Finite Element Analysis of an ANSI Roller Chain Sprocket

Introduction

Roller chains are used in may different applications to transmit rotary motion and power from one shaft to another. Power and motion are transmitted via a multi-toothed sprocket driving the roller chain, a ladder type assembly of free rolling pins and links. The specific setup that was tested in this study is shown at right. A roller chain sprocket is shown with several links engaged in its teeth. The sprocket is connected to the shaft with a brass key. Brass keys are often used in these applications because they are softer than the steel used in the sprocket and the shaft, thus protecting these much more expensive and harder to replace parts from damage in the event of permanent material deformation.

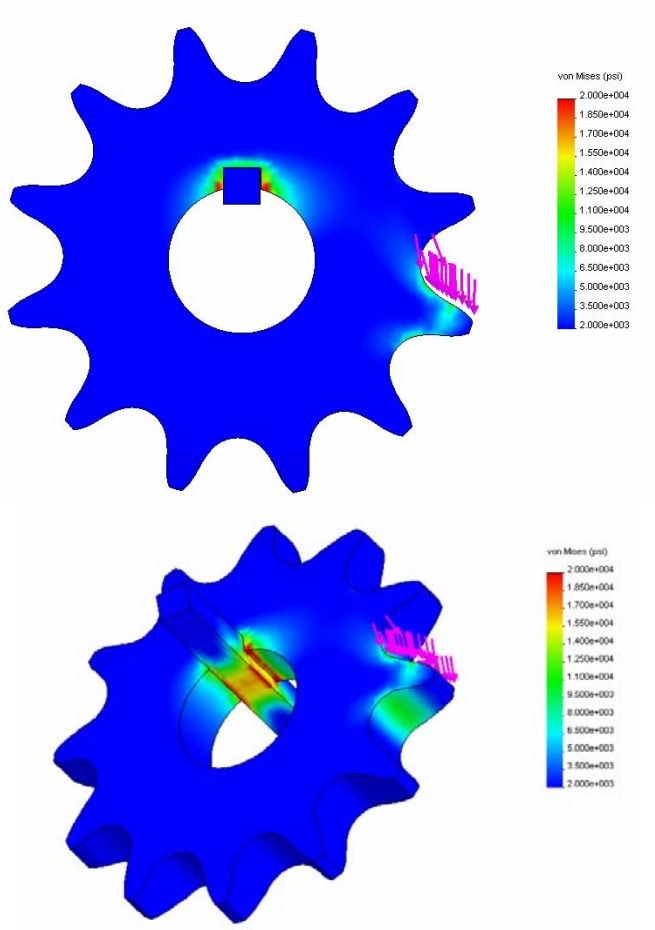
Methods

This study seeks to determine the suitability of ANSI size 60 roller chain sprockets for use on the Cooper Union Mini Baja vehicle. The engine used on the Mini Baja is capable of producing 10HP. Thus, the loads applied to the sprocket are calculated based on the engine's maximum speed and horsepower. The computer program used to compute the Finite Element study was Cosmos Works. This package was chosen based on its ease of

use, compatibility with the design program Solidworks, and its superb image rendering capabilities. The sprocket studied was an ANSI size 60 sprocket with 12 teeth, 1" bore, and a ¼" keyway. The sprocket is made from steel, as well as the shaft. The roller chain links are made from hardened steel, and the key, as previously mentioned, is made from brass. All contact areas are assumed to be perfect, meaning there are no gaps or irregularities. To simplify the computations, the loading of the sprocket was defined as having the entire torque of the motor applied to one side of one tooth. The sprocket was free to spin on the shaft, and a restraint was put on the key forcing the sides of the key to be in constant contact with both the keyway in the shaft and the keyway in the sprocket. These simplifications were made keeping the worst possible loading scenario in mind.

Results

The maximum stress found in the sprocket occurs at the corner of the keyway, as shown in the graphics to the right. The maximum stress is $3.124 * 10^4$ psi. This translates to a factor of safety of 1.114. While low, this factor of safety is permissible due to several factors. First, the motor is governed to operate below 8HP. Second, the drive train of the Mini Baja contains one belted transmission element. This element will most likely slip before the torques used in this study will



ever be transferred to the sprocket.

Conclusions

The ANSI size 60 roller chain is sufficiently sized to safely operate when connected to the 10HP engine used by the Mini Baja. This size roller chain is typically used in motorcycles with engines capable of producing 50 to 70 HP. The Finite Element study conducted here has corroborated the preliminary calculations and estimations of the design team.