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OPTIMIZATION OF PIPE SPECIFICATION FOR WELDING IN B WAVE STRUCTURE USING TAGUCHI PARAMETRIC OPTIMIZATION TECHNIQUE

Ashish Yadav [1], Ashutosh Palkhe [2]
[1,] Assistant Professor M.P.C.T.,Gwalior
[2,] Students, M.P.C.T.,Gwalior.

ABSTRACT
This work is a step to find out best optimized parameter of a frame taking material of pipe, pipe diameter and the thickness of pipe as prime parameter. .This stress analysis we have accomplished with the help of ANSYS software and Taguchi methodology. The objective of this project is to design best frame. We did this to avoid any possibilities of failure in the structure and also to provide an enough stronger supporting member to make the frame stronger in term of deformation. After making the frame we analyze it for stress due to inertia load and found the region of maximum stress and its possible value. We did same procedure for nine combinations of material, thickness and diameter according to orthogonal array and observed the induced stress. We predicted that the M_3+T_3+D_3 will give the optimum result of induced stress. We checked the stress for M_3+T_3+D_3 and found it satisfactory. Finally we derived a mathematical model for induced stress for impact loading with the help of MATLAB software. Result of induced stress both from ANSYS and mathematical model are approximately same.

Keywords: Structure, Yield Stress, Thickness .Diameter, Taguchi, ANSYS, MATLAB

INTRODUCTION
Frame is like a skeleton which gives support to the whole infrastructure of any item Design of frame depends upon load which is to be carry and other requirement of item regarding comfort, ergonomics, strength, utility, transportation and aesthetic of item. . Force considered on the frame always is equal to the rate of change of momentum of the body during the impact. During collision of frame maximum stress induced in chassis is crushing stress .Although shearing and tensile stress will also occur but value which we had calculate is the induced compressive stress during the collision We have taken pipes of different material, thickness and diameter to make frame.

OBJECTIVES
The objectives of paper are as follows:
a) The selection of material for B Waves frame.
b) To construct the appropriate B Waves frame.
c) To determine the maximum stress concentration areas.

METHODOLOGY
This technique is completely based on statistical concepts and. Many renowned firms have achieved great success by applying this method. Taguchi method adopted experimentally to investigate influence of parameters such as material stress, thickness and diameter of pipe on the induced stress in chassis. The Taguchi process helps to select or to determine the optimum combination for material stress, thickness of pipe and diameter of pipe and effect of these parameters on induced compressive stress on chassis during time of collision. Many researchers developed many mathematical models to optimize these parameters to get maximum induced stress in various processes.

PHILOSOPHY OF THE TAGUCHI METHOD
1. Quality of product depends on the process by which it has been produced. One can improve the quality by optimising the parameter affects the process.
2. Best quality can be achieved by minimizing uncontrollable environmental factor which leads to deviation from a target.
3. The cost of quality should be measured as a function of deviation from the standard and the losses should be measured system wide.

PROCEDURE AND STEPS OF TAGUCHI PARAMETERS DESIGN

Step-1: Selection of the quality characteristic

There are three types of quality characteristics in the Taguchi methodology, such as **smaller-the-better, larger the- better, and nominal-the-best**. For example, smaller-the-better is considered when measuring fuel consumption of fuel in automobile or roughness in surface finish. The goal of this research was to find the effect of parameters and achieve maximum compressive stress induced during collision

Our characteristic is Smaller is better stress induced in B wave structure.

Step–2: Selection of factors

In this step, the controllable factors are material (M), thickness of pipe (T) and diameter of pipe (D) which was selected because these are the factors which affect the induced compressive stress. Since these factors are controllable so they are considered as controllable factors in the study? Uncontrollable factor may be the ambiance temperature, Humidity, road quality and human error.

S.No.	Symbol	Process Parameter	Levels		
			Low	Medium	High
1.	M	Material type	AISI 1018	AISI 1040	AISI 4130
2	T	Thickness of pipe (mm)	1.5	2.0	2.5
3	D	Diameter of pipe (mm)	20	22.5	25

Table 1 Selection op factors

Step–3: Selection of Orthogonal Array

There are 9 basic types of standard Orthogonal Arrays (OA) in the Taguchi parameter design. Selection of arrays depends on the degree of freedom of selected parameter. Degree of freedom of all three parameter is 6 . An L_9 Orthogonal Array is selected from Appendix B, 2nd edition, 2005, Taguchi Techniques for Quality Engineering, Philip J Ross, Tata McGraw-Hill Publishing Company limited, for this work. An L_9 Orthogonal Array is selected for this work. The layout of this L_9 OA is as mentioned in Table 2.

Experiment	P1	P2	P3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

Table 2: L9 Orthogonal Array

Step–4: Conducting the experiments

Table 3.1 illustrates the experimental settings in this study for maximum compressive stress. The parameters used in this experiment are material (three different material), thickness of pipe (three different thickness) and the diameter of pipe (three different diameter). All nine analysis have been conducted on ANSYS software result of which have been observed.

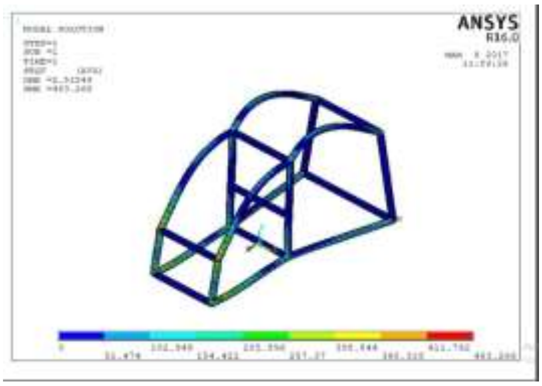


Fig 1 : B wave Structure

Exp. No	P1 Yield Stress (MP)	P2 Thickness (mm)	P3 Diameter (mm)	(Induced Stress) MP
1	370	1.5	20.0	1098.27
2	370	2.0	22.5	679.80
3	370	2.5	25.0	456.28
4	450	1.5	22.5	847.35
5	450	2.0	25.0	536.80
6	450	2.5	20.0	767.43
7	460	1.5	25.0	673.65
8	460	2.0	20.0	888.90
9	460	2.5	22.5	581.96

Table 3 : Observation Table

Step–5: Predicting Optimum Performance

Using the aforementioned data, one could predict the optimum combination of material, thickness and diameter for maximum compressive stress induced during impact of collision. With this prediction, one could conclude that which combination will creates the better result. A confirmation of the experimental design was necessary in order to verify the optimum variables combination.

Table 4: Optimum parameters

P	Controllable Factors	Breaking Load (N)		
		L	M	H
M	Material	744.78	717.19	**714.83**
T	Thickness	873.09	701.83	**601.89**
D	Diameter	918.2	703.03	**555.57**

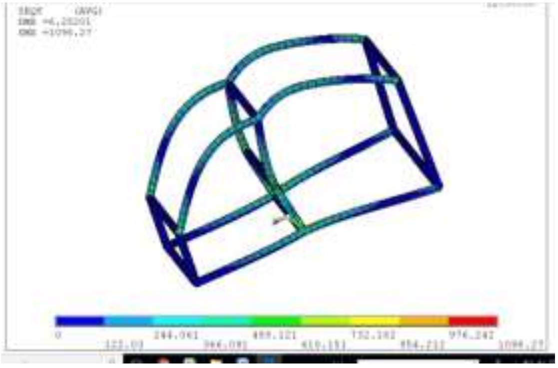
Step-6: Establishing the design by using a confirmation experiment

The confirmation experiment helps to verify our prediction particularly when small fractional factorial experiments are utilized. The purpose of the confirmation experiment in this study was to validate the optimum compressive stress induced during collision

DESIGN

The chassis is designed considering the factors like factor of safety - maximum load carrying capacity, force absorption capacity, required space for accessories and driver and specific dimensions.

The design of chassis is performed by using software's ANSYS. The load distribution in the chassis should be uniform. The structural design gives the idea about the chassis.

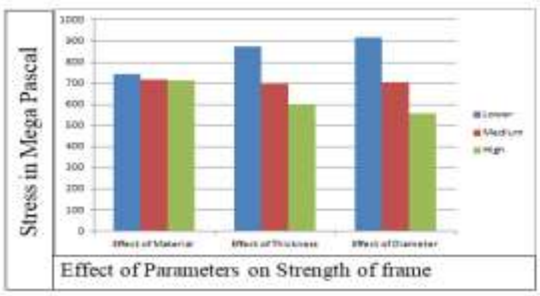


MODELING

The 3-D modeling of chassis is created by ANSYS:

Analysis

The next stage after design is analysis of chassis under various impact forces and overall dynamic loads applied during race. By performing analysis, the stresses induced in the structure can be determined.



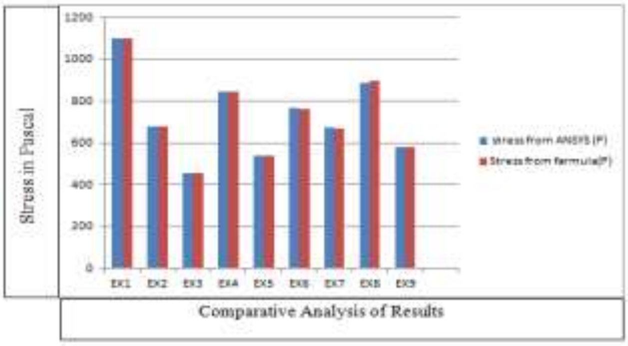
Graph1: Effect of parameters

MATHEMATICAL MODELING WITH THE HELP OF MAT LAB

Induced Stress $=1047901.342\ (\text{Yield Stress})^{0.0356} * (\text{Thickness})^{-0.7347} * (\text{Diameter})^{-2.2607}$

Exp. No	M	T (mm)	D(mm)	**Induced stress (MP) Actual**	**Breaking Load (MP) From formula**
1	370	1.5	20.0	1098.27	1099.34
2	370	2.0	22.5	679.80	681.87
3	370	2.5	25.0	456.28	456.09
4	450	1.5	22.5	847.35	848.24
5	450	2.0	25.0	536.80	541.10
6	450	2.5	20.0	767.43	760.62
7	460	1.5	25.0	673.65	668.98
8	460	2.0	20.0	888.90	896.82
9	460	2.5	22.5	581.96	583.26

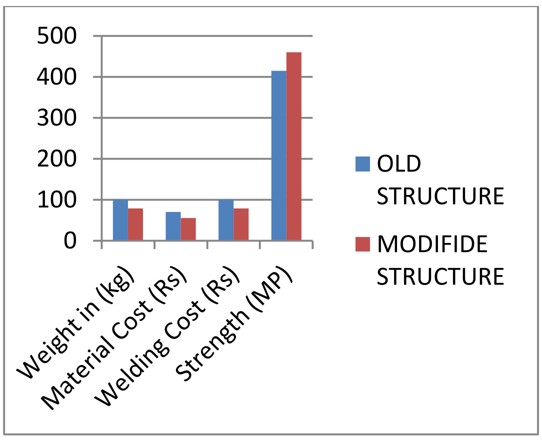
Table5: S/N Ratio of induced stress



Graph 2:Comperision between the induced stress from actual model & Mathematical model

S.N.	Particular	Previous Structure	Modified Structure
1	Material	HR 7209	AISI 4130
2	Material cost	70 Rs/Kg	55Rs/Kg
3	Yield Stress	415 MP	460 MP
4	Cross Section	Square (625 mm^2)	Circular (491 mm^2)
5	Weight Per structure	100 kg	78.8 kg
6	Welding Cost /Unit length	100 Rs	78.5 Rs
7	Stress Concentration	High	Low
8	Failure Rate	High	Less
9	Welding type	Electric	Electric
10	Handling	Poor	good
11	Ergonomic	Poor	Good
12	Aesthetic	Poor	Good

Table 6: Comparisons between previous structure & Modified structure



Graph 3: Economic Analysis

CONCLUSION

Conclusion From the response graph plotted between parameters it is observed that there is decreased in induced stress as the yield stress, Thickness of pipe and diameter of pipe are increased From response table and graph observational findings are illustrated as following.

1. Level III for Material = lower induced stress indicated as the optimum situation in terms of mean value.
2. Level III for Thickness of pipe = lower induced stress indicated as the optimum situation in terms of mean value.
3. Level III for Diameter of pipe = lower induced stress indicated as the optimum situation in terms of mean value.
4 By the application of Mathematical regression modeling researcher has find out the empirical formula, which shows the relation between these three factors i.e. yield stress , thickness , diameter . By the use of this formula can be find out the value of stress at the time of impact at any given combination between given range. Formula is

Induced Stress $=1047901.342\ (\text{Yield Stress})^{0.0356} * (\text{Thickness})^{-0.7347} * (\text{Diameter})^{-2.2607}$

5 Modified Structure is more economic than previous structure

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