Walker Ingram Associates
Office S4
Flexspace
Wakefield
West Yorkshire
WF2 7AS

01924 792 312
info@walkeringram.co.uk
www.walkeringram.co.uk

WALKER INGRAM ASSOCIATES
CONSULTING ENGINEERS

PREPARED BY:	DATE:
MA	Jun 2020
CHECKED BY:	DATE:
WW	Jun 2020
APPROVED BY:	DATE:

PROJECT TITLE: Dearne & Dove Works Mineshaft Cap

PROJECT REF: 100.058

CLIENT NAME: Longleys (Barnsley) Ltd

CONTENTS

STATUS

APPROVAL

REVISIONS

REF	**DATE**	**DESCRIPTION**	**CHECKED**	**APPROVED**
0	Jun 20	First Issue	WW	

1) INTRODUCTION

The following calculations are for the design of a reinforced concrete mineshaft cap. Walker Ingram Associates have been advised that the shaft recorded on site is 2.75m in diameter and rockhead is approximately 0.9m below existing ground level.

The site is currently being cleared to make way for a possible future development, the details of which are unknown at the time of designing the cap.it is proposed to design the cap for the greater of load model 1 from EC1 or 33kN/m^2.

In addition to being asessed for the conditions indicated above, the reinforcement provided will be no less than that indicated by the Coal Authority’s standard details.

2) DESIGN CODES & REFERENCES

Eurocode: Basis of structural design **(EN 1990)**

Eurocode 1: Actions on structures **(EN 1991)**

Part 1-1: Densities, self-weight, imposed loads for buildings (EN 1991-1-1)

Eurocode 2: Design of concrete structures **(EN 1992)**
Part 1-1: General rules, and rules for buildings (EN 1992-1-1)

Project		Job Ref
WALKER INGRAM ASSOCIATES CONSULTING ENGINEERS	Dearne & Dove Works - Mineshaft Cap	100.058
	Section: Mineshaft Cap	Sheet No./rev.: 4

Calc By	Date	Chc'd By	Date	Appr'd by	Date
MA	Jun-20	WW	Jun-20		

RC Mineshaft Cap Design

Slab has approx 1.425 m cover   Shaft Diameter/width 2.75 m

Assuming	0	m	surfacing	Density	25	kN/m^3
	2	m	fill	Density	19	kN/m^3
	0.5	m	Cap	Density	25	kN/m^3

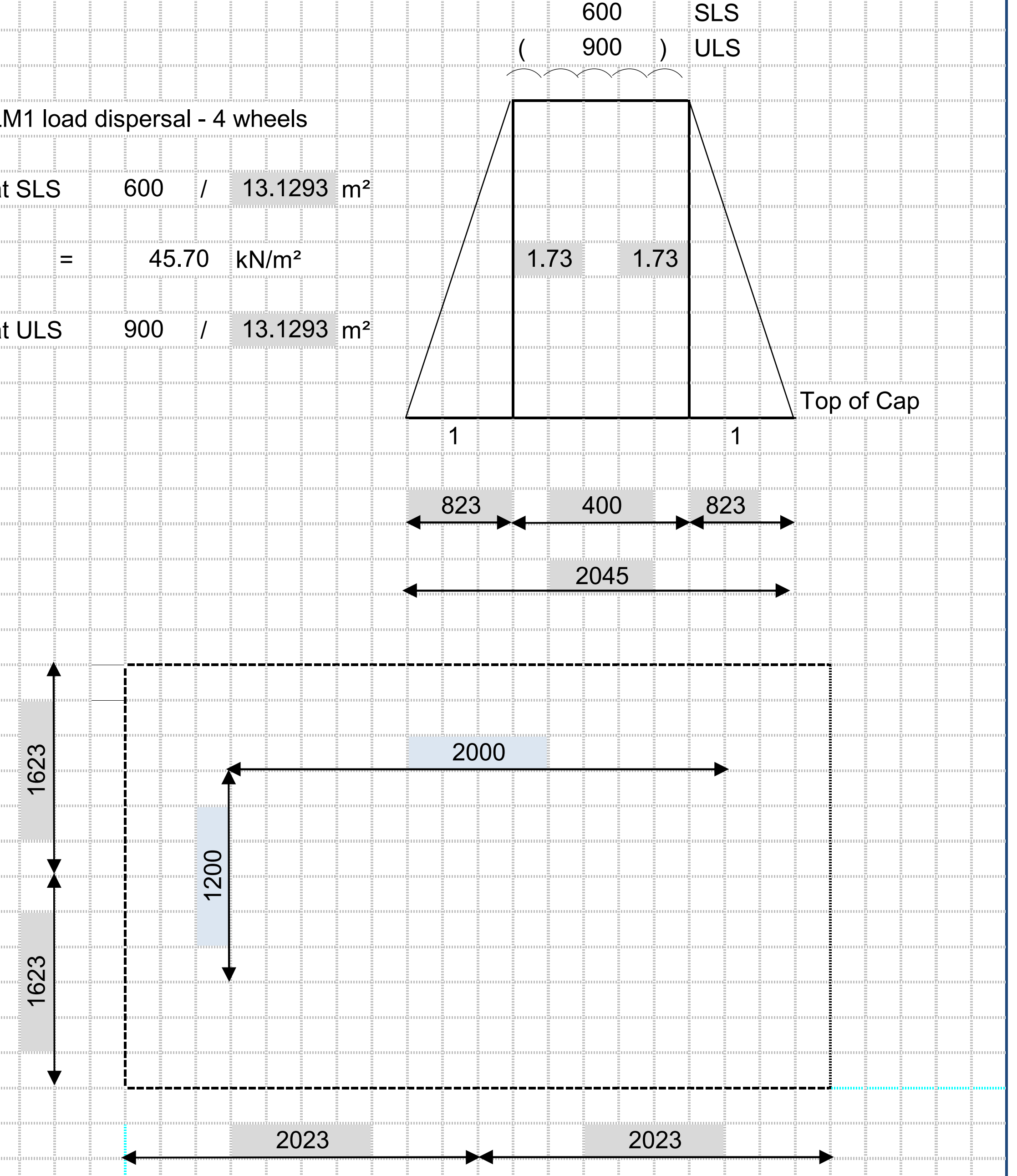
Load is spread 1: tan 30 ° through surfacing and fill in accordance with Eurocodes and 1:1 thro conc slab

LM1 load dispersal - 4 wheels

at SLS 600 / 13.1293 m²

= 45.70 kN/m²

at ULS 900 / 13.1293 m²



Project	Job Ref
Dearne & Dove Works - Mineshaft Cap	100.058
Section	**Sheet No./rev.**
Mineshaft Cap	5

Calc By	Date	Chc'd By	Date	Appr'd by	Date
MA	Jun-20	WW	Jun-20		

WALKER INGRAM ASSOCIATES
CONSULTING ENGINEERS

For a conservative design assume a blanket live load

Dead Loads	SLS		ULS
Surfacing	0.00	→	0.00
Fill	38.00	→	51.30
Slab (Cover)	7.92	→	10.69
	45.92	→	61.99
Live Load			
Load Model 1	45.70	→	68.55

Use EC1 LM1 as greater than British Coal load of 33kN/m2

Design slab as a 2 way spanning simply supported slab

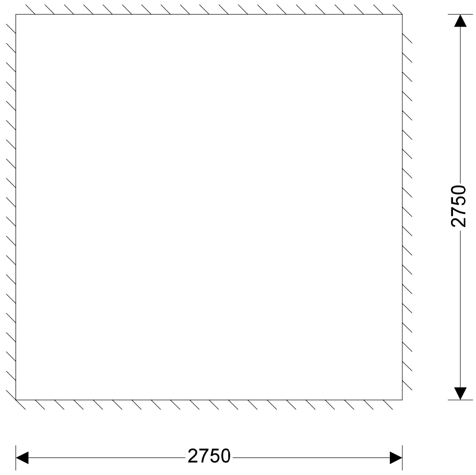
MINESHAFT CAP

RC slab design in accordance with EN1992-1-1:2004 incorporating corrigendum January 2008 and the UK national annex

Tedds calculation version 1.0.19

Design summary

Description	Unit	Provided	Required	Utilisation	Result
Short span					
Reinf. at midspan	mm^2/m	1571	778	0.495	PASS
Bar spacing at midspan	mm	200	300	0.667	PASS
Shear at discont. supp	kN/m	210.2	179.5	0.854	PASS
Deflection ratio		5.56	40.00	0.139	PASS
Long span					
Reinf. at midspan	mm^2/m	1571	810	0.516	PASS
Bar spacing at midspan	mm	200	300	0.667	PASS
Shear at discont. supp	kN/m	214.2	179.5	0.838	PASS
Cover					
Min cover bottom	mm	75	30	0.400	PASS



Slab definition

Slab reference name; **Mineshaft Cap**

Type of slab; **Two way spanning with unrestrained edges**

Overall slab depth; h = **600** mm

Shorter effective span of panel; l_x = **2750** mm

Longer effective span of panel; l_y = **2750** mm

Support conditions; **Four edges simply supported**

;

Bottom outer layer of reinforcement; **Long span direction**

Loading

Characteristic permanent action; G_k = **45.9** kN/m^2

Characteristic variable action; Q_k = **45.7** kN/m^2

Partial factor for permanent action; γ_G = **1.35**

Partial factor for variable action; γ_Q = **1.50**

Quasi-permanent value of variable action; ψ_2 = **0.30**

Design ultimate load; $q = \gamma_G \times G_k + \gamma_Q \times Q_k$ = **130.5** kN/m^2

Quasi-permanent load; $q_{SLS} = 1.0 \times G_k + \psi_2 \times Q_k$ = **59.6** kN/m^2

Concrete properties

Concrete strength class;	C32/40
Characteristic cylinder strength;	f_{ck} = **32** N/mm^2
Partial factor (Table 2.1N);	γ_C = **1.50**
Compressive strength factor (cl. 3.1.6);	α_{cc} = **0.85**
Design compressive strength (cl. 3.1.6);	f_{cd} = **18.1** N/mm^2
Mean axial tensile strength (Table 3.1);	$f_{ctm} = 0.30\text{ N/mm}^2 \times (f_{ck} / 1\text{ N/mm}^2)^{2/3}$ = **3.0** N/mm^2
Maximum aggregate size;	d_g = **20** mm

Reinforcement properties

Characteristic yield strength;	f_{yk} = **500** N/mm^2
Partial factor (Table 2.1N);	γ_S = **1.15**
Design yield strength (fig. 3.8);	$f_{yd} = f_{yk} / \gamma_S$ = **434.8** N/mm^2

Concrete cover to reinforcement

Nominal cover to outer bottom reinforcement;	c_{nom_b} = **75** mm
Fire resistance period to bottom of slab;	R_{btm} = **30** min
Axia distance to bottom reinft (Table 5.8);	a_{fi_b} = **10** mm
Min. btm cover requirement with regard to bond;	c_{min,b_b} = **20** mm
Reinforcement fabrication;	**Not subject to QA system**
Cover allowance for deviation;	Δc_{dev} = **10** mm
Min. required nominal cover to bottom reinft;	$c_{nom\_b\_min}$ = **30.0** mm

PASS - There is sufficient cover to the bottom reinforcement

Reinforcement design at midspan in short span direction (cl. 6.1)

Bending moment coefficient;	α_{sx_p} = **0.0620**
Design bending moment;	$M_{x\_p} = \alpha_{sx\_p} \times q \times l_x^2$ = **61.2** kNm/m
Reinforcement provided;	20 mm dia. bars at 200 mm centres
Area provided;	A_{sx_p} = 1571 mm^2/m
Effective depth to tension reinforcement;	$d_{x\_p} = h - c_{nom\_b} - \phi_{y\_p} - \phi_{x\_p} / 2$ = **495.0** mm
K factor;	$K = M_{x\_p} / (b \times d_{x\_p}^2 \times f_{ck})$ = **0.008**
Redistribution ratio;	δ = 1.0
K' factor;	$K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21$ = **0.208**

K < K' - Compression reinforcement is not required

Lever arm;	$z = \min(0.95 \times d_{x\_p}, d_{x\_p}/2 \times (1 + \sqrt{(1 - 3.53 \times K)}))$ = **470.3** mm
Area of reinforcement required for bending;	$A_{sx\_p\_m} = M_{x\_p} / (f_{yd} \times z)$ = **299** mm^2/m
Minimum area of reinforcement required;	$A_{sx\_p\_min} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{x\_p}, 0.0013 \times b \times d_{x\_p})$ = **778** mm^2/m
Area of reinforcement required;	$A_{sx\_p\_req} = \max(A_{sx\_p\_m}, A_{sx\_p\_min})$ = **778** mm^2/m

PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress;	$\sigma_{sx\_p} = (f_{yk} / \gamma_S) \times \min((A_{sx\_p\_m}/A_{sx\_p}), 1.0) \times q_{SLS} / q$ = **37.9** N/mm^2
Maximum allowable spacing (Table 7.3N);	$s_{max\_x\_p}$ = **300** mm
Actual bar spacing;	s_{x_p} = **200** mm

PASS - The reinforcement spacing is acceptable

Reinforcement design at midspan in long span direction (cl. 6.1)

Bending moment coefficient;	α_{sy_p} = **0.0620**
Design bending moment;	$M_{y\_p} = \alpha_{sy\_p} \times q \times l_x^2$ = **61.2** kNm/m
Reinforcement provided;	20 mm dia. bars at 200 mm centres

Area provided; A_{sy_p} = 1571 mm^2/m

Effective depth to tension reinforcement; $d_{y\_p} = h - c_{nom\_b} - \phi_{y\_p} / 2 =$ **515.0** mm

K factor; $K = M_{y\_p} / (b \times d_{y\_p}^2 \times f_{ck}) =$ **0.007**

Redistribution ratio; $\delta = 1.0$

K' factor; $K' = 0.598 \times \delta - 0.18 \times \delta^2 - 0.21 =$ **0.208**

K < K' - Compression reinforcement is not required

Lever arm; $z = \min(0.95 \times d_{y\_p}, d_{y\_p}/2 \times (1 + \sqrt{(1 - 3.53 \times K)})) =$ **489.2** mm

Area of reinforcement required for bending; $A_{sy\_p\_m} = M_{y\_p} / (f_{yd} \times z) =$ **288** mm^2/m

Minimum area of reinforcement required; $A_{sy\_p\_min} = \max(0.26 \times (f_{ctm}/f_{yk}) \times b \times d_{y\_p}, 0.0013 \times b \times d_{y\_p}) =$ **810** mm^2/m

Area of reinforcement required; $A_{sy\_p\_req} = \max(A_{sy\_p\_m}, A_{sy\_p\_min}) =$ **810** mm^2/m

PASS - Area of reinforcement provided exceeds area required

Check reinforcement spacing

Reinforcement service stress; $\sigma_{sy\_p} = (f_{yk} / \gamma_S) \times \min((A_{sy\_p\_m}/A_{sy\_p}), 1.0) \times q_{SLS} / q =$ **36.4** N/mm^2

Maximum allowable spacing (Table 7.3N); $s_{max\_y\_p} =$ **300** mm

Actual bar spacing; $s_{y\_p} =$ **200** mm

PASS - The reinforcement spacing is acceptable

Shear capacity check at short span discontinuous support

Shear force; $V_{x\_d} = q \times l_x / 2 =$;**179.5**; kN/m;

Reinforcement provided; **20 mm dia. bars at 200 mm centres**

Area provided; A_{sx_d} = **1571** mm^2/m

Effective depth; $d_{x\_d} = d_{x\_p} =$;**495.0**; mm

Effective depth factor; $k = \min(2.0, 1 + (200 \text{ mm} / d_{x\_d})^{0.5}) =$ **1.636**

Reinforcement ratio; $\rho_l = \min(0.02, A_{sx\_d} / (b \times d_{x\_d})) =$ **0.0032**

Minimum shear resistance; $V_{Rd,c\_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{x\_d}$

V_{Rd,c_min} = **205.0** kN/m

Shear resistance constant (cl. 6.2.2); $C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_C =$ **0.12** N/mm^2

Shear resistance;

$V_{Rd,c\_x\_d} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{x\_d}) =$ **210.2** kN/m

PASS - Shear capacity is adequate (0.854)

Shear capacity check at long span discontinuous support

Shear force; $V_{y\_d} = q \times l_x / 2 =$;**179.5**; kN/m;

Reinforcement provided; **20 mm dia. bars at 200 mm centres**

Area provided; A_{sy_d} = **1571** mm^2/m

Effective depth; $d_{y\_d} = d_{y\_p} =$;**515.0**; mm

Effective depth factor; $k = \min(2.0, 1 + (200 \text{ mm} / d_{y\_d})^{0.5}) =$ **1.623**

Reinforcement ratio; $\rho_l = \min(0.02, A_{sy\_d} / (b \times d_{y\_d})) =$ **0.0031**

Minimum shear resistance; $V_{Rd,c\_min} = 0.035 \text{ N/mm}^2 \times k^{1.5} \times (f_{ck} / 1 \text{ N/mm}^2)^{0.5} \times b \times d_{y\_d}$

V_{Rd,c_min} = **210.9** kN/m

Shear resistance constant (cl. 6.2.2); $C_{Rd,c} = 0.18 \text{ N/mm}^2 / \gamma_C =$ **0.12** N/mm^2

Shear resistance;

$V_{Rd,c\_y\_d} = \max(V_{Rd,c\_min}, C_{Rd,c} \times k \times (100 \times \rho_l \times (f_{ck}/1 \text{ N/mm}^2))^{0.333} \times b \times d_{y\_d}) =$ **214.2** kN/m

PASS - Shear capacity is adequate (0.838)

Basic span-to-depth deflection ratio check (cl. 7.4.2)

Reference reinforcement ratio; $\rho_0 = (f_{ck} / 1 \text{ N/mm}^2)^{0.5} / 1000 =$ **0.0057**

Required tension reinforcement ratio; $\rho = \max(0.0035, A_{sx\_p\_req} / (b \times d_{x\_p})) =$ **0.0035**

Required compression reinforcement ratio; $\rho' = A_{scx\_p\_req} / (b \times d_{x\_p})$ = **0.0000**

Stuctural system factor (Table 7.4N); K_δ = **1.0**

Basic limit span-to-depth ratio (Exp. 7.16);

$ratio_{lim\_x\_bas} = K_\delta \times [11 + 1.5\times(f_{ck}/1\ N/mm^2)^{0.5}\times\rho_0/\rho + 3.2\times(f_{ck}/1\ N/mm^2)^{0.5}\times(\rho_0/\rho - 1)^{1.5}]$ = **33.47**

Mod span-to-depth ratio limit;

$ratio_{lim\_x} = \min(40 \times K_\delta, \min(1.5, (500\ N/mm^2/ f_{yk}) \times (A_{sx\_p} / A_{sx\_p\_m})) \times ratio_{lim\_x\_bas})$ = **40.00**

Actual span-to-eff. depth ratio; $ratio_{act\_x} = l_x / d_{x\_p}$ = **5.56**

PASS - Actual span-to-effective depth ratio is acceptable

Reinforcement summary

Midspan in short span direction; **20 mm dia. bars at 200 mm centres B2**

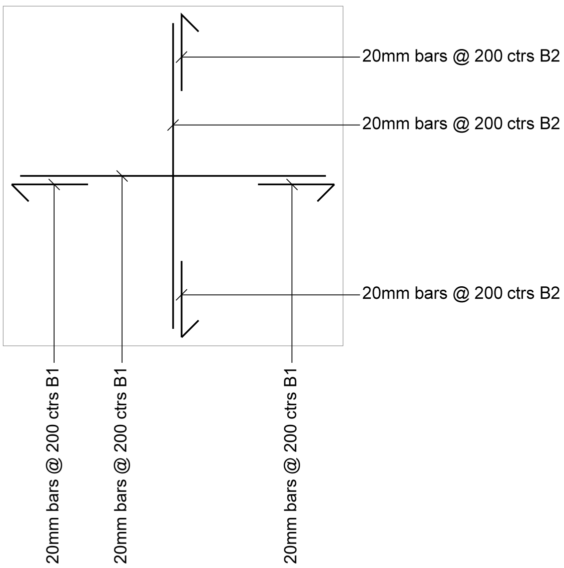
Midspan in long span direction; **20 mm dia. bars at 200 mm centres B1**

Discontinuous support in short span direction; **20 mm dia. bars at 200 mm centres B2**

Discontinuous support in long span direction; **20 mm dia. bars at 200 mm centres B1**

Reinforcement sketch

The following sketch is indicative only. Note that additional reinforcement may be required in accordance with clauses 9.2.1.2, 9.2.1.4 and 9.2.1.5 of EN 1992-1-1:2004 to meet detailing rules.



;