

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

**Band:** 12 (1984)

**Artikel:** Interaction analysis of asymmetric sway frames

**Autor:** Scholz, H.

**DOI:** <https://doi.org/10.5169/seals-12237>

### **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:** 21.02.2026

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



## Interaction Analysis of Asymmetric Sway Frames

H. SCHOLZ

Senior Lecturer

Univ. of the Witwatersrand

Johannesburg, Rep. South Africa

A novel method is presented for the approximate three-dimensional analysis of asymmetric sway frames subjected to torsional loading causing P-Delta effects.

The two most significant aspects of the new procedure are:

1. That actual structures need not individually be analysed on a rigorous elastic-plastic basis but by using their elastic buckling load and rigid plastic collapse load as reference parameters i.e similar to the conventional in-plane analysis of single columns without the need for iterations.
2. That the proposed method can be used on a story-by-story basis for multi-story structures, thereby greatly reducing the number of variables compared with an investigation of the full frame. The load factor of the weakest story is then taken as the load factor applicable to the entire frame-work. More details and the principles of the new analysis technique are given in Refs.1-4.

The technique is suitable for three-dimensional frame structures made up of intersecting rectangular grids, ignoring local and torsional buckling of the members and disregarding their torsion and warping resistances.

The fundamental assumptions can be summarised as follows:

1. Any given frame structure can be grouped into a unique family of frames.
2. Each family of frames can be represented by a specific curve in a multicurve interaction graph.
3. The significant frames within a particular family of frames are a frame unaffected by P-Delta effects for which the failure load is equal to its rigid-plastic collapse load and a frame that fails completely elastically, i.e failure is related to elastic buckling. The latter frame is termed the "limiting frame" of the frame family.
4. Between the two significant frames other frames can be located on the failure curve by reference to their ratio of elastic buckling load to rigid-plastic collapse load.

The presence of torsion is recognised by examining rigid-plastic collapse modes and elastic buckling modes in both directions of the rectangular frame grid and by elastically distributing the total applied lateral load to the individual frames on the grid when it comes to defining the geometry of the "limiting frame". The parameter  $(0,4P_C/P_P)_\ell$  of the "limiting frame" is used to select the relevant curve from the multicurve diagram. The actual structure is then located on that curve by its ratio  $0,4P_C/P_P$ .

The establishment of the "limiting frame" is thus of prime importance when obtaining the failure load from the interaction graph. In its simplest format the ratio  $(0,4P_C/P_P)_\ell$  of the "limiting frame" can be found from the equivalent ratio applicable to the actual structure, i.e  $0,4P_C/P_P$ , by using Eq.(1) which is derived by equating elastic failure and first yield.

$$\left(\frac{0,4P_C}{P_P}\right)_\ell = \frac{0,4P_C}{P_P} \frac{Zf_p}{M} R \quad \text{Eq. (1)}$$

To solve Eq.(1) the actual structure is subjected to loading of the same configuration as the factored applied load but in magnitude related to the elastic buckling load of the frame. The parameter Z is the elastic section modulus, M=second-order elastic moment,  $f_p$ =stress at onset of yield. The factor R recognises that the reduction to the fully-plastic moment capacity of column sections due to axial load and bi-axial bending may be different for the actual and the "limiting frame". The value R can often be estimated, however, R=1 will mostly give satisfactory results. For the structure under consideration the lowest ratio  $(0,4P_C/P_P)_\ell$  is significant.

The presented method compares well with experimental and rigorous analytical results. A single-story model framework subjected to torsion was recently tested by the author. The experimental failure load exceeded the predicted value by less than three per cent.

The shown multi-story structure is similar to a framework previously analysed by Hibbard and Adams(5). The lowest story load factor for proportionate vertical and horizontal loading is found as 0,95.

### REFERENCES

1. Scholz, H "Evolution of an approx. analysis technique for unbraced steel frames", to be published in The Civil Engineer in South Africa
2. Scholz, H "Simplified interaction method for sway frames", Journal of Structural Division, ASCE, Vol 110, No.5, May 1984, pp992-1007
3. Scholz, H "A new multi-curve interaction method for the analysis of steel sway frames", Proc.3rd Intern.Colloquium on Stability of Metal Structures, Toronto, May 1983, pp431-448
4. Scholz, H "Interaction analysis of asymmetric sway subassemblages", to be published in Journal of Structural Division, ASCE, Vol.110, No.10, Oct.1984
5. Hibbard JR, Adams PF "Subassemblage technique for asymmetric structures", Journal of Structural Division, ASCE, Vol.99, ST11, Nov.1983, pp 2259-2268

# INTERACTION ANALYSIS OF ASYMMETRIC SWAY FRAMES

