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FORM PLANET

Determination of fatigue resistance through a fatigue test based on damage mechanics

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The accelerated pace of the industry requires tools to overcome the main limitations during the development of steels and the design of complex components. Sometimes, these limitations are given by the characterisation of the material, which is not always straightforward as in the case of fatigue resistance. Conventional high cycle fatigue tests are known to be time-consuming and expensive, especially the determination of the fatigue limit with a wide number of specimens [1].

The application of the fatigue test method based on continuum damage mechanics (CDM) [2] used in this work provides the industry with a **fast, cheap and easy to use method to accurately determine the fatigue endurance of different steels and conditions** for a better material selection in terms of fatigue.

Fatigue test
The stiffness method

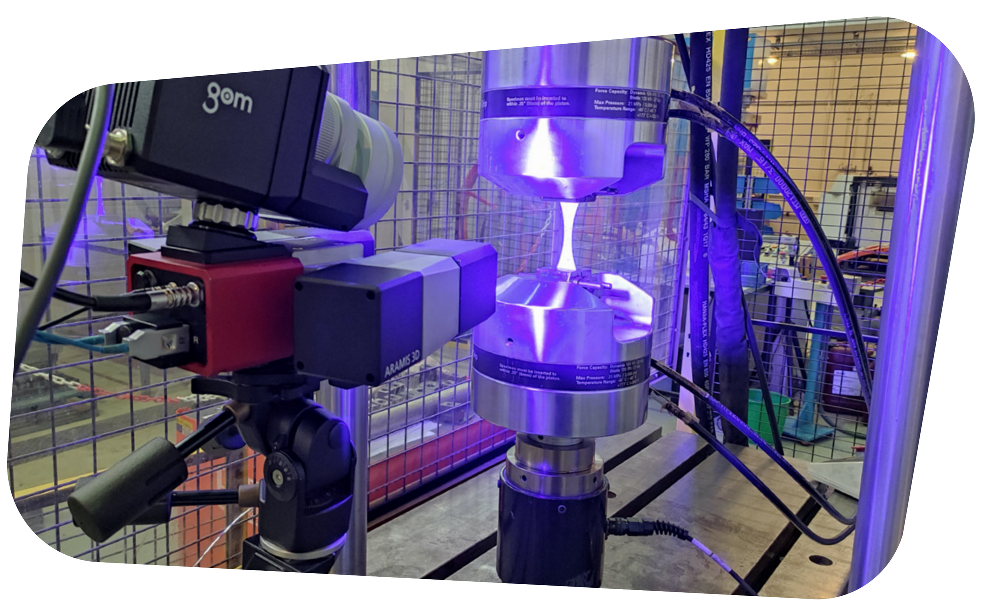

Figure 1. Fatigue test setup with the Digital Image Correlation (DIC) system to measure the elongation and determine the stiffness degradation.

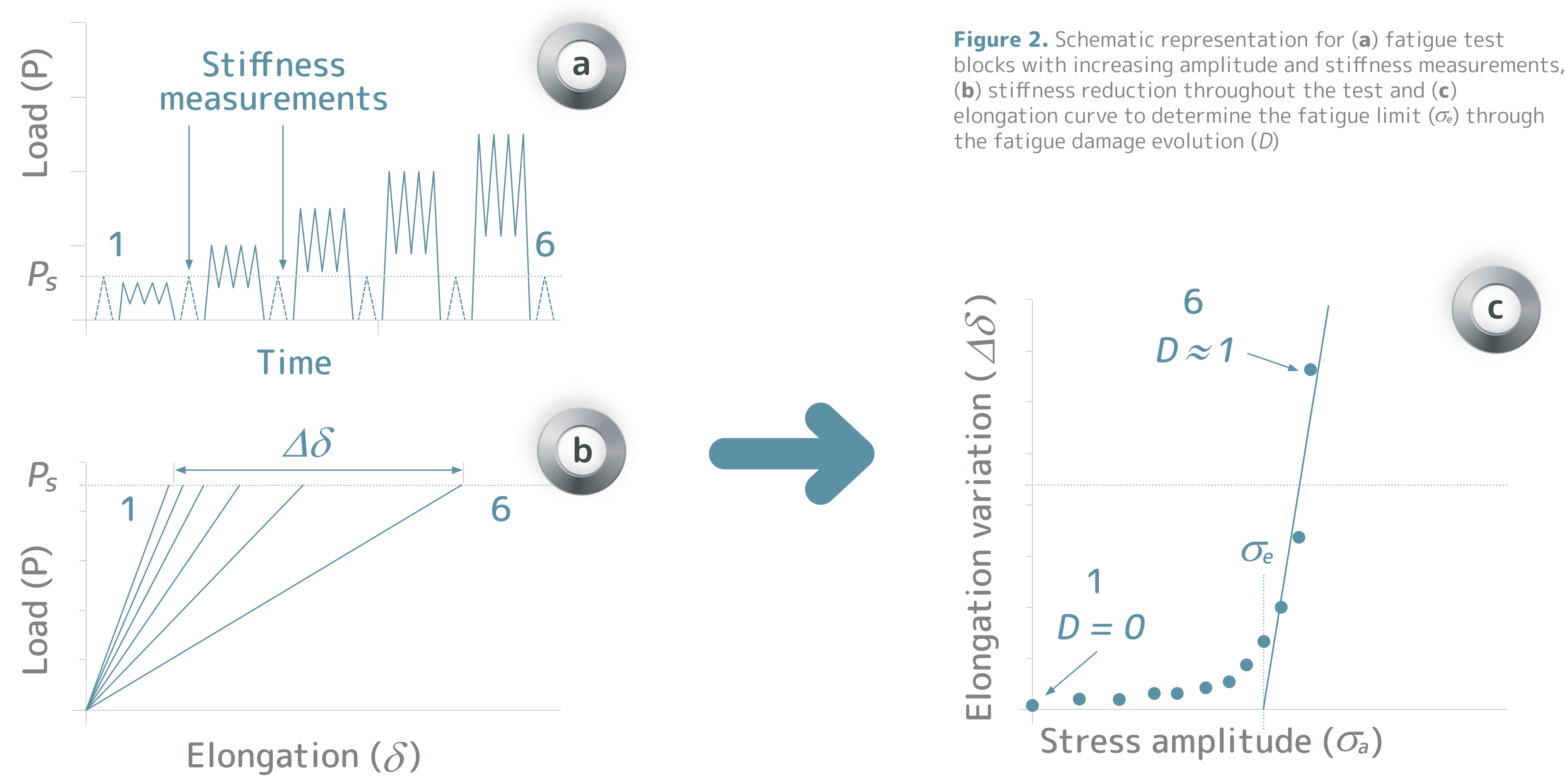

Figure 2. Schematic representation for (**a**) fatigue test blocks with increasing amplitude and stiffness measurements, (**b**) stiffness reduction throughout the test and (**c**) elongation curve to determine the fatigue limit (σ_e) through the fatigue damage evolution (D)

Applicable to different steels

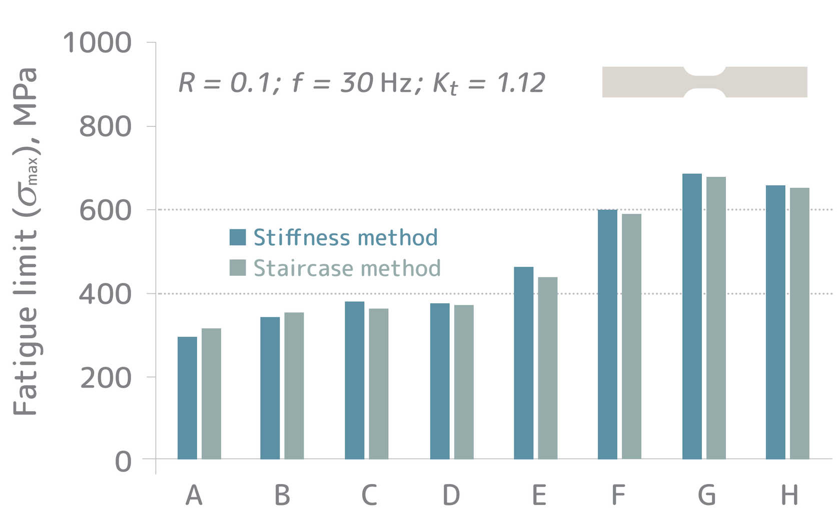

Figure 3. Fatigue results for electrical steels (A, B, C, D, E), TWIP steel (F), martensitic stainless steel (G) and martensitic steel (H) with the stiffness and staircase method.

Fatigue limit determined in 2h

Only 3 specimens required

Conventional equipment

Effect of manufacturing process

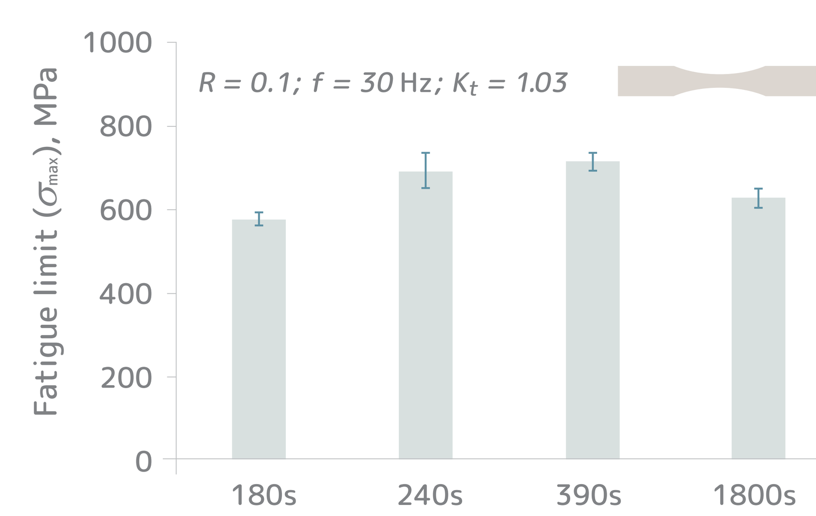

Figure 4. Evaluation of the effect of the austenitization time on the fatigue resistance of 22MnB5 [3].

Conclusions

1. The testing time to determine the fatigue limit of steels can be **drastically reduced** from days to hours by the *stiffness method*.
2. The method is robust and reliable to evaluate the fatigue resistance of **different steels** and **manufacturing processes effects**.
3. Only a conventional extensometer or DIC system is required to apply the stiffness method on a **reduced number of specimens**.
4. Common specimens determined according to ASTM E466 can be used without geometric restrictions.

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[3] S. Parareda, D. Casellas, D. Frómeta, E. Garcia-Llamas, A. Lara, J. Pujante, A. Mateo, Effect of heat treatment conditions on the fatigue resistance of press hardened 22MnB5 steel evaluated through rapid testing technique, IOP Conf. Ser. Mater. Sci. Eng. 1157 (2021) 012014. https://doi.org/10.1088/1757-899X/1157/1/012014.

Consortium

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