

Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 70 (1993)

Artikel: Dynamic analysis of church masonry
Autor: Gavarini, Carlo / Mollaioli, Fabrizio / Valente, Gianfranco
DOI: <https://doi.org/10.5169/seals-53335>

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: 01.04.2026

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



Dynamic Analysis of Church Masonry

Analyse dynamique d'une église en maçonnerie

Dynamische Berechnung von Mauerwerkskirchen

Carlo GAVARINI

Prof. of Structural Mech.
University 'La Sapienza'
Rome, Italy

Fabrizio MOLLAIOLI

Civil Eng.
CNR-GNDT
Rome, Italy

Gianfranco VALENTE

Ass. Prof. of Struct. Eng.
L'Aquila University
L'Aquila, Italy

1. INTRODUCTION

For the ancient masonry wall, we neglect the tensile strength and fracture energy, due to the time damaging. Tensile failure occurs when one tensile principal stress tends to become positive. In this case a plane of failure develops at right angle to the previous principal direction and is conserved its orientation at onset of cracking for the whole loading process. Subsequent failure planes could be only orthogonal to the first and between them. After tensile failure, the normal coefficient in local stiffness matrix is abolished and shear coefficient is multiplied by a constant retention factor less than unity. The nonlinear uniaxial compressive behavior is defined by initial Young's modulus E_0 , crushing point $C(\epsilon_c, \sigma_c)$, ultimate point $U(\epsilon_u, \sigma_u)$. In multiaxial compressive state compression, the crushing and the ultimate points of uniaxial test may be enhanced relating to the projection on the triaxial failure envelope. Unloading from a compressive state is parallel to the initial Young's modulus. Isoparametric plane elements with a maximum of eight nodes and four integration points in each direction are used. The tangent stiffness matrix is referred to:

- principal stress direction before tensile failure;
- failure coordinate system (axes parallel and transverse to the crack planes after tensile failure).

Various ancient buildings are taken into account. Different accelerograms are used, a few real, other obtained by power spectra according to current rules. The Newmark's integration method is used obtaining: stress and strain fields, crack patterns, displacements velocities and accelerations in each node. In conclusion, a method apt to analyse dynamically any masonry building with great accuracy is proposed.



2. PROBLEM DESCRIPTION.

ADINA Code is used. A church masonry is taken into account, having span and height 10.20m, depth 3.90m. The vertical walls are stone made and in the upper arch and over there are bricks. The materials mean features are: $E_0=1000.N/mm^2$, $\sigma_c=-3.N/mm^2$, $\epsilon_c=-.01$, at crushing and tension cut-off. The Model and F.E. mesh are represented in Fig.1. Accelerations are applied as in Fig.2, having maximum value 0.2g. The Newmark's integration method is used obtaining the nodal results as in Figs.3-5.

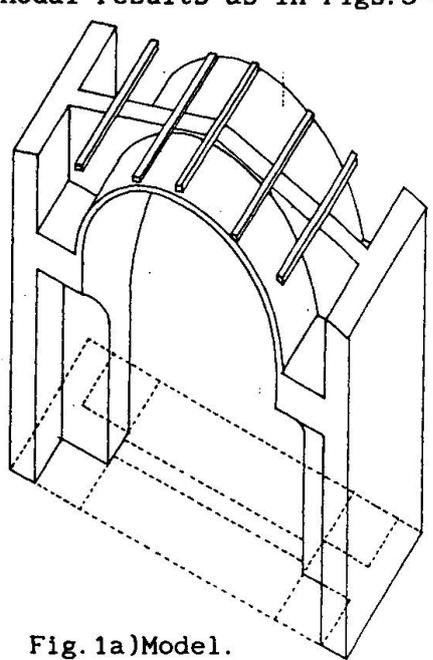


Fig. 1a) Model.
0.2g

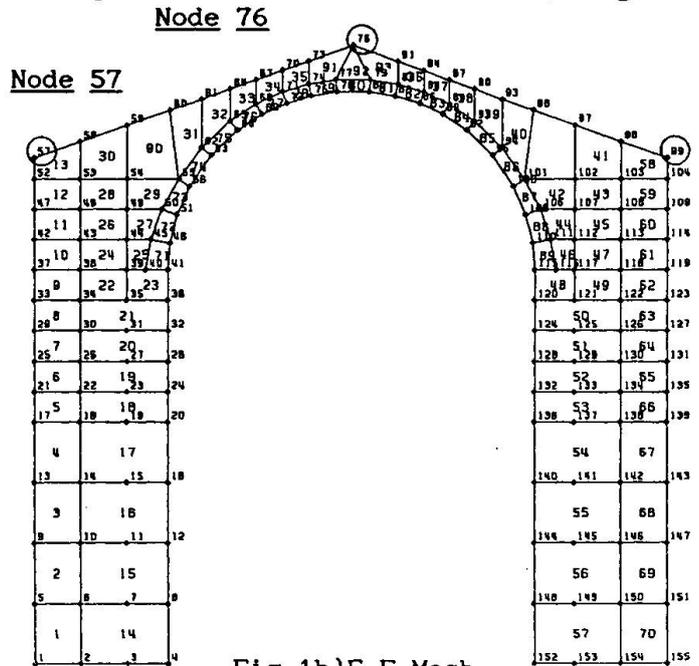


Fig. 1b) F. E. Mesh.

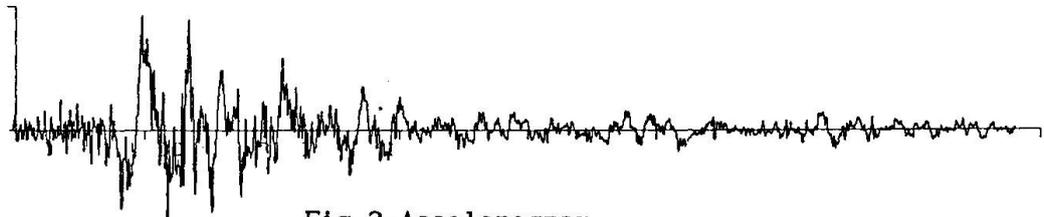


Fig. 2-Accelerogram.

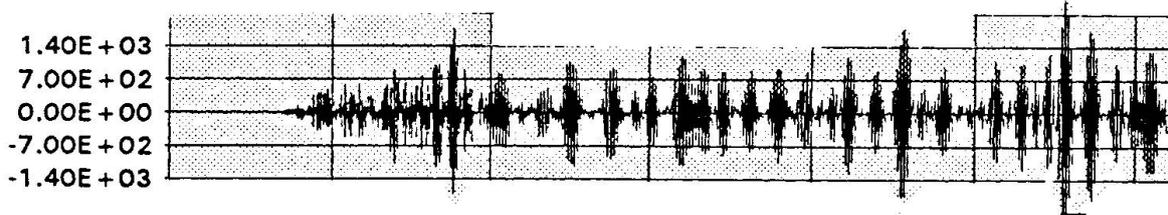


Fig. 3-Accelerations Node 76, [cm/sec²].

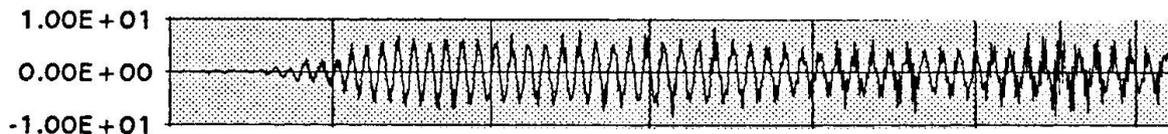
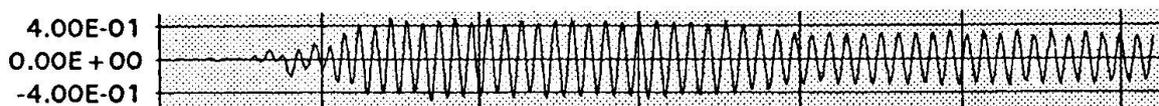


Fig. 4-Velocities Node 76, [cm/sec].



0.0 5.0 10.0 15.0 20.0 25.0 30.0 [sec]
Fig. 5-Displacements Node 76; [cm].