

# MACROSEISMIC INTENSITY SCALE

## Classifications used in the European Macroseismic Scale (EMS)

### *Differentiation of structures (buildings) into vulnerability classes (Vulnerability Table)*

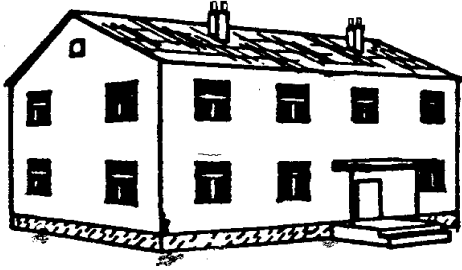
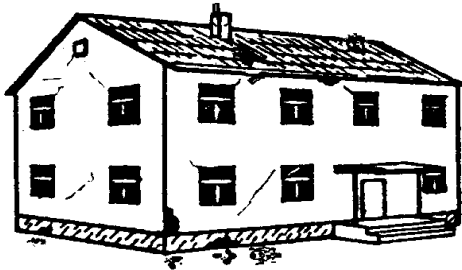
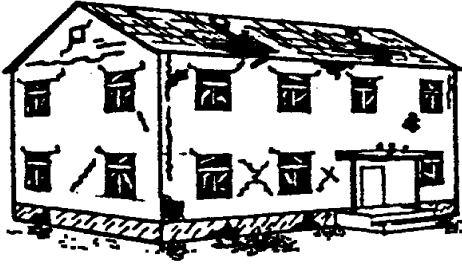

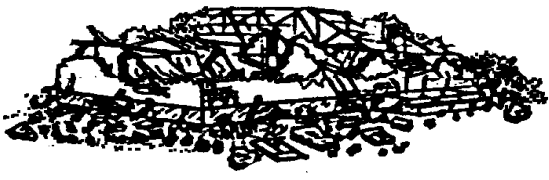
Type of Structure		Vulnerability Class					
		A	B	C	D	E	F
MASONRY	rubble stone, fieldstone	○					
	adobe (earth brick)	○—					
	simple stone	—○					
	massive stone		—○—				
	unreinforced, with manufactured stone units	—○—					
	unreinforced, with RC floors reinforced or confined			—○—			
REINFORCED CONCRETE (RC)	frame without earthquake-resistant design (ERD)		—○—				
	frame with moderate level of ERD			—○—			
	frame with high level of ERD				—○—		
	walls without ERD		—○—				
	walls with moderate level of ERD			—○—			
	walls with high level of ERD				—○—		
STEEL	steel structures			—○—			
WOOD	timber structures		—○—				

○ most likely vulnerability class; — probable range;  
 .....range of less probable, exceptional cases

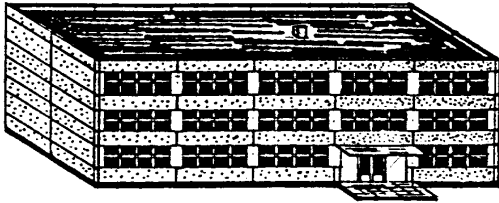
The masonry types of structures are to be read as, e.g., simple stone masonry, whereas the reinforced concrete (RC) structure types are to be read as, e.g., RC frame or RC wall. See section 2 of the Guidelines and Background Materials for more details, also with respect to the use of structures with earthquake resistant design.

**Classification of damage**

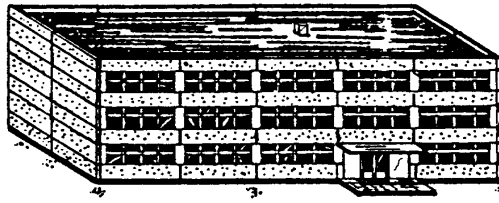
Note: the way in which a building deforms under earthquake loading depends on the building type. As a broad categorisation one can group together types of masonry buildings as well as buildings of reinforced concrete.

<b>Classification of damage to masonry buildings</b>	
	<p><b>Grade 1: Negligible to slight damage</b>  <b>(no structural damage, slight non-structural damage)</b>            Hair-line cracks in very few walls.            Fall of small pieces of plaster only.            Fall of loose stones from upper parts of buildings in very few cases.</p>
	<p><b>Grade 2: Moderate damage</b>  <b>(slight structural damage, moderate non-structural damage)</b>            Cracks in many walls.            Fall of fairly large pieces of plaster.            Partial collapse of chimneys.</p>
	<p><b>Grade 3: Substantial to heavy damage</b>  <b>(moderate structural damage, heavy non-structural damage)</b>            Large and extensive cracks in most walls.            Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).</p>
	<p><b>Grade 4: Very heavy damage</b>  <b>(heavy structural damage, very heavy non-structural damage)</b>            Serious failure of walls; partial structural failure of roofs and floors.</p>
	<p><b>Grade 5: Destruction</b>  <b>(very heavy structural damage)</b>            Total or near total collapse.</p>

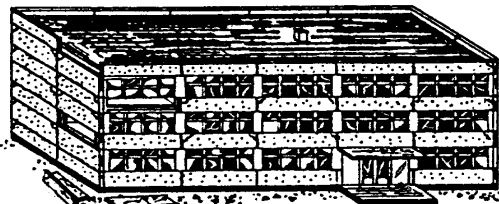
**Classification of damage to buildings of reinforced concrete**



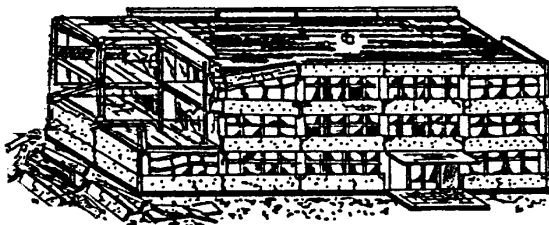
**Grade 1: Negligible to slight damage**  
**(no structural damage, slight non-structural damage)**  
 Fine cracks in plaster over frame members or in walls at the base.  
 Fine cracks in partitions and infills.



**Grade 2: Moderate damage**  
**(slight structural damage, moderate non-structural damage)**  
 Cracks in columns and beams of frames and in structural walls.  
 Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels.



**Grade 3: Substantial to heavy damage**  
**(moderate structural damage, heavy non-structural damage)**  
 Cracks in columns and beam column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced rods.  
 Large cracks in partition and infill walls, failure of individual infill panels.

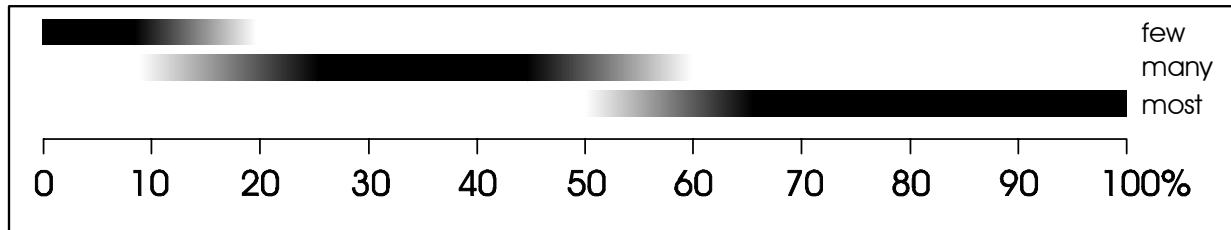


**Grade 4: Very heavy damage**  
**(heavy structural damage, very heavy non-structural damage)**  
 Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforced bars; tilting of columns.  
 Collapse of a few columns or of a single upper floor.



**Grade 5: Destruction**  
**(very heavy structural damage)**  
 Collapse of ground floor or parts (e. g. wings) of buildings.

## Definitions of quantity



## Definitions of intensity degrees

### Arrangement of the scale:

- a) Effects on humans
- b) Effects on objects and on nature  
(effects on ground and ground failure are dealt with especially in Section 7)
- c) Damage to buildings

### Introductory remark:

The single intensity degrees can include the effects of shaking of the respective lower intensity degree(s) also, when these effects are not mentioned explicitly.

### I. Not felt

- a) Not felt, even under the most favourable circumstances.
- b) No effect.
- c) No damage.

### II. Scarcely felt

- a) The tremor is felt only at isolated instances (<1%) of individuals at rest and in a specially receptive position indoors.
- b) No effect.
- c) No damage.

### **III. Weak**

- a) The earthquake is felt indoors by a few. People at rest feel a swaying or light trembling.
- b) Hanging objects swing slightly.
- c) No damage.

### **IV. Largely observed**

- a) The earthquake is felt indoors by many and felt outdoors only by very few. A few people are awakened. The level of vibration is not frightening. The vibration is moderate. Observers feel a slight trembling or swaying of the building, room or bed, chair etc.
- b) China, glasses, windows and doors rattle. Hanging objects swing. Light furniture shakes visibly in a few cases. Woodwork creaks in a few cases.
- c) No damage.

### **V. Strong**

- a) The earthquake is felt indoors by most, outdoors by few. A few people are frightened and run outdoors. Many sleeping people awake. Observers feel a strong shaking or rocking of the whole building, room or furniture.
- b) Hanging objects swing considerably. China and glasses clatter together. Small, top-heavy and/or precariously supported objects may be shifted or fall down. Doors and windows swing open or shut. In a few cases window panes break. Liquids oscillate and may spill from well-filled containers. Animals indoors may become uneasy.
- c) Damage of grade 1 to a few buildings of vulnerability class A and B.

### **VI. Slightly damaging**

- a) Felt by most indoors and by many outdoors. A few persons lose their balance. Many people are frightened and run outdoors.
- b) Small objects of ordinary stability may fall and furniture may be shifted. In few instances dishes and glassware may break. Farm animals (even outdoors) may be frightened.
- c) Damage of grade 1 is sustained by many buildings of vulnerability class A and B; a few of class A and B suffer damage of grade 2; a few of class C suffer damage of grade 1.

## **VII. Damaging**

- a) Most people are frightened and try to run outdoors. Many find it difficult to stand, especially on upper floors.
- b) Furniture is shifted and top-heavy furniture may be overturned. Objects fall from shelves in large numbers. Water splashes from containers, tanks and pools.
- c) Many buildings of vulnerability class A suffer damage of grade 3; a few of grade 4. Many buildings of vulnerability class B suffer damage of grade 2; a few of grade 3. A few buildings of vulnerability class C sustain damage of grade 2. A few buildings of vulnerability class D sustain damage of grade 1.

## **VIII. Heavily damaging**

- a) Many people find it difficult to stand, even outdoors.
- b) Furniture may be overturned. Objects like TV sets, typewriters etc. fall to the ground. Tombstones may occasionally be displaced, twisted or overturned. Waves may be seen on very soft ground.
- c) Many buildings of vulnerability class A suffer damage of grade 4; a few of grade 5. Many buildings of vulnerability class B suffer damage of grade 3; a few of grade 4. Many buildings of vulnerability class C suffer damage of grade 2; a few of grade 3. A few buildings of vulnerability class D sustain damage of grade 2.

## **IX. Destructive**

- a) General panic. People may be forcibly thrown to the ground.
- b) Many monuments and columns fall or are twisted. Waves are seen on soft ground.
- c) Many buildings of vulnerability class A sustain damage of grade 5. Many buildings of vulnerability class B suffer damage of grade 4; a few of grade 5. Many buildings of vulnerability class C suffer damage of grade 3; a few of grade 4. Many buildings of vulnerability class D suffer damage of grade 2; a few of grade 3. A few buildings of vulnerability class E sustain damage of grade 2.

## **X. Very destructive**

- c) Most buildings of vulnerability class A sustain damage of grade 5.  
Many buildings of vulnerability class B sustain damage of grade 5.  
Many buildings of vulnerability class C suffer damage of grade 4; a few of grade 5.  
Many buildings of vulnerability class D suffer damage of grade 3; a few of grade 4.  
Many buildings of vulnerability class E suffer damage of grade 2; a few of grade 3.  
A few buildings of vulnerability class F sustain damage of grade 2.

## **XI. Devastating**

- c) Most buildings of vulnerability class B sustain damage of grade 5.  
Most buildings of vulnerability class C suffer damage of grade 4; many of grade 5.  
Many buildings of vulnerability class D suffer damage of grade 4; a few of grade 5.  
Many buildings of vulnerability class E suffer damage of grade 3; a few of grade 4.  
Many buildings of vulnerability class F suffer damage of grade 2; a few of grade 3.

## **XII. Completely devastating**

- c) All buildings of vulnerability class A, B and practically all of vulnerability class C are destroyed. Most buildings of vulnerability class D, E and F are destroyed. The earthquake effects have reached the maximum conceivable effects.