[redacted]

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A four-story building has a steel special moment resisting frame (SMRF). The frame consists of W24 beams and W14 columns with the following member strength properties (determined under 2213.4.2 and 2213.7.5):

Beams at Levels 1 and 2:

$M_b = ZF_y = 250$ kip-ft

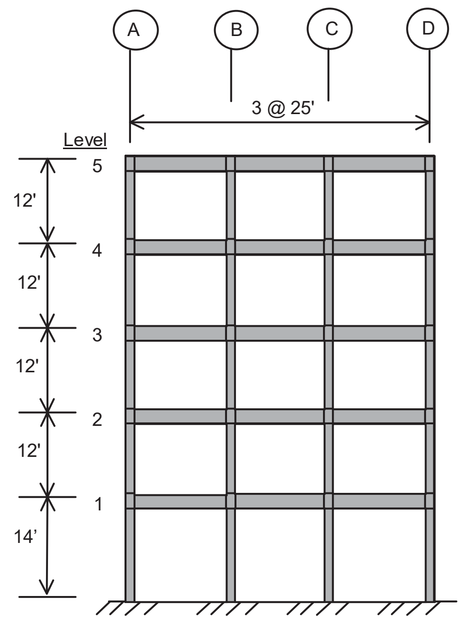
Columns on lines A, B, C, and D at both levels:

$M_c = Z(F_y - f_a) = 200$ kip-ft at axial loading of $1.2P_D + 0.5P_L$.

Column base connections at grade:

$M_f = 100$ kip-ft

In addition, the columns meet the exception of §2213.7.5 such that a strong beam-weak column condition is permitted.



Determine if a Type 5 vertical irregularity—discontinuity in capacity-weak story—condition exists in the first story:

1. **Determine first story strength.**

2. **Determine second story strength.**

3. **Determine if weak story exists at first story.**

Calculations and Discussion — *Code Reference*

A Type 5 weak story discontinuity in capacity exists when the story strength is less than 80 percent of that of the story above. The story strength is considered to be the total strength of all seismic force-resisting elements that share the story shear for the direction under consideration.

To determine if a weak story exists in the first story, the sums of the column shears in the first and second stories—when the member moment capacities are developed by lateral loading—must be determined and compared.

In this example, it is assumed that the beam moments at a beam-column joint are distributed equally to the sections of the columns directly above and below the joint. Given below is the calculations for first and second stories.

1. Determine first story strength.

Columns A and D must be checked for strong column-weak beam considerations.

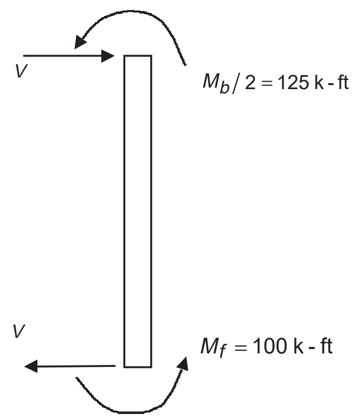
$$2M_c = 400 > M_b = 250$$

$\therefore$ strong column-weak beam condition exists.

Next, the shear in each column must be determined.

Clear height = 14 ft − 2 ft = 12 ft

$$V_A = V_D = \frac{125 + 100}{12} = 18.75 \text{ k}$$



Checking columns B and C for strong column-weak beam considerations.

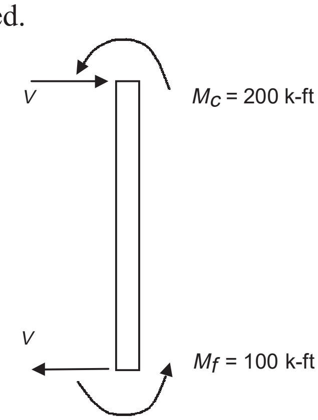
$$2M_c = 400 < 2M_b = 500$$

$\therefore$ Strong beam-weak column condition exists.

Next, the shear in each column must be determined.

Clear height = 14 ft − 2 ft = 12 ft

$$V_B = V_C = \frac{200 + 100}{12} = 25.0 \text{ k}$$



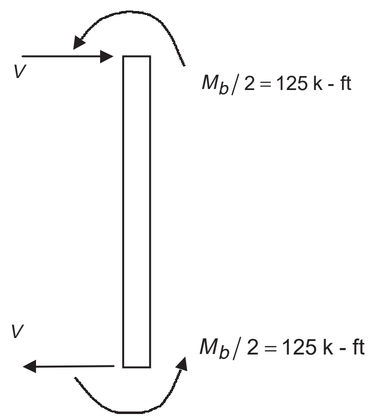
First story strength = $V_A + V_B + V_C + V_D = 2(18.75) + 2(25.0) = \underline{\underline{87.5 \text{ k}}}$

2. **Determine second story strength.**

Columns A and D must be checked for strong column-weak beam at Level 2.

$$2M_c = 400 > M_b = 250$$

$\therefore$ strong column-weak beam condition exists.



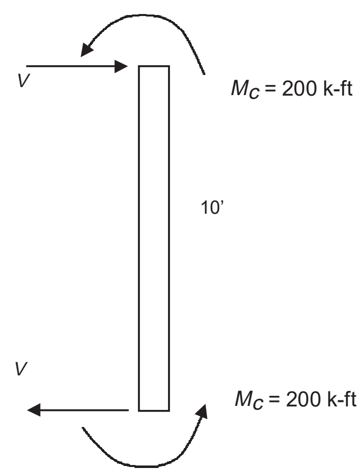
Clear height = 12 ft − 2 ft = 10 ft

$$V_A = V_D = \frac{125 + 125}{10} = 25.0 \text{ k}$$

Checking columns B and C for strong column-weak beam considerations.

$$2M_c = 400 < 2M_b = 500$$

$\therefore$ Strong beam-weak column condition exists.



Clear height = 12 ft − 2 ft = 10 ft

$$V_B = V_C = \frac{200 + 200}{10} = 40.0 \text{ k}$$

Second story strength = $V_A + V_B + V_C + V_D = 2(25.0) + 2(40.0) = \underline{\underline{130.0 \text{ k}}}$

3. **Determine if weak story exists at first story.**

First story strength = 87.5 k

Second story strength = 130.0 k

$$87.5 < 0.80(130) = 104$$ Table 16-L Item 5

$\therefore$ Weak story condition in first story exists