A Study on the Vibratory Behavior of Switched Reluctance Motor due to Stator Geometry

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***Abstract* – The influence of the various pole shapes and stator geometry in SRM on the mechanical behavior is investigated in this paper. The predictions of the vibration performance caused by the electromagnetic force are derived from the mechanical stress, displacement and dynamic response of the stator. The simultaneous analysis about electromagnetic and vibration behavior allows us to propose a less vibration structure, based on the structural and the electromagnetic finite element method.**

INTRODUCTION

In recent years, there is a growing interest in Switched Reluctance Motor (SRM) drives. The rugged construction, simple electronic control circuits with minimum components, and high power density are the factors that are in favor of such drives. Due to the absence of any winding on the rotor the efficiency of the motor will be comparable to that of the induction motor despite the increased core loss, vibration and torque ripple.

The interaction of electromagnetic force and mechanical structure of the motor can become the major cause of the noise and vibration. Therefore, in order to reduce the vibration, it is necessary to predict the forced vibration behavior coupled with the electromagnetic force in design stage. The existing researches on the vibration of SRM can be classified into two groups, These are the mechanical characteristics related to the design aspects of the machine geometry and to the current wave according to the control mode [1-3].

The focus of this paper is to predict the forced vibration behavior coupled with the electromagnetic force in proposed design stage. Several efforts have been made to analyze the mechanical characteristic aspects for SRM design related to the conventional stator and pole geometry such as the round stator with parallel pole.

This paper presents design criteria of SRM related to five kinds of pole shape and three kinds of stator geometry. The vibration behavior with regard to the various pole shapes and stator geometry is investigated to reduce the vibration. Then a new structure of low vibration and good performance SRM will be designed in extended version.

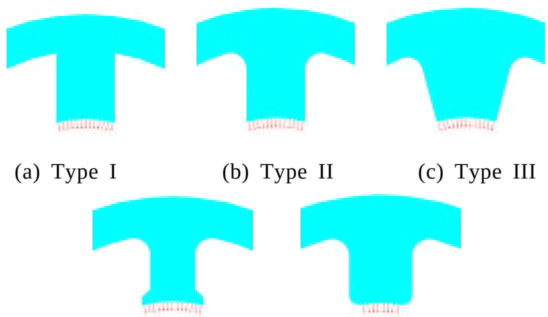
ANALYSIS MODEL AND DESIGN

When the radial electromagnetic forces are acting on stator pole, the mechanical characteristics related to the stress, displacement and dynamic response of the stator are analyzed. In addition, the natural frequencies and the mode shapes are examined to avoid the resonance caused by the force frequency and the radial vibration of the stator, respectively. A robust configuration is proposed that act against the electromagnetic force of SRM and leads to a less noisy machine.

This work is based on the study of a 6/4 SRM and the analysis models of the pole shapes and the stator geometry are as follows:

- Pole shape: parallel-side pole, trapezoidal pole, T-shaped pole, and parallel-side pole with fillet and parallel-side pole with round edge [4].
- Stator geometry: round stator, hexagon stator and novel hexagon stator (the poles are located at the corner of stator.)

Fig. 1 shows the several pole shapes with the arrow entity presenting the direction of the radial electromagnetic forces. The displacement at stator pole surface and the maximum stress caused by the electromagnetic force are shown in Table I.



(a) Type I (b) Type II (c) Type III

(d) Type IV (e) Type V

Fig. 1 Various Pole Shape

Table I. Displacement and Stress of Stator According to Pole Shape

Type	I	II	III	IV	V
Displacement (μm)	20.84	17.04	12.75	19.81	10.71
Stress (Mpa)	40.97	30.62	25.78	33.46	25.80

REFERENCES

[1] C. G. C. Neves *et al*, "Vibrational behavior of switched reluctance motors by simulation and experimental procedures," *IEEE Tans. on Magn.* Vol. 34, No. 5, pp. 3158-3161, 1998.

[2] C. Pollock and C. Y. Wu, "Acoustic noise cancellation techniques for switched reluctance drives," *IEEE Trans. on Industry Appl.*, Vol. 33, No. 5, pp. 477-484, 1997.

[3] M. Besbes *et al*, "Influence of stator geometry upon vibratory behavior and electromagnetic performances of switched reluctance motors," *IEE Proc. Electr. Power Appl.*, Vol. 145, No. 5, pp. 462-468.

[4] T. J. Miller, *Switched reluctance motors and their control*, Clarendon press, 1993.