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# Design and Analysis of Nylon66 Ceiling Fan Blade Using Finite Element Method

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***Abstract*- The main objective of this paper work is to look into the fundamental issues regarding fan blade design and develop a new, easy to use software program that would allow for optimal, flexible blade designs. In this design of fan blade, material converted from existing aluminum into Nylon66. Fan blade design procedure for an optimum result according to FEM theory is performed. The designed blade shape is modified such that modified blade will be light in weight and less costly from existing blade material. In order to reduce the cost of product by selecting Nylon66.[1][2] The new designed blade thickness is increased from existing aluminum blade. It is seen that after increasing the thickness of plastic Nylon66 blade from 1mm, 1.5mm & 2mm with angular velocity of 10.47, 20.98 & 39.79rad/s, the deformation and stress are change. With the help of FEM, it finds the optimum results and also compare with existing blade results. The effects of results are evaluated with aluminum to Nylon66 material properties.**

***Keywords*-** *Nylon66 Fan Blade, Design and Analysis, FEM.*

## I. Introduction

A ceiling fan is a mechanical device, which is generally run by electric power, suspended from the ceiling of a room. That uses hub mounted rotating blades to circulate air. The basic application of ceiling fan is to circulate the air inside the room. Due to lack of natural resources (metals like Aluminum), it can be replace by other the material like Nylon66 which is less costly compared to aluminum.[10]

In recent years, a best method, the finite element Numerical analysis, has been developed for the analysis of complicated parts, structures etc.[5] For designing, dimensions are measured with the help of existing blade dimensions by using vernier caliper, micrometer and different measuring instruments. A CAD model is prepared with the help of CATIA software.[1] This model imports in ANSYS software. There has been considering properties like Young's modulus, Density & Poisson ratio of both the materials. Results are in terms of deformation and stress induced in blade due to self weight and different angular velocity. After finding the results compare with aluminum to nylon66. But with same thickness results are not satisfied therefore increase in thickness of nylon66 blade and results found. These results are comparatively better than previous. So it can be possible to replace with plastic nylon66.[3] The material used for ceiling fan blade must have corrosive resistance, show good resistance to shock and a good dimensional stability.

| Material | Density ($kg/m^3$) | Young modulus ($N/mm^2$) | **Poission Ratio** |
|---|---|---|---|
| Nylon66 | 1130 | 2800 | **0.39** |
| Al | 2700 | 70000 | **0.33** |

*Table 1.1 Comparison of Properties of Nylon66 & Al*

**Nylon 66** - Nylon is a thermoplastic, Nylon 66 (polyhexamethylenediamine adipamide) is a polyamide made from adipic acid and hexa methylenediamine by

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polycondensation. The resulting polymer is extruded into a wide range of fiber types. The fibers are drawn, or stretched, in a process that increases their length with reduces their diameter and reorients the material's molecules parallel to one another to produce a strong, elastic pigments. The thermo-plasticity of nylon permits permanent deformation of the fibers and provides strength and plastic properties.[4]

Nylon 6-6, also referred to as nylon 66. Nylon comes in many types, the two most common for plastics industries and textile are: Nylon 6 and Nylon 66.

Polyamides known as nylons are crystalline engineering thermoplastics having high performance characteristics such as high melting point, high strength, ductility, and excellent resistance to abrasion and fatigue.[7]

Nylon was projected to be a synthetic substitute for metal as well as substituted for it in many different products with enhanced properties.[6] It replaced silk in armed forces applications such as parachutes, and was used in many types of vehicle parts. Nylon fibers are used in many different applications, including fabrics, carpets, musical strings, and rope.

Solid nylon is used for replacement of mechanical parts such as machine screws, gears and lever other low- to medium-stress apparatus formerly cast in metal. Engineering-grade nylon is processed by extrusion, and injection molding. It is also used in domestic appliances. Nylon was the first commercially successful synthetic polymer.

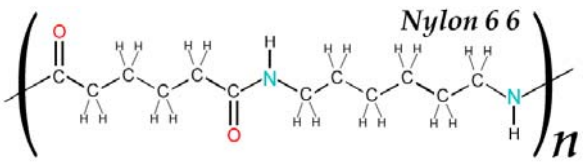


*Fig. 1.1 Chemical Formula of Nylon66*

There are two common methods of making nylon for fiber applications. First approach, molecules with an acid (COOH) group on each end is reacted with molecules containing amine ($NH_2$) groups on each end. The resulting nylon is named on the basis of the number of carbon atoms separating the two acid groups and the two amines. These are formed into monomers of intermediate molecular weight, which are then reacted to form long polymer chains.[9]

## PHYSICAL PROPERTIES

1. Nylon 66 has a melting point of 265°C for fiber, and most resistant to heat and friction.
2. Its long molecular chain results in more sites for hydrogen bonds, creating chemical "springs" and making it very hard-wearing.
3. It has a dense structure. This means that nylon 66 is difficult to dye, but one time dyed it has superior color and good in appearance.

## CHARACTERISTICS

1. Nylon has the ability to be very good lustrous,
2. It has good durability and long life,
3. High elongation,
4. Excellent abrasion resistance,
5. High resistance to insects, fungi, animals, as well as molds,
6. It can be recycled.

**FEM** - The finite element method (FEM) is a numerical technique for solving approximate solution of partial differential equation (PDE) as well as integral equation.[8] The solution approach is based either on eliminating the differential equation completely (steady state problem), or representation the PDE into an approximation system of ordinary differential equation, which are then numerically integrated using standard technique such as Euler's method, Runga-kutta, etc.

**ANSYS,** is an engineering simulation software (computer-aided engineering, or CAE) developer that is headquartered south of Pittsburgh in the South pointe business park in Cecil Township, Pennsylvania, United States.

ANSYS was listed on the NASDAQ stock exchange in 1996. In late 2011, ANSYS received the highest possible score on its Smart Select Composite Ratings according to Investor's Business Daily. The organization reinvests 15 percent of its revenues each year into research to continually refine the software.

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**CATIA V5 – CATIA (Computer Aided Three-dimensional Interactive Application)** is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systemes. CATIA **V5** is modeling software, is used for preparing a model of engineering parts and equipments etc.

## II. METHODOLOGY

In this project work, a 3D model of fan blade have been considered for further investigation .The field data obtained by actual experimental data have been compared with numerical simulation results by using ANSYS software.

For modeling of blade the CAD model is prepared. Nylon66 is generally used for making industrial and domestic product. The following figure shows the fan blade which has to be modeled to perform static analysis and compare the numerical simulations with the available data.

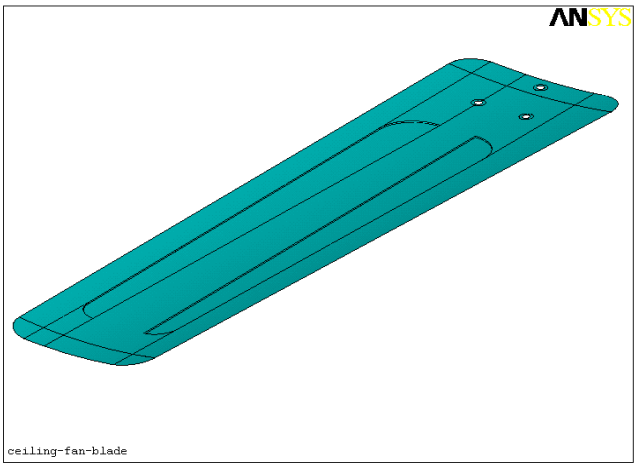


*Fig. 2.1 CAD model of Ceiling Fan Blade*

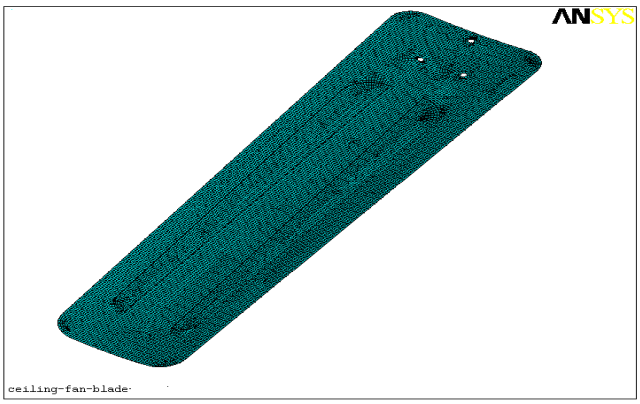


*Fig. 2.2 Meshing of Ceiling Fan Blade*

## III. EXPERIMENTAL

| Blade Material | Weight (kg) | Deflection/ deformation (mm) | Stress (MPa) |
|---|---|---|---|
| Aluminium (thick-1mm) | 0.156 | 1.395 | 11.848 |
| Nylon66 (thick-1mm) | 0.0656 | 14.509 | 5.153 |
| Nylon66 (thick-1.5mm) | 0.0984 | 12.052 | 4.523 |
| Nylon66 (thick-2mm) | 0.131 | 10.369 | 4.078 |

*Table 3.1 Angular velocity (ω) 10.47 rad/s and self weight at 100 rpm*

| Blade Material | Weight ( kg) | Deflection/ Deformation ( mm) | Stress (MPa) |
|---|---|---|---|
| Aluminium (thick-1mm) | 0.156 | 1.413 | 11.917 |
| Nylon66 (thick-1mm) | 0.0656 | 14.703 | 5.187 |
| Nylon66 (thick-1.5mm) | 0.0984 | 12.207 | 4.519 |
| Nylon66 (thick-2mm) | 0.131 | 10.503 | 4.05 |

*Table 3.2 Angular velocity (ω) 20.94 rad/s and self weight at 200 rpm*

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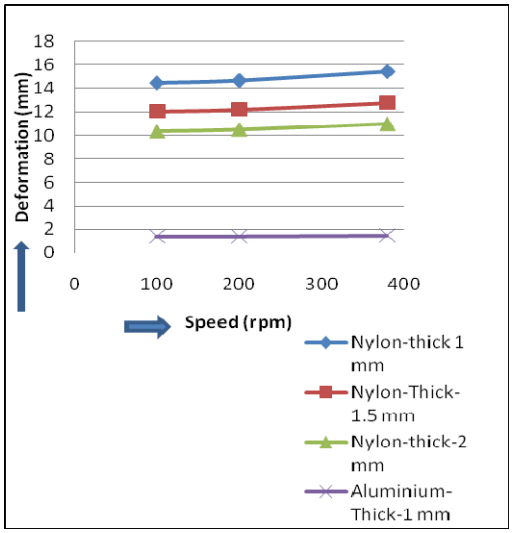
| Blade Material | Weight (kg) | Deflection/ deformation (mm) | Stress (MPa) |
|---|---|---|---|
| Aluminium (thick-1mm) | 0.156 | 1.481 | 12.306 |
| Nylon66 (thick-1mm) | 0.0656 | 15.434 | 5.36 |
| Nylon66 (thick-1.5mm) | 0.0984 | 12.756 | 4.707 |
| Nylon66 (thick-2mm) | 0.131 | 10.968 | 4.304 |

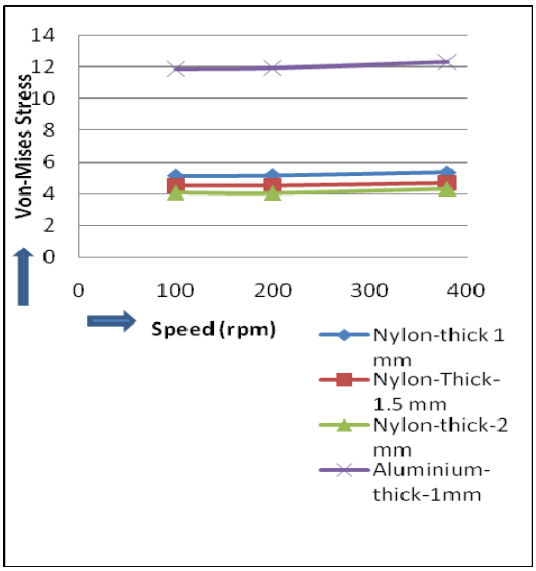
*Table 3.3 Angular velocity(ω) 39.79 rad/s and self weight at 380 rpm*

## IV. Results and Discussion:

After performing test in ANSYS software these results are obtained. It has been concluded by graphical representation with varying thickness of Nylon66 plastic blade and its effects in terms of stress induced, deformation.




*Graph 4.1 Speed v/s Deformation*




*Graph 4.2 Speed v/s Stress*

## V. Conclusion

Overall good result level has been obtained with the Aluminium and Nylon66, with the experimental analysis in different speed and thickness in FEA software ANSYS. Nylon66 is an ideal replacement for Aluminum. For weight reduction, comparable strength/mass, chemical resistance, hardness, and low cost.Nylon66 most comparable in strength, yet lighter and more cost effective than Aluminium.

The work is still carried further to enhance the various mechanical parts with different plastic polymers. This impact modified polyamides can be suitable for many engineering & metal replacement applications.

## VI. References

1. Mahajan Vandana N.,* Shekhawat Sanjay P. Analysis Of Blades Of Axial Flow Fan Using Ansys, Research Article, E-Issn 0976-3945,Vol Ii April-June 2011

2. Finite-Element Analysis Of Quasi-Static Characterization Tests In Thermoplastic Materials: Experimental And Numerical

Analysis Results Correlation With ANSYS A. Arriaga, J.M. Lazkano, R. Pagaldai ,A. M. Zaldua ,R. Hernandez

3. V. Siva Prasad1, Syed Altaf Hussain2, V.Pandurangadu3, K.PalaniKumar4, Modeling and Analysis of Spur Gear for Sugarcane Juice Machine under Static Load Condition by Using FEA, ISSN: 2249-6645, Vol.2, Issue.4, July-Aug 2012 pp-2862-2866

4. "Polymers, High-Temperature".Ullmann's Encyclopedia of Industrial Chemistry (online version ^ David Parker, Jan Bussink, Hendrik T. van de Grampe, Gary W. Wheatley, Ernst-Ulrich Dorf, Edgar Ostlinning, Klaus Reinking (15 April 2012).

5. Balasubramanian Ashwin, Plate Analysis With Different Goemetries And Arbitrary Boundary Conditions, December 2011,

6. Jason Bragg1, Alberto Alvarez-Castillo2, Monica Trejo-Duran3 And Victor Castano1, Preparation And Properties Of (Epoxy Resin)/(Nylon 6,6 Oligomer) Blends, Vol. 3, No. 2, 2009,

7. P. Vaishali Vaghela R,²Prof R.N Desai,³Mr. K Patel, Modification Of Nylon 6,6(ISSN : 2277-1581, Volume No.1, Issue No.2 Pg:79-82

8. L. Lafronza, W.Song, A. McAlpine, R.J. Astley and A.J. Keane 6th European Turbo Machinery Conf. France, 2005 Vol. 2, pp 1085-1095

9. Richard L. Clark, Influence Of The Interphase On The Mechanical Properties Of Nylon 66 Composites, August, 1996 Blacksburg, Virginia,

10. Marc A. Rosen, 2000 Simcoe Street North, Oshawa, Ontario, L1H 7K4, Canada, Development Of An Enhanced Ceiling Fan: An Engineering Design Case Study Highlighting Health, Safety And The Environment