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# GROUND MOVEMENT ASSESSMENT REPORT

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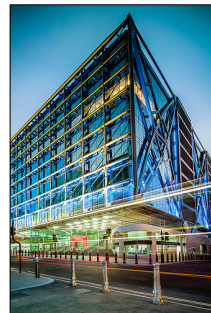
Royal Academy of  
Dramatic Art  
16-18 Cheries Street  
London WC1E 7EX

Client: Royal Academy of Dramatic Art



Engineer: Price & Myers

J15215

March 2016



## Document Control

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## 1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Price and Myers Consulting Engineers (P&M), on behalf of the Royal Academy of Dramatic Art (RADA), to complete a ground movement assessment for the proposed extension of an existing basement at RADA's site at 16-18 Chenies Street, London, WC1E 7EX.

A Site Investigation and Basement Impact Assessment has previously been carried out by GEA (report ref J15215, dated November 2015) and the findings of this report, along with an additional borehole by others, have been used in the derivation of parameters for use in this assessment.

The purpose of this assessment has been to assess any effects of the proposed basement construction upon nearby sensitive structures.

### 1.1 Proposed Development

It is proposed to extend the existing single-storey basement that is present beneath the Drill Hall at No 16 Chenies Street as well as extending an existing basement beneath No 18 Chenies Street. The extension below No 16 is already at about 1.9 m depth and will be extended laterally by some 7 m and deepened by approximately 0.9 m. The existing basement at No 18 Chenies Street will be extended by some 4 m to 5 m laterally. The basement extensions will be the same depth as the existing, of 2.8 m below ground level.

This report is specific to the proposed development and the advice herein should be reviewed if the development proposals are amended.

### 1.2 Limitations

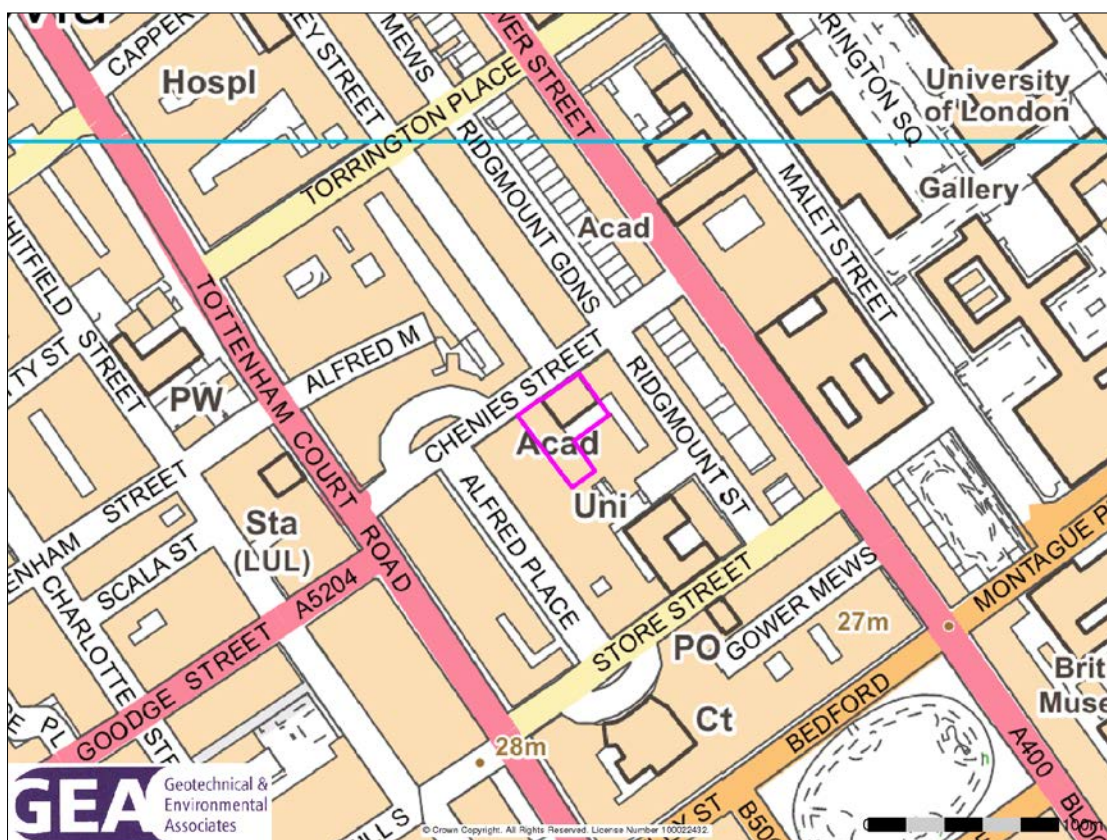
The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

## 2.0 THE SITE

### 2.1 Site Description

The site is located in the London Borough of Camden, approximately 150 m northwest of the British Museum. It is bounded to the north by Chenies Street with access to the rear of the building via Ridgmount Street to the east and by five-storey and seven-storey buildings to the east and west respectively. It may be additionally located by National Grid Reference 529670, 181850 and is shown on the map extract overleaf.

The site is accessed at the front of the building, and is roughly L shaped, measuring approximately 45 m by 40 m; it is occupied by the Royal Academy of Dramatic Arts (RADA), a three-storey Victorian brick building with a single level basement. The site is devoid of vegetation and sensibly levelled.



### 3.0 SUMMARY OF GROUND CONDITIONS

The site investigation confirmed the findings of the previous investigation in that, below a significant thickness of made ground, Lynch Hill Gravel is present over London Clay.

The made ground generally comprised brownish grey clay with fragments of brick, concrete, mortar and ash and extended to depths of 3.30 m and 5.00 m below ground level. The Lynch Hill Gravel initially comprised firm orange-brown silty sandy clay with occasional fine to medium subangular to subrounded flint gravel with fine sand pockets to a depth of 4.10 m. This initial layer was underlain by dense yellowish brown fine to medium sand with occasional fine to medium subangular to subrounded flint gravel becoming more abundant with depth, to 6.30 m. The London Clay initially comprised an upper weathered horizon of firm brown silty clay to a depth of 6.40 m, underlain by stiff grey fissured silty clay with pockets of sand to 9.10 m. Abundant pockets and partings of silt were noted from 15.50 m to 18.00 m, the maximum depth investigated.

A borehole record from the adjacent Alfred Street building indicates that the London Clay extends to a depth of 26.0 m whereupon the soils of the Lambeth Group (listed as the Woolwich and Reading Beds) were encountered and underlain in turn by Thanet Sand at 38.1 m and ultimately chalk at 42.2 m.

Groundwater was not encountered in the boreholes during drilling, but subsequent monitoring of standpipes has measured water at a depth of 5.45 m.

### 3.1 Surrounding Structures

Following Issue No 1 of the ground movement analysis, Price and Myers have provided a

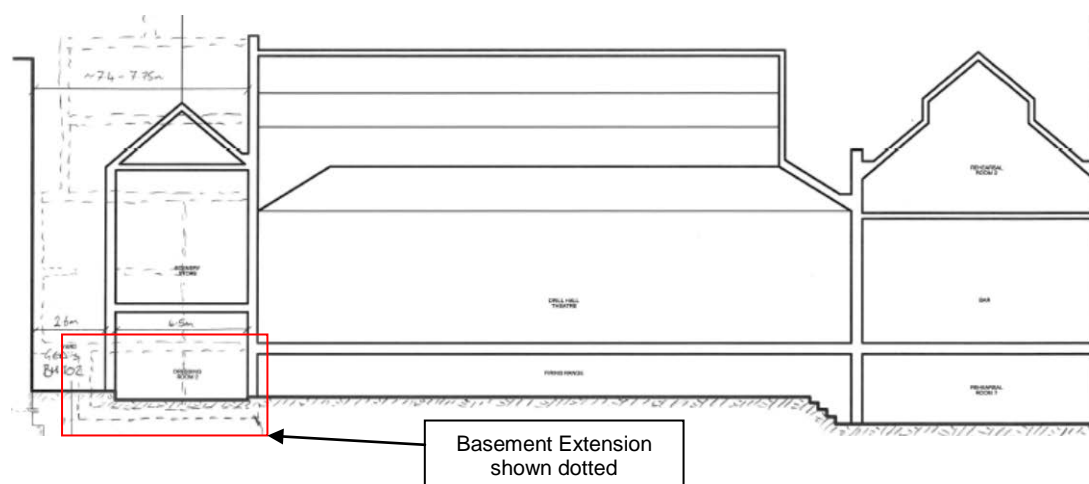
report on the nature and extent of the buildings that adjoin the site. The report, entitled Description of Adjacent Buildings, is appended and rules out the need for ground movement assessment for all surrounding structures other than 'the modest section of infill to the rear of the Law Building'. The main reasoning behind the Price and Myers conclusion is that a number of the surrounding structures have basements themselves that are in some cases deeper than those proposed for this site with secondary reasoning that the relative bulk of the buildings would require foundations sufficiently massive so as not to be affected by these two relatively small extensions to existing basements.

Notwithstanding the above an assessment of ground movements has been undertaken in detail for No 16 Chenies Street and for No 18 Chenies Street as well as the University of Law building and its infill building that abuts No 16 Chenies Street.

## 4.0 CONSTRUCTION SEQUENCE

### 4.1 16 Chenies Street

A section through the proposed building at No 16 Chenies Street including its basement is included below.



For the purposes of the ground movement assessment, the existing external ground level has been taken as 0.0 m and the proposed basement will be formed at a depth between 0.5 m to 0.8 m deeper than at present. The underpinning of the external walls will be through traditional methods and will deepen their foundations by around 0.9 m to bear at a depth 2.8 m from the existing ground level.

The new structure that is to be formed within the basement extension is to be supported upon piled foundations and will be completely independent of the existing structure. The drawings within the Construction Method Statement (CMS) show that the piles are relatively widely spaced and therefore can be deemed to act singly. On this basis the loading of the piles will not affect the existing building but the limited unloading due to the basement deepening will cause a minor degree of heave. Price and Myers have provided drawings that indicate the unloading effects of the development and also the reloading information for the remaining parts of the building. The reloading occurs where new spread foundations are to be cast or where existing walls are to support additional load. For the purpose of this analysis, the unloading and subsequent loading at basement level will be applied at a depth of 2.80 m below existing ground level.

The construction sequence has been provided within the CMS and the construction has been modelled at three stages. These are short term unloading only, short term unloading and reloading and then unloading and reloading in the long term when reversion to drained soil parameters has been assumed to take place.

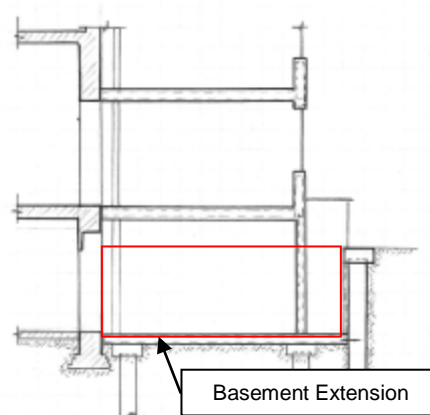
## 4.2 18 Chenies Street

A section through the proposed building at No 18 Chenies Street including its basement is included below.

The section, right, shows the location of a small length of bored pile wall which enables the lateral extension of the existing basement by between 4.0 m and 5.0 m.

The wall is to retain approximately 3.0 m of soil and will initially act as a cantilever with propping force provided in the long term by the basement slab and ground beams.

For such a retained height it is considered that a bored pile wall of 450 mm diameter contiguous piles should be sufficient and that with a ratio of embedded length to exposed length of 2:1 for a cantilevered wall the pile lengths may be expected to be about 9.0 m.



## 5.0 GROUND MOVEMENTS

An assessment of ground movements within and surrounding the excavation has been undertaken using the X\_Disp and P-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp program has been used to predict ground movements likely to arise from the construction of the proposed basement. This includes the settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement) which occur due to the installation of piling and underpinning together and subsequent excavation.

The analysis of potential ground movements within the excavation, as a result of unloading of the underlying soils and subsequent reloading as the building is constructed, has been carried out using the Oasys P-Disp Version 19.3 software package and is based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains.

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction roughly perpendicular to Chenies Street and the y-direction parallel with the same road. Vertical movement is in the z-direction.

The output movement contour plots are included within the appendix along with the full data set of results and line graphs for the walls analysed.

## 5.1 Movements Surrounding the Excavations

### 5.1.1 Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are based on the default values within CIRIA report C580<sup>1</sup>. The C580 movements were derived from a number of historic case studies of the short term movements that result from wall installation and basement excavation.

Given the limited extent of the mass concrete underpinning it would seem reasonable to adopt the ground movement curves for ‘no horizontal and vertical movement’ for this analysis. In practice, however, there will always be a potential for a small degree of movement to take place, typically less than 2 mm for the 0.9 m depth of underpinning. A more cautious approach has, however, been taken in this instance using the installation of a planar diaphragm wall to model the panel-like installation of the underpinning.

On the basis of the notes in Section 4.2 above, a pile length of 9.0 m has been assumed along with a maximum basement excavation depth of 3.0 m. Groundwater has not been encountered within the proposed basement depth and therefore a contiguous bored pile wall is deemed appropriate; a lining wall will provide long term water-tightness. The piled wall, which will act as a cantilever, falls into the low stiffness category in C580.

### 5.1.2 Results

The X-Disp analysis has been used to estimate the movements behind the walls resulting from pile installation and basement excavation. This includes the settlement of the ground (vertical movement) and the lateral movement of soil behind the wall (horizontal movement). The contour graphs of these movement predictions are appended for the piling phase together with the total movement prediction which combined the effects.

The following values of vertical and horizontal movement are those occurring immediately behind the piled wall and reduce to zero at the distance noted as the maximum lateral influence.

Phase of Works (CIRIA C580 Movement Curve)	Maximum Movements at Existing Ground Level of 0.0 m	
	Vertical Settlement (mm) [Maximum lateral influence (m)]	Horizontal Movement (mm) [Maximum lateral influence (m)]
Piling Phase (C580 Contiguous Bored Pile Wall)	<4 [18.0]	<4 [13.5]
Combined Piling and Basement Excavation Phases (Excavation in front of a low stiffness wall)	10 [12.0]	10 to 16 [12.0]

<sup>1</sup> Gaba, A, Simpson, B, Powrie, W and Beadman, D (2003) *Embedded retaining walls – guidance for economic design*. CIRIA Report C580.



## 5.2 Movements within the Excavations

### 5.2.1 Model Used

At this site the loading configurations supplied by P&M indicates that the various walls and slab areas will be subject to unloading and different walls and areas will be reloaded. The annotated drawings are contained within the CMS but essentially the loading and unloading are relatively small. For complete clarity the 55 kN/m<sup>2</sup> noted within Section 7 of the GEA BIA only relates to the small area of basement extension to No 18 Chenies and the load changes to No 16 are small. Where there is a net unloading of the London Clay, there will be a reduction in vertical stress in the short term that will cause heave to take place. Undrained soil parameters have been used to estimate the potential short term movements, which include the “immediate” or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total long-term movement.

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and well-established methods have been used to provide our estimates. These relate values of  $E_u$  and  $E'$ , the drained and undrained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock<sup>2</sup> and Butler<sup>3</sup> and more recently by O’Brien and Sharp<sup>4</sup>. Relationships of  $E_u = 500 C_u$  and  $E' = 300 C_u$  for the cohesive soils have been used to obtain values of Young’s modulus. More recent published data<sup>5</sup> indicates stiffness values of 750 x  $C_u$  for the London Clay and a ratio of  $E'$  to  $E_u$  of 0.75 but it is considered that the use of the more conservative values provides a sensible approach for this site at this stage in the design.

The soil parameters used in this assessment are tabulated below.

Stratum	Depth range (m)	$E_u$ (MPa)	$E'$ (MPa)
Made Ground	G/L to 3.3	25	15
Firm Clay	3.3 – 4.1	37.5	22.5
Lynch Hill Gravel	4.1 – 6.3	54	54
London Clay	6.3 – 20	55 – 108	33 – 64.8
London Clay	20 – 26	55	108

It is noted that the made ground extended to a depth of 5.0 m in Borehole No 1 beyond the end of the building. This thickness of made ground is considered to derive from the Dallas House building that stood on that part of the site, but was demolished following World War II, such that it is not considered to be representative of the typical conditions beneath the site. The ground conditions in the table above are based on GEA Borehole No 101 which is essentially consistent with the findings of LBH Borehole No 1 and therefore considered to be a better representation of the ground conditions on the wider site.

<sup>2</sup> Padfield CJ and Sharrock MJ (1983) *Settlement of structures on clay soils*. CIRIA Special Publication 27

<sup>3</sup> Butler FG (1974) *Heavily overconsolidated clays: a state of the art review*. Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond

<sup>4</sup> O’Brien AS and Sharp P (2001) *Settlement and heave of overconsolidated clays - a simplified non-linear method*. Part Two, Ground Engineering, Nov 2001, 48-53

<sup>5</sup> Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension*. CIRIA Special Publication 200

A rigid boundary for the analysis has been set within the London Clay at a depth of 26.0 m below existing ground level, where the nearby BGS records indicate that the base of this formation is likely to be present at its interface with the soils of the Lambeth Group. Below this depth the soils are considered essentially incompressible.

## 5.2.2 Results

The P-Disp analysis indicates that, by the time the basement construction is complete, less than 5 mm of heave is likely to have taken place at the centre of the proposed extension, whilst settlement much less than 5 mm is predicted beneath the external walls.

Following completion of the basement construction and application of new loads, the heave is predicted to increase by a further 5 mm or so but there will be only nominal additional settlement to remain well below 5 mm beneath the external walls.

The results of the P-Disp analysis can be used to indicate the likely impact of the proposed basement construction beyond the site boundaries. At a distance of about 2.5 m away from the basement extension excavation, the total movements reduce to roughly 1.0 mm of heave and at a similar distance from the external walls; the settlement is roughly 1.0 mm indicating sensibly negligible movements. Movements outside the excavation will be constrained to a certain extent by the presence of the new retaining walls and off-set to a large extent by the movements during pile and underpin installation. The estimated movements obtained from the analysis may therefore not occur in practice.

Basement Location	Movement (mm) Heave -ve / Settlement +ve		
	Short-term Heave (Unloading / excavation phase)	Short-term Heave / Settlement (Post-construction)	Total Heave / Settlement
16 Chenies Street	<-2	-2 to +1	-3 to +2
18 Chenies Street	<-5	<-5	-5 to -10

A void or layer of compressible material may need to be incorporated into the design to accommodate these potential long term movements. This analysis suggests that if such a compressible material is to be used beneath the slab, it will need to be designed to be able to resist the limited potential uplift forces generated by the ground movements and relating to less than 10 mm of total uplift movement.

## 6.0 DAMAGE ASSESSMENT

In addition to the above assessment of the likely movements that will result from the proposed development, the neighbouring buildings are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 2.5 of C580<sup>1</sup>.

All structures are shown on the appended site plan.

### 6.1 Damage to Neighbouring Structures

The movements resulting from the construction of the basement extension have been considered with the infill wall to the Law Building taken as being sensitive to the ground movements as well as the four main walls of No 16 Chenies Street, the retained wall at No 18 Chenies Street and the nearest two walls of the University of law building.

A building damage assessment is included within the X-Disp analysis and indicates that all walls other than one segment in each of the Eastern wall of 16 Chenies Street and the Infill Building will suffer movement equivalent to Damage Category 0 – ‘Negligible’. The other two segments are indicated to be Category 1 – ‘Very Slight’.

Reference to the appended movement contour plots indicates that heave movements of up to 1.5 mm in the short term unloading case rising to 3.0 mm in the long term with maximum settlement after reloading of 1.0 mm and 2.0 mm in the short term and long term respectively.

Analysis of the line plot for the wall to the Law Building infill taken from the P-Disp analysis shows that the total movement will generate ‘negligible’ damage with the deflection ratios shown as much less than 1 in 400 through either the ‘hogging’ heave movements or ‘sagging’ settlements.

The long walls of 16 Chenies Street show movements that align with very small deflection ratios but are subject to ‘spikes’ where the existing foundations are to be locally deepened. The spikes are deemed to be a function of the program and will not perfectly represent the manner in which the structure will behave in reality because the analysis takes no account of load distribution within the wall between bases due to the wall stiffness, which would tend to smooth out these spikes. The real movement is therefore considered to be represented by the general trend of the movement profile in these locations.

## 6.2 Monitoring of Ground Movements

The predictions of ground movement based on the ground movement analysis should be checked by monitoring of the adjacent properties and structures and following confirmation of the foundation arrangements. The structures to be monitored during the construction stages should include the neighbouring structures. Condition surveys of the above existing structures should be carried out before and after the proposed works.

However, it should be remembered that the context is that this is a small extension to an existing basement and that the movements predicted are relatively small.

An indicative monitoring strategy has been compiled by Price and Myers although the precise strategy will be developed at a later stage and it will be subject to discussions and agreements with the owners of the adjacent structures under the obligations of the Party Wall Act. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

## 7.0 CONCLUSIONS

The analysis has concluded that the predicted damage to the neighbouring properties from the construction of the basement extension would generally be ‘Negligible’ with two small segments of walls that would be ‘very slight’ for which the damage that would occur would fall within the acceptable limits. It is recommended that movement monitoring is carried out on all structures prior to and during the proposed basement construction.

The separate phases of work, including excavation of the proposed basement, will in practice be separated by a number of weeks during which time construction of permanent supports, basement slab and retaining wall curing will take place. This will provide an opportunity for the ground movements during and immediately after underpin construction to be measured

and the data acquired can be fed back into the design and compared with the predicted values. Such a comparison will allow the ground model to be reviewed and the predicted wall movements to be reassessed prior to the main excavation taking place so that propping arrangements can be adjusted if required.

## **APPENDICES**

### **X-DISP ANALYSIS**

Pile and Underpinning Installation Movement  
Contour Plots and Tabular Data

Excavation Movement Contour Plots  
and Tabular Data

### **P-DISP ANALYSIS**

Short Term Movement Contour Plots – Unloading

Short Term Movement Contour Plots – Reloading

Total Movement Contour Plots

Cross Section Line Plots

Basement Plan and Loading  
Information



**Royal Academy of Dramatic Arts**  
**16-18 Chenies Street Development**  
**Pile and underpinning Installation**

**Dr. Ref.**

**Made by** **Date** **Checked**  
**MC** **23-Mar-2016**

**Problem Type**

Problem Type : Tunnelling and Embedded Wall Excavations

**Displacement Data**

Type	Name	Direction of extrusion	Point/Line/Line for extrusion				No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels		
			First point		Second point								
			X	Y	Z (level)	X	Y	Z (level)					
			[m]	[m]	[m]	[m]	[m]	[m]					
Grid	Grid 1	Global X	-10.00000	-20.00000	-2.80000	-	30.00000	-2.80000	25	70.00000	35	Yes	Surface
Line	Law Bdg Infill	-	2.00000	6.00000	-1.50000	18.00000	6.00000	-1.50000	15	-	-	Yes	Surface
Line	16 Chenies Wst	-	2.00000	22.00000	-2.80000	53.00000	22.00000	-2.80000	45	-	-	Yes	Surface
Line	16 Chenies Sth	-	2.00000	21.90000	-2.80000	2.00000	6.10000	-2.80000	15	-	-	Yes	Surface
Line	16 Chenies Est	-	2.00000	6.00000	-2.80000	53.00000	6.00000	-2.80000	45	-	-	Yes	Surface
Line	16 Chenies Nth	-	53.00000	21.90000	-2.80000	53.00000	6.10000	-2.80000	15	-	-	Yes	Surface
Line	18 Chenies	-	39.00000	-13.60000	-3.50000	39.00000	6.00000	-3.50000	20	-	-	Yes	Surface
Line	Retained Wall	-	21.60000	4.00000	-2.80000	21.60000	-17.00000	-2.80000	20	-	-	Yes	Surface
Line	Law Bdg Nth	-	21.60000	-17.10000	-2.80000	0.00000	-17.10000	-2.80000	20	-	-	Yes	Surface
Line	Law Bdg Est	-	21.60000	-17.10000	-2.80000	0.00000	-17.10000	-2.80000	20	-	-	Yes	Surface

**Vertical Ground Movement Curves**

**Curve Name:** No vertical ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 1  
 y Order: 0  
 Polynomial: z = 0.0x + 0.0  
 Coeff. of -2147483648.E+2147483647  
**Determination:**

**Curve Name:** Installation of contiguous bored pile wall in stiff clay (CIRIA 580 Fig. 2.8(b))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.040][2.000,0.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -2.0E-2x + 4.0E-2  
 Coeff. of 1.0  
**Determination:**

**Curve Name:** Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(b))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.050][0.050,0.000,0.047][0.100,0.000,0.043][0.150,0.000,0.040]  
 [0.200,0.000,0.037][0.250,0.000,0.034][0.300,0.000,0.031][0.350,0.000,0.028]  
 [0.400,0.000,0.025][0.450,0.000,0.022][0.500,0.000,0.020][0.550,0.000,0.018]  
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 [1.200,0.000,0.002][1.250,0.000,0.001][1.300,0.000,0.001][1.350,0.000,0.001]  
 [1.400,0.000,0.001][1.450,0.000,0.000][1.500,0.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 4  
 y Order: 0  
 Polynomial: z = -1.2355E-2x<sup>4</sup> + 3.4814E-2x<sup>3</sup> - 2.8885E-3x<sup>2</sup> - 6.5618E-2x + 4.9987E-2  
 Coeff. of 1.0000  
**Determination:**

**Horizontal Ground Movement Curves**

**Curve Name:** No horizontal ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 0  
 y Order: 0  
 Polynomial: z = 0.0  
 Coeff. of -2147483648.E+2147483647  
**Determination:**

**Curve Name:** Installation of contiguous bored pile wall in stiff clay (CIRIA 580 Fig. 2.8(a))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.041][0.050,0.000,0.039][0.100,0.000,0.036][0.150,0.000,0.034]  
 [0.200,0.000,0.032][0.250,0.000,0.030][0.300,0.000,0.029][0.350,0.000,0.027]  
 [0.400,0.000,0.025][0.450,0.000,0.023][0.500,0.000,0.022][0.550,0.000,0.020]  
 [0.600,0.000,0.019][0.650,0.000,0.018][0.700,0.000,0.016][0.750,0.000,0.015]  
 [0.800,0.000,0.014][0.850,0.000,0.013][0.900,0.000,0.012][0.950,0.000,0.010]  
 [1.000,0.000,0.009][1.050,0.000,0.008][1.100,0.000,0.007][1.150,0.000,0.006]  
 [1.200,0.000,0.005][1.250,0.000,0.004][1.300,0.000,0.004][1.350,0.000,0.003]  
 [1.400,0.000,0.002][1.450,0.000,0.001][1.500,0.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 3  
 y Order: 0  
 Polynomial: z = -4.2486E-3x<sup>3</sup> + 1.9096E-2x<sup>2</sup> - 4.6221E-2x + 4.0729E-2  
 Coeff. of 1.0000  
**Determination:**

**Curve Name:** Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(a))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.050][1.500,0.000,0.000]  
**Curve Fitting** Polynomial  
**Method:**  
 x Order: 1  
 y Order: 0  
 Polynomial: z = -3.33E-2x + 5.00E-2  
 Coeff. of 1.00  
**Determination:**

**Polygonal Excavations**

**Excavation Name:** 16 Chenies Underpinning  
**Surface level [m]:** -1.9000  
**Contribution:** Positive  
**Enabled:** Yes  
**Surface movement curves which are selected are applied between surface and [m]:** -2.8000  
**Corner** x y Base Stiffened Previous Side Next Side  
 Level d pl p2\* d pl p2\*



**Royal Academy of Dramatic Arts**  
**16-18 Chenies Street Development**  
**Pile and underpinning Installation**

**Dr. Ref.**

**Made by**  
**MC**

**Date**  
**23-Mar-2016**

**Checked**

	[m]	[m]	[m]		[m]	[%]	[%]	[m]	[%]	[%]
1	3.5000	6.0000	-2.8000	No	-	-	-	-	-	-
2	3.5000	22.0000	-2.8000	No	-	-	-	-	-	-
3	9.8000	22.0000	-2.8000	No	-	-	-	-	-	-
4	9.8000	6.0000	-2.8000	No	-	-	-	-	-	-

Side	Corner 1		Corner 2		Ground Movement Curve	
	x	y	x	y	Vertical	Horizontal
1	3.5000	6.0000	3.5000	22.0000	No vertical ground movement	No horizontal ground movement
2	3.5000	22.0000	9.8000	22.0000	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(b))	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(a))
3	9.8000	22.0000	9.8000	6.0000	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(b))	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(a))
4	9.8000	6.0000	3.5000	6.0000	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(b))	Installation of planar diaphragm wall in stiff clay (CIRIA 580 Fig. 2.9(a))

**Excavation Name:** 18 Chenies Piling  
**Surface level [m]:** 0.0  
**Contribution:** Positive  
**Enabled:** Yes  
 Surface movement curves which are selected are applied between surface and [m]: -9.0000

Corner	x	y	Base Level	Stiffened	Previous Side	Next Side	
						d	p2*
1	28.0000	5.7000	-9.0000	No	-	-	
2	35.5000	5.7000	-9.0000	No	-	-	
3	35.5000	-11.0000	-3.0000	No	-	-	
4	30.0000	-11.0000	-9.0000	No	-	-	

Side	Corner 1		Corner 2		Ground Movement Curve	
	x	y	x	y	Vertical	Horizontal
1	28.0000	5.7000	35.5000	5.7000	No vertical ground movement	No horizontal ground movement
2	35.5000	5.7000	35.5000	-11.0000	No vertical ground movement	No horizontal ground movement
3	35.5000	-11.0000	30.0000	-11.0000	No vertical ground movement	No horizontal ground movement
4	30.0000	-11.0000	28.0000	5.7000	Installation of contiguous bored pile wall in stiff clay (CIRIA 580 Fig. 2.8(b))	Installation of contiguous bored pile wall in stiff clay (CIRIA 580 Fig. 2.8(a))

**Damage Category Strains**

Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
	to	to	to	to
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

**Specific Structures - Geometry**

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category	Strains	Poisson's Ratio	E/G
Law Building	Infill	Law Bdg Infill	0.00000	15.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
16 Chenies	West	16 Chenies Wst	0.00000	50.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
16 Chenies	South	16 Chenies Sth	0.00000	15.70000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
16 Chenies	East	16 Chenies Est	0.00000	50.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
16 Chenies	North	16 Chenies Nth	0.00000	15.70000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
18 Chenies	Retained Wall	18 Chenies	0.00000	19.50000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Law Building	North	Law Bdg Nth	0.00000	20.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	
Law Building	East	Law Bdg Est	0.00000	21.50000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000	

**Specific Structures - Bending Parameters**

Structure Name	Sub-Structure Name	Height	Default Properties	Hogging			Sagging		
				2nd Moment of Area (per unit width)	Distance of Bending from N.A.	Distance of N.A. from Edge of Beam in Tension	2nd Moment of Area (per unit width)	Distance of Bending from N.A.	Distance of N.A. from Edge of Beam in Tension
Law Building	Infill	10.0000	Yes	333.33	10.0000	10.0000	83.333	5.0000	5.0000
16 Chenies	West	16.0000	Yes	1365.3	16.0000	16.0000	341.33	8.0000	8.0000
16 Chenies	South	16.0000	Yes	1365.3	16.0000	16.0000	341.33	8.0000	8.0000
16 Chenies	East	16.0000	Yes	1365.3	16.0000	16.0000	341.33	8.0000	8.0000
16 Chenies	North	16.0000	Yes	1365.3	16.0000	16.0000	341.33	8.0000	8.0000
18 Chenies	Retained Wall	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
Law Building	North	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000
Law Building	East	22.0000	Yes	3549.3	22.0000	22.0000	887.33	11.0000	11.0000

**Building Segment Combinations**

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations	Segment Start	Length	Curvature	Combined Segment
No structures have segments combined.						

**Warnings**

- Multiple excavations have been specified. The displacements resulting from these excavations are calculated by summing the displacements resulting from each individual excavation. No account has been taken of the interactions between excavations (e.g. overlapping zones of influence or 'shielding' of one excavation by another).
- If an embedded wall excavation is assigned a 'surface' ground movement curve and if the 'allow movement calculation to level' option is checked for the excavation then displacements induced by it are calculated for points at the surface, and points below the surface to the level specified. Others are ignored. An example of such a combination, for which displacements will not be calculated is Excavation XPI/Side 2/Line 1/Vertical. This is an example only. There are 11 others.
- If an embedded wall excavation is assigned a 'sub-surface' ground movement curve then displacements induced by it can only be calculated for those points that are level with or below the embedded wall excavation's 'surface level'. Others are ignored. An example of such a combination, for which displacements will not be calculated is Excavation XPI/Side 1/Line 1/Vertical. This is an example only. There are 1 others.

**Displacement and Strain Results**

Type/No.	Coordinates						Displacements			Angle of Line to x Axis
	Name	Dist.	x	y	z	x	y	z		
Horizontal displacement along the Line										
Horizontal displacement perpendicular to Line										







GEA LIMITED

(GEOTECHNICAL & ENV ASSOC) J15215

Job No.

Sheet No.

Rev.

Royal Academy of Dramatic Arts
16-18 Cheries Street Development
Pile and underpinning Installation

Drg. Ref.

Made by
MC

Date
23-Mar-2016

Checked

Table with columns: Type/No., Name, Dist., Coordinates (x, y, z), Displacements (x, y, z, Horizontal displacement, Horizontal displacement), Angle of Line to x Axis. The table lists data for multiple points, including coordinates and displacement values, with some notes indicating points within excavations.





GEA LIMITED (GEOTECHNICAL & ENV ASSOC) J15215

Royal Academy of Dramatic Arts 16-18 Cheries Street Development Pile and underpinning Installation

Job No. Sheet No. Rev. Drg. Ref. Made by MC Date 23-Mar-2016 Checked

Main data table with columns: Type/No., Name, Dist., Coordinates (x, y, z), Displacements (Horizontal, Vertical), Angle of Line to x Axis. Includes numerous rows of data points.





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(GEOTECHNICAL & ENV ASSOC) J15215

Job No. Sheet No. Rev.

Dr. Ref.

Made by MC Date 23-Mar-2016 Checked

Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Pile and underpinning Installation

Table with columns: Type/No., Coordinates (x, y, z), Displacements (Horizontal, Horizontal), Angle of Line to x Axis. Contains data for pile and underpinning installation.





GEA LIMITED
(GEOTECHNICAL & ENV ASSOC) J15215

Job No. Sheet No. Rev.
Drg. Ref.
Made by MC Date 23-Mar-2016 Checked

Royal Academy of Dramatic Arts
16-18 Cheries Street Development
Pile and underpinning Installation

Table with columns: Type/No., Name, Dist., Coordinates (x, y, z), Displacements (Horizontal, Vertical), Angle of Line to x Axis. Contains data for 16 Cheries Line 3, 4, 5 and 18 Cheries Line 6.











**Royal Academy of Dramatic Arts**  
**16-18 Chenies Street Development**  
**Pile and underpinning Installation**

**Dist. Coordinates Displacements**

[m]	x [m]	y [m]	z [m]	z [mm]
-----	-------	-------	-------	--------

**Dist. Coordinates Displacements**

[m]	x [m]	y [m]	z [m]	z [mm]
-----	-------	-------	-------	--------

**Vertical Offset 1**

0.0	2.00000	6.00000	-2.80000	0.0
1.1333	3.13333	6.00000	-2.80000	0.0
2.2667	4.26667	6.00000	-2.80000	0.0
3.4000	5.40000	6.00000	-2.80000	0.0
4.5333	6.53333	6.00000	-2.80000	0.0
5.6667	7.66667	6.00000	-2.80000	0.0
6.8000	8.80000	6.00000	-2.80000	0.0
7.9333	9.93333	6.00000	-2.80000	0.0
9.0667	11.06667	6.00000	-2.80000	0.19556
10.2000	12.20000	6.00000	-2.80000	0.40350
11.3333	13.33333	6.00000	-2.80000	0.61102
12.4667	14.46667	6.00000	-2.80000	0.81800
13.6000	15.60000	6.00000	-2.80000	1.0243
14.7333	16.73333	6.00000	-2.80000	1.2297
15.8667	17.86667	6.00000	-2.80000	1.4340
17.0000	19.00000	6.00000	-2.80000	1.6366
18.1333	20.13333	6.00000	-2.80000	1.8370
19.2667	21.26667	6.00000	-2.80000	2.0338
20.4000	22.40000	6.00000	-2.80000	2.2251
21.5333	23.53333	6.00000	-2.80000	2.4066
22.6667	24.66667	6.00000	-2.80000	2.5683
23.8000	25.80000	6.00000	-2.80000	2.6803
24.9333	26.93333	6.00000	-2.80000	2.5920
26.0667	28.06667	6.00000	-2.80000	0.0
27.2000	29.20000	6.00000	-2.80000	0.0
28.3333	30.33333	6.00000	-2.80000	0.0
29.4667	31.46667	6.00000	-2.80000	0.0
30.6000	32.60000	6.00000	-2.80000	0.0
31.7333	33.73333	6.00000	-2.80000	0.0
32.8667	34.86667	6.00000	-2.80000	0.0
34.0000	36.00000	6.00000	-2.80000	0.0
35.1333	37.13333	6.00000	-2.80000	0.0
36.2667	38.26667	6.00000	-2.80000	0.0
37.4000	39.40000	6.00000	-2.80000	0.0
38.5333	40.53333	6.00000	-2.80000	0.0
39.6667	41.66667	6.00000	-2.80000	0.0
40.8000	42.80000	6.00000	-2.80000	0.0
41.9333	43.93333	6.00000	-2.80000	0.0
43.0667	45.06667	6.00000	-2.80000	0.0
44.2000	46.20000	6.00000	-2.80000	0.0
45.3333	47.33333	6.00000	-2.80000	0.0
46.4667	48.46667	6.00000	-2.80000	0.0
47.6000	49.60000	6.00000	-2.80000	0.0
48.7333	50.73333	6.00000	-2.80000	0.0
49.8667	51.86667	6.00000	-2.80000	0.0
51.0000	53.00000	6.00000	-2.80000	0.0

Structure: 16 Chenies | Sub-structure: North

**Dist. Coordinates Displacements**

[m]	x [m]	y [m]	z [m]	z [mm]
-----	-------	-------	-------	--------

**Vertical Offset 1**

0.0	53.00000	21.90000	-2.80000	0.0
1.0533	53.00000	20.84667	-2.80000	0.0
2.1067	53.00000	19.79333	-2.80000	0.0
3.1600	53.00000	18.74000	-2.80000	0.0
4.2133	53.00000	17.68667	-2.80000	0.0
5.2667	53.00000	16.63333	-2.80000	0.0
6.3200	53.00000	15.58000	-2.80000	0.0
7.3733	53.00000	14.52667	-2.80000	0.0
8.4267	53.00000	13.47333	-2.80000	0.0
9.4800	53.00000	12.42000	-2.80000	0.0
10.5333	53.00000	11.36667	-2.80000	0.0
11.5867	53.00000	10.31333	-2.80000	0.0
12.6400	53.00000	9.26000	-2.80000	0.0
13.6933	53.00000	8.20667	-2.80000	0.0
14.7467	53.00000	7.15333	-2.80000	0.0
15.8000	53.00000	6.10000	-2.80000	0.0

Structure: 18 Chenies | Sub-structure: Retained Wall

**Dist. Coordinates Displacements**

[m]	x [m]	y [m]	z [m]	z [mm]
-----	-------	-------	-------	--------

**Vertical Offset 1**

0.0	39.00000	-13.60000	-3.50000	0.0
0.9800	39.00000	-12.62000	-3.50000	0.0
1.9600	39.00000	-11.64000	-3.50000	0.0
2.9400	39.00000	-10.66000	-3.50000	0.0
3.9200	39.00000	-9.68000	-3.50000	0.0
4.9000	39.00000	-8.70000	-3.50000	0.0
5.8800	39.00000	-7.72000	-3.50000	0.0
6.8600	39.00000	-6.74000	-3.50000	0.0
7.8400	39.00000	-5.76000	-3.50000	0.0
8.8200	39.00000	-4.78000	-3.50000	0.0
9.8000	39.00000	-3.80000	-3.50000	0.0
10.7800	39.00000	-2.82000	-3.50000	0.0
11.7600	39.00000	-1.84000	-3.50000	0.0
12.7400	39.00000	-0.86000	-3.50000	0.0
13.7200	39.00000	0.12000	-3.50000	0.0
14.7000	39.00000	1.10000	-3.50000	0.0
15.6800	39.00000	2.08000	-3.50000	0.0
16.6600	39.00000	3.06000	-3.50000	0.0
17.6400	39.00000	4.04000	-3.50000	0.0
18.6200	39.00000	5.02000	-3.50000	0.0
19.6000	39.00000	6.00000	-3.50000	0.0

Structure: Law Building | Sub-structure: North

**Dist. Coordinates Displacements**

[m]	x [m]	y [m]	z [m]	z [mm]
-----	-------	-------	-------	--------

**Vertical Offset 1**

0.0	21.60000	4.00000	-2.80000	2.2887
1.0500	21.60000	2.95000	-2.80000	2.2637
2.1000	21.60000	1.90000	-2.80000	2.2387
3.1500	21.60000	0.85000	-2.80000	2.2137
4.2000	21.60000	-0.20000	-2.80000	2.1888
5.2500	21.60000	-1.25000	-2.80000	2.1638
6.3000	21.60000	-2.30000	-2.80000	2.1388
7.3500	21.60000	-3.35000	-2.80000	2.1139
8.4000	21.60000	-4.40000	-2.80000	2.0889
9.4500	21.60000	-5.45000	-2.80000	2.0639
10.5000	21.60000	-6.50000	-2.80000	2.0389
11.5500	21.60000	-7.55000	-2.80000	2.0140
12.6000	21.60000	-8.60000	-2.80000	1.9890
13.6500	21.60000	-9.65000	-2.80000	1.9640
14.7000	21.60000	-10.70000	-2.80000	1.9391
15.7500	21.60000	-11.75000	-2.80000	1.9141
16.8000	21.60000	-12.80000	-2.80000	1.7627
17.8500	21.60000	-13.85000	-2.80000	1.5644
18.9000	21.60000	-14.90000	-2.80000	1.3679
19.9500	21.60000	-15.95000	-2.80000	1.1802
21.0000	21.60000	-17.00000	-2.80000	1.0054

Structure: Law Building | Sub-structure: East



**Royal Academy of Dramatic Arts**  
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**Dr. Ref.**

**Made by**  
**MC**

**Date**  
**23-Mar-2016**

**Checked**

**Dist.** **Coordinates** **Displacements**  
[m] **x** **y** **z** **z**  
[m] [m] [m] [mm]

**Dist.** **Coordinates** **Displacements**  
[m] **x** **y** **z** **z**  
[m] [m] [m] [mm]

**Vertical Offset 1**

Dist.	x	y	z	z
[m]	[m]	[m]	[m]	[mm]
0.0	21.60000	-17.10000	-2.80000	0.98956
1.0800	20.52000	-17.10000	-2.80000	0.92594
2.1600	19.44000	-17.10000	-2.80000	0.83734
3.2400	18.36000	-17.10000	-2.80000	0.72836
4.3200	17.28000	-17.10000	-2.80000	0.60268
5.4000	16.20000	-17.10000	-2.80000	0.45222
6.4800	15.12000	-17.10000	-2.80000	0.31232
7.5600	14.04000	-17.10000	-2.80000	0.15184
8.6400	12.96000	-17.10000	-2.80000	0.0
9.7200	11.88000	-17.10000	-2.80000	0.0
10.8000	10.80000	-17.10000	-2.80000	0.0
11.8800	9.72000	-17.10000	-2.80000	0.0
12.9600	8.64000	-17.10000	-2.80000	0.0
14.0400	7.56000	-17.10000	-2.80000	0.0
15.1200	6.48000	-17.10000	-2.80000	0.0
16.2000	5.40000	-17.10000	-2.80000	0.0
17.2800	4.32000	-17.10000	-2.80000	0.0
18.3600	3.24000	-17.10000	-2.80000	0.0
19.4400	2.16000	-17.10000	-2.80000	0.0
20.5200	1.08000	-17.10000	-2.80000	0.0
21.6000	0.00000	-17.10000	-2.80000	0.0

**Specific Building Damage Results - All Segments**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	2.1333	2.1333	Sagging	0.0	0.0	0.0	0.0	-421.76E-6	10116.	0 (Negligible)
	2	4.2667	1.0667	None	0.0	0.0	0.0	0.0	0.0	-	0 (Negligible)
	3	5.3333	2.3541	Sagging	0.0022158	-0.0018069	0.0017162	192.75E-6	262.91E-6	16249.	0 (Negligible)
	4	7.6874	4.0148	Hogging	0.0070358	0.0010595	0.0074166	192.75E-6	262.91E-6	7591.1	0 (Negligible)
	5	11.702	4.1978	Sagging	39.719E-6	0.013480	0.013505	-172.25E-6	-182.94E-6	927960.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	All settlements are less than the Settlement Trough Limit Sensitivity.										

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	All settlements are less than the Settlement Trough Limit Sensitivity.										

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	9.0667	2.0784	Sagging	9.2610E-6	0.0	9.1910E-6	0.0	-183.48E-6	23365.	0 (Negligible)
	2	11.145	13.788	Sagging	0.0022575	0.017028	0.019542	0.0020759	0.0022918	1737.9	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	All settlements are less than the Settlement Trough Limit Sensitivity.										

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	All settlements are less than the Settlement Trough Limit Sensitivity.										

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	1.6994	Sagging	0.0	352.43E-6	352.44E-6	-3.5387E-6	23.782E-6	260.49E+9	0 (Negligible)
	2	1.6994	0.66306	Sagging	0.0	348.63E-6	348.65E-6	-3.5010E-6	23.782E-6	2.3204E+12	0 (Negligible)
	3	2.3625	3.4125	Sagging	0.0	341.40E-6	341.43E-6	-3.4639E-6	23.782E-6	578.71E+9	0 (Negligible)
	4	5.7750	0.87500	Sagging	0.0	334.30E-6	334.27E-6	-3.3567E-6	23.782E-6	2.3246E+12	0 (Negligible)
	5	6.6500	2.8000	Sagging	0.0	328.48E-6	328.48E-6	-3.3224E-6	23.782E-6	772.26E+9	0 (Negligible)
	6	9.4500	0.0	None	0.0	0.0	0.0	-3.2558E-6	23.782E-6	-	0 (Negligible)
	7	9.4500	3.6750	Sagging	0.0	318.35E-6	318.32E-6	-3.2558E-6	23.782E-6	580.18E+9	0 (Negligible)



**GEA LIMITED**  
**(GEOTECHNICAL & ENV ASSOC) J15215**

<b>Job No.</b>	<b>Sheet No.</b>	<b>Rev.</b>
<b>Dr. Ref.</b>		
<b>Made by</b> <b>MC</b>	<b>Date</b> <b>23-Mar-2016</b>	<b>Checked</b>

Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Pile and underpinning Installation

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature	Damage Category
	8	13.125	0.52500	Sagging	0.0	313.10E-6	313.10E-6	-3.1310E-6	23.782E-6	2.3325E+12	0 (Negligible)
	9	13.650	4.7369	Sagging	0.0036220	-0.0027181	0.0028462	64.461E-6	188.87E-6	14732.	0 (Negligible)
	10	18.387	2.5131	Hogging	353.26E-6	0.0010639	0.0011550	-28.979E-6	187.15E-6	74684.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature	Damage Category
Calculations		[m]	[m]		[%]	[%]	[%]			[m]	
0.0	1	0.0	6.6106	Sagging	0.0012116	0.0045077	0.0050551	-94.622E-6	148.60E-6	44651.	0 (Negligible)
	2	6.6106	0.94935	Hogging	0.0	0.0	0.0	0.0	148.60E-6	29242.	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

**Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0070358	0.013480	-421.76E-6	1.4399	0.013505	192.75E-6	-421.76E-6	7591.1	10116.0	0 (Negligible)

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0022575	0.017028	0.0022918	2.6788	0.019542	0.0020759	0.0022918	-	1737.9	0 (Negligible)

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0036220	-0.0027181	188.87E-6	2.2887	0.0028462	64.461E-6	188.87E-6	74684.	14732.0	0 (Negligible)

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement	Maximum Gradient of Vertical Displacement	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
Calculations	[%]	[%]		[mm]	[%]			[m]	[m]	
0.0	0.0012116	0.0045077	148.60E-6	0.98956	0.0050551	-94.622E-6	148.60E-6	29242.	44651.0	0 (Negligible)

**Specific Building Damage Results - Critical Segments within Each Structure**

Structure Name	Parameter	Critical Sub-Structure	Segment	Start	End	Curvature	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
				[m]	[m]					[m]	[m]	
Law Building	Maximum Slope	Infill	1	2.1333	4.2667	Sagging	421.76E-6	0.44988	0.0	-	10116.0	0 (Negligible)
	Maximum Settlement	North	1	0.0	1.6994	Sagging	23.782E-6	2.2887	352.44E-6	-	260.49E+9	0 (Negligible)
	Max. Tensile Strain	Infill	5	11.702	15.900	Sagging	182.94E-6	1.4399	0.013505	-	927960.0	0 (Negligible)
	Min. Radius of Curvature (Hogging)	Infill	4	7.6874	11.702	Hogging	262.91E-6	0.67844	0.0074166	7591.1	-	0 (Negligible)
	Min. Radius of Infill	Infill	1	2.1333	4.2667	Sagging	421.76E-6	0.44988	0.0	-	10116.0	0 (Negligible)



**Royal Academy of Dramatic Arts**  
**16-18 Chenies Street Development**  
**Pile and underpinning Installation**

**Dr. Ref.**

**Made by** **Date** **Checked**  
**MC** **23-Mar-2016**

Structure Name	Parameter	Critical Sub-Structure	Critical Segment	Start	End	Curvature	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
16 Chenies	Curvature (Sagging)			2 11.145	24.933	Sagging	0.0022918	2.6788	0.019542	-	1737.9 0	(Negligible)
	Maximum Slope	East		2 11.145	24.933	Sagging	0.0022918	<b>2.6788</b>	0.019542	-	1737.9 0	(Negligible)
	Maximum Settlement	East		2 11.145	24.933	Sagging	0.0022918	2.6788	<b>0.019542</b>	-	1737.9 0	(Negligible)
	Max. Tensile Strain	East		2 11.145	24.933	Sagging	0.0022918	2.6788	<b>0.019542</b>	-	1737.9 0	(Negligible)
	Min. Radius of Curvature (Hogging)			-	-	-	-	-	-	-	-	-
	Min. Radius of Curvature (Sagging)	East		2 11.145	24.933	Sagging	0.0022918	2.6788	0.019542	-	<b>1737.9 0</b>	(Negligible)
18 Chenies	All settlements are less than the Settlement Trough Limit Sensitivity. All settlements are less than the Settlement Trough Limit Sensitivity. All settlements are less than the Settlement Trough Limit Sensitivity. All settlements are less than the Settlement Trough Limit Sensitivity.											

**Specific Building Damage Results - All Combined Segments**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]	[m]	[m]			[%]	[%]	[%]	
No structures have segments combined.								

Royal Academy of Dramatic Arts  
16-18 Cheries Street Development  
Pile and underpinning Installation

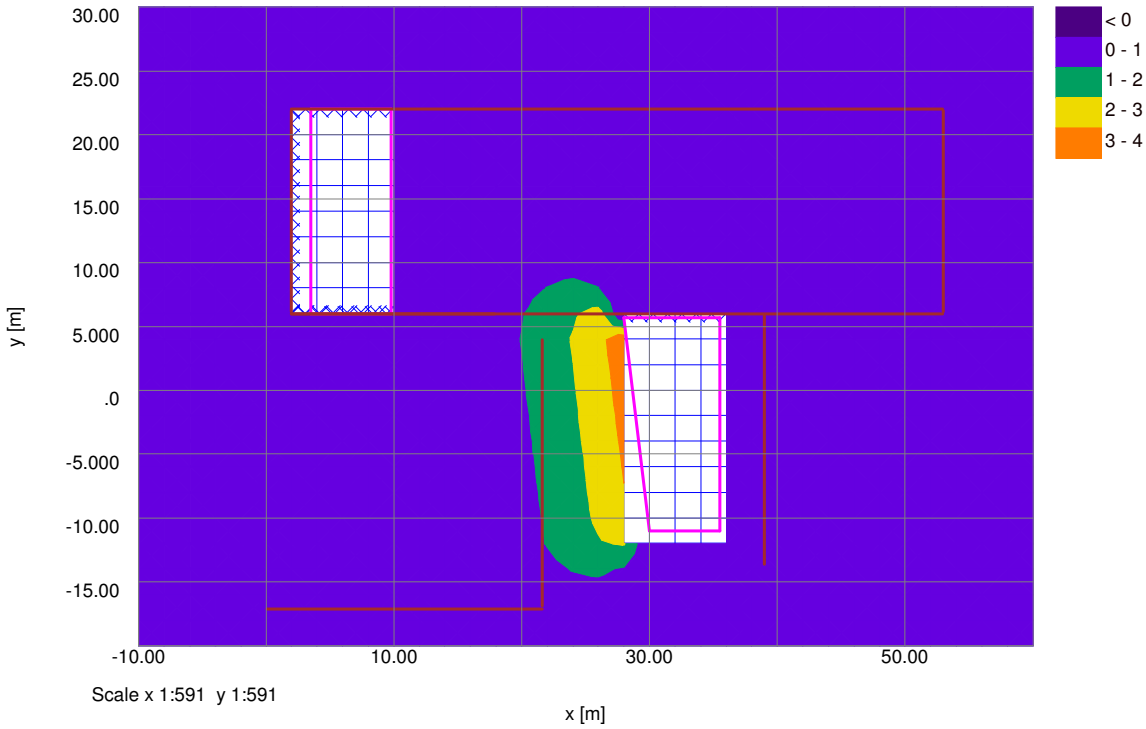
*Drg. Ref.*

*Made by*  
**MC**

*Date*  
**23-Mar-2016**

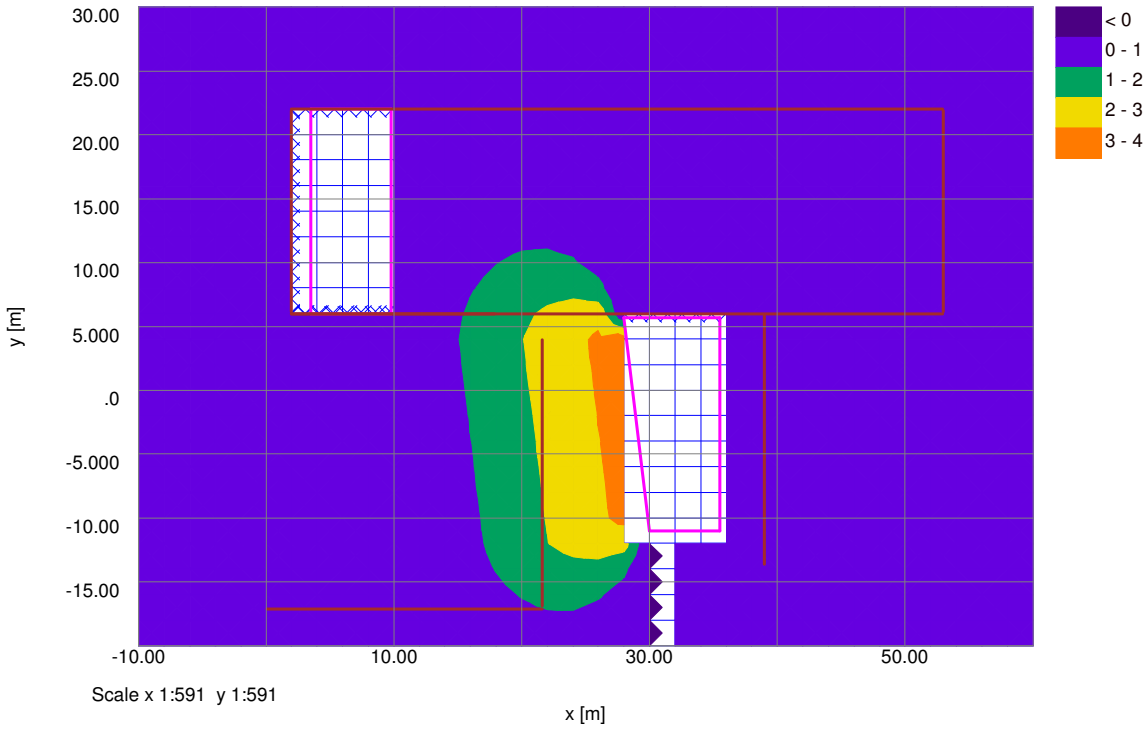
*Checked*

Horizontal Displacement Contours: Grid 1 (level -2.800m) Interval 1mm



<b>Job No.</b>	<b>Sheet No.</b>	<b>Rev.</b>
<b>Drg. Ref.</b>		
<b>Made by</b> MC	<b>Date</b> 23-Mar-2016	<b>Checked</b>

Vertical Settlement Contours: Grid 1 (level -2.800m) (Interval 1mm)







**GEA LIMITED**  
**(GEOTECHNICAL & ENV ASSOC) J15215**

**Job No.** **Sheet No.** **Rev.**

Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Installation and Excavation

**Dr. Ref.**

**Made by**  
**MC**

**Date**  
**23-Mar-2016**

**Checked**

**Problem Type**

Problem Type : Tunnelling and Embedded Wall Excavations

**Displacement Data**

Type	Name	Direction of extrusion	Point/Line/Line for extrusion				No. of intervals across extrusion/line	Extrusion depth	No. of intervals along extrusion	Calculate	Surface type for tunnels		
			First point		Second point								
			X [m]	z(level) [m]	X [m]	z(level) [m]							
Grid	Grid 1	Global X	-10.00000	-20.00000	-2.80000	-	30.00000	-2.80000	25	70.00000	35 Yes	Surface	
Line	Law Bdg Infill	-	2.00000	6.00000	-1.50000	18.00000	6.00000	-1.50000	15	-	-	Yes	Surface
Line	16 Chenies Wst	-	2.00000	22.00000	-2.80000	53.00000	22.00000	-2.80000	45	-	-	Yes	Surface
Line	16 Chenies Sth	-	2.00000	21.90000	-2.80000	2.00000	6.10000	-2.80000	15	-	-	Yes	Surface
Line	16 Chenies Est	-	2.00000	6.00000	-2.80000	53.00000	6.00000	-2.80000	45	-	-	Yes	Surface
Line	16 Chenies Nth	-	53.00000	21.90000	-2.80000	53.00000	6.10000	-2.80000	15	-	-	Yes	Surface
Line	18 Chenies	-	39.00000	-13.60000	-3.50000	39.00000	6.00000	-3.50000	20	-	-	Yes	Surface
Line	Retained Wall	-	-	-	-	-	-	-	-	-	-	-	-
Line	Law Bdg Nth	-	21.60000	4.00000	-2.80000	21.60000	-17.00000	-2.80000	20	-	-	Yes	Surface
Line	Law Bdg Est	-	21.60000	-17.10000	-2.80000	0.00000	-17.10000	-2.80000	20	-	-	Yes	Surface

**Imported Displacements**

The following data points and displacements were found in the import file Xdispl Installation.csv.

Line No.	Coordinates			Displacements		
	x [m]	y [m]	z [m]	x [mm]	y [mm]	z [mm]
1089	-10.000	-20.000	-2.8000	0.0	0.0	0.0
1090	-8.0000	-20.000	-2.8000	0.0	0.0	0.0
1091	-6.0000	-20.000	-2.8000	0.0	0.0	0.0
1092	-4.0000	-20.000	-2.8000	0.0	0.0	0.0
1093	-2.0000	-20.000	-2.8000	0.0	0.0	0.0
1094	0.0	-20.000	-2.8000	0.0	0.0	0.0
1095	2.0000	-20.000	-2.8000	0.0	0.0	0.0
1096	4.0000	-20.000	-2.8000	0.0	0.0	0.0
1097	6.0000	-20.000	-2.8000	0.0	0.0	0.0
1098	8.0000	-20.000	-2.8000	0.0	0.0	0.0
1099	10.000	-20.000	-2.8000	0.0	0.0	0.0
1100	12.000	-20.000	-2.8000	0.0	0.0	0.0
1101	14.000	-20.000	-2.8000	0.0	0.0	0.0
1102	16.000	-20.000	-2.8000	0.0	0.0	0.18682
1103	18.000	-20.000	-2.8000	0.0	0.0	0.38328
1104	20.000	-20.000	-2.8000	0.0044231	0.0039808	0.52491
1105	22.000	-20.000	-2.8000	0.086655	0.097487	0.59653
1106	24.000	-20.000	-2.8000	0.10890	0.16336	0.58195
1107	26.000	-20.000	-2.8000	0.078441	0.17649	0.46969
1108	28.000	-20.000	-2.8000	0.026034	0.11715	0.26454
1109	30.000	-20.000	-2.8000	0.0	0.0	0.0
1110	32.000	-20.000	-2.8000	0.0	0.0	0.0
1111	34.000	-20.000	-2.8000	0.0	0.0	0.0
1112	36.000	-20.000	-2.8000	0.0	0.0	0.0
1113	38.000	-20.000	-2.8000	0.0	0.0	0.0
1114	40.000	-20.000	-2.8000	0.0	0.0	0.0
1115	42.000	-20.000	-2.8000	0.0	0.0	0.0
1116	44.000	-20.000	-2.8000	0.0	0.0	0.0
1117	46.000	-20.000	-2.8000	0.0	0.0	0.0
1118	48.000	-20.000	-2.8000	0.0	0.0	0.0
1119	50.000	-20.000	-2.8000	0.0	0.0	0.0
1120	52.000	-20.000	-2.8000	0.0	0.0	0.0
1121	54.000	-20.000	-2.8000	0.0	0.0	0.0
1122	56.000	-20.000	-2.8000	0.0	0.0	0.0
1123	58.000	-20.000	-2.8000	0.0	0.0	0.0
1124	60.000	-20.000	-2.8000	0.0	0.0	0.0
1125	-10.000	-18.000	-2.8000	0.0	0.0	0.0
1126	-8.0000	-18.000	-2.8000	0.0	0.0	0.0
1127	-6.0000	-18.000	-2.8000	0.0	0.0	0.0
1128	-4.0000	-18.000	-2.8000	0.0	0.0	0.0
1129	-2.0000	-18.000	-2.8000	0.0	0.0	0.0
1130	0.0	-18.000	-2.8000	0.0	0.0	0.0
1131	2.0000	-18.000	-2.8000	0.0	0.0	0.0
1132	4.0000	-18.000	-2.8000	0.0	0.0	0.0
1133	6.0000	-18.000	-2.8000	0.0	0.0	0.0
1134	8.0000	-18.000	-2.8000	0.0	0.0	0.0
1135	10.000	-18.000	-2.8000	0.0	0.0	0.0
1136	12.000	-18.000	-2.8000	0.0	0.0	0.0
1137	14.000	-18.000	-2.8000	0.0	0.0	0.085506
1138	16.000	-18.000	-2.8000	0.0	0.0	0.35809
1139	18.000	-18.000	-2.8000	0.0	0.0	0.59011
1140	20.000	-18.000	-2.8000	0.12518	0.087626	0.76634
1141	22.000	-18.000	-2.8000	0.22958	0.20088	0.86509
1142	24.000	-18.000	-2.8000	0.25310	0.29528	0.85727
1143	26.000	-18.000	-2.8000	0.18514	0.32399	0.71082
1144	28.000	-18.000	-2.8000	0.064404	0.22541	0.41104
1145	30.000	-18.000	-2.8000	0.0	0.0	0.0
1146	32.000	-18.000	-2.8000	0.0	0.0	0.0
1147	34.000	-18.000	-2.8000	0.0	0.0	0.0
1148	36.000	-18.000	-2.8000	0.0	0.0	0.0
1149	38.000	-18.000	-2.8000	0.0	0.0	0.0
1150	40.000	-18.000	-2.8000	0.0	0.0	0.0
1151	42.000	-18.000	-2.8000	0.0	0.0	0.0
1152	44.000	-18.000	-2.8000	0.0	0.0	0.0
1153	46.000	-18.000	-2.8000	0.0	0.0	0.0
1154	48.000	-18.000	-2.8000	0.0	0.0	0.0
1155	50.000	-18.000	-2.8000	0.0	0.0	0.0
1156	52.000	-18.000	-2.8000	0.0	0.0	0.0
1157	54.000	-18.000	-2.8000	0.0	0.0	0.0
1158	56.000	-18.000	-2.8000	0.0	0.0	0.0
1159	58.000	-18.000	-2.8000	0.0	0.0	0.0
1160	60.000	-18.000	-2.8000	0.0	0.0	0.0
1161	-10.000	-16.000	-2.8000	0.0	0.0	0.0
1162	-8.0000	-16.000	-2.8000	0.0	0.0	0.0
1163	-6.0000	-16.000	-2.8000	0.0	0.0	0.0
1164	-4.0000	-16.000	-2.8000	0.0	0.0	0.0
1165	-2.0000	-16.000	-2.8000	0.0	0.0	0.0
1166	0.0	-16.000	-2.8000	0.0	0.0	0.0
1167	2.0000	-16.000	-2.8000	0.0	0.0	0.0
1168	4.0000	-16.000	-2.8000	0.0	0.0	0.0
1169	6.0000	-16.000	-2.8000	0.0	0.0	0.0
1170	8.0000	-16.000	-2.8000	0.0	0.0	0.0
1171	10.000	-16.000	-2.8000	0.0	0.0	0.0
1172	12.000	-16.000	-2.8000	0.0	0.0	0.0
1173	14.000	-16.000	-2.8000	0.0	0.0	0.21608
1174	16.000	-16.000	-2.8000	0.0	0.0	0.53014
1175	18.000	-16.000	-2.8000	0.067498	0.028124	0.81014
1176	20.000	-16.000	-2.8000	0.28453	0.14226	1.0403
1177	22.000	-16.000	-2.8000	0.44530	0.27831	1.1946
1178	24.000	-16.000	-2.8000	0.50998	0.42499	1.2299
1179	26.000	-16.000	-2.8000	0.41962	0.52203	1.0781
1180	28.000	-16.000	-2.8000	0.16646	0.41616	0.66134
1181	30.000	-16.000	-2.8000	0.0	0.0	0.0
1182	32.000	-16.000	-2.8000	0.0	0.0	0.0
1183	34.000	-16.000	-2.8000	0.0	0.0	0.0













**GEA LIMITED**  
**(GEOTECHNICAL & ENV ASSOC) J15215**

Job No. Sheet No. Rev.

J15215

Drg. Ref.

Made by  
MC

Date  
23-Mar-2016

Checked

Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Installation and Excavation

Line No.	Coordinates			Displacements		
	x [m]	y [m]	z [m]	x [mm]	y [mm]	z [mm]
1824	20.000	20.000	-2.8000	0.0	0.0	0.097446
1825	22.000	20.000	-2.8000	0.0	0.0	0.11717
1826	24.000	20.000	-2.8000	0.0	0.0	0.10171
1827	26.000	20.000	-2.8000	0.0	0.0	0.058557
1828	28.000	20.000	-2.8000	0.0	0.0	0.0
1829	30.000	20.000	-2.8000	0.0	0.0	0.0
1830	32.000	20.000	-2.8000	0.0	0.0	0.0
1831	34.000	20.000	-2.8000	0.0	0.0	0.0
1832	36.000	20.000	-2.8000	0.0	0.0	0.0
1833	38.000	20.000	-2.8000	0.0	0.0	0.0
1834	40.000	20.000	-2.8000	0.0	0.0	0.0
1835	42.000	20.000	-2.8000	0.0	0.0	0.0
1836	44.000	20.000	-2.8000	0.0	0.0	0.0
1837	46.000	20.000	-2.8000	0.0	0.0	0.0
1838	48.000	20.000	-2.8000	0.0	0.0	0.0
1839	50.000	20.000	-2.8000	0.0	0.0	0.0
1840	52.000	20.000	-2.8000	0.0	0.0	0.0
1841	54.000	20.000	-2.8000	0.0	0.0	0.0
1842	56.000	20.000	-2.8000	0.0	0.0	0.0
1843	58.000	20.000	-2.8000	0.0	0.0	0.0
1844	60.000	20.000	-2.8000	0.0	0.0	0.0
1845	-10.000	22.000	-2.8000	0.0	0.0	0.0
1846	-8.0000	22.000	-2.8000	0.0	0.0	0.0
1847	-6.0000	22.000	-2.8000	0.0	0.0	0.0
1848	-4.0000	22.000	-2.8000	0.0	0.0	0.0
1849	-2.0000	22.000	-2.8000	0.0	0.0	0.0
1850	0.0	22.000	-2.8000	0.0	0.0	0.0
1851	2.0000	22.000	-2.8000	0.0	0.0	0.0 1,2,6
1852	4.0000	22.000	-2.8000	0.0	0.0	0.0
1853	6.0000	22.000	-2.8000	0.0	0.0	0.0
1854	8.0000	22.000	-2.8000	0.0	0.0	0.0
1855	10.000	22.000	-2.8000	0.0	0.0	0.0
1856	12.000	22.000	-2.8000	0.0	0.0	0.0
1857	14.000	22.000	-2.8000	0.0	0.0	0.0
1858	16.000	22.000	-2.8000	0.0	0.0	0.0
1859	18.000	22.000	-2.8000	0.0	0.0	0.0
1860	20.000	22.000	-2.8000	0.0	0.0	0.0
1861	22.000	22.000	-2.8000	0.0	0.0	0.026329
1862	24.000	22.000	-2.8000	0.0	0.0	0.034641
1863	26.000	22.000	-2.8000	0.0	0.0	0.022796
1864	28.000	22.000	-2.8000	0.0	0.0	0.0
1865	30.000	22.000	-2.8000	0.0	0.0	0.0
1866	32.000	22.000	-2.8000	0.0	0.0	0.0
1867	34.000	22.000	-2.8000	0.0	0.0	0.0
1868	36.000	22.000	-2.8000	0.0	0.0	0.0 1,2,6
1869	38.000	22.000	-2.8000	0.0	0.0	0.0
1870	40.000	22.000	-2.8000	0.0	0.0	0.0
1871	42.000	22.000	-2.8000	0.0	0.0	0.0
1872	44.000	22.000	-2.8000	0.0	0.0	0.0
1873	46.000	22.000	-2.8000	0.0	0.0	0.0
1874	48.000	22.000	-2.8000	0.0	0.0	0.0
1875	50.000	22.000	-2.8000	0.0	0.0	0.0
1876	52.000	22.000	-2.8000	0.0	0.0	0.0
1877	54.000	22.000	-2.8000	0.0	0.0	0.0
1878	56.000	22.000	-2.8000	0.0	0.0	0.0
1879	58.000	22.000	-2.8000	0.0	0.0	0.0
1880	60.000	22.000	-2.8000	0.0	0.0	0.0
1881	-10.000	24.000	-2.8000	0.0	0.0	0.0
1882	-8.0000	24.000	-2.8000	0.0	0.0	0.0
1883	-6.0000	24.000	-2.8000	0.0	0.0	0.0
1884	-4.0000	24.000	-2.8000	0.0	0.0	0.0
1885	-2.0000	24.000	-2.8000	0.0	0.0	0.0
1886	0.0	24.000	-2.8000	0.0	0.0	0.0
1887	2.0000	24.000	-2.8000	0.0	0.0	0.0
1888	4.0000	24.000	-2.8000	0.0	0.0	0.0
1889	6.0000	24.000	-2.8000	0.0	0.0	0.0
1890	8.0000	24.000	-2.8000	0.0	0.0	0.0
1891	10.000	24.000	-2.8000	0.0	0.0	0.0
1892	12.000	24.000	-2.8000	0.0	0.0	0.0
1893	14.000	24.000	-2.8000	0.0	0.0	0.0
1894	16.000	24.000	-2.8000	0.0	0.0	0.0
1895	18.000	24.000	-2.8000	0.0	0.0	0.0
1896	20.000	24.000	-2.8000	0.0	0.0	0.0
1897	22.000	24.000	-2.8000	0.0	0.0	0.0
1898	24.000	24.000	-2.8000	0.0	0.0	0.0
1899	26.000	24.000	-2.8000	0.0	0.0	0.0
1900	28.000	24.000	-2.8000	0.0	0.0	0.0
1901	30.000	24.000	-2.8000	0.0	0.0	0.0
1902	32.000	24.000	-2.8000	0.0	0.0	0.0
1903	34.000	24.000	-2.8000	0.0	0.0	0.0
1904	36.000	24.000	-2.8000	0.0	0.0	0.0
1905	38.000	24.000	-2.8000	0.0	0.0	0.0
1906	40.000	24.000	-2.8000	0.0	0.0	0.0
1907	42.000	24.000	-2.8000	0.0	0.0	0.0
1908	44.000	24.000	-2.8000	0.0	0.0	0.0
1909	46.000	24.000	-2.8000	0.0	0.0	0.0
1910	48.000	24.000	-2.8000	0.0	0.0	0.0
1911	50.000	24.000	-2.8000	0.0	0.0	0.0
1912	52.000	24.000	-2.8000	0.0	0.0	0.0
1913	54.000	24.000	-2.8000	0.0	0.0	0.0
1914	56.000	24.000	-2.8000	0.0	0.0	0.0
1915	58.000	24.000	-2.8000	0.0	0.0	0.0
1916	60.000	24.000	-2.8000	0.0	0.0	0.0
1917	-10.000	26.000	-2.8000	0.0	0.0	0.0
1918	-8.0000	26.000	-2.8000	0.0	0.0	0.0
1919	-6.0000	26.000	-2.8000	0.0	0.0	0.0
1920	-4.0000	26.000	-2.8000	0.0	0.0	0.0
1921	-2.0000	26.000	-2.8000	0.0	0.0	0.0
1922	0.0	26.000	-2.8000	0.0	0.0	0.0
1923	2.0000	26.000	-2.8000	0.0	0.0	0.0
1924	4.0000	26.000	-2.8000	0.0	0.0	0.0
1925	6.0000	26.000	-2.8000	0.0	0.0	0.0
1926	8.0000	26.000	-2.8000	0.0	0.0	0.0
1927	10.000	26.000	-2.8000	0.0	0.0	0.0
1928	12.000	26.000	-2.8000	0.0	0.0	0.0
1929	14.000	26.000	-2.8000	0.0	0.0	0.0
1930	16.000	26.000	-2.8000	0.0	0.0	0.0
1931	18.000	26.000	-2.8000	0.0	0.0	0.0
1932	20.000	26.000	-2.8000	0.0	0.0	0.0
1933	22.000	26.000	-2.8000	0.0	0.0	0.0
1934	24.000	26.000	-2.8000	0.0	0.0	0.0
1935	26.000	26.000	-2.8000	0.0	0.0	0.0
1936	28.000	26.000	-2.8000	0.0	0.0	0.0
1937	30.000	26.000	-2.8000	0.0	0.0	0.0
1938	32.000	26.000	-2.8000	0.0	0.0	0.0
1939	34.000	26.000	-2.8000	0.0	0.0	0.0
1940	36.000	26.000	-2.8000	0.0	0.0	0.0
1941	38.000	26.000	-2.8000	0.0	0.0	0.0
1942	40.000	26.000	-2.8000	0.0	0.0	0.0
1943	42.000	26.000	-2.8000	0.0	0.0	0.0
1944	44.000	26.000	-2.8000	0.0	0.0	0.0
1945	46.000	26.000	-2.8000	0.0	0.0	0.0
1946	48.000	26.000	-2.8000	0.0	0.0	0.0
1947	50.000	26.000	-2.8000	0.0	0.0	0.0
1948	52.000	26.000	-2.8000	0.0	0.0	0.0
1949	54.000	26.000	-2.8000	0.0	0.0	0.0
1950	56.000	26.000	-2.8000	0.0	0.0	0.0
1951	58.000	26.000	-2.8000	0.0	0.0	0.0









**GEA LIMITED**  
**(GEOTECHNICAL & ENV ASSOC) J15215**

<b>Job No.</b>	<b>Sheet No.</b>	<b>Rev.</b>
<b>Dr. Ref.</b>		
<b>Made by</b> <b>MC</b>	<b>Date</b> <b>23-Mar-2016</b>	<b>Checked</b>

**Royal Academy of Dramatic Arts**  
16-18 Chenies Street Development  
Installation and Excavation

Line No.	Coordinates			Displacements		
	x [m]	y [m]	z [m]	x [mm]	y [mm]	z [mm]
2208	20.520	-17.100	-2.8000	0.23152	0.14897	0.92594
2209	19.440	-17.100	-2.8000	0.14555	0.084079	0.83734
2210	18.360	-17.100	-2.8000	0.043352	0.022719	0.72836
2211	17.280	-17.100	-2.8000	0.0	0.0	0.60268
2212	16.200	-17.100	-2.8000	0.0	0.0	0.46322
2213	15.120	-17.100	-2.8000	0.0	0.0	0.31232
2214	14.040	-17.100	-2.8000	0.0	0.0	0.15184
2215	12.960	-17.100	-2.8000	0.0	0.0	0.0
2216	11.880	-17.100	-2.8000	0.0	0.0	0.0
2217	10.800	-17.100	-2.8000	0.0	0.0	0.0
2218	9.7200	-17.100	-2.8000	0.0	0.0	0.0
2219	8.6400	-17.100	-2.8000	0.0	0.0	0.0
2220	7.5600	-17.100	-2.8000	0.0	0.0	0.0
2221	6.4800	-17.100	-2.8000	0.0	0.0	0.0
2222	5.4000	-17.100	-2.8000	0.0	0.0	0.0
2223	4.3200	-17.100	-2.8000	0.0	0.0	0.0
2224	3.2400	-17.100	-2.8000	0.0	0.0	0.0
2225	2.1600	-17.100	-2.8000	0.0	0.0	0.0
2226	1.0800	-17.100	-2.8000	0.0	0.0	0.0
2227	0.0	-17.100	-2.8000	0.0	0.0	0.0

- 1 - Data point coincident with displacement data. Its displacement has been added to those calculated by Xdisp.
- 2 - Data point coincident with horizontal movement calculation point for a specific building. Its displacement has been added before performing building damage calculations.
- 6 - Data point coincident with vertical movement calculation point for a specific building. Its displacement has been added before performing building damage calculations.

**Vertical Ground Movement Curves**

**Curve Name:** No vertical ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 1  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = 0.0x + 0.0  
**Coeff. of Determination:** -2147483648.E+2147483647

**Curve Name:** Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.039][0.100,0.000,0.049][0.200,0.000,0.056][0.300,0.000,0.062][0.400,0.000,0.067][0.500,0.000,0.070][0.600,0.000,0.072][0.700,0.000,0.073][0.800,0.000,0.073][0.900,0.000,0.072][1.000,0.000,0.070][1.100,0.000,0.068][1.200,0.000,0.065][1.300,0.000,0.061][1.400,0.000,0.058][1.500,0.000,0.054][1.600,0.000,0.050][1.700,0.000,0.046][1.800,0.000,0.042][1.900,0.000,0.038][2.000,0.000,0.034][2.100,0.000,0.030][2.200,0.000,0.027][2.300,0.000,0.023][2.400,0.000,0.020][2.500,0.000,0.017][2.600,0.000,0.014][2.700,0.000,0.012][2.800,0.000,0.010][2.900,0.000,0.008][3.000,0.000,0.007][3.100,0.000,0.005][3.200,0.000,0.004][3.300,0.000,0.004][3.400,0.000,0.003][3.500,0.000,0.002][3.600,0.000,0.002][3.700,0.000,0.002][3.800,0.000,0.001][3.900,0.000,0.001][4.000,0.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 4  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = -2.6455E-3x<sup>4</sup> + 2.8495E-2x<sup>3</sup> - 1.0051E-1x<sup>2</sup> + 1.0569E-1x + 3.8990E-2  
**Coeff. of Determination:** 9.9991E-1

**Curve Name:** Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Settlement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.345][0.100,0.000,0.327][0.200,0.000,0.311][0.300,0.000,0.294][0.400,0.000,0.279][0.500,0.000,0.264][0.600,0.000,0.250][0.700,0.000,0.237][0.800,0.000,0.224][0.900,0.000,0.212][1.000,0.000,0.200][1.100,0.000,0.189][1.200,0.000,0.178][1.300,0.000,0.168][1.400,0.000,0.158][1.500,0.000,0.149][1.600,0.000,0.140][1.700,0.000,0.132][1.800,0.000,0.124][1.900,0.000,0.116][2.000,0.000,0.109][2.100,0.000,0.101][2.200,0.000,0.095][2.300,0.000,0.088][2.400,0.000,0.082][2.500,0.000,0.076][2.600,0.000,0.070][2.700,0.000,0.065][2.800,0.000,0.059][2.900,0.000,0.054][3.000,0.000,0.049][3.100,0.000,0.044][3.200,0.000,0.039][3.300,0.000,0.034][3.400,0.000,0.029][3.500,0.000,0.025][3.600,0.000,0.020][3.700,0.000,0.015][3.800,0.000,0.010][3.900,0.000,0.005][4.000,0.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 3  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = -3.5383E-3x<sup>3</sup> + 3.7194E-2x<sup>2</sup> - 1.7831E-1x + 3.4467E-1  
**Coeff. of Determination:** 9.9999E-1

**Horizontal Ground Movement Curves**

**Curve Name:** No horizontal ground movement  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.000][1.000,0.000,0.000][0.000,1.000,0.000][1.000,1.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 0  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = 0.0  
**Coeff. of Determination:** -2147483648.E+2147483647

**Curve Name:** Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.150][4.000,0.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 1  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = -3.75E-2x + 1.50E-1  
**Coeff. of Determination:** 1.00

**Curve Name:** Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))  
**Coordinates:** [Distance from wall / wall depth or max. excavation depth (x), Depth / wall depth or max. excavation depth (y), Horizontal movement / wall depth or max. excavation depth (z) (%) ]  
 [0.000,0.000,0.400][4.000,0.000,0.000]  
**Curve Fitting Method:** Polynomial  
**Method:** 1  
**x Order:** 0  
**y Order:** 0  
**Polynomial:** z = -10.E-2x + 4.0E-1  
**Coeff. of Determination:** 1.0

**Polygonal Excavations**

**Excavation Name:** 16 Chenies Underpinning  
**Surface level [m]:** -1.9000  
**Contribution:** Positive  
**Enabled:** Yes  
**Surface movement curves which are:** -2.8000



Royal Academy of Dramatic Arts  
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Installation and Excavation

Line No.	Coordinates			Displacements		
	x [m]	y [m]	z [m]	x [mm]	y [mm]	z [mm]
selected are applied between surface and [m]:						
Corner	x [m]	y [m]	Base Level [m]	Stiffened	Previous Side	Next Side
1	3.5000	6.0000	-2.8000	No	-	-
2	3.5000	22.0000	-2.8000	No	-	-
3	9.8000	22.0000	-2.8000	No	-	-
4	9.8000	6.0000	-2.8000	No	-	-

Side	Corner 1		Corner 2		Vertical	Ground Movement Curve	Horizontal
	x [m]	y [m]	x [m]	y [m]			
1	3.5000	6.0000	3.5000	22.0000	No vertical ground movement	No horizontal ground movement	
2	3.5000	22.0000	9.8000	22.0000	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))	
3	9.8000	22.0000	9.8000	6.0000	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))	
4	9.8000	6.0000	3.5000	6.0000	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))	Excavation in front of high stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))	

**Excavation Name:** 18 Chenies Piling  
**Surface level [m]:** 0.0  
**Contribution:** Positive  
**Enabled:** Yes  
 Surface movement curves which are selected are applied between surface and [m]: -3.0000

Corner	x [m]	y [m]	Base Level [m]	Stiffened	Previous Side		Next Side			
					d [m]	pl [%]	p2* [%]	d [m]	pl [%]	p2* [%]
1	28.0000	5.7000	-3.0000	Yes	0.0	67.0000	25.0000	0.0	67.0000	25.0000
2	35.5000	5.7000	0.0	No	-	-	-	-	-	-
3	35.5000	-11.0000	-3.5000	No	-	-	-	-	-	-
4	30.0000	-11.0000	-3.0000	Yes	0.0	67.0000	25.0000	0.0	67.0000	25.0000

Side	Corner 1		Corner 2		Vertical	Ground Movement Curve	Horizontal
	x [m]	y [m]	x [m]	y [m]			
1	28.0000	5.7000	35.5000	5.7000	No vertical ground movement	No horizontal ground movement	
2	35.5000	5.7000	35.5000	-11.0000	No vertical ground movement	No horizontal ground movement	
3	35.5000	-11.0000	30.0000	-11.0000	Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))	Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))	
4	30.0000	-11.0000	28.0000	5.7000	Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(b))	Excavation in front of low stiffness wall in stiff clay (CIRIA 580 Fig. 2.11(a))	

**Damage Category Strains**

Name	0 (Negligible)	1 (Very Slight)	2 (Slight)	3 (Moderate)
Burland Strain Limits	0.0	500.00E-6	750.00E-6	0.0015000

**Specific Structures - Geometry**

Structure Name	Sub-Structure Name	Displacement Line	Start Distance Along Line	End Distance Along Line	Vertical Offsets from Line for Vertical Movement Calculations	Vertical Displacement Limit Sensitivity	Damage Category Strains	Poisson's Ratio	E/G
Law Building	Infill	Law Bdg Infill	0.00000	15.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
16 Chenies	West	16 Chenies Wst	0.00000	50.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
16 Chenies	South	16 Chenies Sth	0.00000	15.70000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
16 Chenies	East	16 Chenies Est	0.00000	50.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
16 Chenies	North	16 Chenies Nth	0.00000	15.70000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
18 Chenies	Retained Wall	18 Chenies Retained Wall	0.00000	19.50000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Law Building	North	Law Bdg Nth	0.00000	20.90000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000
Law Building	East	Law Bdg Est	0.00000	21.50000	0.0	0.10000	Burland Strain Limits	0.20000	2.6000

**Specific Structures - Bending Parameters**

Structure Name	Sub-Structure Name	Height [m]	Default Properties	Hogging		Sagging	
				2nd Moment of Area (per unit width)	Distance of N.A. of Beam in Tension	2nd Moment of Area (per unit width)	Distance of N.A. of Beam in Tension
Law Building	Infill	16.0000	Yes	333.33	10.000	83.333	5.0000
16 Chenies	West	16.0000	Yes	1365.3	16.000	341.33	8.0000
16 Chenies	South	16.0000	Yes	1365.3	16.000	341.33	8.0000
16 Chenies	East	16.0000	Yes	1365.3	16.000	341.33	8.0000
16 Chenies	North	16.0000	Yes	1365.3	16.000	341.33	8.0000
18 Chenies	Retained Wall	22.0000	Yes	3549.3	22.000	887.33	11.000
Law Building	North	22.0000	Yes	3549.3	22.000	887.33	11.000
Law Building	East	22.0000	Yes	3549.3	22.000	887.33	11.000

**Building Segment Combinations**

Structure Name	Sub-Structure Name	Vertical Offset from Line for Vertical Movement Calculations [m]	Segment Start [m]	Length [m]	Curvature	Combined Segment
No structures have segments combined.						

**Warnings**

- Multiple excavations have been specified. The displacements resulting from these excavations are calculated by summing the displacements resulting from each individual excavation. No account has been taken of the interactions between excavations (e.g. overlapping zones of influence or 'shielding' of one excavation by another).
- If an embedded wall excavation is assigned a 'surface' ground movement curve and if the 'allow movement calculation to level' option is checked for the excavation then displacements induced by it are calculated for points at the surface, and points below the surface to the level specified. Others are ignored. An example of such a combination, for which displacements will not be calculated is Excavation XP1/Side 2/Line 1/Vertical. This is an example only. There are 15 others.
- If an embedded wall excavation is assigned a 'sub-surface' ground movement curve then displacements induced by it can only be calculated for those points that are level with or below the embedded wall excavation's 'surface level'. Others are ignored. An example of such a combination, for which displacements will not be calculated is Excavation XP1/Side 1/Line 1/Vertical. This is an example only. There are 1 others.

**Displacement and Strain Results**











GEA LIMITED
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Job No. Sheet No. Rev.

Dr. Ref.

Made by MC Date 23-Mar-2016 Checked

Royal Academy of Dramatic Arts
16-18 Chenies Street Development
Installation and Excavation

Table with columns: Type/No., Name, Dist., Coordinates (x, y, z), Displacements (Horizontal, Horizontal), Angle of Line to x Axis. Contains 100 rows of numerical data.















**GEA LIMITED**  
**(GEOTECHNICAL & ENV ASSOC) J15215**

<b>Job No.</b>	<b>Sheet No.</b>	<b>Rev.</b>
<b>Dr. Ref.</b>		
<b>Made by</b> <b>MC</b>	<b>Date</b> <b>23-Mar-2016</b>	<b>Checked</b>

Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Installation and Excavation

Dist.	Coordinates			Displacements		Horizontal displacement along the	Horizontal displacement perpendicular
	x	y	z	x	y		
8.4000	21.60000	-4.40000	-2.80000	5.5630	0.66623	-0.66623	5.5630 d
9.4500	21.60000	-5.45000	-2.80000	5.4105	0.64796	-0.64796	5.4105 d
10.5000	21.60000	-6.50000	-2.80000	5.2582	0.62973	-0.62973	5.2582 d
11.5500	21.60000	-7.55000	-2.80000	5.1063	0.61153	-0.61153	5.1063 d
12.6000	21.60000	-8.60000	-2.80000	4.9546	0.59337	-0.59337	4.9546 d
13.6500	21.60000	-9.65000	-2.80000	4.8032	0.57523	-0.57523	4.8032 d
14.7000	21.60000	-10.70000	-2.80000	4.6520	0.55713	-0.55713	4.6520 d
15.7500	21.60000	-11.75000	-2.80000	4.5011	0.53905	-0.53905	4.5011 d
16.8000	21.60000	-12.80000	-2.80000	3.1008	0.66446	-0.66446	3.1008 d
17.8500	21.60000	-13.85000	-2.80000	2.6316	0.89287	-0.89287	2.6316 d
18.9000	21.60000	-14.90000	-2.80000	2.1164	0.98263	-0.98263	2.1164 d
19.9500	21.60000	-15.95000	-2.80000	1.5990	0.94228	-0.94228	1.5990 d
21.0000	21.60000	-17.00000	-2.80000	1.1087	0.79193	-0.79193	1.1087 d

d - Displacements include imported displacements.

Structure: Law Building | Sub-structure: East

Dist.	Coordinates			Displacements		Horizontal displacement along the Line	Horizontal displacement perpendicular to Line
	x	y	z	x	y		
[m]	[m]	[m]	[m]	[mm]	[mm]	[mm]	[mm]
0.0	21.60000	-17.10000	-2.80000	1.0641	0.77274	-1.0641	-0.77274 d
1.0800	20.52000	-17.10000	-2.80000	0.59656	0.38386	-0.59656	-0.38386 d
2.1600	19.44000	-17.10000	-2.80000	0.14955	0.084079	-0.14955	-0.084079 d
3.2400	18.36000	-17.10000	-2.80000	0.043352	0.022719	-0.043352	-0.022719 d
4.3200	17.28000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
5.4000	16.20000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
6.4800	15.12000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
7.5600	14.04000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
8.6400	12.96000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
9.7200	11.88000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
10.8000	10.80000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
11.8800	9.72000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
12.9600	8.64000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
14.0400	7.56000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
15.1200	6.48000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
16.2000	5.40000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
17.2800	4.32000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
18.3600	3.24000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
19.4400	2.16000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
20.5200	1.08000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d
21.6000	0.00000	-17.10000	-2.80000	0.0	0.0	0.0	0.0 d

d - Displacements include imported displacements.

**Specific Building Damage Results - Vertical Displacements**

Structure: Law Building | Sub-structure: Infill

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
0.0	2.00000	6.00000	-1.50000	0.0 d
1.0667	3.06667	6.00000	-1.50000	0.0 d
2.1333	4.13333	6.00000	-1.50000	0.80079 d
3.2000	5.20000	6.00000	-1.50000	0.80079 d
4.2667	6.26667	6.00000	-1.50000	0.80079 d
5.3333	7.33333	6.00000	-1.50000	0.80079 d
6.4000	8.40000	6.00000	-1.50000	0.80079 d
7.4667	9.46667	6.00000	-1.50000	0.80079 d
8.5333	10.53333	6.00000	-1.50000	0.82317 d
9.6000	11.60000	6.00000	-1.50000	0.52929 d
10.6667	12.66667	6.00000	-1.50000	0.52929 d
11.7333	13.73333	6.00000	-1.50000	0.68414 d
12.8000	14.80000	6.00000	-1.50000	0.87876 d
13.8667	15.86667	6.00000	-1.50000	1.0727 d
14.9333	16.93333	6.00000	-1.50000	1.5203 d
16.0000	18.00000	6.00000	-1.50000	1.9942 d

d - Displacements include imported displacements.

Structure: 16 Chenies | Sub-structure: West

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
0.0	2.00000	22.00000	-2.80000	0.0 d
1.1333	3.13333	22.00000	-2.80000	0.0 d
2.2667	4.26667	22.00000	-2.80000	0.0 d
3.4000	5.40000	22.00000	-2.80000	0.0 d
4.5333	6.53333	22.00000	-2.80000	0.0 d
5.6667	7.66667	22.00000	-2.80000	0.0 d
6.8000	8.80000	22.00000	-2.80000	0.0 d
7.9333	9.93333	22.00000	-2.80000	0.0 d
9.0667	11.06667	22.00000	-2.80000	0.0 d
10.2000	12.20000	22.00000	-2.80000	0.0 d
11.3333	13.33333	22.00000	-2.80000	0.0 d
12.4667	14.46667	22.00000	-2.80000	0.0 d
13.6000	15.60000	22.00000	-2.80000	0.0 d
14.7333	16.73333	22.00000	-2.80000	0.0 d
15.8667	17.86667	22.00000	-2.80000	0.0 d
17.0000	19.00000	22.00000	-2.80000	0.0 d
18.1333	20.13333	22.00000	-2.80000	0.0 d
19.2667	21.26667	22.00000	-2.80000	0.016876 d
20.4000	22.40000	22.00000	-2.80000	0.029954 d
21.5333	23.53333	22.00000	-2.80000	0.034789 d
22.6667	24.66667	22.00000	-2.80000	0.032530 d
23.8000	25.80000	22.00000	-2.80000	0.024644 d
24.9333	26.93333	22.00000	-2.80000	0.012877 d
26.0667	28.06667	22.00000	-2.80000	0.0 d
27.2000	29.20000	22.00000	-2.80000	0.0 d
28.3333	30.33333	22.00000	-2.80000	0.0 d
29.4667	31.46667	22.00000	-2.80000	0.0 d
30.6000	32.60000	22.00000	-2.80000	0.0 d
31.7333	33.73333	22.00000	-2.80000	0.0 d
32.8667	34.86667	22.00000	-2.80000	0.0 d
34.0000	36.00000	22.00000	-2.80000	0.0 d
35.1333	37.13333	22.00000	-2.80000	0.0 d
36.2667	38.26667	22.00000	-2.80000	0.0 d
37.4000	39.40000	22.00000	-2.80000	0.0 d
38.5333	40.53333	22.00000	-2.80000	0.0 d
39.6667	41.66667	22.00000	-2.80000	0.0 d
40.8000	42.80000	22.00000	-2.80000	0.0 d
41.9333	43.93333	22.00000	-2.80000	0.0 d
43.0667	45.06667	22.00000	-2.80000	0.0 d
44.2000	46.20000	22.00000	-2.80000	0.0 d
45.3333	47.33333	22.00000	-2.80000	0.0 d
46.4667	48.46667	22.00000	-2.80000	0.0 d
47.6000	49.60000	22.00000	-2.80000	0.0 d
48.7333	50.73333	22.00000	-2.80000	0.0 d
49.8667	51.86667	22.00000	-2.80000	0.0 d
51.0000	53.00000	22.00000	-2.80000	0.0 d

d - Displacements include imported displacements.

Structure: 16 Chenies | Sub-structure: South

Dist.	Coordinates			Displacements
	x	y	z	
[m]	[m]	[m]	[m]	[mm]
0.0	2.00000	22.00000	-2.80000	0.0 d



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Dist.	Coordinates			Displacements	
	x	y	z	z	z
[m]	[m]	[m]	[m]	[mm]	[mm]
0.0	2.00000	21.90000	-2.80000	0.0	d
1.0533	2.00000	20.84667	-2.80000	0.0	d
2.1067	2.00000	19.79333	-2.80000	0.0	d
3.1600	2.00000	18.74000	-2.80000	0.0	d
4.2133	2.00000	17.68667	-2.80000	0.0	d
5.2667	2.00000	16.63333	-2.80000	0.0	d
6.3200	2.00000	15.58000	-2.80000	0.0	d
7.3733	2.00000	14.52667	-2.80000	0.0	d
8.4267	2.00000	13.47333	-2.80000	0.0	d
9.4800	2.00000	12.42000	-2.80000	0.0	d
10.5333	2.00000	11.36667	-2.80000	0.0	d
11.587	2.00000	10.31333	-2.80000	0.0	d
12.640	2.00000	9.26000	-2.80000	0.0	d
13.693	2.00000	8.20667	-2.80000	0.0	d
14.747	2.00000	7.15333	-2.80000	0.0	d
15.800	2.00000	6.10000	-2.80000	0.0	d

d - Displacements include imported displacements.

Structure: 16 Chenies | Sub-structure: East

Dist.	Coordinates			Displacements	
	x	y	z	z	z
[m]	[m]	[m]	[m]	[mm]	[mm]
<b>Vertical Offset 1</b>					
0.0	2.00000	6.00000	-2.80000	0.0	d
1.1333	3.13333	6.00000	-2.80000	0.0	d
2.2667	4.26667	6.00000	-2.80000	0.0	d
3.4000	5.40000	6.00000	-2.80000	0.0	d
4.5333	6.53333	6.00000	-2.80000	0.0	d
5.6667	7.66667	6.00000	-2.80000	0.0	d
6.8000	8.80000	6.00000	-2.80000	0.0	d
7.9333	9.93333	6.00000	-2.80000	0.0	d
9.0667	11.06667	6.00000	-2.80000	0.19556	d
10.2000	12.20000	6.00000	-2.80000	0.40350	d
11.3333	13.33333	6.00000	-2.80000	0.61102	d
12.467	14.46667	6.00000	-2.80000	0.81800	d
13.600	15.60000	6.00000	-2.80000	1.0243	d
14.733	16.73333	6.00000	-2.80000	1.4308	d
15.867	17.86667	6.00000	-2.80000	1.9350	d
17.000	19.00000	6.00000	-2.80000	2.4418	d
18.133	20.13333	6.00000	-2.80000	2.9683	d
19.267	21.26667	6.00000	-2.80000	3.5301	d
20.400	22.40000	6.00000	-2.80000	4.1396	d
21.533	23.53333	6.00000	-2.80000	4.8024	d
22.667	24.66667	6.00000	-2.80000	5.5054	d
23.800	25.80000	6.00000	-2.80000	6.1699	d
24.933	26.93333	6.00000	-2.80000	6.3241	d
26.067	28.06667	6.00000	-2.80000	0.0	d
27.200	29.20000	6.00000	-2.80000	0.0	d
28.333	30.33333	6.00000	-2.80000	0.0	d
29.467	31.46667	6.00000	-2.80000	0.0	d
30.600	32.60000	6.00000	-2.80000	0.0	d
31.733	33.73333	6.00000	-2.80000	0.0	d
32.867	34.86667	6.00000	-2.80000	0.0	d
34.000	36.00000	6.00000	-2.80000	0.0	d
35.133	37.13333	6.00000	-2.80000	0.0	d
36.267	38.26667	6.00000	-2.80000	0.0	d
37.400	39.40000	6.00000	-2.80000	0.0	d
38.533	40.53333	6.00000	-2.80000	0.0	d
39.667	41.66667	6.00000	-2.80000	0.0	d
40.800	42.80000	6.00000	-2.80000	0.0	d
41.933	43.93333	6.00000	-2.80000	0.0	d
43.067	45.06667	6.00000	-2.80000	0.0	d
44.200	46.20000	6.00000	-2.80000	0.0	d
45.333	47.33333	6.00000	-2.80000	0.0	d
46.467	48.46667	6.00000	-2.80000	0.0	d
47.600	49.60000	6.00000	-2.80000	0.0	d
48.733	50.73333	6.00000	-2.80000	0.0	d
49.867	51.86667	6.00000	-2.80000	0.0	d
51.000	53.00000	6.00000	-2.80000	0.0	d

d - Displacements include imported displacements.

Structure: 16 Chenies | Sub-structure: North

Dist.	Coordinates			Displacements	
	x	y	z	z	z
[m]	[m]	[m]	[m]	[mm]	[mm]
<b>Vertical Offset 1</b>					
0.0	53.00000	21.90000	-2.80000	0.0	d
1.0533	53.00000	20.84667	-2.80000	0.0	d
2.1067	53.00000	19.79333	-2.80000	0.0	d
3.1600	53.00000	18.74000	-2.80000	0.0	d
4.2133	53.00000	17.68667	-2.80000	0.0	d
5.2667	53.00000	16.63333	-2.80000	0.0	d
6.3200	53.00000	15.58000	-2.80000	0.0	d
7.3733	53.00000	14.52667	-2.80000	0.0	d
8.4267	53.00000	13.47333	-2.80000	0.0	d
9.4800	53.00000	12.42000	-2.80000	0.0	d
10.5333	53.00000	11.36667	-2.80000	0.0	d
11.587	53.00000	10.31333	-2.80000	0.0	d
12.640	53.00000	9.26000	-2.80000	0.0	d
13.693	53.00000	8.20667	-2.80000	0.0	d
14.747	53.00000	7.15333	-2.80000	0.0	d
15.800	53.00000	6.10000	-2.80000	0.0	d

d - Displacements include imported displacements.

Structure: 18 Chenies | Sub-structure: Retained Wall

Dist.	Coordinates			Displacements	
	x	y	z	z	z
[m]	[m]	[m]	[m]	[mm]	[mm]
<b>Vertical Offset 1</b>					
0.0	39.00000	-13.60000	-3.50000	0.0	d
0.98000	39.00000	-12.62000	-3.50000	0.0	d
1.96000	39.00000	-11.64000	-3.50000	0.0	d
2.94000	39.00000	-10.66000	-3.50000	0.0	d
3.92000	39.00000	-9.68000	-3.50000	0.0	d
4.90000	39.00000	-8.70000	-3.50000	0.0	d
5.88000	39.00000	-7.72000	-3.50000	0.0	d
6.86000	39.00000	-6.74000	-3.50000	0.0	d
7.84000	39.00000	-5.76000	-3.50000	0.0	d
8.82000	39.00000	-4.78000	-3.50000	0.0	d
9.80000	39.00000	-3.80000	-3.50000	0.0	d
10.78000	39.00000	-2.82000	-3.50000	0.0	d
11.76000	39.00000	-1.84000	-3.50000	0.0	d
12.74000	39.00000	-0.86000	-3.50000	0.0	d
13.72000	39.00000	0.12000	-3.50000	0.0	d
14.70000	39.00000	1.10000	-3.50000	0.0	d
15.68000	39.00000	2.08000	-3.50000	0.0	d
16.66000	39.00000	3.06000	-3.50000	0.0	d
17.64000	39.00000	4.04000	-3.50000	0.0	d
18.62000	39.00000	5.02000	-3.50000	0.0	d
19.60000	39.00000	6.00000	-3.50000	0.0	d

d - Displacements include imported displacements.

Structure: Law Building | Sub-structure: North

Dist.	Coordinates			Displacements	
	x	y	z	z	z
[m]	[m]	[m]	[m]	[mm]	[mm]
<b>Vertical Offset 1</b>					
0.0	21.60000	4.00000	-2.80000	5.1595	d



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Dist.	Coordinates		Displacements	
	x [m]	y [m]	z [m]	z [mm]
1.0500	21.60000	2.95000	-2.80000	5.0523 d
2.1000	21.60000	1.90000	-2.80000	4.9466 d
3.1500	21.60000	0.85000	-2.80000	4.8421 d
4.2000	21.60000	-0.20000	-2.80000	4.7390 d
5.2500	21.60000	-1.25000	-2.80000	4.6372 d
6.3000	21.60000	-2.30000	-2.80000	4.5366 d
7.3500	21.60000	-3.35000	-2.80000	4.4371 d
8.4000	21.60000	-4.40000	-2.80000	4.3388 d
9.4500	21.60000	-5.45000	-2.80000	4.2416 d
10.5000	21.60000	-6.50000	-2.80000	4.1454 d
11.5500	21.60000	-7.55000	-2.80000	4.0503 d
12.6000	21.60000	-8.60000	-2.80000	3.9560 d
13.6500	21.60000	-9.65000	-2.80000	3.8627 d
14.7000	21.60000	-10.70000	-2.80000	3.7702 d
15.7500	21.60000	-11.75000	-2.80000	3.6786 d
16.8000	21.60000	-12.80000	-2.80000	3.5867 d
17.8500	21.60000	-13.85000	-2.80000	3.4922 d
18.9000	21.60000	-14.90000	-2.80000	3.3963 d
19.9500	21.60000	-15.95000	-2.80000	3.2980 d
21.0000	21.60000	-17.00000	-2.80000	3.1973 d

d - Displacements include imported displacements.

Structure: Law Building | Sub-structure: East

Dist.	Coordinates		Displacements	
	x [m]	y [m]	z [m]	z [mm]
<b>Vertical Offset 1</b>				
0.0	21.60000	-17.10000	-2.80000	1.4531 d
1.0800	20.52000	-17.10000	-2.80000	1.1426 d
2.1600	19.44000	-17.10000	-2.80000	0.8374 d
3.2400	18.36000	-17.10000	-2.80000	0.72836 d
4.3200	17.28000	-17.10000	-2.80000	0.62028 d
5.4000	16.20000	-17.10000	-2.80000	0.46322 d
6.4800	15.12000	-17.10000	-2.80000	0.31232 d
7.5600	14.04000	-17.10000	-2.80000	0.15184 d
8.6400	12.96000	-17.10000	-2.80000	0.0 d
9.7200	11.88000	-17.10000	-2.80000	0.0 d
10.8000	10.80000	-17.10000	-2.80000	0.0 d
11.8800	9.72000	-17.10000	-2.80000	0.0 d
12.9600	8.64000	-17.10000	-2.80000	0.0 d
14.0400	7.56000	-17.10000	-2.80000	0.0 d
15.1200	6.48000	-17.10000	-2.80000	0.0 d
16.2000	5.40000	-17.10000	-2.80000	0.0 d
17.2800	4.32000	-17.10000	-2.80000	0.0 d
18.3600	3.24000	-17.10000	-2.80000	0.0 d
19.4400	2.16000	-17.10000	-2.80000	0.0 d
20.5200	1.08000	-17.10000	-2.80000	0.0 d
21.6000	0.00000	-17.10000	-2.80000	0.0 d

d - Displacements include imported displacements.

**Specific Building Damage Results - All Segments**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
0.0		1 2.1333	2.1333	None	0.0	0.0	0.0	0.0	-750.74E-6	5683.3	0 (Negligible)
		2 4.2667	1.0667	None	0.0	0.0	0.0	0.0	0.0	-	0 (Negligible)
		3 5.3333	1.1734	Sagging	0.0	0.0	0.0	0.0	0.0	203190.	0 (Negligible)
		4 6.5068	2.5869	Sagging	0.0037182	-0.037204	0.0077381	0.0012020	209.77E-6	14450.	0 (Negligible)
		5 9.0937	6.5699	Hogging	0.0072878	0.036549	0.040133	-720.73E-6	-443.89E-6	7148.3	0 (Negligible)
		6 15.664	0.23637	Sagging	0.0	0.072125	0.072125	-720.73E-6	-443.89E-6	43337.	1 (Very Slight)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
0.0		All settlements are less than the Settlement Trough Limit Sensitivity.									

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
0.0		All settlements are less than the Settlement Trough Limit Sensitivity.									

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
0.0		1 9.0667	2.0784	Sagging	9.2618E-6	0.0	9.1910E-6	0.0	-183.48E-6	23365.	0 (Negligible)
		2 11.145	0.20064	Sagging	2.6863E-6	0.0	2.6822E-6	0.0	-183.10E-6	2.3676E+6	0 (Negligible)
		3 11.346	10.356	Hogging	0.0056413	0.056738	0.059474	-743.92E-6	-619.88E-6	10433.	1 (Very Slight)
		4 21.702	3.2318	Sagging	0.010554	0.033096	0.036342	0.0061660	0.0056145	676.91	0 (Negligible)

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
0.0		All settlements are less than the Settlement Trough Limit Sensitivity.									

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset	Segment	Start	Length	Curvature	Deflection	Average	Max.	Maximum	Maximum	Min.	Damage
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from Line for Vertical Movement Calculations  
[m] 0.0  
Ratio [%] 0.0  
Horizontal Strain [%] 0.0  
Tensile Strain [%] 0.0  
Gradient of Horizontal Displacement Curve [%] 0.0017467  
Gradient of Vertical Displacement Curve [%] 0.0018301  
Radius of Curvature [m] 777320.0

All settlements are less than the Settlement Trough Limit Sensitivity.  
Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	13.655 Hogging	178.96E-6	0.0017467	0.0018301	-17.678E-6	102.09E-6	777320.0	(Negligible) 0
				2.9723 Sagging	0.013566	-0.0023120	0.012649	119.45E-6	744.76E-6	4757.3	(Negligible) 0
				2.2019 Hogging	0.0029956	-0.015111	0.0035036	217.58E-6	744.76E-6	11060.0	(Negligible) 0
				0.91464 Sagging	38.895E-6	0.0028866	0.0028892	85.490E-6	344.44E-6	153980.0	(Negligible) 0
				1.1559 Hogging	54.126E-6	0.012453	0.012455	-143.17E-6	344.44E-6	171340.0	(Negligible) 0

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature	Damage Category
[m] 0.0		[m] 1	[m] 0.0	0.48112 None	0.0	0.043290	0.043290	-432.72E-6	287.37E-6	27426.0	(Negligible) 0
				3.5449 Hogging	0.0043997	0.023810	0.024470	-432.72E-6	287.37E-6	12279.0	(Negligible) 0
				2.5847 Sagging	353.24E-6	456.63E-6	628.75E-6	-40.139E-6	148.60E-6	83993.0	(Negligible) 0
				0.94935 Hogging	0.0	0.0	0.0	0.0	148.60E-6	29242.0	(Negligible) 0

Tensile horizontal strains are +ve, compressive horizontal strains are -ve.

**Specific Building Damage Results - Critical Values for All Segments within Each Sub-Structure**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.0072878	0.072125	-750.74E-6	1.9497	0.072125	0.0012020	-750.74E-6	7148.3	14450.1	(Very Slight)

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.0072878	0.072125	-750.74E-6	1.9497	0.072125	0.0012020	-750.74E-6	7148.3	14450.1	(Very Slight)

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.0072878	0.072125	-750.74E-6	1.9497	0.072125	0.0012020	-750.74E-6	7148.3	14450.1	(Very Slight)

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.010554	0.056738	0.0056145	6.3241	0.059474	0.0061660	0.0056145	10433.0	676.91	1 (Very Slight)

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.013566	-0.015111	744.76E-6	5.1595	0.012649	217.58E-6	744.76E-6	11060.0	4757.3	0 (Negligible)

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.013566	-0.015111	744.76E-6	5.1595	0.012649	217.58E-6	744.76E-6	11060.0	4757.3	0 (Negligible)

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.013566	-0.015111	744.76E-6	5.1595	0.012649	217.58E-6	744.76E-6	11060.0	4757.3	0 (Negligible)

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Deflection Ratio	Average Horizontal Strain	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Maximum Gradient of Horizontal Displacement Curve	Maximum Gradient of Vertical Displacement Curve	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
[m] 0.0	0.013566	-0.015111	744.76E-6	5.1595	0.012649	217.58E-6	744.76E-6	11060.0	4757.3	0 (Negligible)



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Offset from Line for Vertical Movement Calculations	Ratio	Horizontal Strain	Slope	Settlement	Tensile Strain	Gradient of Horizontal Displacement Curve	Gradient of Vertical Displacement Curve	Radius of Curvature (Hogging)	Radius of Curvature (Sagging)
[m]	[%]	[%]		[mm]	[%]			[m]	[m]
0.0	0.0043997	0.043290	287.37E-6	1.4531	0.043290	-432.72E-6	287.37E-6	12279.	83993.0 (Negligible)

**Specific Building Damage Results - Critical Segments within Each Structure**

Structure Name	Parameter	Critical Sub-Structure	Critical Start Segment	End	Curvature	Maximum Slope	Maximum Settlement	Max. Tensile Strain	Min. Radius of Curvature (Hogging)	Min. Radius of Curvature (Sagging)	Damage Category
			[m]	[m]			[mm]	[%]	[m]	[m]	
Law Building	Maximum Slope	Infill North	1	2.1333	4.2667	Sagging	<b>750.74E-6</b>	0.80079	0.0	-	5683.3 0 (Negligible)
	Maximum Settlement		1	0.0	13.655	Hogging	102.09E-6	<b>5.1595</b>	0.0018301	777320.	- 0 (Negligible)
	Max. Tensile Strain	Infill North	6	15.664	15.900	Sagging	443.89E-6	1.9497	<b>0.072125</b>	-	43337. 1 (Very Slight)
	Min. Radius of Curvature (Hogging)		5	9.0937	15.664	Hogging	443.89E-6	1.8447	0.040133	<b>7148.3</b>	- 0 (Negligible)
	Min. Radius of Curvature (Sagging)	North	2	13.655	16.627	Sagging	744.76E-6	3.8623	0.012649	-	<b>4757.3</b> 0 (Negligible)
16 Chenies	Maximum Slope		East East	4	21.702	24.933	Sagging	<b>0.0056145</b>	6.3241	0.036342	-
	Maximum Settlement	4		21.702	24.933	Sagging	0.0056145	<b>6.3241</b>	0.036342	-	676.91 0 (Negligible)
	Max. Tensile Strain	East East	3	11.346	21.702	Hogging	619.88E-6	4.9067	<b>0.059474</b>	10433.	- 1 (Very Slight)
	Min. Radius of Curvature (Hogging)		3	11.346	21.702	Hogging	619.88E-6	4.9067	0.059474	<b>10433.</b>	- 1 (Very Slight)
	Min. Radius of Curvature (Sagging)	East	4	21.702	24.933	Sagging	0.0056145	6.3241	0.036342	-	<b>676.91</b> 0 (Negligible)
18 Chenies	All settlements are less than the Settlement Trough Limit Sensitivity.										
	All settlements are less than the Settlement Trough Limit Sensitivity.										
	All settlements are less than the Settlement Trough Limit Sensitivity.										
	All settlements are less than the Settlement Trough Limit Sensitivity.										

**Specific Building Damage Results - All Combined Segments**

Structure: Law Building | Sub-structure: Infill

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: West

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: South

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: 16 Chenies | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: 18 Chenies | Sub-structure: Retained Wall

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: Law Building | Sub-structure: North

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

Structure: Law Building | Sub-structure: East

Vertical Offset from Line for Vertical Movement Calculations	Combined Segment	Start	Length	Curvature	Deflection Ratio	Average Horizontal Strain	Max. Tensile Strain	Damage Category
[m]		[m]	[m]		[%]	[%]	[%]	
No structures have segments combined.								

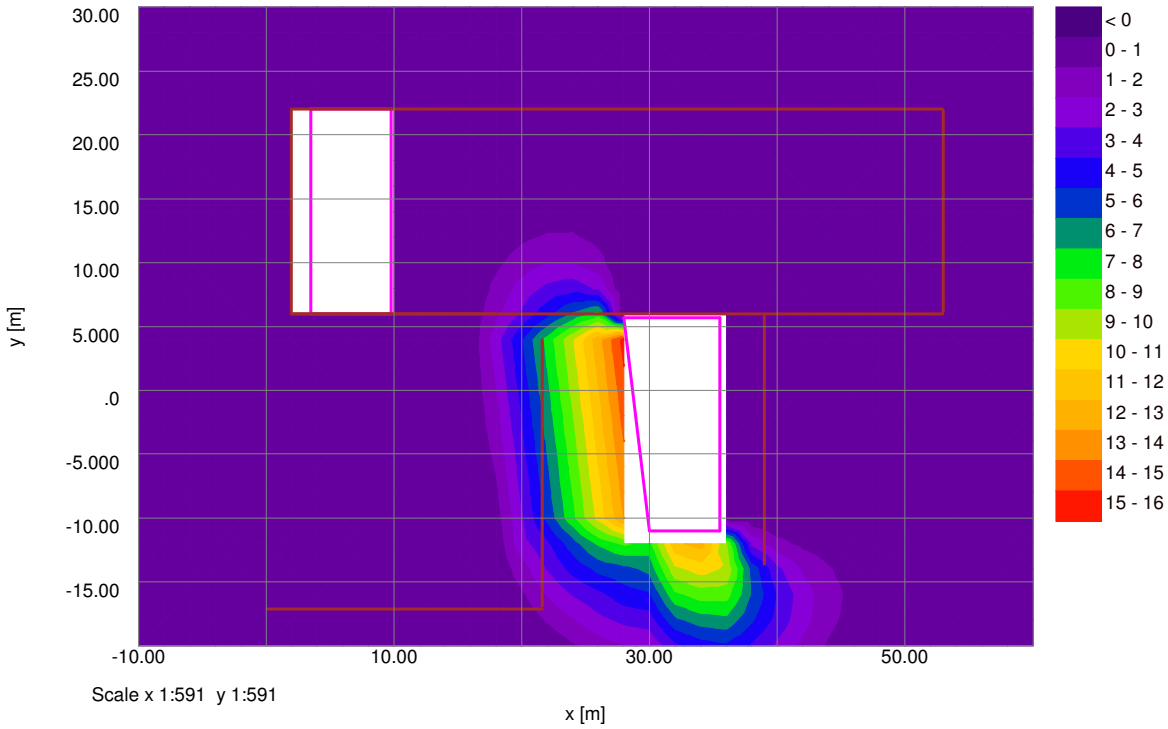


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Line for Vertical Movement Calculations	[m]	[m]	[%]	Strain	Strain	[%]
No structures have segments combined.						

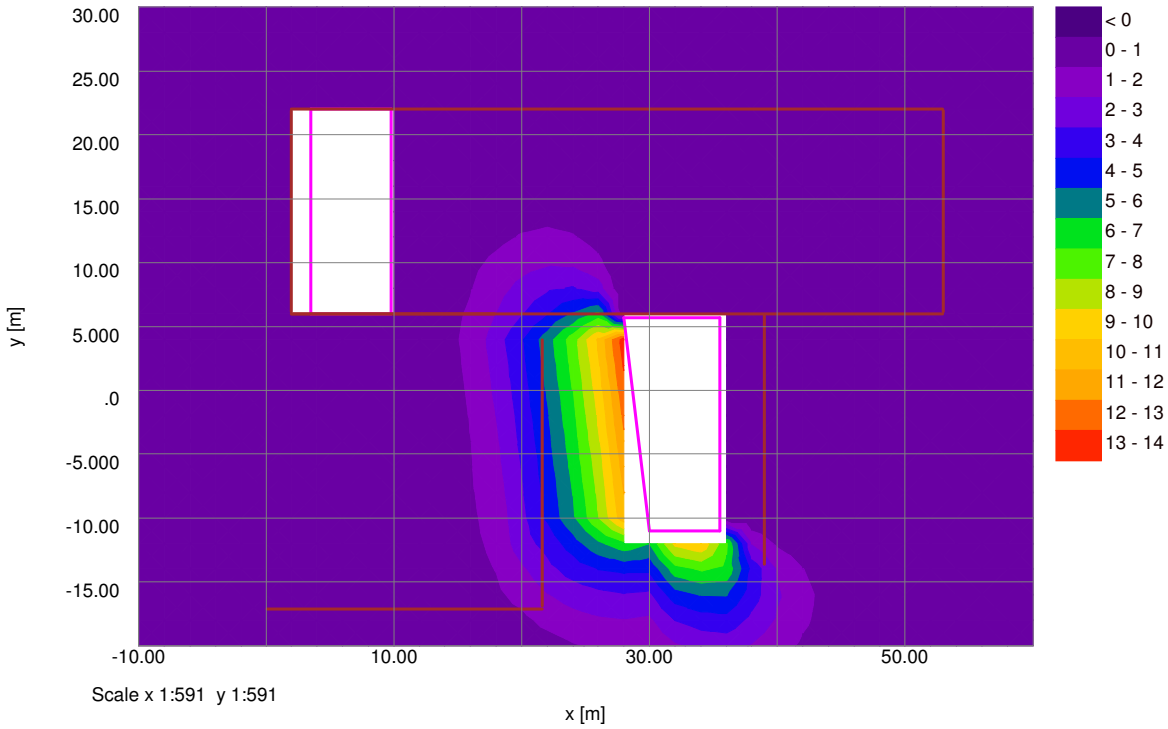
Job No.	Sheet No.	Rev.
<b>Drg. Ref.</b>		
<b>Made by</b> MC	<b>Date</b> 23-Mar-2016	<b>Checked</b>

Horizontal Displacement Contours: Grid 1 (level -2.800m) Interval 1mm



Job No.	Sheet No.	Rev.
Drg. Ref.		
Made by MC	Date 23-Mar-2016	Checked

Vertical Settlement Contours: Grid 1 (level -2.800m) (Interval 1mm)

























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**Job No.** **Sheet No.** **Rev.**

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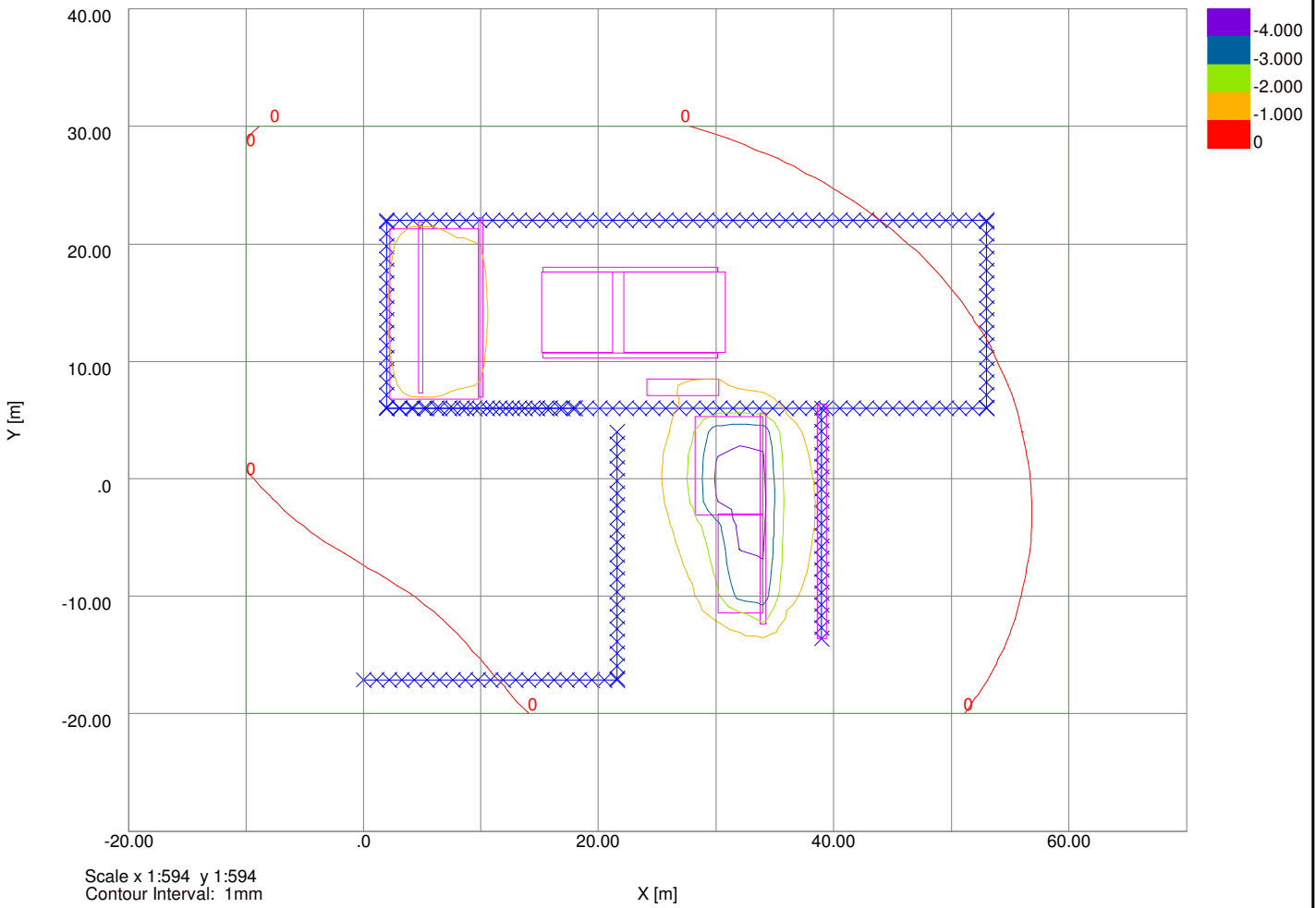
**Drq. Ref.**

**Made by** **Date** **Checked**  
**MC**

Name	Location		Z [Level] [mOD]	Z [mm]	Stresses			Vert Strain [-]
	X [m]	Y [m]			Calc Level [mOD]	Vert Stress [kN/m <sup>2</sup> ]	Sum Princ [kN/m <sup>2</sup> ]	
39.00000	-12.62000	-3.50000	-0.65165	-3.6500	-10.799	-26.422	-79.660E-6	
39.00000	-11.64000	-3.50000	-0.72996	-3.6500	-10.806	-26.889	-73.721E-6	
39.00000	-10.66000	-3.50000	-0.79645	-3.6500	-10.810	-27.174	-70.097E-6	
39.00000	-9.68000	-3.50000	-0.85509	-3.6500	-10.814	-27.416	-67.028E-6	
39.00000	-8.70000	-3.50000	-0.90624	-3.6500	-10.817	-27.622	-64.394E-6	
39.00000	-7.72000	-3.50000	-0.94993	-3.6500	-10.820	-27.794	-62.194E-6	
39.00000	-6.74000	-3.50000	-0.98586	-3.6500	-10.821	-27.934	-60.409E-6	
39.00000	-5.76000	-3.50000	-1.0146	-3.6500	-10.823	-28.043	-59.005E-6	
39.00000	-4.78000	-3.50000	-1.0361	-3.6500	-10.824	-28.124	-57.951E-6	
39.00000	-3.80000	-3.50000	-1.0505	-3.6500	-10.824	-28.180	-57.230E-6	
39.00000	-2.82000	-3.50000	-1.0577	-3.6500	-10.824	-28.210	-56.845E-6	
39.00000	-1.84000	-3.50000	-1.0573	-3.6500	-10.824	-28.212	-56.810E-6	
39.00000	-0.86000	-3.50000	-1.0490	-3.6500	-10.824	-28.186	-57.153E-6	
39.00000	0.12000	-3.50000	-1.0323	-3.6500	-10.823	-28.127	-57.909E-6	
39.00000	1.10000	-3.50000	-1.0066	-3.6500	-10.822	-28.032	-59.129E-6	
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39.00000	3.06000	-3.50000	-0.92600	-3.6500	-10.818	-27.714	-63.182E-6	
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39.00000	6.00000	-3.50000	-0.70457	-3.6500	-10.727	-25.554	-88.378E-6	
Law Bdg Nth	4.00000	4.00000	-0.41321	-3.0500	-350.74E-6	-0.44317	8.8424E-6	
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21.60000	0.85000	-2.80000	-0.42584	-3.0500	-315.08E-6	-0.44412	8.8635E-6	
21.60000	-0.20000	-2.80000	-0.42234	-3.0500	-306.06E-6	-0.43793	8.7402E-6	
21.60000	-1.25000	-2.80000	-0.41563	-3.0500	-290.63E-6	-0.42608	8.5042E-6	
21.60000	-2.30000	-2.80000	-0.40407	-3.0500	-269.00E-6	-0.40887	8.1613E-6	
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21.60000	-9.65000	-2.80000	-0.25342	-3.0500	-108.69E-6	-0.23554	4.7043E-6	
21.60000	-10.70000	-2.80000	-0.22818	-3.0500	-92.63E-6	-0.21143	4.2231E-6	
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21.60000	-12.80000	-2.80000	-0.17886	-3.0500	-63.96E-6	-0.16628	3.3217E-6	
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21.60000	-17.00000	-2.80000	-0.094541	-3.0500	-25.598E-6	-0.096286	1.9242E-6	
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17.28000	-17.10000	-2.80000	-0.039956	-3.0500	-9.4035E-6	-0.059038	1.1802E-6	
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Job No.	Sheet No.	Rev.
Drg. Ref.		
Made by MC	Date	Checked

Settlement Contours : Grid 1 at -2.8000m



Scale x 1:594 y 1:594  
Contour Interval: 1mm

X [m]







GEA LIMITED (GEOTECHNICAL & ENV ASSOC) J15215

Job No. Sheet No. Rev.

Royal Academy of Dramatic Arts 16-18 Chenies Street Development Short term unloading and reloading

Drng. Ref.

Made by Date Checked

Table with columns: Ref., Type, Name, Direction of Extrusion, X [m], Y [m], Z [Level] [m], Line/Line for extrusion, Second point X [m], Y [m], Z [Level] [m], No. of intrvl across extrusion/line, Extrusion Depth [m], No. of intrvl along extrusion, Calculate, Show Detailed results

applies to other displacement points. Only 25 are listed here.

RESULTS FOR GRIDS

Analysis: Boussinesq Global Poisson's ratio: 0.50 Horizontal rigid boundary level: -40.00 [m OD]

The maximum displacement difference between Boussinesq method (0.94668mm) and Mindlin method (0.41608mm) occurs at point X=15.867m Y=6.0000m Level -1.5000mOD and is 0.53060mm

Large table with columns: Name, Location X [m], Y [m], Z [Level] [m], Z [mm], Calc Level [mOD], Vert Stress [kN/m²], Sum Princ [kN/m²], Vert Strain [-]





GEA LIMITED
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Job No. Sheet No. Rev.

Royal Academy of Dramatic Arts
16-18 Chenies Street Development
Short term unloading and reloading

Dr. Ref.

Made by Date Checked
MC

Table with columns: Name, Location (X, Y, Z), Stresses (Calc Level, Vert Stress, Sum Princ, Vert Strain). Rows contain numerical data for stress analysis at various depths and locations.











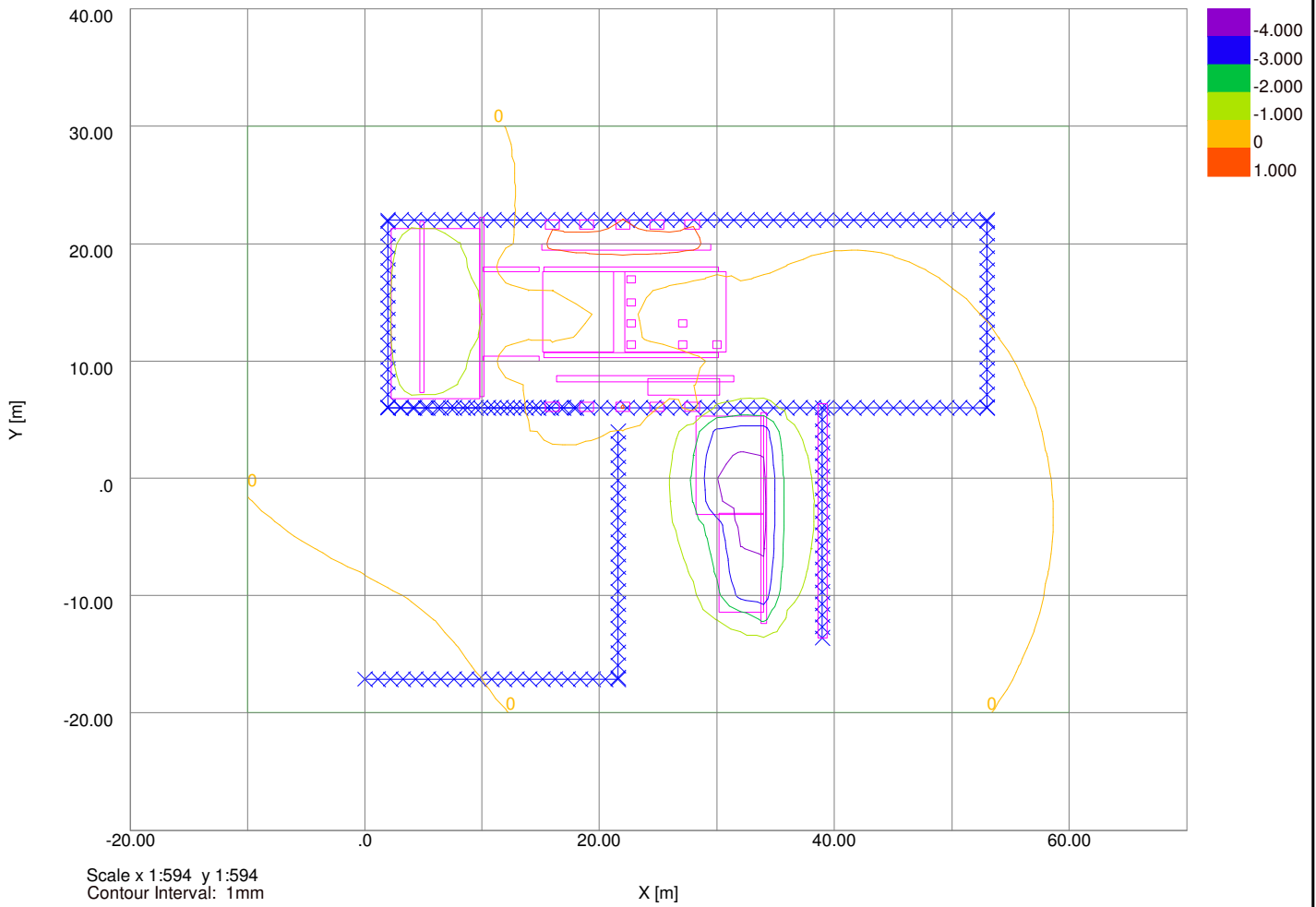




Royal Academy of Dramatic Arts  
16-18 Cheries Street Development  
Short term unloading and reloading

MC

Settlement Contours : Grid 1 at -2.8000m



















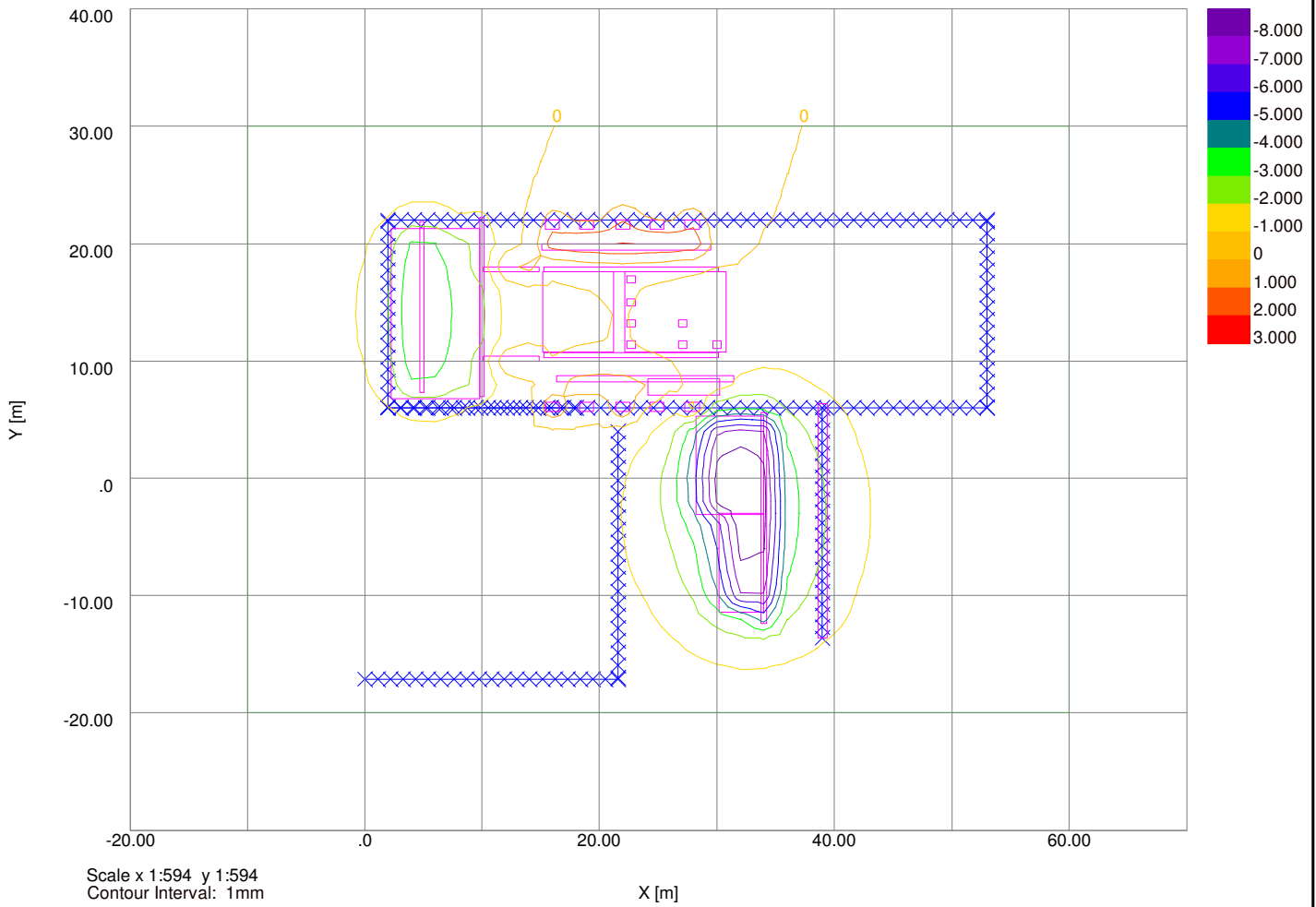






Job No.	Sheet No.	Rev.
Drg. Ref.		
Made by MC	Date	Checked

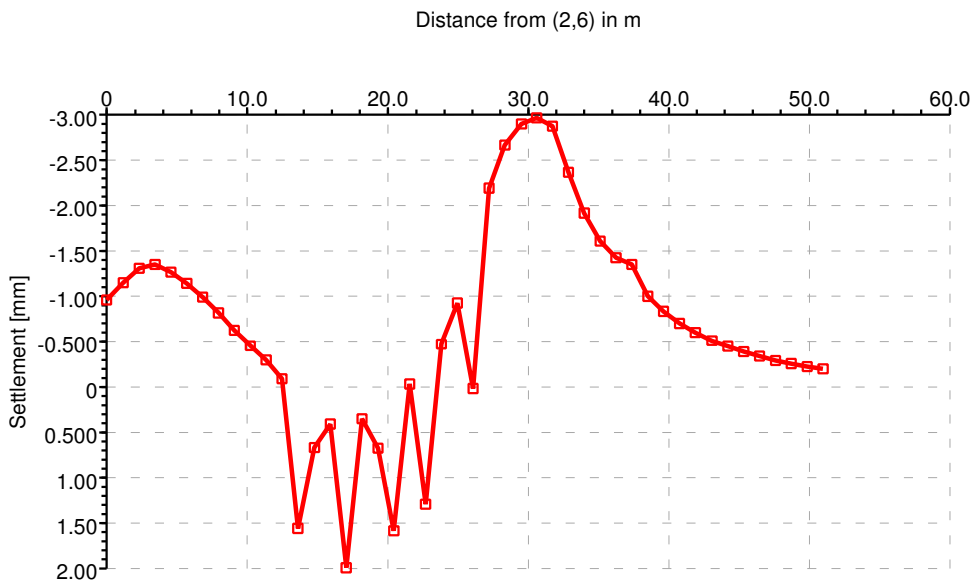
Settlement Contours : Grid 1 at -2.8000m



<b>Job No.</b>	<b>Sheet No.</b>	<b>Rev.</b>
<b>Dr. Ref.</b>		
<b>Made by</b>	<b>Date</b>	<b>Checked</b>
<b>MC</b>		

## Displacement for 16 Cheries Est

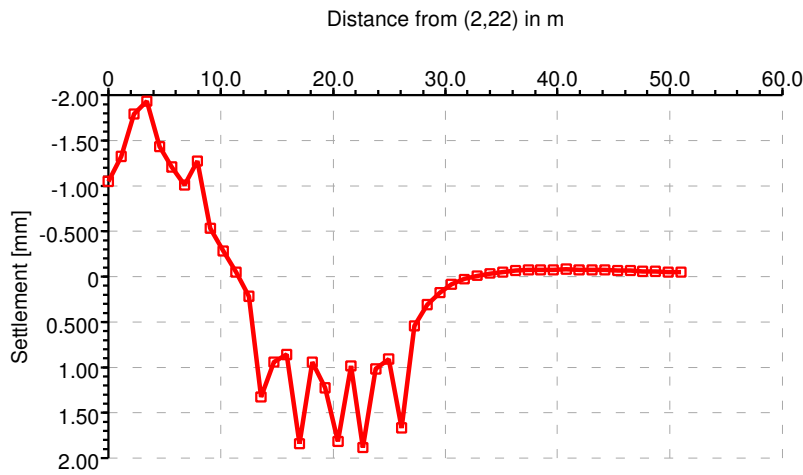
—■— Line Displacement



Royal Academy of Dramatic Arts  
16-18 Cheries Street Development  
Long term unloading and reloading

## Displacement for 16 Cheries Wst

—■— Line Displacement

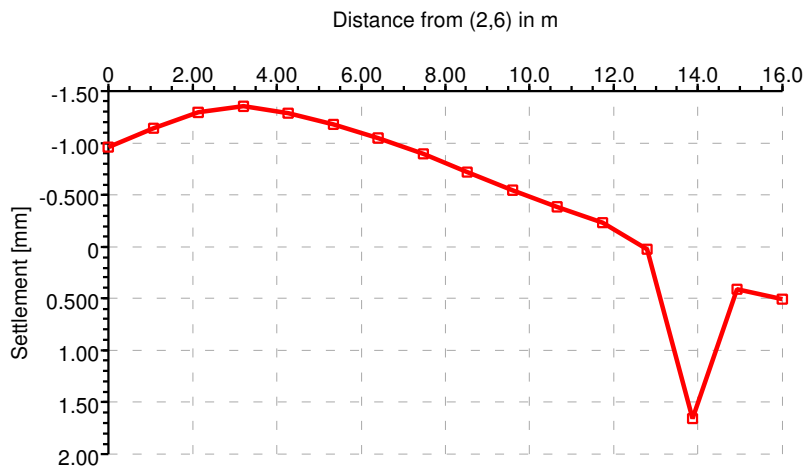




Royal Academy of Dramatic Arts  
16-18 Cheries Street Development  
Long term unloading and reloading

## Displacement for Law Bdg Infill

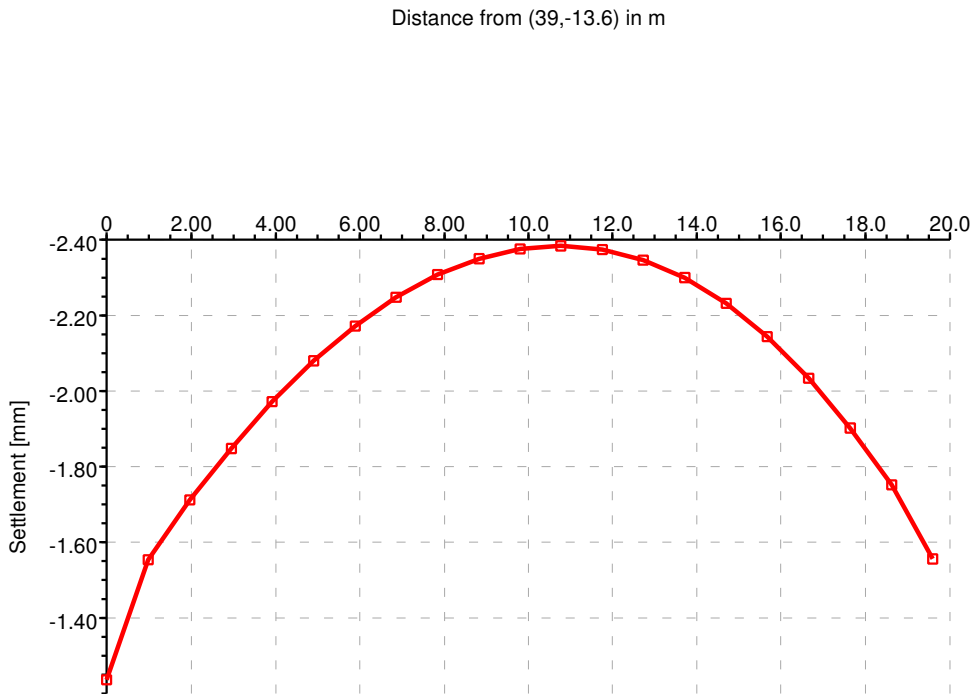
—■— Line Displacement



Royal Academy of Dramatic Arts  
16-18 Chenies Street Development  
Long term unloading and reloading

## Displacement for 18 Chenies Retained Wall

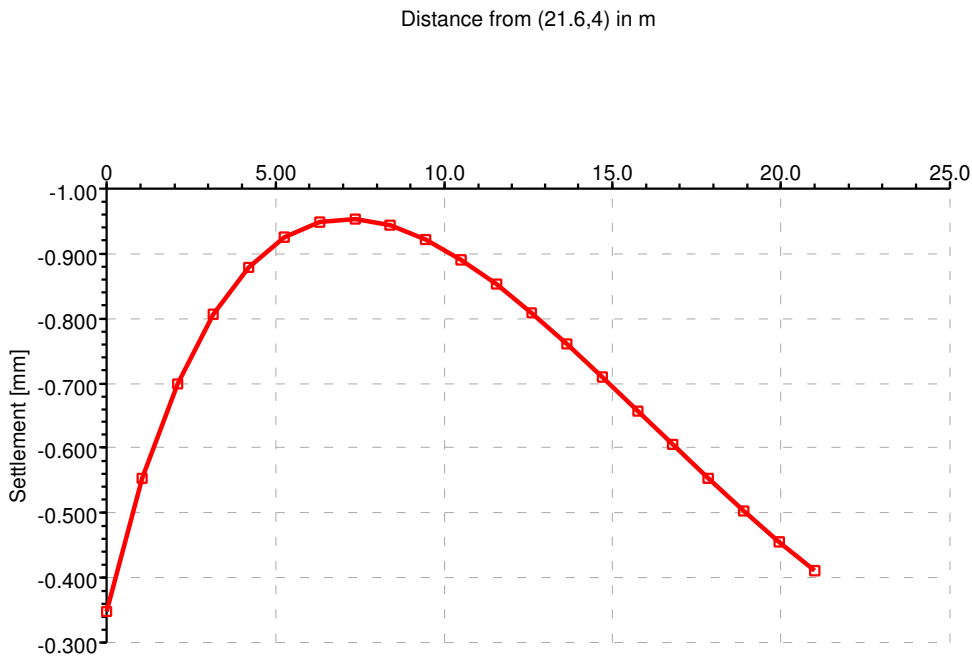
—■— Line Displacement



Job No.	Sheet No.	Rev.
Drg. Ref.		
Made by MC	Date	Checked

## Displacement for Law Bdg Nth

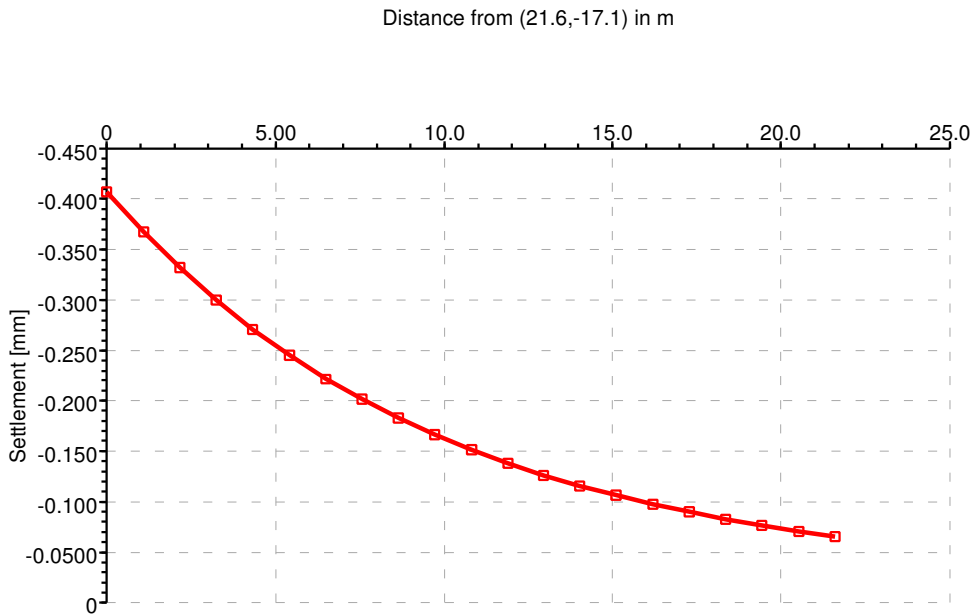
—■— Line Displacement



Royal Academy of Dramatic Arts  
16-18 Cheries Street Development  
Long term unloading and reloading

## Displacement for Law Bbg Est

—■— Line Displacement



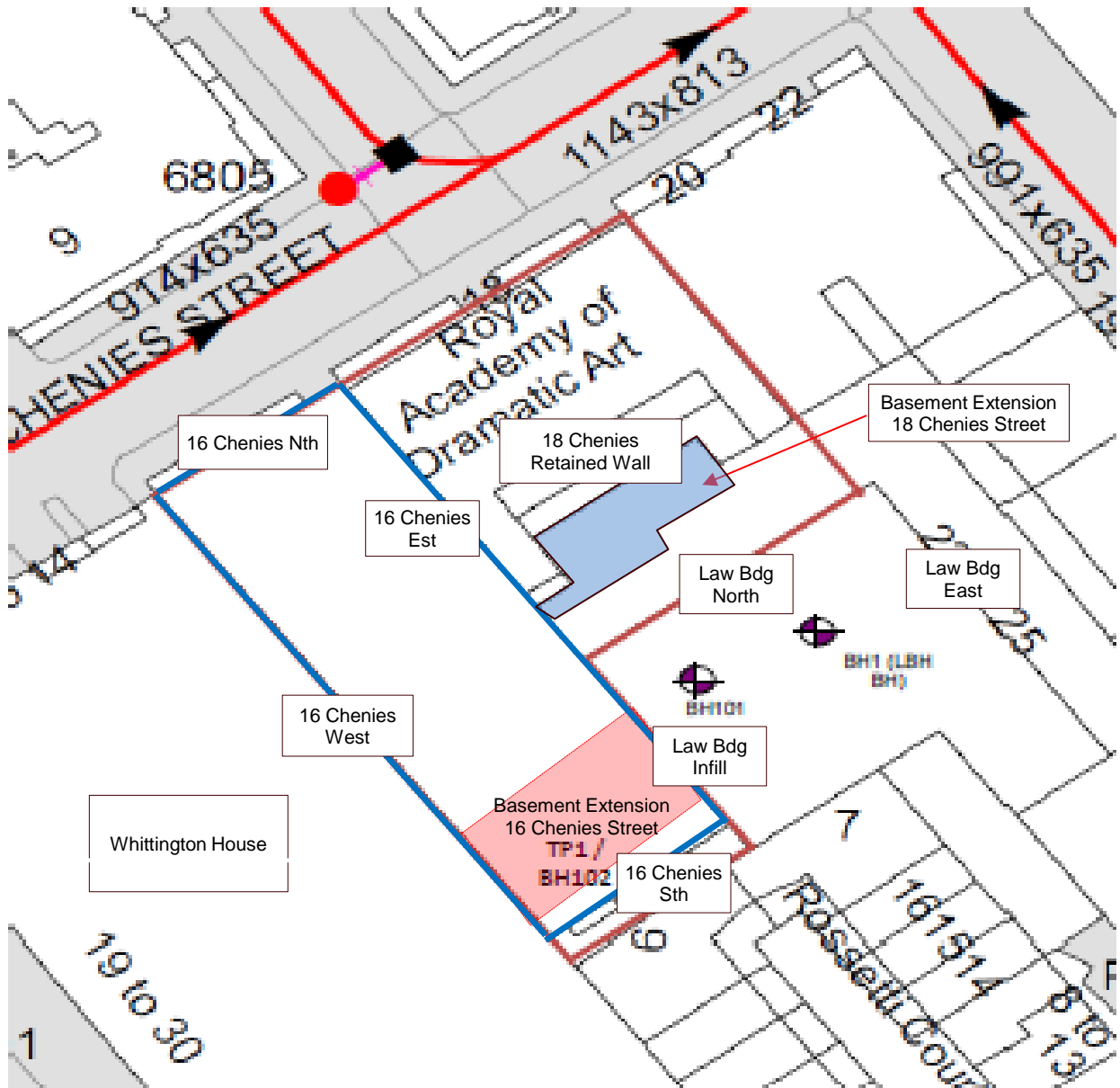
**Site** Royal Academy of Dramatic Arts, 16-18 Cheries Street, London, WC1E 7EX

**Job Number**  
J15215

**Client** Royal Academy of Dramatic Arts

**Sheet**  
1 / 1

**Engineer** Price and Myers



Geotechnical & Environmental Associates (GEA) is an engineer-led and client-focused independent specialist providing a complete range of geotechnical and contaminated land investigation, analytical and consultancy services to the property and construction industries.

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where information can be found on all of the services that we offer.

