OUTCOME

PhD position in Marie Skłodowska-Curie ITN-ETN

The outstanding challenge in Solid Mechanics: engineering structures subjected to extreme loading conditions

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In this project we aim to train early-stage researchers in what is referred to as an outstanding challenge in solid mechanics: developing novel solutions for the analysis and design of aerospace and defense structures subjected to extreme loading conditions. Structural elements used in aerospace and defense industries are frequently subjected to a large variety of unusually severe thermo-mechanical solicitations. One easily realizes that this type of structures (e.g. components for satellites) has to be designed to sustain extreme temperatures, which may vary hundred degrees in short periods of time, and extreme mechanical loadings like hypervelocity impacts. New specific structural solutions are constantly developed to fulfill such requirements, which place these industrial sectors in the forefront of the technological innovation. We have formed a consortium composed of 3 academic and 4 industrial partners which aims at developing specific training for early-stage researchers within the field of aerospace and defense structures subjected to severe thermo-mechanical loads. The leitmotif of this ITN is to train creative and innovative researchers ready to face structural-engineering challenges which arise in the vanguard of technological innovation. OUTCOME is a unique opportunity for 8 motivated early-stage researchers that are willing to set the basis of their scientific career within the field of Solid Mechanics.

PhD Research

Development of necking instabilities in anisotropic ductile plates subjected to dynamic loading

Host

University Carlos III of Madrid

Supervisor

Professor José A. Rodríguez-Martínez

Synopsis

Thin plates of lightweight alloys are commonly used in the manufacture of aircraft and spacecraft structures. Likewise, assemblies used for the protection of critical systems are frequently made of metal sheets. These structures may be submitted to impact or blast loads and their aptitude to absorb the energy of the dynamic load is strongly related to their ability to delay the onset of plastic instabilities which trigger failure in ductile metals. Since strain rate affects both plastic flow and failure, its influence has been studied in the last decades both theoretically and experimentally. In particular, the 3 academic partners of OUTCOME have strongly contributed to this field through the development of original theoretical and experimental methodologies, leading to a deeper knowledge on the effect that individually inertia, strain rate, loading path and anisotropy have on the localization of plastic

instabilities and failure. In particular, the systematic confrontation of results obtained from linear perturbation analysis and finite element calculations has allowed to the academic members of OUTCOME to provide new insights into the specific localization patterns that emerge under dynamic biaxial loading. This investigation settled a theoretical framework that can be used in the design of structures for energy absorption, with the ultimate aim of predicting the limits in material ductility which imposes important restrictions to this type of applications. However, the coupled influence of all these material and loading effects, needed for a higher reliability in design, deserves further analysis.

Research outputs

Development of a linear perturbation model to assess the joint effect that inertia, strain rate, loading path, porosity and anisotropy have on the onset and development of necking instabilities in ductile plates subjected to dynamic loading.

Multidisciplinary / intersectoral research approach

The ESR will develop at the **University Carlos III of Madrid** the core of a linear perturbation analysis to assess the interplay between inertia, strain rate, loading path and anisotropy in the formation of necks in ductile plates subjected to dynamic loading. Moreover she/he will carry out a research period at the **TECHNION** where she/he will perform Split Hopkinson Tensile Bar tests in ductile sheets in order to have our own experimental validation of the linear perturbation model. Additionally the ESR will carry out a research period in France during which the ESR will stay both at the University of Lorraine and at CIMULEC. At the **University of Lorraine** she/he will develop the comparison between the linear stability analysis and the experimental results. At **CIMULEC** where she/he will identify and model real cases in which aerospace components fail due to plastic localization.

Training activities

The successful candidate will have access to the PhD program of the **University Carlos III of Madrid** as well as to the training activities organized within the OUTCOME consortium. These activities include, among others:

- **Attendance to the Workshop**: Extreme structural mechanics in aerospace applications to be organized by AEROSERTEC in Madrid.
- **Attendance to the Workshop**: Extreme structural mechanics in defense applications to be organized by RAFAEL in HAIFA.
- **Attendance to the course**: Horizon 2020 Proposal Development to be organized by EUROPA Media in Budapest.
- **Attendance of the course:** Damage and failure of solids subjected to extreme loading conditions to be organized by the University of Lorraine.
- **Attendance to the course**: From PhD to Scientific Leadership to be organized by Yellow Research in Madrid.
- **Attendance to prestigious international conferences** on damage and failure of engineering materials.

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Benefits

The successful candidate will be employed for 3 years and receive a **financial package plus an additional mobility and family allowance** according to the rules for Early Stage Researchers (ESRs) in an EU Marie Skłodowska-Curie Actions Innovative Training Networks (ITN):

- Living allowance – 3035.36€ (per month)
- Mobility allowance – 600€ (per month)
- Family allowance – 500€ (per month – if applicable)

This amount is a gross contribution to the salary costs. Net salary will result from deducting all compulsory social security/direct taxes from the gross salary according to the law applicable to the agreement concluded with the ESR.

Additional information about the funding provided by the ITN projects can be found in: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-msca_en.pdf

Key publications

Dudzinski D., Molinari, A. Instability of visco-plastic deformation in biaxial loading. *Comptes Rendues Academie Science Paris*. 1988; 307: 1315–1321.

Dudzinski D., Molinari A. Perturbation analysis of thermoviscoplastic instabilities in biaxial loading. *International Journal of Solids and Structures*. 1991; 27: 601–628.

Rodríguez-Martínez J. A., Vadillo G., Fernandez-Sáez J., Molinari A. Identification of the critical wavelength responsible for the fragmentation of ductile rings expanding at very high strain rates. *Journal of the Mechanics and Physics of Solids*. 2013; 61: 1357–1376.

Rodríguez-Martínez J. A., Vadillo G., Zaera R., Fernandez-Sáez J. On the complete extinction of selected imperfection wavelengths in dynamically expanded ductile rings. *Mechanics of Materials*. 2013; 60: 107–120.

Zaera, R., Rodríguez-Martínez, J. A., Vadillo, G., Fernandez-Sáez J., Molinari, A. Collective behaviour and spacing of necks in ductile plates subjected to dynamic biaxial loading. *Journal of the Mechanics and Physics of Solids*. 2015; 85: 245-269.

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Profile

We are looking for highly motivated early-stage researchers with the following profile:

- Hands-on mentality, good organizational and communication skills.
- Proactive attitude and ability to work both independently/autonomously and within a team.
- Good communication skills in English.

In order to meet the specific requirements of the Marie Skłodowska-Curie funded PhDs, you must not have resided or carried out your main activity (work, studies, etc.) in **Spain** for more than 12 months in the last 3 years. You may be of any Nationality.

Required educational level

Degree	Master degree or equivalent
Degree field	Engineering: civil, mechanical, aerospace
Degree	Master degree or equivalent
Degree field	Physics

Career stage

Early stage researcher or 0-4 years (Post graduate)

Professional and/or research experience

We will particularly consider those candidates with proven experience in technological and/or research activities. Publication/s in journals indexed in the Journal of Citation Reports will be especially welcomed.

Letter of motivation

The candidates must provide a letter of motivation where they clearly state why, under their point of view, they should be enrolled in OUTCOME.

References

At least, one recommendation letter from the scientist/s who mentored the candidate during her/his master studies is required. The letter must clearly expose the profile of the candidate with emphasis in the qualities which make her/him suitable for being recruited in OUTCOME. Additional recommendation letters from any other professor/professional will be most welcomed.

Specific qualifications

Candidates should have a solid background in Continuum Mechanics, Mathematics and Programming.

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Flexible working conditions

We are committed to provide flexible hours and home working conditions for researchers having family obligations. The following web-site contains relevant information **related to the EU equal opportunities policy** https://ec.europa.eu/research/science-society/women/wir/index_en.html. Moreover, the web-site http://www.partnerjob.com/ facilitates geographic mobility by providing help to find a job for an accompanying partner.

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Contact details

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The application period closes in June 2016

The PhD starts in September 2016