Design of fatigue-stressed building parts made of high- and ultra-high strength fine grained steels in crane and plant construction (P778)

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Since the efficiency of crane and mobile crane construction can be seriously increased by using high-strength steels, the so called “Praktikergespräch Kranbau” (practioner dialog crane structures) investigated systematically the fatigue resistancees of specific crane notch details made of high-strength steels in the past years. Within this research project, present investigations are extended and supplemented, and the theoretical background of different standards and guidelines is cleared.

The research project deals with the basics of the assessment methods for steel members subjected to fatigue loading, in particular details of crane engineering. For this purpose, miscellaneous standards (Eurocode 3, DIN 15018-1, DIN EN 13001-3-1) and guidelines (IIW documents and FKM guideline) are available which are based on a unique mechanical theory. However, the practical implementation of these basics partially shows elementary differences between these documents regarding the methodology, time exposure and results obtained for a fatigue verification. Furthermore, in part I some selected standards are directly compared, and the significant differences with respect to verification and basic assumptions are presented in detail.

In addition, the results of numerous fatigue tests on different specific crane details are presented. The weld details „circular cover plate“ and „welded rail anchor“ are not covered by fatigue detail catalogues up to now. Existing test series on “longitudinal attachments” and “transverse butt welds” are extended by low-cycle fatigue tests with numbers of load cycles between 10,000 and 40,000. The focus lies on steel grades S690QL, S960QL and S1100QL. In addition, the thermomechanical rolled steel DOMEX960 and the ultra high-strength steel S1300QL are considered. In part II of this report, those investigations are verified by numerical simulations on some selected structural details. Test results support also the present classification of these welded details for high-strength steels. The presented results facilitate an efficient use of high-strength steels and allow an increase of capacity while reducing the constructional weight at the same time.

Another main part of the project are measurements on various tower cranes in use on different construction sites, which have been taken to determine their load spectra. When proving fatigue strength - as well as static strength - of

tower cranes, it is necessary to determine the level of loadings such to be on the safe side, but still to be in accordance with reality. This level should be just slightly higher than the actual appearing loads in order to avoid developing non-economical products which cannot survive on international markets. Detailed knowledge of working conditions and operational behavior of cranes is of high importance to get accurate calculation results. The recorded rated load and load moment spectra allow an insight in the actual loading situation of tower cranes on current construction sites. The analysis of the series of measurements allow a first comparison of normative classification of these cranes according to national and international standards.

This research project represents a necessary completion of previous investigations and makes the foregoing research projects rounder.

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