

Introduction to Structural Engineering

12-100 Introduction to Civil and
Environmental Engineering

Fall 1999

Outline

- Objective of Structural Engineering
- Structural Engineering Process
- Types of loads
- Types of structures
- Load paths in structures
- Summary

Civil Engineering Subdisciplines

- structural
- geotechnical
- environmental
- transportation
- construction

Objectives of Structural Engineering

Structural engineering is the science and art of designing and making, with economy and elegance, buildings, bridges, frameworks, and other structures so that they can safely resist the forces to which they may be subjected.

The Structural Engineer,

Official Journal of the British Institute of
Structural Engineers

Structural Engineering Process

- Determine types magnitudes of loads
- Determine structural context
 - geometric and geological information
 - cost / schedule / height/ etc. limitations
- Generate alternative structural systems
- Analyze one or more alternatives
- Select and perform detailed design
- Implement (usually done by contractor)

Types of loads

- Dead loads
- Live loads
- Dynamic loads (e.g., trains, equipment)
- Wind loads
- Earthquake loads
- Thermal loads
- Settlement loads

Dead Loads

- weight of the structure itself
 - floors, beams, roofs, decks, beams/stringers, superstructure
- loads that are “always there”



Photos courtesy of Corel, Inc.

Live Loads

- People, furniture, equipment
- Loads that may move or change mass or weight
- Minimum design loadings are usually specified in the building code

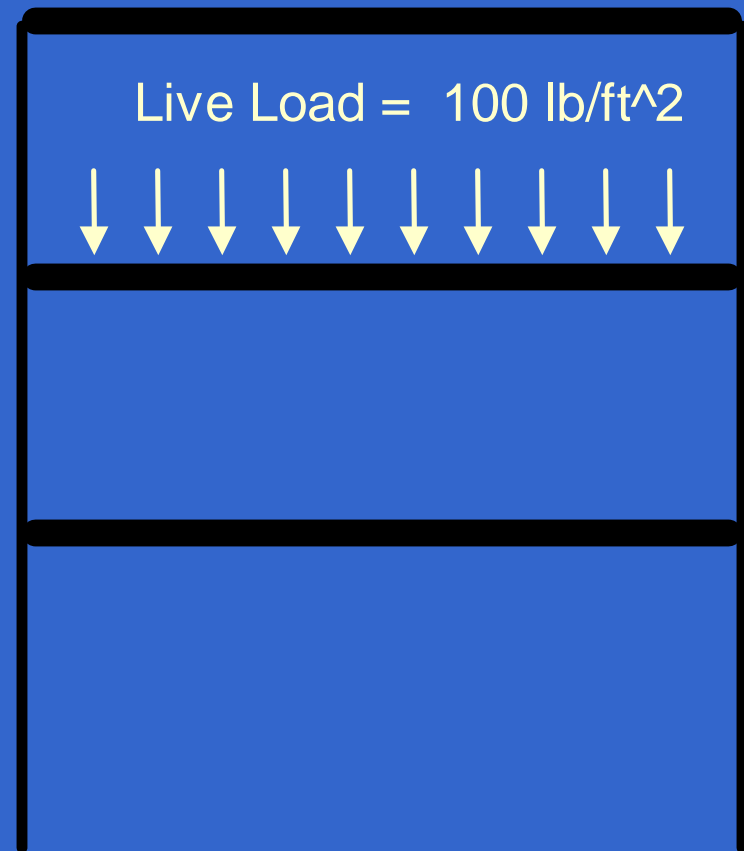
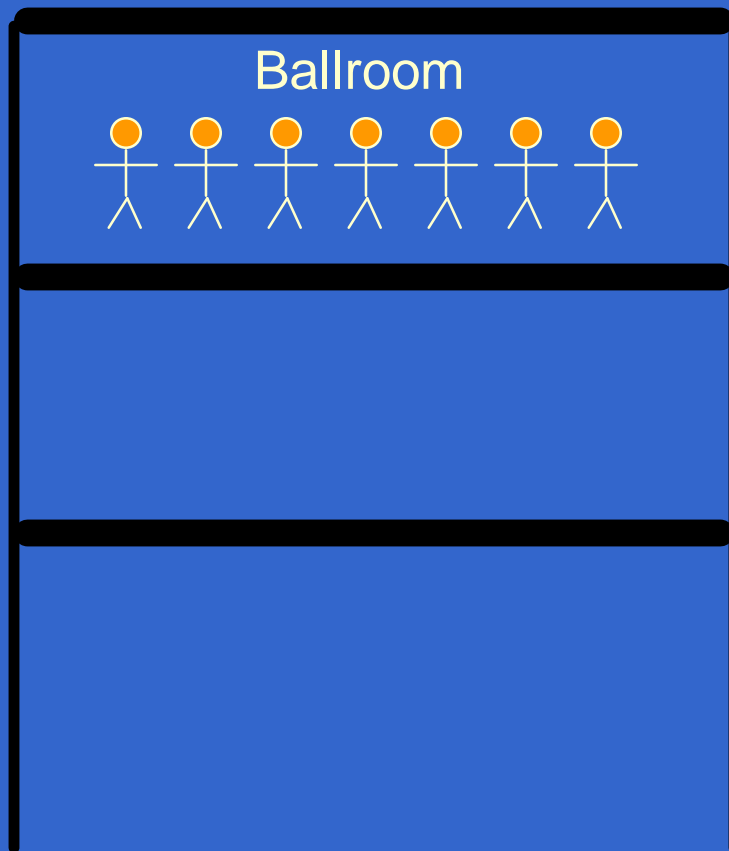


Photo courtesy of Corel, Inc.



Photo courtesy of Prof. P. Steif

Load Example: Live Load in Ballroom



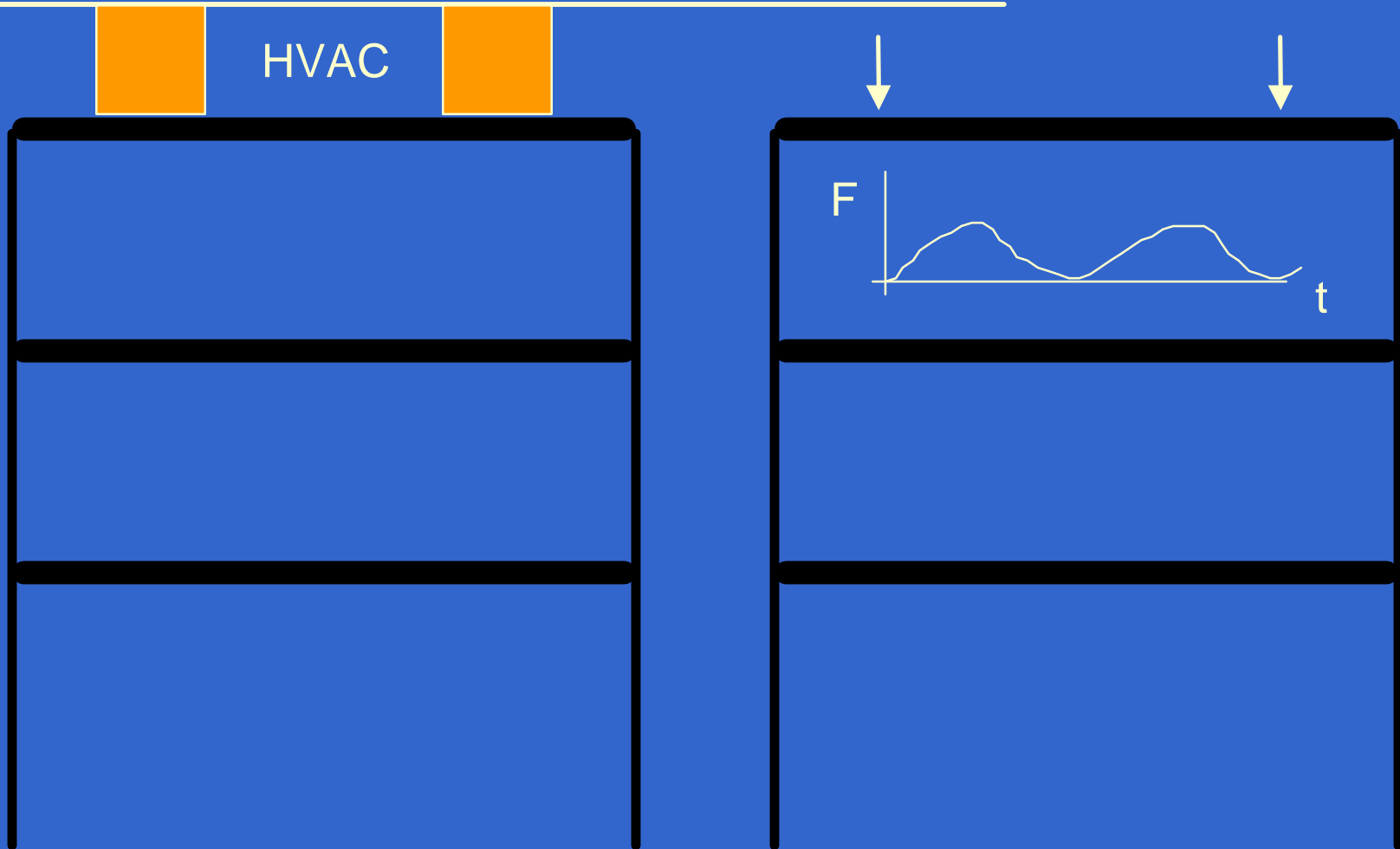
Dynamic Loads

- Moving loads (e.g. traffic)
- Impact loads
- Gusts of wind
- Loads due to cycling machinery



Photo courtesy of Corel, Inc.

Load Example: Dynamic Load



Load Example: Water in a dam

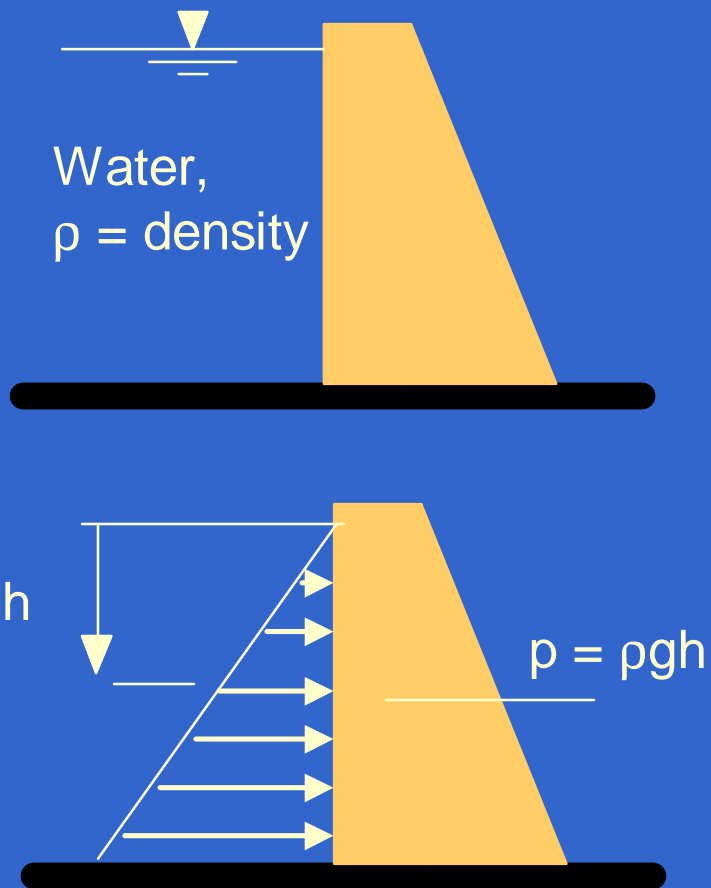
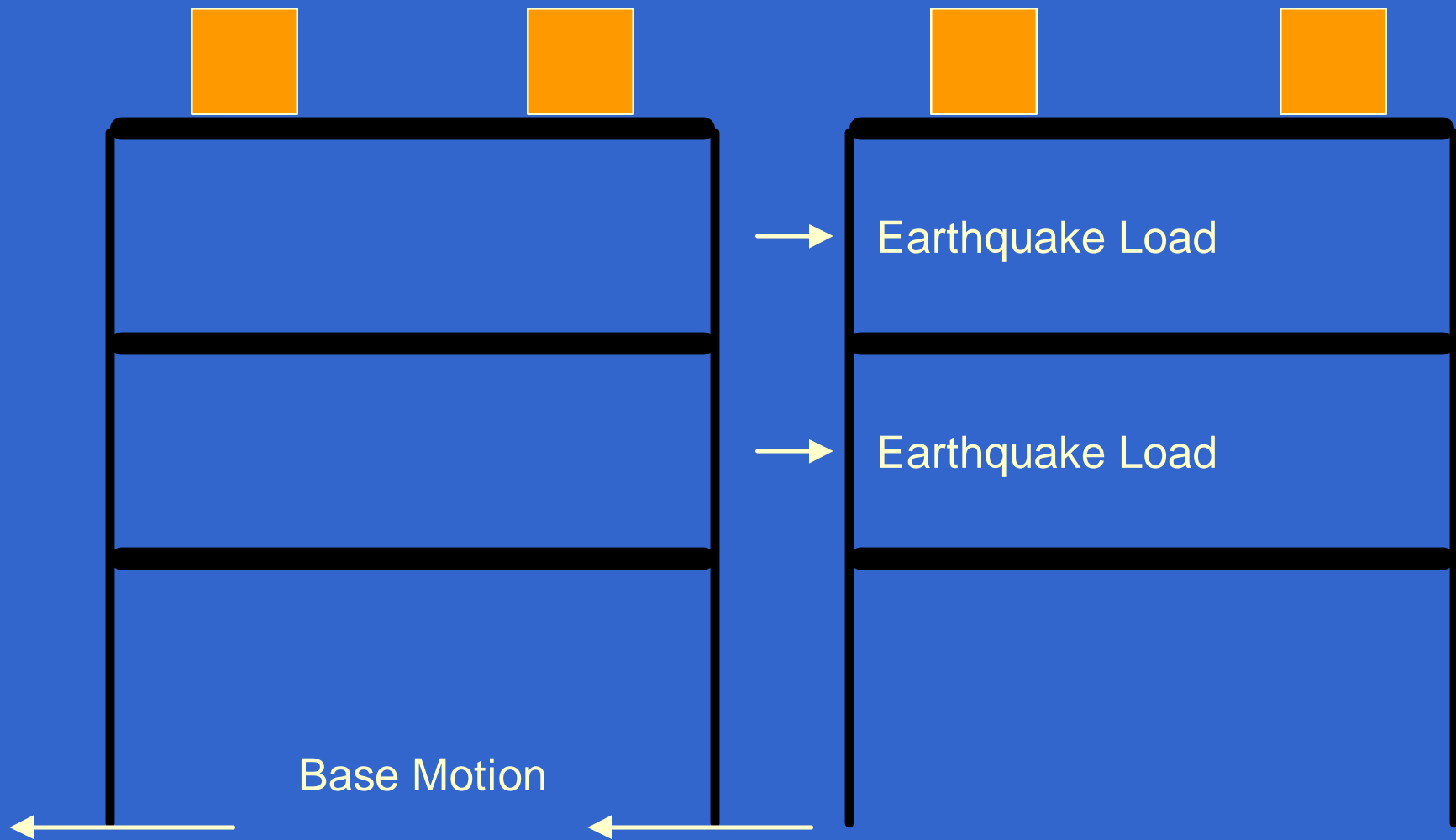


Photo courtesy of Corel, Inc.

Earthquake Loads

- Structure loaded when base is shaken
- Response of structure is dependent on the frequency of motion
- When frequencies match with natural frequency of structure - resonance

Load Example: Earthquake Load



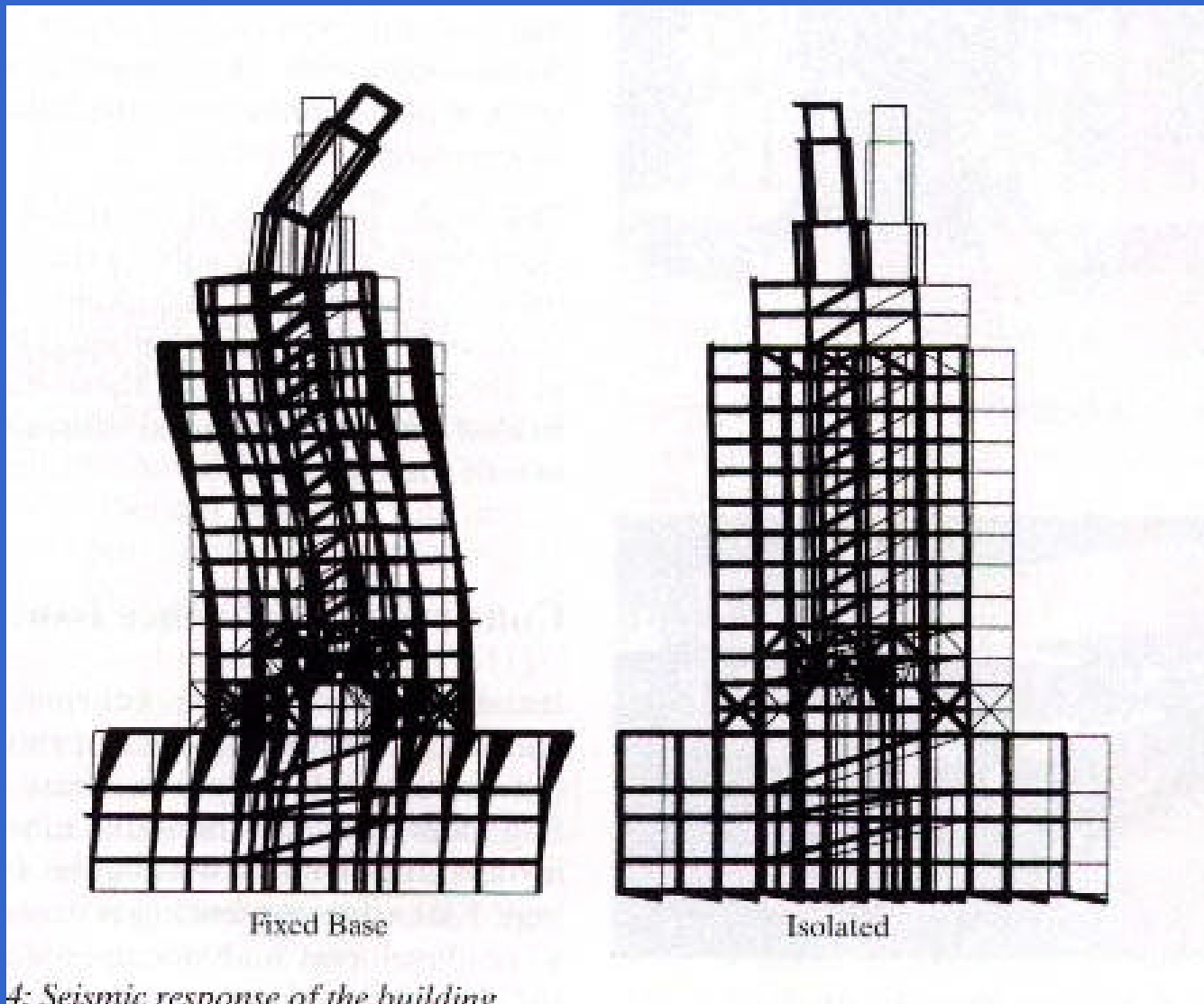
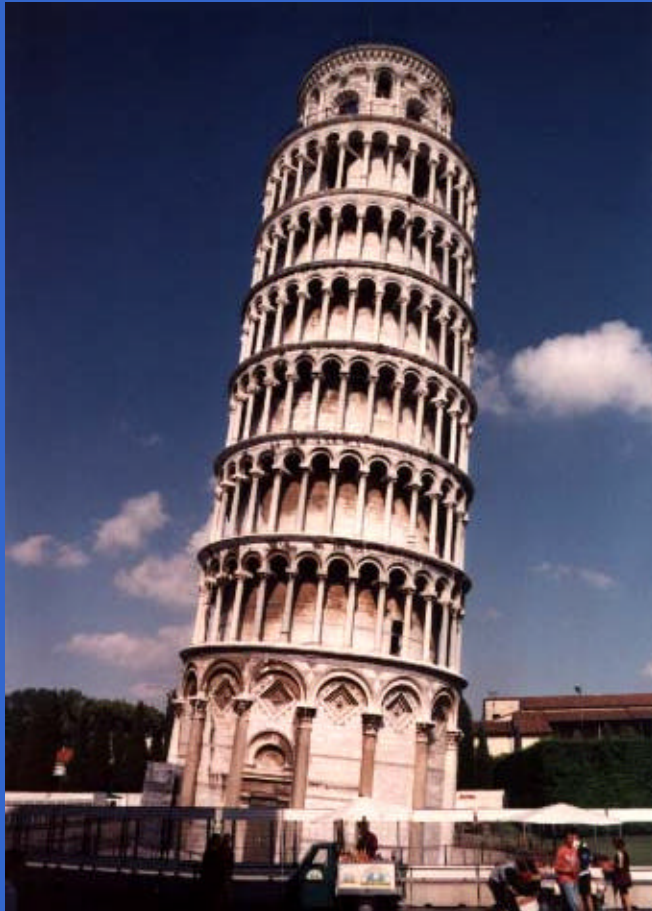




Photo courtesy of Corel, Inc.

Settlement



J. Garrett

The Committee was constituted as follows:

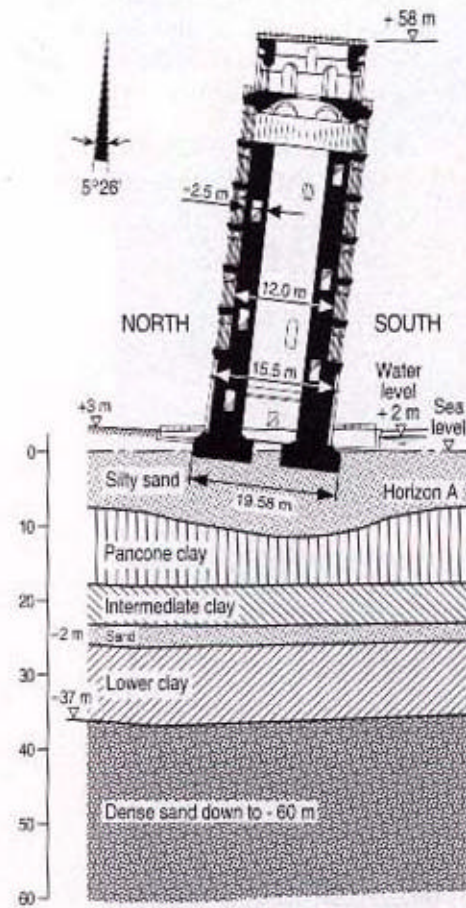
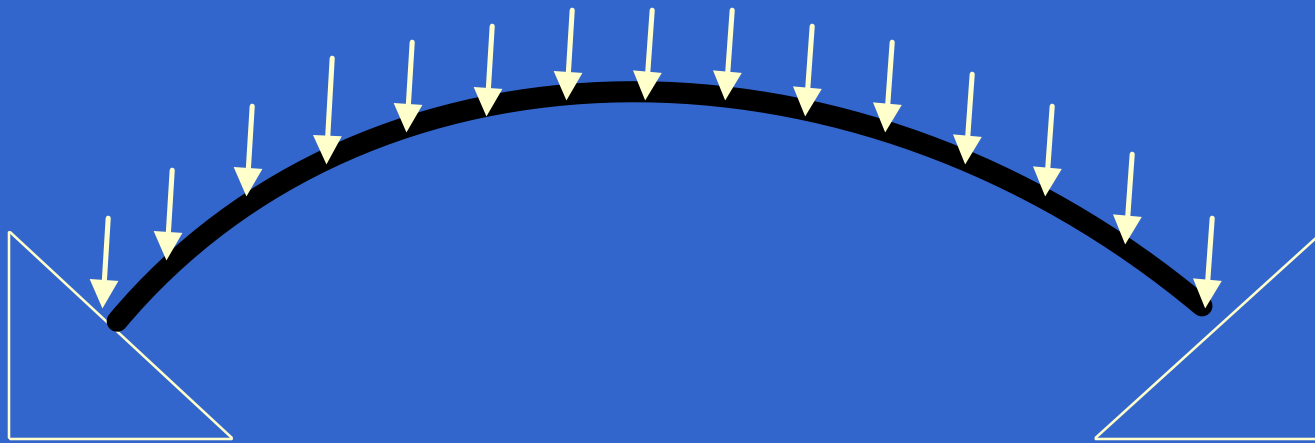


Fig. 2: Soil profile

Some Types of Structures

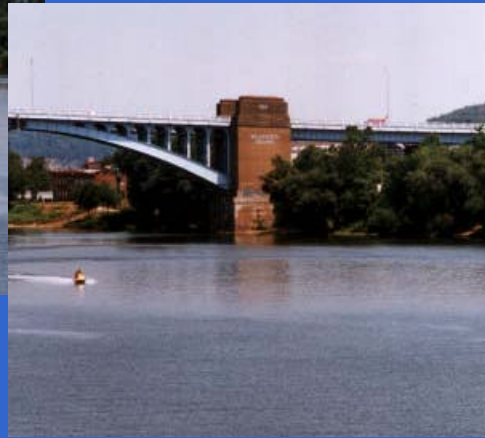
- Arch
- Planar Truss
- Beam/Girder
- Braced Frame
- Rigid Frame
- Space Truss
- Cable Suspended Structure

Arch



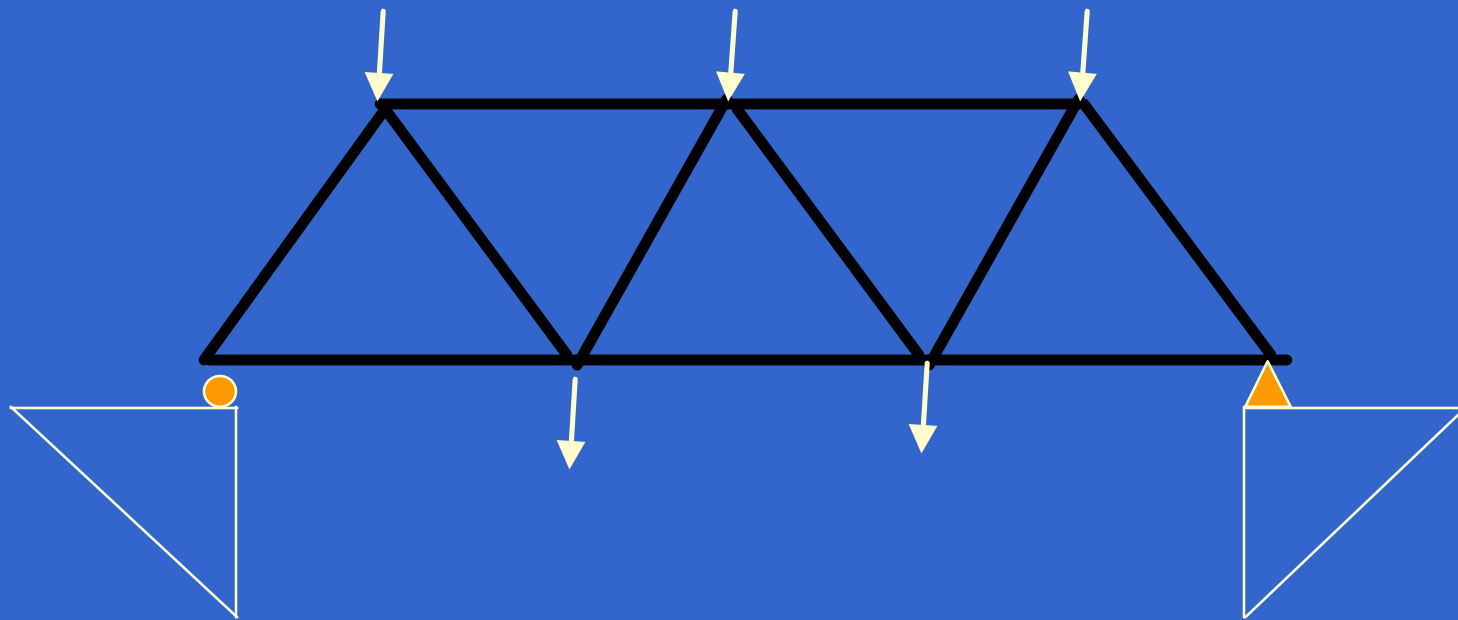


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Photos courtesy of Corel, Inc.

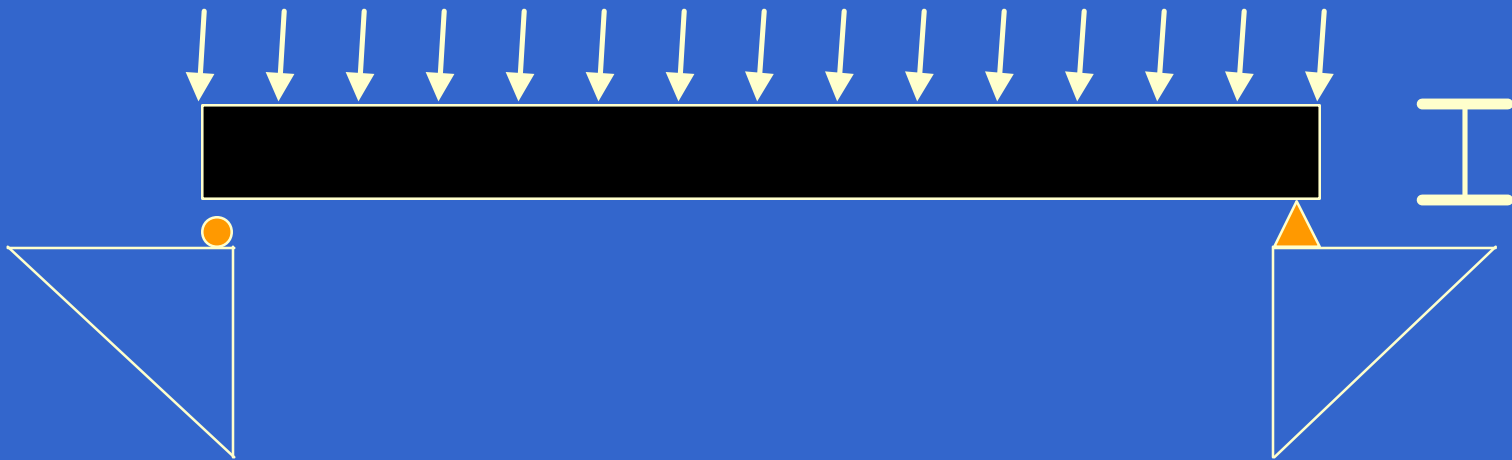
Planar Truss





Photos courtesy of Corel, Inc.

Beam/Girder



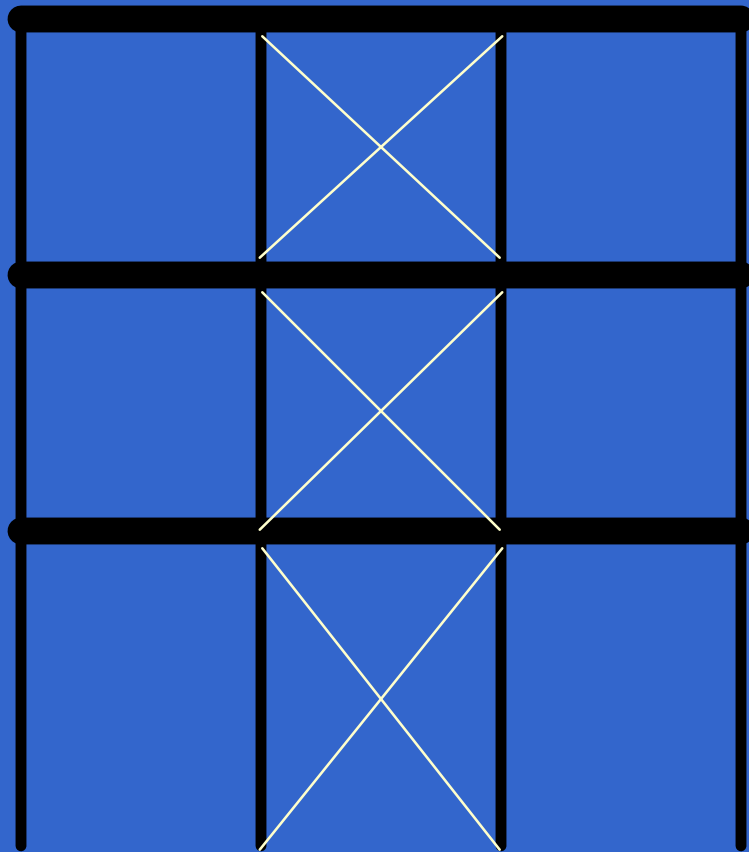


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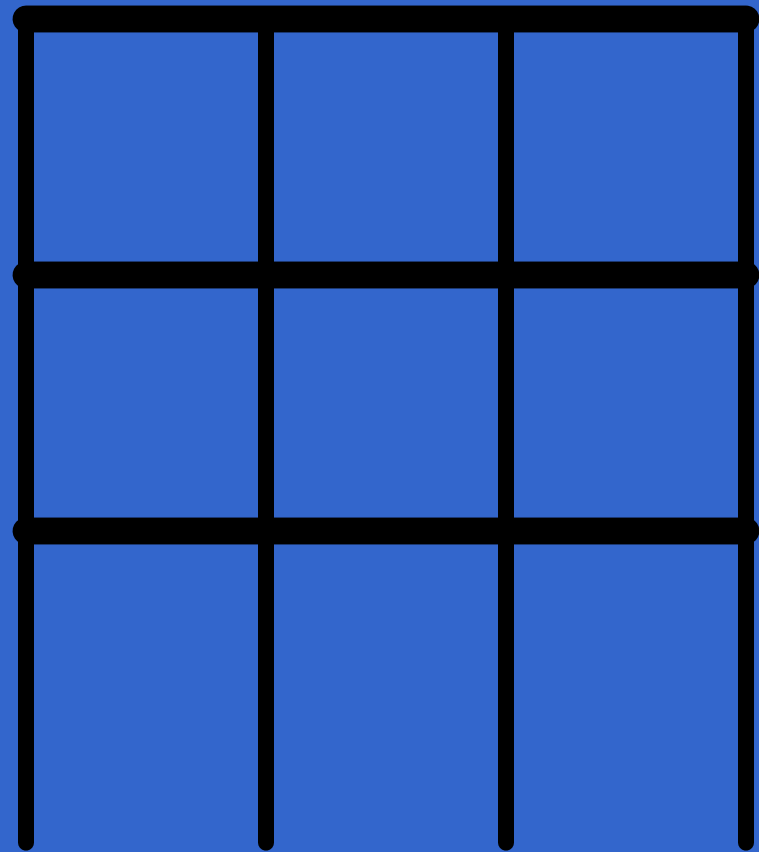
Photo courtesy of Prof. P. Steif

Frames

Braced

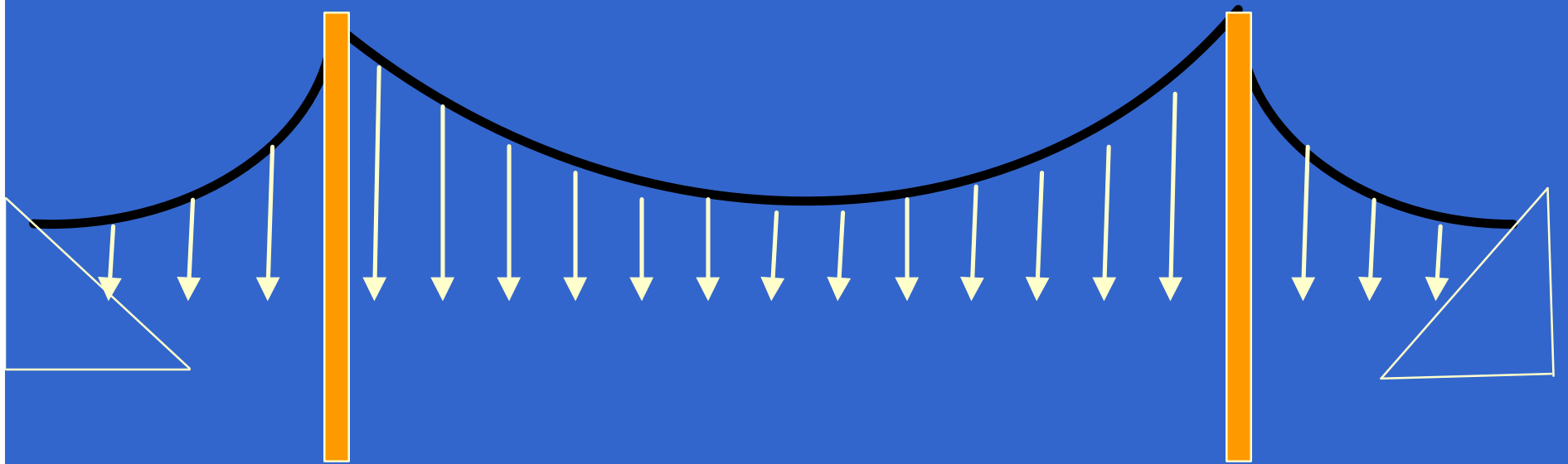


Rigid



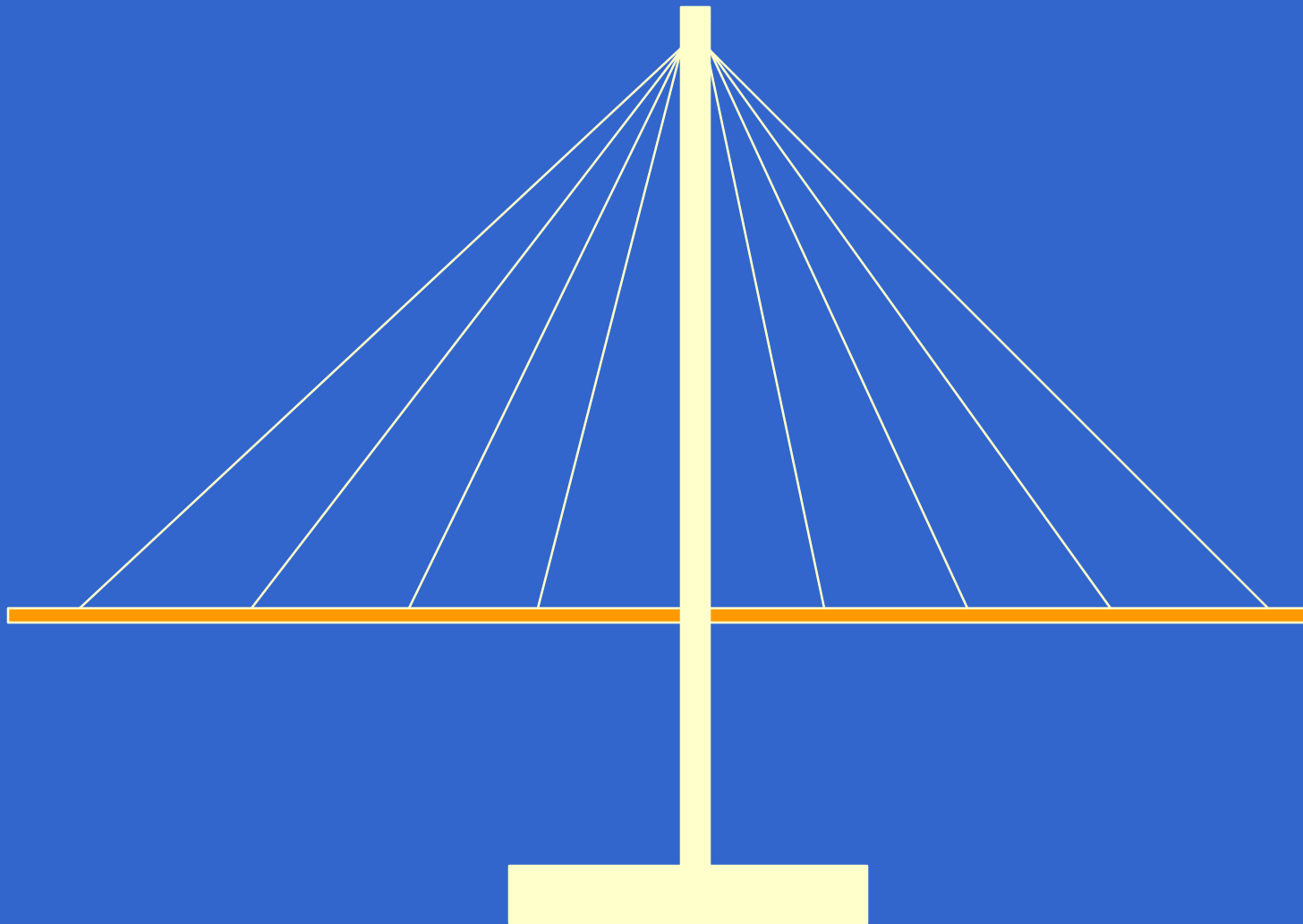


Cable Suspended Structure





Cable Stayed Bridge

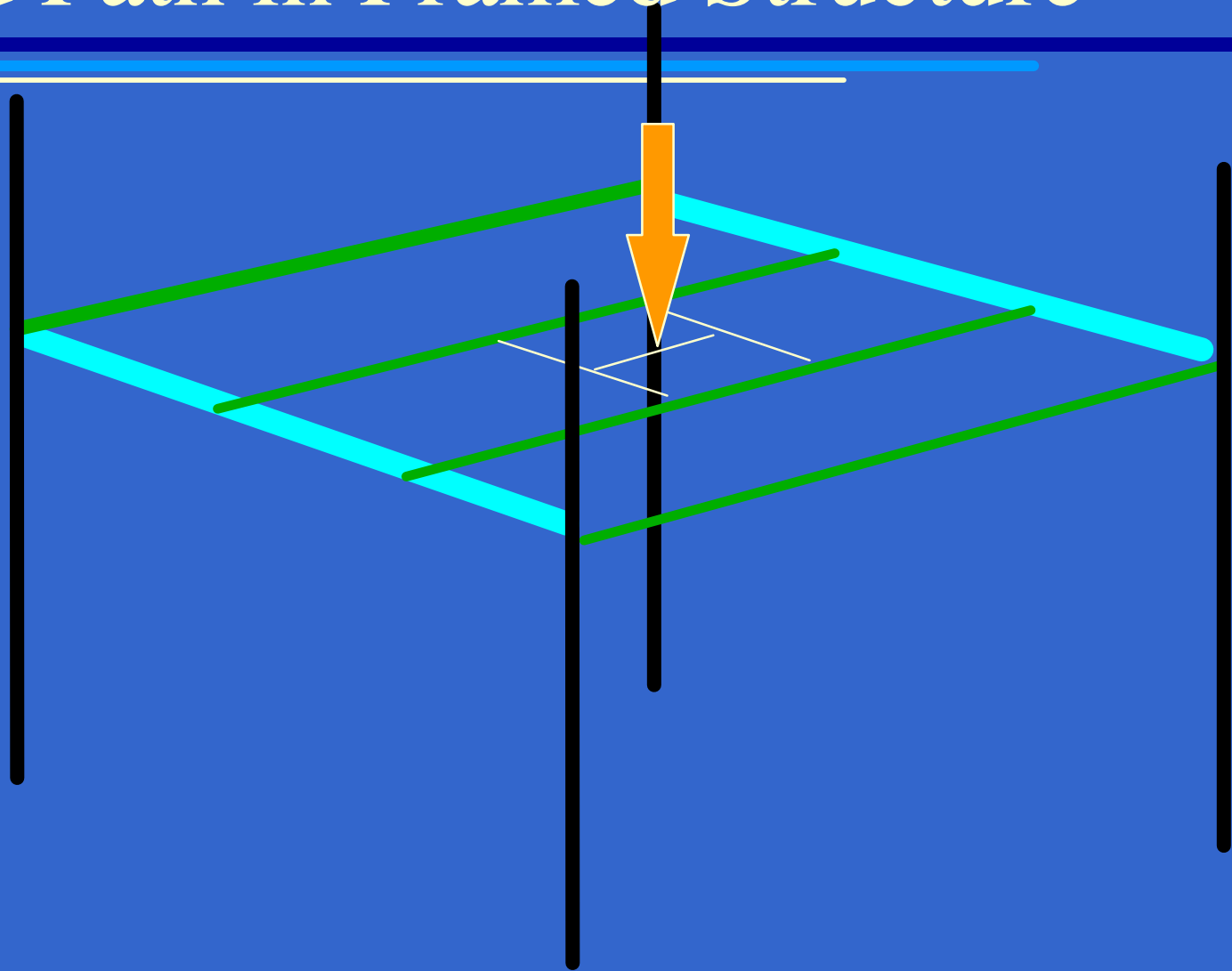




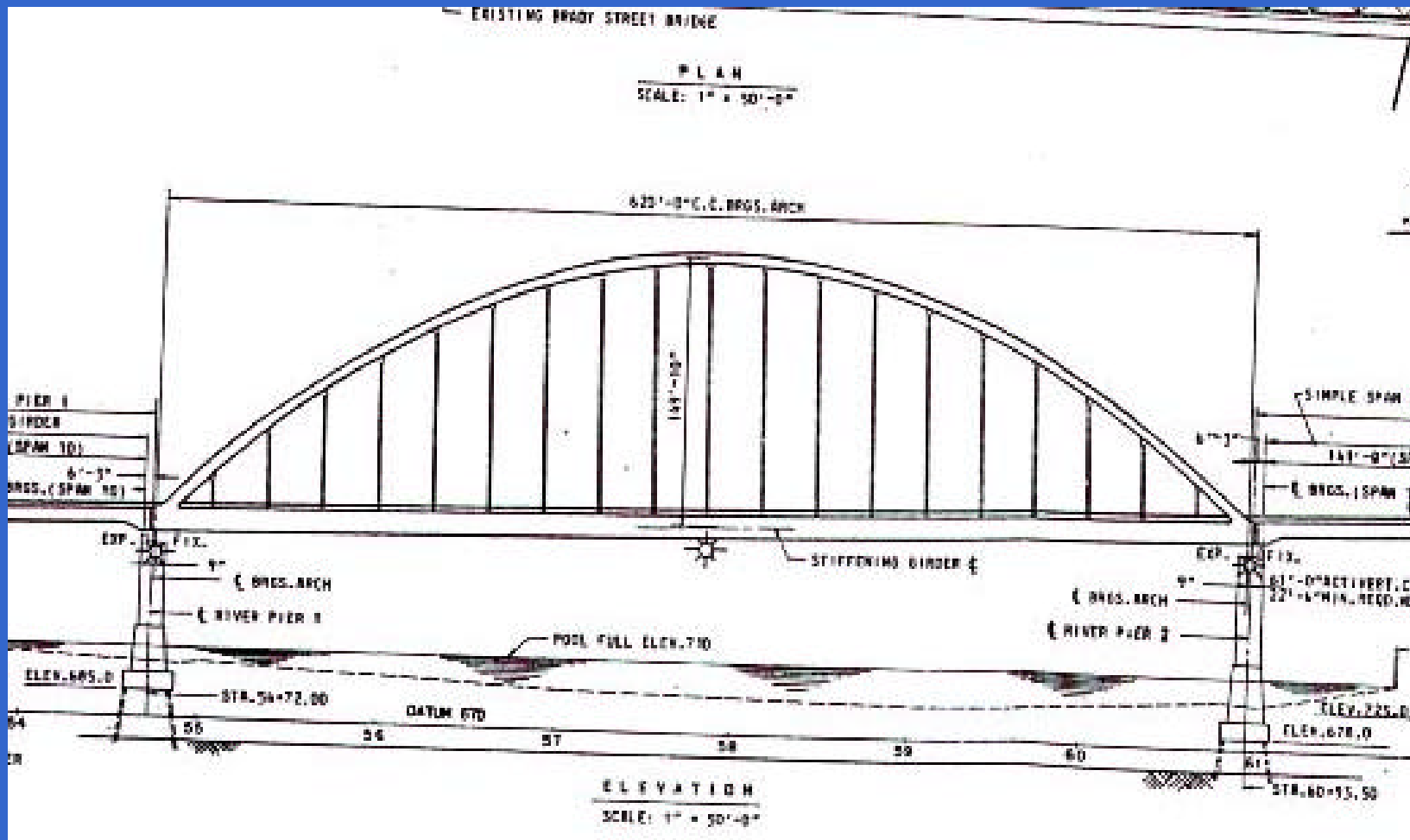
Load Paths in Structures

- Load Path is the term used to describe the path by which loads are transmitted to the foundations
- Different structures have different load paths
- Some structures have only one path
- Some have several (redundancy good)

Load Path in Framed Structure



Load Path in a Tied Arch



Courtesy of Pennsylvania Department of Transportation

Summary

- Structural Engineering:
 - identifies loads to be resisted
 - identifies alternatives for providing load paths (arch, truss, frame, ...)
 - designs structure to provide safe and economical load paths (material, size, connections)
 - to be economical and safe, we must be able to predict what forces are in structure.