Farm Machinery

Tillage is the mechanical manipulation of soil to provide conditions favourable to crop growth.

(1) primary tillage :- It is consists of deep opening and loosening of soil to prepare seed bed.
mould board, disc, rotary tillers.

(2) secondary tillage → conditioning the soil to meet different tillage objects.
Rotavator, harrow.

Types of implements.

i) pull-type → that is pulled and guided from a single hitch point is never completely supported by the tractor.

ii) Mounted implement :- that is completely supported by the tractor when in the raised position.

iii) Semi mounted implement :- implement is attached to the tractor through a horizontal or nearly horizontal hinge axis and is partially supported by the tractor.

Field Performance of Machines :-

(1) Theoretical field capacity (Fc) :- The rated forward speed and always covered 100%. of its rated width. It is expressed as.

$$f_c = \frac{S \times W}{10}, \text{ ha/h}$$

(2) effective field capacity (Fce) :- The actual average rate of coverage by the machine, based on its total time consumed and its width.

$F_{ce} = \frac{\text{actual area coved (ha)}}{\text{time taken (h)}}$

$$F_{ce} = \frac{S \times W}{10} \times \frac{E_f}{100} = \frac{S \times W'}{10}$$

W' = actual width of implement (m).

(3) Field efficiency (E_f) :- It is ratio of effective field capacity to theortical field capacity.

$$F_f = \frac{\text{actual field capacity}}{\text{theortical field capacity}} \times 100$$

But In terms of time
$FE = \frac{\text{throtical time}}{\text{actual time}} \times 100$

$FE = \frac{T_o}{T_t + T_e + T_m}$

(1) Pull :- The total force required to pull an implement.

(2) draft :- the horizontal component of the pull, parallel to the line of motion

$$D = P\cos\theta$$

(1) draft power : $D_p = \frac{D \times S}{75}$ hp. (draft) (kg), (speed) (m/s)

Unit draft :- $D_u = \frac{D}{A} = \frac{P\cos\theta}{A}$

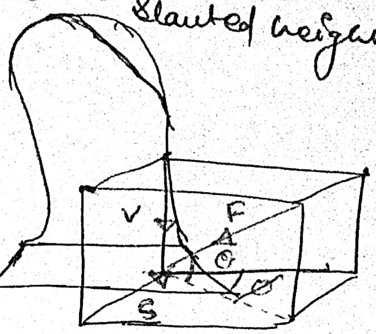
⑤ disc angle → plane of cutting edge of disc is inclined to the direction of travel is said to be disc angle. It values is 42-45°. width of cut ⇒ $y = 2\sqrt{2Rx - x^2}$ actual width = $a_0 \sin\alpha$

⑥ Tilt angle :- the disc is inclined to vertical is said to be tilt angle. It is value is 15-20°. depth of cut $x = \frac{d}{\cos\theta}$ → Slanted height

Forces acting upon a tillage implements.

three types of forces are found.

① force of gravity
② Soil reaction on implement
③ pull of the power unit.



horizontal angle θ = the angle of inclination in horizontal surface

Side draft $S = F\cos\theta \cdot \sin\phi$

vertical angle ϕ = the angle of inclination in transverse vertical plane with

L = represented the draft of the implement (draft) $L = F\cos\theta \cdot \cos\phi$ Horizontal

Vertical component = $V \Rightarrow F\cos\phi \cdot \sin\theta$ ϕ = vertical plane angle.

Note :- Vertical plane is the force containing L and V components.

$P = \sqrt{L^2 + V^2} = F\cos\phi$,

Torque :- is the moment of force tending to produce rotation about a point.

Note ① To measure penetration resistance, a simple instrumented known as a penetrometer :- F per unit A.

② dynamometer are often used for measuring drawbar pull.

③ effect of speed on draft :

draft increase (↑) with increase in speed (↑) in most of the tillage implements.

④ acceleration force increase (↑)

Draft can, frictional resistance (↑).

$D_s = D_0 + ks^2$, forward speed. draft. static components of draft,

Cost estimation :-

① fixed cost :-

ⓐ Straight line Method :- Measured depreciation of agricultural Machine (which used decided the value of a tractor by an equal annual each year decay)

$$D = \frac{P - S}{L \times H}$$

D = is the depreciation Rs/hr
P = the purchase price
S = salvage value
L = is useful life of Machine
H = is the working hours per year.

ⓑ Declining balance Method :- (uniform rate is used for each year)

depreciated value after n-years.

$D = P(1-r)^n$

(c) Sum of year digits Method. Compound interest Method.

(i) depreciation become zero at the end of Machine life.

$$D = \frac{L-(n-1)}{Y_D}(P-S)$$

$$Y_D = \frac{L(L+1)}{2}$$

(II) Interest :- following formula is used.

$$I = \frac{P+S}{2} \times \frac{i}{H}, \ ₹/h$$

Belt drives :- (Types of Belt).

(a) Flat Belt :- distance more than 10 m.

(b) V-belt :- transmission distance b/w pulleys are very closed.

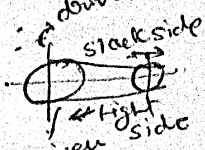
(c) circular belt :- used for more than 5 m distance.

(d) factor of safety → 8 to 10, Belt speed, 20 to 22.5 m/s.

Mechanism of V-belt :-

$$\frac{T_t}{T_s} = e^{\mu(\operatorname{cosec}\beta)\theta} \quad \left(\frac{T_1}{T_2} = e^{\mu\theta}\right)$$

Mechanism of Flat belt :



(2) Tension Ratio (Ra)

$$Ra = \frac{T_t}{T_s} = e^{\mu\theta}$$

(3) Velocity Ratio :-

$$V.R = \frac{N_1}{N_2} = \frac{D_2+t}{D_1+t}\left[1 - \frac{(S_1+S_2)}{100}\right]$$

(4) Length of belt :-

(a) open belt (l_o)

$$= \frac{\pi}{2}(D_1+D_2) + \frac{(D_1-D_2)^2}{4x} + 2x$$

(b) cross belt

$$(l_c) = \frac{\pi}{2}(D_1+D_2) + \frac{(D_1+D_2)^2}{4x} + 2x$$

x = distance b/w centre of both pulley

(5) angle of contact or lap

(1) open belt $\theta_o = (180 - 2\alpha)°$

$$\alpha = \sin^{-1}\left(\frac{r_1 - r_2}{x}\right)$$

(2) cross belt $\theta_c = (180+2\alpha)$

$$\alpha = \sin^{-1}\left(\frac{r_1+r_2}{x}\right)$$

(6) power transmission (P) :-

$$P = (T_t - T_s)v, \ W$$

(7) Slip of Belt (s)

$$\frac{N_1}{N_2} = \frac{d_2+t}{d_1+t}\left(1 - \frac{s}{100}\right)$$

(8) Creep of Belt

$$\frac{N_1}{N_2} = \frac{d_2}{d_1} \times \frac{E+\sqrt{\sigma_1}}{E+\sqrt{\sigma_2}}$$

(9) Maximum tension in the belt.

$$T = \text{Maximum Stress}(\sigma) \times A$$

Length of V-belt :-

$$L = 2x + 1.57(D+d) + \frac{(D-d)^2}{4x}$$

(10) Condition for the Transmission of Maximum Power,

$$T_t = \frac{2T_m}{3}$$

$$T_m = 3T_c, \quad v = \sqrt{\frac{T_m}{3m}}$$

T = Maximum tension in the belt

T_c = centrifugal tension

→ Theortical length of cut $L = \frac{2\pi r_1 \tan\theta}{n}$

→ Power required to drive flywheel $P = \frac{1}{2}mv_r^2$

→ centrifugal force considered condition

$$T_c = mv^2$$

$$T_t = T_m - T_c = T_m - T_m/3$$

$$T_t = \frac{2T_m}{3}$$

Gear Ratio :

Speed ratio (N.R) = $\frac{N_1}{N_2} = \frac{T_2}{T_1}$

Gear value $\left[\frac{N_2}{N_1} = \frac{T_1}{T_2} \right]$

$\frac{N_1}{N_2} \times \frac{N_3}{N_4} \times \frac{N_5}{N_6} = \frac{T_2}{T_1} \times \frac{T_4}{T_3} \times \frac{T_6}{T_5}$

$\boxed{\frac{N_1}{N_6} = \frac{T_2 \times T_4 \times T_6}{T_1 \times T_3 \times T_5}}$

(b) double shear on shear pin

$\boxed{P(kW) = 0.822 \times N \times D \times d_1^2 \times S_s \times 10^{-8}}$

N = shaft speed rpm
D = dia of shaft mm
d_1 = dia of shear pin mm,
S_s = ultimate shear strength of shear pin, MPa.

double acting hydraulic cylinder :-

$\boxed{\frac{N_2}{N_1} = \frac{(d_{bore})^2 \times \pi/4}{(d_{bore}^2 - d_{rod}^2)\, \pi/4}}$

Sowing Machine :-

Seed drill :-

plant population/m^2 = Total no. of seeds/ha × germination rate.

Volume of seed by one fluted roller in one revolution

$\boxed{V_f = A \times L \times Z}$ → No. of cell

total volume = $V_f \times n$ → No. of row of seed tube

Step (I) Total width of coverage

W = No. of cell × distance b/w two cell m

$\boxed{W = \text{No. of furrow openers} \times \text{spacing b/w two furrow, m}}$

Step (II) Area covered in one revolution of the wheel.

width covered × circumference of wheel

= $W \times \pi D$

Step (III) No. of revolution to cover 1/10 th hectare land (No. of turn of ground wheel/ha)

$= \frac{1000}{W \times \pi D}$

(4) Measured seed rate = $\frac{\text{Seed Collected}}{\text{area}}$ kg/ha

Transmission ratio $i = \frac{N_r}{N_g} = \frac{\text{rpm of fluted roller}}{\text{rpm of ground roller}}$

(5) No. of turn of fluted roller/ha $= \frac{10000}{\pi D_g \times W} \times i$

Imp Note $\boxed{Q_u = \frac{10000}{\pi D_g \times W} \times i \times V_m \times S_H}$ → Fill index

formula's

(1) To drop one seed, the number of revolution of seed plate

$= \frac{1}{\text{No. of cells on seed plate}} = \frac{1}{Z/i} = \frac{1}{Z \times i}$

(2) velocity wheel = $\pi D N$

spacing (seed to seed) = $\frac{\pi D_g}{Z \times i}$ → ground wheel dia.

(3) Area covered for Each Hill = $L \times B = m^2$

(4) No. of Hill in one hectare land (n)

$\boxed{n = \frac{10^4}{B \times L}}$

(5) $\boxed{\text{Gear Ratio} = \frac{1}{V.R}}$

(7) $\boxed{\text{Power (P)} = T \times \omega}$, ω

torque × speed radial (N-m).

(6) Time Required (t) = $\frac{10 \times 100}{S \times W \times E_f}$

E_f = field efficiency

Note No. of seed/ha = plant population

$\frac{10000}{\pi D_g \times W} \times i \times Z$ = $\frac{\text{germination rate}}{\text{-"-}}$

skid

Threshing efficiency = $\frac{\text{Threshed grain in kg}}{\text{total grain input}} \times 100$

rectangular section

$\frac{\sigma}{y} = \frac{M}{I}$

$\frac{\sigma}{d/2} = \frac{M}{\frac{bd^3}{12}}$

$\frac{d}{b}$ = ratio

threshing efficiency = 100 − % of unthreshed grain.

↳ Note — throughput capacity → tonnes/h (How much input)

7) according to ASAE :-

→ 540 rpm → dia. of shaft → 35 mm → power required → 19 kW

→ 1000 rpm → dia. of shaft → 45 mm → 35 kW.

8) according to ASAE :-

V-belts and double-V belts

Sheave groove angle increase as dia. is increased.

9) :- Rotary pumps are popular for low-pressure sprayers.

formula of sprayers :-

In generally Irrigation ↳ requirement pump used Reciprocating pump

→ Time taken for spraying or dusting (t).

$t = \frac{Q}{Q_r}$

Q is the total discharge.

Q_r is the discharge rate.

→ discharge (Q) = discharge co-efficient × Area × velocity

Q = area covered × application rate

→ $\text{power}(P) = \frac{Q_r \cdot p}{75}$ hp.

Q_r = discharge rate L/s.

p = is the pressure Pa.

$\eta_p = \frac{\text{hydraulic power}}{\text{Shaft power}}$

Boom height of Nozzle

$\tan\theta/2 = \frac{D/2}{h} = \frac{D}{2h}$ → height

formula of fertilizer application :-

1) Area covered in one revolution = Circumference × width $= \pi D \times W$

2) No. of revolution one hectare :- $\frac{10000}{\pi D W}$

3) Rate of application $Q_r = C_d \times A \times \sqrt{\frac{P_1 - P_2}{V_2 - V_1}}$ kg/s

P = pressure Pa

V = specific volume of liquid m³/kg.

4) Rate of application = $\frac{\text{kg/ha}}{\text{density}}$, m³/ha.

Percentage change in the flow = $\frac{Q_1 - Q_2}{Q_1} \times 100$

Note 1) discharge of sprayer: $Q = n \times q$ (n = No. of Nozzle, q = flow rate of each Nozzle (litre/min))

$q = \frac{A \times V \times b}{60{,}000}$ (V = velocity km/h, b = Nozzle spacing (cm), q = litre/min)

2) Nozzle flow rate :- $q = m d^2 \sqrt{p}$

p = pressure kPa; d = dia. of Nozzle; m = coefficient of discharge

① hydraulic power:

Sahi formula

(kW) $P = 0.1667 \times Q \times P$ m³/min

$P_h = Q \times \Delta P$ kW (HP) (l/min)

Q = discharge, l/min

P = pressure Pa.

$P_h = 0.01667 \times Q$ (l/s) $\times \Delta P$ (Pa)

② threshing efficiency = $\frac{\text{threshed grain in kg}}{\text{total grain input}} \times 100$

threshing efficiency = 100 − % of unthreshed grain

critical angular speed (ω_c) (for rasp-bar type threshing drum)

$\omega_c = 8.65 \sqrt{\frac{P(1-f)}{mR^2}}$

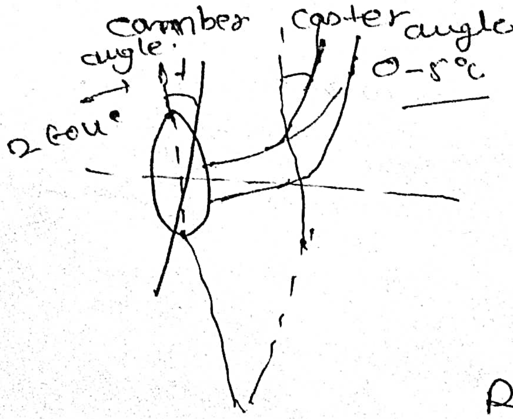
m = mass of material.

P = horse power

f = coefficient of material

R = drum radius

Steering Mechanism :-



Caster angle :-

the tilt of the king pin or ball joint centre line from the vertical toward line. the front or rear (+ive) (−ive) caster of the vehicle.

Range = 0 to 5°c

Camber :-

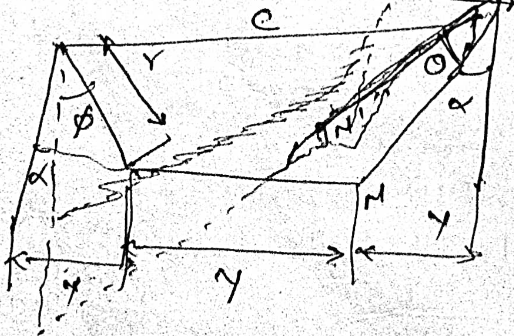
Camber angle is the inclination b/w the centre line of the tyre and the vertical.

Range → 2 to 4°c

Ackerman steering system :

relationship

⇒ $\sin(\alpha+\theta) + \sin(\alpha-\theta) = \frac{2y}{r} = 2\sin\alpha$



LATERAL Stability :-

$V (m/s) = \sqrt{\frac{g \times y/2 \times R}{Z_g \cos\theta}}$

V = forward speed

A = moment arm = tread width/2

Z_g = centre of gravity = $y/2$

$F_c = \frac{W_t}{g} \cdot \frac{V^2}{r}$

$F_c \, Z_g > W_t \cdot y/2$

(tearing moment) (restoring moment)

Steering Mechanism :- Fundamental condition for true rolling

$\cot\phi - \cot\theta = \frac{c}{b}$

θ = the angle of inside lock

φ = the angle of outside lock

c = distance b/w the pivot centres

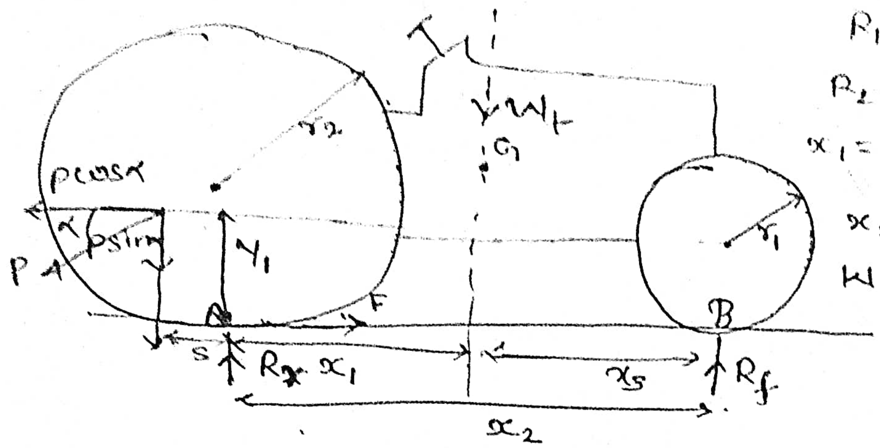
b = wheel base of the vehicles

MECHANICS OF TRACTOR CHASIS

Main principle a simple approach is followed considering the main forces

(1) gravitation (2) soil reaction

(3) traction force (4) drawbar pull.



R_1 = Normal reaction force. front wheel

R_2 = —— rear wheel

x_1 = perpendicular distance b/w R_2 & W

x_2 = —— b/w R_1 & R_2.

W = weight of tractor.

$\frac{Wx_1}{x_2} = 0$ so, front wheel leave the ground

Force acting on a tractor in pull condition.

all algebraic sum of all forces acting parallel or perpendicular to the direction of motion as well as algebraic sum of moments about any point.

$\Sigma H = 0, \Sigma V = 0, \Sigma M = 0$

force, Horizontal force (H), V → Vertical force,

$H = F - P\cos\alpha = 0$ $V = R_1 + R_2 - W - P\sin\alpha = 0$

F = frictional force.

Taking moment about point A

$\Sigma M = Wx_1 - Y_1 P\cos\alpha - R_f x_2 - SP\sin\alpha = 0$

$$\frac{Wx_1}{x_2} - \frac{Y_1 P\cos\alpha + SP\sin\alpha}{x_2} = R_f$$

also $W = R_f + R_r$ [weight transfer]

Imp (1) In rest condition :- Static condition

$R_f + R_r = W$

$W.x_1 = R_f x_2$

$\boxed{R_f = \frac{x_1 \times W}{x_2}}$ and $R_r = W\left(1 - \frac{x_1}{x_2}\right)$ $\left(\frac{x_1}{x_2}\right) = \left(1 - \frac{R_r}{W_t}\right)$

about B moment

$R_r \times x_2 - W_t x_3 - Py - P(x_2 + S) = 0$

$R_r x_2 = W_t x_3 + P\cos\theta\, y + P\sin\theta (x_2 + S)$.

$R_r = W_t\left(1 - \frac{x_1}{x_2}\right)$

$R_r' \times x_2 = W_t x_3 + P y_1$ according B moment

change in reaction condition

$R_r' - R_r =$

(2) dynamic condition

$R_r = R_f$ = Same weight

$\frac{Wx_1}{x_2}$ = negative overturning

(3) when implement is attached and pulled.

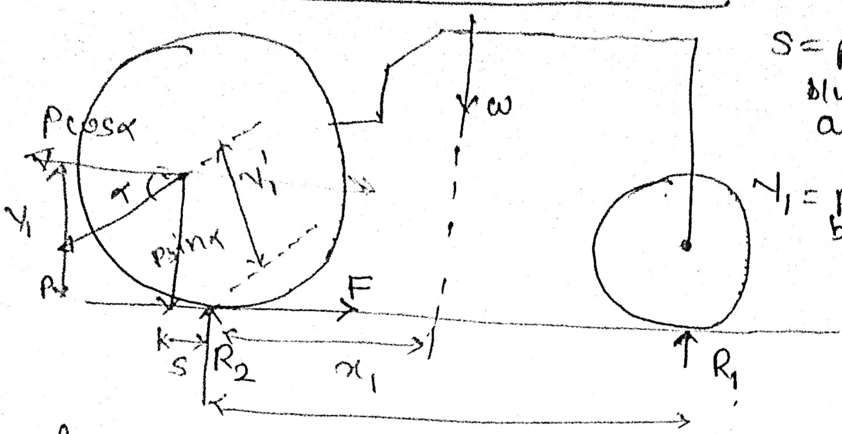
$$R_f = \frac{Wx_1}{x_2} - \frac{Y_1 P\cos\alpha + SP\sin\alpha}{x_2}$$ $\left[\frac{Y_1 P\cos\alpha + SP\sin\alpha}{x_2}\text{ weight transfer}\right]$

⇒ $\boxed{\frac{Wx_1}{x_2}}$ = static weight distribution on front wheel in pull condition.

positive value → stable condition

$\frac{PY_1}{x_2}$ (when pull is parallel to ground)

Motion of tractor on level ground.



S = perpendicular distance b/w the hitch point and rear wheel

Y_1 = perpendicular distance b/w hitch point and ground surface.

analysis of motion of a tractor on level ground.

$$F = AC + R_2 \tan\phi$$

force balance:

$$R_1 + R_2 = W + P\sin\alpha \quad \text{[Vertical force]}$$

$$F = P\cos\alpha + TF_r \quad \text{[Horizontal force]}$$
$$= P\cos\alpha + R_2 \rho.$$

Momentum balance :-

case ①
when pull is parallel to horizontal ground

$$R_1 x_2 + P Y_1 = W x_1 \quad \text{[dynamic weight]}$$

case ②
when pull is inclined with horizontal ground.
ⓐ when pull is resolved into two components

$$R_1 x_2 + P\cos\alpha Y_1' + S P\sin\alpha = W x_1$$

Power transmission in tractor:-

Step in power transmission in a tractor.

Piston cylinder
↓
Connecting rod.
↓
crankshaft
↓
clutch
↓
Gearbox
↓
Bevel pinion
↓
(crown gear) ← Ring gear → Part of differential
↓
Rear half axle.
↓
final drive.
↓
Bull gear

Stability factor = $\frac{\text{front wheel base} \times \text{static front weight}}{\text{Pull} \times \text{height of line of pull}}$ → Note: draw pull parallel to ground; static line of pull perpendicular to ground

chaff cutter
length

$$\Rightarrow L = \frac{\pi D_f N_f}{n \times N_w}$$

D_f = dia. of feed roller
N_f = revolution of feed roller
N_w = revolution of flywheel.
Linear velocity of feed
$$V_f = n L N_c \Rightarrow \frac{V_f}{n \times N_c} = L$$

capacity of chaff cutter:-
$$= n \times \rho \times L \times H \times W \times N \times 60$$
ρ = density kg/m³; /1000; N = rpm
(t/hr)

Differential lock :- The tractor comes out from the mud etc, as both wheel moves with the same speed and apply equal traction.

(Note :- Apply differential lock : speed will be same but torque different according to traction.)

Differential unit :- is a special arrangement of gears to permit one of the gear wheels of the tractor to rotates slower or faster than the other. While turning the tractor on curved path, the inner wheel has to travel lesser distance than the outer wheel. The inner wheel requires lesser power than the outer wheel, this condition fulfilled by differential unit.

(1) Speed relationship

$$\frac{N_{IN}}{G} = \frac{N_L + N_R}{2}$$

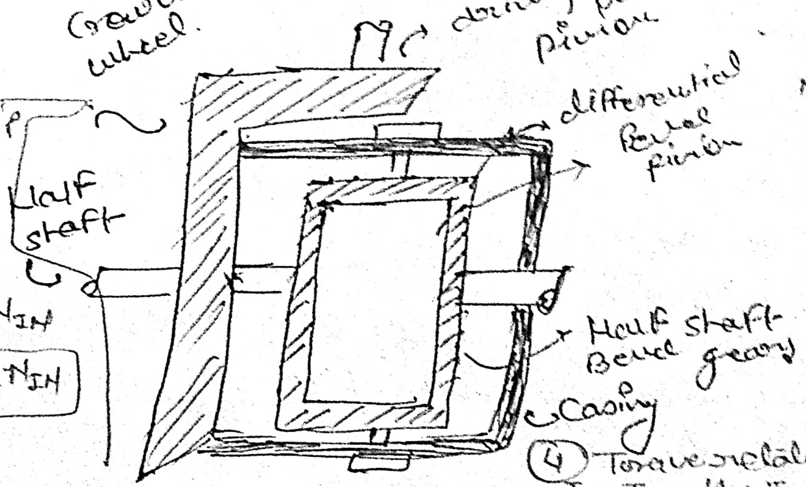
(2) Power relationship (imp)

$P_{out} = \eta_d \times P_{IN}$

$P_L + P_R = \eta_d \times P_{IN}$

$P_L + P_R = \eta_d \times T_{IN} \times N_{IN}$

$$T_L N_L + T_R N_R = \eta_d \times T_{IN} \times N_{IN}$$



(1) differential gear reduction :- = No. of teeth of crown gear / No. of teeth of bevel pinion = dia. of crown gear / dia. of bevel pinion

$$\frac{T_c}{T_b} = G$$

$$G = r_g / r_p$$

(4) Torque relationship equation

$$T_L = T_R = \frac{\eta_d T_{IN} N_{IN}}{(N_L + N_R)}$$

(3) $T_L = T_R$ without differential condition

Note (1) imp → flow rate ∝ √pressure

$$Q \propto \sqrt{P}$$

$$\Rightarrow \frac{Q_2}{Q_1} = \frac{\sqrt{P_2}}{\sqrt{P_1}}$$

(2) droplet size ∝ $\frac{1}{\sqrt{pressure}}$

$$\frac{d_2}{d_1} = \sqrt{\frac{P_1}{P_2}}$$

uniformity spray distribution: $\tan\theta/2 = \frac{D/2}{h}$, $x < D$ overlapping, $d = f \times D$, x = nozzle spacing, h = boom height, θ = spray angle

(3) $Q \propto S$ → speed (kmph)

$$\frac{Q_2}{Q_1} = \frac{S_2}{S_1}$$

formula in sprayer :-

(1) Area covered by sprayer or duster $= \frac{S \times W}{10} \times E_f$

(2) time taken for spraying or duster $t = \frac{Q}{Q_r} = \frac{\text{total discharge}}{\text{discharge rate}}$

(3) discharge $Q = C_d \times \text{Area} \times \text{Velocity}$
= Area covered × application rate.

(4) Power (P) $= \frac{Q_r \times P}{75}$ hp. P = pressure, Pa; Q = l/s

(5) amount = Q × time

(6) $\eta_P = \frac{\text{hydraulic power}}{\text{shaft power}}$

(7) Area covered in one revolution
= circumference × width
= πD × W × N

(8) No. of revolution to cover 1 hectare land
$= \frac{10^4}{\text{circumference}} = \frac{10^4}{\pi D W}$

(9) application rate (Q_r)
$= C_d \times A \sqrt{\frac{P_1 - P_2}{V_2 - V_1}}$ kg/s
specific volume m³/kg, pressure

(10) Rate of application $= \frac{\text{kg/ha}}{\text{density}}$, m³/ha

(11) % change in the flow $= \frac{Q_1 - Q_2}{Q_1} \times 100$

Imp (3) $\boxed{\text{Volume Mean dia.} \propto \frac{1}{P^{1/3}}}$

generally air used

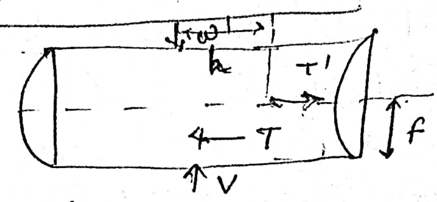
$$\Rightarrow \frac{v_1}{v_2} = \left(\frac{P_2}{P_1}\right)^{2/3}$$

$$\frac{V_1}{V_2} = \left(\frac{P_2}{P_1}\right)^{1/3}$$

$$\boxed{\left(\frac{V_1}{V_2}\right)^3 = \frac{P_2}{P_1}}$$

Analysis of vertical force on disc Harrow

Couple acting on disc harrowgang:-



$$\Rightarrow \boxed{w' \times h = T \times f}$$

T = Soil force thrust below axis

T' = Balancing force by bearing along axis

w' = Net upward force (Apparent wt)

h = distance of apparent C.G from centre of gage

f = distance from axis to the point of action of soil reaction.

Spur and Helical Gears:-

Have been teeth that are <u>parallel to the axis</u> of rotation of the gear, whereas the teeth of <u>helical gear</u> are at an angle of the axis of <u>rotation</u>.

Spiral bevel gear:-

Have curved teeth that are angled like helical gear teeth, so that the load is gradually transferred from tooth to tooth. spiral bevel gear will transmit

⇒ <u>high load</u> at <u>high speed</u> with much <u>less noise</u>.

Bevel gear:-

used to connect shaft with intersecting ones.

→ ⓐ <u>hypoid gear</u>:- is similar to the spiral bevel gear, but the shaft do not intersect.

planetary gear ratio can determined

Imp

$$\boxed{n_s = n_c - (n_r - n_c) N_r/N_s}$$

→ planetary ratio $= \frac{\text{rpm input}}{\text{rpm output}} = \boxed{\frac{n_s}{n_c} = 1 + \frac{N_r}{N_s}}$ (No. of teeth)

n_s = the rpm of sun gear.

n_c = the rpm of the carrier.

n_r = the rpm of the ring gear.

N_r = the Number of teeth in the ring gear.

N_s = the Number of teeth in the sun gear.

planetary efficiency:-

$$\eta = \frac{T_c n_c}{T_s n_s}$$

planetary gear torque relationship:-

$$\boxed{\frac{T_c}{T_s} = 1 + 0.975\frac{N_r}{N_s}}$$

Sprinkler :-

① Best suited to sandy soils with high infiltration rates
clay soil, → not suitable for sprinklers

② discharge of sprinkler :-
Q of an individual
sprinkler $Q = \frac{L \times S \times q}{360}$ m^3/hr
= L = Lateral spacing m,
S = sprinkler spacing, m
q = application rate m^3/ha

Pitman angle
① $\cos\phi = \frac{\sqrt{l^2 - H_c^2}}{l}$
$= \frac{\sqrt{l^2 - S^2}}{l}$ → centre attached
Mower, crank, position
Stroke length: extension
$S_e = \sqrt{(l+r)^2 - S^2}$
and retraction Stroke
$S_r = \sqrt{(l-r)^2 - S^2}$
Stroke length $= S_e - S_r$
S = offset distance
$S_w = \sqrt{T \mp (4rT)^2}$
T = thrust force.

Hitching System :-

① In generally :- hitching system support force → "parasitic forces"
② upper link is always in compression when implement is in ground.

Note :- An epicyclic gear train is one in which the gears in addition to the rotation about their respective axes have.
⇒ ↗ One axis fixed about which other axes revolve.

→ :: ⇒ amount of offset in disc harrow :- $\frac{dS_r + b(S_r - S_f)}{(L_f + L_r)}$ → P_x
$= b\tan\alpha + \frac{dS_r}{L_f + L_r}$
→ (Py) → this equation according to moment eff
In generally (No side draft position case $b(S_r - S_f)$ = value is zero
S = Side draft in each gang.
b = distance b/w centre of front gang and hitch point
d = distance b/w the centres of each gang measured along the direction of motion
L_f and L_r = draft of front and rear gauge.

① amount of offset
→ No side draft :-
$e_o = \frac{dS_r}{L_f + L_r}$
Some time equation as AAI moment
$\frac{bS_f + dS_r - bS_f}{L_f + L_r}$

Dynamic weight :-

$$R_r = W\left(1 - \frac{x_1}{x_2}\right) + P\sin\alpha + \left(\frac{P\cos\alpha\, y_1 + P\sin\alpha .\, S}{x_2}\right)$$

↳ Static weight distribution on rear wheel in pull condition.
↳ weight transfer

① The brake fluid which is usually a mixture of glycerine + Alcohol
② Tractor run at high speed engine, rear wheel of tractor engine require power at low speed and high torque
② If the engine power is constant so that high torque at wheel, low speed is required and vice versa.
③ If gear is fitted b/w engine and rear wheel for variable torque and speed.
④ Ballasts are used on front tyre of a 4-wheel tractor Increase stability,

Fluid Mechanics

viscosity → N.s/m²
Surface tension = N/m

→ **Shear Stress :-**

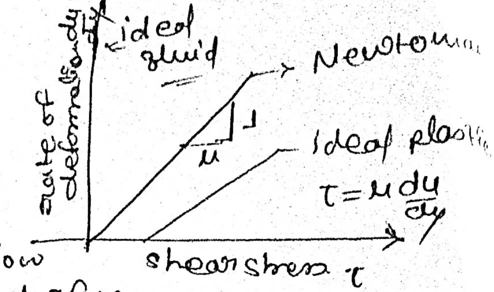
$\tau = \mu \frac{du}{dy}$ (change in velocity with respect to distance rate of shear)

Maximum Shear stress $\tau_w = \mu\left(\frac{8\bar{v}}{D}\right)$ velocity average, shear rate

$\tau = \frac{F}{A}$

$F = A\mu \frac{du}{dy}$

pressure drop in a pipe flow → $\Delta P = \frac{4\tau_w L}{D}$



→ Surface tension :- The intensity of inter-molecular traction per unit length along the free surface of a fluid, SI → N/m

Note ① negative gauge pressure is also know as vacum pressure.
② absolute pressure will always be positive
③ atm pressure measured by a Mercury barometer.
$P_{atm} = \rho g h$.

Flownet :- flow net for Homogeneous Isotropic System
↓
flow consists of two set of line flow line and equipotentials line [which must always be orthogonal] (perpendicular to each other)
(constant Head).

Flownet :- find total head

$q/b = k \times H \times \frac{N_f}{N_d}$ (no. of flow channel) (no. of potential drop) $\Delta H_F = \frac{\Delta h}{N_d}$

Δh = total head difference across the net
N_d = No. of potential drop.

Note: ① ideal fluid have zero viscosity → Incompressible (no friction in fluid) (Nonviscous) ($\nu_t \neq 0$) fluid can be "slide" along the solid boundary
② Real fluid viscosity exists → Compressible (Tangential velocity = 0)

① "continuity equation" following law is based on
Ans- Law of conservation of Mass

② Bernoulli equation → first (Ist) and IInd law of thermodynamics (Energy and entropy equation) $\frac{P}{\rho g} + \frac{1}{2}mv^2 + z$ = constant (Static pressure, + dynamic + hydrostatic)

③ Ist law of thermodynamics :- Based on "Conservation Energy"

④ IInd law thermodynamics :- refrigeration system work on.

⑤ capillary tube :- (surface tension) $= \frac{2T\cos\theta}{\rho g r}$

Note ① The lateral stability of a four wheel tractor in a turning situation can be increased by.
Ans:- Increasing the hight of the centre of gravity.

(1) Power tiller is not suited for rotary cultivation ...
(ii) It generate negative draft (4) its traction requirement is low
(3) It provides high degree of soil pulverization

- penetration is improved (↑) disc angle → (dependent width of cut)
- (2) penetration is improved (↓) the tilt angle on standard disc plough
(3) penetration is improved by adding weight → (depth of cut)

(6) performance index → depth

$$PI = \frac{d \times A \times I \times P}{D}$$

→ soil pulverization (cm); A → EFC (ha/day); I → soil inversion; D → draft

(7) Unthreshed seed discharge cause cylinder loss

(8) Reel speed index: — The ratio of reel peripheral speed to forward speed known as Reel index, range: b/w 1.25 to 1.5 under most condition in upright crops.
⇒ Increase the value of index 1.5 so, increase shatter loss

Note: — (1) Increasing the concave (↑) length increasing the seed separation efficiency (↑), reduced loss (↓)
(2) (↑) the speed of cylinder (↓) cylinder losses (reduced), but (↑) seed damage.
(3) Seed damaged (↑), M.C (↓) (reduced)
(4) If cylinder speed is (↑), % of non-grain (↑), but clearance (↓)
(5) Cylinder peripheral speed can be (↓) clearance is (↑) (reduced seed damage (↓))
(6) Alfalfa test and one-third (1/3) of the total in the barley test
(7) According to ASAE capacity as the total feed rate at 3% processing loss (cylinder + walker + shoe)
(8) The concentration being measured with "fluorometers", "colorimeters", or atomic absorption spectrophotometers, respectively.

(1) In restrained link operation of three point hitch, the line of pull passes (above the virtual hitch point and bending force exists on lower link)
(2) The virtual hitch point for free link operation is at the intersection of parallel link or in other words at infinity

(1) The use of differential lock in a 4-wheel tractor is to improve the traction by allowing equal torque to be applied to both the rear wheels.

Hitching implement (3-point hitches)
(1) ASAE — SAE standards for 3-point hitches specify all dimension related to the 3-connecting point b/w implement
(a) minimum limits for lift height
(b) laterally leveling adjustment and side sway
(c) the minimum lift force to be available at the hitch pin, (hitch pin dia.)

⇒ Dimension are included for 4-hitch category for different range of maximum drawbar power as follow,

I – category	15–35 (kW)	(20–45 hp)
II – category	30–75 (kW)	(40–100 hp)
III – IV category	60–168 (kW)	(80–225 hp)
IV – VI category	135–300 (kW)	(180–400 hp)

(1) How to improve the stability of a four wheel tractor up a hill.
Ans. (1) By decreasing the height of line of drawbar pull
(2) By increasing the wheel base.

Irrigation efficiency:-

① **Water conveyance efficiency (E_c):-**

$$E_c = \frac{W_f}{W_r} \times 100$$

W_f = water conveyance efficiency, delivered to the field.
W_r = water released from source.

② **Water application efficiency (E_a):-**
(E_a) (deep percolation and runoff).

$$E_a = \frac{W_s}{W_f} \times 100$$

$W_f = W_s + R_f + D_f$.
$W_f - R_f - D_p = W_s$
R_f = surface runoff from farm
D_p = deep percolation
W_s = water stored in the root zone.
W_f = water delivered to farm.

③ **Water storage efficiency:-** (E_s) (How much the root zone has been filled with the required amount of water.

$$E_s = \frac{W_s}{W_n} \times 100$$

W_n = water needed by irrigation period.

④ **Water distribution efficiency.** (E_d)

$$E_d = \left(1 - \frac{y}{d}\right) \times 100 \qquad d_{avg.} = \frac{d_1 + d_2}{2}$$

$d_1 - d = y_1$
$d_2 - d = y_2$
$\frac{y_1 + y_2}{2} = y$

y = Average numerical deviation in depth of water stored from average depth stored during irrigation
d = Average depth of water stored during the irrigation.

⑤ **Consumptive use efficiency:-** (E_{cu}) loss of water by deep percolation and surface evaporation

$$E_{cu} = \frac{W_{cu}}{W_{nd}} \times 100$$

W_{cu} = Normal consumptive use of water
W_{nd} = Net amount of water depleted from root zone

⑥ **Water use efficiency:-** (E_{cw})

① crop water use efficiency (E_{cw}) = Y/ET → (Evapotranspiration or constive use ha-cm).

② field water use efficiency. (E_{fu}) = Y/W_R

W_R = total water used in the yield.