Question:- In a third system of pulleys there are 4-pulleys. If the $\eta = 75\%$, then what is the effort required to lift the load of 12 KN? find the effort loss in friction also.

(B.T.E.U.P. 1997)

Given data:- $n = 4$, 3rd. system of pulleys

$\eta = 75\% = 0.75$, $W = 12$ KN

To find out:- (i) $P = ?$

(ii) $P_{Loss} = ?$

$\Rightarrow$ $V.R. = M.A. = 2^n - 1$

$V.R. = m.A = 2^4 - 1$

$[V.R. = 15]$

(i) * $\eta = \frac{mA}{VR}$

$0.75 = \frac{\frac{W}{P}}{15}$

$0.75 = \frac{\frac{12}{P}}{15}$

$P = \frac{12}{0.75 \times 15}$

$[P = \underline{1.0666}\ KN]$

(ii) If there is no friction

$\underline{m.A. = V.R.}$

$\frac{W}{P} = 2^n - 1 = 2^4 - 1$

$\frac{W}{P} = 15$

$P = \frac{W}{15} = \frac{12}{15}$

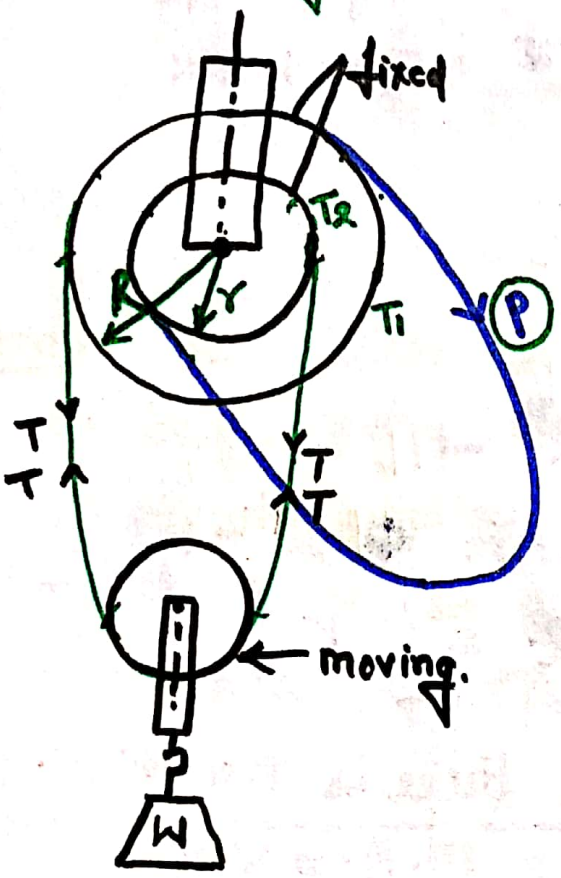
$[P = \underline{0.8000}\ KN]$ ideal

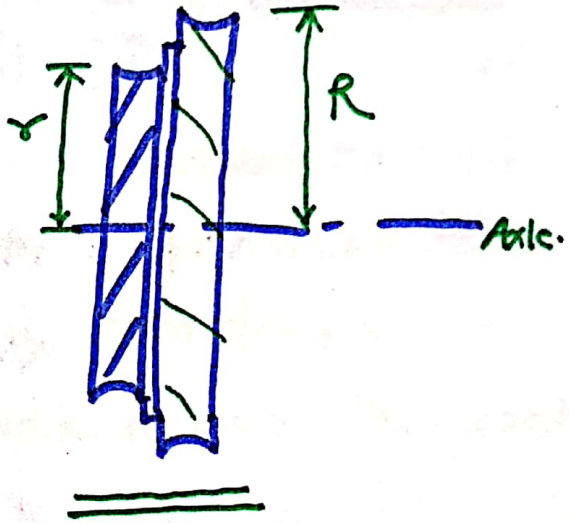
$P_{Loss} = P_{act.} - P_{ideal}$

$= [1.066 - 0.8 = 0.2666\ KN]$ //

Weston's Differential pulley :-

- → powerful pulley
- → Two block → one fixed, one moving.
- → In upper fixed block there are two pulleys in which there is a difference of dia. are attached on a single axle, moving with same time.





Side view

① $V.R. = \frac{D}{d} = \frac{2\pi R}{\left(\frac{2\pi R - 2\pi r}{2}\right)} = \frac{2\pi R}{\pi(R-r)} = \frac{2R}{(R-r)}$

② $M.A. = \frac{W}{P}$

if $\eta = 100 \Rightarrow M.A. = V.R.$

$\left[M.A. = \frac{2\pi R}{\pi(R-r)}\right]$

For Real machine

$\eta = \frac{mA}{VR}$ $\quad \eta \neq 100\%$

$M.A. = \eta \times VR$

$\left[M.A. = \eta \times \left(\frac{2\pi R}{\pi(R-r)}\right)\right]$ //

Note :- (1) **In terms of Diameter :-**

$$V.R. = \frac{2D}{D-d}$$

fixed one

D = dia. of Bigger pulley

d = dia of Smaller pulley

(2) **In terms of No. of teeth :-**

$$\left[V.R. = \frac{2T_1}{T_1 - T_2}\right]$$

T_1 = Teeth on bigger pulley

T_2 = Teeth on smaller pulley

⇒ fixed pulley

Question :- In a differential pulley, there are 20 teeth on bigger pulley and 16 teeth on smaller pulley. If effort applied is 250 N then find the V.R. If the η of the pulley block is 30% then what load can be lifted?

Given data :- $T_1 = 20$; $T_2 = 16$

$P = 250\,N$; $\eta = 30\% = 0.3$

To find :- (i) V.R. = ? (ii) W = ?

Solve :-

$$V.R. = \frac{2T_1}{T_1 - T_2} = \frac{2 \times 20}{20 - 16} = \frac{40}{4} = 10$$

(ii) $M.A. = \eta \times V.R$

$$\frac{W}{P} = \eta \times 10 = 0.3 \times 10$$

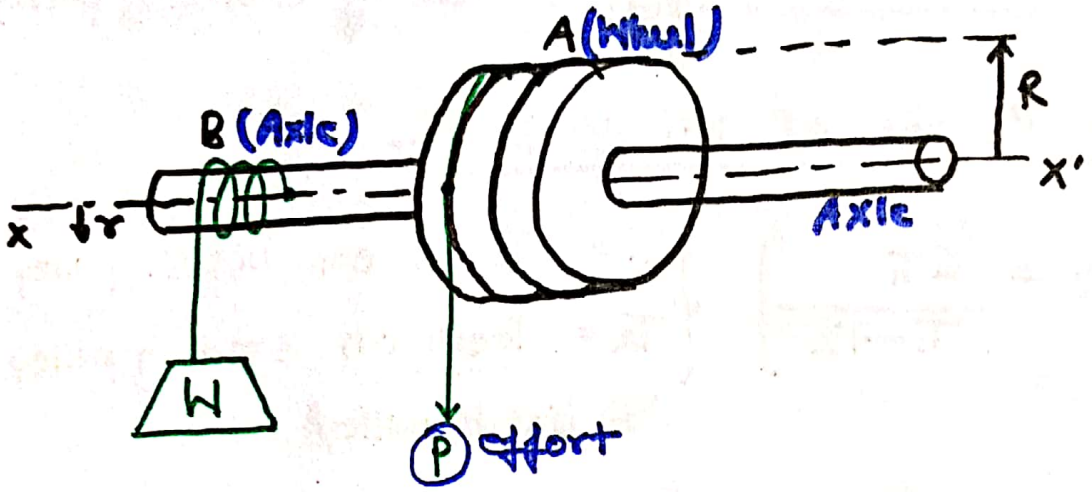
$$\frac{W}{P} = 3$$

$$\frac{W}{250} = 3$$

$$W = 250 \times 3$$

$$[W = 750\,N]_{//}$$

Simple wheel and Axle :-



→ In one cycle of string opens $2\pi R$ on wheel and wrapps up on axle = $2\pi r$.

i.e. Distance moved by effort ⇒ $D_E = 2\pi R$

Distance moved by Weight ⇒ $d_L = 2\pi r$

$$\therefore \left[V.R. = \frac{D_E}{d_L} = \frac{2\pi R}{2\pi r} = \frac{R}{r} \right]$$

If ideal, $\eta = 100\%$. $\eta = \frac{M.A.}{V.R.}$

$$\left[M.A. = V.R. = \left(\frac{R}{r}\right) \right]$$