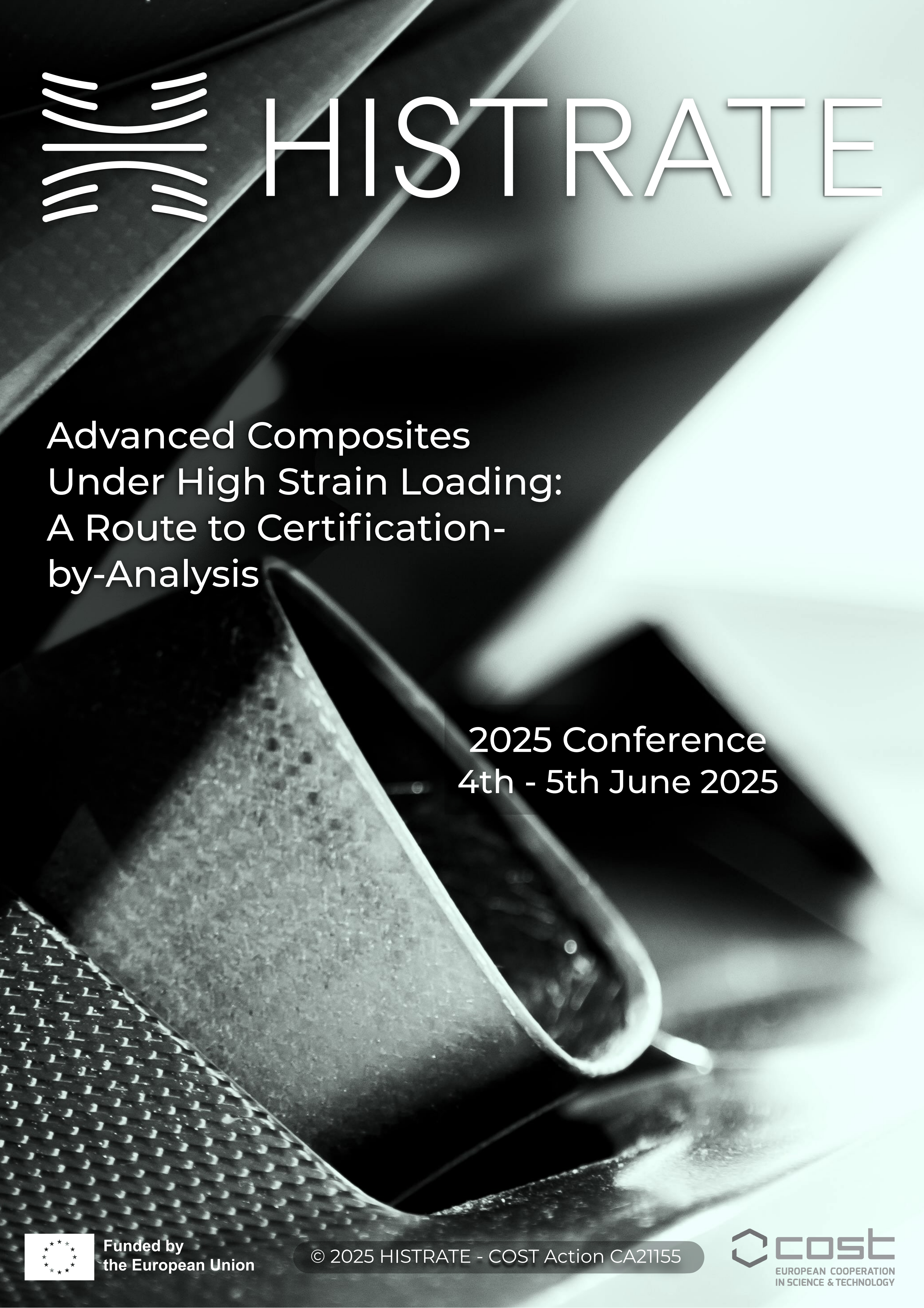

HISTRATE

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

HISTRATE

Advanced Composites under High Strain Rate Loading A Route to Certification-by-Analysis

2025 Conference

4th – 5th JUNE 2025

Session 1 - Novel simulation methods and best practices for composites under high strain rates (WG4)

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The effect of laser assisted tape placement processing conditions on flexural strength of in-situ carbon fibre/PEEK laminates

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Abstract: Laser-assisted automated tape placement (LATP) has great potential for cost-effective production of thermoplastic parts. The purpose is to investigate how LATP processing conditions affect the flexural strength of laminates made from carbon fibers and polyether ketone (PEEK). The experiments were made by processing the prepreg under different conditions, and the most influential factors were taken into account: laser temperature, compact pressure of the roller, and laser placement angle. Flexural strength tests were performed on all manufactured specimens, and some conclusions regarding process parameters and the ultimate properties of composite specimens were developed based on the experimental data received.

1. Experiment

In this study for the production of the thermoplastic composite laminates, thermoplastic unidirectional prepreg material (UD) was used. Composite specimens with different technological parameters (all possible combinations of the parameters - 8 different samples) were produced with help of laser-assisted automated tape placement head (LATP) (Fig.1). Head is attached to a robot arm, as it is shown in Fig. 2. The tape head consists of: a consolidation roller (outer diameter of 90 mm), a tape feed, guidance, tensioning, and cutting system for UD prepreg tape, an optic lens connected via a fibre-optic cable to a remotely-located 3 kW diodelaser heat source and a temperature sensor (pyrometer) [1-3].

a) b)

Fig. 1. a) Schematic representation of of automatic tape laying process b) Automatic laser - assisted of UD laying

A tape placement process involves pulling of the thermoplastic prepreg tape from a spool through the feed and guide assembly. On the way to the consolidation roller, the tape is heated on temperature (based of the type of polymer) using a laser. The tape is then placed on the tool and consolidated with a roller [2-4]. During the tape laying, several factors were observed: laser temperature, compact pressure of roller and and laser placement angle, so composite plates with thickness of ~1,5 mm (8 layers prepreg) were manufactured. An investigation of the effect of technological parameters on mechanical properties of laminate panels was performed. The flexural testing was performed according to ASTM D790, using test rupture. Based on the three-point bending test (3pb), prepared specimens were elongated till rupture with help of test fixture and the flexural strength is calculated respectively, according to the standard.

2. Results and discussion

The test results for flexural strength (mean velue of five replications) of each combination are presented in Table 1. The test results indicated an effect of compact pressure of roller and laser temperature on mechanical properties of composite specimens. Namely, the bigger compact pressure of roller and higher laser temperature led to a higher flexural properties of laminate panels. In a polymer composite, each layer has contribution to the whole strength, and when one of the layers in the structure starts to fail, it cracks the matrix around and there appears an increase in the strain. The strain response of the laminate is restored but the load carrying thickness of the panels is decreased due to the failure of one of the layers. As the wall thickness of the laminate panels is decreased, it cannot carry more load anymore, and fails [5,6].

Table 1. Condition of the experiments and flexural test results

Number of exp.	Sample designation **LATP-UD**			**Test results**
	Laser temperature, °C	**Laser angle, °**	**Compact pressure, N**	**Flexural strength, MPa**
1	380	25	380	1036,81
2	360	25	380	941,73
3	380	22	380	1011,50
4	360	22	380	927,41
5	380	25	270	903,88
6	360	25	270	858,90
7	380	22	270	921,83
8	360	22	270	892,37

Figures 1 shows a typical force - time diagram at ambient temperature for samples (1 and 6) with the highest and lowest values for the flexural strength. The load-time curves of the specimens 1 (five replications) are similar and the laminated samples have a linear behaviour up to cracking of the some layers of samples. The curves have an appearance which is like zigzag at the higher values of the force which corresponds to the cracking of the fiber layers. In the case of the specimens 6 there is a linear behaviour up to cracking of some layers of fibers but the samples are still not destroyed. With continuing of the force, the curves continue to have a view which is like linear up to cracking of the samples.

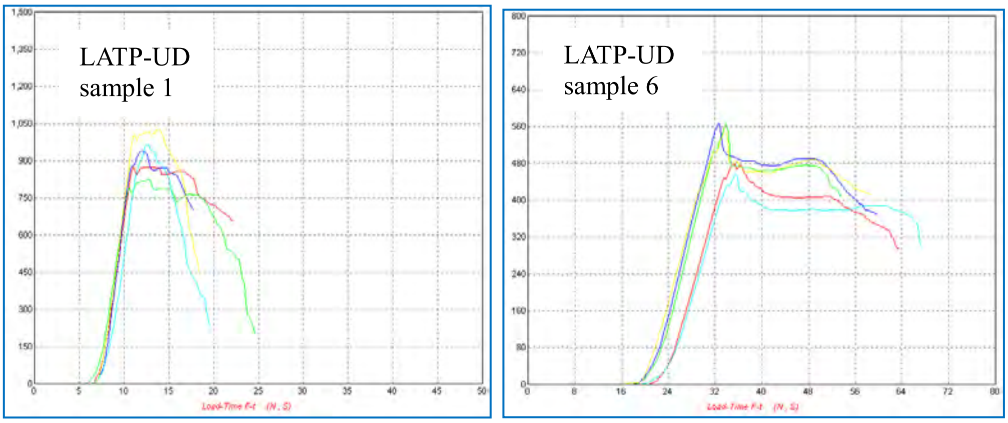

Fig. 2. Load -time diagrams for LATP-UD: sample 1 and sample 6

It can conclude that high quality of laminates made by LATP process depends on the processing parameters fed to the LATP system. Moreover, the compaction force applied during the lay-up process and the laser temperature play a crucial role in achieving of obtaining of defect-free laminates using the thermoplastic UD prepreg materials.

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