Lecture 11.
THE EQUATION OF SHEARING FORCE FOR THE BEAMS

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Plan of lecture

- 1. The classification of beams
- 2. About statically determinate and statically indeterminate beams
- 3. About connection of shearing forces and bending moments

The classification of beams

A bar subject to forces or couples that lie in a plane containing the longitudinal axis of the bar is called a ***beam***

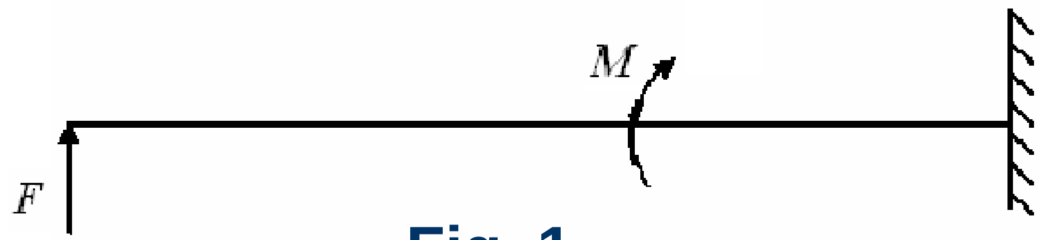


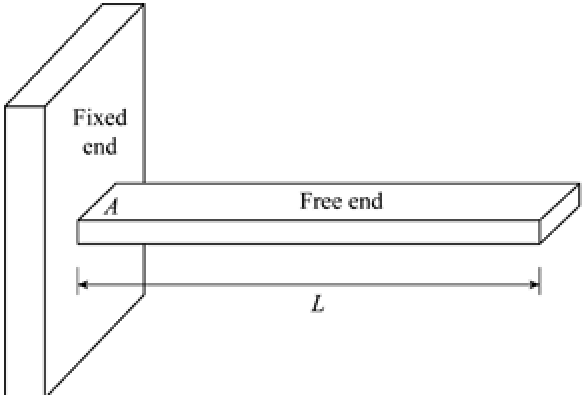
Fig. 1

If a beam is supported at only one end and in such a manner that the axis or the beam cannot rotate at that point, it is called **a *cantilever beam***

The classification of beams

Balcony

Model



The classification of beams

A beam that is freely supported at both ends is called a ***simple beam***.

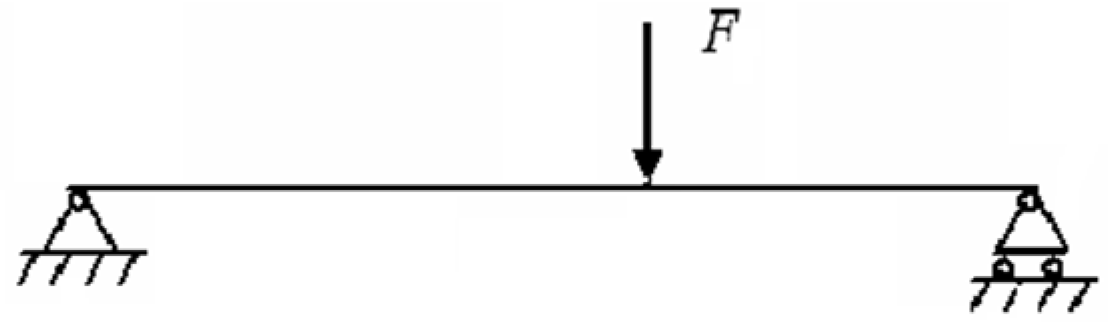


Fig. 2

The classification of beams

A beam freely supported at two points and having one or both ends extending beyond these supports is termed an ***overhanging beam***

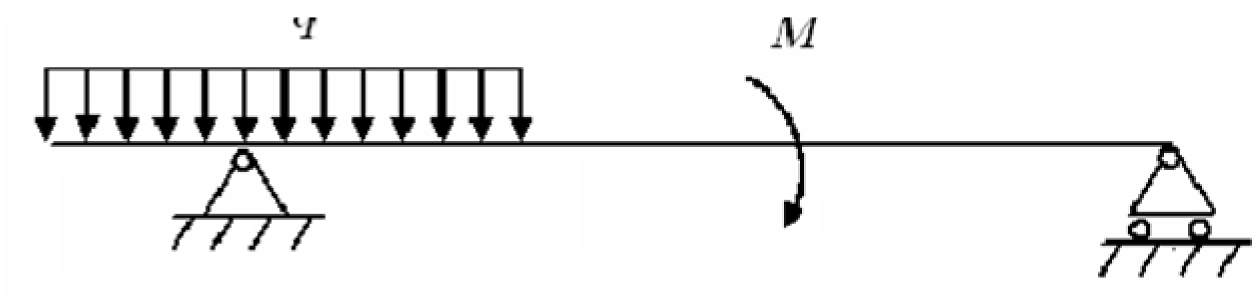
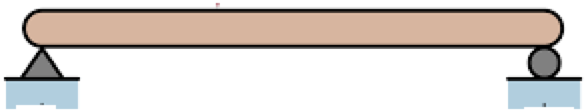


Fig. 3

The classification of beams

Overlap

Model



About statically determinate and statically indeterminate beams

The values of these reactions are independent of the deformations of the beam. Such beams are said to be ***statically determinate***.

If the number of reactions exerted upon the beam exceeds the number of equations of static equilibrium, then the static equations must be supplemented by equations based upon the deformation s of the beam. In this case the beam is said to he ***statically indeterminate***.

About statically determinate and statically indeterminate beams

Example of statically indeterminate beam

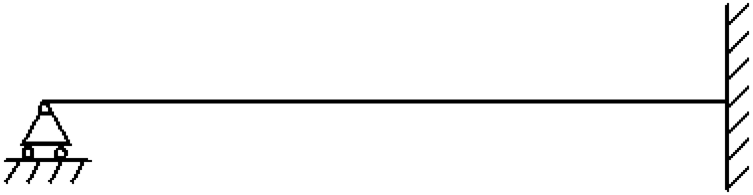


Fig. 4

m =4 – the number of beфm supports

The static indetermination is **N = m - 3 = 4 – 3 = 1**

This beam is one statically indeterminate system

About connection of shearing forces and bending moments

Let us consider the beam to be cut at D and the portion of the beam to the right of D removed.

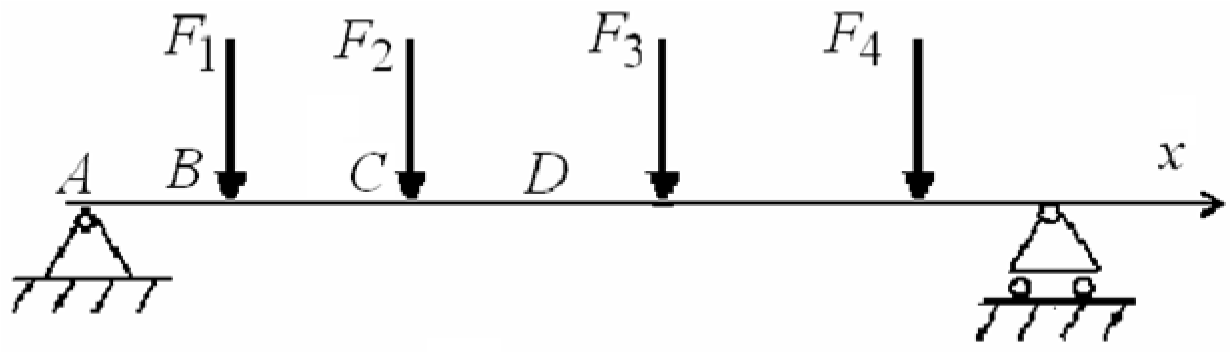


Fig. 5

About connection of shearing forces and bending moments

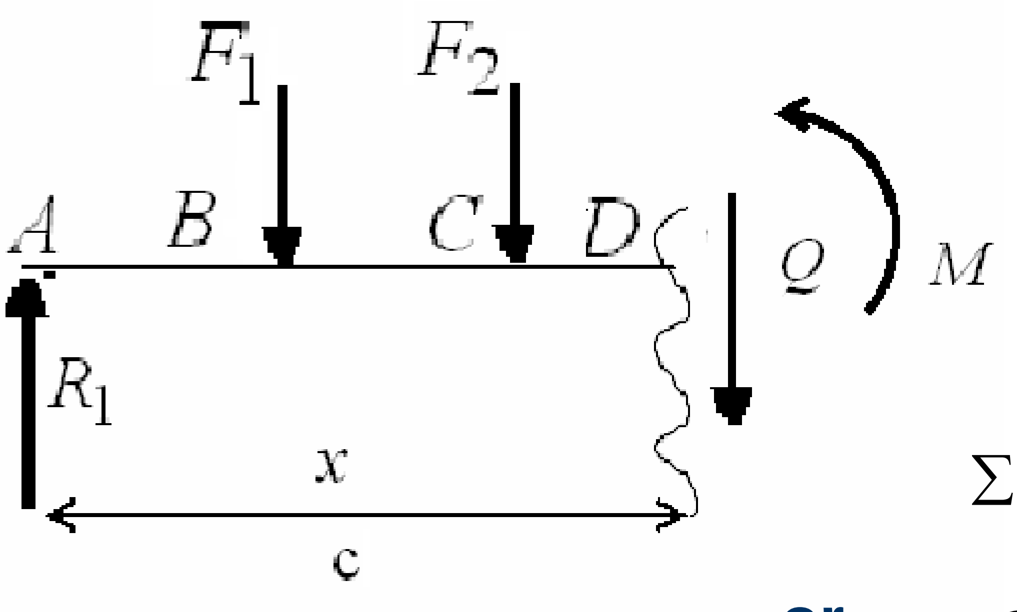


Fig. 6

The vertical force Q shown in 6, is called the resisting shear at section D

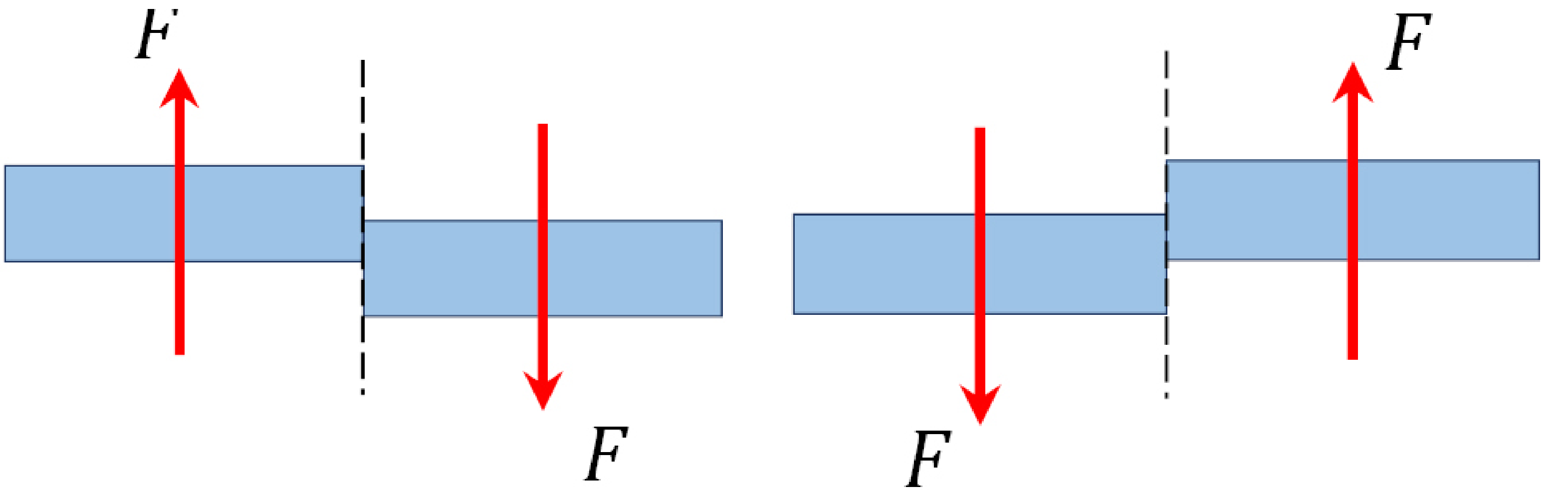
$$\sum F_y = R_1 - P_1 - P_2 - Q = 0$$

or

$$Q = R_1 - P_1 - P_2$$

About connection of shearing forces and bending moments

The sign of shearing force direction



Positive shearing force
Negative shearing force

About connection of shearing forces and bending moments

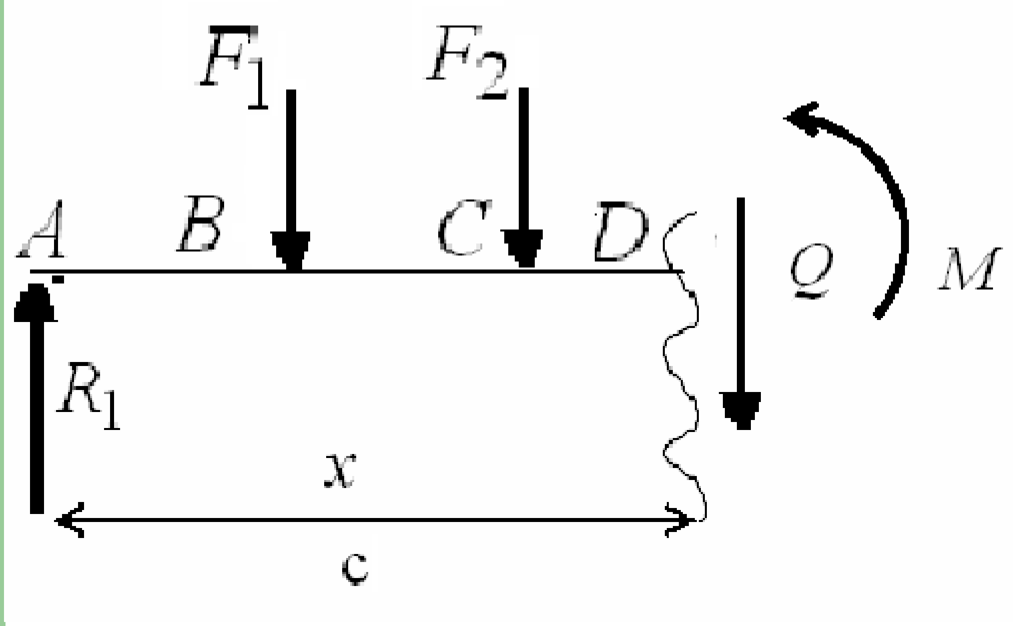


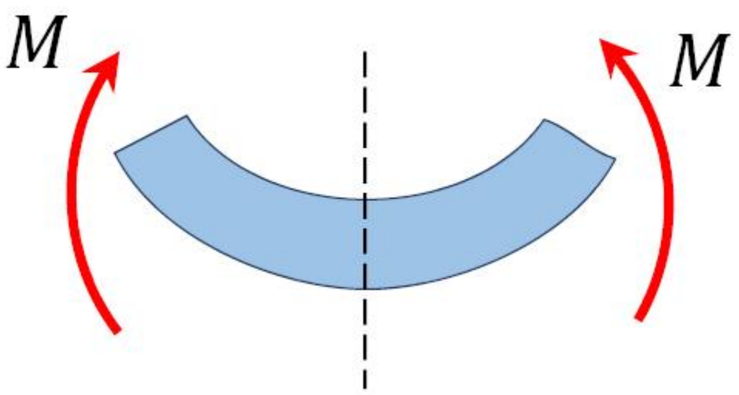
Fig. 6

The resisting moment M is the resultant couple due to stresses that are distributed over the vertical section at D

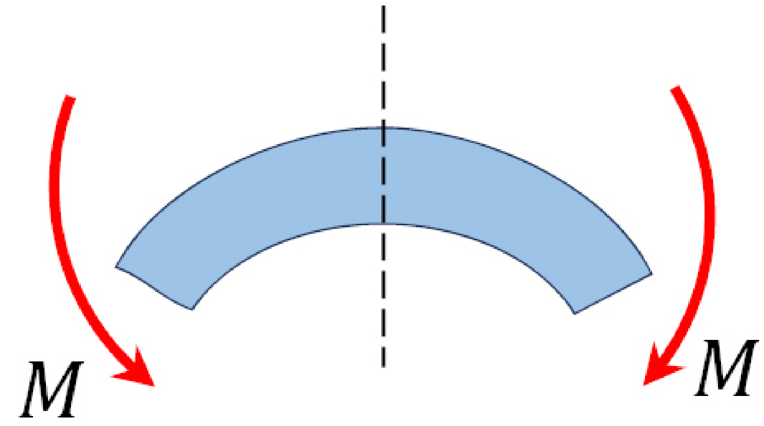
$$M = R_1 \cdot x - P_1(x-a) - P_2(x-b)$$

About connection of shearing forces and bending moments

Thus, the bending moment is opposite in direction to the resisting moment but is of the same magnitude



Positive bending moment



Negative bending moment

About connection of shearing forces and bending moments

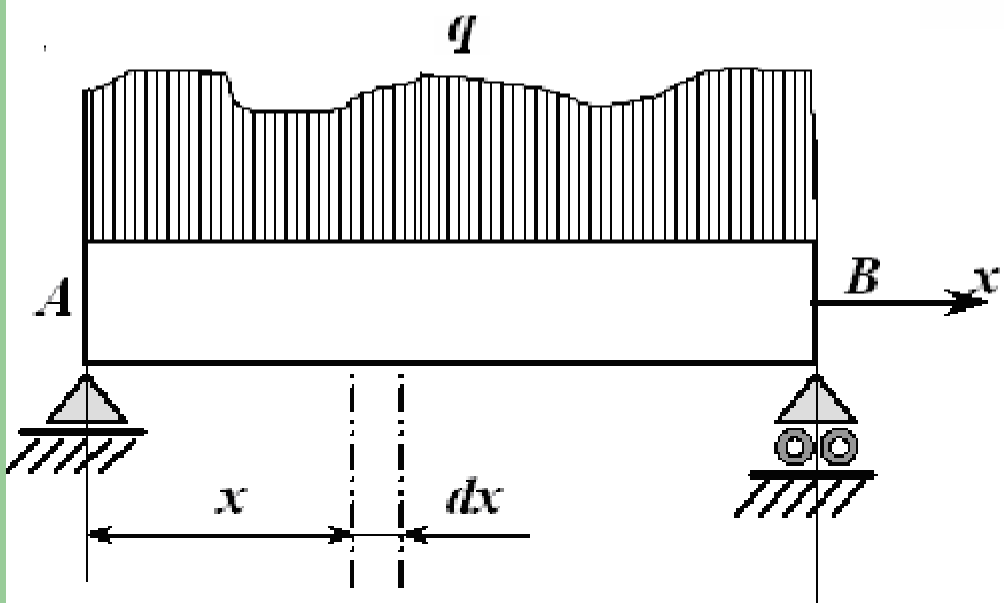


Fig. 7

For any value of the relationship between the load q(x) and the shearing force Q is:

$$q = \frac{dQ}{dx}$$

About connection of shearing forces and bending moments

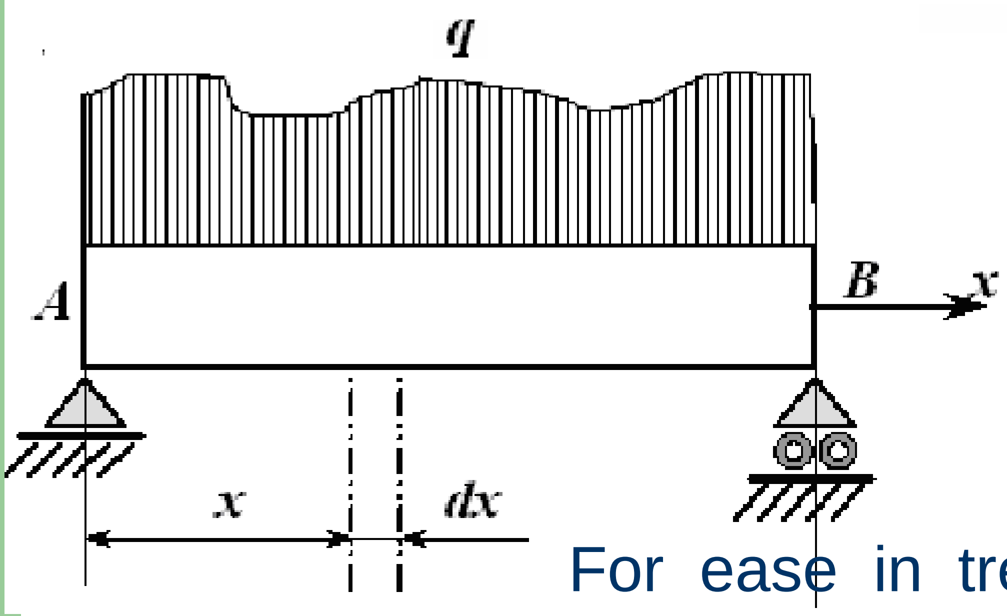


Fig. 7

The relationship between shearing force Q and bending moment M is:

$$Q = \frac{dM}{dx}$$

For ease in treating problems involving concentrated forces and concentrated moments we introduce the function:

$$f_n(x) = (x-a)^n$$

Thank you!

Good bye!