

Direct solution of the dynamic aseismic design problem of multi-story systems, with the use of electronic analog computer

Autor(en): **Ikonomou, A.**

Objektyp: **Article**

Zeitschrift: **IABSE congress report = Rapport du congrès AIPC = IVBH
Kongressbericht**

Band (Jahr): **8 (1968)**

PDF erstellt am: **14.05.2024**

Persistenter Link: <https://doi.org/10.5169/seals-8881>

Nutzungsbedingungen

Die ETH-Bibliothek ist Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Inhalten der Zeitschriften. Die Rechte liegen in der Regel bei den Herausgebern.

Die auf der Plattform e-periodica veröffentlichten Dokumente stehen für nicht-kommerzielle Zwecke in Lehre und Forschung sowie für die private Nutzung frei zur Verfügung. Einzelne Dateien oder Ausdrucke aus diesem Angebot können zusammen mit diesen Nutzungsbedingungen und den korrekten Herkunftsbezeichnungen weitergegeben werden.

Das Veröffentlichen von Bildern in Print- und Online-Publikationen ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Die systematische Speicherung von Teilen des elektronischen Angebots auf anderen Servern bedarf ebenfalls des schriftlichen Einverständnisses der Rechteinhaber.

Haftungsausschluss

Alle Angaben erfolgen ohne Gewähr für Vollständigkeit oder Richtigkeit. Es wird keine Haftung übernommen für Schäden durch die Verwendung von Informationen aus diesem Online-Angebot oder durch das Fehlen von Informationen. Dies gilt auch für Inhalte Dritter, die über dieses Angebot zugänglich sind.

DISCUSSION LIBRE / FREIE DISKUSSION / FREE DISCUSSION

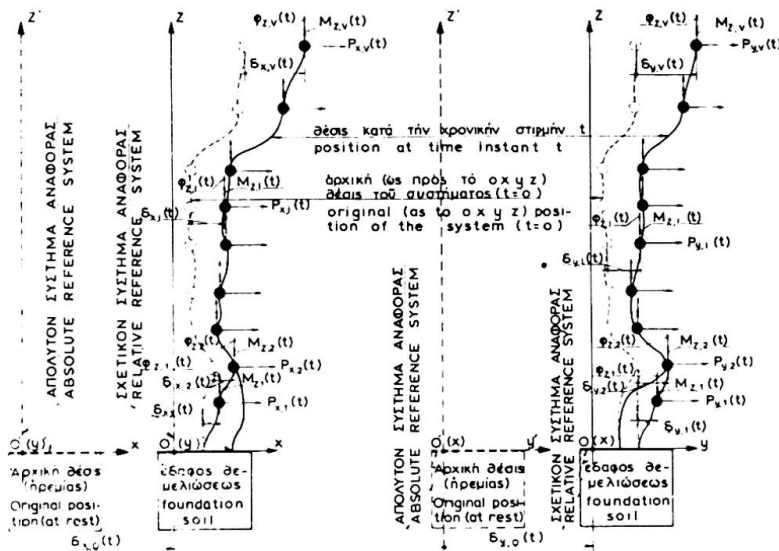
Direct Solution of the Dynamic Aseismic Design Problem of Multi-Story Systems, with the Use of Electronic Analog Computer

Solution directe du comportement dynamique dû au séisme de bâtiments de grand hauteur à l'aide d'une calculatrice analogue

Direkte Lösung des dynamischen Verhaltens bei Erdbeben von Hochhäusern mittels des Analog-Elektronenrechners

A. IKONOMOU
Dr., Athens

A method is suggested which considers an idealized lumped mass multi-



degree of freedom system subjected to forced vibrations caused by earthquake ground motion (see fig.). These masses are connected to each other by elastic joints with known elastic properties. The vertical components of the mass displacements and the rotations about horizontal axes are neglected. Elastic behavior of the material is assumed. The mass m_i have horizontal displacement δ_i and rotations

ϕ_i about the vertical axis with respect to a three dimensional reference system OXYZ fixed on the ground. At an instant t the forces acting on the mass are linear functions of the above deformations and are given by the matrix equation

$$E = \varepsilon \Pi \quad (a)$$

On the other hand the equation of dynamic equilibrium of the system are expressed by the matrix equation

$$m \Pi''_0 + m \Pi'_i = E = \varepsilon \Pi_i \quad (b)$$

In the above equations E = column vector of elastic forces or loading vector Π_i = the column vector of the relative distortions δ_i , ϕ_i of the system,

E = the known square stiffness matrix, Π_i'' = the column vector of the relative accelerations of the masses, m = the diagonal square matrix of masses and mass moments of inertia (also known) and Π_o'' = the column vector of the ground accelerations with respect to an absolute reference system $OX'Y'Z'$. The ground motion vertical and rotational components are ignored. The functions $\delta_i(t)$ and $\phi_i(t)$ due to a given ground motion are obtained by the solution of the system (b) of second degree differential equations.

The proposed method makes use of tables referring to a given "standard" seismic vibration and to a variety of "standard" mass and rigidity distributions in the system. The standard form is reduced to the actual seismic vibration, mass and rigidity distribution in the following manner: Let the indices Σ' , Σ symbolize two different n -story systems with the same number of masses and let the corresponding stiffness and mass matrices be related by the expressions $E_{\Sigma'} = \eta_1 E_{\Sigma}$, $m_{\Sigma'} = \eta_2 m_{\Sigma}$. The two systems being subjected to different ground motions, their absolute acceleration matrices

$\Pi_{o\Sigma'}''$, $\Pi_{o\Sigma}''$ will be related by $\Pi_{o\Sigma'}(t) = \eta_3 \Pi_{o\Sigma}(\eta_4 t) = \eta_3 \Pi_o(\eta_4 \lambda t)$ in which

$\Pi_o(\lambda t)$ = seismogram depending on the values of the parameter λ given in the tables ($\eta_1, \eta_2, \eta_3, \eta_4$ = constants). The above systems are regarded under these conditions as "similar" and their dynamic deflections $\Pi_{i\Sigma'}$ and $\Pi_{i\Sigma}$ are obtained from the solution of the equations

$$m_{\Sigma'} \Pi_{o\Sigma'}'' + m_{\Sigma'} \Pi_{i\Sigma'}'' = E_{\Sigma'} \Pi_{i\Sigma'} \quad (c)$$

$$m_{\Sigma} \Pi_{o\Sigma}'' + m_{\Sigma} \Pi_{i\Sigma}'' = E_{\Sigma} \Pi_{i\Sigma} \quad (d)$$

The equation (c) can be transformed into the following:

$$\eta_3 m_{\Sigma} \Pi_{o\Sigma}''(\lambda t) + m_{\Sigma} \Pi_{i\Sigma'}'' = E_{\Sigma} \Pi_{i\Sigma'} \quad (e)$$

in which $\lambda = \eta_4 \cdot k \cdot \sqrt{\eta_1 / \eta_2}$ (f)

It is easily seen from (d) and (e) that the dynamic deformation of Σ' at any t are equal to the corresponding deformations of the "similar" system Σ subjected to a vibration $\eta_3 \Pi_o(\lambda t)$. If the system Σ is considered as a "model" and is solved by an electronic analog computer for a wide variation of the values of λ then the solution for any other system Σ' with known mass stiffness distributions and subjected to any vibration $\Pi_{o\Sigma'}(t)$ can be obtained by measuring the resulting $\Pi_{i\Sigma}$ at the position of the ordinate λ given by (f) and by multiplying the result by η_3 . The theory can also be easily expanded to include the influence of damping in the structure.