TORSIONAL BUCKLING OF FRP COMPOSITE THIN COLUMNS USING THE COMPLEX FINITE STRIP METHOD

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Key words: Buckling, FRP composites, finite strip method, orthotropic material, torsional buckling, thin columns.

Summary. Torsional buckling of thin cross section columns has been evaluated in present article.

1 INTRODUCTION

Composite materials have gained wide applications in both civil and mechanical engineering since they offer various types of product and material characteristics. Pultruded FRP profiles are realized with most of the fibers oriented along the axial direction of the element defining very different mechanical characteristics in the longitudinal and transversal directions. In presented article a complex finite strip method is used to consider the torsional buckling of thin cross section columns.

2 NUMERICAL STUDY

Accordingly, the displacement vectors are defined by the equation (1) as shown in figure 1.

\[
\mathbf{d}_1^T = \begin{pmatrix} v_1 & iu_1 & v_2 & iu_2 \end{pmatrix} ; \quad \mathbf{d}_0^T = \begin{pmatrix} \phi_1 & w_1 & \phi_2 & w_2 \end{pmatrix}
\]

(1)

The standard finite element procedure based on virtual work is used to derive the stiffness matrices. In Figure 2, the initial buckling stress \( \sigma_{cr} \) of cross sections under uniform compressive stresses, is given as a function of the dimensionless buckling half-wavelength, \( \lambda/b_w \), where \( b_w \) is the depth of the section.

3 CONCLUSION

The results show that torsional buckling of thin and long span cross section beams is the same for isotropic and orthotropic materials. Table 1 shows the comparison of the results of finite strip and the results of close form solution presented in the literature.
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Figure 1: Strip degrees of freedom

Figure 2: Critical stresses for cross sections

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<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>$b_w$</td>
<td>$t_f$</td>
<td>$t_w$</td>
<td>$l_{r_4}$</td>
<td>$C_w$</td>
<td>$J_4$</td>
<td>Critical stress</td>
<td>error(%)</td>
</tr>
<tr>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm)</td>
<td>(mm³)</td>
<td>(mm⁶)</td>
<td>(mm⁴)</td>
<td>Close form solution</td>
<td>Finite strip</td>
</tr>
<tr>
<td>500</td>
<td>10</td>
<td>10</td>
<td>21.10⁵</td>
<td>17.10⁸</td>
<td>3.3.10⁷</td>
<td>38.57</td>
<td>38.58</td>
</tr>
<tr>
<td>450</td>
<td>10</td>
<td>10</td>
<td>15.10⁶</td>
<td>13.10⁸</td>
<td>3.0.10⁷</td>
<td>47.56</td>
<td>47.59</td>
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<tr>
<td>400</td>
<td>10</td>
<td>10</td>
<td>11.10⁷</td>
<td>8.9.10⁸</td>
<td>2.7.10⁷</td>
<td>60.14</td>
<td>60.18</td>
</tr>
<tr>
<td>350</td>
<td>10</td>
<td>10</td>
<td>7.2.10⁸</td>
<td>6.0.10⁸</td>
<td>2.3.10⁷</td>
<td>78.48</td>
<td>78.55</td>
</tr>
</tbody>
</table>

Table 1: Comparison of the results of finite strip and close form solution

4 REFERENCES


