

CHAPTER

2

Investigation of Structures

This chapter consists of a survey of basic concepts and procedures from the field of applied mechanics as they have evolved in the process of the investigation of the behavior of structures. The purpose of studying this material is twofold. First is the general need for an understanding of what structures must do and how they do it. Second is the need for some factual, quantified basis for the exercise of judgment in the process of structural design. If it is accepted that the understanding of a problem is the necessary first step in its solution, this essentially analytical study should be seen as the basic cornerstone of any successful design process.

2.1 INTRODUCTION TO STRUCTURAL INVESTIGATION

The material in this section consists of discussions of the nature, purposes, and various techniques of the work of the investigation of structures. As in all of the work in this book, the primary focus is on material relevant to the tasks of structural design.

Purpose of Investigation

Most structures exist because of some usage need. Their evaluation must therefore begin with consideration of the effectiveness with which they facilitate or satisfy the usage requirements. Three factors of this effectiveness may be considered: the structure's functionality, feasibility, and safety.

Functionality deals with the physical relationships of the structure's form, detail, durability, fire resistance, and so on, as these relate to its intended use. Feasibility includes considerations of cost, the availability of materials, and the practicality of production. Safety in terms of structural actions

is generally obtained in the form of some margin between the structure's capacity for resistance and the demands placed on it.

Analysis of structural behaviors serves to establish the nature of the structure's deformations (pertinent to its usage) and to relate its performance to its requirements. There are two critical phases of the structure's behavior: its working condition in service and its ultimate response or limit at failure.

Means of Investigation

Analysis for investigation may progress with the following considerations.

- Determination of the structure's physical being with regard to material, form, detail, scale, orientation, location, support conditions, and internal character
- Determination of the demands placed on the structure, that is, the loads and the manner of their application and any usage limits on deformation
- Determination of the structure's responses in terms of deformations and development of internal stresses
- Determination of the limits of the structure's capabilities
- Evaluation of the structure's effectiveness

Analysis may be performed in several ways. One can visualize the nature of the structure's deformation under load—through mental images or with sketches. Using available theories and techniques, one can manipulate mathematical models of the structure. Finally, one can load and measure responses of the structure itself or of a scaled model of the actual structure.

When reasonably precise quantitative evaluations are required, the most useful tools are direct measurements of physical responses or careful mathematical modeling with