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A Geometric Design Algorithm for a Slotted Disc Spring from Early Prescribed Function

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1. Introduction

Since each nonlinear slotted disc spring application requires a unique load-displacement function, a spring geometric parameters must be precisely custom designed. However, there is no specific algorithm available to calculate such geometric design parameterization. The aim of this study is to propose a generalized algorithm for a slotted disc spring geometric design that ensures the output design exhibits identical load-displacement function with any prescribed one.

2. Construction of Prescribed Function

As a reference, prescribed function was plotted using formulation [3] as target function.

3. Algorithm Description

The first consideration on the prescribed load-displacement function is the limited range of the function. The limited range is very sensitive to the predicted geometric design parameters as this function will be used as our main reference to search the best combination of optimal design variables that produce the minimum least mean square error between the predicted and prescribed function. However, we do not particularly describe the limit range of the prescribed function in this study since the main concern of this work is to produce a generalized algorithm that can match any prescribed function. Specifically, the displacement and load range requirement is deferred for future work.

By referring to the first literature work on a conical disc spring [1], our present algorithm keeps the assumptions given by Almenz-Laszlo as follows: (a) angular deflection of the cross section is relatively small, (b) cross section remains undistorted in the deflection position, and (d) the loading and support are uniformly distributed.

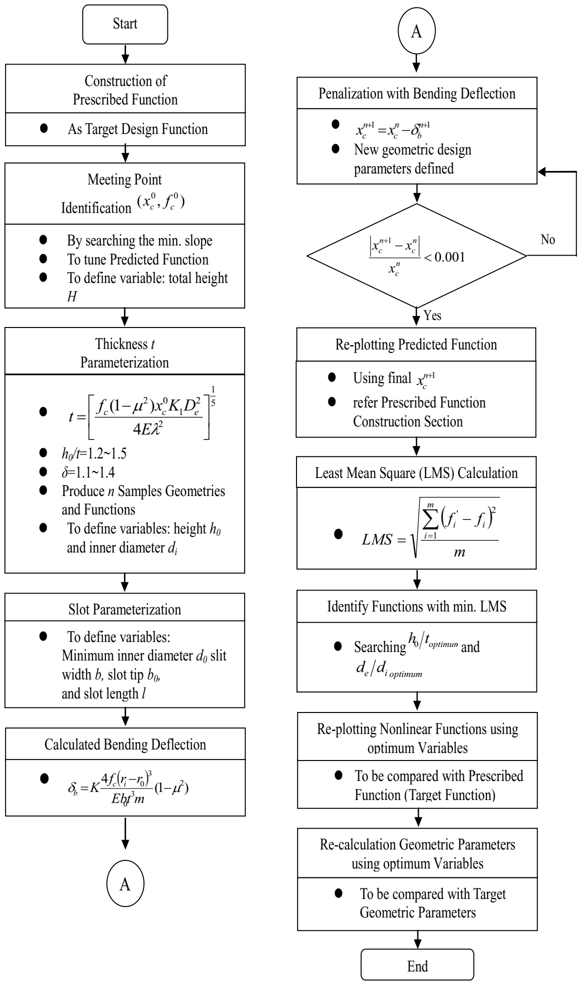

Fig. 1 Algorithm Description

4. Example

To assess the proposed algorithm explained in the previous section, an example is shown by comparing the results obtained between our proposed algorithm and the original geometric parameters used to plot the prescribed function. Fig. 2~Fig. 3 show the obtained calculated results.

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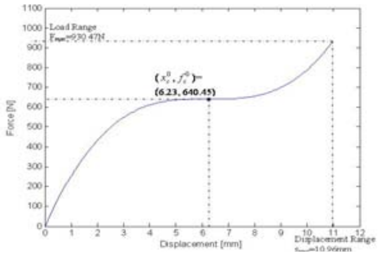

Fig. 2 Determination of Meeting Point

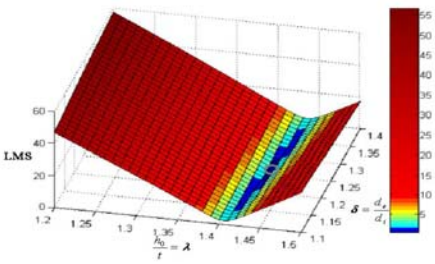

Fig. 3 LMS Distribution

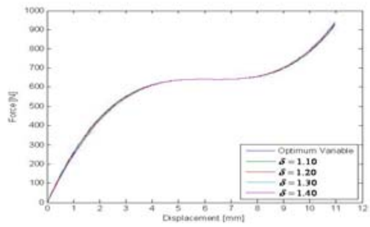

Fig. 4 Predicted non-linear Function

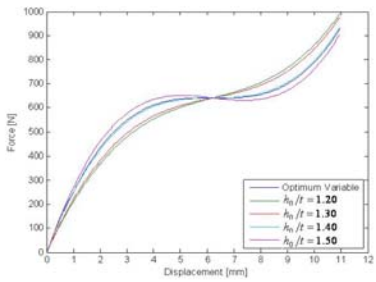

Fig. 5 Predicted non-linear Function

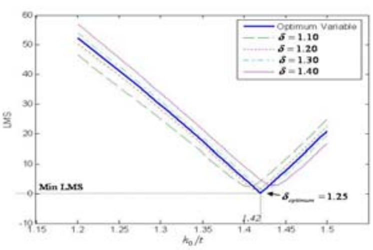

Fig. 6 LMS Distribution with Variation of h_0/t

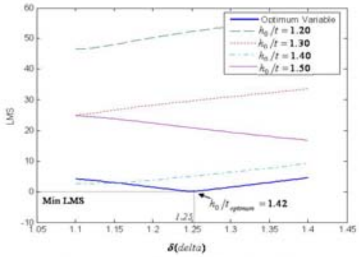

Fig. 7 LMS Distribution with Variation of δ

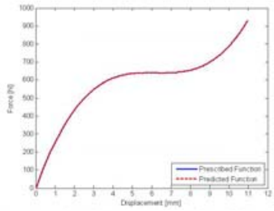

Fig. 8 Prescribed and Predicted Function

(unit:mm)

Comparison	d_e	d_i	d_0	t	h_0	H	l
Prescribed Geometric Parameters	120	96.0	56.00	1.60	2.27	6.058	20.00
Proposed Geometric Design Parameters	120	96.0	55.99	1.60	2.27	6.060	20.00
Error (%)	0.00	0.00	0.03	0.00	0.00	0.30	0.00

Table 1 Comparison between Geometric Designs using Proposed Algorithm and Prescribed Geometric Design

7. Conclusion and Further Study

This study has presented a novel of new generalized algorithm to propose the geometric parameters of a slotted disc spring which are required to meet a prescribed function. The new proposed algorithm can be used to meet the industrial needs which are always looking for new design method to improve their production.

8. References

[1] Almen, J. O., and Laszlo, A.,1936, "The Uniform Section Disc Spring," Trans. ASME, **58**(4), pp. 305-314

[2] Society of Automotive Engineers, 1982 "Design and Manufacture of Coned Disc Springs (Belleville Springs) and Spring Washer" SAE HS-1582.

[3] Shen, W., and Fang, W., 2007, "Design of a Friction Clutch using Dual Belleville Structures, " Journal of Mechanical Design, **129**, pp. 986-990.