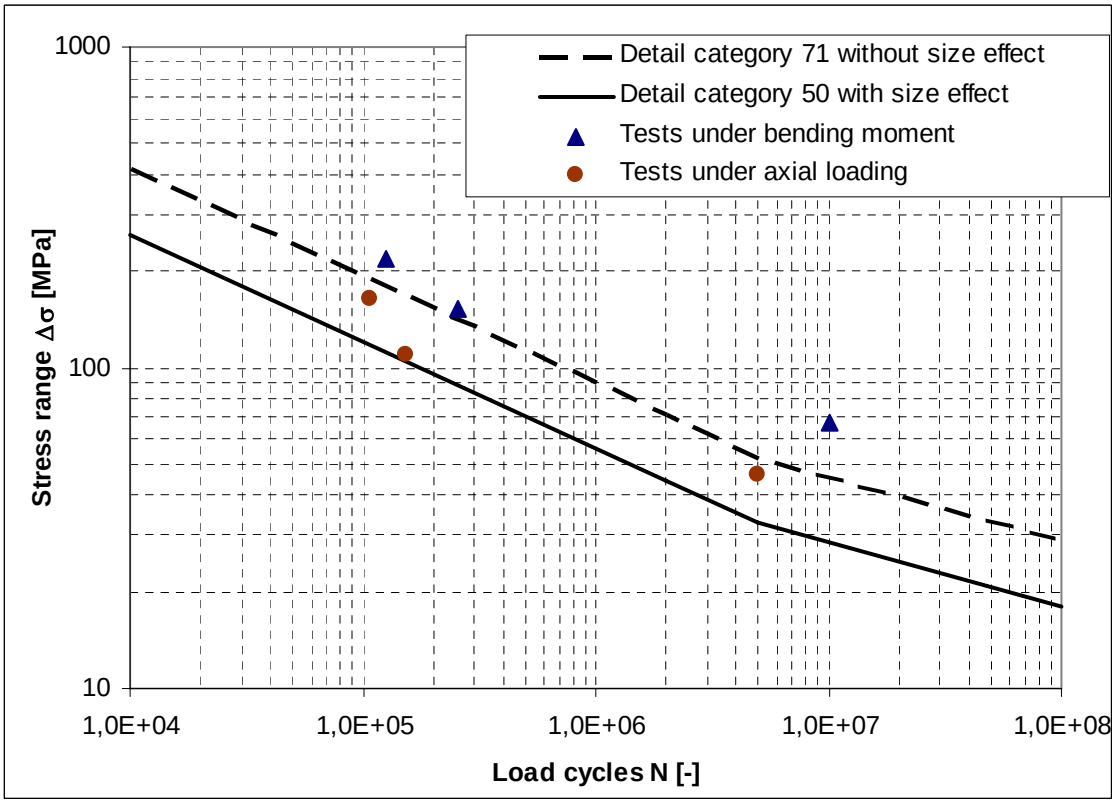
# Experimental determination of S-N-Curves for large bolts

High strength bolts with large diameters are used mainly in the ring flange connections between tower segments of modern wind energy converters with high capacity. Due to the design lifetime of 20 years the bolts have to resist more than $10^9$ load cycles. Therefore the fatigue resistance of these components becomes essential.
In this research project two S-N-curves for high strength bolts with a diameter of 48mm (M48) have been developed from axial loading and from bending moment fatigue tests. The objective was to verify the regulations in the Eurocode 3 for bolt diameters larger than M36.
The fatigue tests were carried out on resonance testing stands at a frequency of 60 Hz. As the tests under axial loading conditions were performed on a commercial test stand a special testing device has been used for the tests under bending moment condition. The tests were carried out with bolt sets from three different manufacturers to take a possible manufacturing influence into account. From statistical point of view the results have been treated as one sample.
The bolts under axial loading were tested with an average load of 200 kN. The bolts for the bending moment tests were preloaded with 500 kN. Two stress range horizons with 10 tests each were investigated for both loading conditions in the low cycle fatigue area. The transition area to the fatigue limit has been identified by 30 tests for each loading condition.
The test results of the two test series in comparison to the S-N-curves in the Eurocode 3 are shown in the figure below.




**Comparison between S-N-Curves from Eurocode 3 and test results**

All test results lie above the curve of detail category 50 taking the size effect of the Eurocode 3 into account, which is valid for bolts under axial loading condition. For this reason the code regulations have been confirmed. Furthermore the test results show that the fatigue behaviour is better for bending moment condition than for axial loading.