Development of Reliability-Based Damage Tolerant Structural Design Methodology

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The Joint Advanced Materials and Structures Center of Excellence

FAA Sponsored Project Information

- **Principal Investigator:**
- **Research Scientist:**
- **Pre-Doctoral Research Assistant:**
- **FAA Technical Monitor:**
- **Other FAA Personnel:**
- **Industry Participants:**
- **Industry Sponsors:**

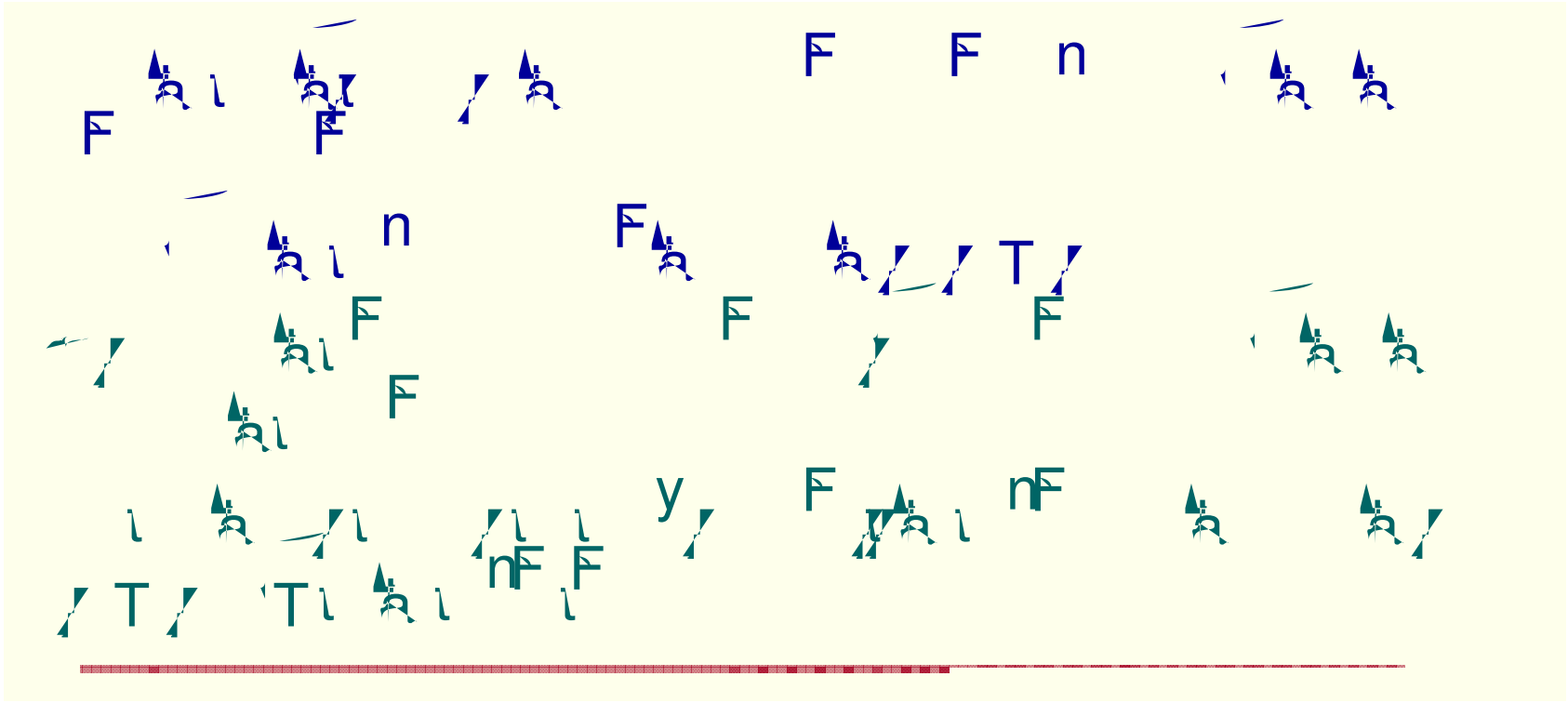
Reliability-Based Damage Tolerant Structural Design Methodology

- ***Motivation and Key I ue :***

- ***Objective:***

Technical Approach

Program Capabilities: Various Failure Modes



**See the FAA Grant "Combined Local-Global Variability and Uncertainty in the Aeroservoelasticity of Composite Aircraft"*

Accomplishments

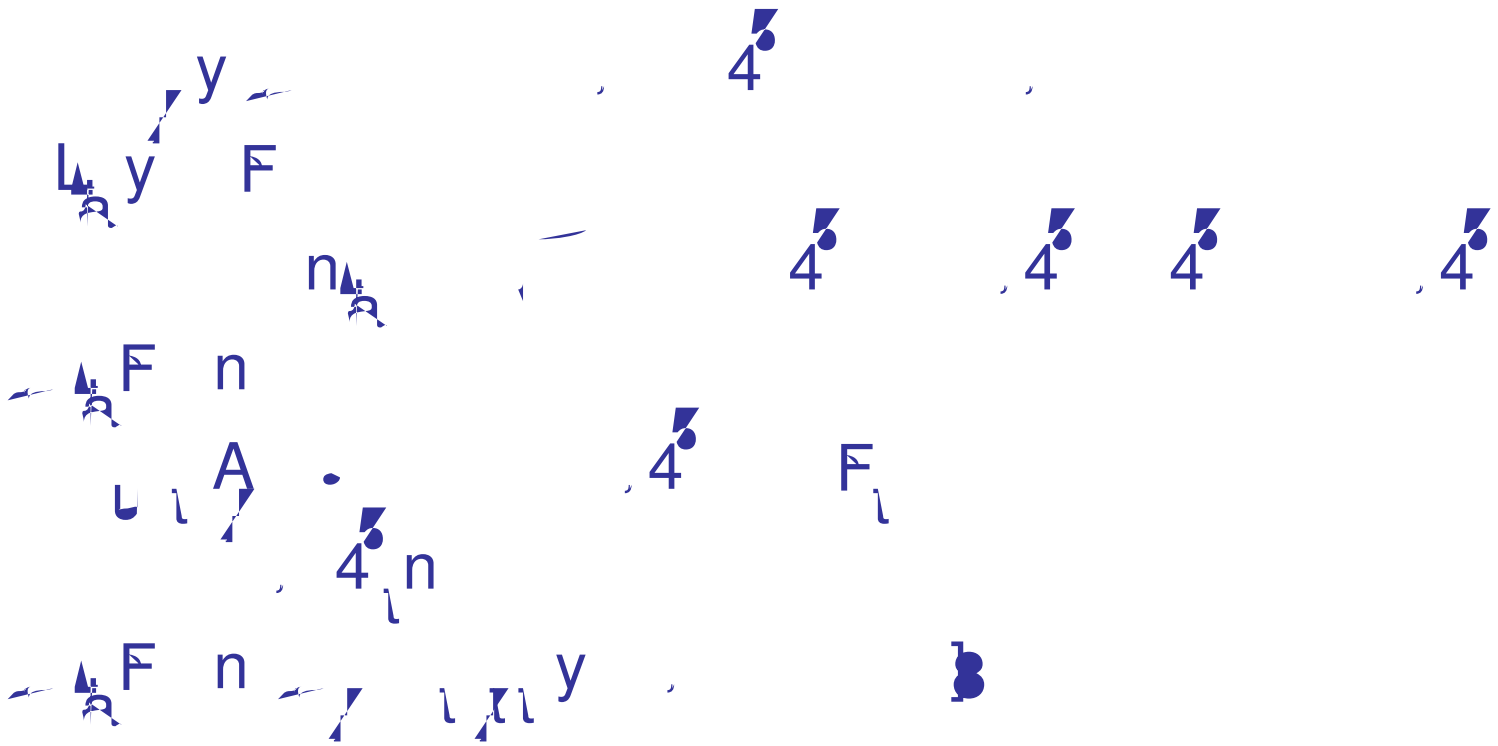
Work Accomplished: Phase 1

Current Research

Analysis of Disbond/Delamination Arrest Mechanisms


Stringer
Skin

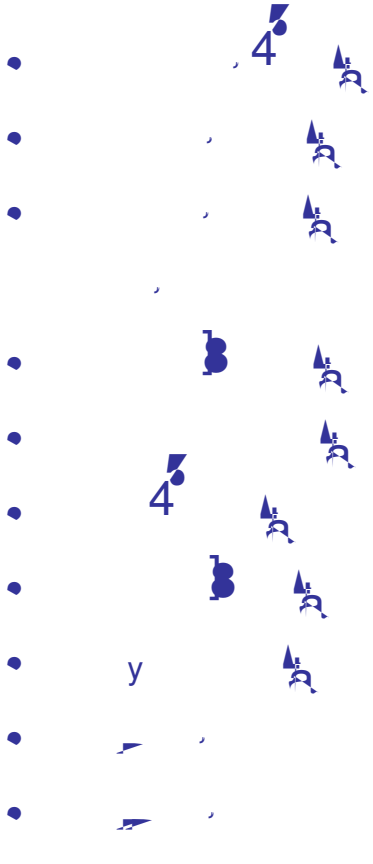
Model Description



$$C = \frac{t_1 + t}{d}^{a} \frac{b}{n} \left(\frac{1}{t_1 E_1} - \frac{1}{nt\ E} - \frac{1}{nt_1 E_3} - \frac{1}{nt\ E_3} \right)$$

Model Description

Material Properties (AS4/3501-6)



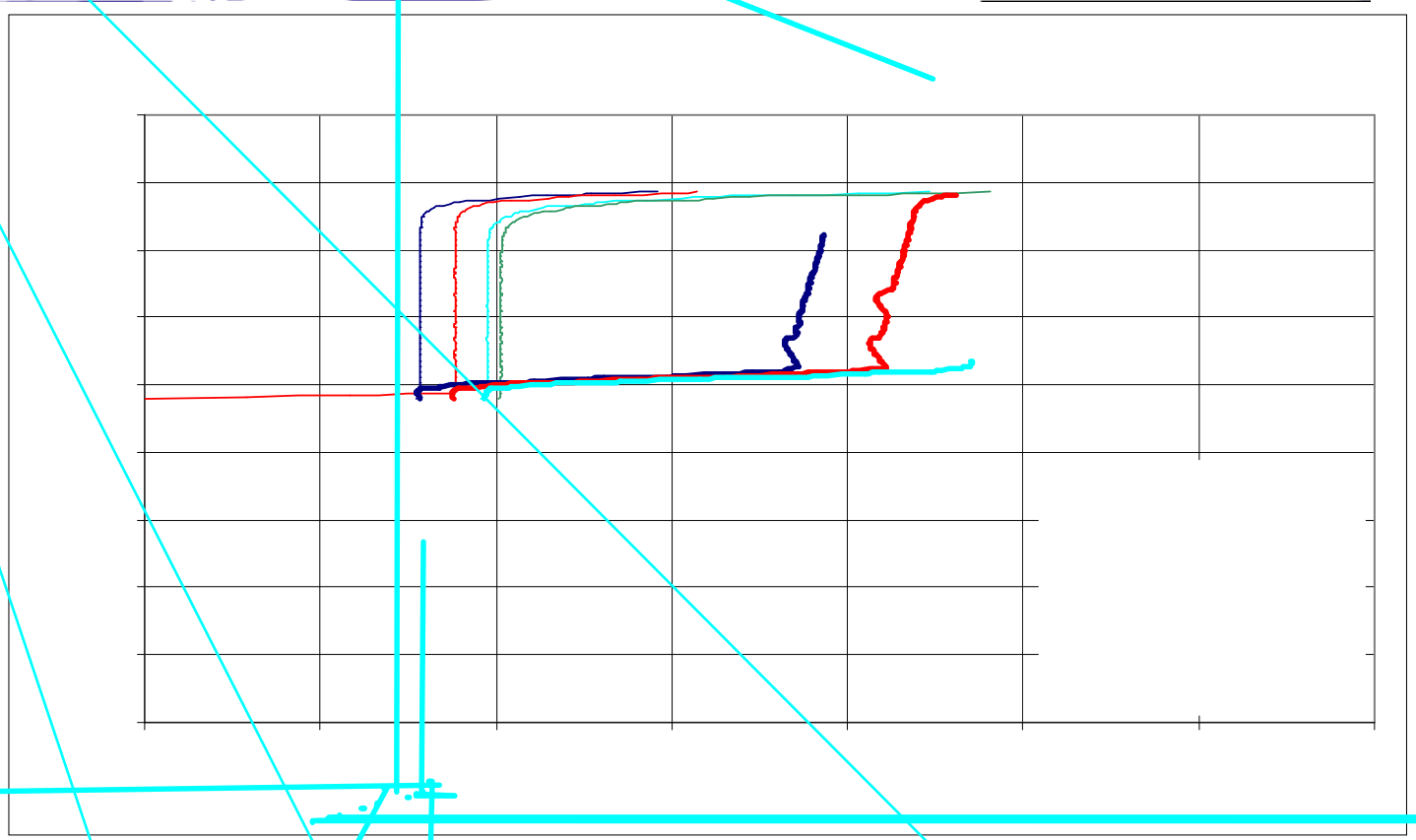
Laminate Configuration (16 plies)

0-ply	Lay-up	E_x	C (in/lb)
4	4 4 4 4 F	, „	, „
, 4	4 4 4 4 F	, „	, 4 „
4 ,	4 4 F	, „	4 , 4„
, 4	4 4 F	, „	4 4„

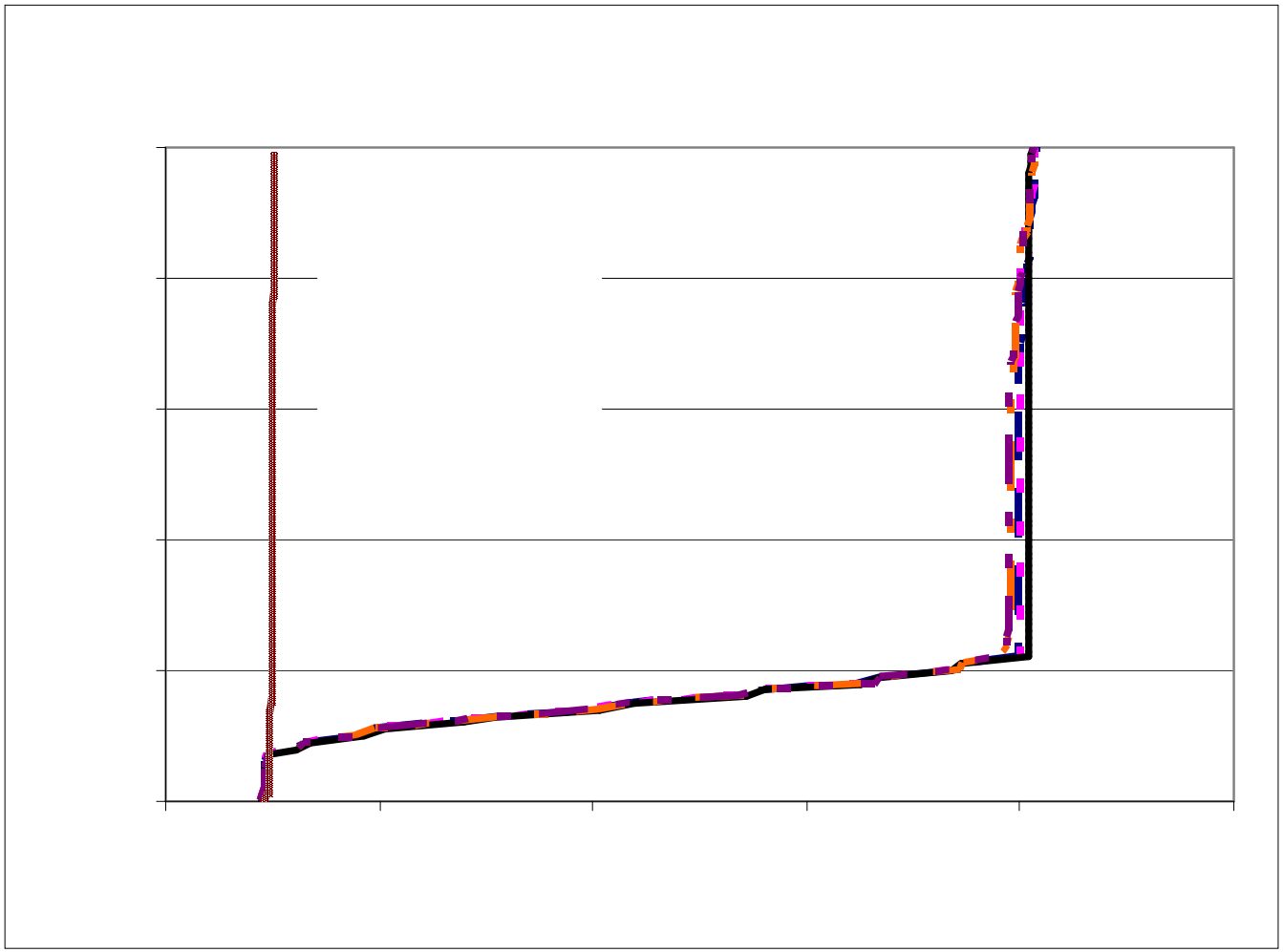
$$C = \frac{t_1 + t}{d}^{a} \frac{b}{n} \left(\frac{1}{t_1 E_1} + \frac{1}{nt\ E} + \frac{1}{nt_1 E_3} + \frac{1}{nt\ E_3} \right)$$

$$a = \ / 3, \ b = 1 \ . \ , \ n = 1$$

Results: Applied Moment M Only

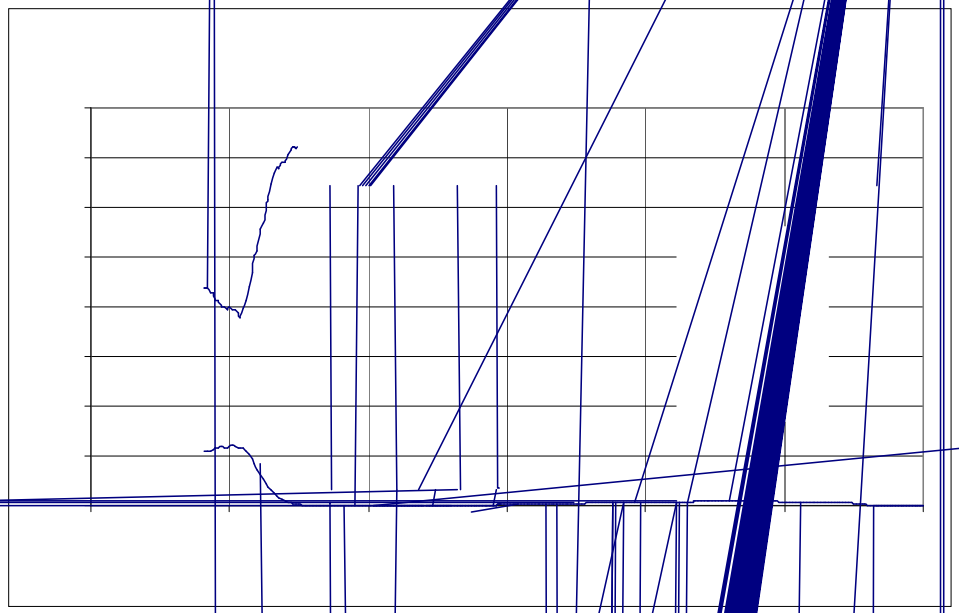


Growth of a Disbond Caused by Applied Moment M



Mode Decomposition: Applied Moment M Only

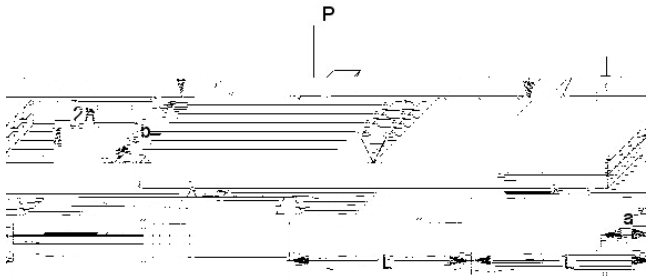
Mode Decomposition: Applied Tension N Only



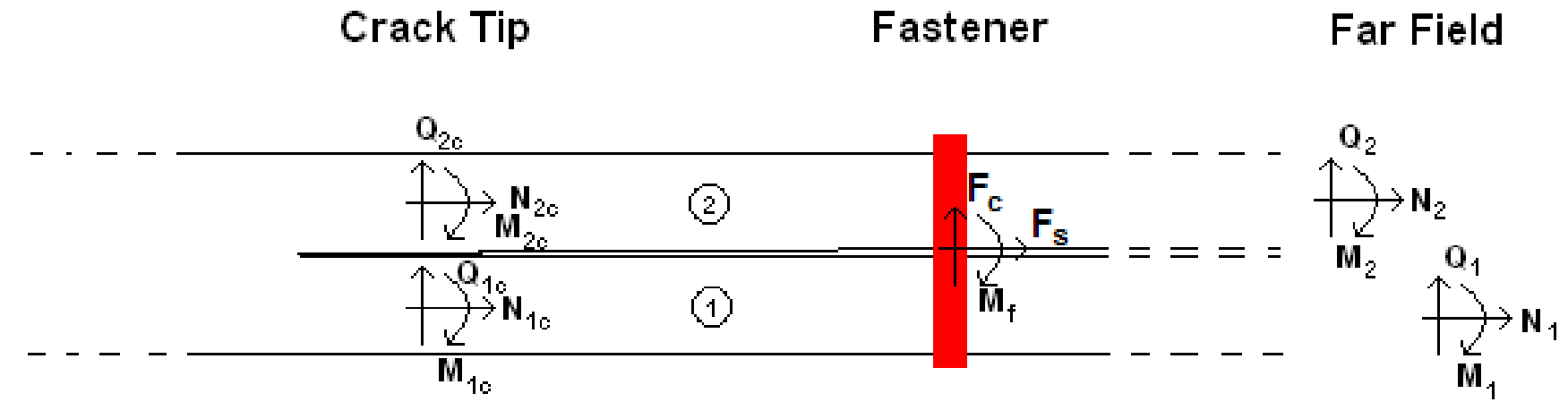
Crack-Tip Fracture Analysis

- F F F F n n y n
  n n

Comparison with Classical Beam Solutions



Local Crack-tip and Far-field Applied Forces and Moments



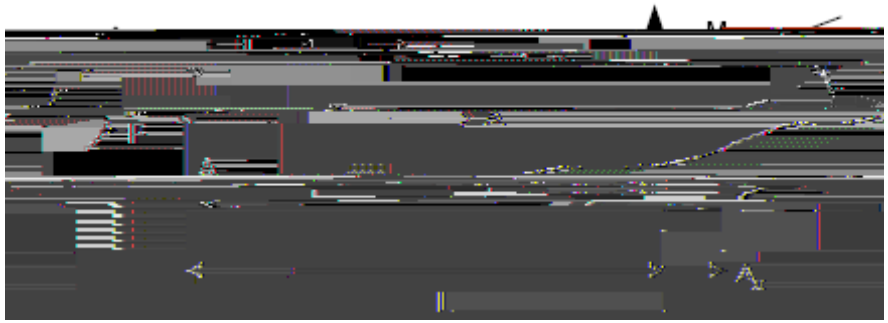
Nonlinear Beam Analysis

$$\frac{E}{} \quad \frac{M}{I}$$

$$\frac{1}{} \quad \frac{Y''}{(1 \quad Y \quad)^{3/} \quad 1}$$

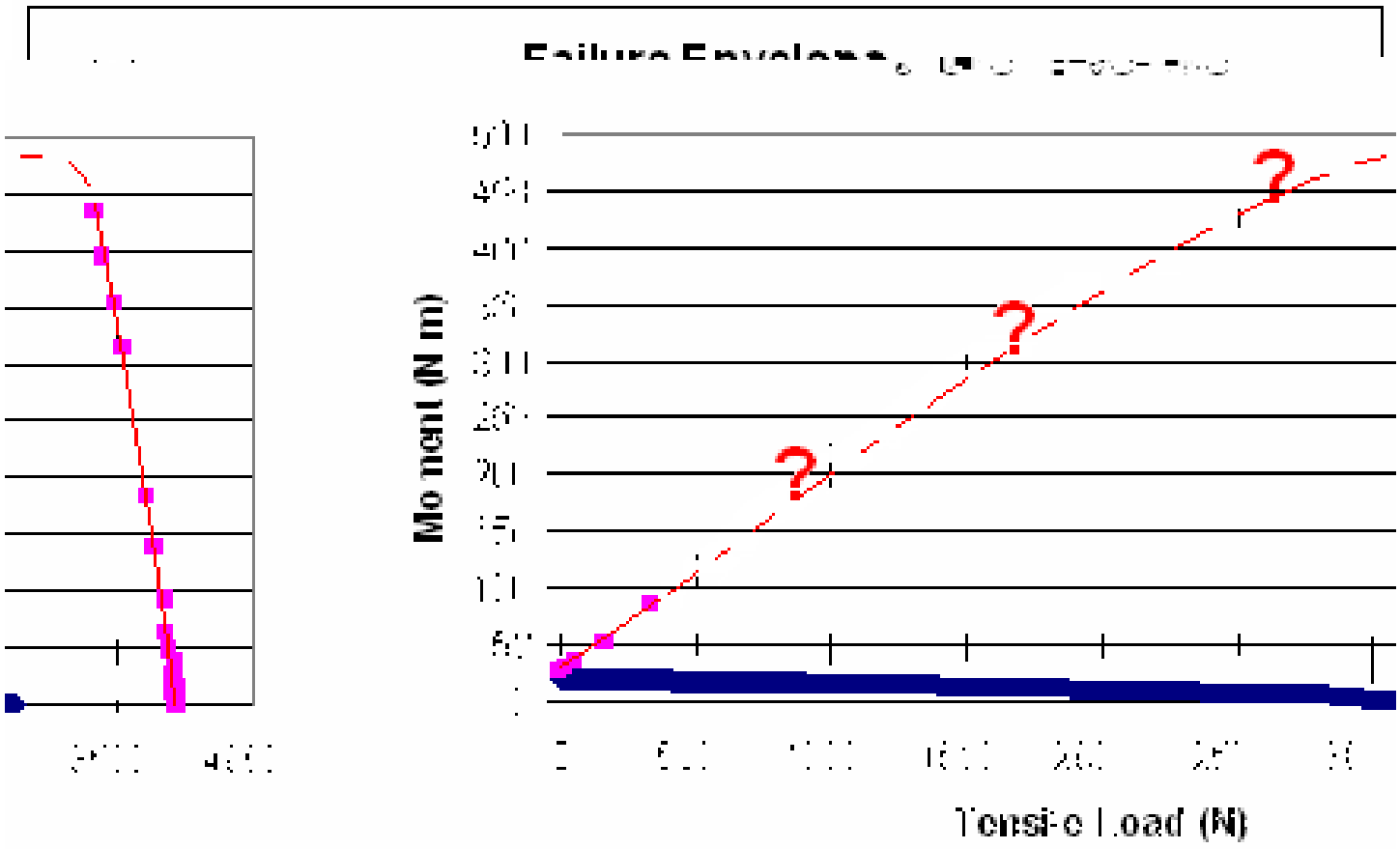
$$(\quad) \qquad (\quad _x \quad) \quad (\quad _y \quad)$$

$$'' \qquad (\quad _x \quad) \quad (\quad _y \quad)$$



Comparison Between Linear and

Failure Envelope Between N and M



Work in Progress / Future Work

A Look Forward

Benefit to Aviation

Future needs