

DBA Module content

Introduction to DBA

Competencies

Lesson Notes

Introduction – Part 1

Pressure Vessel Design Context
Pressure vessels - industrial context
Pressure vessel codes of practice - historical perspective

Introduction to Pressure Vessel Design
DBA and design checks
Some observations with respect to codes of practice
Comments on the interaction of failure mechanisms

Introduction – Part 2

Some Definitions
Linear Elastic Analysis
Linear Elastic-Plastic Analysis
Yield Criteria
Limit and Plastic Collapse Loads

Introduction – Part 3

Reflection on the Lower Bound Theorem and FEA
Pressure Vessel DBA Codes of Practice and FEA
Pressure Vessel-related Simulation Competencies
Some Practical FEA Guidelines
Simulation Context

Introduction to DBA Self Test Quiz: 19 Questions

Elastic Analysis

Competencies

Lesson Notes

Design by Elastic Analysis

Stress Categories
Stress Limits
General procedure for Design by Elastic Analysis
Difficulties encountered when performing stress categorisation
Linearization through the wall thickness
European code EN13445-3 Annex C

Pseudo Inelastic Analysis

Pseudo-inelastic analysis methods
The reduced modulus method
Limit analysis for primary stress classification
The reduced modulus procedure and computational limit analysis
The elastic compensation method and computational limit analysis
Linear matching method
Elastic compensation example: The two bar structure

Worked Examples (2)

Thin un-welded flat end - Stress categorization
Thick Hemisphere - Limit analysis using elastic compensation method

Tutorials (1)

TUT1 – Elastic Analysis Tutorial

Elastic Analysis Self Test Quiz: 23 Questions

Plastic Analysis

Competencies

Lesson Notes

Gross Plastic Deformation

Introduction

Gross plastic deformation

Limit Analysis

Plastic Analysis

Incremental Plastic Collapse

Incremental plastic collapse

Proportional loading

Non-proportional loading

Worked Examples (4)

Thick Hemisphere - Limit load analysis

Thick Hemisphere - Plastic load analysis

Plate with a hole under cyclic proportional loading: Shakedown analysis

Plate with a hole under cyclic non-proportional loading: Shakedown analysis

Tutorials (1)

TUT2 – Plastic Analysis Tutorial

Plastic Analysis Self Test Quiz: 10 Questions

Creep

Competencies

Lesson Notes

Creep – Part 1

Introduction

Overview of Creep-related Phenomena

Mathematical Modelling of Uniaxial Creep

Creep Rupture

Variable Stress Creep Behaviour

Stress Relaxation

Multi-Axial Stresses

Finite Element Creep Formulation

Creep – Part 2

The DBA Codes

ASME VIII Div2 Alternative Rules

EN13445: Unfired Pressure Vessels – Part 3 Design

Closing Remarks

Some Thoughts on V&V

"Cold" Creep

Creep and Welded Joints

Worked Examples (2)

Isothermal transient creep of a rectangular beam in bending

Isothermal steady-state creep of a long thick-walled cylinder under internal pressure

Creep Self Test Quiz: 9 Questions

Fatigue

Competencies

Lesson Notes

Fatigue – Part 1

Review of Cyclic Loading Phenomena

Elastic Shakedown

Ratchetting

Alternating Plasticity

Overview of Fatigue

Historical and Wider Industry Perspective

Vibration

Fatigue – Part 2

Approaches to Fatigue Analysis

Classical Stress-life-based Assessment

Strain-life-based Assessment

Fatigue – Part 3

Modelling & Fatigue Assessment of Welds and Dissimilar Joints

Brief Overview of the Challenges

Weld Improvement Methods

Theoretical Elastic Stress Singularities and Welds & Dissimilar Material Joints

Stresses Used for the Fatigue Assessment of Welds

Determination of the Cyclic Stress Range - Summary

The Pro's and Con's of Shell Idealisations

Various Shell Idealization Improvement Techniques

Further Relevant Observations from a Lamp-post

Some Observations from Weld Round-Robins

Fatigue – Part 4

What the Codes Say

PD5500

ASME III

ASME VIII Div2

EN 13445

BS 7608

BS 7910

Closing Remarks

Fatigue Self Test Quiz: 15 Questions

Note: Worked Examples covering Fatigue are in the Codes of Practice and DBA in Action sections

Instability & Buckling

Competencies

Lesson Notes

Instability & Buckling – Part 1

Introduction to Some Basic Definitions and Fundamental Concepts
Linear Euler Buckling
Empirical Formulae for the Design of Struts/Columns
Slenderness Ratio of Struts/Columns
Energy Methods for the Design of Struts - the Rayleigh Ritz Method

Instability & Buckling – Part 2
Buckling Behaviour of Shells
Eigenvalue Buckling Using FEM
Nonlinear Buckling & Post-Buckling

Instability & Buckling – Part 3
Review of Finite Element Background & Modelling Issues
Some Further Instability & Buckling Thoughts & Examples

Buckling Self Test Quiz: 9 Questions

Note: Worked Examples covering Instability & Buckling are in the Codes of Practice and DBA in Action sections

Other Failure Mechanisms

Competencies

Lesson Notes

Introduction

Corrosion
Types of Corrosion
Corrosion Control

Brittle Fracture

Irradiation Effects

Codes of Practice

Competencies

Lesson Notes

EN13445 Part 3: Annex B
Overview
GPD-DC
PD-DC
I-DC
F-DC
SE-DC
CR-DC

ASME Section VIII Div 2 – Part 5
Overview
Protection against plastic collapse
Protection against local failure
Protection against collapse from buckling
Protection against collapse from cyclic loading

Codes of Practice Self Test Quiz: 26 Questions

DBA in Action

Competencies

Worked Examples – EN (17)

Hemisphere with nozzle intersection

GPD-DC

PD-DC

F-DC

Cylinder under external pressure

I-DC

Skirted vessel

SE-DC

Thin un-welded flat end

GPD-DC

PD-DC

F-DC

Hemisphere

GPD-DC

PD-DC

Dished end with nozzle in knuckle region

GPD-DC

PD-DC

F-DC

Cylinder with two nozzles

GPD-DC

PD-DC

F-DC

Torispherical head under internal pressure

I-DC

Worked Examples – ASME (13)

Hemisphere with nozzle intersection

Plastic Collapse

Local yielding

Fatigue

Cylinder under external pressure

Buckling

Thin unwelded flat end

Plastic Collapse

Local yielding

Fatigue

Hemisphere

Plastic Collapse

Local yielding

Dished end with nozzle in knuckle region

Plastic Collapse

Local yielding

Fatigue

Torispherical head under internal pressure

Buckling

TOTALS

7 Quizzes with 111 Questions

2 Tutorials

38 Worked examples