

Numerical studies of Three Dimensional Triple-Bay Prestressed Stayed Columns

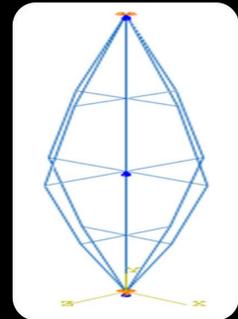
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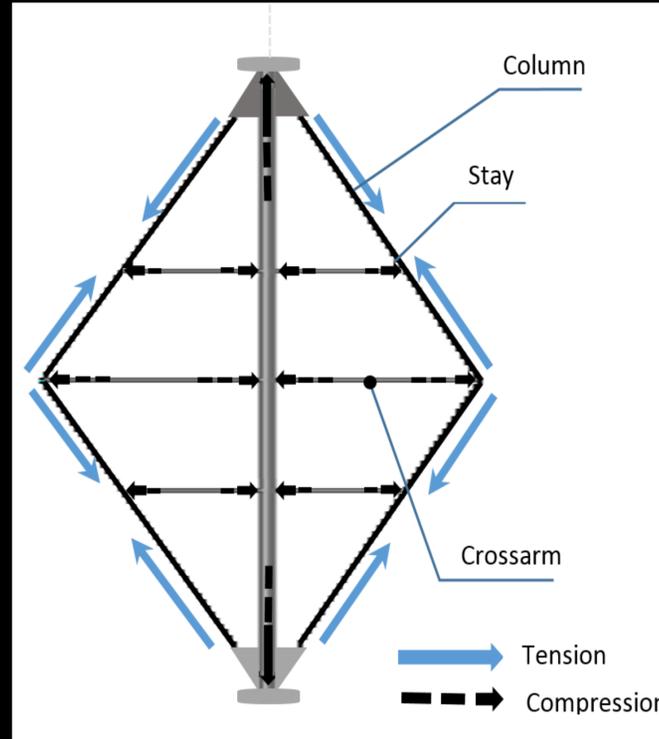
INTRODUCTION

Prestressed stayed slender columns provide an efficient and lightweight structural solution that fulfils the demands of the dynamic surrounding environment (Yu and Wadee, 2015). This phenomenon provides extra axial strength to a conventional column through the addition of crossarms and cable stays. These structural elements block the principal movement of the column during conventional buckling, by pre-tensioning the stays, the crossarms and the column are put into compression.

MODEL FORMULATION



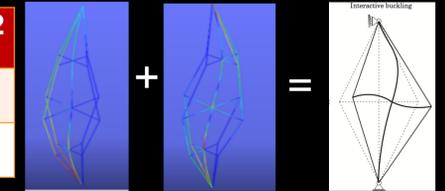
The Model was assembled via the finite element software ABAQUS. The column and the crossarms were modelled as beam elements and the stays are modelled as truss elements of types B32 and T3D2 respectively. The "No Compression" option was activated to avoid the stays from experiencing any compressive load. As for the boundary conditions, the tip movement was restricted in the x and z direction, but allowed to move freely in the vertical direction. The bottom of the column was set as a pinned node in all directions. To avoid twisting arising, the rotation about the vertical axis was also prohibited.



POST-BUCKLING

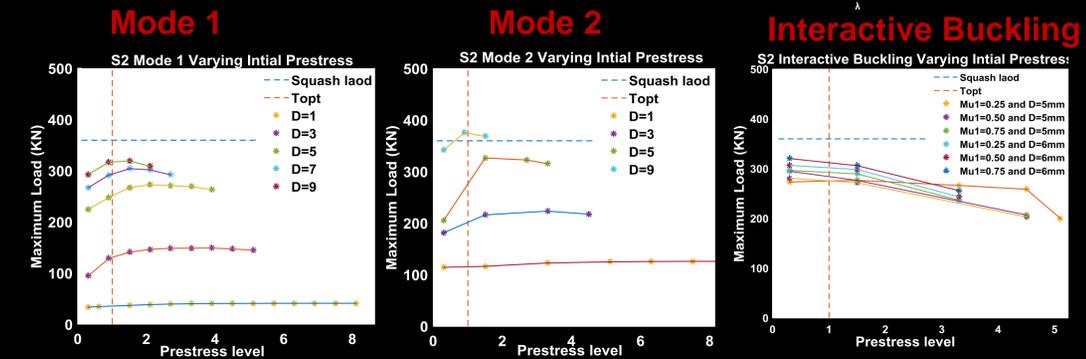
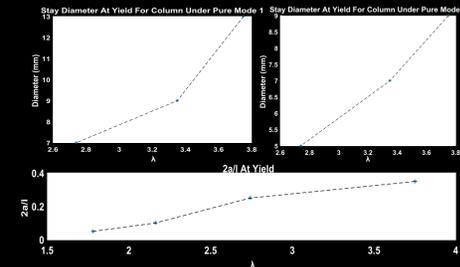
There are two responses in the post-buckling behaviour when the ant symmetrical mode is critical in the critical buckling analysis. The first and the most frequent is that interactive buckling governs and the second is mode one being critical. Otherwise, Mode 1 is always critical.

	Mode 1	Case 1	Case 2	Case 3	Mode 2
μ_1	10.16	7.62	5.08	2.54	0.00
μ_2	0.00	3.36	4.47	4.92	5.08



COLUMNS WITH DIFFERENT SLENDERNESS

Column outer Diameter (mm)	N_c (KN)	N_y (KN)	$\bar{\lambda}$	$\frac{1}{\bar{\lambda}^2}$
Case 1 D=38.10	6.38	224.89	5.94	0.028
Case 2 D=57.15	25.52	359.76	3.75	0.071
Case 3 D=66.68	39.68	446.51	3.35	0.089
Case 4 D=76.20	65.87	494.51	2.74	0.133



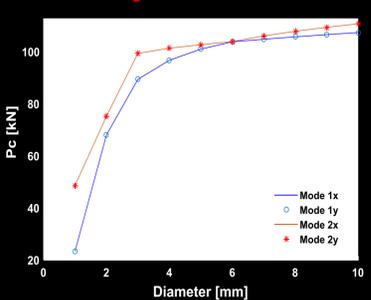
CONCLUSIONS

- By undertaking linear analysis, it was demonstrated that the column buckles either in a symmetrical shape (Mode 1) or antisymmetrical shape (Mode 2). Moreover, mode 1 is always critical for moderate values of these three parameters
- The load carrying capacity drops when introducing imperfections to the model, hence, the non-linear analysis has to be taken in account to ensure the safety of the structure.
- Interactive buckling is present only when mode 2 is critical in the eigenvalue analysis.
- Higher load capacity is achieved when increasing the prestress beyond the theoretical optimal prestress (T_{opt}).
- Slenderness of the column of around 3 is recommended for efficient design
- High strength steel is a recommended material for stayed columns

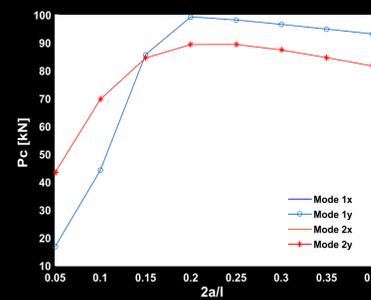
CRITICAL BUCKLING ANALYSIS

In the parametric study, there were three parameters to vary: the stay diameter ϕ_s , the middle crossarm length a_m , and the length ratio of the edge to the middle crossarm γ .

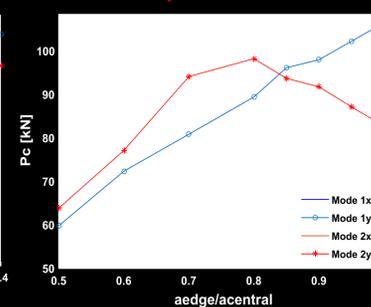
Stay Diameter



2a/l Ratio



γ Ratio



ACKNOWLEDGEMENTS

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REFERENCES

Yu, J., Wadee, M.A. (2015) Numerical and analytical studies of prestressed stayed columns with multiple cross-arms. In: Lisbon 2015: Eighth International Conference on Advances in steel structures.

NONLINEAR ANALYSIS OF PRESTRESSED STAYED COLUMNS USING HIGH STRENGTH STEEL

