Gary B. Marquis - IIW: developing global best practices for the fatigue assessment of welded structures

The International Institute of Welding (IIW) acts as the global network of knowledge exchange concerning the joining of materials. One of the working teams, i.e. Committee XIII, is dedicated to new research results and the implementation of innovative technologies in order to avoid fatigue failures in welded structures. Presently, the Committee is developing several new guidelines aimed to increase the fatigue service life of welded structures. One of the guidelines is concerned with the frequent use of mechanical treatment is a method of increasing the fatigue strength of welded structures. The article discusses aspects of the above-named guidelines and the unique international IIW collaboration enabling the development of these guidelines.

E. Meiß - DIN 2304 – quality requirements for adhesive bonding processes

Today's adhesives are high quality products. Their proper use normally leads to a zero-defect-production. If bonding failures nevertheless occur, more than 90 % these failures result from failures in the adhesive bonding process and do not result from failures of the adhesive. Precisely in this contradiction (high quality adhesives for a zero-defect-production vs. adhesive bonding failures) DIN 2304 starts to take effect: DIN 2304 implements quality standards for the proper use of adhesives. The standard determines the current state of the art for the organization of a proper realization of adhesive bonding processes in the user-company. Therefore, the quality of the adhesive bonding process will be adapted to the quality of the adhesive production process. In this context. DIN 2304 concerns every adhesively bonded material compound with the main function of transferring mechanical loads, independent from the strength and deformability characteristics as well as the solidification mechanism of the used adhesive. Due to the fact that the OEM Working Group "Automotive" has decided to implement the standard into their productions, DIN 2304 may rapidly become global - for the automotive producers as well as for their suppliers.

S. Keitel, U. Wolski, U. Mückenheim, Ch. Sondershausen, J. Müglitz - MIG welding machines for large steel structures

The volume of welding fabrication, geometry and quality standards in the wind power sector require automation. The use of conventional industrial robots is often impossible due to safety, costs, workplace accessibility and programming time. On the other hand, typical processing tasks and post-processing activities such as cutting, arc welding and ultrasonic tests are excessively complex to be mechanised using simple tooling. Small and inexpensive modular devices on rails, known as crawlers, bridge the gap between simple mechanised equipment and industrial robots. Such devices combine easy handling and operational versatility, even in difficult site conditions, characteristic of mechanised equipment with programmability and sensor-controlled movements typical of industrial robots. This article discusses the possibilities and limitations of the above-presented concept in relation to a number of its practical applications.

M. Fiedler, A. Plozner, B. Rutzinger, W. Scherleitner - Control of mechanical properties of high strength steels through optimized welding processes

The cooling time between 800°C and 500°C is a crucial factor significantly determining the properties of welded joints made of high strength steels. In field welding, the cooling time t8/5 can be controlled by heat input even if different wall thicknesses of base materials are used. Modern arc processes with

reduced heat input allow obtaining the same with comparable deposition rates and increase the stability of the strength level due to optimized equipment settings. This paper compares conventional GMAW processes, e.g. short arc, spray arc GMAW pulse with new processes such as PMC (Pulse Multi Control) and others processes in relation to weld properties. Particular emphasis is given to all weld metals and welds. The deliberations presented in the paper allow drawing practical conclusions and formulating recommendations aimed to optimize welding-related properties.

J. Górka, S. Stano - Laser beam welding of 10 mm thick T-joints made of TMCP steel

The article presents research on the laser beam welding of 10 mm thick T-joints made of thermomechanically worked high-strength steel S700MC without using a filler metal. The research-related tests involved making single-sided and double-sided welded joints as well as performing non-destructive tests. The quality of joints satisfied the requirements of quality level B according to the PN-EN ISO 13919-1 standard. The single-sided welding performed using a beam power of 11 kW enabled the obtainment of 8 mm deep penetration without noticeable displacements in the web. The double-sided welded joints were characterized by correct geometry; the dimensions of pores present in the weld metal satisfied the maximum pore size criterion specified for quality level B. The weld microstructure was bainitic-ferritic; the hardness of the weld was by about 60 HV1 higher than that of the base material (280 HV1). The HAZ revealed a small decrease in hardness in comparison with that of the base material.

V. van der Mee – Welding of (super) duplex stainless steels

The article presents and describes in detail duplex steels used in modern sectors of industry (duplex, super duplex, lean duplex and hyper duplex), with particular attention paid to corrosion resistance and primary areas of application. The article also discusses welding-related issues including the preparation of the base material, welding techniques and procedures, requirements concerning heat input as well as pre-weld and post-weld heat treatment. The article emphasizes the growing use of duplex steels, among other things in welded structures, and forecasts their further development.

P. Bernasovský, A. Petráňová – Failures of high alloy austenitic steel structures – case studies

The article presents failures of structures made of austenitic steels. The first part is concerned with accelerated (centrifugally) cast tubes (Ø 52.6 x 5.8 mm) made of steel 25-35 CrNi exposed to high temperature and severe reducing environment (ac >> 1). The second part of the article presents test results related to a water meter element and a cooling water pipeline made of austenitic steel. In both cases, a relatively short period of service was accompanied by the appearance of leaks. The tests revealed that the failures were triggered by microbiological corrosion caused by a sulphur reducing bacteria and not by the welding technology applied.

O. Obruch, S. Jüttner, G. Ballschmiter, M. Kühn, K. Dröder – Resistance welding of hybrid structures made of Fibre-Reinforced Plastics and steel using special connecting elements made of metal

The article presents a technology used for the thermal joining of composite materials and metal elements, making up hybrid structures, using auxiliary connecting elements. The penetration of the these elements into the composite material was performed using an iterative process assuming the lowest damage to the material. In addition, the article presents primary requirements concerning the welding of auxiliary elements in relation to this process. The article also presents and analyses various

joining concepts as well as pays attention to the necessity of providing low heat input to the material aimed to minimise thermal damage to the composites and, as a result thereof, proposes a new approach to spot welding. Finally, the article presents selected solutions taking into consideration the above named aspects as well as describes mechanical properties of joints and welding parameters.

M. Hudycz, T. Chmielewski, D. Golański – Analysis of distribution of temperature and stresses during the friction metallisation of AlN ceramics with titanium

The article presents the results of the numerical analysis of an AlN-Ti joint obtained during friction welding, where a titanium probe was rubbed frontally into the base of nitride ceramics. The process aimed to create a thin metallic (titanium) coating on the ceramic base enabling its further joining with metals. Until today, the metallisation of ceramics through friction has not been used for the metallisation of ceramics and, as initial tests have proven, this solution can constitute an advantageous alternative to currently used expensive processes of ceramics metallisation. The numerical modelling of the friction of AlN ceramics with titanium enabled the obtainment of information concerning the distribution of temperature fields and stresses on the contact surfaces of the AlN-Ti system during friction. The obtained results will be useful when analysing the mechanism related to the formation of the interpass of the joint connecting the AlN ceramics with z titanium.

J. Adamiec – Properties of laser welded finned tubes made of nickel alloys

The article presents test results concerning properties of ribbed pipes made of the Inconel 625 nickel alloy in terms of their thermal efficiency, resistance to high-temperature corrosion and electrochemical corrosion resistance. It was ascertained that the use of ribs (fins) as the extension of heat exchange surface increases the thermal efficiency of pipes almost by thrice without compromising high corrosion resistance in flue gas atmosphere and electrochemical corrosion.

K. Wojsyk, M. Macherzyński – Determination of linear welding energy by measuring cross-sectional areas of welds

The article proposes the method of estimating heat input to materials by measuring the cross-sectional area of volumes melted during fusion or pressure welding. In addition, the article describes methods presently used to estimate linear energy involving the fixing of wattmeters to arc power sources and referring this energy to the linear dimensions of welds. The article justifies the necessity of changing the approach to methods of calculating linear energy by the development of new welding methods and the launching of new materials sensitive to heat. The introduction of numerous impulse and hybrid (laser-based) welding methods contests the conventional methods of linear energy calculation (illustrated by examples). The article proposes a manner of calculating heat input during spot welding.

S.G. Grigorenko, S.W. Achonin, W.Ju. Belous, R.W. Selin - Heat treatment effect on the structure and properties of electron beam welded joints made of high-alloy titanium

The article presents the specific formation of a joint made of high-strength high-alloy titanium alloy (α + β) subjected to electron beam welding in vacuum. Tests involved the use of Ti-Al-Mo-V-Nb-Cr-Fe-Zr specimens obtained through electron melting. The research involved tests focused on the effect of a welding thermal cycle and post-weld heat treatment on structural-phase transformations in the weld metal and HAZ of welded joints. It was revealed that the weld metal and HAZ were composed of a structure dominated by the metastable phase β, which led to the reduction of plasticity and toughness indexes. The improvement of the structure and mechanical properties of electron beam welded joints

required the performance of post-weld heat treatment. The best mechanical characteristics of welded joints were obtained after a heat treatment performed in a furnace (annealing at T=900˚C for 1 hour and cooling along with the furnace) favouring the obtainment of an almost homogenous structure and the decomposition of metastable phases in the weld and HAZ.

A.A. Goljakiewicz, Ł.N. Orłow – Surfacing performed using flux-cored wire in Ukrainian companies

The article describes experience of extending the service life of various machinery parts by surfacing them with flux-cored wires. High wear resistance during the rolling and straightening of steel is achieved by the formation of a martensitic matrix reinforced with dispersive carbides.

M. Beloev, N. Lolov – Selected technological aspects concerning the making of ammonia storage tanks

The article discusses factors connected with the stress corrosion cracking of ammonia storage tanks and presents the details of a welding technology ensuring the obtainment of the maximum service life of these tanks.

T. Piwowarczyk, M. Korzeniowski, A. Ambroziak, T. Kowal, R. Rutka, M. Karolewski – Effect of pipe face preparation on the quality of magnetically impelled arc welded joints

The article presents magnetically impelled arc welding – a technology used when making butt joints mainly of elements having circular cross-sections. In addition, the articles indicates issues related to the preparation of pipe faces and its effect on the quality of welds. The research-related experiment involved the use of selected power transmission elements. The research also included the performance of visual, geometry, metallographic, functional and technological tests of the joints as well as the determination of critical imperfections disqualifying the use of welded joints.

Z. Mikno – High-frequency invertor welding machine – advantages of new technology

The article presents advantages of inverter welding machines having a high operating frequency of 10kHz and compares conventional AC 50Hz welding machines as well as inverter welding machines having operating frequency of 1 and 10kHz. The article presents research results obtained within a currently implemented project of Programme of Applied Research (PBS3/B4/12/2015).

A. Bicz, W. Bicz, M. Korzeniowski, T. Piwowarczyk, A. Ambroziak – Ultrasonic tests in the analysis of the quality of cross-sectional welded elements

The article presents currently used ultrasonic tests of elements having tubular cross-sections, joined by means of various welding methods. In addition, the article discusses various ultrasonic signals in industrial (primarily automatic) applications in relation to selected technological solutions as well as presents existing industrial stations for testing pipes, machinery parts/components and mechanical elements as well as parts connected with the acquisition of ultrasonic signals.

K. Kaczmarek, P. Irek, Ł. Rawicki, J. Słania - Detection of imperfections in welded joints using the Time-of-Flight-Diffraction Technique (TOFD)

The paper presents the results of research on an ultrasonic testing technique known as the time-of-flight-diffraction (TOFD) technique. The research-related tests involved a 10 mm thick MMA welded

butt joint containing imperfections in the form of linear slag inclusions. The paper contains TOFD images obtained by scanning the face and the root side of the weld. The TOFD examination results were compared with the results of micro and macroscopic metallographic examinations performed at selected points of the welded joint.

T. Hejwowski, K. Marczewska-Boczkowska, E. Zięba – Microstructure, wear resistance and corrosion resistance of coatings surfaced with Ni-Co-based alloys

The article presents results of tests concerning coatings subjected to plasma surfacing involving the use of Co and Ni-based powder mixtures. The research involved the performance of abrasive wear tests (with corundum abrasive) and adhesive wear tests in the roller-block system. Test concerning electrochemical corrosion were performed in a 3% aqueous solution of NaCl. The article demonstrates the possibility of making wear resistant coatings of intermediate chemical compositions.

J. Pikuła, M. Łomozik, T. Pfeifer - TIG method in the multiple repair welding of long-operated components in the power industry

The article presents the results concerning the repair welding of a long-operated waterwall using the mechanized TIG method. The tests were focused on determining the effect of a repair performed in order to remove cracks in welded joints located along flat bars opening on the tube wall side on the structure and hardness of the heat affected zone (HAZ) of a repair welded joint in the waterwall. In addition, the tests investigated the influence of multiple repair welding on the formation of structural notches in the HAZ.

K. Luksa, M. Bednarek – Weldability of toughened steels used in ballistic shields

The article characterises selected toughened steels used in the production of ballistic shields, presents standard requirements in terms of the properties and chemical composition of these steels as well as enumerates and discusses guidance on the welding of such steels. The article also presents the results concerning the comparison of the carbon equivalents (Ce) of selected steels used for ballistic shields and preheating temperatures suggested by steel producers. The analysis of collected information revealed that the above named steels should be welded using low-hydrogen processes ensuring the obtainment of a diffusive hydrogen content below 5 cm3 per 100 g of the weld deposit. It was also ascertained that sheets having thicknesses above 30 mm should be subjected to preheating and that interpass temperature should not exceed 200OC. In addition, it was determined that welding should be performed using multiple runs and austenitic high-alloy filler metals, preferably G 18 8 Mn and that gas mixture-shielded welding processes should be performed using argon-based mixtures; preferably 82% Ar + 18% CO_2 or 92% Ar + 8% CO_2.

S. Stano, J. Adamiec, J. Dworak, M. Urbańczyk – Laser welding of T-joints made of thin austenitic sheets

The article presents test results concerning the CO2 and Yb:YAG laser welding of thin-walled T-joints made of steel X5CrNi18-10 (steel 304), X6CrNi18-10 (steel 304H) and X15CrNiSi25-21 (steel 310) selected as stainless steels potentially useful in the production of ribbed pipes (finned tubes) intended for operation in boilers of supercritical parameters. Welding tests were performed using two different laser sources, i.e. a CO2 gas laser and a Yb:YAG solid state laser. The tests involved the determination of the appropriate angle of laser beam insertion into the interface of sheets, enabling the obtainment of properly shaped welds. Non-destructive tests classified the joints as representing quality

level B in accordance with standard 13919-1. Selected joints were tested for the distribution of alloying constituents in the joint area. It was ascertained that laser welding made it possible to maintain the uniform distribution of alloying constituents without their significant depletion in the weld area. The tests were financed using the funds of project PBS1/A5/13/2012.

A. Świerczyńska, J. Łabanowski, D. Fydrych – Effect of linear energy and microstructure on the content of retained hydrogen in welded joints made of superduplex steels

The article presents tests concerning the content of retained hydrogen present in FCAW and SAW welded joints made of superduplex steel. The use of various welding technologies resulted in the obtainment of welds having different microstructures and ferrite contents. Measurements of retained hydrogen present in joints (performed using the complete combustion method) revealed various contents of hydrogen in the base material and in the welds subjected to the tests. It was determined that the content of hydrogen in welds made of superduplex steels depends not only on the volumetric content of microstructures but also on their composition and welding linear energy.

L. Szubert, J. Matusiak, P. Skoczewski, J. Wyciślik – Measurement and data processing system for welding parameters and noise level during manufacturing process of welded structures

This paper presents the design, technical possibilities and the intended use of a multi-station measurement system for assessing welding process parameters and noise levels. The system is an innovative solution as regards the measurement technique related to welding process parameters and acoustic pressure in production floors. Once implemented industrially, the system enables the monitoring and recording of noise levels in individual work centres as well as the monitoring and recording of technological conditions accompanying the welding of various structures and products.