Thrust Verification of the Segmented-type Switched Reluctance Linear Synchronous Motor (SSRLSM)

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ABSTRACT: The SSRLSM has been designed and developed. The fabricated SSRLSM was measured in order to obtain the characteristics of the static thrust, *F*. The measured static thrust was then compared with the simulated static thrust for verification. The comparison shows that the measured and simulated static thrust are in agreement. The highest measured thrust identified at 5.0 A is 1573 N with 46% percentage error.

Keywords: *linear motor; SRLSM; segmented SRLSM (maximum of three keywords)*

1. INTRODUCTION

The vertical transportations has become one of the essential things in our daily lives. They help to move us from one floor to another floor especially in high buildings. A few example of the vertical transportations that we commonly used in our daily lives are escalators, travellators and lifts. Talking about lifts, in recent years, their applications not only limited to high rise buildings but also applicable in the domestic houses.

In the modern lift application, most of the lift systems are gearless traction. This type of lift has more compact design due to elimination of the gearbox [1], and can be driven by either rotational motor [2] or linear motor [3]. Hence, this type of lift system is suitable for the domestic lift application. In this project, the segmented-type switched reluctance linear synchronous motor (SSRLSM) for domestic lift application has been designed and discussed in [4]. The SSRLSM discussed in [4] was then fabricated in lab scale for measurement and result verification.

2. BASIC STRUCTURE of the SSRLSM

Basically, the design of the SRLSM as the segmented-type is to reduce the manufacturing tolerance [5] faced by the conventional SRLSM. In this SSRLSM design, the SSRLSM is designed as a three-phase electrical motor where each phase of the SSRLSM consist of two coils. The SSRLSM consist of stator part (stator pole and stator track) and mover part (mover yoke and mover coil). In the design process, the stator pole length, l_{st} and stator pole thickness, t_{st} were varied in order to obtain the best structure of the SSRLSM. The final structure was selected based on their thrust performances as discussed in [3]. The Figure 1 shows the basic structure of the SSRLSM.

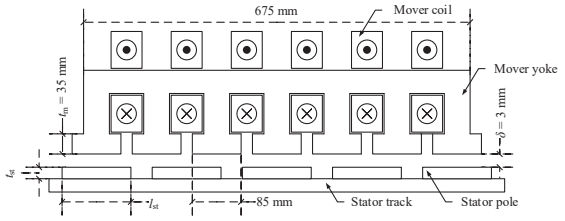

Figure 1 SSRLSM basic structure

3. EXPERIMENTAL SETUP

Figure 2 and 3 shows the schematic diagram and experimental setup of the static thrust measurement of the SSRLSM, respectively. For the static thrust measurement, each phase of the SSRLSM; Phase A, Phase B and Phase C is measured separately. In this measurement, the coil in each phase is connected in series. By using DC power supply, the excitation current, *I* was varied from 1.0 A to 5.0 A with 1.0 A increment. The SSRLSM was moved up and down manually by using electrical jack. The thrust measured was then tabulated and plotted for comparison and verification.

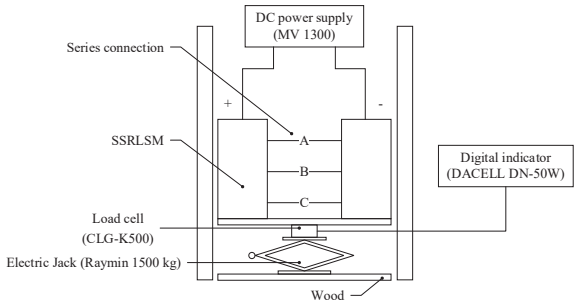

Figure 2 SSRLSM schematic diagram for static thrust measurement

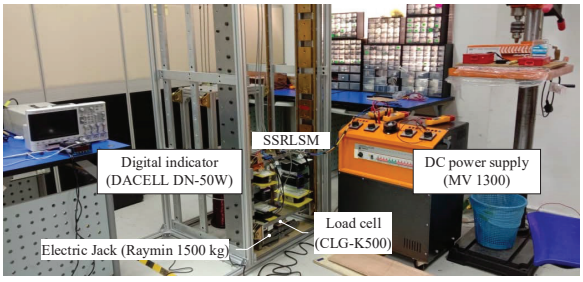

Figure 3 SSRLSM experimental setup for static thrust measurement

4. STATIC THRUST PERFOMANCES

The static thrust of the SSRLSM was measured and the results obtained were compared with the simulation results for result verification.

4.1 Static thrust characteristics

Figure 4 shows the characteristics of the SSRLSM static thrust. It shows that measured thrust, $F_{measured}$ is in agreement with the simulated thrust, $F_{simulated}$. Based on Figure 4, it can be seen that, the difference between the measured thrust, $F_{measured}$ and simulated thrust, $F_{simulated}$ at lower current (I = 3.0 A) is lower compared to that at higher current (I = 5.0 A).

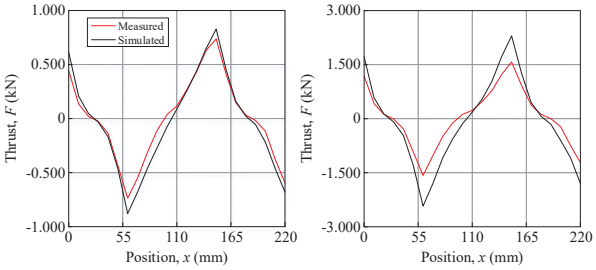

Figure 4 SSRLSM static thrust characteristics

4.2 Maximum thrust, F_{max} and thrust percentage error, $\mathcal{E}$

Based on the thrust, F characteristics in Figure 4, the maximum thrust obtained at each excitation current, I were identified. Henceforth, based on the comparison of the maximum measured thrust, $F_{max,measured}$ and maximum simulated thrust, $F_{max,simulated}$ the percentage error, $\mathcal{E}$ was calculated. The percentage error, $\mathcal{E}$ obtained is shown in Figure 5 (b). It shows that the percentage error increased as the excitation current increased. The highest percentage error, $\mathcal{E}$ obtained is at 5.0 A which is 46%. Table 1 shows the SSRLSM maximum thrust and their percentage error, $\mathcal{E}$.

Table 1 SSRLSM thrust characteristics

Current, I (A)	Maximum thrust, F_{max} (N)		Percentage error, $\mathcal{E}$ (%)
	Measured	Simulated	
1.0	83	89	7
2.0	329	363	11
3.0	736	829	13
4.0	1240	1480	19
5.0	1573	2301	46

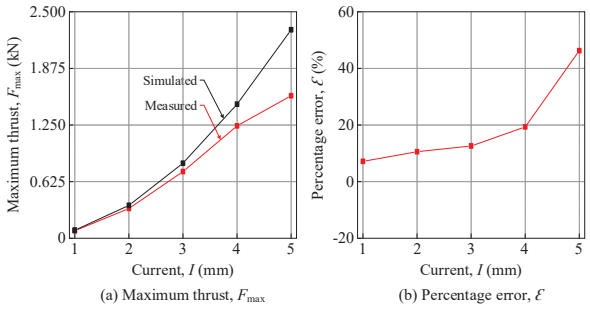

Figure 5 SSRLSM static thrust comparison

5. CONCLUSION

The lab scale SSRLSM has been measured for their static thrust characteristics. The measured static thrust was then compared with the simulated static thrust. The static thrust characteristics shows that the measured thrust is in agreement with the simulated thrust. Apart from that, based on the thrust comparison, it shows that at higher current, the percentage error increased. The highest percentage error obtained is 46% taken at excitation current, I of 5.0 A.

ACKNOWLEDGEMENT

Authors would like to thank Universiti Teknikal Malaysia Melaka for the financial support through FRGS/2018/FKE-CERIA/F00356.

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