DESIGN OF CUP HOLDER RETENTION TEST EQUIPMENT AND TESTING ON IT

Prof B. D. Patil [1], Prafull Shinde[2], Shubham Salunkhe[3], Paresh Shelar[4], Anup Phadatare[5]

[1] Assistant Professor, Padmabhooshan Vasantdada Patil Institute of Technology, Bavdhan, Pune, Maharashtra, 411038, India

[2,3,4,5]Department of Mechanical Engineering, Padmabhooshan Vasantdada Patil Institute of Technology, Bavdhan, Pune, Maharashtra, 411038, India

---******---

Abstract- *A Cup holder is a device which is used to hold a cup or other drinking vessels. Many people, particularly in the United States, consider the design, location and number of cup holders in a vehicle to be one of the most important attributes influencing their vehicle purchase. This report describes design of cup holder retention test equipment and testing by using same equipment. This procedure describes the method for determining the retention of beverage containers in cup holder assemblies. This method is appropriate in the evaluation of interior cup holders located in the floor console, instrument panels, seats, and hard trim. This procedure is designed to evaluate the retention of beverage containers in cup holder assemblies, while simulating in vehicle acceleration, braking, right turn and left turn conditions. Thus it involves different design consideration for designing of test setup so that it can fulfil test requirement. The beverage container shall not eject from the cup holder. Tipping of the beverage container is allowed as long as it remains secured within the cup holder environment. Beverage containers shall be easily inserted and removed from the cup holder.*

Index Terms – Testing, Trasmission, Cup holder Retention, controller, Slip Ring.

1. INTRODUCTION

The cup holder assembly primary function is to hold and retain beverage containers of different sizes in a convenient location for the customer. Cup holder assemblies can be found in various locations within the vehicle interior (e.g. floor console assembly, instrument panel assembly, seat assemblies, hard trim assemblies, etc.). This procedure describes the method for determining the retention of beverage containers in cup holder assemblies. This method is appropriate in the evaluation of interior cup holders located in the floor console, instrument panels, seats, and hard trim.

The beverage container shall not eject from the cup holder. Tipping of the beverage container is allowed as long as it remains secured within the cup holder environment. Beverage containers shall be easily inserted and removed from the cup holder. During the contain reinsertion and removal process, the cup holder mechanical retaining features, liner, and mat shall remain secured to the cup holder assembly. If the beverage container tips out or does not fulfill our criteria then strength of retainers will be increase.

1.1 Problem Statement

Following are the parameter which we have taken into consideration

- AC/DC motor with variable speed control VFD.
- Suitable gear box to hold and rotate the expected test mass at required speed.
- Speed can be controlled from ~ 30 to 250 RPM.
- The rotating base will be given with sufficient size to hold the cup holder in all 4 directions.
- Clamping will be provided for cup holder.

- RPM Indicator with maximum hold will be provided to indicate the RPM at the time of contact.
- Suitable arrangement will be made to take the contact signal out while rotating.

1.2 Objectives

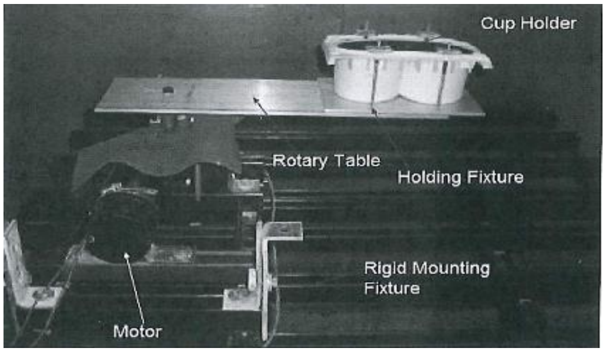
- This procedure is designed to evaluate the retention of beverage containers in cup holder assemblies, while simulating in vehicle acceleration, braking, right turn and left turn conditions.
- To establish a design methodology to make design process simpler and less time consuming by making use of acoustic theories and experience, practical approach to get better design.

2. LITERATURE REVIEW

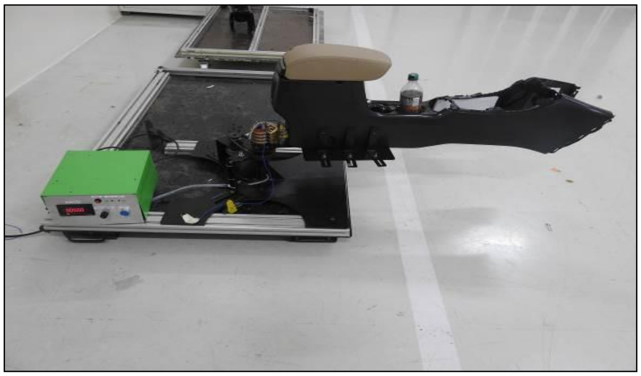
- Christopher Pesta et.al. had explained the brief information regarding the beverage container retention test equipment and testing procedure to evaluate the retention of beverage containers in cup holder assemblies, while simulating in vehicle acceleration, braking, right turn and left turn conditions.[2013][1]
- Christopher Pesta et.al. had explained gives brief information regarding cup holder assembly. It also include environmental resistance requirements, Fluid resistance requirements, Clean ability requirements , appearance requirements, aesthetical requirements, ergonomic requirements, cup holder size requirements ,weight requirements, mechanical requirements and material requirements. It also involve container retention test, electrical requirements, cup holder Durability requirements.[2014][2]

3. DESIGN OF TEST EQUIPMENT

While designing the test equipment we have to select DC motor, Slip Ring, Proximity Sensor as per our required parameter which are stated in the our problem statement. We design the belt taking consideration of power, input pulley speed, output pulley speed, centre distance etc.



EXISTING MODEL



NEW MODEL

4. CALCULATIONS

Operating Condition:-

Power (p) = 350 w (0.47 hp)

Input Pulley speed (n) = 400 rpm

Output Pulley speed (N) = 215 rpm.

Centre Distance= Approx.. 180 mm

1. Design Power-

$$Pd = Pt \times Fs$$

Where, Pd = Design Power

Pt = Rated Power

Fs = Service Factor.

Thus, Pd = 350×1

= 350W

= 0.35kW

2. **Selection Of V-Belt Cross Section-**

From data, for Pd = 0.35kW and n=400 rpm

A-section is selected for V-belt

3. **Calculation for pulley diameter-**

Assuming the belt speed of 1m/s

$$V = \frac{\pi d n}{60 \times 1000}$$

Where, V= belt speed

d= diameter of small pulley

n= Input pulley speed

$$1 = \frac{\pi \times d \times 400}{60 \times 1000}$$

$$d = \frac{60 \times 1000}{\pi \times 400}$$

$$d = 47.746mm$$

We have,

$$\frac{n}{N} = \frac{D}{d}$$

Thus, $D = \frac{d \times n}{N}$

$$D = \frac{47.746 \times 400}{215}$$

D = 88.8295mm

4. **Selection of standard pulley diameter –**

From data, the standard diameter selected as

Thus d =48mm,

D=90mm

The correct belt speed is

$$V = \frac{\pi d n}{60 \times 1000}$$

Where, V = Belt speed in m/s

d = diameter of smaller pulley in mm.

n = Input pulley speed

$$V = \frac{\pi \times 48 \times 400}{60 \times 1000}$$

=1.005 m/s

5. **Approximate pitch length and inside length-**

Pitch length,

$$L = 2C + \frac{\pi}{2}(D + d) + \frac{(D-d)^2}{4C}$$

Where, L = Pitch length in mm.

C = Center distance in mm

D = diameter of larger pulley in mm.

d = diameter of smaller pulley in mm.

$$L = 2 \times 180 + \frac{\pi}{2}(90 + 48) + \frac{(90-48)^2}{4 \times 180}$$
$$= 360 + 216.7634 + 2.45$$
$$= 579.2134 \text{ mm}$$

Thus, inside length, $L_i = L - \delta$

$= 576.2134 - 36$

$L_i = 543.21$

6. **Exact inside length and pitch length**

From data, the nearest standard inside length is

$L_i = 560$ mm

Standard pitch length

$L = L_i + \delta$

= 560+36

= 596 mm

7. **Exact centre distance-**

$$C = A + \sqrt{A^2 - B}$$

Where, $A = \frac{1}{4}\left[L - \frac{\pi}{2}(D + d)\right]$

$= \frac{1}{4}\left[596 - \frac{\pi}{2}(90 + 48)\right]$

=94.8091 mm

And $B = \frac{(D-d)^2}{8}$

=220.5 mm

Thus $C = A + \sqrt{A^2 - B}$

$$C = 94.8091 + \sqrt{A94.8091^2 - 220.5}$$
$$= 94.8091 + 93.639$$
$$= 188.4481mm.$$

8. Power rating 'kW' of selected V-belt.

From data, the power rating of A-section V-belt for faster pulley of 48mm diameter is,

P_r=0.33+0.04

=0.37

9. Arc of contact correction factor (F_d)-

$\propto = \sin^{-1}\frac{(D-d)}{2C}$

$$\propto = \sin^{-1}\frac{(90-48)}{2\times 188.4481}$$

$\propto = 6.3981^{\circ} or 0.111 rad$

Thus , θ=π-2α

=π-2×0.111

=2.9195or 167.28°

From data, assuming linear interpolation,

Thus $Fd = 0.95 + \frac{(0.975-0.95)(167.28-160)}{(170-160)}$

=0.9682

10. Belt length correction factor (Fc)-

From data ,for belt of a section of inside length 560mm

$F_c = 0.77 + \frac{(0.78-0.77)(560-540)}{(570-540)}$

=0.776

11. Number of belt-

$$Number\ of\ belt = \frac{P_d}{Pr\times F_d\times F_c}$$

Where ,Pd = Design Power

Pr = Power factor

Fd = Arc of contact correction Factor.

Fc= Belt length correction Factor.

$$= \frac{0.34}{0.37\times 0.9682\times 0.776}$$

$= 1.22$

≈ 1

5. Testing

5.1. Summary of Testing:-

This procedure is designed to evaluate the retention of beverage container in cup holder assemblies while simulating in vehicle acceleration, braking, right turn and left turn conditions. Electrical conductive tape is placed around the cup holder periphery and beverage container and connected to a power source and counter. The cup holder assembly is placed on the a rotating test fixture and at a given speed, the beverage container will tip, contacting the edge of the cup holder. Once the rotation speed is determined, the gravitational force applied to the beverage container can be calculated.

5.2. Preparation:

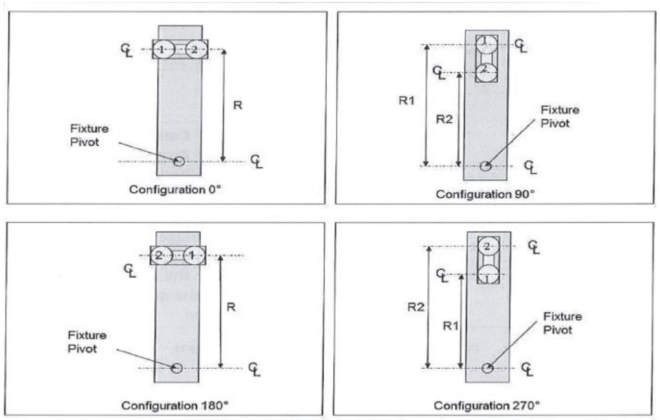
Apply the electrical conductive tape around the periphery of the cup holder opening, including the mug slot handle location. The applied tape shall be of one continuous piece, and shall allow to be connected to the electrical source.

Place the beverage container within the cup holder and tip by hand towards the cup holder edges to determine where the beverage container would contact the edge of the cup holder opening. Secure the cup holder assembly to the rotating test table as it would appear in vehicle. Turn on rotating table to determine if table is free to rotate freely without harmonic motion. Complete electrical circuit by connecting cup holder and beverage container to power source as outlined. Ensure all electrical connections will remain secured when rotating table is in motion .Apply power to conductive tape and verify circuit will record table speed when beverage container contacts the cup holder periphery.

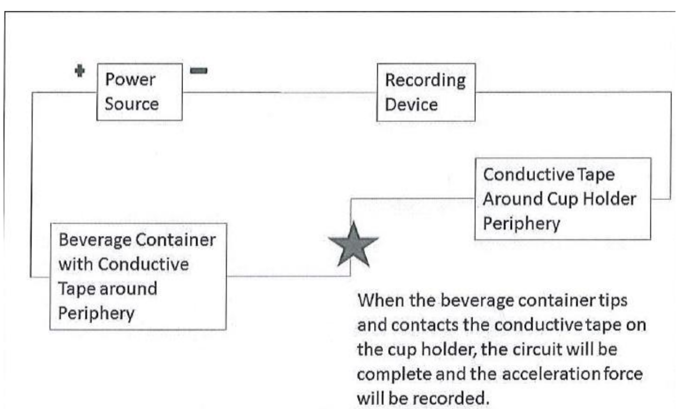
5.3. Acceptance Criteria:

Beverage container shall not tip before 0.8G.
Beverage container shall not eject before 1.0G.
No fluid losses observe.

5.4. Test Configuration Diagram:



Electric Circuit Diagram:



6. CONCLUSION

The main objective behind this project was to evaluate the retention of beverage containers in cup holder assemblies, while simulating in vehicle acceleration, braking, right turn and left turn condition. We had developed a test equipment to fulfill our objective. Designing of test equipment involve selection of motor, selection of transmission drive, controller unit, slip ring based on required parameter.

Another important part of our project is testing of console assemblies. These console assembly can be configured to 0^0, 90^0, 180^0 and 270^0 to find out acceleration on fluid while stimulating in vehicle acceleration, braking, right turn and left turn condition.

Indirectly we are interested to find out strength of cup holder retainer. We had tested three console assemblies for all configuration and based upon observation for console assemblies, we accepted all three assemblies.

7. ACKNOWLEDGMENT

Every orientation work has imprint of many people and this work is no different. This work gives me an opportunity to express deep gratitude for the same while preparing project report received endless help from no number of people this report would complete if I don't convey my sincere thanks to all those who were in involved. First and foremost I would like to thank my respected guide Prof. B.D. PATIL and Head of Department Dr. K.B. WAGHULDE (Department of Mechanical Engineering) for giving me an opportunity to present this project and his indispensable support, priceless suggestions and valuable time .Finally I wish to thanks my friends and my family for being supportive of me, without whom his this seminar would not have seen the light if day. Every work is an outcome of full proof planning, continuous hard work and organized effort. This work is combination of all the three put together sincerely.

8. REFERENCES

1. Pf90108,FCA US-INT COCKPIT-1320 ,06-nov-2014, Cup holder assembly, 2014(pesta christofer)
2. LP-11990_2013, FCA US-INT COCKPIT-1320 ,22-FEB-2012 ,beverage container retention test,2013(pesta christofer)
3. Theory of machine by R.S. khurmi
4. Design of machine element by V.B. Bhandari.
5. Electric motors and drives by Austin hughes.