Performing the FEA analysis of welded joint having different shapes of fillet profile

Chetan Chadokar, Amit Kaimkuriya
Millennium Institute of Technology, Bhopal

Abstract: During welding of joint, it is necessary to maintain all the parameters to the optimum level so that the performance of welded joint gets increased. The performance of welded joint depends on different parameters that are welding current, welding speed filler material shape of component were welding is going to be done and many others. For increasing the fatigue life of welded joints, here in this work different fillet profile was made on the welding components before welding. Before welding the components, the corner fillet profile was made having different shapes and different radius of curvature. For analysing the effect of different position of concave shape fillet profile, in this work two different position that is fillet along the side of sample profile and perpendicular to side of sample profile was analysed. It also analysed the effect of giving chamfering on both side as considered in concave shape fillet. For analysing the effect of different fillet curvature radius on the performance of joint, it considered four different radius of curvature in each case. For measuring the performance of welded joint, numerical fatigue analysis of joint was done using ANSYS static-structure. It calculates the value of equivalent stress, total deformation and fatigue life cycle of joint for each case of analysis. Through numerical analysis it is found that sample having perpendicular fillet profile with 140 mm curvature radius shows maximum number of fatigue life cycle as compared to other profile.

Keywords: joints, fillet, fatigue life, deformation, strength, von misses stress

1. Introduction

The strength of the welded joints depends on different parameters of the welding and shapes of the components which are going to be weld. For increasing the performance and life of the welded joint, here in this work different fillet profiles were given to the welding components and life of the joint was calculated through numerical analysis using finite element method (FEM). For analyzing the effect of different profiles here it considered concave, convex and fillet types profiles having different radius and slopes. The finite element analysis of each case was analyzed in deep and calculates the value of fatigue life of the joint in each case. The complete simulation and FEM of different case was shown in the below section.

2. Development of finite element analysis of joint

In order to achieve the above mention objectives, it is necessary to first develop the finite element analysis model of joint. For developing the model first it has to develop the solid model of joint that is considered during the validation is shown in the below fig.

For performing the numerical analysis of joint the solid model of joint which is developed on the basis of geometric parameters as mention in the base paper and considered during the validation is shown in the below fig.
Above fig. shows the computational zone model which is considered during the fatigue analysis of joint. After developing the solid model mesh of the given geometry is performed. The mesh of the complete geometry is shown in the below section.

2.2 Meshing
During meshing the complete body get discretize in to number of nodes and elements. For performing FEM analysis and getting exact answer it is necessary to optimize the number of nodes and elements required to discretize complete geometry. Here in this case of tetrahedral elements is considered to discretize the complete solid model of joint. The mesh of the given system considered during analysis is shown in the below fig.

2.3 Boundary condition
For validating the FEM model of joint same boundary conditions was applied on the current model of joint as considered during the experimental analysis performed in the base paper. During FEM analysis of joint, 810 kN load is applied on the one side of the joint component where as other another side of the component were remain fixed. The application of load on the joint is shown in the below fig.

2.4 Conditions considered during the fatigue analysis
For performing the fatigue analysis of joint different boundary conditions was considered during the analysis. During fatigue analysis of joint fully reverse loading was considered and for determining the fatigue life of component Goodman theory was considered during numerical analysis of joint. The selection of different conditions was shown in the below figure.
3. Validation of fem analysis of joint

For validating the FEM numerical analysis of joint, here in this work it first initially considered the case of joint with sharp corner edge joint of two component as considered during the experimental analysis performed in the base paper. With the help of numerical analysis it calculates the value of equivalent stress, total deformation and fatigue life of joint.

4. Result and Discussion

4.1 Effect of corner Fillet profile

Here in this case effect of different corner fillet profile was analyzed. For evaluating the effect of different shapes of fillet profile on the performance of joint concave, convex and chamfering profile were considered during the analysis of joint. It also calculated the effect of give profile that is along the side of sample profile and perpendicular side of sample profile. With change in profile shapes, effect of change in fillet profile curvature radius was also analyzed during the analysis of joint.

The performance parameters for perpendicular side fillet with different radius is mention in the below table.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Perpendicular side fillet radius (mm)</th>
<th>Equivalent stress (MPa)</th>
<th>Total Deformation</th>
<th>Fatigue life (cycle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>125.98</td>
<td>0.425</td>
<td>139170</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>125.35</td>
<td>0.416</td>
<td>141740</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>122.29</td>
<td>0.409</td>
<td>155050</td>
</tr>
<tr>
<td>4</td>
<td>140</td>
<td>119.13</td>
<td>0.396</td>
<td>170460</td>
</tr>
</tbody>
</table>

4.2 When fillet provided along the side of the sample profile

Here in this case of analysis, fillet profile is given along the same side where sample profile is given. For this case also it analyzed the effect of different fillet radius and calculates the different performance parameters.
Table 4.2 Value of different output parameters for different fillet radius.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Alongside fillet radius (mm)</th>
<th>Equivalent stress (MPa)</th>
<th>Total Deformation (mm)</th>
<th>Fatigue life (cycle)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>80</td>
<td>127.12</td>
<td>0.443</td>
<td>127458</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>125.78</td>
<td>0.424</td>
<td>139980</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>123.45</td>
<td>0.417</td>
<td>151478</td>
</tr>
<tr>
<td>4</td>
<td>140</td>
<td>121.41</td>
<td>0.408</td>
<td>164780</td>
</tr>
</tbody>
</table>

From above table it is found that as we are increasing the fillet radius of joint the life of the joint get increased, whereas the value of stress get decreases.

5. Comparison of joints having different corner profiles
In order to increases the fatigue life of the joint different corner profiles with different specification were analyzed numerically. So in order to find the best corner profile for increasing the life of joint it is necessary to compare equivalent stress, total deformation and fatigue life of the component of different joints. The comparison of joint having different profiles shows the feasibility of each case and through that it can predict the working nature of joint.

![Equivalent Stress Graph](image)

Fig 4.43 comparison of value of equivalent stress for different samples having different fillet profiles.

From above comparison graph it is found that value of equivalent stress for sample 5 that is joint having 80 mm fillet profile along the side of sample profile shows the maximum value of equivalent stress. Whereas sample 4 that is joint having 140 mm fillet profile perpendicular to the side of sample profile shows the minimum value of equivalent stress.

6. Conclusion
- Form analysis it is found that in case of fillet, as the fillet radius increases the fatigue life of the joint get increases.
- From alongside and perpendicular side of fillet profile given to the joint, it is found that for perpendicular side fillet fatigue life of the sample is higher than the alongside of sample for all fillet radius.
- Through analysis it is found that the life of the sample having chamfering along the side as well as perpendicular side both have low life as compared to fillet profiles.
It is conclude that perpendicular side fillet profile having 140 mm radius shows the maximum life of joint as compared to other joint with different profiles.

References