

Numerical Consideration of Local Joint Flexibilities

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LOCAL JOINT FLEXIBILITY

ABSTRACT

In this paper, different approaches to consider local joint flexibilities in the numerical modelling of lattice support structures for offshore wind turbines are investigated and compared. Local joint flexibilities have an influence on the dynamics of the structures as well as on the distribution of member forces within the structures. The bending moment distribution and size of bending moment largely depends on the level of joint flexibility. Therefore, a verification of the fatigue strength of a joint should be based on an appropriate model including the joint flexibility.

KEY WORDS: Wind Energy, Local Joint Flexibility, FE Analysis, Fatigue

INTRODUCTION

In the next years a significant portion of the energy demand is planned to be supplied by large offshore wind farms around Europe. In Germany, offshore wind farms will be located in the German bight, in water depths of about 20 to 40 meters. The conditions at those sites often require the use of lattice support structures like Jacket and Tripod rather than the comparatively soft monopole foundations.

For lattice structures, the joints of chords and braces are always the weakest point in terms of fatigue resistance. Structural discontinuities due to the crossing of members as well as notches due to the welds at the joints result in high local stresses and hence reduce the fatigue strength of these structural elements. On the other hand, the joints are highly loaded components, because of the distribution of moments along the members increasing in the direction of the nodes.

In this paper the so-called Local Joint Flexibility (LJF) will be discussed as an opportunity to reduce the member end forces and hence the fatigue loading of the joints by modifying the distribution of member forces within the structures. However, incorporating joint flexibility in the analysis mainly influences the distribution of moments while the effect on the axial load distribution is only marginal.

General

Lattice offshore support structures can usually be modelled in finite element codes using beam elements for chords and braces only. Normally, in those models chords and braces are assumed to be rigidly connected at the joints, i.e. the deformations of all members connected to a certain node of the finite element model are equal to the deformations of this node. Fig. 1 shows the schematic of a simple T-joint modelled with rigidly connected beam elements.

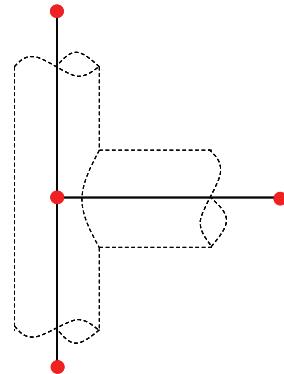


Fig. 1: T-joint modelled with beam elements

While chords and braces behave like beams globally, the local behaviour at the joints is dominated by the shell properties of the tubulars in reality. Hence, bending of a brace leads to local deformations of the shell surface of the chord, as can be seen in the FE-plot in Fig. 2. The axes of the chord and brace remain more or less undeformed, the deformation is driven only by the above-mentioned deformation of the shell, the effect of which is reduced with increasing distance from the actual joint.

This behaviour leads to the so-called Local Joint Flexibility (LJF), which has an influence on the eigenfrequencies of the structures as well as on the distribution of member forces within the structures, as will be shown in the following sections.