

264 Belsize Road London, NW6 4BT

Structural Inspection & Analysis Report

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Date 06/2023 Revision P02 Notes/Amendments/Issue Purpose For information

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Note:

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1 Introduction

Price & Myers visited 264 Belsize Road on behalf of Roxburg Overseas Ltd, on 25/04/2023. The purpose of the inspection was to survey the existing structure, to advise on the structural condition of the portal framed building and its suitability for alteration to suit new proposals by Alan Power Architects.

All structure was exposed as part of some strip-out works, so it was possible to inspect the entirety of the structure internally. No further intrusive investigations were carried out.



The site is located on Belsize Road, with the nearest tube station being Kilburn High Road.

Figure 1 - Site location

The original structure was constructed in 1995-1996 with Michael Blacker as the Structural Engineers and Alan Power as the original Architects. The original steel frame fabricators were John Reid & Sons.

Some archive drawings and calculation relating to the original structural scheme have been provided to us by Alan Power Architects.

2 Description of Existing Structure

The drawings show an existing portalised cranked steel frame structure. The structure comprises 6 portal frames, spanning 12.45m. A mezzanine floor is also present which is fixed to the portal framed structure around the perimeter with steel columns supporting the central zone of the mezzanine. The mezzanine slab is 125mm of reinforced concrete - poured on a steel sheet acting as permanent shuttering (CF46 by Chorus). All columns are supported on isolated RC pad footings. The ground floor layout is shown in the Figure 2 below.

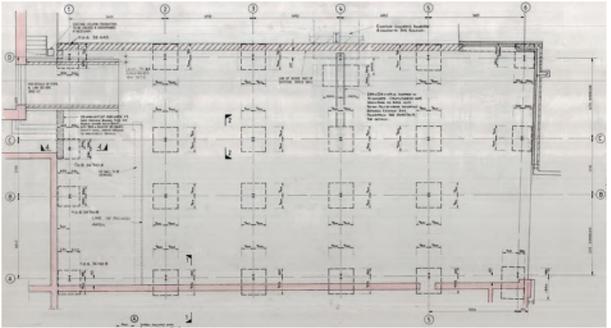


Figure 2 - Archive drawing of ground floor

The site visit on the 25th of April was set up to confirm the sizes and layout on the Michael Blacker drawings as well as find the sizes not shown on the drawings; the obvious missing elements being the mezzanine beams.

The layout and member sizes of the portal frame are shown in the figure and collated in the table below.

Element	Size
Portal Frame columns	254x146x31 UB
Mezzanine columns	152x152x30 UC
Portal Frame rafters	254x146x31 UB
Primary mezzanine beams (GL A - GL D)	406x140x53 UB
Secondary mezzanine beams (perp to above)	254x102x22 UB
Roof purlins	125x1.5 Z
Knee braces	120x5.0 SHS
Horizontal bracing	89x3.2 CHS
Vertical bracing (Bay 5-6)	12mm Steel Rod V bracing

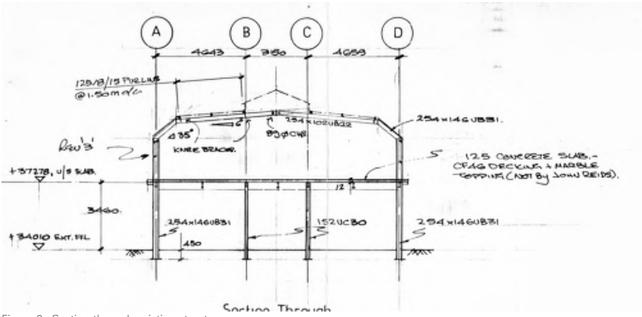


Figure 3 - Section through existing structure

3 Observations

General observations

The steel frame appeared to be in good general condition with no visible signs of wear or corrosion. There is an opening in the slab between gridlines C3 and B4 which has been post cut which has not been made good leaving the slab rebar and the steel sheet exposed.

Deviations from drawings

The concrete and metal deck cantilever over GL 1 as shown in the figure below. Some steel stubs have been installed as mezzanine level to pick up this edge as shown in Fig. These 152x89x16 UBs cantilever 770mm.



Figure 4 - Mezzanine overhang

Trimming steels have been installed between gridlines 1 and 2 shown in green on the figure below, however this opening has not yet been cut through the slab.

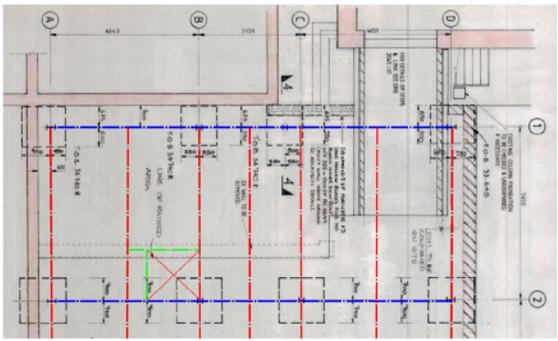


Figure 5 - Indicative mezzanine arrangement

The final deviations is that there are SHS 'knee braces' located at the rafter level of the portal frame providing further racking strength.

4 Analysis

Model construction and assumptions

Using the information from the archive drawings and the site survey, P&M were able to construct an analytical model of the existing portal frame structure.



Figure 5 - Model set up

Assumptions

- All mezzanine beams are pinned connection at both ends
- All portal frames are pinned connection at the bases
- Portal frames have moment connections between the rafters and columns
- All bracing members modelled with pinned connections
- Purlins have not been modelled for simplicity but loading has been accounted for
- Steel beams have been assumed to be designed non-compositely
- All flanges of portal frame elements are designed to be fully restrained by the purlins, bracing and incoming beams
- All steel is S275
- Top flange of mezzanine beams is fully restrained by the slab
- All primary mezzanine beams have been designed as continuous

Loading

Loading is in accordance with BS EN 1991-1-1

Load on Mezzanine	kN/m2
Mezzanine slab self weight	1.9
Ceiling and services	0.2
Finishes	0.5
Partitions - lightweight (Imposed)	0.5
CAT A (Imposed)	1.5

Load on Mezzanine	kN/m2
Existing steel sheet	0.5
Ceiling and services	0.2
Purlins	0.1
Maintenance (Imposed)	0.6

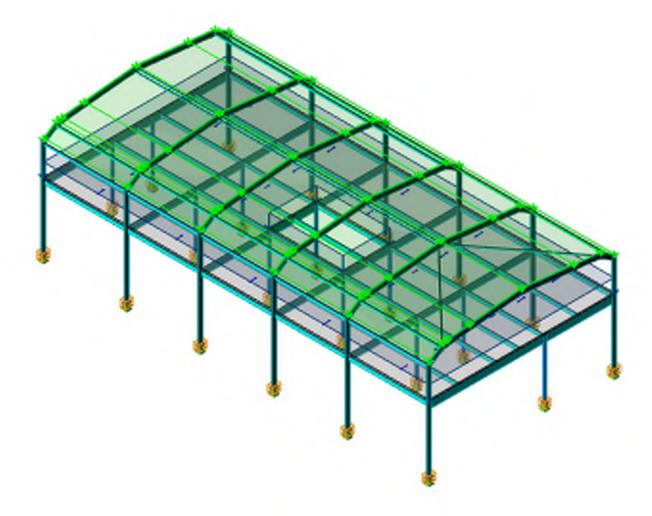


Figure 6 - Loading applied

Analysis and results

Tekla structural designer has been used to check the existing members based on the loadings and assumptions stipulated above.

Mezzanine structure

The figure below shows the utilisation ratios of the mezzanine beams. All beams are OK under the prescribed loading, however the blue members are working very hard at ~0.9% UR.

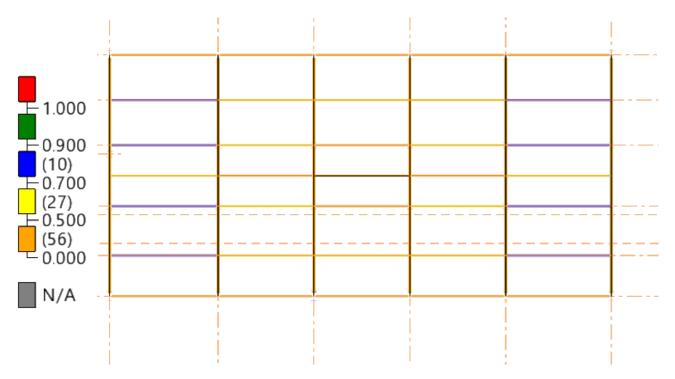


Figure 7 - Utilization of mezzanine beams

· · · · ·	Summary UKB 254x102x22(S275)	Sum	mary UKB 254x102x22(5275))					
÷	Classification		Design Condition	#	Design Value	Design Capacity	Units	U.R.	Status
	Shear Major Shear Minor	\triangleright	Classification	1	Class 1	-	-	-	🗸 Pass
<u>∎</u>	Buckling Shear Web	\triangleright	Shear Major	1	45.1	248.0	kN	0.182	🗸 Pass
÷	Moment Major		Shear Minor	-	No	forces	kN	-	Not required
÷D	Moment Minor	\triangleright	Buckling Shear Web	-	42.175	66.558	-	-	🗸 Pass
÷-Ð	Axial	\triangleright	Moment Major	1	63.2	71.2	kNm	0.887	🗸 Pass
			Moment Minor	-	No	forces	kNm	-	Not required
÷D	Buckling Lateral Torsional Buckling Compression		Axial	-	No	forces	kN	-	Not required
÷	Buckling Combined		Axial Bending Combined			No forces			Not required
÷	Torsion		Buckling Lateral Torsional	-	-	-	-	-	Not required
÷	Deflection		Buckling Compression				Not required		
			Buckling Combined			No forces			Not required
			Torsion		No 9	Gignificant Forces			Not required
		\triangleright	Deflection Self weight	1	0.5	-	mm	-	-
		\triangleright	Deflection Slab	1	10.7	22.4	mm	0.479	🗸 Pass
		\triangleright	Deflection Imposed	1	10.2	15.6	mm	0.653	🗸 Pass

Figure 8 - Design of secondary beams

	Summary UKB 406x140x53(S275)	Sum	mary UKB 406x140x53(5275))					
÷	Classification		Design Condition	#	Design Value	Design Capacity	Units	U.R.	Status
	\triangleright	Classification	1	Class 1	-	-	-	🗸 Pass	
	Buckling Shear Web	\triangleright	Shear Major	1	55.1	549.8	kN	0.100	🗸 Pass
÷	Moment Major		Shear Minor	-	No	forces	kN	-	Not required
÷D	Moment Minor	\triangleright	Buckling Shear Web	-	48.203	66.558	-	-	🗸 Pass
÷ - P	Axial	\triangleright	Moment Major	1	77.5	283.5	kNm	0.273	🖌 Pass
÷-Ð	Axial Bending Combined		Moment Minor	-	No	forces	kNm	-	Not required
⊕ √	Buckling Lateral Torsional Buckling Compression		Axial	-	No	forces	kN	-	Not required
÷-Ð	Buckling Combined		Axial Bending Combined		No forces				Not required
÷		\triangleright	Buckling Lateral Torsional	1	77.5	184.0	kNm	0.421	🖌 Pass
÷ 🗸	Deflection		Buckling Compression				Not required		
			Buckling Combined			No forces			Not required
			Torsion		No S	Significant Forces			Not required
		\triangleright	Deflection Self weight	1	0.1	-	mm	-	-
		\triangleright	Deflection Slab	1	1.0	18.6	mm	0.055	🗸 Pass
		\triangleright	Deflection Imposed	1	1.0	12.9	mm	0.074	🖌 Pass

Figure 9 - Design of primary beams

The figure below shows the mezzanine columns, all have a utilization ratio of under 0.6 under the prescribed loading.

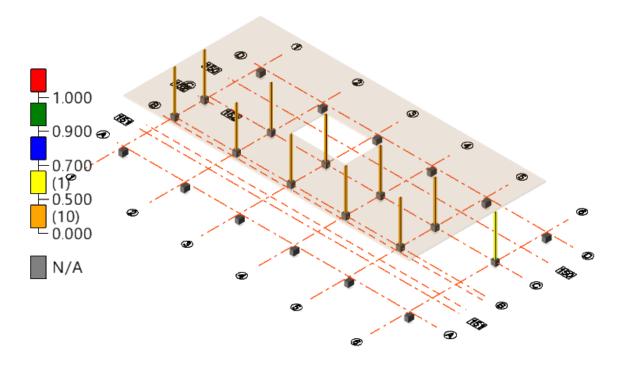


Figure 10 -utilization of mezzanine columns

Summary UKC 152x152x30(S275)	Sum	mary UKC 152x152x30(5275)					
+ V Classification		Design Condition	Combination Name	Design Value	Design Capacity	Units	U.R.	Status
		Classification	1	Class 1	-	-	-	🗸 Pass
Buckling Shear Web		Shear Major	1	0.8	183.5	kN	0.004	🖌 Pass
🗄 🗸 🖌 Moment Major		Shear Minor	No	Significant	Forces	kN	-	Not required
🖅 🗸 Moment Minor		Buckling Shear Web	-	21.35	66.56	-	-	🗸 Pass
🗄 ··· 🗸 Axial		Moment Major	1	3.1	68.1	kNm	0.046	🗸 Pass
🗄 🗸 Axial Bending Combined		Moment Minor	1	0.5	30.7	kNm	0.017	🖌 Pass
Buckling Lateral Torsional Buckling Compression		Axial	1	173.5	1052.2	kN	0.165	🖌 Pass
Buckling Compression		Axial Bending Combined	1	-	-	-	0.020	🗸 Pass
		Buckling Lateral Torsional	1	3.1	61.8	kNm	0.050	🗸 Pass
		Buckling Compression	1	173.5	468.2	kN	0.371	🗸 Pass
		Buckling Combined	1	-	-	-	0.442	🖌 Pass

Figure 11 - Mezzanine column check

Portal frame checks

The figure below shows that all portal frame members are Ok under the prescribed loading. The rafter members are close to full utilisation.

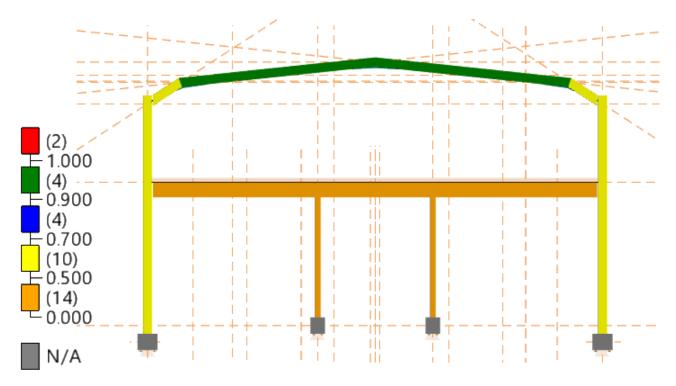


Figure 12 - Portal frame utilization

The relevant force diagrams are shown below.

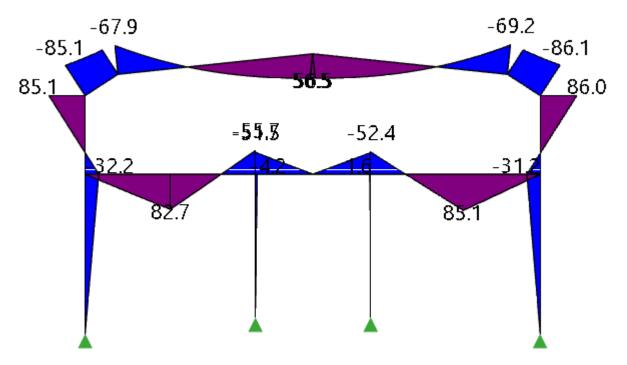


Figure 13 - Bending moment diagram

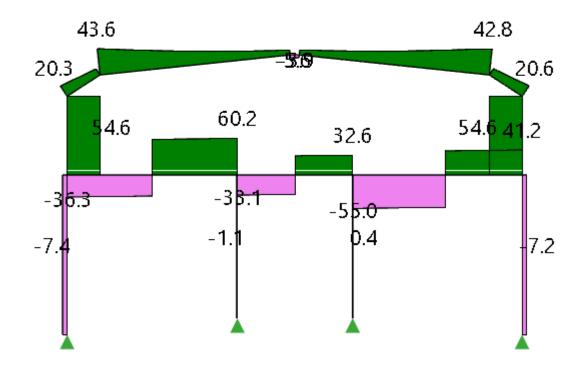


Figure 14 - Shear force diagram

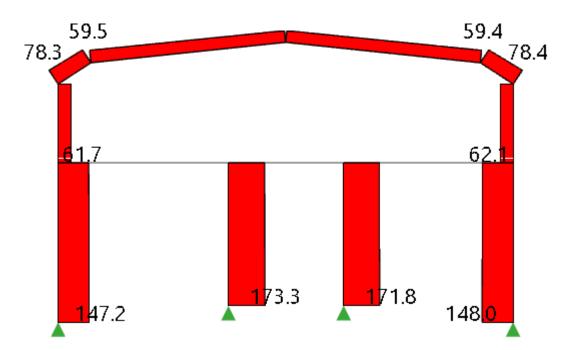


Figure 15 - Axial force diagram

- · · · · · · · · · · · · · · · · · · ·	Summary UB 254x102x22(S275)	Sum	mary UB 254x102x22(5275)						
± 🗸	Classification		Design Condition	#	Design Value	Design Capacity	Units	U.R.	Status
	Shear Major Shear Minor	\triangleright	Classification	1	Class 1	-	-	-	🗸 Pass
	Buckling Shear Web	\triangleright	Shear Major	1	42.8	248.0	kN	0.172	🖌 Pass
÷	Moment Major		Shear Minor	-	No	forces	kN	-	Not required
÷	Moment Minor	\triangleright	Buckling Shear Web	-	42.175	66.558	-	-	🗸 Pass
÷	Axial	\triangleright	Moment Major	1	-69.2	71.2	kNm	0.972	🗹 Pass
<u>∔</u> ✓	Axial Bending Combined		Moment Minor	-	No	forces	kNm	-	Not required
	Buckling Lateral Torsional Buckling Compression	\triangleright	Axial	1	59.4	770.4	kN	0.077	🖌 Pass
÷	Buckling Combined	\triangleright	Axial Bending Combined	1	-	-	-	0.980	🗸 Pass
÷	Deflection		Buckling Lateral Torsional	-		Fully restra	ained		
		\triangleright	Buckling Compression	1	59.4	80.7	kN	0.736	🖌 Pass
		\triangleright	Buckling Combined	1	-	-	-	0.982	🖌 Pass
		\triangleright	Deflection Self weight	1	0.4	-	mm	-	-
		\triangleright	Deflection Slab	1	-0.1	21.4	mm	0.002	🖌 Pass
		\triangleright	Deflection Dead	1	3.7	10.7	mm	0.346	🖌 Pass
		\triangleright	Deflection Imposed	1	3.8	14.9	mm	0.254	🖌 Pass
		\triangleright	Deflection Total	1	7.9	26.8	mm	0.295	🖌 Pass

Figure 16 - Rafter design

Summary UKB 254x146x31(5275)

~	Summary UKB 254x146x31(S275)	Sum	mary UKB 254x146x31(5275)					
÷	Classification		Design Condition	Combination Name	Design Value	Design Capacity	Units	U.R.	Status
	Shear Major Shear Minor	\triangleright	Classification	1	Class 1	-	-	-	🗸 Pass
	Buckling Shear Web	\triangleright	Shear Major	1	50.2	259.9	kN	0.193	🗸 Pass
÷	Moment Major		Shear Minor	No	Significant	Forces	kN	-	Not required
÷D	Moment Minor	\triangleright	Buckling Shear Web	-	39.03	66.56	-	-	🗸 Pass
÷	Axial	\triangleright	Moment Major	1	79.2	108.1	kNm	0.733	🗸 Pass
÷	Axial Bending Combined		Moment Minor	No	Significant	Forces	kNm	-	Not required
	Buckling Lateral Torsional Buckling Compression	\triangleright	Axial	1	142.4	1091.1	kN	0.131	🗸 Pass
	Buckling Compression	\triangleright	Axial Bending Combined	1	-	-	-	0.542	🗸 Pass
		\geq	Buckling Lateral Torsional	1	79.2	107.3	kNm	0.738	🗸 Pass
		\triangleright	Buckling Compression	1	142.4	375.3	kN	0.380	🗸 Pass
		\triangleright	Buckling Combined	1	-	-	-	0.791	🗸 Pass

Figure 17 - Column design

5 Mezzanine slab and foundation analysis

The slab to the mezzanine is called up on the drawing as a 125mm concrete slab cast on Comflor 46 decking. Until we receive the calculations from the previous engineer we have to assume the slab has been designed non-compositely.

Below shows the input into the comflor software based on the drawings our assumptions which have been conservative.

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SERVICEABUTY: 0.54		Info A
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Figure 18 - Deck design

The results show the max utilization factor is 0.62. Indicating plenty of spare capacity in the existing floor. Although on site it did feel 'wobbly' over the longer spanning areas, which is likely related to the design of the steel beams rather than the deck. During the construction phase the slabs and beams should be propped adequately to allow for additional construction loading. Spreader beams and back propping around the locations for new openings will also mitigate any risk during the construction phase.

The archive drawings show that the foundations have been designed to a bearing capacity of 150kN/m2. The figure below shows the SLS column reactions under the worst-case load combination in kN.

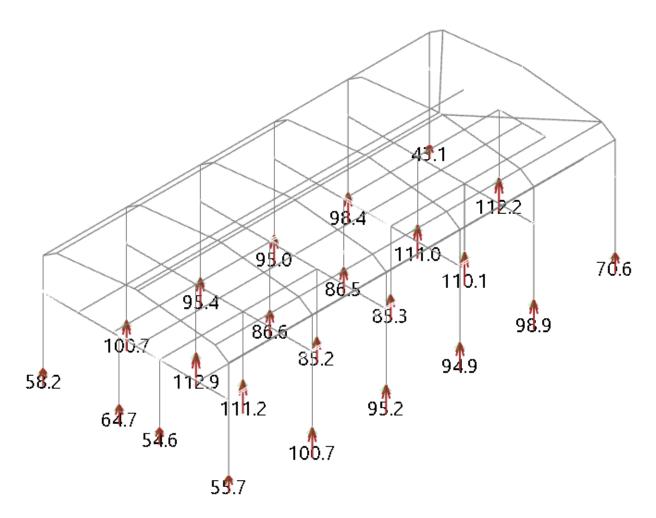


Figure 19 - Column reactions at foundation

Worst case point load - 113kN Pad size (according to drawing) -0.95m x 0.95m

Bearing stress -113/0.95^2 =124kN/m2

Therefore, foundation are OK - around 30 kN of spare capacity at the worst-case footing.

6 Conclusions

Having undertaken an analysis of the existing structural frame – based on a prescribed/assumed set of residential loadings – it's clear that the there is plenty of spare capacity in the reinforced concrete mezzanine level slab, the central/primary mezzanine floor beams, and steel portal frame columns. The inclined portal frame rafters, and a selection of the secondary mezzanine beams however are working close to full capacity.

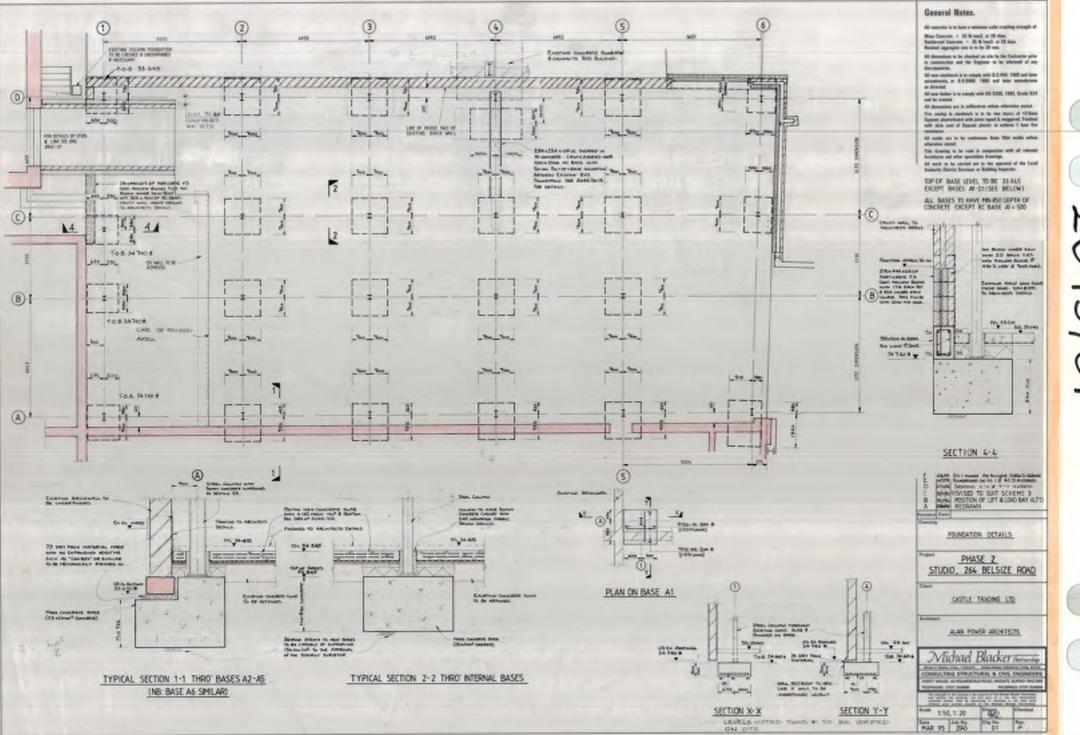
With structures of this nature, it's typical for the inclined steel portal rafters to be close to capacity. It's likely that for the proposed scheme – which involves some higher roof loadings – some remedial strengthening works may be required, e.g. added stiffening plates.

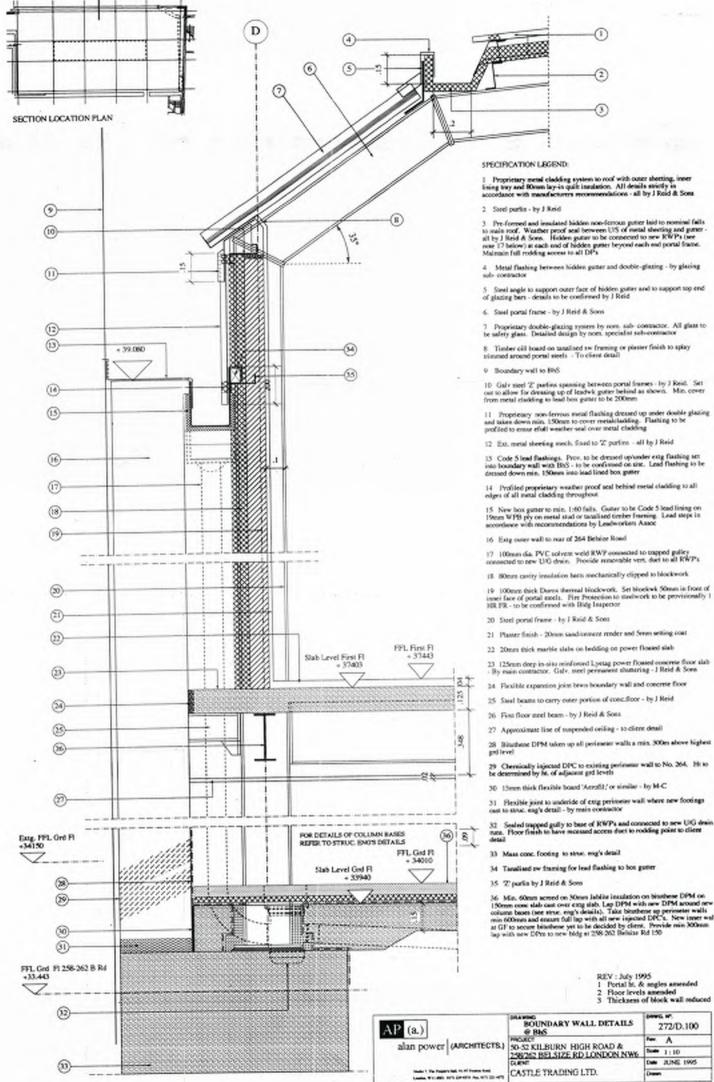
Checks on the existing foundations were also carried out. It was calculated that the existing pad sizes were all suitable for the new loading allowances, with a modest amount of spare capacity.

With the load redundancy in the mezzanine columns and deck, it does indicate that the beams were likely designed compositely, usually in the forms or pre-welded metal studs encased within the concrete slab along the beam lengths. If this is the case, it's possible to further the load capacity (30% betterment). As part of some further investigation, it could be useful to expose the tops of the beams locally to check the as-built detail.

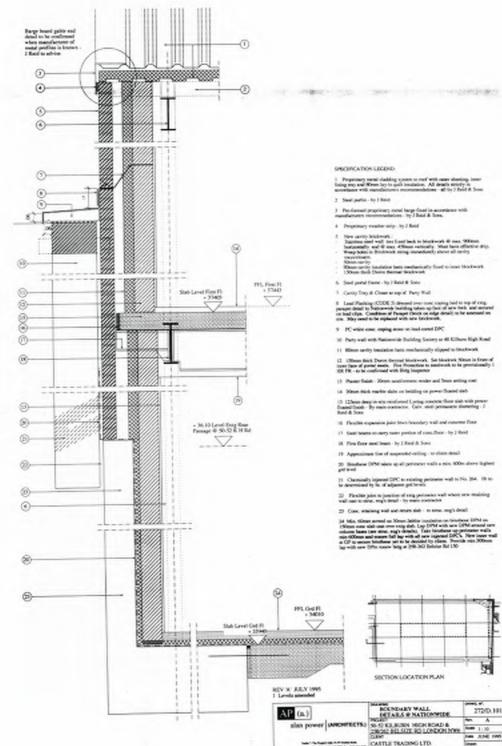
Overall, all superstructure and substructure elements were found to have sufficient capacity to accept a new residential load allowance. Certain steel elements were 'close' to capacity, thus likely requiring some added strengthening works. This can be incorporated into any addition steelwork that is required as part of the reworking of the main frame to suit the new resident scheme layout.

Appendix A Archive Drawings





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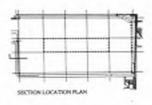
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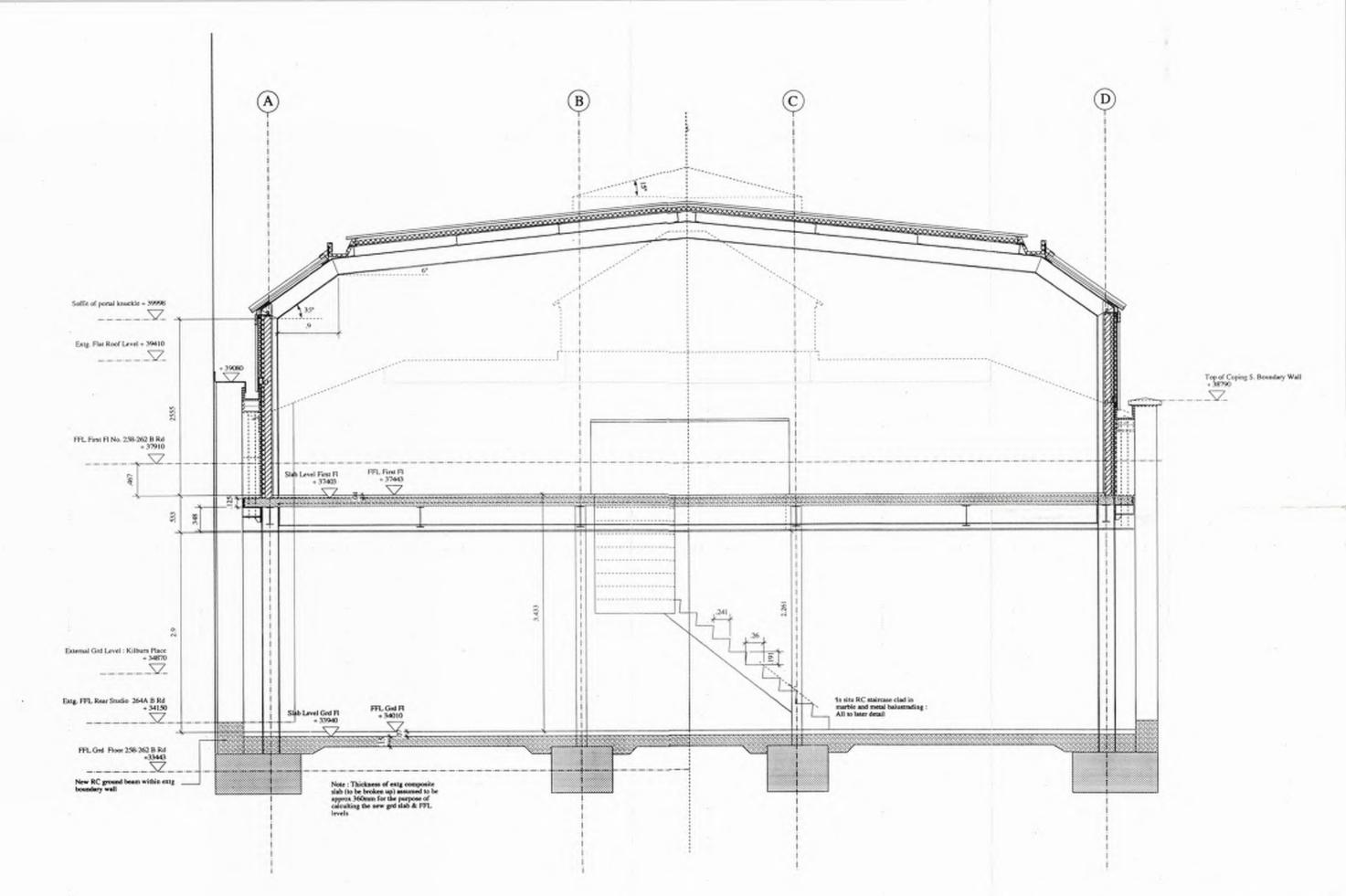
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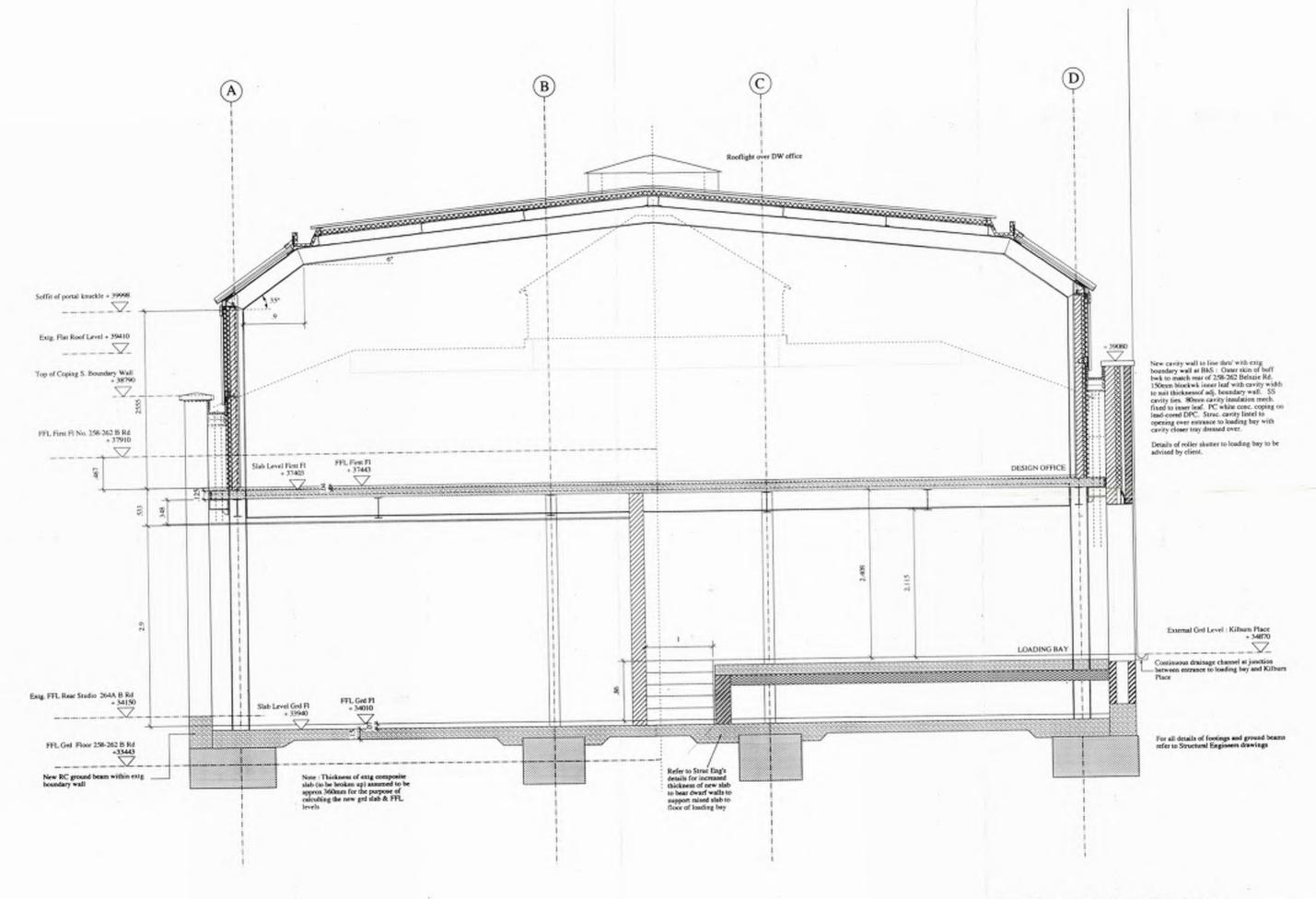
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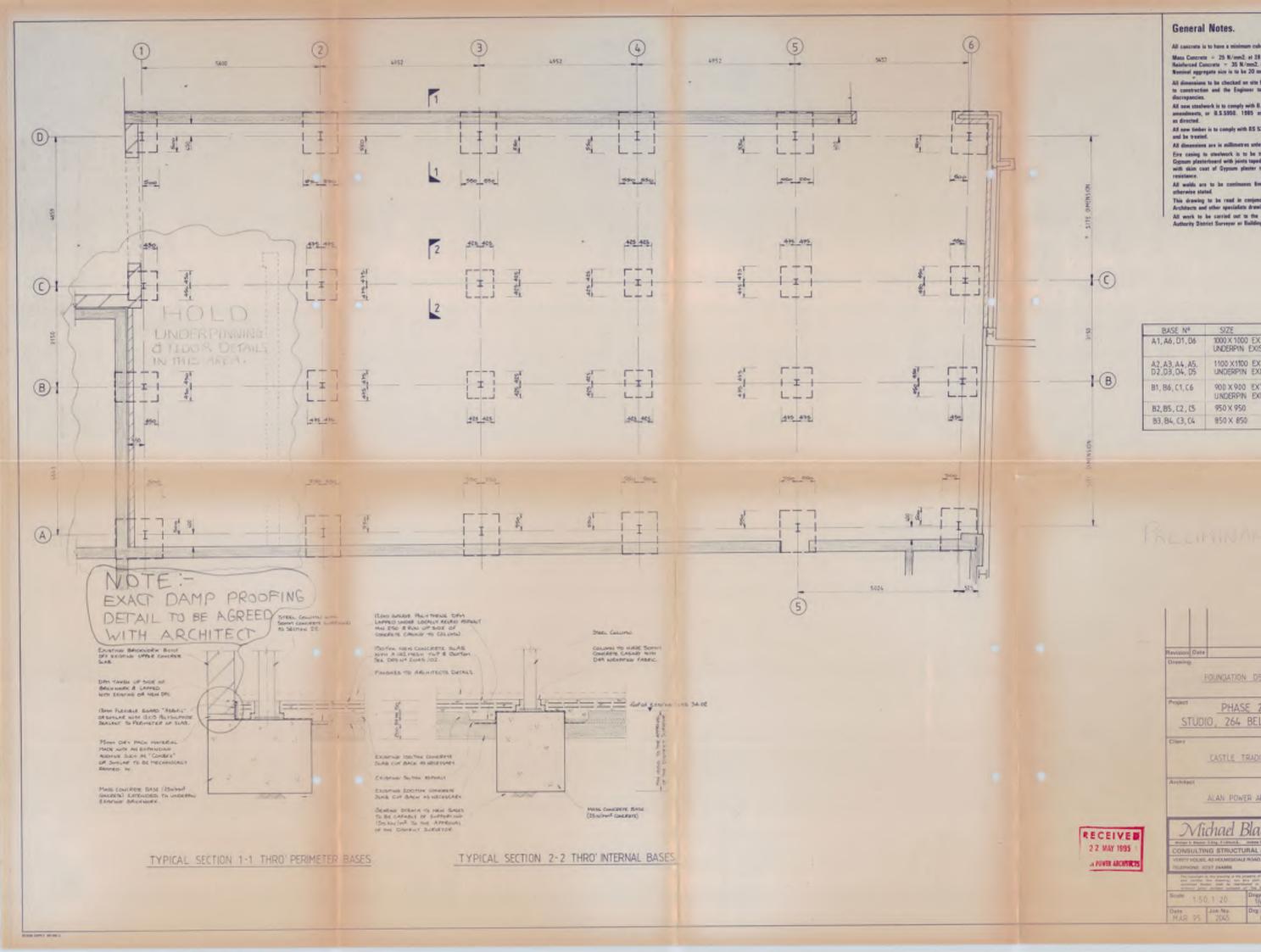
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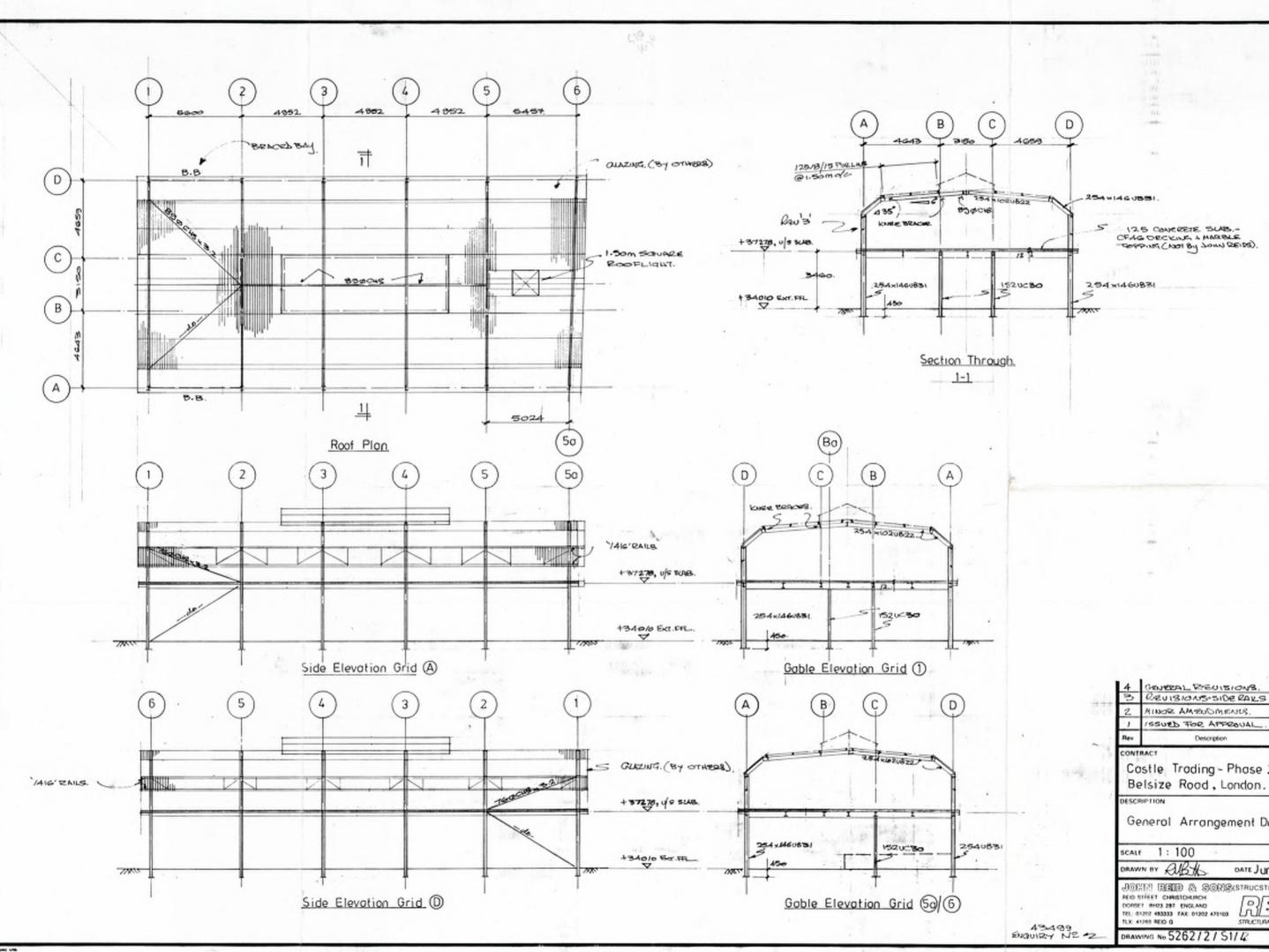
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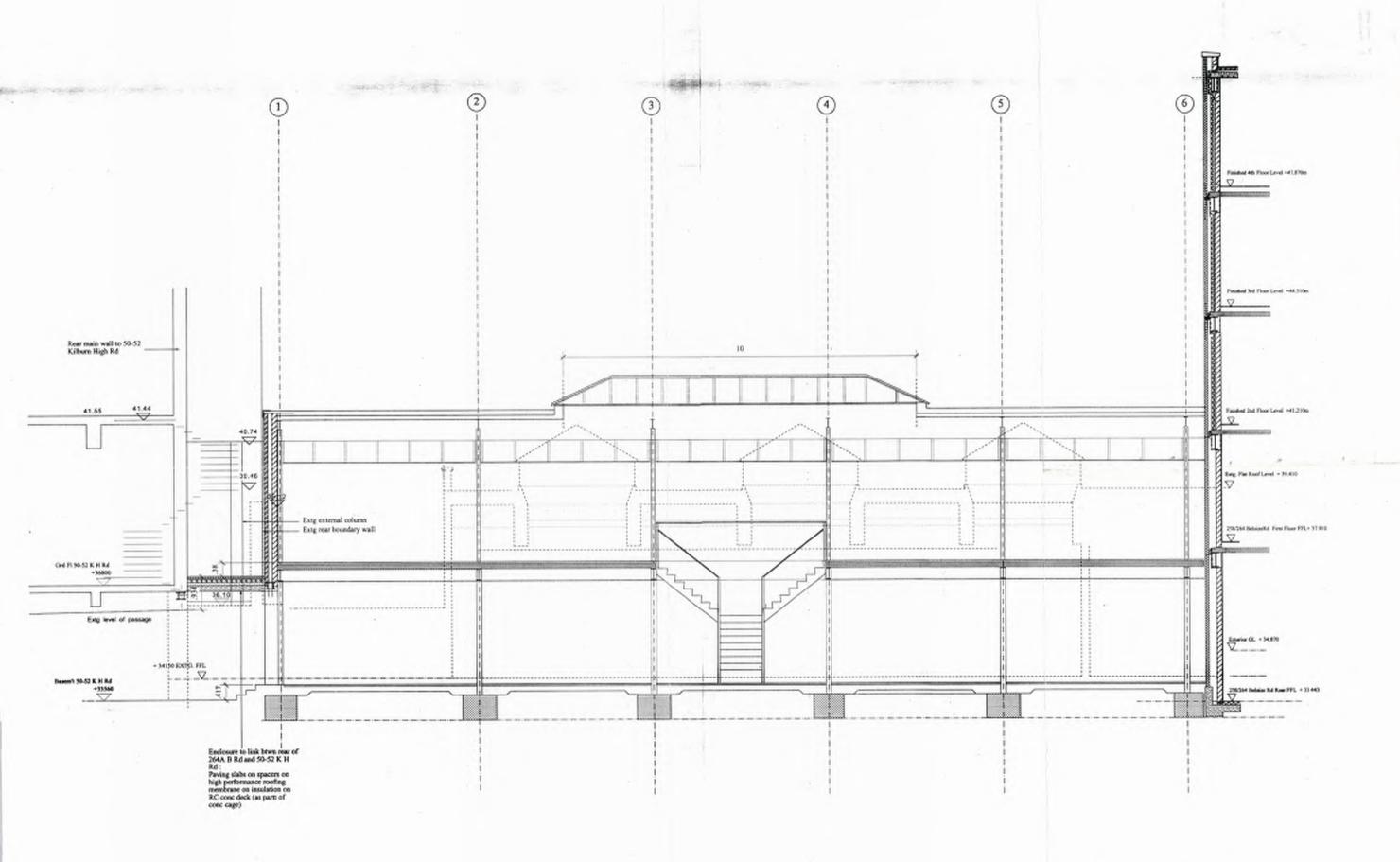


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