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*The **Department of Civil and Environmental Engineering**, **PhD programme in Structural, Seismic and Geotechnical Engineering**, is glad to invite you to the following:*

Colloquia Doctoralia Seminar

PhD Final Exam – Fourth Session

Speaker: Dr. Eelco Jansen (Leibniz Universität Hannover)

9th March 2017
15:30 – 16:30

Aula Beltrami
Campus Leonardo
Building 5 – Ground floor

Failure analysis of polycrystalline silicon solar cells considering the effect of residual stresses

Dr. Eelco Jansen

Mechanically induced microcracks in silicon wafers, the principal components of solar cells, are a limiting factor for the operation life time of photovoltaic modules. Microcracks can occur at any stage during the life cycle of photovoltaic modules. In particular, the production process induces localized residual stresses which can develop into microcracks.
In order to better understand the effect of residual stresses on the mechanical reliability of polycrystalline silicon solar cells, three different thermo-mechanical production processes (cofiring, flattening and soldering processes) have been modelled and numerically simulated within a robust numerical framework. During the production processes the solar cell undergoes significant thermomechanical loadings that induce permanent deformations in the solar cell before being laminated in photovoltaic modules. These permanent deformations can correspond to significant residual stresses in the solar cells. These residual stresses can affect the mechanical reliability of the encapsulated solar cells in photovoltaic modules. In particular, results of numerical investigations of the co-firing process are presented. The effects of the material heterogeneity of the polycrystalline silicon layer (grain orientations and grain sizes), thickness of the silicon layer and thickness of the aluminum-paste layer on the scatter of the maximum deflection of a commercially produced polycrystalline silicon solar cell after the co-firing process have been investigated.
Furthermore, in order to reduce the computational costs of the numerical failure analyses, a submodeling approach, making use of the finite element code Abaqus, has been employed. Using this approach, the failure analyses can be performed on the structural level. The residual stresses resulting from the different production processes of the solar cell are considered in the submodel and were included in the numerical simulation of an experimental four line bending test of a photovoltaic module. The crack patterns in the solar cells obtained in the analysis have been compared with the experimental results and in addition, the values of the crack opening displacements in the solar cells in the analysis were compared with the experimental measurements.

Short Bio

Dr. Eelco Jansen

Dr. ir. Eelco Jansen is a senior faculty member, head of the Section “Composites” at the Institute of Structural Analysis of Leibniz Universität Hannover since 2009. Formerly (2000 – 2009) he was an assistant professor at Delft University of Technology, Faculty of Aerospace Engineering, Aerospace Structures Group, where he also obtained his PhD in 2001.
He coordinates a wide range of research topics in the area of composite and layered structures and has a specific expertise and long-time experience in the field of nonlinear stability and dynamic analysis of thin-walled structures.