



Planning Application P2020/0433

Plot 1 Former Wernddu Bungalow Site Neath SA10 7DZ

Supporting Document 02

21st September 2020

Structural Calculations for Existing Mineshaft Cap

Dear Andrea,

Further to submission of our previous Supporting Document 01 on 30th June 2020, we write to confirm that in line with discussions with the Coal Authority we have now carried out structural design calculations on the existing mine shaft cap.

Please find appended to this document the calculations which confirm the mine shaft cap as built is capable of taking loads of at least 77.96 kN/m^2 . Our previous correspondence confirmed that the proposed dwelling loads, including the raft foundation and soil surcharge, produce a load of 61.5 kN/m^2 and therefore both structural engineer's are satisfied that our proposals are acceptable.

We would be grateful if you can issue this correspondence to the Coal Authority, through your consultee process, for agreement and so that the CMRA risk rating can be amended accordingly and objections removed.

Kind regards,

Gareth Owen
Director

STRUCTURAL DESIGN CALCULATIONS

Mine Shaft Capping Slab

at

Wernddu Bungalow

Tyllwyd Road, Bruncoch

Neath

Job No. 12108

CALCULATION SHEET

LOADING

Ref drawing 12108-100 - Section through Mine Cap

+ Structural Design Calculations - Plot 1 - August 2012.

DEAD LOAD

Thickness of GF2 / type 1 Structural fill = 2.6m

$$VDL \text{ ON SHAFT CAP} = 2.6 \times 20.6 = 53.5 \text{ kN/m}^2$$

$$VDL \text{ FROM RAFT @ FORMATION LEVEL} = 15.1 \text{ kN/m}^2$$

$$\begin{aligned} \text{ULT DESIGN LOAD} &= 1.4 \times 53.5 + 1.6 \times 15.1 \\ &= 77.96 \text{ kN/m}^2 \end{aligned}$$

Shaft cap = 400mm thick RC40 concrete

Spanning a 3.00m shaft width.

Slab reinforced with 2 layers A393

Mesh in bottom.

$$\text{ULT Sagging Moment} = WL^2/8 = 77.96 \times 3^2/8 = 87.71 \text{ kNm}$$

$$\text{ULT SF} = WL/2 = 77.96 \times 3/2 = 116.94 \text{ kN/m width}$$

CALCULATION SHEET

SHAFT CAP DESIGN

Ref Tedds output overleaf:

VSE 400mm THK GRADE RC 32/40
Slab, reinforced with 2 Layers
A393 Mesh in Bottom.
Min. Cover to tension reinforcement
= 40mm.

This image shows a full page of blank graph paper. The grid consists of small, equal-sized squares formed by thin black lines. There are no margins, text, or other markings on the page.

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RC SLAB DESIGN (BS8110:PART1:1997)

TEDDS calculation version 1.0.04

TWO WAY SPANNING SLAB DEFINITION – SIMPLY SUPPORTED

Overall depth of slab $h = 400$ mm

Outer sagging steel

Cover to outer tension reinforcement resisting sagging $c_{sag} = 40$ mm

Trial bar diameter $D_{tryx} = 10$ mm

Depth to outer tension steel (resisting sagging)

$$d_x = h - c_{sag} - D_{tryx}/2 = 355 \text{ mm}$$

Inner sagging steel

Trial bar diameter $D_{tryy} = 10$ mm

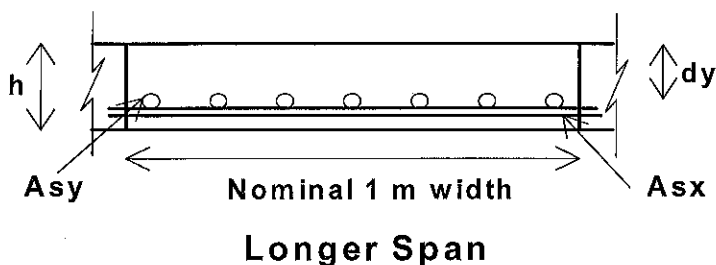
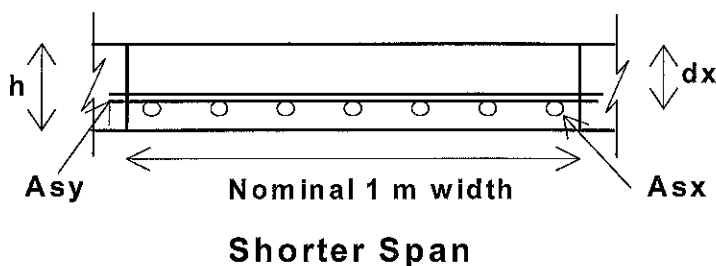
Depth to inner tension steel (resisting sagging)

$$d_y = h - c_{sag} - D_{tryx} - D_{tryy}/2 = 345 \text{ mm}$$

Materials

Characteristic strength of reinforcement $f_y = 500$ N/mm²

Characteristic strength of concrete $f_{cu} = 40$ N/mm²



Two-way spanning slab (simple)

MAXIMUM DESIGN MOMENTS

Length of shorter side of slab $l_x = 3.000$ m

Length of longer side of slab $l_y = 3.000$ m

Design ultimate load per unit area $n_s = 87.7$ kN/m²

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Moment coefficients

$$\alpha_{sx} = (l_y / l_x)^4 / (8 \times (1 + (l_y / l_x)^4)) = 0.063$$

$$\alpha_{sy} = (l_y / l_x)^2 / (8 \times (1 + (l_y / l_x)^4)) = 0.063$$

Maximum moments per unit width - simply supported slabs

$$m_{sx} = \alpha_{sx} \times n_s \times l_x^2 = 49.3 \text{ kNm/m}$$

$$m_{sy} = \alpha_{sy} \times n_s \times l_x^2 = 49.3 \text{ kNm/m}$$

CONCRETE SLAB DESIGN – SAGGING – OUTER LAYER OF STEEL (CL 3.5.4)

Design sagging moment (per m width of slab) $m_{sx} = 49.3 \text{ kNm/m}$

Moment Redistribution Factor $\beta_{bx} = 1.0$

Area of reinforcement required

$$K_x = \text{abs}(m_{sx}) / (d_x^2 \times f_{cu}) = 0.010$$

$$K'_x = \min(0.156, (0.402 \times (\beta_{bx} - 0.4)) - (0.18 \times (\beta_{bx} - 0.4)^2)) = 0.156$$

Outer compression steel not required to resist sagging

Slab requiring outer tension steel only - bars (sagging)

$$z_x = \min((0.95 \times d_x), (d_x \times (0.5 + \sqrt{(0.25 - K_x / 0.9)}))) = 337 \text{ mm}$$

$$\text{Neutral axis depth } x_x = (d_x - z_x) / 0.45 = 39 \text{ mm}$$

Area of tension steel required

$$A_{sx_req} = \text{abs}(m_{sx}) / (1/\gamma_{ms} \times f_y \times z_x) = 336 \text{ mm}^2/\text{m}$$

Tension steel

Provide 10 dia bars @ 100 centres outer tension steel resisting sagging

$$A_{sx_prov} = A_{sx} = 785 \text{ mm}^2/\text{m}$$

Area of outer tension steel provided sufficient to resist sagging

Concrete Slab Design - Sagging - Inner layer of steel (cl. 3.5.4)

Design sagging moment (per m width of slab) $m_{sy} = 49.3 \text{ kNm/m}$

Moment Redistribution Factor $\beta_{by} = 1.0$

Area of reinforcement required

$$K_y = \text{abs}(m_{sy}) / (d_y^2 \times f_{cu}) = 0.010$$

$$K'_y = \min(0.156, (0.402 \times (\beta_{by} - 0.4)) - (0.18 \times (\beta_{by} - 0.4)^2)) = 0.156$$

Inner compression steel not required to resist sagging

Slab requiring inner tension steel only - bars (sagging)

$$z_y = \min((0.95 \times d_y), (d_y \times (0.5 + \sqrt{(0.25 - K_y / 0.9)}))) = 328 \text{ mm}$$

$$\text{Neutral axis depth } x_y = (d_y - z_y) / 0.45 = 38 \text{ mm}$$

Area of tension steel required

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$$A_{sy_req} = \text{abs}(m_{sy}) / (1/\gamma_{ms} \times f_y \times z_y) = 346 \text{ mm}^2/\text{m}$$

Tension steel

Provide 10 dia bars @ 100 centres inner tension steel resisting sagging

$$A_{sy_prov} = A_{sy} = 785 \text{ mm}^2/\text{m}$$

Area of inner tension steel provided sufficient to resist sagging

Check min and max areas of steel resisting sagging

$$\text{Total area of concrete } A_c = h = 400000 \text{ mm}^2/\text{m}$$

$$\text{Minimum \% reinforcement } k = 0.13 \%$$

$$A_{st_min} = k \times A_c = 520 \text{ mm}^2/\text{m}$$

$$A_{st_max} = 4 \% \times A_c = 16000 \text{ mm}^2/\text{m}$$

Steel defined:

$$\text{Outer steel resisting sagging } A_{sx_prov} = 785 \text{ mm}^2/\text{m}$$

Area of outer steel provided (sagging) OK

$$\text{Inner steel resisting sagging } A_{sy_prov} = 785 \text{ mm}^2/\text{m}$$

Area of inner steel provided (sagging) OK

SHEAR RESISTANCE OF CONCRETE SLABS (CL 3.5.5)

Outer tension steel resisting sagging moments

$$\text{Depth to tension steel from compression face } d_x = 355 \text{ mm}$$

$$\text{Area of tension reinforcement provided (per m width of slab) } A_{sx_prov} = 785 \text{ mm}^2/\text{m}$$

$$\text{Design ultimate shear force (per m width of slab) } V_x = 117 \text{ kN/m}$$

$$\text{Characteristic strength of concrete } f_{cu} = 40 \text{ N/mm}^2$$

Applied shear stress

$$v_x = V_x / d_x = 0.33 \text{ N/mm}^2$$

Check shear stress to clause 3.5.5.2

$$V_{allowable} = \min((0.8 \text{ N}^{1/2}/\text{mm}) \times \sqrt{f_{cu}}, 5 \text{ N/mm}^2) = 5.00 \text{ N/mm}^2$$

Shear stress - OK

Shear stresses to clause 3.5.5.3

Design shear stress

$$f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/mm}^2, 40/25, f_{cu}/(25 \text{ N/mm}^2)) = 1.600$$

$$v_{cx} = 0.79 \text{ N/mm}^2 \times \min(3,100 \times A_{sx_prov} / d_x)^{1/3} \times \max(0.67, (400 \text{ mm} / d_x)^{1/4}) / 1.25 \times f_{cu_ratio}^{1/3}$$

$$v_{cx} = 0.46 \text{ N/mm}^2$$

Applied shear stress

$$v_x = 0.33 \text{ N/mm}^2$$

No shear reinforcement required

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SHEAR RESISTANCE OF CONCRETE SLABS (CL 3.5.5)

Inner tension steel resisting sagging moments

Depth to tension steel from compression face $d_y = 345 \text{ mm}$

Area of tension reinforcement provided (per m width of slab) $A_{sy_prov} = 785 \text{ mm}^2/\text{m}$

Design ultimate shear force (per m width of slab) $V_y = 117 \text{ kN/m}$

Characteristic strength of concrete $f_{cu} = 40 \text{ N/mm}^2$

Applied shear stress

$$v_y = V_y / d_y = 0.34 \text{ N/mm}^2$$

Check shear stress to clause 3.5.5.2

$$V_{allowable} = \min ((0.8 \text{ N}^{1/2}/\text{mm}) \times \sqrt{f_{cu}}, 5 \text{ N/mm}^2) = 5.00 \text{ N/mm}^2$$

Shear stress - OK

Shear stresses to clause 3.5.5.3

Design shear stress

$$f_{cu_ratio} = \text{if } (f_{cu} > 40 \text{ N/mm}^2, 40/25, f_{cu}/(25 \text{ N/mm}^2)) = 1.600$$

$$v_{oy} = 0.79 \text{ N/mm}^2 \times \min(3,100 \times A_{sy_prov} / d_y)^{1/3} \times \max(0.67, (400 \text{ mm}) / d_y)^{1/4} / 1.25 \times f_{cu_ratio}^{1/3}$$

$$v_{oy} = 0.47 \text{ N/mm}^2$$

Applied shear stress

$$v_y = 0.34 \text{ N/mm}^2$$

No shear reinforcement required

CONCRETE SLAB DEFLECTION CHECK (CL 3.5.7)

Slab span length $l_x = 3.000 \text{ m}$

Design ultimate moment in shorter span per m width $m_{sx} = 49 \text{ kNm/m}$

Depth to outer tension steel $d_x = 355 \text{ mm}$

Tension steel

Area of outer tension reinforcement provided $A_{sx_prov} = 785 \text{ mm}^2/\text{m}$

Area of tension reinforcement required $A_{sx_req} = 336 \text{ mm}^2/\text{m}$

Moment Redistribution Factor $\beta_{bx} = 1.00$

Modification Factors

Basic span / effective depth ratio (Table 3.9) $\text{ratio}_{\text{span_depth}} = 20$

The modification factor for spans in excess of 10m (ref. cl 3.4.6.4) has not been included.

$$f_s = 2 \times f_y \times A_{sx_req} / (3 \times A_{sx_prov} \times \beta_{bx}) = 142.9 \text{ N/mm}^2$$

$$\text{factor}_{\text{tens}} = \min (2, 0.55 + (477 \text{ N/mm}^2 - f_s) / (120 \times (0.9 \text{ N/mm}^2 + m_{sx} / d_x^2))) = 2.000$$

Calculate Maximum Span

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This is a simplified approach and further attention should be given where special circumstances exist. Refer to clauses 3.4.6.4 and 3.4.6.7.

$$\text{Maximum span } l_{\max} = \text{ratio}_{\text{span_depth}} \times \text{factor}_{\text{tens}} \times d_x = 14.20 \text{ m}$$

Check the actual beam span

$$\text{Actual span/depth ratio } l_x / d_x = 8.45$$

$$\text{Span depth limit } \text{ratio}_{\text{span_depth}} \times \text{factor}_{\text{tens}} = 40.00$$

Span/Depth ratio check satisfied

CHECK OF NOMINAL COVER (SAGGING) – (BS8110:PT 1, TABLE 3.4)

$$\text{Slab thickness } h = 400 \text{ mm}$$

$$\text{Effective depth to bottom outer tension reinforcement } d_x = 355.0 \text{ mm}$$

$$\text{Diameter of tension reinforcement } D_x = 10 \text{ mm}$$

$$\text{Diameter of links } L_{\text{dialx}} = 0 \text{ mm}$$

Cover to outer tension reinforcement

$$c_{\text{tenx}} = h - d_x - D_x / 2 = 40.0 \text{ mm}$$

Nominal cover to links steel

$$c_{\text{nomx}} = c_{\text{tenx}} - L_{\text{dialx}} = 40.0 \text{ mm}$$

Permissible minimum nominal cover to all reinforcement (Table 3.4)

$$c_{\text{min}} = 40 \text{ mm}$$

Cover over steel resisting sagging OK