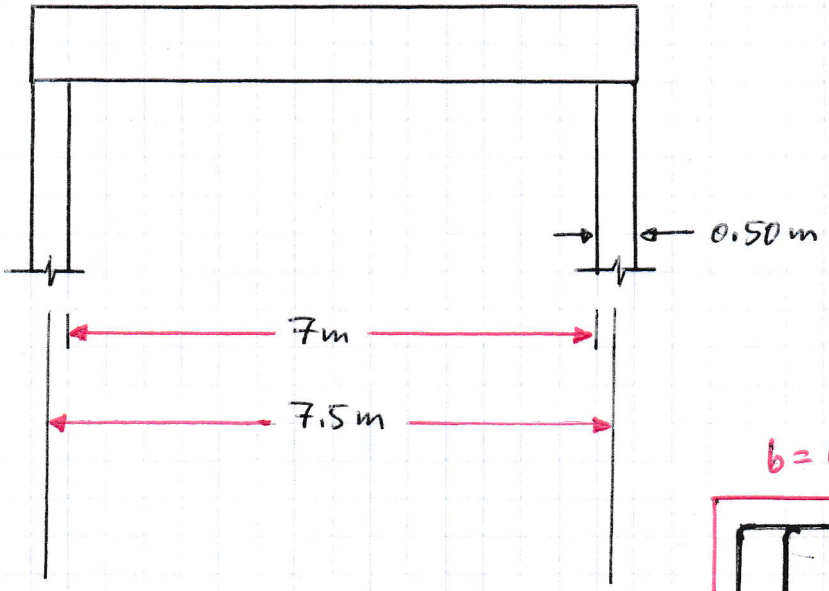
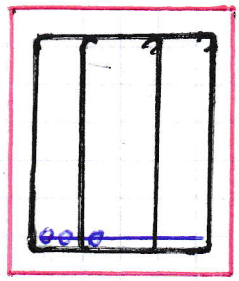
Example:

Service Loads: $W_{DL} = 12\ t/m$ $\times 1.2 = 14.4\ t/m$

$W_{LL} = 8\ t/m$ $\times 1.6 = 12.8\ t/m$

$W_u = 27.2\ t/m$





$f'_c = 28 MPa$

$f_y = 420 MPa$

$$\phi V_c = 0.75\,(0.17)(1.0)\frac{\sqrt{28}}{100}(60)(62)$$

$$= 25.10\ t$$

$$\frac{\phi V_c}{2} = 12.55\ t$$

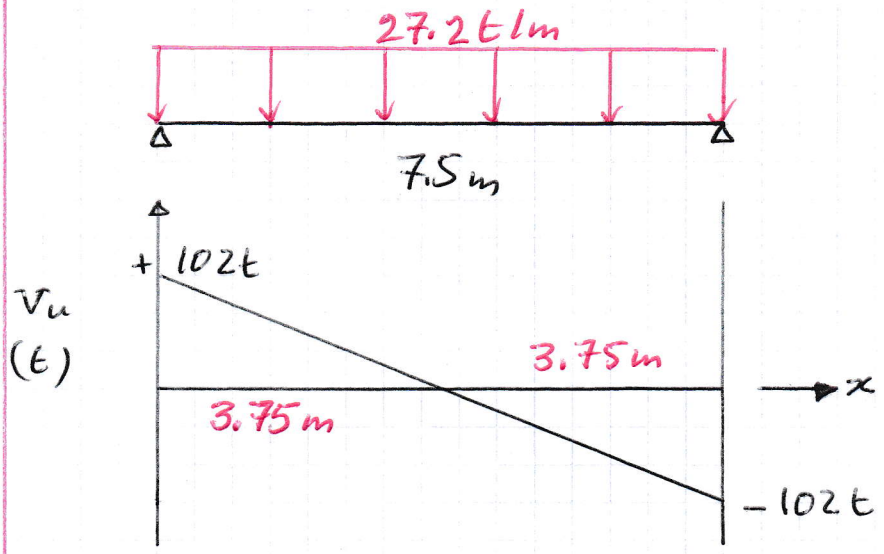
$$3\phi V_c = 75.29\ t$$

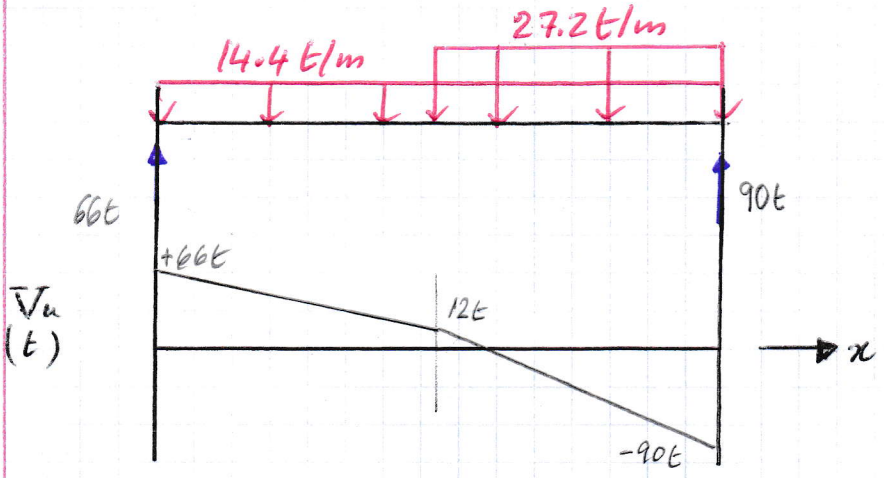
$$5\phi V_c = 125.5\ t$$

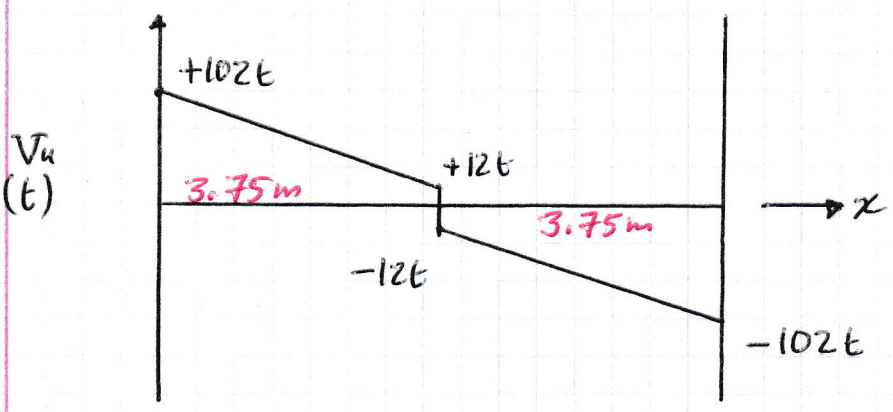
$w_{DL(u)} = 14.4\ t/m$

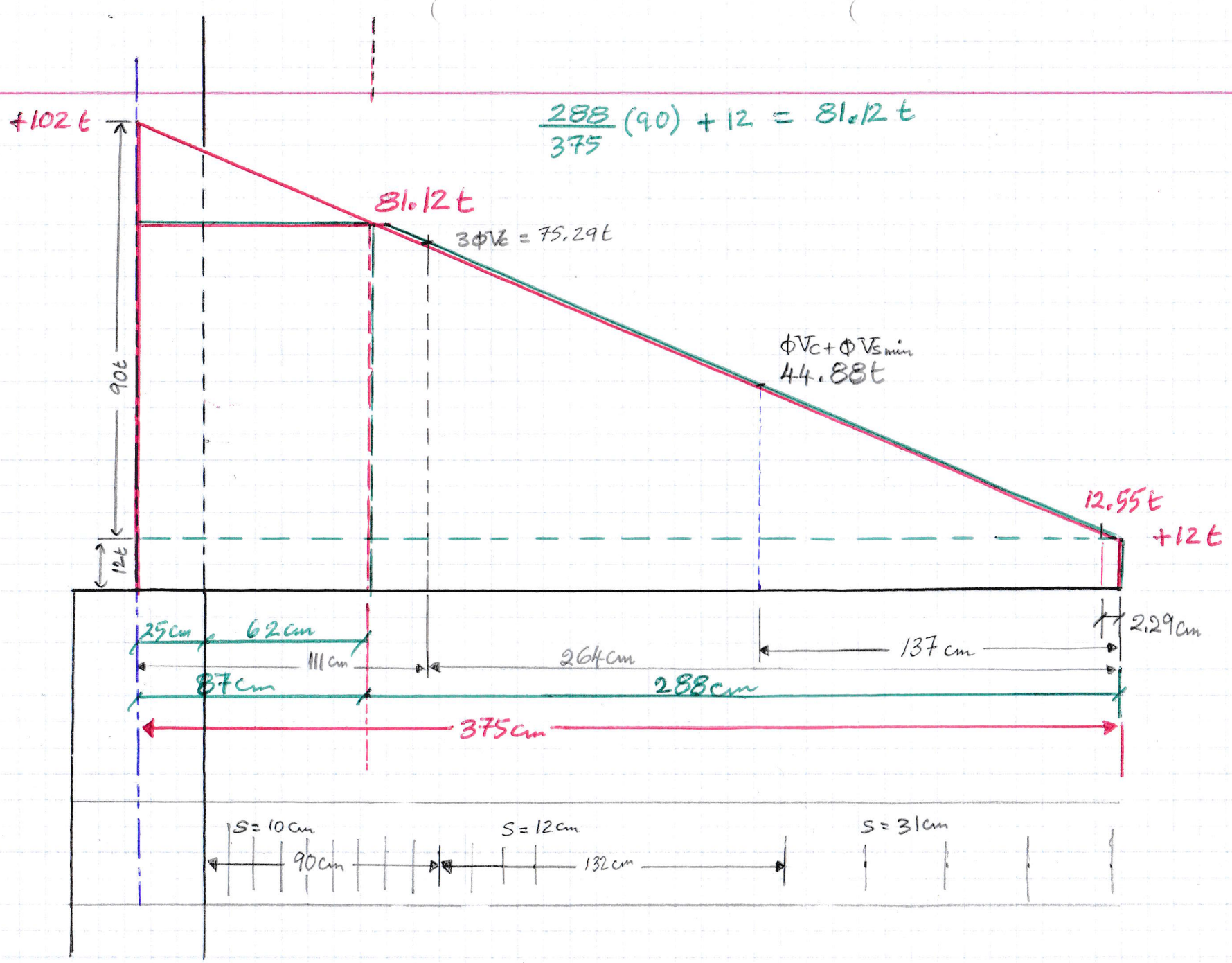
$w_{LL(u)} = 12.8\ t/m$

$w_u = 27.2\ t/m$









$$\frac{288}{375}(90) + 12 = 81.12\ t$$

$S_{max} \leq \dfrac{3.14(420)}{0.062\sqrt{28}(60)} = 67.0\ cm$

$\leq \dfrac{3.14(420)}{0.35(60)} = 62.8\ cm$

$\leq d/2 = \underline{31\ cm}$ controls

$\leq 60\ cm$

$\phi V_{s\,min} = \dfrac{0.75(3.14)(4.2)(62)}{31} = 19.78\ t$

$\phi V_c + \phi V_{s\,min} = 25.10 + 19.78 = 44.88\ t$

For $V_u = 81.12\ t$

$\phi V_{s\,req} = 81.12 - 25.10 = 56.02\ t$

$S_{req} = \dfrac{0.75(3.14)(4.2)(62)}{56.02} = 10.95\ cm$

$S_{max} \leq 67.0\ cm$
$\leq 62.8\ cm$
$\leq d/4 = 15.5\ cm$
$\leq 30\ cm$

use $S = 10\ cm$ c/c

for $V_u = 75.29\ t$

$\phi V_{s\,req} = 75.29 - 25.10 = 50.19\ t$

$S_{req} = \dfrac{0.75(3.14)(4.2)(62)}{50.19} = 12.2\ cm$

use $S = 12\ cm$ c/c