Low Temp. Asphalt Behavior

Presented by

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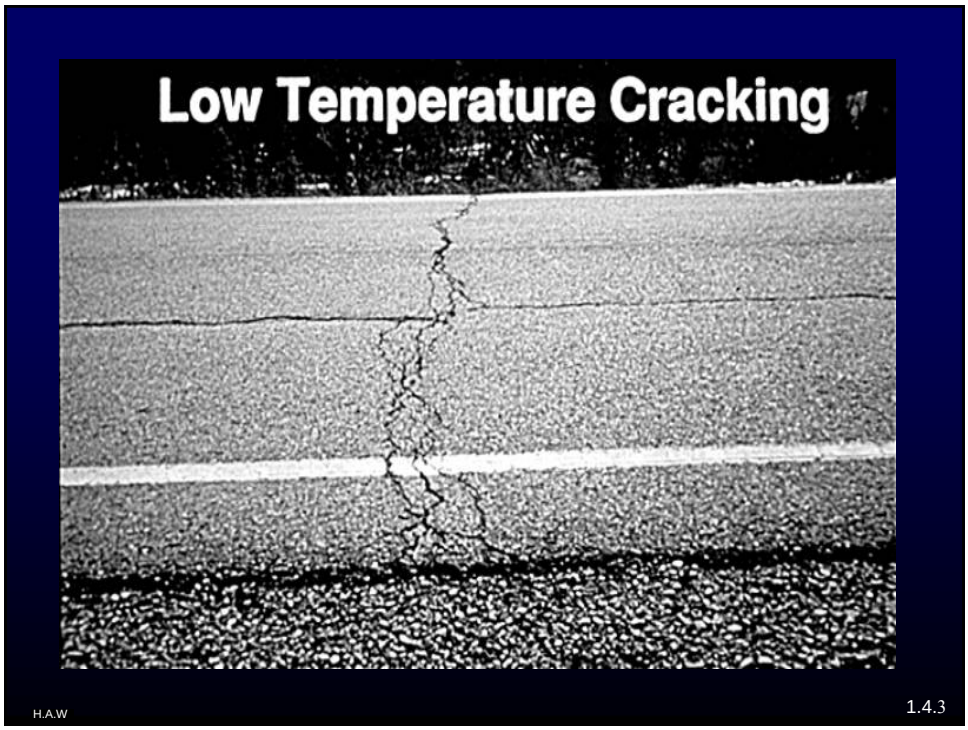
CONTENT

ASPHALT BINDER BEHAVIOR & TESTING AT LOW-TEMPEPATURE



Pavement Field Performance

Pavement Temperature, C

-20 20 60 135

Environment and Load **Construction**

Low Temp Cracking | Fatigue Cracking | Rutting | Workability

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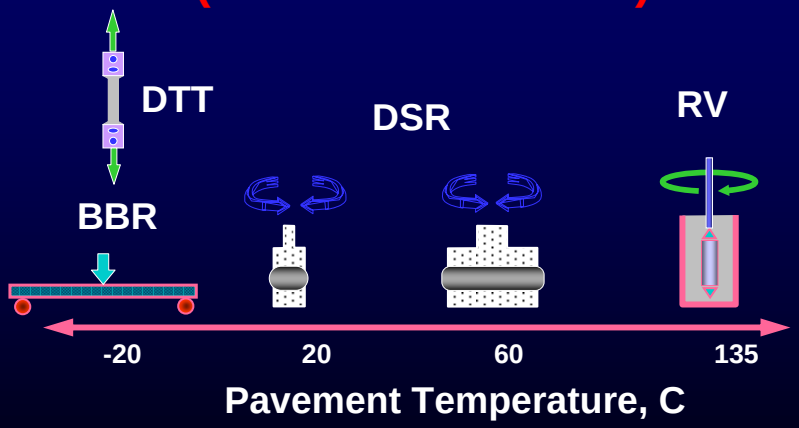
SHRP SPECIFICATIONS (ASPHALT BINDER)



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Question?

How to specify **ASPHALT** binder for low temperature cracking resistance ?

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Low Temperature Behavior

- At low temp pavement shrinks at cold weather.
- Tensile stresses build-up within the layer.
- When stresses exceeds tensile strength, cracks occur.
- Usually happens in one cycle, but worse at repeated low temp. cycles.
- This behavior depends on the source of asphalt and mix properties.

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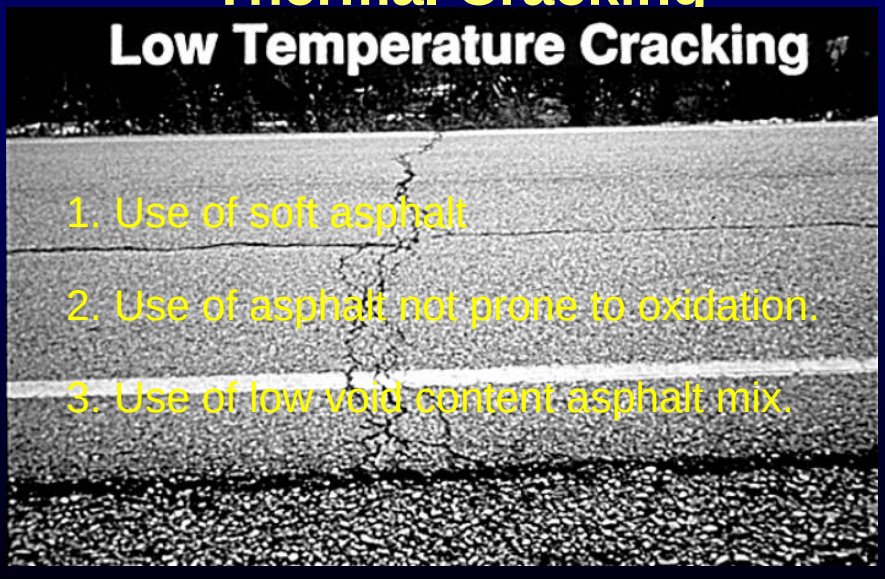
Thermal Cracking



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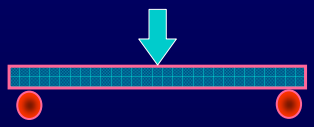
SHRP SPECIFICATIONS

Bending Beam Rheometer (BBR)



Direct Tension Tester (DTT)

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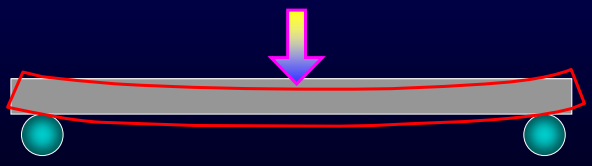
1.4.9

Bending Beam Rheometer (BBR)



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Bending Beam Rheometer

- **Purpose**
  -- low temperature stiffness properties
- **Output**
  -- creep stiffness (**S**)
  -- slope of log **S** vs. log time plot (**m**)

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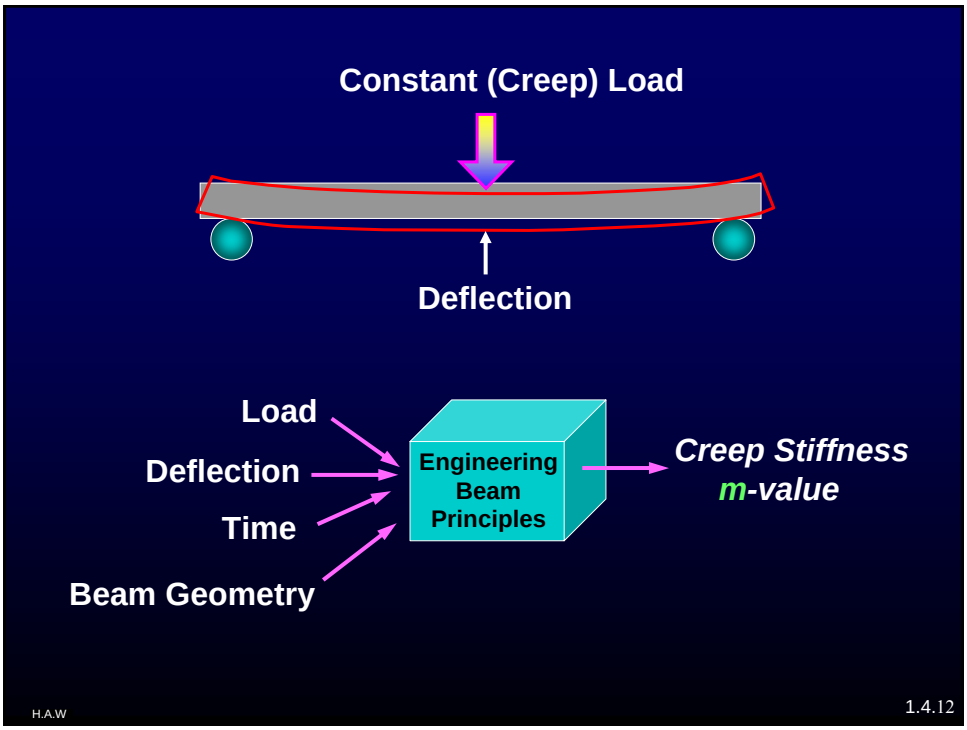

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OUTPUT Interpretation?

S: Measures how the asphalt binder resist the constant loading

m: Measures how the stiffness changes as loads are applied.

Desirable: Low S and High m

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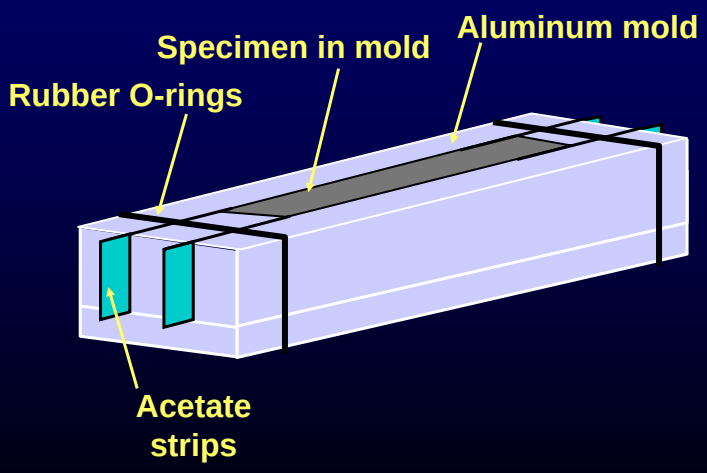
Specimen Preparation



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Specimen Preparation

- Assemble Mold
- Fill Mold with Binder
- Cool
- Demold Specimen

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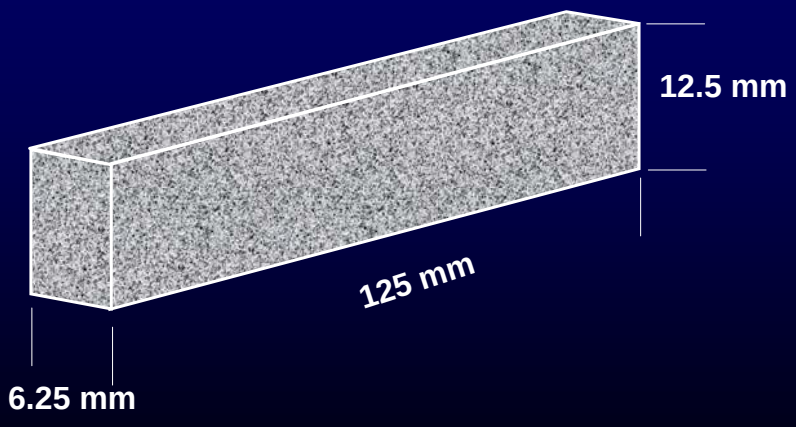
Specimen Preparation



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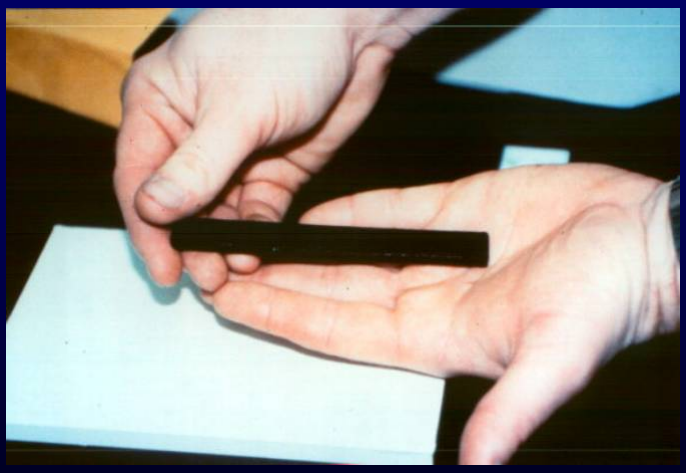
Bending Beam Rheometer Sample



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Specimen Preparation

Temperature Conditioning

-- use rheometer test bath at test temperature for 60 ± 5 minutes

-- "Physical Hardening" phenomenon requires tight tolerance on conditioning period.

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Tester Equipment

- **Loading Frame**
  - -- loading shaft
  - -- air bearing
  - -- deflection transducer
  - -- load cell
  - -- beam supports
- **Controlled Temperature Liquid Bath**
  - -- glycol, Methanol, and water
  - -- circulating bath
  - -- test bath
- **Computerized Data Acquisition System**

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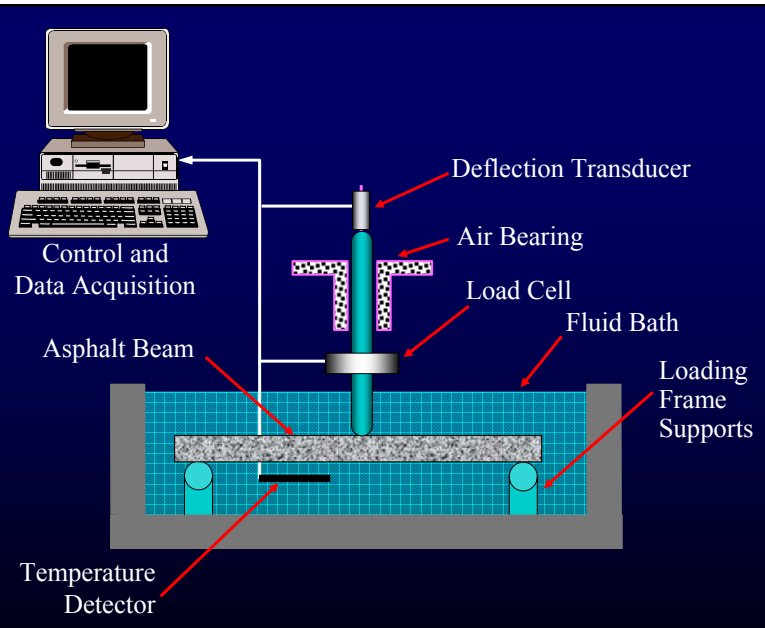

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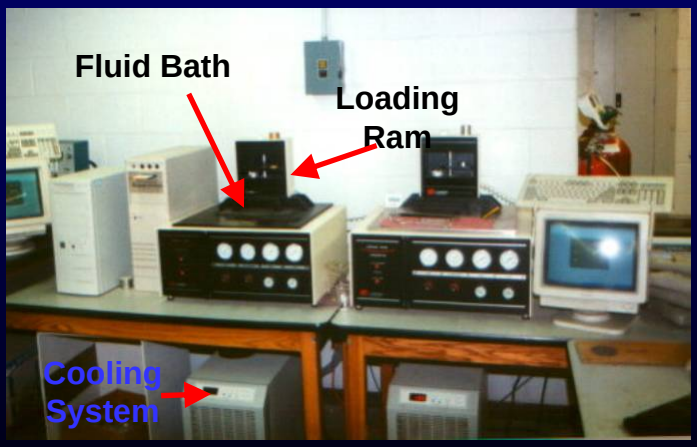
Bending Beam Rheometer Equipment



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Overview of Procedure

- **Apply Preload**
  - -- 25 to 35 mN (2.5 to 3.5g)
  - -- keeps specimen in contact with supports
- **Apply Seating Load**
  - -- 980 mN (100 g) for 1 sec
  - -- 20 sec recovery period
- **Apply Test Load**
  - -- 980 mN (100 g) for 240 sec
  - -- observe load/deflection plots on computer screen

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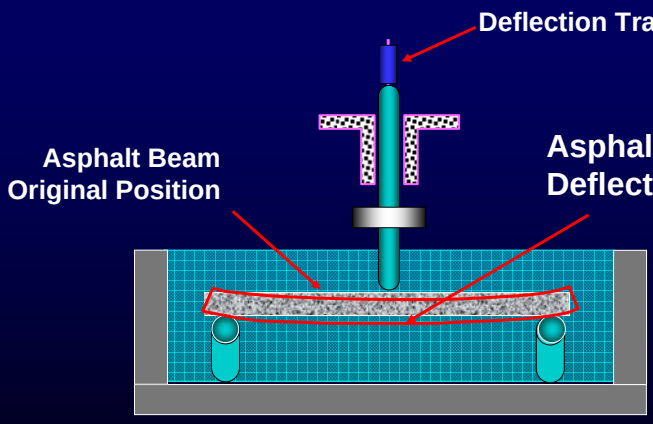

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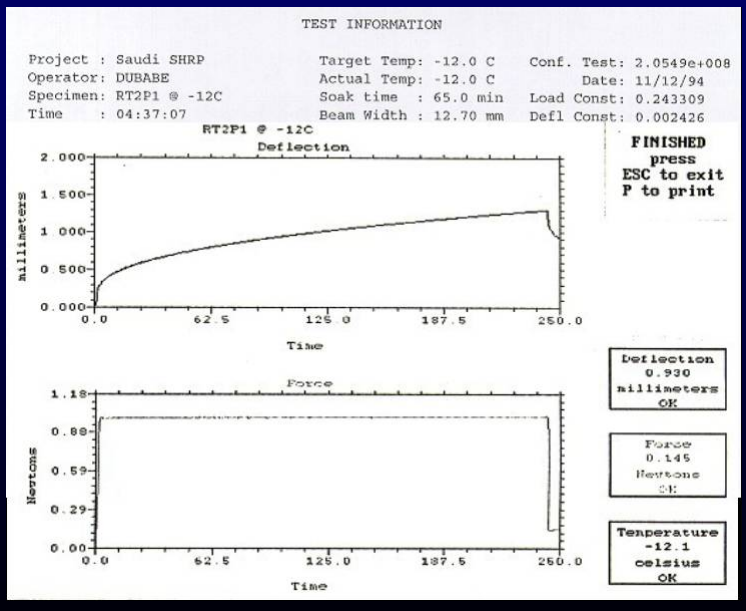
Typical Output



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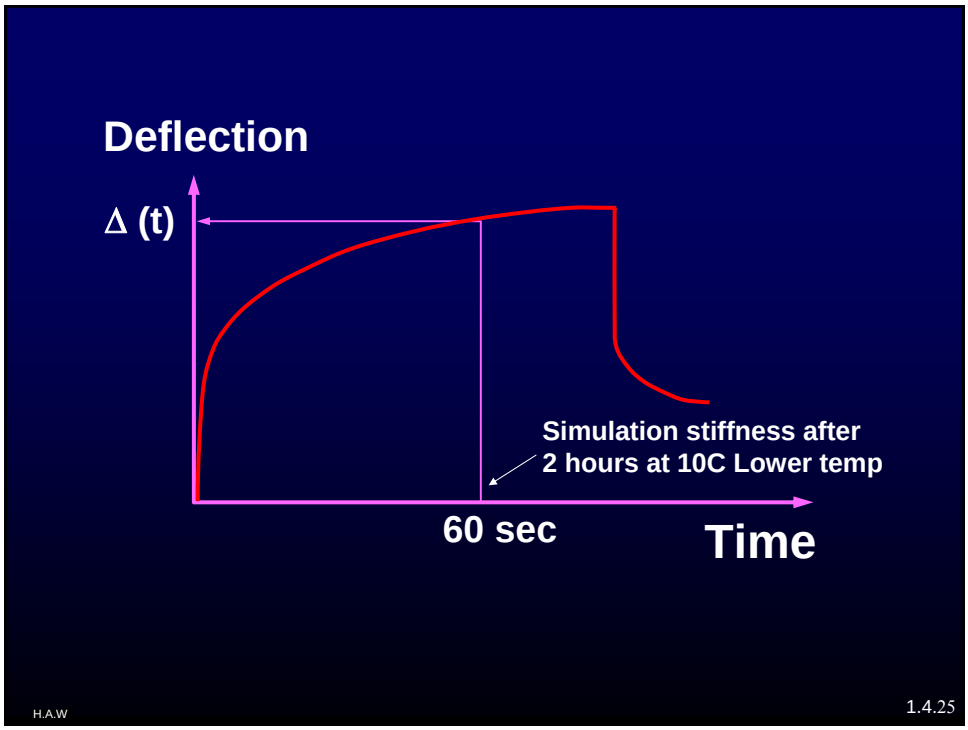
Deflection
Δ (t)
Simulation stiffness after
2 hours at 10C Lower temp
60 sec
Time
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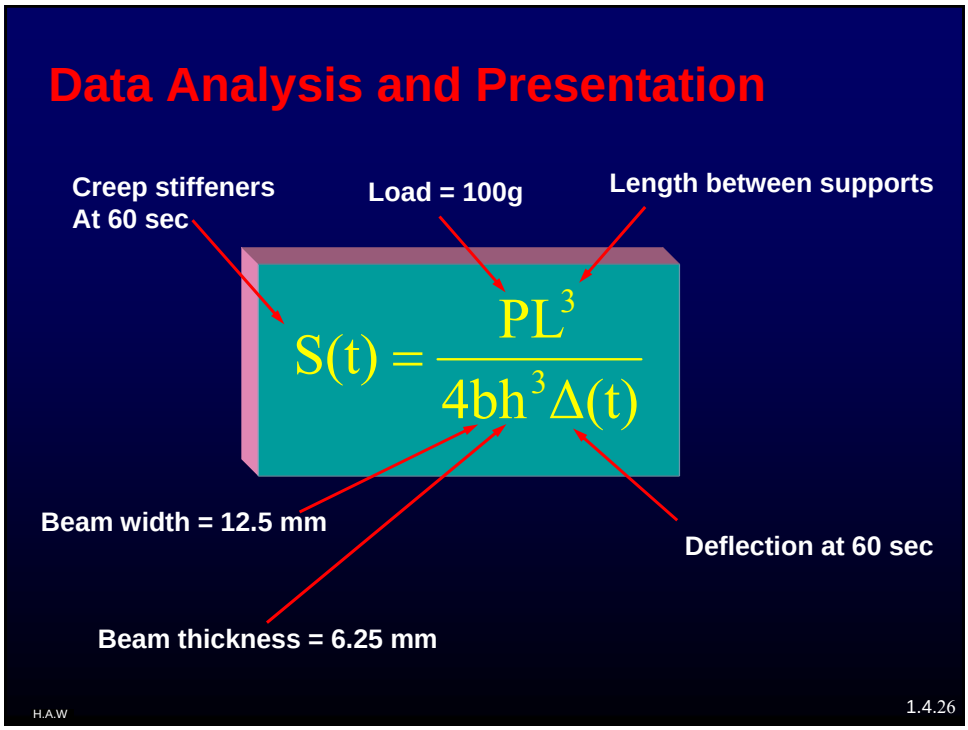
1.4.25


Data Analysis and Presentation
Creep stiffeners
At 60 sec
Load = 100g
Length between supports
$S(t) = \frac{PL^3}{4bh^3\Delta(t)}$
Beam width = 12.5 mm
Deflection at 60 sec
Beam thickness = 6.25 mm
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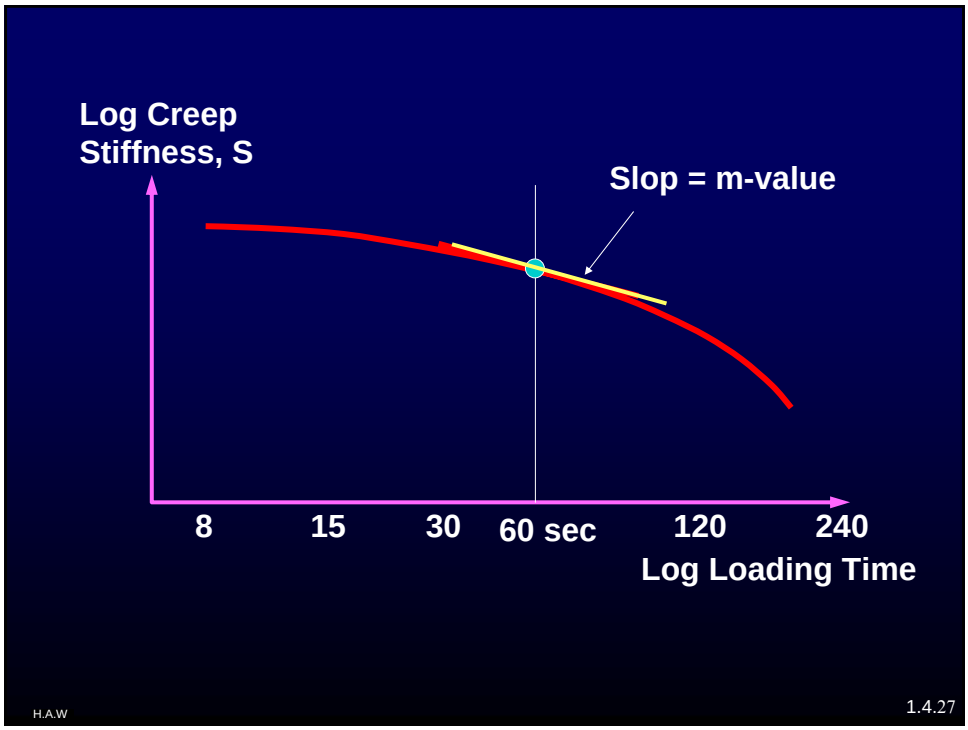

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Data Analysis and Presentation

- *All Calculations Performed by Computer*
- Report S and m-Value at Test Temperature

-- $m \geq 0.30$

-- $S \leq 300$ MPa, or

-- $S \leq 600$ MPa if tensile failure stain ≥ 1.0 %

esp. polymer modify Ac.

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Direct Tension Tester

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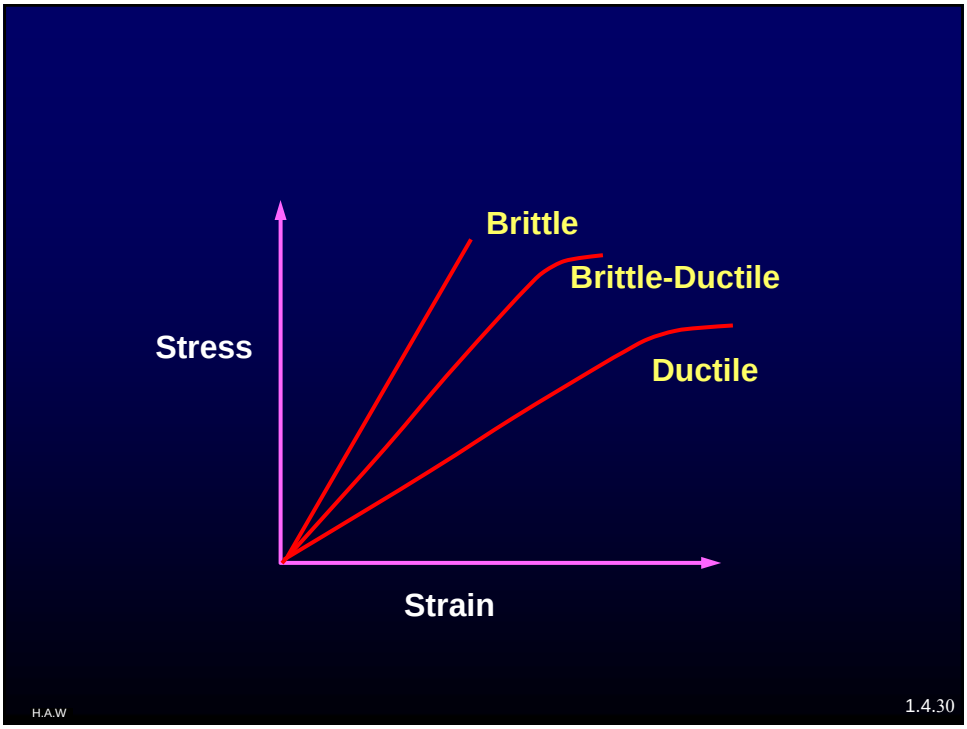
1.4.29



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Direct Tension Tester

- **Purpose**
  - -- low temperature ability to stretch
- **Output**
  - -- tensile strain at failure

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It is a continuation and confirmation of BBR
for
S = 300 to 600 MPa if $m \geq 0.30$.

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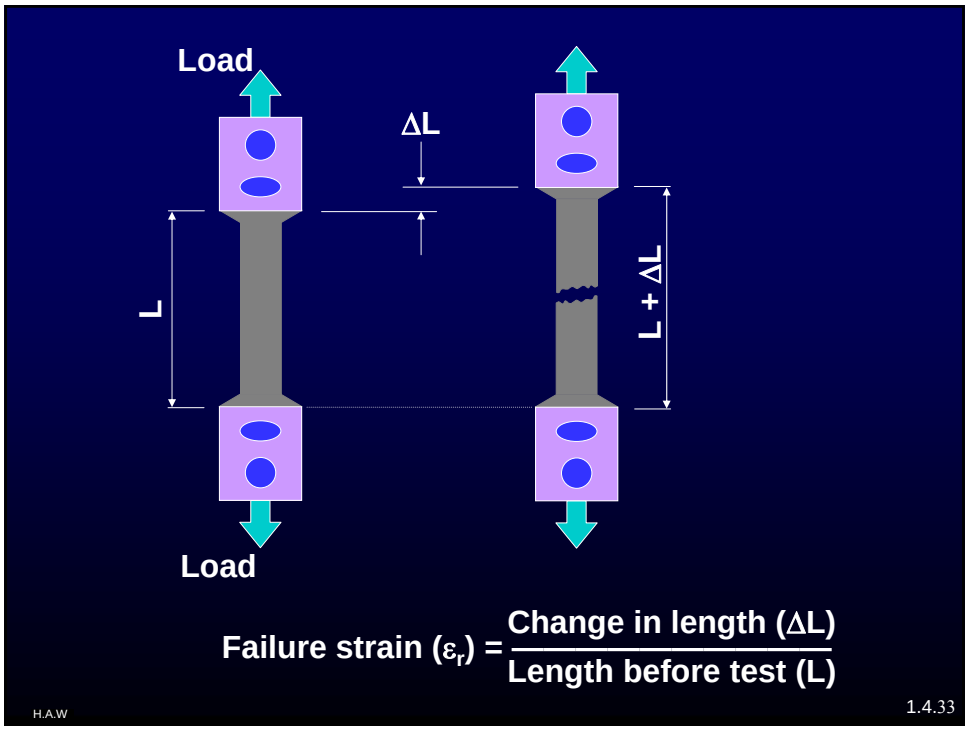
1.4.32



$$\text{Failure strain } (\varepsilon_f) = \frac{\text{Change in length } (\Delta L)}{\text{Length before test } (L)}$$

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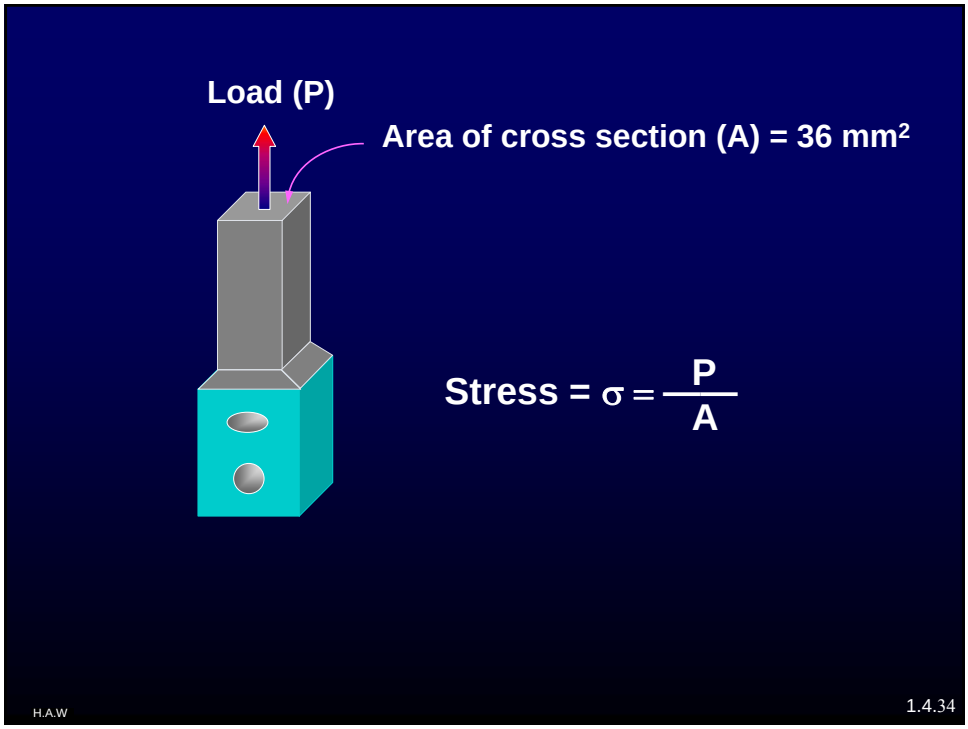
1.4.33



$$\text{Stress} = \sigma = \frac{P}{A}$$

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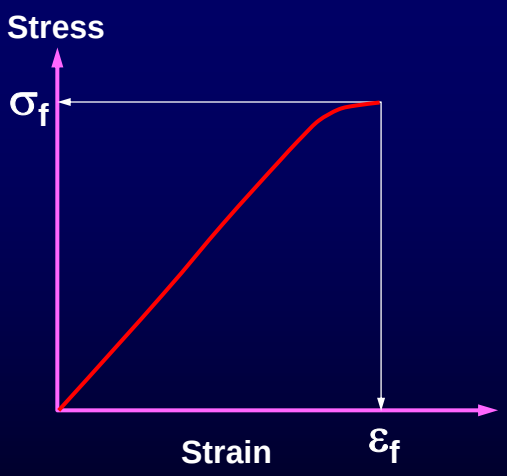

$$\varepsilon_f = \frac{\Delta L}{L_e} = \frac{\Delta L}{27\ \text{mm}}$$

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Specimen Preparation

- Silicon Rubber Mold
  -- 4 specimen per test
- Fill Mold with Binder
- Cool
- Trim
- Demold

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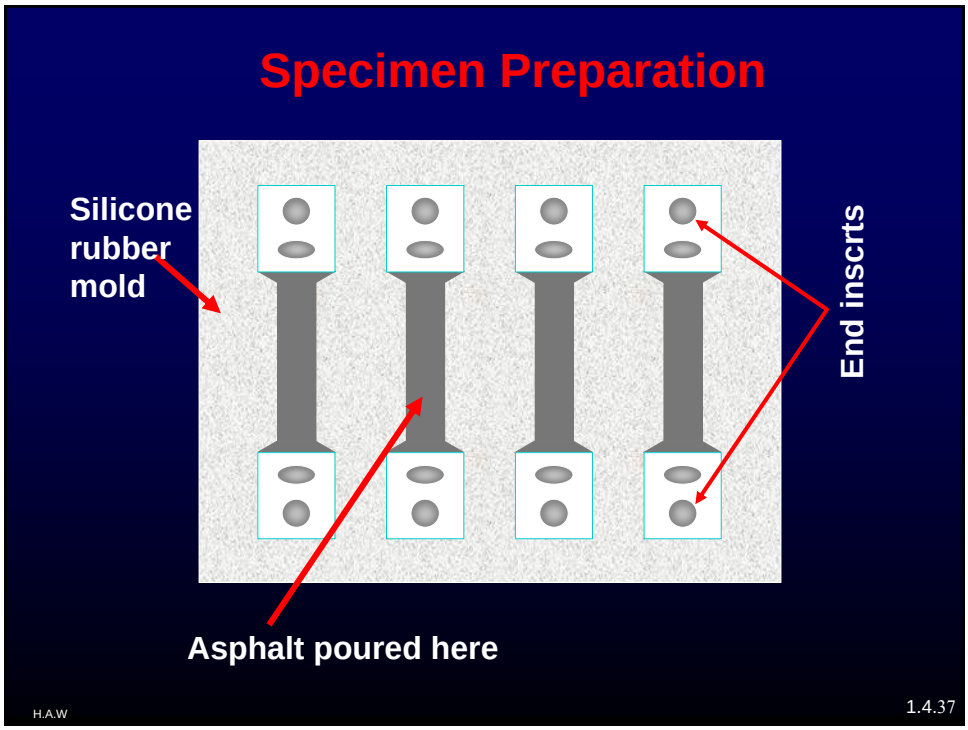
1.4.36


Specimen Preparation
Silicone rubber mold
End inscrts
Asphalt poured here
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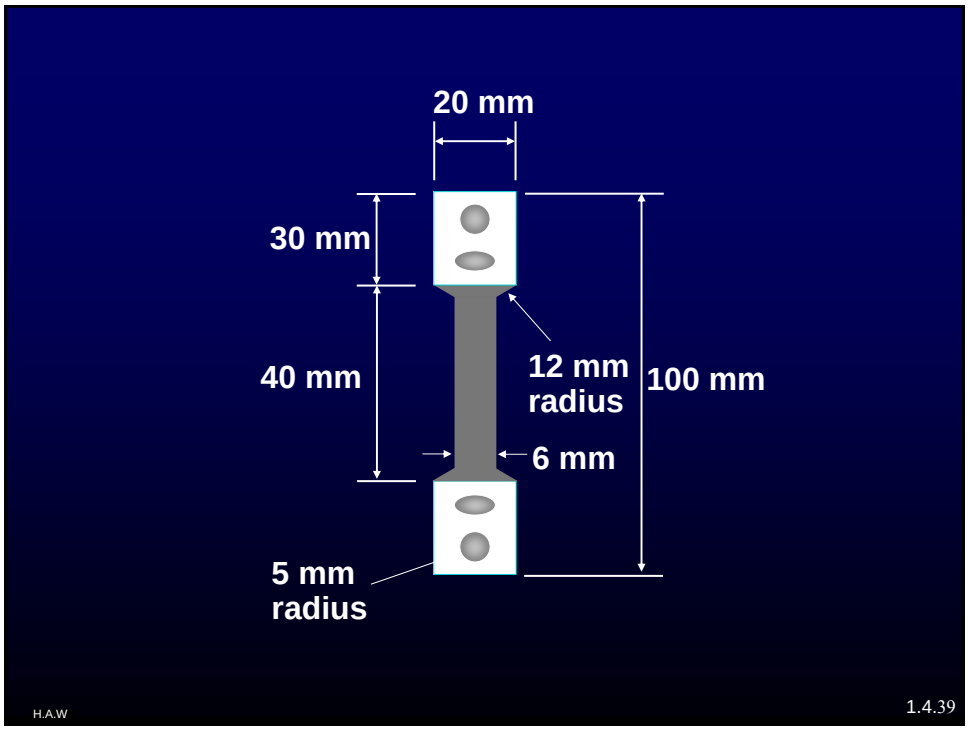
1.4.37



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1.4.39

Test Equipment

- **Testing Device**
  - -- grip specimen
  - -- apply load
- **Deformation Measuring System**
  - -- measure small elongations
- **Environmental System**
  - -- as low as - 40 C ± 0.2 C
  - -- mechanical refrigeration unit
  - -- chamber with access hole

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Direct Tension Test

Courtesy of FHWA

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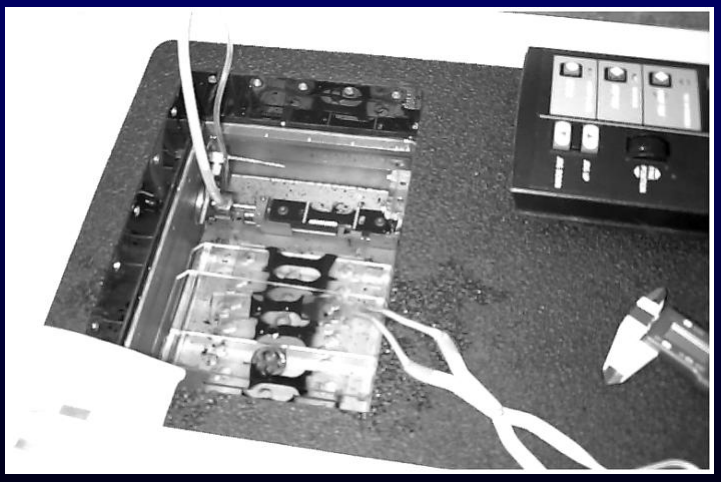
1.4.41

Direct Tension Test



Courtesy of FHWA

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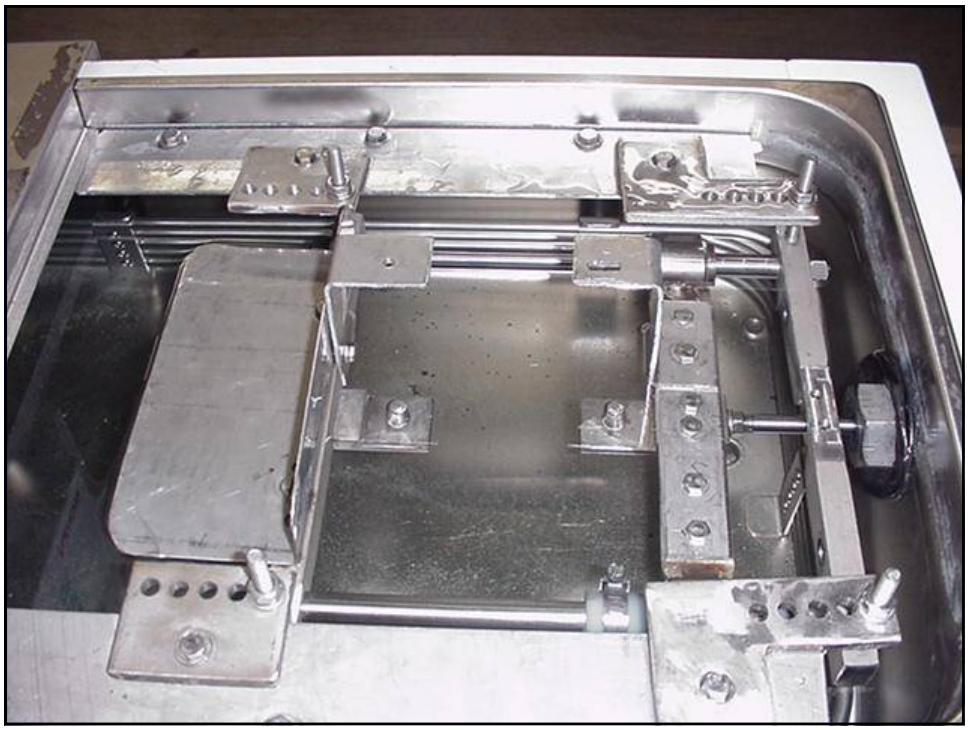
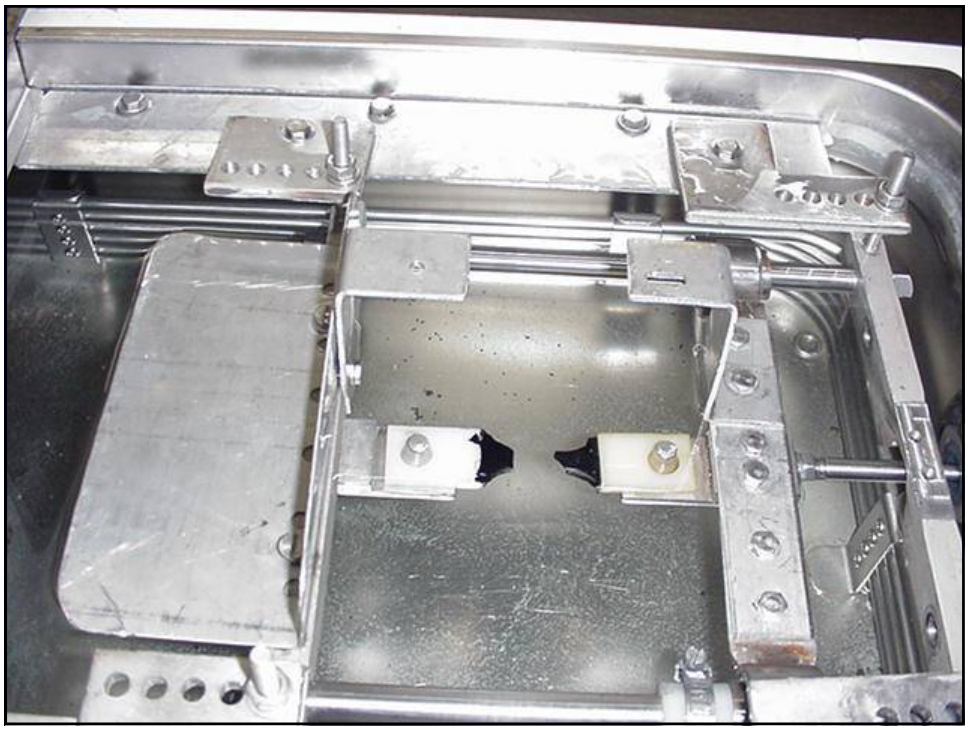
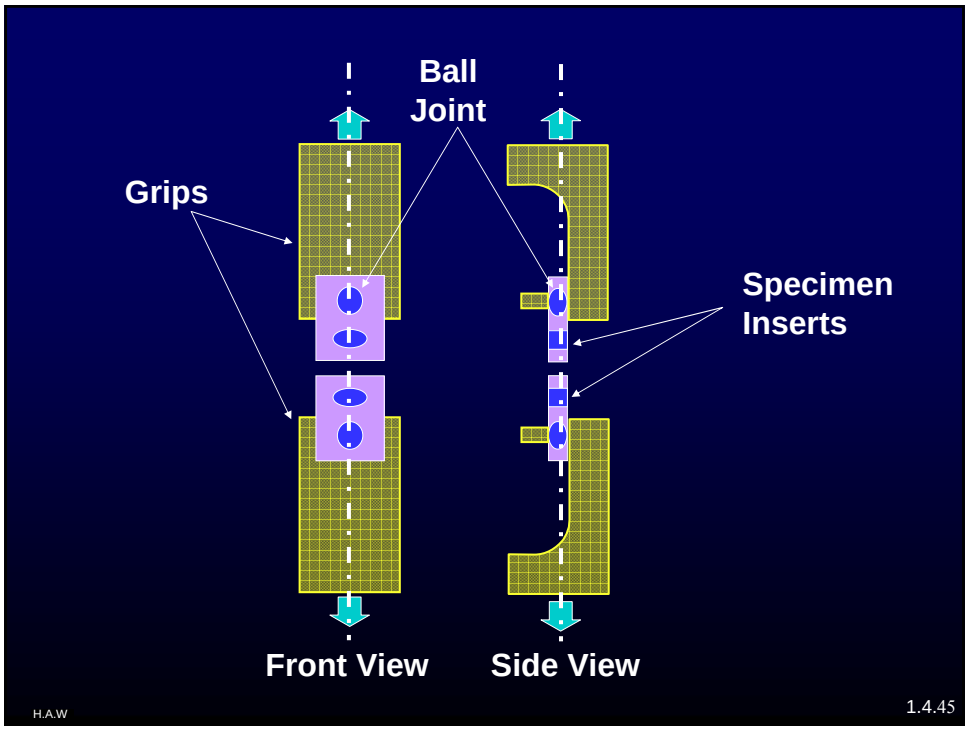
1.4.42







Overview of Procedure

- **Mount Specimen**
  - -- use access hole
- **Initialize Equipment**
  - -- load
  - -- strain indicators
  - -- laser micrometer
- **Run Test**
  - -- deformation rate = 1 mm/min
  - -- apply tensile load to failure

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1.4.46

Data Analysis and Interpretation

Report

-- tensile strain at failure

-- four specimens

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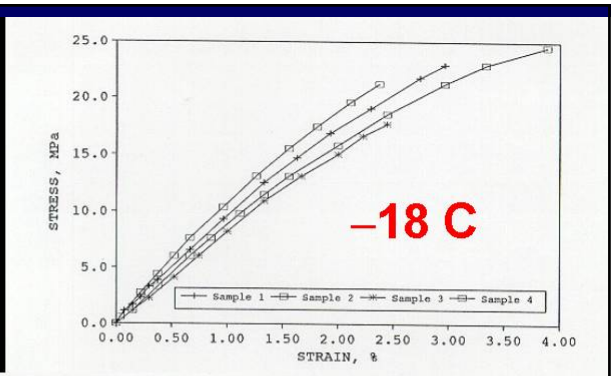
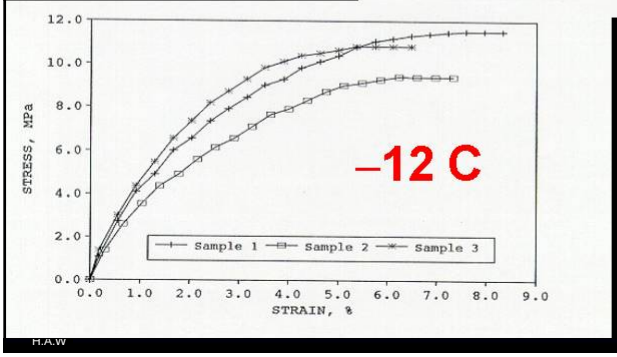
1.4.47

TYPICAL EXAMPLES





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END RESULT

- LOWER TEMPERATURE FOR PG BINDER (EXAMPLE PG70-22)
- SPECIFICATION OF ASPHALT BINDER THAT IS LOW TEMP. CRACKING RESISTANCE

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1.4.49