2.6 KEY STRUCTURAL PRINCIPLES

- Design Criteria report by Structural Engineers

Please see attached document 600326-HEX-ZZ-ZZ-RP-S-10001

Winvic Construction Ltd

Kent Street

Birmingham

600326

600326-HEX-ZZ-ZZ-RP-S-10001
Civil and Structures Design Philosophy

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1.0 Introduction

1.1 This report sets out the Design Philosophy for the civil and structural design for the proposed residential development on Kent Street, Birmingham.

1.2 The development comprises the construction of 4No. blocks of apartments up to 19No. storeys in height, built off a podium slab over a combined basement.

2.0 The Site

2.1 The site of the proposed development is bounded by Kent Street and Gooch Street in the centre of Birmingham. The site is currently vacant, though was previously occupied by a swimming pool.

2.2 There is a significant variation is levels across the site, rising approximately 4m south to north.

3.0 Ground Conditions

3.1 A Phase II Geo-Environmental Site Investigation has been carried out, document reference 063793-CUR-00-XX-RP-GE-00001-Phase 2 SI-V05-Phase 2 SI.

The ground conditions at the site generally comprised Made Ground to an average depth of 1.89mbgl, over SAND and GRAVEL residual soils to an average depth of 9.30mbgl, underlain by Bromsgrove SANDSTONE to an unconfirmed depth of 22.66mbgl. Groundwater is recorded as being typically 2m below the lowest floor level..

4.0 Structural Framing

4.1 The buildings structure comprises of cast in situ reinforced concrete framing formed of columns, flat slabs and walls around stair and lift cores.

4.2 Overall stability is provided by the reinforced concrete walls located within the lift and stair cores, cantilevered off the foundations, with wind loads transferred from the façade to the cores by the diaphragm action inherently provided by the floor slabs.

4.3 The building is supported on piled foundations. Isolated pile groups are provided below each column, with a reinforced pile cap provided to distribute vertical and horizontal loads into the piles. A large single pile cap is provided below each core again designed to transfer vertical, horizontal and overturning forces into the piles

4.4 The basement walls comprise a combination of contiguous piled walls and traditional cast insitu reinforced concrete retaining walls. A reinforced concrete capping beam is provided to the head of the contiguous piled wall and where applicable this beam is designed as a stiff element to distribute column loads into the piles. It is considered that the depth of the ground water is

sufficiently deep that uplift does not need to be considered in the design of the basement structure.

5.0 Gas Protection and Waterproofing

5.1 The site investigation determines that the site is categorised as CS2 and hence gas protection is required. This will be provided using a combination of a gas membrane and the cast insitu reinforced concrete slabs in the habitable parts of the basement. Mechanical ventilation is provided in the car park and hence no further gas protection measures are required.

5.2 The grade of waterproofing adopted within the basement varies dependent on the use of the spaces, typically Grade 1 for plant rooms and car parks and Grade 3 for Block C lower ground floor.

6.0 Structural Design

6.1 The building is designed using a combination of computational analysis and hand calculations as follows:

Floor slabs are designed using RAM Concept 3D Finite Element analysis software (Figure 1). Slabs are modelled as two way spanning flat slabs supported on walls and columns. Supporting columns are modelled as vertically compressible elements, fixed at the slab/column connection. Punching shear is checked using the column reactions derived from RAM Concept in accordance with BS EN 1992, using the RCC Spreadsheets. Long term deflections are checked using load history analysis.

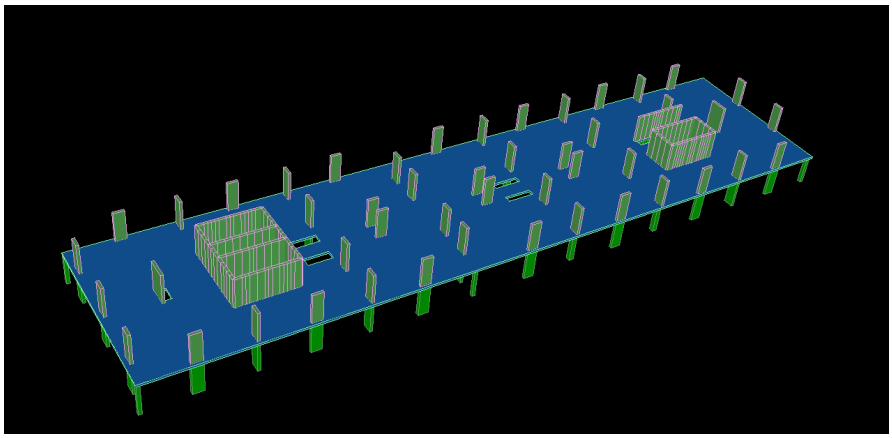

Figure 1: Ram Concept Finite Element Analysis Model for Block A

- Columns and walls are designed using the 3D analysis modelling software Tekla Structural Designer (Figure 2). The software is also used to check overall stability and wind-drift.

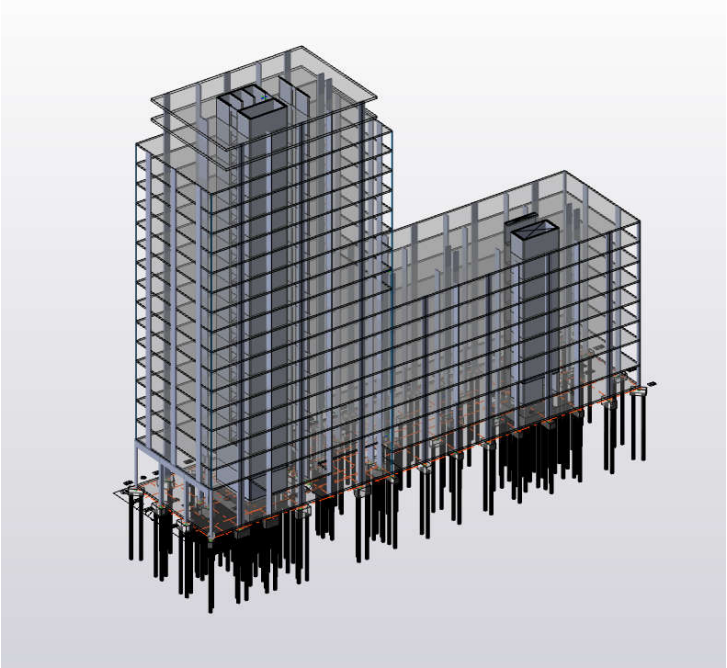

Figure 2: Tekla Structural Designer Analysis Model Block A

6.2 The development is designed in accordance with the current Building regulations and Design Codes as listed below:

General Loading	BS EN 1991-1-1 + UK NA (2002)
Wind Loading	BS EN 1991-1-4 + UK NA (2005)
Snow Loading	BS EN 1991-1-3 + UK NA (2003)
Combinations	BS EN 1990 + UK NA (2002)
Steel Design	BS EN 1993-1-1 + UK NA (2005)
Concrete Design	BS EN 1992-1-1 + UK NA (2004)
Composite Design	BS EN 1994-1-1 + UK NA (2004)
Masonry Design	BS EN 1996-1-1 + UK NA (2005)
Foundation Design	BS EN 1997-1 + UK NA (2004)

7.0 Design Loads

7.1 Permanent Loads

Apartments	Ceiling	0.15	kN/m^2
	Services	0.25	kN/m^2
	Finishes	0.1	kN/m^2
	Total	**0.5**	**kN/m^2**
Commercial	Ceiling	0.15	kN/m^2
	Services	0.25	kN/m^2
	Finishes	0.05	kN/m^2
	Raised Access Floor	1.5	kN/m^2

	Total	**1.95**	**kN/m²**
Roof	Insulation & Membrane	0.25	kN/m²
	Ballast	1.35	kN/m²
	Ceiling	0.15	kN/m²
	Services	0.25	kN/m²
	Total	**2.0**	**kN/m²**
Podium Block Paving	80mm Block Paving	1.8	kN/m²
	30mm Sand	0.6	kN/m²
	125mm DBM	2.63	kN/m²
	EPS Void Former	0.1	kN/m²
	Total	**5.13**	**kN/m²**
Podium Landscaping	450mm LW topsoil (12.5kN/m³)	5.65	kN/m²
	Drainage Board	0.5	kN/m²
	Total	**6.15**	**kN/m²**
Podium Lawn	150mm LW topsoil (12.5kN/m³)	1.875	kN/m²
	Drainage Board	0.5	kN/m²
	Total	**2.375**	**kN/m²**
Block E High Level Roof	Allowance	0.4	kN/m²
Façade	25mm plaster board	0.25	kN/m²
	SFS + Insulation	0.1	kN/m²
	CP Board	0.1	kN/m²
	Brick Slip System	0.75	kN/m²
	Total	**1.2**	**kN/m²**

7.2 Variable Loads

The variable loads have been defined where applicable in accordance with BS EN 1991-1-1 + UK NA (2002).

Area	Distributed Load (kN/m²)	Concentrated Load (kN)
Residential Apartments	1.5	1.4
Corridors & Stairs	3.0	4.5

Retail/Commercial Areas	4.0	3.6
Roof Areas	1.5	
Ground Floor Plant Areas	7.5	4.5
Podium	10	20
Block E Level L00, L01	2.5	
Block E Terrace	2.5	

7.3 Wind Load

The wind load shall be calculated in accordance with BS EN 1991-1-4 + UK NA (2005).

Site reference = SP070859

8.0 Disproportionate Collapse

8.1 The buildings are categorised as Class 2B in accordance with Part A3 of the Building Regulations, with the exception of Block A1 which is categorised as Class 3. For the Class 2B elements calculations have been carried out to determine that the reinforcement within the columns and slabs is able to resist the tie forces as stipulated in BS EN 1992-1-1.

8.2 Building A1 is 19 Storeys in height and hence is categorised as Class 3. Part A3 of the Building Regulations requires a systematic risk assessment to be undertaken considering the normal and abnormal hazards that could reasonably occur and result in accidental forces being applied to the building. Applicable hazards to consider for Block A1 would be as follows:

Vehicle Impact — There are no vertical elements that form part of the Block A1 structure that extend into the car part hence there is no risk of vehicle impact within the building footprint. The building is located at the back of the footpath adjacent Bromsgrove Street. This is an urban road with frequent junctions, street parking and a wide footpath and hence it is considered the risk of vehicle impact to the building is not enhanced.

Internal Explosion — Building A1 is occupied primarily by residential accommodation, with office space at ground floor. There is no gas supply into the building and hence it is considered that the risk of explosion is not enhanced.

Unstable Ground	The building is supported on piled foundations, bearing onto bedrock and hence the risk of ground movement is considered unlikely.

Whilst the building is categorised as class 3 it is considered there is no enhanced risk of disproportionate collapse and hence robustness will be provided as for the Class 2B structures by the provision of vertical and horizontal ties in accordance with BS EN 1992-1-1.

9.0 Standards & Material Properties

9.1 Refer to material specification documents.

10.0 Movement and Deflection

10.1 Vertical Deflections – Upper floor slabs

Total short term deflection will be limited to the lesser of diagonal Span/500 or 15mm

Total long term deflection will be limited to the lesser of diagonal Span/300 or 25mm

10.2 Vertical Deflections – Foundations

Piled Foundations

- Total pile settlement is to be limited to 10mm under service loads.

Differential settlement of piles

- Differential settlement of piles to be limited to the lesser of the distance between piles / pilecaps/500 or 15mm.

10.3 Horizontal Deflections – Superstructure

Lateral deflections due to wind:

- Lateral deflection under wind loading to be less than total building height / 500.

Lateral Inter Storey sway:

- The lateral inter storey sway, i.e. horizontal movement between floors is to be limited to storey height / 400.

Non - Structural Elements – Lateral Deflection:

- The total horizontal deflection of non- structural elements will be limited to height / 200 for cladding and glazing and height / 300 for masonry. Specific requirements of the cladding system are to be advised by the supplier if more onerous than the above.

Vertical movement joints will be provided in masonry walls to accommodate horizontal movement due to shrinkage and thermal expansion / contraction.

10.4 Vibration of floors

- The natural frequency of floors is to be limited to 4Hz.

10.5 Position of Movement Joints

Secondary elements, partitions, cladding and applied finishes should be designed for the movements quoted in this specification and joints should be provided between the secondary elements and structure to accommodate this movement.

10.6 Design Crack Widths

All elements formed in reinforced concrete will be designed for a flexural crack width of 0.3mm.

10.7 Margins of Error

Calculation of structural movements (especially of concrete elements) is not an exact since due to the variability of many of the input parameters.

Unless otherwise stated, limiting deflections given do not require a margin of error.

Unless otherwise stated, predicted steel and steel composite deflections given in this document require a margin of error of +/- 15%.

Unless otherwise s stated, predicted concrete deflections given in this document require a margin of error of +/- 30%.

11.0 Testing

11.1 Refer to the project specific specification for concrete, document reference 600326-HEX-ZZ-ZZ-SP-S-0007.