KINEMATIC AND DYNAMIC ANALYSIS OF CRANK SHAFT USED IN POWER PRESS

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Abstract— Crank shaft is critical component in power press industry. Because of impact load continuously acting on it, Crank shaft of press machine always experience continuous shear stress and over loading. Press machine continuously deals with stress and because of that crank fails in machine under uneven condition. Which lead to complete shutdown of machine. So, as crank is a main and critical part of power press, it must be design carefully considering the entire factor's responsible for its failure. This project is about to find the failure of crankshaft in industry and redesign of the same component. It consists of design and analysis of each components by doing Positional analysis for displacement, Kinematic Analysis for velocity, Dynamic Analysis for Acceleration for finding out critical point on shaft or failure point. It will lead to our failure area and then redesign of the shaft for prevent the cause on industry.

Keywords—Position Analysis, Kinematic Analysis, Dynamic Analysis.

I. INTRODUCTION

Historically, Later hammer were constructed to press more metal at once or to press thicker materials. Often smith would employ a helper or apprentice to swing the sledgehammer while the smith concentrated on positioning the work piece. Adding windmill or steam yielded still larger hammers such as steam hammers. Most modern machine presses use a combination of electric motors and hydraulic to achieve necessary pressure. Along with evolution of presses came the evolution of the dies used within them.

Today, crank shaft is the critical components in industry and technology is one of the bastions of our modern lifestyle. The basis for our prosperity, in which metal forming technology plays a central role. Alongside the manufacture of semi-finished products through rolling, wire drawing and extrusion, the production of discrete components using sheet metal and solid forming techniques is of major significance. Its fields of application range from automotive engineering, production line and container construction through to the building construction, household appliance and packaging industries.

Developments in this field created the technological basis to flow line, optimum strength characteristics and low material and energy input, to be combined with higher production output, dimensional control and surface quality. application of the crank shaft are (i)a punch press is used to form holes. (ii)a stamping press is a machine press used to shape or cut metal by deforming it with a die. It generally consists of a press frame, a bolster plate, and a ram.

The basic Power Press[1]Machine are SNX-35, SNX-45, SNX-63 and SNX-110. The Service department of Power Press was receiving many complains about their product SNX-63. The problem was failure of crank shaft due to shear stress and overloading. During working period in scrap department it is that seen many crank as failure. So contact with the design department for understands to how failure is occur and how to resolve that. So I took this problem for analysis as my industrial defined problem.

Now, calculation of crank shaft used in design software and find out the position, velocity and acceleration for FEA(finite element analysis). In view of this abnormal phenomenon, analysis of modal and dynamic response is performed for the initial and magnified crankshaft with finite element analysis software. By this means, the reason why crankshaft crack and crank is explicit.

II. DESIGN AND GEOMETRY DRAWING OF POWER PRESS MACHINE

Power press is one of among the heavy mechanical machine. In power press, crank shaft is critical element. This is used to transmit whole force to the ram by converting rotary motion into reciprocating motion. Stroke length of the power press is depends on the eccentricity of crankshaft. After doing the literature reviews, methodology was decided for solution of this problem. As discussed in the problem definition the failure of crank shaft to solve this, software Creo parametric 2.0 is used. Creo parametric software is modeling software, it is used to do a sketch, solid part modeling, sheet metal part modeling, design assembly, mold layout assembly, manufacturing, cast cavity, mold cavity, 2D drawing, diagram, layout and markup. So to solve particularly this problem, first of all geometric drawing and 3d model was created from existing data from company **.**

A. Components of power press machine

Geometric drawing and 3d model of crank shaft[2] was created using existing data from industry as in fig.1 with help of Creo parametric 2. 0

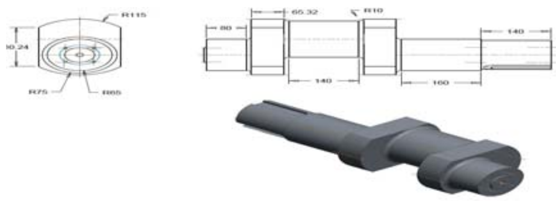


Fig. 1 Geometric drawing and 3d model of crank shaft

Geometric drawing and 3d model of ball screw[2] was created using existing data from industry as in fig.2 with help of Creo parametric 2.0

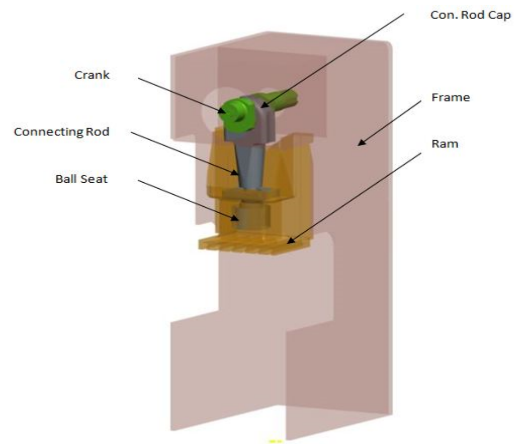


Fig. 2 Geometric drawing and 3d model of ball screw

Geometric drawing and 3d model of ball seat[2] was created using existing data from industry with help of Creo parametric 2.0

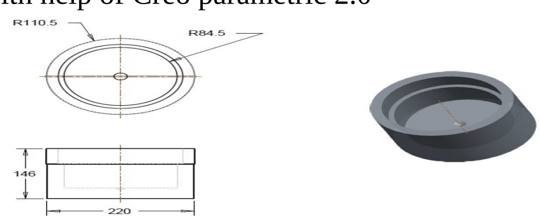


Fig. 3 Geometric drawing and 3d model of ball seat

Geometric drawing and 3d model of Frame[2] was created using existing data from industry with help of Creo parametric 2.0

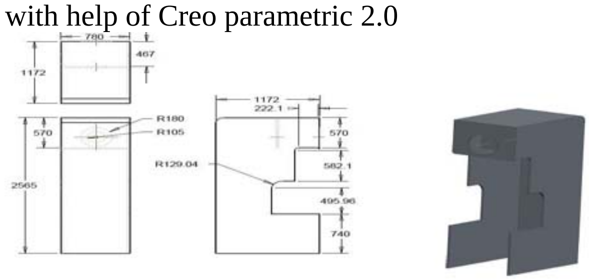


Fig. 4 Geometric drawing and 3d model of frame

Geometric drawing and 3d model of ram[2] was created using existing data from industry with help of Creo parametric 2.0

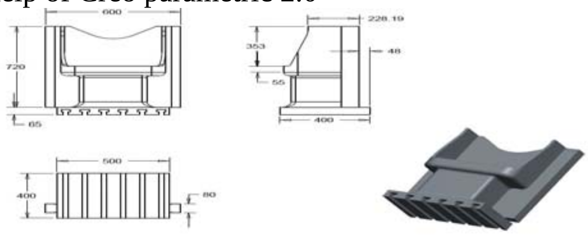


Fig. 5 Geometric drawing and 3d model of ram

Geometric drawing and 3d model of connecting rod[2] was created using existing data from industry as in fig.6 with help of Creo parametric 2.0

Fig.6 Geometric drawing and 3d model of connecting rod

B. Design assembly of power press machine

Design assembly of power press by using Creo parametric 2.0 software is shown in fig.7. Assembly module of Creo parametric 2.0 support joint like pin, slider, cylinder, slot, bolts etc. Using required joint mechanism assembly of power press was prepared.

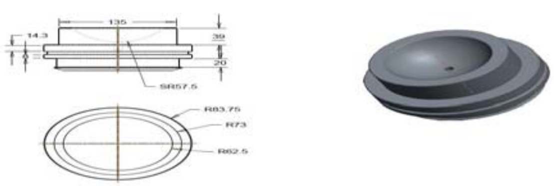


Fig. 7 power press machine

C. Technical specification Table of power press[2]

Table I Technical specification of power press

III. MOTION ANALYSIS

After preparation of assembly under mechanism module servo motor placed at crank axis for mechanism design servo motor at crank axis was added. Mechanism module is use to simulate exact mechanism function and often referred to as the mechanism design extension (MDX). It was used to simulate belt drive, Gear,

Description	Dimension
Model	SNX-63
Tonnage	63
Fixed stroke (mm)	130
Adjustable stroke (mm)	8-100
Rating point (mm)	4
Die height (mm)	300
Slide adjustment (mm)	70
Slide area (mm2)	500 x 400
Tool bore (mm)	50.8
Bolster area (mm2)	900 x 520
Major motor (hp x P)	7.5 x 4
Slide adj. motor (kw)	0.4

Cam etc. by define require parameter, also give indication regarding collision of component used in mechanism. It also do the position analysis, kinematic analysis, dynamic analysis, force analysis and static analysis. To measure displacement, velocity and acceleration following analysis are done.

A. POSITION ANALYSIS OF CRANK USED IN POWER PRESS

It is used to measure the exact position and displacement of pre-define point for complete cycle in Creo parametric 2.0. After completing mechanism design select mechanism module under application tab. Add servomotor at crankshaft axis and enter parameter as per existing design. Select analysis definition type as position analysis and run analysis to generate position analysis definition. To measure displacement of predefine point select measure tool and define point and coordinate system. In result set select measure definition type as "position" and check on prepare graph separately' after that click on graph button to obtain the result in graphical format for complete cycle.

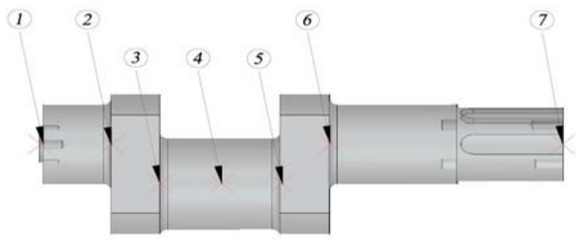


Fig. 8 Pre-define Point Of at Crank Shaft

Generate a require measure of displacement for pre-define points using a measure tool and with help of position analysis definition in Creo Parametric 2.0 .Obtain a graph from result of analysis definition. Compare the obtain result with real machine, same result validates the assembly. Finding the maximum displacement on shaft to be measured.

Position analysis of crank in one complete cycle for point 1 to 7 is given below,

(i)Displacement at point 1 is suited at intersection of front plane and center axis of crank shaft were servo motor was added. By position analysis the result obtain as shown in fig. 9.

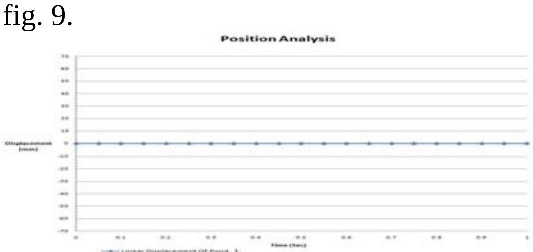


Fig. 9 position analysis at point 1

(ii)Displacement point 2 is suited at intersection of plane were section-A and center axis of crank shaft were servo motor was added. By position analysis the result obtain as shown in fig. 10.

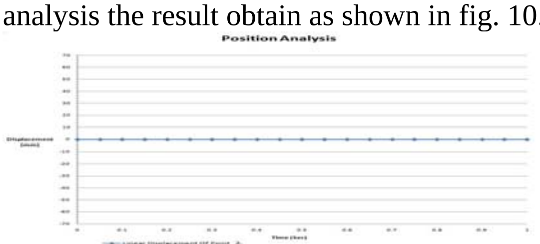
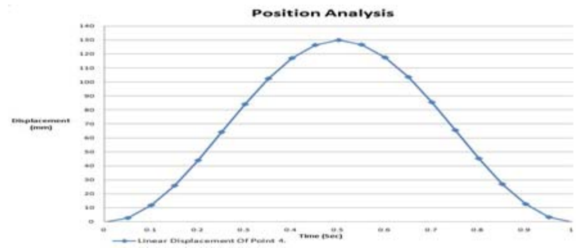


Fig. 10 position analysis at point 2

(iii) Displacement at point 3 is suited at section-A and intersection of eccentric axis at crank shaft. It was consider to the axis of connecting rod. By position analysis the result obtain as shown in fig.11.

Fig. 11 position analysis at point 3

(iv) Displacement at point 4 is suited at middle



of section-A and section-B were eccentric axis of crank shaft which is intersect. It was consider to the axis of connecting rod. By position analysis the result obtain as shown in fig. 12.

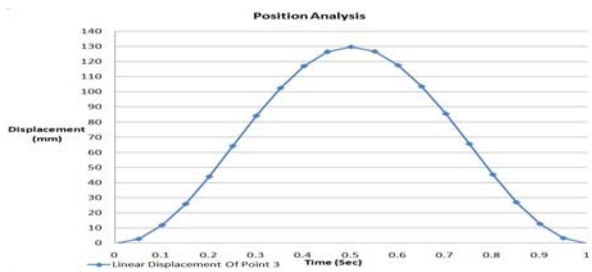


Fig. 12 position analysis at point 4

(v) Displacement at point 5 is situated at section-B and intersection of eccentric axis at crank shaft. It coincided to the axis of connecting rod. By position analysis the result obtain as shown in fig.13

Fig. 13 position analysis at point 5

(vi) Displacement at point 6 is situated at intersection of plane of section-C and center axis of crank shaft where servo motor was added. By position analysis the result obtain as shown in fig.14.

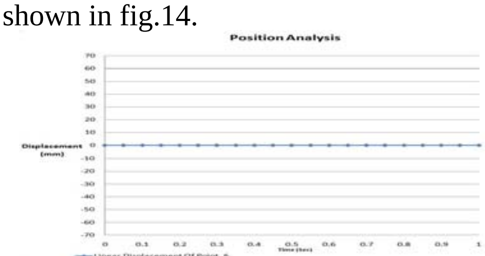


Fig. 14 position analysis at point 6

(vii) Displacement at point 7 is situated at intersection of Rear plane and center axis of crank shaft where servo motor was added. By position analysis the obtain result as shown in fig. 15

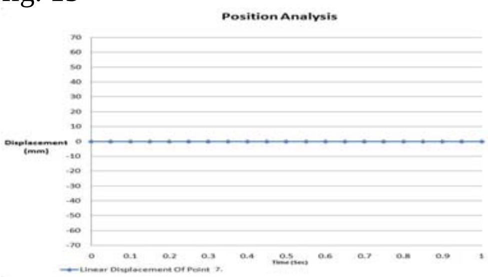


Fig. 15 position analysis at point 7

(viii)Displacement at all point

It is observed from above graph that the maximum Displacement of 129.773 mm is occur At point 3,Point 4 , Point 5 using Position analysis of crank shaft using creo parametric2..0 While actual maximum Displacement Is of 130m. So result generated from position analysis definition in creo parametric 2.0 an actual result is equivalent to each other, so assembly of power press is a valid to actual machine.

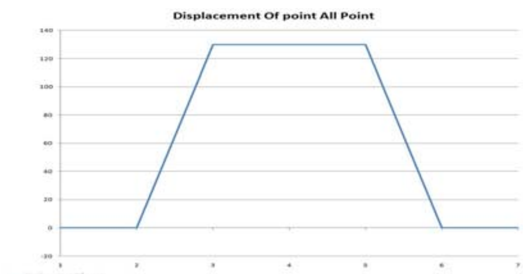


Fig. 16 displacement at all point

B. KINAMATIC ANALYSIS OF CRANK USED IN POWER PRESS

It is used to measure the exact velocity of pre-define point for complete cycle in Creo parametric 2.0. After completing mechanism design select mechanism module under application tab. Add servomotor at crankshaft axis and enter parameter as per existing design. Select analysis definition type as kinematic analysis and run analysis to generate kinematic analysis definition. To measure velocity of predefine point select measure tool and define point and coordinate system. In result set select measure definition type as “kinematic” and check on prepare graph separately after that click on graph button to obtain the result in graphical format for complete cycle.

(i) Velocity point 1 is situated at intersection of front plane and center axis of crank shaft where servo motor was added. By Kinematic analysis the result obtain as shown in graph.

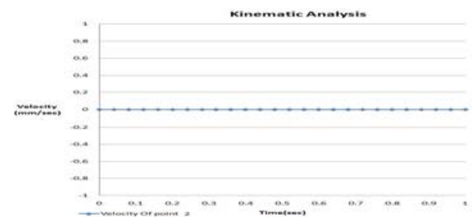


Fig. 17 Kinematic analysis at point 1

(ii) Velocity point 2 is situated at intersection of plane were section-A and center axis of crank shaft were servo motor was added. By Kinematic analysis the result obtain as shown in graph.

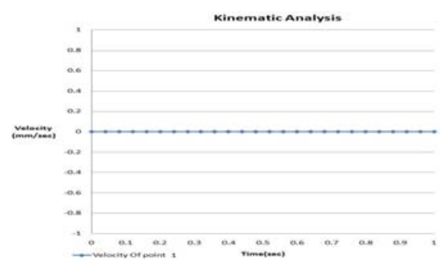


Fig. 18 Kinematic analysis at point 2

(iii) Velocity point 3 is situated at section-A and intersection of eccentric axis at crank shaft. It coincided to the axis of connecting rod. By Kinematic analysis the result obtain as shown in graph.

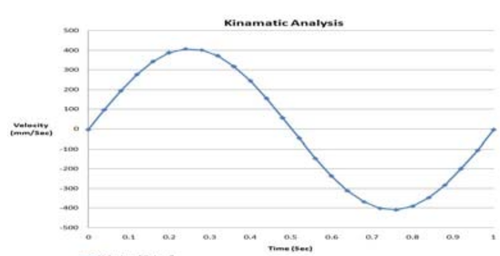


Fig. 19 Kinematic analysis at point 3

(iv) Velocity point 4 is situated at middle of section-A and section-B were eccentric axis of crank shaft which is intersect. It coincided to the axis of connecting rod. By Kinematic analysis the result obtain as shown in graph.

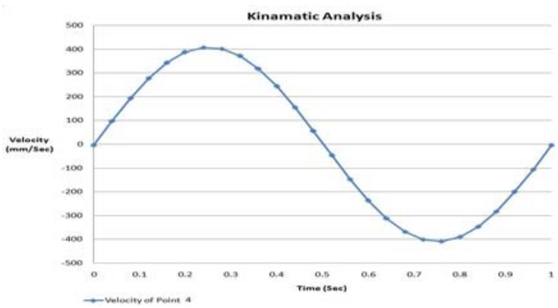


Fig. 20 Kinematic analysis at point 4

(v) Velocity point 5 is situated at section-B and intersection of eccentric axis at crank shaft. It was coincided to the axis of connecting rod. By Kinematic analysis the result obtain as shown in graph.

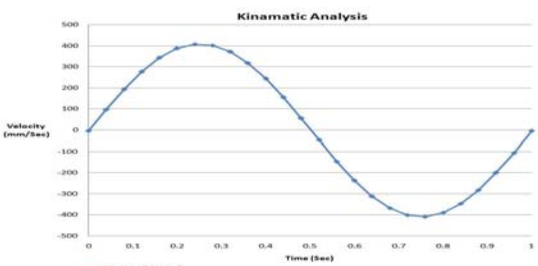


Fig. 21 Kinematic analysis at point 5

(vi) Velocity point 6 is situated at intersection of plane were section-C and center axis of crank shaft were servo motor was added. By Kinematic analysis the result obtain as shown in graph.

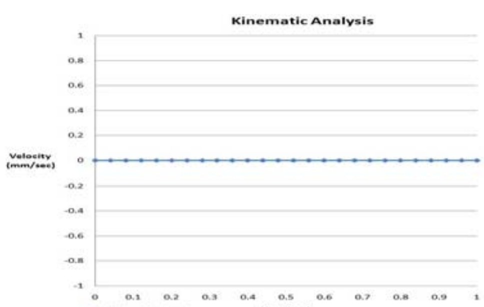


Fig. 22 Kinematic analysis at point 6

(vii) Velocity point 7 is situated at intersection of plane were section-C and center axis of crank shaft were servo motor was added. By Kinematic analysis the result obtain as shown in graph.

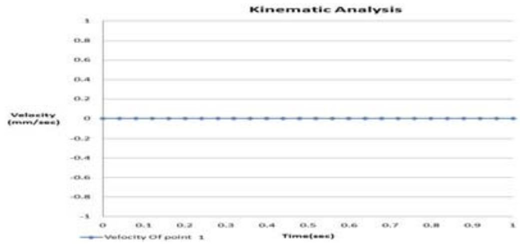


Fig. 23 Kinematic analysis at point 7

(viii)Velocity at all point on crank shaft

Here, kinematic analysis conclude that the relative velocity at all point is differ and at point 3 ,4 and 5 are same by simulating in creo perametric2.0. The value of velocity is given in millimeter per second and it is 400mm/s.

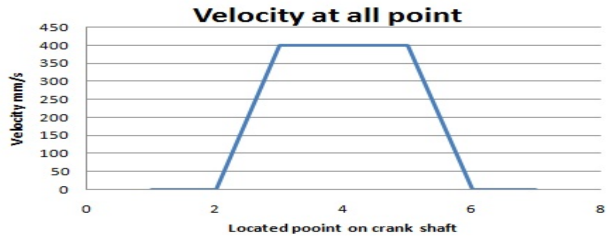


Fig. 24 velocity at all point

C. DYNAMIC ANALYSIS OF CRANK USED IN POWER PRESS

In dynamic analysis I find the acceleration value of each and every point on shaft for finding maximum value of force to determine the stress at all the point. For dynamic analysis select analysis definition type “dynamic” in analysis tool and select servomotor for 360 degree/sec run the analysis for crank shaft cycle time 1sec.

To measure the result for acceleration of each connecting point, select “measure“ tool and measure results graph type measure versus time and in result set select measure definition type dynamic, than by select the defined connecting point obtain the results graph of acceleration for crank shaft cycle time 1 second

(i)Acceleration point 1 is situated at intersection of front plane and center axis of crank shaft where servo motor was added. By dynamic analysis the result obtain as shown in graph.

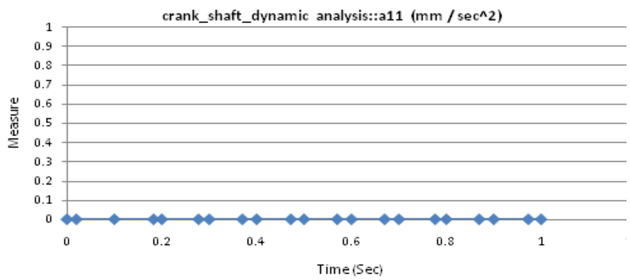


Fig. 25 dynamic analysis at point 1

(ii) Acceleration point 2 is situated at intersection of plane were section-A and center axis of crank shaft were servo motor was added. By Dynamic analysis the result obtain as shown in Graph. The value of a=2960 mm/s^2

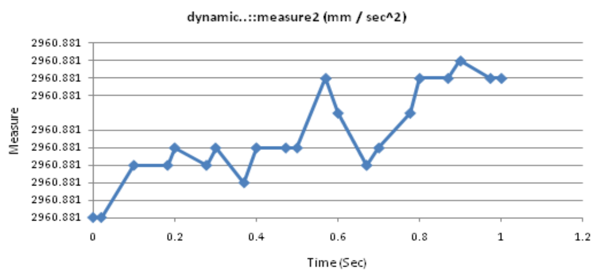


Fig. 26 dynamic analysis at point 2

(iii)Acceleration point 3 is situated at section-A and intersection of eccentric axis at crank shaft. It coincided to the axis of connecting rod. By dynamic analysis the result obtain as shown in Graph.

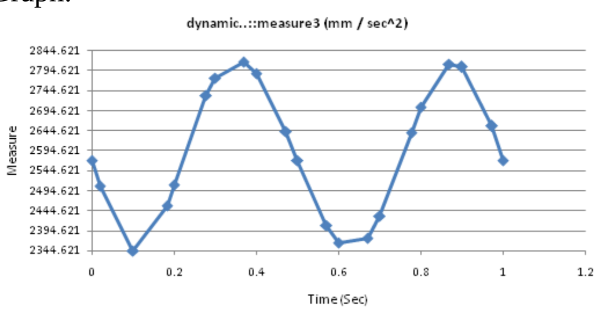


Fig. 27 dynamic analysis at point 3

(iv) acceleration point 4 is situated at middle of section-A and section-B were eccentric axis of crank shaft which is intersect. It coincided to the axis of connecting rod. By dynamic analysis the result obtain as shown in Graph.

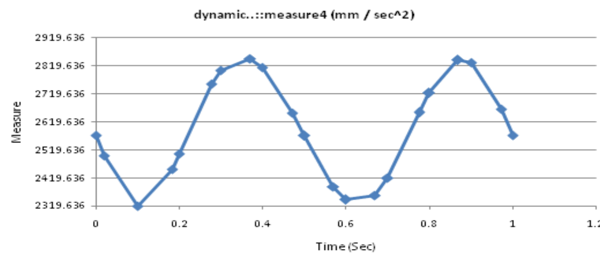


Fig. 28 dynamic analysis at point 4

(v)Acceleration point 5 is situated at section-B and intersection of eccentric axis at crank shaft. It was coincided to the axis of connecting rod. By dynamic analysis the result obtain as shown in Graph

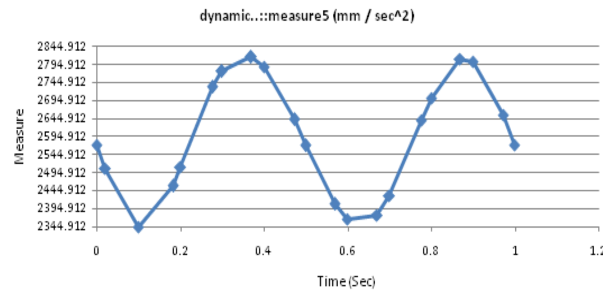


Fig. 29 dynamic analysis at point 5

(vi)Acceleration point 6 is situated at intersection of plane were section-C and center axis of crank shaft were servo motor was added. By dynamic analysis the result obtain as shown in Graph.

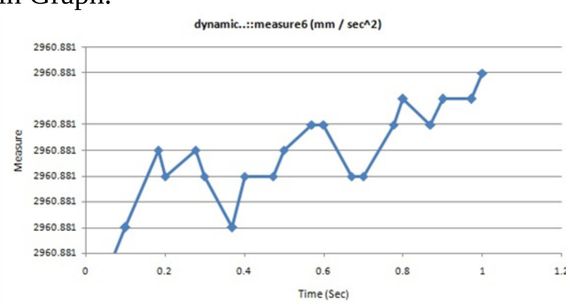


Fig. 30 dynamic analysis at point 6

(vii)Acceleration point at 7 is situated at intersection of plane were section-C and center axis of crank shaft were servo motor was added. By dynamic analysis the result obtain as shown in graph.

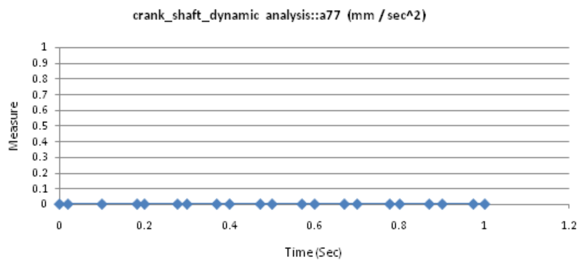


Fig. 31 dynamic analysis at point 7

(viii)Acceleration at all point

It is observed from above graph that the maximum acceleration of 2730 mm/s^2 is occur At critical point using Dynamic analysis of crank shaft using creo parametric2.0.

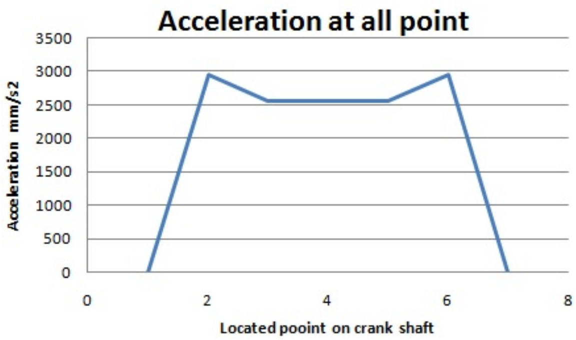


Fig. 32 acceleration at all point

So result generated from Dynamic analysis definition in creo parametric 2.0 an actual result is equivalent to each other, so assembly of power press is a valid to actual machine. Hence, design is safe.

IV. CONCLUSION

Creo parametric 2.0 can be used to do a position, kinematic and dynamic analysis of complex mechanism. To solve this problem position analysis of crank was done, which gave a result of maximum displacement 129.773 mm and actual maximum displacement is 130 mm. Also from kinematic analysis we get a velocity at pre define points which is equivalent to the actual velocity, and also from the dynamic analysis acceleration is 2730 mm/s^2 maximum and it implies that there is no collision in between parts in motion and mechanism run smoothly Therefore it can be said that obtained result is equivalent to the actual result and thus it assures that designed mechanism assembly is correct and design is safe for the particular material EN24[5].Result of dynamic analysis which would be generated in Creo parametric 2.0 would be used to do a FEA of crank shaft in a analysis software as a boundary condition of component.

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