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

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

HOUSING REPORT
Medium/high rise moment resisting reinforced concrete frame building

Report #	97
Report Date	19-07-2003
Country	ROMANIA
Housing Type	RC Moment Frame Building
Housing Sub-Type	RC Moment Frame Building : Designed for gravity loads only, with URM infills
Author(s)	Maria D. Bostenaru
Reviewer(s)	Svetlana N. Brzev

Summary

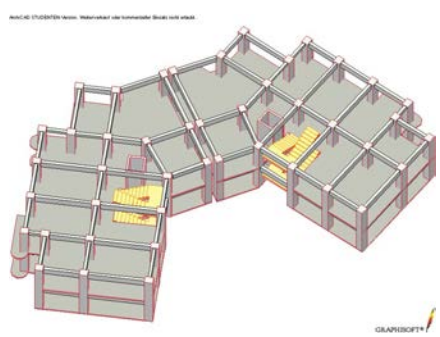
Such buildings generally range from 10 to 17 storeys in height with the ground floor being used for commercial purposes, whilst the upper floors house residential units. The vertical load bearing structure consists of moment-resisting reinforced-concrete frames which also generally

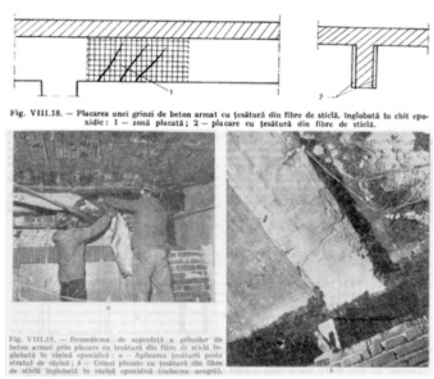
serve as the lateral load-resisting system. However, when larger spans are encountered, reinforced-concrete structural walls are included to provide a dual structural system. Masonry infills built from lightweight concrete masonry units provide architectural space delineation. The seismic performance of such buildings constructed prior to 1977 varies from no damage to complete collapse. To date damage has usually been attributable to conceptual and construction mistakes.

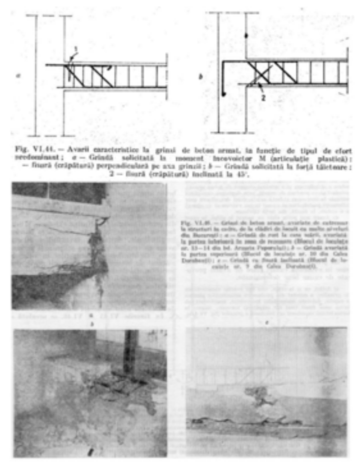
1. General Information

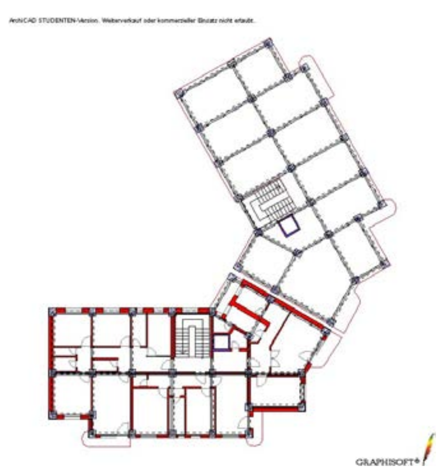
Buildings of this construction type can be found in Romania. According to Balan (1982), 90% of the building stock in Romania at the time of writing, was built after 1950. In Bucharest itself, between 1950 and the earthquake that occurred in 1977, a total of around 400,000 new residential apartment units were constructed, and two thirds of these were housed in medium rise constructions. Out of the latter about 4% where built using a reinforced concrete frame structure. This type of housing construction is commonly found in urban areas. This construction type has been in practice for less than 25 years.

Currently, this type of construction is being built. After 1990 new buildings were no longer constructed in the architectural socialist post-modern style. Two buildings of this latter period in two different styles are shown in Fig. 1A and 1B.









2. Architectural Aspects

2.1 Siting

These buildings are typically found in flat terrain. They do not share common walls with adjacent buildings. When separated from adjacent buildings, the typical distance from a neighboring building is 0 meters.

2.2 Building Configuration

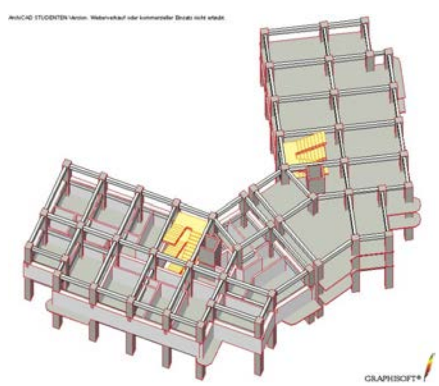
The plan shape can be any shape, but most typically it is either a rectangular, square, L or U layout. Openings are formed in the masonry infill (see fig. 2,2B and 2C). Since the masonry infill is usually out of light concrete (beton celular autoclavizat), the position and size of openings is not generally considered to influence the structural characteristics at the design stage.

2.3 Functional Planning

The main function of this building typology is mixed use (both commercial and residential use). See fig. 3, 3A and 3B. In a typical building of this type, there are no elevators and 1-2 fire-protected exit staircases. stairs, lift(s).

2.4 Modification to Building

The light partition/infill walls have allowed for numerous modifications to the interior spaces of these buildings without directly influencing the geometrical characteristics of the main reinforced concrete structural members. After 1990 many facades of these constructions have been modified with balconies being closed off and included in the glass and metal facade structures installed.



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)	☐
	Adobe/ Earthen Walls	3	Mud walls	☐
		4	Mud walls with horizontal wood elements	☐
		5	Adobe block walls	☐
		6	Rammed earth/Pise construction	☐
	Unreinforced masonry	7	Brick masonry in mud/lime mortar	☐
		8	Brick masonry in mud/lime mortar with vertical posts	☐

Masonry	walls	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	☐
Timber	Load-bearing timber frame	36	Thatch	☐
		37	Walls with bamboo/reed mesh and post (Wattle and Daub)	☐
		38	Masonry with horizontal beams/planks at intermediate levels	☐
		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)	☐

3.2 Gravity Load-Resisting System

The vertical load-resisting system is reinforced concrete moment resisting frame. Monolithic cast in-situ reinforced concrete slabs transfer the gravity loads to the reinforced concrete beam and column framing down to the foundation. Various architectural requirements give rise to particular cases, such as where window openings result in the beams being cast as up-stands (Fig. 2A) rather than down-stands. Furthermore, in some cases brick masonry infills (Fig. 2C) might actually carry some local vertical load.

3.3 Lateral Load-Resisting System

The lateral load-resisting system is reinforced concrete moment resisting frame. The main lateral load resisting system is provided by the reinforced concrete moment resisting frames (Fig. 2). The infills (Fig. 4) then, although not accounted for in design, invariably contribute to the building's stiffness. The use of a higher storey height for the lower floor for commercial purposes gives rise to an increased likelihood of a soft storey mechanism.

3.4 Building Dimensions

The typical plan dimensions of these buildings are: lengths between 12.7 and 30 meters, and widths between 12 and 17 meters. The building has 4 to 18 storey(s). The typical span of the roofing/flooring system is 6 meters. Typical Plan Dimensions: up to 8 'tronsons' (units of this type) for a building. Typical Number of Stories: According to Balan (1982) some buildings are mid-rise (ground floor and 3-4 upper floors) but most of them are high-rise (ground floor and 8-14 upper floors or even more). Typical Story Height: Soft ground storey 4.0m Lower height basement 2.005m Typical Span: Older construction of this type is based on a 4.5x5.0 meter grid. However, buildings housing commercial ground floors have a 6.0x6.0 meter grid. Nevertheless, the solution adopting a 5.40x3.60 meter grid which also permitted commercial use, was found to be the most economic in lieu of the amount of structural materials used, according to Balan (1982). The typical storey height in such buildings is 2.75 meters. The typical structural wall density is up to 10 %. The above values are for the (lightweight concrete) infill walls.

3.5 Floor and Roof System

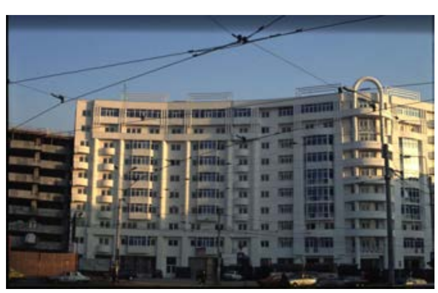
Material	Description of floor/roof system	Most appropriate floor	Most appropriate roof
Masonry	Vaulted	☐	☐
	Composite system of concrete joists and masonry panels	☐	☐
Structural concrete	Solid slabs (cast-in-place)	☑	☑
	Waffle slabs (cast-in-place)	☐	☐
	Flat slabs (cast-in-place)	☐	☐
	Precast joist system	☐	☐
	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)	☐	☐
	Rammed earth with ballast and concrete or plaster finishing	☐	☐
	Wood planks or beams with ballast and concrete or plaster finishing	☐	☐

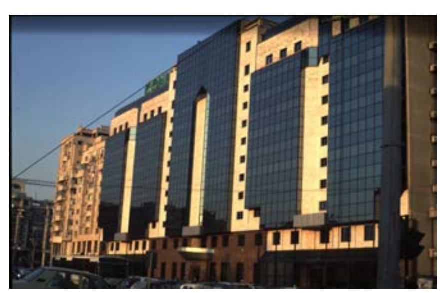
Timber	Thatched roof supported on wood purlins	☐	☐
	Wood shingle roof	☐	☐
	Wood planks or beams that support clay tiles	☐	☐
	Wood planks or beams supporting natural stones slates	☐	☐
	Wood planks or beams that support slate, metal, asbestos-cement or plastic corrugated sheets or tiles	☐	☐
	Wood plank, plywood or manufactured wood panels on joists supported by beams or walls	☐	☐
Other	Described below	☑	☑

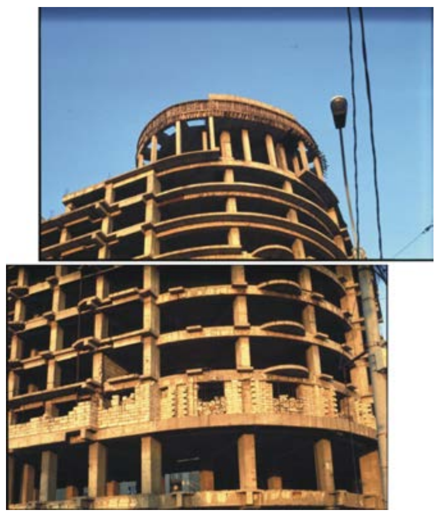
3.6 Foundation

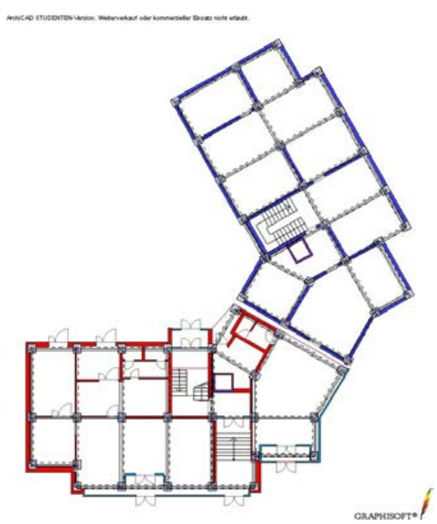
Type	Description	Most appropriate type
Shallow foundation	Wall or column embedded in soil, without footing	☐
	Rubble stone, fieldstone isolated footing	☐
	Rubble stone, fieldstone strip footing	☐
	Reinforced-concrete isolated footing	☐
	Reinforced-concrete strip footing	☐
	Mat foundation	☑
	No foundation	☐
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	☐

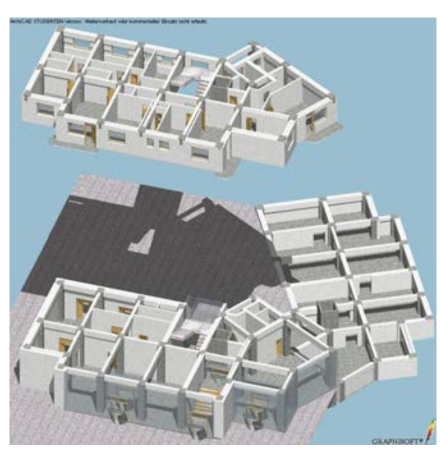
Probably other foundation forms are encountered, such as piles in certain cases.





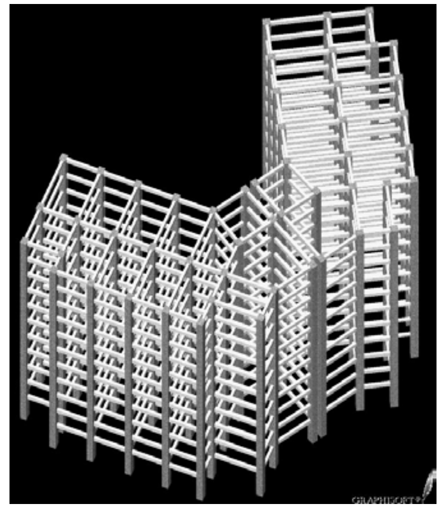


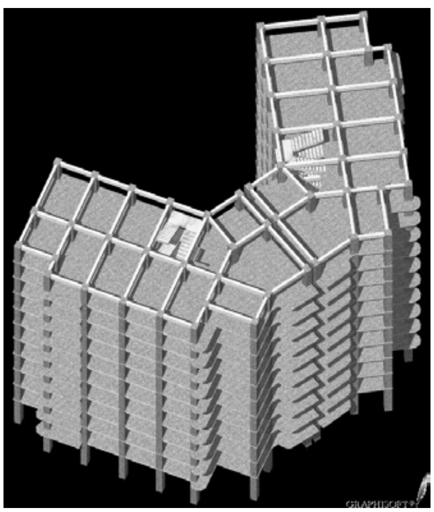

ArchiCAD STUDENTEN-Version. Weiterverkauf oder kommerzieller Einsatz nicht erlaubt.
GRAPHISOFT®

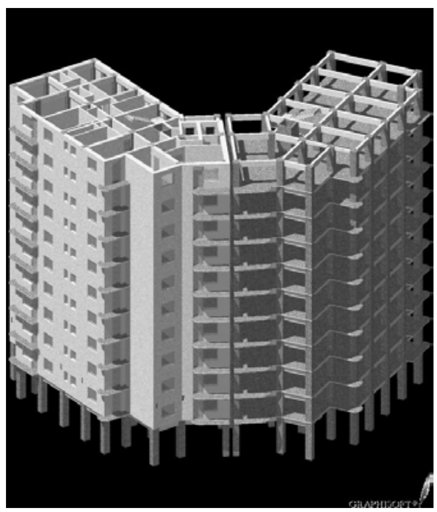

GRAPHISOFT®


STRADA
TOAMNEI-129

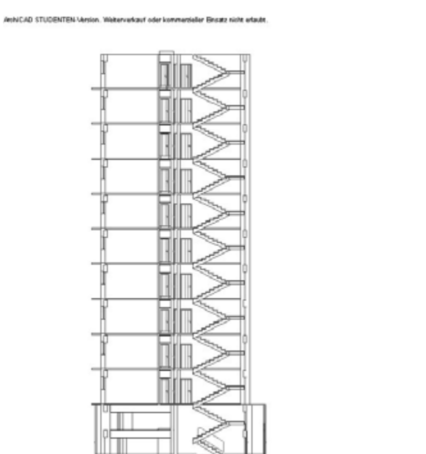

STRADA
TOAMNEI-129

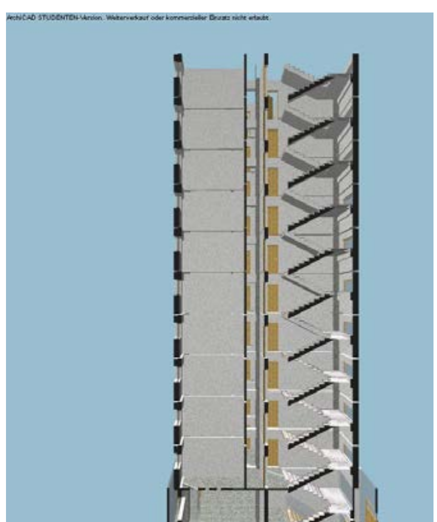

GRAPHISOFT®


GRAPHISOFT®


GRAPHISOFT®


GRAPHISOFT®


ArchiCAD STUDENTEN-Version. Weiterverkauf oder kommerzieller Einsatz nicht erlaubt.
GRAPHISOFT®


ArchiCAD STUDENTEN-Version. Weiterverkauf oder kommerzieller Einsatz nicht erlaubt.
GRAPHISOFT®

4. Socio-Economic Aspects

4.1 Number of Housing Units and Inhabitants

Each building typically has 21-50 housing unit(s). 30 units in each building. See fig. 3 for a typical floor plan. The number of inhabitants in a building during the day or business hours is more than 20. The number of inhabitants during the evening and night is more than 20.

4.2 Patterns of Occupancy

One family occupies a single flat.

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)	☐

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)	☑

Originally the buildings were constructed with government financing and then rented out. The tenants later had the opportunity to buy their apartment at a favorable price, given that they had rented them for a certain amount of time. In each housing unit, there are 1 bathroom(s) without toilet(s), 1 toilet(s) only and 1 bathroom(s) including toilet(s).

4.4 Ownership

The type of ownership or occupancy is renting and individual ownership.

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)	☐

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 walls;			

Wall openings	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				

5.2 Seismic Features

Structural Element	Seismic Deficiency	Earthquake Resilient Features	Earthquake Damage Patterns
Frame	Where commercial premises are housed a soft storey mechanism can be prevalent, due to the larger storey heights and possible larger spans, (fig 5, 5E and 5F). During the structural design, the influence of the masonry infills is not taken into account. The amount of reinforcement in the main structural members is not always exactly prescribed. The detailing of the beam-column connections. Poor construction material quality, mistakes during construction, such as out-of-plumb columns. Where precast structural members are used the connections are a cause of concern.	A regular and three dimensional column grid giving rise to a robust moment resisting spatial frame system (Fig. 2E, 5A). In some buildings structural reinforced concrete walls are incorporated to give rise to a dual system.	Weak storey: slender columns, concrete spalling, buckling of the reinforcement in plastic hinge locations (fig 6A, 6C, 6G). Central and short columns suffer, stirrup rupture, column dislocation, cracks, brittle failures especially at the intersection with staircases which give rise to a captive column effect. Typical storeys: In the columns, horizontal cracks directly under /over the beams, orthogonally to the column axis, concrete spalling, buckling of the reinforcement bars at plastic hinges, inclined X-shaped cracks (Fig. 6B, 6E, 6G). In the beams, larger span beams suffer from concrete spalling in the plastic hinge zones. Cracks in the beam-column connections (Fig 6B, 6E). In shorter span beams, inclined cracks on the lower half of the beams. Inclined X-shaped cracks, vertical flexural cracks in secondary beams.
Infill	poor construction material quality (light concrete brick Fig. 2D), not considered in structural design, soft storey effects where infills are omitted to provide larger architectural spaces.	- small percentage of openings (fig 5C and 5D)	Superficial cracks in the plastering, separation cracks on the perimeter. Inclined X-cracks (Fig. 6D), sliding failure in the first storey and at construction joints, partial or complete failure of the masonry (Fig 6A), deformation of the window frames with glass breakages, cracks in the lintels, disintegration of the partition walls especially where construction joints are present.
Roof and floors	none	stiff cast in-situ floors (Fig. 5B)	cracks in the lower storeys where interaction with central and short column
Other			

Evaluation based on Balan et al. (1982).

5.3 Overall Seismic Vulnerability Rating

The overall rating of the seismic vulnerability of the housing type is A: HIGH VULNERABILITY (i.e., very poor seismic performance), the lower bound (i.e., the worst possible) is A: HIGH VULNERABILITY (i.e., very poor seismic performance), and the upper bound (i.e., the best possible) is A: HIGH VULNERABILITY (i.e., very poor seismic performance).

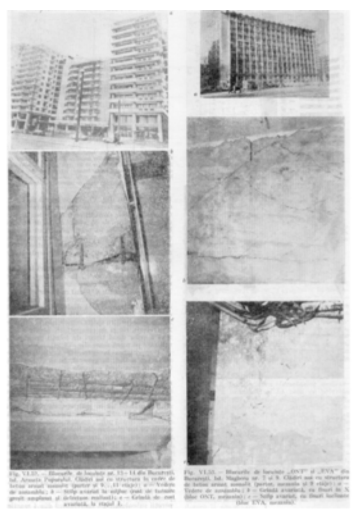
Vulnerability	high	medium-high	medium	medium-low	low	very low

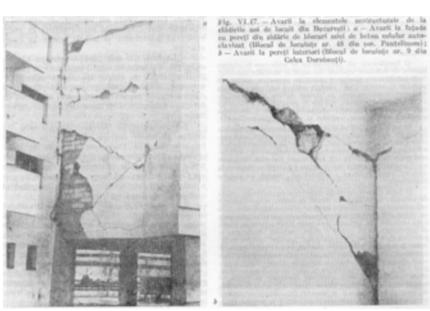
	very poor	poor	moderate	good	very good	excellent
Vulnerability Class	A	B	C	D	E	F
	☑	☐	☐	☐	☐	☐

5.4 History of Past Earthquakes

Date	Epicenter, region	Magnitude	Max. Intensity
1977	Vrancea	7.2	8
1986	Vrancea	7	8
1990	Vrancea	6.7	7
2004	Vrancea	5.9	6

According to Balan (1982), during the 1977 earthquake, damage was typically concentrated locally in the reinforced concrete columns and beams on the ground floor and up to the fourth storey, as shown in Fig. 6. Furthermore, severe damage to the masonry infill walls was evidenced as well.





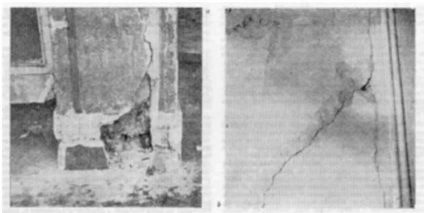
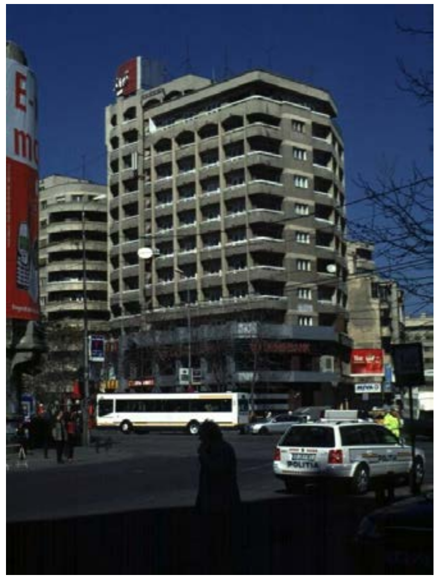


Fig. VI.45. – Stîlpi de beton armat avariaţi de cutremur la structuri în cadre, de la clădiri de locuit noi cu multe niveluri, din Bucureşti : a – Stîlp de colţ la parter, avariat la capitelul inferior (Blocul de locuinţe 118 – 128 din şos. Ştefan cel Mare) ; b – Stîlp de la parter, cu rupere înclinată (Blocul de locuinţe nr. 10 din Calea Dorobanţi).



6. Construction

6.1 Building Materials

Structural element	Building material	Characteristic strength	Mix proportions/dimensions	Comments
Walls	Interior (partition) infill Walls: first brick masonry then light concrete ('beton celular autoclavizat') masonry (fig. 2F) then light beton strips. Facade infill walls: first brick masonry (fig. 2H) then light concrete ('beton celular autoclavizat') masonry then light beton strips or reinforced concrete precast panels in sandwich type.		Interior (partition) infill Walls: 1956-1963: 25cm brick masonry Facade infill walls: 1956-1963: 37,5cm brick masonry	Used also for jacketing of the columns, in order to avoid thermal bridging (fig. 4A) and also for aesthetic purposes.
Foundation	reinforced concrete	older construction used B170 and B200, and later B300. (250 daN/cm²)		
Frames (beams & columns)	Columns: reinforced concrete Beams: reinforced concrete (fig. 2G)	initially B170 and B200, later (1974-76) B300. (250 daN/cm²)	Columns: 1974-76: 60x70-80cm at ground floor and first floor, reduced sections at upper floors. Beams: 1974-76: constant section at all floors: 30x65cm in the interior and 30x55cm on the perimeter.	Columns: cast-in-situ Beams: cast-in-situ (fig. 4A) and very rarely precast.
Roof and floor(s)	reinforced concrete	initially B170 and B200, later (1974-76) B300. (250 daN/cm²) ex 8cm over concrete on 5cm "predale" (prefabricated slab)	1974-76: precast semi-panels with large in-situ zones or with over concrete 'predale', or, in some cases, 15cm thick cast-in-place concrete 'dale'.	In-situ topping on 5 cm thick prefabricated "predale" type slabs.

6.2 Builder

The builder does not typically live in this construction type as they were not built by developers but by state enterprises.

6.3 Construction Process, Problems and Phasing

Little data are available, apart from the obvious steps in constructing an RC framed building. Figures 2A-2H. The construction of this type of housing takes place in a single phase. Typically, the building is originally designed for its final constructed size.

6.4 Design and Construction Expertise

State enterprises provide all professional architectural and engineering services. The architectural plans are developed by architects. Structural design and construction supervision is typically carried out by engineers.

6.5 Building Codes and Standards

This construction type is addressed by the codes/standards of the country. P.13-70. The year the first code/standard addressing this type of construction issued was 1970. The most recent code/standard addressing this construction type issued was 1992. Title of the code or standard: According to Balan et al. (1982), pp. 493-495: March 1977: new seismic zonation (decree 66) > new zonation standard in 1978. March 1977: publishing for public discussion the project of the law nr. 8 regarding the durability, the safety in usage, functionality and quality of constructions > new anti-seismic design code (normative): P.100-78, later improved in P.100-1981, containing new prescriptions regarding the set-up of cast-in-place and precast reinforced concrete, metal and masonry constructions. It took in consideration the new zonation, and accentuated the reduction of construction weight, and the rational shape of the assembly, computing coefficients were changed, the computing of displacements prescribed in order to avoid pounding damage, ductility was desirable, and also the execution conditions were prescribed (work phases). Documents were made immediately after the earthquake also regarding reparation measures (technical instructions). The document from 1981 did not bring radical modifications, but more precision (regarding the dynamic coefficient depending on local site conditions, limits of relative displacements and the way to evaluate these, computing methods for eccentricity etc). The main completions regard installations and an annex considering spatial oscillations. P.13-70 Year the first code/standard addressing this type of construction issued: 1970 When was the most recent code/standard addressing this construction type issued? 1992.

There used to be a quality control organization, CTC (Control Tecnic de Calitate services).

6.6 Building Permits and Development Control Rules

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

no available data. no available data.

7. Insurance

Earthquake insurance for this construction type is typically available. For seismically strengthened existing buildings or new buildings incorporating seismically resilient features, an insurance premium discount or more complete coverage is available. According to "Magazinul Românesc" 2% of the residences were earthquake assured by the time of the 2004 earthquake. According to "Magazinul Românesc" the insurance costs 0,3-0,5% of the value of the residence.

8. Strengthening

8.1 Description of Seismic Strengthening Provisions

Strengthening of Existing Construction :

Seismic Deficiency	Description of Seismic Strengthening provisions used
superficial rifts in reinforced concrete elements	epoxy resin injection
deep rifts, concrete spalling in reinforced concrete elements	recasting of concrete, eventually with local jacketing (Fig. 7D, 7E)
break of concrete and reinforcement in reinforced concrete elements	Columns: epoxy resin injection, steel/reinforced concrete jacketing; Beams: surface plating (Fig. 7); Reinforced concrete structural walls: Jacketing, eventually with shotcrete; Reinforced concrete slabs: overconcrete; stairs: rarely shotcrete, supporting elements are added.

8.2 Seismic Strengthening Adopted

Has seismic strengthening described in the above table been performed in design and construction practice, and if so, to what extent?

Yes.

Was the work done as a mitigation effort on an undamaged building, or as repair following an earthquake?

Following the 1977 Vrancea earthquake, various repairs were carried out. Nowadays buildings are being retrofitted as a mitigation measure (refer to Fig. 7C).

8.3 Construction and Performance of Seismic Strengthening

Was the construction inspected in the same manner as the new construction?

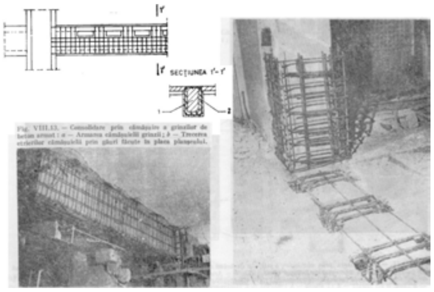
No.

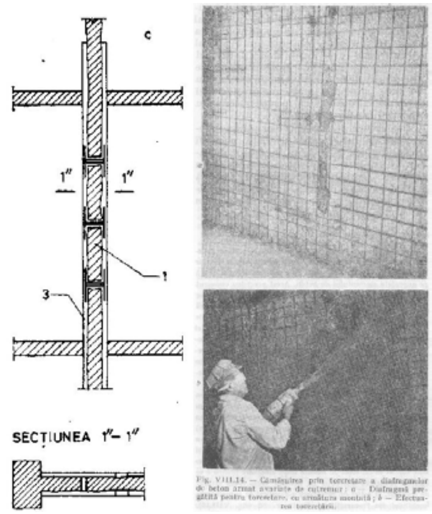
Who performed the construction seismic retrofit measures: a contractor, or owner/user? Was an architect or engineer involved?

Contractors performed the construction and both architecture and engineering institutions were involved.

What was the performance of retrofitted buildings of this type in subsequent earthquakes?

The performance was good but the subsequent earthquakes were weaker.





Reference(s)

1. "The 1977 March 4, Earthquake in Romania" (in Roma
   M. Lupan

2. "Economic Efficiency and Applicability of Building
   Maria Bostenaru Dan

3. "At a degree from disaster" (in Romanian). In: Mag

4. Karl Steinbrugge collection

Author(s)

1. Maria D. Bostenaru
   researcher, History and Theory of Architecture & Heritage Cons, Ion Mincu University of Architecture and Urbanism
   str. Academiei nr. 18-20, Bucharest 010014, ROMANIA
   Email:Maria.Bostenaru-Dan@alumni.uni-karlsruhe.de FAX: 0040213077178

Reviewer(s)

1. Svetlana N. Brzev
   Instructor
   Civil and Structural Engineering Technology, British Columbia Institute of Technology
   Burnaby BC V5G 3H2, CANADA
   Email:sbrzev@bcit.ca FAX: (604) 432-8973