

lecture
eight

shear & bending
moment diagrams



Forum, Pompeii

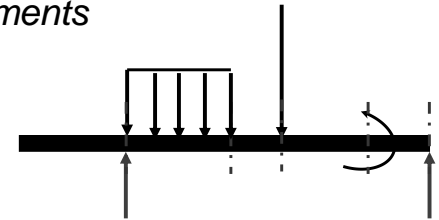
Semigraphical Method

- by knowing
 - area under loading curve = change in V
 - area under shear curve = change in M
 - concentrated forces cause “jump” in V
 - concentrated moments cause “jump” in M

$$V_D - V_C = - \int_{x_C}^{x_D} w dx \quad M_D - M_C = \int_{x_C}^{x_D} V dx$$

Equilibrium Method

- important places
 - supports
 - concentrated loads
 - start and end of distributed loads
 - concentrated moments
- free ends
 - zero forces



Semigraphical M

- relationships

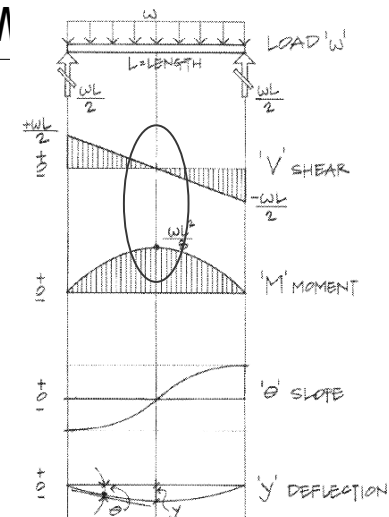
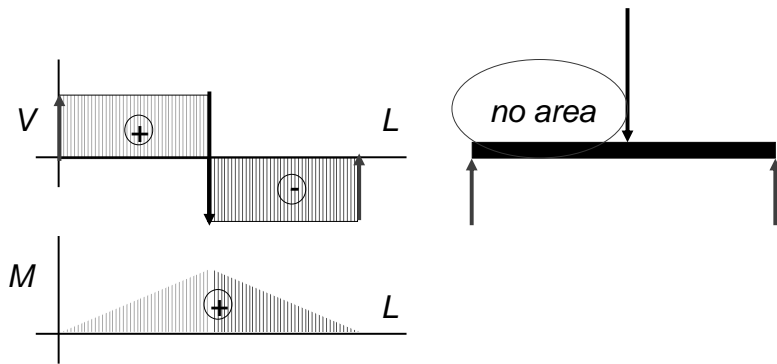


Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.

Semigraphical Method

- M_{max} occurs where $V = 0$ (calculus)



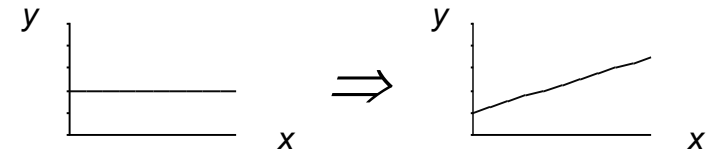
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Curve Relationships

- integration of functions
- line with 0 slope, integrates to sloped



- ex: load to shear, shear to moment

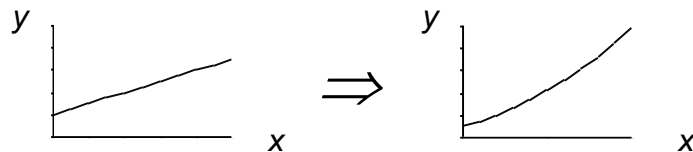
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Curve Relationships

- line with slope, integrates to parabola



- ex: load to shear, shear to moment

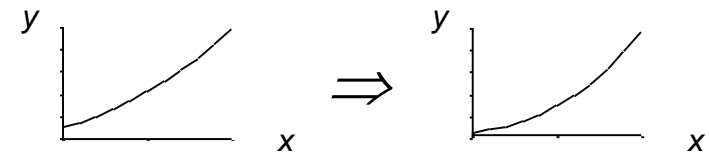
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Curve Relationships

- parabola, integrates to 3rd order curve



- ex: load to shear, shear to moment

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Basic Procedure

1. Find reaction forces & moments
Plot axes, underneath beam load diagram

V:

2. Starting at left
3. Shear is 0 at free ends
4. Shear jumps with concentrated load
5. Shear changes with area under load

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Basic Procedure

M:

6. Starting at left
7. Moment is 0 at free ends
8. Moment jumps with moment
9. Moment changes with area under V
10. Maximum moment is where shear = 0!
(locate where $V = 0$)

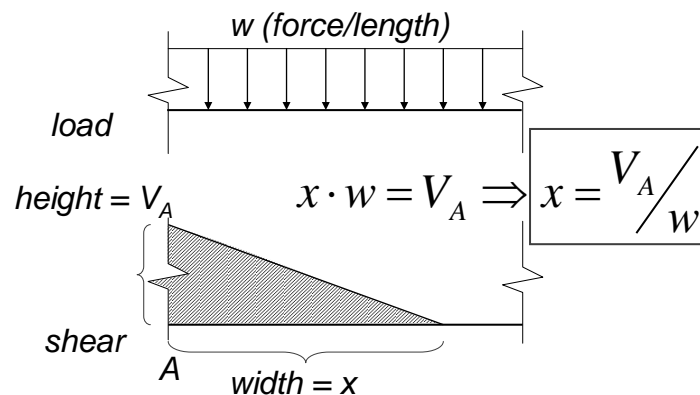
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Shear Through Zero

- slope of V is w ($-w:1$)



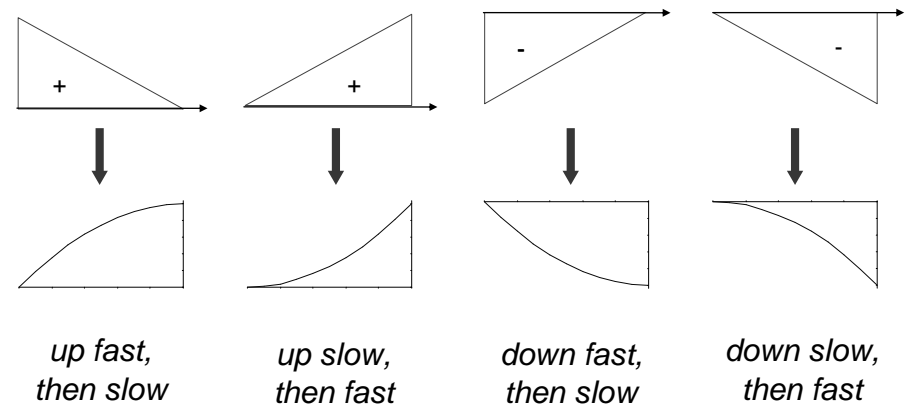
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Parabolic Shapes

- cases



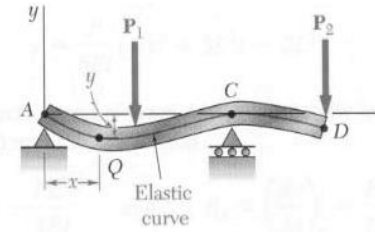
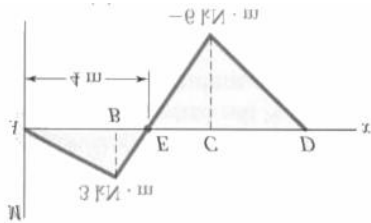
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Deflected Shape & M(x)

- $-M(x)$ gives shape indication
- boundary conditions must be met



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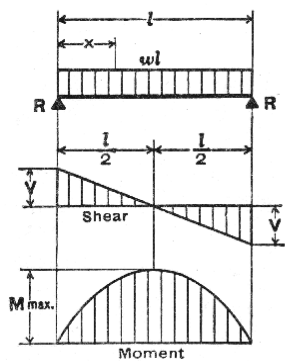
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Tabulated Beam Formulas

- how to read charts

1. SIMPLE BEAM—UNIFORMLY DISTRIBUTED LOAD



$$\begin{aligned}
 \text{Total Equiv. Uniform Load} & \dots = wl \\
 R = V & \dots = \frac{wl}{2} \\
 V_x & \dots = w \left(\frac{l}{2} - x \right) \\
 M_{\text{max. (at center)}} & \dots = \frac{wl^2}{8} \\
 M_x & \dots = \frac{wx}{2} (l - x) \\
 \Delta_{\text{max. (at center)}} & \dots = \frac{5wl^4}{384EI} \\
 \Delta_x & \dots = \frac{wx}{24EI} (l^3 - 2lx^2 + x^3)
 \end{aligned}$$

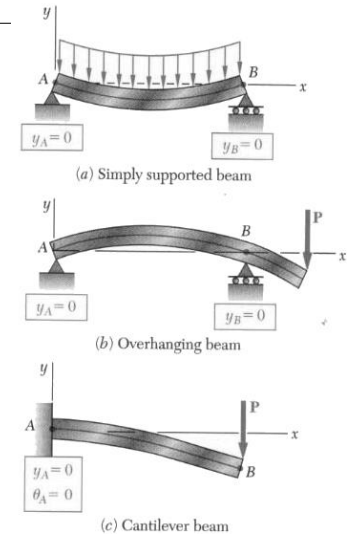
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Boundary Conditions

- at pins, rollers, fixed supports: $y = 0$
- at fixed supports: $\theta = 0$
- at inflection points from symmetry: $\theta = 0$
- y_{max} at $\frac{dy}{dx} = 0$



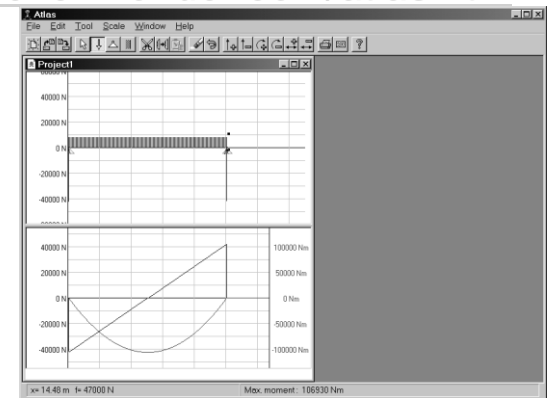
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Tools

- software & spreadsheets help
- <http://www.rekenwonder.com/atlas.htm>



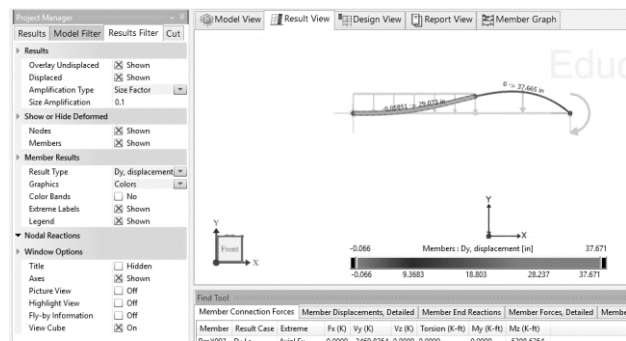
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Tools – Visual Analysis (VA Edu)

- in open access labs and VOAL and <https://www.iesweb.com/edu/index.htm>



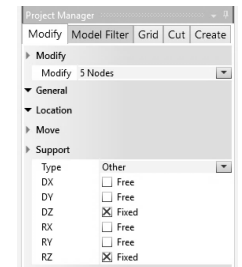
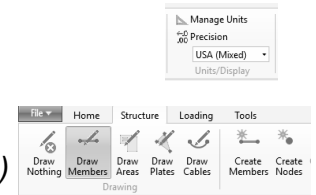
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Tools – Visual Analysis (VA Edu)

- model view / structure tab
 - grid and units
 - define beam members
 - or pre-defined beams (Create)
 - select points, assign supports
 - select members, assign member shapes & any connection types



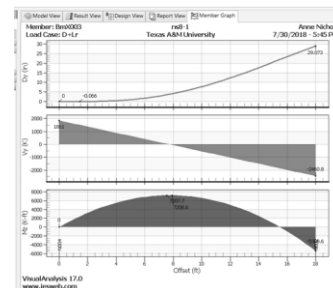
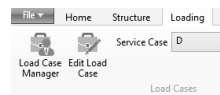
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Tools – Visual Analysis (VA Edu)

- loading tab
 - select points, add point load
 - (edit load case with no self weight)
- results view
 - status bar
 - results filter
- member graph
 - choose options
- report view - choose and drag options



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