

World Housing Encyclopedia

A Resource on Construction in Earthquake Regions



an initiative of
Earthquake Engineering Research Institute (EERI) and
International Association for Earthquake Engineering (IAEE)

HOUSING REPORT PC Frame Buildings (Series 1-451)

Report#	202
Last Updated	
Country	Armenia
Author(s)	
Reviewers	

Important

This encyclopedia contains information contributed by various earthquake engineering professionals around the world. All opinions, findings, conclusions & recommendations expressed herein are those of the various participants, and do not necessarily reflect the views of the Earthquake Engineering Research Institute, the International Association for Earthquake Engineering, the Engineering Information Foundation, John

General Information

Building Type:	PC Frame Buildings (Series 1-451)
Country:	Armenia
Author(s):	
Last Updated:	
Regions Where Found:	This building typology can be found in all big cities in Armenia. Roughly estimated, around 15% of the multi-apartment building stock of the country consist of this typology.
Summary:	Stone buildings, Mydis-type walls of cement mortar and crushed stones are standard with thicknesses of 50 cm. Stone masonry type with clear joints is rarely used where located at inner court that cannot be seen from the main roads. Pre-cast concrete void slabs. Seismic bands are provided around the floor slabs. Usually for 3 to 5-storey multi-apartment buildings, constructed between 1958 and 1970. Generally used for construction in seismic regions of intensity 7-8.
Length of time practiced:	25-60 years
Still Practiced:	Yes
In practice as of:	
Building Occupancy:	Residential, 20-49 units Residential, 50+ units
Typical number of stories:	3-5
Terrain-Flat:	Off
Terrain-Sloped:	Off
Comments:	Construction type typically on both flat and sloped (hilly) terrains.

Features

Plan Shape	Rectangular, solid
Additional comments on	Typical plan length: 35 - 50 m Typical plan width: 11

plan shape	mTypical storey height: 2.7 m
Typical plan length (meters)	
Typical plan width (meters)	
Typical story height (meters)	
Type of Structural System	Masonry: Unreinforced Masonry Walls: Concrete block masonry in cement mortar Masonry: Reinforced Masonry: Concrete block masonry in cement mortar
Additional comments on structural system	
Gravity load-bearing & lateral load-resisting systems	The typical wall densities usually exceed 20% (total wall area / plan area). Usually this type of construction has no common walls with adjacent buildings.
Typical wall densities in direction 1	>20%
Typical wall densities in direction 2	>20%
Additional comments on typical wall densities	
Wall Openings	
Is it typical for buildings of this type to have common walls with adjacent buildings?	Off
Modifications of buildings	
Type of Foundation	Other Foundation
Additional comments on foundation	Belt foundation
Type of Floor System	Cast-in-place beamless reinforced concrete floor Precast concrete floor with reinforced concrete topping
Additional comments on floor system	
Type of Roof System	Cast-in-place beamless reinforced concrete roof Precast concrete roof with reinforced concrete

toppingRoof system, other

Additional comments on roof system

Additional comments section 2

Infill wall material

Building Materials and Construction Process

Description of Building Materials

Structural Element	Building Material (s)	Comment (s)
Wall/Frame		
Foundations		
Floors		
Roof		
Other		

Design Process

Who is involved with the design process?	Owner
Roles of those involved in the design process	
Expertise of those involved in the design process	

Construction Process

Who typically builds this construction type?	Other
Roles of those involved in the building process	
Expertise of those involved in building process	
Construction process and phasing	

Construction issues

Building Codes and Standards

Is this construction type address by codes/standards?

Yes

Applicable codes or standards

Engineers are involved in the design process; the construction is carried out by builders. All buildings were constructed according to SNIP 62 used for all countries in the Soviet Union. Some modifications had been made in 1984 and 1994. The current standards are the Seismic Code of the Republic of Armenia CHPA II-2.02-94.

Process for building code enforcement

Building Permits and Development Control Rules

Are building permits required?

Off

Is this typically informal construction?

Off

Is this construction typically authorized as per development control rules?

Off

Additional comments on building permits and development control rules

Building Maintenance and Condition

Typical problems associated with this type of construction

Who typically maintains buildings of this type?

Other

Additional comments on maintenance and building condition

Construction Economics

Unit construction cost	Generally, code provisions were followed in the construction process. Construction is typically formal (with permits, plans, etc) and authorized as per development control rules. The owner, if interested, is the one who maintains the building. Total construction cost between 840-3300 thousand Soviet Rubles (as of 1959).
Labor requirements	
Additional comments section 3	

Socio-Economic Issues

Patterns of occupancy	
Number of inhabitants in a typical building of this construction type during the day	>20
Number of inhabitants in a typical building of this construction type during the evening/night	>20
Additional comments on number of inhabitants	
Economic level of inhabitants	Low-income class (poor) Middle-income class High-income class (rich)
Additional comments on economic level of inhabitants	Number of inhabitants generally varies between 100 and 300. Regarding the financing, these were government-owned housing, with ownership later transferred to the inhabitants. Type of ownership for these buildings: own outright.
Typical Source of Financing	Other
Additional comments on financing	
Type of Ownership	Other
Additional comments on ownership	
Is earthquake insurance for this construction type typically available?	No

What does earthquake insurance typically cover/cost	
Are premium discounts or higher coverages available for seismically strengthened buildings or new buildings built to incorporate seismically resistant features?	Off
Additional comments on premium discounts	
Additional comments section 4	

Earthquakes

Past Earthquakes in the country which affected buildings of this type

Year	Earthquake Epicenter

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	The 1988 Earthquake with epicenter in Spitak, Armenia (Mw 6.9) affected buildings of this construction typology. The lack of unification between the seismic bands and the floor void slabs, as well as the floor void slabs supported by longitudinal walls, caused larger damages such as out-of-plane failures of stone-bearing walls located at the side of the buildings.
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Additional comments on earthquake damage patterns	
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Structural and Architectural Features for Seismic Resistance

The main reference publication used in developing the statements used in this table is

FEMA 310 “Handbook for the Seismic Evaluation of Buildings-A Pre-standard”, Federal Emergency Management Agency, Washington, D.C., 1998.

The total width of door and window openings in a wall is: For brick masonry construction in cement mortar : less than $\frac{1}{2}$ of the distance between the adjacent cross walls; For adobe masonry, stone masonry and brick masonry in mud mortar: less than $\frac{1}{3}$ of the distance between the adjacent cross walls; For precast concrete wall structures: less than $\frac{3}{4}$ of the length of a perimeter wall.

Structural/Architectural Feature	Statement	Seismic Resistance
Lateral load path	The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer inertial forces from the building to the foundation.	N/A
Building Configuration-Vertical	The building is regular with regards to the elevation. (Specify in 5.4.1)	N/A
Building Configuration-Horizontal	The building is regular with regards to the plan. (Specify in 5.4.2)	N/A
Roof Construction	The roof diaphragm is considered to be rigid and it is expected that the roof structure will maintain its integrity, i.e. shape and form, during an earthquake of intensity expected in this area.	N/A
Floor Construction	The floor diaphragm(s) are considered to be rigid and it is expected that the floor structure(s) will maintain its integrity during an earthquake of intensity expected in this area.	N/A
Foundation Performance	There is no evidence of excessive foundation movement (e.g. settlement) that would affect the integrity or performance of the	N/A

structure in an earthquake.

Wall and Frame Structures-Redundancy	The number of lines of walls or frames in each principal direction is greater than or equal to 2.	N/A
Wall Proportions	Height-to-thickness ratio of the shear walls at each floor level is: Less than 25 (concrete walls); Less than 30 (reinforced masonry walls); Less than 13 (unreinforced masonry walls);	N/A
Foundation-Wall Connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doveled into the foundation.	N/A
Wall-Roof Connections	Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.	N/A
Wall Openings		N/A
Quality of Building Materials	Quality of building materials is considered to be adequate per the requirements of national codes and standards (an estimate).	N/A
Quality of Workmanship	Quality of workmanship (based on visual inspection of a few typical buildings) is considered to be good (per local construction standards).	N/A
Maintenance	Buildings of this type are generally well maintained and there are no visible signs of deterioration of building	N/A

elements (concrete, steel, timber).

Building Irregularities

Additional comments on structural and architectural features for seismic resistance	
Vertical irregularities typically found in this construction type	Other
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	
Earthquake-resilient features in walls	
Seismic deficiency in frames	
Earthquake-resilient features in frame	
Seismic deficiency in roof and floors	
Earthquake resilient features in roof and floors	
Seismic deficiency in foundation	
Earthquake-resilient features in foundation	

Seismic Vulnerability Rating

For information about how seismic vulnerability ratings were selected see the [Seismic Vulnerability Guidelines](#)

	High vulnerability		Medium vulnerability		Low vulnerability	
	A	B	C	D	E	F

Seismic vulnerability class



Partial Collapse of Masonry Building, Spitak, Armenia



Partially collapsed five-story stone masonry building in Spitak. Such unreinforced buildings were all heavily damaged in Spitak, but in Leninakan many survived with little or no damage.

(a) Out-of-plane collapse of stone walls (ref. 1) (b) Partial collapse of building at Gyumri (by NSSP EEC)
 Figure 5.3-7 Damages of stone buildings, series 1-451, at the Spitak earthquake

Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	Seismic Strengthening
<p>Additional comments on seismic strengthening provisions</p>	
<p>Has seismic strengthening described in the above table been performed?</p>	
<p>Was the work done as a mitigation effort on an undamaged building or as a repair following earthquake damages?</p>	
<p>Was the construction inspected in the same manner as new construction?</p>	
<p>Who performed the construction: a contractor or owner/user? Was an</p>	

**architect or engineer
involved?**

**What has been the
performance of
retrofitted buildings of
this type in subsequent
earthquakes?**

**Additional comments
section 6**

References

Authors

Name	Title	Affiliation	Location	Email
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Reviewers

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