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Optimization of Composite Rocket Launcher Using GA

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ABSTRACT

Nowadays, as is well known, optimized composite materials are employed in many constructions when high strength to weight ratio and increasing the section rigidity of the light weight structures and ease of manufacturing are required. In this paper, new optimization method of graphite-epoxy composite cylindrical shell, under thermo mechanical loading is done by MATLAB SOFTWARE coding in GENETIC algorithm method to decrease weight of structure in satisfactory limit. The completely mathematical method of composite layup is reached by using of approximately approach analysis of long shells and plates. The failure criterion of Composite materials is T-SaiHill. Final results of analysis for obtain the critical points of rocket shooting, are done by ABAQUS SOFTWARE.

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Abaqus,
Matlab,
Genetic Algorithm,
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1.Introduction

Although the geometry of the multi objective optimization of laminated composite is simple, they can have wide range of answers due to the existence of variables like: angle, arrangement, type and number of layers. The developed explorer algorithms like genetic algorithm have high capabilities in such kind of optimizations apart from complexity of analysis, owing to the fact that they directly consider the set of answers and avoid the system analysis. In utilization of intelligent investigation procedures, the number of accomplishments of an algorithm is considered the highest amount, in order to achieve the best results with highest confidentiality. Regarding the analysis of composite material, ref. [1-4], the effects of geometric variables like thickness and direction of fibers are studied using genetic algorithm.

2.1. Evaluation of Matlab code

The composite Plate shown in Fig.1 has "a"as length, "b" as width and "α"as thickness and is under bending load of q(x,y). The shown composite surface is located in coordinates x, y, and z, and has K layers that its thickness is h_k and the angle of fibers is θ_k and k=1,2,…,k.

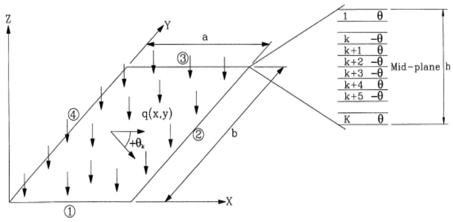

Fig.1: Geometry and Loading Condition of composite Plate

The material used in Composite surface is of graphite-epoxy type (T300/5208) and their specifications are as follows:

$E_1 = 181$ GPa $E_2 = 10.3$ GPa

$G_{12} = 7.17$ GPa $\upsilon_{12} = 0.28$

$X_t = 1500$ MPa $X_c = 1500$ MPa

$Y_t = 40$ MPa $Y_c = 246$ MPa

$S = 68$ MPa

The composite layers have symmetrical china layers as $[\theta_1/\theta_2/\theta_3/\theta_4 \| t_1/t_2/t_3/t_4]_{sys}$ and are under an even loading.

2-2. Method of Plate Analysis

For optimization of a Compound laminated using genetic algorithm and Finite element procedure, first the finite element model is created in Abaqus software, then using the link with mathlab software the process of optimization begins. In 2003, the optimization of a Compound laminated was accomplished by walker and Smith to optimize the weight and displacement using some design variables.

The design constraints are considered on the basis of Tsai failure Factor and.

The composite surface is symmetrical and includes 8 layers; therefore, for 4 layers of the composite surface, angle and thickness are optimized with the definition of average weight in the function and designation of it's minimum. For designation of an application china layer, the optimum angle is selected from the angles used in industry. Most of common angles in industry include 0, $\pm 30, \pm 45, \pm 60, 90$ which in Ref.[1] they include 0.5, 0.75, 1, 1.25, 1.5, 2, 2.25, thicknesses . In order to show the accuracy of genetic algorithm performance in this article, the results are compared to [1].

2-3. Design Variation in Plate Optimization

In this optimization each person has 2 chromosomes. One chromosome contains the angles of Fiber and the other one includes the thickness of layers. Panel can include at most 8 layers and at least 4 layers which are symmetric with regard to the centric axis of the panel. So, because of the asymmetry, each chromosome will contain 4 genes. Table 1, indicates the angles, thicknesses and related codes.

Table.1: Related Thickness and Angles Code's

No. Of Angle Gen.		No. Of Thickness Gen.	
Code	Fiber angle. (degree)	Code	Layer Thickness.(mm)
1	0	1	0.5
2	30	2	0.75
3	-30	3	1
4	45	4	1.25
5	-45	5	1.5
6	60	6	1.75
7	-60	7	2
8	90	8	2.25

In order to show the accuracy of the written algorithm, this composite surface is considered under boundar conditions (C,C,C,C) (F,S,C,S) and in a situation in which the boundary conditions are (F,S,C,S), for aspect ratios of 1.5 and 2 are studied and the results are presented in tables 2 and 3. The out coming results portend the high efficiency of the algorithm.

5	-45	5	1.5
6	60	6	1.75
7	-60	7	2
8	90	8	2.25

2-4. The stoppage criterion in this problem is of two states

The first scale is the maximum number of generation that is considered 250 and the 2nd scale is the maximum number of generation without improvement of proper optimum point which is considered 125.

2-5. The entries of composite surface program

The entries of the program are as follows:
Population = 8
The number of genes For each chromosome = 4
The percentage of mutation = 1%
The percentage of layer arrangement mutation = 80%
The percentage of layer increment mutation = 4%
The Percentage of layer decrement mutation = 4%
Minimum No. of layer = 2
Code collection of Gen. thickness = [1,8]
Code collection of Gen. angle = [1,8]
Elitism factor = 80%
The maximum number of generation = 250
The maximum number of generation without improvement = 125

2-6. The comparison of code results and reference for Plate

In [1], optimization of the composite surface for different boundary conditions and aspect ratios has been considered. in Fig. 1, 4 edges of the composite surface are numbered. Boundary conditions for this problem include a free end (F)[3], a clamped end (C)[4] , and simple support (S)[5] which in[1] six different admixtures of boundary conditions in forms of (F,S,F,S) ،(F,S,C,S) ،(S,S,S,S) ،(C,S,C,S) ، (C,S,C,S) and (C,C,C,C) is shown, and for a situation that boundary conditions are in the form of (F,S,C,S) , the aspect ratio $(\frac{a}{b})$ for values 0.5, 0.75, 1, 1.5 and 2 is considered.

Table.2: A comparison between the results of genetic algorithm and reference [1] for different boundary conditions und aspect ratio 1

Analyze Method	Boundary Condition	Layup (angle(degree)‖Thickness (m))	Weight(kg)	T-sai woo	Displacement(m)
Ref.[12]	F.S. C.S	(0/90/0/90‖2.25/2.25/1.5/ 0.75)	21.6	0.99	0.053
Related Algorithm	F.S. C.S	(0/0/90/90‖1.5/1/2/2.5)	21.6	1	0.052
Ref.[12]	C.C. C.C	(0/90/0/90‖0.75/2/0.75/0. 75)	13.6	0.98	0.032
Related Algorithm	C.C. C.C	(0/90/90/90‖0.75/0.75/0.7 5/2)	13.6	0.97	0.032

Table.3: A comparison between the results of genetic algorithm and reference [1] for boundary conditions (F,S,C,S)

Analyze Method	Aspect Ratio	Layup (angle(degree)‖Thickness(m))	Weight(kg)	T-sai woo	Displacement(m)
Ref.[12]	1.5	(60/-60/60/-60‖2/2/2.25/2.25)	4.08	1	0.111
Related Algorithm	1.5	(-60/60/60/-60‖2/2.25/2.25/2)	4.08	0.96	0.109
Ref.[12]	2	(90/90/0/0‖2.25/2.25/2.25/2.25)	57.6	0.99	0.152
Related Algorithm	2	(-60/60/60/60‖2.25/2.25/2.25/2.25)	57.6	1	0.133

3-1. Simulation of fire conditions in Abaqus software

In this part 70mm Haidra racket is mounted in the launcher and the racket is ready to shoot. In this position, part of the racket war head is out of the launcher which is shown below. The safety factor and construction amounts are taken with regard to the standard MIL-STD-2131A [5] to exposed loads on structure.

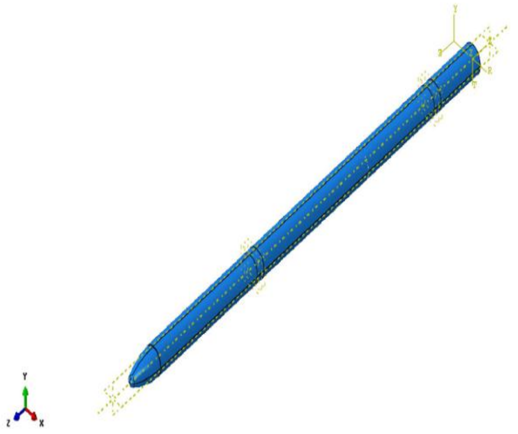

Fig.2: Launcher and Rocket Shooting Schematic

For analyzing the failure of the launcher in Abaqus software The Tsai-Hill Failure Factor is used. Tsai-Hill failure factor is presented as equation (1).

$$\frac{\sigma_1^2}{X^2} - \frac{\sigma_1\sigma_2}{X^2} + \frac{\sigma_2^2}{Y^2} + \frac{\tau_{12}^2}{S^2} = 1 \qquad (1)$$

In above mentioned equation based on the point that the tensions δ_1, δ_2 are either tensional or compressional, X, or $1/t$ and for compressional cases by X_c or Y_c.

3-2. stopping criterions in optimization of composite cylindrical (launcher)

stopping Criterion in this problem has two states as well. The first scale is the maximum number of generations which equals 400 and the second scale the maximum number of generations, without improvement of optimum spot which is considered to be 200.

3-3. The entries for composite cylindrical (launcher)

The entries of the program are as follows:
Population = 8
The number of genes For each chromosome = 4
The percentage of mutation = 1%
The percentage of layer arrangement mutation = 80%
The percentage of layer increment mutation = 4%
The Percentage of layer decrement mutation = 4%
Minimum No. of layer = 2
Code collection of Gen. thickness = [1,8]
Code collection of Gen. angle = [1,8]
Elitism factor = 80%
The maximum number of generation = 400
The maximum number of generation without improvement = 200

4. Conclusion and the results of genetic algorithm code and mathlab and Abaqus software links for composite cylindrical (launcher)

The final optimized results for composite Fiber made of graphite epoxy are presented in table 4.

Table.4: Results of GA for composite fibers

No. Of Angle Gen.		No. Of Thickness Gen.	
Code	Fiber angle. (degree)	Code	Layer Thickness.(mm)
1	0	1	0.0315
2	30	2	0.0562
3	-30	3	0.0821
4	45	4	0.1052
5	-45	5	0.1185
6	60	6	0.1494
7	-60	7	0.1508
8	90	8	0.1658

Considering the point that according to Fig.3 there are 19 launchers in each tube. The comparison between the weight of Aluminum and optimized composite launchers are presented in table (5).

Fig.3: 19 Rockets in Each Launcher

Table.5: Weight of aluminium and composite launcher

Material used in launcher	Weight of each launcher	Weight of 19 launchers
Al	2.7	51.3
Glass-Epoxy	1.27	24.13

Considering the results for china layer, it is observed that the highest effects among Fibers is allocated to the Fiber with 90^{o} angle. Furthermore the considerable weight decrement could be really important putting the military application into consideration.

References

[1] Walker .M, Smith. R.E., 2003, A technique for the multi objective optimization of laminated composite structures using genetic algorithms and finite element analysis, Composite Structures 62, pp. 123–128.

[2] Almedia, F.s., 2008, Design optimization of composite laminated structures using genetic algorithms and finite element analysis, composite structures65, pp. 12–18..

[3] Akbulut M. and Sonmez F.O., 2008, Optimum Design of Composite Laminates for Minimum Thickness, Computers and Structures, pp. 1974-1982.

[4] Walker M. and Reiss T. and Adali S., 1997, Optimal Design of Symmetrically Laminated Plates for Minimum Deflection and Weight, Composite Structures, Vol. 39, No. 3-4, pp. 337-346.

[5] MIL-STD-2131A, 1991 ‘’Launcher, Ejection, Guided Missile, Aircraft, General Design Criteria for’’ Vol. 40, No. 3-4, pp. 25-48.