ARTICLE 9
PROCEDURES FOR FOUNDATIONS AND GEOLOGIC SITE HAZARDS

9.0 INTRODUCTION

The seismic evaluation of an existing building shall include an examination of the building foundation, an assessment of the capability of the soil beneath the foundation to withstand the forces applied during an earthquake, and an evaluation of any nearby geologic hazards that may affect the stability of the foundation.

9.1 CONDITION OF FOUNDATIONS

9.1.1 FOUNDATION PERFORMANCE: The structure does not show evidence of excessive foundation movement such as settlement or heave that would affect its integrity or strength.

The deficiency is reduction of the integrity and strength of foundation elements by cracking, yielding, tipping, or buckling of the foundation. Visually examine lower level walls, partitions, grade beams, visible footings, pile caps, and the like for cracking, yielding, buckling, and out-of-level conditions. Report evidence of movement as a deficiency.

9.1.2 DETERIORATION: There is no evidence that foundation elements have deteriorated due to corrosion, sulphate attack, material breakdown, or other reasons in a manner that would affect the integrity or strength of the structure.

The deficiency is weakening of the foundation due to deterioration, with the same consequences as discussed in Sec. 9.1.1. Determine if there is historical evidence in the local area of deterioration of the particular type of foundation elements in the building where site conditions are similar. Examine the visible foundation elements for evidence of loss of support as specified in Sec. 9.1.1.

9.2 CAPACITY OF FOUNDATIONS

9.2.1 OVERTURNING: The ratio of the effective horizontal dimension, at the foundation level of the seismic resisting system, to the building height (base/height) exceeds 1.4 A_v.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is the concentration of seismic inertial response into narrow elements by the seismic resisting system, which may overcome the ability of the foundation elements, either structure or soil, to provide adequate resistance. For shallow foundations, evaluate the shear and moment capacity of the foundation elements for adequacy to resist calculated seismic forces. Evaluate the vertical bearing pressure of the soil under seismic loading conditions due to the total gravity and overturning loads and compare to two times the allowable static bearing pressure. For deep foundations, evaluate the ultimate vertical capacity of the pile or pier under seismic loads. Compare the foundation capacity to the gravity loads plus the overturning loads.

9.2.2 TIES BETWEEN FOUNDATION ELEMENTS: Foundation ties adequate for seismic forces exist where footings, piles, and piers are not restrained by beams, slabs, or competent soils or rock.

For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is the possibility of significant differential lateral deformations of the foundations. Evaluate the lateral restraint to seismic forces provided by the foundation materials or the structural ties. For shallow foundations, evaluate the horizontal capacity of the foundation soils under seismic loading conditions (the lateral resistance of the footings due to passive resistance on affected sides of the footings plus the friction on the base of the footings) and compare to the base shear of the building. In the evaluation of base friction, consideration shall be given to the effect of the vertical component of ground motion.

9.2.3 LOAD PATH AT PILE CAPS: The pile caps are capable of transferring overturning and lateral forces between the structure and individual piles in the pile cap.
The deficiency is insufficient capacity of the pile cap to transfer seismic forces from the superstructure to the individual piles. Check the moment and shear capacity to transfer uplift and lateral forces from the point of application on the pile cap to each pile. Conforming buildings which fail this check shall be placed in SPC 4.

9.2.4 LATERAL FORCE ON DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil.
The deficiencies include inadequate flexural strength and ductility of piles or piers at the connection to the cap and the upper portion of the pile. Compare the maximum lateral resistance of soil against piles or piers and caps against the demand. For concrete piles, check for a minimal amount of longitudinal reinforcement in the upper portion of piles or piers and for hoops or ties immediately beneath the caps. Also check for confining transverse reinforcement wherever bending moments might be high, including changes in soil stiffness. Conforming buildings which fail this check shall be placed in SPC 4.

9.2.5 POLE BUILDINGS: Pole foundations have adequate embedment.
For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. The deficiency is inadequate strength of the pole foundation. Check lateral force resistance of embedded poles using conventional procedures comparing with conventional allowable pressures times 1.5.

9.2.6 SLOPING SITES: The grade difference from one side of the building to another does not exceed one-half story.
For conforming buildings, the evaluator may consider this condition as mitigated, and no calculations are necessary. If this statement is false, include the horizontal force due to the grade difference, appropriately modified for seismic motions, with the seismic inertial force when checking sliding stability and the lateral force resisting system below grade.

9.3 GEOLOGIC SITE HAZARDS

This section addresses geologic and local site conditions that can lead to building structural damage and threaten life safety in an earthquake. In the seismic evaluation of buildings for life-safety considerations, it will be necessary to investigate the site to establish that there are no geologic site hazards present or, if they are present, that their threat is not significant or is mitigated by the design. Requirements for Engineering Geological Reports are given in Section 2.1.2.

9.3.1 LIQUEFACTION: Liquefaction susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 feet under the building.
The deficiency is the potential for liquefaction that will result in vertical settlement and potential loss of foundation support for spread footings, or for lateral spreading of liquefied soils that can occur on nearly flat slopes and be detrimental to the foundation system. Evaluate the liquefaction potential and consequences of vertical settlement or lateral movement of the foundations. Conforming buildings which fail this check shall be placed in SPC 4.

9.3.2 SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating small predicted movements without failure.
Evaluate the likely movements associated with seismically induced slope failures beneath, above, or adjacent to the building and their effect on the structural integrity of the building. Conforming buildings which fail this check shall be placed in SPC 4.

9.3.3 SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site is not anticipated.
Evaluate the proximity of known active faults to the building. If the potential for surface fault rupture and surface displacement at the building site is present, nonconforming buildings shall be placed in SPC 1. Conforming buildings which fail this check shall be placed in SPC 4.