Hooke's Law

TN-017-HookesLaw

Dr John S Glover*

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1 Hooke's Law

Hooke's Law applies to elastic bodies and is defined as [2]:

> The magnitude of the restoring force is directly proportional to the deformation.

A fuller discussion can be found in *The Feynman Lectures on Physics*, [1]

$$F = -kx \tag{1}$$

where

- F is the force in N;
- x is the displacement in m;
- k is the spring constant in Nm^{-1}.

1.1 Springs connected in parallel

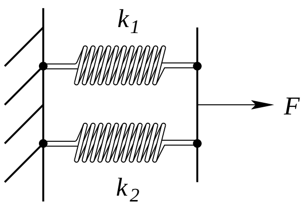

Figure 1: Springs connected in parallel.

For springs connected in parallel, Figure 1, the combined spring constant, k, is given by (2).

$$k = k_1 + k_2 \tag{2}$$

where k_1 and k_2 are the individual spring constants.

*email: *jsglover@zetnet.co.uk*

This can be proved as follows. The total force, F, is the sum of the forces across both springs, F_1 and F_2, therefore:

$$F = F_1 + F_2$$

Both springs are extended by the same displacement, x,

$$-kx = -(k_1x + k_2x)$$

$$k = k_1 + k_2$$

1.2 Springs connected in series

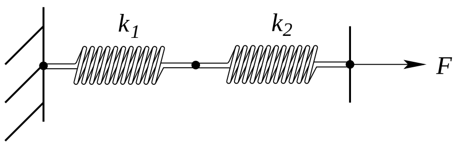

Figure 2: Springs connected in series.

For springs connected in series, Figure 2, the combined spring constant, k, is given by (3).

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} \tag{3}$$

where k_1 and k_2 are the individual spring constants.

This can be proved as follows. Rearranging (1)

$$x = -\frac{F}{k}$$

The extension of the spring, x, is the sum of the extensions of both spring, x_1 and x_2, therefore:

$$x = x_1 + x_2$$

Both springs experience the same force, F,

$$\frac{F}{k} = \frac{F}{k_1} + \frac{F}{k_2}$$

$$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2}$$

2 Summary

In this short article Hooke's Law has been presented. In addition, the equations for combining springs in parallel and series have been derived. Note, the analogy that could drawn with combining electrical capacitance in parallel and series.

References

[1] Sands Feynman, Leighton. *The Feynman Lectures on Physics, Volume II.* `http://www.feynmanlectures.caltech.edu/`.

[2] Hans C. Ohanian. *Physics.* W. W. Norten & Company, 1985.