Finite Element Analysis & Testing

Finite Element Analysis (FEA) is a numerical method used to solve a mathematical model of a structure or system. FEA predicts the response of a structure (e.g., automotive bushing, O-ring, seal) to applied forces, temperatures and vibrations. The inputs to the model are the material properties, geometry and ambient conditions.

The stress-strain properties of polymeric and elastomeric materials are nonlinear and highly temperature dependent. The complexity in carrying out FEA is further compounded by the presence of viscoelastic characteristics and geometry dependent deformations.

In many engineering applications, analytical solutions may not be possible, and FEA may be the only practical way to analyze the design.

Benefits of Finite Element Analysis

- Can be incorporated during the design phase to select the best design for a given application
- Economical and faster product development by cutting prototype developments and expensive testing
- Detailed failure mode and effect analysis can be carried out to study failed designs
- Can be used at any phase in the product life cycle to pinpoint anomalies and establish performances
- Provides a platform to continuously upgrade and develop an optimum product
- Can be interfaced with optimization and probabilistic design algorithms to generate a robust design problem statement

Procedures Used to Analyze Engineering Structures

- Acoustic Analysis
- Coupled Fluid-Structure Analysis
- Coupled Thermal-Structural System Analysis
- Dynamic Analysis
- Static Analysis
- Thermal (Heat Transfer) Analysis

ARDL Modeling & Testing Capabilities

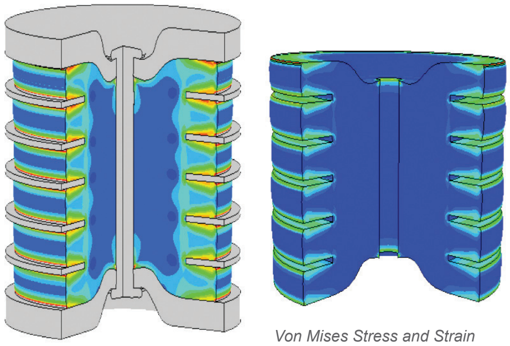
ARDL uses the most reliable computational engineering tools available and has an array of simulation packages and testing machines available to carry out FEA services and testing.

For Solid Modeling and FEA Model Creation
- SolidWorks®
- Abaqus CAE®

For Finite Element Analysis
- Abaqus®
- LS-Dyna Explicit®
- In-house Codes (Material Subroutines)

For Design Optimization
- LS-Opt®

For Material and Component Testing
- Servohydraulic MTS® Machines
- Machines Developed In-house for Tire Testing and Vibration Analysis



Von Mises Stress and Strain Energy Distribution in a Deformed Bearing Pad

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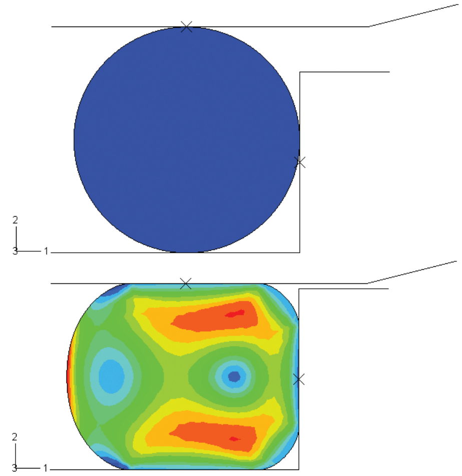
Rubber. Plastic. Latex.

Finite Element Analysis Support Testing (for Non-Linear FEA of Elastomeric Products)

The effectiveness of design analysis is directly related to the quality of the input material coefficients. ARDL has developed a reliable history of standard procedures for the determination of these coefficients from experimental test data. The test data is generated by four primary tests and supported by additional testing as necessary.

Primary Tests

1. Planar Shear
2. Uniaxial Compression
3. Uniaxial Tension
4. Volumetric Compression



FEA of an O-ring: Before Compression (top), and After Compression (bottom).

Additional Tests

- Crack Growth
- Creep & Stress Relaxation
- Damping Properties
- Dynamic Characterization
- Fatigue Characterization
- FEA Verification Part Testing

Applications

ARDL's testing capabilities also allow the above tests to be performed over a wide range of temperatures in various aging fluids on various materials including:

- Composites
- Engineering Plastics
- Structural Adhesives
- Structural Foams
- Thermoplastic Elastomers
- Thermoset Elastomers

Aging conditions in fluids can also be suitably incorporated to simulate real world applications. ARDL is thoroughly experienced in carrying out complex nonlinear analysis and is capable of measuring material properties from –40° to 150°C under diverse aging conditions.

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