IDAC Materials Database Key and Guide

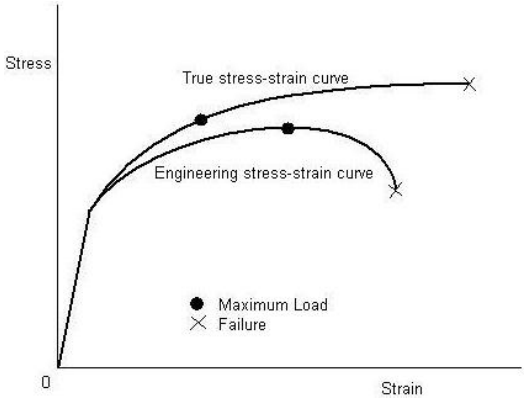
Introduction

This document is designed to assist users in the use of the IDAC Materials Database release 2.0. This document describes how the material properties are specified and details a 'key' that helps the user identify which material properties are included in a given material library entry. Please keep an eye out for product and documentation updates on our website.

Multilinear Isotropic Hardening (ML)

Multilinear isotropic hardening data is in the form of a graph of Stress vs. Plastic Strain, starting from the yield stress. From this, the stress-strain behaviour of the material after its yield point can be found.

The data is input as true stress vs. logarithmic true plastic strain, to account for changes in cross-sectional area of the component during. This is different to the traditional engineering stress vs. engineering strain that is commonly found.



This material model is often used in large strain analyses. Do not use this model for cyclic or highly non-proportional load histories in small-strain analyses.

All the data is taken from test specimens under longitudinal, tensile stresses only, except for ceramics, where compressive tests were performed. The actual stress-strain behaviour of a component may vary from this data due to different geometries of material and the particular treatment of the material. The data becomes less accurate after the point of necking, due to the inconsistent behaviour of most metals under necking, and so analyses of very large strains past this point may be less genuine.

Uniaxial Test (UT)

Uniaxial test data is in the form of a graph of Stress vs. Strain. From this, the stress-strain behaviour of elastomers, undergoing hyperelasticity, can be found.

Hyperelasticity can be used to analyze elastomers that undergo large strains and displacements, with small volume changes (nearly incompressible materials). This data can be used as data input to a material curve fit, to calculate hyperelasticity coefficients.

Temperature-dependent Young's Modulus (YM)

Temperature-dependent Young's Modulus data is in the form of Young's Modulus vs. Temperature. From this, the behaviour of the Young's Modulus with varying temperature can be found.

Temperature-dependent Poisson's Ratio (PR)

Temperature-dependent Poisson's Ratio data is in the form of Poisson's Ratio vs. Temperature. From this, the behaviour of the Poisson's Ratio with varying temperature can be found.

Temperature-dependent Thermal Expansion (TE)

Temperature-dependent Thermal Expansion data is in the form of Thermal Expansion vs. Temperature. From this, the behaviour of the thermal expansion coefficient with varying temperature can be found.

Temperature-dependent Thermal Conductivity (TC)

Temperature-dependent thermal conductivity data is in the form of Thermal Conductivity vs. Temperature. From this, the behaviour of the thermal conductivity with varying temperature can be found.

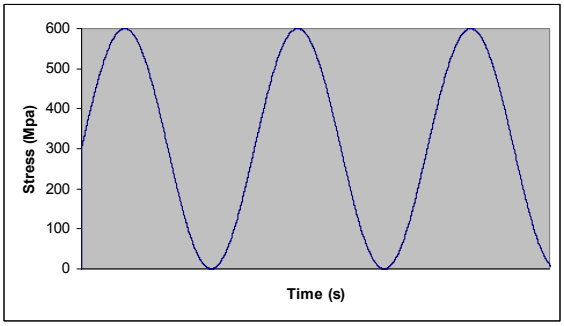
Alternating Stress (AS)

Alternating stress data is in the form of a graph of Cyclic Stress vs. Cycles to Failure (an SN curve). From this, the fatigue life of the material can be found, i.e. the number of cycles which the material can undergo before it will fail due to fatigue.

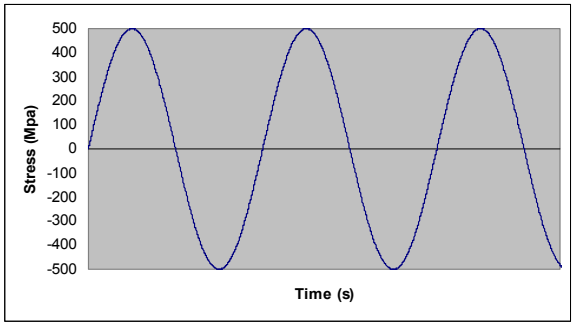
Some materials have more than one curve, which corresponds to different r-ratios. The r-ratio is defined as the ratio of the second loading to the first: $r = L_2 / L_1$. Typical experimental r-ratios are -1 (fully reversed), 0 (zero-based), and 0.1 (to ensure that a tensile stress always exists in the part).

For example:

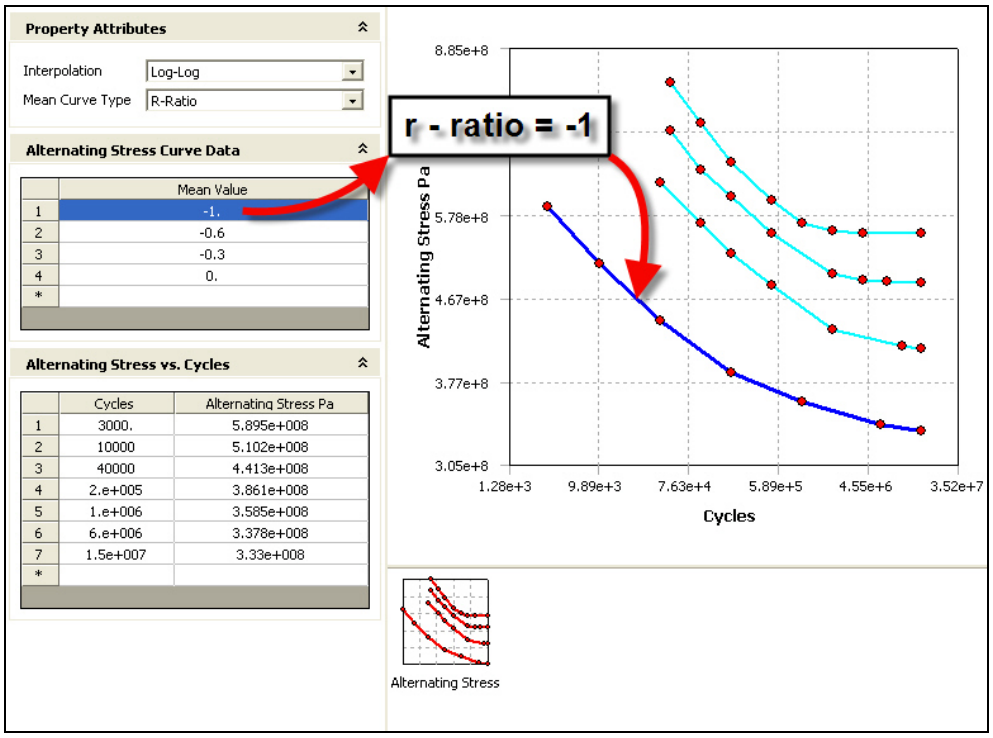
Cyclic Stress = 600 MPa, r = 0



Cyclic Stress = 500 MPa, r = -1



The relevant r-ratio must be chosen, depending on the particular load case in the analysis.



All the data is taken from test specimens under longitudinal stresses only. The actual fatigue life of a component may vary from this data due to different geometries of material, the particular treatment of the material, and the statistical nature of fatigue life analysis.

Materials Database Description Key:

Material Class – Sub-Category – Material Specification (treatment) @temperature – Data Type

For example:

Nickel – Inconel Alloys – Inconel 706 (solution-treated & aged) @200deg – ML,YM

- This indicates that the material :
  - has a base constituent of nickel
  - is an Inconel Alloy
  - is Inconel 706, specifically
  - has been solution-treated and aged
  - is at 200 degrees Celcius
  - contains Multilinear Isotropic Hardening and Temperature-dependent Young's Modulus data

- The data types are abbreviated as follows:
  - **AS** = **A**lternating **S**tress (fatigue)
  - **ML** = **M**ulti**l**inear Isotropic Hardening (stress-strain)
  - **PR** = Temperature-dependent **P**oison's **R**atio
  - **TC** = Temperature-dependent **T**hermal **C**onductivity
  - **TE** = Temperature-dependent **T**hermal **E**xpansion
  - **UT** = **U**niaxial **T**est (stress-strain for hyperelastic behaviour)
  - **YM** = Temperature-dependent **Y**oung's **M**odulus

- The Material Classes are as follows:
  - Aluminium
  - Beryllium
  - Ceramics
  - Cobalt
  - Copper
  - Iron
  - Magnesium
  - Nickel
  - Polymers
  - Steels
  - Titanium
  - Zirconium

- Please note:
  - Materials which have no temperature reference in their classification are at room temperature (22 degrees Celcius).
  - Steels with no treatment reference have had standard quenching and tempering treatment.
  - Steels of the same specification, but with different levels of heat treatment, are classified by their tensile strength (**TS**). For example:

    Steels – Low Alloy – 4340 TS1090 – AS,YM and **Steels – Low Alloy – 4340 TS1450 – AS,YM**

    indicates that these steels have been heat treated to a different degree, resulting in Tensile Strengths of 1090 MPa and 1450 MPa respectively.

Full Material List

Aluminium - 1000 Series - 1060-H18 - ML
Aluminium - 1000 Series - 1060-O - ML
Aluminium - 1000 Series - 1100-H18 - ML
Aluminium - 1000 Series - 1100-O - ML
Aluminium - 2000 Series - 2014-T6 - AS,ML,YM
Aluminium - 2000 Series - 2017-T4 - YM
Aluminium - 2000 Series - 2024-T3 - AS,ML,YM
Aluminium - 2000 Series - 2024-T4 - AS,ML,YM
Aluminium - 2000 Series - 2024-T851 - ML,YM
Aluminium - 2000 Series - 2219-T62 - ML
Aluminium - 2000 Series - 2219-T87 - ML
Aluminium - 2000 Series - 2618-T61 - ML
Aluminium - 5000 Series - 5052-O - YM
Aluminium - 5000 Series - 5083-O - ML
Aluminium - 5000 Series - 5086-O - ML
Aluminium - 5000 Series - 5086-H34 - ML
Aluminium - 6000 Series - 6060 - AS
Aluminium - 6000 Series - 6061-T6 - AS,ML,YM
Aluminium - 6000 Series - 6063 - AS
Aluminium - 6000 Series - 6082 - AS
Aluminium - 7000 Series - 7049-T73 - AS
Aluminium - 7000 Series - 7050-T74 - AS
Aluminium - 7000 Series - 7075 - AS
Aluminium - 7000 Series - 7075-T6 - AS,ML,YM
Aluminium - 7000 Series - 7075-T73 - AS
Aluminium - 7000 Series - 7150-T77511 - AS
Aluminium - 7000 Series - 7475 - AS
Aluminium - 7000 Series - 7475-T61 - AS,ML
Aluminium - 300.0 Series - A356.0-T6P - ML
Beryllium - Pure - Beryllium (hot-pressed) - YM
Ceramics - Porous - Concrete - ML
Cobalt - Cobalt-Base Alloys - HS 188 (solution treated) - PR
Copper - Copper Alloys - C51100 (Hard Temper) - ML
Copper - Brass - 70/30 Brass (annealed) - ML
Copper - Brass - 70/30 Brass (drawn) - ML
Copper - Brass - C26000 (Extra Hard Temper) - ML
Copper - Brass - C87500 - AS
Copper - Bronzes - C52100 (10M Temper) - ML
Copper - Bronzes - C92200 - AS
Copper - Bronzes - C93700 - AS
Copper - Pure - Copper (annealed) - ML
Iron - Cr:Ni Alloys - A-286 (solution-treated & aged) - PR,YM
Iron - Cr:Ni Alloys - A-286 (solution-treated & aged) @430deg - AS,PR,YM
Iron - Cr:Ni Alloys - A-286 (solution-treated & aged) @540deg - AS,PR,YM
Iron - Cr:Ni Alloys - A-286 (solution-treated & aged) @680deg - AS,PR,YM
Iron - Cr:Ni Alloys - N-155 (solution-treated) - PR,YM
Iron - Gray Iron - Gray Iron (cast) - AS,YM
Magnesium - Wrought Alloys - AZ31B-F - AS,ML
Magnesium - Wrought Alloys - AZ31B-H24 - YM
Magnesium - Wrought Alloys - AZ31B-O - YM
Magnesium - Wrought Alloys - ZK60A-T5 - AS
Magnesium - Cast Alloys - AZ91C/E-T6 - YM
Magnesium - Cast Alloys - AZ92A-T6 - YM
Magnesium - Cast Alloys - QE22A-T6 - YM
Magnesium - Cast Alloys - ZE41A-T5 - YM
Nickel - Inconel Alloys - Inconel 600 (annealed) - YM
Nickel - Inconel Alloys - Inconel 625 (annealed) - AS,PR,YM
Nickel - Inconel Alloys - Inconel 706 (solution-treated & aged) - ML,YM
Nickel - Inconel Alloys - Inconel 718 (solution-treated & aged) - AS,PR,YM
Nickel - Inconel Alloys - Inconel X-750 (annealed & aged) - YM
Nickel - Rene Alloys - Rene 41 (solution-treated & aged) - YM
Nickel - Waspaloy Alloys - Waspaloy (solution,stabilization & precipitation heat treated) - YM
Nickel - Haynes Alloys - Haynes 230 (annealed) - ML,YM
Nickel - Haynes Alloys - Haynes 230 (annealed) @95deg - ML,YM
Nickel - Haynes Alloys - Haynes 230 (annealed) @430deg - ML,YM
Nickel - Haynes Alloys - Haynes 230 (annealed) @650deg - ML,YM
Nickel - Haynes Alloys - Haynes 230 (annealed) @980deg - ML,YM
Nickel - Haynes Alloys - Haynes HR-120 (annealed) - YM
Polymers - Elastomers - Natural Rubber 75 Shore A - UT
Polymers - Elastomers - Neoprene 65 Shore A - UT
Polymers - Elastomers - Polyurethane 80 Shore A - UT
Polymers - Elastomers - Polyurethane 95 Shore A - UT
Polymers - Thermoplastics - Cycoloy PC/ABS - AS,ML
Polymers - Thermoplastics - Cycoloy PC/ABS @-20deg - ML
Polymers - Thermoplastics - Cycoloy PC/ABS @80deg - ML

Polymers - Thermoplastics - Geloy ASA - ML
Polymers - Thermoplastics - Lexan PC - AS,ML
Polymers - Thermoplastics - Lexan PC @-30deg - ML
Polymers - Thermoplastics - Lexan PC @90deg - ML
Polymers - Thermoplastics - Noryl PPE - AS,ML
Polymers - Thermoplastics - Noryl PPE @-20deg - ML
Polymers - Thermoplastics - Noryl PPE @90deg - ML
Polymers - Thermoplastics - Ultem PEI - AS,ML
Steels - Low Alloy - 1038 - ML,YM
Steels - Low Alloy - 1040 (cast) - AS,YM
Steels - Low Alloy - 1040 (wrought) - AS,YM
Steels - Low Alloy - 4130 (normalised) - AS,TC,YM
Steels - Low Alloy - 4130 TS1240 - AS,YM
Steels - Low Alloy - 4135 (cast) - AS,YM
Steels - Low Alloy - 4140 (wrought) - AS,YM
Steels - Low Alloy - 4340 (normalised) - TC,YM
Steels - Low Alloy - 4340 TS860 - AS,YM
Steels - Low Alloy - 4340 TS1090 - AS,YM
Steels - Low Alloy - 4340 TS1090 @315deg - AS,YM
Steels - Low Alloy - 4340 TS1090 @425deg - AS,YM
Steels - Low Alloy - 4340 TS1090 @535deg - AS,YM
Steels - Low Alloy - 4340 TS1450 - AS,YM
Steels - Low Alloy - 4340 TS1850 - AS,YM
Steels - Low Alloy - 8630 (normalised) - ML,YM
Steels - Low Alloy - 8630 (cast) - AS,YM
Steels - Low Alloy - 8630 TS860 - ML,YM
Steels - Low Alloy - 8630 TS860 @260deg - ML,YM
Steels - Low Alloy - 8630 TS860 @450deg - ML,YM
Steels - Low Alloy - 8630 TS860 @540deg - ML,YM
Steels - Low Alloy - 8630 TS1030 - ML,YM
Steels - Low Alloy - 8630 TS1270 - ML,YM
Steels - Low Alloy - 8630 TS1380 - ML,YM
Steels - Low Alloy - 8640 (wrought) - AS,YM
Steels - Low Alloy - 300M - AS,YM
Steels - Intermediate Alloy - 5Cr-Mo-V - TC
Steels - Intermediate Alloy - 9Ni-4Co-0.20C - TE,YM
Steels - Intermediate Alloy - 9Ni-4Co-0.30C - ML,TE,YM
Steels - Intermediate Alloy - 9Ni-4Co-0.30C @-80deg - ML
Steels - Intermediate Alloy - 9Ni-4Co-0.30C @150deg - ML
Steels - Intermediate Alloy - 9Ni-4Co-0.30C @260deg - ML
Steels - High Alloy - 250 maraging - TC,TE,YM
Steels - High Alloy - 280 maraging - TC,TE,ML,YM
Steels - High Alloy - AerMet 100 - ML
Steels - Stainless - 301 (half hard) - YM
Steels - Stainless - 301 (full hard) - YM
Steels - Stainless - 15-5PH (H1025) - AS,YM
Steels - Stainless - 17-4PH (H900) - AS,YM
Steels - Stainless - 17-7PH (TH 1050) - PR,YM
Steels - Stainless - AM-350 (SCT 850) - TC,TE,YM
Steels - Stainless - AM-355 (SCT 850) - TC,TE,YM
Steels - Stainless - Custom 455 (H950) - AS,TC
Steels - Stainless - Custom 465 (H950) - ML
Steels - Stainless - Custom 465 (H1000) - ML
Steels - Stainless - PH13-8Mo (H1000) - AS,ML
Steels - Stainless - PH15-7Mo (TH1050) - AS,YM
Steels - Stainless - PH15-7Mo (TH1050) @260deg - AS
Titanium - Alpha Alloys - Ti-5Al-2.5Sn (annealed) - YM
Titanium - Alpha Alloys - Ti-6Al-2Sn-4Zr-2Mo (duplex annealed) - ML,YM
Titanium - Alpha Alloys - Ti-6Al-2Sn-4Zr-2Mo (duplex annealed) @315deg - ML,YM
Titanium - Alpha Alloys - Ti-6Al-2Sn-4Zr-2Mo (duplex annealed) @480deg - ML,YM
Titanium - Alpha Alloys - Ti-8Al-1Mo-1V (duplex annealed) - AS,YM
Titanium - Alpha Alloys - Ti-8Al-1Mo-1V (duplex annealed) @200deg - AS,YM
Titanium - Alpha Alloys - Ti-8Al-1Mo-1V (duplex annealed) @340deg - AS,YM
Titanium - Alpha-Beta Alloys - Ti-6Al-4V (annealed) - AS,ML,YM
Titanium - Alpha-Beta Alloys - Ti-6Al-4V (solution-treated & aged) - AS,ML,YM
Titanium - Alpha-Beta Alloys - Ti-6Al-4V (solution-treated & aged) @200deg - AS,ML,YM
Titanium - Alpha-Beta Alloys - Ti-6Al-4V (solution-treated & aged) @480deg - AS,ML,YM
Titanium - Alpha-Beta Alloys - Ti-6Al-6V-2Sn (annealed) - AS,ML
Titanium - Alpha-Beta Alloys - Ti-4.5Al-3V-2Fe-2Mo (annealed) - AS,ML
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (annealed) - AS,YM
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (annealed) @315deg - AS,YM
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (annealed) @430deg - AS,YM
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (solution-treated & aged) - AS,YM
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (solution-treated & aged) @315deg - AS,YM
Titanium - Beta Alloys - Ti-13V-11Cr-3Al (solution-treated & aged) @430deg - AS,YM
Zirconium - Zirconium Alloys - 702 - AS
Zirconium - Zirconium Alloys - 702 @400deg - AS