abaqus prony series

abaqus prony series is a fundamental tool for simulating viscoelastic materials in engineering and scientific research. This article explores the essential concepts behind the Prony series formulation, its implementation within the Abaqus finite element analysis software, and its significance for accurately modeling time-dependent material behavior. Readers will gain a comprehensive understanding of how the Prony series is used to characterize viscoelasticity, the steps required to define it in Abaqus, practical applications across various industries, and best practices for achieving reliable simulation results. Whether you are new to viscoelastic modeling or seeking to optimize your analysis workflow, this guide provides the expert insights and actionable information necessary to master the abaqus prony series, improve your simulation accuracy, and address common challenges in material modeling.

Understanding the Prony Series in Viscoelastic Modeling

The Prony series is a mathematical representation widely used to characterize the viscoelastic behavior of polymers, rubbers, and biological tissues. In finite element analysis, the abaqus prony series enables engineers to simulate how materials respond to loading over time, capturing both elastic and time-dependent viscous effects. By fitting experimental data to a series of exponential decay functions, the Prony series provides a practical method to express complex relaxation phenomena with a manageable set of parameters.

When modeling viscoelasticity within Abaqus, the Prony series is essential for defining the relaxation modulus or shear relaxation modulus as a sum of weighted exponential functions. This approach facilitates accurate predictions of material performance in applications such as automotive components, biomedical devices, and consumer goods. Understanding the fundamentals of the Prony series is the first step to leveraging its full potential in simulation-driven design.

Key Principles of Viscoelasticity

Basics of Viscoelastic Material Behavior

Viscoelasticity refers to the property of materials that exhibit both elastic (instantaneous, recoverable deformation) and viscous (time-dependent, permanent deformation) responses under stress. The abaqus prony series allows users to capture these dual characteristics, which are crucial for materials subjected to dynamic or cyclic loading conditions.

Time-Dependent Stress-Strain Relationship

The stress-strain relationship in viscoelastic materials is inherently time-dependent, meaning the

response varies based on the rate and duration of applied loads. The Prony series models this behavior through a combination of short-term and long-term relaxation mechanisms, enabling engineers to simulate creep, stress relaxation, and dynamic mechanical analyses with a high degree of fidelity.

Mathematical Formulation of Prony Series

The abaqus prony series is typically expressed as:

- $G(t) = G_{\square} + \square G_i \exp(-t/\square_i)$
- $E(t) = E_{\square} + \square E_i \exp(-t/\square_i)$

where G(t) and E(t) represent the shear and elastic moduli as functions of time, $G_{\square}$ and $E_{\square}$ are the long-term moduli, G_i and E_i are the Prony series coefficients, and $\square_i$ are the relaxation times.

Implementation of Prony Series in Abaqus

Overview of Abaqus Viscoelastic Material Models

Abaqus provides robust features for modeling time-dependent material behavior, including linear and nonlinear viscoelasticity. The abaqus prony series is implemented within the material property definitions, allowing users to input relaxation parameters directly for accurate simulation of polymers, elastomers, and other viscoelastic substances.

Supported Analysis Types for Prony Series

The Prony series can be used in various Abaqus analysis types, including:

- Static and quasi-static analysis
- Dynamic analysis
- Frequency domain analysis
- Transient viscoelastic response

This flexibility makes abaqus prony series modeling suitable for a wide range of applications, from vibration damping studies to impact simulations and fatigue evaluations.

Step-by-Step Guide: Defining Prony Series Parameters

Preparation of Experimental Data

The accuracy of abaqus prony series modeling depends on high-quality experimental data. Users typically perform stress relaxation or creep tests to obtain the necessary time-dependent modulus data, which is then fitted to the Prony series representation using curve-fitting techniques.

Inputting Prony Series in Abaqus

To define the Prony series in Abaqus:

1. Open the material definition dialog in Abaqus/CAE or Abaqus input file.

2. Select "Viscoelastic" as the material behavior type.

3. Choose the "Time Domain" option for viscoelasticity.

4. Enter Prony series coefficients (G_i or E_i) and relaxation times (τ_i).

5. Specify the number of terms in the series based on data fitting accuracy.

Abaqus provides validation checks to ensure the sum of coefficients does not exceed physical limits, maintaining stability and convergence in simulations.

Verifying and Adjusting Prony Series Parameters

After input, users should run preliminary simulations to validate material response against experimental results. Adjustments to Prony series coefficients or relaxation times may be necessary to improve the fit. Sensitivity analysis can help determine the impact of each parameter on overall simulation outcomes.

Applications and Use Cases

Automotive Engineering

abaqus prony series modeling is extensively used in the automotive industry to predict the long-term behavior of polymers and rubbers in seals, gaskets, and vibration damping components. Accurate

viscoelastic simulations help optimize product performance and durability.

Biomedical Device Design

In biomedical engineering, viscoelastic material properties are critical for designing prosthetics, implants, and soft tissue analogs. The Prony series in Abaqus enables precise modeling of biological tissues, supporting the development of innovative healthcare solutions.

Consumer Goods and Packaging

Manufacturers of packaging and consumer goods use abaqus prony series analysis to evaluate time-dependent deformation, stress relaxation, and shelf-life predictions for plastic and elastomeric products, ensuring quality control and regulatory compliance.

Best Practices for Accurate Prony Series Modeling

- Always use high-resolution experimental data for fitting Prony series parameters.
- Limit the number of Prony series terms to the minimum required for an accurate fit to avoid overfitting.
- Verify model predictions with independent test data whenever possible.
- Regularly update material models to reflect changes in manufacturing or material formulation.
- Document all steps of parameter extraction and model validation for traceability.

By following these best practices, engineers can maximize the reliability and predictive power of abaqus prony series simulations.

Common Challenges and Solutions

Challenge: Overfitting Prony Series Parameters

Using too many terms in the Prony series may lead to overfitting and instability in simulation results. Experts recommend selecting the smallest number of terms that provides an acceptable fit to experimental data.

Challenge: Limited Experimental Data

When data is scarce, it can be difficult to accurately fit the Prony series. In such cases, use literature values, perform sensitivity studies, or conduct additional experiments to improve model fidelity.

Challenge: Numerical Instabilities in Abaqus Simulations

Improperly defined Prony series parameters may cause convergence issues. Ensure all coefficients are positive, the sum of coefficients is physically reasonable, and relaxation times are appropriately scaled for the analysis duration.

Conclusion

The abaqus prony series offers a powerful and flexible approach for simulating viscoelastic materials in finite element analysis. By understanding the principles of viscoelasticity, implementing the Prony series in Abaqus, and applying best practices, engineers can achieve accurate and reliable predictions for a wide range of applications. Careful parameter selection, model validation, and awareness of common challenges are essential for successful viscoelastic modeling. As industries continue to demand more advanced material simulations, expertise in abaqus prony series will remain a key asset for professionals in engineering and research.

Q: What is the Prony series and why is it used in Abaqus?

A: The Prony series is a mathematical model used to describe the viscoelastic behavior of materials by representing their relaxation modulus as a sum of exponential decay functions. In Abaqus, it enables accurate simulation of time-dependent material responses such as stress relaxation and creep.

Q: How do I input Prony series parameters in Abaqus?

A: Prony series parameters are entered in the material definition section of Abaqus/CAE or input files. Users specify the coefficients and relaxation times for each term in the series under the viscoelastic material model in the time domain.

Q: What types of materials can be modeled using the Prony series in Abaqus?

A: The Prony series in Abaqus is suitable for modeling polymers, rubbers, biological tissues, and other materials that exhibit viscoelastic behavior with time-dependent stress-strain characteristics.

Q: How many terms should I use in the Prony series?

A: The number of terms should be sufficient to capture the main features of the experimental data without overfitting; typically, 3 to 6 terms are used, but this depends on the complexity of the material response and the quality of the data.

Q: Can the Prony series be used for both shear and bulk viscoelastic properties?

A: Yes, the Prony series can represent both shear (G) and bulk (K) relaxation moduli, allowing comprehensive modeling of viscoelastic behavior in Abaqus.

Q: What experimental tests are commonly used to determine Prony series parameters?

A: Stress relaxation tests and creep tests are most commonly used to generate the data needed for Prony series parameter fitting.

Q: How does the Prony series affect simulation accuracy in Abaqus?

A: Accurate Prony series parameters lead to more reliable predictions of time-dependent material behavior, impacting results for applications such as vibration damping, fatigue, and long-term deformation.

Q: What are common problems when using the Prony series in Abaqus and how can they be avoided?

A: Common issues include overfitting, insufficient data, and numerical instability. These can be avoided by using high-quality experimental data, limiting the number of terms, and validating the model with

independent tests.

Q: Is the Prony series applicable to nonlinear viscoelastic modeling in Abaqus?

A: The Prony series is primarily used for linear viscoelastic modeling. For nonlinear viscoelasticity, Abaqus provides other material models and advanced user-defined options.

Q: Why is it important to validate Prony series parameters?

A: Validation ensures that the simulated material response matches real-world behavior, increasing confidence in the results and enabling reliable engineering decisions.

Abaqus Prony Series

Abaqus Prony Series: A Comprehensive Guide for Material Modeling

Are you struggling to accurately model the viscoelastic behavior of materials in Abaqus? Understanding and effectively utilizing the Prony series within Abaqus is crucial for achieving realistic simulations. This comprehensive guide dives deep into the intricacies of the Abaqus Prony series, providing a clear understanding of its application, parameters, and practical implications for accurate material modeling. We'll cover everything from the fundamental theory behind the Prony series to advanced techniques for data fitting and implementation within the Abaqus software. Get ready to master this powerful tool and elevate the accuracy of your simulations.

What is the Abaqus Prony Series?

The Abaqus Prony series is a mathematical representation of viscoelastic material behavior. Viscoelastic materials exhibit both viscous (fluid-like) and elastic (solid-like) properties, meaning their response to stress depends on both the instantaneous load and the loading history. Unlike purely elastic materials, which instantaneously deform and recover, viscoelastic materials exhibit time-dependent deformation and stress relaxation. The Prony series allows us to capture this complex behavior by representing the material's relaxation modulus or creep compliance as a sum of exponential terms. This series effectively approximates the material's response over time, enabling accurate prediction of its behavior under various loading conditions.

Understanding the Parameters of the Prony Series in Abaqus

The Prony series in Abaqus is defined by a set of parameters that determine the material's viscoelastic response. These parameters include:

The initial modulus (G0 or E0): This represents the instantaneous elastic response of the material. It’s the elastic modulus at time t=0.

Relaxation times (τi): These parameters define the characteristic time scales over which the material relaxes. Each relaxation time represents a specific mode of viscoelastic response. A longer relaxation time indicates slower stress relaxation.

Weighting factors (gi or ai): These parameters determine the contribution of each exponential term to the overall relaxation modulus (or creep compliance). They represent the relative importance of each relaxation time in the material's response. The sum of all weighting factors should generally equal 1 (or less if an instantaneous response is desired).

The precise number of terms in the series (i.e., the number of relaxation times and weighting factors) depends on the complexity of the material's behavior and the accuracy required. More terms generally lead to a more accurate representation but increase computational cost.

Fitting Experimental Data to the Prony Series

Accurate material modeling requires precise determination of the Prony series parameters. This usually involves fitting experimental data obtained from relaxation or creep tests. Several methods can be employed for this fitting process:

Nonlinear least-squares regression: This is a common approach that minimizes the difference between the experimental data and the Prony series prediction. Specialized software packages or Abaqus' built-in capabilities can assist with this process.

Linear regression (for simplified cases): Under certain conditions, linear regression can be used to

estimate the Prony series parameters, offering a simplified approach.

Manual iterative fitting: While less efficient, this method allows for closer examination of the fitting process and better understanding of the model’s limitations.

It is crucial to ensure that the chosen fitting method adequately captures the material's behavior across the relevant time scales. Poorly fitted data will lead to inaccurate simulation results.

Implementing the Abaqus Prony Series in a Simulation

Once the Prony series parameters have been determined, implementing them in an Abaqus simulation is relatively straightforward. This typically involves defining the material model within the Abaqus material editor and inputting the calculated parameters. The specific steps will depend on the chosen material model (e.g., viscoelastic, hyperelastic-viscoelastic). Careful attention should be paid to ensuring the units are consistent throughout the process.

Advanced Considerations and Best Practices

Choosing the appropriate number of terms: The number of terms in the Prony series should be carefully chosen to balance accuracy and computational cost. Start with a smaller number of terms and increase it iteratively until the desired accuracy is achieved.

Data quality: The accuracy of the Prony series parameters depends heavily on the quality of the experimental data. Ensure the experimental data is accurate, reliable, and covers the relevant time scales.

Material temperature dependence: The viscoelastic properties of many materials are temperature-dependent. For accurate simulations, consider incorporating temperature-dependent Prony series parameters.

Verification and Validation: After implementing the Prony series, it's essential to verify and validate the model through comparison with experimental data or analytical solutions. This ensures the model accurately represents the material's behavior.

Conclusion

The Abaqus Prony series is a powerful tool for modeling the viscoelastic behavior of materials. By carefully determining the parameters and implementing them correctly within Abaqus, engineers can achieve accurate and realistic simulations. This guide has provided a comprehensive overview of

the theory, implementation, and best practices associated with using the Abaqus Prony series, empowering you to enhance the precision and reliability of your finite element analyses.

FAQs

1. Can I use the Prony series for all viscoelastic materials? While widely applicable, the suitability of the Prony series depends on the material's specific viscoelastic behavior. Some materials may require more complex models.

2. How do I determine the optimal number of terms in the Prony series? Start with a small number of terms and gradually increase it until the model adequately captures the experimental data while minimizing computational cost.

3. What happens if I use an incorrect number of terms? An insufficient number of terms might lead to inaccurate representation of the material's viscoelastic response, while an excessive number can unnecessarily increase computational time without significant improvement in accuracy.

4. What software can assist in fitting experimental data to a Prony series? Several software packages, including specialized curve-fitting programs and even scripting within Abaqus itself, can assist in the process.

5. Are there alternatives to the Prony series for modeling viscoelasticity in Abaqus? Yes, other models like the generalized Maxwell model or the fractional derivative model can also be used depending on the specific material behavior and simulation requirements.

abaqus prony series: ABAQUS/Standard , 2001

abaqus prony series: Constitutive Models for Rubber III J. Busfield, A. Muhr, 2003-01-01 Recent developments in the modelling of rubber are collated in this volume, including not only stress-strain behaviour and the use of the large strain finite element method for simulation, but also fatigue, fracture, filler reinforcement, dynamic properties and the effects of ageing.

abaqus prony series: *ABAQUS/Explicit* , 2001

abaqus prony series: Proceedings of the 4th International Conference on Numerical Modelling in Engineering Magd Abdel Wahab, 2022-03-28 This book gathers outstanding papers on numerical modeling in Mechanical Engineering (Volume 2) as part of the 2-volume proceedings of the 4th International Conference on Numerical Modeling in Engineering (NME 2021), which was held in Ghent, Belgium, on 24-25 August 2021. The overall objective of the conference was to bring together international scientists and engineers in academia and industry from fields related to advanced numerical techniques, such as the finite element method (FEM), boundary element method (BEM), isogeometric analysis (IGA), etc., and their applications to a wide range of engineering disciplines. This book addresses numerical simulations of various mechanical and materials engineering industrial applications such as aerospace applications, acoustic analysis, bio-mechanical applications, contact problems and wear, heat transfer analysis, vibration and dynamics, transient analysis, nonlinear analysis, composite materials, polymers, metal alloys, fracture mechanics, fatigue of materials, creep, mechanical behavior, micro-structure, phase transformation, and crystal plasticity.

abaqus prony series: Ageing Studies and Lifetime Extension of Materials Les Mallinson,

2012-12-06 The first International Conference on Ageing Studies and Lifetime Extension of Materials was held on th July 12-14 , 1999 at St. Catherine's College, Oxford, United Kingdom. Over 230 delegates attended during the three days and heard nearly ninety papers, together with over thirty poster presentations. Sixteen of these papers were keynotes from invited speakers eminent in their field of research. The proceedings were organised into six separate sessions: observation and understanding of real-time and accelerated ageing; experimental techniques; modelling and theoretical studies; lifetime prediction and validation; lifetime extension; and material design for ageing. In doing this, it was hoped to cover most issues of scientific concern inthefield ofmaterials ageing. One important aspect was that the conference did not concentrateon any particular group or type ofmaterial; rather the aim was to attract contributions from workers engaged in ageing studies with as wide a range of materials as possible. In this way, it was hoped that delegates could interactwith and learnfrom those whom they perhapswould not normally come across and that metallurgists could learn from polymer scientists, ceramicists could talk to modellers, and so on, in this important field. A read through the diverse papers contained within these proceedings will confirm that this aim was happily satisfied. Why hold such a meeting? In the modem world, engineered systems are expected to last longer.

abaqus prony series: Advanced Materials XII Tahir Ikram, Iftichar Us Salam, Karim Ahmed, 2012-05-14 Selected, peer reviewed papers from the 12th International Symposium on Advanced Materials, 26-30 September, 2011, Islamabad, Pakistan

abaqus prony series: *ABAQUS Keywords Manual* , 2000

abaqus prony series: *Finite Element Analysis of Composite Materials using AbaqusTM* Ever J. Barbero, 2013-04-18 Developed from the author's graduate-level course on advanced mechanics of composite materials, Finite Element Analysis of Composite Materials with Abaqus shows how powerful finite element tools address practical problems in the structural analysis of composites. Unlike other texts, this one takes the theory to a hands-on level by actually solving

abaqus prony series: Mechanics of Biological Tissue Gerhard A. Holzapfel, Ray W. Ogden, 2006-06-03 The mechanics of biological tissues is a multidisciplinary and rapidly expanding area of research. This book points to important directions combining mechanical sciences with the new developments in biology. It delivers articles on mechanics of tissues at the molecular, cellular, tissue and organ levels.

abaqus prony series: Challenging Glass 4 & COST Action TU0905 Final Conference Christian Louter, Freek Bos, Jan Belis, Jean-Paul Lebet, 2014-01-28 This proceedings volume of the Challenging Glass 4 & COST Action TU0905 Final Conference, held 6-7 February 2014 at the EPFL in Lausanne, Switzerland, represents the Final Action Publication of the European research network COST Action TU0905 Structural Glass Novel design methods and next generation products. It contains nearly 100 peer-rev

abaqus prony series: *Bridging the Centuries with SAMPE's Materials and Processes Technology* Steve Loud, 2000

abaqus prony series: Computational and Experimental Mechanics of Advanced Materials Vadim V. Silberschmidt, 2009-11-24 Advanced materials play a crucial role in modern engineering applications where they are often exposed to complex loading and environmental conditions. In many cases, new approaches are needed to characterise these materials and to model their behaviour. Such approaches should be calibrated and validated by specific experimental techniques, quantifying both microstructural features and respective mechanisms at various length scales. The book provides an overview of modern modelling tools and experimental methods that can be employed to analyse and estimate properties and performance of advanced materials. A special feature of the book is the analysis of case studies used to demonstrate the strategies of solving the real-life problems, in which the microstructure of materials directly affects their response to loading and/or environmental conditions. The reader will benefit from a detailed analysis of various methods as well as their implementation for dealing with various advanced materials.

abaqus prony series: Engineering Viscoelasticity Danton Gutierrez-Lemini, 2013-09-12

Engineering Viscoelasticity covers all aspects of the thermo- mechanical response of viscoelastic substances that a practitioner in the field of viscoelasticity would need to design experiments, interpret test data, develop stress-strain models, perform stress analyses, design structural components, and carry out research work. The material in each chapter is developed from the elementary to the esoteric, providing the background in mathematics and mechanics that are central to understanding the subject matter being presented. This book also examines how viscoelastic materials respond to the application of loads, and provides practical guidelines to use them in the design of commercial, military and industrial applications.

abaqus prony series: ABAQUS/standard Hibbitt, Karlsson and Sorensen, 1995

abaqus prony series: Coupled Thermo-Hydro-Mechanical Processes of Fractured Media O. Stephanson, L. Jing, C.-F. Tsang, 1997-02-10 This work brings together the results, information and data that emerged from an international cooperative project, DECOVALEX, 1992-1995. This project was concerned with the mathematical and experimental studies of coupled thermo(T) -hydro(H) -mechanical(M) processes in fractured media related to radioactive waste disposal. The book presents, for the first time, the systematic formulation of mathematical models of the coupled T-H-M processes of fractured media, their validation against theoretical bench-mark tests, and experimental studies at both laboratory and field scales. It also presents, for the first time, a comprehensive analysis of continuum, and discrete approaches to the study of the problems of (as well as a complete description of), the computer codes applied to the studies. The first two chapters provide a conceptual introduction to the coupled T-H-M processes in fractured media and the DECOVALEX project. The next seven chapters give a state-of-the-art survey of the constitutive models of rock fractures and formulation of coupled T-H-M phenomena with continuum and discontinuum approaches, and associated numerical methods. A study on the three generic Bench-Mark Test problems and six Test Case problems of laboratory and field experiments are reported in chapters 10 to 18. Chapter 19 contains lessons learned during the project. The research contained in this book will be valuable for designers, practising engineers and national waste management officials who are concerned with planning, design and performance, and safety assessments of radioactive waste repositories. Researchers and postgraduate students working in this field will also find the book of particular relevance.

abaqus prony series: Viscoelastic Materials Roderic S. Lakes, 2009-04-27 This graduate text on viscoelastic materials addresses design applications as diverse as earplugs, computer disks and medical diagnostics.

abaqus prony series: Constitutive Models for Rubber IV Per-Erik Austrell, 2017-12-04 The unique properties of elastomeric materials offer numerous advantages in many engineering applications. Elastomeric units are used as couplings or mountings between rigid components, for example in shock absorbers, vibration insulators, flexible joints, seals and suspensions, etc. However, the complicated nature of the behaviour of such material makes it difficult to accurately predict the performance of these units using finite element modelling, for example. It is imperative that constitutive models accurately capture relevant aspects of mechanical behaviour. The latest developments concerning constitutive modelling of rubber is collected in these Proceedings. Topics included in this volume are, Hyperelastic models, Strength, fracture & fatigue, Dynamic properties & the Fletcher-Gent effect, Micro-mechanical & statistical approaches, Stress softening, iscoelasticity, Filler reinforcement, and Tyres, fibre & cord reinforced rubber.

abaqus prony series: Constitutive Modeling of Engineering Materials Vladimir Buljak, Gianluca Ranzi, 2021-02-18 Constitutive Modeling of Engineering Materials provides an extensive theoretical overview of elastic, plastic, damage, and fracture models, giving readers the foundational knowledge needed to successfully apply them to and solve common engineering material problems. Particular attention is given to inverse analysis, parameter identification, and the numerical implementation of models with the finite element method. Application in practice is discussed in detail, showing examples of working computer programs for simple constitutive behaviors. Examples explore the important components of material modeling which form the building blocks of any

complex constitutive behavior. - Addresses complex behaviors in a wide range of materials, from polymers, to metals and shape memory alloys - Covers constitutive models with both small and large deformations - Provides detailed examples of computer implementations for material models

abaqus prony series: Human-Centered Technology for a Better Tomorrow Mohd Hasnun Arif Hassan, Zulkifli Ahmad (a) Manap, Mohamad Zairi Baharom, Nasrul Hadi Johari, Ummu Kulthum Jamaludin, Muhammad Hilmi Jalil, Idris Mat Sahat, Mohd Nadzeri Omar, 2021-10-01 This book acts as a compilation of papers presented in the Human Engineering Symposium (HUMENS 2021). The symposium theme, "Human-centered Technology for A Better Tomorrow," covers the following research topics: ergonomics, biomechanics, sports technology, medical device and instrumentation, artificial intelligence / machine learning, industrial design, rehabilitation, additive manufacturing, modelling and bio-simulation, and signal processing. Fifty-nine articles published in this book are divided into four parts, namely Part 1—Artificial Intelligence and Biosimulation, Part 2—Biomechanics, Safety and Sports, Part 3—Design and Instrumentation, and Part 4—Ergonomics.

abaqus prony series: ABAQUS/Standard Example Problems Manual Hibbitt, Karlsson and Sorensen, Inc.., 1995

abaqus prony series: *Topics in Modal Analysis I, Volume 5* R. Allemang, J. De Clerck, C. Niezrecki, J.R. Blough, 2012-05-17 Topics in Modal Analysis I, Volume 5. Proceedings of the 30th IMAC, A Conference and Exposition on Structural Dynamics, 2012, the fifth volume of six from the Conference, brings together 53 contributions to this important area of research and engineering. The collection presents early findings and case studies on fundamental and applied aspects of Structural Dynamics, including papers on: Modal Parameter Identification Damping of Materials and Members New Methods Structural Health Monitoring Processing Modal Data Operational Modal Analysis Damping Excitation Methods Active Control Damage Detection for Civil Structures System Identification: Applications

abaqus prony series: Constitutive Models for Rubber VI Gert Heinrich, Michael Kaliske, Alexander Lion, Stefanie Reese, 2009-09-01 Recent developments in order to represent the material behaviour of filler-reinforced elastomers under realistic operating conditions are collected in this volume. Special topics are finite element simulations and methods, dynamic material properties, experimental characterization, lifetime prediction, friction, multiphysics and biomechanics, reinf

abaqus prony series: *Challenges in Mechanics of Time-Dependent Materials, Volume 2* Alex Arzoumanidis, Meredith Silberstein, Alireza Amirkhizi, 2018-08-09 Challenges in Mechanics of Time-Dependent Materials, Volume 2 of the Proceedings of the 2018 SEM Annual Conference& Exposition on Experimental and Applied Mechanics, the second volume of eight from the Conference, brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on fundamental and applied aspects of Experimental Mechanics, including papers in the following general technical research areas: Characterization Across Length Scales Extreme Environments & Environmental Effects Soft Materials Damage, fatigue and Fracture Inhomogeneities & Interfaces Viscoelasticity Research in Progress

abaqus prony series: Design and Modeling of Mechanical Systems Mohamed Haddar, Lotfi Romdhane, Jamel Louati, Abdelmajid Ben Amara, 2013-03-12 The 5th International Congress on Design and Modeling of Mechanical Systems (CMSM) was held in Djerba, Tunisia on March 25-27, 2013 and followed four previous successful editions, which brought together international experts in the fields of design and modeling of mechanical systems, thus contributing to the exchange of information and skills and leading to a considerable progress in research among the participating teams. The fifth edition of the congress (CMSM´2013), organized by the Unit of Mechanics, Modeling and Manufacturing (U2MP) of the National School of Engineers of Sfax, Tunisia, the Mechanical Engineering Laboratory (MBL) of the National School of Engineers of Monastir, Tunisia and the Mechanics Laboratory of Sousse (LMS) of the National School of Engineers of Sousse, Tunisia, saw a significant increase of the international participation. This edition brought together nearly 300 attendees who exposed their work on the following topics: mechatronics and robotics,

dynamics of mechanical systems, fluid structure interaction and vibroacoustics, modeling and analysis of materials and structures, design and manufacturing of mechanical systems. This book is the proceedings of CMSM´2013 and contains a careful selection of high quality contributions, which were exposed during various sessions of the congress. The original articles presented here provide an overview of recent research advancements accomplished in the field mechanical engineering.

abaqus prony series: Viscoelastic Properties of Polymers John D. Ferry, 1980-09-16 Viscoelastic behavior reflects the combined viscous and elastic responses, under mechanical stress, of materials which are intermediate between liquids and solids in character. Polymers the basic materials of the rubber and plastic industries and important to the textile, petroleum, automobile, paper, and pharmaceutical industries as well exhibit viscoelasticity to a pronounced degree. Their viscoelastic properties determine the mechanical performance of the final products of these industries, and also the success of processing methods at intermediate stages of production. Viscoelastic Properties of Polymers examines, in detail, the effects of the many variables on which the basic viscoelastic properties depend. These include temperature, pressure, and time; polymer chemical composition, molecular weight and weight distribution, branching and crystallinity; dilution with solvents or plasticizers; and mixture with other materials to form composite systems. With guidance by molecular theory, the dependence of viscoelastic properties on these variables can be simplified by introducing certain ancillary concepts such as the fractional free volume, the monomeric friction coefficient, and the spacing between entanglement loci, to provide a qualitative understanding and in many cases a quantitative prediction of how to achieve desired results. The phenomenological theory of viscoelasticity which permits interrelation of the results of different types of experiments is presented first, with many useful approximation procedures for calculations given. A wide variety of experimental methods is then described, with critical evaluation of their applicability to polymeric materials of different consistencies and in different regions of the time scale (or, for oscillating deformations, the frequency scale). A review of the present state of molecular theory follows, so that viscoelasticity can be related to the motions of flexible polymer molecules and their entanglements and network junctions. The dependence of viscoestic properties on temperature and pressure, and its descriptions using reduced variables, are discussed in detail. Several chapters are then devoted to the dependence of viscoelastic properties on chemical composition, molecular weight, presence of diluents, and other features, for several characteristic classes of polymer materials. Finally, a few examples are given to illustrate the many potential applications of these principles to practical problems in the processing and use of rubbers, plastics, and fibers, and in the control of vibration and noise. The third edition has been brought up to date to reflect the important developments, in a decade of exceptionally active research, which have led to a wider use of polymers, and a wider recognition of the importance and range of application of viscoelastic properties. Additional data have been incorporated, and the book s chapters on dilute solutions, theory of undiluted polymers, plateau and terminal zones, cross-linked polymers, and concentrated solutions have been extensively rewritten to take into account new theories and new experimental results. Technical managers and research workers in the wide range of industries in which polymers play an important role will find that the book provides basic information for practical applications, and graduate students in chemistry and engineering will find, in its illustrations with real data and real numbers, an accessible introduction to the principles of viscoelasticity.

abaqus prony series: *Advanced Asphalt Materials and Paving Technologies* Zhanping You, Qingli Dai, Feipeng Xiao, 2018-05-04 This book is a printed edition of the Special Issue Advanced Asphalt Materials and Paving Technologies that was published in Applied Sciences

abaqus prony series: Preventive Biomechanics Gerhard Silber, Christophe Then, 2012-08-04 How can we optimize a bedridden patient’s mattress? How can we make a passenger seat on a long distance flight or ride more comfortable? What qualities should a runner’s shoes have? To objectively address such questions using engineering and scientific methods, adequate virtual human body models for use in computer simulation of loading scenarios are required. The authors

have developed a novel method incorporating subject studies, magnetic resonance imaging, 3D-CAD-reconstruction, continuum mechanics, material theory and the finite element method. The focus is laid upon the mechanical in vivo-characterization of human soft tissue, which is indispensable for simulating its mechanical interaction with, for example, medical bedding or automotive and airplane seating systems. Using the examples of arbitrary body support systems, the presented approach provides visual insight into simulated internal mechanical body tissue stress and strain, with the goal of biomechanical optimization of body support systems. This book is intended for engineers, manufacturers and physicians and also provides students with guidance in solving problems related to support system optimization.

abaqus prony series: Advances in Manufacturing Technology XV Tim O'Hagan, 2001-11-28 An overview of the latest advances in manufacturing In manufacturing, staying up to date with the newest technology has a direct impact on the bottom line. To this end, Advances in Manufacturing Technology XV provides an invaluable resource: papers presented at the 15th National Conference on Manufacturing Research, highlighting the latest findings and ongoing work of the world's leading labs. Showcasing innovation in efficiency, speed, safety, capability, and much more, these works represent the forefront of manufacturing today.

abaqus prony series: Constitutive Models for Rubber IX Bohdana Marvalova, Iva Petrikova, 2015-10-22 The unique properties of rubber make it ideal for use in a wide variety of engineering applications such as tyres, engine mounts, shock absorbers, flexible joints and seals. Developing diverse elastomeric elements for various structures involves numerical simulations of their performance, which are based on reliable constitutive models of the mater

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abaqus prony series: Advances in Pavement Design through Full-scale Accelerated Pavement Testing David Jones, John Harvey, Imad L. Al-Qadi, Angel Mateos, 2012-10-08 Pack: Book and CDInternationally, full-scale accelerated pavement testing, either on test roads or linear/circular test tracks, has proven to be a valuable tool that fills the gap between models and laboratory tests and long-term experiments on in-service pavements. Accelerated pavement testing is used to improve understanding of pavement behavior,

abaqus prony series: Advances in Materials and Pavement Prediction Eyad Masad, Amit Bhasin, Tom Scarpas, Ilaria Menapace, Anupam Kumar, 2018-07-16 Advances in Materials and Pavement Performance Prediction contains the papers presented at the International Conference on Advances in Materials and Pavement Performance Prediction (AM3P, Doha, Qatar, 16- 18 April 2018). There has been an increasing emphasis internationally in the design and construction of sustainable pavement systems. Advances in Materials and Pavement Prediction reflects this development highlighting various approaches to predict pavement performance. The contributions discuss links and interactions between material characterization methods, empirical predictions, mechanistic modeling, and statistically-sound calibration and validation methods. There is also emphasis on comparisons between modeling results and observed performance. The topics of the book include (but are not limited to): • Experimental laboratory material characterization • Field measurements and in situ material characterization • Constitutive modeling and simulation • Innovative pavement materials and interface systems • Non-destructive measurement techniques • Surface characterization, tire-surface interaction, pavement noise • Pavement rehabilitation • Case studies Advances in Materials and Pavement Performance Prediction will be of interest to academics and engineers involved in pavement engineering.

abaqus prony series: Viscoelastic Solids (1998) Roderic S. Lakes, 2017-11-22 Viscoelastic

Solids covers the mathematical theory of viscoelasticity and physical insights, causal mechanisms, and practical applications. The book: presents a development of the theory, addressing both transient and dynamic aspects as well as emphasizing linear viscoelasticity synthesizes the structure of the theory with the aim of developing physical insight illustrates the methods for the solution of stress analysis problems in viscoelastic objects explores experimental methods for the characterization of viscoelastic materials describes the phenomenology of viscoelasticity in a variety of materials, including polymers, metals, high damping alloys, rock, piezoelectric materials, cellular solids, dense composite materials, and biological materials analyzes high damping and extremely low damping provides the theory of viscoelastic composite materials, including examples of various types of structure and the relationships between structure and mechanical properties contains examples on the use of viscoelastic materials in preventing and alleviating human suffering Viscoelastic Solids also demonstrates the use of viscoelasticity for diverse applications, such as earplugs, gaskets, computer disks, satellite stability, medical diagnosis, injury prevention, vibration abatement, tire performance, sports, spacecraft explosions, and music.

abaqus prony series: *Advancement of Optical Methods in Experimental Mechanics, Volume 3* Helena Jin, Cesar Sciammarella, Sanichiro Yoshida, Luciano Lamberti, 2014-10-25 Advancement of Optical Methods in Experimental Mechanics, Volume 3: Proceedings of the 2014 Annual Conference on Experimental and Applied Mechanics, the third volume of eight from the Conference, brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on a wide range of optical methods ranging from traditional photoelasticity and interferometry to more recent DIC and DVC techniques, and includes papers in the following general technical research areas: · Advanced optical methods for frontier applications · Advanced optical interferometry · Optical measurement systems using polarized light · Optical methods for advanced manufacturing · Digital image correlation · Optical methods at the micro/nano-scale · Three-dimensional imaging and volumetric correlation · Imaging methods for thermomechanics applications · Opto-acoustical methods in experimental mechanics · Optical measurements in challenging environments · Optical methods for inverse problems · Advances in optical methods

abaqus prony series: Computational Viscoelasticity Severino P. C. Marques, Guillermo J. Creus, 2012-01-04 This text is a guide how to solve problems in which viscoelasticity is present using existing commercial computational codes. The book gives information on codes' structure and use, data preparation and output interpretation and verification. The first part of the book introduces the reader to the subject, and to provide the models, equations and notation to be used in the computational applications. The second part shows the most important Computational techniques: Finite elements formulation, Boundary elements formulation, and presents the solutions of Viscoelastic problems with Abaqus.

abaqus prony series: Engineering Plasticity and Its Applications from Nanoscale to Macroscale Hoon Huh, 2009 The primary objective of the Asia-Pacific Conference on Engineering Plasticity and Its Applications (AEPA) is to provide a free forum for exchanging ideas and introducing the latest research findings in the field of engineering plasticity. This conference is unique among the related conferences in that it provides a forum for all fields of plasticity so that multi-disciplinary research works are encouraged. This proceedings volume consists of papers presented at AEPA2008, and covers the following categories in all fields of engineering plasticity: constitutive modeling; damage, fracture, fatigue and failure; dynamic loading and crash dynamics; engineering applications and case studies; experimental and numerical techniques; molecular dynamics; nano, meso, micro and crystal plasticity; phase transformations; plastic instability and strain localization; plasticity in advanced materials; plasticity in materials processing technology; plasticity in tribology; porous, cellular and composite materials; structural plasticity; superplasticity; and time-dependent deformation. Ranging from nanoscale to macroscale applications of engineering plasticity, this book touches upon fields as diverse as mechanical engineering, materials science, physics, chemistry and civil engineering.

abaqus prony series: Bituminous Mixtures and Pavements VII A.F. Nikolaides, E. Manthos, 2019-05-24 Highway engineers are facing the challenge not only to design and construct sustainable and safe pavements properly and economically. This implies a thorough understanding of materials behaviour, their appropriate use in the continuously changing environment, and implementation of constantly improved technologies and methodologies. Bituminous Mixtures and Pavements VII contains more than 100 contributions that were presented at the 7th International Conference 'Bituminous Mixtures and Pavements' (7ICONFBMP, Thessaloniki, Greece 12-14 June 2019). The papers cover a wide range of topics: - Bituminous binders - Aggregates, unbound layers and subgrade - Bituminous mixtures (Hot, Warm and Cold) - Pavements (Design, Construction, Maintenance, Sustainability, Energy and environment consideration) - Pavement management - Pavement recycling - Geosynthetics - Pavement assessment, surface characteristics and safety - Posters Bituminous Mixtures and Pavements VII reflects recent advances in highway materials technology and pavement engineering, and will be of interest to academics and professionals interested or involved in these areas.

abaqus prony series: Ballistics 2011 Ernest Baker, Douglas Templeton, 2011-09 Includes papers that were first presented at a September 2011 conference organized by the National Defense Industrial Association and the International Ballistics Society. This title includes a CD-ROM that displays figures and illustrations in articles in full color along with a title screen and main menu screen.

abaqus prony series: Processing and Fabrication of Advanced Materials, Volume 2 Ajay Kumar,

abaqus prony series: Computational Mechanics Zhenhan Yao, M. W. Yuan, Wanxie Zhong, 2004