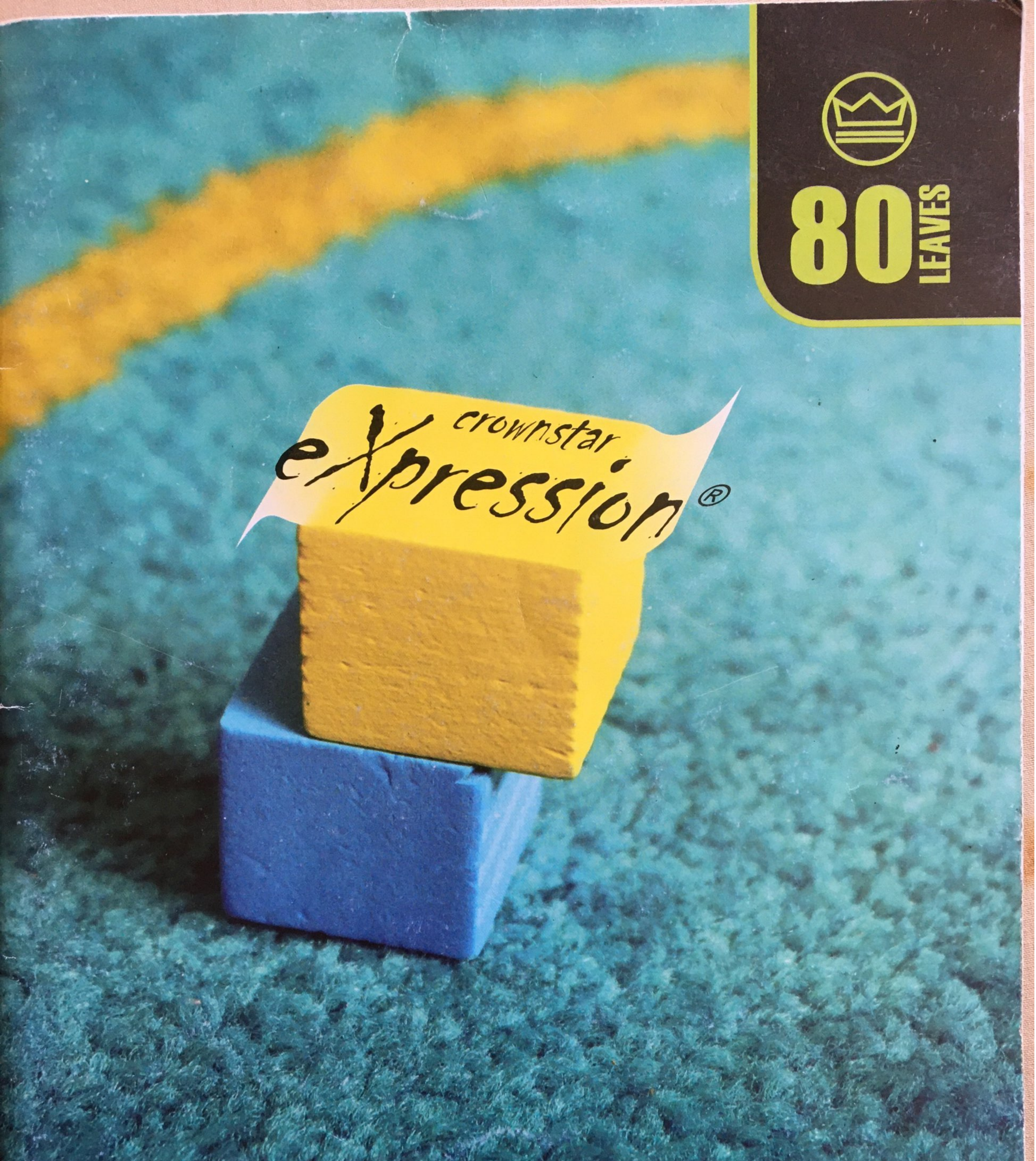

Name : MATERIAL HANDLING & EQUIPMENT
Class : ________ Date : ________
Subject : MEE 501
School : ________

12th October, 2021

Course Outline

1. Classifications of material handling & equipment.
2. Performance characteristics.
3. Economic choice.
4. Design of hoisting equipment (ropes, sheade, chains, rope drums)
5. Design of transport equipment such as lorries, trucks, conveyors, shovels.
6 Design of belts, bucket elevator and screw ropes.

factory vs plant

19th October, 2021

Overview of Material Handling.

Material handling involves the short distance movement that usually takes place within the convines of a building such as plants, or warehouses and between the a building, also transportation industry. It can be used to create time and place utility through the handling, storage and control of materials as distinct from manufacturing.

Principles of Material Handling Equipment.

1. Planning Principle: All material handling should be the result of deliberate plans where the needs, performance objectives and functional specifications.

2. Standardization Principle

3. Work Principle: Material handling work should be minimized without sacrificing productivity.

4. Egronomics Principles: Using the right designs for convenience.

5. Unit Load Principle: Unit load shall be appropriately ~~signed~~ sized and configured in the way that achieves the material flow.

Scanned with CamScanner

and inventory objectives at each stage on the supply chain.

6. Space utilization principle.
7. System principle
8. Automation principle
9. Environmental principle
10. Life cycle cost principle.

Advantages and Disadvantages of Unit Load

A unit load is either a single unit of an item or multiple units arranged or restricted that can be handled in a single unit and maintain their integrity.

Advantages

1. More items can be handled at the same time, thereby reducing the number of trips required and potentially reducing the handling cost, loading and unloading times and product damage.
2. Enables the use of standardized material handling equipment.

Disadvantages

1. Time spent informing and breaking down the unit load.

2. Cost of containers / palettes and other load restraining materials used in the unit load.
3. Empty containers or palettes may need to be returned to their point of origin.

Basic Ways of Restraining Unit Load

1. Self restraining e.g block arranging
2. Platforms e.g arranging palettes
3. Sheets e.g A4 paper packaging
4. Reusable containers e.g baskets, hampers
5. Disposable container e.g cartons, crates
6. Racks.

Basic Ways of Moving Unit Load

1. Use of lifting devices under the mass of load e.g palettes, forklifts, etc
2. Inserting a lifting element
3. Squeezing the load between the two lifting surfaces.
4. Suspending the load using hoisting devices e.g cranes, elevators, etc.

Major Equipment Categories

1. Transport equipment ; cranes, elevators, conveyors, forklifts, etc.
2. Positioning equipment ;
3. Unit Load formation equipment
4. Storage equipment
5. Identification and control equipment.

1. Transport Equipment

These are used to move materials from one location to another. The major sub categories of transport equipments are: conveyors, cranes, industrial trucks. Materials can also be transported manually using no equipment.

2. Positioning Equipment:

These are equipments used to handle materials at a single location. Unlike transport equipment, positioning equipment are used to handle materials in a single workplace. Materials can also be positioned manually.

3. Unit Load Formation Equipment

These are equipment used to restrict materials so that they maintain their integrity when handled. Materials can be self restraining (manual restraining)

4. Storage Equipment

Storage equipment are used for holding or buffering materials over a period of time. Some storage equipment may include the transport of materials. If the materials are ~~blocked~~ stacked, directly on the floor, then no equipment is needed.

5. Identification and Control Equipment

These are equipment used to collect and communicate information that is used to coordinate the flow of material within the facilities and between a facility and its ~~supp~~ suppliers and customers.

Transport Equipment

Conveyors

Types of Conveyors

1. Chute Conveyor
2. Wheel conveyor
3. Roller conveyor
4. Chain conveyor
5. Slat conveyor
6. Flat belt conveyor
7. Magnetic Belt conveyor
8. Bucket conveyor
9. Vibrating conveyor

10. Screw conveyor
11. Pneumatic conveyor
12. Vertical Conveyor
13. Cart on track Conveyor
14. Tow conveyor
15. Trolley conveyor
16. Power & free conveyor
17. Mono rail

Cranes

1. JIB crane
2. Bridge crane
3. Gantry crane
4. Stacker Crane

Industrial Trucks

Types of Industrial Trucks

1. Hand truck
2. Palette jack
3. Walkie stacker
4. Palette truck
5. Platform truck
6. Counterbalanced lift truck
7. Side loader
8. Order picker

Positioning Equipment

Types of Position Equipment.

1. Manual positioning
2. Lift or turn table
3. Dock lever
4. Ball transfer table
5. Rotary index table
6. ~~Parts~~ feeder
7. Air film device
8. Hoist
9. Balancer
10. Manipulator
11. Industrial robot.

Unit Load Formation Equipment

Types of Load Formation Equipment.

1. Self restraining
2. Palettes
3. Skids (heavier load carrying capacity)
4. Tote pans
5. Palette/skid boxes
6. Beams, baskets and racks
7. Cartons
8. Bags
9. Crates
10. Bulk load containers.
11. Intermodal container.
12. Strapping tape.
13. Palettizer.

9th November, 2021

Design of Hoist Equipments

Design of Rope Drives

Rope drives are widely used when large amount of power is to be transferred from one pulley to another over a considerable distance. It may be noted that the use of flat belts is limited for the transmission of moderate power from one pulley to another when the two pulleys are no more than 8m apart. If large amount of power is to be transmitted from one pulley to another then it will result in excessive cross belt.

Ropes can be categorized into two:

1. Fibre ropes
2. Wire ropes

Fibre ropes for transmitting power are made from fibrous materials such as hemp, manilla and cotton. Since the hemp and manilla fibres are raw, the rope made from the fibres are not very flexible and possesses poor mechanical properties. The hemp rope has less strength as compared to manilla rope. When the hemp and manilla ropes are bent over sheaves, there would be sliding of the fibre, causing the rope to wear. In order to minimize this defect, the rope fibre are lubricated with a tar or graphite. The cotton ropes are very soft and smooth. The lubrication of the cotton rope is not necessary, but if it is done, it reduces the external wear between the rope and the groove of its sheaves

$P = (T_1 - T_2) n V$ — μ = coeffient of friction, n = no of ropes

$T = T_1 + T_c$ — θ = lap angle btwn groove & rope

θ in rad — $T_c = mv^2$, $T_c = T/3$ — T = max tension T_1 = tension in tight side

$2.3 \log \frac{T_1}{T_2} = \mu\theta \operatorname{cosec}\beta$ — T_2 = tension in slack side T_c = tension in pulley

$V = \sqrt{\frac{T}{3m}} = \frac{\pi d N}{60}$ — β = half of groove angle

m = mass per unit length

<u>Question 1.</u> — P = power transmitted

A pulley used to transmit power by means of rope has a diameter of 3.6m and has 15 groves of 45° angle. The angle of contact is 170° and the coeffient of friction between the rope and the groove is 0.28. The maximum possible tension in the rope is 960N and the mass of the rope is 1.5kg/m length. Determine the speed of the pulley in RPM and the power transmitted if the condition of the max power prevails

Advantages of Fibre Ropes

1. They give smooth and quiet service
2. They're not too affected by outdoor conditions
3. The shaft may be out of strict allignment
4. They give high mechanical efficiency
5. Power may be taken off in any direction

Solution to Question 1

Given:

$d = 3.6m$

$n = 15$

$2\beta = 45°$; $\beta = 22.5°$

$\theta = 170°$ (in degrees) $= 170 \times \frac{\pi}{180} = 2.967 \simeq 2.97$ rad

$\mu = 0.28$

$T = 960N$

$m = 1.5kg/m$, Calculate N & P

$V = \frac{\pi d N}{60}$; $V = \sqrt{\frac{T}{3m}} = \sqrt{\frac{960}{3 \times 1.5}} = 14.6ms^{-1}$

$14.6 = \frac{\pi \times 3.6 \times N}{60}$; $\frac{14.6 \times 60}{\pi \times 3.6} = N$; $N = 77.45$ rpm

319.56 $\qquad\qquad$ 1.5×146^2

11. $P = (T_1 - T_2) n V$

$T_1 = T - T_c$; $T_c = \frac{T}{3} = \frac{960}{3} = 320N$

$T_1 = 960 - 320$

$T_1 = 640N$

For T_2

$2.3 \log \frac{T_1}{T_2} = \mu \theta \operatorname{Cosec} \beta$

$2.3 \log \frac{640}{T_2} = 0.28 \times 2.97 \times \operatorname{Cosec} 22.5$

$\log \frac{640}{T_2} = \frac{0.28 \times 2.97 \operatorname{Cosec} 22.5}{2.3}$

$\log \frac{640}{T_2} = \frac{0.28 \times 2.97 \times 2.61}{2.3}$

$\log \frac{640}{T_2} = 0.94$

$\frac{640}{T_2} = \text{Antilog } 0.94$

$\frac{640}{T_2} = 8.70$; $T_2 = \frac{640}{8.7} = 73.56N$

$P = (T_1 - T_2)nV$

$P = (640 - 73) \times 15 \times 14.6$

$P = 567 \times 219$

$P = 124,173\ W$

2.) A rope pulley with 10 ropes and peripheral speed of ~~50~~ 1500 m/min transmits 115KW. The angle of lap for each rope is 180° and the groove angle is 45°. The coefficient of friction between the rope and pulley is 0.2. Assuming the rope is to be joist ~~at~~ the point of slipping - find the tension in the tight and slack side of the rope. The mass of each rope is 0.6 ~~k~~g/m

Solution

Given:

$n = 10$

$V = \cancel{50}\ 1500\ m/min = 1500/60 = \cancel{0.83 ms^{-1}}\ 25 ms^{-1}$

$P = 115KW = 115,000\ W$

$\theta = 180° = 180 \times \frac{\pi}{180} = 3.142$

$2\beta = 45° \therefore \beta = 22.5$

$\mu = 0.2$

$m = 0.6\ kg/m$

Calculate T_1 & T_2

$$P = (T_1 - T_2)vn$$

$$\cancel{T = v^2 \times 3m}$$

$$115{,}000 = (T_1 - T_2)\,10 \times 25$$

Centrifugal tension

$$T_c = mv^2$$

$$= 0.6 \times (25)^2$$

$$T_c = 375N,$$

$$\frac{115{,}000}{250} = T_1 - T_2$$

$$T_1 - T_2 = 460N$$

$$2.3 \log \frac{T_1}{T_2} = \mu \theta \operatorname{cosec} \beta$$

$$\log \frac{T_1}{T_2} = \frac{0.2 \times 3.142 \operatorname{cosec} 22.5}{2.3}$$

$$\log \frac{T_1}{T_2} = 0.71$$

$$\frac{T_1}{T_2} = \text{antilog } 0.71$$

$$\cancel{T_1/T_2} \quad \frac{T_1}{T_2} = 5.13 \quad ; \quad T_1 = 5.13 T_2$$

Recall $T_1 - T_2 = 460$

$$(5.13 T_2) - T_2 = 460$$

$$4.13 T_2 = 460$$

$$T_2 = \frac{460}{4.13} = 111.4N$$

$T_1 - T_2 = 460$

$T_1 - 111.4 = 460$

$T_1 = 460 + 111.4$

$T_1 = 571.4N$

Tension in the tight side

$T_{t_1} = T_1 + T_c$

$= 571.4 + 375$

$T_{t_1} = 946.4N$

Tension in the slack side

$T_{t_2} = T_2 + T_c$

$= 111.4 + 375$

$T_{t_2} = 486.4N$

$T_1 = 571.4 N$

$T_2 = 111.4 N$ //

16th November, 2021

WIRE ROPES

When a large amount of power is to be transmitted over a long distance from one pulley to another (when the pulley are up to 150m apart) then wire ropes are used. The wire ropes are widely used in elevators, mine hoist, conveyors, hauling devices and suspension bridges. The wire ropes can run on grooved pulleys but they rest on the bottom of the grooves. The wire rope is made from cold drawn wire in order to have increased strength and ductility. It may be noted that the strength of wire rope increases as the size decreases. The various materials used for wire ropes in order to have increased strength are wrought iron, cast steel, extra strong cast steel and alloy steel

Advantages of Wire Ropes

1. They're lighter in weight (not necessarily lighter than fibre ropes).
2. They can withstand shock load.
3. They are durable
4. They have high efficiency.
5. Low cost
6. They do not fail suddenly. They experience fatigue
7. They are more reliable.

Designation of Wire Ropes

In designation of wire ropes, we do so with number of strands and wires. We have different categories;

1. 6×7 (strand, wires) ropes which is a standard rope used as haulage in mines and power transmission.
2. 6×19 ropes. 6 strand and 19 wires which is a standard hoisting rope used for hoisting purposes in crane, elevators, dredges, well drilling.
3. 6×37 ropes, it is an extra flexible hoisting rope

used in ~~lagoons~~ laddles, cranes and high speed elevators.

4. 8×19 ropes, it is an extra flexible hoisting rope.

Classification of Wire Ropes.

1. **Cross or Regular Lay Rope**

In this type of rope, the direction of twist of wire in the strands is in opposite to the direction of twist on the strand.

2. **Parallel or Lang Lay Rope**

In this type of rope, the direction of twist of wires is the same as that of strands in the rope.

3. **Composite or Reverse Lay Rope**

In this type of rope, the wires in the two adjacent strands are twisted in opposite directions.

Stresses in Wire Ropes

1. Direct Stress,

Direct Load = Applied Load + weight

$= W + w$

$$\sigma_d = \frac{W + w}{A}$$

A = cross sectional area of rope

$$W_d = W + w$$

2. Bending Stress;

$$\sigma_b = \frac{E_r * d_w}{D}$$

E_r = Young M of material

d_w = diameter of wire

D = Diameter of Pulley sheet

$$W_b = \frac{E_r \times d_w \times A}{D}$$

$$W_b = \sigma_b \times A$$

3. Additional stress due to acceleration

$$\sigma_a = \frac{W + w}{g} \times \frac{a}{A}$$

W = Applied load

w = weight

a = acc. of rope

g = acc due to gravity

A = area

$$W_a = \frac{W + w}{g} \times a$$

4. Starting Stress; σ_{st}

Starting Load, $W_{st} = (W+w) \left[1 + \sqrt{1 + \frac{2 \times a \times h \times E_r}{\sigma_d \times L \times g}}\right]$

$v = \sqrt{2ah}$

$$W_{st} = W + w \left[1 + \sqrt{1 + \frac{v^2 E_r}{\sigma_d \times L \times g}}\right]$$

when there is no slack, h = 0

$\therefore W_{st} = 2(W + w)$

$\sigma_{st} = \frac{2(W+w)}{A}$, when there is no slack.

5. Effective Stresses

The three effective stresses are:

(i) Effective Stresses due to normal working condition

$$= \sigma_d + \sigma_b$$

(ii) Effective stress during starting

$$= \sigma_{st} + \sigma_b$$

(iii) Effective stress during acceleration of load.

$$= \sigma_d + \sigma_a + \sigma_b$$

(ia) factor of Safety during working normal condition

$$f.o.s = \frac{\text{maximum load}}{W_d + W_b}$$

(iib) f.o.s during starting

$$f.o.s = \frac{\text{max load}}{W_{st} + W_b}$$

(iiic) f.o.s during acc. of load

$$f.o.s = \frac{\text{max load}}{W_b + W_a + W_b}$$

Procedure for Designing a Wire Rope

1. Select suitable type of rope from Table 20.6, 20.7, 20.8 for a given application.
2. Find the design load by assuming a f o s of 2-2.5 times the factor of safety given in Table 20.11
3. Find the diameter of the wire rope by equating the tensile strength of the rope selected (20.6) to the design load.
4. Find the diameter of the wire and the area of rope from table 20.10.
5. Find the various stresses in the rope as earlier discussed.
6. Find the effective stresses during normal working condition, starting and acceleration of load.
7. Find the factor of safety and compare to the factor of safety given in table 20.11. If the factor of safety is within the permissible limit, then the design is safe.

Scanned with CamScanner

$$f.o.s = \frac{\text{max load}}{\text{working load}}$$

Example 1

Select a suitable wire rope for a vertical mine hoist to lift a load of 55KN from a depth of 300m, the rope speed is 500m/min is to be attained in 10s.

Solution

$W = 55kN = 55,000N$

$d = 300m$

$v = 500m/min = 8.3m/s$

Steps

1. We chose 6x19 rope
2. We assume a f.o.s of 2.14 and use the corresponding depth (300m) to chose a f.o.s from the table which is 7 to get our f.os, $2.14 \times 7 = 15$

$$f.o.s = \frac{\text{max load}}{\text{working load}}$$

$$15 = \frac{\text{max. load}}{55,000}$$

design load
max load $= 15 \times 55,000$

$= 825,000N$

3. Diameter of the wire rope

$595d^2 = 825,000$, $d^2 = \frac{825,000}{595}$, $d = 37.24m$

from table 20.6

4. Diameter of wire and area of wire rope (20.10)

Diameter of wire $d_w = 0.063 d$

$= 0.063 \times 37.24$

$= 2.35 m \simeq 2.4$

~~Area of wire rope = $\frac{\pi d_w^2}{4} = \frac{\pi \times (2.34)^2}{4} =$~~

Area of wire rope, $A_w = 0.38 \times d^2$

$= 0.38 \times (37.24)^2$

$= 0.38 \times 1386.8176$

$= 526.99 m^2$

5. Various Stresses

needed = $W = 55,000 N$, $W_d = W + w = 55,000 + 50 = 55,050 N$

Table (20.6) $w = 0.036 d^2 = 0.036 \times 37.24^2 = \cancel{49.92}\ 50.34 \simeq 50 N$

$E_r =$

$l =$

$g = 9.81$

$a = v/t = 8.3/10 = 0.83 ms^{-2}$

$A =$

$d_w =$

Table (20.12) $D = 100 \times d = 100 \times 37.24 = 3724 m$

Scanned with CamScanner

$$E_r = 84 \times 10^3 \, N/mm^2$$

$$W_b = \frac{E_r \cdot d_w}{D} \times A$$

$$\sigma_b = \frac{E_r d_w}{D}$$

$$W_a = \frac{W + w}{g} \times a$$

$$\sigma_a$$

$$W_{st} = 2(W + w)$$

$$\sigma_{st} = \frac{2(W + w)}{A}$$

6. Effective Stress in normal con

$$= \sigma_d + \sigma_b$$

during starting

$$= \sigma_{st} + \sigma_b$$

during acceleration of load

$$= \sigma_d + \sigma_a + \sigma_b$$

Scanned with CamScanner

7. Factor of Safety under working con

$$F.o.S = \frac{max.\ Load}{W_d + W_b}$$

during starting

$$F.o.S = \frac{max\ Load}{W_{st} + W_b}$$

during acc of Load

$$F.o.S = \frac{max\ Load}{W_{st} + W_a + W_d}$$

If any of the F.o.S is less than 7, then the design is not safe.