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DESIGN AND FINITE ELEMENT ANALYSIS OF AUTOMATIC CAR COVER

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Abstract - *In early of 20th century car has become widely available, most of the time cars are parked in garage or in a shady place to protect the car from sun radiation and rain or car cover can be used. Car cover has a rough shape of car which is made by certain materials. These materials are selected according to the use of application. Covering the car with car cover is done with man effort and this job is a tricky one. In our project we are going to present an automatic car cover mechanism which will opens and closes itself with the help of the push button. It covers the whole car with a thin, but a strong material that not only protects the car from rain, dust and mud (in parked situation) but also from minor scratches. If there is a car cover deploys automatically, it will protect the luxury cars even at the worst situation. It is purpose of the current application to provide a car cover that comes out of a car's trunk, deploys and restored into the trunk automatically by a simple press of a key.*

Key Words: Protect, Radiation, Automatic, Mechanism, Deploy.

1. INTRODUCTION

For almost a century, cars have been utilized for transportation. Cars are mostly utilized to transport people rather than products due to limited space and the number of passengers seated. Today's technology has advanced, and every aspect of an automobile has been designed with the user's comfort in mind. Cars were increasingly accessible in the early twentieth century, replacing animal-drawn carriages and carts. Cars are often kept in a garage or in a shaded location to protect them from UV rays and rain, but a vehicle cover can be utilized. Automobile covers have a rough outline of a car and are constructed of various materials. These materials are chosen based on their intended function. Covering the car with a car cover requires manual work and is a difficult task. We must first identify the front and back of the cover. Then, first, wrap the cover around the front bumper, then drag it over the top of the car, and last, wrap it around the back bumper.

A car shelter is a huge sheet of protective fabric material in the shape of a car. When a vehicle is not utilized for an extended period of time, a car shelter is used to protect it. Car shelters can protect your parked car from the harmful effects of acid rain, UV radiation, bird droppings, sun fading, windborne particles, animal claws, and even the prying eyes of criminals. A good cover within your garage provides a barrier against foot-borne varmints and airborne filth.

In this project, we will demonstrate an automatic car cover mechanism that will open and close itself using a push button. It covers the entire automobile with a thin but durable covering that not only protects the car from rain, dust, and dirt (while parked), but also small scratches. If a car cover deploys automatically, it will safeguard the expensive vehicles even in the worst-case scenario. The present application's goal is to offer a car cover that automatically comes out of a car's trunk, deploys, and returns to the trunk with the touch of a key.

1.1 About car cover

The usage of a car cover has many benefits and a few drawbacks, since they are both protective and potentially harmful. A car cover that does not fit properly may be more harmful than no cover at all. If the car cover is just too loose, wind may force it to flap against the paint, causing serious damage. Order a canopy that is custom fitted for your car's year and manufacture to ensure the best fit. The "one size fits all" styles are less costly, but they do not provide the necessary tight fit. If the car isn't clean, dirt can become trapped between the duvet and the paint, causing scratches when the cover is removed or fitted, or when the car cover is blown around by the wind. To avoid these difficulties, use a properly fitted vehicle cover on a clean automobile. Certain car covers include a bottom locking feature that allows a cable (that is plastic coated) to comfortably carry the rock bottom of the duvet. This may assist prevent duvet movement and burglars from sneaking a peek.

1.2 Car shelter

Owning a fresh new automobile and maintaining it is a source of pride. A vehicle cover or parking in a shaded area

can protect your car from UV rays and rain. Shaded areas might be found beneath a roof or in a tent. These each have their own set of benefits and drawbacks. The vehicle cover may be inexpensive to purchase, but it takes time and manpower to place it on the car and time to remove and fold it. However, when it rains, the covering procedure takes longer because of the wind, and the worker gets wet while doing it. And as for the tent or roof, these may be purchased and erected; it is possible to park a car beneath it, but it cannot be carried.

Nowadays, technology has advanced, and there are several varieties of vehicle shelters on the market. The following are some of the most recent forms of car shelters:

In this mechanism an automated car umbrella is mounted on the roof of the vehicle and is controlled by a remote control. The system may be repaired or uninstalled and kept in the automobile (portable).

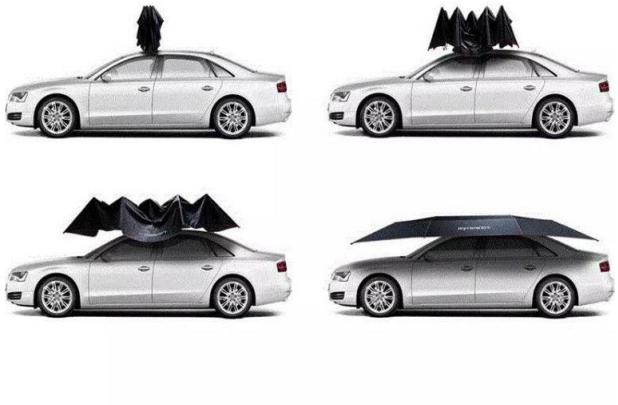

Fig 1.1: Automatic car umbrella type

This system is stationary in a foldable portable garage; once installed and finished, you must park your automobile there; it cannot be carried. However, if we relocate, this system may be dismantled and reinstalled in a new area.

Fig 1.2: Folding portable garage

This system is retractable in solar powered retractable car garage, so some space may be conserved, plus it is solar powered. This system is stationary.

Fig 1.3 Solar powered retractable car garage

In the semi-automatic roller vehicle cover system, we must do some manual effort. This system is portable and may be taken in the automobile.

Fig 1.4: Semi-automatic roller car cover.

1.3 Car cover material

With the right knowledge, you can make an informed decision about whether to use a car cover and which type is ideal for your needs. There are three main types of car covers available on the market, each with its own set of benefits and drawbacks.

a. Water proof
b. Water resistant
c. Non-water resistant

The major benefit of having a water proof vehicle cover is that it keeps rain off the car. These waterproof car coverings are often made of a plastic coated or film cloth that will keep rain off your vehicle. However, employing this type of canopy will trap moisture between the car and your car cover. The trapped moisture may produce problems that are worse than if you had just left the automobile exposed. This type of car cover is utilized while storing your vehicle in a garage throughout the winter. One of the finest methods is to place a flannel fabric cover against the surface.

The second kind is water resistant vehicle covers, also known as breathable car covers, which come in a dizzying

array of fabrics, styles, and weights. These types of vehicle coverings will keep the majority of the rain out while yet allowing air to flow and reducing dampness. Most are mildew resistant and have UV filters woven into the mesh to help them withstand solar deterioration.

The third most common type of cover material is cotton/polyester blends or pure cotton vehicle covers, which are available in flannel or standard fabric styles. These car covers are not waterproof and should not be left outside for extended periods of time. The majority of consumers utilize these types of protection for interior usage, and these materials are mild on paint, whereas polyester may damage the paint.

2. PROBLEM STATEMENT

According to the information gathered on car shelters, problems linked with them have been identified. In certain cases, the system (vehicle covering system) is portable; nevertheless, this method needs human work and expertise to cover the automobile, unlike in automatic car umbrella types, the entire car is not covered. At certain cases, the technology is not portable, therefore the automobile must be parked just in that location. It's also tough to conceal the automobile.

3. OBJECTIVE OF WORK

• Develop an automated vehicle cover with a different mechanism.

• A FEM method was used to investigate the stress, strain, and deformation of an automatic car cover.

• Linear static structural analysis was used to estimate the linear stress, strain, and deformation of an automatic car cover.

• Determination of the fatigue life of an automated car cover.

• Thermal study of a self-closing vehicle cover.

4. METHODOLOGY

- **Define problem**

The aim of this activity is to define a statement that include what are the problems occurring in certain situation.

- **Gather information**

Information are collected from various source like from internet and journals. These information's are important, they are used in further process.

- **Concept generation**

Various concepts are generated using software's and sketching is done such that is should satisfy the problem statement.

- **Concept selection**

Here using Pugh matrix, concepts are varied with different criteria and the best concept is selected here.

- **System level design**

Components involved in in the system are named.

- **Detail design**

Specification of all component is done and calculations are done

- **Analysis**

Critical part analysis is done using ANASYS software.

5. LITERATURE SURVEY

In this chapter, we will utilize mechanisms that we have chosen for this project based on that mechanism, and some of the people will use the same mechanism for their other job. The rack and pinion gear system and the oscillation mechanism were explored in the literature. Also reviewed was the literature relating to the cover that we are employing to launch the automobile. The other literatures are on the substance of telescopic links and how the rollers mechanism works. Some of the tests and outcomes are listed below.

Rack and pinion gears convert rotational motion to linear motion. A pinion gear is spun in this mechanism, and the gear teeth mesh with the teeth of the rack, causing the rack to move relative to the pinion in either a forward or backward direction depending on gear rotation. The rack and pinion combination are often employed as part of a basic linear actuation in which shaft rotation is translated to linear motion. A typical use of rack and pinion is in steering mechanisms, as detailed in a study by Rajasekar.et.al. [1]. The journal paper discusses the design and manufacture of variable rack and pinion systems. Variable steering geometry is used to enhance steering behavior. A variable steering

ratio system is one that has multiple ratios on the rack ranging from higher to lower in order to sensitivity the steering. Because the gap between the teeth is tiny in the centre of the rack, steering is more responsive when the steering wheel is near to its centre position. As the pinion travels down the rack, the available area expands [2].

Telescoping in mechanics refers to the movement of one part sliding out from another from its rest condition, resulting in the elongation of the system. A telescopic tubular mast is a multi-sectional mast in which the top part is extended and retracted in a controlled predefined sequence, with each segment locking to the next lower section when completely extended. (adjacent section) by [3-4]

Astro aerospace has been developing telescopic tubular masts for a number of years, and they have a variety of applications. The telescopic tubular mast is made up of many circular tubes that are deployed and retracted with the use of a storable tubular extensible mechanism (STEM). Mehram Mobreem [5] designed and tested a telescopic tubular mast for a long boom use, with a particular design case of 34.4m long selected and tested.

The guideway's major job is to ensure that the machine tool or cutting tool element goes along a regulated specified route, therefore it plays an essential part in machine tools. Because the guideway provides a smooth and predetermined linear motion in the machine tool, more accuracy and precision may be attained. A linear motion guideway has a mechanism that bears both the load and guides the linear motion at the same time [6-7].

Rollers are cylindrical or round-shaped components that revolve about a central axis and are utilized in a variety of devices. The gadget is moved using rollers. B. Santosh sarma [8-9] produced a study on roller mechanism power production. Instead of a speed breaker, a roller configuration is installed, and as the vehicle passes over these rollers, the roller rotates and is connected to a DC generator. Electricity is generated as the shaft of the DC generator rotates.

One of the most essential machine elements in a mechanical power transmission system is the gear. Spur gear is a type of transmission gear that is used to transfer power between parallel shafts. Pinaknath Dewanji [13] released a spur gear article in which a spur gear is constructed and analyzed. He deduced from the study results that the highest stress for gear teeth occurred in the root area of the gear tooth. Furthermore, by lowering the maximum induced stresses, the geared system's loading capacity and operating speed may be improved [14].

6. SYSTEM DESIGN

Components in the system

The following are the components of the vehicle shelter. The sliding mechanism and oscillating motion, in which the link moves in an arc, are the two major mechanics of the vehicle shelter assembly. To operate a sliding mechanism, a roller, a guideway, a shaft, and some gear to rotate the roller are required. Similarly, for oscillation motion, a specific gear is employed, and its role is to move the shaft at an angle together with the roller. A housing is used to house the majority of the components, such as gears, arm supports, and rollers. It has a rear component that stores the car cover. To move the assembly, we employ a hydraulic system. And a cover to protect the automobile. Components

Fig 6.1: Gear

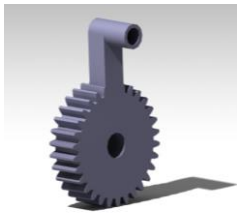

Fig 6.2: Gear with handle

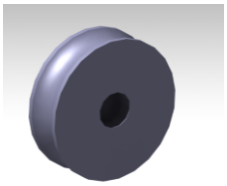

Fig 6.3: Roller

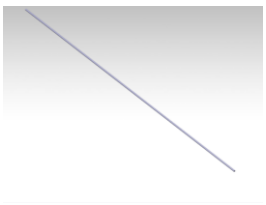

Fig 6.4: Hallow shaf

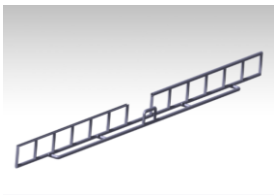

Fig 6.5: Arm support

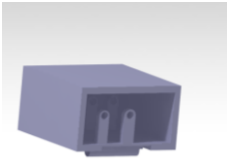

Fig 6.6: Housing

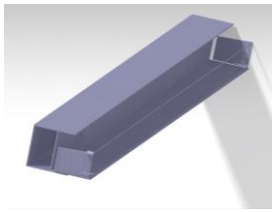

Fig 6.7: Back Component

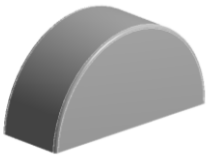

Fig 6.8: Car cover

CALULATIONS

Dimensions of the vehicle

We averaged the length, breadth, clearance, and wheel base measurements.

Car length = 4810.0mm

Car width = 1757.0mm

wheelbase = 2500.0mm

Because the clearance is 220mm, the arm length should be less than 2500mm.

The width of the housing should be smaller t Gear calculation

Number of teeth = T = 20

Module = m = 1.5

Face width = 15.0 mm

Total pressure angle = 20°

Pitch circle radius of gear = R = $\frac{mT}{2}$ = $\frac{1.5*20}{2}$ = 15.0 mm

Addendum circle radius of gear = RA = R + 1m

= 15+1.5 = 16.50mm

Diameter of addendum = 2*16.5 = 33.0mm

Dedendum circle radius of gear = RD = R – 1.25m

= 15 – 1.25*1.5

= 15 – 1.875 =13.1250mm

Diameter of dedendum circle of gear = 2*13.125 = 26.250mm

Gear with handle calculation

Gear calculations

Number of teeth = T = 30

Module = m = 1.5

Face width = 15.0 mm

Total pressure angle = 20°

Pitch circle radius of gear = R = $\frac{mT}{2}$ = $\frac{1.5*30}{2}$ = 22.50 mm

Addendum circle radius of gear = RA = R + 1m

= 22.5 + 1.5 = 24mm

Diameter of addendum = 2*24 = 48.0mm

Dedendum circle radius of gear = RD = R – 1.25m

= 22.5 – 1.25*1.5

= 22.5 – 1.875 = 20.6250mm

Diameter of dedendum circle of gear = 2*20.625 = 41.250mm

7. MODELING

Creating a prototype before production is a good idea, but it has its own set of benefits and drawbacks. If the prototype's function works well, there will be no problems; nevertheless, if the prototype fails in any function, we must diagnose the problem and construct a new prototype. As a result, the development cost rises. So, before making a physical prototype, it is better to utilize software. With software, we can construct a virtual model, conduct simulations, and even perform analysis on the model. This phase may take some time, but it has a useful use in product design. For modelling, we utilize the catia software. CATIA (computer aided three-dimensional interactive application) is a commercial program used for physical modelling in various mechanical and aerospace sectors that has advanced significantly in recent years.

Working Procedure

The entire equipment is tucked beneath the car. We have two major assemblies here. The first is the housing, while the second is the rear assembly.

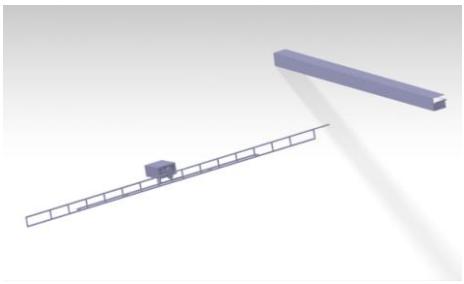

Fig 7.1: Assembly of car cover

The housing is made up of two motors, three gears, two of which are mounted on the motors, a gear with handle, two rollers, one of which is mounted on the gear with handle, a pinion shaft (in which a gear, gear with handle, and a roller are mounted), a hallow shaft, and an arm support that supports the hallow shaft, as shown in the figure.

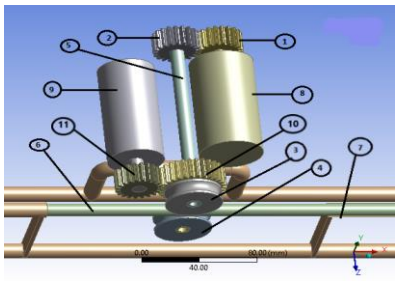

Fig 7.2: Gear assembly in housing

- 8,9 motors
- 1,2,11 gears
- 10 gear with handle
- 3,4 rollers
- 5 pinion shaft
- 6 hallow shaft
- 7 guide way

Back assembly

The back component is made up of a vehicle cover and a link. The car cover is linked to the connection, and as the link travels, so does the cover. A cap is connected to the connection, and the hallow shaft from the housing travels towards and secures to it.

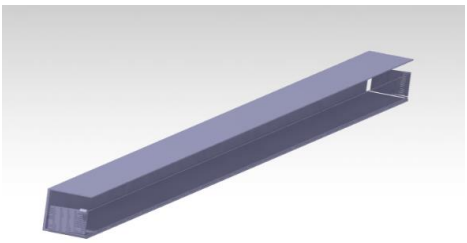

Fig 7.3: Back assembly

First, we must bring the arm support outside the automobile, so the housing will move lower using the hydraulic system, and then the arm support will be pulled out using the hydraulic system.

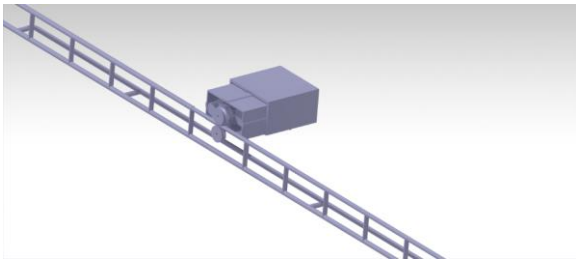

Fig 7.4: Horizontal movement of arm support

At the same moment, the back-assembly slides lower, and the car cover is brought outside the vehicle via the hydraulic system.

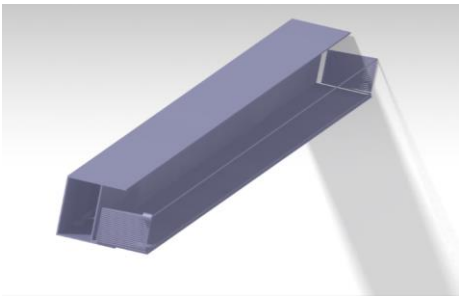

Fig 7.5: Car Cover moving outside the assembly

Once the arm support and car cover are removed from the vehicle, we must complete two mechanisms.

1. Roller mechanism
2. Unfolding mechanism

Roller mechanism

The roller is rotated in the roller mechanism by motor 1. Between the rollers is a hollow shaft rod. When the roller is turned, the cylindrical hallow shaft rotates until it is firmly seated in the rear assembly cap.

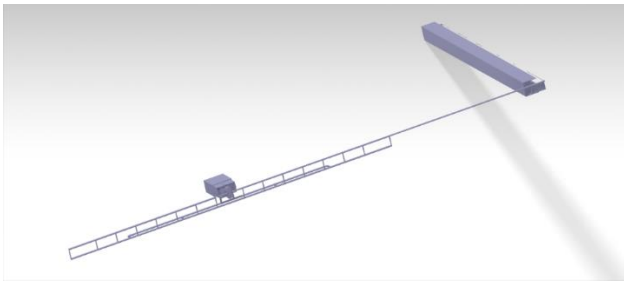

Fig 7.6: Hallow shaft attached to back assembly

Unfolding mechanism

After connecting the hallow shaft to the cap in the rear assembly, motor 2 begins and spins the gear with the handle. The gear with the handle holds the roller, which spins together with the shaft, causing the link to move and the vehicle cover to unfold and cover the automobile.

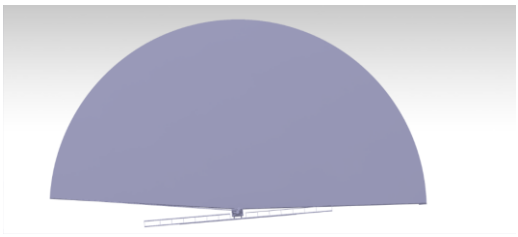

Fig 7.7: Car Cover covering the Car.

The process is reversed to unfold the car cover, the car cover retracts, the hollow shaft retracts, and the housing and rear component are returned to their original positions using hydraulics.

8. ANALYSIS

Analysis aids in understanding how a product will react under various situations. The analysis is a visual examination of how the component performs in severe or unstable situations. ANSYS software is used in this case. Analytic is carried out with the use of analysis software.

General procedure

In Ansys workbench certain step are followed;

- First select analysis system for analysis here we conduct static and thermal analysis.
- The following step is to input material characteristics.
- The model is then either built or imported into the system.
- The meshing process is then carried out (The elements used for the mesh of the model are tetrahedral three-dimensional elements with 8 nodes)
- The boundary condition is applied.
- Then choose the desired outcome, and finally solve to generate result.

Critical part analysis

We chose the hallow shaft as a crucial element for examination in this case. Because the hallow shaft raises the lid, it experiences some tension and distortion. Material selected for hallow shaft is aluminium and properties are as follow:

- Density = 2.9 g/cc.
- Young's modulus = 7400 Mpa.
- Poisson's ratio = 0.33.

Weight of car cover is about 10 pounds so we have selected load as 44.1 N for analysis.

Fig 8.1 : isometric view of hallow shaft

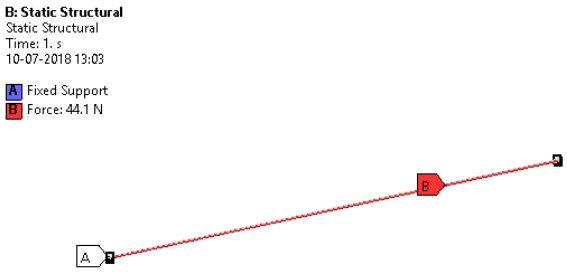

Fig 8.2: Boundary condition of hallow shaft.

The figure depicts the boundary condition of the hallow shaft. In this case, one end is fixed and a force of 44.1 N is applied to the surface of the hollow shaft

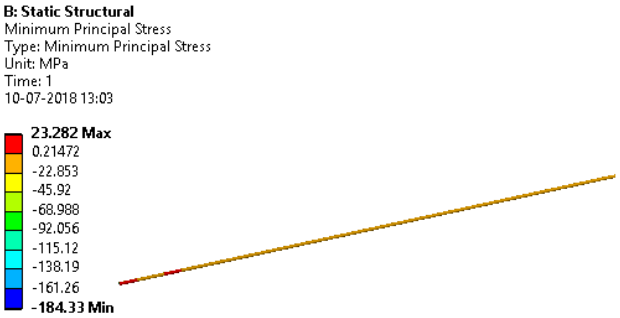

Fig 8.3: Minimum principal stress of hallow shaft.

The figure depicts the minimal principal stress of a hollow shaft, which is 23.2820 Mpa.

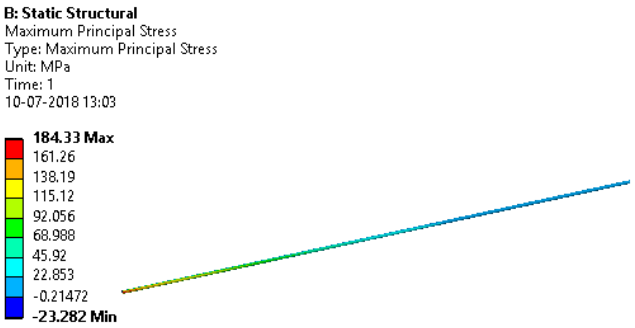

Fig 8.4 : Maximum principal stress of hallow shaft.

The figure depicts the maximum main stress of a hollow shaft, which is 184.330 Mpa.

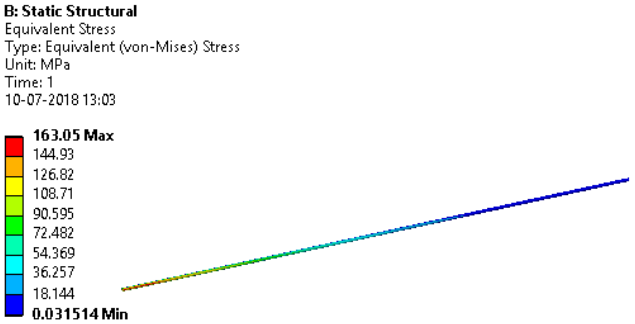

Fig 8.5: Equivalent stress of hallow shaft.

The figure depicts the equivalent stress of a hollow shaft, which is 163.0 Mpa.

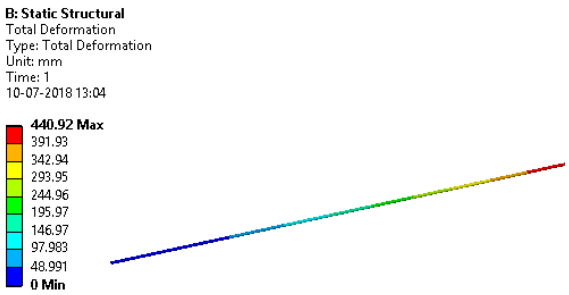

Fig 8.6 : Total deformation of hallow shaft.

The figure depicts the overall deformation of the hallow shaft, which is 440.920 mm in this case.

After the static linear analysis is conducted on the considered critical part (hollow shaft). Stress analysis and thermal analysis is performed on three different materials with respect to material properties, to determine the best suited material to manufacture a car cover.

This process is performed by using FE approach. The materials and their respective material properties are as follows:

Properties of PEVA material

Density = 0.95 g/cm3

Yield strength = 60 Mpa

Poission's ratio = 0.4 W/mc.

Thermal conductivity = 0.4 W/mc

Properties of PVC material

Density = 1.38 g/cm3

Yield strength = 3400 Mpa

Poission's ratio = 0.41 W/mc.

Thermal conductivity = 0.19 W/mc

Polyester Fabric material

Density = 1.39 g/cm3

Yield strength = 3348 Mpa

Poission's ratio = 0.392 W/mc.

Thermal conductivity = 0.17 W/mc

Material	Equivalent stress (Mpa)	Max principal stress (Mpa)	Minimum principal stress (Mpa)	Total DF (mm)
PEVA	0.118520	0.12638	0.019090	0.1530
PVC	0.118590	0.12628	0.017762	0.0028
PES Fabric	0.11840	0.12584	0.015670	0.0030

The stress analysis results of the materials are tabulated in the above tabular column.

The Equivalent stress of polyester fabric material is (0.11840 Mpa), which is smaller than that of other materials.

Material	Total heat flux
PEVA	3.87350 e-15
PVC	1.84110 e-15
PES Fabric	1.64730 e-15

The thermal flux analysis results of the materials are tabulated in the above tabular column.

The Max heat flex of polyester fabric is (1.6430e-15), which is smaller than that of other materials.

9. CONCLUSIONS

A car shelter is a huge sheet of protective fabric material in the shape of an automobile. When a car is not used for an extended period of time, a car shelter is used to protect it. Car shelters can protect your parked car from the harmful effects of acid rain, UV radiation, bird droppings, sun fading, windborne particles, animal claws, and even the prying eyes of criminals. A good cover within your garage provides a barrier against foot-borne varmints and airborne filth.

In this project, we will demonstrate an autonomous vehicle cover mechanism that will open and close itself using a push button. It covers the entire automobile with a thin but durable covering that not only protects the car from rain, dust, and dirt (while parked), but also small scratches. If a car cover deploys automatically, it will safeguard the expensive vehicles even in the worst-case scenario. The present application's goal is to offer a vehicle cover that automatically comes out of a car's trunk, deploys, and returns to the trunk with the touch of a button.

FEM approaches were found better and easy to study the mechanical properties of automatic car cover.

Static linear analysis is performed using the FE method, and the maximum equivalent stress is equal to (163.05 MPa), which is less than the yield stress, indicating that the structure is safe.

The Equivalent stress of polyester fabric material is (0.1184 Mpa), which is smaller than that of other materials.

Static analysis is performed using the FEM method, and life is estimated to be e6 cycles. As a result, polyester fabric

material is thought to be the finest choice for vehicle cover material.

Using a single system, car covers are made for many types of vehicles.

The findings of fatigue life and thermal analysis were examined and determined to be good.

REFERENCES

1. Design and fabrication of variable rack and pinion steering geometry, R.Rajasekar, T.Kathireshan,Rohit G Prasad,M.Pradhyumnan, International Conference on Energy Efficient Technologies For Automobiles (EETA' 15).
2. Modelling and simulation of rack-pinion steering systems with manufacturing errors for performance prediction, Angelo Piantoni, International Journal of Vehicle Systems Modelling and Testing 13(2):178,(2019)
3. Telescoping mast with improved holddown-locking mechanism,Adams Daniel.S,Butlet Gene R, Tri-Ex Tower Corporation (Visalia CA 02)
4. Tulare County Historical Society Publications Index, JosephL. Vicenti.Indexer Revised 2013
5. Design and Performance of the Telescopic Tubular Mast, M. Mobrem, C. Spier, Proceedings of the 41st Aerospace Mechanisms Symposium, Jet Propulsion Laboratory,(2012).
6. Design of Precision Linear Drives, Wanqun Chen, Yazhou Sun., precision machines (2018).
7. Hydrostatic, Aerostatic and Hybrid Bearing Design, W. Brian Rowe, Butterworth-Heinemann (2012).
8. Electric Power Generation Using Roller Mechanism, B. Santosh Sarma, B. Udaya Kumar. IJERT (2014).
9. A transport mechanism using tapered rubber rollers to generate cross-directional tractive force. J. tomamoto,k yoshida, Microsystem Technologies 9 (2003)
10. A Review on Various Method of Power Generation in Automobile Suspension System, Nithiyesh Kumar, international Journal of Latest Trends in Engineering and Technology (IJLTET) (2015).
11. Design of Power Generation Unit Using Roller Mechanism, V. Jyothi, D. Sudhir, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) (2014).
12. B. Santhosh Sarma, V. Jyothi, D. Sudhir, "Design of Power Generation Unit Using Roller Mechanism", IOSR Journal of electricaland electronics Engineering (IOSR-JEEE) Vol. 9 No. 3, pp 55-60, 2014. ISSN: 2278-1676
13. Design and analysis of spur gear, Pinaknath Dewanj, International Journal of Mechanical Engineering and Technology (IJMET) (2016).
14. Review Paper on Design Analysis and Modification of Spur Gear, Ramneek Singh, International Journal of Scientific Research and Engineering Development-– Volume 2 Issue 3, May- June 2019.