Project description

The project includes technical analyses and report writing. The report should be easily readable and complete by itself, e.g. include introduction, approach, assumptions, results, discussion, conclusion, and references. The technical analyses must use ANSYS FE software and be based on a programmed input deck, not the GUI. You must check your results against manual implementations of the FE method, which may require the use of MatLab for numerical applications. Use the von Mises failure criterion for yielding. For compression members, include buckling as additional criterion.

Undergraduate students should work in groups of 2 or 3. Graduate students will work on their own.

Project timeline:

- Project selection: Oct. 31
- Reports due: Dec. 5 beginning of class, no extensions

Project 1: Bicycle frame design

The schematic dimensions of a bicycle are shown in Fig. 1. The following two cases should be considered.

1) Vertical loads: when an adult rides the bike, the nominal load is estimated as a downward load of 900 N at the seat position and a load of 300 N at the pedal crank location. When a dynamic environment is simulated using static analysis, the static loads are often mutiplied by a dynamic laod factor G. In this design project, use $G = 2$. Use ball-joint boundary conditions for the front dropout (location1) and sliding conditions for the rear dropouts (locations 5 and 6).

2) Horizontal impact: the frame should be able to withstand a horizontal load of 1,000 N applied at the front dropout with rear dropouts constrained from any translational motion. For this load case, assume the front dropout can only move in the horizontal direction. Use $G = 2$.

Choose aluminium tubes of various diameters for the various members of the frame such that the bicycle is as light as possible. The minimum outside diameter is 12 mm and the wall thickness is 2 mm. Approximate the frame as a plane frame by giving the same coordinates to Nodes 5 and 6. In addition to the dynamic load factor, use a safety factor of 1.5 for yielding and buckling. For aluminium, take Young's modulus $E = 70$ GPa, Poisson's ratio $\nu = 0.33$, density $\rho = 2{,}580$ kg/m^3, yield strength $\sigma_Y = 210$ MPa.Verifications against hand calculations for one frame configuration are mandatory.

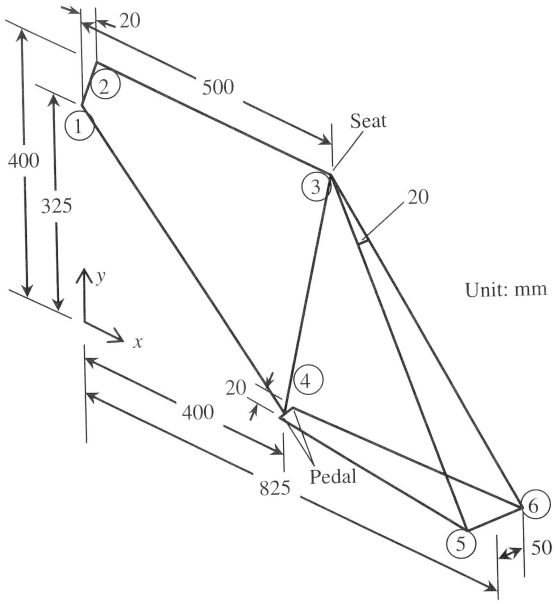

Figure 1

Project 2: Road bridge design

Size the members of the bridge shown in Fig. 2 for the case in which traffic is backed up with a total of four trucks equally spaced on the bridge. A typical truck has a payload weight of 64,000 lb and a cab weight of 800 lb. As a starting point, you may use one cross-section for all beam elements. You may also assume one cross-section for all truss members. The roadbed weighs 1500 lb/ft and is supported by I-beams. Use standard steel I-beam sizes. Design your own truss configuration. In your analysis, you may assume that the concrete column does not deflect significantly. Verifications against hand calculations for one truss configuration are mandatory.

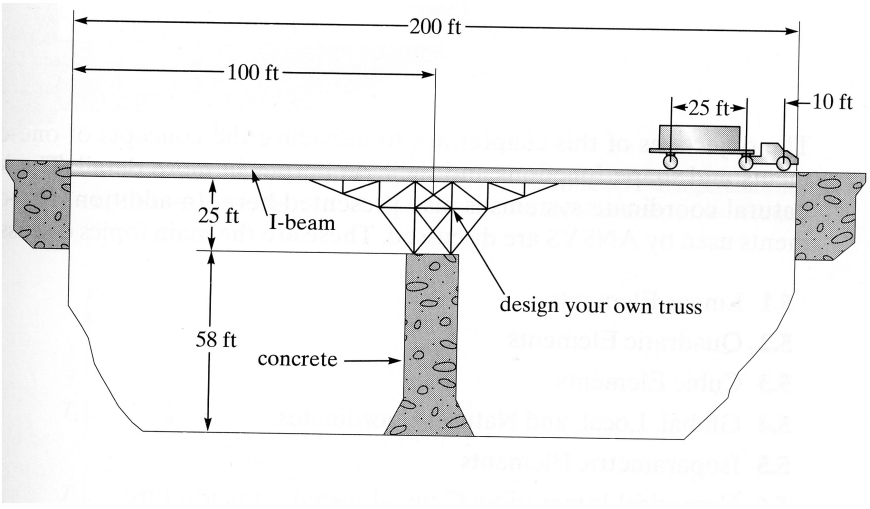

Figure 2