DATABASE OF MECHANICAL PROPERTIES

To access the files of mechanical properties supplied please open the directory **\FE material data** on the CD-ROM.

Disclaimer: These data are provided solely as typical examples of the mechanical properties of the types of adhesives studied within the PAJ programme and to enable users to repeat some of the analyses referred to in the reports. **NPL makes no warranty as to the accuracy of the information provided and takes no responsibility or liability for any subsequent use of the data. It is strongly recommended that material properties be determined from production batches of materials and designs validated experimentally as batch-to-batch and process variations may significantly affect final material properties.**

Background:

This database of mechanical properties has been generated in the Performance of Adhesive Joints programme. It is recognised that the properties of polymeric adhesives will be sensitive to strain rate and temperature. Therefore, material properties determined from bulk test specimens at different temperatures and different rates of strain are included. Tests under different states of stress were performed at comparable strain rates. Adhesives are defined as being either flexible or structural depending on whether their glass transition temperature is above room temperature or at/below room temperature. Flexible adhesives have low glass transition temperatures, low elastic modulus but high extensions to failure. Structural adhesives have high glass transition temperatures, high elastic modulus but low extensions to failure.

Contents

Flexible Adhesives:

Data are provided as either elastic constants (with plastic hardening curves if applicable), HYPERELASTIC coefficients or test data from HYPERELASTIC tests (from which HYPERELASTIC coefficients can be calculated). All files containing test data for flexible adhesives are in comma separated variable (CSV) format and can be opened into either word processing or spreadsheet applications. Files consist of two columns. The first column in the file is stress (in MPa). The second column in the file is strain. This is the format for ABAQUS input files.

Evode Elastomer M70: 1-part, hot cured elastomer adhesive (polybutadiene). Further details on the stress and strain dependence of the mechanical properties of the adhesive M70 are given in the report CMMT(A)262.
3M Scotchweld DP609: 2-part, room temperature curing polyurethane adhesive (also known as 3M Scotchweld B/A 3532). Further details on the mechanical properties of this adhesive are described in report MATC(A)23.

data file names (flexible adhesives)

The data file names are constructed as 4 or 5 segments separated by underscores (_).

The first segment gives the adhesive name (e.g. M70).
The second segment gives the test method used to obtain the data (U = uniaxial tension, P = planar tension, B = biaxial tension, S = shear).
The third segment gives the test temperature (in degrees C).
The fourth segment gives the strain rate (in strain per second with the '
format 3E2 = 0.03 s^{-1}, 3E4 = 0.0003 s^{-1}, etc.).
The optional fifth segment gives additional information (EP = plastic stress-strain data for an ELASTIC-PLASTIC analysis)

Structural Adhesives:

The data are provided as elastic constants and ELASTIC-PLASTIC hardening curves.

Ciba AV119: 1-part, hot curing epoxy adhesive, sold as Araldite 2007.
Ciba LMD1142: 1-part, hot curing toughened epoxy adhesive.
Essex Betamate XD4601: 1-part, hot curing toughened epoxy adhesive. Further details on the mechanical properties of this adhesive are described in the Good Practice Guide NPL MGPG No. 48.
ITW Plexus MA310: 2-part, room temperature curing acrylic adhesive

Typical data for adherend materials, mild steel, aluminium and titanium, are also provided

Structural adhesives have high glass transition temperatures, flexible adhesives low glass transition temperatures. Below the glass stransition temperature the adhesive will be an ELASTIC or ELASTIC PLASTIC material. Adhesives have high modulus but strains to failure are generally low. Above the glass transition, strains to failure are large suggesting that HYPERELASTIC models may be appropriate.

DATA FILES

The ELASTIC properties are used when performing stress analyses using ELASTIC or ELASTIC-PLASTIC material models.

The PLASTIC properties are used when performing stress analyses using ELASTIC-PLASTIC material models. Additional parameters are given for the use of Drucker-Prager plasticity models with some of the adhesives. See Good Practice Guide NPL MGPG No. 48 for further information.

The HYPERELASTIC properties are used when performing stress analyses using HYPERELASTIC material models. HYPERELASTIC models are suitable for materials that experience large strains (e.g. rubbers). HYPERELASTIC model coefficients are fitted using the stress-strain data provided. It is possible to obtain coefficients through supplying only one set of stress-strain data. However, the normal recommendation is that data are supplied under different states of stress. Here data are presented under uniaxial tension, plane strain (planar) tension and equi-biaxial (biaxial) tension. Additionally test data from a volumetric test are required. See Good Practice Guide NPL MGPG No. 45 for further information.

HYPERELASTIC TEST METHODS USED

Test machines: 4500 series Instrons
Extensometry:
video extensometery (uniaxial, planar and biaxial tension)
clip-on extensometers (lap shear)

Uniaxial Tension:
Temperatures -40, 0, 20, 40 and 80 degrees C
Test Speeds: 1, 10, 100 and 250 mm/min

- corresponding to strain rates 3x10E-4, 3x10E-3, 3x10E-2 and 8x10E-2 strain per second respectively.

Planar Tension:
Temperatures -40, 0, 20, 40 and 80 degrees C
Test Speeds: selected to give strain rates 3x10E-4, 3x10E-3, 3x10E-2 and 8x10E-2 strain per second.

Biaxial Tension
Temperatures -40, 0, 20, 40 and 80 degrees C
Test Speeds: selected to give strain rates 3x10E-4, 3x10E-3, 3x10E-2 and 8x10E-2 strain per second.

Shear (lap shear joint)
Temperatures -40, 0, 20, 40 and 80 degrees C
Test Speeds: selected to give strain rates 3x10E-4, 3x10E-3, 3x10E-2 and 8x10E-2 strain per second.
For specimen dimensions see CMMT(A)262

For further information on test methods see reports CMMT(A)183, CMMT(A)226 and CMMT(A)262 written in the PAJ/PAJX programmes.