Design Of Wind Shield wiper mechanism with minimum torque and shaking Forces

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MOTIVATION

The current wind shield wiper mechanisms cannot be used in the newly designed light weight military vehicles due to their high shaking forces when run at high speeds

Problem Definition:

weight of the wiper blade :20lb
wind load on blade :50lb
coefficient of the friction :0.9
angle to be swept by blade :90

Goal Statement:

Designing a sophisticated wind shield wiper mechanism with minimum torque requirement and shaking forces

Performance Specifications:

wind shield dimensions = 1.5m*0.75m

wind load on the blade perpendicular to wind shield =220N

coefficient of friction between blade and shield =0.9

General motor specifications for wind wiper mechanism:

No load speed	70+_10 rpm
Rated speed	50 ± 15 rpm
Rated torque	≥ 8.0 N-m
Rated voltage	12-24 V
Rated current	≤ 8.0 A
Stall current	≤ 25 A

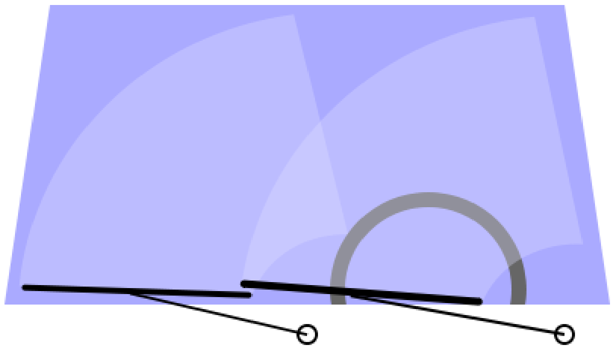
Background Research

What is a Wind Shield Wiper?

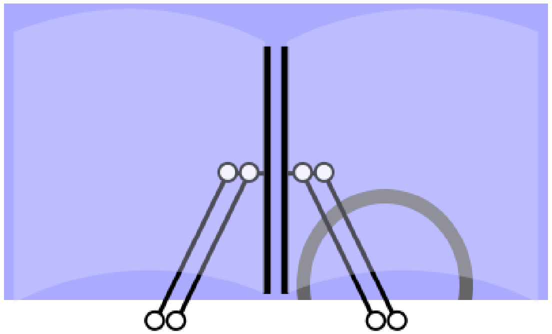
- A windscreen wiper or windshield wiper is a device used to remove rain, snow, ice and debris from a windscreen or windshield
- A wiper generally consists of a metal arm, pivoting at one end and with a long rubber blade attached to the other.

Types of Wind Wiper Arms:

1. Radial



2. Pantograph

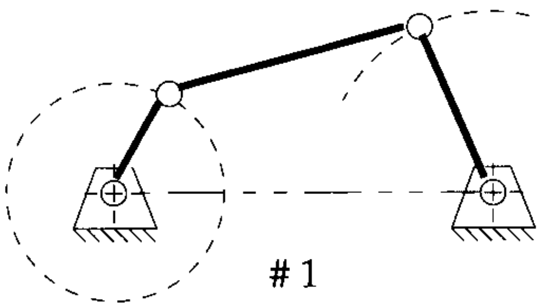


Most wipers are of the radial type, they are attached to a single arm, which in turn is attached to the motor. Pantograph wipers feature two arms for each blade, with the blade assembly itself supported on a horizontal bar connecting the two arms.

Mechanism of Wind Shield Wiper

- Most commonly used mechanism is 4-bar linkage mechanism and type of mechanism is crank-rocker mechanism with input link being the smallest link.
- Most widely used types of operation are single-lever systems and double-lever systems.

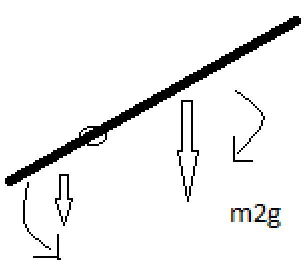
Crank-Rocker mechanism



- Input crank must be smallest for complete rotation
- Output rocker motion is subjected to equal forward and backward motion time

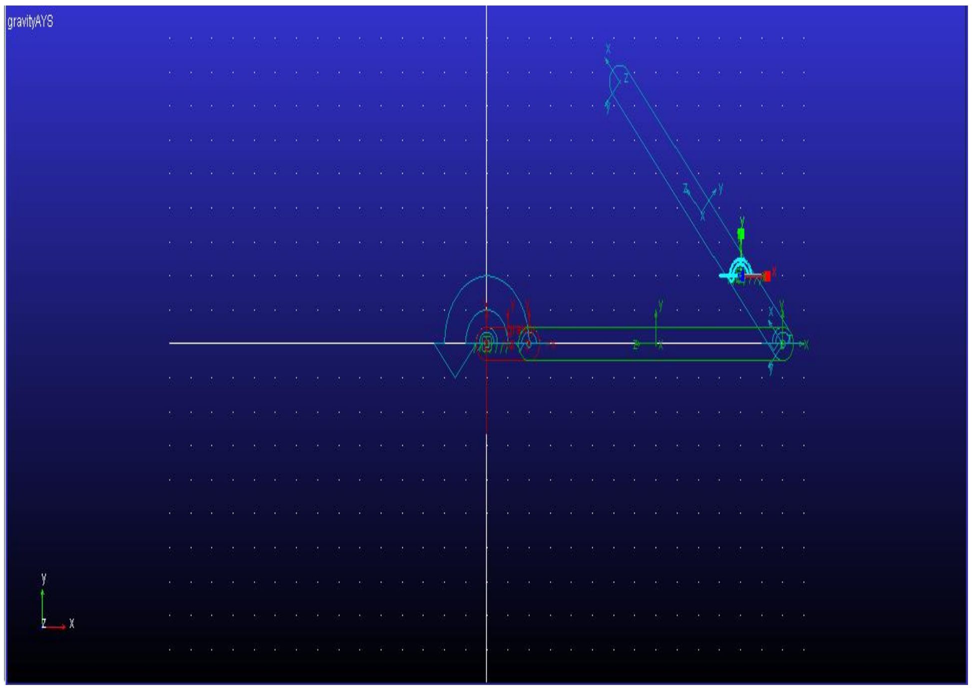
Bench Marking:

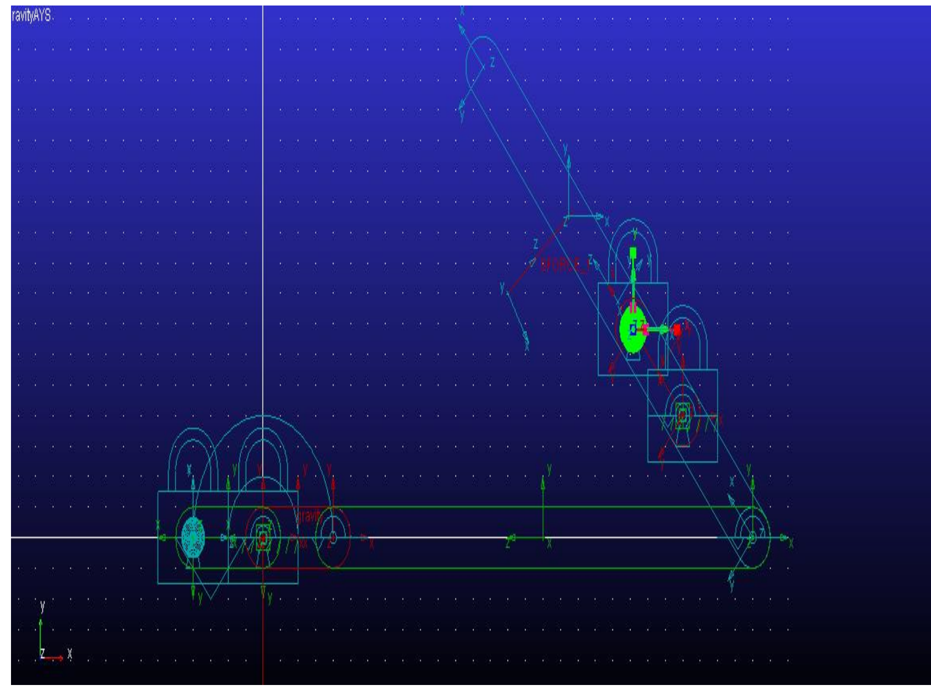
- Minimizing the torque by adding counter weight
- Using the slider to cover maximum swept area



Ideation And Proposed Design:

- Minimizing torque requirement
- Minimizing shaking forces
- Maximizing Swept Area

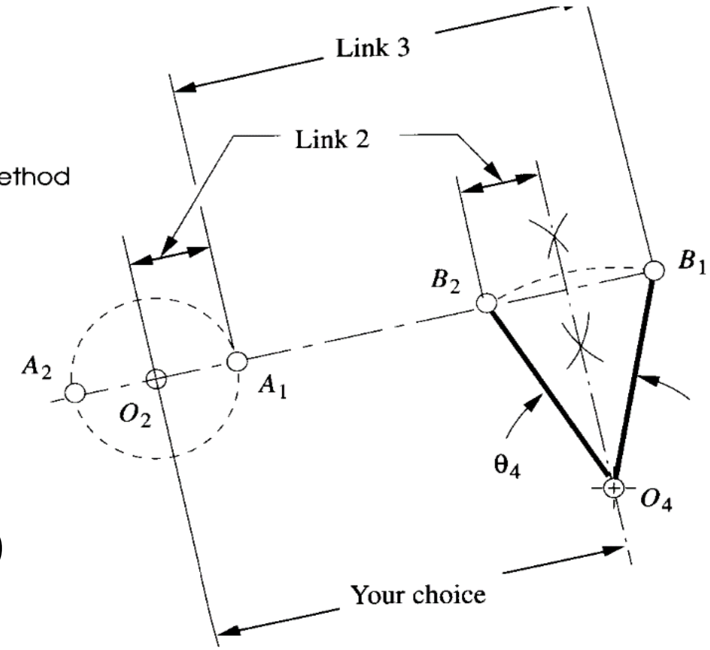




Initial unbalanced design

Proposed design after balancing

Preliminary Analysis



Linkage Synthesis:

-Number of DOF=1 (Angular Disp.=90)

-Min no. of links to produce 1 DOF= 4

- Link lengths(cm): ground= 60; L2=10; L3=60; L4=14.44, L5=40
- Material used : stainless steel(density=7888.77 kg/m^3)
- Link masses(Kg) : m2=0.27 ; m3=2.02; m4=0.44
- After balancing the masses added at radius are mentioned below
- Radius at which extra mass added = .10 m
- Masses added(Kg): M2= 0.8750, M4 = 1.1363

Torque requirement for wiper blade:

Torque on blade , τ =rxF

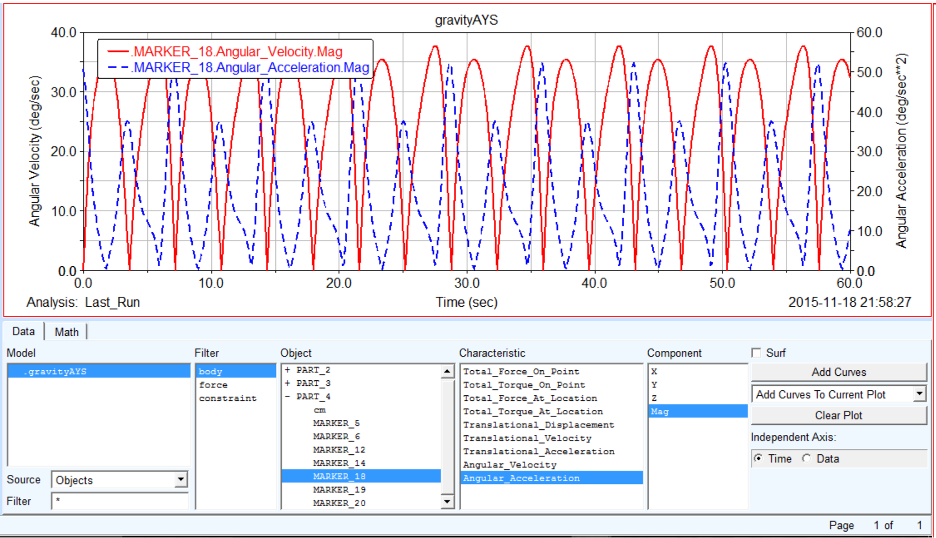
normal force on the blade, F= 222.411N

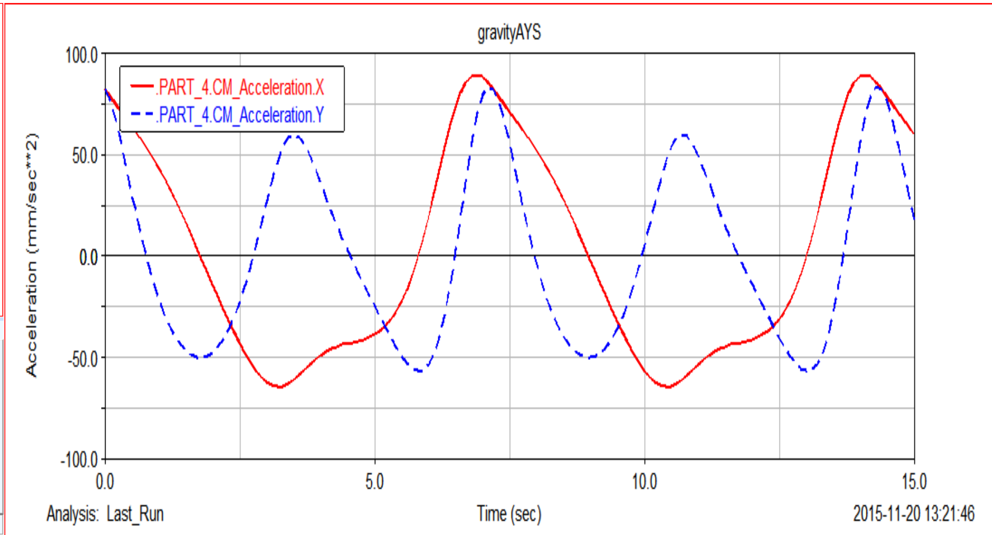
frictional force, $f = F * 0.9$

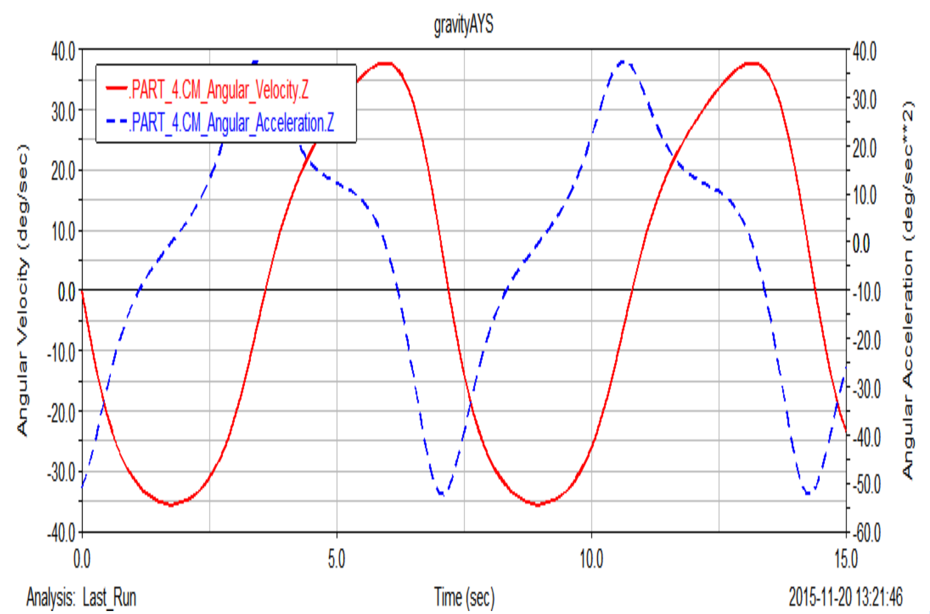
Torque due to frictional on the wiper = $\int_0^R F * 0.9 * r.dr = 16.013Nm$

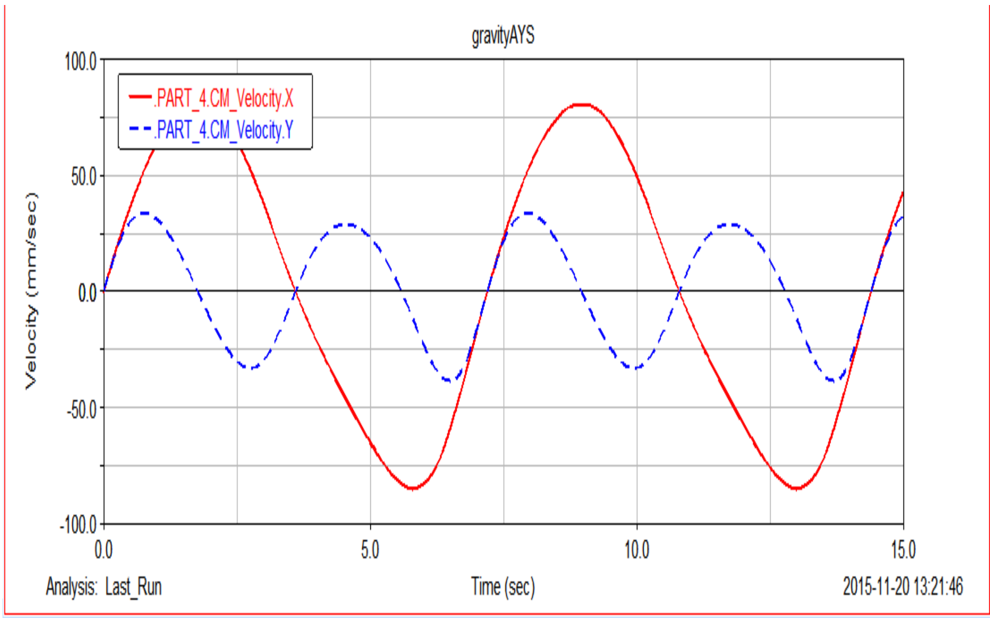
Detailed Analysis

Kinematic (velocity and Acceleration analysis)



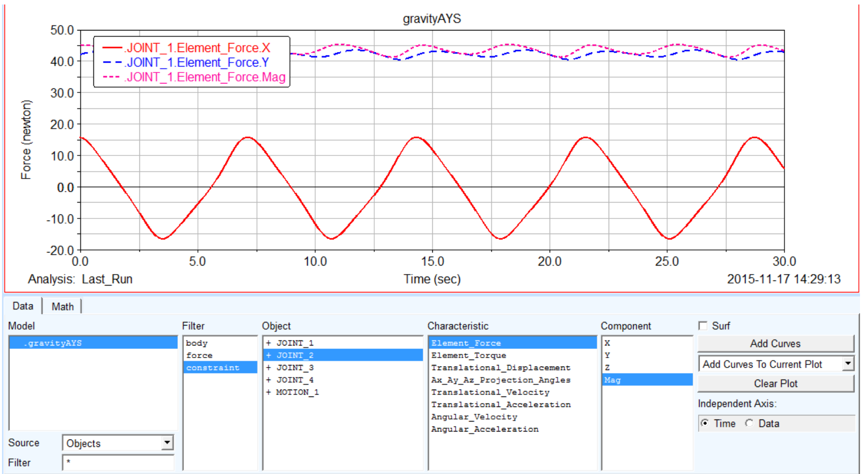




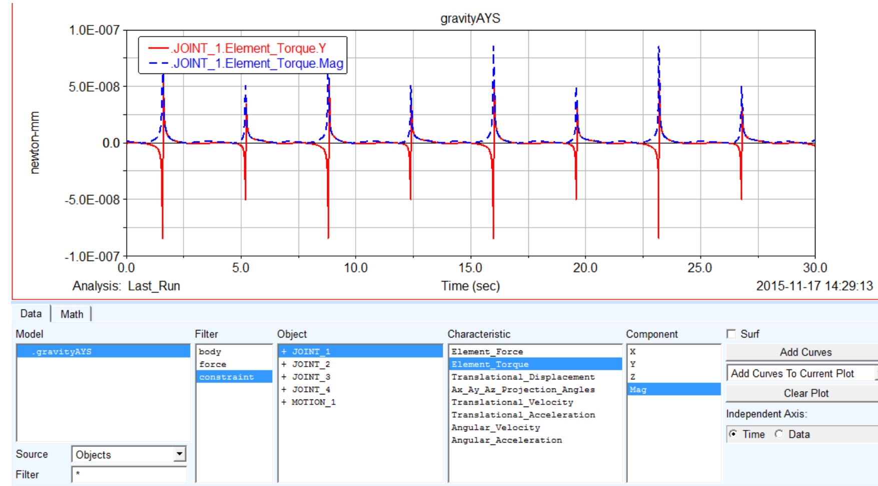


Detailed Analysis

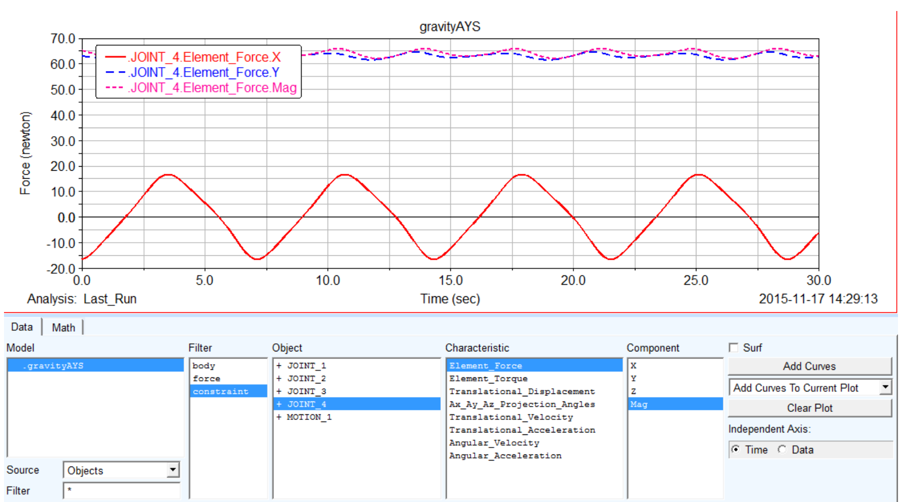
Unbalanced



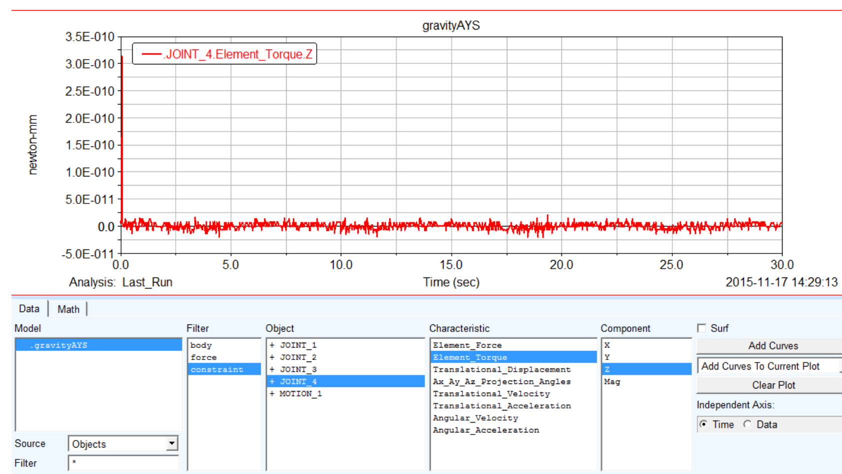
Pin1 forces



Pin1 Torque



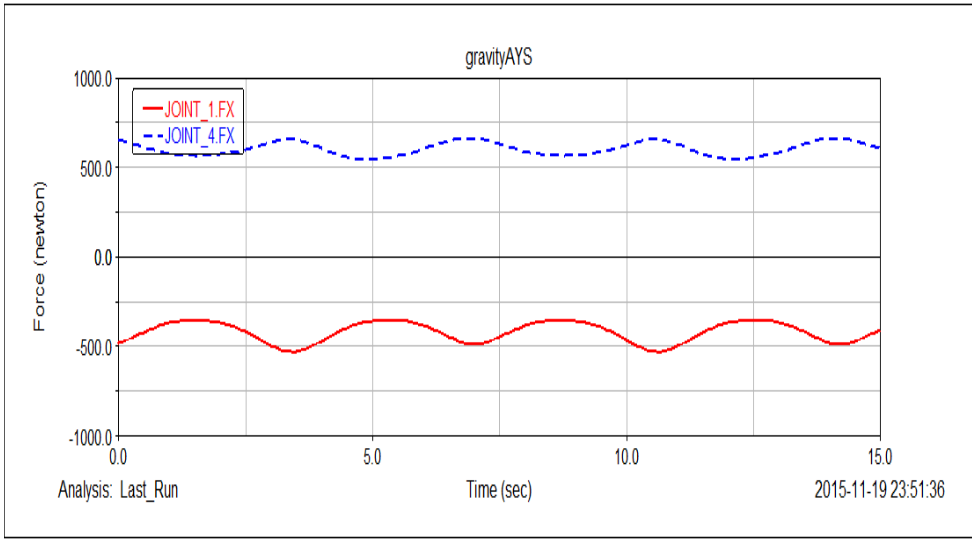
Pin4 forces

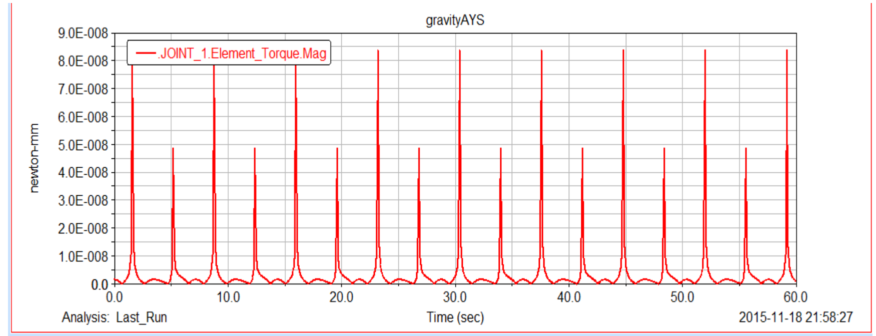


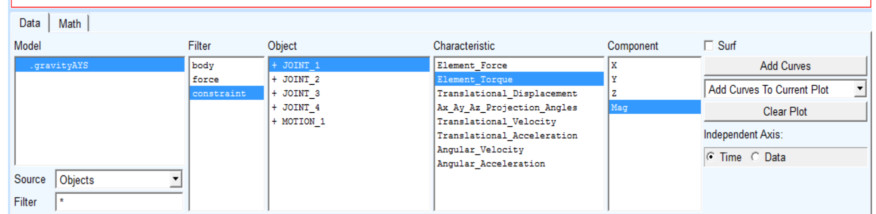
Pin4 Torque

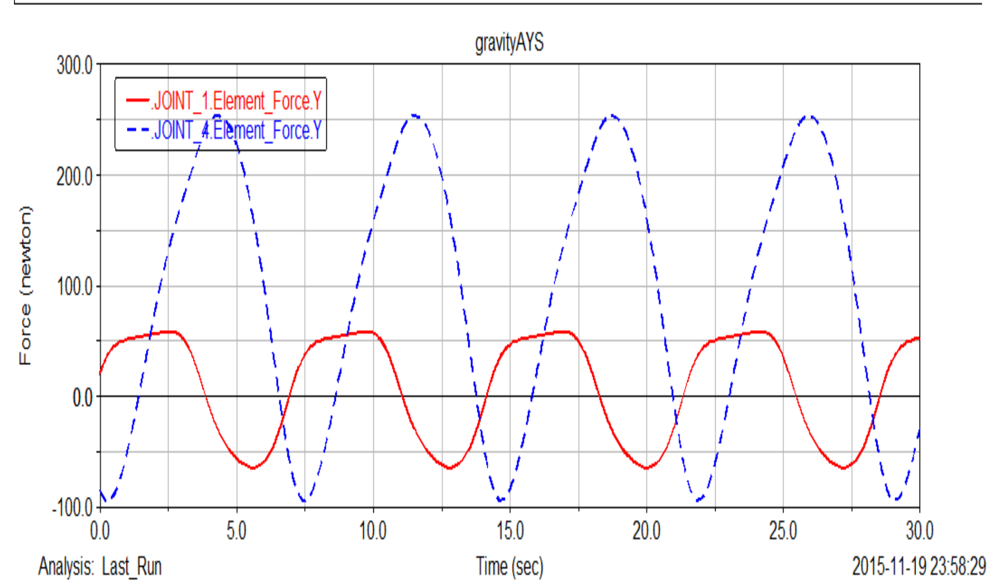
Detailed Analysis

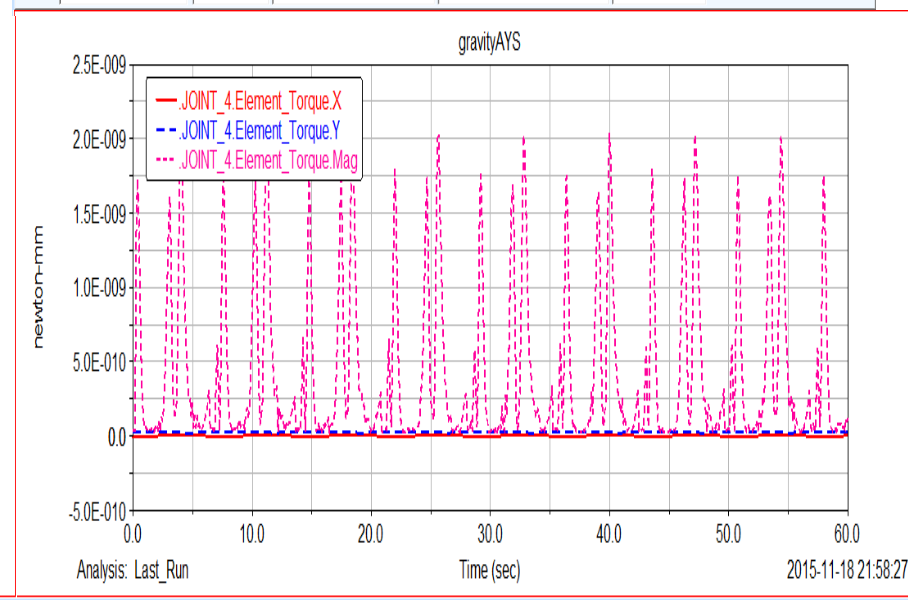
Minimizing Shaking force And Torque











Concluding Remarks

- Shaking forces have been minimized
- Shaking moments can be minimized by adding the gears (gear ratio=-1) to the crank and rocker
- Mass moment of inertia for gear2, I2= 0.0258 Kg.m^2
- Mass moment of inertia for gear4, I4=0.0399Kg.m^2

Contribution of each group member

- Kinematic analysis in ADAMS – Jaideep
- Dynamic analysis and Balancing in ADAMS- Vinay Reddy, Aswanth
- Solving Balancing equations using matlab – Aswanth
- Linkage synthesis (determining mass and lengths of links- Vinay Reddy)

Week	Task	
Week 1	Determining link masses and lengths Position analysis, toggle position analysis solid works modelling	(Jaideep) (Aswanth) (Vinay)
Week 2	Kinematic analysis ADAMS simulation(without masses)	(Vinay , Jaideep) (Aswanth)
Week 3	Dynamic analysis (Inverse dynamics) ADAMS simulation (without gravity)	(Jaideep) (Aswanth, Vinay)
Week 4	ADAMS simulation(including masses and gravity) Dynamic balancing of links and redesigning	(Jaideep) (Vinay, Aswanth)
Week 5	Dynamic balancing of linkages(minimizing shaking forces) Addition of new masses(C.G and weights) Redesigning new linkages according to changes	(Aswanth) (Jaideep) (Vinay)
Week 6	Minimizing shaking torque Redesigning new linkage according to changes	(VInay) (Aswanth, Jaideep)
Week 7	Running ADAMS simulation of complete design	(All)
Week 8	Conclusion Scope of improvement Report preparation	(All)