CVEN 7511 - Fall 2001

Computational Mechanics of Solids and Structures

Homework # 2

Effect of Progressive Damage :

1. Problem:

   Consider the effect of progressive damage in the axial force member when the tensile stress exceeds the tensile strength, $f_t = 300 \ psi$. Adopting a bilinear hardening-softening material law, analyze the same serial arrangement of three axial force members as in HW #1. Using an incremental formulation examine the case of progressive element erosion of the intermediate element stiffness according to the elastic damage concept $d\sigma = E_{\tan} \ d\varepsilon$, where $E_{\tan} = \left[1 - d - \frac{\partial d}{\partial \varepsilon}\varepsilon\right] E_o$. Determine the force-displacement response when the right end of the bar assembly is stretched in displacement control, while the left end is constrained. Compare the global $f - u$ response to the stress-strain $\sigma - \varepsilon$ response in each of the three elements and sketch the stress and strain distributions along the axis of the three bar structure at different stages of stretching when the linear softening modulus is $E_{soft} = -\frac{E_0}{4}$. Note that the serial structure of three bar elements turns singular when $E_{soft} = -\frac{E_0}{2}$.

2. Problem:

   Extend the previous study to a parallel arrangement in which the center bar is subjected to progressive degradation, $d(\varepsilon) \geq 0$. For definiteness assume that $A = 10 \ in^2, L = 10 \ in, E_0 = 3,000 \ ksi$, and analyze the resdistribution of element stresses due to progressive damage under increasing end displacement, $\Delta u_p > 0$. Note that the parallel structure of three bar elements turns singular when $E_{soft} = -2E_0$.