ACTIVITIES OF TALLINN TECHNICAL UNIVERSITY ON INVESTIGATION OF THIN-WALLED AND SPATIAL STRUCTURES

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Department of Engineering Structures at Tallinn Technical University has been active in theoretical and experimental investigation of thin-walled and spatial structures within the last 45 years. Objects for our investigation have been concrete and wooden roof shells, thin-walled steel beams and frames, suspended cable and tent structures and cylindrical reactors and reservoirs and equipment for their mounting.

First objects under investigation have been reinforced concrete shells. However, roof shell application started in Estonia already in 1917 by erection of three reinforced concrete shells with positive Gaussian curvature and dimensions of 36 x 36 m. In the beginning of 1950-ies Prof. H. Laul presented the method of approximation of shear forces for cylindrical reinforced concrete shell calculation in view of the real boundary conditions. His method has later been applied to the other types of reinforced concrete shells. The results of this method have been applied to design and construct in Estonia a number of shells with zero and negative Gaussian curvature.

Next structures for experimental and theoretical research have been thin-walled metal structures. Under the supervision of Prof. J. Aare a calculation method for welded metal girders and frames was developed with taking into account the post-critical behaviour of the web and real rigidity of contour elements. Thin-walled metal girders and frames have been put into practice in a tennis-hall structure in Tallinn (span 55 m) and pedestrian bridge structures in Tallinn (span 32 m) and in Tartu (span 66 m).

Studies connected with the design and erection of the acoustic screen of Tallinn singer tribune (1958-1960) served as a basis for further investigations in the field of suspended structures. Calculation methods both for networks with a limited number of cables and for the continuous networks taking into consideration the edge beam displacements were worked out by Prof. V. Kulbach. It was shown that a network is able to bear loads with very small rigidity of the edge beam without any external horizontal supports. A special type of networks of this kind is under erection in Tartu as the acoustic screen for a new song festival tribune. The bearing structure of this screen is hypar-formed network within a spatial contour having elliptic and parabolic projections and supported by three plane supports. The supports do not resist to symmetrical horizontal displacements of the contour. That is the main difference between the acoustic screens in Tallinn and Tartu. The first has the contour with two plane arches supported by massive counterforts. The counterforts develop considerable horizontal reactions to the arch forces. In connection with the mentioned investigations, some more universal problems have been analysed. So, analogous form of calculation formulae for single cables, prestressed cable trusses, thin plates, suspended bridges and hypar-formed hanging roofs has been argued. The possibility of applying the superposition principle for geometrically nonlinear structures was verified. It enables to calculate displacements and inner forces by loading the structure step by step. When calculating the next step of loading, the changes of initial form and initial forces must be taken into account.

In 1960-ies theoretical and experimental research of the wooden hypar shells with nail and glue joints was carried out under the supervision of Ass. Prof. K. Öiger. Results of these investigations were used to design and construct a number of wooden shells in Estonia, mainly for agricultural buildings. During the last years the investigations of wooden structures are widened to the compound systems with different nail plates and special nailed profiles. These investigations may be regarded as a base for the wide application of nail plate structures for a great number of agricultural buildings by restoration of individual farms in Estonia.

Investigations on tent roof structures were carried out by K. Öiger and Ass. Prof. R. Oras in the beginning of 1980-ies. A calculation method was presented, taking into account the geometrical and physical nonlinearity of the problem. A number of tent structures were erected in Estonia.

Our department has also taken part in developing and adopting of new equipment for mountage of cylindrical oil reservoirs of great capacity and for mounting high-rise super heavy structures. The mast hoists AKG-1000 for mounting reactors with 1000 tons mass and 100 m height have been worked out by J. Aare and V. Kulbach. Our staff members have prolonged experience as experts and consultants by designing and erecting the most complicated engineering structures. Our department has close contacts with international scientific associations and European technical universities. Especially effective collaboration our department has developed with Universities of Technology in Helsinki and Tampere. As an introduction to the mentioned collaboration served our meeting with Prof. Heimo Paavola 20 years ago in Leningrad on the 3-rd International Conference on Prestressed Metal Structures. After that the staff members of structural engineering departments of Finnish and Estonian technical universities have had regular mutual visits for common scientific and teaching activities. By designing and equiping our Laboratory of Lightweight Structures we have been greatly used the wide experience of Finnish laboratories. Our contacts which began for Estonia in period of Soviet occupation, will be for us even more important in conditions of transformation of teaching and scientific system in independent Estonia according to European requirements.

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