Method 1: Equilibrium
- cut sections at important places
- plot V & M

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 $M$

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

Method 2
- relationships

$V$ shear
$M$ moment
$y$ slope
$y$ deflection

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

- $M_{\text{max}}$ 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

Triangle Geometry

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

\[
\begin{align*}
\text{load} & \quad w \text{ (force/length)} \\
\text{height} = V_A & \quad \begin{array}{c}
\downarrow \\
\end{array} \\
\text{shear} & \quad \begin{array}{c}
\Rightarrow \\
A \quad \begin{array}{c}
\downarrow \\
\end{array} \\
\end{array}
\end{align*}
\]
\[
\begin{align*}
x \cdot w &= V_A \\
x &= \frac{V_A}{W}
\end{align*}
\]

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](http://www.rekenwonder.com/atlas.htm)

Tools – Multiframe 2D

- frame window
  - define beam member
  - select points, assign supports
  - select members, assign section
- load window
  - select point or member, add point or distributed loads

Tools – Multiframe 2D

- in computer lab

- to run analysis choose
  - case menu
    - Analyse Linear
  - plot
    - choose options
  - results
    - choose options