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DESIGN OF WELDMENTS—PART II

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The classified subject selected for this issue of the IWJ is Design of Weldments—Part-II. Part-I has been published in April 1983 issue of the journal. Each of the retrieved articles is referred to by a WRI file number, title of the article, the author(s) name, the journal code with volume and issue number. These details are followed by the abstract and keywords of the article.

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1. **037005** *Fundamentals of pressure vessel design.*

BOTTEMA. M. J. W.W. V.006 No. 001.68

Abstract: This article was submitted to Commission XI "Pressure vessels, boilers and pipelines" of the IIW. The design procedure of pressure vessel is indicated. The procedure consists of a number of elements, which to a certain degree can be studied separately. Typical schematic diagrams and nomographs are available. Service conditions are highlighted. Failure analysis have been made and some of the items such as types of failure, stress types, allowable stresses, various calculations and considerations have been dealt with in more detail.

Keywords: Design: Pressure; Pressure Vessels; Temperature; Stress Analysis; Chemical Analysis; Development; Pressure Parts; Components; Diagrams; Nomographs.

2. **037016** *Some remarks on cumulative damage in fatigue testing and fatigue design.*

FREUDENTHAL. A. M. W.W. V.006. No. 004.68

Abstract: This article was submitted to Commission XIII "Fatigue Testing" of the IIW. The purpose of the article was to present a concise summary of the most important established facts that are relevant to fatigue testing and fatigue design and the author had made an attempt to present these facts together with a short discussion of their implications. Damage accumulation resulting from cyclic straining proceeds by different mechanisms in the different stages of the fatigue process and at different levels of the applied cyclic strain are indicted. In view of the difference in the significant mechanisms of damage accumulation in the material and in the structure, conclusions reached in materials fatigue research are not directly applicable to structures. Studies of fatigue crack propagation process in large specimens and structural parts have been demonstrated.

Keywords: Metallurgy; Steels; Mech. properties; Fatigue Strength; Mech. Testing; Design; Fatigue loading; Development; Fatigue; Crack propagation; Nomographs.

3. **037093** *The design, fabrication and erection of steel structures with mechanised arc welding.*

BLODGETT. O.W., W.J.V.047 No. 008.8.68

Abstract: This is a paper presented at the AWS 49th Annual meeting held in Chicago. The paper deals in detail with the design, fabrication and erection, of steel structures with mechanised arc welding and the associated cost advantages and the use of items such as a welding head with travel motor and a self-propelled tractor which guides itself and hence electrode holders, along the joint. Typical diagrams on joint preparation and the technique of using partial penetration welds are indicated. Photographs are available where in a structural beam becomes a weldment when passages are cut through its web for duct work. This method of saving space between floors increases the amount of welding in building construction. Field erection welding methods are also throughly discussed in this paper.

Keywords: Welding; Structures; Design; Manufacturing; Construction; Mechanisation; Equipment;

Development; Structural members; Electric arcs.

4. **041002** *Integration of metallurgical Fracture Mechanics concepts of transition temperature factors relating to fracture safe design for structural steel.*

PELLINI. W. S. and LOSS F. J. WRC No. 141.06.69

Abstract: This article deals with the brittle to ductile transition for cleavage fracture of steels investigated with integrated considerations of micromechanical and macromechanical features. The evolution of transition temperature approaches to fracture-safe design has been based on concepts that metal ductility factors should override mechanical constraint factors, in the higher temperature range, determined by dynamic fracture tests has provided the necessary guidance for the development of improved steels. The dynamic tear test represents the most advanced engineering test which provides accurate indexing of the true transition temperature range and the specific interval in this range for which fracture mechanics applies. All of these factors have been integrated into simple reference diagrams which index flaw size-stress relationships for fracture initiation in the transition range. The Fracture Analysis Diagram (FAD) procedure has been extended to cover the full range of thickness. The experience factors serve to validate the predictions of Fracture Mechanics theory and continue to provide engineering assurance that the analytical methods can be relied on.

Keywords: Cracking; Design; Dynamic behaviour; Fracture mechanics; Metallurgy; Structural steels; Temperature; Crack initiation.

5. **041233** *Design aspects of fabrications for modern aircraft gas turbines.*

WILKINSON S. C. M.C.B.W.J. V.001 No. 001.01.69

Abstract: This paper is presented at the Spring Meeting of the Welding Institute in April 1968. The development of the gas turbine as an aircraft power plant has been so rapid that it is difficult to appreciate that only 25 years ago very few people had heard of this method of aircraft propulsion. Since the introduction of the gas turbine, much progress has been made in terms of performance and weight. New and improved materials are a continuous requirement for the aero engine industry and as the temperature and pressure requirements increase, so the use of steel and titanium grows at the expense of materials such as magnesium and aluminium. To obtain maximum utilisation of the expensive materials which have been developed, fabrication technology has become a major factor in the manufacture of gas turbines. The paper deals in detail with fabrication and design aspects of these materials which are used in aircraft gas turbine manufacture.

Keywords: Development; Gas turbines; Joint design; Stress analysis; Weld shape; Welding; Design; Aircraft fabrication.

6. **041330** *Problems associated with the design, inspection and use of large diameter ferritic/ austenitic joints in power plant.*

ROWLEY. T., ROWEERRY. T. R. and ALLDRIDGE. C. M.C.B.W.J. V.001 No. 012.08.69

Abstract: Where austenitic steam pipe-work has been used in conventional coal-fired plant, transition joints have been required, to connect this pipe work to the ferritic turbine casting material. It is here that the transition joints of 230-413 mm o.d. has been used at steam conditions upto 1.0342 h bar/m^2 (1500 lbf/in^2) and 566°C. It is of interest to establish how thicker section joints would behave at higher stress. Since the first introduction of large diameter transition joints in 1954, considerable service experience has been gained in the performance of certain types, together with information obtained from service simulation trials of full size assemblies attached to an operating boiler. During the period 1954-69, only one type of joint has been eliminated from the plant because of complete failure, but all the other joint types in service on plant have shown incidences of bore cracking or external surface defects. This paper examines the design and performance of transition joints in large diameter pipes of wall thickness 48.5-84.4 mm and considers what factors are most significant for assessing the potential performance of joints at more arduous conditions. At the present time no specific design code is available for transition joints and this paper indicates the problems involved in obtaining relevant design data.

Keywords: Development; Dissimilar metals; Ferritic; Mech. properties; NDT; Quality control; Steels; Weldability; Welding; Design.

7. **049087** *Design and welding fork truck lift assemblies.*

DON WIEDENHEFT W.J. V050 No. 007.07.71

Abstract: The need for new performance requirements, higher strength properties, better structural wear characteristics, better weldability and reduced costs resulted in a new lift assembly design for fork lift trucks. This paper deals with evaluation of weldability for proper material and welding process selection, the prime weld parameters-chemistry and heat input were studied as to their relation to maximum heat-affected zone hardness attained. Each of the material possibilities was welded with the conventional low hydrogen covered electrode process, the CO_2-shielded bare electrode process and the CO_2-shielded flux cored

electrode process. The combination of material and welding processes that best meets the requirements is a modified medium carbon steel, welded with a flux-cored electrode process with CO_2 shielding gas and no preheat or postheat treatment.

Keywords: Design; Hydrogen; Mech. properties; Process parameters; Weldability; Welding; Covered electrodes; Electric arcs; Cranes; Materials handling.

8. **053054** *Design of tapered Members.*

LEE. G. C., MORRELL. M. L. and KETTER R. L. W.R.C. No. 173.6.72

Abstract: This paper was sponsored for publication by the Structural Steel Committee of the Welding Research Council. In this paper, both analytical and experimental investigations were conducted on the behaviour of tapered structural members. This paper summarizes many of the conclusions of those investigations concerned primarily with the over-all analysis of tapered member framing and the development of the design formulas regarding the proportioning of tapered members. A general treatment for any arbitrarily tapered beam would be very ambitious and in general impractical due primarily to the difficulties associated with the coupling of flexural and torsional deformations. For this reason the most common tapered I section was chosen for examination, and design formulas for such members were developed. However the formulas suggested may also be applied to other sections which are sufficiently braced to prevent torsional deformation. A later section of this report is devoted to the problem of effective length of a tapered column in rigid frames.

Keywords: Deformation; Design; Frames; Shape; Stress analysis; Stress; Structural members; Welding; Geometry; Mechanical Engg.

9. **053132** *Determination of thickness of domed pressure vessel ends by non-iterative procedures.*

STANLEY. P. M.C.B.W.J. V.004 No. 005.05.72

Abstract: This is a paper dealing in detail with suitable mathematics, the design and determination of thickness of domed pressure-vessel ends by non-iterative procedures. Iterative procedures entail first the assumption and then derivation of a thickness value, the process being repeated until assumed and derived values are identical. It is timeconsuming and should be avoided. The thickness of a domed (ie. hemispherical, semi-ellipsoidal or torispherical) pressure vessel end in the codes (BS 1113, BS 1515 parts 1&2 and BS 3915) is determined from standard equations. The procedure for determining the thickness of an unpierced end is given. Alternative procedures are given here which permit a direct once-through determination of thickness without iteration, for both the unpierced end and the end with uncompensated openings. Suitable graphs are also available in this paper.

Keywords: Design; Thickness; Welding; Components; Pressure vessel; Pressure; Process procedures; Spheres; Edge welds; Cylinders.

10. **053170** *Determination of fatigue design stresses for welded structures from an analysis of data.*

GURNEY T. R. & MADDOX. J. M.C.B.W.J. V 004 No. 011.11.72

Abstract: This article summarises work described in Welding Institute Research Report E/44/72-A reanalysis of fatigue data for welded joints in steel. In this article, fatigue test data for a large number of welded joints have been analysed statistically in an attempt to derive design S-N curves which express fatigue strength in terms of known probability of failure. Also, a correction procedure was applied to take account of the fact that specimens with transverse welds would not have contained residual stresses of the level likely to arise in actual structures. The resulting design curves, which had slopes that were consistent with propagation data, was used in BS 153. It is emphasised that this work is a continuing exercise and that as new data become available it will be incorporated in the analysis. It follows that the design stresses suggested should not be regarded as final.

Keywords: Design; Data; Fatigue Strength; Metallurgy; Residual stresses; Structures; Welding; Cracking; Fatigue loading; Analysis.

11. **054179** *Automation of statistical calculations and analysis of the characteristics of welded joints.*

BURMISTROV V. T. W.P.V019. No. 005.05.72

Abstract: This article considers problems involved in the automation of labourious statistical calculations and the analysis of the design, technological and strength particulars of welded joints from the results of inspection and testing by existing methods. The initial relationships for the accepted method of solving the problem with a BESM-4 electronic computer are given. Provision was made for calculating sufficient, effective and unbiassed estimates of the mean value, the variance and the mean square deviation for each column, the coefficients of pairwise correlation and regression equations and also the correlation ratios. For this purpose a universal programme was worked out and stored in the memory of a BESM-4 machine, and the results of the corresponding calculations were obtained.

Keywords: Design; Automation; Process Parameters; Quality Control; Strength; Welding; Computation; Analysis; Characteristics; Welded Joints.