objectives

show how to use the method of sections to determine the internal loadings in a member.

to generalize this procedure by Formulating equations that can be plotted so that they describe the internal shear and moment throughout a member

CHP 7.1 - Internal Forces Developed in Structural

Use the Method of Sections on a continues cantilever beam

Examining the LHS & RHS we find certain Forces & Moments develop

\[ N_B \quad - \quad \text{Normal Force} \]
\[ V_B \quad - \quad \text{Shear Force} \]
\[ M_B \quad - \quad \text{Bending Moment} \]

Prevents Translation
Prevents Rotation

Normal Force
Sheer Force
Bending Moment
Sign Convention

Novel Force is if the normal force creates tension

Shear Force is if the shear force on the section would cause clockwise rotation

Bending Moment is if the moment will cause an concave upward bend

All Loads opposite to these conventions are considered

Tension

Clockwise

Positive normal force

Positive shear

Positive moment

concave upward bending
Procedure for Analysis

The method of sections can be used to determine the internal loadings on the cross section of a member using the following procedure.

Support Reactions.
- Before the member is sectioned, it may first be necessary to determine its support reactions, so that the equilibrium equations can be used to solve for the internal loadings only after the member is sectioned.

Free-Body Diagram.
- Keep all distributed loadings, couple moments, and forces acting on the member in their exact locations, then pass an imaginary section through the member, perpendicular to its axis at the point where the internal loadings are to be determined.
- After the section is made, draw a free-body diagram of the segment that has the least number of loads on it, and indicate the components of the internal force and couple moment resultants at the cross section acting in their positive directions to the established sign convention.

Equations of Equilibrium:
- Moments should be summed at the section. This way the normal and shear forces at the section are eliminated, and we can obtain a direct solution for the moment.
- If the solution of the equilibrium equations yields a negative scalar, the sense of the quantity is opposite to that shown on the free-body diagram.
Simply Supported Beam
- pinned at one end
- roller at the other

Cantilever Beam
- fixed at one end
- free at the other

To design a beam, internal Shear Forces (v) and Bending Moments (M) must be studied at every point along the beam.

In general, the internal shear force and moments will be discontinuous, or their slopes will be discontinuous, at points where a distributed load changes or where concentrated Forces or moments are applied.

Use the Method of Sections

Shear Diagram

Moment Diagram

Sections
- OA → x₁
- OB → x₂
- OL → x₃
Procedure for Analysis

The shear and bending-moment diagrams for a beam can be constructed using the following procedure.

Support Reactions.

• Determine all the reactive forces and couple moments acting on the beam and resolve all the forces into components acting perpendicular and parallel to the beam’s axis.

Shear and Moment Functions.

• Specify separate coordinates $x$ having an origin at the beam’s left end and extending to regions of the beam between concentrated forces and/or couple moments, or where the distributed loading is continuous.

• Section the beam at each distance $x$ and draw the free-body diagram of one of the segments. Be sure $V$ and $M$ are shown acting in their positive sense, in accordance with the sign convention given in Fig. 7–10.

• The shear $V$ is obtained by summing forces perpendicular to the beam’s axis.

• The moment $M$ is obtained by summing moments about the sectioned end of the segment.

Shear and Moment Diagrams.

• Plot the shear diagram ($V$ versus $x$) and the moment diagram ($M$ versus $x$). If computed values of the functions describing $V$ and $M$ are positive, the values are plotted above the $x$ axis, whereas negative values are plotted below the $x$ axis.

• Generally, it is convenient to plot the shear and bending-moment diagrams directly below the free-body diagram of the beam.

Read Chapter 7.1-7.2

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