EFOP-3.6.1-16-2016-00018

Improving the role of research + development + innovation in the higher education through institutional developments assisting intelligent specialization in Sopron and Szombathely

Innovative processing technologies, applications of energy engineering and implementation of wide range techniques for microstructure investigation

2nd Workshop on Innovative Materials Processing, Applications in Energy Engineering and System Control

Szombathely, 2019

SZÉCHENYI 2020

MAGYARORSZÁG KORMÁNYA

Európai Unió
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BEFEKTETÉS A JÖVŐBE

2nd Workshop on Innovative Materials Processing, Applications in Energy Engineering and System Control
Chairpersons: Dr. Jurij SIDOR and Dr. László KOLLÁR
Organizing Committee: Dr. László KOLLÁR, Dr. Jurij SIDOR and Dr. Ferenc SAFRANYIK
Date: May 30, 2019

Venue: Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Károlyi Gáspár tér 4, 9700 Szombathely, Hungary
Room #: B209

Workshop is supported by EFOP-3.6.1-16-2016-00018 project: 'Improving the role of research + development + innovation in the higher education through institutional developments assisting intelligent specialization in Sopron and Szombathely'

Program

8.55-9.00 Jurij Sidor: ***Introduction***

9.00-9.20 Caio Meneses Carvalho
Modelling of Transmission Line Insulators and Towers Exposed to Dynamic Effects
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

9.20-9.40 Felipe Ortega Silva Santos
Effects of blade shape on icing of wind turbine blades
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

9.40-10.00 Gustavo Henrique Moers
Analysis of relationship between mechanical properties and technological parameters of sheet metals
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

10.00-10.20 Hugo Emanoel de Andrade Costa
Motion of Wind Turbine Blades Exposed to Non-Uniform Wind Velocity Distribution
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

10.20-10.35 Luis Rubio Rodriguez, László E. Kollár
Fluid Structure Interaction Analysis for 3D Model of Wind Turbine
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

10.35-10.50 Ferenc Safranyik
Lagrangian method to predict mechanical behavior of granular assemblies
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

10.50-11.05 Tej Singh
Development of innovative materials/products by utilizing waste and natural recourses
Eötvös Loránd University, Faculty of Informatics, Savaria Institute of Technology, Szombathely, Hungary

11.05 Closing Remarks

Abstracts

Modelling of Transmission Line Insulators and Towers Exposed to Dynamic Effects

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Abstract.
Wind and ice accretion on power networks may cause heavy dynamic load resulting in serious damages to the transmission line. The present study aims to examine the effects of wind and ice shedding on the insulators and on the tower of a transmission line considering the loads acting from the vibrating conductors. The geometry is based on a tower of a 275-kV-line with two different insulator diameters (80 mm and 120 mm), and with two different insulator-tower connection (fixed, and via joint allowing free rotation). Three types of models have been constructed: line body static models, 3D static models and 3D transient dynamic models. Three load cases were simulated: (i) no ice on any cable, (ii) ice on the cables on either side of the tower, and (iii) ice on all cables. The loads on the insulators were calculated so as to consider the forces from 30-mm-diameter cables attached to the insulators, which were made of structural steel or porcelain. When simulating ice accretion, 50-mm-thick ice on the cable was assumed. For both of the static and transient dynamic models, the structural steel insulator has a smaller deformation than the porcelain insulator due to its higher Young's modulus, and greater stress develops in the structural steel insulator. The joints between the insulator and the tower reduced the deformation and stresses substantially, even for the 80-mm-diameter insulators. Further simulations of ice shedding from the conductor would allow to determine frequencies and amplitudes of the forces acting on the insulator from the vibrating conductor.

Keywords: Ansys, Ice shedding, Power network, Tower, Transient analysis

Effects of blade shape on icing of wind turbine blades

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Abstract.
The demand for energy has been increasing exponentially over the years, which is partly due to population growth and economic development. In order to fulfil this demand, new energy sources such as wind power are in development and widely used worldwide. The wind power represents a great solution for energy demand but the icing of wind turbine blades is an issue that can affect energy production. Therefore, the present study aims to establish the relationship between the blade shape of wind turbines and the icing of that shape, which is essential from the point of view of design of the blades and efficiency of the wind turbine. In order to describe the relationship between the choice of the blade shape and the ice accumulation, several computational tests (CFD) were performed to analyze the aerodynamic properties of the blade before and after the icing event. The computed aerodynamic parameters of the blade with different shapes were compared to available data. After the validation of the numerical model, the relationships between blade shape, ice accumulation, and influence on blade efficiency could be obtained. Two essentially different icing conditions were considered in the present study: (i) freezing drizzle, and (ii) in-cloud icing. More ice accumulated under freezing drizzle conditions, causing an abrupt decrease in the lift-to-drag ratio even after one hour of exposure to icing conditions. However, for in-cloud icing, it was possible to observe a significantly slower decrease in the lift-to-drag ratio. The results show that the accumulation of ice in this last condition was smaller, but it led to more "pointed" shapes than under freezing drizzle conditions. Hence, the application of the results of the present study contributes to improving the design of the blade geometry, which has great importance for increasing the efficiency in the production of energy under the type of climatic conditions considered.

Keywords: CFD, ice accretion, Fensap-ice, Wind turbine

Analysis of relationship between mechanical properties and technological parameters of sheet metals

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Abstract.
Knowledge of dependency between technological and mechanical properties of sheet metals is essential from the viewpoint of tool design and effective manufacturing. In order to describe mathematical relationship between springback coefficient and elastic-plastic properties of sheet metals, series of FEM (finite elements method) simulations and laboratory edge bending tests were accomplished. To create an ideal elastic-plastic material model of different metals tensile tests were carried out. Thereby, theoretical and numerical methods of springback prediction were analyzed and compared to edge bending tests. With the validated numerical model, springback coefficient can be calculated in a wide range of mechanical properties.

Keywords: Experimental Validation, Numerical Method, Sheet Metal Bending, Springback, Theoretical Method

Motion of Wind Turbine Blades Exposed to Non-Uniform Wind Velocity Distribution

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Abstract.
Nowadays, engineers and researchers are required to work in the wind energy field. It is due to the fact that problems and challenges related to this field have been increasing to be solved by companies and industries. The main purpose of this research is to develop models that are applicable to study the motion of wind turbine blades exposed to non-uniform wind and to determine the stress in the blade under such conditions and how the loads influence the motion of this blade. Simulations have been carried out applying Fluid Flow (Fluent) analysis, Static Structural Analysis and Transient Structural Analysis in Ansys Workbench 19.2. In order to construct numerical models of wind turbine blades exposed to non-uniform wind, a parabolic wind profile was assumed and its time dependence locally on the blade surface was considered as the blade moved in this velocity field. The drag and lift coefficients of a blade section were calculated in the fluid flow analysis, whereas the total deformation and the maximum equivalent stress in a 3D model of a blade with constant cross section were determined in the static and in the transient dynamic analysis. The Maximum Equivalent Stress was below the limit of tensile yield strength and tensile ultimate strength of the material considered. The Total Deformation in the Transient Structural Analysis was significantly smaller than in the Static Structural analysis since the rotation of the blade was allowed. Moreover, the Equivalent Stress is also reduced in the Transient Structural analysis as compared to the Static Structural analysis. Thus, it is concluded that there was no risk of blade damage under the conditions considered.

Keywords: Ansys Workbench, Static structural analysis, Transient structural analysis, Wind turbine blade

Fluid Structure Interaction Analysis for 3D Model of Wind Turbine

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Abstract.
Numerical methods approach to study complex systems to save time and money in nowadays industries. In this presentation, a comprehensive methodology for studying a 3D model of wind turbine is presented in order to investigate the behaviour of the system. ANSYS software, FLUID and FEA packages, is used for this purpose. Computational fluid dynamics (CFD) solves the equations of the air flow; mass and momentum conservation of the air flow in a pre-defined volume-domain. In this case, it is taken into account the k-omega turbulence SST model in order to define a constant 12 m⁄s velocity of the wind. CFD outputs the pressure distribution on the wind turbine blade surface. It is imported as a load, in FEA package, in order to calculate the mechanical behaviour of the blades.
Blades are composed by orthotropic composite material, which is lately used in eolic industry for this purpose. Moreover, the angular velocity of the blade is considered as centripetal load. FEA analysis results in the study of the deflection/deformation of the blade, equivalent stress (Von-Misses), and force and moment reaction. Finally, theoretical results given by ANSYS are presented and analysed. Furthermore, approximated hand calculations are provided based on data provided by industry and data obtained in the simulations. They are compared in order to give us an idea about the accuracy of our theoretical simulated results.

Keywords: Ansys, CFD, Finite element analysis, Simulation, Wind turbine

Lagrangian method to predict mechanical behavior of granular assemblies

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Abstract.
Discrete Element Method (DEM) is a numerical technique developed by Cundall and Strack in 1979 for modeling mechanical properties of particulate materials based on solving the equation of motion of all individual particles. Normal and tangential forces and moments during particle-particle and particle-wall interactions are calculated by a simulation cycle in discrete time steps with repeated use of Newton's second law of motion and the angular momentum theorem. This method is commonly used to define behavior and motion of granular materials in several fields of research included granular phenomena. By using this method, the mechanical properties of granules can be described and beneficial information could be obtained to understand complex behavior of these materials. However determination of micromechanical parameters (calibration of the discrete model) and computational demand of simulations are two main shortcomings of DEM. Using this numerical technique, macro behavior of granular assemblies is modeled with multiple, so-called micromechanical parameters of individual elements, nevertheless nowadays there is no suitable method for calibrating these parameters, thus macro behavior of particulate systems are highly dependent on micro behaviors. Other main disadvantage of discrete element based calculations is their great computational demand. Approximate interaction detection and solving dynamic equations on all single elements in every discrete time steps is a challenge even for the best computers, because not only the number of particles, but also total number of calculation steps increases simulation time. One of the most difficult problems during discrete modeling is the simulation of industrial scale processes, namely even simplest procedure involves several billion of interactions and particles, and for this reason it is impossible to model these both from practical and computing viewpoint.

Keywords: Calibration, Discrete element method, Mechanics of granular materials

Development of innovative materials/products by utilizing waste and natural recourses

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Abstract.
One can envision that the evolution within the field of science and technology to a great extent relied upon the advancement of materials. The prosperity and the progress of our society are governed and mainly judged by the availability or ample production of quality products, which originate from materials. Industrialization plays a central role in today's society by producing quality goods and products by using different materials that stimulate economic growth and raise the standard of living. At one side industrialization has a beneficial influence on the economy of any country and on the other side any industrial activity generates various kinds of waste, which can impose a negative impact on our health and environment. The demand of good living standard along with ever increasing population results in waste generation growth. Landfilling, incineration, recycling or reuse of waste and prevention of synthetic materials are generally adopted for reducing waste and for developing a sustainable environment. One cannot totally prevent the use of synthetic materials but the materials can be synthesized using sustainable "green energy" approach instead of chemical approach. In this presentation, the potential outcome of using industrial waste such as cement bypass dust in the development of an innovative product such as car`s disc brake pads and metal nanoparticles synthesis, using natural recourses such as Cannabis sativa is presented. The study demonstrates that the utilization of waste and natural recourses not only helps in reducing the production cost but also helps in lowering the environmental burden.

Keywords: Brake pad, Cannabis sativa, Cement bypass dust, Nanoparticle, Waste material