Module 6 - Spring Systems

ME3050 - Dynamics Modeling and Controls

Mechanical Engineering

Tennessee Technological University

Topic 1 - The Ideal Spring

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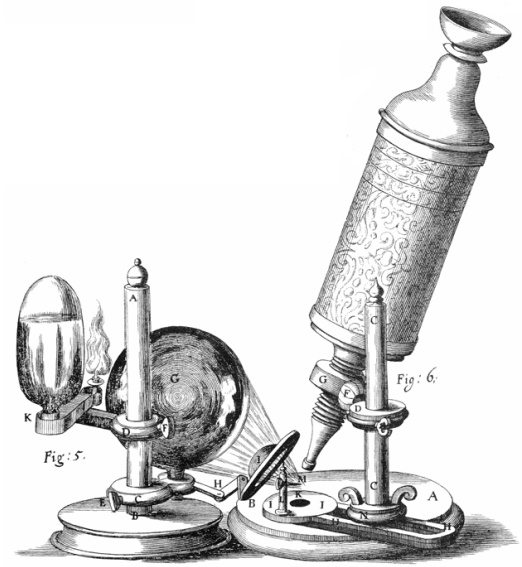
- Robert Hooke
- Hooke's law of Springs
- The Spring Model
- Structure Stiffness

Robert Hooke



- Mechanics
- Gravitation
- Horology
- Microscopy
- Palaeontology
- Astronomy
- Memory

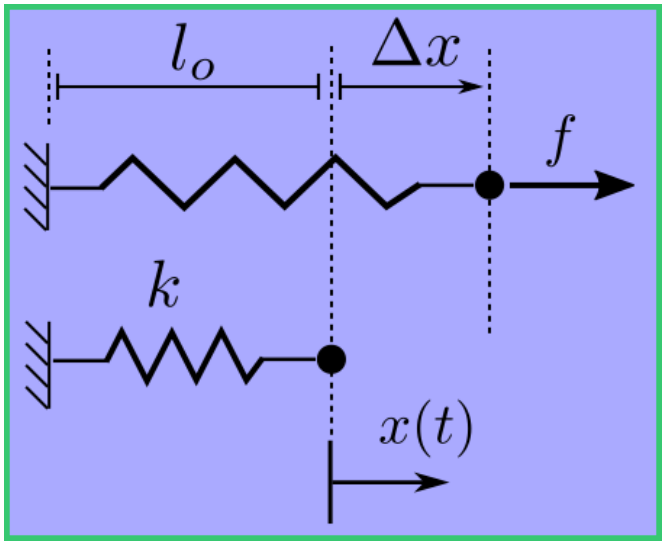
Images: Wikipedia

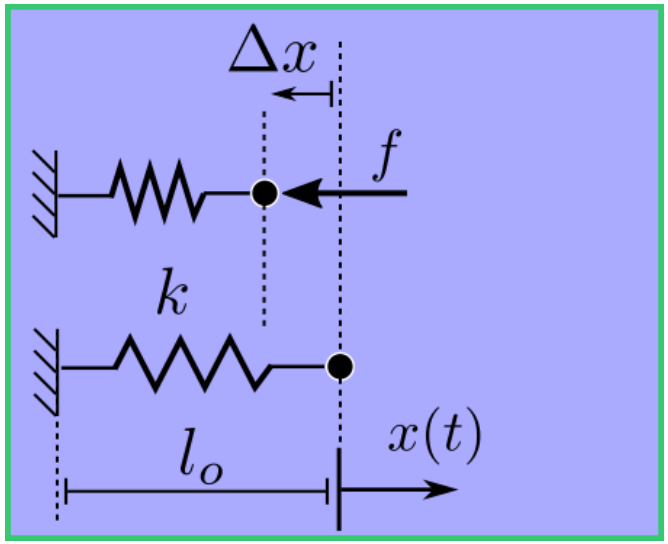
Robert Hooke

Robert Hooke FRS (...1635 ...1703) was an English natural philosopher, architect and polymath. As a young adult, he was a financially impoverished scientific inquirer, but came into wealth and good reputation following his actions as Surveyor to the City of London after the great fire of 1666 (in which he appears to have performed more than half of all the surveys after the fire). At that time, he was also the curator of experiments of the Royal Society, a member of its council, and the Gresham Professor of Geometry. He was also an important architect of his time—though few of his buildings now survive and some of those are generally misattributed—and was instrumental in devising a set of planning controls for London, the influence of which remains today. Allan Chapman has characterised him as "England's Leonardo".[1]

Text: Wikipedia

Hooke's law of Springs





The simple and effective model of spring behavior is called the linear force-deflection model.

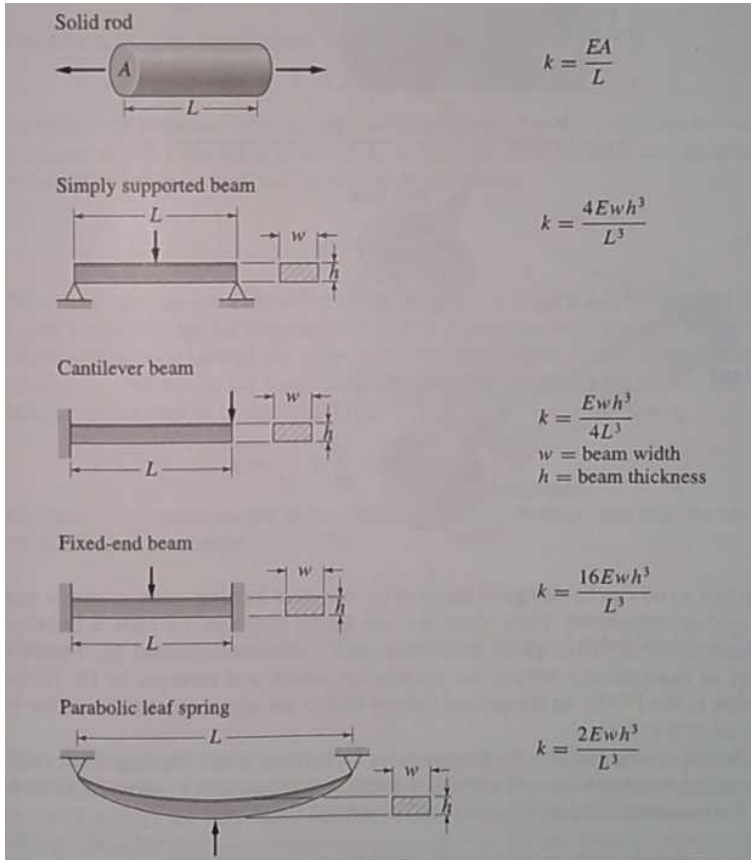
$$f = kx \quad , \quad \textit{force equals spring constant times deflection}$$

Hooke's law of Springs

$$k = \frac{Gd^4}{64nR^3}$$

Table 2 Shear Modulus of Elasticity(G)

Material		G Value N/mm²(kgf/mm²)	Symbol
Spring Steel		78×10³{8×10³}	SUP6,7,9,9A,10, 11A,12,13
Hard Steel Wire		78×10³{8×10³}	SW-B,SW-C
Piano Wire		78×10³{8×10³}	SWP
Oil Tempered Steel Wire		78×10³{8×10³}	SWO,SWO-V,SWOC-V, SWOSC-V,SWOSM,SWOSC-B
Stainless Steel Wire	SUS 302	69×10³{7×10³}	SUS 302
	SUS 304		SUS 304
	SUS 304N1		SUS 304N1
	SUS 316		SUS 316
	SUS 631 J1	74×10³{7.5×10³}	SUS 631 J1

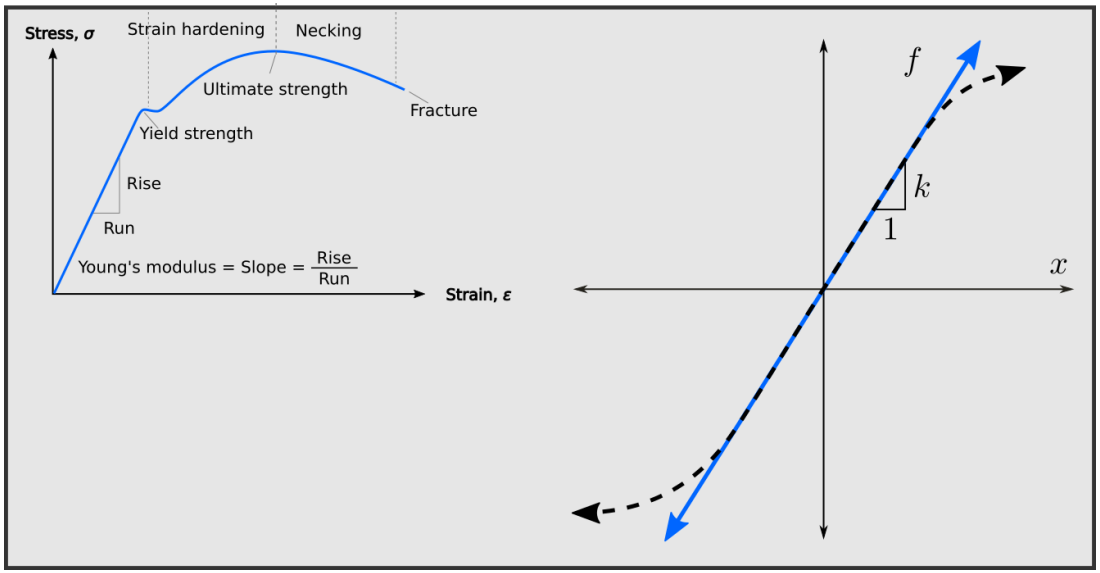


Images: Wikipedia, System Dynamics

Data: MISUMI

The Spring Model

The ideal linear force-deflection model is only an approximation of the true behavior. However, homogeneous isotropic materials do behave this way in the *linear elastic region*.



Images: T. Hill

Structure Stiffness

All physical structures deform under load, and as we know, every force as reaction force. Therefore any structure *acts* like a spring under load.