Simulation & Analysis of the different possible component connections to the PTO

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Aim of the Project

The Aim of the project is to Simulate and Analyse the different possible component connections used in a wave energy converter. Determine which component would perform the best when used in a wave energy converter.

Project Objectives

- Research the different possible component connections for the wave energy converter.
- Create Components in SolidWorks.
- Apply Materials, fixtures and loads to components.
- Create Mesh and perform simulations.
- Analyze results of simulations.
- Determine from results which component would perform best if used in a wave energy converter (WEC).

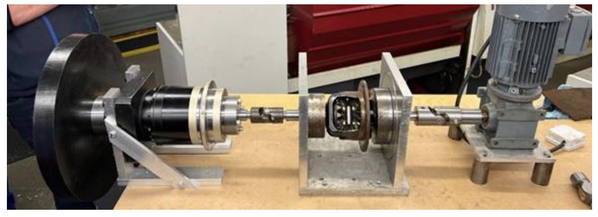

Figure 1: Limerick Waves Newest WEC

Background

A universal joint also known as a U-joint or Universal Coupling is used to transfer mechanical power in the form of rotary motion along two axes.

Figure 2: Universal Joint

Universal Joints are often used to connect two components where there is a difference in the heights or centres of the two components.

A spline shaft is shaft which has teeth or ridges on the outer surface, these teeth help the shaft transfer torque better when put into a spline housing. The housing ensures no mechanical motion is wasted as the shafts will go in from either end and unless the teeth break there cannot be any extra movement except for a small movement in slack before the teeth touch.

Figure 3: Spline Shaft

Figure 4: Spline Housing

Figure 5: Rubber Coupling

A rubber coupling aims to transmit torque from one piece of rotating equipment to another while allowing for a small amount of misalignment

Methodology

The simulations were carried out on SolidWorks simulation tool. The main aim was to see which component could handle the most torque while having the least amount of deformation. The three components were first made on SolidWorks.

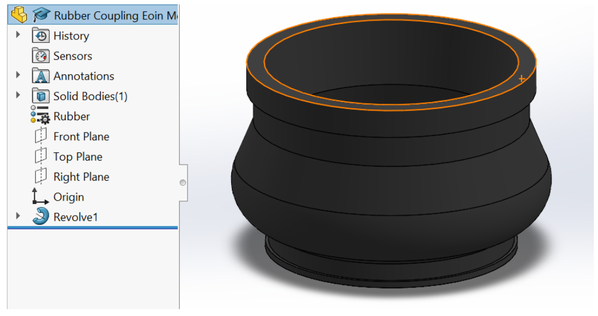

Figure 6: Rubber Coupling Model

From there a new study was created. Materials of component was applied. Any fixed geometry was set. The torque values were then selected (one per simulation). Finally, a mesh was applied which consists of nodes and elements used to calculate results for the simulation.

Results

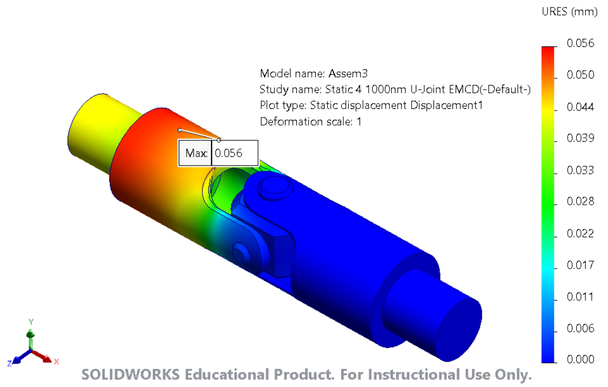

Figure 7: Universal Joint URES Results

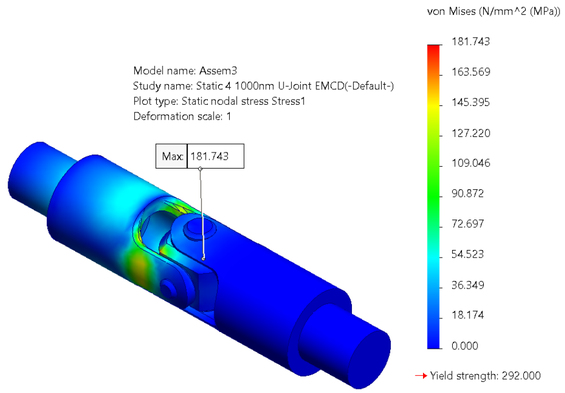

Figure 8: Universal Joint Von Mises Results

As shown in figure 6 above the URES (Displacement) of the universal joint under 1000 Nm of torque was 0.056 mm. To check if the component is deformed go to the stress plots (von mises) and compare the max stress to the yield strength of the material of the component. Figure 7 shows max stress is 181 Mpa and the yield strength is 292 Mpa. This means there is no deformation.

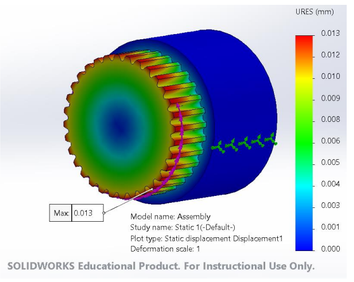

Figure 9: Spline Shaft URES Results 500 Nm torque

The displacement (mm) and max stress (Mpa) was retrieved from the simulations under torque values from 500-2500 Nm in steps of 500 Nm

Torque (Nm)	Universal Joint (SS) Yeild = 292 Mpa		Spline Shaft (SS) Yeild = 292 MPa		Rubber Coupling (Rubber) Yeild = 9.237 Mpa	
	Displacement (mm)	Max Stress (Mpa)	Displacement (mm)	Max Stress (Mpa)	Displacement (mm)	Max Stress (Mpa)
500	0.028	90.872	0.013	139.841	22.224	2.095
1000	0.056	181.743	0.026	279.683	28.49	2.634
1500	0.083	272.615	0.039	419.524	28.49	2.634
2000	0.111	363.487	0.051	559.366	28.49	2.634
2500	0.139	454.359	0.051	699.207	28.49	2.634

Table 1: Simulation Results

Conclusion

- Each component was researched, created on SolidWorks with appropriate materials assigned and simulations carried out
- The universal joint was able to withstand the highest torque 1500 Nm while having the least stress 272.615 MPa.
- The spline shaft had the least deformation with a displacement of 0.051 mm at 2500 Nm.
- The rubber coupling failed under all torques showing it would not be suitable for the potential high torques of the WEC.
- The Universal Joint makes most sense to use with Limerick waves due to not having to align shafts concentric.

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