

**WORCESTER POLYTECHNIC INSTITUTE
MECHANICAL ENGINEERING DEPARTMENT**

PH.D. DISSERTATION

ENTITLED

**“IMPROVING THE FATIGUE LIFE OF CYLINDRICAL
THREAD ROLLING DIES”**

BY

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Abstract:

Thread rolling is a unique metal forming process which is commonly used to form screw threads on threaded fasteners and precision leadscrews at relatively high rates of speed. Threads are formed on a cylindrical blank by flat or cylindrical dies having the reverse form on them, which rotate and penetrate the blank simultaneously, to plastically deform it into a precise geometry. Thread rolling dies are exposed to a complex state of cyclical contact stresses that eventually cause the dies to fail by fatigue and wear. The stress state is not easily ascertained through standard analytical models due to complex geometry and process conditions. This research seeks to better understand the state of contact stresses present in cylindrical thread rolling dies as they form material, to aid in identifying and testing economical methods of improving thread rolling die fatigue life. Some work has been published on using FEA simulation software to model the thread rolling process, but no work has been published on using FEA software to analyze the stresses in thread rolling dies. DEFORM®-3D Forming Simulation Software by Scientific Forming Technologies Corporation in Columbus, Ohio was used to simulate the throughfeed thread rolling process and model the state of stresses in the dies. The results were compared to the Hertzian contact stress model and the Smith Liu equations for rolling and sliding friction. Fatigue life prediction methods involving S-N curves, surface fatigue strength, and Weibull probability distributions were tested using the simulation data against field results. An optimized die design was generated from a design of experiments simulating different die design geometry. Findings show that field failures correlate well to the DEFORM® simulation results. The Hertz model with Smith Liu equations improved correlation with the simulation. Fatigue life prediction models correlated reasonably well to field results using the simulation data for inputs. These findings can aid in selecting appropriate die materials, design parameters, and fatigue life treatments.

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4:00 pm

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