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"Design and Fabrication of a Single Sided Three Phase Linear Induction Motor"

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Abstract— Linear Induction Motor invented in 1890, only two years after the discovery of the rotary induction principle. Basically the concept of the linear device consists of unrolling of rotary machine cutting along radial plane such that primary consists of a single row of coils in slots in a laminated steel core**.** The force can be applied uniformly to the belt over a wide area without mechanical contact that's the reason for which linear induction motor is used to drive conveyor belt system. Hence drive becomes independent of friction. This paper presents a simple and fast methodology for designing and fabrication of Single sided linear induction motor (SLIM). Analysis and design problems, as unique to linear machines are discussed. Several possible applications of these machines are included.

Keywords—Electric Motors, linear Induction Motor (LIM), Single-Sided linear (SLIM)

I. NOMENCLATURE

- Phase angle
- I/p of motor in KVA
–Diameter of stator bore in - Length of stator core in - O/p coefficient

Vs - Synchronous speed in . . . - Winding factor
- Specific electric loading / - Specific magnetic loading / 2 f - Frequency in

p - Number of pole of motor F - Thrust (N)

II. INTRODUCTION

The rotary induction motor and linear induction motor has same principle of operation. Basically linear induction motor is obtained by opening the squirrel cage rotor and laying it flat shown in Fig. (a). Linear force is produced instead of producing rotary torque in linear induction motor. Several thousands of Newtons thrust produced by LIM. the factors which determine speed are the winding design and supply frequency.

Principle of linear induction motor is same as of conventional rotary machine which is "Faraday's low of Electro-Magnetic Induction". When supply is given to uniformly place winding in stator, it will produce magnetic field which will get sinusoidally distributed rotating at uniform speed 4πf/p, where f is supply frequency and p is the number of poles. Voltage produced in rotor because of relative motion between rotor conductors and magnetic field. This voltage produces current flow, which generates another magnetic field .These fields are opposite in nature hence interaction of these field produces torque and this torque drag the rotor in direction of magnetic field.

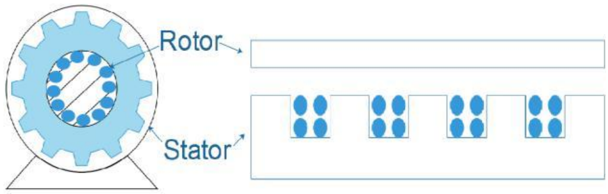


Fig. (a)

There are some types of linear induction motor:1] Single sided linear induction motor shown in Fig. (c) And 2] Double sided linear induction motor shown in Fig. (b). In single sided LIM there is single stator and single rotor and covering of metal strip or ferromagnetic strip. In double sided LIM there are two stators with single rotor in between them. For reducing cost of the project we designed SLIM.

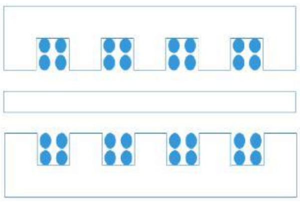


Fig. (b)

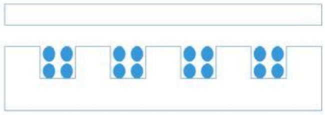


Fig.(c)

III. SLIM

There are three forces which are generated in LIM, listed below:1] Thrust 2] Normal force 3] Lateral force. Thrust is main driving force of LIM. In Z-direction to the stator, normal forces are perpendicular. Because of orientation of stator undesirable forces are created which are the lateral forces.

The objective of this paper is to design a SLIM for conveyor belt system of specified parameters. The design and fabrication include developing SLIM equations, design procedures, fabrication procedures and performance conclusion.

Goodness factor applied to conveyor belt system: Generally small-stator machine is for conveyor belt system.it economic to have flexible rotor and lead it back into the stator as a continuous loop.

There are some advantages of LIM used for conveyor belt system: conveyor belt system compared to conventional conveyor system. The driving force of conventional belt applied to belt through roller, relaying on coefficient of friction between belt and roller to transmit force. The pressure between belt and the roller determines the frictional force, which in turn depends on belt tension. To ensure that very little stretching occurs at the belt, very heavy and expensive belts are used for long conveyor system. Tension of belt increases as stretching of belt occurs and drive is lost.

As LIM drive put the force over large area of belt, and not on the small area of in contact with roller. This is the main advantage of LIM over conventional conveyor. There are some methods by which LIM is effectively applicable for conveyor belt system shown in fig. (d) and fig. (e).

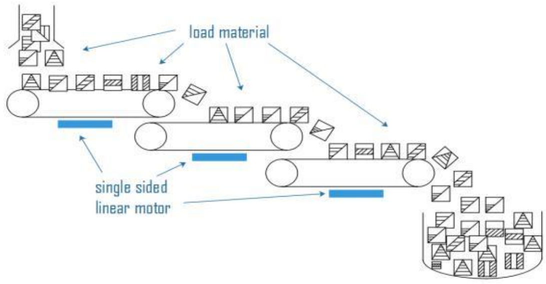


Fig. (d)

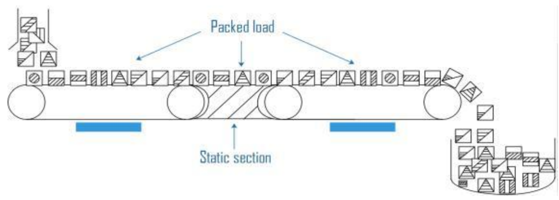


Fig. (e)

IV. DESIGN

For designing of SLIM, basically we have to consider the design of Rotary Induction Motor as periphery of RIM becomes length of SLIM and diameter of RIM becomes width of SLIM hence design a 3HP, 440v, 3phase, 4 pole squirrel cage induction motor, the machine is connected in Delta.

1] Calculation of main Dimensions:

Output in = 3∗ /1000

From Standard data sheet of 4 pole motor

Efficiency=0.81

Power factor=0.81

KVA input of motor: -

= ∗0.746*η∗ 2 L= /(∗) Where,

= 11∗ ∗ ∗ ∗10-3 Where,

=winding factor=0.955
= 0.44 / 2 ....(assumed)
=21000 / ....(assumed)
= 2 /
Remaining calculation part is as same as the design of induction motor.

2] Calculation and design of stator core and weight: -

Area of the insulated conductor

Number of conductor per slot

Minimum slot area

We select standard E.I. type laminations as show in fig. (f) (Refer from A.K. Sahwney book of DEM)

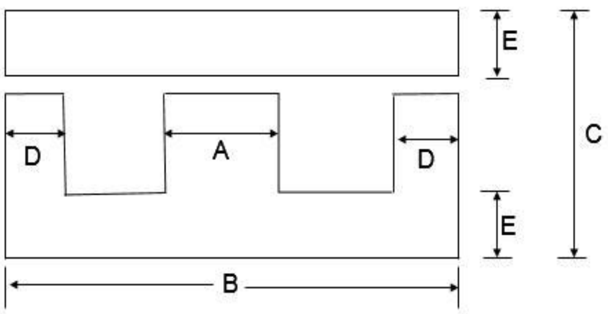


Fig. (f)

3] Area of stamping

Width length = (− −2 /2)

Height = −2

From standard data sheet E-I stamping area can be calculated as above

For stamping number 30

= 20, =60, =50, = 10,

=10

Area = = (− −2 /2) = −2

So we select such stamping number 30.

4] Core weight:

So length of stack

Number of slot

Stamping have 2 slots

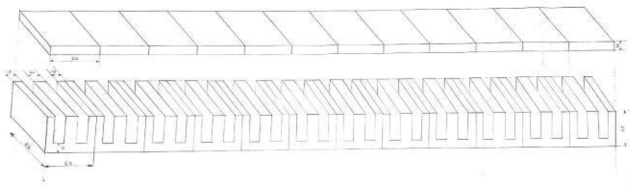
So we used 12 stamping kept parallel in straight line

5] Area of E-I stamping

6] Volume of one E-I stamping

7] Total volume of 12 E-I stamping

8] Total Weight of core = volume*density



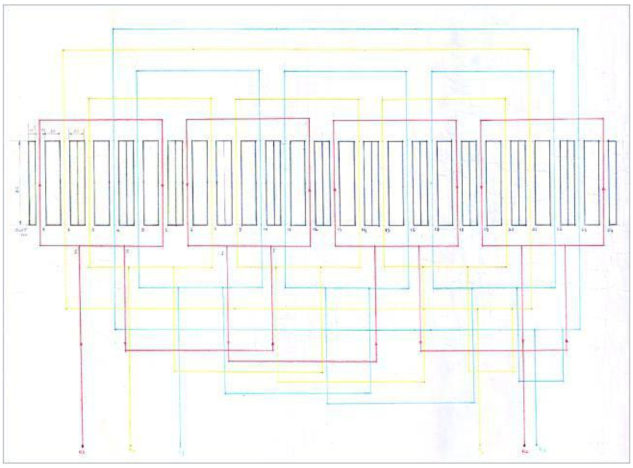
9] Copper Calculations:

Total coils =12.

10 coils have same dimensions and remaining 2 coils have different dimensions.

1. Total Length of coil
2. Volume of coils = area of conductor* total length of coils
3. Total weight of copper = volume *copper density

10] Winding Diagram:

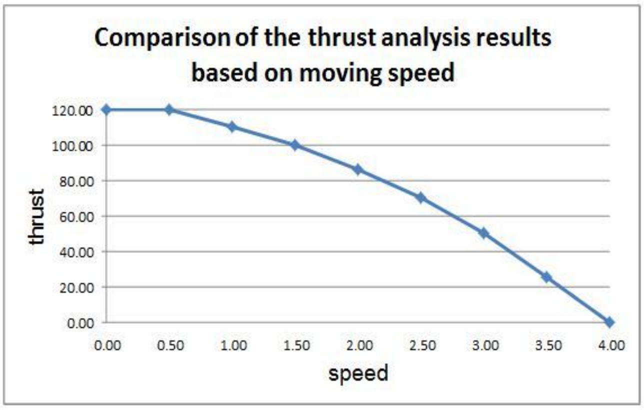


V. RESULT

1. KVA input of motor ( ) = 3.369 KVA
2. Air gap = 4mm
3. Weight of stator core = 20 Kg.
4. Total length of stator core= 720 mm
5. Total height of stator core= 40mm
6. Length of E-I stamping stack = 86mm

7. Total coils = 12
8. Total weight of copper = 11Kg
9. Thrust= 5 N
10. Actual SLIM:

11. Thrust Vs. Speed

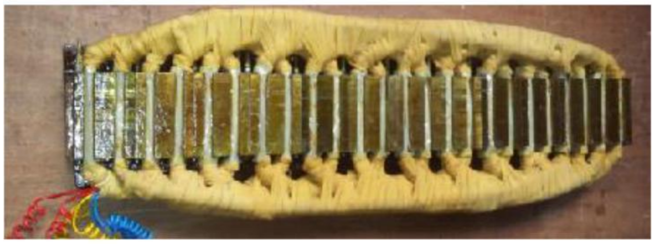


VI. CONCLUSION

The objective was in accordance with the necessity of the use of this linear induction motor for conveyor application. The design procedure was first done analytically considering the parameters required like efficiency, power factor, size of motor, output power, air gap length between stator and rotor. The motor design was thus carried out systematically and desired characteristics and performance was obtained. The next part of the fabrication was the most difficult part which required time commitment and patience. The fabrication was completed trying to achieve the design considerations.

After the fabrication motor was tested and analytical and practical parameters like efficiency, power factor, losses, thrust, linear speed, torque etc. were matched. Thus the project was completed successfully in all aspects to achieve the objective. The project was an enriching experience for all of us in terms of analytical and practical experience. The knowledge in this field gained by us is incomparably rich. It will thus remain as a knowledgeable and eventful experience period in our life.

Appendix:



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