

# Conclusions

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## II

### CONCLUSIONS / SCHLUSSFOLGERUNGEN / CONCLUSIONS

#### Thin-Walled Structures

Dünnwandige Konstruktionen

Structures en éléments minces

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1. The linear theory of plate stability is not an adequate basis for design of struts and girders consisting of thin walled sections. Such design method must consider the initial geometrical imperfections of the plates as well as the residual stresses and the different yield stresses over the section and over the length of the structural member. It is necessary to calculate the maximum membrane stresses and strains in the post-buckling range since average stresses, supposing plane sheets, are not a sufficient design criterion.
2. Tests carried out with plate girders, having only vertical stiffeners at the supports, proved that the real collapse load can rise till threefold the classic buckling load. Simplified methods checked by tests enable to design medium sized plate girders without interior stiffeners, fabricated by automatic welding. However the presented test results and theoretical investigations for stiffened plates in the postcritical range are rather incomplete and we still lack a general mathematical approach to establish a design method taking into account all important parameters of the system and considering also the geometrical and structural imperfections of the sheet. However it is proved that a plate girder with adequate arrangement of the horizontal stiffeners can support the full plastic moment.

New carefully planned test series and computer simulati-

ons, including the post buckling behavior (membrane action) of the sheet, are therefore strongly recommended. These tests should be extended to corrugated sheets to find out the best shape of the corrugation. Professor Massonnet's tests may form the basis of further investigations.

3. Strain hardening through cold forming is a practical and effective way of increasing the yield strength. Theoretical investigations and tests have proved, that it is possible to use systematically the higher yield stresses in dimensioning girders and struts. Professor Winter's theory of the effective width of a locally buckled sheet has been fully checked by tests. The increase in strength of the steel at the cold formed corners is particularly usefull because, due to the previous buckling of the free edges, the stresses will be concentrated in these corners. The next edition of the "Light-Gage Cold-Formed Steel Design Manual" will include the strengthening by cold forming in the design rules.
4. The interaction of conventional steel frames with thin-walled diaphragms as cladding, roofing and flooring as well as the interaction of steel sheets with plastic material (sandwich plates) can be an important source of economy. Further research work as well as tests are therefore needed to clarify the elastic and plastic behavior of these composite structures.
5. Protection against corrosion of thin steel sheets is an important problem which needs further investigation considering primers of plastic or synthetic resin.
6. Mass-produced cold formed structural components as for roofing, flooring and walling have been developed. Considering the whole structure, shear resistance of these slabs forms an important part in the structural behavior of the building. Special attention must be given to the adequate design of the shear connectors between the components as well as between the slabs and the frames. Thin walled steel hyperbolic paraboloid components for roofing have been investigated at Cornell University. Shells with double curvature show a very favorable buckling behavior.
7. Development of new types of houses, schools, factories etc. built up by prefabricated, thin walled, cold formed steel components is strongly recommended.