Experiment No :

Experiment Name : Determination of the properties of the Helical Spring.

Introduction:

Spring : A spring is defined as an elastic body whose function is to distort when loaded and to recover its original shape when the load is removed.

Today we will learn about types of springs in mechanical used for various purposes. Spring is an elastic machine element that can deflect under the application of load. When the load is removed it regains its original position. In other words, spring is a mechanical object made up of material having very high yield strength to restore elastic. It is used in various machines to absorb shocks or it also resist to transfer shocks and vibrations on various critical machine members.

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Spring Materials:

The material used to make springs are called a spring steel. Spring steels are mostly low-alloy manganese, low carbon steel or high carbon steel with very high yield strength. Examples of spring materials are as follows:

1. Oil Tempered Steel.
2. Stainless Steel.
3. Elgiloy.
4. Carbon Value.
5. Iconel.
7. Monel.
6. Titanium.
7. Chrome Silicon.

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Types of spring in Mechanical:

Figure1: Helical compression spring

Fig2: Helical Extension Spring

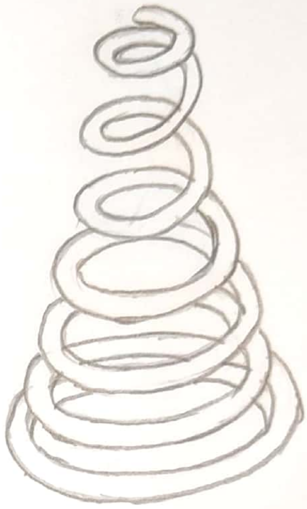

Fig3: Conical Spring

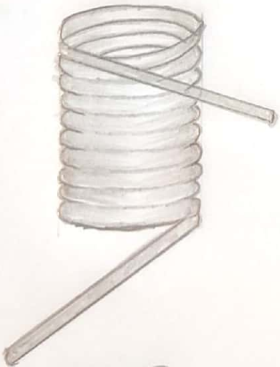

Fig-4: Torsion spring

Fig-5: Laminated Leaf spring

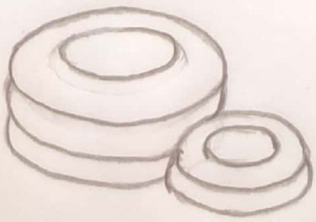

Fig-6: Disc or Belleville spring

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Why we need a Mechanical springs:

Springs are a very useful machine element. There are various regions to use spring. Some of them are below:

1. To absorb shock load.
2. To store energy.
3. To measure force.
4. To motive power.
5. To return motion.
6. To control of vibrations.
7. To retaining of rings.

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Helical springs:

The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads and Torque forces.

According to the loading condition helical springs are classified into following four types.

a. Open coil springs. or Compression helical springs.

b. Closed coil springs or Tension helical springs.

c. Torsion spring

d. Spiral spring.

a) Compression springs: These springs are open coil helical spring. A helical spring or coil is pressed or squeezes by load. It resists compressive or push forces. It also knows resistance to linear compressive forces.

Application:

1. Motorcycle's suspensions. 2. Pen

3. Lock 4. Couches

5. Lighter

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b) Tension spring: Tension springs are also called as Extension Springs. Pull force is applied, resulting in extension of the spring. These type of springs have hook or expanded eyes either one or both ends.

Applications;

1. Lever mechanisms.
2. Counterbalancing of garage doors.
3. Weighing machine.
4. Vise-grip pilers.
5. Garage door assemblies.

c.) Torsion spring: In this type of spring the load applied to coil is a torque or twisting force. In other words, Helical springs which can hold and release angular energy. Or these springs try to hold a system in place. After twisting, the helical coil applies proportional force to opposite direction. The torsion springs are used in application which rotates less than 360 degree. These springs have either clockwise or anticlockwise rotation.

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Applications:

1. Mouse trap
2. Rocker switches
3. Clothes pin
4. Automobile starters.
5. Door hinges.

d.) Spiral springs: Spiral spring is also known as clock spring or constant force spring. A number of times band of steel wrapped around it to form this type of springs. This type of springs releases a constant amount of force. This types of spring are used in machines that need to rotate a number of times and the same time has to release same amount of load constantly. These types of springs are used to when more power is required. Some of these springs are with thicker bond so that they can give fever rotations These types of springs are used in heavy duty applications.

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Applications:

1. Automotive seat recliners.

2. Alarm timepiece.

3. Watch

4. Window Regulators.

5. DC Motors

2. Leaf springs:

Leaf springs are also called as a semi-elliptical spring or Cart spring. It is one of the oldest forms of springs. Leaf springs are long and flat slender arc-shaped. These types of springs are used in Vehicle suspensions. Location for axel is center of the arc. And either end of loop is attached to the vehicle. It spreads the load over vehicle chassis.

Advantages:

1. Leaf springs are easy to construct.

2. These springs are strong.

3. No need for separate linkage to hold the axle in position, leaf springs work as a linkage.

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4. Rear axle location helps in reducing the extra weight.

5. Axle damping is controlled by leaf springs.

6. It reduces cost by eliminating the need of trailing arm and pan hard rod.

Applications:

1. Automobile Suspension.

2. Used by blacksmiths (due to its relatively high quality steel)

3. Belleville Spring:

A Belleville spring is also known as coned-disc spring, conical spring washer, disc spring, Belleville washer or cupped spring washer. Belleville washers are mostly coin shape spring with a hole in center. This disc springs are dynamically or statically loaded to its axis. This spring required less space for installation but can bear a very large load. These springs have more advantages compare to other springs.

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Applications:

1. Slip Clutch
2. Overload Cluthches
3. High Pressure Valve
4. Drill Bit Stock Absorber

4. Volute and conical spring:

These springs are conical shape compression springs. Conical springs are also known as tapered springs. These springs used to provide stability and reduce solid height.

5. Special purpose spring:

As the name suggest this springs are made for special purpose use. Special purpose springs are made up from different types of material all together such as Air and water.

Other types of spring are:

1. Constant spring
2. Variable spring
3. Variable stiffness spring
4. Flat spring
5. Machined Spring
6. Serpentime spring.
7. Cantilever Springs.
8. Hairspring or Balance spring
9. V-spring
10. Gas spring
11. Ideal spring
12. Main spring
13. Negator spring
14. Progressive coil springs.

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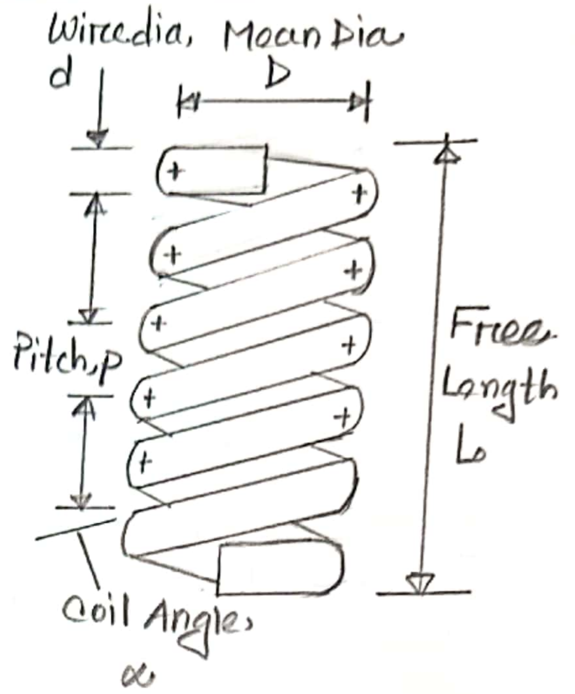
Pitch

Spring Constant $(m) = \frac{D}{d}$

Mean Radius, $R = \frac{D-d}{2}$



Maximum Shearing Stress of Helical spring:

$$\tau = \tau_1 + \tau_2 = \frac{4P}{\pi d^2} + \frac{16PR}{\pi d^3}$$

$$\tau = \frac{16PR}{\pi d^3}\left(1 + \frac{d}{4R}\right)$$

$$\tau_{max} = \frac{16(PR)}{\pi d^3}\left(\frac{4m-1}{4m-4} + \frac{0.615}{m}\right)$$

$$\tau_{max} = \frac{16PR}{\pi d^3}\left(1 + \frac{0.5}{m}\right)$$

Deflection of Helical Springs:

$$\delta = \frac{64PR^3 n}{Gd^4}$$

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Objectives:

1. To determine the maximum shearing stress
2. To determine the maximum deflection.
3. To determine the modulus of rigidity.
4. To determine the spring constant m.
5. To determine the modulus of rigidity from graph.

Apparatus:

1. Helical Spring Machine
2. Slide Calipers
3. Deflection gauge
4. Scale
5. Spring
6. Balance Weight.

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Procedure:

1. The number of turns of helical spring was counted and recorded

2. The diameter of the spring and wire were measured with slide calipers.

3. Then the helical spring machine was set up for doing next steps.

4. Firstly, 1.130 kg of weight was hanged up and the deflection of dial or deflection gauge was recorded.

5. Without removing the first weight another amount of weight was hanged up and the reading of deflection gauge was recorded. In this way, the weights were added with the previous one and the readings of deflection gauge were recorded till the end.

6. So, in this way, five readings were taken successfully and the readings were recorded in cumulative way automatically.

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The force vector

Observation Sheet:

Outer diameter of the spring, $D_1 = 3.15\ cm$
$= 0.0315\ m$

diameter of the wire of the spring, $d = 0.3\ cm$
$= 0.003\ m$

No of turns, $n = 8$

Mean Radius of the spring, $R = \frac{D_1 - d}{2}$

$= \frac{0.0315 - 0.003}{2}\ m$

$= 0.01425\ m$

1 small division of dial gauge $= 0.01\ mm$
$= 0.001\ cm = 10^{-3}\ cm$
$= 10^{-5}\ m$

Mean diameter of the spring, $D = (0.01425 \times 2)\ m$
$= 0.0285\ m$

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Data table: Determination of the maximum deflection of Helical spring

Serial No	Applied Load (kg)	Dial gauge reading (div)	Dial gauge constant (m)	Deflection (m)
1	1.130	74		74×10^{-5}
2	3.890	216		216×10^{-5}
3	7.910	515	10^{-5}	515×10^{-5}
4	12.02	835		835×10^{-5}
5	21.96	1332		1332×10^{-5}

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Calculations:

Spring Constant, $m = \frac{D}{d} = \frac{0.0285}{0.003} = 9.5$

$\therefore m = 9.5$

Maximum shearing stress of Helical Spring:

$$\tau_{max} = \frac{16PR}{\pi d^3}\left(\frac{4m-1}{4m-4} + \frac{0.615}{m}\right)$$

$$= \frac{16 \times 21.96 \times 0.01425}{\pi \times (0.003)^3}\left(\frac{4\times 9.5-1}{4\times 9.5-4} + \frac{0.615}{9.5}\right)$$

$\tau_{max} = 68.057 \times 10^6 \ kg/m^2$

Here, $P = 21.96 \ kg$

$R = 0.01425 \ m$

$d = 0.003 \ m$

$m = 9.5$

Maximum deflection, $\delta = 1332 \times 10^{-5} m$

Maximum deflection, $\delta = \frac{64 PR^3 n}{G d^4}$

So, The Modulus of Rigidity, $G = \frac{64 PR^3 n}{\delta d^4}$ Here, $n = 8$

$$= \frac{64 \times 21.96 \times (0.01425)^3 \times 8}{1332 \times 10^{-5} \times (0.003)^4}$$

$G = 3.015 \times 10^{10} \ kg/m^2$

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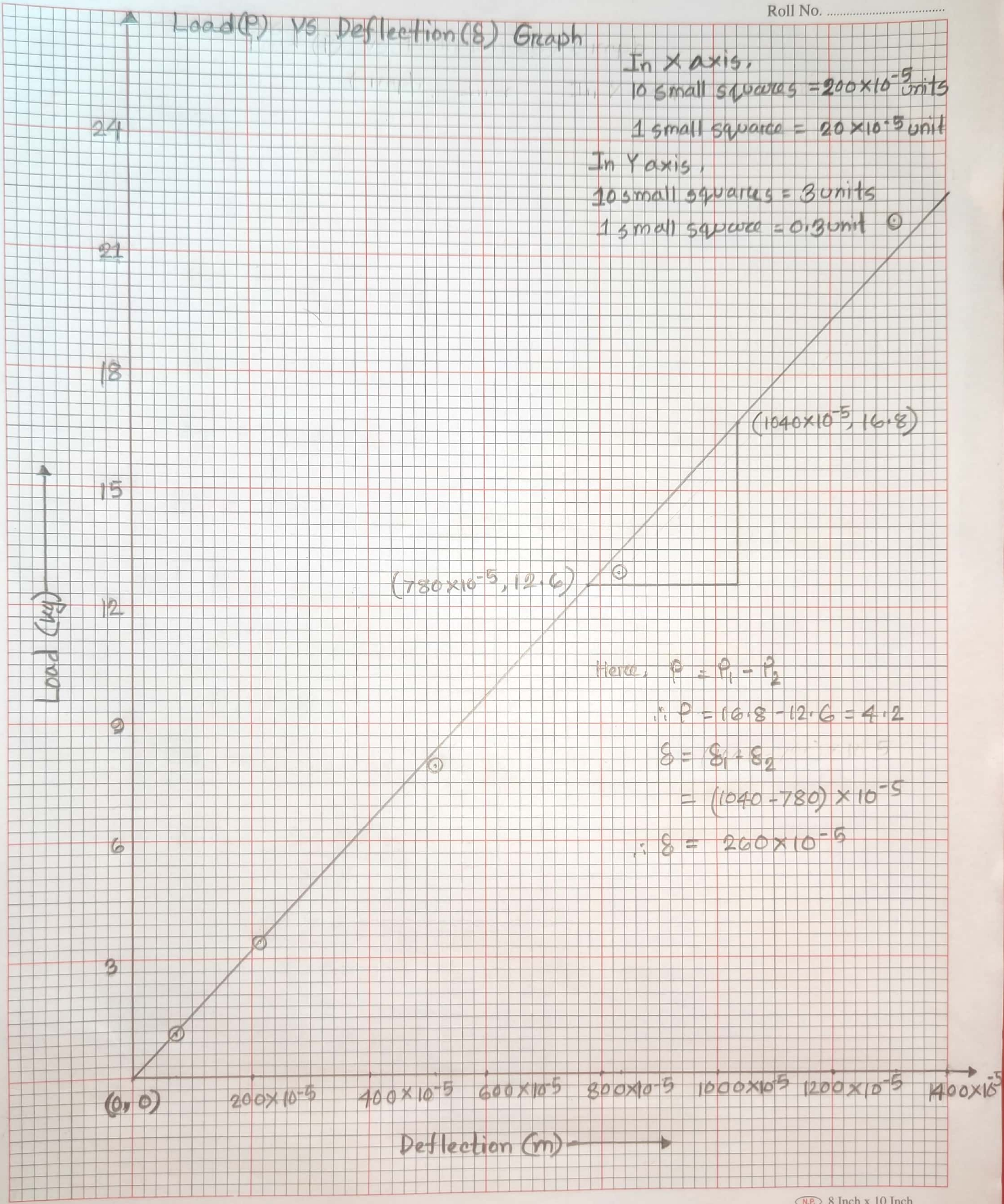
Roll No. ....

Load(P) VS Deflection(δ) Graph



In X axis,
10 small squares $= 200\times10^{-5}$ units
1 small square $= 20\times10^{-5}$ unit

In Y axis,
10 small squares = 3 units
1 small square = 0.3 unit

Here, $P = P_1 - P_2$

$\therefore P = 16.8 - 12.6 = 4.2$

$\delta = \delta_1 - \delta_2$

$= (1040 - 780)\times10^{-5}$

$\therefore \delta = 260\times10^{-5}$

MICRO
N.P. 8 Inch x 10 Inch

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Calculations from Graph:

Here,

$P_1 = 16.8$

$P_2 = 12.6$

$P = (P_1 - P_2) = 4.2$

$\delta_1 = 1040 \times 10^{-5}$

$\delta_2 = 780 \times 10^{-5}$

$\delta = (\delta_1 - \delta_2) = (1040 - 780) \times 10^{-5} = 260 \times 10^{-5}$

and $R = 0.01425\, m$

$d = 0.003\, m$

$n = 8$

∴ The modulus of Rigidity from Graph,

$$G = \frac{64 P R^3 n}{\delta d^4}$$

$$= \frac{64 \times 4.2 \times (0.01425)^3 \times 8}{260 \times 10^{-5} \times (0.003)^4} \quad kg/m^2$$

$$\boxed{G = 2.95 \times 10^{10}\ kg/m^2}$$

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Results:

Maximum shearing stress, τ_{max} = 68.06 $\times 10^6$ kg/m^2

Maximum deflection, δ = 1332 $\times 10^{-5}$ m

Spring constant, m = 10.5

Modulus of rigidity (from calculation), G = 3.015 $\times 10^{10}$ kg/m^2

Modulus of rigidity (from graph), G = 2.95 $\times 10^{10}$ kg/m^2

Discussion:

While measuring the reading of deflection from dial gauge, it was quite tough to take readings for heavy weights because the pointer deflected so quickly. Whatever, the readings were recorded carefully as far as possible. That's why, the values of modulus of rigidity from calculation and graph came close enough. So, this also proves that the other readings were taken consciously as far as possible.

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