US Army Corps
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Engineer Research and
Development Center

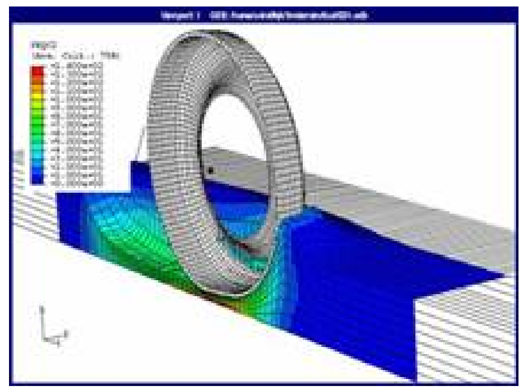
Tire–Terrain Modeling

Description

ERDC's Cold Regions Research and Engineering Laboratory (CRREL) uses a three-dimensional model of a deformable tire on a deformable surface to predict vehicle mobility, terrain deformation under vehicle loads, off-road tire design, and tire specification for specific off-road machinery. CRREL studies focus on the vehicle/terrain interface for wheeled, tracked, air cushion, and hybrid vehicles operating on ice, deep and shallow snow, and thawing soil terrains. These studies are relevant and timely because vehicle mobility on unpaved surfaces is important to the military and for agriculture, forestry, mining, and construction industries.

Capabilities

CRREL utilizes field and laboratory tests, together with analytical and numerical tools, to evaluate the tractive, resistive, and maneuvering forces on both the vehicle and the terrain.



Actual tire–terrain interaction and finite element model of tire–terrain interaction.

Snow is marked to measure deformation after vehicle passage.

Supporting Technology

This model provides for the deformable nature of both the tire and terrain, simulates the important three-dimensional characteristics of the interaction, and has an efficient tire model to allow efficient tire rolling simulations. Because both terrain and tire are highly deformable, a rigid approximation of either is a gross oversimplification that yields erroneous contact conditions critical to the solution. A three-dimensional analysis is important because it allows a highly deformable surface material (mud, snow, or soft soil) to realistically contact and resist tire movement similar to actual conditions. This contact has been shown to have a significant impact on the rolling resistance.

This model uses an empirically determined composite material property to simulate the tire rather than modeling individual tire components (tread, sidewalls, reinforcement, etc.). The result is an efficient model that enables the tire to accurately roll over obstacles and/or distances of 20 meters in only minutes of computational time. Recent advancements in finite element tire–terrain contact formulations, faster computers, and tire modeling efficiencies have made this type of simulation possible. Results have been compared to field measurements of tire forces, deflection, and contact area for both hard and deformable surfaces with very good results.

Benefits

These studies help to enable the prediction of vehicle performance on terrain over a wide range of weather and surface conditions (e.g., will the vehicle get stuck, how much traction is available to climb or pull, what are the power requirements?) and help to determine the consequences of vehicle trafficking, including rut formation, shearing/tearing of roots, soil compaction, and the effects of these factors on vegetation and erosion.

ERDC POC(s)

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