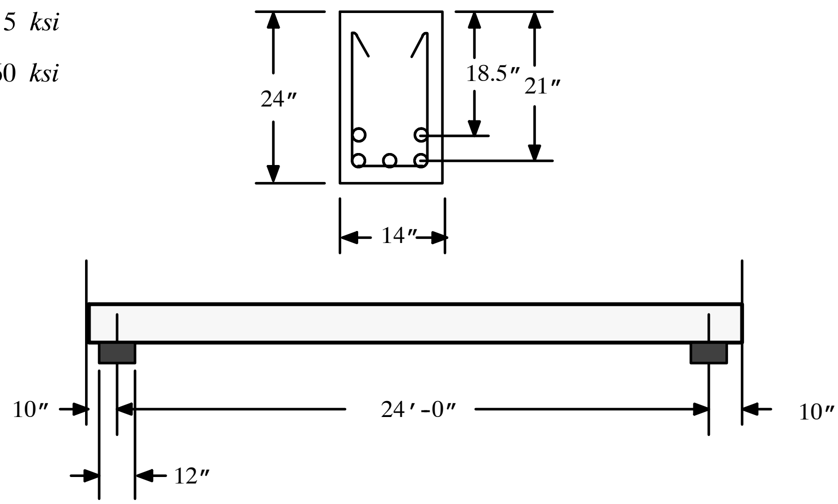
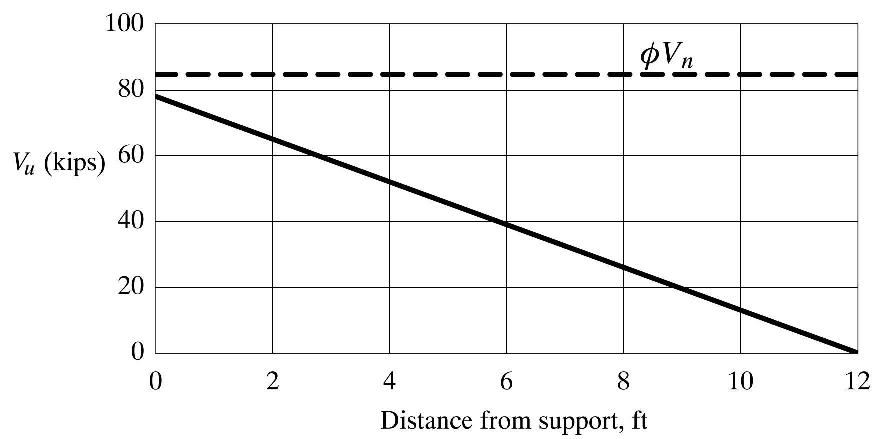
Example 2.

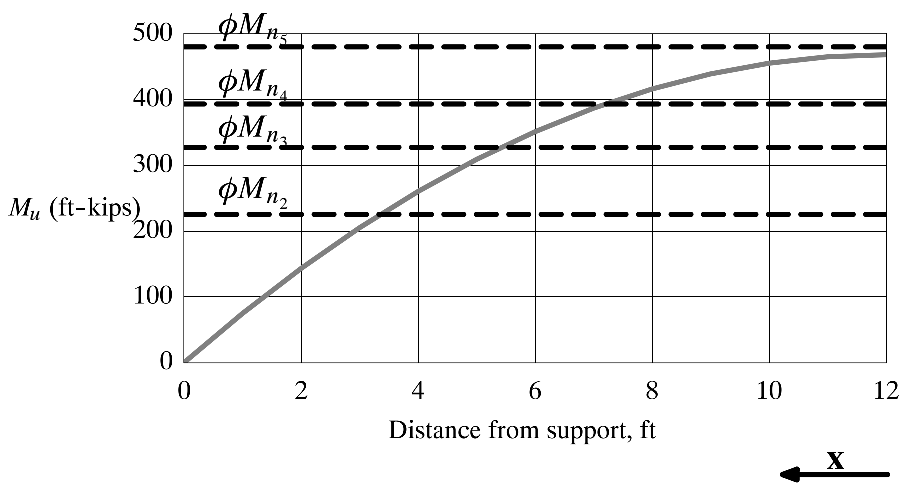
The simply supported beam shown below is subjected to a uniform load. Cut the longitudinal reinforcing bars where they are not required for flexure. Satisfy the provisions given in Chapter 12 of **ACI** 318-89.

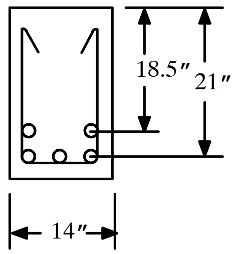
$f_c' = 5\ ksi$

$f_y = 60\ ksi$









5 - #10 bars	4 - #10 bars	3 - #10 bars	2 - #10 bars
$\phi M_{n_5} = 480 \; kips - ft$	$\phi M_{n_4} = 393 \; kips - ft$	$\phi M_{n_3} = 327 \; kips - ft$	$\phi M_{n_2} = 225 \; kips - ft$
d = 20 in	d = 19.75 in	d = 21 in	d = 21 in

Determine the permited shear force

$$V_c = 2\sqrt{f_c'}\, b_w d = \frac{2\sqrt{5,000}(14)(20)}{1,000} = 39.6 \; kips$$

$$V_s = \frac{A_v f_y d}{s} = \frac{(0.4)(60)(20)}{8} = 60 \; kips$$

$$V_n = V_c + V_s = 99.6 \; kips$$

d varies with cross-section but assume d = 20 in for shear calculations.

$$\phi V_n = 84.7 \; kips$$

$$\frac{2}{3}\phi V_n = 56.5 \; kips$$

if x is measured in feet from the beam centerline:

$$M_u = \frac{w_u L^2}{8} - \frac{w_u x^2}{2} \qquad V_u = w_u x$$

Number of Bars	ϕM_n kip-ft	Intersection of M_u with ϕM_n x (ft)	x(in)
5	480	-	-
4	393	4.8	57.7
3	327	6.6	79.0
2	225	8.6	103.7

OPTION 1: (d varies with cross-section, use d = 21 in.)

Cut two upper bars first

l_d from centerline

OR

d, $12d_b$ from where no longer needed for flexure

79 in + 21 in

43.1 in

100 in

$$V_u(x = 100in) = 6.5 \times \frac{100}{12} = 54.2 \ kips < \frac{2}{3}\phi V_n$$

satisfies 12.10.5

Cut middle bar