Experimental Investigation on Weld Joint Characterization of Thin Wall Structure Mild Steel Tube at Diverse Loading Condition

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Abstract

This paper aims to investigate the effect of input parameters on plateau stress and specific energy of thin-wall structure circular mild steel (MS) tube. 32 samples of tube have been fabricated in two sets, one is without weld (WOW) and another is with weld (WW), having same dimensions. The tube was made up of available commercial MS (AISI 1010). During compression test the value of plateau stress and specific energy are obtained at varying input parameters and compared the results between WOW and WW tube samples. And its chemical composition verified with the help of Energy-dispersive X-ray spectroscopy test of the welded joint and parent material. Three optimization techniques are used in this study to validate the experimental results namely Taguchi method, Analysis of variance (ANOVA) and Artificial Neural Network (ANN). Taguchi L_{16} orthogonal array are used to identify the most effective input parameters which affect the energy absorption behaviour. Percentage contribution of individual input parameters analyzed by ANOVA method and also ANN was performed for non-linear mapping of the input and output parameters which are influenced by compression test. Experimental results have been validated with the optimization technique results and found to be in good agreement with them. Copyright © VBRI Press.

Keywords: Mild steel tube, weld joint, energy absorption, plateau stress.

Introduction

In industrial production, structural support and pipeline constructions, circular tubes have been widely used due to their unique geometry and material characteristics such as high strength, energy absorption capacity, abundant resources, weight etc. These tubes are also used in many fields such as aerospace, marine, chemical, petroleum and industries for various purposes. Due to the simplicity of thin-walled structures, it is the most conventional passive energy absorbing element [**1**]. Due to inherent flexibility and moderate amount of carbon, the machining of MS is easy. At moderate temperature, good combination of strength and toughness, metal fabricated easily and shows excellent weld-ability. For joining and assembling the metal, welding is one of the most common technique and MS is ideal for welding and fabricating among the other carbon steel. The commonly used welding processes are electric arc welding, Tungsten inert gas (TIG) welding, Gas Metal Arc Welding (GMAW), friction welding etc. Among them TIG welding are most suitable particularly in welding of thin sheets as GMAW process have high deposition rate, high welding speed and deep penetration [**2-5**]. The well-established process which is used for welding process is TIG. It is used in all metal industry and among the arc welding process; TIG produces the best quality of welds [**6**]. It is an extremely important arc welding process used to weld different steel, copper, titanium, even two dissimilar metals. This method uses a non-consumable tungsten electrode and inert gas (argon or an argon mixture) surrounding it for the shielding of arc. Using TIG welding two tubes have been joined axially and welded over their periphery.

Many research papers were studied before selecting the materials and performing the test; the various input parameters taken are mass, density, relative density and strain rates. The effect on specific energy and plateau stress depends upon these input parameters. Among them strain rate is most favorable parameters which directly effects the plateau stress. Many authors consider the crushing test for obtaining the energy absorption capacity on various materials and cross-section of thin-walled structure tube [**1, 7**]. Some of the authors also used a range of welding techniques with various process parameters [**4, 8**]. In this study, various input parameters have been considered during compression test instead of welding process parameter to determine and improve the energy absorption capability of thin-walled structures of MS tube using different optimization techniques. Three optimization techniques namely Taguchi method, Analysis of variance (ANOVA) and Artificial Neural Network (ANN) are used to validate the experimental results [**9, 10**]. Taguchi L_{16} orthogonal arrays were used to identify the parameters which influence the energy absorption capacity. By using ANOVA, percentage contributions of individual parameters have been analyzed. Non-linear mapping of the input and output parameters which influenced the compression test was performed by ANN techniques. Joining of two similar MS tube performed by TIG welding process and electrode EN 26848 is used. 32 samples of tube have been fabricated in two sets as per design of experiments (DOE). By considering the mass (g), density (gcm^{-3}), relative density and strain rates (s^{-1}), the compression test were performed [**11**]. During the compression test, the value of plateau stress is recorded and with these data specific energy is calculated.

Materials and methods

Material selection and fabrication techniques

Sample material is collected from commercially available thin-wall structure circular MS tube (AISI 1010). This tube has been assumed to be homogeneous, isotropic and prismatic in nature. It is suitable for welding purposes, because it conducts electric current effectively without tarnishing the metal surface. Initially a large length tube is taken and cleaned well to avoid impurities such as rust, moisture, grease etc. with the help of emery paper [**12**]. Tube is cut into 30mm and 60mm samples with the help of metal hacksaw machine and the length is measured at three different places along its circumference to assure same average length.

Its cross-section of the cutting samples is smoothened using the grinding wheel such that the two tube when touch each other axially, there is no gap between tubes throughout its circumference and same notation for both the tubes have been marked. By selecting the two equal length tubes and matching these marks, a single piece has been made by welding these two tubes with the help of TIG welding process. The two sets of sample were prepared, one is WOW and other is welded of two 30mm tubes axially, these tube samples are shown in **Fig. 1 (a) and (b)** while the schematic line diagram of TIG welding equipment and welding workbench setup are shown in **(c) and (d),** respectively. The TIG welding process used for tube to tube butt joint and electrode EN 26848 was used during the welding process. The weld process will be done very carefully in such a manner that the tubes are co-axial and the welding is done over the periphery of the tube. The approximate welded portion width in prepared samples is 3.0mm. As tube samples are very thin (≈ 1.0 mm) hence treated as sheet metal. The input parameters are considered for performing this job, a low current of 45 Amp, flow rate (11-13 L/min) and pressure (0.11 MPa) at room temperature.

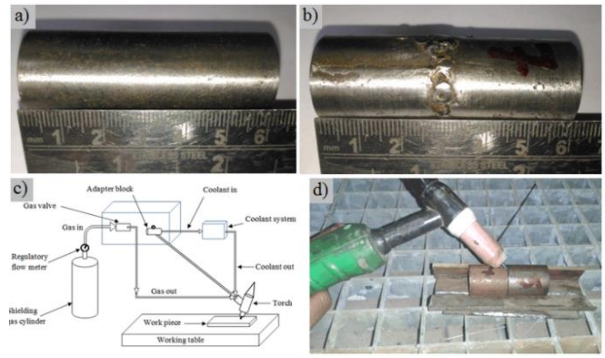

Fig. 1. (a) WOW tube of 60mm (b) welded tube of length 60mm (c) Schematic line diagram of TIG welding equipment and (d) Welding workbench

Compression test

The prepared samples for compression test are marked with numbers. The mass, length, density of individual tube sample is measured and noted in tabular form, also the relative density has been found. The compression test is used to determine the energy absorption capacity of WOW and WW tube samples under different loading conditions [**12-14**]. To measure the energy absorption capacity, a quasi-static axial load is applied on the specimen at different load rates varies from 16000 to 30000 Ns^{-1}. The compression test was carried out at room temperature on Compression Testing Machine (CTM) [CONTROLS (MODEL: C86Z00)] for all samples in the CONCRETE LAB, Department of Civil Engineering, IIT(ISM) Dhanbad. This machine has a maximum loading capacity of 3000kN. In this test procedure, the sample is placed in between the jaws and a predefined compressive force is applied at various loading condition in axial direction [**15, 16**]. When load is applied, lower jaw moved upward with constant velocity and compresses the specimen. During the compression test, plateau stress is obtained and analyzed various influencing parameters.

Microstructure/SEM test

The samples are cut and made into a flat square section (8mm×8mm) for microstructure test. One side of these samples is cleaned and make smooth with the help of emery papers. Now it is washed by suitable chemical and wait for 5min to dry. Optical microscope is used to watch the samples, if the sample surface shows unidirectional scratch it is considered for microstructure test, if not the process is repeated again. The micro structural examination and Scanning Electron Microscope (SEM) test explores the material characteristics for base material and welded zone [**13, 16**]. These tests were performed at high vacuum for all prepared samples. This studied had been carried out under the SEM apparatus (Model: ZEISS, SPURA 55, Germany), at Central Research Facility, IIT(ISM) Dhanbad. The microstructure of the MS tube and bonding interface between two tubes are observed, and achieved the 40 different magnified images at different places with various magnification factors.

Material property

The material AISI 1010 used in this study is supposed to be homogeneous and isotropic in nature. The thickness of the tube are 1.0mm, outer diameter and inner diameter are 26mm and 24 mm respectively. The density of the selected material is calculated by taking the ratio of their mass and volume. The average density of samples is found to be 7.3111gcm^{-3}. The calculated average industry grade density is 7.86109gcm^{-3} which is used in finding the relative density of the specimen. MS is a plain carbon steel with 0.09 wt% C, 0.45 wt% Mn, 0.05 wt% S, 0.04 wt% P and the rest is iron (Fe). During the Energy dispersive X-ray analysis (EDAX), the chemical composition by their weight ratio and atomic ratio are obtained for both WOW and WW MS samples. The chemical composition of different elements present in sample as shown in **Table 1.**

Table 1. Chemical composition of parent material.

MS	Element	Fe	Mn	P	S	C
(AISI 1010)	Wt%	99.37	0.45	0.04	0.05	0.09

Optimization technique

In this investigation, the 3 different optimization techniques have been used to examine the energy absorption capacity of each specimen and compare the better value in both set of samples with various input parameters. The optimization techniques used in this study are Taguchi, ANOVA and ANN simulation.

Taguchi method

The Taguchi method is used for the optimizing of input parameters. It is one of the statistical methods used to improve the performance and qualities of product [**5, 19**]. For solving this, a special design of orthogonal arrays used to study the input parameters of same level with lesser number of experiments. A quality loss function is introduced to measure the performance like Signal-to-Noise (SN) ratio, used to identify the best set of parameters for the responses generated during the compression test. The quality characteristics can be measured by smaller-the-better, nominal-the-better and the larger-the-better types. In this study, the larger the better type is taken for energy absorption capacity measurement through various input parameters [**5**]. For optimal level of input parameter, the SN ratio should be high as higher SN ratio represents better quality characteristic [**8**]. This experiment is carried out by Taguchi L_{16} orthogonal array factors having four sets of levels. The input parameters are mass (g), density (gcm^{-3}), relative density and strain rates (s^{-1}). These inputs are considered as it influences the plateau stress value. The **Table 2** shows the orthogonal array factors and their levels, while **Table 3** depicted the experimental layout of L_{16} orthogonal array according to the Taguchi method for both WOW and welded samples. The four input parameters are combined with four different set of levels to find out the value of plateau stress and specific energy.

Table 2. L_{16} Experimental factors and their levels (WOW and WW samples).

Factors	Level (WOW)				Level (WW)			
	1	2	3	4	1	2	3	4
Mass (g)	34.2	34.4	34.5	34.7	34.4	34.5	34.6	34.8
Density (gcm^{-3})	7.258	7.301	7.322	7.364	7.205	7.226	7.247	7.289
Relative density	0.923	0.929	0.931	0.937	0.916	0.919	0.922	0.927
Strain Rate (s^{-1})	0.001	0.010	0.100	1.000	0.001	0.010	0.100	1.000

Table 3. Experimental layout for input parameters of L_{16} orthogonal array.

Experiment number	Input parameters			
	Mass (g)	Density (gcm^{-3})	Relative density	Strain rate (s^{-1})
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	1	4	4	4
5	2	1	2	3
6	2	2	1	4
7	2	3	4	1
8	2	4	3	2
9	3	1	3	4
10	3	2	4	3
11	3	3	1	2
12	3	4	2	1
13	4	1	4	2
14	4	2	3	1
15	4	3	2	4
16	4	4	1	3
Corresponding values of 1, 2, 3 and 4 for WOW	1 = 34.2 2 = 34.4 3 = 34.5 4 = 34.7	1 = 7.258 2 = 7.301 3 = 7.322 4 = 7.364	1 = 0.923 2 = 0.929 3 = 0.931 4 = 0.937	1 = 0.001 2 = 0.010 3 = 0.100 4 = 1.000
Corresponding values of 1, 2, 3 and 4 for WW	1 = 34.4 2 = 34.5 3 = 34.6 4 = 34.8	1 = 7.205 2 = 7.226 3 = 7.247 4 = 7.289	1 = 0.916 2 = 0.919 3 = 0.922 4 = 0.927	1 = 0.001 2 = 0.010 3 = 0.100 4 = 1.000

Analysis of variance (ANOVA) method

The statistical significance of various input parameters has been predicted with the help of analysis of variance (ANOVA) methods. The effect of individual input on the output parameter is determined. By comparing the mean square at specific confidence level, test the significance of main factors and their interaction. In this investigation the energy absorption capacity of compressed samples is find out with standard ANOVA process using mean value. The percentage contribution of individual input parameter is also obtained. These data are used to estimate the F value (F-test) and P-value.

Artificial Neural Network (ANN)

A parallel-distributed structure is combined with number of nodes and linkages in neural networks. A large number of variables requires a lot of time for experimental study. The optimum design needs defining a number of unknown variables; so, ANN can manage this case quickly and accurately. In last few decades, ANN is used in different areas as it can manage the solution of complicated problems. The ANN model is applied to predict the energy absorption capacity by providing experimental data. This model provides optimal value by automatically developed plateau stress and specific energy characteristics over time. The non-linear mappings of input-output parameters are solved by using Multilayer perceptron (MLP) network [**9, 17**]. It consists the three different layers namely input layer, hidden layer and output layer, which is used to model complex relationship between a set of input-outputs without any prior assumption. Using the ANN model, predict the value of plateau stress and specific energy, and compare these results with experimental results.

Results and discussion

Microstructure / SEM characterization

A typical SEM micrograph of MS tube and welded portion of tube is shown in **Fig. 2**. The arrow in yellow colour on magnified image denotes the non-homogeneous character of the material; this is due to the scratches on the material surfaces during the manufacturing process, manufacturing condition and before performing the test. It is assumed that, the non-homogeneous nature is randomly distributed throughout the tube so as to maintain it's homogeneous at macroscopic level. This allows a uniform macroscopic approximation of the discrete microscopic behavior of the material over a suitably large area. The red colour arrow marked on images indicates the non-uniform weld deposits over it. This comes due to sparks, local spots in weld and spatter flying near the welding zone which is clearly seen in zoomed view of welded specimen.

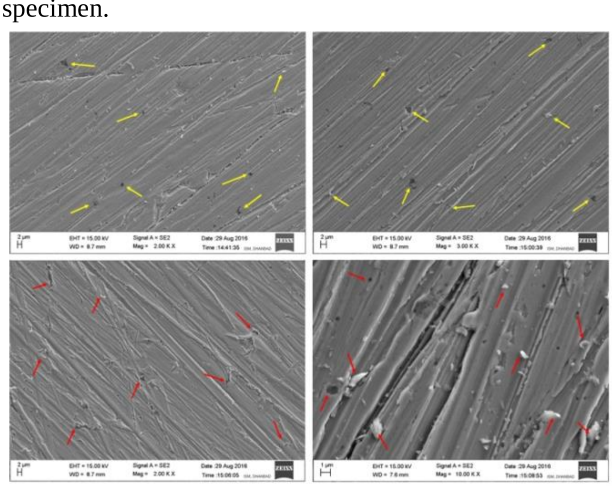

Fig. 2. SEM micrograph of MS tube (Yellow arrow) and welded interface (Red arrow) at different magnification factor.

Compression test result

The prepared sample of thin-walled structure MS tube is considered for compression test. A quasi-static axial load is applied on each specimen one by one at different load rates. During the compression test, the plateau stress value of tube is obtained [**13-15, 18**]. The result obtained from test shows that, the plateau stress value of welded tubes is greater than that of WOW tubes. The maximum value of plateau stress for welded tube is 11.501MPa, while this value for WOW is 11.097MPa at strain rate 0.1s^{-1}. With these obtained plateau stress value, the specific energy value also calculated. The average plateau stress and specific energy of WOW tube sample increases from 10.368MPa to 10.945MPa and 11.909MPa to 12.787MPa respectively as compare to welded tube. These obtained values have been optimized with three different techniques.

Energy dispersive X-ray analysis

The prepared sample (parent material and welded section) are used for Energy Dispersive X-ray (EDX) analysis. The different images of samples are shown in **Fig. 3.** The center image is the macrostructure of MS tube and welded part, left and right image are magnified microstructure and EDX images respectively.

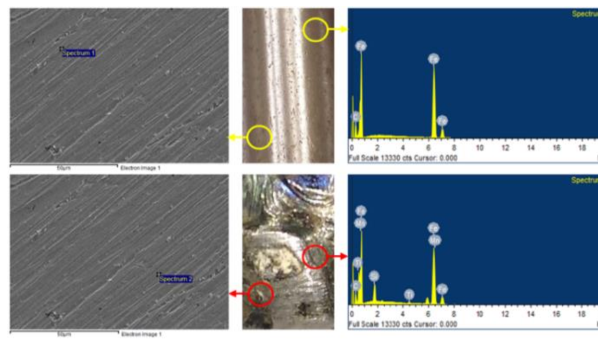

Fig. 3. Magnified images and EDX analysis of MS tube and welded part.

Taguchi method

The compression test is carried out to obtain the energy absorption capacity by considering different input parameter of sample. The experiment is carried out by Taguchi L_{16} orthogonal array factors and four set of levels to optimize the output parameters of WOW and welded tubes [**8, 19**]. The plateau stress and specific energy value are mainly depends upon strain rate. **Table 4** shows the experimental layout of input and output parameters of the compression test according to the L_{16} orthogonal array of WOW and WW tubes respectively. Furthermore, a statistical analysis of variance (ANOVA) and ANN is performed to verify which parameters are more significant.

Signal to noise ratio

The influence of individual factor in compression test is obtained by using the MINITAB 17 software in Advance Research Lab, IIT(ISM) Dhanbad. For finding maximum output, the larger-the-better condition is opted for SN ratio. The response table for means and SN ratio of WOW samples are shown in **Table 5 (a)** while **(b)** shows the same for welded samples. The value obtained through statically software shows a unique set of input parameter for maximum plateau stress [**8**]. **Fig. 4 (a)** shows the main effect plot for means and SN ratio of WOW samples while in **Fig. 4 (b)** shows the same for welded samples. This observation explains the plateau stress of specimen is achieved due to influence of various input parameter selected for compression test. It also shows the most influenced parameter is strain rate.

Table 4. Experimental layouts for input and output parameters of L_{16} orthogonal array (WOW and WW samples).

Exp. No.	Input and output parameters of L_{16} orthogonal array (WOW)						Input and output parameters of L_{16} orthogonal array (WW)					
	Input parameters				Output (in MPa)		Input parameters				Output (in MPa)	
	Mass (g)	Density (gcm^{-3})	Relative density	Strain rate (s^{-1})	Plateau Stress	Specific Energy	Mass (g)	Density (gcm^{-3})	Relative density	Strain rate (s^{-1})	Plateau Stress	Specific Energy
1	34.2	7.258	0.923	0.001	9.5191	11.091	34.4	7.205	0.916	0.001	10.129	11.853
2	34.2	7.301	0.929	0.010	9.8798	11.585	34.4	7.226	0.919	0.010	10.509	12.388
3	34.2	7.322	0.931	0.100	10.459	12.027	34.4	7.247	0.922	0.100	11.112	12.842
4	34.2	7.364	0.937	1.000	10.788	12.702	34.4	7.289	0.927	1.000	11.467	13.524
5	34.4	7.258	0.929	0.100	10.189	11.981	34.5	7.205	0.919	0.100	10.835	12.849
6	34.4	7.301	0.923	1.000	10.953	12.684	34.5	7.226	0.916	1.000	11.264	13.365
7	34.4	7.322	0.937	0.001	9.5829	10.931	34.5	7.247	0.927	0.001	10.738	11.966
8	34.4	7.364	0.931	0.010	10.185	11.862	34.5	7.289	0.922	0.010	10.981	12.345
9	34.5	7.258	0.931	1.000	10.772	12.727	34.6	7.205	0.922	1.000	11.461	13.571
10	34.5	7.301	0.937	0.100	10.924	12.497	34.6	7.226	0.927	0.100	11.441	13.458
11	34.5	7.322	0.923	0.010	10.734	11.315	34.6	7.247	0.916	0.010	10.351	12.389
12	34.5	7.364	0.929	0.001	9.8707	11.246	34.6	7.289	0.919	0.001	10.514	12.156
13	34.7	7.258	0.937	0.010	9.9871	11.601	34.8	7.205	0.927	0.010	10.621	12.373
14	34.7	7.301	0.931	0.001	10.256	10.936	34.8	7.226	0.922	0.001	10.828	12.214
15	34.7	7.322	0.929	1.000	10.697	12.534	34.8	7.247	0.919	1.000	11.376	13.442
16	34.7	7.364	0.923	0.100	11.097	12.832	34.8	7.289	0.916	0.100	11.501	13.867

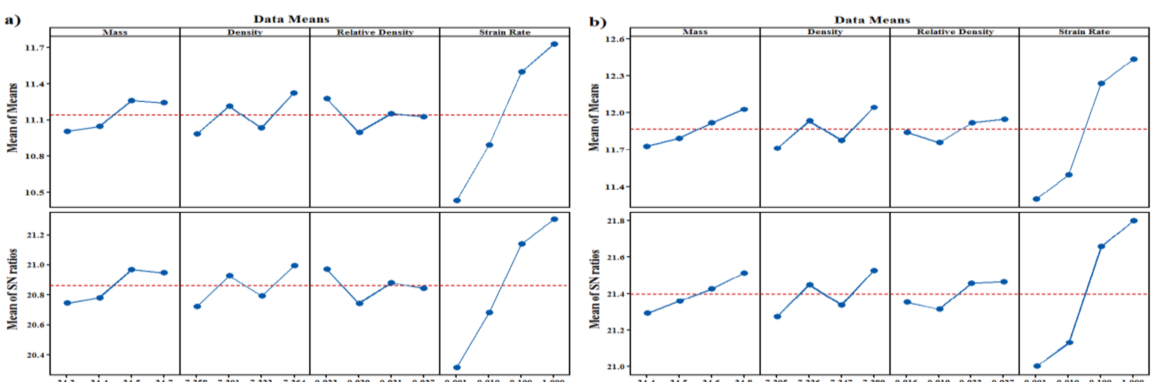

Fig. 4. Main effect plot for means and SN ratio a)WOW and b)WW.

Table 5. (a) Response table for means and SN ratio (WOW).

Level	Response table for means (WOW)				Response table for SN ratio (WOW)			
	Mass (g)	Density (gcm^{-3})	Relative density	SR (s^{-1})	Mass (g)	Density (gcm^{-3})	Relative density	SR (s^{-1})
1	11.01	10.98	11.28	10.43	20.75	20.72	20.97	20.31
2	11.05	11.21	11.00	10.89	20.78	20.93	20.74	20.68
3	11.26	11.03	11.15	11.50	20.97	20.79	20.88	21.14
4	11.24	11.32	11.13	11.73	20.95	21.00	20.84	21.31
Delta	0.25	0.34	0.28	1.30	0.22	0.27	0.23	0.99
Rank	4	2	3	1	4	2	3	1

Table 5. (b) Response table for means and SN ratio (WW).

Level	Response table for means (WW)				Response table for SN ratio (WW)			
	Mass (g)	Density (gcm^{-3})	Relative density	SR (s^{-1})	Mass (g)	Density (gcm^{-3})	Relative density	SR (s^{-1})
1	11.73	11.71	11.84	11.30	21.29	21.28	21.35	21.00
2	11.79	11.93	11.76	11.49	21.36	21.45	21.32	21.13
3	11.92	11.78	11.92	12.24	21.43	21.34	21.46	21.66
4	12.03	12.04	11.95	12.43	21.51	21.53	21.47	21.80
Delta	0.30	0.33	0.19	1.13	0.22	0.25	0.15	0.80
Rank	3	2	4	1	3	2	4	1

Table 6. The results obtained from ANOVA - Plateau Stress and Specific Energy (WOW and WW samples).

Nature	Source	Mass	Density	Relative Density	Strain Rate	Error	Total
Plateau Stress of WOW samples	DF	3	3	3	3	3	15
	Adj. SS	0.50112	0.38044	0.36622	2.48914	0.08179	3.81871
	Adj. MS	0.16704	0.12681	0.12207	0.82971	0.02726	
	F-value	6.13	4.65	4.48	30.43		
	P-value	0.085	0.119	0.125	0.01		
	% Contribution	13.42	10.18	9.8	66.6		100
Specific Energy of WOW samples	DF	3	3	3	3	3	15
	Adj. SS	0.04463	0.43983	0.04549	6.33967	0.20318	7.07279
	Adj. MS	0.01488	0.14661	0.01516	2.11322	0.06773	
	F-value	0.22	2.16	0.22	31.2		
	P-value	0.877	0.271	0.875	0.009		
	% Contribution	0.65	6.39	0.65	92.31		100
Plateau Stress of WW samples	DF	3	3	3	3	3	15
	Adj. SS	0.15417	0.27877	0.29597	2.15799	0.09185	2.97876
	Adj. MS	0.05139	0.09292	0.09866	0.71933	0.03062	
	F-value	1.68	3.04	3.22	23.5		
	P-value	0.34	0.139	0.181	0.014		
	% Contribution	5.34	9.67	10.24	74.75		100
Specific Energy of WW samples	DF	3	3	3	3	3	15
	Adj. SS	0.35544	0.28533	0.06628	5.6405	0.15413	6.50169
	Adj. MS	0.11848	0.09511	0.02209	1.88017	0.05138	
	F-value	2.31	1.85	0.43	36.59		
	P-value	0.255	0.313	0.747	0.007		
	% Contribution	5.61	4.49	1.05	88.85		100

Where, DF: Degree of Freedom; Adj. SS: Adjusted sum of squares; Adj. MS: Adjusted mean squares; F: Statistical test; P: Probability.

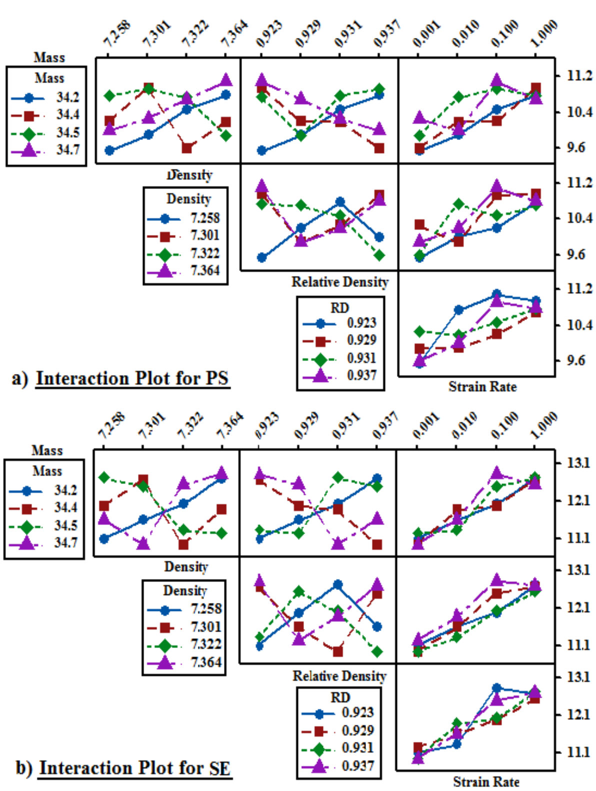

Fig. 5. Interaction Plot for (a) Plateau Stress and (b) Specific Energy (WOW).

Analysis of variance (ANOVA)

The effect of individual parameters on output parameters and their percentage contribution is determined by ANOVA technique [**10, 19, 20**]. The maximum value of plateau stress and specific energy are obtained at best combination of input parameter. The desired level of confidence for plateau stress was considered to be strain rate of 66.60% followed by mass while its value for specific energy is 92.31% followed by density in case of WOW samples. The result obtained from ANOVA implicates the strain rate is the major contributed input parameter for obtaining the energy absorption capacity. For the welded samples, the level of confidence for plateau stress obtained from ANOVA table was strain rate of 74.75% followed by relative density and specific energy is 88.85% followed by mass. The interaction plot for plateau stress and specific energy of WOW and welded samples are shown in **Fig 5 & 6,** respectively. The percentage contribution of individual parameter on output value is obtained from ANOVA method is recorded in **Table 6**. From these tabular values, one can conclude that the value of plateau stress and specific energy mainly depends on strain rate values.

Artificial Neural Network (ANN) Analysis

ANN technique is a non-linear statistical data modeling tool and used to model complex relationship between input and output data. It is composed of one input layer and an output layer with one or more hidden layers. Each layer consists of neurons that are the processing element of ANN. Each neuron in every layer is duly connected to other neurons in the subsequent layers which are referred to as feed forward MLP networks. The number of neurons and hidden layers were either increased or decreased so that correlation coefficient

(R) reached nearer to unity. The R value is closer to unity is selected as the optimum network. The results predicted by ANN showing the similar trend towards the experimented values with respect to their input parameter. The overall correlation coefficient, R = 0.99759 and R = 0.99788 for WOW and welded samples respectively as shown in **Fig. 7**. The energy absorption capacity of each sample is predicted by using ANN technique. The experimental value is compared with corresponding value obtained from ANN technique to make suitable relation between them. The relation between the Experimental value and value obtained from ANN technique are shown in **Fig 8** for WOW and WW samples. In **Table 8**, the average value of plateau stress and specific energy is presented which is obtained from experimental observations and predicted from ANN. Further, percentage error was calculated with respect to corresponding predicted value.

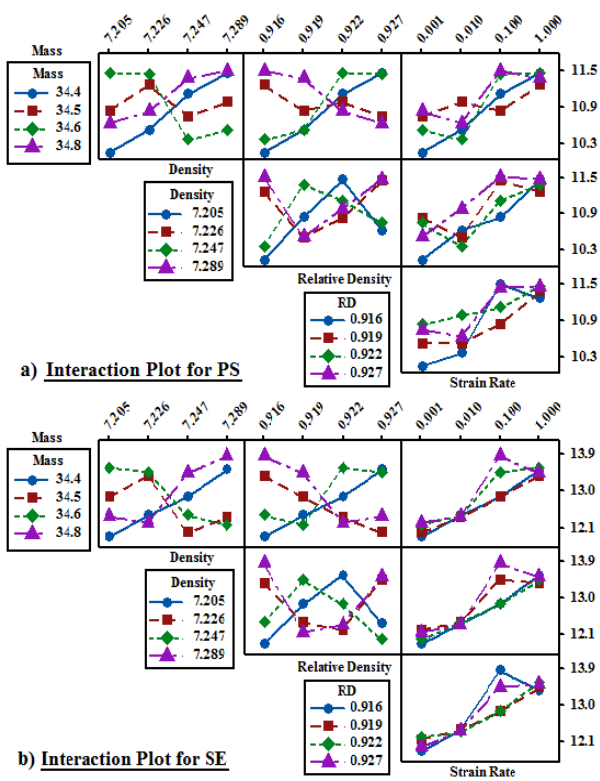

Fig. 6. Interaction Plot for (a) Plateau Stress and (b) Specific Energy (WW).

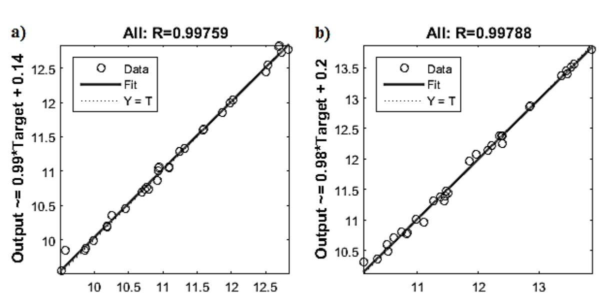

Fig. 7. Overall predictive performance of ANN model (a) WOW (b) WW.

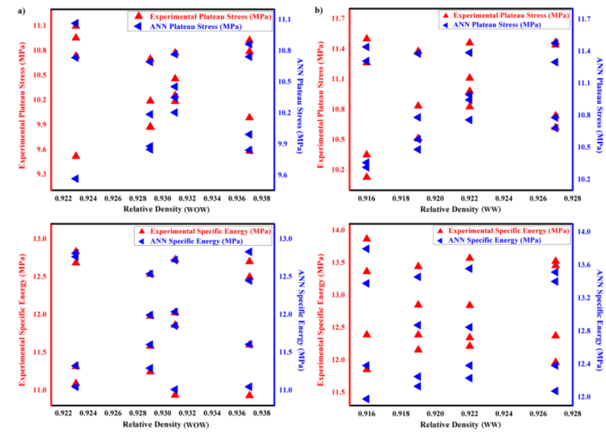

Fig. 8. Relation between the Experimental and ANN (a) Plateau Stress and (b) Specific Energy of WOW and WW samples respectively.

Conclusions

In this study, the compression test of thin wall structure MS tube (WOW and WW) samples at diverse loading condition was performed at diverse strain rates ($10^{-3}s^{-1}$ to $1.0s^{-1}$). The values of Energy absorption capacity were calculated during the compression test. The maximum value of plateau stress is 11.501MPa for welded tube while its value is 11.097MPa for without weld tube at strain rate $0.1s^{-1}$. The average experimental value of plateau stress of welded tube sample is 5.56% higher than that of WOW tube while in case of specific energy, the value is 7.37%. The optimization method implemented to verify the experimental results and it is found in good agreement. Taguchi L_{16} orthogonal array is used to verifying the other input parameter and satisfied the nature of curve. Using ANOVA technique, individual effect of input parameter is found and it is concluded that the most effective input parameter is strain rate. ANN approach was successfully applied for the MPL and overall correlation coefficient obtained as R = 0.99759 and R = 0.99788 for WOW and WW samples respectively. The EDX test and microstructure test also perform to confirm the material composition and the bonding condition between the tubes.

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