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Optometric Methods for Testing Sections of Buckling
Marcin Kempny
DOI: 10.327730/mswt.2023.67.5-6.1

Key words: stability of sections, Digital Image Correlation, Young's modulus, stable equilibrium, unstable equilibrium, elastic buckling, Euler critical force

The article presents a study aimed to experimentally identify the correlation between the deflection arrow of a buckled flat bar and the magnitude of applied force *P* as well as to determine the value of critical force necessary for maintaining the equilibrium of the flat bar in its bent form. The study-related tests involved the use of a Gleeble 3800 metallurgical process simulator. Based on the data obtained in the tests and using Euler's equation, it was possible to determine the transverse modulus of elasticity. An inductance-type extensometer (usually used in the Gleeble simulator) and a digital image correlation system (used in both the visible and ultraviolet light configuration) were applied to record changes in the length of the flat bar in time. The study also included the investigation of methods used when marking the surface of materials subjected to measurements involving the use of digital image correlation, i.e.:

- covering the surface with light-coloured paint and depositing the "speckled pattern",
- deposition of the "speckled pattern" in the form of an impression using a microhardness tester,
- deposition of the "speckled pattern" in the form of a pattern burnt out by the laser beam on the specimen surface.

Microwave-Assisted Preparation of Sinter Samples for Chemical Composition Analysis by IPC-OES Technique
Piotr Knapik, Aleksandra Latacz, Michał Kubecki
DOI: 10.327730/mswt.2023.67.5-6.2

Key words: ICP-OES, microwave mineralization, iron ores, sinters

The article discusses tests aimed to develop a method enabling the preparation of iron ore sinters applying microwave-assisted mineralisation and subsequently used in the ICP-OES technique-based chemical composition analysis. The tests involved the use of various mineralising mixtures, one of which was selected to prepare specimens of sinters used in the ICP-OES technique-based chemical composition analysis. The repeatability of the microwave-assisted mineralisation of sinters was investigated through the repeated mineralisation of the same sinter specimen performed under the same conditions. The test results revealed that the microwave-assisted mineralisation technique could be used routinely in ICP-OES technique-based sinter analytics. The preparation of the sinters performed using the above-named technique was less laborious and involved the use of small amounts of chemical reagents.

Environmental Assessment Concerning the Use of Char from Biomass in the Iron Ore Sintering Process
Janusz Stecko
DOI: 10.327730/mswt.2023.67.5-6.3

Key words: sintering process, char, emissions to the environment, exhaust fumes recycling

The article presents results of tests concerning the use of waste biomass-derived char as a partial substitute for solid fuel used in the iron ore sintering process (primarily coke breeze). The tests were performed in a system used for the physical simulation of the sintering process, making it possible for flue gases to be recycled back to the process. During the tests, particular attention was paid to the analysis of properties of flue gases with the simultaneous recirculation of these gases back to the process. The optimal fraction of char from biomass (i.e. not worsening either sintering process or sinter parameters) in the total fuel was determined on the basis of previous experience. It was found that the use of carbonised biomass improved the reducing properties of the sinter and had a positive effect on its strength. At the same time it was observed that the amounts of CO_2 and NO_x as well as of CO and CH_4 emitted when using char were higher than those accompanying the use of coke breeze (only) as fuel. In order to reduce the impact of the char addition on flue gas parameters, sintering process-related tests also included the recycling of flue gas back to the sintering process. Flue gas properties were identified (both before dedusting and in the stack) using stationary flue gas analysers. The tests also included measurements of volatile organic compounds. The measurement results were used to determine the influence of the use of waste biomass-derived char on flue gas properties and primary parameters of the sintering process. The overall test results revealed failure to obtain expected reduction in the emission of undesirable compounds in off-gases (in relation to the use of the constant 15 % fraction of waste biomass-derived char and the gradual 45 % increase in the amount of off-gases recycled back to the process).

The Comparison of Cavitation Resistance of Laser Metal Deposited Layers
Karolina Płatek, Leszek Łatka, Bernard Wyględacz, Mirosław Szala, Monika Górnik, Artur Czupryński
DOI: 10.327730/mswt.2023.67.5-6.4

Key words: plasma hardfacing, powders, metallic and cermet layers, cavitation erosion resistance

Cavitation erosion is a specific case of wear, primarily affecting elements exposed to a watery environment, e.g. elements of pumps, valves and compression-ignition engines. Nickel-based alloys are regarded as materials of potentially high cavitation erosion resistance. The study discussed in the article involved the examination of cavitation erosion resistance of hardfacing layers made of NiCrBSi and NiCrBSi + 35 % wt. WC, deposited using the PPTAW method. Resistance to cavitation erosion was tested in accordance with the ASTM G-32 standard. The test results were subsequently compared with those obtained in relation to layers made of powders, the composition of which corresponded to stainless steel X5CrNiMo17-12-2 (used as a reference material). The results revealed that both nickel-based materials were characterised by significantly higher erosion resistance than that of the reference steel. The mean depth of the reference erosion of overlay welds made using X5CrNiMo17-12-2 amounted to 28.72 μm,

whereas the depth of erosion in the hardfacing layers made of NiCrBSi and NiCrBSi + 35 % wt. WC amounted to 7.19 μm and 6.92 μm respectively. The above-presented differences resulted from the significantly higher hardness and plastic strain resistance of the nickel-based overlay welds than those of the steel overlay weld. It was also observed that, in spite of their higher hardness, the layers made of NiCrBSi + 35 % wt. WC were characterised by lower cavitation erosion resistance than the layers made of NiCrBSi (which could be ascribed to the chipping of the hardening phase).

The MIG Welding of Thin-Walled Tantalum Elements
Tomasz Pfeifer, Józef Glogowski, Mirosław Łomozik, Eugeniusz Turyk
DOI: 10.327730/mswt.2023.67.5-6.5

Key words: Tantalum, TIG welding, repair welding

Research-related tests discussed in the article included the manual TIG welding of thin-walled elements made of tantalum, i.e. a sheet having a thickness of 0.55 mm, a tube (Ø10×1.0 mm) and a chemical equipment nozzle tip. Welding jigs were placed in a chamber filled with argon. The verification of the correctness of the welding technology developed during the tests included the welding-based filling of the crack in the girth fillet weld of the tantalum tube and the making of a repair weld in the nozzle tip.

Numerical Simulation and the Improved Welding of Storage Tank Heads with Respect to Minimised Welding Strains
Robert Czech, Marek Mróz, Janusz Pikuła, Marcin Spólnik, Bogdan Kupiec, Andrzej Dec, Marek Węglowski
DOI: 10.327730/mswt.2023.67.5-6.6

Key words: MAG, numerical simulation, storage tank, large-size structure, welding strains

The article presents results of Sysweld software programme-based tests involving the use of numerical simulation in the improvement of the welding of a storage tank head with respect to the minimisation of welding strains (distortions). The development of CAD models and mock-ups used in the FEM analysis was based on drawing documentation. The numerical simulation concerning the distribution of the field of displacements in the storage tank head was performed for four models, involving various welding sequences and directions. Related analyses involved the initial model applied in the technology currently used in the fabrication of storage tank heads as well as three new models (of welding sequences and directions). The comparative analysis, involving the initial model and the three new models, was concerned with different values of displacements in all directions (X, Y and Z) and at all characteristic points of the storage tank head. The simulation results revealed the existence of correlations between welding sequence and directions and varied distributions of fields of displacements (strains/distortions). Post-weld distributions of fields of displacements in the initial model and models 2-4 were characterised by varied values of displacements, yet also by the similar nature of tank head stress-triggered distortions. Dimensionally relevant displacements (distortions) of the storage tank head were observed in direction Z (i.e. direction perpendicular to the surface). In all the models subjected to analysis, the greatest displacements were identified in the areas of storage tank head nodes. Selected welding stages in the initial model were characterised by greater displacements than those observed in models 2-4. In line 1, higher values were observed at stages 8-10, 12 and 13. In turn, in line 2, higher values were observed at stages 8-10. In addition, in line 2, stages 11-14 were characterised by greater displacements in the initial model if compared with those identified in models 3 and 4. The FEM-based analysis of the tank head enabled the qualitative verification of tank-related welding schemes in terms of welding strains.

Innovative Electric Propulsion Systems for Aviation and the Nautical Industry
Tomasz Wolnik, Jan Mikoś, Maciej Brochocki, Cezary Górniak
DOI: 10.327730/mswt.2023.67.5-6.7

Key words: electric propulsion, boat propulsion, aircraft propulsion, propulsion system

The publication presents two innovative solutions of drive systems recently developed at the Łukasiewicz – Upper Silesian Institute of Technology, Center of Electric Drives and Machines. The first one is an integrated drive unit with a power of 21 kW, dedicated to floating vessels, in particular houseboats. The drive is characterized by a compact design and high energy efficiency. The second solution is a LEMoK 300 motor with a maximum power of 90 kW, dedicated to small aircraft. The motor only weighs 18 kg and has very high power density, which allowed its direct use in a prototype hybrid aircraft. Both solutions were developed in cooperation and at the request of business partners, i.e. Sun Yacht – Boating Holidays and Artus Aircraft. The paper presents the primary operational characteristics and data of the design solutions developed by the Authors.