Historically, aseismic design has been based upon a combination of strength and ductility. For small, frequent seismic disturbances, the structure is expected to remain in the elastic range, with all stresses well below yield levels. However, it is not reasonable to expect that a traditional structure will respond elastically when subjected to a major earthquake. Instead, the design engineer relies upon the inherent ductility of buildings to prevent catastrophic failure, while accepting a certain level of structural and nonstructural damage. This philosophy has led to the development of aseismic design codes featuring lateral force methods and, more recently, inelastic design response spectra. Ultimately, with these approaches, the structure is designed to resist an ‘equivalent’ static load. Results have been reasonably successful. Even an approximate accounting for lateral effects will almost certainly improve building survivability.

However, by considering the actual dynamic nature of environmental disturbances, more dramatic improvements can be realized. As a result of this dynamical point of view, new and innovative concepts of structural protection have been advanced and are at various stages of development. Modern structural protective systems can be divided into three major groups:

• **Seismic Isolation**
  - Elastomeric Bearings
  - Lead Rubber Bearings
  - Combined Elastomeric and Sliding Bearings
  - Sliding Friction Pendulum Systems
  - Sliding Bearings with Restoring Force

• **Passive Energy Dissipation**
  - Metallic Dampers
  - Friction Dampers
  - Viscoelastic Solid Dampers
  - Viscoelastic or Viscous Fluid Dampers
  - Tuned Mass Dampers
  - Tuned Liquid Dampers
• Semi-active and Active Systems
  Active Bracing Systems
  Active Mass Dampers
  Variable Stiffness and Damping Systems
  Smart Materials

These groups can be distinguished by examining the approaches employed to manage the energy associated with transient environmental events.

The technique of seismic isolation is now widely used in many parts of the world. A seismic isolation system is typically placed at the foundation of a structure. By means of its flexibility and energy absorption capability, the isolation system partially reflects and partially absorbs some of the earthquake input energy before this energy can be transmitted to the structure. The net effect is a reduction of energy dissipation demand on the structural system, resulting in an increase in its survivability.

On the other end of the spectrum are semi-active and active control systems. Semi-active and active structural control is an area of structural protection in which the motion of a structure is controlled or modified by means of the action of a control system through some external energy supply. However, semi-active systems require only nominal amounts of energy to adjust their mechanical properties and, unlike fully active systems, they cannot add energy to the structure. Considerable attention has been paid to semi-active and active structural control research in recent years, with particular emphasis on the alleviation of wind and seismic response. The technology is now at the stage where actual systems have been designed, fabricated and installed in full-scale structures.

While all these technologies are likely to have an increasingly important role in structural design, the scope of the present monograph is limited to a discussion of passive energy dissipation systems, and, to a limited extent, semi-active devices. Research and development of passive energy dissipation devices for structural applications have roughly a 25-year history. The basic function of passive energy dissipation devices when incorporated into the superstructure of a building is to absorb or consume a portion of the input energy, thereby reducing energy dissipation demand on primary structural members and minimizing possible structural damage. Unlike seismic isolation, however, these devices can be effective against wind induced motions as well as those due to earthquakes. Contrary to active control systems, there is no need for an external supply of power.

In recent years, serious efforts have been undertaken to develop the concept of energy dissipation or supplemental damping into a workable technology, and a number of these devices have been installed in...
structures throughout the world. This monograph introduces the basic concepts of passive energy dissipation, and discusses current research, development, design and code-related activities in this exciting and fast expanding field. At the same time, it should be emphasized that this entire technology is still evolving. Significant improvements in both hardware and design procedures will certainly continue for a number of years to come.