# Plastic design of tall buildings

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Objekttyp: **Article**

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

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

PDF erstellt am: **12.07.2024**

Persistenter Link: https://doi.org/10.5169/seals-8800

# Plastic Design of Tall Buildings

Dimensionnement plastique de bâtiments élancés

Plastische Bemessung von Hochhäusern

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The conference topic, Plastic Design of Tall Buildings, has been particularly timely in connection with a current project of the American Society of Civil Engineers. An ad hoc committee of ASCE is currently (1968) nearing completion of its work in revising ASCE Manual No. 41, "Plastic Design in Steel". Included in the committee are many members from abroad, and their attendance at this meeting has made possible a number of valuable informal discussions.

Much additional information is now available on the status of plastic design, new research, new applications, and problems requiring further study. The second edition of ASCE Manual No. 41 is being revised on a modest basis to include this information, to incorporate braced multi-story frames, and to encompass modifications to simple plastic theory where necessary to extend its applicability. It will cover steels with yield points up to 65 ksi, and additional attention is given to repeated loading effects. It is hoped that the second edition of the Manual will be available early in 1969.

Discussion by Professor Hrennikoff

With respect to the prior discussion by Professor Hrennikoff, two comments are pertinent. In the first place, so-called elastic design would have the same inadequacies that he attributes to plastic design. If what Professor Hrennikoff says is true, then most of the buildings designed in the last two decades would either be unsafe or would be uneconomical--and that can scarcely be the case. It was in 1945 that the American Institute of Steel Construction first incorporated a provision to allow a 20% increase in stress at points of interior support in continuous beams. This amounted to a direct use, albeit on a somewhat arbitrary basis, of the plastic strength of steel structures. It is a provision that has been used in design ever since. In Europe plastic design has been used for decades in proportioning continuous beams. Thus one cannot in any way understand why Professor Hrennikoff continues to be concerned.

In the second place, as engineers we tend to be interested in stress. But the user and the owner are concerned about safety (that the structure has adequate strength) and with performance (that it doesn't deform too much). These latter are the truly important criteria: strength and deformation. Where stress is a logical basis for design it is only so because it assures that one or the other of these two design requirements will be met.

Therefore, we reject Professor Hrennikoff's thesis.

## Contributors to the Plastic Theory of Structures

Earlier in the discussion of this theme, Professor Massonnet mentioned a conference on engineering plasticity at Cambridge University, England. It was the writers privilege to be able to attend this conference which honored Sir John Baker on the occasion of his completing his service to Cambridge. This honor to Sir John (Fig. 1) was particularly appropriate because he put into motion a new era in structural design. As a pioneer into new areas of structural design, he understood the weaknesses of past design techniques and the significant opportunities for improvement. Not only was he able to set forth the new concept, but he made that essential next step: to stimulate in a dramatic way the application of research findings to design. It is indeed fortunate that the engineering profession continues to benefit from his active contributions.

Fig. 1

The Conference on Engineering Plasticity was also important, as are all conferences, because of the people who attended. A special group are the four shown in Fig. 2--individuals who were true pioneers in various aspects of maximum load design*. Commencing from the right, Professor Prager headed a most important team at Brown University; their studies and writings are the major contributions to the mathematical theory of plasticity. It was Professor Baker's genius that made plastic design a practical, useful technique for the structural engineer. Professor Johansen gave the profession the

Fig. 2

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*Regretably, the photograph does not include M. Massonnet, also present at the Conference, and in Europe a leader in plastic design developments.

yield line theory. Finally, Dr. Stüssi, honorary president of the IABSE, gave us searching and challenging questions; and it is only the fact that it has been possible to answer these questions that plastic design has become the practical and useful tool that it is today.

Not included in the photograph, but active in this current New York IABSE conference (and pictured in Fig. 3) is one who, more than any other, has made possible the rapid advances in all aspects of steel design in the United States: T. R. Higgins, Director of Engineering and Research of the American Institute of Steel Construction. He is an integral member of the pioneering group. His grasp of the essence of new concepts, his untiring participation in the work of research councils, and his leadership in transferring research to practice have contributed significantly to the remarkable advances in design techniques that are available to the practicing engineer in the world today.

Fig. 3

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