GE 207
MECHANICS OF MATERIALS

Big Dig Tunnel, Boston, MA

Lab 07:
Creep Test

PROFESSOR
CORRIE WALTON-
MACAULAY

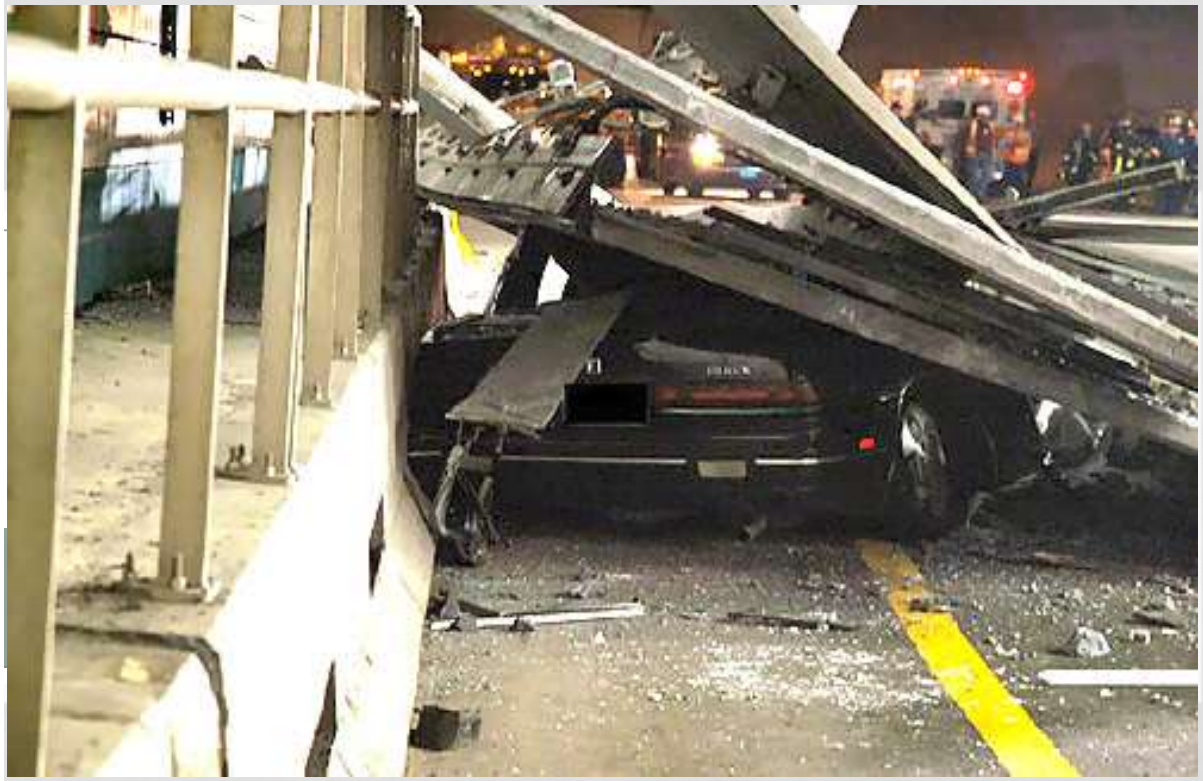


Photo Source: https://www.tunneltalk.com

LECTURE OUTLINE

- Recall Concepts (Walton-Macaulay)
  - Creep Test

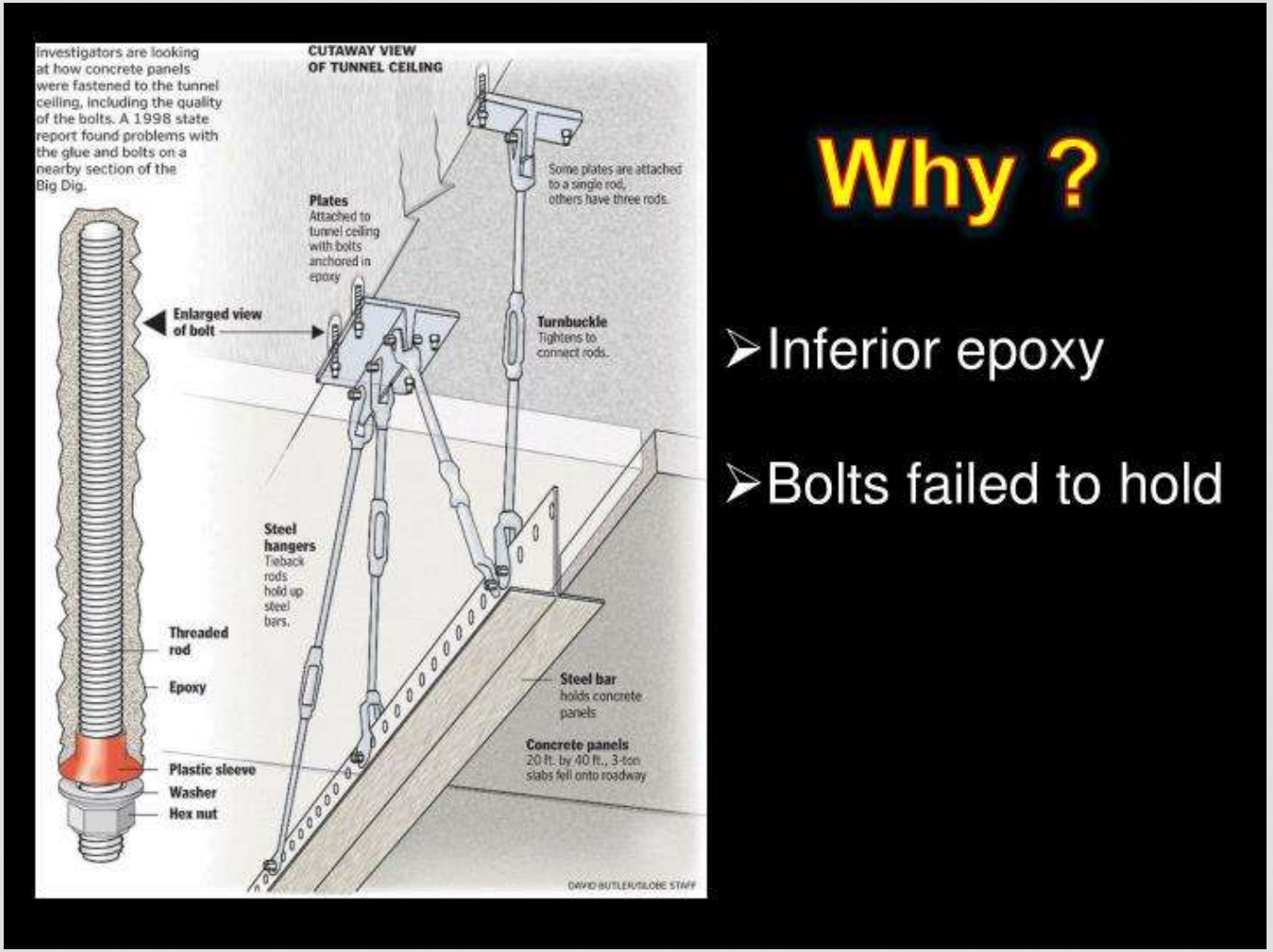
LECTURE OUTLINE

- Shear Force in a Beam
  - Many did not present a table of the reactions
  - How well does the theoretical shear forces predict the behavior of the beam? Not Answered

UPCOMING SCHEDULE

DATE	Class Lab	TOPIC	Reference		Repot Due Dates	
30-Mar	10	Creep			Final	13-Apr
31-Mar					Final	14-Apr
6-Apr	11	Computation/Report Lab / TakeDown Creep Test				
7-Apr						
13-Apr	12	Creep Test Report due				
14-Apr						
20-Apr	13	Course Evaluation				
21-Apr						
27-Apr		No Lab				
28-Apr						

BIG DIG CREEP FAILURE



BIG DIG CREEP FAILURE

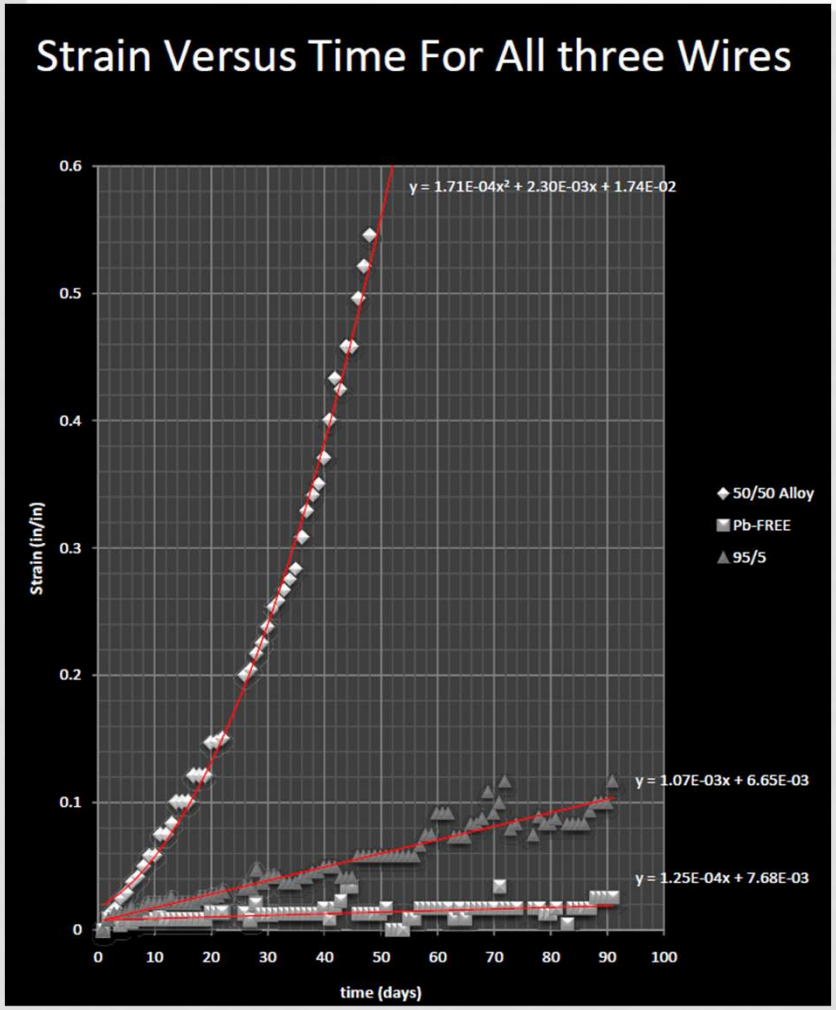
Why Bolts Fail?

- Overstress
- Fatigue
- Creep

Why Humans Fail?

- Overstress
- Fatigue
- They become creeps

CREEP TEST


Strain Versus Time For All three Wires
y = 1.71E-04x² + 2.30E-03x + 1.74E-02
y = 1.07E-03x + 6.65E-03
y = 1.25E-04x + 7.68E-03
50/50 Alloy
Pb-FREE
95/5
Strain (in/in)
time (days)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
10
20
30
40
50
60
70
80
90
100

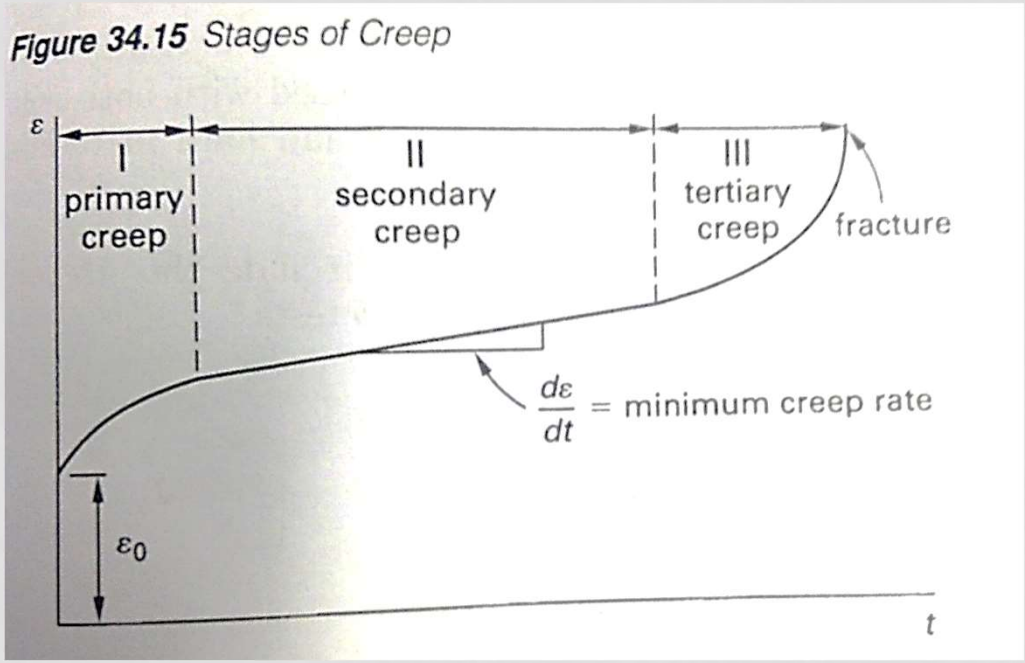


Figure 34.15 Stages of Creep
ε
I
primary
creep
II
secondary
creep
III
tertiary
creep
fracture
dε/dt = minimum creep rate
ε0
t

CREEP TEST (AKA CREEP STRAIN)

- Continuous yielding of a material under constant stress
- During creep test: low tensile load of constant magnitude is applied to a specimen
- Strain measured as a function of time

DEFINITION

- Creep strength: stress that results in specific creep rate (usually 0.001% or 0.0001% per hour)
- Rupture strength: stress that results in a failure after a given amount of time
- Creep rate: rate of change of strain over rate of change of time

$$\frac{d\varepsilon}{dt} = creep\ rate$$

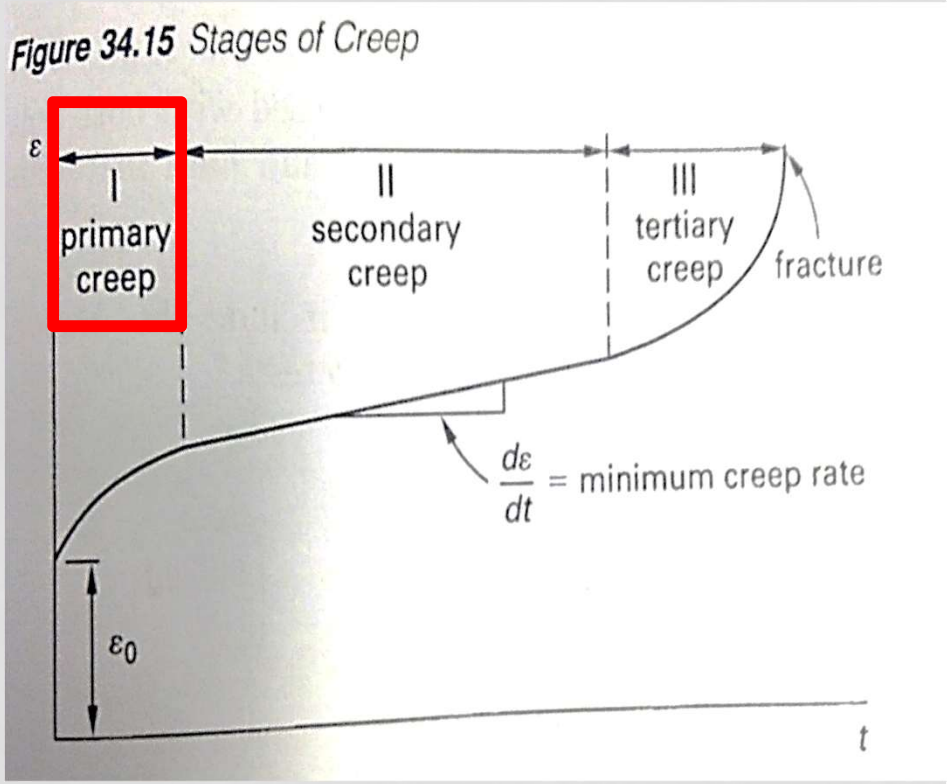
THREE STAGES OF CREEP

I. Primary Creep

Creep rate decreases since *strain hardening* occurs at a greater rate than *annealing*

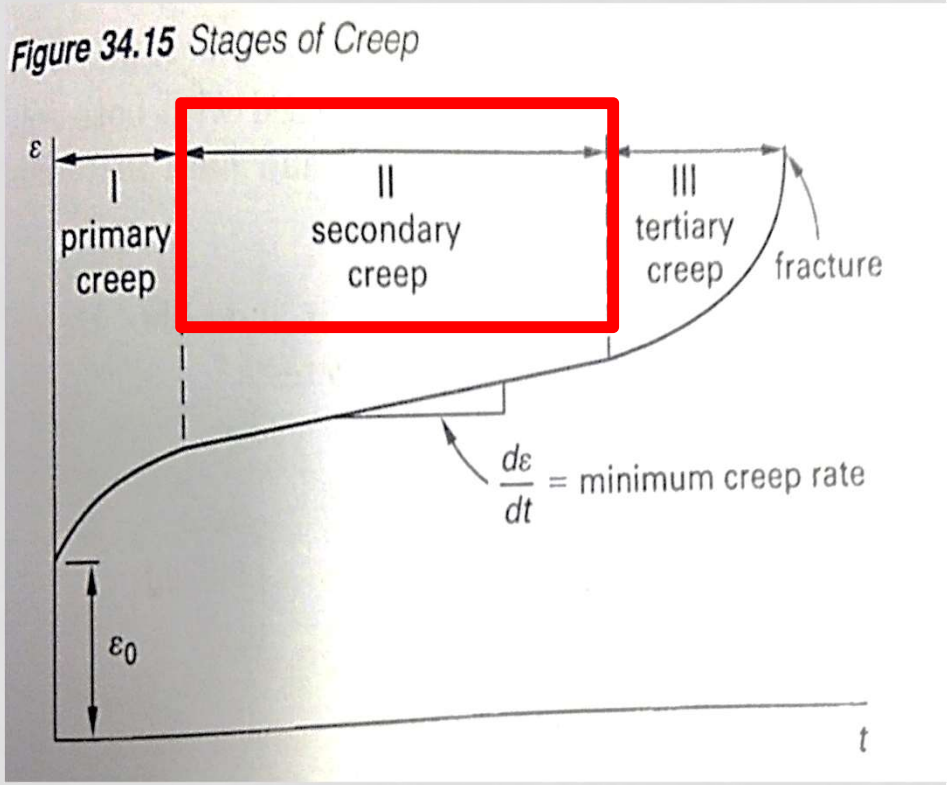
Strain hardening: dislocation generation and interaction with grain boundaries and other barriers)

Annealing: annihilation of dislocations, climb, cross-slip, and some recrystallization



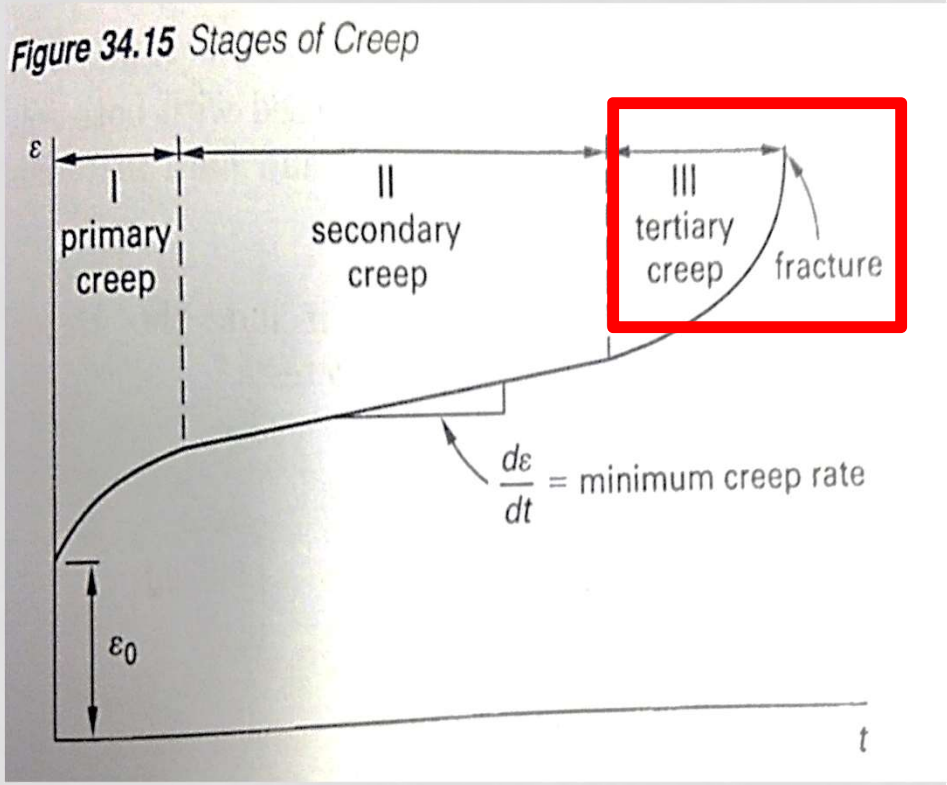
THREE STAGES OF CREEP

II. Secondary Creep (aka cold flow)
- Creep rate is constant;
- strain hardening and annealing occurring at same time
- typically, rate is lower than primary and tertiary creep rates
- Creep rate in secondary creep represented by slope (on log-log scale) is stress and temperature dependent



THREE STAGES OF CREEP

III. Tertiary Creep (aka cold flow)
   - Specimen begins to "neck down"
   - Rupture eventually occurs



RESULTS AND DISCUSSION SECTION

- Graph: Plot a graph of creep strain versus time (in days)
- Are three stages of creep evident in the graph you developed?
  - Label and discuss the three stages of creep (if it is evident)

- Determine values for the provided data
  - E.g. note equation for best fit curve
  - the R^2 values of the graphs
  - Determine the minimum creep rate (if evident)

RESULTS AND DISCUSSION SECTION

- Consider how variation in temperature might influence the creep strain versus time curve. Was this significant in your actual experiment?
- Do experiments involve "relaxation"?
- Compare 2017 data to 2023 data
  - E.g. note equation for best fit curve
  - the R^2 values of the graphs
  - How did completeness of data affect the "fitness" of your curve?

REPORT TYPE

- Group report
  - Full Report
    - Abstract
    - Introduction
    - Procedure
    - Results and Discussion
    - Conclusion
    - Reference
    - Apendix