Question- Four-legged shield type support units are used support strata in a longwall mining process. If yielding strength of the support unit is 90 tonnes/leg and shield (contact) area of each unit is 2.25 m², determine the maximum depth of overburden to achieve supporting with a safety factor of 1.8 (Assume vertical pressure is a function of depth as \( P_v = z \gamma \) where \( z \) is depth and \( \gamma \) is unit weight of strata=2 g/cm³).

Answer

For four legged unit, capacity = \( 90 \text{ t/leg} \times 4 \text{ legs} = 360 \text{ tonnes} \)

Support density = \( \frac{360}{2.25} = 160 \text{ t/m}^2 \)

For safety factor, max. support density = \( \frac{160}{1.8} = 88.9 \text{ t/m}^2 \)

For equilibrium, \( P_v = \text{max.support density} = z \gamma \), then max. depth, \( z = \frac{88.9}{2} = 44.45 \text{ m.} \)

Question- A massive ore has a tonnage factor of 0.2 m³/t. The ore contains 20% Galena, 30% Sphalerite and 50% Pyrite by weight. If the specific gravities of Galena and Sphalerite are 7.5 and 4.2 respectively, determine the specific gravity of Pyrite.

Answer

Unit weight of ore = \( \frac{1}{0.2} = 5 \text{ t/m}^3 \) → Specific gravity of ore = 5

If % by weight (Assume 100 tonnes of ore)

\[
\frac{20}{7.5} + \frac{30}{4.2} + \frac{50}{X} = 100/5 \rightarrow X = \frac{50}{(20-2.67-7.14)} \rightarrow X \text{ (SG of Pyrite)} = \frac{50}{10.19} = 4.90
\]

Question- A material's volume increases 40% when it is loosened. If 1.3 m³ of loose material weights 2200 kg, determine;

a) Swell factor of the material
b) Loose unit weight, in gr/cm³
c) Bank unit weight, in gr/cm³

Answer

a. Swell Factor = \( 100/(100+%\text{of swell}) = 100/140 = 0.714 \) or

\( \text{Swell Factor} = (100+%\text{of swell})/100 = 140/100 = 1.4 \)

b. Loose unit weight = 2200 kg/1.3 m³ = 1692 kg/m³ = 1.692 t/m³ = 1692 g/cm³

c. If SF<1 then Bank unit weight = Loose unit weight / SF = 1.692 g/cm³ / 0.714 = 2.37 g/cm³

If SF>1 then Bank unit weight = Loose unit weight * SF = 1.692 g/cm³ * 1.4 = 2.37 g/cm³

Question- Bank specific weight of a material is 3.0 g/cm³. If 0.8 m³ of loose material weights 2000 kg, determine swell factor and percent swell of the material.

Answer

Loose specific weight = \( (2000 \times 1/0.8) = 2500 \text{ kg/m}^3 = 2.5 \text{ gr/cm}^3 \)

Swell Factor (SF) = Bank Sp.W./Loose Sp.W. = 3.0/2.5 = 1.2 or 2.5/3.0 = 0.83

Swell percentage = \( 100 \times SF-100 = 100 \times 1.2-100 = 20\% \)
Question- A horizontal adit with a 4 m² face excavation area is driven as shown. A locomotive is run to carry the broken material to the surface. If the followings are given, determine the amount of advance per cut.

Intact (bank) rock density : 2.2 g/cm³
Car weight : 1000 kg.
Number of cars : 4
Locomotive weight : 2500 kg.
Locomotive power : 20 HP
Loaded travel time : 10 min.
Friction coefficient on rail : 0.02
Motor efficiency : 80%

Answer

\[ V = \frac{1500}{10 \times 60} = 2.5 \text{ m/s} \]
\[ N = \frac{\Sigma F \cdot V}{(75 \cdot \eta)} \Rightarrow \Sigma F = 20 \times 75 \times 0.8 / 2.5 = 480 \text{ kg.} \]
\[ \Sigma F = (\mu \pm i) [W_g + n(W_w + W_l)] \Rightarrow 480 = 0.02 [2500 + 4(1000 + W_f)] \Rightarrow \]
Total material for four cars : \[ 4W_l = (480 \times 50 - 6500) = 17500 \text{ kg} \]
\[ 17500 \text{ kg} / 2200 \text{ kg/m}^3 = 7.95 \text{ m}^3 \]
\[ 4 \text{ m}^2 \times L = 7.95 \text{ m}^3 \Rightarrow L \text{ (advance per cut)} = 7.95 / 4 = 1.99 \text{ m} \]

Question- A circular pillar is left in underground to protect an area at the surface. The coal seam is horizontally bedded at 250 m below surface. If diameter of the pillar is 320 m and the angle of draw is 22°, determine size of protected area in m² (thickness of seam is ignored).

Answer

\[ CD = AD \times \text{tan} 22° = 250 \times \text{tan} 22° = 101 \text{ m} = EF \]
\[ AB = DE = 320 - 2 \times 110 = 118 \text{ m} \text{ (diameter of protected area at the surface, circular)} \]
Area of protected shape \[ \pi r^2 = \pi (118/2)^2 = 10935 \text{ m}^2 \]

Question- A sump located in underground is used to pump mine water via an inclined drift. For givens, determine the pipe diameter to run the system. (Neglect fitting losses).

Pipe diameter : ? cm.
Water speed in pipe : 1.8 m/s
Gravity : 9.81 m/s²
Efficiency : 80%
Friction factor of pipe : 0.02
Water flow rate : 1.2 l/s
Pump power : 3 HP

Answer

\[ N = \frac{(Q \cdot \Sigma \cdot H \cdot \gamma)}{(75 \cdot \eta)} \Rightarrow \Sigma H = (3 \times 75 \times 0.8)/(0.0012 \times 1000) = 150 \text{ m} \]
\[ \Sigma H = \Delta H + H_s \text{ (fitting loss is neglected)} \Rightarrow 150 = (h_y - h_0) + H_s \Rightarrow H_s = 150 - (456 - 320) = 14 \text{ m} \]
\[ L = [(h_y - h_0) / \sin \alpha] + h_s = [(456 - 324) / \sin 30] + 8 = 272 \text{ m} \]
Friction loss, \[ H_s = [(\lambda \cdot V^2 \cdot L) / (2 \cdot g \cdot D)] = (0.02 \times 1.6^2 \times 272) / (2 \times 9.81 \times 4) = 4.5 \text{ m} \]
\[ D = (0.02 \times 1.6^2 \times 272) / (2 \times 9.81 \times 4) = 17.62 / 274.68 = 0.064 \text{ m} = 6.4 \text{ cm} \]
Question- A vertical ore seam with an uniform thickness of 12 meter is mined. If the figure and parameters are given, determine the stripping cost in TL/m³. Consider that 180 m is the critical depth to mine by surface mining method.

<table>
<thead>
<tr>
<th>Type of Mining</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open pit mining</td>
<td>16 TL/t</td>
</tr>
<tr>
<td>Underground mining</td>
<td>35 TL/t</td>
</tr>
<tr>
<td>Critical depth</td>
<td>180 m</td>
</tr>
<tr>
<td>Density of coal</td>
<td>1.3 g/cm³</td>
</tr>
</tbody>
</table>

Answer

Critical Stripping Ratio = (Underground cost - Open Pit Cost) / Stripping Cost

According to costs, SR will be m³/t (= (TL/t)/(TL/m³)). That means m³ waste/tonnage of coal

To determine the coal and waste amount, we assume any length in the 3rd direction. Ex. 1 m.

Coal volume = 180*12*1 = 2160 m³
Coal weight = 2160 m³*1.3 t/m³ = 2808 tonnes
Waste volume = 180*180*tan32°*1 = 20245 m³
SR = 20245 m³/2808 t = 7.21 m³/t

7.21 m³/t = (35-16 TL/t) / Stripping Cost<br>Stripping Cost = (19 TL/t) / 7.21 m³/t = 2.64 TL/m³

Question- A car hoisting system is running on an inclined drift as shown in the figure. Determine required motor power (HP) to run the system.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste weight in car</td>
<td>2000 kg</td>
</tr>
<tr>
<td>Car empty weight</td>
<td>750 kg</td>
</tr>
<tr>
<td>Slope</td>
<td>30°</td>
</tr>
<tr>
<td>Road distance</td>
<td>120 m</td>
</tr>
<tr>
<td>Traction coefficient</td>
<td>10 kg/t</td>
</tr>
<tr>
<td>Friction on rollers</td>
<td>0.2</td>
</tr>
<tr>
<td>Hoisting speed</td>
<td>1 m/s</td>
</tr>
<tr>
<td>Motor efficiency</td>
<td>80%</td>
</tr>
<tr>
<td>Rope weight</td>
<td>0.45 kg/m</td>
</tr>
</tbody>
</table>

Answer

Static weight, \(W = W_b + W_t = 2000+750 = 2750\) kg

\(W_x = W \cdot \sin \alpha = 2750 \cdot \sin 30 = 1375\) kg

\(W_y = W \cdot \cos \alpha = 2750 \cdot \cos 30 = 2382\) kg = 2.38 t

Traction force, \(F_s = T \cdot W_y = 10 \cdot 2.38 = 23.8\) kg

Forces due to traction and material, \(F = W_x + F_s = 1375+23.8 = 1398.8\) kg

Forces due to rope weight and friction on rollers;

\(F_r = q \cdot S \cdot \sin \alpha + q \cdot S \cdot \cos \alpha \cdot \mu = 0.45 \cdot 120 \cdot \sin 30 + 0.45 \cdot 120 \cdot \cos 30 \cdot 0.2 = 27 + 9.4 = 36.4\) kg

Total force, \(\Sigma F = F + F_r = 1398.8 + 36.4 = 1435.2\) kg

Motor power, \(N = (\Sigma F \cdot V) / (75 \cdot n) = (1435.2 \cdot 1) / (75 \cdot 0.8) = 23.9\) HP or \(23.9 \cdot 0.75 = 18\) kW

Question- Rectangular pillars, 4 m x 6 m in dimensions, are left to support and the rest is mined. If the extraction percentage (ratio) is 80%, determine the influence area of a singular pillar.

Answer

the influence area of a pillar is equal to whole area as well

\(e (extraction\ ratio) = \frac{excavated\ area}{whole\ area} = \frac{(whole\ area - pillar\ area)}{whole\ area}\)

then,

\(0.8 = (x-(4 \cdot 6)) / x \Rightarrow x = 24 / (1-0.8) = 120\) m²
Question- A sump will be located in underground to pump mine water via an inclined drift. For givens, determine the elevation at discharge point \( (h_y) \). (Ignore fitting losses).

Pipe diameter : 5 cm.
Water speed in pipe : 1.6 m/s
Gravity : 9.81 m/s²
Efficiency : 80%
Friction factor of pipe : 0.02
Water flow rate : 1.2 l/s
Pump power : 4 HP

Answer

\[
N = \frac{(Q \cdot \Sigma H \cdot \gamma)}{(75 \cdot \eta) } \Rightarrow \Sigma H = (4 \cdot 75 \cdot 0.8)/(0.0012 \cdot 1000) = 200 \text{ m}
\]
Friction loss, \( H_s = [(\lambda \cdot V^2 \cdot L)/(2 \cdot g \cdot D)] = [(0.02 \cdot 1.6^2 \cdot L)/(2 \cdot 9.81 \cdot 0.05)] = 0.0522L \)
Pipe length, \( L = [(h_y-h_t)/\sin \alpha] + h_s = [(h_y-324)/\sin 30] + 8 = 2h_y-648+8 = 2h_y-640 \)
\( \Sigma H = \Delta h + H_s \) (fitting loss is ignored) \( \Rightarrow \) \( 200 = (h_y-h_t)+0.0522L \) \( \Rightarrow \)
\( 200 = (h_y-320)+0.0522(2h_y-640) = h_y+0.1044h_y-33.41-320 \)
\( 1.1044h_y = 200+353.41 \) \( \Rightarrow \) \( h_y = 553.41/1.1044 = 501.1 \text{ m} \)

Question- A mine drift with a cross-sectional face area of 12 m² is driven upwards with an inclination (grade) of 0.3%. The broken material is hauled by a locomotive. For information given below, determine the amount of advance per round. Assume cars are full with their capacities.

Unit weight of intact (bank) rock; 2 g/cm³
Car empty weight; 800 kg.
Locomotive weight; 2500 kg.
Locomotive velocity (loaded); 6 m/sec
Friction coefficient on rail; 0.01
Number of cars; 6
Locomotive motor power; 30 HP
Motor efficiency; 80%

Answer

\[
30 \text{ HP} = \frac{(\Sigma F \cdot 6 \text{ m/s})}{(75 \cdot 0.8)} \Rightarrow \Sigma F = 300 \text{ kg}
\]
\( 300 \text{ kg} = (0.01-0.003) \cdot [2500+6(800+x)] \Rightarrow 6x = (300/0.007)-2500-4800 \) then
\( 6x = 35557 \text{ kg} \) (Total amount of material hauled after per advance in drift)
Volume = 35557/2000 = 17.78 m³ (volume of hauled material)
Advance = 17.78/12 = 1.48 m. advance per round

Question- A horizontal (flat) coal seam with a constant thickness of 4 m is situated 200 m below surface. A pillar of coal in square shape (top view) is left to protect the shaft and the surface area around the shaft. The amount of coal left in pillar is 360000 m³. Angle of draw is 20°. Determine the size of the area protected at the surface. (Use analytical solution).

Answer

Pillar area = 360000/4 = 90000 m²
Pillar size (square) = \((90000)^{1/2} = 300 \text{ m}\)
Size at surface = 300-2*200*tan20° = 154.4 m (side of square area protected at the surface)
Protected area = 154.4*154.4 = 23843 m²
Question- A horizontal mine drift with a cross-sectional face area of 10 m² is driven and the broken material is hauled by a locomotive. For information given below, determine the maximum amount of material (in kg or tonnes) can be carried by each of the cars.

- Unit weight of Intact (bank) rock; 2 g/cm³
- Car empty weight; 700 kg.
- Locomotive weight; 2500 kg.
- Locomotive velocity (loaded/unloaded); 3 m/sec
- Friction coefficient on rail; 0.01
- Number of cars; 6
- Locomotive motor power; 10 HP
- Motor efficiency; 80%

Answer

\[
10 \text{ HP} = (\Sigma F \times 3 \text{ m/s}) / (75 \times 0.8) \Rightarrow \Sigma F = (10 \times 75 \times 0.8) / 3 = 200 \text{ kg}
\]

\[
200 \text{ kg} = (0.01) [2500 + 6 (700 + x)] \Rightarrow 6x = (2000/0.01) - 2500 - 4200 \quad \text{then}
\]

\[
6x = 13300 \text{ kg} \quad \text{(Total amount of material carried at once)}
\]

Capacity of per car = 13300/6 = 2216 kg

Question- A sump will be located in underground to pump mine water via an inclined drift. For given parameters, determine the pump power. (Ignore fitting losses).

- Pipe diameter : 5 cm.
- Water speed in pipe : 1.2 m/s
- Gravitational acc. : 9.81 m/s²
- Efficiency : 75%
- Friction factor of pipe : 0.02
- Water flow rate : 3.4 l/s

Answer

\[
\Delta h = [(h_y-h_s) = 480-320 = 160 \text{ m}] \quad L = (h_y-h_t)/\sin 28^\circ + 8 = 156/\sin 28^\circ + 8 = 340 \text{ m}
\]

If we ignore fitting losses,

\[
\Sigma H = \Delta h + [(\lambda \cdot V^2 \cdot L)/(2 \cdot g \cdot D)] = 160 + 0.02 \times 1.2^2 \times 340/2 \times 9.81 \times 0.05 = 160 + 9.98 = 170 \text{ m}
\]

Pump Power, \(N = (Q \cdot \Sigma H \cdot \gamma) / (75 \cdot \eta) = 170 \times 3.4 \times 10^{-3} \times 1000/(75 \times 0.75) = 10.3 \text{ HP}\)

Question- 760 kg of a loose material occupies a volume of 0.8 m³. Determine bank unit weight of this material if its swell percentage is 40 percent by volume.

Answer

Loose unit weight = 760/0.8 = 950 kg

Swell factor = 1.4 = Bank U.W./Loose U.W. \quad \text{then}

Bank Unit Weight = 950 \times 1.4 = 1330 kg/m³ = 1.33 g/cm³

Question- In a room-and-pillar mining, rectangular pillars of 4 mx6 m in dimensions are left to support and the rest of the seam is mined. If the influence area of a single pillar is 96 m² determine extraction percentage (ratio).

Answer

the influence area of a pillar is equal to whole area as well

\[
e = \frac{\text{excavated area}}{\text{whole area}}
\]

then,

\[
e = (96-24)/96 = 75%
\]