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Walker Ingram Associates Office S4			МА	Jun 2020	
Office S4 Flexspace Wakefield West Yorkshire WALKER INGRAM			CHECKED BY:	DATE:	
			ww	Jun 2020	
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			CONSULTING ENGINEERS		
t 01924 7	92 312		PROJECT TITLE: Dearne & Dove Works M	lineshaft Cap	
info@wa	alkeringram.co	o.uk	PROJECT REF: 100.058		
🕐 www.wa	alkeringram.co	o.uk	CLIENT NAME: Longlovs (Barnslov) Ltd		
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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/m².

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.

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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)

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RC Mineshaft Can Design	ן ו						
Slab has	annrox	1 42	5 m c	nver	Shaft Diamet	er/width 2 75 m	
	appion			5761			
Assumin	n	0	m	surfacing	Density	25 kN/m ³	
	9	2	 m	fill	Density	19 kN/m ³	
		0.5	m	Cap	Density	25 kN/m ³	
I oad is spread 1 [.] tan	30	^o through s	surfacir	and fill in a	accordance with	Furocodes and	
1:1 thro conc slab		anough	Janaon				
					600 SI	S	
				(900 \ 11	<u>-</u>	
I M1 load dieper	rsal _ / ·	wheele		/			
	Jai - 4	**116619					
	ר ר ר	13 1203	m2	/			
	<i>,</i>	10.1200	111				
	15 70	kNI/m²		/ 1	73 1 73		
	+3.70	KIN/III		1.1	3 1.73		
	n /	12 1202	m2				
	J /	13.1293	m-	/			
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For a conservative desi	an assume a b	lanket 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 that	n
Design slab as	s a 2 way spann	ning simply suppo	orted slab	British (Coal load of 33kN/m	2

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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	mm²/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	mm²/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;	$\psi_2 = 0.30$
Design ultimate load;	$q = \gamma_G \times G_k + \gamma_Q \times Q_k = 130.5 \text{ kN/m}^2$
Quasi-permanent load;	$q_{SLS} \texttt{=} 1.0 \times G_k \texttt{+} \psi_2 \times Q_k \texttt{=} \texttt{59.6} \text{ kN/m}^2$

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Concrete properties								
Concrete strength class;		C32/40						
Characteristic cylinder strength	;	f _{ck} = 32	N/mm ²					
Partial factor (Table 2.1N);		γ _C = 1.5	ס					
Compressive strength factor (c	l. 3.1.6);	α _{cc} = 0.8	35					
Design compressive strength (cl. 3.1.6);	f _{cd} = 18.	1 N/mm ²					
Mean axial tensile strength (Ta	ble 3.1);	f _{ctm} = 0.3	$30 \text{ N/mm}^2 \times (f_{ck} / $	1 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);		γs = 1.1	5					
Design yield strength (fig. 3.8);		$f_{yd} = f_{yk}$ /	γs = 434.8 N/mn	n ²				
Concrete cover to reinforcem	nent							
Nominal cover to outer bottom	reinforcement;	C _{nom_b} =	75 mm					
Fire resistance period to botton	n of slab;	R _{btm} = 3	0 min					
Axia distance to bottom reinft (Table 5.8);	a _{fi_b} = 1 () mm					
Min. btm cover requirement wit	h regard to boi	nd; C _{min,b_b} =	20 mm					
Reinforcement fabrication;	einforcement fabrication;			Not subject to QA system				
Cover allowance for deviation;		$\Delta c_{dev} = r$	I0 mm					
Min. required nominal cover to	bottom reinft;	C _{nom_b_mi}	_n = 30.0 mm					
		P	ASS - There is s	ufficient cover t	o the bottom	reinforcemer		
Reinforcement design at mid	span in short	span direction	n (cl. 6.1)					
Bending moment coefficient;		$\alpha_{sx_p} = 0$.0620					
Design bending moment;		M _{x_p} = α	$sx_p \times q \times I_x^2 = 61$.2 kNm/m				
Reinforcement provided;		20 mm o	lia. bars at 200 n	nm centres				
Area provided;		$A_{sx_p} = 1$	571 mm²/m					
Effective depth to tension reinfo	prcement;	$d_{x_p} = h$	- C _{nom_b} - φ _{y_p} - φ _x	_p / 2 = 495.0 mm	I			
K factor;		K = M _{x_r}	$h / (b \times d_{x_p^2} \times f_{ck})$	= 0.008				
Redistribution ratio;		δ = 1.0						
K' factor;		K' = 0.59	$98 \times \delta$ - 0.18 $\times \delta^2$	- 0.21 = 0.208				
			K < K' -	Compression re	inforcement	is not require		
Lever arm;		z = min($0.95 \times d_{x_p}, d_{x_p/2}$	2 × (1 + √(1 - 3.53	8 × K))) =			
	, , ,,	470.3 m	m	24				
Area of reinforcement required	for bending;	A _{sx_p_m} =	= M _{x_p} / (t _{yd} × z) =	299 mm²/m		2/		
Minimum area of reinforcement	t required;	A _{sx_p_min}	$= \max(0.26 \times (f_{cl}))$	$_{\rm tm}/f_{\rm yk}$) × b × d _{x_p} , 0).0013×b×d _{x_p}) = 778 mm²/m		
Area of reinforcement required;	,	Asx_p_req	= max(A _{sx_p_m} , A	.sx_p_min) = 778 mn	n²/m vided exceed	a araa raquira		
		FA	55 - Area Or Tell	norcement prov		s alea lequile		
Cneck reinforcement spacing	3	,	F. ()		a	• N1/mana?		
Reinforcement service stress;		$\sigma_{sx_p} = ($	$f_{yk} / \gamma_S $ × min((As)	x_p_m/Asx_p), 1.0) ×	qsls / q = 37	.9 N/mm²		
Maximum allowable spacing (1	able 7.3N);	Smax_x_p	= 300 mm					
Actual bal spacing,		S _{x_p} – 20	PASS	S - The reinforce	ment snacin	a is accentabl		
Doinforcoment design start	onon in lass	non dire etter	(a) 6 4)		incin spacing	η το αυτοριαμί		
Reinforcement design at Mid	span in iong s		(01. 0.1)					
Denuing moment coefficient;		$\alpha_{sy_p} = 0$	1.0020	2 kNm/m				
Design handing managet								
Design bending moment;		$W_{y_p} = \alpha$	$sy_p \times q \times lx^2 = 61$					

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Area provided:		$A_{sy,p} = 157$	71 mm ² /m					
Effective depth to tension reinfor	cement:	$d_{v,n} = h - c$	$r_{\rm hom} = \phi_{\rm v} = /2 =$	515 0 mm				
K factor:	oomont,	K = My n /	$(b \times d_{y})^{2} \times f_{ak} =$	0 007				
Redistribution ratio:		8 – 1 0		0.007				
K' factor		6 = 1.0 K' = 0.508	v § 0 18 v §2	0.21 - 0.202				
R laciol,		K - 0.590	× 0 - 0.10 × 0 -	0.21 - 0.200	nforcomont i	s not required		
Lover erm:		$z = \min(0)$		$(1 \pm \sqrt{1 + 2})$		s not required		
Lever ann,		2 = 11111(0.:	95 × Uy_p, Uy_p/2	× (1 +)(1 - 3.55	× N))) -			
Area of reinforcement required f	or bending:	409.2 mm	(furt ∨ 7) = 2	88 mm ² /m				
Minimum area of reinforcement	required:	Asy_p_m = n	$\max(0.26 \times (f_{\text{true}})) = \mathbf{z}$	/fu) x b x du a 0 (0013vbvd)	- 810 mm ² /m		
Area of reinforcement required:	equileu,	Asy_p_min -	$max(0.20 \times (1ctm))$	$(1) = 810 \text{ mm}^2$	$2/m^{2}$	- 810 11111 /111		
Area of ternorcement required,		Asy_p_req =	S - Area of reinf	_p_min) = 010 mini	//// ded exceeds	area required		
		7 400		or cement provid		urcu requircu		
		/5	()			N1/		
Reinforcement service stress,		σsy_p – (lyk	/γs) × min((Asy_p	p_m/Asy_p , 1.0 × 0	JSLS / Y - JO.4	FIN/IIIII-		
Maximum allowable spacing (Ta	Maximum allowable spacing (Table 7.3N);							
Actual bar spacing,		Sy_p – 200	DASS.	The reinforcer	ont enacina	is accontablo		
.			FA33	· me remorcen	iem spacing	is acceptable		
Shear capacity check at short	span disconti	inuous support						
Snear force;		$V_{x_d} = q \times$	I _x / 2 = ;1/9.5; Ki	N/m;				
Reinforcement provided;		20 mm dia	a. bars at 200 m $\frac{1}{2}$	m centres				
Area provided;		$A_{sx_d} = 15$	1 mm²/m					
Effective depth factor		$d_{x_d} = d_{x_p}$	= ; 495.0 ; mm	$(d_{1})(0.5) = 4.626$				
Ellective deptil lactor,		$\kappa = \min(2)$	0, 1 + (200 mm /	$(u_{x_d})^{(n)} = 1.030$				
Minimum choor resistance:		$p_i = \min(0, \dots, -$	$02, Asx_d / (b \times d)$	x_d)) - 0.0032	∞2\0.5 bd			
Minimum snear resistance,		VRd,c_min -	$V_{Rd,c_{min}} = 0.035 \text{ N/mm}^2 \times \text{K}^{1.3} \times (\text{T}_{ck} / 1 \text{ N/mm}^2)^{0.3} \times \text{D} \times \text{d}_{x_{d}}$					
Shaar resistance constant (cl. 6	2 2).		203.0 KN/III	12 N/mm^2				
Shear resistance	Z.Z),	CRa,c - 0.1	ο N/IIII / γc – C	J. 12 IN/IIIII				
	Ved a v d = m			$(f_{ck}/1 \text{ N/mm}^2))^{(1)}$	$0.333 \times h \times d_{2} d^{3}$) = 210 2 kN/m		
	vita,c_x_d			PASS - Shear ca	apacity is add	equate (0.854)		
Shear canacity check at long	snan discontir	nuous support						
Shear force:			l√ / 2 = · 179 5 · ki	N/m·				
Reinforcement provided:		20 mm di:	a bars at 200 m	m centres				
Area provided:		$A_{sy d} = 157$	71 mm ² /m					
Effective depth:		$d_{y,d} = d_{y,n}$	= · 515.0 mm					
Effective depth factor:		k = min(2.0)). 1 + (200 mm /	$(d_{v,d})^{0.5}$ = 1.623				
Reinforcement ratio:		$\alpha = \min(0)$	02. A _{sv. d} / (b × d	(d) = 0.0031				
Minimum shear resistance:		VRd c min =	$0.035 \text{ N/mm}^2 \times 1$	$k^{1.5} \times (f_{ck} / 1 \text{ N/mr})$	$m^{2})^{0.5} \times h \times d_{v}$	d		
	winimum snear resistance;				11) × 6 × 4 <u>9</u>	_u		
Shear resistance constant (cl. 6	2.2):	$C_{\text{Rd},c} = 0.1$	$8 \text{ N/mm}^2 / \gamma_c = 0$).12 N/mm ²				
Shear resistance;	,	- 1 4,0 - 1 -						
	$V_{Rd,c_y_d} = rr$	nax(V _{Rd,c_min} , C _{Rd}	$_{\rm d,c} \times \mathbf{k} \times (100 \times \rho)$	ı × (f _{ck} /1 N/mm²)) ⁽ PASS - Shear ca	^{).333} × b × d _{y_d}) apacity is add) = 214.2 kN/m equate (0.838)		
Basic span-to-depth deflection	n ratio check (cl. 7.4.2)						
Reference reinforcement ratio:	· · · ·	ρ ₀ = (f _{ck} / 1	N/mm ²) ^{0.5} / 100	0 = 0.0057				
Required tension reinforcement	ratio;	ρ = max(0	.0035, A _{sx_p_req} /	(b × d _{x_p})) = 0.00	35			

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Poquired compression reinford	omont ratio:	o' = A	/ (b x d) =	- 0 0000					
		$p - A_{scx}$	_p_req / (D × Ux_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 _δ × [11 +1.5×	(f _{ck} /1 N/mm ²) ^{0.5} ×	ρ₀/ρ + 3.2×(fck/1 N	/mm²) ^{0.5} ×(ρ₀/ρ	-1) ^{1.5}] = 33.47			
Mod span-to-depth ratio limit;									
	ratio _{lim_x} = ı	min(40 $ imes$ K $_{\delta}$, mir	n(1.5, (500 N/mm	1^2 / f_{yk}) × (A_{sx_p} / A_{sx_p}	_{x_p_m})) × ratio _{lim}	_x_bas) = 40.00			
Actual span-to-eff. depth ratio;		ratio _{act_x}	= I _x / d _{x_p} = 5.56						
			PASS - Actua	l span-to-effectiv	e depth ratio	is acceptable			
Reinforcement summary									
Midspan in short span directior	1;	20 mm o	dia. bars at 200	mm centres B2					
Midspan in long span direction;	Midspan in long span direction;			20 mm dia. bars at 200 mm centres B1					
Discontinuous support in short	span direction	; 20 mm o	20 mm dia. bars at 200 mm centres B2						
Discontinuous support in long s	span direction;	20 mm o	dia. bars at 200	mm centres B1					

Reinforcement sketch

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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.



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