Lateral Buckling

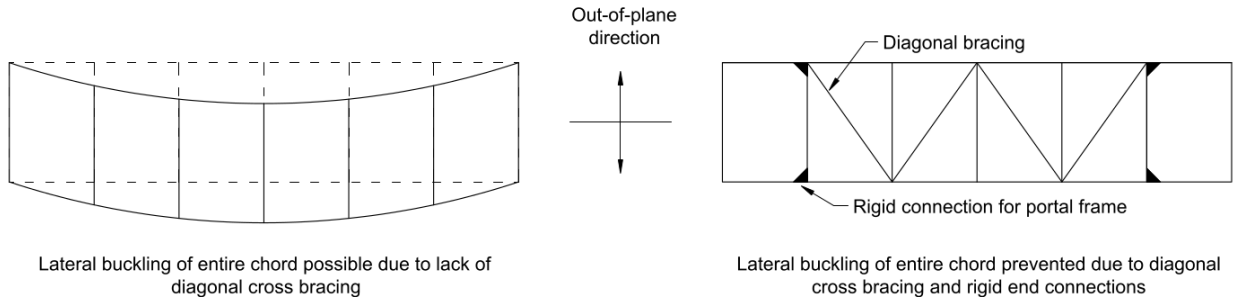
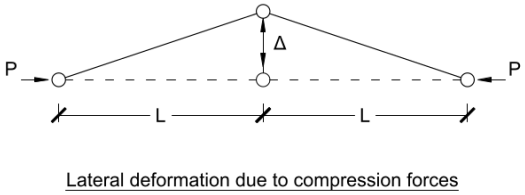
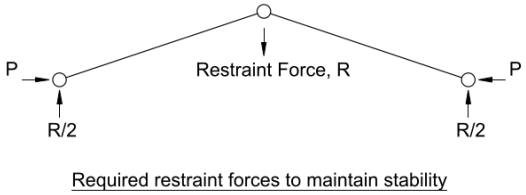


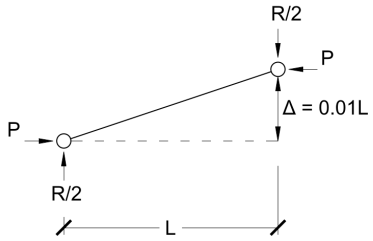
Figure 1: Cross bracing can restrain the chords from buckling over the entire span

- When designing the truss, the members were assumed to be perfectly aligned, but this is not the case in real life
- If cross bracing is not added, compression members in the top chord can buckle over the entire span and fail at a much lower load than expected

Design Checks for Stability







- In the figure above, the joint at midpoint is not restrained, so it buckles and displaces by Δ; a restraining force R is required to pull it back
- R depends on Δ; a reasonable estimate for Δ in modern construction is $0.01L$ (i.e. 1%)
- In the FBD, taking the moment about the left joint yields $M = P\Delta - \frac{R}{2}L = 0 \implies R = 2\frac{P\Delta}{L}$, substituting $\Delta = 0.01L$ yields $R = 0.02P$
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- The restraining force in a truss bridge is provided by the cross bracing
- Since the chords can buckle in either direction on either side, there are 4 cases to design for:
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- The stability check is a local check at each joint, as opposed to global analysis of wind and other forces

Cross Bracing Design Process

- The cross bracing can be done after the main truss is designed for gravity loads

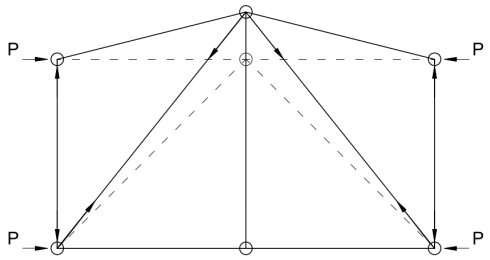

Figure 2: Cross bracing restrains joints from buckling outwards

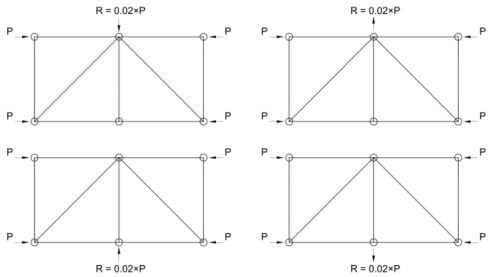

Figure 3: Design cases for cross bracing

- The bottom bracing does not need to consider stability because the bottom chords are in tension
- To design the cross bracing:
  1. Calculate the wind loads and determine the forces in the members of the top bracing using method of joints/sections
  2. Calculate the forces required to stabilize the compression chords under gravity loads
     - Note this may be different between the two sides due to asymmetry; take the larger of the two to be conservative
  3. Select appropriate HSS sections based on the larger of the two forces
     - Note the braces are designed for the more severe case, not both cases at the same time
     - It is unlikely that both will happen at the same time; e.g. during severe windstorms there will not be a lot of people on the bridge creating a large gravity load