Geo-Environmental

BUILDING DAMAGE ASSESSMENT

for the site at

1 ELSWORTHY TERRACE,

LONDON, NW3 3DR

on behalf of

MRS MIRYAM CAROLINE NOURANI

Report:	**BUILDING DAMAGE ASSESSMENT**
Site:	**LAND AT REAR OF 1 ELSWORTHY TERRACE**
Client:	**MRS MIRYAM CAROLINE NOURANI**
Date:	**15/06/2016**
Reference:	**GE11003 – BDAv1JT160615**
Version:	**1.0**
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1.0 INTRODUCTION

1.1 General

Geo-Environmental Services Limited (Geo-Environmental) was instructed by Mrs Nourani to prepare a Building Damage Assessment for a proposed new development with a double level basement at land to the rear of 1 Elsworthy Terrace, London, NW3 3DR. Geo-Environmental had previously prepared a Desk Study and Basement Impact Scoping Report for the site, and for further details reference should be made to these reports(referenced: GE11003 – BIA/JO01/150921 and GE11003 – GARv2JK160201).

The report was to provide information on the effect the new excavation would have on the neighbouring properties No. 23 Elsworthy Road and No.s 2 & 3 Elsworthy Terrace. When viewed from Elsworthy Road, No.23 Elsworthy Road was located on the left hand side (east) and No.1 & 2 Elsworthy Terrace were to the right (west) of the property. The layout of the buildings is shown in Figure 1. No. 23 Elsworthy Road was not thought to have an existing basement, whilst No.1 Elsworthy Terrace appeared to have a lower ground floor which was approximately one metre lower than the level of the proposed site.

The basement for the new development was to be formed by contiguous bored piles (see Figure 2).

1.2 Conditions

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1.3 Construction Methodology

The proposed basement excavation will extend to circa 7.0m and should be founding wholly within the London Clay. The current plans suggest that (at its' closest) the house and basement will be approximately 3.6m from the nearest habitable property.

Due to the proximity of the adjacent buildings, temporary support of the excavations will be required to retain the adjoining soils, walls and buildings. It is anticipated that due to the depth of excavations required and the nature of the soils on site a concrete bored pile retaining wall will be constructed. This will limit anticipated vibrations during installation to a minimum. The pile wall will be provided around the full basement perimeter. It is likely that the piles will be designed as propped piles to ensure anticipated deflections and soil settlements are kept to a minimum and any damage to adjoining buildings is mitigated.

The following sequence of work is anticipated for the construction of the basement and is based on the adoption of a contiguous bored pile wall extending into the clay subsoil:

- Install suitable piling mat across the footprint of the basement to an agreed level.
- Install contiguous bored piles in accordance with piling contractors design.
- Excavate ground to just below underside of proposed concrete capping beam.
- Construct capping beam to perimeter of basement and install temporary propping.
- Excavate soils within the basement footprint to formation level, installing any additional temporary propping if required by the pile design as work progresses.

- Prepare the formation in preparation for installing surface and foul drainage and for constructing the new reinforced concrete basement foundation slab. These works are to be inspected and approved by the Building Control officer prior to the pouring of basement concrete.
- Construct suspended basement slabs and walls to an agreed sequence.
- Construct ground floor slab to an agreed sequence.
- Remove any temporary propping in line with the agreed sequence once the permanent concrete structure is in place and of sufficient strength.
- Basement construction complete. Commence construction of superstructure above.

2.0 ENCOUNTERED CONDITIONS

A factual record of the conditions encountered during the intrusive investigation of the site is presented in the following sections.

2.1 Ground Conditions

The investigation encountered the anticipated geological conditions of the London Clay Formation beneath variable thicknesses of Topsoil and Made Ground. A summary of the ground conditions encountered within exploratory holes is presented in Table 2.1.

Top (m bgl)	Base (m bgl)	Description
0.00	0.15 – 0.30	TOPSOIL: Dark greyish and brownish black silty and sandy clay with occasional flint gravel, rootlets, brick and carbonaceous inclusions
0.15 – 0.30	0.35 – 0.95	MADE GROUND: Dark brown silty clay with occasional flint gravel, rootlets and roots, brick, calcareous and carbonaceous inclusions and clinker
0.35 – 0.95	15.00	LONDON CLAY FORMATION: Firm to stiff light brown and grey mottled becoming dark grey silty CLAY with occasional silt and claystone lenses and frequent selenite crystals

Table 2.1 – Summary of ground conditions

Rootlets and roots were encountered within several of the intrusive locations to a maximum observed depth of 8.00m (within BH1).

2.2 Groundwater

Groundwater was not encountered within the intrusive locations during the investigation. A standpipe was installed within BH1 to a depth of 8.00m. A return monitoring visit was undertaken on 5th January 2016.

Water was encountered at a depth of 4.90m within the standpipe during the return monitoring visit. However, this is not considered to be representative of the true groundwater level in the area and is likely an accumulation of perched water from within claystone lenses of the London Clay Formation.

The proposed basement extends to depths of between 7mbgl and given the ground conditions is not anticipated to encounter groundwater.

3.0 GROUND MOVEMENTS

There is the potential for ground movements to occur due to the proposed development, e.g. from the excavation process, including formation of contiguous bored piles, and from the changes in vertical stress within the soil resulting from the changes in loading from the development.

The effect of excavating soil is to cause a reduction in stress at the new formation level, due to the weight of the overburden removed. Since typically, construction follows on shortly after excavation, this unloading of the ground is normally modelled as producing a short term (undrained) response in cohesive strata. However, if there is a delay in the construction phase, a fully drained response to the unloading may develop. In the case of the proposed development, such movements have not been calculated separately using the software Pdisp as it has been assumed that subsequent modelling using the software Xdisp and CIRIA 580 ground movement curves for excavation in front of a contiguous bored pile wall would include any such movement. Furthermore, it was considered that these movements will occur within the perimeter of the excavation and the surrounding piles will restrict the magnitude of any movements beyond the extent of the excavation.

The loading that results from the new construction will apply in the long term, over the structure's lifetime. Hence there will be both a short term and long term response. Generally, the long term behaviour results in larger movements. The overall movement of the ground following construction is, however, driven by the total changes in loading that have occurred; thus it is a combination of the unloading caused by demolition and excavation of soil and the imposed loading from the new structure. It has again been considered that these movements would be largely constrained within the bored pile wall and as such their contribution to movements beyond the excavation would be negligible.

Therefore, the movement considered in this building damage assessment are associated with the movement due to the pile installation, and movements of the piled wall due to excavation in front of the retaining wall to form the basement excavation

3.1 Movements due to pile installation, and basement excavation.

The ground movements around the excavation have been modelled using OASYS XDisp. Each wall around the excavation has been assigned a horizontal and vertical ground movement curve which are used to calculate the displacements at various distances from the excavation.

In Xdisp it is not possible to model re-entrant corners, and therefore the modelled footprint of the proposed excavation has been modified slightly to include an angled portion in the north-eastern corner of the excavation. This change in the modelled is not anticipated to cause any significant changes to the movements calculated.

The assessment of the ground movements due to the construction of the bored pile wall and subsequent excavation has been undertaken in accordance with methodology provided in CIRIA guide C580, "Embedded retaining walls – guidance for economic design". This provides guidance on the horizontal and vertical movements at the soil surface adjacent to an embedded retaining wall as a result of pile installation and of excavation in front of the wall. The guidance is based on numerous case histories, and based on the construction methodology proposed in this case a high stiffness (propped) retaining wall has been assumed. The guidance states that few walls are constructed entirely in stiff over consolidated fine-grained soils. Although walls may be embedded into such soils, it is likely that they will also retain other soils such as Made Ground, River Terrace Deposits and other alluvial soils. The guidance and principles presented in the guidance also apply to these ground conditions. In this case, the bored pile wall would be with the exception of a thin mantle of Made Ground wholly within London Clay, and as such the movement curves are considered applicable to the site conditions.

The movements derived from XDISP is based on the surface ground movement curves presented in the CIRIA guidance, which are based on empirical data. As such, it is assumed that they include any short-term element of ground movement due to vertical stress change.

The movements given by CIRIA are for excavations with straight walls; corners tend to restrict movements, such that horizontal deflections towards an excavation in the vicinity of a corner to the excavation are typically reduced to about half that predicted from 'plane strain' movements, though this does not apply for re-entrant corners. The effect of the corner stiffening is calculated in XDISP in accordance with the methodology derived by Fuentes R. and Devriendt M. (2010).

Ground movement guidance in C580 is divided into movements resulting from pile installation and from the mass excavation in front of the wall. Based on the proposed excavation depth of 7.0mbgl the XDisp analyses indicates vertical settlements around the perimeter of the excavation (at ground level) ranging between 2-6mm, with a maximum of 7mm at c.4m from the basement. The settlements then decrease to 1-2mm at a distance of c.13m from the excavation. A contour plot of the settlements is presented in Figure 3.

Horizontal movements in towards the excavation have also been analysed using XDisp and are likely to be in the order of 10-13mm at the perimeter of the excavation, becoming negligible at 15-16m from the excavation. As stated above, the XDisp analyses have considered corner stiffening which serves to restrict movements at the corners of excavations. A contour plot of the settlements is presented in Figure 4.

The structures considered in the building damage assessment are summarised in the Table 3.1:

Structure(s)	Detail	Assumed Length (m)	Assumed Height (m)
No. 23 Elsworthy Road	Party Wall	14	13
No. 23 Elsworthy Road	Front Facade	17	13
No. 23 Elsworthy Road	Rear Wall	17	13
No. 1 & 2 Elsworthy Terrace	Rear Wall	13	10
No. 1 Elsworthy Terrace	Side Wall	11.5	10
No. 1 & 2 Elsworthy Terrace	Party Wall	11.5	10
No. 23 Elsworthy Road	Potential Internal Wall	16.9	13
No. 2 & 3 Elsworthy Terrace	Party Wall	11.5	10
No. 23 Elsworthy Road	Garage Party Wall	6	2.4
No. 23 Elsworthy Road	Garage Front Elevation	2.9	2.4
No. 23 Elsworthy Road	Garage Side Wall	6	2.4
No. 23 Elsworthy Road	Garage Rear Wall	2.9	2.4

Table 3.1 Structures Assessed

The maximum and minimum horizontal and vertical free field surface movements recorded along each structure is presented in the table below. Building displacement charts for each structure are also presented in Figures 5-16

Structure(s)	Detail	Maximum Ground Surface Displacement		Minimum Ground Surface Displacement	
		Horizontal (mm)	Vertical (mm)	Horizontal (mm)	Vertical (mm)
No. 23 Elsworthy Road	Party Wall	9	5	2	3
No. 23 Elsworthy Road	Front Facade	4	4	<1	<1
No. 23 Elsworthy Road	Rear Wall	4	3	<1	<1
No. 1 & 2 Elsworthy Terrace	Rear Wall	9	6	2	2
No. 1 Elsworthy Terrace	Side Wall	9	6	4	1
No. 1 & 2 Elsworthy Terrace	Party Wall	5	4	2	<1
No. 23 Elsworthy Road	Potential Internal Wall	6	3	2	<1
No. 2 & 3 Elsworthy Terrace	Party Wall	2	2	2	<1
No. 23 Elsworthy Road	Garage Party Wall	10	3	<1	2
No. 23 Elsworthy Road	Garage Front Elevation	11	7	9.5	3
No. 23 Elsworthy Road	Garage Side Wall	11	7	3	4
No. 23 Elsworthy Road	Garage Rear Wall	6	4	4	3

Table 3.2: Summary of Displacements

4.0 BUILDING DAMAGE ASSESSMENT

4.1 Classification of Damage

The adjoining structures have been modelled in XDisp in order to assess the potential category of damage in accordance with the criteria derived by Burland (1997) presented below:

Building / Structure Damage Risk Classification (Burland (1997)

Damage Category	Category of damage	Description of typical damage+ (Ease of repair is underlined)	Approx. crack width* (mm)	Limiting tensile strain (%)
0	Negligible	Hairline cracks	< 0.1	< 0.05
1	Very Slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in buildings. Cracks in external brickwork visible on inspection.	< 1	0.05 - 0.075
2	Slight	Cracks easily filled. Redecorating probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weather tightness. Doors and windows may stick slightly.	< 5	0.075 - 0.15
3	Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable linings. 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.	5 - 15 or a number of cracks > 3	0.15 – 0.3
4	Severe	Extensive repair work involving breaking out and replacing sections of walls, especially over doors and windows. Windows and door frames distorted, floor sloping noticeably. Walls leaning and bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15 - 25 but also depends on number of cracks	> 0.3
5	Very Severe	This requires a major repair job involving partial or complete rebuilding. Beams lose bearing, walls lean badly and require shoring. Windows broken due to distortion. Danger of instability.	Usually > 25 but depends on number of cracks.	-

Notes
+ In assessing the degree of damage, account must be taken of its location in the building or structure.
* Crack width is only one aspect of damage and should not be used on its own as a direct measure.

The ground displacements have been calculated for the existing surface level. However, the existing foundations for adjacent structures are likely to be bearing at 1-2m below ground and as such movements at the depths of the foundations are likely to be less than those calculated for the surface level.

Table 4.1 below summarises the deflection ratios and maximum tensile strains in the structures assessed and the worst case category of damage calculated.

Structure(s)	Detail	Deflection Ratio (%)	Average Horizontal Strain (%)	Maximum Tensile Strain (%)	Damage Category
No. 23 Elsworthy Road	Party Wall	0.022284	-0.14079	0.031034	Negligible
No. 23 Elsworthy Road	Front Facade	0.0034925	0.015948	0.019126	Negligible
No. 23 Elsworthy Road	Rear Wall	0.0017084	0.0039709	0.0019086	Negligible
No. 1 & 2 Elsworthy Terrace	Rear Wall	0.044066	-0.052248	0.33114	Negligible
No. 1 Elsworthy Terrace	Side Wall	0.026719	0.060506	0.069169	Very Slight
No. 1 & 2 Elsworthy Terrace	Party Wall	0.016129	0.030607	0.036612	Negligible
No. 23 Elsworthy Road	Potential Internal Wall	0.0052925	0.025125	0.029949	Negligible
No. 2 & 3 Elsworthy Terrace	Party Wall	0.00031026	0.0046294	0.0048842	Negligible
No. 23 Elsworthy Road	Garage Party Wall	0.030931	-0.23409	0.04977	Negligible
No. 23 Elsworthy Road	Garage Front Elevation	0.081828	-0.064315	0.062565	Very Slight
No. 23 Elsworthy Road	Garage Side Wall	0.052600	-0.033878	-0.034725	Negligible
No. 23 Elsworthy Road	Garage Rear Wall	0.027819	-0.10975	0.026694	Negligible
No. 23 Elsworthy Road	Party Wall	0.023176	0.0012672	0.031034	Negligible

Table 4.1 Damage category summary

Building damage interaction charts, for each of the structures listed in the table above are presented in Figures 17-28.

In summary, the analysis indicates that the predicted ground movements in response to the basement excavation would cause negligible to slight damage to the adjoining structures. It is anticipated that, where necessary, cross-

propping of the excavation will be introduced early in the works, providing a very stiff support system to the walls. Furthermore, it has been assumed that the wall construction will be carried out to a high standard of workmanship and measures will be taken to avoid instability of excavations and keep ground loss to a minimum. Furthermore, it is acknowledged that with good construction and controls the actual movements may be significantly less than those predicted by the CIRIA C580 methodology.

Full details of the XDISP results are available on request.

4.2 Monitoring

The results of the assessment indicate that with good construction control, damage to adjacent structures generated by the assumed construction methods and sequence are likely to be within Category 0 and 1 i.e. 'Negligible' to 'Very Slight'. A formal monitoring strategy is recommended in order to observe and control ground movements during construction. This should ensure movement do not start to fall outside of that predicted.

It is recommended that the monitoring system be designed and operated broadly in accordance with the 'Observational Method' as defined in CIRIA Report 185. Regular monitoring of positions will determine if any horizontal translation, tilt or differential settlement of the neighbouring structures is occurring as the construction progresses. Monitoring data should be checked against predefined trigger limits and should also be further analysed to assess and manage the damage category of the adjacent building as construction progresses.

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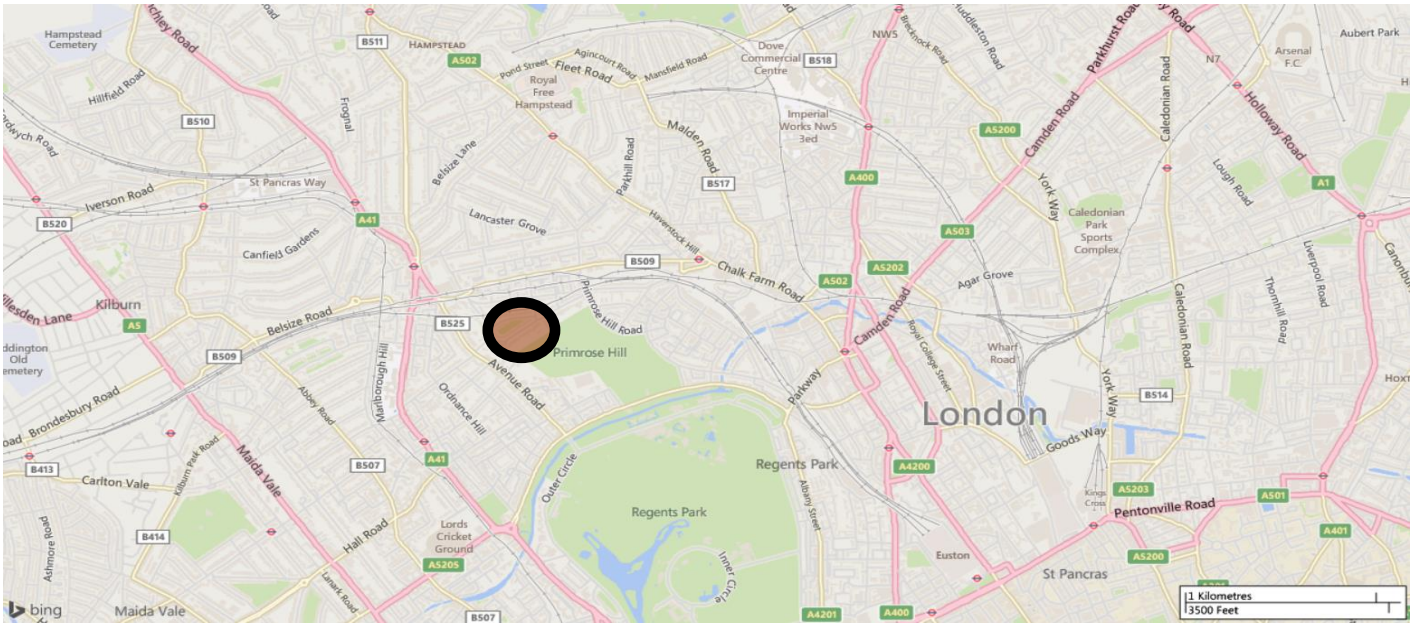
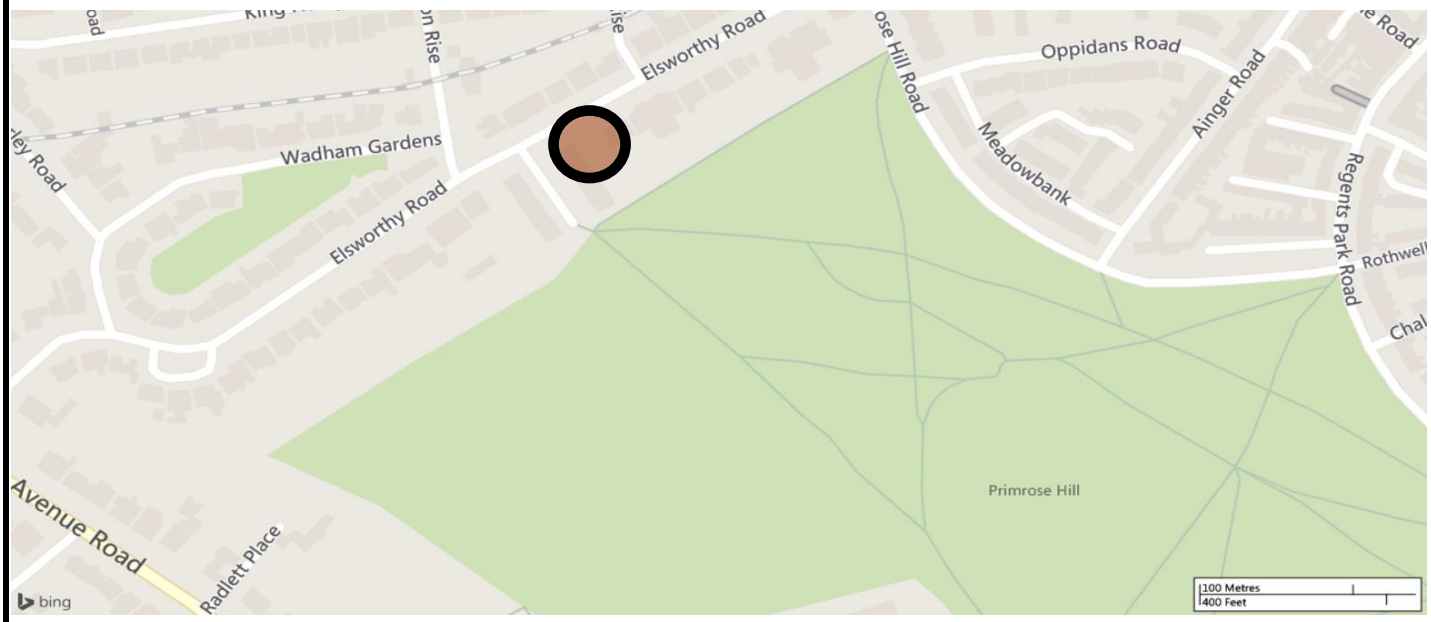
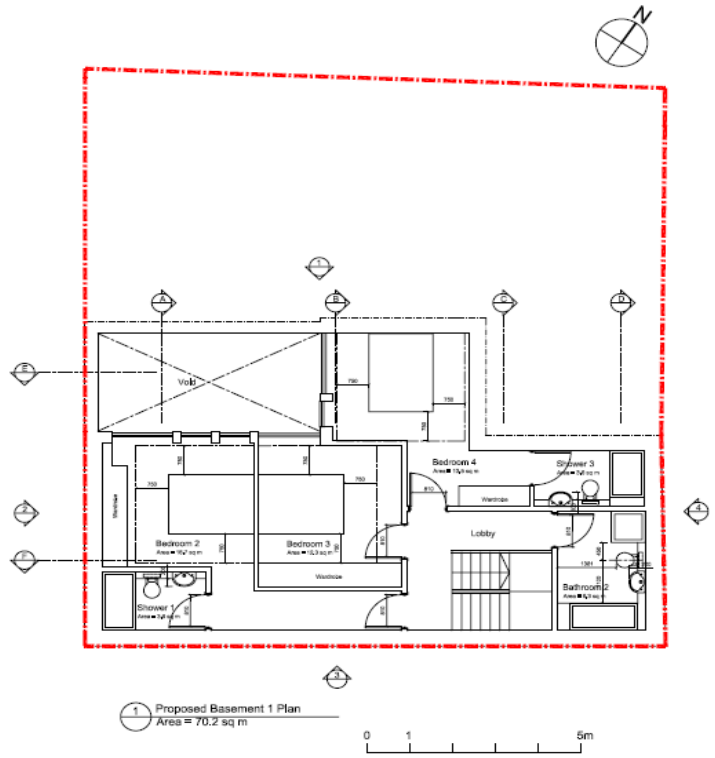


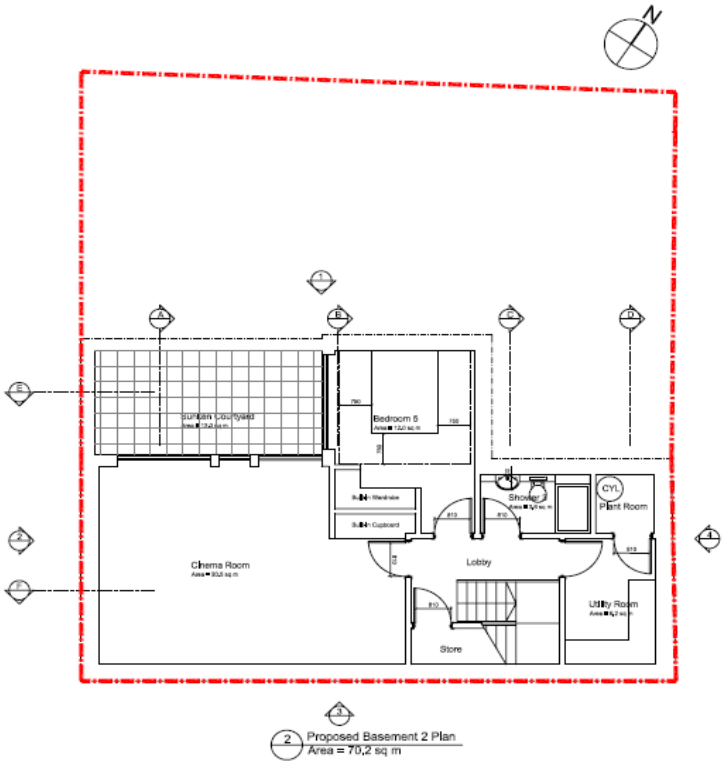


locations are indicative unless dimensions are given

Project:	Land at rear of Elsworthy Terrace, London			**Title**	Site Location Plan
Client:	Hastings International Ltd			**Geo-Environmental Services Ltd**	
Ref No:	GE11003	**Revision:**	v1	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	JO	**Date:**	21/09/2015	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	1	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

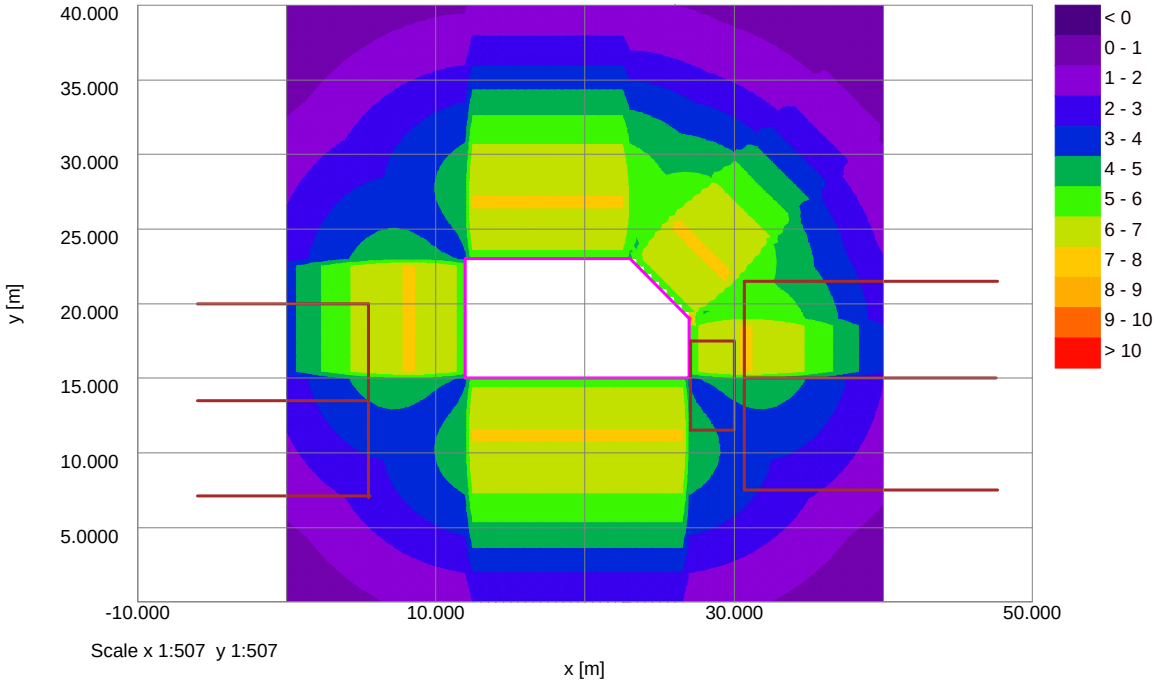
Geo-Environmental



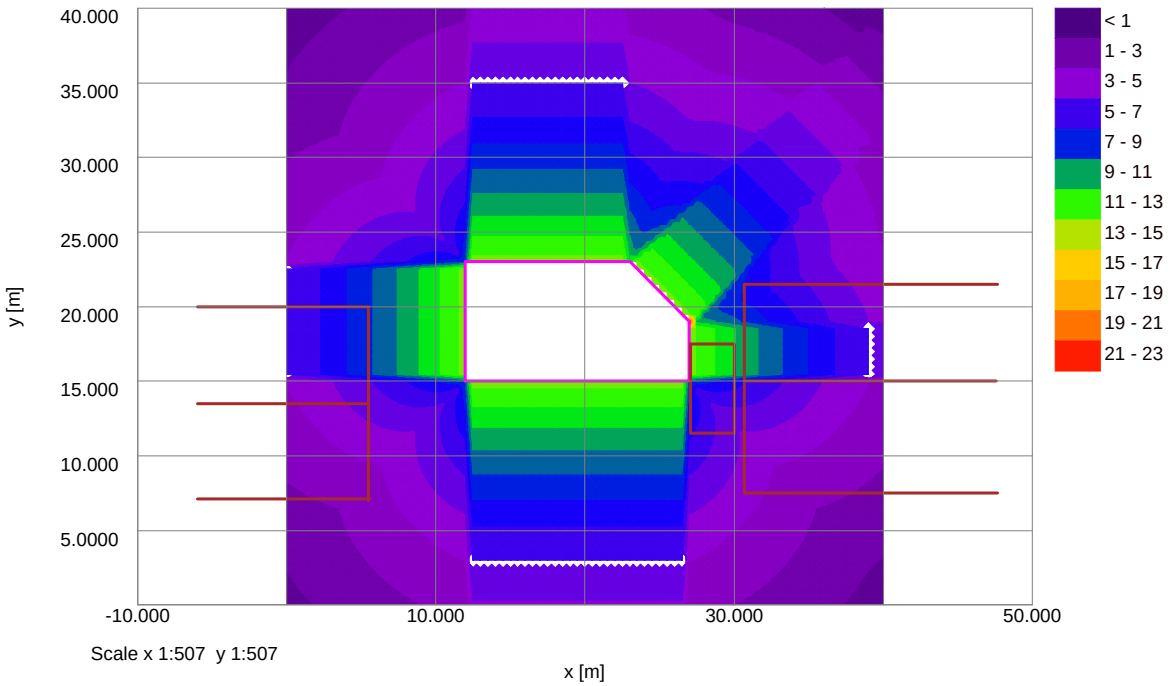


Project:	Land at rear of Elsworthy Terrace, London			**Title**	Proposed Basement Plans
Client:	Mrs Nourani			**Geo-Environmental Services Ltd**	
Ref No:	GE11003	**Revision:**	v1	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	JT	**Date:**	May 16	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	1	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

Vertical Settlement Contours: Grid 1 (level 0.000m) (Interval 1mm)

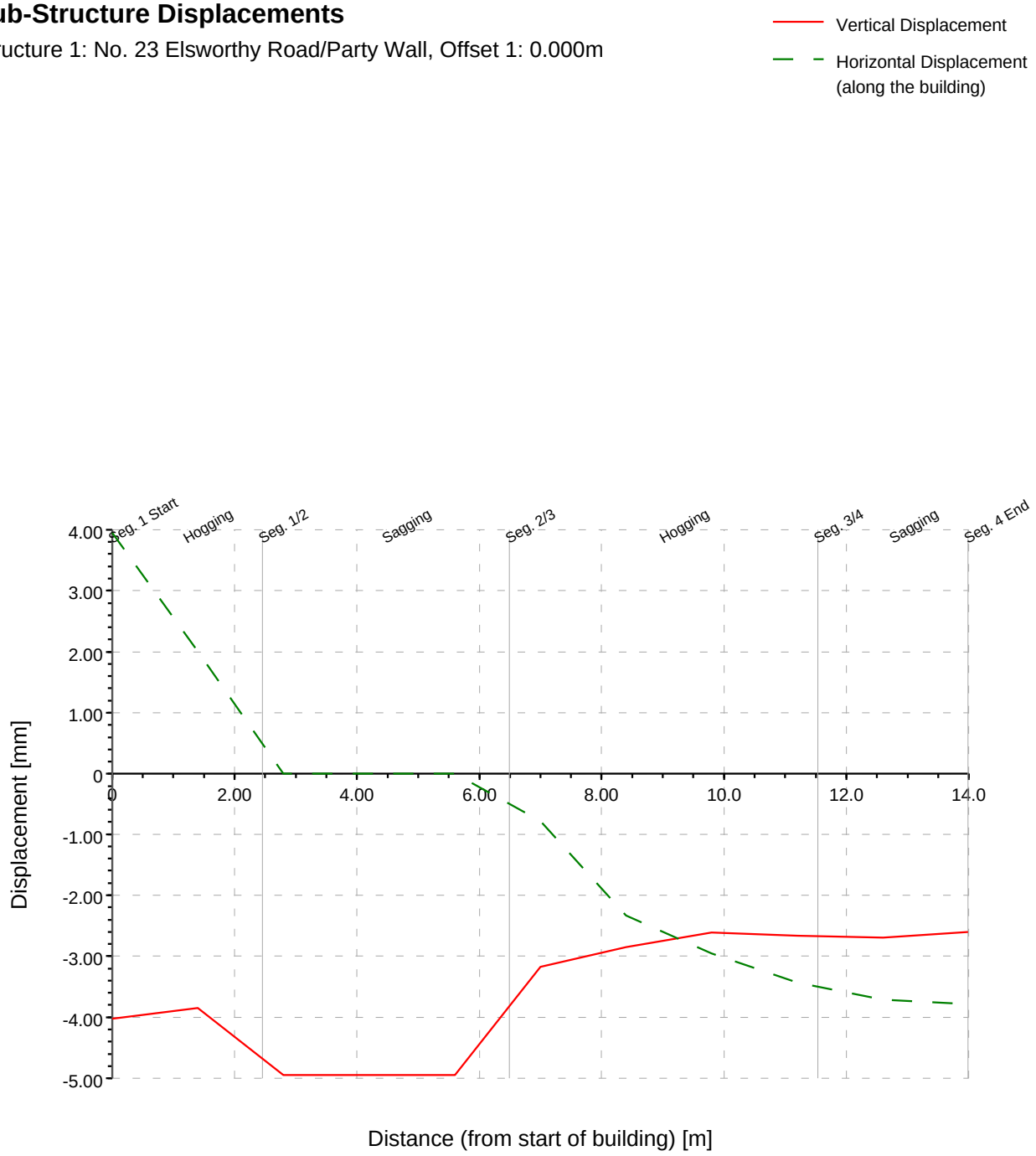


Horizontal Displacement Contours: Grid 1 (level 0.000m) Interval 1mm



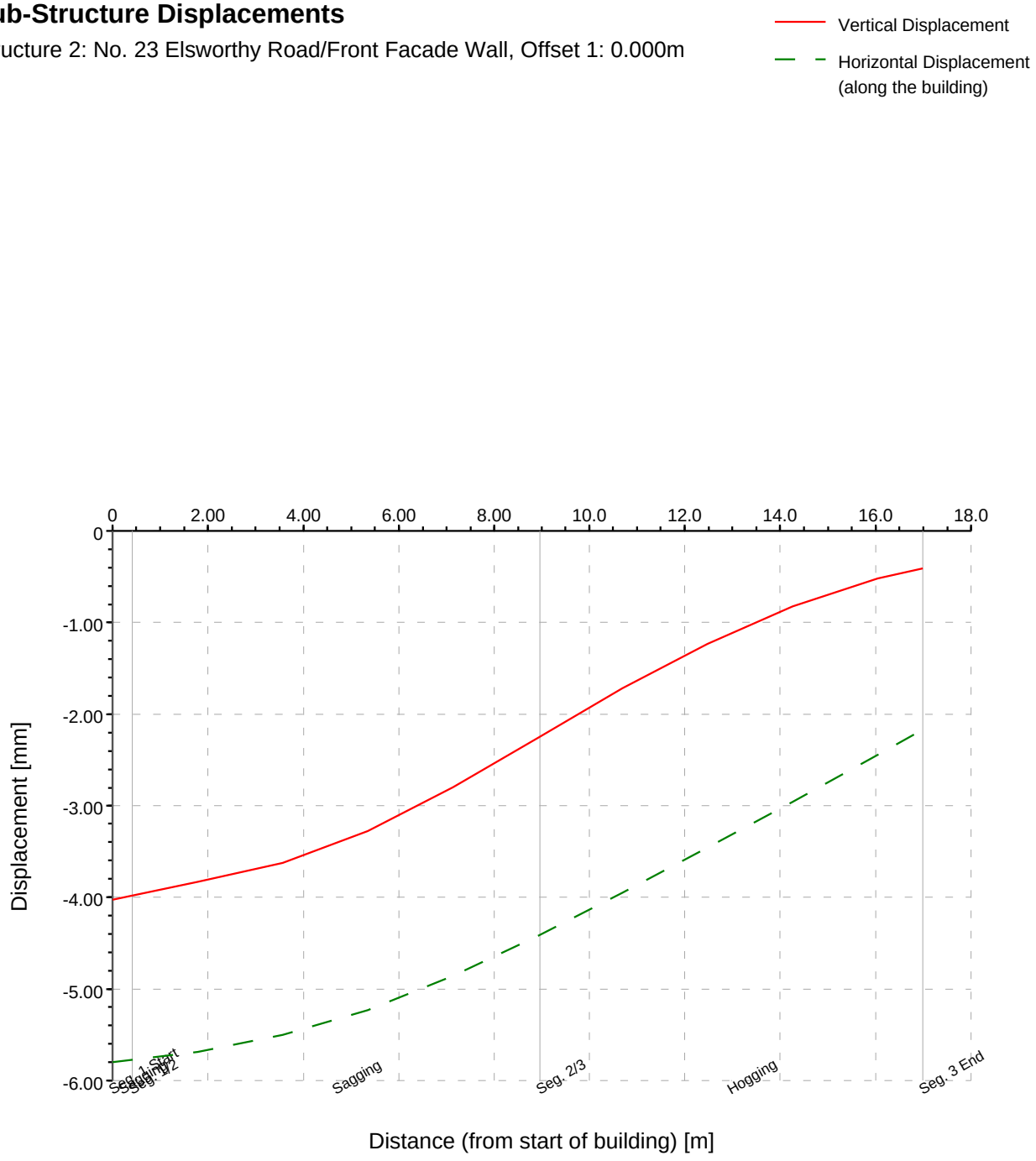
Sub-Structure Displacements

Structure 1: No. 23 Elsworthy Road/Party Wall, Offset 1: 0.000m



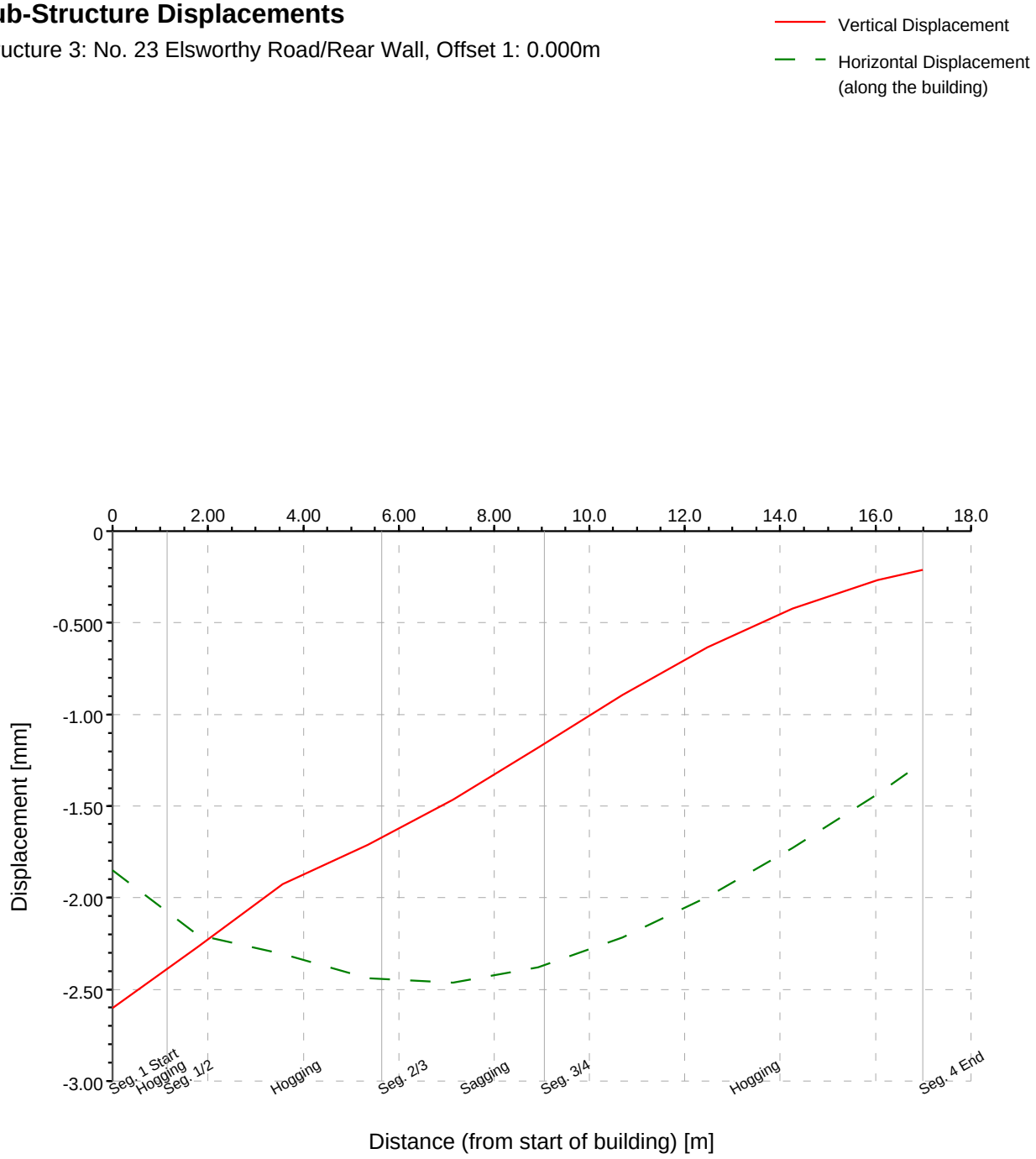
Sub-Structure Displacements

Structure 2: No. 23 Elsworthy Road/Front Facade Wall, Offset 1: 0.000m



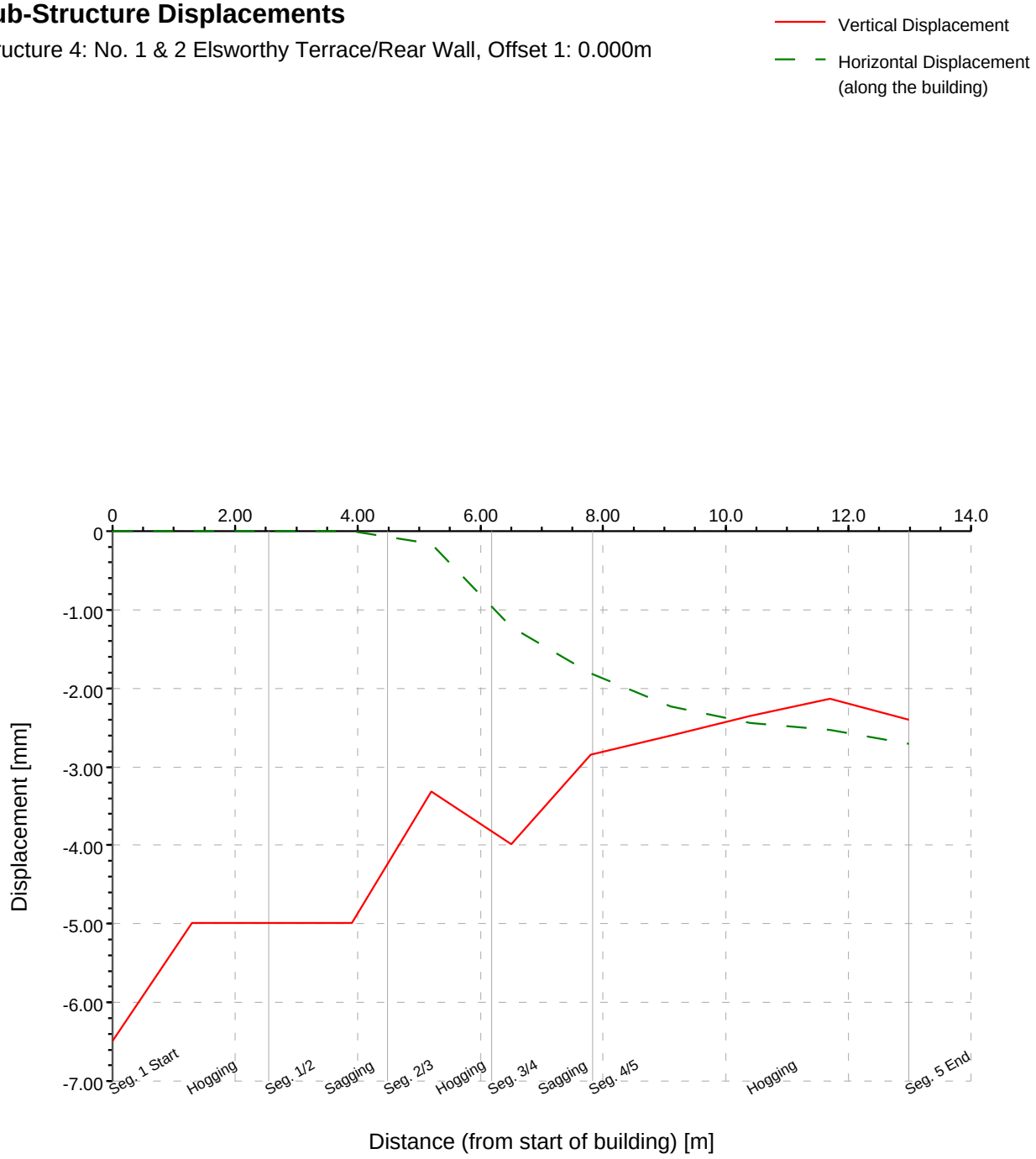
Sub-Structure Displacements

Structure 3: No. 23 Elsworthy Road/Rear Wall, Offset 1: 0.000m



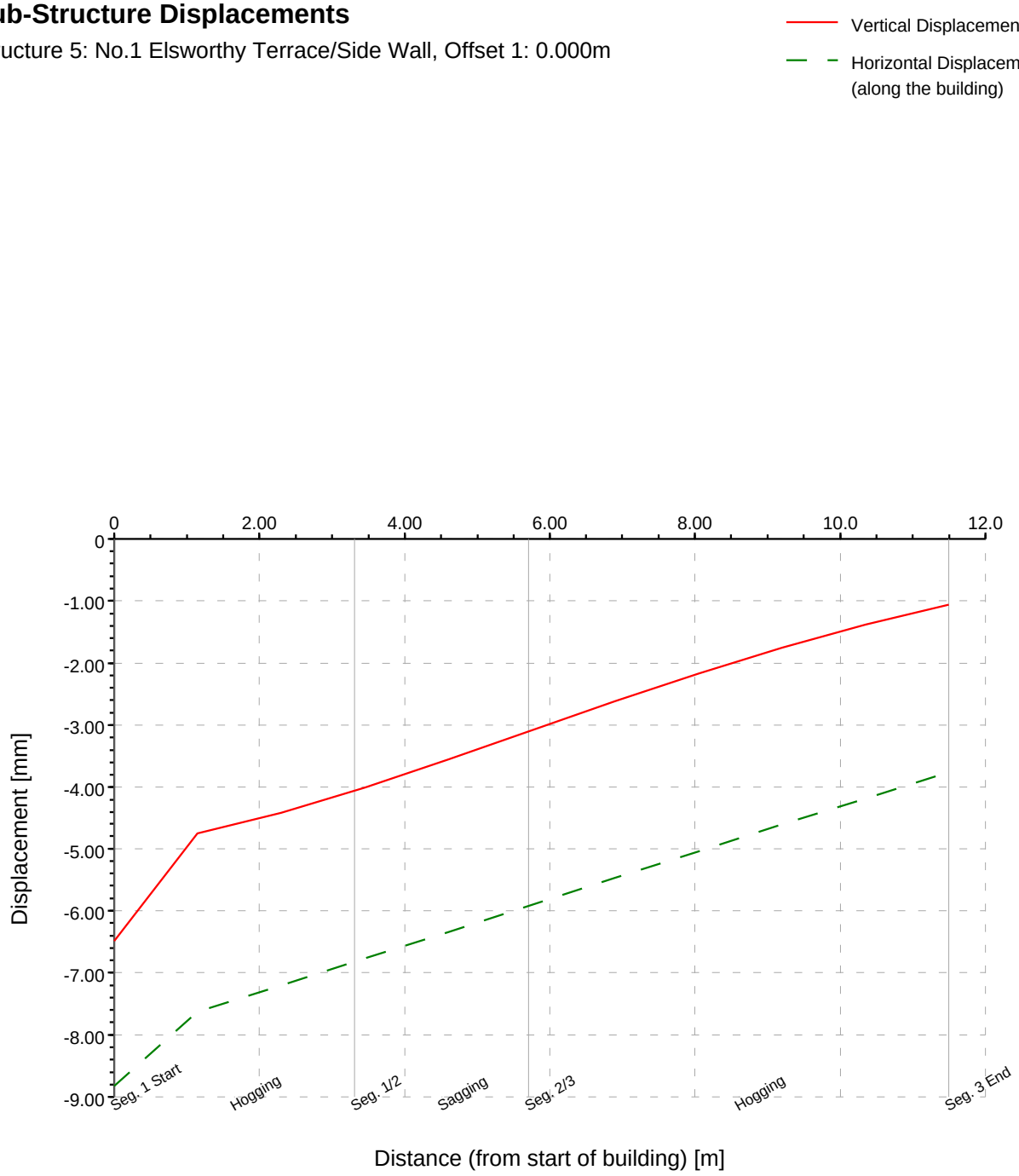
Sub-Structure Displacements

Structure 4: No. 1 & 2 Elsworthy Terrace/Rear Wall, Offset 1: 0.000m



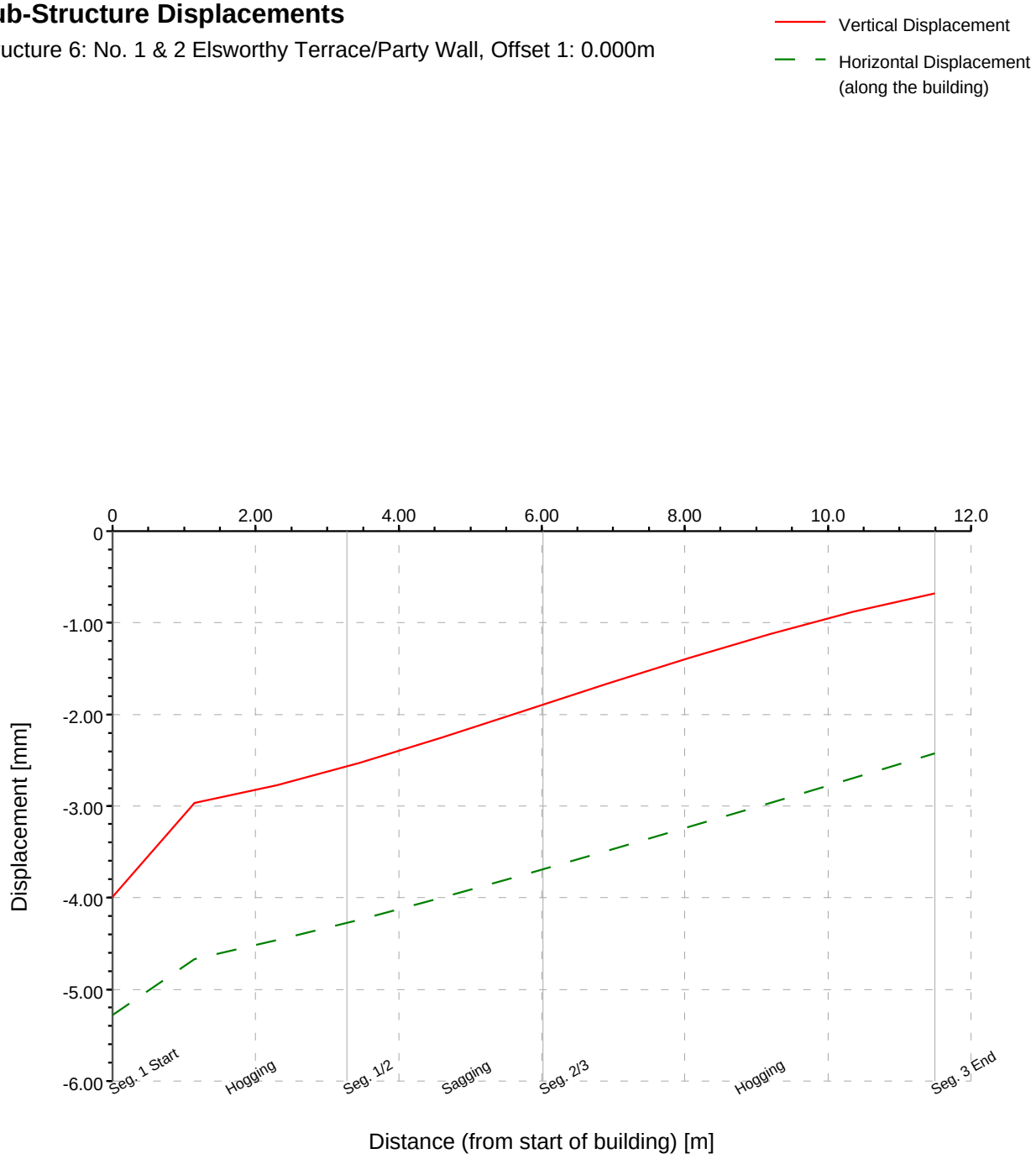
Sub-Structure Displacements

Structure 5: No.1 Elsworthy Terrace/Side Wall, Offset 1: 0.000m



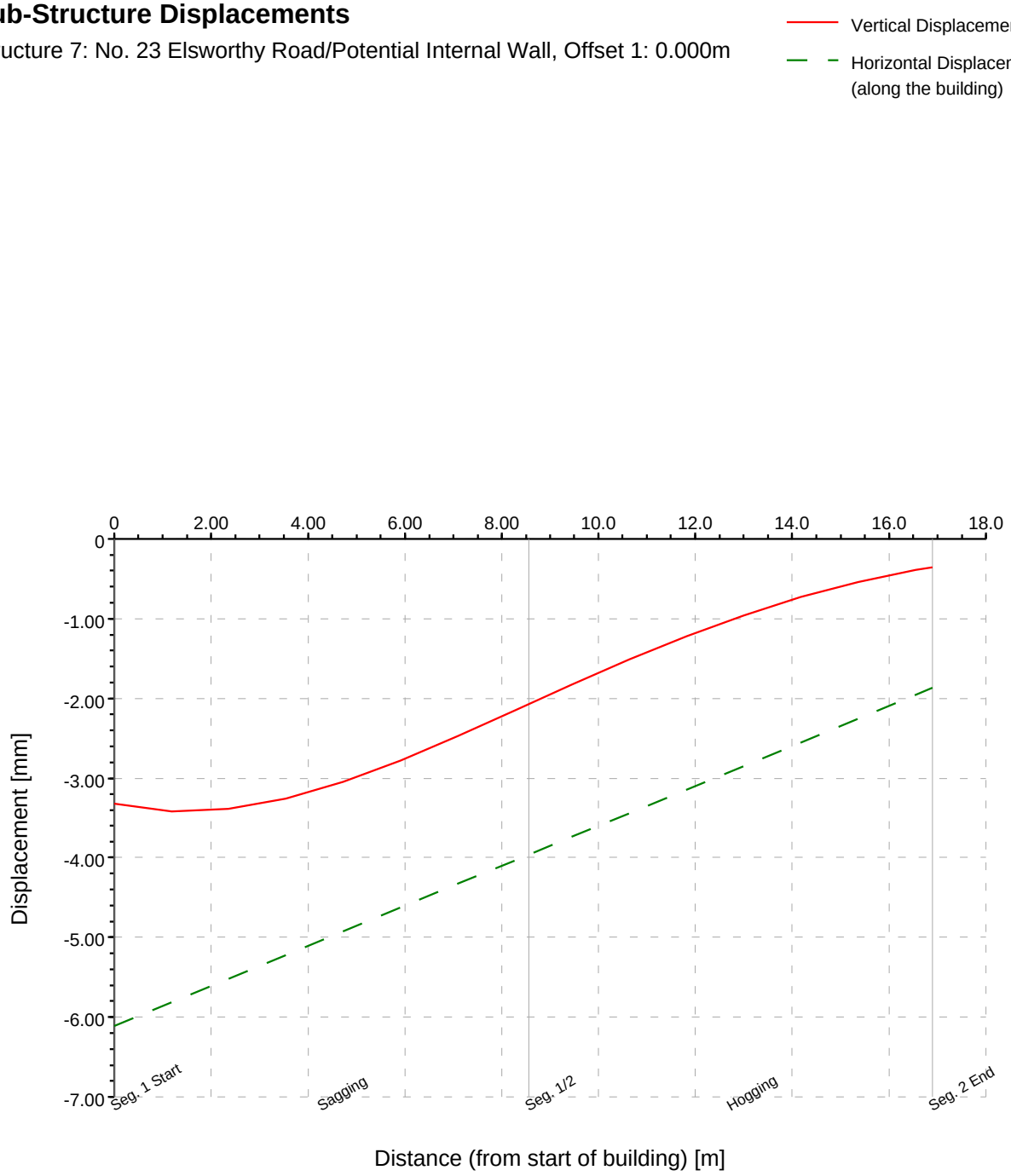
Sub-Structure Displacements

Structure 6: No. 1 & 2 Elsworthy Terrace/Party Wall, Offset 1: 0.000m



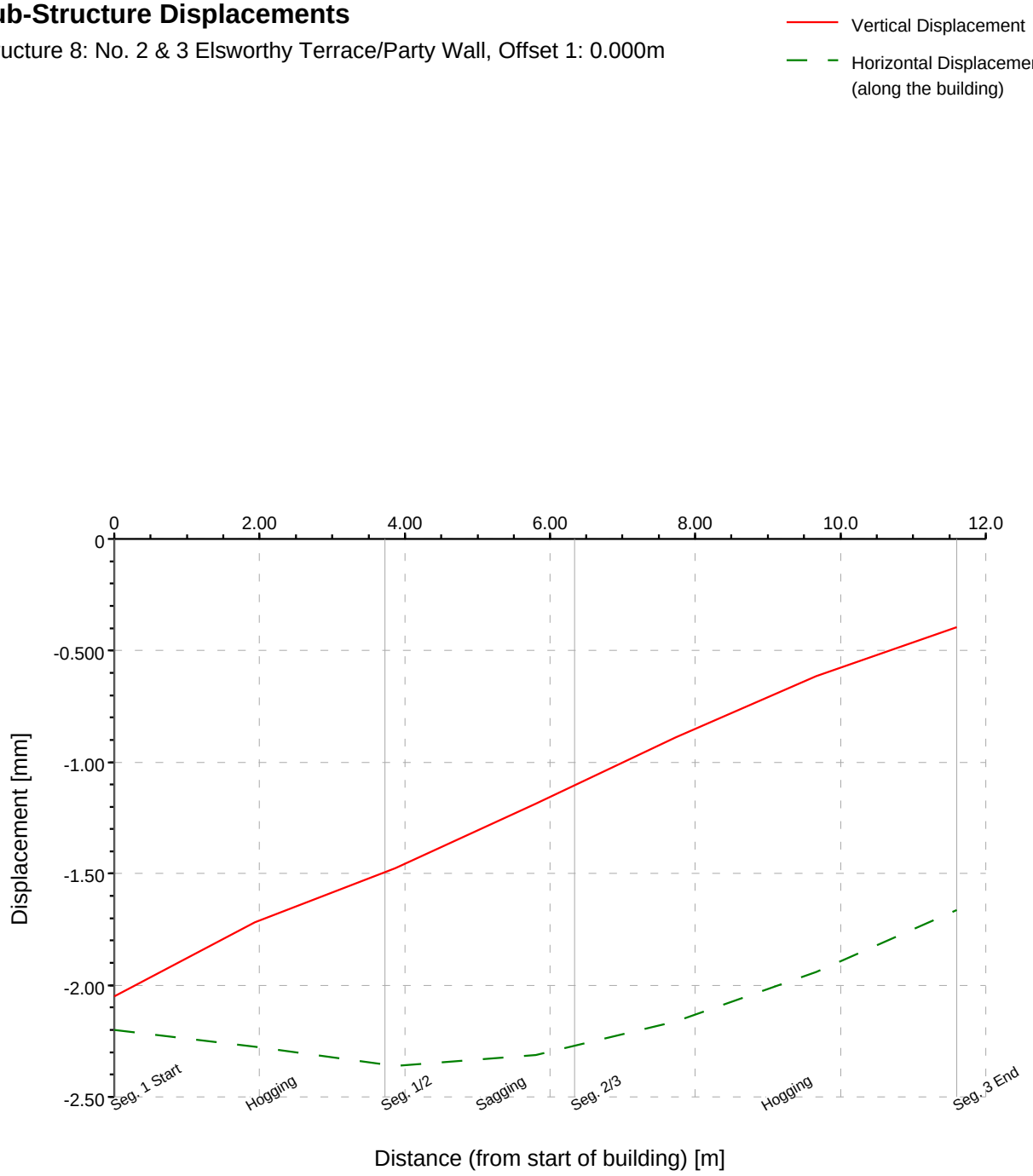
Sub-Structure Displacements

Structure 7: No. 23 Elsworthy Road/Potential Internal Wall, Offset 1: 0.000m



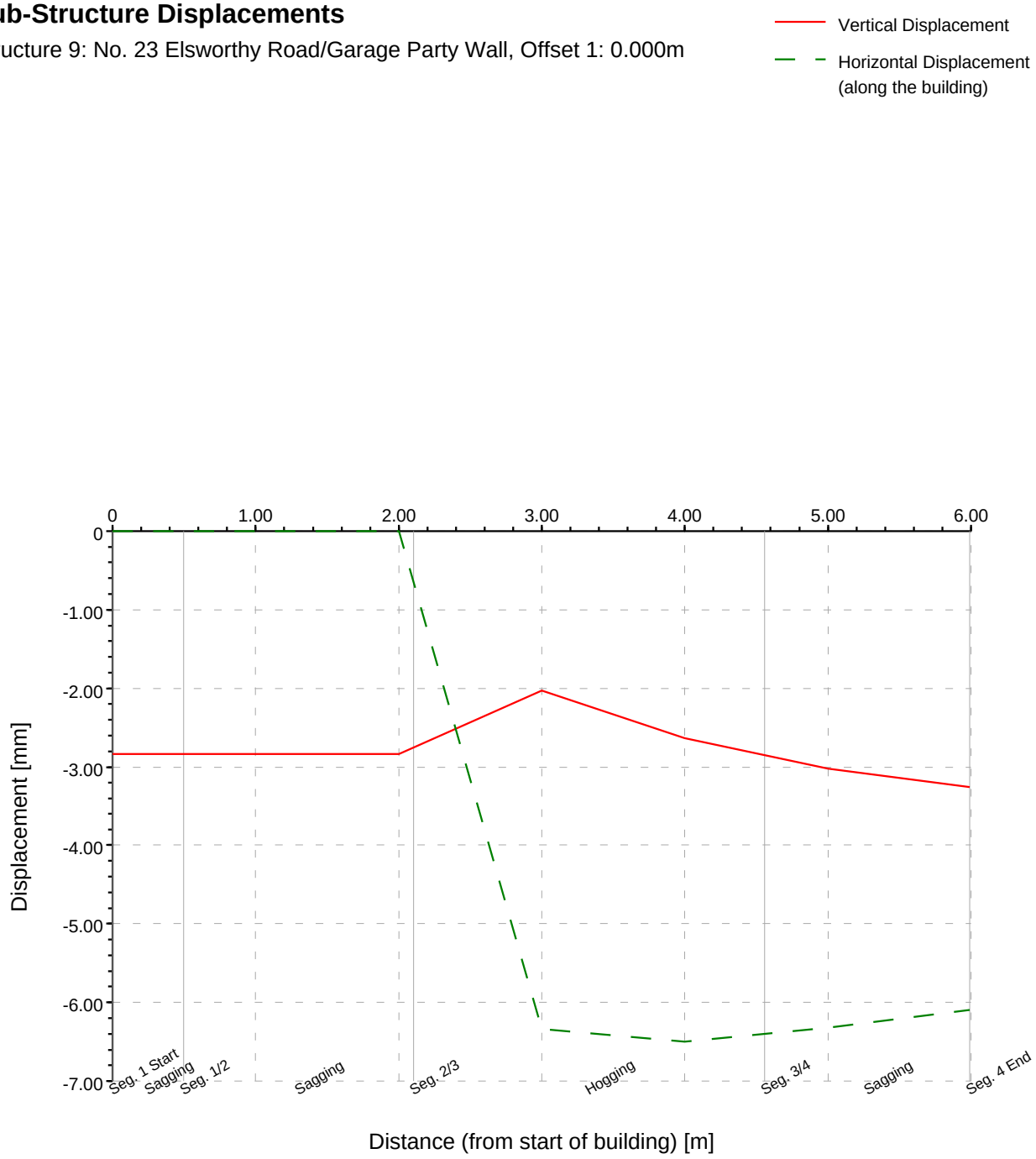
Sub-Structure Displacements

Structure 8: No. 2 & 3 Elsworthy Terrace/Party Wall, Offset 1: 0.000m



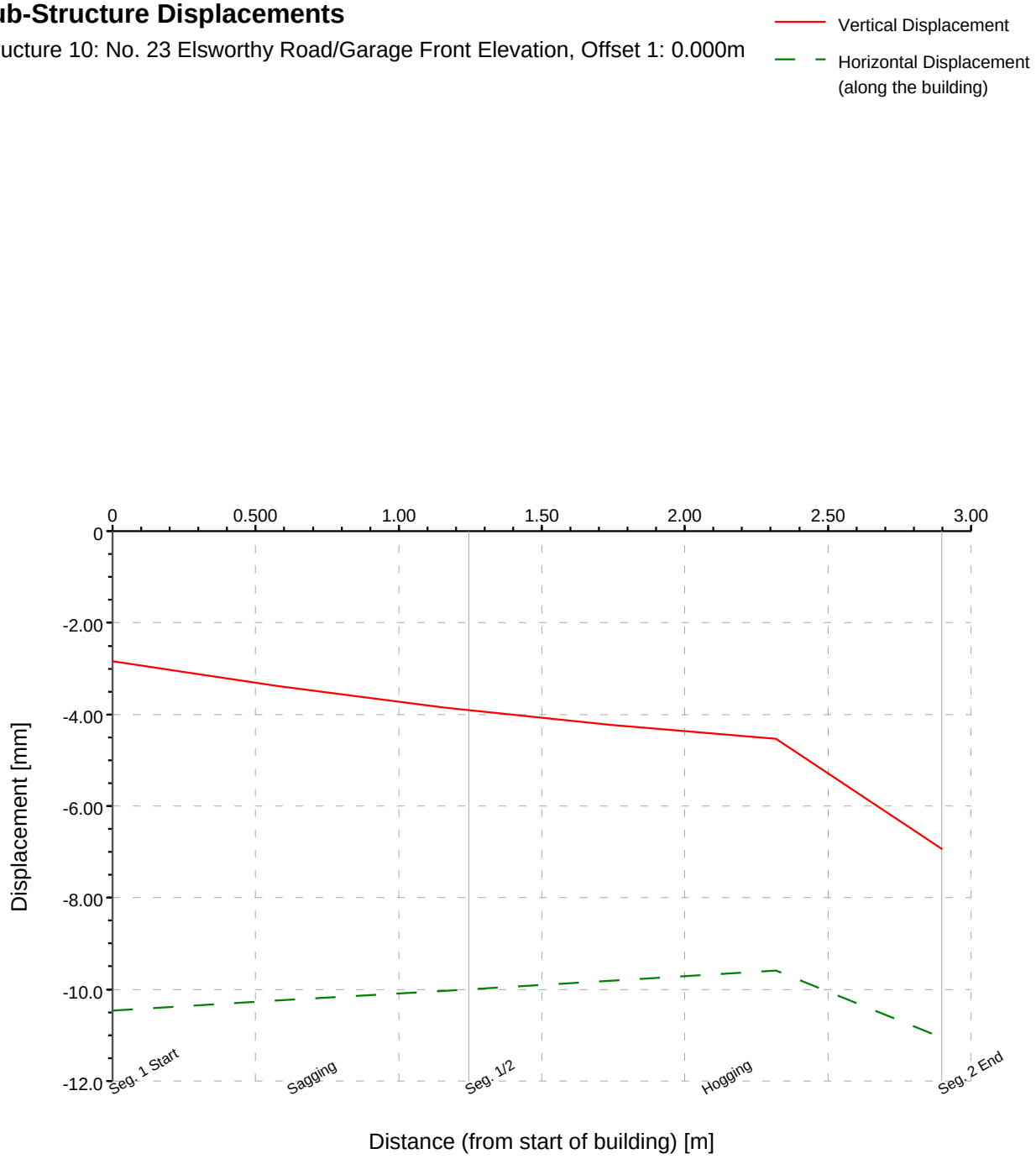
Sub-Structure Displacements

Structure 9: No. 23 Elsworthy Road/Garage Party Wall, Offset 1: 0.000m



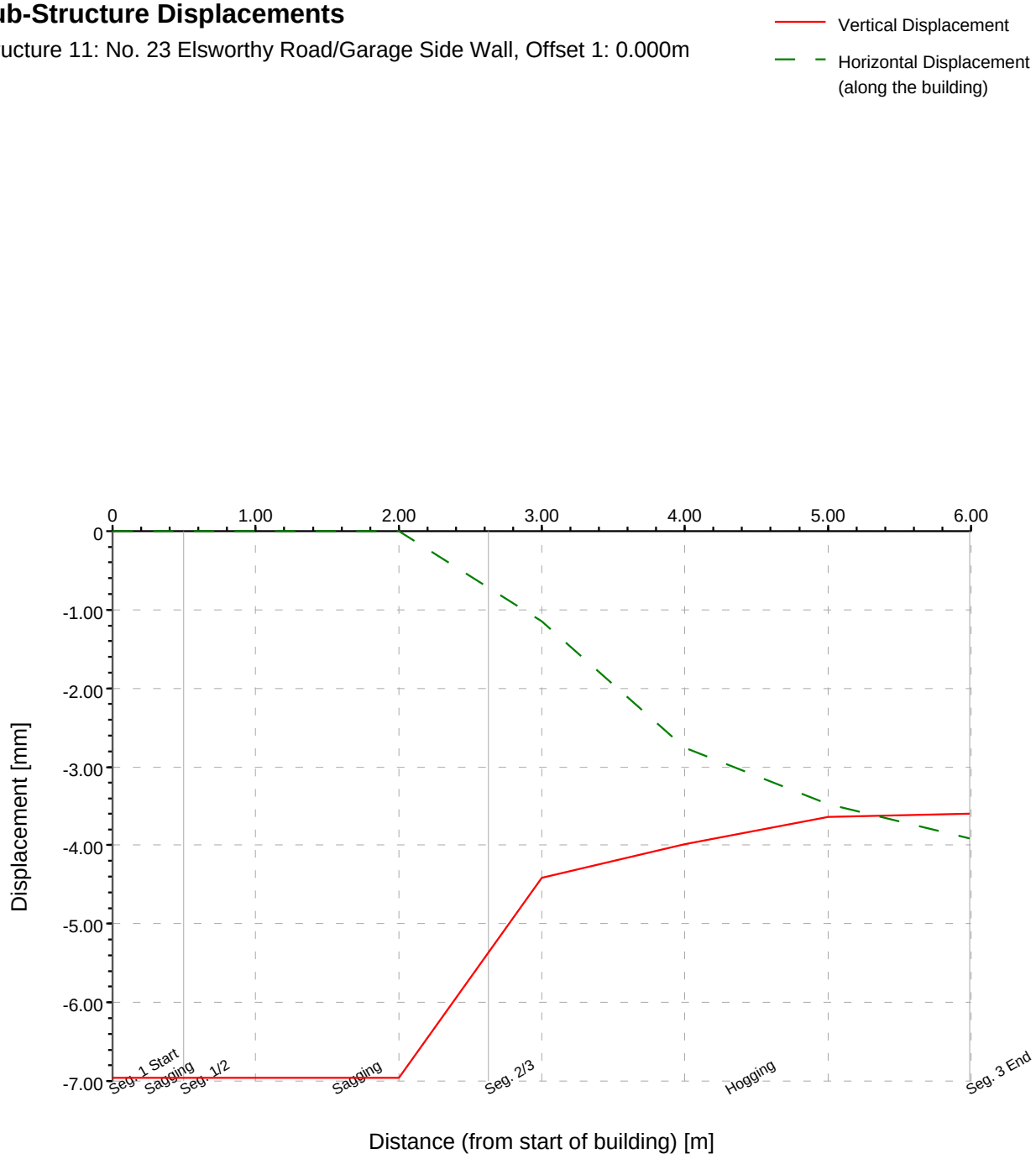
Sub-Structure Displacements

Structure 10: No. 23 Elsworthy Road/Garage Front Elevation, Offset 1: 0.000m



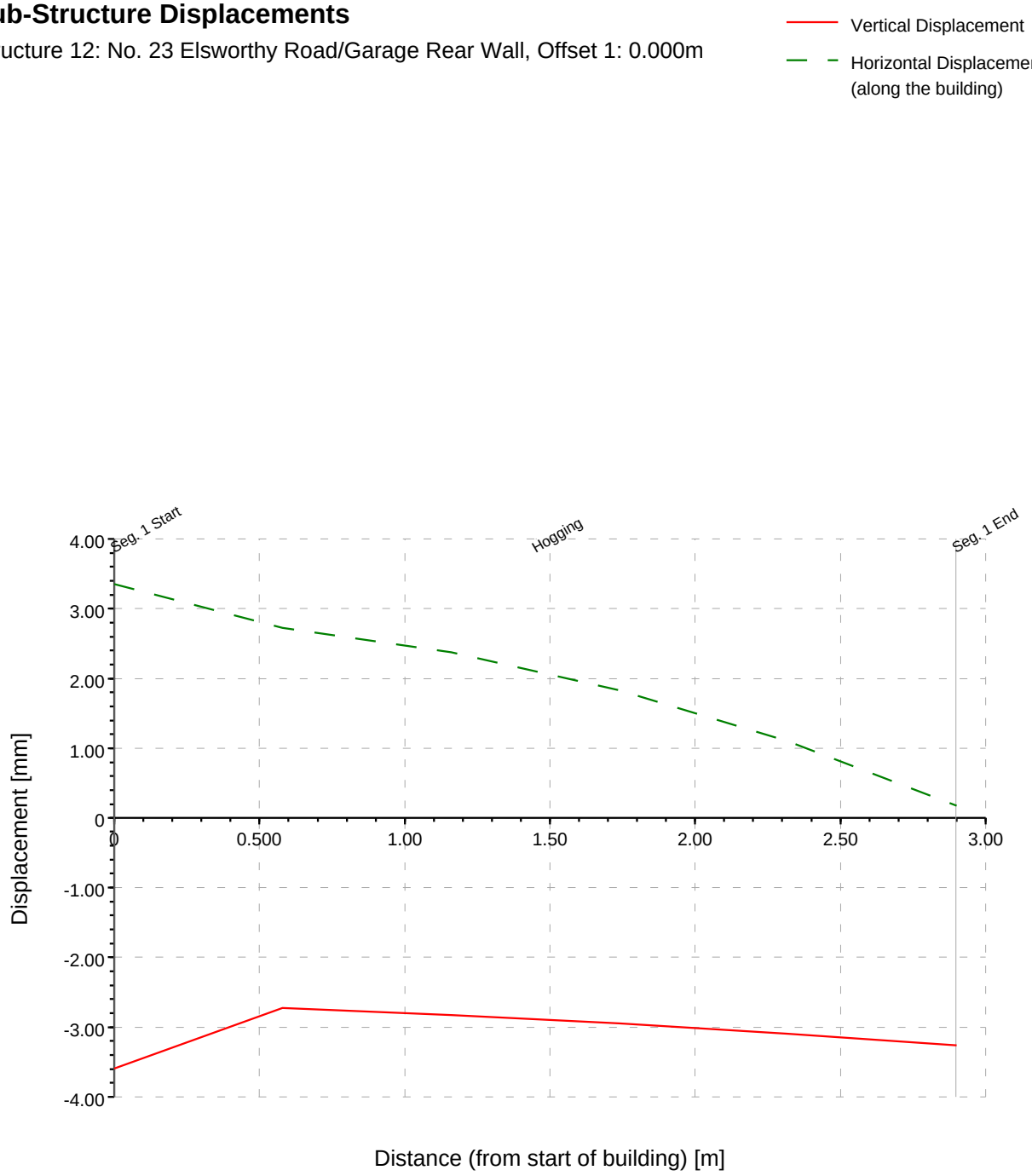
Sub-Structure Displacements

Structure 11: No. 23 Elsworthy Road/Garage Side Wall, Offset 1: 0.000m



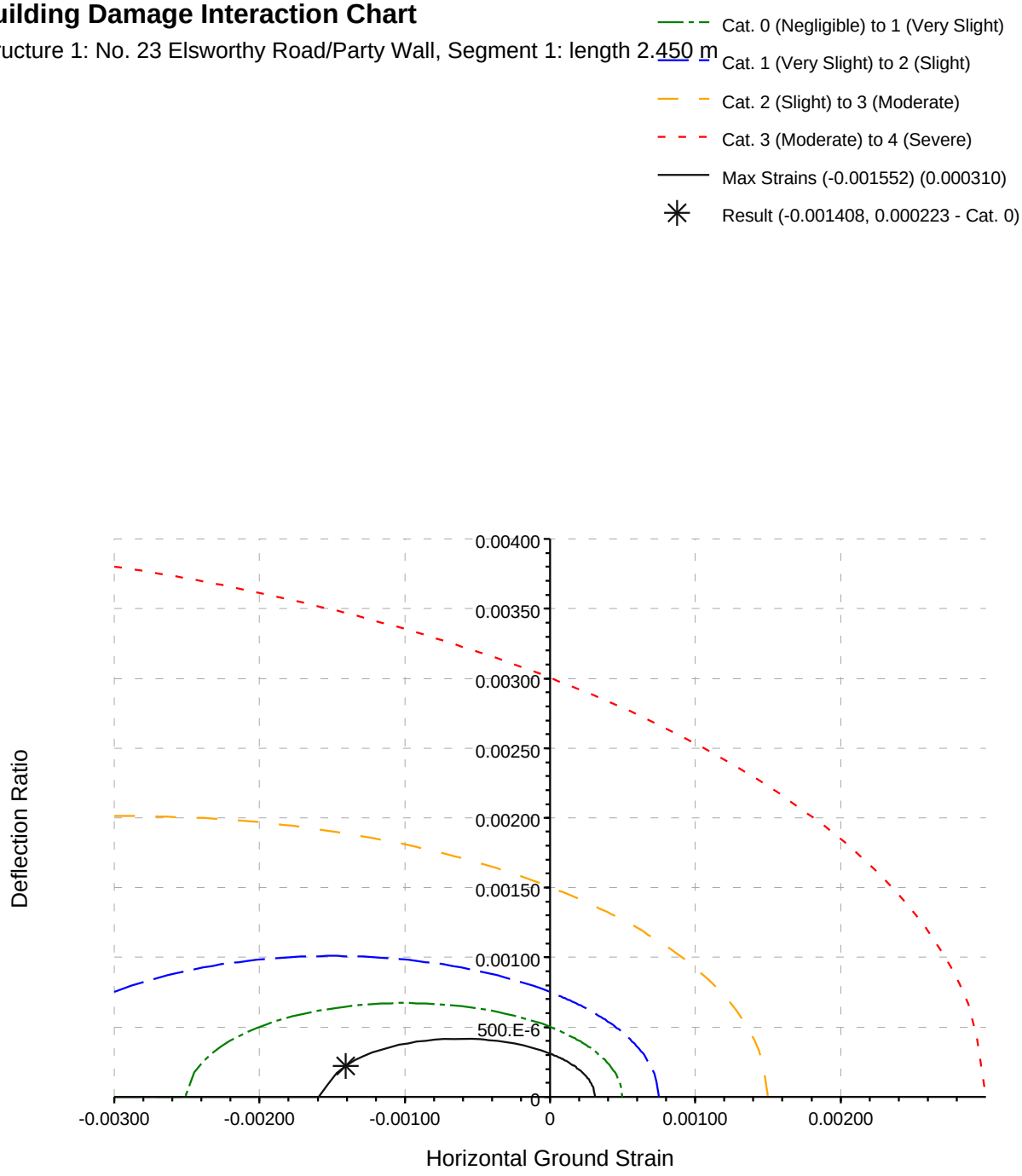
Sub-Structure Displacements

Structure 12: No. 23 Elsworthy Road/Garage Rear Wall, Offset 1: 0.000m



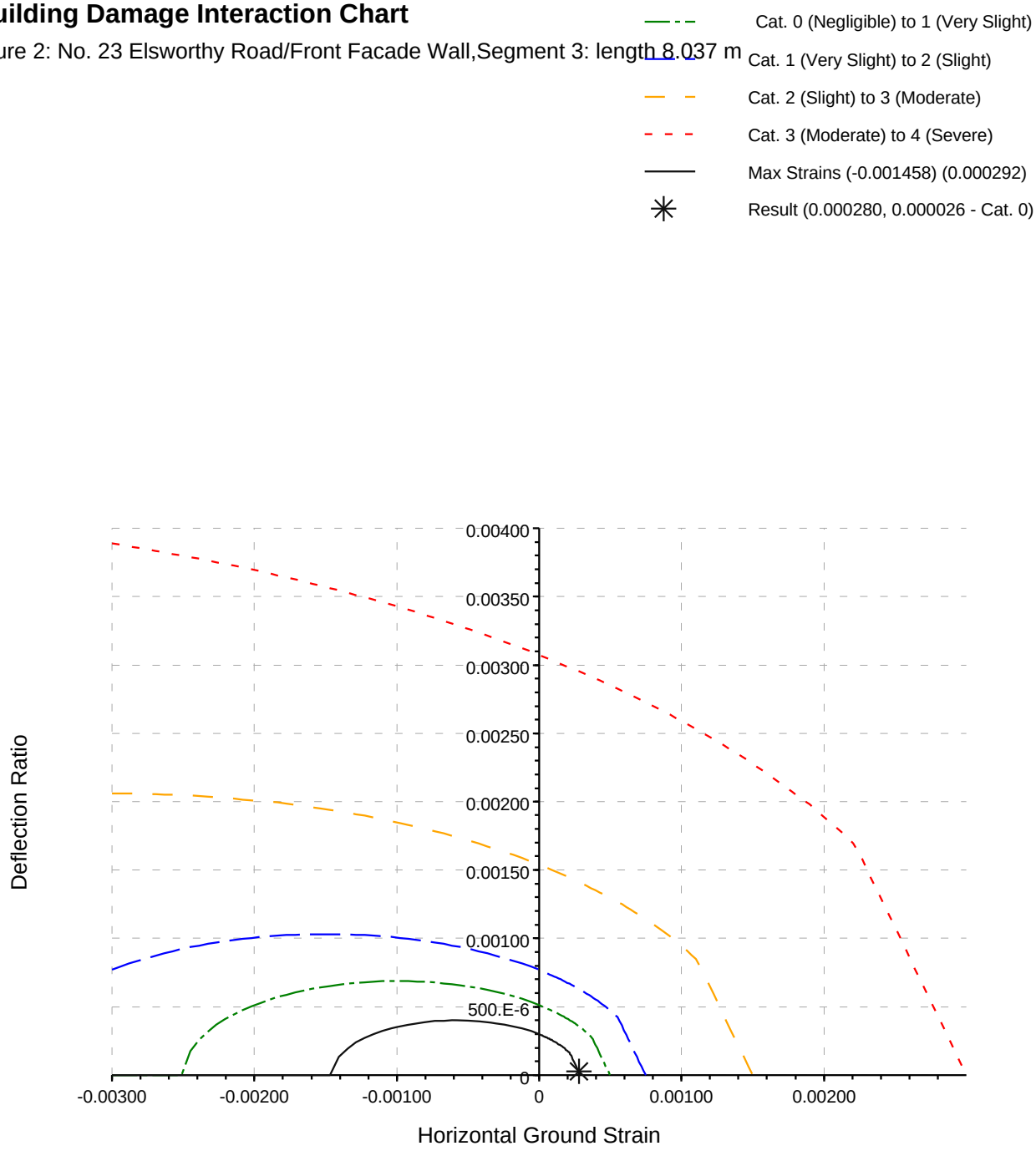
Building Damage Interaction Chart

Structure 1: No. 23 Elsworthy Road/Party Wall, Segment 1: length 2.450 m



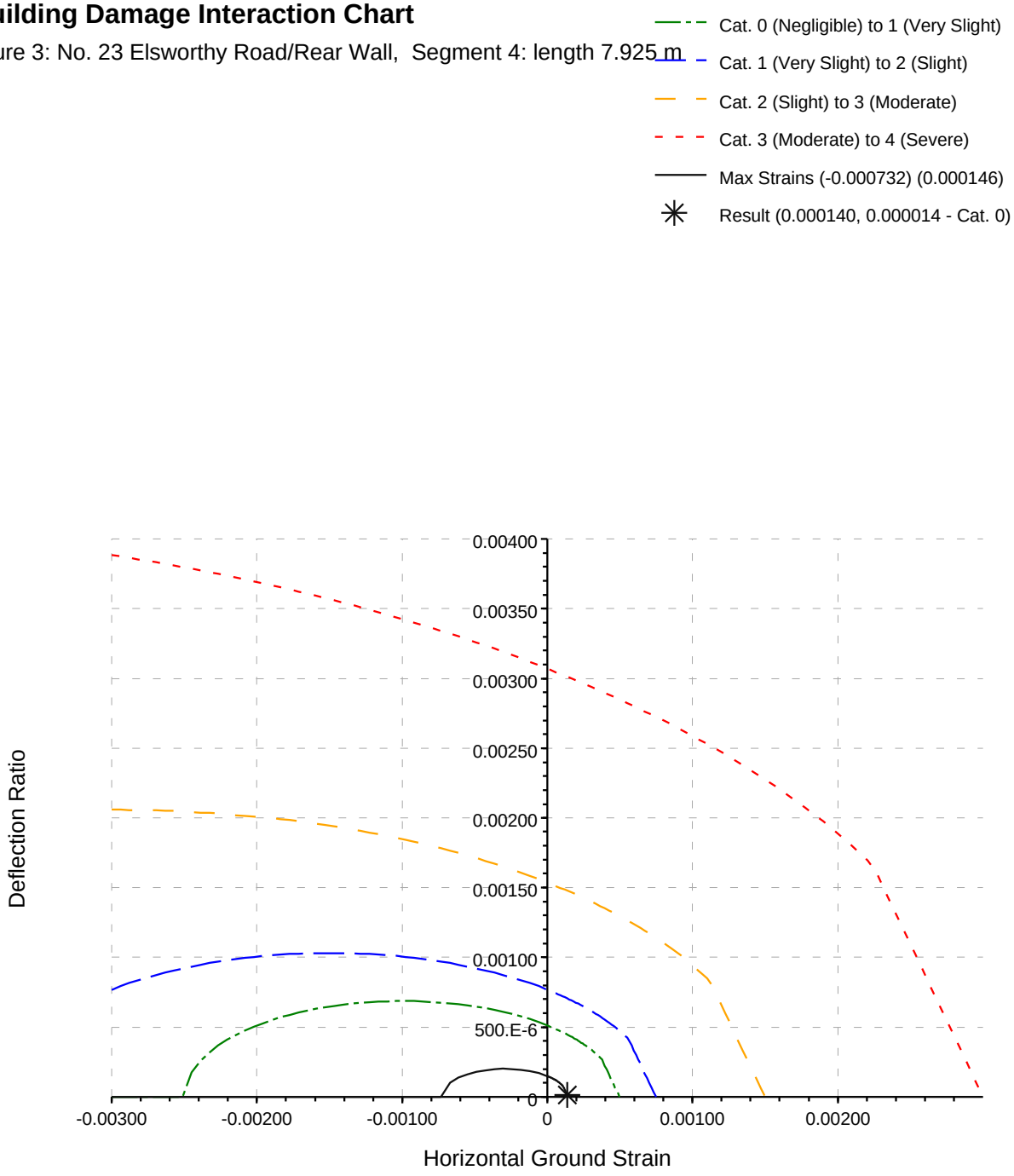
Building Damage Interaction Chart

Structure 2: No. 23 Elsworthy Road/Front Facade Wall,Segment 3: length 8.037 m



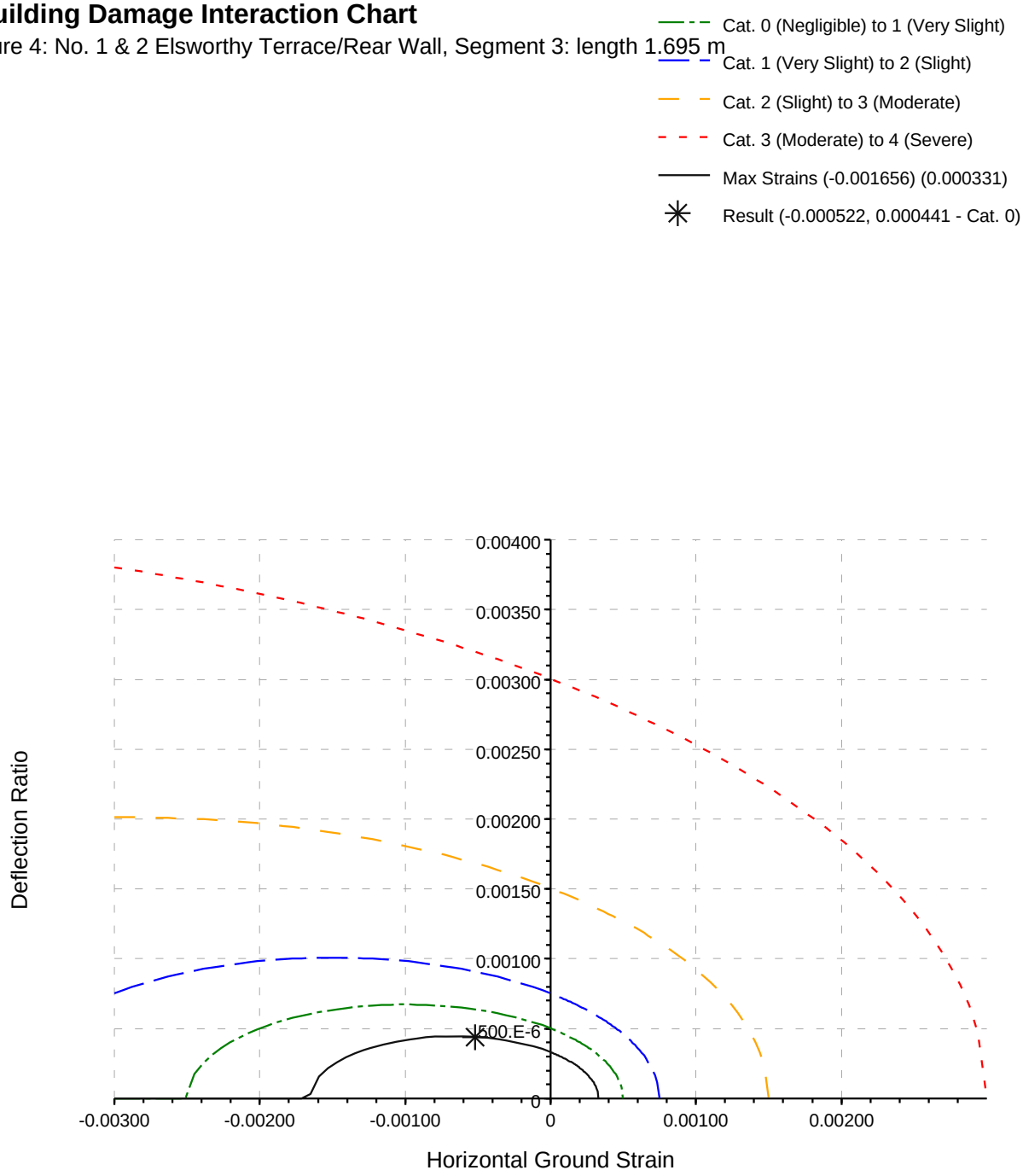
Building Damage Interaction Chart

Structure 3: No. 23 Elsworthy Road/Rear Wall, Segment 4: length 7.925 m



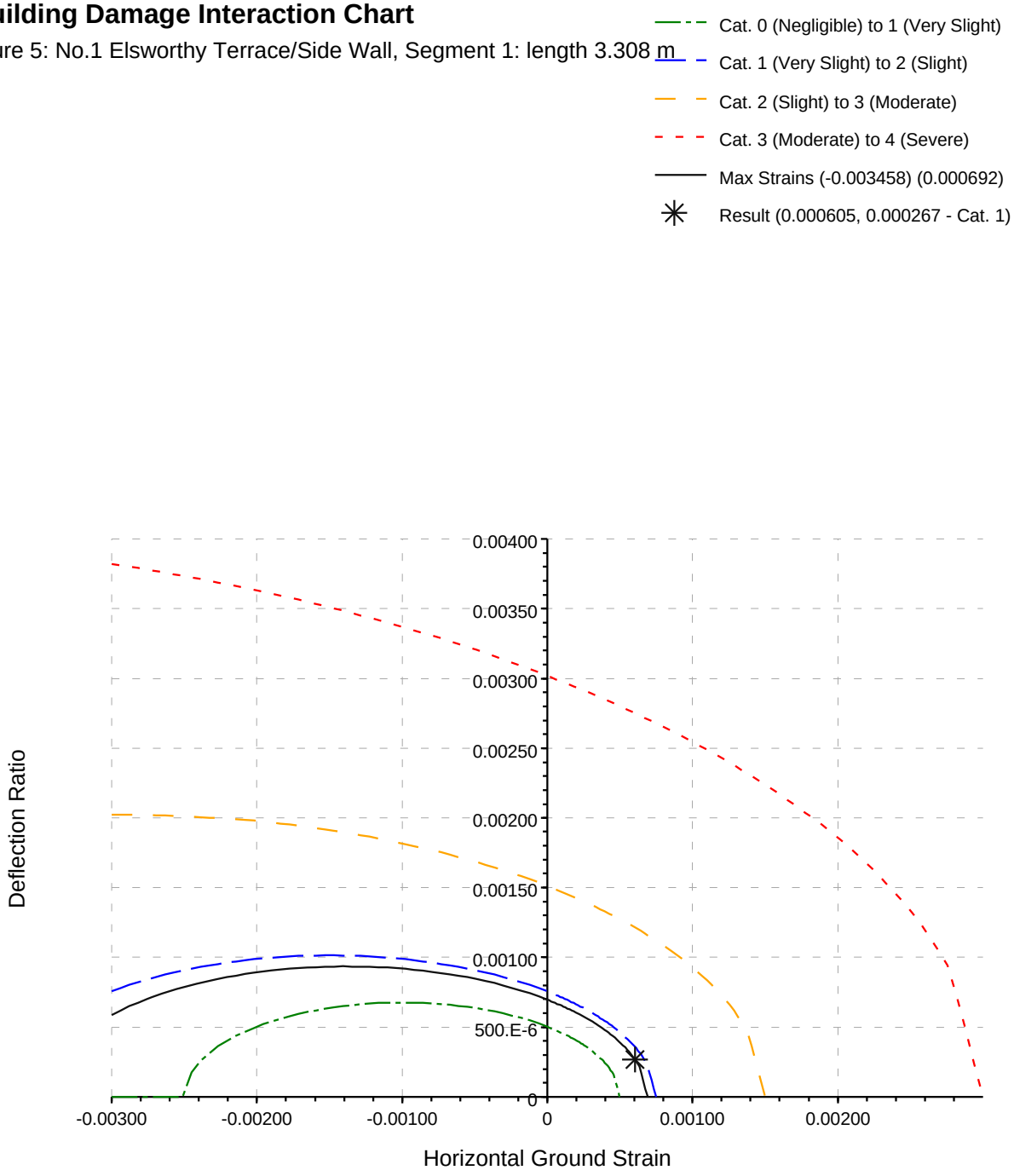
Building Damage Interaction Chart

Structure 4: No. 1 & 2 Elsworthy Terrace/Rear Wall, Segment 3: length 1.695 m



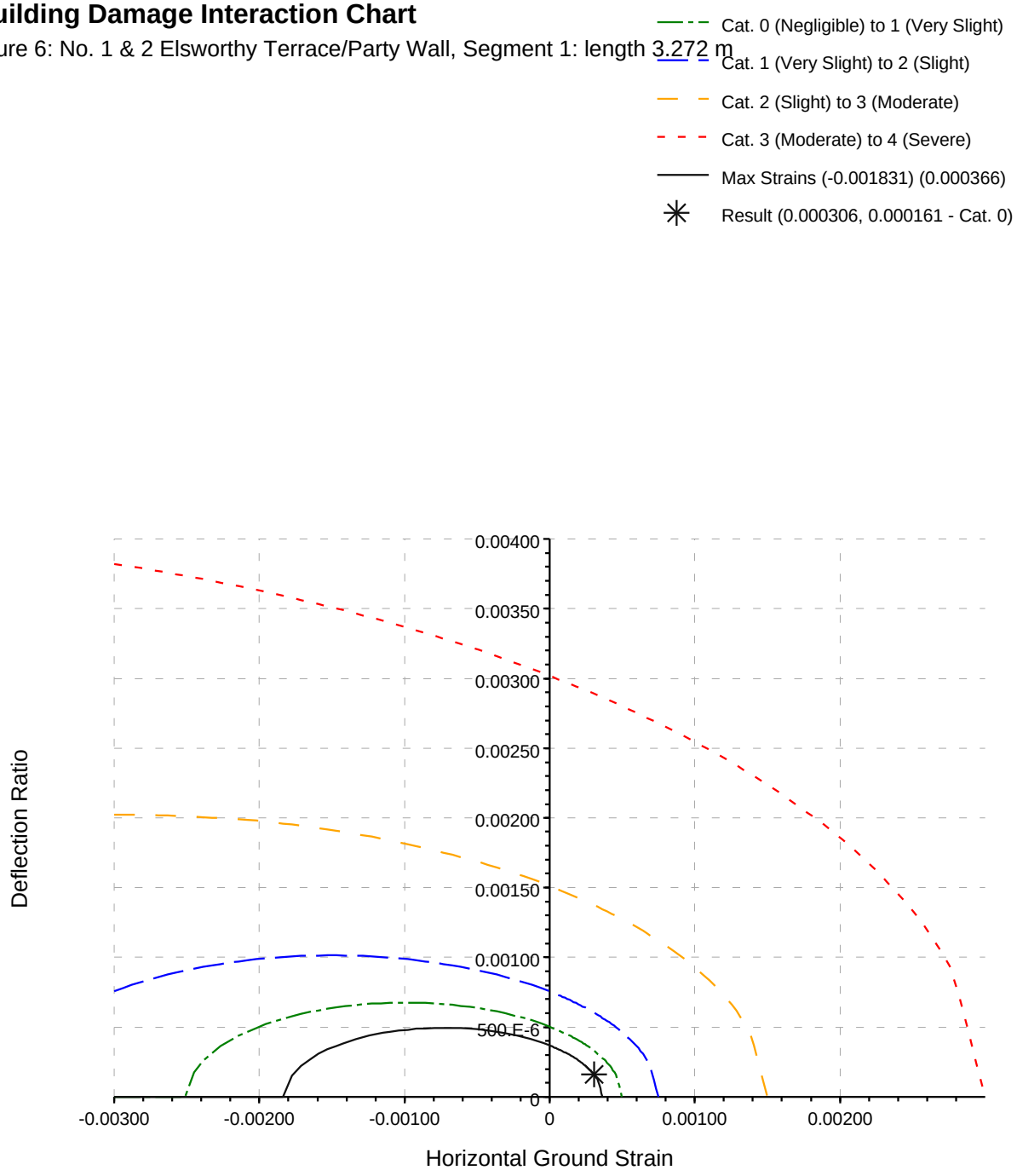
Building Damage Interaction Chart

Structure 5: No.1 Elsworthy Terrace/Side Wall, Segment 1: length 3.308 m



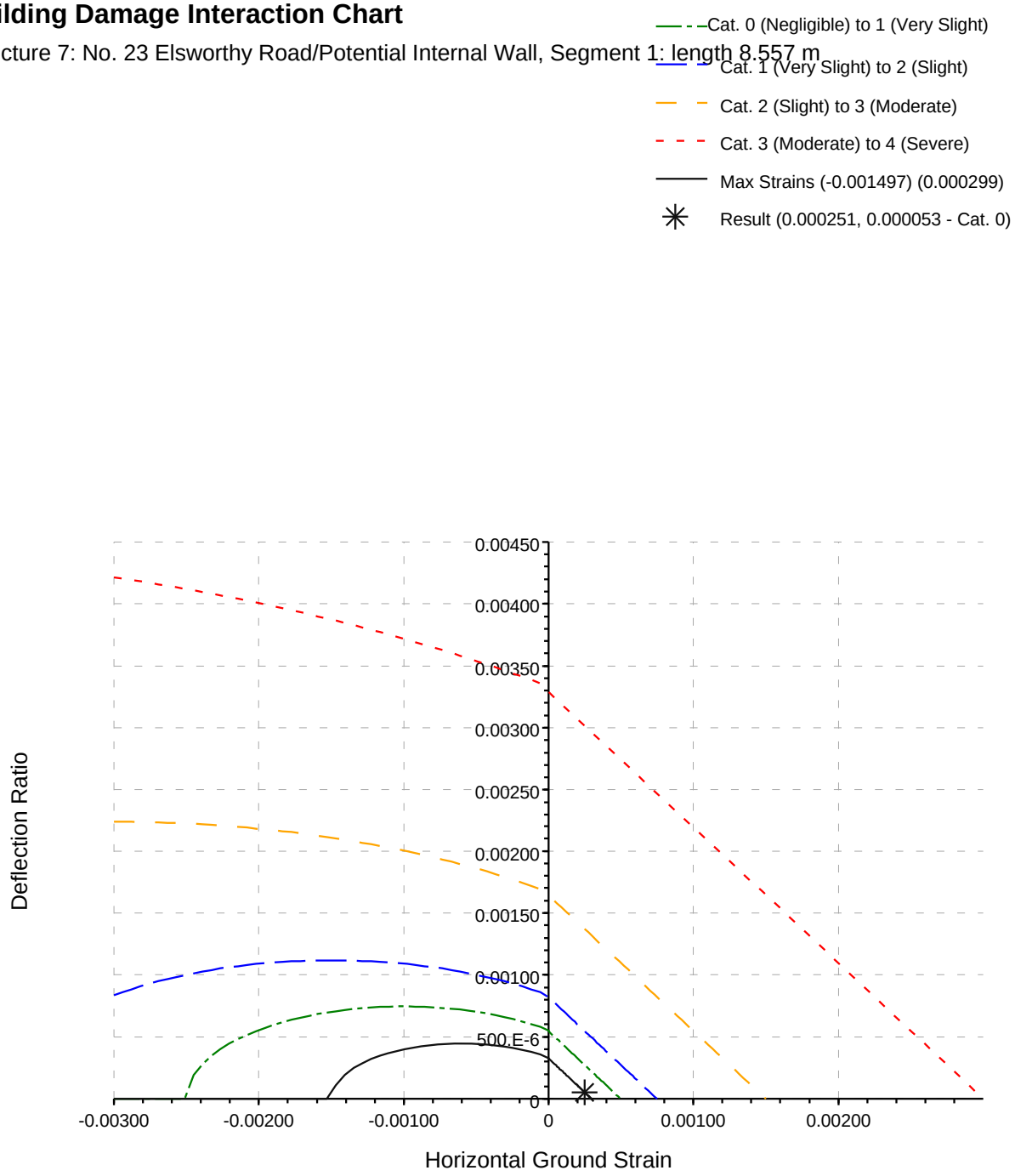
Building Damage Interaction Chart

Structure 6: No. 1 & 2 Elsworthy Terrace/Party Wall, Segment 1: length 3.272 m



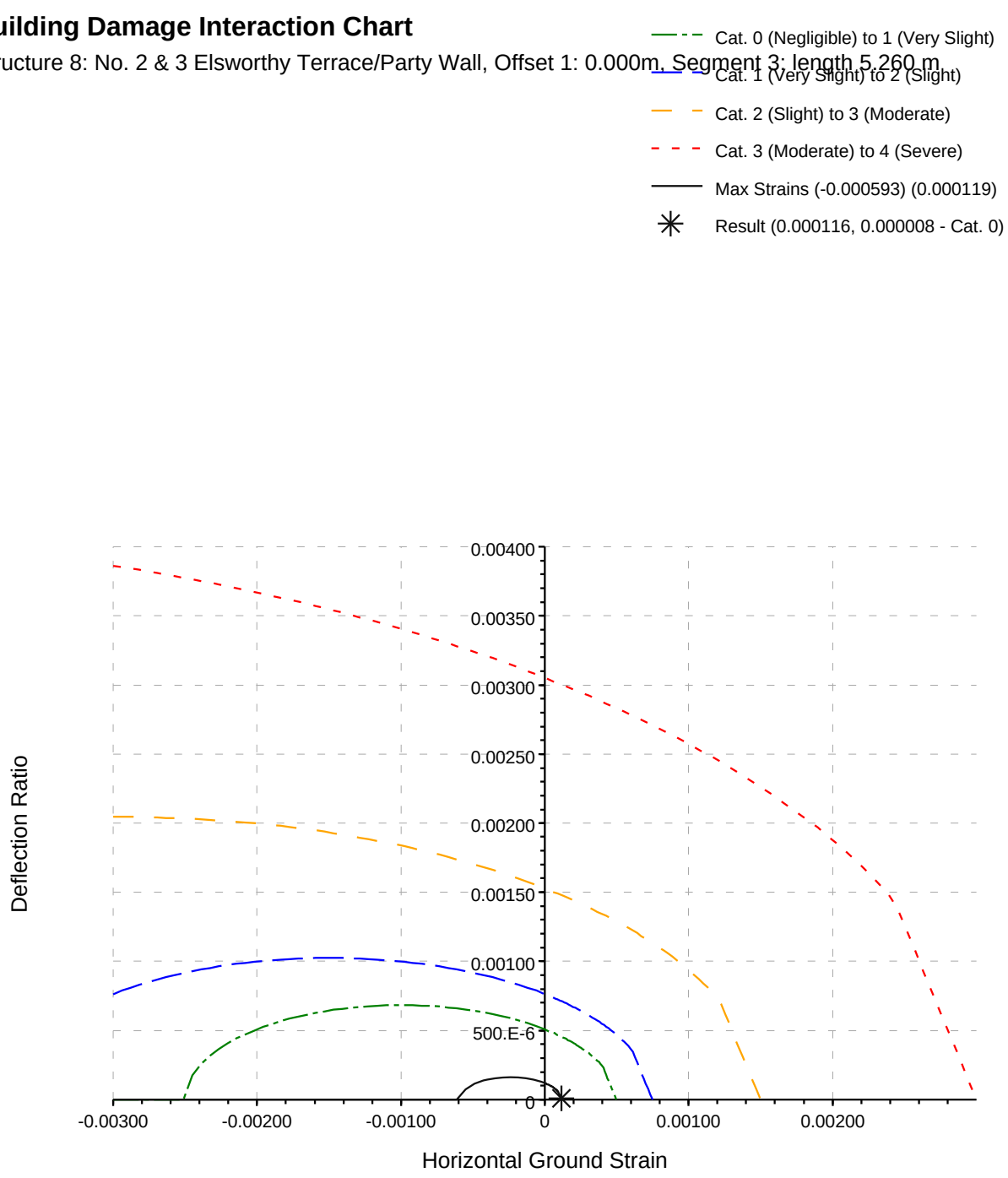
Building Damage Interaction Chart

Structure 7: No. 23 Elsworthy Road/Potential Internal Wall, Segment 1: length 8.557 m



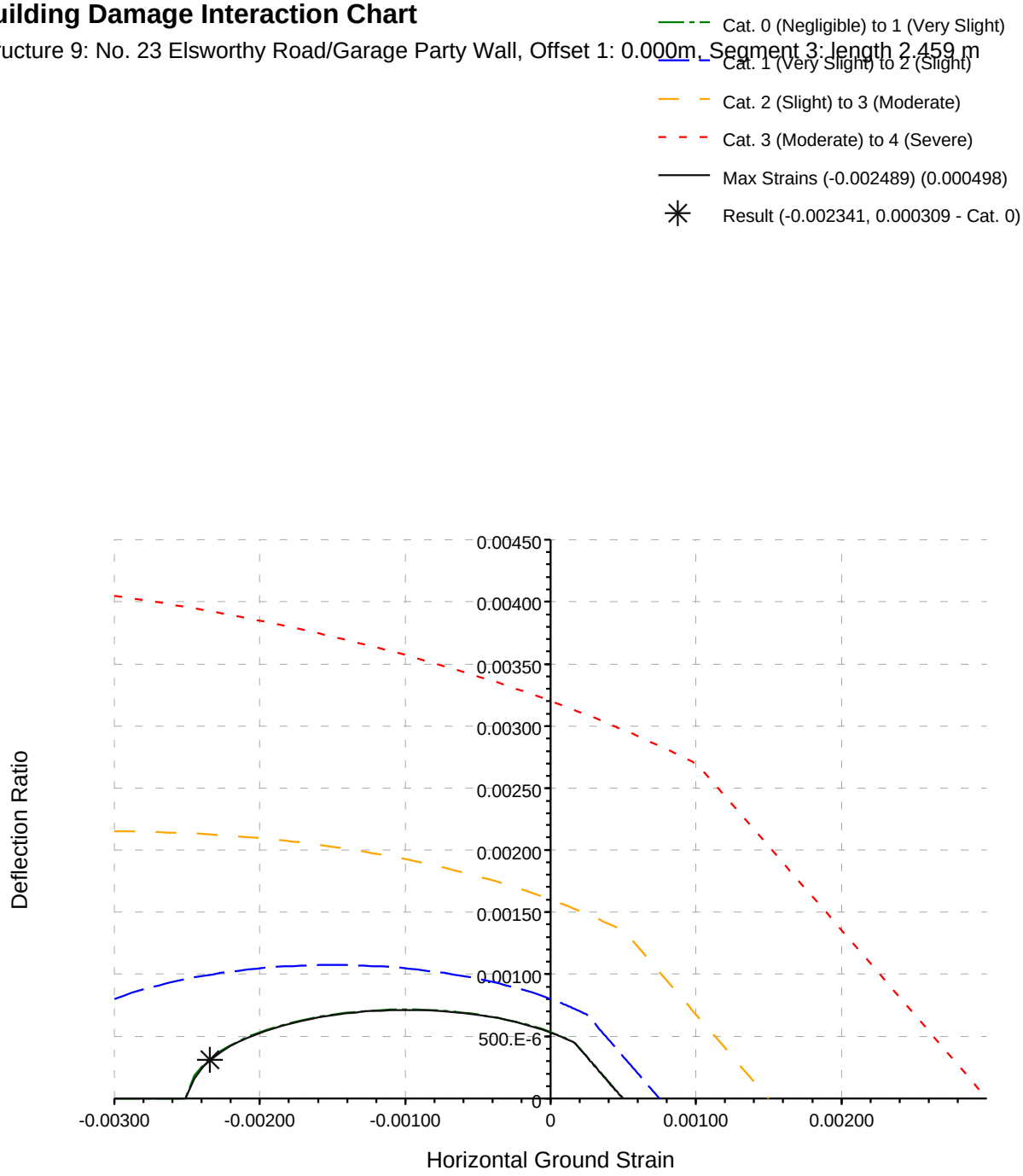
Building Damage Interaction Chart

Structure 8: No. 2 & 3 Elsworthy Terrace/Party Wall, Offset 1: 0.000m, Segment 3: length 5.260 m



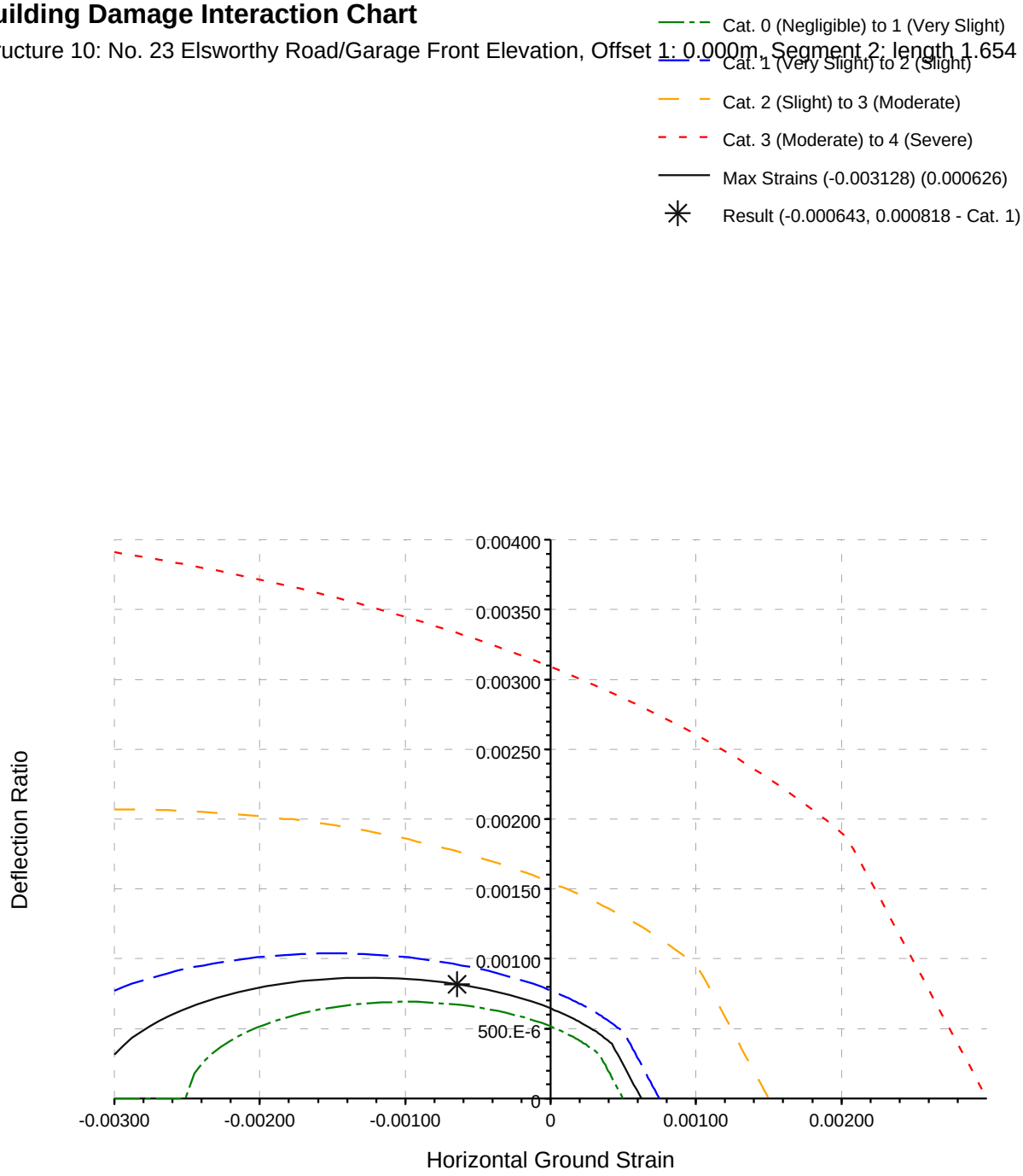
Building Damage Interaction Chart

Structure 9: No. 23 Elsworthy Road/Garage Party Wall, Offset 1: 0.000m, Segment 3: length 2.459 m



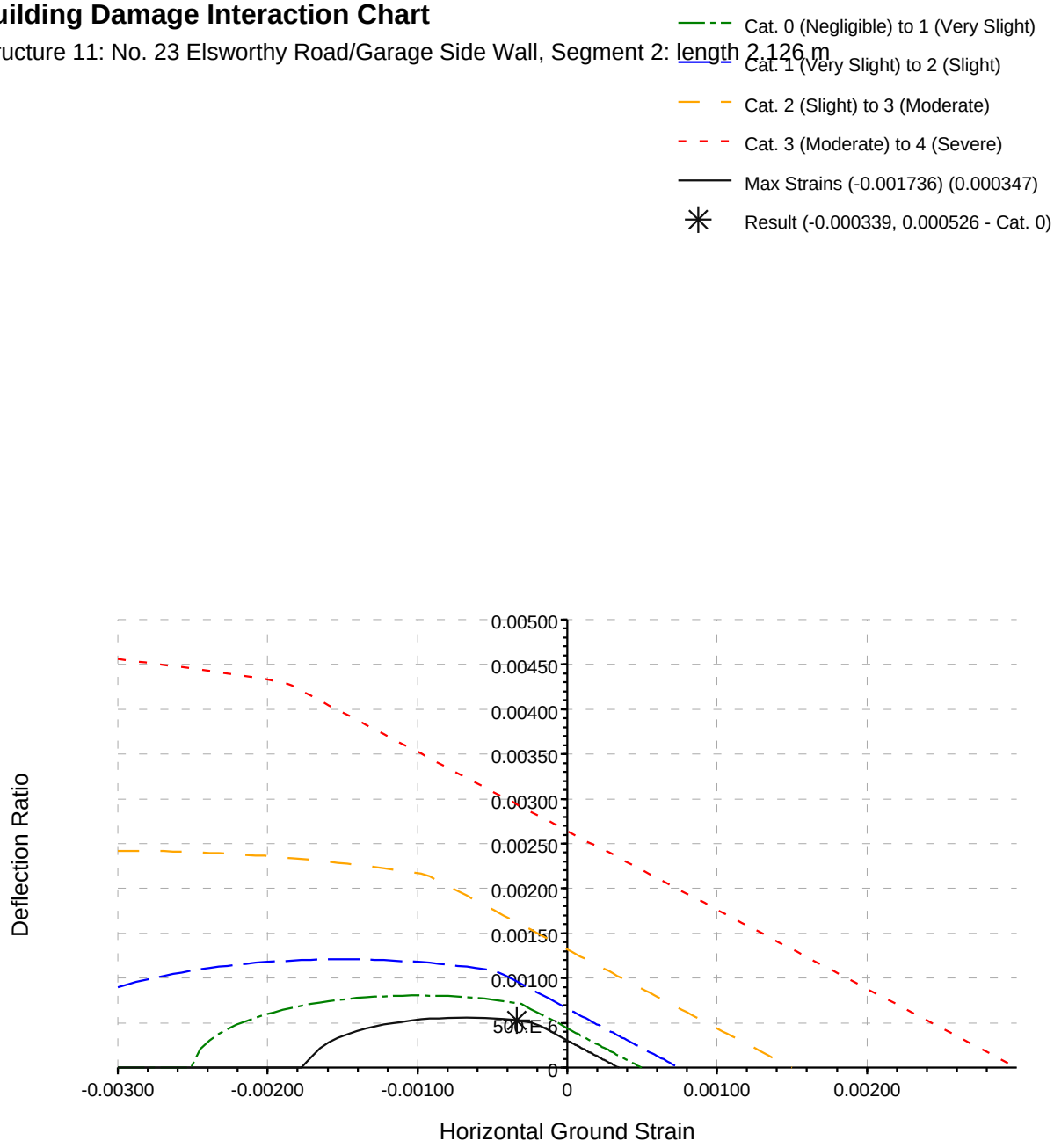
Building Damage Interaction Chart

Structure 10: No. 23 Elsworthy Road/Garage Front Elevation, Offset 1: 0.000m, Segment 2: length 1.654 m



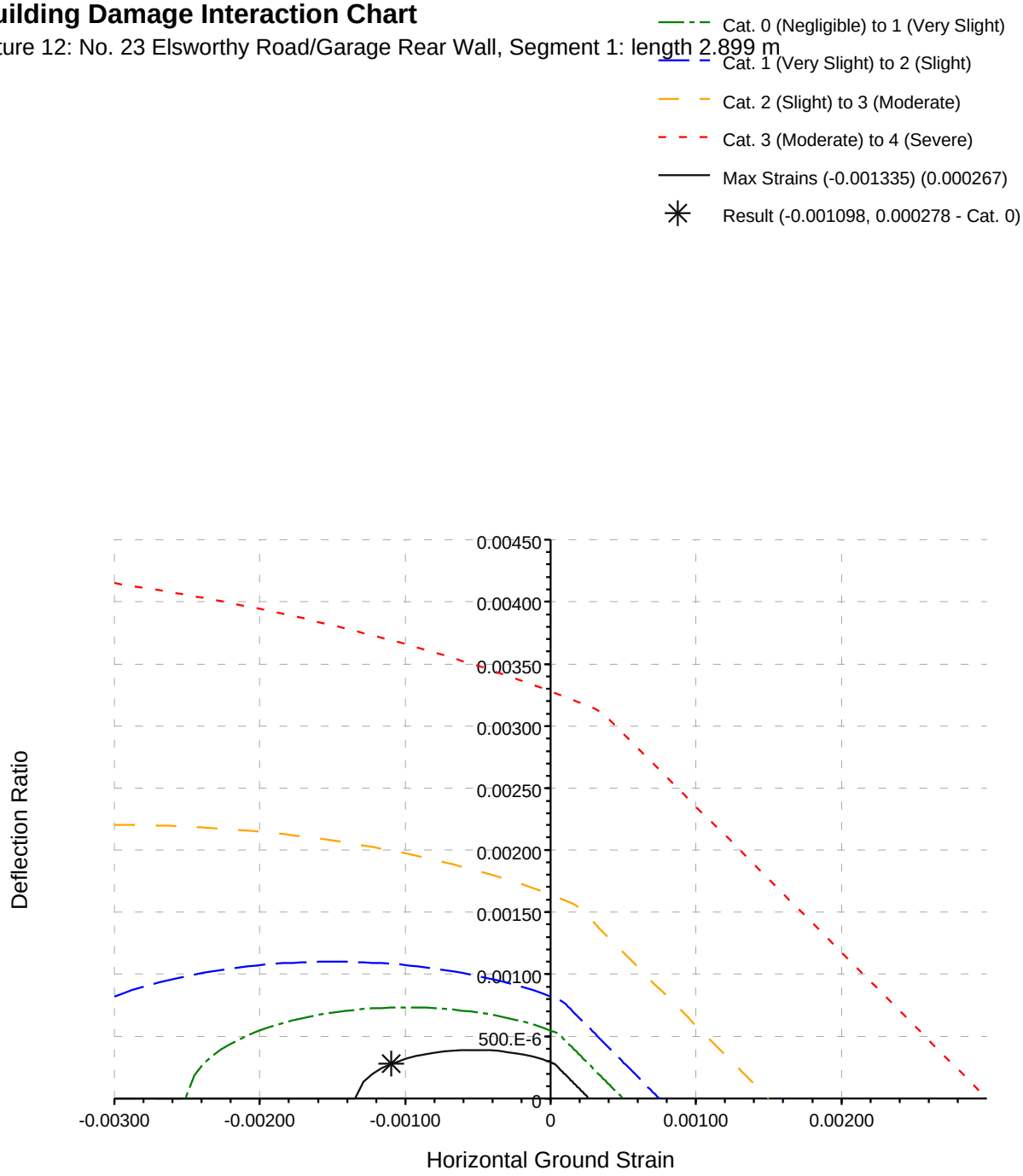
Building Damage Interaction Chart

Structure 11: No. 23 Elsworthy Road/Garage Side Wall, Segment 2: length 2.126 m



Building Damage Interaction Chart

Structure 12: No. 23 Elsworthy Road/Garage Rear Wall, Segment 1: length 2.899 m



Graphics Display