



**HAL**  
open science

## **A new finite thickness/width rate-dependent cohesive zone model**

Andres Mario Planas, Eric Paroissien, Frédéric Lachaud, Pierre Gérard

### ► **To cite this version:**

Andres Mario Planas, Eric Paroissien, Frédéric Lachaud, Pierre Gérard. A new finite thickness/width rate-dependent cohesive zone model. 7th International Conference on Structural Adhesive Bonding Conference (AB2023), Jul 2023, Porto, Portugal. <hal-04768572>

**HAL Id: hal-04768572**

**<https://hal.science/hal-04768572v1>**

Submitted on 12 Nov 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

## A new finite thickness/width rate-dependent cohesive zone model

M Planas Andrés<sup>1</sup>, E Paroissien<sup>1</sup>, F Lachaud<sup>1</sup>, Pierre Gérard<sup>2</sup>

<sup>1</sup>Institut Clément Ader (ICA), Université de Toulouse, ISAE SUPAERO, CNRS, 3 Rue Caroline Aigle, 31400, Toulouse, France.

<sup>2</sup>ARKEMA BP 34, 64170 Lacq, France.

This paper presents a new cohesive element (*CE*) formulation for modeling the mechanical response of double cantilever beam (*DCB*) bonded joints. The proposed formulation is capable of modelling accurately structural adhesively bonded joints, while keeping a low computational cost. The model accounts for both the thickness and the width of the adhesive layer, as well as for the rate-dependence of the mechanical response leading to crack initiation and propagation. The fundamental assumption of this model is the existence of an intrinsic fracture energy, which leads to the definition of the *CE* as a zero-thickness interface core embedded in a solid bulk adhesive region. The interface is responsible for the degradation of the *CE* and for dissipating the intrinsic fracture energy. Meanwhile, the bulk adhesive region accounts for the viscoelastic behaviour and the thickness/width of the adhesive layer, and for their contribution to the total dissipated fracture energy. The formulation is based on the Winkler Elastic Foundation Theory (*WEFT*) coupled with a cohesive zone model (*CZM*), which introduces damage in the adhesive layer. However, whereas a classic *WEFT* model analyses the behaviour of the adhesive layer as the one of an infinite set of springs, a special equivalent spring is used here. This equivalent spring employs a rheological model to introduce the desired mechanical behaviour, which contains two terms to represent the two regions into which the *CE* is split. The interface is modelled using a spring whose stiffness is degraded by a damage variable following a classic bilinear traction-separation law, while the bulk adhesive region is modelled using a Standard Linear Solid model. This approach allows for capturing different effects, such as the stress-strain state—which depends on the position within a wide/finite-thickness adhesive layer—or the inherent viscosity of most of today's structural adhesives. This new *CE* formulation is based on the research work done by Sarrado et al. [1], Cabello et al. [2] and Musto, Škec and Alfano [3, 4], and has been implemented using two different types of computational tools: a finite element method (*FEM*) combining ABAQUS and a user custom material routine, and a semi-analytical in-house tool known as the Macro-Element method [5].

- [1] C. Sarrado, F. A. Leone and A. Turon, *Eng. Fract. Mech.*, 168, 105 (2016).
- [2] M. Cabello, A. Turon, J. Zurbitu, J. Renart, C. Sarrado and F. Martínez, *Eur. J. Mech. A/Solids.*, 63, 22 (2017).
- [3] M. Musto and G. Alfano, *Comput Struct.*, 118, 126 (2013).
- [4] L. Škec and G. Alfano, *J. Adhes.*, 1 (2022).
- [5] E. Paroissien, F. Lachaud and S. Schwartz, *Prog. Aerosp. Sci.*, 130 (2022).