

**ARCHITECTURAL STRUCTURES:
FORM, BEHAVIOR, AND DESIGN**

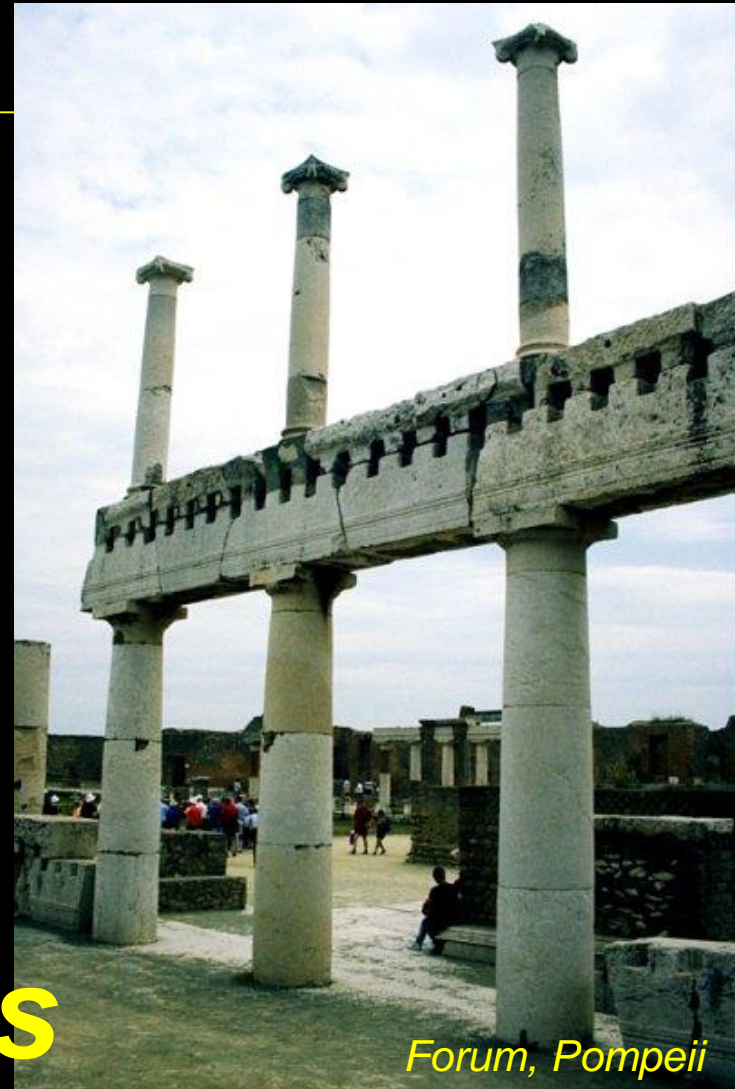
ARCH 331

DR. ANNE NICHOLS

FALL 2018

**lecture
eight**

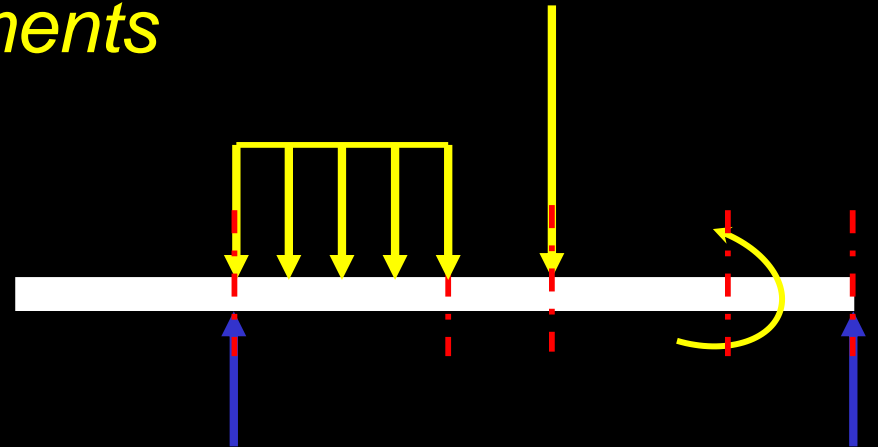
**shear & bending
moment diagrams**



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*

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

Semigraphical M

- relationships

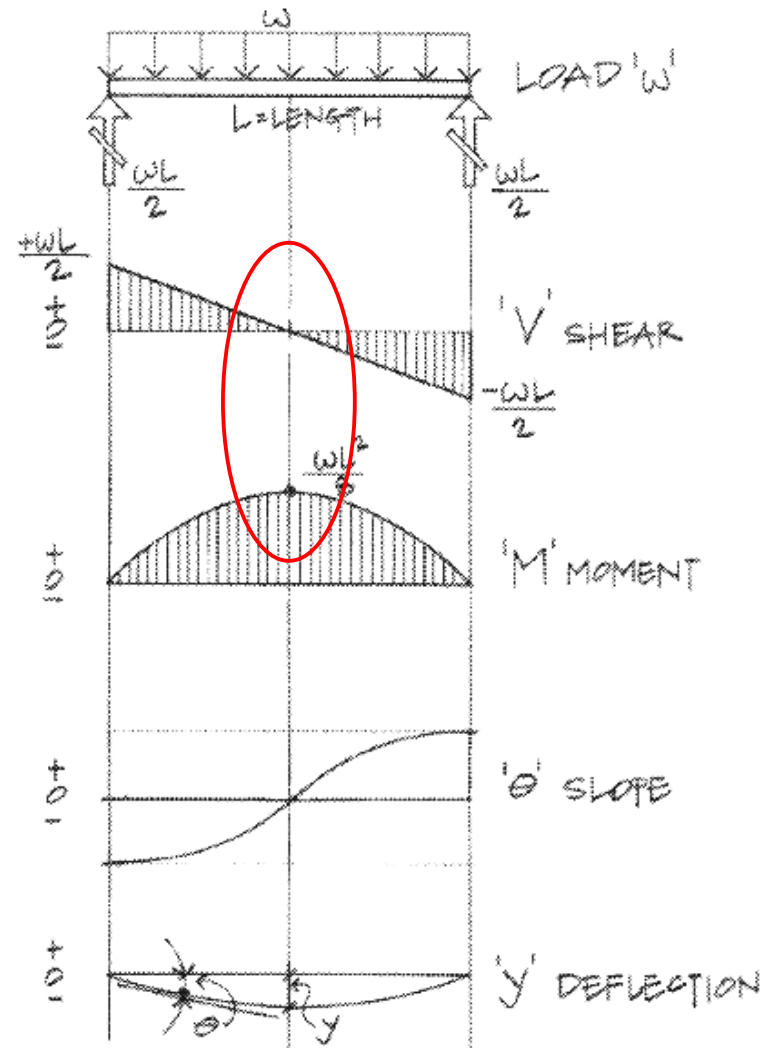
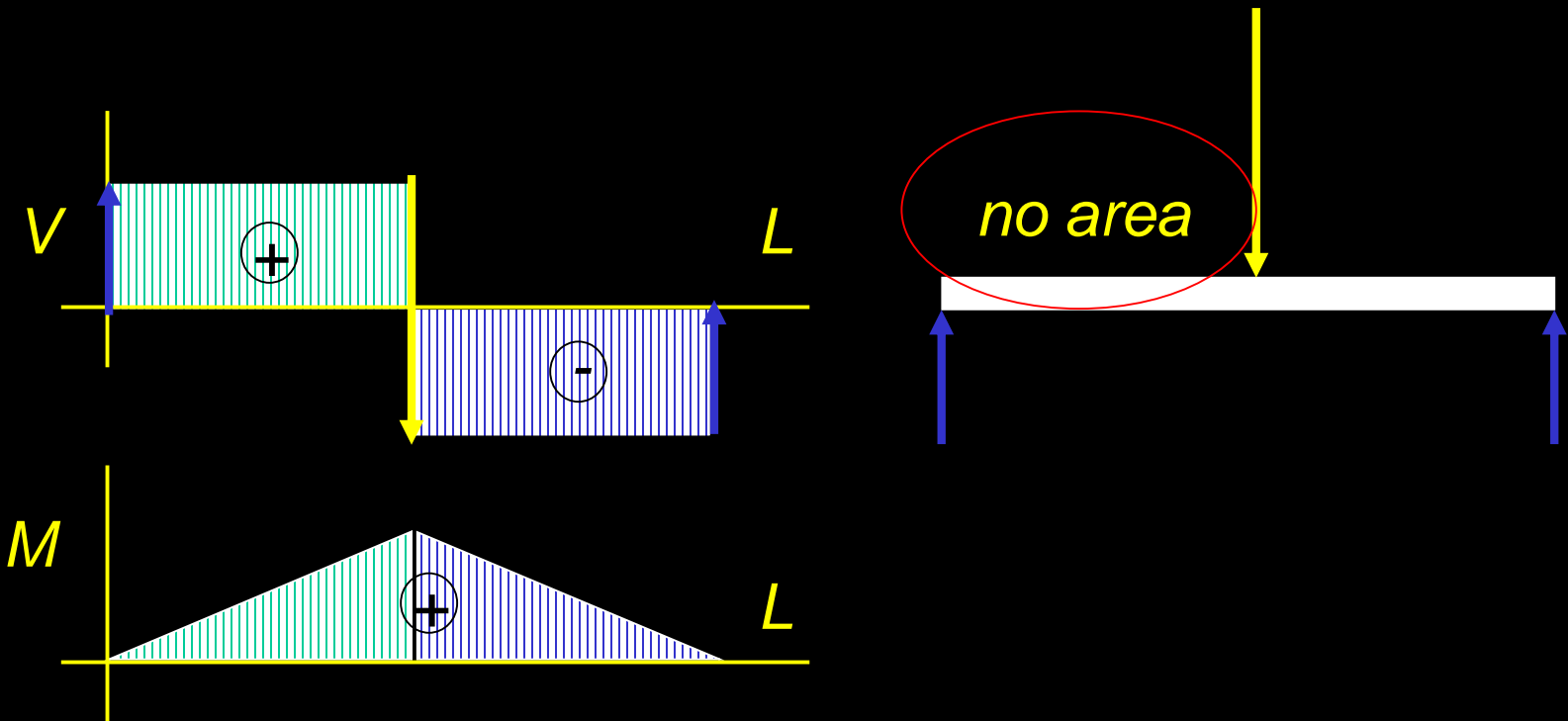


Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.

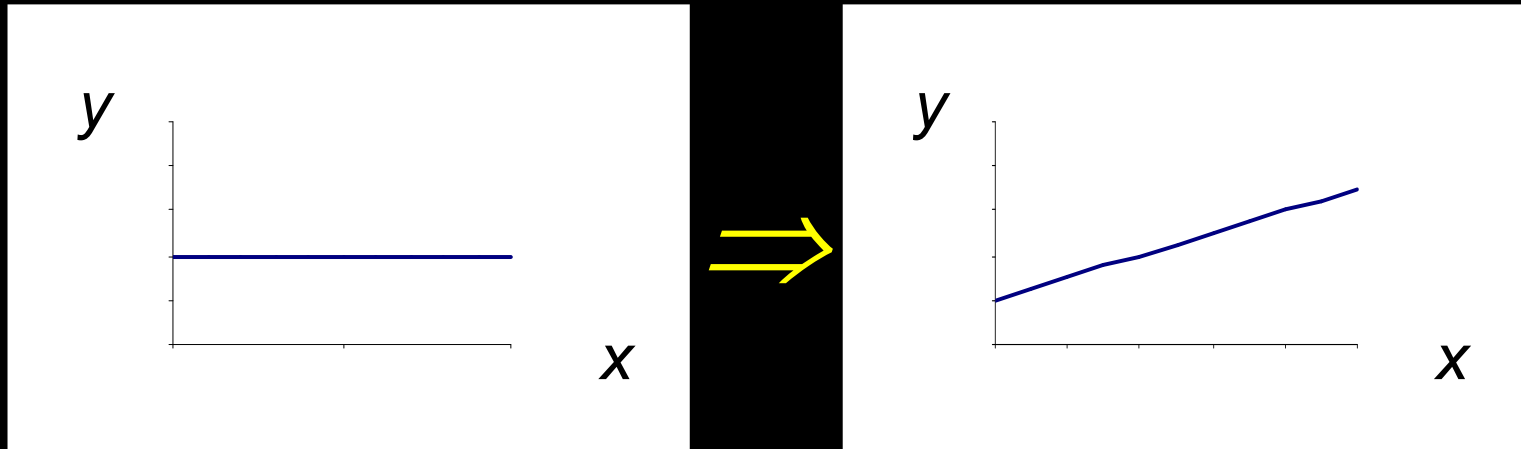
Semigraphical Method

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



Curve Relationships

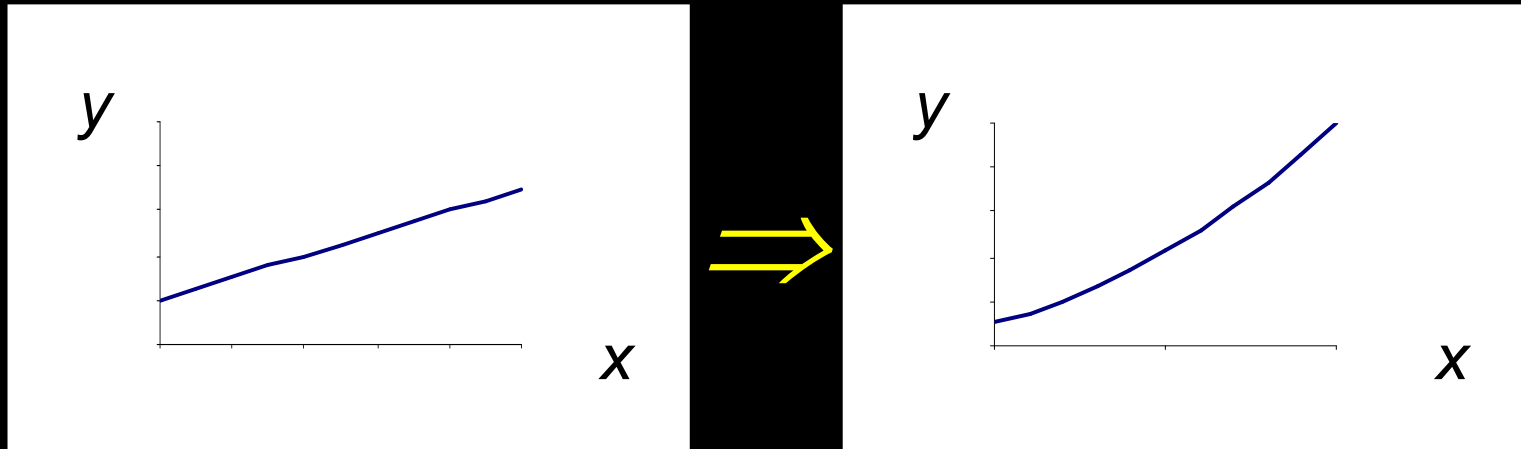
- *integration of functions*
- *line with 0 slope, integrates to sloped*



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

Curve Relationships

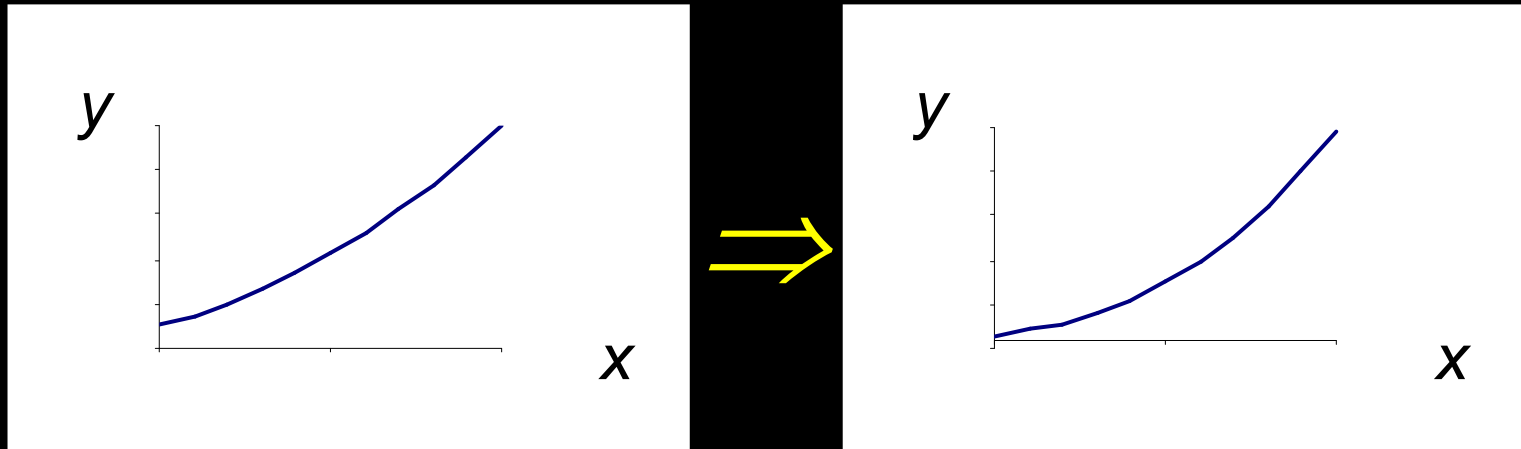
- *line with slope, integrates to parabola*



- *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

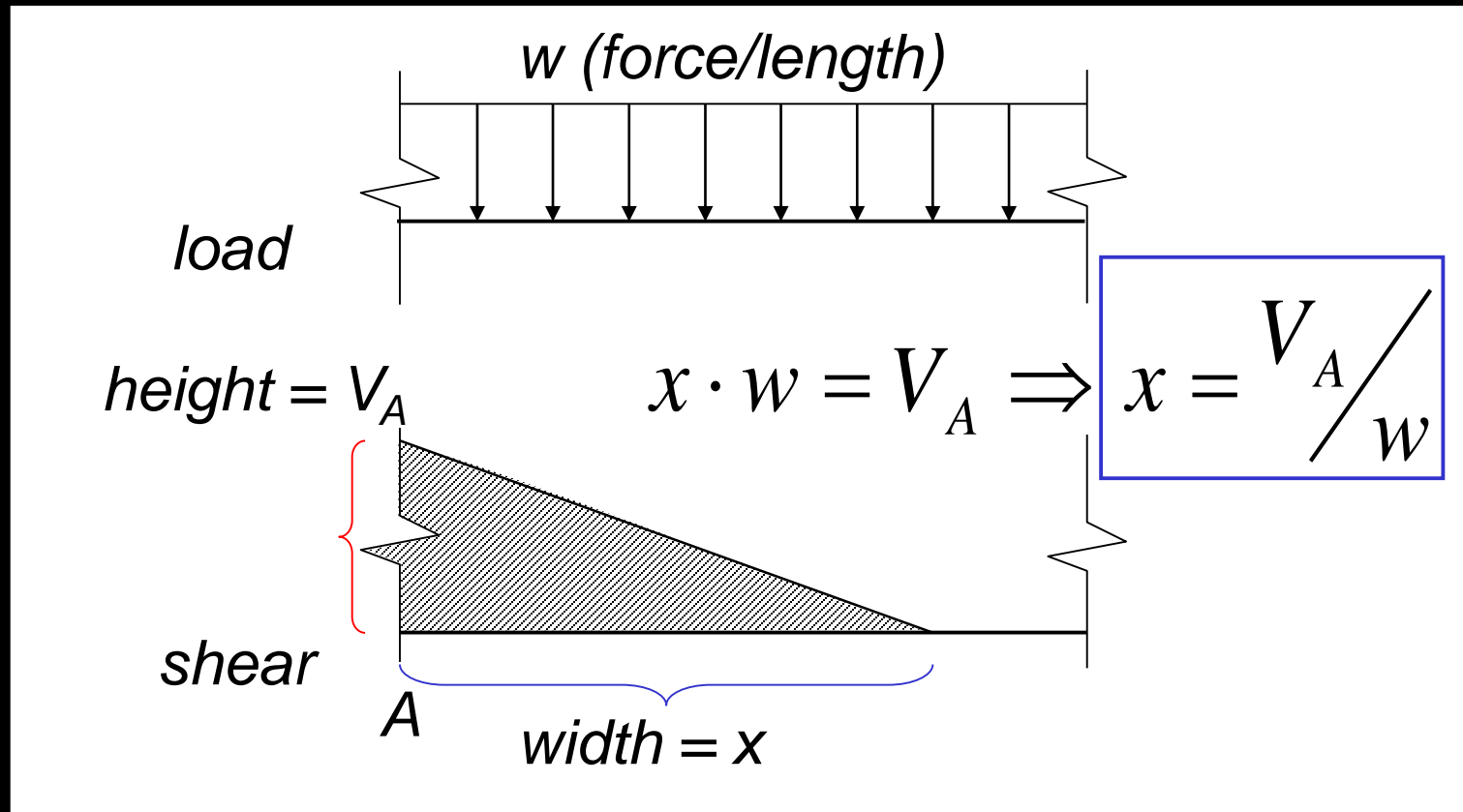
8. Moment jumps with moment

9. Moment changes with area under V

*10. Maximum moment is where shear = 0!
(locate where $V = 0$)*

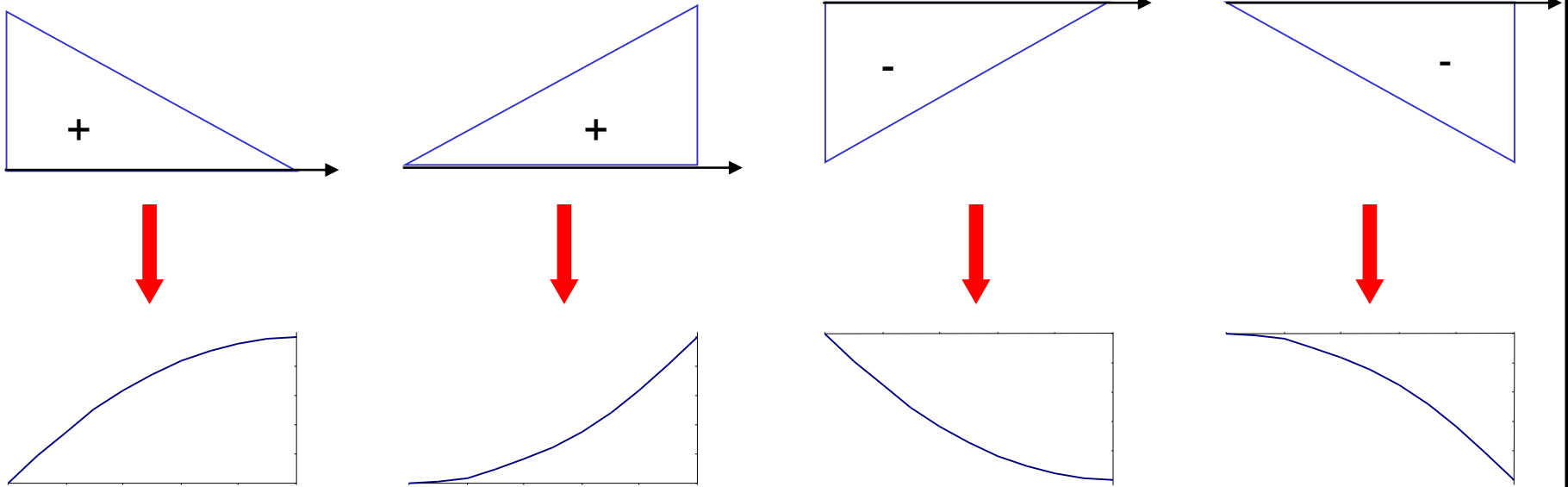
Shear Through Zero

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



Parabolic Shapes

- cases



*up fast,
then slow*

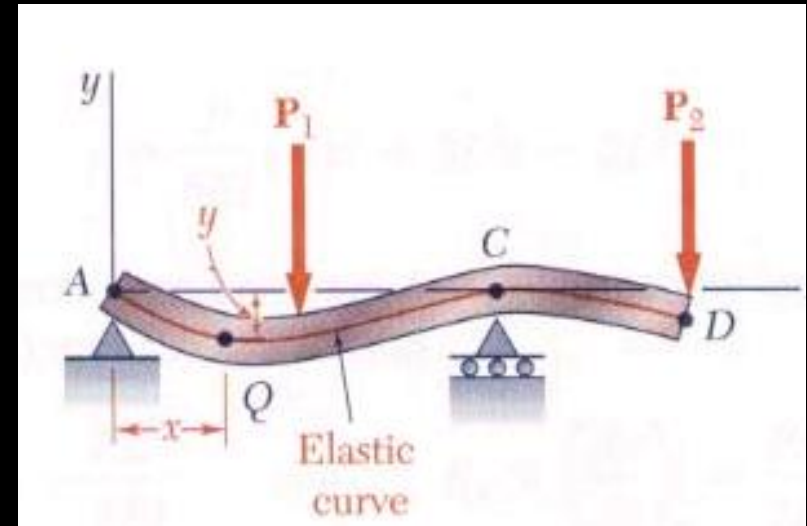
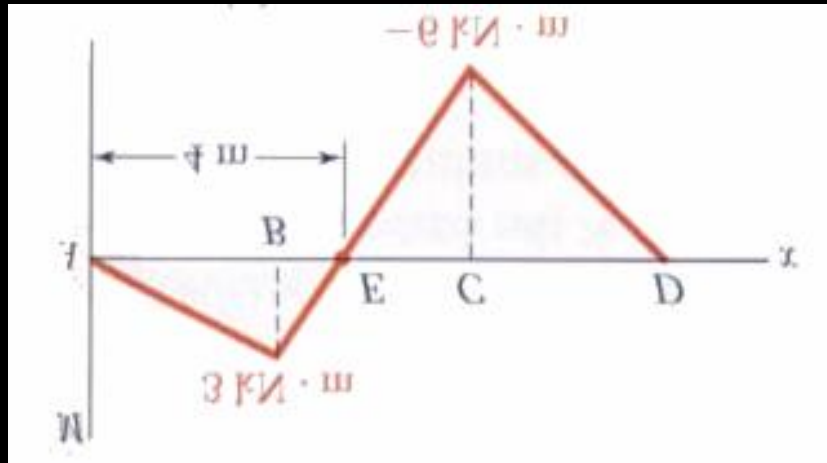
*up slow,
then fast*

*down fast,
then slow*

*down slow,
then fast*

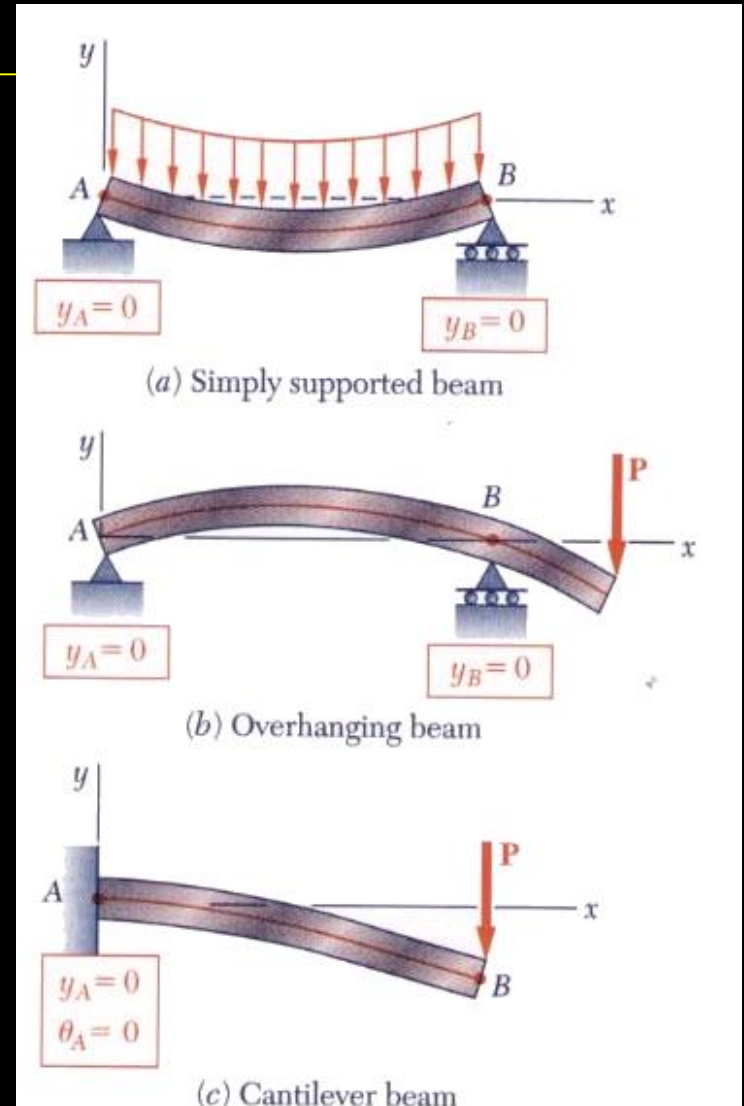
Deflected Shape & $M(x)$

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



Boundary Conditions

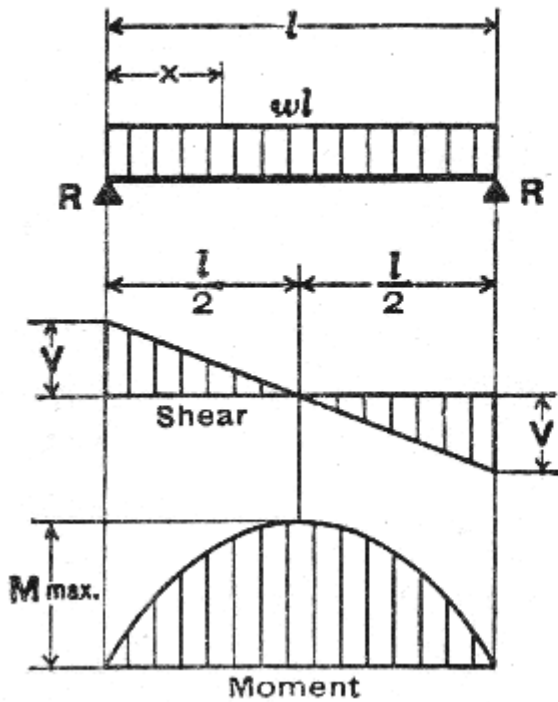
- at pins, rollers, fixed supports: $y = 0$
- at fixed supports: $\theta = 0$
- at inflection points from symmetry: $\theta = 0$
- y_{max} at $\frac{dy}{dx} = 0$



Tabulated Beam Formulas

- *how to read charts*

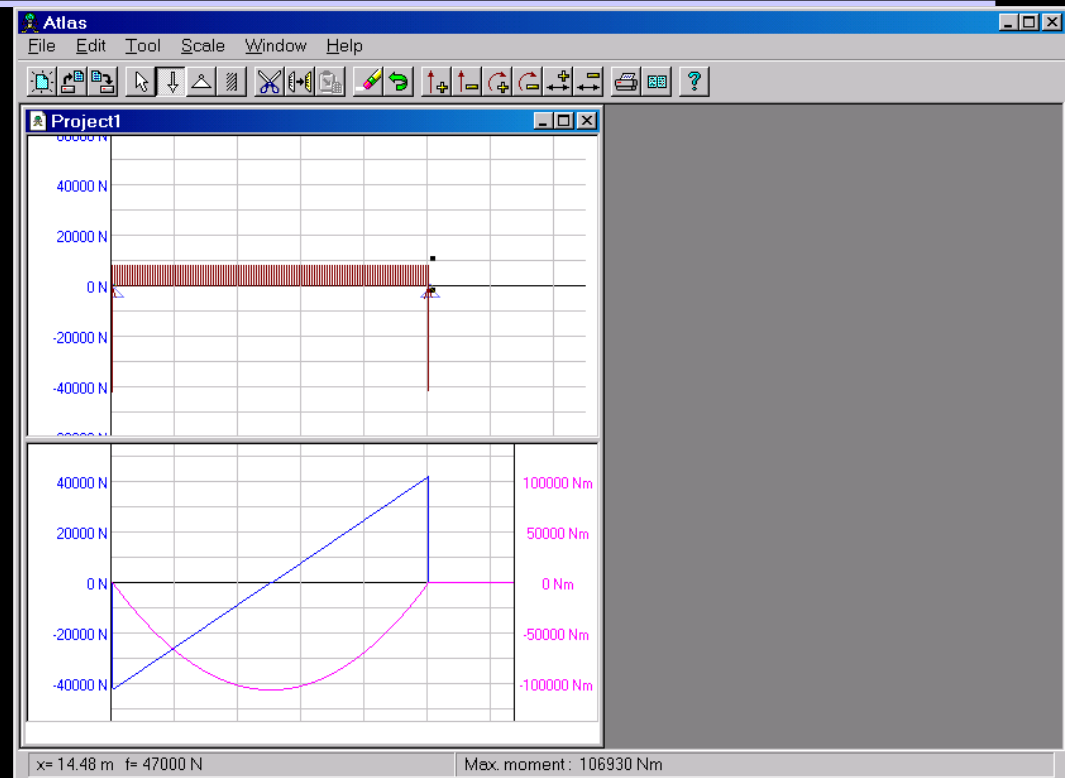
1. SIMPLE BEAM—UNIFORMLY DISTRIBUTED LOAD



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	$= \frac{wx}{2} (l - x)$
Δ_{max} (at center)	$= \frac{5wl^4}{384EI}$
Δ_x	$= \frac{wx}{24EI} (l^3 - 2lx^2 + x^3)$

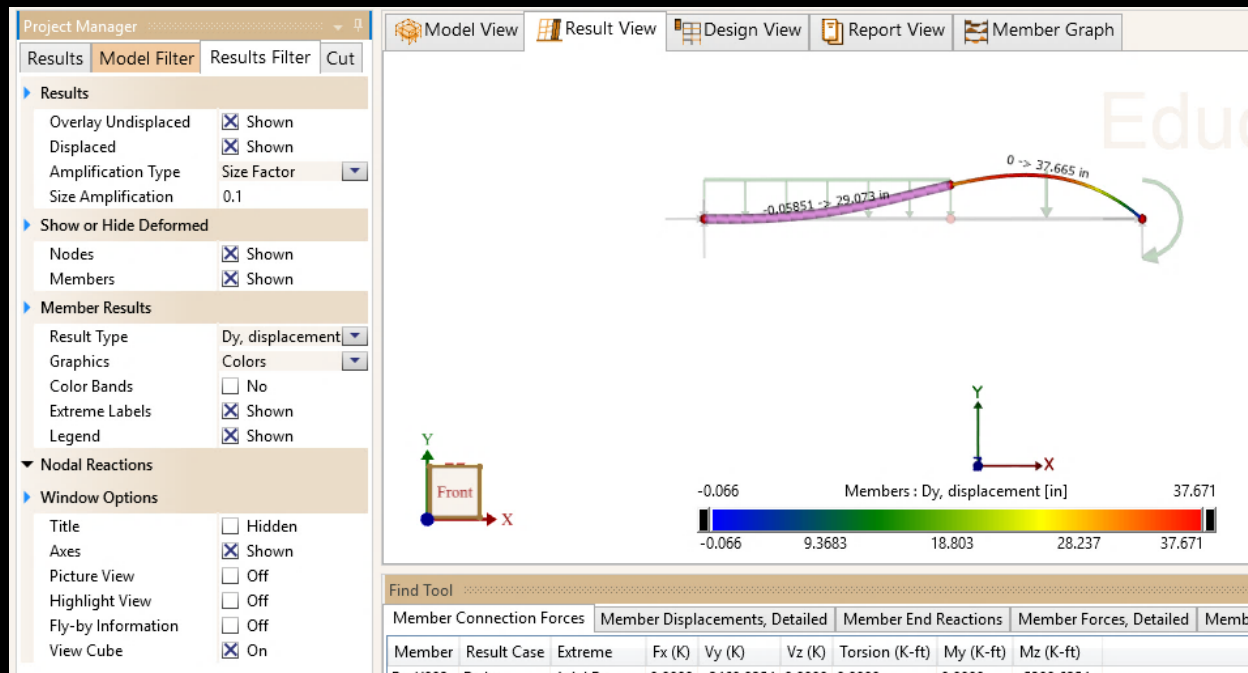
Tools

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



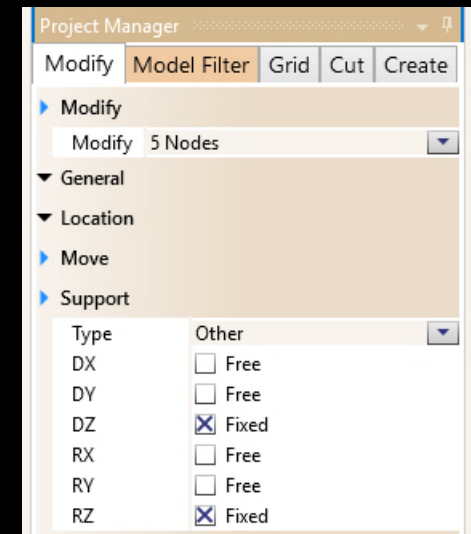
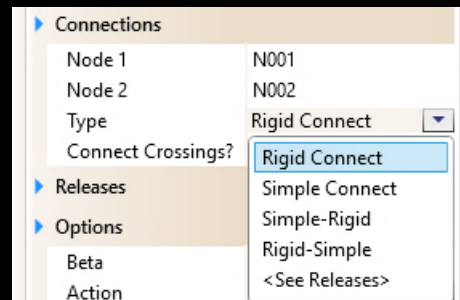
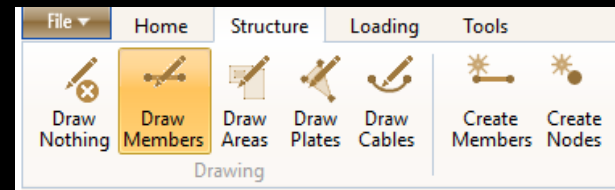
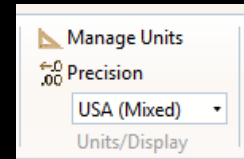
Tools – Visual Analysis (VA Edu)

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



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*



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*

