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FINITE ELEMENT ANALYSIS AND WEAR PREDICTION OF POLYURETHANE-STEEL TENSION MEMBER BELT FOR WAVE ENERGY

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INTRODUCTION

Using a belt as a replacement for a rope on a rotary power take-offs (PTO) system has become more common for wave energy converters (WECs). Using belts instead of ropes for winching elements is shown to improve Cyclic Bend Over Sheave (CBOS) performance with a smaller bending thickness for belts. However, the service life predictions of PTO is a major concern in design, because belt performances under harsh underwater environment is largely unknown. With belts subjected to three-dimensional fleet angle rotations, stress concentration and reduced contact area cannot be avoided. One way to estimate the service life of such belts is to analyze their behaviors within the scope of wear and tear models, which would necessitate accurate stress predictions for possible fleet angles. Prior experimental work [1] attempted to quantify the CBOS performance of a hybrid polyurethane-steel belt tested to two million cycles.

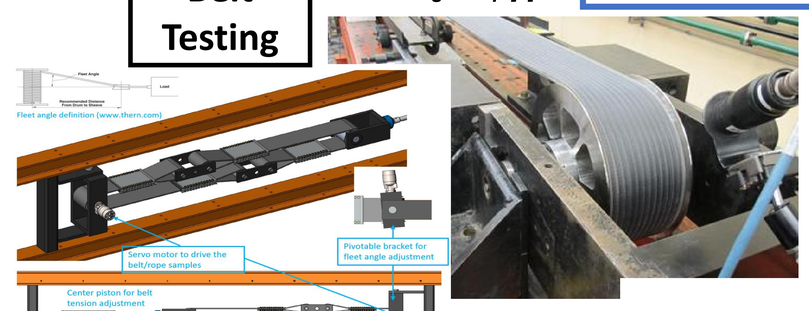
RESEARCH AIM & METHODS

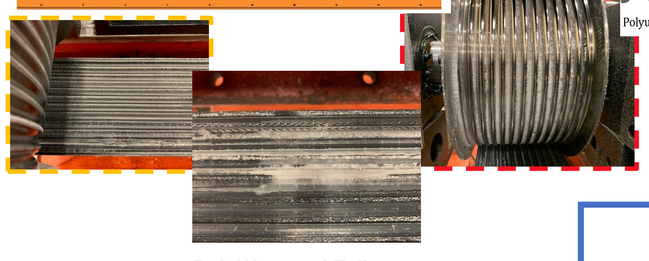
- In this work, three-dimensional equivalent static finite element models are constructed to **evaluate the complex stress state** of **polyurethane-steel belts** around steel drums.
- **Two models** are established, the first is to capture the response of the **aforementioned experimental** work and the second is for an **existing functional PTO**.
- In both models, the **belt** is represented with a **homogenized equivalent polyurethane model** to consider the **change of stiffness due to steel reinforcement**.
- The **drum** is being presented with **elastic-plastic steel model** and **allowed to rotate** around its center.
- Different friction coefficients are used to define a simulation matrix with each of In-plane load misalignment and belt twist angle.
- In this study, In-plane load misalignment and belt twist angle were not considered to have a high probability to happen concurrently. In fact, they are each considered as a unique idealization for the fleet angle problem.
- **In both models**, the following parameters are being studied:
  - friction coefficient between the belt and drum ranging from 0.15 to 0.65,
  - In-plane load misalignment up to 3 degrees,
  - belt twist angle of the belt up to 3 degrees.

RESULTS

Belt Testing

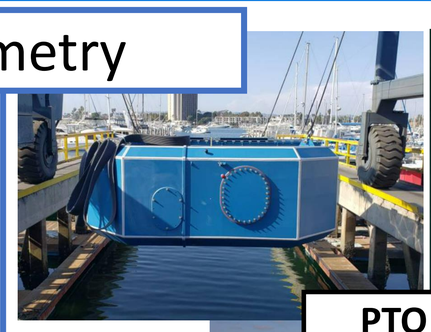
Belt Testing Setup [1]

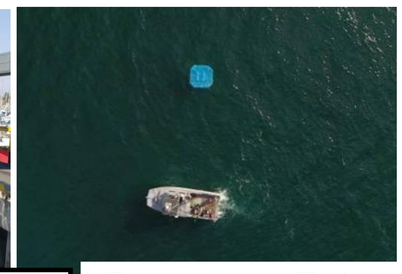




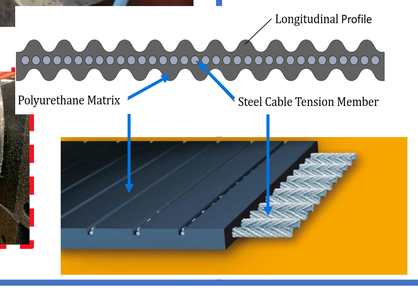
Belt Wear and Failure

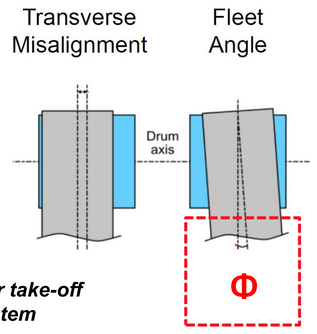
Geometry





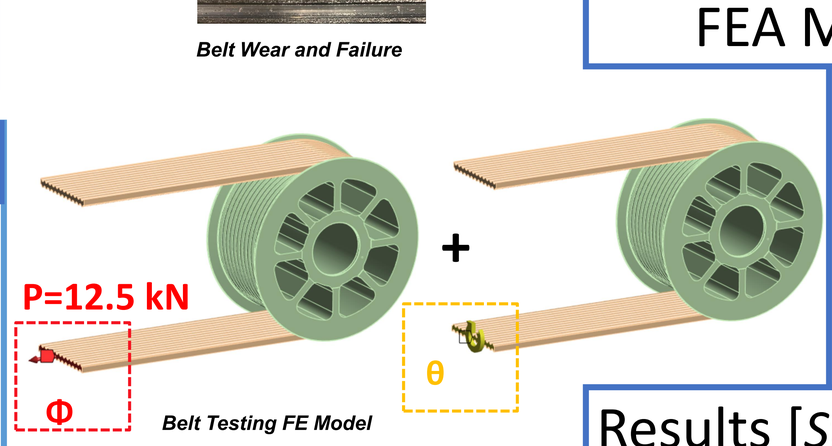
PTO



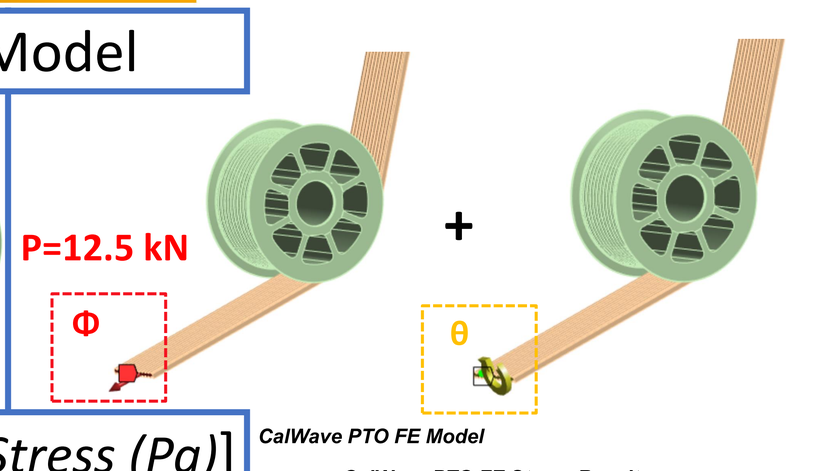


Calwave power take-off (PTO) System

FEA Model



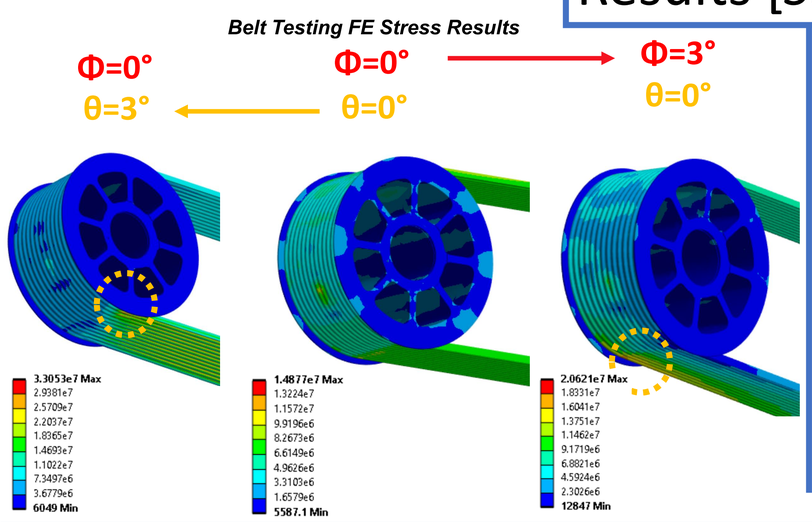
Belt Testing FE Model



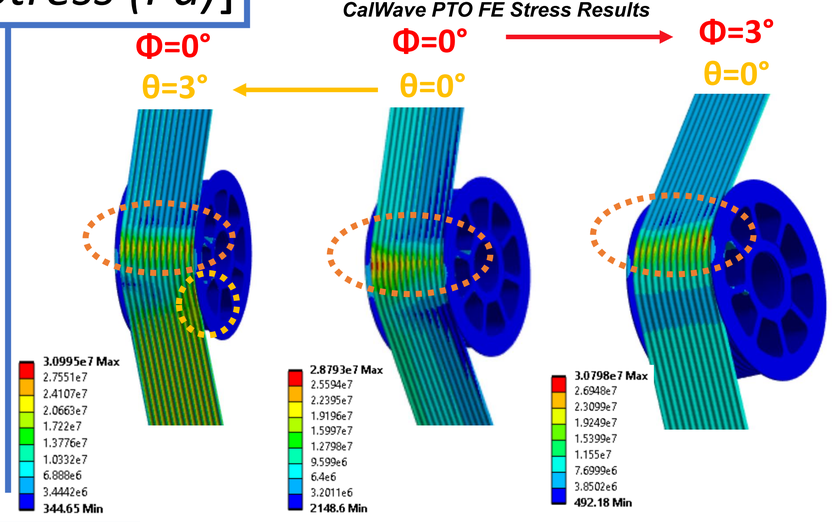
CalWave PTO FE Model

Results [*Stress (Pa)*]

Belt Testing FE Stress Results



CalWave PTO FE Stress Results



CONCLUSIONS

- The models are implemented in the commercial code ANSYS structural solver to simulate the stress concentration.
- The resulting stress states are then used to understand the performances and stress states of the former experimental program and the existing functional PTO.
- The acquired numerical results show a significant effect for **belt twist angle** on **stresses concentration,** and **in-plane feet angle** on **contact area**. Both impacting the estimated service life.

ACKNOWLEDGEMENT

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REFERENCES

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