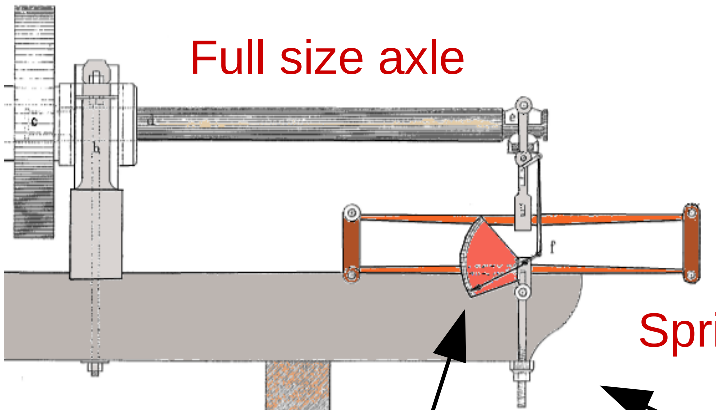
Load Measurement

Loads need to be measured on components or specimens in order to compute the stress at critical locations where fatigue cracks will initiate or are propagating

Full size axle



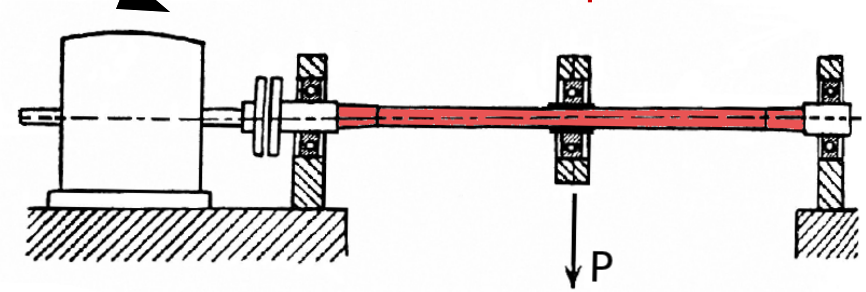
Springs

Deflection indicator

In Wöhler's axle test machine for example, the loads are applied by springs whose deflections have been calibrated with dead weights.

Comparing Load vs. life doesn't make sense

Small shaft specimen



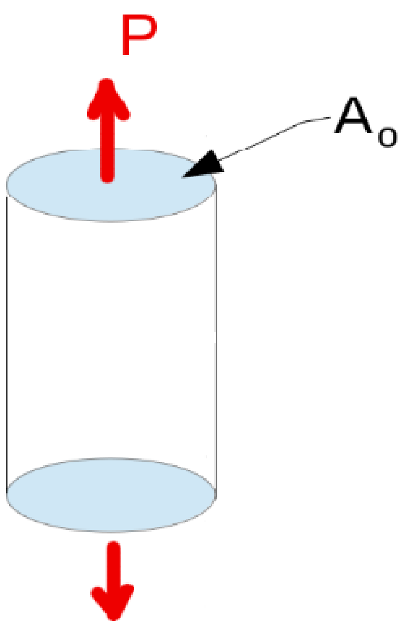
Comparisons were made to smaller, less expensive specimen results by calculation of the Bending Stress at critical locations.

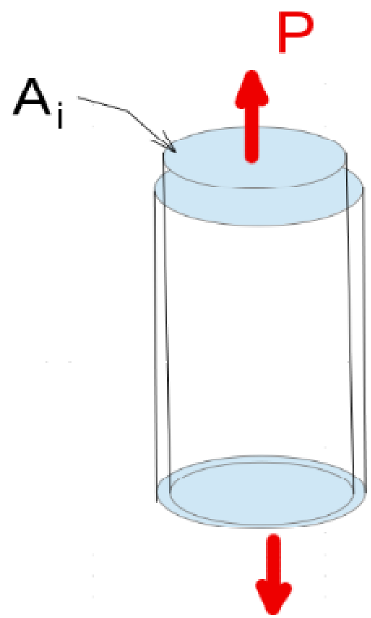
https://en.wikipedia.org/wiki/Bending_moment

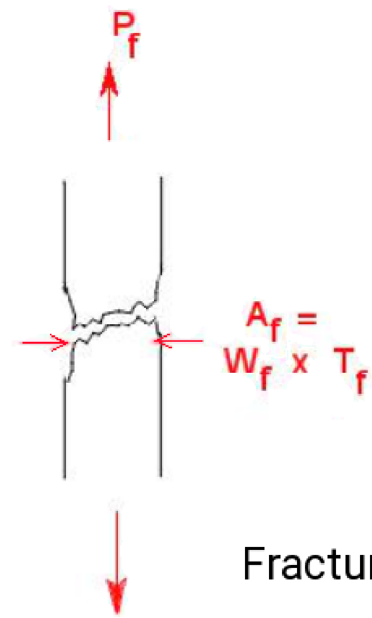
http://www.mathalino.com/reviewer/mechanics-and-strength-of-materials/flexure-formula

Some Stress Definitions

Where:
P = Load
A_0 = Initial Area
A_i = Instantaneous Area
W = width, T= thickness







Fracture

$$S = \frac{P}{A_o}$$

Engr. Stress

$$\sigma = \frac{P}{A_i}$$

True Stress

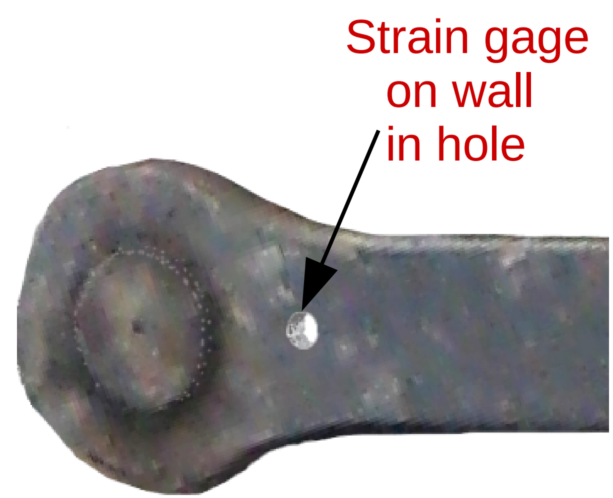
$$\varepsilon_f = \ln(A_o / A_f)$$

$$\sigma_f = \frac{P_f}{A_f}$$

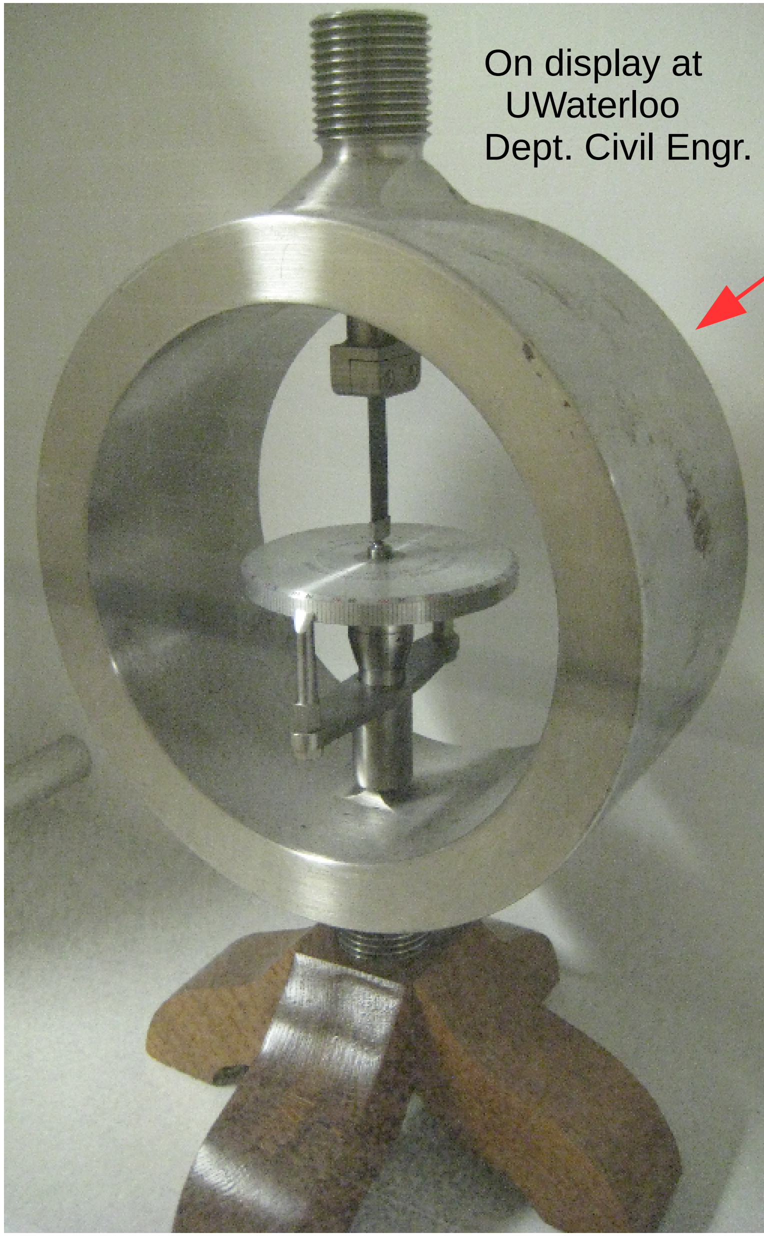
Components as Load Cells

By attaching strain gages to components one can,
with dead weight calibration, create a Load Cell.

If the signal from the above gage is weak,
one can “amplify” the signal by
placing the strain gage in a drilled
hole that magnifies the strain 2 or 3 times.



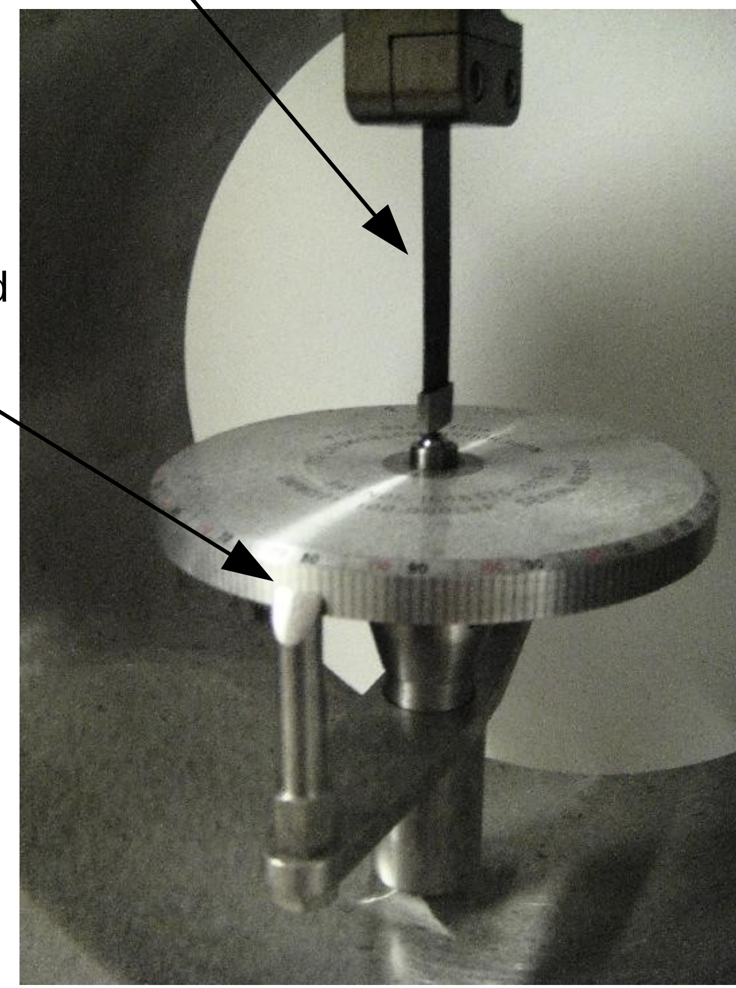
Note that component strains should remain elastic
(no permanent deformation due to loads)



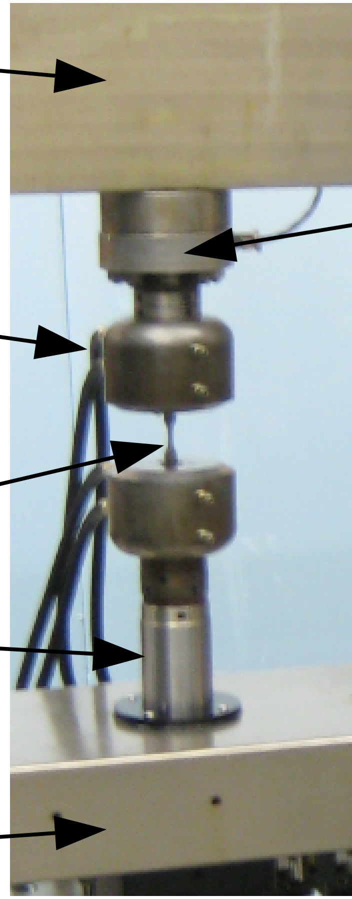
Morehouse Inst. Co.
100,000 lbf
Compression-Tension
Series 100 Proving Ring
Donated by Paul Thorpe
Practical Application Technology

"Load Ring" : Elastic deformation of steel ring is measured by a micrometer contacting a flexible band

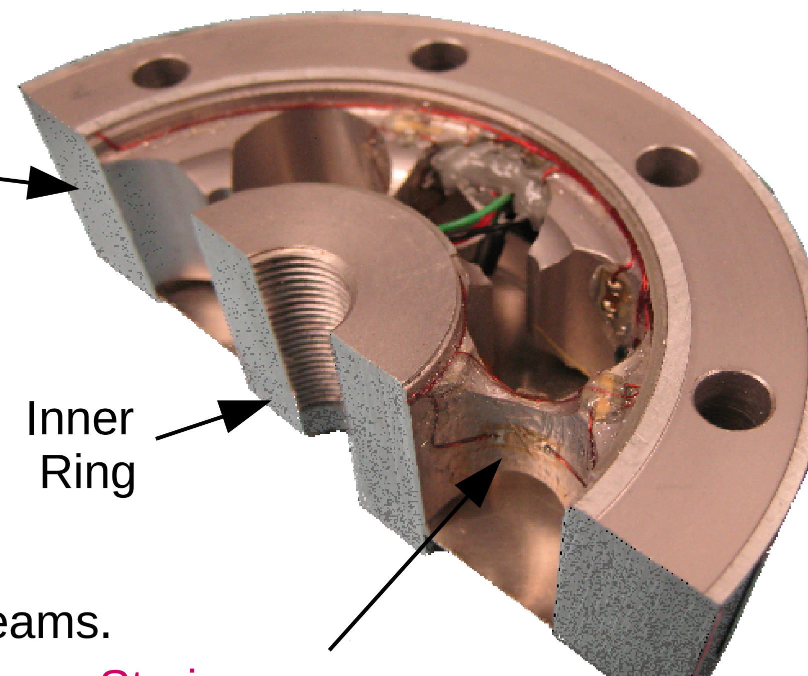
When band is straight and touching micrometer, load is read from calibrated dial



The deformation of membranes or beams are used to measure load in many load cells.



This particular cell uses short beams, sensitive to shear deformations, to generate a signal calibrated to load.



Load from the specimen entering the inner ring, is transferred to the outer ring by the gaged shear beams. Outer ring is attached to top Platten.

Other Load Measurement Devices

Wheel Force Transducers

Photo courtesy of Michigan Scientific Corp
http://www.michsci.com

Measure:

Mx
My
Mz

Fx
Fy
Fz

Loads and Moments measured
using strain gaged elements

Transducers on a test vehicle