Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 77 (1998)

Artikel: Confining of masonry walls with steel elements
Autor: Mandara, Alberto / Mazzolani, Federico M.
DOI: https://doi.org/10.5169/seals-58250

Nutzungsbedingungen
Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Mehr erfahren

Conditions d'utilisation
L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. En savoir plus

Terms of use
The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. Find out more

Download PDF: 06.02.2026

ETH-Bibliothek Zürich, E-Periodica, https://www.e-periodica.ch

Confining of Masonry Walls with Steel Elements

Alberto MANDARA
Dr Eng.
Univ. of Naples
Aversa, Italy

Alberto Mandara, born 1963, is Research Assistant at the Second University of Naples. Graduated in 1987, he got the PhD degree in 1993. Author of more than 40 papers on steel and aluminium structures.

Federico M. MAZZOLANI
Professor
University "Federico II"
Naples, Italy

Federico M. Mazzolani, born 1938, is Full Professor of Structural Engineering at the University "Federico II" of Naples. Author of more than 350 papers and 12 books in the field of metal structures, seismic design and rehabilitation.

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.

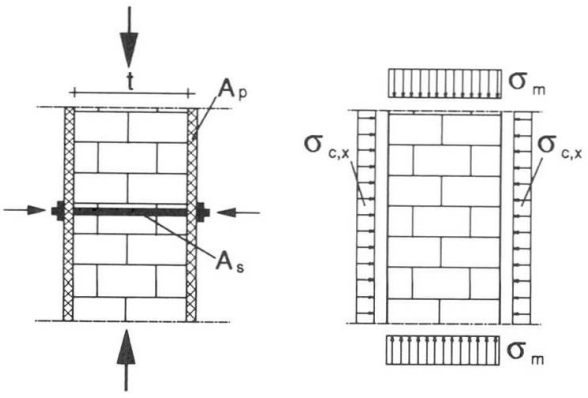

Fig. 1 Idealisation of confined masonry

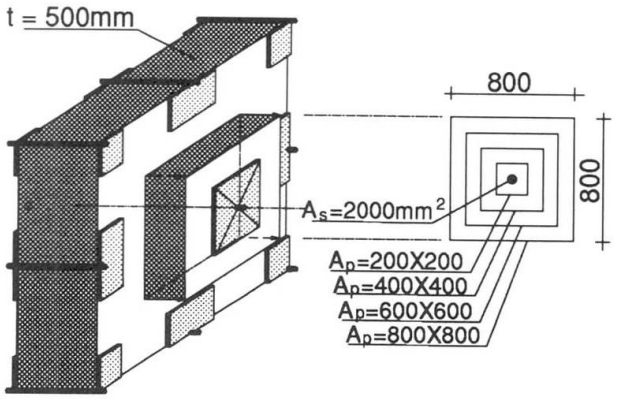

Fig.2 The masonry panel considered with F.E.M. simulation

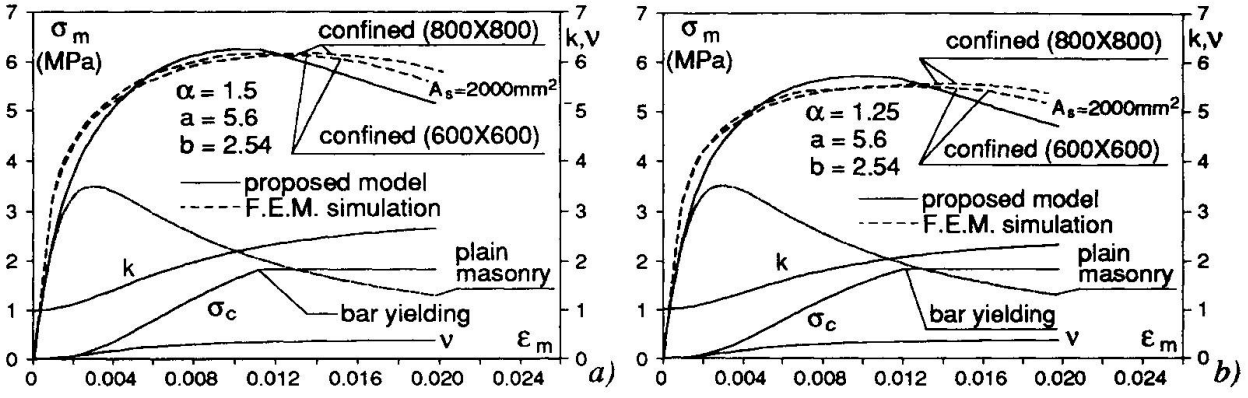

Fig.3 Fitting of the proposed theoretical model for t=500mm (a) and t=300mm (b)

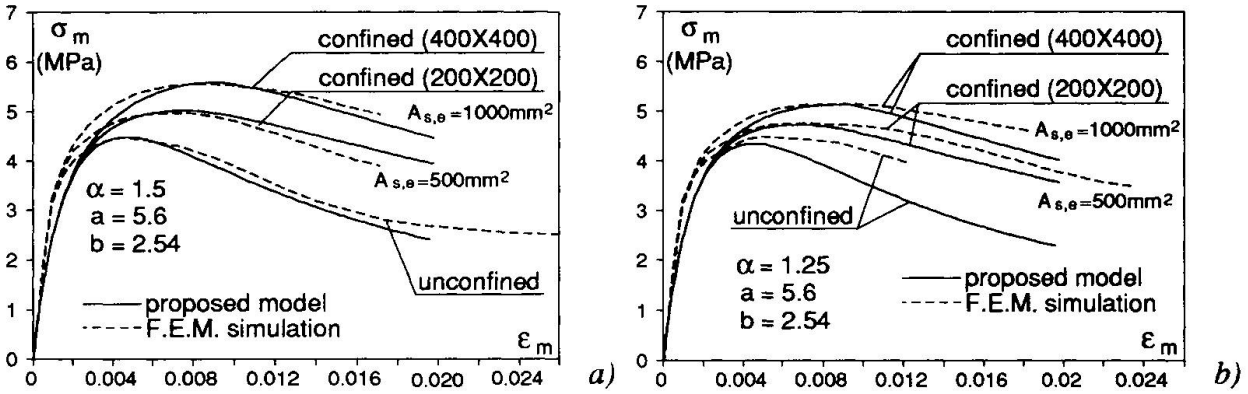

Fig.4 Values of $A_{s,e}$ for t=500mm (a) and 300mm (b) and corresponding behavioural curves

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

[1] Mazzolani, F.M.: *"Strengthening Options in Rehabilitation by means of Steelwork"*, Proc. of SSRC International Colloquium on Structural Stability, Rio de Janeiro, 1996.
[2] Ballio, G., Calvi, G.M.: *"Strengthening of Masonry Structures by Lateral Confinement"*, Proc. of IABSE Symp. *"Structural Preservation of the Architectural Heritage"*, Rome, 1993.
[3] Faella, G., Manfredi G., Realfonzo, R.: *"Stress-Strain Relationships for Tuff Masonry: Experimental Results and Analytical Formulations"*, Masonry Int., Vol. 7, No. 2, 35-61, 1993.