# Beam modeling of wind turbine blades

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## INTRODUCTION

This project investigates the modeling of wind turbine blades as beams with different kinds of beam elements. The wind turbine blades are investigated with respect to static deflections and with respect to the first three free eigenfrequencies. In the investigations both a modified version of a classical beam element is used as well as a statically determinate beam element which is better at handling beams with varying cross section parameters.

## WHY IS IT A GREEN PROJECT?

The project itself might not seem like a very green project – for instance it does not directly affect the overall carbon footprint. It is a very green project though – indirectly! It will be possible to design a wind turbine blade all on paper - with respect to the structural properties. Therefore the project has a lot of green perspectives. It CAN improve the material consumption, since it will no longer be necessary to produce a wind turbine blade and then test it in a "trial and error"-way as it has been and partly still is in the wind turbine industry. The project is therefore green – maybe not in a direct way, but it has some very green byproducts that could help the world with the current climate problems.

## FOR THE TECHIES

The standard beam elements have been modified, so the stiffness matrix is no longer predefined from length, bending stiffness etc. Instead a three-dimensional beam element is modified so that it makes numerical integration and determines the stiffness matrix in that way. The element then contains information of moment of inertia with respect to the axes, axial stiffness etc. in distinct points of the element. If two points are known, linear interpolation is used and if multiple points are known then cubic spline-functions are used to interpolate the data.

The statically determinate beam elements have been suggested before by Jan Høgsberg and Steen Krenk. This kind of element is ideal because it is analytical correct even though the cross section parameters are not – opposing to the standard beam element, which is only analytically correct when the cross section parameters are constant. The same method of interpolating the data is used for the statically determinate beam element as for the standard beam element.

## CONCLUSION

The project is at the current time (May 2012) still running and all of the data have not been analyzed yet, so the total improvement of the elements is still not fully determined. Some of early conclusions are clear though – the modified standard beam element is able to calculate the correct first eigenfrequency of a 62.5 meter long wind turbine blade with an error margin of less than 0.8% when using only 3 elements and 40% of the structural data for the blade. And that is a time saver when calculating on bigger constructions, a whole wind turbine and so on. Indeed very interesting. So come say hi to us in June and hear how it all ends – and how we hopefully can help the world become greener in a smarter way!