

Jacek ABRAMCZYK  
Zakład Geometrii i Grafiki Inżynierskiej  
WBiIS Politechniki Rzeszowskiej

## **GEOMETRYCZNE KSZTAŁTOWANIE PASMOWYCH PRZEKRYĆ POWŁOKOWYCH Z PŁASKICH ARKUSZY BLACHY TRAPEZOWEJ**

### **PROPOSITION OF GEOMETRICAL SHAPING OF SHELL STRIPED COVERS MADE OF TRAPEZOIDAL STEEL SHEETS**

The paper presents a way of geometrical shaping of the building structural covers of many striped shells made of the flat profiled steel sheets free deformed to the shell shape during assembly work. The striped cover is composed of the continuous rectilinear shells (stripes) running transversely the whole structure, so that the neighboring strips have got the common edges or the flat discontinuity between the neighboring strips are there.

The way consists in creating planes separating the neighboring sectors  $\Sigma_{i-1}$  and  $\Sigma_i$  (of the ruled surfaces  $\sigma_{i-1}$  and  $\sigma_i$ ) of the space geometrical structure  $\theta_p$  modeling the building structural cover. The ruling  $t_i$  of the ruled surface  $\delta$  containing the border lines of the sectors  $\Sigma_{i-1}$  and  $\Sigma_i$  are calculated in these planes.

The way assures the freedom of transversal strains of the free deformed sheets during assembly, hence the sheets are subject to free deformations. The above activity makes it possible to obtain the small intentional effort and reserve the conveyance capacity of the useful load for the successive shell folds although the shell form can be almost free and attractive.

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Jacek ABRAMCZYK  
Zakład Geometrii i Grafiki Inżynierskiej  
WBiIS Politechniki Rzeszowskiej

## **GEOMETRYCZNE KSZTAŁTOWANIE SEGMENTOWYCH PRZEKRYĆ POWŁOKOWYCH Z PŁASKICH ARKUSZY BLACHY TRAPEZOWEJ**

### **PROPOSITION OF GEOMETRICAL SHAPING OF SHELL SEGMENT COVERS MADE OF TRAPEZOIDAL STEEL SHEETS**

The paper presents a way of geometrical shaping of the building structural covers consisting of many rectilinear shells made of flat profiled steel sheets free deformed to the shell shape during assembly work. The way consists in creating two families of planes separating the neighboring sectors  $\Sigma_{i-1,j}$  and  $\Sigma_{i,j}$  (of the ruled surfaces  $\sigma_{i-1,j}$  and  $\sigma_{i,j}$ ) of the space geometrical

structure  $\theta_r$ , modeling the building structural cover. The ruling  $t_{i,j}$  of the ruled surface  $\delta_j$  containing the border lines of the sectors  $\Sigma_{i,j}$  are calculated in these planes.

Each pair of the sectors  $\Sigma_{i-1,j}$  and  $\Sigma_{i,j}$  of the continuous structure  $\theta_r$  has got the common segment of the border lines being the space quadrangles whereas each pair of the neighboring sectors  $\Sigma_{i-1,j}$  and  $\Sigma_{i,j}$  of the discontinuous structure  $\theta_r$  has got the suitable segments of the border lines contained in the same plane.

The way assures the freedom of transversal strains of the free deformed sheets during assembly, hence the sheets are subject to free deformations. The above activity makes it possible to obtain the small intentional effort and reserve the conveyance capacity of the useful load for the successive shell folds although the shell form can be almost free and attractive.

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Zbigniew BAĆ  
Politechnika Wrocławska  
Janusz REBIELAK  
Politechnika Krakowska

## **OBIEKTY CENTRALNE W AUTORSKIEJ KONCEPCJI PROJEKTOWEJ DLA EXPO WROCŁAW 2010**

### **BUILDINGS OF CENTRAL AREA IN THE AUTHOR'S CONCEPTUAL PROJECT FOR EXPO WROCŁAW 2010**

In the paper are spoken main aspects taken into consideration by the authors during design process of two objects proposed for Expo 2010 previously intended to organize in Wrocław. In the central part it is proposed to locate Hall 2010, being a huge dome of clear span equals 365,25 m and having a lightweight tension-strut structure of the roof. The second object is a tall building, called Expo Gate, having the height 182,625 m, what is the exact the half value of total clear span of the dome structure.

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Wioleta BARCEWICZ  
Marian GIŻEJOWSKI  
Politechnika Warszawska

## **STALOWO – BETONOWE WĘZŁY ZESPOLONE Z WYKORZYSTANIEM BLACH PROFILOWANYCH**

### **COMPOSITE STEEL-CONCRETE JOINTS WITH AN APPLICATION OF PROFILED SHEETING**

In this paper selected guidelines on good practice in design and detailing of composite steel-concrete joints with a usage of profiled sheeting, treated not only as a formwork but also acted in composite manner with reinforced concrete slab, are described. Some aspects dealing with the effect of profiled sheeting type (trapezoidal or dovetail) as well as the direction of its ribs (parallel or perpendicular) to the beam axis on certain parameters influencing on the joint

behaviour are presented. One of them is partial or full composite action which influences mostly the joint ductility, but the most important one is the reinforcement ratio which can significantly change the level of the moment capacity of the composite joint. The generalized analytical model of the  $M-\phi$  curve description dependent on the reinforcement ratio of the slab cast on a steel profiled sheeting is presented.

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Zbigniew BIENIEK  
Wydział Budownictwa i Inżynierii Środowiska  
Politechnika Rzeszowska

## **PODSTAWY MECHANIKI SYSTEMÓW TENSEGRITY**

### **BASIC MECHANICS OF TENSEGRITY SYSTEMS**

A common feature of tensegrity structures is that their static equilibrium equations are not sufficient for uniquely determining internal and reaction forces. Hence, such structures are called statically indeterminate structures. There are important areas of study in computational mechanics that deal with modeling, form-finding and displacement analysis of statically, and frequently cinematically, indeterminate structures. This paper shows a simple examples that illustrate this problem of statics where the statical indeterminacy largely depends on the geometry and pre-stress the structure has adopted.

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Zbigniew BIENIEK  
Wydział Budownictwa i Inżynierii Środowiska  
Politechnika Rzeszowska

## **ZARYS MORFOLOGII SYSTEMÓW TENSEGRITY**

### **OUTLINE OF THE MORPHOLOGY OF TENSEGRITY SYSTEMS**

A tensegrity structure is a cable-bar and prestressable stable truss-like system. Unlike regular trusses, tensegrities involve cable elements that are capable of transmitting loads in one direction only. Admissible connections between elements are ball joints. External loads can only act at the joints so that no torque can be applied on the elements. Many experts have been working for the past decades on the subject. Tensegrities are of interest in structural design studies because of their aesthetic value and lightweight property. One essential problem is the initial geometry on which a tensegrity structure is based. This paper presents an introduction to the inventions of tensegrity and the evolution of classic tensegrity systems.

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Jan BILISZCZUK  
Jerzy ONYSYK  
Politechnika Wrocławska  
Zespół Badawczo-Projektowy MOSTY-WROCŁAW s.c.

Wojciech BARCIK  
Zespół Badawczo-Projektowy MOSTY-WROCŁAW s.c.  
Mostostal Warszawa S.A.

Jacek SZCZEPAŃSKI  
Artur TUKENDORF  
Kamil TUKENDORF  
Zespół Badawczo-Projektowy MOSTY-WROCŁAW s.c.

## **KSZTAŁTOWANIE KONSTRUKCYJNO -TECHNOLOGICZNE BETONOWEGO MOSTU PODWIESZONEGO W CIĄGU AUTOSTRADOWEJ OBWODNICY WROCŁAWIA**

### **STRUCTURAL AND TECHNOLOGICAL SKAPING OF CONCRETE CABLE STAYED BRIDGE ALONG HIGHWAY RING ROAD OF WROCŁAW**

The largest bridge of the highway ring road of Wroclaw will be a cable stayed bridge over the Odra River near Rędzin stage of fall. The river flows there in its main bed, while inland navigation uses additional channel with two locks. An island with several residential buildings is located between the river and the channel. It has its own connections with mainland over the lock gates in inland navigation channel. The pylon of the new highway bridge will be placed on the island.

The designed bridge is 1742 m long and consists of:

- south flyover 610 m long (40+2x52+56+6x60+50 m). It is a continuous eleven span prestressed concrete box structure,
- main bridge 612 m long (50+2x256+50 m) with two separate decks connected to a single concrete H-shaped pylon.
- north flyover 520 m long (50+7x60+50 m), continuous girders made of prestressed concrete.

The bridge is being erected with application of longitudinal launching method and temporary supports. Segments prefabrication is being held on three assembly stands. Maximal segments length is 32 m for viaducts and 24 for the main bridge. The pylon is being built with application of moving scaffoldings. The expected erection time is 30 months.

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Tomasz DOMAŃSKI  
Politechnika Krakowska

## **CZĘŚCIOWE WSPÓŁCZYNNIKI BEZPIECZEŃSTWA KONSTRUKCJI DREWNIANYCH**

### **PARTIAL SAFETY FACTORS OF TIMBER STRUCTURES**

Load duration behavior is one of the most significant effects distinguishing timber materials from other structural materials. The stochastic damage accumulation process has been investigated. Safety assessments of structures built in the past require taking into consideration many different parameters. These parameters are mostly random and describe materials characteristics, actions and history of actions. The load bearing capacity of timber structures decreases with time. It depends on the type of load and timber. Strength reduction effects, referred to as creep-rupture effects, due to long term loading at high stress ratio levels are known for many materials. Timber materials are highly affected by this reduction in strength with duration of load factors.

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Artur DUCHACZEK  
Wyższa Szkoła Oficerska Wojsk Lądowych im. gen. T. Kościuszki we Wrocławiu  
Zbigniew MAŃKO  
Instytut Budownictwa, Uniwersytet Przyrodniczy we Wrocławiu

## **BADANIA ZMĘCZENIOWE DŹWIGARA STALOWEGO ZE SZCZELINĄ W ŚRODNIKU**

### **LOW-CYCLE FATIGUE TESTS OF MILITARY BRIDGE STEEL GIRDER HAVING CRACK**

The paper presents the results of experimental tests on a low-level bridge steel girder with respect to fatigue loads. The analyses concerned the increases in strains (normal stresses) in typical places of the structure under loads. A special attention was paid to the influence of assembly holes and the fatigue crack made on the stress pattern within assembly holes in the web of a girder.

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Kazimierz FLAGA  
Krystyna JANUSZKIEWICZ  
Politechnika Krakowska

## **BETON – TWORZYWO KONSTRUKCYJNE DO KSZTAŁTOWANIA OBIEKTÓW BUDOWLANYCH I INŻYNIERSKICH**

### **CONCRETE - STRUCTURAL MATERIAL FOR SHAPING OF CONSTRUCTION AND ENGINEERING OBJECTS**

This paper characterizes concrete - the artificial stone - as an excellent material for shaping of civil engineering objects. Review of basic characteristics of concrete: low cost of production, relatively high compressive strength, transformation from viscous fluid to the solid during hardening is presented. Further, the utilization index of the concrete strength in building members are introduced. Development of employment of these new features for shaping of exceptional and expressive works of architecture and construction are shown. The works of such masters as Max Berg, Pier Luigi Nervi, Robert Maillart, Felix Candela, Eero Saarinen, Eduardo Torroja, Santiago Calatrava, Le Corbusier, Zaha Hadid, Günter Domenig, Antonio Gaudi, Friedensreich Hundertwasser, Waław Zalewski, Wojciech Szymborski, and Ali Rahim are presented. At the end a new possibilities of shaping using the digital technologies and progress in the technology of structural concrete are introduced.

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Bronisław GOSOWSKI<sup>1</sup>  
Maciej GOSOWSKI<sup>2</sup>  
Paweł LORKOWSKI<sup>1</sup>

<sup>1</sup> Politechnika Wrocławska, Wrocław

<sup>2</sup> PROKON, Wrocław

## **NOŚNOŚĆ NA WYRYWANIE WKRĘTÓW MOCOWANYCH W CIENKIM PODŁOŻU**

### **PULL-OUT FAILURE LOAD FOR SCREWS FIXED IN THE THIN WALLED BASE**

The work is about experimental investigations on screw connections used for the light insulated roof, constructed from a trapezoidal sheet on Z-purlins and the insulation core covered by an upper trapezoidal sheet. The tests on pull-out failure load for screws fixed in the thin-walled elements, with thickness less than 2 mm, have been conducted to define the causes of the roof failure of a new erected hall, in which the covering was broken away of the large area due to wind suction. Four different connections that were used in the roof structure and executed from two kinds of self-drilling screws, were examined. The static relationship load-displacement of the connections are apparently non-linear, which considerable elastic and plastic strains. Thus, the obtained results showed the necessity of the screws' pull-out failure load determining can not be based on the destruction but on serviceability limit state.

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Knut GÖPPERT

Lorenz HASPEL

Andrzej WINKLER

Schlaich Bergermann und Partner, Structural Consulting Engineers, Stuttgart

## **NATIONAL STADIUM IN WARSAW GENERAL DESCRIPTION OF THE STRUCTURE**

The National Stadium in Warsaw, Poland was designed for 55 thousand spectators. The roof structure is a cable supported membrane structure which spans in between a circular arranged steel structure that is supported by a series of steel columns. The roof covers the entire stadium including the football field - the inner portion of the roof was designed as a retractable roof.

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Marian GWÓZDŹ

Justyna FERENC

Politechnika Krakowska

## **NOŚNOŚĆ CIENKOŚCIENNYCH ALUMINIOWYCH KONSTRUKCJI Z BLACH PROFILOWANYCH**

### **LOAD CAPACITY OF PROFILED ALUMINUM SHEETS' THIN-WALLED STRUCTURES**

The main issue taken up in the paper is load capacity of cover structure of the cold-formed aluminum sheets, co-working with the framework construction of the building. The basis of structures' safety assessment is presented. Partial safety factors,  $\gamma_M$  for cold-formed aluminum sheets, contained in the PN-EN 1999-1-4, include the simplifications adopted in the load models of individual components of construction. This paper also describes the model adopted in the engineering calculations for the thin-walled aluminum shell, susceptible for the effects of local buckling.

Differences in the safety assessment and the analysis of load capacity of steel and aluminum thin-walled structures, designed according to European standards, are also pointed out.

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Grzegorz HARPULA  
MTA Engineering Sp. Z o.o. w Rzeszowie.

## **ROZWIĄZANIA KONSTRUKCYJNE DACHU KOŚCIOŁA W SĘDZISZOWIE MAŁOPOLSKIM**

### **STRUCTURAL SOLUTIONS FOR THE ROOF STRUCTURE OF CHURCH IN SEDZISZOW MALOPOLSKI**

The subject of paper is structural shaping of the roof construction of church in Sedziszow Malopolski. General structural assumptions and solutions have been presented. Some details of shaping nodes and elements have been described. Technical aspects of shaping the structure have been discussed.

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Joanna JANKOWSKA – SANDBERG  
Politechnika Koszalińska

## **NOŚNOŚĆ CIENKOŚCIENNYCH ELEMENTÓW ZGINANYCH O PRZEKROJU CEOWYM ZGODNIE Z PN-EN 1993-1-3 ORAZ PN-B-03207**

### **RESISTANCE OF THIN-WALLED BENDING ELEMENTS WITH CHANNEL CROSS- SECTION ACCORDING TO PN-EN 1993-1-3 AND PN-B-03207**

This paper presents select problems of resistance of cold-formed bending elements with C-cross-section according to PN-EN 1993-1-3 [1] and PN-B-03207 [3]. The study is concentrated on the analysis of effective area of C-section with the single edge fold stiffener and the effects of local and distortional buckling. The difference of the calculation rules according to this normative documents are presented. It was proved that the procedure given in [3] does not enough correlate with the results given by [1, 2] and Sharp and Hancock's modification method [4]. It is therefore possible that the buckling factor  $k_{\sigma}$  should be in [3] given by the same formula as in [1].

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Stanisław JURCZAKIEWICZ  
Janusz REBIELAK  
Politechnika Krakowska

## **WSTĘPNA ANALIZA STATYCZNA JEDNEJ Z ODMIAN KONSTRUKCJI TYPU JR TETRA SYSTEM**

### **INITIAL STATIC ANALYSIS OF ONE TYPE OF STRUCTURE OF JR TETRA SYSTEM**

The paper presents general description of the JR Tetra System built by means of various forms of tetrahedron module. There are presented results of preliminary static analysis of a simple form of a hall building designed by means of this structural system.

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Tomasz KACZMAREK  
Grzegorz FREJ  
ARCADIS Sp. z o.o. Biuro Infrastruktury Mostowej w Katowicach  
Firma Inżynierska GF- MOSTY Piekary Śląskie

## **PROPOZYCJA KRATOWYCH KŁADEK DLA PIESZYCH Z KSZTAŁTOWNIKÓW ZAMKNIĘTYCH**

### **PROPOSAL OF TRUSS FOOTBRIDGES MADE OF HOLLOW SECTIONS**

The three truss footbridges for operating personnel made of cold formed hollow sections were constructed at "Kościuszko" Barrage on the Vistula near Cracow. Following good features of those structures the similar public footbridges were proposed. The 3,0 m wide footbridges were considered for the span lengths from 20,0 m to 45,0 m. The structures were analysed using FEM and structural components were proportioned according to ULS criteria. Deflections due to live loads and natural frequencies were calculated. Steel quantities per m<sup>2</sup> of deck were compiled and costs estimated.

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Paweł KAWECKI  
Biuro Inżynierskie Mostostal Sp.j. Wojciech Kawecki, Paweł Kawecki

## **KSZTAŁTOWANIE KONSTRUKCJI NA PRZYKŁADZIE STALOWEJ ESTAKADY TRANSPORTOWEJ NA TERENIE GÓRNICZYM**

### **STRUCTURAL SHAPING OF STEEL TRESTLE BRIDGE SYSTEM ON THE MINE SUBSIDENCE AREA**

The required reliability to safety and serviceability of structural systems on the mine subsidence areas shall be achieved by appropriate choice of structural schema and types of joints.

The paper presents the example of steel trestle bridge system 2500m long designed on subsiding trough. The supports of space truss structure with pinned, nominally pinned and semi rigid – full strength joints, are designed to vertical settlement 1600mm and horizontal displacements  $\pm 400$ mm. Requirements for the quality, execution and maintenance inspections are also described.

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Kamil KĘDZIOR  
Aleksander KOZŁOWSKI  
Politechnika Rzeszowska

## **SZTYWNOŚĆ BUDYNKU ZE STĘŻENIAMI O RÓŻNEJ KONFIGURACJI**

### **STIFFNESS OF BUILDING WITH VARIOUS BRACING CONFIGURATION**

One of the most often used bracing system in multi-storey buildings is truss system. In this system horizontal loading is transmitted by stiff floor plates to the vertical bracings, located in selected planes. Vertical bracing truss was designed as cantilever fixed in foundation. Traditionally, vertical truss was composed of member located in one tract, i.e. each bracing field placed above previous one. In many practical cases, mainly because of functional reasons, it is a need to change location of selected bracing members.

The aim of the paper is to investigate how various bracing configuration influence steel skeleton members exertion and overall stiffness of building. Analysis was conducted on three frames types: two-, five-, and twelve-storey. Each of them was analyzed as plane as well as space frame, altogether 29 frames were calculated.

It was concluded that non-conventional bracing location leads to decreasing of frame lateral drift, while do not change essentially members exertion.

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Tomasz KOZŁOWSKI  
Politechnika Rzeszowska

## **DOM DOSTĘPNY – MIĘDZYNARODOWE SPOJRZENIE NA JEDNORODZINNE BUDOWNICTWO EKONOMICZNE**

### **AFFORDABLE HOUSE – INTERNATIONAL VIEWS ON THE SUBJECT OF SINGLE FAMILY LOW-COST HOUSING**

The paper presents the results of the international research program on affordable steel housing, called “Affordable House Project” and sponsored by Arcelor Mittal. The socio-economical background for the low-cost housing in Poland is presented, as well as the definition of the term “affordable” in relation to single family housing. Budget housing in Poland is identified and the Polish solution of affordable steel-structure-house is presented and compared to

the low-cost model houses worked out in Czech Republic, Portugal, Romania and Brazil. All subject projects are presented and briefly described. The paper presents the comparison of the specific features of the designs, such as: the area, internal layout, structural design, technical solutions and economical advantages over traditional building methods.

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Stanisław KUŚ  
Politechnika Rzeszowska

## **STADION MIEJSKI W RZESZOWIE**

### **CITY STADIUM IN RZESZOW**

The shape of new stade in Rzeszów is presented. The stade is designed for 18000 spectators as well for football as for the speedway championship. The original solution of the shape lies in folded 42 steel sectors of 14,20x41,00 m with 33,00 m cantilever over the spectators viewing area and speedway path. Inclined concrete trapezoidal plate is foreseen for dumping the noise, and hosting over the stade the wind gusts.

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Stanisław KUŚ  
Politechnika Rzeszowska

## **ROLA KONSTRUKTORA W KSZTAŁTOWANIU WSPÓŁCZESNEJ ARCHITEKTURY NA PRZYKŁADZIE PETERA RICE'A (1935 – 1992)**

### **INFLUENCE OF STRUCTURAL ENGINEER ON SHAPING OF CONTEMPORARY ARCHITECTURE PETER RICE (1935 - 1992)**

Excellent examples of modern architecture are always the result of manual cooperation of architect and structural engineer.

Basic difference in studies and professional duties: mathematics, mechanics of structures and function and shape of designed objects differ these disciplines. But the result of the design and its effectiveness, economy and elegance unify the authors.

Peter Rice an engineer of Ove Arup presents very good example of creativity in structures high estimated by famous architects. His high part in design of Sydney Opera, Centre Pompidou in Paris, structures of glass panel's elevations and Bari stadium is presented.

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Joanna LENAR  
PPH Transsystem S.A., Wola Dalsza  
Lucjan ŚLĘCZKA  
Wydział Budownictwa i Inżynierii Środowiska, Politechnika Rzeszowska

## **KSZTAŁTOWANIE WIEŻY TELEKOMUNIKACYJNEJ O NIETYPOWYM KSZTAŁCIE**

### **FORMING OF UNTYPICAL SHAPE OF LATTICE TELECOMMUNICATION TOWER**

First part of this paper presents requirements for designing of steel lattice telecommunication towers and presents typical shapes of such towers used in Poland. Second part is devoted to forming new aesthetic type of tower, which can become an architectural fit into the landscape. Various draft proposals were made, and after that two towers were analyzed in details.

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Mariusz MAŚLAK  
Politechnika Krakowska

## **CZEŚCIOWE WSPÓŁCZYNNIKI BEZPIECZEŃSTWA W WYJĄTKOWEJ SYTUACJI POŻARU -PRZYCZYNEK DO DYSKUSJI**

### **PARTIAL SAFETY FACTORS IN ACCIDENTAL FIRE SITUATION – CONTRIBUTION TO DISCUSSION**

A more accurate technique of calibration of partial safety factors in semi-probabilistic structural analysis related to the accidental fire situation is presented and discussed. Values of such factors, proposed by the European standard recommendations, are harmonized with design methodology commonly used in the analysis of persistent design situation; however, such simplified approach arouses controversy. In the article the assumption is made that acceptable probability of upcrossing of design value of the action effect should be as great as the probability of downcrossing of design value of member resistance. As a result of the study the new minimum values of considered safety factors are proposed by the author for differentiated safety requirements.

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Hanna MICHALAK  
Politechnika Warszawska

**O TENDENCJACH KSZTAŁTOWANIA  
KONSTRUKCYJNO-PRZESTRZENNEGO PRZEKRYĆ CIĘGNOWYCH  
DUŻYCH ROZPIĘTOŚCI**

**STRUCTURAL AND SPATIAL PLANNING OF  
THE LARGE SPAN TENSEGRITY ROOF STRUCTURES**

Tensegrity structures are one of the first architectural forms which stem out from Nature and surrounding Environment. Throughout the ages, cable structures were used only to a certain, rather narrow, extent. Development of steel structures and steel prefabrication technologies, rapid computerization gave the possibility to a wider utilization of tensegrity structures.

Historical features of the development of tensegrity structures and their use in buildings of different function are presented.

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Jan B. OBREŃBSKI  
Politechnika Warszawska, Wydział Inżynierii Lądowej

**PRZEGLĄD FORM REGULARNOŚCI KONSTRUKCJI PRĘTOWYCH  
STOSOWANYCH W PRACACH WŁASNYCH**

**REVIEW OF REGULARITY FORMS FOR SPACE BAR STRUCTURES  
APPLIED IN OWN WORKS**

In the paper are discussed some forms of structures regularities applied in authors works in period of 41 years of his scientific researches. Are shown the manners of structures description, its analysis and synthesis, for space bar coverings single and two-layered, flat, cylindrical, barrel, conical and many other types. One of the most interesting proposals are space bar domes of UNIDOM type. Are pointed some different kinds of regularity for such structures, its advantages and weak sides. In range of structure synthesis are pointed own works and doctor theses elaborated in cooperation with author. The existing professional specialized programs and possible there manners of structure description by user are commented, too. In certain range is mentioned also regularity of thin-walled bars used as elements of structure and its influence on strength calculations.

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Zdzisław PISAREK  
Politechnika Rzeszowska

## **KSZTAŁTOWANIE RAM PORTALOWYCH Z ZASTOSOWANIEM POŁĄCZEŃ ŚRUBOWYCH**

### **SHAPING OF PORTAL FRAMES WITH BOLTED JOINTS**

The rational shaping of steel portal frames relies not only on suitable choice of the structural system, static schema or the type of sections, but also on the suitable solution of joints and their actual characteristics. In the paper, the influence of the strength and stiffness of the joints on redistribution of internal forces in the one-storey portal frame was presented. The procedure for calculation of the stiffness of the bolted splice joints was elaborated too.

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Wojciech RADOMSKI  
Politechnika Warszawska

## **PRZYSZŁOŚĆ MOSTOWNICTWA W ŚWIETLE OBSERWOWANYCH KIERUNKÓW JEGO ROZWOJU**

### **FUTURE OF BRIDGE ENGINEERING IN THE LIGHT OF TRENDS IN ITS DEVELOPMENT**

Trends in the development of bridge engineering during the last years are listed and discussed according to subjective author's opinion. Implementation of non-conventional structural materials for bridge construction, design of the large bridge spans as well as design of the bridge structures with original (sometimes even sophisticated) architectural forms are presented in particular. A new social and economical role of bridge engineering is also pointed out. Based on the above mentioned problems, the conclusions concerning the future role of bridge engineering in the world's and national economy and social life are formulated.

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Adam REICHHART  
Politechnika Rzeszowska, Wydział Budownictwa i Inżynierii Środowiska  
Katedra Konstrukcji Budowlanych

## **KSZTAŁTOWANIE KONSTRUKCJI PRZEKRYCIA O NIEREGULARNEJ FORMIE KOŚCIOŁA W SĘDZISZOWIE MAŁOPOLSKIM**

### **SHAPING STRUCTURE OF THE ROOF IN IRREGULAR FORM ON A CHURCH IN SĘDZISZÓW MAŁOPOLSKI**

The form of a designed construction prepared by an architect is often complete, comprehensive. Then constructor's task consists in building appropriate structure into such a

form. When the form is irregular, shaping of the structure is more complicated. This article presents an example of shaping structure in such a situation.

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Wiesław ROKICKI  
Kazimierz SZULBORSKI  
Wydział Architektury Politechniki Warszawskiej

## **KSZTAŁTOWANIE STRUKTUR NOŚNYCH W BUDYNKACH O NIEKONWENCJONALNEJ FORMIE**

### **STRUCTURAL SHAPING IN UNCONVENTIONAL BUILDINGS**

Diversity, changeability and message that architecture is a branch from the edge of art, having very big influence on cultural and social life, puts far higher requirements not only on architects but on engineers as well. As a result of a constant creative search new original and amazing forms are created. Recent avangarde solutions of new spectacular and innovative ideas prove that time for structural searching has begun. A traditional view on function and space hand in hand with rather rigid forms are becoming more flexible. Due to the constant increase of possibilities to do complicated projects, it is natural that more extreme and creative ideas are being completed. Ahythmic architecture also known as an aeurythmic is an example of a concious deforming of building blocks. Dynamic , unconventional architecture puts on far more difficult challenges for rational building. It results in a need for constant changes in designed constructions . Unusual configurations of rods can be far better solutions used for structural systems. Creating and studying original unconventional and optimized constructional solutions, which are followed by defined rules and are based on wide knowledge of static and strength of materials, has become an inspiring designing task.

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Adam RYBKA  
Jarosław JAWORSKI  
Sławomir RYBKA  
Politechnika Rzeszowska

## **BUDYNEK BIUROWY W KONSTRUKCJI STALOWEJ**

### **THE STEEL CONSTRUCTION OF THE OFFICE BUILDING**

Many constructional arrangements exist, to assure equilibrium and the endurance of the buildings and safety while they are in the use. Steel construction as bearing arrangements appear together with the growth of the height of the buildings. In the bearing mixed case system of buildings reaching 40 floors often is happened. Get buildings about the considerable height, one should use the steel construction to the arrangement. Obtainment of the liberty of division of the usable surface of the building, one gets to thanks to the steel skeletal construction.

The small own weight of the construction also speaks on the thing of the steel skeleton. The project of the many - level office building was introduced. The basic function was replenished by the service and hotel functions. The object will be constructing in Rzeszow. As the arrangement of the construction of the building, core system co-operating with the system of flat frames having for the task of the transfer was applied both horizontal and perpendicular strengths. Central core and four spreading wings make the layout of the building. The layout of the building is unique in the comparison with already existing buildings. The object possesses interesting functional solutions. It is the example of the use of modern constructional possibilities to formation of the form of the height office building.

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Jerzy SENDKOWSKI  
Anna TKACZYK  
Łukasz TKACZYK  
Biuro Budowlane Ankra Sp. z o.o.

## **ANALIZA USZKODZEŃ KONSTRUKCJI ZADASZENIA PARKINGU**

### **ANALYSIS OF THE CAR PARK METAL ROOFING**

The article presents case of failure of the car park roof supporting structure. There was cause of failure assigned as insufficient anchorage of steel sheet to the car park roof supporting structure. Furthermore damage repair was presented in this paper.

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Tomasz SIWOWSKI  
Politechnika Rzeszowska  
Piotr ŻÓŁTOWSKI  
Promost Consulting Sp. z o.o., Rzeszów

## **KSZTAŁTOWANIE ARCHITEKTONICZNO – KONSTRUKCYJNE KŁADKI DLA PIESZYCH PRZEZ WISŁĘ W KRAKOWIE**

### **ARCHITECTURAL AND STRUCTURAL SHAPING OF THE FOOTBRIDGE OVER VISTULA RIVER IN CRACOW**

The structure of the new footbridge over Vistula River in Cracow has been presented in the paper. The authors briefly described architectural form of the structure and than its structural solutions. The steel structure of the span has been widely outlined following the presentation of main assumption for FEM analysis of the span. The shaping of main span (i.e. tubular arch girder and the steel deck, suspended to the girder) and the supports on the pale foundations have been presented in details. The total unit cost of the footbridge was over 10,500 €/ m<sup>2</sup>, which is one of the highest price for the bridge of this kind built in Europe recently. However, this is the price paid nowadays by some European cities for landmark structures.

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Tomasz SIWOWSKI  
Politechnika Rzeszowska

## **KSZTAŁTOWANIE OBIEKTÓW MOSTOWYCH ZE STOPÓW ALUMINIUM**

### **STRUCTURAL SHAPING OF ALUMINIUM BRIDGES**

The aluminium bridges have been built worldwide since 75 years. There are some areas of bridge engineering, where the aluminium superstructures show their great construction potential, f.e. footbridges, bascule bridges and small road bridges. The tendency of shaping an aluminium bridges including aesthetic issues has been considered along with the possibilities, offered by the utilization of aluminium alloys. The advantages of aluminium application and the selected contemporary examples of aluminium bridges have been also presented.

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Szymon SWIERCZYNA  
Walter WUWER  
Politechnika Śląska w Gliwicach

## **TARCIE OBROTOWE W POŁĄCZENIACH ZAKŁADKOWYCH NA SWORZNIE W ZŁOŻONYM STANIE OBCIĄŻENIA**

### **JOURNAL FRICTION IN BOLTED LAP JOINTS IN COMPLEX STATE OF LOAD**

The paper presents the calculation model of any single-cut lap-joint, extended – in relation to up to now considered one by authors – about values of torsional moments  $M_{i,\phi}$ . Torsional moments result from journal friction occurring in the axis of every bolt in the joint which is simultaneously bended and sheared. The modified analytical model has been verified experimentally on the example of eccentrically loaded 3- and 4-bolts joints, where walls of cold formed sections were connected by means of blind bolts of the type BOM R16. Experimental and numerical results are compared on the diagrams of relationship occurring between moment  $M$  bending the connection and angle of mutual rotation  $\phi$  of joined walls. Values of stiffnesses of a 3-bolt joint according to EC3 determined on the basis of initial stiffness  $S_{j,ini}$  and by means of component method were compared.

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Maciej SZUMIGAŁA  
Katarzyna TERESIŃSKA  
Politechnika Poznańska  
Zakład Konstrukcji Metalowych

## **KRYTERIA DOBORU KONSTRUKCJI W BUDYNKACH SZKIELETOWYCH**

### **CRITERIA FOR THE CHOICE OF THE STRUCTURE IN SKELETAL BUILDINGS**

Rush growth of buildings of the public utility, like shopping centers, office administration objects and communications infrastructure (stations and an airports), and associated with them and multilevel car parks caused some interest in composite steel-concrete structures.

In this paper the attention will be focus on some tied problems with designing buildings of the skeletal type on the example of multi-storey car parks concerning the selection of the type of the structure. Results of analyses will be presented computational consuming associated with the optimization, for which will be a function of the objective steel. Other parameters taken into account will stay in analysis as dimensions of diameters and the functionality of the structure resulting out of necessity of installing.

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Lucjan ŚLĘCZKA  
Wydział Budownictwa i Inżynierii Środowiska, Politechnika Rzeszowska

## **KSZTAŁTOWANIE WEZŁÓW RAM STALOWYCH NARAŻONYCH NA ODDZIAŁYWANIA SEJSMICZNE**

### **FORMING OF JOINTS IN MOMENT RESISTING STEEL FRAMES SUBJECTED TO SEISMIC ACTIONS**

Seismic resistant steel structures are usually designed to allow for the dissipation of the seismic energy input in specially selected zones of structures. In moment resisting steel frames subjected to seismic actions, beam to column connections can play an important role, influencing the localization of dissipative zones. Designing of reinforced moment-resisting connections or reduced beam sections moment connections creates dissipative zones in the ends of the beams. Designing of semi-rigid, partial-strength joints permits to create of dissipative zones also in the connections. In this case the cyclic behaviour of beam-to-column connections is affected by the type of components engaged in the plastic range. The proper choice of the dissipative component and suitable detailing of the connection are key elements of seismic design.

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Krzysztof TROJNAR  
Politechnika Rzeszowska

## **FUNDAMENTY HYBRYDOWE W BUDOWNICTWIE KOMUNIKACYJNYM**

### **THE HYBRID FOUNDATIONS IN ROAD CONSTRUCTION**

Efficient design of retaining structures needs defining the stability of the piles and their actual displacement values as they decide the use of the building. Consideration of the soil-pile-cap interaction makes it possible to put more horizontal load on the pile foundation, than when such interaction is ignored. The author's investigations proved that a group of hybrid foundations can be distinguish out of the well-known types of pile foundations. The group shows greater lateral stiffness due to the effective interaction between the vertical pile, horizontal plate and soil within a definite range of displacement caused by lateral load.

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Szczepan WOLIŃSKI  
Politechnika Rzeszowska

## **O KRYTERIACH KSZTAŁTOWANIA KONSTRUKCJI**

### **REMARKS ON SHAPING CRITERIA OF STRUCTURES**

The paper deals with some aspects of shaping criteria for design of building structures. Shaping of structures was defined by prof. W. Zalewski as „qualitative approach to optimization of the flow of forces in a structure based on the rational principles of their physical and geometrical assessment”. Traditionally, the least weight criterion of completely deterministic structures (deterministic structural properties, materials and loads) are considered in that type of structural optimization. While there is a certain elegance about these solutions, they are not robust and even small variations in loading pattern, material and geometrical properties can cause a structure designed to such an optimal solution to fail. Optimization criteria based on requirements recommended in the Eurocode are briefly reviewed. Two probabilistic criteria, namely the maximum reliability and the minimum risk are presented and discussed in detail. The minimum risk criterion provides in especial optimization possibilities with respect to the technical design code criteria and to both the quantitative and qualitative requirements.

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Walter WUWER  
Kamil SŁOWIŃSKI  
Politechnika Śląska w Gliwicach

## **BADANIA ZŁOŻONEGO ELEMENTU CIENKOŚCIENNEGO Z PODATNYMI POŁĄCZENIAMI SWORZNIOWYMI**

### **INVESTIGATIONS OF BUILT-UP THIN-WALLED STEEL MEMBER WITH FLEXIBLY JOINTS**

The paper presents preliminary results of analytical investigations concerning an axially compressed closely spaced element, verified experimentally. The investigated tentative element consists of three branches, made of cold-bent steel sheet. Two branches with a channel-bar cross-section are strengthened by the third branch with a tubular cross-section, the walls of which adjoin the webs of the channel bars. The walls of the three branches forming a bisymmetric cross-section are connected with each other flexibly by means of blind bolts. The tubular branch takes over more than 30 % of the entire load of the complex tentative element, as has been proved both by analytical and experimental results.

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Jan ZAMOROWSKI  
Politechnika Śląska w Gliwicach

## **SPECYFIKA KONSTRUKCJI HALI WIDOWISKOWO-SPORTOWEJ „SPODEK” W KATOWICACH**

### **SPECIFIC CHARACTERISTICS OF THE STRUCTURE OF THE ASSEMBLY AND SPORTS HALL „SPODEK” IN KATOWICE**

The paper presents the complex structure of the assembly and sports hall „Spodek” in Katowice. This edifice is founded on a site exposed to possible damages due to mining activities. Constructing this building, the so-called kinematic system of founding was applied, consisting in the upheaval of the spot footings checking the creeping of the soil, reducing in this way the effect of the curvature of the terrain on the deformation of the main foundation ring. Advanced procedures of calculations have been presented, which permitted to assess the actual effort of the most important carrying elements of the hall. The way of strengthening those elements, whose load-bearing capacity was insufficient, has been characterized.

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Henryk ZOBEL  
Thakaa ALKHAFAJI  
Politechnika Warszawska, Instytut Dróg i Mostów

## **KSZTAŁTOWANIE WSPÓŁCZESNYCH DREWNIANYCH KŁADEK DLA PIESZYCH**

### **CONTEMPORARY PEDESTRIAN TIMBER BRIDGES**

New structural solution of pedestrian Bridges made of glued-laminated timber and stress-laminated timber are presented in this paper. Their shape, structural and material solutions are against common opinion that timber structures are old fashion, not durable and expensive for maintenance. Newest achievements in the area of fire, chemical and biological protection cause that durability of timber bridges is now comparable to concrete and steel bridges. Therefore, it is necessary to keep hope that one time we will see more exceptional pedestrian timber bridges in Poland.

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Krzysztof ŻÓŁTOWSKI  
Tomasz ROMASZKIEWICZ  
Politechnika Gdańska

## **KŁADKA PRZEZ WISŁĘ W KRAKOWIE. CECHY DYNAMICZNE I ICH WPŁYW NA OSTATECZNĄ FORMĘ KONSTRUKCYJNĄ OBIEKTU**

### **FOOTBRIDGE OVER VISTULA RIVER IN CRACOW. DYNAMIC ASPECTS AND THEIR INFLUENCE ON A FINAL STRUCTURAL DESIGN.**

Paper presents a footbridge which is being build over Vistula river in Cracow. The original structural design has been changed due to serious problems with foundation. Complex numerical dynamic analysis has been done, during which many variants of pedestrian loading were considered. Results are presented. The paper compares both structural designs and presents essential differences.

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Krzysztof ŻÓŁTOWSKI  
Tomasz ROMASZKIEWICZ  
Politechnika Gdańska

## **PRZEKRYCIE STADIONU PIŁKARSKIEGO NA EURO 2012 W GDAŃSKU LETNICY**

### **ROOF OF THE FOOTBALL STADIUM FOR EURO 2012 IN GDAŃSK.**

Paper presents general structural assumptions of steel construction designed for a new football stadium to be built for UEFA Championship 2012 in the city of Gdańsk. Superstructure is founded directly on the modified abutment. Facade and roof is collected from 82 steel girders made of tube profiles. Girders are braced by circular beams and X tension rods. All this creates a quasi – dome covered by polycarbonate cladding.

During fabrication and erection several problems occurred. Major difficulties and repairing procedures are presented.

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