Structural Performance of Polymeric Composite Members in a Transmission Line Tower

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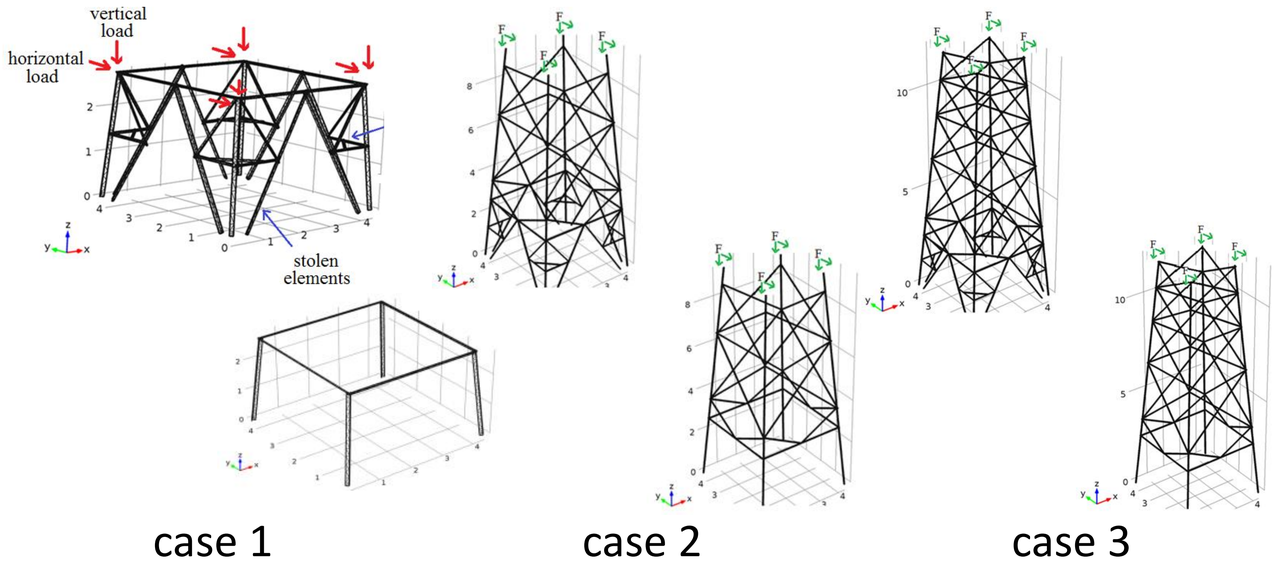
Introduction: The objective is to evaluate the feasibility for using polymeric composite members instead of steel members as redundant members in transmission towers by computing the critical buckling load trough a linear buckling analysis.

Figure 1. Transmission line tower with and without redundant members in the bottom panel.

Computational Methods: The evaluation is performed by determining the value of the load at which the tower instability occurs, solving an eigenvalue problem for the load multiplier λ.

$$(K_L)\mathbf{u}_0 = \mathbf{f}_0$$
$$(K_L + \lambda K_{LN}(\mathbf{u}_0))\mathbf{u} = 0$$

where **u** is the displacement vector, **f** is stationary load and *K* is the total stiffness matrix. *K* is split into a lineal part (K_L), and a nonlinear contribution (K_{NL}). The obtained value of λ at which the structure becomes unstable is the critical load factor



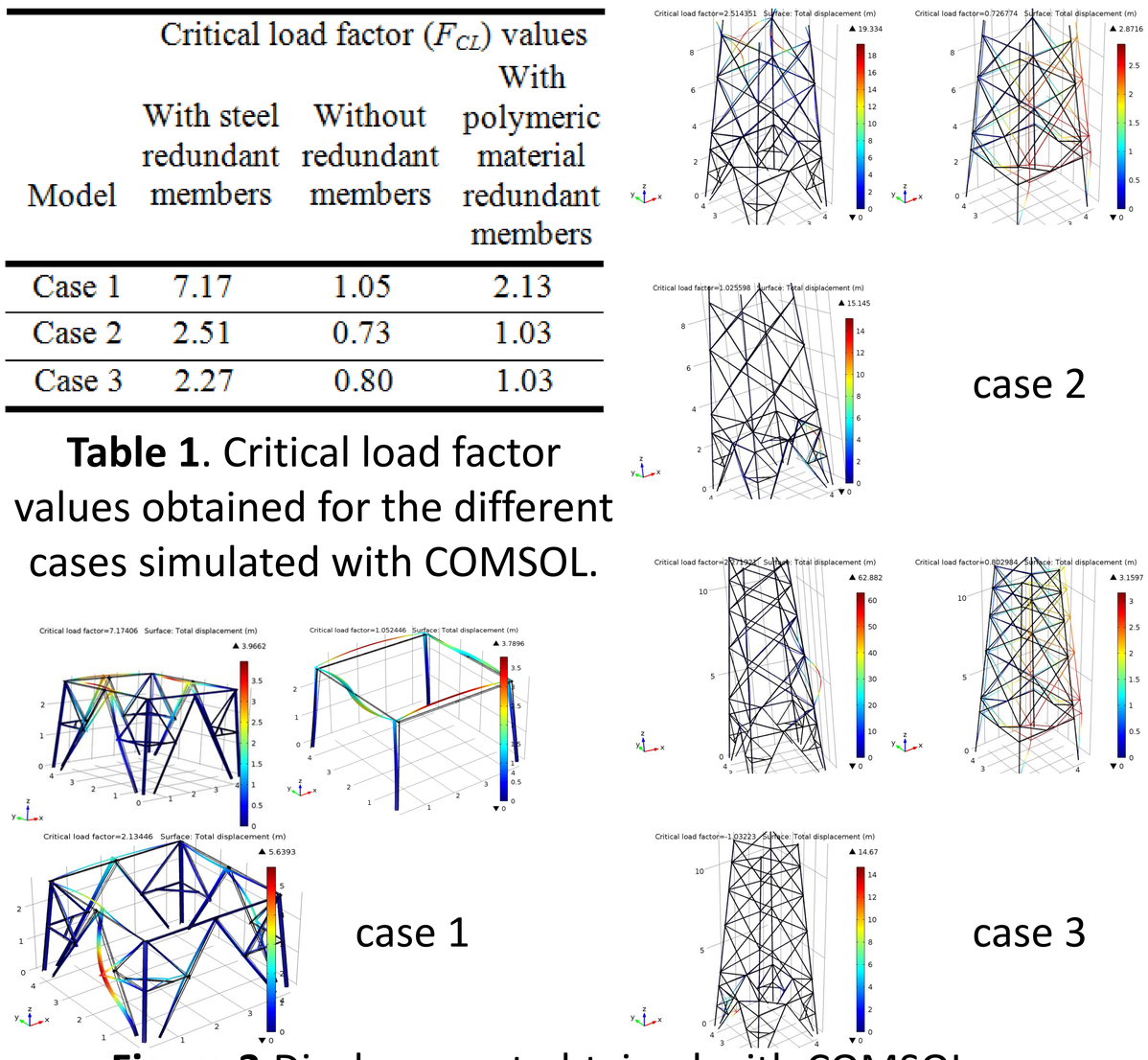
case 1 case 2 case 3

Figure 2. Made models to analyze the structural performance.

Results: The results obtained, in terms of critical load factor (FCL), are presented in Table 1. Figure 3 shows the total displacements for the different simulated cases. A critical load factor lower than 1 means that the structure is in an elastic instability condition.

Model	Critical load factor (F_{CL}) values: With steel redundant members	Without redundant members	With polymeric material redundant members
Case 1	7.17	1.05	2.13
Case 2	2.51	0.73	1.03
Case 3	2.27	0.80	1.03

Table 1. Critical load factor values obtained for the different cases simulated with COMSOL.



case 1 case 2 case 3

Figure 3.Displacement obtained with COMSOL.

Conclusions: The feasibility of use composite material redundant members in the bottom panel of a transmission line tower was evaluated using COMSOL. The evaluation was performed by a linear buckling analysis.

References:

1. ASCE 10-97 Standard, Design of Latticed Steel Transmission Structures, (2000).
2. Selvaraj, M., Kulkarni, S.M., and Ramesh Babu, R., Structural Evaluation of FRP Pultruded Sections in Overhead Transmission Line Towers, *International Journal of Civil and Structural Engineering*, **vol. 2**, no.3, pp. 943-949 (2012).