CEE 432/532 Developing Software for Engineering Applications

Project 4

Three-Dimensional Finite Element Modeling Using Beam and Plate Elements

Fall 2015 Semester

Overview: The basic motivation in this project is to take practical structural systems and model them using beam **and** thin plate/shell finite elements. You will have to write a report that as a minimum, has the following elements.

(1) A complete problem description. Clearly identify what are your modeling goals and the response parameters that you are monitoring.
(2) Description of the complete finite element model - FE mesh (nodes and elements), fixity conditions, material properties, element properties, and loads. State analysis and modeling assumptions used.
(3) Show a convergence analysis of the important response parameters.
(4) How the analysis results will be used to design the structural elements. Clearly state what design code is applicable.

Bonus points may be given for a thorough discussion of modeling techniques and limitations, error checks, insights on member layout to reduce lateral deflections and minimize torsional effects, relationship of your model to contemporary practice etc.

You can either do the entire project as an individual project and turn in an individual report, or work in 2-member teams and turn in a team report. The expectations for team reports will be proportionately higher.

Turn in one zipped file - lastname(s)_firstname(s).zip that includes the final report as a MS Word file as well as the GS-USA Frame3D command and database files.

Classroom Presentation (~5 minutes): 4 slides – (1) Problem Statement (2) FE Model (3) FE Results (4) Findings

Option 1: FE Analysis of a Multi-Storied Building

Problem Statement (Do **NOT** use this specific example): The overall task is to analyze a 16-storied building located in Tempe downtown for one unfactored load case - dead plus live plus wind load (blowing N-S). The floor plan is shown in Fig. 1.1. The height from the basement to the lobby is 16 ft. The 15 other floors heights are 13 ft each. The floor system consists of 3" cellular steel deck with 2.5 inch concrete slab, supported on the steel joists. Live loads are 100 psf on the first, or lobby floor, 80 psf on the upper floors, and 20 psf on the roof. Use appropriate bracing between columns to reduce lateral deflections as well as increase the torsional resistance. Assume felt and gravel roofing as 6 psf and decking as 42 psf on the roof.

Use one of the following materials:
(a) Use W shapes, or welded box beam. Assume a suitable grade for steel.
(b) Use high strength reinforced concrete.

You are free to assume any data that is not explicitly stated provided you justify the assumed data.

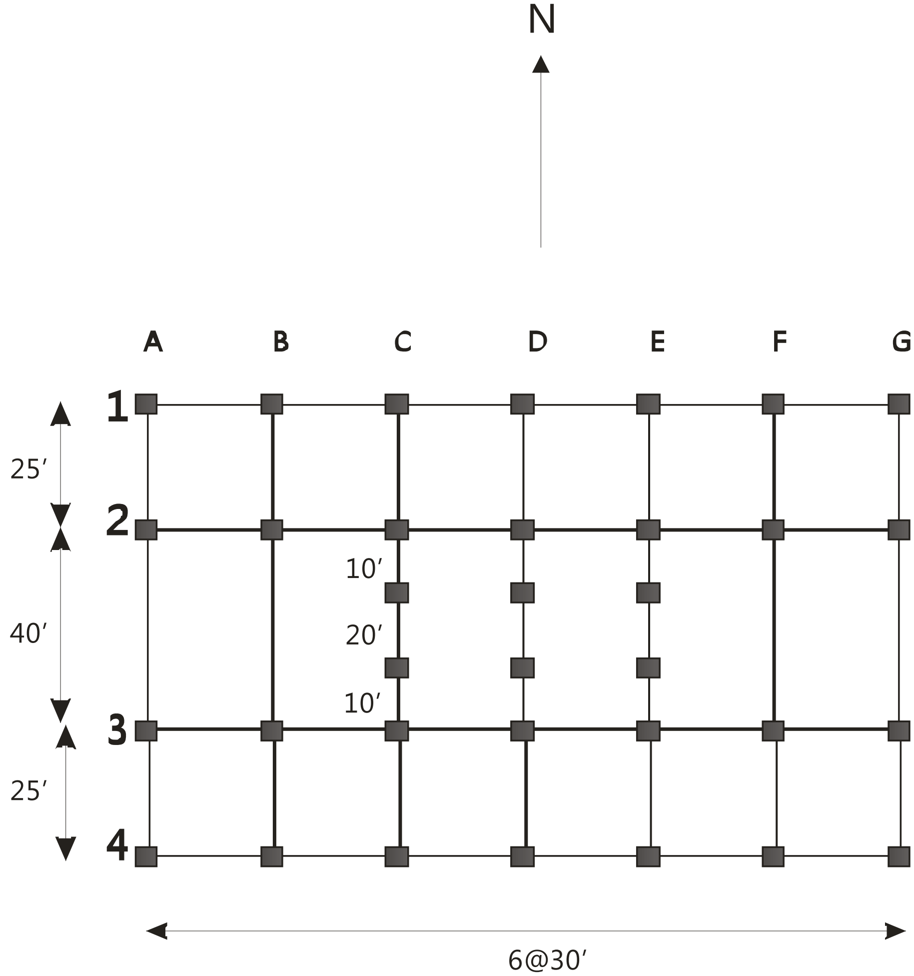

Fig. 1.1 Typical floor plan

Option 2: FE Analysis of Construction Steel Safety Box

Problem Statement: Design a steel box structure that is 4 ft wide by 8 ft long by 8 ft high (Fig. 2.1). The 4 sides are made of thin plates and steel ribs. Assume that the loading is from wet soil (density of 62.5 lb/ft^3) and varies linearly with depth. The soil loading can act only on the long sides and is normal to the surface (z-direction). The allowable deflection is 1 in and the allowable stress is 20 ksi. Determine the thickness of the plate and the type and dimensions of the ribs.

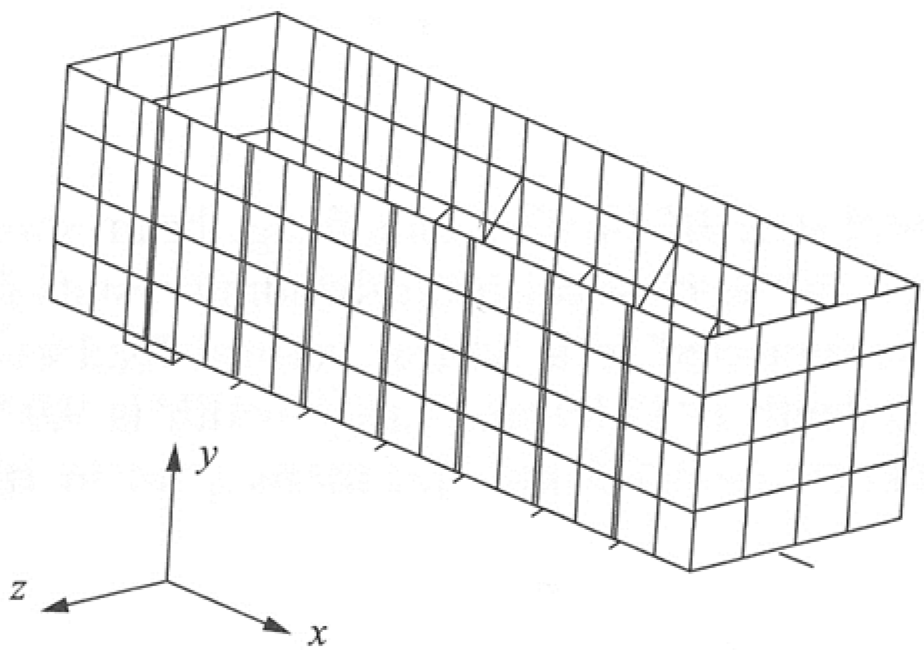

Fig. 2.1 Steel box structure

Option 4: FE Analysis of a *Scaled Model* Cable-Stayed Bridge

Problem Statement: Fig. 4.1 shows the schematic layout of a scaled cable-stayed bridge that is made from a variety of materials. The bridge deck is made of corrugated cardboard. The columns are made of wood.

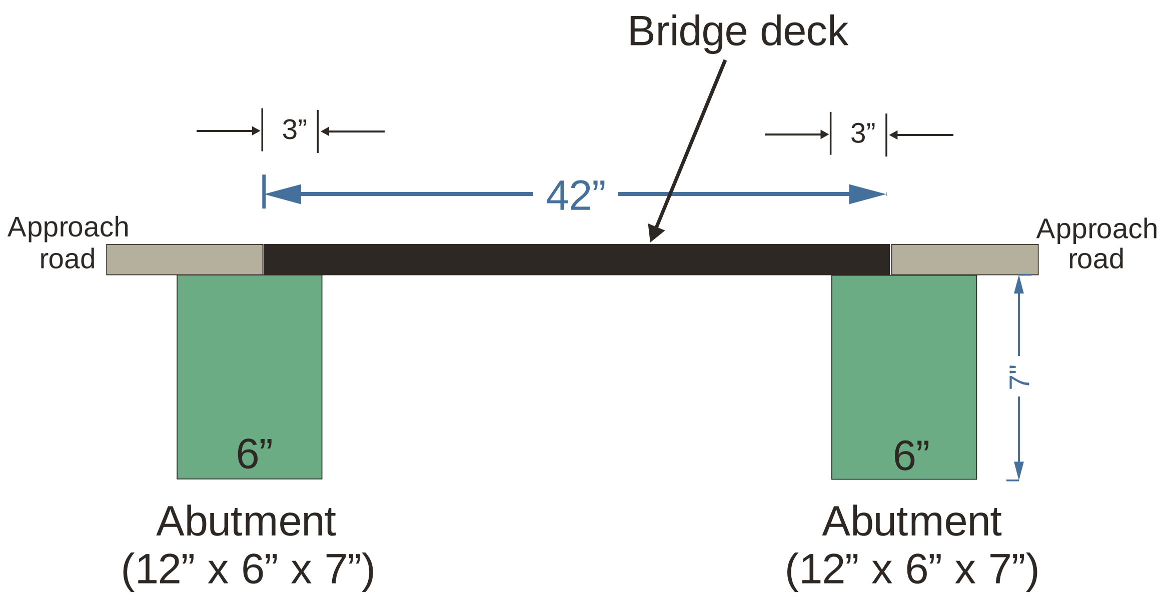

Fig. 4.1(a) Site and bridge diagram

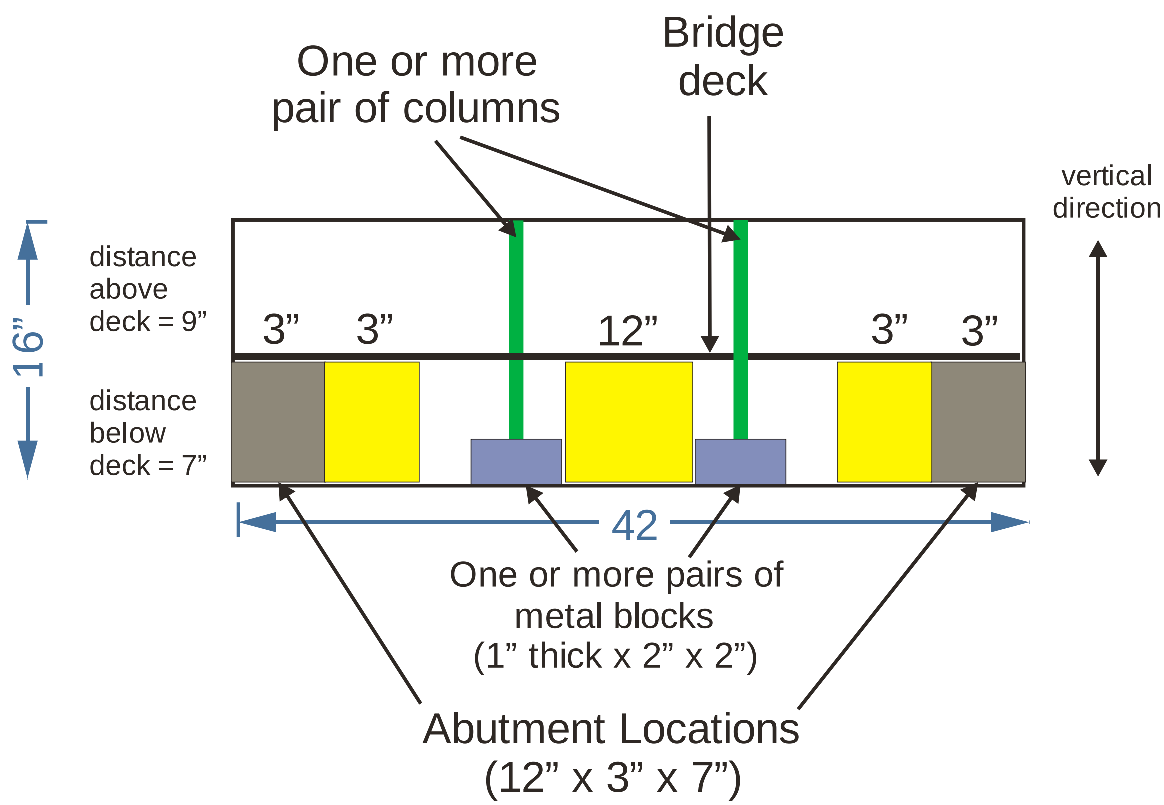

Fig. 4.1(b) Elevation view showing one of many possibilities with required obstruction-free areas below the bridge deck. At least one 12” continuous obstruction-free space must be available under the bridge deck (note this space does not include the 3” obstruction-free space next to the abutments).

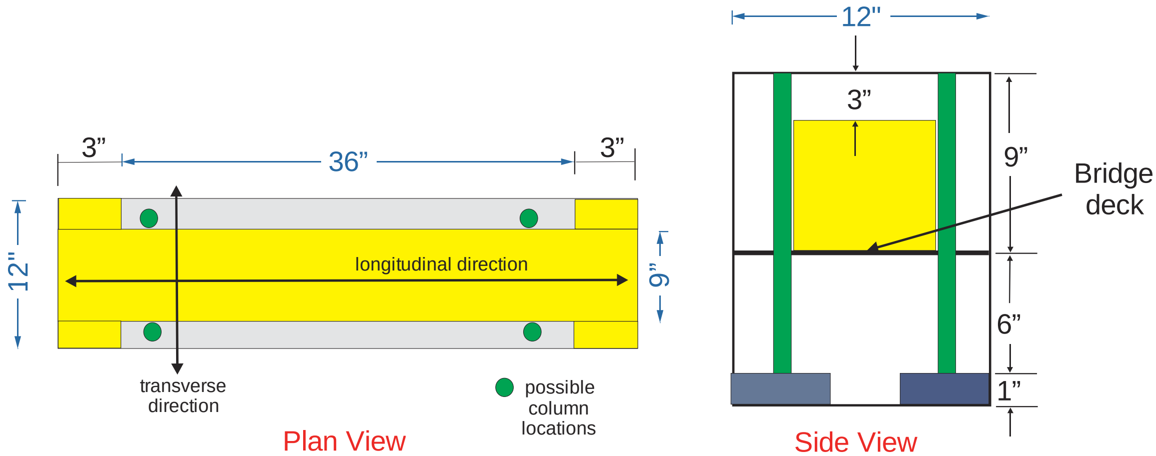

Fig. 4.1(c) Plan and side views showing one of many possibilities with required obstruction-free areas above the bridge deck (note that if columns are used, they must be placed within the 1.5” space on the edges of the bridge deck as shown)

Model and design the lightest bridge subject to scaled loading as per AASHTO standards.

Option 5: FE Analysis of a Reinforced Concrete & Steel Cable-Stayed Bridge

Problem Statement: Use appropriately modified statement from Option 4. Some example bridges are shown in Fig. 5.1.

Fig. 5.1 Example cable-stayed bridges

Option 6: FE Analysis of Utility Towers - Cell-Phone and Power Transmission

Problem Statement: Utility towers such as those used as cell phone transmission (Fig. 6.1(a)) or high-voltage power transmission towers (Fig. 6.1(b)) can be analyzed using finite element models. Construct and analyze the FE model.

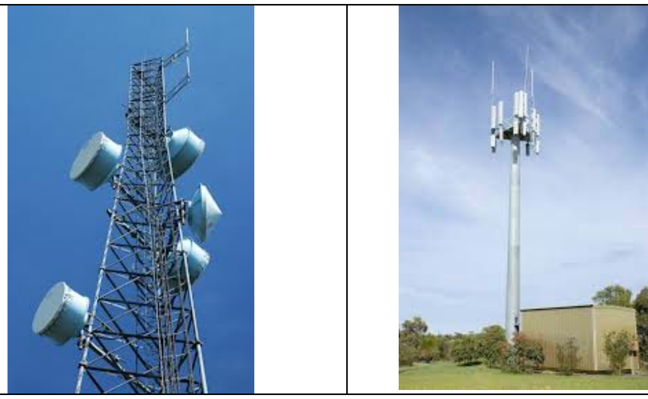

Fig. 6.1(a) Example cell phone towers

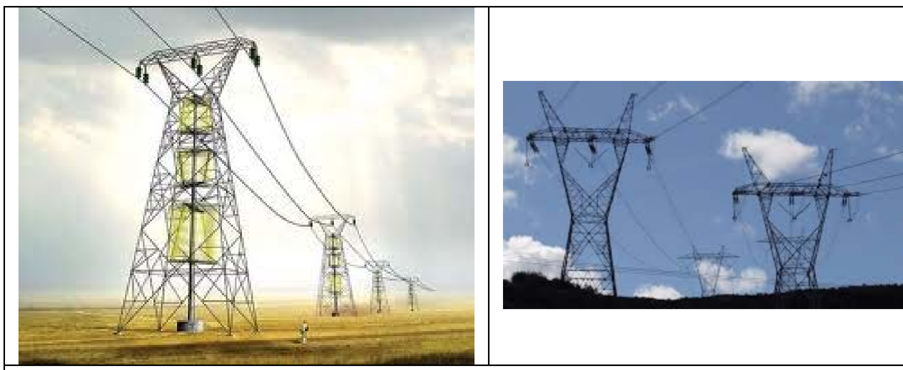

Fig. 6.1 Example power transmission towers