

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

Band: 12 (1984)

Artikel: Elastic-plastic analysis of three dimensional buildings, with substructure method

Autor: Aizawa, S. / Nagashima, T. / Higashibata, Y.

DOI: <https://doi.org/10.5169/seals-12253>

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: 10.08.2025

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



Elastic-Plastic Analysis of Three Dimensional Buildings, with Substructure Method

S. AIZAWA, T. NAGASHIMA, Y. HIGASHIBATA,
J. IMAMIYA, Y. HAYAMIZU, I. YAMAGUCHI

Takenaka Komuten Co. Ltd.
Tokyo, Japan

The authors developed the pseudo-three-dimensional elastic-plastic analysis program using substructure-method, as practical analysis method to obtain the horizontal ultimate strength of a building and the stiffness for dynamic analysis.

Frames interconnected by floor diaphragms which are rigid in their own plane are considered as substructures in the basic formulation. And the three-dimensional effect of a building was adopted as the following taking the practicability into account.

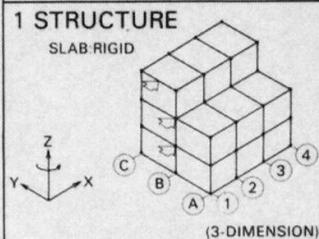
- 1) The geometrical horizontal position of each plane frame in the floor is considered, the plane frame-matrix is converted into the global coordinate system, the stiffness matrix of the whole building is drawn up and the horizontal rotation-stiffness considering the eccentricity of the rigidity against the center of gravity is drawn up.
- 2) The plane frame-matrix is condensed leaving the vertical degree of freedom of the joint designated as external degree of freedom, when drawing up the total stiffness matrix, the constrained effect of straight crossed frame is considered by making coincide as common vertical degree of freedom of mutual frames.

The elastic-plastic judgments are carried out at the member level, and the elastic-plastic elements of each member are as follows. The bending and shearing element has rigid-plastic rotational springs in both ends, and the central part consists of beam models of bending = elasticity and shearing = elastic plasticity. The rotational spring part is condensed when the element matrix is piled up to the plane frame-matrix. Each restoring force model of bending and shearing adopts in principle the tri-linear type, the bending buckling can be considered, the M-N correlation is considered in the column model, and axial elements adopts the bi-linear model considering buckling. As hysterical characteristics of each element, normal, degrading and slip models are provided. In order to confirm the adaptability of this program, the analysis of static force experimental model of (1) RC plane frame (3 layers, 3 spans, $H \times L = 1.8 \times 3 \text{ m}$), (2) RC three-dimensional frame(3 layers, 3 x 2 spans, $H \times L \times W = 1.32 \times 2.25 \times 1.5 \text{ m}$) including the anti-seismic wall. The experimental result and the analytic result of every models corresponded well, and especially in the model of (2) the effect of the pseudo-three-dimensional analysis was well expressed.

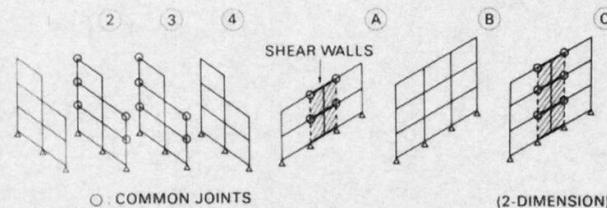
NONLINEAR ANALYSIS OF THREE DIMENSIONAL BUILDINGS

The authors developed the pseudo-three-dimensional elastic-plastic analysis program using substructure-method, as practical analysis method to obtain the horizontal ultimate strength of a building and the stiffness for dynamic analysis. Analytical flow is:
 1 → 2 → 3 → 4 → 5 → 6
 5 → 6

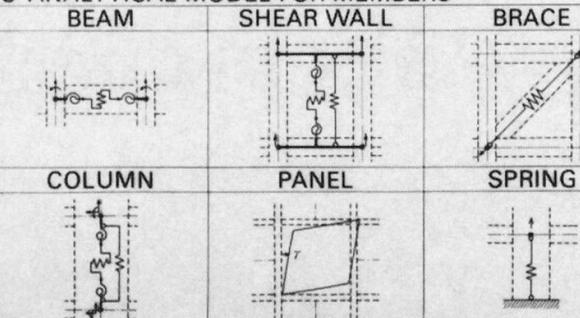
THE OUTLINE OF ANALYSIS PROGRAM



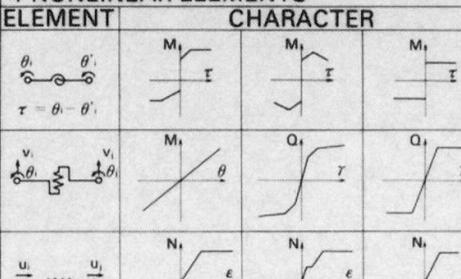
2 DECOMPOSITION



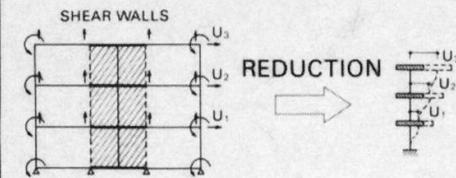
3 ANALYTICAL MODEL FOR MEMBERS



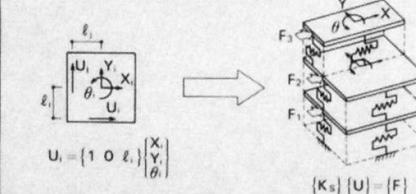
4 NONLINEAR ELEMENTS



5 A PLANE FRAME SUBSTRUCTURE

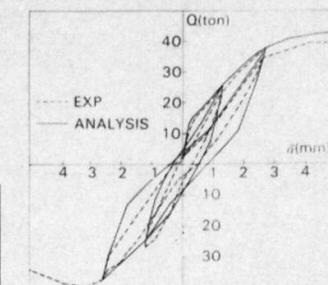
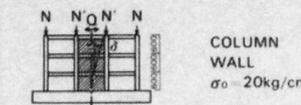


6 ASSEMBLY AND SOLUTION OF OVERALL STRUCTURE



COMPARISON WITH EXPERIMENTAL RESULTS

• 3-STORY REINFORCED CONCRETE PLANE FRAME-WALL STRUCTURE MODEL



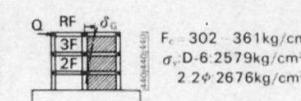
	BEAM	COLUMN	WALL
REINF.	TOP 3-D13 BOT 3-D13	6-D13	H & V $5\phi = 150$
b × D	120 × 150	200 × 150	t = 50

$F_c = 275\text{kg/cm}^2$ $\sigma_y = 3840\text{kg/cm}^2$

$5\phi = 4050\text{kg/cm}^2$

• 3-STORY REINFORCED CONCRETE 3-D FRAME-WALL STRUCTURE WITH ECCENTRICITY*

	BEAM(X)	BEAM(Y)	COLUMN	WALL	SLAB
REINF.	TOP 2-D6 BOT 2-D6	TOP 2-D6 BOT 2-D6	4-D6	H & V $2.2\phi = 35$	RF TOP 4-φ 55 BOT 3.2φ 55
b × D	55 × 90	55 × 80	80 × 80	t = 25	$2.3F$ t = 20 2.2φ = 55



ANALYTICAL ASSUMPTIONS

No	CONSIDERATION	SLAB DISP.
1	Y-Di. FRAMES	Y
2	Y-Di. FRAMES	Y & Rotation
3	X & Y FRAMES	Y & Rotation
4	X & Y FRAMES COMMON JOINTS	Y & Rotation

* J. Onose et al. TOHOKU TECHNICAL INST REPORTS OF THE ANNUAL MEETING OF AT&T 1982