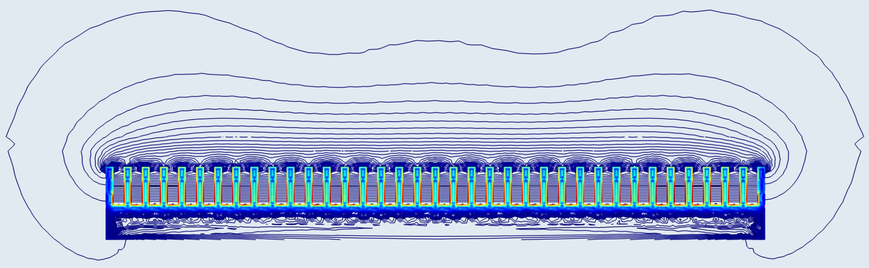

2D Transient Magnetic Field analyses of Linear Induction Motor

Linear Induction Motor (LIM) is a key element for electromagnetic launching technology. A projectile can be accelerated to a required velocity in a controllable manner employing LIM based system.

A.Kundu[1], P.P. Rao[1], Y.S.S.Srinivas[1], V. C. Chaudhary[1], A.Kumar[1], A.Jaiswal[1], A.Patel[1], E.R.Kumar[1]

1. Institute for Plasma Research, Gandhinagar, India

Abstract:

A linear induction motor (LIM)uses alternating current to generate magnetic fields that propel a carriage along a track. A simplified two-dimensional geometry including stator core region and copper winding in the slots of the core was modelled in COMSOL as per the actual physical parameters of the motor. The geometrical model consists of a linear coil assembly of active length of 728 mm excluding the overhang area of winding. Double layer winding is modelled as per the actual coil winding. A rectangular air domain which acts as infinite boundary is modelled. A SS plate of length 1010 mm, width 200 mm and thickness 16 mm is placed ~18 mm above the coil assembly. Time averaged magnetic flux and eddy current distribution on the SS plate are analysed. Time averaged Lorentz force acting on the SS is estimated and compared with experimental result. The simulated value of thrust force is found to be in good agreement with the measured value.

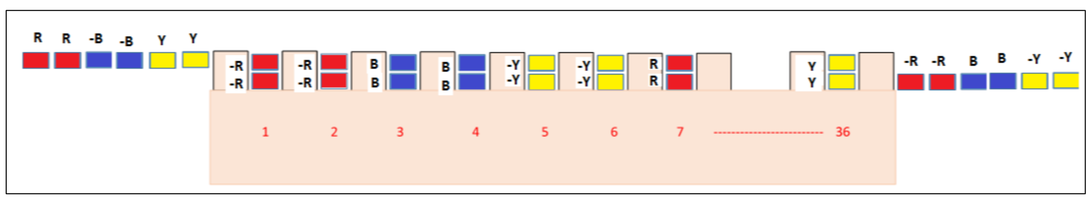

FIGURE 1. Three phase coil winding diagram in LIM.

Methodology:

- 2D transient analyses carried out with coils charged as per phase sequence.
- Low carbon steel material with relative permeability 4000 is used as core material.
- Conducting part of rotor i.e. SS plate is modeled using Ampère's law:

$$\mathbf{E} = -\frac{\partial \mathbf{A}}{\partial t}$$

$$\nabla \times \mathbf{H} = \mathbf{J}$$

$$\mathbf{B} = \nabla \times \mathbf{A}$$

$$\mathbf{J} = \sigma \mathbf{E}$$

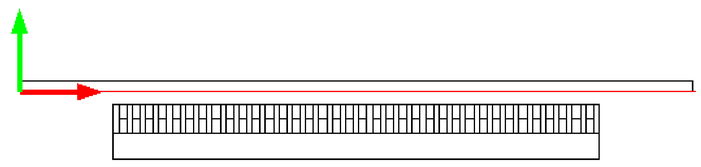

FIGURE 2. Bottom line of SS plate placed ~18 mm above LIM surface.

Geometrical Parameters of LIM

Parameter	Value
LIM Active Length	728 mm
Tooth width	8 mm
Slot width	12 mm
Tooth height	43 mm
Yoke height	40 mm
No. of slots	36 mm
Pole pairs	3

Electrical Parameters of LIM

Parameter	Value
Current	Phase A: 40 A, Phase B: 37.1 A, Phase 3: 38 A
Mean Current	38.4 A
No. of turns/winding	10
Total turns/ slot	20
Conductor cross-section	12 mm * 2 mm
Conductor area	24 mm^2

Results:

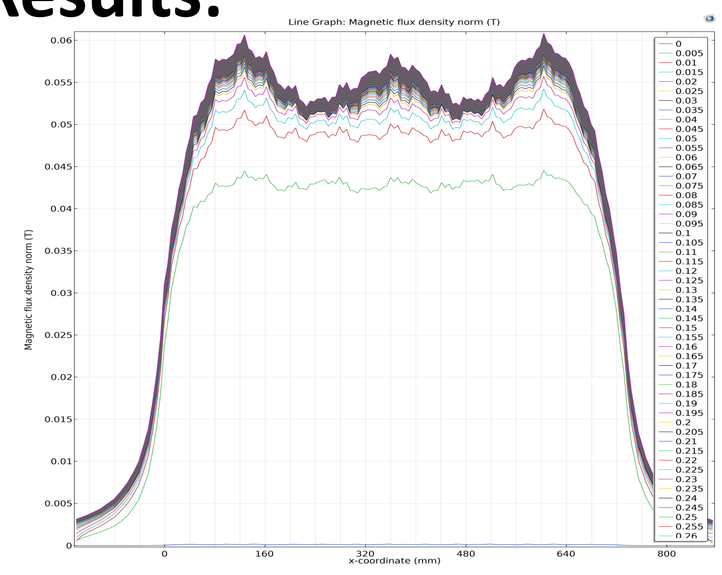

FIGURE 3: Magnetic Flux Density Along Bottom Line of SS Plate

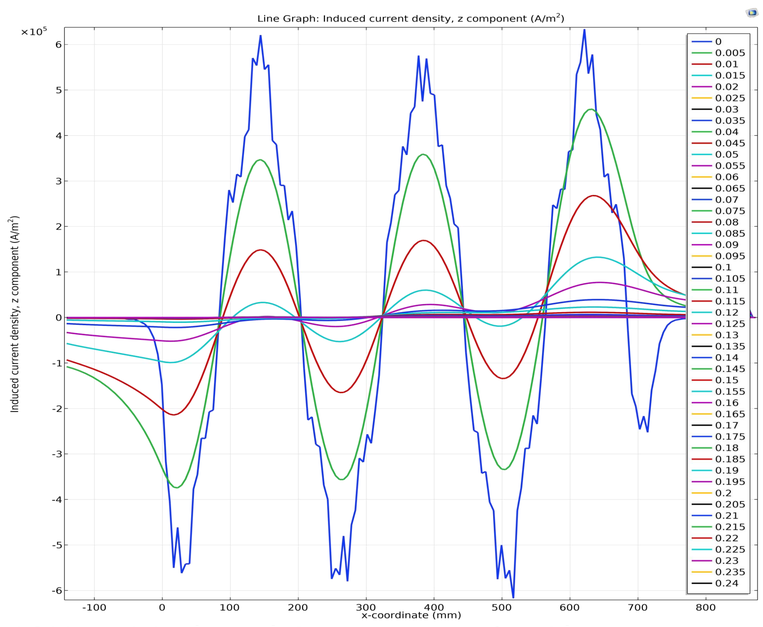

FIGURE 4:Induced Current Density Along Bottom Line of SS Plate

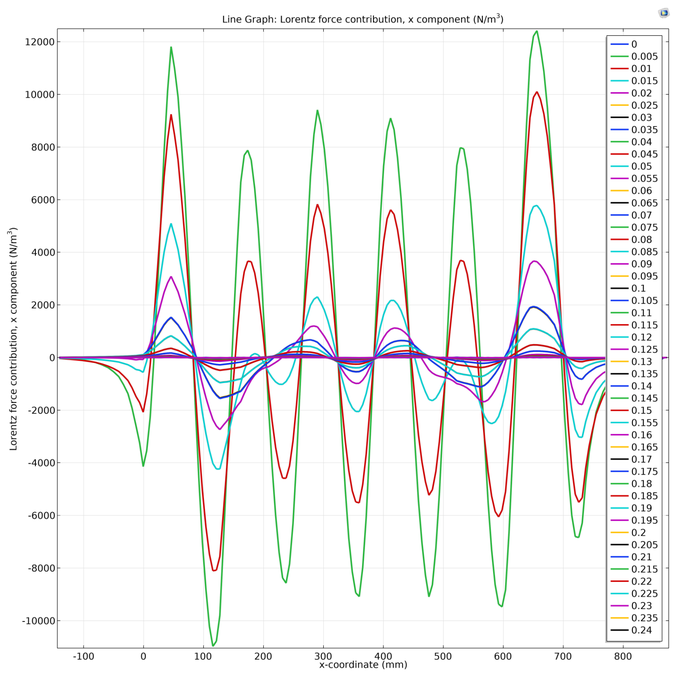

FIGURE 5: Volumetric Lorentz Force Density Along Bottom Line of SS Plate

REFERENCES

1. M.S. Manna et al., "Performance Optimization of Linear Induction Motor by Eddy Current and Flux Density Distribution Analyses", *Journal of engineering Science and Technology*, vol. 6, pp. 769-776, 2011.
2. Gang-Hyeon Jang et al. , "Electro Magnetic Field and Eddy Current Analysis of Linear Induction Motor Using Analytical Method", *International Journal of Pure and Applied Mathematics*, vol. 118, pp.1717-1720, 2018.

- 2D magnetic transient analyses of a LIM is carried out.
- Magnetic field and induced eddy current on the SS plate have been analyzed.
- Thrust force/horizontal component of Lorentz force value at the plate location as obtained from analyses matches closely with the measured force value.

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