Elements of Architectural Structures: Form, Behavior, and Design

ARCH 614
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Spring 2013

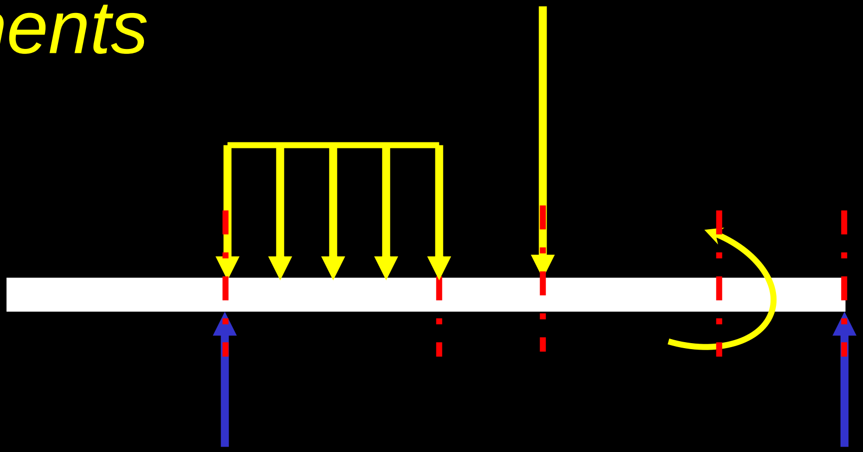
lecture
seven

shear & bending moment diagrams


Forum, Pompeii

Equilibrium Method

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



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*

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

Semigraphical M

- *relationships*

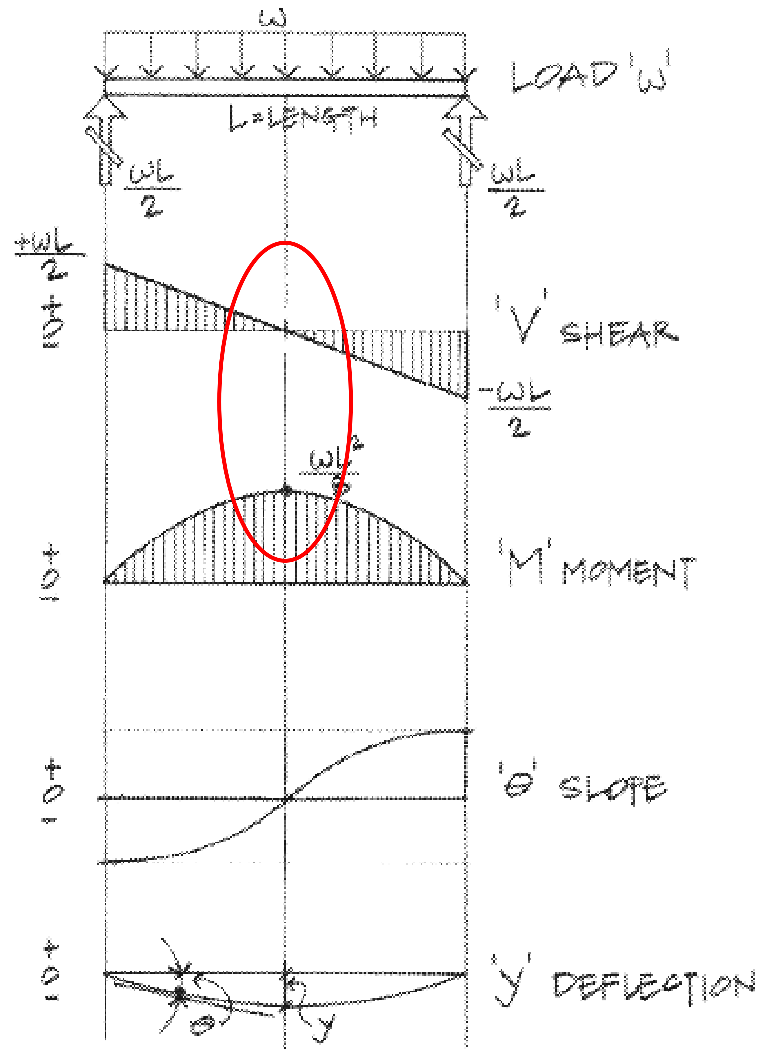
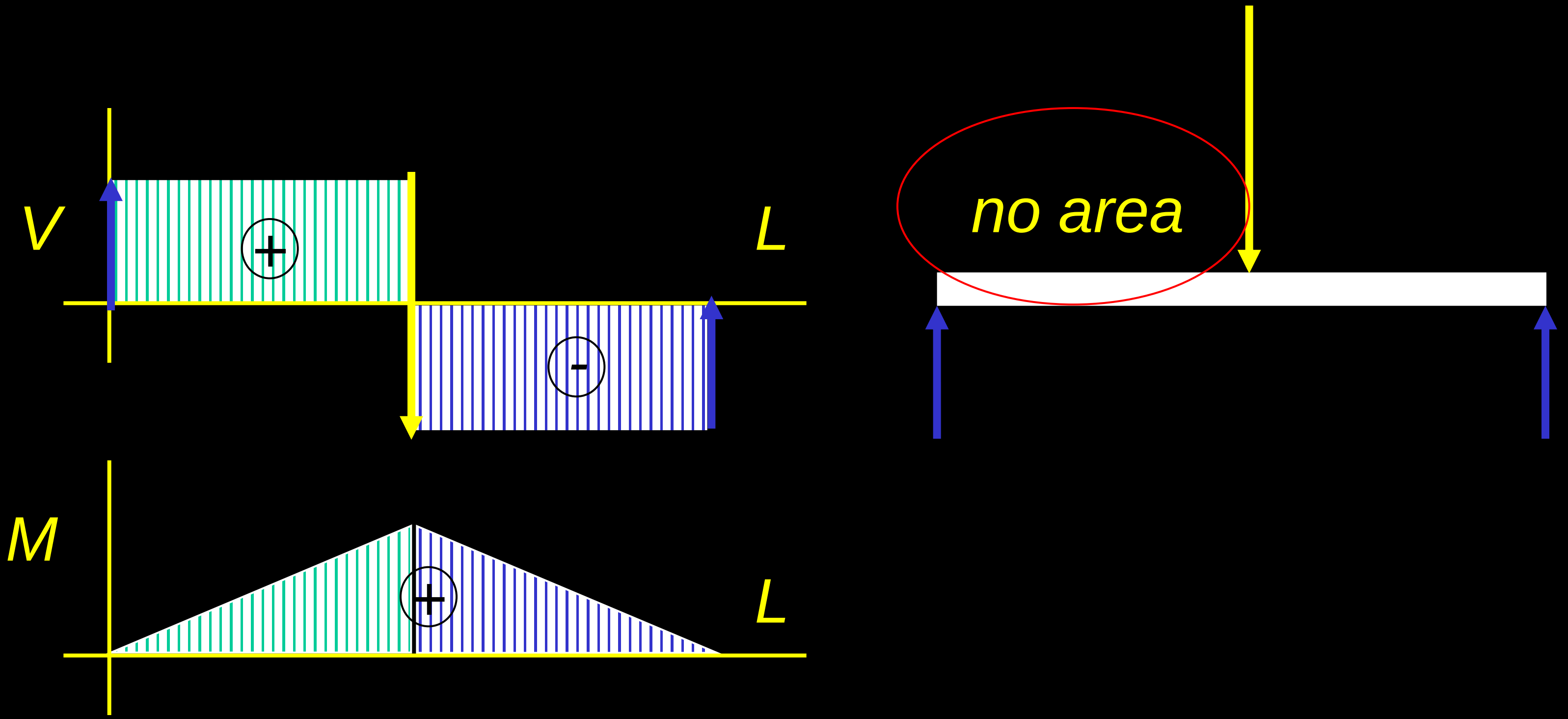


Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.

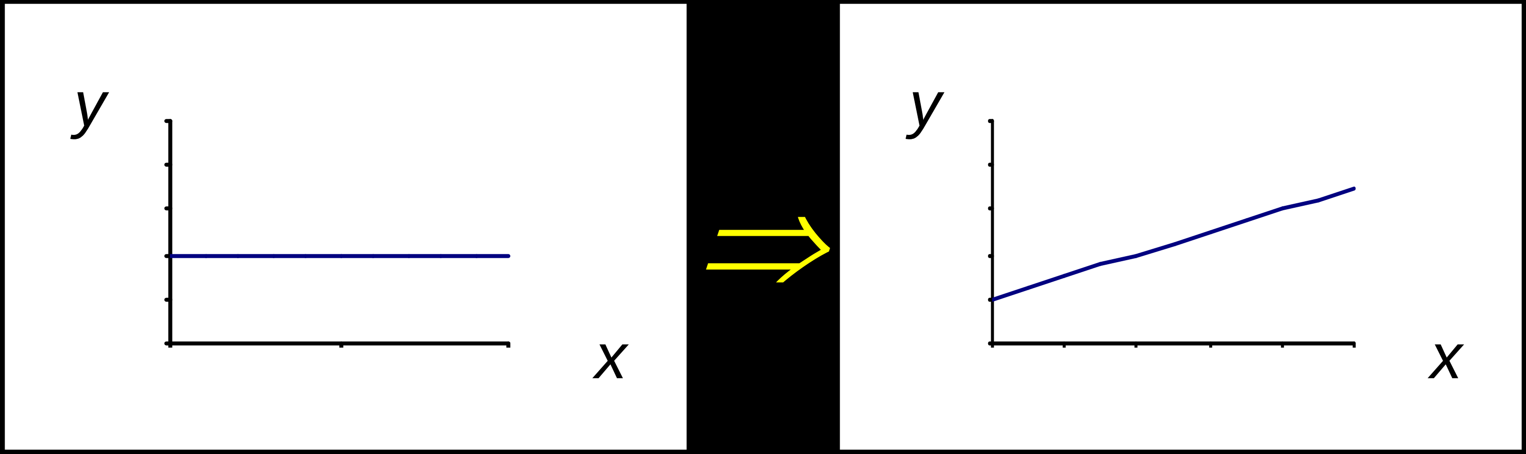
Semigraphical Method

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



Curve Relationships

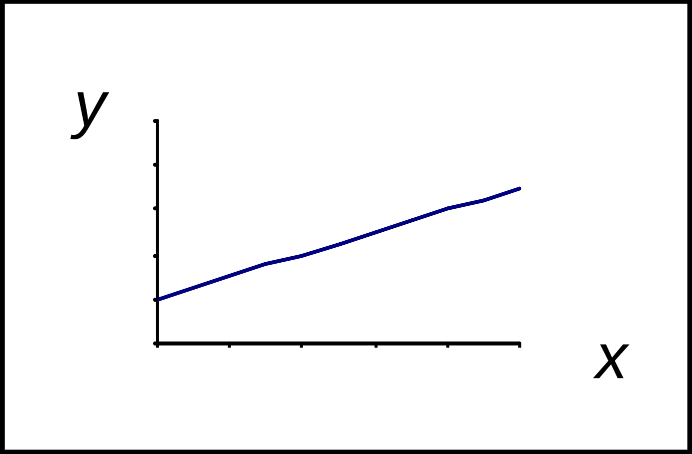
- integration of functions
- line with 0 slope, integrates to sloped



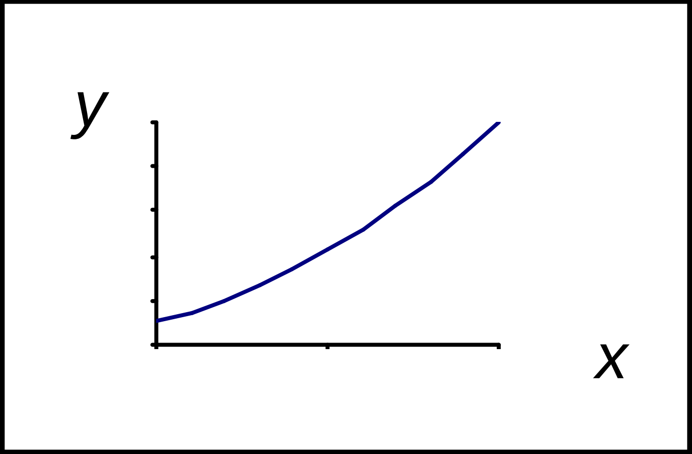
- ex: load to shear, shear to moment

Curve Relationships

- *line with slope, integrates to parabola*



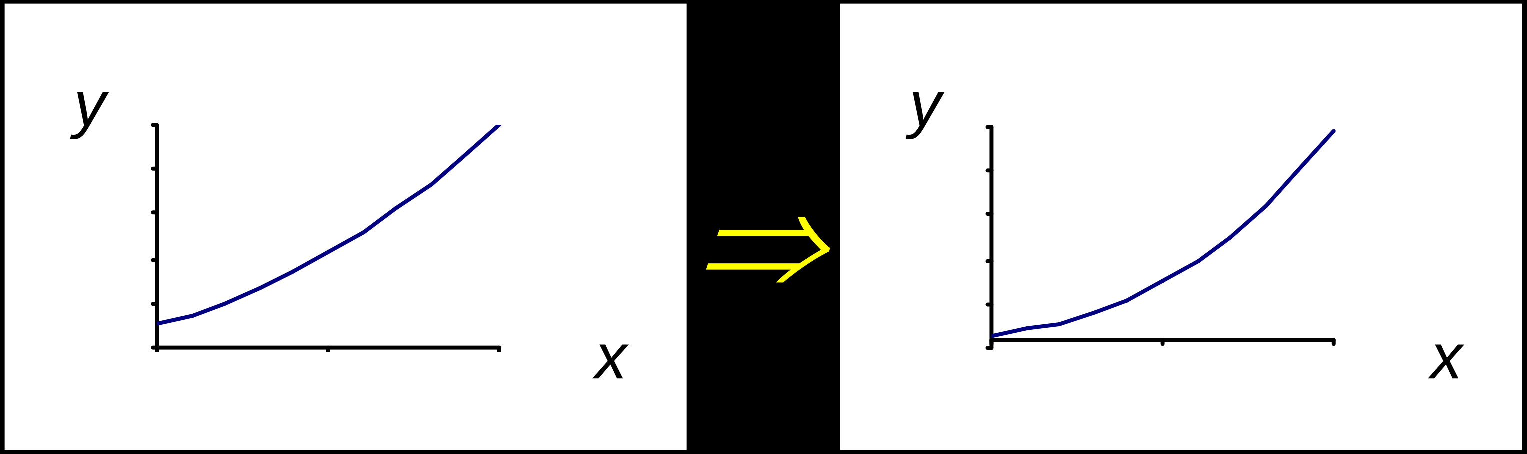
$\Rightarrow$



- *ex: load to shear, shear to moment*

Curve Relationships

- parabola, integrates to 3rd order curve



- ex: load to shear, shear to moment

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*

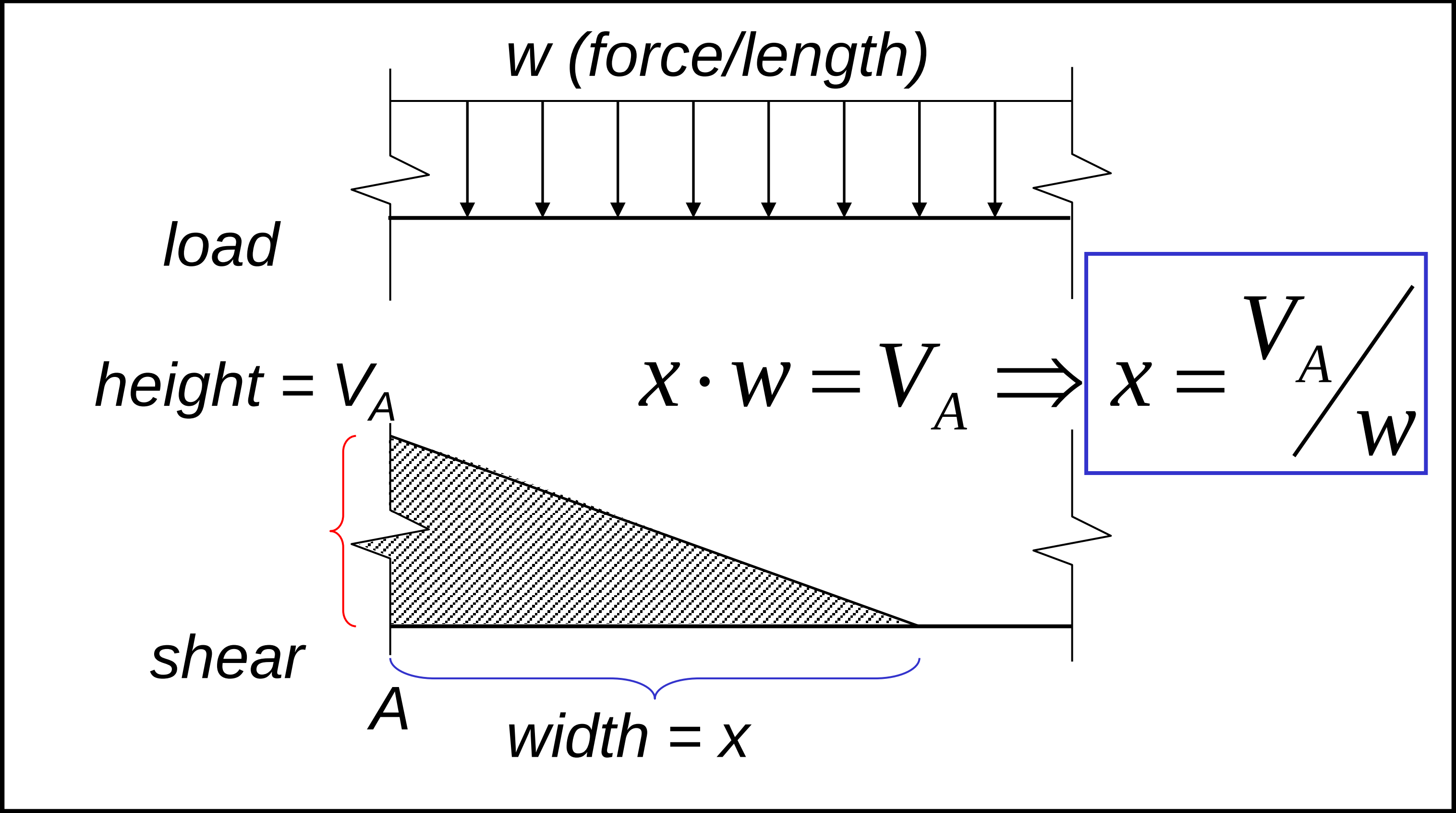
Basic Procedure

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)

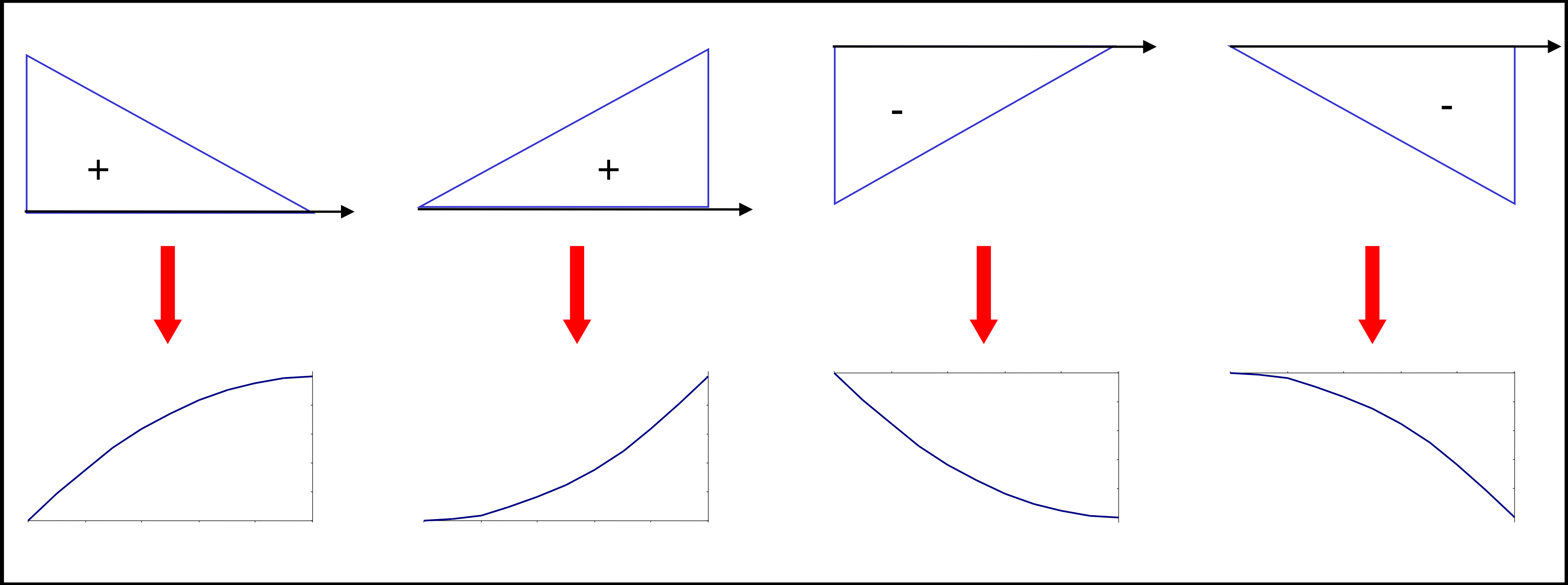
Triangle Geometry

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



Parabolic Shapes

- *cases*



up fast, then slow

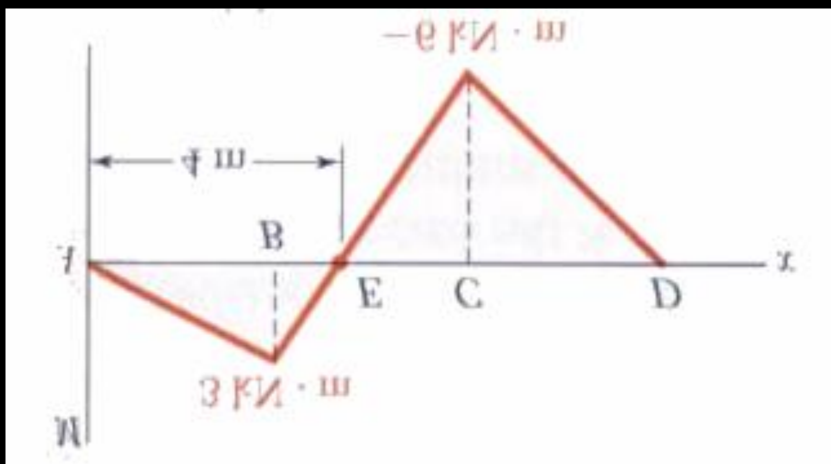
up slow, then fast

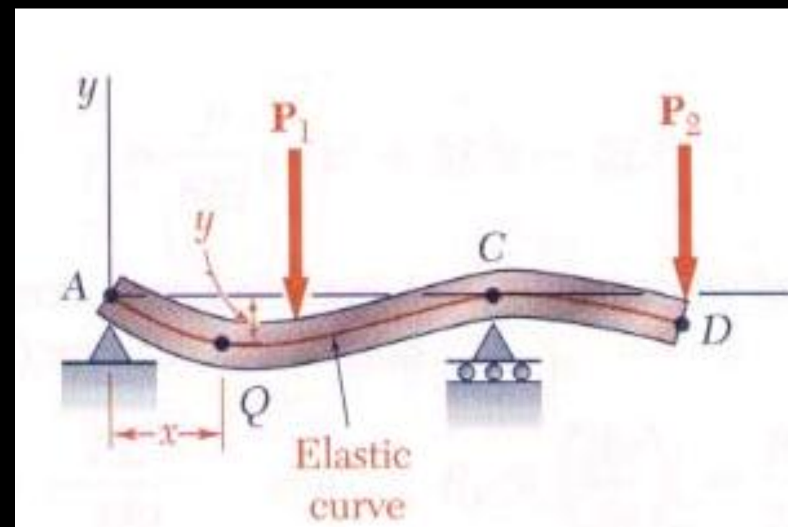
down fast, then slow

down slow, then fast

Deflected Shape & M(x)

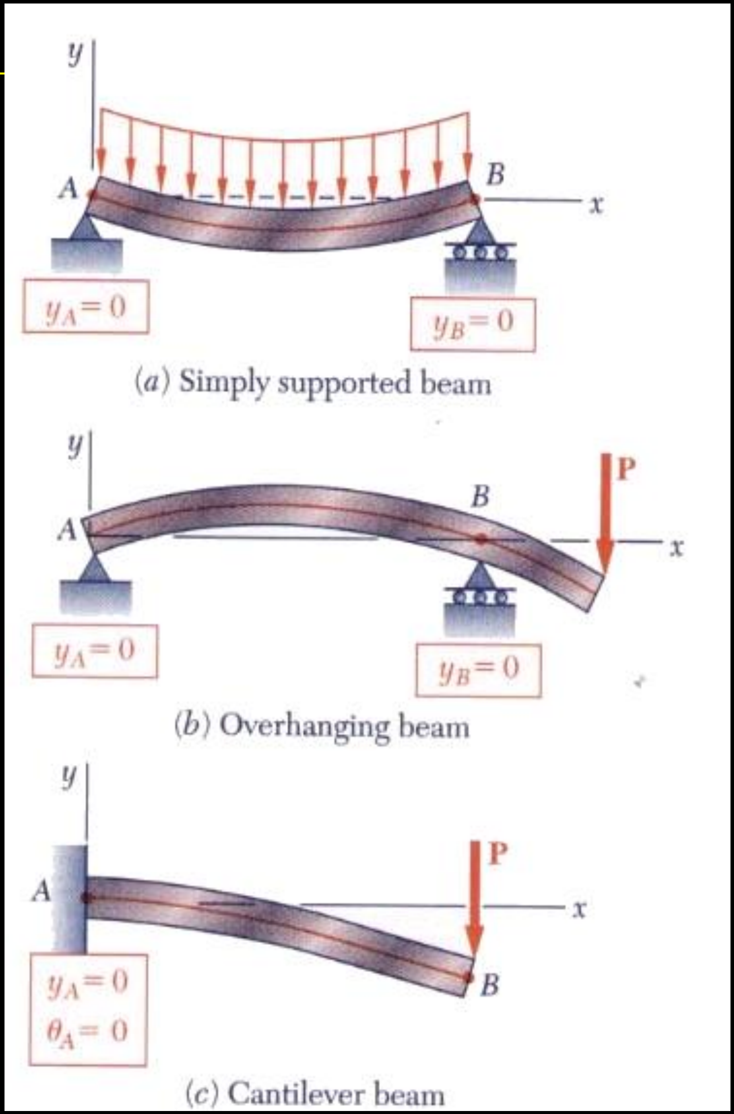
- -M(x) gives shape indication
- boundary conditions must be met





Boundary Conditions

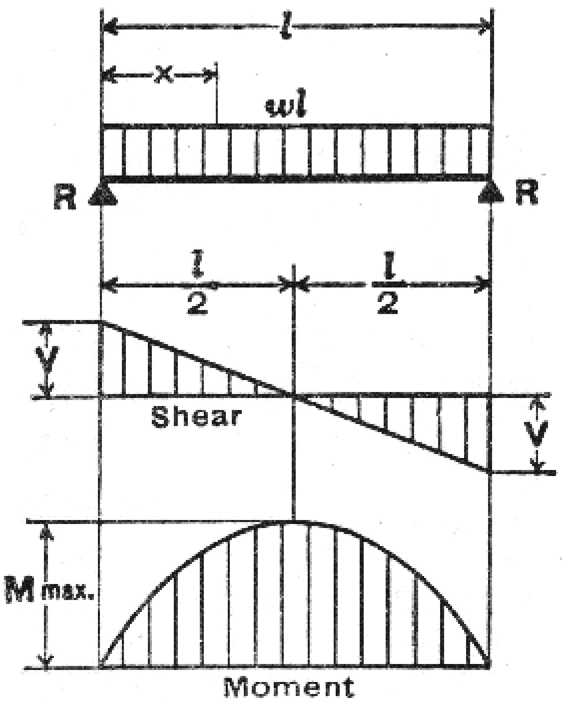
- *at pins, rollers, fixed supports:* $y = 0$
- *at fixed supports:* $\theta = 0$
- *at inflection points from symmetry:* $\theta = 0$
- y_{max} *at* $\dfrac{dy}{dx} = 0$



Tabulated Beam Formulas

- *how to read charts*

1. SIMPLE BEAM—UNIFORMLY DISTRIBUTED LOAD



Total Equiv. Uniform Load . . . . $= wl$

R = V . . . . $= \frac{wl}{2}$

V_x . . . . $= w\left(\frac{l}{2} - x\right)$

M max. (at center) . . . . $= \frac{wl^2}{8}$

M_x . . . . $= \frac{wx}{2}(l - x)$

Δmax. (at center) . . . . $= \frac{5wl^4}{384EI}$

Δx . . . . $= \frac{wx}{24EI}(l^3 - 2lx^2 + x^3)$