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Fatigue Testing a Mechanized Percussion Well Drilling System for Water Access in Western Africa

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Micah Clark

Introduction

The current goal of Mechanized Percussion Well Drilling (MPWD) team is to determine the difference, if any, between a high-quality name-brand chain and a low-quality off-brand chain through a testing rig the team designs and produces. Additionally, the team was tasked with running a variety of simulations on the frame of the model in SolidWorks to determine where improvements need to be made.

As a whole, the project's goal is to provide a system to the client, Joseph Longenecker with Open Door Development, that they can use as an outreach into West Africa to provide work to local believers and easier access to water through improved equipment.

Clients

Joseph Longenecker, Open Door Development (ODD), and Serving in Mission (SIM)

Joseph Longenecker, along with his family, have been working in West Africa for 2 years. He is a Messiah alumnus who traveled to West Africa with his Collaboratory team when he was a student, and currently serves as the liaison between ODD and Messiah University. ODD was founded by Dale Johnson and Matt Walsh in 2012 as a SIM community development ministry. Their mission is to share the gospel by equipping the local church for community service and by ministering to human needs. Joseph particularly wants to help teach young engineers innovate to meet needs for Christ's sake.

Joseph Longenecker with his wife Erin and his two children, Lucie and William

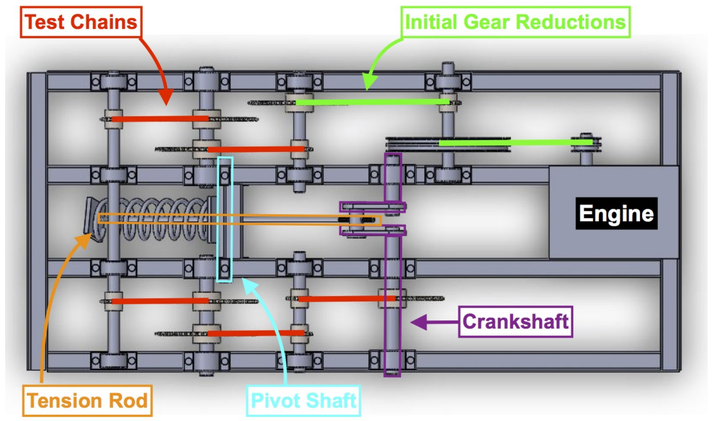
Fatigue Chain Testing

The team is determining the difference in high- and low-quality chains.

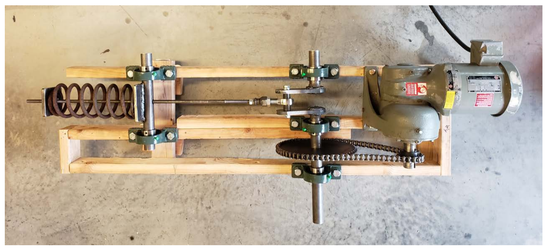
In order to test the chains, a testing rig was designed and the team plans to construct it during the 2021-2022 school year.

This design involves 5 key elements:

1. Five test chains connected in series
2. An initial gear reduction to set the proper speed and torque conditions
3. The engine to drive the system
4. A crankshaft which transfers the load onto the chains
5. The load application system, consisting of a spring sandwiched between two steel plates



Top view



Prototyping

To confirm and verify the design, the team built and ran a prototype using a geared motor, a single gear connection, crankshaft, and a substitute spring load application system.

Our Team

From left to right: Tommy Denlinger, Micah Clark, Benjamin Gates, Matt Higgs, Robert Donley, Dr. Philip Tan

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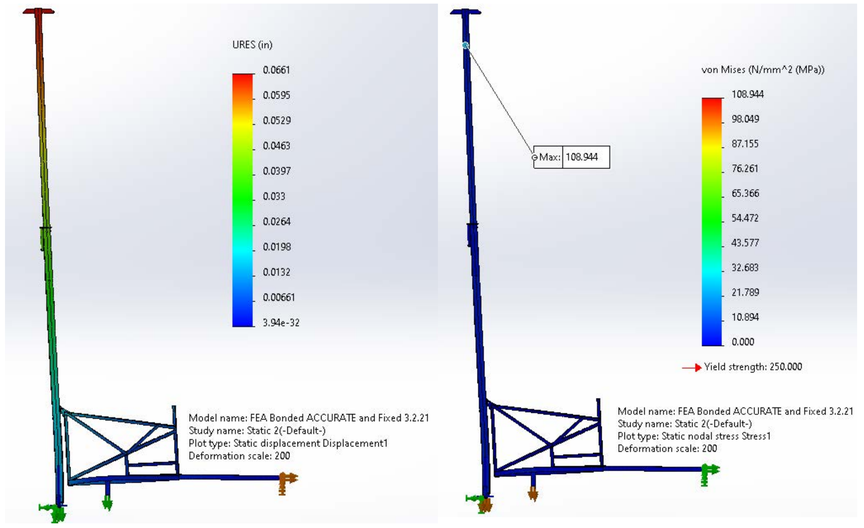
SolidWorks Finite Element Analysis

In order to do fatigue testing on the rig frame, the team used a 3D SolidWorks Model to run Finite Element Analysis (FEA) with the program's built in testing software.



Displacement (left) and stress (right) in the model after the load was applied

In order to run the FEA static study, the team set several key boundaries on the model:

1. The model had to be fixed in space, where the green and orange arrows are shown in the figures above, so that it would not move in space and to accurately reflect the how the ground interacts with the rig.
2. The load had to be calculated and applied correctly. A load of 3,924 N or about 2000 lb was applied at the top of the system where a pulley is connected to the rig based on data from the client.
3. The program had to create mesh and connection constraints that give a simplified shape and tell the software how the connections should be represented to run the analysis. The mesh was as detailed and fine as possible so the study would be as accurate as possible.

The team has run a static study and will run a fatigue and buckling simulation in 2021-22

Conclusion

- The team has a viable design for a testing rig, proven by a prototype, that will be under construction shortly and will then be used for fatigue testing.
- The team also has a successful FEA study that will be revised based on client feedback and then become a baseline for several other studies.

Acknowledgments

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- Advising Engineers: John Meyer, Dr. Tim Van Dyke

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