World Housing Encyclopedia Report

Country: Kyrgyzstan

Housing Type: Buildings with cast in-situ load-bearing reinforced concrete walls.

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1 General Information

1.1 Country
Kyrgyzstan

1.3 Housing Type

1.4 Summary
Buildings with cast in-situ load-bearing reinforced concrete walls are widespread in many Republics of the former Soviet Union. There are many such buildings in Kyrgyzstan in the areas with the design seismicity of 8 and 9 on the MSK scale. The buildings with cast in-situ walls are typically medium- to high-rise buildings (4-18 stories high; often 12-stories high). High-rise buildings of this type (9-18 stories high) have basements. Load-bearing structure consists of cast in-situ reinforced concrete walls and precast reinforced concrete floor slabs. Floor slabs are either two-way solid slab structures, or, less often, hollow-core slabs. Buildings of this type do not have any frame elements (columns and beams). Facade walls are usually made of lightweight (ceramsite) concrete. Buildings of this type are supported by concrete strip or mat foundations. This building type is considered to be earthquake-resistant. Problems are mainly related to the quality of construction.

1.5 Typical Period of Practice for Buildings of This Construction Type

<table>
<thead>
<tr>
<th>How long has this construction been practiced</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25 years</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>&lt; 50 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 75 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 100 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 200 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 200 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Is this construction still being practiced? Yes | No
X

1.6 Region(s) Where Used
Many buildings of this type exist in Bishkek (Kyrgyzstan) and the other Republics of the former Soviet Union. Many buildings with cast in-situ load-bearing reinforced concrete walls can be found in Moldova.

1.7 Urban vs. Rural Construction

<table>
<thead>
<tr>
<th>Where is this construction commonly found?</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>in urban areas</td>
<td>X</td>
</tr>
<tr>
<td>in rural areas</td>
<td></td>
</tr>
</tbody>
</table>
| In suburban areas
| Both in rural and urban areas |
2 Architectural Features

2.1 Openings
Typical window opening size is 1.3 m (height) X 1.8m (width), door openings: 2m (height) X 1 m (width). Overall window and door areas constitute up to 20% of the overall wall area. There are 20 to 25 windows in a building with plan dimensions of 28 X 26m.

2.2 Siting

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is this type of construction typically found on flat terrain?</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Is this type of construction typically found on sloped terrain? (hilly areas)</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Is it typical for buildings of this type to have common walls with adjacent buildings?</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

The typical separation distance between buildings is 20 meters

2.3 Building Configuration
Typical shape of a building plan for this housing type is rectangular or square; in some cases, the plan consists of two rectangles or squares.

2.4 Building Function

<table>
<thead>
<tr>
<th>What is the main function for buildings of this type?</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single family house</td>
<td>X</td>
</tr>
<tr>
<td>Multiple housing units</td>
<td></td>
</tr>
<tr>
<td>Mixed use (commercial ground floor, residential above)</td>
<td>X</td>
</tr>
<tr>
<td>Other (explain below)</td>
<td></td>
</tr>
</tbody>
</table>

2.5 Means of Escape
There is one stair per building unit. Typically, one building unit consists of 4 to 8 housing units per floor.

2.6 Modification of Buildings
Typical patterns of modification include the perforation of walls with door openings. This has been a very serious problem in Kyrgyzstan since 1992. There has been a trend for the people to purchase apartments at low cost and use them as shops. As a result of these modifications, the number of door openings in exterior load-bearing walls has been increased, the fragments of the walls have been removed, and the apertures in the lower stories have been made. Modifications of this type have resulted in the increased seismic vulnerability of buildings of this type. In an attempt to regulate this process in Kyrgyzstan, an annex to the Building Code has been developed, under the title "Change of the building function of some space of the existing apartment buildings" (SNiP 31-01-95). It is interesting to note that in Uzbekistan, modifications in the apartment buildings of this type are prohibited at the ground floor level.
3 Socio-Economic Issues

3.1 Patterns of Occupancy
Each floor in a building has 4-8 housing units. One family occupies one housing unit. Depending on the number of stories, 20 to 90 families occupy one building.

3.2 Number of Housing Units in a Building
54 units in each building.

Additional Comments: Usually 20-90 units there are in building.

3.3 Average Number of Inhabitants in a Building

<table>
<thead>
<tr>
<th>How many inhabitants reside in a typical building of this construction type?</th>
<th>During the day / business hours</th>
<th>During the evening / night</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 to 10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-20</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.4 Number of Bathrooms or Latrines per Housing Unit
Number of Bathrooms: 1  
Number of Latrines: 0

3.5 Economic Level of Inhabitants

<table>
<thead>
<tr>
<th>Economic Status</th>
<th>House Price/Annual Income (Ratio)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>/</td>
</tr>
<tr>
<td>Poor</td>
<td>X /</td>
</tr>
<tr>
<td>Middle Class</td>
<td>X /</td>
</tr>
<tr>
<td>Rich</td>
<td>/</td>
</tr>
</tbody>
</table>

Additional Comments: 60% poor, 40% middle class

3.6 Typical Sources of Financing

<table>
<thead>
<tr>
<th>What is the typical source of financing for buildings of this type?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Financed</td>
</tr>
<tr>
<td>Personal Savings</td>
</tr>
<tr>
<td>Informal Network: friends and relatives</td>
</tr>
<tr>
<td>Small lending institutions/microfinance institutions</td>
</tr>
<tr>
<td>Commercial banks / mortages</td>
</tr>
<tr>
<td>Investment pools</td>
</tr>
<tr>
<td>Combination (explain)</td>
</tr>
<tr>
<td>Government-owned housing</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

Additional Comments: Until 1990 (the breakdown of the Soviet Union), the main source of financing for buildings of this type had been provided by the Government. At the present time, all new and existing apartment buildings are privately owned.

3.7 Ownership
<table>
<thead>
<tr>
<th>Type of Ownership/Occupancy</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent</td>
<td>X</td>
</tr>
<tr>
<td>Own outright</td>
<td>X</td>
</tr>
<tr>
<td>Own with Debt (mortgage or other)</td>
<td></td>
</tr>
<tr>
<td>Units owned individually (condominium)</td>
<td>X</td>
</tr>
<tr>
<td>Owned by group or pool</td>
<td></td>
</tr>
<tr>
<td>Long-term lease</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>
4 Structural Features

4.1 Lateral Load-Resisting System
Lateral load-resisting system consists of reinforced concrete walls and reinforced concrete slabs. Walls and slabs are joined together in a rigid space (3-D) system. This system works as a uniform (box-type) construction. Floor slabs are either flat slab structures, or, less often, hollow-core slabs. Buildings of this type do not have any frame elements (columns and beams). Thickness of exterior (façade) walls is usually 300-400 mm, and the thickness of interior walls is 160-200 mm. Thickness of flat slabs and hollow-core slabs is 160 mm and 220 mm respectively. Facade walls are usually made of lightweight (ceramsite) concrete; thickness is variable depending on the thermal insulation requirements. Buildings of this type are supported by concrete strip or mat foundations. Wall reinforcement is designed based on the Building Code requirements. Vertical reinforcement bars are located close to the door and window openings, as well as at the wall end zones and at the wall intersections. Distributed vertical reinforcement is typically installed throughout the wall length, typically in two layers. In addition, two layers of welded-wire mesh are typically installed close to the exterior wall surfaces. If the walls are perforated with openings, coupling beams (spandrel beams) are designed for bending and shear effects. The reinforcement bars are joined together by welding or lap splices.

4.2 Gravity Load-Bearing Structure
Gravity load-bearing structure consists of reinforced concrete walls and slabs.
### 4.3 Type of Structural System

<table>
<thead>
<tr>
<th>Material</th>
<th>Type of Load-Bearing Structure</th>
<th>#</th>
<th>Subtypes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Masonry</strong></td>
<td>Stone masonry walls</td>
<td>1</td>
<td>Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Massive stone masonry (in lime or cement mortar)</td>
</tr>
<tr>
<td>Earthen walls</td>
<td>3</td>
<td>Mud walls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Mud walls with horizontal wood elements</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Adobe block or brick walls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Rammed earth/Pise construction</td>
<td></td>
</tr>
<tr>
<td><strong>Unreinforced brick masonry walls</strong></td>
<td>7</td>
<td>Unreinforced brick masonry in mud or lime mortar</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Unreinforced brick masonry in mud or lime mortar with vertical posts</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Unreinforced brick masonry in cement or lime mortar (various floor/roof systems)</td>
<td></td>
</tr>
<tr>
<td><strong>Confined masonry</strong></td>
<td>10</td>
<td>Confined brick/block masonry with concrete posts/tie columns and beams</td>
<td></td>
</tr>
<tr>
<td>Concrete block masonry walls</td>
<td>11</td>
<td>Unreinforced in lime or cement mortar (various floor/roof systems)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Reinforced in cement mortar (various floor/roof systems)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>Large concrete block walls with concrete floors and roofs</td>
<td></td>
</tr>
<tr>
<td><strong>Concrete</strong></td>
<td>Moment resisting frame</td>
<td>14</td>
<td>Designed for gravity loads only (predating seismic codes i.e. no seismic features)</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Designed with seismic features (various ages)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Frame with unreinforced masonry infill walls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Flat slab structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>Precast frame structure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Frame with concrete shear walls-dual system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Precast prestressed frame with shear walls</td>
<td></td>
</tr>
<tr>
<td><strong>Shear wall structure</strong></td>
<td>21</td>
<td>Walls cast in-situ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Precast wall panel structure</td>
<td></td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>Moment resisting frame</td>
<td>23</td>
<td>With brick masonry partitions</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>With cast in-situ concrete walls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>With lightweight partitions</td>
<td></td>
</tr>
<tr>
<td>Braced frame</td>
<td>26</td>
<td>Concentric</td>
<td></td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>Eccentric</td>
<td></td>
</tr>
<tr>
<td><strong>Timber</strong></td>
<td>Load-bearing timber frame</td>
<td>28</td>
<td>Thatch</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>Post and beam frame</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>Walls with bamboo/reed mesh and post (wattle and daub)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>Wooden frame (with or without infill)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>32</td>
<td>Stud wall frame with plywood/gypsum board sheathing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>Wooden panel or log construction</td>
<td></td>
</tr>
<tr>
<td><strong>Various</strong></td>
<td>Seismic protection systems</td>
<td>34</td>
<td>Building protected with base isolation devices or seismic dampers</td>
</tr>
<tr>
<td>Other</td>
<td>35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.4 Type of Foundation

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shallow Foundation</strong></td>
<td>Wall or column embedded in soil, without footing</td>
</tr>
<tr>
<td></td>
<td>Rubble stone (fieldstone) isolated footing</td>
</tr>
<tr>
<td></td>
<td>Rubble stone (fieldstone) strip footing</td>
</tr>
<tr>
<td></td>
<td>Reinforced concrete isolated footing</td>
</tr>
<tr>
<td></td>
<td>Reinforced concrete strip footing</td>
</tr>
<tr>
<td></td>
<td>Mat foundation</td>
</tr>
<tr>
<td></td>
<td>No foundation</td>
</tr>
<tr>
<td><strong>Deep Foundation</strong></td>
<td>Reinforced concrete bearing piles</td>
</tr>
<tr>
<td></td>
<td>Reinforced concrete skin friction piles</td>
</tr>
<tr>
<td></td>
<td>Steel bearing piles</td>
</tr>
<tr>
<td></td>
<td>Wood piles</td>
</tr>
<tr>
<td></td>
<td>Steel skin friction piles</td>
</tr>
<tr>
<td></td>
<td>Cast in place concrete piers</td>
</tr>
<tr>
<td></td>
<td>Caissons</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
</tr>
</tbody>
</table>

### 4.5 Type of Floor/Roof System

<table>
<thead>
<tr>
<th>Material</th>
<th>Description of floor/roof system</th>
<th>Floor</th>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Masonry</strong></td>
<td>Vaulted</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Composite masonry and concrete joist</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Structural</strong></td>
<td>Solid slabs (cast in place or precast)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Concrete</td>
<td>Cast in place waffle slabs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cast in place flat slabs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Precast joist system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Precast hollow core slabs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Precast beams with concrete topping</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-tensioned slabs</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>Composite steel deck with concrete slab</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Timber</strong></td>
<td>Rammed earth with ballast and concrete or plaster finishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood planks or beams with ballast and concrete or plaster finishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thatched roof supported on wood purlins</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood single roof</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood planks or beams that support clay tiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood planks or beams that support slate, asbestos-cement or plastic corrugated sheets or tiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wood plank, plywood or manufactured wood panels on joists supported by beams or walls</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Structural</strong></td>
<td>Precast hollow-core slabs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>concrete</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Additional Comments:* Floor and roof slabs are of precast construction (either hollow core slabs or solid slabs).

### 4.6 Typical Plan Dimensions

- **Length:** 30 - 30 meters
- **Width:** 30 - 30 meters

*Additional Comments:* Variation of length: 26-30 meters. Variation of width: 12-14 meters.

### 4.7 Typical Number of Stories

- 4 - 18

### 4.8 Typical Story Height

- 3 meters

### 4.9 Typical Span
3.6 meters

Additional Comments: Distance between cross walls is 3.6 m and between longitudinal walls is 5.4m.

4.10 Typical Wall Density
The total wall density in both directions is on the order of 15%. Wall density in one direction amounts to approx. 70-80% of the wall density in the other direction i.e. walls are rather uniformly distributed in the two principal directions.

4.11 General Applicability of Answers to Questions in Section 4
This contribution has been based on the authors' experience with the design and construction of buildings of this type, and it is not based on a case study of any particular building.
## 5.1 Structural and Architectural Features: Seismic Resistance

<table>
<thead>
<tr>
<th>Structural/Architectural Feature</th>
<th>Statement</th>
<th>True</th>
<th>False</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral load path</td>
<td>The structure contains a complete load path for seismic force effects from any horizontal direction that serves to transfer inertial forces form the building to the foundation.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building configuration</td>
<td>The building is regular with regards to both the plan and the elevation.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction</td>
<td>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.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor construction</td>
<td>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.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation performance</td>
<td>There is no evidence of excessive foundation movement (e.g. settlement) that would affect the integrity or performance of the structure in an earthquake.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall and frame structures-redundancy</td>
<td>The number of lines of walls or frames in each principal direction is greater than or equal to 2.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall proportions</td>
<td>Height-to-thickness ratio of the shear walls at each floor level is: 1) Less than 25 (concrete walls); 2) Less than 30 (reinforced masonry walls); 3) Less than 13 (unreinforced masonry walls).</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation-wall connection</td>
<td>Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall-roof connections</td>
<td>Exterior walls are anchored for out-of-plane seismic effects at each diaphragm level with metal anchors or straps.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall openings</td>
<td>The total width of door and window openings in a wall is: 1) for brick masonry construction in cement mortar: less than 1/2 of the distance between the adjacent cross walls; 2) for adobe masonry, stone masonry and brick masonry in mud mortar: less than 1/3 of the distance between the adjacent cross walls; 3) for precast concrete wall structures: less than 3/4 of the length of a perimeter wall.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of building materials</td>
<td>Quality of building materials is considered to be adequate per requirements of national codes and standards (an estimate).</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of workmanship</td>
<td>Quality of workmanship (based on visual inspection of few typical buildings) is considered to be good (per local construction standards).</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Buildings of this type are generally well maintained and there are no visible signs of deterioration of building elements (concrete, steel, timber).</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## 5.2 Seismic Features

<table>
<thead>
<tr>
<th>Structural Element</th>
<th>Seismic Deficiency</th>
<th>Earthquake-Resilient Features</th>
<th>Earthquake Damage Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall</td>
<td>Poor quality of concrete, especially at the locations of construction joints; the &quot;as constructed&quot; reinforcement locations do not match with the designed locations, inadequate length of lap splices in steel rebars; inadequate confinement in the highly stressed areas.</td>
<td>The load-bearing structure (consisting of walls and slabs) represents a rigid box system favorable for resisting lateral load effects.</td>
<td>The most common type of damage includes concrete crushing and spalling at the locations of construction joints, as well as the inclined diagonal cracks in the wall piers (due to the shear failure). Severe damage and collapse is not expected.</td>
</tr>
<tr>
<td>Frame (columns, beams)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof and floors</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Additional Comments: The most serious problem with the buildings of this type is poor quality of concrete.
## 5.3 Seismic Vulnerability Rating

<table>
<thead>
<tr>
<th>Seismic Vulnerability Class</th>
<th>Vulnerability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (Very Poor Seismic Performance)</td>
<td>A</td>
</tr>
<tr>
<td>Low (Excellent Seismic Performance)</td>
<td>&lt;</td>
</tr>
</tbody>
</table>

0 - probable value
< - lower bound
> - upper bound
6 Earthquake Damage Patterns

6.1 Past Earthquakes Reported To Affect This Construction

<table>
<thead>
<tr>
<th>Year</th>
<th>Earthquake Epicenter</th>
<th>Richter magnitude (M)</th>
<th>Maximum Intensity (Indicate Scale e.g. MMI, MSK)</th>
</tr>
</thead>
</table>

*Additional Comments:* Buildings of this type have not been subjected to the effects of damaging earthquakes in Kyrgyzstan as yet. However, many existing buildings of this type in Kichinev, Moldova, were exposed to an earthquake of intensity 8 on the MSK scale. Many of these 12-story buildings suffered damage in piers at the lower stories due to the poor quality of concrete construction.
7 Building Materials and Construction Process

7.1 Description of Building Materials

<table>
<thead>
<tr>
<th>Structural Element</th>
<th>Building Material</th>
<th>Characteristic Strength</th>
<th>Mix Proportions/ Dimensions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>Reinforced concrete</td>
<td>30-35 MPa (cube compressive strength) 390 MPa (steel yield strength)</td>
<td>variable, depending on the type of ingredients in the mix</td>
<td></td>
</tr>
<tr>
<td>Foundations</td>
<td>Reinforced concrete</td>
<td>10-15 MPa (cube compressive strength) 295 MPa (Steel yield strength)</td>
<td>variable, depending on the type of ingredients in the mix</td>
<td></td>
</tr>
<tr>
<td>Roof and floors</td>
<td>Reinforced concrete</td>
<td>30-35 MPa (cube compressive strength) 390 MPa (Steel yield limit)</td>
<td>variable, depending on the type of ingredients in the mix</td>
<td></td>
</tr>
</tbody>
</table>

7.2 Does the builder typically live in this construction type, or is it more typically built by developers or for speculation?
Anyone can live in buildings of this construction type.

7.3 Construction Process
Construction is performed by builders. Design (construction) documents are developed in the design institutes. Specialized construction companies fabricate precast concrete elements and perform casting of concrete in-situ. Precast elements are made at the factory. The main construction equipment includes crane, welding equipment and concrete mixers.

7.4 Design/Construction Expertise
Expertise related to the design and construction of this building type according to the building regulations of Kyrgyzstan was available. Designs were prepared by specialized design institutes with expertise in this construction practice.

7.5 Building Codes and Standards

<table>
<thead>
<tr>
<th>Is this construction type addressed by codes/standards?</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Title of the code or standard: SNiP II-7-81. Building in Seismic Regions. Design code.
Year the first code/standard addressing this type of construction issued: 1981
When was the most recent code/standard addressing this construction type issued? 1981

7.6 Role of Engineers and Architects
Design for this construction type was done completely by engineers and architects. Engineers played a leading role at each stage of construction.

7.7 Building Permits and Development Control Rules

<table>
<thead>
<tr>
<th>Building permits are required</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Informal construction

<table>
<thead>
<tr>
<th>Construction authorized per development control rules</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.8 Phasing of Construction

<table>
<thead>
<tr>
<th>Construction takes place over time (incrementally)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Building originally designed for its final constructed size

| X |

7.9 Building Maintenance
Who typically maintains buildings of this type?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Builder</td>
<td>X</td>
</tr>
<tr>
<td>Owner(s)</td>
<td>X</td>
</tr>
<tr>
<td>Renter(s)</td>
<td>X</td>
</tr>
<tr>
<td>No one</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

7.10 Process for Building Code Enforcement

Building permit is issued if the design documents have been approved by the State Experts. The State Experts check the compliance of design documents with the pertinent Building Codes. According to the building bylaw, a building cannot be used without the formal approval.

7.11 Typical Problems Associated with this Type of Construction

Poor quality of construction and inadequate concrete strength.
8 Construction Economics

8.1 Unit Construction Cost (estimate)
For load-bearing structure only: about 150 US$/m².

8.2 Labor Requirements (estimate)
It would take from 10 to 18 month for a team of 15 workers to construct a load-bearing structure for a building of this type.
9 Insurance

9.1 Insurance Issues

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthquake insurance for this construction type is typically available</td>
<td>X</td>
</tr>
<tr>
<td>Insurance premium discounts or higher coverages are available for seismically strengthened buildings or new buildings built to incorporate seismically resistant features</td>
<td>X</td>
</tr>
</tbody>
</table>

9.2 If earthquake insurance is available, what does this insurance typically cover/cost?
10 Seismic Strengthening Technologies

10.1 Description of Seismic Strengthening Provisions

<table>
<thead>
<tr>
<th>Type of intervention</th>
<th>Structural Deficiency</th>
<th>Description of seismic strengthening provision used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrofit (Strengthening)</td>
<td>Poor quality of concrete (especially at the lower part of the building); poor quality of construction joints</td>
<td>Reinforced concrete jacketing, shotcreting</td>
</tr>
</tbody>
</table>

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

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

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

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

10.6 What has been the performance of retrofitted buildings of this type in subsequent earthquakes?
11 References


<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
<th>Address</th>
<th>City</th>
<th>Zipcode</th>
<th>Country</th>
<th>Phone</th>
<th>Fax</th>
<th>Email</th>
<th>Webpage</th>
</tr>
</thead>
<tbody>
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<td>Canada</td>
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<td>996-3312-224355</td>
<td><a href="mailto:uransv@yahoo.com">uransv@yahoo.com</a></td>
<td></td>
</tr>
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<td></td>
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<td>996-3312-224355</td>
<td><a href="mailto:utbegaliev@yahoo.com">utbegaliev@yahoo.com</a></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>Shui prospect 164A</td>
<td>Bishkek</td>
<td>720001</td>
<td>Kyrgyzstan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 1: Typical Building

WALL INTERSECTION

FIGURE 2: Key Load-Bearing Elements
FIGURE 3B: Plan of Typical Building
FIGURE 4: Wall Details