Part I

Imperfect Behavior at Simple Critical Points

This part, Part I, is devoted to the study of imperfect behavior in the neighborhood of a simple critical point, whereas the study of a double critical point will be given in Part II with the use of group theory. Emphasis is placed on the case of a large number of initial imperfection parameters, while it is customary to deal with a single imperfection parameter. As cited in the Preface, major viewpoints of this part are:

(1) theories of the strength of (structural) systems that is defined as the value of a bifurcation parameter at a bifurcation point; and

(2) a systematic method to deal with observed bifurcation diagrams.

In the description of imperfections, the mathematical rigor related to universal unfoldings is not emphasized throughout Part I, in favor of the engineering pragmatism to capture the most important imperfections and their influences in an asymptotic sense.

Part I is organized as follows:

In Chapter 2 the bifurcation equation is derived for three types of simple critical points, including the limit point, the transcritical point of bifurcation, and the pitchfork point of bifurcation. The asymptotic influence of an initial imperfection on the loci of equilibrium of the bifurcation equation is illustrated.

In Chapter 3, in order to formulate the dependence of the critical load on initial imperfections, the imperfection sensitivity laws for simple critical points are derived from the bifurcation equation.

In Chapter 4 the concept of the critical (worst) initial imperfection pattern that reduces the critical load most rapidly is introduced. The explicit formula for the critical imperfection is derived based on the imperfection sensitivity laws.

In Chapter 5 the variation of the critical load, due to the probabilistic variation of initial imperfections, is formulated. Emphasis is placed on initial imperfections subject to a multivariate normal distribution.

In Chapter 6 the independent variable in the bifurcation equation is transformed into a variable that is to be observed in an experiment so as to arrive at an experimentally observed bifurcation diagram. Then a series of imperfection sensitivity laws for this diagram is derived, and its usefulness is assessed based on experimental results.