

Metal Inelasticity in Abaqus

Abaqus 2018







About this Course

Course objectives

Upon completion of this course you will be able to model:

- Metals that show inelastic work hardening
- The Bauschinger effect
- "Ratcheting" and relaxation of the mean stress under cyclic loading
- Strain-rate-dependent inelastic behavior
- Temperature-dependent plasticity
- Heat generated by plastic deformation
- Ductile failure of metallic materials
- Plastic behavior in brittle (cast iron) metals
- Creep behavior in metals

Targeted audience

Simulation Analysts

Prerequisites

This course is recommended for engineers with experience using Abaqus



Day 1

	Lecture 1	Introduction
	Lecture 2	Ductile Metal Response
	Workshop 1	Metal Plasticity Tutorials
Lecture 3		Classical Metal Plasticity in Abaqus
	Workshop 2	Cyclic Loading of a Flange
	Lecture 4	Johnson-Cook Plasticity

Day 2

Lecture 5	Metal Failure Models
Lecture 6	Creep and Swelling
Workshop 3	Sagging of a Pipe
Lecture 7	Two-Layer Viscoplasticity
Lecture 8	Gray Cast Iron Plasticity
Lecture 9	Time Integration

Additional Material

- Appendix 1 Basic Concepts of Plasticity Theory
- Appendix 2 Porous Metal Plasticity
- Appendix 3 References

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 - Abaqus, Isight, Tosca, fe-safe, Simpack



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> Full Schedule

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Lecture 1	11/17	Updated for Abaqus 2018
Lecture 2	11/17	Updated for Abaqus 2018
Lecture 3	11/17	Updated for Abaqus 2018
Lecture 4	11/17	Updated for Abaqus 2018
Lecture 5	11/17	Updated for Abaqus 2018
Lecture 6	11/17	Updated for Abaqus 2018
Lecture 7	11/17	Updated for Abaqus 2018
Lecture 8	11/17	Updated for Abaqus 2018
Lecture 9	11/17	Updated for Abaqus 2018
Appendix 1	11/17	Updated for Abaqus 2018
Appendix 2	11/17	Updated for Abaqus 2018
Appendix 3	11/17	Updated for Abaqus 2018
Workshop 1	11/17	Updated for Abaqus 2018
Workshop 2	11/17	Updated for Abaqus 2018
Workshop 3	11/17	Updated for Abaqus 2018

Lesson 1: Introduction

- Purpose
- Focus on design applications
- Micromechanics approach
- Phenomenological approach

Lesson 2: Ductile Metal Response

- Uniaxial Test at Low Temperatures
 - Stress and strain measures
 - Yield
 - Strain reversal after yield
 - Cyclic loading
 - Necking
 - Temperature and strain-rate dependence
- Uniaxial Test at Elevated Temperatures
- Workshop Preliminaries
- Workshop 1: Metal Plasticity Tutorials



Lesson 3: Classical Metal Plasticity in Abaqus

Lesson content:

- Basic Assumptions
- Temperature and Field Variable Dependence
- Elasticity
- Strain Rate Decomposition
- Yield Functions
- Calibrating Hill's Anisotropic Plasticity Model
- Hardening
- Initial Hardening
- Rate Dependence

- Chaboche Unified Viscoplastic Model
- Annealing or Melting
- User Subroutine (V)UHARD
- Heat Generation for Thermo-Mechanical Problems
- Element Selection Issues
- Procedure Considerations
- Direct Cyclic Procedure
- Workshop 2: Cyclic Loading of a Flange (IA)
- Workshop 2: Cyclic Loading of a Flange (KW)

Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



Lesson 4: Johnson-Cook Plasticity

- Introduction
- Elasticity
- Yield Function and Plastic Flow
- Hardening
- Strain Rate Dependence
- Annealing or Melting
- Heat Generation
- Dynamic Failure
- Example: Oblique Impact of a Copper Rod



Lesson 5: Metal Failure Models

- Progressive Damage and Failure
- Damage Initiation Criteria for Fracture of Metals
- Damage Initiation Criteria for Sheet Metal Instability
- Damage Evolution for Ductile Metals
- Element Removal
- Damage and Failure in Low-cycle Fatigue
- Alternative Failure Models



Lesson 6: Creep and Swelling

Lesson content:

- Basic Assumptions
- Elasticity
- Stress Potentials
- Deviatoric Creep Models
- Volumetric Swelling
- Inelastic Flow in Creep/Swelling Models
- Temperature and Field Variable Dependence
- Analysis Procedures
- Creep Integration and Time Incrementation
- Workshop 3: Sagging of a Pipe (IA)
- Workshop 3: Sagging of a Pipe (KW)



Both interactive (IA) and keywords (KW) versions of the workshop are provided. Complete only one.



Lesson 7: Two-Layer Viscoplasticity

- Two-Layer Viscoplasticity
- Abaqus Usage
- Calibration Procedure
- ▶ Example



Lesson 8: Gray Cast Iron Plasticity

- Introduction
- Elasticity
- Yield Function
- Flow Rule
- Hardening
- Element Selection and Output
- Example: Biaxial Loads on Gray Cast Iron
- Limitations
- Alternative Cast Iron Model



Lesson 9: Time Integration

- Plasticity
- Creep



Appendix 1: Basic Concepts of Plasticity Theory

Appendix content:

- Introduction
- The Strain Rate Decomposition
- The Yield Function
- The Flow Rule
- The Hardening Rule
- Summary

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Appendix 2: Porous Metal Plasticity

Appendix content:

- Basic Assumptions
- Yield Function
- Hardening and Plastic Flow
- Void Nucleation and Growth
- Failure Model in Abaqus/Explicit
- Initial Conditions
- Element Selection



Appendix 3: References

Appendix content:

References

