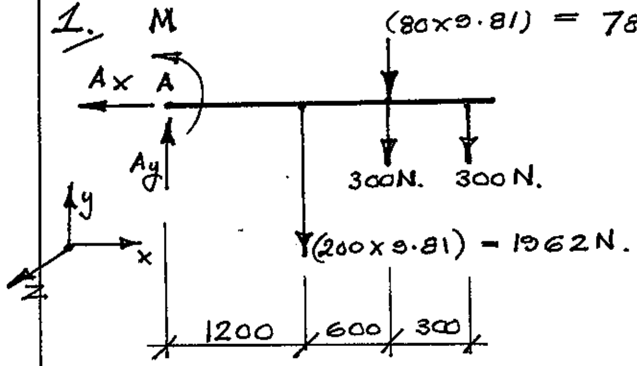
1.



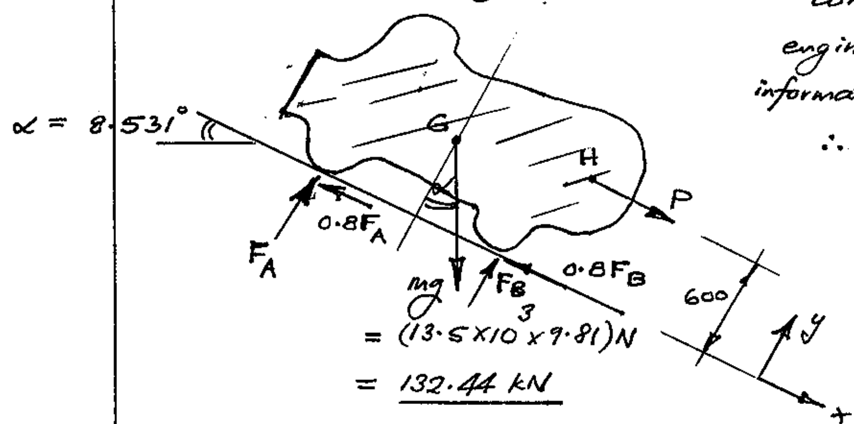
Free Body Diagram of Beam.

$$\Sigma M_A = 0 \therefore (1962)(1.2) + (784.8)(1.8) + (300)(2.1) + (300)(1.8) - M = 0$$

$\therefore M = 4937$ Nm.

$\therefore \underline{M = 4.94\ kNm}$

2. Free Body Diagram of Vehicle



$= (13.5\times 10^3 \times 9.81)N$
$= \underline{132.44\ kN}$

Constant speed = 5 km/hr. Note: "Real" engineering situations contain a lot of redundant information. Constant speed $\Rightarrow \underset{\sim}{a} = 0$

$\therefore$ In Equilibrium ($F = m\underset{\sim}{a} = 0$).

3 Unknowns: F_A, F_B, P $\therefore$ Solvable!

$\Sigma F_y = 0$

$\therefore F_A + F_B - 132.44 \cos 8.5308° = 0$

$\therefore \underline{F_A + F_B = 130.97\ kN}$ ——— ①

ΣM_H (the Hook Point) = 0 too

$$\therefore (3.6)(F_A) + (1.8)F_B + (0.8F_A)(0.6) + (0.8F_B)(0.6) - (132.44)\cos 8.531°(2.4) + (132.44)\sin 8.531°(0.225) = 0$$

$$\therefore 3.6F_A + 1.8F_B + 0.48F_A + 0.48F_B - 314.34 + 4.42 = 0$$

$\therefore \underline{4.08F_A + 2.28F_B = 309.92\ kN}$ ——— ②

Substituting ① into ②, $4.08F_A + 2.28(130.97 - F_A) = 309.92$

$\therefore F_A = 6.28\ kN$

& $F_B = 124.69\ kN.$

$\therefore$ Total Normal Reaction, $\underline{N_B}$, under the rear wheels = $\underline{124.7\ kN.}$ *

$\Sigma F_x = 0 \rightarrow P + 132.44(\sin 8.531°) = 0.8F_A + 0.8F_B$

$\therefore P + 19.65 = 0.8(6.28 + 124.69)$

$\therefore \underline{P = 85.1\ kN.}$ *

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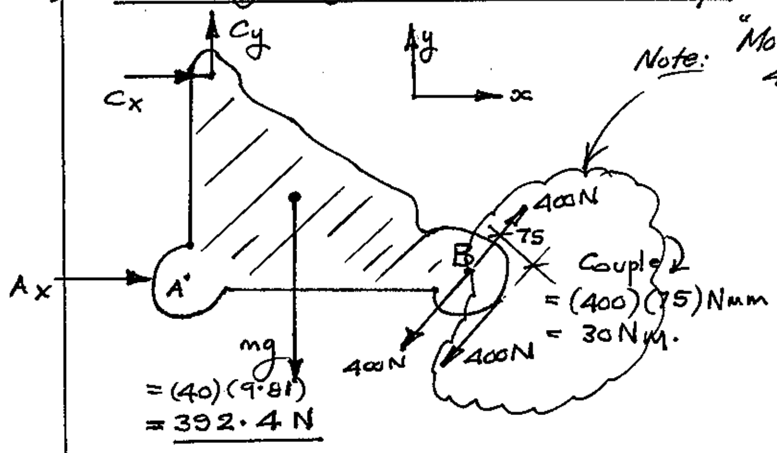
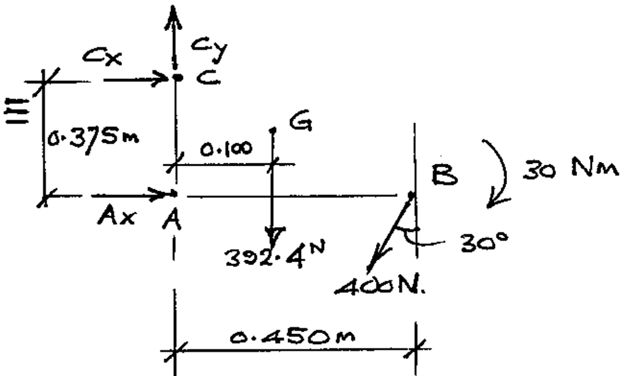
3. Free Body Diagram of Bracket & Pulley.

Note: "Move" the 400N. force to B, and replace by a 400N force @ B plus a couple = 30 Nm.





$\Sigma M_A = 0$

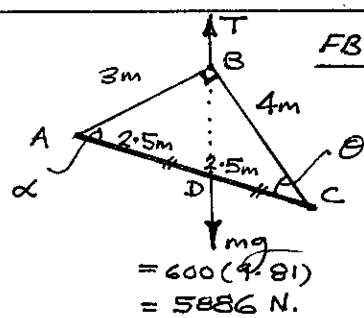
$\therefore C_x(0.375) + 392.4(0.100) + 400\cos 30^\circ(0.450) + 30\text{ Nm} = 0.$

$\therefore \underline{C_x = -600.3\text{ N}}$

$\Sigma F_y = 0 \quad \therefore \quad C_y - 392.4 - 400\cos 30^\circ = 0 \quad \therefore \quad \underline{C_y = 738.8\text{ N}}$

$\therefore \left|\text{Force @ Pin C}\right| = \sqrt{600.3^2 + 738.8^2} = \underline{\underline{952\text{N.}}}$

4. FBD of ABC



Note: For this FBD, Σ Vertical Forces $= 0$

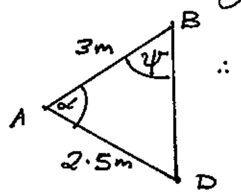
$\Rightarrow T = mg = \underline{5886\text{ N}}$

& $\Sigma M_B = 0 \quad \therefore$ mg lines up with T.

$\sin\theta = 3/5$

$\therefore \theta = 36.87^\circ$

$\therefore \underline{\alpha = 53.13^\circ}$



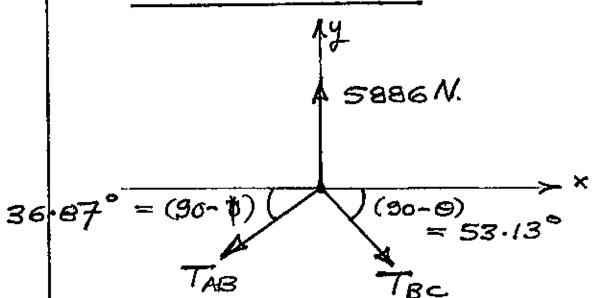
$\therefore BD^2 = 3^2 + 2.5^2 - 2(3)(2.5)\cos 53.13^\circ$

$\therefore \underline{BD = 2.50\text{m.}}$

Also, $\dfrac{2.5}{\sin\psi} = \dfrac{2.5}{\sin\alpha}$

$\therefore \underline{\psi = 53.13^\circ \text{ too.}}$

FBD of Point B.



$\Sigma F_x = 0 \quad \therefore \quad T_{AB}\cos 36.87^\circ = T_{BC}\cos 53.13^\circ$

$\therefore \underline{T_{BC} = 1.333\, T_{AB}}$

$\Sigma F_y = 0 \quad \therefore \quad T_{AB}\sin 36.87^\circ + T_{BC}\sin 53.13^\circ = 5886.$

$\therefore \quad 0.6T_{AB} + (1.333\,T_{AB})(0.8) = 5886$

$\therefore \quad T_{AB} = 3532\text{ N}$

or $\underline{\underline{T_{AB} = 3.53\text{ kN}}}$

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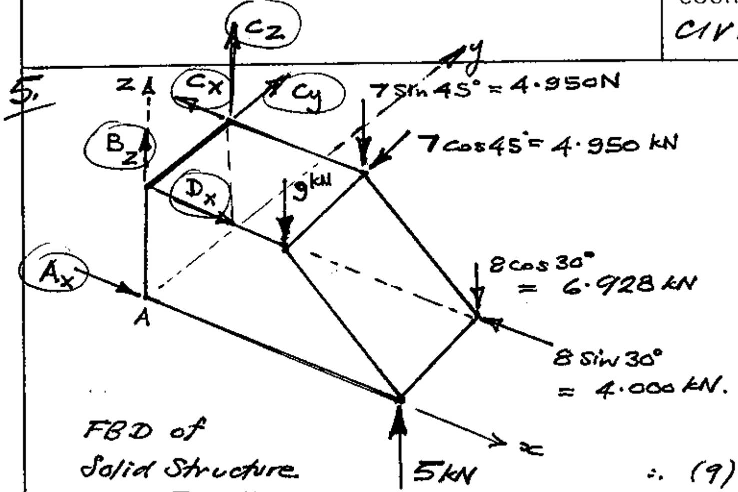
5.



FBD of Solid Structure + Rods.

6 unknowns as drawn ∴ OK.

∴ Assume no moment resistance @ C.

① $\Sigma F_y = 0$ ∴ $\underline{C_y = 4.95 \text{ kN.}}$

② $\Sigma M_{y_A} = 0$.

[See original figure for dimensions].

∴ $(9)(4) + (4.95)(4) + (6.928)(7) - (5)(7) - C_x(3) = 0$

∴ $\underline{C_x = 23.10 \text{ kN.}}$

③ $\Sigma M_{z_{C/D}} = 0 \Rightarrow (A_x)(3.9) - (4.95)(4) - (4.00)(0.7) = 0$ ∴ $\underline{A_x = 5.79 \text{ kN}}$

④. $\Sigma M_{z_A} = 0 \Rightarrow (C_x)(3.9) - D_x(3.9) - (4.95)(4) + (4.00)(3.2) = 0$

∴ $\underline{D_x = 21.31 \text{ kN}}$

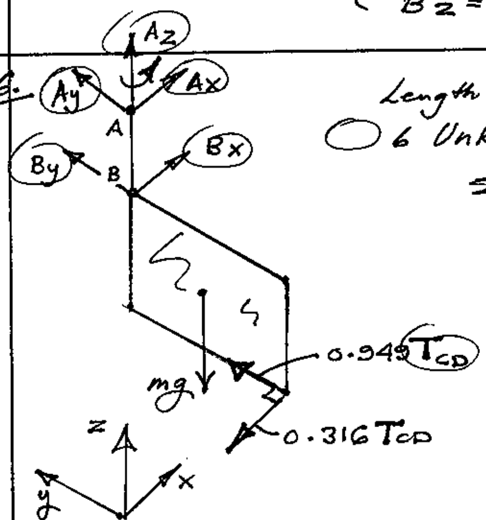
⑤ $\Sigma M_{x_C} = 0 \Rightarrow -B_z(3.9) + 9(3.2) + (4.95)(0.7) + (6.93)(0.7) - 5(3.2) = 0$

∴ $\underline{B_z = 5.41 \text{ kN}}$

⑥. $\Sigma F_z = 0 \Rightarrow 5.41 + C_z - 9 - 4.95 - 6.93 + 5.0 = 0$ ∴ $\underline{C_z = 10.47 \text{ kN}}$

∴ Reactions are: –
$$\left\{\begin{array}{ll} A_x = 5.79 \text{ kN} & C_x = 23.1 \text{ kN} \\ D_x = 21.3 \text{ kN} & C_y = 4.95 \text{ kN} \\ B_z = 5.41 \text{ kN} & C_z = 10.47 \text{ kN} \end{array}\right\}$$
in the directions shown above.

6.



FBD of Plate + Connecting Rod

Length of CD = 0.6325 m.

[See original figure for dimensions].

6 Unknowns as drawn ∴ O.K.

$\Sigma M_{z_A} = 0$ ∴ $120 - (0.316 T_{CD})(0.6) = 0$

∴ $\underline{T_{CD} = 632.5 N.}$

$\Sigma M_{x_A} = 0$

∴ $B_y(0.2) + (15)(9.81)(0.3) + 0.949(632.5)(0.680) = 0$

∴ $\underline{B_y = -2263.7 N}$

$\Sigma M_{y_A} = 0$

∴ $B_x(-0.2) + 0.316(632.5)(0.680) = 0.$

∴ $\underline{B_x = 679.6 N}$

∴ $\underline{\left|\text{Force Supported @ B}\right|} = \sqrt{B_x^2 + B_y^2} = \underline{2.36 \text{ kN.}}$