World Housing Encyclopedia

A Resource on Construction in Earthquake Regions

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International Association for Earthquake Engineering (IAEE)

HOUSING REPORT

Low-ductile RC frame buildings (C1L, C1M)

Report#	183
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Country	Cuba
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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 A, Martin & Associates, Inc. or the participant's organizations.

General Information

Building Type:	Low-ductile RC frame buildings (C1L, C1M)
Country:	Cuba
Author(s):	Grisel Morejon Blanco Kenia Leyva Chang Dario Candebat Sanchez Zulima Rivera Alvarez Yelena Berenguer Heredia Madelin Villalon Semanat Dominik H. Lang Abdelghani Meslem
Last Updated:	01/26/2016
Regions Where Found:	Santiago de Cuba
Summary:	Low-ductile RC frames with unreinforced masonry infill walls made of hollow concrete blocks or rectangular fired clay bricks
Length of time practiced:	Less than 25 years
Still Practiced:	Yes
In practice as of:	2008 until today
Building Occupancy:	Residential, unknown type
Typical number of stories:	1-5
Terrain-Flat:	
Terrain-Sloped:	
Comments:	

Features

Plan Shape	Rectangular, solid
Additional comments on plan shape	

Typical plan length (meters)	
Typical plan width (meters)	
Typical story height (meters)	
Type of Structural System	Structural Concrete: Moment Resisting Frame: Designed with seismic effects, with URM infill walls
Additional comments on structural system	GRAVITY: RC frame: RC solid slabs, transferring the gravity loads to the beams and columns and finally to the footingsLATERAL: RC frame: Framing elements are designed to resist seismic loading, the stiffness of infill walls is not considered in the design.
Gravity load-bearing & lateral load-resisting systems	
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?	
Modifications of buildings	
Type of Foundation	Shallow Foundation: Reinforced concrete isolated footing
Additional comments on foundation	
Type of Floor System	Cast-in-place beamless reinforced concrete floor
Additional comments on floor system	
Type of Roof System	Cast-in-place beamless reinforced concrete roof
Additional comments on roof system	

Additional comments section 2	

Figure 2. Low-Rise Concrete Moment Frame House

Figure 3. Mid-Rise Concrete Moment Frame Building

Figure 4. Mid-Rise Concrete Moment Frame Building

Figure 5. Mid-Rise Concrete Moment Frame Building

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?	
Applicable codes or standards	NC 46:1999 "Construcciones sismorresistentes. Requisitos para el diseno y construccion"
Process for building code enforcement	

Building Permits and Development Control Rules

Are building permits required?	Yes
Is this typically informal	

construction?	
Is this construction typically authorized as per development control rules?	
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	400 CUC/m2
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	

Economic level of inhabitants	Middle-income class
Additional comments on economic level of inhabitants	
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?	
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	None
Additional comments on earthquake damage patterns	

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 ½ of the distance between the adjacent cross walls; For adobe masonry, stone masonry and brick masonry in mud mortar: less than 1/3 of the distance between the adjacent cross walls; For precast concrete wall structures: less than 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.	
Building Configuration-Vertical	The building is regular with regards to the elevation. (Specify in 5.4.1)	
Building Configuration-Horizontal	The building is regular with regards to the plan. (Specify in 5.4.2)	
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.	

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.	
Foundation Performance	There is no evidence of excessive foundation movement (e.g. settlement) that would affect the integrity or performance of the 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.	
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);	
Foundation-Wall Connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.	
Wall-Roof Connections	Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.	
Wall Openings		
Quality of Building Materials	Quality of building materials is considered to be adequate per the requirements of national	

	codes and standards (an estimate).	
Quality of Workmanship	Quality of workmanship (based on visual inspection of a few typical buildings) is considered to be good (per local construction standards).	
Maintenance	Buildings of this type are generally well maintained and there are no visible signs of deterioration of building 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	Inadequate details and construction quality during their construction
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	Unknown deficiencies

foundation	Unknown deficiencies
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			o	o		

Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	**Seismic Strengthening**

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

involved?	
What has been the performance of retrofitted buildings of this type in subsequent earthquakes?	
Additional comments section 6	

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