RESEARCH ARTICLE OPEN ACCESS

# DESIGN AND ANALYSIS OF TURBINE BLADES IN STEAM POWER PLANT

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**ABSTRACT**
The development of any country directly relates on capital energy consumption. The demand for power generation on the large scale is increasing day by day. Owing to their major contribution towards power production, thermal power plants have a vital role to play in the development of nation. Due to the scarcity of power every power plant needs to be operated at maximum level of efficiency. In case of thermal power plants this applies equally to all its auxiliaries.

The turbine blade plays a major role in the increase of the overall thermal efficiency of the plant. In the manufacturing of the turbine blades several precautions should be taken such as the quantity and quality of alloys used in the manufacturing of blades.

The turbine blades used the in turbine having the capacity of 210MW are considered into the analysis, also the shape and size of the turbine blade is also taken into the analysis.

The analysis has been carried through the FEA package in which Ansys has been used in the process to find out the Stress and other factors affecting the turbine blade. Due to this, in the manufacturing process the turbine blade the choosing of alloys would be easier.

And also in the manufacturing process the types of alloys used in order to increase the properties of the material, so that there would be a modification in the optimum performance. And also gives enough efficiency.

## ROLE OF TURBINE BLADE IN STEAM POWER PLANT

### WHAT IS TURBINE BLADE?

A turbine blade is the individual component which makes up the turbine section of a gas turbine. The blades are responsible for extracting energy from the high temperature, high pressure steam produced by the boilor. The turbine blades are often the limiting component of steam turbines.

**Steam Turbine Blades**

### About Frequency of Turbine Blade:

As we know that when the super saturated steam, which is having the dryness fraction 1. Hits the turbine blade it possess some amount of damage due to the impact pressure of the steam.

Also due that there would be some amount of vibrations may also be caused due to the resonance in the frequency of the turbine blade and the steam.

### VIBRATIONS:

Vibration can be particularly troublesome in long blades. The failure of blades in the turbines has been traced to vibrations at resonance frequencies, attributable to faulty design. In designing the last-stage blades one must calculate resonance frequencies and where the nodal points will occur.

**DAMPING CHARACTERISTICS:**

The steel should also have high damping characteristics to minimize vibration. Finally, the steel should lend itself to machining or forging; more exotic means of shaping a blade are usually very costly.

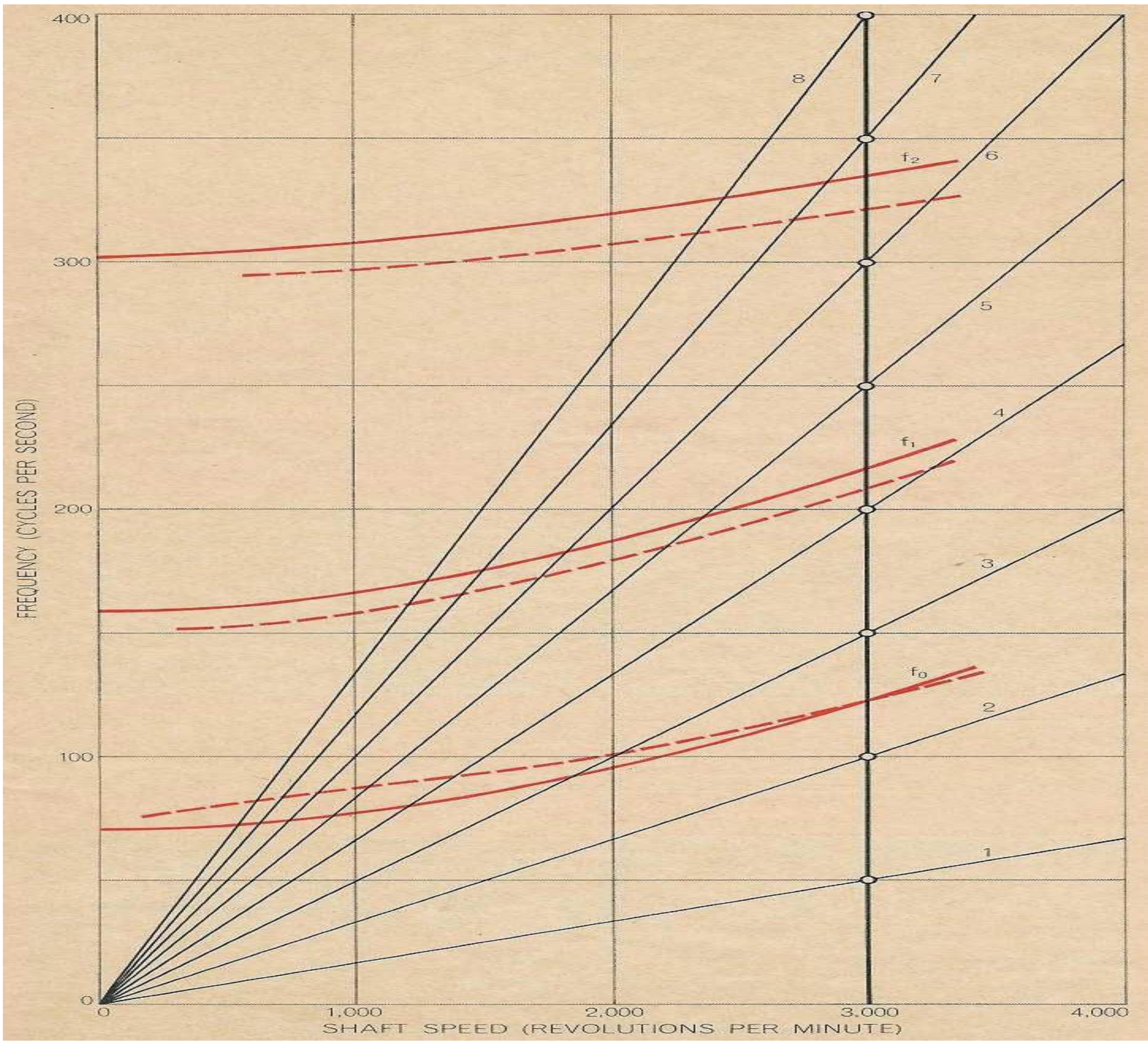
**TORSIONAL FREQUENCIES:**

The calculation method accounts for centrifugal and torsion frequencies as well as for their coupled effect. The calculated values must then be verified by static and rotational tests; close agreement is usually obtained between calculation and experiment.

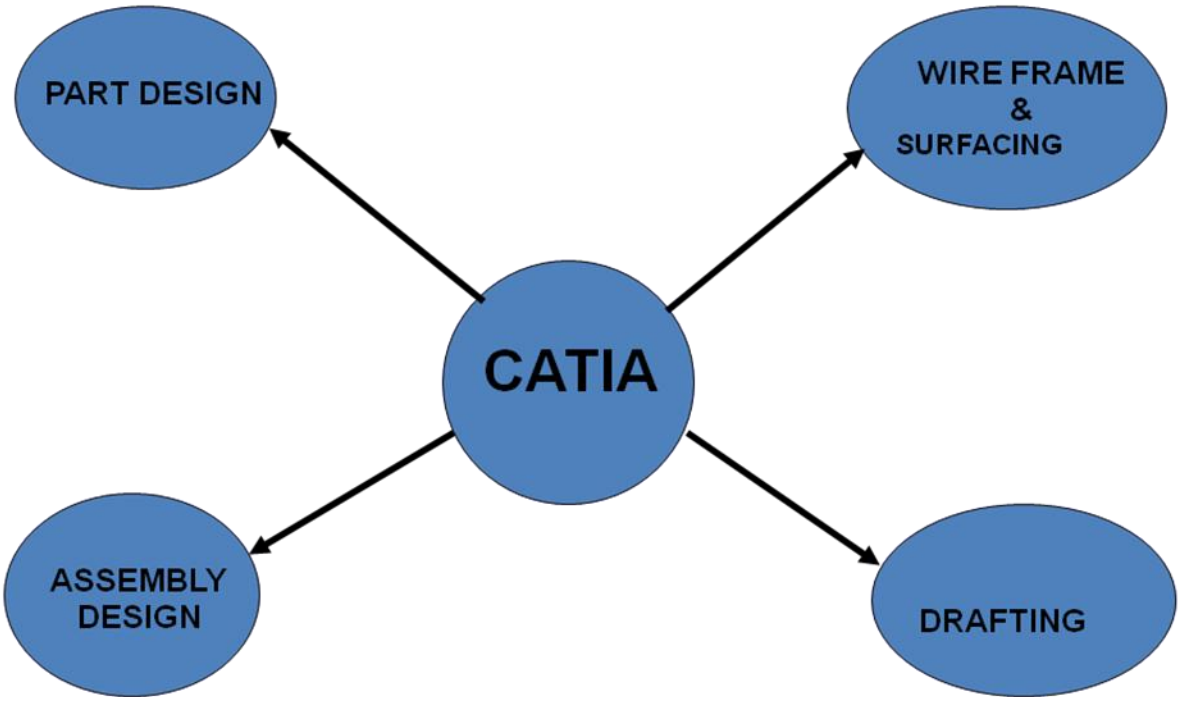
**RESONANCE FREQUENCIES** *:*

Resonance frequencies of last-stage blades can now be calculated with good accuracy. The slanting lines (1 through 8) are potential exciting frequencies. Conditions to be avoided (open dots) occur where these lines intersect the vertical line at the normal shaft speed here 3,000 revolutions per minute. The solid lines in color (f0, f1, f2) are resonant frequencies of the blade as obtained by calculation. The broken lines are measured values.

The following graphical representation gives a detail description about the resonance frequencies in the turbine blades.




**MODELLING OF TURBINE BLADE**

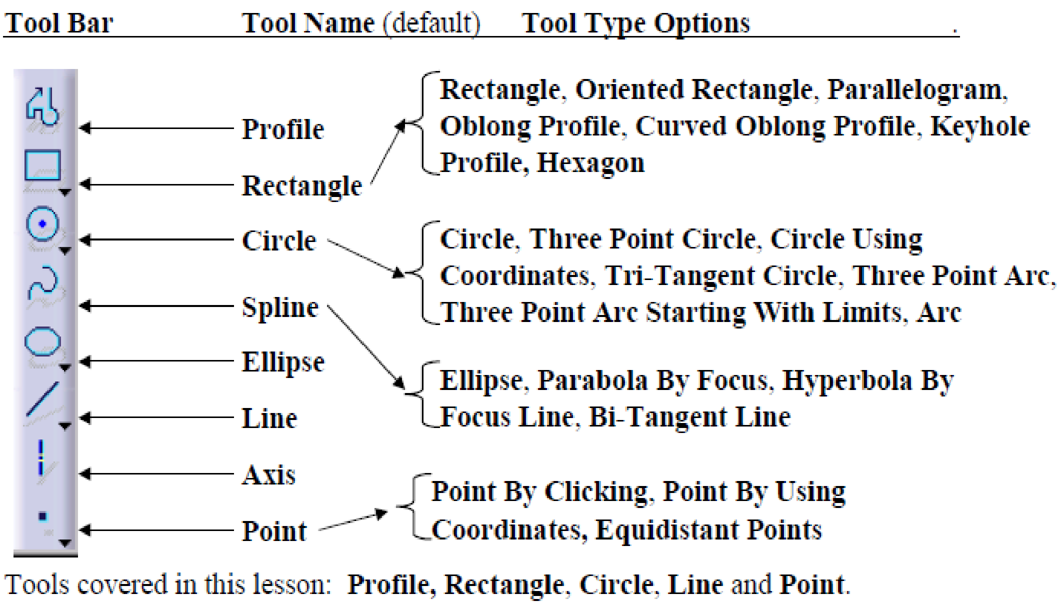



**CATIA FEATURES**

**4.1 FEATURES OF CATIA:**

- Easy accessible software
- Predefined shapes
- Powerful in surfacing
- User pattern facilities
- Supports CSG and feature based
- Retrieving data is very easy

It is powerful program used to create complex designs with a great precision. The design intent of any 3-d modal of any assembly is defined by its specification and its use the powerful tool of Catia 3-D can be used capture the design. Intent of any complex modal by incorporating intelligence to the design. To make the designing process simple and easy.



**Tool Bar** **Tool Name** (default) **Tool Type Options**

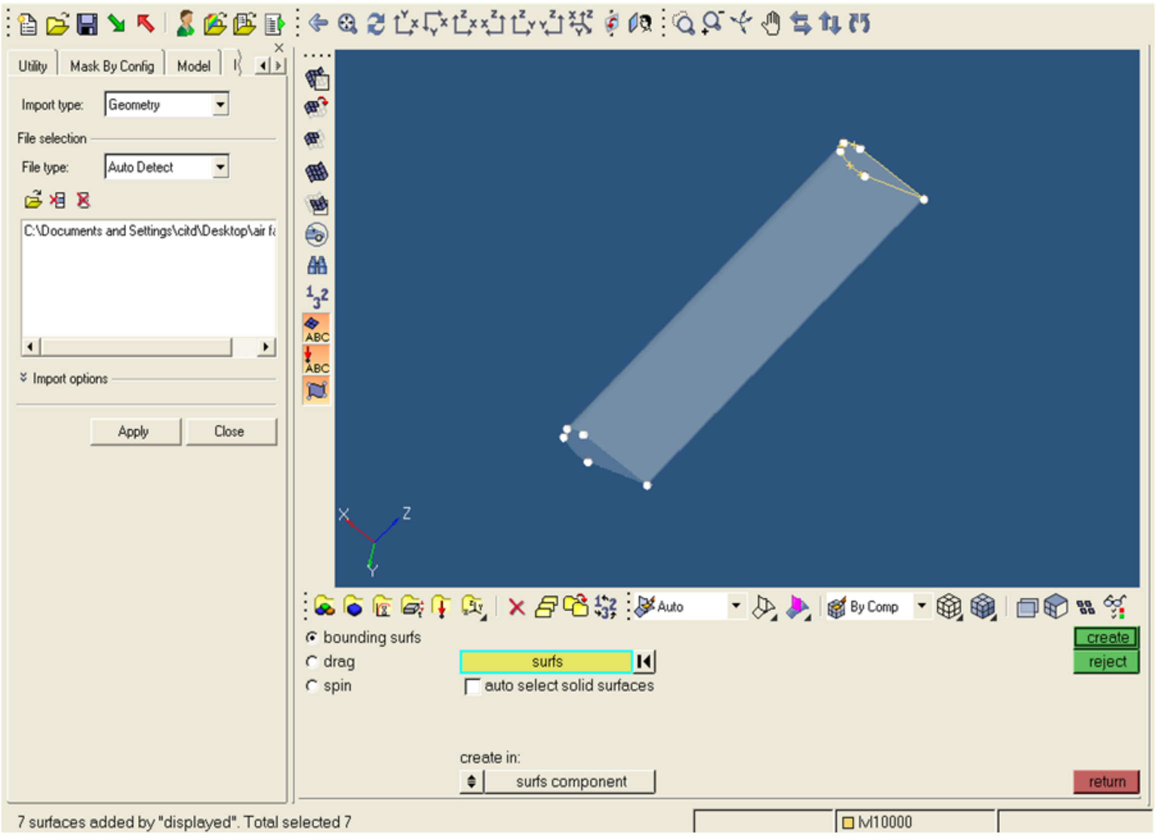
**Constraints Defined In Dialog Box**

**Constraint**

**Auto Constraint**

**Animate Constraint**

**CONSTRUCTION OF STEAM TURBINE BLADE:**




**DESIGN PROCESS:**
Sketching using basic sketch entities.
Converting the sketch into feature and parts.
Assembly different parts and analysis them
Manufacturing of the final parts and assembly

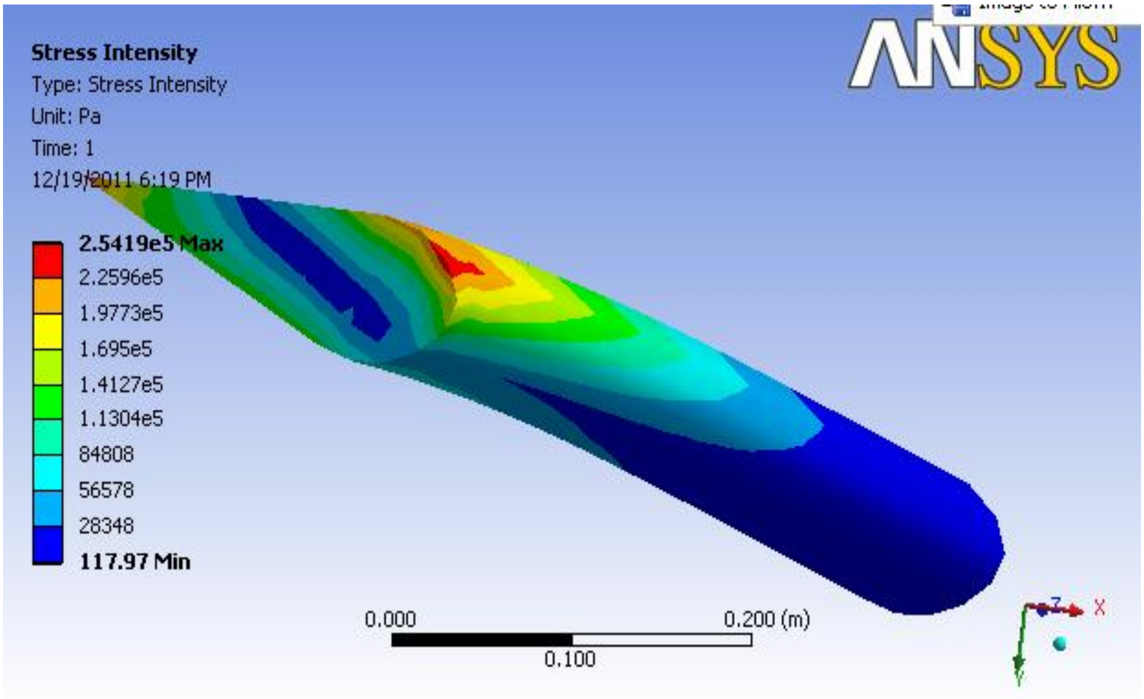
**PART DESIGN:**

Create sketched features including, cuts, and slots made by either, extruding, revolving sweeping along a2-d sketched trajectory, or blending between parallel sections, create “pick and place” features, such as holes, shafts, chamfer, rounds, shell, regular drafts, flanges ribs etc.

Sketch cosmetic features, reference datum planes, axes, points, curves, coordinate systems, and shapes for creating non solid reference datum, modify, delete, suppress, redefine, and reorder features. Suppress, redefine, and reorder features. As well as making features “read only”.

Create geometric tolerances and surface finished on models, assign defines, units, material properties or user specified mass properties to a model

**WORKING OF ANSYS:**




**ADVANTAGES OF FINITE ELEMENT ANALYSIS:**

In contrast to other variation and residual approaches the finite element method does not require trial solutions, which apply to entire multi dimensional continuum.

The use of separate sub region~~s, or f~~inite element~~s, for t~~he trial solutions permits a greater flexibility in considering of complex shape. Rather than requiring every trail solution to satisfy the boundary conditions, one prescribes the conditions after obtaining the algebraic equations for the assemblage.

As boundary conditions do not enter in to equations for the individual finite elements, one can use the same field variable for both internal and boundary elements. The field variable models need not be changed when the boundary conditions change.

The introduction of boundary conditions in to assembled equations is a relatively easy process. No special techniques or artificial device are necessary.

The finite element method not only accommodates complex geometry and boundary conditions, but also proven successful in representing various types of complicated material properties that are difficult to incorporate in the numerical methods.

The finite element method readily accounts for non-homogeneity by the simple tactic of assigning different properties to different elements.

The simple generality of the finite element procedure makes it a powerful and versatile tool for a wide range of problems.

**LIMITATIONS OF FINITE ELEMENT ANALYSIS:**

The finite element method does not accommodate few complex phenomena such As

- Cracking and fracture behavior.
- Contact problems.
- Bond failures of composite materials.
- Non-linear behavior with work softening.
- It does not account for transient, unconfined seepage problems.
- The finite element analysis has reached a high level of development as a solution technique. However, the method yields realistic results only if the coefficients or material parameters, which describe the basic phenomena, are available.
- The most tedious aspect of the use of finite element method is the basic process of sub dividing the continuum error free input data for the computer.

**LIMITATION OF TURBINE BLADE:**

The efficiency of power plant increases with increase in number of blades, but it is not economical to large number of blades to increase the efficiency. On the basis of the techno-economic study the numbers of blades generally used in 210 MW or 500 MW units are as many as possible, based on the design of turbine. Thus the efficiency increased by 5 to 6% approximately.

## CONCLUSION

Two observations made at the plant which might be more possible reasons for the above differences are

| EFFICIENCY OF STAGE / UNIT | STAGE - 1 | STAGE - 2 |
|---|---|---|
| η (With Advanced Alloy Designed Blade) | 47.7% | 45.45% |
| η (Without Advanced Alloy Designed Blade) | 44.34% | 44.28% |

The two units considered results same efficiency Without Advanced Alloy Designed Blade It is clearly observed from the above results that there is considerable increment in the efficiency due to Advanced Alloy Designed Blade.

For certain reasons which are to be diagnosed the efficiency of stage-2 has shown less improvement than the other units considered. The unit of stage-1 has gained an efficiency of 3.36% where as the unit of stage-2 has gained only 1.17%.

The stage-2 unit has only 6 Turbine Blades where as stage-1 has 8 Turbine Blades.

Hence an effective analysis is required to optimize the number of Advanced Alloy Blades to be used in the system. Also the maintenance of the blades in the form of scale or corrosion plays an important role in the overall performance of the plant. We conclude that by increasing the number of Turbine blades we can increase the cycle efficiency of the Plant.

The following conclusions can be made from the present work for the better performance of the plant.

1) Replacement of damage or worn-out components.
2) The excessive use of tubes dummies must be taken care, so as to increase the effective heat transfer.
3) Effective instrumentation is needed to evaluate the total system & sub-systems performance.

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