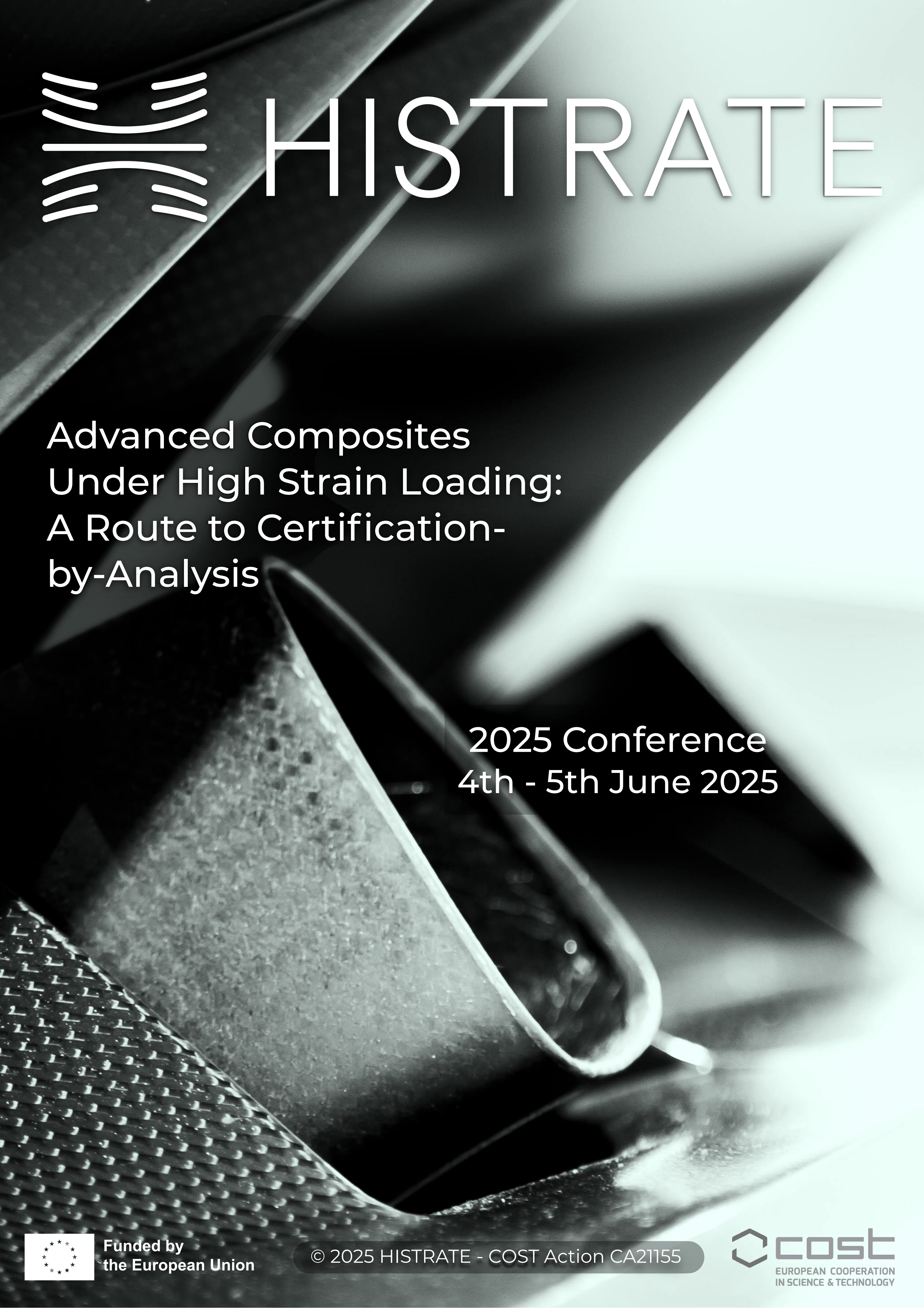

HISTRATE

Advanced Composites Under High Strain Loading: A Route to Certification-by-Analysis

2025 Conference
4th - 5th June 2025

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Preface

We present the **Book of Abstracts for the Second HISTRATE Conference — *Advanced Composites under HIgh STRAin raTEs Loading: A Route to Certification-by-Analysis***, held from June 4 to 5, 2025, in San Sebastian, Spain**.** Following the enthusiastic response to the first edition of HISTRATE conference, this year's event reaffirms its role as a dedicated forum for specialists working at the intersection of composite materials, dynamic loading, and computational certification methodologies. Nestled between the rolling green hills of the Basque Country and the sparkling waters of the Bay of Biscay, San Sebastián offers a stunning setting for intellectual exchange.

As advanced composite materials play an increasingly central role in industries such as aerospace, automotive, defense, marine, and renewable energy where lightweight, high-performance, and impact-resistant structures are vital. The accurate understanding of their behavior under high strain rate conditions has become both a scientific and engineering imperative. In parallel, the concept of certification-by-analysis is gaining momentum as an efficient, reliable, and cost-effective alternative to traditional testing regimes. This shift relies fundamentally on the development of validated, high-fidelity numerical models capable of predicting material and structural responses under dynamic events with confidence.

The HISTRATE conference series was started to bring together an international community of researchers, engineers, industry representatives, and regulatory stakeholders to exchange knowledge, share new methodologies, and discuss both the advances achieved and the hurdles yet to be overcome in the domain of composites. The 2025 edition focuses particularly on integrating experimental, numerical, and analytical approaches to support and accelerate the transition towards certification-by-analysis for composite structures subjected to high strain rate loading.

This Book of Abstracts reflects the diversity, depth, and forward-looking spirit of the conference. It compiles contributions from 35 universities, 11 academic research centers, and 5 industrial research centers, covering a broad spectrum of topics. These include innovative experimental techniques for dynamic characterization, advances in constitutive modeling and failure criteria under high strain rates, multiscale simulation approaches, novel composite architectures for improved dynamic performance, and strategies for integrating numerical predictions into certification pathways. Emerging themes such as the use of artificial intelligence and machine learning in high-strain-rate material modeling, and the role of uncertainty quantification in predictive simulations, are also represented. The conference united authors from Belgium (2), Bulgaria (2), Czech Republic (3), Cyprus (1), France (1), Georgia (2), Germany (3), Greece (3), Ireland (1), Italy (5), Latvia (2), Lithuania (1), The Netherlands (2), North Macedonia (5), Poland (7), Slovakia (2), Turkiye (12), UK (9). One third of the corresponding authors are early career researchers.

The conference program features keynote lectures by experts from industry**,** technical sessions and poster presentations organized around thematic tracks in the COST CA21155 Working groups and the Action use cases, including research from early-career scientists. This dynamic format is designed to foster both formal and informal exchanges, encouraging collaborations that extend beyond the conference itself.

We wish to thank all the authors for their valuable contributions, the reviewers for their thorough evaluations, and the members of the organizing and scientific committees for their

tireless work in shaping this conference. Special recognition is also due to our host from University of the Basque Country for their organizing efforts and generous support.

We believe this collection of abstracts will serve not only as a useful reference but also as a lasting record of the ongoing efforts to push the boundaries of composite material technology and certification practices under dynamic loading conditions.

The HISTRATE 2025 Organizing Committee

Influence of some technological parameters on the content of voids on the in-situ thermoplastic composites in Pultrusion, FW and AFP/ATP technologies

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Abstract: The manufacturing processes, such as pultrusion, filament winding and automated fiber/tape placement, have been used conventionally for thermoset composites. The automated processes can be adapted to include in situ consolidation for the fabrication of thermoplastic composites.
In this paper, a detailed review of the factors affecting the in-situ consolidation process is presented for each technology in detail. Experimental tests were performed with changing parameters for the three technologies in order to minimize voids for the fabrication of thermoplastic composites. Optimizing these parameters ensures high-quality composite parts with superior mechanical properties who to be used in many applications.

1. Experiment

1.1. Materials

The manufacturing of fiber reinforced thermoplastic polymer (FRP) composites is generally much less time consuming due to their short consolidation cycles. Besides this, FRTP composites also have other advantages over thermoset based FRP composites, including higher toughness, long shelf life, ease of repairing and potential for recycling [1]. For the experiments with pultrusion and FW technology GF/ PP was used, that for AFP/ATP technology, GF/PP and GF/PA6 as and other thermoplastics such as PPS/PEEK were used.

1.2. Production of FRTP composites with in-situ consolidation in multiple technologies (Pultrusion, FW and AFP/ATL)

In-situ consolidation relies on heating the thermoplastic polymer matrix rapidly above its melting temperature, followed by fusing the molten surfaces during cooling. This process eliminates a second step of autoclave or hot-press mold consolidation, thereby reducing processing steps and manufacturing expenses.

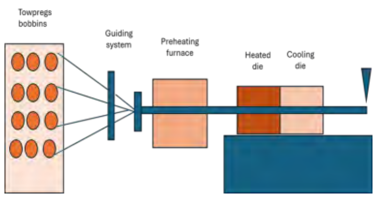

Fig. 1 Schematic layout of designed laboratory pultrusion

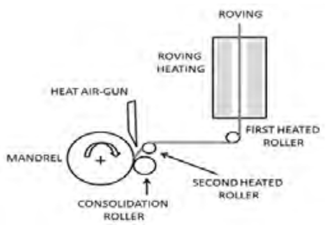

Fig. 2 Schematic layout of designed FW laboratory head

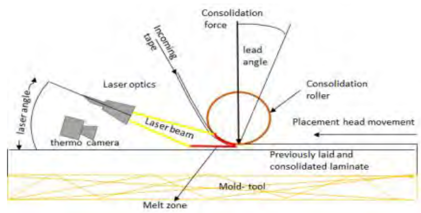

Fig. 3 Schematic layout of designed AFP/ATL laboratory head

There are more technologies for In-situ consolidation, they are:

- The term in-situ thermoplastic Pultrusion refers to the use of thermoplastic resins in the pultrusion process. In this case, the thermoplastic resin is introduced directly into the pultrusion process allowing the thermoplastic material to fuse and bond around the reinforcement fibers [2-5].
- In-situ thermoplastic Filament Winding (FW) is an innovative process that combines the benefits of thermoplastic resins with the precise and efficient filament winding technique [6].
- In-situ consolidation in Automated Fiber/Tape Placement (AFP/ATP) enhances the fiber placement process by integrating the resin activation and consolidation directly into the manufacturing workflow.

However, these processes require careful management of key parameters, including temperature, fiber tension, compact pressure and resin flow, to ensure optimal consolidation and part performance. Optimizing these parameters ensures high-quality composite parts with superior mechanical properties. These technologies offer significant benefits across a variety of industries, including aerospace, automotive, defense, and energy, by providing high-performance composite materials with tailored properties [7].

2. Results and Discussion

The content of voids in thermoplastic composites produced using pultrusion, filament winding (FW), and automated fiber placement (AFP) technologies is a critical factor influencing the mechanical properties, performance, and durability of the final composite material. The presence of voids can significantly degrade the strength, stiffness, fatigue resistance, and overall integrity of the composite, making it essential to minimize their formation during manufacturing. Various technological parameters in each process can affect void content, and understanding their influence is key to producing high-quality thermoplastic composites Table1.

Table 1. Technological Parameter Influence on Void Content

Parameter	Pultrusion	Filament Winding (FW)	Automated Fiber /Tape Placement (AFP/ ATP)
Resin Viscosity	Affects resin flow and fiber impregnation, influencing voids.	Influences resin impregnation and void formation.	Influences resin impregnation and voids.
Temperature/Heating	Critical for resin melting and consolidation, avoiding voids.	Affects resin melting and cooling rate.	Temperature control ensures proper resin consolidation.
Pulling/Placement Speed	Too fast reduces impregnation time, causing voids.	Higher speed can lead to incomplete impregnation.	High speed risks incomplete resin impregnation.
Fiber Tension	Uneven tension causes uneven resin distribution and voids.	Tension controls fiber alignment and resin flow.	Consistent tension ensures uniform impregnation and reduced voids.
Mandrel/Tool Temperature	Affects resin consolidation, avoiding void formation.	Ensures proper resin solidification on the mandrel.	Uniform mandrel temperature avoids resin issues and voids.
Layer Overlap and Alignment	Not typically applicable in pultrusion, but fiber alignment affects resin bonding.	Proper layer alignment prevents voids.	Proper layer overlap ensures complete fiber bonding, reducing voids.

Technological parameters such as resin viscosity, temperature control, fiber tension, speed of processing, and fiber placement alignment all play crucial roles in the formation of voids in thermoplastic composites produced by pultrusion, filament winding (FW), and automated fiber placement (AFP). Understanding and controlling these parameters allows manufacturers to minimize void content and produce high-quality, high-performance composites with optimal mechanical properties. Minimizing void content requires careful attention to each step of the manufacturing process—material selection, resin impregnation, machine settings (e.g., tension and pressure), curing, and post-processing. The results from experiments for void percentages for these technologies are given in Table 2.

Table 2 The lowest percentage of voids from the experiments in all three technologies

Parameter	Pultrusion	Filament Winding (FW)	Automated Fiber /Tape Placement (AFP/ ATP)
Void contents	1% to 5%	1% to 3%	1% to 5%

3. Summary

Low void content (< 2%) is generally desired for high-performance applications (e.g., aerospace, automotive) because it ensures better mechanical properties like strength, stiffness, and durability. Higher void content can sometimes be tolerated in less critical applications, though it always comes with trade-offs in mechanical properties.

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