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Reduction of Detent Force in Permanent Magnet Linear Synchronous Motor Utilizing Auxiliary Poles

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The significant drawback of Permanent magnet linear synchronous motors (PMLSMs) is large detent force, which will result in mechanical vibration, acoustic noise, velocity oscillation, and deteriorate the performance of PMLSM [1]. This paper proposes a novel technique to reduce the detent force in PMLSM using auxiliary poles. The detent force that is caused by the attraction between permanent magnet (PM) and the iron core without input current can be divided into two components: the slot effect and the end effect [2]. To reduce these two effects of detent force, we analyze the detent force characteristics according to semi-closed slot clearance length and auxiliary poles position using two-dimensional (2-D) finite element method (FEM).

Fig. 1 shows the PMLSM structure fixed with auxiliary poles. Fig. 2 shows the detent force according to the mover displacement with different semi-closed slot clearance length. The peak value of the detent force is obviously reduced from 103.5[N] to 43.4[N]. Fig. 3 shows the calculated and measured detent forces with/without auxiliary poles. The detent force is reduced to 6.9[N] that satisfies the design requirement for only 1.15% of the rated electromagnetic force 600[N]. Moreover, the numerical calculations and the experimental results are in good agreement. These prove that this proposed technique has a good effect on the reduction of the detent force.

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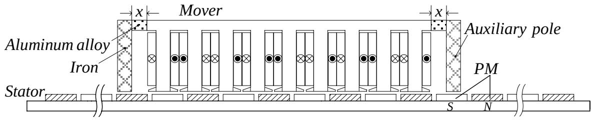

Fig. 1. PMLSM structure.

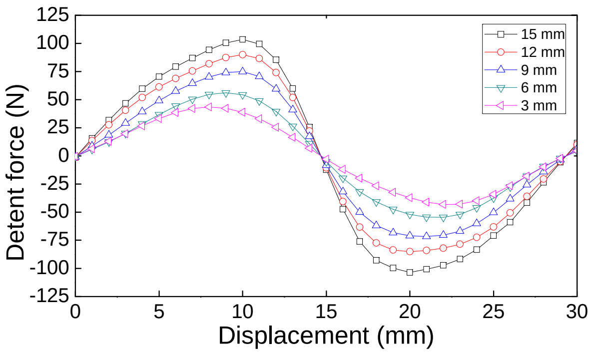

Fig. 2. Detent force in terms of semi-closed slot clearance length.

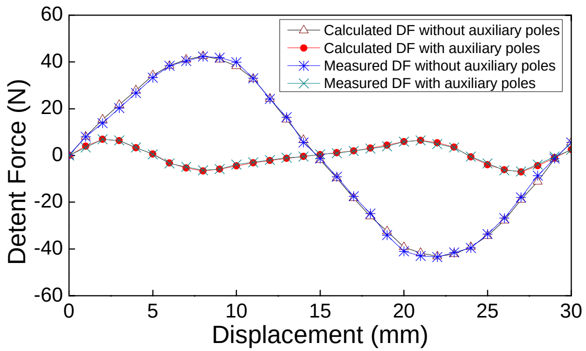

Fig. 3. Simulated and experimental detent forces with/without auxiliary poles.

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Investigation of Linear Induction Motor According to Secondary Conductor Structure

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This paper presents the analysis of single-sided linear induction motors (SLIMs) for the application in various system demanding direct linear motion. In order to investigate the characteristics of linear induction motor according to secondary conductor structures, the equivalent circuit of SLIM is described and the equivalent parameters are computed and compared. In addition, the characteristics such as the air-gap flux density, thrust, normal force, force ripple, speed response, and so on are analyzed by 2-D FEM with the external circuit, and then the simulated results are compared.

Fig. 1 shows the general configuration of a plate-type single-sided LIM adopted in this paper. Fig. 2 shows the proposed secondary conductor shapes with the same primary core of SLIM. The squirrel-cage conductor models as shown Fig.2 (b), (c), (d) and (e) have the structure consisted of four conductor-bars per pole, 3-slot/4-bar. Although the secondary structure has the different shape, the conductor area per unit area of secondary is almost the same value in all of the cases. Fig. 3 shows FEM simulation results of the thrust, the plate-type LIM has higher thrust than the others in the high slip region but has lower thrust in the low slip region. These curves have closed relation with the equivalent circuit parameters. Fig. 4 shows the thrust characteristics of SLIM with no-load and Fig. 5 shows it with rated slip, 0.2. As the result of this analysis, the transient characteristic responses can be divided into 3 groups. More detailed results will be shown in the full paper.

This work is supported by Research Funds from Dong-A University.

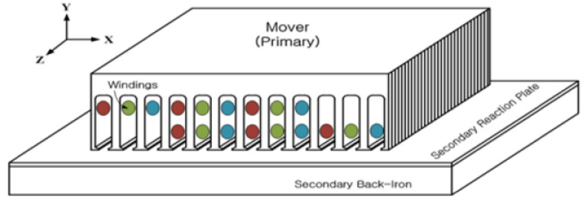

Fig. 1. Configuration of the plate-type linear inductio n motor.

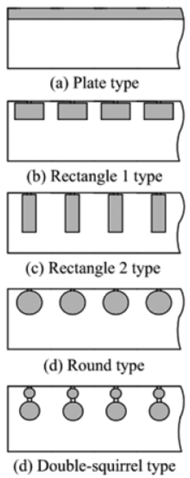

Fig. 2. Analysis model of the secondary part.

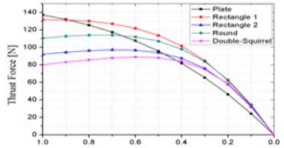

Fig. 3. Thrust curve according to the slip.

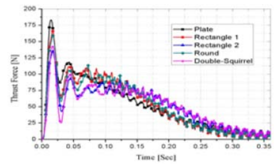

Fig. 4. Thrust characteristics throught the transient analysis.

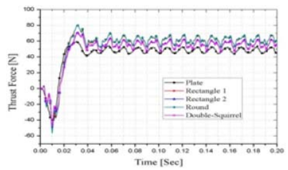

Fig. 5. Thrust curve when the slip is rated, 0.2.

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