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Retraction

Retracted: Application and Optimization of Wing Structure Design of DF-2 Light Sports Aircraft Based on Composite Material Characteristics

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] F. Li, S. Zhang, and W. Cheng, "Application and Optimization of Wing Structure Design of DF-2 Light Sports Aircraft Based on Composite Material Characteristics," *Journal of Nanomaterials*, vol. 2022, Article ID 6967016, 10 pages, 2022.

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Research Article

Application and Optimization of Wing Structure Design of DF-2 Light Sports Aircraft Based on Composite Material Characteristics

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Compared with ordinary metal structures, advanced composite materials have the characteristics of high strength, high rigidity, and light weight. The use of composite materials in aircraft structures is currently a hot research topic. This research mainly discusses the optimization design of the composite wing structure of the DF-2 light sports aircraft. This article takes the DF-2 light sports aircraft planned to be produced by the company as the source. Based on its overall design basis, aerodynamic requirements, and the original wing structure design, according to the composite material aircraft structure design theory and method, the aircraft wing structure is carried out. Composite materials are materials with new properties that are composed of two or more materials with different properties at the macroscale by physical and chemical methods. Composite materials can be divided into functional composite materials and structural composite materials according to the nature of the application. Functional composites are materials with special functions, such as conductive composites, ablative materials, and frictional composites. At present, the main research is on structural composite materials, which are composed of two components: matrix material and reinforcing material. The new structural scheme design and structural strength analysis are designed to meet the structural strength requirements of the wing and the lightest weight. In this paper, according to the force transmission characteristics of different structural types of the wing, the characteristics of the load transmission are analyzed, and the shape parameters and load parameters of the wing structure design are used as initial conditions, and the quantitative analysis model of the wing structure is constructed according to the requirements of strength, stiffness, and stability. Through rapid mathematical modeling and analysis of the wing structure, the weight and efficiency of different configurations can be evaluated. Through the quantitative analysis model of the wing, the wing structure type can be quickly determined according to the wing parameters in the preliminary design, which makes the basis for the selection of the wing structure type. After optimization, the weight of the wing structure decreased from 0.966 kg to 0.803 kg, a decrease of 16.87%. The designability of composite materials is one of its major characteristics. By optimizing the layup angle, layup sequence, and dropout area, the performance indicators of the structure are finally improved. This research will promote the further development of the aerospace field.

1. Introduction

Compared with the conventional mechanical structure design, aviation structural design requires very strict control of its structural weight. Because composite materials have superior performance in this respect, they are favored by aviation manufacturers and are more and more widely used in the design of aircraft structures.

Excessive cost is still the main obstacle restricting the large-scale application of composite materials in aircraft structures. If manufacturing and assembly problems are considered at the design stage, the aircraft can have an adjustable lift-to-drag ratio, shorter take-off and landing distance, less fuel consumption, wider range, higher ceiling, and higher mobility and stealth performance. And stealth performance is another important trend in the development of composite materials.

Composite structures have different structural properties due to the different percentage and sequence of layering at different angles. Yuan et al.'s loading of Au nanoparticles (AuNPs) onto environmentally sensitive polymer microgels is increasingly used to regulate their optical properties and catalytic activity. Here, they synthesized a composite polymer microgel composed of poly (n-isopropylacrylamide-co-3-methylpropyltrimethoxysilane)/poly (acrylic acid) with a core-shell structure and used nanoparticles to load AuNPs onto the network chain of the polymer microgel in a controlled manner. The prepared AuNP composite has good pH sensitivity. Therefore, the electromagnetic coupling between AuNPs can be regulated by the swelling/deswelling of polymer microgels under various acidic/alkaline conditions. More importantly, the coordination interaction between carboxyl groups and Cu ions in the PAA chain is altered by changing the content of Cu ions at different pH conditions, thus modulating the local surface plasmon resonance of AuNPs. These structural characteristics of the prepared composite microgel can adjust the optical properties of AuNPs in the following ways [1]. Chesterman et al. believe that resin-based composites (RBC) are increasingly used in posterior tooth restoration. The growing demand for aesthetically pleasing, tooth color restorations, coupled with patient concerns about using mercury-containing restorations, has driven the explosion in RBC material use. With the minamata convention of 2013 calling for the phasing out of dental amalgam and dental schools increasingly teaching RBC repair techniques for posterior teeth, the dental industry's reliance on RBC repair for posterior teeth is likely only to grow. To simplify and speed the placement of large rear RBCs, manufacturers produce a range of materials that can be placed in single or deeper increments, called bulk RBCs. In a relatively short period of time, many bulk RBCs have become available, with incremental depths of between 4 and 10 mm. The placement of these large incremental RBCs may reduce the time required to repair after placement, thus reducing technical sensitivity [2]. Palumbo et al. believe that thermoelastic signal phases associated with inherent dissipation processes occurring in materials have been used to locate and assess damage areas in a quantitative manner. In addition, thermoelastic phase analysis leads to the evaluation of the durability limits of composites. In fact, by comparing the results with those provided by standard test methods, the potential of the proposed procedure is shown first as a nondestructive technique for continuous monitoring of damage to composite structures subjected to fatigue loads and secondly as a fatigue limit index [3]. Boumhaout et al.'s work deals with the thermomechanical properties of composites made from mortar and date fiber mesh (DPF). The objective is to evaluate the thermal and mechanical properties of this material for building insulation. The volume percentage of date FibreNet in tested samples ranged from 0% to 51%. The thermal characteristics of the sample are experimentally determined in terms of conductivity, diffusivity, capacity, and flow rate. In addition, the bending and compression strengths of the samples were systematically evaluated. DPF grid has a positive effect on the thermomechanical properties of composites. In fact, it significantly improves the insulation ability of mortar, increases the thermal diffusion damping rate, and makes mortar lighter. DPF mesh also improves the ductility of mortar and meets the mechanical requirements of building materials [4]. Based on plant waste corn cob and nitrogen source melamine, Li et al. adopted an innovative method to controllable synthesis of multistage nanotube @ mesoporous carbon composites through heat treatment. Corn cobs provide a carbon source and a small amount of Fe as a catalyst, while melamine provides a nitrogen source. The corn cob is pretreated with concentrated sulfuric acid and then mixed with melamine. After calcination at 800°C for 2 hours, a large number of thin walled nitrogen-doped carbon nanotubes (MWNTS) grew vertically on mesoporous carbon skeleton with unique structure. The diameter of the nanotubes is about 50 nm, and their length varies between 0.1 and 20 μm, which can be controlled by adjusting the ratio of the pretreated corn cob to melamine. At the same time, the composite material has stable interconnect pores and channels with a surface area up to 1100 m^2/g, which significantly accelerates the ion and electron transport rates [5]. In the assembly of composite components, the fastener holes need to be processed not only in large quantity and high quality requirements but also difficult, which is one of the most difficult processing procedures in composite processing. It is easy to produce delamination, tearing, splitting, and other phenomena when making holes in composite materials, so the hole making connection is an important link that affects the assembly quality of composite components. Composite layup optimization is to optimize the design in the combination of these types of layup angles, while considering the laying position of each layer of composite materials, so as to maximize the excellent properties of composite materials [6].

Table 1: Main performance parameters of composite materials used in wing structure.

Material	T700/ epoxy	Fabric_ T700	NOMEX
Axial modulus (GPa)	120	56	0.3
Transverse modulus (GPa)	9	56	0.3
Z-direction modulus (GPa)	9	8	91
Shear modulus (XY/GPa)	4.8	4.6	0.06
Shear modulus (YZ/GPa)	4.8	4.6	20
Shear modulus (XZ/GPa)	4.8	4.6	30
Poisson's ratio (XY)	0.3	0.15	0.33
Poisson's ratio (YZ)	0.3	0.15	0.01
Poisson's ratio (XZ)	0.3	0.15	0.01

The honeycomb sandwich structure has been widely used in aircraft structural parts due to its excellent bending stiffness characteristics. The full-height sandwich structure is used on the control surface, which achieves a significant weight reduction effect on the premise of ensuring strength and rigidity [7]. Combining the design theories and methods of composite laminates and sandwich panels, as well as the introduction of bioengineering structural design concepts and topological structure design concepts, this article will maximize the use of composite materials to design the wing in detail. According to the requirements of the initial design, after designing and analyzing the initial structure, tests were carried out to prove the feasibility of the design. From the test, it can be seen that the initial design is relatively conservative, and the strength of the material and the rigidity of the structure are still too high. Based on this situation, a lightweight design of the wing was implemented. Regarding the feasibility and operability of the molding scheme of various structural components, the explanation is based on the analysis of factors such as the existing technical level and manufacturing cost, manufacturing cycle, and technical level of personnel.

2. Optimized Plan for Composite Wing

2.1. Optimizing the Thickness of Composite Material Structure Ply

2.1.1. Establishment of Optimization Model. The honeycomb structure has high deformation and supporting force and is suitable as a candidate for a deformed structure. However, the general honeycomb cannot be actively deformed, and the active deformation honeycomb based on shape memory materials has a slow deformation speed and cannot meet the requirements of an adaptive structure [8].

If the material structure and shape of the honeycomb core layer are determined, the core layer structure can be treated as a laminate when designing the honeycomb core layer composite structure. The core layer is just another layer, and the thickness is the same as the height of the core layer. The core material of the skin's honeycomb is NOMEX honeycomb [9]. The closed wing box structure is composed of the skin and the beams and ribs of the wing. The skin of the wing box is mainly used for torsion, improving the torsional rigidity of the skin and making the skin with high damage and peeling resistance. It is covered by carbon fiber cloth. Fabric is the outermost layer of the T700 wing, and the carbon fiber cloth is composed of longitudinal fibers and transverse fibers. The main performance parameters of the composite materials used in the wing structure are shown in Table 1.

2.1.2. Stiffness Performance of Composite Laminates. The physical equations of laminates can be derived from the classical laminate theory of composite materials [10, 11]:

$$\left(\frac{V}{M}\right) = \begin{pmatrix} A & B \\ C & D \end{pmatrix} \left\{\frac{\chi}{\gamma}\right\}. \tag{1}$$

N is the resultant force array in the middle of the laminate; M is the resultant moment array in the middle of the laminate [12].

Since the lower wing panel mainly bears the tensile load, the tensile load-bearing capacity of the initial model of the open area can be calculated first. In order to explore other properties of the open-ended laminate, the stability load-bearing capacity and postbuckling load-bearing capacity of the structure are also calculated. Analyze the calculation result and use it as the design basis for the reinforcement scheme of the opening area. Tensile stiffness array of laminate A is as follows[13]:

$$A = \sum_{k=1}^{n} Q(Z_K - Z_{K-1}) = \sum_{k=1}^{n} Qh_K. \tag{2}$$

Laminated plate tension and bending coupling stiffness matrix B are as follows [14]:

$$B = \frac{1}{2}\sum_{K=1} Q\left(Z_K^2 - Z_{K-1}^2\right) = \sum_{K=1} QZHK + 1. \tag{3}$$

Among them, Z represents the distance between the middle surface and the middle surface of the k-th layer [15, 16].

The plies involved in this article are symmetrical and balanced pavement designs, and a reasonable pavement structure design that meets the requirements of structural rigidity, strength, and stability has been found.

2.2. Kriging Model. In this paper, the response surface method of Kriging model is applied to the optimization of the wing spar position, thereby improving the prediction accuracy of its response surface. In the Kriging model, the original unknown function can be expressed as follows [17]:

$$y(x) = f(x) + Z(x), \tag{4}$$

where $f(x)$ is an unknown function of x.

The predicted estimated value $y(x)$ of the response value $y(x)$ at the unknown vector x is given by the following formula [18, 19]:

$$\widehat{y}(x) = \widehat{\beta} + r^T(x)R^{-1}\left(y(x) - f\widehat{\beta}\right). \tag{5}$$

Table 2: Test protocol and results.

Test number	$W1$ /mm	$W2$ /mm	Wing tip deformation/mm	Maximum stress/MPa
1	320	190	19.551	184.11
2	280	190	11.836	126.1
3	360	190	11.92	122.07
4	320	223	23.011	173.84
5	280	223	15.327	121.21
6	360	223	16.614	101.76
7	320	256	22.55	183.54
8	280	256	13.633	76.959
9	360	256	15.613	91.109

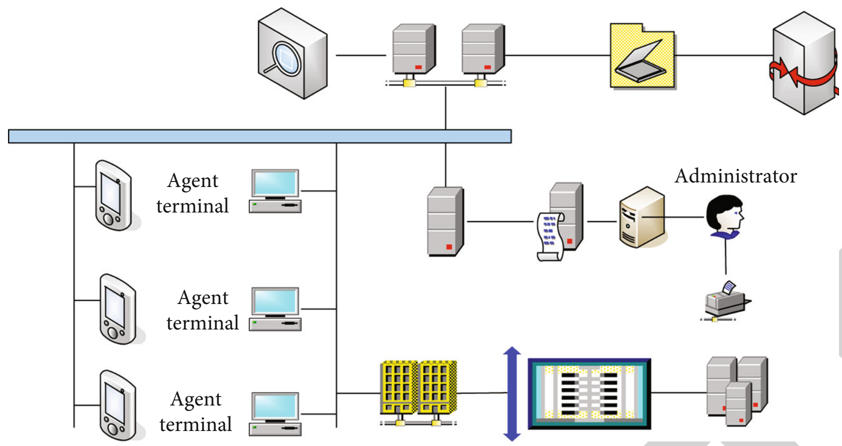

FIGURE 1: The integration process of genetic evolution.

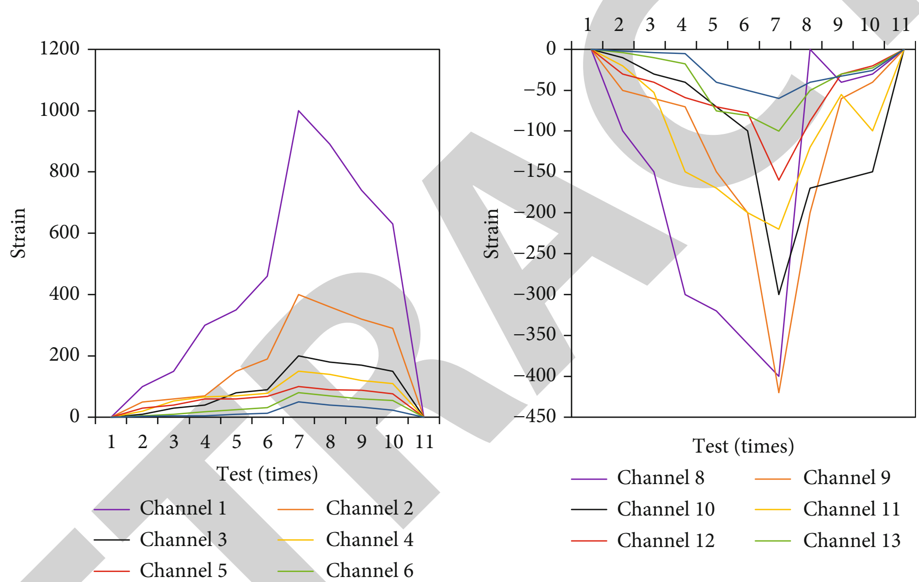

FIGURE 2: Strain of each test point.

Among them, $r^T(x)$ is the correlation vector between the unknown vector x of length n and the sample data [20].

$$r^T(x) = [R(x, x_1), R(x, x_2), R(x, x_3), \cdots, R(x, x_n)]^T. \quad (6)$$

From the narrative about the Kriging model, we can know that having a certain amount of sample data is the premise of establishing the Kriging model. When selecting samples in the entire design space, a limited number of samples should be used. It is possible to fully reflect the characteristics of the design space, which requires experimental design. There are many methods of experimental design, such as full factorial design and central composite design. This paper uses the central composite design method to arrange the response surface test, which is designed on three levels, and a total of 9 sets of parameter variables $W1$ and $W2$ are designed. The test plan and results are shown in Table 2.

2.3. Optimal Mathematical Model. Since changing the position of the spar has little effect on the quality of the wing, it is not considered here. Under the condition of meeting the strength requirements, the stiffness of the structure is selected as the objective function, which is measured by the deformation of the wing tip [21].

According to the constraints of the wing geometry size, the variation ranges of the parameter variables $W1$ and $W2$ are, respectively, taken as $280\,\text{mm} \leq W1 \leq 360\,\text{mm}$ and $190\,\text{mm} \leq W2 \leq 256\,\text{mm}$, and the optimized mathematical model can be described as follows [22, 23]:

$$\begin{cases} \min S(X) \\ |F|_{\max}(x) - 1 < 0 \\ X_i \leq X_n \leq X_k. \end{cases} \quad (7)$$

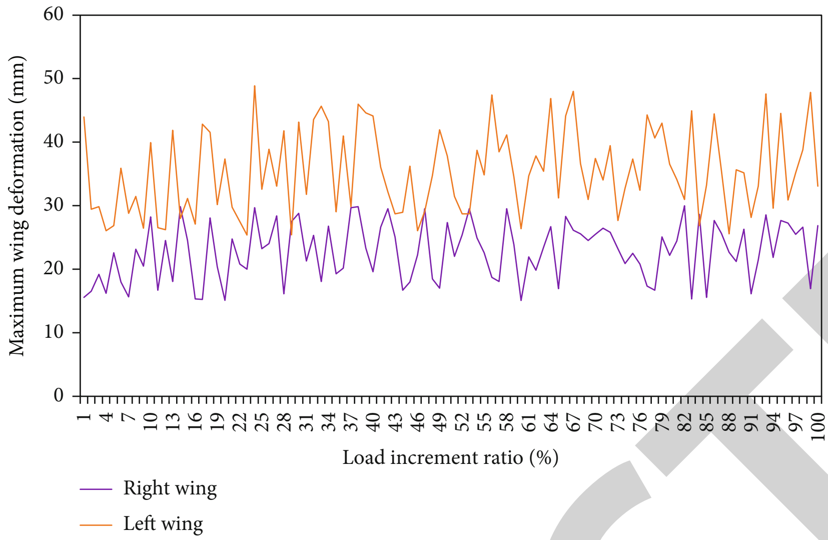

Figure 3: Left and right wing stiffness test.

Among them, S is the stiffness index. This paper selects the maximum deformation of the wing tip to characterize it; X_n is the position parameter of the spar; F is the failure factor of the wing structure [24].

2.4. Optimized Structure. ISIGHT can integrate various types of simulation software into a unified framework. The setting of input files and output files; the writing of the call commands of the process simulation software; the drawing, reading, and writing of parameters; the selection of design variables; and other comprehensive optimization algorithms create the entire design process to achieve generalization, automation, parameterization, and visualization, eliminating the limitations of conventional settings in the accounting process. ISIGHT has powerful postprocessing functions. Users can draw optimization process curves, output data tables, and generate analysis reports.

The ISIGHT software has the data interface of many mainstream engineering software, so it can fully realize the data transmission between various software. Using the ISIGHT software to integrate MATLAB and ABAQUS, a multi-island genetic algorithm for optimizing stack thickness is realized. First, use MATLAB to generate the layup information of the front and rear wing beams, and send the layup information. The results were imported into the ABAQUS software, and a finite element model was established for the calculation. The calculated structural quality, TSui-Wu damage coefficient, and maximum deformation displacement information are introduced by MATLAB, and selection and transfer operations are performed to generate the next generation of hierarchical information and then generate the next generation of genetic evolution. The integration process is shown in Figure 1.

2.5. Load Test. The design load test is a test to evaluate the ability of the test piece to bear the design load. In all major design cases, the load usually must be 100% of the design load. However, in the main structure, under the premise of ensuring the structural strength, a certain proportion of the initial design load can be load tested on a part of the design case. For each main design case, when the test load exceeds the use load test, the load needs to be adjusted in stages according to an increment of less than 5% of the design load at each stage, as well as strain, displacement, and damage. The test parts must be measured and recorded periodically. The test piece can bear 100% of the design load, and the structure will not be damaged for at least 3 seconds under 100% of the design load.

3. Optimization Results of Composite Wing Structure of DF-2 Light Sports Aircraft

It can be seen from the curve shape of Figure 2 that when the titanium alloy joint is subjected to the maximum load, the strain at each test point will not change, but will change linearly. After the load is completely removed, the strain will all return to zero. Observe all the distortion curves and obtain the maximum distortion curve of the curve corresponding to each 10 channels; the maximum value is 1019 $\mu\varepsilon$. The position of the tenth strain gauge is the connection structure between the wing and the fuselage at the wing beam. According to calculations, the stress value at this point is 1088 MPa. Therefore, the maximum stress is all less than 42.73 MPa. Because the tensile strength of the titanium alloy is 900 MPa, it can be seen that all the measurement points meet the strength requirements of the titanium alloy. Moreover, the finite element simulation data, the contrast test data, and the finite element simulation of the stress value of 10~131 MPa are much larger than the actual test data. This is the result of finite element simulation analysis and contact. The use of components to establish bolted connections has stress concentration, and the finite element simulation error is very large. Therefore, in the connection of the titanium alloy, the maximum stress value of the composite material and the titanium alloy that reaches 1079 MPa is a big error. Combined with the previous engineering design experience, the structural design here will

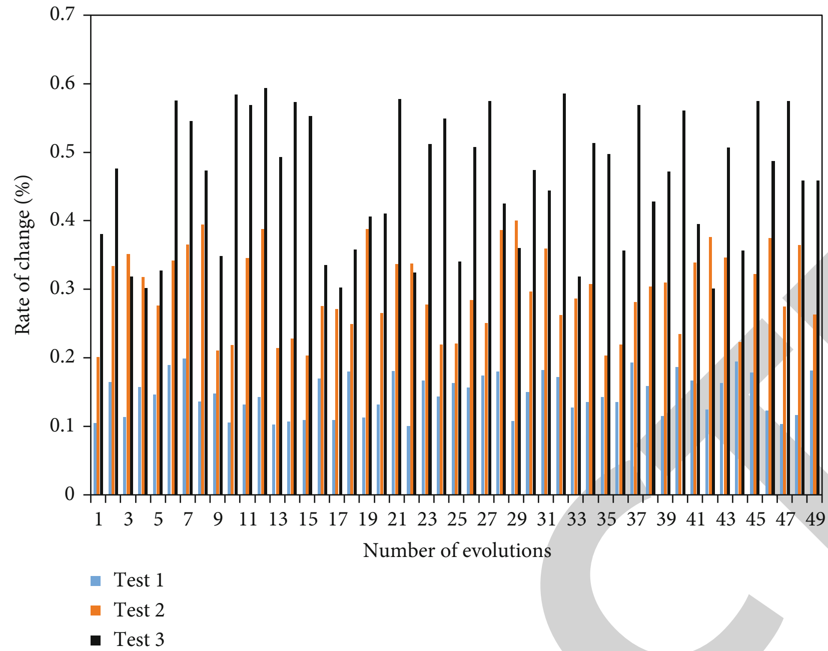

Figure 4: Evolutionary process.

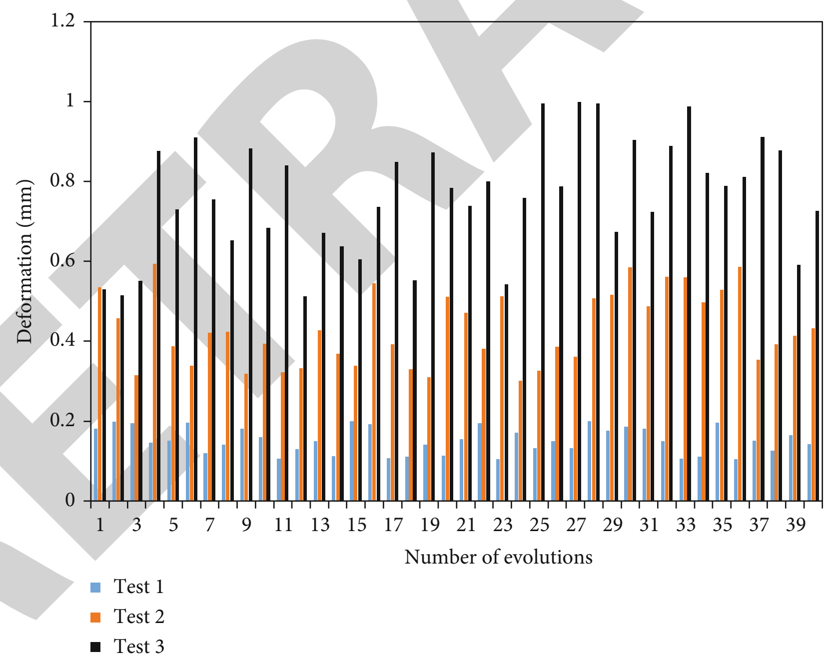

Figure 5: The evolution process of laminate ply angle optimization.

not fail but can meet the strength requirements. The strain of each test point is shown in Figure 2.

It can be seen from Figure 3 that the deformation curves of the left and right wing ends are quite different. When the test load is applied in stages, the left and right wing ends often have a deviation of about 20 mm. This is mainly due to the error of the measurement position selected by the test operator during the measurement process and the unstable initial configuration. The maximum deformation of the blade obtained by finite element simulation is 96.519 mm. The maximum deformation error and simulation data of the left and right wings are 16.81% and 8.39%, respectively. Since the test data and simulation data are both above 180 mm, the rigidity of the wing structure is very high, which meets the conditions. The left and right wing stiffness test is shown in Figure 3.

After 10 generations of genetic evolution, the 753th evolutionary individual in the eighth generation was found

Table 3: Hierarchical optimization results of wing structure.

	Parameters before optimization	Parameters after optimization
Beam ratio 1	0.3	0.32
Beam ratio 2	0.75	0.78
Beam ratio 3	0.3	0.27
Beam ratio 4	0.75	0.86
Beam 1 width (mm)	15	15.21
Beam 2 width (mm)	15	14.23
Rib 1 (mm)	300	267.21
Rib 2 (mm)	600	576.34

Table 4: The height record of the root and tip of the wing at both ends of the wing during the test.

Load	Left wing tip height	Left root height	Left wing difference	Right wing tip height
10% load	253.98	214.46	39.52	241.8
20% load	267.9	216.88	51.02	245.28
30% load	273.6	218.54	55.06	254.22
40% load	275.5	211.56	63.94	256.2
50% load	284.68	212.8	71.88	258.42
60% load	291.62	214.58	77.04	265.00
70% load	294.00	208.46	85.54	268.38
80% load	299.02	208.28	90.74	272.82

to meet the design requirements and the lowest quality individual. The layer thickness information expressed is as follows: the variable cross-section area of the front beam 1-7 is 6/4/2/2/2/2/2, and the variable cross-section area of the rear beam 1-7 is 8/4/4/2. The weight of the wing structure decreased from 0.966 kg to 0.803 kg, a decrease of 16.87%. The evolution process is shown in Figure 4.

The angle optimization of the laminate ply adopts the same method as the thickness optimization, and the evolution process is shown in Figure 5.

Through the first-level optimization of the beam and rib layout and the second-level optimization of the composite material ply, the structural mass is reduced from 1.173 kg to 0.803 kg, and the mass is reduced by 31.54%. The maximum deformation displacement of the structure changed from 34.49 mm to 40.95 mm, an increase of 18.7%. The failure factor of Tsai-Wu changed from 0.512 to 0.472, a decrease of 7.8%. Through the grading optimization study of the wing structure, a good weight reduction effect has been achieved under the premise of meeting various design indicators. The hierarchical optimization results of the wing structure are shown in Table 3. The Tsai-Wu criterion will be applied to determine the safety factor for composite orthotropic shells. This criterion considers the total strain energy (including distortion energy and expansion energy) for predicting failure.

During the test, the record of the height of the wing root and wing tip at both ends of the wing during the test is shown in Table 4. The data in the table is plotted against the aforementioned analysis data. Since this test is a load test, the design load (150% use load), 87.2 mm of the analysis result is converted into the use load result, and the resulting deformation is 58.1 mm. Therefore, the error of the test and analysis results is 3%, which is considered acceptable within the scope of the project, and neither of them exceeds the overall required value.

Quantitative analysis method is a method for analyzing the quantitative characteristics, quantitative relationships, and quantitative changes of social phenomena. The quantitative analysis model method is used to model and analyze the two structural types of beam configuration and monolithic configuration. With the shape parameters as the initial conditions, the mathematical analysis model is constructed, and the weight of the wing structure under different loads is obtained by changing the value of the load. The relationship curve with load is shown in Figure 6. The load density at the root of the wing is 1357 N/mm. It can be seen from Figure 6 that the monolithic configuration is selected at this load level, and the weight of the wing structure is lighter.

4. Discussion

After the outer panel and the number of positions of the composite wing are fixed, the components need to be assembled. However, most of the initial researches on the manufacturing process of composite wings mainly focus on the design, molding, and performance testing of composite parts. There is almost no research on the assembly process of composite parts, especially the assembly of composite parts. The structural optimization technology of composite materials refers to engineering application technologies that improve the rigidity, strength, and stability of fiber-reinforced resin matrix composites by optimizing layer shape, ply angle, and other layer information. As the proportion of aircraft structural composite materials increases, the assembly of aircraft composite structures will account for an increasing proportion of aircraft assembly. New assembly tools must fully consider the structural characteristics of composite materials, combined with new technologies such as flexibility and reconstruction, and improve the quality and efficiency of assembly during the design process. Different load-bearing levels will affect the choice of wing structure and the internal configuration of the wing structure. Before explaining the influence of different load levels on the wing structure layout, the single wing load level range must be defined. The typical stress modes of various wing structures are beam type, monolithic type, and multiwall type. Based on the above analysis, the choice of wing structure mainly affects the rigidity and stability

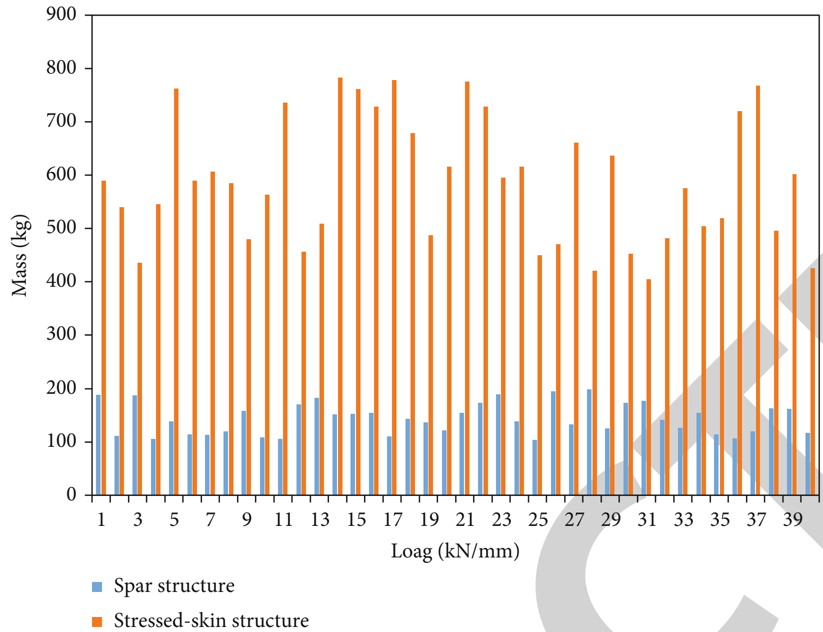

Figure 6: The relationship between the weight of the wing structure and the load under different loads.

of the wing structure. In the assembly process, it is necessary to repeatedly optimize the assembly sequence to find a suitable assembly process to ensure the adjusted assembly of the chassis. In addition, due to the limitations of natural material forming processes and methods, compared with metal components, the manufacturing geometric accuracy of composite components is not easy to control and can be assembled due to large rigidity, brittle matrix, and weak interlayer strength. The deformation is very small, and it is generally not allowed to drop, and it is difficult to correct the assembly gap. These all show the high components of composite components [25, 26].

The connection design and strength analysis of composite structures are different from those of metal structures. The influencing factors of composite material structure are much more complicated than the influencing factors of metal structure, and the damage mechanism is essentially different from the influencing factors of metal structure. Regarding the metal connection, according to the plasticity of the metal material, the load can be redistributed to the multinail connection, and the force of each nail element becomes uniform. After confirming the connection strength of the nail elements, each nail element is loaded. However, composite materials are brittle materials with small plastic deformation, multiple nail connections, and large difference in load distribution of nail elements. In addition, the nail holes in the connecting parts of the composite material cut off the reinforcing fibers, resulting in a complicated stress distribution and a more serious stress concentration problem at the end of the hole. There are various types of combinations of wing separation surfaces. Therefore, it is necessary to comprehensively consider the overall structural characteristics and determine the appropriate power transmission path according to the link components such as the beam edge between the wing segments and the long truss configuration. There is a unified design of the connection method of the wing separation surface, which largely depends on the designer's design experience [27].

Composite materials are widely used in aerospace and completely replaced metals in some fields such as wind power blades. Carbon fiber reinforced composite material (CFRP) has the advantages of high specific strength, high specific rigidity, and high heat resistance, so it is widely used in ultra-high-speed aircraft. Due to corrosion resistance, fatigue resistance, and design, composite materials can be used in complex environments such as plains, plateaus, and the sea. The working hours and maintenance intervals become longer, and they can play an irreplaceable role in some areas such as forwards. Compared with the traditional optimization method, the optimization method adopted in this paper has a series of optimization characteristics, including generalization, automation, parameterization, and visualization. For complex design variables such as panel and number of bits, the platform can be optimized at the same time. The optimization results show that the structural quality is reduced, the strength and rigidity are improved, and the optimization efficiency of the composite material is improved. This research includes finite element theoretical research on laminated plate structure and honeycomb sandwich structure. The typical structure of the composite wing, such as the main beam, will be analyzed and optimized according to the general requirements of the engineering field [28, 29].

The extensive use of composite materials in the aviation field actually brings many possibilities to the structural design of aircraft. This is because, compared with metal materials, composite materials have higher strength and higher designability. The wing layer has orthotropic anisotropy, and the structural characteristics are determined by the angle and order of the layers. In the past, the aircraft manufacturing and assembly process, the number of tools, the size, and the diversity all have the disadvantages of high cost and a lot of labor costs for disassembly and assembly. To cooperate with automated robotic mining systems, reconfigurable, low-cost design, and manufacturing technologies are required. The positioning configuration adopts a modular design, which can complete the positioning of the dynamic module and modify the mode of the dynamic module by moving various dynamic modules. This technology is very important for reducing costs and achieving flexible assembly.

According to the anisotropy and unevenness of the lamination of the composite material, the longitudinal and transverse characteristics are completely different, and the tensile characteristics and compression characteristics are also different. According to the anisotropy, the direction of each layer of the composite material can be adjusted at will, personalized design according to various structures and uses, and the elastic properties and strength properties of the material can be adjusted according to various needs to obtain the best structural effect. The deformable aircraft can change its shape according to different flight conditions, so it can obtain the best performance in the entire flight process. The outer panel of a deformable aircraft can not only deform with the structure but also needs to withstand the air load. Foaming material is a new type of composite material using fuel gas filler. There are many types of foam materials, but they generally have the following characteristics: light weight, material saving, low thermal conductivity, excellent heat insulation performance, excellent sound insulation effect, impact load absorption, excellent cushioning performance, and high strength.

With the intensification of market competition, the aviation industry has undergone fundamental changes in the performance and cost of aircraft design concepts. Aircraft designers and manufacturers have begun to focus on ways to reduce aircraft costs to obtain higher performance, and as a result, they have carried out aircraft design. In addition to considering the aerodynamic shape and structural weight, manufacturing possibilities, manufacturing costs, and other factors must also be considered. The final decision of the design plan not only considers the mechanical point of view (aerodynamic characteristics and structural characteristics) but also considers whether the structure is easy to manufacture and whether it can accept manufacturing costs and other factors. According to the final design plan, factors such as aerodynamics, structure, manufacturing possibilities, and manufacturing costs are comprehensively balanced. The use of smart materials and structures can realize the configuration and reorganization of the aircraft during flight and obtain the best air performance. In the future, airplanes can fly like birds, and intelligently deformed airplanes are an important direction for future development of airplanes. The deformable aircraft can be adapted to various flight conditions by changing its configuration to achieve the best overall performance. Deformable technology, high energy density drive technology, and adaptive construction technology are still the main technologies for realizing deformable aircraft [30].

5. Conclusion

This article first introduces the main types of wing structures and the design characteristics of composite materials and then summarizes the main methods of modern wing structure selection and design and proposes a quantitative analysis model method that combines force transmission analysis with finite element. According to the force transmission characteristics of different components, a specific construction method that is different from the construction standard of the quantitative analysis model is provided. Next, a quantitative analysis model of the beam configuration and the monolithic configuration is constructed, and the load-weight characteristic curve of the structure is displayed. The box section simulation process restores the actual stress distribution of the wing structure through multiple modeling analyses. The calculation formula for important elements of the stability of the box segment has been optimized to ensure the accuracy of the calculation results. On this basis, through the strength analysis of the wing structure, the classification method, the optimized size layout of the wing structure, and the optimization process analysis and comparison of the structural efficiency of the design schemes, the best design of the wing can be completed quickly and accurately structure. This article did not study the ply sequence and ply optimization of composite laminate structure or sandwich structure. In the future, it should be combined with related theories and algorithms to make the structure design more perfect.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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