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Experimental study of the effect of high electric voltage on the fatigue life of glass fiber composites

Mehrtash Manouchehr[1], Christian Berggreen[1], Joachim Holbøll[2]
[1]Lightweight Structures Group, Department of Mechanical Engineering, Nils Koppels Allé, Building 404, 2800 Kgs. Lyngby, Denmark
[2]Department of Electrical Engineering, Elektrovej, Building 325, 2800 Kgs. Lyngby, Denmark
e-mail: manou@mek.dtu.dk, cbe@mek.dtu.dk, jh@elektro.dtu.dk

Mehrtash Manouchehr is PhD student at the Mechanical department of the Technical University of Denmark.
Research areas: Strength and fatigue endurance of composite materials and structures, numerical and experimental methods.

Christian Berggreen is the Head of Lightweight Structures Group and his primary research interests are experimental mechanics, hybrid testing, composite materials and structures.

Joachim Holbøll is professor in High Voltage Engineering. His research is mainly focused on components for the future grid and wind turbine applications. Modelling and performance investigations of high voltage components and equipment are covered, including lightning protection, in particular of wind turbines.

The primary transmission system for high voltage (300-700 kV) electricity transfer is based on overhead line systems, since they provide safety of supply with minimum loss [1]. For many years, due to public resistance against erecting traditional truss towers, manufacturers have faced new challenges and are forced to introduce new designs and ideas in order to get public acceptance. Underground cables are an alternative, but due to technical difficulties and high costs especially in rough terrain, underground cables are not yet generally practical for all high voltage transmission lines.

One of the innovative designs for a new transmission tower system are pylon structures, suggested by the Danish architectural company, BYSTRUP. The Pylon tower design takes advantage of the non-conductivity of glass fiber composites and integrates the electrical insulators in the Pylon arms themselves. This property makes it possible to reduce the size of the Pylon considerably, which comes along with other benefits such as a lighter structure, formability, reduced visual noise and easier and faster installation. Hence, it becomes a great applicant as an alternative to current truss tower structures, which are a design over 70 years old. Figure 1.

Figure 1: Conventional high voltage tower, left, comparing to the innovative composite Pylon by BYSTRUP, right. [2]

The composite materials in these Pylon arms are loaded not only mechanically but also electrically, which arises the question of possible reduction in the lifetime of the material more than, what would be the case for pure mechanical loadings. To investigate this, different series of combined mechanical-electrical loading at the scale of coupon specimens and full size Pylon arms (appx 10-12 m) are designed, and multiple combined fatigue loadings have been investigated throughout this research. Figure 2, shows the schematic of such setups for coupon specimens. The contents of the presented work is based on these

experimental results in order to uncover the damage mechanisms and effect of combined mechanical-electrical loading on the lifetime of GFRP materials.
The results from these experiments will be used later on to assist the prediction of the fatigue lifetime of a full-length power pylon arm (appx 12 m); which will be loaded mechanically and electrically simultaneously.

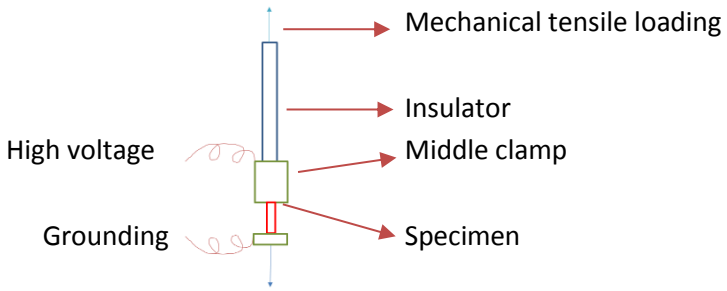

Figure 2: Schematic of combined mechanical-electrical setup.

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