World Housing Encyclopedia

A Resource on Construction in Earthquake Regions

an initiative of
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International Association for Earthquake Engineering (IAEE)

HOUSING REPORT

Unreinforced concrete and masonry bearing wall construction (designed for gravity loads only)

Report#	49
Last Updated	
Country	PALESTINIAN TERRITORIES
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Important

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General Information

Building Type:	Unreinforced concrete and masonry bearing wall construction (designed for gravity loads only)
Country:	PALESTINIAN TERRITORIES
Author(s):	Jalal N. Al Dabbeek Abdel H. W. Al-Jawhari
Last Updated:	
Regions Where Found:	Buildings of this construction type can be found in the main cities of West Bank like East of Jerusalem, Nablus, Ramallah, Bethlehem and Jenin. It represents 20 to 30% of the housing stock in these cities. For Gaza Strip, it was applied on a small scale because the stone blocks needed were not available there. This type of housing construction is commonly found in both rural and urban areas.
Summary:	This building type is usually found in most cities of the West Bank and less often in the Gaza Strip. It is a traditional, non-engineered, low-rise construction practice. The main lateral load-resisting system consists of bearing walls with unreinforced concrete strip foundation. The interior masonry walls consist of plain concrete (system #2) or two wythe stone masonry walls filled with plain concrete (system #1). The exterior bearing walls consist of stone masonry facing with a plain concrete backup. Wall thickness ranges from 400 to 500 mm (system #1) to 300-mm thickness in system #2. It is important to note that system #1 represents the old practice for bearing-wall construction while system #2 represents the new trend which was developed and used from the 1950s to the 1970s. This construction is not practiced at the present time.
Length of time practiced:	76-100 years
Still Practiced:	No
In practice as of:	
Building Occupancy:	Residential, 3-4 unitsMixed residential/commercial
Typical number of stories:	2
Terrain-Flat:	Typically
Terrain-Sloped:	Typically

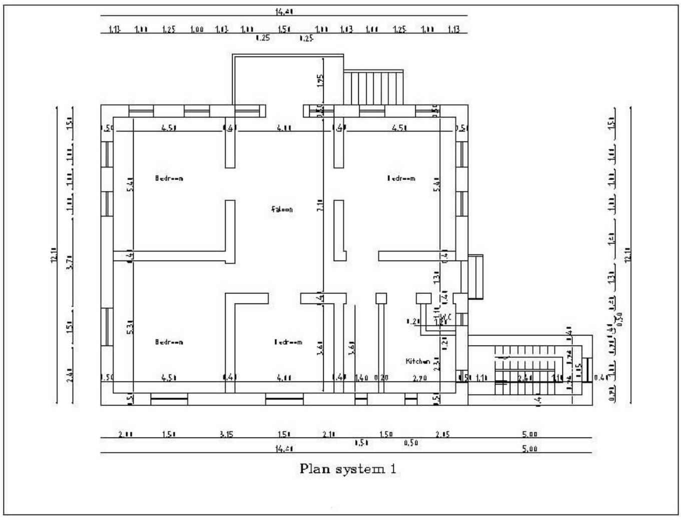
Comments:	The main function of this building typology is mixed use (both commercial and residential use).

Features

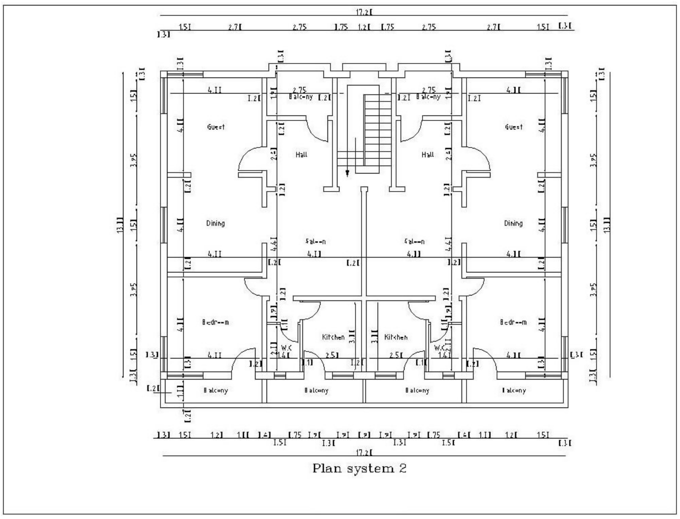
Plan Shape	Rectangular, solid
Additional comments on plan shape	
Typical plan length (meters)	20
Typical plan width (meters)	20
Typical story height (meters)	41734
Type of Structural System	Masonry: Stone Masonry Walls: Massive stone masonry (in lime/cement mortar)
Additional comments on structural system	The vertical and lateral load bearing systems are the same. These walls transfer the vertical loads to the foundations. The foundations typically consist of spread footings of plain concrete with stone boulders resting on stiff soil or rock. The lateral load resisting system consists of bearing walls resting on unreinforced concrete strip foundation. These masonry walls consist of plain concrete with or without stone. They are very thick (40-50 cm) and of high density. Thus the building weight is very high, and it generates high inertia forces during earthquake. The walls are not connected properly to the foundation, to the floor slabs and to each other. The buildings are generally regular and have only minor variation in stiffness between different floors, except the irregularity due to some variations or changes in the stiffness of the internal walls. The initial stiffness of these walls is not a reliable measure of its strength since it degrades very quickly after the first earthquake shock. This is especially true for the buildings having more than two stories (see Figures 11, 12 and 13).
Gravity load-bearing & lateral load-resisting systems	The selection of the type of structural system represents system #1, whereas system #2 can be classified as masonry concrete with stone covering for the external walls and without for the internal walls.
Typical wall densities in direction 1	10-15%
Typical wall densities in	

Typical wall densities in direction 2	10-15%
Additional comments on typical wall densities	10% - 15% total wall area/plan area (for each floor) is the range between the ratios of the area of all the walls in each principal direction divided by the total area of the plan.
Wall Openings	The windows and doors are usually centered within the wall. The height of the windows usually varies from 1.8 to 2.0 meters, and the width has a variable size depending on the architect's experience and personal judgment. Generally, the windows represent 10 to 20% of the wall area. The doors are 1.2 to 1.5 meters wide and 2.2 to 2.5 meters high as an average.
Is it typical for buildings of this type to have common walls with adjacent buildings?	No
Modifications of buildings	Investigations on this type of buildings showed the following: - Some changes in the size and location of the openings are made especially in the internal walls. - Extensions to buildings are applied in many cases using either short, medium or long time intervals. - Staircases are added whenever additional floors are needed. This happens in very few cases where staircases do not exist in single floor buildings. - When adding additional floors, the bearing wall system is usually changed according to the new function, architectural and structural system adopted.
Type of Foundation	Shallow Foundation: Rubble stone, fieldstone strip footing
Additional comments on foundation	
Type of Floor System	Other floor system
Additional comments on floor system	(cast-in-place) reinforced-concrete slabs resting on steel girders (see Figure 10). (cast-in-place) reinforced-concrete slabs resting on steel girders (see Figure 10).
Type of Roof System	Roof system, other
Additional comments on roof system	(cast-in-place) reinforced-concrete slabs resting on steel girders (see Figure 10). (cast-in-place) reinforced-concrete slabs resting on steel girders (see Figure 10).
	Typical Plan Dimensions: Length and width are varied from 10 to 20 meters. Typical Story Height: Typical story height is 4 - 5 meters. Typical Span:

Additional comments section 2	Usually typical span ranges from 4 to 6 meter. The typical storey height in such buildings is 5 meters. The distance between adjacent buildings varies from 6 to 10 meters in the areas classified for housing purposes and zero for commercial areas



Plan of a Typical Building



Typical Plan

Building Materials and Construction Process

Description of Building Materials

Structural Element	Building Material (s)	Comment (s)
Wall/Frame	Wall: Concrete bearing wall (internal) Concrete/Stone (external)	Wall: Characteristic Strength - 1.0-2.0/15-20 /1.0- 2.0 1.0-2.0/15-20/1.0-2.0 Mix proportions - 1:3:6 - 1:3:5 Comments - The stone used for decorative purposes in the external walls is neglected in the strength (Represents system 2 only since system1 was not governed by identified parameters)
Foundations	Concrete	Characteristic Strength - 1-2/15-20/1-2 Mix proportions - 1:3:6 Comments - (Represents system 2 since system 1 was not governed by identified parameters).

Floors	Concrete	Characteristic Strength - 1-2/15-20/1-2 Mix proportions - 1:3:6 Comments - (Represents system 2 since system 1 was not governed by identified parameters).
Roof	Concrete	Characteristic Strength - 1-2/15-20/1-2 Mix proportions - 1:3:6 Comments - (Represents system 2 since system 1 was not governed by identified parameters).
Other		

Design Process

Who is involved with the design process?	Other
Roles of those involved in the design process	For system 1, no engineers were available except for very few number of draftsmen or authorized designers. The engineers association was not there. For system 2, very few engineers were available and the engineers association was just started. In both cases, the personal experience of the workmen and the conventional methods governed the process. As mentioned above, the engineers played only a limited role especially in preparing the drawings for system
Expertise of those involved in the design process	

Construction Process

Who typically builds this construction type?	Owner
Roles of those involved in the building process	The builder lives in this type in many cases. Also, a developer sometimes built the house for investment purposes and others bought or rented it.
Expertise of those involved in building process	The major role during the construction process was played by the contractors and local builders.
	The construction process can be briefly described as follows: (1) For system 1 : - A draftsman or a licensed engineer (very rarely) made the drawings for the building. The drawings followed only the

Construction process and phasing	traditional forms used by people at that time. Sometimes the owners with the help of the local builders made their own houses without preparing drawings by specialized people. - Many of the buildings had the same design concerning heights, dimensions, openings, and sometimes number and distribution of rooms and spaces. - The drawings which usually included only architectural design without any detailing were signed by the designer mentioned above and submitted to the municipality or the authorized departments for building license. - A contractor or a builder was assigned by the owner to build the house without using any procurement process. - The work was not usually done under the supervision of the engineers who were not available. - Generally, traditional building methods were applied and all the work was done manually using traditional tools and depending on the personal experience of the builders. - The time of construction used to be very long and sometimes lasted for years. (2) For system 2 - The architectural and structural drawings were prepared by the engineer (usually the same) without preparing the necessary detailing. - The drawings were signed by the authorized engineer and submitted to the municipality for building license - No electrical or mechanical design was made. This was usually applied on site and during construction by skilled labors who used only their personal experience and conventional methods. - The work was awarded by the owner to local contractors or builders. Procurement methods were rarely applied.. - More effective building techniques were applied but still conventional and also the personal experience of the contractor or builder governed the process. - The time of construction as a result was relatively long but less than that for system 1 - Some of the buildings were built under the supervision of engineers. The construction of this type of housing takes place incrementally over time. Typically, the building is originally not designed for its final constructed size.
Construction issues	

Building Codes and Standards

Is this construction type address by codes/standards?	No
Applicable codes or standards	
Process for building code	There was no national code for this type of

Process for building code enforcement	construction. Also no specified court of law was applied to ensure good quality construction.

Building Permits and Development Control Rules

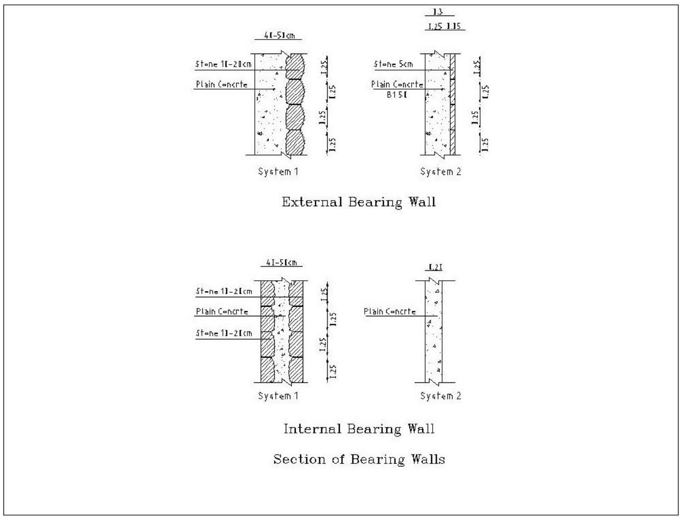
Are building permits required?	Yes
Is this typically informal construction?	No
Is this construction typically authorized as per development control rules?	No
Additional comments on building permits and development control rules	

Building Maintenance and Condition

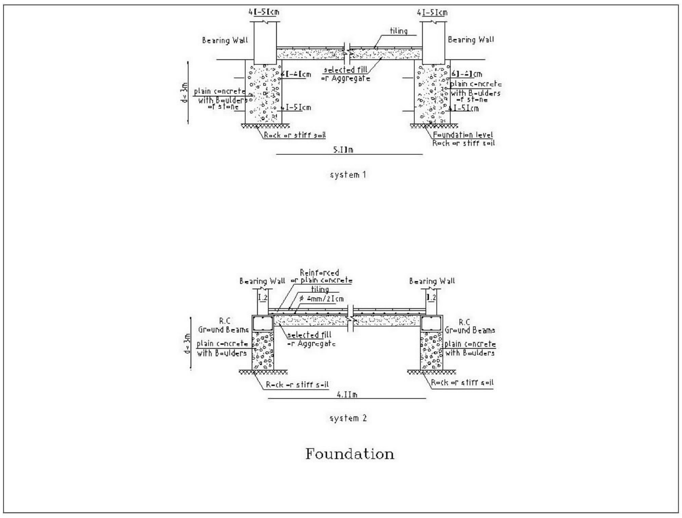
Typical problems associated with this type of construction	
Who typically maintains buildings of this type?	Owner(s)Renter(s)
Additional comments on maintenance and building condition	

Construction Economics

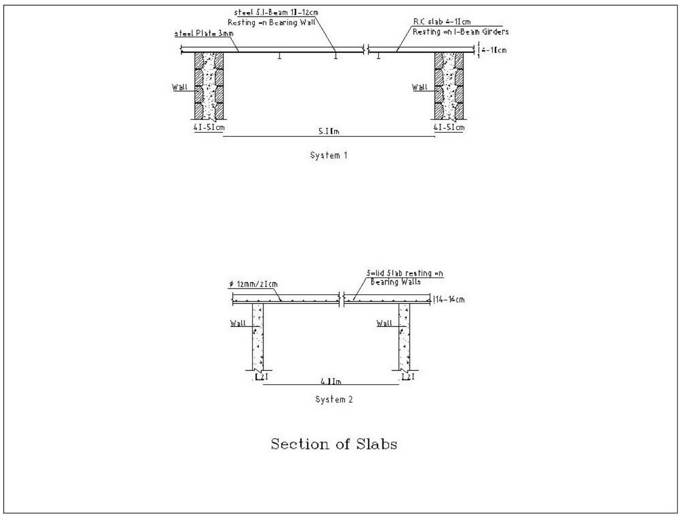
Unit construction cost	These housing systems are not used anymore. To build a housing unit of this type or even to buy it, the cost is more than 50000 $US. The estimated cost at the time of construction (during the 1950s) is around 2000 $US (This does not include the land price which was generally cheap at that time).
Labor requirements	For a housing unit of system 1 nearly 1500 workdays or person days were required to complete the construction and for system 2 the number was 1000 workdays.
Additional comments section 3	



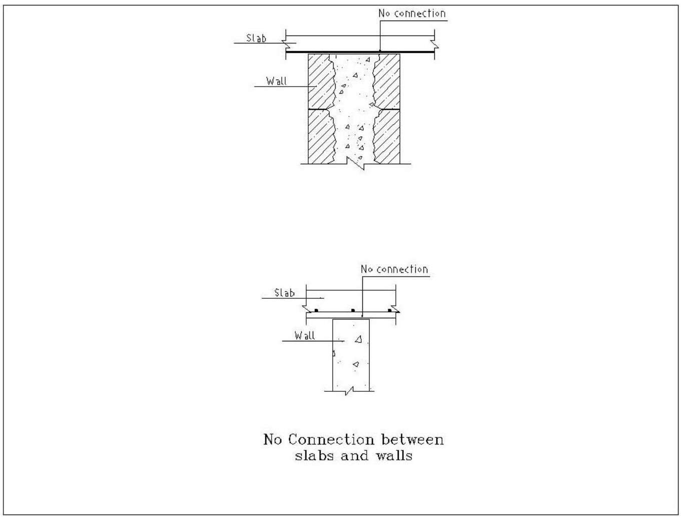
Critical Structural Details (e.g. wall section, foundations, roof-wall connections, etc.)



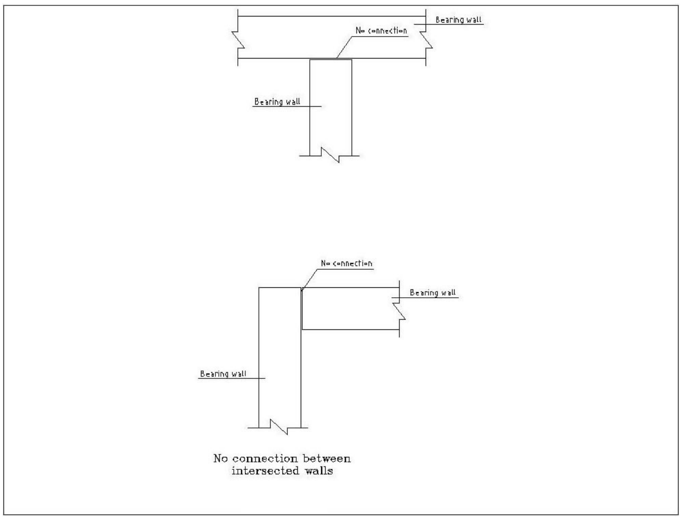
Critical Structural Details



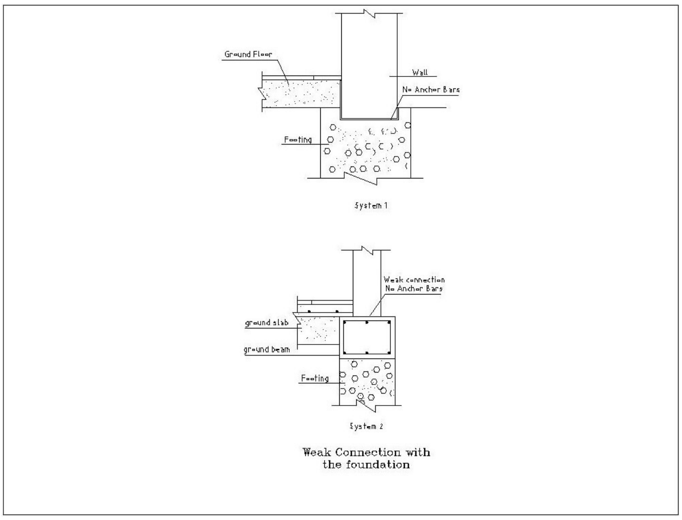
Critical Structural Details



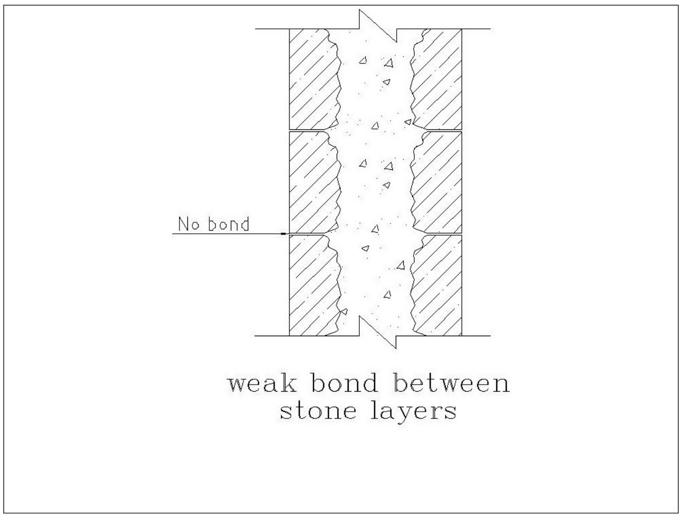
An Illustration of Key Seismic Features and/or Deficiencies



Key Seismic Features and/or Deficiencies



Key Seismic Features and/or Deficiencies



Key Seismic Features and/or Deficiencies

Socio-Economic Issues

Patterns of occupancy	One family generally occupies one housing unit. We can find in very few cases or even rarely more than one family in one housing unit. Each building typically has multiple housing units. Ground floor can be used for commercial purposes. Each building typically has 4 housing unit(s). The number of housing units in the type considered in this study (as Figure 1) varies between 2-4. In few cases, especially in Nablus and Ramallah cities, the number of the units may reach up to 8 units in each building.
Number of inhabitants in a typical building of this construction type during the day	5-10
Number of inhabitants in a typical building of this construction type during the evening/night	10-20
Additional comments on number of inhabitants	
Economic level of inhabitants	Low-income class (poor)Middle-income class
Additional comments on economic level of inhabitants	These figures represent the present cost. The cost of construction was much lower when these building were constructed. Economic Level: For Poor Class the Housing Unit Price is 40,000 and Annual Income is 5,000. For Middle Class the Housing Unit Price is

	40,000 and the Annual Income is 9,000. Ratio of housing unit price to annual income: 5:1 or worse
Typical Source of Financing	Owner financedPersonal savings
Additional comments on financing	
Type of Ownership	RentOwn outrightOwned by group or pool
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?	No
Additional comments on premium discounts	
Additional comments section 4	

Earthquakes

Past Earthquakes in the country which affected buildings of this type

Year	Earthquake Epicenter
1927	Jericho
1995	Aqaba Gulf

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	- The magnitude of the Aqaba Gulf earthquake ranged between 6.2-6.5. -The magnitude of the Jerico earthquake ranged between 6.2-6.3. - In the 1995 earthquake, the Epicenter was located about 100 kilometers south of Aqaba and Elat cities where MMI was VII.
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.	FALSE
Building Configuration-Vertical	The building is regular with regards to the elevation. (Specify in 5.4.1)	TRUE
Building Configuration-Horizontal	The building is regular with regards to the plan. (Specify in 5.4.2)	TRUE
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.	TRUE
Floor Construction	The floor diaphragm(s) are considered to be	TRUE

	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.	TRUE
Wall and Frame Structures-Redundancy	The number of lines of walls or frames in each principal direction is greater than or equal to 2.	TRUE
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);	TRUE
Foundation-Wall Connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.	FALSE
Wall-Roof Connections	Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.	FALSE
Wall Openings		TRUE
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	TRUE

	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).	FALSE

Building Irregularities

Additional comments on structural and architectural features for seismic resistance	Interconnection of different components: foundation, walls, roof slabs is poor.
Vertical irregularities typically found in this construction type	Other
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	#NAME?
Earthquake-resilient features in walls	
Seismic deficiency in frames	
Earthquake-resilient features in frame	
Seismic deficiency in roof and floors	#NAME?
Earthquake resilient features in roof and floors	
Seismic deficiency in foundation	The footings are not well connected to achieve the necessary stiffness
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	-|			

Earthquake damage

Earthquake damage

Earthquake damage

Earthquake damage

Earthquake damage

Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	Seismic Strengthening

Additional comments on seismic strengthening provisions	The retrofitting of these structures is not described in any provisions. It is performed rarely by individual engineers without applying unique principles and tools. In general, jacketing using reinforced concrete or steel is used for strengthening purposes.
Has seismic strengthening described in the above table been performed?	Information not available.
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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