(17)

MetroLink - Module 1

1. Tunnelling, Excavation Related Issues (Groundborne Noise & Vibration, Hydrogeological and soils impacts, settlement, property damage
2. Airborne Noise & Vibration

Monday 4th March

Witness Statement by [Brian Kavanagh of GARLAND] on Behalf of Charlemont & Dartmouth Community Group in relation to [Building Settlement]

1. Introduction

This statement is submitted on behalf the Charlemont & Dartmouth Community Group (DCDG). DCDG made submissions on behalf of

- Dartmouth Road Residents
- Dartmouth Square West Residents
- General Area

This statement relates to building settlement and principally concerns impacts upon Dartmouth Road properties 26-28 and 32-35 and Dartmouth Square West nos. 1, 3, 5, 7, 9, 10, 11, 12, 13, 14, 15, 16.

2. Qualifications

Brian Kavanagh, B.E., Dip. Proj. Mgmt., Eur.Ing., CEng., M.I.E.I., F.Cons.E.I., F.I.E.I, is Chairman and Director of Garland, Civil and Structural Engineering Consultancy and has over 35 years' experience in the planning, design and construction of civil and structural engineering of projects and has acted as Project Manager/Team Leader for design, contract administration and supervision of construction for large projects. He has particularly experience on historic and protected structures, such as Christ Church Cathedral, All Hallows College and Molyneux Apartments, Leeson Park which are very close to the area in question. He was-President of the ACEI for the 2022/2023 term and is still serving on the ACEI Executive Committee. Brian is also the Convenor of the BCAR Committee of the ACEI. He was the inaugural Chairman of the Structures and Construction Division of Engineers Ireland and spent 10 years as a member of the Council and Executive of Engineers Ireland along with 7 years as Chairman of the Finance Committee.

Cross Reference with TII Response

(This can be broken down in a themed manner if appropriate)

Dartmouth Road Submission (TII Response 40)

Dartmouth Square West Submission (TII Response 41)

Themes	TII Response Item No.
Overview	
Theme 1 (e.g. methodology)	TII Submission 40 – Point 2,3,
Theme 2 (e.g ground noise)	
Theme 3 (EIAR conclusions)	
Overall Conclusions	

3. Overview

4. Building Settlement

TII Building Damage Section (Appendix 5.19) has predicted "conservative" settlement figures in the area of the Charlemont Station / Turnback In the order of

30mm Rear of Dartmouth Walk / Square West

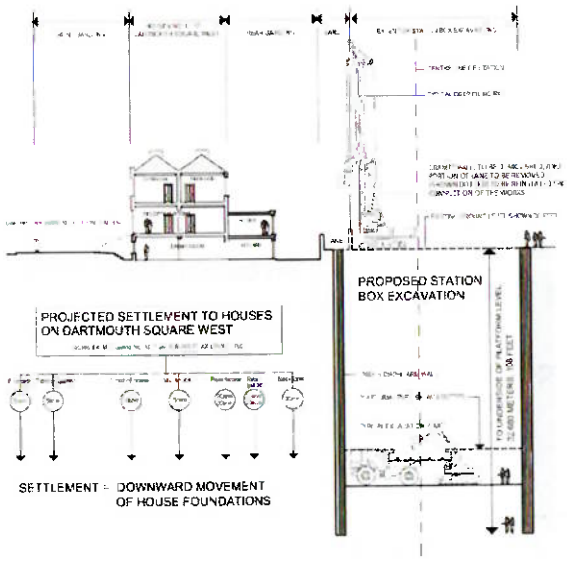
10mm Front of Dartmouth Walk / Square West

45mm Front of Dartmouth Road

35mm Rear of Dartmouth Road

We refer to the revised predicted settlements reproduced below.

(Extract from Drawing ML1-JAI-EIA-ROUT_XX-DR-Y-21147)

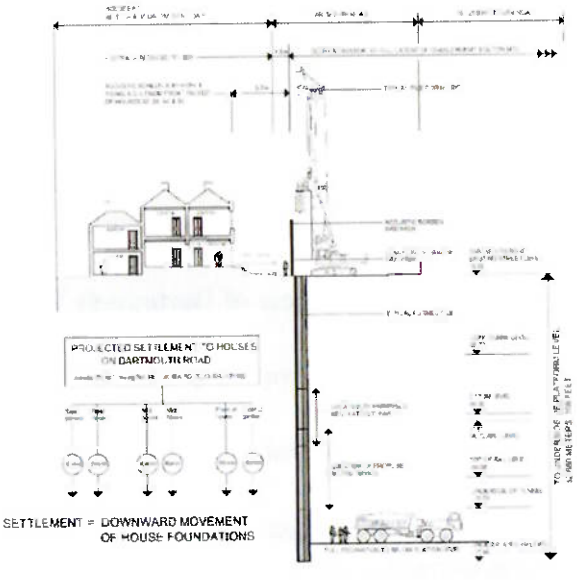


SETTLEMENT OF 30mm PROJECTED FOR HOUSES AT DARTMOUTH SQUARE WEST

A EXTREME DEPTH OF EXCAVATIONS - SETTLEMENT CONCERNS
B PROXIMITY OF CONSTRUCTION PILING RIGS AND PILES - VIBRATION AND SETTLEMENT CONCERNS
C PROXIMITY OF METRO TUNNEL AND STATION BOX - VIBRATION AND SETTLEMENT CONCERNS
D SEE ALSO ACCOMPANYING COLOURED CONTOUR PLAN PROJECTED SETTELEMENTS

DEEP EXCAVATION, PROJECTED SETTLEMENT TO HOUSES AT DARTMOUTH SQUARE WEST

7 DECEMBER 2020
REVISION 4



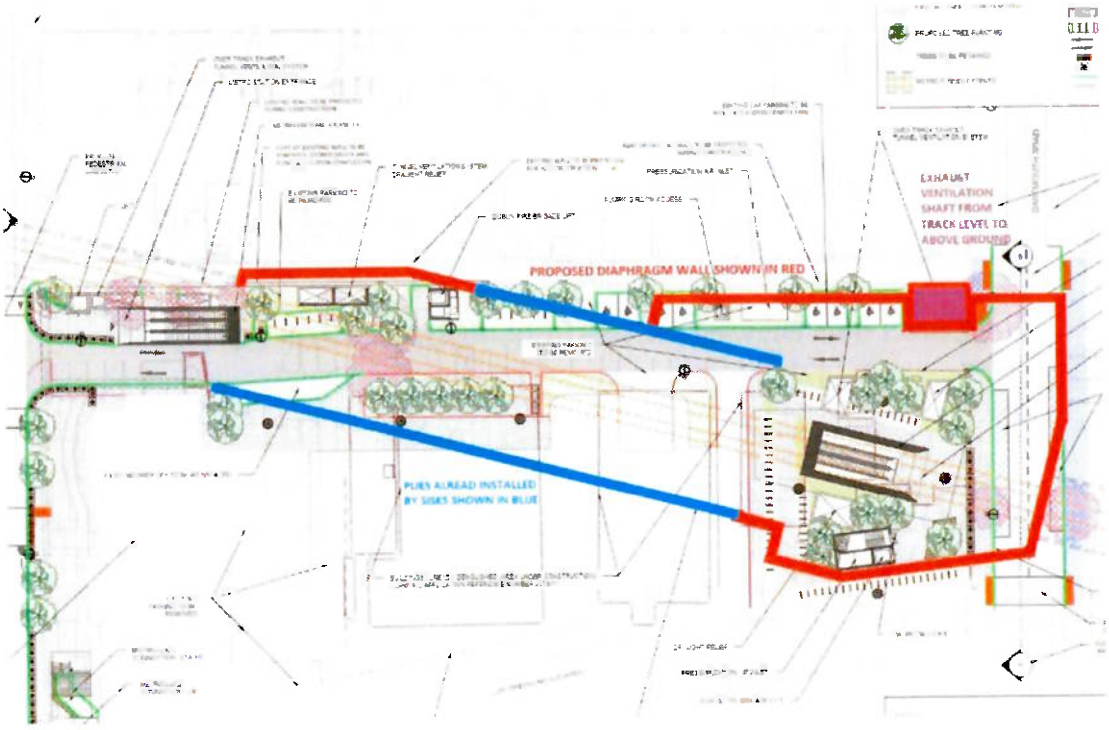
SETTLEMENT OF 45 mm PROJECTED FOR HOUSES 32 TO 35 DARTMOUTH ROAD

A EXTREME DEPTH OF EXCAVATIONS - SETTLEMENT CONCERNS
B PROXIMITY OF CONSTRUCTION PILING RIGS AND PILES - VIBRATION AND SETTLEMENT CONCERNS
C PROXIMITY OF METRO TUNNEL AND VENTILATION TUNNEL - VIBRATION AND SETTLEMENT CONCERNS
D RESTRICTED FOOTPATH REDUCED TO 1.8M FOR 8.5 YEARS - DARK - UNSAFE
E EXISTING HEIGHT OF HOARDING AND SCREENING 8.5m HIGH FOR 8.5 YEARS - OVERBEARING

DEEP EXCAVATION, PROJECTED SETTLEMENT TO HOUSES AT 32 TO 35 DARTMOUTH ROAD

7 DECEMBER 2020 REVISION 1

However, these settlements are based on a "rectangular" station box. In fact, the actual extent of the station is considerably more, see extract from drawing below.



Nevertheless, the settlements which are noted above are differential settlements between the front and rear of masonry buildings dating from the mid-1800s. The impact of differential settlement on these tall, masonry buildings will be severe.

All of these houses represented by the Charlemont & Dartmouth Community Group are Protected Structures and located in an Architectural Conservation Zone and, as such, are more susceptible to damage by both ground movement and vibration than more modern structures. Moreover, they are terraced structures which share party walls.

The structures of these buildings generally do not have a redundancy built into them as they contain susceptible brick and stone walls containing lime mortars, lath and plaster ceilings, period cornices, timber floors, door & architraves along with timber windows. The walls support timber rafters with brittle slate coverings and lead flashings. Unless the roofs have been replaced, the secondary waterproofing is based on "daubing" which is extremely sensitive to any movement, Nonetheless any movement in the roof structures will also inevitably lead to water ingress and further damage to the protected building fabric.

Section 4.1 of Appendix A5.17 indicates "In the context of building damage assessment, 'special' considerations refer to buildings (hereafter referred as 'special' buildings) in proximity of the excavation, with deep basements, or those identified as designated Protected Structures...". However, the protected buildings on Dartmouth Square West and on Dartmouth Road are excluded.

We also note that the technical note provided by Alberto Jaen Toribio on the Impact of the Preliminary Design Building Damage Assessment results due to the imposition of limits of deviation concludes that the building damage assessment is based on the tunnel alignment and not the station box construction. However it concludes that no additional building would qualify for the Phase 3 assessment.

A review of the EIAR and associated appendices, it is evident that a very limited assessment of settlement and subsidence has been carried out. It can be seen from the above diagram that the houses directly over the tunnels on Dartmouth Road fall within the 35mm to 45mm settlement zone. This is defined as "slight" risk category. We would query this classification as "slight". However, given that all bar one of the buildings covered by this submission are protected structures, they should be classed as damage category risk 3 (moderate) or 4 (severe). We will discuss this later.

A phased system of assessment is proposed

Phase 1 – the assessment of the greenfield settlement contours using generic ground parameters

and the identification of buildings that are

a) enclosed by the 10mm contour or with a ground settlement slope > 1:500 and

b) those buildings enclosed by the 1mm contour subject to 'special' considerations.

Phase 2 – all the buildings identified in Phase 1 are assessed using the greenfield ground movement profile making credible foundation assumptions and are classified into Damage Categories 0 – 5;

those buildings placed in Damage Category 3 or above, and those subject to 'special' considerations see below) are carried through to Phase 3.

Phase 3 – each identified building is considered individually to determine its behaviour using detailed information and assessment methods; this may include a refined ground model, detailed structural surveys, refined construction methodology and use of sophisticated soil-structure interaction analysis such as finite element analysis.

Taking the 20mm differential settlement across the Dartmouth Walk buildings, this could equate to cumulative cracking of up to 20mm. (based on parapet height of 8m and a depth of 16m). Again we are not assessing the effect of a long terrace of buildings in this damage.

We refer to the BRE Digest Assessment of Damage in Low Risk Buildings, and specifically Table 1:

Table 1 Classification of visible damage to walls with particular reference to ease of repair of plaster and brickwork or masonry

Crack width is one factor in assessing category of damage and should not be used on its own as a direct measure of it.

Category of damage	Description of typical damage *Ease of repair in italic type*
0	Hairline cracks of less than about 0.1 mm which are classed as negligible. *No action required.*
1	Fine cracks which can *be treated easily using normal decoration*. Damage generally restricted to internal wall finishes; cracks rarely visible in external brickwork. Typical crack widths up to 1 mm.
2	*Cracks easily filled. Recurrent cracks can be masked by suitable linings*. Cracks not necessarily visible externally; *some external repointing may be required to ensure weather-tightness*. Doors and windows may stick slightly and *require easing and adjusting*. Typical crack widths up to 5 mm.
3	Cracks which *require some opening up and can be patched by a mason. Repointing of external brickwork and possibly a small amount of brickwork to be replaced.* Doors and windows sticking. Service pipes may fracture. Weather-tightness often impaired. Typical crack widths are 5 to 15 mm, or several of, say, 3 mm.
4	Extensive damage which *requires breaking-out and replacing sections of walls*, especially over doors and windows. Windows and door frames distorted, floor sloping noticeably*. Walls leaning or bulging noticeably*, some loss of bearing in beams. Service pipes disrupted. Typical crack widths are 15 to 25 mm, but also depends on number of cracks.
5	Structural damage which *requires a major repair job, involving partial or complete rebuilding*. Beams lose bearing, walls lean badly and require shoring. Windows broken with distortion. Danger of instability. Typical crack widths are greater than 25 mm, but depends on number of cracks.

As can be seen from the above table, category 2 cracks of up to 5mm mean there is not only cracking present, but windows and doors do not close easily. Category 3 cracks of upto 15mm or multiplies of 3mm cracks mean that cracks may require opening up and repair, repointing and replacement of external brickwork. Sticking Doors and Windows and service pipes may fracture.

However we are likely to be in Category 4 damage, which is

Extensive Damage which requires the breaking out and replacing of sections of walls, especially over the weak points of doors and windows. Floors will slope noticeably. Walls will lean and bulge noticeably.

The majority of the drainage pipes in this area are earthenware and are extremely susceptible to fracture. This would lead to escape of both surface water and foul drainage in and around the buildings.

Such water escape would further exacerbate the settlement of the buildings leading to more excessive cracking and damage.

Even from a from a cosmetic view, which is not the damage to the fragile front brick facade will have ever-lasting consequences for how the buildings are perceived - currently, pretty perfect, will permanently display signs of structural damage repaired - not a good look, and very hard to hide.

Damage of this magnitude will make the homes unliveable, resulting the displacement of the community for the duration of the works.

5. Vibration

In relation to vibrations: TII have indicated that vibrations from tunnelling and blasting are in the range of 11.2 mm/s for blasting alone.

We would refer to BS 7385-2: 1993 guidance reproduced below which gives guidance on the threshold for Significant effects on building structures.

Type of Property	**Allowable Vibrations (ppv)at the closest part of the property to the source of vibration at a frequency of 4 Hz (mm/s)**	
	Continuous Vibrations	**Transient Vibrations**
Residential or light Commercial type Buildings	15	7.5
Protected and Historic Buildings	3-7.5	6-15
Identified Potentially Vulnerable Structures and Buildings with Low Threshold	3	

The TII document actually provides a table which sets out lower limits than those noted above.

Table 14.3: Guideline Values for Vibration Velocity, v_{max}, for Evaluating the Effects of Short-Term Vibration on Structures

-	Type of Structure	Guideline				
		Foundation, all directions, i = x, y, z, at a frequency of			Topmost floor, horizontal direction, i – x, y	Floor slabs, vertical direction, i = z
		1Hz to 10Hz	10Hz to 50Hz	50Hz to 100Hz[a]	All frequencies	All frequencies
	1	2	3	4	5	6
1	Buildings used for commercial purposes, industrial buildings, and buildings of a similar design	20	20 to 40	40 to 50	40	20
2	Residential buildings and buildings of similar design and/or occupancy	5	5 to 15	40 to 50	15	20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings)	3	3 to 8	8 to 10	8	20[b]
NOTE Even if guideline values as in line 1, columns 2 to 5, are compiled with, minor damage cannot be excluded.						
[a] At frequencies above 100Hz, the guideline values for 100Hz can be applied as minimum values [b] Paragraph 2 of 5.1.2 in DIN 4150 says "In the case of building types as in Table 1, line 3, it may be necessary to lower the relevant guideline value markedly to prevent minor damage"						

The figures given for blasting exceed the minimum limits for protected structures and come close to the upper limits for BS 7385 and are significantly above those limits set out in Table 14.3 above, for Protected Structures, however the residual impacts are described as "Not Significant".

The report contradicts itself when it states that potential significant impacts have been identified at 16 receptors where any required preconstruction repair works will be undertaken. These 16 sites include;

11 to 16 Dartmouth Square West

19A Dartmouth Road

19-25 Dartmouth Road

33 & 34 Dartmouth Road.

Combined with the damage from settlements the damage associated with vibrations from the construction process will place intolerable damage on these buildings which are part of the historic footprint of Dublin.

6. Conclusions

The level of design that is set out in the railway order is at far too an early stage to allow realistic assessment of ground movements to be made and as such the consequential damage to the historic structures of Dubin and in particular the Protected structures which make up the Architectural Conservation Area of Dartmouth Square and it's environs.

TII have not demonstrated that the damage to the buildings in this area will not be Category 3 or even Category 5, which could never be "Slight" damage but is rather moderate or severe.

The mitigation of property surveys is akin to shutting the door after the horse has bolted!.

We would respectively ask that the Railway Order is refused on the basis of insufficient design, lack of protection of property rights and excessive nuisance in terms of damage, noise and vibration during the construction phase.