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INTEGRATED CHECK STRAP FOR CAR DOOR

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Abstract— A conventional door check functions to stop the door at in between positions as well as at end position i.e. at full open condition. Door check in modern days comprises of a strip of metal or plastic with indentations. This strip moves in a case as door is opened or closed. The case comprises of rollers and rubber springs which make sure that roller always contact the strip. When roller is in between two indentations it results in door stop. The check strap is the device which has been installed in car doors it allows the car door to stop and hold it at specified interval while opening the door. It is useful for passenger ingress and egress. As all of us know that need is mother of invention, this invention project of check strap is result of need .In this project need was to provide check strap function in car but at the same time target of low cost target has been kept in front of us.

Index Terms— check strap, hinge, catiaV5R19, finit element analysis using ANSYS / ABAQAS, study of conventional & integrated check strap.

1 Introduction

The check strap is the device which has been installed in car doors it allows the car door to stop and hold it at specified interval while opening the door. It is useful for passenger ingress and egress. A conventional door check functions to stop the door at in between positions as well as at end position i.e. at full open condition. Door check in modern days comprises of a strip of metal or plastic with indentations. This strip moves in a case as door is opened or closed. The case comprises of rollers and rubber springs which make sure that roller always contact the strip. When roller is in between two indentations it results in door stop [1].

To achieve set target we have developed many concepts of check strap using brainstorming technique. After Brainstorming many concept for check strap has come up out of which one has been selected by evaluating functional requirement. While selecting the idea various factors like cost of project, no of total parts, ease of manufacturing and life are considered [2].

This paper is organized as follows. In Section II, we present the system model for Hinge bracket. Different parameters required for Hinge design is described in Section III. Future scope of proposed system is provided in Section IV. Finally, conclusions are given in Section V.

2 System Model

The assembly of integrated check strap is mounted on vehicle. Hinge bracket body side leaf is bolted on body whereas Hinge bracket door side leaf is mounted on door.

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Fig. 1 shows arrangement of integrated door check strap on car .door side leaf of Integrated door check strap is mounted on door of a car with the help of two M8X12 bolts with designed torque .the body side leaf of integrated door check strap is mounted on body with the help of 3 bolts of M8X12 and these bolts are also tightened with the specified designed torque.

There are three positions are shown in fig 1:
Position A ---- Door in closed condition
Position B ---- Door opened partially (45 degree)
Position C ---- Door fully open (7. degree)

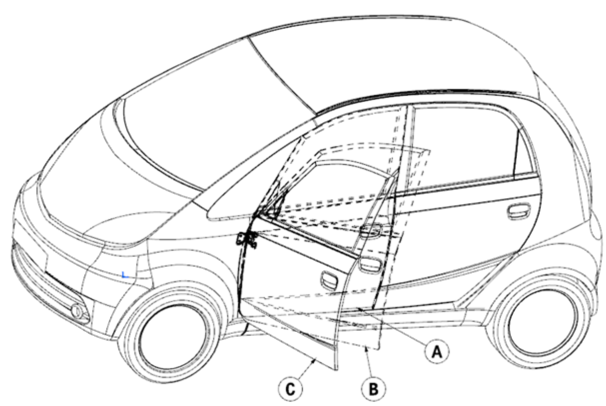

Fig. 1(a). Door Structure

First of all we consider the door is in closed position that is at position A, now when passenger wants to open the door he will simply unlatch the door from inside using inner handle. Then he will push the door from inside until position B he can easily push the door from inside but after 45 degree he will required bit more force as he has to overcome the cam force of check strap as soon as he overcomes the cam force the door will come in position B. At position B if passenger stops apply-

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ing force from inside of vehicle the door will remain as position B

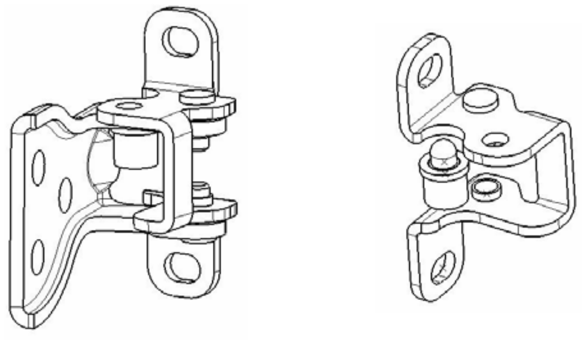


Fig. 1(b). Hinge Structure

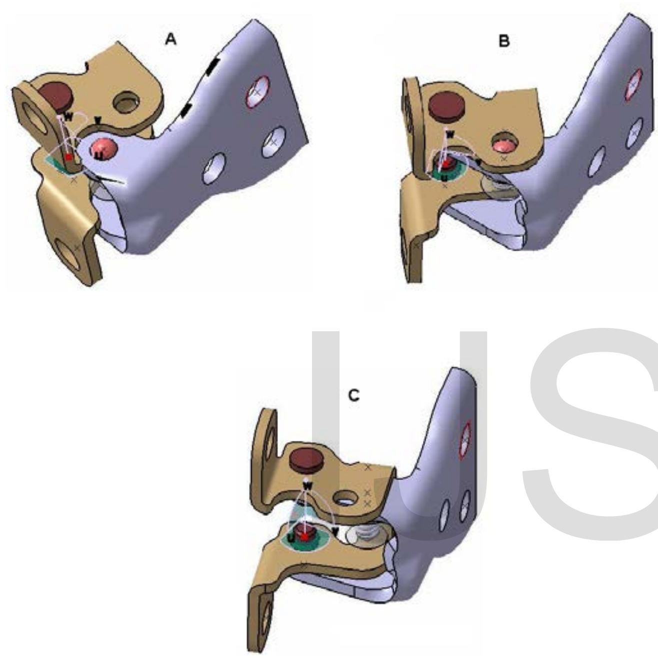


Fig. 1(c). Positions of Hinge

If passenger want to further open the door to fully open condition he has to overcome force on cam at position C and after he has to push the door until end that is position C. When position C is reached door will hold its position because of check strap. Exactly opposite happens when passenger open door from outside.

Position B helps passenger for ease in ingress and egress without holding the door from inside or outside. This helps a passenger a lot when passenger is entering or exiting the vehicle with some goods are there in his hands. Even this is very helpful when vehicle is standing on slope or tilted condition.

The position of 45 degree is designed with the help of human body ergonomics and posture. The angle 45 degree is the angle at which the child or adult occupants can ingress or egress the car with ease and at this angle there are less chances for any injury causing. Similarly 72 positions are helpful when passenger is putting luggage inside the vehicle. The position of 72 degree helps the passenger to put in or take out the luggage from his car without holding the door by one hand.

This check strap is tested for 30000 cycles. 30000 cycles means opening and closing of door for 30000 times for checking its endurance limit

3 Proposed System Design

3.1. Design of Hinge

The parameters required to design a Hinge are given below [3]-[4]:

Door weight equal to applied force on hinge 8 kN

We are using two hinges in door. Force in one hinge P = 4 kN.

CARBON STEELS E-34 with tensile yield strength of 400 N/mm^2

CARBON STEELS 4431-1978 with tensile yield strength of 400 N/mm^2

Syc = Syt and Ssy = 0.577 Syt

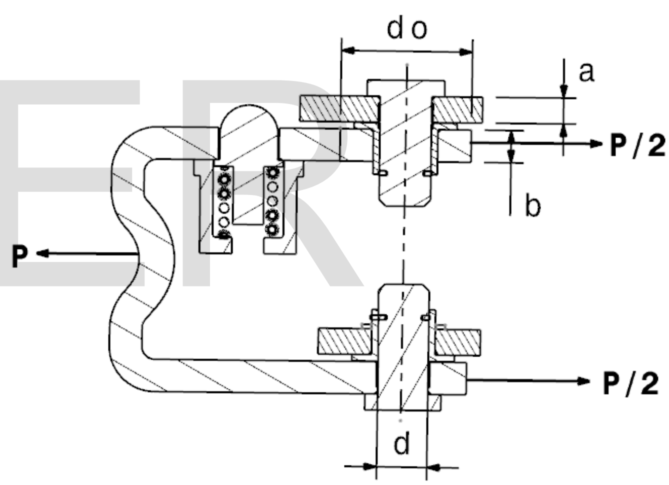
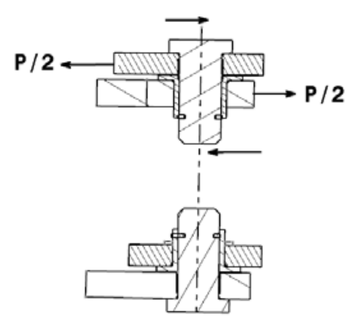


Fig. 2 Design parameters of Hinge



(a)

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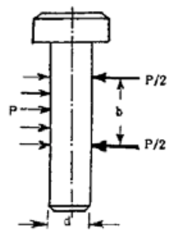

(b)

Fig. 3. Stresses in pin

The pin is subjected to different stresses at deferent cross section:-

The flier due to shear stresses occurs at two planes each with cross section area of

$$\left(\frac{\pi}{4}d^2\right). \quad (1)$$

$$2\left(\frac{\pi}{4}d^2\right)\tau = P \quad (2)$$

$$d = \sqrt{\frac{2P}{\pi\tau}} \quad (3)$$

There are compressive stresses between the pin and body leaf bracket. Projected area between the two is (bd)

$$2bd\sigma_c = P \quad (4)$$

$$\sigma_c = \frac{P}{2db} \quad (5)$$

Similarly there are compressive stresses between the pin and door leaf bracket.
Projected area between the two is (2da)

$$2da\sigma_c = P \quad (6)$$

$$\sigma_c = \frac{P}{2da} \quad (7)$$

The pin is also subjected to a banding moment as show in fig. The pin is traded as a simply supported beam with span of b and subjected to uniform load

Max banding moment occurs at the centre of pin.

$$M_b = \frac{Pb}{8} \qquad I = \frac{\pi d^4}{64} \qquad y = \frac{d}{2} \quad (8)$$

$$\sigma_b = \frac{M_b y}{I} = \frac{4Pb}{\pi d^3} \quad (9)$$

By using Equation (9) we can evaluate the bending movement.

3.2. Stresses in body leaf bracket

The body bracket fail in tension across the hole of the pin as show in Fig. 4.

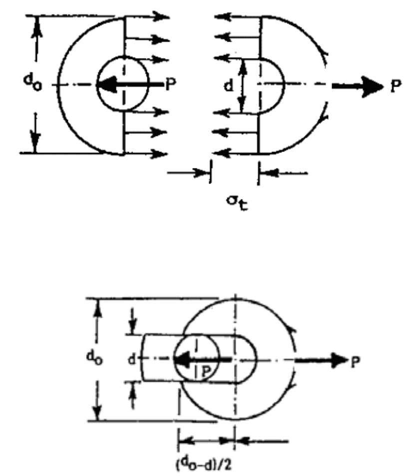

Fig. 4. Tension across the hole of the pin

Tension across the hole of the pin is given by

$$2b(d_0 - d)\sigma_t = P \quad (10)$$

where

$$\sigma_t = \frac{P}{2b(d_0 - d)} \quad (11)$$

The pin may shear out the body bracket in a manner similar to that show in Fig. 4.
There are two surfaces each with an area of b (d0-d1) which resist shearing.

$$2b(d_0 - d)\cdot\tau = P \quad (12)$$

$$\tau = \frac{P}{2b(d_0 - d)} \ \textbf{(Approx)} \quad (13)$$

3.3. Stresses in door leaf bracket

The stresses in door bracket are similar to stresses in body leaf bracket.
The min. cross sectional area of the fork subjected to tensile stresses is 2a (d0-d)

$$2a(d_0 - d)\sigma_t = P \quad (14)$$

$$\sigma_t = \frac{P}{2a(d_0 - d)} \quad (15)$$

The shear stresses in the door bracket resisting tearing out by pin are given by

$$\tau = \frac{P}{2a(d_0 - d)} \quad \text{(approx)} \tag{16}$$

Permissible stresses:

$$\sigma_t = \frac{S_{yt}}{(fs)} = \frac{400}{5} = 80 \text{ N/mm}^2$$
$$\sigma_c = \frac{S_{yc}}{(fs)} = \frac{S_{yt}}{(fs)} = \frac{400}{5} = 80 \text{ N/mm}^2$$
$$\tau = \frac{S_{sy}}{(fs)} = \frac{0.577 S_{yt}}{(fs)} = \frac{0.577(400)}{5} = 46.16 \text{ N/mm}^2 \tag{17}$$

Design of hinge elements is given by

$$d = \sqrt{\frac{2P}{\pi\tau}} = \sqrt{\frac{2(4000)}{\pi(46.16)}} = 7.4 \simeq 8 \text{ mm} \tag{18}$$

3.4. Comparison between conventional & Integrated check strap

i. ALIGNMENT:

Conventional: In conventional check strap there are number of parts to be assemble.

on the door while assemble, so this needs lot of pre size tolerance to be maintained, and it takes more time to fix on the door like body side bkt & door side bkt fix on it while doing this alignment operator should concentrate on the alignment of door bkt & as well as body side bkt at the same time [5].

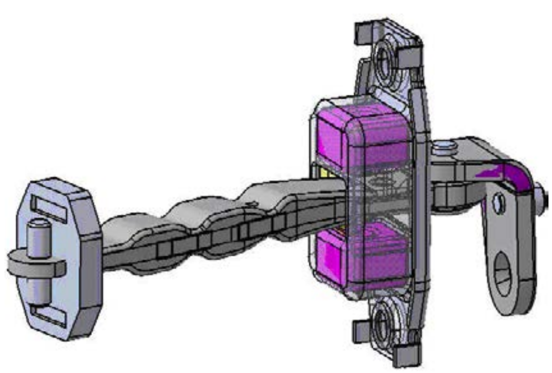

Fig. 5. Conventional Check Strap

Integrated: In integrated check strap there is less time required fix on the door, there is need not mount any bkt like as in the conventional check strap. As it is already assembled in the hinge itself for better alignment than the conventional check strap.

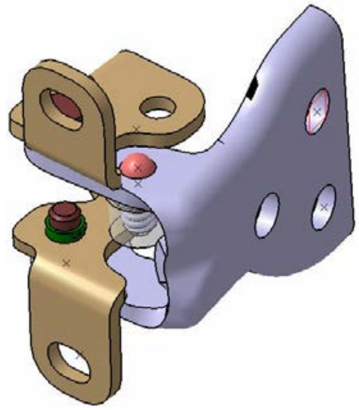

Fig. 6. check strap integrated with hinge

ii. DESIGN REQUIRMENT:

Conventional: For different variant vehicle models have varies in door size like thickness of the door, need to have different length of check strap rod, it causes multiple design in length, cam step, etc, this cause performance of a check strap can decreases.

Integrated: In integrated check strap we can use same hinge for the different variants of models it saves the multiple design work for the same mechanism & also in cost wise.

iii. RIGIDITY:

Conventional: After assembled of check strap it must have more rigidity for better operation for this we need to provide more reinforcements to get good rigidity in conventional check strap it causes increase in child parts & get more cost.

Integrated: Integrated check strap is more rigid with less no of parts because of its construction

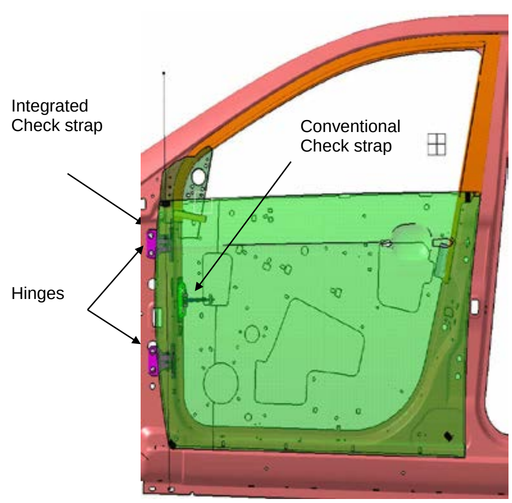

Fig. 7. comparison of mounting for conventional and integrated check strap

iv. PACKAGING:

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Conventional: While packaging of conventional check strap on the door there must have a provision like cut out on the door inner panel to mount the check strap & it require more space to mount as it has more volume.

Integrated: In integrated check strap the space required less space than the conventional check strap as it has less volume than the conventional.

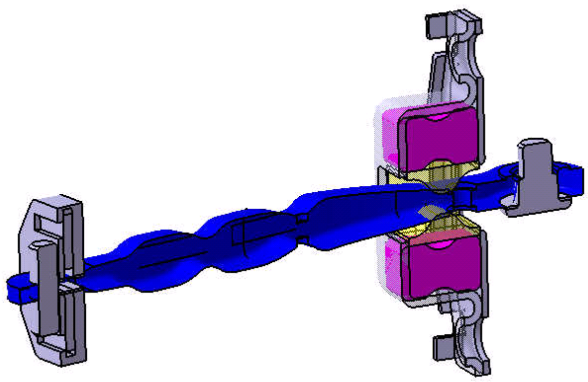

Fig. 8. Detail Section of conventional Check strap

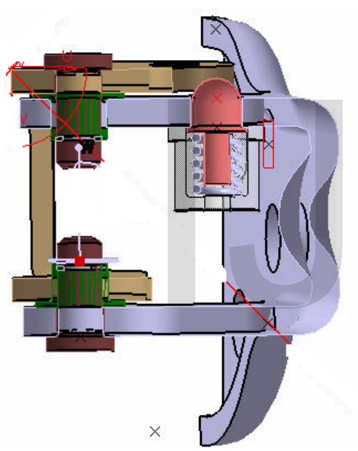

Fig. 9. Detail Section of Integrated Check strap in Hinge

4 Future Scope

The Future scope of work for second stage of project is as bellows.

- Design of a hinge
- Stress analysis in bracket.
- Design of check strap.
- 3D modeling of check strap.
- Finite element analysis using ANSYS/Abaqus.
- Study of conventional and integrated check strap.

5 Conclusion

In this paper, we have proposed a new approach Integrated Check Strap for car door system.

Integrated check strap required less space for mounting. It requires less time to fix on the door.

In integrated check strap we can use same hinge for the different variants of models it saves the multiple design work for the same mechanism & also in cost wise.

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