

WHY FATIGUE LIFE PREDICTIONS DO NOT AGREE WITH EXPERIMENTS: QUANTIFYING THE PREDICTION SCATTER THROUGH THE FABEST BENCHMARK COMPETITION

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FABER CA23109 Chair

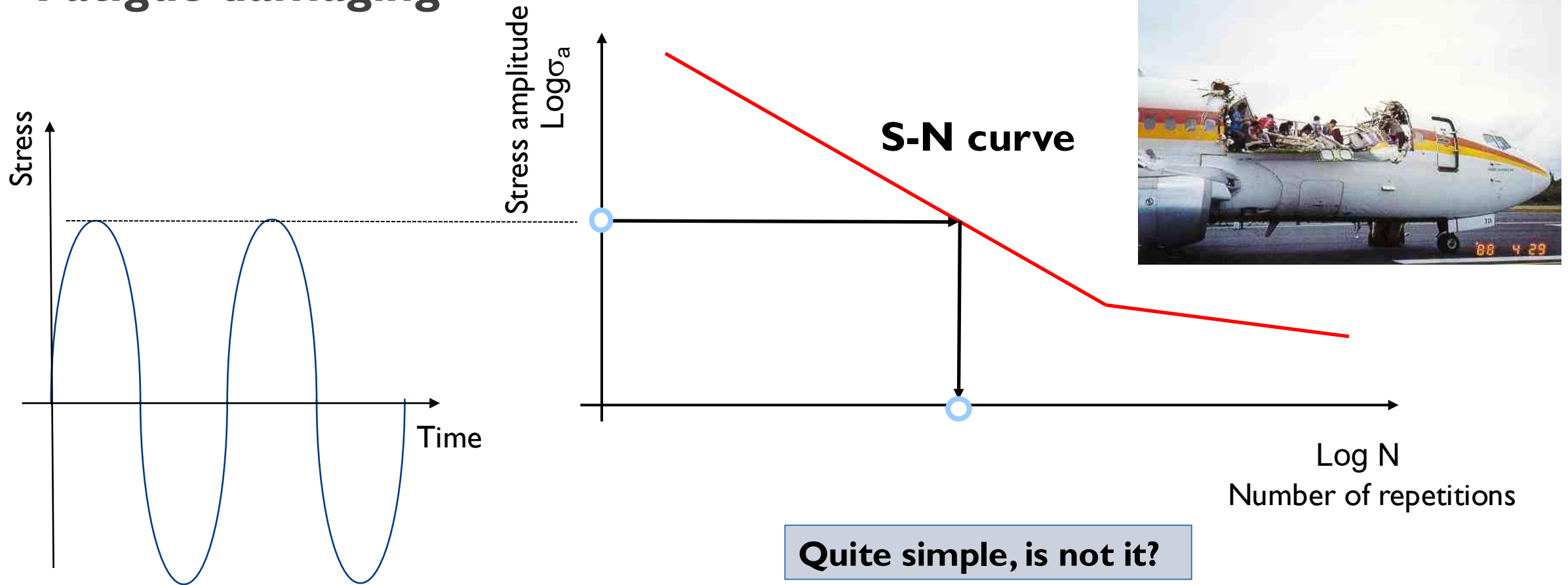


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WWW.FABER-COST.EU

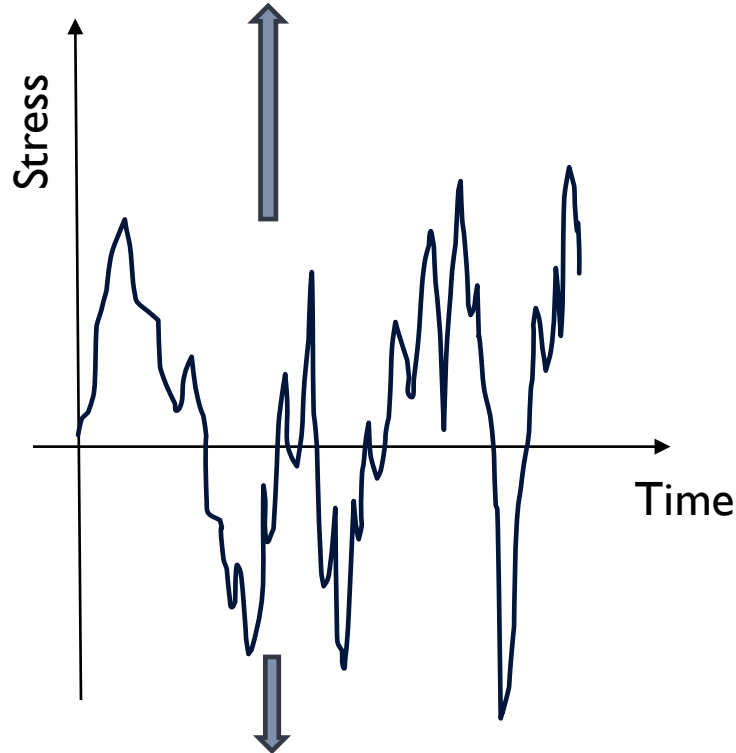
WHAT MAKES MACHINES FAIL

■ Fatigue damaging

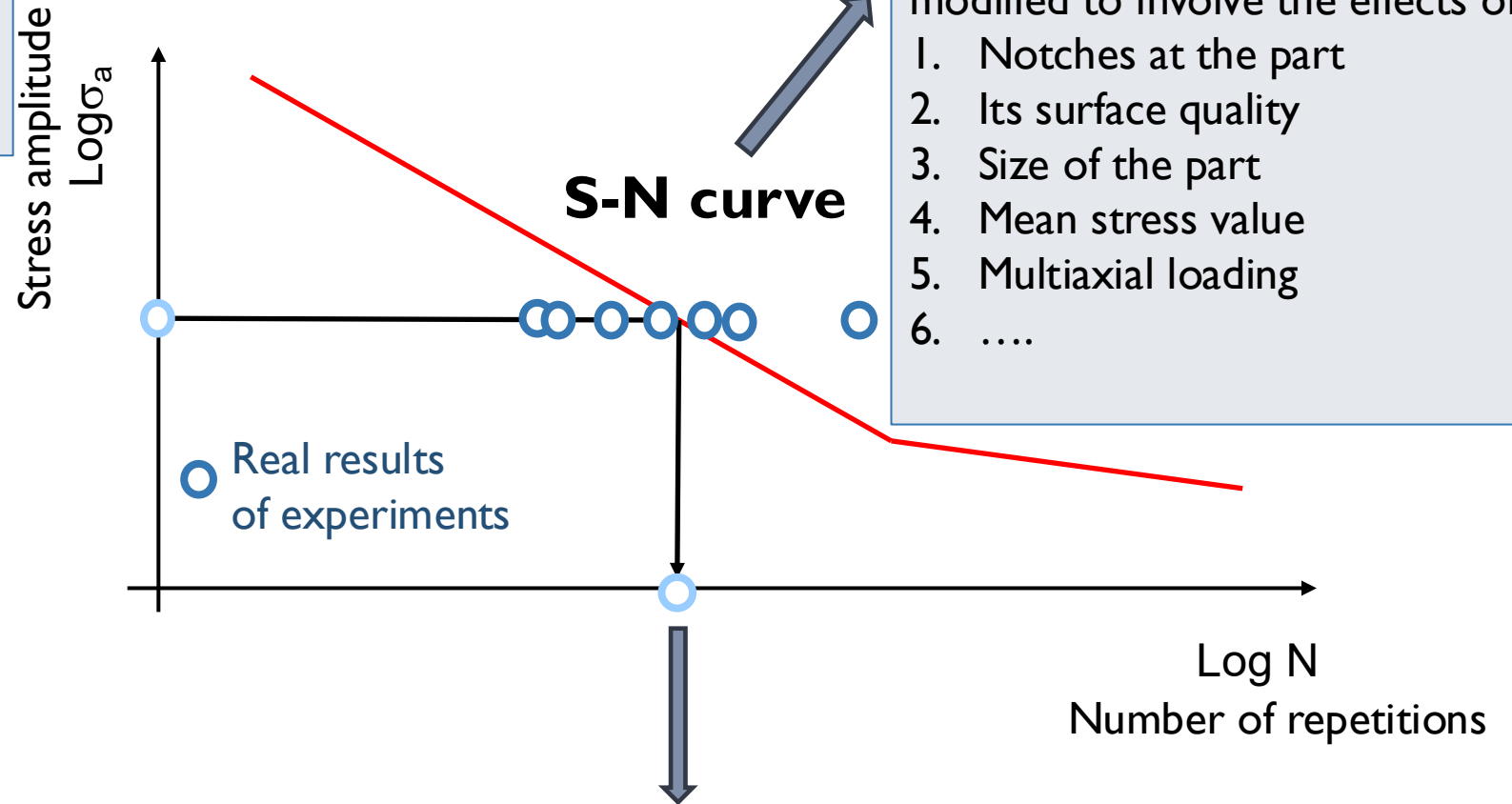


WHY IS FATIGUE ESTIMATION COMPLICATED?

1. What is the stress amplitude?
2. How can I turn this record to cycles to define the amplitude?
3. There are more cycles of other sizes, how to treat them?



1. How I get to this record of the process?
2. Does it represent „general“ machine of this type?



Though it is originally material characteristics, it must be modified to involve the effects of:

1. Notches at the part
2. Its surface quality
3. Size of the part
4. Mean stress value
5. Multiaxial loading
6.

1. The S-N curve shows „typical“ behaviour
2. In 50% of cases, the break comes sooner
3. How to make the service safe?

WHY IS FATIGUE LIFE PREDICTION STILL DIFFICULT?

- Many concurrent effects
- Many computational methods
- Many commercial solvers
- Many research papers



- Limited public datasets
- Little objective validation
- Difficult comparison
- Hard to separate a single effect
- Hard to assess how multiple effects cooperate

**Prediction without benchmarking
cannot build confidence.**

FKM-GUIDELINE V.7

FKM-Guideline: Analytical Strength Assessment of Components. 7th revised edition. VDMA Verlag, Frankfurt am Main 2020.

$$K_{WK,\sigma} = \frac{1}{n_\sigma} \left[1 + \frac{1}{\tilde{K}_{f,\sigma}} \cdot \left(\frac{1}{K_{R,\sigma}} - 1 \right) \right] \cdot \frac{1}{K_V \cdot K_S \cdot K_{NLE}}$$

Notch factor
estimate

Roughness
factor

Factor of
protecting
coat

Grey cast
iron factor

Boundary
layer factor

Support factor – from v.6, it is
computed from 3 separate factors

- Statistical size factor
- Mechanical deformation factor
- Fracture mechanics factor

**FATIGUE CURVE
MODIFICATIONS**



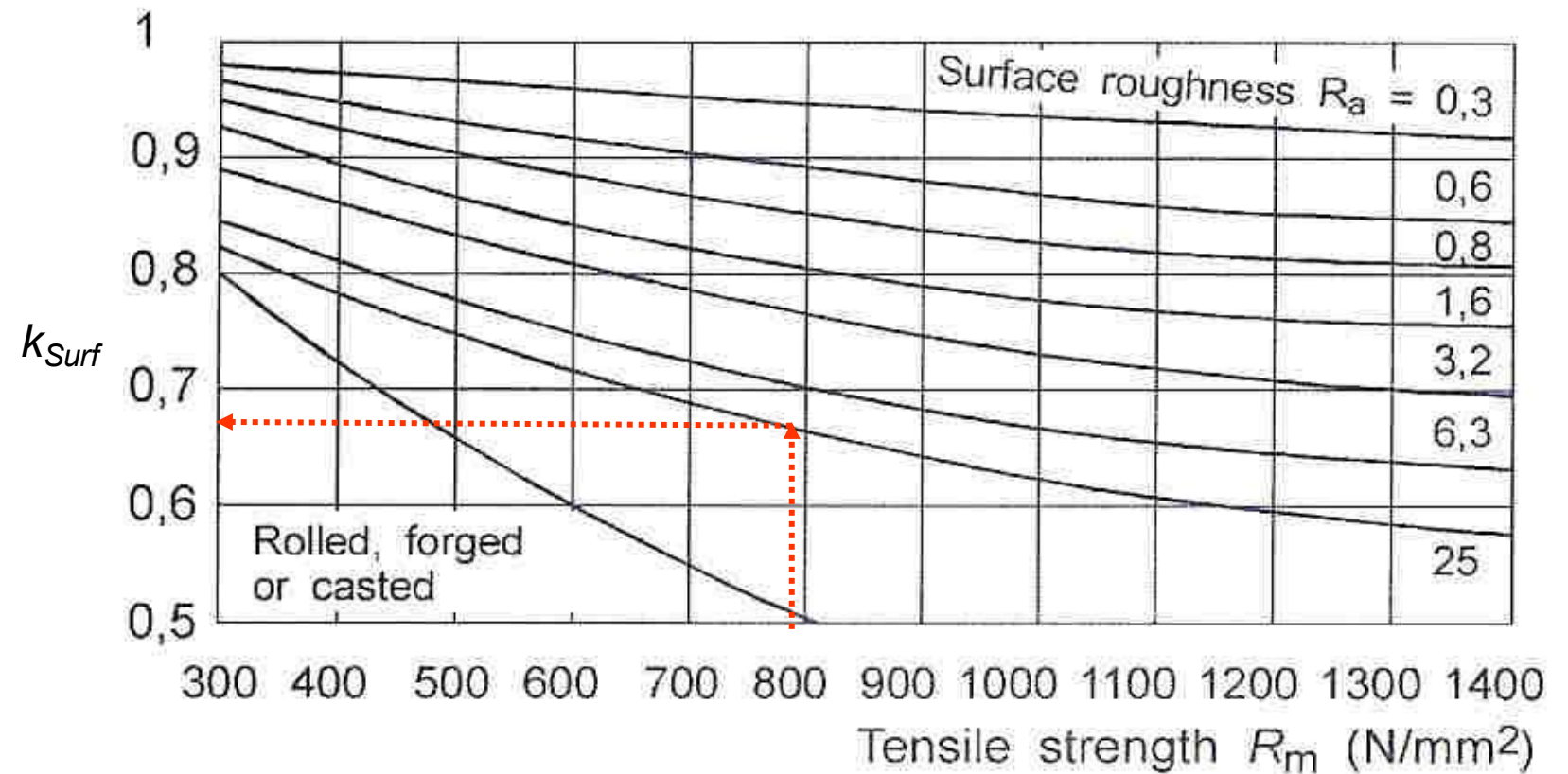
Inclusion of:

- Mean stress effect
- Variable amplitude
loading / load spectra
- Multiaxial loading

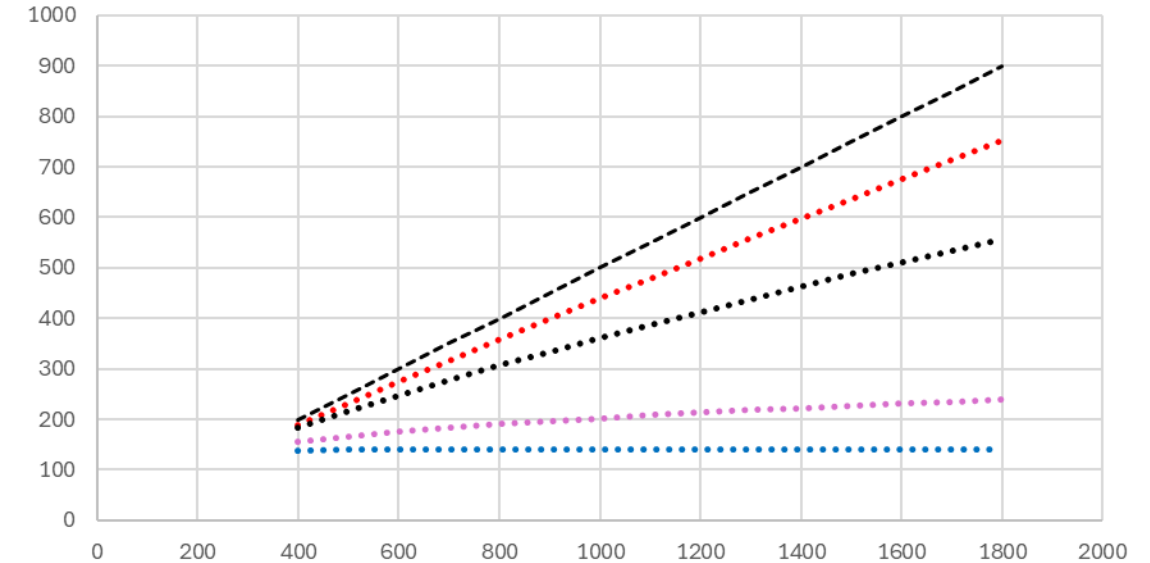
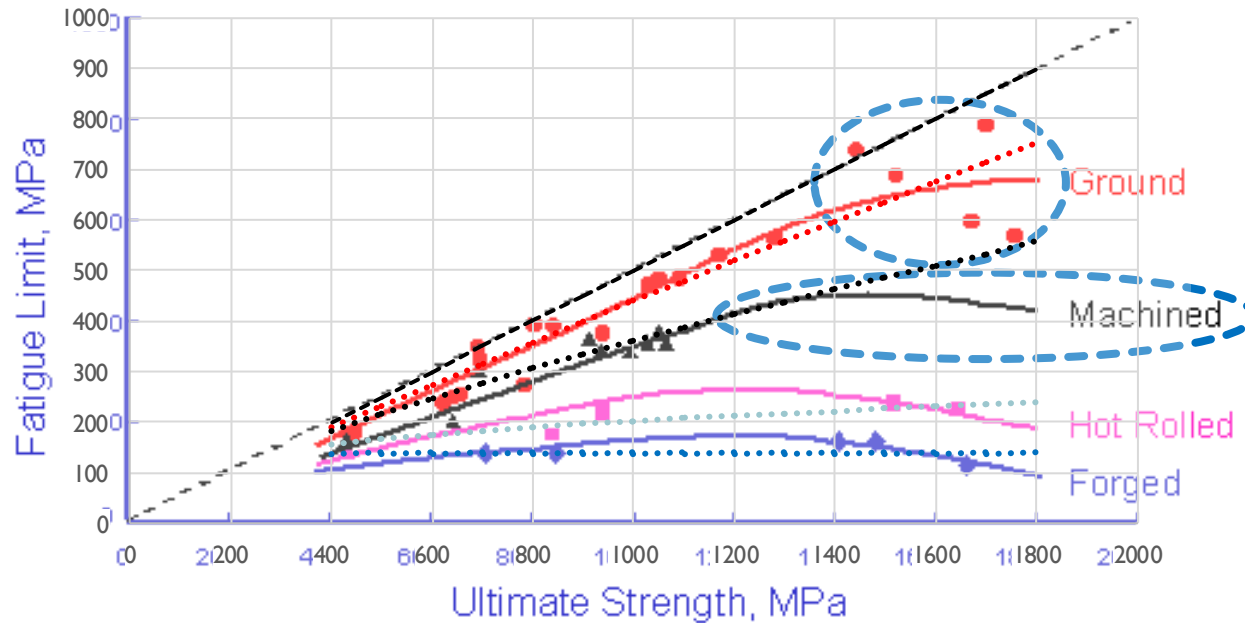
**EQUIVALENT
STRESS
MODIFICATIONS**

EFFECT OF SURFACE ROUGHNESS

$$k_{Surf} = \frac{\sigma_{FL}^{real}}{\sigma_{FL}^{specimen}}$$



EFFECT OF SURFACE ROUGHNESS



These are mean trends, not the safe ones!

Source: www.efatigue.com

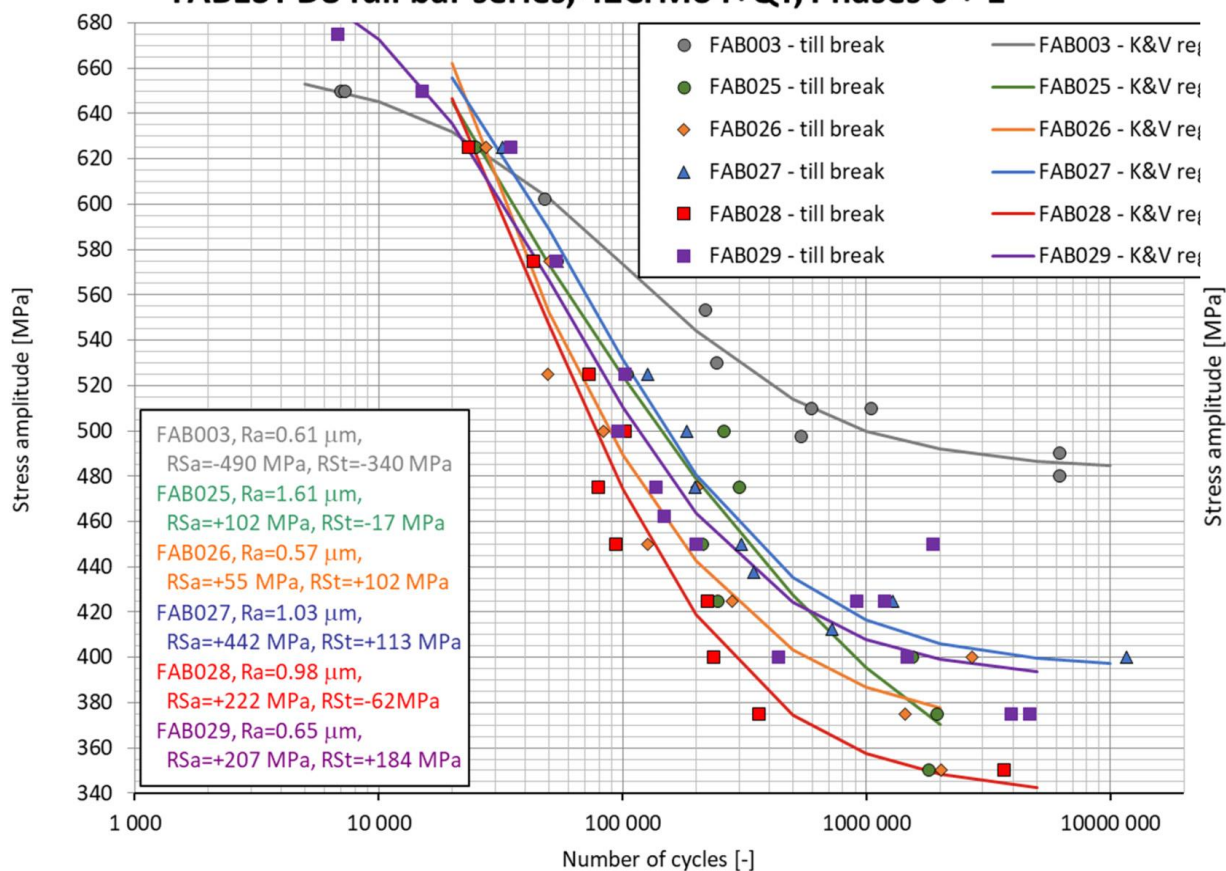
$$k_{surf} = a \cdot R_m^\beta$$

	a	β
Ground	1.58	-0.085
Machined	4.51	-0.265
Hot rolled	57.7	-0.718
Forged	272	-0.995

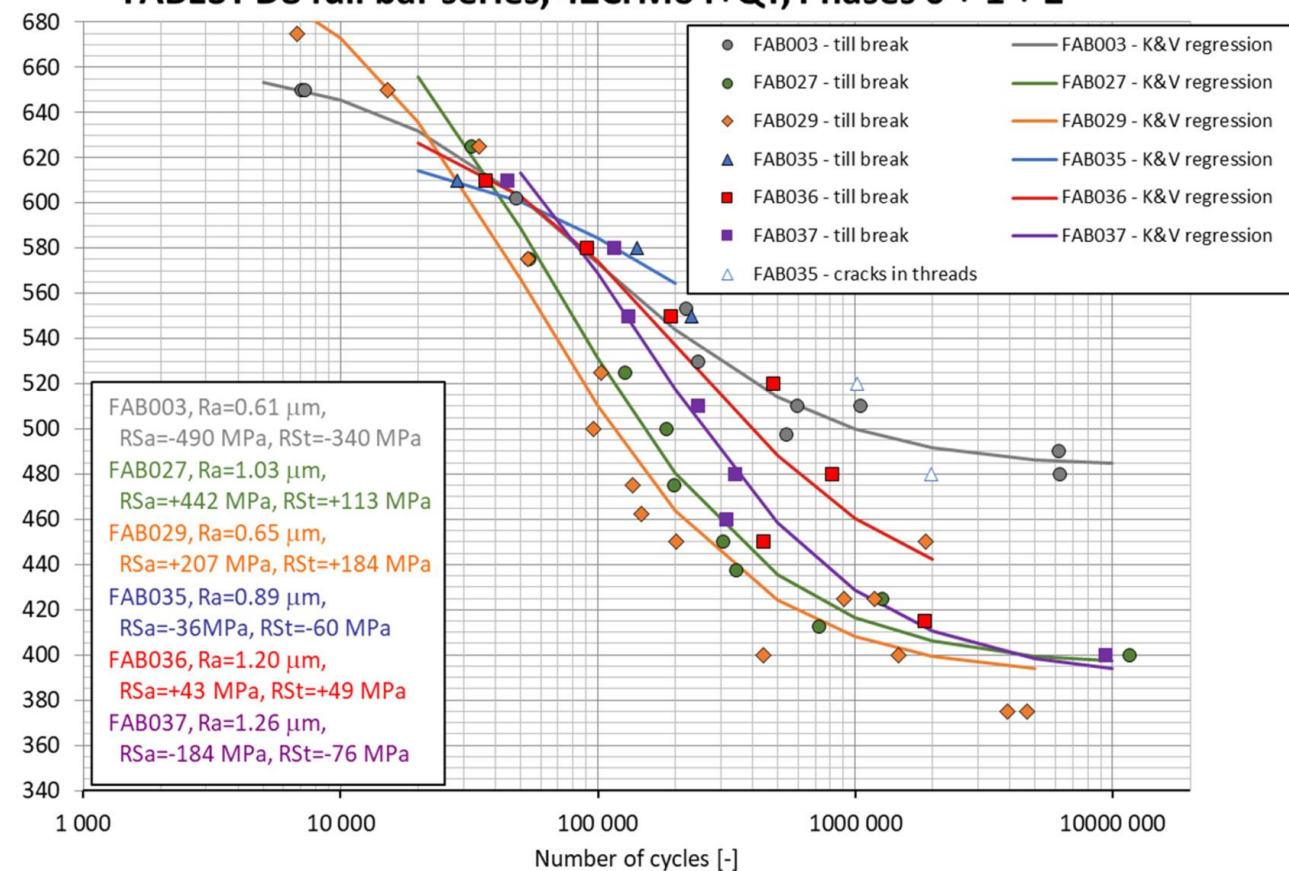
Roughness effect observed on FABEST 42CrMo4 +QT

Matušů, M. et al. The effect of machining parameters on surface integrity and fatigue performance of 42CrMo4 + QT high-strength steel. Mater. Sci. Technol. (2025) doi:10.1177/02670836251362509.

FABEST D8 full bar series, 42CrMo4+QT, Phases 0 + 1



FABEST D8 full bar series, 42CrMo4+QT, Phases 0 + 1 + 2

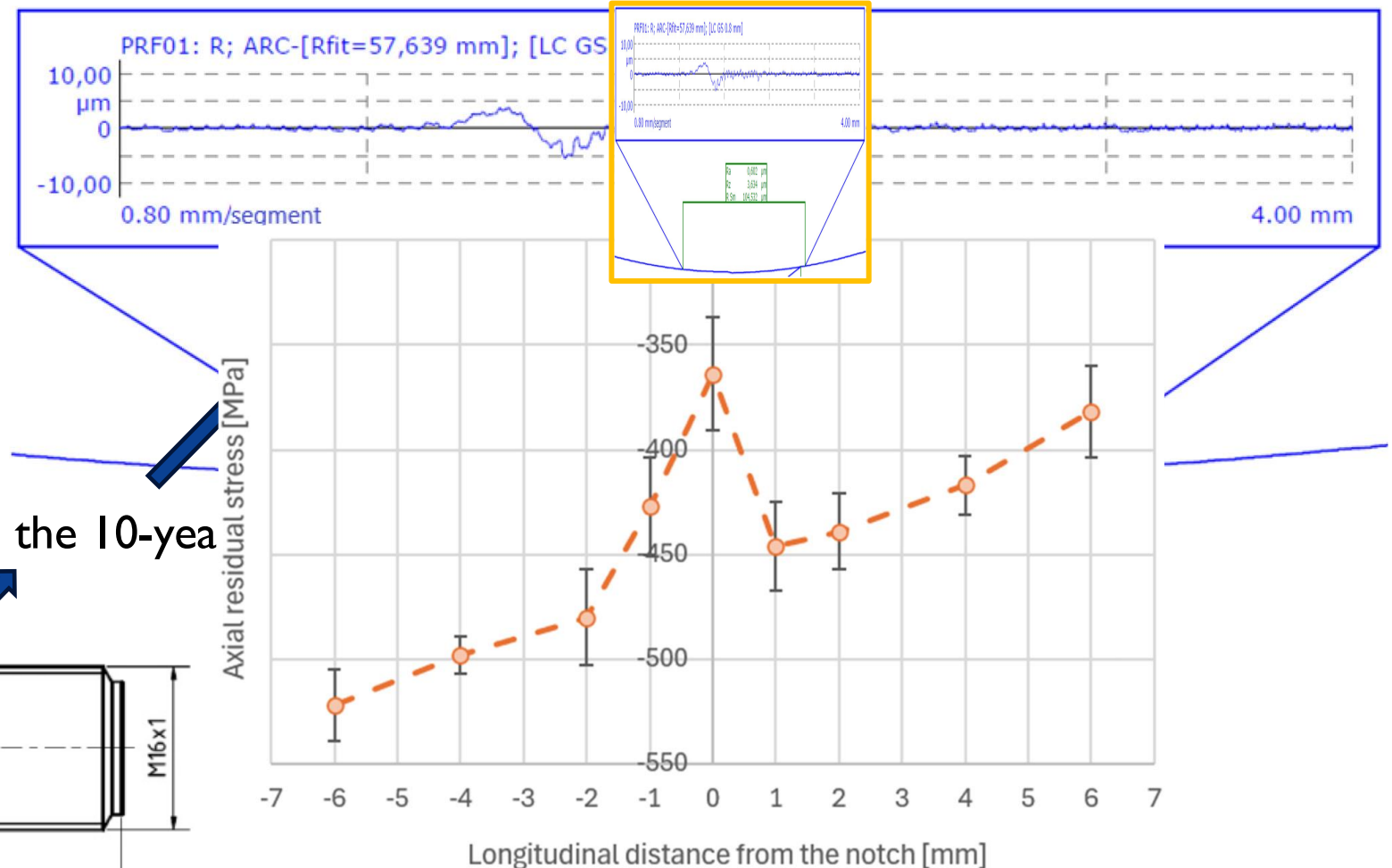
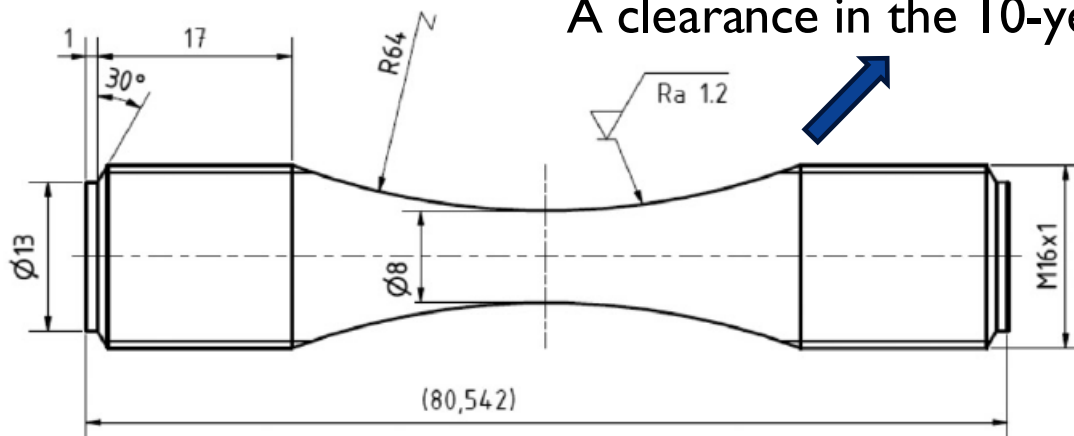


Effect of residual stresses?

- In practice, how would you measure residual stresses to make them accountable?
- How stable are they in time / under cyclic loading?
- For this material, they can span between -500 MPa and 300 MPa

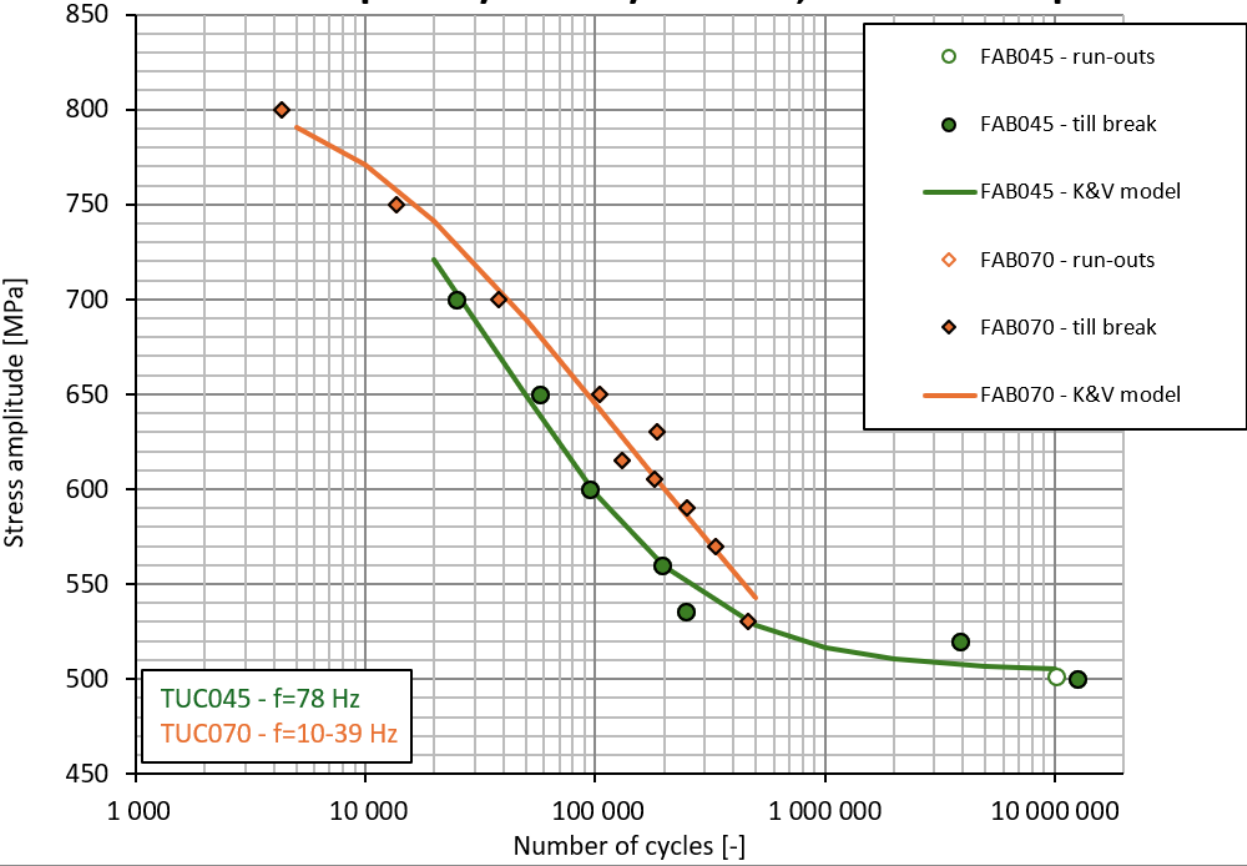
Matušů, M. et al. The effect of machining parameters on surface integrity and fatigue performance of 42CrMo4 + QT high-strength steel. Mater. Sci. Technol. (2025) doi:10.1177/02670836251362509.

A clearance in the 10-yea

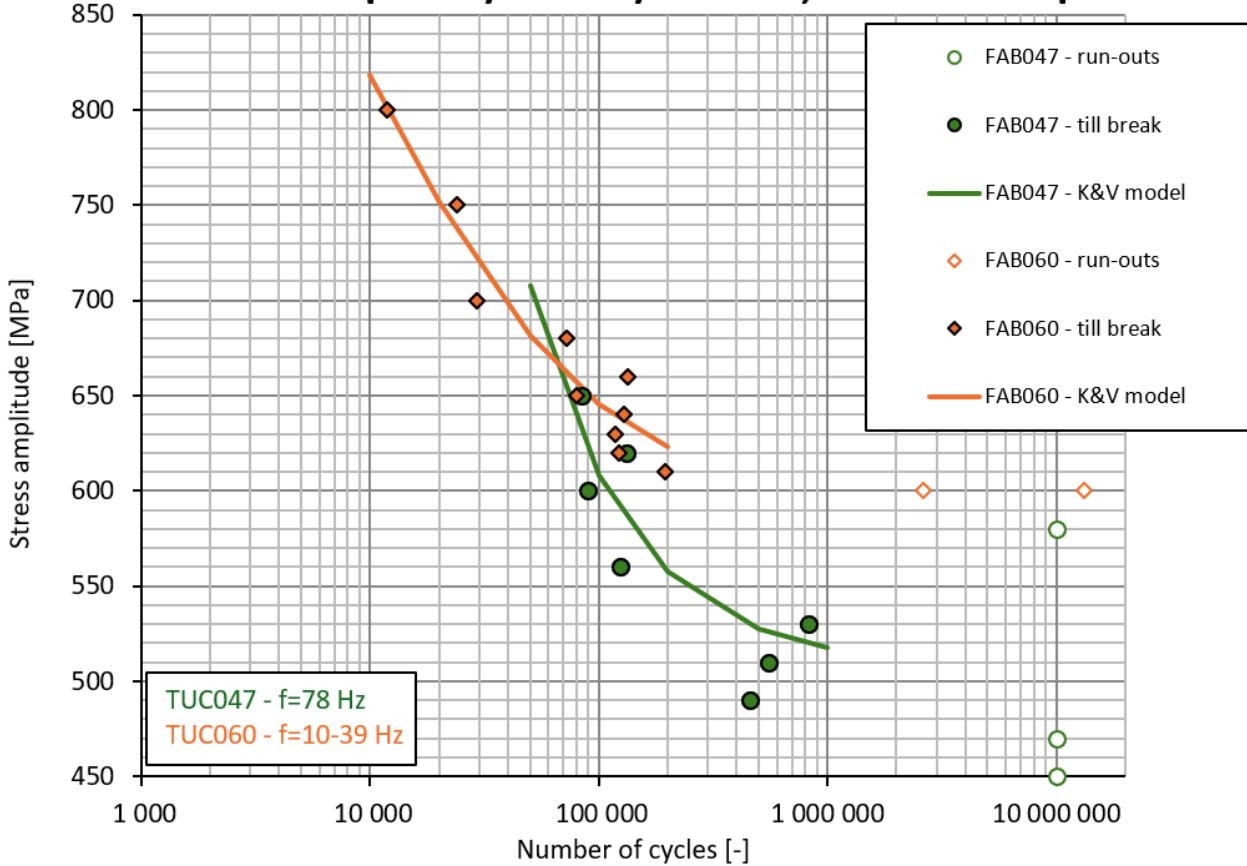


EFFECT OF LOAD FREQUENCY

Hollow spec. D/d = 8.1/7.0 mm, Manuf. setup #1



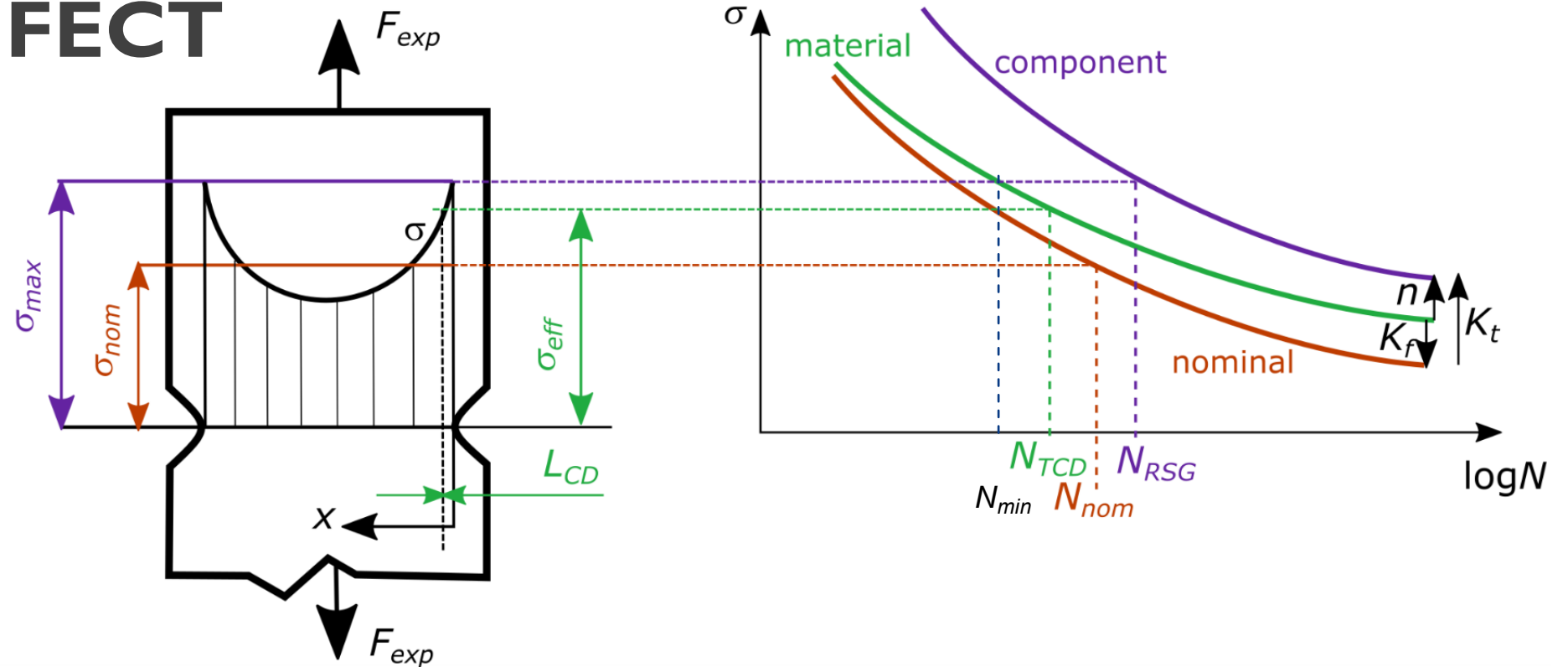
Hollow spec. D/d = 8.1/7.0 mm, Manuf. setup #2



	Residual stresses [MPa]	
	Axial	Tangential
Manuf. Setup #1	-383	-131
Manuf. Setup #2	-278	-56

	Roughness [mm]			
	mean Ra	st.dev. Ra	mean Rz	st. dev. Rz
Manuf. Setup #1	1.83	0.42	10.46	2.37
Manuf. Setup #2	1.40	0.32	8.41	1.66

NOTCH EFFECT



- Maximum stress with material S-N curve $\Rightarrow N_{min}$
- Nominal Stress methods $\Rightarrow N_{nom}$
- Relative Stress Gradient methods $\Rightarrow N_{RSG}$
- Critical Distance methods $\Rightarrow N_{TCD}$

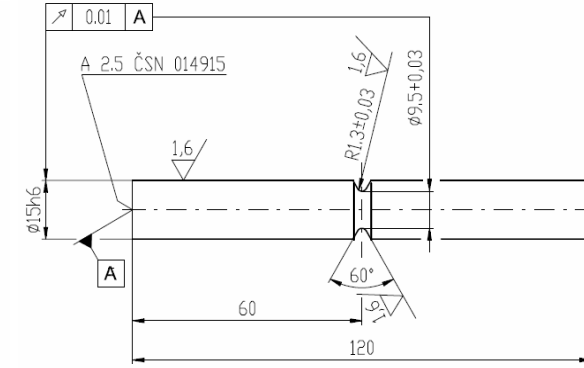
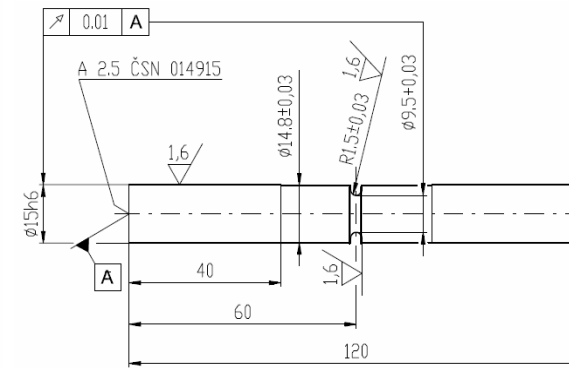
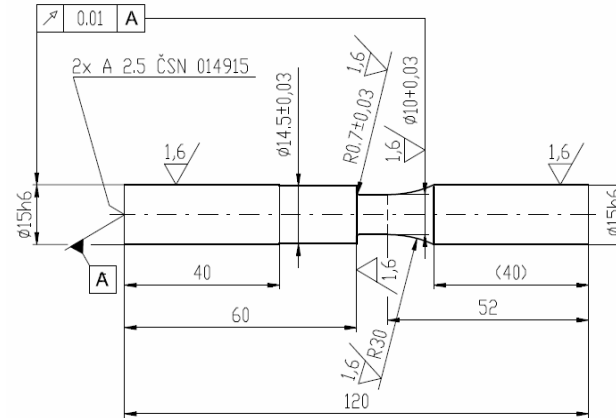
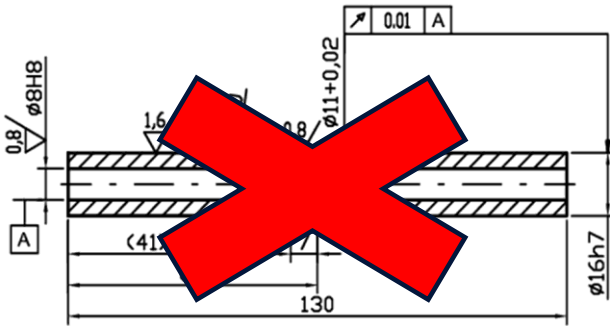
$$\gamma' = \frac{1}{\sigma_{max}} \frac{d\sigma}{dx}$$

$$n = f(\gamma', material)$$

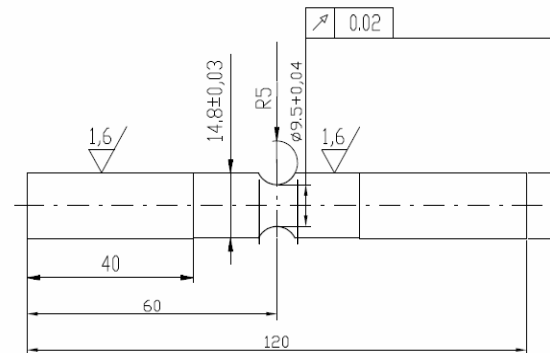
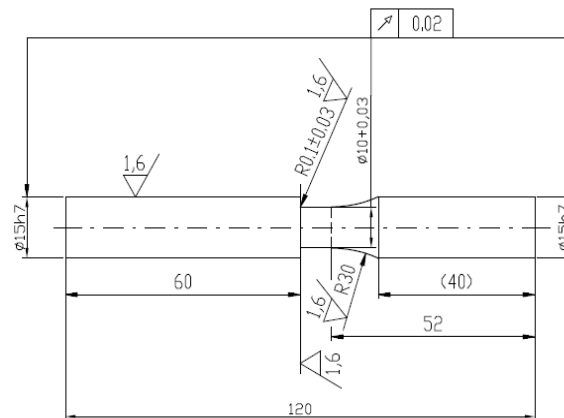
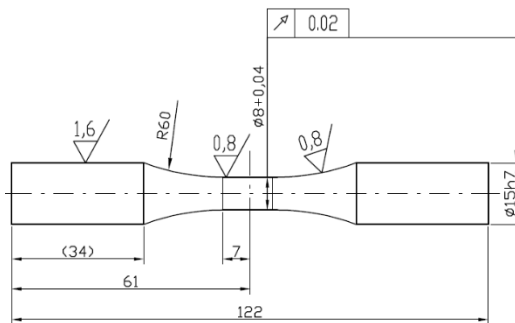
OUR VALIDATION INPUT

ČSN 41 1523 structural steel
equivalent to **S355J2**

Push-pull or torsion load cases, no mean stress

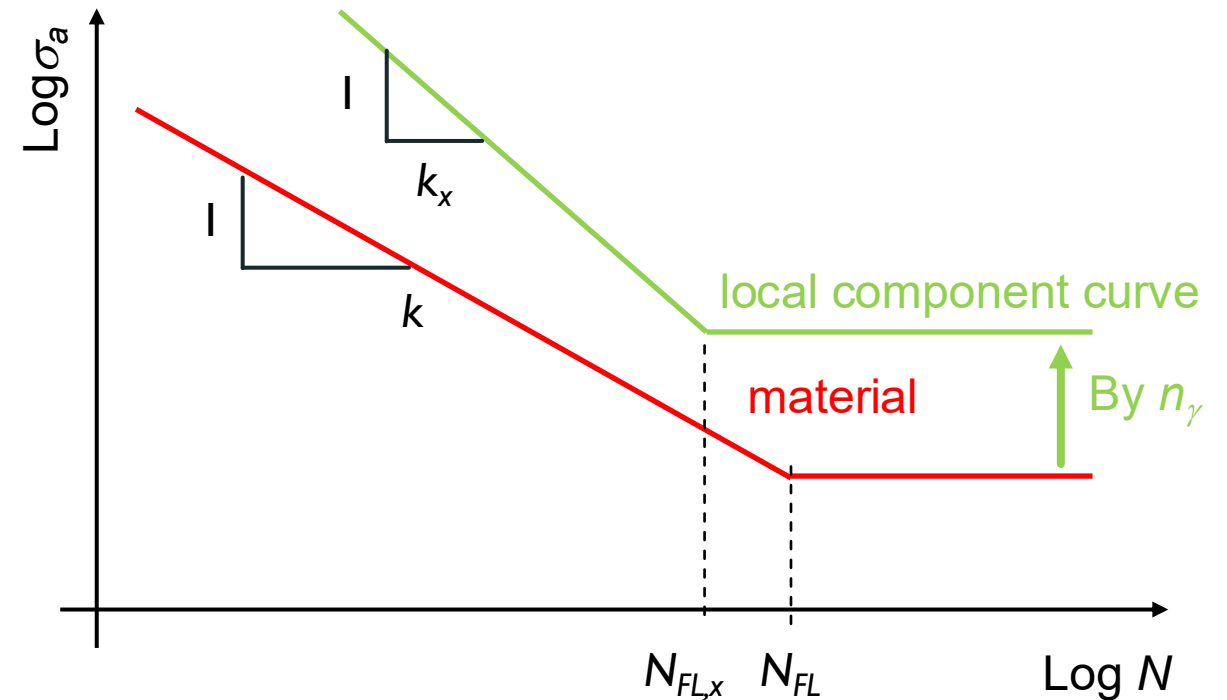


Push-pull or torsion or plane bending load cases, no mean stress



M. Nesládek, F. Fojtík, M. Mžourek, J. Papuga,
Notched structural steel
specimens assessed by
selected fatigue analysis
methods, Journal of
Constructional Steel
Research 219 (2024)
108789.
<https://doi.org/10.1016/j.jcsr.2024.108789>.

RSG APPROACH @ LOWER LIFETIMES



FEMFAT:

$$k_x = \frac{k - 3}{\left(1 + \frac{1.8\gamma'^{1.2}}{n_\gamma}\right)^2} + 3$$

$$N_{FL,x} = N_{FL} \cdot 10^{\frac{3.6}{k} - \frac{3.6}{k_x}}$$

FKM:

$$k_x = 5$$

$$N_{FL,x} = N_{FL}$$

RSG VALIDATION

Relative error:

$$ERR_{\sigma} = \frac{\sigma_{FS,exp}(N) - \sigma_{FS,est}(N)}{\sigma_{FS,exp}(N)}$$

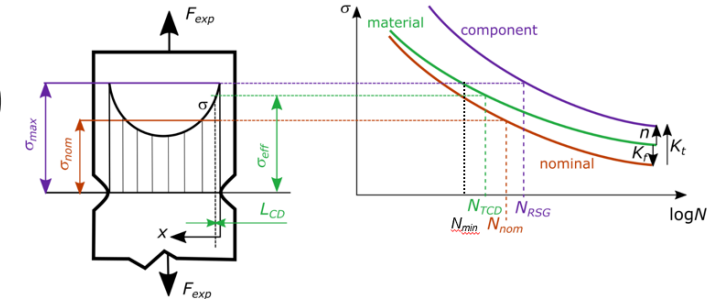
for $N=100,000; 200,000$ and $500,000$ cycles

Method		Maximum	Minimum	Range	St.dev.	Average value			
						Tension	Torsion	Bending	All
FKMv6	Stieler	48.3%	6.3%	42.0%	13.5%	26.9%	14.3%	13.2%	18.1%
	new	46.7%	4.6%	42.2%	13.2%	24.4%	13.5%	11.7%	16.5%
Femfat	Stieler	50.4%	1.9%	48.5%	15.6%	17.0%	17.9%	16.5%	17.2%
	Hück	46.1%	-20.1%	66.2%	22.1%	0.6%	-0.7%	0.1%	0.0%
	Eichlseder	62.2%	-4.0%	66.3%	21.1%	20.8%	16.4%	20.7%	19.3%

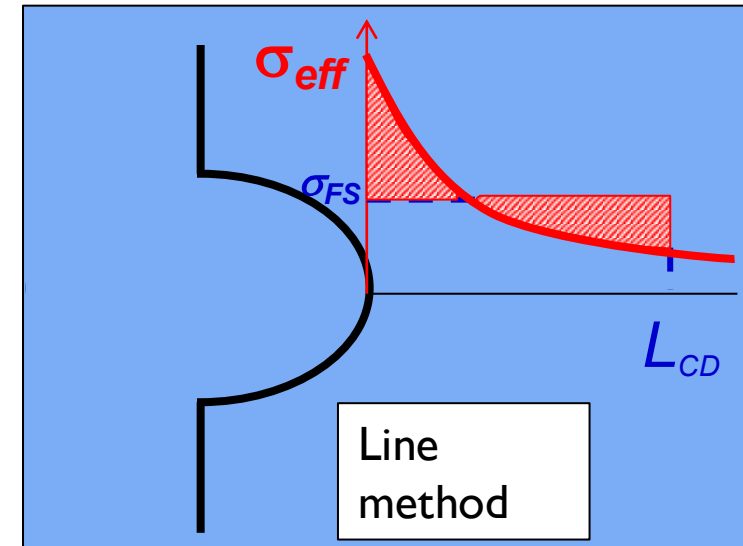
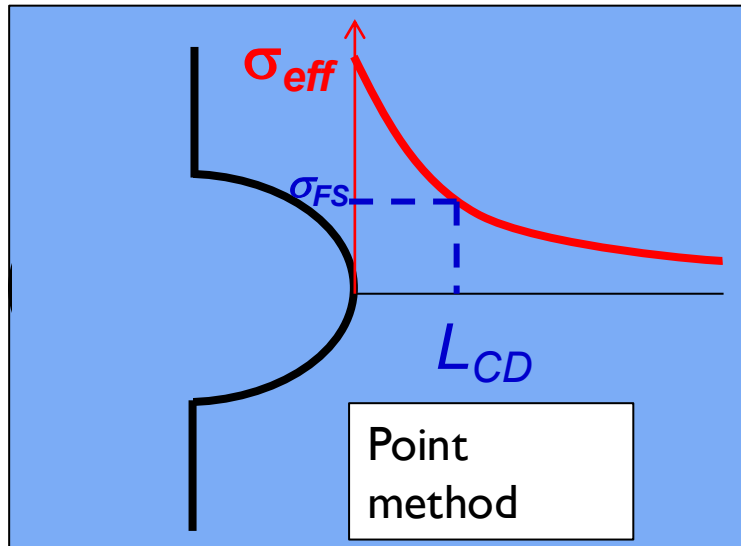
- The Eichlseder and Hück methods tend to result in too scattered results quality
- Both FKM-Guideline approaches provide generally safe estimates with a low scatter
- Superiority of FKM-Guideline v.7 over v.5 is not convincing
- No additional experimental data necessary
- No further tuning of any of the methods by available experimental data performed

THEORY OF CRITICAL DISTANCE (TCD)

The crack initiation at the notch starts in the moment, when some reference effective value (σ_{Mises} , σ_1 , Damage Parameter P) reaches the critical value in a defined depth below the surface :



- Point method (crit. depth L_{CD})
- Line method (analyses the integral **mean of the stress from the notch root to the distance L_{CD}**)



TCD VALIDATION

Relative error:

$$ERR_{\sigma} = \frac{\sigma_{FS,exp}(N) - \sigma_{FS,est}(N)}{\sigma_{FS,exp}(N)}$$

- Critical distance is not a material constant
- TCD requests tuning by additional experiments
- Using tests in plane bending and a very sharp notch for L_{CD} reduces the scatter
- Even best results worse than delivered by RSG

Push-pull load mode (a notched and the unnotched configurations in push-pull compared)										
L_{CD} defined from:	U1.5	V1.3	OS0.7	U5.0	OS0.2	U1.5	V1.3	OS0.7	U5.0	OS0.2
TCD version	Point method					Line method				
Average	-19.2%	-13.7%	3.5%	-82.3%	47.4%	-11.8%	-7.2%	5.7%	-63.0%	45.5%
Maximum	36.4%	36.2%	38.4%	15.2%	56.5%	35.8%	35.6%	37.3%	15.4%	55.7%
Minimum	-172.7%	-151.7%	-98.7%	-310.6%	32.6%	-122.5%	-107.0%	-75.4%	-232.0%	30.2%
Range	209.1%	187.9%	137.1%	325.8%	23.9%	158.3%	142.6%	112.7%	247.3%	25.5%
Standard deviation	58.9%	54.5%	44.3%	89.8%	6.3%	45.0%	41.8%	35.9%	66.2%	7.0%

Bending load mode (notched and the unnotched configurations in plane bending compared)										
L_{CD} defined from:	U1.5	V1.3	OS0.7	U5.0	OS0.2	U1.5	V1.3	OS0.7	U5.0	OS0.2
TCD version	Point method					Line method				
Average	3.2%	2.3%	12.6%	-15.7%	44.8%	2.9%	5.0%	14.1%	-10.8%	43.4%
Maximum	31.8%	30.9%	38.6%	17.8%	56.9%	31.6%	30.7%	38.2%	17.8%	56.4%
Minimum	-100.5%	-98.7%	-68.0%	-134.0%	29.2%	-72.0%	-70.6%	-50.5%	-97.2%	26.7%
Range	132.3%	129.6%	106.6%	151.9%	27.7%	103.6%	101.3%	88.8%	115.0%	29.8%
Standard deviation	30.7%	31.7%	27.5%	38.7%	6.2%	28.6%	25.8%	23.2%	29.4%	6.7%

CRITERIA FOR MULTIAXIAL FATIGUE LIMIT ESTIMATION

How to check them?

- All fatigue criteria converted to the standard:

$$D_p \leq f_{-1}$$

f_{-1} - fatigue limit in fully reversed axial loading

- For an experimentally set multiaxial fatigue limit:

$$D_p = f_{-1}$$

- Fatigue index error:

$$\Delta FI = \left(\frac{D_P - f_{-1}}{f_{-1}} \right) \cdot 100\%$$

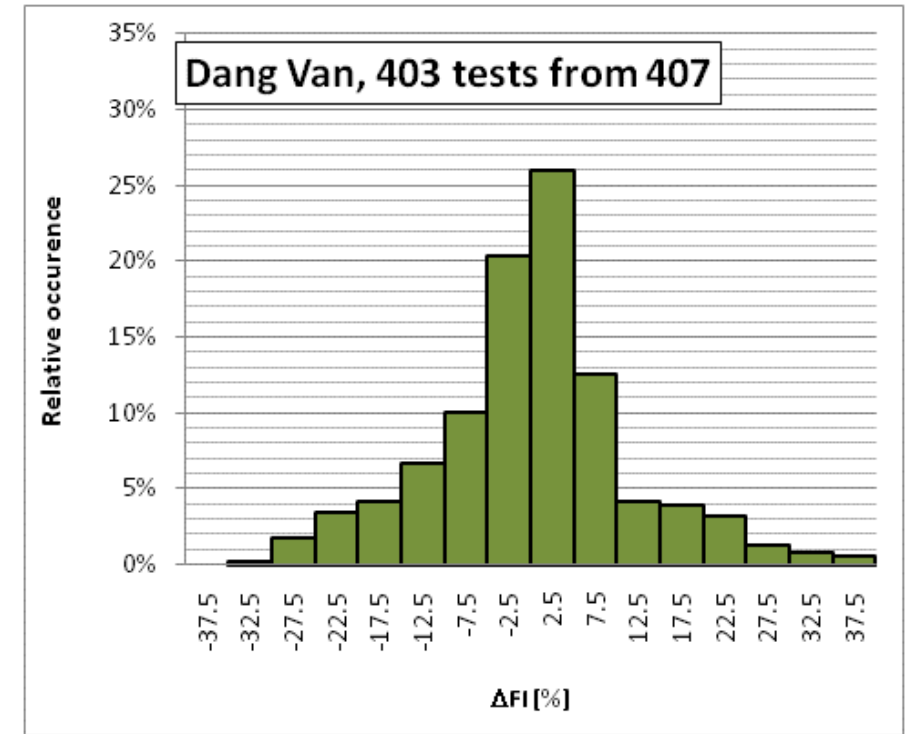


f_{-1} – type of axial loading (push-pull, bending, rotating bending) corresponds to the fatigue limit used in calculation

DANG VAN CRITERION

$$a_{DV} \cdot C_a + b_{DV} \cdot \sigma_{H,\max} \leq f_{-1}$$

- Critical plane criterion
- The most often used representative of multiaxial criteria
- Use of maximum hydrostatic stress does not seem to give acceptable results
- Conservative: MS, Ax+Ax
- Non-conservative:
 - nMS, OP
 - MS, To



average: -0.1%

range: 92.9%

standard deviation: 12.2%

WEAKNESS OF DANG VAN METHOD

Mean values of ΔF_I in individual groups (tests)	CRO	DV
All (407)	-8.0	-0.1
nMS (171)	-3.1	-0.6
nMS,OP (40)	-11.5	-7.9
nMS,IP (131)	-0.5	1.7

relative difference between predicted and experimental fatigue limit

no mean stress, out-of-phase loading

no mean stress, in-phase loading

- There is a significant difference in mean prediction values depending on the phase shift of individual load channels

MANSON-MCKNIGHT

- So simple, that it can be computed in MS Excel
 - !The cycle has to be detected a priori!
- Amplitude and mean value of each stress component is evaluated:

$$\sigma_a = \sqrt{\frac{1}{2} \left[(\sigma_{x,a} - \sigma_{y,a})^2 + (\sigma_{y,a} - \sigma_{z,a})^2 + (\sigma_{z,a} - \sigma_{x,a})^2 + 6(\tau_{xy,a}^2 + \tau_{yz,a}^2 + \tau_{zx,a}^2) \right]}$$

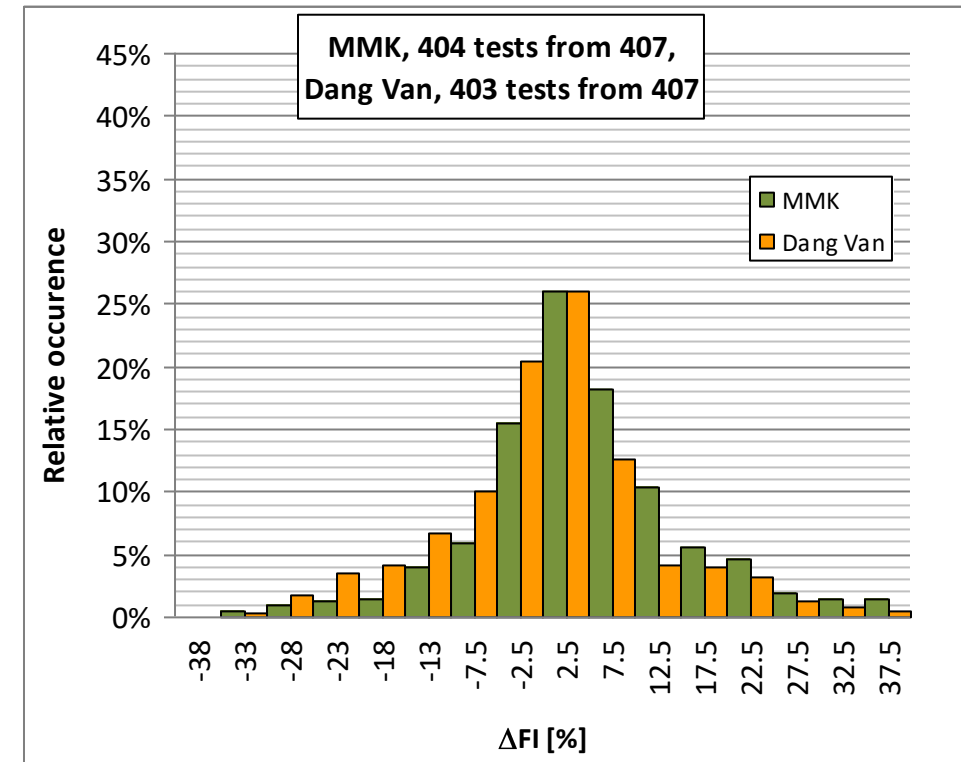
$$\sigma_m^* = \text{sign}[I_{1,d}] \cdot \sqrt{\frac{1}{2} \left[(\sigma_{x,m} - \sigma_{y,m})^2 + (\sigma_{y,m} - \sigma_{z,m})^2 + (\sigma_{z,m} - \sigma_{x,m})^2 + 6(\tau_{xy,m}^2 + \tau_{yz,m}^2 + \tau_{zx,m}^2) \right]}$$

- The mean equivalent value is signed according to the stress tensor invariant with biggest magnitude

MANSON-MCKNIGHT - RESULTS

- Not that bad as provided for the signed von Mises stress
- Many evaluated classes of experiments with conservative mean value (T_0 ; nMS-OP; $A_x + T_0$; brittle materials)
- $A_x + A_x$ with phase shift – dangerously non-conservative (mean value DFI=-17.2% !)
- In evaluation of individual classes is the Dang Van method better, but fails in mean stress effect

Papuga J, Vargas M, Hronek M. Evaluation of uniaxial fatigue criteria applied to multiaxially loaded unnotched samples. Eng Mech 2012;19:99-111.



... AND NOW THE ISSUES

DV – Dang Van critical plane method (1974)

MMKF –Manson-McKnight according to Filippini (2010)

MMK not to be used for

- brittle materials
- MS,Ax+Ax, PS<>0
- out-of-phase loading

MMK useful for pressure vessels

- MS,Ax+Ax,noPS

The difference is not big overall!

ΔFI in individual groups (tests)	Mean values			Range			Standard deviation		
	DV	MMKF	Diff	DV	MMKF	Diff	DV	MMKF	Diff
All (407)	0	1	1	93	106	13	12	12	-1
nMS (171)	-1	5	5	53	71	18	8	9	1
nMS,OP (40)	-8	8	16	53	70	18	12	14	2
nMS,IP (131)	2	4	2	22	45	22	4	7	3
MS (236)	0	-1	-2	93	82	-11	15	12	-2
MS,Ax (41)	-1	0	1	64	62	-2	13	11	-2
MS,To (18)	-16	-5	11	46	65	19	12	16	4
MS,Ax+Ax (36)	12	-11	-23	57	43	-14	13	12	-1
MS,Ax+Ax,noPS (18)	15	-3	-18	43	22	-20	12	8	-4
MS,Ax+Ax, PS<>0 (18)	9	-19	-28	57	40	-18	14	10	-4
Ax+To (285)	-2	3	5	63	96	33	10	10	0
MS,Ax+To (114)	-3	0	3	61	66	5	12	10	-1
MS-Ax, Ax+To (52)	-1	6	7	61	43	-18	12	9	-4
MS-To, Ax+To (31)	-10	-6	3	41	41	1	9	8	-1
ductile (352)	0	0	0	93	82	-11	13	11	-2
ductile,nMS (118)	-1	4	4	43	30	-12	8	5	-3
ductile,nMS,IP (86)	3	3	1	18	18	1	4	5	1
brittle (37)	-1	11	12	42	75	33	7	16	9
brittle, nMS(35)	-1	12	13	42	70	27	7	16	9
brittle,nMS,IP (29)	-2	8	10	16	44	28	3	11	8
extra-ductile (18)	2	0	-2	19	18	-1	5	4	-1
extra-ductile,nMS,IP (16)	3	-1	-4	12	11	-2	3	3	0

PAPUGA QCP CRITERION

$$\sqrt{a_Q \cdot C_a \cdot (C_a + c_Q \cdot C_m) + b_Q \cdot N_a \cdot (N_a + d_Q \cdot N_m)} \leq f_{-1}$$

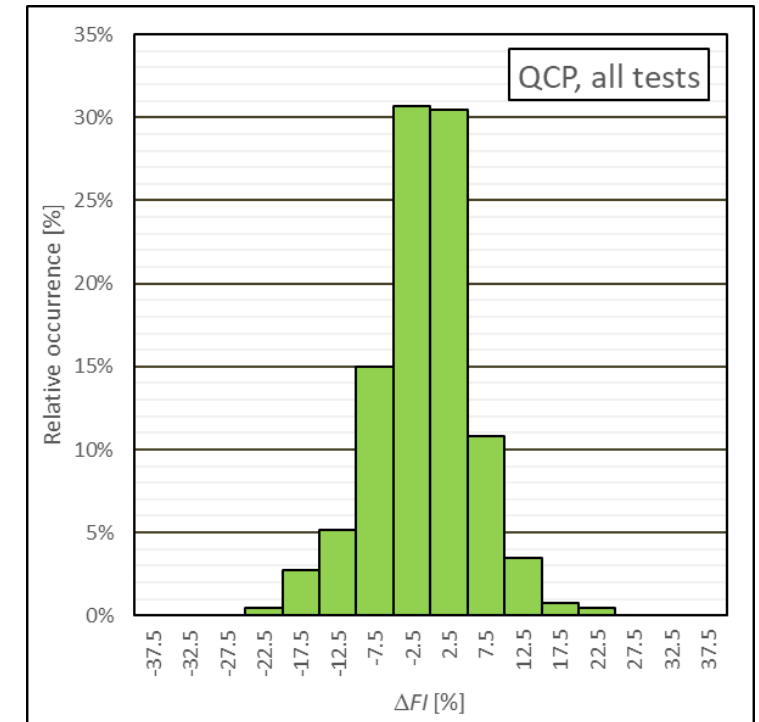
$$a_{QN} = \kappa^2$$

$$c_{QN} = \frac{4t_{-1}^2}{t_0^2} - 1$$

$$1 \leq \kappa < \sqrt{2}: b_{QN} = 1; \quad d_{QN} = \frac{4f_{-1}^2}{b_{QN}f_0^2} - 1$$

$$\kappa \geq \sqrt{2}: \quad b_{QN} = \kappa^2 - \kappa^4/4;$$

$$d_{QN} = \frac{4f_{-1}^2}{b_{QN}t_0^2} \left(1 - \frac{\kappa_0^2}{4}\right) - 1$$



average: -0.9%

range: 44.9%

standard deviation: 6.7%

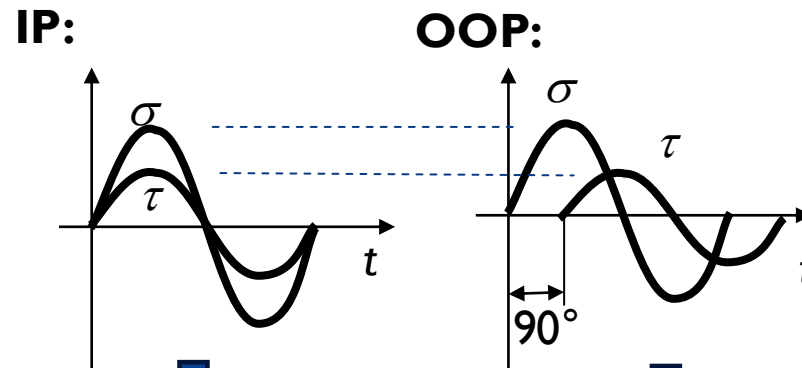
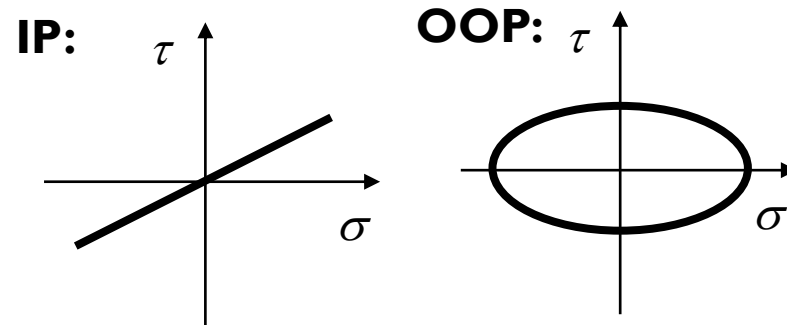
Papuga J, Halama R. Mean stress effect in multiaxial fatigue limit criteria. Arch Appl Mech. 2019;89(5):823-834.

PROPORTIONAL VS NON-PROPORTIONAL LOADING

IN-PHASE VS OUT-OF-PHASE LOADING

$$r_\sigma = \frac{\sigma_a}{\tau_a}$$

$r_\sigma \sim$ stress ratio
between applied axial
and torsion stress
amplitudes



FI_{IP}



FI_{OOP}

$$\frac{FI_{OOP}}{FI_{IP}} > 1$$

The criterion assumes that de-phasing of both harmonic signals causes increase of induced damage

EFFECT OF THE SHEAR STRESS PATH EVALUATION

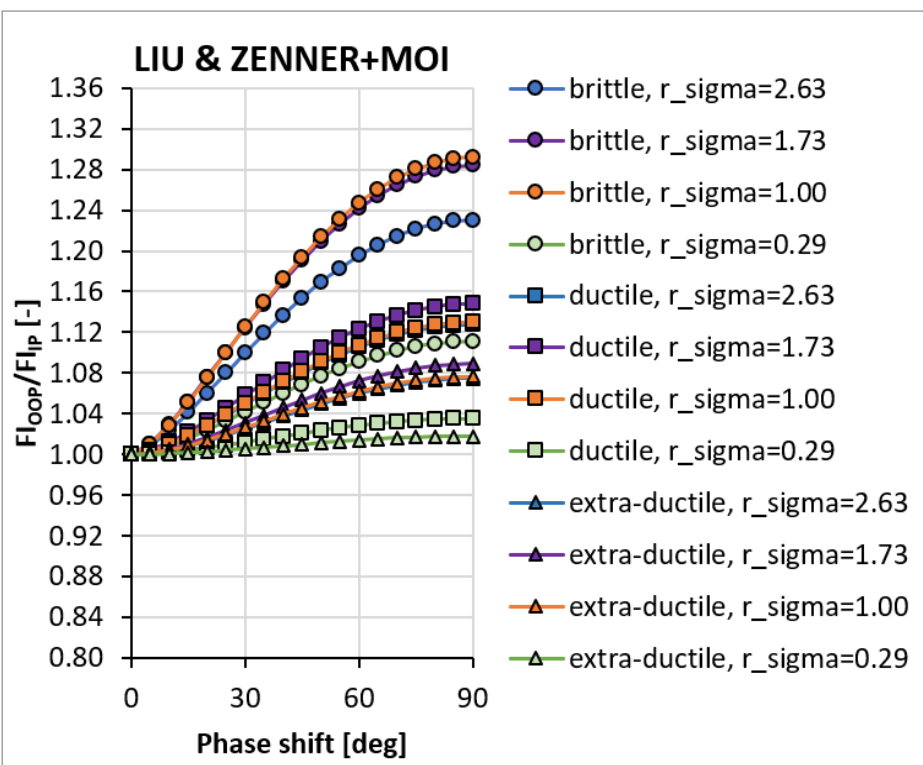
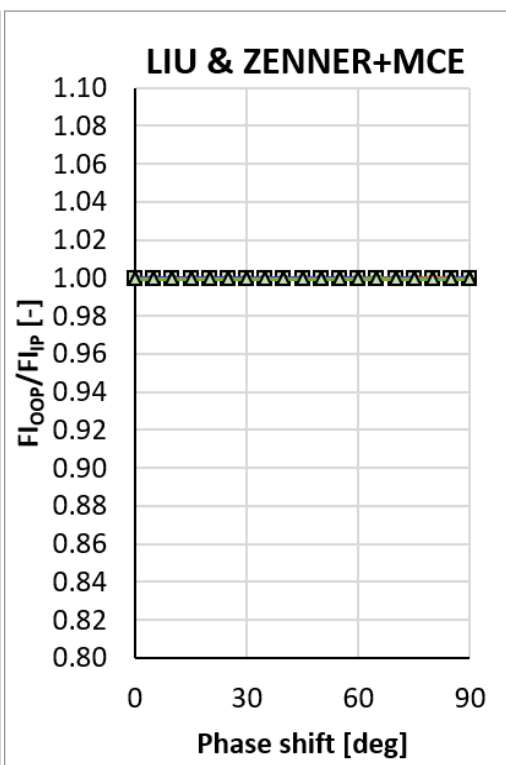
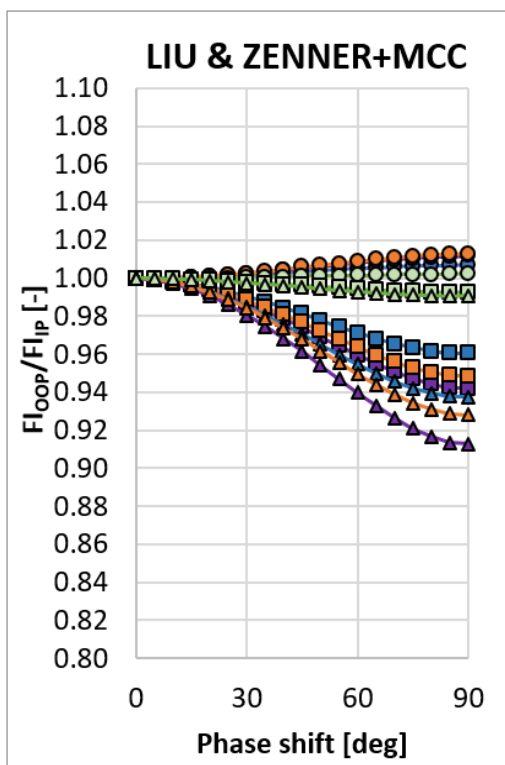
Meggiolaro, M.A.; Castro, J.T.P.D. The moment of inertia method to calculate equivalent ranges in non-proportional tension-torsion histories. J. Mater. Res. Technol. 2015, 4, 229-234. doi:10.1016/j.jmrt.2015.01.004.



Moment of Inertia

Minimum
Circumscribed Circle

Minimum
Circumscribed Ellipse



$$\kappa(N) = \frac{\sigma_{FS}(N)}{\tau_{FS}(N)}$$

$\kappa = 1.07$ brittle

$\kappa = 1.58$ ductile

$\kappa = 1.82$ extra-ductile

J. Papuga, E. Cízová, and A. Karolczuk. Validating the Methods to Process the Stress Path in Multiaxial High-Cycle Fatigue Criteria. Materials 14,206 (2021).

$r_sigma \sim$ stress ratio between applied axial and torsion stress amplitudes

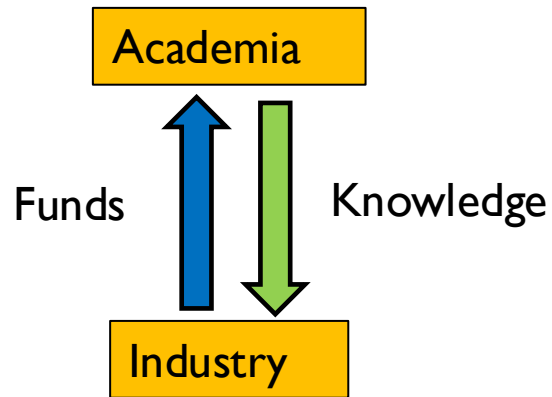
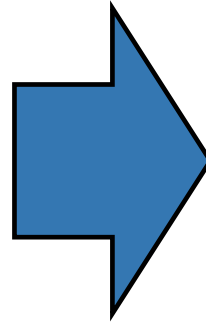
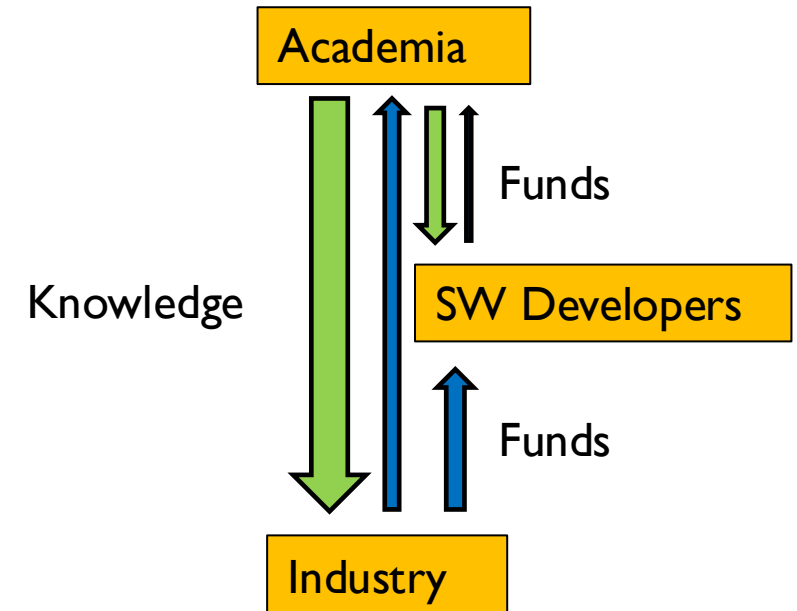
FATIGUE ESTIMATION MODELS

- Fatigue emerged as an engineering domain to study at the second end of 19th century
- They are purely empirical
- Fatigue damaging can be described as a weakest-link mechanism
 - Under further repeated loading, any minor partial damage can cause the whole structure to collapse
- Multiple concurrent mechanisms, effects and issues are preventing to find a general theory
- Experiments and experimental data to support or validate models are extremely costly

FATIGUE SOLVERS

- Emerged at the 80's of the 20th century
- Implemented the current status quo of the fatigue analysis
- They focus on automation of existing empirical knowledge
- Thanks to that they provide a stable output less subject to human factor
- Dependency on current users and their habits prevents frequent updates and improvements
- They cannot provide a universal solution
- Their use includes warranty denial
 - The only person responsible for the results of the analysis using the software is its user

STAKEHOLDERS

1960:**Free market competition****Computerization****2020:**

“... The users don’t really want to do their own research anymore. They expect nCode etc to "build-in" any new concept. Unfortunately this has stifled research by others. The major fatigue research labs in N.America are dying off....”

From personal e-mail communication with Al Conle (retired from Ford), 2009

WARRANTY DISCLAIMERS VS ADVERTISEMENT

- „MSC Fatigue enables durability engineers **to quickly and accurately predict** how long products will last **under any combination** of time-dependent or frequency-dependent loading conditions.“
MSCsoftware.com (2018). MSC Fatigue: FE Based Durability Solution. [online] Available at: <http://www.mscsoftware.com/product/msc-fatigue> [Accessed 30 Aug. 2018]

- “Do I need to be a fatigue expert?
No, you can leave that to us. There are factors which cannot be ignored if results are to be trusted. However, because fe-safe is technically advanced, it is configured to take into account many variables which will affect the accuracy of your results automatically.”
3ds.com. (2018). FE-SAFE - SIMULIATM 3D Software - Dassault Systèmes®. [online] Available at: <https://www.3ds.com/products-services/simulia/products/fe-safe/> [Accessed 30 Aug. 2018].

The goal today - Search for an intelligent system: The same (wo)man builds the virtual CAD model, meshes it, adds boundary conditions and runs the FE-analysis, which (s)he then uses for the subsequent fatigue analysis. The computer (program / AI-model) assists to these actions and prevents any potential errors.

THE DEADLOCK

Industry

- Rarely funds academic fatigue research directly
- Free market -> The cheaper the better

Fatigue solver developers

- Use the outcome of their research for any compensation.
- Prevent the use of their products through EULAs that restrict the use of use, often suggest that fatigue analysis is

Academia

- Sees little incentive to engage with software developers.
- Researchers rely on government funding that necessitate ambitious, forward-looking objectives rather than immediate practical applications.

Can we afford to rely on outdated, decades-old calculation models simply because they are automated?

At what point does this lack of progress become a liability rather than a convenience?

THE WAY OUT

Industry: Demand Transparency and Validation

- Not to accept the black-box scenario
- Demand independent benchmarking studies
- Provide access to verified fatigue data
- Define industry-wide validation protocols

Fatigue solver developers

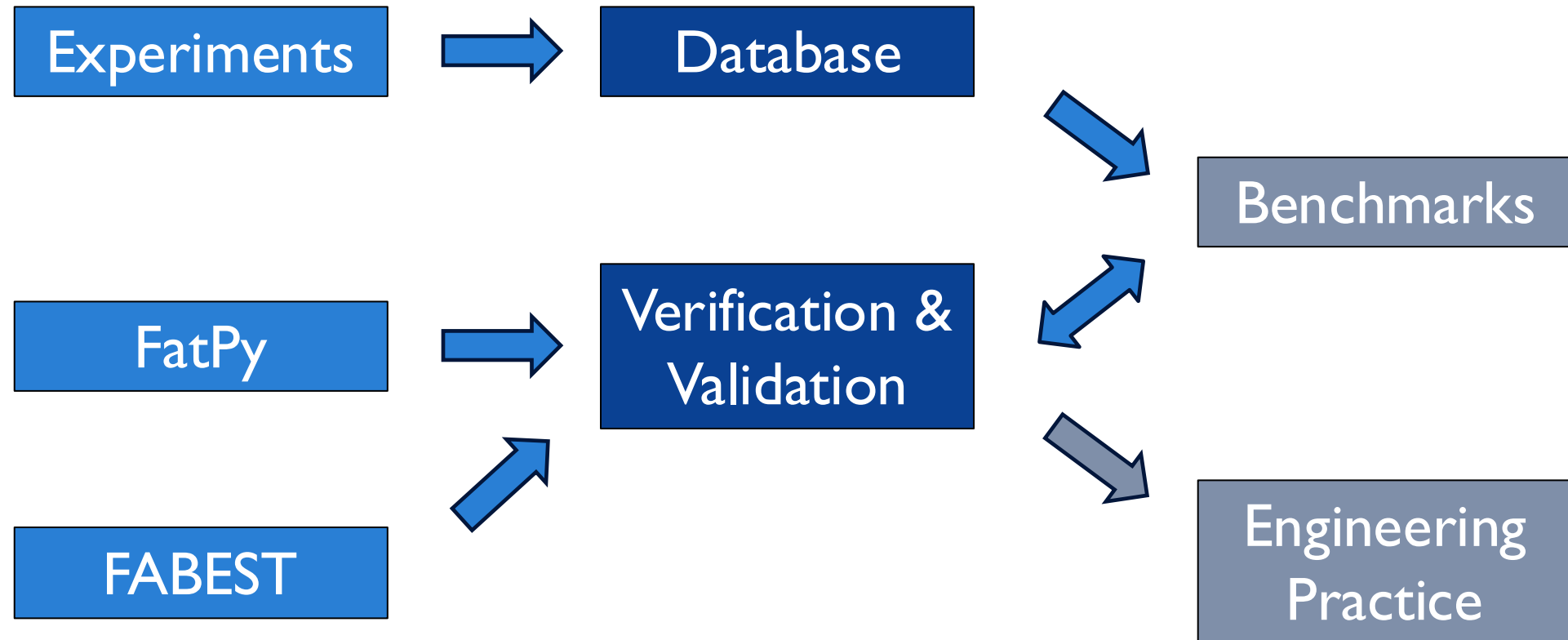
- Acknowledge the responsibility not only for automation but also for ensuring accuracy
- Support open-access benchmarking initiatives
- Provide the users with a clear understanding of their software's limitations

Academia

- Recognize the importance of validating and refining existing fatigue models
- Creating standardized, publicly available fatigue datasets for validation
- Collaborate with industry and SW developers in testing of real-world applications

-
- The diagram illustrates the FABER architecture, centered around the **Fatigue Benchmark Repository (FABER)**, which is identified by the code **COST CA23109**. The architecture involves several workgroups (WGs) and their interactions:
- WG1: Data Management** (Orange box) and **WG2: Analysis of Fatigue Data** (Green box) are at the top. They exchange **Data structure** and **Processing routines**.
 - WG3: FABEST Competition** (Blue box) is on the right. It exchanges **Data models** with WG2 and **Data** and **Task** information with WG4.
 - WG4: Fatigue Estimation Categories** (Purple box) is at the bottom right. It exchanges **Data** and **Task** information with WG3 and **Processing routines** with WG5.
 - WG5: Compound Problems** (Yellow-green box) is at the bottom left. It exchanges **Processing routines** with WG4 and **Data structure requests** with WG1.
 - WG6: Open-Source Fatigue Library** (Pink box) is on the left. It exchanges **Solver** information with WG5 and **Model rules** with WG1 and WG2.
- The central **FABER** repository acts as a hub, with **Model rules** being distributed to WG1 and WG2, and **Data structure requests** being sent to WG1. The **Solver** is also a key component, interacting with WG5 and WG6.

THE FABER CONCEPT



FABER connects all parts of this chain

FABEST

Single source of material (42CrMo4 +QT,
approx. 200 m of D=35 mm round bars
~ 1.4 tons

Input base for participants:

- Material certificate
- Geometry of specimens
- Machining parameters
- Residual stresses
- Roughness
- Static tests
- S-N curves
- One Manson-Coffin curve



FABEST 2026

BLIND FATIGUE-LIFE PREDICTION CHALLENGE
Based on real fatigue experimental data



CAN YOUR MODEL PREDICT REALITY?

Join researchers, engineers, and students worldwide in a **blind prediction** challenge. Predict fatigue life. **Benchmark** results. **Rank** against the best.

WHY JOIN?



**BENCHMARK
YOUR MODEL**



**COMPARE
GLOBALLY**



**PUBLISH
YOUR RESULTS**



**WIN
PRIZES**

LCF Contest

Low-Cycle Fatigue

Launch
5 MAY
2026



Deadline
31 DECEMBER
2026

PRIZES



iPhone/iPad
for the winners
of each category

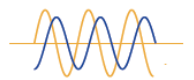


Top 3 performers
co-authorship
of review paper

HCF Contest

High-Cycle Fatigue

Launch
28 JUNE
2026



Deadline
31 DECEMBER
2026

PRIZES



1-month
scientific mission



Free FABER
conference
attendance



Top 2 performers
co-authorship
of review paper

LCF



DOWNLOAD DATASETS



SUBMIT PREDICTIONS



JOIN THE COMMUNITY

HCF



DOWNLOAD DATASETS



SUBMIT PREDICTIONS



JOIN THE COMMUNITY

QUESTIONS? | LCF: Prof. Radim Halama radim.halama@vsb.cz | HCF: Dr. Jan Papuga jan.papuga@fs.cvut.cz

FABEST HCF

There are 60 of such records!

S-N curve header

A	B	C	D	E
MAT_NAME	42CrMo4QT			
ID_MAT				
ID_REF	016/j.ijfatigue.2023.107743 ;			
SRC_TYPE	graph generated by computer			
SPECIMEN	Solid bar of circular cross-section, unnot			
SP_LOADS	related to net section			
SP_KT_TEN				
SP_KT_TOR				
SP_KT_BND				
LOCAL COMMENTS				
SN_W	17.594			
SN_C	2.69E+53			
SN_R2	0.9618			
SN_SLOGN	0.181			
SN_SLOGS	0.010			
SN_SS	12.703			
SN_NMIN	7023			
SN_NMAX	1049796			
SN_POINTS	05, 08, 03, 01, 04, 02, 05, 07			
SN_POINTN	8			
SN_PQS	0			
SN_PFL	2			
SN_PX	0			
SN_FL	496.4175866			
SN_NFL	1.00E+06			
KV_A	22162.7			
KV_BETA	-0.314			
KV_B	73017			
KV_C	199609			
KV_R2	0.9844			
KV_SLOGN	0.244			
KV_SLOGS	0.008			
KV_SS	9.882			
KV_NMIN	7023			
KV_NMAX	6212392			
KV_POINTS	05, 08, 03, 01, 04, 02, 05, 07, 10, 09			
KV_POINTN	10			
KV_PX	1			
L1_CON	12.6			
L1_LIN	-0.013			

Regression data

Experimental results

F	G	H	I	J	K	L	M	N	O
point ID	lead variable	load channel No. 1				number of cycles		finished / interrupted	comments
		tension-compression							
		amplitude [MPa]	mean value [MPa]	frequency [Hz]	phase shift [deg]	till END	till break		
FAB003_Rm		650.0	650.0	0	160	0	0.25	0.25	finished
FAB003_5	650.0	650.0	650.0	0	160	0	7 023	7 023	finished broken
FAB003_8	650.0	650.0	650.0	0	160	0	7 268	7 268	finished crack (central part)
FAB003_3	602.1	602.1	602.1	0	160	0	48 213	48 213	finished crack (central part)
FAB003_1	553.3	553.3	553.3	0	160	0	219 101	219 101	finished crack (central part)
FAB003_4	530.0	530.0	530.0	0	160	0	244 258	244 258	finished broken
FAB003_2	497.5	497.5	497.5	0	160	0	542 000	542 000	finished crack (central part)
FAB003_6	510.0	510.0	510.0	0	160	0	593 010	593 010	finished crack (central part)
FAB003_7	510.0	510.0	510.0	0	160	0	1 049 796	1 049 796	finished broken, radiography
FAB003_10	490.0	490.0	490.0	0	160	0	6 200 803	6 200 803	finished metallography
FAB003_9	480.0	480.0	480.0	0	160	0	6 212 392	6 212 392	finished crack (central part), radiography

Wöhler Curve - Basquin-Type Formula	lead variable	load channel No. 1				number of cycles
		tension-compression				
		amplitude [MPa]	mean value [MPa]	frequency [Hz]	phase shift [deg]	till break
SN_NMIN	658.0	658.0	0	160	0	7 023
SN_NMAX	495.0	495.0	0	160	0	1 049 796
FAB003_1E+3	735.1	735.1	0	160	0	1 000
FAB003_2E+3	706.7	706.7	0	160	0	2 000
FAB003_5E+3	670.9	670.9	0	160	0	5 000
FAB003_1E+4	644.9	644.9	0	160	0	10 000
FAB003_2E+4	620.0	620.0	0	160	0	20 000
FAB003_5E+4	588.6	588.6	0	160	0	50 000
FAB003_1E+5	565.8	565.8	0	160	0	100 000
FAB003_2E+5	544.0	544.0	0	160	0	200 000
FAB003_5E+5	516.4	516.4	0	160	0	500 000
FAB003_1E+6	496.4	496.4	0	160	0	1 000 000
FAB003_2E+6	477.2	477.2	0	160	0	2 000 000
FAB003_5E+6	453.0	453.0	0	160	0	5 000 000
FAB003_1E+7	435.5	435.5	0	160	0	10 000 000
FAB003_2E+7	418.7	418.7	0	160	0	20 000 000
FAB003_5E+7	397.4	397.4	0	160	0	50 000 000
FAB003_1E+8	382.1	382.1	0	160	0	100 000 000

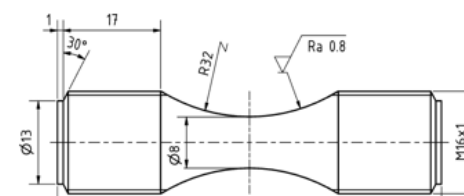
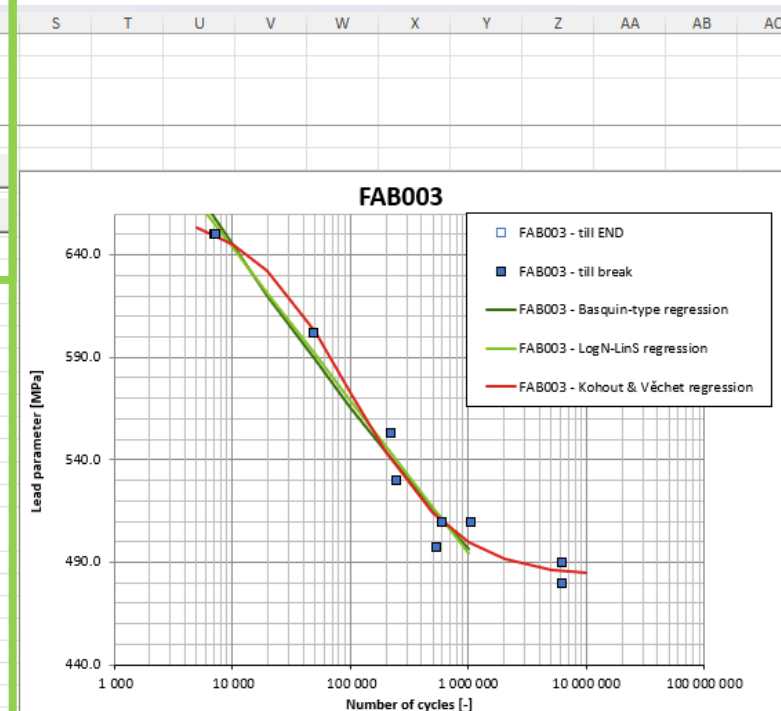
Inputs for graphs (K-V and LogLin model follow below)

Regression buttons

S-N Curve

K&V Curve

S-N curve graph



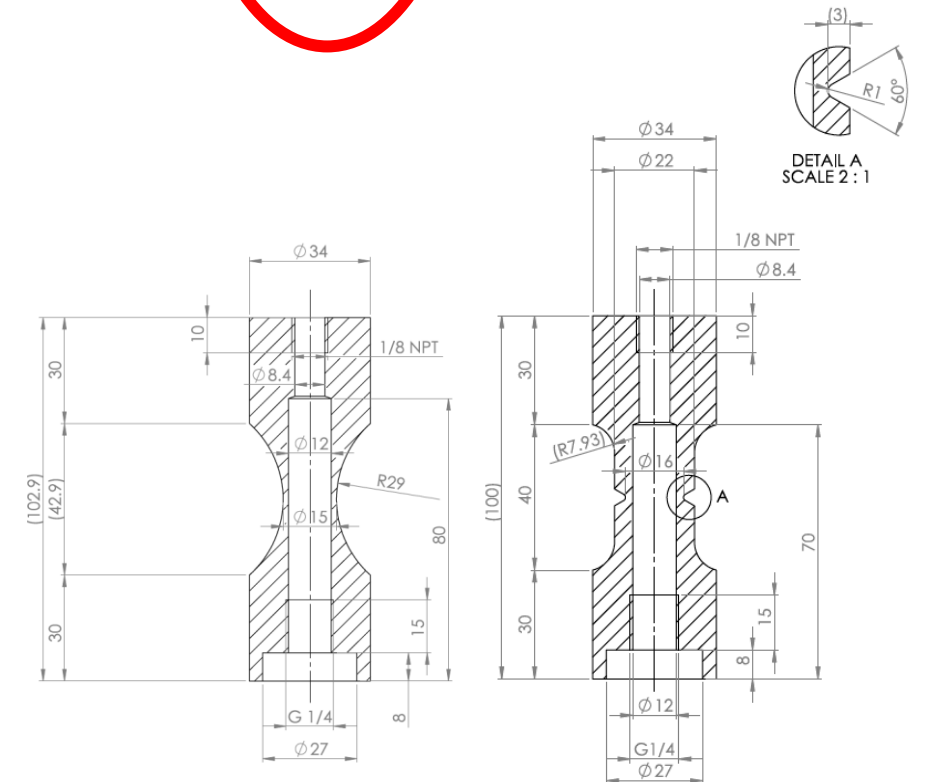
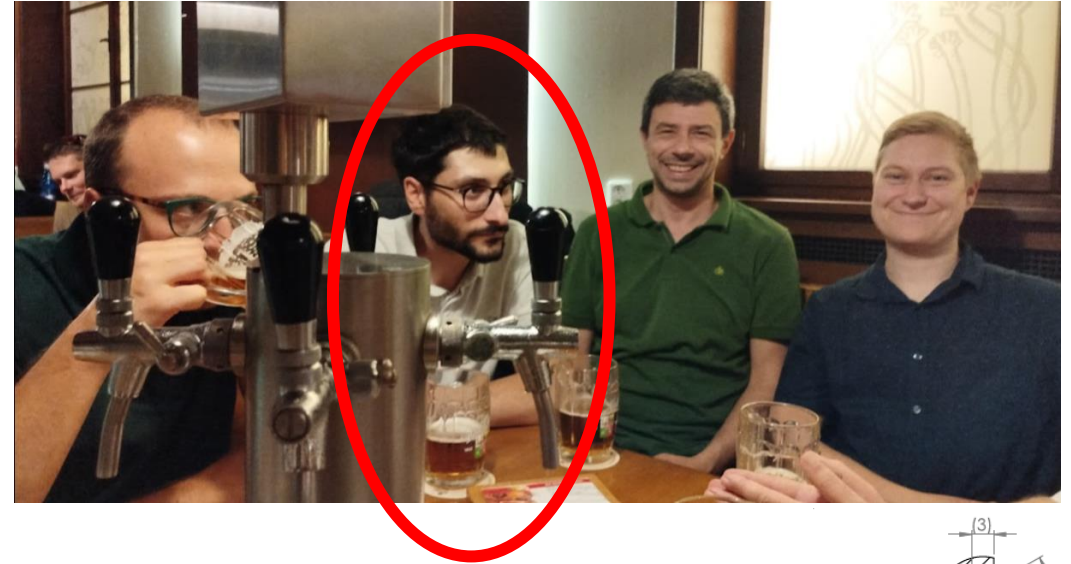
Specimen drawing

FABEST HCF TASK

Prepared by Andrea Chiocca, University of Pisa

Multiaxial tests

- Axial fully reversed loading
- Torsional fully reversed loading
- Constant inner pressure
- 0 or 90 phase degrees between Ax and To
- Tests run after all submissions delivered



FABEST SCHEDULE

We are delayed



- Xlsm on base data is ready
- Specimens for the final tests still under production
- Roughness measurements and residual stress measurements will follow
- Submissions to be delivered by December 31
- Experiments run approx. to end of March 2027
- Winner goes to 2nd FABER conference, May 11-13 2027
- Official announcement in Fatigue Design 2027, Senlis
- Paper on analysis of submissions readied in 2027

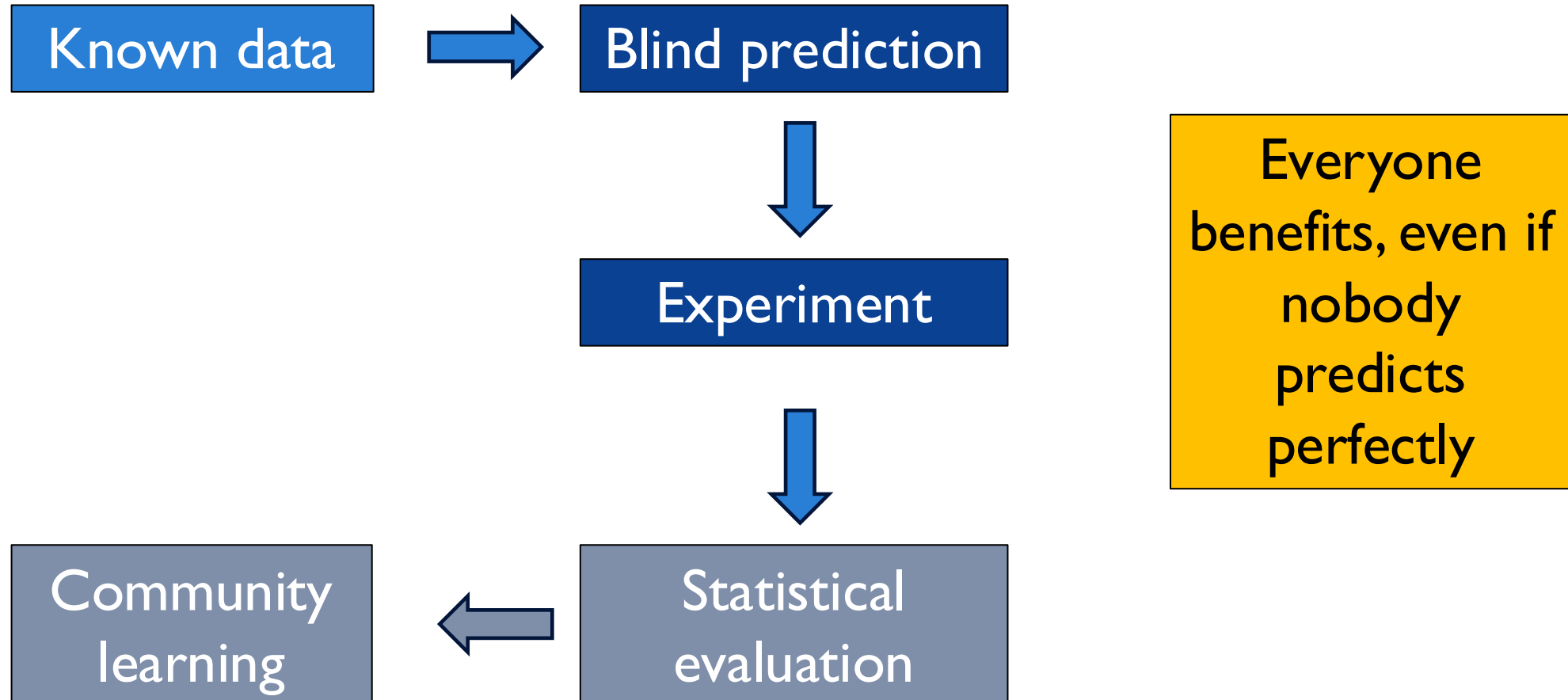
Register yourself at:

<https://docs.google.com/forms/d/e/1FAIpQLSe78MA6lGCu5olhIBV66z8x2gtgEgwkUOti2keIntpgmdXywg/viewform>

FABEST vol. 2

- To be launched in autumn 2027
- Variable amplitude loading / random loading

WHY COMPETITIONS?



CALL TO ACTION

Academia

- [Join us](#) to redefine the quality of fatigue life estimation

Industry: Invest in Reliable Fatigue Estimation

- [Fund](#) targeted research and development within FABER.
- [Provide access](#) to proprietary fatigue datasets.
- [Participate in FABER](#) to help define benchmark requirements that reflect real-world challenges.

Fatigue solver developers

- [Integrate](#) FABER benchmarks [into validation](#) pipelines.
- [Allow](#) independent [benchmarking](#) of your tools.
- [Collaborate](#) with academia and industry to refine existing fatigue models and ensure their accuracy.

Your Benefits



- Contacts
- Research topics
- Base data for research



- Understanding the limits of used SW
- Confidence in your fatigue estimates
- Reduced risk of unexpected failures



- Credibility of your products
- Trust of your users
- Base for further enhancements
- Validation outsourced for free

2024-2028

papuga@pragtic.com

COST (EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY) IS A FUNDING AGENCY FOR RESEARCH AND INNOVATION NETWORKS. OUR ACTIONS HELP CONNECT RESEARCH INITIATIVES ACROSS EUROPE AND ENABLE SCIENTISTS TO GROW THEIR IDEAS BY SHARING THEM WITH THEIR PEERS. THIS BOOSTS THEIR RESEARCH, CAREER AND INNOVATION.

WWW.COST.EU



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