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COMPUTER AIDED MODELING AND ANALYSIS OF CRANK AND SLOTTED LEVER QUICK RETURN MECHANISM

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ABSTRACT

In this paper we have calculated the time ratio and angle turned by crank during return stroke (α) for different lengths of crank for constant distances between the pivots. From these calculations we obtained maximum time ratio and the most efficient ratio of length of crank to the distance between the pivots. Also a CAM model of mechanism is made on PTC Creo parametric 3.0 for simulating the results. Various dimensions of links made on PTC Creo parametric 3.0 which give maximum time ratio are as shown in the figures. By using some suitable scale the links are fabricated to obtain the crank and slotted quick return mechanism having best possible time ratio.

KEYWORDS: Quick return mechanism, CAM model, PTC Creo parametric 3.0, time ratio.

INTRODUCTION

The crank and slotted lever quick return mechanism converts the rotary motion into reciprocating motion. It is the inversion of single slider crank chain. This mechanism consists of two strokes cutting stroke (forward stroke) and idle stroke (return stroke). During the cutting stroke the material is cut by the tool, but during the idle or return stroke no material is cut. Hence we have to reduce the time of return stroke or idle stroke to save the time and to increase the productivity. This mechanism is called quick return mechanism as the time taken during return stroke is less than the time taken during cutting stroke. As the time taken during return stroke is less hence it leads to increased productivity. This mechanism is widely used in various, machines in industry such as shaper machine, slotter machine, power driven hack saw and rotary internal combustion engine. The performance of the mechanism is depend on the time ratio of the mechanism. The time ratio of the mechanism is ratio of time take during cutting stroke to the time taken during return stroke. Lesser the time of return stroke greater will be the time ratio and better will be the mechanism. This mechanism basically consists of four links as crank, frame, connecting rod and slider. The ram and lever connecting the ram is not the part of basic inversion.

The design of the mechanism is made on PTC creo parametric 3.0 software. This software is 3D CAD/CAM/CAE featured based, associative solid modeling software. In this software there are two methods to for creating the mechanism-top down assembly and bottom up assembly. The bottom up approach is used when the dimensions of mechanism is known. When the dimensions of mechanism are not known we use the top down approach. Since in this mechanism we know the dimensions hence we have used the bottom up approach.

There are variety of quick return mechanism such as the offset crank slider mechanism, the crank-shaper mechanisms, the double crank mechanisms, crank rocker mechanism and Whitworth mechanism. The advantage of this quick return mechanism over other quick return mechanism is that, this is the simplest among all the mechanisms.

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WORKING

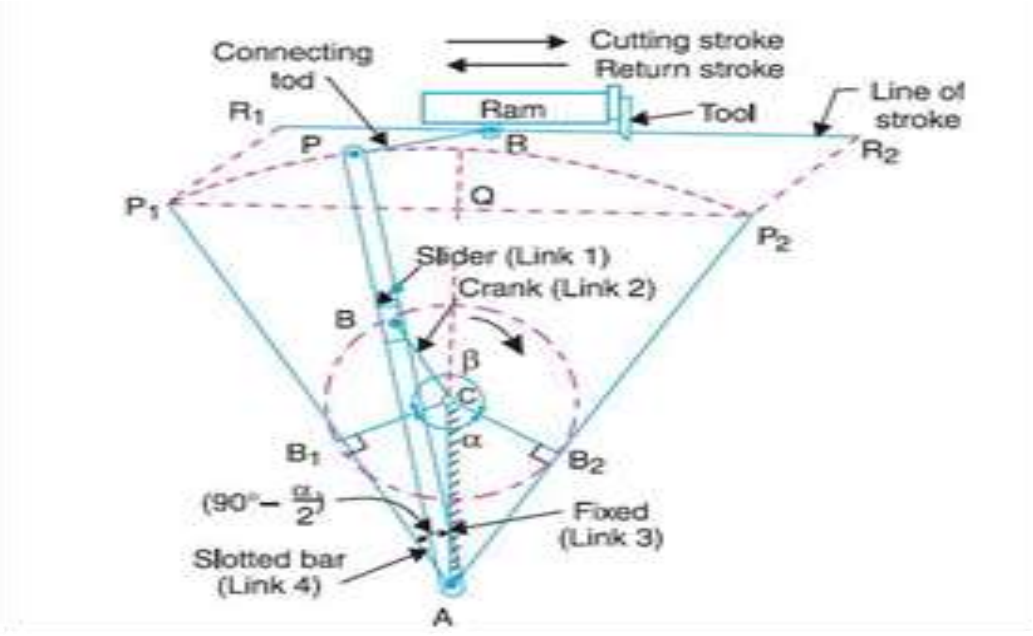

Figure 1: crank and slotted lever quick return mechanism

In this mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in Fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block is attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced. In the extreme positions, AP1 and AP2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB1 to CB2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB2 to CB1 (or through angle α) in the clockwise direction.

The time ratio is given by-

$$\text{Time ratio} = \frac{time of cutting stroke}{time of return stroke} = \frac{360-\alpha}{\alpha}$$

From figure-

$$\sin \angle CAB_1 = \sin(90^0 - \frac{\alpha}{2}) = \frac{B_1C}{AC} = \frac{Length\ of\ crank}{distance\ between\ pivot\ centres}$$

We have used these two formulas for determining various time ratios and angle turned by crank during return stroke for constant distance between pivots.

DETERMINATION OF TIME RATIO AND ANGLE TURNED BY CRANK DURING RETURN STROKE

For modeling of crank and slotted lever mechanism which has maximum time ratio for the certain length of crank and constant distance between pivot we have done analytical analysis to determine the length of crank for a constant distance between pivots which will give the maximum possible time ratio.

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Sr no.	*Crank length(mm)*	*Distance between pivots(mm)*	*Angle turned by crank during return stroke(α)*	*Time ratio(sec)*
1	10	120	170.439	1.112
2	20	120	160.811	1.238
3	30	120	151.044	1.383
5	50	120	130.75	1.753
6	60	120	120	2
7	70	120	108.62	2.314
8	80	120	96.38	2.735
9	90	120	82.82	3.346
10	100	120	67.11	4.3643
11	110	120	47.12	6.64

***Table 1: Time ratio and angle turned by cringle during return stroke for different length of crank and constant distance between pivots*.**

As we have to kept, the clearance of 20mm between the length of crank and distance between pivots hence, we cannot increase the length of crank beyond 100 mm, for the fixed distance between pivots of 120mm. hence the maximum possible angle turned by crank during return stroke is $67.11^0$and the time ratio is 4.3643. Also the ratio of distance between the pivots and crank length should be in between 1 to 1.2 for obtaining maximum time ratio

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COMPUTER AIDED MODELING

As discussed previously this mechanism is completely created on PTC creo parametric 3.0 software by bottom up approach. The mechanism is shown in figure.

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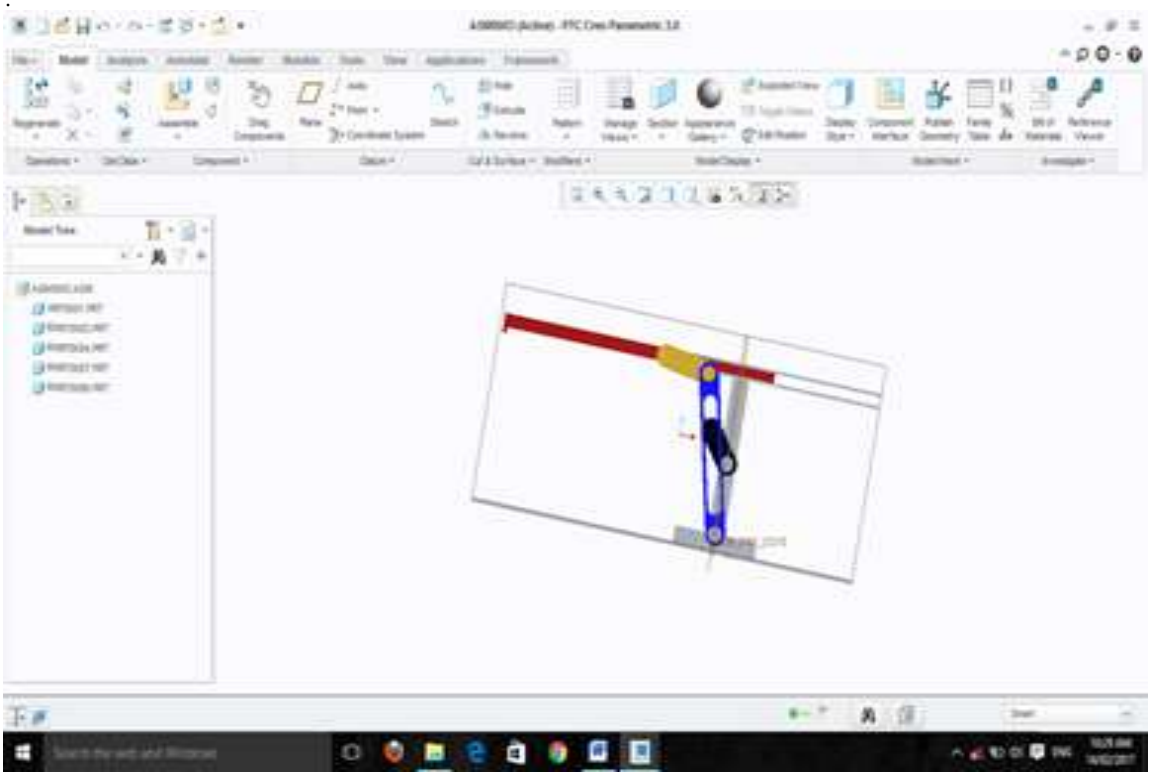

Figure 2: Complete mechanism made in PTC parametric creo 3.0

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The various links made by using some suitable scale are shown in figures below:

FRAME

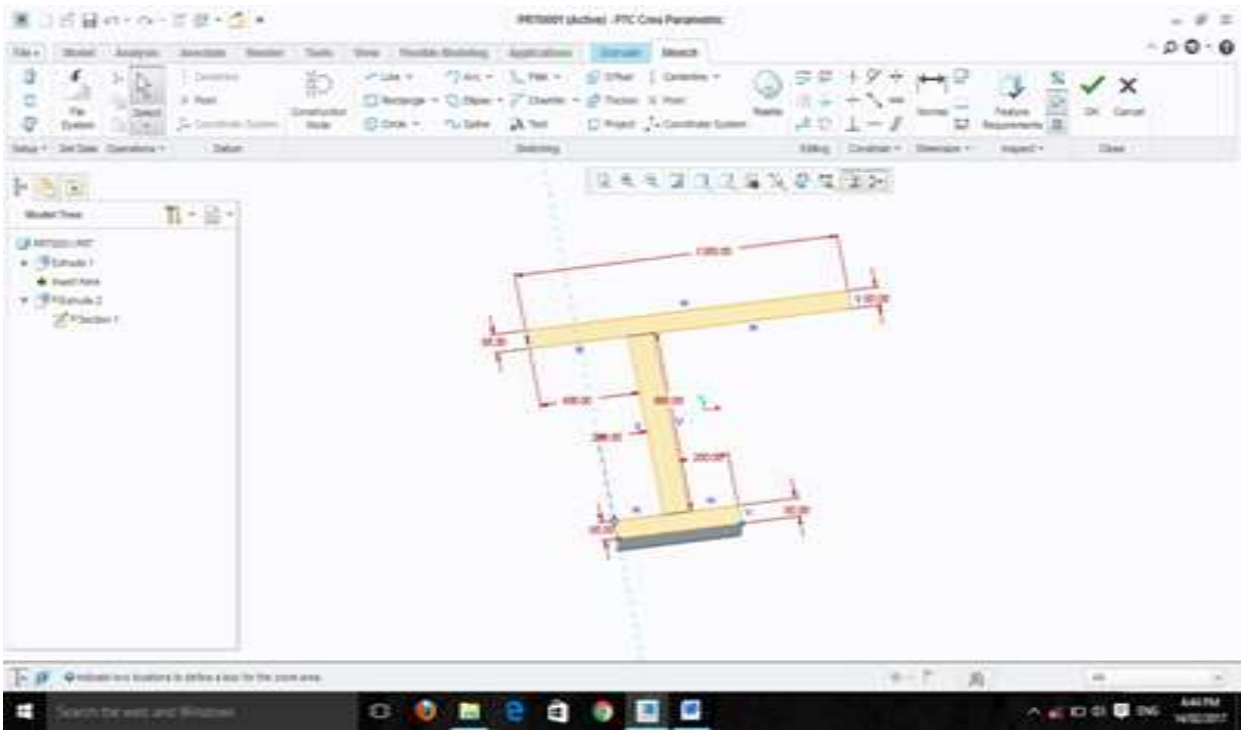

Figure 3: Frame of mechanism

This is the first link of the mechanism which is fixed.

CRANK

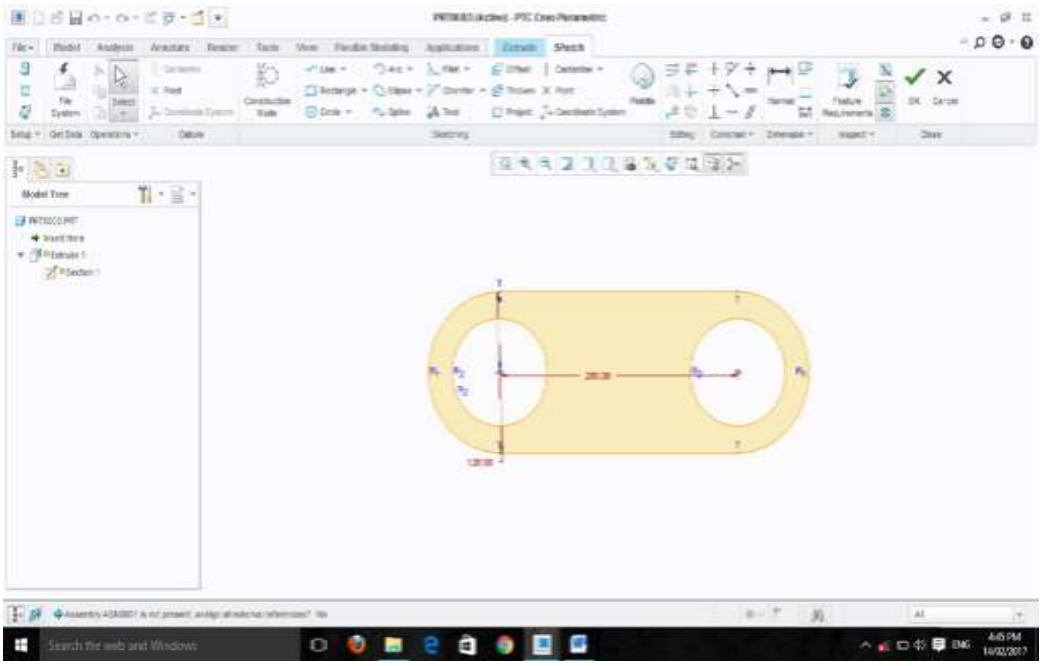

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Figure 4: Crank of mechanism

Crank is the second link of the mechanism. It connects the frame with the connecting rod. The slider is also attached on the crank. When the crank rotates the slider slides in the slot provided in the connecting rod and hence the connecting rod oscillates due to which the ram moves to and fro.

Connecting rod

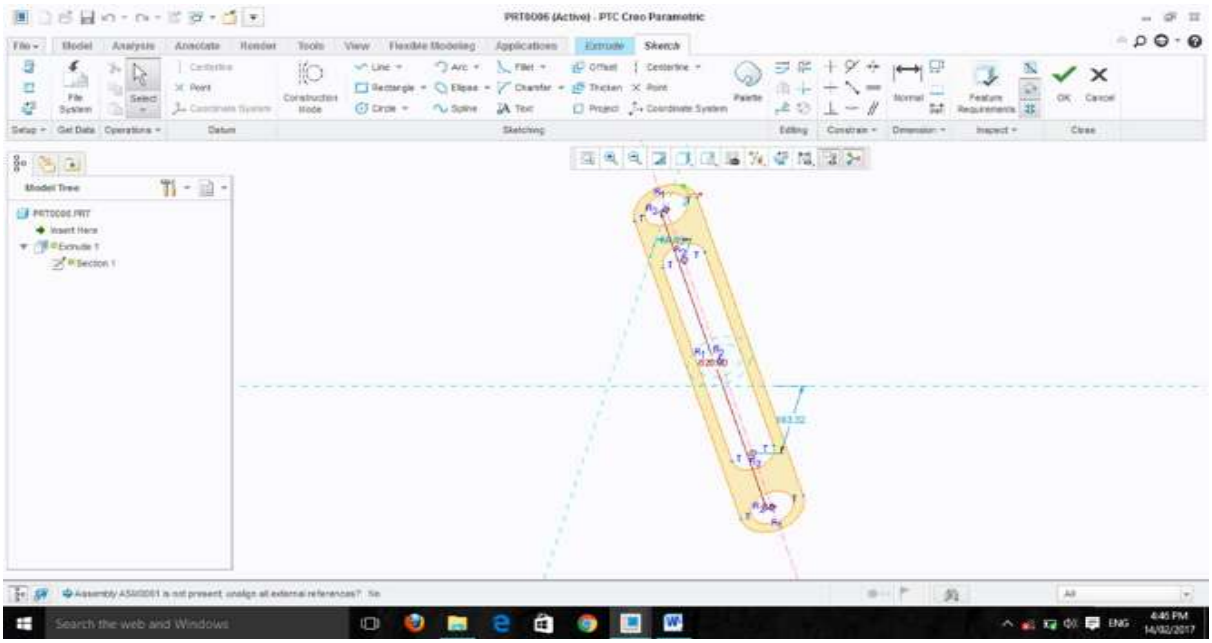

Figure 5: Connecting rod of mechanism

Connecting rod is connected to the lever, which in turn is connected with the slider. It has slot cut on it in which the slider slides.

Slider

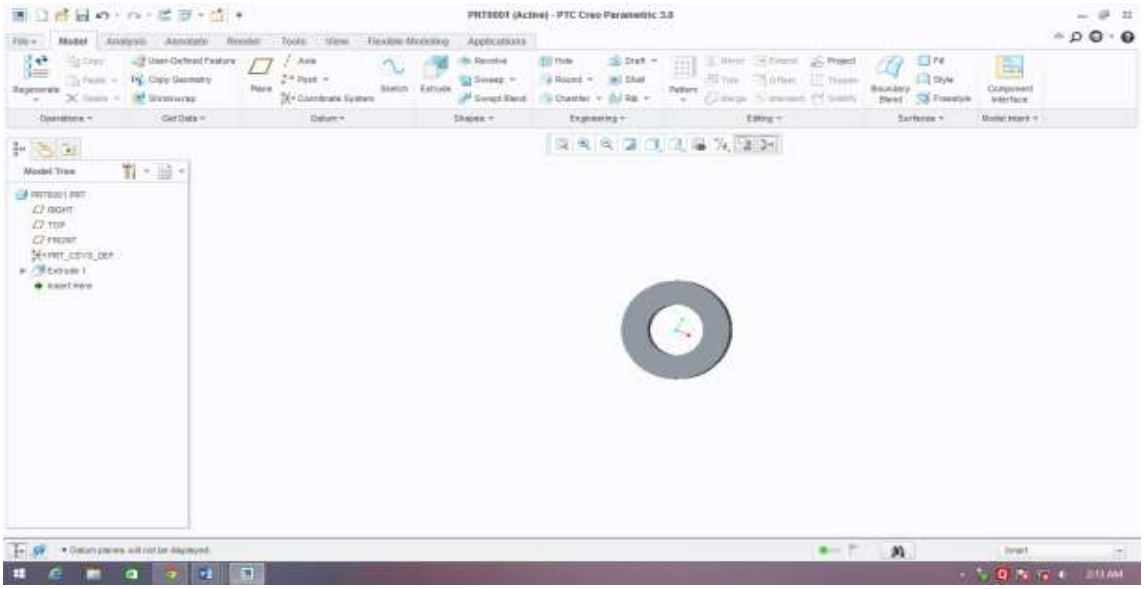

Figure 6: Slider of mechanism

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The slider is connected with the crank and slides in the slot provided in the connecting rod.

FABRICATION

Fabrication is an industrial term refers to building metal structures by cutting, machining and drilling .For the manufacturing and fabrication of these mechanism various tools and machines are used. The tools and machines used are: Radial drilling machine, Lathe machine, Grinding machine, Hammer, screws and adhesive.

The frame of the mechanism is made of wooden. The various links are made of Formica which has very smooth surface. Hence the friction which is main factor of any mechanism or machine is also reduce. The guides in which the slider slides is made up of aluminum due to its light weight

CONCLUSION

From the above analysis it is concluded that for obtaining maximum time ratio, the ratio of the distance between the pivots and crank length should be in between 1 to 1.2. Thus for crank length of 100mm and distance between pivots of 120mm we have calculated the time ratio which is found to be 4.3643 angle turned by crank during return stroke is 67.11^0 This approach will help the designer to synthesize crank and slotted lever quick return mechanism having best time ratio for given length of crank and distance between the pivots.

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