Practical No. 7: Determine mechanical advantage and velocity ratio of geared pulley block 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 gear pulley is used for lifting heavy loads in confined spaces. After conducting this experiment, a graduate engineer can assess the suitability of the Geard pulley based on the given load 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

Worm Gear Pulley Block: In a gear pulley block, an axle is coaxially attached to an effort wheel having T1 number teeth. A pinion having teeth T2 and a ratchet and clutch are attached coaxially on the axle. A pawl presses against this ratchet and clutch with the help of a spring. The pinion is geared with a spur wheel having teeth T3. On the same axle as spur wheel a load drum having teeth T4 is keyed on its circumference. An endless rope or chain is wound over effort wheel with which the effort is applied. The motion is transmitted from effort wheel to load drum through pinion and spur wheel. A separate rope is wound around half the perimeter of load drum. One end of it is fixed to the frame and other end holds the load. When the load is hoisted, the ratchet passes under the pawl. On the removal of effort, the pawl prevents the load from falling down. Hence, it is self-locking arrangement. In single rotation of effort wheel, effort moves through a distance proportional to Ti. At the same time, the spur wheel and the load drum rotate by (T2/Ti) of a rotation. In single rotation of load drum, the load is lifted through distance proportional to 4. So far, a single rotation of effort wheel, the load is lifted by a distance (T2/T3) x T4.

Hence,

$$\text{Velocity Ratio (V.R.)} = \frac{T_1}{\frac{T2}{T3} - T4} = \frac{T_1 \times T_3}{T_2 \times T_4}$$

Where,

T_1 = No. of teeth or cogs on effort wheel

IX. Precautions to be followed

1. Effort must be applied gradually

X. Procedure

1. Observe the machine carefully and identify the various components of machine.
2. Set the machine and check the reversibility of it.
3. Calculate friction in the given machine at 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 or number of cogs of larger and smaller pulley.
8. Determine M.A., V.R., Efficiency, Ideal effort and Effort lost in friction for given Weston's differential pulley block.
9. Plot graphs load against effort and load against efficiency.

Observations and Calculations

$$V.R. = \frac{T_1}{\frac{T2}{T3} - T4} = \frac{T_1 \times T_3}{T_2 \times T_4}$$

1. T_1 = ... No.
2. T_2 = ... No.
3. T_3 = ... No.
4. T_4 = ... 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	30	3·33	5·8	5·74	1·72	28·28
2	150	40	3·75		6·46	2·58	37·42
3	200	50	4		6·89	3·44	46·56
4	250	60	4·1		7·09	3·31	55·69
5	300	70	4·2		7·24	5·17	64·83

Sample Calculations

$$M.A. = \frac{\text{Load}}{\text{Effort}} = \frac{W}{P} = \frac{100}{30} = 3.33$$

$$\text{Efficiency } (\eta) = \frac{M.A.}{V.R.} \times 100\% = \frac{3.33}{5.8} \times 100 = 5.74$$

$P_i = \frac{W}{V.R.} = \frac{100}{58} = 1.72$

$P_f = P - P_i =$ 30 - 1.72 = 28.28

Law of Machine is P = mW + C

Where,

M = Slope = $\frac{P2-P1}{W2-W1} = \frac{40-30}{150-100} = \frac{10}{50} = 0.2$

C = Y intercept (i.e. Machine Friction) = 10 N

XII. Results

1. The law of machine is P = (..0.2....) W + (...10.....) N
2. The average efficiency of machine is = 6.678... %

XIII. Interpretation of results

Machine is .non-reversible

Friction loss is (i.e. Y – intercept = ..10.....) reduced by ...10..... 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.....

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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. Determine the effort required to lift a load of 200 kn from law of machine.
2. State the two situations in field where worm gear pulley block is used
3. Differentiate between differential and worm gear pulley block.
4. State is the capacity of chain block you have used?
5. State no. of chain used in differential pulley block and worm geared pulley block.

Space for answers

Q.1 ——— ?

Ans:- a) to lift a newz load like car the horizontal steblizer of air craft

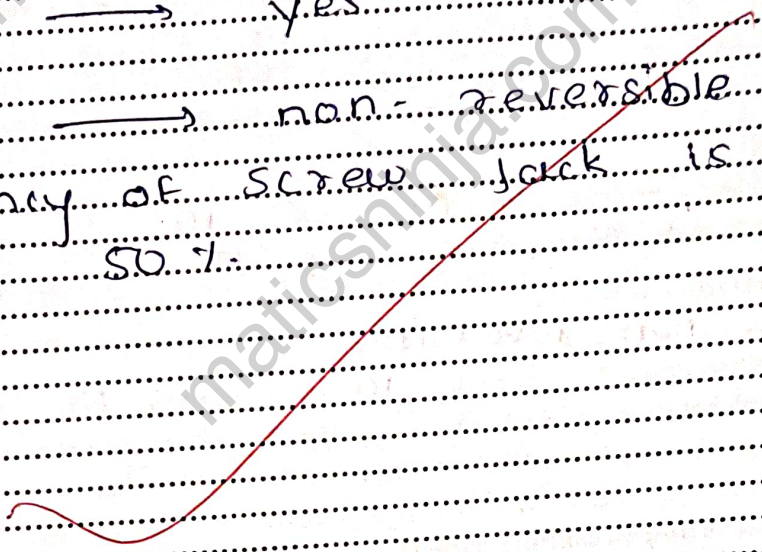
c) To support for heavy load.

b) To lift the heavy load.

2 ⟶ maximum load lifting capacity of the screw jack is 20 to 30 kN

Q. 3 ⟶ yes

Q. 4 ⟶ non-reversible because efficiency of screw jack is always less 50 %.



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://4.imimg.com/data4/LQ/SG/MY-27606486/7-5-ton-automatic-chain-pulley 500x500.jpg	Worm geared Pulley Block image
4	http://nitttrc.edu.in/nptel/courses/video/112106286/L01.html	Introduction to engineering mechanics