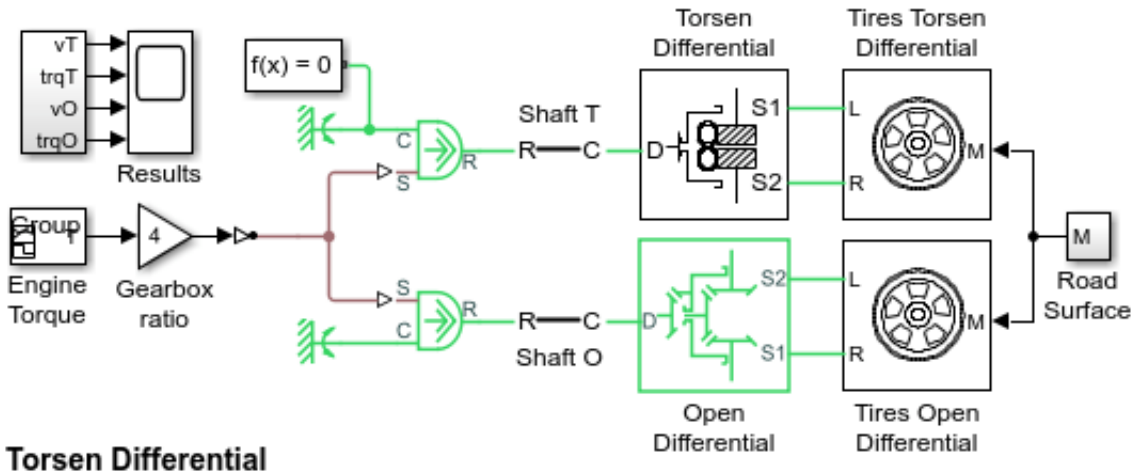
Torsen Differential

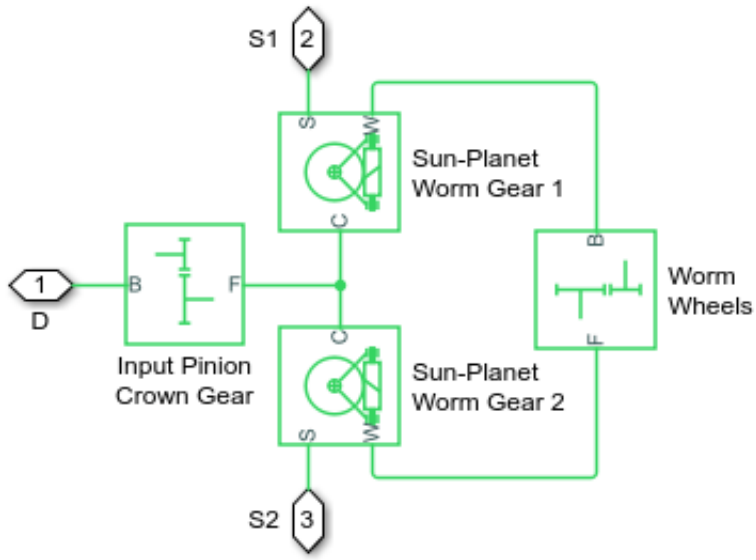
This example shows a comparison between the behavior of an open differential and a Torsen limited slip differential. The Torsen differential is modeled using components from the Gears library in Simscape™ Driveline™. Slip is limited in the Torsen differential because it uses non-backdrivable worm gears, which are modeled by Sun-Planet Worm Gear components. The result is higher torque applied to the wheel with greater traction, and identical speeds for the left and right axles.

The test surface includes an icy patch under the left wheel. This effect is introduced using the variable-friction coefficient variant of the Tire (Magic Formula) block. Comparing the two differentials on the same test surface shows that the Torsen differential locks up under the split surface road condition.

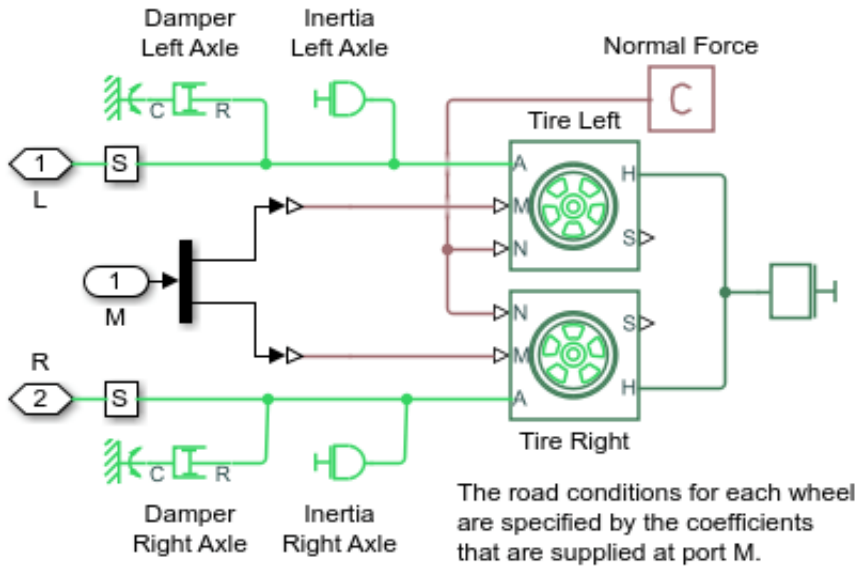
Model



Torsen Differential Subsystem

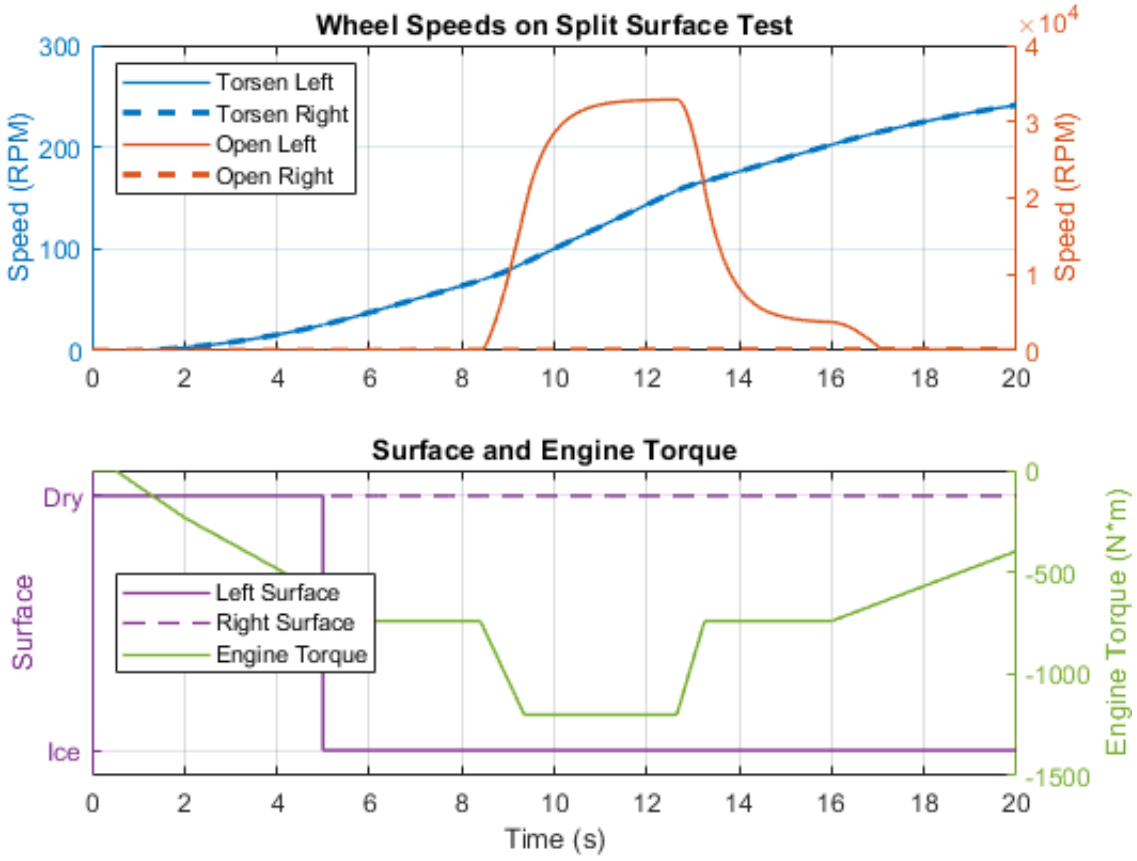


Tires Subsystem

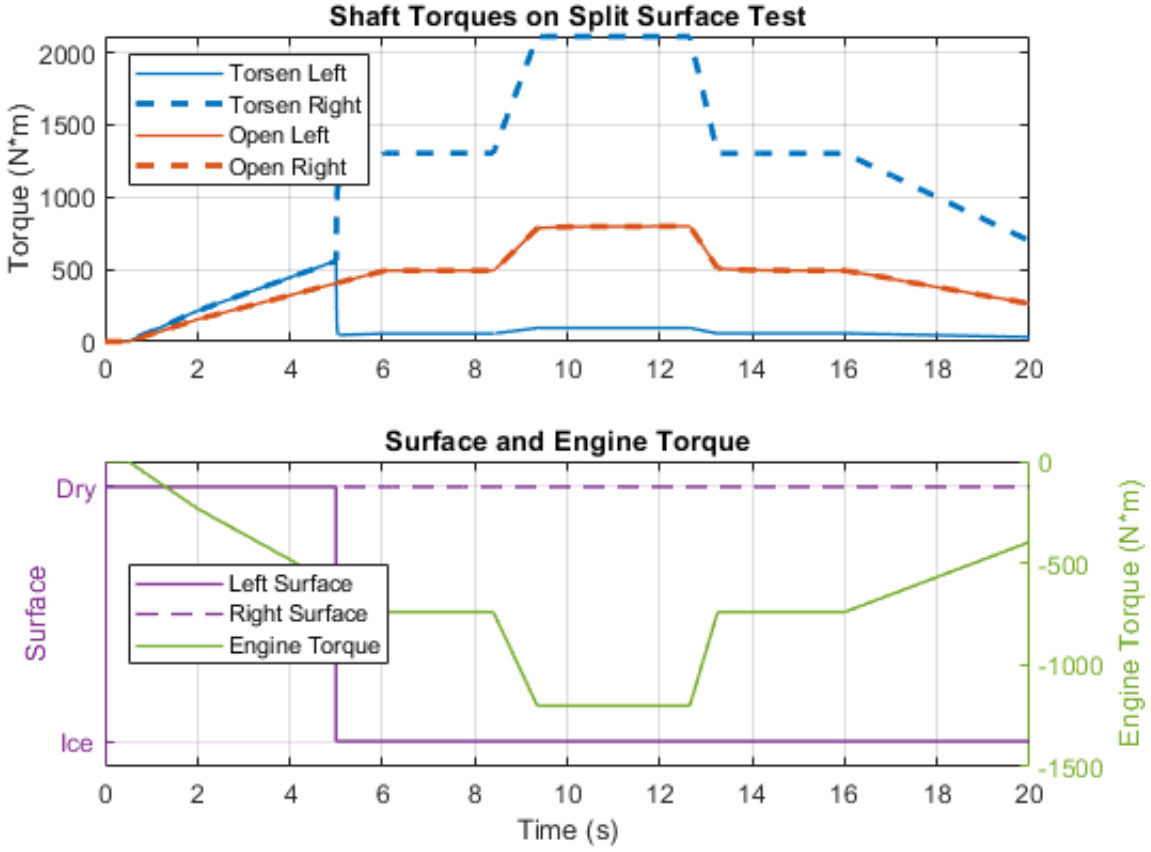


Simulation Results from Simscape Logging

The plot below shows the performance of open and Torsen differentials on a split surface (ice and tarmac). The Torsen differential locks instantly when the left wheel encounters the icy patch, and the left and right wheel speeds remain the same. The open differential does not lock and applies the same torque to both shafts. The result is that the left wheel loses traction on the icy patch and slips.



The plot below shows the performance of open and Torsen differentials on a split surface (ice and tarmac). The Torsen differential locks instantly when the left wheel encounters the icy patch. As a result, the wheels turn at the same speed and more torque is applied to the wheel on the high friction surface. The open differential does not lock. The same torque is applied to both wheels, resulting in the left wheel slipping extensively on the icy patch.


Shaft Torques on Split Surface Test
Torque (N*m)
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20
Torsen Left
Torsen Right
Open Left
Open Right
Surface and Engine Torque
Surface
Dry
Ice
Engine Torque (N*m)
0
-500
-1000
-1500
Left Surface
Right Surface
Engine Torque
Time (s)