Modeling Of Welded Connections In Solidworks Simulation

Preliminary Photoelastic Investigation of Shearing Stress Distribution in Transversely Welded Connections
Fatigue of Welded Connections
Enhancements to Program IDARC
Design of Welded Tubular Connections
Thermomechanical Modeling of Welding and Galvanizing a Steel Beam Connection Detail to Examine Susceptibility to Cracking
Characterization and Modeling of Polymers in the Vicinity of Hot-plate Welded Joints
Practical Finite Element Analysis
Further Refinement of a Methodology for Fatigue Life Estimation in Resistance Spot Weld Connections
Modeling of Cleavage Fracture in Connections of Welded Steel Moment Resistant Frames
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A Fatigue Failure Mode Transition Criterion for Sizing Load Carrying Fillet Welded Connections
Guidelines for Modeling Cylinder-To-Cylinder Connections
The Theory of Welded Connections
Hybrid Simulation of Steel Frames with Semi-rigid Connections
Residual Stress Analysis on Welded Joints by Means of Numerical Simulation and Experiments
Annals of Scientific Society for Assembly, Handling and Industrial Robotics
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Metallurgical Modelling of Welding
Design of Joints in Steel Structures
Connection Model for the Seismic Analysis of Welded Steel Moment Frames
Design, Fabrication and Economy of Welded Structures
Behavior of Eccentrically and Concentrically Loaded Fillet Welded Connections
Laboratory Testing and Finite Element Modeling of Precast Bridge Deck Panel Transverse Connections
Finite Element Study of Mast Arm Socket Welded Connections
Contribution on the behavior of welded joints to metallic structural elements with tubular section
Computational Welding Mechanics
A Thermo-metallurgical Model Predicting the Strength of Welded Joints Using the Finite Element Method

FRANKLIN CHOI

Preliminary Photoelastic Investigation of Shearing Stress Distribution in Transversely Welded Connections CRC Press

Local approaches to fatigue assessment are used to predict the structural durability of welded joints, to optimise their design and to evaluate unforeseen joint failures. This standard work provides a systematic survey of the principles and practical applications of the various methods. It covers the hot spot structural stress approach to fatigue in general, the notch stress and notch strain approach to crack initiation and the fracture mechanics approach to crack propagation. Seam-welded and spot-welded joints in structural steels and aluminium alloys are also considered.This completely reworked second edition takes into account the tremendous progress in understanding and applying local approaches which has been achieved in the last decade. It is a standard reference for designers, structural analysts and testing engineers who are responsible for the fatigue-resistant in-service behaviour of welded structures. Completely reworked second edition of a standard work providing a systematic survey of the principles and practical applications of the various methods Covers the hot spot structural stress approach to fatigue in general, the notch stress and notch strain approach to crack initiation and the fracture mechanics approach to crack propagation. Written by a distinguished

team of authors
Fatigue of Welded Connections Elsevier
This book details the basic concepts and the design rules included in Eurocode 3 "Design of steel structures" Part 1-8 "Design of joints". Joints in composite construction are also addressed through references to Eurocode 4 "Design of composite steel and concrete structures" Part 1-1 "General rules and rules for buildings". Moreover, the relevant UK National Annexes are also taken into account. Attention has to be duly paid to the joints when designing a steel or composite structure, in terms of the global safety of the construction, and also in terms of the overall cost, including fabrication, transportation and erection. Therefore, in this book, the design of the joints themselves is widely detailed, and aspects of selection of joint configuration and integration of the joints into the analysis and the design process of the whole construction are also fully covered. Connections using mechanical fasteners, welded connections, simple joints, moment-resisting joints and lattice girder joints are considered. Various joint configurations are treated, including beam-to-column, beam-to-beam, column bases, and beam and column splice configurations, under different loading situations (axial forces, shear forces, bending moments and their combinations). The book also briefly summarises the available knowledge relating to the application of the Eurocode rules to joints under fire, fatigue, earthquake, etc., and also to

joints in a structure subjected to exceptional loadings, where the risk of progressive collapse has to be mitigated. Finally, there are some worked examples, plus references to already published examples and to design tools, which will provide practical help to practitioners.

Enhancements to Program IDARC
Elsevier
Analytical and experimental studies were conducted to investigate the application of fracture tough overlay welds for the repair and/or upgrading of welded steel moment connections. Cyclic tests on 5 exterior connection specimens were conducted. Analytical studies consisted of detailed finite element simulations of the exterior connection using both plate elements and solid elements. Six finite models were developed for the intermediate specimen and included the original configuration and 5 variations that included the application of weld overlays.

Design of Welded Tubular Connections
CRC Press
This Open Access proceedings present a good overview of the current research landscape of industrial robots. The objective of MHI Colloquium is a successful networking at academic and management level. Thereby the colloquium is focussing on a high level academic exchange to distribute the obtained research results, determine synergetic effects and trends, connect the actors personally and in conclusion strengthen the research field as well as

the MHI community. Additionally there is the possibility to become acquainted with the organizing institute. Primary audience are members of the scientific association for assembly, handling and industrial robots (WG MHI).

Thermomechanical Modeling of Welding and Galvanizing a Steel Beam Connection Detail to Examine Susceptibility to Cracking BoD – Books on Demand

In load-carrying fillet-welded connections, two distinct fatigue failure modes are possible depending upon fillet weld leg size and loading conditions. One is weld toe cracking through base plate thickness and the other is through weld metal, often referred to as weld root cracking. Weld root cracking mode has always been a concern in design and analysis of load-carrying fillet welded connections. In the past, it has been noticed that weld root cracking mode could be avoided by enlarging the fillet weld size or weld penetration, and numerous theoretical studies had been performed to construct such a design reference to prevent weld root cracking. However, the theoretically developed design reference cannot include shop floor practices, which may result in unfavorable fillet weld size design. In this study, experimentally based analysis on fatigue failure mode transition behavior is performed based on a recent comprehensive fatigue testing program in support of construction of lightweight ship structures reflecting typical shop floor practices and through introducing a newly developed analytical weld throat

stress model and misalignment-induced stress concentration factors. As a result, a critical weld size reflecting typical shop floor practice is obtained. It is determined that the actual critical weld size obtained from test data is much lower than the theoretical one due to the combination effect of weld penetration and misalignments. Finally, a statistical procedure is proposed to construct a mathematical model that is able to provide a confidence level to avoid weld root cracking mode for designed fillet weld size.

Characterization and Modeling of Polymers in the Vicinity of Hot-plate Welded Joints GRIN Verlag

Highlights of the book: Discussion about all the fields of Computer Aided Engineering, Finite Element Analysis Sharing of worldwide experience by more than 10 working professionals Emphasis on Practical usuage and minimum mathematics Simple language, more than 1000 colour images International quality printing on specially imported paper Why this book has been written ... FEA is gaining popularity day by day & is a sought after dream career for mechanical engineers. Enthusiastic engineers and managers who want to refresh or update the knowledge on FEA are encountered with volume of published books. Often professionals realize that they are not in touch with theoretical concepts as being pre-requisite and find it too mathematical and Hi-Fi. Many a times these books just end up being decoration in their book shelves ... All the authors of this book

are from IITÂ€Â™s & IISc and after joining the industry realized gap between university education and the practical FEA. Over the years they learned it via interaction with experts from international community, sharing experience with each other and hard route of trial & error method. The basic aim of this book is to share the knowledge & practices used in the industry with experienced and in particular beginners so as to reduce the learning curve & avoid reinvention of the cycle. Emphasis is on simple language, practical usage, minimum mathematics & no pre-requisites. All basic concepts of engineering are included as & where it is required. It is hoped that this book would be helpful to beginners, experienced users, managers, group leaders and as additional reading material for university courses.

Practical Finite Element Analysis CRC Press

There has been a rise in the number of failures of traffic cantilever signal mast arms in recent years due to increasing spans of mast arms and the inherent flexibility of the structures. This increased flexibility makes mast arm socket welded connections more critical. Extensive finite element analysis using Abaqus was carried out in this study to determine the effect of different geometric variables like end plate thickness, mast arm diameter, mast arm thickness and weld geometry on stress at the weld toe by estimating the Stress Concentration Factor (SCF) at weld toe. Two different approaches, Dong’s

Structural Stress and Det Norske Veritas (DNV), were used to calculate the SCF at weld toe. To study the effect of end plate thickness, six models with different end plate thicknesses were analyzed. Effect of geometric variables like mast arm thickness, mast arm diameter, and weld geometry were studied for all the six different end plate thicknesses. It was found that of all of the geometric variables analyzed, end plate thickness had a greater effect on stresses at weld toe. Experimental results of fatigue behavior of mast arms socket welded connections from other research projects were used to investigate the hypothesis which states that, fatigue life (N) is some constant (A) times the stress range (SCF x SR) raised to the third power, where the constant (A) is the fatigue life coefficient. Investigation of the above stated hypothesis was done using both approaches for calculating SCF, namely Dong's Structural Stress and DNV. From hypothesis investigation, it was found that scatter in the experimental data is reduced when maximum stress range at weld toe (SCF x nominal stress range) is plotted against fatigue life as compared to plotting nominal stress range against fatigue life

Further Refinement of a Methodology for Fatigue Life Estimation in Resistance Spot Weld Connections John Wiley & Sons

Computational Welding Mechanics (CWM) provides readers with a complete introduction to the principles and applications of computational welding including coverage of the methods

engineers and designers are using in computational welding mechanics to predict distortion and residual stress in welded structures, thereby creating safer, more reliable and lower cost structures. Drawing upon years of practical experience and the study of computational welding mechanics the authors instruct the reader how to: - understand and interpret computer simulation and virtual welding techniques including an in depth analysis of heat flow during welding, microstructure evolution and distortion analysis and fracture of welded structures, - relate CWM to the processes of design, build, inspect, regulate, operate and maintain welded structures, - apply computational welding mechanics to industries such as ship building, natural gas and automobile manufacturing. Ideally suited for practicing engineers and engineering students, Computational Welding Mechanics is a must-have book for understanding welded structures and recent technological advances in welding, and it provides a unified summary of recent research results contributed by other researchers.

Modeling of Cleavage Fracture in Connections of Welded Steel Moment Resistant Frames Woodhead Publishing

Hot-dip galvanizing is the process of submerging steel elements into molten zinc to form a metallurgically bonded zinc coating that serves as corrosion protection for the steel substrate. Used with great success on an industrial scale for many decades, hot-dip galvanizing is

a ubiquitous process. On occasion, cracks in steel members develop during galvanizing. While such cracking remains a poorly understood phenomenon, previous research has attributed the formation of cracks to the combined effects of residual strains introduced by welding and temperature-induced deformations caused by the hot-dip galvanizing process. This article presents thermomechanical analyses of a structural steel beam with a welded double-angle connection detail where cracking occurred during hot-dip galvanizing. Three-dimensional finite element models of the beam and connection detail were analyzed using the finite element analysis software Abaqus (Dassault Systèmes, Vélizy-Villacoublay, France). The welding process was simulated using the Abaqus Welding Interface, maintaining the welding sequence of the connection. After welding, the entire beam was subjected to a temperature field that was specified through a user subroutine in Abaqus, simulating the hot-dip galvanizing process. The temperature field had a bath temperature of 450°C and a thermal cycle that included dipping, dwell time, and removal from the bath. Material properties used in the simulation were nonlinear and temperature dependent. The parameters of the study were the welding sequences, heat input during welding, and the depth of the double-angle connection. It was observed that strain demands due to welding and hot-dip galvanizing were high magnitude at the

cracked location in the beam. The relative significance of strain demands due to welding and of hot-dip galvanizing on the propensity for the beam to develop cracks are discussed.

Improvement of Welded Connections Using Fracture Tough Overlays Springer Nature

This presentation examines the basic concepts behind fatigue including the definition, application and causation; as well as welded connections and variables affecting fatigue. The presentation then reviews the aspects of the design model including fatigue testing, categories of connection details and predictive model.

Structural Hot-Spot Stress Approach to Fatigue Analysis of Welded Components Springer

These proceedings cover the fields of different materials and fatigue of welded joints, thin-walled structures, tubular structures, frames, plates and shells and also incorporate special optimization problems, fire and earthquake resistant design, special applications and applied mechanics, and thus provide an important reference for civil and mechanical engineers, architects, designers and fabricators. Proceedings cover the fields of different materials and fatigue of welded joints, thin-walled structures, tubular structures, frames, plates and shells Also incorporate special optimization problems, fire and earthquake resistant design, special applications and applied mechanics Provide an important reference for civil and mechanical engineers, architects,

designers and fabricators

A Model for Prediction of Fracture Initiation in Finite Element Analyses of Welded Steel Connections CRC Press

Fully-welded connections for earthquake resistance of steel frames are costly and their performance is adversely affected by weld defects and low-cycle fatigue. An alternative to welded connections is the bolted top and seat angle connection. The latter configuration can be designed to exhibit moment capacities that are lower than both the connected beams and columns. Such ǿ8partial strength connectionsǿ9 provide attractive seismic design features by alleviating the overstrength requirements that codes impose on column design, to ensure a weak beam-strong-column performance. Towards this end, an experimental program was initiated at the University of Illinois, as described below. Full-scale hybrid simulation of a semi-rigid steel frame is conducted and its ductility and drift ratios are studied. The experimental component of the simulation comprises a beam-column subassembly with top and seat angle with double web angle connection and is instrumented to measure moment-rotation characteristics, as well as strains on the individual angle plates and slip of bolts. The simulation setup and software is described in detail. Simulation results are presented including story drift and base shear time histories. In addition, the moment-rotation diagrams from the hybrid simulation and cyclic testing are

presented. Finally, a phenomenological model based on the Bouc-Wen formulation is fitted to the moment-rotation data. The model is suitable for extensive parametric studies on the type of connection tested, to guide future large scale testing and to derive design guidance.

Connections in Steel Structures

Springer Science & Business Media

Doctoral Thesis / Dissertation from the year 2022 in the subject Engineering - Civil Engineering, grade: Summa cum laude, , language: English, abstract: Steel structures, which are made of hollow section profiles are mainly used for construction structures. There are many fields of applications for structures made of hollow section profiles. Hollow section profiles are lightweight and have got a high resistance to compression, which is an advantage for column structures. The most common profile types have squared or circular hollow cross sections. Connecting two or more pipes by welding, the joints have got different shapes. These joints are part of trusses or columns with a tree-shaped optic. The standards have got restrictions regarding the geometry, material or load cases. By choosing a node, which is excluded in the standards, designing engineers have to create their own models. This thesis is about the designing of a Y-shaped steel joint, full overlapped on top connection, which is not defined in current standards up to the time the thesis is created. In this thesis only uniplanar joints are investigated. A special focus is on the

welding line, which has got a three-dimensional shape. The aim is to figure out the influence on the inclination angle between the two members on the resistance of the joint. Beside this, the profile shape and profile thickness vary to see the differences in their resistance. Square and circular hollow section profiles are in focus. To analyse the behaviour of the different steel joints, a numerical and experimental investigation is executed. Design charts are created as a medium for designing engineers to calculate the ultimate resistance in the elastic and plastic state, depending on the steel profile, thickness and inclination angle. The structure of the thesis is split into four main parts. Firstly, there is an explanation of the general topic with its difficultness. Secondly, there is the state-of-the-art presentation of literature and standards in this range. Thirdly, there is a numerical analysis of the joints. The basement of the numerical studies is detailed in pre-studies, which explain and compare different mesh types or geometrical variations. Fourthly, there is an experimental verification of the numerical tests. It is figured out, if the inclination angle increase, the resistance of the steel joint will decrease significantly. This effect is non-linear. Beside this, it is found, that the full overlapped joint with the squared profile has got a higher resistance than a comparable joint with a similar circular hollow section.

Pipeline Integrity Management Under Geohazard Conditions FINITE

TO INFINITE

This book on Pipeline Integrity Management Under Geohazard Conditions (PIMG), includes 42 peer-refereed papers prepared by key industry subject matter experts. The papers compile the results of extensive research as well as assemble pipeline operators' experiences in tackling geohazard challenges for both new and vintage pipelines. In addition to the experts' papers, the editors of the book prepared an introduction to each section that includes summary review of the different papers in the section. The papers are presented in 10 sections addressing all aspects of geohazard integrity management. The fi rst section highlights the geohazard impact on pipeline integrity. The next four sections focused on the geohazard demand and its management by addressing geohazard characterization, monitoring, management and mitigation. The following four sections focused on the strain capacity by addressing strain capacity predictions, management and monitoring. The last chapter tied both strain demand and capacity through structural reliability and risk assessment protocols. The information in this book is not only intended for use by pipeline designers and operators but it is expected to also be used by regulators and standards writing organizations. It is therefore, the intention of ASME to update this book on a regular basis as new data, case studies and advancement of the state of practice become available.

Finite element modelling for the assessment of residual stresses and failure mechanisms in welded connections

This paper investigates the implementation of damage mechanics into finite element models of fillet-welded structural steel assemblies in order to predict connection fracture at realistic displacements. Utilizing a previously developed IDS (instability, ductile, and shear) material failure envelop for aluminum extrusions, the failure loci of the aluminum material were scaled to meet the point of fracture in welded steel lap splice assemblies, loaded in-plane at various angles, with a fillet weld leg size of 5 mm. The weld electrode under investigation was CSA E480xx, which is equivalent to AWS E70xx electrodes. A linear relationship for damage data scaling factors, as they relate to the loading angle of the fillet weld, was established. Three similar assemblies with fillet leg sizes of 9 mm were modeled employing this damage scaling relationship and deformations at fracture were found to coincide with experimental results and established relationships. This modeling methodology was also investigated for use in a T-stub connection tension scenario.

Fatigue Assessment of Welded Joints by Local Approaches

This study applies an advanced micro-mechanics model of cleavage fracture in ferritic steels to examine the fracture behavior of welded, moment resistant steel frames of the type widely

constructed prior to the Northridge earthquake. The Weibull stress model for cleavage, coupled with 3-D analyses of connections containing crack-like defects, provides a quantitative estimate of the cumulative failure probabilities with increasing beam moment. A set of previously conducted, 15 full-scale tests on T-connections of the pre-Northridge design provide fracture moments to calibrate parameters of the Weibull stress model. Once calibrated, the model is used to examine the importance of welding-induced residual stresses in the lower-flange and the effects of seismic loading rates. The model predicts the cumulative failure probability as a function of beam moment for these various configurations.

Mathematical Model for Welded Connection Behavior

Although tubular structures are reasonably well understood by designers of offshore platforms, onshore applications often suffer from "learning curve" problems, particularly in the connections, tending to inhibit the wider use of tubes. This book was written primarily to help this situation. Representing 25 years of work by one of the pioneers in the field of tubular structures, the book covers research, synthesis of design criteria, and successful application to the practical design, construction, inspection, and lifetime monitoring of major structures. Written by the principal author of the AWS D1.1 Code Provisions for Tubular Structures this book is intended to be used in conjunction with the AWS

Structural Welding Code - Steel, AWS D1.1-88 published by the American Welding Society, Miami, FL, USA. Users of this Code, writers of other codes, students and researchers alike will find it an indispensable source of background material in their work with tubular structures.

Modeling of Residual Stress and Distortion in Welded Structures

The overall objective of this research is to develop a general model of fatigue crack propagation in resistance spot-welded joints. An important feature of this development is that the model and accompanying methodology should be accessible to designers evaluating fatigue response of structures containing multiple welds. This objective is achieved by examining the stress state around a resistance spot weld. A general expression for the structural stress around the weld is formulated that is dependent only on the loading immediately surrounding the weld; as such, it is specimen independent.

A Fatigue Failure Mode Transition Criterion for Sizing Load Carrying Fillet Welded Connections

This book is the Proceedings of a State-of-the-Art Workshop on Connenctions and the Behaviour, Strength and Design of Steel Structures held at Laboratoire de Mecanique et Technologie, Ecole Normale, Cachan France from 25th to 27th May 1987. It contains the papers presented at the above proceedings and is split into eight main sections covering: Local Analysis of Joints, Mathematical Models, Classification, Frame Analysis,

Frame Stability and Simplified Methods, Design Requirements, Data Base Organisation, Research and Development Needs. With papers from 50 international contributors this text will provide essential reading for all those involved with steel structures.

Guidelines for Modeling Cylinder-To-Cylinder Connections

This book provides background and guidance on the use of the structural hot-spot stress approach to fatigue analysis. The book also offers Design S-N curves for use with the structural hot-spot stress for a range of weld details, and presents parametric formulas for calculating stress increases due to misalignment and structural discontinuities. Highlighting the extension to structures fabricated from plates and non-tubular sections. The structural hot-spot stress approach focuses on cases of potential fatigue cracking from the weld toe and it has been in use for many years in tubular joints. Following an explanation of the structural hot-spot stress, its definition and its relevance to fatigue, the book describes methods for its determination. It considers stress determination from both finite element analysis and strain gauge measurements, and emphasizes the use of finite element stress analysis, providing guidance on the choice of element type and size for use with either solid or shell elements. Lastly, it illustrates the use of the recommendations in four case studies involving the fatigue assessment of welded structures using the structural

hot-spot stress

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