STRESZCZENIA

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A MATHEMATICAL MODEL OF FREE DEFORMED CORRUGATED FLAT SHEET OF RECTILINEAR SHELL

The paper presents a mathematical model of a flat trapezoidal steel sheet deformed in a planned way during assembly work, to the directives of the building shell. This model has been based on the results of the experimental tests concerning free deformations of flat sheets. The examined flat sheets were undergoing planned free bend or free twist deformations. The shells shaped with the help of a new method using this mathematical model are characterized by relatively free forms and relatively little effort resulting from free deformations of their sheets at their assembly. This method is more accurate than the methods used so far.

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THE EFFECT OF CROSS-SECTION STIFFNESS RATIOS ON THE RESISTANCE OF JOINT COMPOSED OF RECTANGULAR AND CIRCULAR HOLLOW SECTIONS

The paper presented focuses on the comparison of the measurement results obtained in laboratory experiments on joints composed of rectangular and circular hollow sections. Special attention is paid to T-section joints that consist of single chord and brace members. The evaluation procedure monitors the resistances and deformations of such joints.
KEYWORDS: T-joints, circular hollow sections, rectangular hollow sections, vertical deformation, horizontal deformation

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CHANGES OF THE RESONANT VIBRATION FREQUENCIES FOR DIFFERENT CONCRETE BEAMS

This paper provides information about changes of resonant vibration frequencies for concrete and reinforced concrete (RC) beams. The objects of research were concrete beams of different dimensions and RC beams. The concrete beams were damaged by stage of cutting but RC beams were damaged by stage of static loading. After each stage of damage, the resonant vibration frequencies were determined. The parameters change their values while cutting or loading the beams due to cracking. On the basis of the obtained results from different beams, an effort was made to correlate the different dimension of beams, influence of reinforce and the damage of the tested beams with the changes of the modal parameters.
KEYWORDS: frequencies, beam, damage, concrete, reinforced concrete.

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EXPERIMENTS WITH HIGH PERFORMANCE STEEL AND COMPOSITE MEMBERS

It is generally known that reduction of total construction mass leads to a decrease of secondary costs as for example transport, assembly, disassembly etc. High performance materials can be effectively used in many types of common structures. Despite a good accessibility they are still not frequently used nowadays. The basic difficulty is a missing knowledge of their behaviour in structures.
KEYWORDS: steel, concrete, high strength, high performance, shear connection, long joint, bolt

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SHAPING OF EFFECTIVE STEEL STRUCTURES

On the basis of the performed design of metal combined structures, it is shown, that logical, rational conception in the process of design is the most rational method of stress regulation. Such method requires no additional material charges. It is underlined, that the problem of structural design, in that number of combined, above all is a problem of their rational shape. There is developed generalized mathematical model of calculation of the combined structures on the basis of energy approach taking into account the deformed state of stiff beam. Idea of calculation method: at first on the basis of decomposition method system is divided on two subsystems - main and secondary. Further, using the synthesis of the system, its stress- deformation state is calculated. The algorithm of regulation of the stress- deformation state of the system is represented. The efficiency of such regulation and examples of introductions of such rational structures is shown. Result can be applied to industrial and civil engineering.
KEYWORDS: model, method, equal stress state, efforts regulation, “combined” structures, efficiency.

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RESEARCH ON STEEL BRIDGES DURABILITY IN CZECH REPUBLIC

The paper summarizes the results of a research project carried out to evaluate the condition of steel and steel-concrete road bridges in different stages of service life. The behaviour and failure mechanisms were observed on different lifetime bridges in order to provide the resume of a condition, frequent failures and rising causes on steel bridges in Czech Republic. The custom in failure detection applies the visual way for the most part. The new bridge inspection guide was developed that will improve the field work in practice.
KEYWORDS: steelwork, steel bridge, service life, durability, reliability, failure,

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EFECTIVE USING OF HIGHER STRENGTH STRUCTURAL STEELS IN COMPRESSION MEMBERS

The chosen results of numerical analysis of middle and higher strength structural steels using in compression members are presented in the paper. The homogeneous cross-sections of the members with web slenderness β_w = 40, 48, 60, 80, 120; member length L = 3,0; 4,0; 5,0 and 6,0 m and structural steels S235, S275, S355, S420 and S460 are assumed. The full reference plastic load N_{pl}, local post-critical load N_{ul} and global buckling load $N_{u,y}$ and $N_{u,z}$ for all members by actual Slovak Standard STN EN 73 1401:1998 and by new European standards EN 1993-1-1:2005 and EN 1993-1-1:2006 for the design of steel structures, taking account the geometrical optimalization determined. The obtained numerical results are compared and analyzed from the economical point of view.
KEYWORD: compressed steel member, homogeneous cross-section, yield stress, elastic-plastic loading, post-critical behavior, local and global buckling, load-carrying capacity.

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INVESTIGATION OF TIMBER - CONCRETE COMPOSITE BEAMS UNDER LONG TERM LOADING

Experimental investigation of timber-concrete composite beams subjected to long term loading is presented. The first type of experimentally tested timber-concrete composite beams consisting from the vertically nailed timber planks with concrete deck on the top. Shear connection between the concrete layer and timber members by

grooves in timber was realized, which guarantee the composite action of two layers. The second type of the composite beams consists from separated vertically oriented timber planks in certain distance covered by OSB sheet and from fiber reinforced concrete layer on the top. Shear transfer between the timber planks and upper layers by the pair of steel screws spaced along the timber beams was realized. Three by three from both types of beams to four point bending tests was exposed. Experimental results with existing theoretical models are compared.
KEYWORDS: timber – concrete, long – term behavior, experimental test

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STRUCTURAL PHYSICAL PROBLEMS RESEARCH OF INDUSTRIAL PRODUCTION HALL BUILDINGS

Research of the structural and physical problems of envelope structures and physical components of internal environment and their mutual interaction in industrial buildings mostly of a hall type is the subject of the investigation of this article. The research was solved in close touch with the grant projects VEGA 1/9023/02 “The Interaction of Physical Factors in the Creation of an Appropriate Working Environment” and 1/2562/05 “Evaluation of thermal, humidity and lighting conditions of the production industrial buildings“ joining with the research project 1/0695/08 with the title „Thermal flows in interaction of building construction and underground as well as external outdoor conditions for large space hall buildings“, supported by Slovak Fund for Scientific Research, task which is being presently elaborated.
KEYWORDS: industrial buildings, production halls, indoor microclimate, physical parameters, envelope structures, daylighting

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MATHEMATICAL MODELLING OF TRANSVERSE AND TORSION VIBRATIONS OF COMPOUND METALWARES

Mathematical models and algorithms of calculation of free transverse and torsion vibrations of long-length metalware on example of vehicle’s body are developed. Load-carrying system is considered as a continuous beam with step change of the cross-section. Characteristics of beam’s rigidity are defined experimentally. Modal analysis is carried out using a matrix method of initial parameters. Results of calculation of the lowest eigenfrequencies of vehicle’s body with experimental results are compared.
KEYWORDS: mechanical vibratory system, modal analysis, compound metalware, continuing.

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INITIAL STIFFNESS OF BOLTED JOINTS USED IN STEEL THIN WALLED STRUCTURES

Bolted lap joints are often used in steel thin walled structures. In the global analysis, this kind of joints is conventionally considered as a hinge. Such simplification has an influence on increasing the value of bending moment in a beam, and the size of its cross section. In fact, such connections are semi-rigid. Their moment-rotation (M-ϕ) characteristic can be effectively predicted by experimental testing, but such tests in a majority of cases are costly and labour-absorbing. The numerical simulations are alternative method to obtain the flexibility parameters of such joints. This simulations can be carried out using the computer software based on FEM, ie. ADINA software. A next possibility to obtain joint flexibility characteristics is mechanical modeling of the joint.
This paper presents the mechanical model of bolted lap joint permitting to calculate the initial stiffness of connection. To create this model a component method was used.
KEYWORDS: thin walled steel structures, bolted lap joints, initial stiffness of joints.

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DEVELOPMENT OF FUNICULAR STRUCTURES FROM PLANE TO SPACE

The paper presents the origin of the idea of funicular structures from the mathematical equation: $y = ax^2 + bx + c$ till the three dimensional folded structures of single, double and triple curvature chords. About 1860 they were used as effective bridge beams in Great Britain and Germany – and after the Second World War in Poland for industrial and sport halls as elegant shape structures space.
KEYWORDS: equation of second order, funicular structures bridge beams and roof curved structures.

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JOINT EFFECT OF STEEL FRAME EQUIVALENT GEOMETRICAL IMPERFECTIONS

In the paper, in first order critique of hitherto existing conceptions of taking into consideration equivalent imperfections of initial tilt and initial bow joint effect on carrying capacity of steel frames is presented.
Statistically based models of random equivalent imperfections assumed in the paper were obtained utilizing authors' research. Combination of column initial tilts random sequence and column random initial bows multiplied by random binary sequence is considered. Conception mentioned above is applied to analyse carrying capacity of 2-bay 5-story example steel frame. Numerical simulations of considered frame carrying capacity are conducted. It enables to evaluate influence of taking into consideration column random initial bows aside from column random initial tilts on steel frame carrying capacity. Results obtained out of conducted analyses shows that influence of column random initial bows on frame limit strength value associated with limit point on frame equilibrium path is slight. This influence turns out significant in case of frame ultimate load carrying capacity analysis according to the most efforted cross-sections criterion.
KEYWORDS: Multistorey steel frames, random equivalent initial tilt, random equivalent initial bow, joint effect.

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MOMENT REDISTRIBUTION IN STEEL CONTINUOUS BEAM ACCORDING TO LIMITED PLASTICITY CONCEPT

Conventional approach to elastic – plastic analysis of steel continuous beam, according to which it is assumed that two plastic hinges occur in an edge span at the ultimate limit state, not always gives safe evaluations of real member resistance. The reason is mainly the possibility of unlimited accumulation of permanent strains. Therefore some limitations of moment redistribution should be defined. Two of them are proposed and discussed by the author in the present paper. It is accepted that the first plastic hinge arises in the cross-section in which maximum elastic bending moment is induced; however, in the second critical cross-section its appearance is not admissible. Only elastic in the first case, or limited elastic – plastic ultimate moment in the second example is there considered. The design methodology presented in the article is connected with the reduction of member redundancy and transformation of the whole beam into unstable mechanism is not allowable.
KEYWORDS: redundant system, plastic reserve, ultimate limit state, moment redistribution.

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SEMI – RIGID JOINTS OF TIMBER STRUCTURES

Traditional timber joints behaviour remains badly known. Recent studies have shown that some kind of carpentry joints can be considered as semi-rigid connections. Their rigidity (bending stiffness) in general sense plays an important role in computation of the global deformations and force distribution of timber roofing frames. Developments in computer-controlled manufacture of timber members enable a revival of traditional timber connec-

tions without steel fasteners. This study will focus on deformation, failure processes and bending stiffness of rafter-tie beam connection and modern tenon (dovetail) joint as secondary beam-main beam connection (both joints are made by CNC wood-working machine).
KEYWORDS: carpentry joints, semi-rigid, bending stiffness, tenon (dovetail) joint.

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COMPUTER-AIDED DESIGN AND OPTIMIZATION OF STEEL STRUCTURAL SYSTEMS
A new computer-aided methodology for design and optimization of steel structures based on hybrid genetic algorithm with gradient learning of the best individual has been reported. The optimum design problem is formulated as the structural-parametric mathematical programming task with Boolean, integer and real design variables. In this way, cross sectional sizes of structural members, node coordinates as well as topology parameters can be considered as design variables. The system of constraints includes load-carrying capacity and stiffness conditions for structural members and entire steel construction according to building standards and regulations. Architectural, technological and other requirements can be integrated to constraint system as well. Determination of purpose function takes into account design specifications and ability to formulate the analytical expression as function of design variables. Hybrid genetic algorithm based on the parallel operations of genetic operators and update gradient method was used for solving the structural-parametric optimization task. Proposed technique was realized with elaborated software. Numerical example with new optimal design decision of plane two-hinged transverse frame with lattice structural members demonstrates the effectiveness of the proposed optimization methodology.
KEYWORDS: structural optimization, steel constructions, steel transverse frames, computer-aided design, genetic algorithm, gradient method, finite element method, software.

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RESISTANCE AND STIFFNESS OF THE BEAM TO COLUMN JOINTS WITH ANGLE FLANGE CLEATS
The method of calculation of the moment resistance and initial stiffness for bolted angle flange cleats connections has been presented. Calculation of this characteristic without computer use is rather troublesome. Simple formulae for calculation of the moment resistance and initial stiffness was developed and presented in this paper.
KEYWORDS: steel structures, semi-rigid joints, strength, stiffness, simplified formula.

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ANALYSIS OF PROFILED SHEET SHELLS AS A SYSTEM OF FOLDS
It is possible to shape shells of flat profiled sheets thanks to their high geometrical orthotropy. A general method of geometrical shaping of shells is presented in brief. The method can be applied to build any shells of flat profiled sheets. A computer programme enables the determination of shell generatrices and other shell lines necessary for the design of shells. The structural analysis of flat roofs made of profiled sheeting is normalised. According the standards, an analysis of sheets consists in verifying individual folds as sheeting members. In shells, the shape and dimensions of individual folds are longitudinally variable, and folds are inclined longitudinally and transversely. Research has shown that twist of folds does not have significant impact on their stiffness.
KEYWORDS: profiled sheet, shell, design, analysis, space structure.

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EVALUATION OF CLADDING ELEMENT´S PRESTRESSING FOR SADDLE-SHAPED CABLE ROOF

Prestressed cladding element for the long span saddle-shaped cable roofs was considered. Peculiarity of the prestressed cladding element is absence of rigid contour. The generally woven by the basket weave fabric from the Vectra (LCP) yarns, which is covered by the PoliTetraFluoroEthylene (PTFE) copolymer foil, steel cables and steel pipes were considered as the materials of covered fabric, load-bearing cables and central pillar, correspondingly. The covered fabric is joined directly with the cables of saddle-shaped roof and the displacements of the cables have significant influence on the prestressing level of cladding element. Influence of the displacements of 50x50 m cable net of saddle-shaped roof on the prestressing level of cladding element was evaluated.
KEYWORDS: cable net, tensioned fabric, steel cables, vertical displacements.

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REINFORCED CONCRETE MEMBERS UNDER THE INFLUENCE OF ELEVATED TEMPERATURES

The paper is focused on performed experiments and created solving model for determination of strain and state of stress of temperature loaded, symmetrically reinforced concrete element. The attention is also paid to comparison of experimental dependence and dependence resulting from the created mathematical model between length strain and tensile stress of reinforced concrete specimens, which were caused by force effects of steel reinforcement under the influence of elevated temperatures up to 100^{o}C. Calculations according to the created model fit well the processes running at the heating up to 60^{o}C without taking into consideration thermal creep. Above the temperature of 60^{o}C, it is necessary to consider the influence of the thermal creep, which, as it is shown, is not negligible above the mentioned temperature also during its short term effect.

KEYWORDS: elevated temperature, thermal length strain, tensile stresses

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INFLUENCE OF CHANGE IN USE CONDITIONS ON AN INDUSTRIAL BUILDING SAFETY

The article describes the state of failure of a building for storing material to produce ceramic building elements. The hall belongs to the biggest brickyard in the Podkarpacie Region. The failure occurred in May 2008. Its direct cause was a sudden increase in the pressure exerted by a dump of clay stored directly at the retaining wall of the building. Due to its excessive height and faulty construction the dump lost stability and overloading the structure of the storage hall and consequently causing excessive deformation and damage to its structural and finishing elements. The article presents the extent of the damage, the results of the strength – static analysis and the suggested necessary amount of work to restore the building to its former use.
KEYWORDS: industrial building, storage hall, reinforced concrete structure, retaining wall, loss of stability, failure.
