Test of Closely Coiled Helical Spring



Introduction

A spring is defined as an elastic element that deflects under the action of the load and returns to its original shape when the load is removed.

A spring formed by winding wire into a helix along the surface of a cylinder is called helical spring.

The external force acts along the axis of the spring and induces torsion shear stress in the spring wire.

Objective

- To find the stiffness (k) of the spring.
- To compare theoretical stiffness with observed stiffness.
- To find out max shear stress and max torque.

Terms used in Helical Spring

Solid length: When the compression spring is compressed until the coils come in contact with each other, then the spring is said to be solid. The solid length of a spring is the product of total number of coils and the diameter of the wire.

Free length: The free length of a compression spring is the length of the spring in the free or unloaded condition.

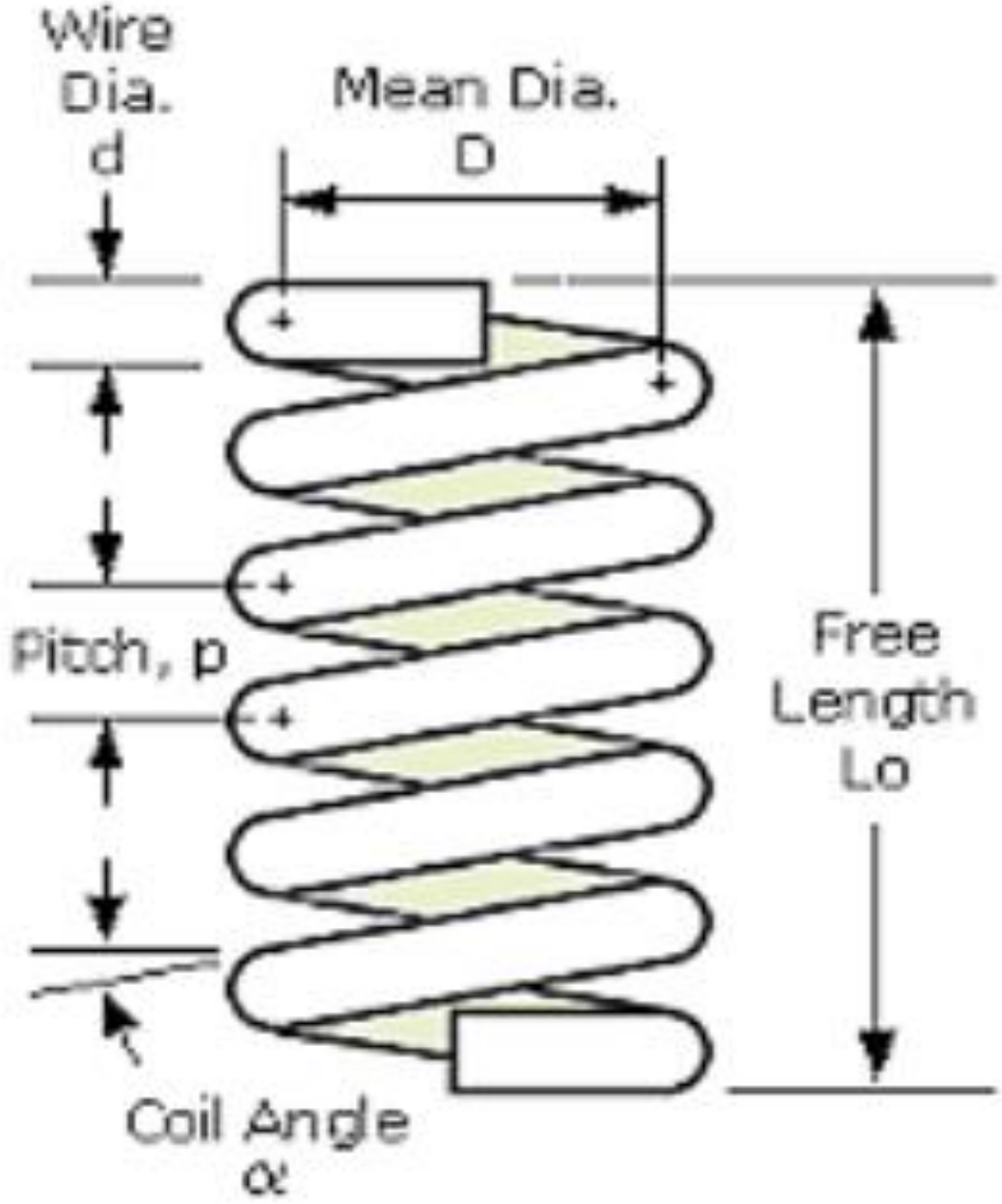
Terms used in Helical Spring

Active Coils (N_a): The number of coils which actually deform when the spring is loaded

Coil diameter (D): The mean diameter of the helix, i.e., (D outer + Dinner)/2.

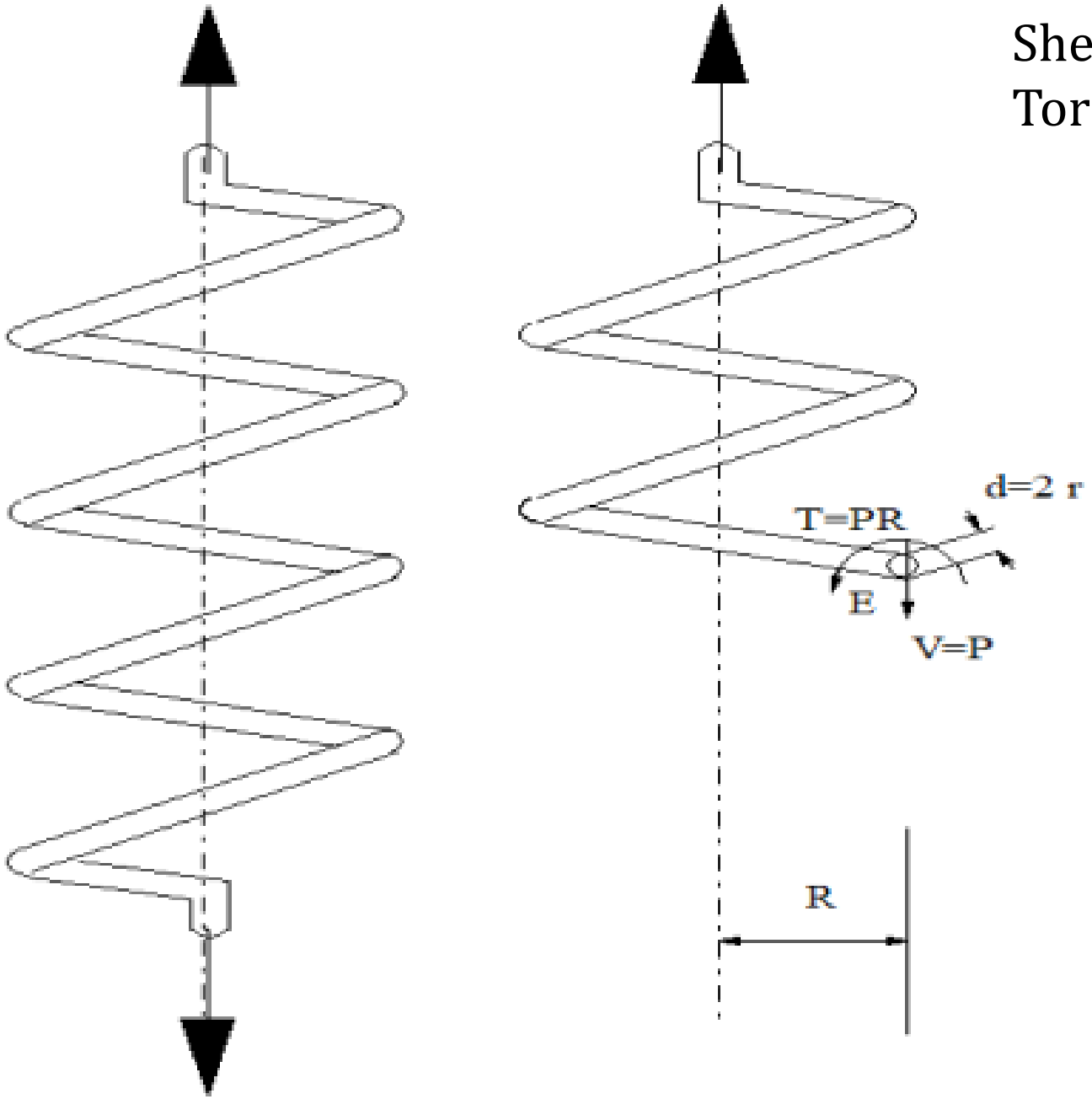
Pitch (p): The distance from center to center of the wire in adjacent active coils.

Pitch angle (a): The angle between the coils and the base of the spring.


Wire
Dia.
d
Mean Dia.
D
Pitch, p
Free
Length
Lo
Coil Angle
α

Behavior of Helical Spring

Helical springs made of wires of circular cross section may be analyzed in the elastic range by superposition of the shearing stresses. One important assumption needs to be made here is that any one coil of such a spring will be assumed to lie in a plane which is nearly perpendicular to the axis of the spring. This assumption can be made if the adjoining coils are close enough. With this assumption, a section taken perpendicular to the spring's rod may be taken to be vertical.



Shear force V=P

Torque T = PR

Behavior of Helical Spring

The maximum shearing stress at an arbitrary section of the spring can be found by superposing the direct and torsional shear stresses.

$\tau_{max} = \tau_{direct} + \tau_{torsion}$

$\tau_{max} = \frac{P_{max}}{A} \left(1 + \frac{2R}{r}\right)$

r = radius of spring's rod

$A = \pi r^2$

Max Torque, $T_{max} = P_{max} \times R$

Behavior of Helical Spring

$$K = \frac{P}{\Delta} = \frac{Gd^4}{64R^3N} \qquad G = \frac{E}{2(1+\mu)}$$

K = theoretical spring constant or stiffness

P = force

G = shear modulus of elasticity

E = modulus of elasticity

μ = Poisson ratio

N = number of active coils

Apparatus

Procedure

Data Sheet (Test of Helical spring)

Applied load (N)	Load Increasing		Load Decreasing		Average Deflection $\sigma=(\sigma1+\sigma2)/2$ in mm	Actual Stifness	Average Actual Stifness	Theoritical Stifness
	Scale Reading	Deflection ($\sigma1$) in mm	Scale Reading	Deflection ($\sigma2$) in mm				
0	48	0	47	0	0	0	0.575	0.542
1	46	2	46	1	1.5	0.667		
2	44	4	44	3	3.5	0.571		
3	42	6	42	5	5.5	0.545		
4	40	8	40	7	7.5	0.533		
5	38	10	38	9	9.5	0.526		
6	37	11	37	10	10.5	0.571		
7	36	12	36	11	11.5	0.609		

Calculation

- Calculate modulus of rigidity
- Calculate theoretical stiffness
- Calculate actual stiffness for individual deflection.
- Calculate actual stiffness from load vs deflection graph.