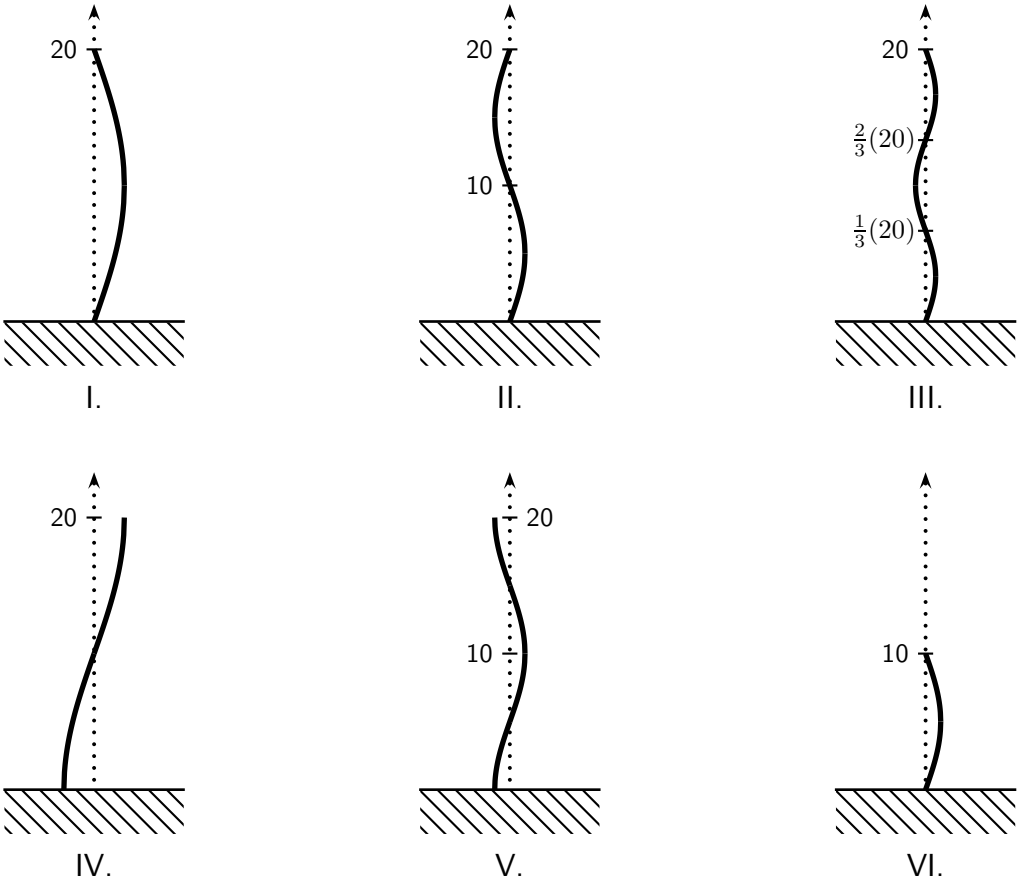
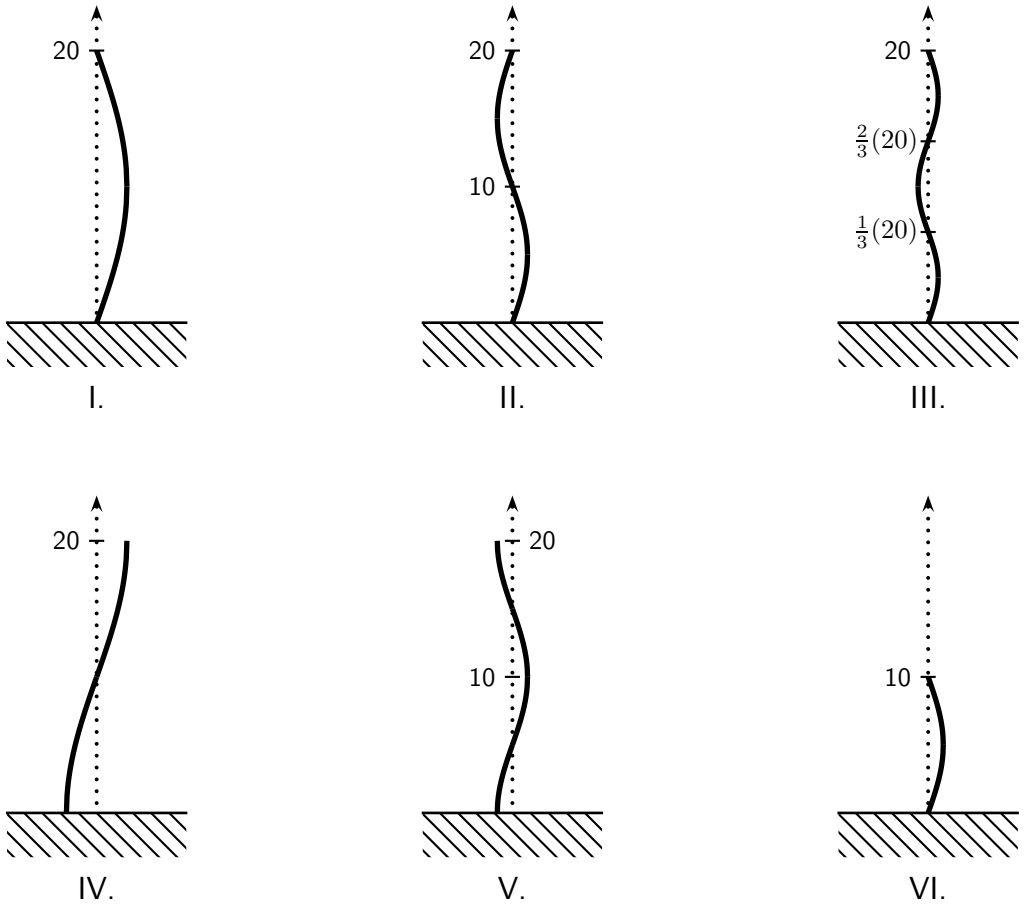
Slender Vertical Columns



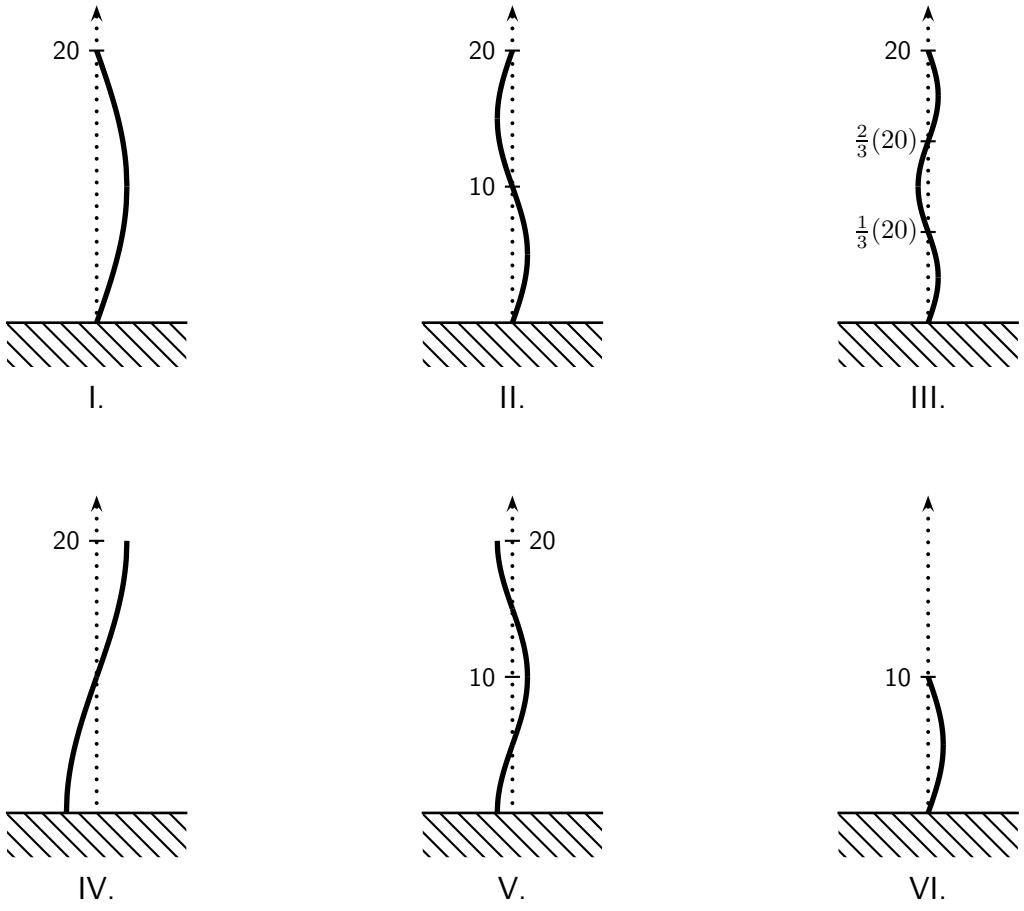
1. Which configurations represent both ends pinned? What are the boundary conditions for both ends pinned?

2. Which configurations represent both ends embedded with no drift?



3. What are the boundary conditions for both ends embedded? What additional condition must be met if drift is *NOT* allowed?

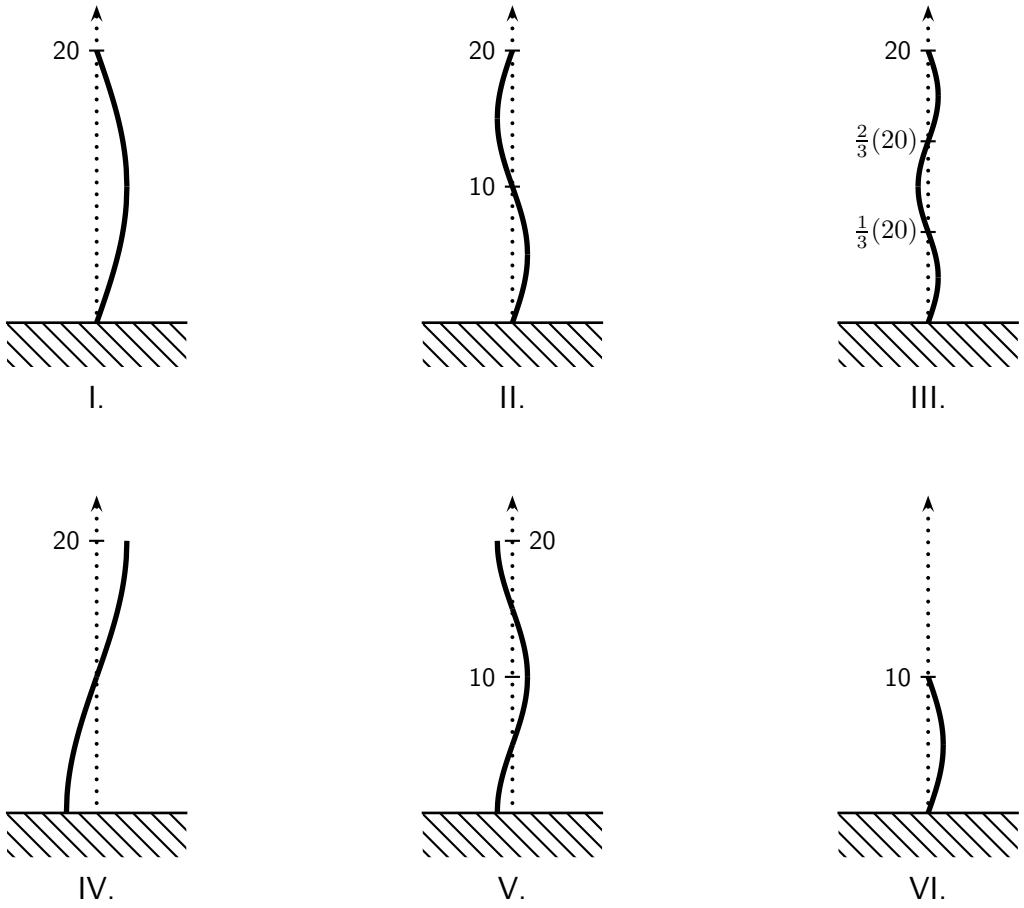
4. Give the number of the buckling mode/critical load for each of the columns shown in I through III.



The columns in II and III are pinned at one and two points, respectively, along their lengths. None of the others are pinned along their lengths.

5. Would you guess that pinning along the length increases, or decreases, the strength of a column?

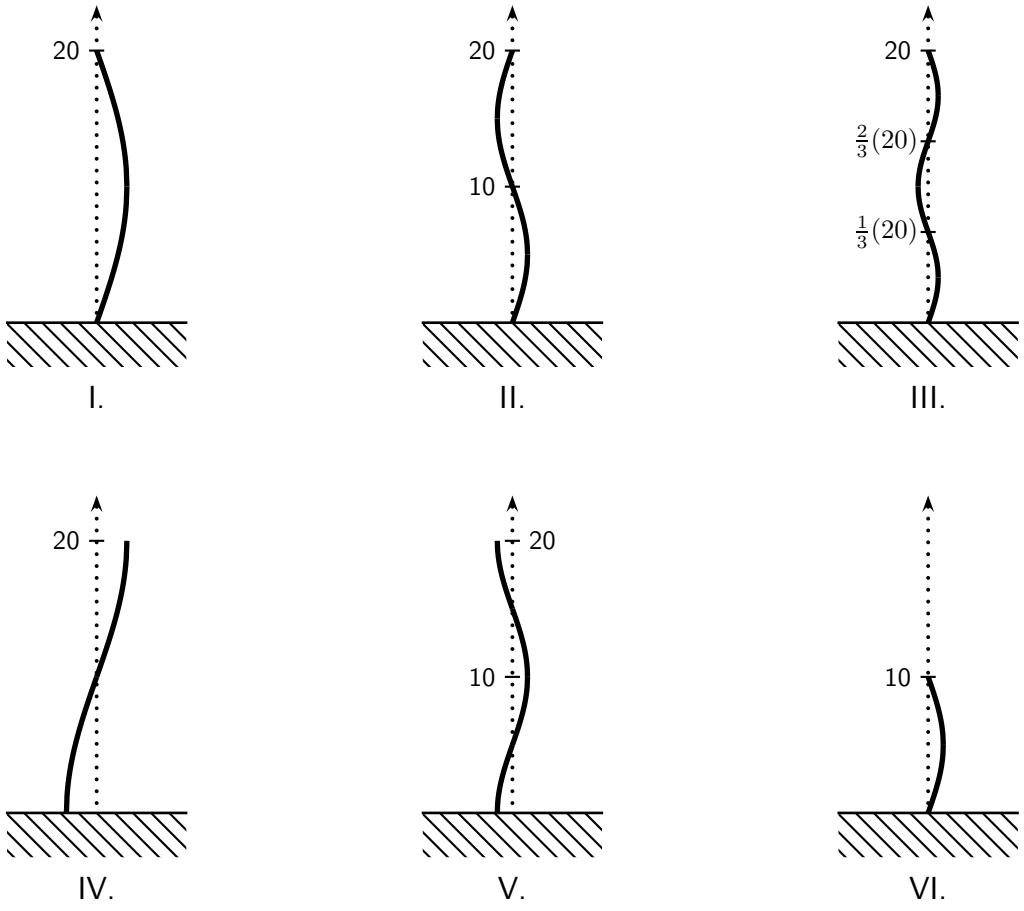
6. Would you guess that decreasing the length of a column increases, or decreases, the strength of the column, all else being the same? (For example, the column in VI versus the one in I.)



Guiding Principle 1: If vertical Columns A and B have the same length and Column B exhibits n times as many half periods of sine or cosine (through how the ends are fixed or pinning) as Column A, then Column B is n^2 times stronger than Column A.

7. How does the strength of the column in III compare with that of the column in I?

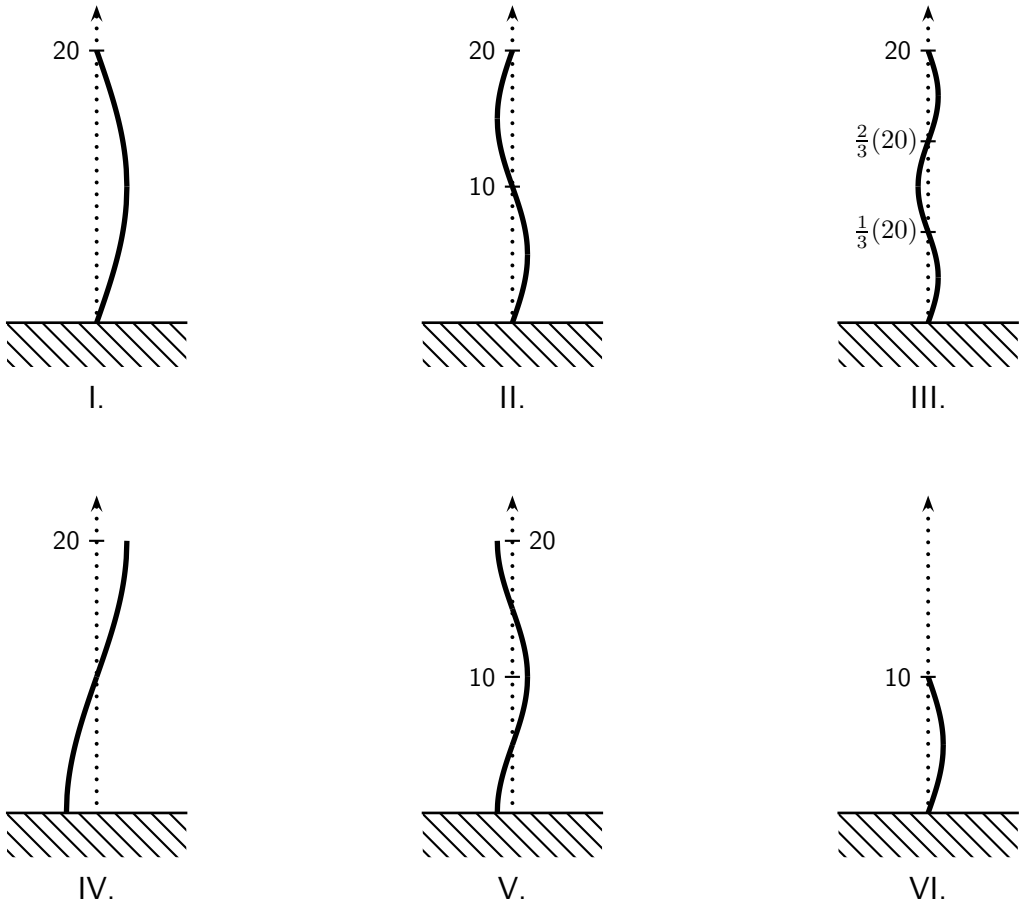
8. How does the strength of the column in IV compare with that of the column in I?



9. Which diagram shows the first buckling mode for both ends embedded and drift *NOT* allowed?

10. Which diagram shows the first buckling mode for both ends embedded and drift allowed?

11. When both ends are embedded, does allowing drift increase or decrease the strength? By what factor?



Guiding Principle 2: If vertical Columns A and B have the same end conditions and pinning and Column B is $\frac{1}{n}$ as long as Column A, then Column B is n^2 times stronger than Column A.

12. How does the strength of the column in VI compare with that of the column in I?

13. Which pictures show columns with the same strength as the column in II?

14. Give the strength of the column in each picture, relative to the column in I.

Answers:

1. I, II, III, VI
2. V
3. $y'(0) = 0,\ y'(20) = 0$, if no drift, $y(20) = y(0)$
4. 1st, 2nd, 3rd
5. increases
6. increases
7. It is nine times as strong.
8. It is the same.
9. V
10. IV
11. Allowing drift decreases the strength by a factor of four.
12. It is four times as strong.
13. V
14. twice, three times, the same, twice, twice