Schriftenreihe des Instituts für Werkstofftechnik Kassel

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Untersuchung der mechanischen Eigenschaften injektionsgefügter Rundsteckverbindungen

Shaker Verlag
Aachen 2006

Bibliografische Information der Deutschen Bibliothek
Die Deutsche Bibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.ddb.de abrufbar.

Zugl.: Karlsruhe, Univ., Diss., 2006

Die vorliegende Arbeit wurde vom Fachbereich Maschinenbau der Universität Kassel als Kasseler Dissertation zur Erlangung des akademischen Grades eines Doktors der Ingenieurwissenschaften (Dr.-Ing.) angenommen.

Erster Gutachter:	Prof. Dr.-Ing. M. Schlimmer
Zweiter Gutachter:	Prof. Dr.-Ing. O. Hahn
Tag der mündlichen Prüfung:	16.02.2006

ISBN-10: 3-8322-5412-9
ISBN-13: 978-3-8322-5412-4
ISSN 1613-3498

Shaker Verlag GmbH • Postfach 101818 • 52018 Aachen
Telefon: 02407 / 95 96 - 0 • Telefax: 02407 / 95 96 - 9
Internet: www.shaker.de • E-Mail: info@shaker.de

Abstract Dissertation Marc Siebert

Analysis of mechanical properties of adhesive bonded tubular plug-in joints

This paper deals with the analysis of mechanical properties of adhesive bonded tubular plug-in joints. Special procedures based on the method of adhesive injection have been developed and used for the production of such joints. In comparison with usual application techniques, these procedures are characterised by their fault tolerance, process stability, and extraordinary suitability for everyday use. Compared with joining techniques based on the adhesive bonding technology which have been used until now, the mechanical properties of adhesive joints produced with the method of adhesive injection could be improved significantly.

The material for the assembly components were metallic (steel, high-grade steel) materials and combinations of metallic and cellular metallic materials (aluminium, aluminium foam). For both groups of material, guidelines for the production of bonded tubular plug-in joints could be deduced from the detailed analysis of the flow processes of the adhesive during the injection operation and from the mechanical characterisation of adhesive joints.

The mechanical properties of the adhesive joints were identified in quasi-static and torsion tests. The adhesives were mainly two-component adhesive systems on an epoxy basis (2C-EP). To identify the characteristics of the adhesives used adhesive specimen were analysed. In addition to the specimen joined and stored at room temperature, some adhesive joints were exposed to different thermal and medial conditions and afterwards underwent quasi-static tensile and torsional tests.

In addition to taking into account the dominating loads of torsion and pull or pressure, for safety reasons it is important to account for the bending load, e.g. when using adhesive bonded tubular plug-in joints for hand and guard rails.
A specific mounting arrangement, which facilitates the bending stresses of specimen with varying diameters, was realised on a 4 axis servo-hydraulic testing machine to carry out bending tests with adhesive bonded tubular plug-in joints.

In the case of adhesive joints with a cellular metallic assembly partner the primary failure was always the failure of the cellular metallic material far below the capacity of the adhesive system used. With adhesive joints with metallic assembly partners the failure of the adhesive layer was always in the field of the load capability of the adhesive system used.

In conclusion, it may be stated that, with regard to the component safety, to the adhesive application, and to the efficiency of adhesive-bonded tubular plug-in joints, it was possible to make fundamental progress in comparison with those joining techniques based on adhesive bonding technology which have been used until now. Moreover, the developed method of adhesive injection is characterised by exceptional error tolerance and medial resistance.