STIFFENING ARRANGEMENT OPTIMIZATION FOR RECTANGULAR SURFACE CONDENSERS BY PARAMETRIC FEM APPROACH

Sagar Kailas More
Department of Mechanical Engineering, PDVVP College of Engineering,
Ahmednagar, India

Susheel M.Magar
Department of Mechanical Engineering, PDVVP College of Engineering,
Ahmednagar, India

ABSTRACT
In a power plant condenser is most important equipment. This equipment uses number of sub-components like condenser upper exhaust neck, Condenser lower exhaust neck, main condenser, nozzles. Steam leaving from the turbine gets absorbed inside a condenser through a exhaust neck & steam gets condensed inside a condenser main body. Stiffening arrangements are provided to support the internal components of the condenser as well as to restrict their deformation and buckling. By using parametric finite element method model we can achieve flexibility in a design changes and optimization. Here various sub components of rectangular surface condenser will get analyzed to optimize stiffener size. Response surface optimization along with design of experiment methodology will be used for stiffener optimization. This optimization will help to reduce obstruction to steam flow in condenser.
Keywords: parametric finite element method, Stiffening arrangements, design of experiment methodology.

INTRODUCTION
The power plant surface condenser is attached to the lower pressure exhaust of steam turbine. Its purpose is to condense turbine exhaust steam for reuse in the closed cycle. Since in this type of condenser the cooling water and the exhaust steam do not mix with each other, the condensate is directly available as an ideal boiler feed. Due to this factor, if a sufficient amount of cooling water is available and the initial cost of the condenser is not of prime consideration, surface condenser is preferred to other types of condensers. The exhaust neck sub-assemblies i.e. UEN and LEN of the condenser consisting of different plates. These plates are rectangular and trapezoidal in shape. The plates are welded together to form the required sub-assembly. So, it is necessary to analyze the rectangular or trapezoidal plates with appropriate boundary condition. Also, for strengthening and restricting deformation of plate to allowable value, support of stiffener is important. This survey is consisting of analysis of plates and stiffened plates.
Plates are initially flat structural members bounded by two parallel planes, called faces. The distance between the plane faces is called the thickness of the plate.

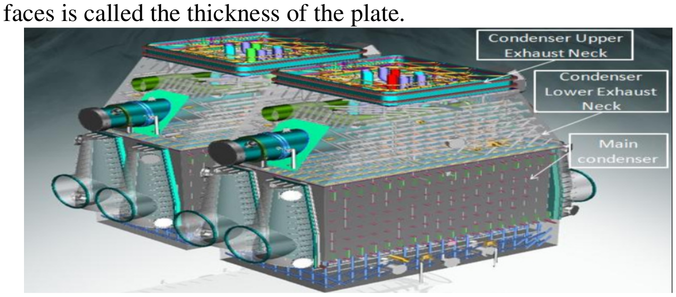

Fig 1.basic structure of industrial surface condenser

It will be assumed that the plate thickness is small compared with other characteristic dimensions of the faces (length, width, diameter etc.). The static or dynamic loads carried by plates are predominantly perpendicular to the plate face.

LITERATURE REVIEW

The load-carrying action of a plate is similar, to a certain extent, to that of beams. Plates can be approximated by a grid work of an infinite number of beams. This two-dimensional structural action of plates results in lighter structures, and therefore offers numerous economic advantages. The plate, being originally flat, develops shear forces, bending and twisting moments to resist transverse loads. Because the loads are generally carried in both directions plate is considerably stiffer than a beam of comparable span and thickness. So, thin flat plates combine light weight and form efficiency with high load-carrying capacity, economical and technological effectiveness. Because of the distinct advantages discussed above, thin flat plates are extensively used in all fields of engineering. Plates are used in architectural structures, bridges, hydraulic structures, containers, airplanes, missiles, ships, instruments, machine parts etc.

Warren C. Young and Richard g. Budynas have given the formulas for deflection and stresses of thin flat plate e.g. circular and rectangular etc. with different boundary condition. S. Timoshenko and S. Woinowsky Krieger analyzed different plates and shells with various boundary conditions. Continuous rectangular plate i.e. plate having larger dimensions which gives large deflection also analysed. In this, formulation for deflection of rectangular plate supported by the rows of equidistant columns in order to restrict deflection is given. If the dimensions of plate are large in comparison with the distances between the column and the lateral load in uniformly distributed, it can be concluded that bending in all panels, which may not close to the boundary of the plate, may be assumed to be identical, so that we can limit the problem to the bending of one plate only. Stephen Timoshenko and James Gere studied the bending and buckling of thin plates and shells with different loadings and boundary conditions.

N.E. Shanmugam et al.(2014) described experimental study on stiffened plates subjected to combined action of in-plane load and lateral pressure. Results show that lateral load carrying capacity of stiffened plate drops with increase in axial tensile load and vice-versa. It is found that plate slenderness ratio has significant influence on ultimate capacity of stiffened plates subjected to both in plane load and lateral pressure. Increase of plate slenderness ratio (length to thickness ratio) results in a decrease of ultimate load capacity of stiffened plate.

Ahmad Rahbar-Ranji (2013) presented the elastic buckling analysis of longitudinally stiffened plates with flat -bar stiffeners. Different buckling modes of stiffened plates including plate buckling, torsional buckling, web buckling and interactions of them when either plate or stiffener are under compression are studied. D. Venugopal Rao et al.(1993) presented finite element analysis of the large deflection behavior of stiffened plates using the iso-parametric quadratic stiffened plate bending element. The Non-linear equations are solved by the Newton-Raphson iteration technique. Numerical solutions are presented for rectangular plates and skew stiffened plates.

T.S. Koko et al.(1991) presented new numerical technique for large deflection elastic-plastic analysis of stiffened plates. The method uses super finite elements which are macro elements having analytical as well as the usual finite element shape functions

PROPOSED SYSTEM

RELATED WORK

Linear elastic FE analysis of two bay stiffened plates subjected to transverse loading condition has been reported for deflection calculation and deflection is calculated at different points. Simple plate and stiffener configuration is as shown in Fig.as below

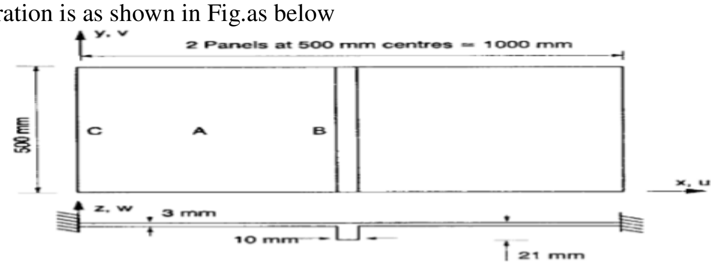

Fig 2: Configuration of 2-bay stiffened plate

Different types of experimental designs are analyzed briefly. Response surface optimization methodology (RSM) is used to determine the optimal point. In RSM, it is important to get good regression model. Different experimental designs used in this methodology are discussed e.g. Central composite design (CCD), Box-behnken design, Custom experimental design etc. Types of CCDs like face centered, circumscribed and inscribed etc. are illustrated. The distribution of sample points for different input parameters with different experimental methods is explained. The CCD has been studied by many statisticians in response surface analysis, and is perhaps the most popular class of second order designs. In this study, optimal CCDs under several design criteria are discussed for fitting second order response surface regression models when the model is of second order or third order. Design of experiments (DOE) methodology is explained along with different approaches. Different experimental factorial designs are explained in detail.

SYSTEM ARCHITECTURE

RSM is efficient goal driven optimization method as it gives accurate enough results with less computation time compared to other optimization techniques .In RSM, system draws information from its own response surface component, and so is Dependent on the quality of the response surface. Response surface optimization has following steps

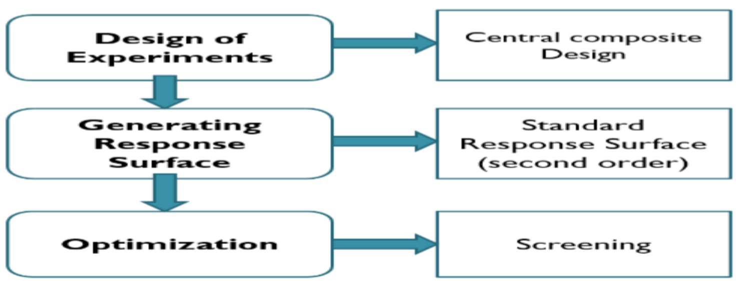

Fig 3.Steps in response surface optimization

CONCLUSIONS

In this paper, Deformation computed by performing FE analysis of condenser sub-assemblies (without stiffening arrangement) i.e. condenser UEN and LEN etc. is in good agreement with those determined by analytical method. DOE can be done by methods other than CCD method e.g. Box-Behnken design, Custom Sampling design etc. Optimization can be performed by different methods like Multiple Objective Genetic Algorithm method. Different nozzles present over surface condenser can also be analyzed for given loading condition e.g. Operating, Wind, Seismic etc.

REFERENCES

[1] N.E. Shanmugam, Zhu Dongqi, Y.S. Choo, M.Arockiaswamy(2014). Experimental studies on stiffened plates under in-plane load and lateral pressure.thin walled structures ,80,22-31.
[2] Ahmed Rahbar-Ranji.(2013).Elastic buckling analysis of longitudinally stiffend plates with flat -bar stiffeners.Ocean engineering,58,48-59.
[3] D.Venugopal Rao,A.H.Sheikh,M.Mukhopadhyay.(1993).A finite element large displacement analysis of stiffened plates.Computer and structures,47,987-993.
[4] T.S.Koko,M.D.Olson.(1991).Non linear analysis of stiffened plates using supper elements.International journal of nimerical methods in engineering.31,319-343.
[5] Sung Hyun Pack,Hyun Joo Kim,Jae Cho.(2008).Optimal central composite designs for fitting second order response surface regression models.323-339.