A Novel Method converting Bentazone-contaminated Groundwater into Clean Drinking Water

T. S. Jepsen
DTU Environment, Technical University of Denmark
S062301@student.dtu.dk

The safe and healthy Danish drinking water is threatened by pesticide contamination. Pesticides are found in 20 to 25% of the drinking water abstraction wells (Thorling, et al., 2011) and previously 150 wells have been closed each year due to contamination (Brüsch, 2007). This has significant economic and environmental costs for Society in terms of identification of uncontaminated areas and installation of new wells, besides higher carbon dioxide footprint caused by deeper wells and longer transportation of water. Bentazone is the second most frequently found pesticide in the drinking water wells. In the last ten years the part of the Danish aquifer contaminated with Bentazone has increased to 5% (Thorling, et al., 2011). It is a pesticide used in the agriculture thus it is spread in large areas making a diffuse contamination that cannot be controlled or removed at the source.

This project present a novel method for clean-up of pesticide contaminated chalk aquifers by natural microbial degradation enhanced by addition of oxygen. It is a solution for in-situ decontamination of the areas used for groundwater abstraction. Laboratory experiments are conducted mixing natural chalk and groundwater from locations around Copenhagen. It is investigated if bentazone is degraded by organisms naturally present in groundwater from bentazone contaminated aquifers. Furthermore it is examined if the removal rate is governed by the amount of oxygen present in the aquifer.

The enhanced remediation of bentazone-contaminated groundwater wells can be carried out simply by supplying the chalk aquifer with oxygen. The solution is economical, social and environmentally beneficial as:
- The present wells can be used for future abstraction of safe and clean drinking water.
- The method is based on natural occurring processes using no xenobiotic chemicals.
- The clean-up will improve the general state of the groundwater aquifer reducing the negative impacts from the use of pesticides.

Further work is ongoing to show that the oxygen concentration in an aquifer can be increased sustainably by intelligent pumping of the wells. The aim is to utilize naturally occurring oxygen infiltrated with rainwater. As an advantage the existing wells can be used in order to keep the costs low and save environmental resources.

Nonlinear finite element analysis of buckling driven delamination growth in wind turbine blades

P. Haselbach
DTU Wind Energy, Technical University of Denmark

ABSTRACT

Wind turbine blades are made of light and strong composite materials. Low weight core materials are used as well as strong fiber materials. The different material components are typically laminated or bonded together by polymer adhesives. Inside the composite structure various types of damages and cracks such as buckling driven delamination can occur. Delaminations are defects and can be defined as areas without bonding between adjacent layers. Structures with delaminations subjected to compressive loading, like for example the load carrying box girder of a wind turbine blade, may buckle and this can reduce the strength of wind turbine rotor blades significantly. Hence delaminations are considered as one of the most critical failure types that can occur in composite structures.

For better, lighter and more reliable constructions it is necessary to understand the evolution of damage. Numerical analyses are excellent suitable to intensify this understanding. Usually a fine discretization has to be used to simulate the delamination growth accurately. Therefore, delamination modeling in large scale is challenging and computation time costly.

A less computational expensive procedure for the numerical analysis of buckling driven delaminations in wind turbine blades is presented and leads to new findings in the field of delamination growth. Cohesive zone elements based on a continuum damage mechanics approach are used to model large scale delamination growth and to analyze the effects of defects on the structure. For this purpose nonlinear finite element analyses (NLFEA) of buckling driven delaminations in the load carrying part of a novel 10 MW wind turbine blade are investigated and compared with experimental and numerical data of small scale panels.

Summarizing the analysis of buckling driven delamination growth shows two different kind of buckling modes, local and global buckling modes. It can be concluded that initial delaminations close to the surface and with larger initial delaminated area tend to cause a local buckling, whereas deeper and smaller delaminations are likely to cause global buckling. Additionally, two different kinds of delamination behavior can be assigned to local and global buckling modes. In local buckling modes the sublamine buckles and delaminates from the basic laminate, which causes a significant decrease of the critical buckling load. In contradistinction to the local buckling behavior, the numerical simulation shows that global buckling behavior does not have a significant effect on the strength.

Furthermore the analysis shows that delaminations with local buckling mode behavior seem to be triggered by a combination of normal (mode I loading) and shear stresses (mode II loading), whereas delaminations related to global buckling modes are mainly caused by shear stresses. Moreover local delaminations growth during the local buckling occurs gradually as contrasted with global buckling that occurs at higher energy levels instantly.

Keywords:
- Buckling
- Cohesive element
- Crack growth
- Delamination propagation
- Nonlinear finite element analysis
- Wind turbine blade