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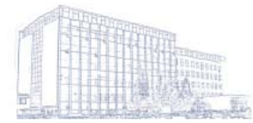

Parametric Modeling of a Cycloid Drive Relative to Input Shaft Angle

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***Abstract*— Creating an equidistant of the shortened epitrochoid curve for a cycloid drive disc is a complex process. By automating this process using a parametric input curve drawing program, the geometry can be precisely defined. In this paper a cycloid drive model is created using such a program written for these purposes. The program input also creates other drive component curves and places them in their current positions relative to the input shaft rotation angle. The model generated from this geometry represents a valuable and time efficient initiate for further stress analyses of cycloid drive components. Automating this process also decreases the possibility of human error and allows for easily changeable input shaft angles.**

***Keywords*— cycloid drive, cycloid gear, parametric modeling, gear position, automated generating**

I. Introduction

Cycloid drives, which are a part of the planetary drive group, have a wide industrial application. This is mainly due to their excellent characteristics, a wide range of gear rations, high efficiency, smooth transmission, high overload capacity, compact overall size, low noise, long and reliable service life as well as suitability for frequent start-stop and reverse duty.

The key component of the cyclo drive is the cycloid disc. The cycloid disc profile is an equidistant of the shortened epitrochoid while the annular sun (central) gear has rollers instead of teeth. The cycloid gear is made with one tooth less than the number of rollers on the central gear (only some newer cycloid drive designs have two teeth less). In practice, most commonly used systems of cyclo drives have two cycloid disks which are rotated by 180º of each.

Basic information about cycloid gearing was covered by Kudrijavcev [1] as well as by Lehmann [2]. Parametric equations for equidistant of trochoid have been developed by Litvin and Feng [3]. Meshing conditions have been covered in detail by Chen, Fang, Li and Wang [4]. Computerized design for generation of surfaces and curves has been developed in [5]. An analytical model has been developed by Blanche and Yang [6] with machining tolerances to minimize backlash and torque ripple. Distribution of loads has been analysed in [7], [8], and [9]. Level of efficiency has been examined by Gorla, Davoli, Rosa, etc. in [10]. The need to cover a wide range of possible analysis on this type of drive starts with being able to create a model which is easily editable.

Stress analyses in the contact of the cycloid disc and the central rollers, for example, are most commonly performed for a few characteristic positions of the gear meshing relative to the input shaft angle. This is the case due to the complex geometry of the cycloid disc which has to be rotated around the central axis by the offset cam and around its own axis, which is a time-consuming process if done manually. By automating the modelling process it is possible to avoid the likelihood of human error as well as shortening the time needed to draw the drive, position the gear meshing in the desired contact position and edit any further iteration.

As a basis, a three-dimensional part created in Autodesk Inventor can be imported into any analysis program as reference geometry. Autodesk Inventor has the capabilities of automating the modelling process, and as such is ideal for the purposes of parametric modelling of whole cycloid drive.

II. Cycloid Drive Parameters and Profile

A cycloid is a curve which is traced by a point located anywhere on a (rolling) circle which rolls along a stationary (basic) circle. The rolling circle has a radius, R_a (1), while the stationary circle's radius is, R_b (2). For defining these radiuses it is necessary to know the pitch circle radius of the central gear, r, as well as the gear ratio, u_{rc}.

The position of the rolling circle in relation to the basic circle and the position of the rolling circle in relation to the rolling curve which traces the cycloid defines the type of cycloid form. The most commonly used tooth profile for cycloid gears is an equidistant of the shortened epitrochoid.

$$R_a = \frac{r}{u_{CR} + 1} \tag{1}$$

$$R_b = r - R_a \tag{2}$$

The equations for x and y coordinates for the equidistant of the shortened epitrochoid are given by functions (3) and (4).

$$x = (R_b + R_b) \cdot \cos\alpha + e \cdot \cos(\alpha + \beta) - q \cdot \cos(\alpha + \phi) \tag{3}$$