

Structuring and preparation of a lesson: **EAS module 4 (Durability)**

| time | Theme, core information, statements or questions | Learning objectives ¹ | Methods (e.g. presentation/ discussion/group work) | Media/ training material |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| 0,5h | <p><u>4.1 Introduction - Durability</u></p> <p>Repeat of basic knowledge of:</p> <p>Adhesive Joints and different effects on joints (thermal, moisture, chemical, mechanical, combined, weathering, ageing effects).</p> <p>Durability Assessment for Adhesive Joints.</p> <p>Life Prediction for Adhesive Joints</p> | <p>Be able to interpret and describe the fundamental principles of durability of joints (1).</p> <p>Be able to describe the fundamental principles of different and combination of effects on joints (1).</p> <p>Be able to describe the fundamental for Assessment of Adhesive joints (1).</p> <p>Be able to describe the fundamental principle of Life Prediction of Adhesive joints (3).</p> | <p>Presentation of theory.</p> <p>Presentation of durability problems on a bonding process.</p> <p>Presentation of assessment techniques.</p> <p>Presentation of an overview of life prediction process with group discussion.</p> | <p>Slides presentation</p> <p>White board.</p> |
| 1h | <p><u>Thermal Effects on Adhesive Joints:</u></p> <p>Differential thermal expansion.</p> <p>Thermal transition in adhesives.</p> <p>Thermal degradation of adhesives.</p> <p>Thermal conductivity of adhesives.</p> | <p>Be able to describe thermal effects on adhesive joints (1).</p> <p>Be able to describe thermal expansion, thermal degradation and thermal conductivity (1).</p> <p>Be able to identify which</p> | <p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p> | <p>Slides presentation.</p> <p>Examples pictures and videos.</p> <p>White board.</p> |

¹ (1) Know and understand, (2) transfer and practically apply, (3) analyze and assess; (0) no learning objective; additional information

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| | Temperature limits of adhesives. | bonding process is suitable for thermal intensive environments (2). | Demonstration with discussion of practical use of theoretical knowledge. | |
| 1h | <p><u>Moisture Effects on Adhesive Joints</u></p> <p>Procedure and Migration of water in adhesive joints</p> <ul style="list-style-type: none"> - Water diffusion in adhesives - Critical water concentration <p>Strength degradation and failure mode</p> <p>Mechanism of strength loss</p> <ul style="list-style-type: none"> - Displacement of adhesive by water - Hydration of oxide layers <p>Improvement of Joint Durability</p> <ul style="list-style-type: none"> - Increasing barrier to water diffusion - Hydration inhibition or retardation - Application of primer | <p>Be able to describe moisture effects on adhesive joints (1).</p> <p>Be able to describe water diffusion, strength degradation and failure modes caused by moisture (1).</p> <p>Be able to identify improvements in Adhesive joints in connection with moisture effects (2).</p> | <p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p> <p>Demonstration of practical samples.</p> <p>Group work on suitable practical use of theory.</p> <p>Demonstration with discussion of practical use of theoretical knowledge.</p> | <p>Slides presentation.</p> <p>Examples pictures or videos.</p> <p>White board.</p> |

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| 1h | <p>Chemical Effects on Adhesive Joints</p> <p>Often encountered chemical agents. Chemical resistance of adhesives by chemical family Chemical resistance of common adherents</p> <p>Methods of bonded joint protection - Paints and coatings - Water displacing materials - Elastomeric sealants</p> <p>Chemical resistance test methods.</p> | <p>Be able to describe chemical effects on adhesive joints (1).</p> <p>Be able to identify features of most encountered chemical agents and their interaction with different adhesives (2).</p> <p>Be able to list bonded joints protection by paints, sealants and coatings (2).</p> | <p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p> <p>Demonstration of practical samples.</p> | <p>Slides presentation.</p> <p>Examples - pictures or videos.</p> <p>White board.</p> |
| 4,5h | <p>Mechanical Stress Effects on Adhesive Joints</p> <p>Creep (permanent loading) - definition.</p> <p>Specimens for creep and fatigue testing of adhesive joints.</p> | <p>Be able to explain deep knowledge Mechanical Stress Effects on Adhesive Joints (3).</p> <p>Be able to explain Mechanical Stress Effects on Adhesive Joints (1).</p> <p>Be able to identify</p> | <p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p> <p>Demonstration of</p> | <p>Slides presentation.</p> <p>Samples from practice.</p> <p>Examples - pictures and videos.</p> <p>White board.</p> |

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| | <p>Allowable stresses (or strains) in adhesives for creep and fatigue.</p> <p>Fracture mechanics.</p> <p>Working examples and applications.</p> | <p>permanent loading effect, dynamic loading effects (2).</p> <p>Be able to identify failure mechanisms with use of theoretical models (3).</p> <p>Be able to list models for life predictions of Adhesive Joints (2).</p> | <p>practical samples.</p> <p>Group work on suitable practical use of theory.</p> <p>Demonstration with discussion of practical use of theoretical knowledge.</p> | |
| 2h | <p><u>Combined Temperature - Moisture - Mechanical Stress Effects on Adhesive Joints</u></p> <p>Thermal effects</p> <p>Combined effects</p> <p>Evaluation parameters.</p> <p>Accelerated service life testing.</p> | <p>Be able to identify Combined Temperature - Moisture - Mechanical Stress Effects on Adhesive Joints (1).</p> <p>Be able to identify evaluation parameters for combined effects on Adhesive Joints (1).</p> <p>Be able to explain Accelerated service life testing (2).</p> | <p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p> <p>Demonstration of practical samples.</p> <p>Demonstration with discussion of practical use of theoretical knowledge.</p> | <p>Slides presentation.</p> <p>Samples from practice.</p> <p>Examples on pictures and videos.</p> <p>White board.</p> |

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| 1,5h | <p><u>Weathering and Ageing Effects on Adhesive Joints</u></p> <p>Definition of an environment. Short term testing. Long term testing. Comparison of short and long term testing. Environmental effects (moisture, water, chemicals) Combined effects</p> | <p>Be able to explain definition of environment from point of view of adhesive joints (2). Be able to name types of testing of Adhesive joints (1). Be able to list types of testing of Adhesive joints and their suitability for certain use (1).</p> | <p>Presentation of theory. Demonstration of practical samples. Demonstration with discussion of practical use of theoretical knowledge.</p> | <p>Slides presentation. Samples from practice. Examples on pictures and videos. White board.</p> |
| 1h | <p><u>Durability Assessment and Life Prediction for Adhesive Joints</u></p> <p>Durability test techniques - general. Adhesion dominated durability: wedge, test, wet peel test Corrosion dominated durability: salt spray test.</p> | <p>Be able to list Durability test techniques (1). Be able to explain Diffusion (3). Adhesion and Corrosion dominated durability tests (2).</p> | <p>Presentation of theory. Discussion about connection between theory and practice. Visit of laboratory and do some practical testing or video presentation of testing and group discussion.</p> | <p>Slides presentation. Laboratory demonstration. Examples pictures and videos. White board.</p> |

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