Quality Improvement of Shock Absorber Outer Tube by Implementation of Proof Load Testing Machine

[1]Sancheti D. D.,[2]Sancheti S. D.,[3]Bagmar P. D. [4]Patil S. B.

[1]Assistant Professor,[2]Assosiate Professor,[3]Assistant Professor, [2]Assosiate Professor

[1]Department of Mechanical Engineering,

[1]SNJB's Late Sau. K. B. Jain college of Engineering, Chandwad, India

Abstract: High demands are placed on vehicle damping systems. Shock absorbers have to minimize vibrations and post-oscillation in the vehicle body generated by uneven road surfaces. Deficient shock absorbers can have an adverse effect on suspension components and tires, and can be extremely dangerous. For the safety of shock absorbers outer tube welds must be properly welded and sustain the certain load. Generally UTM is a used in the industry for weld strength checking but as being destructive test method; it is not possible to check each and every component. To overcome the above problem SPMs are designed and fabricated to test welds at proof load which is same or more severe than those encountered by the welds in the field so that each tube can be checked and defective tubes can be scrap before the material is released for use in the field and forestall injury and inconvenience to personnel. The objective of the testing is to ensure that the outer tube is structurally sound and fit for the use for which it is designed.

Index Terms **- Proof load testing, SPM, Outer tube**

I. Introduction

NSK Fab andWeld manufacture the outer tube of the shock absorber. It is a major component of the shock absorber which contains oil to maintain the required damping characteristic of the shock absorber. The manufacturing process of outer tube consists of welding of different parts like spring sheet, bracket, eye ring and end cap to a tube. For the safety of shock absorber, these welds must be properly welded at specified location and sustain the particular load.

1.1 Quality Characteristics of Outer Tube-

i. Weld strength at spring sheet welding = 2000 kg
ii. Weld strength at eye ring= 2000 kg
iii. Leakage= No leak
iv. No rust or spatter is allowed on internal and external surface allowed.
v. Powder not allowed inside the tube.
vi. No deformation of the tube is permitted.

1.2 Present Inspection Method

Presently industry has a universal testing machine available for weld testing, such as pictured in figure 1.1. This machine use servo-hydraulic systems for high capacity tensile and compressive testing of materials and manufactured components. At the time of starting of shift two components are checked on the UTM by applying maximum load it can sustain and then after every two hour one component is tested for welding strength.

1.3 Limitation of Present Inspection Method

It is the fact that there are inherent flaws in materials due to crystal lattice imperfections and dislocations, however, microscopic they may be. Manufacturing processes such as welding may cause further flaws or defects. Outer tubes are used under various conditions of stress, fatigue, and corrosion, which may create additional errors or aggravate present ones. It has been established that most material failures occur because these defects reach dangerous proportions such that remaining parts of the materials could not withstand the stress they are subjected to, thus become ductile or brittle.

Therefore, there is a need to detect the welding strength of component manufactured. One method of inspection is to subject the material or weld to destructive tests, which would provide information about the performance of that test object. The UTM method is well covered in standards and recommended practices, but as being destructive test method; as the name implies, the test object is destroyed in the process, so it is not possible to check each and every component. Therefore, all the components manufactured in a shift cannot test for weld strength due to which some defective outer tubes may be supplied and get fitted on a vehicle which will cause discomfort and can lead to accidents.

II. Concept of Proof Load

A proof load is a type of quality test designed to ensure that various goods are manufactured in compliance with safety regulations and are capable of maintaining structural integrity during normal use. Some companies submit products to a proof load that is slightly above the stress of anticipated usage, just to make sure the goods successfully make it through a proof test. Proof loading is a common means of evaluating a quality of all types of goods, ranging from clothing to zippers and fasteners and even various types of electronic equipment.

Therefore, to avoid the failure of the shock absorber, testing of outer tube welds must conduct at the proof load. This is crucial since the failure of a weld can mean severe damage to the components that the product holds together, performing a proof load test to determine the outer tube are manufactured within the required specifications is imperative. The objective of the test is to demonstrate that the welding of an outer tube is structurally sound and fit for the use for which it is designed.

Proof load is the maximum tensile force that can be applied to an outer tube that will not result in plastic deformation of a weld joint. In other words, the material must remain in its elastic region when loaded up to its proof load. Proof load is typically taken as 1/3rd of the maximum strength.

Therefore,

$$Proof\ load = \frac{Maximum\ welding\ strength}{3}$$

$$= \frac{2000}{3}, \text{ Kgf}$$

$$= 666.667, \text{ Kgf}$$

According to the literature survey documents and brief discussions with the company engineers it was taken into account to manufacture a proof load testing machine. Design of machine is carried out in following steps:

a) Pneumatic circuit design
b) Electric circuit design

Mechanical design

III. EXPERIMENTAL DESIGN

3.1 Experimental Design Procedure an Outline

The statistical approach to experimental design is necessary if we wish to draw the meaningful conclusion from the data. Thus, there are two aspects to any experimental design: the design of experiment and the statistical analysis of the collected data. They are closely related since the method of statistical analysis depends on the design employed.

3.2 Validation of Proof Load Testing Machine

The table 6.1 shows process characteristic for spring sheet seam welding machine

Table 3.1: Process Characteristics- Spring Sheet Seam Welding

Sr. No.	Parameter Characteristics	Specification
1	Welding Pressure	1.8 Kg/cm2
2	Squeeze Cycle Time	20
3	Weld Time	2.5
4	Cool Time	2.5
5	Current-I/Current-II /Current-III	1-2.5
6	%Heat-I/%Heat-II/%Heat-III	0/30-45/0
7	Hold Time	20

In this validation work, which is carried out for 2 factors (current and % Heat), each factor at 6 levels, an L_{36} (6^2) orthogonal array is chosen for conducting the experiments.

The design of L_{36} OA provides 6 levels for each factor at a different level combination. The assignments of levels to the different independent factors used in investigation and it's a coding is shown below in tables 6.2

Table 3.2: Assigning of Levels to the Variable as Applicable Practically

Assigning of Levels to The Variable As to Seam Welding	Level →					
Current, kA	0.5	1	1.5	2	2.5	3
% Heat	25	30	35	40	45	50

Table 3.3 shows there are totally 36 trials (experiments) to be conducted and each trial is based on the combination of level values as shown in the table.

Table 3.3: Model of Experimentations

Expt. No	Current	% Heat	Expt. No	Current	% Heat	Expt. No	Current	% Heat
1	0.5	25	13	1.5	25	25	2.5	25
2	0.5	30	14	1.5	30	26	2.5	30
3	0.5	35	15	1.5	35	27	2.5	35
4	0.5	40	16	1.5	40	28	2.5	40
5	0.5	45	17	1.5	45	29	2.5	45
6	0.5	50	18	1.5	50	30	2.5	50
7	1	25	19	2	25	31	3	25
8	1	30	20	2	30	32	3	30
9	1	35	21	2	35	33	3	35
10	1	40	22	2	40	34	3	40
11	1	45	23	2	45	35	3	45
12	1	50	24	2	50	36	3	50

IV. EXPERIMENTATION

1. To validate the performance of proof load testing 36 outer tubes were manufactured (2 set) with assigned levels of the variable on seam welding machine as per given model of experimentations.
2. Testing of outer tube (1 set) for welding strength was performed on the universal testing machine for the maximum load it can sustain and load at which it fails was recorded.
3. The second set of outer tube was tested on proof load testing machine. Observations were recorded and presented in the table form as below.

<table>
<tr><td colspan="2">NSK Fab and Weld
MIDC AMBAD</td><td colspan="4">INPROCESS INSPECTION REPORT</td></tr>
<tr><td colspan="4">PROCESS: PROOF LOAD TESTING
PRODUCT NAME: OUTER TUBE</td><td colspan="2">MACHINE NO: WE 10</td></tr>
<tr><td colspan="6">OPERATION DETAILS: Spring Seat Seam Welding Strength Checking on Proof Load Testing Machine</td></tr>
<tr><td colspan="2">Duration</td><td rowspan="2">Shift timing</td><td rowspan="2">Quantity manufactured</td><td rowspan="2">Rejection Quantity</td><td rowspan="2">Remark</td></tr>
<tr><td>From</td><td>To</td></tr>
<tr><td>28/3/2016</td><td>15/6/2016</td><td>12 Hrs</td><td>5000</td><td>70-95</td><td>Rejection due to weld failure, Operation missing</td></tr>
<tr><td colspan="6">PREPARED BY: Dipak D. SanchetiAPPROOVED BY: Mr. Kamlesh Ushir</td></tr>
</table>

CONCLUSION

In this chapter the main findings of the dissertation are summarized,

1. The Proof load testing machine has been successfully fabricated in the workshop. Further it has been tested for proper functioning by using validation tests. Considering process validation record the process qualifies to parameters set in Thirty six trials for SPMs.
2. The concepts of the proof load testing machine have proven to be effective for the inspection of each outer tube at proof load. Also the calibration factors are linear, the actuators and sensors seem to be operating very reliably.
3. A good agreement is found in results from the universal testing machine and proof load testing machine.
4. The quality of outer tube is increased as defective tubes are scrapped in the manufacturing steps itself.
5. Wide range of outer tubes can be tested with these instruments.

6. Upon completion of the proof load testing machine this work will serve as a guide for the engineers of NSK Fab and Weld, Nashik

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