Design of Bush Mounting Fixture with Critical Part Analysis

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Abstract - Fixture designed is depicted by so many others; however fixture designed itself having innovative area for various components. So we need apply theoretical knowledge to industrial application. To make the press fitted assembly of lever with hand is time consuming, less accuracy and human error. This paper presents Design and analysis of fixture for bush mounting on lever. After careful study of final assembly, a few concepts designed. Among these concept best concept selected, and developed fixture to meet the assembly requirement. So, there is need to develop fixture which can help to increase productivity in batch type production.

The design of the fixture is modeled using 3D-software; manufacturing drawing is created using same software. The critical parts are validating using analysis software. Fixtures reduce human error, operation time and increases productivity and high quality of operation.

Index Terms- Fixture design, die spring, coil spring

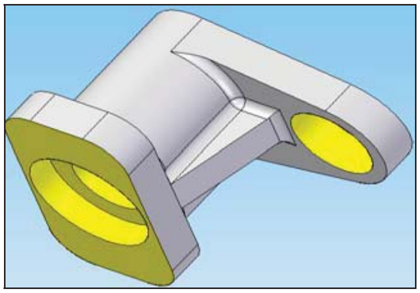
I. Introduction

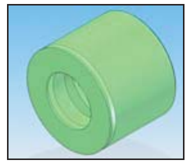
Over the few decades, manufacturing is progressing widely. The machine technologies, high-performance advance technology, and modern manufacturing processes are making today's industries to make parts faster and better than ever before. So the fixture method also advanced considerably, however the basic principles of clamping the work piece and locating is still the same[5].

Mass production methods are demanding a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures will be specially designed so that large numbers of components can be machined or assembled identically, and to require interchangeability of components globally. The economical production or considering cost of engineering components is greatly helped by the provision of jigs and fixtures.

II. IDENTIFICATION OF PROBLEM

Design lever holding fixture to mount on AL 400 press to fit one bush in lever as shown in figure 1. The lever is manufactured with casting process and further machined to meet final requirement of product. All machined faces are marked in yellow color. The Bush is purchased part or vendor part 3D model shown in figure 2, having the outside ø45mm.





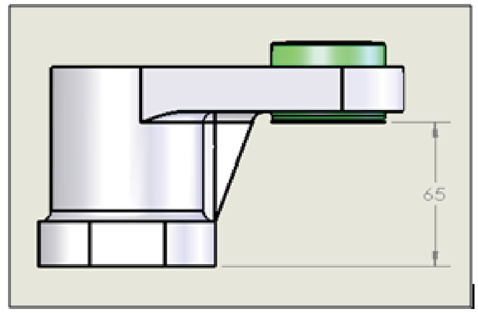


Figure1. Lever Figure 2. Bush Figure 3. Final Product Assembly

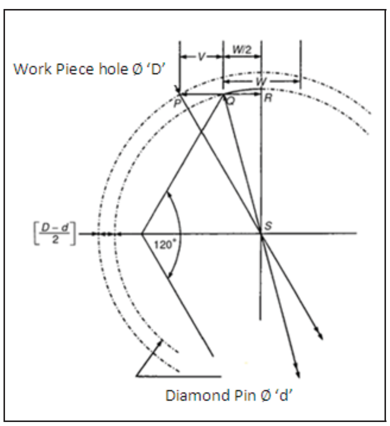
The figure 3 is shows the final product assembly. The Final product assembly shall be maintained 65 dimension form bottom of lever to the bottom of the bush.

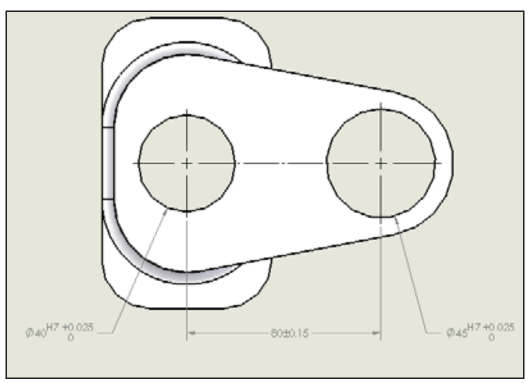
III. DESIGN OF FIXTURE AND ANALYSIS OF CRITICAL PART

As seems that that the machining has done on holes, we could mount this locating pin. However we need one cylindrical pin and diamond locating pin to adjust the tolerance between two holes.

Diamond Pin calculation:

When we have to use two holes in work piece for location, we must take into account the variation in the centre distance of the two holes due to the wear of the guide bushes for cutting tool.
The variation can be taken care of by making one of the two location pins diamond shaped.





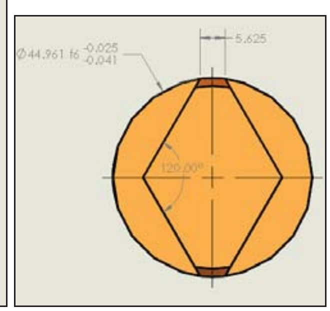


Figure 43. Principle of Diamond Pin10 Figure 5. Dimensional Details Figure 6. Diamonond pin detail

Where, figure 4 shows the all principle of Diamond pin, and calculate diameter by below formula, [10]
C - Centre distance between locating pin
D - Work piece bore min (Max. material condition of hole)
V- Variation in centre distance
d - Diamond pin dia. Max (Min. material Condition of shaft)
W= Engagement width (D⁄8)

$$\therefore d = 2\sqrt{\left(\frac{D^2}{4}\right) - V^2 - VW}$$

Where,
Diamond pin locating hole surface dia = 45 H7

= 45.025/45.000
D = Work piece bore min. (Max. material condition of hole) = 45.000
Variation, V = 0.15
W= Engagement width = (D/8) = (45.000/8) = 5.625
Piece bore min (Max. material condition of hole) = 45.000

$$\therefore d = 2\sqrt{\left(\frac{45^2}{4}\right) - 0.15^2 - (0.15 * 5.625)}$$

d = 44.961mm

Radial Clearance (D-d)/2 is 0.02mm, But clearance at location at location Q is 0.15mm i.e. 7.5 times the radial distance. The pins should be made further undersize to provide precision running fit H7/f6 with work piece[10]

Diamond pin = d= 44.961 f6
=44.961 -0.025/-0.041

Figure 6 shows the new dimension details of Diamond pin, which is calculated.

IV. CONCEPT GENERATION

Concept I (Dog Pin Screw Arrangement):

Figure 7 shows Diamond pin is actuated with Compression spring. When RAM is moving downward the spring will be compressed, till compress until diamond pin is touched the spring block. We can achieve 65mm dimension when diamond pin and spring block is get mate.

The returning force of compression spring is controlled by dog point screw.

Concept II (Lock Plate Arrangement):

In Figure 8 shows the case that, also we could achieve the 65 mm using diamond pin and spring block. However in this case we could use spring lock plate instead of dog point screw.

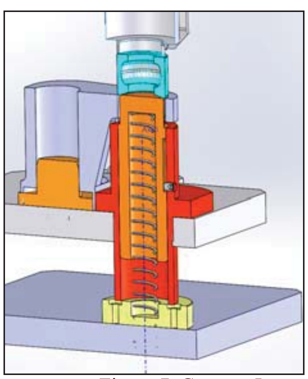


Figure 7. Concept I

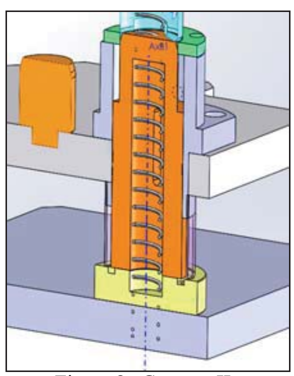


Figure 8. Concept II

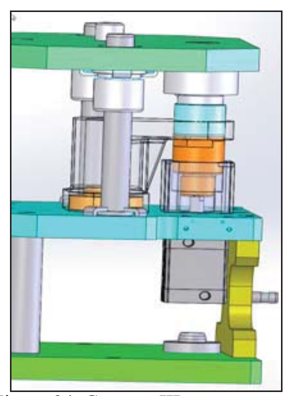


Figure 94. Concept III

Concept III (Actuator Arrangement):

In Figure 9 Shows the case, the actuation of diamond pin can be controlled with Double acting pneumatic cylinder. In this case we can achieve the 65 mm dimension with double acting pneumatic cylinder and proximity sensor

V. SELECTION CONCEPT DESIGNS WITH MODIFICATION:

We have selected concept I as it is simple in construction As its seem that, the more parts to be machined and manufactured in Concept II and also in concept III, we need to purchase actuator cylinder, and related power pack, sensor.

Concept I, need to be concentrated for cushioning effect of die spring and make the easy to manufacturing part.
Figure 10 shows the location of die spring in fixture. Figure 11 shows the maximum available distance in fixture.

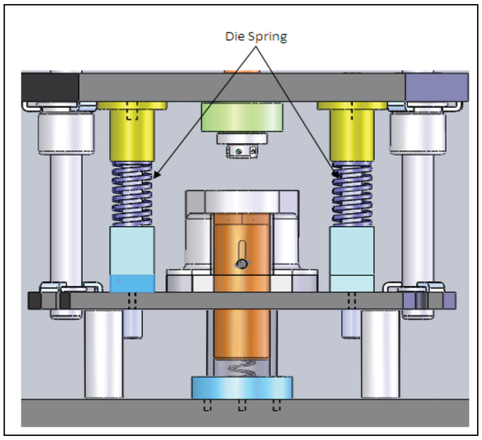


Figure 10: Die Spring Fixture

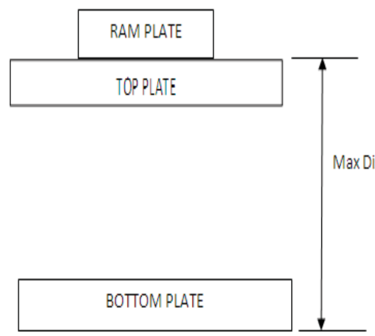


Figure 5. Available Fixture Height

VI. FORCE CALCULATION ON DIE SPRING:

RAM exerting force =**2×10^3 N**
We have selected Two spring at this location, So force applied on each spring. =**1×10^3 N.**
Considering 30% FOS, So Therefore the force acting single spring is **1.3×10^3N.**

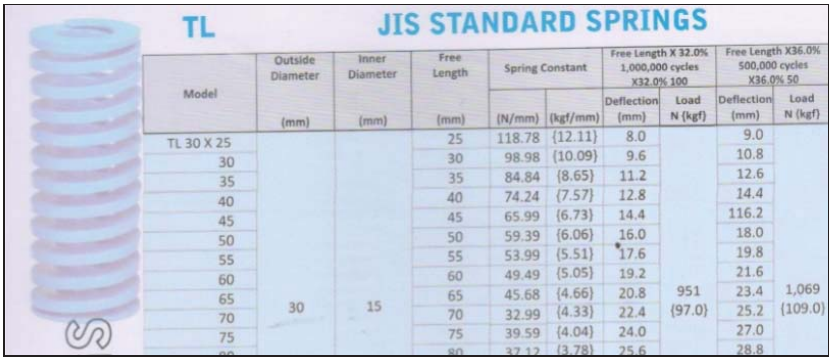
VII. SELECTION OF DIE SPRING FROM STANDARD CATALOG:

As we required spring defection is 27 mm, so need to select spring considering spring constant (N/mm).

Load acting on each spring without FOS = **1×10^3 N.**

Max spring constant = Actual load/required deflection
= $1 \times 10^3 / 27$
=37.03 N/mm

The spring constant of selecting spring should be **less than 37.03 N/mm**
Available spring length in fixture is in between **60 to 80mm**
Figure 12 Shows the JIS spring catalog various spring details.



Model	Outside Diameter (mm)	Inner Diameter (mm)	Free Length (mm)	Spring Constant		Free Length X 32.0% 1,000,000 cycles X32.0% 100		Free Length X36.0% 500,000 cycles X36.0% 50	
				(N/mm)	(kgf/mm)	Deflection (mm)	Load N (kgf)	Deflection (mm)	Load N (kgf)
TL 30 X 25			25	118.78	{12.11}	8.0		9.0	
30			30	98.98	{10.09}	9.6		10.8	
35			35	84.84	{8.65}	11.2		12.6	
40			40	74.24	{7.57}	12.8		14.4	
45			45	65.99	{6.73}	14.4		116.2	
50			50	59.39	{6.06}	16.0		18.0	
55			55	53.99	{5.51}	17.6		19.8	
60			60	49.49	{5.05}	19.2		21.6	
65			65	45.68	{4.66}	20.8	951	23.4	1,069
70	30	15	70	32.99	{4.33}	22.4	{97.0}	25.2	{109.0}
75			75	39.59	{4.04}	24.0		27.0	
[illegible]			80	37.12	{3.78}	25.6		28.8	

Figure 12. Spring Catalog

Details of spring which is selected form catalog.
Outside Diameter = 30mm
Inner Diameter = 15mm
Free length = 70 mm
Spring Constant = 32.99 N/mm

However we need to check life of Die spring:
As per Catalog the life of spring increases with less deformation.

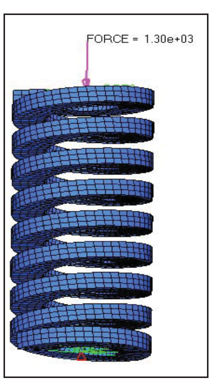
Figure 17 shows that, spring life for various deformations.
Free length x 32.0% deformation = 1, 0000,000 cycle
Free length x 36.0% deformation= 5, 00,000 cycle

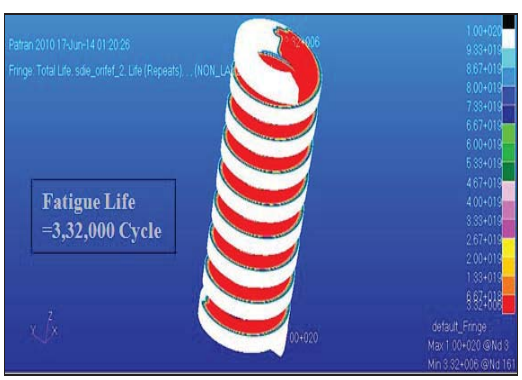
Percentage of deformation required for current application:
= (Deformation required /free length) x 100
= (27/70) x100
= 38.57 %
Need to calculate life of spring for 38.57% deformation.
The life is calculated in analysis.

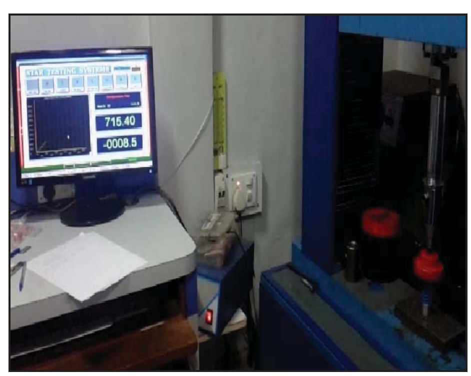
VIII. ANALYSIS OF DIE SPRING:

Material: Steel Spring
Young's Modulus: 2.1 X 105N/mm^2
Density: 7.9 x 106kg/mm^3
Poisson's Ratio: 03
Yield Stress: 1680N/mm^2

Boundary Condition: *Life of spring:* *Fatigue life Testing:*



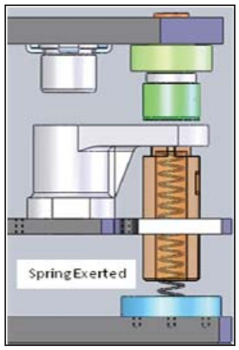


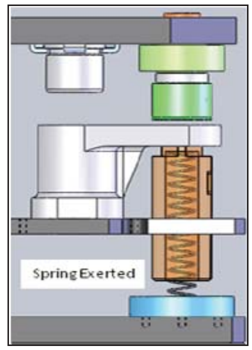


Result	With Analysis	With Experiment
Life of the Spring	3,32,000 Cycle	3,50,000 Cycle

IX. Selection of Compression spring in diamond pin

Diamond pin material: EN 353
Wight of Diamond Pin = 10.99 N





Available length In Diamond pin after initial pre-compressed condition = 151.5 mm
Initial compression of the spring =10-15 mm approx.

Required free length of helical compression spring= 151.5+ (10-15) **= 161.5 To 166.5 mm**

So we need to design the thrust force or return force of a spring is **more than 11 N**
We have selected spring form standard spring catalog,
Free length= 165 mm
Outside Diameter= 17.60 m
Wire Diameter= 1.60 mm
Spring rate= 0.73 N/mm,

Therefore,
Spring exerting force= (initial comp. of the spring+ spring comp. due applied load of press) X spring const.
= (13.5+14) X 0.73
Spring exerting force = 20.075 N

X. Selection and validation of dog point screw

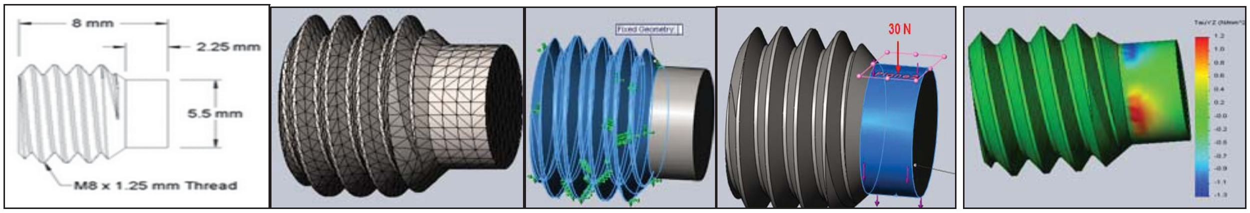
So as per easily availability of Dog point screw from purchase department in Industry
We have selected from Stainless Steel M8 x 1.25 Dog Point screw

Tensile Strength, Yield 215 MPA,
Shear strength= = 124.05 MPA of Stainless steel
Design Stress (Max allowable stress) = 82.5 N/mm2

Dog pin diameter = 5.5 mm
Force= (initial compression + max deflection) X Spring const
= (13.5 + 14) X 0.73
= 20.075
Force =30 N (…… Considering 1.5 FOS)

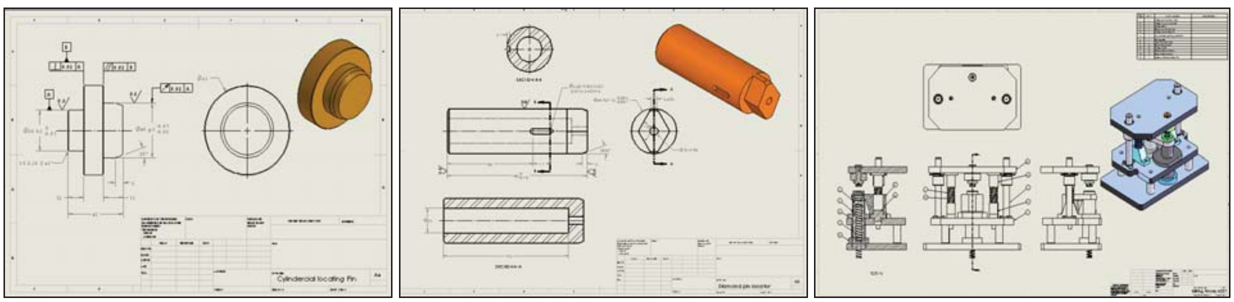
Shear stress induced in extended pin = force/ Area

Shear Stress induced in extended spring = 1.26 N/mm2



Result	**Allowable Stress**	**Analytical**	**With Analysis**	**Result**
Shear stress Induced in Dog Point Screw	82.5 N/mm2	1.26 N/ mm^2	1.3 N/mm^2	Safe

XI. MANUFACTURING DRAWING (FEW LISTED HERE)



XII. CONCLUSION

An effort is taken to design to hold the components in fixture and calculated all dimension to hold securely. This fixture prevents the damages bush while pressing in lever. The effort of the operator is also reduced.

New developed fixture is technically justified, and proven its effectiveness, accuracies over conventionally the clamping force available from RAM has, validated using analysis software for critical part. Various new manufactured drawing which is created from new designed has submitted to fixture Design Company.

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