 The RF cage shielding for the MRI scanner will be designed by specialists.

2.5 Information made available on the weight of the medical equipment has been reviewed by WSP.

MAGNETOM Prisma				
		Weight (kg), Heat dissipation to the air (W)		
Pos.	Description	kg	W	Remark
1.01	Magnet	12000	3000	#1/#2
1.02	Fixed patient table	240		
1.03	RF-cabin			
1.04	RF-door			
1.05	RF-window			
1.06	RF-System filter plate	130	250	#7
1.07	Magnet stop			
1.08	Coil storage cart for PA Matrix-coil	86		optional
1.09	Electronics cabinet GPA/EPC	1500		#1/#3
1.10	SEP cabinet	318		#2/#3
1.11	Power distributor	52		by customer
1.12	Control unit MR AWP	20	200	
1.13	Host PC MR AWP	22	700	
1.14	Intercom system			
1.15	Alarm box	1		
1.16	Coil storage cart	136		optional
1.17	Air conditioning cabinet			by customer
1.18	Host PC container 50 cm			optional
1.19	Spectro Shim Support (ASC-2)	350		optional
	#1 Heat dissipation depending on measuring #2 Additional water cooling system necessary #3 Typical heat dissipation of both components to the environment in the Technical-Room ≤ 1 kW #7 Installation of non-SIEMENS components prohibited			

Figure 3 - SIEMENS 3T MRI Scanner

2.6 There is no blast load requirements identified, other than accidental loads expected for the design of key elements under the Progressive Collapse clauses in the Building Regulations. An allowance for a nominal axial force of 75kN should be made in the design of the main steelwork connections for ensuring robustness and avoiding disproportionate collapse according to BS EN 1991-1.7 (A.1).

2.7 A survey for the rooms was carried out by CSM /DD Porter in October 2017.

2.8 Information, where possible, has also been extracted from existing structural drawings.

3 HEALTH AND SAFETY

3.1 WSP Design Risk Assessments are produced for identified hazards and steps taken to mitigate or reduce the associated risks during the lifecycle of the building. Risk Assessments are continually reviewed during the design development process.

3.2 All activities carried out during the design conform to the Health and Safety Act 1974 and the CDM Regulations 2015. The Principal Designer will be issued with this design base statement so that they are made aware of the basis of the developed design with respect to Health and Safety.

4 DESIGN CRITERIA

4.1 Materials –

4.1.1 The following properties have been assumed in preparing load take downs and the design of elements. Any deviation from the details below will be highlighted in the calculations.

4.1.2 Concrete

4.1.2.1 Ground Slab:
Characteristic f_{cu}: 40N/mm^2
Density: 2400kg/m^3
Max aggregate size: 20mm
Modulus of elasticity: 26kN/mm^2 (Average)

4.1.2.2 RC Stub Columns & Foundations:
Characteristic f_{cu}: 40N/mm^2
Density: 2400kg/m^3
Max aggregate size: 20mm
Modulus of elasticity: 26kN/mm^2 (Average)

4.1.3 Reinforcement

4.1.3.1 Standard Steel Reinforcement
Modulus of Elasticity: 200kN/mm^2
Main bars: High yield to BS 4449
Yield strength: 500N/mm^2
Shear Links: High yield bars

4.1.3.2 Stainless Steel Reinforcement
Modulus of Elasticity: 200 - 240kN/mm^2
Main bars: High yield to BS 4449
Yield strength: 314N/mm^2
Shear Links: High yield bars

4.1.4 Structural Steelwork

4.1.4.1 Principle members: Grade S355
Yield strength p_y: 355N/mm^2 up to 15mm thick
Modulus of Elasticity: 210kN/mm^2

4.1.4 Masonry (non-loadbearing)

4.1.4.1 Blockwork Density: 1400kg/m^3
Strength: 7N/mm^2
Thermal expansion: 10 x10^{-6} /^{o}C

4.1.4.2 Brickwork Density: 1960kg/m^3
Minimum strength: 27N/mm^2
Water absorbtion: >12%
Thermal Expansion: 5 x10^{-6} /^{o}C

4.2 Fire Protection

4.2.1 Reinforced Concrete Elements

4.2.1.1 All reinforced concrete is designed for 60 minutes fire resistance unless stated otherwise.

4.3 Loading Schedule

Floor Level	Description	UDL (kN/m^2)	PL (kN)
Existing Roof (General)	**Dead**		
	350mm thk mixed RC Slab and asphalt	8.40	
	Services	0.50	
	Finishes	0.10	
	Ceilings (Low Level)	0.25	
	Imposed		
	Lightweight Plant	5.00	4.50
Existing Ground Floor – Fifth Floor	**FLOORS GENERALLY**		
	Dead		
	350mm RC Slab	8.40	
	Finishes	0.10	
	Ceilings	0.25	
	Services	0.50	
	Imposed		
	Live Load – Office space	2.50	4.00
	Demountable Partitions	1.00	
	Nominal Plant Locations	5.00	4.50

Lower Ground Floor	**FLOORS GENERALLY**		
	Dead		
	350mm RC slab	8.40	
	Finishes	0.10	
	Ceilings	0.25	
	Services	0.50	
	Imposed		
	Live Load - Library	4.00	2.50
	Demountable Partitions	1.00	
Proposed MRI Slab	**FLOORS GENERALLY**		
	Dead		
	350mm RC slab	8.40	
	Finishes/RF Cage	0.25	
	Imposed		
	MRI Scanner Self Weight (12000kg) over an area of $5m^2$	24.00	
	RF Cage/Demountable Partitions to Treatment Room	2.25	

Table 1 - Loading Schedule

Note:
1. Imposed loads from BS EN 1991-1-1 unless specified otherwise.
2. All corridors to be designed for an imposed load of 4.0 kN/m^2 U.N.O.
3. No live load reduction factors will be applied at this stage.

5 STRUCTURAL PHILOSOPHY

5.1 Foundations

5.1.1 Groundworks for the existing structure are formed of pile caps /piled foundations. The foundations for the strengthening works are via localised Pad Foundations to the RC Stub Columns.

5.2 Ground Floor Slab

5.2.1 The new slab underneath the MRI will be a 350mm RC suspended slab. This slab will use stainless steel reinforcement (Grade SS 314L) as not to disturb the magnetic imaging system employed by the scanner.

5.2.2 The new suspended slab will be supported on RC stub columns which will transfer the load of the new scanner and structural self-weight to the foundations.

5.2.3 Where possible (refer to the structural drawings), thickenings and dowel bars are used to connect back to the existing structure.

5.3 Structural frame

5.3.1 The shielding required for the RF cage will be supported by steel beams, spanning back onto steel columns where these loads are transferred to the new RC slab. All columns and connections are assumed to be pinned.

5.3.2 For the MRI delivery 2nr existing RC columns have to be removed. A new steel frame will be installed to support the existing loadings down to the foundations. This will consist of steel beams spanning below the existing floor slab above, spanning back to new steel columns, adequately spaced apart to suit the delivery.

5.4 Internal Partitions and Walls

5.4.1 Lightweight Stud Partitions

5.4.1.1 The majority of internal partitions are to be constructed from timber or metal stud panels, lined with two skins of plasterboard on each side (refer to Architects Specification).

5.4.1.2 Where light to medium weight equipment, such as standard monitors/television screens, wash basins etc. are identified, one skin of plasterboard may be replaced with plywood boards to enable adequate fixings to be provided. Equipment weights for this type of fixing should generally not exceed 200kg with a maximum distance from face of fixing to the applied force of 300mm, although this load may be increased dependant on the type of fixing and the final partition specification used.

6 STANDARDS AND DESIGN GUIDES

REFERENCE	DESCRIPTION
Eurocode EC0: BS EN 1990	Basis of Structural Design
Eurocode EC1: BS EN 1991	Actions on Structures
Eurocode EC2: BS EN 1992	Design of Concrete Structures
Eurocode EC3: BS EN 1993	Design of Steel Structures
Eurocode EC6: BS EN 1996	Design of Masonry Structures
Eurocode EC7: BS EN 1997	Geotechnical Design
BS 8500: Pt1	Guide to specifying concrete
Concrete Society TR34	Concrete industrial ground floor slabs – Guide to design and construction

Table 2 - List of design Standards Used

1 Queens Drive
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