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

Timber log building

Report#	56
Last Updated	
Country	Russia
Author(s)	Mark Klyachko, Andrey Benin, Janna Bagdanova,
Reviewers	Svetlana Uranova,

Important

This encyclopedia contains information contributed by various earthquake engineering professionals around the world. All opinions, findings, conclusions & recommendations expressed herein are those of the various participants, and do not necessarily reflect the views of the Earthquake Engineering Research Institute, the International Association for Earthquake Engineering, the Engineering Information Foundation, John A, Martin & Associates, Inc. or the

participant’s organizations.

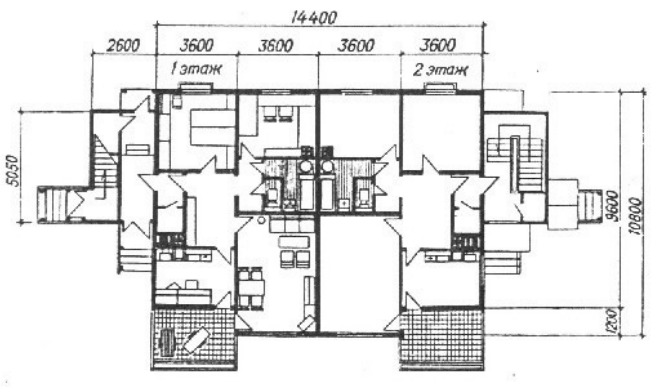
General Information

Building Type:	Timber log building
Country:	Russia
Author(s):	Mark Klyachko Andrey Benin Janna Bagdanova
Last Updated:	
Regions Where Found:	Buildings of this construction type can be found in seismically prone areas of Russia (Far East, Siberia, Baikal Lake Region, North Caucasus) where this construction type covers 5 to100% of the housing stock. This type of housing construction is commonly found in rural areas.
Summary:	This is a rural housing construction practice widespread in the Russian forests. Buildings of this type are common for seismically prone areas of Russia (Far East, Siberia, Baikal Lake Region, North Caucasus). The load-bearing structure is made of wood. Walls are made of horizontal sawn timber logs of square or circular cross section with special end joints (similar to dovetail joints). Buildings have timber roof and fieldstone or concrete strip foundation. Typical seria 146-115-77 cm of #Giprolesprom# for seismic regions is an example of this building type. Seismic performance of these buildings is good, provided the quality of construction is adequate.
Length of time practiced:	More than 200 years
Still Practiced:	Yes
In practice as of:	
Building Occupancy:	Residential, 2 units
Typical number of stories:	1-2
Terrain-Flat:	Typically
Terrain-Sloped:	3
Comments:	This is a traditional construction practice in the region followed for many centuries. The main function of this building typol

Features

Plan Shape	Rectangular, solid
Additional comments on plan shape	
Typical plan length (meters)	14.4
Typical plan width (meters)	6.6-9.9
Typical story height (meters)	2.7
Type of Structural System	Wooden Structure: Load-bearing Timber Frame: Wooden panel walls
Additional comments on structural system	The load-bearing structure is made of wood. Walls are made of horizontal square sawn timber logs with special end joints (similar to dovetail joints), as illustrated in Figure 9. Vertical wall elevation is shown on Figure 8. Buildings have timber roof and fieldstone or concrete strip foundation.
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	The typical structural wall density is up to 10 %. 8-12%.
Wall Openings	Windows: 10-15%; Doors: 5-8%.
Is it typical for buildings of this type to have common walls with adjacent buildings?	No
Modifications of buildings	Building modifications are not common.
Type of Foundation	Shallow Foundation: Rubble stone, fieldstone strip footingShallow Foundation: Reinforced concrete strip footing
Additional comments on foundation	Isolated footings are common in some cases.
Type of Floor System	Other floor system
Additional comments on floor system	Wood planks or beams with ballast and concrete or plaster finishing; Wood planks or beams that support slate, metal, asbestos-cement or plastic corrugated sheets or tiles; Wood planks or beams that support slate, metal asbestos-cement or plastic corrugated sheets or tiles.
Type of Roof System	Roof system, other

Additional comments on roof system	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 planks or beams that support slate, metal, asbestos-cement or plastic corrugated sheets or tiles.
Additional comments section 2	When separated from adjacent buildings, the typical distance from a neighboring building is 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	wooden (larch) spars wooden (larch) logs	800 Kg/sq cm (ultimate strength) Typical log diameter is 150-200 mm
Foundations	Concrete	10 MPa (cube compressive strength)
Floors	wooden beams (larch)	800 Kg/sq cm (ultimate strength
Roof	wooden beams (larch)	800 Kg/sq cm (ultimate strength
Other		

Design Process

Who is involved with the design process?	EngineerArchitect

Roles of those involved in the design process	Special design by Professional Engineers and architects (for typical projects and design applications);
Expertise of those involved in the design process	Design expertise related to this construction type buildings is available, including the construction quality procedure developed by the author of this contribution.

Construction Process

Who typically builds this construction type?	Contractor
Roles of those involved in the building process	This construction type is typically built by contractors.
Expertise of those involved in building process	
Construction process and phasing	Simple carpentry tools are used in the construction. The construction of this type of housing takes place in a single phase. Typically, the building is originally 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	Wood construction. Building code., Building Catalog of Typical Project for Housing, Vol.1, Part 2, div.1, #14, Seria 115, 1957y; SNiP II-7-81. Building in Seismic Regions. Design code (1981)
Process for building code enforcement	The process consists of issuing permits for the design & construction, including the architectural permits and urban planning/municipal permits. Designers need to have licence to practice and are responsible to follow the building codes. Building inspection is performed and the permit is issued.

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	

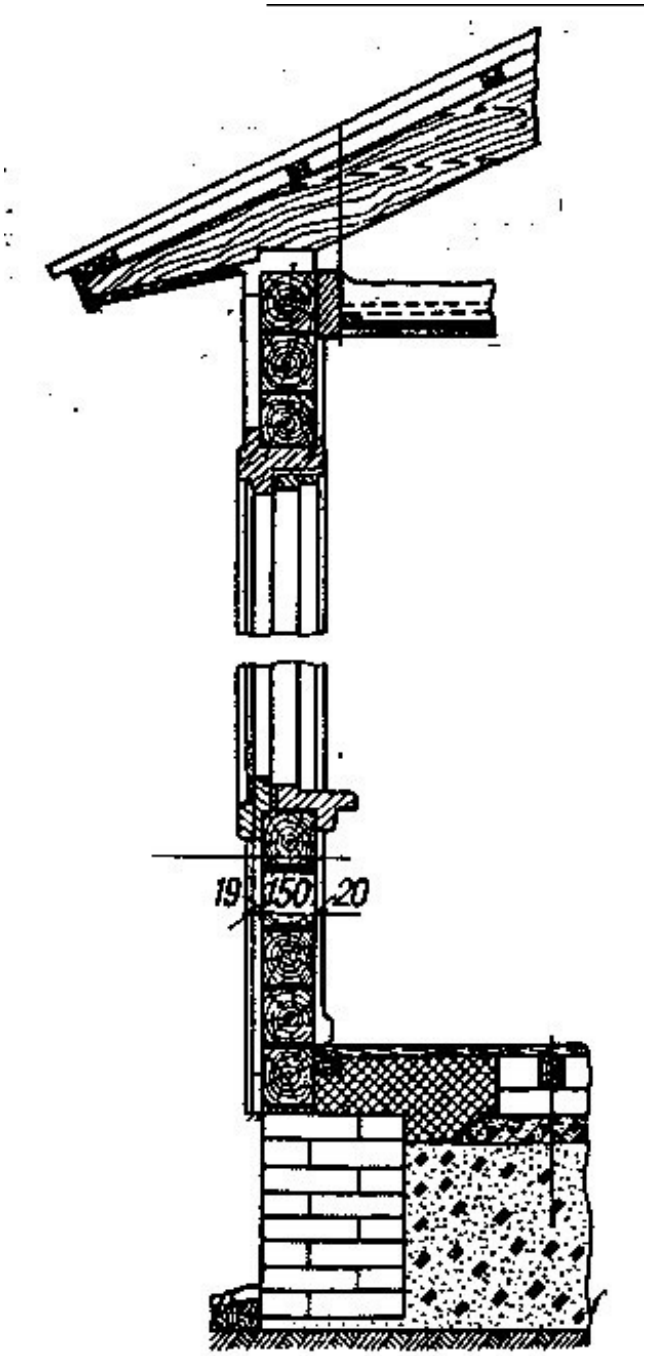
development control rules

Building Maintenance and Condition

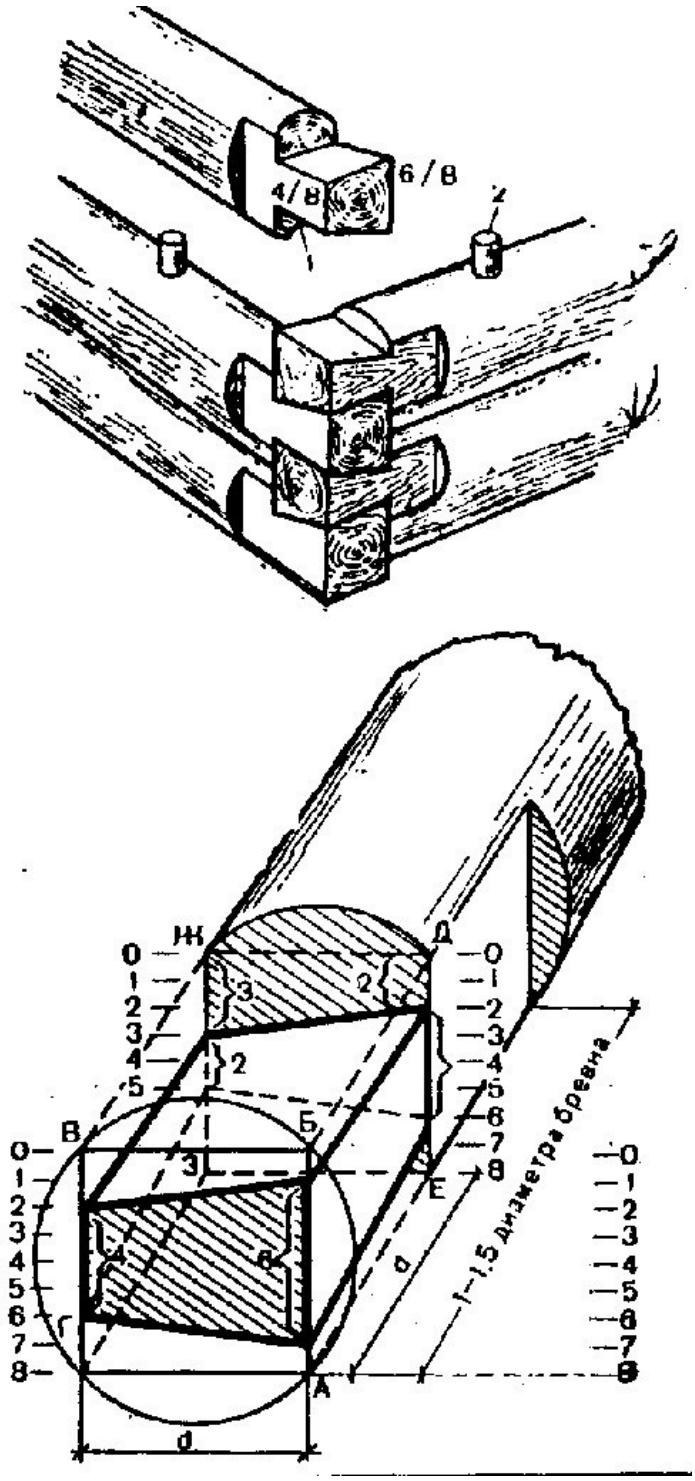
Typical problems associated with this type of construction	-Fire-resistance; -Walls need to be joined together by means of vertical steel bars, -Walls need to be anchored into the foundation; -Vertical clenching (vising) members need to be provided in walls for two-story buildings.
Who typically maintains buildings of this type?	Owner(s)
Additional comments on maintenance and building condition	The maintenance is performed either by the owner (city) or (periodically) by a contractor # a maintenance firm.

Construction Economics

Unit construction cost	140 rub/m.sq. (50-100$US/m.sq.)-official rate
Labor requirements	50-70 person-days per building.
Additional comments section 3	



Wall Section



Timber Log Connection

Socio-Economic Issues

Patterns of occupancy	One family per unit (apartment). Each building typically has 2 housing unit(s).
Number of inhabitants in a typical building of this construction type during the day	5-10

Number of inhabitants in a typical building of this construction type during the evening/night	5-10
Additional comments on number of inhabitants	Inhabitants during the day: <5, 5-10 Inhabitants during the night: 5-10, 10-20
Economic level of inhabitants	Very low-income class (very poor)Low-income class (poor)High-income class (rich)
Additional comments on economic level of inhabitants	Rich people use timber log houses as cottages. Ratio of housing unit price to annual income: 1:1 or better
Typical Source of Financing	Government-owned housing
Additional comments on financing	
Type of Ownership	Own outrightLong-term lease
Additional comments on ownership	Own outright (for one apartment), long-term lease (most common)
Is earthquake insurance for this construction type typically available?	Yes
What does earthquake insurance typically cover/cost	The insurance is available as a part of the usual property insurance. About 3-5% of the total estimated property value.
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
1958	Kamchatka,Kronotsky Gulf

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	Some buildings of this type were damaged in the 1958 Kamchatka earthquake.
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)	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.	FALSE
Floor Construction	The floor diaphragm(s) are	TRUE

	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.	TRUE
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);	N/A
Foundation-Wall Connection	Vertical load-bearing elements (columns, walls) are attached to the foundations; concrete columns and walls are doweled into the foundation.	FALSE
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		N/A
Quality of Building Materials	Quality of building materials is considered to be adequate per the requirements of national codes and standards (an estimate).	TRUE
Quality of Workmanship	Quality of workmanship (based on visual inspection of a few typical buildings) is considered to be good (per local construction	FALSE

	standards).	
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	Other
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	Poor log connections; Inadequate wall-foundation connections.
Earthquake-resilient features in walls	
Seismic deficiency in frames	Frames not provided around openings (doors, windows)
Earthquake-resilient features in frame	
Seismic deficiency in roof and floors	Poor roof connections (ceiling, tie-beams).
Earthquake resilient features in roof and floors	
Seismic deficiency in foundation	
Earthquake-resilient features in foundation	

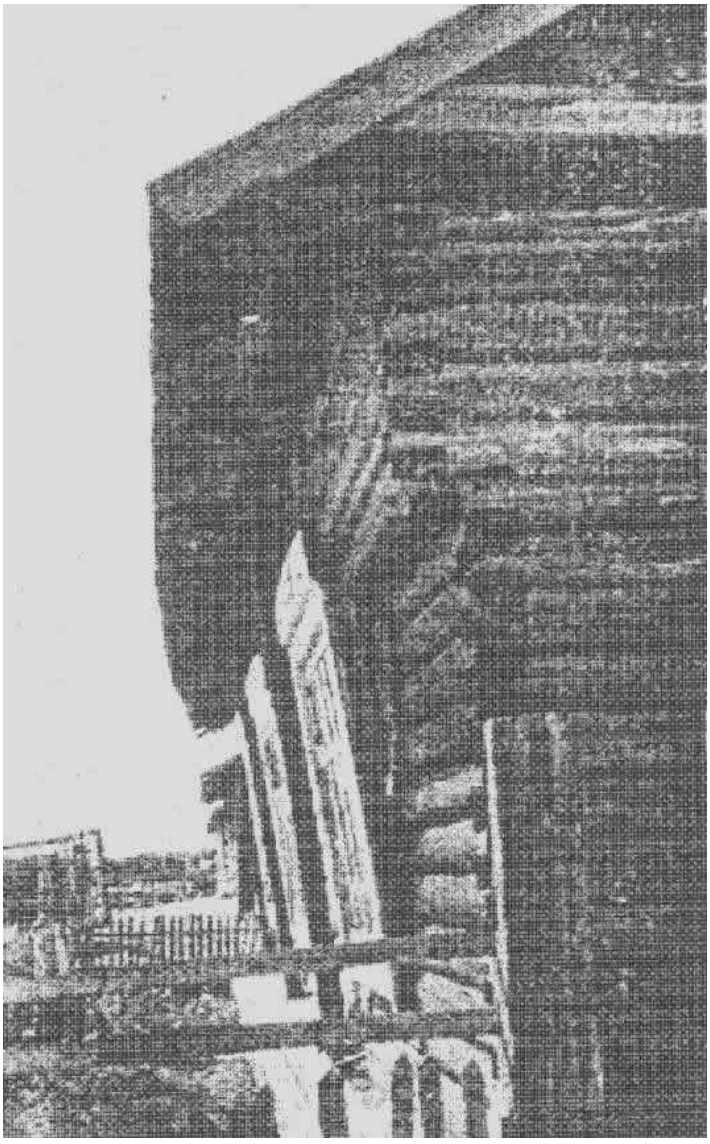
Seismic Vulnerability Rating

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	-|	

A Photograph Illustrating Typical Earthquake Damage (1958 Kamchatka earthquake)



Wall damage in the 1958 Kamchatka earthquake (showing a side view of the building)

Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	Seismic Strengthening
Walls	- Installation of vertical clenching members in the walls for two-story buildings; - Connecting wood logs using vertical steel bars - Installation of the frames around the openings
Wall- Foundation connection	#NAME?

Additional comments on seismic strengthening provisions	
Has seismic strengthening described in the above table been performed?	No. In general, it is considered that seismic strengthening for this construction is not feasible.
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

Manual on Certification of Buildings and Structures in the Seismic-Prone Areas, Second Edition, CENDR, Petropavlovsk, Kamchatka, Russia, 1990.

Building Catalog of Typical Housing Projects, Vol.1, Part 2, Div.1, Seria 115, #14, 1984.

Authors

Name	Title	Affiliation	Location	Email
Mark Klyachko	Dr./Director	Centre on EQE&NDR, (CENDR)	9 Pobeda Ave., Petropavlovsk, Kamchatka	cendr@svyaz.kamchatka.su or cendr@peterlink.ru

			683006 Russia	
Andrey Benin	Senior researcher	Centre on EQE&NDR, (CENDR)	9 Pobeda Ave., Petropavlovsk, Kamchatka 683006 Russia	cendr@svyaz.kamchatka.su or cendr@peterlink.ru
Janna Bagdanova	Senior researcher	Centre on EQE&NDR, (CENDR)	9 Pobeda Ave., Petropavlovsk, Kamchatka 683006 Russia	cendr@svyaz.kamchatka.su or cendr@peterlink.ru

Reviewers

Name	Title	Affiliation	Location	Email
Svetlana Uranova	Head of the Laboratory	KRSU	Bishkek 720000, KYRGYZSTAN	uransv@yahoo.com