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

Artikel: Dynamic analysis of church masonry
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DOI: https://doi.org/10.5169/seals-53335

Dynamic Analysis of Church Masonry

Analyse dynamique d'une église en maçonnerie

Dynamische Berechnung von Mauerwerkskirchen

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1. INTRODUCTION

For the acient 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_o, crushing point $C(\varepsilon_c,\sigma_c)$, ultimate point $U(\varepsilon_u,\sigma_u)$. 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 acient 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 dinamically any masonry building with great accurancy 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_o=1000. N/mmq, σ_c=-3. N/mmq, ε_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.

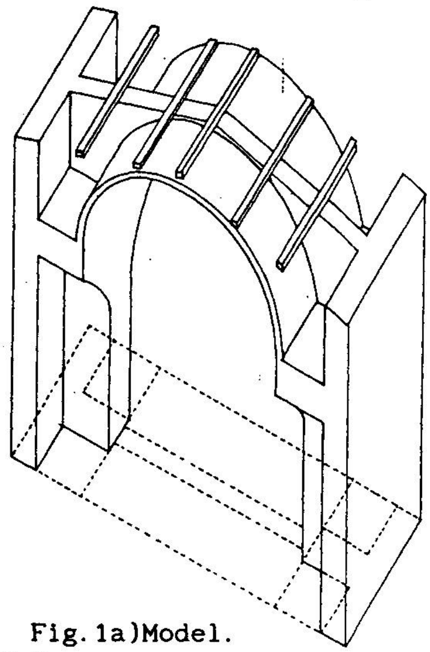

Fig. 1a)Model.

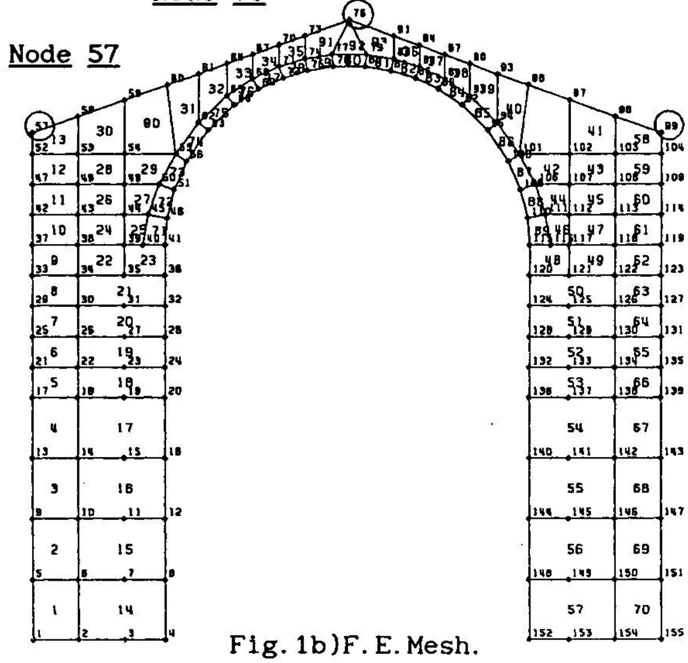

Fig. 1b)F. E. Mesh.

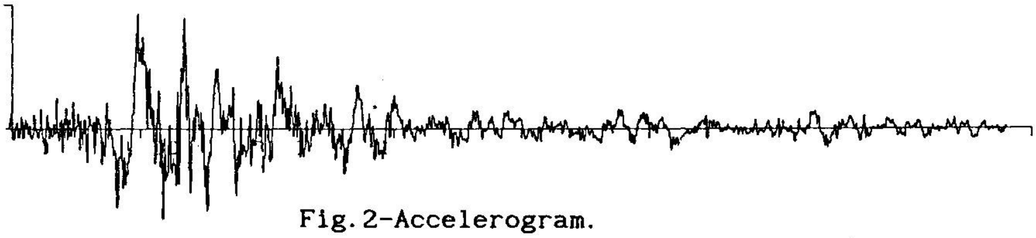

Fig. 2-Accelerogram.

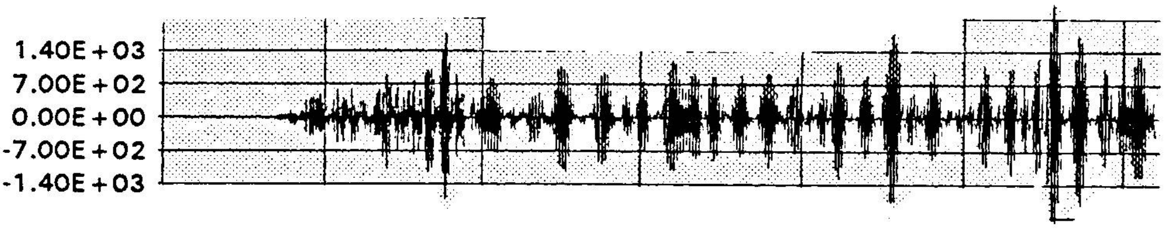

Fig. 3-Accelerations Node 76, [cm/sec^2].

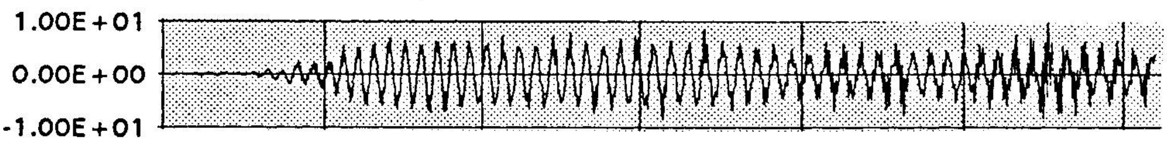

Fig. 4-Velocities Node 76, [cm/sec].

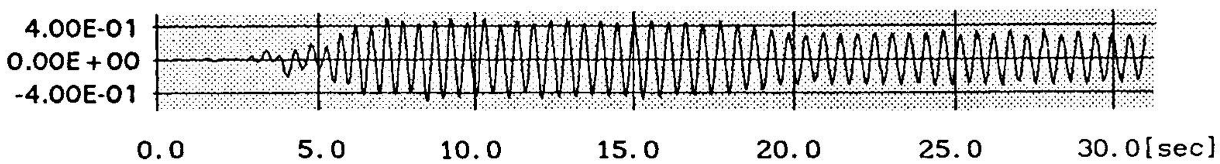

Fig. 5-Displacements Node 76; [cm].