Design of Rim locks using FEA analysis

Mala Harish[1], K. Vikash Kumar[2]

[1]PG student, Department of Mechanical Engineering, GIET University Gunupur

[2]Asst.Professor, Department of Mechanical Engineering, GIET University Gunupur

ABSTRACT

Rim lock series are most popular for their compatibility, aesthetic looks, ease of mounting, better strength, crowbar proof, etc. But they are mostly over designed without analysing the design parameters, which increases the usage of material and manufacturing that leads to increase in the cost. The main objective of the work is to design the lock using complaint mechanism which allows to flex the components itself to act like spring action which will not only improve the design but also reduce the number of components to be used.FEA analysis and DFM has been used to improve the quality of design by which the usage of material reduced which leads to decrease in the manufacturing cost.

Key words: Rim lock, complaint mechanism, FEA, DFM.

1. INTRODUCTION

Rim lock is working under lever slide mechanism which has been designed with minimum number of components and single spring component with multiple functions for actuating the mechanism. Usage of minimum components in the mechanism will minimize the cost of manufacturing and at the same time error in component is minimized as less number of components are used. The mechanism allows the user to operate using handle of lock as well as the automatic lock when the door is closed. There are sufficient features has been provided which will be easier for the user to operate. Only securing features for the door are used, which allows the product to be made using very less cost of manufacturing. Use of less components will increase the serviceability. One of the important features is that, when user operate using handle of the lock the latch slides in allowing opening the door and when handle released the latch again comes to the original position securing the door. When door is in open condition and user close it the latch automatically slides in and when door closes completely then the latch slides out to the original position by securing the door. This mechanism can only used in swing type of doors.

2. DESIGN AND ANALYSIS OF RIM LOCK

2.1 Description

The design view of rim lock has shown in figure 1, figure 2 and figure3. Each component of rim lock has been represented by numbers. Referring these figures, the design description has been written.

The slide 2 have two guide slots are there which are face 2a and two studs 11 in body 1 have corresponding faces 11a which are stationary with respect to slide 2 and fixed with body 1. The faces 2a in the slide 2 slide against faces 11a of stud 11 allowing slide 2 to slide against body 1 to make relative motion of the slide 2 with respect to body 1. Slide 2 will slide until the slots 2a ends in both directions or with the desired allowed travel of the mechanism.

The studs 11 of body 1 have threaded faces 11a are screwed using nuts 10 for restricting the removal of the slide 2 from the body 1 studs 11.

Guide stud component 3 is used to guide the latch component 4. The face 3a of the guide slot component 3 guides the face 4a of the latch component 4 allowing translation motion. The other side of the latch component 4 face 4b is guided with the face 2b of slide 2. Then the guide stud component 3 is fixed with the slide 2. The face 3a of the guide stud component 3 assembled and fixed at faces 2c of slide 2. The latch component 4 is restricted at the one end with the face 4c of the latch component 4 with the face 2d of the slide 2. The other side of the latch component 4 is guided with guide stud component 3. The face 2d of the slide 2 will restrict the removal of the latch component 4.

The lever component 5 is placed onto the slide 2 at the face 2e of slide 2. The face of lever component 5 and the face 5a of the slide component are placed collinearly with the axis of the faces. The face 5c of the lever component 5 is stacked by touching onto the face 2f of the slide 2. The lever stud pin 6 is used for fixing the lever component 5 with the slide 2 so that the lever component is only rotated at the fixed axis. The face 6a of the lever stud pin 6 is touched with the face 2f of the slide 2 and fixed to the slide 2. The face 6b of the lever stud pin 6 will restrict the removal of the lever component 5 from the desired place. The face 5a of the lever component 5 rotates against the face 6c of the lever stud pin 6 allowing only rotational motion of the lever component 5.

The spring 7 is assembled with one end being attached to the body 1 and the other end of the spring 7 attached to lever component 5. The face 7a of the spring 7 is hooked into the face 1a of the body 1 and at other end the face 7b of the spring 7 hooked with the face 5b of the lever component 5 so that the tension of the spring 7 is acting between body 1 and the lever component 5. The spring tension of the spring 7 onto the lever component 5 thereby transferred to the slide 2 through lever stud pin 6 making the slide 2 under continuous tension against the face 1b of the body 1 with the face 2g of the slide 2.

The lever component 5 is placed onto the latch component 4 by which the spring force of the spring 7 is transferred to the latch component 4. The face 5b of the lever component 5 is stacked onto the face 7b of the latch component 4 so that there is a continuous force applied onto the latch component 4. Which in return restrict the motion of the latch component 4 and providing desired motion when sufficient amount of the force is applied onto the latch component 4. When sufficient load is applied onto the latch component 4 at the face 4d then the latch component 4 tried to move linearly with respect to the slide 2 and the guide stud component 3 through the faces 2b & 3a correspondingly while the face 5d of the lever component 5 will slide against the face 4e of the latch component 4 by rotation of the lever component 5 at the face 5a against face 6c of the lever stud pin 6.

Handle component 9 is used for actuating the mechanism. The face 9a of the handle component 9 is placed or inserted into the body 1 at the face 1c. Both the faces 9a & 1c are placed collinearly. Handle spacer 8 is inserted against the handle component 9 from the inside of the body 1. The face 8a of the handle spacer 8 and the face 9a of the handle 9 are collinearly placed along with the body 1 in between the handle 9 and the handle spacer 8. The handle follower 12 is placed onto the handle 9 from inside of the body 1. The face 12a of the handle follower 12 is aligned with the face 9b of the handle 9. Also, the face 12c of the handle follower 12 are kept touching with the face 2h of the slide 2. Handle follower 12 is fixed against the

handle 9 touching the face 12b of the handle follower 12 and face 9c of the handle 9 at the face 12a & 9b of handle follower 12 and handle 9 corresponding. The handle 9 is only allowed to rotate against the body 1. When the handle 9 is rotated than the handle follower 12 also rotates as it is fixed to the handle 9, then the face 12c of the handle follower 12 slide against the face 2h of the slide 2 till the face 2i of the slide 2 touches the face 1d of the body 1.

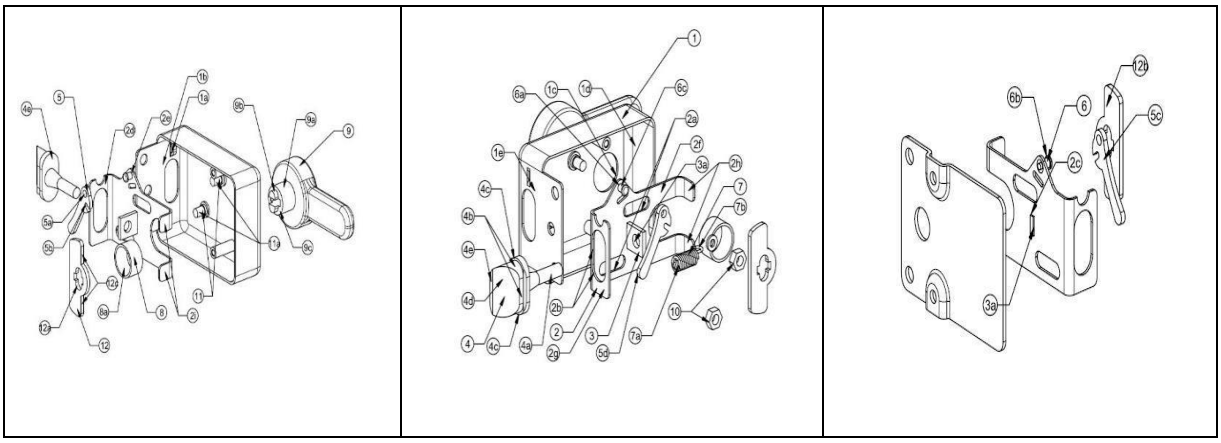

Figure 1: Views of the lock

When the handle 9 rotated either side, the handle follower 12 also rotated along with the handle 9 by the same rotated angle. The rotation of the handle follower 12 component actuates the slide 2, when the handle follower 12 rotated the face 12c of the handle follower 12 slides against the face 2h of the slide component 2. Therefore, the slide 2 is applied by the angle of rotation of the handle 9 which results in the sliding of the slide 2 by the help of the face 2a with respect to the face 11a of the stud 11 attached to the body 1 linearly. Linear motion of the slide component pulls the latch component 4 through the face 2d to the face 4c while the spring 7 undergoes to the elongation resulting in resistance force applied onto the laver 5 to the slide 2. The motion of the slide component when applied rotational force at handle 9 is allows till the faces 2i of the slide 2 touches the face 1d of the body 1 and the constrained. The instant the slide 2 gets to the extreme point of the travel the maximum elongation of the spring 7 can be seen which tries to restrict the motion of the slide 2 and simultaneously energy stored in the spring. Along with the slide 2 the attached latch component 4 also moved in the corresponding direction guiding the face 4b at face 2b of the slide 2. When handle 9 is released the energy stored in the spring 7 because of the elongation start to convert with kinetic energy allowing the slide component to move to the initial position. Slide 2 travels back all the way to its initial position. Which in turn facilitates the disengagement and engagement of the latch 4 with door when user operates the handle.

Independent of the rotation of the handle 9 latch component 4 can slide into the body 1 when sufficient load is applied at on to it. When desired load is applied on the face 4d of the latch component 4 it tries to slide into the body 1. The movement of the latch 4 results in sliding of the face 5d of the lever 5 and lever try to rotate at its hinge point face 5a. As a result the movement of the latch component 4 rotates the lever 5. But the lever 5 is attached to spring 7 at the face 5b which tries to restrict the motion of the latch 4 and storing of the potential energy on the spring coil. The latch 4 moves as much as the face 4e comes collinear with the face 1e of the body 1 whereas the face 5d of the lever 5 also travels the same linear distance because of rotation of the lever 5 at face 5a. When the latch 4 is released from

applied load it again try to come to its original position as the stored energy in the spring 7 released and supports the movement of the latch 4 in the same direction. The deflection in the spring 7 when operated using latch movement is smaller than the deflection in case lock Is operated through the use of handle which differs the energy required to move the latch in both conditions. The energy or effort required for moving the latch 4 using handle 9 is less than the energy or effort used for moving the latch 4 from the face 4d.

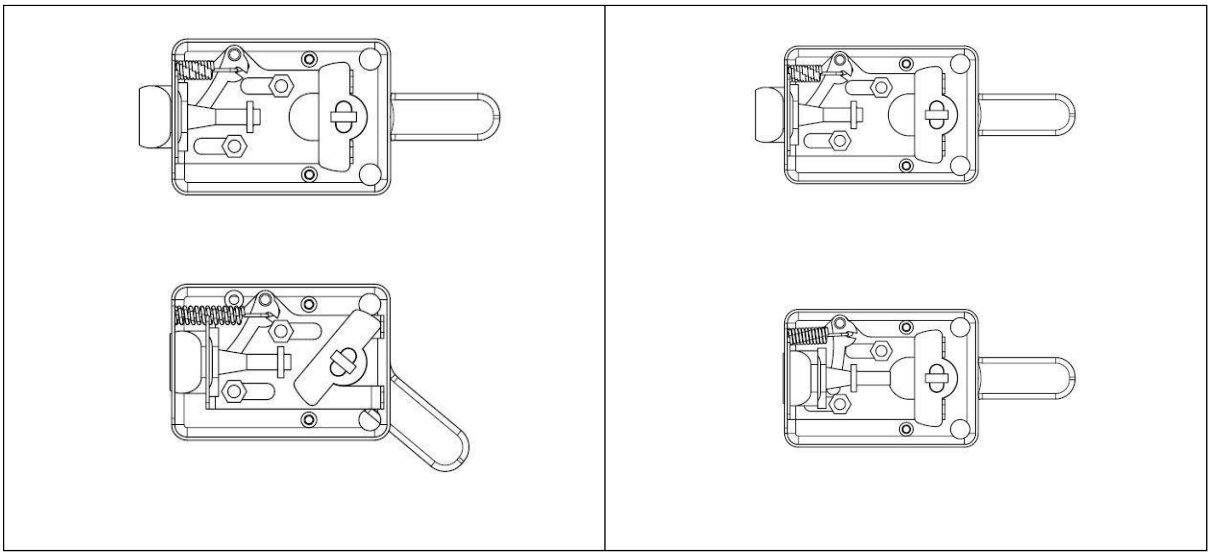

Figure: 2 Front views of the Lock

2.2 CAD Modelling

The design of the lock is based on commercial locks which are used in the home security purposes. CAD modeling is done on CAD software Unigraphics NX 10.0. The engagement of the latch is 10mm which will ensure full engagement for secure locking. The geometry of the parts of lock are designed to fit the most used swing type doors. The below figure no.6 shows the CAD model representation of the design for reference purpose. Following are the material consideration of the part,

Table 1: Composition and Mechanical Properties of Material

	Composition	**Mechanical Properties**
Material 1 (IS 513 DD Grade Steel/ CR3 Steel)	Iron – 99 % Carbon - 0.10 % Manganese - 0.45 % Sulphur - 0.030 % Phosphorus - 0.025 %	Maximum yield strength - 220 Mpa Maximum Tensile Strength - 350 Mpa Density - 7.8 gm/cm3
Material 2 (AISI - 12L14 Steel)	Iron – 98 % Carbon - 0.15 % Manganese - 1 % Sulphur - 0.3 % Phosphorus - 0.06 % Lead – 0.25 %	Maximum yield strength - 540 Mpa Maximum Tensile Strength - 415 Mpa Density - 7.87 gm/cm3

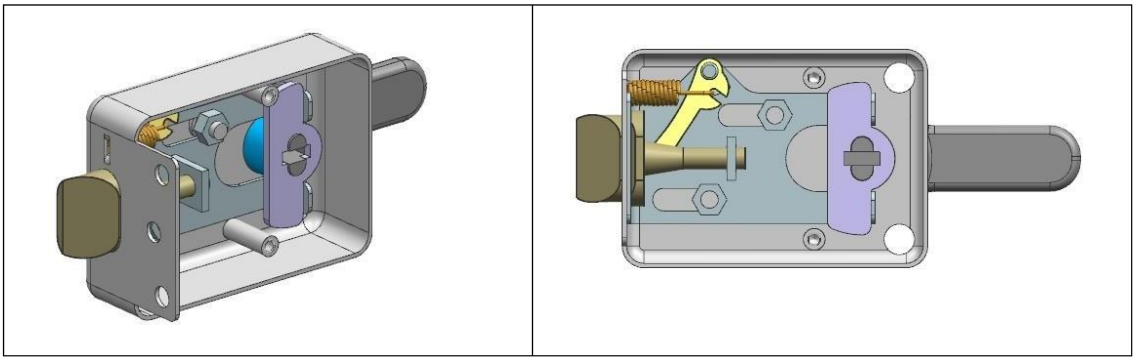

Figure 3 : CAD Modelling of lock

2.3 FEM Analysis

CAD modeling Design is tested for FEA analysis or failure analysis using Fusion 360 – Simulation workbench for static load analysis. The test was conducted for the lock to sustain applied load applied on the latch as per the testing conditions. The FEA test results are the following.

Table 2: FEA test result

Applied Load (in kgf)	500
Type of load	UDL load type on latch
Stress value (Von Mises)(in Mpa)	390
Displacement (in mm)	0.2mm
Factor of safety	1

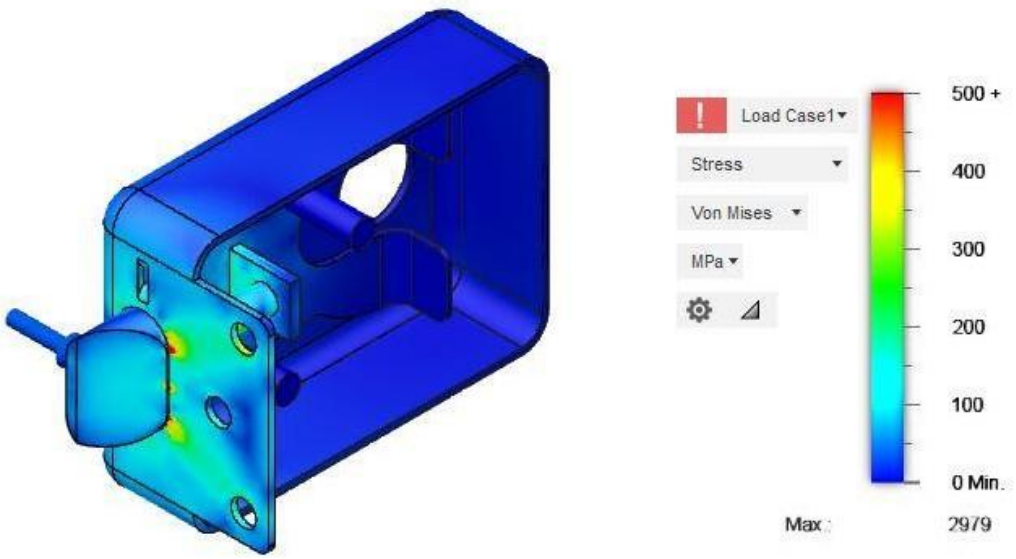

Figure 4: Displacement and stress distribution on Latch

3. CONCLUSION

The design of a rim lock series locking device for home and commercial purpose to be mounted on swing type doors for securing the home. The design is made with the help of CAD modeling software and FEA tools for optimizing the design. The final designed lock has a capacity to withstand a load upto 500 kgf without any failure and it has optimized mechanism which allows less cost of manufacturing therefore the product cost will reduce. There are most required security features are used in the lock.

REFERENCES

1. Klaus Peter Wegge and Dirk Zimmermann, Accessibility, Usability, Safety, Ergonomics: Concepts, Models, and Differences,Springer-Verlag Berlin Heidelberg 2007,pp. 294–301.
2. Hans Sebastian Heese and Jayashankar M. Swaminathan, Product Line Design with Component Commonality and Cost-Reduction Effort, 2006 INFORMS, , pp. 206–219.
3. Tatikonda and Mohan V, Design For Assembly: A Critical Methodology For Product Reengineering and New Product Development, Production and Inventory Management Journal, pp. 31-37.
4. Ron Adner and Daniel Levinthal, Demand Heterogeneity and Technology Evolution: Implications for Product and Process Innovation, 2001 INFORMS, pp. 611–628.
5. Bonanno, G. and B. Haworth, Intensity of competition and the choice between product and process innovation, 1998 Elsevier Science B.V, pp. 495 –510.