*ARCHITECTURAL STRUCTURES I:*

*STATICS AND STRENGTH OF MATERIALS*

*ENDS 231*

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*FALL 2007*
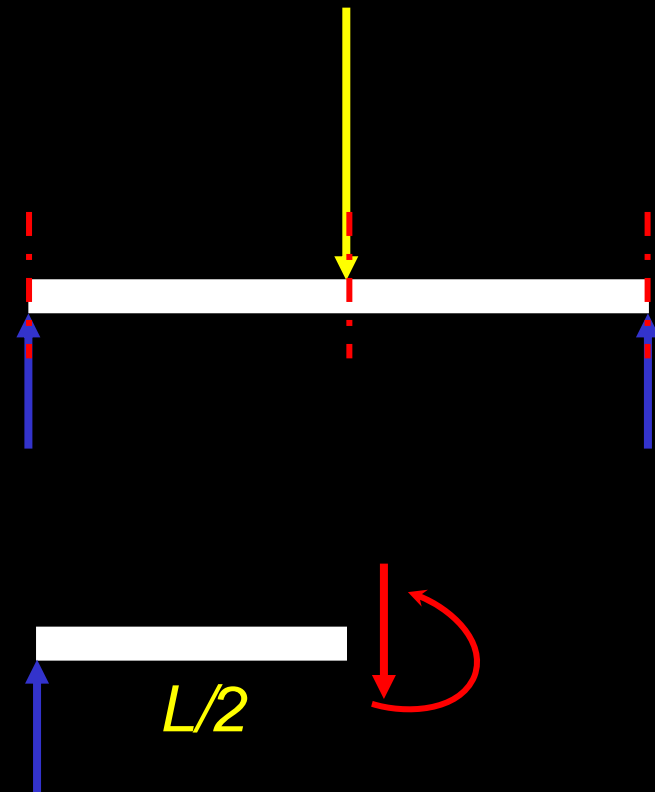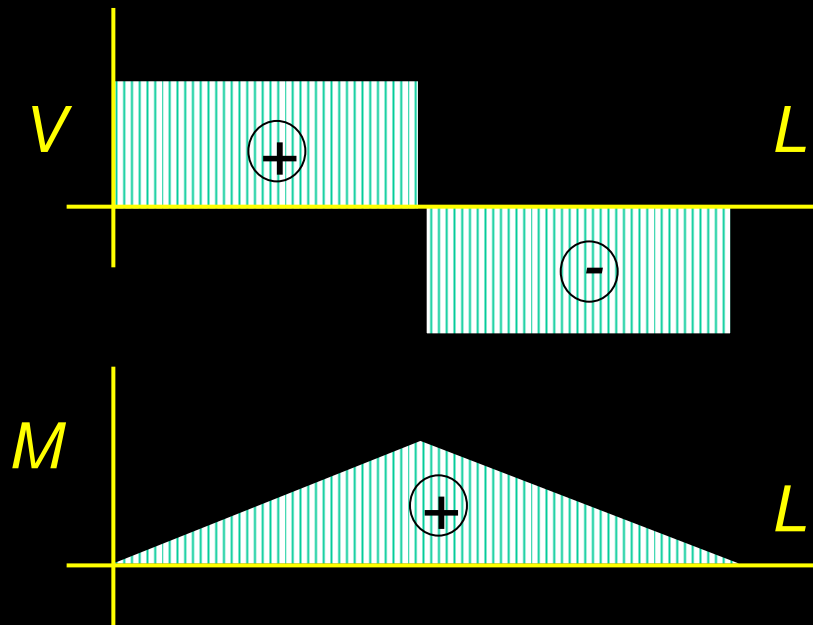
*lecture*
*fourteen*

## shear and bending moment diagrams

# Method 1: Equilibrium

- *cut sections at important places*

- *plot V & M*

V

+

L

-

M

+

L

L

L/2

# *Method 2: Semigraphical*

- *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*

$$V_D - V_C = -\int_{x_C}^{x_D} w\,dx \qquad M_D - M_C = \int_{x_C}^{x_D} V\,dx$$
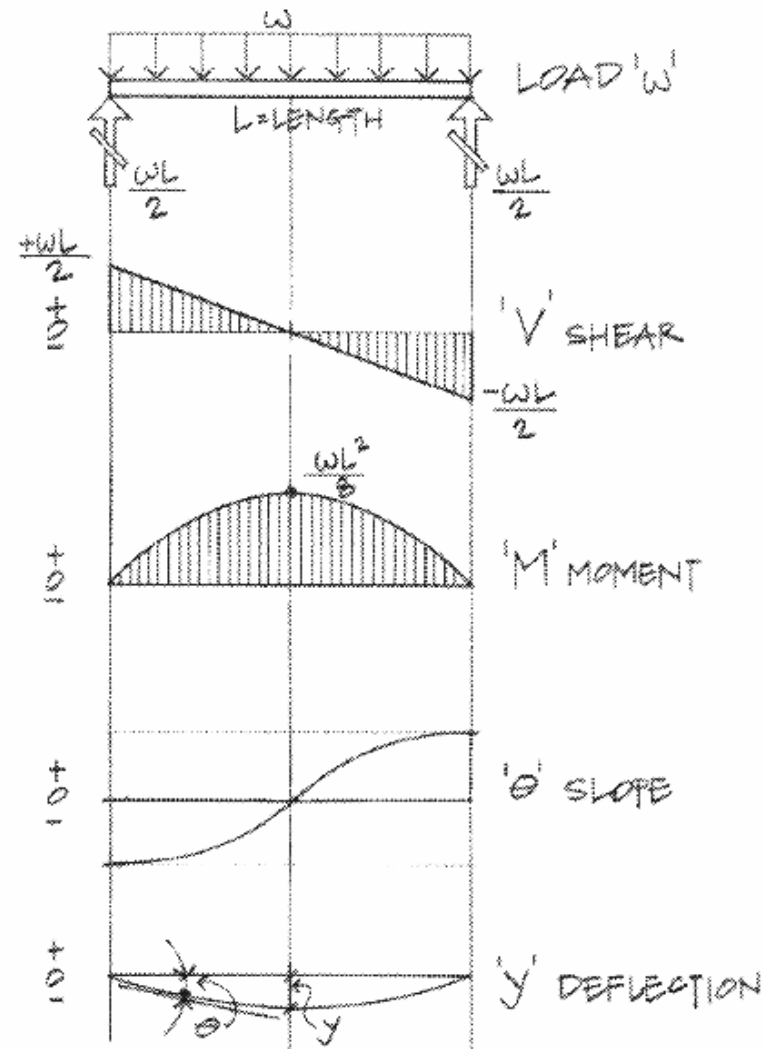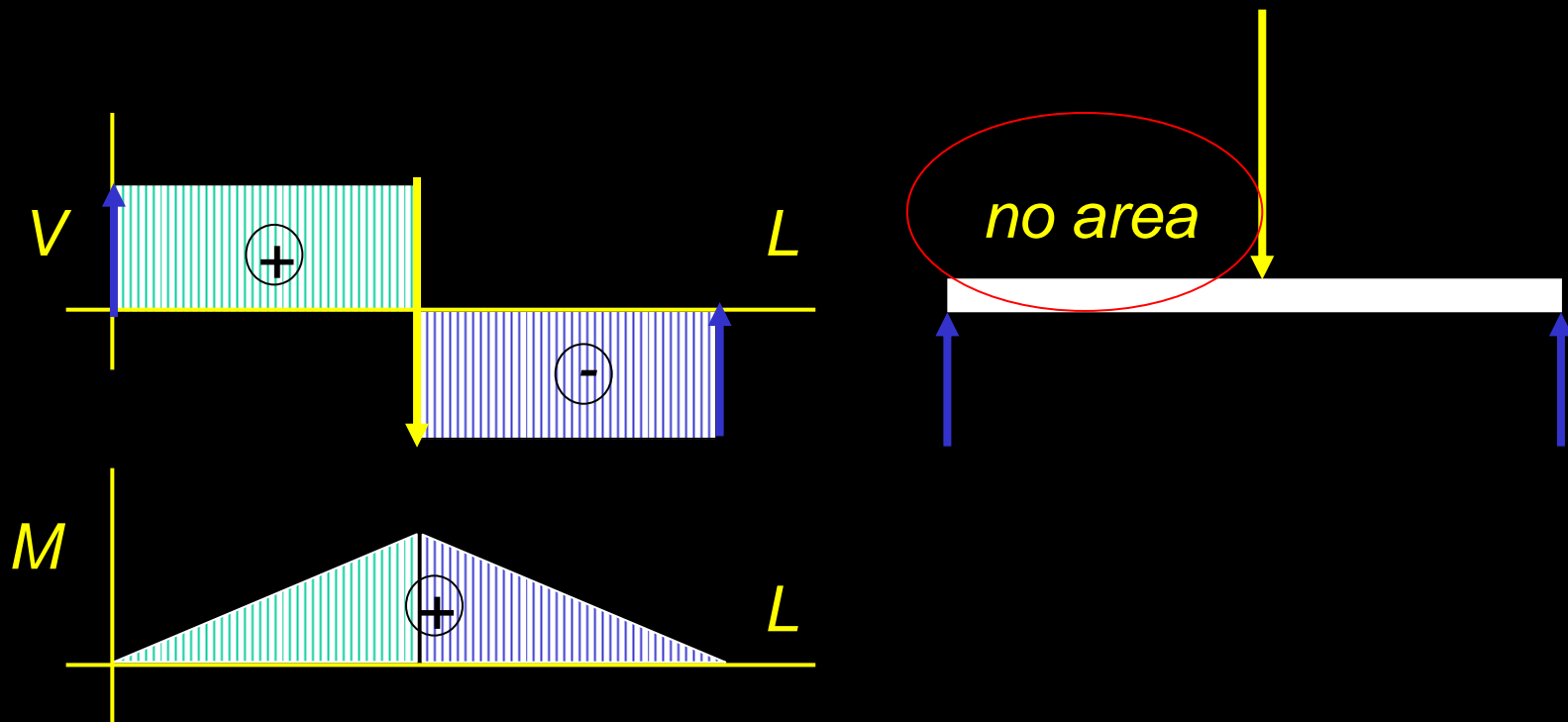
# *Method 2*

- *relationships*



Figure 7.11 Relationship of load, shear, moment, slope, and deflection diagrams.
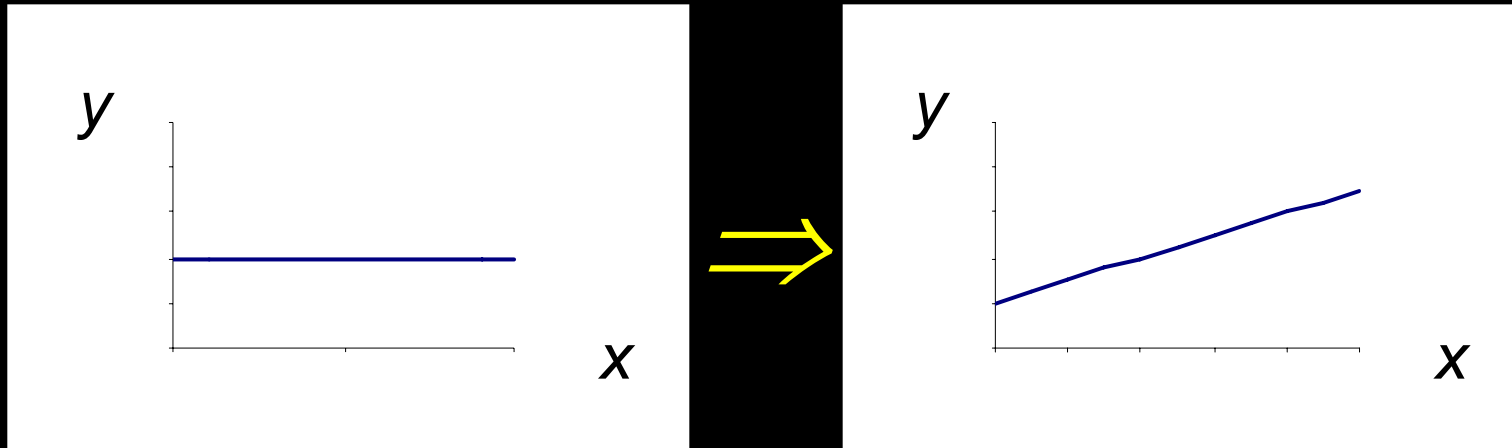
# Method 2: Semigraphical

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

V

+

−

L

M

+

L

no area

# *Curve Relationships*

- *integration of functions*

- *line with 0 slope, integrates to sloped*
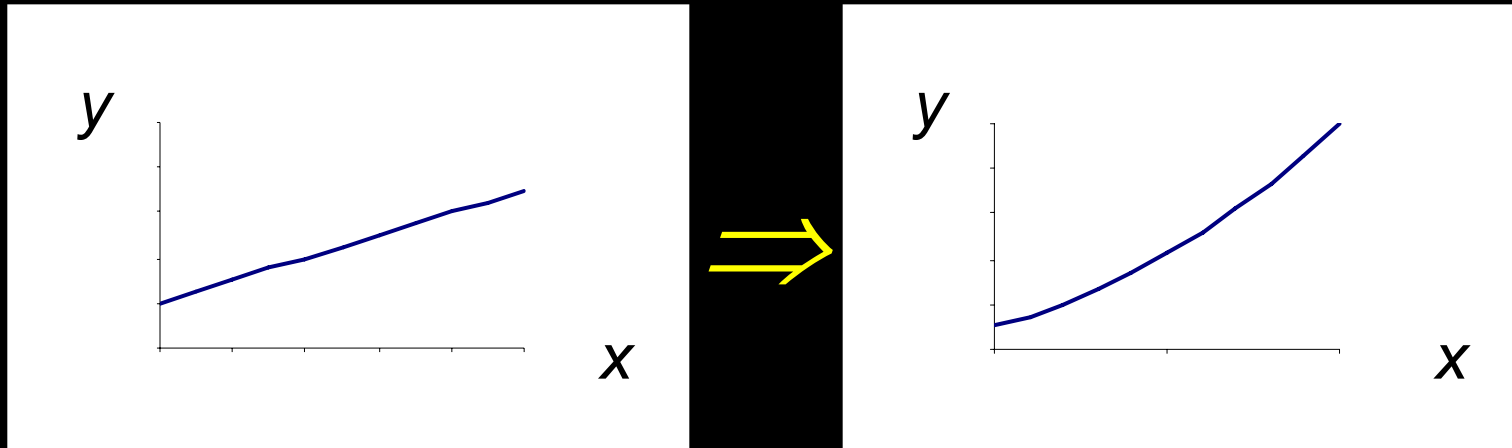


- *ex: load to shear, shear to moment*

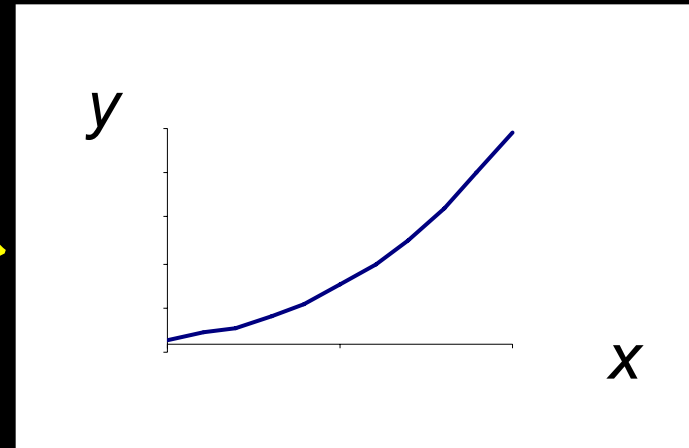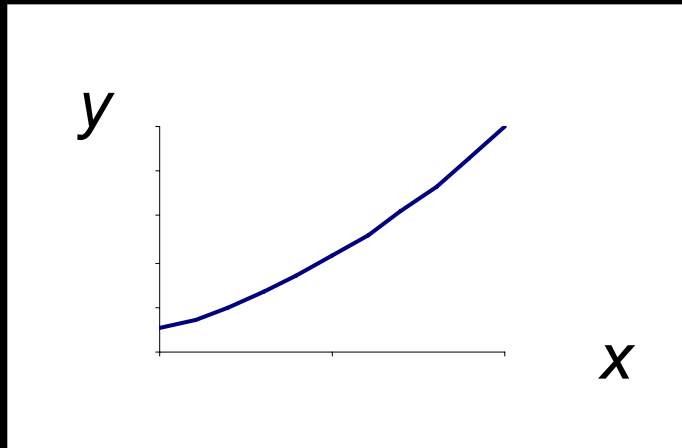# Curve Relationships

- *line with slope, integrates to parabola*



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

# *Curve Relationships*

- *parabola, integrates to 3$^{rd}$ 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*

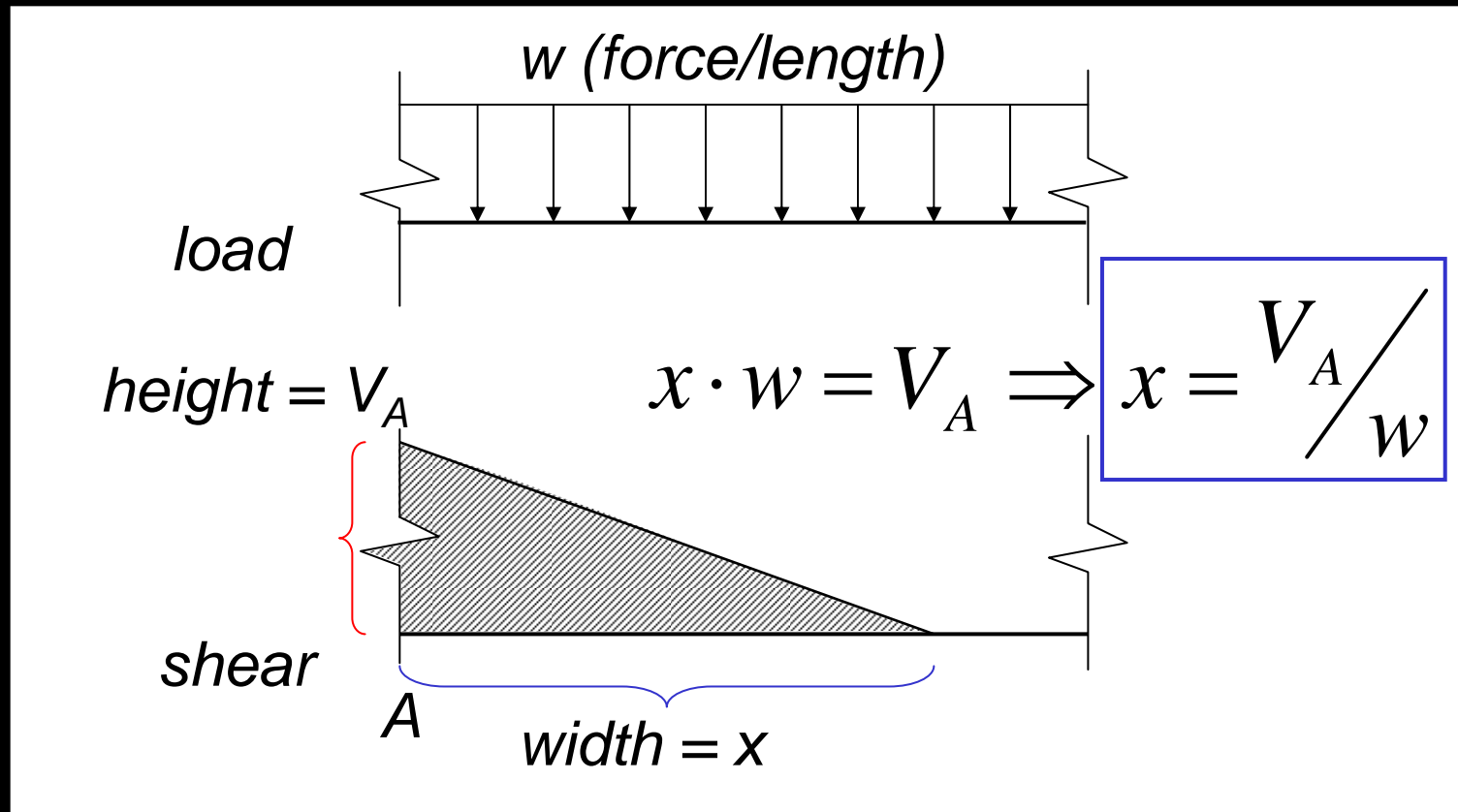7. *Moment is 0 at free ends*

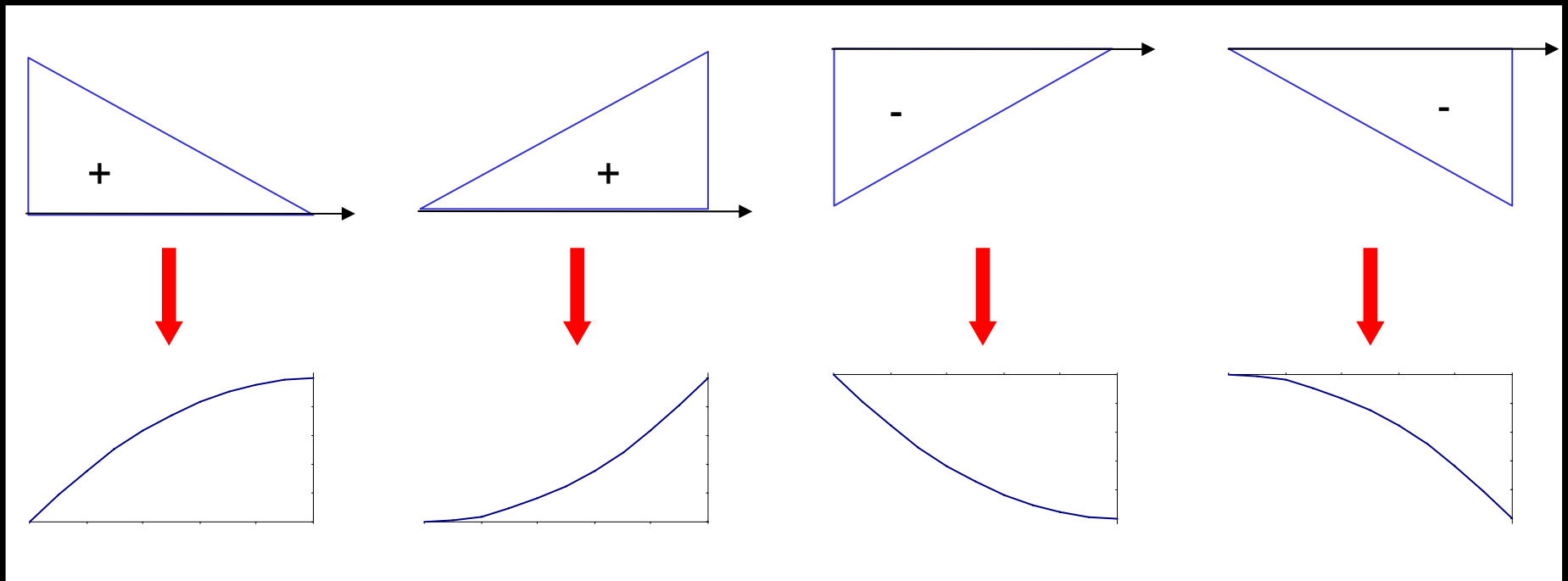8. *Moment jumps with moment*

9. *Moment changes with area under V*

# *Triangle Geometry*

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

w (force/length)

load

$$height = V_A$$

$$x \cdot w = V_A \implies x = \frac{V_A}{w}$$

shear

A

width = x

# *Parabolic Shapes*

- *cases*



*up fast,*
*then slow*

*up slow,*
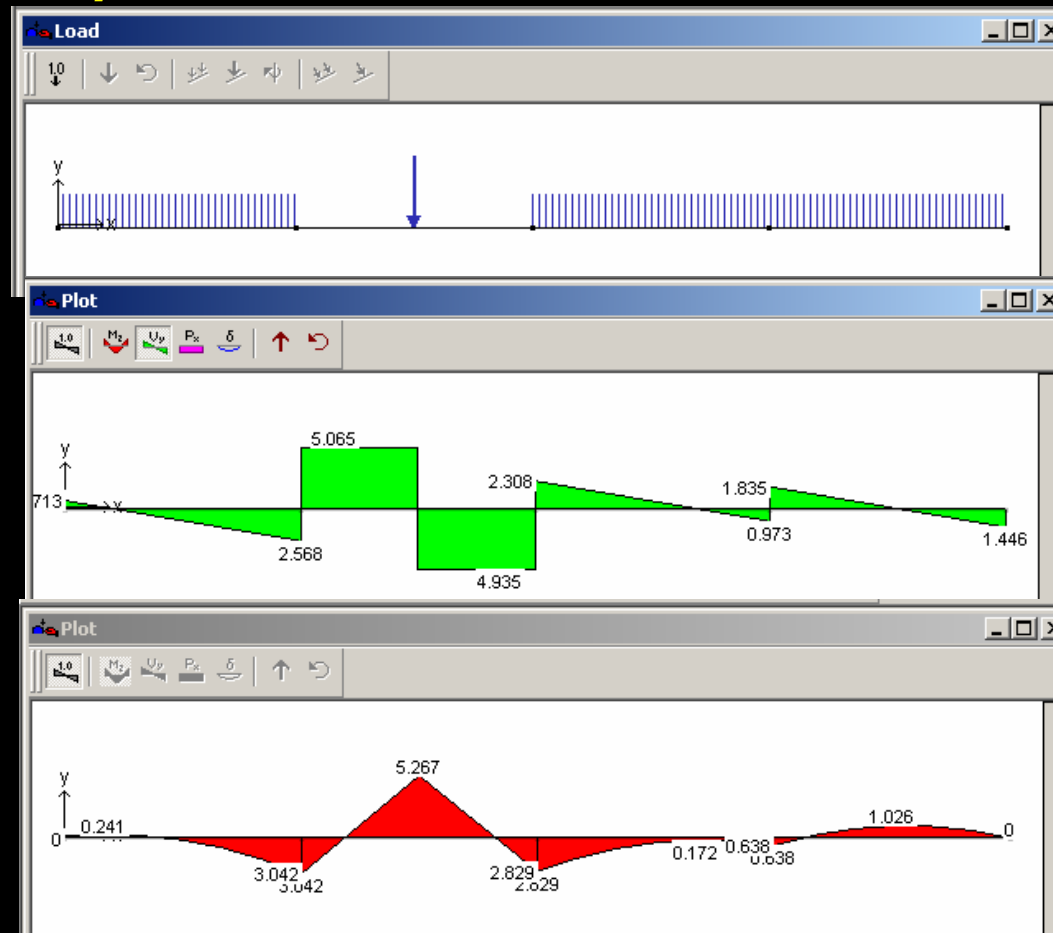*then fast*

*down fast,*
*then slow*

*down slow,*
*then fast*
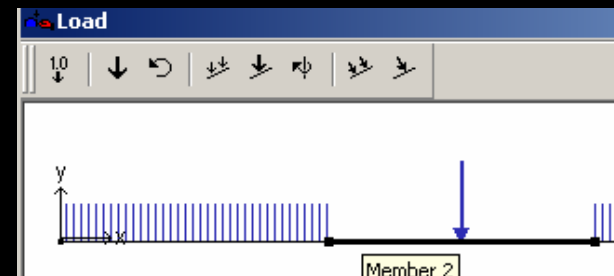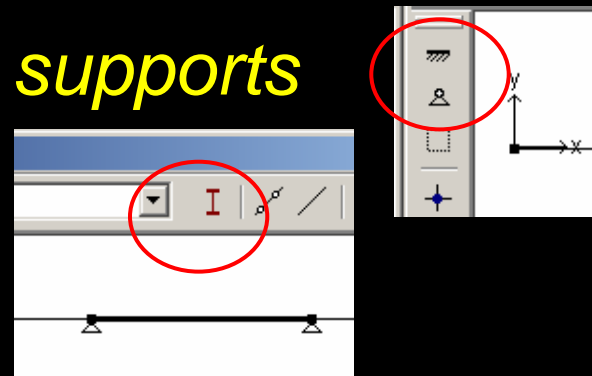
# *Tools*

- *software & spreadsheets help*
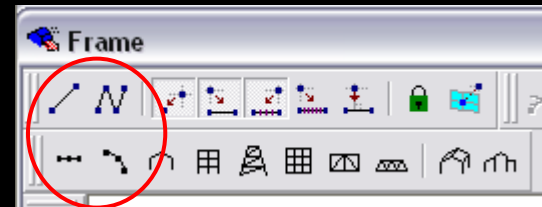
- *http://www.rekenwonder.com/atlas.htm*
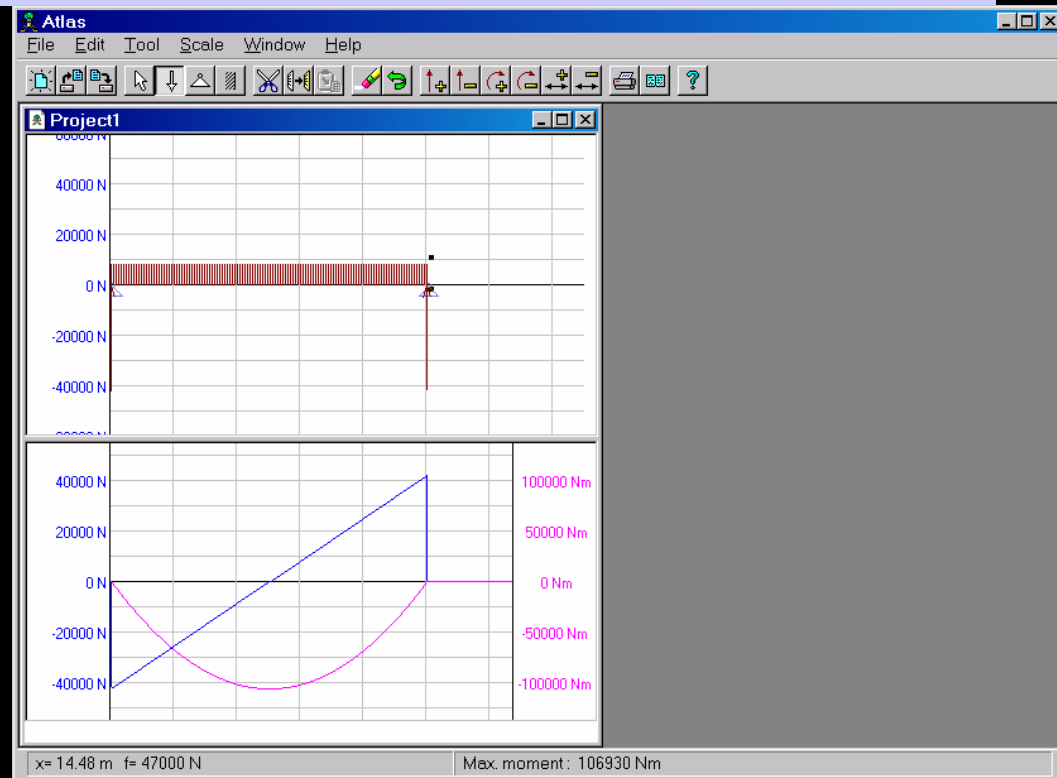
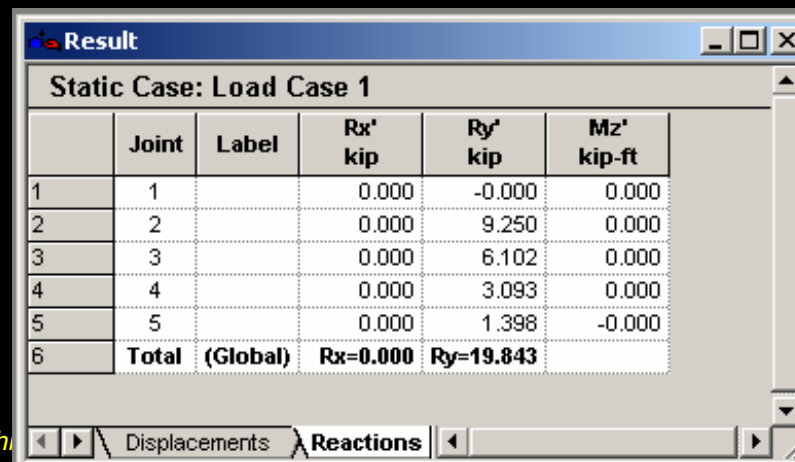# *Tools – Multiframe4D*
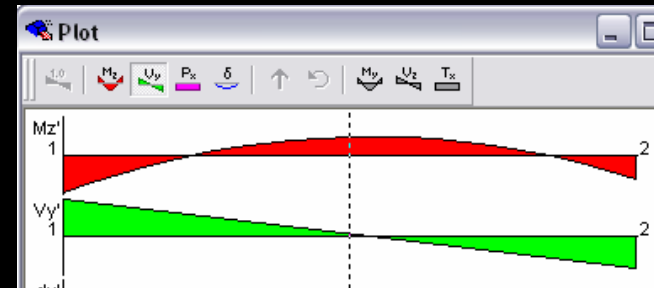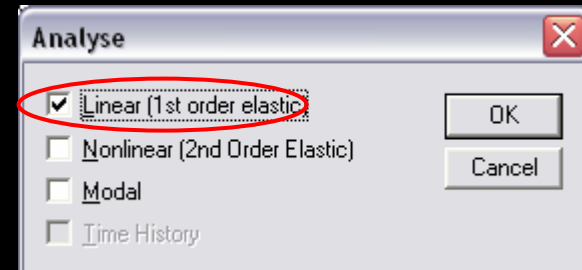
- *in computer lab*

# *Tools – Multiframe4D*

- *frame window*
  - *define beam members*
  - *select points, assign supports*
  - *select members, assign <u>section</u>*
- *load window*
  - *select point or member, add point or distributed loads*

# *Tools – Multiframe4D*

- *to run analysis choose*
  - *case menu*
    - *Analyse...*
      - *Linear (1st order elastic)*

- *plot*
  - *choose options*
  - *double click (all)*

- *results*
  - *choose options*