

# Eddy Current Loss Calculation by Rapid Process in Solid and Laminated Cores of Transverse Flux Linear Motor

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**Abstract**— Transverse Flux Linear Motor (TFLM) is getting to be widely used in low speed and high power systems. For easy fabrication, solid core is more useful than laminated core. However, eddy current losses are increased in solid core, and it makes efficiency decreased. Some experiment results show the fact. Therefore, estimation of eddy current losses is important to select core type. This paper describes a rapid practical technique to analyze the eddy current losses in solid and laminated cores of a TFLM. The calculation is carried out with the aid of 3D Equivalent Magnetic Circuit Network Method and 2D Finite Element Analysis Method. The calculated results and the limits of the proposed methods are discussed.

## I. INTRODUCTION

Transverse Flux Linear Motors (TFLMs) have a number of useful features distinguished from other motors [1]. TFLM offers a very high force density, and it is suitable for direct drive applications because the mover can produce high flux density in air gap compared with other motor types. This high flux density, however, can cause considerable core losses, which affect the motor performances. When solid core is used for easy fabrication, the core loss problem is more serious because of eddy current loss increasing.

Fig. 1 shows a TFLM and its experiment result. The mover has solid core and the stator has both solid and laminated cores. When the mover goes at the constant speed from on the solid core through on the laminated core of the stator, the current is changed from (S) to (L). The (O) is the span when the mover is over both solid and laminated cores. This experiment result shows the fact that eddy current losses can severely increase depending on core type. Therefore, estimation of eddy current losses is necessary to select core type.

Although there are several studies to calculate 3D eddy current losses for example [2] and [3], the computation time is several hours or days even for small analysis model. This is very troublesome especially on the design stage.

Therefore, this paper proposes a rapid practical method to estimate eddy current losses in the TFLM. The calculation is carried out with the aid of 3D Equivalent Magnetic Circuit Network Method (3D EMCN) and 2D Finite Element Analysis Method (2D FEA).

## II. EDDY CURRENT LOSS CALCULATION METHOD

3D EMCN is used to calculate magnetic field intensity,  $H$ , in each element of a meshed analysis model. Then, 2D FEA is used to calculate eddy current losses with the  $H$ . The detail calculation process consists of 6 steps as shown in Fig. 2, and the detail explanation and the calculated results will be discussed in extended paper.

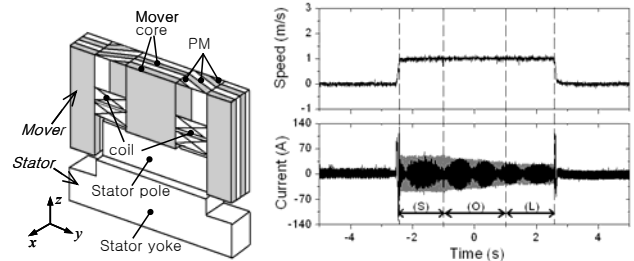


Fig. 1. (left) A partial configuration of transverse flux linear motor; (right) Current variation according to mover position; (S), (O), and (L) are mover position on solid core, between solid and laminated cores, and laminated core of stator, respectively.

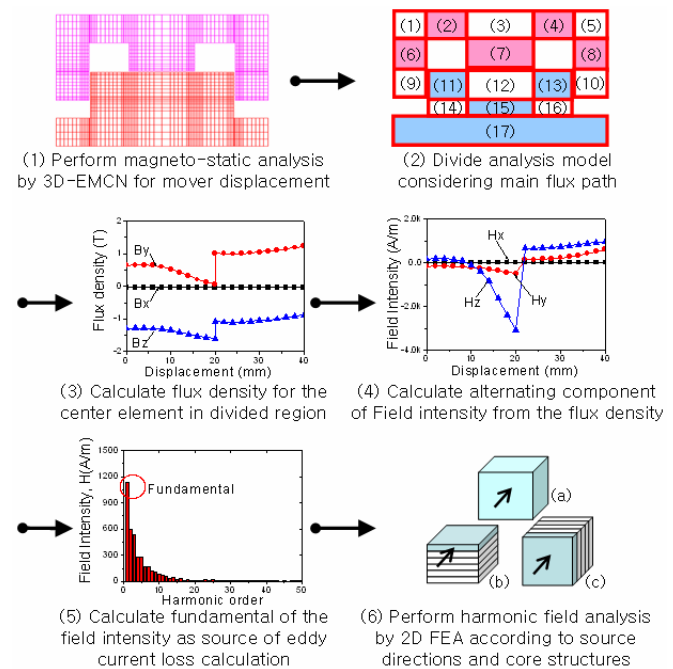


Fig. 2. Proposed rapid process to calculate eddy current losses.

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