Experimental Plan

1. Place two strain gages on sample (middle-top and middle-bottom).
2. Place in bending fixture
3. Connect strain gages
4. Bend sample
    a. Gather data

Data Analysis:

The strain in a simple beam is a function of the distance from the neutral plain according to equation (1):

$$\varepsilon = -y * \frac{\varepsilon_m}{c} \qquad (1)$$

where ε is the strain at a plane that is y units from the neutral plane, and ε_m is the strain in the outer fibers, which are c units from the neutral axis.

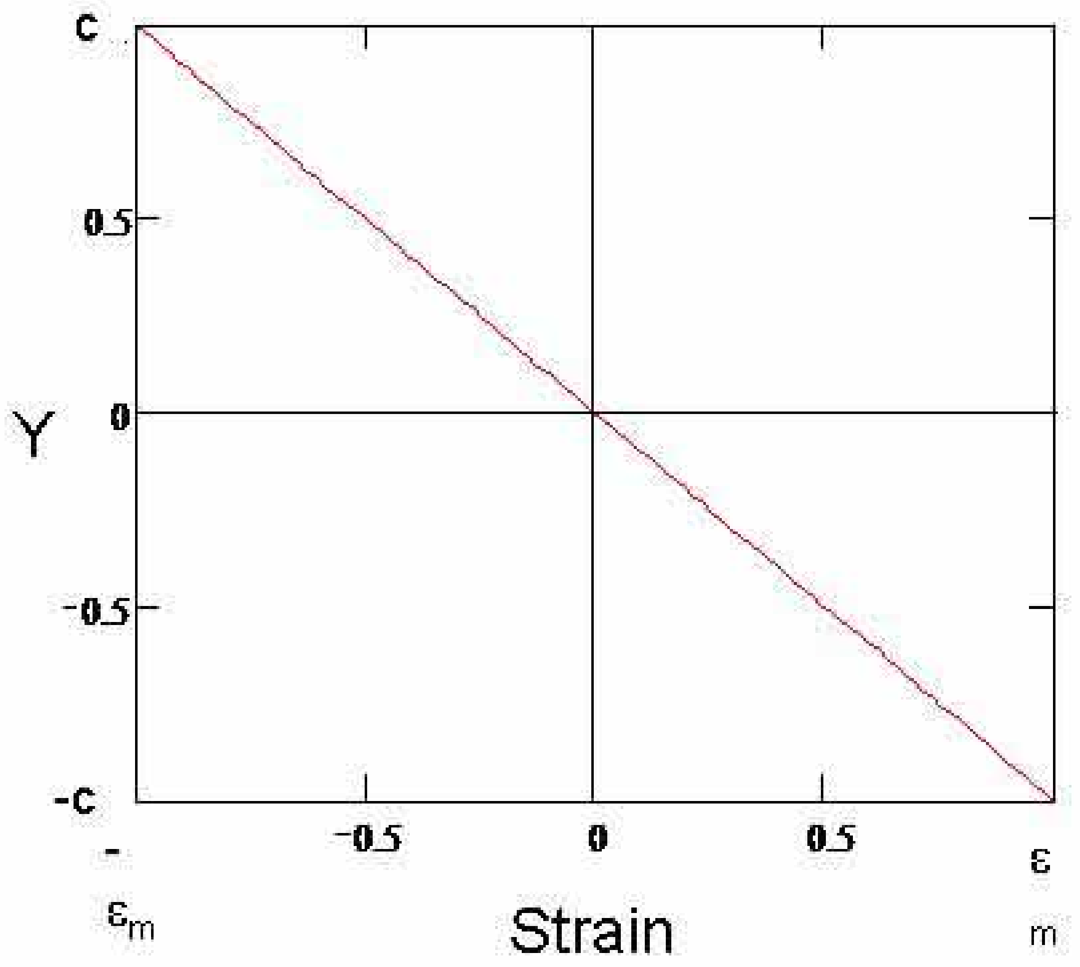

Figure 1: Through-depth strain distribution during bend test

Using equation (1), in conjunction with the maximum strain measured by the strain gages, one can establish the strain distribution throughout the depth of the beam as shown in figure 1. Next, using the equations developed in the paper "Uniaxial Stress-Strain Curves from a Bending Test" by Mayville and Finnie, the through-depth stress distribution in the sample, while still in the loaded condition, is created as shown in figure 2.

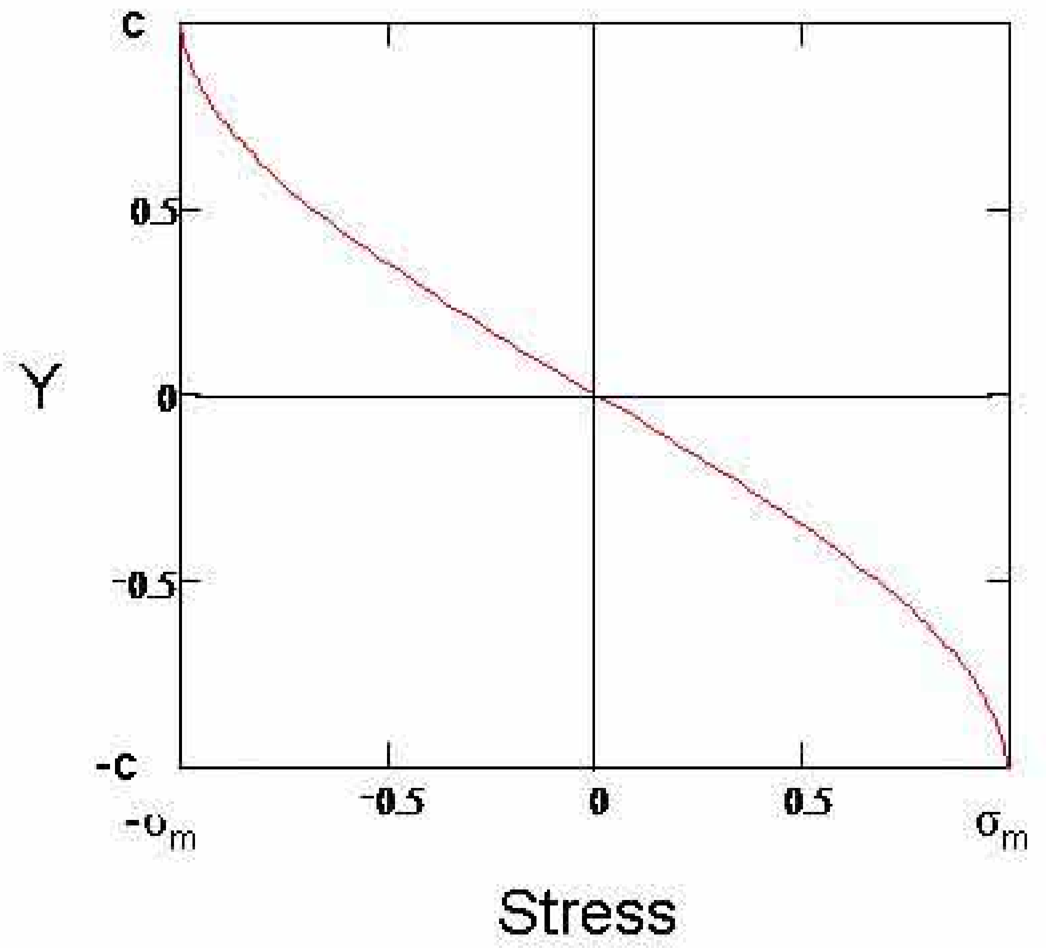

Figure 2: Resulting through-depth stress distribution during loading phase

Next, an unloading curve is developed as a purely elastic curve according to distribution given by:

$$\sigma = \frac{-M * y}{I} \qquad (2)$$

where σ is the stress, M is the induced moment at the location of strain-gage, and I is the moment of inertia of the cross-section. Figure 3 shows the graphical representation of bending stresses given by equation. (2).

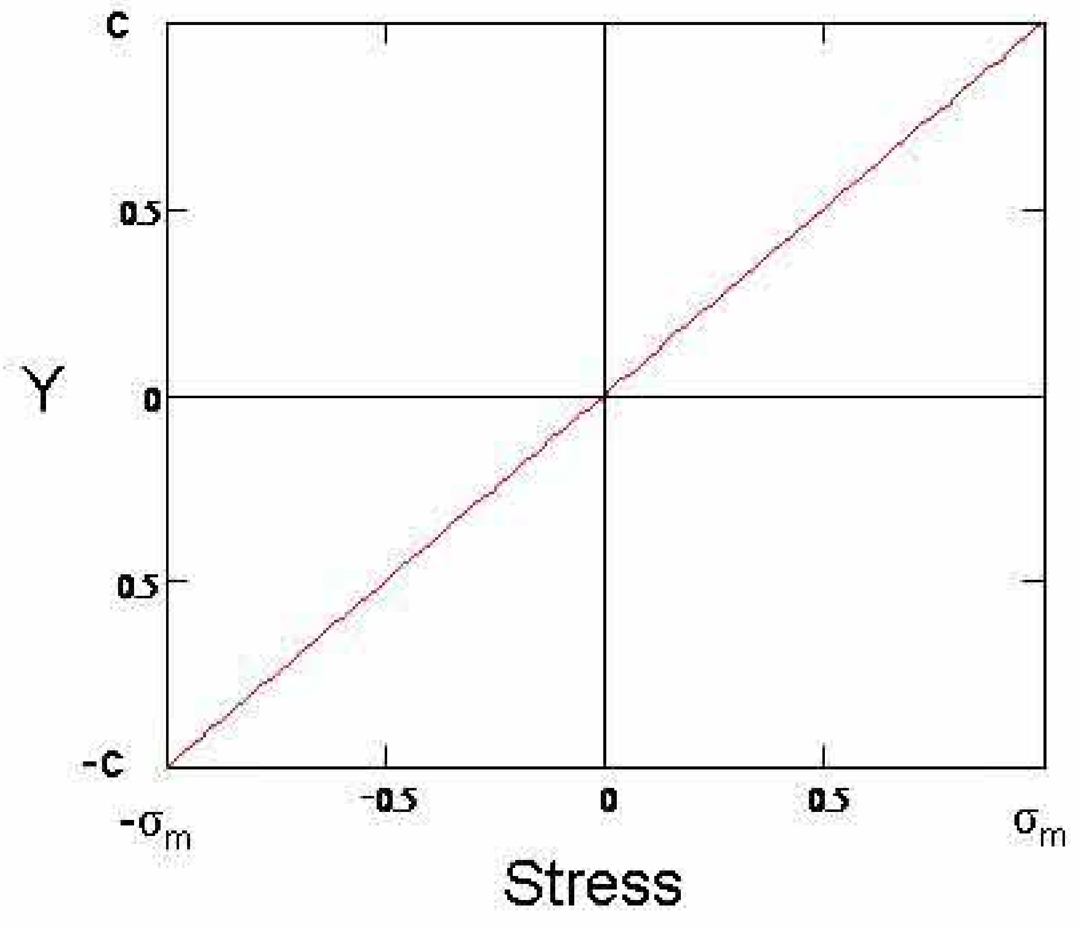

Figure 3: Through-depth distribution of unloading stress

Superimposing the unloading stresses of figure 3 onto the loading stresses of figure 2, results in the residual stress profile shown in figure 4.

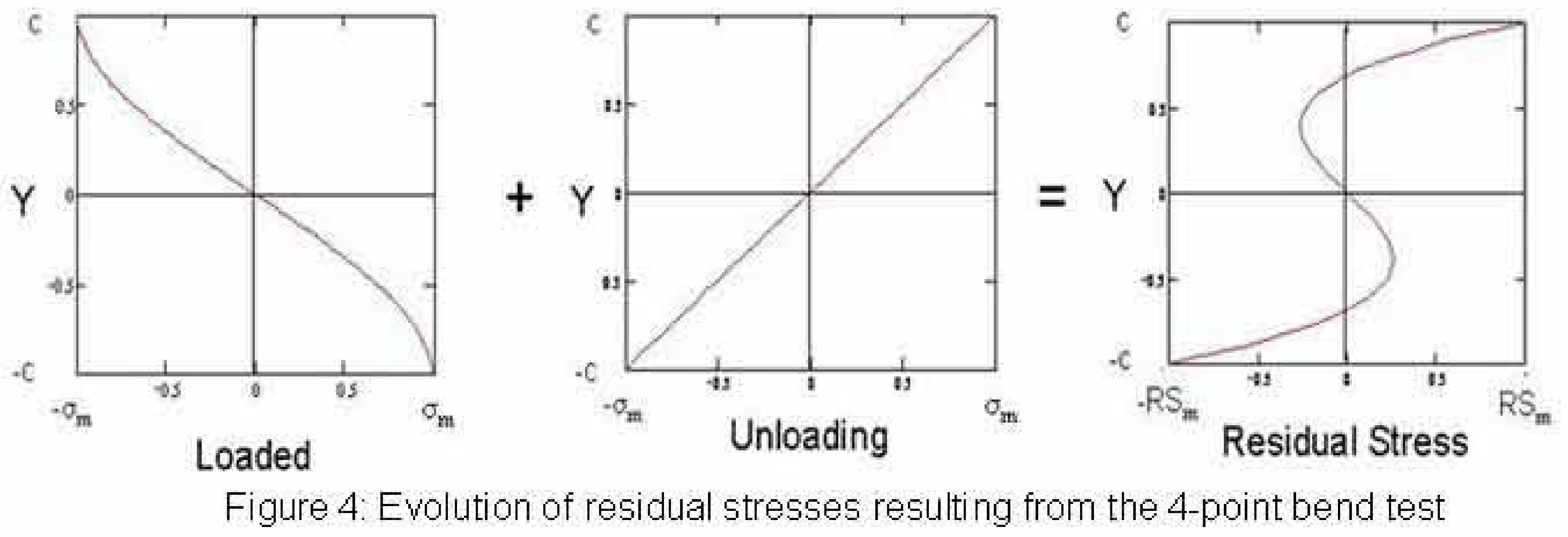

Figure 4: Evolution of residual stresses resulting from the 4-point bend test