IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 2 Ver. VII (Mar- Apr. 2014), PP 84-89
www.iosrjournals.org

Redesign the Steering Column Assembly with Crimping Method

M.Balaji*, MalarMohan*
Dep't of Mechanical Engineering, College of Engineering, Anna University, Guindy, Chennai, India

Abstract: *Our project work named "Redesign the Steering column assembly with crimping method" is to ensure Energy absorption load of steering column shaft assembly and reduce failure due to noise. It also reduces the dependency of process parameters which is considered as important factor in existing injection molding process. Energy Absorbing Steering Column is a kind of Steering Column which minimizes the injury to the driver during a car meets accident by collapse particular part of system. The design of the steering column has remained unchanged since its inception; the column still consists of a long shaft connecting the steering wheel to the vehicle's gearbox. Column shaft assembly is made by joining shaft and tube through injection moulding process which has high variation and dependency on process parameters. Energy absorption load will be ensured by periodic inspection of parts and setting parameters. To overcome the existing problem, we proposed crimping method to join shaft and tube assembly and ensure energy absorption load during the process and improve the performance of the steering column assembly.*
Keywords: *Abacus,Steering Column Assembly*

I. Introduction

A steering column is a mechanism that is used to transfer energy from the steering wheel into the steering gear box, which transfers energy to turn the wheels of a vehicle. The steering column is the shaft directly under the steering wheel in which the ignition and automatic shift levers are often located.

When the steering column was first invented, it consisted of a single, long, steel rod connecting the steering wheel to the steering gear box. While this single-piece construction was efficient, and effective in controlling the vehicle, it soon became apparent that its design was unsafe in frontal collisions. Under the single-piece system, when such an impact occurred, the steering column would often impale the driver as it was rammed toward the rear of the vehicle.The unsafe attributes of single-piece steering columns called for the invention of a safer steering column design, which is why BelaBarenyi designed the collapsible steering column to replace it. The safely enhanced construction of the collapsible steering column, no matter which design is used, absorbs, rather than transfers, frontal impact energy by collapsing or breaking upon impact. In this way, drivers involved in frontal impact collisions are able to avoid the dangers of non-collapsible steering parts. Though the designs for steering columns have varied since their inception, a typical collapsible steering column looks like two interlocking shafts that attach directly to the steering wheel and the steering gear box. Collapsible steering columns still consist of a long shaft that connects the steering wheel to the steering gear box. However, the collapsible design is composed of an inner and an outer sleeves jointed together to withstand certain load.

In the event of a frontal impact, the joint of sleeves breaks, allowing the inner sleeve to be moved further into the outer sleeve in telescopic fashion before enough pressure is achieved to ram the whole steering column into the driver. In this manner, the energy received through a frontal impact is completely absorbed by the steering column's collapsing parts, allowing most modern drivers to remain completely unaware of the danger they have avoided

II. Parts of steering column assembly

A collapsible steering column assembly consists of shaft assembly which connects steering wheel at one end and intermediate shaft assembly at other end. Column assembly consists of two hollow tubes named Upper tube and lower tube which has mounting provision on it to fix with vehicle body. The various components of steering column assemblies are,

1. Column assembly
2. Intermediate shaft assembly
3. Shaft assembly
4. Universal joint assembly

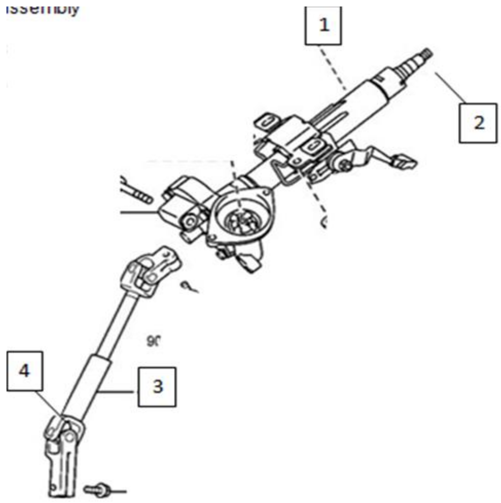


Figure 1.Steering column assembly

III. Working Principle Of Collapsible Column

During a collision, two forces are applied to the steering column. The first is the force of the steering box being forced back towards the steering column, and towards the driver. Plastic shear pins allow the lower shaft to move over the upper shaft. The second force is the mass of the driver striking the steering wheel. This force breaks the brackets on the upper part of the column, driving the upper column into the lower column.

The steering column is connected to the input shaft of the steering gear by a flexible joint. This allows for alignment, and reduces the transmission of road shocks back to the driver. Some steering columns have an intermediate shaft, which runs at an oblique angle, from the column to the steering gear. In a collision, the universal joints on the shaft allow it to fold under, preventing the force from impact being transferred directly to the column.Some manufacturers fit sensors and control units to the steering column, which provide information to steering control modules as part of an electric assisted or 4-wheel steering system. The sensor and control units are able to sense rotational pressure exerted by the driver and control both the speed and direction of the electric motor. This motor is contained inside the steering rack & provides the steering assistance.

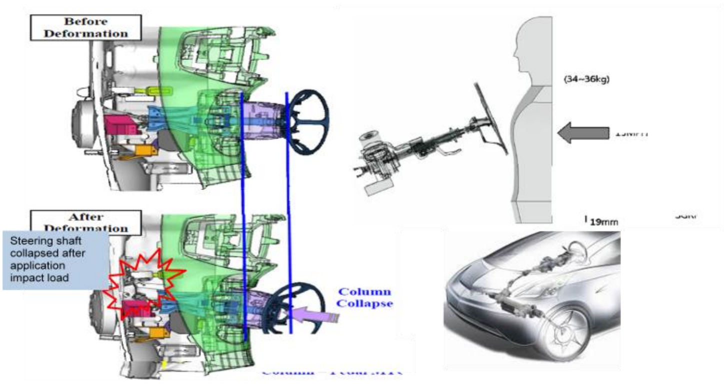


Figure 2 .Schematic of steering column collapse mechanism

IV. Problem Definition

The steering shaft assembly (2) is connected to the steering wheel and steering gear. The conventional steering shaft assembly (2) comprises upper shaft, tube and shaft. The tube has four holes and the shaft has grooves. A particular plastic resin is injected in the holes of tube and grooves of shaft when both are aligned. This leads to formation of four plastic shear pins. At the time of collision, these shear pins break at certain load, usually 300 ~ 450 Kgf and the shaft slides into tube thereby protecting the driver.

The disadvantages of Injection molding type steering shaft assembly are as follows:

- High production cycle time.
- Difficulties in manufacturing as various parameters are to be controlled for ensuring the required shear force.
- Deterioration in the performance in the field due to loosening of injected plastic resulting to increase in warranty problems (Noise or rough roads).

The intermediate shaft assembly (3) consists of sub-shaft (7), lower tube (6) and universal joint (4). The lower tube has four holes and thesub-shaft has grooves. Plastic resin is injected in the holes of lower tube (6) and grooves of sub-shaft (7) when both are aligned. This leads to formation of four plastic shear pins. At the time of collision, these shear pins break at certain load, normally 300 -450 Kgf.cm and the sub-shaft slides into lower tube.

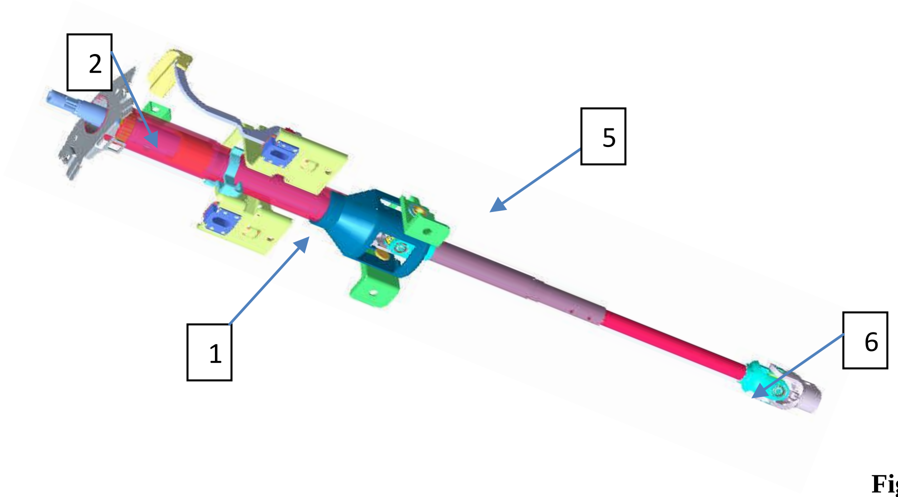


Figure 3.Steering column assembly

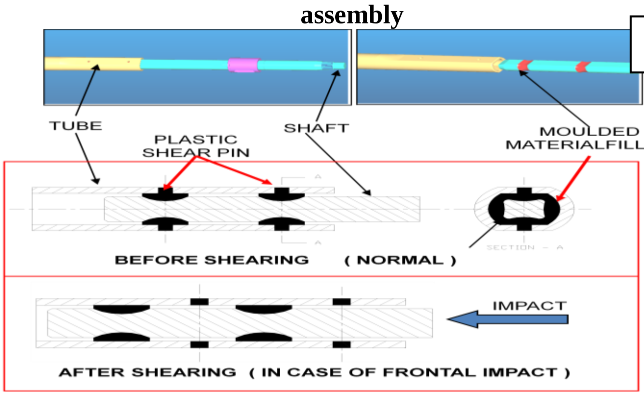


Figure 4. Sketch of Intermediate shaft assembly collapse mechanism

The disadvantages of Intermediate shaft assembly are as follows:

- energy absorption load cannot be confirmed on all assemblies
-

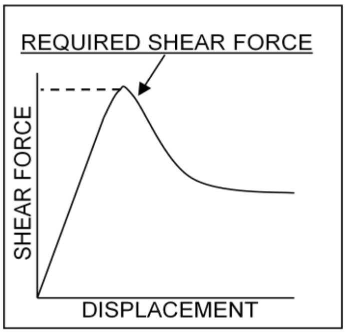


Figure 5. Shear load Vs Displacement chart

- Difficulties in manufacturing as various parameters are to be controlled for ensuring the required shear force.

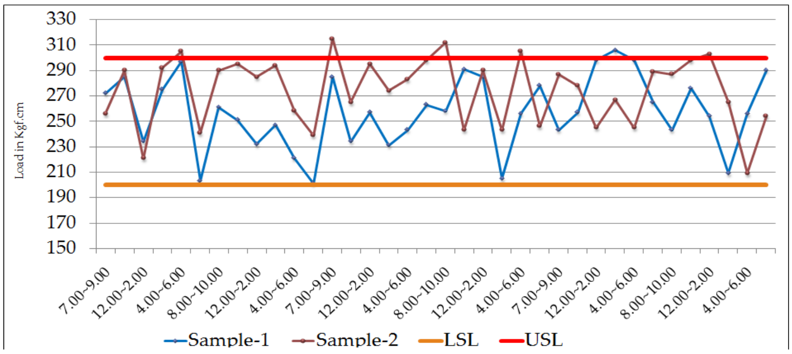


Figure 6. Collapse load distribution chart of injection moulding process

- Deterioration in the performance in the field due to loosening of injected plastic resulting to increase in warranty problems (Noise on rough roads).

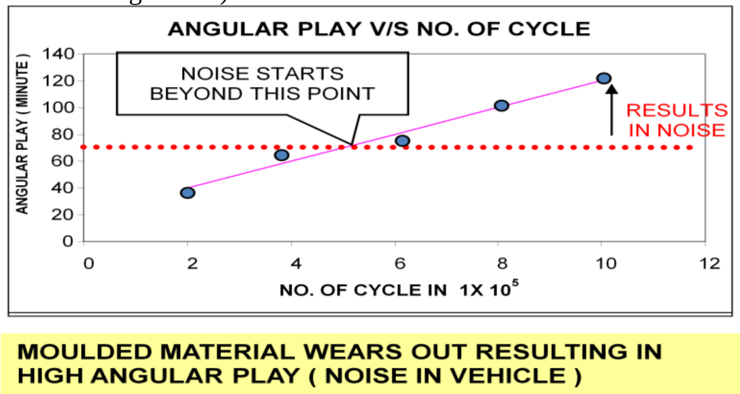


Figure 6. Angular play Vs Number of cycle of operation

V. Proposal of alternate design and Evaluation

The proposal of providing serration on sub-shaft and tube and introducing crimping process to join shaft and tube meets the desired criteria of this project objective.

Different methods of crimping process

Serration on shaft and tube process is selected as suitable design. The manufacturing process design are proposed with various methods of crimping of tube and shaft in order to achieve the required shear force in intermediate shaft assembly as follows,

1. Method-A: Shaft inserted fully into the tube and pin pressing on tube to form crimping
2. Method-B: Crimping on hollow tube with pin and insertion of shaft
3. Method-C: Partial insertion of shaft into tube, pin pressing on tube to form crimping and insert the shaft into tube to the desired length

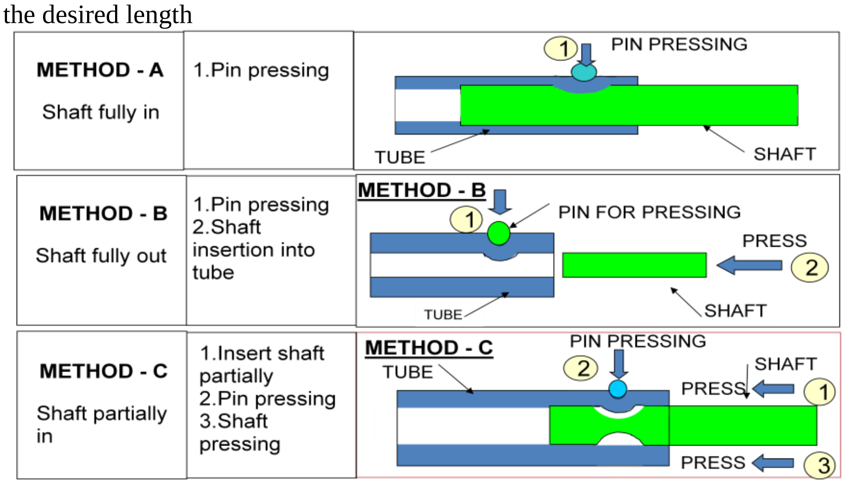


Figure 7. Sketch of various crimping methods

The method-C of doing the crimping process in two stages meets our desired criteria based on its merits and demerits.

VI. Establishment of crimping process

The proposal of providing serration on sub-shaft and tube and introducing crimping process to join shaft and tube meets the desired criteria of this project objective.

Two different types of fixture designed to carry out the test by controlling i. Crimping force and ii.by controlled depth of indent.

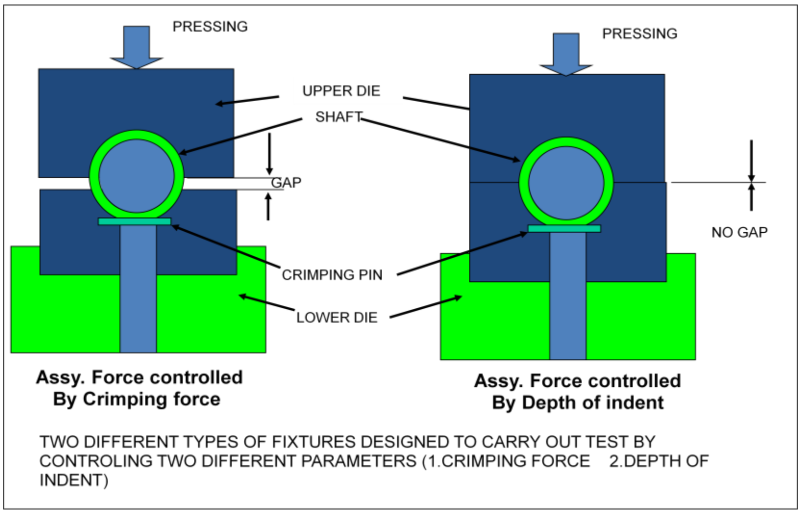


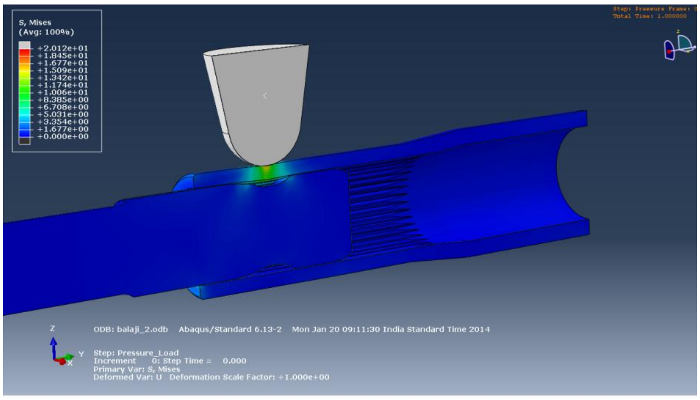
Figure 8. Sketch of various crimping methods

Analysis of Crimping process using ABACUS

Different iterations of study carried out with different diameter of punch and various indentation depth

Study-1: Depth of indent is 0.6mm

Figure 9. Collapse load of shaft and tube



Study-2: Depth of indent is 0.8mm

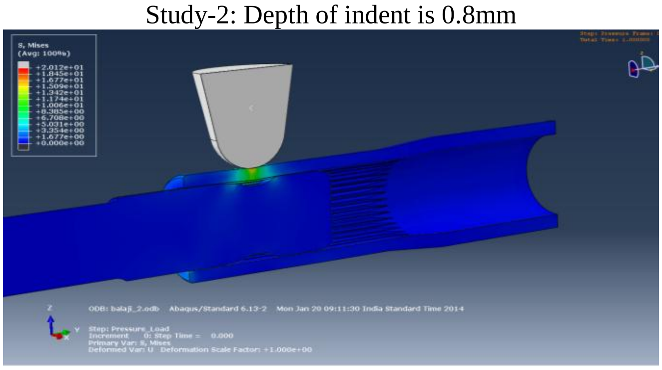


Figure 10. Sketch of various crimping methods

The study has been done different depth of indent of punch and diameter and results are shown in below table.

Depth (in MM)	Applied load (in Kgf.cm)
0.6	268
0.8	321
1	373
1.2	415
1.4	464
1.6	494

VII. Conclusion

This report deals with the working principle, collapse mechanism of steering components, analysis of existing process, proposal of alternative design and process for intermediate shaft assembly in collapsible steering column assembly and proposed new process design with serration on shaft and tube with crimping method. The design modification of shaft, tube and crimping tool, fixture design , Design of components based on proposed concept, Analysis of proposed process design to meet EA load requirement, Detailed drawings of tools and fixtures of the new system, Develop proto samples, Conduct trails on new design process and establish the process. By this method, the collapse load of shaft & tube can be confirmed during insertion process. By adjusting depth of indent and diameter of punch, various collapse load can be achieved.

Acknowledgements

I express my gratitude to Dr. Srinivasan, Professor and Director, AU-FRG Institute for CAD/CAM, College of Engineering Guindy, Anna University for allowing me to do the project and continuous encouragement for doing this project work.

References

[1] JTEKT - Product review web site
[2] Sona Koyo Intranet – Design and standards Guide Lines
[3] Sona Koyo – After markets websites
[4] Steering column assembly - Wikipedia, the free encyclopedia websites
[5] Universal Joint. US patent no. 1,665,280.
[6] US patent 1979768 , Pearce, John W.B., " Universal Joint", issued 1934-11-06
[7] US patent 2947158, King, Kenneth K., "Universal Joint Centering Device", issued 1960-08-02, assigned to General Motors Corporation
[8] Tyler G Hicks (2006), “Handbook of Engineering Calculations”, McGraw-Hill.