

# **ANALYSIS OF FRACTURE PROCESS IN STRUCTURAL MATERIALS BY USING THE STRAIN ENERGY DENSITY AND THE EQUIVALENT MATERIAL CONCEPT**

**JUAN DIEGO FUENTES BENITO**

## 1. Competencies developed through the PhD. Experience

- I. A systematic comprehension of a particular field of study as well as a thorough knowledge of its related skills and methods: **Fracture mechanics on structural materials**
- II. Ability to conceive, design or model, put in practice or choose a particular process of researching: **Different experimental programmes developed and analysed**
- III. Ability to contribute to the development at the frontiers of the knowledge addressing an original research: **PhD dissertation, publications...**
- IV. Ability to synthesize, analyze or assess critically new complex ideas: **Daily work**
- V. Ability to communicate and explain advanced ideas or knowledge for the academic community or for Society: **Publications, participation in conferences (national and international)...**
- VI. Ability to promote scientific, technological, social, artistic or cultural progress in a based knowledge Society, either in academic or professional environments **PhD dissertation, publications, conferences and ORGANIZATION AND MANAGEMENT OF TWO CONFERENCES (INT & NAT)**

To work within contexts with little specific information; to find the key questions in order to solve complex problems; to design, create, develop and undertake new and innovative projects in a particular field of knowledge; Teamwork and international context; to either criticize or support intellectual proposals...

## 2. Evaluation:

- ✓ Assessment of the activity and performance of the PhD. student:  
*DAD (Document of Activities of the student)*
- ✓ Assessment and endorsement of competencies:  
*PR (Plan of research)*

**Academic Committee of the doctoral program**



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## Theoretical and Applied Fracture Mechanics

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### Some default values to estimate the critical distance and their effect on structural integrity assessments



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#### ABSTRACT

When the structural integrity of notched components is analysed, it is generally assumed that notches behave as cracks, something which generally provides overconservative results. Thus, it is necessary to derive models that take into account the higher fracture resistance developed by structural materials when notches (and not cracks) are present. In this sense, the use of the Theory of Critical Distances (TCD) for the estimation of the apparent fracture toughness ( $K_c^N$ ) observed in notched components has been validated for different types of materials, such as ceramics, polymers, composites and metals. The estimations, for U-shaped notches, arise from the combination of the TCD with the Creager-Paris stress distribution ahead of the notch tip, and apply a notch correction factor to the material fracture toughness observed in cracked conditions ( $K_c$ ). Such correction only depends on the geometry (notch radius) and the material critical distance ( $L$ ). The latter is the requires calibration through experimental re-lation of experimental results with finite ele-ues of the material inherent strength that i value of  $L$ , without any further calibration, t tions and subsequent structural integrity as:

**Impact Factor**

**2.659** **2.079**  
2016 5 años

April  
2017

RESEARCH STATUS / CONTRIBUTIONS

Categoría de JCR ®	Clasificación en la categoría	Cuartil en la categoría
ENGINEERING, MECHANICAL	24 de 130	Q1
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ORIGINAL CONTRIBUTION

WILEY

## On the use of British standard 7910 option 1 failure assessment diagram to non-metallic materials

J.D. Fuentes | S. Cicero  | F.T. Ibáñez-Gutiérrez | I. Procopio

Fatigue and fracture of  
engineering materials  
and structures

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### Abstract

This paper provides a structural integrity assessment methodology for the analysis of non-metallic materials. The approach uses the British standard 7910 option 1 failure assessment diagram, originally proposed for the fracture-plastic collapse assessment of metallic materials. The methodology has been applied to 60 fracture specimens, combining 12 different materials and covering polymers, composites, and rocks. The results obtained validate the proposed assessment methodology and demonstrate its safety for the materials analysed here.

### KEYWORDS

failure criterion, fracture mechanics, structural integrity

Impact Factor

**1.984** **1.926**  
2016 5 años

Categoría de JCR ®	Clasificación en la categoría	Cuartil en la categoría
MATERIALS SCIENCE, MULTIDISCIPLINARY	127 de 275	Q2
METALLURGY & METALLURGICAL ENGINEERING	13 de 74	Q1

June  
2017

3



metals



Article

## Estimation of Fracture Loads in AL7075-T651 Notched Specimens Using the Equivalent Material Concept Combined with the Strain Energy Density Criterion and with the Theory of Critical Distances

Juan Diego Fuentes <sup>1,\*</sup>, Sergio Cicero <sup>1</sup>, Filippo Berto <sup>2</sup>, Ali Reza Torabi <sup>3</sup>, Virginia Madrazo <sup>4</sup> and Payman Azizi <sup>5</sup>

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**Abstract:** The main goal of this paper is the application of the Strain Energy Density (SED) criterion and the Theory of Critical Distances (TCD), both of them in combination with the Equivalent Material Concept (EMC), to predict the fracture loads of aluminum alloy Al7075-T651 Compact Tension (CT) specimens containing U-shaped notches. For this purpose, 45 fracture tests were performed combining two rolling orientations (transverse and longitudinal) and 6 notch radii, which cover from crack-type defects (0 mm) up to 2 mm-notch radius. Crack-type specimens are used to define the fracture properties of the material and the rest of the tests are used to check and compare the experimental fracture loads with the loads predicted using the different aforementioned criteria: SED, EMC-SED and EMC-TCD. The theoretical results of the fracture load predict material obtained employing the EMC are in good agreement with the experimental results for real samples.

Impact Factor  
**1.984** **1.926**  
2016 5 años

Categoría de JCR ®	Clasificación en la categoría	Cuartil en la categoría
MATERIALS SCIENCE, MULTIDISCIPLINARY	127 de 275	Q2
METALLURGY & METALLURGICAL ENGINEERING	13 de 74	Q1

January  
2018

- International Symposium on Notch Fracture (Santander, 03.2017)
  - **SOME DEFAULT VALUES TO ESTIMATE THE CRITICAL DISTANCE AND THEIR EFFECT ON STRUCTURAL INTEGRITY ASSESSMENTS**
  
- 35<sup>th</sup> Meeting of the Spanish Society of Structural Integrity (Málaga, 03.2018)
  - **USO DE LA OPCIÓN 1 DEL DIAGRAMA DE FALLO PROPUESTO POR LA BRITISH STANDARD 7910 EN MATERIALES POLIMÉRICOS Y COMPUESTOS**
  - **ESTIMACIÓN DE LA CARGA DE ROTURA EN PROBETAS ENTALLADAS DE ALUMINIO AL 7075-T651 MEDIANTE EL USO DEL CONCEPTO DEL MATERIAL EQUIVALENTE COMBINADO CON EL CRITERIO DE LA DENSIDAD DE ENERGÍA DE DEFORMACIÓN**

#### OTHER MEETINGS / COMMUNICATIONS

- Il Encuentro Internacional de Doctorandos en Ingeniería Civil – EIDEIC 2016 (Santander, Mayo 2016)
  - **ESTUDIO DEL PROCESO DE FRACTURA DE MATERIALES ENTALLADOS MEDIANTE EL MÉTODO DE LA DENSIDAD DE ENERGÍA**

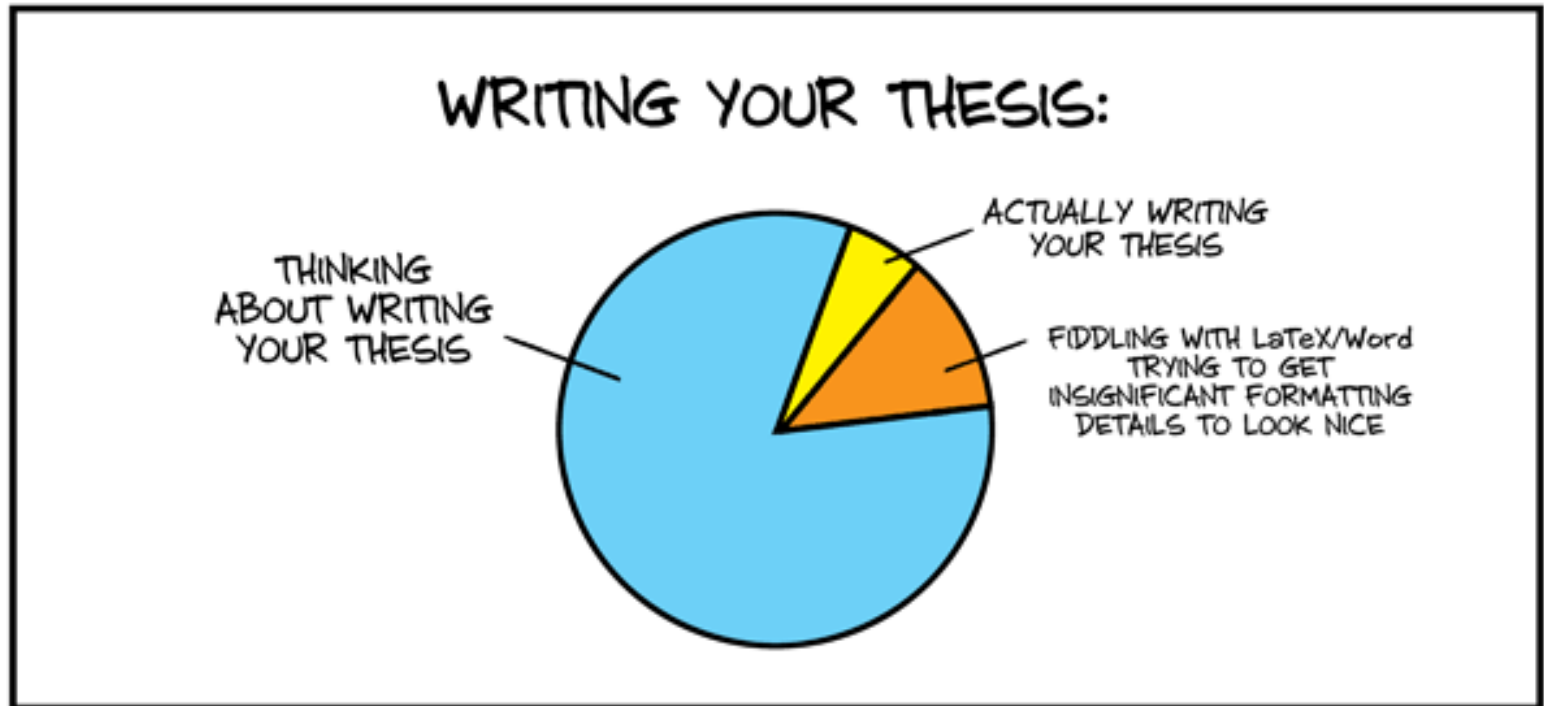
Organization and management of conferences

- ❖ 3 days parallel conferences:
  - 34<sup>th</sup> Meeting of the Spanish Society of Structural Integrity – 34<sup>o</sup> Encuentro del Grupo Español de Fractura (Santander, 03.2017)
  - **Member of both the scientific and organising committee**
  - International Symposium on Notch Fracture (Santander, 03.2017)
  - **Member of the scientific committee**
  - **Editor of the publications of the conference:**
    - **Proceedings** (ISBN: 978-84-617-9463-8)
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> 150 delegates





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*\*\*footnote: Thanks to Philip from U. of Toronto for this comic idea!*



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