EFFECTS OF ERROR, VARIABILITY, TESTING AND SAFETY FACTORS ON AIRCRAFT SAFETY

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This paper explores the effect of various representative safety measures taken while designing aircraft structures against uncertainties. Uncertainties include errors, such as in predicting the response (stress, deflection etc.) of the structure and variability in materials, loading and geometry. Passenger aircraft are built using conservative design practice at each stage .The use of a traditional safety factor of 1.5, alone is equivalent to a probability of failure of between 10^{-2} and 10^{-3}. Yet airliners are much safer, with crashes due to structural failure being extremely rare based on accident records. This paper looks at contribution of two other measures to safety--the use of conservative material properties and certification tests--using a simple model of failure of a representative aircraft structure. We find that the three safety measures together may be able to reduce the calculated probability of failure to about 10^{-7}, and that additional measures, such as conservative load specifications, and structural redundancy may be responsible for the higher safety encountered in practice. In addition, the paper sheds light on the effectiveness of certification tests for improving safety. It is found that certification tests reduce the calculated failure probabilities by updating the modeling error. We find that these tests are most effective when safety factors are low and when most of the uncertainty is due to systemic errors rather than variability. The effect of individual safety measure on structural reliability is shown in the figure below.

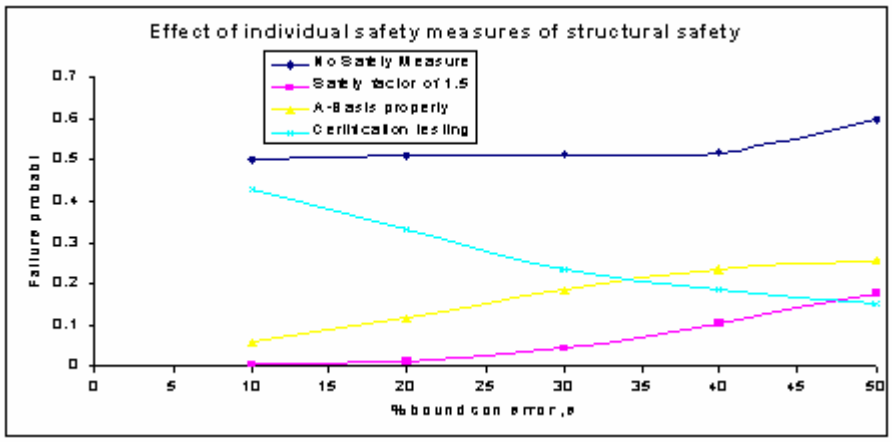

Figure 1: Effect of safety measures on reliability of aircraft

References

[1] Oberkampf, W.L., Deland, S.M., Rutherford, B.M., Diegert, K.V., and Alvin, K.F., "Estimation of Total Uncertainty in Modeling and Simulation," Sandia Report SAND2000-0824, 2000.