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Design Analysis, Development of Punching cum Pressing Mechanism for four Wheeler Automobile –A Practical Problem of Industry

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Abstract: *Today's industry demands versatile, efficient and cost effective equipment while at the same time providing more flexibility along with significant savings through increased productivity. Developing an industrial activity gives an exposure to the budding engineers to get familiar with the industrial area, in which they are supposed to work in future. Also the interaction happened during the development of an activity include investigation of available methodologies, finding the drawbacks in the existing system, creation of new innovative ideas, checking the feasibility of ideas, gathering of relevant information, application of theoretical knowledge for designing of system, verification using computer oriented technologies, finally implementation of best solution gives us the opportunities to come true is time consuming problem of manual punching holes and then press the lock button manually in the interior carpet of four wheeler automobile, this problem is selected for the design development of mechanism ,analysis and finding the best solution. Presentely this work of manual punching the holes and then press the button in the interior carpet of an automobile in HP Pelzer Automotive Pvt. Limited, which is located in Chakan MIDC, Pune. The company profile is to manufacture the automobile interior and exterior carpet for various renowned automobile companies such as SKODA, VOLKSWAGAN etc. Currently they are producing interior carpet for Volkswagan Polo and Vento cars. At present the task of time consuming is that they are doing work of punching and pressing operation manually using hammer, mallet and special purpose punch hand tool for fixing of lock button in carpet to hold rubber mat. In this paper, Investigations for the problem currently in use was analyzed for various modes of time taken, time l.ps and then select methodology for the design, development of mechanism to recover the problem of industry and then for the analysis and furthermore the results are compared with FEA software- ANSYS.*

Keywords: *Industry problems, investigations, Mechanism, design analysis, ANSYS software etc.*

1. INTRODUCTION

The findings at the shop floor, undergoing the development of a design, development activity for the industry, includes that a reliable, safe, and low cost, fully automated activity type mechanism can be installed for punching and pressing operation as application intends. During the investigation for available alternatives, associated technology, working methods, suitability for application; among the various forms of structure of mechanism, the cross type mechanism' was found satisfying all the requirements. The objective of our developed design system is to make 4 holes of 6 mm diameter in interior carpet of car having thickness 3mm for fixing lock button in carpet of automobile for holding rubber mat automatically as shown in fig1. The design analysis of developed mechanism is carried out using ANSYS software.

Fig. 1: Car Carpet showing holes and lock buttons

2. DESIGN METHODOLOGY

Existing task/work-At present they are doing the activity for punching and pressing operation manually using hammer, mallet and special purpose punch hand tool for fixing of lock button in carpet to hold rubber mat. The process of manual activity is as first take carpet and place on worktable and then take rubber mat for reference, place on carpet and marks at appropriate position by marker then remove rubber mat. Now make punch at marking on carpet by using special purpose punch hand tool providing required force by hammer. After

that place lock buttons at proper position and press them by using mallet. The activity of punching and pressing lock buttons is done and removes the carpet and takes next. The whole operation took 40-50 seconds. It gives back pain to workers and also there is more consumption of manual energy, also increase in human error, less accuracy, time required. For that operation we think to make a semi-automatic machine which reduces manual working, increase accuracy and reduce time. In this work process we have to carry carpet from one side to another side by manually. It gets fixed into the fixture and we locked it by clamp. Then worker has to press a switch to start process of punching by pneumatic control unit. After process complete operator will off the switch. After that operator put lock buttons to proper position and again switch ON process for pressing operation. In this process lock button pressed by both sides and gets lock on carpet

Suggested Solution methodology-Initially the switch unit operates the compressor which delivers the air to the solenoid valve at certain pressure. The solenoid controls the flow direction of air to the pneumatic cylinder. Thus the reciprocating motion of the pneumatic cylinder creates high force to punch the work piece. Our client HP Pelzer is a company situated at Chakan. The company profile is to manufacture the automobile interior and exterior carpet for various renowned automobile companies such as SKODA, VOLKSWAGAN etc. Currently they are producing interior carpet for Volkswagan Polo and Vento cars. The main objective of this paper is to designing and developing a very compact, punching cum pressing machine so that the activity is done automatically. It increases the productivity of the company.

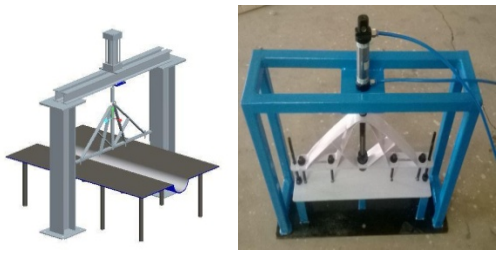

Fig. 2. 3D Model in PRO-E and Prototype Model

3. DESIGN ANALYSIS

3.1 Analysis for Displacement of Frame Structure

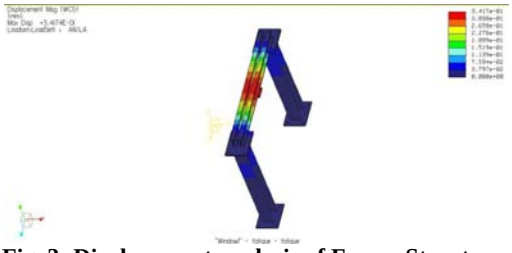

Fig. 3: Displacement analysis of Frame Structure

When the compressed air is passed to the pneumatic cylinder which is placed at the top of the frame, the frame may deform due to fluctuating load on it. The displacement value is varied at different portions of I channel-frame shown by color variation in the above figure3.The blue color represents 0 mm displacement value. So the portion of the frame represented by blue color is not subjected to any deformations. The red color represents the highest displacement value. Analyzing the deformation of frame, the maximum displacement observed at the central portion of the frame is found to be varying from $2.525e^{-01}$ to $2.885e^{-01}$ mm.

3.2 Analysis for Strain by Maximum Principle Theory

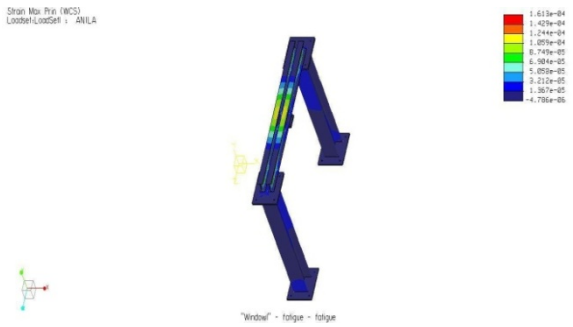

Fig. 4: Strain Analysis by Max. Principle Theory

The strain value is varied at different portions of I channel-frame shown by color variation in the above Fig. 4. The dark blue color represents $-1.069e^{-0.4}$ strain values. So the portion of the frame represented by dark blue color is subjected to minimum strain. The yellow color represents the highest strain value. Analyzing the strain in the frame, the maximum strain observed at the central portion of the frame is found to be $1.147e^{-0.4}$.

3.3 Analysis for Stress by Von Mises Theory

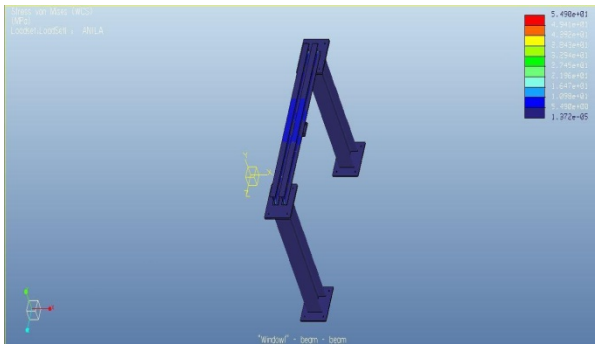

Fig. 5: Stress analysis by Von Mises Theory

The stress value is varied at different portions of the I Channel -frame shown by color variation in the above Fig. 5. The dark blue color represents $1.372e^{-05}$ N/mm^2 stress value. So the portion of the frame represented by dark blue color is subjected to minimum deformations. The red color represents the highest stress value and more deformation. Analyzing the

deformation in the frame, the maximum stress observed at the central portion of the frame is found to be varying from 1.265 to 1.423 N/mm2

3.4 Analysis for Fatigue Confidence of life

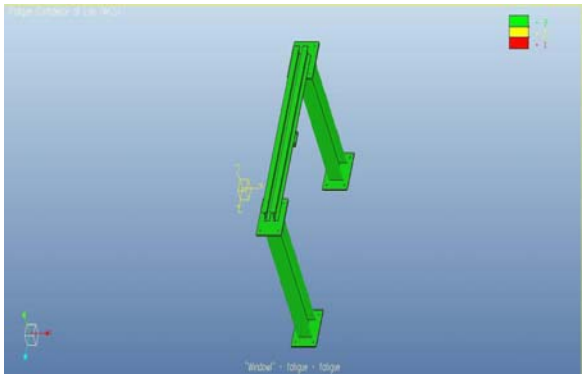

Fig. 6: Analysis for Fatigue Confidence of life

The above Fig. 6. represents the results of analysis for the maximum fatigue confidence of life. The value of the fatigue confidence of life varied at the different portion of the I-Channel frame. The green color represents the 3 fatigue confidence of life value.

3.5 Analysis for Fatigue Factor of Safety

The below Fig. 7. represents the results of analysis for the fatigue factor of safety. The value of the fatigue factor of safety varied at the different portion of the I-Channel frame. The red color represents the 11 times more fatigue factor of safety

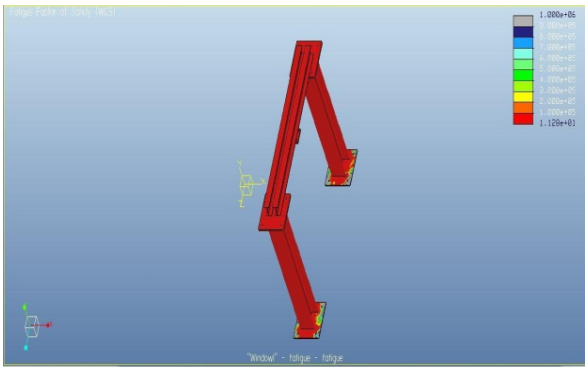

Fig. 7: Analysis for Fatigue Factor of Safety

3.6 Analysis for Displacement of Truss structure

The displacement value is varied at different portions of truss structure shown by color variation in the above Fig. 8.The blue color represents 0 mm displacement value. So the portion of the truss structure represented by blue color is not subjected to any deformations. The red color represents the highest displacement value. Analyzing the deformation of truss structure, the maximum displacement observed at the central portion of the truss structure.

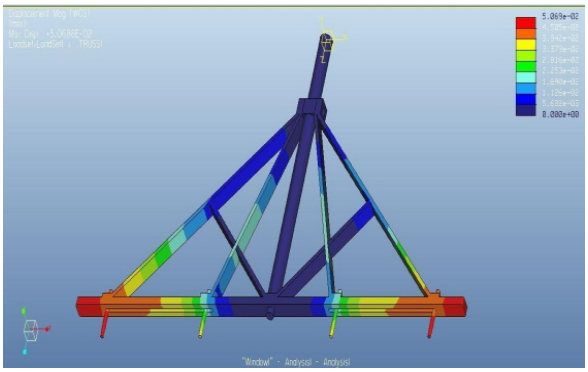

Fig. 8: Analysis for Displacement of Truss structure

4. CONCLUSION

This developed design mechanism of punching cum pressing machine fulfills the requirements in automobile component manufacturing. As planned, human interference is minimized by implementing semi –automation by using pneumatics. It provides the company with a suitable punching cum pressing machine for required operations. As the machine is semi-automatic, it is easy to operate and it yields accurate operations. The machine is compact and simple. The cost of manufacturing is moderate as compared to the job to be performed by our client. Thus, as an Industry practical problem for the Design, analysis and simulation of punching cum pressing machine‟ is a successful attempt in application of engineering sciences. The design analysis such as analysis for strain, stress, displacement, fatigue of different components of developed mechanism for the task are compared and the results are found out using ANSYS software.

5. ACKNOWLEDGEMENTS

“Completing a task is never a one man‟s effort. Several prominent people in production, academics, and administrative field have helped in Design analysis, development of punching cum pressing mechanism for four wheeler automobile – a practical problem of industry for this present research work. Their collective support has led in successful design and development of this work. To name them all is impossible.”

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