RELIABILITY ANALYSIS OF MECHANICAL COMPONENTS AND SYSTEMS

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A comprehensive definition of Reliability is given and discussed in terms of mechanical components and systems. A step-wise methodology is given for designing a specified Reliability into mechanical components and systems.

The methodology is based on (1) defining the design problem and what constitutes successful function, (2) identifying all of the significant variables and parameters involved in determining the failure governing strength and stress, (3) conducting a "Failure Modes, Effects and Criticality Analysis" which identify all components of the systems, list all significant failure modes and their causes, identify the parameters contributing to their causes, and list them in order of significance of contribution of the failure probability of each component to establish an order of priority of study, (4) verifying the selection of the significant and critical design parameters, (5) formulating the applicable failure governing criteria for each component failure mode, (6) formulating the relationship between the critical design parameters and the failure governing strength for each component for each critical failure mode, (7) determining the failure governing strength distribution by statistical and probabilistic methods using the previous relationship, (8) formulating the relationship between the critical design parameters and the failure governing stress for each component and critical mode, (9) determining the failure governing stress distribution by statistical and probabilistic methods using the previous relationship, (10) calculating the Reliability associated with each critical failure mode, and (11) synthesizing the Reliabilities for each failure mode in a component into the overall Reliability of each component considering all failure modes.

The failure governing criteria are discussed, and statistical and probabilistic methods of determining the failure governing strength and stress distributions are outlined. Methods for evaluating Reliability and for calculating the lower, one-sided, confidence limit on the actual Reliability are described.

Once each component's Reliability is determined, then the system's Reliability can be calculated by well known system Reliability prediction techniques.

The statistical static and dynamic design data requirements for the Design by Reliability methodology are discussed. The latest such data generated at The University of Arizona Reliability Research Laboratory are presented. A call is issued for a cooperative, international effort to generate and pool such statistical design data.

The Reliability methodology is applied to the design of statically or dynamically loaded mechanical components, including those subjected to fatigue loads, to illustrate the presented methodologies.

This methodology is compared with the conventional safety factor, SF, and safety margin, SM, approach. The inadequacy of the SF and SM approaches is brought out; however, the way is pointed out to unifying the SF or SM approaches with the Design by Reliability approach, thus taking advantage of both concepts.

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