

VULNERABILITY REDUCTION SOLUTIONS

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

LOAD BEARING MASONRY BUILDINGS

STRENGTHENING INTERVENTION:

INJECTION TECHNIQUE

APPLICABLE BUILDING TYPES:

	Taxonomy Parameters				
Main Structural System:.....	A <input type="checkbox"/>	UCM-URM <input checked="" type="checkbox"/>	CM <input checked="" type="checkbox"/>	RM <input 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"/>	
Structural Health Condition.....			Poor (PC) <input checked="" type="checkbox"/>	Good (GC) <input type="checkbox"/>	

EXISTING STRUCTURAL DEFICIENCIES:

- Limited tensile strength, cohesion and friction due to poor quality or deteriorated materials; - Localized failure of walls; - Existing cracks; - Poorly connected wythes in multi-wythes walls

STRUCTURAL IMPROVEMENTS AFTER STRENGTHENING:

- Shear and tensile strength is increased thereby improving the wall integrity, strength and ductility.
- Local failure modes are controlled.
- Existing cracks and voids are sealed.
- Out of plane detachment of wall panels is controlled.
- Wythes are connected properly for combined action thus reducing the possibility of delamination.

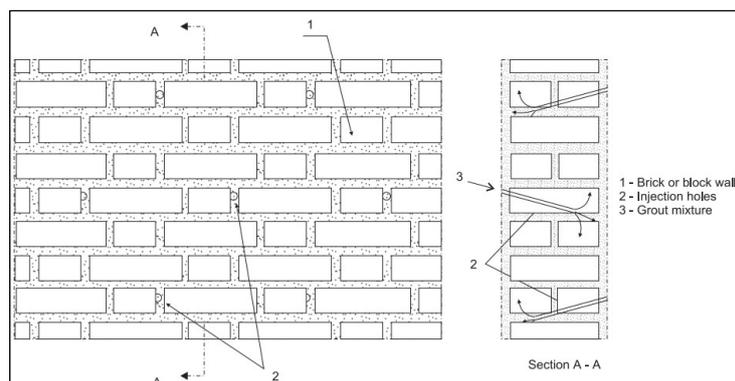
STRENGTHENING INTERVENTION DESCRIPTION:

This is a local type of non-invasive intervention technique on masonry structures. In this technique, cement based grout or epoxy resins are used as the injection material. Epoxy resins are excellent binding agents. This intervention does not alter the aesthetic or the architectural features of the building.

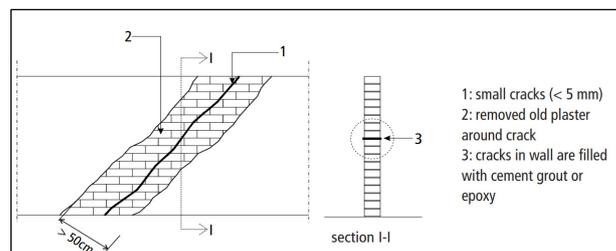
If the cracks are minor (less than about 2 mm), epoxy resins are appropriate, while cement-based grouts are favorable for filling larger cracks (ElGawady et al., 2004). In the weaker walls, holes are created and epoxy or grout is injected through the holes to improve the integrity of the walls. Injection technique can also be used to improve the tensile strength, cohesion and friction at the wall-frame interface in CM buildings by removing the existing poor quality mortar layer and injecting epoxy resin or cement based grouts. Cement-based grouting can be also used to fill the empty collar in the multi-wythes walls.

For more details on strengthening walls using injection technique, refer to Calvi and Magenes (1994), FEMA-308 (FEMA, 1999), ElGawady et al. (2004), IAEE (2004), Arya et al. (2013).

ILLUSTRATIVE FIGURES:



Grout or epoxy injection in existing weak walls (Reproduced from IAEE, 2004).



Grout of epoxy injection in existing cracks in masonry walls (Reproduced from Arya et al., 2013).

Example illustration and procedure for injection techniques to strengthen weaker walls or to repair small cracks in masonry.

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PRECAUTIONS AND LIMITATIONS:

This strengthening technique requires skilled masons as it involves plaster removal, drilling through the walls etc. The injector machine might not be available in particular areas.

REFERENCES:

Arya, A.S., Boen, T. and Ishiyama, Y. (2013). Guidelines for Earthquake Resistant Non-Engineered Construction. UNESCO, France.

Calvi, G. M., & Magenes, G. (1994). Experimental results on unreinforced masonry shear walls damaged and repaired. In Proceedings of the 10th International brick masonry conference (Vol. 2, pp. 509-518).

ElGawady, M., Lestuzzi, P., & Badoux, M. (2004). A review of conventional seismic retrofitting techniques for URM. In 13th international brick and block masonry conference (pp. 1-10).

FEMA (1999). Repair of Earthquake Damaged Concrete and Masonry Wall Buildings. Federal Emergency Management Agency, Washington DC, USA.

IAEE (2004). Guidelines for Earthquake Resistant Non-Engineered Construction. International Association for Earthquake Engineering (IAEE).

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.