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Confining of Masonry Walls with Steel Elements

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1. Introduction

The transverse confinement of masonry is generally obtained by means of steel elements, namely tie-bars or tie-beams, conveniently fastened to the masonry with steel end-plates [1]. In this way a quite effective structural system is obtained, in which the existing materials are stressed in the most rational way. In addition, the intervention can be arranged in such a way to be easily controlled or removed, if necessary. This paper is focused upon the definition of a theoretical procedure for the prediction of the effect of confinement. The inelastic behaviour of both masonry and steel is accounted for. The method is applied in order to reproduce the results of a F.E.M. numerical simulation carried out with the non linear code ABAQUS, whose reliability has been checked in turn by means of a direct comparison with some existing experimental data [2]. The case under consideration is that of masonry walls subjected to compressive load and confined by tied steel plates. In spite of some simplifications introduced into the analytical developments, the method proposed can be considered as a first attempt to the direct evaluation of the load bearing capacity of confined masonry.

2. The theoretical model for confined masonry

The model presented hereafter concerns the case of a masonry wall uniformly confined along its transverse direction by means of tied end-plates (fig.1). It is assumed that:

1) the behaviour of masonry is assumed to be isotropic;
2) the steel confining plate is fully rigid;
3) the behaviour of masonry in compression is represented by means of a suitable non-linear σ–ε law, whose parameters are fitted on the basis of experimental evidence;
4) the mutual relationship between the applied stress and the confining stresses and is of pseudo-elastic type, i.e. *Navier*-like equations hold in both elastic and post-elastic range.

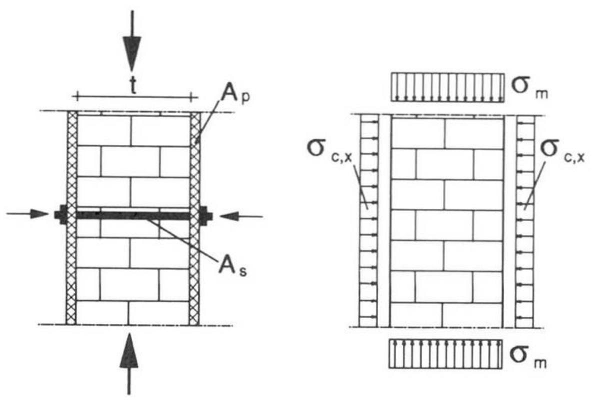

Fig. 1 Idealisation of confined masonry

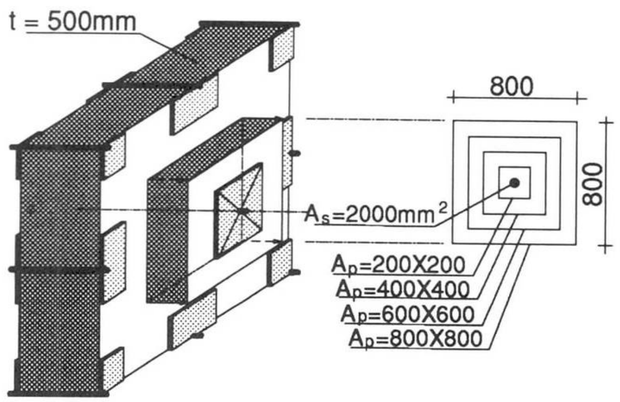

Fig.2 The masonry panel considered with F.E.M. simulation

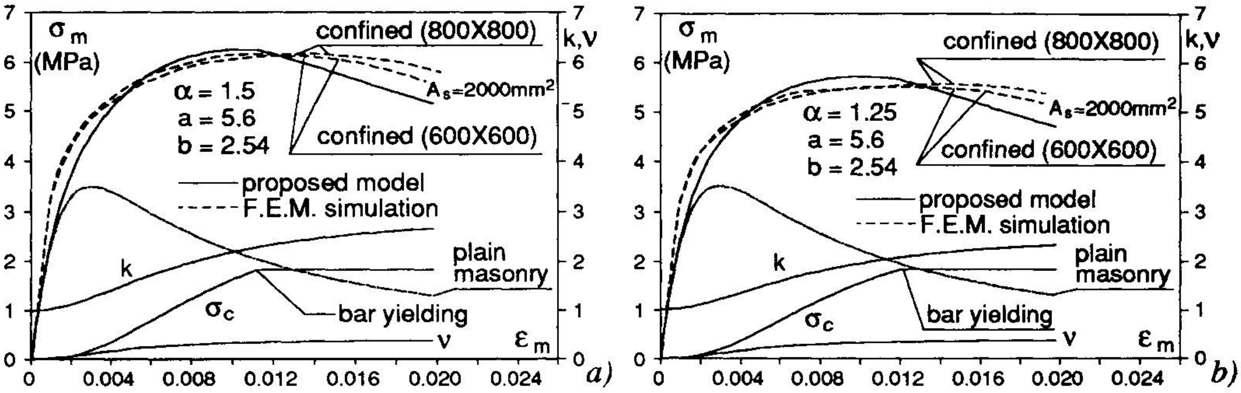

Fig.3 Fitting of the proposed theoretical model for t=500mm (a) and t=300mm (b)

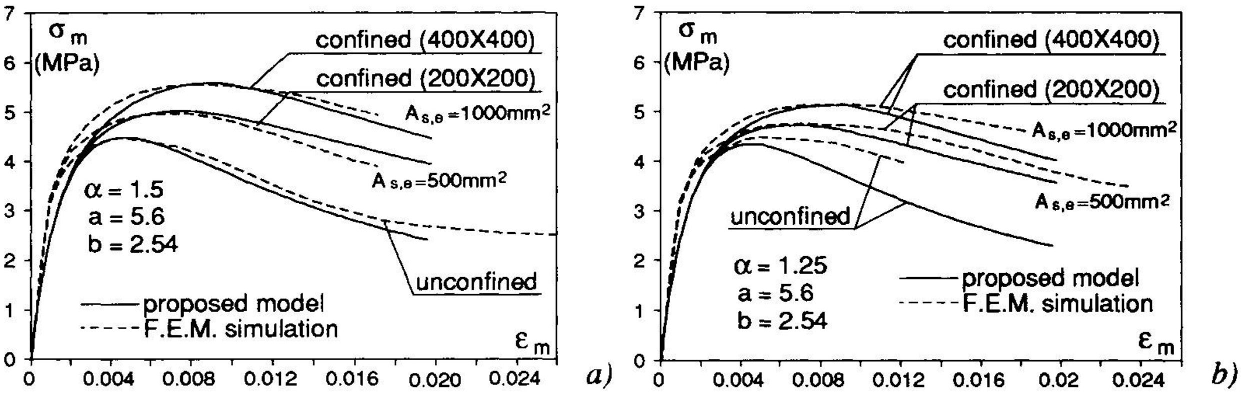

Fig.4 Values of $A_{s,e}$ for t=500mm (a) and 300mm (b) and corresponding behavioural curves

Under these hypotheses the expressions for the state of stress in the confined wall are found. They are able to take into account the yielding of steel bars. The *Saenz*' s law for concrete is considered for the representation of the behaviour of plain masonry. A suitable law is assumed for the *Poisson*' s modulus ν [3] and for the masonry strength enhancement factor k accounting for the combined state of stress. With respect to the existing models, mostly concerned with concrete, in this procedure the number of parameters to be fitted empirically is drastically reduced to k and ν ,only. With a suitable choice of these factors, the proposed model can interpret experimental or numerical results with a satisfying degree of accuracy (fig 3). When a partial confinement with smaller plates is considered, the concept of equivalent steel area $A_{s,e}$ is introduced (fig. 4). This is defined as the cross section area of the steel bar which, in case of global confinement, would have produced the same load bearing capacity for the wall. Nevertheless, as far as this concept is concerned, the general validity of the method has been not completely assessed. When, in fact, partial confining with smaller plates is considered, the failure mechanism of the wall could be different, with a possible collapse due to punching or shear-tension in the masonry. For this reason, an *ad-hoc* experimental program is presently being planned, in order to provide new elements for the set-up of the proposed model.

Essential references

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