

Term project-1
7-bar hybrid press mechanism

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SECTION I: MODEL SPECIFICATION

SECTION 1.1: PICTORIAL DEPICTION:

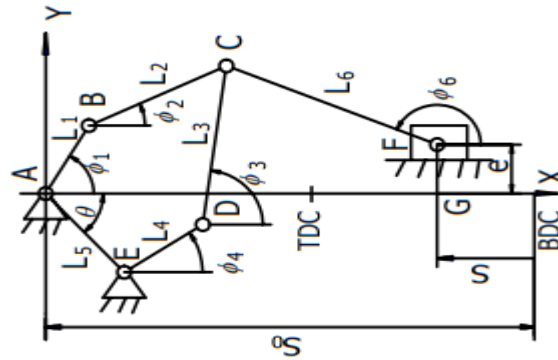


Fig 1(a): 7-bar hybrid press mechanism

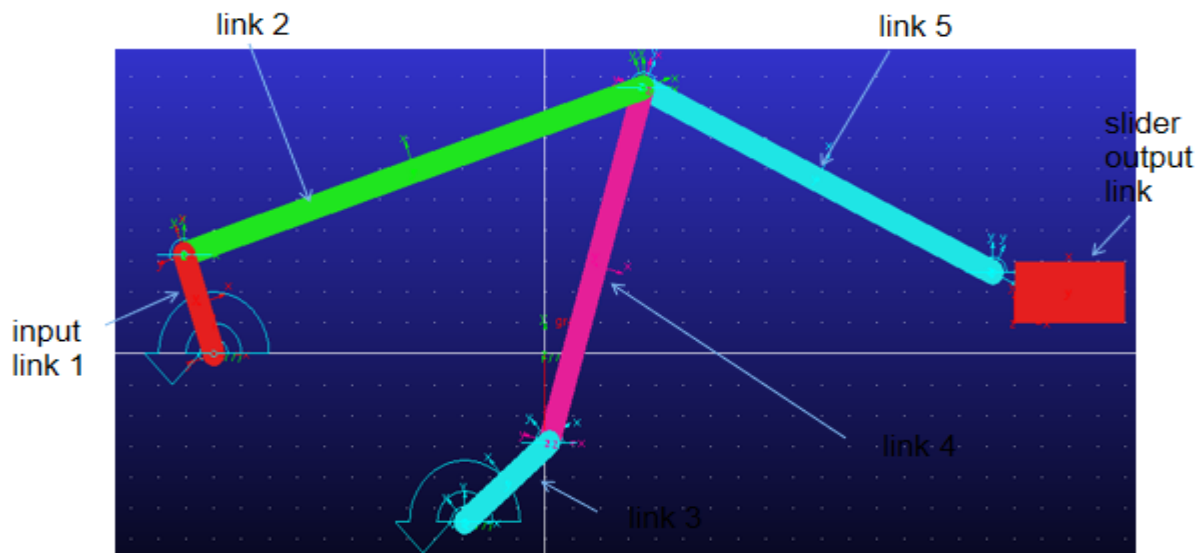


Fig1(b): Front view

Fig1(b):

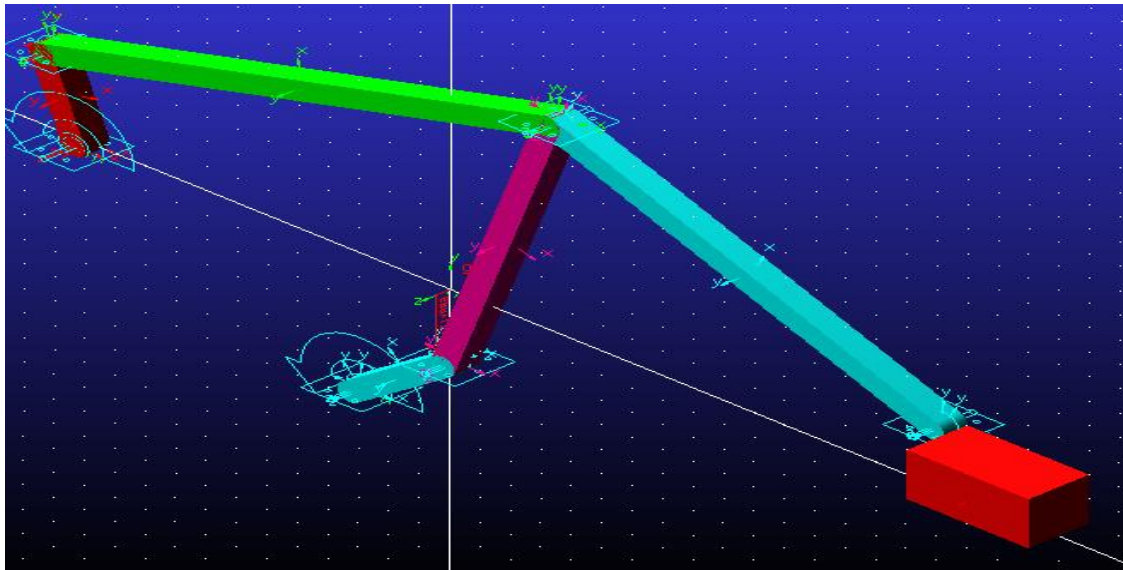


Fig 1(c): isometric view

1.2.1 DIMENSIONS OF EVERY COMPONENT:

All link thickness = 20 mm

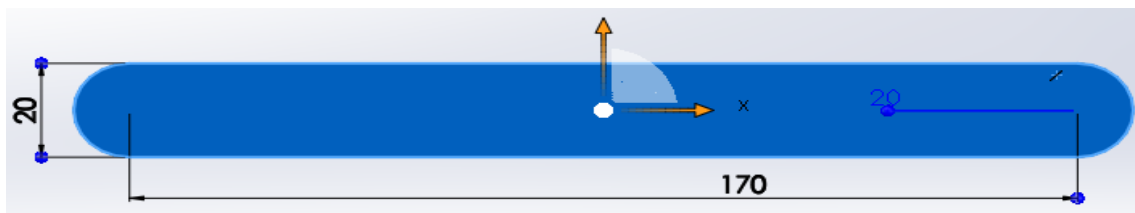


Fig 1.2.1: link 1



Fig 1.2.2: link 2



Fig 1.2.3: link 3

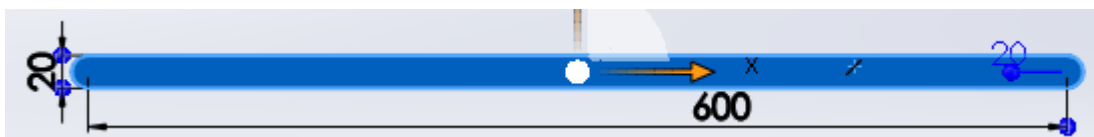


Fig 1.2.4: link 4

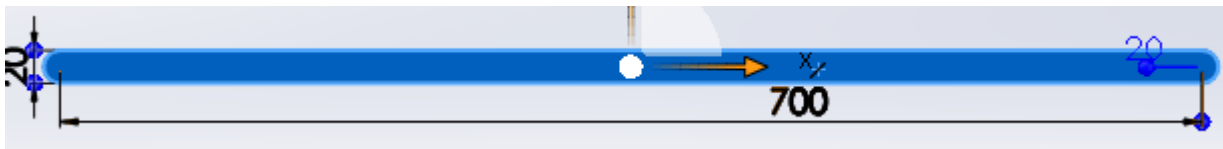


Fig 1.2.5: Link 5

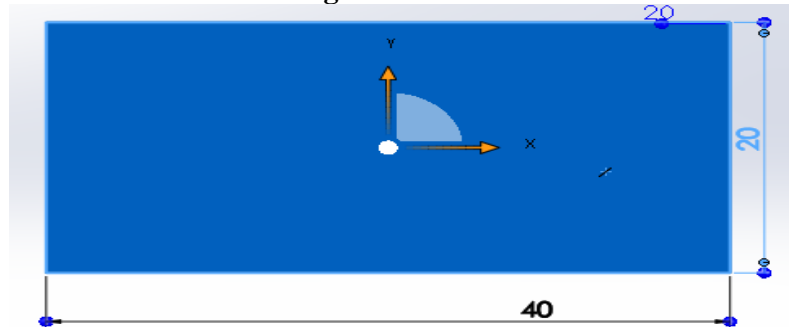


Fig 1.2.6: Slider

SECTION 1.2: GEOMETRY AND MATERIAL:

- All the parts are made of Mild Steel which are later plated. Density = 7800 Kg/mm³
- All the dimensions are in mm.

1.2.2 MASS OF EACH COMPONENT:

Linkage	Mass (kg)
Input link 1	2.5075
Link 2	11.3002
Link 3	2.8820
Link 4	7.8746
Link 5	9.1228
Output link	15.602

1.2.3 MOMENT OF INERTIA OF EACH COMPONENT:

Linkage	MOMENT OF INERTIA (Kg*mm ²)		
	I _{xx}	I _{yy}	I _{zz}
Input link 1	8821.1466	8807.6606	655.2005
Link 2	7.7360854332E+05	7.7359505732E+05	2999.9062420364
Link 3	1.3249698734E+04	1.3236212726E+04	755.053363319
Link 4	2.6241811924E+05	2.6240463324E+05	2.6240463324E+05
Link 5	4.0754150751E+05	4.0752802151E+05	2419.2666938049
Output link	6.5008333333E+04	6.5008333333E+04	2.6003333333E+04

SECTION 1.3 CONSTRAINT:

- In this mechanism link 1 which is input link & link 3 which is other input link is grounded.
- Hear revolute joint given between link 1 & link 2.
- In this mechanism revolt joint given between link 3 & link 4.
- In this mechanism link 2 & link 4 join by revolute joint.
- In this mechanism link 5 join with link 3 & link 4 by ternary revolt joint.
- In this mechanism link 5 join with slider with binary revolt joint.
- Slider which is work as punch in this mechanism.
- Slider motion is our study of interest.

SECTION 1.4 : MOTION TRANSMISSION

1.4.1 : DRIVING COMPONENT:

- In this mechanism there is input motion given at link 1 & link 3.
- Link 1 given higher rotational speed around 90 degree/s.
- Link 2 given lower rotational speed around 5 degree/s.
- Here we give combine motion of 90 degree/s & 5 degree/s.

1.4.2 : COMPONENT WHICH GIVES OUTPUT OF INTEREST:

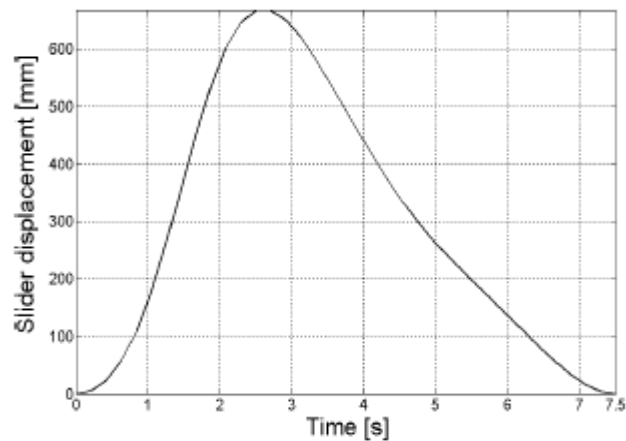
- In this mechanism output motion is given by link 6 which is slider.
- Slider doing quich return translation motion so it act as punch in press.

SECTION 2: KINEMATIC SIMULATION:

SECTION 2.1: OUTPUT COMPONENT:

2.1.1 SIMULATED AND EXPECTED DISPLACEMENT PROFILE OF OUTPUT COMPONENT:

EXPECTED DISPLACEMENT PROFILE:

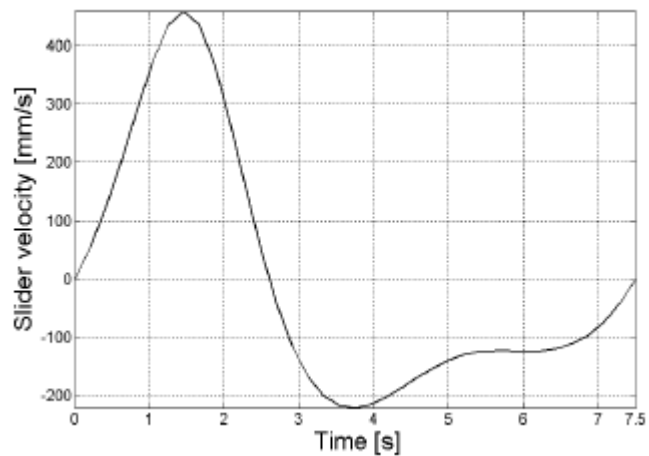


SIMULATED DISPLACEMENT PROFILE:

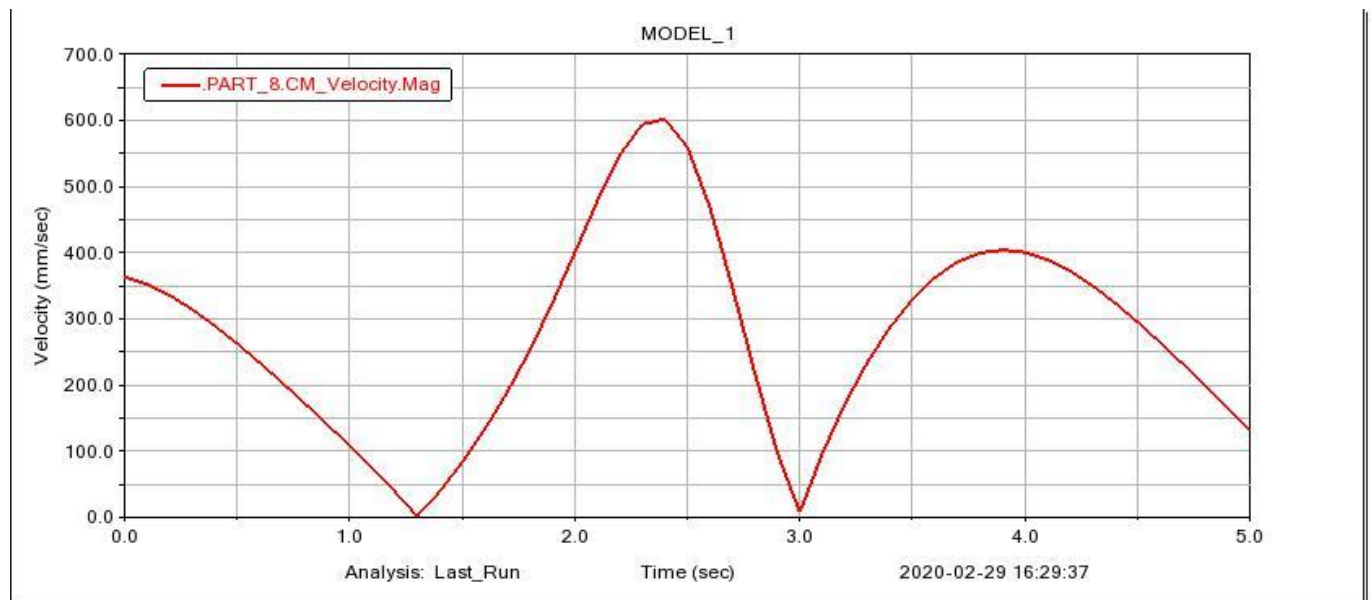


2.1.2 SIMULATED AND EXPECTED VELOCITY PROFILE OF OUTPUT COMPONENT:

EXPECTED VELOCITY PROFILE:

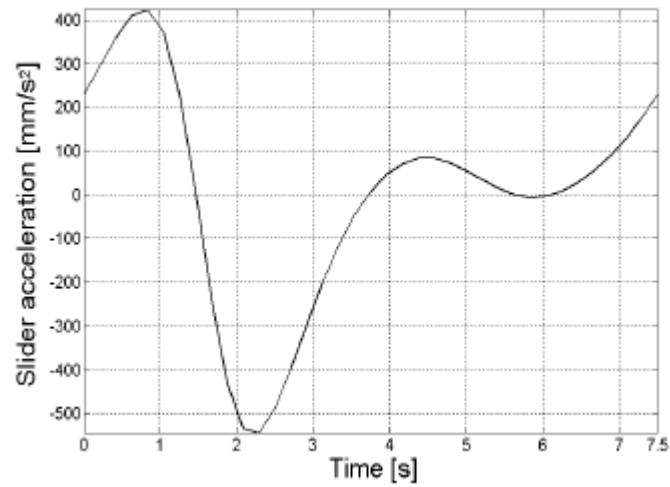


SIMULATED VELOCITY PROFILE:

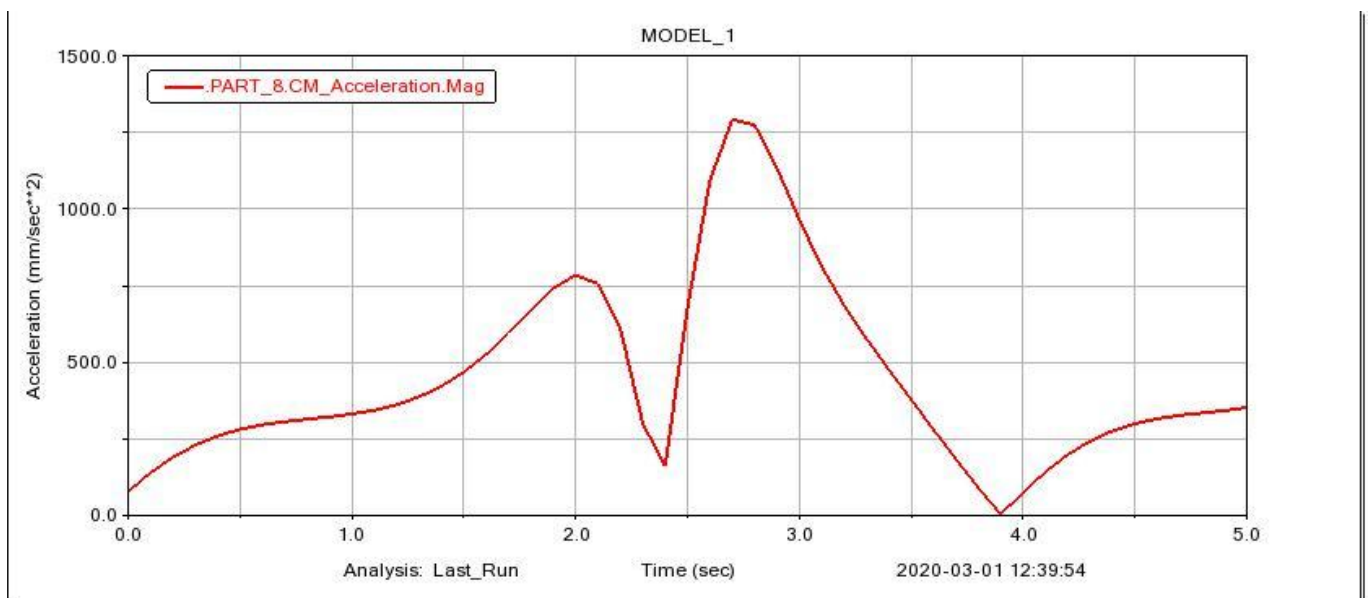


2.1.3 SIMULATED AND EXPECTED ACCELERATION PROFILE OF OUTPUT COMPONENT:

EXPECTED ACCELERATION PROFILE:



SIMULATED ACCELERATION PROFILE:



2.1.4: COMMENTS:

1. Simulated Displacement profile follows the expected displacement profile as shown above.
2. Here different between simulated & expected displacement profile is only direction of motion e.g., in expected motion rotation of input link is ccw when in simulated motion rotation of input link is cw. So we can see different displacement profile.
3. In simulated velocity profile velocity decrease first & reach zero value, after reaching zero value decrease then rapidly increase so it clearly show quick return motion.
4. Here it clear that velocity decrease show punching operation & zero velocity show end of punching operation & increase velocity show return stock.
5. Here difference show in simulated & expected velocity because of as given input in direction of input motion as mention in displacement.
6. Here in simulated acceleration profile acceleration increase very slowly reach maximum & after that decrease rapidly after that again it increase it reached maximum value which around 800 mm/s^2 this happen because of 2 input motion.
7. 800 mm/s^2 value acceleration occur during return stock. Here expected & simulated acceleration profile not match with each other.

SECTION 2.2: SENSITIVITY ANALYSIS:

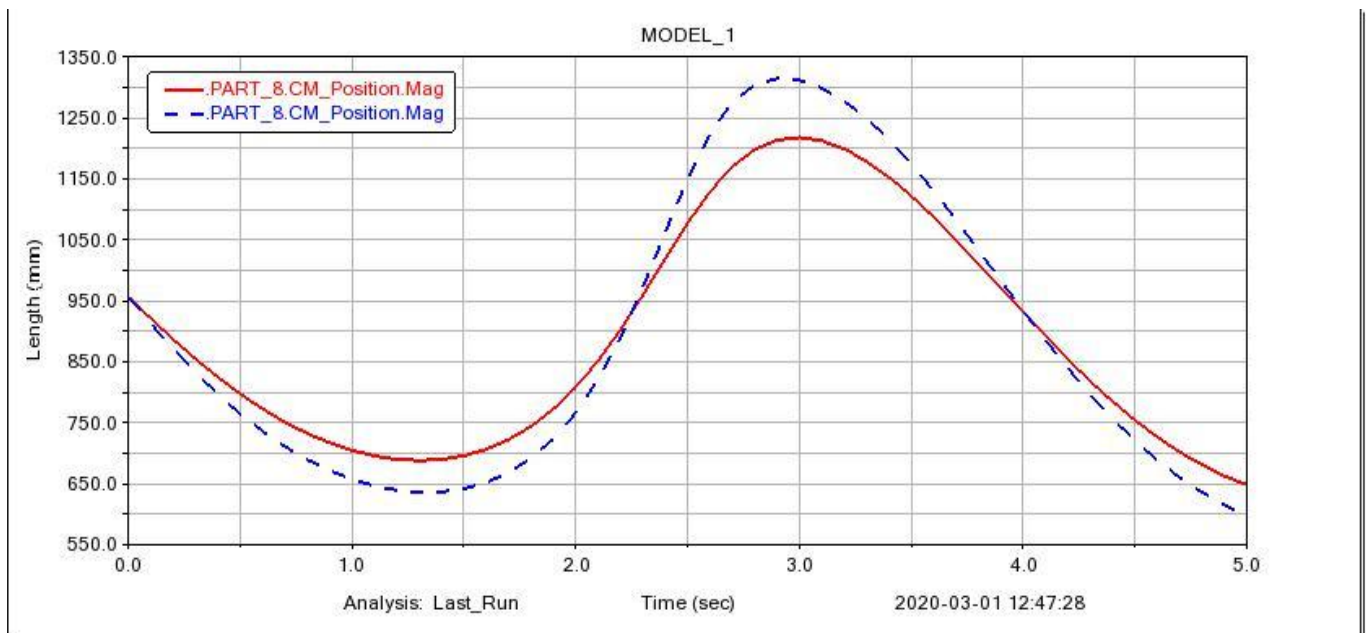
Here we will check the sensitivity of the kinematic parameters of the output component to small changes in the dimensions of the two other components.

Components whose dimensions we are changing slightly:

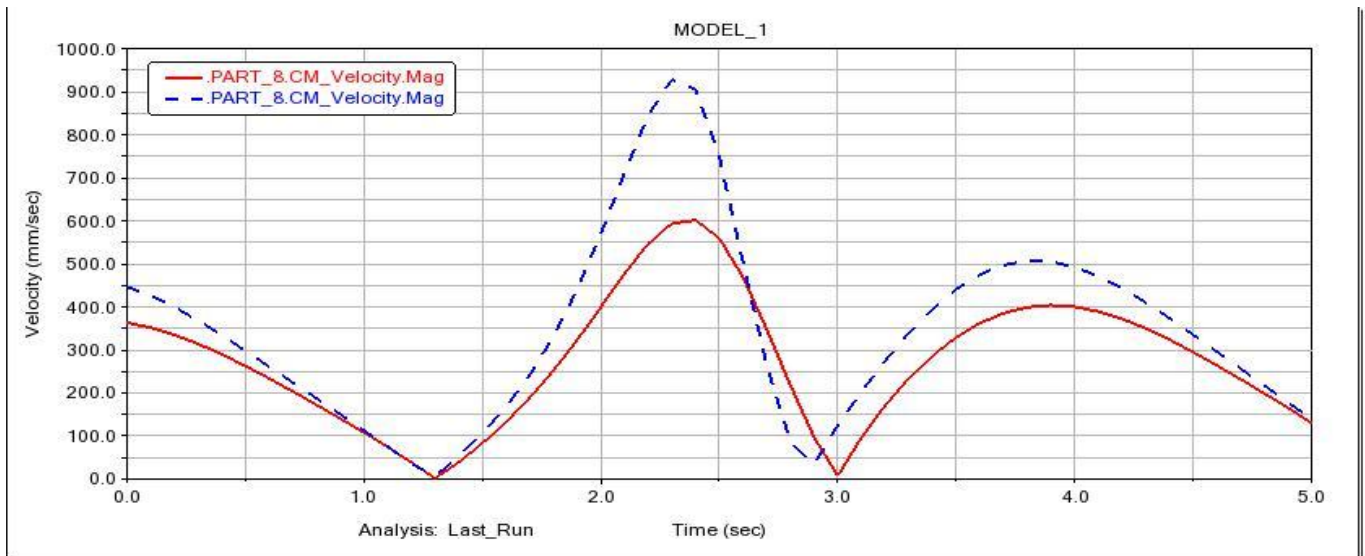
1. Input link 1: Here in input link we have center to center distance of both ends is 170mm. we changing it to 220 mm for sensitivity analysis.
2. Link 2: Here in link 2 we have center to center distance of both ends is 874.5 mm. We are changing it to 889 mm for sensitivity analysis.

2.2.1 DISPLACEMENT PROFILE OF OUTPUT COMPONENT AFTER CHANGING DIMENSIONS OF OTHER TWO COMPONENTS AND ORIGINAL DISPLACEMENT PROFILE:

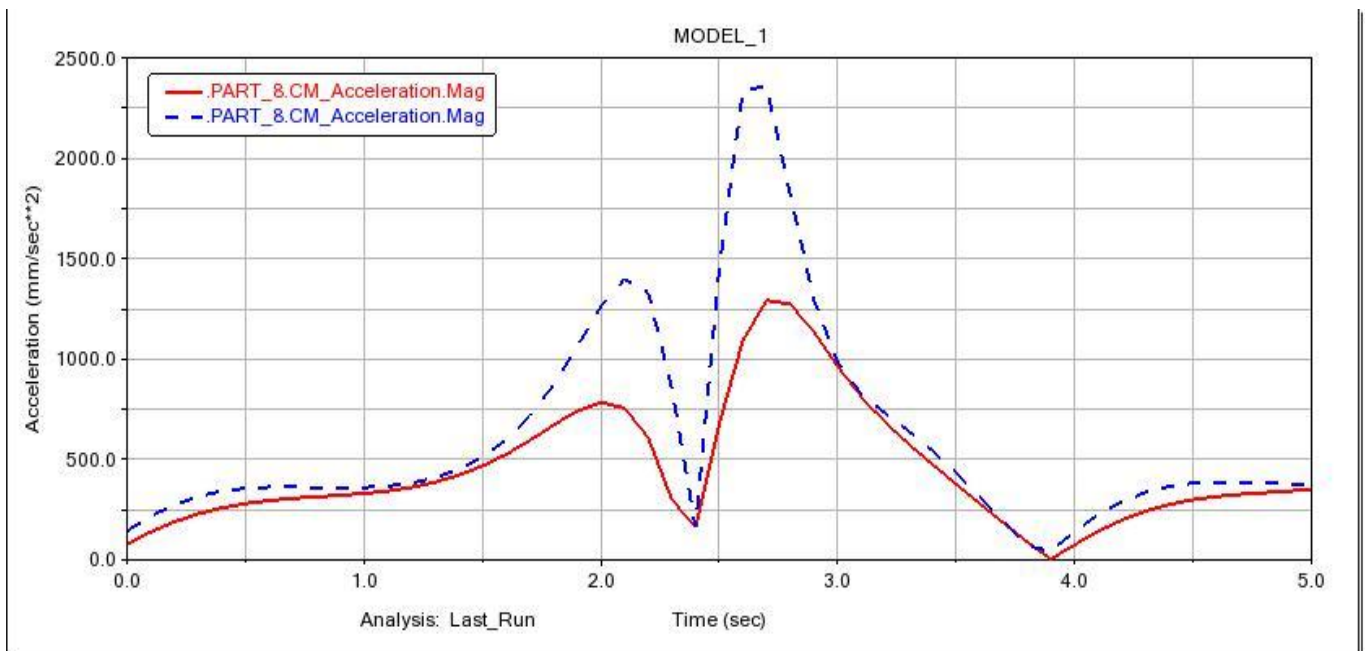
Here red solid line: analysis original dimension blue - line: analysis with dimension change



2.2.2 VELOCITY PROFILE OF OUTPUT COMPONENT AFTER CHANGING DIMENSIONS OF OTHER TWO COMPONENTS AND ORIGINAL VELOCITY PROFILE:



2.2.3 ACCELERATION PROFILE OF OUTPUT COMPONENT AFTER CHANGING DIMENSIONS OF OTHER TWO COMPONENTS AND ORIGINAL ACCELERATION PROFILE:



SECTION 2.3: ANALYSIS OF JOINT CLEARANCE:

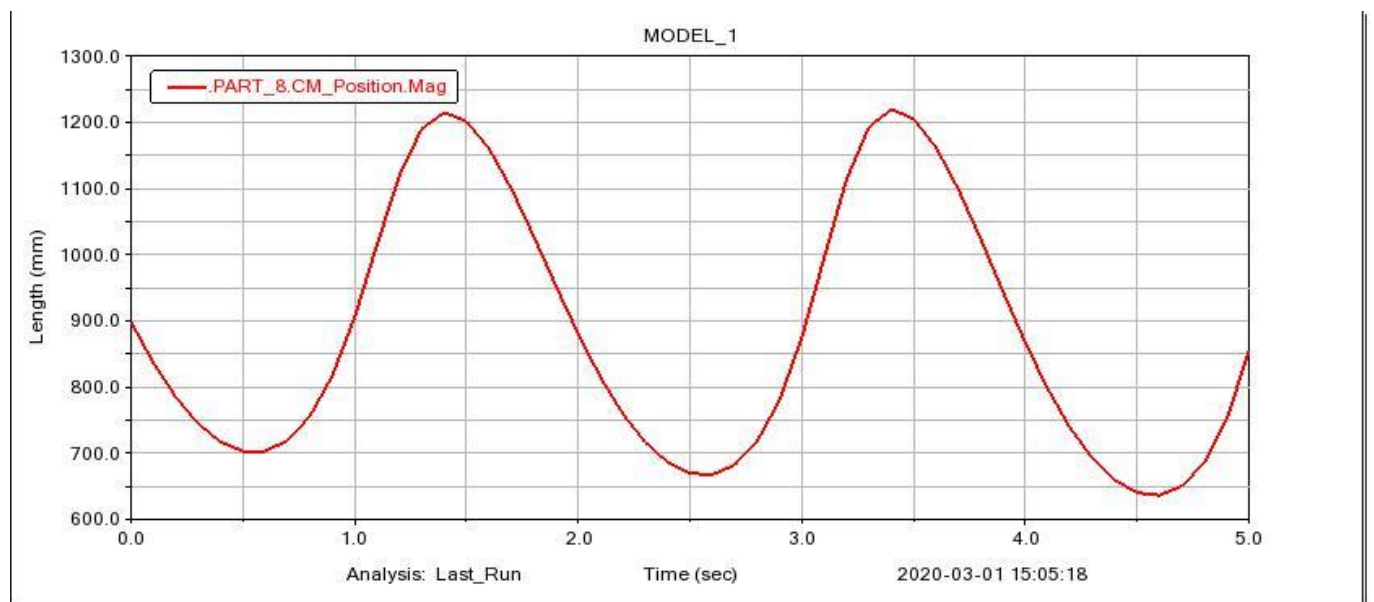
Here in this part, we check the effect of clearance on the motion parameters of output component.

We will give clearance on input link 1 i.e. the end connected to link 1 and link 2. The inner diameter of the link 1 end is 6mm. now we are changing it to 9mm to see the effect of clearance on output component.

2.3.1 SIMULATED DISPLACEMENT PROFILE OF MECHANISM WITH CLEARANCE AT NORMAL SPEED:



2.3.2 SIMULATED DISPLACEMENT PROFILE OF MECHANISM WITH CLEARANCE AT HIGH SPEED:

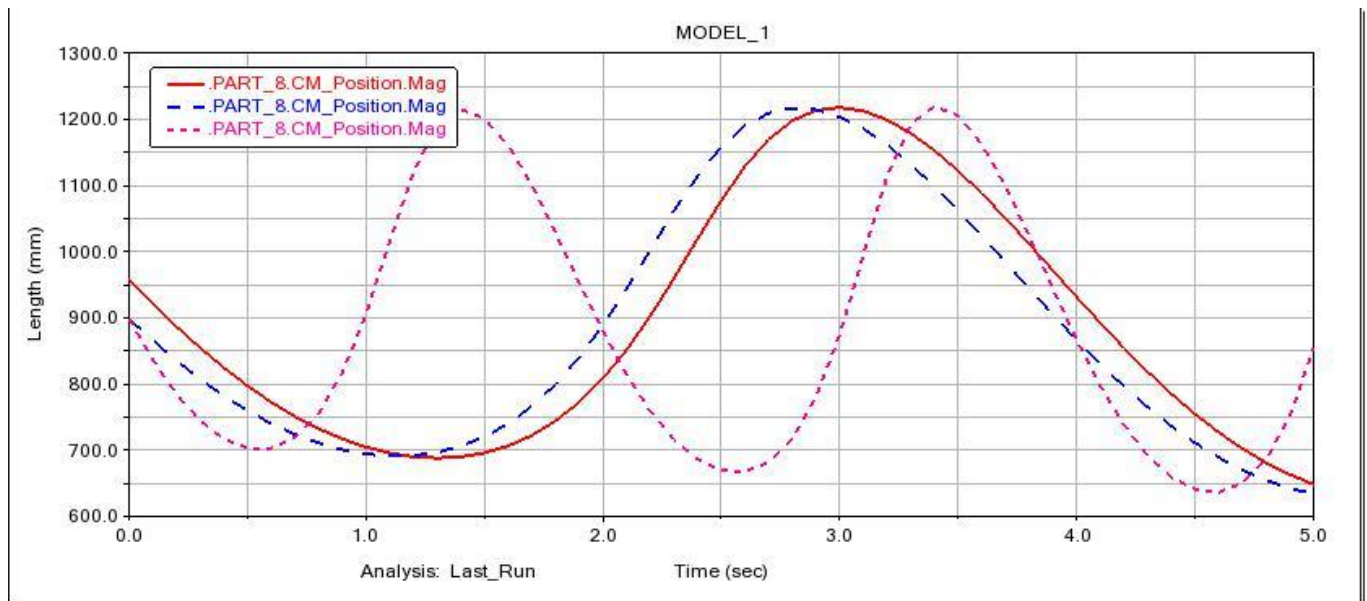


2.3.3 SUPERIMPOSED PLOT OF SIMULATED DISPLACEMENT PROFILE OF MECHANISM WITH CLEARANCE AT NORMAL SPEED, HIGH SPEED AND NORMAL SPEED WITHOUT CLEARANCE:

Here red line: normal speed without clearance

Blue line: normal speed with clearance

Pink line: high speed with clearance



Section 3.1 Theoretical evaluation of kinematic parameters

Whole kinematic diagram of mechanism is drawn and then distance between fixed link and output slider. When crank is at its zero degree



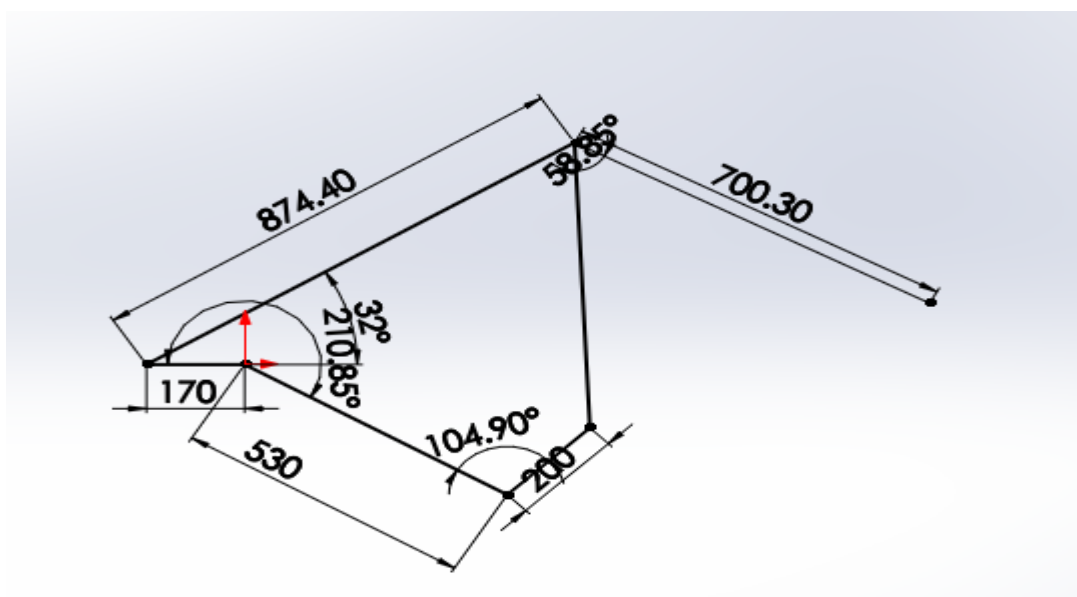


Fig 3.3 displacement at 180 degree

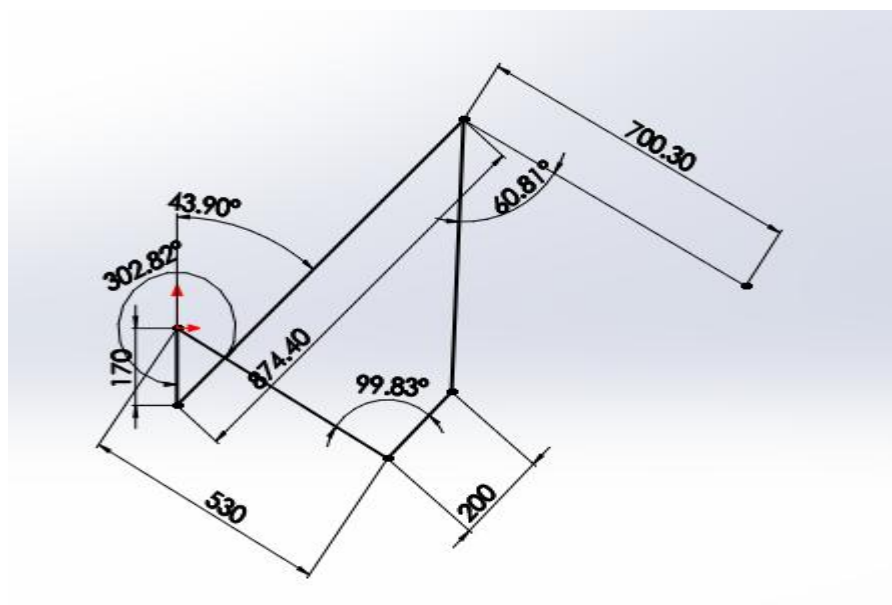
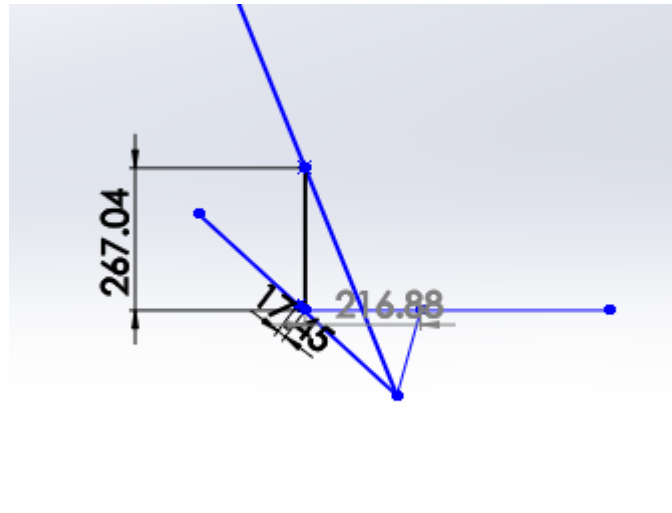
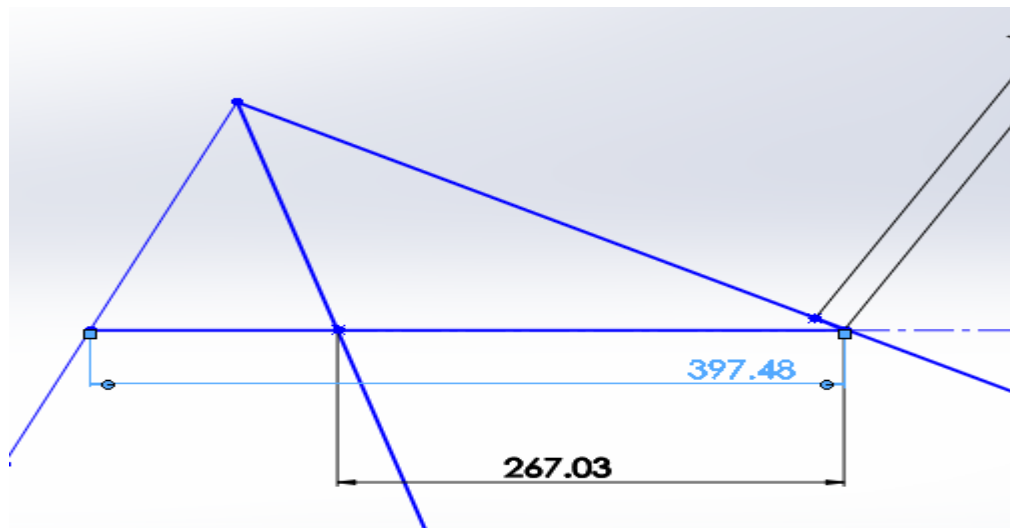


Fig 3.4 Displacement at 270 degree

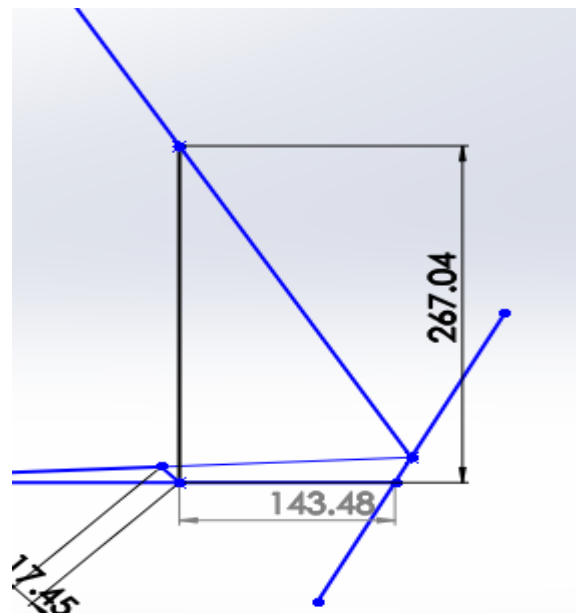
2) Velocity analysis by graphical method



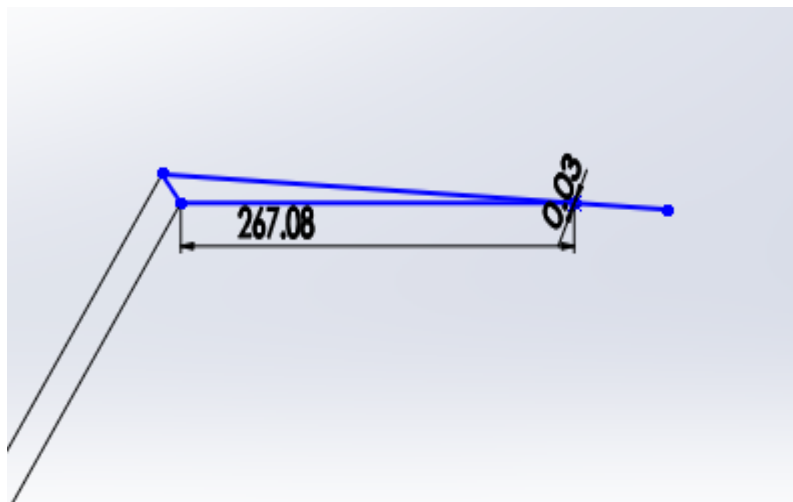
Velocity diagram at 0 degree



Velocity diagram at 90 degree



Velocity diagram at 180 degree

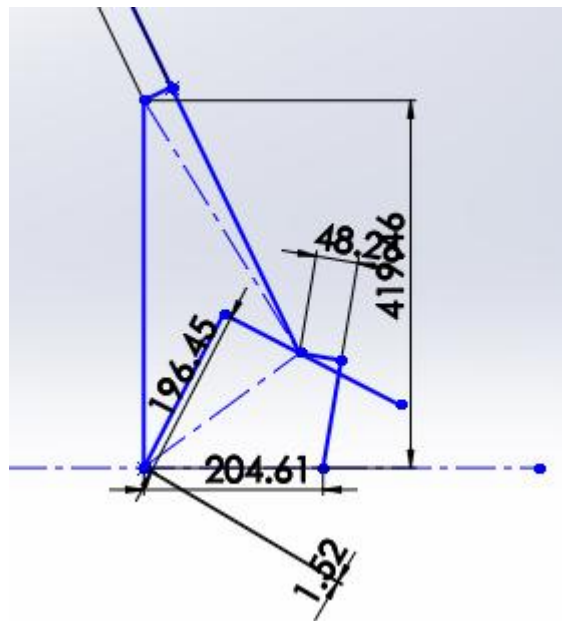


Velocity diagram at 270 degree

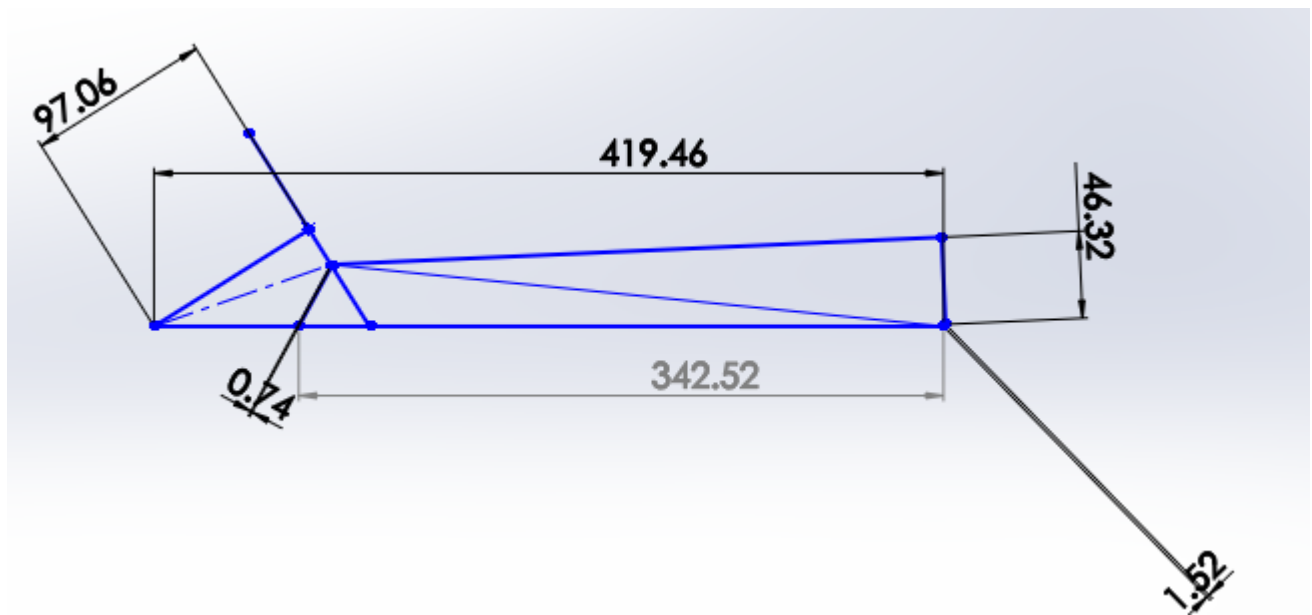
Acceleration analysis by graphical method:



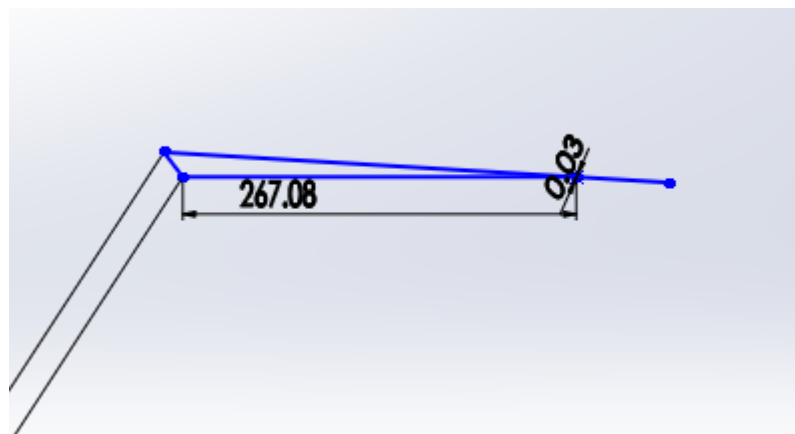
Acceleration diagram at 0 degree



Acceleration diagram at 90 degree



Acceleration diagram at 180 degree



Acceleration diagram at 270 degree

Section 3.2: Comparison Of Kinematic Parameters

Section 3.2.1: The Four Values Of Displacement Evaluated In Section 3.1 Superimposed In The Plot Of Section 2.1.1.



validation of simulated and calculated displacement graph

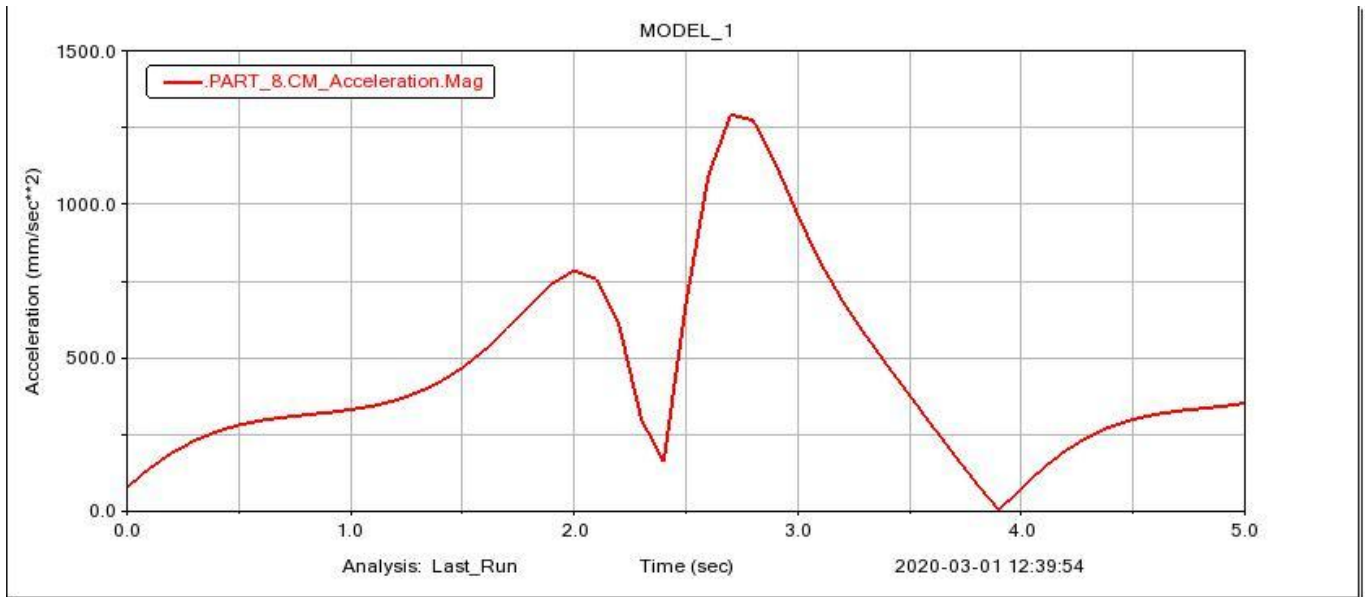
Note: blue dots are values gained by graphical method

Section 3.2.2 The four values of velocity evaluated in section 3.1 superimposed in the plot of section 2.1.2



validation of simulated and calculated velocity graph

Section 3.2.3 The four values of acceleration evaluated in section 3.1 superimposed in the plot of section 2.1.3



validification of simulated and calculated acceleration graph

Section 3.2.4 Comments

degree	Displacement			velocity			Acceleration		
	simulated	calculated	error (%)	simulated	calculated	error (%)	simulated	calculated	error (%)
0	732.4258	733.11	0.1	172.54	143.48	15.84	314.5173	342.5173	8.9
90	743.8889	747.70	0.52	252.0306	267.08	5.97	742.416	779.88	4.9
180	1197.81	1196.48	0.1	218.438	216.88	0.9	1274.84	1238.52	2.8
270	1011	1014.41	0.4	399.1973	397.48	0.66	90.8767	100.45	11.1

There is difference in the values obtained from simulation and the calculation. For most of the points in displacement profile, error is less than 20%. For acceleration and velocity, error is higher comparatively because velocity diagram is made using displacement and acceleration diagram is made using velocity diagram which themselves have some error. So the error gets compounded in each calculation

