FEM ANALYSIS OF CONSEQUENT STRESS DISTRIBUTION ON THE LP BLADE OF A STEAM

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ABSTRACT:

FEM analysis of consequent stress distribution at the LP blade of a steam turbine. LP blade modules are the twisted bladed designs consisting of the final degrees of the steam turbine. due to the fact that these blades are pretty loaded stresses are to be evaluated as it should be to avoid blade failure or cracking. in the present work the impact of blade floor stress loading on the stresses increase has been studied solely and additionally with centrifugal strain all through rotation. surface pressure distribution on the blade has been evaluated with the assist of the CFD package deal (Blade gen and Blade gen plus). The three-D model of the twisted blade is generated from the given profile conditions with the help of (Blade gen). And analysis has been achieved from the given boundary situations with the help of (Blade gen plus) bundle. For the stress evaluation module has been organized with the assist of ANSYS bundle. The stress distribution statistics at sections of the blade has been superimposed on the ANSYS version and stress analysis been finished.

1.0 INTRODUCTON

The damage down and disasters of turbo machineries were influencing along with consequential damages, risks to public life and most importantly the cost to repairs .To avoid these, it is apparent that the blading of faster equipment have to be made structurally stronger, meaning no longer in dimensions and/or use of substances of creation, but preserving the working stresses nicely within the limits.

turbo machinery blades are categorised into categories relying on their way of operation as either impulse or reaction blades. Impulse blades function with the aid of redirecting the passing fluid (steam or gasoline) float, through a certain perspective. a piece producing force is advanced by means of resulting trade of momentum of passing fluid drift.

Failures in steam turbine blades

In the following paragraphs various failure modes of the turbine blade are discussed along with different kinds of stresses in the blade and the nature of aerodynamic excitation. A brief discussion of each of the above failure mechanisms follows in order to understand their significance.

Theory of turbine blade vibration

A rotating turbine blade is the factor, which converts the power of the flowing fluid into mechanical electricity. for this reason the reliability of these blades is very crucial for the a success operation of a turbine. Metallurgical examinations of failed blades show that the majority the screw ups may be attributed to the fatigue of metal. Blade screw ups because of fatigue are predominately vibration related.

Turbine vibration is thought to be caused by numerous mechanisms, however from time to time disasters of blade arise which can not be defined by using those mechanisms. these blades are referred to as "rogue blades". but, research have shown that those failures have been caused by abnormally high stresses. The effects of those discoveries have cause massive studies of bladed disc vibration traits.

Application for FEM:

Applications of the FEM can be divided into three categories, depending on the nature of the problem to be solved. In the first category, is all the problems known as equilibrium problems or time independent problems. For the solutions of equilibrium problems in the solid mechanics area, we need to find pressure, velocity, temperature and sometimes concentration distributions under steady state conditions.

2.0 **LITERATURE REVIEW**

The previous chapter has highlighted significance of the reliable operation anticipated from steam generators used in various sectors of the industry. numerous failure mechanisms and the overall practices accompanied by way of a blade clothier for determining a blade configuration have been also described inside the preceding chapter.

Leissa, MacBain and Kielb [1] made a complete have a look at of the severa previous investigations at the unfastened vibration of twisted cantilever plates of rectangular platform that are consequences of a joint enterprise, government and university attempt.

Tsuiji and Sueoka [2] cope with the unfastened vibration of cylindrical panels with the aid of the usage of Raleigh-Ritz approach. Blades of faster equipment are twisted in axial direction and cambered inside the chord smart direction. The blade has been idealized to a twisted cantilevered cylindrical panel and numerical techniques have investigated its vibratory traits.

Le- Chung shaiu and Teng [3] studied the loose vibration behavior of buckled composite plates by using the use of finite element method. not like beams or columns, plates can bring a miles-elevated load after buckling without failure. right here triangular plate element is taken for finite element analysis. This detail is evolved based on a simplified excessive order plate principle and massive deformation assumptions.

3.0 Finite Element Analysis:

Finite Element Analysis (FEA) is a computer-based numerical technique for calculating the strength and behavior of engineering structures. It can be used to calculate deflection, stress, vibration, buckling behavior and many other phenomena. It can be used to analyze either small or large-scale deflection under loading or applied displacement. It can analyze elastic deformation, or "permanently bent out of shape" plastic deformation. The computer is required because of the astronomical number of calculations needed to analyze a large structure. The power and low cost of modern computers has made Finite Element Analysis available to many disciplines and companies.

FEM modal details:

Material is isotropic

Modulus of elasticity is 2.10e5 N/Sq.mm

Poisson's ratio is 0.3

Density of the material is 7.80e-9 Kg/cu.mm

Material used is steel

Loads Applied

Applied pressure on the pressure side = 0.5 ata

Applied pressure on the suction side = 0.3 ata
Total number of elements is 33,286
Total number of nodes is 22,703
The maximum yield stress of the steam turbine blade of the material steel is 600N/sq.mm.

Design procedure:
A rapid system blade is usually a cantilever beam or plate is tapered and twisted with an airfoil cross-section. usually a rapid system has numerous stages, every degree with a stator and rotor. in the stator, they are all inserted as diaphragms or nozzles in a ring to guide the go with the flow medium at the correct entry attitude into rotor blades. The rotor blades are established on a disc at a stagger attitude to the machine axis and they convert the thermal energy into mechanical electricity in turbine. In turbine steam enters at excessive pressure and temperature inside the first stage and expands at the same time as passing thru the several levels earlier than it's miles let out from the last
level with low temperature and stress after extracting as a whole lot as thermal power as feasible as a result, the quick blades in high strain have excessive frequency of the order of 1000Hz, which becomes regularly decrease about 100Hz inside the closing degree long blades. in the compressor level, the operation precept is reversed to compress the gases using the furnished mechanical energy.

Governing equation for single blade vibration:

- The structure has constant stiffness and mass effects.
- There is no damping.
- The structure has no time varying forces, displacements, pressure or temperature applied.
- The model considered as cantilever and its simple form is shown in figure below.

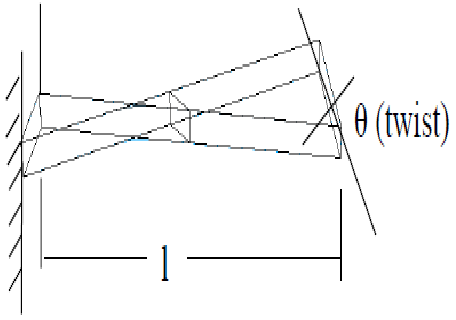

Figure: Simple Cantilever Beam

At fixed end *u* (longitudinal), *v* and *w* (transverse) are taken as zero. At free end the longitudinal (i.e., *u* =0) displacement is taken as zero. It is implied that there are no longitudinal vibrations. Only transverse and torsional displacements are considered.

Idealization: It is also called mathematical or analytical modelling. The formulation of the set of mathematical equations that models the physical problem within the scale and accuracy required by the application

Discretization: The reduction of the mathematical model to a discrete model with finite number of degrees of freedom. In the stiffness method of solution, these degrees of freedom are physical or generalized displacements. The formulation of the discrete equations is done by making restrictive assumptions on the behavior of components of the model. These components are called finite elements.

Result interpretation: The interpretation of the numerical results in terms of their mathematical and physical significance. An important ingredient of this step is the assessment of the modelling and discretization errors indicated in Fig. (The solution error is generally unimportant.)

4.0 ANALYSIS OF FREE-STANDING BLADE

The rapid gadget blade is lengthy, twisted and tapered, so provision became made for lacing cord to avoid fluctuating forces even as strolling. because of the formation of knife-part on the blade on the time of operation lacing wires are reduce causing the breakdown of the gadget. as a result re-modelling became achieved for the blade without provision for lacing twine and freestanding blade evaluation become achieved to look at the vibration conduct. due to the fact turbine blades are subjected to high variable masses that may purpose failure, designing dependable blade require in-depth vibration and stress analysis. The purpose of the analysis is to study of loose-status blade and verification of the consequences with the experimental consequences. the usage of ANSYS package deal model is generated and mesh technology changed into done on this package deal. Static and Modal analysis is finished in ANSYS.

MODAL ANALYSIS:

In order to know the frequency distribution, modal analysis is carried out. This is done for four sub steps and the results are shown in the following figures

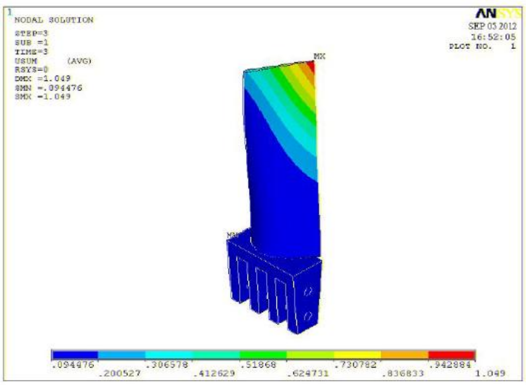

Figure: frequency distribution

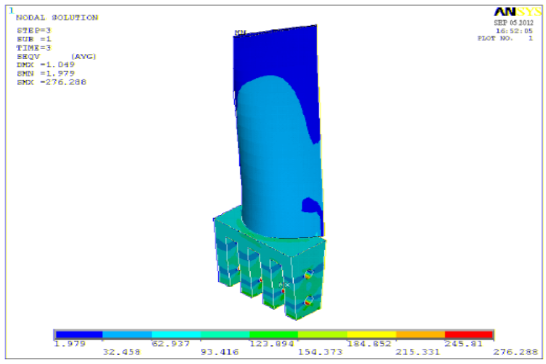

Figure: blade is rotates (angular velocity)

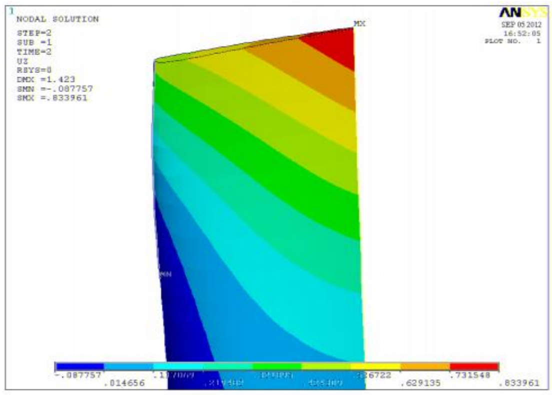

Figure: Deformation along z-direction

CONCLUSIONS:

The look at provides the method and methodology for studying the vibration behaviour of turbine blade. The study highlights the truth that even though the primary advances had been made within the blade vibration design era, failures still take vicinity, there by emphasizing that blade behaviour is complicated. Finite element outcomes without spending a dime status blades deliver a whole image of structural characteristics, that could applied for the improvement in the layout and optimization of the running situations. The effects are correlated with the experimental effects . The very last blade profiles acquired after complete evaluation changed into free from resonance within the working vicinity. The above studies can deliver more correct values of dynamic pressure levels, if the significance of dynamic pressure skilled with the aid of the blade is exactly regarded. The blade is subjected to such forces due to waft excitation and waft disturbances under diverse running conditions. The consequences received from the analytical work suits pretty closely with the experimental outcomes thus displaying the accuracy of the version and adequacy of boundary situations. An strive became made to model the blade for wide frequency operation. sizeable work in this location continues to be required and must be attempted to absolutely analyze the blade behaviour.

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