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Parameter Estimation for Synthetic Rope Models

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Introduction

Synthetic ropes demonstrate complex time domain behaviour which is not accounted for by existing modelling software. This poster will demonstrate parameter estimation of these ropes, building on previous work [1, 2].

Objectives

- To develop a time domain model to simulate synthetic rope response;
- To validate this model against physical test data;
- To integrate the model into commercial mooring system modelling software.

Methods

The work order of this project follows the workflow diagram (Figure 1). The rope behaviour is modelled using Burgers' material model (Figure 2). Parameter estimation is performed by minimising the errors (calculated as the mean absolute percentage error, MAPE) between measured and estimated tension using differential evolution. This takes starting conditions of a population of 50, mutation factor of 0.5, recombination factor of 0.7 and maximum population of 300.

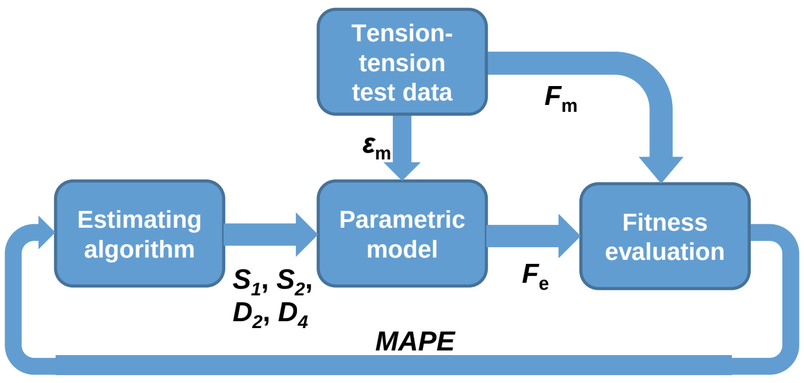

Figure 1, Workflow diagram [1]

$$\sigma + \left(\frac{D_4}{S_1} + \frac{D_4}{S_2} + \frac{D_2}{S_2}\right)\dot{\sigma} + \frac{D_2 D_4}{S_1 S_2}\ddot{\sigma} = D_4\dot{\varepsilon} + D_4\frac{D_2}{S_2}\ddot{\varepsilon}$$

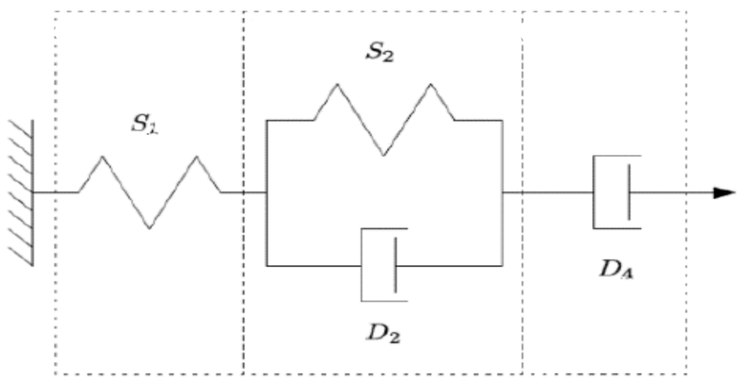

Figure 2, Burgers four model [3]

Results

The results displayed in figures 3, 4 and 5 show the estimated and measured tensions of different synthetic rope materials (thin and thick lines respectively). It can be seen that the estimated tensions closely resemble the measured ones.

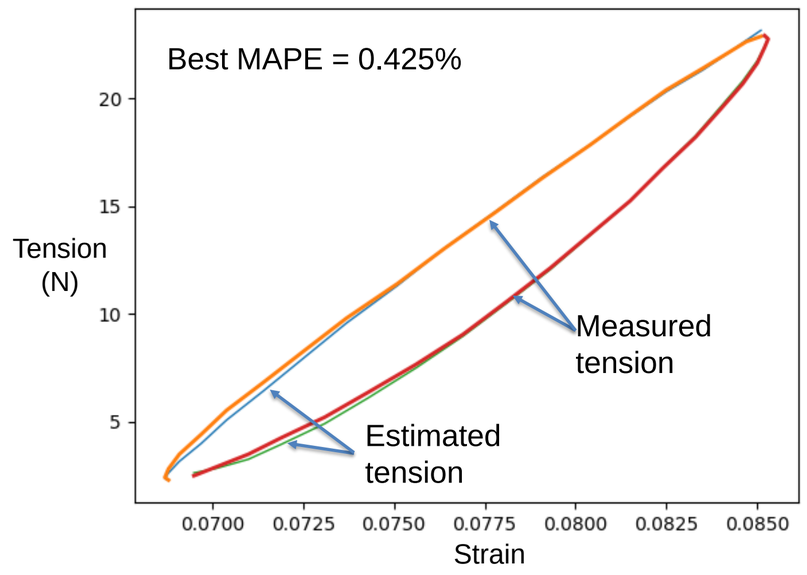

Figure 3, 44mm nylon parallel lay rope regular cycles

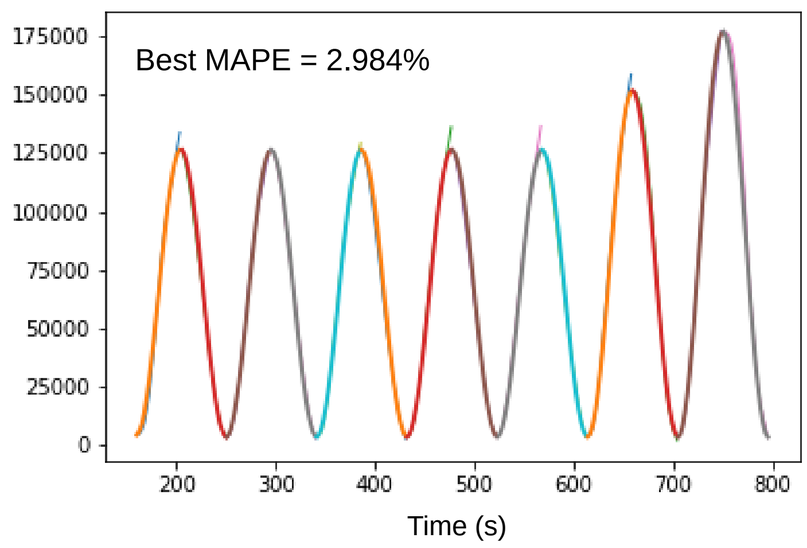

Figure 4, 150mm polyester rope regular cycles

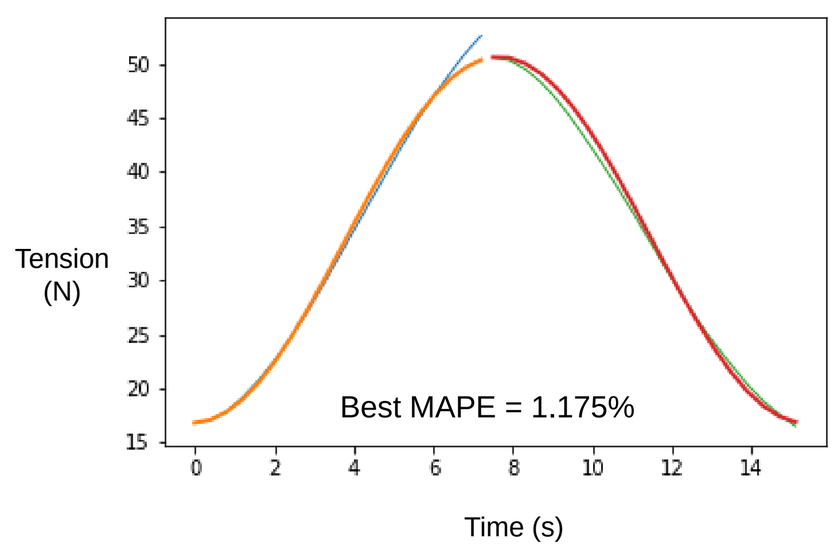

Figure 5, Vectran rope 100th cycle

Further Work

- Integration of the model into commercial modelling software (Orcaflex);
- Further investigation using different input parameters to improve either accuracy or processing speed of the model.

References

[1] S.D. Weller, S.J. Banfield and J. Canedo, Proceedings of OMAE18, Madrid, Spain, June 17-22, 2018.

[2] S.D. Weller, L. Johanning, P. Davies, S.J. Banfield, *Renewable Energy*, **83**, 1268-1278. 2015

[3] J. F. Flory and V. Ahjem, Proceedings of OCEANS 2013 MTS/IEEE, Bergen, Norway, 2013.

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