



RETAINING WALL ANALYSIS

McDonald's Barnsley Upper New Street (NB8543)

Prepared for: McDonald's Restaurants Ltd
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Document History

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1	04 Jul. 18			

Glanville

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Introduction

This document is intended to outline the proposed approach to maintaining the stability of the retaining structures that are in place along the boundaries of the proposed McDonalds unit at Upper New Street, Barnsley.

There are two distinct types of retaining system in place at present. The older part of the building exhibits a reinforced blockwork construction spanning between the steel frame of the superstructure itself.

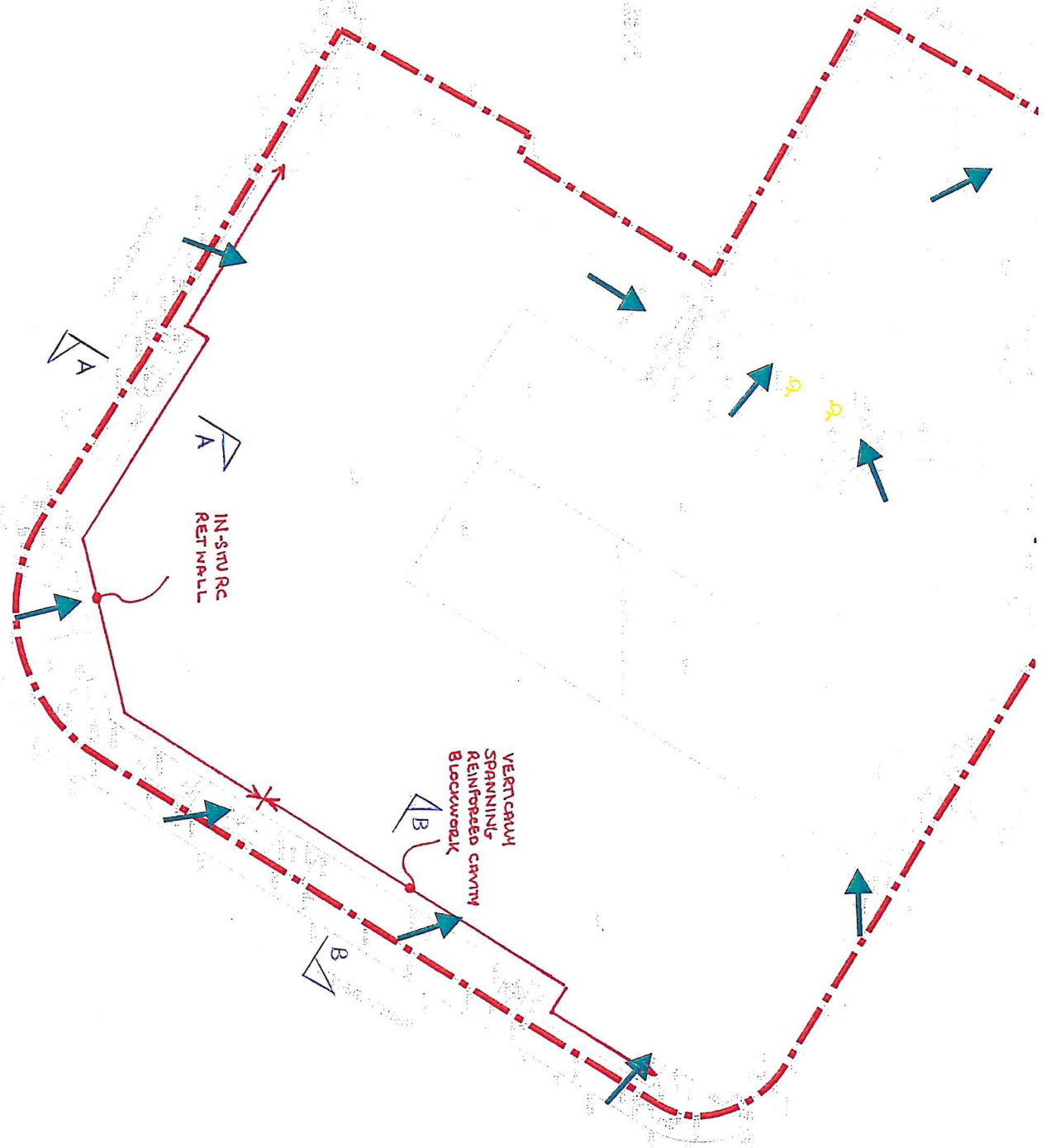
The newer portion of building is defined by an in-situ reinforced concrete wall.

The proposals involve the installation of a waling and raking prop system to stabilise each wall type, in order to maintain structural integrity during demolition of the superstructure of the main shell.

This propping system will remain in place for the permanent phase and be supplemented with further structure.

In the case of the blockwork wall we will install a secondary precast wall in front of the existing in order to relieve the pressure on the existing system. In the case of the RC wall we are implementing a mass concrete ballast system to increase the dead load of the system to enable the wall to act as a gravity wall.

The approaches are shown on the below sketches with the positions indicated on the key plan.



Calculations

Job Title: McDi's BARNISLEY

Job Title:

Date:

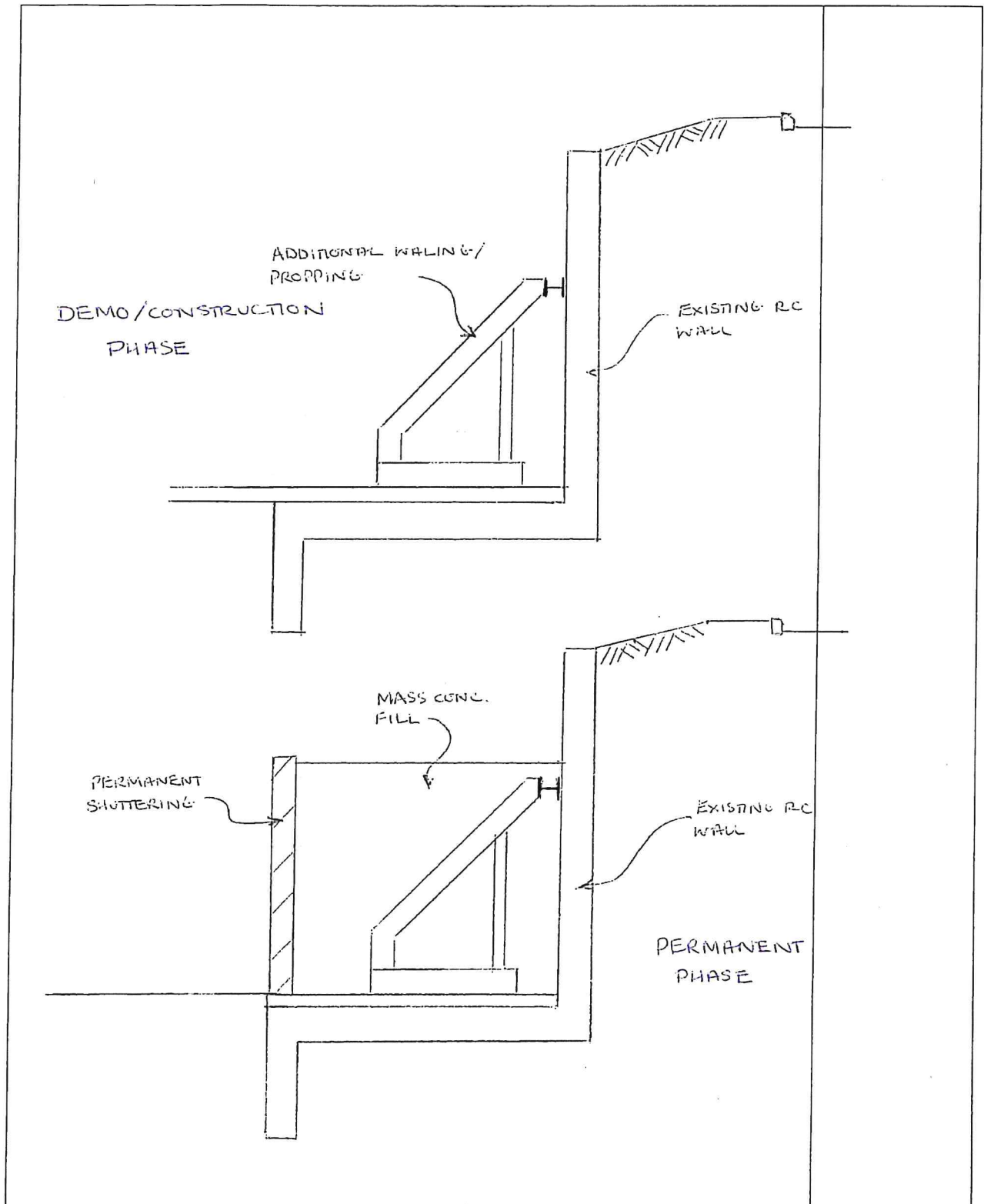
Member/Location: SECTION A-A

Sheet No:

Engineer:

Checked/Approved:

Revision:

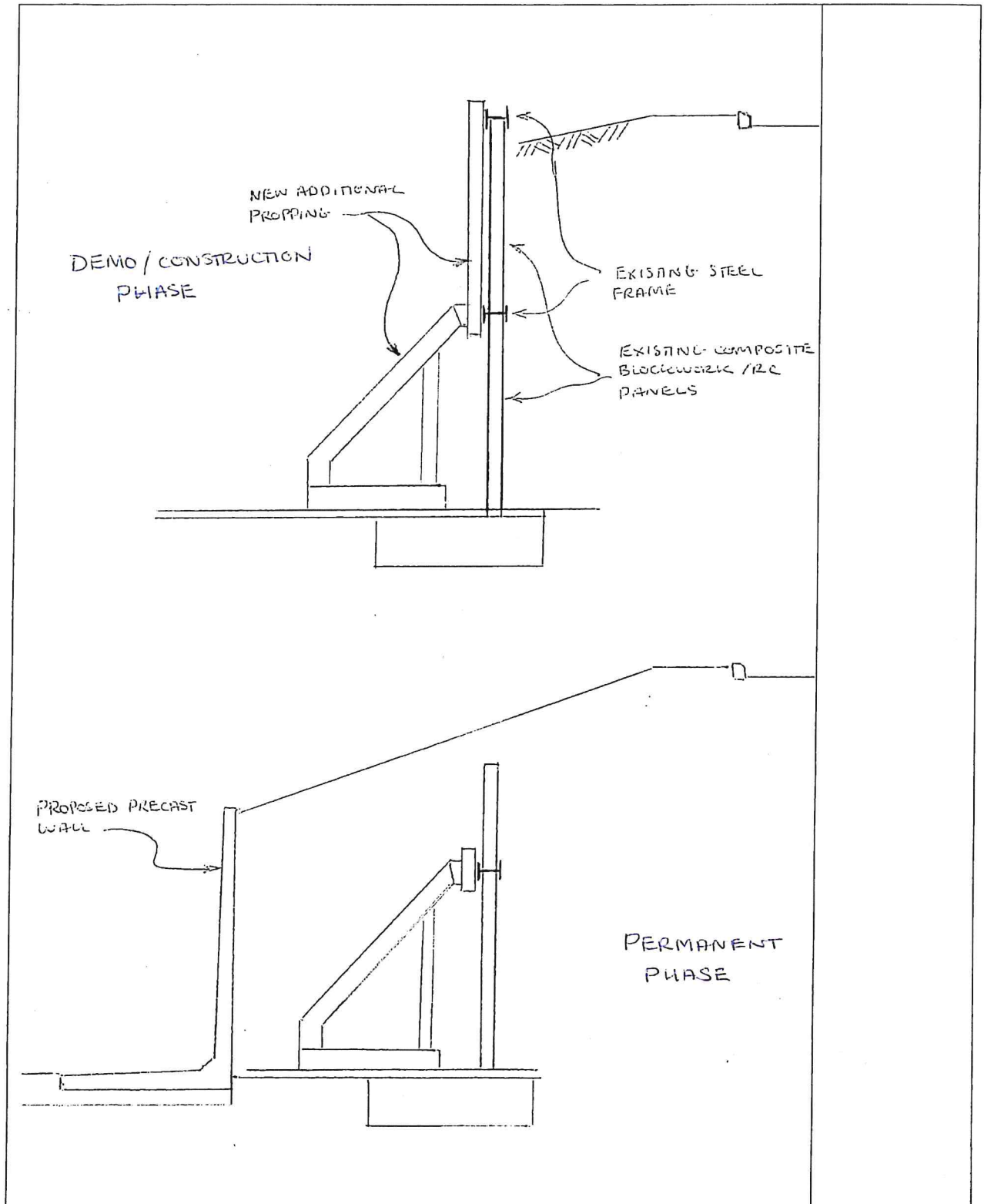


Calculations

Job Title: Job Title: Date:

Member/Location: Sheet No:

Engineer: Checked/Approved: Revision:



Job Title: UNS - BARNSELEY

Job Title: 4160891

Date: JUNE '18

Member/Location: ANALYSIS OF BLOCKWORK/STEEL RETAINING SYSTEM

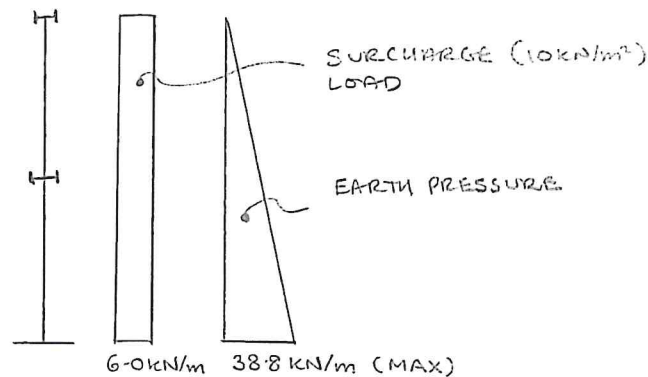
Sheet No:

Engineer: DB

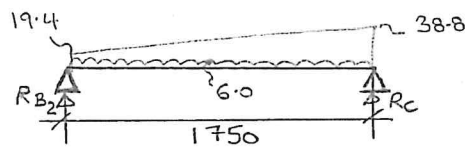
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Revision:

LOADING ANALYSIS FOR REINFORCED CAVITY WALL
3.6m RETAINED MATERIAL



ISOLATE BOTTOM PANEL

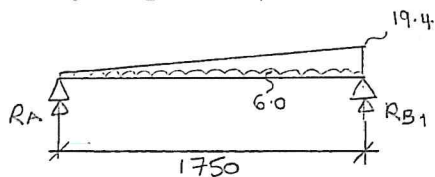


$$M = 18.9 \text{ kNm [UDL]}$$

$$R_{B2} = 5.25 + 22.6 = 27.85 \text{ kN (SLS)}, 39.0 \text{ kN [ULS]}$$

$$R_C = 5.25 + 28.3 = 33.6 \text{ kN (SLS)}, 47.0 \text{ kN [ULS]}$$

ISOLATE TOP PANEL



$$M = 8.54 \text{ kNm [UDL]}$$

$$R_A = 10.9 \text{ kN (SLS)}, 15.3 \text{ kN [ULS]}$$

$$R_{B1} = 23.2 \text{ kN [ULS]}$$

REACTIONS SUMMARY (LOADING TO HORIZONTAL SUPPORTS)

$$R_A = 15.3 \text{ kN/m [ULS]}$$

$$R_B = 39 + 23.2 = 62.2 \text{ kN/m [ULS]}$$

$$R_C = 47 \text{ kN/m [ULS]}$$

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Date:

Sheet No:

Revision:

$$R_B = 206 \text{ kN} \quad [\text{ULS}]$$

SHEAR CAPACITY = 241 kN > 103 kN $\therefore$ OK

$$R_A = R_B = 40.5 \text{ kN} \quad [\text{ULS}]$$

BASED ON 203 UC 46 BEAM OK (LESS ONEROUS THAN ABOVE)

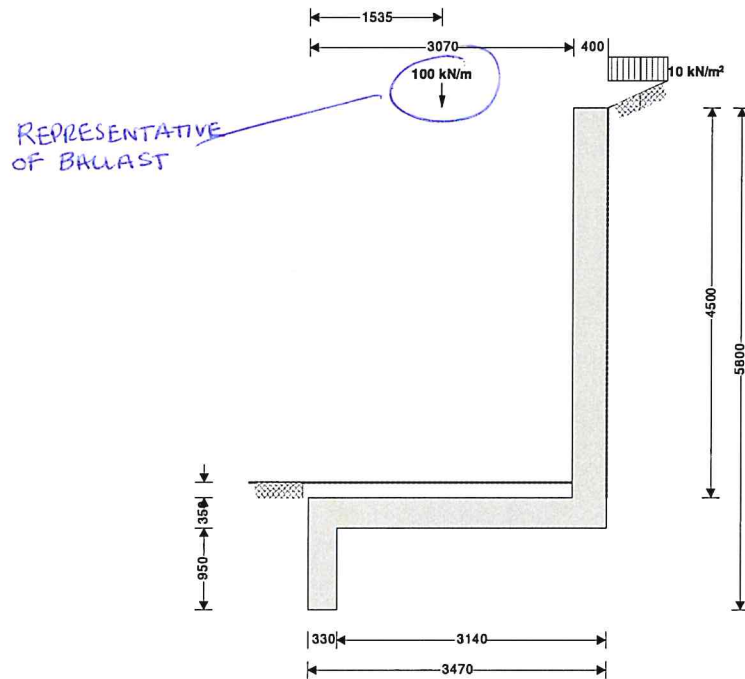
MAX APPLIED SHEAR FORCE = 233.6 kN [ULS]
CAPACITY = 360.6 kN ∴ OK

ALL SECTIONS BASED ON SITE OBSERVATIONS.

Project McDonalds - Upper New Street, Barnsley				Job no. 4160891	
Calcs for Additional Stability Measures to Existing RC Wall				Start page no./Revision 1	
Calcs by DB	Calcs date 15/06/2018	Checked by	Checked date	Approved by	Approved date

RETAINING WALL ANALYSIS (BS 8002:1994)

TEDDS calculation version 1.2.01.06



Wall details

- Retaining wall type
- Height of retaining wall stem
- Thickness of wall stem
- Length of toe
- Length of heel
- Overall length of base
- Thickness of base
- Depth of downstand
- Position of downstand
- Thickness of downstand
- Height of retaining wall
- Depth of cover in front of wall
- Depth of unplanned excavation
- Height of ground water behind wall
- Height of saturated fill above base
- Density of wall construction
- Density of base construction
- Angle of rear face of wall
- Angle of soil surface behind wall
- Effective height at virtual back of wall

Retained material details

Mobilisation factor

Moist density of retained material

Unpropped cantilever

$$\begin{aligned}h_{\text{stem}} &= 4500 \text{ mm} \\t_{\text{wall}} &= 400 \text{ mm} \\l_{\text{toe}} &= 3070 \text{ mm} \\l_{\text{heel}} &= 0 \text{ mm} \\l_{\text{base}} &= l_{\text{toe}} + l_{\text{heel}} + t_{\text{wall}} = 3470 \text{ mm} \\t_{\text{base}} &= 350 \text{ mm} \\d_{\text{ds}} &= 950 \text{ mm} \\l_{\text{ds}} &= 0 \text{ mm} \\t_{\text{ds}} &= 330 \text{ mm} \\h_{\text{wall}} &= h_{\text{stem}} + t_{\text{base}} + d_{\text{ds}} = 5800 \text{ mm} \\d_{\text{cover}} &= 175 \text{ mm} \\d_{\text{exc}} &= 0 \text{ mm} \\h_{\text{water}} &= 0 \text{ mm} \\h_{\text{sat}} &= \max(h_{\text{water}} - t_{\text{base}} - d_{\text{ds}}, 0 \text{ mm}) = 0 \text{ mm} \\\gamma_{\text{wall}} &= 23.6 \text{ kN/m}^3 \\\gamma_{\text{base}} &= 23.6 \text{ kN/m}^3 \\\alpha &= 90.0 \text{ deg} \\\beta &= 24.0 \text{ deg} \\h_{\text{eff}} &= h_{\text{wall}} + l_{\text{heel}} \times \tan(\beta) = 5800 \text{ mm}\end{aligned}$$

$M = 1.5$
 $\gamma_m = 16.0 \text{ kN/m}^3$

	Project McDonalds - Upper New Street, Barnsley		Job no. 4160891	
	Calcs for Additional Stability Measures to Existing RC Wall		Start page no./Revision 2	
	Calcs by DB	Calcs date 15/06/2018	Checked by	Checked date
			Approved by	Approved date

Saturated density of retained material

$$\gamma_s = 18.0 \text{ kN/m}^3$$

Design shear strength

$$\phi' = 33.0 \text{ deg}$$

Angle of wall friction

$$\delta = 24.2 \text{ deg}$$

Base material details

Stiff clay

Moist density

$$\gamma_{mb} = 18.0 \text{ kN/m}^3$$

Design shear strength

$$\phi'_b = 28.0 \text{ deg}$$

Design base friction

$$\delta_b = 22.0 \text{ deg}$$

Allowable bearing pressure

$$P_{\text{bearing}} = 200 \text{ kN/m}^2$$

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(\alpha + \phi')^2 / (\sin(\alpha)^2 \times \sin(\alpha - \delta) \times [1 + \sqrt{(\sin(\phi' + \delta) \times \sin(\phi' - \beta) / (\sin(\alpha - \delta) \times \sin(\alpha + \beta)))}]^2) = 0.395$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - \phi'_b)^2 / (\sin(90 - \delta_b) \times [1 - \sqrt{(\sin(\phi'_b + \delta_b) \times \sin(\phi'_b) / (\sin(90 + \delta_b)))}]^2) = 5.910$$

At-rest pressure

At-rest pressure for retained material

$$K_0 = 1 - \sin(\phi') = 0.455$$

Loading details

Surcharge load on plan

$$\text{Surcharge} = 10.0 \text{ kN/m}^2$$

Applied vertical dead load on wall

$$W_{\text{dead}} = 100.0 \text{ kN/m}$$

Applied vertical live load on wall

$$W_{\text{live}} = 0.0 \text{ kN/m}$$

Position of applied vertical load on wall

$$l_{\text{load}} = 1535 \text{ mm}$$

Applied horizontal dead load on wall

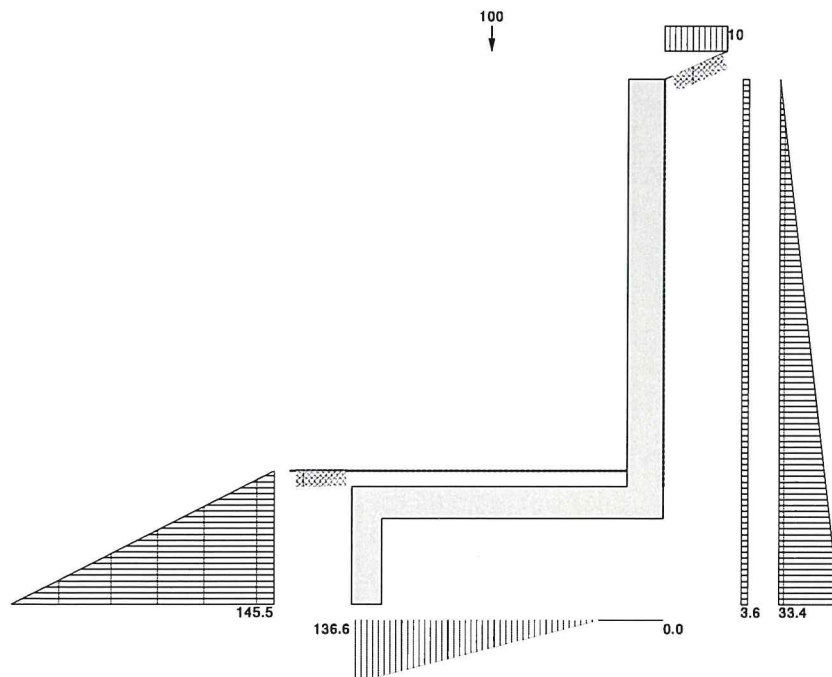
$$F_{\text{dead}} = 0.0 \text{ kN/m}$$

Applied horizontal live load on wall

$$F_{\text{live}} = 0.0 \text{ kN/m}$$

Height of applied horizontal load on wall

$$h_{\text{load}} = 0 \text{ mm}$$



Loads shown in kN/m, pressures shown in kN/m²

Project McDonalds - Upper New Street, Barnsley			Job no. 4160891		
Calcs for Additional Stability Measures to Existing RC Wall			Start page no./Revision 3		
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Vertical forces on wall

Wall stem	$W_{wall} = h_{stem} \times t_{wall} \times \gamma_{wall} = 42.5 \text{ kN/m}$
Wall base	$W_{base} = l_{base} \times t_{base} \times \gamma_{base} = 28.7 \text{ kN/m}$
Wall downstand	$W_{ds} = d_{ds} \times t_{ds} \times \gamma_{base} = 7.4 \text{ kN/m}$
Soil in front of wall	$W_p = l_{toe} \times d_{cover} \times \gamma_{mb} = 9.7 \text{ kN/m}$
Applied vertical load	$W_v = W_{dead} + W_{live} = 100 \text{ kN/m}$
Total vertical load	$W_{total} = W_{wall} + W_{base} + W_{ds} + W_p + W_v = 188.2 \text{ kN/m}$

Horizontal forces on wall

Surcharge	$F_{sur} = K_a \times \cos(90 - \alpha + \delta) \times \text{Surcharge} \times h_{eff} = 20.9 \text{ kN/m}$
Moist backfill above water table	$F_{m_a} = 0.5 \times K_a \times \cos(90 - \alpha + \delta) \times \gamma_m \times (h_{eff} - h_{water})^2 = 97 \text{ kN/m}$
Total horizontal load	$F_{total} = F_{sur} + F_{m_a} = 117.9 \text{ kN/m}$

Calculate stability against sliding

Passive resistance of soil in front of wall	$F_p = 0.5 \times K_p \times \cos(\delta_b) \times (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \times \gamma_{mb} = 107.3 \text{ kN/m}$
Resistance to sliding	$F_{res} = F_p + W_{total} \times \tan(\delta_b) = 183.3 \text{ kN/m}$

PASS - Resistance force is greater than sliding force

Overturning moments

Surcharge	$M_{sur} = F_{sur} \times (h_{eff} - 2 \times d_{ds}) / 2 = 40.7 \text{ kNm/m}$
Moist backfill above water table	$M_{m_a} = F_{m_a} \times (h_{eff} + 2 \times h_{water} - 3 \times d_{ds}) / 3 = 95.3 \text{ kNm/m}$
Soil in front of wall	$M_{p_o} = F_p \times [2 \times d_{ds} - t_{base} - d_{cover} + d_{exc}] / 3 = 49.2 \text{ kNm/m}$
Total overturning moment	$M_{ot} = M_{sur} + M_{m_a} + M_{p_o} = 185.3 \text{ kNm/m}$

Restoring moments

Wall stem	$M_{wall} = W_{wall} \times (l_{toe} + t_{wall} / 2) = 138.9 \text{ kNm/m}$
Wall base	$M_{base} = W_{base} \times l_{base} / 2 = 49.7 \text{ kNm/m}$
Wall downstand	$M_{ds} = W_{ds} \times (l_{ds} + t_{ds} / 2) = 1.2 \text{ kNm/m}$
Soil in front of wall	$M_{p_r} = W_p \times l_{toe} / 2 = 14.8 \text{ kNm/m}$
Design vertical load	$M_v = W_v \times l_{load} = 153.5 \text{ kNm/m}$
Total restoring moment	$M_{rest} = M_{wall} + M_{base} + M_{ds} + M_{p_r} + M_v = 358.2 \text{ kNm/m}$

Check stability against overturning

Total overturning moment	$M_{ot} = 185.3 \text{ kNm/m}$
Total restoring moment	$M_{rest} = 358.2 \text{ kNm/m}$

PASS - Restoring moment is greater than overturning moment

Check bearing pressure

Total moment for bearing	$M_{total} = M_{rest} - M_{ot} = 172.9 \text{ kNm/m}$
Total vertical reaction	$R = W_{total} = 188.2 \text{ kN/m}$
Distance to reaction	$x_{bar} = M_{total} / R = 919 \text{ mm}$
Eccentricity of reaction	$e = \text{abs}((l_{base} / 2) - x_{bar}) = 816 \text{ mm}$

Reaction acts outside middle third of base

Bearing pressure at toe	$p_{toe} = R / (1.5 \times x_{bar}) = 136.6 \text{ kN/m}^2$
Bearing pressure at heel	$p_{heel} = 0 \text{ kN/m}^2 = 0 \text{ kN/m}^2$

PASS - Maximum bearing pressure is less than allowable bearing pressure



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