Development of Reinforcement:

transfer of force between the reinforcement and the surrounding concrete. "bond"

Adhesion at the surface
Bearing on the raised ribs of the deformed bars.

"development length"

"Slippage" of a reinforcing bar = pull-out failure

"splitting" of the surrounding concrete

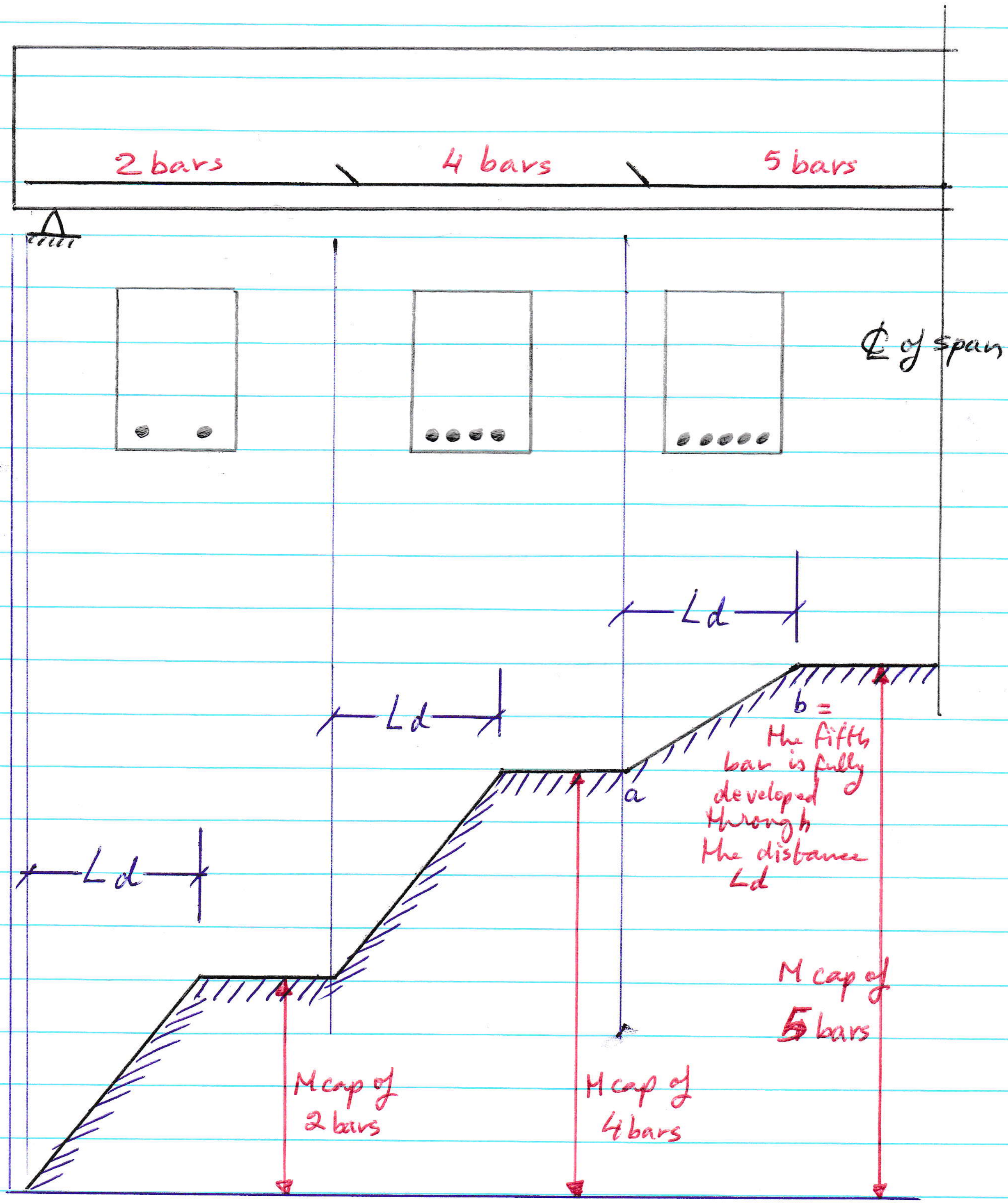
When space limitations prevent providing the proper amount of straight embedment, standard hooks are used.

The moment capacity (i.e. strength) for a singly reinforced rectangular beam may be expressed as:

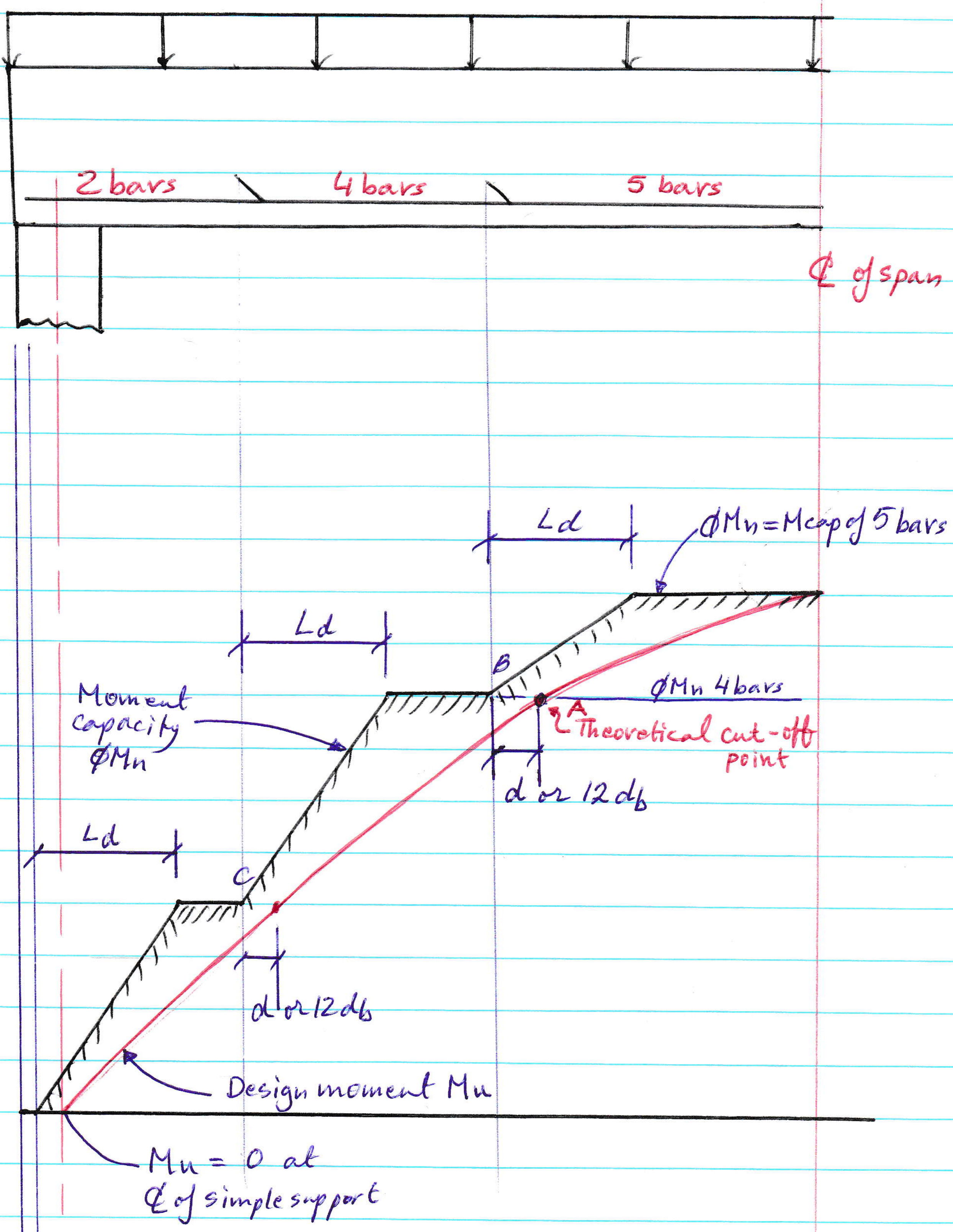
$$M_n = A_s f_y (d - a/2)$$

assuming that the steel reinforcement is adequately embedded in "each direction" by the required development length L_d from the section where M_n is computed such that f_y is reached.

Qualitatively:



Moment Capacity Diagram



The use of the ϕM_n diagram for determining the locations of cutoff or bend points.

5 bars provide exactly the required strength at midspan

a) Compute actual ϕM_n for each bar grouping, 5, 4, and 2 bars

b) Determine which bars must extend entirely across the span and into the support.

ACI — 1/3 positive reinforcement in simple members at least 6" (15 cm).

c) ϕM_n diagram closest to the factored moment M_u diagram — determine the order of cutting the remaining bars.

d) Restrictions:

ACI — d or $12 d_b$, whichever is greater

e) Special conditions:

ACI

Points B and C have bars terminated in a tension zone - shear strength is reduced. If these bars were bent up and anchored in the compression zone, no further investigation would be necessary.

Notes: * Hooks are not effective in compression

* For lap splices, use a lap length = 1.3 Ld

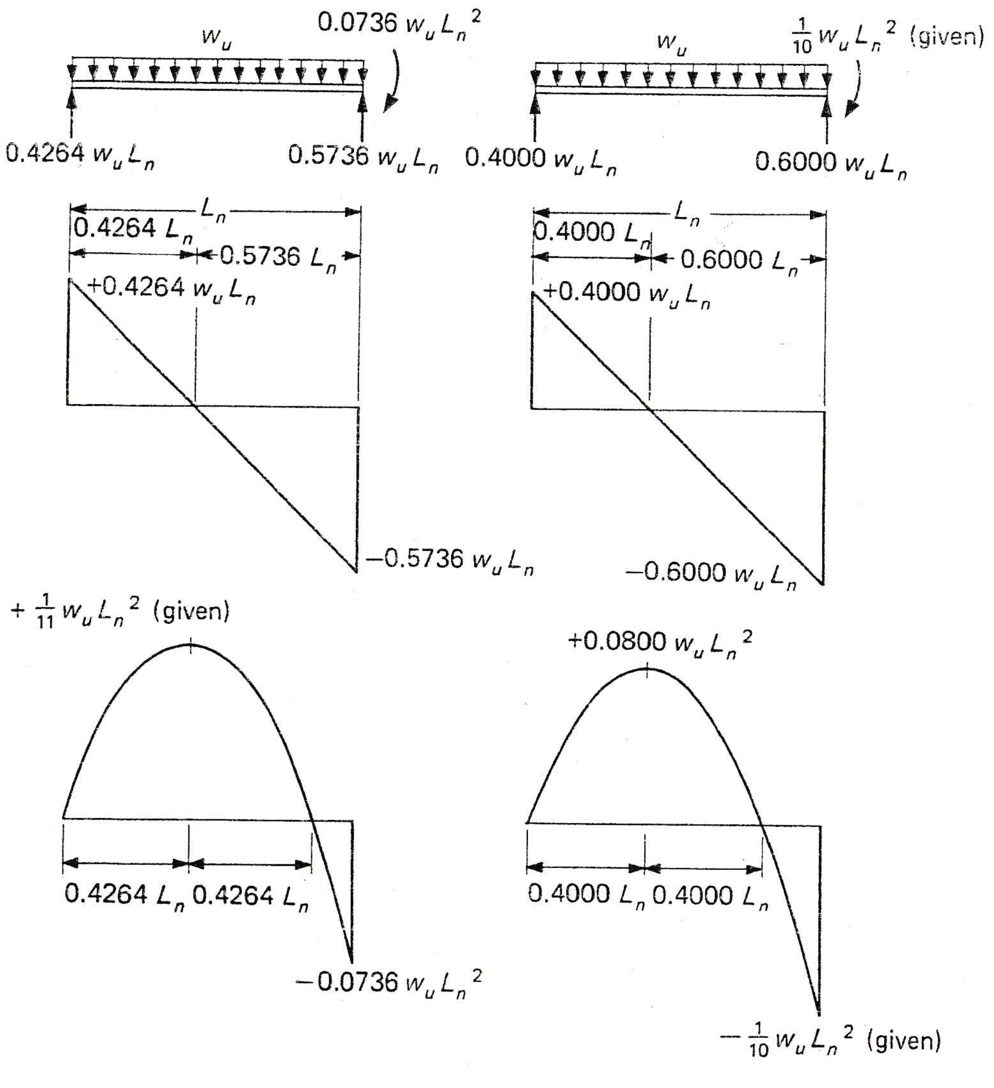


Figure 7.5.1 Exterior span with discontinuous end unrestrained.

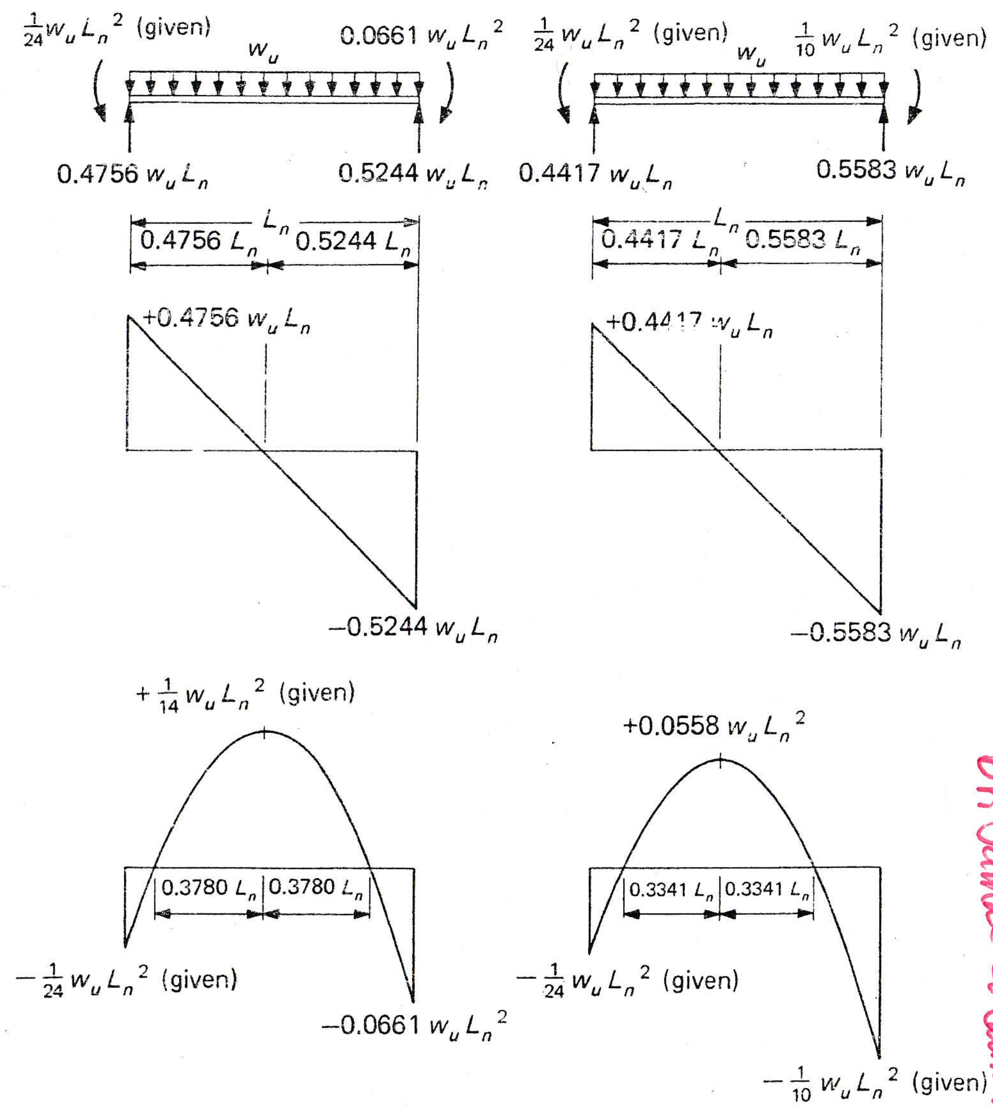


Figure 7.5.2 Exterior span with exterior support built integrally with spandrel beam or girder.

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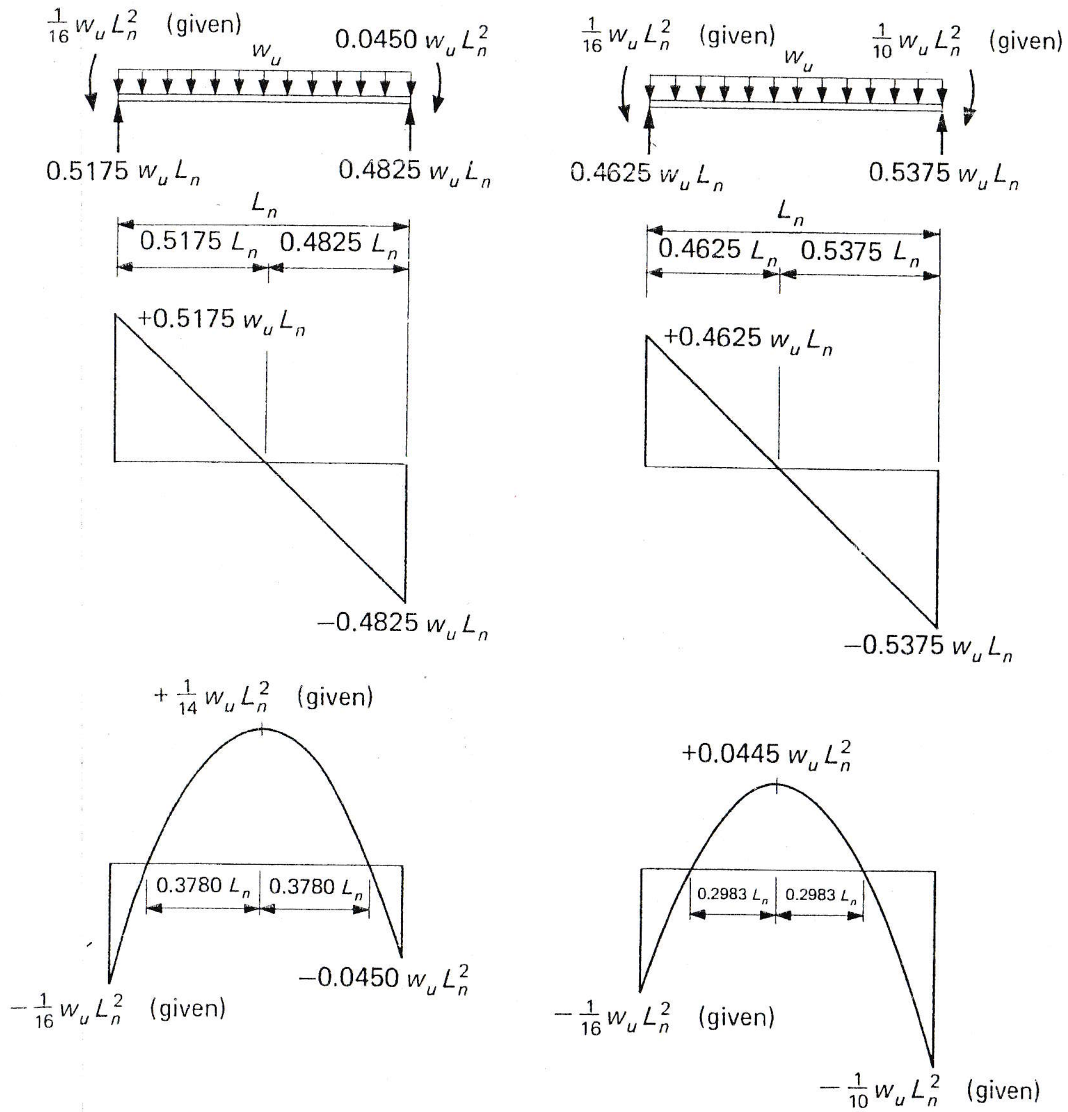
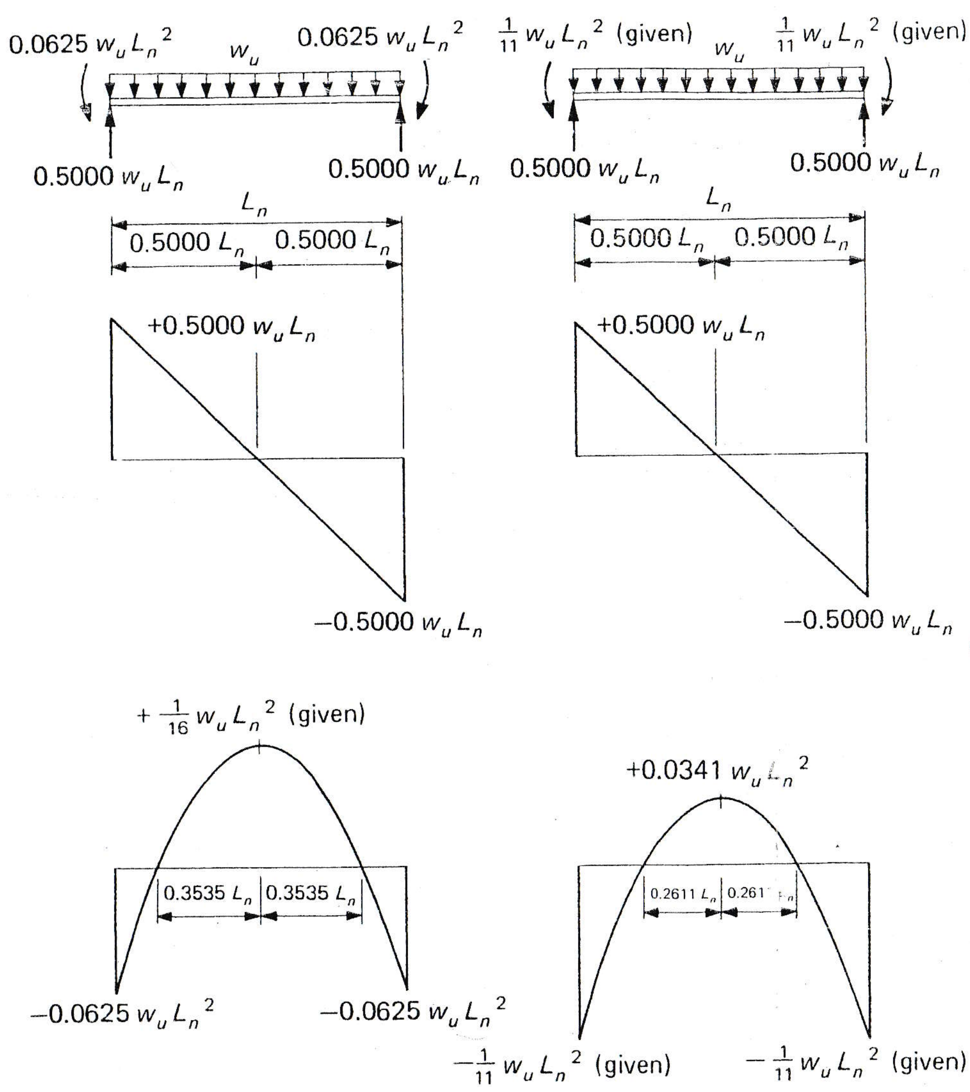


(a) Maximum in the positive zone (b) Maximum in the negative zone

Figure 7.5.3 Exterior span with exterior support built integrally with column.



(a) Maximum in the positive zone (b) Maximum in the negative zone

Figure 7.5.4 Interior span.

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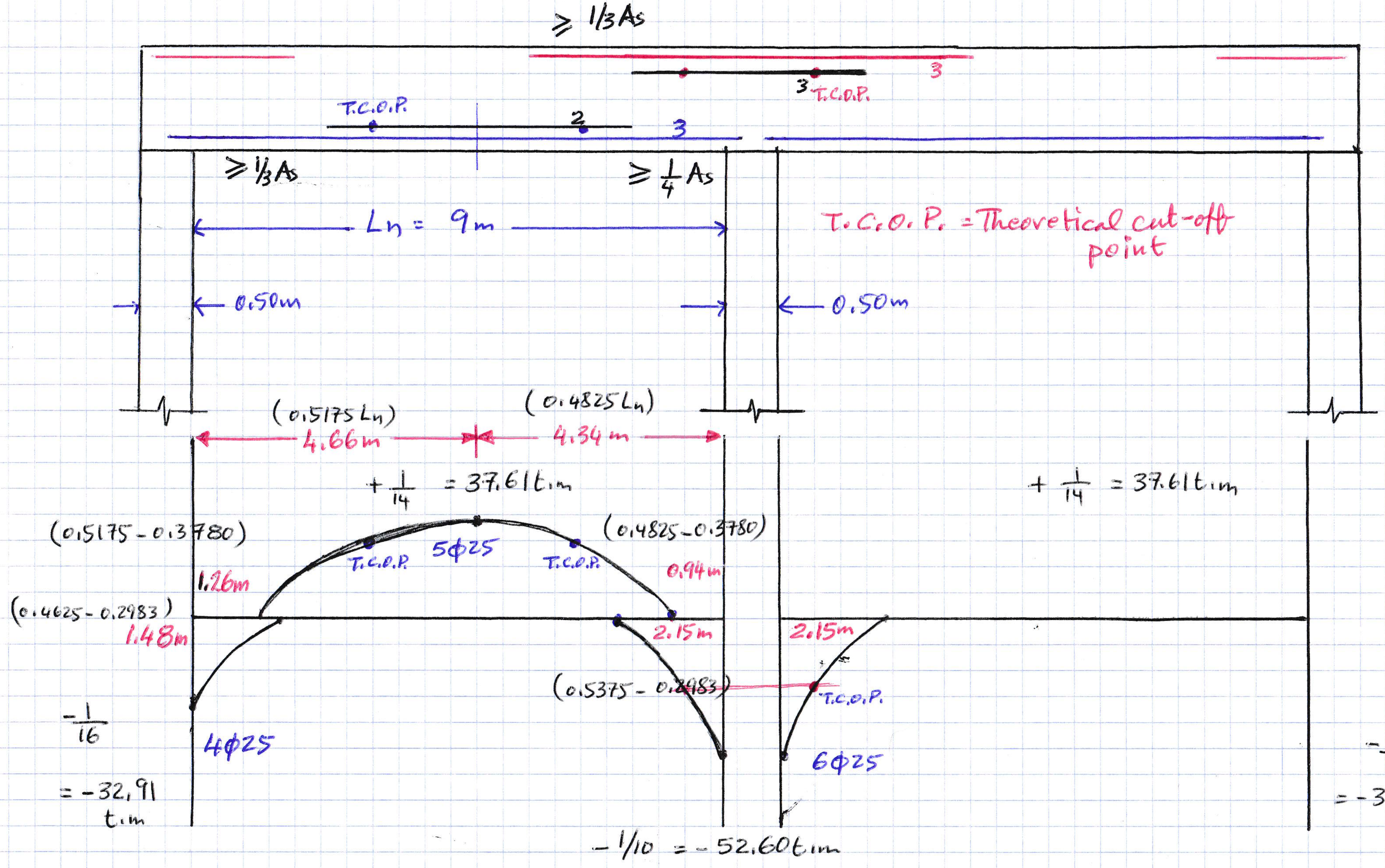

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$W_u = 6.5\ t/m$

$M_u = 52.6\ t.m$

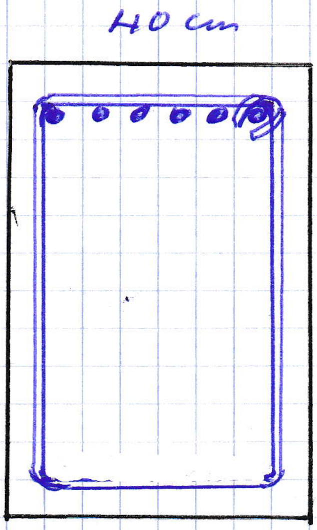
$M_{n\,req} = 58.45\ t.m$

$\frac{As_{actual}}{As_{max\ \epsilon_t = 0.005}} = 0.76$

6φ25 in one layer

$h = 60\ cm$

$d = 53.75\ cm$



$As_{provided} = 6\phi 25 = 29.45\ cm^2$

$T_{actual} = 29.45 \times 4.2 = 123.7\ t$

$$a = \frac{123.7}{0.85(0.28)(40)} = 12.99\ cm$$

$$M_n = 123.7\left(\frac{53.75 - 12.99/2}{100}\right) = 58.45\ t.m$$

$$\phi M_n = (0.9)(58.45) = 52.61\ t.m$$

for $M_u = 37.61\ t.m$, $M_{n\,req} = 41.79\ t.m$

$5\phi 25 = 25.54\ cm^2$

for $M_u = 32.91\ t.m$, $M_{n\,req} = 36.57\ t.m$

$4\phi 25 = 19.63\ cm^2$

$$As_{min} = \frac{0.25\sqrt{28}}{420}(40)(53.75) \geq \frac{1.4}{420}(40)(53.75)$$

$$= 6.77\ cm^2 \geq 7.17\ cm^2$$

Note $2\phi 25 = 9.82\ cm^2$