POUNDFIELD PRODUCTS LTD

CASE STUDY: SHUTTABLOC INSTALLATION

LOCATION: STAPLES VEGETABLES LTD, WRANGLE

TABLE OF CONTENTS

INTRODUCTION

Shuttablocs are reinforced hollow wall sections which are placed together, sealed and then filled with concrete on site to form a retaining wall with the same properties as a wall which has been cast *in situ*.

The benefits of the Shuttabloc include:

- No on site formwork
- Faster installation
- No concrete finishing on site

Anchors are fixed into the two sides to connect them both to the inner core when poured with concrete. These anchor points then act as supports for the horizontal reinforcing which is placed inside to form a continuous wall when filled on site with concrete.

Both ends of the units have semi-circular rebates to form a continuous vertical joint on site and seal the wall.

In September 2009, Poundfield Products Limited were approached by Staples Vegetables to create the best option for a boundary wall on a new anaerobic digestion plant.

Staples Vegetables are one of the largest independent producers of brassicas in the UK, with multiple sites across Lincolnshire and the Isle of Wight.

They subsequently placed an order for 360m of Shuttabloc wall sections.

The design criteria for the wall involved providing a unit which could have loading plant driven to the full height. It was also necessary to allow for some accidental striking of the wall by loading plant. Added to the onerous loading criteria, the ground conditions were poor and so additional loading details were required.

Foundation Details for Shuttabloc Wall

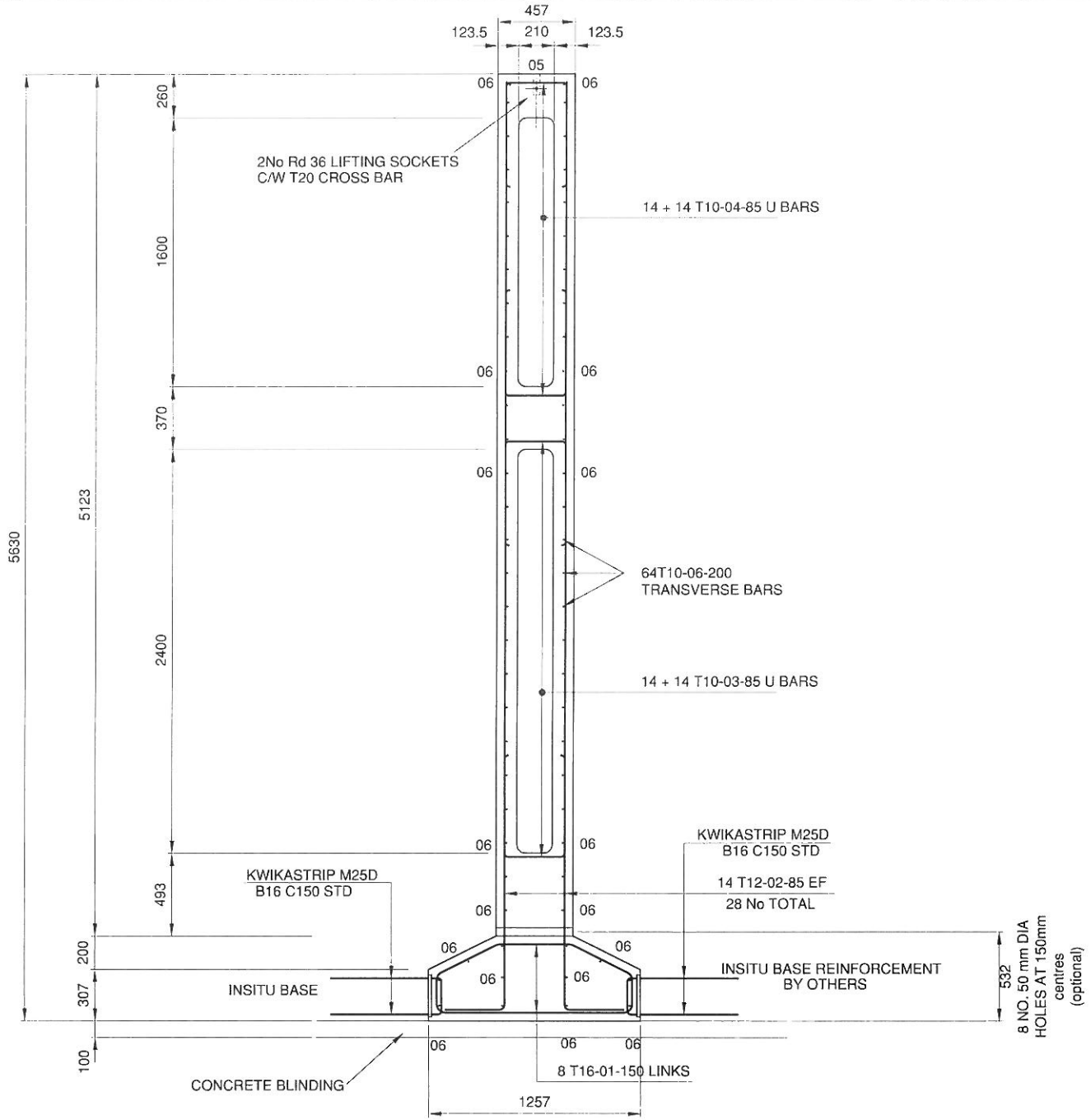
The Staples Vegetables site at Wrangle is in the heart of the Fens and ground conditions were poor.

The foundation detail specified was for 200mm of compacted Type 1 fill topped with a 100mm thick layer of semi-dry lean mix concrete.

(see over page for drawing)

The units are then placed onto the above and shimmed.

A3



SECTION THROUGH 5m HIGH WALL – 1220mm LONG

NOTES.

1. CONCRETE GRADE TO BE C40/C50
2. MINIMUM COVER TO REINFORCEMENT 50mm.
3. UNITS DESIGNED TO HAVE INTERNAL VOIDS FULLY GROUTED WITH CONCRETE PRIOR TO BACKFILLING.
4. UNITS DESIGNED TO BE BACKFILLED LEVEL WITH TOPS WITH FREE DRAINING GRANULAR MATERIAL. AN ADDITIONAL SURCHARGE LOAD OF 10 KN/M2 HAS BEEN ALLOWED FOR IN THE DESIGN.
5. CONNECTION WITH INSITU BASE TO BE DESIGNED/CHECKED BY PROJECT ENGINEER TO ENSURE OVERTURNING, SLIDING AND BEARING CRITERIA ARE MET.
6. UNITS NOT TO BE ERECTED IN WINDY CONDITIONS.

Rev.	Date	Amendments	By	Chk. by
B	Jan 2010	Geometry Ammd	DJE	
A	Oct 09	Holes added	DJE	

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Client: POUNDFIELD PRODUCTS

Project: SHUTTABLOC WALLS

Drawing Title: 5.63m Shuttabloc Wall Unit

	Drawn	Checked
Init.	REY	
Date	Oct 09	

Status: Construction

Scale: 1:25

Project No.: 09-001

Drawing No.: 01

Revision: B

File Path:

Reinforcing

The Shuttabloc units have Halfen Kwikastrip® bars cast in at the point of manufacture.

These bars are folded out on site to provide a connection to the in-situ concrete slab.

Bars are connected on site to the Kwikastrip®.

Due to ground conditions the perimeter walls (as they had no slab behind) were detailed with longer reinforcement bars.

Horizontal Reinforcing

Steel end shutters and corner shutters are fitted prior to filling with concrete.

Filling with concrete on site

Firstly, the foundation steel is poured to give the unit stability for fixing.

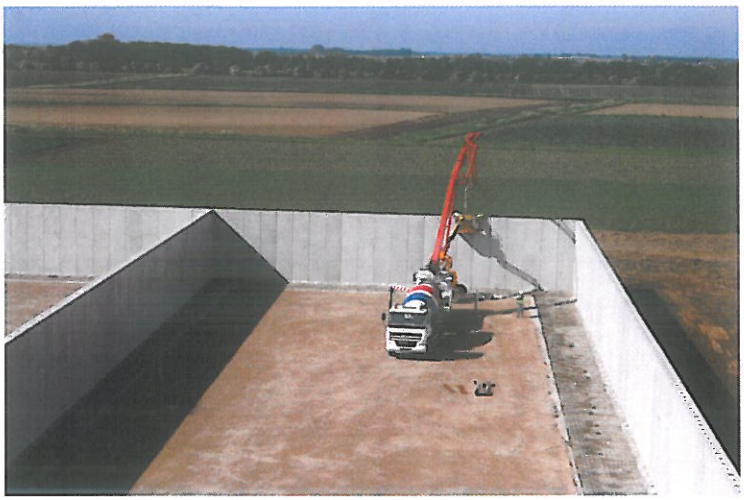
The units are then filled using a concrete pump.

Summary

The 360 metres of precast Shuttabloc units were placed in 10 working days.

An average of 20 x 1.22m long units per day = approximately 36 metre run per day.

From start to finish, the whole works were completed in 36 working days.



Date.	By	Checked	Sheet Ref.
Oct 09	DJE		001

Project.	Project Ref.
AD Plant, Wrangle	09/0001

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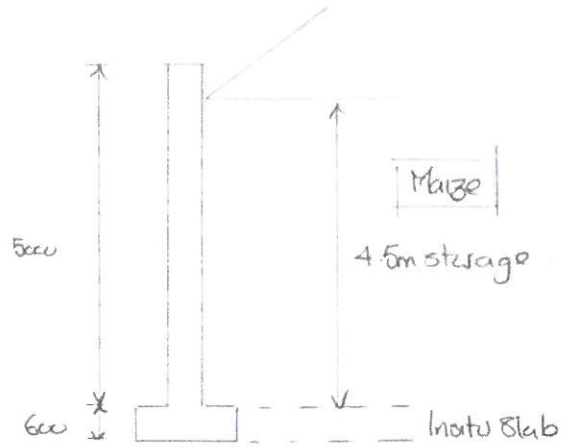
5m High Delta Wall, AD Plant, Wrangle.

References : Roundfield E-mail dated 15 Oct 09
BS 8110 - Structural Use of Concrete
BS 5502. Pt 22 - Buildings & Structures for Agriculture

Loadings :

Maize :
density = 750 kg/m³
ϕ = 30°.

either surcharged or with BT loading vehicle.



Stem design.

$\gamma = 7.4 kN/m^3$
$K_a = 0.75$

BM(ULS) surcharged grain = $1.4 (0.75 \times 7.4) 4.5^3/6$
= 118.0 kNm/m

$K_a = 0.33$

BM(ULS) Level grain + vehicle = $1.4 (0.33 \times 7.4) 4.5^3/6$
$+ 1.4 (4.0)(4.5 - 0.6)$ *
= 73.8 kNm/m

* 2 x 4.0 kN load acting 0.6m below surface.
BS 5502. Pt 22 Cl 15.6.3.

∴ Max BM(ULS) = 118.0 < 240.8 kNm/m Capacity of 5m Delta Wall Stem
(See Standard Calcs - Sheet 001)

∴ Stem Satisfactory.

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Oct 09	DJE		002

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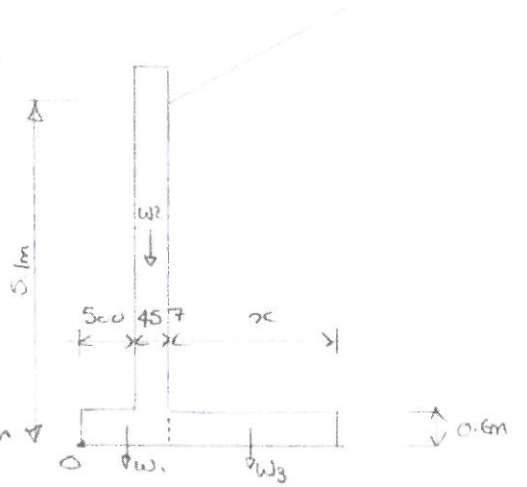
Check overturning

Assume FoS against overturning of 1.5.



OTM $= (0.75 \times 7.4)5.1\frac{3}{6} = 122.7$ kNm/m

W_1 base $= 0.957 \times 0.6 \times 25 = 14.36$ kN/m

W_2 Stem $= 0.457 \times 5.0 \times 25 = 57.1$ kN/m

W_3 base + Fill* $= (7.4 \times 4.5 + 0.6 \times 25)x = 48.3x$ kN/m

* ignore surcharged load (conservative).

Taking moments about O.

$$122.7 \times 1.5 = 14.36 \times \frac{0.957}{2} + 57.1 \times 0.73 + 48.3x\left(0.957 + \frac{x}{2}\right)$$

$$184.0 = 6.9 + 41.7 + 46.2x + 24.2x^2$$

$$\therefore 24.2x^2 + 46.2x - 135.4 = 0$$

$$\therefore x = \frac{-46.2 \pm \sqrt{46.2^2 - 4 \times 24.2(-135.4)}}{2 \times 24.2}$$

$$= \frac{-46.2 + 123.4}{48.4} = 1.591$$

$\therefore$ Overall base length $= 500 + 457 + 1591$

$= 2547$mm say 2600mm

$\therefore$ Provide 2600mm long base

Check Bearing Pressure

				eccen.	R Mnt
Base	:	$0.6 \times 2.6 \times 25$	= 39.0	1.3	50.7
Stem	:	$0.457 \times 5.0 \times 25$	= 57.1	0.73	41.7
Fill	:	$1.6 \times 4.5 \times 7.4$	= 53.3	1.76	93.8
Surcharge	:	$\frac{1.6(\tan 30° 1.6) \times 7.4}{2}$	= 5.5	2.02	11.1
			154.9 kN/m		197.3 kNm/m

Date	By	Checked	Sheet Ref.
Oct 09	b/e		003

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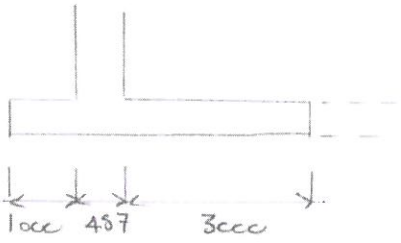
$\therefore \quad 154.9\bar{x} = 197.3 - \left(0.75 \times 7.4 \times \frac{4.5^3}{6}\right)$

$\bar{x} = \frac{113.0}{154.9} = 0.73m$ outside middle 1/3.

$\therefore$ Max Ground Bearing Pressure $= \frac{2 \times 154.9}{3 \times 0.73} = 141.5 kN/m^2$

$> 75 kN/m^2$ allowable.

$\therefore$ Increase effective base size thus:-



Base	:	$4.457 \times 0.6 \times 25$	= 66.8	2.23	149.0
Stem	:	$0.457 \times 5.0 \times 25$	= 57.1	1.23	70.2
Fill	:	$3.0 \times 4.5 \times 7.4$	= 100.0	3.0	300.0
Surcharge	:	$3.0 \times \tan\frac{30°}{2} \times 3.0 \times 7.4$	= 19.2	2.9	55.7
			243.1 kN/m		574.9 kN/m

$\therefore \quad 243.1\bar{x} = 574.9 - \left(0.75 \times 7.4 \times \frac{4.5^3}{6}\right)$

$\bar{x} = \frac{490.6}{243.1} = 2.02$ (within middle 1/3)

$\therefore$ ecc $= \frac{4.457}{2} - 2.02 = 0.21m.$

$\therefore$ Max BP $= \frac{243.1}{4.457}\left(1 + \frac{6 \times 0.21}{4.457}\right)$

$= 69.9 kN/m^2 < 75.0 kN/m^2$ acceptable

$\therefore$ Provide 1.0m toe & 3.0m heel

(4.457m O/A)

Date.	By	Checked	Sheet Ref.
Oct 09	DJE		004

Project.	Project Ref.
AD Plant, Wrangle	09/001

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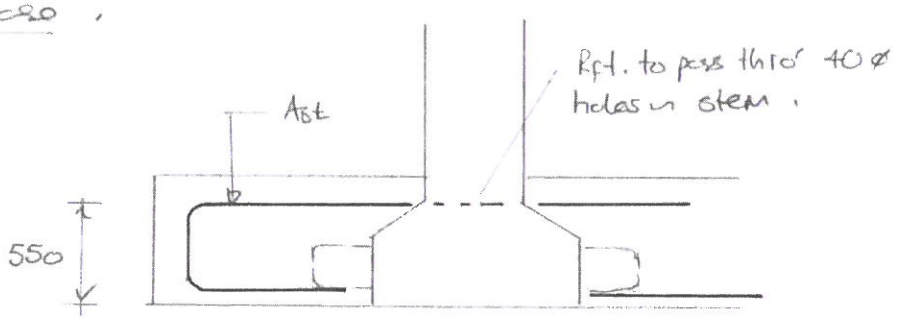
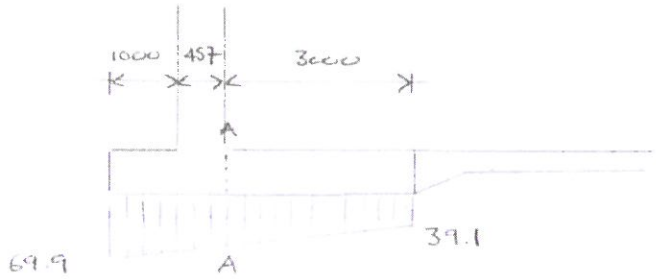
Check Rft in base.





Take Mnt about A-A

$BM(ULS) = 1.4\left(7.4\times3.0\times4.5\times\frac{3.0}{2} + 25\times0.6\times\frac{3.0^2}{6} + \frac{3.0\times\tan30^\circ\times3.0\times7.4\times2.0}{2}\right)$

$= 358 kNm/m$

For $d = 550$ $\quad f_{cu} = 40 N/mm^2$

$K = 358\times10^6/1000\times550^2\times40 = 0.029$ $\quad \therefore z = 0.95d = 522mm$

$A_s^{req} = 358\times10^6/0.95\times460\times522 = 1569 mm^2/m$

$\therefore$ Provide T20 @150 c/s

$(A_s = 2198 mm^2/m)$

Date.	By	Checked	Sheet Ref.
Oct 09	D/E		005

Project.	Project Ref.
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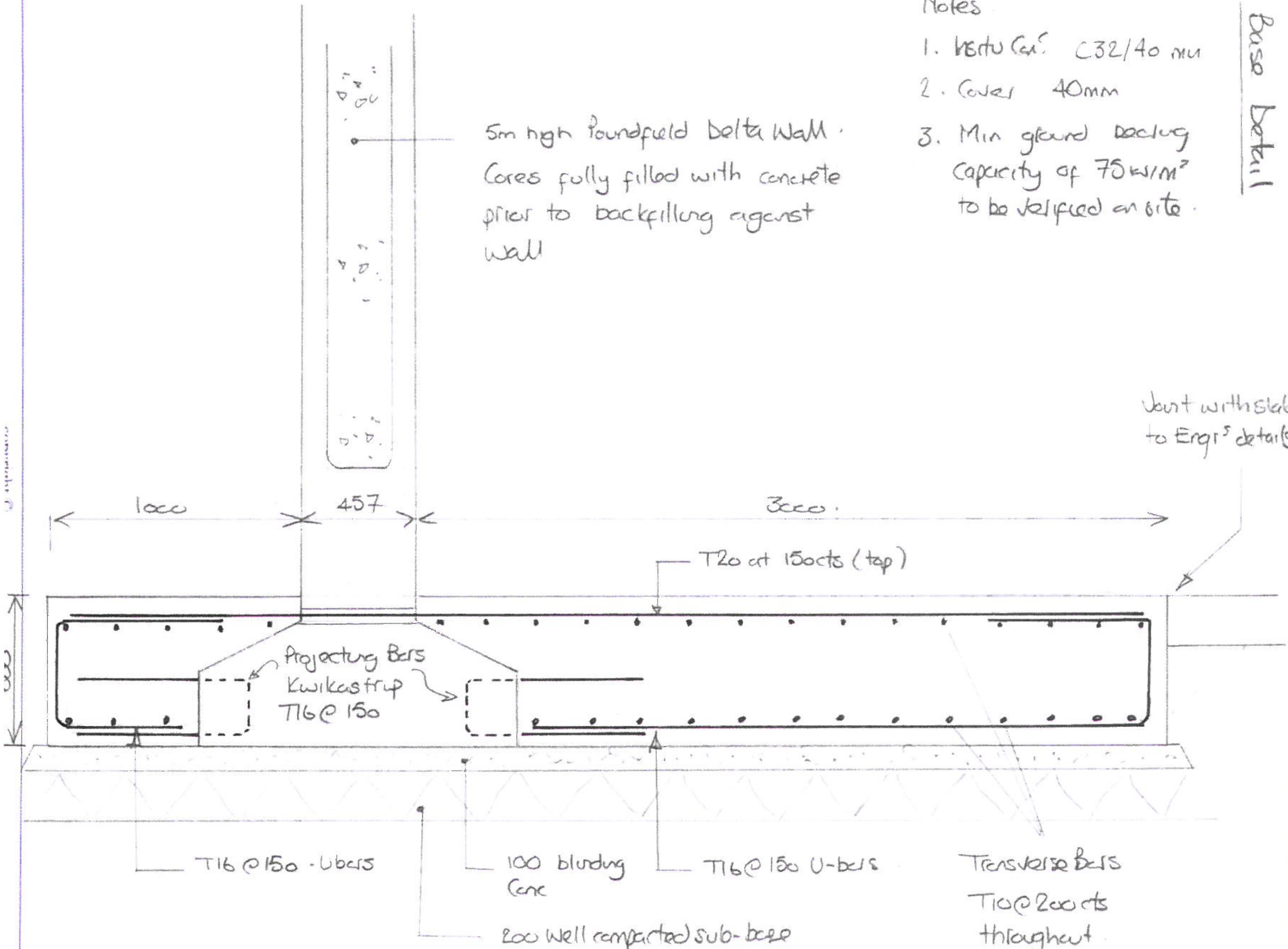
Base Detail

Notes

1. Insitu Conc C32/40 mix
2. Cover 40mm
3. Min ground bearing capacity of 75 kN/m² to be verified on site.



Date	By	Checked	Sheet Ref.
Oct 09	DJE		Delta Stem 001 .

Project.	Project Ref.
5m Delta Wall	09/001

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Design Calculations for 5m High Delta Wall.

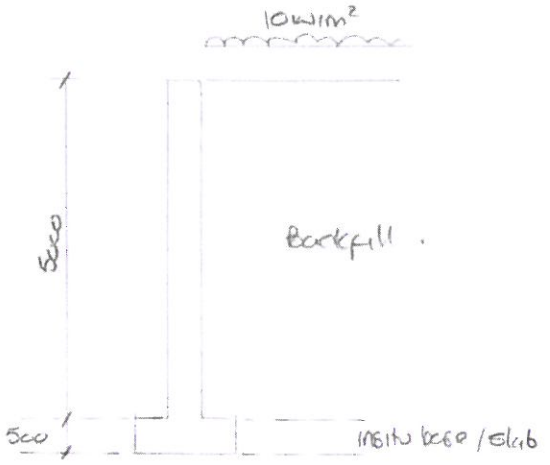
References : BS 8110 Structural Use of Concrete

Loadings : 1) Level backfill + 10kN/m² surcharge
2) Rolled silage.

determine max BM's

1) Level backfill + 10kN/m² surcharge

Assumptions : Backfill well drained
$\gamma = 18 kN/m^3$
$\phi = 35°$
$K_a = 0.27$

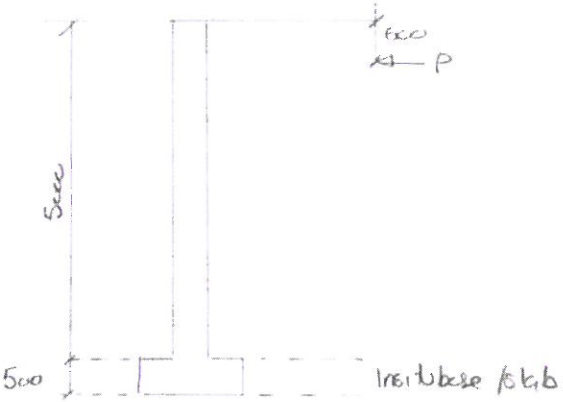


∴ BM stem (ULS) $= 1.4 \left(0.27 \times 18 \times \frac{5.0^3}{6} + 0.27 \times 10.0 \times \frac{5.0^2}{2} \right)$

$= 189.0 kNm/m$.

2) Rolled Silage (Ref: BS5502 Pt 22)

Assumptions : Max 10T vehicle
M/C < 80%
No wheel contact on wall.
$W_g = 4.5 kN/m^2$ uniform load
$T_g = 4.5 kN/m^2$ increases with depth
$P = 5 kN$ wheel load.



∴ BM (stem) ULS) $= 1.4 \left(4.5 \times \frac{5.0^2}{2} + 4.5 \times \frac{5.0^3}{6} + 5.0 \times 4.4 \right)$

$= 240.8 kNm/m$

Date	By	Checked	Sheet Ref.
Oct 09	DJE		Delta Stem 002

Project.	Project Ref.
5m Delta Wall	09/001

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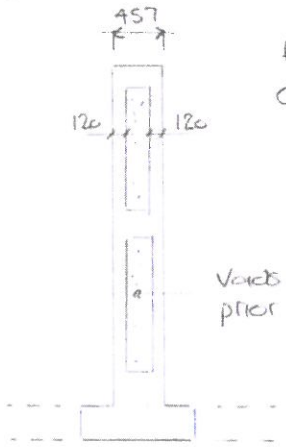
Stem Design :

Max BM (ULS) = 240.8kNm/m Unit width = 1220mm.

$\Rightarrow 240.8 \times 1.22 = 294.0$ kNm per unit



f_{cu} = C40/50
Cover = 50 mm.

$\therefore d = 457 - \frac{120}{2} = 397$mm.

$\therefore K = \frac{240.8 \times 10^6}{1220 \times 397^2 \times 50} = 0.025$

$z = 0.95d = 377$mm

$A_s^{req} = \frac{240.8 \times 10^6}{0.95 \times 460 \times 377} = 1461 mm^2/unit$

$A_s^{min} = 0.13\% \times 1220 \times 457 = 724 mm^2/unit$

Voids filled on site prior to backfilling

$\therefore$ Provide H12 @ 85 c/s

($A_s = 1583 mm^2$)

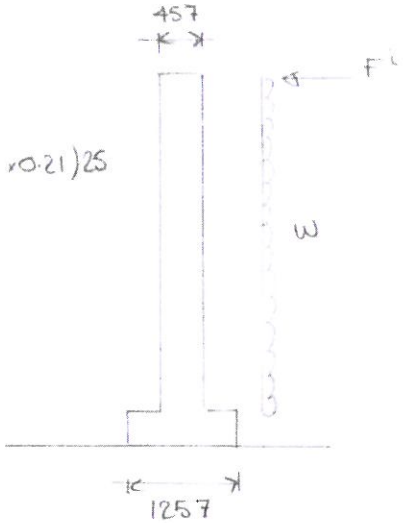
Check Temp Stability.

Consider wind of accidental load F^i.

Self Wt of wall $= \left[(5.0 \times 0.457 - 1.459 \times 0.21 - 2.633 \times 0.21)25 + 0.8 \times 0.507 \times 25\right] 1.22$

$= 55.8$kN.

$\therefore$ Rest Mnt $= 55.8 \times \frac{1.257}{2} = 35.1$kNm



apply FoS of 1.5 against overturning

$\therefore$ OTM (wind) $= w \cdot 5.5^2/2 < \frac{35.1}{1.5}$

$\therefore w < 1.55$kN/m $\Rightarrow 1.27$ kN/m^2

OTM (F^i) $= F^i \times 5.5 < \frac{35.1}{1.5}$

$\therefore F^i < 4.25$ kN/unit $\Rightarrow 3.5$kN/m.

Date.	By	Checked	Sheet Ref.	Erskine Hurt
Oct 09	DJE		DeltaStem 003	Consultants Limited
Project.			Project Ref.	
5m Delta Wall			09/001	

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Temperary Condition.

Max udl on wall (i.e. wind) = 1.27 kN/m² windy conditions.

Max point load at top (i.e. impact) = 3.5 kN/m

Check Overturning.

Delta Wall must be tied / lapped into suitable insitu concrete base or slab. Min thickness 500mm.

To be assessed on individual basis.

Check Bearing Pressure beneath Base.

To be assessed on individual basis. Assume maximum 100kN/m² allowable bearing pressure unless advised otherwise.

Sliding.

Assume resisted by insitu base / slab unless advised otherwise