Optimum Design for Magnetorheological Brake using COMSOL Multiphysics®

Thanikachalam.J*[1], Nagaraj.P[2], Sathish Kumar.G[3] & Selvendira Janahi Ram.S[4]
[1]Asst. Professor, Dept. of Mechanical Engg, Mepco Schlenk Engineering College, Sivakasi, India
[2]Professor & Head, Dept. of Mechanical Engg, Mepco Schlenk Engineering College, Sivakasi, India
[3,4]PG Scholar, Dept. of Mechanical Engg, Mepco Schlenk Engineering College, Sivakasi, India

Introduction: Magnetorheological (MR) fluids are smart fluids that change their rheological behavior when a magnetic field is applied. Typically and this change is manifested by the development of yield stress that increases with the applied field. When the magnetic field is absent, MR fluids behave like a Newtonian fluid.The proposed MR Brake (MRB) system consists of rotating disks immersed in MR fluid and is enclosed in an electromagnet. The yield stress of the fluid changes as a function of the applied magnetic field by the electromagnet.

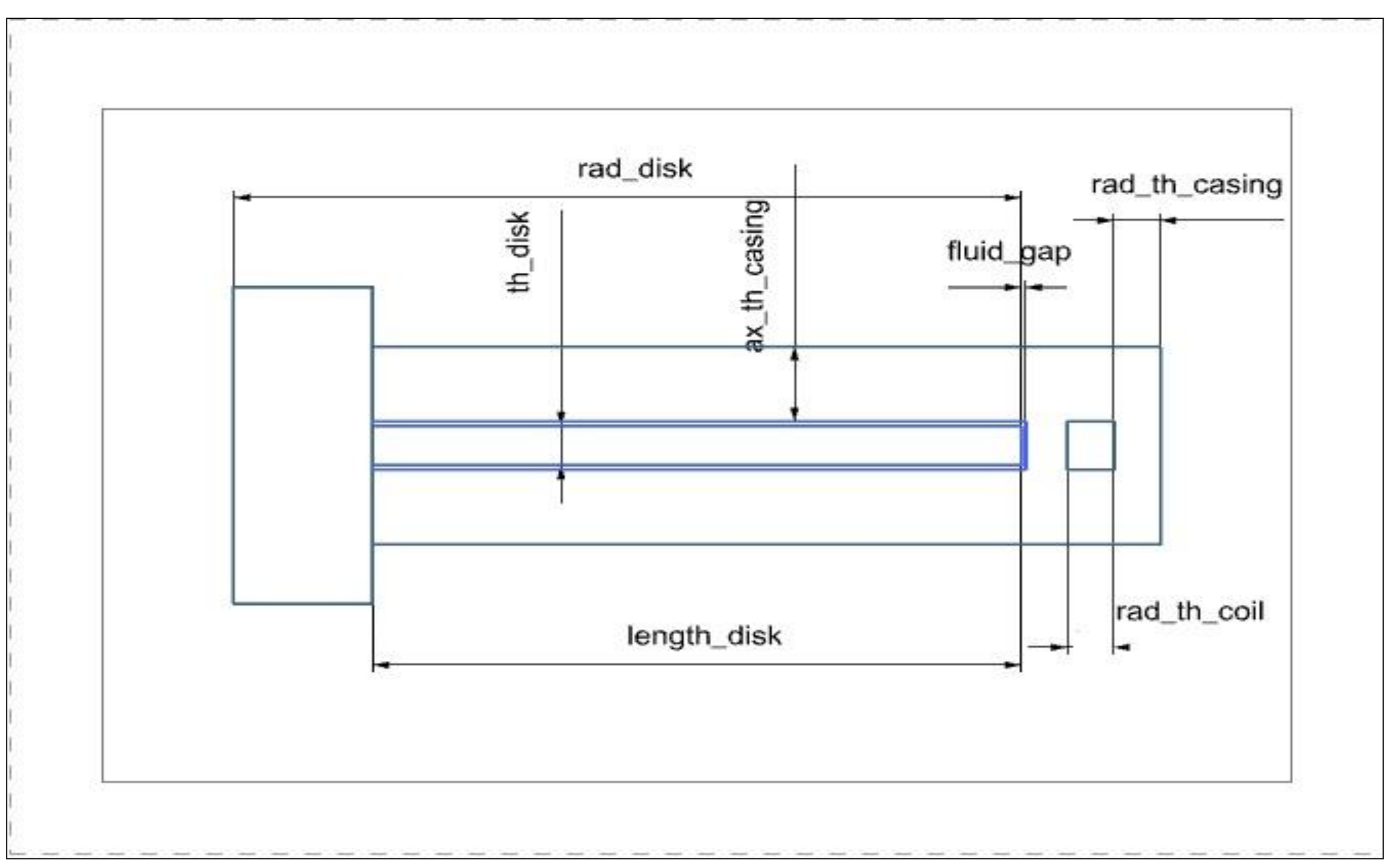

Figure 1. Drawing view of proposed MRB

Optimization and Fabrication of MRB: Optimum design for the MRB should be done to find the significant geometric dimensions of MRB that maximizes the torque and minimizes the weight.

Parameter	Initial value	Optimum value
th_disk	0.01 m	0.0141 m
rad_disk	0.17 m	0.18 m
rad_th_coil	0.01 m	0.0134 m
rad_th_casing	0.015 m	0.01 m
ax_th_casing	0.019 m	0.015 m
length_disk	0.14 m	0.1382 m

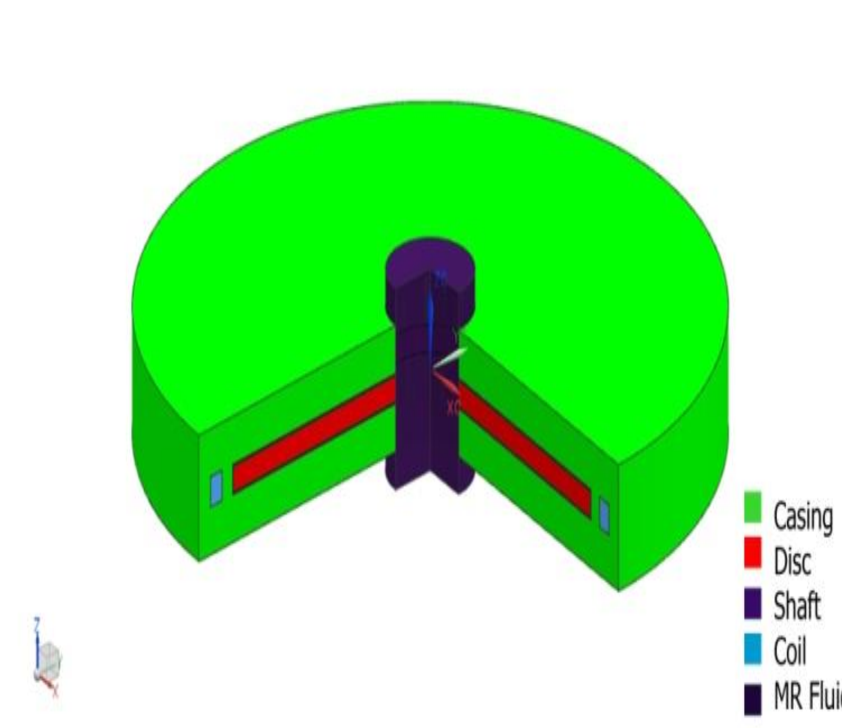

Figure 2. 3D CAD model MRB   Figure 3. Fabricated MRB

Results: The results obtained from the magneto static analysis for the magnetic flux density within the MR brake for an input current of 1.5 A along the coil is given in the fig.10. The shear stress distribution and temperature distribution in the MRB when 1.5 A current is given to the coil is given in fig.11 and fig.12 respectively.

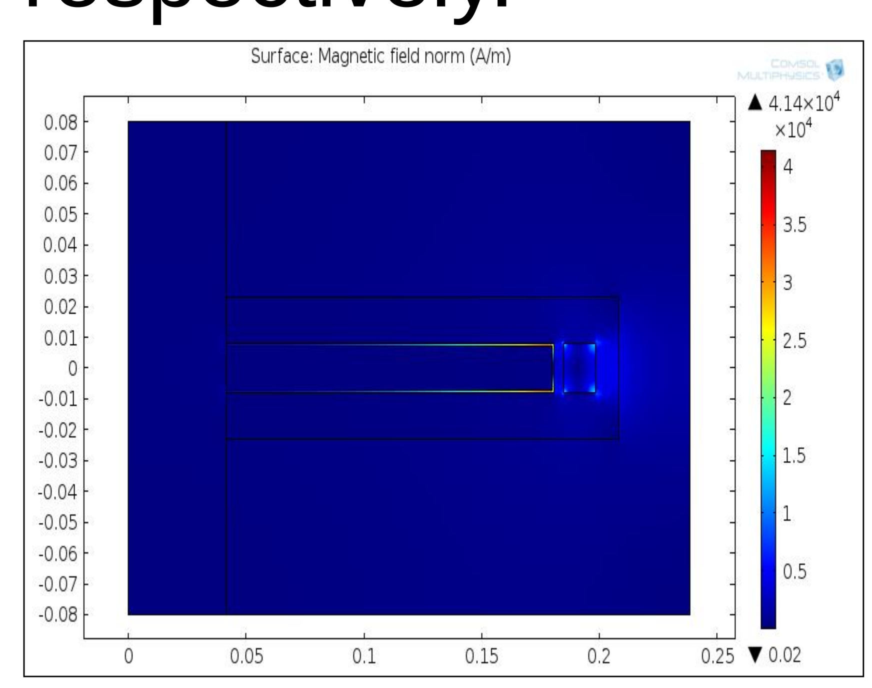

Fig 4. Magnetic field distribution

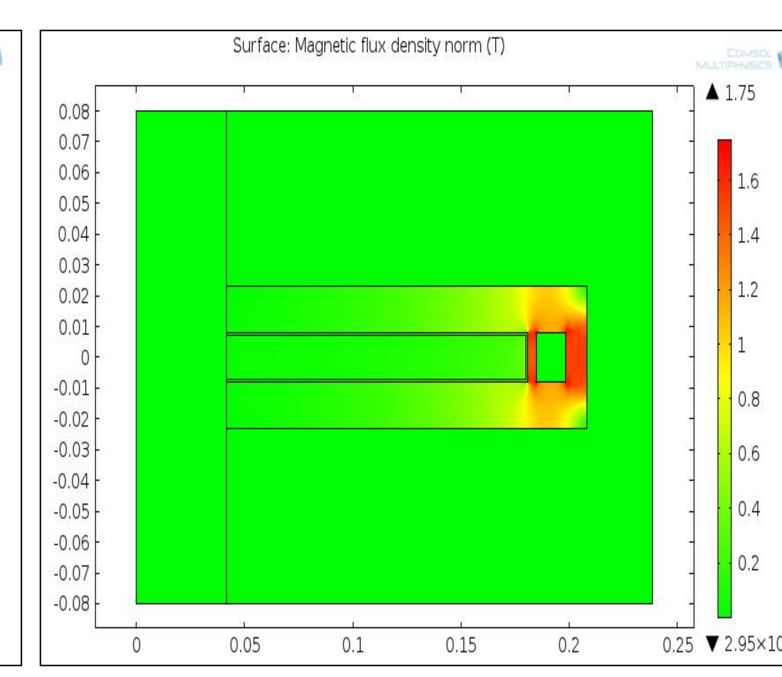

Fig 5. Magnetic flux density

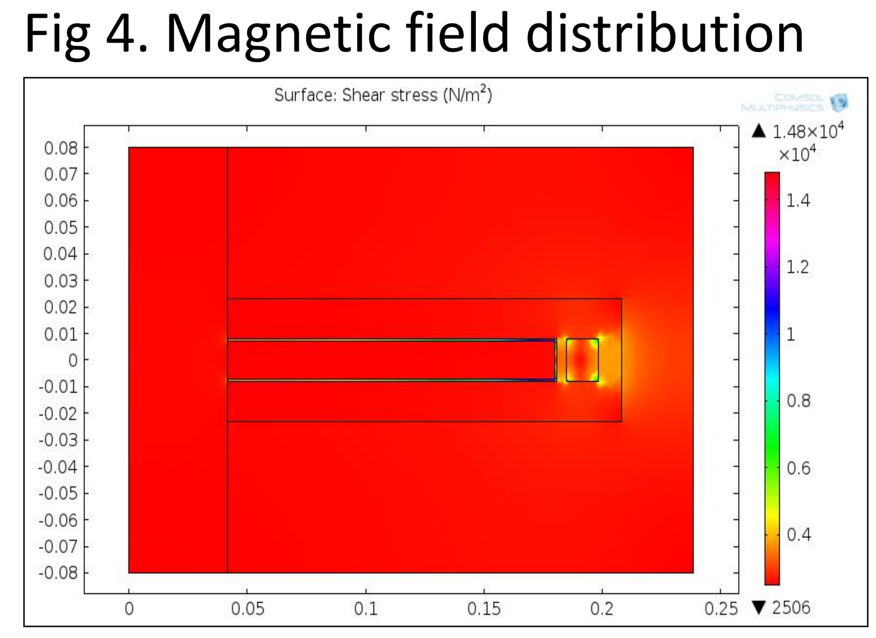

Fig 6. Shear stress distribution

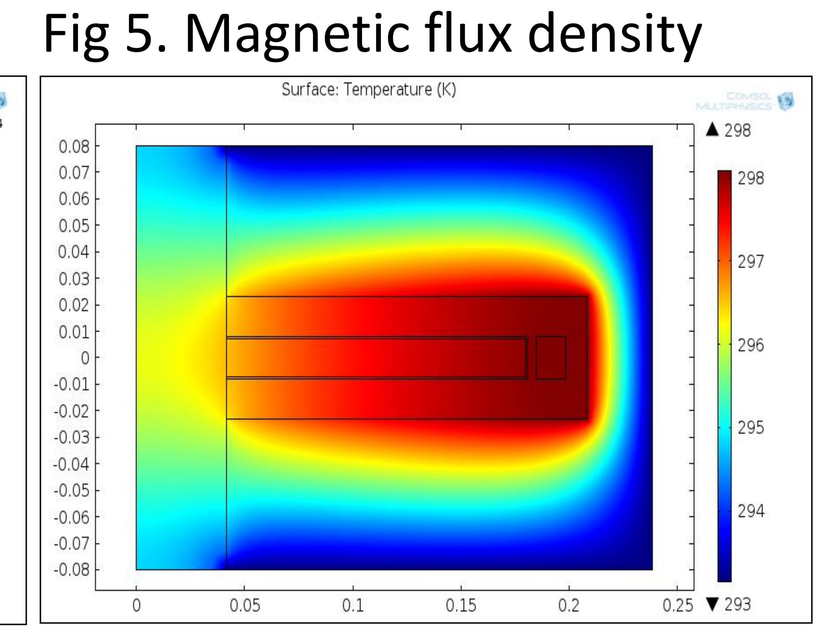

Fig 7. Temperature distribution

Conclusion: In this paper, a magneto-rheological brake (MRB) with single disk design has been introduced as an alternative to the current conventional hydraulic brake (CHB) device.

References:

[1] Edward J. Park, Dilian Stoikov, Luis Falcao da Luz, Afzal Suleman, A performance evaluation of an automotive magnetorheological brake design with a sliding mode controller, *Mechatronics 16,* 405–416 (2006)
[2] Introduction to COMSOL Multiphysics® [online], available: www.comsol.com

Excerpt from the Proceedings of the 2014 COMSOL Conference in Bangalore