

Seismic Vulnerability Rating: A Guideline

“The term vulnerability is used in this document to express differences in the way that buildings respond to earthquake shaking. If two groups of buildings are subjected to exactly the same earthquake shaking, and one group performs better than the other, then it can be said that the buildings that were less damaged had lower earthquake vulnerability than the ones that were more damaged, or it can be stated that the buildings that were less damaged are more earthquake-resistant, and vice versa.” (an excerpt from the publication *European Macroseismic Scale 1998 (EMS1998)*, prepared by the European Seismological Commission, Cahiers du Centre European de Geodynamique et de Seismologie, Vol.15, Luxembourg 1998). Note, therefore, that the use of word vulnerability in this document is not necessarily the same as other uses and definitions of the same word.

Classification of all structural types included in this document into six (6) classes of decreasing vulnerability (A, B, C, D, E, and F) is largely based on a similar classification presented in the EMS1998.

The first three classes A, B, and C, represent the most vulnerable (i.e. least earthquake-resistant) building types; e.g. Class A - adobe masonry or rubble stone masonry; class B- typical brick masonry building; Class C - reinforced concrete frame structure without seismic provisions; Classes D and E are intended to represent building types characterized with the reduced vulnerability (i.e. increased earthquake-resistance) as a result of inherent structural features and also special seismic design provisions; well-built timber, reinforced concrete and steel structures, as well as confined and reinforced masonry structures generally fall into vulnerability classes D and E. Class F is intended to represent a structure with a high level of earthquake-resistant design (e.g. base isolated building).

Participants should use their judgment in assigning the seismic vulnerability class to their building type. The table below has been prepared as a guide in the selection of a seismic vulnerability class and in the absence of other information can be used by the participant for the appropriate structural type. The vulnerability rating is subjective, and is intended to give a general estimation of the seismic vulnerability of the building type. It should not be used as a basis for statistical loss estimation or for evaluation of an individual building without additional information.

Guidelines for Seismic Vulnerability of Construction Types according to EMS 1998
(NOTE: structural systems correspond to Table 4.3 in the report)

Material	Type of Load-Bearing Structure	No	Subtypes	Vulnerability Class						
				A	B	C	D	E	F	
Masonry	Stone Masonry Walls	1	Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)	O						
		2	Massive stone masonry (in lime/cement mortar)		-	O	-			
	Earthen/Mud/Adobe/Rammed Earthen Walls	3	Mud walls	O						
		4	Mud walls with horizontal wood elements	-	O	-				
		5	Adobe block or brick walls	O						
		6	Rammed earth/Pise construction							
	Unreinforced brick masonry walls	7	Unreinforced brick masonry in mud or lime mortar	-	O	-				
		8	Unreinforced brick masonry in mud or lime mortar with vertical posts							
		9	Unreinforced brick masonry in cement or lime mortar with reinforced concrete floor/roof slabs		-	O	-			
	Confined masonry	10	Confined brick/block masonry with concrete posts/tie columns and beams			-	O	-		
	Concrete block masonry	11	Unreinforced in lime or cement mortar (various floor/roof systems)							
		12	Reinforced, in cement mortar (various floor/roof systems)			-	O	-		
		13	Large concrete block walls with concrete floors and roofs							
Structural concrete	Moment resisting frame	14	Designed for gravity loads only (predating seismic codes i.e. no seismic features)	-	-	O	-			
		15	Designed with seismic features (various ages)			-	-	O	-	
		16	Frame with unreinforced masonry infill walls							
		17	Flat slab structure		-	O	-			
		18	Precast frame structure							
		19	Frame with concrete shear walls-dual system							
		20	Precast prestressed frame with shear walls							
	Shear wall structure	21	Walls cast in-situ				-	O	-	
		22	Precast wall panel structure		-	O	-			

Steel	Moment-resisting frame	23	With brick masonry partitions							
		24	With cast in-situ concrete walls							
		25	With lightweight partitions							
	Braced frame	26	Concentric					-	O	-
		27	Eccentric							
Wooden structures	Load-bearing timber frame	28	Thatch			-	O	-		
		29	Post and beam frame				-	O	-	
		30	Walls with bamboo/reed mesh and post (Wattle and Daub)							
		31	Wooden frame (with/without infill)							
		32	Stud wall frame with plywood/gypsum board sheathing							
		33	Wooden panel or log construction					-	O	-
Various	Seismic protection systems	34	Building protected with base isolation devices or seismic dampers							
	Other	35								