

Investigation of Compliant Constant-Force Mechanisms

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Compliant mechanisms draw their motion from the elastic deformation of flexible links without conventional joints. The mechanisms that deliver a nearly constant reaction force upon displacement are called compliant CFMs. This thesis is about investigating such mechanisms analytically and numerically.

Analytical Aspect

For the analytical part, there are several techniques developed to convert a compliant mechanism into a corresponding conventional mechanism using torsional springs. These models are called pseudo-rigid body models (PRBM)¹. Once we have the PRBM of the mechanism, we can use the potential energy method or the principle of virtual work to analyse the mechanism in a conventional way.

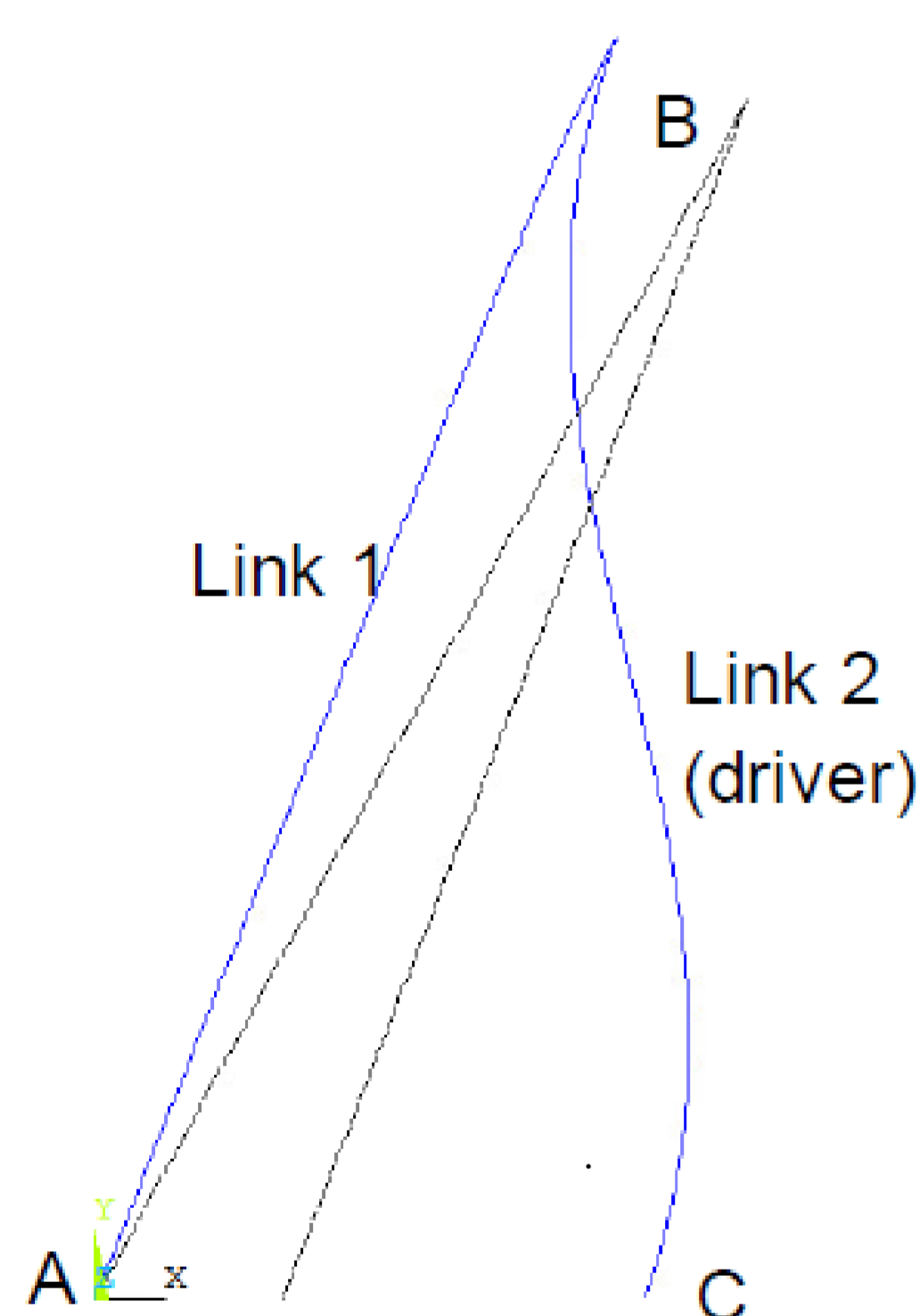


Figure 1 : Deformation of Tolman Mechanism

A compliant CFM developed by Tolman, Kyler A.² et. al. is demonstrated here as an example. A simplified version of the mechanism used in Ansys Parametric Design Language (APDL) is shown in figure 1. The curve in blue is the deformed version when the point C is slid horizontally.

Outlook

Compliant mechanisms offer many advantages such as ease of manufacturing, low wear and tear, minimal or no assembly requirement, no lubrication requirement. There are a few disadvantages too like fatigue and reduced range of motion. However, these mechanisms have been used in many applications without any major challenge.

Acknowledging this, more research should be done in this area so that more accurate and cost effective compliant mechanisms can be developed.

Numerical Example

The results of the non-linear analysis of the Tolman mechanism in APDL in the form of a force-displacement plot is shown in figure 2. It demonstrates a nearly constant force for a displacement of 5 to 15 cms at point C. Therefore, this will be the operating range for this mechanism.

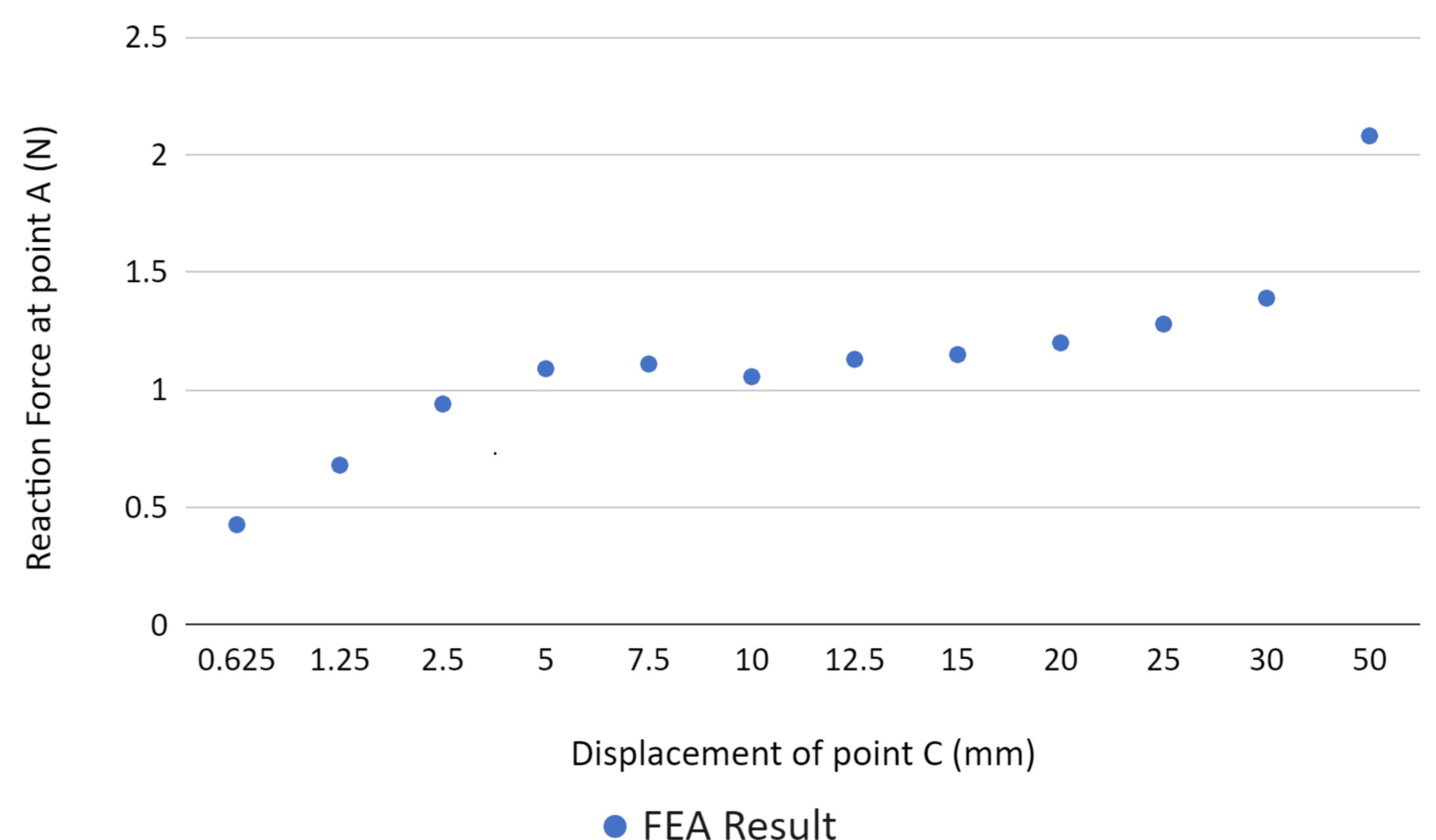


Figure 2 : Force-displacement graph for Tolman Mechanism

Literature

1. Howell, Larry L.: Compliant mechanisms. In: 21st century kinematics. Springer, 2013, S. 189–216
2. Tolman, Kyler A.; Merriam, Ezekiel G.; Howell, Larry L.: Compliant constant-force linear-motion mechanism. In: Mechanism and Machine Theory 106 (2016), S. 68–79