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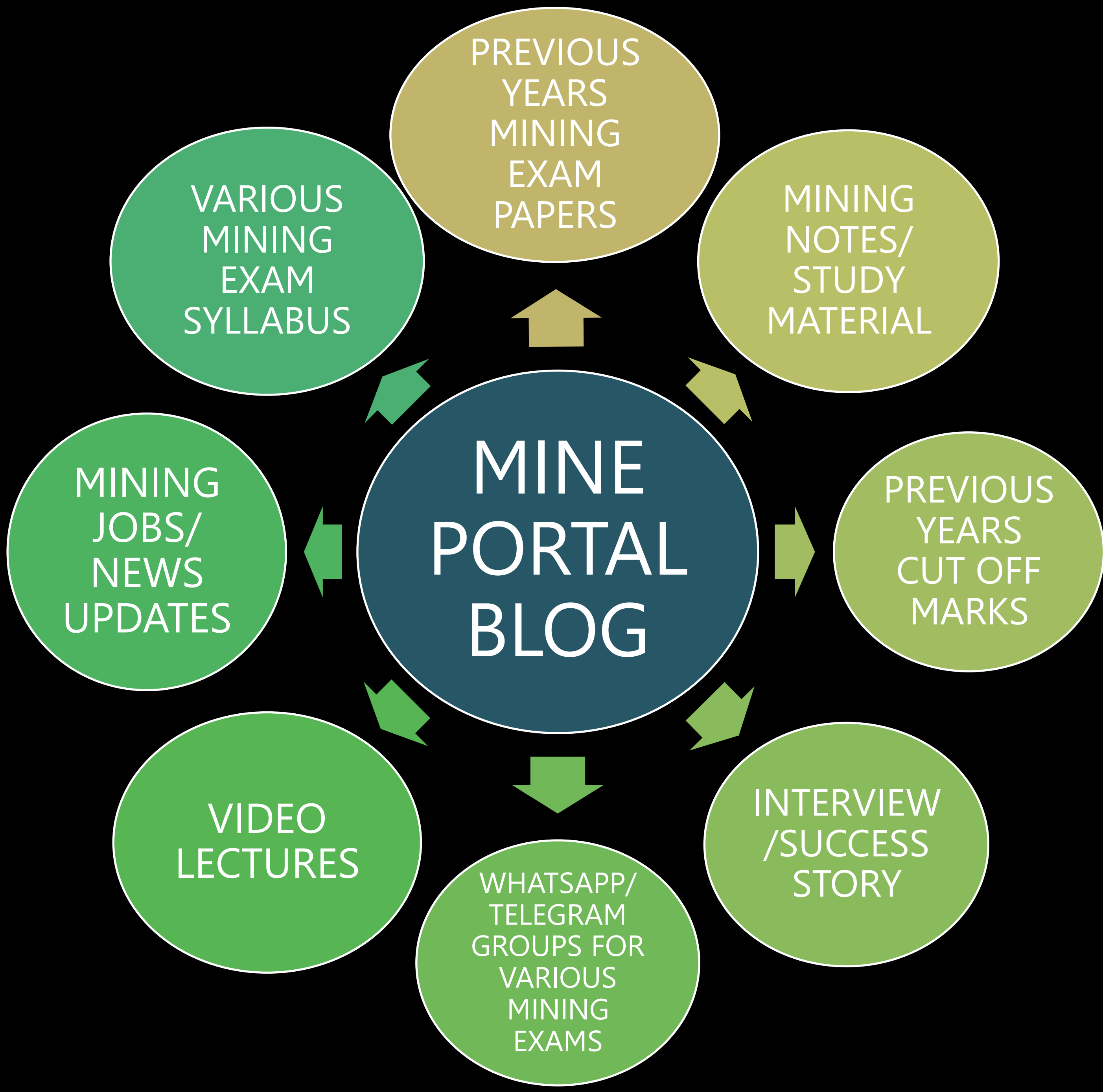

SEARCH ‘MINEPORTAL’ IN TELEGRAM TO JOIN VARIOUS MINING EXAM GROUPS

GATE MINING EXAMS IMPORTANT FORMULAES

Rock Mechanics Gate formula

① RQD(%) = $100 \cdot e^{-0.1\lambda} \times (-0.1\lambda + 1)$

λ = no. of fractures per m length

② Unit weight (γ) = $\dfrac{\text{wt of rock}}{\text{Volume of rock}} = \dfrac{N}{m^3}$

③ Sp. gravity = $\dfrac{\text{Density of solid}}{\text{Density of water } (1000\ kg/m^3)}$ / $\dfrac{\text{wt of solid in air}}{\text{wt of solid in air} - \text{wt of solid (water)}}$

④ Void Ratio = $\dfrac{\text{Volume of Void}}{\text{Volume of Solid}} = \dfrac{V_v}{V_s} = e$ $(V_s = 1)$ then $V_v = e$

⑤ Porosity = $\dfrac{\text{Volume of Void}}{\text{Total Volume}} = \dfrac{V_v}{V_v + V_s} = \dfrac{e}{e+1}$

⑥ Degree of Saturation (s) = $\dfrac{\text{Volume of Water}}{\text{Volume of Void}} = \dfrac{V_w}{V_v} = \boxed{S \cdot e = V_w}$

⑦ Moisture Content (W) = $\dfrac{\text{wt of water}}{\text{wt of sample}} \times 100$

⑧ Bulk Density = $\dfrac{\text{Mass}}{\text{Volume}} = \dfrac{M_a + M_w + M_s}{V_T} = \dfrac{S \cdot e\, \rho_w + S_G\, \rho_w \cdot 1}{1+e}$

⑨ Saturated Density = $\dfrac{\text{Mass}}{\text{Volume}} = \dfrac{M_w + M_s}{V_T} = \dfrac{Se\, \rho_w + S_G\, \rho_w \cdot 1}{1+e}$

⑩ Dry Density = $\dfrac{\text{Mass}}{\text{Volume}} = \dfrac{M_a + M_s}{V_T} = \dfrac{\rho_w \cdot S_G \cdot 1}{1+e}$ M_a = Negligible

⑪ Permeability (Darcy's law) $Q = KIA$

Q → m^3/s; K → m/h or day; I → Hydraulic gradient; A → Area (m^2)

⑫ Young Modulus $E = \dfrac{\text{Stress}}{\text{Strain}} = \dfrac{F/A}{\Delta L/L}$ = N/m^2 or Pascal

⑬ Strain Energy $U = \dfrac{F \cdot \Delta L}{2} = \dfrac{F}{2} \times \dfrac{FL}{AE} = \dfrac{F^2 L}{2AE}$

⑭ Poisson's Ratio (μ or m) = $\dfrac{\text{lateral strain}}{\text{longitudinal strain}}$ $\boxed{m < 1}$

$= \dfrac{\Delta D/D}{\Delta L/L}$

⑮ Volumetric strain $\dfrac{\Delta V}{V} = \underset{\text{longitudinal strain}}{\varepsilon}\,(1 - 2\underset{\text{Poisson ratio}}{m})$

$$\boxed{E = 2G(1+m) = 3K(1-2m)}$$

G = Shear Modulus / Modulus of Rigidity

K = Bulk Modulus

Hydraulic stress = K × Volumetric strain

$\sigma = K \varepsilon_v$

Bulk Modulus $\boxed{\rightarrow K = \dfrac{\sigma}{\varepsilon_v}}$

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$$\boxed{\frac{\sigma_H}{\sigma_V} = \frac{m}{1-m}}$$

(17) Mohr Circle

Major Principal stress $\rightarrow \sigma_1 = \frac{\sigma_x+\sigma_y}{2} + R \rightarrow$ Radius of circle $= \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + \tau_{xy}^2}$

Minor Principal stress $\rightarrow \sigma_2 = \frac{\sigma_x+\sigma_y}{2} - R$

$\frac{\sigma_x+\sigma_y}{2}$ → center coordinates

Mohr circle ke question ache se kar exam time

At any pt on circle N_0 (Normal stress) $= \frac{\sigma_x+\sigma_y}{2} + R\cos 2\theta$

T_0 (shear stress) $= \cancel{\sigma}\ R\sin 2\theta$

(18) Peak shear strength $= \tau = c + \sigma \tan\phi$

c = cohesion ϕ = angle of internal friction σ = stress

Mohr Coulumb Criteria for Triaxial data

$$\sigma_1 = \frac{2c\cos\phi}{1-\sin\phi} + \frac{1+\sin\phi}{1-\sin\phi}\cdot\sigma_2$$

c = cohesion

ϕ = angle of internal friction

$$\boxed{\sigma_1 = \sigma_{ci} + \frac{\sigma_{ci}}{\sigma_{tensile}}\cdot\sigma_2}$$

σ_{ci} = Uniaxial compressive strength

$\sigma_{tensile}$ = Uniaxial tensile strength

$$\boxed{\sigma_{ci} = \frac{2c\cos\phi}{1-\sin\phi}} \qquad \boxed{\sigma_{tensile} = \frac{2c\cos\phi}{1+\sin\phi}}$$

+ Motive Column $H = \frac{D(T_u - T_o)}{T_u}$ $T_u = 273 + c°$ $T_o = 273 + c°$

Critical Pressure of Booster $P_c = \frac{P_f \times R_s}{R_T}$ (P_f → fan Pressure, R_s → split, R_T → Trunk)

Booster = P, ↑ se

Regulator = Q ↓ or ↑ se, P remain same

Torque = Tension × Radius $V = \omega r$

Power = Tension × Velocity $\omega = 2\pi n/60$

Number of faces available for board & pillar development district with 'n' no. of headings : Max = $3n-2$

Mini = n

Average = $2n-1$

Friction clutch = endless rope haulage

Claw or Dog or Jaw clutch = Winding drum & large direct haulage

Diametrical pitch = $\boxed{\frac{N}{D}}$ n = no. of teeth

D = pitch diameter

Center to Center distance = $\frac{PDG_1 + PDG_2}{2}$ or $\frac{(N_1+N_2)m}{2}$

PDG_1 = Pitch Diameter of gear 1 & 2

N_1 & N_2 = No. of teeth m = module = $\boxed{D/N}$ = $\frac{1}{\text{Dia. Pitch}}$

Gear ratio = $\boxed{\frac{\text{No. of teeth on driven gear}}{\text{No. of teeth on drive gear}}}$

Velocity = Pitch circle circumference × RPM

Standing Rope = guide rope in shaft, bucket supporting rope

Running Rope = Rope used in cranes, coal cutting machines

Application of Wire Rope = Lang lay → Winding Rope

Non Rotating type (Regular) or locked coil = Shaft sinking

Haulage Rope = lang's lay

Guide Rope = Half locked coil type

Coal cutting Machine = Regular lay type

Dragline hoist = lang lay

Space factor = $7\frac{d^2}{D^2}$ d = ~~wire~~ strand dia

D = rope dia

Higher space factor, Higher is strength

Mass of Rope = KD^2 Kg/m (K = constant, D = dia (cm))

Strength of Rope = SD^2 [KN] (S = Constant, D = dia (cm))

Capping of Rope → split capel with rivet

→ coned socket type capel

→ interlocking type capel (Reliance capel)

* Dia of headgear pulley atleast 100 times dia of rope
* Rope should be cold drawn steel wire
* Breaking load = 10 times max. static load

7 times max static load (Koepe winder

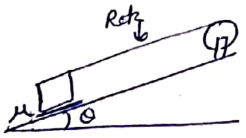
Arrangement of cage attachment =
Rope → Cappel → D link → detaching hook → d-link → Bull chain → D-link → Triangular plate → Cage chain → cage.

Koepe winder = $\frac{T_1}{T_2} = e^{\mu\theta}$

- Direct rope Haulage = Min. gradient 12°
  Speed → 8 - 12 km/h
  slip ring motor with drum controller
- Endless Haulage = gradient 1 in 6
  speed = 3 - 7 km/h
  clifton Pulley, squirrel cage motor, Smallman Clip, Screw
- Main & Tail Rope = Undulating Roadway
- gravity Haulage = Jig Pulley, gradient = 14°
- Super elevation - $\tan\theta = \boxed{\frac{V^2}{gR}}$ $h = d\tan\theta$ (on road)
  d = width of road
  $\tan\theta = \boxed{\frac{GV^2}{gR}}$ G = guage of track, & $h = d\tan\theta$ (railway)

- Monkey Catch = Endless haulage
- Backstay = direct haulage or endless haulage

Power = Force × Velocity or Tension × ω



$$\boxed{F = M_t g \sin\theta + \mu_t M_t g \cos\theta + M_r g \sin\theta + \mu_r M_r g \cos\theta}$$

μ_t & μ_r = coeff of friction for tubs & rope
M_t & M_r = Mass of tub & rope

If the gradient (θ) is negative then power requirement is

$$P = (M_t g \sin\theta - \mu_t M_t g \cos\theta + M_r g \sin\theta - \mu_r M_r g \cos\theta) \times \text{velocity}$$

If gradient = 0 then $P = (\mu_t \cdot M_t g \cancel{\cos\theta} + \mu_r \cdot M_r \cdot g) \times \text{velocity}$

Endless Rope Haulage = Tractive effort = drawbar pull = Pull required to draw loaded mine cars + Pull required to draw empty cars + pull required to draw rope

Airflow through Mine Opening =

Nature of flow $Re = \frac{VD\rho}{\mu} = \boxed{\frac{VD}{\nu}}$

Re = Reynolds No.

V = Velocity

$D = 4A/P$ → Perimeter (A → area)

ρ = density $= 1.2\ kg/m^3$

μ = viscosity

$\nu = \rho/\mu$ = Kinematic viscosity

Pressure drop $\Delta P_f = \boxed{\frac{f L \rho P V^2}{8A} = \frac{KSQ^2}{A^3} = RQ^2}$

f = resistance coeff.

ρ = density of air

L = length of flow

P = Perimeter

V = velocity of flow

A = Area of duct

$K = f/8$ $[Ns^2m^{-4}]$

S = Perimeter × length

R = resistance of path $= KS/A^3$

Q = flow through airway

For laminar flow $f = \cancel{Re}\ 64/Re = 64 \times \mu / VD\rho$

★ Shock loss $= \boxed{X * P_v = X * \frac{\rho V^2}{2} = \Delta P_s}$

P_v = velocity Pressure X = Shock factor

Air Power $AP = \Delta P \times Q = RQ^2 \times Q = \boxed{RQ^3}$

$\boxed{NVP = D(\rho_d - \rho_u)g}$

D = depth ρ_d & ρ_u = Density

Motive Column $h = \boxed{\frac{NVP}{\rho_d \times g}}$

Equivalent orifice :→ $A = \boxed{\frac{1.29\ Q}{\sqrt{P}}}$ or $\boxed{\frac{1.2}{\sqrt{R_R}}}$ (R (Regulator))

Head generated by backward bladed fan $\boxed{H = \frac{V^2 - uV\cot\alpha}{g}}$

forward bladed $\boxed{H = \frac{V^2 + uV\cot\alpha}{g}}$

Radial $H = \boxed{H = \frac{V^2}{g}}$

u = radial or actual velocity

V = Tangential velocity $= \frac{\pi D n}{60}$ α = Blade angle

If fan are in series, $P \uparrow$se Q = same

If fan are in parallel, P = same, $Q = \uparrow$se

Ventilation of drift or tunnel =

$$Q = 2.3\left(\frac{V_m}{t}\right)\log\left(\frac{C_o}{C_p}\right) + \frac{(V - V_m)}{t} \quad \boxed{m^3/min}$$

V_m = Mixing zone $= 15 \times W \times h$

t = safe re-entry time $= 30$ min

C_o = Conc. of Nitrous fume $= \frac{\text{Amount of fume}}{V_m} \times 100$

C_p - Permissible conc. of fum

V = Volume of total drift or tunnel $= L \times W \times H$

* Dilution of emission of gases – $Q = \frac{100q}{C_p - C_a} - q$ $\boxed{m^3/s}$

air required for dilution

in return gas conc (%)

entry gas conc (%)

gas emission in panel / district

Fan laws :→ $H \propto D^2$ or n^2 → Head or Pressure

$Q \propto n$ or D^3

Power $\propto n^3$ or D^5

As per Indian Mine Regulation in all mechanically ventilated mines, quantity measurement should be made every 14 days in case of gassy coal mines & every 30 days in case of non gassy coal mines. Measurement should be made in main intake & return of seam in splits near starting points & ventilation district. There is also provision of monitoring temperature, humidity & other environmental conditions in every 30 days

Total pressure = Static Pressure + Kinetic pressure

Pitot static tube :→ $\boxed{V = \sqrt{\frac{2P_v}{K\rho}}}$

v = velocity (m/s)

P_v = velocity pressure (Pa)

ρ = density of air

K = correction factor = 1

Relative Humidity

[100 − 7(D.B.T − W.B.T)] for D.B.T > 25°C

[100 − 8(D.B.T − W.B.T)] for 20°C < D.B.T < 25°C

[100 − 9(D.B.T − W.B.T)] for D.B.T < 20°C

$$\boxed{\text{Tractive effort} = F + f + 2f_1 + G - g = \mu W + \mu w + 2\mu_1 w_1 + W - w}$$ for endless haulage

F = frictional resistance of loaded car
f = " " of empty car
f_1 = " " of rope
G = gradient resistance of loaded car
g = gradient resistance of empty car.
μ = coeff of friction b/w mine car wheel & track
μ_1 = rope & roller friction

W = wt of loaded car
w = wt of empty car
w_1 = wt of rope

Locomotive transport - Tractive force generated by loco to move & accelerate loco as well as provide draw bar pull to move mine car.

Tractive effort = $\boxed{\mu W}$
μ = coeff. of adhesion
W = wt of loco.

Draw bar pull = Tractive effort - Force required to move loco.
Max. angle of inclination for PVC belt conveyor = 16°
Thruster brake type is used to stop the belt

Capacity of belt = $\boxed{a \times b \times V}$ (te/sec)
a = avg. area = $\frac{w^2}{10}$ to $\frac{w^2}{12}$ w = width of belt
b = bulk density = te/m3
V = speed (m/s)

Cable belt conveyor = suitable for long length & inclination
Disc Conveyor = Steep gradient
High Angle Conveyor - steep gradient upto 60°

Total Suction head :→ Suction pressure head + static suction head + velocity head - friction head in suction line

$$\boxed{H_s = h_{ps} + h_s + h_{vs} - h_{fs}}$$

Total discharge head :→ discharge pressure head + static discharge head + velocity head + friction head in delivery line

$$\boxed{H_d = H_{pd} + h_d + h_{vd} + h_{fd}}$$

Total differential head (H_T) = $H_d + H_s$ (for suction lift)
$H_d - H_s$ = (for suction head)

Power input or brake horsepower $\boxed{BHP = \frac{Q \times H_T \times Sp.G}{3960 \times \text{efficiency} (\%)}}$

Q = gallon per minute
H_T = diff. head (ft)

Pump output or hydraulic or water horsepower (WHP) = $\frac{Q \times H_T \times Sp.Gr}{3960}$

Efficiency of construction $\eta = \frac{B_r}{n \times B_s} \Big/ \frac{B_r}{n \times B_w}$

B_r = Breaking strength of Rope
B_s = " " of strand
B_w = " " of wire
n = no. of strand / wire

Scanned by CamScanner

* Representative factor = $\dfrac{\text{Ratio of map distance}}{\text{Corresponding ground distance}}$

Distance Measuring Instrument - Pacing, Passometer, Pedometer, Odometer, Speedometer, Perambulator,

B

Correction due to incorrect chain = $\dfrac{L \pm \Delta L}{L}$ $\qquad L+\Delta L$ = Expand $\qquad L-\Delta L$ = contract

$$\boxed{\text{Actual length} = C.F \times \text{measured length}}$$

Area = $(CF)^2 \times$ measured area

Volume = $(CF)^3 \times$ measured volume

Slope correction factor = $C = \dfrac{H^2}{2L}$ $\quad | \; L - L\cos\theta$

True length = $L - \dfrac{H^2}{2L}$ $\quad | \; L\theta - L + L\cos\theta = L\cos\alpha$

Correction for temp = $C_t = \alpha (T_m - T_0) L$

INDUSTRIAL ORGANISATION AND ENGINEERING ECONOMICS

Classification of Business

(a) Industry. This is a business activity which concerns itself with the production, processing or fabrication of products. The industries may be either of these 4 types: Extractive (fishing, mining, agriculture etc.), Genetic (breeding farms, poultry farms, selling of horticulture plants etc.), Construction (buildings, bridges, roads, dams, canals etc.), and Manufacturing industries like analytical, synthetic, processing and assembly line industries etc.)

(b) Commerce. Commerce is an activity whereby goods are transferred to those who need them.

(c) Trade

Objectives of Business

(i) Organic Objectives. To try for survival, and then to gain prestige and win recognition from the society and thus try to grow.

(ii) Economic Objectives. To earn as much profit as possible.

(iii) Social Objectives. Business must fulfill its obligations to society, by way of supply of quality goods, avoidance of profiteering and antisocial practices, and providing employment.

(iv) Human Objectives. These are (a) fair deal to employees, (b) development of human resources, (c) participation, and (d) job satisfaction.

(v) National Objectives. These are (a) ensuring social justice, (b) development of small enterprises, (c) production according to national priorities, (d) self sufficiency and export development and (e) development of skill of personnel.

1.2 TYPES OF BUSINESS ORGANISATIONS

Several types of business organisations are existing in order to satisfy various social, economic and human requirements. Following are the main types of business organisations :

(A) Private Sector :
1. Individual Ownership or Sole Proprietorship
2. Partnership Organisations
3. Joint Stock Companies
4. Co-operative Organisations
5. Joint Hindu Family Firm.

(B) Public Sector (State Ownership and Control) :
1. Departmental Organisations
2. Public Corporations (or Statutory Companies)
3. Government Companies.

(C) Joint Sector :
Ownership and control shared by private enterpreneur, state and public.

PRIVATE SECTOR ORGANISATIONS

Private Companies (Individual Ownership)

As the name suggests (such type of business is owned by one man. The businessman invests ... employs labour and machines) This is the oldest and simplest form of business organisation. In such business owner supplies all the capital needed to run the organisation. He ... only with the help of his own land, capital and labour. Hence owner alone enjoys the ... and suffers the losses in his business. Therefore, he is the supreme authority to decide

FORMS OF BUSINESS ORGANISATION 5

into different matters concerning to his business and has unlimited freedom of action within legal jurisdiction.

Overall control in single hand helps him in quick decision, efficient administation and working. In this type of organisation, owner must be anxious to obtain valuable advice and guidance from other sources.

In such organisations owner himself is responsible for all the liabilities. Hence creditor can collect the money even from the personal property. Therefore, to have this type of business it is not the money alone of the debtor that is necessary to start but also the zeal, enthusiasm, courage and faith of the person.

Applications. This form of organisation is most satisfactory in the following cases :

1. In small enterprises requiring small capital which can be spared by the one man (owner).
2. Where risk required is not too heavy. Because in this system risk involved is very high.
3. Where management by one man is possible.

Advantages.

Following are the advantages of this form of organisation :

Quick decision making & effective follow up, feeder etc.

1. Such individual enterprises can easily be formed and simple to run and at the same time owner is free from all legal restrictions.
2. His (owner's) interest, care and efficiency directly effects the profit in the business. Hence efforts and rewards are directly related.
3. In this system owner himself is in touch with customers and hence can know their likings.
4. Since it is supervised by the proprietor himself, the overheads are very less and products can be sold cheaply.
5. Most of the business have their monoploy because of certain secrecy in their functioning. In this form of organisation such secret functions are performed by the owner himself and he does not disclose it to any body else. Therefore, he has the greatest possibility of running business well. In other forms of organisation, there are little chances of keeping such activities secret for a longer period.
6. It offers full freedom for work and hence such persons who do not want to serve under or with any body can get the chance to work independently and can show their talent. Thus they can enjoy free life.
7. As he has not to seek direction for any decision to be taken, he can act promptly. If at any time he feels some benefit in doing some work, he can act quickly without any body's advice and can avail the benefit.

Disadvantages.

This type of organisation has the following disadvantages :

1. Amount of capital that can be invested is limited, therefore, modern factory cannot be run with this system of organisation.
2. Owner cannot be the master of all techniques like management, sales, engineering processes etc. Hence work suffers.
3. Due to unlimited liability owner cannot take risk to start a big industry.

Some difficulties / Ignorance about environment

α = coeff of Thermal expansion

T_m = Temp during measurement

T_0 = Temp at which tape / chain is standarise

Actual length = $\boxed{L \pm C_t}$ $\qquad L + C_t$ = Expand $\qquad L - C_t$ = contract

Correction for pull :→ $C_p = \dfrac{(P_m - P_0) L}{A \cdot E}$

P_m = Pull during measurement

P_0 = standard pull

L = Measured length

E = Elastic Modulus

A = Cross sectional area

$\boxed{\text{Actual length} = L + C_p}$ Always

Binomial distribution, Variance of random variable x is given

$$Var[x] = \boxed{np[1-p]}$$

when p = probability of success

n = no. of trial

If $\vec{A} = a\hat{i} + b\hat{j} + c\hat{k}$ $\quad \vec{B} = e\hat{i} + k\hat{j} + f\hat{k}$

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ a & b & c \\ e & k & f \end{vmatrix} \quad \hat{i}(bf - ke) - \hat{j}(ak - ec) + \hat{k}(ak - eb)$$

Area of parallelogram $= |\vec{A} \times \vec{B}| = bf - ke \mp ak - e^2 + (ak - eb)$

$$\boxed{\text{BOD of sample} = \frac{\text{Oxygen Depletion (mg/l)}}{\text{Sample volume (ml)}} \times \text{Volume Diluted (ml)}}$$

Sample volume + water volume

Semivariogram at lag distance (h) $=$ ~~Covariance~~ $\boxed{\text{Sill} - \text{Covariance at same lag dist}}$

Sill > Covariance

Orthogonal matrix $\boxed{= AA^T = I}$

Transpose

self contained chemical oxygen self Rescuer, oxygen is produced by potassium peroxide

Reliability $R(t) = \boxed{e^{-t/m} \text{ or } e^{-\lambda t}}$ where $\lambda = \frac{1}{m}$

t = time for which reliability is taken out

m = mean time between failure

Tacheometry $= \frac{f}{i}$ → stadia interval $\quad f + k$ → dist b/w object glass & vertical axis

Integration formula $\int_0^a \sqrt{a^2 - x^2}\,dx = \boxed{\frac{x}{2}\sqrt{a^2 - x^2} + \frac{a^2}{2}\sin^{-1}\frac{x}{a}}$

Haldane Apparatus :→ $CH_4\% = \frac{2 \times \text{Contraction} - CO_2}{3} - H_2$

H_2 = Total contraction $- O_2$ consumed

Probability density function $= \int_{-\infty}^{\infty} f(x)\,dx = 1$

Bivariate distribution of two variable x & y

correlation coeff $= \boxed{\frac{cov(x, y)}{\sigma_x \cdot \sigma_y}}$

$Cov(x, y) = E(xy) - \mu_x \mu_y$

μ_x & μ_y = mean of x & y

σ_x^2 = variance $= E(x^2) - [E(x)]^2$

$E_x = \mu_x$ = mean.

σ_y^2 = variance $= E(y^2) - [E(y)]^2$

$$= \frac{cov(x, y)}{\sqrt{E(x^2) - [E(x)]^2} \times \sqrt{E(y^2) - [E(y)]^2}}$$

Overall slope angle (β) $=$

$\tan^{-1} \frac{3H}{2B + 3x}$

$\tan^{-1} \frac{3H}{2B + 3\frac{H}{\tan\theta}}$

13 bench, it will be changed acc.

Detonating Pressure

$P_d = 0.25 \times VOD^2 \times \rho$

density of explosive

Max. shear stress = $\boxed{\dfrac{\sigma_1 - \sigma_2}{2}}$ σ_1 & σ_2 = Major & Minor principal stress

$\tan 2\theta = \dfrac{-(\sigma_1 - \sigma_2)}{2\tau_{xy}}$

$\angle$ direction of shear stress

* Concentration Ratio :- $\dfrac{\text{amount of metal per tonne of conc}}{\text{amount of metal per tonne of ore}}$

Torque = Tractive force × Radius

Tractive force = acc. force + frictional Resistance } use in loco.

* Semivariogram model is used for reserve estimation of mineral deposit by geostatistical method.
* Lane's algorithm is applied to determine mill cut off grade
* Relative Bulk Strength - $\dfrac{\text{Absolute Bulk Strength of explosive}}{\text{A.B.S of ANFO}} \times 100$

ABS = Absolute wt strength × density

* Subsidence = subsidence factor × mining height

$S = a \times m$

$S < a \times m$ for subcritical

* Coefficient of Variation = $\dfrac{\text{Standard deviation}}{\text{mean}}$
* $1° = \frac{1}{15} h$ $1' = \frac{1}{15}$ min $1'' = \frac{1}{15}$ sec
* Angle = $\dfrac{\text{Arc}}{\text{Radius}}$ (Radian)

Setting & Yield load of hydraulic prop S<Y

* Two vectors are orthogonal to each other $\vec{a}\cdot\vec{b} = 0$ i.e. cos90
* Thermal diffusivity = $\dfrac{\text{Thermal conductivity}}{\text{density} \times \text{specific heat}}$

* Poisson distribution :-> $P_x = \dfrac{e^{-m}\cdot m^x}{x!}$

$x = 0, 1, 2, 3$

m = mean = $n \times P$ (n → no. of event, P → Probability of event)

$1 l = 10^{-3} m^3$

Pump power = $P \times Q \times 10^{-3}$ KW

2014 Paper → Ques → 42 imp (Direct Rope Haulage)

$NPV = \sum_{t=0}^{N} \dfrac{R_t}{(1+i)^t}$ R_t → Cash flow.

Availability = $\dfrac{\text{Up time}}{\text{Total time}} = \dfrac{\text{Up time}}{\text{Up time} + \text{Down time}}$

$= \dfrac{MTTF}{MTTF + MTTR}$

MTTF = Mean time to failure

MTTR = Mean time to Repair

Slake durability Test = $\frac{\text{Mass of oven dried sample}}{\text{Mass of normal sample}} \times 100$

Maximum Shear stress = $\boxed{\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}}$

σ_1 = major principal stress
σ_2 = minor principal stress

aylor Series = $\boxed{f(x) = F(x) + (x-1)F'(x) + \frac{(x-1)^2}{2} f''(x) - - -}$

F(x) = Putting x in function
F(x) & F'(x) will be given   f(x) is to be taken out

For linear motion vector sum of all forces = 0
For rotation, vector sum of all moment = 0
automatic contrivance prevents over speed & over winding & helps in slow banking at speed less than 1.5 m/s

Semi Variogram for lag distance h

$$\boxed{\gamma(h) = \frac{1}{2n} \sum_{n=1}^{n} (z(x) - z(x+h))^2}$$

roximate analysis of coal on dry ash free basis

$$\boxed{\% \text{ of Volatile matter} = \frac{\% \text{ of Volatile Matter in analysis}}{100 - (\text{Moisture } \% + \text{Ash } \%)} \times 100}$$

% of V, M & A are given as result of Proximate analysis

hen locomotive is pulling tubs on a gradient haulage

$$\boxed{\mu \times W_L = (W_t + W_L)\left(\mu_r + i + \frac{a}{9.81}\right)}$$

μ = coeff of adhesion b/w wheel & track
W_t = wt of tub
W_L = wt of loco
μ_r = frictional coeff resistance
i = gradient (like 1 in 50 & like that)
a = acc with which loco is moving

Dose % of sound exposure = $\boxed{100 \times \left[\frac{C_1}{T_1} + \frac{C_2}{T_2}\right]}$

C_1 & C_2 are time exposure

T_1 & T_2 = $\boxed{\frac{8}{2^{(L-90)/5}}}$ where L = measured sound level

TWA of Corresponding dose = $\boxed{16.61 \log_{10}\left[\frac{D}{100}\right] + 90}$ dB

where D = dose (simple put numeric value no % needed

Match factor ⇒ $\frac{\text{No. of truck} \times \text{loader cycle time}}{\text{No. of loader} \times \text{truck cycle time}}$

Factor of safety of Rope = $\frac{\text{Breaking strength of rope}}{\text{load applied on it}}$

⇒ winding rope - life = 3.5 yr
⇒ guide rope life = 10 yr
⇒ Head gear system = 10 yr.

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FORMULAS

① Strength of pillar = $7.2 \times \frac{(W)^{0.46}}{(H)^{0.66}}$ MPa / $1320 \times \frac{W^{0.46}}{H^{0.66}}$ Salomon's formula

W & H are width & height of pillar

$\boxed{1 m = 3.28 ft}$ $\boxed{1 \, lb/in^2 = \cancel{ft}\; 0.0705 \, Kgf/cm^2}$

② Sound pressure due to HEMM at radial distance r_1 & r_2

$$\boxed{L_{P_1} - L_{P_2} = 20 \times [\log_{10}(r_2) - \log(r_1)]}$$

where L_{P_1} & L_{P_2} = sound pressure level at radial distance r_1 & r_2 respectively.

③ Shovel-dumper optimization (Match factor)

$$\text{Match factor} = \boxed{\frac{\text{dumper productivity}}{\text{shovel productivity}}}$$

$$= \frac{\dfrac{n_d \times \text{capacity of dumper}}{\text{dumper cycle time}}}{\dfrac{n_s \times \text{capacity of shovel}}{\text{shovel cycle time}}}$$

④ Photogrametry :- Relief displacement formula

Relief displacement → $\boxed{d = \frac{r h}{H}}$

r → distance from principle point

h → elevation of station

H → Flying height of drone

when ... from ... of build... is giv...

⑤ Volumetric efficiency of pump :- (Reciprocating)

$$\text{Volumetric efficiency} = \frac{\text{Actual flow}}{\text{Theoritical flow}}$$

Relief distance $\boxed{d = \frac{r h}{H - h}}$ when bottom of building is given

* Idempotent Matrix iff $A^2 = A$
* Involutory Matrix iff $A^2 = I$
* Nillpotent Matrix iff $A^x = 0$ & $A^{x-1} \neq 0$

$$\begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}$$

since $A \neq 0$ & $A^2 \neq 0$ but $A^3 = 0$

$-A$ = each element of matrix is multiply by (-1)

$\cancel{X} + A = \cancel{X} + B$ $\quad -A = B$

* Depletion allowance for a year = $(q/Q) \times P$

q = extraction in 1st year

Q = Recovarable reserve

P = Initial cost of ore bearing ~~parcel~~ land roductivity of shovel = $\frac{\text{Bucket Capacity} \times \text{Utilization factor} \times \text{fill factor}}{\text{cycle time} \times \text{swell factor}}$

★ Break even stripping ratio (m^3/t) = $\frac{A - B}{C\,(m^3)}$ → per ton

A = Revenue per tonne of ore
B = Production cost per tonne of ore (including all cost to the point of sale, excluding stripping)
C = Stripping cost per m^3 of ore

Konimeter is used to measure Dust in mine atmosphere
oolamite is mixture of iodine pentaoxide & sulphuric acid. greyish white colour of hoolamite will be converted to shade of green, brown or black by reaction of CO which liberates iodine.
horizon mining system, laterals are roads driven Parallel to strike.

t Load strength = $\frac{P}{d^2}$ = $\frac{\text{(load at rupture)}}{\text{distance b/w point load}}$

iaxial compressive strength = $\sigma_u = 24 \times I_{s(d)}$ → point load strength

dherence strength = $\frac{P_t}{\pi D L}$ → yield load in N; Dia & L = length

[always rember whenever load is given in Pa Means N/m^2 which means you have to multiply it with area (m^2) to get N only)

Brazilian-test = Indirect tensile strength = $\frac{2F}{\pi D L}$

ght of immediate roof :> $h = \frac{H}{K-1}$

H = extraction thickness
K = Bulking factor > 1

nch Shear Test = Shear strength = $S = \frac{P}{A}$ (kg/cm²)

ending test = tensile strength = σ_t (kg/cm²) = $\frac{3 P L n}{b d^3}$ (P → kg, L → cm, n → distance from neutral axis to farthermost fibre)

Slenderness ratio $\boxed{= Le/r}$
r = radius
Le = Equivalent length

$$\boxed{Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}}$$

Q = rock mass quality index
RQD = Rock Quality designation
J_n = no. of joint set
J_r = roughness of most imp joint
J_a = wall rock condition & filling material
J_w = water flow characteristics
SRF = stress conditions

stored strain energy = $\frac{\sigma_1 m_1}{2}$ = $\boxed{\frac{\sigma_1\left(\frac{\sigma_1}{E}\right)}{2}}$

Indian Coalfields related theory = drift theory, ~~it is not applicable to~~ insitu theory is not applicable to Indian coalfield

$\boxed{\begin{array}{l} f = \text{unitless} \\ K = NS^2m^{-4} \\ R = NS^2m^{-8} \end{array}}$

Pressure for circulating required air quantity through mine airway

$$P = \frac{KSQ^2}{A^3} = RQ^2, \quad R = \frac{KS}{A^3}, \quad \frac{f L S P V^2}{8A}$$

K → Kilomurgy (generally = 0.001); S → Perimeter; Q → m^3/s; A → Area

Mine Ventilation Quantity $= A \times V$
A = Area V = Velocity

★ Pressure develop due to velocity $= \frac{1}{2} \rho V^2$

V = velocity ρ = density of air = 1.2 kg/m³

★ Pressure develop due to water guage = $P = \rho g h$
ρ = density of air = 1.2 kg/m³
$g = 9.81$

★ Percussive drilling (10-75 mm dia, 300 m depth, soft & medium hardness)

★ Churn or Cable drilling (75-100 mm dia, 300-600 m depth, Placer deposit, moderate soft formation)

★ Diamond drilling (30-200 mm dia, 100-3000 m depth, Any rock formation)

★ Calyx or chilled shot drilling (75-1800 mm, < 450 m, Any rock except hard

★ Strength of pillar = $\boxed{K \frac{W^{0.46}}{H^{0.66}}}$

W = width of pillar
H = Height of pillar

$K = 1320$ lb/in²
$1m = 3.28$ ft
$1 \text{ lb/in}^2 = 0.0705$ kg/cm²

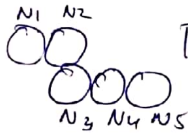
★ Max. no. of faces in Board & P Working = $\boxed{2n+1}$

n = no. of face

★ Relief distance in Aerial photography → $d = \frac{r h}{H}$

d = relief displacement
r = dist from principal axes
h = elevation of station
H = Flying height of drone

Gear Ratio related formula $\boxed{\frac{N_1}{N_2} = \frac{D_2}{D_1} = \frac{T_2}{T_1}}$ Pitch Diameter



$\boxed{N_2 = N_3}$

$$\boxed{\frac{N_1}{N_2} \times \frac{N_2}{N_4} \times \frac{N_4}{N_5} = \frac{T_2}{T_1} \times \frac{T_4}{T_3} \times \frac{T_5}{T_5}}$$

Factor of Safety of Rope :→ $\frac{\text{Breaking strength of Rope}}{\text{Maximum load applied on it}}$

Motor size of winder is determined by root mean square torque

$$RMS = \sqrt{\frac{\frac{1}{3}(T_1^2 + T_1T_2 + T_2^2)^{2}}{\frac{2}{3}(t_a + t_r) + t_c + \frac{1}{3}t_d}}$$

T_1 = Torque at start (t = 0) (Nm)

T_2 = Torque during duty cycle (N-m)

t_a = acc. period (sec)

t_r = retardation period (sec)

t_d = decking time (sec) t_c = duty cycle period (sec)

FOS = $\frac{\text{Strength}}{\text{Stress}}$ Pillar

$$\boxed{\frac{2}{3}(t_a + t_r) + t_c + \frac{1}{3}t_d = \text{Equivalent time}}$$

Main & tail rope Haulage = Total force = $M_t g \sin\theta + \mu_t M_t g \cos\theta + m_{mr} g \sin\theta$ − (tub, main rope)

$2 m_{tailr} g \sin\theta + \mu_{mr} m_{mr} g \cos\theta +$ (main rope)

$2 \mu_{tr} m_{tr} g \cos\theta$

Gravity Haulage ⇒ $\boxed{M_e g \sin\theta + M_r g \sin\theta + \mu_t M_t g \cos\theta + \mu_e M_e g \cos\theta + \mu_r M_r g \cos\theta}$

M_e = Mass of empty tub M_r = Mass of rope

M_t = Mass of loaded tub

Trolley wire loco = ~~Mg sin~~ $Mg \sin\theta + \mu mg \cos\theta + nmg \sin\theta + n\mu mg \cos\theta$

Belt Conveyor :⇒ $\boxed{T_1 - T_2}$ Tension on tight side / Tension on slack side

Factor of safety :→ $\boxed{\frac{e^{\mu\theta'} - 1}{e^{\mu\theta} - 1}}$

θ' = angle of Belt conveyor

θ = angle of contact

$\boxed{\text{Work} = \text{Force} \times \text{distance}}$

Dyne = 10^{-5} N 1 bar = 10^5 Pa

$\boxed{v = u + at}$ / $\boxed{v^2 = u^2 + 2as}$ / $\boxed{s = ut + \frac{1}{2}at^2}$

α = angular acceleration = $\boxed{\frac{a}{r}}$ normal acc. 1 Kgf = 9.81 N.

Pull = Force = $\boxed{m \times a}$

centripetal ~~force~~ acc = $\boxed{\frac{v^2}{r}}$ centri. force = $\boxed{\frac{mv^2}{R}}$

Two vector force acting at any angle θ

$R = P^2 + Q^2 + 2PQ\cos\theta$

$\tan\theta = \frac{Q\sin\theta}{P + Q\cos\theta}$

Power = $\frac{W}{t}$ Work ~~Power~~ = F × dist / Power = F × Velo

Power = Torque × ω Joule/s = N m/s

$\frac{T_1}{T_2} = e^{\mu\theta}$ or $\boxed{\frac{T_1}{T_2} = 2.718^{\mu\theta}}$ / $\boxed{2.3 \log_{10}\frac{T_1}{T_2} = \mu\theta}$

$\log\frac{T_1}{T_2} = \mu\theta \log(2.718)$

* Future Worth = $\boxed{P.V(1+i)^n}$

i = interest rate

P.V = Present value

n = no. of years

Future worth = $\boxed{A\left[\frac{(1+i)^n-1}{i}\right]}$

A = Annuity (Equal Yearly Payment)

$$\boxed{PV = A\left[\frac{(1+i)^n-1}{i(1+i)^n}\right]}$$

* Payback period = time required for repaying loan with annuity which means NPV = 0

$$NPV = -X + A\left[\frac{(1+i)^n-1}{i(1+i)^n}\right] = 0$$

$$\boxed{X = A\left[\frac{(1+i)^n-1}{i(1+i)^n}\right]}$$

where n = no. of yeas = payback period

In the same i = internal rate of return

NPV = $\boxed{-X + \frac{X_1}{(1+i)} + \frac{X_2}{(1+i)^2} + \frac{X_3}{(1+i)^3}}$

Hanskold formula

$-X$ = Outflow

X_1, X_2, X_3 = inflow i = rate

Geometric progression = $\boxed{\frac{a(r^n-1)}{(r-1)}}$

Payback period = $\boxed{\frac{\text{Initial Investment}}{\text{Constant annual cash flow in project}}}$

Profitability Index = Benefit-Cost Ratio or Desirability Index = $\boxed{\frac{\sum_{r=1}^{n} \frac{X_n}{(1+i)^n}}{X}}$

$X_n \rightarrow$ inflow (Means), i → rate, $X \rightarrow$ outflow

P.I > 1 Then Project accepted

P.I < 1 then Project rejected

Yearly Depriciation Value = $\frac{\text{Investment} - \text{Salvage value after completion}}{\text{Life of project}}$

* If payback period is less than project life, then it is accepted
* In case of many project accept that project which has least Payback

$$\boxed{P.B.P = \text{Initial Year} + \frac{\text{Funds needed to recover investment}}{\text{Cash flows in succeeding year}}}$$

* ARR (Accounting / Average Rate of Return)

$$\boxed{ARR = \frac{\text{Average Income}}{\text{Average Investment}} \times 100}$$

Average Income = $\frac{\text{Total Income}}{\text{No. of years}}$

Average Investment = Scrap Value + $\frac{1}{2}$ (Investment - scrap value) + Additional working capital

If ARR is greater than predetermined ARR, then project accepted otherwise rejected

Product of eigen value = Determinant
Sum of eigen value = trace [A] = sum of diagonal elem

$$\frac{\text{Explosive impedance}}{\text{Rock impedance}} = \frac{(VOD) \times Sp \cdot G \text{ of explosive}}{(VOD) \times sp \text{ of rock}}$$

Under standard temp & pressure, theoritical max. height in m which water can be lifted using an air lift pump is 10.33 m

Stokes settling velocity :→ $v = \dfrac{g\, d^2 (\rho_{particle} - \rho_{fluid})}{18 \times \eta \text{ (viscosity of air)}}$

$\frac{d^2x}{dt^2} + 2x^3 = 0$ degree of differential eq is ~~highest~~ power of highest order derivative = 1

Order of differential equation = 2

$\frac{T_1}{T_2} = e^{\mu\theta}$ vale formula m conversion ke lim Natural log (ln) lenge Na ki $\log_{10}$

Aerial Photography ⇒ L_g = length covered in 1 photo = $S \times L_p \times (1 - O_L)$

L_W = wigth covered in 1 photo = $S \times W_p \times (1 - O_W)$

O_L & O_W = overlap across width & length

L_p & L_W = width & length of photo

S = scale of photo $= \frac{1}{10000}$ S = 10000

$$\text{No of photo} = \boxed{\frac{L \times W}{L_g \times L_W}} \begin{matrix} \to \text{ground area} \\ \to \text{photograph} \end{matrix}$$

$R \cdot F = \frac{f}{H - h}$ → focal length

→ height of station

↳ Height of aeroplan

Survey Curve = Chord length = $2R \sin \theta/2$

Rise of curve = $R(1 - \cos\theta/2)$

tangent length = $R \tan \theta/2$

external length $R(\sec\theta/2 - 1)$

$\boxed{\text{Max. wet bulb temp} = 33.5°C}$

Mini width of haul road = 3 times dumper size + 5 m extra

Pillar stress = $\dfrac{\text{load acting on pillar}}{\text{cross section area of pillar}} = \dfrac{\gamma \times D \times (a+b)^2}{a^2}$ (γ → unit weight)

FOS = $\dfrac{\text{strength of pillar}}{\text{Pillar stress}}$

Divergence of vector

$$\nabla \cdot \vec{x} = \left(\frac{\partial}{\partial x}\hat{i} + \hat{j}\frac{\partial}{\partial y} + \hat{k}\frac{\partial}{\partial z}\right) \cdot (a\hat{i} + b\hat{j} + c\hat{k})$$

$$\boxed{\varepsilon_{xx} = \frac{1}{E}\left[\sigma_{xx} - m(\sigma_{yy} + \sigma_{zz})\right]}$$

ε_{xx} → strain in x direction

E → modulus of elasticity

m → poisson ratio

$\sigma_{xx}\, \sigma_{yy}\, \sigma_{zz}$ = Stress in x, y, z direction

$^nP_r = \frac{n!}{(n-r)!}$ | $^nC_r = \frac{n!}{r!(n-r)!}$

Binomial distribution :→ $\boxed{P(r) = {}^nC_r (p)^r (q)^{n-r}}$

It is applicable when outcome is binary in nature like Yes or No, Head or Tail, Accept or Reject

$\boxed{\begin{array}{l} \text{Mean} = np \\ \text{Variance} = npq \end{array}}$

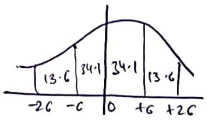
n = no of trials
p = Probability of Success

when no. of trials is more than fifty then binomial does not give accurate results for this purpose Poisson formula.

Poisson formula $P(r) = \frac{e^{-m}(m)^r}{r!}$

m = mean = np
Mean & Variance are equal

★ **Normal or Gaussian distribution** :→ $\boxed{f(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-z^2/2}}$



converting variable into normal distribution
$z = \frac{x - \mu}{\sigma}$ (μ → mean, σ → standard deviation)

★ **Random Variable** :→ Expected word use ho tu random variable con apply

Expectation or Mean, $E(x) = \Sigma x P(x)$ → Probability / value of function at x

Probability mass function

Variance $V(x) = E(x^2) - [E(x)]^2$

Standard Deviation $\sigma = \sqrt{V(x)}$

★ **Cummulative Density function** :→ Sum of all probabilities

x	$P(x)$	$F(x)$ → cummulative Density function
1	0.5	0.5
-1	0.5	1 → 0.5 + 0.5

★ **Probability Density function** :→ $P(x) = \int_{-\infty}^{\infty} f(x)\,dx$

for PDF function being; area under the curve is unity

$f(x) = \frac{d}{dx} F(x)$ $\qquad \boxed{E(x) = \int_{-\infty}^{\infty} x f(x)\,dx}$ $\qquad \boxed{CDF = F(x) = \int_0^x f(x)\,dx}$

variance = $\boxed{E(x^2) - [E(x)]^2}$

★ **Regula falsi - false position method** :→ order of convergence = 1

$\boxed{x = \frac{a f(b) - b f(a)}{f(b) - f(a)}}$

★ **Bisection method** $x = \frac{a+b}{2}$ $\qquad \frac{|b-a|}{2^n} < e$ (b → upper limit, a → lower limit, e → error)

★ **Regression line** :→ Regression line of x on y = $(x - \bar{x}) = b_{xy}(y - \bar{y})$
Regression line of y on x = $(y - \bar{y}) = b_{yx}(x - \bar{x})$

$b_{xy} = r\frac{\sigma_x}{\sigma_y}$ $\qquad$ σ_x & σ_y = Standard deviation $\qquad r = \pm\sqrt{b_{yx} \times b_{xy}}$

r = rank corelation

Coeff = $\frac{cov(xy)}{\sigma_x \cdot \sigma_y} = \frac{\frac{\Sigma xy}{n} - \frac{\Sigma x \Sigma y}{n^2}}{\sigma_x \cdot \sigma_y}$ $\qquad \sigma_x = \sqrt{\frac{\Sigma x^2}{n} - \left(\frac{\Sigma x}{n}\right)^2}$ / $\sigma_y = \sqrt{\frac{\Sigma y^2}{n} - \left(\frac{\Sigma y}{n}\right)^2}$

r cannot be greater than 1
$-1 < x < 1$

20) Hock-Brown strength criteria

$$\sigma_1 = \sigma_2 + \sigma_{ci}\left[m\frac{\sigma_2}{\sigma_{ci}} + s\right]^a$$

m, s, a will be given

σ_{ci} = compressive strength of intact rock $\sigma_{ci} > \sigma_2$

σ_2 - Minor principal stress

σ_1 - Major principal stress

uniaxial compressive strength = $\boxed{\sigma_c = \sigma_{ci} \times s^a}$

uniaxial tensile strength = $\boxed{\sigma_t = \frac{s \times \sigma_{ci}}{m_b}}$

) Factor of safety = FOS = $\frac{\text{Total force resistance}}{\text{Force applied}}$ (generally > 1)

- FOS of plane failure FOS = $\frac{CA + W\cos\beta \tan\phi}{W\sin\beta}$

- FOS of plane failure with crack = FOS = $\frac{CA + (W\cos\beta \mp P\sin\beta)\tan\phi}{W\sin\beta + P\cos\beta}$

bt length of roof bolt = $\frac{B}{2}\left[\frac{100 - RMR}{100}\right]$ B = span

) Pwave = $\sqrt{\frac{\frac{4}{3}G + K}{\rho}}$ Swave = $\sqrt{\frac{G}{\rho}}$

$\boxed{\text{Stress in Circular excavation / tunnel}}$

$$\sigma_r = \frac{P}{2}\left[(1+k)\left(1-\frac{a^2}{r^2}\right) - (1-k)\left(1 - 4\frac{a^2}{r^2} + 3\frac{a^4}{r^4}\right)\cos 2\theta\right]$$

radial

$$\sigma_\theta = \frac{P}{2}\left[(1+k)\left(1+\frac{a^2}{r^2}\right) + (1+k)\left(1 + 3\frac{a^4}{r^4}\right)\cos 2\theta\right]$$

tangential

$$\sigma_{r\theta} = \frac{P}{2}\left[(1-k)\left(1 - 3\frac{a^2}{r^2} + 2\frac{a^4}{r^4}\right)\cos 2\theta\right]$$

shear stress / resultant stress

at hydrostatic condition = $\sigma_r = P\left(1 - \frac{a^2}{r^2}\right)$

P = original stress field (generally vertical stress)

r = radial distance of a point

a = radius

K = ratio of insitu stress (σ_H / σ_V)

Mine Environment

) Sound pressure level (SPL) = $20 \times \log_{10}\left[\frac{P}{P_0}\right]$ dB

$P_0 = 2 \times 10^{-5}$, SPL = dB

) Sound power level $L_W = 10 \times \log_{10}\left[\frac{W}{W_{ref}}\right]$ dB

W = watt , W_{ref} = internationally accepted level $= 10^{-12}$ watt

) Sound intensity level $L_i = 10 \times \log\left[\frac{I}{I_{ref}}\right]$ dB

I = sound intensity of interest (W/m^2)

I_{ref} = internationally reference for sound intensity $= 10^{-12}\ W/m^2$

Acutely poisonous gas = CO, NO_2, SO_2, H_2S

Toxic gases = CO_2, Radon & product

Non toxic but explosive = CH_4, C_2H_2, H_2

specific gravity = SO_2 = 2.264 (Heaviest) H_2 = 0.070 (Lightest) CH_4 = 0.559

Permissible Conc. of different gases

① CO_2 = 0.5% (5000 ppm)

② CO = 0.005% (50 ppm)

③ Oxides of Nitrogen = 0.0005% (5 ppm)

④ H_2S = 0.001% (10 ppm)

⑤ SO_2 = 0.0005% (5 ppm)

Gas monitoring instrument -

CH_4
- MSA 0-6 Methanometer = Wheatstone bridge
- Flame safety lamp = Length of flame
- MSA Automatic firedamp detector - Wheatstone bridge
- Interference Methanometer = Refractive index of methane

CO
- Drager multigas Detector with P.S. Detector = Silica gel impregnated with light yellow potassium palladium sulphite
- Drager multigas detector with Hopcalite = $MnO_2 + Cu_2O$
- Drager multigas detector with Hoolamite Tube = $I_2O_5 + H_2SO_4$

★ Methane content of 9.5% in air forms the most explosive mixture

★ Limit of explosibility of methane = 5.4% - 14.8%

limit of explosibility of mixture of combustible gases = $\frac{100}{V_1/x_1 + V_2/x_2 + \cdots}$ %

V_1 = Volume % of gases

x_1 = limit of explosibility

Equivalent Noise level $L_{eq} = 10 \times \log_{10}\left[\sum_{i=1}^{n} t_i \times 10^{l_i/10}\right]$ dB

L_{eq} = equivalent noise level (dB)
t_i = fraction of time for sound pressure level L_i
L_i = sound pressure level for duration t_i

Day night equivalent Noise level
$$L_{eq} = 10 \times \log_{10}\left[\frac{2}{3} \times 10^{l_d/10} + \frac{1}{3} \times 10^{l_n/10}\right] \text{ dB}$$
day time = 6 AM - 10 PM l_d = SPL at day
Night time = 10 PM - 6 AM l_n = SPL at night

Relationship between sound pressure & power level is given by
$$L_p = L_W - 20 \log_{10}(r) - 11 \text{ [dB]}$$
L_W = Sound power level r = radial distance in m
L_p = SPL

SPL between two different point $L_{P_1} - L_{P_2} = 20(\log r_2 - \log r_1)$ Point source
$L_{P_1} - L_{P_2} = 10(\log r_2 - \log r_1)$ line source

Biochemical oxygen demand = $\boxed{BOD_t = BOD_u \times (1 - e^{-kt})}$
BOD_u = ultimate BOD BOD_t = BOD at any time, t
k = rate of BOD reaction
$$BOD_t = (DO_i - DO_f) \times D.F$$
DO_i = Dissolved oxygen (initial)   D.F = Dillution factor = $\frac{\text{Vol. of Solution (Big)}}{\text{(Small) Vol. of Sample}}$
DO_f = Dissolved oxygen (final)
D F > 1

Coal Mining

Percentage of Extraction $R = \frac{(a_1+b_1)(a_2+b_2) - a_1 \times a_2}{(a_1+b_1)(a_2+b_2)}$

a_1 & a_2 length & breadth of pillar
b_1 & b_2 = size of gallery in dip & rise direction

If $a_1 = a_2$ & $b_1 = b_2$ $R = \boxed{1 - \frac{a^2}{(a+b)^2}}$

Tributory Area = $\boxed{(a_1+b_1) \times (a_2+b_2) - a_1 \times a_2}$

Load Acting on Pillar = $P = \gamma \times D \times \frac{1}{1-R}$ or $\boxed{\gamma \times D \times \frac{(a+b)^2}{a^2}}$

R = percentage of extraction
γ = weight per unit volume of super incumbent rock
D = Depth of pillar from surface
a & b = pillar & gallery size

Strength of Pillar (By Salamon & Munro)
$$S = K \frac{W^\alpha}{L^\beta} \qquad \alpha = 0.46 \qquad \beta = 0.66$$
W = Width of pillar in ft
L = height of pillar in ft
S = strength of pillar in lb/in²
K = 1320 lb/in²

Scanned by CamScanner

★ Distance required for complete mixing of methane by turbulent diffusion

$$\boxed{L = 22 \times r\sqrt{f}}$$

L = distance from source of gas
r = radius of duct
f = dimensionless resistance coefficient

★ Methane layering number

$$\boxed{L = c\left(\frac{24 \times V^2}{C\sqrt{F}}\right)^{1/3}}$$

V = velocity
C = % of CH_4
F = cross section area of station (m)

★ Graham Ratio = $\dfrac{CO \text{ produced}}{O_2 \text{ consumed}} = \dfrac{CO_f - CO_i}{O_{2i} - O_{2f}} \times 100 = \boxed{\dfrac{CO_f - CO_i}{0.265\,N_{2f} - O_{2f}} \times 100}$

G.R.
- 1% = existance of spontaneous heating
- 2% = heating in advance stage
- 3% = active fire

(0.1–0.5% = normal in coal m

★ Proto self contained compressed oxygen apparatus (closed circuit operation) → Proto Mar IV, Proto Mark V (2 lit O_2/min

★ Drager self contained compressed oxygen apparatus (closed circuit) → BG 174 → 1.5 lit/min → 4 hr use.

★ Chemical Oxygen Breathing Apparatus (AVER/SAR-30) – 30 min use.

★ Self Rescue Breathing Apparatus – Spiral 2C (KO_2 is used)

★ Self Rescuer → Open circuit operation, conversion of CO to CO_2 (Hopcalite catalyst used where max. CO is 2%

★ Gas Mask = Open Circuit operation, conversion of CO to CO_2 & Hopcalite catalyst

★ Reviving Apparatus = Pulmometer → supply O_2 to unconscious person.

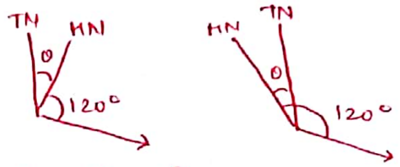
uction due to Sag:- $C_s = \frac{L\omega^2}{24P^2}$ (Hamesa jyda measure krke dega means contraction)

$\boxed{L - C_s = \text{Actual length}}$

ω = wt of chain b/w support
P = Pull applied
L = measured distance

hen Angle of declination is in West

$\boxed{\text{True} \cdot B = H \cdot B + \theta}$



TN = 120+θ°

T·B = 120 − θ°

when Angle of declination is in east

$\boxed{T \cdot B = M \cdot B - \theta}$

when F·B > 180° $\boxed{F \cdot B = B \cdot B + 180°}$

F·B < 180 $\boxed{F \cdot B = B \cdot B - 180°}$

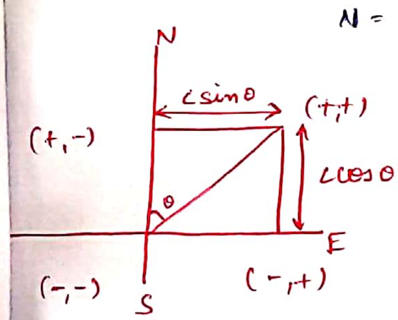
Permissible linear Error in Theodolite Traverse

$$\boxed{L_e = \frac{P}{1000} \times \sqrt{1 + \frac{e^2 N}{12}}}$$

L_e = closing error in m
P = Perimeter of traverse (m)
e = Permissible error per angle (1′)
N = No. of side of traverse

Permissible Angular Error = $\boxed{A_e = L\sqrt{N}}$

A_e = Permissible angular error of closure
L = Least count of Theodolite (20″ or 1′)
N = No. of sides



Projection of line in N-S direction = latitude = $L\cos\theta$ (Northing)

Projection of line in EW direction = longitude = $L\sin\theta$ (easting)

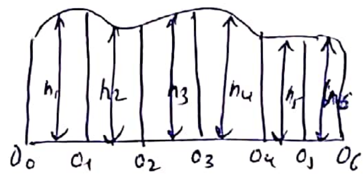
Coordinate = $(L\cos\theta, L\sin\theta)$

$$\boxed{\text{Closing error} = \sqrt{(\Sigma L\cos\theta)^2 + (\Sigma L\sin\theta)^2}}$$

$$\boxed{\text{Direction of closing error } \beta = \tan^{-1}\left(\frac{\Sigma L\sin\theta}{\Sigma L\cos\theta}\right)}$$

$$\boxed{\text{Area of traverse} = \frac{1}{2}\left(y_1(x_1 - x_2) + y_2(x_2 - x_3) + y_3(x_3 - x_1)\right)}$$

id ordinate Rule:→ Area = $\boxed{\frac{h_1 + h_2 + h_3 + h_4 - - + h_n}{n} \times d \times n}$



h_1, h_2, h - - - h_6 → mid points of each division
n = no. of equal division
d = distance between ordinates
L = length of base line

erage Ordinate Rule:→ Area = $\boxed{\frac{O_0 + O_1 + O_2 + - - - + O_n}{n+1} \times d \times n}$

Trapezoidal Rule:→ Area = $\left[\left(\frac{O_0 + O_6}{2}\right) + (O_1 + O_2 + O_3 + O_4 + O_5)\right] \times d$ when division are odd ordinate even.

Simpson Rule:→ Area = $(O_0 + O_6) + 4(O_1 + O_3 + O_5) + 2(O_2 + O_4) \times d$ when division is even ordinates odd.

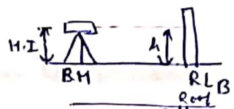
Reciprocal levelling :→ $RL_A - RL_B = \frac{(y_1-x_1)+(y_2-x_2)}{2}$

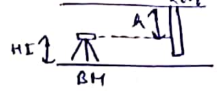
$\text{error} = \frac{(y_1-x_1)-(y_2-x_2)}{2}$

Inverse staff Reading :→ $RL_B = B.M + H.I - h$

$RL_{Roof} = B.H + H.I + h$

$\boxed{RL_{Roof} - RL_B = \text{Height of Roof}}$





$H.I = B.M + B.S$

RL of station $= \boxed{H.I - F.S}$

Correction for Curvature in levelling - $\frac{D^2}{2R}$ D^2 → dist b/w station & staff pt, $2R$ → Radius of earth

correction is subtractive $\boxed{= 0.0785\,D^2}$

True staff Reading = Observed staff Reading $- 0.0785\,D^2$

Correction for Refraction $= \frac{D^2}{7(2R)}$ D^2 → dist b/w station & staff, $2R$ → Radius

correction is additive

True staff Reading = Observed staff Reading $+ 0.0112\,D^2$

Combined Correction = Correction for curvature - Correction for Refraction

subtractive $\boxed{= -\frac{6}{7} \times \frac{D^2}{2R}}$ D^2 → dist b/w station & staff, $2R$ → Radius of Earth.

Tacheometric levelling :→ $\boxed{D = \left(\frac{f}{i}\right)s + (f+k)}$

RL of station $= \boxed{H.I - S_3}$ (Middle staff intercept)

* When line of sight is inclined to horizontal & staff is vertical

$D = \left(\frac{f}{i}\right)s\cos^2\theta + (f+k)\cos\theta$

RL of station $= H.I + \left(\frac{f}{i}\right)s\cos\theta\sin\theta + (f+k)\sin\theta - S_3$

* When line of sight is inclined to horizontal & staff is normal to line of sight

$D = \left(\frac{f}{i}\right)s\cos\theta + (f+k)\cos\theta + S_3\sin\theta$

R.L of Staff Station $= H.I + \left(\frac{f}{i}\right)s\cos\theta\sin\theta + (f+k)\sin\theta - S_3\sin\theta$

$B.S - F.S = \oplus ve$ (Then Rise)

$B.S - F.S = \ominus ve$ (Fall)

$\boxed{\Sigma B.S - \Sigma F.S = \text{Rise} - \text{Fall} = \text{R.L of last} - \text{R.L. first}}$

* Hoskold formula is used for speculative rate of return
* As per DCF analysis project report is acceptable if Discount rate < IRR

Ritinger (Theory/law) → Measurement of Surface Area

Kicks (theory/law) → Volume of products particles

Bonds (Theory/law) → Length of crack formation

* Length of line in Northing easting $= \sqrt{(x_1-x_2)^2+(y_1-y_2)^2}$

$\theta = \tan^{-1}\left[\frac{y_1-y_2}{x_1-x_2}\right]$

Combined RMR $= \frac{\text{RMR of each bed} \times \text{bed thickness}}{\text{Thickness of each bed}}$

* liquidity = $\frac{\text{Current assets}}{\text{Current liability}}$

$1 m^3$ CH_4 at NTP = 0.716 Kg mass.

* ROI = $\frac{\text{profit}}{\text{Capital employed}} \times 100$

Empirical relation between depth of hole (h) & gas content (v) = $V = \frac{Ah}{1+Bh}$

Methane layering number = $\frac{v}{\left(4.32 \frac{q}{w}\right)^{1/3}}$

standards of ventilation

1, 2 & 3 degree - Immediate outbye ventilation connection from face = $30 m^3/min$

1 & 2 degree = 4.5 m from any face whether working or discontinued on intake side of brattice = $30 m^3/min$

7.5 m outbye of discharge end of air pipe = $15 m^3/min$

At max. span of longwall face = $60 m^3/min$

3rd degree = 4.5 m from any face whether working or discontinued on intake side of brattice or partition = $45 m^3/min$

= 7.5 m outbye of discharge end of air pipe = $25 m^3/min$

= At max. span of longwall face = $75 m^3/min$

Natural Ventilation pressure = $\frac{g d B (Tu - Td) \times 10^3}{287.1 \times Tu \times Td}$ (Pascal

g = 9.81

Tu & Td = Temp in Kelvin

d = depth of shaft

B = Mean Barometric pressure $\frac{(Bu+Bd)}{2}$

* coeff of utilization of space = $\frac{\text{Car capacity}}{\text{product of length, width \& height}}$

* tare load ratio = $\frac{\text{Mine Car Capacity}}{\text{weight of car}}$

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