THERMAL ANALYSIS OF PROJECTION WELDING

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Abstract - *This paper has developed a three-dimensional finite element model to simulate dynamically the Projection Welding process of steel sheets. The numerical simulation was conducted using a non-linear transient thermal analysis by changing the welding parameters. A moving Gaussian distributed heat source is implemented. All major physical phenomena associated with the Projection Welding process, such as thermal conduction and convection heat losses, are considered in the model development. The developed model can calculate the temperature field and predict the weld geometry profile during the welding process. The model employs the conjugate heat transfer analysis technique to avoid estimating a value for the heat transfer coefficient that arises with conventional heat transfer analysis. We are going to fix the nut on the plate Using projection welding. we are using study state thermal analysis. To find the temperature distribution on the nut and plate using ANSYS 2022R2.*

Key Words: **Projection Welding, Finite Element Analysis, Temperature, Heat flex, Mesh…**

1. INTRODUCTION

Welding is a common method of joining metals. A method of joining two or more metals together using temperature at the molecular level. Two pieces of metal can be joined using molten filler metal at the point of joining. Some external welding can be done without filler metal using pressure and heat. Welding is widely used in the construction and automotive industry. The welding process is very easy to understand and learn its basic technique. Gas metal arc (MIG), gas tungsten arc (TIG), carbon arc, and oxy-hydrogen gas welding are the most common types of welding used in industries. Projection welding is a type of electric projection welding. Forms a connection between suitable electrodes at an internalized point in the workspace under pressure. Unlike other types of welding, projection welding uses heat and pressure to bond the two metals together using a lump of metal. The heat used is generated by electrical resistance. Used in the electronics and automotive industry. Projection welding varies depending on the welding design, force, power, time, type, and thickness of the material being welded.

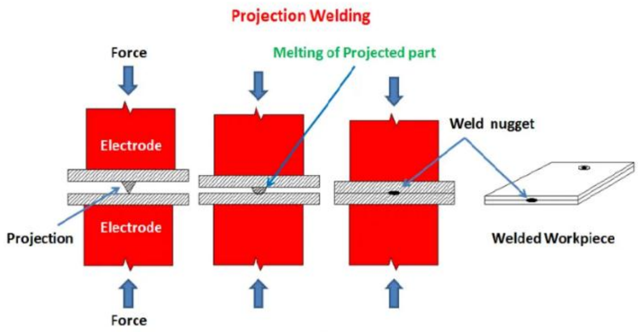

Fig -1: Projection welding

2. THREE-DIMENSIONAL MODELING

In our project, we designed 3D models of the tool and the weld plates using AUTOCAD software. AUTOCAD is a family or suite of design software supporting product design for discrete manufacturers and is developed by Autodesk. Autodesk is a scalable, interoperable suite of product design software that delivers fast time to value. It helps teams create, analyze, view, and leverage product designs downstream utilizing 2D CAD, 3D CAD, and parametric & direct modeling. AUTOCAD provides the broadest range of powerful yet flexible 3D CAD capabilities to accelerate the product development process. By automating tasks such as creating engineering drawings, we can avoid errors and save significant time.

The software also lets us analyze, create renderings and animations, and optimize productivity across a full range of other mechanical design tasks, including checking how well our design conforms to best practices. AUTOCAD Parametric enables us to design higher-quality products faster and allows us to communicate more efficiently with manufacturing, and suppliers.

In our present work, we considered two similar metals STEEL perform projection welding on them, For this purpose, we created 3D models of the weld plates, the nut of both the metals to be joined, and the tool profiles with which the stir welding is performed, with the following specifications Length of the plate = 100mm

Width of the plate = 30mm

Diameter of the nut= 5mm

Thickness= 3.5mm

Height= 10mm

Welding projection height=0.6 mm

Welding projection radius = 0.7mm

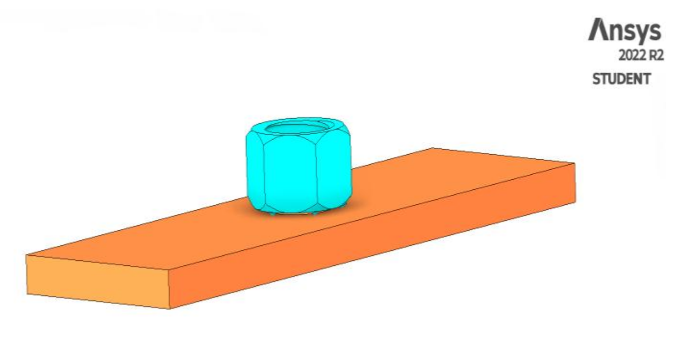

Fig -2: Plate and nut (stage 1)

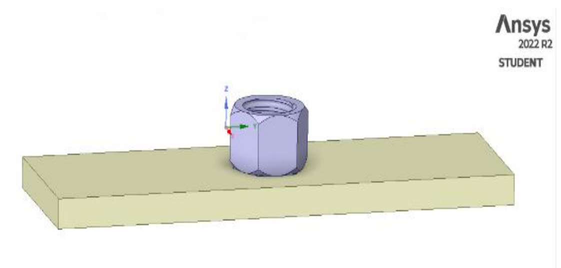

Fig -3: Plate and nut (stage 2)

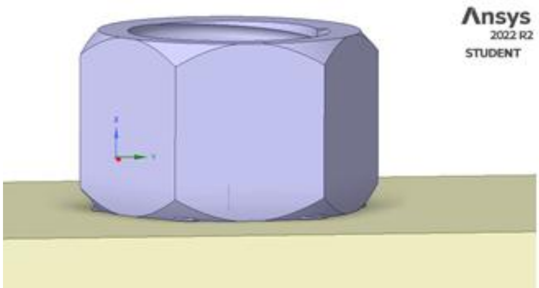

Fig -4: Plate and nut (stage 3)

3. WORKING PRINCIPLE

As per the definition, different projections are formed in this welding technique. Here, the metal pieces that are to be joined are kept in between the two electrodes. A larger pressure force is applied to the electrodes. As current is passed through the system, heat formation takes place due to the internal resistance of the metal workpieces. One point that you must note down here, is that the heat generation takes place due to the internal resistance of the metal workpieces rather than an electric arc. Those projections concentrate the heat. As the pressure applied to the electrodes increases, this projection collapses and the formation of the fused weld nugget takes place. Thus, a quality weld is formed.

3.1 Advantages

Now, it is time to know about the advantages. So, let's discuss some of the most important benefits of this welding technique:

- As above stated, this welding requires a very small supply of current, and thus, it saves electricity usage.
- So, less electricity requirement and a longer electrode life are the two most prominent benefits of this welding process.
- While doing spot welding there is a limitation on the thickness of the metal that has to be welded. But in this welding, almost metals of all thicknesses are welded.
- It can be used effectively for welding joints that are in complicated locations.
- The heat balance is an important part of any welding process and this welding gives a good heat balance while welding.

3.2 Disadvantages

- This welding process does not apply to some types of coppers and brasses.
- Projection formation is a quite complicated process and it takes time to form the projections. It is very difficult to form a spherical projection and a skilled person is required to form such projections. While making those projections, the height of the projection has to be maintained properly.
- This process does not apply to all types of workpieces. The composition of the metal workpieces has to be considered while this process and it has some limitations.

3.3 Application

As Projection welding is mostly used for mass production. It has many applications such as:

- The automobile industry uses projection welding to a very large extent. This welding process is also used for fan covers and hollow metal doors. It is also used for producing compressor parts and for semiconductors.
- Have you heard about diamond segment welding? In diamond segment welding, projection welding finds its applications.

So, this is the exact working principle as well as the advantages, disadvantages, and applications of projection welding. We are sure that you get the exact details of the projection welding.

4 RESULTS AND ANALYSIS

4.1 Thermal analysis of stage 1

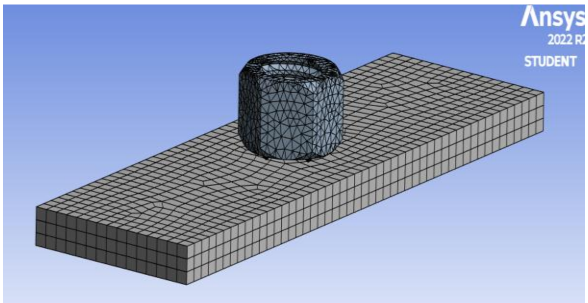

Fig -5: Mesh modal

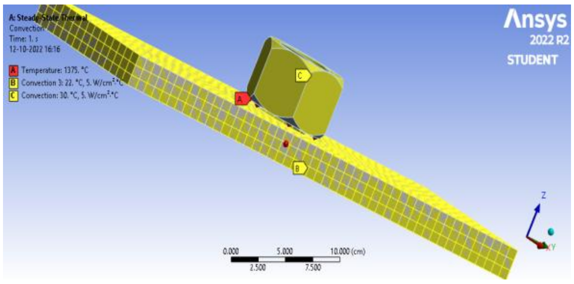

Fig -6: Boundary condition

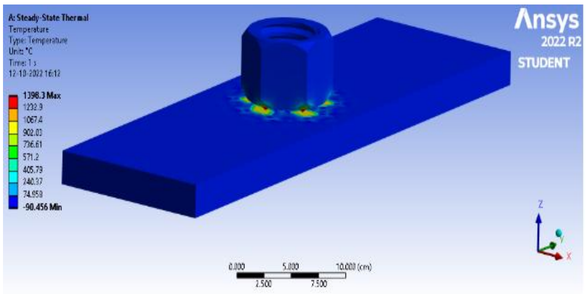

Fig -7: Temperature distribution

From the above figure, the temperature distribution on the weld plates is obtained in stage 1. The blue color indicates the lowest temperature zone which is 90.546oC and the red color, which was below the tool, ie at the tool tip indicates the maximum temperature zone which is 1396 C. The intermediate temperatures are obtained in the middle range indicated by different colors in the graph.

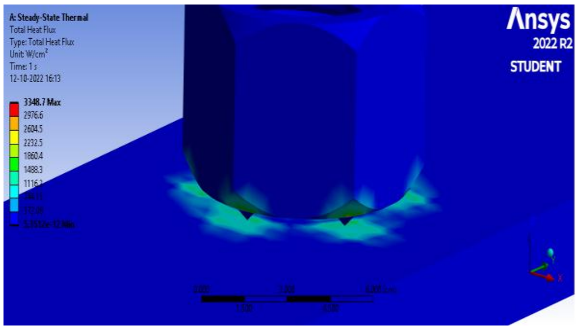

Fig -8: Heat flex

From the above figure, the total heat flux on the weld plates is obtained. The blue color indicates the area of lowest heat flux which is 5.3512e-12W/mm2 and the red color indicates the area of maximum heat flux which is 3348.7 W/mm2. The intermediate values of total heat flux on the weld plates are obtained in the middle range indicated by different colors in the graph.

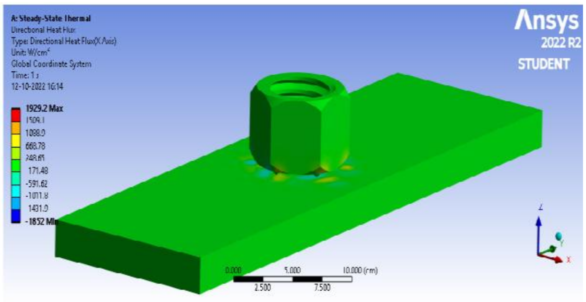

Fig -9: Directional Heat flex

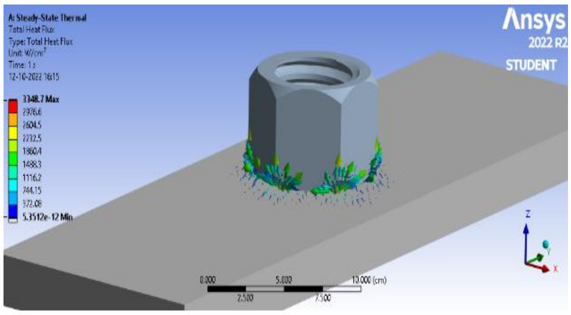

Fig -10: vector on plate and nut heat flex

Table -1: Analysis Result Stage 1

Results	Minimum	Maximum	Units	Times(s)
Temperature	-90.456	1398.3	°C	1.
Total Heat Flux	5.3512e-012	3348.7	W/cm^2	1.
Directional Heat Flux	-1852.	1929.2	W/cm^2	1.

4.2 Thermal analysis of stage 2

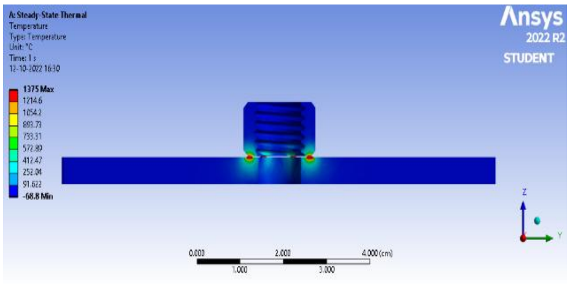

Fig -11: Temperature distribution

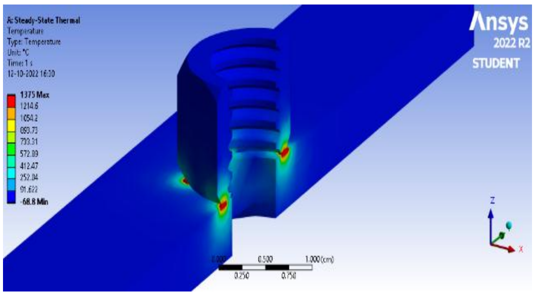

Fig -12: Temperature distribution section view

From the above figure, the temperature distribution on the weld plates is obtained in stage 2. The blue color indicates the lowest temperature zone which is 68.8oC and the red color, which was below the tool, ie at the tool tip indicates the maximum temperature zone which is 1375 C. The intermediate temperatures are obtained in the middle range indicated by different colors in the graph.

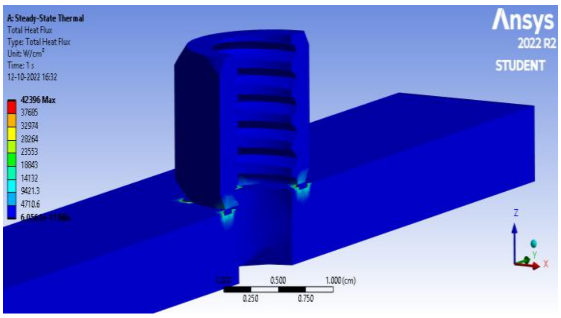

Fig -13: Heat flex

From the above figure, the total heat flux on the weld plates is obtained. The blue color indicates the area of lowest heat flux which is 6.0561e-11W/mm2 and the red color indicates the area of maximum heat flux which is 42396 W/mm2. The intermediate values of total heat flux on the weld plates are obtained in the middle range indicated by different colors in the figure.

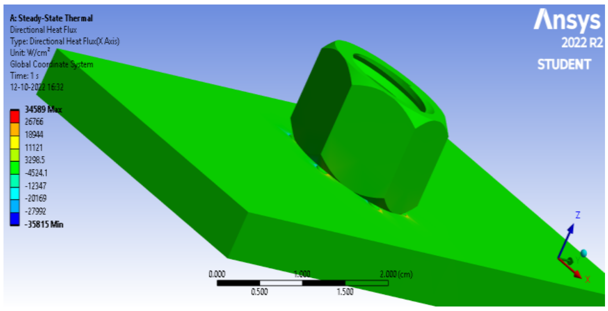

Fig -14: Directional Heat flex

Table -2: Analysis Result Stage 2

Results	Minimum	Maximum	Units	Times (s)
Temperature	-68.8	1375	°C	1.
Total Heat Flux	6.0561e-011	42396	W/cm^2	1.
Directional Heat Flux	-35815	34589	W/cm^2	1.

4.3 Thermal analysis of stage 3

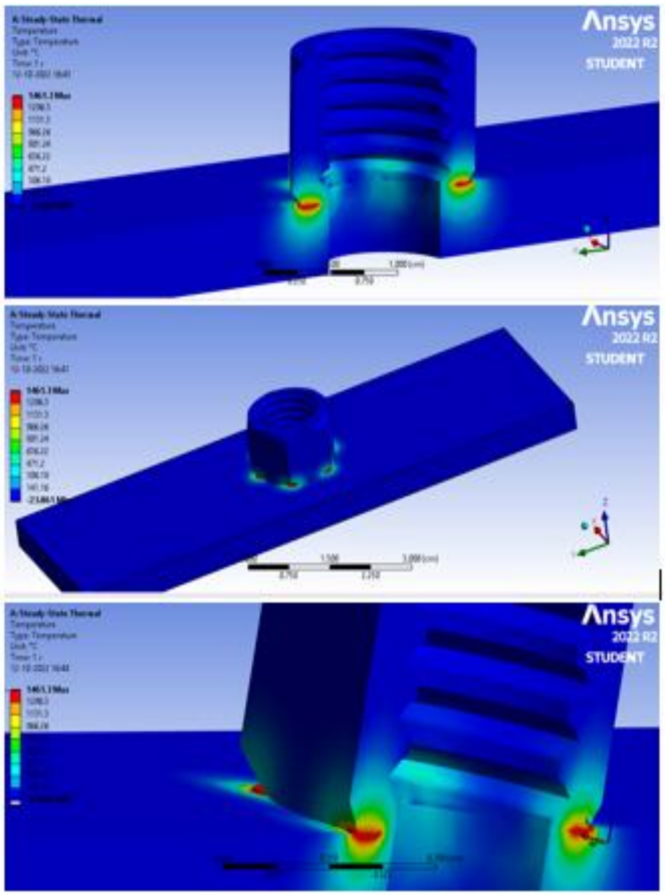

Fig -15: Temperature distribution

From the above figure, the temperature distribution on the weld plates is obtained in stage 3. The blue color indicates the lowest temperature zone which is 23.861oC and the red color, which was below the tool, ie at the tool tip indicates the maximum temperature zone which is 1461 C. The intermediate temperatures are obtained in the middle range indicated by different colors in the graph.

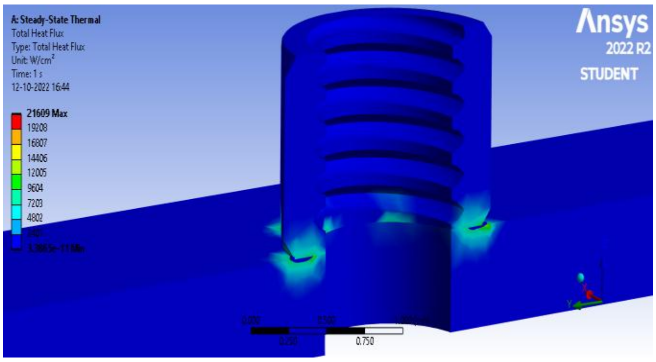

Fig -16: Heat flex

From the above figure, the total heat flux on the weld plates is obtained. The blue color indicates the area of lowest heat flux which is 3.3865e-11W/mm2 and the red color indicates the area of maximum heat flux which is 21609 W/mm2. The intermediate values of total heat flux on the weld plates are obtained in the middle range indicated by different colors in the graph.

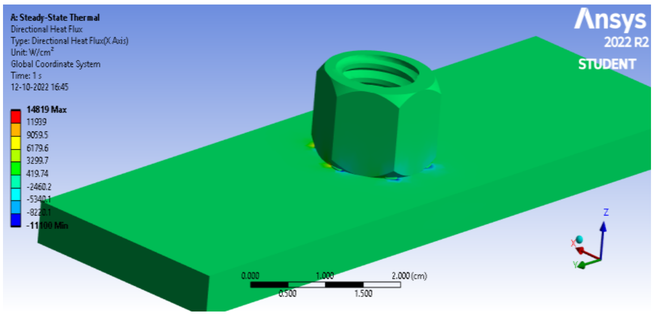

Fig -17: Directional Heat flex

Table -3: Analysis Result Stage 3

Results	Minimum	Maximum	Units	Times(s)
Temperature	-23.861	1461.3	°C	1.
Total Heat Flux	3.3865e-011	21609	W/cm^2	1.
Directional Heat Flux	-11100	14819	W/cm^2	1.

Similarly, the Thermal Analysis was performed for both round and square tooltips at traverse speeds of 60 mm/min and 80 mm/min.

V. CONCLUSIONS

3D modeling of the work plates and weld tool tips are produced and imported successfully for joining two similar metals steel. • Finite Element Analysis is done on the nut and plate. • From the Thermal Analysis temperature distribution, and thermal flux, are obtained. From the results, it is observed that thermal flux and temperature are more in stage 3 than the stage 2.The temperature produced is sufficient for obtaining the melting points of the plates. From FEA analysis it is evident that stage 3 is preferable the stage 2, in projection welding. Not remove the burr on projection welding. Not remove the burr on projection welding. 95% projection welding successfully fixed on plate and nut.

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