

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

time	Theme, core information, statements or questions	Learning objectives ¹	Methods (e.g. presentation/ discussion/group work)	Media/ training material
1h	<p><u>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 explain the fundamental principles of durability of joints (1).</p> <p>Be able to explain the fundamental principles of different and combination of effects on joints (1).</p> <p>Be able to explain the fundamental steps for Assessment of Adhesive joints (1).</p> <p>Be able to explain 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> <p>Examples videos.</p>
4h	<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 explain thermal effects on adhesive joints (1).</p> <p>Be able to explain thermal expansion, thermal degradation and thermal conductivity (3).</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>Samples from practice.</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

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

	Temperature limits of adhesives.	bonding process is suitable for thermal intensive environments (2).	Demonstration of practical samples. Group work on suitable practical use of theory. Demonstration with discussion of practical use of theoretical knowledge.	
4h	<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 explain moisture effects on adhesive joints (1).</p> <p>Be able to explain water diffusion, strength degradation and failure modes caused with moisture (2).</p> <p>Be able to identify improvements in Adhesive joints in connection by moisture effects(3).</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</p>	<p>Slides presentation.</p> <p>Samples from practice.</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

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

			practical use of theoretical knowledge.	
2h	<p><u>Electrochemical and Corrosion Effects on Adhesive Joints</u></p> <p>Exposure in electro chemically inert conditions Effect of high cathodic potentials Effect of impressed current Effect of dissimilar metals in contact Effect of mechanical strain Effect of corrosion and adhesive joint failure Theoretical models and failure mechanisms Increasing resistance to cathodic bond failure in adhesive joint applications.</p>	<p>Be able to explain electrochemical effects on adhesive joints (1).</p> <p>Be able to explain high cathodic potentials, impressed current, corrosion, contact voltage effects by dissimilar materials and mechanical strain effects (2).</p> <p>Be able to identify improvements in Adhesive joints to resist cathodic bond failures (3).</p> <p>Be able to explain theoretical models and failure analysis on practical cases (3).</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>Demonstration of environmental effects and discussion on how to prevent the effects</p>	<p>Slides presentation.</p> <p>Samples from practice.</p> <p>Examples - pictures and videos.</p> <p>White board.</p>
2h	<p><u>Chemical Effects on Adhesive Joints</u></p> <p>Often encountered chemical agents. Chemical resistance of adhesives by</p>	<p>Be able to explain chemical effects on adhesive joints (1).</p>	<p>Presentation of theory.</p> <p>Demonstration of</p>	<p>Slides presentation.</p> <p>Samples from practice.</p>

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

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

	<p>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 explain features of most encountered chemical agents and their interaction with different adhesives (3).</p> <p>Be able to identify bonded joints protection by paints, sealants and coatings (2).</p>	<p>practical samples.</p> <p>Demonstration with discussion of practical use of theoretical knowledge.</p>	<p>Examples - pictures or videos.</p> <p>White board.</p>
1h	<p><u>Radiation and Vacuum Effects on Adhesives in Bonded Joints</u></p> <p>Suitability to be used in vacuum and space environment.</p> <p>Methods of evaluation (simulated vacuum environment).</p> <p>Results of adhesive evaluation.</p>	<p>Be able to explain Radiation and Vacuum effects on adhesive joints (1).</p> <p>Be able to evaluate suitability of different joints for vacuum and space environment (3).</p> <p>Be able to identify methods of evaluation of adhesive joints for vacuum applications (3).</p>	<p>Presentation of theory.</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 - pictures or videos.</p> <p>White board.</p>
7h	<p>Mechanical Stress Effects on Adhesive Joints</p> <p>Creep (permanent loading) - definition.</p> <p>Fatigue (cyclic or dynamic loading) -</p>	<p>Be able to explain deep knowledge Mechanical Stress Effects on Adhesive Joints (3).</p> <p>Be able to explain permanent loading</p>	<p>Presentation of theory.</p> <p>Discussion about connection between theory and practice.</p>	<p>Slides presentation.</p> <p>Samples from practice.</p> <p>Examples - pictures and videos.</p>

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

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

	<p>definition.</p> <p>Specimens for creep and fatigue testing of adhesive joints.</p> <p>Allowable stresses (or strains) in adhesives for creep and fatigue.</p> <p>Optimized joint geometry for creep and fatigue resistance.</p> <p>Theoretical models and failure mechanisms for creep and fatigue.</p> <p>Models for life predictions.</p> <p>Fracture mechanics.</p> <p>Working examples and applications.</p>	<p>effect, dynamic loading effects (2).</p> <p>Be able to explain failure mechanisms with use of theoretical models (2).</p> <p>Be able to explain models for life predictions of Adhesive Joints (3).</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>White board.</p>
4h	<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 explain Combined Temperature - Moisture - Mechanical Stress Effects on Adhesive Joints (1).</p> <p>Be able to explain evaluation parameters for combined effects on Adhesive Joints (1).</p> <p>Be able to explain Accelerated service life</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</p>	<p>Slides presentation.</p> <p>Samples from practice.</p> <p>Examples on 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

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

		testing (2).	suitable practical use of theory. Demonstration with discussion of practical use of theoretical knowledge.	
2h	<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 (1). Be able to explain types of testing of Adhesive joints (2). Be able to compare types of testing of Adhesive joints and theirs suitability for certain use (2).</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>
1,5h	<p><u>Durability Assessment and Life Prediction for Adhesive Joints</u></p> <p>Durability test techniques - general. Diffusion dominated durability: spring loaded share specimens Adhesion dominated durability: wedge, test, wet peel test Corrosion dominated durability: salt spray</p>	<p>Be able to explain Durability test techniques (1). Be able to explain Diffusion, Adhesion and Corrosion dominated durability tests (2). Be able to identify which test is suitable for certain</p>	<p>Presentation of theory. Discussion about connection between theory and practice. Visit of laboratory and do some</p>	<p>Slides presentation. Laboratory demonstration. Examples pictures and videos. White board.</p>

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

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

	test.	practical needs (3).	practical testing or video presentation of testing and group discussion. Group discussion on suitable practical use of theory on testing.	
--	-------	----------------------	--	--

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