Choice of a Safety Factor

Selected from "Machine Design: An Integrated Approach", R.L. Norton

Some guidelines for the choice of a safety factor in machine design can be defined based on the quality and appropriateness of the material-property data available, the expected environmental conditions compared to those under which the material test data were obtained, and the accuracy of the loading and stress analysis models developed for the analyses. Table 1-3 shows a set of factors for ductile materials which can be chosen in each of the three categories listed based on the designer's knowledge or judgment of the quality of information used. The overall safety factor is then taken as the largest of the three factors chosen. Given the uncertainties involved, a safety factor typically should not be taken to more than 1 decimal place accuracy.

$$N_{ductile} \cong MAX(F1, F2, F3) \tag{1.1a}$$

The ductility or brittleness of the material is also a concern. Brittle materials are designed against the ultimate strength, so failure means fracture. Ductile materials under static loads are designed against the yield strength and are expected to give some visible warning of failure before fracture unless cracks indicate the possibility of a fracture-mechanics failure (see Sections 5-3 and 6-3). For these reasons, the safety factor for brittle materials is often made twice that which would be used for a ductile material in the same situation:

$$N_{brittle} \cong 2 * MAX(F1, F2, F3) \tag{1.1b}$$

This method of determining a safety factor is only a guideline to obtain a starting point and is obviously subject to the judgment of the designer in selecting factors in each category. The designer has the ultimate responsibility to ensure that the design is safe. A larger safety factor than any shown in Table 1-3 may be appropriate in some circumstances.

Table 1-3 Factors Used to Determine a Safety Factor for Ductile Materials

Information	Quality of Information	Factor
		F1
	The actual material used was tested	1.3
Material property data	Representative material test data are available	2
available from tests	Fairly representative material test data are available	3
	Poorly representative material test data are available	5+
		F2
	Are identical to material test conditions	1.3
Environmental conditions	Essentially room-ambient environment	2
in which it will be used	Moderately challenging environment	3
	Extremely challenging environment	5+
		F3
	Models have been tested against experiments	1.3
Analytical models for	Models accurately represent system	2
loading and stress	Models approximately represent system	3
	Models are crude approximations	5+