Scientific Journal of Impact Factor (SJIF): 3.134
e-ISSN(O): 2348-4470
p-ISSN(P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 2, Issue 5, May -2015

Design & Analysis of Fork pin & its Assembly in Pneumatic cylinder

Niraj R Vangani[1],Piyush J Mandaliya[2]

[1]Mech M.E(CAD/CAM),Atmiya Institute of Tech & Science-Rajkot
[2]Mechanical (Asst. Prof), Atmiya institute of Technology and Science-Rajkot

Abstract- The traditional fork pin connects the next part in hydraulic/pneumatic cylinder with the help of bolt and nut. But, main problem occurs, when motion is transferred through the existing pin, the nut could be loose due to improper fitting and due to vibrations produced by the piston stroke, may get detached from the assembly. Because of this problem, the assembly may get disassembled and may damage to other parts and leads to catastrophic failure. Another problem considering, tightening & loosening of both nuts consume too much time. So in this research, with used of design of X concept which suggests to replace screw-nut type fasteners with snap fits in DFA approach. So here, the main aim is to replace traditional nut & threaded pin with modern snap on spring fork pin by making effort on high strength to withstand desired motions and emphasizing on ease of locking and unlocking with snapping concept by improving pin stress. So having said that, with the use of CREO modeling, analytical analysis, ANSYs based analysis, it has been carried out a throughout analysis of fork pin with its assembly of existing design and the modified snap on spring fork pin assembly design by using comparative results with the practical conditions to achieve maximum strength and ease of locking and unlocking.

Keywords- *Fork, pin, snap on spring, Modeling, StressAnalysis*

I. INTRODUCTION

A mechanical joint(here i.e. **Fork pin**) is a part of a machine which is used to connect another mechanical part such as cylinder and rod assemblies. Mechanical joints may be temporary or permanent, most types are designed for assembling & disassembling when required. A fork joint is used to connect the two fork ends which are under the tensile load as well as compressive load, when requirement of small amount of flexibility or angular moment is necessary. There is always axial or linear line of action of load in terms of cylinder.The fork joint shafts connected at the end portion of the cylinder.Double eye or fork pin with side mount ring can be fitted and dismantled without tools, i.e. by hand. Another application considering for locking the piston in cylinder bore as well as gives work during strokes. At the one end of the rod the single eye is formed and double eye is formed at the other end of the rod. Both the single and double eyes are connected by a pin inserted through eye. The pin has a head at one end and at other end there is a split pin or taper pin. For gripping purpose the ends of the rod are made in octagonal forms. Now, during the two eyes are pulled apart, the pin holds them together .The rod portion which is made of solid with the joint in this case is much stronger than the portion through which the pin passes.

II. MODELINGOF NEW DESIGN

TABLE 1 NEW DESIGN DATA ESTIMATIONS OF FORK BASED ON CREO

SR	NOMENCLATURE	PARTUCULARS	VALUE	UOM
1	V	VOLUME	84846	MM3
2	SA	SURFACE AREA	26277.00	MM2
3	Þ	DENSITY	0.0000074	KG/MM3
4	MP	MASS OF FORK	0.66	KG
5	CG (X)	CENTRE OF GRAVITY X	0.00	M
6	CG(Y)	CENTRE OF GRAVITY Y	0.00	MM
7	CG(Z)	CENTRE OF GRAVITY Z	50.90	MM
8	DP	DIA. OF FULCRUM PIN	20.00	MM
9	PC	PAY LOAD	250.00	KG
10	L	TOTAL LENGTH OF FORK PIN	112.00	MM
12	SO	STROKE	250.00	MM

TABLE 2 NEW ASSOCIATED PART DESIGN DATA OF PIN

SR	NOMENCLATURE	PARTUCULARS	VALUE	UOM
1	V	VOLUME	15004.00	MM3
2	SA	SURFACE AREA	314	MM2
3	Þ	DENSITY	0.000008	KG/MM3
4	MP	MASS OF FORK PIN	0.66	KG
5	CG (X)	CENTRE OF GRAVITY X	0.00	M
6	CG(Y)	CENTRE OF GRAVITY Y	0.00	MM
7	CG(Z)	CENTRE OF GRAVITY Z	(-2.20)	MM
8	DP	DIA. OF PIN	20.00	MM

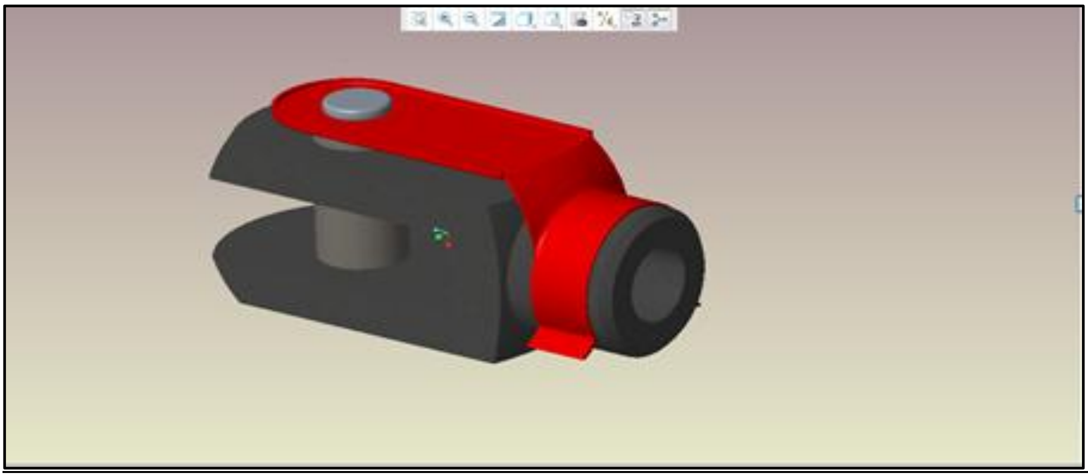


Fig 1. Model of new snap on spring fork

Here, Modeling of new fork pin is done to counter the previous problems happened in the existing design. Modeling considers 4 parts fork, pin, snap on spring and button. In this snap on spring the concept of snipping is used, which is more often used in dismantling and locking. In ladies purse, we see that snapping tool to lock and unlock the stickles. Creo based modeling fig is given in this section. The 2d drawing generated by it is given below:

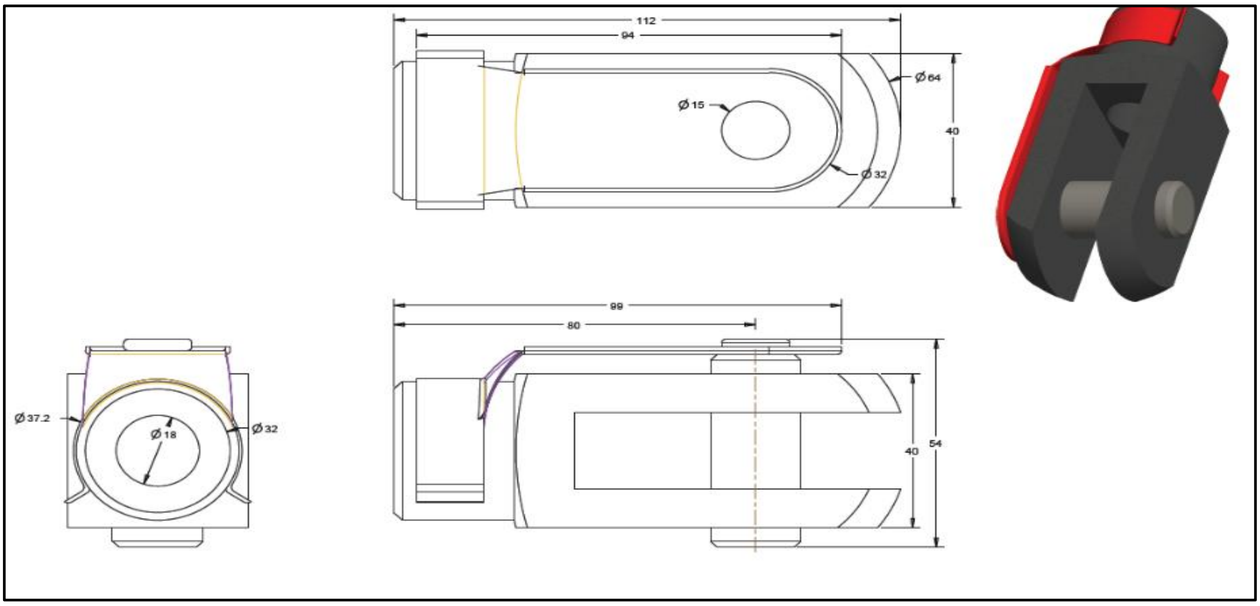


Fig 2. 2D Drawing of new assembly

III. ANSYS BASED ANALYSIS OF NEW FORK PIN

As per the process shown in previous chapter the analysis it taken into account considering meshing (in this case it is triangular fine mesh). Here also material taken into consideration is stainless steel.

TABLE 3 STAINLESS STEEL POPERTY		
Tensile Strength (ULTIMATE)	430	MPA
Thermal Conductivity	16.2	K
Tensile Strength, Yield	215	MPA
Density	7.15	g/cc

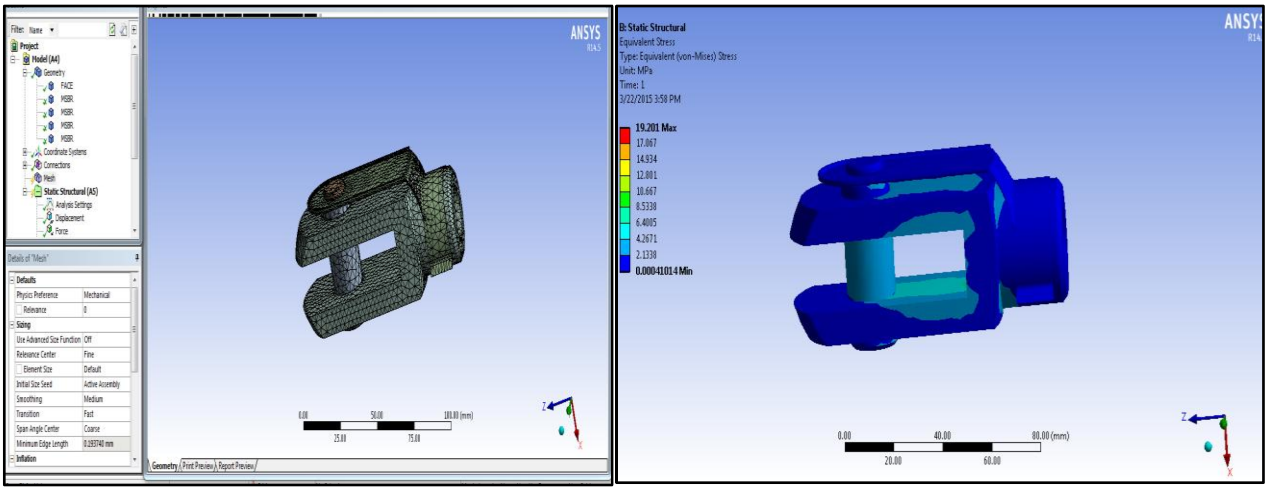


Fig 3. Meshing and Equivalent von mises stress of new design

Sr	Symbol	Force type	Value	Uom	Value
TABLE 4 FORCE CALCULATIONS OF NEWDESIGN					
1	P1	Frame load or payload on fork pin assembly	250.00	Kg	2452.50N
2	W1	Associated part load	0.66	Kg	6.46N
3	W1	Self weight	0.65	Kg	6.38N
4	W2	Weight of button	0.0083	Kg	0.081N
5	W3	Weight of snap on spring	0.0312	kg	0.3N
		Total force	250.81	Kg	2466.82N

Thus how force evaluation is done. F= 2466.82 N
On Ansys displacement can be taken only in Z direction as piston stroke comes in that direction. On the basis of that we will get elongation and deformation. If we fix the displacement deformation will be on that basis.

Here results are taken for equivalent von mises stress and deformation which is quite nearer infect better than the existing design in terms of strength. Here the figure is given for deformation and stress.

Equivalent von mises stress (max) = 19.20 N/mm^2 (for whole system)
Equivalent von mises stress (min) = 0.0041 N/mm^2 (for whole system)

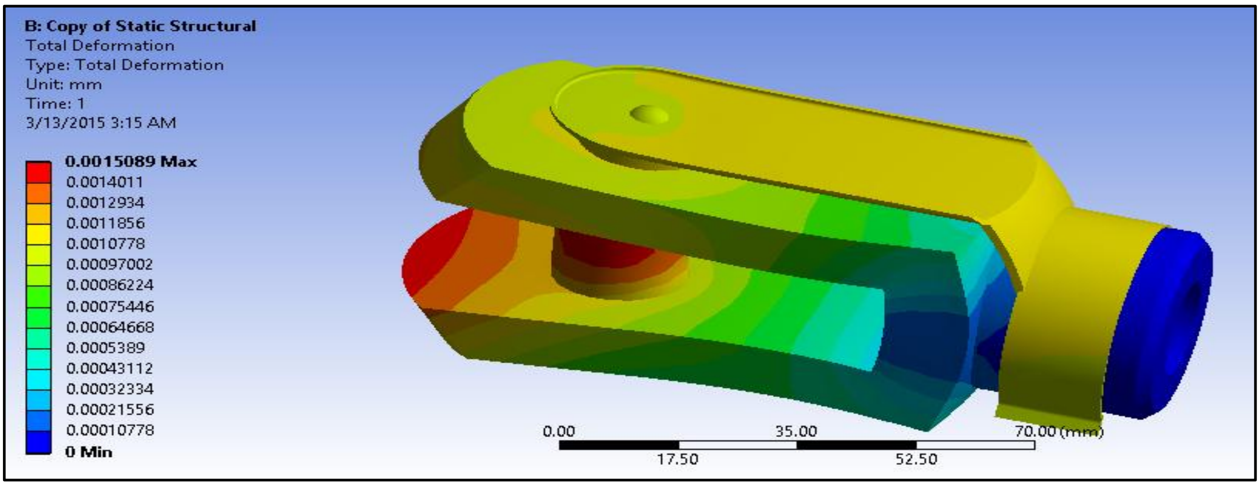


Fig 4. Deformation of new design

Max deformation (fixed support) = 0.00150 mm
Min deformation (fixed support) = 0 mm

Now the main area of focus that is pin which is to be replaced gives safe results and very less stress then the previous one. The figure for alternating stress on pin is given below. This is in safe region as per the theory of fatigue.

According to Goodman theatrical concept,

$$\frac{\sigma a}{\sigma e} + \frac{\sigma m}{\sigma u} = 1$$

$$\sigma_e = 3.86\text{N/ mm}^2$$

So it should be the limit of this limiting stress 3.86 N/mm^2 and from Ansys we can see this maximum stress we are getting for new design is 2.426 N/mm^2. Which is safe.

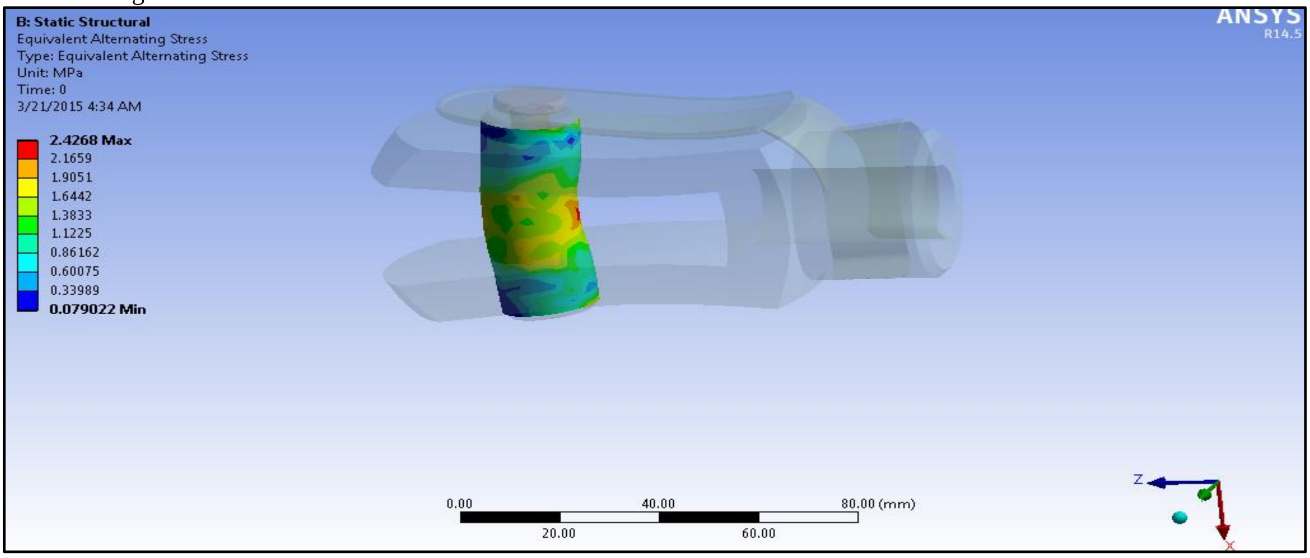


Fig 5. Alternating stress on pin

Maximum stress on pin = 2.42 N/mm^2
Minimum stress on pin = 0.079 N/mm^2

IV. VALIDATION

A working model is manufactured based on the creo parametric model, during trial run for various measurements are taken and Ansysanalysis is carried out to validate the assembly against basic requirement.

4.1 NEW DESIGN OPERATIONAL VALIDATION VIEWS AND SPECIFICATIONS

The new design which is being developed has following manufacturing specifications:

- Thread type in fork hole attached with cylinder –M16

- Pitch of thread- 2mm
- Hole diameter b- 16mm
- Total length of fork l -115 mm (standard)
- Distance between pin center to fork end l_2 -64 mm

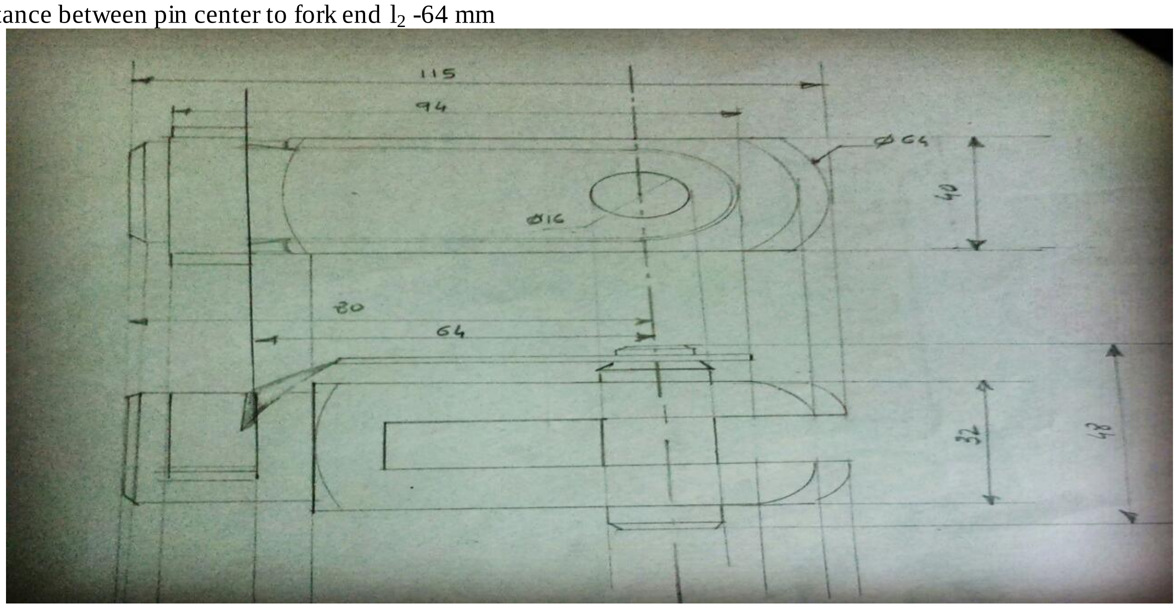


Fig 6. Detailed front & top views of new assembly

- **Material data: (As per company norms)**
  - For spring steel, hardened and tempered, zinc-plated.
  - For fork and pin stainless steel is used.

TABLE 5 STAINLESS STEEL POPERTY		
Tensile Strength (ultimate)	430	MPA
Thermal Conductivity	16.2	K
Tensile Strength, Yield	215	MPA
Density	7.15	g/cc

-

- **Photo based results:**
  These following Photos are taken at the hard floor of industry which works with the new design considering snap on spring fork pin replacing traditional screw nut assembly based on design of x concept. Fig 5.3 & 5.4 are showing the attachment of snap on spring on fork pin with different views.

Fig 7. Manufacturing feasibility of new design

Fig 8. Tested view

4.2 COMPARISONS OF RESULTS BASED ON STAINLESS STEEL

TABLE 6 ANALYSIS (STAINLESS STEEL)		
Type of analysis	New Model	Existing Model
Equivalent von-mises stress for assembly σ	**19.20 N/mm^2 (max)**	21.06 N/mm^2 (max)
Deformation	0.0015 mm	0.00147 mm
Alternating pin stress	**2.4268 N/mm^2** (safe)	7.799 N/mm^2 (unsafe)

Indicate good result

Here the comparisons of results are shown based on analytical and ansys results considering table 5.2 & following charts. Results indicate that the new design gives the better results in terms of equivalent von mises stress for whole assembly (system) & alternating pin stress. With the analysis based on alternating pin stress, the results come under the safe region which was not possible before in existing design. Deformation won't change, it remains same as the load was similar applied before.

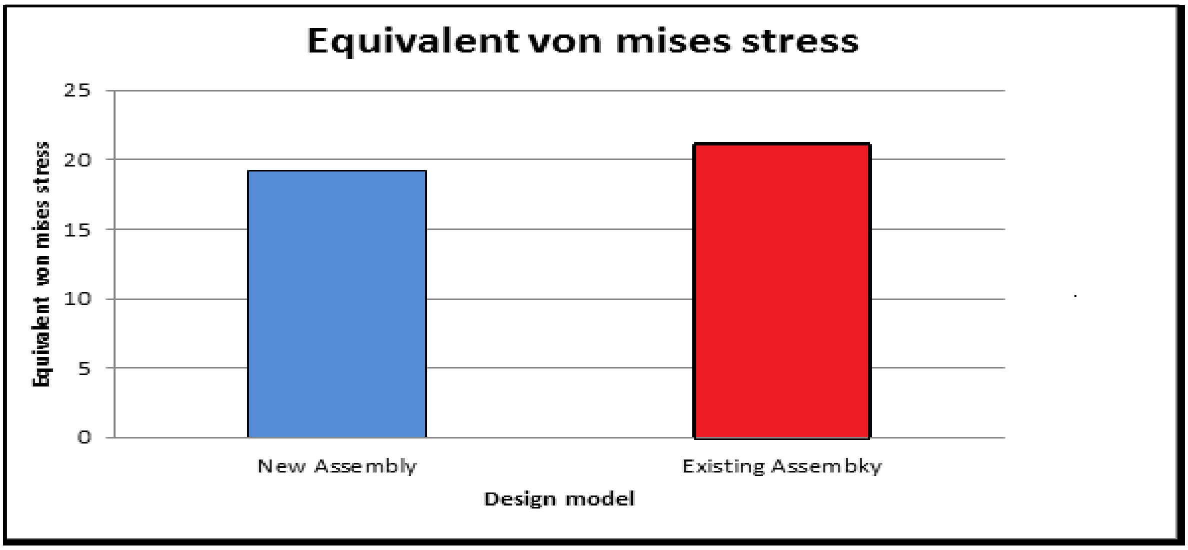
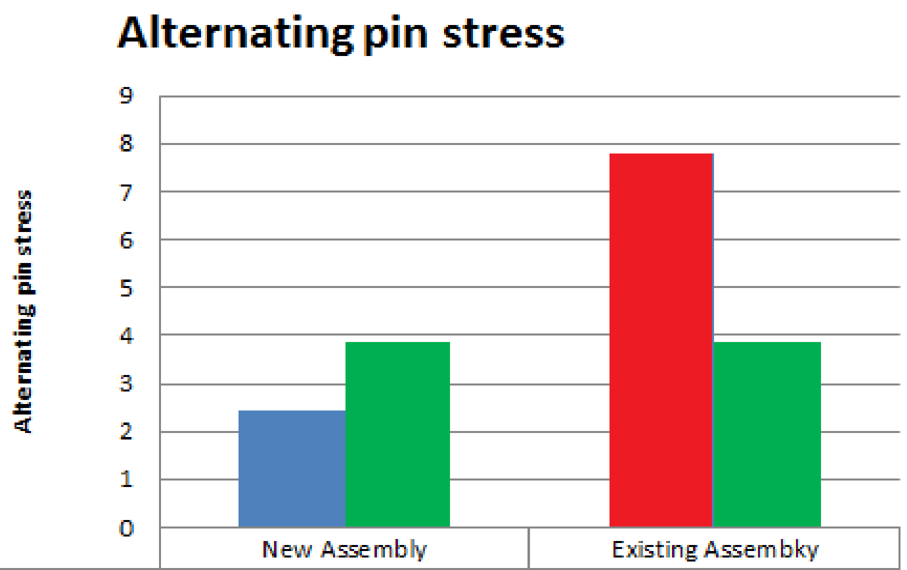


Fig 9.Graphical result of Equivalent von mises stress



	New Assembly	Existing Assembky
Values of alternating pin stresses for new & existing assmebly	2.42	7.799
Safe value of alternating pin stess	3.88	3.88

Fig 10. Graphical result of Alternating pin stress

V. CONCLUSION

5.1 CONCLUSION

The main aim of this research is to switch over to the advancing design concepts based on design of x from the traditional approaches. This research is giving throughout analysis of proposed design for the replaced fastener in the pneumatic cylinder. Time consuming problems faced during the assembling and dissembling by threaded screw, nuts is eased by using snap on concept replacing traditional screw nuts with snap on spring in fork pin assembly of pneumatic cylinder is achieved in this case. Here with the application, strength criteria is analyzed with the new design by considering alternating pin stress and equivalent von mises stress which gives decent results then the previous existing assembly.

5.2 FUTURE DIRECTIONS OF RESEARCH

As a future scope, this snapping concept is used in other applications of mechanical components and assemblies where assembly and disassembly are the prior terms by considering another modern design of x concepts based on DFA , DFM , DFR.

REFERENCES

[1] Bhandari, V.B. (2001) .Inrodution to machine design. New Delhi : Tata McGraw-Hill.
[2] KamleshPurohit. (2005), ''Design of Machine Elements'', (3^{rd} Edition), ISBN:81-203-1955-9.
[3] Blake, Alexander (1985). Design of Mechanical joints. CRC press. ISBN 978-0-8247-7351-9.
[4] JaroslavMackerle[7] , ''Finite element analysis of fastening and joining: A bibliography (1990–2002)''
[5] Sourav Das, VishvendraBartaria, PrashantPandey[1], ''Analysis of knuckle joint of 30C8 steel for automobile application'', IJERT, ISSN :2278-0181 vol.3, issue 1, Jan 2014.
[6] Geng-Sheng Wang[6],''Computational Method for Evaluating the Fatigue Life of Mechanical Joints'' (2001),FOI – Swedish Defence Research Agency, ISSN: 1650-1942.
[7] R.A. Ibrahima,*, C.L. Pettitb[5] (2003), '' Uncertainties and dynamic problems of bolted joints and other fasteners''
[8] D. Croccolo, R. Cuppini and N. Vincenzi[4] ''The design and the optimization of the Fork-pin compression joints in front Motorbike Suspensions.'', IDC-2006,Dubrovnik-croatia,May2006.

[9] Dario Croccolo, RossanoCuppini and FilippoBerto[3], '' Fatigue limit prediction of a compression fork-pin coupling of a front Motorbike suspension under fully reversed bending load''.
[10] William Lewis, Bruce Field and John Weir [2], ''Assessing quality of ideas in conceptual Mechanical design''(2011),ICED11.
[11] John R. Steffen[1], ''Analysis of Machine Elements using cosmos analysis''(2008), schroff Development Corporation,2008. ISBN: 1585034746,9781585034741.
[12] Thomas Kunhe, ''Models in Software Engineering : Workshops & Symposia at Models 2006, GENOA, Springer science & media.
[13] Bui Minh Duc., ''Real-time oject uniform design methodology with UML'',Springer-science & business media.(2007).
[14] Way Kuo, Ming J. Juo, ''Optimal Reliability Modeling: Principles and Applications'', John Wiley and sons publications, ISBN: 0-471-39761-X
[15] Steffen Bangsow, ''Discrete Event Simulation: Research and Appliance'', Springer publications, ISBN: 78-3-642-28776-3.
[16] http://www.en.m.wikipedia.org
[17] Technical expertise manual- snap fit design manual, o-BASF the technical company

