RE Certificate

Paper 2: Coal option

Memorandum – June 2003 Exam

Question 1

<u>Question 1(a)</u>

$$SF = k\frac{w^{2.46}}{0.025Hh^{0.66}C^2}$$

If w is reduced by factor f to fw, then

$$SF_1 = k\frac{(fw)^{2.46}}{0.025Hh^{0.66}C^2}$$

Safety factor reduction is SF/SF_1 or

$$\frac{SF}{SF_1} = \frac{k\frac{w^{2.46}}{.025Hh^{.66}C^2}}{k\frac{(fw)^{2.46}}{.025Hh^{.66}C^2}}$$

$$= f^{2.46}$$

In this case width is reduced by 10% to 0.9w, or f=.9 and then

$$\frac{SF}{SF_1} = .9^{2.46} = .77$$

Therefore reduction is 23%

<u>Question 1(b)</u>

(i) Minimum pillar width = 5 m
(ii) Minimum w/h = 2
(iii) Minimum SF = 1.6
(iv) Maximum extraction = 75%
(v) (I) to (iv) all to be valid at the same time

<u>Question 1(c)</u>

See Figure 1c next page

For w/h = <5, use Salamon-Munro
For w/h > 5, use Squat

Sketch should clearly indicate concave shape at w/h< 5 and convex shape at w/h> 5

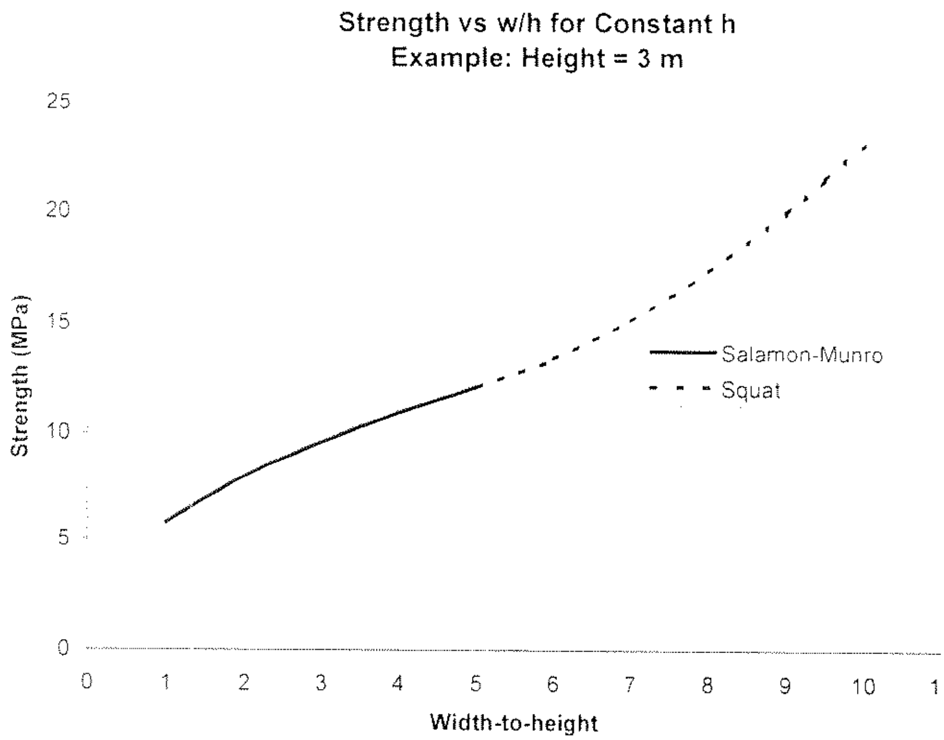

Figure 1c

Question 2

Question 2(a)
The table shows that beyond a fall height of 0.6 m, there are structural features involved. A general rule should cater for suspension up to 0.6 m complemented by a special joint/dyke rule that should cater for falls to 1.3 m. This will eventually prevent > 99% of all falls.

The normal suspension rule for a height of 0.6 m will prevent 90% of falls, see figure 2a.

Question 2(b)

By inspection of the borehole log, it is clear that the first roof unit capable of supporting the nether roof is the 2 m thick sandstone. Even if only 0.6 m of roof is to be suspended from it in the design, it will have to be strong enough to bear the load of its own weight plus everything underneath it, with a combined thickness of t_T. A safety factor, F, of 1.5 should be used.

The stability of the sandstone layer with thickness t_s is also a function of the road width, B. The maximum road width over which the sandstone will be stable under these conditions can be calculated as follows:

$\sigma = \dfrac{F\rho g t_T B^2}{2t_s^2}$ from which it follows that

$$B = 1.414 t_s \sqrt{\frac{\sigma}{F \rho g t_T}} = 24.2m$$

Note: candidates should derive the equation and use reasonable values for the tensile strength of sandstone, 5 to 8 MPa. This answer is for 5 MPa.

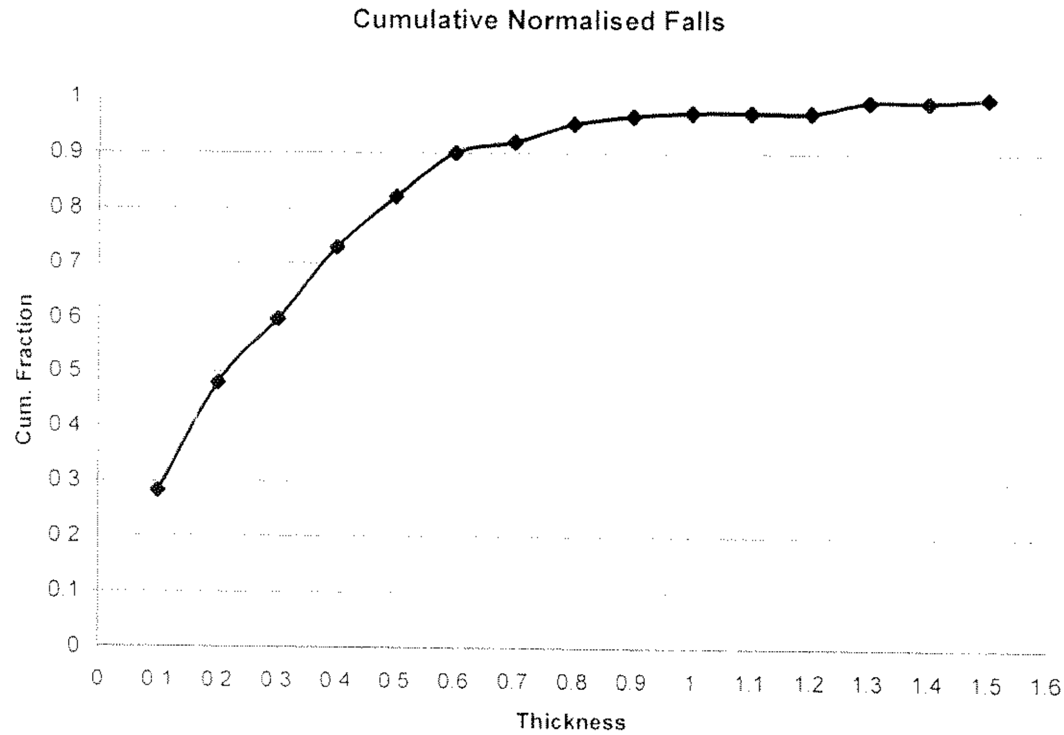

Figure 2a

Question 2(c)

Assumptions to be stated:

Bolt diameter (M16, M20 or M25, width 2 mm less than thread, so 14 mm, 18 mm or 23 mm bolt also fine)

Hole diameter (4 – 8 mm wider than bolt)

Bolt & hole diameter choice must be motivated – i.e. based on corrosion considerations, mixability of resin, ease of drilling, reliability of installation, etc.

Shear strength of resin/rock contact (range of 1.0 to 3.0 MPa acceptable)

$$l_a = \frac{\gamma s_b^2 t_w}{\pi d_h \tau} + .05$$

Then, bolt length = anchor length + thickness of weak layer

Note: It ias also acceptable to use a weak layer thickness of 0.9 (i.e. everything underneath the sandstone, although it has an unnecessary cost implication to the mine. For this, 1 mark is deducted)

Acceptable Answers:

Hole dia	Shear str	Weak thickness	Anchor length	Bolt length
.025	2	.6	.26	.86
.028	2	.6	.24	.84
.025	1.5	.6	.34	.94
.028	1.5	.6	.31	.91
.025	2.5	.6	.22	.82
.028	2.5	.6	.20	.80
.025	2	.9	.37	1.27
.028	2	.9	.34	1.24
.025	1.5	.9	.48	1.38
.028	1.5	.9	.43	1.33
.025	2.5	.9	.31	1.21
.028	2.5	.9	.28	1.18

Question 3

Question 3(a)

See Figure 3(a)

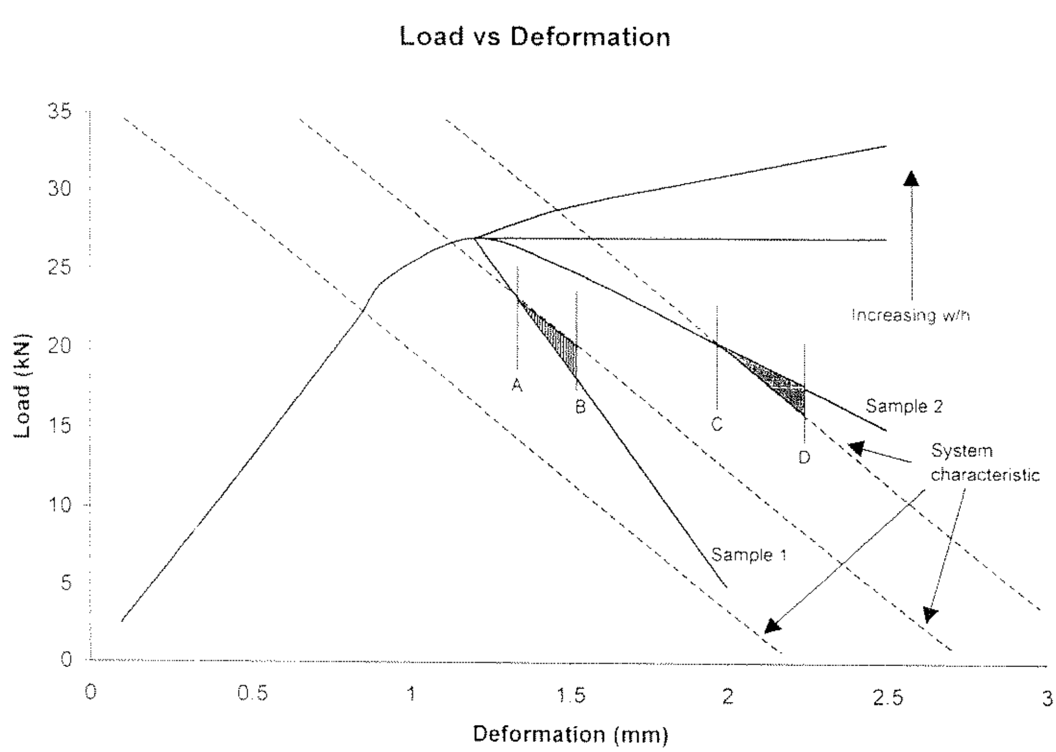

Figure 3(a)

Stable failure occurs when the unloading characteristic of the loading system has a steeper negative slope than the post failure load/deformation characteristic of the pillar, i.e. point C-D on Sample 2 in the figure. The area underneath the Sample line represents the energy required to drive the deformation of the sample from C to D. The area underneath the System line represents the energy available in the system for the same deformation. The energy available in the system is less than that required, therefore further deformation can only occur if an amount of energy represented by the shaded portion is added to the system.

Violent failure occurs when the load/deformation curve of the pillar has a steeper negative slope than the unloading characteristic of the loading system, as at A-B in the figure. By the same argument as above, there is now more energy available than required by the pillar. This energy is transformed into kinetic energy, resulting in the specimen (pillar) "exploding" violently.

Question 3(b)
The post failure stiffness of a pillar is determined by its w/h ratio.
As the width-to-height ratio of the pillar increases, the post failure modulus also increases (becomes less negative) – see figure.
At a w/h of approximately 4, it is 0 and at higher w/h ratio's, it will always be positive.
It influences the mode of failure because the mode is governed by the difference between the post failure modulus and the system unloading characteristic.

Question 3(c)
The stiffness of the loading system on a pillar is the stiffness of the overburden. The stiffer it is, the greater the negative slope of the unloading line in the figure.
Therefore, the less the overburden deflects, the stiffer it is.
Stiff material, like dolerite > stiffness
Thick layers > stiffness
The narrower the panel, the > stiffness

The worst case is a failed overburden with frictionless contacts, which is a dead weight situation with zero stiffness (a horizontal unloading line in the figure).

Question 4(a)

Check for dolerite failure

$$\gamma_m = .025\frac{H-T}{H} + .03\frac{T}{H} = .0259$$

$$\beta = \frac{1.53}{\gamma} - .8 = 58.25$$

$$L_c = 2T\sqrt{k + \frac{\beta}{D}} + 2(H-D)\tan\phi = 97.7m$$

Panel width > L_c thus dolerite will fail.

$$S_m = .39h\left(\frac{W}{H}\right)^{32} = 1.54m$$

$$T_m = 21.6S_m + 7 = 40.3mm/m$$

$$\varepsilon - = -9.1S_m - 2.8 = -16.8mm/m$$

$$\varepsilon + = 4.2S_m + 1.7 = 8.2mm/m$$

Question ~~2~~4(b)
S_m/H = 1.54/110 = .014

Thus Class C subsidence:
Smooth profile, noticable in flat terrain, cracks 2 to 10 cm wide, compression ridges 1 to 5 cm high.

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Question 3(c)
Essential to mine continuously, no off-days
Service equipment before time
Ensure proper tip support
Support gate roads

Question 5

Question	True	False	Question	True	False
a i	x		f i		x
ii		x	ii		x
iii	x		iii		x
iv		x	iv		x
b i		x	g i		x
ii		x	ii		x
iii		x	iii	x	
iv		x	iv	x	
c i	x		h i		x
ii		x	ii		x
iii		x	iii		x
iv	x or	x	iv	x	
d i		x	i i		x
ii	x		ii		x
iii		x	iii		x
iv		x	iv	x	
e i		x	j i		x
ii	x		ii		x
iii		x	iii		x
iv	x		iv		x