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waterman moylan

MetroLink Submission

Project:	Cadenza – MetroLink Submission	**Job No:**	18-020
Subject:	Review of MetroLink Rail Order		
Prepared by:	R.Osborne	**Date:**	20 March 2024

Introduction

I, Richard Osborne, Director of Waterman Moylan Consulting Engineers Limited, have prepared this submission based on a review of the documents and information provided. I have over 25 years of experience in design, construction and management. I am a Chartered Engineer ("CEng"), a Fellow of the Association of Consulting Engineers ("FConsEI") and a Member of the Institution of Engineers of Ireland ("MIEI"). Irish Life Assurance plc has retained me concerning the impact of the MetroLink tunnel passing under the recently completed Cadenza Building.

Module 1

Damage to the Cadenza Building

The issue of concern for our client is that although a submission was made to the TII informing them of the structural form and geometry of the existing Cadenza Building, the TII ignored the information.

The "EIAR Addendum Downward Realignment St Stephens Green Station to Charlemont Station", which incorporates the lowering of the Metrolink Tunnel to avoid clashing with the existing tension anchors, has reassessed the expected settlement/subsidence due to the Metrolink Tunnel.

Specific Building	Parameter	Critical Segment	Start [m]	End [m]	Curvature	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
B-53	Max Slope	1	0	9.1263	Sagging	1.79E-04	14.945	0.0366		4746.7	Negligible
	Max Settlement	1	0	9.1263	Sagging	1.79E-04	14.945	0.0366		4746.7	Negligible
	Max Tensile Strain	2	9.1263	28.939	Hogging	1.79E-04	9.0642	0.0361	1264		Negligible
	Min Radius of Curvature (Hogging)	2	9.1263	28.939	Hogging	1.79E-04	9.0642	0.0361	1264		Negligible
	Min Radius of Curvature (Sagging)	1	0	9.1263	Sagging	1.79E-04	14.945	0.0366		4746.7	Negligible
B-147	Max Slope	1			Hogging	1.00E-03		0.0400			Negligible
	Max Settlement	1			Hogging	1.00E-03		0.0400			Negligible
	Max Tensile Strain	1			Hogging	1.00E-03		0.0400			Negligible
	Min Radius of Curvature (Hogging)	1			Hogging	1.00E-03		0.0400			Negligible
	Min Radius of Curvature (Sagging)	1			Hogging	1.00E-03		0.0400			Negligible

The expected settlement/subsidence has now further reduced to 19.45mm and has been categorised as negligible. We believe that this categorisation is incorrect.

As previously stated in our initial submission, the level of damage the Cadenza Building could reasonably accommodate is less than 0.1mm. Even at this level, there are still concerns that the basement waterproofing system will be compromised and that remedial work will be required to be done to an occupied building.

If the Metrolink Tunnel is to pass under or close to the Cadenza Building, we require a detailed Phase 3 assessment using the correct building geometry and structural form to be completed and independently verified, ensuring the maximum damage caused to the Cadenza Building is limited to 0.1mm cracking. We still believe the proposed tunnel elevation may need to be lowered further, possibly more than the current LOD downwards would allow.

The primary concern for our client is physical damage to the Cadenza Building, either through the Tunnel Boring Machine damaging the existing structure or the secondary effects caused by the Tunnel Boring Machine, such as subsidence/settlement of the ground damaging the integrity of the waterproofing system, structure and facades.

The revised information submitted by TII does not provide our client with any further comfort that the Cadenza Building will not be damaged due to the Metrolink Tunnelling Works.

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Module 2

Future Extension of the Cadenza Building

The Cadenza Building is a modern building. However, it is likely that at some point in the future, there will be a need to either extend the existing building vertically or demolish it and replace it with a new building.

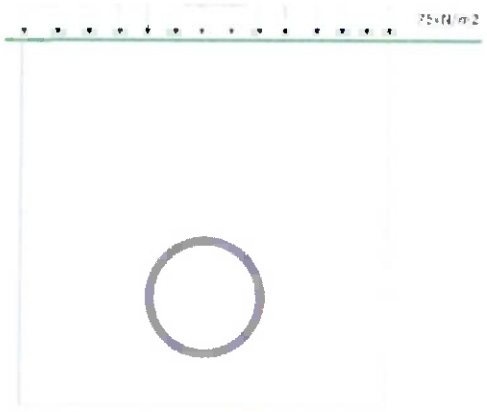
The existing building could be vertically extended by removing the upper step back floors and adding four additional floors to the existing structure without causing any distress to the existing structure or foundations. The foundation loads would increase to support the additional floors of the building.

The vertical extension would be subject to limitations imposed by the Metrolink Tunnel being located so close (directly under) the existing substructure of the Cadenza Building. In this regard, in section 2.1.1. of the Draft Guidance Note For Developers document, the zones are defined as follows:

- ***Exclusion Zone*** *is the volume of subsoil along the bored tunnel, cut and cover tunnel and retained cut alignment in which no future works or developments are allowed to encroach. Future surface works or developments are allowed above a subsurface Exclusion Zone, provided the foundation does not intrude into the Exclusion Zone, and the MetroLink structures are not adversely affected.*
- ***Protection Zone*** *is the volume of subsoil and the area on the ground surface along the bored tunnel, cut-and-cover tunnel and retained cut alignment in which future works or developments could impact the MetroLink structures. Future works or developments are allowed in the Protection Zone with any depth of foundation, provided it does not adversely affect the MetroLink structures and is subject to written agreement with TII.*

In addition, section 2.1.4 of the Draft Guidance Note For Developers document and figure 10 confirm:-

- *The tunnel lining design has been prepared on the basis that the bored tunnels are able to carry an over-site load of 75kN/m². The imposed vertical loading for the tunnels is shown diagrammatically in the following.*



If this level of load limiting is imposed due to the Metrolink Tunnel, it would not be possible to build a traditional house, let alone extend or rebuild the Cadenza Building, which imposes 1000kN/m² at the underside of the foundation level directly above the tunnel.

The conditions imposed by the Metrolink Tunnel would preclude either the vertical extension or future redevelopment of the Cadenza Building, and the exclusion zone would also appear to preclude the deepening of the existing basement level.

We are concerned that TII has not adequately considered the level of foundation loading so close to the Metrolink Tunnel.

Summary

Based on the findings of our review, we believe the following limitations Metrolink Tunnel must be imposed :

Limitations Summary

Maximum ground settlement over Metrolink tunnel	= 3.0mm (to prevent damage to the façade)
Maximum ground slope	= 1:4000 (to prevent damage to the façade)
LOD vertically	= +0 upward / -5 downward
LOD horizontally	= +0 westward / -15 eastward
Maximum crack width induced in basement structure	= 0.1mm (to maintain waterproofing integrity)

A robust Phase 3 assessment (based on parameters agreed between the parties) for Property must be completed by TII by 31 May 2024 and provided to the Owner.

TII should be required to design and construct the tunnel to ensure that the tunnel's loading tolerances beneath the Property will be capable of supporting the construction of an additional two storeys on top of the Cadenza Building.

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