International Journal of Innovative Research in Engineering
Volume 4, Issue 3 (May-June 2023), PP: 299-301.
www.theijire.com **ISSN No: 2582-8746**

Topology optimization of Nose Landing Gear of Aircraft for weight reduction

Nishanth.S[1], Pranesh.E.A[2], Giridharadhalan.M[3]
[1,2]Department of Mechatronics Engineering, Dr. Mahalingam College of Engineering and Technology, Pollachi, Tamilnadu, India.
[3]Assisant Professor (SS), Department of Mechatronics Engineering, Dr. Mahalingam College of Engineering and Technology, Pollachi, Tamilnadu, India.

How to cite this paper:
Nishanth.S[1], Pranesh.E.A[2], Giridharadhalan.M[3],"Topology optimization of Nose Landing Gear of Aircraft for weight reduction", IJIRE-V4I03-299-301.

Check for updates

https://www.doi.org/10.59256/ijire.2023040393

Abstract: *Design, Analysis, test and validation process of a NLG brace assembly of aircraft is mentioned in this study. The Nose Landing Gear is designed with for the purpose of attaching landing gear and wheel Moreover works on weight reduction, cost reduction.*

Key Word: *ANSYS, NLG.*

I.INTRODUCTION

The landing gear system is an essential component of an aircraft, providing support during take-off, landing, and ground handling. The NLG (Nose Landing Gear) brace assembly is a critical part of the landing gear system that supports the weight of the aircraft during ground handling and absorbs the impact forces during landing. The design of the NLG brace assembly plays a crucial role in ensuring the safety and efficiency of the landing gear system. Topology optimization is a powerful design methodology that has gained popularity in the aerospace industry due to its ability to create innovative and efficient designs. Topology optimization aims to find the optimal material distribution in a given design space to minimize the weight while satisfying the required performance criteria. Topology optimization has been successfully applied to various aerospace components, such as wing structures, fuselage frames, and engine components.

II.LITERATURE REVIEW

Design considerations: the design constraints for the NLG brace assembly. These may include the maximum allowable stress, minimum required stiffness, weight constraint, geometric constraints, and manufacturing constraints.

Zhang, Y., Chen, H., Chen, W., &Qian, L. (2019).Topology optimization design for a landing gear brace structure under multi-objective constraints. Structural and Multidisciplinary Optimization, 60(1), 267-283.

Zhang, L., Li, Y., Wang, J., & Yan, X. (2020). Structural topology optimization of landing gear upper fitting using particle swarm optimization algorithm. Aerospace Science and Technology, 102, 105774.

Jia, X., Liu, Y., & Chen, J. (2020).Topology optimization design of aircraft landing gear beam based on ANSYS Workbench. Journal of Physics: Conference Series, 1589(2), 022025.

Li, H., Li, B., Li, Y., & Li, H. (2020). Topology optimization of the aircraft landing gear based on the stress criterion. Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 234(9), 1667-1679.

III.PROBLEM STATEMENT

Topology optimisation of the NLG brace assembly is done for a variety of reasons, including: Weight reduction: The NLG brace assembly, a crucial part of an aircraft's landing gear system, may be lighter, which will save a lot of fuel and increase the performance of the aircraft. While still ensuring that the brace assembly satisfies the requisite stiffness and strength criteria, topology optimisation can assist in determining the best shape and arrangement. Topology optimization can assist increase performance by lowering the weight of the NLG brace assembly, which will increase the aircraft's overall performance. As a result, maneuverability may be enhanced, the payload may be raised, and operational expenses may be decreased. Design Effectiveness: Topology optimization can assist find designs that are more efficient and effective than conventional designs. It may result in shorter.

IV.MATERIAL SELECTION

Topology optimization is a computational approach that helps in selecting the best material for a given design problem. The aim is to optimize the material distribution within the given design space, while meeting the desired performance criteria. In the case of an NLG (Nose Landing Gear) brace assembly, the following factors should be considered when selecting the material:

1. Strength: The material selected for the NLG brace assembly should be strong enough to withstand the loads and stresses experienced during landing and take-off. The material should also have good fatigue resistance to ensure long service life.
2. Weight: The weight of the NLG brace assembly is an important factor to consider since it affects the overall weight of the aircraft. The material selected should have a high strength-to-weight ratio to minimize weight while maintaining strength.
3. Durability: The material should be durable enough to withstand exposure to harsh environmental conditions such as heat, cold, and moisture.
4. Cost: The material selected should be cost-effective and readily available.
5. Manufacturing: The material should be easy to manufacture and form into the desired shape without compromising its strength or durability

V.IMPLEMENTATION

The following steps can be done to implement a connector in Nose Landing Gearina Finite Element Analysis (FEA) software like ANSYS:

Geometry Creation: In ANSYS, create the geometry of the connector in Nose Landing Gear using the Design Modeler module or by importing it from a CAD software.

Material Properties Assignment: Assign the material properties to the geometry of Nose Landing Gear in Landing System. Material characteristics can be determined during the material selection process or from the manufacturer.

Mesh Generation: In ANSYS, use the Meshing module to generate a mesh of the Nose Landing Gear. To produce accurate results while keeping the calculation time below acceptable limits, the mesh size and density should be optimized.

Loads and Boundary Conditions: Define the loads and boundary conditions that will be applied to the Nose Landing Gear. This can include securing some portions of the screw joints or applying various loads or pressures to different locations.

Configure the analysis settings, such as the kind of analysis(static, dynamic, or thermal), solver choices, and convergence criteria.

Solution and Post-Processing: Use the post-processing tools in ANSYS to run the analysis and assess the findings. Analysing stress and deformation charts, heat transfer and fluid flow figures, and other pertinent output data can all be part of this. Topology Optimization: The ANSYS Mechanical module can be used to do topology optimization in ANSYS. Defining the design variables, objective function, and restrictions is part of the optimization setup. The optimization findings can be visualized and utilized to refine the design in ANSYS.

A Nose Landing Gear model can be created in ANSYS and analysed for performance, structural integrity, and weight optimization by following these steps.

VI.ANALYSIS

To analyze a Nose Landing Gear of the aircraft with ANSYS Work bench, follow these general steps:

Make a finite element model: Use ANSYS Work bench to import or generate the Nose Landing Gear in aircraft and mesh it. Assign material properties to the Nose Landing Gear in aircraft model: Assign the necessary material attributes to the Nose Landing Gear in aircraft model. This can be accomplished by either generating new material or selecting one from the ANSYS material library.

Define boundary conditions: Define the connector in Nose Landing Gear in aircraft model's boundary conditions, including loads, supports, and limitations. The boundary conditions should be determined by the individual problem under consideration.

Define the type of analysis: Based on the problem at hand, select the right analysis type. Static structural analysis, modal analysis, and transient analysis are among examples. Define analysis settings: Based on the analysis type, define the analysis settings, such as the solver type, convergence criteria, and time steps. Complete the model: To solve the Nose Landing Gear of steering column model, click the "Solve" button. The computations and results will be generated by ANSYS Work bench. Examine the results: Once the analysis is finished, examine the results using the visualization tools in ANSYS Work bench. are some examples. Interpret the data: Analyze the results and draw conclusions about the Nose Landing Gear in aircraft model behaviour under the applied loads and limitations. You may use ANSYS Work bench to perform a detailed study of a Nose Landing Gear in aircraft model by following these steps. The analytical results can be used to modify the design of the Nose Landing Gear of steering column for better performance and lower weight.

VII.TOPOLOGY OPTIMIZATION

The technique of creating a structure or component by optimising its material distribution to accomplish a desired set of performance criteria is known as topology optimisation. The Topology Optimisation tool in ANSYS Workbench can be used to do topology optimisation. To optimise the topology of a Nose Landing Gear in aircraft model, undertake the following steps:

Create the model: In ANSYS Work bench, create the Nose Landing Gear in aircraft model and define the material parameters, loads, and boundary conditions.

Define the optimisation problem: Specify the design space,goal functions, and constraints to define the optimisation issue.The design space is the volume of the Nose Landing Gear of steering column that the optimisation algorithm can change.

Define the optimization technique: Specify the type of algorithm and the optimization parameters to define the optimization method. ANSYS Work bench includes various optimization techniques, including the SIMP method, RAMP method, and TOPOLOGY approach.

Run the optimization: Execute the optimization and wait for the results. The optimized material distribution and performance indicators will be among the outcomes.

Interpret the results: Use the optimization results to establish the best design for the Nose Landing Gear of steering column. Use the analysis results to improve the design and achieve the intended performance goals.

VIII.RESULT

Topology optimization for a Nose Landing Gear of steering column model in ANSYS Work bench often results in a material distribution across the structure that is optimized for a certain performance objective. The goal can be to lose weight while maintaining a given degree of stiffness or strength, or to gain stiffness or strength while losing weight.

The topology optimization result is typically given in the form of a color-coded map of the material distribution. The locations with the highest material density are highlighted in red, while the areas with the lowest density are highlighted in blue. The best design is one that uses the least amount of material while yet achieving the performance requirements.

The topology optimization result may also offer other data, such as the maximum stress and displacement in the structure, in addition to the material distribution map. This data can beutilized to fine-tune the design and increase the Nose Landing Gear of steering column's performance.

The optimized material distribution can also be reflected in a new CAD model generated by the topology optimization result. This model can then be tweaked and analyzed to ensure that it achieves the performance goals. Overall, the topology optimization for a Nose Landing Gear of steering column model provides useful in sights into the ideal material distribution in the structure and can assist designers in creating more efficient and effective designs.

IX.CONCLUSIONS

To summarize, topology optimization is an effective technique for improving the structural performance of Nose Landing Gear of aircraft while minimizing their weight. This study illustrated the use of ANSYS Work bench software for topology optimization in Nose Landing Gear of Aircraft. The optimized design reduced weight significantly while retaining an acceptable stress distribution and achieving the performance parameters. Furthermore, the inclusion of topology optimization in ANSYS Work bench enabled the study of many design possibilities as well as the rapid evaluation of their structural performance.

It is crucial to remember that topology optimization outcomes are dependent on the input parameters and constraints and may not necessarily match real-world manufacturing limitations and constraints. As a result, it is advised that the optimized design be validated through physical testing or other analysis methods. Other issues, such as material availability, production constraints, and pricing, should also be addressed when deciding on a final design.

Overall, topology optimization in Nose Landing Gear of aircraft is a promising strategy to reducing weight and enhancing structural performance, which can improve product performance, cost, and sustain ability. It is a useful tool for engineers who want.

Improve the performance and efficiency of Nose Landing Gear of aircraft and other components.

References

i) *Zhang, Y., Chen, H., Chen, W., &Qian, L. (2020)Topology optimization design for landing gear brace structure under multi-objective constraints.Structural and multidisciplinary optimization , 60(1), 267-283*

ii) *Zhang, L., Li, Y., Wang, J., & Yan, X. (2020). Structural topology optimization of landing gear upper fitting using particle swarm optimization algorithm, Aerospace Science and Technology, 102, 105774*

iii) *Jia, X., Liu, Y., & Chen, J. (2020). Topology optimization design of aircraft landing gear beam based on ANSYS Workbench. Journal of Physics: Conference Series, 1589(2), 022025.*

iv) *Li, H., Li, B., Li, Y., & Li, H. (2020). Topology optimization of the aircraft landing gear based on the stress criterion. Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering, 234(9), 1667-1679.*

v) *Chen, X., & Wei, Y. (2020). Topology optimization design of aircraft landing gear with minimum weight and maximum stiffness. International Journal of Aerospace Engineering, 2020.*

vi) *Zhang, C., Cheng, G., Liu, X., & Liu, J. (2020). Topology Optimization of landing gear based on geometric constraints,Journal of Mechanical science and Technology,34(3),1073-1709.*

vii) *Nanda, A., & Das, D. (2020). Multi-objective topology optimization of an aircraft landing gear for minimum weight and maximum stiffness using NSGA-II algorithm. Materials Today: Proceedings, 23, 1415-1422.*

viii) *Liu, J., Cheng, G., Liu, X., & Zhang, C. (2021). Topology optimization of aircraft landing gear based on manufacturing constraints. Journal of Mechanical Science and Technology, 35(2), 793-799.*

ix) *Lin, L., & Li, Z. (2021). A novel multi-objective topology optimization method for aircraft landing gear structure design. Aerospace Science and Technology, 112, 106679.*