

Influence of length tolerances in space frames' resistance

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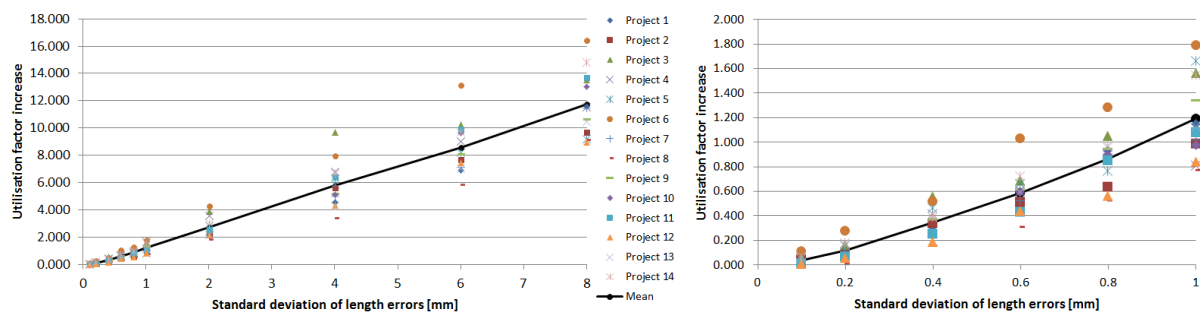
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Abstract

Space frames have been used in construction for years. Different systems have been developed and thousands of structures have been built. Their design and calculation is simple for a structural engineer, thanks to the matrix of stiffness method. Their main challenges lay on their geometry, optimization and manufacturing. One of their strength is that they are highly hyper-static structures. If one element fails, efforts are redistributed so that the structure will not collapse. However, the hyper-staticity may also become a problem if the bars are not manufactured with accurate tolerances. Despite the common use of space frames, no deep researches have been made on this field. Therefore, there are no unified criteria for them and it relies on the accuracy of each manufacturer.

The study was based in the ORTZ system, which has been used in space frames by Lanik since 1978, and was divided in two parts. First of all, the manufacturing tolerances of the system were checked, measuring 1288 bars of variable dimensions and obtaining the length distribution errors of a built system. Later, in order to study the effect of tolerances, 14 projects have been analysed. On each of them, the length variation of the bars has been applied as a load case. The differences in length follow a normal distribution, with a zero-mean (no error) and 10 different standard deviations, equivalent to manufacturing tolerances. The research shows that standard deviations of 0.8 mm lead almost to double the utilization factor of at least one of the bars, considering section resistance and buckling.

In conclusion, although these small tolerances of tenths of millimetres are not usual in steel structures, they become necessary in spaces frames. Designers and manufacturers should take this into account in order to avoid problems. However, this study has been done using linear calculations and only shows the effect on the worst bar; therefore, a deeper study shall be done, studying non-linear effects and push-over analyses.



References

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