**Experiment 2: LOAD LIFTING MACHINE LAB**

**THE SCREW JACK**

**BACKGROUND:** Jackscrew, or screw jack, is a type of jack that is operated by turning a leadscrew. It is commonly used to lift moderately heavy weights, such as vehicles; to raise and lower the horizontal stabilizers of aircraft; and an adjustable supports for heavy loads, such as the foundations of houses.

The screw was one of the last of the simple machines to be invented. It first appeared in ancient Greece and Egypt, and by the first century BC was used in the form of the screw press and the Archimedes' screw, but when it was invented is unknown. Greek philosopher Archytas of Tarrentum (428 – 347 BC) was said by the Greeks to have invented the screw. Although the Greek philosopher Archimedes is credited by the Greeks with inventing the Archimedes screw water pump around 234 BC. Records indicate it was first used in ancient Egypt. Archimedes was first to study the screw as a machine, so he is sometimes considered the inventor of the screw. Greek philosophers defined the screw as one of the simple machines and could calculate its (ideal) mechanical advantage. For example, Heron of Alexandria (52 AD) listed the screw as one of the five mechanisms that could "set a load in motion", defined it as an inclined plane wrapped around a cylinder, and described its fabrication and uses, including describing a tap for cutting female screw threads.

**Advantages:** An advantage of jackscrews over some other types of jack is that they are self-locking, which means when the rotational force on the screw is removed, it will remain motionless where it was left and will not rotate backwards, regardless of how much load it is supporting. This makes them inherently safer than hydraulic jacks, for example, which will move backwards under load if the force on the hydraulic actuator is accidentally released.

**Limitations:** Screw jacks are limited in their lifting capacity. Increasing load increases friction within the screw threads. A fine pitch thread, which would increase the advantage of the screw, also reduces the size and strength of the threads. Using a longer operating lever soon reaches the point where the lever will simply bend at its inner end.

Screw jacks have now largely been replaced by hydraulic jacks. This was encouraged in 1858 when jacks by the Tangye Company to Bramah's hydraulic press concept were applied to the successful launching of Brunel's SS Great Eastern, after two failed attempts by other means. The maximum mechanical advantage possible for a hydraulic jack is not limited by the limitations on screw jacks and can be far greater. After World War II, improvements to the grinding of hydraulic rams and the use of O ring seals reduced the price of low-cost hydraulic jacks and they became widespread for use with domestic cars. Screw jacks still remain for minimal cost applications, such as the little-used tyre-changing jacks supplied with cars.

**Applications:** The large area of sliding contact between the screw threads means jackscrews have high friction and low efficiency as power transmission linkages, around 30%–50%. So they are not often used for continuous transmission of high power, but more often in intermittent positioning applications.

In heavy-duty applications, such as screw jacks, a square thread or buttress thread is used, because it has the lowest friction and wear.

In technical application such as actuators, an Acme thread is used, although it has higher friction, because it is easy to manufacture, wear can be compensated for, it is stronger than a comparably sized square thread and it makes for smoother engagement.

The ball screw is a more advanced type of leadscrew that uses a recirculating-ball nut to minimize friction and prolong the life of the screw threads. The thread profile of such screws is approximately semicircular (commonly a "gothic arch" profile) to properly mate with the bearing balls. The disadvantage to this type of screw is that it is not self-locking. Ball screws are prevalent in powered leadscrew actuators.

**Self-Locking Property:** Most screws are designed to be self-locking, and in the absence of torque on the shaft will stay at whatever position they are left. However, some screw mechanisms with a large enough pitch and good lubrication are not self-locking and will overhaul, and a very few, such as a push drill, use the screw in this "backwards" sense, applying axial force to the shaft to turn the screw. This self-locking property is one reason for the very large use of the screw in threaded fasteners such as wood screws, sheet metal screws, studs and bolts. Tightening the fastener by turning it puts compression force on the materials or parts being fastened together, but no amount of force from the parts will cause the screw to untighten. This property is also the basis for the use of screws in screw top container lids, vises, C-clamps, and screw jacks. A heavy object can be raised by turning the jack shaft, but when the shaft is released it will stay at whatever height it is raised to.

**Uses:** A screw conveyor uses a rotating helical screw blade to move bulk materials.

1. Because of its self-locking property the screw is widely used in threaded fasteners to hold objects or materials together: the wood screw, sheet metal screw, stud, and bolt and nut.
2. The self-locking property is also key to the screw's use in a wide range of other applications, such as the corkscrew, screw top container lid, threaded pipe joint, vise, C-clamp, and screw jack.
3. Screws are also used as linkages in machines to transfer power, in the worm gear, lead screw, ball screw, and roller screw. Due to their low efficiency, screw linkages are seldom used to carry high power, but are more often employed in low power, intermittent uses such as positioning actuators.
4. Rotating helical screw blades or chambers are used to move material in the Archimedes' screw, auger earth drill, and screw conveyor.
5. The micrometer uses a precision calibrated screw for measuring lengths with great accuracy.

The screw propeller, although it shares the name screw, works on very different physical principles from the above types of screw, and the information in this article is not applicable to it.

**AIM OF STUDY:** To investigate the efficiency and machine law of a screw jack

**LABORATORY EQUIPMENT:** The annotated experimental screw jack is shown above. **PHOTO.** The turntable is for supporting the load and the radius of the leadscrew which can move up or down the base, depending on the direction of rotation of the turntable. The ring is for supporting the effort together with the hanger on the pulley.

**EXPERIMENTAL PROCEDURE:** Measurement of the velocity ratio (VR) using the first approach: The table level is marked O, the ground is marked G. The initial level of the turntable when the effort is at the table level is marked Ti and the final level of the turntable when the effort is at the ground level is marked Tf then GO = 83.5cm, GTi = 113.3cm and GTf = 111.2cm. The VR (The ratio of the distance covered by the effort to that covered by the load) becomes .

Measurement of the velocity ratio (VR) using the second approach: The pitch of the screw thread is measured with a caliper as p = mm, the diameter of the turntable at the groove is measured as DT = cm and the diameter of the string measured as DS = mm. The VR is theoretically given as .

Loads (W) are placed on the turntable and the corresponding efforts (E) that are just enough to initiate rotational motion of the turntable are recorded.

**RESULTS AND CALCULATIONS:** GO = 84.3cm, GTi = 29.0cm and GTf = 29.7cm

DT = 21.6cm, DS = 0.2mm, DSCREW = 36mm and p = 0.6cm

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| W (kg) | E (kg) | Efitted (kg) | MAmeas,E | MAfitted,E | *ϕ* | *μ* | %Error[%] | %[%] |
| 10 | 0.20 | `0.21 | 50.00 | 47.62 | 9.534 | 0.168 | 4.76 | 4.76 |
| 20 | 0.30 | 0.29 | 66.67 | 66.67 | 9.821 | 0.173 | -3.45 | 3.45 |
| 30 | 0.40 | 0.38 | 75.00 | 78.95 | 9.916 | 0.175 | -5.26 | 5.26 |
| 40 | 0.50 | 0.46 | 80.00 | 86.96 | 9.964 | 0.176 | -8.70 | 8.70 |
| 50 | 0.50 | 0.55 | 100.00 | 90.91 | 10.107 | 0.178 | 9.09 | 9.09 |
| 60 | 0.60 | 0.63 | 100.00 | 95.24 | 10.107 | 0.178 | 4.76 | 4.76 |
| 70 | 0.70 | 0.71 | 100.00 | 98.59 | 10.107 | 0.178 | 1.41 | 1.41 |
| 80 | 0.90 | 0.80 | 88.89 | 100 | 10.035 | 0.177 | -12.5 | 12.5 |
| 90 | 0.80 | 0.88 | 112.50 | 102.27 | 10.171 | 0.179 | 9.09 | 9.09 |
| 100 | 1.00 | 0.97 | 100.00 | 103.09 | 10.107 | 0.178 | -3.09 | 3.09 |
|  |  |  |  |  |  | Mean= | -0.39 | 6.21 |

From the first graph, Slope α1=0.0084 and Intercept α2=0.1267

First approach, =

Second approach,

Stating the machine law as instructed:

***μml=(VR \* α1)-1*** = (120.4286\*0.0084)-1 = 1.00908024-1 = 0.00908024

**Wplf = α2\*VR** = 0.1267\*120.4286 = 15.258

Maximum **MA = 1/α1** = 1/0.0084 = 119.05

Maximum **η = (1/α1VR)** = 98.85%

Helix angle

**OBSERVATIONS:**

From the maximum percentage errors calculated, as it is relatively small |MPE|= and MPE= as this illustrates the accuracy of the machine law to a better

**PRECAUTIONS:**

1. I ensured that the hanger is not dangling on the string while attaching the efforts.
2. I avoided parallax error while taking measurements with
3. I ensured that the screw jack is in good working condition.
4. I ensured that one end of the string is correctly wound round the turntable once.
5. I avoided zero error while taking my readings.
6. I ensured the loads are balanced appropriately on the turntable.
7. I ensured the table on which the experiment is being carried out is stable.

**CONCLUSION**