Practical No. 4-B: Determine mechanical advantage and velocity ratio of Double purchase crab winch for different load and effort.

I. Practical Significance

There is often a need to lift loads and different lifting machines are used depending on the type of load, intensity of the load and other site conditions. The Double Purchase Crab machine is used for lifting heavy loads in confined spaces. According to per. Through this experiment, a qualified engineer can decide on the suitability of a double purchase crab based on the given lifting situation.

II. Industry/Employer Expected Outcomes

Apply the principles of engineering mechanics to analyze, design and automation the prototypes and equipment's of various industries

III. Course Level Learning Outcome(s)

CO1-Select the suitable machine under given loading condition.

IV. Laboratory Learning Outcome(s)

Verify law of machine under the given condition.

V. Relevant Affective Domain related Outcome(s)

a. Follow safety practices and precautions.
b. Demonstrate working as a leader/a team member.
c. Maintain tools and equipment.

VI. Relevant Theoretical Background

Double Purchase Crab: Crab and winch are machines used for hoisting heavy loads applying smaller amount of effort. These machines use gear systems in order to augment velocity ratio. Depending on the number of gear assemblies, crab and winch systems can be classified into two types single and double purchase crab.

In double purchase crab machine, two sets of gear assemblies are used. One additional axle, called an intermediate axle, is deployed. The pinion of teeth T1, mounted on effort wheel axle meshes with spur wheel of teeth T2, mounted on the intermediate axel.

Similarly, the pinion of teeth T3, on intermediate axle meshes with spur wheel of teeth T4, mounted on the load drum. A rope is wound around the effort wheel of diameter D through effort is applied and load is attached to another rope wound around the load drum. Effort then moves the pinion and thereby the spur wheel gets rotated. As the spur wheel is mounted intermediate axle it gets rotated. As intermediate axle rotates the load drum of diameter d, will get rotated. A strong rope is attached with load drum, at the end of which load is connected. Thus, the load is lifted by the rotation of the effort wheel.

For a single rotation of the effort wheel, distance travelled by effort= π D. For single rotation of pinion, on effort axle, spur wheel on intermediate axle rotates= T_1/T_2 times. Now the pinion on the intermediate axle also rotates= T_1/T_2 times. So, the spur wheel of the load drum rotates= $(T_1/T_2) \times (T_3/T_4)$ times. Thus, the displacement of load = $\pi d \times (T_1/T_2) \times (T_3/T_4)$

2. Set the machine and check the reversibility of machine.
3. Calculate friction in the machine based on zero load.
4. Apply the load starting with smaller magnitude.
5. Apply the effort for each corresponding load.
6. Record the observations of load and effort in observation table. Take at least five readings.
7. Measure the radius of effort wheel and load drum. Count number of teeth on pinion gear and spur wheels.
8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Double Purchase Crab.
9. Plot graphs viz. load against effort and load against efficiency

Observations and Calculations

$$\text{Velocity Ratio} = \frac{D \times T_2 \times T_4}{d \times T_1 \times T_3} = \frac{650}{220} \times \frac{72}{12} \times \frac{72}{12} =$$

V.R = 106.36

1. D = 650 ..... mm
2. d = 220 ..... mm
3. T_1 = 12 ..... No.
4. T_2 = 72 ..... No.
5. T_3 = 12 ..... No
6. T_4 = 72 ..... No

XI. Observations Table

Sr. No.	Load W (N)	Effort P (N)	M.A.	Velocity Ratio	Efficiency η (%)	Ideal Effort Pi (N)	Effort Lost in Friction Pf (N)
1	100	10	10	106.36	9.40 %	0.94N	9.06N
2	200	15	13.33		12.53 %	1.88 N	13.12 N
3	300	20	15		14.10 %	2.82N	17.18 N
4	400	24	16.66		15.66 %	3.76 N	20.24N
5	500	31	16.12		15.15 %	4.70N	26.3 N

Sample Calculations

$$\text{M.A.} = \frac{\text{Load}}{\text{Effort}} = \frac{W}{P} = \frac{100}{10} = 10, \quad \frac{200}{15} = 13.33$$

$$\text{Efficiency } (\eta) = \frac{\text{M.A.}}{\text{V.R.}} \times 100\% = \frac{10}{106.36} \times 100 = 9.40$$

$$P_i = \frac{W}{\text{V.R.}} = \frac{100}{106.36} = 0.94$$

$P_f = P - P_j =$ 10 - 0.94 = 9.06.

Law of Machine is P = mW + C

Where,

M = Slope = $\frac{P2-P1}{W2-W1} = \frac{15-10}{200-100} = \frac{5}{100} = 0.05$

C = Y intercept (i.e. Machine Friction) = _____ N

P = mW + C

15 = 0.05 × 200 + C

10 = 0.05 × 100 + C

5 = 100 m

m = $\frac{5}{100}$ = 0.05

10 = 0.05 × 100 + C

10 = 5 + C

C = 10 − 5

C = 5

XII. Results

1. The law of machine is P = (.0.:.0.5..) W + (....5.....) N
2. The average efficiency of machine is = ... %

XIII. Interpretation of results

Machine is ..reversible

Friction loss is (i.e. Y – intercept = ...) reduced by ..... the machine.

The graph between load and effort is a straight line which indicates.....

The graph between load and efficiency is a curve which indicates.....

XIV. Conclusions and Recommendations

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XV. Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO. Write answers of minimum three questions.

1. Calculate the effort required to lift a load of 50 kn from the graph of load against effort.
2. State any two field conditions where this machine can be used.
3. State the difference between single purchase crab and double purchase crab.
4. Describe the law of double purchase crab machine.
5. State, single or double purchase crab machine is preferred at construction site. Give reason.

Space for answers

Q. 3 ⟶ ?

Ans:-

Single purches scrab	double purches srab
① In this set of gear is used	① In this 2 set of gear is used

② load lifted is less

③ If required is space.

② load lifted is more

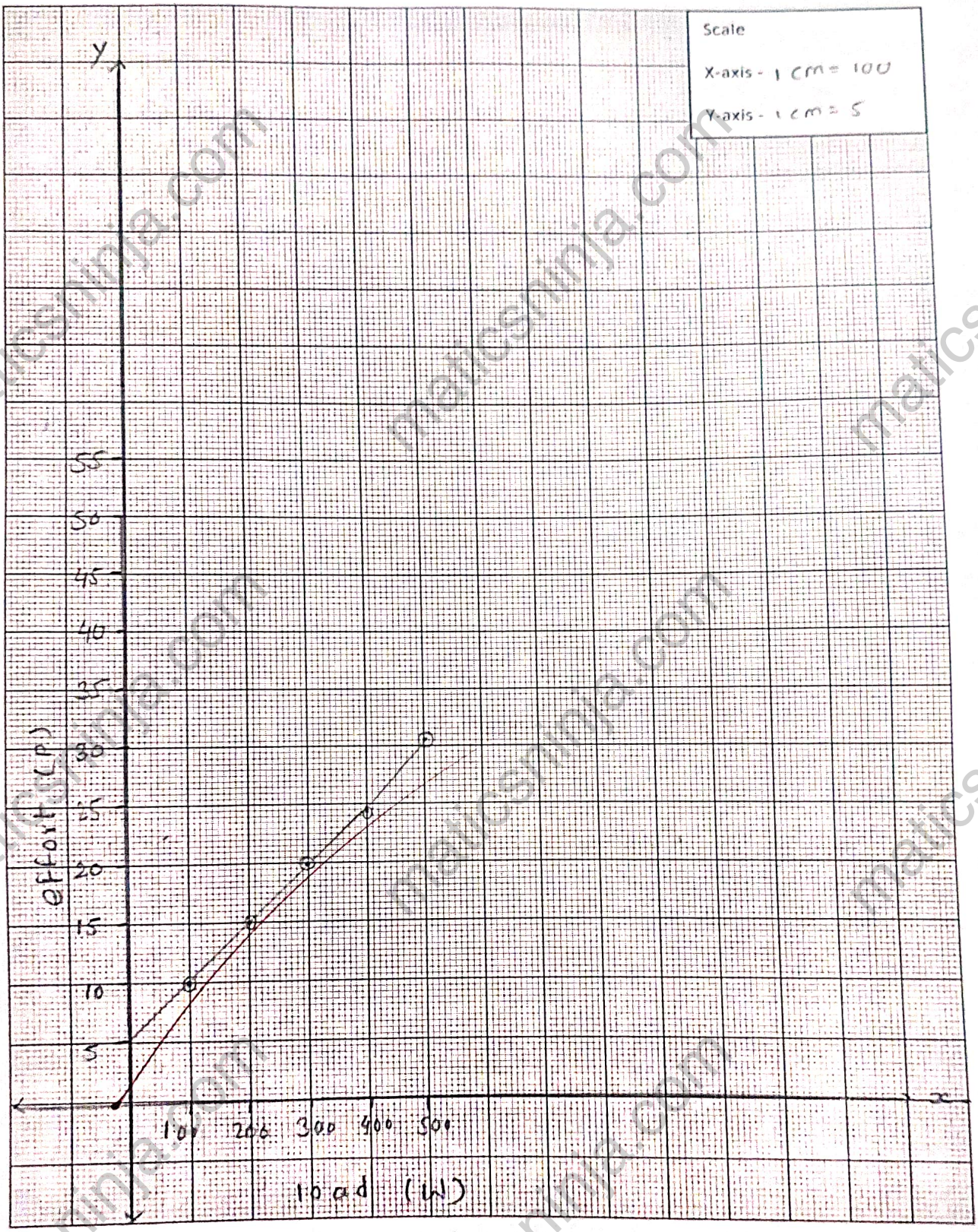
③ If required more space.

Q. 4 ⟶ ?

Crab and which are machine used for the hosting harry loads applying smallar amount is used gear system in order to agument Velocity ratio Depending upon the number of gear crab and which system can be classified into two types singal and double purches scrab:

XVI. References/Suggestions for further Reading

Sr. No.	Link	Description
1	https://www.engineersrail.com/simple-lifting-machine/	Introduction of simple lifting machine
2	https://www.youtube.com/watch?v=kNypk8GReqM	Law of machine and types of machines useful in industry.
3	https://www.google.co.in/www.indiamart.com%2Fproddetail%2Fwinch-crab-machine-model	Double purchase crab winch image
4	http://nitttrc.edu.in/nptel/courses/video/112106286/L01.html	Introduction to engineering mechanics


Scale
X-axis - 1 cm = 100
Y-axis - 1 cm = 5
y
55
50
45
40
35
30
25
20
15
10
5
Effort (P)
100
200
300
400
500
x
Load (W)