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Design and Analysis of Welding Electrode Coating die and set up for coating of flux on SS308 core wire

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Abstract

This project deals with designing and developing of welding electrode coating set up for coating of flux on SS308 core wire. The composition and constituents of flux material like rutile, dolomite, etc. are used for coating of core wire. These compositions can be varied well on hit and trial basis to attain the desired results and observe reduction of welding defects. A small set up for preparing the flux cored welding wires specially for welding austenitic stainless steel of SS 308 is designed using manual feeding and collecting system. Basic process parameters like die cross section, required pressure, wire feed rate in die and volume of flux material required for proper coating of single electrode are calculated with the help of data obtained by industry survey. Analysis of the die used in setup has been presented in this paper. With the help of the calculated values an appropriate die of AISI 304 is designed.

Keywords: *welding defects, flux cored welding wires, rutile etc.*

INTRODUCTION

Welding wires are used in the welding of different metals, in the fabrication of tools for chemical & allied industries, factory sheds, manufacturing of ships, vehicles etc. Welding electrodes comprise of steel core wire and coating ingredients or flux. Stainless steel wires are used for welding in fertilizer, chemical & surgical instruments making industry. Coating ingredients like rutile, potassium silicate, sodium silicate, minerals like quartz, calcite mica etc. These compositions with appropriate constituent play very crucial role in controlling various defects like undercutting, spattering, bubble intensity, hydrogen embrittlement. These compositions can be varied well on the basis of various chemical characteristics exhibited by them using hit and trial basis to attain the desired results and observe reduction of said defects (**Bracarense and Liu, (1997)).** The enormous potentials of flux material can be harnessed if proper research is done on its composition and constituent in the coating of wires. Such a setup that can produce limited number of experimental coated wires to facilitate hit and trial activity on the composition and analyze their effect on welding defects is to be designed and fabricated **(Kakkar et all, (2013)).** This will help in carrying out the analysis of composition on a very economical scale. A small set up for preparing the flux cored welding wires specially for welding as SS 308 is designed using manual feeding and collecting system.

Design Parameters

Material Selection

Cast iron material is used for the base of the setup because it has high toughness, hardness, ductility and elasticity. Cast iron is easily weld and metal transfer to join.

Design Calculations

Initial diameter of core wire= 2 mm
Coating factor is defined as the ratio of coating diameter to the core diameter and is taken as 1.5
Pressure force required= 150kgf (From Industry Survey)
Length of electrode= 300 mm (Standard)

Final diameter of electrode taken standard coating factor in consideration is 3 mm.
Calculated volume of flux required for one electrode
V_1 =1175.5 mm^3 ……. (1)
A DC motor of 100 RPM for giving rotation to the screw holding the core electrode wire is chosen.
Pitch of the screw is 2 mm.
Calculated length of wire travelled in one second
= (wire length)/ (speed of the wire)
= 7.16 mm/sec …… (2)
Calculated time required for complete traveling of wire is 41.87 sec.
Calculated flow rate of flux is 28.07mm^3/sec.
Pressure force required (F_1) is 150kgf or 1471.5 N (From Industry Survey).
Thus, pressure required for feeding flux in die is 83.27 KN/m^2.
A hydraulic jack of diameter 20 mm and 3000 kg capacity is used for applying the required pressure.
Thus, force required (F_2) for pushing electrode wire in die is 2609.97 N.

Child parts of set up
A 60 mm long and 50 mm diameter cylindrical block made up of AISI 304 was designed. A tapered hole of 2mm diameter at one end and 3.7mm at the other end with taper angle of 0.8^0 across the length of the die was drilled. A 20 mm drill was given on the top side of the die for the flux supply as shown in figure 1.

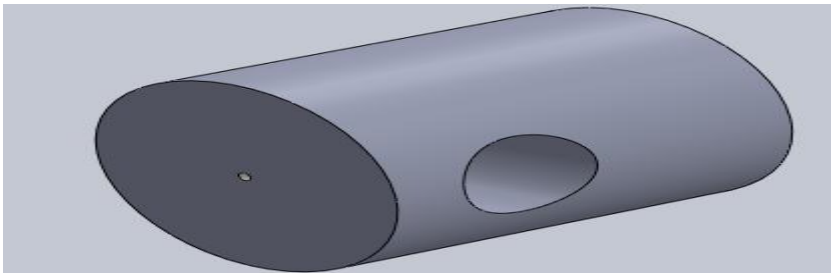

Fig 1 *Design of die on solid works 13*

In order to resist the movement of the die when pressure is applied over it through a jack, 2 U clamps are employed. These adjustable clamps are easily removable and keep the die in fixed position. For facing the flux to be coated over the wire, a 20mm diameter plunger hydraulic jack is used. As the wire is fed through the die, a continuous pressure is applied by the hydraulic plunger.
For wire feeding, lead screw, spur gear, bush &motor were used:

Analysis of die: The die shown in figure 1 was analyzed using solid works 13. The opening of the die for flux entry was analyzed considering 3 tons of force applied using hydraulic jack and working at room temperature 40^0C & jam of flux of material. Results of the analysis are shown in figure 2, 3, 4, 5. The complete assembly of the figure has been developed on solid works 13 as shown in figure 6.

Table 1 *Stress Analysis*

Name	Type	Min	Max
Stress1	von Mises Stress	9.091e^{+005}N/m^2 Node: 7918	8.040e^{+007}N/m^2 Node: 178

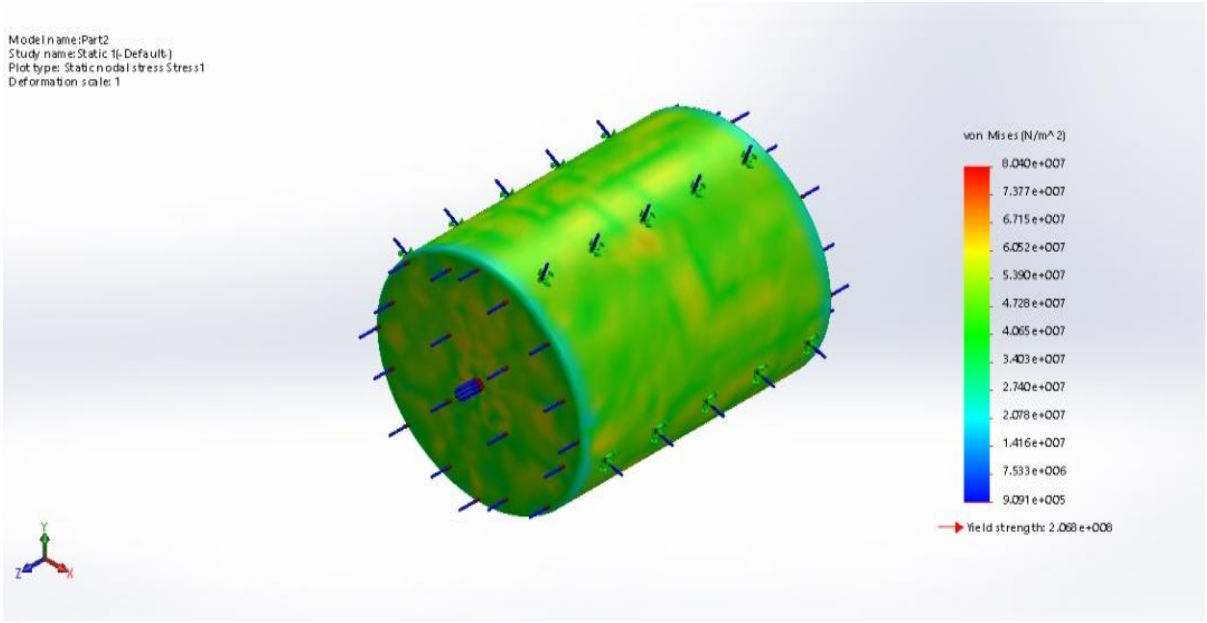

Fig 2 *Stress Analysis*

Table 2 *Displacement Analysis*

Name	**Type**	**Min**	**Max**
Displacement1	Resultant Displacement	0 mm Node: 14	$1.355e^{-003}$mm Node: 14269

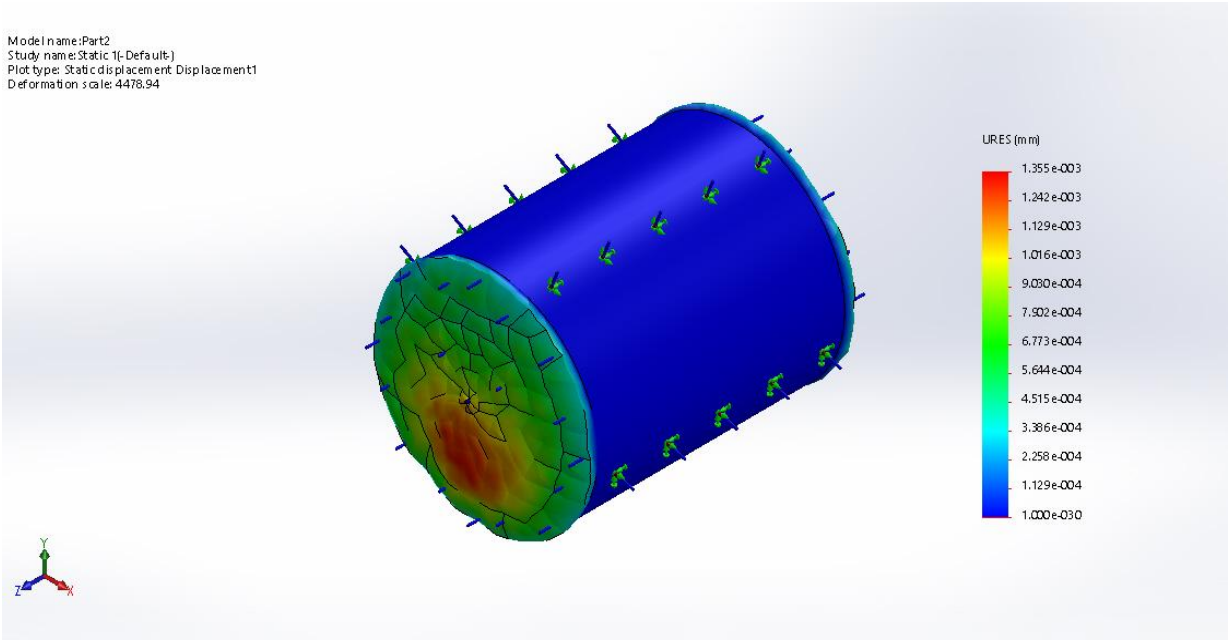

Fig 3 *Displacement Analysis*

Table 3 *Strain Analysis*

Name	**Type**	**Min**	**Max**
Strain1	Equivalent Strain	$2.447e^{-006}$ Element: 9128	$2.223e^{-004}$ Element: 6895

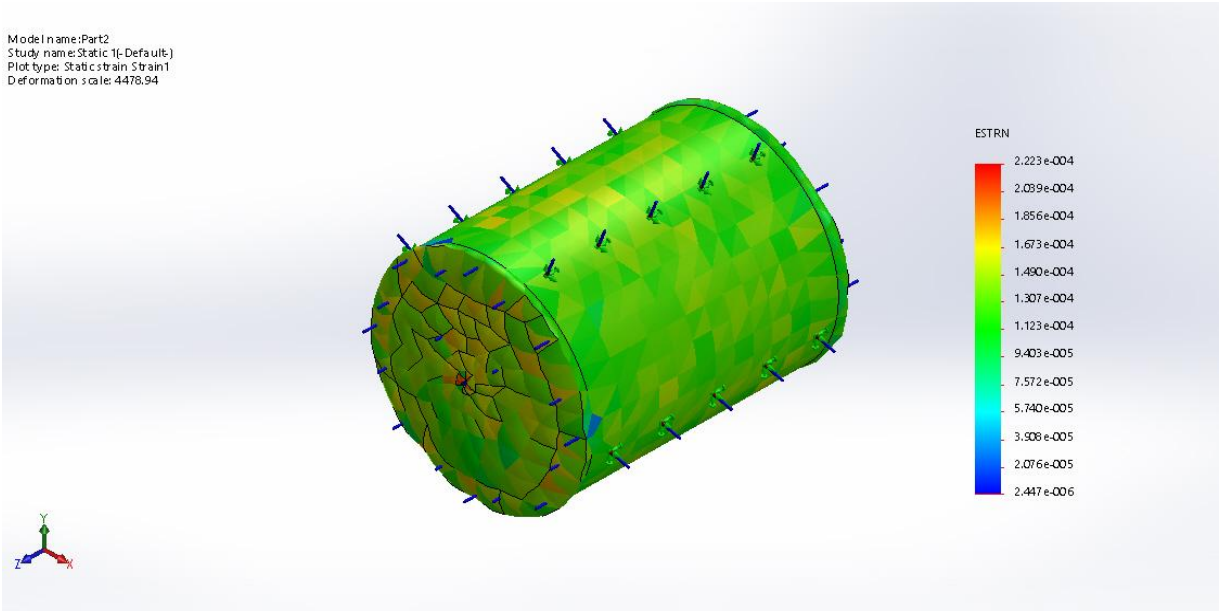

Fig 4 *Strain Analysis*

Table 4 *FOS Analysis*

Name	**Type**	**Min**	**Max**
Factor of Safety1	Automatic	2.57 Node: 178	227.5 Node: 7918

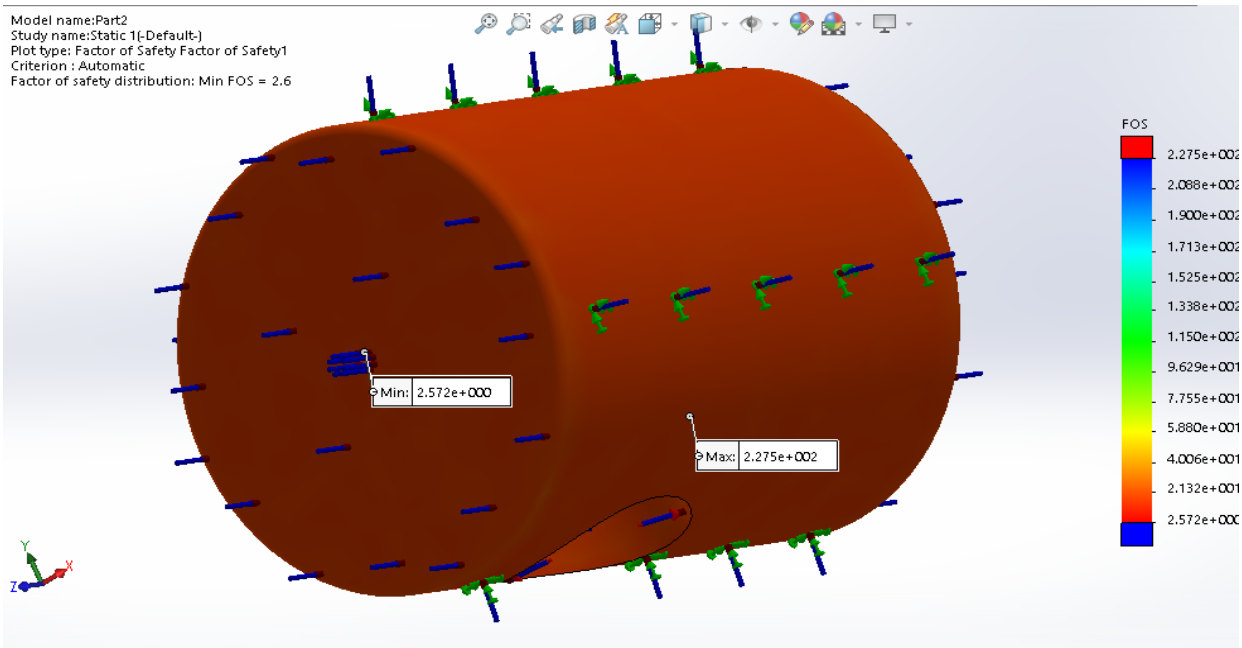

Fig 5 *Factor of Safety Analysis*

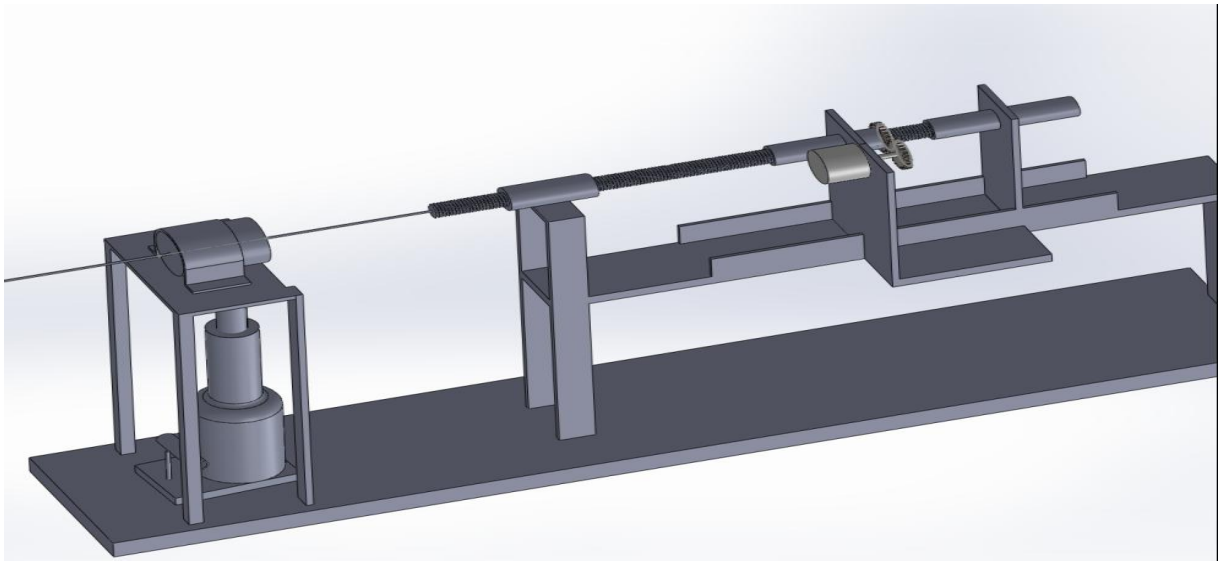

Fig 6 *Complete Assembly*

RESULTS AND DISCUSSIONS

As observed from the analysis of die, it becomes evident that the die stands safe in load analysis with minimum FOS value of 2.6.The maximum and minimum value of stress is $9.091e^{+005}N/m^2$ at node 7918 and $8.040e^{+007}N/m^2$ at node 178, strain is $2.447e^{-006}$ at node 9128 and $2.223e^{-004}$ at node 6895, displacement is 0 mm at node 14 and $1.355e^{-003}$mm at node 14269 as shown in table no 1, 2, 3& 4. The most failure prone area observed in the analysis is the inside of opening of the die for flux material entry. This is because, no pressure drop during coating of flux has been considered.

CONCLUSION

For manufacturing of welding electrode, different machines are used like wire straightening and cutting machine, dry mixture and wet mixture. The designed set up is a solution which can be used by welding electrode manufacturing firms for testing the composition of flux on hit and trial basis by production limited no of electrode.

The design of the die can further be optimized since the range of FOS observed in quite wide from minimum of 2.6 to maximum of 227.

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