

VULNERABILITY REDUCTION SOLUTIONS

Date:	03/10/2018
VRS Code:	HBB
Author:	UCL
Sheet:	1 OF 2

LOAD BEARING MASONRY BUILDINGS

STRENGTHENING INTERVENTION:

HORIZONTAL BAND BEAM

APPLICABLE BUILDING TYPES:

	Taxonomy Parameters				
Main Structural System:.....	A <input checked="" type="checkbox"/>	UCM-URM <input checked="" type="checkbox"/>	CM <input checked="" type="checkbox"/>	RM <input checked="" type="checkbox"/>	SFM <input checked="" type="checkbox"/>
Height Range:.....		Low (LR) <input checked="" type="checkbox"/>	Medium (MR) <input checked="" type="checkbox"/>	High (HR) <input checked="" type="checkbox"/>	
Seismic Design Level:.....	Poor (PD) <input checked="" type="checkbox"/>	Low (LD) <input checked="" type="checkbox"/>	Medium (MD) <input type="checkbox"/>	High (HD) <input type="checkbox"/>	

EXISTING STRUCTURAL DEFICIENCIES:

- Limited capacity due to independent behavior of individual walls; - Out of plane failure of walls; - Corner separation; - Excessive deformation
- Roof structure failure

STRUCTURAL IMPROVEMENTS AFTER STRENGTHENING:

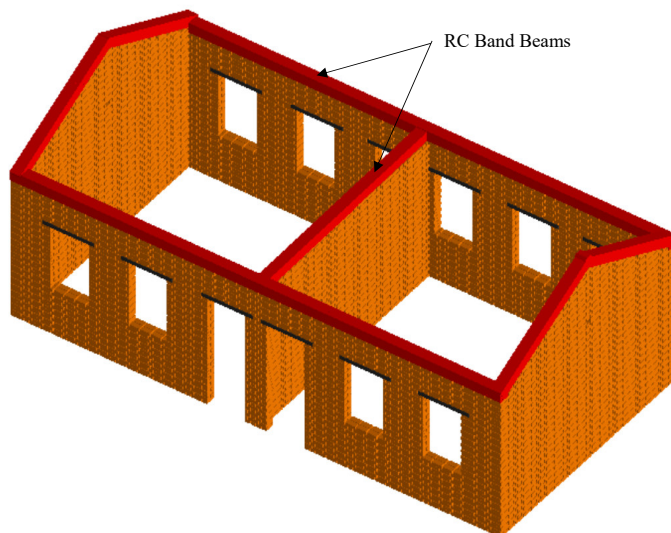
- Global box type behavior is obtained.
- Detachment and collapse of out of plane walls is controlled.
- Corner separation is restricted.
- Excessive deformation is controlled and hence non-structural elements are less vulnerable.
- Roof structure is well connected to the ring beam and hence the roof failure is also controlled.

STRENGTHENING INTERVENTION DESCRIPTION:

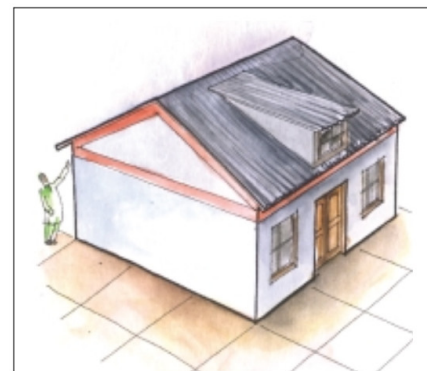
This is an effective type of strengthening which improves the global seismic behavior of a building. The horizontal beam is installed over all the walls (including over the gables) so as to form a band binding all the LBM walls. RC material is usually used for these beams but timber or steel beams can also be used.

Alternatively, seismic belts (a binding layer running through the periphery of the walls) can also be used to improve the box like behavior. For more details on seismic belts installation, refer to UNESCO (2007), NRA (2016).

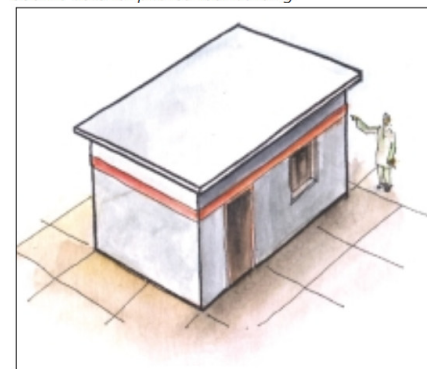
ILLUSTRATIVE FIGURES:



Seismic strengthening of an UCM-URM building using RC ring beams.



Seismic belts for pitched roof building



Seismic belt for slab roof building

Seismic strengthening of an UCM-URM building using seismic belts. (UNESCO, 2007).

Example Illustrations of strengthening of LBM school buildings using horizontal band beams or seismic belt techniques.

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APPLICATION CASE STUDIES:



Horizontal ring beam installed in an LBM type school building in Nepal that was damaged (minor) after the 2015 Nepal earthquake
(Photo from Nepal, Copyright: The World Bank)

PRECAUTIONS AND LIMITATIONS:

Horizontal band beam installation is a major intervention requiring disturbance to the roof structure. Part or all of the roof structure might need to be rebuilt depending on the level and location of roof structure connection to the masonry walls, hence this strengthening can be costlier. The reinforcement from new RC ring beams must be well connected (hooked or anchored) to the roof structure as well as to the underlying masonry walls. The joints of the cross ring beams should be carefully detailed with adequate reinforcements.

REFERENCES:

UNESCO (2007). Manual for Restoration and Retrofitting of Rural Structures in Kashmir, Report No. IN/2007/CL/18, UNESCO New Delhi Office, India.

NRA (2016). Seismic Retrofitting Guidelines for Buildings in Nepal, Nepal Reconstruction Authority, Kathmandu, Nepal.

Notes:

- The design details and figures shown here are for illustration purpose only.
- The authors do not assume any responsibility for the consequences of adopting the proposed strengthening solution.

- Experienced structural engineers have to design (dimensions, details and material specifications) and supervise the interventions for each application case.