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Design and Analysis of Welding Fixture for Inlet Header of Shell and Tube Heat Exchanger

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Abstract— The welding fixture is a special tool for locating, holding and supporting a work piece in during welding operation**.** In welding fixture positioning of a workpiece achieved through locators to maintain the dimensional accuracy. This can be achieved by selecting the optimal location of fixturing elements such as locators and clamps. Design, modeling and analysis of welding fixture components for inlet header of shell and tube heat exchanger. The V locators, Clamp Wheel, Side Bracket and supporting plates are used for locating, clamping the inlet header and to get dimensional accuracy and constrain Degree of Freedom (DOF) completely. Modeling of fixture is done by using Creo 2.0 software. OptiStruct solver software is used to perform FEA simulation and to calculate vibration characteristics which are validated by FFT Analyser. Multiple mode shapes with natural frequencies are plot by using FFT Analyser.

Keywords— Welding Fixture Clamping, Creo 2.0, OptiStruct, FFT Analyser.

INTRODUCTION

Generally Fixture is used in various industries according to their application Fixture will provide dimensional accuracy of welded component and hold exceptional in manufacturing manner. This also increase productiveness and reduce operation time. The welding fixture is extensively used within the enterprise realistic production due to feature and blessings. A fixture includes a set of locators and clamps. Locators are used to decide the location and orientation of a workpiece, while clamps exert clamping forces so that the workpiece is pressed firmly in opposition to locators. Clamping has to be as it should be planned at the level of machining fixture layout. The design of a fixture is an incredibly complex and intuitive technique, which require information. Fixture design performs a critical position at the setup making plans segment. Proper fixture design is important for developing product quality in extra ordinary phrases of accuracy, surface finish and precision of the machined elements. [4]

1. Design Methodology

- **3D Parametric Model of Inlet Header:**

Firstly we have developed 3D parametric model by using Creo 2.0 parametric software as per the drawing and model of inlet header of shell and tube heat exchanger as shown in fig.1

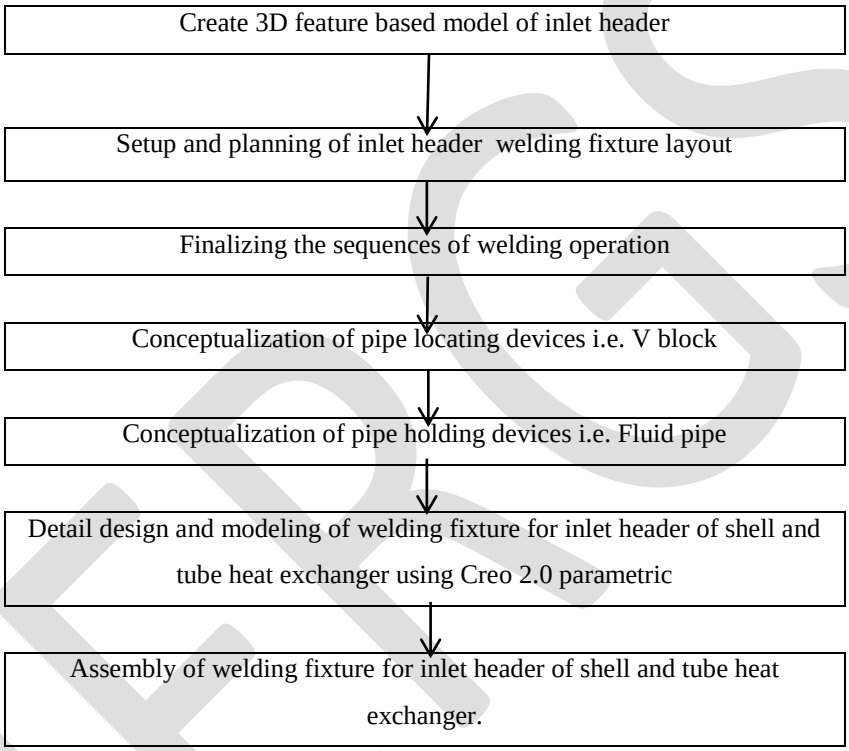
Fig. 1: 3D Parametric Model of Inlet Header

- **Finalized Sequence of Welding Operations**

Welding sequence is very important consideration before going for fixture layout.

1. First fluid pipe welding
2. Second fluid pipe welding
3. Pressure gauge welding
4. Thermowell welding
5. Flange welding

- **Setup and Planning of Inlet Header Welding Fixture Layout**



From a layout point of view, welding fixture fulfills five basic functional requirements:

1. strong resting
2. correct localization
3. support reinforcement
4. stable clamping
5. Accurate welding.

- **Selection and 3D Modeling of Locating and Clamping Devices**

The Following locators and clamps are selected for inlet header welding fixture:

V Locator: V locator is used to locate inlet header because it ideal and extensively cylindrical surfacees from outside.V block is fixed to base plate. Inlet header main pipe is place on V block. Four DOF i.e. UY, UZ, (ROT Y) and (ROT Z) are fixed.

End Bracket: It is used to restrict the UX DOF and locate the pipe at exact dimension. It also used as a support during welding of end plate to main pipe. It is having a half circulate cut to rest the end plate. It is screwed to the base plate.

Side Bracket: The main function is to locate the Fluid pipes to main pipe at exact position so that we get dimensional accuracy during welding. It also used as a support during welding. It is screwed to the base plate. The last DOF i.e. (ROT X) is also constrained.

Screw Clamps: They are used to firmly hold the header pipe during the welding process. It screwed to V block and operates by clamping wheel mounted on stud. Y axis (ROT Y) and translation in Z axis UX direction.[9]

- **Assembly of Inlet Header Welding Fixture Using Creo 2.0 Parametric:**

Top down design approach is used to design fixture in Creo 2.0 software where all parts are design in consideration with inlet header welding process as shown in Fig 2

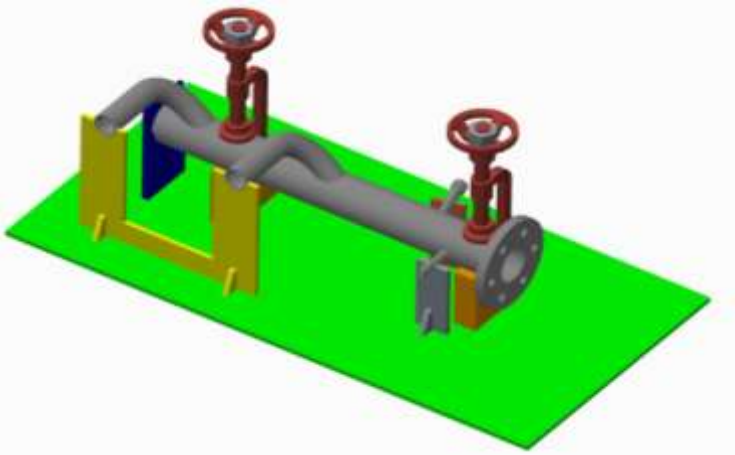


Fig 2: Assembly Design of Inlet Header Welding Fixture

2. Modal Analysis

Modes are inherent residences of a shape, and determined by material property like mass, damping, and stiffness and boundary situations of the shape each mode is described by using a natural (modal) frequency, modal damping, and a method form.

HyperMesh 12.0 and OptiStruct solver software are used for meshing and modal analysis simulation. Assembly model of creo 2.0 parametric is exported in .iges format and imported in the HyperMesh 12.0. Meshing was done with appropriate mesh size and quality parameters then imported in OptiStruct for vibration analysis. In OptiStruct software use the material properties like Young's modulus, Poisson ratio, density and fixed support boundary condition are given. Multiple modes are extracted to simulate realistic modes as shown in Fig 3.

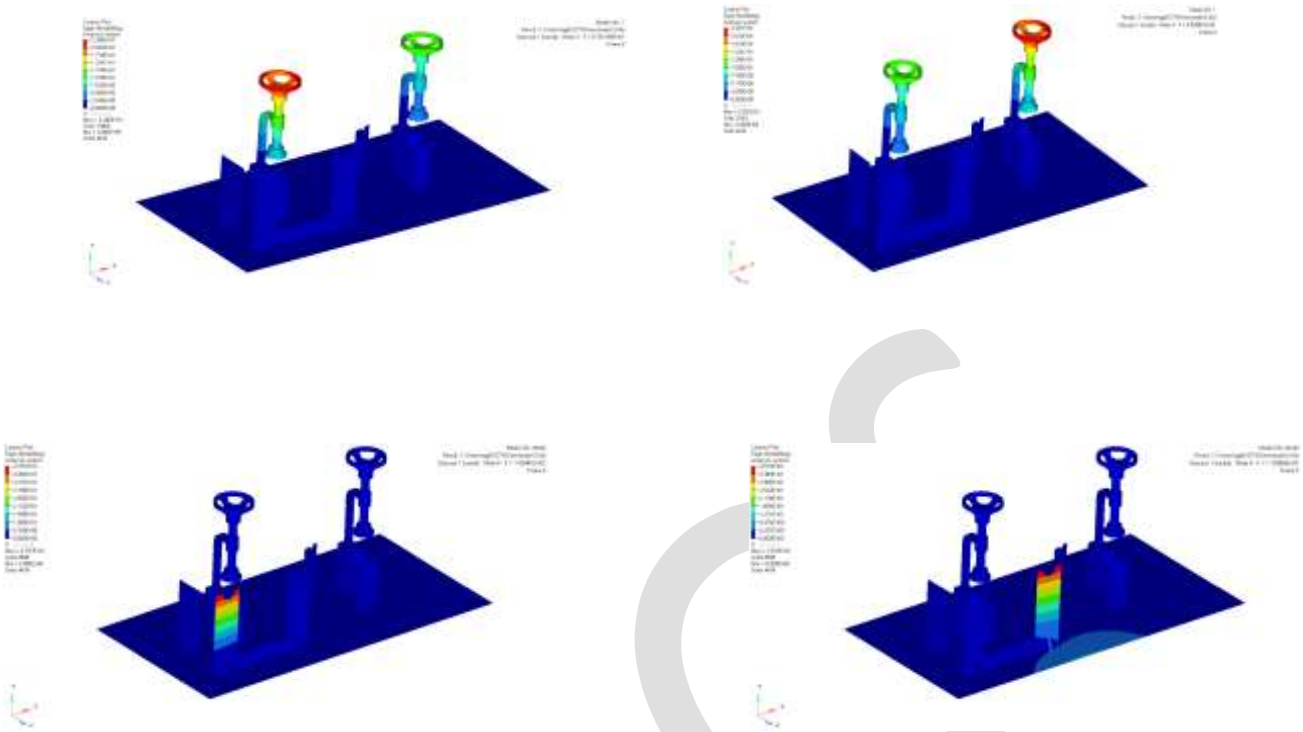


Fig 3: Multiple Mode Shapes with respective Natural Frequencies

3. Experimental Setup

Welding fixture parts are manufactured in the workshop according to dimensions of model which show in fig. 4. Base plate with 10 mm thickness is cut into 1200 X 600 mm size which is mounted on table. V block and other supporting brackets are manufactured as per design. The actual welding process was done with the set up to check dimensional accuracy.[3]

The instrument used in this study are the SVAN 958- A made 4-channel FFT Analyser with 1Hz to 20 kHz Frequency range and accelerometer with magnetic based.

Fig 4: Experimental Testing Setup

Table No.1 Welding Fixture Part List

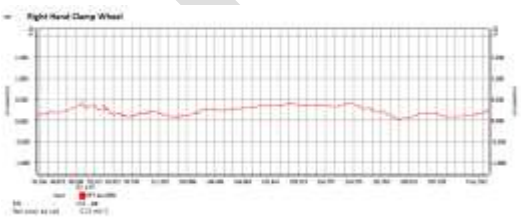
Sr. No	Part Name
1	Clamping wheel
2	End plate
3	Side bracket
4	Accelerometer
5	Thermowell support bracket
6	V block
7	Pressure tube support bracket
8	FFT
9	Base plate

1. In this graph shows that frequency of vibrating body right hand clamp wheel. In this FFT analysis shows frequency 62.145Hz.

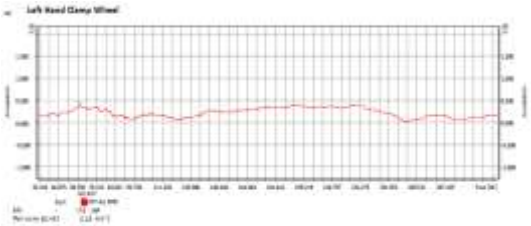
2. In this graph shows that frequency of vibrating body left hand clamp wheel. In this FFT analysis shows frequency 60.457 Hz.

3. In this graph shows that frequency of vibrating body right hand side bracket. In this FFT analysis shows frequency 149.923Hz.

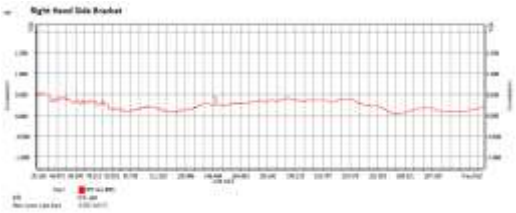
4. In this graph shows that frequency of vibrating body left hand side bracket. In this FFT analysis shows frequency 117.159 Hz.



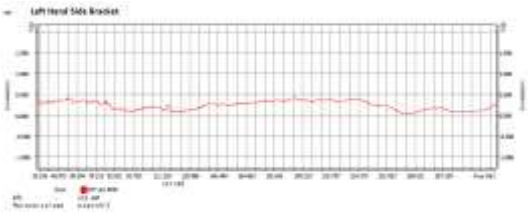
Graph. 1



Graph. 2



Graph. 3



Graph. 4

Fig. 5: FFT Testing Graphs.

4. Result and Discussion

The results are listed in the Table 2 and variation in results is 3.986 to 9.793 %.

Table 2: Result Comparison

Sr.no	Welding fixture part name	FFT Experimental results (Hz)	Modal analysis result (Hz)	Error (%)
1	Right hand clamp wheel	62.145	68.308	9.022
2	Left hand clamp wheel	60.457	67.021	9.793
3	Right hand side bracket	149.923	143.946	3.986
4	Left hand side bracket	117.159	110.006	6.105

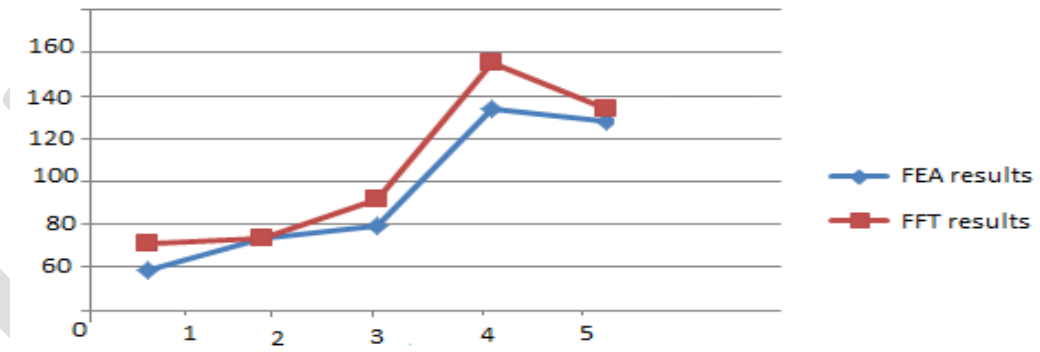


Fig. 6: Variation in FFT and FEA Results

Conclusion

The welding fixture design procedure is validated by actually manufacturing the welding of inlet header which reduces the welding time and increase dimensional accuracy which subsequently help for mass production of inlet header of shell and tube heat exchanger. As compare with manual welding process, Fixture Welding Process for inlet header reduces 75% less time for welding and it also shows that accuracy of fixture welding is higher than manual welding.

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