Shear Force and Bending Moment Diagrams

Shear Force and Bending Moment Diagrams

1. Analyze the Problem

- **Identify the beam type:** Determine whether it's simply supported, cantilevered, or continuous.
- **List all loads and supports:** Include point loads, distributed loads, moments, and reactions.

2. Calculate Support Reactions

1. **Free-Body Diagram (FBD):** Draw the beam with all external forces, moments, and reactions.
2. **Equilibrium Equations:** Use these to solve for the reactions at the supports:

- $\sum F_y = 0$ (Vertical force equilibrium)
- $\sum M = 0$ (Moment equilibrium about any point)

3. Break the Beam into Segments

Divide the beam into sections based on the locations of loads, supports, and discontinuities. Label each segment.

4. Write Equations for Shear Force and Bending Moment

- **Shear Force** $V(x)$: The algebraic sum of vertical forces to the left or right of the section.
- **Bending Moment** $M(x)$: The algebraic sum of moments about the section.

5. Plot the Shear Force Diagram (SFD)

1. **Start at zero at the ends of the beam** (for simply supported beams or free ends).
2. **Add or subtract forces at load points:**
   - A point load changes the shear force instantaneously by its magnitude.
   - A distributed load causes a slope in the SFD.
3. **Mark zero-crossings:** Identify points where the shear force changes sign, indicating a potential maximum or minimum bending moment.

6. Plot the Bending Moment Diagram (BMD)

1. **Start with the calculated moments at the supports or free ends.**
2. **Integrate the shear force:** The area under the SFD gives the bending moment.
3. **Apply boundary conditions:**
   - Fixed ends: Zero slope (moment is maximum/minimum).
   - Simply supported ends: Zero moment.
   - Free ends: Zero shear force and moment.

7. Verify the Results

- **Boundary Conditions:** Ensure the diagrams match the physical behavior of the beam.

Summary

Load Type	**Shear Diagram Shape**	**Moment Diagram Shape**
Point Load	Rectangular (constant)	Triangular
Uniformly Distributed Load (UDL)	Triangular	Parabolas (second degree)