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WP number and title: WP 4 EUROCODES

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Aim of the visit:

- Collecting materials for Cure seminar connected with steel structures.
- Exchanging experience and discussing beams with corrugated webs.

Results:

Literature connected with corrugated webs:

- [1] DAST-Richtlinie 015 (1990) Trager mit schlanken Stegen.
- [2] O. Univ. Prof. D. I. Dr. Gunter Ramberger, Report about calculation of welded double T beams with corrugated web, Wien, 20.12.1989.
- [3] O. Univ. Prof. D. I. Dr. Gunter Ramberger, Report about calculation of welded, double T beams with corrugated web, Wien, 16.11.1990.
- [4] Report of investigation (research) on double T beams with corrugated web. Department of Steel Constructions, Faculty of Implemented Modeled Static in steel Constructions, August 1990.
- [5] Report nr 943040. dynamic research. Technical University of Karlsruhe, 1995.
- [6] Research of fire test on double T beams with corrugated beams, Linz 1995 .
- [7] Final Report of research on beams with corrugated webs, BTU, Department of Steel Constructions, Cottbus, 1996.
- [8] Opinion of the main specialist about ability to carry transversal forces by beams with corrugated beams, TUG, Prof. Hartmut Pasternak, Braunschweig / Cottbus, 1996.

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- [9] Easley: Buckling Formulas for Corrugated Metal Shear Diaphragms. Journal of Struc, ASCE, No. ST7, July 1975, pp1403-1417.tural Division
- [10] Kahonen: Stahlbau 57, 1988/ 8 page 250.
- [12] Lindner, Aschinger: Stahlbau 57, 1988/12 page 377.
- [13] Lindner, Aschinger: Stahlbau 59, 1990/4 page 113.
- [14] Aschinger, Beljaev, Mikhailova: Stahlbau 60, 1991/10 page 314.
- [15] Lindner: Stahlbau 61, 1992/10 page 331.
- [16] Aumayr: Deformation and local buckling corrugated sheet subjected only by shear forces, Technical University of Wienu, 1992 .
- [17] Dina Hannebauer: Stahlbau XX, 2004. (in april in Stahlbau)

Discussion

- a. Model - truss, what are advantages and disadvantages of this model, eventual obstacles in using this model
There are tables in which are rules that are valid for beams that are mentioned in these tables. For other beams which dimensions are completely different to these from these tables additional research should be made. But if the dimensions of cross section are similar then you can implement rules that are presented in the introduction in this tables prepared by Zeman Company. For cross section with different dimension it would be clever to contact Zeman in Austria.
- b. Analysis of internal stresses in web in different cases of load and different thickness of web
The behaviour of the web under different load condition is usually similar. There could occur some differences connected with local redistribution of external force. Of course we are talking about beams presented in Zeman's tables.
- c. Influence of corrugated web on deformation and internal forces (N,T,M) of static systems like frames and multi-span beams
There is G factor which should be reduced by multiplying the "G" value by (w/s). This reduced value is conservative one.
- d. Influence of thickness of web on the beam behaviour.
Web and beams behave similar.
- e. Influence of imperfections (material, geometry, initial stresses from welding process) on limit resistance of beams.
*The influences of geometrical imperfections allowed in codes do not influence the results (to 5%).
There are some investigations to measure the initial stresses in the beam that occur during prefabrications of these beams The values of these forces are probably considerable.*
- f. Analysis of optimal shape of sinusoid web. (I would like to know about eventual test on bending this sinusoidal web)
There were investigations that tried to find the answer for this question, it is well showed in copied articles. But the answer gives the solutions that are really difficult to implement in industry.

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- g. Ultimate resistance of beams with corrugated web in comparison with typical beams with flat web
There is no sense to answer this questions because it is impossible to make comparable typical beam. There is sense to compare a typical beam with beam with corrugated web that can carry the same loads and than we can compare the cost of fabrication and montage of these two beamsl
- h. Analysis of details presented in Zeman's catalogue and others especially details with holes in the web – map of stresses in the beam.
Some of the details are already analysed but some are looking for the researchers .
- i. M_{cr} in beams with lateral restraint – a method to find M_{cr}
In the procedures there is implemented the methodology for beams with trapezoidal web (Ashinger's method), but the authors of that way of thinking are sure that it is a good way and moreover they are conscious that this should be researched and confirmed.

Problems already solved in this subject

There is a lot things done for example:

- General rule for dimensioning this structures
- Tables for engineers to design such elements (on the base of general rules)
- Laboratory research of this beams (different cases of load, and support conditions, different shape of cross-section, different failure modes, etc..)
- Optimisation of the shape of sinusoid of web
- Analysis of different details of the construction systems using “beams” with corrugated web
- Comparison between beams with trapezoidal and sinusoidal web
- Great part of work for static loading is already done

Problems under investigation or problems to solve:

There is a lot things to do, for instance:

- Research and analysis of the procedure to find J_{ω} which is necessary to find M_{cr} for buckling and torsional buckling
- Analysis of some details of the construction systems using “beams” and columns with corrugated web
- Analysis of susceptible nodes in frames (decreasing of bending moment in “stiff” node of the frame and increasing of bending moment in the span of the frame)
- Analysis of internal forces in static systems (frame, multi-span beams, etc...)
- Comparing different systems of frames from economical point of view (for example Astron system vs Zeman system)
- Analysis for the failure mode “flange buckling” and Interaction between flange buckling, torsional and lateral torsional buckling

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- Development of limitations for different corrugations (parameters: length, height)
- Check and continue fatigue analyses, different results in Karlsruhe Research Institution and TU Prag, dynamic loading