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Norwegian University of
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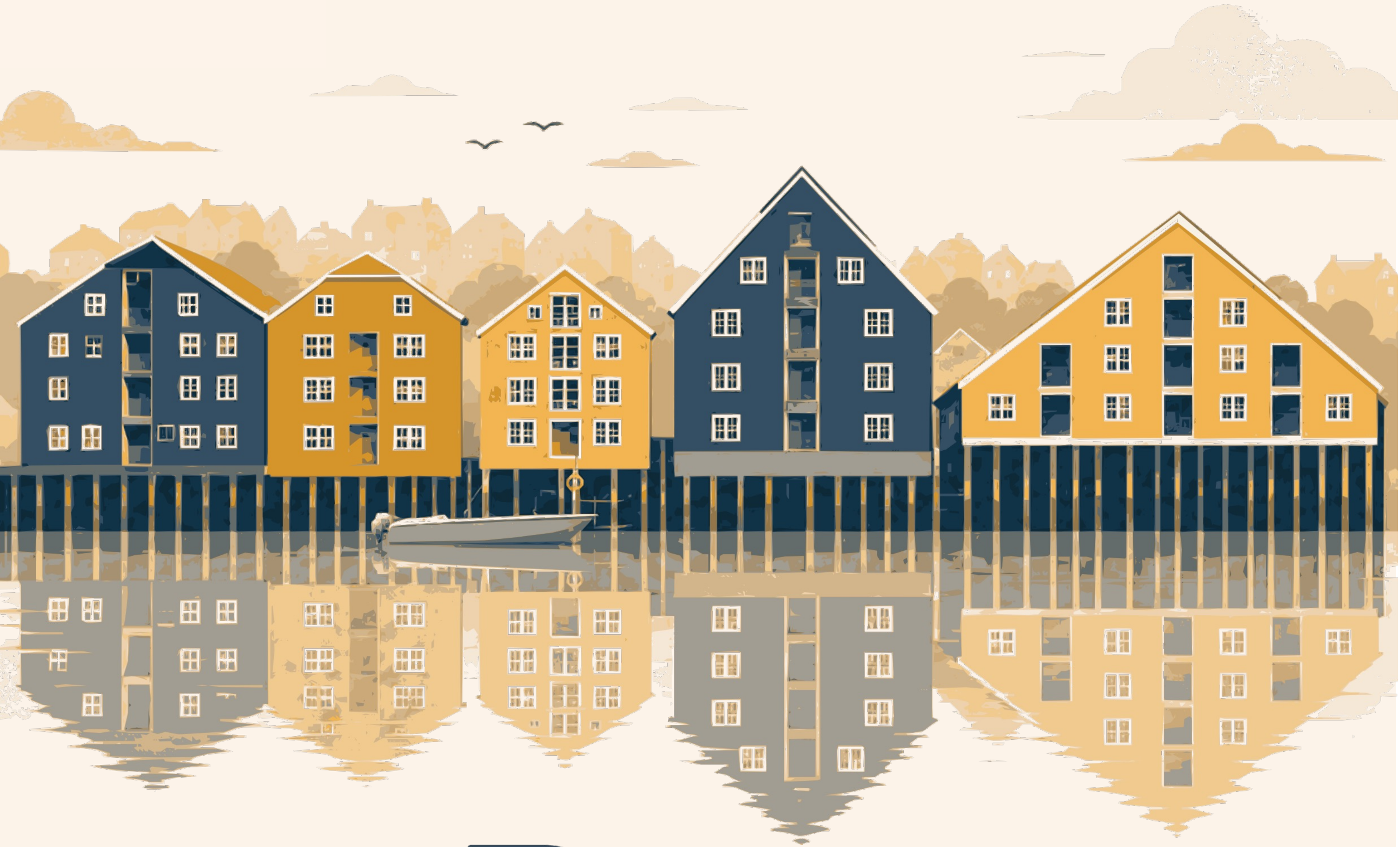
ABSTRACT BOOK



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Preface

This abstract book accompanies the 16th International Aluminium Conference (INALCO 2026), held in Trondheim, Norway, 10-12 June 2026. It brings together 74 accepted abstracts from the final conference submission set and presents them in a consistent format for reference, citation, and archival use.

The abstracts are arranged alphabetically by the last name of the first author and are supported by an index with page references. The layout has been normalised across submissions, while preserving the scientific content, author lists, affiliations, keywords, and relevant proceedings notes.

Committee Note

The conference committee coordinated the scientific programme, confirmed presentation status, and supported the preparation of the final abstract book. The committee's work provided the basis for identifying the abstracts presented at the conference, the abstracts associated with papers in the proceedings, and the exceptional inclusions approved for the proceedings.

Editor's Note

The Editor prepared this compilation from the available abstract PDFs and conference portal records. Editorial work included harmonising the template layout, removing publisher-template branding, formatting affiliations and notes, adding page numbering, and compiling the index. Abstracts 043 and 091 are included under the approved exceptional-circumstances note and do not carry programme presentation details because they were ultimately cancelled.

Index

Abstract

Techno-Economic and Environmental Assessment of Secondary Wrought Aluminium Alloys: A Norwegian Case Study[†]

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

This paper explores the technical, economic, and environmental viability of producing secondary wrought aluminium alloys from post-consumer scrap. The technical review relates to the industrial-level use of Laser-Induced Breakdown Spectroscopy (LIBS) in automated scrap sorting under realistic operating conditions. First, process scrap was used to determine the accuracy of LIBS in sorting and separating wrought aluminium alloys, and then the method was applied to post-consumer scrap streams. The melted products were then analyzed, and their chemical compositions were confirmed using Optical Emission Spectroscopy (OES) to meet the established alloy specifications. The economic analysis compares traditional recycling routes of cast alloys with a second route in which recyclers provide already sorted secondary wrought alloys, with a focus on cost and market feasibility. Simultaneously, an environmental analysis using Life Cycle Analysis (LCA) measures the effects of sorting and manufacturing procedures. The results show that LIBS can effectively sort secondary wrought aluminium under controlled input conditions. The process reaches a break-even point in about five years when a 50% price premium for secondary wrought alloys over mixed scrap is assumed. The method is environmentally beneficial, with the global warming potential per kilogram of aluminium reduced by over 95% compared to the global average. The findings highlight the significant potential of combining advanced sorting technologies, new business models, and sustainability-oriented practices to support the implementation of circular material flows in aluminium recycling.

Keywords: secondary aluminium; LIBS sorting; XRT; wrought alloys; LCA; techno-economic analysis.

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Circularity and Environmental Assessment I | R7

Assessment of Fatigue Design Provisions for Friction Stir Welded Aluminum Using Literature S-N Data†

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

This study focuses on the fatigue resistance of aluminum friction stir welded (FSW) butt joints beyond current design standards such as Eurocode 9 and CSA S6, which use generic S-N curves. A database of 1041 data points from 92 studies is analyzed using a statistical methodology by alloy, FSW variant, and stress ratio. Results show that fatigue strength mainly depends on the alloy rather than the welding FSW variant. While existing codes are conservative for mean behavior, they may be unconservative for probabilistic design due to data scatter, highlighting the need for grade-specific S-N curves and improved guidance on scatter assessment.

Keywords: friction stir welding, high cycle fatigue, S-N curve, statistical analysis, mean stress effect, structure design, aluminum alloys

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Joining and Weld Integrity I | R8

Abstract

Vibration Serviceability Assessment of Lightweight Aluminum Bridges under Traffic Loading[†]

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Abstract

Existing vibration serviceability criteria for highway bridges were largely developed for conventional steel and concrete structures, and their applicability to lightweight aluminum bridges remains uncertain. This study numerically investigates the dynamic response and vibration serviceability of fully aluminum bridge configurations under moving vehicular loads using ABAQUS. The effects of vehicle speed and span length were examined through midspan acceleration and displacement responses. Serviceability was evaluated using the Wright-Walker acceleration limits and the frequency-deflection criterion of the Canadian Highway Bridge Design Code (CSA S6:25). The results highlight a pronounced vibration sensitivity of the investigated configurations under traffic loading.

Keywords: aluminum highway bridges; bridge dynamic responses; bridge vibrations; serviceability limit; numerical analysis

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Structural Systems and Infrastructure I | R5

Consequences on recycling on mechanical properties and thermomechanical processing in 7108 Al-Mg-Zn alloys[†]

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Abstract

The increasing demand for aluminium components with high recycled content is driving the need for alloy systems that can tolerate higher impurity levels without compromising performance. In this study, the consequence of recycling in the Al-Zn-Mg alloy 7108 was simulated by additions of Si, either along or combined with Cu or Mn. Previously published work on these alloy variants has shown a significant reduction in extrudability, including markedly lower extrusion speeds. Here, we investigate the effect of these compositional modifications on mechanical properties after extrusion, including adjustments to the post-extrusion heat treatment to achieve T6 condition. Increased Si addition was found to result in reduced yield and ultimate tensile strength when standard heat treatment parameters were applied. Partial recovery of the strength could be achieved by increasing the solution heat treatment temperature, although this results in microstructural changes. To further mitigate the negative effects of Si, compensational metallurgy strategies involving additions of Mn or Cu were therefore explored. Both approaches successfully restored the mechanical properties to levels comparable with the standard alloy, although ageing kinetics were altered. Overall, the study demonstrates that recycling friendly 7108 based alloys are feasible from a mechanical property perspective, but challenges related to extrudability must be overcome.

Keywords: recycling, 7108 alloy, mechanical properties, heat treatment optimization

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Physical Metallurgy and Alloy Design II | R5

Abstract

FORMING LIMIT PREDICTION OF SHEET METALS USING A FLEXIBLE MATERIAL MODEL FRAMEWORK: COMPARING CRYSTAL PLASTICITY AND CONTINUUM ANISOTROPIC YIELD CRITERIA†

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Abstract

- Sheet metal formability, characterized through Forming Limit Diagrams (FLDs), is crucial for manufacturing industries. We present a versatile computational framework for predicting forming limits that accepts, in principle, any material model as a User Material subroutine (UMAT) compatible with the Abaqus interface. The FLD calculator employs the Marciniak-Kuczynski approach and acts as a wrapper around UMAT, providing great modelling flexibility. We apply this framework to twofundamentallydifferent material models: the Yld2004-18p anisotropic yield criterion and a rate-independent Taylor-Lin crystal plasticity model. The Yld2004-18p is calibrated to reproduce the anisotropic yield surface predicted by theTaylor model for different textures. Careful fitting ensures similar initial yielding behaviour, allowing us to investigate the effect of different material and anisotropy descriptions on forming limit predictions. The crystal plasticity model naturally captures texture evolution and geometrical hardening during deformation, which can affect formability depending on the loading path. This study investigates how accurately phenomenological yield surfaces like Yld2004-18p reproduce the forming limit predictions of the crystal plasticity model.

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Modelling and Digital Methods II | R8

Abstract

The effect of Mn addition on the mechanical properties of air cooled 6063 alloys†

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Abstract

6xxx (Al-Mg-Si) alloys used in automotive crash management systems require high strength combined with high ductility. Air cooling after extrusion is preferred in the industry but can reduce the mechanical properties, particularly the ductility. Addition of small amounts of Mn has been found to help mitigate this effect, however the mechanisms behind it are not yet well understood. This work investigates the effect of increased Mn content, from 0.05 to 0.15 wt%, on the microstructure and mechanical performance of extruded and age-hardened 6063 alloys, in both air cooled and water quenched condition. Transmission electron microscopy (TEM) is used to characterize and quantify the microstructure of the alloys, while mechanical properties are measured by tensile, bending and crush testing. With the small addition of Mn, a large increase in the bending angle is observed, particularly for the air cooled condition. Higher Mn content resulted in an increased number density of dispersoids. The contribution of the dispersoids to the improved ductility is being investigated by studying their effect on the crystallographic texture with EBSD, and their influence on the deformation behavior and fracture mode by TEM investigations of 5% stretched samples and scanning electron microscopy investigations of the fracture surface.

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Physical Metallurgy and Alloy Design II | R5

Abstract

In-situ microscale FIB cold welding of Al and Cu†

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Abstract

As manufacturers of electrical devices push for improved performance, enhanced functionality, cost-efficiency and sustainability, the development of electronics increasingly depends on multi-material metal components [1, 2] with a trend in product miniaturization [3]. Hence this evolution calls out for development of new joining methods. A welding setup in the focused ion beam has been developed. The setup consists of a custom-made Cu micromanipulator needle, which is inserted into a pre-made hole in an Al slab [4]. A bonded interface is created by causing severe plastic deformation and formation of excess vacancies during insertion, while keeping the temperature low (<100°C) [4]. The goal is to induce vacancy enhanced diffusion and get a strong bond between the metals, with limited formation of inter-metallic layers [5, 6]. This project aims to investigate welds made using this procedure by different process parameters, like different strain rates. The welds are analyzed by systematic cross-section images by the focused ion beam, and transmission electron microscopy will be used to perform a detailed characterization of the joints, with focus on both chemical composition and phase identification.

Keywords: Cold welding, Electron microscopy, FIB-SEM, Micro welding

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Joining and Weld Integrity I | R8

Abstract

Using Surrogate Models to Predict Time Evolution of Yield Strength in 6xxx series Aluminium alloys[†]

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Abstract

Physics-based models can predict material properties with high accuracy and provide insights into the mechanisms governing process-microstructure-property relations. However, the increasing complexity of microstructure and mechanical property models results in excessive computational cost, making systematic exploration of large alloy and process parameter spaces impractical. These limitations become more severe when such models are coupled with finite element simulations of manufacturing processes where multiple iterations are required for optimization. Data-driven surrogate models can significantly reduce computational cost while enabling rapid screening of large parameter spaces. In this work, a machinelearning-based surrogate model was developed to predict the time evolution of yield strength in 6xxx aluminium alloys. The model was trained using datasets generated by different physics-based tools based on the Kampmann-Wagner Numerical framework. Training data was sampled using a combination of stratified sampling and low-discrepancy sequences for effective coverage of the input space with a minimal number of samples. The input variables included ageing time, Mg and Si concentrations, and isothermal ageing temperature. Several neural network architectures were evaluated using the PyTorch library, including dense feed-forward networks, recurrent neural networks, and transformers. The developed surrogate model provides fast and accurate predictions and can support aluminum alloy and process design.

Keywords: Al-Mg-Si Alloys; Precipitation Hardening; Machine Learning; Modelling; Neural Networks

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Modelling and Digital Methods I | R8

Methodological Approach for Product Carbon Footprint Assessment of Aluminum LPDC Structural Components in the Automotive Sector[†]

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026.

Abstract

Structural aluminum components play a key role in the reduction of vehicle tailpipe emissions by automotive lightweighting. Given the high energy demand for the primary aluminum reduction from mineral it is critical to assess the potential for increasing recycled content, moving toward secondary structural alloys that maximize environmental benefits without compromising mechanical performance. At the same time, accurate quantification of these emissions is essential, for example to meet industrial increasingly the need for a Product Carbon Footprint (CFP) calculation. This study proposes a methodological framework for the CFP of Low Pressure Die Casting (LPDC) aluminum structural components, aligned with ISO/EN 14067, considering different recycling contents of aluminum ingots. The approach emphasizes the collection of primary industrial data, a rigorous analysis of the LPDC process and a calculation methodology that has to be both accurate and rapid. Mechanical and microstructural characterization were also performed to assess the property of structural secondary aluminum components produced. By generating accurate CFP, this methodology enables informed decisions in material and process selection and optimization. The study underscores the importance of high-quality primary data, methodological rigor and the integration of recycling strategies..

Keywords: secondary Aluminum; Lightweight; Automotive

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Circularity and Environmental Assessment I | R7

Abstract

Structural optimisation of aluminium profiles for battery tray crash protection[†]

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Abstract

This work presents a comprehensive procedure for the structural optimisation of aluminium profiles for battery tray crash protection. The methodology combines experimental characterisation, numerical modelling, and optimisation, and spans from material testing to fullscale component design. Material behaviour is characterised through quasi-static and dynamic tests and used to calibrate a constitutive model including plasticity and ductile failure. The calibration is validated at the component level using component tests performed under both quasi-static and dynamic loading conditions. These experiments are conducted on small-scale extruded profiles manufactured from two aluminium alloys with distinct fracture behaviour, one relatively brittle and one more ductile. The validated material model is implemented in a refined Abaqus/Explicit finite element framework employing solid elements to realistically capture the complex deformation, localisation, and failure mechanisms governing the crash response of these profiles. The framework is subsequently applied to a larger, generic profile representative of battery tray protection structures. Structural performance is improved through a combined size and shape optimisation strategy using LS-OPT, in which the absorbed energy is maximised under a mass constraint. The results demonstrate the influence of material ductility on crash performance and enable the systematic development of optimised aluminium profiles for battery tray crash protection.

Keywords: aluminium, battery protection, structural optimisation, plasticity, fracture, extrusions

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Modelling and Digital Methods II | R8

Abstract

Hardness characterisation of butt-welded 5083-H321 aluminium alloy connections†

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† Accepted for the INALCO 2026 proceedings. Although the paper was not presented at the conference, it was exceptionally included in the proceedings due to documented unforeseen circumstances, as approved by the Editor.

Abstract

Welding aluminium alloys presents several challenges, most notably strength reduction in the heat-affected zone and pronounced welding-induced deformations. Current design provisions for welded connections can result in substantial reductions in the structural capacity of welded components. With the ongoing development of welding processes that enable metal fusion with reduced heat input and potentially less degradation in the heat-affected zone, re-evaluation of these provisions is essential. This paper presents the results of hardness measurements conducted on butt-welded connections made from EN AW-5083-H321 aluminium alloy to quantify the extent of the heat-affected zone. The experimental programme included 12 specimens with plate thicknesses of 10 mm, 8 mm, and 6 mm, fabricated using DC-MIG-P and AC-MIG-P welding processes. The measured extents of the heat-affected zone were between 1.72 and 2.64 times smaller than the Eurocode 9 values for the DC-MIG-P welding process and between 2.29 and 4.62 times smaller for the AC-MIG-P process. Significant variability in the measured extents of the heat-affected zone was observed.

Keywords: Aluminium alloys; Eurocode 9; Pulsed MIG welding; Heat-affected zone; Hardness testing

Abstract

20 industry organizations team up to develop a new generation of aluminum highway bridges†

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

This paper showcases the Aluminum Highway Bridge (AHB) project as a prime example of technical excellence, innovative thinking, and cross-disciplinary expertise in modern infrastructure. Led by WSP and supported by over 20 leading organizations from Canada, the U.S., and Europe, the AHB initiative pioneers low-carbon aluminum road bridges by integrating advanced design, fabrication, and welding technologies. The engineering activities are supported through a combination of public and private funding. The project's rigorous approach to selecting aluminum extrusions, optimizing welded and bolted connections, and addressing logistical challenges demonstrates deep engineering insight. Emphasizing the material's lightness, durability, and recyclability, the project aims to deliver compelling sustainability and lifecycle benefits. Rooted in decades of research and strict adherence to modern engineering standards, the AHB methodology blends constructability with environmental responsibility. By developing a comprehensive framework and fostering collaboration across sectors, this initiative propels global aluminum bridge innovation, empowering stakeholders to advance resilient and sustainable infrastructure. With about half of the project completed, this paper discusses the project's scope, material procurement, construction challenges and initial findings.

Keywords: Aluminum, bridge, deck, ABC, welding, GMAW, FSW, BTFSW, assembly, extrusion

Programme: Friday | 2026-06-12 | 08:30-09:30 | Keynote 5 | Keynote | R7

Abstract

The construction phase of the Montmorency Forest GMAW-welded aluminium deck on steel girders bridge[†]

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

WSP was responsible for the design and detailing of Canada's first GMAW-welded aluminium deck on steel girders bridge for Université Laval. The firm developed welded aluminium panels connected by blind bolts and supported by three steel girders. This 15 m by 8 m structure, designed to support both highway and forest truck loads, was fully preassembled to facilitate rapid onsite installation, consistent with accelerated bridge construction methodologies. In the context of post-pandemic, extrusion procurement challenges and the necessity to refine welding procedures, the fabricator, designer, and owner maintained close collaboration throughout all construction phases. While the project experienced delays, quality was prioritized, culminating in a pioneering structure for Canada and a benchmark for advanced aluminium bridge design globally. This paper explores the construction process, including multiple trials to optimize the 28 mm deep GMAW welds. The fabricator developed an innovative approach for positioning removable backing bars within 10-metre-long hollow extrusions. Non-destructive testing was essential due to the absence of detailed acceptance criteria in current standards. Post-welding deformation control was achieved through several iterations and post-heating process. The bolting plate method effectively joined hollow aluminium components, and custom features were incorporated to accommodate Université Laval's research instrumentation.

Keywords: Aluminum, aluminium, deck, ABC, welding, GMAW, extrusion, NDT, innovation

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Structural Systems and Infrastructure III | R7

Abstract

Fatigue Behaviour of an Aluminium Shoe-Base Connection with a Stiffening Ring†

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

This article investigates the influence of an internal stiffening ring on the fatigue behaviour of an aluminium shoe-base socket connection subjected to cyclic loading. Finite-element models of the connection, with (SBSR) and without (SB) the stiffening ring, are developed and analysed using identical geometry, loading, and boundary conditions in order to isolate the structural effect of the stiffening ring. The numerical results show that the presence of the stiffening ring reduces nominal, hot-spot, and maximum stresses at all load levels, and that the difference between the two configurations becomes more pronounced as the applied load increases. Despite the reduction in absolute stress levels, the stiffened configuration exhibits a higher stress concentration factor due to the redistribution of stresses near the weld toe. Fatigue analyses indicate that fatigue failure in both configurations is governed by the weld toe at the shoe-base pole interface. Overall, the stiffening ring improves the fatigue performance of the connection by reducing local deformation and bending, while local stress concentration at the weld toe remains the critical factor controlling fatigue behaviour.

Keywords: Fatigue, aluminium, stiffening ring, cyclic load, hot spot, shoe-base.

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Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Structural Systems and Infrastructure III | R7

Abstract

Structural performance assessment of 3D-printed aluminium alloys[†]

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Abstract

As of today, extrusion and rolling remain the primary aluminium shaping techniques, however, both demonstrate drawbacks such as high tooling costs and occasionally geometric limitations. Recently, 3D-printing has emerged in the building sector, as a transformative approach towards manufacturing sections of increased optimization and more complex components. Among existing 3D-printing technologies, Wire Arc Additive Manufacturing (WAAM) stands out for its capability of creating large-scale metallic parts with high precision. Although there are many material-level studies, the structural implications of adopting WAAM over traditional methods remain unassessed at the global structural level. To this scope, this study presents a thorough numerical assessment of aluminium members' structural performance considering respective rolling, extrusion and WAAM fabrication methods, while using data from existing experimental activity in literature. The conducted study involves aluminium alloy series used in construction (5xxx, 6xxx) and spans from cross-sectional behavior to global structural scale investigation employing codified provisions. The results highlight that although standard WAAM alloys exhibit comparatively low mechanical properties, the application of high-performance nano-particle reinforced alloys combined with WAAM's geometric flexibility can result in structural systems with improved load-bearing capacity.

Keywords: Aluminium alloy structures; 3D Printing; Wire Arc Additive Manufacturing; Structural assessment; Numerical application; Codification

Effect of Cu, Zn, and Fe Impurities on Intermetallics and Porosity Formation of High-Pressure Die-Cast Al-7Si-0.3Mg Alloy[†]

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Abstract

Recycled aluminum alloys for high pressure die casting (HPDC) are increasingly important for reducing the environmental footprint of structural cast components, but their broader use is constrained by the chemistry of post consumer scrap. During recycling, trace elements such as Cu, Zn, and Fe accumulate and cannot be completely removed, creating uncertainty in compositional tolerances for Al-Si-Mg HPDC alloys. Although the individual effect of these elements on microstructure and intermetallic formation have been reported, understanding of their combined influence on porosity characteristics and tensile ductility is still limited. In this study, Cu, Zn, and Fe are systematically varied at controlled levels, both individually and in combination. Porosity is quantified in terms of area fraction, size distribution using light optical microscopy. SEM and EDS are used to identify Fe rich and Cu rich intermetallic phases and to assess how impurity interactions modify solidification behavior and defect formation. The outcomes provide practical composition windows and impurity thresholds that support higher recycled content while maintaining casting integrity and mechanical performance in HPDC applications.

Keywords: Aluminum alloys; HPDC; Porosity; Intermetallic Phases; Recycling.

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Physical Metallurgy and Alloy Design III | R7

Effect of Fe/Mn Ratio on Intermetallic Evolution and Fatigue Resistance in Al-Si Foundry Alloys[†]

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026.

Abstract

Secondary aluminum feedstock for AlSiMg foundry alloys often carries elevated and variable Fe, promoting Fe rich intermetallic phases whose morphology and distribution can govern fatigue crack initiation under cyclic loading. In AlSi7Mg0.3, Fe commonly precipitates as plate like or needle like Al5FeSi, whereas Mn additions can shift Fe into more compact Al15(Fe,Mn)3Si2 type morphologies that are generally less detrimental as crack initiators. Despite this established qualitative understanding, quantitative guidance linking Fe level and Mn Fe ratio to intermetallic populations and high cycle fatigue performance remains limited for compositions relevant to recycled content. This study evaluates six AlSi7Mg0.3 alloys with two Fe levels (0.10 and 0.30 wt%) and three Mn Fe ratios (0, 0.5, and 1), cast as ingots under fixed conditions. SEM equipped with EDS was used to identify intermetallic types and morphologies and to quantify their size and area fraction. These metrics were correlated with high cycle axial fatigue response using S N curves and fractography to identify crack initiation sites. The results establish practical Fe and Mn composition windows that minimize the formation of deleterious Fe rich morphologies and improve fatigue resistance in secondary AlSi7Mg0.3 cast alloys, supporting higher recycled content in fatigue relevant applications.

Keywords: Aluminum alloys; Secondary Alloys; Fatigue; Intermetallic Phases; Fractography.

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Physical Metallurgy and Alloy Design I | R5

Abstract

Displacement-based design of aluminum shear panels for seismic retrofitting of RC buildings[†]

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026. Paper included in proceedings.

Abstract

This paper presents a displacement-based design method for aluminum shear panels used in the seismic retrofit of RC buildings. The approach follows performance-based princi-ples, directly controlling structural displacements while ensuring stable hysteretic behavior and concentrating damage in replaceable panels. The procedure links displacement demand to panel properties and geometry, enabling efficient design. A case study shows significant reductions in interstory drift and residual deformations, improving seismic performance. The results demonstrate that aluminum shear panels are an effective and sustainable retrofit solution, offering reliable energy dissipation, easy replacement, and minimal impact on existing structures.

Keywords: Aluminum shear panels; RC structures; Displacement-based design; Seismic retrofit.

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Structural Systems and Infrastructure IV | R5

Digital knowledge exchange in physical metallurgy[†]

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Abstract

This work presents a framework for digitally capturing and exchanging materials knowledge. It is applied to physical metallurgy with the goal of making recorded information FAIR, with emphasis on conveying meaning, interoperability, and reuse. Metadata about available resources, such as datasets, materials, processes, samples, instruments, models, and researchers is stored in a central knowledge base. This knowledge base also describes the relations between these resources and provides semantic meaning by relating them to an ontological framework based on the EMMO ontology, which is anchored in physics and ensures consistency with the concepts of materials science. To enhance interoperability with external systems, the framework adopts standard vocabularies when appropriate. DCAT-AP is used to support discovery through DCAT-aware services, while PROV-O is applied for provenance. However, these vocabularies often lack sufficient expressivity for advanced materials-science use cases, such as experimental and modelling workflows where a sample is thermo-mechanically treated and cut into pieces across multiple process steps, or interoperability between different data representations. Novel solutions to address these challenges using the above-mentioned framework will be presented. The Research Council of Norway is acknowledged for funding the SFI PhysMet (309584) project.

Keywords: Physical metallurgy; interoperability; knowledge exchange; ontology; workflows

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Modelling and Digital Methods I | R8

Abstract

Deployable Structures: Investigation of Reverse Bending of Additively Manufactured AlSi10Mg Alloy under Heat-Treated Conditions[†]

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Abstract

Deployable metallic structures offer a new design approach for overcoming the geometric limitations of laser powder bed fusion by enabling compact as-built configurations to be expanded after printing into larger, lightweight architectures suitable for efficient packing and aerospace applications. The formability of solution heat-treated, additively manufactured AlSi10Mg alloy was investigated using U-shaped specimens with controlled radius and thickness parameters, designed to evaluate bending-driven deployment. Across all configurations, the alloy exhibited substantial plastic deformation, reaching bending angles between 90.2° and 179.5°. Full deployment was achieved in the t2 r4 specimen, corresponding to an r/t ratio of 2.0, which straightened to 179.5° without failure while maintaining the lowest measured strain of 18.8%. Experimental observations and numerical analysis indicate that failure is governed not by a single critical strain, but by strain localization at the inner radius, followed by surface slip, crack initiation and crack propagation. These findings demonstrate that heat-treated AlSi10Mg provides a promising route towards lightweight, additively manufactured deployable structures with tunable deformation capacity.

Keywords: aluminium alloy; AlSi10Mg; additive manufacturing; heat treatment; bending behaviour; plastic deformation; formability; deployable structures

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Additive and Solid-State Manufacturing II | R7

Abstract

Modelling of aluminium extrusion ingot casting machine fluid flow and grain refiner addition†

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Abstract

In aluminium DC casting of extrusion ingots, grain refiners are commonly added to control the microstructure and reduce casting defects, particularly during the start-up phase. This work presents a model of an industrial DC casting machine developed using the computational fluid dynamics (CFD) framework OpenFOAM, with particular focus in the start-up phase and the spatial variation of grain refiner concentration in the melt and extrusion ingots. In addition, a grain-size prediction model based on the free-growth approach of Greer et.al. [1] has been implemented to estimate the resulting grain size in the extrusion ingots, based on the grain refiner concentration predicted from the CFD-model. To validate the model an industrial experiment was conducted in a cast house where melt samples and samples from the extrusion ingots were collected. The predicted grain refiner concentration and resulting grain size is being compared with measurements from melt sampling and metallographic grain size analysis. The preliminary results show good agreement between the model predictions and experimental observations, indicating that the model has potential as a tool for analysing and optimizing grain refiner addition during DC-casting. However, the simulations require substantial computational resources, which currently limits their practical application.

Keywords: DC-casting; Grain refinement; Computational fluid dynamics; Free-growth model

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Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Manufacturing Process Control and Forming I | R8

Abstract

Aluminum and Concrete - A new, innovative Material Combination†

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Abstract

The concrete industry faces increasing pressure to reduce CO_2 emissions, driving demand for low carbon alternatives to traditional Portland cement-based systems. However, lowering the carbon footprint typically requires reducing the pH of concrete, which challenges the corrosion protection of conventional steel reinforcement. The idea is to replace steel with aluminum reinforcement to enable low pH, low carbon concrete formulations. [1] Hydro led an R&D program evaluating aluminum reinforcement combined with concrete in which more than 50% of the Portland cement is substituted with sustainable binders such as volcanic pozzolan and calcined clay. These binder systems naturally produce lower pH environments compatible with aluminium's corrosion behavior. The resulting material combination reduces CO_2 emissions and energy consumption while enabling reduced or eliminated concrete cover, facilitating slimmer structures and lower material use. Full scale pilot projects demonstrate excellent structural performance and durability. In 2024, Hydro established a tidal zone test station at Karmøy to document long term behavior of various aluminum alloys and binder systems in highly corrosive marine environments. The findings indicate that aluminum reinforced low carbon concrete offers durable, maintenance reducing, and climate efficient alternative for future construction.

Keywords: aluminium reinforcement; low-carbon concrete; corrosion; durable; sustainability

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Structural Systems and Infrastructure IV | R5

Abstract

Mechanical properties and shear fracture of naturally or cyclically aged 7000 alloys[†]

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Abstract

Hardening occurring during cyclic deformation at room temperature represents an alternative to artificial or natural age-hardening of aluminum 7000 alloys. The resulting precipitation and mechanical properties have been investigated [1-3] considering two different Al-Zn-Mg alloys, with and without copper and compared to natural and artificial aging. Atom probe tomography and transmission electron microscopy revealed that a fine distribution of GP-zones, provided strength after cyclic ageing. Additional ten days natural ageing allowed the clusters to grow into more stable ones, resulting in similar tensile strength and uniform elongation as for the peak aged condition by artificial ageing. Unlike peak aged samples, fracture of the cyclically aged samples occurred earlier, in the form of a ductile slant shear fracture without necking in advance as reaching maximum strength, i.e., at the uniform limit. Natural aged samples revealed similar GP-zones as the cyclic hardened ones and showed the same slant fracture mode.

Keywords: 7000 alloy, natural aging, artificial aging, cyclic aging, fracture

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Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Physical Metallurgy and Alloy Design IV | R7

Abstract

Analytical Fatigue Life Prediction and Numerical Assessment of the Fatigue Performance of PBF-LB AlSi10Mg As-built Specimens†

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Abstract

Additive Manufacturing (AM) enables the production of net-shaped parts with complex geometries that are difficult to produce using traditional manufacturing methods. However, in AM, geometry and process synergistically determine the final part properties, including surface roughness and internal defects, leading to a gradient of fatigue strength throughout the component, especially across features with different thicknesses and build orientations. Therefore, the development of predictive defect-based methods that can give reasonable insight into the fatigue behavior of AM parts with different sizes and build orientations is of primary importance in the design phase of AM functional components. For these reasons, this study focuses on the prediction of the fatigue behavior of the AM aluminium alloy AlSi10Mg manufactured using Laser Powder Bed Fusion with respect to size and build orientation, based on the as-built surface roughness profiles and crack initiation defect sizes. Fatigue Crack Growth theories have been combined with the Murakami defect-based approach to predict fatigue life and demonstrated good correlation with the experimental fatigue test results of a previous study. In addition, fatigue behavior has been assessed numerically in terms of effective stress by applying the Theory of Critical Distances on the real surface roughness profile of each category.

Keywords: Laser Powder Bed Fusion; Aluminium alloy; Fatigue

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Additive and Solid-State Manufacturing II | R7

Effects of Electrode Wear on Nugget Formation in Continuous Resistance Spot Welding of Aluminum Alloys†

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Abstract

In recent years, the use of aluminum alloys in the automotive industry has been increasingly promoted to achieve lightweight vehicle bodies. Meanwhile, resistance spot welding (RSW) has long been widely employed for automotive body assembly, and thus considerable efforts have been devoted to improving the weldability of aluminum alloys by RSW. In particular, the stability of nugget formation - i.e., the molten region - during consecutive welding has emerged as a critical technical challenge. In this study, electrode wear, which is a key factor influencing nugget formation, was investigated to improve the continuous spot weldability of aluminum alloys. The relationship between the extent and morphology of electrode wear and nugget formation behavior was systematically examined. Furthermore, the electrode wear morphology that enhances continuous weldability was identified. The results revealed that stable nugget formation during consecutive welding requires the generation of sufficient heat at the center of the joint during the initial stage of current flow. Moreover, it was demonstrated that achieving such heat concentration at the joint center necessitates maintaining electrode wear as uniform as possible.

Keywords: resistance spot welding; aluminum alloy; continuous spot welding; electrode wear; nugget formation

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Joining and Weld Integrity III | R8

Abstract

Development of metal forming processes with integrated age hardening customized in production of high strength aluminum safety parts for the automotive industry.[†]

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Abstract

The performance of automotive components is strongly controlled by the costs in the process chain from melt to final shaped product. The most critical is the forming operations in shaping the product geometry, formability and tempering, tooling and friction issues. The main objective of the research has been developed and improve metal forming process suitable for mass production. Techniques based on classic cold and hot forming have been further developed to meet the new requirements with respect to productivity and improved product properties. The hot forging technology has moved more into a low loss material process, what can be expressed as Preform Forging. In the field of cold forming based on extrusions the deformation steps in the W-temper/ as-quenched with direct age harden is successful to utilise the full potential of mechanical properties of the ally chosen, named as Extrusion-Forming. Lately a promising new extrusion forming principle has been tested integration of classic sheet metal forming with hot forming integrated with hardening, an extrusion hot Press Forming technique. The reduction of energy and material yield towards a near net shape process in the integrated processing consisting of heat treatment and forming operations is the main step forward.

Keywords: Aluminium alloys, forming technology, thermomechanical processes.

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Manufacturing Process Control and Forming II | R8

Mechanical Properties of DED-Arc Processed ER5356 and ER4046 Aluminum Alloys[†]

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Abstract

Additive manufacturing using wire-arc directed energy deposition (DED-Arc) enables flexible, batch-independent fabrication and modification of aluminum components and is of particular interest for large-scale components and repair applications. Beyond manufacturability, the mechanical properties of the deposited material are decisive for structural applications. While Al-Mg alloys such as ER5356 are established in DED-Arc research, ER4046 (AlSi10Mg) has so far received limited attention, despite its relevance for the modification and repair of cast aluminum components. Accordingly, this study compares the mechanical properties of ER5356 and ER4046 alloys processed by DED-Arc using different deposition strategies, including thin-walled single-bead and volumetric zigzag deposits. ER4046 specimens were heat treated to the T6 condition after deposition, whereas ER5356 was investigated in the as-built state. Metallographic analyses as well as tensile and fatigue tests were conducted, with tensile loading applied in three orientations relative to the build direction (0°, 45°, and 90°). The results indicate a dependence of tensile properties on loading direction, particularly for ER5356. Differences related to the deposition strategy generally fall within the scatter typically observed for DED-Arc materials. Overall, the material properties of both alloys are comparable to those of conventionally wrought or cast aluminum products, indicating their suitability for DED-Arc-based manufacturing.

Keywords: directed energy deposition, wire arc additive manufacturing, aluminum, mechanical properties

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Additive and Solid-State Manufacturing I | R7

Abstract

Microstructure Modeling and Characterization of Pre-Deformed Al-Mg-Si-Cu(-Zn) Alloys†

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026.

Abstract

Pre-deformation prior to age hardening is a practical approach to increase strength in extruded 6xxx-series aluminium profiles. We systematically investigated how 0-35% pre-deformation combined with artificial ageing affects mechanical properties, precipitate characteristics, and phase evolution in AA6061, with and without 0.1 wt.% Zn. Adding Zn increased strength without reducing ductility in both the undeformed and the pre-deformed condition. For a given artificial ageing time and temperature, strength increased with deformation up to 15% strain before reaching a plateau. At higher strains, the additional work-hardening contribution appears to be counterbalanced by the faster coarsening of the precipitates. This accelerated precipitation was taken into account by choosing shorter times for the artificial ageing. Transmission electron microscopy showed that Zn addition increased precipitate density without affecting size, raising the volume fraction. Pre-deformation also increased precipitate density, but a decrease in size resulted in a similar volume fraction as the undeformed condition. Strength modeling using NaMo [1] reproduced the behavior of the Zn-free alloy, including a 60 MPa contribution from work hardening after recovery. While pre-deformation was shown to slightly reduce precipitate strengthening, work hardening fully explained the net increase in strength.

Keywords: 6xxx; Pre-Deformation; TEM; NaMo; Modeling; Precipitates; Dislocations

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Physical Metallurgy and Alloy Design I | R5

Abstract

Experimental Tests on Notched Bars made of 2007-T3 Alloy[†]

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Abstract

This paper presents the first experimental results aimed at characterizing the fracture behaviour of 2007-T3 aluminium alloy. An experimental campaign consisting of six uniaxial tensile tests was carried out on cylindrical specimens with different notch geometries, designed to induce varying levels of stress triaxiality. The tests allowed a detailed observation of the material response up to fracture. Based on the experimental data, the main empirical parameters governing several widely used ductile damage models available in technical and scientific literature were calibrated. The calibration procedure focused on establishing a reliable relationship between the equivalent plastic strain at fracture and the stress triaxiality. The results provide a first assessment of the capability of these models to reproduce the fracture behaviour of aluminium alloy 2007-T3 under different stress conditions. The study represents a preliminary step toward the development of robust fracture criteria for aluminium structural components and offers a valuable experimental database for future numerical and theoretical investigations.

Keywords: Aluminium material; 2007-T3 aluminium alloy, experiments; damage model.

Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Physical Metallurgy and Alloy Design IV | R7

Abstract

Particle-based screw extrusion friction stir deposition (P-SEFSD) additive manufacturing of Al-alloys[†]

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Abstract

Additive Friction Stir Deposition (AFSD), as a solid-state additive manufacturing technique, eliminates fusion-related defects such as thermal cracking and porosity, enabling the near-net-shape fabrication of components. This work introduces a novel particle-based screw-extrusion friction stir deposition (P-SEFSD) technology. By utilizing a screw extrusion mechanism to continuously feed metallic particles, this process achieves seamless continuous solid-state deposition, leveraging frictional heat and intense plastic deformation. To validate the feasibility of the process, AA4043 aluminum alloy particles were utilized to investigate the process behavior and forming mechanism under the continuous feeding condition. Through the optimization of screw shaft configuration, sound metallurgical bonding and high-quality deposition layers were ensured. Microstructural characterization via SEM and EBSD revealed that the manufactured components possess a refined equiaxed grain structure. Mechanical testing confirmed that the deposited layers exhibit isotropic mechanical properties. Furthermore, the mechanisms of plasticization, material flow, and heat generation during the P-SEFSD process were elucidated. Finally, deposition experiments were extended to non-uniform AA6061 aluminum alloy chips, resulting in the successful preliminary fabrication of deposited layers. This work offers a feasible method for solid-state additive manufacturing using particles and machining chip scraps for sustainable processing of lightweight alloys.

Keywords: Screw extrusion friction stir deposition; Continuous particle feeding; Aluminum alloy; Microstructure; Mechanical properties

Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Additive and Solid-State Manufacturing III | R8

Abstract

Numerical Simulation of Additive Friction Stir Deposition of Aluminium Alloy†

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Abstract

Large or severe plastic deformation processing of metallic solids plays a significant role in integrated additive manufacturing as a competitive solid-state route avoiding melting related issues. Recently, a disruptive technology under this route, called additive friction stir deposition (AFSD), or commercially known as MELD, has gained significant attention. AFSD enables the production of large metallic structures in an open-atmosphere environment without powder beds or vacuum systems, providing substantial benefits in productivity, material efficiency, and energy consumption compared with laser- or arc-based additive methods. However, AFSD is a complex thermo-mechanical process characterized by extreme plastic deformation, intricate material flow, frictional bonding interactions, and microstructural evolution. These factors present major challenges in understanding process physics and optimizing deposition quality. In this work, a finite-element (FE)-based modelling framework is established using Transvalor Forge© to simulate AFSD in a continuous and physically representative manner. Particular emphasis is placed on accurately defining frictional and interfacial behaviours, which are essential for numerical stability and predictive fidelity. The proposed model is validated through experimental AFSD on aluminium alloys, demonstrating its capability to capture deformation behaviour and has potential in supporting process optimization for industrial applications.

Keywords: additive friction stir deposition (AFSD); finite element method (FEM); friction; sliding and sticking; large deformation.

Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Additive and Solid-State Manufacturing III | R8

Abstract

Suppression of Nugget Shape Variability in Continuous Resistance Spot Welding of Aluminum Alloys Using Hole Shape on the Sheet Surface[†]

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Abstract

In recent years, increasing environmental concerns have intensified the demand for lightweight vehicle bodies to improve fuel efficiency. Consequently, aluminum alloys have been increasingly applied to automotive body structures. Resistance spot welding (RSW), which enables high-volume production, is widely used in the automotive industry; however, variability in nugget shape causes fluctuations in nugget diameter, resulting in instability in joint strength. In this study, a hole was introduced on the surface of an aluminum alloy sheet to suppress nugget shape variability. Specifically, a hole with a diameter of 2 mm was machined at the center of the aluminum alloy sheet between the sheet and the electrode. The results showed that the variation in nugget diameter was significantly reduced under the hole condition compared with the condition without a hole. Observations of the joint interface revealed that nugget shape variability was also suppressed under the hole condition. These findings indicate that the introduction of a hole stabilizes nugget formation at the faying interface, thereby reducing variation in nugget diameter.

Keywords: resistance spot welding; aluminum alloys; continuous welding; nugget shape; hole shape

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Joining and Weld Integrity III | R8

Abstract

Numerical assessment of the cyclic response of aluminium beams using OpenSees[†]

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Abstract

Aluminium alloys are increasingly adopted in structural engineering due to their favorable strength-to-weight ratio, durability against corrosion, and sustainability benefits. This paper examines the cyclic response of hollow section beams manufactured from 6082-T6 aluminium alloy through a combined numerical-experimental approach. Based on experimental results available in the literature concerning aluminium beams subjected to incremental cyclic bending, an efficient computational model is developed within the Open-Sees framework to reproduce cyclic hardening and low cycle fatigue. The modeling strategy integrates the Giuffrè-Menegotto-Pinto constitutive law with a fatigue material formulation. Model parameters are calibrated against experimental force-displacement responses and cumulative dissipated energy to ensure an accurate representation of observed behaviour. The numerical results show good agreement with experimental data, successfully reproducing both the global cyclic response and material degradation phenomena.

Keywords: Aluminium Beams; Cyclic Loading; OpenSees Modeling.

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Structural Systems and Infrastructure IV | R5

Abstract

Modelling of Evolution of Deformation Textures, Plastic Anisotropy and Formability in Flat Profile Aluminium Extrusions†

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Abstract

Deformation textures developing during the extrusion of flat profiles from round billets of the aluminium alloys AA6063 and AA6082 were modelled by coupling finite-element (FEM) flow simulations with crystal-plasticity calculations and were validated against textures measured by electron backscatter diffraction (EBSD). AA6063 was extruded at 350 °C, whereas AA6082, containing dispersoids to suppress recrystallization, was extruded at 500 °C. Mean-field crystal-plasticity models as Taylor model and Alamel 2-grain-cluster model were used to predict texture evolution along representative material deformation paths extracted from the FEM simulations. Key model parameters, including the relative strengths of non-octahedral slip systems as well as the strain-rate sensitivity, were identified using a global optimization procedure to obtain the best agreement with the measured textures. The Alamel grain-cluster approach provided very good overall predictions: at 350 °C it reproduced the strength of the main texture components, and at 500 °C it captured the S, Brass and Cu components qualitatively. However, none of the investigated models were able to reproduce the strong Cube component observed experimentally after extrusion at 500 °C. Building on the predicted texture evolution at 350 °C, the corresponding evolution of the yield locus was simulated, and the evolution of forming-limit diagrams was computed using the Marciniak-Kuczyński framework. Overall, the results demonstrate the feasibility of a fully interconnected modelling workflow that transfers information consistently from FEM-based extrusion-flow simulations, through crystal-plasticity texture prediction, to downstream assessments of anisotropy and formability. This integrated chain provides a practical route to link extrusion conditions and local deformation histories to the evolving yield surface and forming limits and thereby supports more physics-based design and optimization of extruded flat profiles.

Keywords: Aluminium extrusion; Crystal plasticity; Deformation texture evolution; Plastic anisotropy; Forming Limit Diagram

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Modelling and Digital Methods II | R8

Abstract

Controlling Intermetallic Phase Formation in Al-Si-Mn-Mg-Fe Alloys: Role of Fe, Sr and Cooling Rate[†]

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Abstract

Recycled aluminium often introduces elevated Fe levels into Al-Si alloys, influencing the formation of Fe bearing intermetallics and final properties. This study examines how Fe content (0.1-0.6 wt%) and varying Sr levels affect the microstructure of an Al-Si11-Mn0.6-Mg0.3-Fe0.1 alloy. Lab-scale castings produced in sand and steel moulds enabled comparison of two different solidification conditions. Two main Fe bearing phases were identified: the thermodynamically stable αc-Al15(Fe,Mn)3Si2 phase and a metastable τ4-Al3(Fe,Mn)Si2 phase. To the best of our knowledge, the τ4-phase is reported here for the first time in hypoeutectic Al-Si alloys. Slow cooling with low Fe and high Sr promotes plate-shaped τ4, while slow cooling with high Fe and low Sr produces larger script-like αc particles. Under rapid cooling, both τ4-phase and αc-phase form as smaller particles. Script-like αc is still favored by high Fe and low Sr, whereas higher Sr consistently promotes τ4-phase across both low and high Fe levels. Thermodynamic simulations show that Sr does not change Fe-phase stability, suggesting its influence is kinetic. Possible mechanisms for metastable τ4-phase formation are discussed. Overall, the combined effects of cooling rate, Sr-modification, and Fe-controlled phase stability identified here help improve microstructure predictability in recycled Al-Si alloys.

Keywords: Aluminum alloys; Recycling; Casting; Microstructure; Fe Intermetallics;

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Physical Metallurgy and Alloy Design III | R7

Rapid fatigue life prediction of additively manufactured using inelastic energy dissipation†

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† Presented at the 16th International Aluminium Conference, Trondheim, Norway, 10-12 June 2026.

Abstract

Fatigue characterization demands time-consuming testing, especially for additively manufactured (AM) parts where process-induced variability affects results. This study presents an energy-based fatigue life prediction approach that uses step-loading (SL) tests for characterization of the model. The method extracts hysteresis energy trends to identify the fatigue limit using a previously developed model and then sums dissipated energy in each block up to failure. Validation of the model was performed on additively manufactured specimens. It was determined that the developed model shows exceptional agreement for fatigue life prediction of the tested stress-life (SN) curve. The method significantly reduces the amount of time and the required number of specimens for characterizing materials under cyclic loading.

Keywords: Fatigue life; Step loading method; Hysteresis energy; Additive manufacturing.

Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Additive and Solid-State Manufacturing III | R8

Abstract

Scan-assisted dimensional control in 3D stretch bending of AA6082-T4 using reconfigurable tooling[†]

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Abstract

Reconfigurable multi-point tooling enables flexible manufacturing of aluminum alloy components with complex three-dimensional geometries; however, dimensional accuracy in 3D stretch bending remains limited by springback, asymmetric deformation, and tool-induced variability. This study presents a 3D scanning-assisted dimensional control approach for 3D stretch bending of AA6082-T4 aluminum alloy profiles, integrating optical scan-based measurement with iterative process compensation. Extruded AA6082-T4 rectangular tubes were formed into combined vertical and horizontal curvatures with target radii of 1,400 mm and 2,800 mm, respectively, using a reconfigurable multi-point die. Initial die configurations were generated from CAD-based analytical calculations and verified experimentally. Prior to forming, the die surface geometry was captured using 3D optical scanning to identify positional deviations of individual tool points and enable corrective adjustment. Following stretch bending, the formed profiles were scanned both under load and after springback, and deviations from the nominal CAD geometry were quantified in both bending directions. Based on the measured deviations, successive compensation cycles were applied to correct geometric errors in the vertical and horizontal planes simultaneously. The results demonstrate that scan-assisted feedback significantly reduces dimensional deviations and improves tolerance capability in 3D stretch bending of AA6082-T4, highlighting its potential for manufacturing-oriented reconfigurable forming processes.

Keywords: AA6082-T4; 3D stretch bending; Reconfigurable multi-point tooling; 3D scanning; Flexible forming

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Manufacturing Process Control and Forming II | R8

The formability of single and double-pass friction stir-welded AA6082 tailor-welded blanks†

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Abstract

This study evaluates the formability of single-pass and double-pass friction stir-welded AA6082 tailor-welded blanks produced at a 1,000-rpm rotational speed and 100 mm/min welding speed. The objective is to understand the effect of multi-pass welding strategies on stir zone (SZ) softening, load-bearing capacity, and strain localization during biaxial stretching. Formability was assessed using limiting dome height (LDH) tests, supported by hardness mapping, tensile tests, 3D digital image correlation, and complementary finite element (FE) simulations. Results exhibit similar dome heights (~14 mm) in both weld conditions, but single-pass welds sustain 5 kN higher peak load, better strength, and ductility. Shell-based FE models reproduce the load-displacement response and strain localization within ~5% of experimental results.

Keywords: Tailor welded blanks; Double-pass FSW; AA6082; Limiting dome height; Digital image correlation

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Joining and Weld Integrity IV | R5

Abstract

Improvement of Joint Strength in Steel/Aluminum Alloy Dissimilar Materials Resistance Spot-welded Joints by using Interface Shape Control†

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Abstract

In recent years, the automotive industry has increasingly adopted aluminum alloys in vehicle bodies to improve fuel efficiency. However, it is known that applying resistance spot welding -widely used in automotive production lines-to join steel and aluminum alloys results in the formation of brittle intermetallic compounds at the joint interface, leading to reduced joint strength and increased variability. In this study, the anchor effect-defined as mechanical interlocking at the interface-was examined, and the effect of introducing a rectangular interface on tensile shear strength (TSS) was investigated. The rectangular interface was formed by pre-machining a groove on the steel sheet prior to welding. The effect of the rectangular interface on TSS was examined by comparing joints with and without the interface. The results showed that TSS increased in joints with the rectangular interface. Furthermore, TSS was influenced by the groove geometry, as variations in groove depth and width resulted in changes in TSS. These results indicate that appropriate control of the interface geometry can effectively enhance joint strength.

Keywords: resistance spot welding; dissimilar materials joining; intermetallic compound; tensile shear strength; interface shape

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Joining and Weld Integrity II | R7

Abstract

Effects of cold rolling after natural aging on precipitation behavior during artificial aging and mechanical properties in 7000 series alloy†

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Abstract

Natural aging is unavoidable during the manufacturing of aluminum alloys, making it essential to include natural aging to more practically evaluate the influence of the subsequent processes on the precipitation behavior. In this study, Al-4.5Zn-2Mg-2.5Cu alloy was subjected to natural aging for 5 days, followed by cold rolling (0%, 10%, or 20%) and artificial aging at 120 °C or 140 °C. Hardness testing, electrical conductivity measurements, differential scanning calorimetry (DSC) analysis, and High angle annular dark field scanning transmission electron microscopy (HAADF-STEM) observations were conducted to evaluate the aging behavior. The specimen cold-rolled by 20% and aged at 120 °C reached peak hardness after 24 h, whereas the same cold-rolled condition aged at 140 °C achieved nearly the same peak hardness within only 5 h. Higher artificial aging temperature significantly accelerated precipitation, which led to coarsening precipitates without cold rolling. In contrast, cold rolling after natural aging effectively mitigated this negative effect, resulting in a precipitation microstructure at 140 °C relatively comparable to that obtained at 120 °C but with a much shorter aging time. These results demonstrate that cold rolling allows high-temperature artificial aging without sacrificing peak hardness, offering a promising strategy to shorten heat-treatment time in Al-Zn-Mg-Cu alloys.

Keywords: Aluminum Alloy; Precipitation; Cold rolling; HAADF-STEM

Programme: Friday | 2026-06-12 | 09:30-11:00 | Technical Session 7 | Physical Metallurgy and Alloy Design IV | R7

Abstract

Cyclic Response of Aluminium SHS Beams: Experiments and Numerical Simulation[†]

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Abstract

This work presents an experimental and numerical investigation on the cyclic behaviour of Square Hollow Section (SHS) beams made of 6060-T6 aluminium alloy subjected to non-uniform cyclic bending. Eight specimens with width-to-thickness ratios ranging from 18 to 48 were tested under a three-point cyclic bending protocol. The work provides relevant experimental findings, including moment-chord rotation curves, the number of cycles to local buckling onset, failure modes, and energy dissipation capacity. Additionally, a numerical model was created implementing a damage model to predict the progressive degradation and failure mechanism of the beams. Finally, the reliability of the Finite Element model was assessed by direct comparison of the results with the experimental data

Keywords: Cyclic load, SHS beams, Aluminium alloy, 6060 series, damage model, Eurocode 9.

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Structural Systems and Infrastructure II | R5

Abstract

Digital Manufacturing: Enabling Lightweight, durable and circular aluminium solutions†

Anders Nesse, Ole Runar Myhr and Trond Furu

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Abstract

Digital technologies are advancing at a rapid rate and are reshaping how the manufacturing industry operates. By enabling faster time-to-market, lower production cost, improved quality and sustainability, digital manufacturing is becoming a powerful competitive advantage. The ability to balance and optimize complex trade-offs in process- and product characteristics gives the users an unprecedented decision-making opportunity to drive innovation and efficiency. This paper presents the ongoing challenges and emerging solutions faced by a major industry actor through the applications of digital manufacturing with the mandate to create innovative products and solutions. Cutting edge digital twin systems integrate physics-based models with artificial intelligence in a hybrid modelling framework capable of predicting microstructural evolution throughout the aluminium value chain - from casting and homogenization to extrusion and age hardening. These systems are key enablers to handle the post-consumer scrap revolution, when adaptive processing is necessary to maintain material properties. Together, digital manufacturing and digital laboratory both ensure that the right product is produced, and that the product is produced right, in a way that maximizes efficiency and sustainability, and circularity in aluminium production.

Programme: Thursday | 2026-06-11 | 15:45-16:30 | Keynote 4 | Keynote | R7

Abstract

Design of aluminium I-beams under major axis bending[†]

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Abstract

This paper investigates the design of aluminium I-beams under major-axis bending, fabricated by MIG welding three plates to form the section. The study focuses on beam sizes relevant to pedestrian bridges, with depths ranging from 508 mm to over 2540 mm. The analysis is limited to local buckling behavior. A total of 600 geometrical material nonlinear imperfection analysis - GMNIA and linear buckling analysis - LBA reference numerical results were obtained from validated non-linear shell finite element models. The influence of the Heat-Affected Zone (HAZ) is shown to be pronounced and detrimental to the resistance of welded aluminium beams. Unlike in steel beams, where buckling often governs, local buckling modes in aluminium members may arise but are typically dominated by HAZ-related failure. The effect of strain hardening on the behavior and resistance of aluminium alloys is examined and compared with current design approaches, which typically assume an idealized plastic plateau similar to steel. The results show that strain hardening significantly enhances resistance and is not captured by existing design methods. The effect of residual stresses in welded aluminium members is also investigated. The results indicate that MIG-induced residual stresses are sufficiently small and have a negligible influence on both structural behavior and strength. Their effect can be conservatively accounted for by increasing the amplitude of initial geometric imperfections. The study shows that current design recommendations are inconsistent and mostly unsafe for welded aluminium beams bridge sections governed by local buckling. The findings provide improved insight into the behavior and resistance of such members and contribute to more accurate and efficient design methods.

Keywords: Heat-Affected Zone (HAZ); aluminum I-beams; MIG welding

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Structural Systems and Infrastructure I | R5

Abstract

Driving Aluminium Circularity Forward: Evaluating EU-Recommended LCA Methods Against the Net Scrap Alternative†

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Abstract

Circularity in the aluminium manufacturing and use industries has attracted increasing attention in recent years. This is partly due to the criticality of the raw material and the drive for a more sustainable, greener society through the EU Green Deal and subsequent legislation/frameworks. Several stakeholders regard post-consumer scrap (PCS) as a panacea for this transition to circularity. Obtaining an appropriate, recycling-friendly post-consumer scrap alloy for a product is challenging, thereby intensifying competition in the PCS alloy market. Furthermore, manufacturers in the aluminium industry must conduct accurate and transparent assessments of their products. Life cycle assessment is the primary method used today. While several modelling approaches exist within LCA, the EU recommends using either the product environmental footprint (PEF) (50:50) or the circular footprint formula (CFF) approach. This paper highlights the limitations of these modelling approaches and compares them with the net-scrap approach for LCA of high-voltage aluminium cables. The strength of the netscrap approach lies in its robustness, particularly in demand-heavy PCS markets. It promotes the use of recycled inputs and end-of-life recyclability and allows for the inclusion of metal quality parameters. These are key levers for achieving high circularity (i.e., over 70%) in open-loop recycling of aluminium alloys.

Keywords: lifecycle assessment; aluminium recycling; post-consumer scrap; standards

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Circularity and Environmental Assessment I | R7

Abstract

Predicting mechanical properties of Al-Mg-Si extrusions containing emulated post-consumer scrap content using hybrid modeling[†]

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Abstract

The use of post-consumer scrap (PCS) in aluminium structural components is a challenging but important strategy for reducing carbon footprint in the automotive industry. However, introducing PCS increases uncertainty and compositional variation, which complicates property assurance in serial production. This paper evaluates a parallel hybrid modeling framework that combines a physics-based Kampmann-Wagner precipitation model (NaMo) with a machine-learning (ML) model, using a distance-based, adaptive weighting coefficient pre-trained on earlier non-PCS observations. The hybrid is tested on a separate dataset from alloys that emulate plausible compositional deviations introduced by PCS. To probe robustness, training is repeated with randomized initialization to evaluate distributions of RMSE and R2 for yield strength (Rp0.2) and ultimate tensile strength (Rm). Results show that the hybrid improves average performance relative to both constituent models and also reduces variation in accuracy compared to the ML model. The results support the role of adaptive weighting as a pragmatic safeguard against machine learning extrapolation under domain shift, while also exposing limitations related to coefficient calibration and feature choice in the distance metric. The findings are discussed in the context of decision support tools for recycling-oriented manufacturing and gradual onboarding of PCS chemistries into data-driven property models.

Keywords: Al-Mg-Si; Mechanical properties; Machine learning; Kampmann-Wagner; Hybrid modeling

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Modelling and Digital Methods I | R8

Abstract

Local Buckling and Ultimate Resistance of Aluminum Hollow Sections†

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Abstract

Aluminum hollow structural sections are increasingly used in construction due to their high strength-to-weight ratio, corrosion resistance, formability, and compatibility with advanced manufacturing processes that enable optimized geometries. While the local buckling behavior of conventional Square Hollow Sections (SHS) and Circular Hollow Sections (CHS) has been extensively studied, limited research exists on Polygonal Hollow Sections (PHS), which geometrically bridge SHS and CHS and are commonly used in applications such as sign structures, lighting poles, and transmission towers. This study presents a comprehensive numerical investigation of local buckling behavior and ultimate compressive resistance of aluminum CHS, polygonal, and SHS sections. A wide parametric study covering multiple aluminum alloys, dimensions, and side numbers is conducted. The results demonstrate a progressive transition in buckling behavior from plate-dominated response in SHS to shell dominated response in CHS, with polygonal sections showing intermediate behavior. Increasing the number of polygon sides enhances compressive resistance and reduces sensitivity to slenderness. Comparisons with current design standards highlight gaps in predicting the resistance of polygonal sections, particularly due to the absence of dedicated classification rules and limited consideration of strain hardening effects. The findings support the development of improved design approaches for closed aluminum sections.

Keywords: Compression resistance, local buckling; Finite Element Analyses; Polygonal hollow sections; Circular hollow sections; Square Hollow Sections.

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Structural Systems and Infrastructure I | R5

Abstract

Buckling-Restrained Aluminum Shear-Yielding Dampers for RC Seismic Retrofit: Hysteretic Response and Structural Performance†

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Abstract

This study explores the use of Buckling-Restrained Aluminum Shear-Yielding Panels (BRASYPs) as energy dissipation devices. These are integrated into exoskeletons designed for sustainable interventions. A retrofit strategy was defined for a school building employing exoskeletons integrating BRASYPs. A displacement-based retrofit strategy was applied and validated through nonlinear time-history analyses. Results confirm the effectiveness of the intervention: the Peak Inter-story Drift Ratio remains below the collapse prevention limit, and devices dissipate energy according to design.

Keywords: Shear-Yielding Aluminum Dampers; Seismic retrofit; RC buildings; Exoskel-etons.

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Structural Systems and Infrastructure IV | R5

Abstract

Members in Bending: Annex L of New EN 1999-1-1†

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Abstract

The new version of Eurocode 9 introduces Annex L, which extends the effective thickness method for the assessment of local buckling resistance of aluminium alloy members. This paper presents an overview of the theoretical background and the main procedural steps of Annex L, highlighting its application to thin-walled aluminium profiles susceptible to local instability phenomena. Particular attention is devoted to the definition of effective thicknesses, the treatment of plate elements under different stress distributions, and the consistency of the method with the general design framework of Eurocode 9. To evaluate the accuracy and reliability of the proposed approach, a systematic comparison is carried out between analytical predictions obtained using Annex L and numerical results derived from nonlinear finite element analyses. Several representative cross-sections and loading conditions are considered. The comparison allows assessing the level of agreement between the two approaches and identifying the main sources of discrepancy. The results confirm that Annex L provides a rational and generally conservative estimation of local buckling resistance, supporting its adoption in practical design of aluminium structures.

Keywords: local buckling; thin-walled section; Eurocode 9; Annex L.

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Structural Systems and Infrastructure II | R5

Aluminium Castings in Overhead Line Construction - Reliable Application and Challenges[†]

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Abstract

Aluminium cast components have become increasingly important in overhead line construction, particularly for parts such as cantilevers, tensioning devices, and connectors. Since the 1950s and 1960s, the transition from steel and iron castings to aluminium has enabled significant weight reductions, simplified assembly processes, and improved corrosion resistance-key advantages for enhancing the operational safety and service life of overhead line systems. However, the lower operational and fatigue strength of aluminium castings compared to steel imposes stringent demands on design, material selection, and quality assurance. A thorough understanding of fatigue mechanisms and constraint-induced stresses under cyclic loads from wind and tensile forces is essential to prevent crack initiation and component failure. This paper demonstrates how material analyses, experimental testing, and the targeted application of relevant standards can ensure the operational reliability of aluminium cast components [1]. Furthermore, existing gaps in current standards [2, 3, 4] are identified, whose closure is vital to fully exploit the potential of aluminium castings for durable, lightweight, and low-maintenance overhead line elements.

Keywords: Overhead Line Construction, Cyclic Loading, Cast Alloys, Fatigue Performance, Fatigue Data, Fatigue Design

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Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Structural Systems and Infrastructure III | R7

Abstract

Laser-based welding for manufacturing aluminium structures: industrial challenges and solutions[†]

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Abstract

Aluminium is increasingly adopted in large-scale structural applications due to its high strength-to-weight ratio, corrosion resistance, and excellent recyclability, making it attractive for automotive, aerospace, infrastructure, and renewable energy sectors. Despite these advantages, welding remains a major barrier to the wider use of aluminium in load-carrying structures. This challenge is particularly critical for precipitation-hardened 6xxx series aluminium alloys, where welding-induced thermal cycles can lead to significant strength degradation in the heat-affected zone (HAZ). Strength losses of up to approximately 50% may occur as a result of precipitate dissolution and coarsening. In addition, weld quality can be further compromised by defects such as porosity and lack of fusion. Laser-based welding has emerged as a promising alternative to conventional arc welding due to its high energy density and low overall heat input. These characteristics enable narrower HAZ, reduced distortion, and improved mechanical performance of welded joints, while also offering high productivity and potential cost reductions in the fabrication of large aluminium structures. This paper details industrial challenges, weldability limits, and the mechanisms of beam oscillation, which has emerged as a primary solution for stabilizing the keyhole, suppressing porosity, and refining microstructure. A case study has also been included in this paper to show the potential of laser oscillation in pore suppressing in hybrid laser-arc welding (HLAW) of 6082 aluminium.

Keywords: aluminium structures; laser-based welding; HAZ softening; beam oscillation

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Joining and Weld Integrity II | R7

Low-Cycle Fatigue of Welded EN AW-7020 Joints in the Context of EN 1999-1-3-Influence of Stress Ratio under Constant Amplitude Loading†

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Abstract

The cyclic performance of welded aluminum joints is crucial for the load-bearing capacity and durability of lightweight structural applications, particularly under low cycle fatigue (LCF) conditions. Reliably assessing such behavior is essential to applying and further developing design standards, such as EN 1999-1-3 [1]. This paper presents the results of an experimental study of welded EN AW-7020 aluminum joints (based on [2, 3]) that were subjected to constant-amplitude loading with varying stress ratios. Fatigue tests were conducted on butt welds and cruciform joints with stress ratios ranging from R = -0.25 to R = 0.5. The resulting S-N curves were evaluated and compared with the corresponding detail categories according to EN 1999-1-3 [1]. The results demonstrate a clear dependence of fatigue strength on the applied stress ratio; increasing mean stress reduces the allowable stress range. For all configurations investigated, the experimental fatigue strength exceeds the standardized design curves, indicating a generally conservative assessment within the current design framework. However, the influence of the stress ratio is not adequately captured; significant scatter is observed due to local effects in the welded region, especially in the heat-affected zone. The derived fatigue parameters were integrated into the Aluminum Fatigue Database (Alfabet), which was expanded in this study by combining new experimental results with existing literature data. These findings highlight the limitations of the nominal stress concept in the LCF regime and contribute to developing more accurate, material-specific fatigue design approaches.

Keywords: (Low-Cycle) Fatigue; Welded Joints; EN 1999-1-3 (Eurocode 9), Fatigue Data, Fatigue Design, Mean Stress, Stress Ratio R

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Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Joining and Weld Integrity IV | R5

New applications for aluminium in concrete marine infrastructure†

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Abstract

The transition towards more sustainable constructions motivates the exploration of aluminium in structural roles traditionally reserved to steel. In addition to its high corrosion resistance and excellent recyclability, aluminium offers a favourable strength-to-weight ratio, which can reduce dead loads and associated material demands in composite structures. Recent advances in concrete formulations, including alternative binders, enable renewed consideration of aluminium-reinforced concrete (ARC) composite systems, particularly for applications where durability, weight reduction, and circularity are critical. This study explores the structural viability of ARC and focuses on the influence of material interfaces and geometries, from early-age behaviour to service-level and ultimate conditions. Emphasis is given to the role of geometrical optimization in mitigating stress concentrations and enhancing bearing capacity. Composite dowels are reused to avoid bonding strength limitations and the absence of concrete coating exploited to maximize momenta of inertia. A combined analytical, numerical, and experimental framework is built to evaluate stress development, stiffness evolution, and failure proximity under thermal and mechanical loading. This work aims to support the development of aluminium-enabled composite solutions for lightweight and durable infrastructure. It connects several ongoing projects that promote innovative uses of ARC in the floating offshore industry.

Keywords: aluminium reinforced concrete; marine structures; thermos-mechanical load-ing

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Structural Systems and Infrastructure I | R5

Abstract

A Preliminary All-Aluminium Vehicular Bridge Concept Using Bobbin Tool Friction Stir Welding[†]

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Abstract

Aluminium remains relatively uncommon in civil structures; however, its durability and light-weight nature make it an attractive alternative for vehicular bridges. Recent applications use aluminium bridge decks supported by steel girders. However, galvanic corrosion and thermal incompatibility limit full and optimized behaviour. This research explores the use of Bobbin Tool Friction Stir Welding (BTFSW), which improves the welded aluminium behaviour while significantly improving fatigue detail classification, as it is critical for bridges. This configuration optimizes material use, reduces structural weight, and supports Accelerated Bridge Construction (ABC) practices by enabling modular prefabrication and rapid installation. The findings highlight aluminium's potential as a primary bridge material.

Keywords: Aluminium, Bridges, Bobbin Tool Friction Stir Welding (BTFSW), Fatigue, Accelerated Bridge Construction (ABC)

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Structural Systems and Infrastructure I | R5

Abstract

Heat affected zones in welded Al-Zn-Mg(-Cu) alloy plates[†]

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Abstract

Corrosion is a critical concern in high-strength Al-Zn-Mg-(Cu) alloys and is strongly influenced by microstructural features such as grain boundary precipitates and precipitate-free zones (PFZs) [1,2]. Welding induces complex thermal cycles that modify the microstructure of the heat-affected zone (HAZ). Previous studies report that HAZ I (adjacent to the weld) experiences peak thermal exposure, resulting in a high precipitate density, whereas HAZ II (between HAZ I and the base material) is subjected to intermediate temperatures and contains fewer, coarser precipitates, leading to softening due to precipitate coarsening and reduced dislocation pinning [3]. A study on MIG-welded 7020 alloys found the deepest corrosion penetration at the interface between HAZ II and the base material, although this observation was not further discussed [4]. To address this gap, the present study examines a corrosion-prone region approximately 15 mm from the weld centerline, termed the Corona. Elemental distributions in PFZs near grain boundaries and within grain interiors were analyzed using transmission electron microscopy with energy-dispersive spectroscopy mapping, while microstructural features were assessed by annular dark-field scanning transmission electron microscopy imaging. Results demonstrate that PFZs in the Corona are more enriched in Zn, Mg, and Cu compared with the base material, indicating solute release from intergranular precipitates. Increased Cu content in both PFZs and grain interiors further suggests dissolution of an observed Cu-rich intergranular film which is present in the base material. Elucidating welding-induced microstructural transformations in the HAZ is essential for understanding the increased corrosion susceptibility of the Corona region.

Keywords: TEM; EDS; Aluminium alloys; Al-Zn-Mg; HAZ; MIG welding.

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Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Joining and Weld Integrity III | R8

Abstract

Life Cycle Assessment of Aluminium Bridge Concepts[†]

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Abstract

This study extends a cradle-to-gate life cycle assessment (LCA) of an aluminium-reinforced concrete bridge by incorporating degradation processes and maintenance cycles, enabling a cradle-to-use comparison with a conventional steel-reinforced concrete bridge. The objective is to evaluate how deterioration assumptions and reinforcement replacement strategies influence environmental performance. The analysis shows that these parameters strongly shape the results producing distinct behavioural patterns. Replacement driven activities, such as deck demolition and reinforcement replacement, emerge as the main contributors to impact variation. The wide impact ranges observed indicate a high sensitivity of the model to deterioration assumptions and highlight the importance of accurate use-phase inventories. Overall, the findings demonstrate that bridge deterioration and maintenance strategies have substantial impact in LCA use-phase modelling and its outcomes. They emphasise the need for transparent bridge deck deterioration modelling and inventory data for maintenance activities in steel-reinforced concrete bridges, and further validation of the assumed maintenance-free lifetime for the aluminium-reinforced concrete bridge in order to support robust decision-making in future construction projects.

Keywords: Life Cycle Assessment (LCA); aluminum-reinforced concrete bridge; steel-reinforced concrete bridge

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Circularity and Environmental Assessment I | R7

Abstract

Using Sc and Zr for dispersoid formation in an Al-Mg-Si alloy†

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Abstract

Four Al-Mg-Si alloys, three of them with additions of scandium or scandium and zirconium, were cast, homogenised at 550°C and precipitation hardened at 175°C. For the alloy with highest Sc content, significant discontinuous precipitation of Al3Sc took place during cooling after casting. Homogenisation for 1h lead to formation of Al3Sc or Al3(Sc,Zr) dispersoids. The Al3(Sc,Zr) dispersoids were found in higher number densities than the Al3Sc dispersoids, and the latter were not stable for longer homogenisation times. TEM-observations indicate that the Al3Sc or Al3(Sc,Zr) dispersoids are not preferred nucleation sites for metastable (Mg,Si)-particles. The precipitation hardening behavior of the Al-Mg-Si alloys was not altered by the Sc or Sc+Zr additions.

Keywords: AlMgSi; Homogenisation; Dispersoids; Microstructure; Precipitation

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Physical Metallurgy and Alloy Design II | R5

Abstract

New Method to Predict Stress-Strain Diagrams at High Strain Rates†

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Abstract

Quasi-static mechanical testing is the bed-rock of our fundamental understanding of metal plasticity, yet many practical forming processes occur at faster rates. Thus, extrapolating quasi-static data to higher rates requires a robust constitutive equation. Constitutive relation analyses [1], based on balancing energies expended and stored during plasticity, uses a constitutive framework of flow shear stress, τ, as a function of shear strain, γ, and internal variable mean slip distance, λ, $\tau^2 = [(P\ 4A)\ (2 + \beta)(\alpha\mu b)^2\ b\ ]\ \gamma\ \lambda$ where P is the ratio of segment length over slip area, A an annihilation factor, β a power law factor, α the obstacle strength, μ the shear modulus and b the Burgers vector. A measured stress-strain diagram is fit using two model-equations and their intersection defines $\tau 3$, $\gamma 3$ and $\lambda 3$. τ-γ data is normalized by $\tau 3$ and $\gamma 3$ resulting in a master curve, $\tau/\tau 3 = (\theta/\ \theta 3)\ (\gamma/\gamma 3)$, where θ is the work hardening rate. This curve suggests that double-log representation of ($\tau 3$,$\gamma 3$) versus $\dot{\gamma}$ from quasi-static rates may be extrapolated to industrial sheet forming ones. The method will be demonstrated for polycrystalline Al-MgxSiy T4 alloy sheet tensile tested at 10-5 to 10-2 s-1 [2] and expanded to show how the temperature dependent strain rate sensitivity may be calculated.

Keywords: Al-Mg-Si; constitutive model; formability; high strain rate; stress-strain; T4

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Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Modelling and Digital Methods II | R8

Abstract

Cut the Heat, Save the Gas: Retrofitting Thermal Post Combustions with Oxidation Catalysts[†]

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Abstract

The transition from conventional thermal to catalytic post combustion systems in industrial waste-gas treatment enables energy savings and reductions in climate-relevant emissions. In the aluminium industry, particularly in aluminium recycling processes where solvent-containing exhaust gases, oil aerosols, and organic pollutants can arise from scrap preparation, coating removal, or thermal treatment steps, efficient waste-gas treatment is essential. Integrating a Platinum Promoted Honeycomb catalyst into existing thermal post combustion systems has been shown to lower the required operating temperature from approximately 1000 °C to about 400 °C. This reduction is achieved without loss of oxidation efficiency for volatile organic compounds (VOCs) and odorous pollutants. The lower operating temperature directly decreases natural gas consumption (up to > 80%), as substantially less fuel is needed to maintain process conditions. Beyond reducing operating costs, the approach contributes to lower CO_2 emissions and improved energy efficiency without requiring replacement of the installed abatement system. The retrofit concept shown is particularly attractive for exhaust streams containing solvents or oilaerosols and for fluctuating load conditions, as frequently encountered in aluminium scrap processing, or downstream forming and surface-treatment operations, where thermal systems are commonly operated with substantial operational reserves. High-impact applications are expected in stamping and cutting processes followed by thermal treatment, where fumes and aerosols can be effectively treated at reduced temperatures. The presentation addresses the technical principle, expected energy savings, and practical integration aspects, strongly suggesting catalytic post combustion as a scalable modernization option for existing thermal exhaust-gas treatment infrastructure in aluminium-processing and related manufacturing industries.

Keywords: Catalytic oxidation; catalytic post combustion; thermal post combustion; natural gas reduction; VOCs abatement; retrofit of waste gas treatment systems; CO abatement; OPEX-reduction;

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Manufacturing Process Control and Forming II | R8

Abstract

Investigation of the influence of drawing process parameters on the fatigue strength of aluminium wires intended for overhead power line conductors†

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Abstract

One of the primary factors contributing to the impairment of overhead power lines during operation is fatigue damage arising from conductor vibrations. A number of factors influence the fatigue strength, including chemical composition, strength, surface quality and residual stresses. One solution to the problem of increasing the fatigue strength is to replace aluminium with a higher strength aluminium alloy. Unfortunately, this option is costly and has a detrimental effect on the electrical conductivity of wires. Consequently, a further research direction for improving fatigue strength involves modifying the surface quality and reducing residual stresses in wires. The article presents the findings of research conducted on the influence of drawing parameters of aluminium wires, including the modification of die geometry, on fatigue strength. In the present study, wires were produced using dies with different geometries in the high-speed industrial wire-drawing process. The following tests were then carried out on the aluminium wires: surface quality (SEM), 3D surface topography and fatigue strength. Following a thorough review of the research results, it was determined that selecting die geometry is the most effective way to achieve higher fatigue strength for aluminium wires in industry conditions

Keywords: overhead power lines; aluminium wires; fatigue; die angle; wire drawing

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Manufacturing Process Control and Forming I | R8

Influence of Arc Oscillation Frequency on Bead Geometry Accuracy in Single and Multi-Layer WAAM of Al-4043 Alloy[†]

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Abstract

This study investigates the effect of sinusoidal arc oscillation frequency on bead geometry accuracy in Cold Metal Transfer-based Wire Arc Additive Manufacturing (CMT-WAAM) of Al-4043 alloy. Single-pass depositions were performed at frequencies of 0-4 Hz (1.0 mm amplitude) and 0-5 Hz (1.5 mm amplitude), followed by multi-pass, multi-layer builds using optimal parameters. Cross-sectional analysis revealed that a 3-4 Hz frequency window minimizes wetting angle asymmetry and maximizes bead width-to-height ratio. At 4 Hz with 1.5 mm amplitude, the arc oscillation yielded a symmetric wetting angle deviation of only 1.22°. Multi-layer builds indicated that oscillation improved the effective cross-sectional area ratio from 75% (non-oscillating) to 82%, suggesting superior geometric efficiency and reduced material waste in post-machining.

Keywords: wire arc additive manufacturing; arc oscillation; bead geometry; wetting angle; Al-4043; Cold Metal Transfer; melt pool dynamics; multi-layer deposition

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Additive and Solid-State Manufacturing I | R7

Abstract

A Study on Factors Affecting the Joint Strength of Resistance Spot-welded Joints in Aluminum Casting Alloys and Rolled Aluminum Alloy†

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Abstract

With the increasing adoption of gigacasting in the automotive industry, establishing joining technologies between aluminum casting alloys and rolled aluminum alloys has become an important challenge. In resistance spot welding (RSW) of these dissimilar materials, nugget formation is often absent, and the factors governing joint strength remain unclear. This study aims to clarify the factors affecting joint strength in RSW joints between aluminum casting alloy and rolled aluminum alloy. The relationship between fracture morphology and joint characteristics was systematically investigated through cross tension tests, cross-sectional observations, hardness measurements, and numerical simulations. The results indicate that cross tension strength (CTS) is strongly correlated with crack propagation behavior in the rolled aluminum alloy. In contrast, conventional factors such as penetration and plug diameter show weak correlation with CTS. Furthermore, the deformation range of the rolled aluminum alloy affects the distribution of plastic strain, which in turn controls crack propagation angle and joint strength. These findings demonstrate that the deformation behavior of the rolled aluminum alloy plays a dominant role in determining joint strength in nugget-free RSW joints.

Keywords: resistance spot welding; rolled aluminum alloy; aluminum casting alloy; cross tension strength; fracture morphology; crack propagation

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Joining and Weld Integrity II | R7

Direct description of inherent strains for thin-plate welding distortion modelling†

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Abstract

Numerically efficient and user-friendly modelling of component distortions is the key for enabling numerical design of thin plate structures accounting for welding distortions. This especially concerns large structures, e.g. bridges or ship panels. The direct description of inherent strains is a method for introducing inherent strains into a commercial finite element solver. The presented version utilizes thermo-mechanical local modelling with 3D solid elements in Abaqus as a source for the inherent distortion fields. The resulting inherent strain fields are post-processed and subsequently applied to a low fidelity component model utilizing 3D thin shell elements in Abaqus. The new direct description method of introducing the inherent strain fields for thin shell elements is presented in this paper, and it shows promising results.

Keywords: Welding distortions; Finite element simulations; Inherent strain method; Thin-plate structures; Thin shell elements

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Joining and Weld Integrity IV | R5

Abstract

Melt treatment optimization and end product quality of 6xxx billets†

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Abstract

In this study, it was aimed to examine the metallurgical structures of AA6082 alloys after the casting and homogenization process. During the casting of AA6082 alloys, billets were produced. The porosity was determined by the reduced pressure test and bifilm index were examined. Liquid metal was treated with flux feeder in the holding furnace with different conditions such as changing gas flow rate, changing flux ratio and degassing duration. The billets were then subjected to different homogenization process where microstructures and homogeneity were examined. In addition, SEM and EDS examinations were carried out to characterise the AlFeSi and Mg2Si phase distributions. It was found that the melt cleanliness plays a significant role on the end product quality.

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Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Physical Metallurgy and Alloy Design II | R5

Abstract

Buckling behavior of aluminum tubular beam-columns[†]

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Abstract

This study investigates the buckling behaviour of extruded aluminium square and rectangular hollow section (SHS/RHS) members under compression and combined loading. An experimental program was conducted to examine the response of aluminium members subjected to eccentric compression. The experimental results were used to validate detailed finite element models developed in Abaqus, which were subsequently employed in an extensive parametric study. The outcomes of this study are intended to support the development of new design rules based on the Overall Interaction Concept (O.I.C.).

Keywords: aluminum structures; hollow sections; SHS/RHS members; buckling; beamcolumns; finite element modelling; Overall Interaction Concept; local-global interaction

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Structural Systems and Infrastructure II | R5

Abstract

Effect of Continuous Bending under Tension on aluminum-magnesium alloy†

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Abstract

Reducing vehicle mass is an effective strategy for lowering emissions, which represent a significant contributor to air pollution within the European Union. Although weight reduction during the operational phase of a vehicle is essential [1], environmental impacts associated with manufacturing and end-of-life stages must also be taken into account. Advanced metal forming processes make it possible to utilize high-strength materials while maintaining adequate formability and energy efficiency. Among these processes, continuous bending under tension (CBT) has emerged as a promising technique, as it enables higher levels of plastic deformation compared to conventional forming methods [2]. In the present work, CBT experiments were performed on the aluminum-magnesium alloy, combining uniaxial tensile loading with cyclic bending via a mobile three-roll setup. The effect of the key process parameter, namely bending depth, was systematically investigated. The findings indicate that smaller bending depths permit greater overall deformation prior to fracture and result in higher tensile forces than larger bending depths.

Keywords: aluminum alloys, continuous bending under tension, formability

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Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Manufacturing Process Control and Forming II | R8

Abstract

The formation of L phase precursor originated from Cu-containing Guinier-Preston zone in Al-Mg-Si-Cu alloys†

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Abstract

Al-Si-Mg-Cu alloys are widely used in the transport industry due to their desired combination of strength and formability. The addition of Cu significantly enhances the mechanical properties through the formation of Cu-rich precipitates, commonly referred to as the Q, C, and L phases, which contribute to precipitation strengthening. However, the atomic-scale structure and formation mechanism of the Cu-rich precipitates remain poorly understood. This knowledge gap hinders a thorough understanding of precipitation in Al-Si-Mg-Cu alloys, consequently, hinders the optimizing of thermomechanical processing. In the present study, L phase precursors are discovered in an AA6061-T8 aluminium alloy using high-resolution scanning transmission electron microscopy. Precipitates with a lateral size of approximately 2 nm form after cold rolling and artificial ageing. These fine L phase precursors are characterized by Cu-rich column(s) that form single- or multiple C sub-units as the structural core, which further grow along [001]Al direction through the rearrangement of Mg, Si, and Al atomic columns. Based on the arrangement of C sub-units, two distinct types of L phase precursors are observed, exhibiting different initial structural configurations. Type I precursors initiate from a single C sub-unit, which subsequently develops into an in-plane mirror symmetric structure in cross-section, and grow along the [001]Al direction through further addition of Cu atoms that substitute the Si atoms in its periphery. Type II precursors are characterized by two Cu columns that form two C sub-units in a rotationally symmetric configuration. This structure also grows along the [001]Al direction through additional Cu substitutions of Si columns. Further, the formation of both types of the L phase precursor begins with Cu substitution for Si within the Guinier-Preston (GP) zones during early stages of precipitation. In a specific 2β″ type GP-zone, Cu substitution follows a well-defined pattern. Density functional theory (DFT) calculations indicate that Cu substitution in 2β″ type GP-zones follows the pathway which overcomes the minimum energy barrier, subsequently evolving into an L-phase precursor with a characteristic Cu distribution pattern. These findings establish a direct link between atomic-scale Cu substitution and the early-stage evolution of Cu-rich precipitates in Al-Si-Mg-(Cu) alloys.

Programme: Wednesday | 2026-06-10 | 10:45-12:15 | Technical Session 1 | Physical Metallurgy and Alloy Design I | R5

Abstract

Towards Scrap-Tolerant Aluminium Sheet Materials†

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Abstract

Rising scrap fractions inevitably increase tramp element contents in the common sheet forming alloys, altering microstructure and mechanical behavior. Traditionally, Fe was treated as critical impurity. Recent results show that Fe content alone is not predictive; damage and fracture are governed by the morphology and spatial distributionofprimaryintermetallics, the strength of the surrounding matrix, and the stress state imposed by the loading path. Sheets with impurity levels of 5xxx/6xxx and end-of-life vehicle scrap were produced by scalable casting and rolling and subjected to representative heat treatments. Primary particle size, spacing and fragmentation, as well as porosity (including near-surface regions), were quantified. Mechanical response was assessed by uniaxial tension and 3point bending (with and without 10% pre-strain) and correlated with post-mortem microscopy. Tensile strength-ductility combinations remained attractive when primary intermetallics were refined, uniformly distributed and porosity was suppressed. In contrast, bending was controlled by tensile-surface damage: particle cracking followed by void growth and coalescence. Pre-strain reduced bendability by accelerating stress transfer to particles in a stronger, rapidly hardening matrix. Scrap tolerance must therefore be defined relative to the targeted loading path; robust bending requires particle and porosity control together with matrix-strength trajectories that delay void linkage.

Keywords: Sheet Forming, Recycling, Intermetallics, Bending

Programme: Friday | 2026-06-12 | 11:30-12:15 | Keynote 6 | Keynote | R7

Abstract

Predicting laser-welded joint failure in an AA6082 aluminum alloy[†]

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Abstract

Laser beam welding (LBW) is widely used in aluminium structures, yet the prediction of ductile fracture in welded joints remains challenging due to strong spatial variations in microstructure and mechanical properties within the heat-affected zone (HAZ). In this work, a coupled experimentalnumerical framework is proposed to predict failure initiation and fracture behaviour in a laser-welded AA6082 aluminium alloy. The framework integrates thermal simulation, precipitation modelling, and fracture finite element analysis. A heat transfer model is first used to compute the transient thermal field during welding, from which local thermal histories are obtained and used as input to a precipitation kinetics model to predict microstructural evolution and spatial variations in mechanical properties. These properties are then incorporated into a Gurson-Tvergaard-Needleman (GTN) fracture model, with key parameters calibrated using tensile testing and microstructural characterization of the base material. The calibrated model is applied to simulate a cross-weld tensile test, enabling prediction of strain localization, void evolution, and fracture initiation across the welded joint. The results demonstrate that the proposed framework captures the effect of welding-induced microstructural heterogeneity on ductile fracture behaviour and enables physically consistent prediction of failure location.

Keywords: Laser beam welding; Heat-affected zone; Ductile fracture

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Joining and Weld Integrity III | R8

Abstract

Innovation in Complex Aluminum Grid Structure Systems and Key Technologies for Intelligent Construction†

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Abstract

Traditional aluminum grid structures have long been confined to circular dome forms due to the insufficient shear and flexural rigidity of their predominant gusset plate joints. To overcome this limitation, this research, based on major projects such as G60 S&T Innovation Vally of Yangtze River Delta and the Shanghai Greenhouse Garden project, systematically conducted integrated innovation across the entire chain from structural systems to construction technologies. Regarding structural systems, developments include form-finding and optimization for free-form surfaces, cable-net supported flat structures, self-balanced cable-supported grids with large openings, and inverted prestressed aluminum cable net structures, achieving a leap towards complex spatial systems. At the core technical level, innovations introduced include joints reinforced with vertical or cross webs, double cell closed section, and fully rigid connection details, effectively addressing challenges in transmitting complex internal forces. For construction, a dedicated design platform, digital detailing systems, and smart production lines were developed. Through the integration of BIM and CNC high-precision components technology, the research achieved ultra-high-precision manufacturing and implemented error control strategies forming a complete intelligent construction solution. The research outcomes successfully expand the application boundaries of aluminum alloy grid structures, providing significant technical support for modern long-span architecture.

Keywords: Aluminum Grid Structure; Complex Spatial Structure; Joint Detailing; Structural System Innovation; Intelligent Construction

Programme: Wednesday | 2026-06-10 | 13:15-14:45 | Technical Session 2 | Modelling and Digital Methods I | R8

Abstract

Continuous wire-feeding screw extrusion friction stir deposition (W-SEFSD) additive manufacturing of Al-alloy†

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Abstract

Solid-state additive manufacturing boasts broad application prospects in different manufacturing areas, owing to fewer thermal defects, lower residual stress and higher efficiency. However, rod-based additive friction stir deposition (AFSD) suffers from discontinuous feeding and insufficient flexibility in building complex parts. In this study, we developed a novel solid-state additive manufacturing method-continuous wire-feeding screw extrusion friction stir deposition (W-SEFSD), which offers advantages in excellent interlayer metallurgical bonding, stable processing, and low axial force. A laboratory prototype setup and tools was designed and developed, based on a milling machine. On this basis, a series of additive manufacturing experiments were conducted using commercial AA4043 aluminum alloy wire with a diameter of 2mm. Microstructure characterization and mechanical property tests were performed on formed parts. The results indicate that the formed parts exhibit uniform layer thickness, dense interlayer bonding, and a microstructure consisting of fine equiaxed grains, with tensile strength comparable to the base material and significantly improved elongation, thereby verifying the feasibility of W-SEFSD process and setup. Furthermore, this study preliminarily explored the effects of key process parameters such as rotational speed, transverse speed on the mechanical properties of the formed parts, providing a basis for the flexible and efficient manufacturing of high-performance components.

Keywords: friction stir deposition; continuous wire-feeding; screw extrusion; aluminum alloy; mechanical properties

Programme: Thursday | 2026-06-11 | 13:45-15:15 | Technical Session 6 | Additive and Solid-State Manufacturing II | R7

Role of Aluminum 4104 Foil Interlayer in Controlling Interfacial Behavior of Large-Area AA6063-Cu Joint Fabricated by Contact-Reaction Brazing†

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Abstract

The growing adoption of hybrid and plug-in electric vehicles increases heat generation in power electronic modules, driving demand for effective thermal management materials and reliable Al/Cu joining methods. However, large-area Al/Cu joints are challenging as conventional brazing requires high temperatures and flux, and fusion welding performs poorly with dissimilar metals. Contact Reaction Brazing (CRB), which relies on eutectic-phase formation during heating, presents a promising alternative. Direct CRB of AA6063 and Cu might lead to severe aluminum dissolution above 570 °C. To mitigate this, large-area CRB of AA6063/Cu using a 4104 aluminum-foil interlayer is examined. Brazing temperature, holding time, and pressure are systematically varied to evaluate their influence on joint formation. Interfacial microstructures are characterized by SEM and XRD. Shear-testing is used to assess fracture behavior and mechanical performance. A satisfactory shear strength of 48.8 MPa is achieved for the AA6063/AA4104/Cu joint under a brazing temperature of 540 °C, a holding time of 10 min, and an applied pressure of 600 Pa.

Keywords: Aluminum 6063; Copper; Aluminum 4104; Al/Cu joint; Contact-reaction brazing; Interfacial behavior.

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Joining and Weld Integrity IV | R5

Abstract

Loss of Nanoparticles Added for Additive Manufacturing of Crack-free High Strength Aluminium Alloys with PBF-LB†

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Abstract

High strength wrought aluminium alloys like AA7075 and AA6061 are challenging for additive manufacturing (AM) due to the tendency of hot cracking. The powder bed fusion - laser beam (PBF-LB) is one of the most developed AM technologies. Alloying modification by adding nanoparticles and/or other alloyed powders has demonstrated success for printing crack-free samples, both by our own work and by literature. SINTEF has also been working on a fast-alloy development scheme, where arc-melter is employed to screen the effectiveness against hot cracking of added elements. In this work, we report that crack-free 7075 type alloys were produced using alloy variant 1) adding 1.6wt% ZrH_2 nanoparticle and variant 2) adding 5%wt Si through blending with tens-microns sized AlSi40 powder. The 6061 alloys were crack-free when mixed with 1wt%Ti_4Al_6V powder of tens-microns particle size; but 1wt%ZrB_2 nanoparticles did not prevent the cracking. The chemical composition analysis revealed that only ~50% added nanoparticles are present in the printed parts, based on Zr concentration. While with micron-size powder, the utilization is ~100% based on concentration of Si and Ti. Hence, there is a 50% loss of nanoparticles, which may also explain deviations between arc remelting and printing results.

Keywords: additive manufacturing 1; PBF-LB 2; high strength aluminium alloys 3; hot cracking 4; compensational metallurgy 5

Programme: Wednesday | 2026-06-10 | 16:00-17:50 | Technical Session 3 | Additive and Solid-State Manufacturing I | R7

Abstract

Torsional Strength of Thick-Walled Aluminum Tubes†

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Abstract

An experimental study of closed hollow sections subjected to torsional loading was conducted. The aim was to examine the torsional behavior of thick-walled 6061-T6 aluminum alloy tubes. The test plan included three sets each of circular and rectangular tubes, each with six specimens for a total of 36 torsion tests. Experimental data was used to estimate torsional stiffness, and both first-yield and full plastic-yield strengths. Experimental estimates were compared with theoretical predictions, as well as values computed using the Aluminum Association's Specification for Aluminum Structures (SAS) design rules. The SAS provisions were found to be overly conservative for thick-walled circular tubes, while fairly close agreement of SAS's shear modulus (C) and the torsional plastic section modulus (ZT) resulted in more accurate results for thick-walled rectangular tubes.

Keywords: aluminum alloys; torsion testing; torsional yield strength;

Programme: Thursday | 2026-06-11 | 08:30-10:00 | Technical Session 4 | Structural Systems and Infrastructure II | R5

Abstract

Performance of Blind-Bolted Connections in Aluminum Hollow Structural Sections[†]

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Abstract

Blind-bolted (one-sided) connections are a proven alternative to welding in steel construction, yet far less appears to be known about their performance in aluminum structures. This study examines blind-bolted connections in aluminum hollow square sections (HSS), motivated in part by the significant strength reductions that can occur in the weld heat-affected zone for aluminum members. Experimental tests are being carried out on aluminum (6061-T6) and steel (ASTM A500 Grade C) HSS with matched geometry (3-in. square, ¼-in. wall) to enable direct comparison. Stainless steel and hot-dipped galvanized Lindapter Hollo-Bolts® are used, and the specimens are detailed so that failure occurs in the HSS wall rather than by bolt fracture. For the configurations tested to datesingle-bolt and multi-bolt-punching shear through the HSS wall has governed. Because aluminum's elastic modulus is roughly one-third that of steel, the study also tracks wall distortion under tensile loading as a potential additional limit state. The results are used to assess whether aluminum blind-bolted connections follow the same strength trends observed in steel and whether existing steel-based pull-out guidance can be adapted with simple modification for aluminum HSS.

Keywords: blind-bolted connections; aluminum HSS; pull-out strength

Programme: Thursday | 2026-06-11 | 11:15-12:45 | Technical Session 5 | Structural Systems and Infrastructure III | R7