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Electrical & Mechanical Analysis of Trafoconnect

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Introduction

Transformer connectors is a device which links LV side cable with secondary side transformer bushing

Conventional System
Crimped & Bolted Connection

- High I^2R losses
- Many connections causes hot spots
- Heavy weight
- Oil leakage

Raychem's
Trafoconnect

- Low I^2R losses
- No crimping required
- Light weight
- Reliable, insulated & safe connection
- Design Patent No: 293138

Need for FEA Analysis

- Every supplier has to do type test on electrical equipment's based on customers requirement as per IEC Standards.

- Expensive & Time consuming

- To determine the correctness and efficiency of a design before the system is actually constructed

Problem Definition

- To carry out **short circuit analysis** of the connector as per IEC 61238

- To simulate **tensile loading test** of the connector as per IEC 61238

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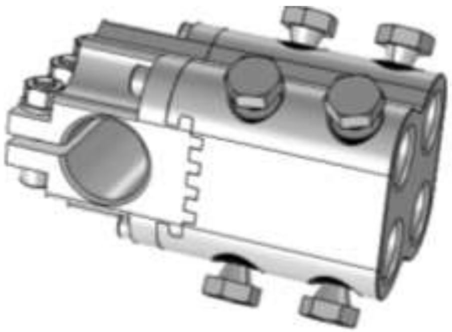
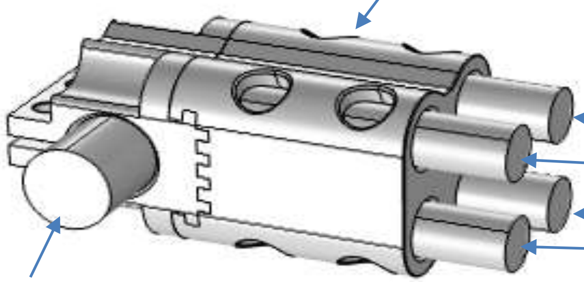
FEM analysis details- Short circuit current ***- 40kA for 3 sec as per IEC 61238*** with an initial peak of 100 kA





Boundary Conditions in FEM

Magnetic and Electric Field (mef)

Incomer @ A.) – 40000*$\sqrt{2}$*($e^{(-t/0.045)}$-$\cos(2 * pi * 50 * t)$

Outgoing @ C.) – to all outgoing conductors.

Time – 0.04 sec (2 cycles)

Lorentz Force was maximum at 0.01 sec (Fig.2)

Solid Mechanics (solid)

Volume force – Lorentz Force Contribution

Fixed Constraint @ A.) & C.) – to all outgoing conductors.

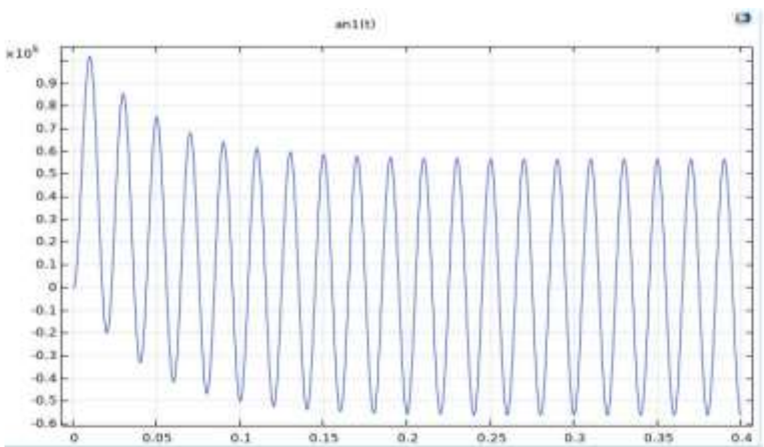
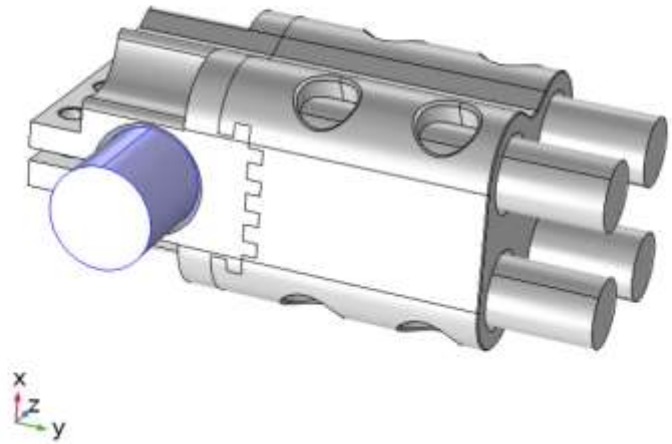
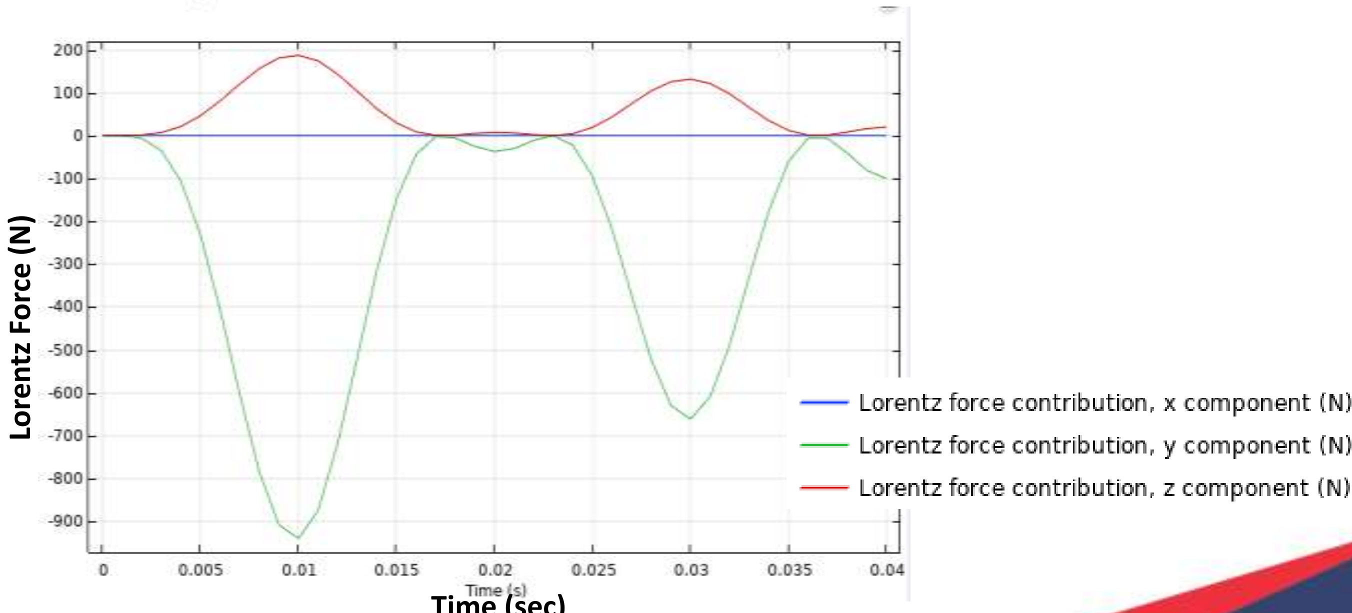


Fig.2 Decaying waveform to terminal having initial peak of 100 kA

Results – Magnetic & Electric Field

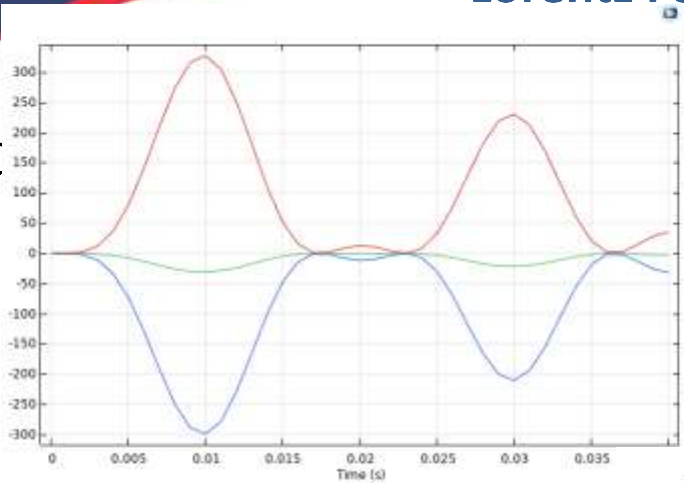
Lorentz Force vs Time – Incoming Stud





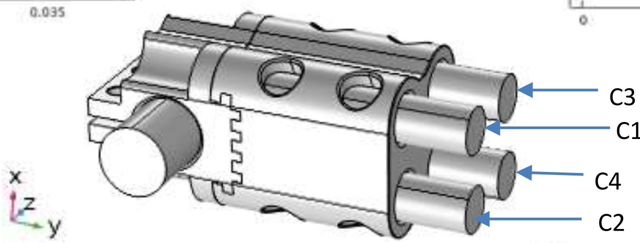
Lorentz Force vs Time – Outgoing Cables

Lorentz Force (N)

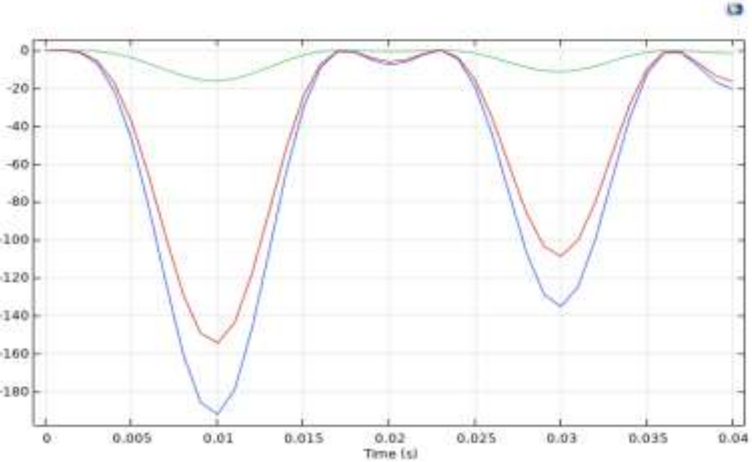


Time (sec)

Lorentz Force – C1



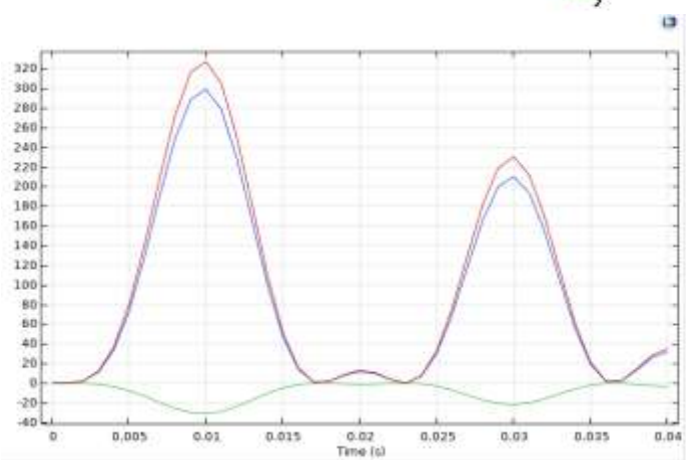
Lorentz Force (N)



Time (sec)

Lorentz Force – C3

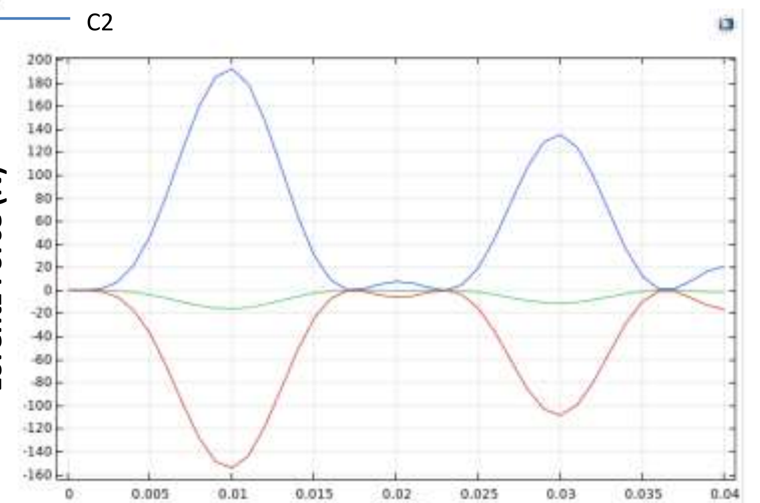
Lorentz Force (N)



Time (sec)

Lorentz Force – C2

Lorentz Force (N)



Time (sec)

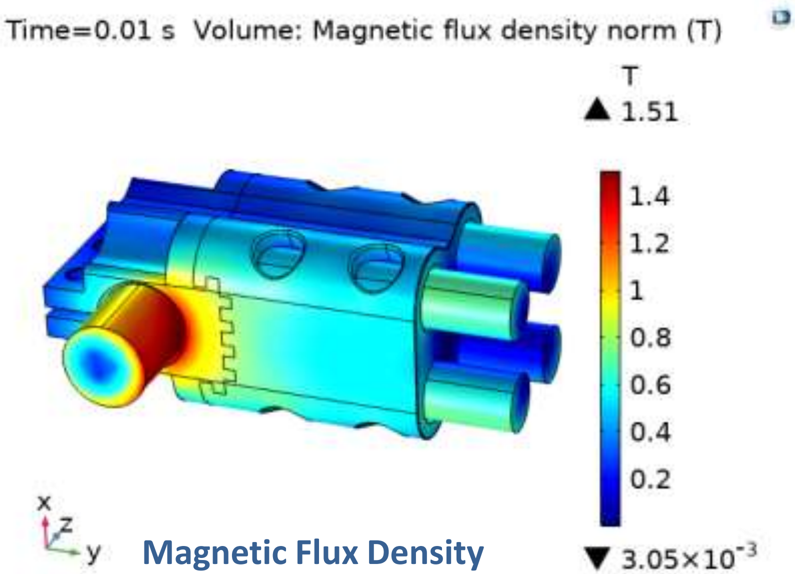
Lorentz Force – C4

Lorentz force contribution, x component (N)

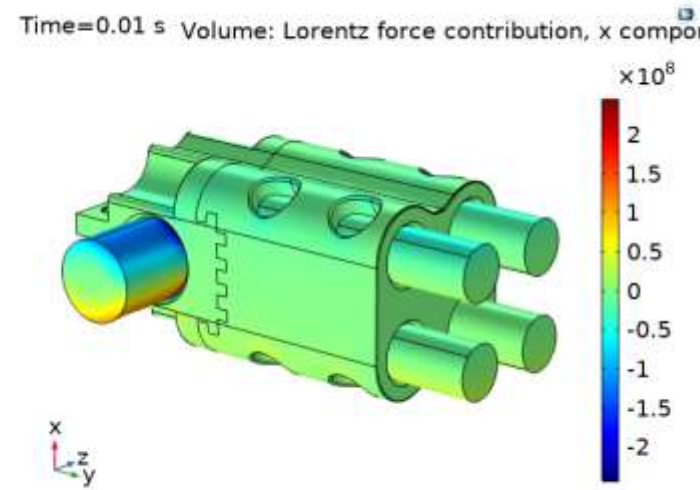
Lorentz force contribution, y component (N)

Lorentz force contribution, z component (N)

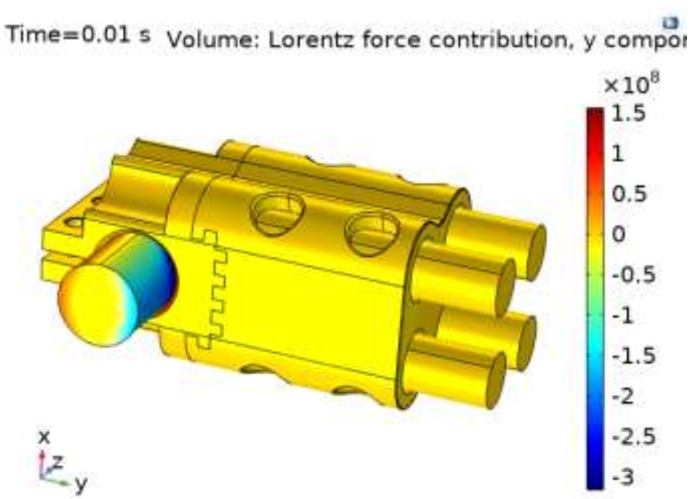
Magnetic Flux density and Lorentz Force Distribution



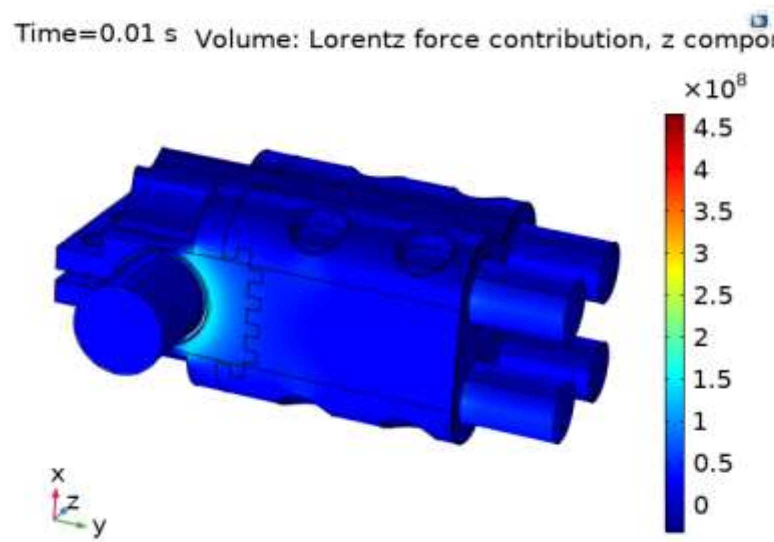
Magnetic Flux Density



Lorentz force contribution – x component

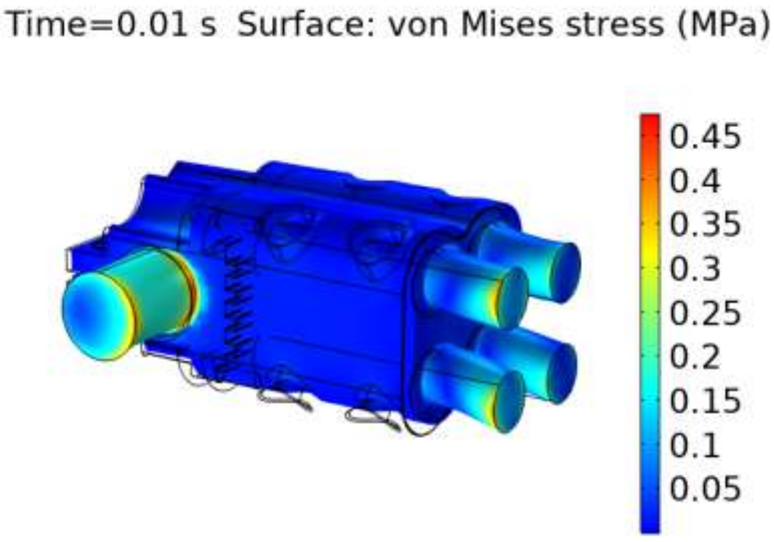


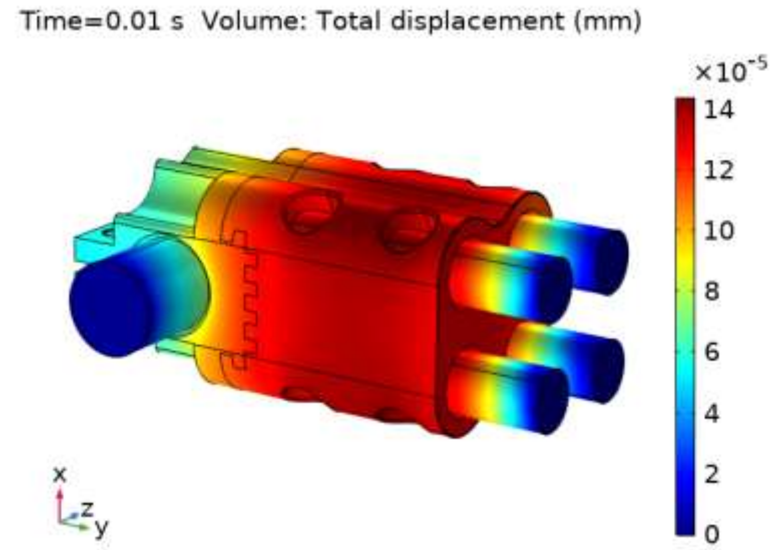
Lorentz force contribution – y component



Lorentz force contribution – z component

Results – Solid Mechanics





Discussion on SC test analysis

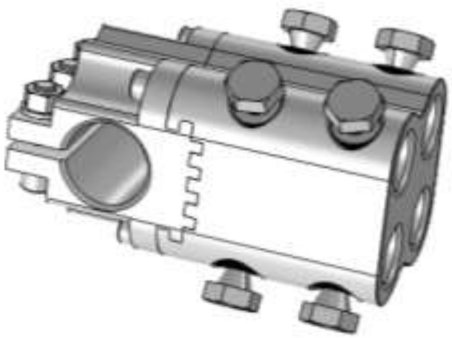
- **Lorentz force** contribution **was a sinusoidal wave with decreasing amplitude** corresponding to incoming sinusoidal wave.

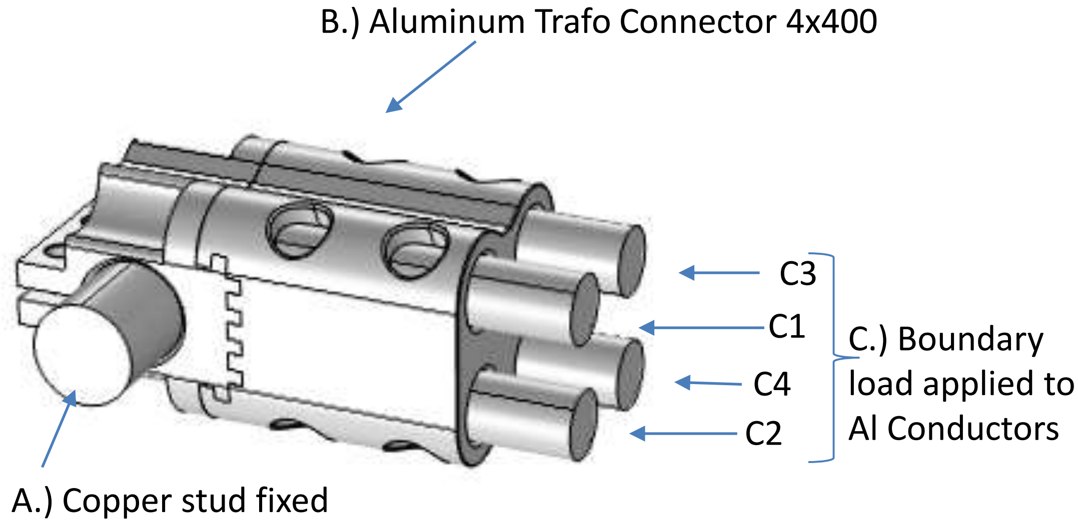
- **Lorentz force** contribution was maximum at the **incoming stud at 0.01 sec**

- **Maximum stress** induced due to Lorentz force **was 0.45 MPa** and **total deformation was 0.14 µm**.

Tensile Load Analysis as per IEC 61238

FEM analysis details- Tensile load of **55 Kg is applied then increased to 110 Kg** and maintained for 1 min **as per IEC 61238**





Boundary Conditions in FEM

Multibody Analysis

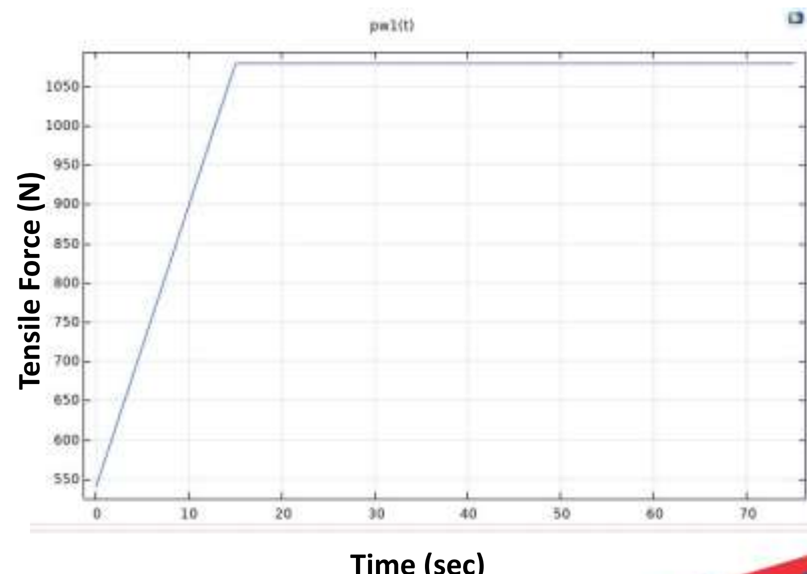
Fixed Constrain @ A.)

Tensile Load @ C.) – to all outgoing conductors.

Contact pressure was varied over conductor to obtained optimum value

Force Function:- F = 539.55+35.97*t $0 \le t < 15$

= 1079.1 $15 < t \le 75$



Results – Displacement & Stress

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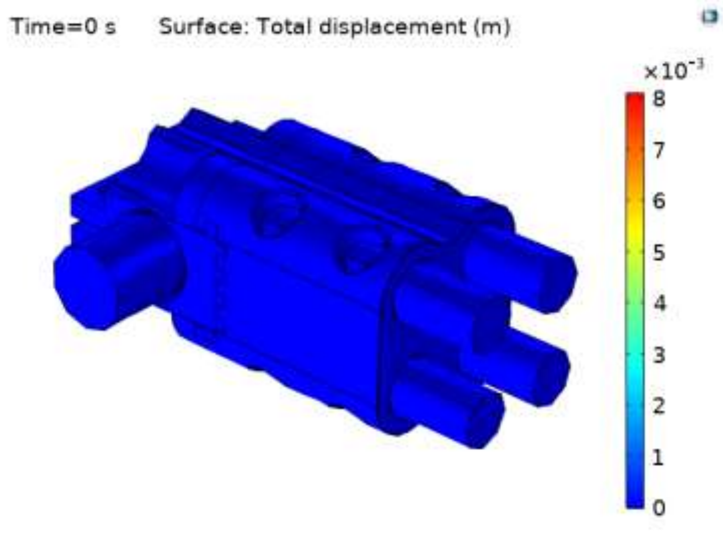
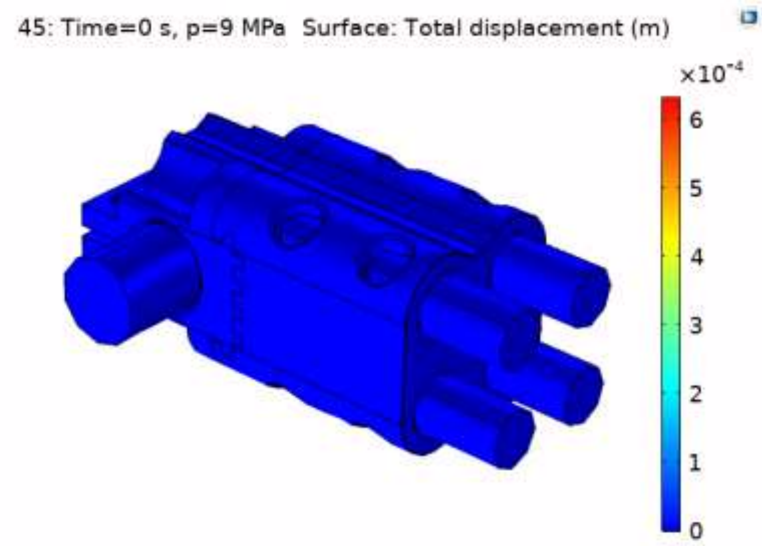
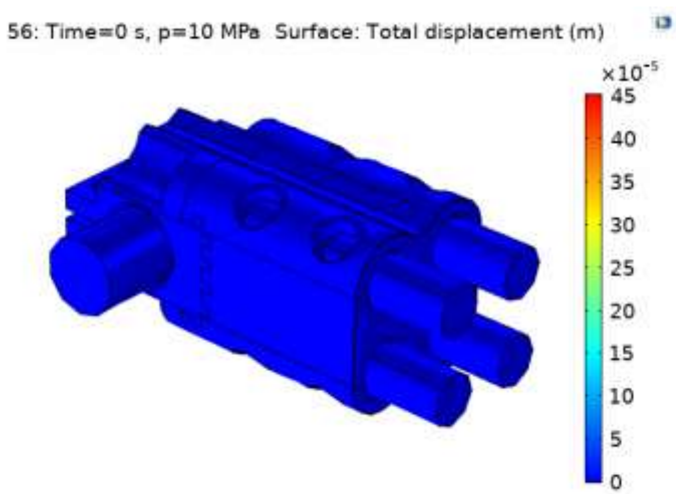


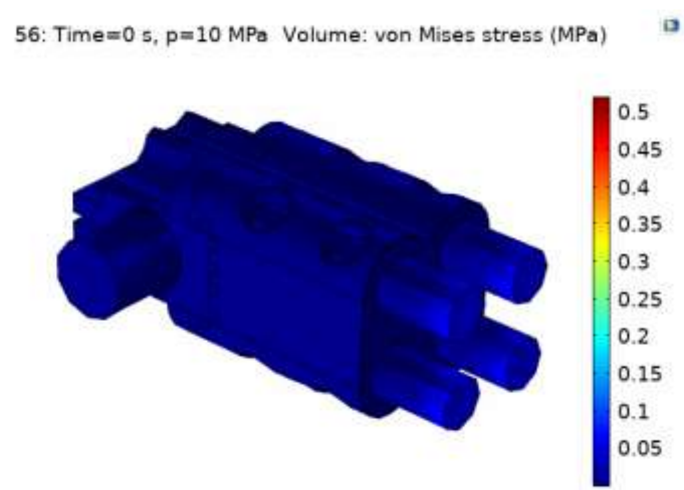
Displacement of **8 mm for 8.3 MPa** Contact Pressure



Displacement of **0.6 mm for 9 MPa** Contact Pressure



Displacement of **0.45mm for 10 MPa** Contact Pressure



Stress **0.5 MPa for 10 MPa** Contact Pressure

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Discussion on Tensile load analysis

- The optimum value of **contact pressure 10 MPa** was obtained to analyze movement of conductor with connector

- Accordingly, shear headed bolts were selected having high contact pressure to resist movement of conductor

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Conclusion

- Methodology for SC analysis was established for the 1st time which can be implemented to other electrical equipment like feeder pillars, connectors, etc.

- Simulation of SC test & Tensile Test using COMSOL was integrated during product development process

- Both the test were validated with the type test at ERDA, Vadodara

Acknowledgement : Chiraj Kothari, Pankaj Nerikar & Damini Singh

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THANK YOU