Ultimate Strength and Post-ultimate Behavior of Hybrid Platform Deck Girders

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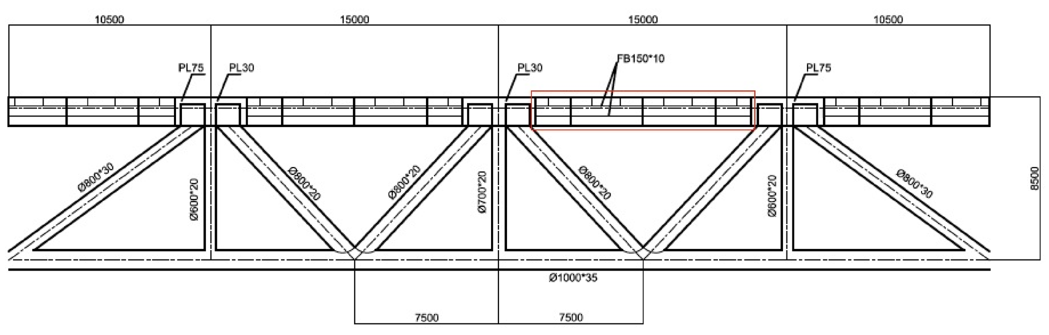
Introduction

A truss-work structure in combination with plate girders is often used as topside load-carrying structures in floating offshore platforms. The red rectangular shows a girder section from the platform deck. Design formulations for plate girder may be conservative and these effects in conjunction with reassessment of the platform may help to enhance the ultimate capacity.



The purpose of this work is to contribute to a better understanding of the ultimate strength and post-ultimate behavior of such deck girder by performing nonlinear analysis with the computer program Abaqus and USFOS.

Methods

In order to analyze the ultimate strength, the linear eigenvalue analysis is necessary for introducing the geometric imperfections, and then the nonlinear analysis based on Riks Arc Length is applied in Abaqus.

In linear buckling analysis, two steps are introduced to calculate eigenvalue and eigenvector.

$$(K_0 + \lambda_i K_\Delta)v_i = 0 \quad (1)$$

In the Riks analysis, the load during a step is always proportional and the current load magnitude is defined by:

$$P_{total} = P_0 + \lambda(P_{ref} - P_0) \quad (2)$$

Regulation check

The simplified methods in DNV RP C201 can provide an estimate of the buckling and ultimate strength for the stiffened structures.

The first method is a conventional buckling code for stiffened and unstiffened steel plates, stiffeners and girders. The second method is a computerised semi-analytical model called PULS (Panel Ultimate Limit State).These two methods will be used to check the results from nonliner FEM.

Further work

Further work should focus on the understanding of stress flow in the shear/bending cases and the specific effects from the stiffeners. In addition, the explaination or further work about the difference existing in these two nonlinear software should be expected.

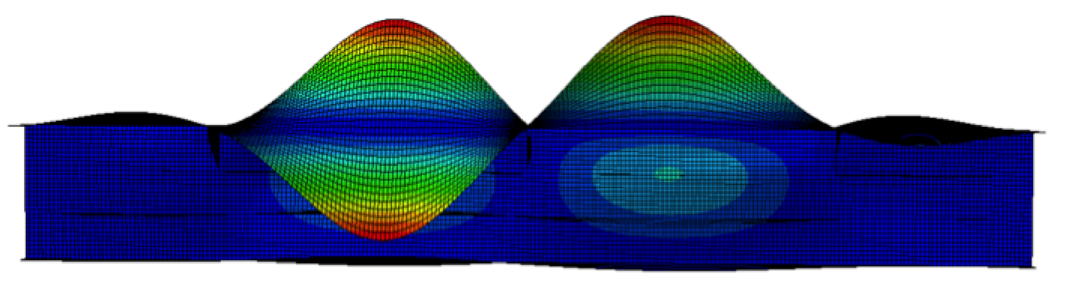
References

[1] H.R.Evans Longitudinally and Transversely Reinforced Plate Guirders In *University college, Cardiff, UK*

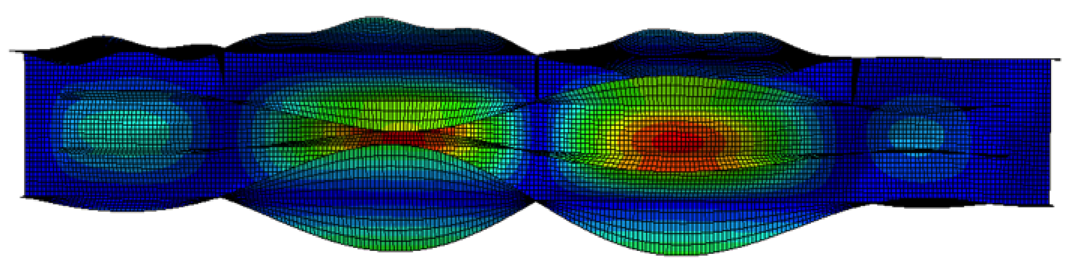
[2] C. Graciano, E. Casanova, J. Martinez Imperfection Sensitivity of Plate Girder Webs Subjected to Patch Loading In *Journal of Constructional Steel Research 2011*

[3] DNV RP C201 Buckling Strength of Plated Structures In *Recommended practice*

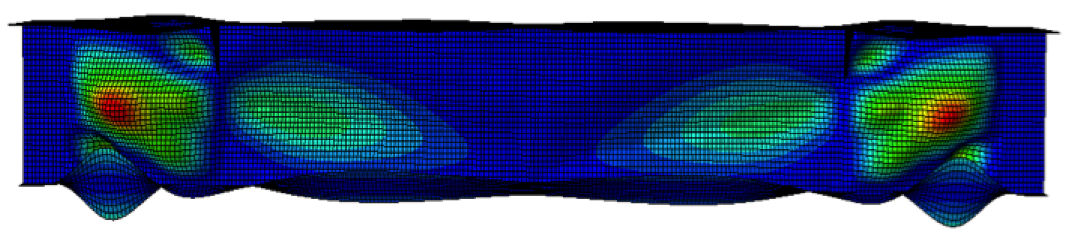
Eigenmode analysis



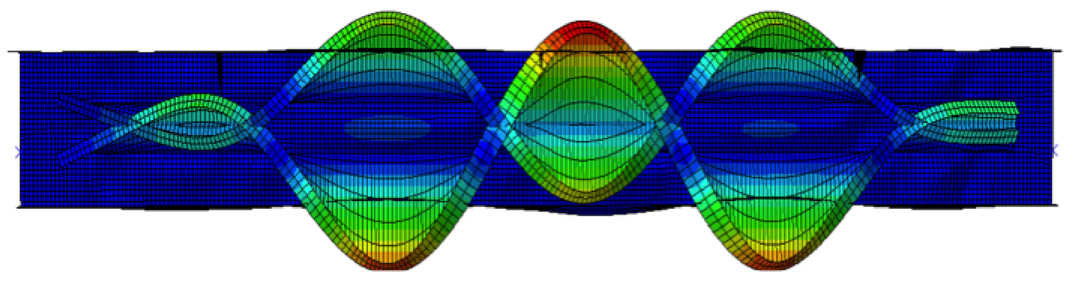
a) Flange dominated buckling mode under compression



b) Web dominated buckling mode under compression

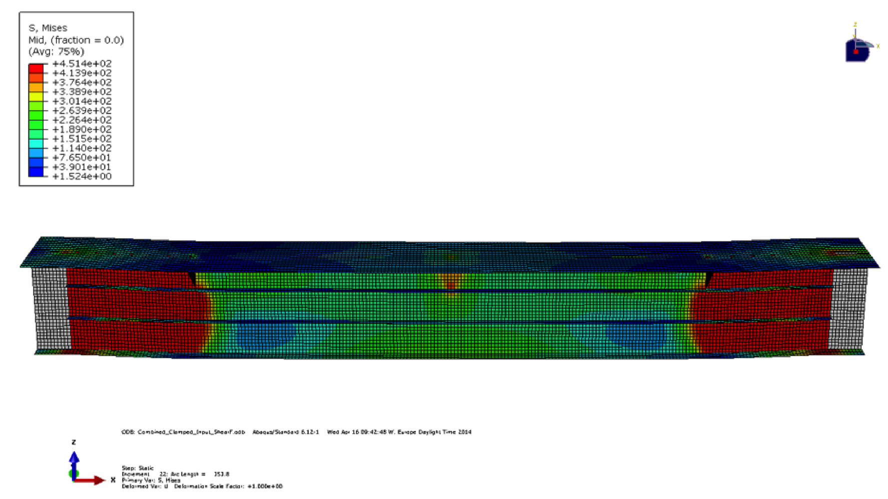


c) Buckling mode under shear

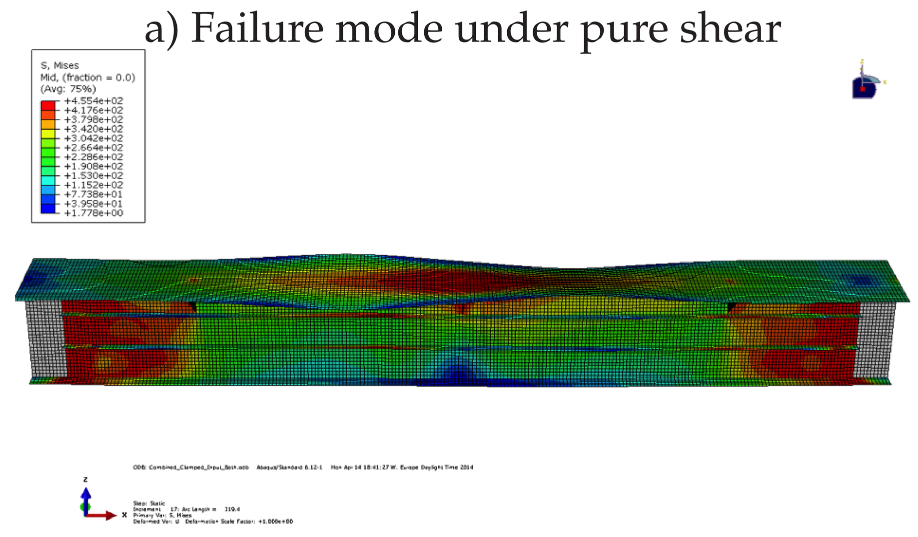


d) Stiffener dominated buckling mode

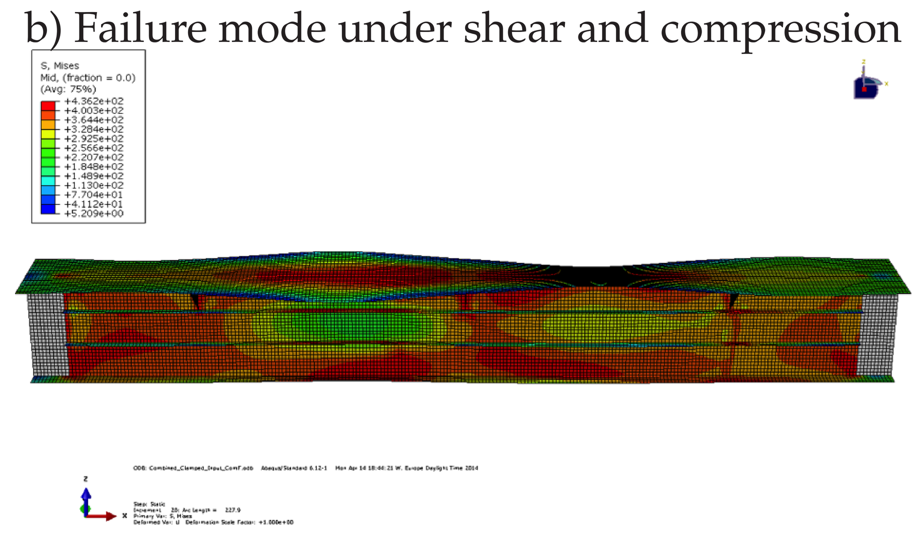
Failuer modes



a) Failure mode under pure shear



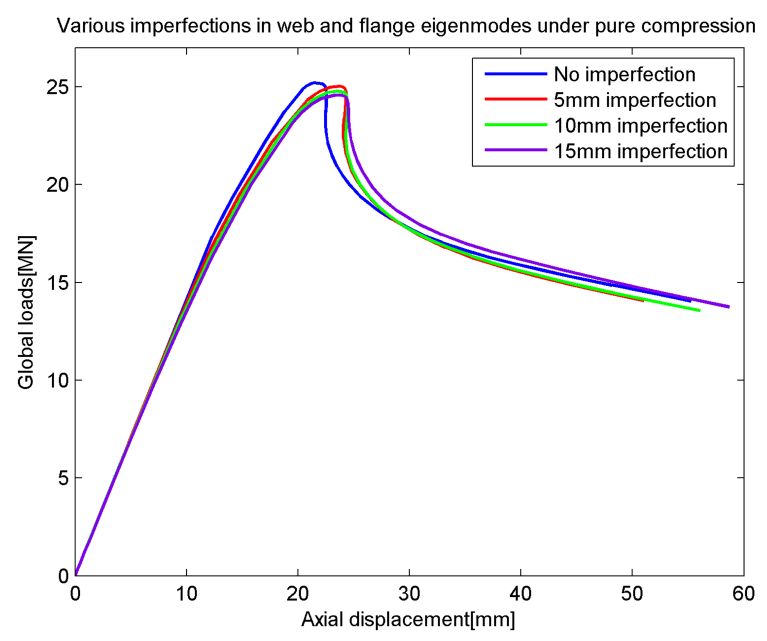
b) Failure mode under shear and compression

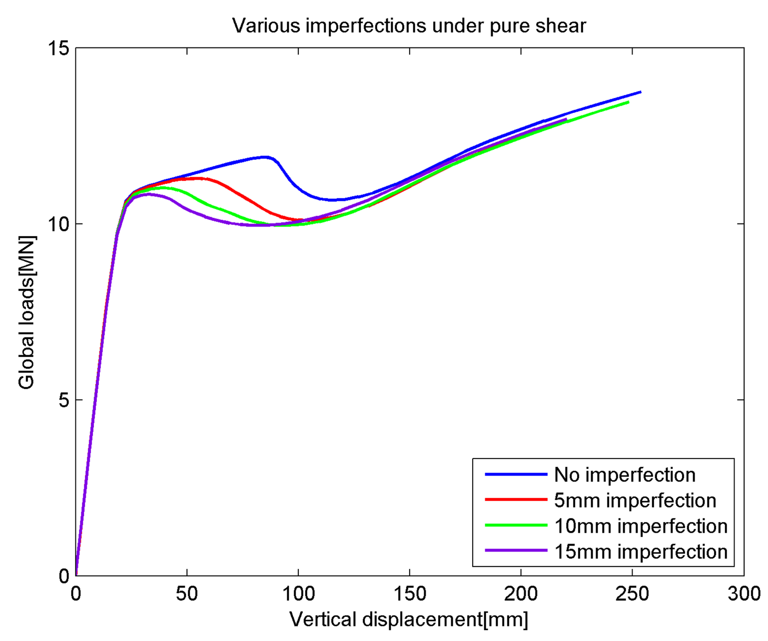


c) Failure mode uner pure compression

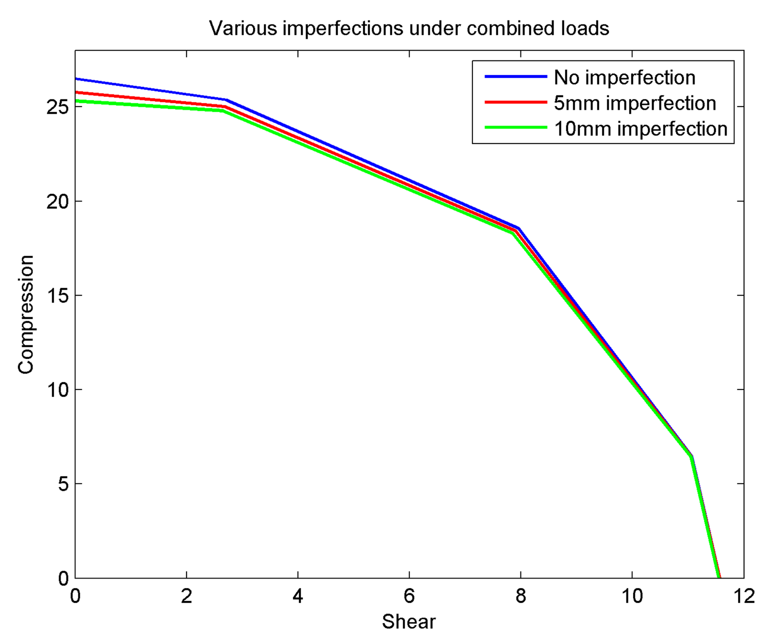
Results and conclusions

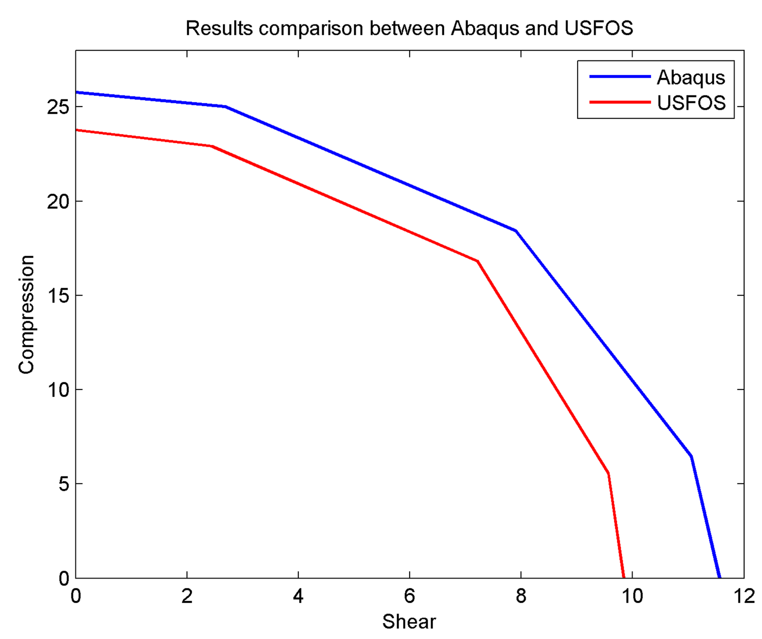
The comparisons based on different input parameters are given below as results to show the effects of these parameter on the ultimate capacity of the deck girder section.



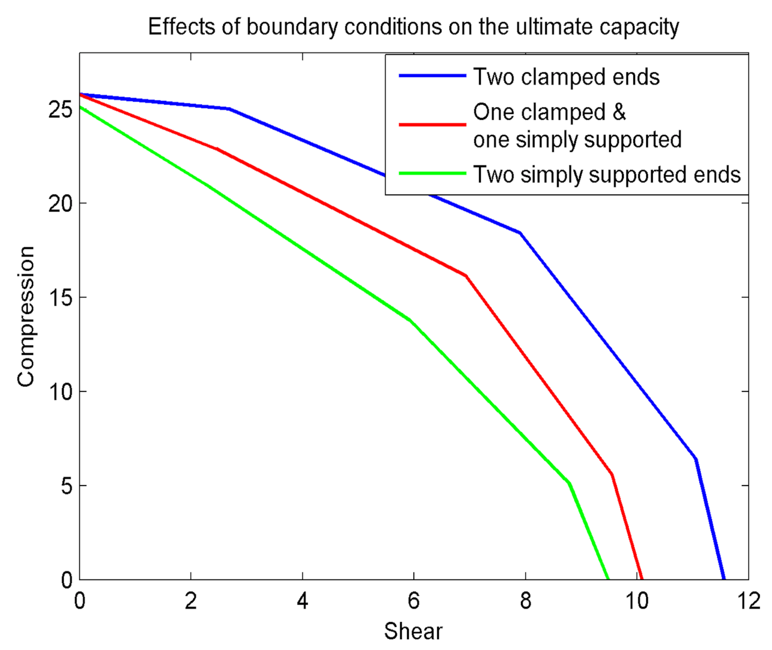


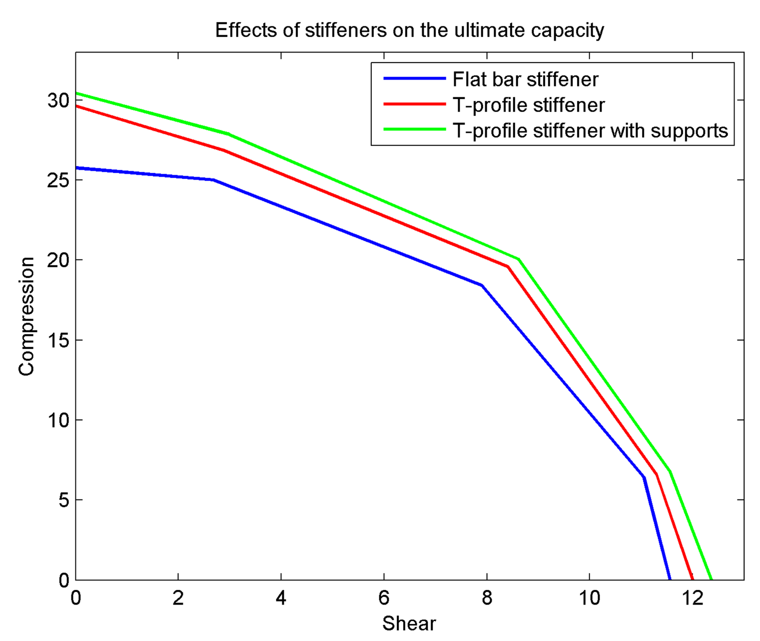
Effects of initial imperection are ploted for pure compression and shear above. For the nonlinear ultimate analysis, the effects are not dramatic for this kind of rubost structure.





The interaction capacity curve for bending and shear is not sensitive to the imperfections as well and the two nonlinear program predict the ultimate strength with an acceptable deviation.





Boundary conditions influence the ultimate capacity, especially for shear dominated cases and reinforced stiffeners can improve the ultimate capacity at a certain and small level.