CVEN 7511 - Fall2001

Computational Mechanics of Solids and Structures

Homework # 3

Effect of Axial Collapse and Localized Damage

1. Problem:

   Develop an explicit time marching algorithm for the axial bar arrangement of five uniform bar elements based on central difference approximations of the time domain. Assuming linear elastic behavior examine the axial stress wave when the tip of the bar is impacted by a rigid body at an initial velocity according to the failure scenario of the WTC. Use stiffness and mass properties which are consistent with the assumptions by Prof. Z. Bazant. Determine the the dynamic load factor of the stress wave assuming no inelastic dissipation.

2. Problem:

   Consider the effect of localized 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 #2 when the length of the softening bar element decreases, $\alpha = \frac{L}{L_0}; 1 \geq \alpha \geq 0.1$, while the adjacent bar elements increase to keep the overall length constant. Determine the force-displacement response when the right end of the bar assembly is stretched in displacement control, while the left end is constrained. 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 $\beta = -\frac{E_{soft}}{E_0} = -\frac{1}{4}$. Determine the value of α when the serial structure of three bar elements turns singular.