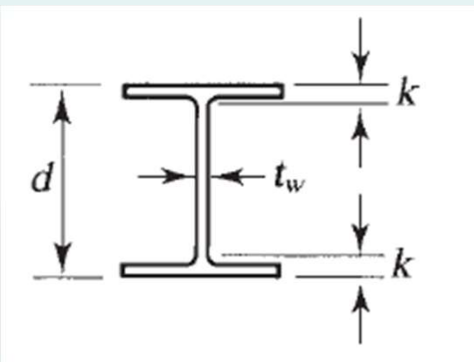
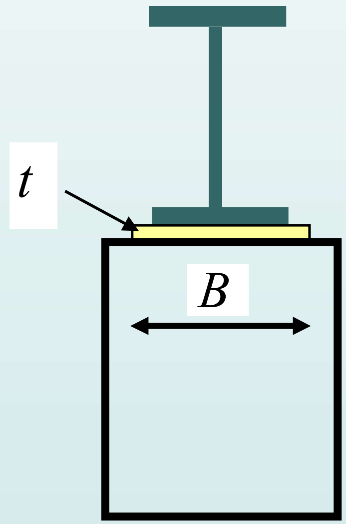
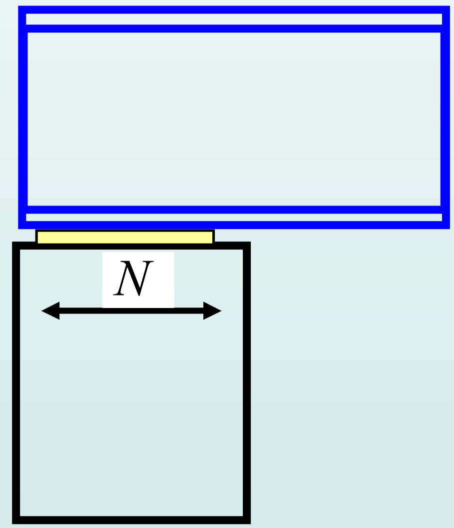
Beam Bearing Plates

- Design of a beam bearing plate would require checking:







- 1- Web Yielding and Web crippling to determine N
- 2- Bearing capacity to determine B
- 3- Plate moment capacity to determine t

AISC Specifications: Chapter K

Beam Bearing Plates

- When a bearing plate is used at beam end, two limit states shall be considered
  - ***1. Web Yielding***

    $$R \leq \phi R_n \qquad \phi = 1.0$$

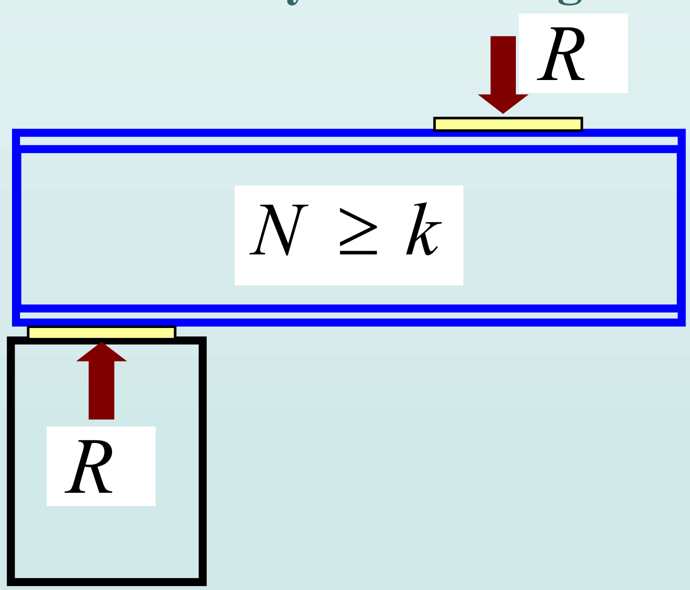
    - This represents yield of the web at the vicinity of the flange due to excessive loading

CASE 1: At Support

$$R_n = (2.5k + N)F_y t_w$$

CASE 2: Interior Load

$$R_n = (5k + N)F_y t_w$$



Beam Bearing Plates

- ***2. Web Crippling***
- **Web crippling represent the possible buckling of the web**

$$R \leq \phi R_n$$ $$\phi = 0.75$$

CASE 1: At Support

$$R_n = 0.4 t_w^2 \left[1 + 3 \left(\frac{N}{d} \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{\frac{E F_y t_f}{t_w}} \qquad \frac{N}{d} \leq 0.2$$

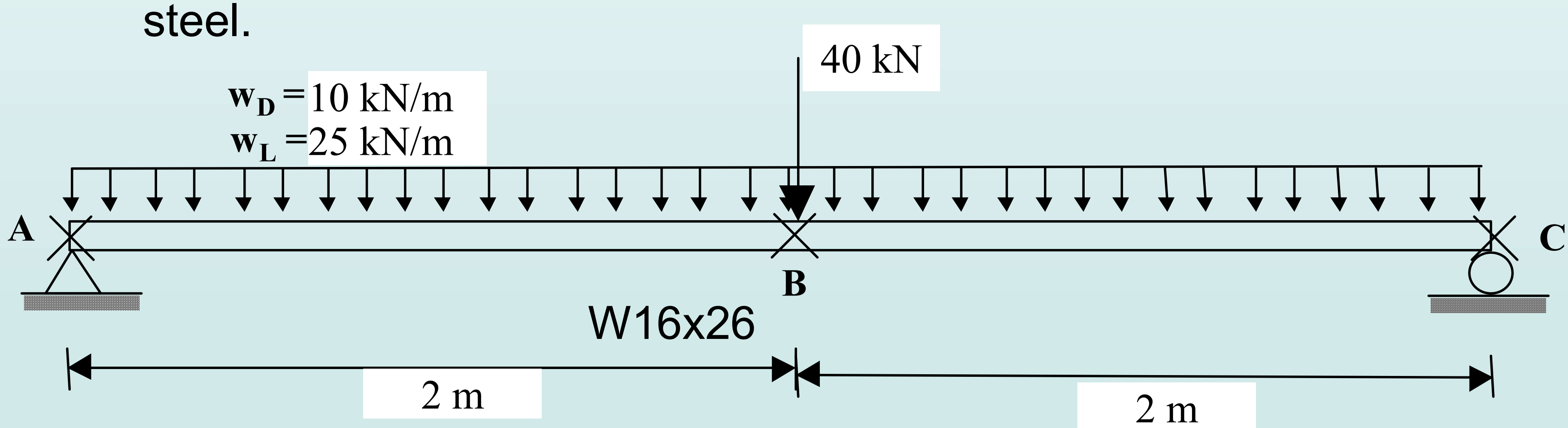
$$R_n = 0.4 t_w^2 \left[1 + \left(\frac{4N}{d} - 0.2 \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{\frac{E F_y t_f}{t_w}} \qquad \frac{N}{d} \geq 0.2$$

CASE 2: Interior Load

$$R_n = 0.8 t_w^2 \left[1 + 3 \left(\frac{N}{d} \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{\frac{E F_y t_f}{t_w}}$$

Ex. 4.7 – Beam Design

- Check the beam shown in the figure below for:
  - Shear capacity.
  - Web yielding.
  - Web crippling.
  - Assume the width of the bearing plate is 100 mm. Use Grade 50 steel.



Ex. 4.7 – Beam Design

- **Step I..**

  The self-weight w_{sw} = 0.38 kN/m

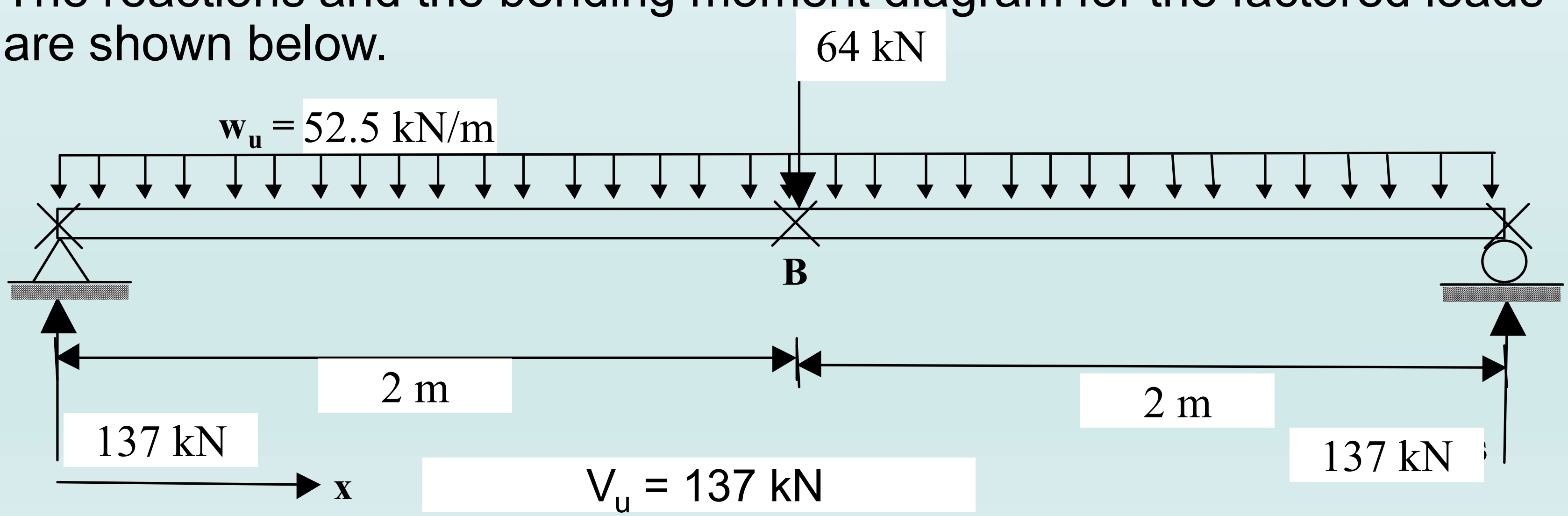
  w_D = 10 + 0.38 = 10.38 kN/m

  w_L = 25 kN/m

  w_u = 1.2 w_D + 1.6 w_L = 52.5 kN/m

  P_u = 1.6 x 40 = 64 kN

  The reactions and the bending moment diagram for the factored loads are shown below.



Ex. 4.7 – Beam Design

- **Step II.** $h/t_w = 56.8$

$$2.24\sqrt{\frac{E}{F_y}} = 2.24\sqrt{\frac{200000}{344}} = 54 < \frac{h}{t_w} = 56.8$$

Assume unstiffened web, h/t_w <260, $k_v = 5$

$$1.10\sqrt{\frac{k_v E}{F_y}} = 1.10\sqrt{\frac{5\times 200000}{344}} = 59.3 > \frac{h}{t_w} = 56.8$$

$$C_v = 1 \quad \phi = 0.9$$

Assume unstiffened web, h/t_w <260, $k_v = 5$

$\phi V_n = 0.9*(0.6F_y)*d*t_w*C_v$

$\phi V_n = 0.9*(0.6x344)*399*6.4x10^{-3}$ = 474.4 kN> V_u

Ex. 4.7 – Beam Design

- **Step III.** Web yielding critical is support

  k = 19 mm

  $\phi R = (2.5k + N)*F_y*t_w$

  ϕR = 1x(2.5x19 + 100)x344x6.4/1000 = 324.7 kN

  ϕR > reaction = 137 kN OK

- **Step IV.** Web crippling critical is support

  d = 399 mm t_w = 6.4 mm t_f = 8.8 mm

  N/d = 100/399 = 0.25 > 0.2

$$R_n = 0.4 t_w^2 \left[1 + \left(\frac{4N}{d} - 0.2 \right) \left(\frac{t_w}{t_f} \right)^{1.5} \right] \sqrt{\frac{E\,F_y\,t_f}{t_w}}$$

Ex. 4.7 – Beam Design

$$R_n = 0.4 \times 6.4^2 \left[1 + \left(\frac{4 \times 100}{399} - 0.2 \right) \left(\frac{6.4}{8.8} \right)^{1.5} \right] \sqrt{\frac{200000 \times 344 \times 8.8}{6.4}} \times 10^{-3} = 238.7\ kN$$

ϕR = 179 kN > reaction = 137 kN OK