
Geotechnical Aspects of Structural Failures

4.1 Introduction

Strong seismic shaking is recognized as the direct cause of structural failures. In many cases, however, the factor that initiates the structural damage is ground failure or ground displacement. This chapter deals with the identification of all geotechnical related structural failures. Surface fault rupture has been a well-acknowledged cause of failures of structures built across or near the fault, which are increasing in frequency as the man-made environment constantly expands to new areas. Seismically induced rockfalls, landslides and slope failures have also been associated with major disasters with an increasing frequency in some cases due to an expanding population, which encroach on areas with landslide risk or in other cases as result of the destruction of the natural environment (vegetation and water routes), which have protected these slopes in the past. Foundation damage may be a result of failure of shallow foundations or piles. In addition, although liquefaction and ground settlement are technically part of foundation failures, they are usually treated as separate, special cases. Retaining wall structures, usually considered as simple systems, may display a complex behaviour, which can be related to extensive seismic failures. Finally, not taking into account soil–structure interaction (SSI) may have a detrimental effect on the dynamic response of structures. Although SSI may never be the direct cause of a structural failure, it has proven to be, in several cases, the underlying reason for the analysis misconception that led to the failure.

Most of the contemporary seismic codes have acknowledged the significant role of geotechnical conditions in the seismic response of structures and attempt to incorporate their influence. This is usually achieved through the application of an amplification factor in the response spectrum or/and other parameters that affect its shape depending on the soil class (usually related to the shear wave velocity of the upper part of the soil stratum). In addition, recommendations are given regarding the near field conditions, soil liquefaction, etc., but also for the design of foundations and earth retaining structures. However, in many cases these recommendations are partly neglected in everyday practice especially in smaller projects in order to reduce the cost. Not uncommonly, the engineer in charge avoids a thorough geotechnical investigation and bases the design on parameters typical for the area, but partly inaccurate assumptions for the soil