World Housing Encyclopedia

A Resource on Construction in Earthquake Regions

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HOUSING REPORT

Reinforced concrete frame buildings without beams (seria KUB)

Report#	39
Last Updated	
Country	Kyrgyzstan
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Important

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General Information

Building Type:	Reinforced concrete frame buildings without beams (seria KUB)
Country:	Kyrgyzstan
Author(s):	Svetlana Uranova Ulugbek T. Begaliev
Last Updated:	
Regions Where Found:	Buildings of this construction type can be found in Duchanbe (Tadjikistan), Nalchik (Russia), and Almaty (Kazachstan). There are some of these buildings in Bishkek (Kyrgyzstan). This type of housing construction is commonly found in urban areas.
Summary:	Frame buildings without beams were introduced in the last decade of the Soviet Union (period 1980-1989) in some of the Soviet Republics: Kyrgyzstan,Tadjikistan, Caucasian region of Russia etc. This type of precast construction is known as seria KUB. This type of apartment building is usually 5-9 stories high; in some cases these buildings are 12 stories high. The load-bearing structure consists of precast reinforced concrete columns and slabs. Precast column elements are usually two stories high. Typically, column spans are equal to 6m. Precast slab elements are made of solid concrete without ribs, and the dimensions are: 3m x 3m x 0.16m (length x width x thickness). Most buildings of this type have some kind of lateral load resisting elements, such as: cast-in-situ shear walls, precast shear walls, shear cross braces, etc. All precast structural elements are combined in 3-D moment frame by a special joint system. Partitions are made of brick masonry or small concrete block masonry. This building type is considered to be very earthquake vulnerable. Seismic resistance of buildings of this type depends on the type of column-to-slab joints. Similar structures were damaged in the 1988 Spitak (Armenia) earthquake.
Length of time practiced:	Less than 25 years
Still Practiced:	Yes

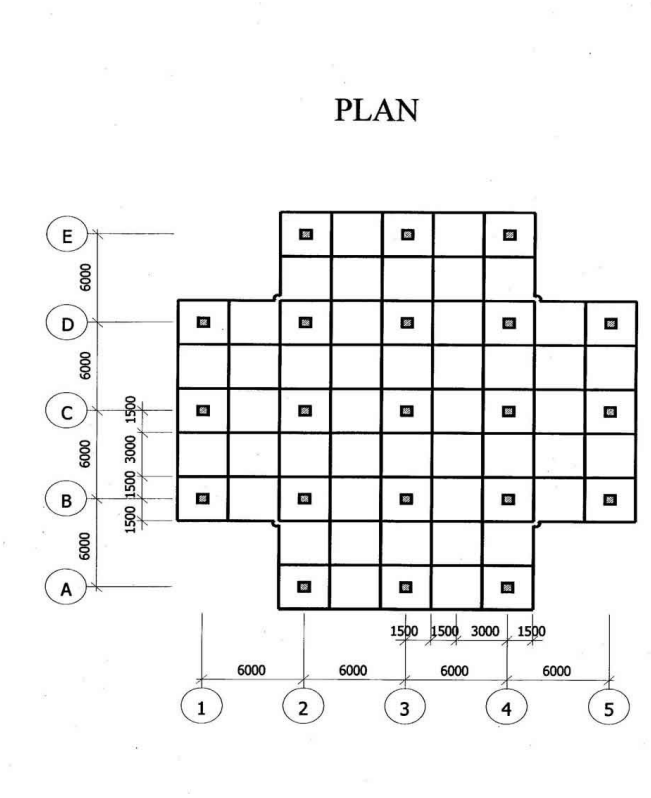
In practice as of:	
Building Occupancy:	Residential, 20-49 units
Typical number of stories:	5-12
Terrain-Flat:	Typically
Terrain-Sloped:	Off
Comments:	

Features

Plan Shape	Square, solidRectangular, solid
Additional comments on plan shape	Typical shape of a building plan for this housing type is rectangular or square with some modifications at the perimeter.
Typical plan length (meters)	24-60
Typical plan width (meters)	18-24
Typical story height (meters)	3
Type of Structural System	Structural Concrete: Precast Concrete: Moment frame
Additional comments on structural system	Gravity load-bearing system consists of reinforced concrete columns and slabs (same elements as in lateral load-resisting system). The lateral load-resisting system consists of reinforced concrete columns and slabs. In addition to this, most buildings of this type have some kind of lateral load resisting elements, such as: cast-in-situ shear walls, precast shear walls, shear cross braces, etc. In case lateral load-resisting elements (shear walls etc.) are not present, lateral load path depends on the ability of slab-column connections to transfer moments. In case of poorly constructed connections this is not possible and in such cases the completeness of lateral load path is questionable. However, properly constructed slab-column joints are capable of transferring moment as shown by several full-scale vibration tests on buldings of this type performed in Kyrgyz Republic. Precast column elements are usually two-storey high. Typically, column spans are equal to 6m. A typical precast column element is shown on Figure 4. Precast slab elements are made

	of solid concrete without ribs and the dimensions are: 3m x 3m x 0.16m (lengthxwidthxthickness). A typical precast slab element is shown on Figure 3. All precast structural elements are combined in a space frame system by means of special joints. The assembly of precast concrete elements is shown on Figures 2 and 7. Precast concrete floor slabs are lifted from the ground up to the final elevation. Longitudinal steel bars-dowels are projected from the adjacent slabs and subsequently welded. Transverse reinforcement bars are installed in-situ. Gaps in the connections are filled with concrete at the site. Details of the slab-column connection are shown on Figure 6.
Gravity load-bearing & lateral load-resisting systems	Shear walls usually do not exist in buildings of this type.
Typical wall densities in direction 1	0-1%
Typical wall densities in direction 2	0-1%
Additional comments on typical wall densities	Walls are not load-bearing structures. If present, shear elements constitute less than 1% of the floor area in a building.
Wall Openings	Walls are not the part of load-bearing structure in frame buildings without beams. If lateral load-resisting elements (e.g. shear walls) are present, the overall wall area usually does not exceed 1% of the floor area. These shear elements are solid (without openings), and are usually located between columns inside the building. Typical size of window openings is: 1.2 to1.5 m (height) x2 m (width), doors: 2m (height)x0.9-1m (width). Overall window area constitutes up to 30 or 40% of the exterior wall area. Less than 10% of the partition walls are perforated by door openings.
Is it typical for buildings of this type to have common walls with adjacent buildings?	No
Modifications of buildings	Usually, modifications are made in non-load-bearing elements e.g. exterior and interior walls.
Type of Foundation	Shallow Foundation: Reinforced concrete isolated footing
Additional comments on foundation	

Type of Floor System	Other floor system
Additional comments on floor system	Concrete: Precast solid slab panels
Type of Roof System	Roof system, other
Additional comments on roof system	Concrete: Precast solid slab panels
Additional comments section 2	Typical separation distance between buildings: minimum 10 meters



Plan of a Typical Building

Building Materials and Construction Process

Description of Building Materials

Structural Element	Building Material (s)	Comment (s)
Wall/Frame	Wall: Brick and gasconcrete masonry	Non bearing structure
Foundations	Reinforced concrete	Characteristic Strength: 10-15 MPa (cube compressive strength) Mix

		Proportion/Dimensions: Variable-depending on the type of mix materials
Floors	Reinforced concrete	Characteristic Strength: 30-35 MPa (cube compressive strength) Mix Proportion/Dimensions: Variable-depending on the type of mix materials
Roof	Reinforced concrete	Characteristic Strength: 30-35 MPa (cube compressive strength) Mix Proportion/Dimensions: Variable-depending on the type of mix materials
Other		

Design Process

Who is involved with the design process?	EngineerArchitectOther
Roles of those involved in the design process	Design institutes develop design documentation. Design for this construction type was done completely by engineers and architects. Engineers played a leading role in each stage of construction.
Expertise of those involved in the design process	Expertise related to design and construction of this type according to the legal system of Kyrgyzstan was available. Designs for buildings of this type were prepared by specialized design institutes with expertise in this type of construction.

Construction Process

Who typically builds this construction type?	Builder
Roles of those involved in the building process	The construction process is performed by builders.
Expertise of those involved in building process	Expertise related to design and construction of this type according to the legal system of Kyrgyzstan was available.
Construction process and phasing	A construction company fabricates precast elements and performs the assembly. Precast elements can be made either at the factory (plant) or at the building site. The main construction equipment includes crane, welding equipment and

	concrete mixers. This building is not typically constructed incrementally and is designed for its final constructed size.
Construction issues	

Building Codes and Standards

Is this construction type address by codes/standards?	Yes
Applicable codes or standards	SNiP II-7-81. Building in Seismic Regions.Design code. The first and most recent code/standard addressing this type of construction was issued 1981.
Process for building code enforcement	Building permit will be given if the design documents have been approved by State Experts. State Experts check compliance of design documents with pertinent Building Codes. According to the building bylaws, buildings cannot be used without the formal approval of a special committee. The committee gives the approval if design documents are complete and construction has been carried out in compliance with the Building Codes.

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?	Yes
Additional comments on building permits and development control rules	

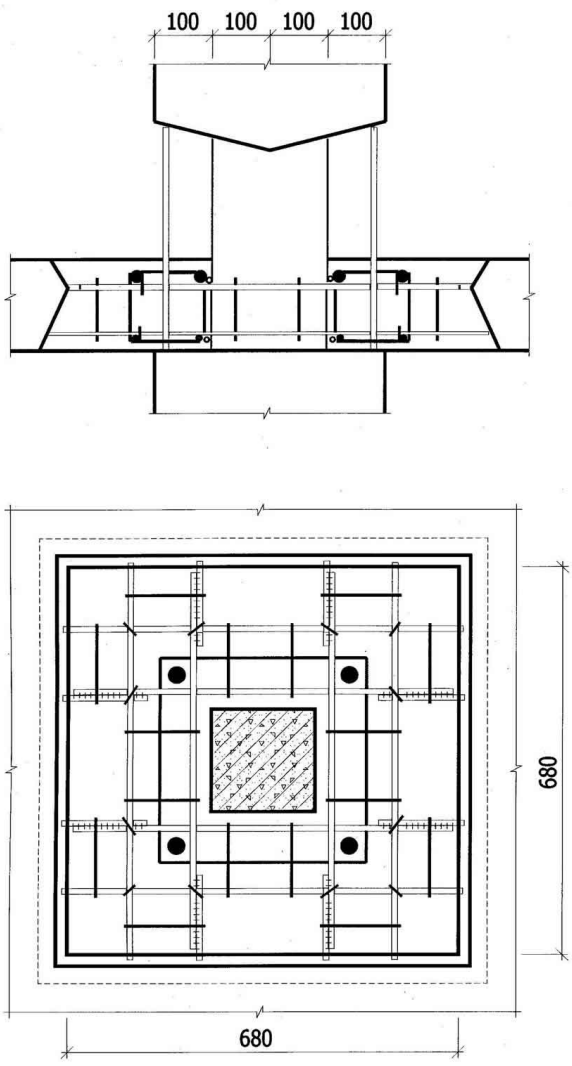
Building Maintenance and Condition

Typical problems associated with this type of construction	
Who typically maintains buildings of this type?	BuilderOwner(s)Renter(s)

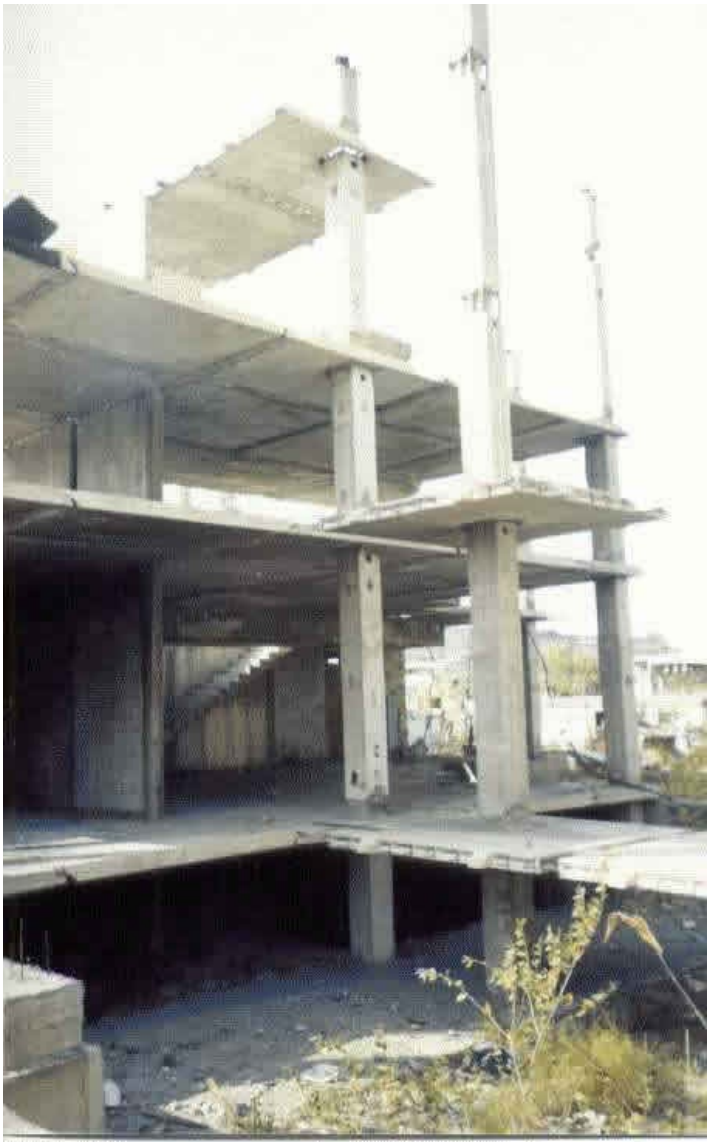
Additional comments on maintenance and building condition	

Construction Economics

Unit construction cost	For load-bearing structure only (without finishes) about 120 US$/sq m.
Labor requirements	It would take between 10 and 15 months for a team of 10 workers to build load-bearing structure for a building of this type.
Additional comments section 3	



Details of a monolithic column-slab connection



Building under construction

Socio-Economic Issues

Patterns of occupancy	Each floor in a building unit consists of 2-6 housing units. One family occupies one housing unit. Depending on the number of building units and stories in a building, number of families occupying one building ranges from 10 to 120; with a common occupancy of 36 to 40 families per building.
Number of inhabitants in a typical building of this construction type during the day	>20
Number of inhabitants in a typical building of this construction type during the evening/night	>20
Additional comments on number of inhabitants	
Economic level of inhabitants	Low-income class (poor)Middle-income class
Additional comments on economic level of inhabitants	It is estimated that 60% poor inhabitants and 40% middle class inhabitants occupy buildings of this type. 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 outrightUnits owned individually (condominium)
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
1988	Spitak, Armenia

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	Buildings of this type (seria KUB) have not been exposed to a major earthquake as of yet. However, buildings with a similar load-bearing structure (seria 111) experienced severe damage or collapse in the 1988 Spitak (Armenia) earthquake. The main cause was considered to be damage and failure of column-slab joints. The difference between seria KUB and seria 111 is in the floor slab construction. Seria KUB consists of smaller floor panels that are joined together in the erected position (see Figure 2). Floor slabs in seria 111 were large panels cast on the ground and then lifted and erected to the final position. It is expected that these two construction types would experience similar earthquake damage.
Additional comments on earthquake damage patterns	Complete or partial (wall) damage Collapse of floors, damage of joint areas

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.	TRUE
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 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	TRUE

	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.	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.	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		FALSE
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	FALSE

	deterioration of building elements (concrete, steel, timber).

Building Irregularities

Additional comments on structural and architectural features for seismic resistance	
Vertical irregularities typically found in this construction type	Other
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	Poor quality of walls and their joints with columns and floors. Walls are generally partitions (i.e. non load-bearing structures).
Earthquake-resilient features in walls	
Seismic deficiency in frames	Poor quality of joints.
Earthquake-resilient features in frame	
Seismic deficiency in roof and floors	Roof and floor slabs are load-bearing structures. The most deficient part is slab-column joint.
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
Column-slab joint	Steel and reinforced concrete cantilever
Column-slab joint (new construction)	Improved design solutions for column-slab joint
Floor slabs(new construction)	Construction of ribbed slabs. Increased slab thickness.

Additional comments on seismic strengthening provisions	
Has seismic strengthening described in the above table been performed?	
Was the work done as a mitigation effort on an undamaged building or as a repair following earthquake damages?	
Was the construction inspected in the same manner as new construction?	
Who performed the construction: a contractor or owner/user? Was an architect or engineer involved?	
What has been the performance of retrofitted buildings of this type in subsequent earthquakes?	
Additional comments	

section 6	

References

King, Stephanie, Vitaly Khalturin and Brian E. Tucker (1996). Seismic Hazard and Buildings Vulnerability in Post-Soviet Central Asia Republics. Proceedings of the NATO Advanced Research Workshop on Earthquake Risk Management Strategies for Post-Soviet Central Asian Republics, Almaty, Kazakhstan, 1996. Kluwer Academic Publishers, Dordrecht, Netherlands.

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