APPENDIX 12.4
MALTINGS BUILDING - WALL ASSESSMENT

Maltings Building- Wall Assessment

Stag Brewery

August 2017

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Client Name:	Dartmouth Capital Advisors Ltd
Document Reference:	WIE10667-102-R-2-1-3
Project Number:	WIE10667

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
00	14/08/17	Vinnothan Balakumarasingham	Lazaros Fotiadis	Ali Karbassi

Comments

Comments

Disclaimer

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Executive Summary

The purpose of this report is to present the assessment of the external walls of the Maltings building on the corner of a proposed development, adjacent to the River Thames, in Mortlake South West London. The walls were assessed against the actions applied by the River Thames water levels rising to the flood defence level currently predicted to occur in 2100.

Figure 1: Wall to be assessed and architectural proposal

The wall was assessed in accordance with Eurocode 6, BD21/01 and the latest architectural drawings which show the windows extending to ground level. A typical section was assessed against the actions of water levels rising and in each instance the element was considered to be one way spanning.

Standard	Bending	Shear
Eurocode 6	2.7	2.0
BD 21/01	2.2	1.9

Table 1: Assessment Results- Factors of Safety

The assessment showed the wall to have sufficient capacity to resist the increase in water level that occurs when the river rises to the 2100 flood defence levels (Table 1).

It should be noted that the assessment presented within this report is based on the assumptions stated in Section 2. Should these assumptions change then the report may have to be revised and reissued.

This report does not cover the capacity of the windows and the measures that would need to be put in place to support them once they have been extended to ground floor level.

1. Introduction

1.1 Project Background

A residential development is proposed on the site of the former Stag Brewery near Mortlake in South West London (Figure 2). A new river wall, constructed behind the existing river wall, is to be provided and this is to tie in with the corner of the listed Maltings building. Preliminary architectural drawings for the scheme can be found in Appendix A.

Figure 2: Site location

1.2 Report Purpose

The purpose of this report is to present the assessment of the external walls of the Maltings building on the corner of the development. The walls were assessed against the actions applied by the River Thames water levels rising to the flood defence level currently predicted to occur in 2100.

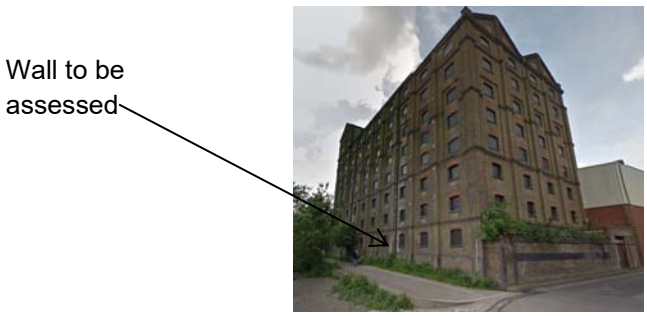


Figure 3: Wall to be assessed

The wall is to be assessed in accordance with Eurocode 6 and BD 21/01. The analysis method is described in Section 4 and a full set of the assessment calculations can be found in Appendix B.

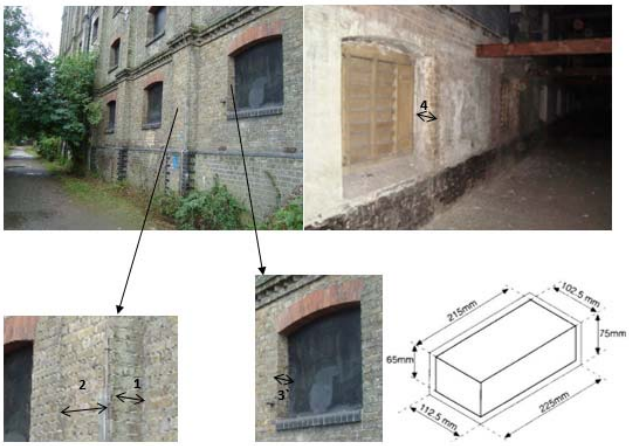
2. Assumptions

2.1 Geometric

Based on the available dimensions the wall measures 30m long and 25m high. Standard brick dimensions of 225mm x 105mm x 75mm shall be adopted.

Figure 4: Dimensions of wall to be assessed

2.1.1 Dimensions for Assessment



Based on standard brick dimensions:

1) 225mm
2) 788mm
3) 225mm
4) 225mm

Wall thickness = 3+4 = 225mm+225mm = 450mm (Therefore consider a 1000mm x 450mm section)

Column cross section = b x h = 2 x (1+3+4) = 788 x (225+225+225) = 788mm x 675mm

Figure 5: Assessment Dimensions

2.2 Material

The wall is constructed out of clay bricks and the photos taken on site suggest that the wall is four bricks thick. In the absence of site specific core holes the following material properties were adopted.

Material Property	Value
Masonry Group [1]	Group 1
Mortar Type [2]	M4 – General purpose mortar
Class of execution control [3]	2
Unit Weight	22.5 kN/m^3
Characteristic shear strength of masonry[4], f_{vk}	0.2 N/mm^2
Characteristic flexural strength of masonry having a plane of failure parallel to the bed joints[5], f_{xk1}	0.5 N/mm^2
Characteristic flexural strength of masonry having a plane of failure perpendicular to the bed joints[5], f_{xk2}	1.5 N/mm^2
Compressive strength of mortar [6]	4 N/mm^2
γ_m [7] Bending	2.7
γ_m [7] Shear	2.5

Table 2: Material properties adopted in the assessment

Notes

1) In accordance with Table 3.1, EN 1996-1-1:2005

2) In accordance with clause 3.2.3.1, EN 1996-1-1:2005

3) Adopt this class in absence of construction information.

4) Table NA.5, NA to BS EN 1996-1-1:2005

5) Table NA.6, NA to BS EN 1996-1-1:2005

6) Table NA.2, NA to BS EN 1996-1-1:2005

7) Material factors adopted Table NA.1 of NA to BS EN 1996-1-1:2005

2.3 Loading

The primary purpose of this report is to assess the wall for the effects that result from the increase in river level. As such this action was considered to act on the bottom 2m of the wall. This is derived from the flood defence level rising to 6.70m AOD in the year 2100 and the minimum existing ground level being taken at 4.70m based on available survey information. The building is currently subject to wind loads so this has been applied to the section of the column that is not subject to water pressures.

The loading calculations can be found in Appendix B.

3. References

3.1 Standards and Technical Documents

Reference	Title
BS EN 1996-1-1:2005	Eurocode 6 — Design of masonry structures — Part 1-1: General rules for reinforced and unreinforced masonry structures
WIE10667-100-R-2-1-4-DO	Stag Brewery, Mortlake Flood Risk and Drainage Briefing Note
BS EN 1991-1-4:2005	Eurocode 1: Actions on structures — Part 1-4: General actions — Wind Actions
BS 5628-1: 2005	Code of practice for the use of masonry — Part 1: Structural use of unreinforced masonry
-	Manual for the design of plain masonry in building structures to Eurocode 6, The Institution of Structural Engineers
-	How to design masonry structures to Eurocode 6, Roberts and Brooker.
BD 21/01	The Assessment of Highway Bridges and Structures
BS 5628-1: 2005	Code of practice for the use of masonry — Part 1: Structural use of unreinforced masonry

Table 3: Standards and Technical Documents Referenced

3.2 Drawings

Drawing Number	Drawing Title
WIE-SA-04-1000	Thames River Wall Condition Survey Defect Plan
WIE-SA-04-1004	Thames River Wall Condition Survey Defect Elevation Sketch

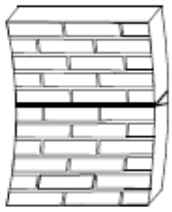
Table 4: Drawings Referenced

4. Assessment

4.1 Methodology

Figure 6: Dimensions of wall and architectural intent for the scheme.

The current architectural intent for the scheme is to extend the ground floor windows down to ground level. As such in the event of the 2100 storm event the water will apply a pressure to the wall panels and columns either side of the windows. The assessment was carried out by considering a 'T-shaped' column section comprising the column and the wall panels either side. The section was assumed to have a fixed support at foundation level and a pinned prop at first floor level.



a) plane of failure parallel to bed joints, f_{xk1}

Figure 7: Planes of failure considered (Figure 3.1 EN 1996-1-1:2005)

The section is to be considered as one way spanning with the critical plane of failure being parallel to the bed joints (Figure 7). The assessment was carried out in accordance with Eurocode 6 and BD21/01. In both instances the wall was treated as being subject to a permanent water pressure load arising from the water rising to the flood defence level.

The assessment calculations can be found in Appendix B. However, the assessment does not consider any of the support arrangements that may be required for the windows to resist the applied water pressure.

4.2 Results

Standard	Bending	Shear
Eurocode 6	2.7	2.0
BD 21/01	2.2	1.9

Table 5: Assessment Results – Factors of safety

5. Conclusion

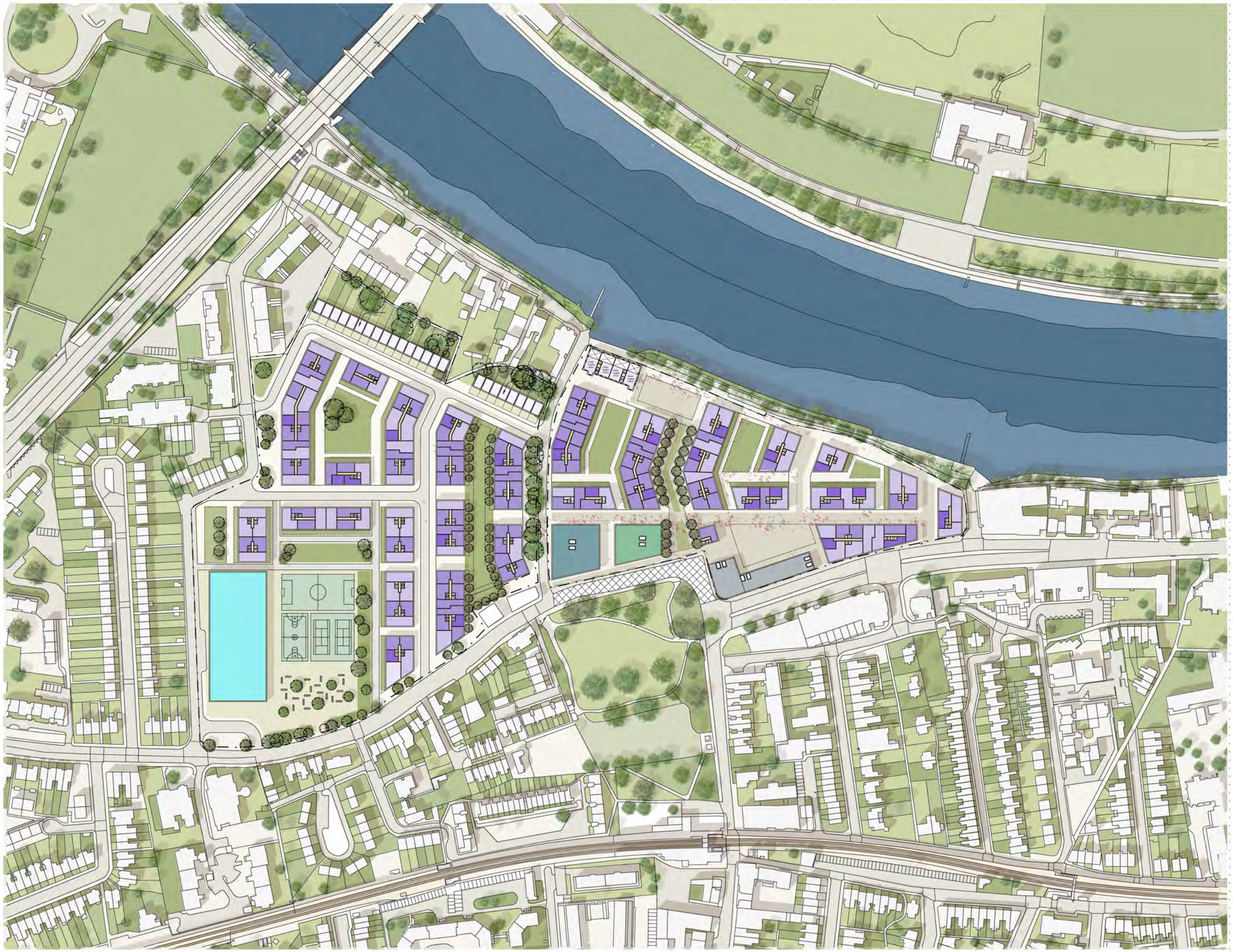
The purpose of this report was to assess the river facing wall of the maltings building on the corner of the proposed development site at Mortlake. The assessment shows the wall to have sufficient capacity to resist the increase in water level that arises when the river rises to the 2100 flood defence levels.

It should be noted that the assessment presented within this report is based on the assumptions stated in Section 2. Should these assumptions change then the report may have to be revised and reissued.

This report does not cover the capacity of the windows and the measures that would need to be put in place to support them once they have been extended to ground floor level.

APPENDICES

A. Reference Drawings



NOTES:

DO NOT SCALE FROM THIS DRAWING. ALL DIMENSIONS TO BE CHECKED ON SITE. ALL OMISSIONS AND DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY.

- 1 Bed
- 2 Bed
- 3 Bed
- 4 Bed
- House
- Hotel
- Residential Lobby
- Office
- Cinema/Gym
- School

Revision description	Date	Check	Rev

SQUIRE & PARTNERS

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www.squireandpartners.com

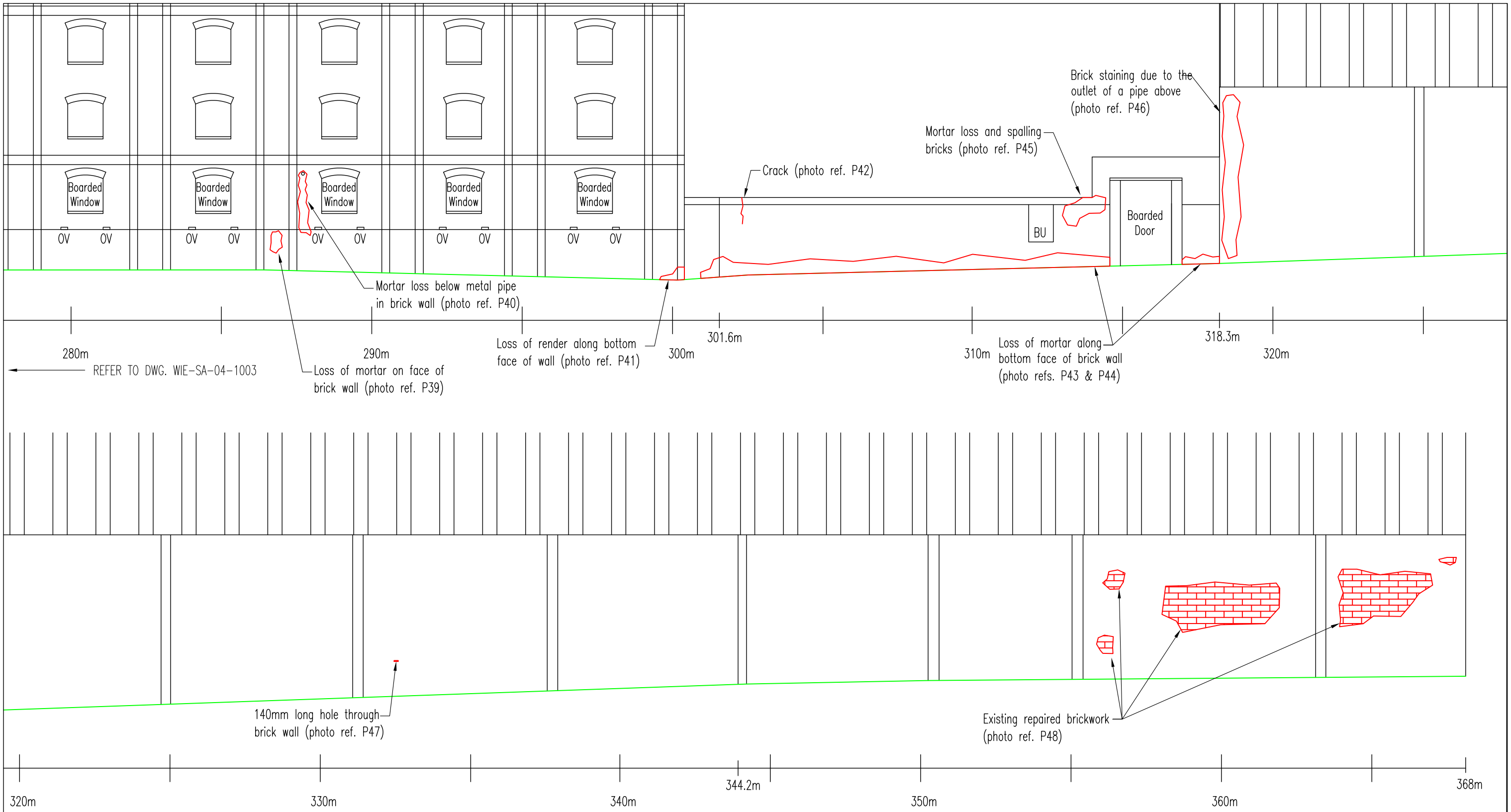
Project
Stag Brewery
Richmond

Drawing
Site Plan
Typical Level

Drawn	Date	Scale
JB	06/08/16	1 : 1250 @ A1 1 : 2500 @ A3

Job Number	Drawing number	Revision
16019	G100_P_02_001	

View of from the River with The Maltings



KEY:
BU = BRICKED UP
OV = OPEN VENT

1:125 0 1m 2m 3m 4m 5m 6m

1:1 0 10 20 30 40 50

1. THIS CONDITION SURVEY WAS CARRIED OUT ON 16TH SEPTEMBER BY TLR & TSC.
2. MINOR VEGETATION GROWTH, GRAFFITI AND WEAR OF THE BRICKS ARE PRESENT ALONG THE LENGTH OF WALL.
3. WALL COMPOSED OF MANY DIFFERENT BRICK WALL SECTIONS. STEEL COLUMNS INSTALLED BEHIND THE EASTERN HALF OF THE WALL AT INTERVALS IN ORDER TO PROVIDE SUPPORT (0m TO 163m). NEWER SECTION OF WALL FROM 163m TO 257m. MALTINGS BUILDING SECTION OF WALL RUNS FROM 257m TO 318m. NEWER SECTION OF WALL RUNS FROM 318m TO 368m.

GENERAL NOTES

Rev	Date	Description	By
A01	14.12.16	ISSUED FOR INFORMATION	TLR

Amendments

Waterman

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Project
STAG BREWERY, MORTLAKE

Title
THAMES RIVER WALL
CONDITION SURVEY
DEFECT ELEVATION SKETCH
(SHEET 1 of 4)

Client
DARTMOUTH CAPITAL ADVISORS LTD

Drawing Status
PRELIMINARY

Designed by TLR	Checked by AAK	Project No WIE10667	
Drawn by TLR	Date DECEMBER 2016		
Scales @ A3 work to figured dimensions only 1:125		Computer File No WIE-10667-SA-04-1004.dwg	

Publisher	Zone	Category	Number	Revision
WIE	SA	04	1004	A01

A3L-Wat-S

B. Calculations

Calculations	Office: London		Project No: WIE10667
Job Title: Stag Brewery - Mortlake	Prepared by: VB	Date: 14/02/17	
Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

Loading

-Determine the load that results from the river rising to the flood defence level.

Existing Ground level	=	4.7	m
2100 Flood defence level	=	6.7	m
Height of water	=	2	m
Unit weight of water	=	10	kN/m3
Accidental load factor	=	1	
Applied pressure	=	20	kN/m2

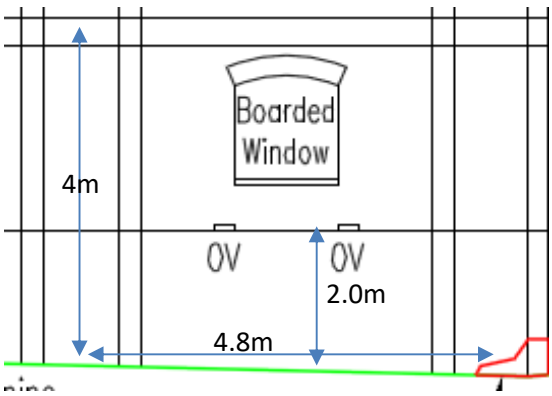
Wind pressure

The building is currently subject to wind pressures and these will be applied to the top section of the column that is not subject to water pressures.

Wind Pressure	=	0.9	kN/m2

Span arrangements

The architectural intent is to extend the windows on the bottom floor down to ground level.

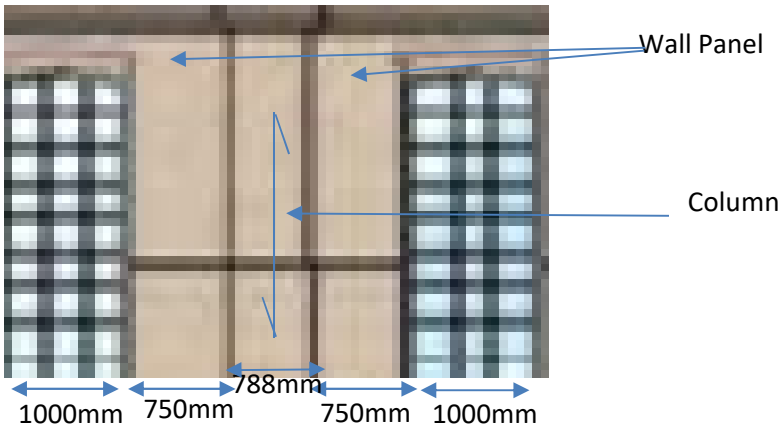


Calculations	Office: London		Project No: WIE10667
Job Title: Stag Brewery - Mortlake	Prepared by: VB	Date: 14/02/17	
Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

The wall panels and column section will be considered as one section with the load from the windows transferrred to the masonry. The combined section will then be considered to span between the ground and the first floor.

A fixed edge condition will be taken for the bottom of the wall and a free edge support condition will be taken for the top of the wall.

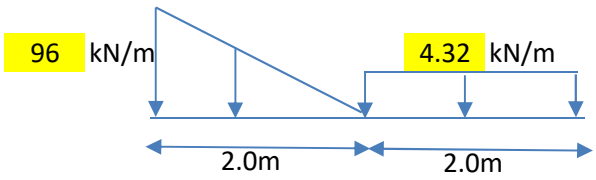
Dimensions:



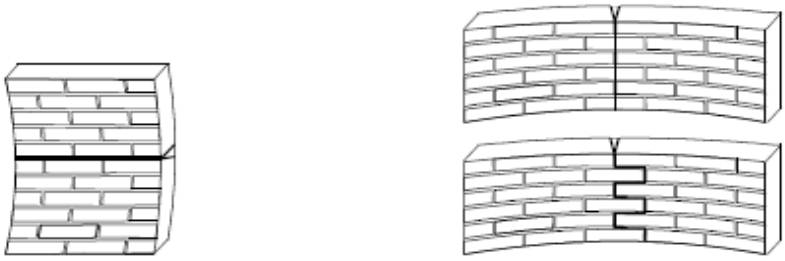
Distance Between Columns = 4800 mm

Loading Diagrams

Determine the total load applied to the column.



Planes of failure



a) plane of failure parallel to bed joints, f_{xk1} b) plane of failure perpendicular to bed joints, f_{xk2}

Calculations	Office: London		Project No: WIE10667
Job Title: Stag Brewery - Mortlake	Prepared by: VB	Date: 14/02/17	
Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

Analysis

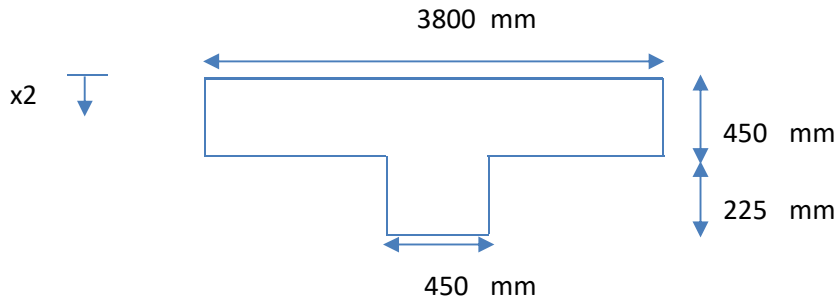
Column

The column spans between the ground and first floor. The bottom two metres is subject to a water pressure in a 2100 storm event.

An analysis model was created in Staad Pro V8i considering a column with a fixed and connection at foundation level and a pinned end connection at first floor level. A hydrostatic water pressure was applied to the bottom two metres of the column and a wind pressure was applied to the top 2m of the column.

M = 46 kNm
V = 94 kN

Section Dimensions



Determine section Z value

x2 = 244 mm
I = 4E+10 mm^4
Z = I/x2
Z = 2E+08 mm^3

Bending and shear stresss checks

Applied bending Stress = M/Z

Z = 2E+08 mm^3
Applied bending Stress = 0.2792 N/mm^2

The critical case for the column in this instance is bending parallel to the bed joint

Characteristic flexural strength of masonry, f_{xk1} = 0.5 N/mm^2
γ_m = 2.70
Capacity = fxk1/γm + σd (σd limited to 0.2fk/γm)

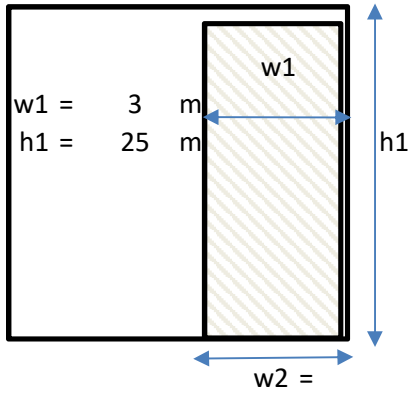
Determine limiting σ_d value:

$f_k = k f_b^{\alpha} f_m^{\beta}$ cl3.6.1.2 EN 1996-1-1:2005
k = 0.75
fb = 50 N/mm^2

Calculations	Office: London		Project No: WIE10667
Job Title: Stag Brewery - Mortlake	Prepared by: VB	Date: 14/02/17	
Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

fm =	4	N/mm^2
α =	0.7	
β =	0.3	
f_k =	17.58	N/mm^2
σ_d =	1.30	N/mm^2

Determine actual σ_d value:



Actual σ_d =	Force / Area	
Force =	Unit Weight x Cross section area x height	
Unit Weight =	22.5	kN/m3
Force =	1018.8	kN
Area =	Cross section Area	
Area =	1.8113	m^2
Actual σ_d =	0.56	N/mm^2
Capacity =	fxk1/γm + σd	
γ_m =	2.50	
Capacity =	0.7625	N/mm^2
FOS =	2.73	

Shear

- Check that the interface between the panel and the wall has sufficient shear capacity
- Checks in accordance with cl 3.6.2 of BS EN 1996-1-1

Applied force =	94.0	kN	
Stress =	0.21	N/mm^2	

Capacity: fvk = 0.5fvko + 0.4 σd $\leq$ 0.045fb

Table 3.4

fvko =	0.2	N/mm^2	(1)
0.045f_b =	2.25	N/mm^2	

Determine sd for panel section

Force =	Unit Weight x Cross section area x height	
Force =	424	kN
Cross section Area =	0.7538	m^2
Actual σ_d =	0.5625	N/mm^2
fvk = =	0.425	N/mm^2
FOS =	2.0	N/mm^2

Calculations	Office: London		Project No: WIE10667
Job Title: Stag Brewery - Mortlake	Prepared by: VB	Date: 14/02/17	
Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

Checks in accordance with BD 21/01

Since the structure would have been designed and constructed prior to the introduction of the Eurocodes an additional check will be carried out in accordance with BD 21/01.

Section 7.16 states that assesments are to be carried out in accordance with BS 5628.

Table 3 of BS 5628 presents the same values as Table NA.6 of BS EN 1996-1-1:2005 as such the same Characteristic flexural strength of masonry will be adopted.

Flexural strength

Characteristic flexural strength of masonry, f_{kx} = 0.5 N/mm^2

32.5.3 flexural resistance = $(f_{xk}/\gamma_m + g_d)$ N/mm^2

table 4 γ_m = 2.5

g_d = design vertical dead load per unit area

The design vertical load per unit area is equivalent to the EC6 σ_d calculation.

flexural strength = 0.76 N/mm^2

Characteristic shear strength

The characteristic shear strength of the masonry is determined in accordance with BS 5628 cl 21.1.1

fv = $f_{vk0} + 0.6g_a$ < 1.4 N/mm^2

cl 21.1.2 (c) f_{vk0} = 0.15 N/mm^2

g_a = design vertical load per unit area

The design vertical load per unit area is equivalent to the EC6 σ_d calculation.

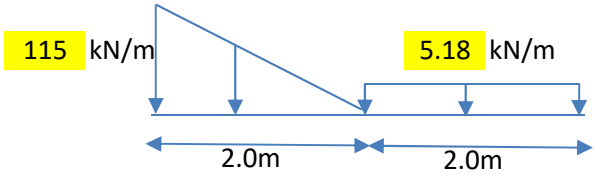
g_a = 0.56 N/mm^2

fv = 0.49 N/mm^2

Applied loads

In accordance with clause 18 of BS 5628 consider the applied loading to be be equal to 1.2Gk+1.2Qk+1.2Wk where Gk, Qk and Wk are equal to design dead, imposed and wind loads. For the raised flood level case the dead load is not applicable for assessing flexure and shear.

Loading Diagram



Calculations	Office: London		Project No: WIE10667
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Calculations Title: Maltings Building External Wall Assessment	Checked by:	Date:	

-Staad pro results:

M = 57 kNm
V = 115 kN

Capacity Checks

Bending:

Applied bending Stress = M/Z
Applied bending Stress = 0.35 N/mm^2
Capacity = 0.76 N/mm^2
FOS = 2.2

Shear:

Applied shear stress = Shear force / cross section
Applied shear stress = 0.26 N/mm^2
Capacity = 0.49 N/mm^2
FOS = 1.91

FOS Summary

	Bending	Shear
EC 6	2.7	2.0
BD 21/01	2.2	1.9

C. Column Analysis Model Input and Output

Job Information

	Engineer	Checked	Approved
Name:	VB		
Date:	24-APR-17		

Structure Type	SPACE FRAME

Number of Nodes	2	Highest Node	2
Number of Elements	1	Highest Beam	1

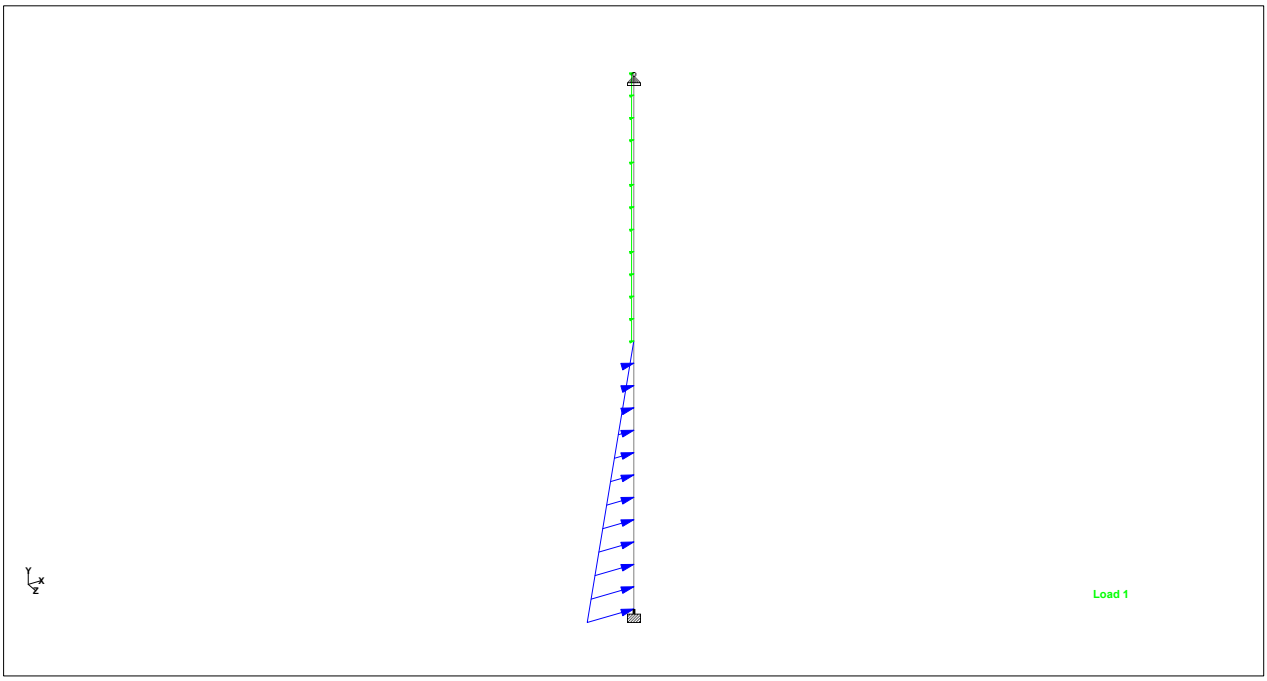
Number of Basic Load Cases	2
Number of Combination Load Cases	0

Included in this printout are data for:

All	The Whole Structure

Included in this printout are results for load cases:

Type	L/C	Name
Primary	1	LOAD CASE 1
Primary	2	LOAD CASE 2



Whole Structure (Input data was modified after picture taken)

Nodes

Node	X (m)	Y (m)	Z (m)
1	0.000	0.000	0.000
2	0.000	4.000	0.000

Beams

Beam	Node A	Node B	Length (m)	Property	β (degrees)
1	1	2	4.000	1	0

Supports

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN-m/deg)	rY (kN-m/deg)	rZ (kN-m/deg)
1	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
2	Fixed	Fixed	Fixed	-	-	-

Primary Load Cases

Number	Name	Type
1	LOAD CASE 1	None
2	LOAD CASE 2	None

Beam End Forces

Sign convention is as the action of the joint on the beam.

			Axial	Shear		Torsion	Bending	
Beam	Node	L/C	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
1	1	1:LOAD CASE	0.000	93.675	0.000	0.000	0.000	46.099
		2:LOAD CASE	0.000	115.081	0.000	0.000	0.000	56.589
	2	1:LOAD CASE	0.000	10.925	0.000	0.000	0.000	0.000
		2:LOAD CASE	0.000	13.319	0.000	0.000	0.000	0.000

Beam Maximum Moments

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max My (kNm)	d (m)	Max Mz (kNm)
1	1	4.000	1:LOAD CASE	Max +ve	0.000	0.000	0.000	46.099
				Max -ve	0.000	0.000	1.667	-13.729
			2:LOAD CASE	Max +ve	0.000	0.000	0.000	56.589
				Max -ve	0.000	0.000	1.667	-16.848

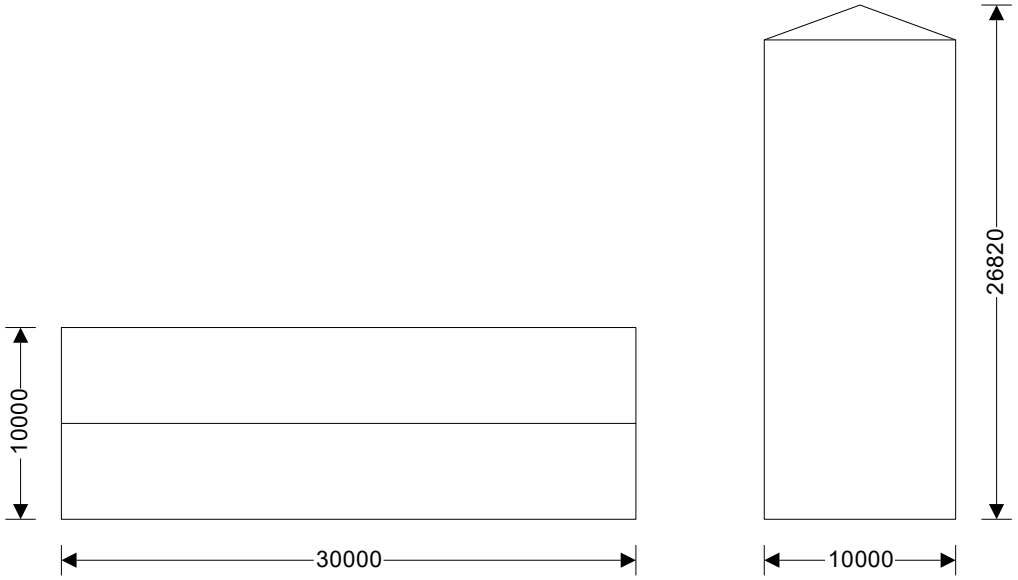
Beam Maximum Shear Forces

Distances to maxima are given from beam end A.

Beam	Node A	Length (m)	L/C		d (m)	Max Fz (kN)	d (m)	Max Fy (kN)
1	1	4.000	1:LOAD CASE	Max +ve	0.000	0.000	0.000	93.675
				Max -ve	0.000	0.000	4.000	-10.925
			2:LOAD CASE	Max +ve	0.000	0.000	0.000	115.081
				Max -ve	0.000	0.000	4.000	-13.319

WIND LOADING (EN1991-1-4)

TEDDS calculation version 3.0.16



Plan Elevation

Building data

Type of roof	Duopitch
Length of building	L = **30000** mm
Width of building	W = **10000** mm
Height to eaves	H = **25000** mm
Pitch of roof	α_0 = **20.0** deg
Total height	h = **26820** mm

Basic values

Location	London
Wind speed velocity (FigureNA.1)	$v_{b,map}$ = **21.4** m/s
Distance to shore	L_{shore} = **66.00** km
Altitude above sea level	A_{alt} = **8.0**m
Altitude factor	$c_{alt} = A_{alt} \times 0.001m^{-1} + 1$ = **1.008**
Fundamental basic wind velocity	$v_{b,0} = v_{b,map} \times c_{alt}$ = **21.6** m/s
Direction factor	c_{dir} = **1.00**
Season factor	c_{season} = **1.00**
Shape parameter K	K = **0.2**
Exponent n	n = **0.5**
Probability factor	$c_{prob} = [(1 - K \times \ln(-\ln(1-p)))/(1 - K \times \ln(-\ln(0.98)))]^n$ = **1.00**
Basic wind velocity (Exp. 4.1)	$v_b = c_{dir} \times c_{season} \times v_{b,0} \times c_{prob}$ = **21.6** m/s
Reference mean velocity pressure	$q_b = 0.5 \times \rho \times v_b^2$ = **0.285** kN/m^2

Orography

Orography factor not significant	c_o = 1.0
Terrain category	Town
Displacement height (sheltering effect excluded)	h_{dis} = 0mm

The velocity pressure for the windward face of the building with a 0 degree wind is to be considered as 1 part as the height h is less than b (cl.7.2.2)

Peak velocity pressure - windward wall - Wind 0 deg

Reference height (at which q is sought)	z = **25000**mm
Displacement height (sheltering effects excluded)	h_{dis} = **0** mm
Exposure factor (Figure NA.7)	c_e = **2.96**
Exposure correction factor (Figure NA.8)	$c_{e,T}$ = **1.00**
Peak velocity pressure	$q_p = c_e \times c_{e,T} \times q_b$ = **0.84** kN/m^2

Structural factor

Structural damping	δ_s = **0.100**
Height of element	h_{part} = **25000** mm
Size factor (Table NA.3)	c_s = **0.892**
Dynamic factor (Figure NA.9)	c_d = **1.000**
Structural factor	$c_{sCd} = c_s \times c_d$ = **0.892**

Peak velocity pressure - roof

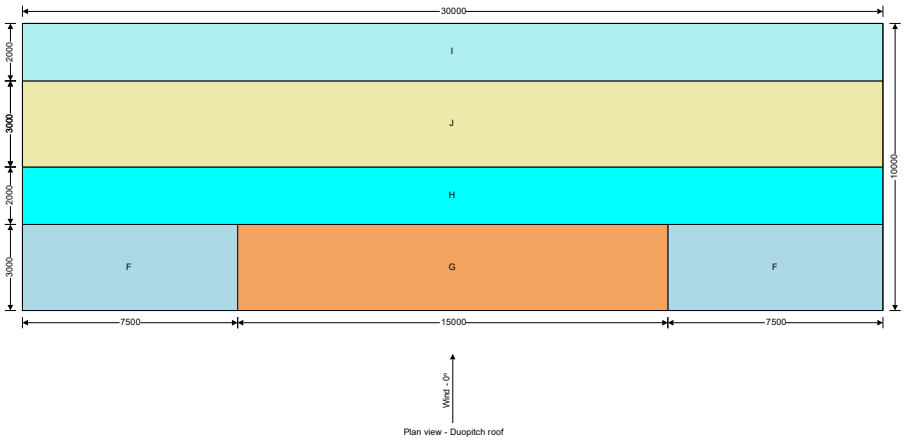
Reference height (at which q is sought)	z = **26820**mm
Displacement height (sheltering effects excluded)	h_{dis} = **0** mm
Exposure factor (Figure NA.7)	c_e = **3.01**
Exposure correction factor (Figure NA.8)	$c_{e,T}$ = **1.00**
Peak velocity pressure	$q_p = c_e \times c_{e,T} \times q_b$ = **0.86** kN/m^2

Structural factor - roof 0 deg

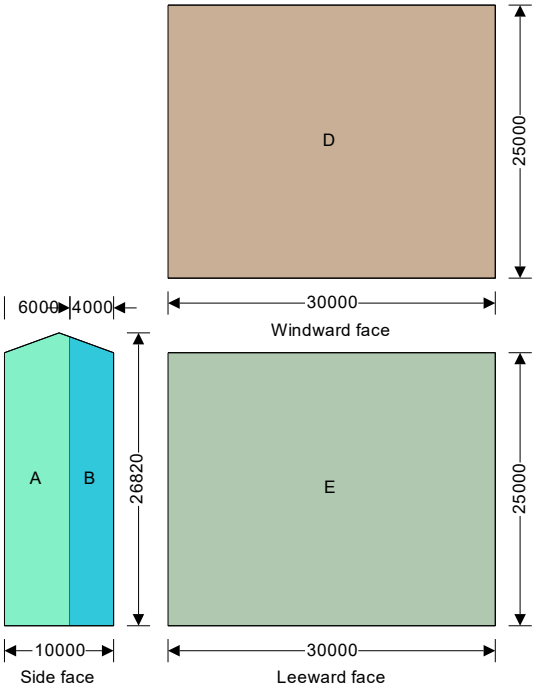
Structural damping	δ_s = **0.100**
Height of element	h_{part} = **26820** mm
Size factor (Table NA.3)	c_s = **0.893**
Dynamic factor (Figure NA.9)	c_d = **1.000**
Structural factor	$c_{sCd} = c_s \times c_d$ = **0.893**

Peak velocity pressure for internal pressure

Peak velocity pressure – internal (as roof press.)	$q_{p,i}$ = **0.86** kN/m^2



Plan view - Duopitch roof


D
25000
6000
4000
30000
Windward face
A
B
26820
E
25000
10000
Side face
30000
Leeward face

UK and Ireland Office Locations