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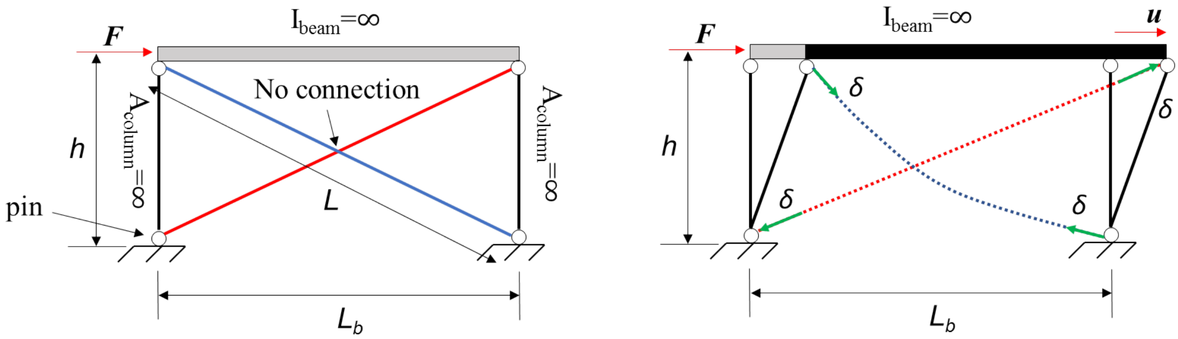
Exercise #11 –Dynamic Method of Equilibrium

The steel braced frame shown in Figure 1a carries a mass, *m* and is subjected to a lateral load *F* as shown in the figure. The lateral stability of the braced frame is only provided by two steel braces with a length, *L* and area, *A* that are not connected at their center (see Figure 1a). The buckling resistance of the two braces is P_{cr} and assume P_{cr}=EA/(*c*L) with *c*>1 m^{-1} (a constant) such that P_{cr} < $P_y=f_yA$ as shown in Figure 2. The braced frame can lose its lateral stability when it is subjected to the lateral force F. This is caused by combined brace buckling and yielding as shown in Figure 1b. The expected brace behavior in tension (negative loading) and compression (positive loading) is shown in Figure 2.



(a) (b)

Figure 1. Steel braced frame under lateral loading

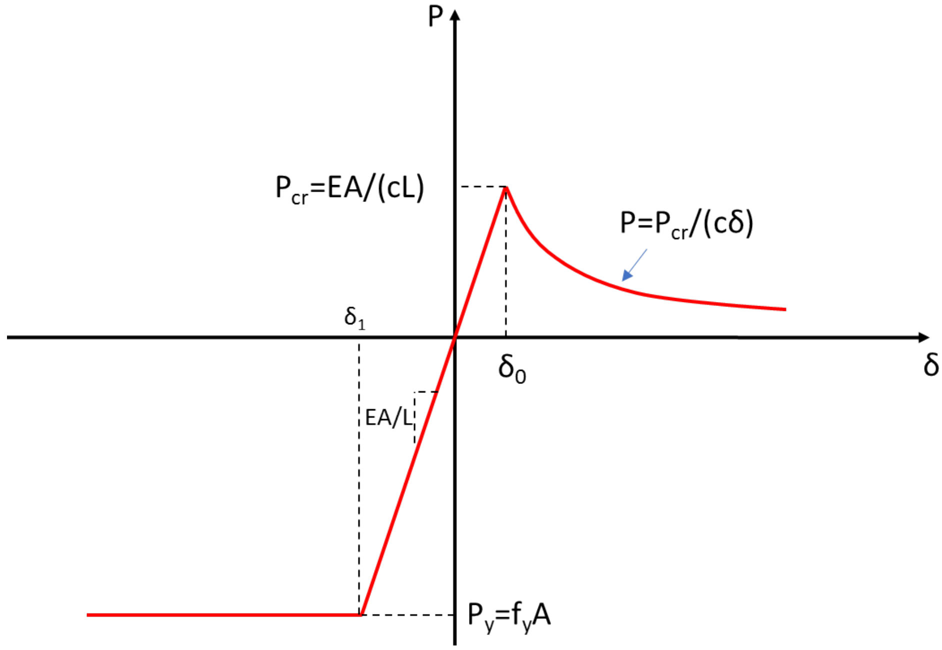


Figure 2. Brace behavior in tension and compression

Compute the following:

1. The lateral stiffness K_{total} of the braced frame before any lateral load application. Explain if the frame is stable or not based on the dynamic approach of stability (computation of radian frequency ω is sufficient in this case).
2. Calculate the lateral displacement u_0 at which the brace in compression buckles. Based on the dynamic approach of stability (computation of radian frequency ω is sufficient in this case), is the braced frame stable at this displacement? Explain your answer.
3. Calculate the displacement $u > u_0$ at which the braced frame loses completely its lateral stability. Explain your answer based on the dynamic approach shown in class (computation of radian frequency ω is sufficient in this case).
4. Suggest a solution to increase the critical load, P_{cr} such that the lateral stability of the braced frame is less of an issue.