



RTU Course "Fracture Mechanics"

15E03 Lidaparātu teorijas un konstrukcijas katedra

General data

| | |
|---|--|
| Code | TAS504 |
| Course title | Fracture Mechanics |
| Course status in the programme | Compulsory/Courses of Limited Choice |
| Course level | Post-graduate Studies |
| Course type | Academic |
| Field of study | Mechanics, Mechanical Engineering, Machine Building |
| Responsible instructor | Pavelko Vitālijs |
| Academic staff | Pavelko Igors |
| Volume of the course: parts and credits points | 1 part, 2.0 Credit Points, 3.0 ECTS credits |
| Language of instruction | LV, EN, RU |
| Possibility of distance learning | Not planned |
| Abstract | Fundamentals of modern fracture mechanics are considered and the methods of their application: Griffith's theory, force and energy forms of critical state on front of a crack, the concept of stress intensity factor and three modes of stress state. Critical state conditions for ductile materials are analyzed: the J-integral as fracture criterion, critical crack opening displacement. Simplified form of dynamic crack propagation is considered. More details are examined on fatigue crack, corrosion-fatigue crack and corrosion critical stress intensity factor K_{sc} . |
| Goals and objectives of the course in terms of competences and skills | Main goal: To provide students with the skills to use modern methods of fracture mechanics assessment of strength and fatigue lifetime of real aircraft design with damage. Must be reached the level when a specialist is able to provide expertise and carry out computer simulation. |
| Structure and tasks of independent studies | 1) 1st test: The stress, strain and strain energy determination near the crack front. 2) Course paper: Remaining strength and lifetime determination for a panel with crack 3) Laboratory work: stress intensity factor experimental determination. 4) Working with literature (6h) |
| Recommended literature | 1. V. Pavelko. Sagrūšanas mehānika. Lekciju konspekts – Rīga: RTU, 2006. – 45 lp. 2. V. Pavelko. Sagrūšanas mehānika. Kurša darba uzdevumi un izpildīšanas metodiskie norādījumi – Rīga: RTU, 2005. – 14 lp.. 3. Fracture Mechanics//M. Janssen, J. Zuidema, R.J.H. Wanhill, (2002) ISBN 90-407-2221-8 4. Anderson, T. L. 1994. Fracture Mechanics: Fundamentals and Applications, 2nd ed., CRC Press, Boca Raton, FL. 5. К.Хеллан. Введение в механику разрушения .- М.: Мир, 1988. – 364 с. 6. Дж.Брок. Основы механики разрушения .- М.: Высшая школа, 1980. – 368 с. 7. D.Broek. Elementāry Engineering Fracture Mechanics. -Leyden: Nordhof International Publishing.-1978. |
| Course prerequisites | Mechanics, Theory of elasticity |

Course outline

| Theme | Hours |
|--|-------|
| Introduction. Elastic problem for infinite plate with elliptic hole. | 1 |
| Strain energy release of a crack in the infinite plate. | 2 |
| The foundations of Griffith's theory. | 2 |
| Energy critical state on front of a crack. The stress state of elastic material near the crack front. | 2 |
| Stress intensity factor. Three modes of stress state near the crack front. | 2 |
| Methods defining stress intensity factor. Elastic compliance method. | 2 |
| Internal forces in small zone of crack surface near the end of the crack. Critical state at crack contour. | 2 |
| Critical stress intensity factor. Energetic kind of critical state at crack contour. | 1 |
| Fracture toughness. Basic problems of fracture mechanics. | 1 |
| Stability of the critical state at crack contour. | 1 |
| The case of a small scale yield. Length of plastic zone near crack contour. | 2 |
| Test for determination the critical stress intensity factor. | 1 |
| Energy J-integral. J-integral as a fracture criterion. | 2 |
| Crack opening displacement. Critical crack opening displacement. | 2 |
| General form of energy balance. 1-D model of dynamic crack propagation. | 1 |
| 2-D model of dynamic crack propagation and consequences. Crack branching. | 1 |
| Use of similarity and dimensioning theory. The tasks of dynamic cracks theory. Test results. | 2 |
| Paris law of fatigue crack propagation. | 2 |
| Effect of corrosion. Corrosion-fatigue crack. | 1 |
| Corrosion-fatigue crack. Corrosion critical stress intensity factor K_{sc} . Corrosion crack propagation at static load. | 2 |

Learning outcomes and assessment

| Learning outcomes | Assessment methods |
|--|---|
| To be able to use the Griffith's theory for strength estimation of a brittle plate with crack. | 1st test: . Stress, strain and strain energy determination near the crack front. |
| To be able to use theoretical and experimental methods for defining stress intensity factor. | Course paper: Remaining strength and lifetime determination for a panel with crack. Exam |
| To be able to estimate the strength and fatigue lifetime of a combined structure using fracture mechanics. | Course paper: Remaining strength and lifetime determination for a panel with crack. Exam |
| To be able to obtain the stress intensity factor by compliance method experimentally. | Laboratory work: stress intensity factor experimental determination. Exam |

Study subject structure

| Part | CP | ECTS | Hours per Week | | | Tests | | |
|------|-----|------|----------------|-----------|------|-------|------|------|
| | | | Lectures | Practical | Lab. | Test | Exam | Work |
| 1. | 2.0 | 3.0 | 1.0 | 0.5 | 0.5 | | * | |