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Fine ceramics (advanced ceramics, advanced technical ceramics) — Weibull statistics for strength data

Céramiques techniques — Statistiques Weibull des données de résistance

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 20501 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Weibull statistics for strength data

1 Scope

This International Standard covers the reporting of uniaxial strength data and the estimation of probability distribution parameters for advanced ceramics which fail in a brittle fashion. The failure strength of advanced ceramics is treated as a continuous random variable. Typically, a number of test specimens with well-defined geometry are brought to failure under well-defined isothermal loading conditions. The load at which each specimen fails is recorded. The resulting failure stresses are used to obtain parameter estimates associated with the underlying population distribution.

This International Standard is restricted to the assumption that the distribution underlying the failure strengths is the two-parameter Weibull distribution with size scaling. Furthermore, this International Standard is restricted to test specimens (tensile, flexural, pressurized ring, etc.) that are primarily subjected to uniaxial stress states. Subclauses 5.4 and 5.5 outline methods of correcting for bias errors in the estimated Weibull parameters, and to calculate confidence bounds on those estimates from data sets where all failures originate from a single flaw population (i.e., a single failure mode). In samples where failures originate from multiple independent flaw populations (e.g., competing failure modes), the methods outlined in 5.4 and 5.5 for bias correction and confidence bounds are not applicable.

Measurements of the strength at failure are taken for one of two reasons: either for a comparison of the relative quality of two materials, or the prediction of the probability of failure (or alternatively the fracture strength) for a structure of interest. This International Standard permits estimates of the distribution parameters which are needed for either. In addition, this International Standard encourages the integration of mechanical property data and fractographic analysis.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1 Defect populations

2.1.1
censored strength data
strength measurements (i.e., a sample) containing suspended observations such as that produced by multiple competing or concurrent flaw populations

NOTE Consider a sample where fractography clearly established the existence of three concurrent flaw distributions (although this discussion is applicable to a sample with any number of concurrent flaw distributions). The three concurrent flaw distributions are referred to here as distributions A, B, and C. Based on fractographic analyses, each specimen strength is assigned to a flaw distribution that initiated failure. In estimating parameters that characterize the strength distribution associated with flaw distribution A, all specimens (and not just those that failed from type-A flaws) must be incorporated in the analysis to assure efficiency and accuracy of the resulting parameter estimates. The strength of a specimen that failed by a type-B (or type-C) flaw is treated as a *right censored* observation relative to the A flaw distribution. Failure due to a type-B (or type-C) flaw restricts, or censors, the information concerning type-A flaws in a specimen by suspending the test before failure occurs by a type-A flaw [2]. The strength from the most severe type-A flaw in those specimens that failed from type-B (or type-C) flaws is higher than (and thus to the *right* of) the observed strength. However, no information is provided regarding the magnitude of that difference. Censored data analysis techniques incorporated in this International Standard utilize this incomplete information to provide efficient and relatively unbiased estimates of the distribution parameters.