World Housing Encyclopedia

A Resource on Construction in Earthquake Regions

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

HOUSING REPORT

Single-family brick masonry house

Report#	36
Last Updated	
Country	Kyrgyzstan
Author(s)	Ulugbek T. Begaliev , Svetlana Uranova,
Reviewers	Ravi Sinha,

Important

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General Information

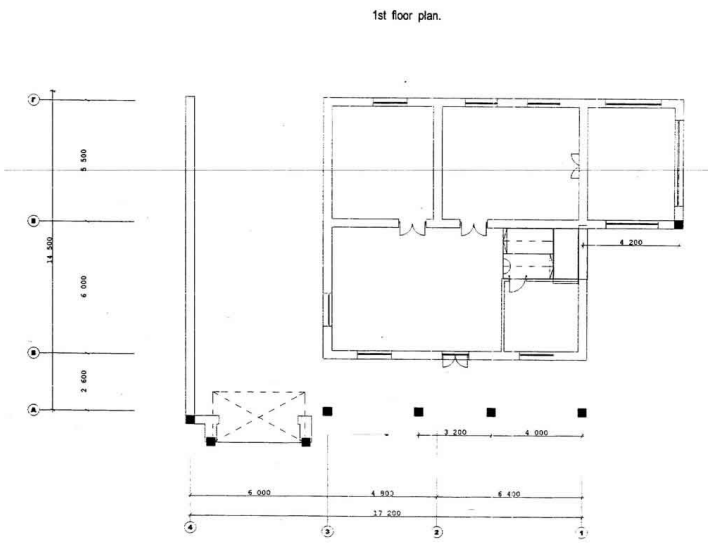
Building Type:	Single-family brick masonry house
Country:	Kyrgyzstan
Author(s):	Ulugbek T. Begaliev Svetlana Uranova
Last Updated:	
Regions Where Found:	Buildings of this construction type can be found in all parts of Kyrgyzstan. This type of housing construction is commonly found in both rural and urban areas
Summary:	This housing type represents a very popular single-family housing construction practice followed in Kyrgyzstan in the recent past. Approximately 80% of the buildings of this type, mostly those constructed after 1990, do not comply with the Building Code requirements. These are low-rise (1- to 2-story high) buildings with a complex plan and wall layout. The main load-bearing system consists of brick masonry walls in cement mortar partially confined with reinforced concrete posts and beams; columns are provided only at some wall corners and intersections. Rigid brick masonry walls have low load-carrying capacity. Wall thickness is either 380 mm or 510 mm. SNiP (Building Code) includes provisions for the horizontal wall reinforcement (welded wire mesh at the wall corners) and the provision of reinforced concrete columns at the wall corners. The floor system consists of precast reinforced concrete hollow-core slabs with typical slab panel dimensions of 5.86 m length x 1.2 m width. Reinforced concrete bond beam (belt) is constructed at the building perimeter at the floor level to provide the confinement and diaphragm action for seismic load effects. Complex building geometry and irregular wall distribution results in significant torsional effects during earthquakes due to the eccentricity between the centre of mass and centre of stiffness. These buildings are located in regions of high seismic hazard, which have experienced earthquakes of intensity VIII, IX or higher (per the MSK scale) in the past. This type of construction is expected to demonstrate poor seismic performance due to poor quality of masonry walls and the complex layout resulting in torsional effects.
Length of time practiced:	Less than 25 years
Still Practiced:	Yes
In practice as of:	

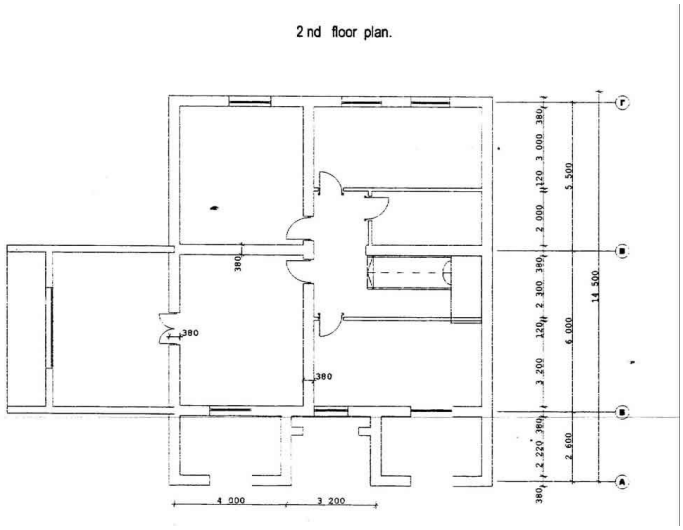
Building Occupancy:	Single dwelling
Typical number of stories:	2
Terrain-Flat:	Typically
Terrain-Sloped:	4
Comments:	

Features

Plan Shape	Irregular plan shape
Additional comments on plan shape	Building plan for this housing type usually has complex plan and geometry.
Typical plan length (meters)	15
Typical plan width (meters)	15
Typical story height (meters)	3
Type of Structural System	Masonry: Confined Masonry: Concrete blocks, tie columns and beams
Additional comments on structural system	Lateral load-resisting system: The main lateral load-resisting system generally consists of brick masonry walls in cement mortar and reinforced concrete posts and beams provided at some locations. According to SNiP (Building Code) it is required to provide columns at the wall ends; column reinforcement is illustrated in Figure 6. SNiP requirements also include the provision of horizontal reinforcement (wire mesh) in mortar bedding joints at each 7th layer. Rigid brick masonry walls have low load-carrying capacity. Poor quality of brick masonry results in low earthquake resistance of the walls even when reinforced with welded wire mesh and steel reinforcement bars. Wall thickness is either 380 mm or 510 mm. The floor system consists of precast reinforced concrete hollow-core slabs with typical slab panel dimensions of 5.86m length x 1.2m width (see Figure 2). Reinforced concrete bond beam (belt) is constructed at the building perimeter at the floor level to provide confinement and diaphragm action for seismic load effects; belt reinforcement details are presented in Figure 5. Roof structures are made of wood or steel. Gravity load-bearing system: Gravity load-bearing structure consists of brick masonry walls, few reinforced concrete columns and beams, and floor concrete panels.
Gravity load-bearing & lateral load-resisting systems	
Typical wall densities in direction 1	10-15%

Typical wall densities in direction 2	10-15%
Additional comments on typical wall densities	Total wall density is 10% - 15% in each direction.
Wall Openings	It is impossible to indicate the typical size of openings since it depends on the architectural requirements. Window size is around 1.2m x 1.5m and doors size is approximately 0.9m x 1.9m. Window and door areas constitute 10 to 15% of the overall wall surface area.
Is it typical for buildings of this type to have common walls with adjacent buildings?	No
Modifications of buildings	Buildings of this type are usually of recent construction and no modifications have been observed so far. However, some buildings have been modified by providing additional doors and windows, expanding the building size (adding new rooms) or by moving the walls.
Type of Foundation	Shallow Foundation: Reinforced concrete strip footing
Additional comments on foundation	Many buildings have precast concrete strip footing made up of concrete blocks.
Type of Floor System	Other floor system
Additional comments on floor system	Precast hollow core slab system is most commonly used.
Type of Roof System	Roof system, other
Additional comments on roof system	Precast hollow core slab system is most commonly used.
Additional comments section 2	Typical separation distance between buildings: 10 meters or more





Plan of the Second Floor for a Typical

Plan of a Typical Building

Plan of the Second Floor for a Typical Building shown in Figure 4

Building Materials and Construction Process

Description of Building Materials

Structural Element	Building Material (s)	Comment (s)
Wall/Frame	Wall:Brick masonry Frame: Reinforced Concrete	Wall: Characteristic Strength- Tension resistance of mortar less 6.0 MPa Mix Proportion/Dimensions- Variable, from 1:8 to 1:20 cement/sand ratio Brick masonry units-dimensions 250x120x70mm Frame: Characteristic Strength- 20 MPa (cube compressive strength) 390 MPa (steel yield stress) Mix Proportion/Dimensions- various Steel - Elasticity Modulus (200,000 MPa)
Foundations	Concrete	Characteristic Strength: 5 MPa (cube compressive strength) Mix Proportion/Dimensions: various
Floors	Reinforced Concrete	Characteristic Strength: 30-35 MPa (cube compressive strength) 390 MPa (steel yield stress) Mix Proportion/Dimensions: variable Steel - Elasticity Modulus (200,000 MPa)
Roof	Reinforced Concrete	Characteristic Strength: 30-35 MPa (cube compressive strength) 390 MPa (steel yield stress) Mix Proportion/Dimensions: variable Steel - Elasticity Modulus (200,000 MPa)
Other		

Design Process

Who is involved with the design process?	None of the above

Roles of those involved in the design process	These constructions are built by developers and sold in the market.
Expertise of those involved in the design process	This building type is not designed or constructed with the required expertise.

Construction Process

Who typically builds this construction type?	Builder
Roles of those involved in the building process	These constructions are built by developers and sold in the market.
Expertise of those involved in building process	This building type is not designed or constructed with the required expertise.
Construction process and phasing	This building type may be erected by builders or by owners. Usually only mobile crane is used for the erection and construction process. This building is not typically constructed incrementally and is designed for its final constructed size.
Construction issues	The construction quality is generally very poor, and the structural design has flaws. This type of construction is expected to display poor behaviour during earthquakes.

Building Codes and Standards

Is this construction type address by codes/standards?	Yes
Applicable codes or standards	Some of buildings correspond to SNiP II-7-81 Design Code: Building in Seismic Regions. The code/standard addressing this type of construction was issued 1981.
Process for building code enforcement	N/A

Building Permits and Development Control Rules

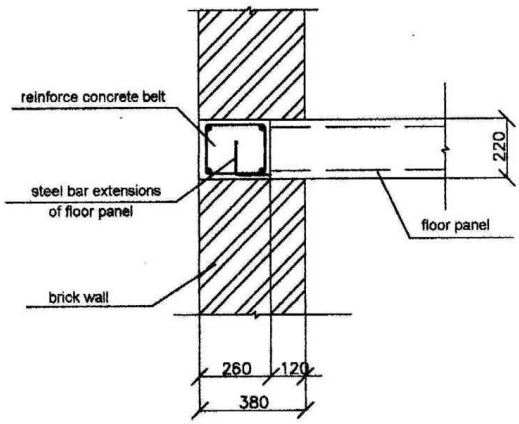
Are building permits required?	No
Is this typically informal construction?	Yes
Is this construction typically authorized as per development control rules?	No
Additional comments on building permits and development control rules	

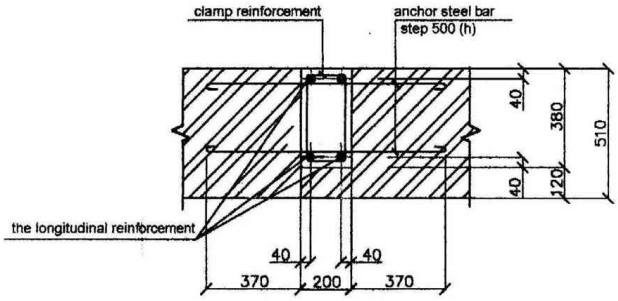
Building Maintenance and Condition

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

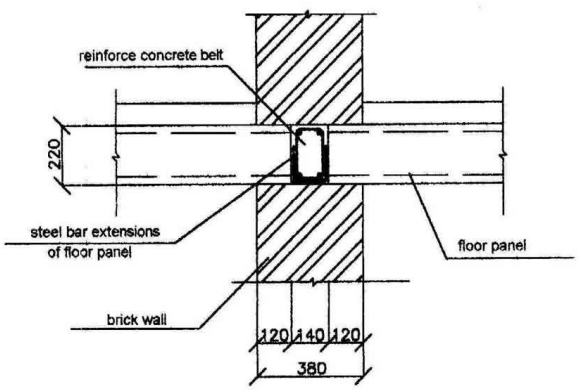
Construction Economics

Unit construction cost	For load-bearing structures about 150$/m.sq.
Labor requirements	The construction of a single-family house can be completed in a period of 10-12 months.
Additional comments section 3	

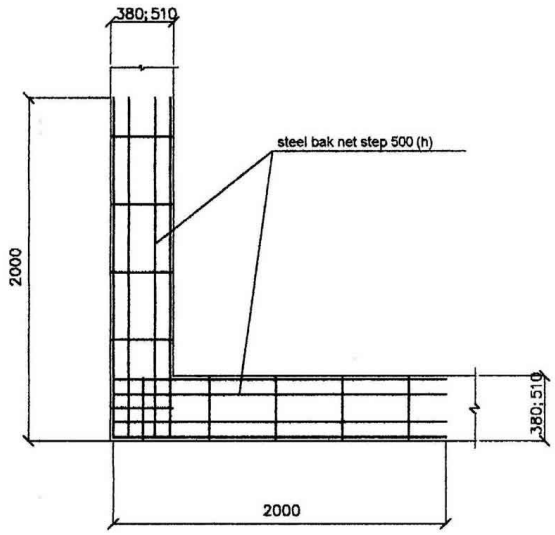




Horizontal Wall Section Showing Reinforced Concrete Column Reinforcement



Critical Structural Details - Wall-Floor Connection Showing Reinforced Concrete Bond Beam (belt) Reinforcement



Horizontal Wall Section Showing Corner Reinforcement

Socio-Economic Issues

Patterns of occupancy	One family typically occupies one house.
Number of inhabitants in a typical building of this construction type during the day	<5
Number of inhabitants in a typical building of this construction type during the evening/night	5-10
Additional comments on number of inhabitants	
Economic level of inhabitants	Middle-income classHigh-income class (rich)
Additional comments on economic level of inhabitants	
Typical Source of Financing	Owner financedPersonal savings
Additional comments on financing	
Type of Ownership	Own outright

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
1992	Suusamir

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	Maximum intensity of the Suusamir earthquake was 9, however buildings of this type were located in the regions with intensity 6-7 on the MSK scale. Buildings of this type had experienced the following wall damage patterns: diagonal "X" cracks in the piers, cracks at the wall corners, and partial destruction of the walls.
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)	FALSE
Building Configuration-Horizontal	The building is regular with regards to the plan. (Specify in 5.4.2)	FALSE
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 rigid and it is expected that the floor structure(s) will maintain its integrity during an earthquake of intensity expected in this area.	TRUE
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	TRUE

	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);	TRUE
Foundation-Wall Connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.	TRUE
Wall-Roof Connections	Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.	TRUE
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).	FALSE
Quality of Workmanship	Quality of workmanship (based on visual inspection of a few typical buildings) is considered to be good (per local construction standards).	FALSE
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	
Vertical irregularities typically	

found in this construction type	Torsion eccentricity
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	- Poor quality of brick masonry; - Different wall rigidity; - The complex building geometry, including the nonsymmetrical wall layout, results in significant torsional effects during earthquakes due to the eccentricity between the centre of mass and centre
Earthquake-resilient features in walls	
Seismic deficiency in frames	
Earthquake-resilient features in frame	
Seismic deficiency in roof and floors	
Earthquake resilient features in roof and floors	
Seismic deficiency in foundation	
Earthquake-resilient features in foundation	

Seismic Vulnerability Rating

For information about how seismic vulnerability ratings were selected see the Seismic Vulnerability Guidelines

	High vulnerability		**Medium vulnerability**		**Low vulnerability**	
	A	B	C	D	E	F
Seismic vulnerability class		|-	o	-|		

Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	**Seismic Strengthening**
Poor seismic resistance of walls	#NAME?
Non- symmetrical location of walls with different rigidity	#NAME?

Additional comments on seismic strengthening provisions	Seismic strengthening provisions presented in the above table are recommendations of the authors of this contribution.
Has seismic strengthening described in the above table been performed?	No.
Was the work done as a mitigation effort on an undamaged building or as a repair following earthquake damages?	N/A
Was the construction inspected in the same manner as new construction?	N/A
Who performed the construction: a contractor or owner/user? Was an architect or engineer involved?	N/A
What has been the performance of retrofitted buildings of this type in subsequent earthquakes?	N/A
Additional comments section 6	

References

Seismic Hazard and Buildings Vulnerability in Post-Soviet Central Asia Republics. Edited by Stephanie A. King, Vitaly I. Khalturin and Brian E. Tucker. Kluwer Academic Publishers, P.O. Box 17, 3300 AA Dordrecht, The Netherlands. (Proceeding of the NATO Advanced Research Workshop on Earthquake Risk Management Strategies for Post-Soviet Central Asian Republics. Almaty, Kazakhstan, 22-25 October 1996)

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Authors

Name	Title	Affiliation	Location	Email

Ulugbek T. Begaliev	Head of Department	KNIIPC	Vost Prom Zone Cholponatisky 2, Bishkek 720571 Kyrgyz Republic	utbegaliev@yahoo.com
Svetlana Uranova	Dr., Head of the Laboratory	KRSU	Kievskai 44, Bishkek 720000 Kyrgyz Republic	uransv@yahoo.com

Reviewers

Name	Title	Affiliation	Location	Email
Ravi Sinha	Professor	Civil Engineering Department, Indian Institute of Technology Bombay	Mumbai 400 076, India	rsinha@civil.iitb.ac.in