Fatigue Life Evaluation of Bracket Cutouts in Air Chilling Unit

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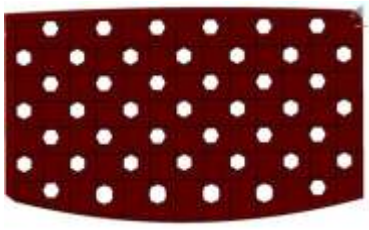
Abstract:

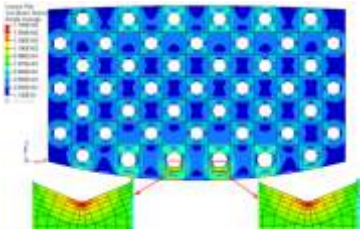
Mechanical component failures involve very complex interaction of repeated load over a period of time. One of the dominant failure modes under repeated loading is fatigue failure. Fatigue is a major reason for premature failure of structure due to initiations of cracks at highest stress concentration sites followed by propagation of cracks, leading to fracture. Fatigue is often in structural components in automobile, marine, aerospace, civil, etc. In marine systems, there are various sub-systems that are required to ensure human comfort. One of the key subsystems in marine system is Air Chilling Unit (ACU). Currently, designers are facing a problem of fatigue crack generation at the corners of polygonal cutouts, thus limiting the life of the bracket in ACU.

An attempt was made in this work to evaluate the fatigue life of the bracket used in ACU subjected to voyage loads using the FE tools. In the initial stage of the work benchmarking studies were conducted to correlate FE and analytical results on a simple plate with hole. This has established a method, which can be applied for evaluating the fatigue life of bracket in ACU.

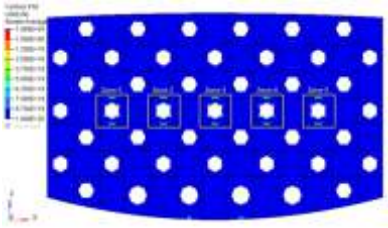
This work was further accomplished in two stages. In the first stage, studies for evaluating Stress Concentration Factor (SCF) around the polygonal shaped cutouts were performed by applying bending, compressive, tensile and twisting loads. The highest SCF was observed for tensile loads. It also indicated that by increasing thickness / fillet radius at cutouts, SCF has reduced. Second stage involves, development of CAD and FE models of the bracket using CATIA V5 and Hypermesh12.0 respectively. Static pressure analysis was performed on the FE model of the bracket, to evaluate stress concentration zones, which was found to have stress less than the yield stress of the material. Using Radioss 12.0, fatigue life evaluation is performed by applying fluctuating loads on the bracket and shown a fatigue life of 34 working days. Further, the fillet radius was increased to 15 mm and 20 mm and obtained a fatigue life of 56 days and 56.7 working days respectively. The outcome of this work gives a FE procedure to evaluate fatigue life of structural components having polygonal shaped cutouts using numerical tools.



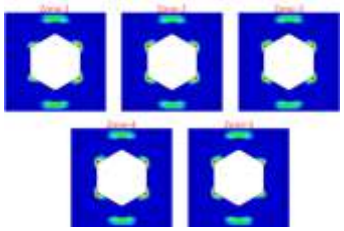
CAD model of bracket



Maximum von-Mises stress due to static analysis



Fatigue life of bracket



Fatigue life at critical locations of bracket