REINFORCEMENT AND REPAIR OF MASONRY BUILDINGS IN SEISMIC AREAS

by

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The Authors are at present studying the possibilities of recuperating and modernising groups of terraced houses such as are frequently found in the oldest Italian settlements; they are also researching on public buildings with complex mural forms erected in varying periods and countries (ref. 1, 2).

The enquiry includes the collection of examples of cracking patterns and the definition of the stresses and strains which have caused them (ref. 3) noting the differences which arise as a result of the various constructional techniques.

To start with it has been studied (ref. 3) the behaviour of buildings of the simplest constructional design, i.e. of rectangular plan with three longitudinal parallel walls and shorter transversal walls at right angles.

These were built out of rough unequal blocks of tufa laid in two interconnecting parallel skins and filled with a concrete made of frangments of tufa and mortar.

The less loaded walls absorb a part of the surcharge of the orthogonal walls (by Haller effect, i.e. by a phenomenon related to the theory of the diffusion of stresses). The equalisation of the pressure due to the vertical loads contributes to a better resistance to seismic effects. In case of damage it is easy to restore the continuity of the external faces of the wall. In the case of internal vacua, connections subsist between the external skins of the same wall: this means that the Haller effect work on the scale of the thickness of the wall. Also between skins and filling there are phenomena of diffusion of stresses. The study of this phenomenon at different scales (between wall and wall, between skin and skin and between skin and filling) is the essence of this research.

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The repairing and successive change of use of earthquake damaged buildings constructed in good masonry like that described above suggest a technique of global restoration consisting of the insertion in the masonry of a frame either realised in steel or r.c. This frame, very often, can simply be created by reinforcing vertical or horizontal bands of the masonry itself.

The Authors have shown the opportunity to generate a state of uniform post-compression in the wall, (restored as above said) by means of vertical cables slightly prestressed: in order to increase the resistence of the masonry to the shear stresses whom successive earthquakes could provoke.

A linearly approximated model of this constructive system (i.e. restored wall with prestressed cables) has been studied by photoelasticity.

According to the architecture of the reinforced wall and the magnitude of the prestressing forces, two different kinds of mechanical behaviour can

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be detected:

(i) a field of diagonal stresses in each panel supports the respective bay;

(ii) the whole wall acts as a single cantilever, (and in this case a single discharge arch, developing through the wall, can be seen from a glance at the isochromes).

The relative stiffnesses of the beams and pillars forming the frame and of the different panels, the nature of the connections between panels and frame, the width and disposition of the openings in the panels and some others features give rise to one or another of the two kinds of behaviour.

Furthermore an easy analytical method for the stressing of the diagonal case (type i) has been studied. The fitness of a very simply law for the loading trasmitted to each panel from the frame has been demonstrated and a program for the stressing of the panels has been written (ref. 5); the hypothesis makes the writing of the equations of equilibrium and congruence of the whole structure (i.e. frame + panels) very simple.

These equations allow the engineer to take into account the prestressing of the single panels (and/or of the whole wall) (ref. 6).

Our aim now is to connect the behaviour of the single wall (restored and prestressed) with the study of the whole building by means of further study of the Haller effect.

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DISCUSSION

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It is interesting to note that use of vertical cables slightly prestressed, increases shear resistance of the masonry walls. Please comment on the superiority of this prestressing force against the lateral buttresses.

Can this logic be extended to masonry retaining walls ?

Author's Closure

Not received.