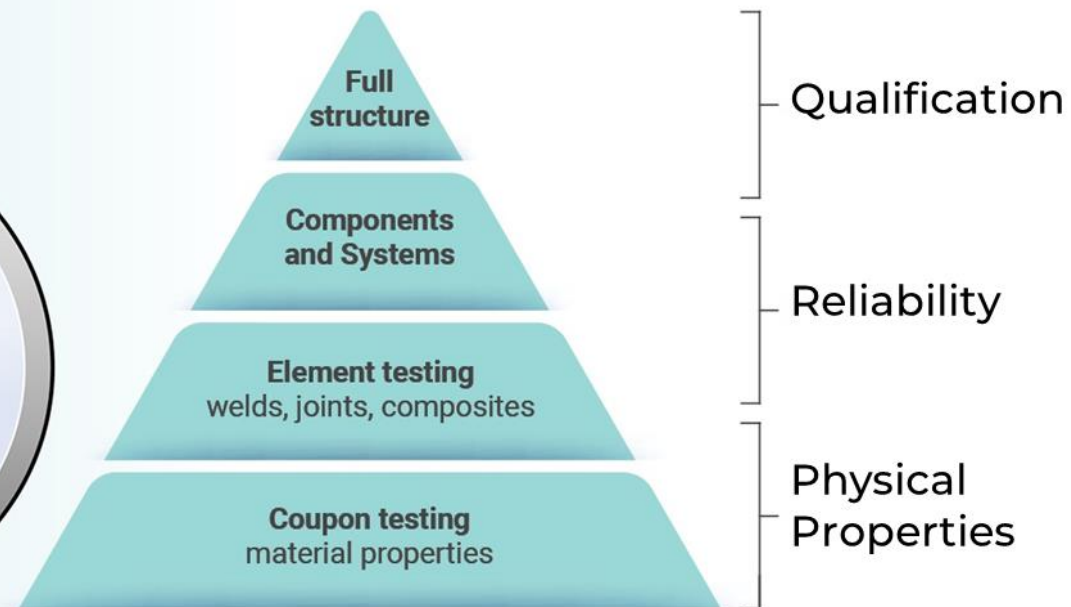
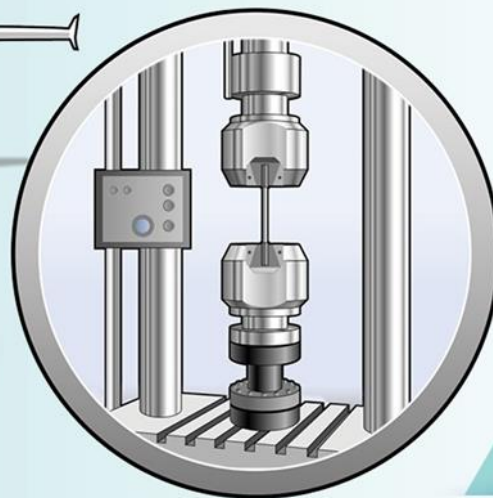
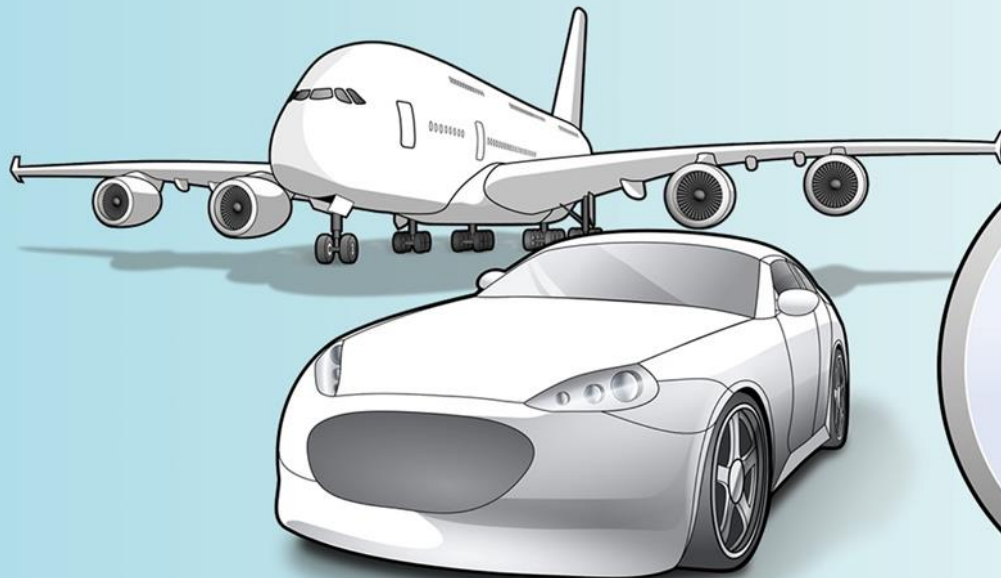




2023 HBK Technology Days

14 November 2023

Materials Surface Finish Data

▲ 300M Steel

- Cadmium Plated
- Chrome Plated
- Chrome Type 2
- Electroless Nickel
- Electrolytic Nickel Plating
- Polished
- Polished, Shot Peened
- Shot Peen and Cadmium Plated
- Shot Peen and Chrome Plated
- Shot Peen and Chrome-Strip-Chrome
- Shot Peen and Chrome Type2
- Shot Peen and Chrome Type2 - HalfLife/Strip/ReChrome
- Shot Peen and Electroless Nickel
- Shot Peen and Electrolytic Nickel

▲ 4340 Steel

- Chrome plated
- Polished
- Shot Peen and Chrome Plated
- Shot Peen and Chrome strip Chrome

▲ 7075-T7351 Aluminium Alloy

- Anodised
- Polished
- Shot Peen and Anodised
- Shot Peen and Anodise-Strip-Anodise

- Material surface treatment fatigue database

Paul Roberts,
Product Manager – nCode DesignLife, HBK

Material surface treatment fatigue database

Abstract

- The nCode Premium Material Database (PMD) contains fatigue properties measured on materials tested at the ISO-9001 certified Advanced Materials Characterisation and Test Facility owned and operated by HBK nCode. This collection of fatigue properties contains over 150 materials, mostly commonly used types of steel and aluminium, plus some other non-ferrous materials, and includes recent additions for additively manufactured titanium and Inconel material.
- From nCode 2024, the PMD will include fatigue properties for baseline materials and surface treatments resulting from work to characterise fatigue performance of aging aircraft landing gear through overhaul and maintenance cycles. The baseline materials are 300M steel, 4340 steel and 7075 aluminium, with a range of surface treatments including; electrolytic nickel, electroless nickel, cadmium and chrome coatings, and many of these with and without shot peen.

About the presenter, Paul Roberts, Product Manager – nCode DesignLife, HBK

- Paul Roberts has been involved with fatigue and durability analysis for the over 40 years. He has been with HBK (formally nCode) for a total of 17 years as an application engineer and product manager for the DesignLife product. Prior to joining nCode, Paul held positions in product development, testing, RLD analysis and FE based engineering consultancy at GKN Technology and Ricardo. Paul graduated with a degree in mechanical engineering from Aston University in Birmingham, UK.

Material Surface Treatment Fatigue Database

Paul Roberts
DesignLife Product Manager



Agenda

1. Introduction to the nCode Material Databases
2. The Premium Materials Database (PMD)
3. Material Surface Treatment Materials Data
4. Summary
5. Questions

Introduction to the nCode Material Databases

nCode Material Databases

Multiple databases available

- nCode Premium
- nCode standard database (iceflow_standard.mxd)
- FKM
 - 5th, 6th and 7th editions
- Mil Handbook 5
- ICG demo materials

nCode Material Databases – Standard database

Standard nCode materials types

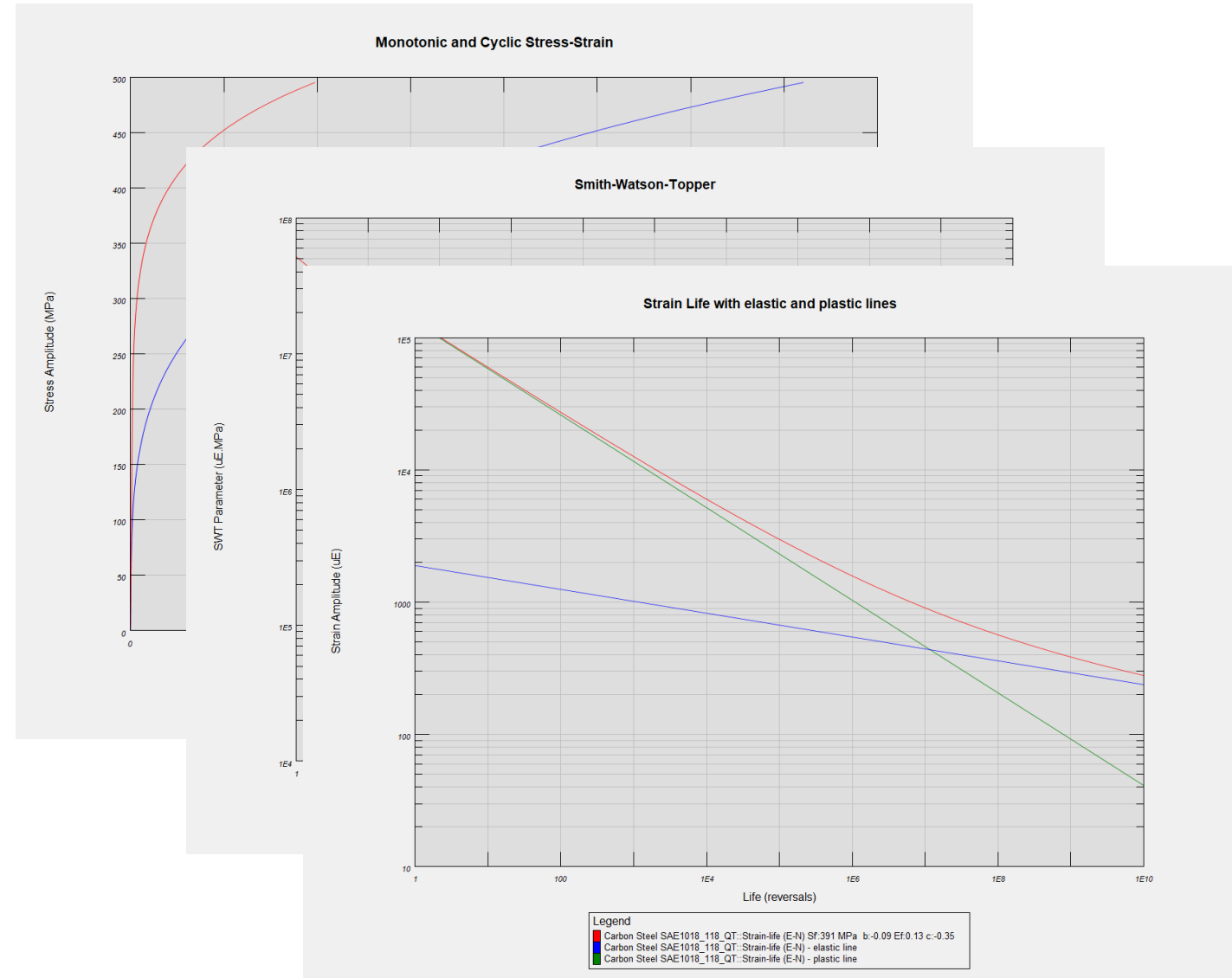
- EN (Stain-Life) >200
- SN (Stress-Life) > 400
- Dang Van > 180
- Seam Weld – 15
- Spot Weld – 12
 - Includes SPR
- Crack growth
- High temperature
 - EN
 - SN
 - Chaboche
 - Larson-Miller

Properties		Graph
	Carbon Steel SAE1018_118_QT::Strain-life (E-N)	Description
MaterialType	13	Material Type
YS	290	Yield Strength (MPa)
UTS	496	Ultimate Tensile Strength (MPa)
E	2.07E5	Elastic Modulus (MPa)
n_monotonic	0.13	Monotonic Work Hardening Exponent
K_monotonic	671	Monotonic Work Hardening Coefficient (MPa)
me		Elastic Poisson's Ratio
mp		Plastic Poisson's Ratio
Sf	391	Fatigue Strength Coefficient (MPa)
b	-0.09	Fatigue Strength Exponent
c	-0.35	Fatigue Ductility Exponent
Ef	0.13	Fatigue Ductility Coefficient
n'	0.25	Cyclic Strain Hardening Exponent
n'90		Out of phase Cyclic Strain Hardening Exponent
K'	640	Cyclic Strength Coefficient (MPa)
K'90		Out of phase Cyclic Strength Coefficient (MPa)
Nc	2E8	Cut-off (Reversals)
SEe	0	Standard Error of Log(e) (Elastic)
SEp	0	Standard Error of Log(e) (Plastic)
SEc	0	Standard Error of Log(e) (Cyclic)
Ne		Endurance Limit (Reversals)
FSN	0.6	Fatemi-Socie parameter
S	1	Wang Brown parameter
SB	0	Wang Brown parameter B
GammaP		Walker Mean stress parameter for +ve mean
GammaN		Walker Mean stress parameter for -ve mean
Comments	Data from "Crack Initiation Fatigue; Data Analysis, Trends and Estimation."	
References	SAE Paper # 820682. Bruce E. Boardman. Deere & Co. Tech. Ctr. Moline, IL.	

nCode Material Databases – Standard database

Example EN materials data

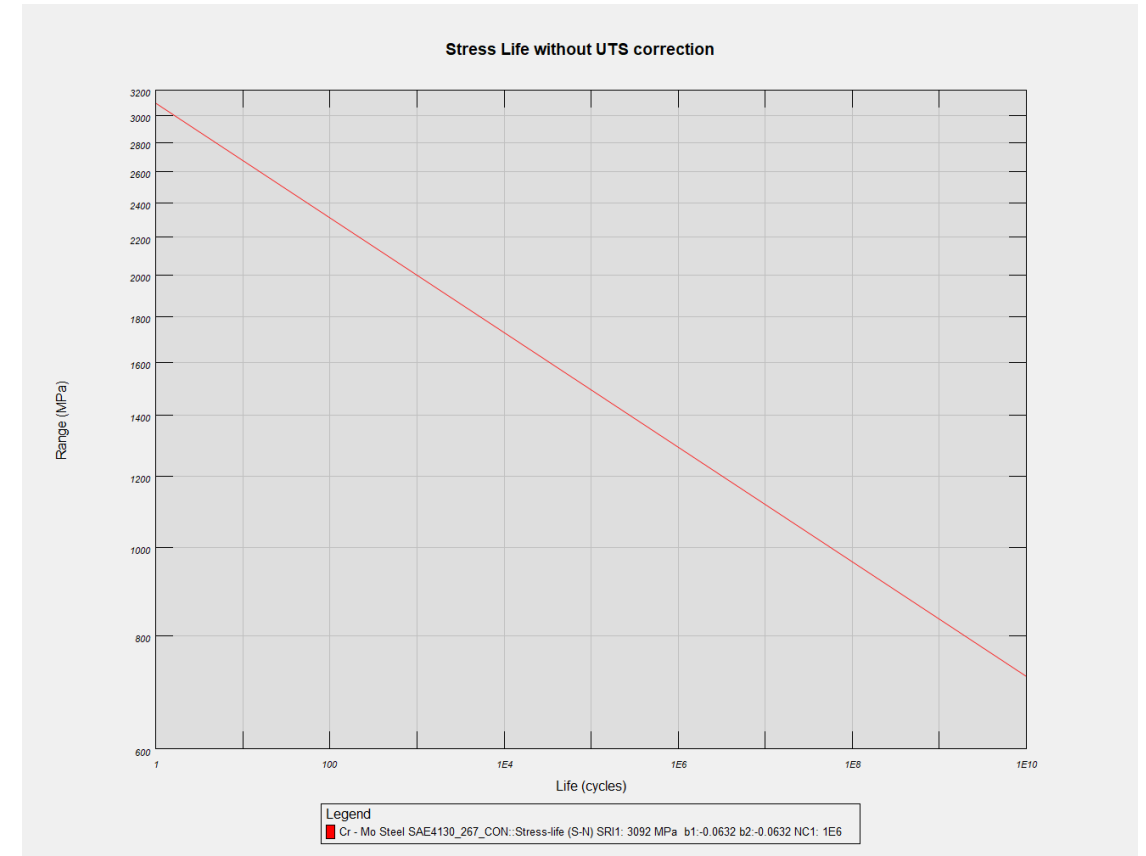
Properties	Graph	
	Carbon Steel SAE1018_118_QT::Strain-life (E-N)	Description
MaterialType	13	Material Type
YS	290	Yield Strength (MPa)
UTS	496	Ultimate Tensile Strength (MPa)
E	2.07E5	Elastic Modulus (MPa)
n_monotonic	0.13	Monotonic Work Hardening Exponent
K_monotonic	671	Monotonic Work Hardening Coefficient (MPa)
me		Elastic Poisson's Ratio
mp		Plastic Poisson's Ratio
Sf	391	Fatigue Strength Coefficient (MPa)
b	-0.09	Fatigue Strength Exponent
c	-0.35	Fatigue Ductility Exponent
Ef	0.13	Fatigue Ductility Coefficient
n'	0.25	Cyclic Strain Hardening Exponent
n'90		Out of phase Cyclic Strain Hardening Exponent
K'	640	Cyclic Strength Coefficient (MPa)
K'90		Out of phase Cyclic Strength Coefficient (MPa)
Nc	2E8	Cut-off (Reversals)
SEe	0	Standard Error of Log(e) (Elastic)
SEp	0	Standard Error of Log(e) (Plastic)
SEc	0	Standard Error of Log(e) (Cyclic)
Ne		Endurance Limit (Reversals)
FSN	0.6	Fatemi-Socie parameter
S	1	Wang Brown parameter
SB	0	Wang Brown parameter B
GammaP		Walker Mean stress parameter for +ve mean
GammaN		Walker Mean stress parameter for -ve mean
Comments	Data from "Crack Initiation Fatigue; Data Analysis, Trends and Estimation."	Comments
References	SAE Paper # 820682. Bruce E. Boardman. Deere & Co. Tech. Ctr. Moline, IL.	References



nCode Material Databases – Standard database

Example SN materials data

Properties	Graph	
	Cr - Mo Steel SAE4130_267_CON::Stress-life (S-N)	Description
MaterialType	99	Material Type
YS	684	Yield Strength (MPa)
UTS	912	Ultimate Tensile Strength (MPa)
E	2.1E5	Elastic Modulus (MPa)
me		Elastic Poisson's Ratio
mp		Plastic Poisson's Ratio
SRI1	3092	Stress Range Intercept (MPa)
b1	-0.0632	First Fatigue Strength Exponent
Nc1	1E6	Fatigue Transition Point (cycles)
b2	-0.0632	Second Fatigue Strength Exponent
SE	0	Standard Error of Log(N)
RR	-1	R-ratio of Test
Nfc	1E30	Fatigue CutOff
M1		Mean stress parameter M1
M2		Mean stress parameter M2
M2b		Mean stress parameter M2b
M3		Mean stress parameter M3
M4		Mean stress parameter M4
GammaP		Walker Mean stress parameter for +ve mean
GammaN		Walker Mean stress parameter for -ve mean
FatigueLimitRatio		Fatigue Limit Ratio
Comments	Tested under reversed bending; results converted for axial loading.	Comments
References	Vibration Analysis for Electronic Equipment, Dave S. Steinberg, 2nd Edn. 1988, Publ. Wiley.	References

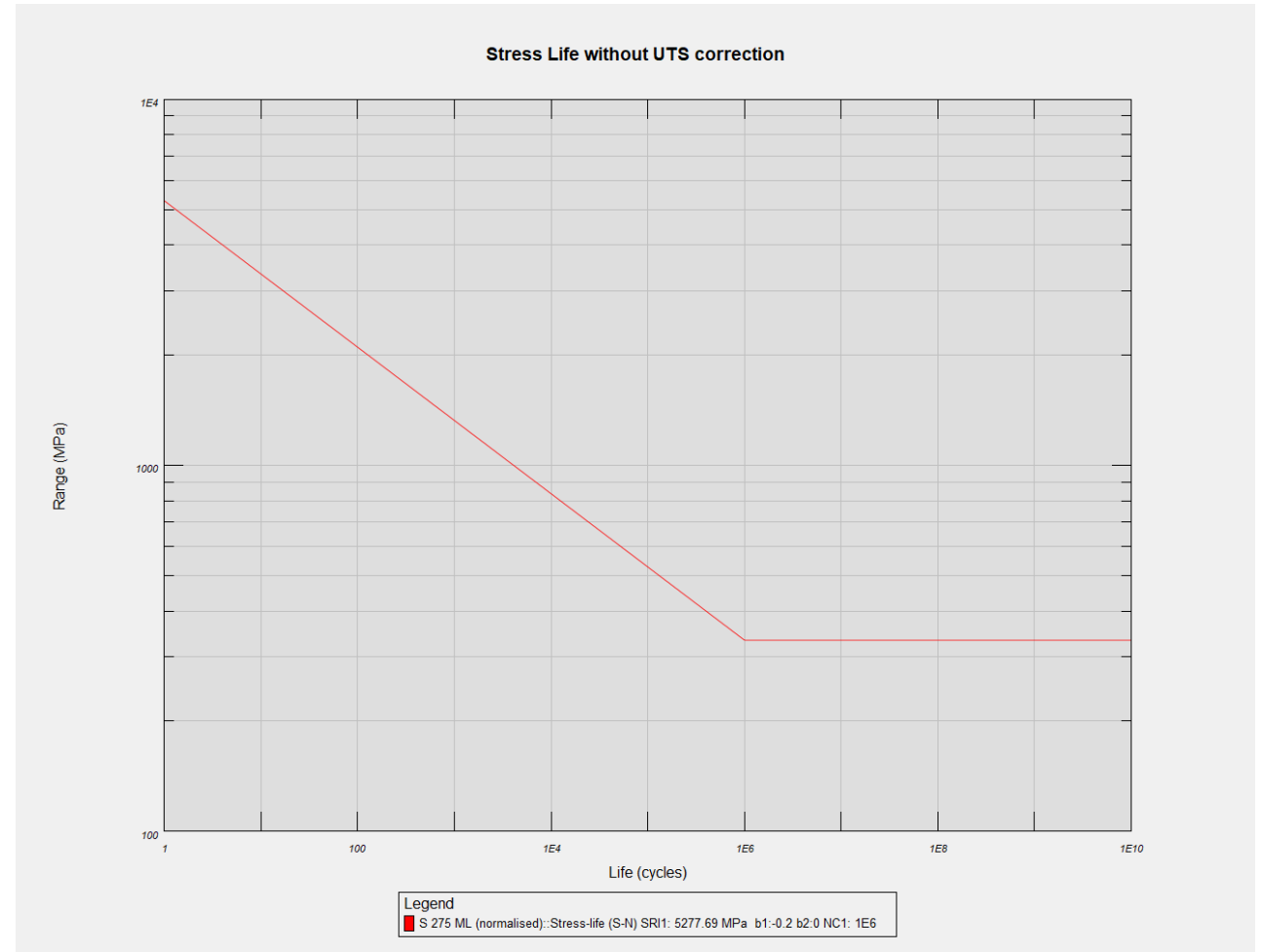


nCode Material Databases - FKM

FKM

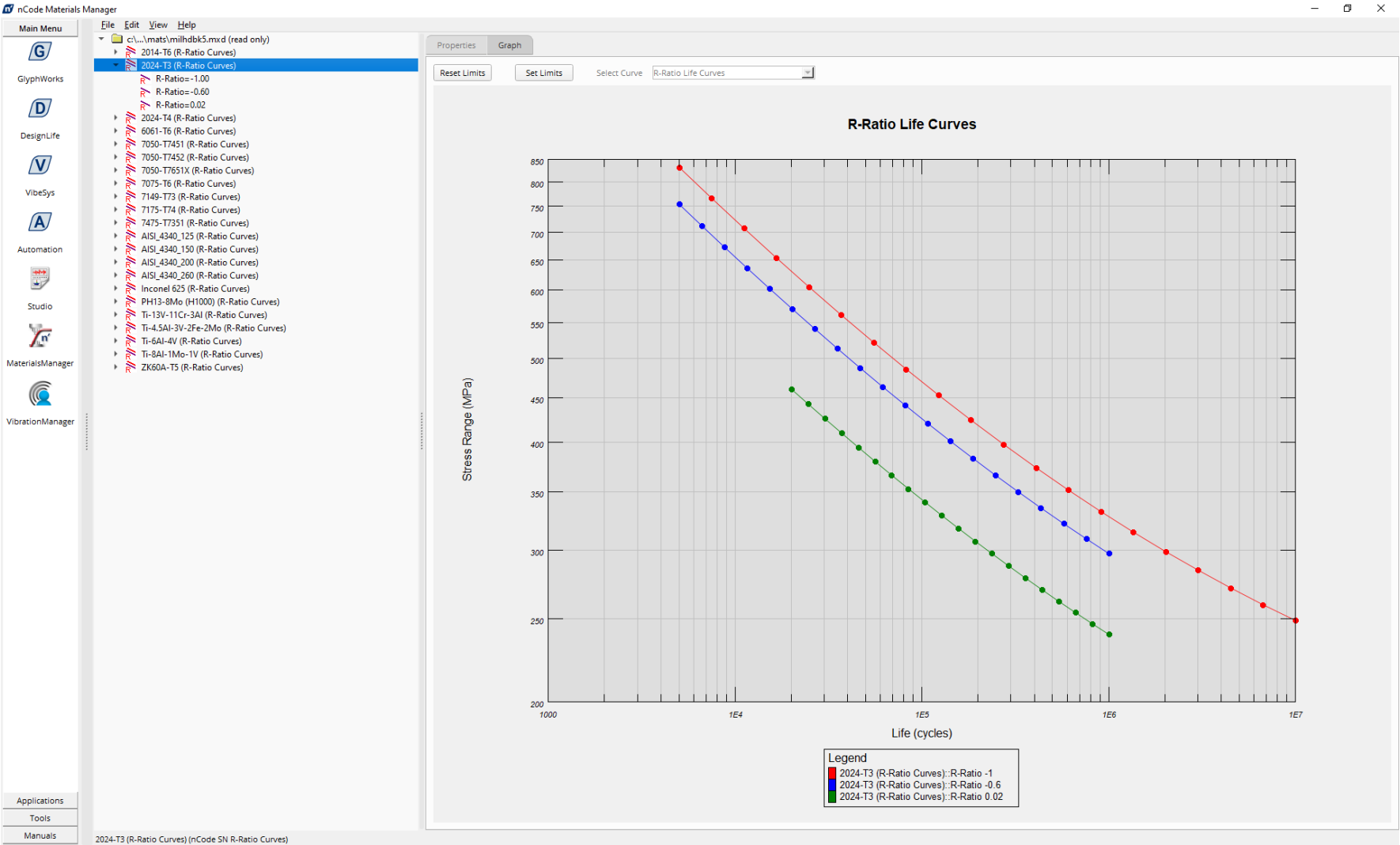
- 5th, 6th and 7th editions
- 761 datasets in the 7th edition

Properties	Graph	
	S 275 ML (normalised)::Stress-life (S-N)	Description
MaterialType	14	Material Type
YS	275	Yield Strength (MPa)
UTS	370	Ultimate Tensile Strength (MPa)
E	2.1E5	Elastic Modulus (MPa)
me		Elastic Poisson's Ratio
mp		Plastic Poisson's Ratio
SRI1	5277.6943	Stress Range Intercept (MPa)
b1	-0.2	First Fatigue Strength Exponent
Nc1	1E6	Fatigue Transition Point (cycles)
b2	0	Second Fatigue Strength Exponent
SE	0	Standard Error of Log(N)
RR	-1	R-ratio of Test
Nfc	1E30	Fatigue CutOff
M1		Mean stress parameter M1
M2		Mean stress parameter M2
M2b		Mean stress parameter M2b
M3		Mean stress parameter M3
M4		Mean stress parameter M4
GammaP		Walker Mean stress parameter for +ve mean
GammaN		Walker Mean stress parameter for -ve mean
FatigueLimitRatio	1.7331	Fatigue Limit Ratio
Comments	synthetic 97.5% SN Curve	Comments
References	based on characteristic values of FKM guidelines 7th edition, 2020	References



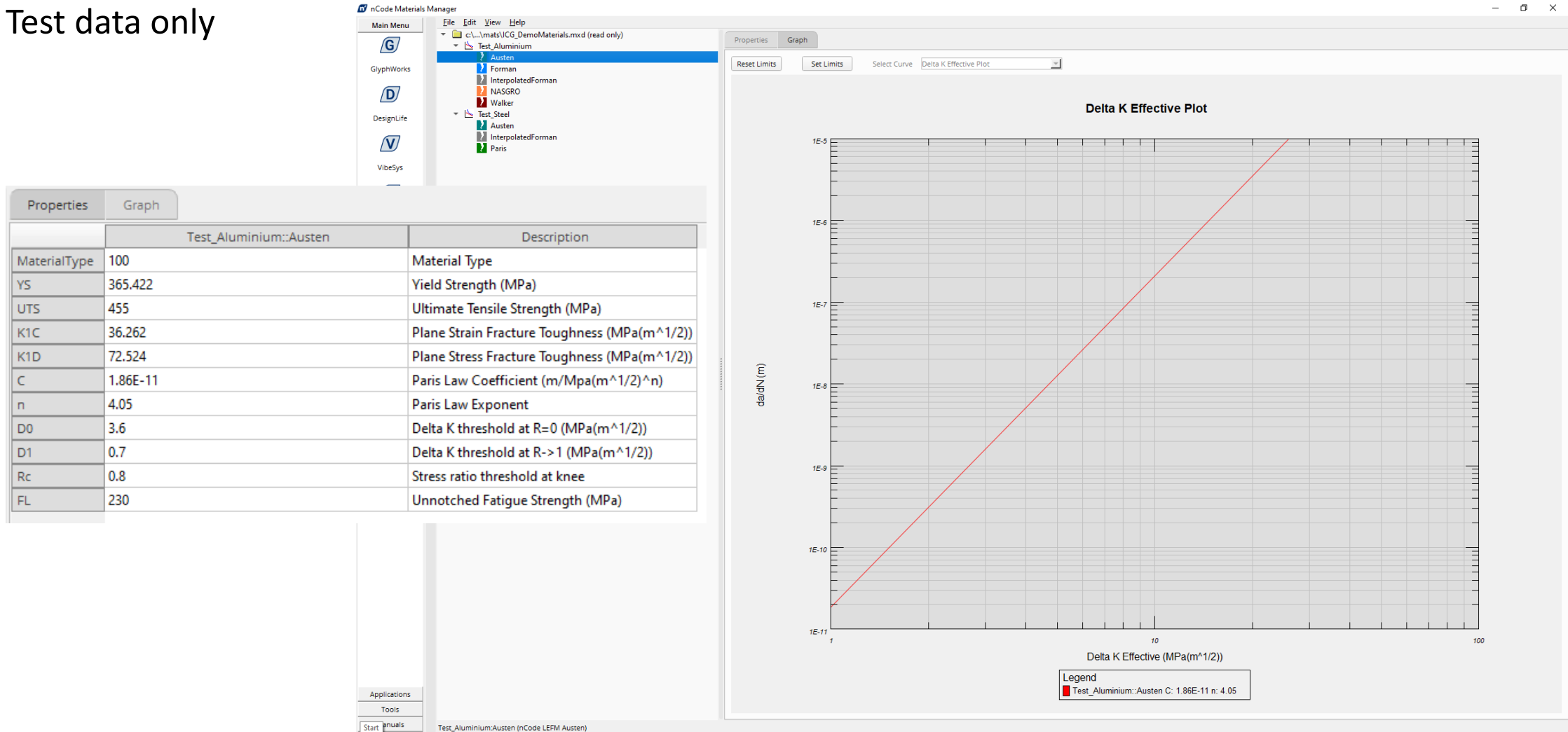
nCode Material Databases – Mil Handbook 5

Mult-R Ratio SN Data



nCode Material Databases – ICG demo materials

Test data only



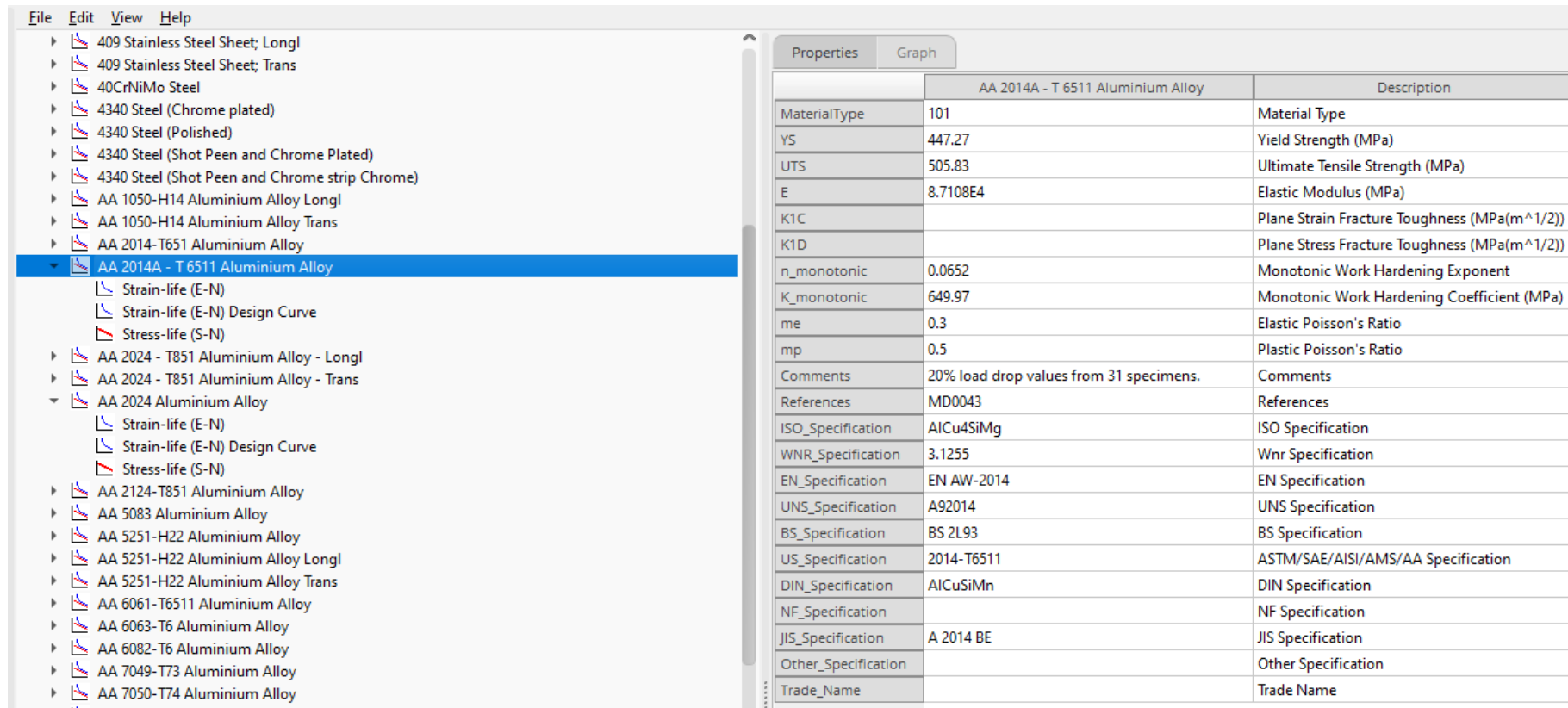
The Premium Materials Database (PMD)

The Premium Materials database

- ▲ All data measured in our own lab
- ▲ 149 data sets for > 120 different materials
- ▲ Includes
 - Steel
 - Cast iron
 - Aluminium
 - Titanium
 - Magnesium
 - Bronze
 - Copper
 - Nickel

The Premium Materials database

Example Data

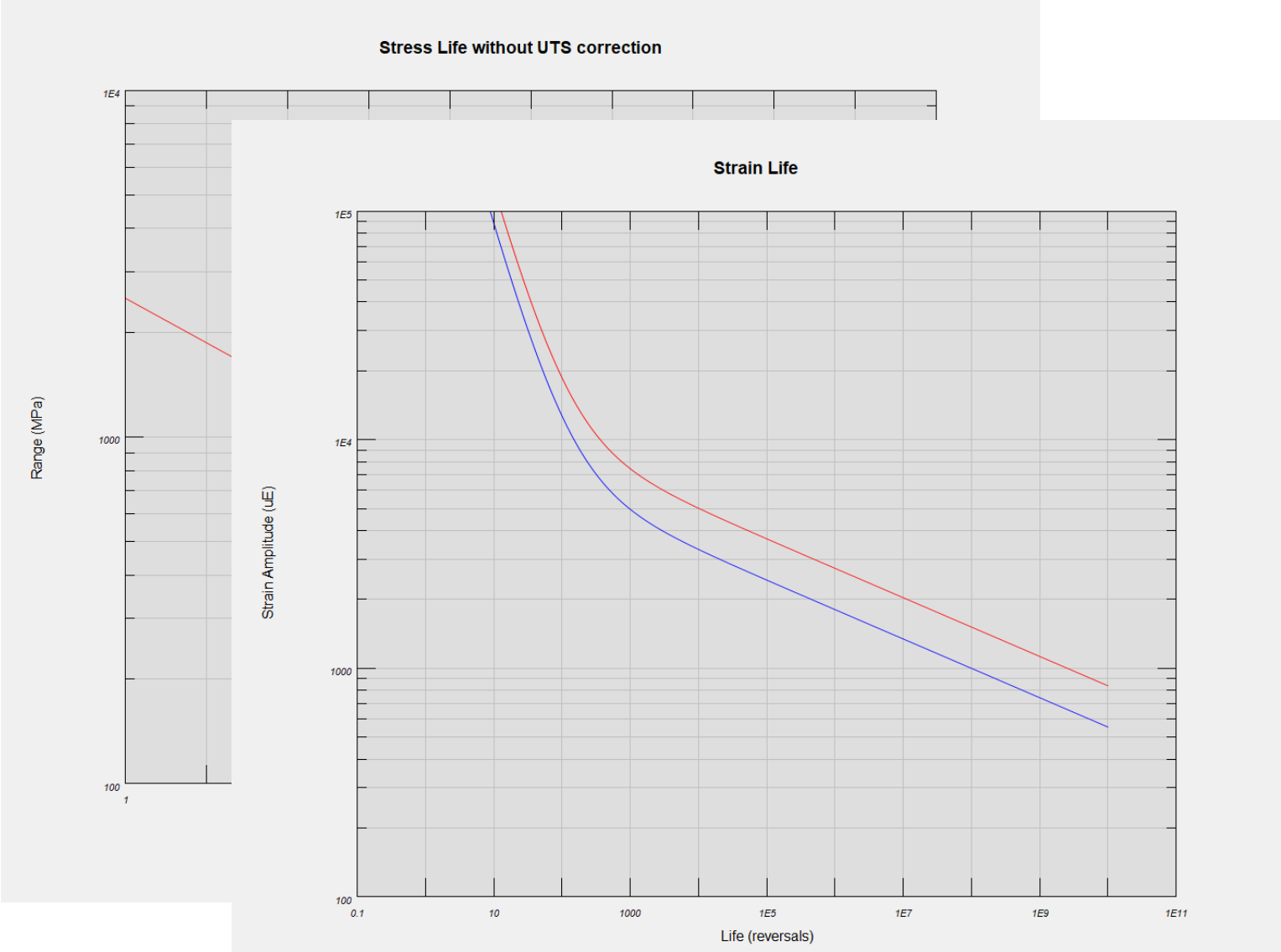


The screenshot displays the Premium Materials database interface. On the left, a tree view lists various materials, with 'AA 2014A - T 6511 Aluminium Alloy' selected. On the right, the 'Properties' tab is active, showing a table of material properties and specifications for the selected alloy.

	AA 2014A - T 6511 Aluminium Alloy	Description
MaterialType	101	Material Type
YS	447.27	Yield Strength (MPa)
UTS	505.83	Ultimate Tensile Strength (MPa)
E	8.7108E4	Elastic Modulus (MPa)
K1C		Plane Strain Fracture Toughness (MPa(m ^{1/2}))
K1D		Plane Stress Fracture Toughness (MPa(m ^{1/2}))
n_monotonic	0.0652	Monotonic Work Hardening Exponent
K_monotonic	649.97	Monotonic Work Hardening Coefficient (MPa)
me	0.3	Elastic Poisson's Ratio
mp	0.5	Plastic Poisson's Ratio
Comments	20% load drop values from 31 specimens.	Comments
References	MD0043	References
ISO_Specification	AlCu4SiMg	ISO Specification
WNR_Specification	3.1255	Wnr Specification
EN_Specification	EN AW-2014	EN Specification
UNS_Specification	A92014	UNS Specification
BS_Specification	BS 2L93	BS Specification
US_Specification	2014-T6511	ASTM/SAE/AISI/AMS/AA Specification
DIN_Specification	AlCuSiMn	DIN Specification
NF_Specification		NF Specification
JIS_Specification	A 2014 BE	JIS Specification
Other_Specification		Other Specification
Trade_Name		Trade Name

The Premium Materials database

Example data



Material Surface Treatment Materials Data

Materials Surface Finish Data

- ▲ Data generated as part of a USAF project run by SES
- ▲ Three materials
 - 300M Steel
 - 4340 Steel
 - 7075-T7351 Aluminium Alloy
- ▲ Multiple surface finishes

Materials Surface Finish Data

▲ 300M Steel

- Cadmium Plated
- Chrome Plated
- Chrome Type 2
- Electroless Nickel
- Electrolytic Nickel Plating
- Polished
- Polished, Shot Peened
- Shot Peen and Cadmium Plated
- Shot Peen and Chrome Plated
- Shot Peen and Chrome-Strip-Chrome
- Shot Peen and Chrome Type2
- Shot Peen and Chrome Type2 - HalfLife/Strip/ReChrome
- Shot Peen and Electroless Nickel
- Shot Peen and Electrolytic Nickel

▲ 4340 Steel

- Chrome plated
- Polished
- Shot Peen and Chrome Plated
- Shot Peen and Chrome strip Chrome

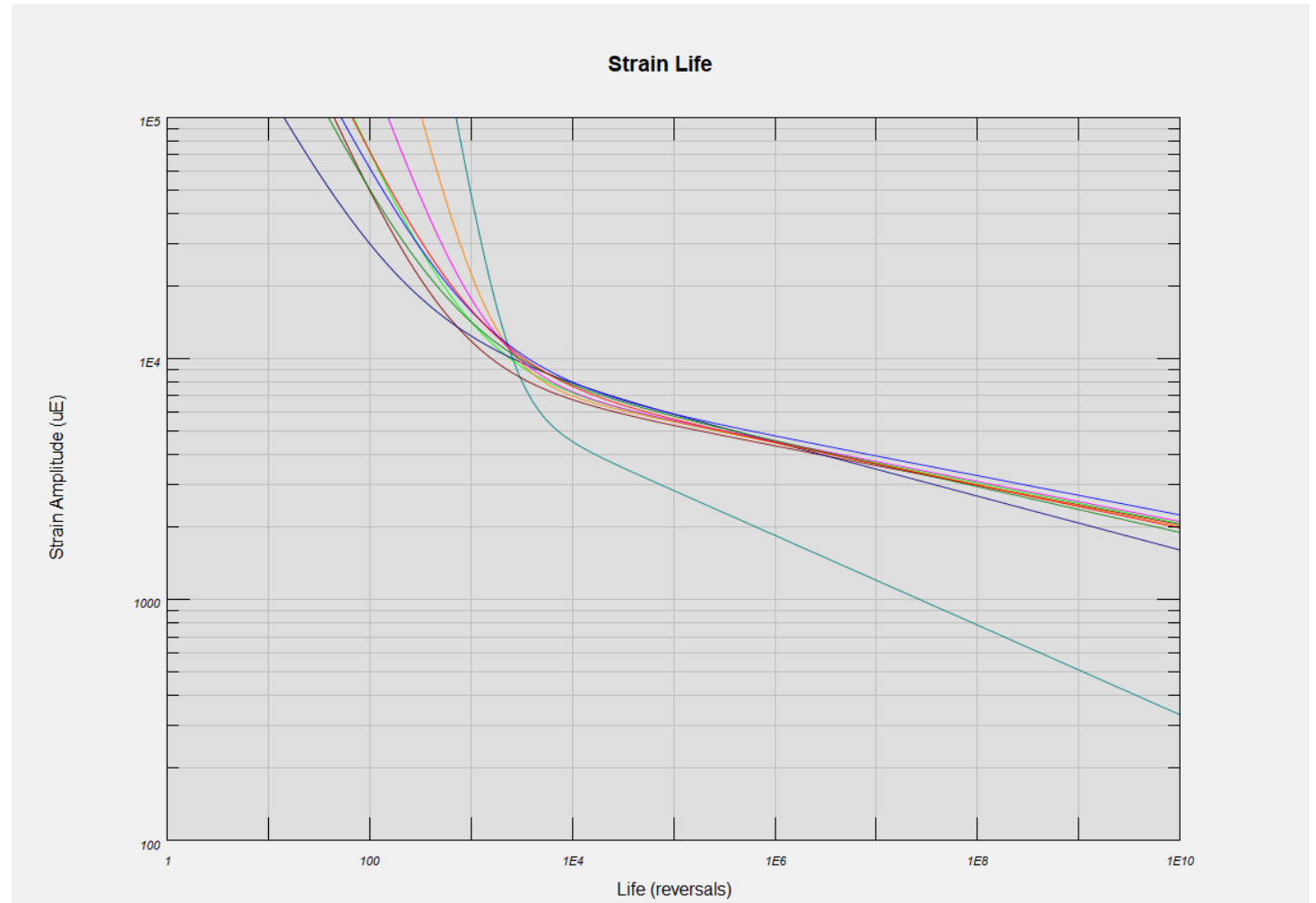
▲ 7075-T7351 Aluminium Alloy

- Anodised
- Polished
- Shot Peen and Anodised
- Shot Peen and Anodise-Strip-Anodise

Materials Surface Finish Data

Example Surface Finish Data

- ▶ 300M Shot Peen and Chrome Type2 (HalfLife/Strip/ReChrome)
- ▶ 300M Steel (Cadmium Plated)
- ▶ 300M Steel (Chrome Plated)
- ▶ 300M Steel (Chrome Type 2)
- ▶ 300M Steel (Electroless Nickel)
- ▶ 300M Steel (Electrolytic Nickel Plating)
- ▶ 300M Steel (Polished)
- ▶ 300M Steel (Polished, Shot Peened)
- ▶ 300M Steel (Shot Peen and Cadmium Plated)
- ▶ 300M Steel (Shot Peen and Chrome Plated)
- ▶ 300M Steel (Shot Peen and Chrome Type2)
- ▶ 300M Steel (Shot Peen and Chrome-Strip-Chrome)
- ▶ 300M Steel (Shot Peen and Electroless Nickel)
- ▶ 300M Steel (Shot Peen and Electrolytic Nickel)
- ▶ 4340 Steel (Chrome plated)
- ▶ 4340 Steel (Polished)
- ▶ 4340 Steel (Shot Peen and Chrome Plated)
- ▶ 4340 Steel (Shot Peen and Chrome strip Chrome)
- ▶ 7075-T7351 Aluminium Alloy (Anodised)
- ▶ 7075-T7351 Aluminium Alloy (Polished)
- ▶ 7075-T7351 Aluminium Alloy (Shot Peen and Anodise-Strip-Anodise)
- ▶ 7075-T7351 Aluminium Alloy (Shot Peen and Anodised)



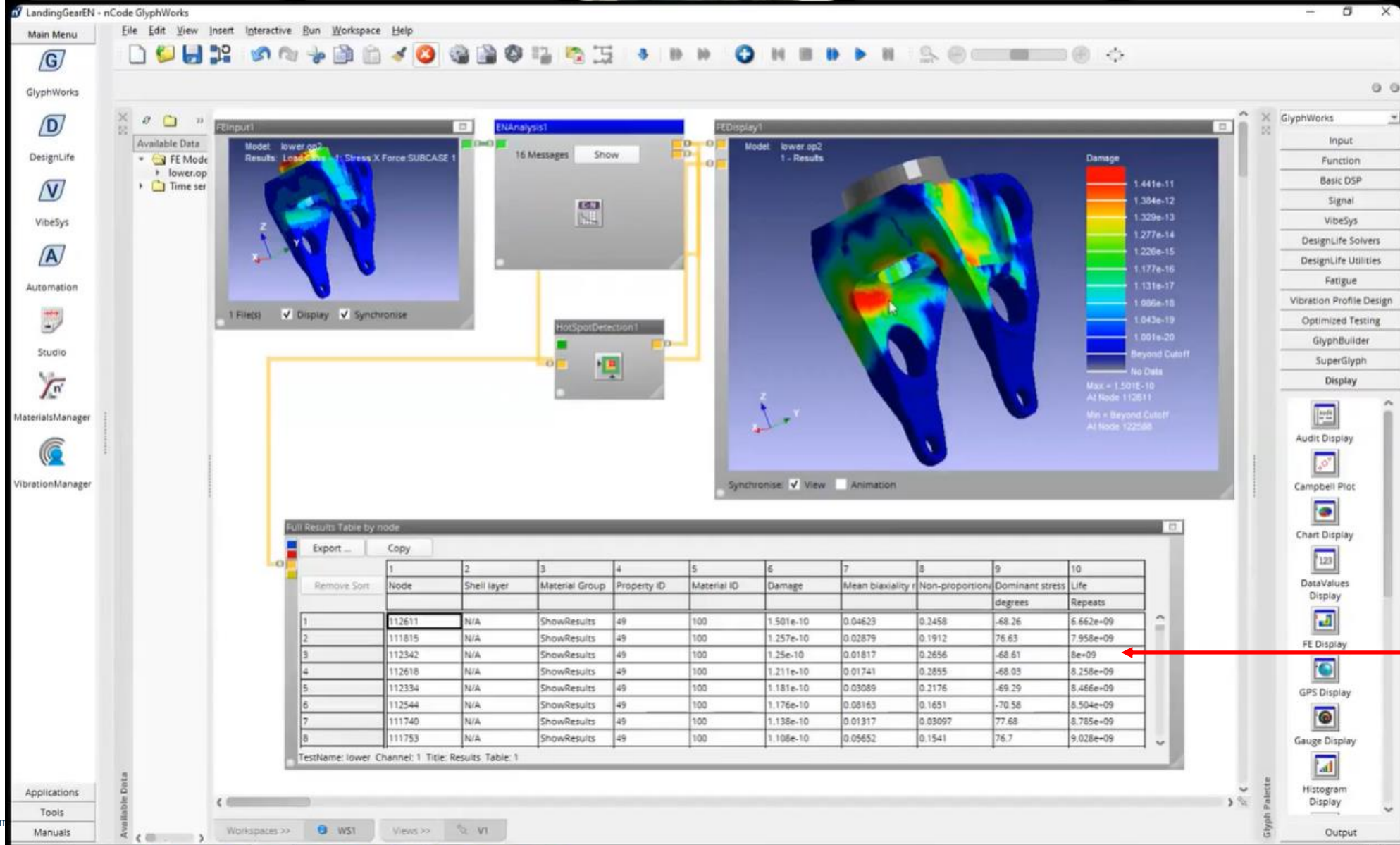
HBK Europe We...

Rob Plaskitt

Paul Roberts

Andrew Halfpenny

Ben Griffiths



LandingGearEN - nCode GlyphWorks

Main Menu

GlyphWorks

DesignLife

VibeSys

Automation

Studio

MaterialsManager

VibrationManager

Available Data

Applications

Tools

Manuals

Edit Material Map

Editing material map: MaterialMap

Material Source: Database

Material Type: Standard EN

Validate Before Run

View Assigned... Create Memory Materials Group Properties...

Material Group	Material Name	Database	Scale	Offset	KTreatment	KUser	Roughness	Shape factor
Default Material	300M Steel (Polished)::Strain-life (E-N)	MatDB	1	0 MPa	1	1	Polished	
ShowResults			1	0 MPa	1	1	Polished	

Select material to assign

Database

MatDB

Folder View Type filter here Filter Database

View... Generate...

Material Name	UTS (MPa)	Yield Strength (MPa)	Elastic Modulus (MPa)
300M Shot Peen and Chrome Type2 (HalfLife/Strip/ReChrome)::Strain-life (E-N)	1815	1413	1.74e05
300M Shot Peen and Chrome Type2 (HalfLife/Strip/ReChrome)::Strain-life (E-N) Design Curve	1815	1413	1.74e05
300M Steel (Cadmium Plated)::Strain-life (E-N)	1977	1589	1.92e05
300M Steel (Cadmium Plated)::Strain-life (E-N) Design Curve	1977	1589	1.92e05
300M Steel (Chrome Plated)::Strain-life (E-N)	1936	1513	1.89e05
300M Steel (Chrome Plated)::Strain-life (E-N) Design Curve	1936	1513	1.89e05
300M Steel (Chrome Type 2)::Strain-life (E-N)	1812	1419	1.71e05
300M Steel (Chrome Type 2)::Strain-life (E-N) Design Curve	1812	1419	1.71e05
300M Steel (Electroless Nickel)::Strain-life (E-N)	1934	1522	1.90e05
300M Steel (Electroless Nickel)::Strain-life (E-N) Design Curve	1934	1522	1.90e05
300M Steel (Electrolytic Nickel Plating)::Strain-life (E-N)	1857	1379	1.86e05
300M Steel (Electrolytic Nickel Plating)::Strain-life (E-N) Design Curve	1857	1379	1.86e05
300M Steel (Polished)::Strain-life (E-N)	1984	1553	1.93e05
300M Steel (Polished)::Strain-life (E-N) Design Curve	1984	1553	1.93e05
300M Steel (Polished, Shot Peened)::Strain-life (E-N)	1994	1568	1.91e05
300M Steel (Polished, Shot Peened)::Strain-life (E-N) Design Curve	1994	1568	1.91e05
300M Steel (Shot Peen and Cadmium Plated)::Strain-life (E-N)	1985	1580	1.95e05
300M Steel (Shot Peen and Cadmium Plated)::Strain-life (E-N) Design Curve	1985	1580	1.95e05

OK Cancel Help

Workspaces >> WS1 Views >> V1

Input

Function

Basic DSP

Signal

VibeSys

DesignLife Solvers

DesignLife Utilities

Fatigue

Vibration Profile Design

Optimized Testing

GlyphBuilder

SuperGlyph

Display

Audit Display

Campbell Plot

Chart Display

DataValues Display

FE Display

GPS Display

Gauge Display

Histogram Display

Output

16:37 14/11/2023

300M steel
with
electroless
nickel coating

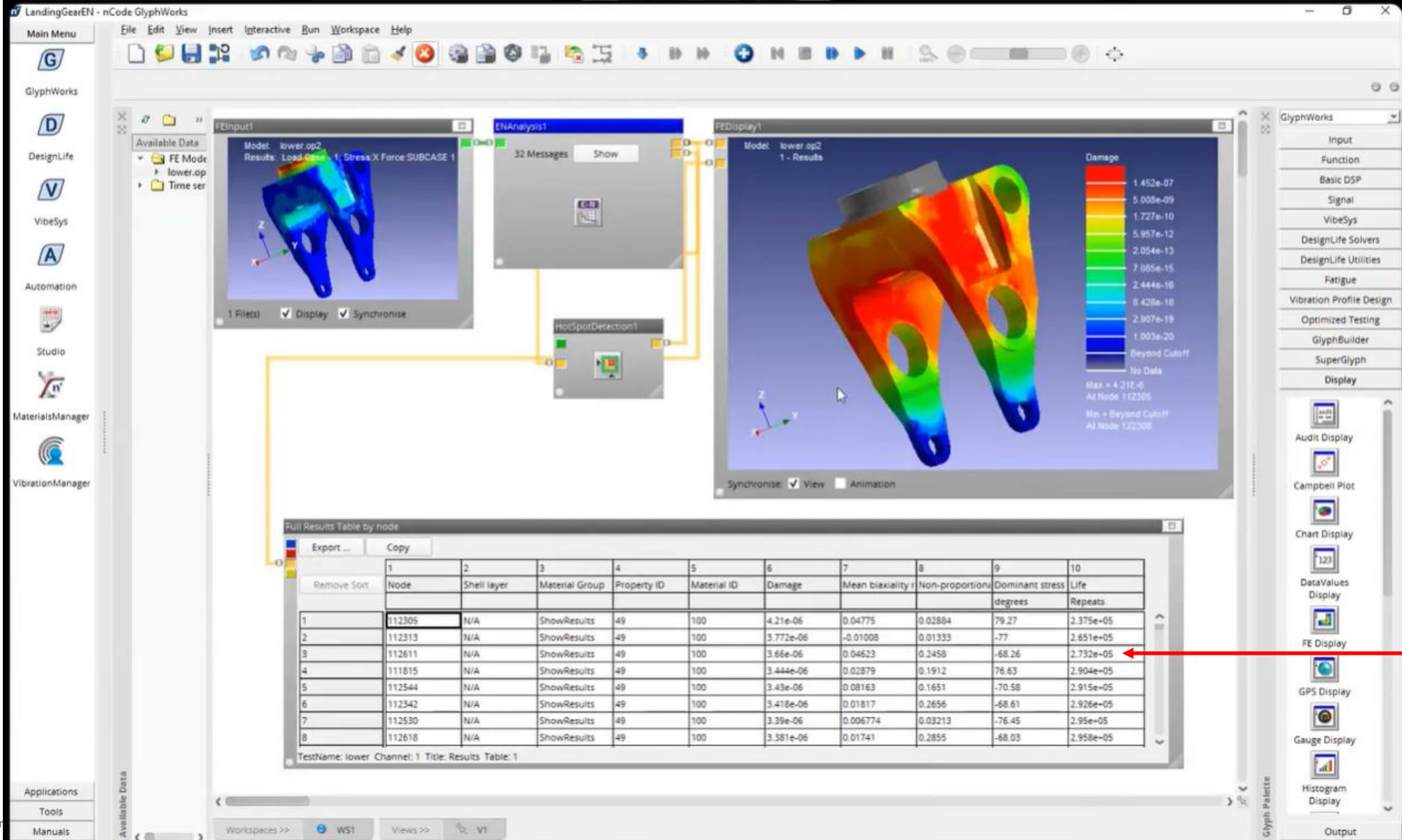
HBK Europe We...

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Ben Griffiths



300M steel
electroless
nickel coating,
predicted life
~3e5 repeats

Summary

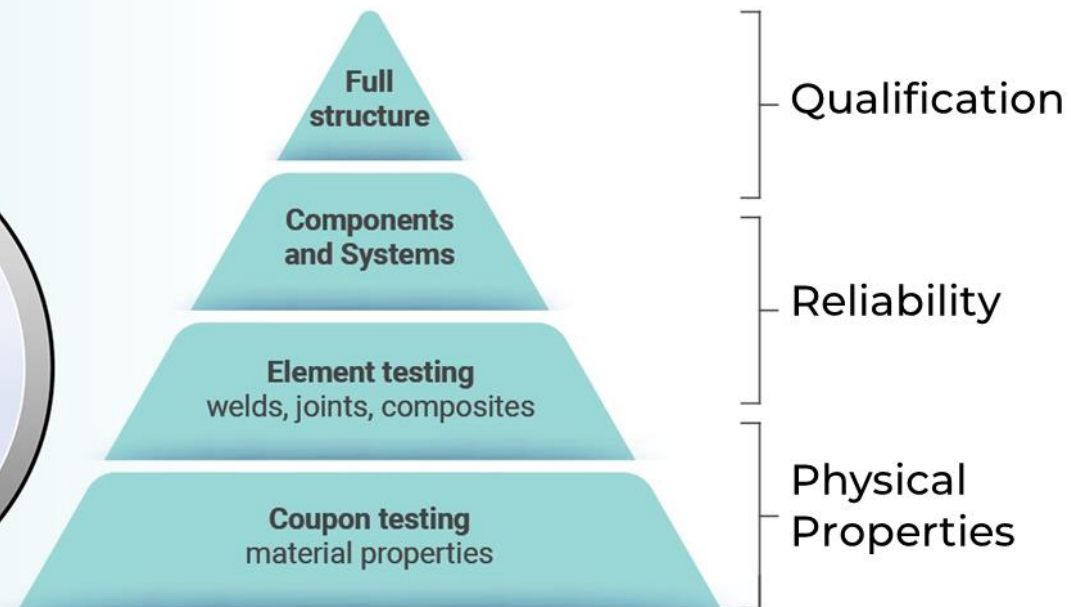
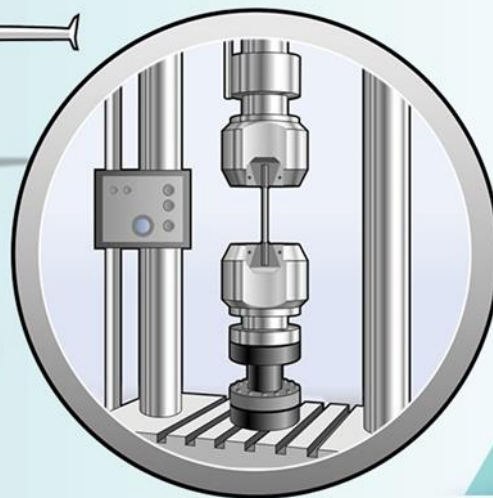
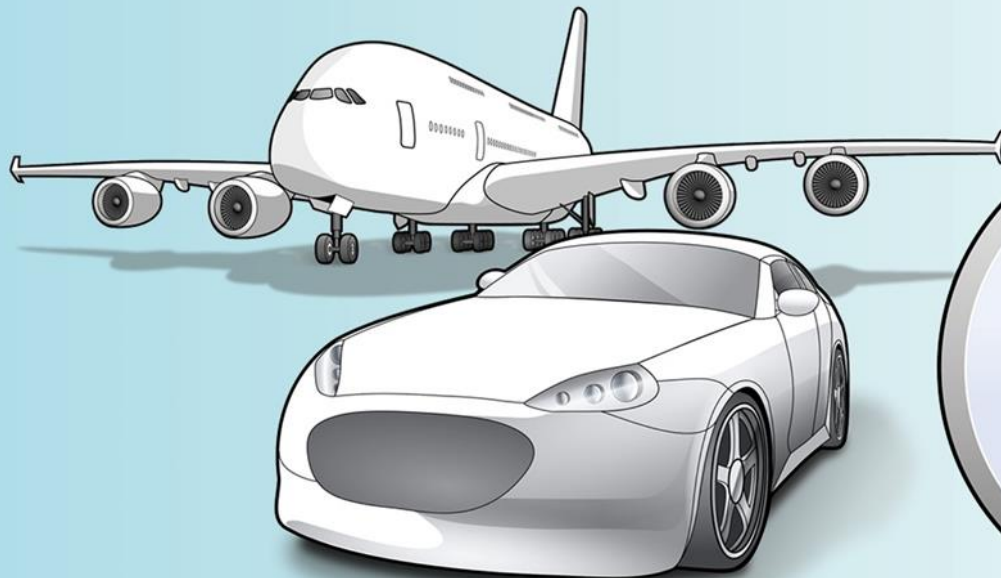
1. Multiple material databases are available
2. The PMD provides an unmatched set of materials data from our AMCT
3. Surface finish data available for use in DesignLife

Q & A

Thank You

Paul Roberts
DesignLife Product Manager

paul.roberts@HBKWORLD.com



2023 HBK Technology Days

14 November 2023

Materials Surface Finish Data

▲ 300M Steel

- Cadmium Plated
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- Chrome Type 2
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- Electrolytic Nickel Plating
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- Shot Peen and Chrome Plated
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- Shot Peen and Chrome Type2
- Shot Peen and Chrome Type2 - HalfLife/Strip/ReChrome
- Shot Peen and Electroless Nickel
- Shot Peen and Electrolytic Nickel

▲ 4340 Steel

- Chrome plated
- Polished
- Shot Peen and Chrome Plated
- Shot Peen and Chrome strip Chrome

▲ 7075-T7351 Aluminium Alloy

- Anodised
- Polished
- Shot Peen and Anodised
- Shot Peen and Anodise-Strip-Anodise

- Material surface treatment fatigue database

Paul Roberts,
Product Manager – nCode DesignLife, HBK