



International Institute of Welding

A world of joining experience

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WELDING IN THE WORLD

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RESISTANCE SPOT WELDING OF UNCOATED AND ZINC COATED ADVANCED HIGH-STRENGTH STEELS (AHSS) - WELDABILITY AND PROCESS RELIABILITY-INFLUENCE OF WELDING PARAMETERS

In lightweight body shell mass production of automobiles, the resistance welding process for joining high-strength multi-phase steels, also called advanced high-strength steels (AHSS), is the most important joining procedure. For uncoated and hot dip zinc coated high-strength TRIP steels and complex phase steels, statements, about process reliability in resistance spot welding based on three-dimensional weldability lobes will be given. A comparison of special two-dimensional weldability lobes of uncoated and hot dip zinc coated AHSS sheets will be given, too. The weldability lobes are realised with different electrode forces for short-, medium- and long-time welds. Especially the influence of the electrode force and of the welding time has been studied in three-dimensional weldability lobes. A procedure for welding parameter optimisation in regard to maximal process reliability for AHSS is applied. Based on the electrode wear and the process reliability, statements relating to the weldability of AHSS are formulated. Furthermore, results concerning the influence of the welding parameters on the hardness and the fatigue behaviour of the spot welded joints will be given.

IIW-Thesaurus keywords: Resistance spot welding; Resistance welding; High strength steels; Steels; Coatings; Weldability; Influencing factors; Process parameters; Process conditions; Hardness; Mechanical properties; Fatigue tests; Mechanical tests; Comparisons; Optimisation; Automobile engineering; Reference lists.

Doc. IIW-1722-05 (ex-doc. III-1347-05) recommended for publication by Commission III "Resistance welding, solid state welding and allied joining processes".

PREDICTION OF SIGMA PHASE PRECIPITATION IN SUPER DUPLEX STAINLESS STEEL WELDMENTS

In order to predict the sigma (σ) phase embrittlement in multipass weldment of duplex stainless steels, the precipitation behaviours of the σ phase in the base metal and the weld metal were investigated using super duplex stainless steels (SAF2507 and DP3W) and a conventional duplex stainless steel (NAS64). In all the steels, the amount of the σ phase precipitated during an isothermal ageing process sigmoidally increased with the length of the ageing time. The kinetics of the σ phase precipitation in the base metal and the weld metal could be expressed approximately by the Johnson-Mehl type equation, however, the initiating time of the σ phase precipitation in the weld metal was longer than that in the base metal. The precipitation of the σ phase in the DP3W base metal was much delayed and depressed compared with the SAF2507 and NAS64 base metals. Increasing the amount of the σ phase drastically decreased the absorbed impact energies of aged steels. They fell to as low as 1/4 of the unaged values when the amount of the σ phase exceeded 5 %. The precipitation of the σ phase in duplex stainless steels during multiple thermal cycle process were predicted using the additivity rule. We predicted that the largest amount of the σ phase and the most significant degradation of impact toughness would occur in the base metal region (HAZ) for peak temperatures of 1 100-1 300 K in multiple thermal cycle.

IIW-Thesaurus keywords: Duplex stainless steels; Stainless steels; Steels; Parent material; Weld metal; Age hardening; Hardening; Heat treatment; Comparisons; Thermal cycling; Prediction; Multirun welding; Microstructure; Impact toughness; Mechanical properties; Toughness; Sigma; Embrittlement; Reference lists.

Doc. IIW-1717-05 (ex-doc. IX-2150-05) recommended for publication by Commission IX "Behaviour of metals subjected to welding".

RECENT ADVANCES AND IMPROVEMENTS IN THE SIMULATION OF RESISTANCE WELDING PROCESSES

Along with introduction of the new welding software SORPAS® since 1999, numerical simulation of resistance welding has gained more and more industrial applications. It has now been applied by many leading manufacturing companies for evaluating the weldability of metal combinations and testing the welding process parameters. In the past few years, new developments have been focused on optimisation of process parameters. In this paper two new functions are presented for automated optimisation of welding current in spot welding. One function is for automated simulations in a specified range of welding current from a low limit to a high limit with a user-defined increment. The results of simulation show a curve of the evolution of the weld nugget diameter as a function of the welding current with indication of possible expulsions. The other function is for fully automated optimisation seeking for the optimised welding current for achieving an objective size of weld nugget. Further developments and improvements have also been made for simulations of projection welding and micro resistance welding especially regarding to dynamic deformation of materials and evolution of the contact interfaces. Examples of simulations are presented to demonstrate the applications of the software.

IIW-Thesaurus keywords: Resistance spot welding; Resistance welding; Projection welding; Simulating; Optimisation; Microjoining; Current; Process parameters; Process conditions; Reference lists.

Doc. IIW-1721-05 (ex-doc. III-1345-05) recommended for publication by Commission III "Resistance welding, solid state welding and allied joining processes".

CONCERNS FOR THE HEALTH AND SAFETY OF WELDERS IN 2005

The author presents a brief review of some of the health and safety topics he believes merit priority attention by the welding industry. These comprise avoiding wear, tear and health wastage; poor standardisation of risk assessment of fume exposure; manganese, manganism, Idiopathic Parkinson's Disease and welding; susceptibility to pneumonia; eye malignancy; excess risk of lung cancer in welders; and preventing a new epidemic of old occupational diseases in industrialising countries.

IIW-Thesaurus keywords: Welding; Health and safety; Fume; Occupational health; Toxic materials; Manganese; Occupational diseases; Reference lists.

Doc. IIW-1719-05 (ex-doc. VIII-1993-05) recommended for publication by Commission VIII "Health and Safety".

OPTIMUM DESIGN AND COST COMPARISON OF A WELDED PLATE STIFFENED ON ONE SIDE AND A CELLULAR PLATE BOTH LOADED BY UNIAXIAL COMPRESSION

Two types of stiffened plates are used in welded structures as follows: plates stiffened on one side and cellular ones, which consist of stiffeners welded between two deck plates. For a realistic cost comparison each type is optimised for minimum cost in the case of axial compression. Both plates are longitudinally stiffened by halved rolled I-section ribs. The deck plate thickness as well as the dimensions and number of stiffeners are sought, which minimise the cost function and fulfil the design and fabrication constraints. The cost function includes the material and fabrication costs. The design constraints relate to the overall and local plate buckling. It is shown that the cellular plate is cheaper than the plate stiffened on one side, since its large torsional stiffness enables us to use smaller plate thicknesses and smaller stiffener height.

IIW-Thesaurus keywords: *Plate; Reinforcement; Structural members; Costs; Economics; Comparisons; Optimisation; Buckling; Deformation; Distortion; Design; Submerged arc welding; Arc welding; Compression; Loading; Reference lists.*

Doc. IIW-1718-05 (ex-doc. XV-1191-05) recommended for publication by Commission XV "Design, analysis and fabrication of welded structures".

CALCULATION METHODS OF ADHESIVE BONDED HYBRID BEAMS IN THE CIVIL ENGINEERING FIELD

Adhesive bonding is predominantly used in the automotive and aircraft industry but can hardly be found in the civil engineering discipline. The lack of design standards in terms of adhesive bonded joints in the civil engineering field is a main reason for this situation. User-friendly calculation methods are important for the success of a new technique such as adhesive bonding. This paper presents a calculation method to design adhesive bonded beams under uniform load; e.g., wind force. This concept can be used for both beams made of one material and hybrid beams made of different materials such as glass and steel or other materials. Adhesive bonding is very advantageous for hybrid beams since it can minimise stress peaks, which occur while using punctiform joining concepts or due to different thermal expansions of the used materials. The paper presents the derivation of equations for the stress and bearing capacity analysis as well as a numerical calculation concept with the Finite Element Method (FEM) for an adhesive bonded beam made of steel and glass. Such hybrid beams are new developments in civil engineering and can be used in roof or facade structures.

IIW-Thesaurus keywords: *Adhesives; Adhesive bonding; Civil engineering; Mathematical models; Computation; Comparisons; Finite element analysis; Glass; Steels; Girders; Structural members.*

Doc. IIW-1715-05 (ex-doc. XVI-840-05) recommended for publication by Commission XVI "Polymer joining and adhesive technology".

MINIMISING ABRASION AND FINE FLUFF IN VIBRATION WELDING

Plastics can be joined reliably and permanently with a large number of welding processes. Vibration welding is used primarily when large parts have to be joined rapidly, firmly and reliably. Despite the many advantages of this joining method, the user often has to accept the drawback of abrasion and fine fluff formation. Vibration welding itself belongs to the friction welding methods. Since vibration welding is a process that has been successfully employed for many years, the process sequence has already been studied in great detail and divided up into four process phases in the context of this work. The first process phase, i.e. the phase up until the joining surface has melted over its full surface area, has been identified as the decisive phase for the development of fine fluff and the phase in which its quantity and size is determined. Tests with thermal preheating were conducted at the institute of plastics engineering in a bid to influence the development of fine fluff during the initial phase. These showed that the first process phase, which determines the abrasion, can be greatly reduced and, in some cases, completely eliminated through infrared radiation (IR) preheating of the workpiece.

IIW-Thesaurus keywords: *Wear; Vibration; Welding; Thermoplastics; Plastics; Preheating; Heat treatment; Infrared; Radiation; Process parameters; Process conditions; Optimisation; Practical investigations.*

Doc. IIW-1716-05 (ex-doc. XVI-842-05) recommended for publication by Commission XVI "Polymer joining and adhesive technology".

INTERNATIONAL ACTIVITY IN HEALTH AND SAFETY IN WELDING – THE INTERNATIONAL INSTITUTE OF WELDING (IIW)

This paper describes the role purpose and current activities of Commission VIII (Health and Safety) in promoting the wellbeing of welders and the welding industry in general. Appropriately qualified people are encouraged to seek membership and play their part in this important work.

IIW-Thesaurus keywords: *Welding; Health and safety.*

Doc. IIW-1720-05 (ex-doc. VIII-2003-05) recommended for publication by Commission VIII "Health and Safety".