VULNERABILITY REDUCTION SOLUTIONS

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LOAD BEARING MASONRY BUILDINGS

STRENGTHENING INTERVENTION: **POLYPROPYLENE (PP) BAND MESH**

APPLICABLE BUILDING TYPES:

	Taxonomy Parameters							
Main Structural System:……	A	X	UCM-URM	X	CM		RM		SFM	X
Height Range:……..……			Low (LR)	X			Medium (MR)	X	High (HR)	X
Seismic Design Level:……..……	Poor (PD)	X	Low (LD)	X			Medium (MD)		High (HD)	
Structural Health Condition……							Poor (PC)	X	Good (GC)	

EXISTING STRUCTURAL DEFICIENCIES:

- Limited shear and flexural capacity of walls due to poor quality of materials; - Localized failure of walls; - Poor cross-wall connection

STRUCTURAL IMPROVEMENTS AFTER STRENGTHENING:

- Shear and tensile strength of materials is increased thereby improving the wall integrity, strength and ductility.
- Local failure modes are controlled.
- Corner separation is restricted.
- If applied on all the walls in all stories, global seismic behavior is improved.

STRENGTHENING INTERVENTION DESCRIPTION:

PP meshing uses common PP packaging straps (PP bands) to form a mesh, which is then used to encase masonry walls (i.e. fixing to both faces of each wall). The mesh prevents the separation of structural elements and the escape of debris, maintaining sufficient structural integrity to prevent collapse. This is a low cost technique similar in principle to the jacketing technique.
The mesh is formed by arranging the individual bands into a grid and electrically 'welding' at intersecting points (using a plastic welder). Covering (i.e. plaster) from each wall to be retrofitted is first removed, holes are drilled through the wall at regular spacing, anchor beams are installed at ground level, and a ring beam at top of wall level if lacking. The mesh is connected to both faces of the wall by fixing to the anchor beams and ring beam and passing through openings and around corners, with sufficient overlap. Meshes are connected together through the wall by wires passing through the previously drilled holes in the walls. Finally the mesh is plastered using cement or mud mortar. Instead of PP band, bamboo mesh can also be used. For more details on strengthening walls using PP band mesh, refer to Macabuag et al. (2010), Sathiparan, (2015).

ILLUSTRATIVE FIGURES:

1. House before retrofitting
2. Fixing of base anchor beam & anchoring inner and outer base anchor beam
3. Fixing the vertical PP-band and concreting on base anchor beam
4. Meshing the horizontal PP band on vertical PP band
5. connecting horizontal PP-Band with vertical PP-Band by Welder
6. Connecting inner and outer meshes by wires and aluminum plate
7. Retrofitted house
8. Plastering the wall with mud mortar
9. Retrofitted house after mud mortar plastering

Example application procedure of PP band mesh in an adobe building (Reproduced from Sathiparan, 2015)

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COUNTRIES IN WHICH SOLUTION HAS BEEN APPLIED:

Nepal, Pakistan

APPLICATION CASE STUDIES:

Retrofitted house in Pakistan using the PP Band meshing: Application of PP band (left) and building after plastering (right) (Reproduced from Macabuag et al. 2010)

Strengthening of an adobe building using PP Band meshing (Photo from Nepal, Photo credit: NSET. Reproduced from Macabuag et al. 2010).

PRECAUTIONS AND LIMITATIONS:

This intervention requires skilled masons at it involves plaster removal, drilling through the walls etc. The PP straps are commonly used for packaging, hence it is a low cost technique. This is applicable mainly to low strength masonry buildings i.e. adobe (A), brick in mud mortar (UCM-URM4) stone in mud mortar (UCM-URM2, UCM-URM3) types of school buildings.

REFERENCES:

Macabuag, J., Guragain, R., & Bhattacharya, S. (2012). Seismic retrofitting of non-engineered masonry in rural Nepal. Proceedings of the Institution of Civil Engineers-Structures and Buildings, 165(6), 273-286.

Sathiparan, N. (2015). Mesh type seismic retrofitting for masonry structures: critical issues and possible strategies. European Journal of Environmental and Civil Engineering, 19(9), 1136-1154.

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.