World Housing Encyclopedia

an Encyclopedia of Housing Construction in
Seismically Active Areas of the World

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HOUSING REPORT
Base Isolation of Confined Masonry

Report #	152
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Country	ARGENTINA
Housing Type	Seismic Protection Systems
Housing Sub-Type	Seismic Protection Systems: Buildings Protected with Base-Isolation Systems
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Summary

Most of Argentine Republic territory may be considered seismic.Great Mendoza is an important social-economic area in the mid- western region and it has the greatest seismic risk in the country. In the last 200 years or so, there have been important earthquakes affecting building structures. Consequently, new techniques aimed at controlling vulnerability must be developed. Methodology: An investigation of the actual application of Basal Seismic Isolation

(BSI) on a building 'Students' House' belonging to the Technological National University (UTN) is implemented. Research of the isolation system for near source motions has been done. The construction of three modules of student houses has been done in 2004, with confined masonry and reinforced concrete for three levels and prestressed slabs. Both buildings have accelerometers to register earthquake effects. The complex is completed with a building of two levels for administration with confined masonry. The aim is to control BSI displacement. The strategy proposed was to add damping to the isolation system within certain limits and the results are compared to similar fixed base building. To control near source displacements, additional damping is an applicable and economic strategy. Although with this strategy there is increased acceleration , it is far less than in the case of fixed base building.

1. General Information

Buildings of this construction type can be found in the city of Mendoza, on the mid-West of the Argentine Republic and on the foot of Los Andes mountains. Buildings are typically not base isolated. The province of Mendoza represents the most important social and economic concentration of the mid-West of Argentine and therefore it is one of the regions of major seismic risk of the country. This type of housing construction is commonly found in urban areas.

In the region 70% of constructions are built with confined masonry which is promoted by the current codes. This is the only building so far with base isolation and constructed with confined masonry in the country. Although base isolation devices are used extensively in others seismic regions of the world, in Argentina there are few examples. This first building was constructed with the aim of research and the excellent results obtained up to date indicate a potential for wider use.

This construction type has been in practice for less than 25 years.

Currently, this type of construction is not being built. The building possesses two important characteristics. First, it is seismically isolated; and the secondly it has been constructed in confined masonry which is also lined with a reinforced concrete layer. Although in the region the use of confined masonry is commonplace, rarely does one find both techniques in the same application.

View of building with base seismic isolation

2. Architectural Aspects

2.1 Siting

These buildings are typically found in flat terrain. They share common walls with adjacent buildings. The building has been constructed in the estate of National Technological University and it is located along with other buildings of students' residences of the Mendoza Regional Faculty When separated from adjacent buildings, the typical distance from a neighboring building is 4 meters.

2.2 Building Configuration

The building has three storeys. The plan of building is rectangular with dimensions, 7.60 x 8.20 m. The architectural configuration is the same in the three levels. In every storey two flats are developed for a maximum of three students in each. Every flat has one bathroom, one office and areas destined for bedrooms. The vertical circulation consists of external (steel stairs) and they link two different buildings. The structure is comprises reinforced concrete slabs, columns and beams. The outer walls are of confined masonry and the inside partitions are plaster board panels. The outer walls are of confined masonry and they are 18 and 27 cm thick. The 18 cm thick walls possess two steel bars in mortar joints. The structure has been designed to transfer the vertical and horizontal loads efficiently. The walls in the East-West direction are 30 cm thick, while the perpendicular walls are 20 cm thick. One of the walls of 30 cm of thickness possesses two windows on each level (dimensions 120 x 120 cm) which represents the 14 % of wall surface. The house reception area penetrates the perpendicular walls. The opening of 280x235 cm represents 33 % of wall surface.

2.3 Functional Planning

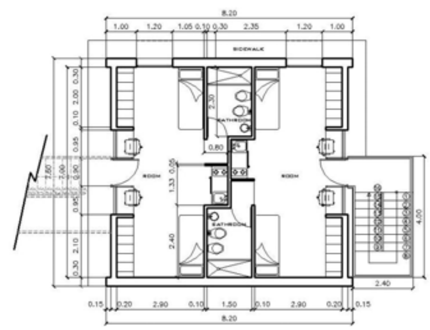
These student residences can accommodate between 36-40 students. From 12-15 students live in the seismically isolated building. In a typical building of this type, there are no elevators and 1-2 fire-protected exit staircases. Every residence possesses a direct egress (external stairs). In case of fire or another catastrophe, the students can quickly evacuate the building.

2.4 Modification to Building

The building has no modifications because it is new construction.

View of confined masonry buildings (North)

View of confined masonry buildings (South)



Plan of BSI Building

3. Structural Details

3.1 Structural System

Material	Type of Load-Bearing Structure	#	Subtypes	Most appropriate type
	Stone Masonry Walls	1	Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)	☐
		2	Dressed stone masonry (in lime/cement mortar)	☐
		3	Mud walls	☐

Masonry	Adobe/ Earthen Walls	4	Mud walls with horizontal wood elements	☐
		5	Adobe block walls	☐
		6	Rammed earth/Pise construction	☐
	Unreinforced masonry walls	7	Brick masonry in mud/lime mortar	☐
		8	Brick masonry in mud/lime mortar with vertical posts	☐
		9	Brick masonry in lime/cement mortar	☐
		10	Concrete block masonry in cement mortar	☐
	Confined masonry	11	Clay brick/tile masonry, with wooden posts and beams	☐
		12	Clay brick masonry, with concrete posts/tie columns and beams	☐
		13	Concrete blocks, tie columns and beams	☐
	Reinforced masonry	14	Stone masonry in cement mortar	☐
		15	Clay brick masonry in cement mortar	☐
		16	Concrete block masonry in cement mortar	☐
Structural concrete	Moment resisting frame	17	Flat slab structure	☐
		18	Designed for gravity loads only, with URM infill walls	☐
		19	Designed for seismic effects, with URM infill walls	☐
		20	Designed for seismic effects, with structural infill walls	☐
		21	Dual system – Frame with shear wall	☐
	Structural wall	22	Moment frame with in-situ shear walls	☐
		23	Moment frame with precast shear walls	☐
	Precast concrete	24	Moment frame	☐
		25	Prestressed moment frame with shear walls	☐
		26	Large panel precast walls	☐
		27	Shear wall structure with walls cast-in-situ	☐
		28	Shear wall structure with precast wall panel structure	☐
Steel	Moment-resisting frame	29	With brick masonry partitions	☐
		30	With cast in-situ concrete walls	☐
		31	With lightweight partitions	☐
	Braced frame	32	Concentric connections in all panels	☐
		33	Eccentric connections in a few panels	☐
	Structural wall	34	Bolted plate	☐
		35	Welded plate	☐
		36	Thatch	☐
		37	Walls with bamboo/reed mesh and post (Wattle and Daub)	☐
		38	Masonry with horizontal beams/planks at intermediate levels	☐

Timber	Load-bearing timber frame	39	Post and beam frame (no special connections)	☐
		40	Wood frame (with special connections)	☐
		41	Stud-wall frame with plywood/gypsum board sheathing	☐
		42	Wooden panel walls	☐
Other	Seismic protection systems	43	Building protected with base-isolation systems	☑
		44	Building protected with seismic dampers	☐
	Hybrid systems	45	other (described below)	☐

The building is constructed of reinforced concrete and reinforced masonry.A layer of reinforced concrete is cast on the faces of masonry walls. The foundations are spread footings joint with rigid concrete reinforced beams. The level of the foundation at its base is 200 to 250 cm below the level of natural ground. All the beams and columns have been designed in reinforced concrete. The slabs are prestressed concrete slabs (thickness 24 cm) with a top layer of reinforced concrete (mesh Ø 4.2 mm @ 25 cm) 4 cm thick to guarantee a monolithic and rigid structural diaphragm at floor and roof level. The masonry walls resist vertical and horizontal loads. Walls located in the North?South direction are 20 cm thick and they possess a steel mesh Ø 4.2 mm on both faces in addition to horizontal reinforcement in the mortar beds(2 Ø 6mm every five courses) The base-isolation system used in the building consists of four helicoidal steel spring packages located at the corners of the building, together with four viscous dampers. These types of devices are normally used to isolate industrial equipment or to filter vibrations from vehicular or railroad traffic. Steel springs have the advantage of well known behavior, they are stable with time, independent of temperature, and have no creep and not residual displacements. They have the disadvantage of low damping (2% of critical), and therefore it is necessary to use additional devices for increasing the damping. Because the load capacity of an individual helicoidal spring is limited, for moderate or large loads, the use of packages of springs is required. The number of springs per isolator depends on the static and dynamic demand imposed by service and seismic loads. In this case, because of asymmetry of loads, two isolators are composed of 30 springs, with a load capacity of 921 kN and the other two are composed of 28 springs for a force capacity of 860 kN. The structural system with isolators has natural horizontal frequencies between 1 and 2 Hz and natural vertical frequencies of 3 to 3.5 Hz. For earthquake input excitation the isolation system allows a dynamic motion composed of vertical, horizontal and swaying and rocking motions. Part of the horizontal excitation is transferred to swaying and rocking modes and it is dissipated by the isolation system thus reducing the seismic demands on the superstructure. The viscous damper comprises a container of viscous material. A piston attached to the upper part is immersed into the viscous material generating viscous forces in three orthogonal directions. The isolation system formed by spring isolators and viscous dampers has linear stiffness in all directions and an almost linear damping as a function of velocity. The design of the viscous damper is a function of maximum and minimum velocity demand that can be expected at the location. The maximum velocities of the selected records are in the range of 0.20 to 1.70 m/s. Viscous damping can be modified easily by changing the number of internal cylinders. In this case, due to the impulsive characteristic of anticipated earthquakes, large damping ratios have been selected in order to control displacements, 26% in horizontal direction and 13% in vertical direction. With these values the horizontal displacements are limited to 150-200 mm and the vertical ones to 30-50 mm, which are compatible with the displacements the springs and dashpots are capable of undergoing.

3.2 Gravity Load-Resisting System

The vertical load-resisting system is reinforced masonry walls. .

3.3 Lateral Load-Resisting System

The lateral load-resisting system is reinforced masonry walls. .

3.4 Building Dimensions

The typical plan dimensions of these buildings are: lengths between 8.20 and 8.20 meters, and widths between 7.60 and 7.60 meters. The building is 3 storey high. The typical span of the roofing/flooring system is 3.50 meters. The length in plan of a typical span is 3.50 meter in East-West direction and 2.50 meter in North-South direction. The building is of regular construction and a rectangular plan with the same dimension at all levels. The typical storey height in such buildings is 2.60 meters. The typical structural wall density is up to 5 %. The walls in

East-West direction is 30 cm thick, while the perpendicular ones are 20 cm thick. One of the walls 30 cm thick possesses two windows on each level (dimensions 120 x 120 cm) that represent the 14 % of wall surface. The housing reception area is located in the the perpendicular walls. The opening of 2.80x2.35 m. represents a 33 % of the wall surface.

3.5 Floor and Roof System

Material	Description of floor/roof system	Most appropriate floor	Most appropriate roof
Masonry	Vaulted	☐	☐
	Composite system of concrete joists and masonry panels	☐	☐
Structural concrete	Solid slabs (cast-in-place)	☐	☐
	Waffle slabs (cast-in-place)	☐	☐
	Flat slabs (cast-in-place)	☐	☐
	Precast joist system	☐	☐
	Hollow core slab (precast)	☑	☑
	Solid slabs (precast)	☐	☐
	Beams and planks (precast) with concrete topping (cast-in-situ)	☐	☐
	Slabs (post-tensioned)	☐	☐
Steel	Composite steel deck with concrete slab (cast-in-situ)	☐	☐
Timber	Rammed earth with ballast and concrete or plaster finishing	☐	☐
	Wood planks or beams with ballast and concrete or plaster finishing	☐	☐
	Thatched roof supported on wood purlins	☐	☐
	Wood shingle roof	☐	☐
	Wood planks or beams that support clay tiles	☐	☐
	Wood planks or beams supporting natural stones slates	☐	☐
	Wood planks or beams that support slate, metal, asbestos-cement or plastic corrugated sheets or tiles	☐	☐
	Wood plank, plywood or manufactured wood panels on joists supported by beams or walls	☐	☐
Other	Described below	☑	☑

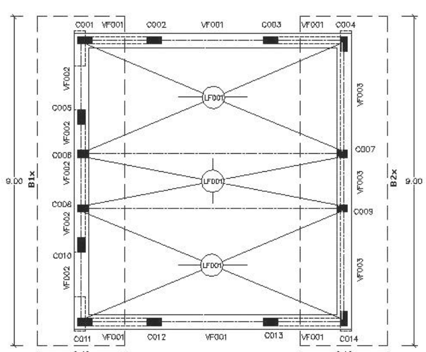
The floor system is comprises prestressed concrete slabs. They are 1.20 meters wide and 7.00 meters long. They are 24 cm thick with a top layer of reinforced concrete (mesh Ø 4.2 mm @ 25 cm) 4 cm thick to guarantee a monolithic and rigid floor diaphragm. The roofing systems is the same as floor systems, both are composed by prestressed reinforced concrete plate. They are 1.20 meter wide and 7.00 meters long. They are 24 cm thick with a top layer of reinforced concrete (mesh Ø 4.2 mm @ 25 cm) of 4 cm thick to guarantee a monolithic and rigid structural element at roof level.

3.6 Foundation

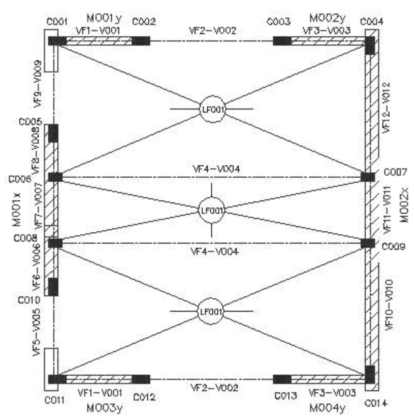
Type	Description	Most appropriate type
Shallow foundation	Wall or column embedded in soil, without footing	☐
	Rubble stone, fieldstone isolated footing	☐
	Rubble stone, fieldstone strip footing	☐
	Reinforced-concrete isolated footing	☐
	Reinforced-concrete strip	

	footing	☐
	Mat foundation	☐
	No foundation	☐
Deep foundation	Reinforced-concrete bearing piles	☐
	Reinforced-concrete skin friction piles	☐
	Steel bearing piles	☐
	Steel skin friction piles	☐
	Wood piles	☐
	Cast-in-place concrete piers	☐
	Caissons	☐
Other	Described below	☐

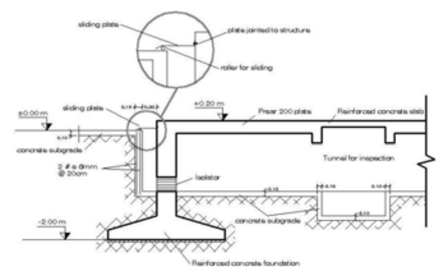
The foundation consists of spread footings joined by continuous reinforced concrete foundation beams The level of foundation of the base is of (-200 to 250 cm) with regard to the level of the natural ground. The isolation devices are located on the rigid beams that connect the bases. of the footings.



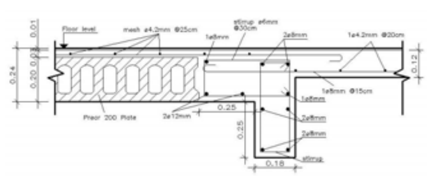
Plan of Footings of BSI Building



Structural Design of Typical Building (plan)



View of Details of Isolation of Building



Details of prestressed concrete plate and reinforced concrete at roof level

View of System of Isolation in BSI Building

4. Socio-Economic Aspects

4.1 Number of Housing Units and Inhabitants

Each building typically has 5-10 housing unit(s). In every level of the building two flats lodge between 4 and 6 students. There are 6 flats for the building. The number of inhabitants in a building during the day or business hours is 11-20. The buildings are inhabited by engineering students. They are also used for teachers visiting the University. Some students work and study therefore they only use the flat to have lunch, dinner and to sleep. The students who only do academic activities occupy the flats during the day and at noon they meet at the University. All the flats are inhabited. The number of inhabitants during the evening and night is 11-20. The students who occupy the residence live out of the City of Mendoza as do the teachers visiting the University, therefore all of them occupy the residence during the evening and night. The students who occupy the residence are not the same every year. This is the reason why the residence is very dynamic in terms of the number and types of people who occupy it.

4.2 Patterns of Occupancy

The buildings of the students' residences are not inhabited by typical families but only by students. Every flat of the building is occupied by 2-3 engineering students. The visiting professors are not accompanied by their families. Every flat can be occupied by a maximum of 2 teachers.

4.3 Economic Level of Inhabitants

Income class	Most appropriate type
a) very low-income class (very poor)	☐
b) low-income class (poor)	☐
c) middle-income class	☑
d) high-income class (rich)	☐

In general the students are from middle class families who live out of the city of Mendoza . Children who belong to upper classes families in general rent apartments or buy them.

Ratio of housing unit price to annual income	Most appropriate type
5:1 or worse	☐
4:1	☐
3:1	☐
1:1 or better	☐

What is a typical source of financing for buildings of this type?	Most appropriate type
Owner financed	☐
Personal savings	☐
Informal network: friends and relatives	☐
Small lending institutions / micro-finance institutions	☐
Commercial banks/mortgages	☐
Employers	☐
Investment pools	☐
Government-owned housing	☑
Combination (explain below)	☐
other (explain below)	☐

The students' residence was financed by the Government of the Province of Mendoza. For the construction of the Students' Residence, the Provincial Institute of Housing granted a 30 year loan to the University. In each housing unit, there are no bathroom(s) without toilet(s), no toilet(s) only and 1 bathroom(s) including toilet(s).

The bathroom possesses all necessary facilities (toilet, bidet and washing). It does not possess a bath but it is provided with a space adapted to take a shower. .

4.4 Ownership

The type of ownership or occupancy is ownership by a group or pool of persons.

Type of ownership or occupancy?	Most appropriate type
Renting	☐
outright ownership	☐
Ownership with debt (mortgage or other)	☐
Individual ownership	☐
Ownership by a group or pool of persons	☑
Long-term lease	☐
other (explain below)	☐

The University owns the students' residences. Students pay a minimal amount of rent.

5. Seismic Vulnerability

5.1 Structural and Architectural Features

Structural/ Architectural Feature	Statement	Most appropriate type		
		Yes	No	N/A
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	The building is regular with regards to both the plan and the elevation.	☑	☐	☐
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	☐	☐	☑
	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			

Wall openings	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.	☑	☐	☐
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 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)	☑	☐	☐
Additional Comments	The building possess a low vulnerability index. The fact of having base isolation seismic implies that the building is not vulnerable to seismic loads. The structural configuration in plan and elevation of the building also reduces vulnerability. The materials also are adapted to control the vulnerability of the building.			

5.2 Seismic Features

Structural Element	Seismic Deficiency	Earthquake Resilient Features	Earthquake Damage Patterns
Wall	None	Suitable wall thickness controls the distortion. Walls with horizontal and vertical steel to improve the ductility.	Good behaviour
Frame (Column, beams)	None	The beams and columns have suitable steel shear reinforcement to allow for energy dissipation and to avoid brittle collapse.	Good behaviour
Roof and floors	None	Possess 26 cm thicknesses to guarantee rigid diaphragms. High rigidity allows inertial forces to be distributed to the vertical resistant Walls in an efficient way.	Good behaviour

The building was inaugurated in 2004 and therefore designed to a modern code. The building has had a good behaviour to vertical loads and to the small ground motions that have happened in the region.

5.3 Overall Seismic Vulnerability Rating

The overall rating of the seismic vulnerability of the housing type is F: VERY LOW VULNERABILITY (i.e., excellent seismic performance), the lower bound (i.e., the worst possible) is F: VERY LOW VULNERABILITY (i.e., excellent seismic performance), and the upper bound (i.e., the best possible) is F: VERY LOW VULNERABILITY (i.e., excellent seismic performance).

Vulnerability	high	medium-high	medium	medium-low	low	very low
	very poor	poor	moderate	good	very good	excellent
Vulnerability Class	A	B	C	D	E	F
	☐	☐	☐	☐	☐	☑

5.4 History of Past Earthquakes

Date	Epicenter, region	Magnitude	Max. Intensity

2008	San Juan	4.5	III
2007	Mendoza	5.1	III
2006	Mendoza	5.7	VI
2006	San Juan	5.0	III
2005	San Juan	5.2	IV

Recent ground motions in the region have been of low magnitude. In general they have not produced serious damage in buildings of this type. The accelerations registered in the base isolated building are, in most cases, up to four times less than that the registered in the same building but of fixed base.

6. Construction

6.1 Building Materials

Structural element	Building material	Characteristic strength	Mix proportions/dimensions	Comments
Walls	Walls: clay brick and artisan brick and some reinforced concrete. Although not standard practice in Argentina, masonry walls are lined with mesh and then a layer of concrete to increase their strength and ductility.	Reinforced concrete: H17 (17 MPa) Clay brick: Compressive strength 2.50 MPa	Masonry mortar mix: 1:3 (cement:sand) Concrete mix: 1:2:3(cement:sand:gravel) Dimensions of masonry units: 130x80x60 for walls of 30 cm of thickness and 260x170x80 for walls of 20 cm of thickness.	The internal divisions are of plaster plate. The wall and floor coverings are ceramic materials.
Foundation	Reinforced concrete Over the foundation structure the isolator device and viscous dampers are located.	Reinforced concrete: H17 (17 MPa)	Concrete mix: 1:2:3(cement:sand:gravel) Dimensions of foundations: Spread footings(900x200x100) cm. with continuous beams (40 wide x150 deep) cm.	
Frames (beams & columns)	Reinforced concrete	Reinforced concrete: H17 (17 MPa)	Concrete mix:1:2:3 (cement: sand: gravel) Dimension beams:(20x30) cm, (30x30) cm and (20x45) cm. Dimension columns: (20x30) cm and (20x40) cm.	
Roof and floor(s)	Prestressed concrete slabs with reinforced concrete topping.	Reinforced concrete: H17 (17 MPa) Prestressed concrete : H30 (30 MPa)	Concrete mix:1:2:3 (cement: sand: gravel) Lengths of 750 cm for prestressed concrete slabs and 200 cm thickness for solid slabs.	.

6.2 Builder

The buildings have been constructed for students' residences. The building with base isolation can be compared with the same building but fixed base located a few meters away. There have been constructed three buildings of equal constructive characteristics and one of them with base isolation seismic. The buildings have the characteristic also to be inhabited by his owners or the same way for developments.

6.3 Construction Process, Problems and Phasing

The building was designed by architects and structural engineers. During construction typical building tools and equipment were used. The construction of this type of housing takes place incrementally over time. Typically, the building is originally designed for its final constructed size.

6.4 Design and Construction Expertise

The building was designed by architects and structural engineers. The diverse phases of building construction were inspected by two architects, two engineers and three students of engineering. The inspection was present from the beginning to the end of the works. The architects and engineers took part in all phases of the work, from the design to construction and completion. Also university civil engineering students collaborated in the design and construction of the buildings.

6.5 Building Codes and Standards

This construction type is addressed by the codes/standards of the country. For reinforced concrete structures we applied the national code CIRSOC 201. To evaluate the effect of the earthquakes on the building we applied the Code of earthquake resistant Constructions of the Province of Mendoza, 1987. To evaluate the capacity of the masonry wall we applied the Code of earthquake resistant Constructions of the Province of Mendoza, also. Finally in order to compare results also there was used the national code INPRES-CIRSOC 103.

The Province of Mendoza for many years, has used code different from the national code. Nevertheless in recent years the codes have been unified and have been adopted at a national level (INPRES-CIRSOC). The INPRES-CIRSOC codes provide regulations regarding design and construction for earthquake conditions. The local regulations, Code of Resistant Constructions of Mendoza have been enforced since 1987, in different town councils of the Province of Mendoza.

6.6 Building Permits and Development Control Rules

This type of construction is an engineered, and authorized as per development control rules.

The municipality authorities examine and approve the projects (architectural, structure and installations). In Argentina the code on seismic isolation and dissipation of energy is in progress. Therefore to approve the construction of the building the authority used the code of Chile (NChOf273). Building permits are required to build this housing type.

6.7 Building Maintenance

Typically, the building of this housing type is maintained by Owner(s).

6.8 Construction Economics

The unit construction cost of the building is of approximately $US 650. The entire area of the building is of approximately 185 square meters. In this area six flat are included. Therefore the entire cost of the building is of $US 120.250. To the value of the building it is necessary to add the cost of the isolation devices. This cost is $US 20.000 approximately.

Construction of Reinforcement of Footings of BSI Building (B1x and B2X)

Construction of Reinforced Masonry

Details of Confined Masonry Walls. Note the layer of reinforcing mesh on the wall that will be covered with concrete inorder to improve wall strength and ductility.

7. Insurance

Earthquake insurance for this construction type is typically unavailable. For seismically strengthened existing buildings or new buildings incorporating seismically resilient features, an insurance premium discount or more complete coverage is unavailable. An insurance does not exist for this type of construction.

8. Strengthening

8.1 Description of Seismic Strengthening Provisions

8.2 Seismic Strengthening Adopted

8.3 Construction and Performance of Seismic Strengthening

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