PAPUA NEW GUINEA UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF MINING ENGINEERING

MN311 BULK MATERIAL HANDLING

EXAM

(Semester #1, 2022)

Time: 3 Hours

Information:

1. You have 5 minutes to read through the instructions and questions carefully.
2. There are five (5) questions.
3. Answer ALL questions.
4. Total marks out of 90.
5. You MUST show all working out and express values in correct units.
6. Calculators, biros and rulers ARE ALLOWED in the test. Notes, mobile phones and any other electronic devices are strictly NOT ALLOWED.
7. Formulas, charts, and tables, are provided.
8. Write ALL answers on the answer sheet provided.
9. Write your NAME and NUMBER on the answer book. DO THIS NOW

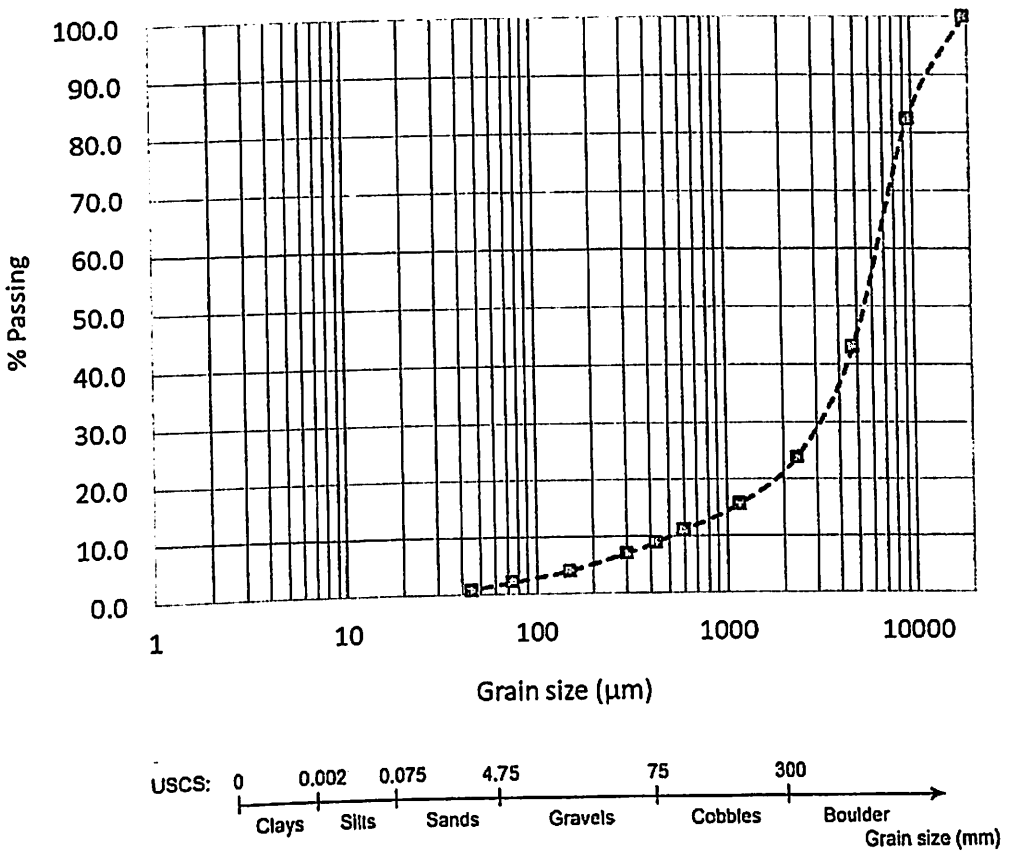
QUESTION 1 **Particle size distributions** **(15 Marks)**

Determine from the particle size distribution curve provided below;

i) % gravel, % sand, and % fines, (5 Marks)

ii) Coefficient of uniformity (C_u) and coefficient of curvature (C_c), and (5 Marks)

iii) Classify the soil using USCS with brief explanation. (5 Marks)



QUESTION 2 **Stockpile** **(15 Marks)**

i) One of the purposes of stockpiling is for 'grade maximization'. Briefly explain the reasons for maximizing grade. (5 Marks)

ii) Explain briefly how a 'ramp stockpile' is established with aid of sketches. (5 Marks)

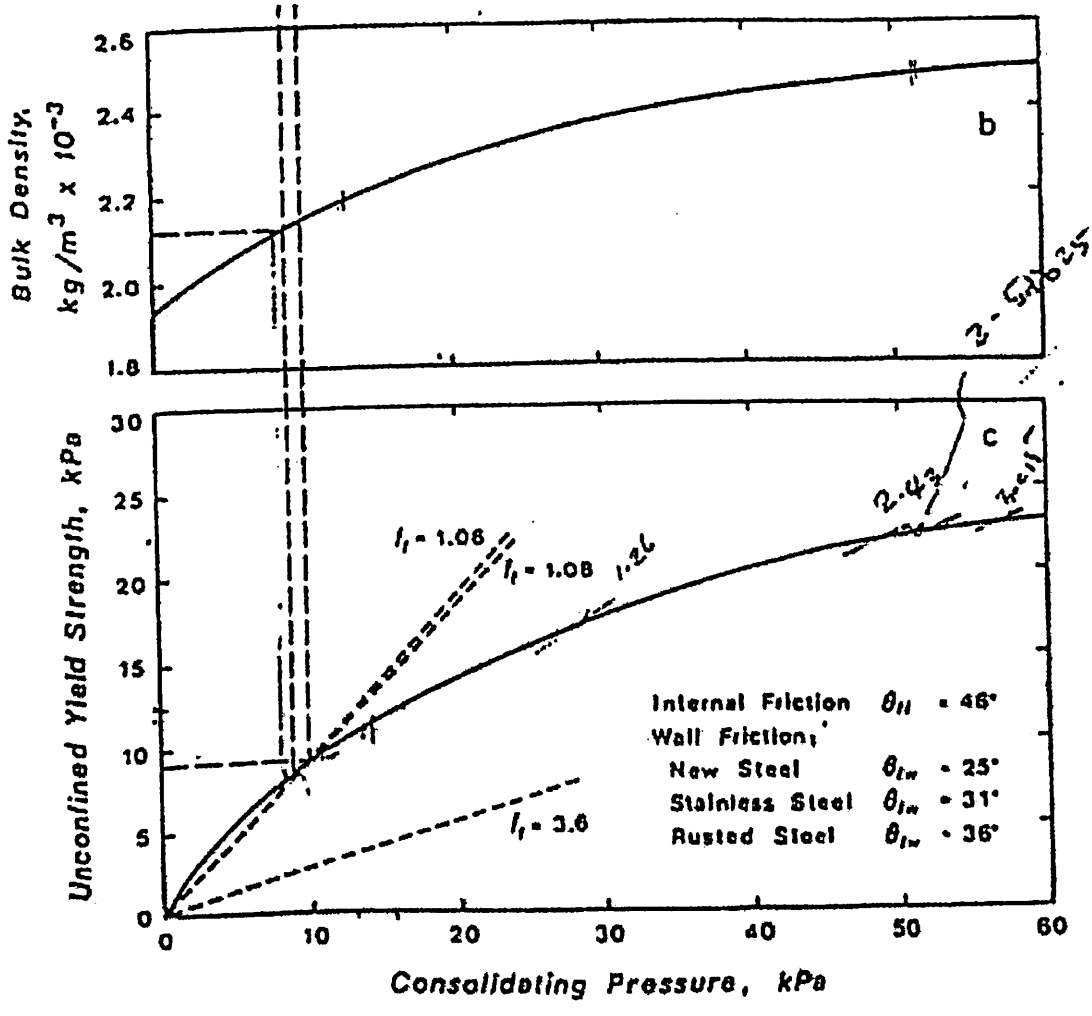
iii) Determine the stockpile dimensions to store 25,000 tonnes of bulk solids having a bulk density of 1.8 t/m^3 and repose angle of 40°. A maximum stockpile height of 5 m, and to be constructed as a windrow parallel stockpile. (5 Marks)

QUESTION 3 **Bin and hopper** **(15 Marks)**

i) State the two most common flow patterns observed in bins and hoppers and explain briefly with neat sketches. (5 Marks)

ii) Consider that iron ore is to be stored in bin and hopper facility for shipment loading purposes. The chart below shows the flow properties. The properties of the material include; P_b of 2300 kg/m^3, θ_{fw} of 38°, θ_{fi} of 39.5°, θ_h of 20°.

Assume; L =2.5*B, $\Theta_h = \Theta_{ch}$, and f_{fa} is 1.8



Determine the;

a) Minimum dimensions to prevent arching for slot type opening. (5 Marks)

b) Discharge flow rate (t/hr) for the slot type opening. (5 Marks)

QUESTION 4 **Conveyor belt** **(20 Marks)**

A coal mine plans to use belt conveyor to transport coarse ore from the stockpile to an uphill wash plant. The ore is lumpy and moderately abrasive has bulk density of 850 kg/m^3, and surcharge angle of 15 degrees. The distance to convey is 100 m at 4 degrees inclination.

- Average duty belt selected with speed 2.5 m/s
- Belt width selected 1000 mm
- Idler configuration for belt is a 3-roller idler set (optimum shape)
- Idler pitches are 1 m and 3 m for carry and return side respectively
- Idler sizes selected 127 mm
- Friction coefficient 0.025

Determine the;

i) Production rate of the belt conveyor. (5 Marks)

ii) Motor power required at 85% efficiency. (15 Marks)

QUESTION 5 **Slurry** **(25 Marks)**

i) Explain the characteristics of a Bingham fluid with aid of a graph. (5 Marks)

ii) Mill tailings from a copper-gold mine is to be transported as slurry over 500 m to the tailing pond. The slurry density is 1400 kg/m^3 , slurry viscosity is 1.8 cp, yield stress is 30 dyne/cm^2, concentration of solid by volume is 35%, slurry velocity is 3 m/s, specific gravity of solid is 2.5, particle shape is predominantly spherical, and the drag coefficient is 0.425. The pipe to be used for the slurry transportation has internal diameter of 20cm, relative roughness of 0.0001. Water as the carrier fluid has viscosity of 1.13 cp. The shock loss due to bends, valves, and joints along the pipe reticulation is equivalent to 3m head loss.

Assuming a heterogeneous flow, determine the;

a) Total pump discharge pressure. (15 Marks)

b) Discharge rate of tailings (t/hr). (5 Marks)

Conversion;

1 cp = 1x10^{-3} Pas (where Pas is Pascal second)

1 dyne = 1x10^{-5} N (kgm/s^2)

FORMULA/ CHARTS/ TABLES

$$\frac{J - J_w}{J_w C_v} = 81\left[\frac{gD(S_s - 1)}{v^2}\frac{1}{\sqrt{C_d}}\right]^{1.5}$$

$$f = \frac{\Delta H\, 2gD}{L\, U^2}$$

$$Re = \frac{\rho v D}{\mu}$$

$$B_{min} = 1.11\left(\frac{\dot{m}_s}{\rho_b k_s U_v}\right)^{0.5} + 0.056$$

$$A = Ub^2$$

$$\dot{m}_s = \rho_b k_s U b^2 v$$

$$M_c = (m_{lc} + m_{lr} + 2m_b \cos\alpha)\, L$$

$$F_{fb} = \mu_{r1} M_c g$$

$$F_{fL} = \mu_{r2} m_L g L$$

$$F_{st} = m_L g H$$

$$F_H = F_{fb} + F_{fL}$$

$$F_H = 0.025g\left(M_c + \frac{m_L}{v}\right)L$$

$$m_L = \frac{m_s}{v},$$

$$F_N = K_{SR} F_H$$

$$F_R = F_{fb} + F_{fL} + F_{st} + F_N$$

$$F_R = (1 + K_{SR})\, F_H + F_{st}$$

$$T_e = (1 + K_{SR})\, F_H + F_{st}$$

$$P = T_e v$$

$$C_u = \frac{D_{60}}{D_{10}}$$

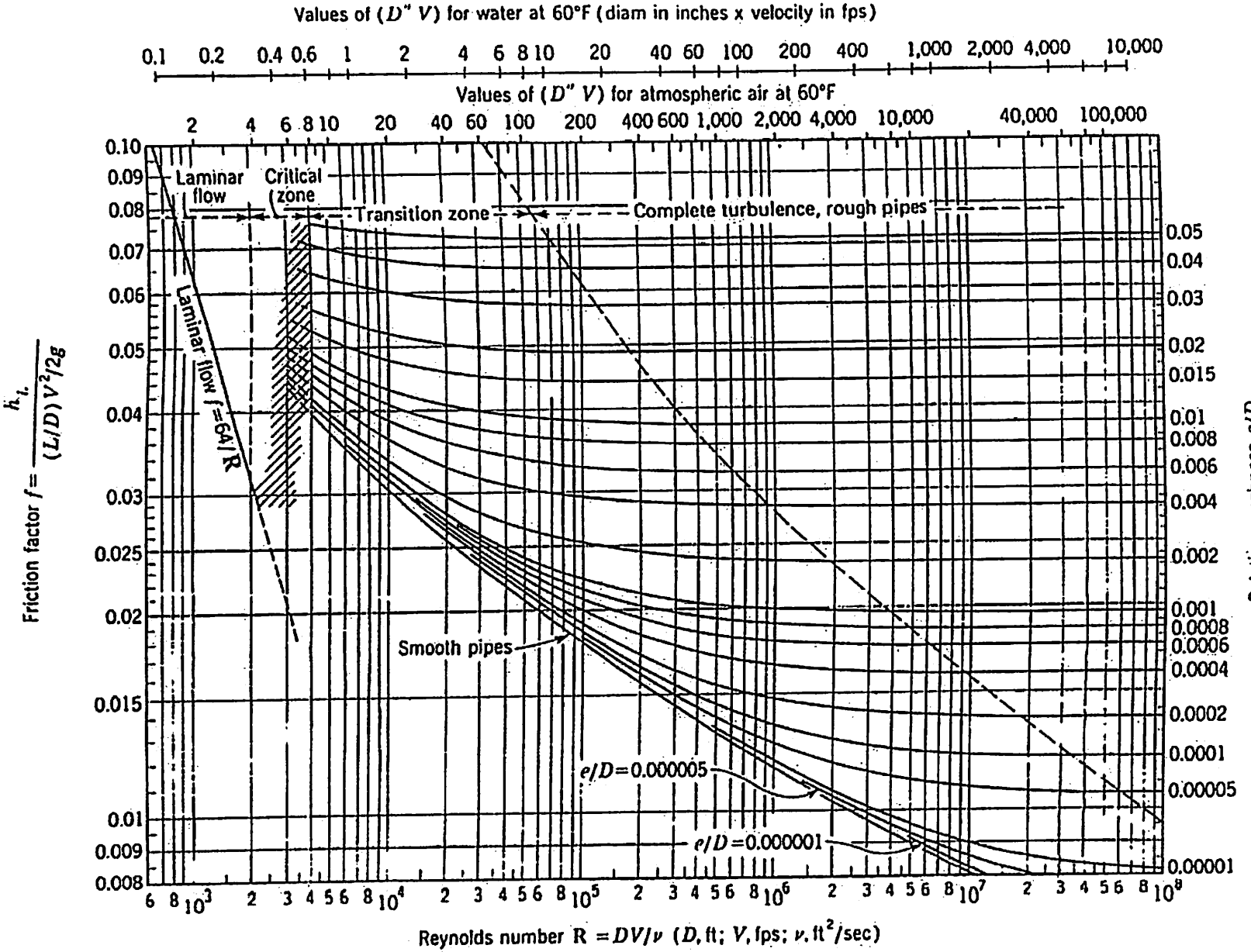
$$C_c = \frac{D_{30}^2}{D_{10} D_{60}}$$

$$B_a \geq \frac{\mathfrak{S}_v}{\rho_b g}$$

$$O_v = BL\left(\frac{Bg}{2\tan\theta_{ch}}\right)^{1/2}\left(1 - \frac{f_f}{f_{f,a}}\right)^{1/2}$$

$$\frac{1}{3}\pi r^2 h$$

$$\frac{1}{2} \times b \times h \times l$$


Values of (D" V) for water at 60°F (diam in inches x velocity in fps)
0.1 0.2 0.4 0.6 1 2 4 6 8 10 20 40 60 100 200 400 1,000 2,000 4,000 10,000
Values of (D" V) for atmospheric air at 60°F
2 4 6 8 10 20 40 60 100 200 400 600 1,000 2,000 4,000 10,000 40,000 100,000
Laminar flow
Critical zone
Transition zone
Complete turbulence, rough pipes
Laminar flow f=64/R
Smooth pipes
e/D=0.000005
e/D=0.000001
Friction factor f = h_L / (L/D) V²/2g
Relative roughness, e/D
0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.025 0.02 0.015 0.01 0.009 0.008
0.05 0.04 0.03 0.02 0.015 0.01 0.008 0.006 0.004 0.002 0.001 0.0008 0.0006 0.0004 0.0002 0.0001 0.00005 0.00001
6 8 10³ 2 3 4 5 6 8 10⁴ 2 3 4 5 6 8 10⁵ 2 3 4 5 6 8 10⁶ 2 3 4 5 6 8 10⁷ 2 3 4 5 6 8 10⁸
Reynolds number R = DV/ν (D, ft; V, fps; ν, ft²/sec)

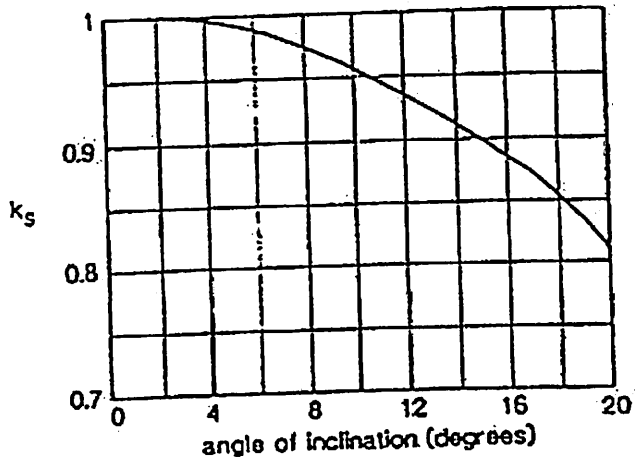


Figure 7.17 Slope factor k_s for smooth (unpatterned) belts operating on a gradient.

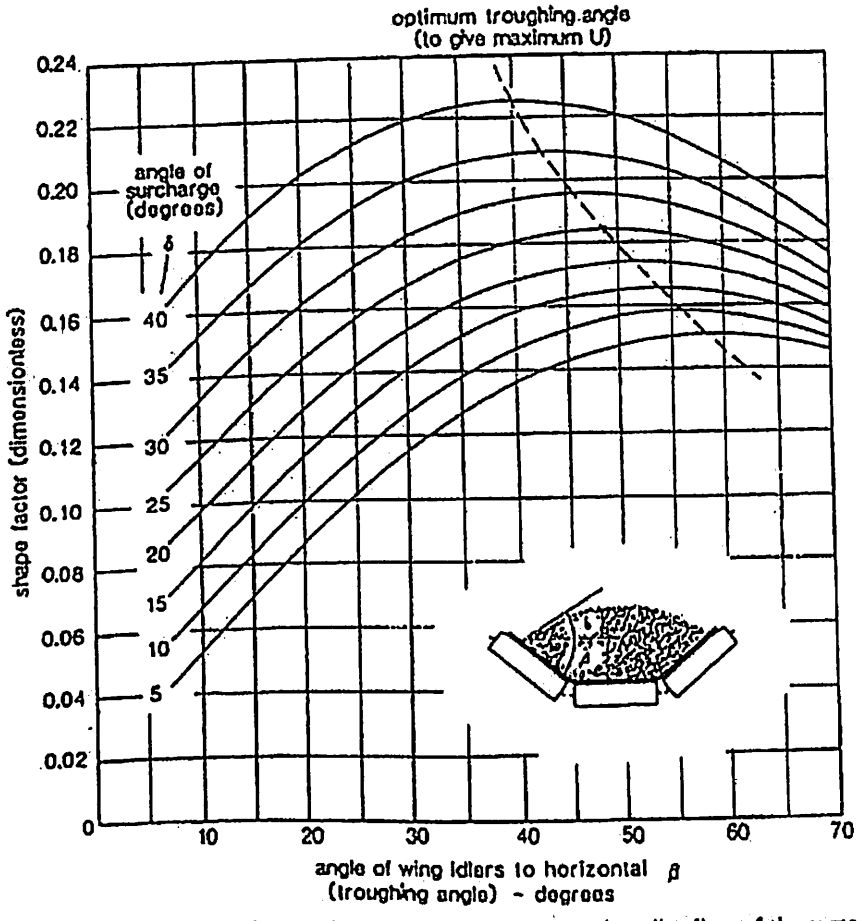
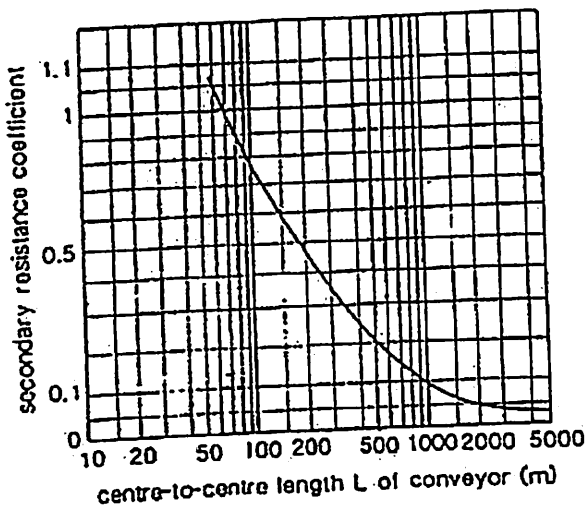


Figure 7.16 Shape factors for standard three-roll idler set having all rollers of the same size.



Variation of secondary resistance coefficient K_{SR} with length of belt conveyor from

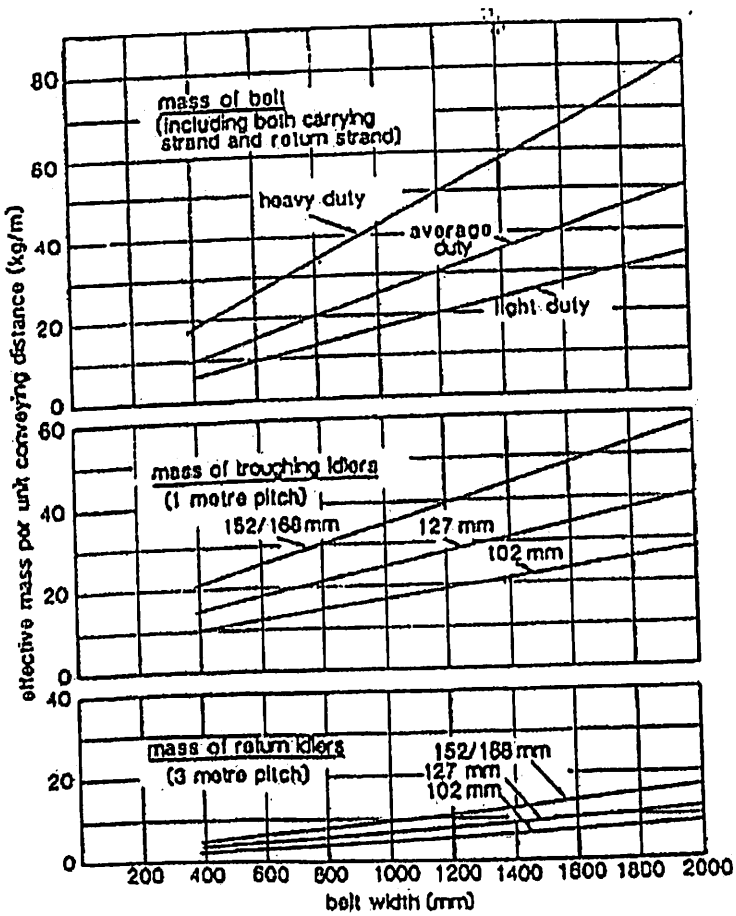


Figure 7.21 Charts for estimating the total mass of moving parts per unit length of conveyor. Example: for 1000 mm wide belt, 127 mm idlers, on average duty, total mass = 6.5 + 24.5 + 25.5 = 56.5 kg/m.