Elements of Architectural Structures: Form, Behavior, and Design

ARCH 614

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Spring 2014

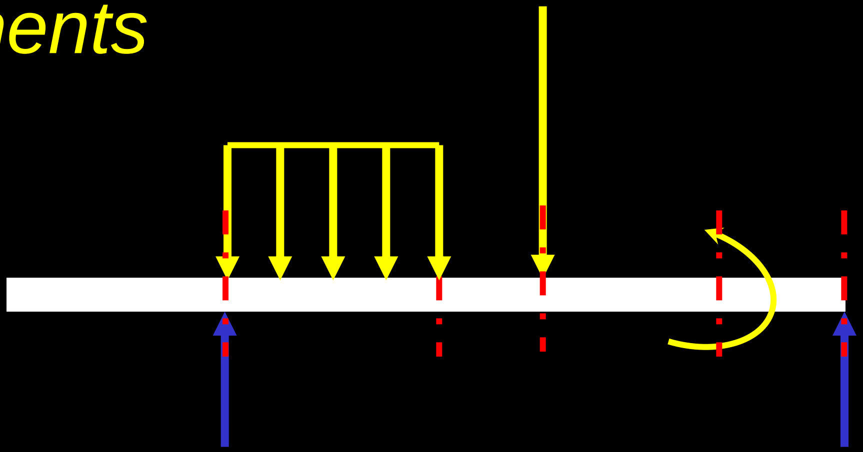
lecture
seven

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*

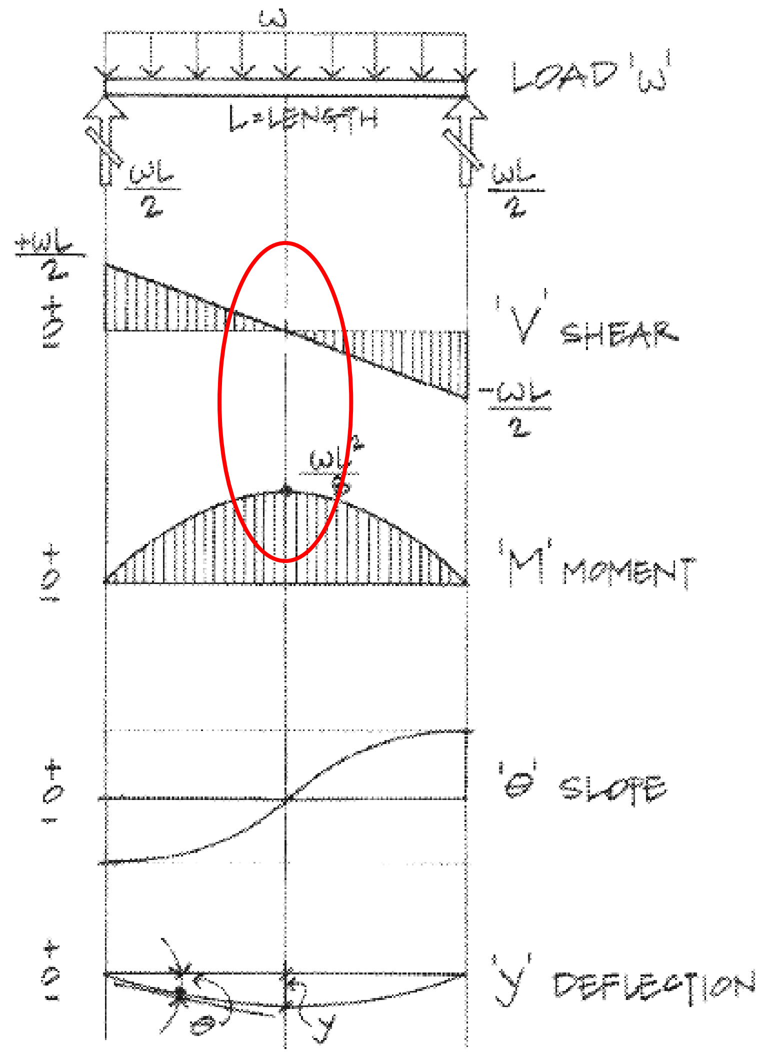
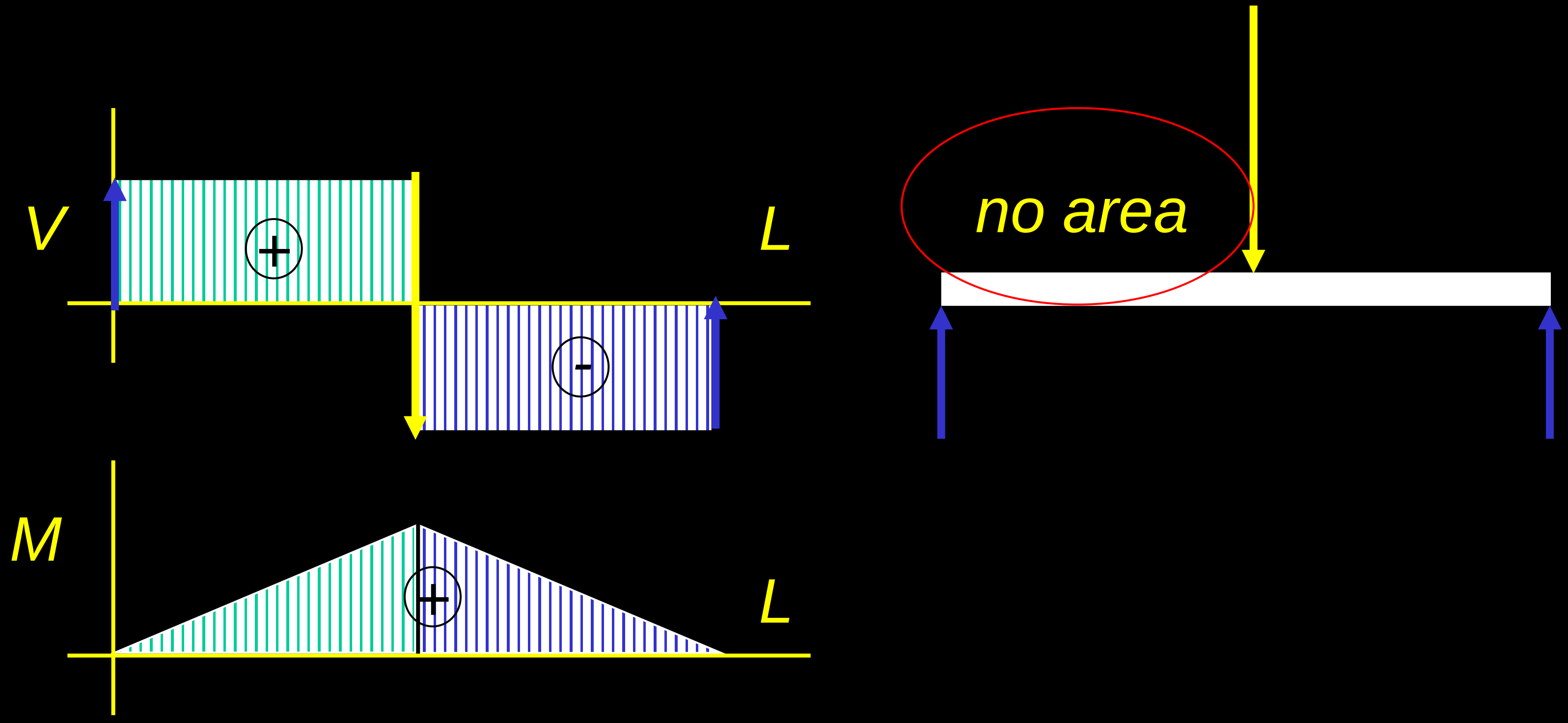


Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.

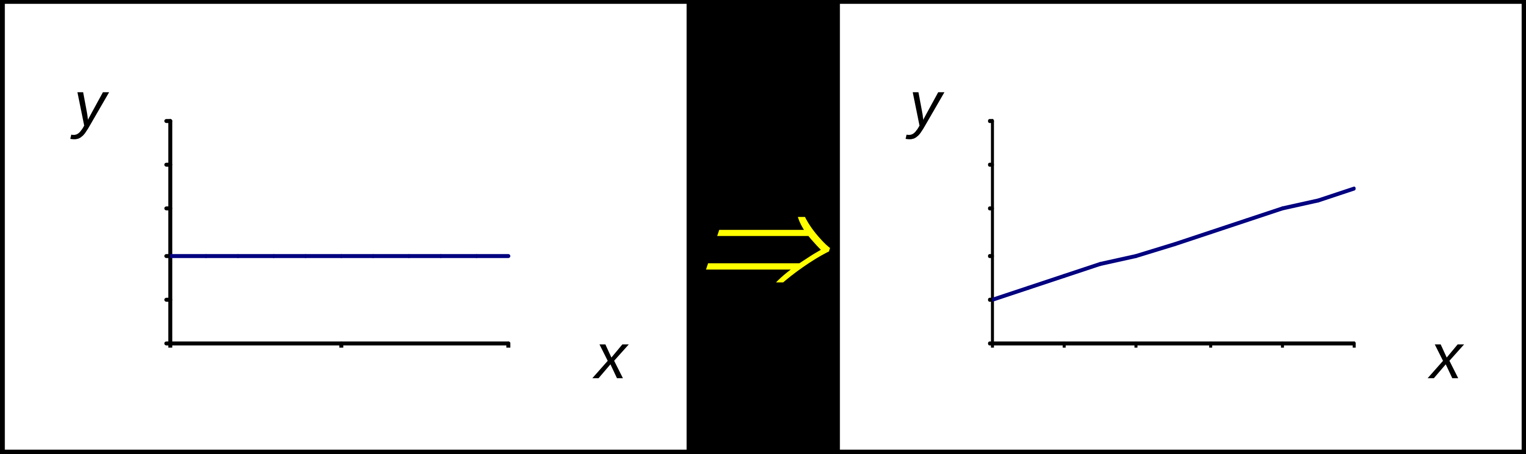
Semigraphical Method

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



Curve Relationships

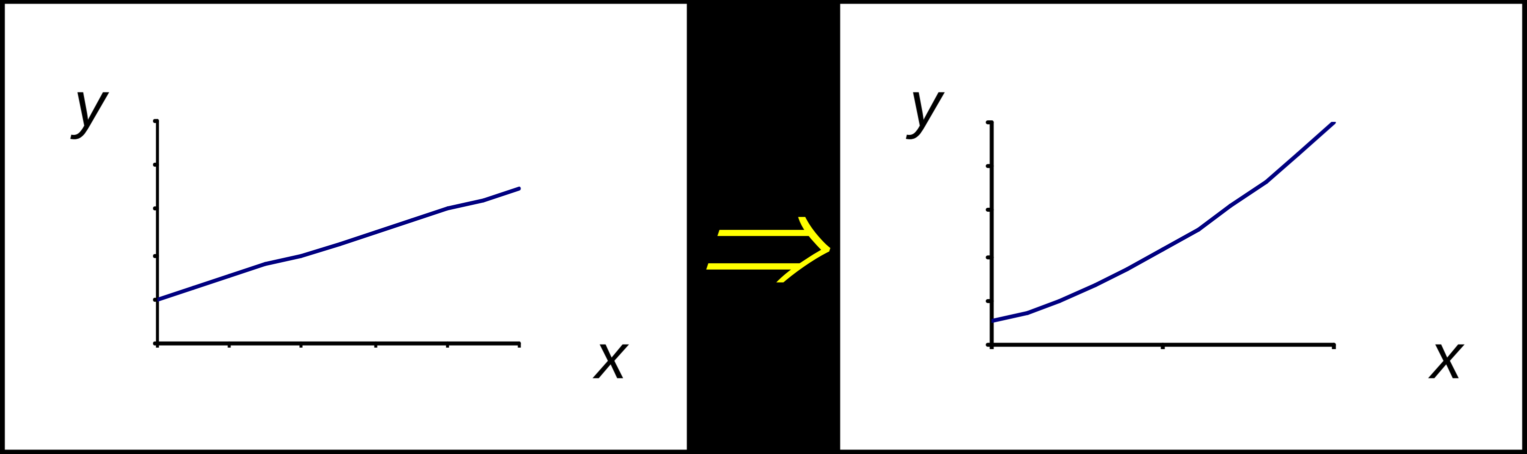
- integration of functions
- line with 0 slope, integrates to sloped



- ex: load to shear, shear to moment

Curve Relationships

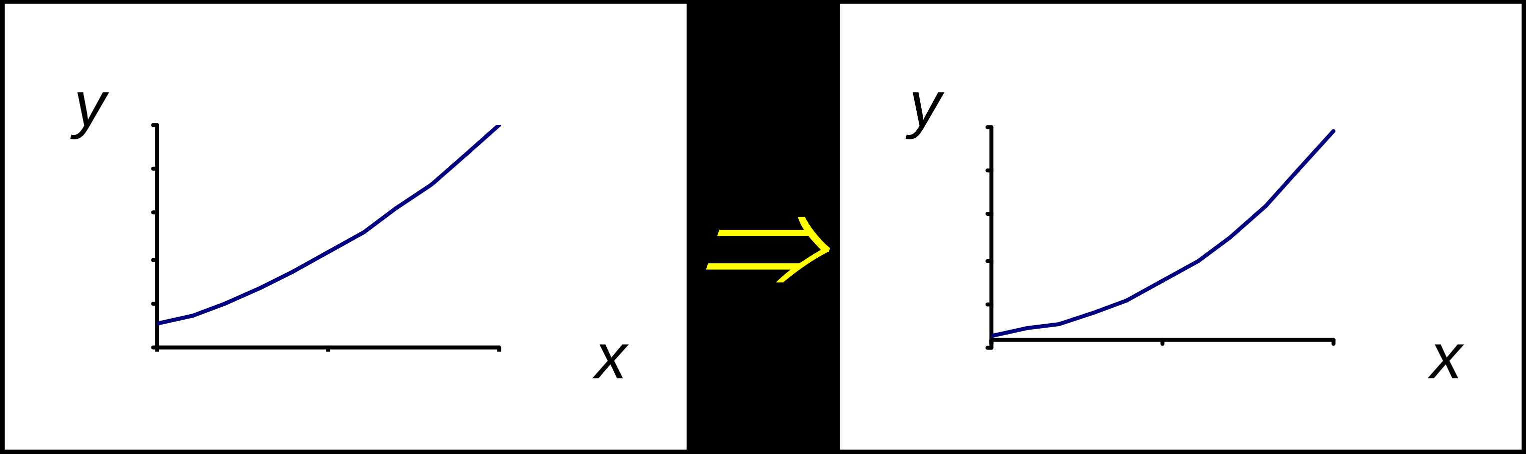
- line with slope, integrates to parabola



- 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*

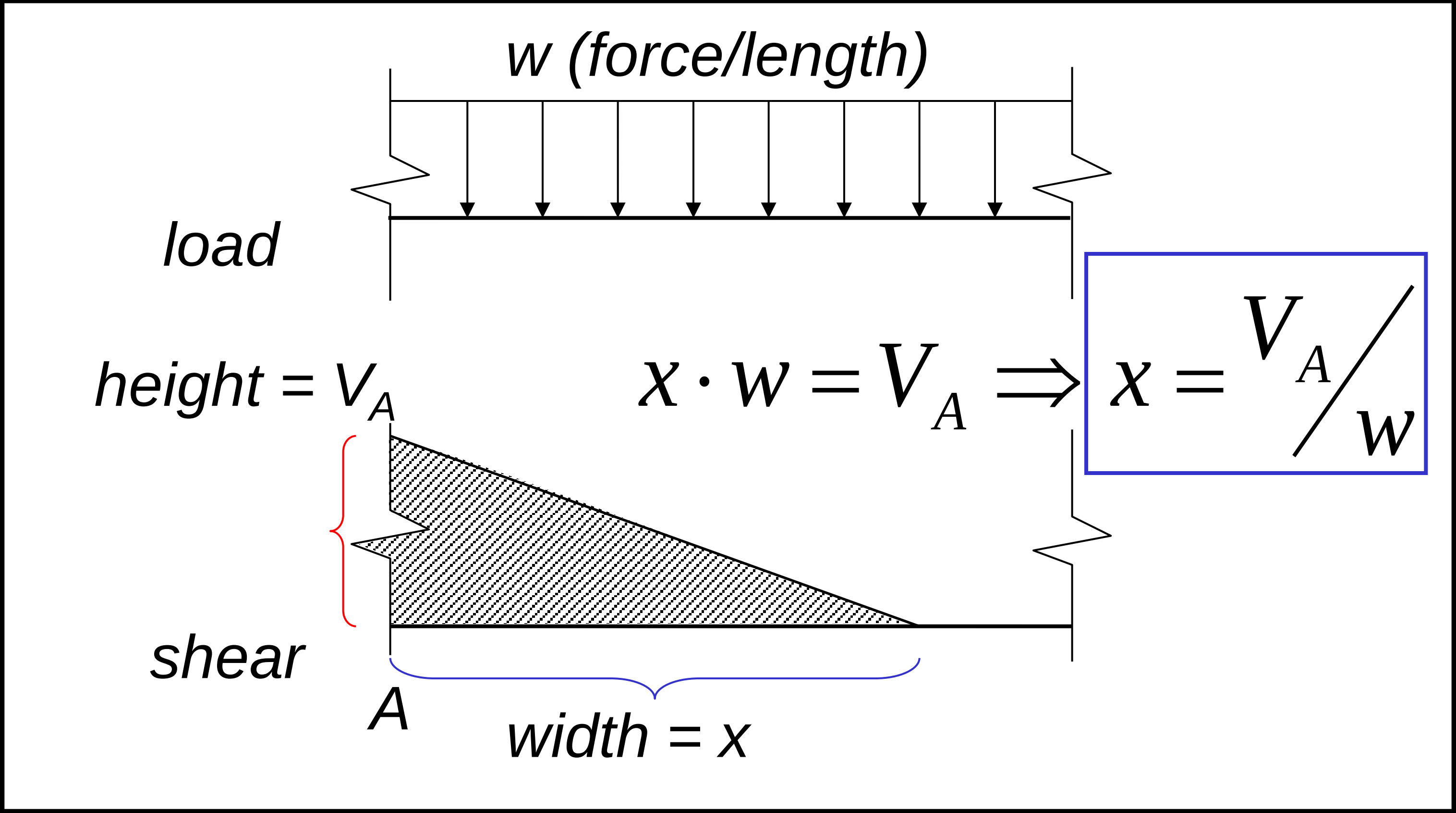
Basic Procedure

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)

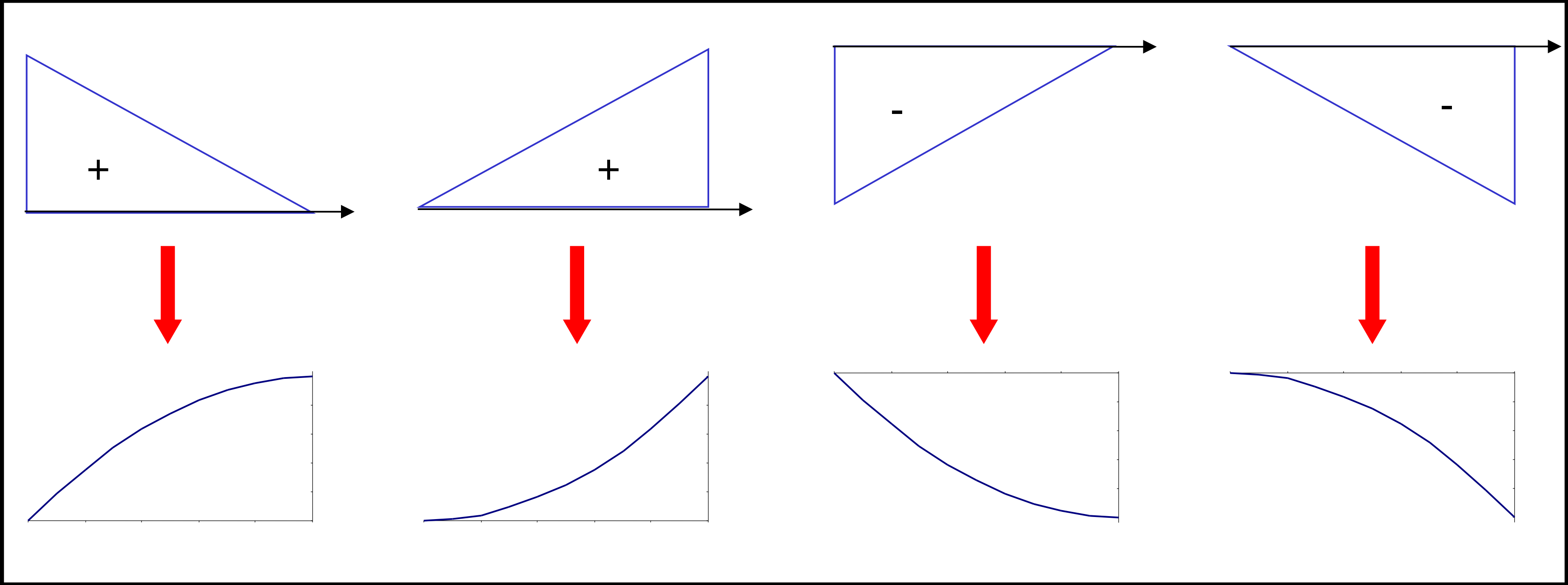
Triangle Geometry

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



Parabolic Shapes

- cases



up fast, then slow

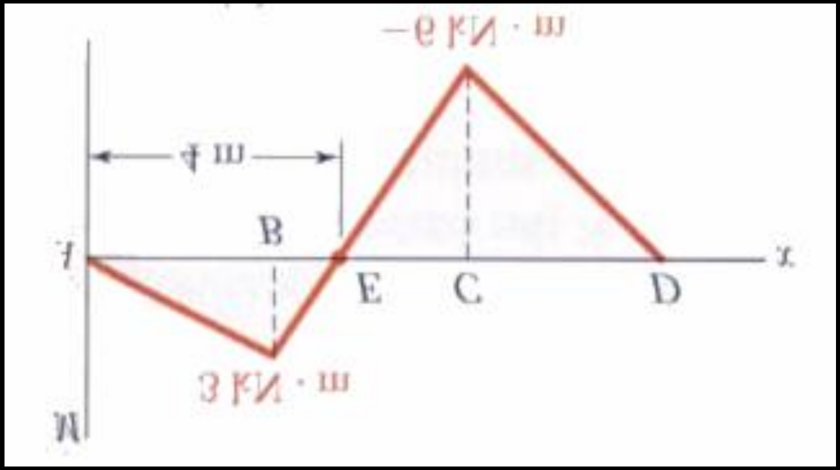
up slow, then fast

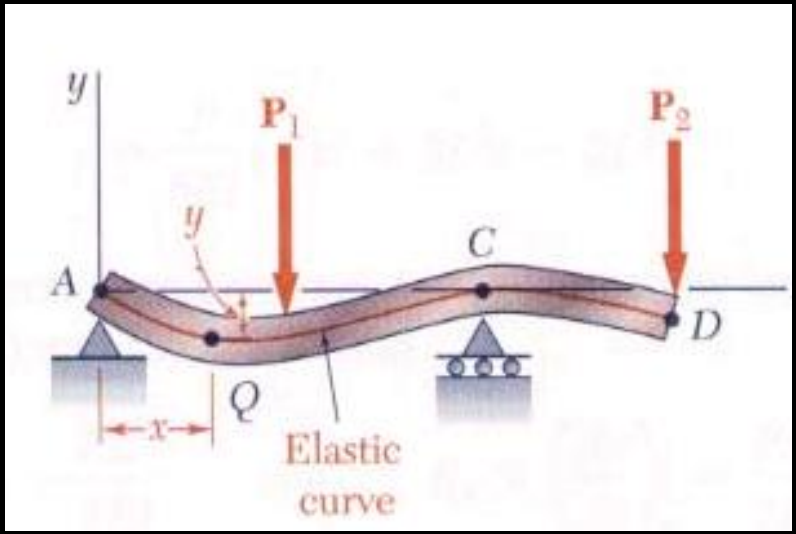
down fast, then slow

down slow, then fast

Deflected Shape & M(x)

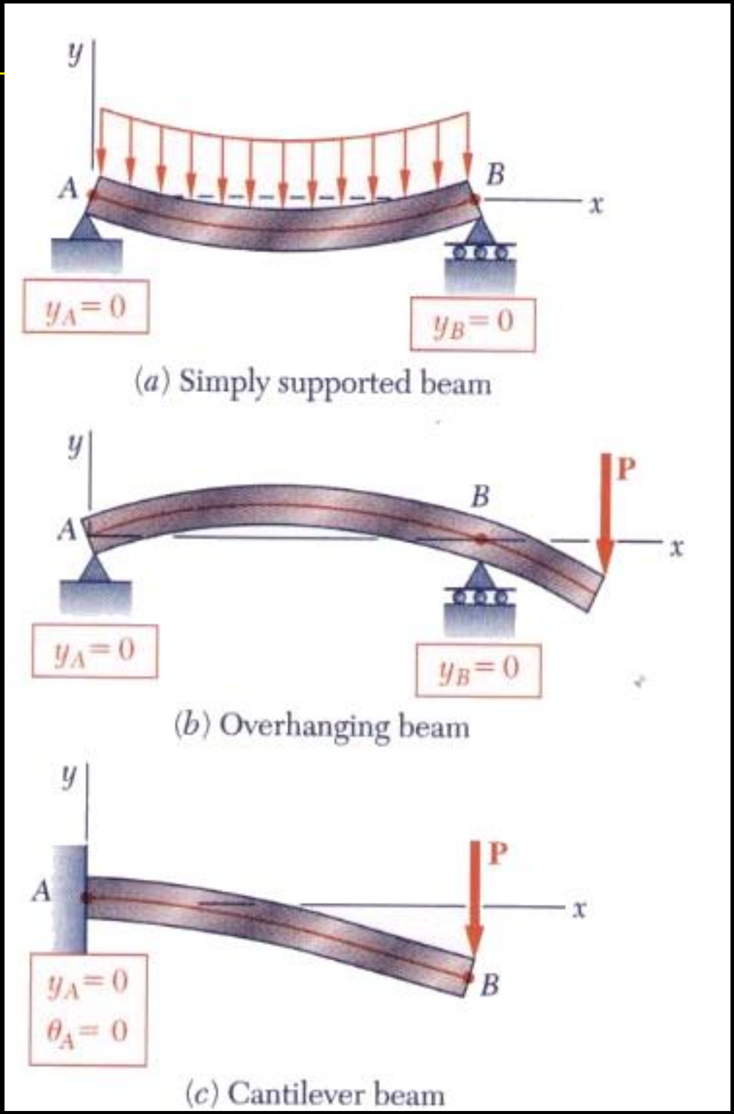
- *-M(x) gives shape indication*
- *boundary conditions must be met*





Boundary Conditions

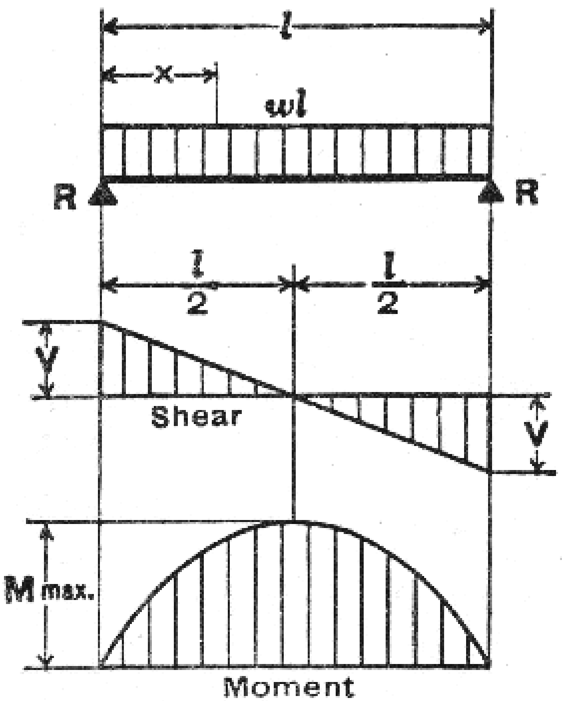
- *at pins, rollers, fixed supports:* $y = 0$
- *at fixed supports:* $\theta = 0$
- *at inflection points from symmetry:* $\theta = 0$
- y_{max} *at* $\dfrac{dy}{dx} = 0$



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