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

EMSB1- single storied brick masonry house generally with GI roof

Report#	91
Last Updated	
Country	Bangladesh
Author(s)	Mehedi Ansary,
Reviewers	

Important

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General Information

Building Type:	EMSB1- single storied brick masonry house generally with GI roof
Country:	Bangladesh
Author(s):	Mehedi Ansary
Last Updated:	
Regions Where Found:	Buildings of this construction type can be found in all parts of Bangladesh. This type of housing construction is commonly found in both rural and urban areas.
Summary:	This is a one-story brick masonry house of fired bricks with cement or lime mortar; roof is either GI sheet or other material. These houses can be seen all over Bangladesh. During the 1918 Srimangal, 1930 Dhubri and some recent earthquakes, these type of houses suffered heavy damage. Houses with a continuous lintel suffered less.
Length of time practiced:	76-100 years
Still Practiced:	Yes
In practice as of:	
Building Occupancy:	Single dwelling
Typical number of stories:	1
Terrain-Flat:	Typically
Terrain-Sloped:	3
Comments:	

Features

Plan Shape	Rectangular, solidL-shape
Additional comments on plan shape	Mostly L-shaped, sometimes rectangular.
Typical plan length	3-5

(meters)	3-5
Typical plan width (meters)	2-4
Typical story height (meters)	2.8
Type of Structural System	Masonry: Unreinforced Masonry Walls: Brick masonry in lime/cement mortar
Additional comments on structural system	The vertical load-resisting system is earthen walls. Traditionally, 10 inch wall is used as load bearing walls. But sometimes poor people use 5 inch wall. Poorer construction do not have any kind of plaster. The lateral load-resisting system is earthen walls. Sometimes there is a continuous lintel, sometimes none. In earthquake prone areas like Chittagong, Sylhet etc. approximately 50% private housing units have continuous lintel. But on the government buildings, the percentage is much lower.
Gravity load-bearing & lateral load-resisting systems	Tie columns are not used.
Typical wall densities in direction 1	15-20%
Typical wall densities in direction 2	15-20%
Additional comments on typical wall densities	The typical structural wall density is up to 20 %. 15 - 20%.
Wall Openings	At least three for a single room (two windows and one door). The buildings generally comprise of two to three rooms. The inner and outer rooms have at least two doors. Opening per wall is around 20%. Doors and windows are located in the middle of the wall.
Is it typical for buildings of this type to have common walls with adjacent buildings?	No
Modifications of buildings	
Type of Foundation	Shallow Foundation: Wall or column embedded in soil, without footing
Additional comments on foundation	Stepped brick foundations with cement mortars are used. Generally foundation bottom lies 2 to 3 ft below GL.

Type of Floor System	Other floor system
Additional comments on floor system	
Type of Roof System	Roof system, other
Additional comments on roof system	GI roofs with purlins.
Additional comments section 2	In the villages this type of housing may be located several 100 meters apart. When separated from adjacent buildings, the typical distance from a neighboring building is 2 meters.

Building Materials and Construction Process

Description of Building Materials

Structural Element	Building Material (s)	Comment (s)
Wall/Frame	Brick, cement mortar	1:4 (cement: sand)
Foundations	Brick, cement mortar	1:4 (cement: sand)
Floors		
Roof		
Other		

Design Process

Who is involved with the design process?	Owner
Roles of those involved in the design process	Owners are the architect and masons are the engineer for this type of housing.
Expertise of those involved in the design process	They do not have a large role, but masons can be trained by the engineers according to the code guideline for construction.

Construction Process

Who typically builds this construction type?	Mason
Roles of those involved in the building process	The house owners hire masons to build these houses. Sometimes masons live in similar houses.
Expertise of those involved in building	No formal training. Masons are trained by their

involved in building process	seniors.
Construction process and phasing	- trench line is planned - excavate 2 to 3 ft deep trench - 6 inch thick sand layer - lay brick and use cement mortar to join them The construction of this type of housing takes place in a single phase. Typically, the building is originally not desig
Construction issues	

Building Codes and Standards

Is this construction type address by codes/standards?	Yes
Applicable codes or standards	This construction type is addressed by the codes/standards of the country. Bangladesh National Building Code. The year the first code/standard addressing this type of construction issued was 1993. BNBC 1993.
Process for building code enforcement	There is no enforcement of building codes for this type of construction.

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	There are no guidelines for this type of housing. No prior approval is required.

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	Total project: US Dollar 50/sq m.
Labor requirements	The labor requirements for a typical house of about 30 to 50 sq.m are about 100 to 120 man-days.
Additional comments section 3	

Typical Construction

Socio-Economic Issues

Patterns of occupancy	As the joint family tradition is strong in the rural areas, an extended family occupy the housing unit. Typically, the families comprise of a father and two-three sons. As the family further expands, the sons families occupy independent units.
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	The middle class housing unit roughly costs USD 1,000, on the other hand the rich housing unit costs USD 1,500 to 2,000. Ratio of housing unit price to annual income: 1:1 or better
Typical Source of Financing	Owner financedPersonal savingsSmall lending institutions/microfinance institutions
Additional comments on financing	
Type of Ownership	RentOwn 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
1885	Bogra-Sirajganj
1897	Assam

1918	Srimangal
1997	Bangladesh-India Border

Past Earthquakes

Damage patterns observed in past earthquakes for this construction type	During the 1897 Assam earthquake, almost 90% of this type of structure suffered some kind of damage.
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.	FALSE
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.	N/A
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.	N/A
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);	FALSE
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	FALSE

	each diaphragm level with metal anchors or straps.	
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).	TRUE

Building Irregularities

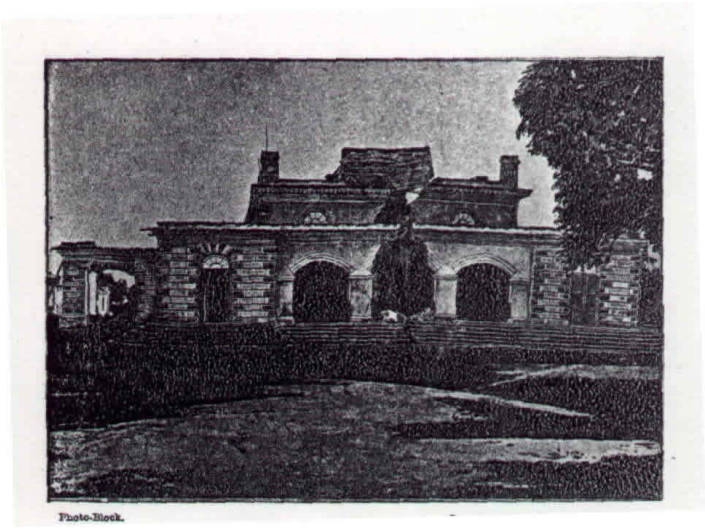
Additional comments on structural and architectural features for seismic resistance	
Vertical irregularities typically found in this construction type	Other
Horizontal irregularities typically found in this construction type	Other
Seismic deficiency in walls	Weak from earthquake point of view; sometimes there are no plaster; lack of lintel bands; no measures to strengthen the corners.
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	

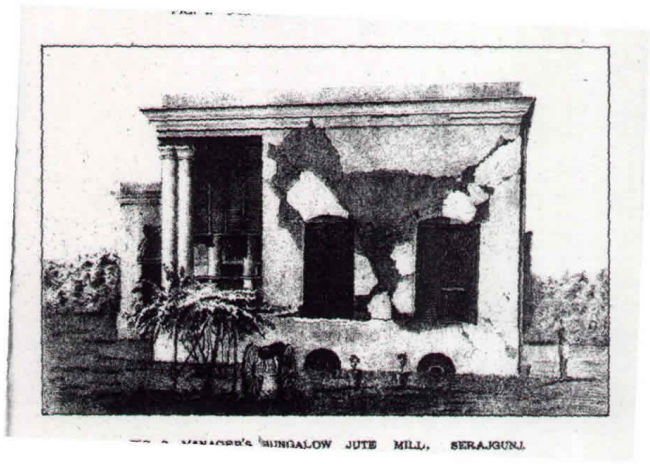
Seismic Vulnerability Rating

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

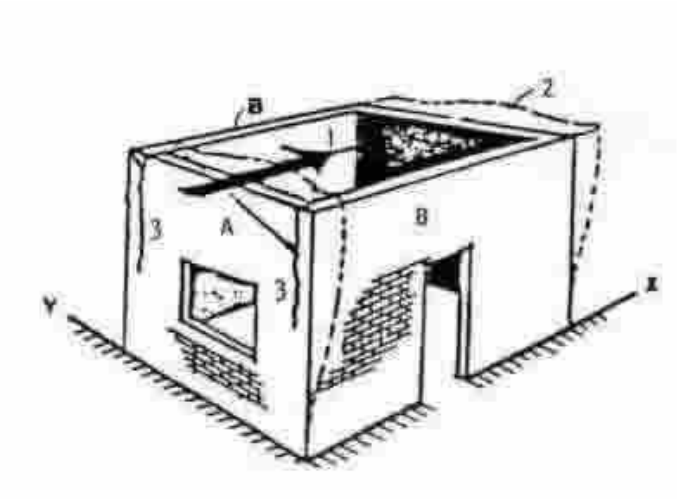
	High vulnerability		**Medium vulnerability**		**Low vulnerability**	
	A	B	C	D	E	F
Seismic vulnerability class	|-	o	-|			



Damage at Rangpur, 1897 earthquake



Damage at Sirajganj, 1897 Earthquake



elevation of typical building

Damage due to 2003 Rangamati Earhquake

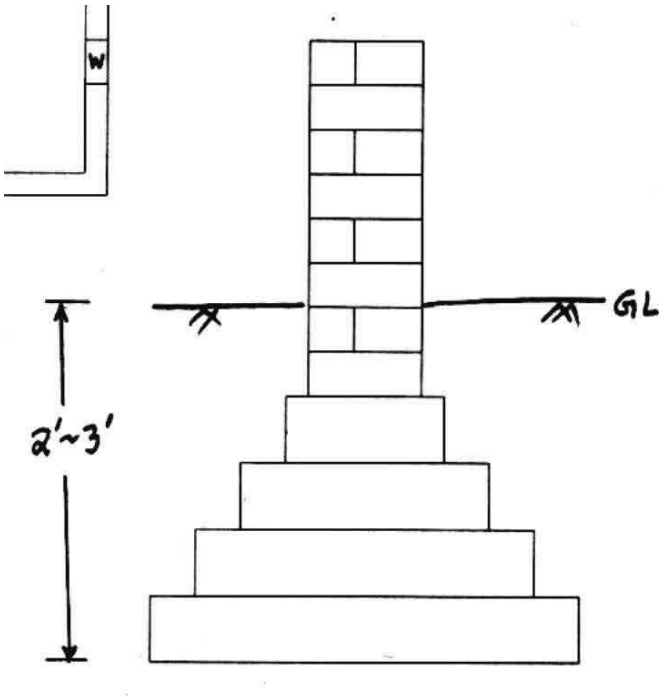
Retrofit Information

Description of Seismic Strengthening Provisions

Structural Deficiency	Seismic Strengthening
Inadequate wall resistance due to the absence of seismic provisions	Covering the wall with 1 ft wide seismic belt (steel wire mesh with cement mortar) at lintel level on both sides of the wall.
Foundations	Strengthening of New Construction : Provision of strip foundation
Walls	Strengthening of New Construction : Provision of RC ring beams at plinth, lintel etc. levels. Provision of vertical steel reinforcement bars at the wall corners and intersections.

Additional comments on seismic strengthening provisions	
Has seismic strengthening described in the above table been performed?	Proposed for the damaged buildings of 2003 Rangamati earthquake.
Was the work done as a mitigation effort on an undamaged building or as a repair following	N/A

earthquake damages?	
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	



Typical foundation

References

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Bangladesh National Building Code, 1993

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