

*ELEMENTS OF ARCHITECTURAL STRUCTURES:*

*FORM, BEHAVIOR, AND DESIGN*

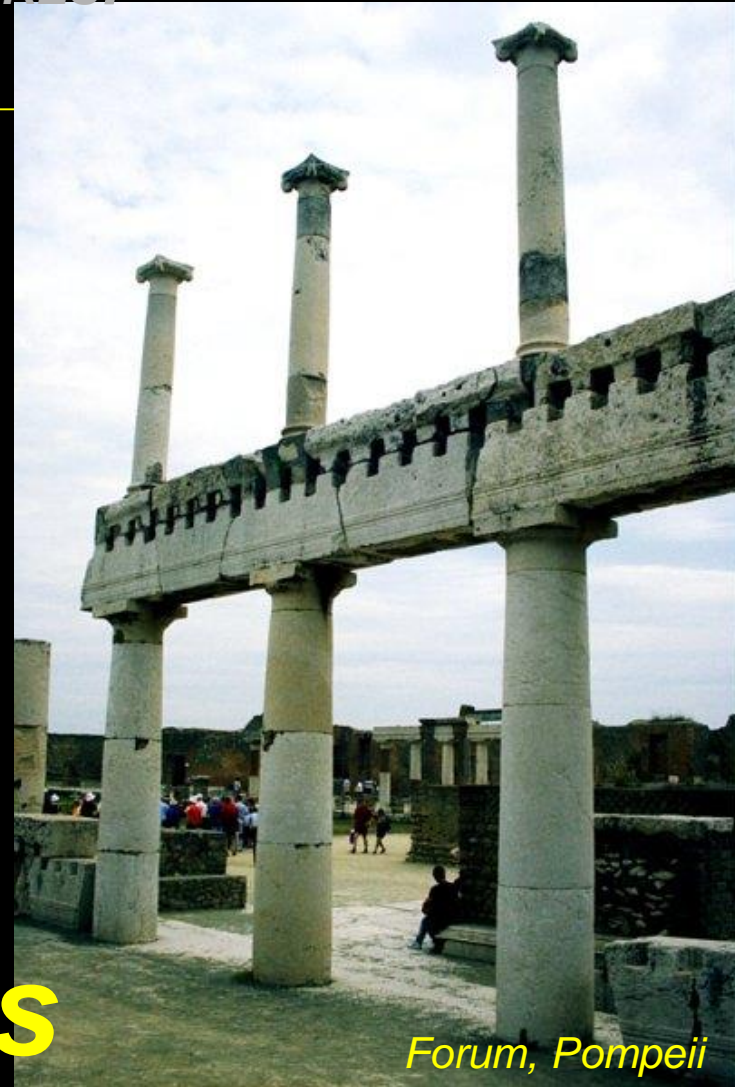
ARCH 614

DR. ANNE NICHOLS

SPRING 2019

*lecture  
seven*

*shear & bending  
moment diagrams*

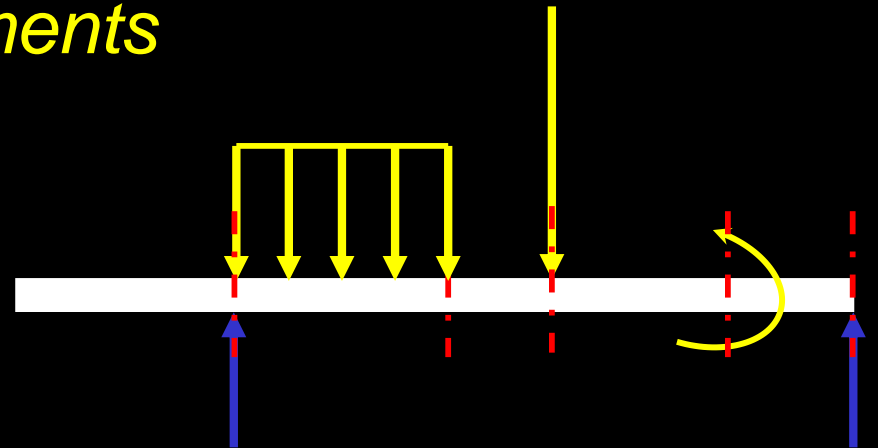


*Forum, Pompeii*

# Equilibrium Method

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



# Semigraphical Method

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- *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*

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

# Semigraphical M

- relationships

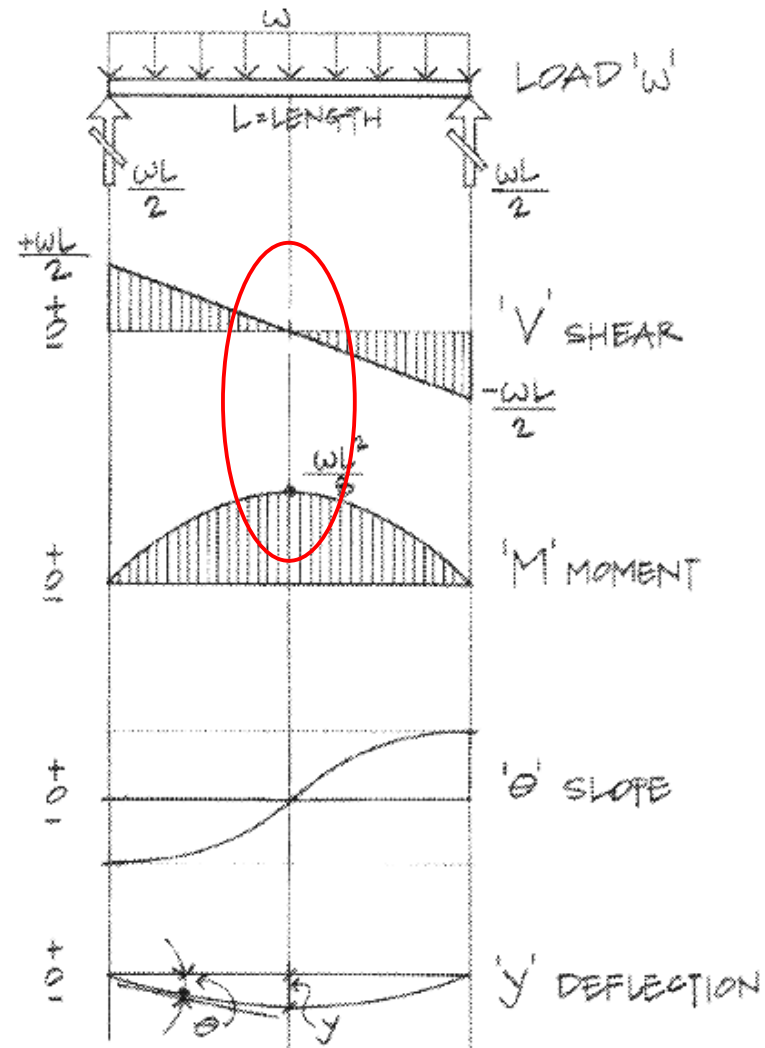
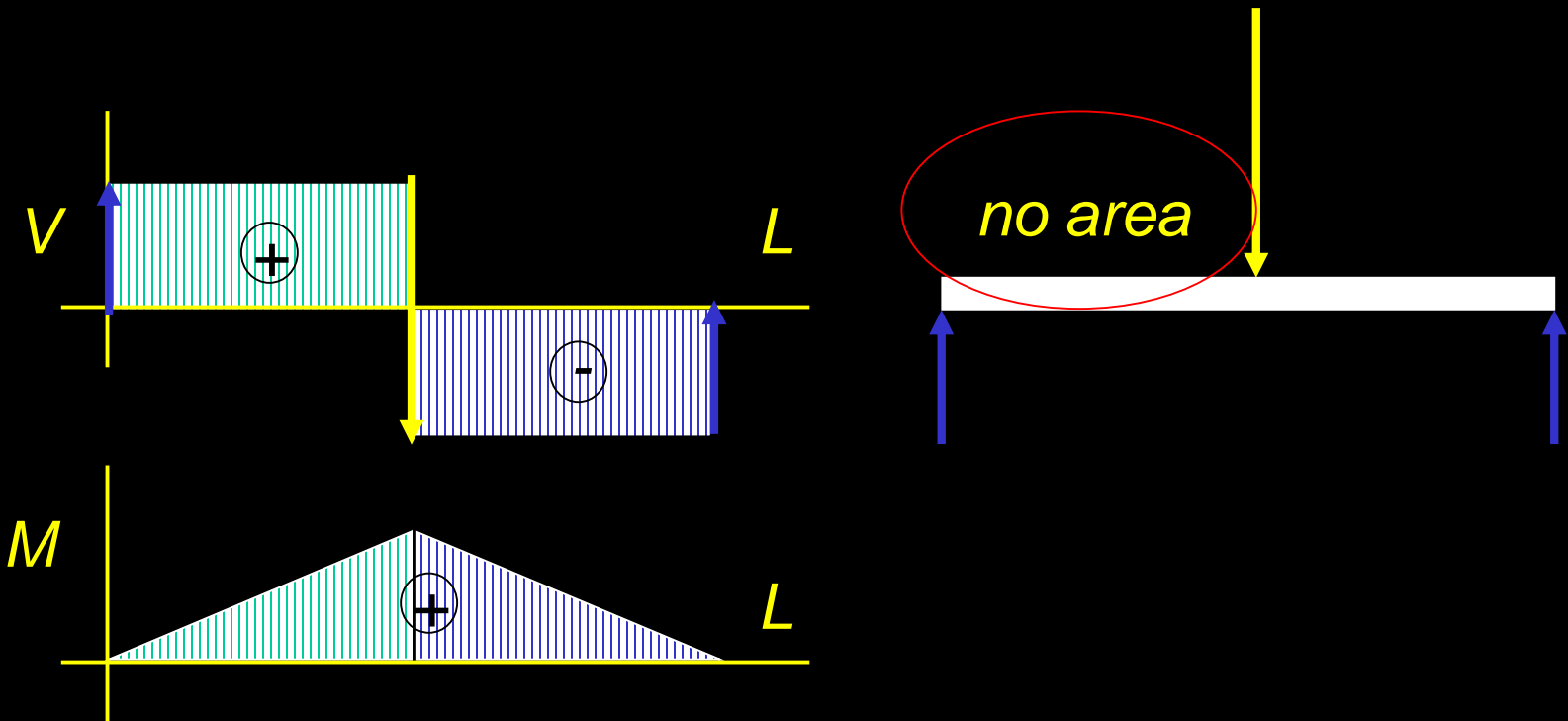


Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.

# Semigraphical Method

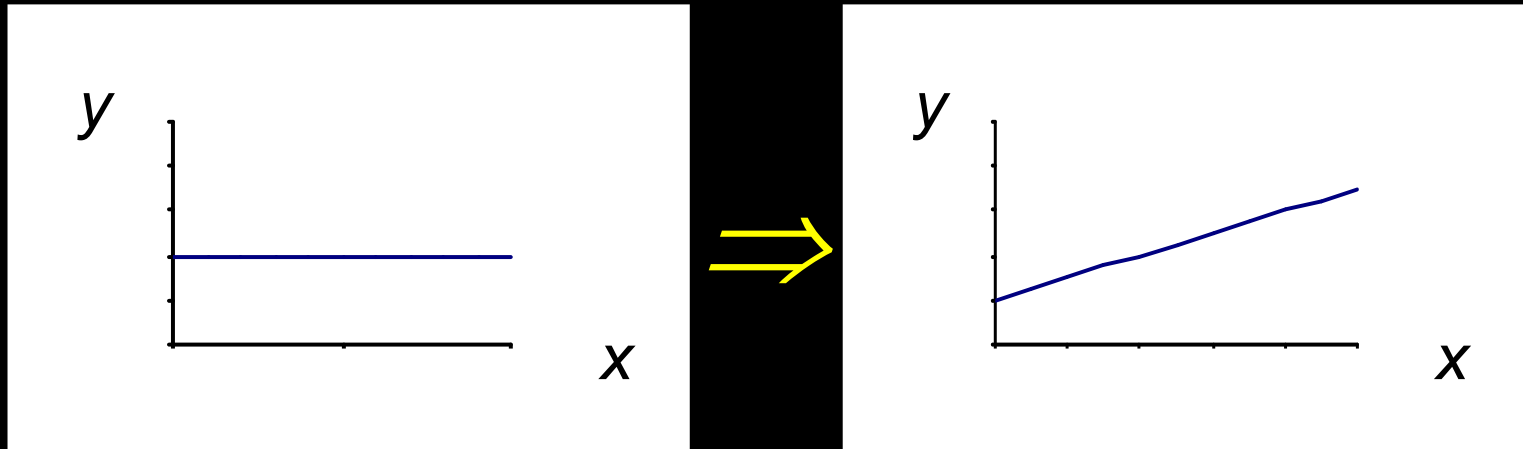
- $M_{max}$  occurs where  $V = 0$  (calculus)



# Curve Relationships

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

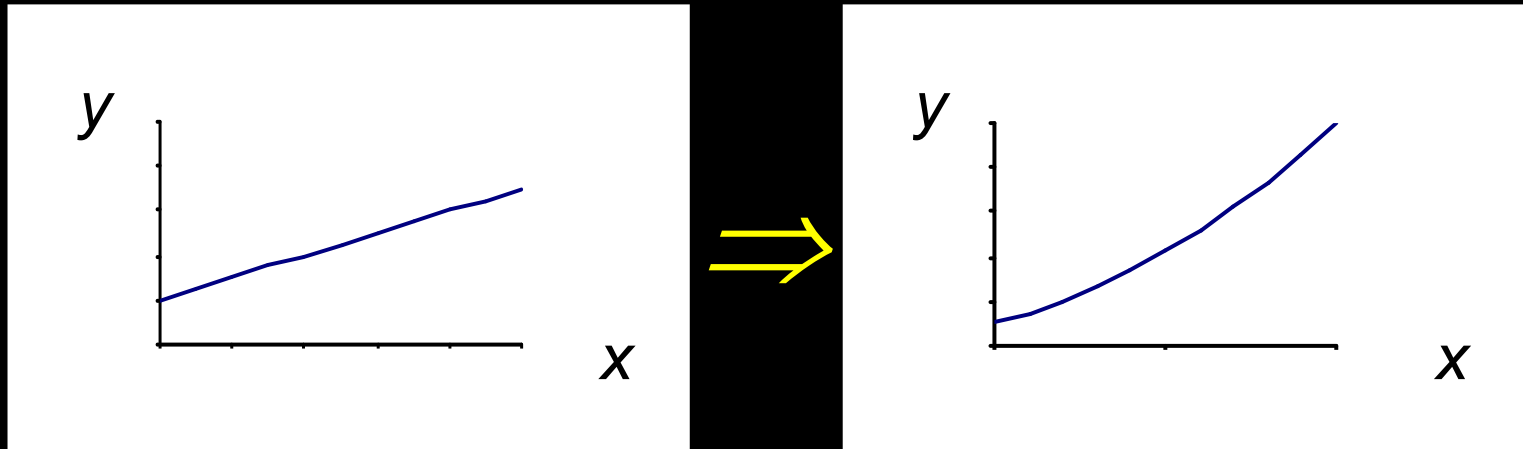


- *ex: load to shear, shear to moment*

# Curve Relationships

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- *line with slope, integrates to parabola*

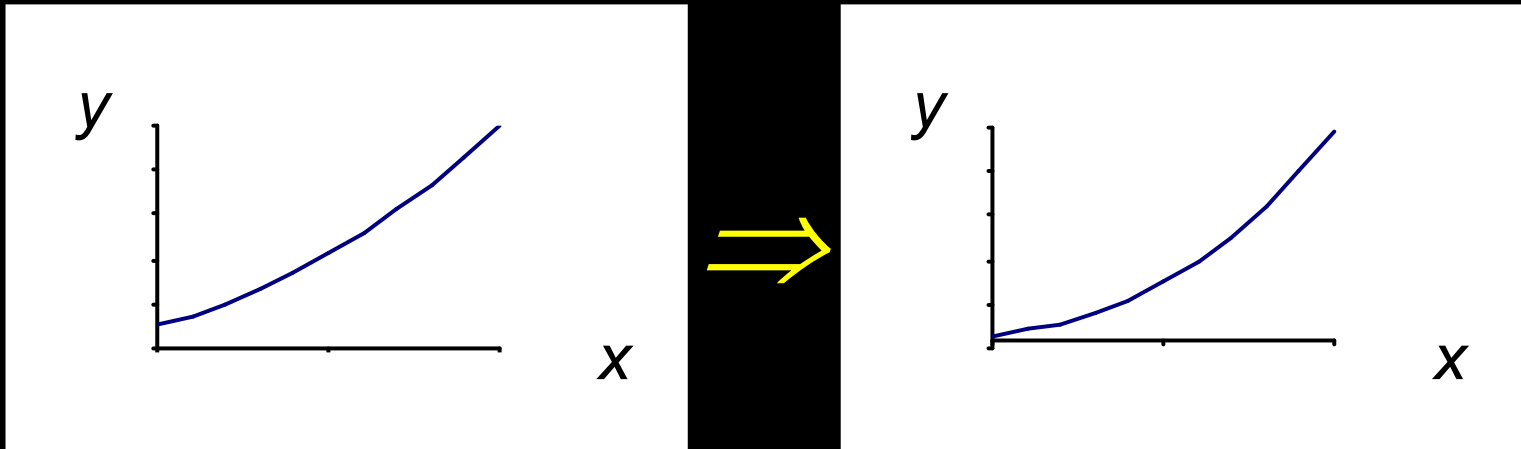


- *ex: load to shear, shear to moment*

# Curve Relationships

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- *parabola, integrates to 3<sup>rd</sup> order curve*



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



# *Basic Procedure*

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- 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*

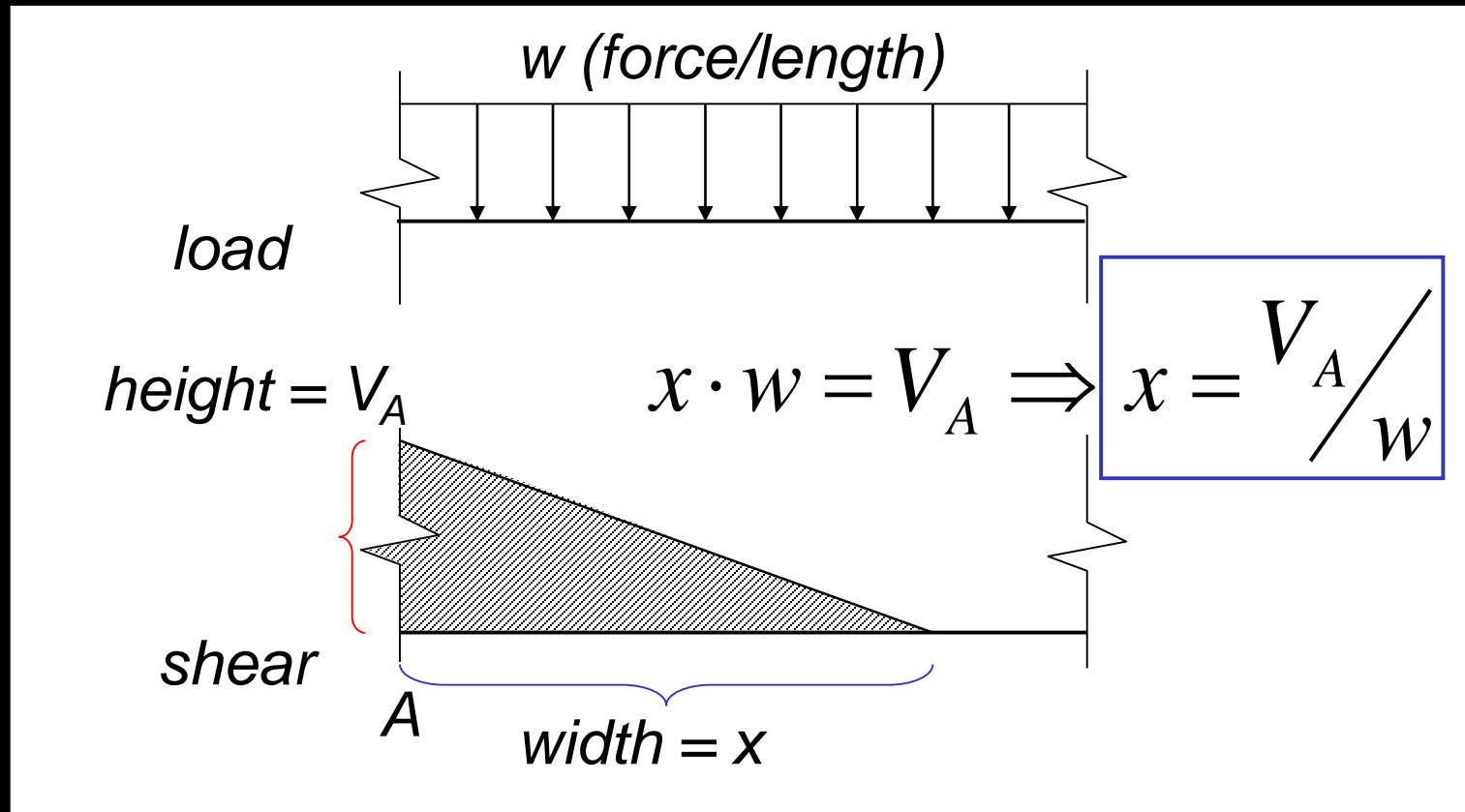
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*M:*

- 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  $V = 0$ )*

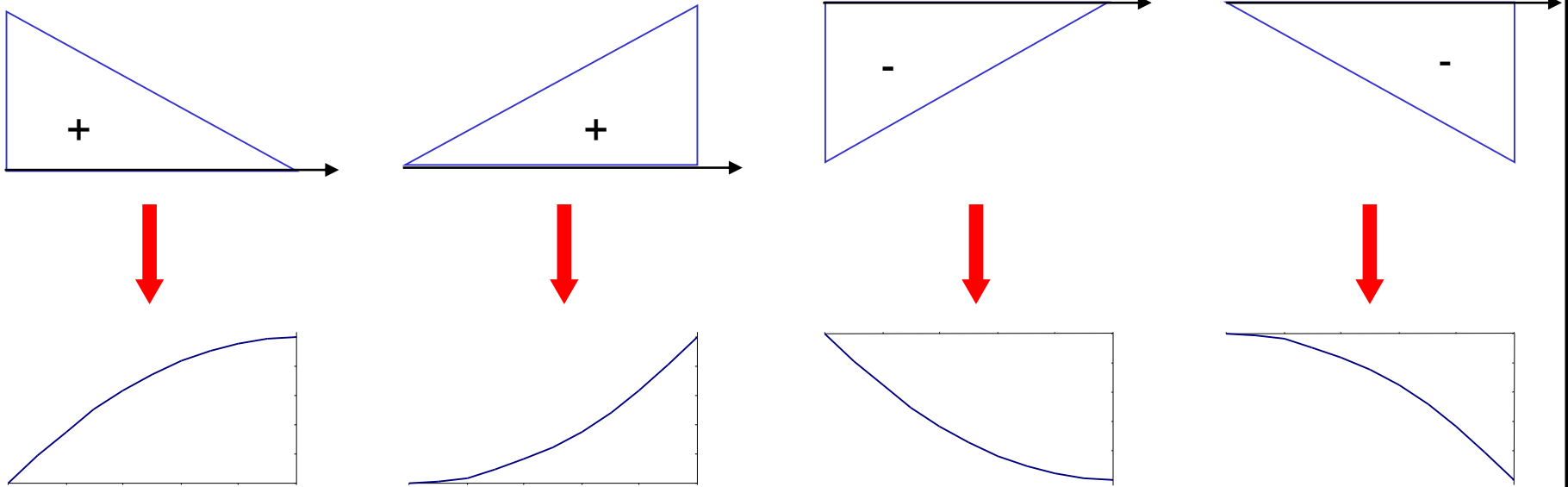
# Triangle Geometry

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



# Parabolic Shapes

- cases



*up fast,  
then slow*

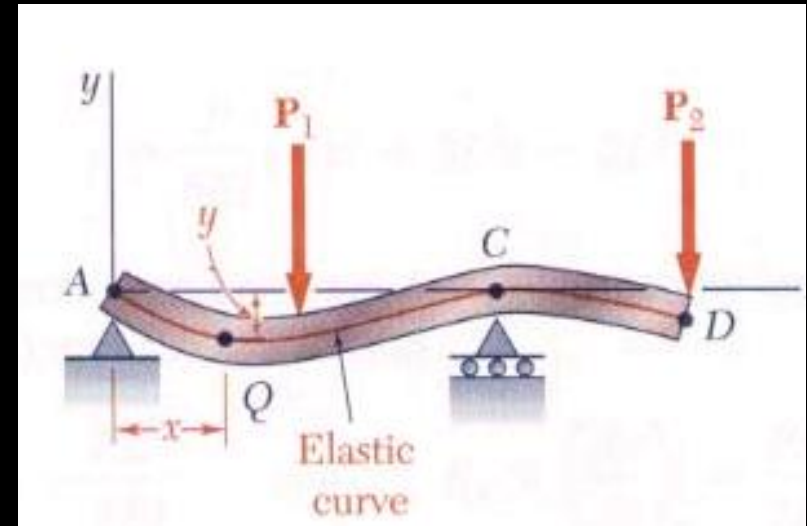
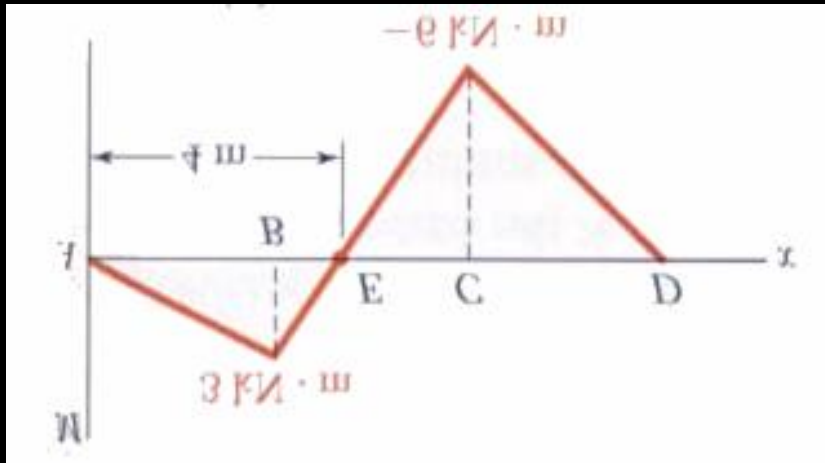
*up slow,  
then fast*

*down fast,  
then slow*

*down slow,  
then fast*

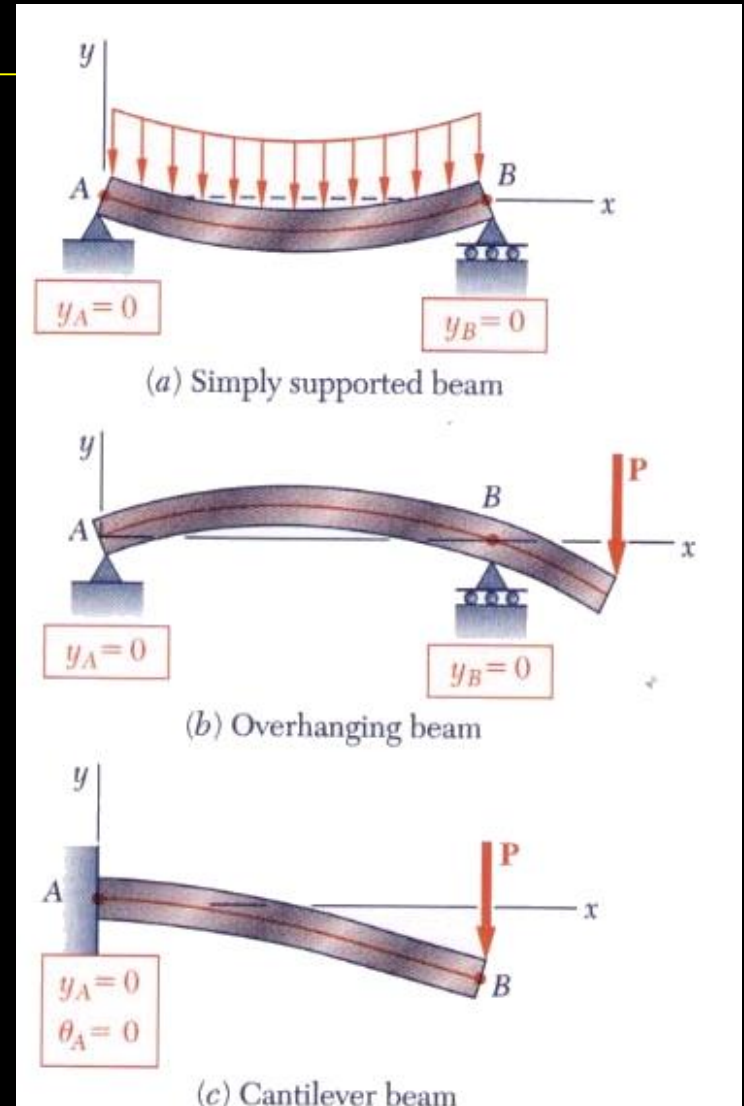
# Deflected Shape & $M(x)$

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



# Boundary Conditions

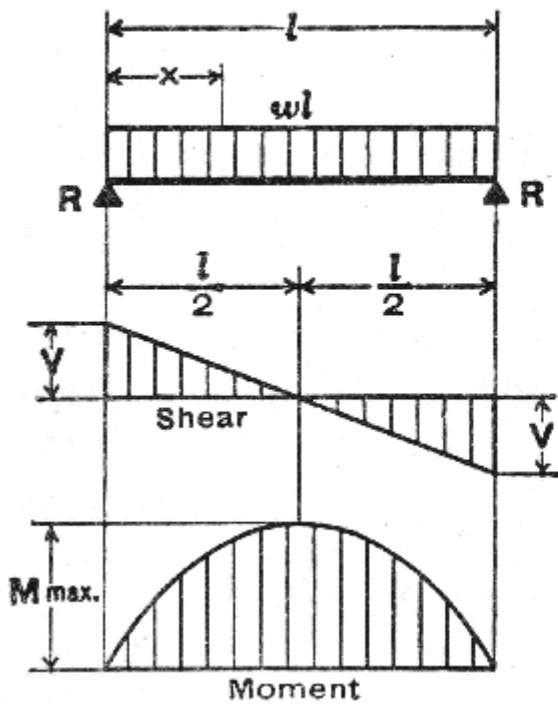
- at pins, rollers, fixed supports:  $y = 0$
- at fixed supports:  $\theta = 0$
- at inflection points from symmetry:  $\theta = 0$
- $y_{max}$  at  $\frac{dy}{dx} = 0$



# 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 ) . . . . .	$= \frac{wl^2}{8}$
$M_x$ . . . . .	$= \frac{wx}{2} (l - x)$
$\Delta_{max}$ ( at center ) . . . . .	$= \frac{5wl^4}{384EI}$
$\Delta_x$ . . . . .	$= \frac{wx}{24EI} (l^3 - 2lx^2 + x^3)$