

National Physical Laboratory

Performance of Adhesive Joints

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This document lists the technical reports, Good Practice Guides and Measurement Notes on issues relating to the design, manufacture, testing and validation of adhesive joints. The technical reports are listed under the projects from which they were produced. All these outputs are available on the NPL Performance of Adhesive Joints CD ROM.

PAJ1: Failure Criteria and Visco-Elastic/Visco-Plastic Adhesives

PAJ2: Dynamic Performance of Adhesively Bonded Joints

PAJ3: Adhesives, Combined Cyclic Loading and Hostile Environments

PAJex1: Rubber-Toughened Adhesives That Deform Through Cavitation.

PAJex2: Flexible Adhesives

Further information on the Performance of Adhesive Joints research can be found at our website:

<http://www.npl.co.uk/npl/cmmt/adhesives/index.html>

For further information on the Performance of Adhesive Joints programme or to order a copy of the Performance of Adhesive Joints CD please contact:

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Good Practice Guides

Dean G and Duncan B, **Preparation and testing of bulk specimens of adhesives**, NPL Good Practice Guide No 17, 1998.

Duncan B, Abbott S and Roberts R, **Adhesive tack**, NPL Good Practice Guide No 26, 1999

Broughton W, **Durability performance of adhesive joints**, NPL Good Practice Guide No 28, 1999.

Duncan B and Crocker L, **Characterisation of flexible adhesives for design**, NPL Good Practice Guide No 45, 2001.

Broughton W and Gower M, **Preparation and Testing of Adhesive Joints**, NPL Good Practice Guide No 47, 2001.

Dean G and Crocker L, **The Use of Finite Element Methods for Design with Adhesives**, NPL Good Practice Guide No 48, 2001.

Measurement Notes

Test methods for determining hyperelastic properties of flexible adhesives, CMMT(MN)054, 1999

Preparation of bulk adhesive test specimens, CMMT(MN)057, 1999

Loop Tack Measurements, MATC(MN)02, 2001

Tensile Testing of Adhesive Butt Joint Specimens, MATC(MN)09, 2001

Geometric and Material Property Effects on the Strength of Rubber-Toughened Adhesive Joints, MATC(MN)10, 2001

Size Effects on the Performance of Flexible Adhesive Joints, Measurement Note MATC(MN)11, 2001.

Project PAJ1: Failure Criteria of Adhesives

Report No.

1. Duncan B C and Olusanya A, *Review of rheological measurement methods for viscoelastic adhesives*, CMMT(B)129, January 1999.
2. Olusanya A, *A criterion of tensile failure for hyperelastic materials and its application to viscoelastic-viscoplastic materials*, CMMT(B)130, April 1997.
3. Charalambides M N and Olusanya A, *The constitutive models suitable for adhesives in some Finite Element codes and suggested methods of generating the appropriate materials data*, CMMT(B)131, April 1997.
4. Olusanya A, *Modifications to a constant stress rheometer to reduce the instrument compliance*, CMMT(B)155, October 1997.
5. Roberts R A, *Review of the methods for the measurement of tack*, September 1997.
6. Hu F and Olusanya A, *Measurement of creep and stress relaxation in rubber and rubber type materials*, CMMT(B)158, December 1997.
7. Hu F and Olusanya A, *Extensions to GLUEMAKER a Finite Element modeling tool for adhesive joints to include material models for flexible adhesives*, CMMT(A)137, August 1998.
8. Hu F, Olusanya A, Lay L A, Urquhart J M and Crocker L E, *A Finite Element model for the assessment of loop tack for pressure sensitive tapes and labels*, CMMT(B)129, August 1998.
9. Barraclough P, *Study of a range of variables on tack of heat activated adhesives*, February 1999.
10. Roberts R A, *Loop tack round robin*, February 1999.
11. Duncan B C and Lay L A, *An intercomparison of tack measurements*, CMMT(A)176, May 1999.
12. Maxwell A S and Duncan B C, *Evaluation of a multi-functional adhesives test station*, CMMT(A)177, April 1999.
13. Duncan B C and Maxwell A S, *Measurement methods for time-dependent properties of flexible adhesives*, CMMT(A)178, May 1999.
14. Crocker L E, Duncan B C, Hughes R G and Urquhart J M, *Hyperelastic modeling of flexible adhesives*, CMMT(A)183, May 1999.
15. Duncan B C, *Comparison between rheological and bulk specimen tests for creep and stress relaxation properties*, CMMT(A)184, May 1999.
16. Duncan B C and Ogilvie-Robb K, *Assessment of the correlation between tack and viscoelasticity*, CMMT(A)190, June 1999.
17. Duncan B C and Ogilvie-Robb K, *Creep of flexible adhesive joints*, CMMT(A)225, September 1999.
18. Duncan B C, Maxwell A S, Crocker L E and Hunt R A, *Verification of Hyperelastic test methods*, CMMT(A)226, October 1999.
19. Duncan B C, *PAJ1 Final Report*, CMMT(A)232, October 1999.

Project PAJ2: Dynamic Performance of Adhesively Bonded Joints

Report No.

1. Dean G D, Duncan B C and Simon H, *Adhesives- methods for preparing bulk specimens*, CMMT (B)90, August 1996.
2. Charalambides M N and Dean G D, *Constitutive models and their data requirements for use in Finite Element Analysis of adhesives under impact loading*, CMMT (A)59, April 1997.
3. Dean G D, *The thick- adherend shear test method*, CMMT(A)81 August 1997.
4. Dean G D, Duncan B C and Read B E, *Prediction of the performance of adhesives under impact loading*, CMMT(B)162 January 1998.
5. Dean G, Duncan B and Hu F *The application of finite element methods to the design of adhesive joints*, CMMT(A)102 March 1998.
6. Duncan B C, *Development of a high rate extensometer*, CMMT(A)109 May 1998.
7. Dean G D, Duncan B C and Read B E, *An evaluation of yield criteria for adhesives for finite element analysis*, CMMT(A)117 January 1999.
8. Duncan B C, *Methods for measuring strains at high rates*, CMMT(A)133 November 1998.
9. Duncan B C and Pearce A, *Comparison of impact and high rate tests for determining properties of adhesives and polymers needed for design under impact loading*, CMMT(A)134 January 1999.
10. Dean G D and Crocker L E, *A proposed failure criterion for tough adhesives*, CMMT(A)158 February 1999.
11. Dean G D, Read B E and Duncan B C, *Strain rate and temperature dependence of the properties of adhesives prediction of high- rate data*, CMMT(A)169 March 1999.
12. Dean G D, Lord G and Duncan B C, *Comparison of the measured and predicted performance of adhesive joints under impact*, CMMT(A)198, October 1999.

Project PAJ3: Combined Cyclic Loading and Hostile Environments

Report No.

1. Broughton W R and Mera R D, *Review of durability test methods and standards for assessing long term performance of adhesive joints*, CMMT(A)61, 1997.
2. Broughton W R and Mera R D, *Review of life prediction methodology and adhesive joint design and analysis software*, CMMT(A)62, 1997.
3. Hall M and Olusanya A, *A guide to the design of experiment methods*, CMMT(A)67, 1997.
4. Broughton W R, Mera R, Olusanya A and Tully K, *A comparison of commercial design of experiment software programmes for the analysis of durability data*, CMMT(A)98, 1998.
5. Olusanya A, *The use of experiment techniques to determine the relative effectiveness of silane coupling agents on the durability of titanium alloy joints*, CMMT(A)128, 1998.
6. Broughton W R, Hinopoulos G and Mera R D, *Environmental degradation of adhesive joints, single-lap joint geometry*, CMMT(A)196, 1999.
7. Broughton W R and Mera R D, *Environmental degradation of adhesive joints, accelerated testing*, CMMT(A)197, 1999.
8. Broughton W R, Hinopoulos G and Mera R D, *Cyclic fatigue testing of adhesive joints, test method assessment*, CMMT(A)191, 1999.
9. Broughton W R and Hinopoulos G, *An improved modelling approach of moisture absorption in adhesive joints using the Finite Element method*, CMMT(A)204, 1999.
10. Broughton W R and Hinopoulos G, *Evaluation of the T-joint using the Finite Element method*, CMMT(A)207, 1997.
11. Broughton W R and Gower M R L, *Fractographic analysis of adhesive joints*, CMMT(A)205, 1999.
12. Broughton W R and Mera R D, *Cyclic fatigue testing of adhesive joints, environmental factors*, CMMT(A)192, 1999.
13. Broughton W R, Mera R D and Hinopoulos G, *Cyclic fatigue testing of adhesive joints*, CMMT(A) 193, 1999.
14. Broughton W R, *Static fatigue testing of adhesive joints, analysis of creep rupture data*, CMMT(A)195, 1999.
15. Broughton W R and Hinopoulos G, *Evaluation of the single-lap joint using finite element analysis*, CMMT(A)206, 1999.
16. Twine T J and Hall M, *Statistical analysis of durability data*, CMMT(A)202, 1999.
17. Twine T J and Broughton W R, *The use of statistical methods for evaluating durability of adhesively bonded joints*, CMMT(A)203, 1999.
18. Broughton W R, *Test methods for assessing durability performance of adhesive joints*, CMMT(A)208, 1999.
19. Broughton W R, Project **PAJ3: Final Report**, CMMT(A)237, 1999.

Project PAJex1: Deformation by Cavitation

1. Read B, Dean G and Ferriss D, *An elastic-plastic model for the non-linear mechanical behaviour of rubber toughened adhesives*, CMMT(A)289, 2000.
2. Dean G and Crocker L, *Comparison of the Measured and Predicted Deformation of an Adhesively Bonded Lap-Joint Specimen*, CMMT(A)293, 2000.
3. Dean G and Crocker L, *Analysis of Joint Tests on an Epoxy Adhesive*, MATC(A)40, 2001
4. Broughton W R, Crocker L E and Urquhart J M, *Strength of Adhesive Joints: A Parametric Study*, NPL Report MATC(A)27, 2001.
5. Crocker L E and Dean G, *Temperature dependence of the properties of an epoxy adhesive*, NPL Report MATC(A)43, 2001.

Project PAJex2: Flexible Adhesives

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2. Duncan B, Crocker L and Urquhart J, *Evaluation of hyperelastic finite element models for flexible adhesive joints*, CMMT(A)285, 2000.
3. Duncan B and Crocker L, *Measurement methods for obtaining volumetric coefficients for hyperelastic modeling of flexible adhesives*, CMMT(A)286, 2001
4. Duncan B, *Hyperelastic properties of a polyurethane adhesive*, MATC(A)23, 2001
5. Duncan B, Crocker L, Urquhart J, Arranz E, Mera R and Broughton W, *Failure of flexible adhesive joints*, Report MATC(A)36, 2001
6. Duncan B, *Effects of moisture on the mechanical properties of M70 Adhesive*, MATC(B)29, 2001