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

Band: 8 (1968)

Artikel: Conclusions

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DOI: https://doi.org/10.5169/seals-8812

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CONCLUSIONS / SCHLUSSFOLGERUNGEN / CONCLUSIONS

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1. The load-factor on which plastic design is based can't be considered as a real safety factor because overloading is only one reason for producing collapse of the structure. A realistic safety-consideration must comprise all kinds of imperfections as in mechanical properties of materials, design, fabrication, assembling and maintenance. Statistical dates are needed to develop semi-stochastic safety calculations of structures.
2. It is recommended to design unbraced tall multi-storey frames such as to exclude previous plastification of the stanchions. In this case it is possible to apply plastic design to the beams and elastic design to the stanchions.

   The tridimensional static action of multi-storey buildings of the tower type has to be considered not only for every structural component (stanchions, beams) but also for the whole structure.
3. Shear resistant walls or cores reduce very much the lateral sway of the structure and permit introduction of subassemblages to make more easy the application of plastic design theory. The investigations about the interaction between shear-walls and frames show clearly that the rigidity relation in the elastic-plastic range is an important factor in economic design. It is recommended to change the shear wall rigidity along the height of the building to obtain an optimum design of the frames.

   Simplified methods for calculating multi-storey buildings

with and without shear walls are in good agreement with more exact theories and tests, but special attention has to be given to the most unfavorable position of the service load. Otherwise designs can result which are less safe than those intended by the designer (see J.Heyman).

4. In very high tall multi-storey buildings the width of the core walls may not be sufficient to obtain the needed stiffness against lateral sway. Therefore in the USA a new type has been developed, bracing the four walls over the whole width with crossed diagonals. Walls and braced floor slabs form a multicellular box with very great resistance against wind forces. Therefore the local frame action can be calculated considering only subassemblages.
5. An attempt is made to extend plastic design theory such as to check continuously the rotation of the plastic hinge and to lock it if a contra-rotation takes place during loading. Furthermore strength hardening is considered calculating the ultimate load of a frame. This is particular important using high tensile steel.
6. Tests proved that shake down takes place due to alternated wind load and earth-quake but special attention must be given to the dynamic response of the building due to forced vibration. It is shown that the hysteresis taken from the loading cycles is very stable.

Important results of the interaction between frames and bracings had been presented. Though some attemps have been made to get an idea of the amount of damping due to non directly load carrying elements (cladding,walling etc.) a closer investigation should be performed considering particularly its influence on earthquake and wind-load.

7. An important research project for the investigation of the dynamic response of a specially built multi-storey framed building in Hongkong has been presented. It is intended to perform a large test program considering static and dynamic loading measuring the distribution and the dynamic effect of the wind forces. Than theoretical investigations and model tests are not sufficient to get a real idea of the behavior of the building under wind forces and earthquake the Hongkong tests will call the attention of the scientists and engineers.

8. The European Convention of Constructional Steelwork Associations has elaborated a first draft of Recommendations for the design of buildings in earthquake regions. The chairman of the corresponding Commission Prof. Giangreco has presented a simplified method to calculate the natural frequency of bi- and tridimensional frames considering different modes of vibrations.

The Working Commission II is convinced that further research work as well as tests should be carried out at an international level to clarify the behavior of multi-storey buildings taking into account static and dynamic loading.

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