1.050 Engineering Mechanics

Lecture 6: Stresses and Equilibrium

Application: Hoover Dam

1.050 – Content overview

I. Dimensional analysis

1. On monsters, mice and mushrooms
2. Similarity relations: Important engineering tools

Lectures 1-3
Sept.

II. Stresses and strength

2. Stresses and equilibrium
3. Strength models (how to design structures, foundations.. against mechanical failure)

Lectures 4-15
Sept./Oct.

III. Deformation and strain

4. How strain gages work?
5. How to measure deformation in a 3D structure/material?

Lectures 16-19
Oct.

IV. Elasticity

5. Elasticity model – link stresses and deformation
6. Variational methods in elasticity

Lectures 20-31
Nov.

V. How things fail – and how to avoid it

7. Elastic instabilities
8. Plasticity (permanent deformation)
9. Fracture mechanics

Lectures 32-37
Dec.

1.050 – Content overview

I. Dimensional analysis

II. Stresses and strength

Lecture 4: Newton's laws, fall of the WTC towers
Lecture 5: Stress vector and stress tensor
Lecture 6: Hydrostatic problem ← Applications
Lecture 7: Soil mechanics / geostatics problem
Lecture 8: Beam stress model
Lecture 9: Beam model II and summary
Lecture 10: Strength models
…

III. Deformation and strain

IV. Elasticity

V. How things fail – and how to avoid it

Content lecture 6

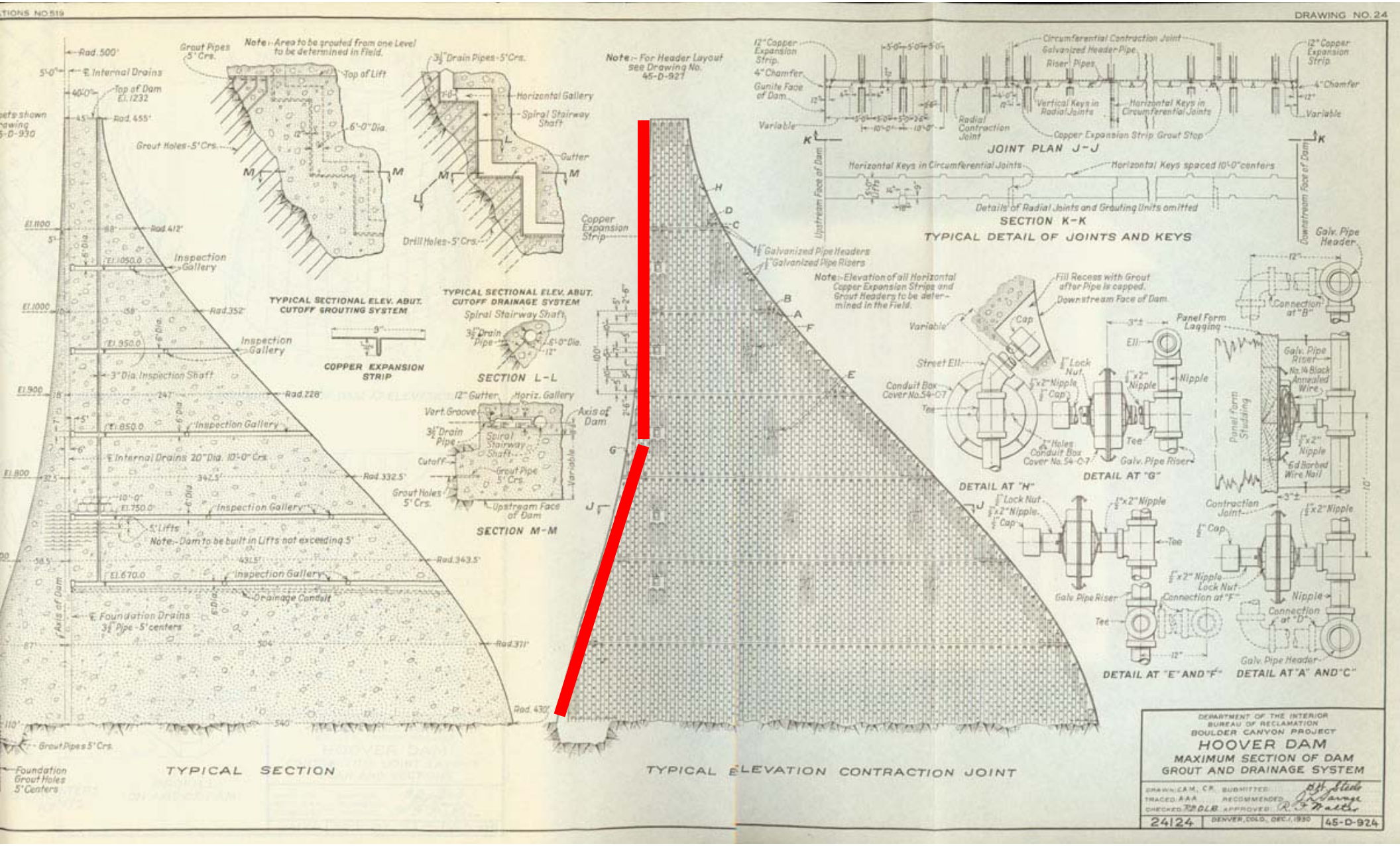
1. **Review: 3-scale continuum model:** Molecular scale, representative volume element (REV), macro-scale; **stress vector and stress tensor**

2. **Implement dynamic resultant theorem for REV**
   - Use Gauss theorem (divergence theorem)
   - Develop differential equilibrium: Partial differential equation

3. **Application: Hoover Dam (hydrostatic problem)**

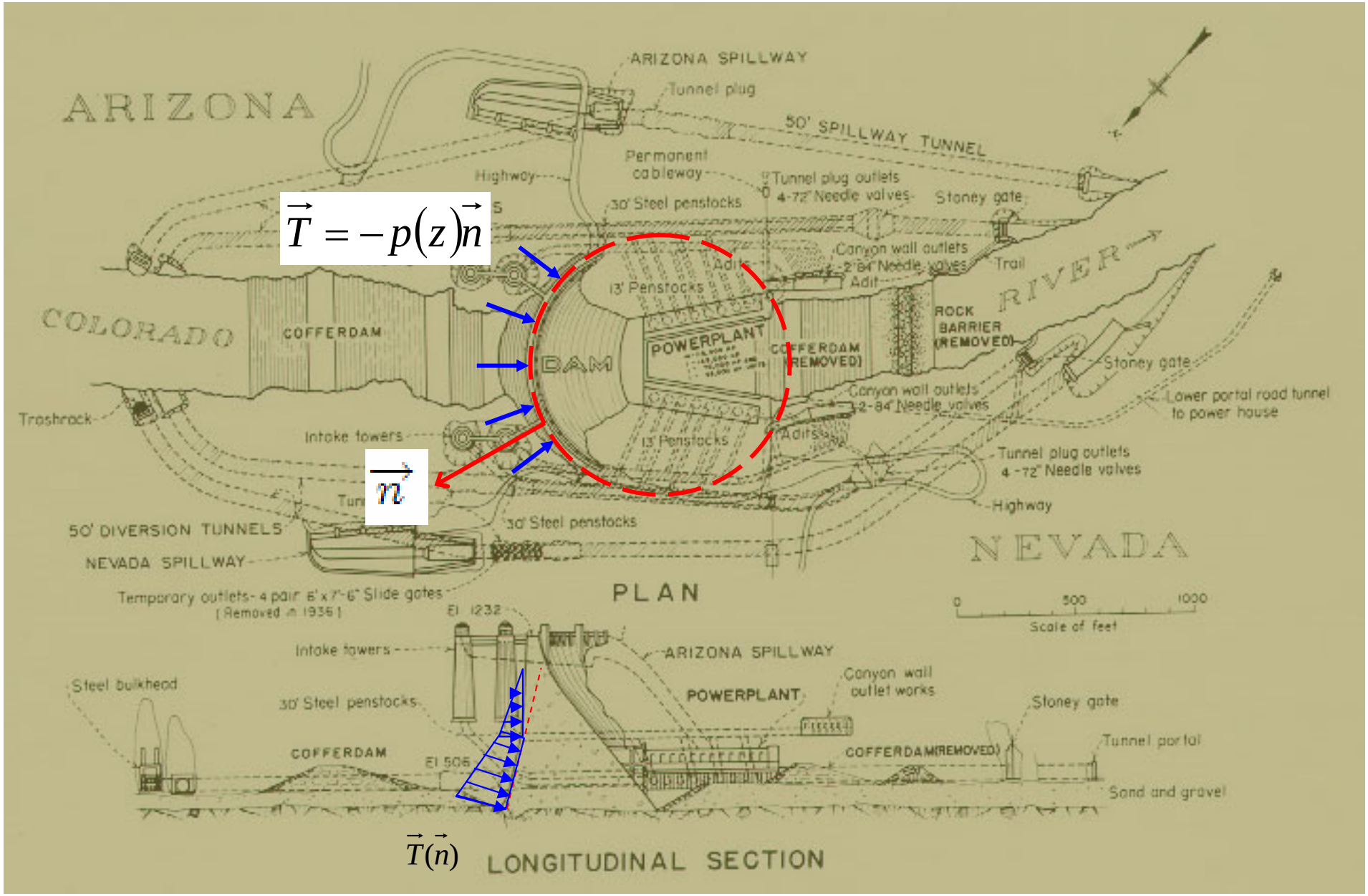
Photographs of Hoover Dam removed due to copyright restrictions.

http://www.concreteresources.net/images/graphics/clip_image004.jpg
http://www.sdsuniverse.info/Upload/hoover_dam.jpg



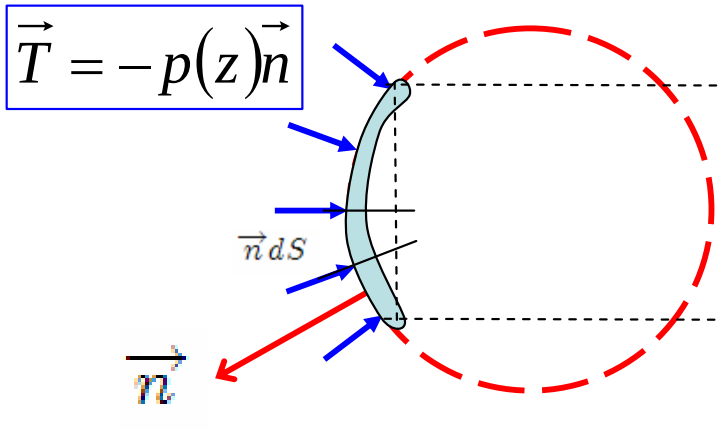
Energy Production ~ 4 billion kilowatt-hours a year ~ 1.3 million people

Forces that act on Hoover Dam



Forces that act on Hoover Dam
Force reduction formula

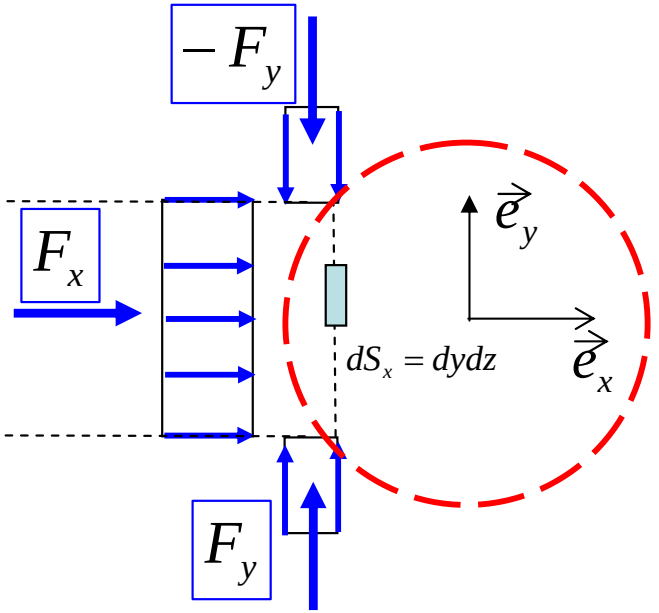
- Forces from stress vector



$$\vec{F} = \int_S \vec{T}(\vec{n})\,dS = \int_S -p(z)\,\vec{n}\,dS$$

Surface on which stress Vector acts

- Force Equivalence



$$F_x = \vec{F} \cdot \vec{e}_x = \int_{S_\infty} p(z)\,dS_x$$

Hoover Dam: F_x ~ 16 billion Newton (weight equivalence of 20 million people, or of the entire population of Australia)