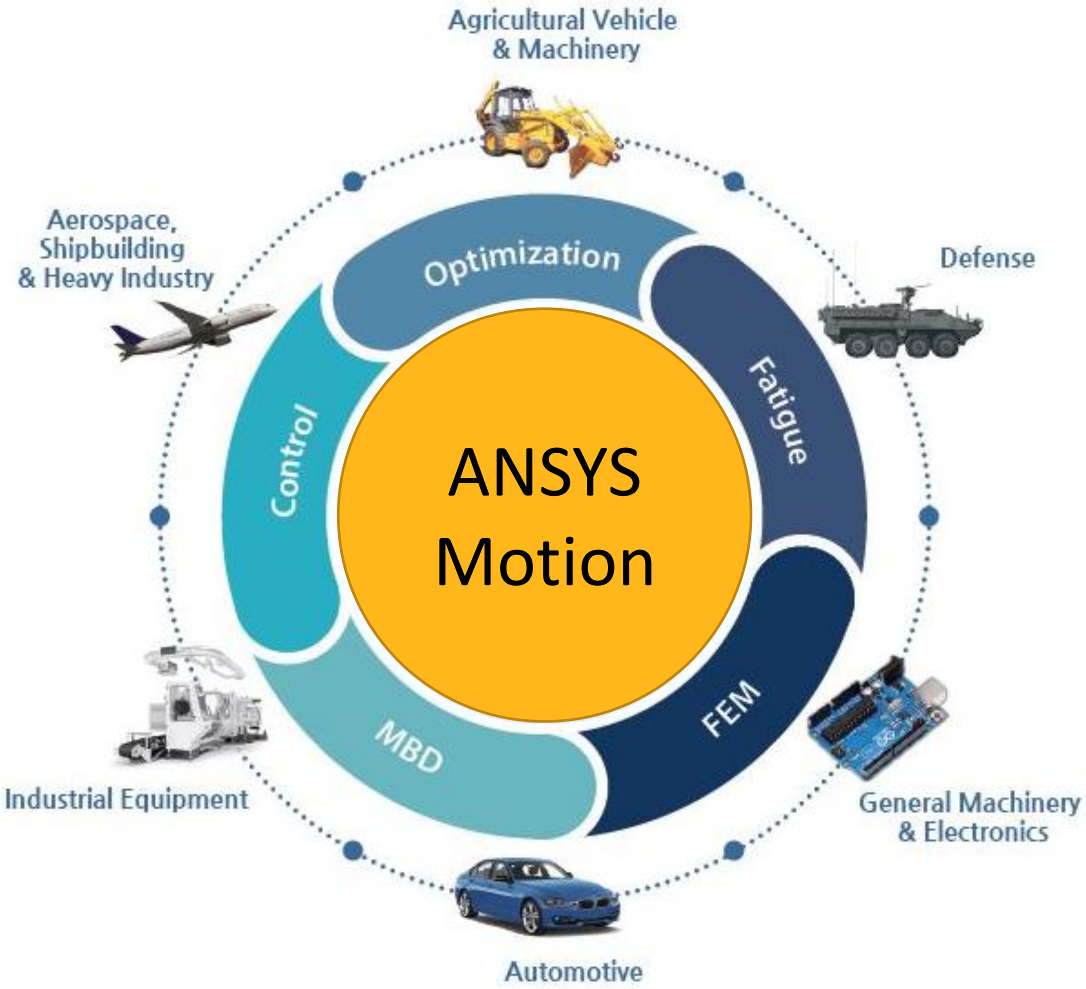
A New paradigm in Multi Body Dynamics Solution in Ansys Motion

ANSYS Motion



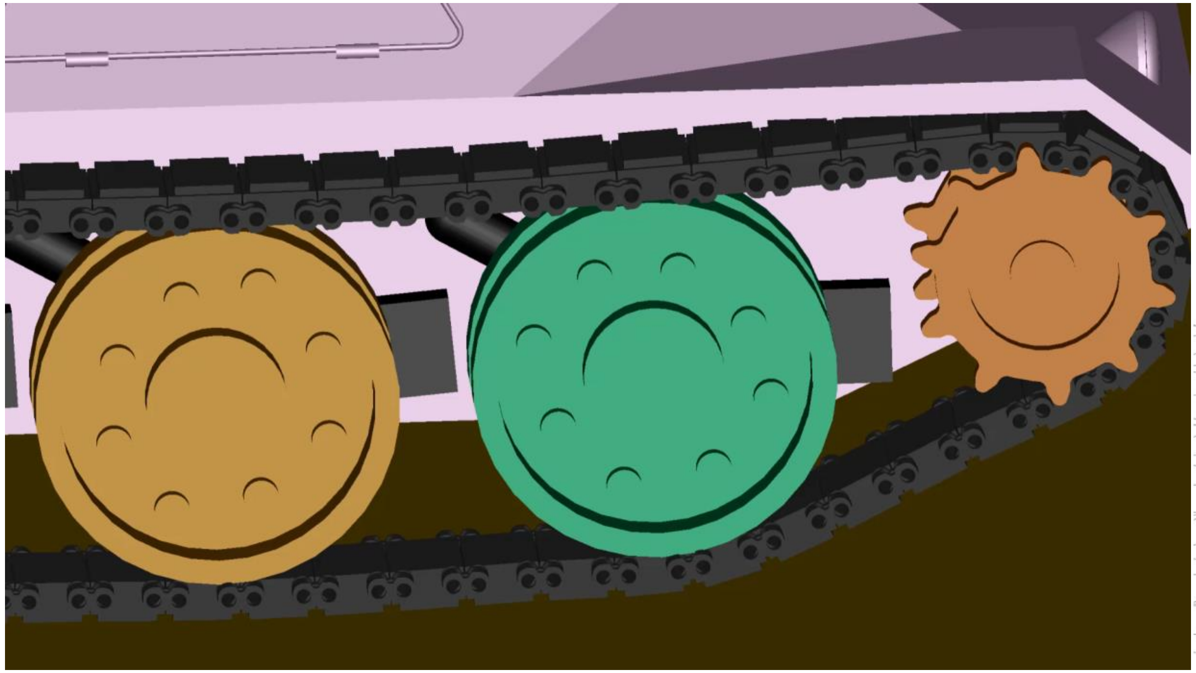
ANSYS Motion: A dedicated Multi Body Dynamics tool.

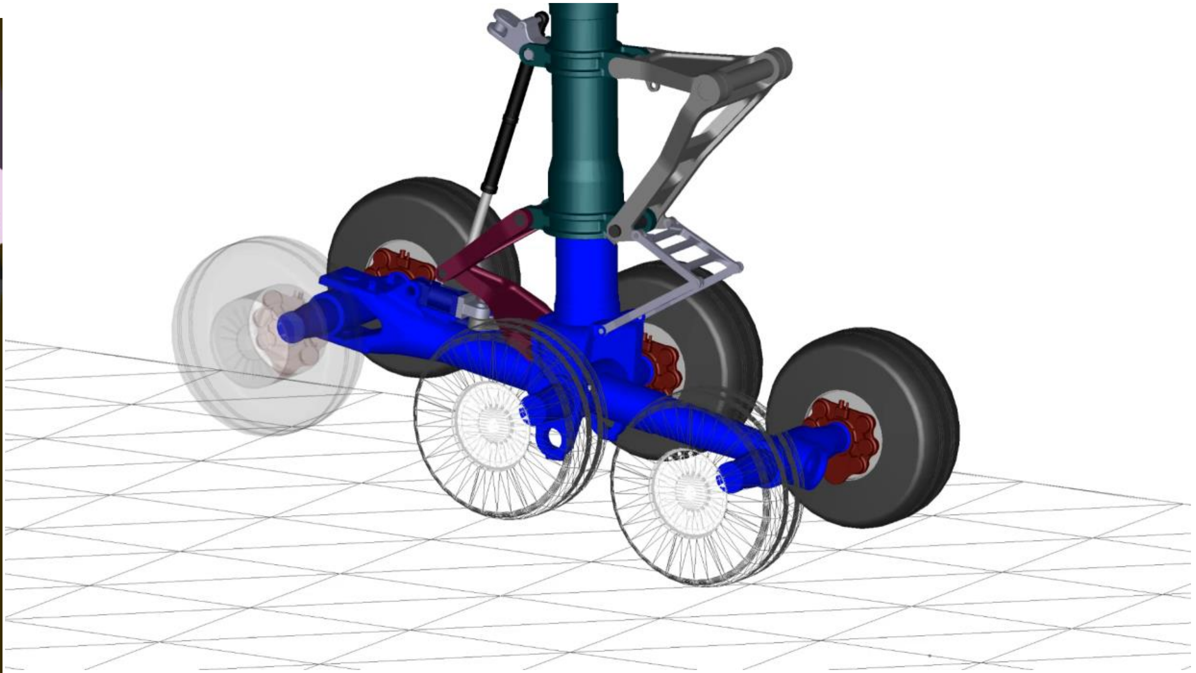
ANSYS Motion: A software suite consisting of a baseline package and four toolkits

- **ANSYS Motion**

- **ANSYS Motion Links Toolkit**
- **ANSYS Motion Drivetrain Toolkit**
- **ANSYS Motion Car Toolkit**
- **ANSYS Motion EasyFlex Toolkit**

Ansys Motion – a new paradigm in Multibody Dynamics





Ansys Motions' advanced contact logic and tightly integrated rigid and flexible solvers give a capability that is unique.

Modules Contained Within ANSYS Motion

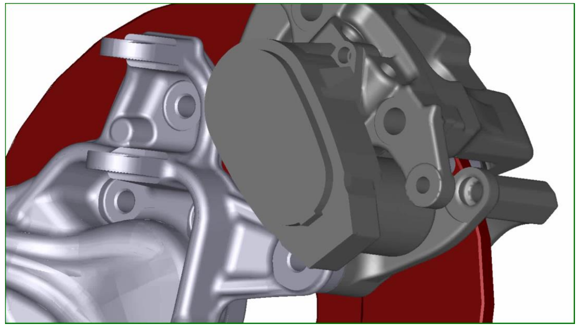
Product	Module	Description
ANSYS Motion	MBD Pro	Multi-Body Dynamics Analysis Package
	FE Dynamics	Multi-Flexible Body Dynamics Analysis Package based on FEM
	Linear	Mode and Natural Frequency Analysis Module
	Fatigue	Fatigue Analysis Module with S/N and E/N curves
	Modal	Modal Flexible Body Module
	SMP	Parallel Processing Module for Solver
	MATLAB Interface	Co-simulation with MATLAB Simulink
	FMI	Co-simulation based on FMI
	API DEV. Execution	API module for developers
Toolkits	**CAR Toolkit**	Vehicle Dynamics Analysis Toolkit
	LINKS Toolkit	Tracked Vehicle Dynamics Analysis Toolkit, Belt and Chain Dynamics Analysis Toolkit
	DRIVETRAIN Toolkit	Power Transfer System Dynamics Analysis Toolkit for NVH
	EASYFLEX Toolkit	Multi-Flexible Body Dynamics Analysis Package based on MeshFree technology

The ANSYS Motion package contains all of the these modules as standard

Toolkits can be used to aid preprocessing for specialist applications

Benefits of ANSYS Motion

Fast simulation speed – ANSYS Motion super solver can accelerate the simulation speed for a large degree of freedom systems. The speed can be further accelerated under SMP parallel processing environment.



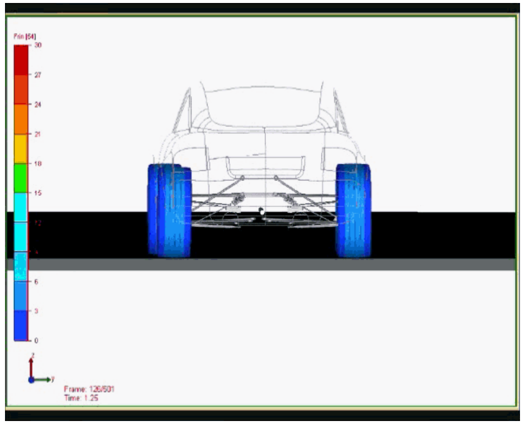
Reliable and accurate solution – Implicit integration method yields stable and accurate solutions.

Tightly integrated multi-body and structural analysis solvers. The governing equations of equilibrium for rigid body, flexible body, force entities, and joints are solved simultaneously.

Good for large degrees of freedom systems – Customized sparse solver for the mixed system of rigid and flexible bodies has been implemented to handle large degree of freedom systems.

Elements and connections - Various modelling elements and entities for structural analysis and multi-body analysis models.

3D surface contact – ANSYS Motion supports both surface representations of NURBS and facet types.



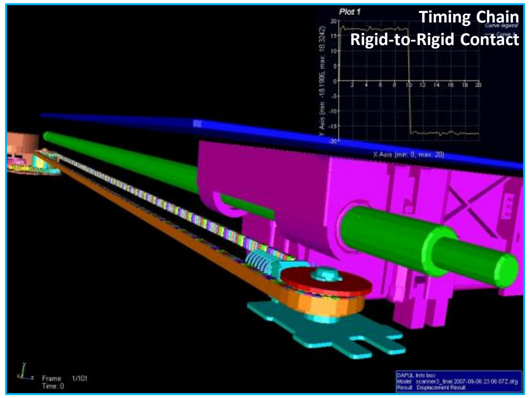
Modal and nodal flexible body methods - ANSYS Motion supports both nodal and modal flexible bodies which can be easily switched from one to another.

Easy interface with other software – ANSYS Motion can be interfaced with other software by using user subroutines, FMI’s and a Matlab interface.

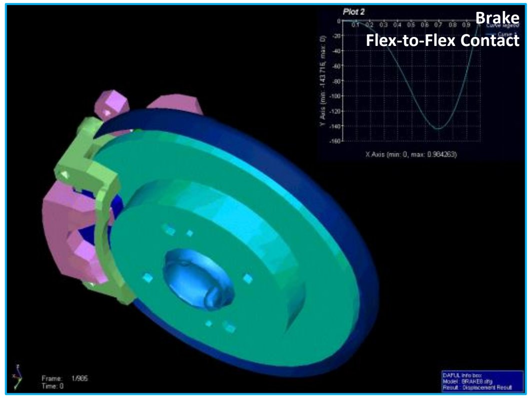
Good for the following applications: Kinematic analysis of mechanical systems, Vehicle dynamics, Large deformation structural analysis, High speed large rotation systems, 3D contact systems, Coupled systems of multi-body motion and structural deformation, Long duration dynamic analysis problems.

Why buy ANSYS Motion?

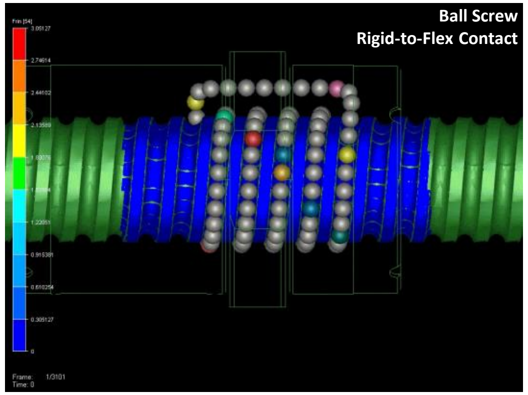
- User wants to get more accurate boundary conditions for static analyses through analysis of complete system dynamics.
- ANSYS Motion has the most advanced solver of any commercially available multi-body dynamics tool.
- ANSYS Motion is strong when it comes to contact of complex geometry and high speed rotating problems.
- ANSYS Motion can solve large deformation problems in the time domain while also considering non-linear material properties



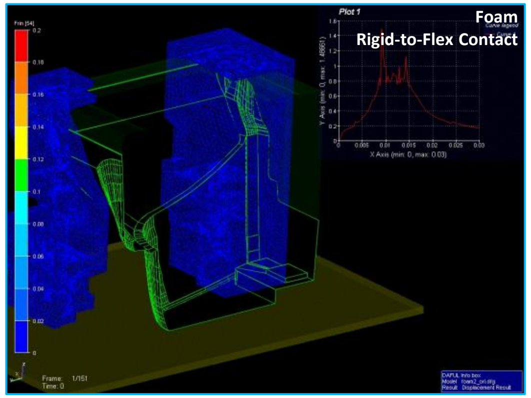
ADAMS	3,000 min
Ansys Motion	46 min.



RecurDyn	4.7 days
Ansys Motion	6 min.

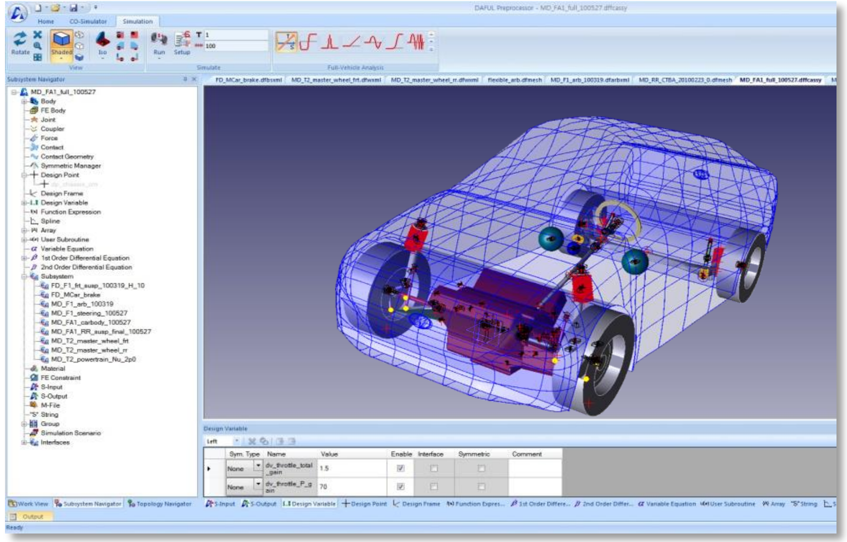


RecurDyn	Not Solved
Ansys Motion	40 min.

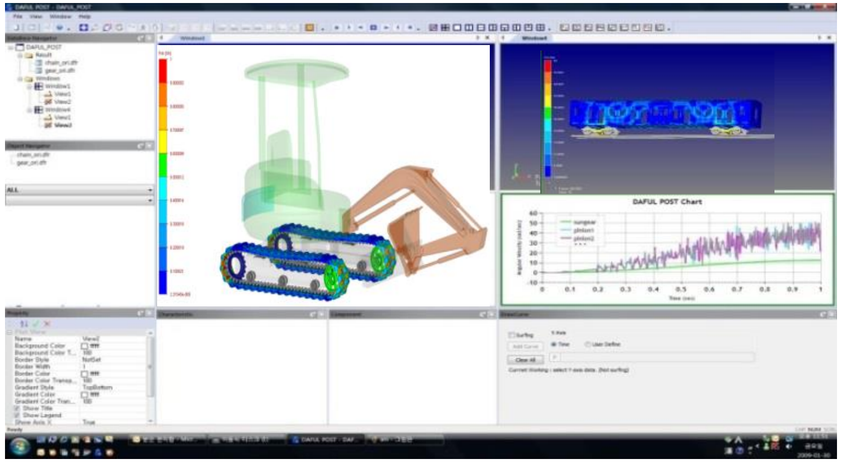


RecurDyn	780 min.
Ansys Motion	45 min.

Ansys Motion



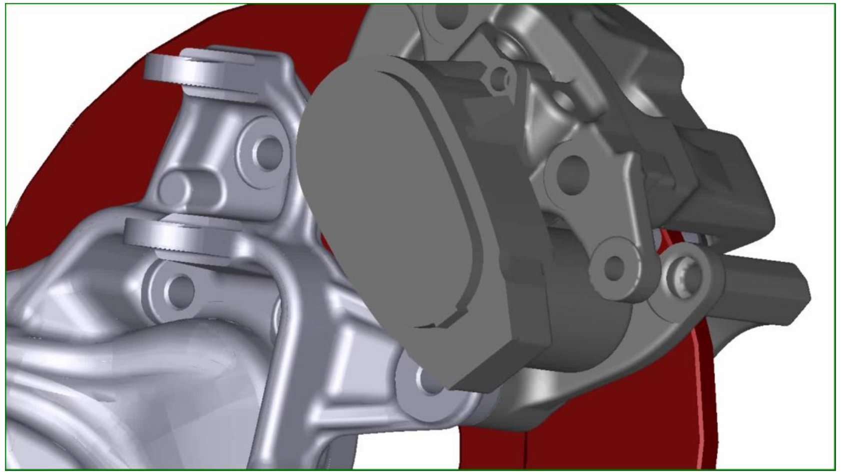
Pre-processor



Post-processor

Analysis Scope

- Multi Body Dynamics (rigid, flexible, linear, non-linear)
- Strength/Fatigue
- Vibration (Linear)
- NVH (Transient)
- Heat Transfer
- Design of Experiments

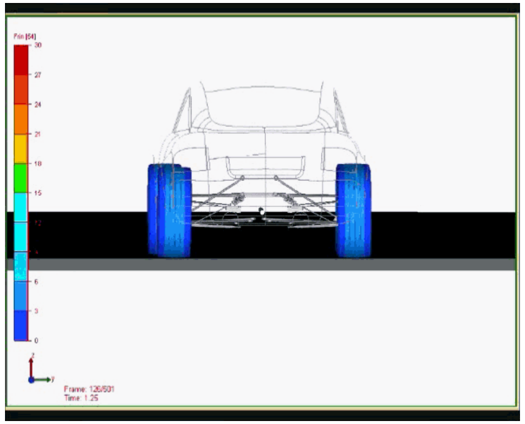


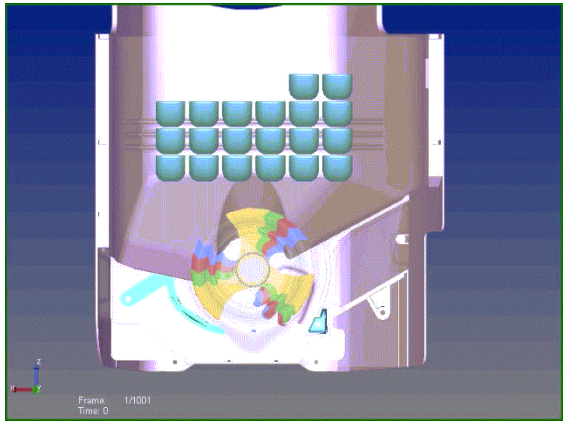
Structural Dynamics Analysis

ANSYS Motion

(PRE, Solver, POST)

Fields of Application

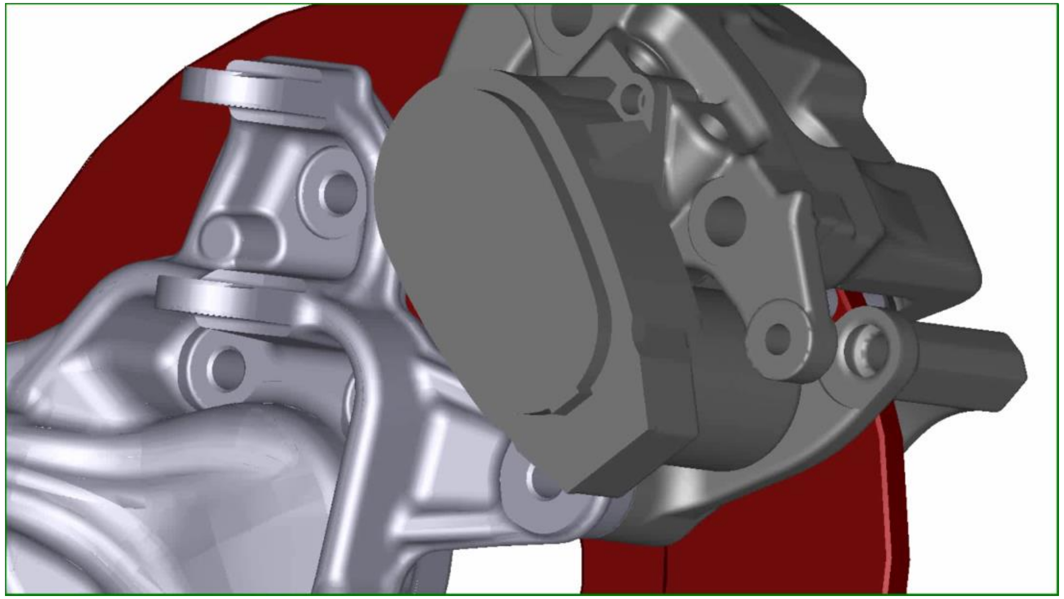




Main Package Capabilities

- Multibody Dynamics
- Strength/Fatigue
- NVH (Linear & Transient)
- Heat Transfer
- FMI/FMU

Transient Stress Analysis of Brake Assembly

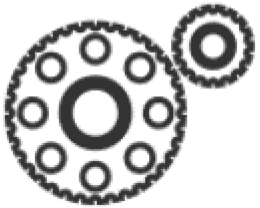


Advanced toolkits

LINKS

Tracks, Chains And Belts

DRIVETRAIN



Gears, Bearings, Shafts

CAR

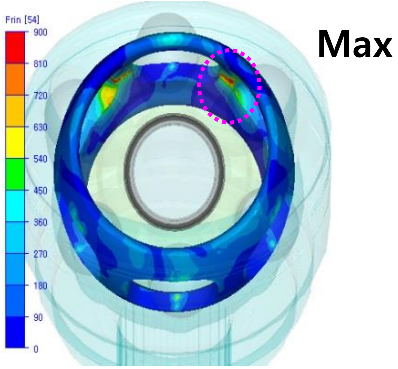
Auto Ride & Handling

EASYFLEX

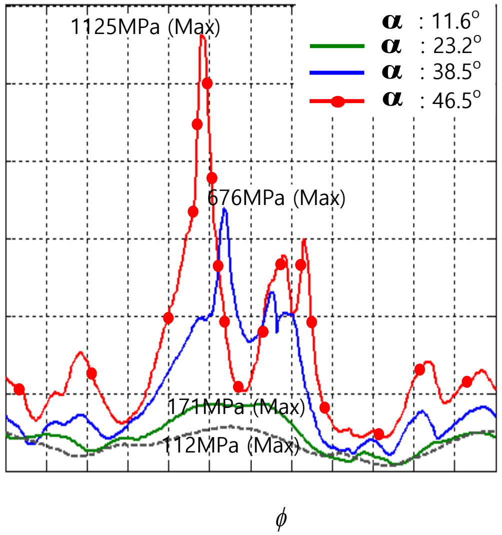
Meshfree Flexible Solver

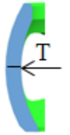
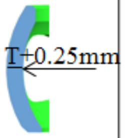
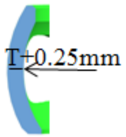
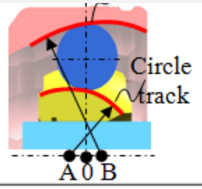
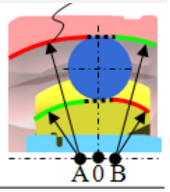
Ansys Motion – Case Study

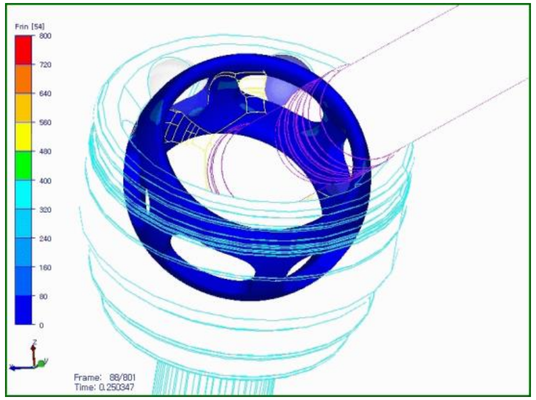
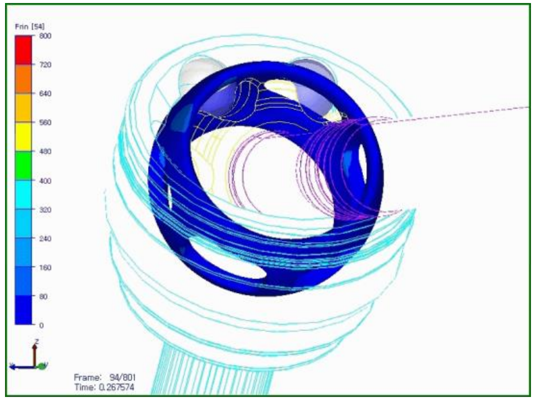
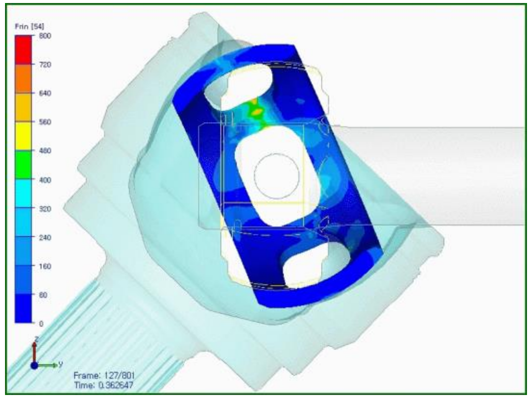
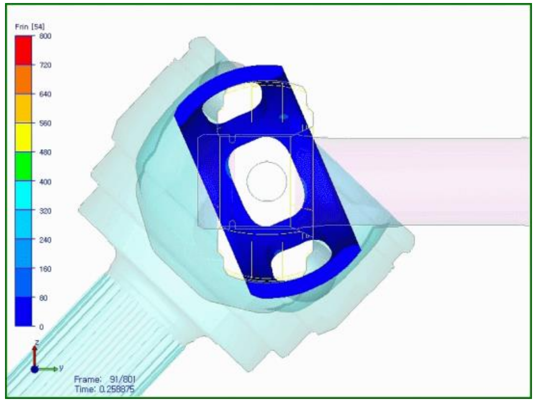
Reproduce Problems



Improve Design and Verify

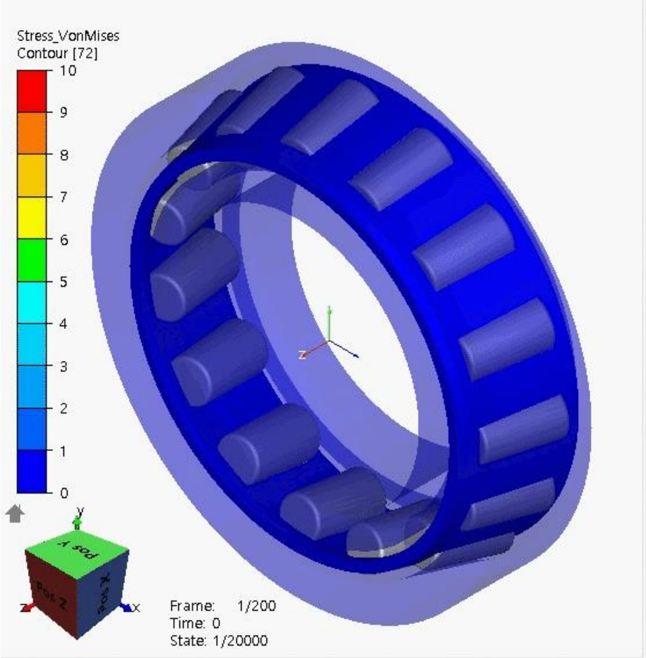


	Case#1	Case#2	Case#3
T			
S	Circle track 		Variable track 

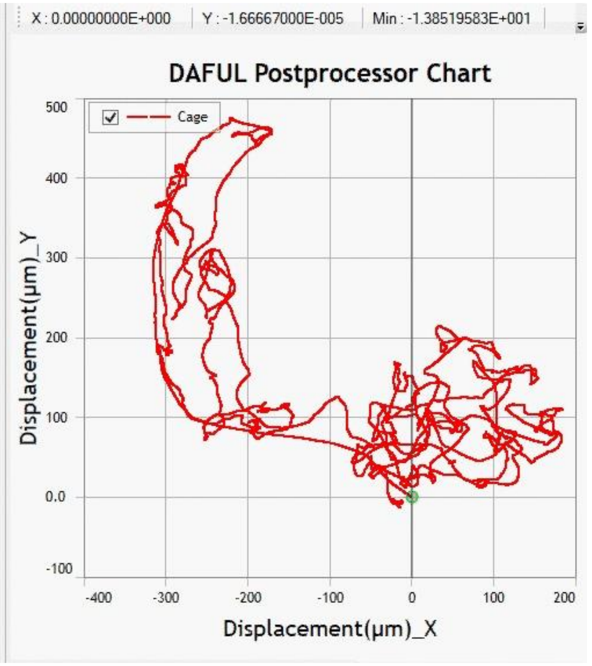
Original (Case#2)	Best Design (Case#3)
	
	

Ansys Motion – Case Study

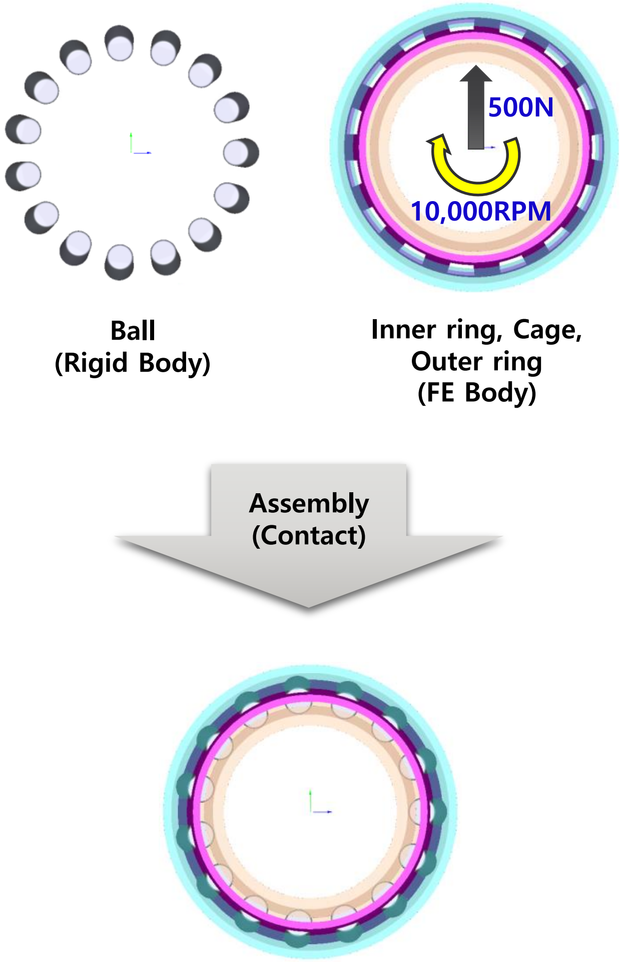
- **Goal**
  - Development of a dynamic model of a Roller bearing
- **Contents**
  - Displacement observation of the cage when rotating the ball bearing
  - Observation of the stress distribution
  - Contact modeling between Roller and Inner ring, Cage, Outer ring



Stress of Ball Bearing



displacement of cage

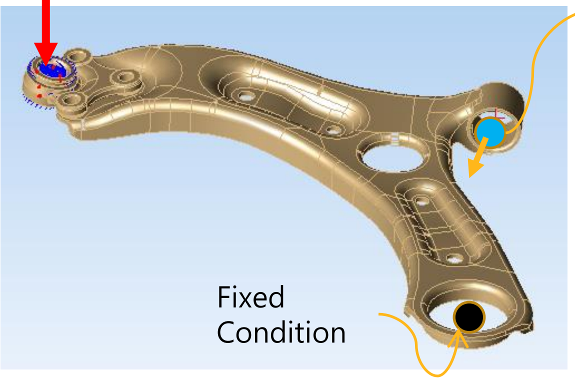


Ansys Motion – Static Analysis

Strength and Compliance Analysis : Linear

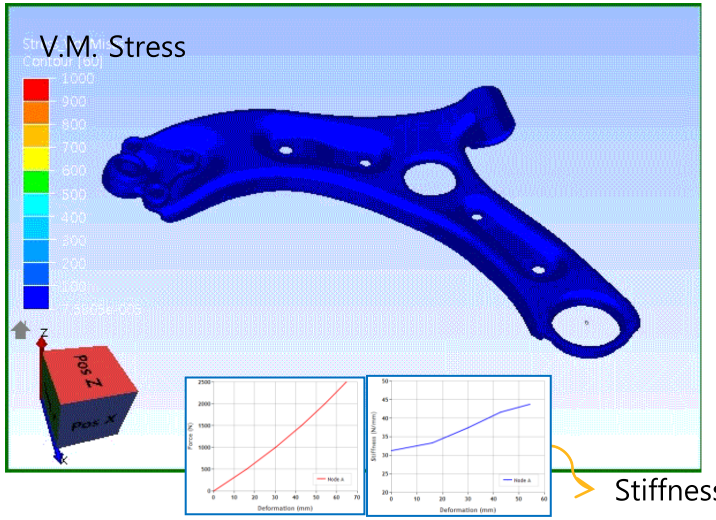
load

✓ Linear Elastic Material
✓ Small Deformation



Rotational Condition

Fixed Condition

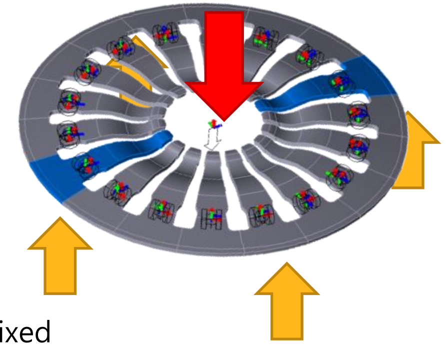


Stiffness

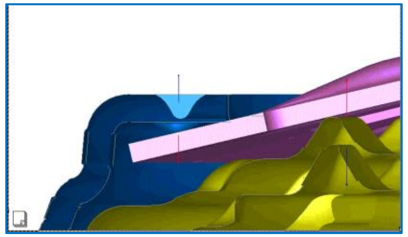
Strength and Compliance Analysis : Non-Linear

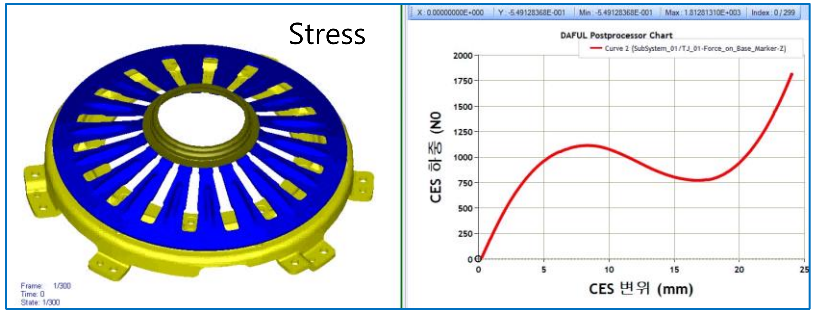
✓ Large Deformation

load



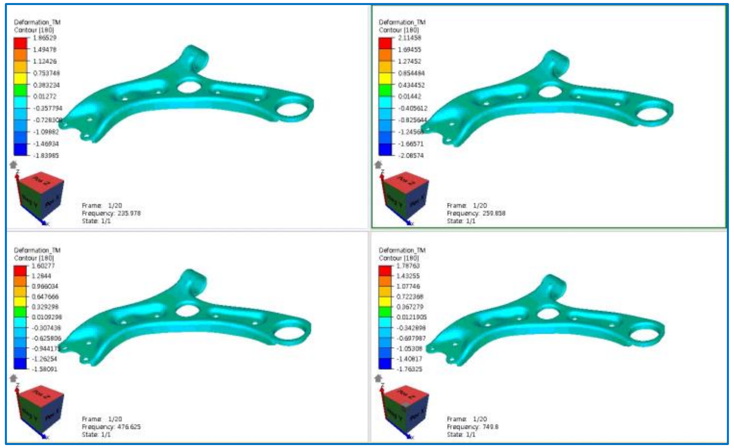
Fixed Condition





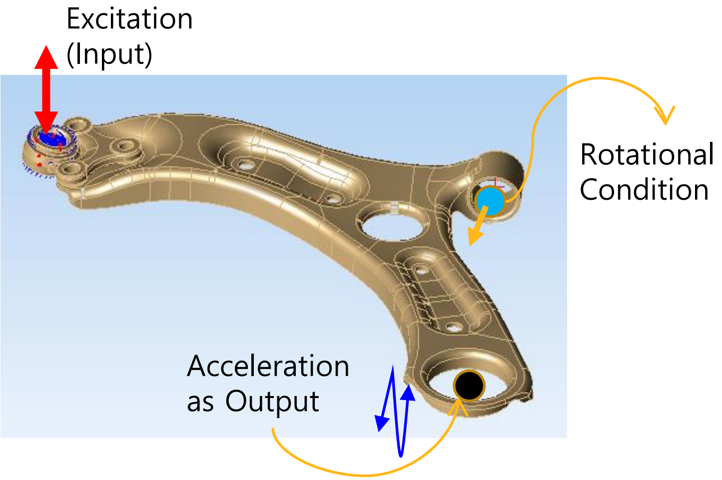
Ansys Motion – Eigenvalue Analysis

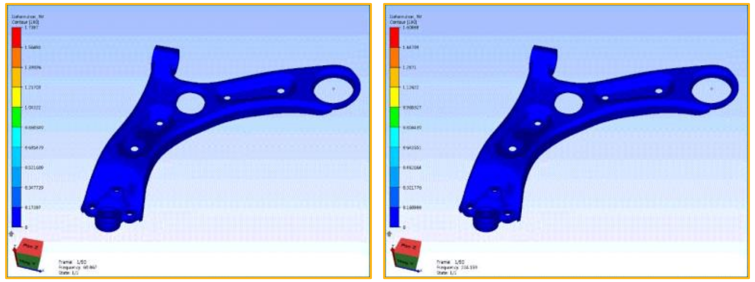
Mode and Natural Frequency Analysis



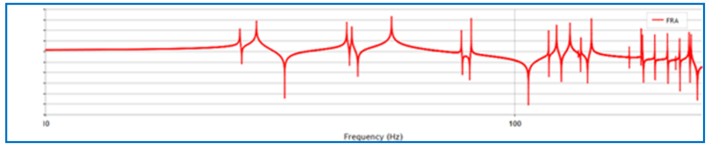
Mode	Natural Frequency (Hz)
1	2.28E+02
2	2.48E+02
3	4.55E+02
4	6.88E+02
5	7.23E+02
6	1.25E+03
7	1.27E+03
8	1.49E+03
9	1.60E+03
10	1.77E+03

Frequency Response Analysis



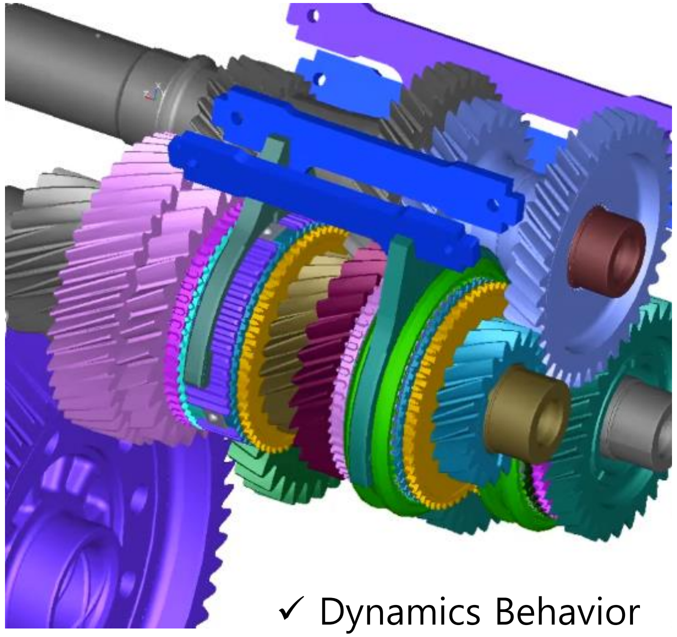


1st Mode 2nd Mode

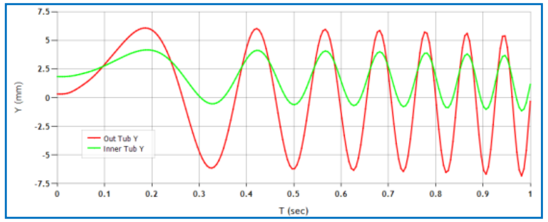


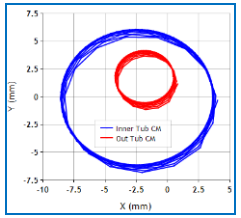
Ansys Motion – Dynamics(NVH) and Fatigue

Dynamics Analysis

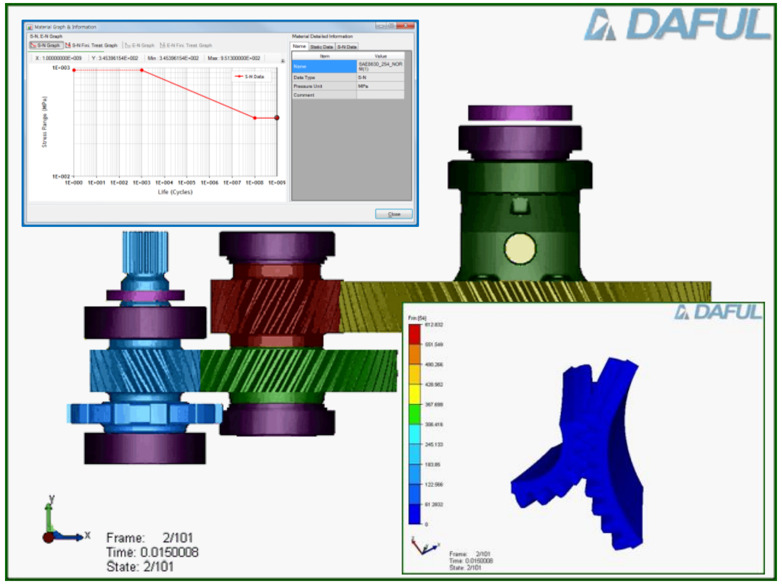


- ✓ Dynamics Behavior
- ✓ Small/Large Deformation
- ✓ Contact Analysis
- ✓ Vibration Analysis

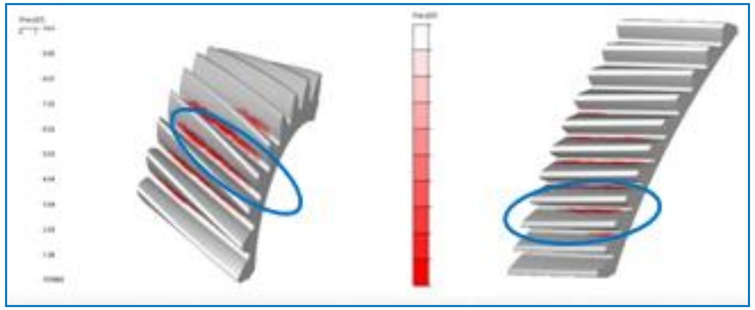




Fatigue and Damage Analysis

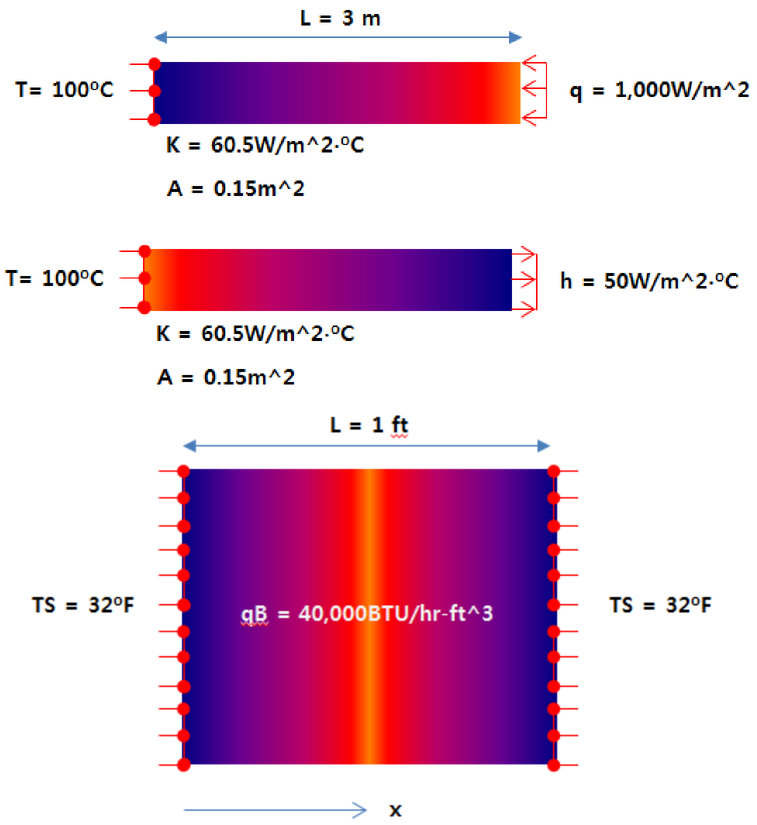


- ✓ Design Stress
- ✓ S/N Curve



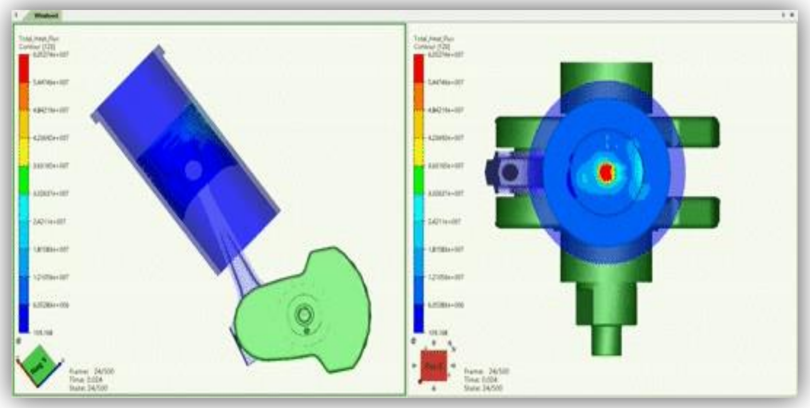
Ansys Motion – Heat Transfer and Thermal Strain

Heat Transfer



- ✓ Conduction and convection
- ✓ Heat Transfer with Contact
- ✓ Steady-state and Transient Analysis

Thermal Strain

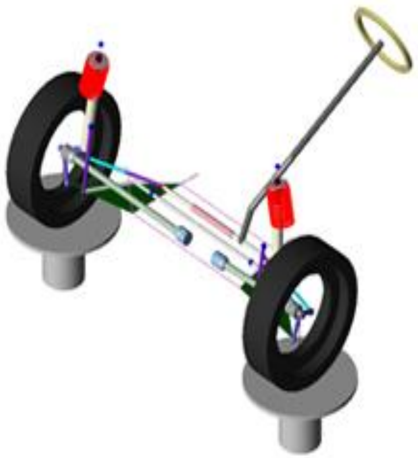


- ✓ Fully Integration with Heat Transfer
- ✓ Statics and Dynamics Analysis

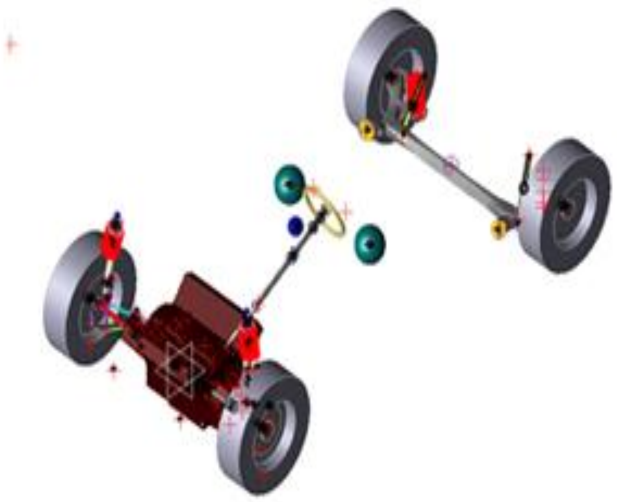
Toolkits

Ansys Motion CAR Toolkit

With this toolkit it is possible to model various templates and subsystems used for vehicle ride and handling analyses such as the suspension system, steering system and brakes.



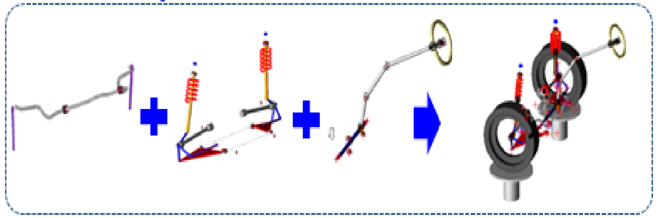
- Dedicated Template and Subsystem modelling tools can be used to build chassis, Suspension, Steering, and Wheel for predefined analysis scenarios.
- Symmetric modelling capability
- Template based modelling to manage vehicle models easily
- Half car model can be analysed independently and can be automatically assembled for a full car.
- Subsystems can be interfaced when they are assembled.
- Suspension analysis scenarios and output items are predefined so that a user can easily check the design requirements.



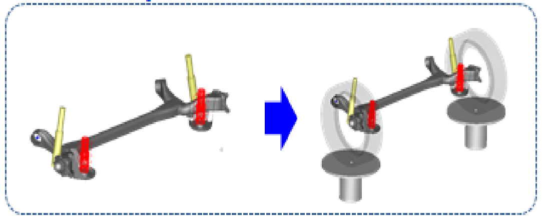
- Kinematics and Compliance analysis for a vehicle suspension.
- Riding and Handling analysis
- Fatigue analysis of components
- Load analysis and vibration analysis during vehicle manoeuvre

Ansys Motion CAR Toolkit

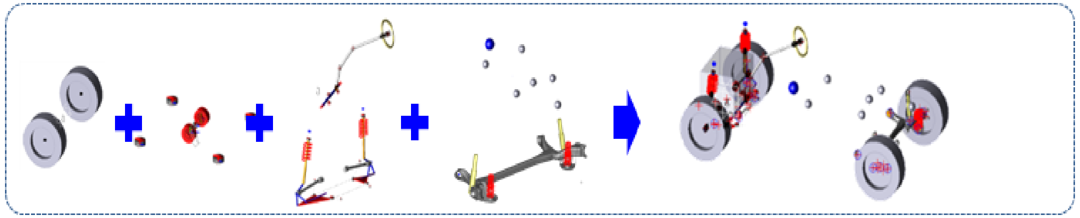
[Front Suspension]



[Rear Suspension]

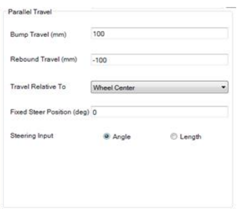


[Full Car]



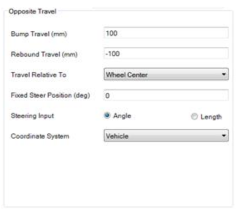
Step for
CAR modeling

vertical



- Result
  - ✓ Toe change
  - ✓ Camber change
  - ✓ Caster change
  - ✓ Wheelbase change
  - ✓ Tread change
  - ✓ Wheel rate
  - ✓ RCH

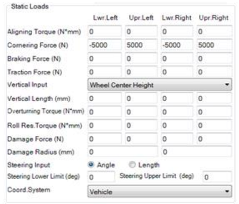
roll



- Result
  - ✓ Roll toe
  - ✓ Roll camber
  - ✓ Roll caster
  - ✓ Roll Rate

lateral

0 mm mode

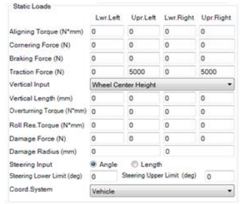


20 mm mode

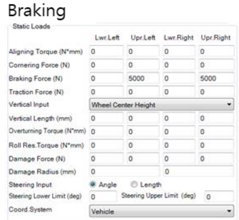
- Result
  - ✓ Stiffness
  - ✓ Toe
  - ✓ Camber

longitudinal

Acceleration

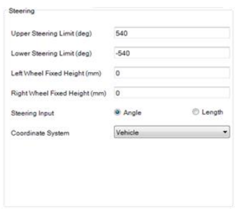


Braking



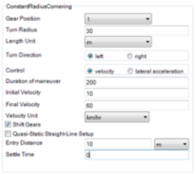
- Result
  - ✓ Stiffness
  - ✓ Toe
  - ✓ Caster

steer



- Result
  - ✓ Steer angle
  - ✓ Ackerman
  - ✓ Percent Ackerman

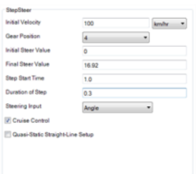
Constant Radius Test



- Constant velocity & skidpad turn

- Results
  - ✓ Roll angle
  - ✓ Lateral acceleration
  - ✓ steering wheel angle

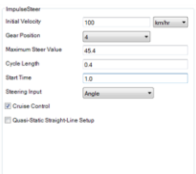
Step Steer Input



- Steering input : step function

- Results
  - ✓ Steering wheel angle
  - ✓ Yaw rate
  - ✓ Lateral acceleration
  - ✓ Body side slip angle
  - ✓ roll angle

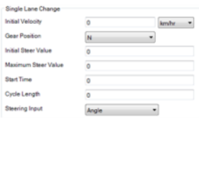
Pulse Input Test



- Steering input : pulse function

- Results
  - ✓ steering wheel angle
  - ✓ Yaw rate
  - ✓ Lateral acceleration
  - ✓ Roll angle

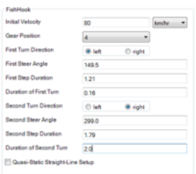
One period sine



- steering input : sine function

- Results
  - ✓ steering wheel angle
  - ✓ Yaw rate
  - ✓ Lateral acceleration
  - ✓ roll angle

Fish hook test



- steering input : step function

- Results
  - ✓ steering wheel angle
  - ✓ Lateral acceleration
  - ✓ Roll angle
  - ✓ Tire vertical force

Double lane change

- Driving in double lane path

- Results
  - ✓ Lateral acceleration
  - ✓ Roll angle
  - ✓ Roll rate
  - ✓ Yaw rate
  - ✓ Steering wheel angle
  - ✓ Front tire vertical force
  - ✓ Body side slip angle

ANSYS Motion LINKS Toolkit

LINKS toolkit contains two areas of functionality:

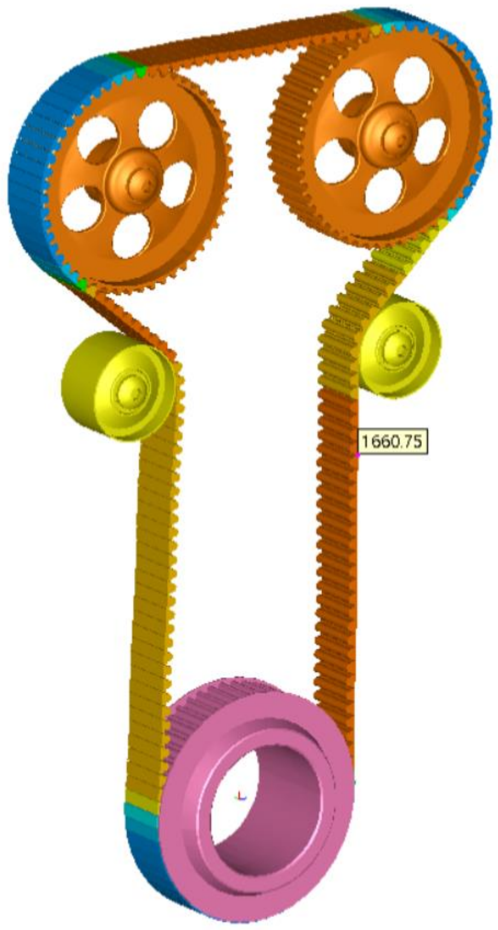
- Continuous track vehicles (caterpillar tracks)
- Chain and belts drives

ANSYS Motion LINKS Toolkit

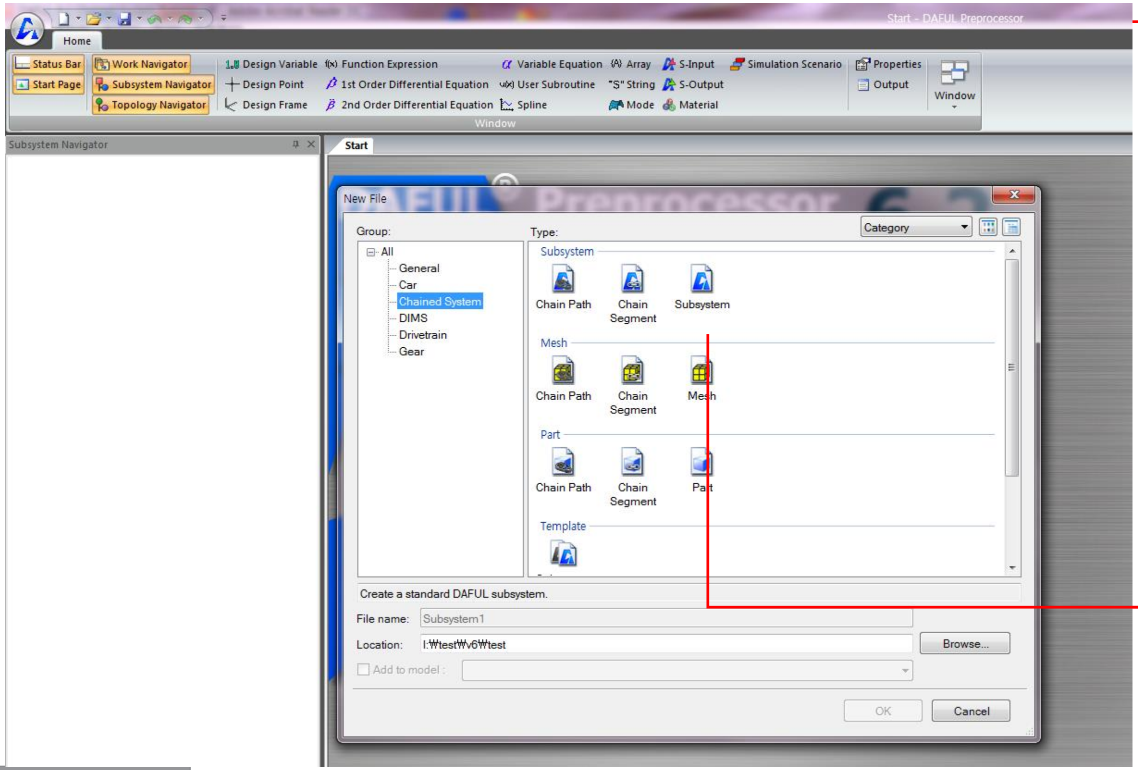
- LINKS toolkit allows a user to analyse systems containing flexible power transmission features like chains, tracks and belts.

- Connections between the individual links and contact between the links and the sprockets, pulleys and rollers mean that many hundreds of thousands of elements need to be setup and have their contact defined. In order to realise this the LINKS Toolkit provides an automated method for quickly setting up these kind of systems and post processing them in an easy manner

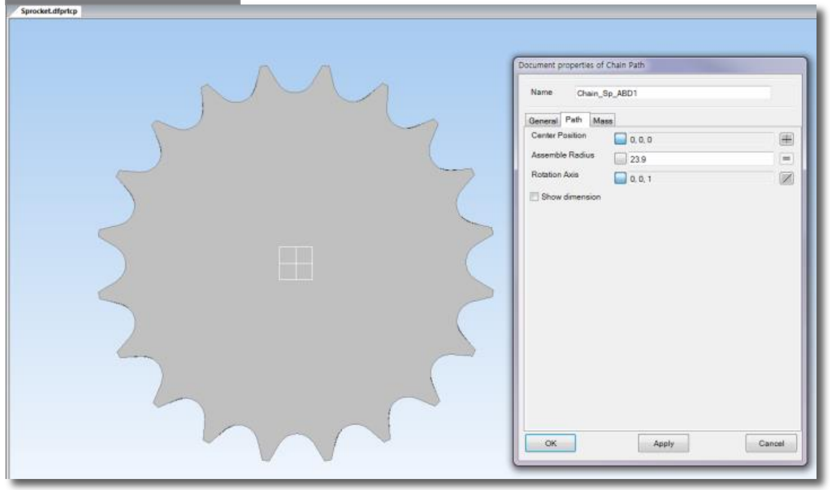
- A chained system consists of path bodies(wound bodies) and segment bodies(winding bodies)
- Once the path and segment bodies are defined, chain assembly is automatically created.
- Path and segment bodies can be a subsystem, part or mesh file. This allows the building of various types of irregular chains.
- One window controls all contact parameters between segment and path bodies.
- Connection between two segments can be any kinds of force or joint or contact entity.
- Engagement of the chain segment and the sprocket tooth can be matched automatically.



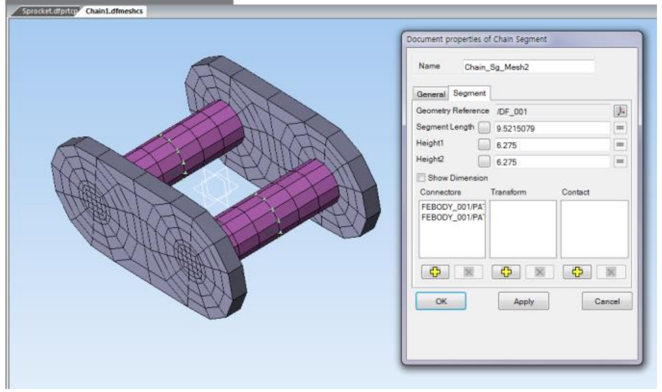
ANSYS Motion LINKS toolkit



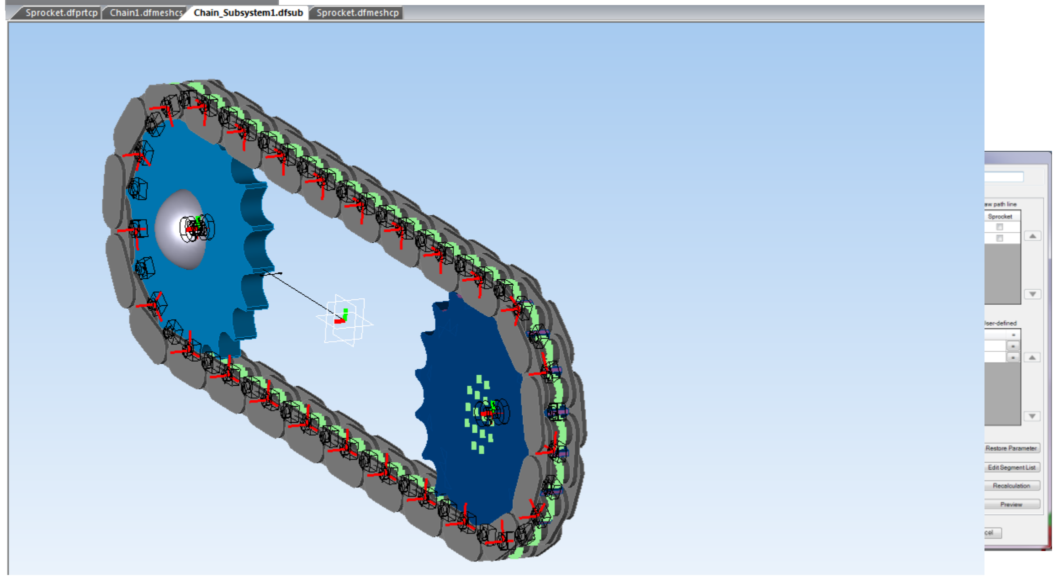
Path



Segment

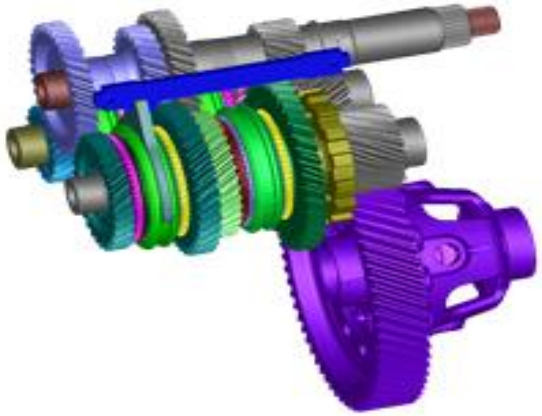


Assemble



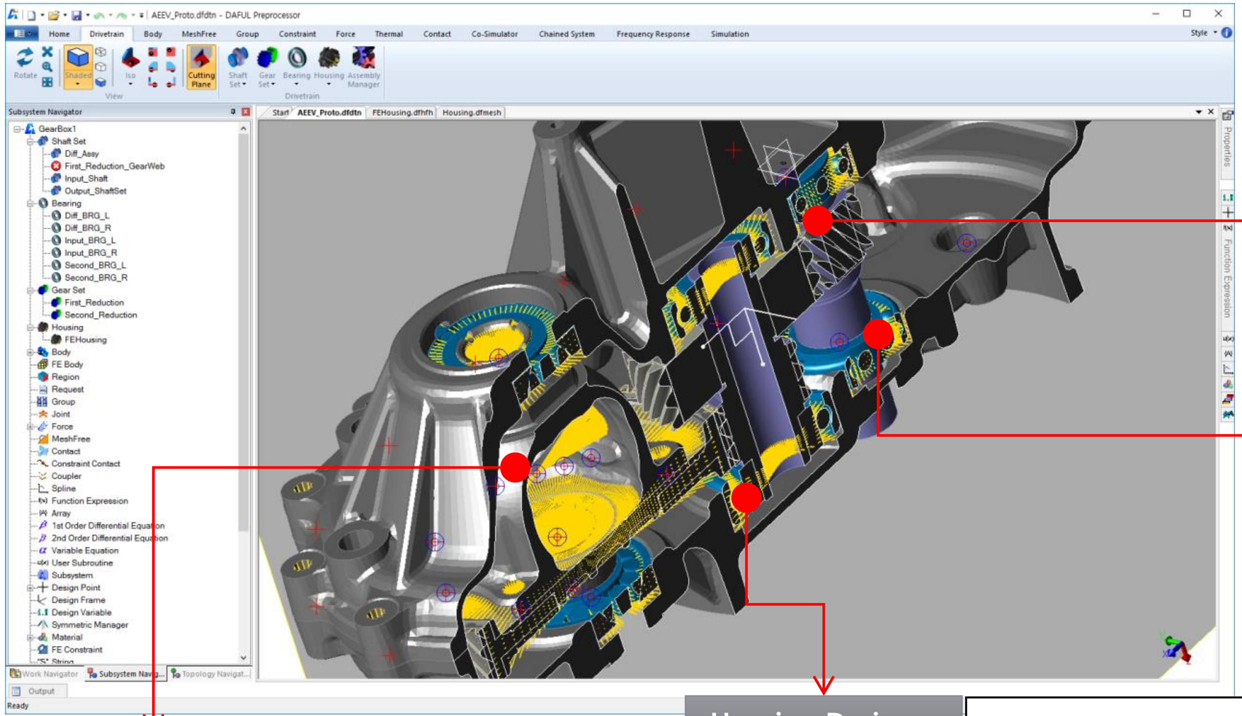
ANSYS Motion DRIVETRAIN Toolkit

- A toolkit that constructs power transmission devices including gears, bearings, shafts and housings.
- Calculates the gear excitation force under fluctuating speed / load conditions.
- Vibration characteristics can be analysed accurately under the same conditions as the actual drive conditions.
- Drivetrain allows you to configure the gear pair model by entering the specifications required for the gear design and analyse the transmission errors for each gear (backlash).
- It provides catalogues from major bearing manufacturers to improve the user's modelling experience and allows gear geometry to be created from parametric sketches.

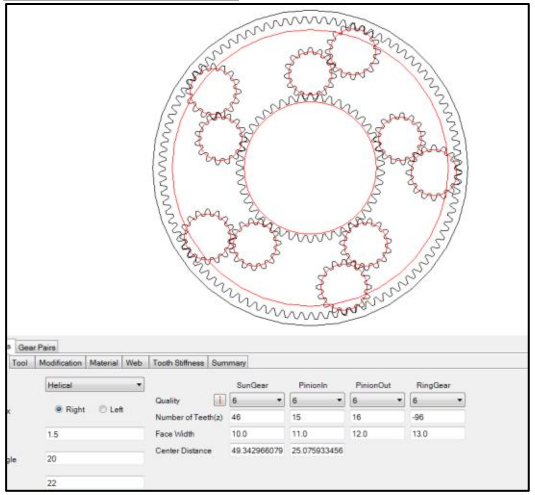


- Automatic creation of gear tooth profile, based on parametric inputs.
- Automatic creation of contacts.
- Gear can be a rigid body or flexible body.
- Gear created outside of ANSYS Motion can be imported and used.
- Spur gear and Helical gear profile modeler.
- Spur and helical gears Automatic contact creation.

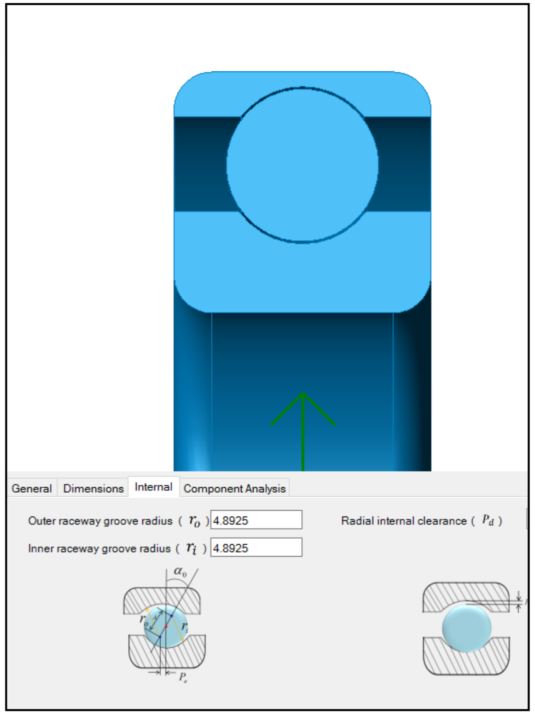
ANSYS Motion DRIVETRAIN Toolkit



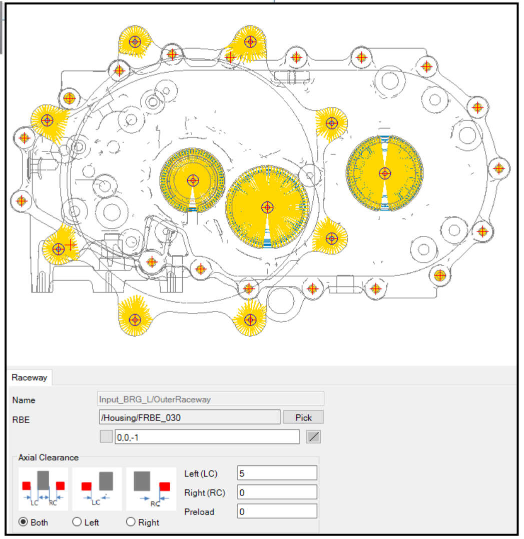
Gear Designer



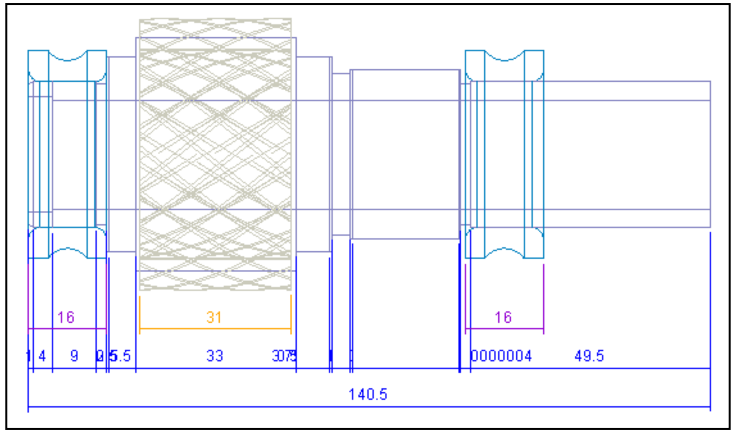
Bearing Designer



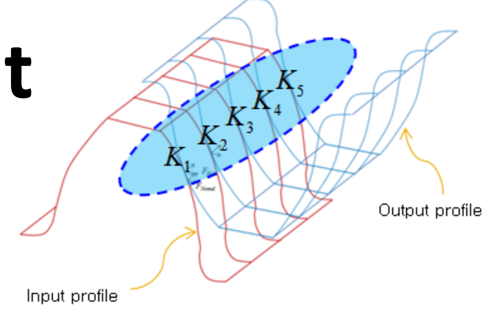
Housing Designer

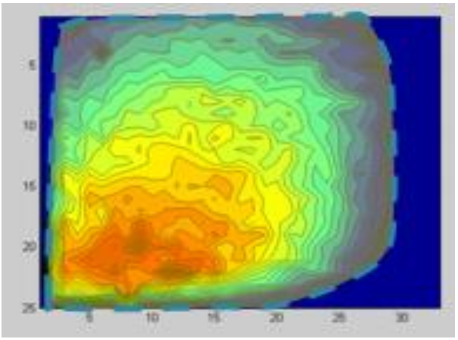


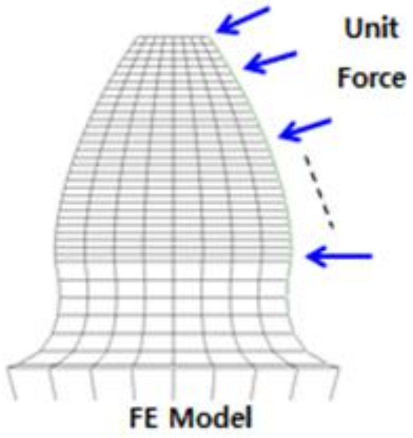
Shaft Designer



ANSYS Motion DRIVETRAIN Toolkit





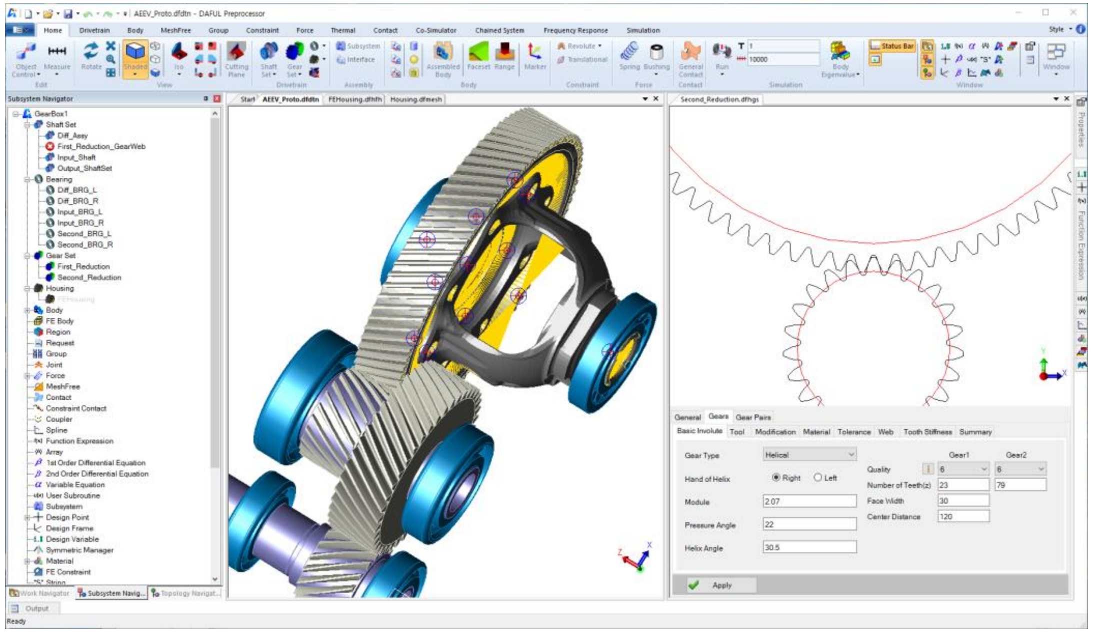


Gear Models

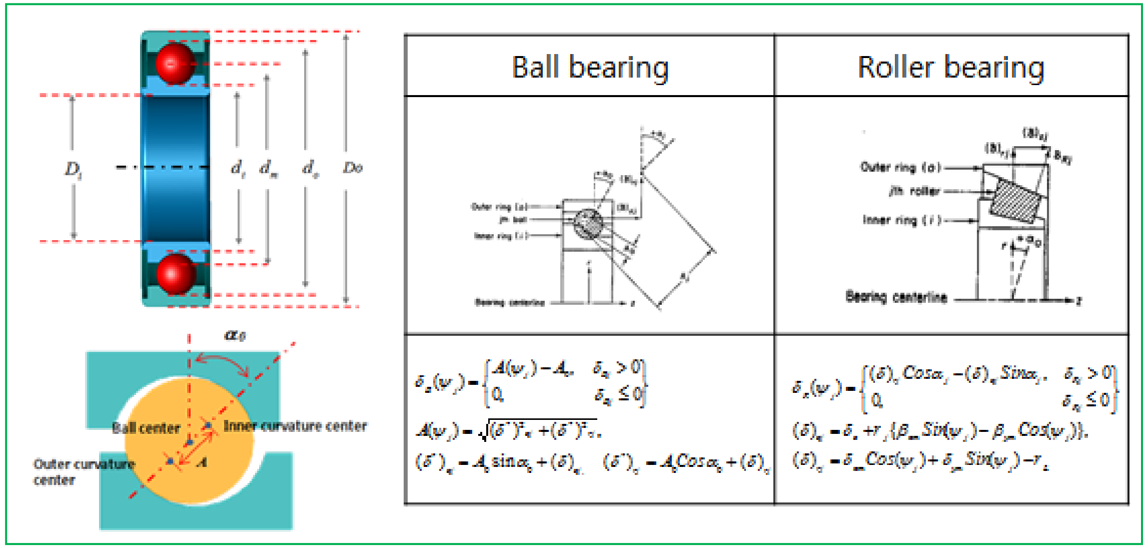
- Supports 2D designer for simple generation and 3D modeler for easy assemble into system
- Exact tooth stiffness from FE model
- Runtime calculation of stiffness & aligning condition
- Extract output at every desired steps

Functionality

Generation	Spur, Helical (Internal, External) Planetary Gear – Single & Double (6.2) Rack & Pinion Cycloid Worm & Worm wheel
Modification	Profile – slope, crown Lead – slope, crown, tip relief
Characteristic	Tooth & variable Mesh stiffness Combination of variable Web stiffness All directional Misalignment
Diagnostic	Reference circles TE & PPTE (Static, Dynamic) Strength (ISO base) Single Tooth pressure

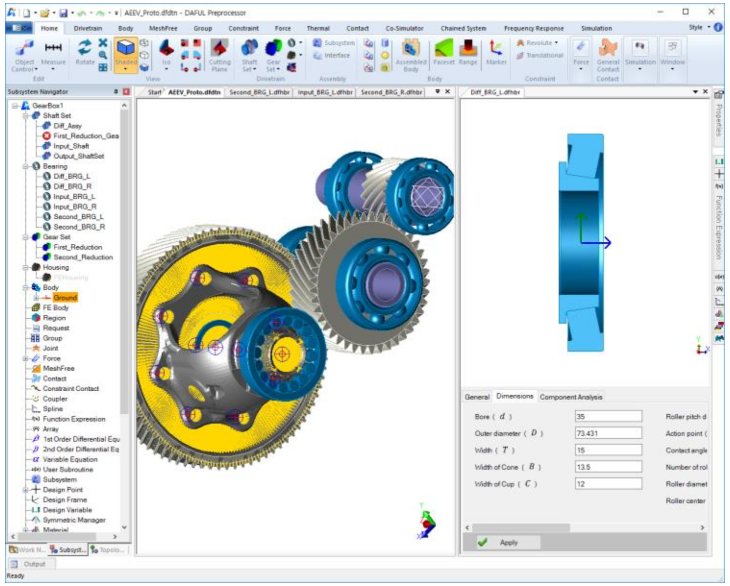


ANSYS Motion DRIVETRAIN Toolkit



Bearing Model

- Fast and stable stiffness model between two raceway
- Stiffness depends on loading condition during analysis
- Basic design from various libraries of each company (NSK, SKF, KOYO, FAG)



Functionality

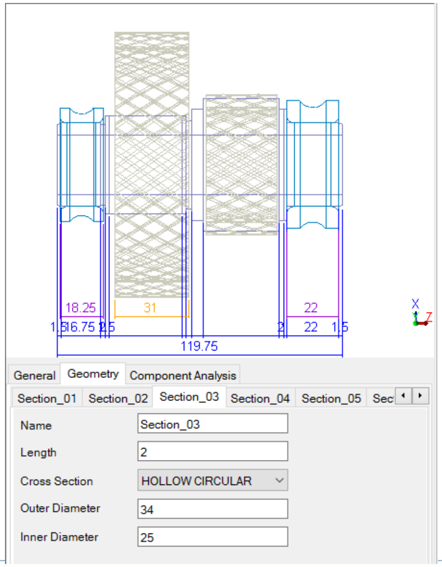
Generation	Ball (Angular contact, 4 point)
	Roller (Tapered, Needle)
	Sliding bearing (Like a bush)
	Stiffness force (User input)
Characteristic	Ball stiffness
	Load dependent stiffness
	Misalignment
	Simple Friction model (Efficiency)
Diagnostic	Stiffness for each direction

ANSYS Motion DRIVETRAIN Toolkit

Shaft Model

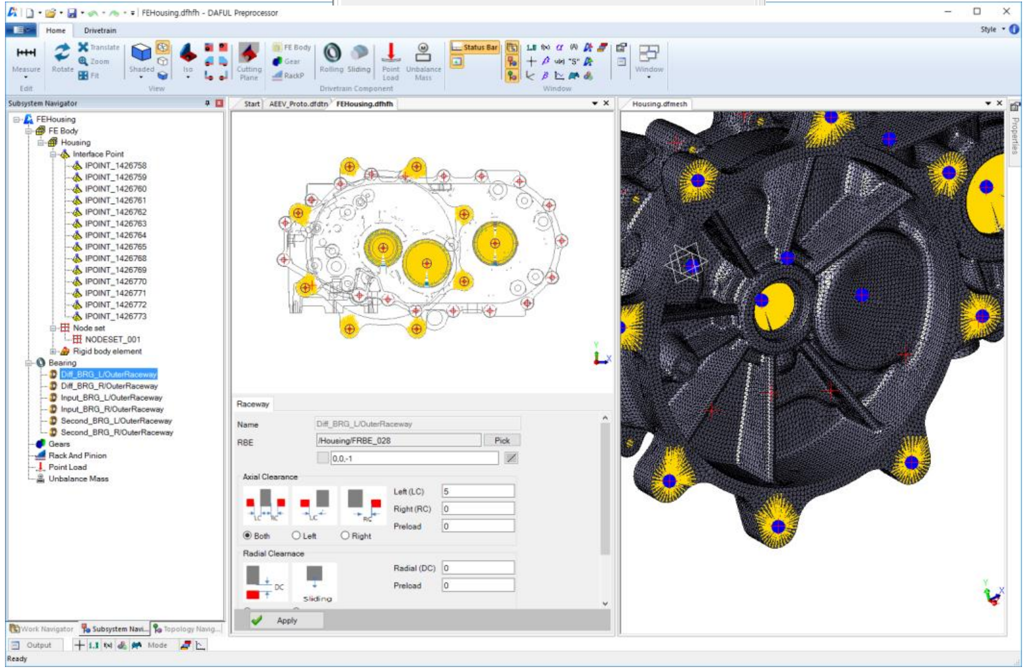
- Various section type (Circular & its hollow, Tapered & its hollow)
- Component analysis to see stiffness characteristic
- Dimension based assemble method (Gear, bearing)

Characteristic	Multi body beam force model
	Direct / Modal FE body
	Point load, Unbalance mass
	Measuring points
Diagnostic	Stiffness calculation



Housing Model

- Supports easy way to assemble all entities mounted on housing with stiffness & clearance condition
- Maintain "assembly condition" directly with Finite element model (*.dfmesh)
- Easy to set modal damping for every single mode (Frequency dependent damping)
- CAD geometry directly used for MeshFree housing

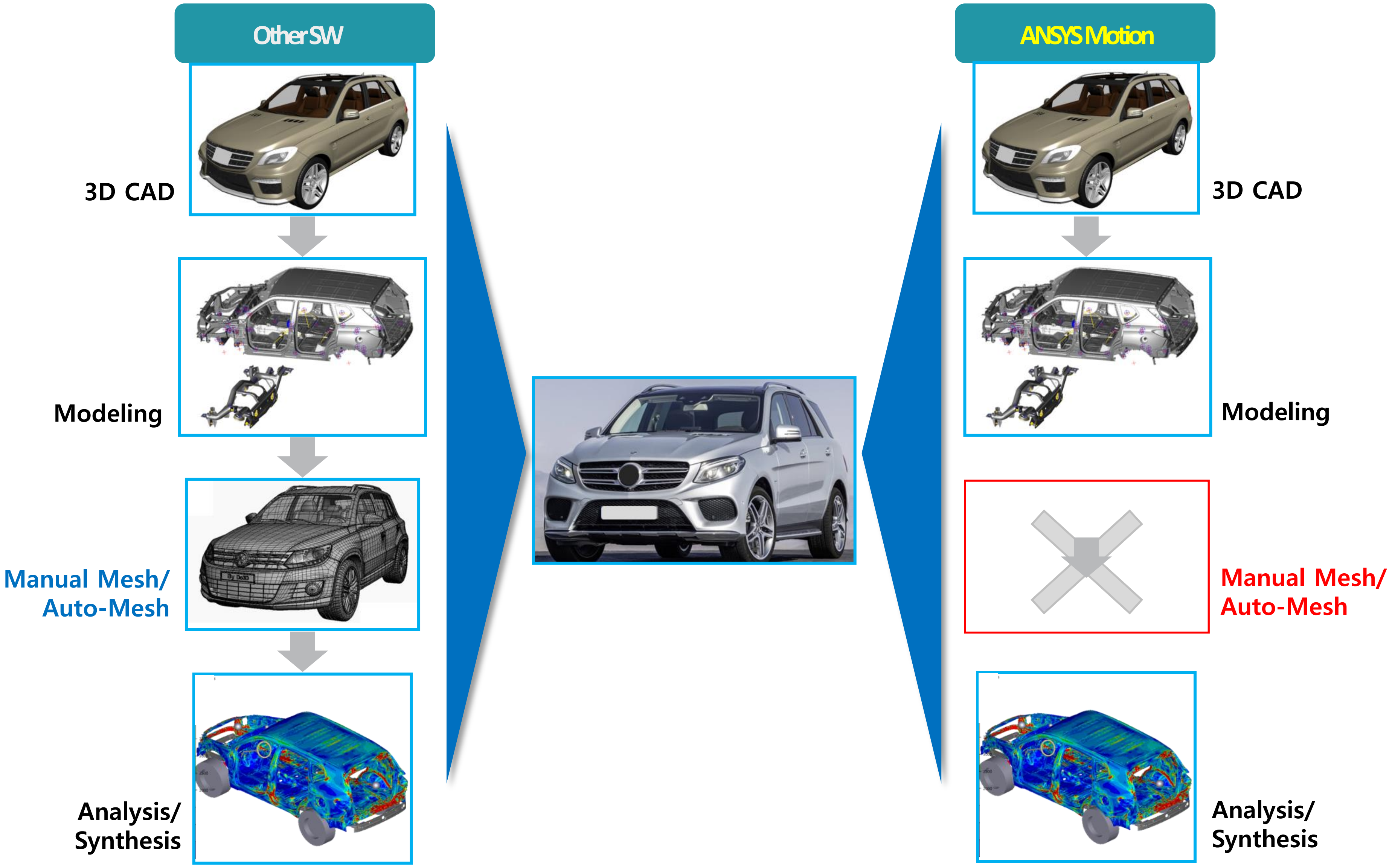


ANSYS Motion DRIVETRAIN Toolkit Capabilities

ANSYS Motion DRIVETRAIN toolkit gives the following functionality including libraries of standard gears and bearings from major manufacturers

	Functionalities	
GEAR	*Basic Gear designer (Gear geometry, Micro geometry, Tooth stiffness)*	
	Type (Spur, Helical for internal & external)	
	Design of Experiments (DOE) - tooth modification	
	Planetary Gear Modeling	Single Pinion
		Double Pinion
		Simpson / Ravigneaux
	Strength Calculation (Strength)	
	Web Stiffness Calculation	
	Additional Gear type	Cycloid
		Worm & Worm wheel
		Bevel (Spiral bevel, Hypoid)
Bearing	*Basic Stiffness model (Ball, Roller)*	
	Component Analysis	
	Libraries include KOYO, NSK, SKF, FAG	
	Life cycle Calculation	
	Full 3D detail model	
	Additional Types	Needle, 4 Point ball
		Thrust (Ball, tapered, needle)
Systems	*Misalignment, Tooth contact contour for Gear*	
	Various special output (STFT, Order Tracking, Misalign, DPPTE)	
	Color map (Waterfall expansion)	
	Chart performance for huge data handling	
	Tooth Contact Pressure at desired time	
	Export internal geometries	
	Various Contour type	
	Sound Pressure Level calculation	
	Window Options in FFT	
	Other basic components	

Ansys Motion EASYFLEX Toolkit



- ANSYS Motion EASYFLEX toolkit removes the need to manually mesh flexible parts within your system.
- For complicated assemblies meshing can be the main bottleneck in workflow
- Removing this bottleneck significantly reduces start-finish simulation time

Example Applications

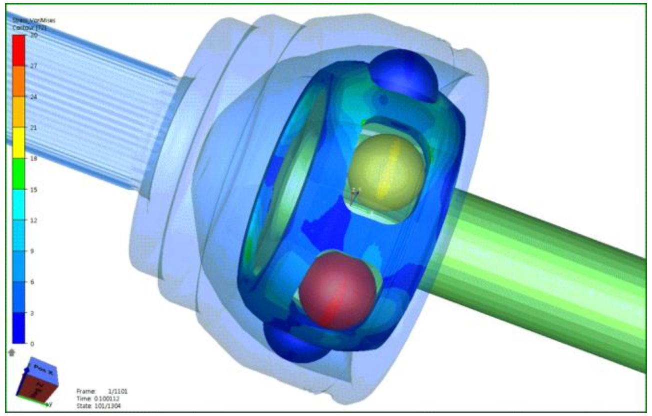
ANSYS Motion - Strength analysis of CV Joint.

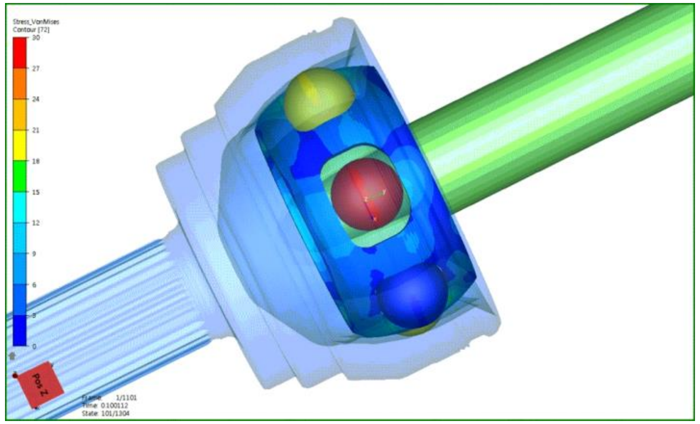
- **Analysis Purpose**
  - Reproduce the failure of a cage in CVJ system

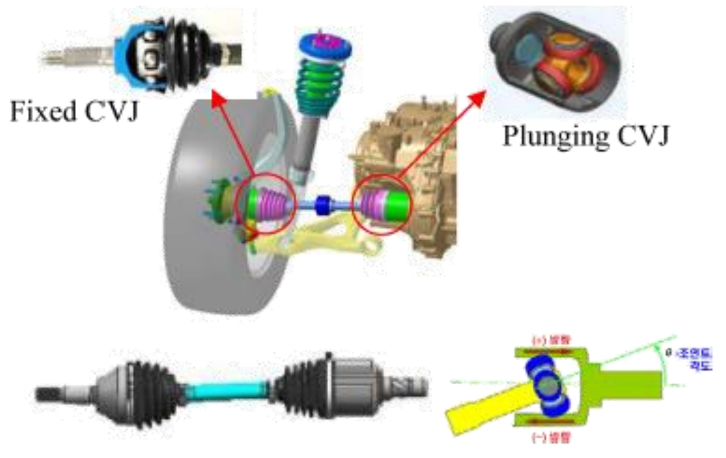
- **Major characteristics**
  - The stress is tested in the maximum articulation angle.
  - The maximum torque is applied on the shaft.
  - This system is highly non-linear due to contacts and rotation.

- **Develop a model**
  - General contact are used to represent the contacts between Inner Race and Ball, Inner Race and Cage, and Outer Race and Ball and Outer Race and Cage.
  - Cage is modeled as the flexible body by using solid elements.

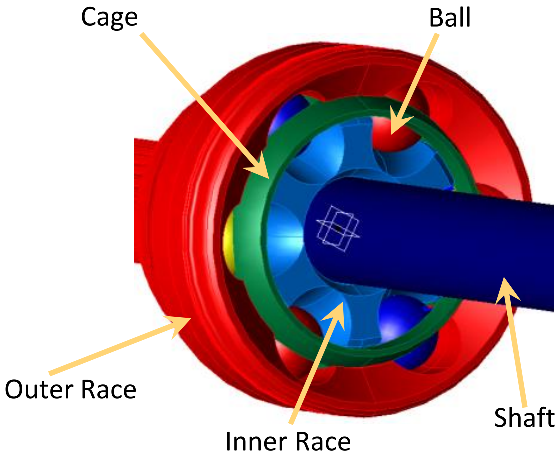
- **Simulation Results**
  - The stress of cage is calculated under the critical condition.







CVJ(Constant Velocity Joint).

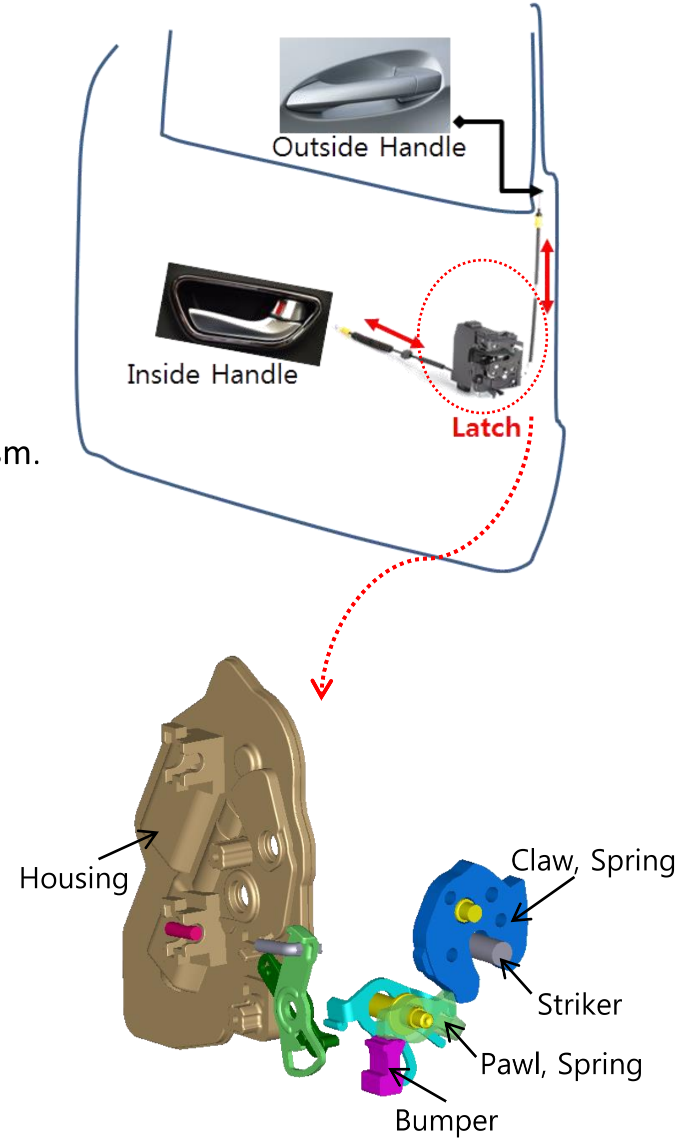


< Fixed CVJ >

ANSYS Motion - Door Latch

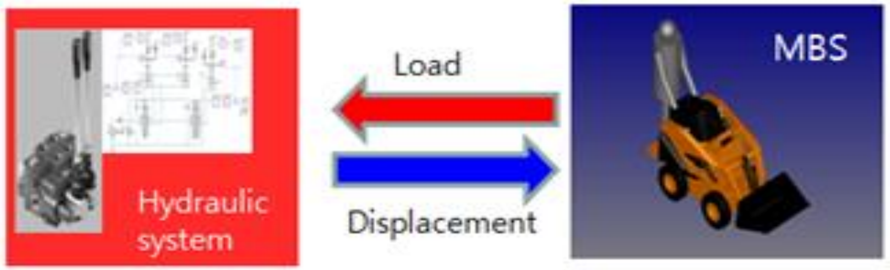
- **Analysis Purpose**
  - Predict the force applied on door handle to release door latch system by passengers. (Effort)
  - Investigate dynamic movement of each component inside of the system.

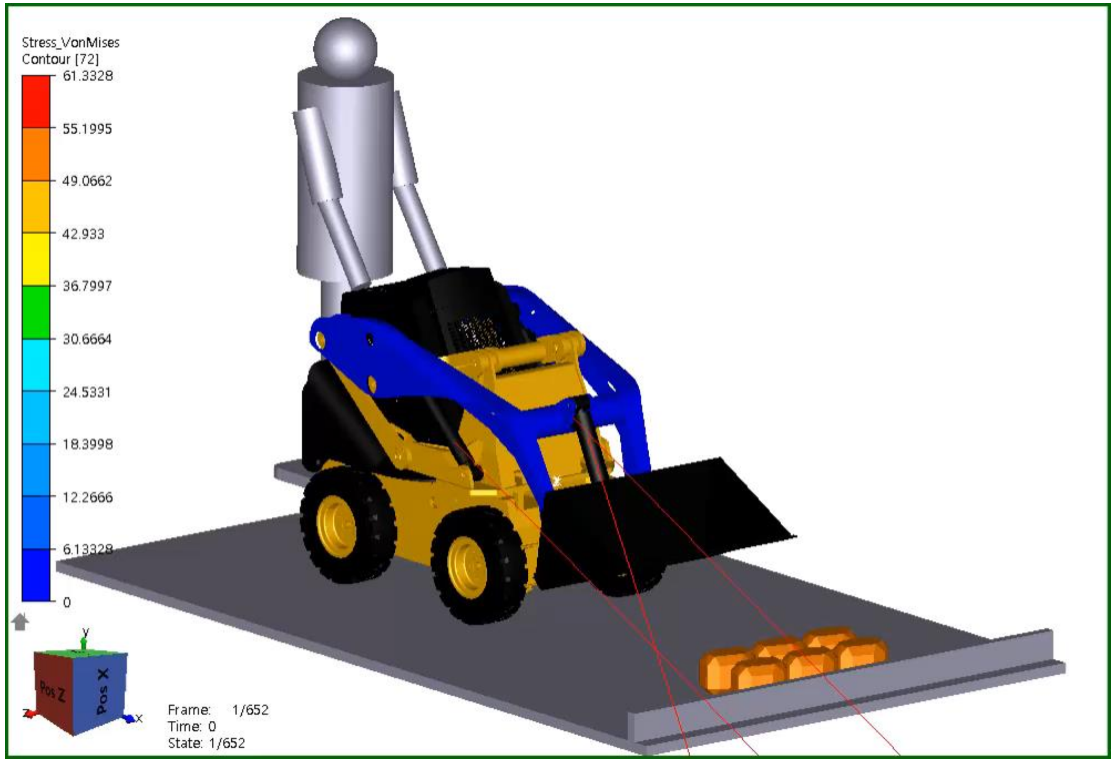
- **Simulation Details**
  - Deformation of each component is not important.
  - The maximum force magnitude which usually called “Effort” should be verified.
  - Latch system stiffness and friction force of each sliding part are important.
  - Profile shape of claw, pawl and rotational springs attached on part play a key role in the mechanism.



ANSYS Motion - Hydraulic System Performance with FMI

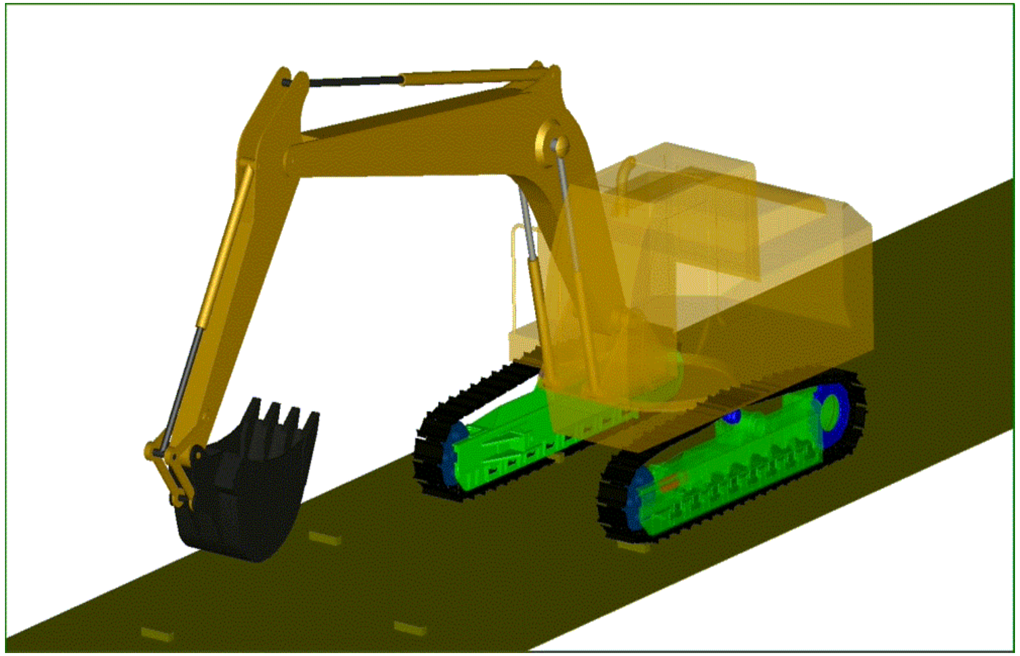
- **Analysis Purpose**
  - Evaluation of hydro actuator performance of mini loader using FMI method.
- **Major characteristics**
  - Ansys Motion calculates the load and SimulationX calculates the speed.
- **Develop a model**
  - Vehicle and Structure models are modeled as ANSYS Motion.
  - Hydraulic circuit and driver models are modeled as SimulationX.
  - Data exchange between ANSYS Motion and SimulationX is done through FMI
- **Simulation Results**
  - Strokes of Bucket and Boom is well matched with input strokes.
  - Loads required to represent strokes of bucket and boom were calculated.

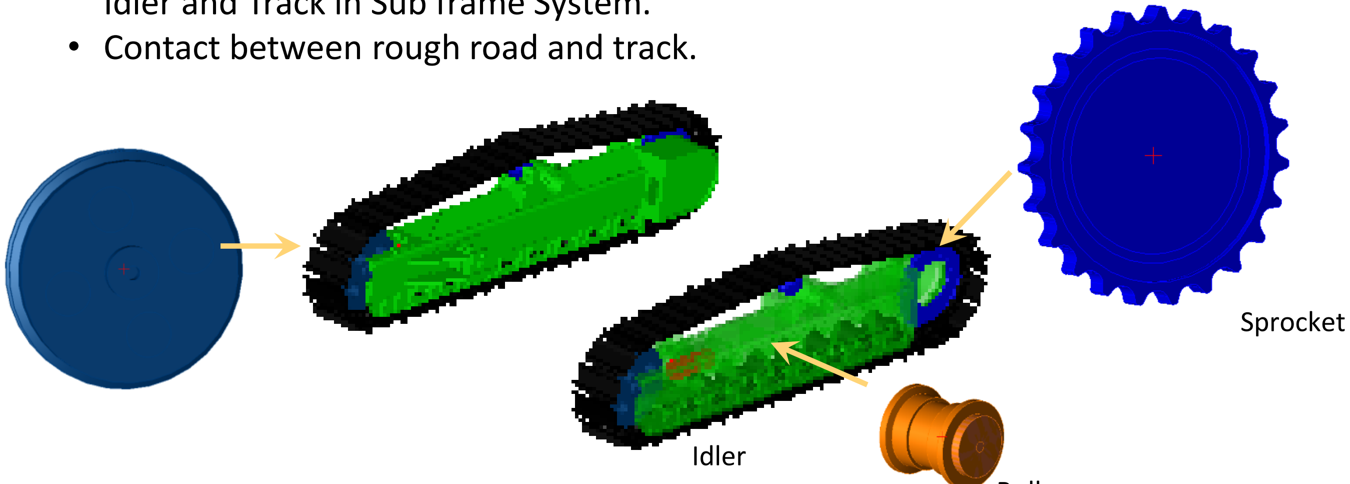




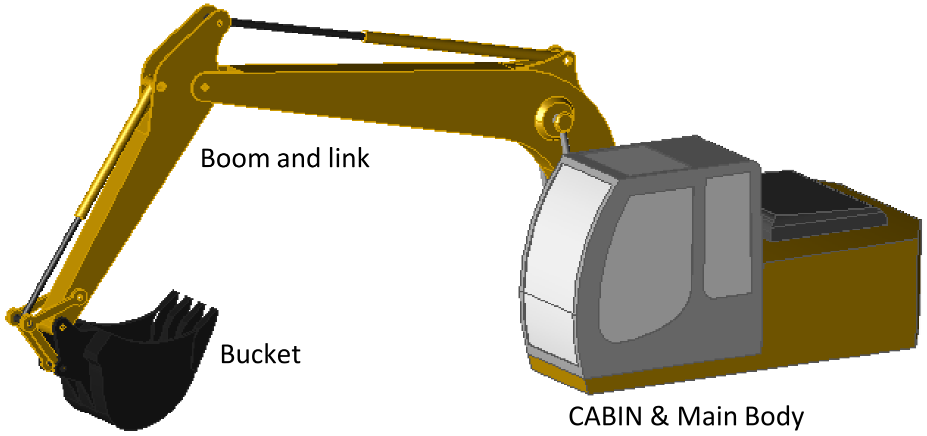
ANSYS Motion Links - Dynamics analysis of excavator system on a rough road

- **Analysis Purpose**
  - Calculate the forces applied on the sub-frame parts under rough road conditions
- **Major characteristics**
  - Tracked vehicle is controlled for straight running.
  - This system is highly non-linear due to contact.
  - 1,300 contact pairs are required.
- **Develop a model**
  - Sub frame is modeled using Ansys Motion Links toolkit.
  - Idler tension spring is modelled using a spring element.
  - General contacts are used to represent the contacts between Roller, Sprocket, Idler and Track in Sub frame System.
  - Contact between rough road and track.





< Sub frame System >



< Upper Component >

ANSYS Motion Drivetrain - Automotive Synchroniser

- **Analysis Purpose**
  - The simulation goal is to analyze synchronization characteristic when DCT gear box is shifting.

- **Major characteristics**
  - Synchronizer analysis contains the contact between sleeve teeth and blocking teeth, meshing period and the impact of sleeve teeth and clutch gear teeth.
  - The cone shape and contact characteristics determine the meshing time.
  - Synchronizer moved due to the operating force.

- **Develop a model**
  - Bodies are connected by constraints on each other.
  - Contacts are defined between each gear.
  - Input shaft is rotating as 628rpm.(Motion)
  - Sleeve is rotating as 964rpm.(Initial velocity)
  - Operating force is applied

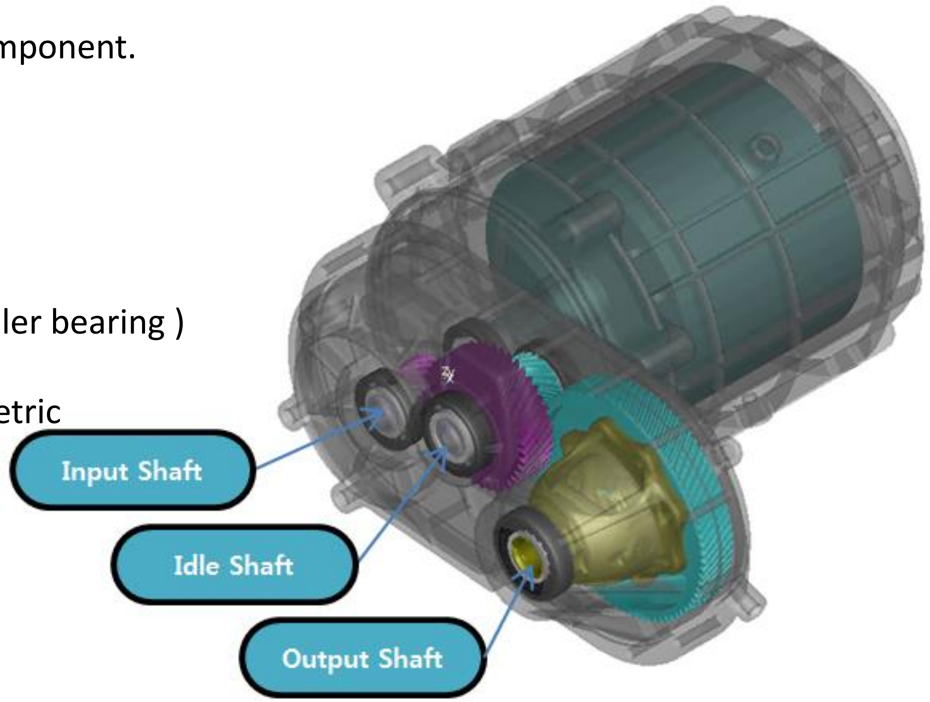
- **Simulation Results**
  - Meshing time(period) is 0.0683sec.
  - The gear set (6th stage) is synchronized well.

ANSYS Motion Drivetrain - Whine of an E-Axle

- **Analysis Purpose**
  - This simulation goal is to analyze a whine noise characteristics of E-axle which consists of the gear train and motor system.

- **Major characteristics**
  - Gear excitation force is calculated while considering the misalignment under the variable driving condition.
  - The misalignments are determined by the stiffness of each component.
  - Motor variable torque is able to estimate by its specifications.

- **Develop a model**
  - Drivetrain toolkit had been used in order to represent major components characteristics.
    (2-External gear set, 4-Deep groove ball bearing, 2-Tapered roller bearing)
  - The case is modeled by FE modal body(Linearized body)
  - Symmetric shafts are modeled by the beam shaft, and asymmetric shaft is modeled by FE modal body(Diff case)
  - Driving RPM increases from 0rpm to 10,000rpm.
  - Also, driving RPM considers the motor specifications.
  - Torque is loaded with 200Nm at output shaft.

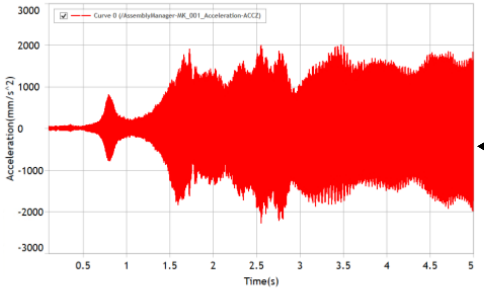


< Specifications of motor>

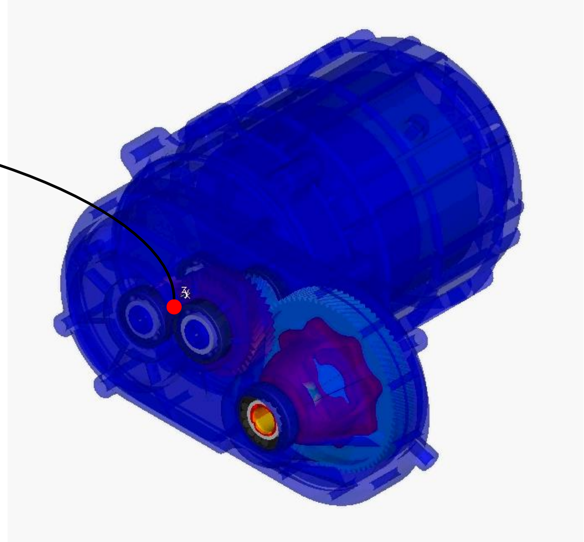
Whine of an E-Axle Cont…

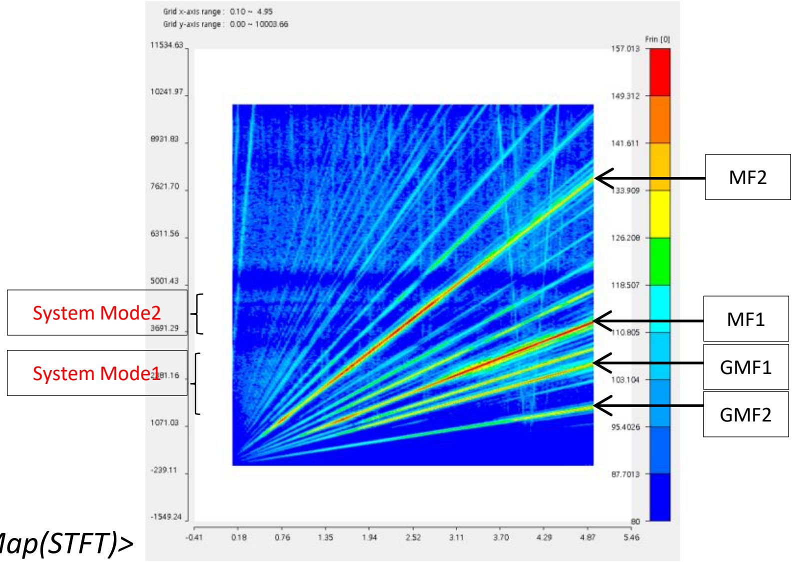
- **Simulation Results**
  - The color map which is created by the acceleration data shows the whine noise of GMF and MF.
  - The harmonics of GMF and MF are shown well.
  - Motor excitation force is estimated as the main noise source of the system.
  - The noise of the 1st gear set is higher than that of 2nd gear set.
  - The vibrations of system modes are shown at the specific frequencies.

GMF : Gear Mesh Frequency
MF : Motor Frequency

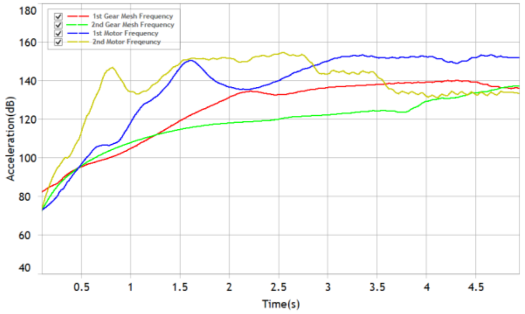


< Z Acceleration raw data >

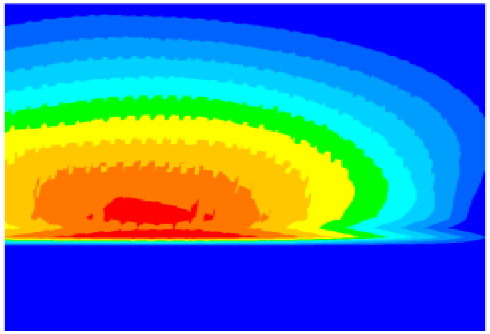




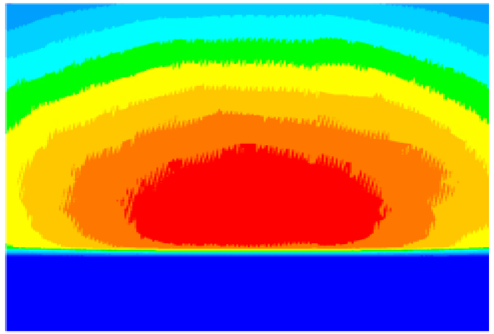
< Color Map(STFT)>



< Order tracking>



<Tooth Pressure(1st)>



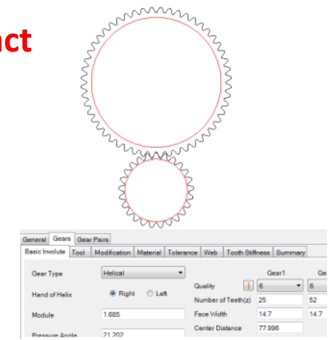
<Tooth Pressure(2nd)>

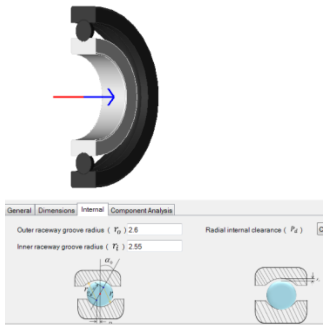
ANSYS Motion Drivetrain - Dynamic NVH

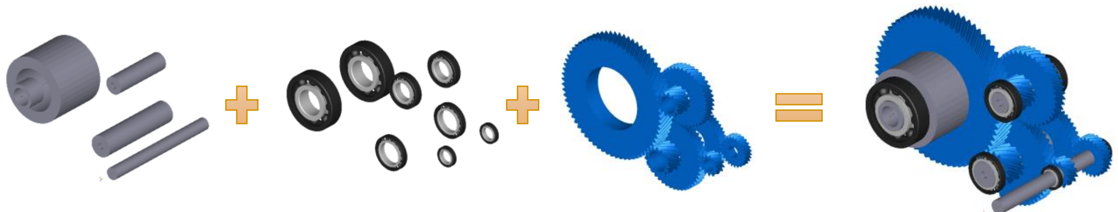
NVH Analysis

✓ **Rattle noise due to contact**

■ Drivetrain Toolkit
☞ External Gear (Spur, Helical)
☞ Beam Shaft
☞ Rolling Bearing



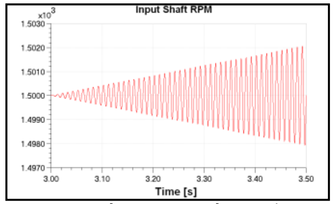




Shaft **Bearing** **Gear** **Assembly**

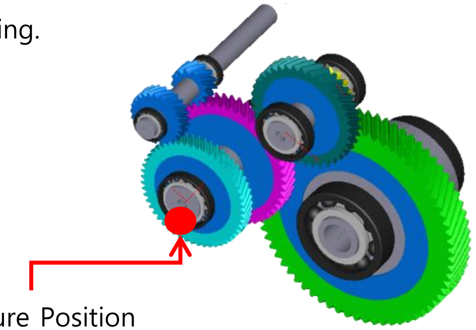
<Transmission Model>

■ Applied test condition
☞ Applied angular acceleration
☞ Result measure the force of component in bearing.
☞ The input shaft angular acceleration increases from 0 to 3000rad/s^2 at 1500 RPM by 100Hz



<Angular Acceleration>

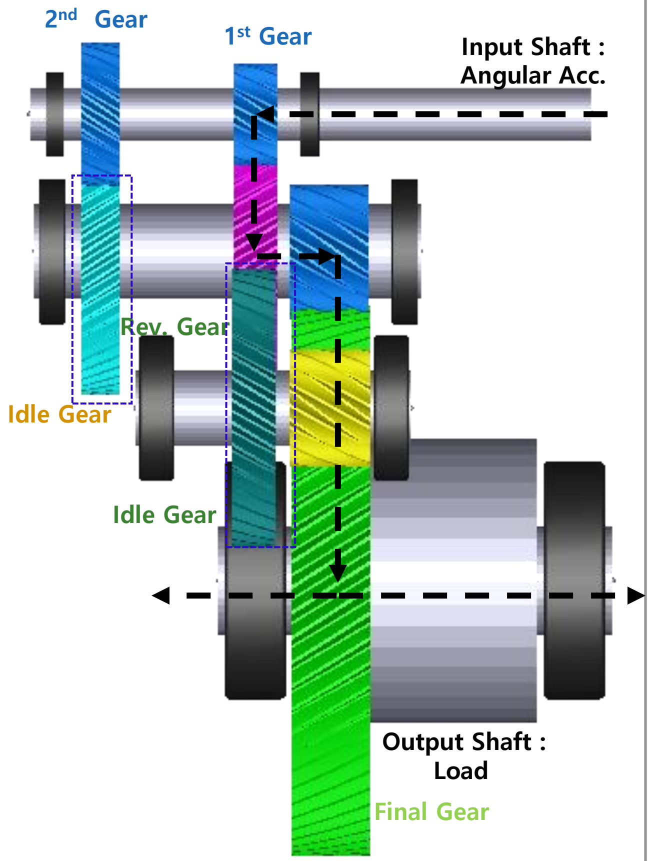
Time (0:5sec)
→ 100Hz Acc
(0:3000rad/s^2)



Measure Position

<Measure Position of Bearing Force>

■ Power Flow and Idle Gear
☞ Synchronizing Condition : 1st gear
☞ Idle Gears : 2nd Gear, Rev. Gear



<Power Flow>

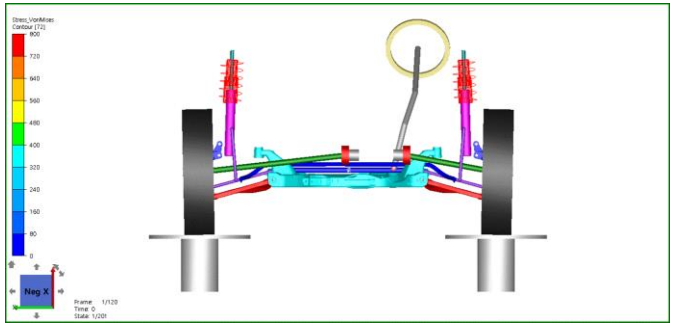
ANSYS Motion Car - Automotive Kinematics and Compliance (K&C), Ride and Handling (R&H) Analysis

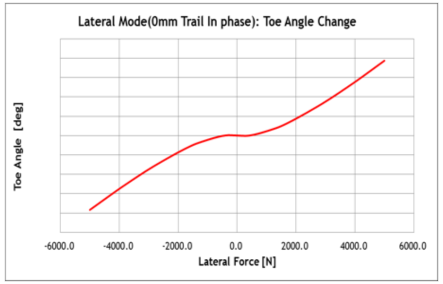
- **Analysis Purpose**
  - Calculate kinematics and compliance characteristics of chassis system and riding and handling performance of the automotive system

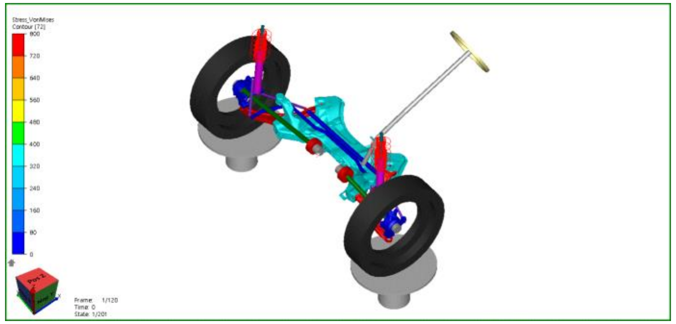
- **Major characteristics**
  - Car toolkit provides various K&C and R&H simulation scenarios.
  - General entities such as rigid body and flexible(modal & nodal) body are used in car model.
  - Various templates such as front/rear suspension, tire, steering, chassis, brake system and test rig templates should be required.
  - Simulation results are presented by table and graph.

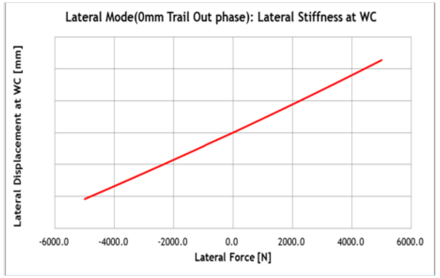
- **Develop a model**
  - Macpherson and multi link type of suspensions are used in the model. And other templates such as steering, anti roll bar and wheel are also used in the model.
  - Anti-roll bar is modeled as the flexible body.
  - The sub-systems are modeled from predefined templates.

- **Simulation Results**
  - Toe angle and lateral stiffness are calculated through K&C analysis.
  - Lateral displacement and acceleration are calculated through R&H analysis



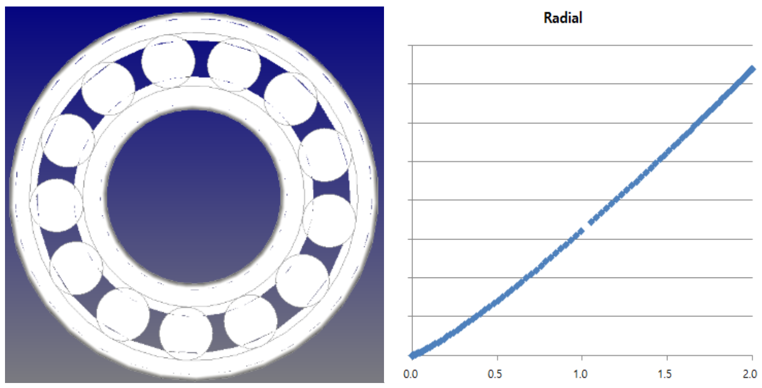




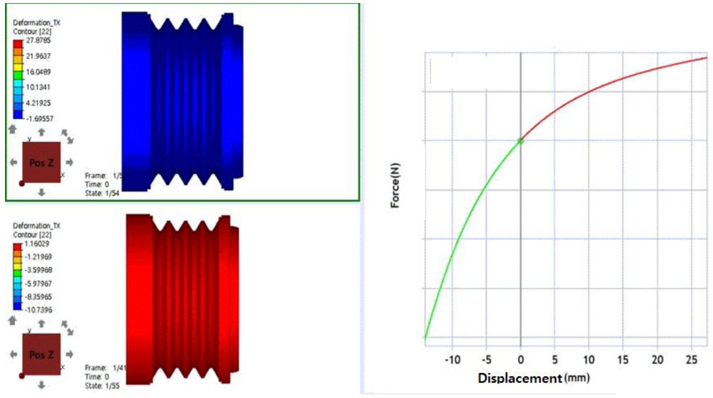


ANSYS Motion EasyFlex - Strength analysis of Vibro-hammer

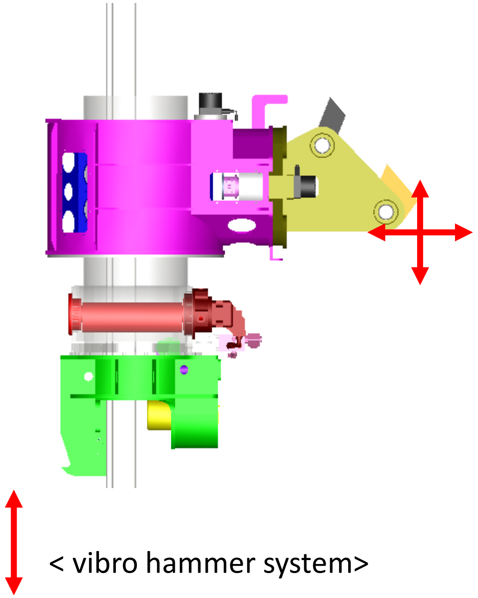
- **Analysis Purpose**
  - To calculates stress of main parts of vibro-hammer considering dynamics motion
- **Major characteristics**
  - The system is excited by the centrifugal force of ring structure
  - Main parts are modeled by flexible bodies with EasyFlex
- **Develop a model**
  - The stiffness of roller bearing is calculated and modeled as the bush entity.
  - The stiffness of anti-vibration rubber is calculated and modeled as the bush entity.
  - The upper frame, lower frame, supporter, and motor box are modeled as flexible bodies by using EasyFlex.



< roller bearing>



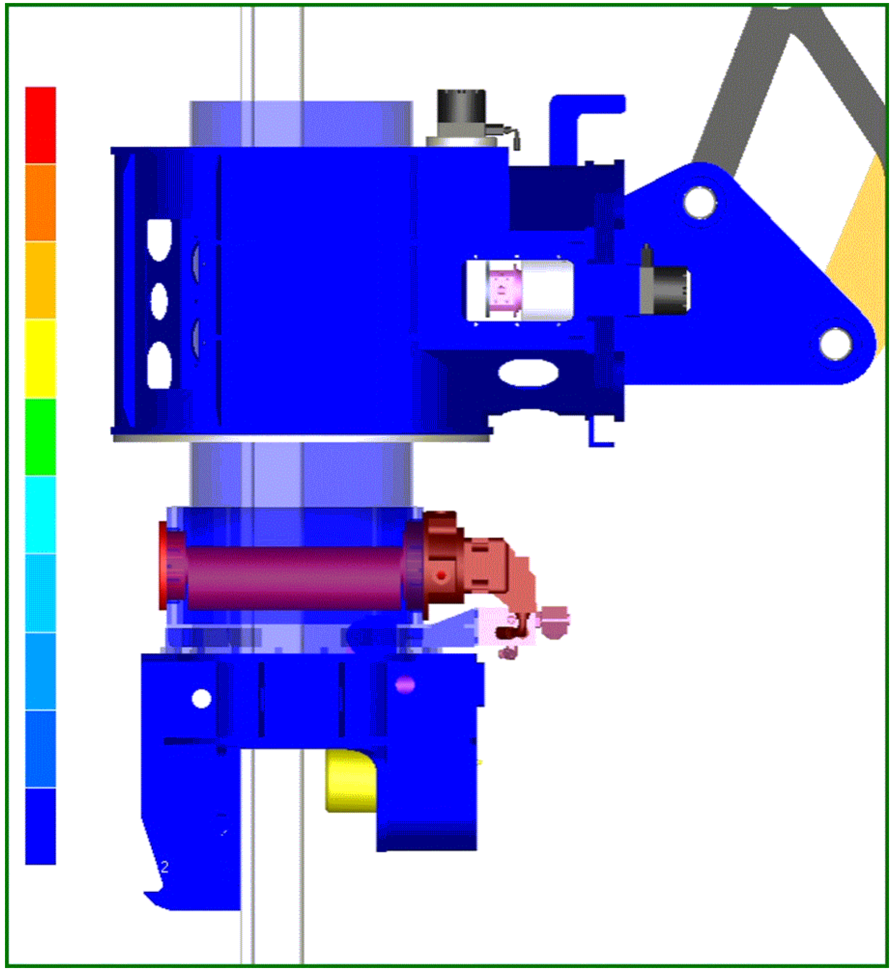
< anti-vibration rubber>

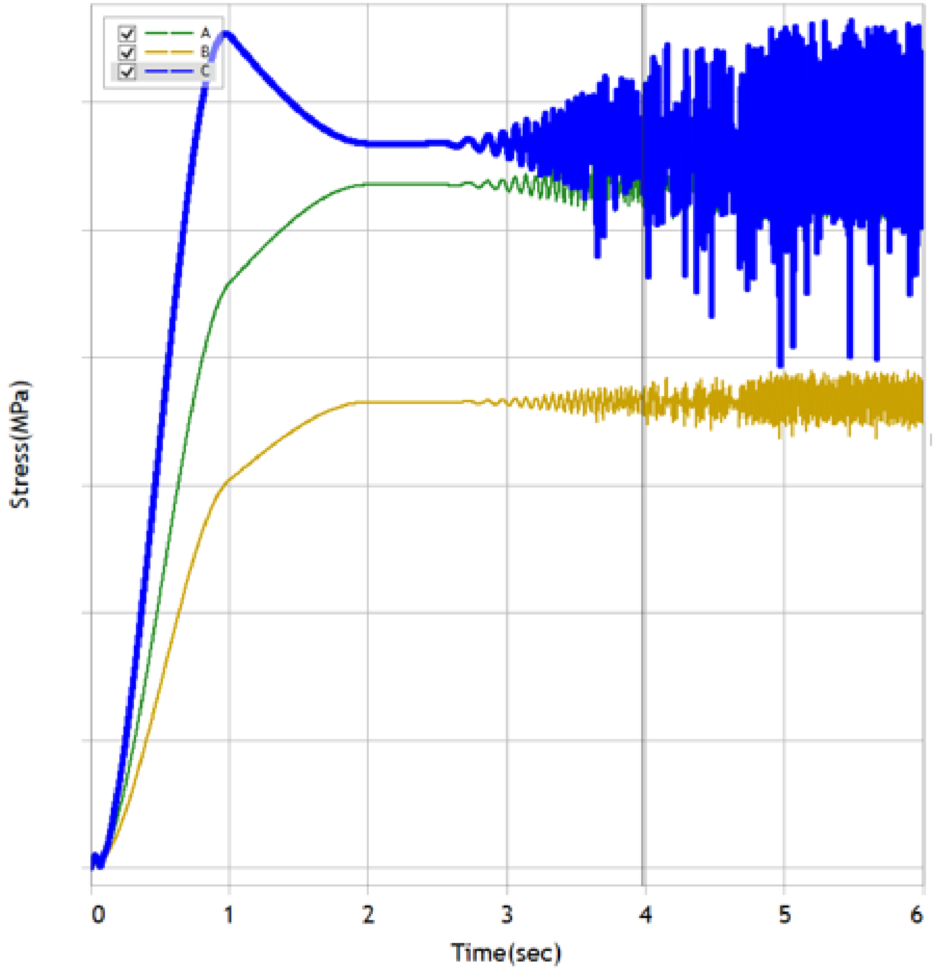


< vibro hammer system>

Strength analysis of Vibro-hammer

- **Simulation Results**
  - The stress of lower frame is highest and its shape is changed to improve the durability.

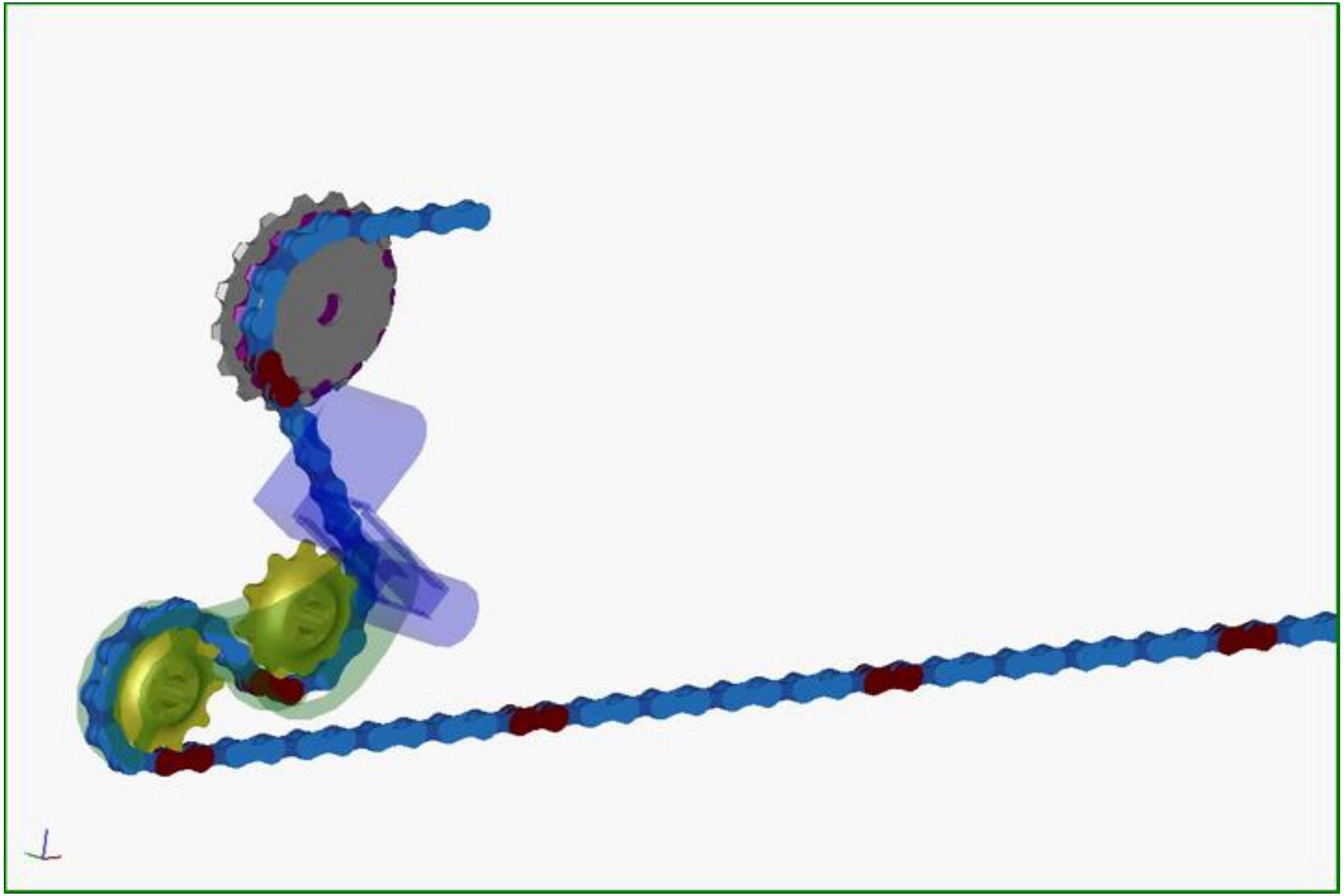




< Stress result and graph on specific location >

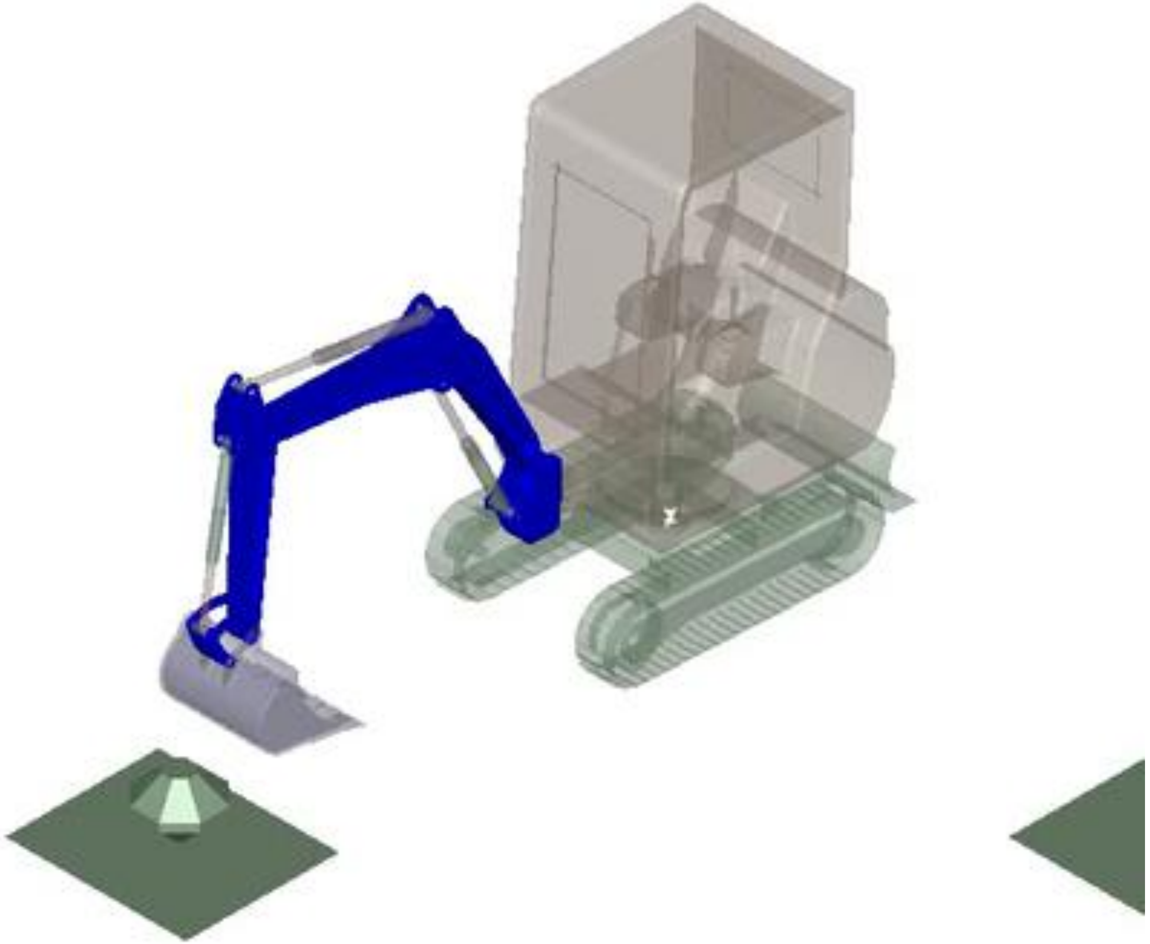
ANSYS Motion
Miscellaneous Use Cases

ANSYS Motion



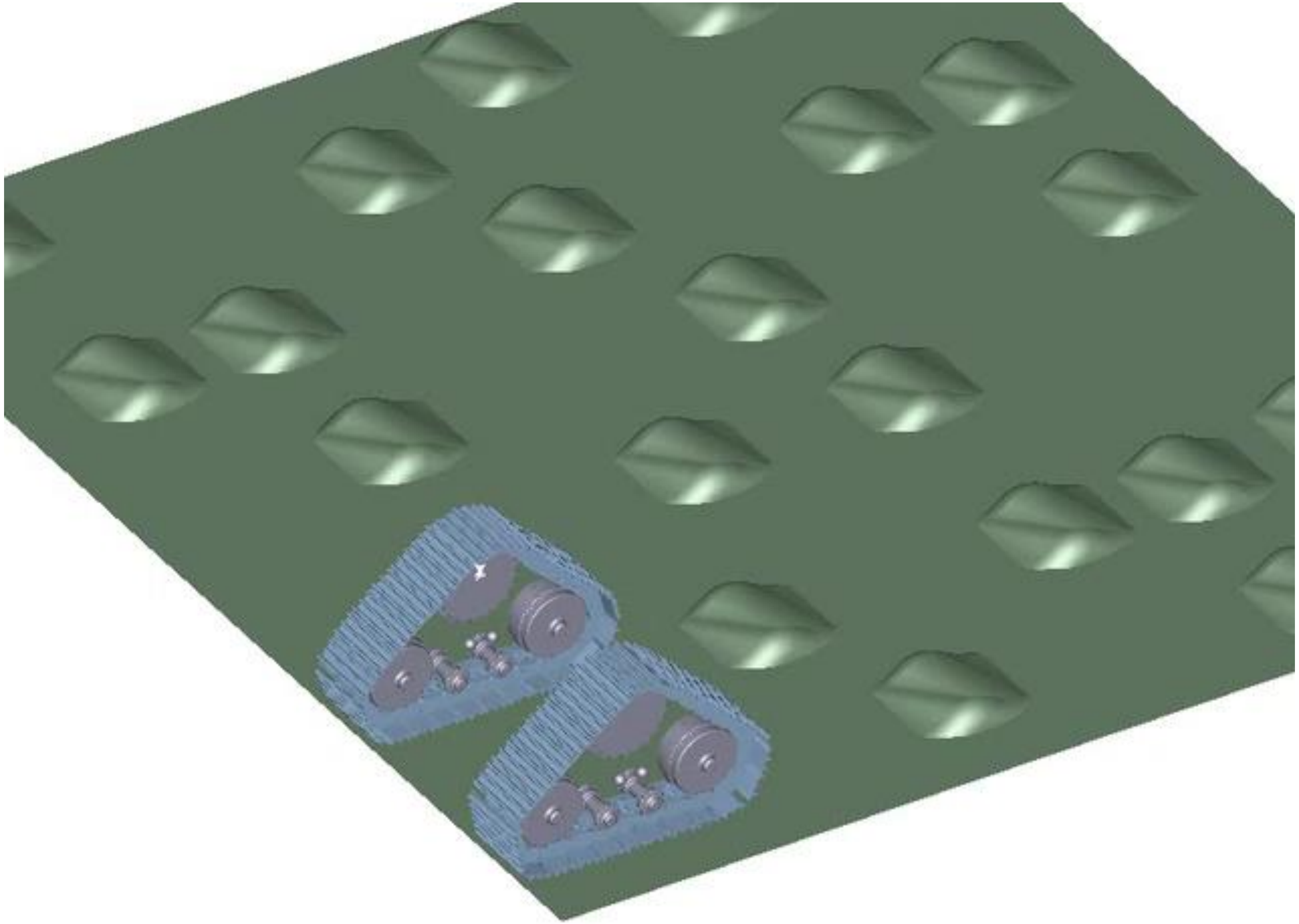
Derailleur gear change

ANSYS Motion



Excavator

ANSYS Motion



Flexible caterpillar track behaviour