OPTIMAL DESIGN BY ELITIST-GENETIC ALGORITHM FOR MAXIMUM FUNDAMENTAL FREQUENCY OF FIBER METAL LAMINATED PLATES

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Summary. In the present paper, fundamental frequency optimization of fiber metal laminated plates (FMLs) is studied using the combination of Elitist-Genetic algorithm (E-GA) and finite strip method (FSM). The design variables are the number of layers, the fiber orientation angles of inner composite layers, edge conditions and plate length/width ratios. The classical laminated plate theory (CLPT) is used to calculate the natural frequencies and the fitness function is computed with a semi-analytical finite strip method which has been developed on the basis of full energy methods. To check the validity, the obtained results are also compared with some other stacking sequences.
1 INTRODUCTION

Fiber metal laminate (FML) composites are laminates composed of alternating layers of reinforced polymeric composites and aluminum alloys in a way that aluminum alloy sheets are outer layers protecting the inner composite layers. The use of aluminum alloy layers improves specific stiffness and strength, and also results in weight savings in the design of tension-dominated stresses in structural components [1].

In the current paper, fundamental frequency optimization of FMLs is studied. The combination of E-GA and FSM are used for this purpose. In order to reduce the calculation time, the elitist strategy is used in Genetic algorithm and the fitness function is computed with a semi-analytical finite stripe model developed originally on the basis of full energy method [2].

2 NUMERICAL RESULTS

The optimization results of the fiber metal laminated plates (h/a=0.01) are given for AS/3501 graphite/epoxy material (inner composite layers) and aluminum alloy 2024-T3 (outer aluminum layers). The material properties are given as below:

Composite layers: $E_1=138$ GPa, $E_2=8.96$ GPa, $G_{12}=7.1$ GPa, $\nu_{12}=0.3$

Aluminum layers: $E=72.4$ GPa, $\nu=0.3$

Each of the lamina is assumed to be same thickness.

Table 1 presents converged optimum solutions for symmetric 8-layer square fiber metal laminated plates with various combinations of F, S and C.

<table>
<thead>
<tr>
<th>BCs</th>
<th>$[\text{Al}/\theta_1/\theta_2/\theta_3]_{S,\text{opt}}$</th>
<th>$\Omega_{\text{opt}}$</th>
<th>BCs</th>
<th>$[\text{Al}/\theta_1/\theta_2/\theta_3]_{S,\text{opt}}$</th>
<th>$\Omega_{\text{opt}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFSF</td>
<td>[Al/0/0/0]$_S$</td>
<td>33.318</td>
<td>CCCF</td>
<td>[Al/0/0/0]$_S$</td>
<td>79.422</td>
</tr>
<tr>
<td>SFCF</td>
<td>[Al/0/-1]$_S$</td>
<td>52.790</td>
<td>SSSS</td>
<td>[Al/-45/-44/49]$_S$</td>
<td>57.241</td>
</tr>
<tr>
<td>CFSCF</td>
<td>[Al/0/-2]$_S$</td>
<td>76.333</td>
<td>SSSC</td>
<td>[Al/60/62/64]$_S$</td>
<td>69.289</td>
</tr>
<tr>
<td>SSSF</td>
<td>[Al/0/0]$_S$</td>
<td>37.036</td>
<td>SSSC</td>
<td>[Al/-40/-40/-41]$_S$</td>
<td>76.490</td>
</tr>
<tr>
<td>SRCF</td>
<td>[Al/0/-2]$_S$</td>
<td>38.874</td>
<td>SCSC</td>
<td>[Al/87/-87/-87]$_S$</td>
<td>88.623</td>
</tr>
<tr>
<td>SSSF</td>
<td>[Al/-4/-4/-5]$_S$</td>
<td>55.818</td>
<td>CCCS</td>
<td>[Al/0/0/2]$_S$</td>
<td>94.283</td>
</tr>
<tr>
<td>SCCF</td>
<td>[Al/-5/-5/-5]$_S$</td>
<td>57.216</td>
<td>CCCC</td>
<td>[Al/1/0/-6]$_S$</td>
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<tr>
<td>CSCF</td>
<td>[Al/0/0/3]$_S$</td>
<td>78.465</td>
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</tr>
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REFERENCES
