TALAT Lecture 4703

Adhesive Joints - Design and Calculation

9 pages, 10 figures
Basic Level

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Objectives:

− to describe the basic types of loadings of adhesive joints and to give examples of recommended joint designs
− to calculate the strength of adhesive joints

Prerequisites:

− general background in production engineering and material science
− background in mechanics and polymer science

Date of Issue: 1994
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4703 Design and Calculation of Adhesive Joints

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4703.01 Design Recommendations for Adhesive Joints

- Basic types of loadings of adhesive joint geometries
- Examples for joint designs:
  - Design of corner joints
  - Design of hollow section joints
  - Design of tube joints

Basic Types of Loadings of Adhesive Joint Geometries

Just as in the case of welding, the adhesive joint has to be specially optimised for adhesive joining in order to have a joint of optimal strength.

Of the possible loading types which an adhesive joint can be subjected to, it is most suited for shear, torsion and compressive loads.

Tensile and in particular cleavage or peeling forces should be avoided (Figure 4703.01.01).
Design types which avoid peeling stresses in adhesive joints of metals are illustrated in Figure 4703.01.02.

Besides the most widely used (one-sided) lap joints shown in Figure 4701.01.01, Figure 4703.01.03 illustrates further possible designs for constructing overlapping adhesive joints. Scarf joints are most suitable for tensile-shear loading since the load distribution is favourable. These joints can, however, be used only for large joint part thicknesses and are complicated to manufacture.
Examples for Joint Designs

Designs which have proved most successful for corner joints, closed-sectioned profile joints and tube joints are illustrated in Figure 4703.01.04, Figure 4703.01.05, and Figure 4703.01.06. While joining tubes of different coefficients of thermal expansion adhesively, the tube with the larger expansion should be designed to be on the outside.
4703.02 Calculation of Adhesive Joint Strength

Figure 4703.02.01 shows a rough method of calculating the strength of a single-sided lap joint based on a simplified form of the Volker equation according to Schliekelmann.

Calculation of Adhesive Joints

The Mean Tensile-Shear Stress at Failure of Adhesive $\tau_{m}$ is:

$$ \tau_{m} = K \cdot M \cdot f $$

where the Adhesive Factor is:

$$ K = \frac{\tau_{\text{max}}}{\sqrt{G}} $$

$\tau_{\text{max}}$ = max. Tensile-Shear Stress at Failure of Adhesive Joint

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d = Adhesive Layer Thickness

$G$ = Shear Modulus

and the Metal Factor is:

$$ M = \sqrt{E} $$

$E$ = Modulus of Elasticity of Joint Material

and the Design Factor is:

$$ f = \frac{\sqrt{s}}{l_{\text{u}}} $$

$s$ = Joint Thickness

$l_{\text{u}}$ = Overlap Length

This results in the Following Final Equation for the Mean Tensile-Shear Stress:

$$ \tau_{m} = \tau_{\text{max}} \cdot \frac{2Esd}{Gl_{\text{u}}^{2}} $$

Depending on the application, it is necessary to choose the appropriate safety factor as well as a number of design and load-dependent reducing factors.
4703.03 Application Examples

Typical application examples for adhesively joint metal constructions are layered or laminated, shell and sandwich constructions Figure 4703.03.01, Figure 4703.03.02, and Figure 4703.03.03. Sandwich constructions are only possible with adhesive joining.
Other applications where adhesive joints are being successfully used are, for example, shaft-hub joints, screw-locking, sealing, in combination with other joining methods i.e., spot welding, riveting or folding.

4703.04 Literature/ References


**4703.05 List of Figures**

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