Rate Dependent Non-Linear Progressive Composite Damage Model (rdnlpCDM) UMAT41

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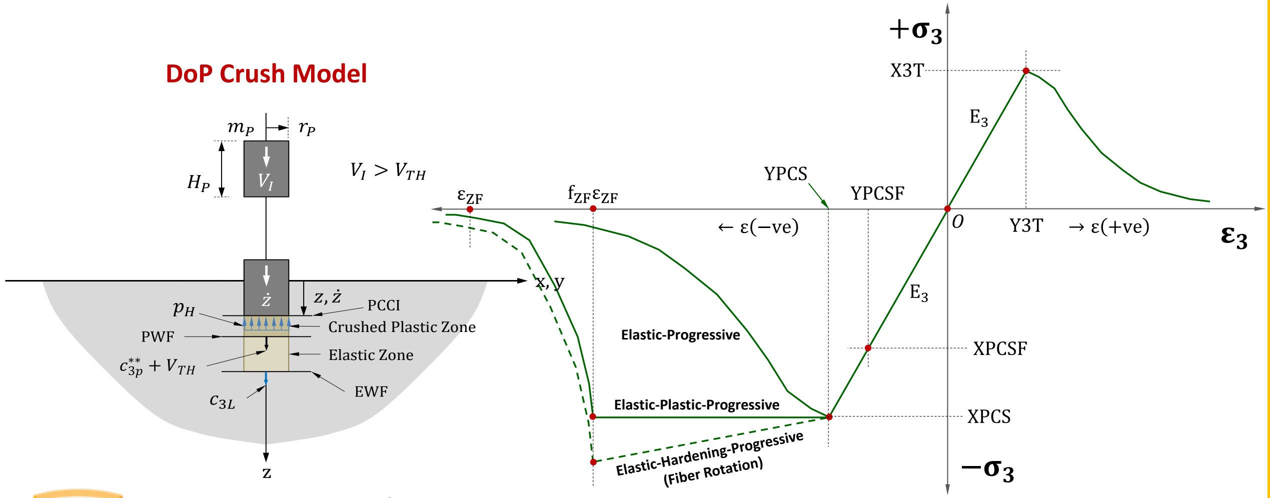
Key Goals and Technical Approach

- ❖ MAT162 in LS-DYNA can model rate dependent progressive damage, with limitations, not available for modification due to copyright
- ❖ Key goals are to develop a new rate-dependent non-linear progressive composite damage model (rdnlpCDM) UMAT41, which will include:
  1. Rate functions for all moduli and strength
  2. New DoP failure model modeling crush
  3. New punch-shear & tension shear model
  4. Compression shear model
  5. In-plane, and interlaminar shear
  6. Compression depen
- ❖ Validate the new UMAT41 by simulation model validating experiments

DoP Crush Model

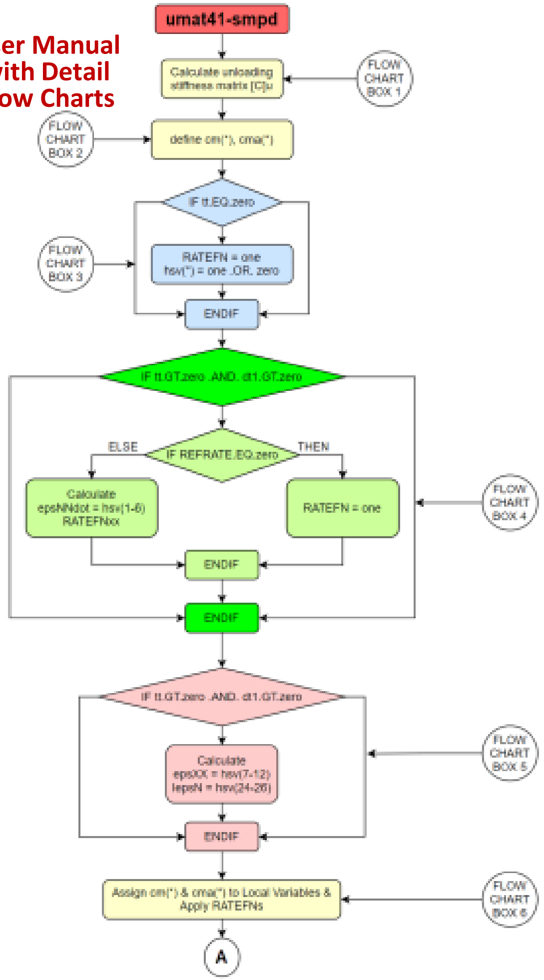


Stress strain under tension and crush

Major Results, Key Accomplishments

- ❖ UMAT41 Salient Features
  1. Rate functions for all moduli and strength
  2. Damage Functions for all moduli and strength
  3. Maximum Stress Progressive Damage
  4. Quadratic HASHIN Progressive Damage
  5. Xaio-Gillespie Failure Equation
  6. Ramberg Osgood In-plane, and interlaminar shear
  7. Modulus in tension and compression are different
  8. Robust erosion criteria
  9. Load-Unload behavior, elastic & Progressive damage

User Manual with Detail Flow Charts



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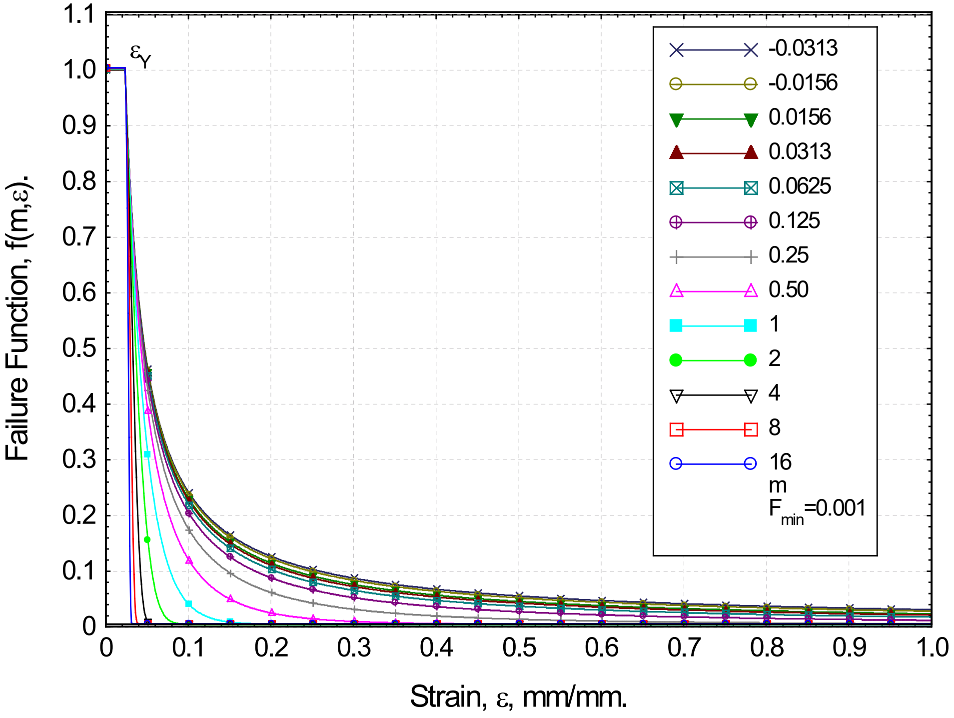
Progressive Damage Failure Functions

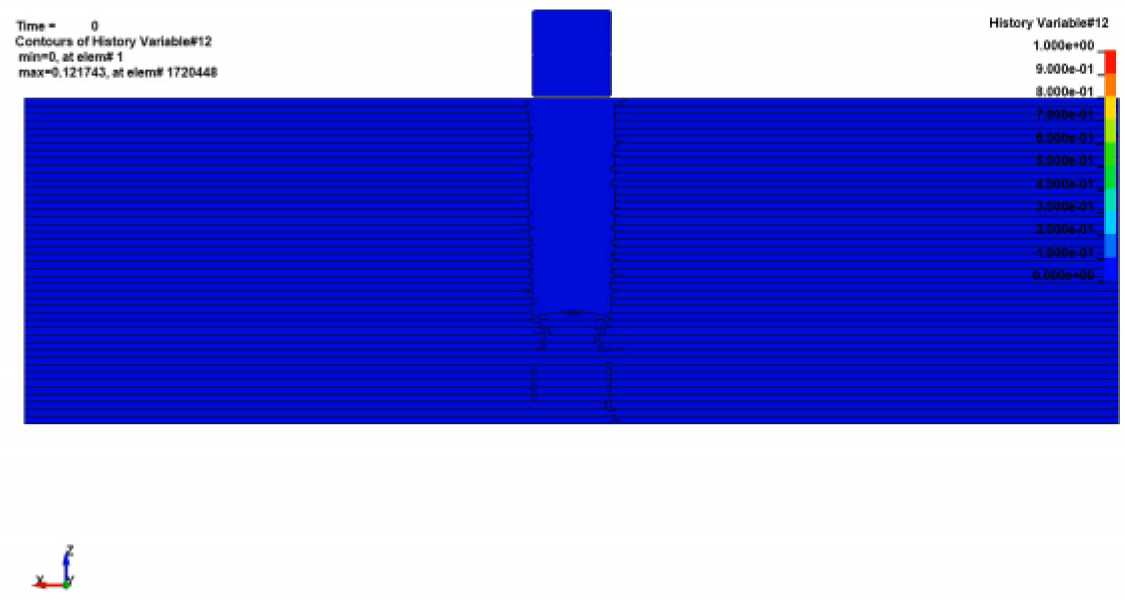
$$f(m,\varepsilon) = F_{min} + (1 - F_{min})\exp\left[\left(\frac{1}{m}\right)\left\{1 - \left(\frac{\varepsilon}{\varepsilon_Y}\right)^m\right\}\right]$$

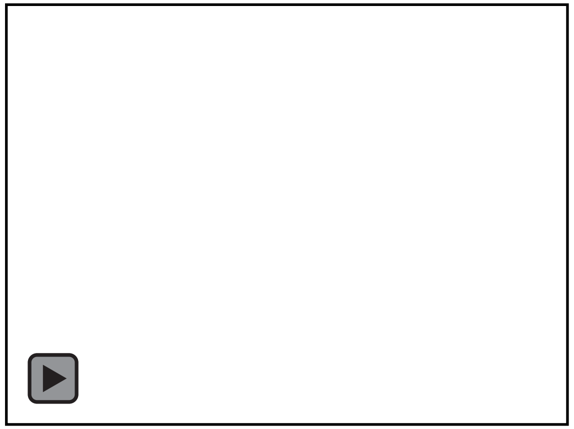


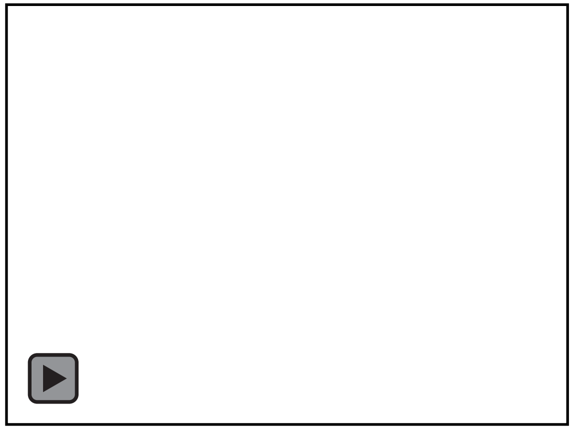
Transitions (materials, codes/tools, legacy publications)

- Maximum Stress Progressive Damage UMAT41 is transitioned
- Quadratic Progressive Damage Models are in Progress
- Stress and Strain Invariant Damage Models are in Progress

MAT162 Modeling Examples Used for UMAT41 Verification







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