A Structural Constitutive Model for Fatigued Bioprosthetic Heart Valves

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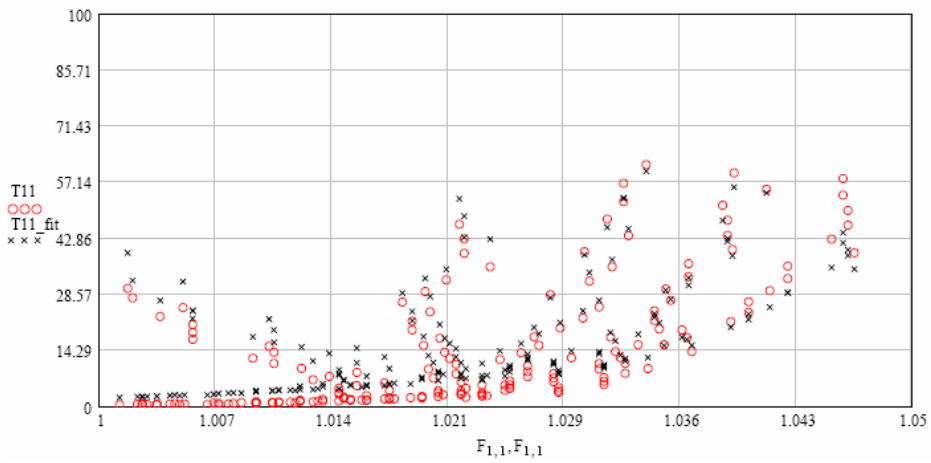
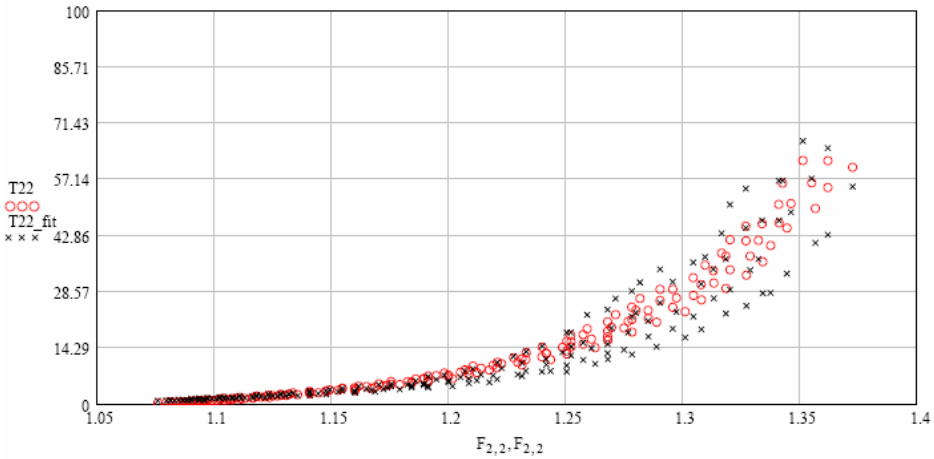
Current treatment options for defective heart valves include replacement with either bioprosthetic or synthetic valves. A number of problems are associated with these techniques, but advances in tissue engineering have provided encouragement for better valve design. Understanding the mechanical properties via modeling of native and replacement valve tissue can help further the development of new tissue engineered valves. Structural constitutive modeling provides predictive capabilities in how stress and strain are related in a given system based on physical properties, rather than phenomenological properties. We propose a structural model for aortic valve tissue and test it on both native and glutaraldehyde-fixed tissue. Improvements of this model include utilizing a modified three-parameter beta function to describe the collagen fiber angular distribution. The model has been shown to fit various biaxial stretch protocols for porcine aortic valve samples fatigued for a range of cycles with success. Future plans are to test the model using tissues fixed at various pressures and investigate parameter changes with increased cycling and pressure.





Example plots of model vs. experimental for fatigued ($300*10^{-6}$ cycles) data