CE 6321 Bridge Structure

INTRODUCTION

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BRIDGES

A bridge is a structure built to span a valley, road, body of water, or other physical obstacle, for the purpose of providing passage over the obstacle.

History of Bridge Development

Natural Bridges

Clapper Bridge
- ✓ Tree trunk
- ✓ Stone

700 A.D. Asia

Great Stone Bridge in China
- ✓ Low Bridge
- ✓ Shallow Arch

Roman Arch Bridge
- ✓ The Arch
- ✓ Natural Cement

100 B.C. Romans

- ✓ Strength of Materials
- ✓ Mathematical Theories
- ✓ Development of Metal

1300 A.D. Renaissance

History of Bridge Development

1800 A.D.

First Cast-Iron Bridge
Coalbrookdale, England

1900 A.D.

Truss Bridges
- ✓ Mechanics of Design

2000 A.D.

- ✓ Prestressed Concrete
- ✓ Cable Stayed

Britannia Tubular Bridge
- ✓ Wrought Iron

1850 A.D.

Suspension Bridges
- ✓ Use of Steel for the suspending cables

1920 A.D.

How Bridges Work?

Every passing vehicle shakes the bridge up and down, making waves that can travel at hundreds of kilometers per hour. Luckily the bridge is designed to damp them out, just as it is designed to ignore the efforts of the wind to turn it into a giant harp. A bridge is not a dead mass of metal and concrete: it has a life of its own, and understanding its movements is as important as understanding the static forces.

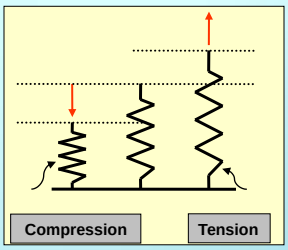
Basic Concepts

Span - the distance between two bridge supports, whether they are columns, towers or the wall of a canyon.

Force - any action that tends to maintain or alter the position of a structure

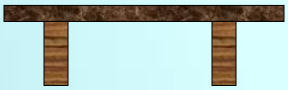
Compression - a force which acts to compress or shorten the thing it is acting on.

Tension - a force which acts to expand or lengthen the thing it is acting on.



Basic Concepts

Beam - a rigid, usually horizontal, structural element



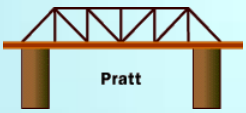
Pier - a vertical supporting structure, such as a pillar

Cantilever - a projecting structure supported only at one end, like a shelf bracket or a diving board

Load - weight distribution throughout a structure

Basic Concepts

Truss - a rigid frame composed of short, straight pieces joined to form a series of triangles or other stable shapes

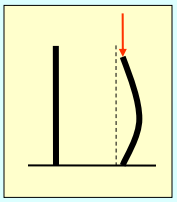


Stable - (adj.) ability to resist collapse and deformation; stability (n.) characteristic of a structure that is able to carry a realistic load without collapsing or deforming significantly

Deform - to change shape

Basic Concepts

Buckling is what happens when the force of compression overcomes an object's ability to handle compression. A mode of failure characterized generally by an unstable lateral deflection due to compressive action on the structural element involved.



Snapping is what happens when tension overcomes an object's ability to handle tension.

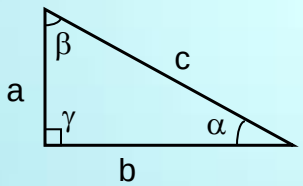
To **dissipate** forces is to spread them out over a greater area, so that no one spot has to bear the impact of the concentrated force.

To **transfer** forces is to move the forces from an area of weakness to an area of strength, an area designed to handle the forces.

Bridge Engineering

Basic math and science concepts

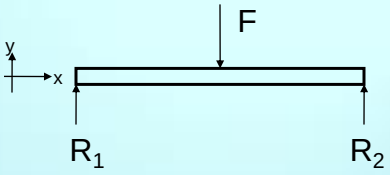
Pythagorean Theorem



- $c^2=b^2+a^2$
- $\alpha+\beta+\gamma=180°$

Basic math and science concepts

Fundamentals of Statics



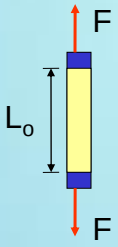
$\Sigma F_x = 0$

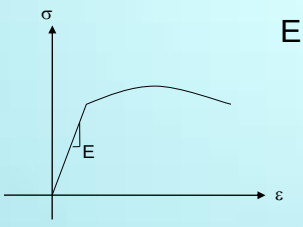
$\Sigma F_y = R_1 + R_2 - P = 0$

Basic math and science concepts

Fundamentals of Mechanics of Materials

Modulus of Elasticity (E):





$$E = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta L/L_o}$$

where:

F = Longitudinal Force

A = Cross-sectional Area

ΔL = Elongation

L_o = Original Length

Basic math and science concepts

To design a bridge like you need to take into account the many ***forces acting on it*** :

- The pull of the earth on every part
- The ground pushing up the supports
- The resistance of the ground to the pull of the cables
- The weight of every vehicle

Then there is the drag and lift produced by the wind

- The turbulence as the air rushes past the towers

Thanks for your attention and success with your study!