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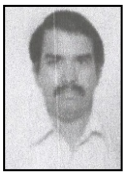
Fatigue Analysis of Welded Joint by Varying Weld Bead Size



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ABSTRACT:

Failure of welded structures/machine components lead to various direct losses such as the cost of repair work, the cost of the work to prevent future failure and accident compensation, and indirect losses such as decrease in production and a damage to company's image. Joints being the weakest elements in any structure/machine are likely to fail first. It is, therefore, imperative to understand the failure of these joints. Understanding a failure occurrence and its propagation will lead to a better appreciation of welded joints from reliability point of view. It may be possible that a few cause events or failure causes may be crucial and could be minimized at design or fabrication stage leading to failure minimization of such joints. Arc welding, which is heat - type welding, is one of the most important manufacturing operations for the joining of structural elements for a wide range of applications, including guide way for trains, ships, bridges, building structures, automobiles, and nuclear reactors, to name a few. It requires a continuous supply of either direct or alternating electric current, which create an electric arc to generate enough heat to melt the metal and form a weld. In this process, stress concentration at the welded joints is analyzed. The type of joints considered is Tree Joint, Butt Joint and Lap Joint. Structural and Fatigue analysis is done on the welded joint in solidwork simulation.

INTRODUCTION:

Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material. Welding is used for making permanent joints.

It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.Welding is fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is often added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that can be as strong as the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld.

WELDING FORCES:

During welding a number of forces will act on the tool:

•A downwards force is necessary to maintain the position of the tool at or below the material surface. Some friction-stir welding machines operate under load control but in many cases the vertical position of the tool is preset and so the load will vary during welding.

•The traverse force acts parallel to the tool motion and is positive in the traverse direction. Since this force arises as a result of the resistance of the material to the motion of the tool it might be expected that this force will decrease as the temperature of the material around the tool is increased.

•The lateral force may act perpendicular to the tool traverse direction and is defined here as positive towards the advancing side of the weld.

•Torque is required to rotate the tool, the amount of which will depend on the down force and friction coefficient (sliding friction) and/or the flow strength of the material in the surrounding region (sticking friction).

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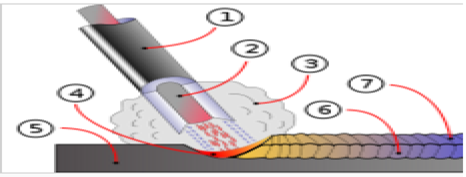

Diagram of arc and weld area, in shielded metal arc welding.
1. Coating Flow
2. Rod
3. Shield Gas
4. Fusion
5. Base metal
6. Weld metal
7. Solidified Slag

WELD JOINTS:

Welds can be geometrically prepared in many different ways. The five basic types of weld joints are the butt joint, lap joint, corner joint, edge joint, and T-joint (a variant of this last is the cruciform joint). Other variations exist as well—for example, double-V preparation joints are characterized by the two pieces of material each tapering to a single center point at one-half their height. Single-U and double-U preparation joints are also fairly common—instead of having straight edges like the single-V and double-V preparation joints, they are curved, forming the shape of a U. Lap joints are also commonly more than two pieces thick—depending on the process used and the thickness of the material, many pieces can be welded together in a lap joint geometry.

SOLID WORKS:

Solid Works is mechanical design automation software that takes advantage of the familiar Microsoft Windows graphical user interface.It is an easy-to-learn tool which makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.A Solid Works model consists of parts, assemblies, and drawings.

•Typically, we begin with a sketch, create a base feature, and then add more features to the model. (One can also begin with an imported surface or solid geometry).
•We are free to refine our design by adding, changing, or reordering features.
•Associativity between parts, assemblies, and drawings assures that changes made to one view are automatically made to all other views.
•We can generate drawings or assemblies at any time in the design process.
•The Solid Works software lets us customize functionality to suit our needs.

INTRODUCTION TO SOLID WORKS:

Solid works mechanical design automation software is a feature-based, parametric solid modeling design tool which advantage of the easy to learn windows TM graphical user interface. We can create fully associate 3-D solid models with or without while utilizing automatic or user defined relations to capture design intent.Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent.

CAD PRODUCTIVITY TOOLS :

Solid Works Toolbox is a library of parts that uses “Smart Part” Technology to automatically select fasteners and assemble them in the desired sequence.
SolidWorks Utilities is software that lets designers find differences between two versions of the same part, or locate, modify, and suppress features within a model.
FeatureWorks is feature recognition software that lets designers make changes to static geometric data, increasing the value of translated files. With FeatureWorks, designers can preserve or introduce new design intent when bringing 3D models created in other software into the SolidWorks environment.

SOLIDWORKS INTERFACE :

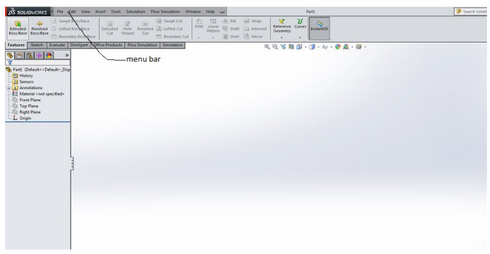

Figure 15 :solidworks interface.

MODELING OF WELD PLATES

Two plates of 60mmx40mmx5mm are modeled and assembled by using weld bead.

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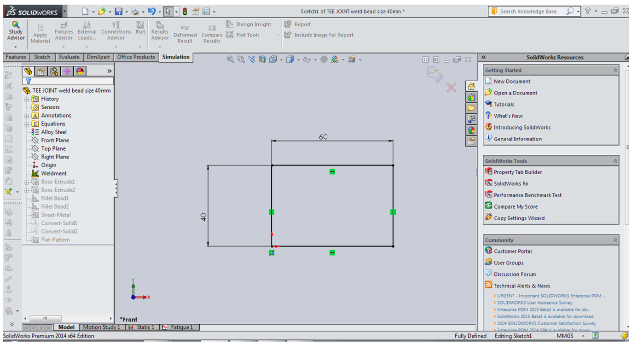
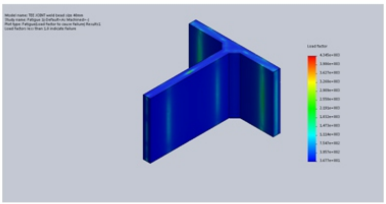
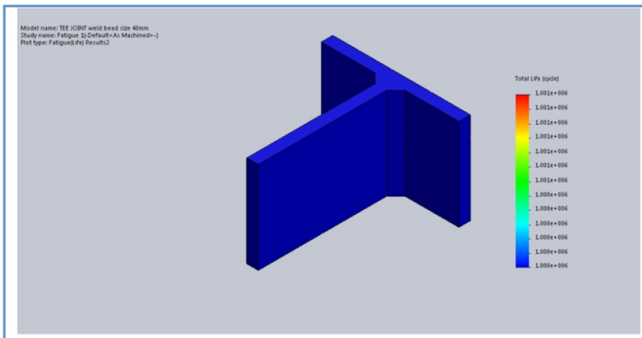


Study Results

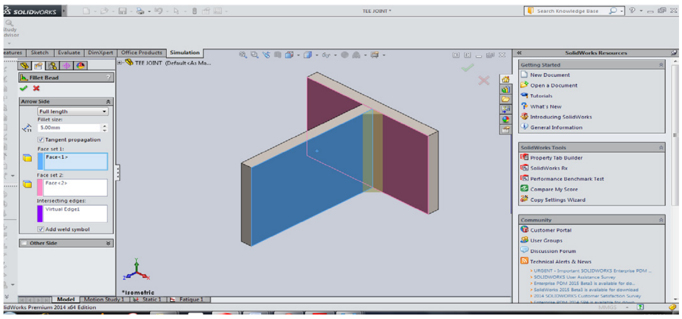
Name	Type	Min	Max
Results1	Load factor	36.7711 Node: 13282	4344.51 Node: 7752



Name	Type	Min	Max
Results2	Life plot	1e+006 cycle Node: 1	1e+006 cycle Node: 1

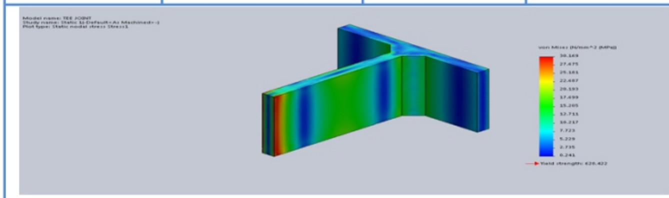


STRUCTURAL ANALYSIS OF WELD PLATES OF WELD BEAD OF 5mm



Study Results:

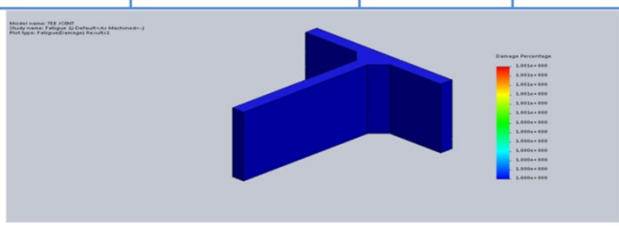
Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.241231 N/mm^2 (MPa) Node: 9016	30.1688 N/mm^2 (MPa) Node: 14015



Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.99567e-006 Element: 6974	0.00010627 Element: 7776

FATIGUE ANALYSIS OF WELDED JOINT OF WELD BEAD 5mm:

Name	Type	Min	Max
Results1	Damage plot	1 Node: 1	1 Node: 1



STRUCTURAL ANALYSIS OF WELD PLATES OF WELD BEAD OF 3mm

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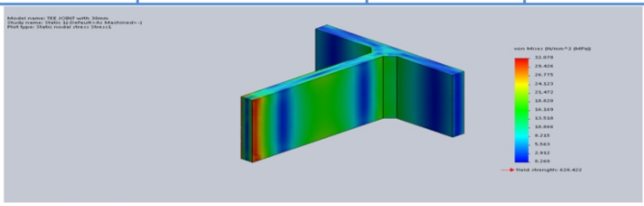
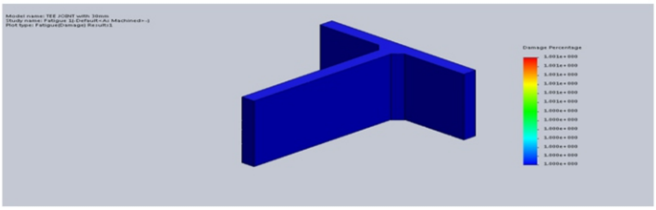
Name	Type	Min	Max
Stress1	VON: von Mises Stress	0.260326 N/mm^2 (MPa) Node: 8294	32.0776 N/mm^2 (MPa) Node: 12577



FATIGUE ANALYSIS OF WELDED JOINT OF WELD BEAD 3mm

Name	Type	Min	Max
Results1	Damage plot	1 Node: 1	1 Node: 1



RESULTS AND DISCUSSIONS

Structural analysis Results:

	Weld bead 3mm	Weld bead 4mm	Weld bead 5mm
Vonmisses stress(Mpa)	32.077	30.9968	30.168
Resultant displacement(mm)	0.00971165	0.00921504	0.00873802
Equivalent strain	0.000113874	0.000110669	0.00010627

Fatigue Analysis Results:

	Weld bead 3mm	Weld bead 4mm	Weld bead 5mm
Life plot	1	1	1
Damage plot	1e+006 cycle	1e+006 cycle	1e+006 cycle

CONCLUSIONS:

•The stress distribution in different welded Joints is investigated with a computer modeling technique.
•The finite element analysis is used for the analysis of joints in the plane – stress condition, under static load.
•Modeling is done in SOLIDWORKS and analysis is done in SOLIDWORKS SIMULATION.
•The T – joint Structural and fatigue analysis are done in solid works simulation. By observing the structural analysis results, all the joints are withstanding the applied pressure as the analyzed stress values are less than the yield strength of steel. T
•he Tree Joint has produced more stress than other joints, so if the load on the welded joint is more, the tree joint fails first than other joints.
•Fatigue analysis is done to analyze the fatigue usage by applying cyclic loading. By observing the analysis results, the fatigue usage is more for Butt Joint, so the life of the Butt Joint is less than other two joints.

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