International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-02, May 2018

Design and Vibration Analysis of Steam Turbine Low Pressure Blade-2 to Enhance Efficiency

[1]V.Suwrana Kumar, [2]G.Prasanna Kumar, [3]S.Varun

[1,2]Assistant Professor, [3]UG Student, Dept. of Mech. Engg., MJCET, Hyderabad-34, INDIA.

[1]*suvarna.kumar@mjcollege.ac.in*, [2]*gpkmani09@gmail.com*, [3]*sathuvarun8@gmail.com*

Abstract: The development of country depends on the amount of power production. Thermal power plant plays a major roe in power production. In thermal power plant steam turbine is one of the essential components and it produces rotational work which is important for production. Limited primary energy resources and awareness of environmental pollution has led to ever increasing endeavor to develop new steam turbine power plants with the highest possible efficiencies. Even small step increase in efficiency can result in major saving for the customer. As overall cycle efficiency is strongly dependent on steam turbine performance the efforts are directed primarily towards improvement in reducing the losses.

The principle of steam turbine is steam energy is converted mechanical work by expansion through the turbine. The expansion takes place through a series of fixed blades (nozzles) and moving blades each row of fixed blades and moving blades is called a stage. The moving blades rotate on the central turbine rotor and the fixed blades are concentrically arranged within the circular turbine casing which is substantially designed to withstand the steam pressure.

The main objective of the paper to identifying the losses occurring in the turbine and to carry vibration analysis test of turbine LP blades to improve efficiency.

Key words: Vibration analysis, Steam Turbine, LP blades.

I. INTRODUCTION

A steam turbine is a mechanical device that extracts thermal energy from pressurized steam, and converts it into rotary motion. It has an emergency stop valve (ESV),control valve(CV), and high & low pressure turbines.

Steam turbines has almost completely replaced the reciprocating piston steam engine because of its greater thermal efficiency and higher power-to-weight ratio. Because the turbine generates rotary motion, it is particularly suited to be used to drive an electrical generator – about 80% of all electricity generation in the world is by use of steam turbines. The steam turbine is a form of heat engine that derives much of its improvement in thermodynamic efficiency through these of multiple stages in the expansion of the steam, which results in a closer approach to the ideal reversible process.

Many industrial plants like sugar, pulp, paper, chemicals, fertilizers, steel and petroleum refineries require steam at low and medium pressures for process purposes and power for driving numerous machines, like turbo generators, compressors, pumps etc ., incorporated in the plant.

The steam turbines are utilized in several industries viz.. Paper, fertilizers, chemical petro chemicals, sugars, refinery, metallurgical etc foe power generation and mechanical drives already described. The following illustration explains the selection - application criteria of industrial turbines.

1.1 ANSYS is a major product for computer based Prototyping. While material Prototyping is as old as mankind, the computerized approach is relatively new and has on offer certain major advantages over the classical approach. In the following some info in regard. The great advantage of computer based prototyping is evident: modifications (e.g. updating material data, changing some dimension) and extensions (adding a new load scenario or a result quantity to evaluate) to the actual model are possible at any stage of simulation. Besides the **ANSYS** product family there are other names of rank in (multi physics) computer based prototyping as e.g. ADINA and COMSOL. We work with ANSYS since the mid-90ies and find it's a versatile too.

NOMENCLATURE

KM	Kilometer
MW	Mega watt
MU	Million units
T	Temperature

 DOI : 10.18231/2454-9150.2018.0181

S	Entropy
HP	High pressure
IP	Intermediate pressure
LP	Low pressure
HPT	High pressure turbine
LP	Low pressure turbine
Ata	Atmospheric technical absolute
TPH	Tons per hour
Ksc	kg/cm^2
HPH	High pressure turbine
LPH	Low pressure turbine
D/A	Deaerator
B	Boiler
BFP	Boiler feed pump
CEP	Condensate extraction pump
GEN	Generator
SH	Super heater
RH	Reheater
ECO	Economizer
TX	Twisted blades with integral shroud

Blades are the heart of a steam turbine, as they are the principal elements that convert the thermal energy into kinetic energy. The efficiency and reliability of a turbine depend on the proper design of the blades. It is therefore necessary for all engineers involved in the steam turbines engineering to have an overview of the importance and the basic design aspects of the steam turbine blades.

Blade design is a multi-disciplinary task. It involves the thermodynamic, aerodynamic, mechanical and material science disciplines. A total development of a new blade is therefore possible only when experts of all these fields come together as a team. The development process of a new profile took years of development and testing in the earlier years. But with the advent of CFD and FEM packages, there is a significant reduction in design and testing times. The feasibility of 3-D designs also has improved because of the advances in these software packages.

II. CONSTRUCTIONAL FEATURES OF A BLADE

The blade can be divided into 3 parts:

- The profile, which converts the thermal energy of steam into kinetic energy, with a certain efficiency depending upon the profile shape.
- The root, which fixes the blade to the turbine rotor, giving a proper anchor to the blade, and transmitting the kinetic energy of the blade to the rotor.
- The damping element, which reduces the vibrations which necessarily occur in the blades due to the steam flowing through the blades. These damping elements may be integral with the blades, or they may be separate elements mounted between the blades.

2.2 L.P. BLADE PROFILES:

The LP blade profiles of moving blades are twisted and tapered. These blades are used when blade height-to-mean stage diameter ratio (h/Dm) exceeds 0.2. In case of KWU blades, when h/D ratio exceeds 0.14, twisted and tapered (F type) moving blades are used, but they are not as twisted and as tapered as moving blades.

The LP blade profiles used in Siemens Wesel turbines (industrial machines) are as follows:

1) –2 blading:

The LP blading has 2 stages. The LP module is designated by the equivalent diameter of the exhaust flange. The 2 stages in LP are also therefore designated in the same fashion. For example, in a EK1100-2 turbine, the LP blading 1st and 2nd stages are designated as ND1100-I and ND1100-II respectively. The profiles of the first stage are of VK family, and the profiles of 2nd stage are of WF family. Only in ND600-I blades, a VN profile is used.

III. METHODOLOGY

3.1VIBRATION ANALYSIS OF STEAM TURBINE BLADES

Vibration Analysis is carried out in turbine blades to find out if there is any vibration occurring in blades .

- Steam turbine LP blades are more prone to failure due to resonance.
- Centrifugal forces acting on LP blades are higher, due to larger size and more mass. This leads to higher stresses .
- Vibration in blades leads to damage of blades and decreases efficiency of the turbine.
- ➢ Vibration Analysis of T-2 blade

Table3.1 First 6 Natural frequencies table ofLPT T-2 blade at different operating speeds rpm

Rpm	Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	mode 6
0	360.73	759.77	1368.2	1479.4	2148.1	2577.7
1000	361.92	761.02	1368.6	1480.5	2149.4	2578.2
2000	365.44	764.73	1369.6	1483.9	2153.2	2579.6
3000	371.19	770.86	1371.3	1489.5	2159.5	2582

First find the different speeds different Natural frequencies forLPT-2 blades.

Next Campbell diagram forlpt-2 blade diagram is drawn.

DOI : 10.18231/2454-9150.2018.0181

International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-02, May 2018

IV. Results And Discussions

MODE SHAPES

MODES SHAPES AT 0 **RPM**

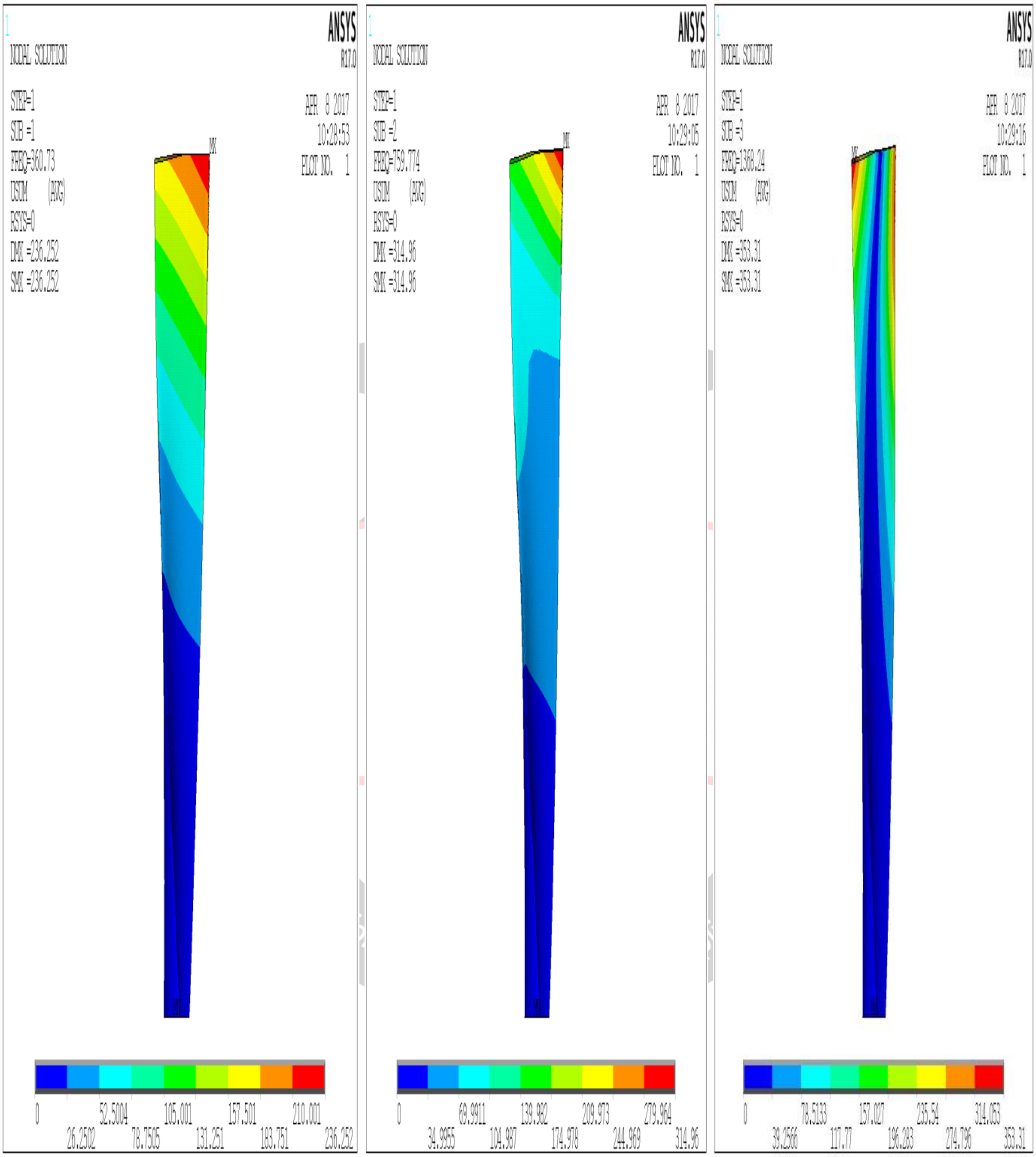
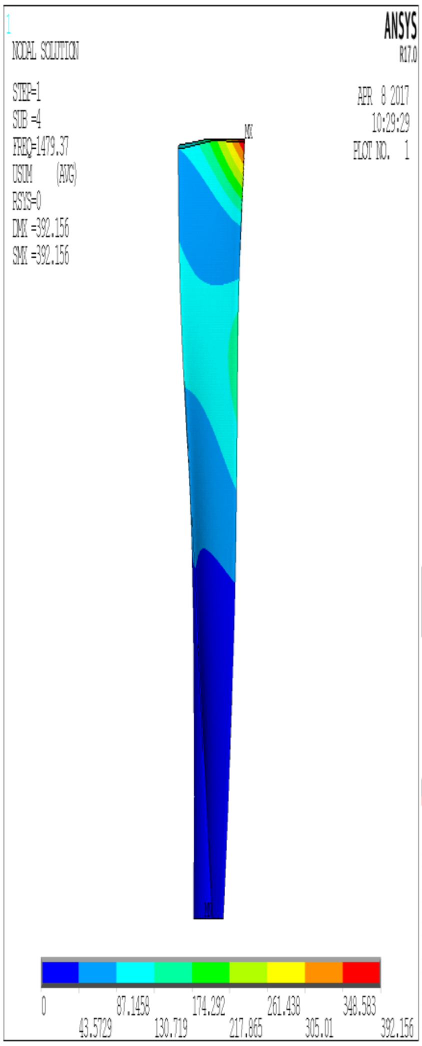
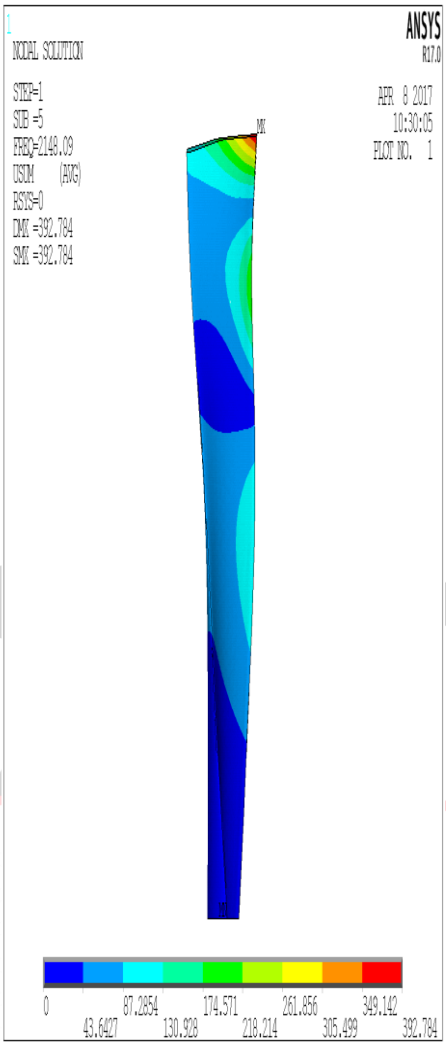


Figure3.1 (a) First mode of LPT-2 blade Figure 3.1 (b) Second mode of LPT-2 blade figure 3.1 (c) third mode of t-2 blade

 DOI : 10.18231/2454-9150.2018.0181





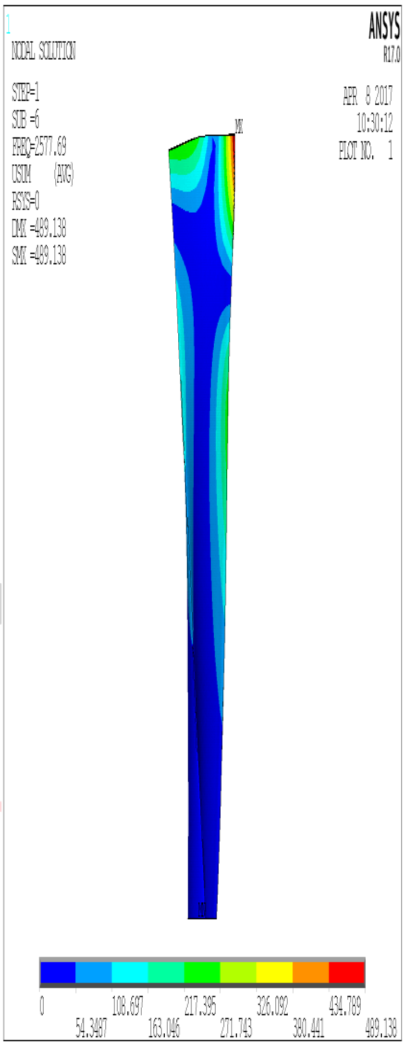
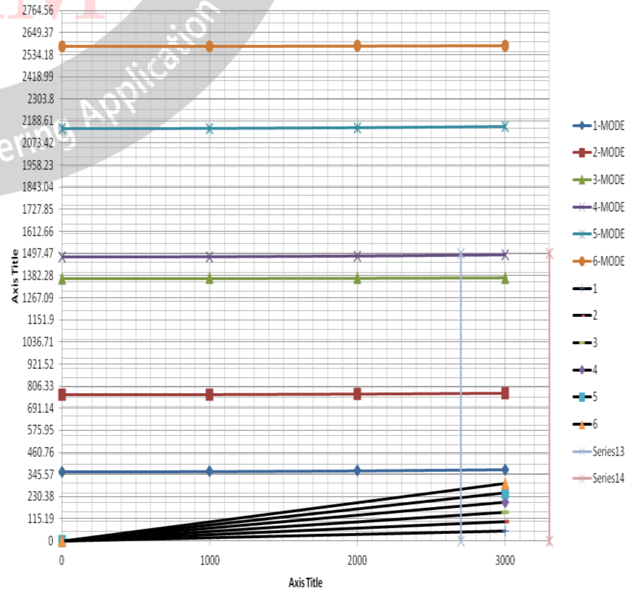


FIGURE (D) FOURTH MODE OF LPT-2 FIGURE 3.1(E) FIFTH MODE OF LPT-2 BLADE FIGURE (F) SIXTH MODE OFLPT-2 BLADE BLADE

1 at all rpm highst naturatial frequnce is obsered in mode

2. 6.mode 6 has 5 to 6 times more natural frequncey than mode1 at any selected rpm .

3.3 CAMPBELL DIAGRAM FORLPT-2 BLADE



X axis – Frequency **Y** axis – Rpm

Figure 2.1.2 (g) Campbell diagram for T-2 blade

 DOI : 10.18231/2454-9150.2018.0181

4. MODIFICATION DONE IN NOZZLE

- No. of Nozzles are increased from : (5+5+3+3) to (9+9+3+3) i.e, total No. of Nozzles from 16 to 24 nozzles.
- Nozzle height is changed from 13.1mm to 12.5mm.
- Nozzle profile is changed from t1-25-45 to t1-25-43

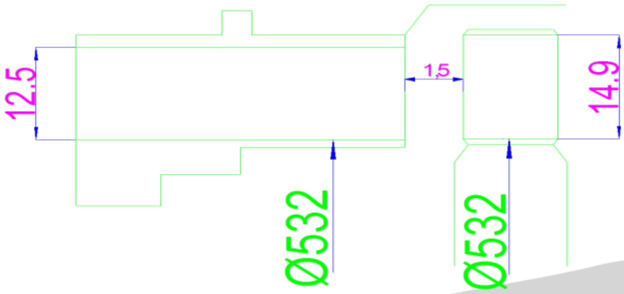


Figure 4.1 Modification of axial clearance between in nozzle

4. Axial clearance between 1st stage Nozzle to A-wheel is reduced from 6mm to 1.5mm

V. CONCLUSION

1 Overall efficiency of the turbine has been increased by 11.5% and all the losses are reduced due to the modifications done at different stages.

.Our idea of increasing the length of the blade to improve efficiency is validated because natural frequencies calculated .

2. When RPM increases natural frequency also increases w.r.t model 6 has more natural frequency. That design best design for LPT-2.

3 . For the analysis, a cantilever beam of length 0.45m and cross section 0.003m x 0.2m is taken.

4. No. of Nozzles are increased from24.this improves efficiency.

5. A Campbell diagram plot represents a arrangement's response range as a utility of its oscillation

REFERENCES

[1] ***R.K.RAJPUT***, A Textbook of Power Plant Engineering (Laxmi Publications Pvt. Ltd)

[2] ***P.K.NAG***, Engineering Thermodynamics, (Tata McGraw Hill, New Delhi)

[3] ***DR R.YADAV***, Fundamentals of Power Plant Engineering,Conventional and Non-Conventional, (Central Publishing House publication, 2011)

[4] ***DR P.C.SHARMA***, Power Plant Engineering, (S.K.Kataria & Sons Publication, 2010) . ***R.K.KAPOORIA, S.KUMAR, K.S.KASANA***, An analysis of a thermal power plantworking on a Rankine cycle: A theoretical investigation, (Journal of Energy in Southern Africa , Vol 19 No 1,February 2008)

[5] ***JOHN. V, T. RAMAKRISHNA***,"""The Design And Analysis Of Steam Turbine Blade", International Journal of Advanced Engineering Research and Studies, VOL,2., ISSUE I,OCT.-DEC.,2012.

[6] ***SUBRAMANYAM*** PAVULURI, DR. ***A. SIVA KUMAR***,,," Experimental Investigation On Design Of High Pressure Steam Turbine Blade"", International Journal of Innovative Research in Science, Engineering and Technology,VOL. 2, ISSUE 5, MAY 2013,

[7] ***S. M. SANJAY KUMAR***, —Creep Life Prediction of Steam Turbine Blade Using Finite Element Method." International Journal of Advanced Engineering Research and Studies, VOL. I, NO.2, PP. 95-98

[8] ***AVINASH V. SARLASHKAR ,MARK L***. Redding," An Ansys-Based Turbine Blade Analysis System"" Impact Technologies, LLC, ROCHESTER, NY 14623, U.S.A

[9] DR.SHANTHARAJA.M, ***DR. KUMAR. K*** .""Design Modification For Fillet Stresses In Steam Turbine Blade"", IJAE International Journal of Advanced Engineering Research and Technology, VOL III,ISSUE 2012.

 DOI : 10.18231/2454-9150.2018.0181