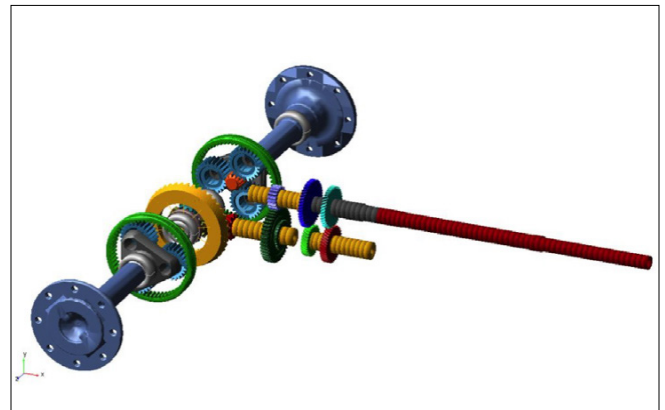


Case Study: **TürkTraktör/Bias Engineering**

Adams/Machinery Predicts Results of Driveline Testing in Only Two Weeks

Overview

With annual production of 50,000 tractors, TürkTraktör is the largest producer of tractors in Turkey. The powertrains of the company's tractors contain many gear pairs and gear groups that transmit torque through the system. For example, the transmission group includes spur and helical gear pairs. Next the torque is transmitted to the differential via a hypoid gear pair. After the differential, a planetary gear group reduces the torque. The torque is transmitted through shafts between gear pairs and most of the shafts are fastened with multiple bearings to the chassis.



Adams model of tractor powertrain

“We selected Adams as the simulation tool because Adams parametric models make it very easy to evaluate the performance of alternative designs. Adams also provides the ability to utilize finite element models from external programs to take flexibility of a mechanism into account.”

Hasan Akce, Simulation Engineer for TürkTraktör

Challenge

In design of a new tractor, the engine and powertrain must be tested under varying load and power conditions for a considerable period of time. The process of building the prototype and running the durability tests takes several months. If a problem is seen during the testing process, then the prototype needs to be modified and the tests need to be run again. The time and cost involved in this process encourages engineers to design the powertrain very conservatively in an effort to meet the design specification with the first design. The problem with this approach is that it tends to lead to a design that is heavier and more expensive than necessary. It's also difficult or impossible to identify excess material in the part during physical testing. The physical test program only points out the areas of the design that are under-designed while the areas that are over-designed are difficult or impossible to identify. TürkTraktör management saw the need for a simulation capability that would enable the design team to evaluate the performance of alternative designs prior to building prototypes.

Solution

TürkTraktör contracted with Bias Engineering, the leading provider of engineering services in Turkey, to develop an accurate dynamic model of the powertrain system that could be used to evaluate the performance and durability of the proposed designs prior to prototyping.

Hunkar Yurt, Simulation Engineer for Bias Engineering, worked together with Hasan Akce, Simulation Engineer for TürkTraktör. “We selected Adams as the simulation tool because Adams parametric models make it very easy to evaluate the performance of alternative designs,” Akce said. “Adams also provides the ability to utilize finite element models from external programs to take flexibility of a mechanism into account.”

Yurt modeled the spur and helical gear pairs using the Adams/Machinery gear module. He modeled these gears by specifying the gear type, selecting simple or detailed modeling method, selecting the contact modeling method, defining the location and geometric parameters, choosing the gear material, etc. He modeled the bevel, hypoid and planetary gears by starting with their solid model geometry and adding contact pairs with the impact formulations. The hypoid gear pair and one of the planetary gear pairs were modeled as flexible bodies in MSC Nastran and the modal neutral files were imported into Adams. This made it possible to calculate the stress distribution on these gears. After the simulation was completed, fatigue life of the pinion gears was calculated by exporting Adams REQ files into nCode DesignLife for calculation of fatigue life based on Dang Van theory.

The flexibility of shafts was included in the calculations through the discrete flexible

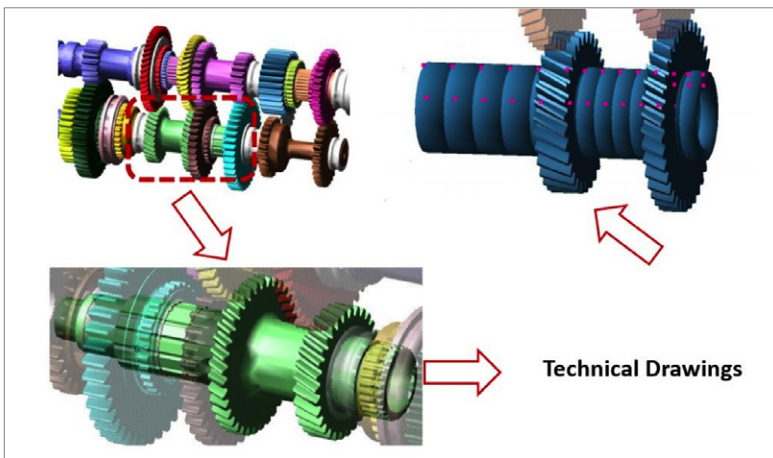
Key Highlights:

Product: Adams

Industry: Machinery/Heavy Equipment

Benefits:

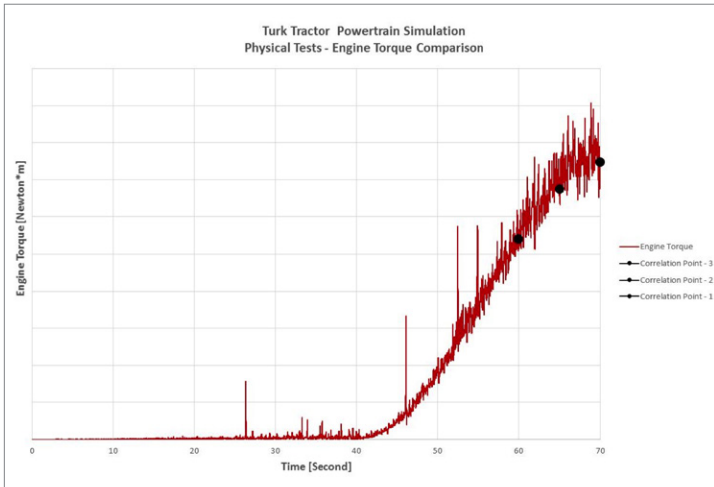
- Accurately predict the results of a testing campaign that takes several months with only two weeks of simulation
- Faster speed and lower cost of simulation will also give them the ability to evaluate more design alternatives than was possible in the past
- Adams/Machinery Gear module was leveraged to quickly and easily model the gear pairs in the driveline system
- Bearing was conveniently generated using the Adams/Machinery bearing library by referencing the product code



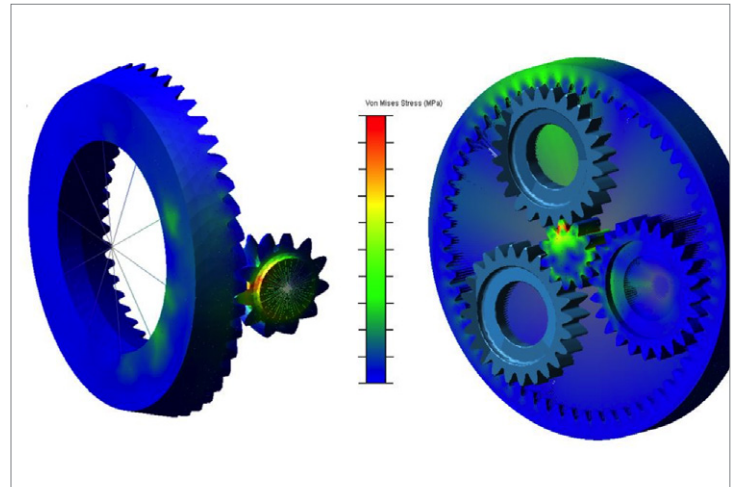
Shaft models



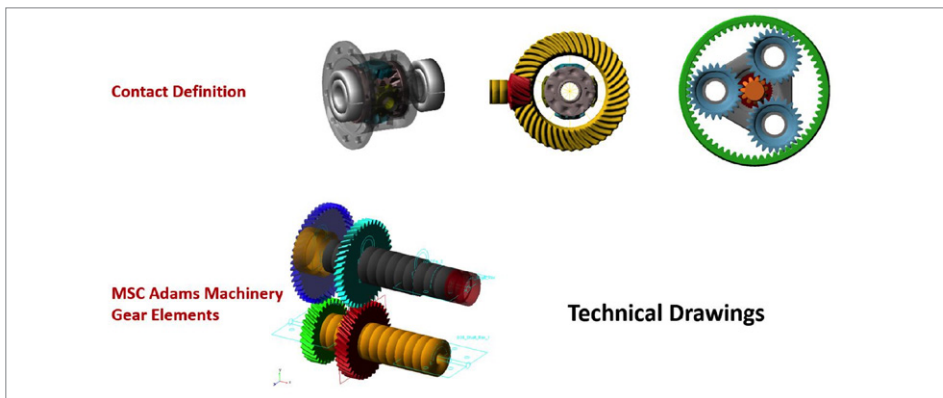
One of the latest products



Simulation predictions of engine torque correlated well with physical tests



Stress results



Gear Models

links approach in Adams. A discrete flexible link consists of two or more rigid bodies connected by beam force elements. The use of flexible shafts makes it possible to more accurately calculate bearing loads and investigate the eccentric behavior caused by shaft deflection. Most of the bearings were modeled as kinematic constraints. During initial simulations, engineers recognized that a pinion gear bearing was exposed to high loads. At this point the decision was made to take advantage of the Kisssoft integration in the Adams/Machinery module to model the nonlinear stiffness of rolling bearings within the Adams/Machinery environment. The bearing was selected from the Adams/Machinery Bearing library by referencing the product code and selecting the detailed modeling method which

includes flexibility. Adams/Machinery also calculated the service life of the bearing. The initial model was created for validation purposes and was based on a tractor which was already in production. Yurt ran the model under the same conditions as tests that had been performed at TürkTraktör. The simulation results matched up very closely to physical testing for values such as torque and power.

Results/Benefits

With the simulation model validated, TürkTraktör engineers will begin using it as part of the design process. "We are planning to use simulation in future development projects to minimize lead time and cost," Akce said. "We have concluded that we can accurately predict the results of a testing

campaign that takes several months with only two weeks of simulation. The faster speed and lower cost of simulation will also give us the ability to evaluate more design alternatives than was possible in the past. This will make it possible to reduce the weight and cost of some parts and to increase the durability of others. Of course, the design will be subjected to durability testing as a final validation step."

About Turk Traktor

TürkTraktör manufactures and distributes farm tractors, harvesters, and other agricultural machinery and equipment under the New Holland, Case IH, Steyrand TürkTraktör brand names. TürkTraktör is a joint venture of Koç Holding and CNH Industrial NV that has operated in Turkey since 1954. With 137 tractor dealers offering the New Holland and Case IH brand, 98 spare parts dealers, and 481 service dealers, TürkTraktör now has the largest tractor dealership network in Turkey. TürkTraktör also has the largest product range in Turkey.

About Bias Engineering

Bias Engineering provides engineering services in Turkey including computer aided engineering solutions and test and measurement systems and sensors. Bias engineering also designs and builds custom machines mainly for the defense and manufacturing industries.

For more information on Adams and for additional Case Studies, please visit www.mscsoftware.com/adams

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