Author's Accepted Manuscript

www.elsevier.com/locate/ijadhadh

Failure Behaviour of Silicone Adhesive in Bonded Connections with Simple Geometry

Yves Staudt, Christoph Odenbreit, Jens Schneider

PII: S0143-7496(17)30242-7
DOI: https://doi.org/10.1016/j.ijadhadh.2017.12.015
Reference: JAAD2103

To appear in: *International Journal of Adhesion and Adhesives*

Received date: 28 April 2017
Accepted date: 14 December 2017

Cite this article as: Yves Staudt, Christoph Odenbreit and Jens Schneider, Failure Behaviour of Silicone Adhesive in Bonded Connections with Simple Geometry, *International Journal of Adhesion and Adhesives,* https://doi.org/10.1016/j.ijadhadh.2017.12.015

Failure Behaviour of Silicone Adhesive in Bonded Connections with Simple Geometry

Yves Staudt[a], Christoph Odenbreit[a,*], Jens Schneider[b]

[a] University of Luxembourg, L-1359 Luxembourg, Luxembourg
[*] Corresponding author, e-mail address: christoph.odenbreit@uni.lu (Christoph Odenbreit)
[b] Technische Universität Darmstadt, D-64295 Darmstadt, Germany

Abstract

In façade structures, adhesively bonded connections between glass panels and metallic substructures represent an attractive alternative to mechanical fixation devices. Apart from positive aspects regarding the construction's energy efficiency and aesthetics, the uniform load transfer reduces stress concentrations in the adherends, which is beneficial especially regarding brittle materials like glass. Structural silicone sealants are generally used for these kind of applications due to their excellent adhesion on glass and their exceptional resistance against environmental influences and ageing. For the verification of the bonded connection, non-linear numerical simulations, such as the Finite Element Method, are increasingly used. The resulting three-dimensional stress states need to be assessed with the help of an appropriate failure criterion. In this paper, an overview is given on available failure criteria for rubber-like materials. The applicability of these criteria on the silicone sealant is verified regarding three characteristic stress states: uniaxial tension, shear and compression. The proposed engineering failure criterion is the true strain magnitude, which is valid for bonded connections in form of linear beads for cohesive failure of the adhesive. For Dow Corning® 993 structural silicone sealant, the strain magnitude, evaluated using true strains, at failure could be determined as 1.6.

Keywords: A. Silicones, C. Finite element stress analysis, D. Mechanical properties of adhesives, Failure criterion

1. Introduction

1.1. Structural Sealant Glazing Systems

In façade applications, the usage of glass has constantly increased over the last decades. Glass is chosen in an attempt to create on the one hand an architectural attractive façade and on the other hand a highly transparent building skin, allowing for the usage of natural illumination [1]. Regarding the brittle material behaviour of glass, the inevitably question of its connection to the mostly metallic substructure becomes crucial. Different techniques, such as mechanical and adhesive connections, can be envisaged [2].

In the field of mechanical connections, glass can either be linearly supported or point-wise by bolted connections. The use of linear connections reduces the transparency of the façade and creates to a certain extend thermal bridges, because parts of the mechanical connection are in contact with the external surface of the building skin [3]. Bolted connections however significantly weaken the glass pane as boreholes have to be drilled into the glass. The related manufacturing process can generate scratches and flaws, which reduce the strength of glass. Furthermore, high stresses are generated in the glass pane due to the small area of load transfer between the bolt and the borehole [2].