VULNERABILITY REDUCTION SOLUTIONS

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Sheet:	1 OF 2

LOAD BEARING MASONRY BUILDINGS

STRENGTHENING INTERVENTION: **SPLINT AND BANDAGE TECHNIQUE**

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 connection between cross

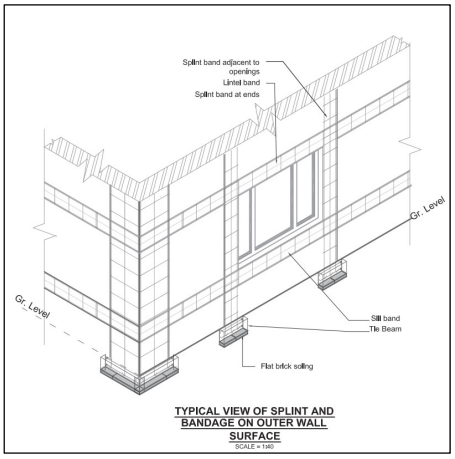
STRUCTURAL IMPROVEMENTS AFTER STRENGTHENING:

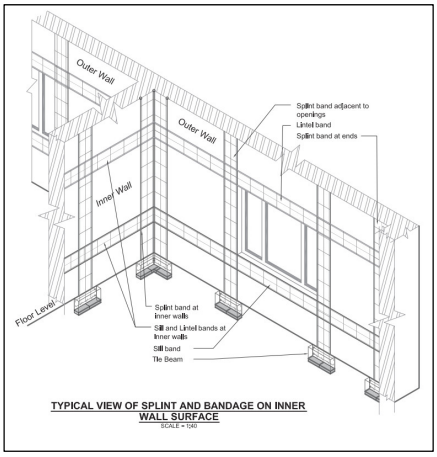
- Shear and tensile strength of materials are increased thereby improving the wall integrity, strength and ductility.
- Local failure modes are controlled.
- Corner separation is restricted.
- If applied on all the walls in all stories, global seismic behavior is improved.

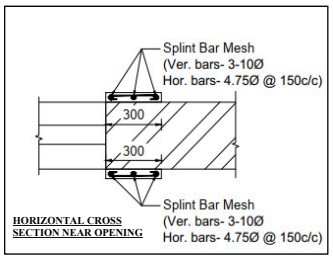
STRENGTHENING INTERVENTION DESCRIPTION:

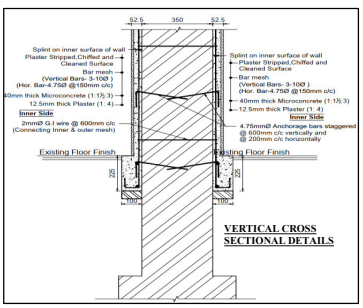
This is a local (or global if applied on all the walls) type of intervention technique on low strength unreinforced masonry structures. The splint and bandage technique is very similar to jacketing but are applied in the form of vertical column (splint) and horizontal beam (bandage) like reinforced plaster/shotcrete layers. These are also usually applied on both sides (inner and outer) of the walls.
In this technique, galvanized welded wire mesh (WWM) or steel reinforcement bars mesh in the form of splint and bandage are placed on both sides of the walls both of which are connected to each other using steel bar connectors through the walls at regular intervals. Or anchored nails can also be used to connect these meshes to the walls. Then, these meshes are covered with cement plaster or shotcrete (of thickness about 50 mm to prevent corrosion of mesh) to form the splint and bandage layers. For more details on strengthening walls using splint and bandage technique, refer to Shrestha et al. (2012), Anwar et al. (2016) and NRA (2017).

ILLUSTRATIVE FIGURES:









Example design details of the seismic strengthening of an low strength UCM-URM walls using RC Splint and Bandage technique on both (inner and outer) sides (Retrofit Design by NSET-Nepal, adapted from Anwar et al., (2016), NRA (2017)).

APPLICATION CASE STUDIES:

An UCM-URM4 type of LBM school building being strengthened using RC Splint and Bandage technique (Photo from Nepal, Credit: Sunil Kumar Yadav, MoE, Nepal).

PRECAUTIONS AND LIMITATIONS:

This intervention requires highly skilled masons at it involves plaster removal, drilling through the walls etc. New foundation along side the older one should be dug out carefully so that the jacketing starts from the foundation for increased stability and integrity. 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. 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:

Anwar, N., Adhikari, S., Sahid, M. and Shrestha, S. (2016). Making Schools Safer From Earthquakes - Effective Retrofitting: Case Studies from Nepal, Asian Institute of Technology, Thailand.

Shrestha, H., Pradhan, S., & Guragain, R. (2012). Experiences on retrofitting of low strength masonry buildings by different retrofitting techniques in Nepal. In 15th world conference on earthquake engineering, Lisbon, Portugal.

NRA (2017). Repair And Retrofitting Manual For Masonry Structure, Nepal Reconstruction Authority, Government of Nepal, 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.