## 2. Construction of Nonlinear Stress-Strain Curve

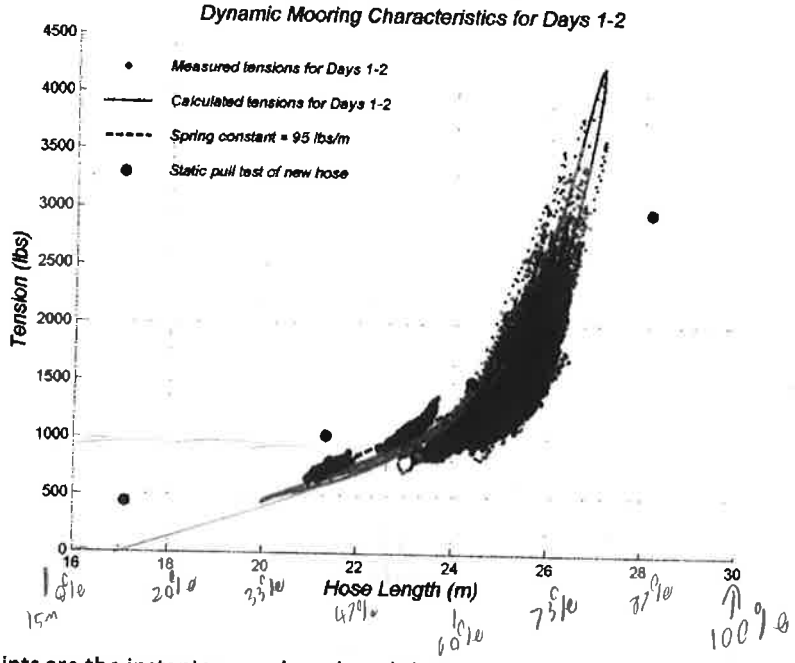


Figure 6. The blue points are the instantaneous hose length (calculated using the previous formula) for 8 out of the 16 time series data recorded during days 1-2. Only 8 time series are presented for clarity in graphing the results. The other 8 time series are consistent with the presented results. Each blue data point represents the heave motion and tension at a particular instant in time. Each time series has 8,000 data points sampled every 0.1 seconds (see example in Figure 5). So there are a total of 64,000 data points represented in the plot. The blue dots give an accurate picture of how the hose behaves in waves. The black dots are "on-land" static pull tests of a new hose. The black dashed line shows the linear spring constant of 95 lbs/m and comes from fitting the mean data in Figure 4. Not surprisingly the linear spring constant matches the static pull-test data for shorter hose lengths. However, notice that the dynamic nature of waves with their relatively high frequency causes a significant stiffening of the hose in storms when there is a combination of large static loading (from current and wind) and dynamic loading (from wave motion). Finally, the red line is from dynamic simulations using the range of static and dynamic loading found in the 8 measured time series. The simulation models the hose stretch with a nonlinear stress-strain curve that matches the linear stiffness of the hose for small strain, but increases significantly (to the $5^{th}$ power of the strain) at larger strains. This curve is valid for hose tensions up to about 4300 lbs as shown in the plot. At higher tensions, one would be extrapolating a $5^{th}$ order polynomial.

The nonlinear stress –strain curve of the hose is used to simulate the design storm conditions for the AST2 mooring with the idea that the 100 foot hoses (to be used in AST2) will behave similarly to the AST1 50 foot hoses on deployment.

A second nonlinear stress-strain curve will be developed to represent days 5-36 with the idea that the hoses could go through a similar transition later in the deployment. The hose during days 5-36 had more permanent stretch and lower stiffness. Therefore, it would be expected that the predicted mooring line tensions would be less severe compared to the stiffer hose that existed during days 1-2.