Note on Engineering Details

No: GL RC-R-MMit-extern-001, Rev. 2

Title: **Partial safety factors for welded and structural steel for certification according to IEC 61400-1, 3rd Edition**

Ref.: IEC 61400-1, 3rd Edition, Section 7.6

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The international standard IEC 61400-1, 3rd Edition, defines partial safety factors for materials. In the sections titled “Partial safety factors for materials where recognized design codes are not available”, values are defined for extreme load calculations (section 7.6.2.2) as well as fatigue load calculations (section 7.6.3.2). Furthermore, it is required that if recognized design codes are available, the combined partial safety factors for loads, materials and the consequences of failure shall not be less than specified in IEC 61400-1, 3rd Edition.

Extreme load calculations

For extreme load calculations, the partial safety factor for non-failsafe structures of component class 2 results in $\gamma_M = \gamma_m * \gamma_n = 1.10$ with $\gamma_m = 1.10$ and $\gamma_n = 1.00$ (cf. section 7.6.2.2). For global buckling of curved shells such as tubular towers and blades, please refer to DWR-MHs-extern-003.

Fatigue load calculations

For fatigue load calculations, the partial safety factor for non-failsafe structures of component class 2 results in $\gamma_M = \gamma_m * \gamma_n = 1.265$ with $\gamma_m = 1.10$ and $\gamma_n = 1.15$ (cf. section 7.6.3.2).

According to section 7.6.3.2 it is acceptable to use a lower value of γ_m in cases, if it is possible to detect critical crack development by introduction of a periodic inspection programme.

The periodic inspection of good accessible components may therefore be used as justification for a reduction of the value γ_m. Since the standard periodic inspection is only visual, the reduction has to be limited to $\gamma_m = 1.00$. The inspection programme shall be documented in the maintenance manuals. In case of crack detection during inspection further measures shall be taken.

Basically this approach corresponds to GL Wind Guideline for the Certification of Wind Turbines, Edition 2003 with Supplement 2004 as well as the DIBt Guideline for Wind Turbines, Edition 2004, where a tower partial safety factor for good accessible components is allowed.

A further reduction to the minimum value of $\gamma_m = 0.90$ as specified in section 7.6.3.2 might be chosen only by considering a more detailed inspection programme which has to be applied, including testing

and further fail-safe calculations if applicable. This procedure has to be agreed with the certification body.

For poor accessible components, which cannot be inspected both periodically and completely, the reduction of γ_m is not acceptable.

For example, the partial safety factors of materials used for a tubular steel tower and a foundation steel section are given in the following.

- Components of wind turbine towers are generally defined to be non-failsafe. Components with good accessibility are e.g. butt welds of the tower shell. In multipile bolted connections e.g. bolts in ring flange connections a reduction maybe considered due to indication of failure by single bolt. Therefore, the value γ_m may be reduced to 1.00 if a periodic inspection will be performed as it is standard for wind turbines. For non-failsafe components, $\gamma_n = 1.15$ has to be applied. The partial safety factor for good accessible metallic materials results in $\gamma_M = \gamma_m * \gamma_n = 1.15$.

- The foundation steel section is also defined to be non-failsafe. The part of the steel section set in concrete is poorly accessible. Therefore, a reduction of γ_m is not acceptable for the part of the steel section set in concrete.
  The partial safety factor for metallic materials set in concrete results in $\gamma_M = \gamma_m * \gamma_n = 1.265$.

General remark

This approach is also applicable on EN 61400-1, 3rd Editition, which content refers to IEC 61400-1, 3rd Edition.

The note GL RC-R-MMit-extern-001, Rev. 2, substitutes the note DWR-MMit-extern-001, Rev. 1.

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