CIVL 6122 Frame Design Project

This project aims to design a steel frame storage building. Figure 1 shows the general configuration of the structure. To maximize the utility of the storage space, symmetrical clear-span frames without interior columns and a minimum head clearance of 15 ft. are required.

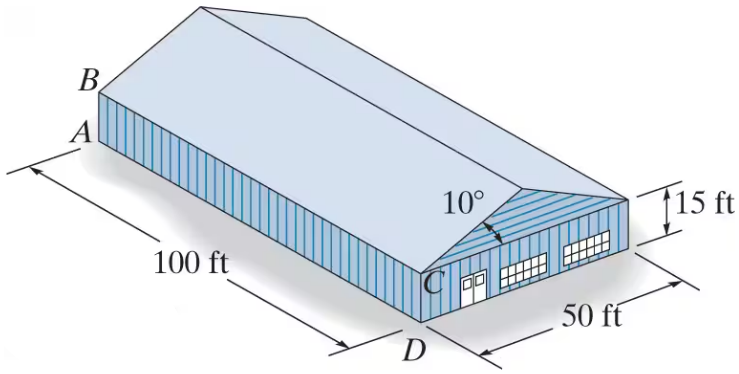

Figure 1. The general configuration of the frame structure.

Your design should include the size and spacing of the clear span frames, the roof purlins, the sidewall girts, the endwall frames, and rod bracing, as shown in Figure 2. Use the SAP2000 steel frame design tool to size all the elements in your design.

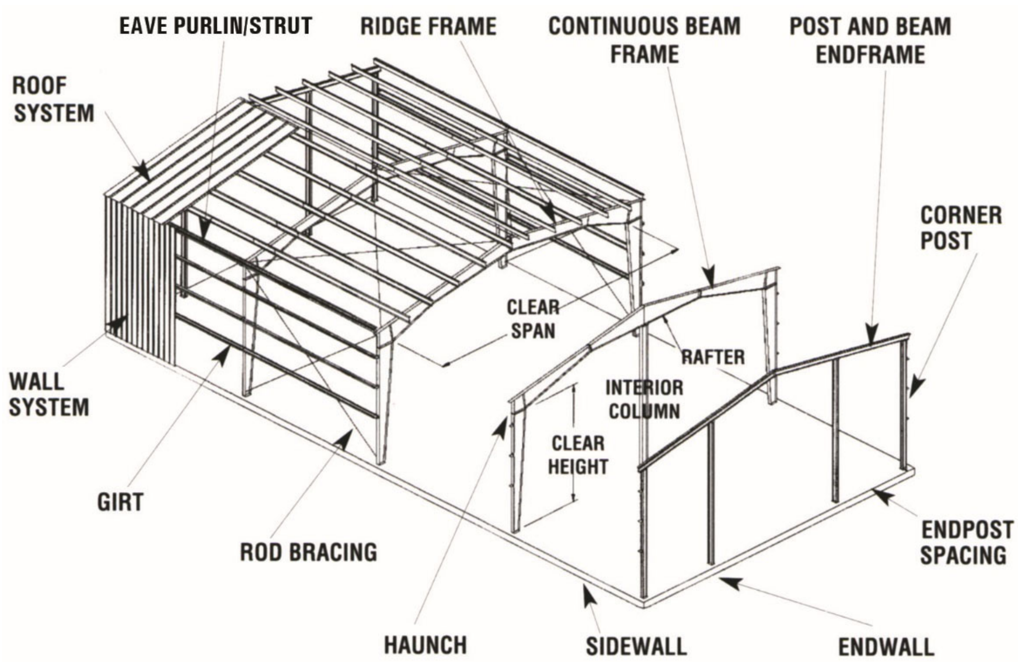

Figure 2. The general configuration of the frame structure.

Loads on the frame structure should include dead loads, roof live loads, snow loads, and wind loads. Dead load is the permanent weight of all structural and nonstructural components. The roof live load accounts for maintenance by workers, equipment, and materials during the structure's life. In areas that see snowfall in winter months, accumulation of snow on roofs and decks can cause deflection of structural members and even cause the collapse of under-designed structures. The dead loads, the live roof loads, and the snow loads are applied to the structure's roof.

The wind loads are more complicated. In general, wind exerts three types of forces on a structure:

1) Uplift load - wind flow pressures that create a strong lifting effect, like the effect on airplane wings. Wind flow under a roof pushes upward; wind flow over a roof pulls upward.#
2) Shear load – horizontal wind pressure that could cause racking of walls, making a building tilt.
3) Lateral load – horizontal pushing and pulling pressure on walls that could make a structure slide off the foundation or overturn.

For design purposes, assume the wind is directed as on structure, as shown in Figure 3. Determine the design wind pressure acting on the windward and leeward portions of the roof, the endwalls, and the windward and leeward sidewalls using the ASCE 7-16 Specifications.

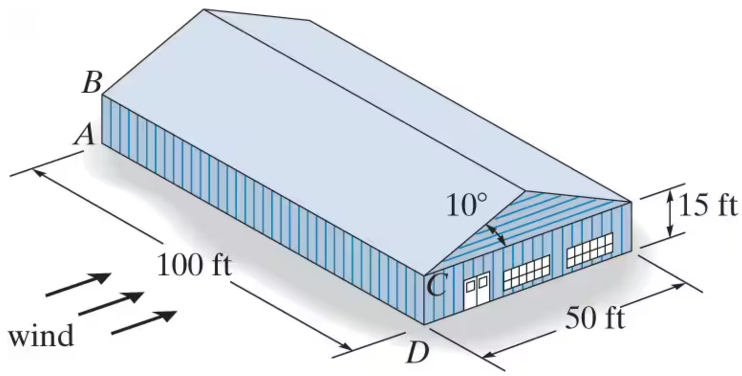

Figure 3. Wind direction on the frame structure.

Since uncertainty can be considered using probability theory, there has been an increasing trend to *separate* material uncertainty from load uncertainty. This method is called strength design or LRFD (load and resistance factor design). For example, this method uses load factors applied to the loads or combinations of loads to account for the uncertainty of loads. According to the ASCE 7-16 Standard, some of the load factors and combinations that are not to be exceeded include

- 1.4 (dead)
- 1.2 (dead) + 0.5 (roof live or snow)
- 1.2 (dead) + 1.6 (roof live or snow) + 0.5 (wind)
- 1.2 (dead) + 1.0 (wind) + 0.5 (roof live or snow)
- 1.2 (dead) + 0.2 (snow)
- 0.9 (dead) + 1.0 (wind)
- 0.9 (dead)

In all these cases, the combination of loads is thought to provide the structure with a maximum yet realistic loading.