

Slag inclusions in steels: from lab to large tooling volumes, how their size scales up?

Cleanliness level of steel is usually assessed by optical methods. However, when small volumes (samples) are evaluated against Very High Cycle Fatigue (VHCF), the fatigue crack initiates at an internal slag inclusion, called defect. This defect is of the largest size in each known tested volume. Thus, using VHCF testing, a population of defect sizes can be acquired. By collecting defect-size data from multiple specimens and applying extreme-value statistics and reliability modelling, a defect size distribution curve can be constructed. However, it is known that the size of the defects is volume related, meaning that in larger volumes, the detected defects will be of larger size.

Would it be feasible to use the defect size distribution obtained from Very High Cycle Fatigue testing to estimate how defect sizes scale up with increasing volume: from laboratory specimens to components, larger structures, and potentially very large tooling volumes?

The long-term idea would be to investigate whether a probabilistic framework could be developed linking:

Steel cleanliness → defects → component volume → reliability

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