EXPERIMENTAL INVESTIGATION OF PERFORATING MASONRY BRICK WALLS IN CENTER CORE REHABILITATION METHOD; DEVELOPMENT OF TECHNIQUES AND EQUIPMENT

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Many of important structures around the world such as schools and hospitals are unreinforced masonry buildings which are vulnerable to earthquakes and need to be retrofitted. An advantageous method for retrofitting of brick unreinforced masonry buildings is center core. In this method vertical holes with given intervals are perforated through the brick walls to the footing and then reinforcing steel bars are embedded in the holes and grout will be injected finally to create bond strength between wall and bars. However, the difficulty of conducting such deep boreholes in weak and thin brick walls especially of older buildings remains a serious challenge in the method. So a practical investigation is designed to investigate the feasibility of the method and develop the techniques and the equipment needed to perforate deep boreholes in brick walls. This article aims to report the results of the experiment. The main contribution of the study has been finding new techniques and designing of the best suited drilling bit which is particularly appropriate for boring brick walls in center core rehabilitation method without damaging the walls.

An advanced, advantageous method for retrofitting of URM buildings is center core (CC). Center core strengthening system consists of a reinforced grouted core placed in the center of an existing URM wall. Coring a vertical hole from the top continuously through the wall into the existing footing will provide the core. Reinforcing steel bars are then embedded in these holes and grout would be injected finally to create bond strength between wall and bars. CC could almost be done typically for many URM structures. Also, it does not affect the inner and outer appearance of the building (same as nondestructive methods), therefore it would be suitable for historical buildings. It could be also achieved without thorough evacuation of the building from residents and furniture because it can be done externally from the roof.

The main part of obscurities encompasses the feasibility and practicability study of the method. This part includes some aspects such as effective techniques of perforating masonry brick walls in height without damaging walls, constructional methodology, drilling techniques and required equipment. Since, there was no previous experience of conducting CC in the region, serious doubts about the practicability of the method for a large number of school buildings were encountered. An internet search did not reveal any serious investigation on this part either. Although, CC rehabilitation method based on perforating walls has been under consideration in recent years, the difficulties and uncertainties about deep perforating operation have made it infeasible. As for, Iranian code of practice (BHRC, 2005) permits construction of only one or two-story URM buildings, therefore, the target structures would be generally between three to seven meters high. The thickness of bearing brick walls are mostly between 20 to 40 centimeters. The difficulty of conducting such deep boreholes in weak and thin brick walls remains a serious challenge in the method. So a practical investigation is needed to investigate the feasibility of the method, develop the techniques and the required equipment. The focus of the present article is on the second part of obscurities mentioned - finding special techniques of perforating holes in brick walls without destroying or cracking walls. It is assumable that for practical purposes of the project, this part must be investigated first.

Boring, drilling and coring are common practices in different fields of engineering. They might be done for site exploration in geotechnical or mining engineering, concrete, rock or wood sampling for material property tests, pit or tunnel digging and many other applications. There are many specifications, regulations and technical notes for each specific application. There has been done a lot of work to develop the related technology and equipment. However deep boring in thin old weak brick

walls that is needed in CC method is a quite different process. It must be a deliberate and precise action to prevent damaging weak brick walls or the finishing material. Only a very little deviation of the bit can be acceptable. There is little academic or practical research on this part. It might be owing to the following reasons: (a) CC is a relatively new and modern retrofitting method; (b) Such researches may need costly practical experiments. Whatever the reasons are the uncertainties about CC implementation have prevented the widespread application of the technique. It is clear that successful and widespread use of CC would be completely dependent on revealing how it can be executed without causing any damages to the wall and its finishing plaster.

Considering the experiences during the experiment presented in this paper, the following conclusions can be drawn:

1- Center core is a feasible method for retrofitting of brick masonry buildings. Many of URM structures and infrastructures can be retrofitted by this method. It is also suitable for historical buildings and could be achieved without thorough evacuation of the place.

2- The bit type is a greatly influential parameter in successful boring process of a brick wall. Inappropriate selection of the bit type can result in damaging the wall or its finishing. Other effective parameters in damaging walls in CC method are: (a) high air pressure which mostly happens near the bit and stabilizers locations, especially if the vertical seams between bricks are empty of mortar that prepares a way to let air flow out; (b) deviation or eccentricity of the bit due to looseness of the rod connections, limp motor of the drilling machine and careless adjustment of the system. Whatever fewer pieces of rods are used in the system, the precision of boring would be higher.

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