FABEST in LCF

A Flagship Initiative of FABER COST Action (CA23109)

Official Website: https://www.faber-cost.eu/

Official Rules and Task Description

1. Introduction and Scientific Challenge

The FABEST in LCF (FAtigue Benchmarking and Evaluation Study in Low-Cycle Fatigue) focuses on the complex cyclic behaviour of 42CrMo4+QT steel. The ultimate scientific challenge of this benchmark lies in the identification of a robust fatigue criterion capable of capturing the coupled effects of ratcheting, mean stress relaxation, and significant cyclic softening behaviour (damage evolution) throughout the material's life. As this is the first global benchmarking challenge of its kind, the competition focuses on uniaxial loading as a fundamental and necessary step toward more complex scenarios.

2. Participation Categories

The competition is open to everyone (academia and industry). Participants can choose to submit their results for:

- **Category A ONLY** (Cyclic Plasticity Modeling)
- **Category B ONLY** (Fatigue Life Prediction)
- **BOTH Categories** (Recommended for full model validation)

To ensure a clear focus on individual or small-team contributions, each submission is limited to a maximum of two contributors/researchers (typically a PhD student and their supervisor). In case of a joint PhD supervision, two supervisors may be included as contibutors.

3. Experimental Data and Scope

The competition is based on a high-quality experimental dataset produced at VŠB – Technical University of Ostrava (Czech Republic). All tests are uniaxial LCF tests at room temperature.

2.1 Calibration Set (Provided to participants)

Participants will receive the full history of 24 experiments:

- *Case 1*: Strain-controlled, fully reversed, with strain ratio $R_\varepsilon = \varepsilon_{min}/\varepsilon_{max} = -1$.
- *Case 2*: Strain-controlled with constant mean strain $\varepsilon_m = +0.5\ \%$.
- *Case 3*: Stress-controlled with stress ratio $R_\sigma = \sigma_{min}/\sigma_{max} = -0.5$.

2.2 Validation Set (The "Blind" Target)

Participants are challenged to predict the behaviour for two new scenarios:

- *Case 4*: Strain-controlled with a more severe mean strain $\varepsilon_m = +1.0\ \%$.
- *Case 5*: Stress-controlled with a stress ratio $R_\sigma = -0.7$.

4. Required Submission Subset (List of Experiment IDs)

To ensure a fair and objective evaluation of the submissions, participants must submit predictions ONLY for the specific experiments listed in the table below. While the full calibration dataset is provided for model tuning, the competition evaluation is strictly limited to these 17 mandatory experiments.

Case ID	Control Type	Loading Condition	Amplitude level	ID	Amplitude value	Number of cycles in simulation N
Case 1 (Calibration)	Strain-controlled	$R_\varepsilon = -1$	High (H)	**Exp 1-1H**	1.25 %	**200**
			Medium (M)	**Exp 1-4M**	0.75 %	**1000**
			Low (L)	**Exp 1-7L**	0.4 %	**5000**
Case 2 (Calibration)	Strain-controlled	$\varepsilon_m = +0.5\%$	High (H)	**Exp 2-1H**	1.25 %	**200**
			Medium (M)	**Exp 2-4M**	0.75 %	**1000**
			Low (L)	**Exp 2-7L**	0.4 %	**5000**
Case 3 (Calibration)	Stress-controlled	$R_\sigma = -0.5$	High (H)	**Exp 3-1H**	790 MPa	**100**
			Medium (M)	**Exp 3-4M**	731 MPa	**1000**
			Low (L)	**Exp 3-7L**	675 MPa	**5000**
Case 4* (**BLIND**)	Strain-controlled	$\varepsilon_m = +1.0\%$	Level A	**Exp 4-1A**	1.25 %	**100**
			Level B	**Exp 4-3B**	0.85 %	**500**
			Level C	**Exp 4-5C**	0.6 %	**1000**
			Level D	**Exp 4-7D**	0.4 %	**5000**
Case 5* (**BLIND**)	Stress-controlled	$R_\sigma = -0.7$	Level A	**Exp 5-1A**	850 MPa	**100**
			Level B	**Exp 5-3B**	800 MPa	**500**
			Level C	**Exp 5-5C**	750 MPa	**2000**
			Level D	**Exp 5-7D**	700 MPa	**5000**

*NOTE: values of strain/stress amplitudes may be slightly revised/adjusted during the tests.

5. Technical Requirements per Category

5.1 Category A: Cyclic Plasticity Modeling

Predict the evolution of the cyclic response from the first cycle to failure (N_f).

- *Reporting:* Submit data for specific logarithmic cycles (e.g., 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, and 5000). It should be noted that the maximal number of cycles in simulation should be lower than N_f in calibration tests, but N_f is not known for validation cases. Therefore, required maximum number of cycles for each mandatory test is specified in the table above. For each mandatory test must be created a CSV file, where ε_a, ε_m, σ_a, σ_m and *cycle number* will be separated by semicolons, e.g. cyc_plast_**5_7D**.CSV file, where **5** means corresponding case and **7D** is the experiment ID (as per Table above). All 17 files must be placed within a folder named Category_A inside the final submission ZIP archive.
- *Documentation*: A brief PDF report describing the constitutive model used is mandatory (template will be provided by July 17th, 2026). The template will be a simple 2-page document focusing on the constitutive model formulation and parameter identification process.

- *Metric*: Integrated relative error over the entire fatigue life, weighting both mean value evolution and amplitude:

$$E_A = \frac{1}{n}\sum_{i=1}^{n}\left[\frac{1}{N_f}\sum_{j=1}^{N_f}\left(0.6\cdot\frac{\left|X_{m,j}^{pred}-X_{m,j}^{exp}\right|}{X_{m,1}^{exp}}+0.4\cdot\frac{\left|X_{a,j}^{pred}-X_{a,j}^{exp}\right|}{X_{a,1}^{exp}}\right)\right]$$

where n is the number of mandatory experiments (17 in total), $X_{m,j}$ and $X_{a,j}$ are the mean values and amplitudes of response quantities in j-th cycle, respectively (stress in strain-controlled test and strain in stress-controlled test), whereas *pred* and *exp* correspond to a result of prediction and experiment respectively. The error is normalized by the first cycle's amplitude/mean experimental value $X_{m,1}^{exp}$ and $X_{a,1}^{exp}$ respectively.

5.2 Category B: Fatigue Life Prediction

Predict the number of cycles to failure (N_f) for all mandatory experiments.

- *Definition:* Experimental number of cycles to failure (N_f^{exp}) is defined as a 10% decrease in the dynamic modulus evaluated from the compressive part of the hysteresis loop (E_{dyn}^{comp}).
- *Reporting:* Submit predictions for all mandatory tests in the form of a single CSV file, where N_f^{pred} and ID will be separated by semicolons. Submit predictions for all mandatory tests in a single CSV file named Life_Pred.csv. This file must be placed within a folder named Category_B inside the final submission ZIP archive.
- *Documentation*: A brief PDF report describing the damage criteria used is mandatory (template will be provided by July 17th, 2026). The template will be a simple 2-page document focusing on the fatigue model formulation and parameter identification process.
- *Metric*: Root Mean Square Logarithmic Error (RMSLE).

$$E_B = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(log_{10}N_f^{pred}-log_{10}N_f^{exp}\right)^2}$$

where n is the number of mandatory experiments (17 in total). It should be noted that the column "Number of cycles in simulation N" in the table above is important just for the category A. To ensure a fair and objective ranking by minimizing the influence of inherent experimental scatter, the submitted predictions for the validation experiments (Cases 4 and 5) will be compared against the statistically smoothed (best-fit) life curves derived from the complete validation test campaign. The reference value for each mandatory level will be the number of cycles (N_f^{exp}) calculated from these fitted curves for the given loading amplitude.

5.3 Submission Format

The complete submission must be packed into a single ZIP archive named as:

- Surname_FABEST_LCF_categ[X].zip

(Replace Surname with the corresponding author's surname and [X] with A, B, or AB depending on your chosen categories).

6. Reference and Data Access

The experimental foundation and detailed material characterization are provided in the following pre-print:

- Halama, R., et al. (2026): Cyclic Softening and Ratcheting of 42CrMo4+QT Steel: Experimental Basis for the FABEST LCF Benchmark. In: Proceedings of Experimental Stress Analysis (EAN 2026), 25.-27.5.2026, Hotel Maximus, Brno, Czech Republic, 8 p.

Datasets and Templates: The complete calibration dataset, CSV templates, and the EAN2026 pre-print are available at the ZENODO repository:

https://doi.org/10.5281/zenodo.19896970.

7. Timeline & Prizes

- *Official Launch*: May 5-6, 2026 (1st FABER Conference, Hvar, Croatia).
- *Support*: Training School in Ostrava (July 2026) at VSB-Technical University of Ostrava (Czechia).
- *Submission Deadline*: October 31, 2026.
- *Award Ceremony*: July 2027 (Fatigue 2027, Cambridge, UK).
- *Main Prizes*: High-end mobile devices (iPhone/iPad) for the winners of each category, sponsored by our Main Prize Partners.
- *Scientific Recognition*: Top 3 performers in each category will be invited to co-author a high-impact review paper within WG4.7.

Contacts

Scientific Committee & Competition Oversight:

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For further details or interest in sponsorship of the FABEST in LCF or the Training School, please contact:

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