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INVESTIGATION OF SEALING EFFECTIVENESS FOR A SAFETY RESTRAINT AUTOMOTIVE CONNECTOR

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ABSTRACT

Liquid silicone rubber has been applied to various products such as electronic devices owing to its excellent thermal and chemical resistance. Hyperelastic materials, however, have properties distinguished from general metal materials. Hyperelastic materials show elastic behaviours in the range of large deformation in which load has a nonlinear relation with deformation. In addition, they have characteristics of nonlinearity, and incompressibility, on a large scale. On account of such characteristics, there are many difficulties in design and production using these materials.

In this study, the load-deformation, compression strain, and contact pressure relation were obtained from the mating test of two different tolerance test blocks whereas applied to finite element analysis to design waterproof connectors for automobiles. Effectiveness of the finite element analysis was confirmed by comparing the results of the analysis.

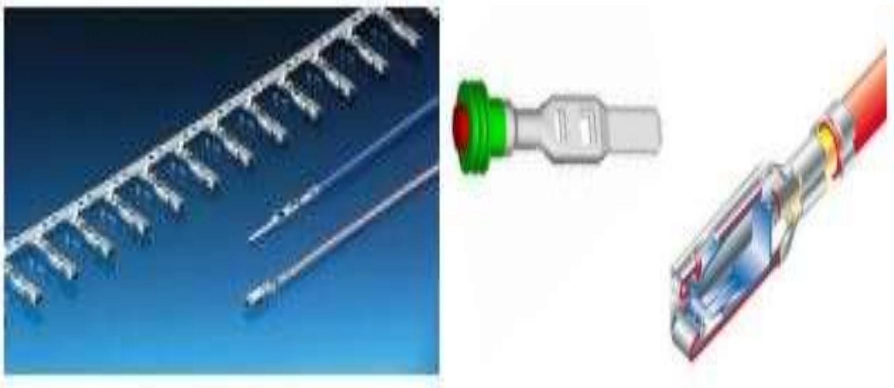
Keywords: Liquid silicone rubber, seals

1. INTRODUCTION

A connector is a plastic device providing insulation of electrical contacts and assuming a mechanical interface for mating. A terminal is a metallic device creating a link between two electrical points, made up of flexible blades, pressuring the pin and containing male and female contact. The main function of connectors is to maintain electric contact between the terminals. It also provides contact from environmental conditions like mechanical vibrations, dust, humidity, heat, and short circuits. Figure1.1 shows the male and female contact and figure

Electrical connectors are used in the electrical system to transmit an electrical signal, allow electrical devices to interact, and transmit power through its contact points. The mating part of the connector's cable terminal in an electrical circuit is called electrical contact points which are a current-carrying interface that allows electrical connection without constriction for electrical current flow across it. There are different

types of electrical connectors; these can be classified based on their application, size, working environment, mounting location, surface geometry, and other means. Also, the connectors based on their mounting location can be categorized as suitable for cab, chassis, or powertrain (engine, gearbox, and differential).



2. METHODOLOGY

The entire process including the pre-processing and numerical analysis of results is done in Abaqus software version 2022 Hf1. It contains different modules like part, property, assembly, step, interaction, load, mesh, optimization, job, and visualization module

2.1 PRE-PROCESSING

The connector and seal CAD model has been developed using NX CAD software shown in the figure 4.1. Modeling in NX is done using a solid modeling sectionas per the standard rules followed in the organization.

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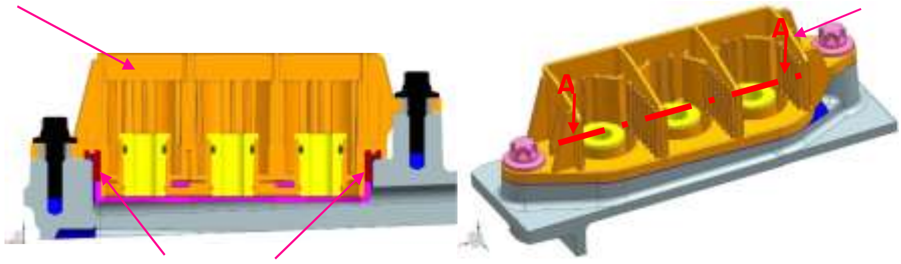
2.2 CAD Model



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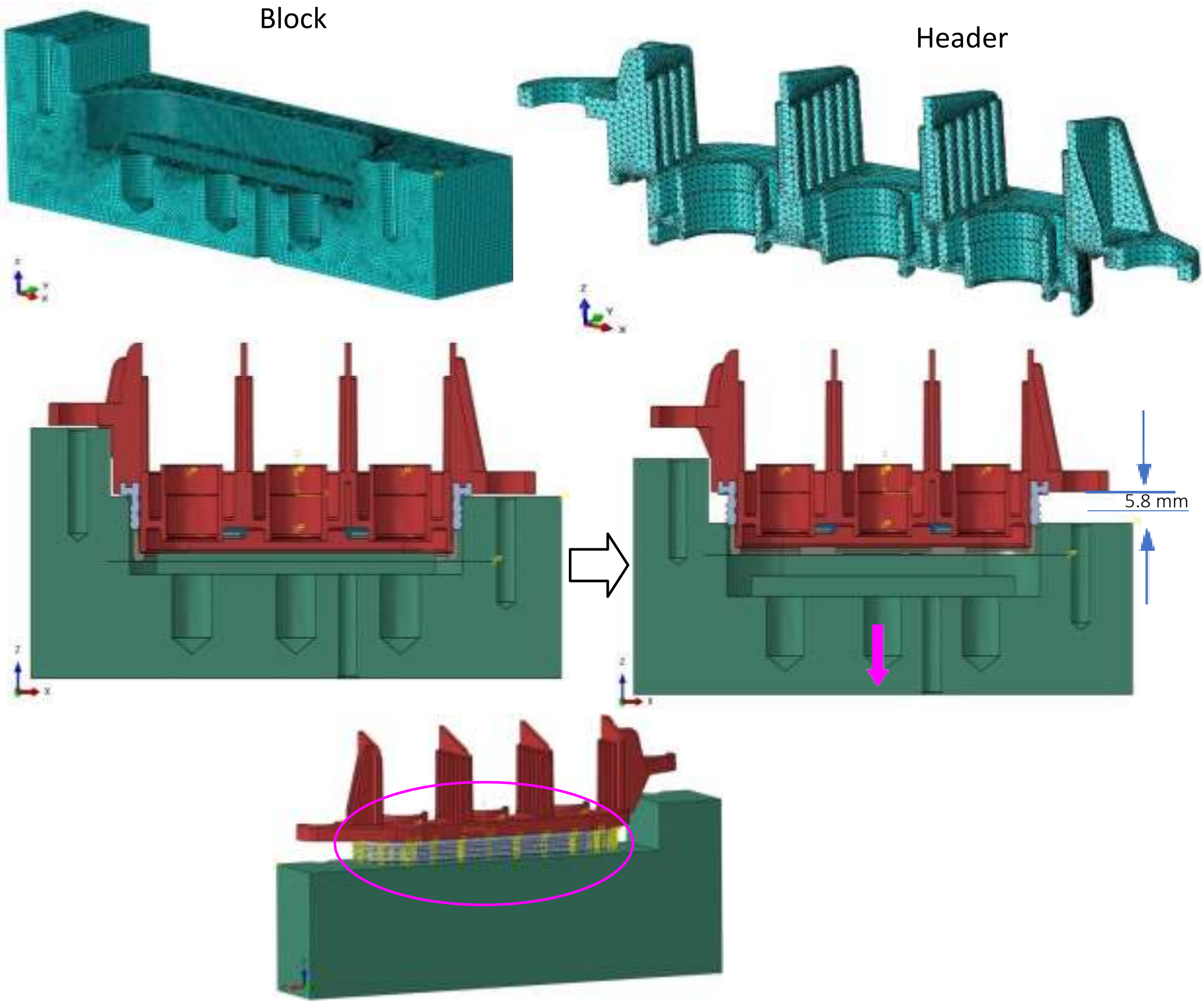
Abaqus CAE is a software suite for finite element analysis and computer-aided engineering, originally released in 1978. It is a product of Dassault systems. It is a software application used for both the modeling and analysis of mechanical components and assemblies (pre-processing) and visualizing the finite element analysis result. A subset of Abaqus/CAE including only the post-processing module can be launched independently in the Abaqus/Viewer product.

The simplified CAD model parts are converted into the Parasolid format after giving suitable names and, this Parasolid file is imported to Abaqus CAE for carrying out the further simulation.

Assembly

Once the material is defined the parts needs to be assembled to the initial position of the analysis. So, the test block is move back 5.8mm negative Z-direction for analysis. Figure 4.6 shows the initial position of assembly along with side view parts.The step sequence provides a convenient way to capture changes in the loading and boundary conditions of the model, changes in the way parts of the model interact with each other, the removal or addition of parts, and any other changes that may occur in the model during the course of the analysis. In addition, steps allows us to change the analysis procedure, the data output, and various controls. The figure 4.7 shows the step manager dialogue box for explicit analysis.



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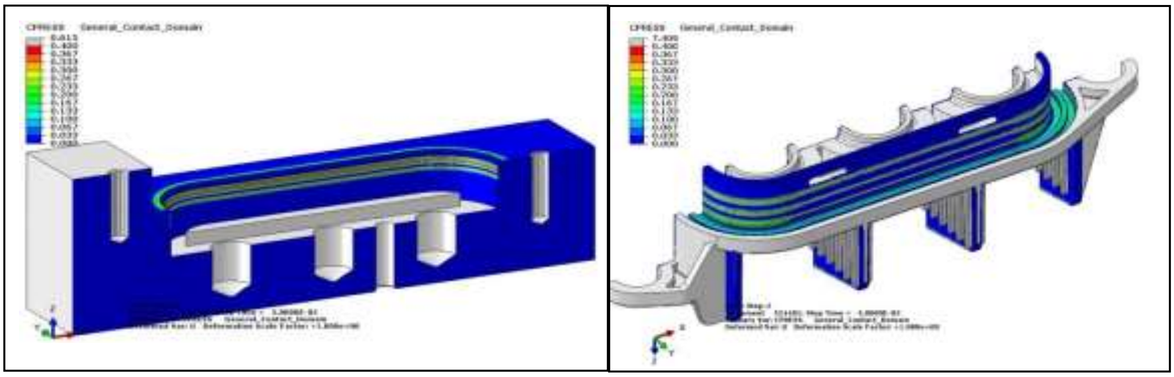
3. RESULTS AND DISCUSSION



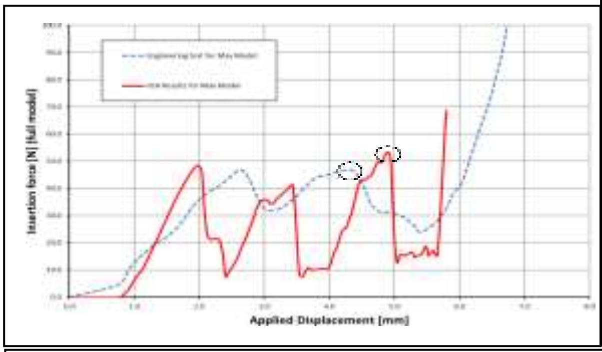
SIMULATION RESULT ANALYSIS

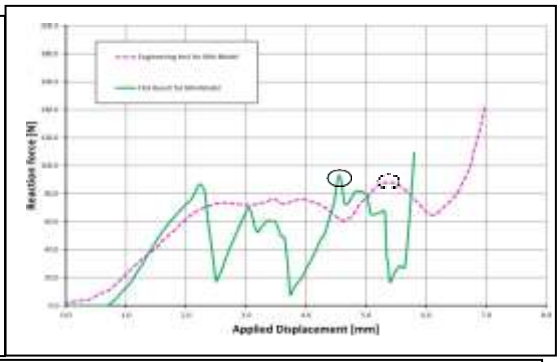
The grey region of seal indicates the contact pressure of seal crossed the scaled limit (0.4 MPa & 0.5 MPa).

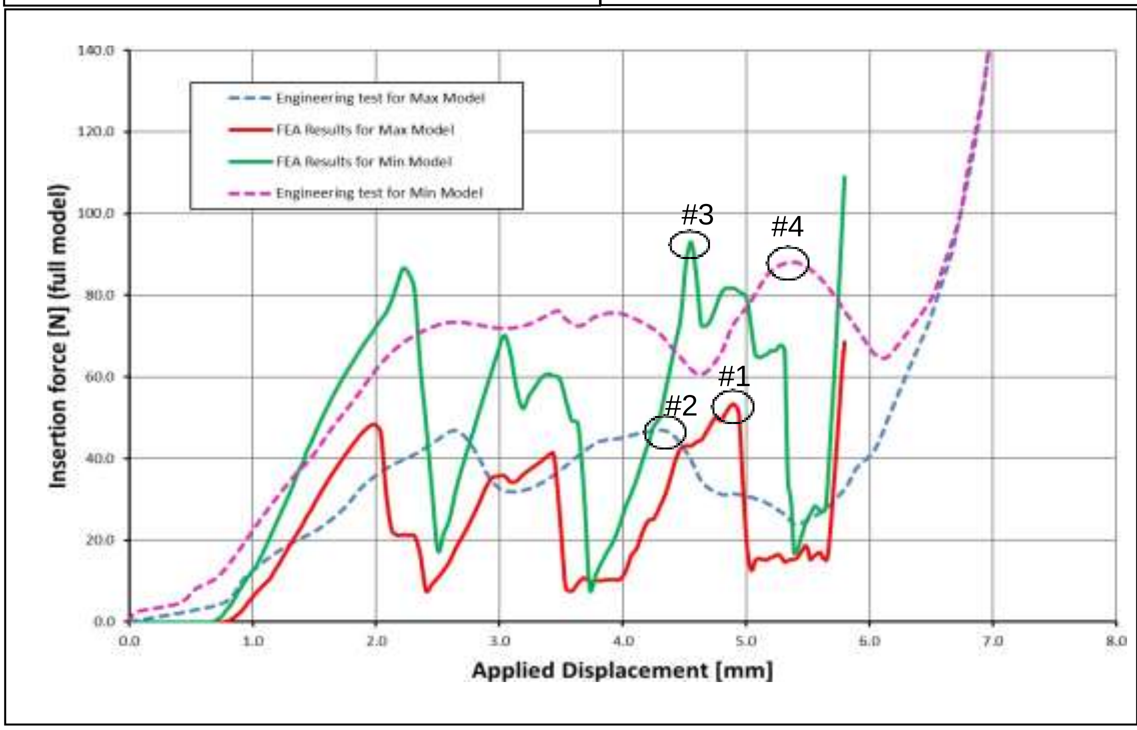
The grey region of seal is uniformly distributed in three lips in figures 5.1(a) & 5.3(c) comparing than figures 5.2(b) & 5.4(d). So, we can finalize the contact pressure of maximum tolerance test block is 0.4 MPa.

The contact pressure, compression strain and maximum insertion forces are obtained successfully after the analysis is completed. And, exported the graph in excel sheet format after plotting insertion force vs applied displacement results during mating. Finally, compare these simulation result with experimental results.

Unless or otherwise specified specific gravity values reported shall be based on waterat 270C. So the specific gravity at 27^0C= K Sp. gravity at Tx^0C. The specific gravity of the soil particles liewith in the range of 2.65 to 2.85. Soilscontaining organic matter and porousparticles may have specific gravity values below2.0. Soils having heavy substances may have values above 3.0.







4. CONCLUSION

In this study, the deformation behavior of seal like compression strain, contact pressure and mating/insertion force of two different tolerance test blocks obtained from numerical explicit analysis to design waterproof connectors for automobiles. And, these effectiveness parameter of simulation results successfully compared with experimental test.From the result summary, the simulation result of mating forces is approximate1.1 times higher than the experimental tests. And, the mating/insertion force of connector is inversely proportional to the tolerance of test block.The contact pressure of minimum tolerance test block is 0.1 MPa higher than the maximum tolerance of test block. And, the contact pressure of interfacial seal is inversely proportional to the tolerance of test block.The compression strain of minimum tolerance test block is 5% higher than the maximum tolerance test block. And, the compression strain of interfacial seal isinversely proportional to the tolerance of test block.Hence, the study of sealing effectiveness for an automotive connector is done by numerical and experimental tests.

5. REFERENCES

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