OPTIMIZATION OF THE COMPOSITE CONE STRUCTURE LAYERS UNDER BUCKLING LOAD

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Summary. Composites structures involve complex definitions that include numerous layers, materials, thicknesses and orientations. The orientation of fibers in the layers is an important factor that must be obtained in order to predict how well the finished product will perform under real-world working conditions. In this research, a five layer composite cone structure under buckling load was considered. First, the simulation of the structure was done utilizing finite element method and was confirmed comparing with the analytical models results developed for the cone structure. Then neural network and genetic algorithm methods were utilized to obtain the optimum orientations of fibers in each layer using the training data obtained from finite element simulation for about 15000 different orientations of fibers in each layer. The results showed that the cone with the obtained optimum layers would stand considerably more buckling load.

1 INTRODUCTION

New materials like fiber reinforced plastic (FRP) have been extensively studied for their capabilities due to the fact that it is lighter and stronger [1]. Research groups reported that energy absorption of a well design FRP composite can perform better than metals. Unlike metals, composite materials such as carbon and glass fiber reinforced plastics composites subjected to axial load will undergo of fracture and buckling to obtain energy absorption rather than plastic deformation which exhibited in metal tubing [2].

In composite tubes fabrication, fiber orientations effects on axial load behavior were studied. Carroll et al. [3] reported that for ±55 filament-wound glass fiber/epoxy under quasi-static compression, the failure depends on stress ratio and rate of loading. It was suggested that strength and stiffness were a function of loading direction and the total energy absorbed was
related to the stress strain behavior. On the other hand, epoxy/carbon fiber layers of (±0) and (±90) were able to crush progressively and absorbed more energy compared to layers (+45/-45k) which deformed plastically without fracture due to higher flexural rigidity [2].

2 RESULT & DISCUSSION

Figure.1 shows the neural network training for about 15000 data. The R-value was obtained about 98.7% for the training, test and validation data. Then genetic algorithm method was employed to optimize the orientation angle of layers. Figure.2 shows the genetic algorithm (GA) process. The GA process was obtained by try and error method. Meanwhile, the optimum values of mutation rate and cross-over were obtained 0.04 and 0.8, respectively. Finally, the optimum orientations of fibers in each layer were obtained as shown in Table 1.

![Figure 1: neural network training](image)

![Figure 2: genetic algorithm process](image)

<table>
<thead>
<tr>
<th>Layer 1</th>
<th>Layer 2</th>
<th>Layer 3</th>
<th>Layer 4</th>
<th>Layer 5</th>
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<td>89.94395</td>
<td>90</td>
<td>20.40858</td>
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</tbody>
</table>

Table 1: The optimum angles for each layer

REFERENCES

