Abaqus-EDEM Coupling: Virtual Equipment Design using Realistic Bulk Material Loads

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What is EDEM?

- Bulk material simulation software
- Powered by Discrete Element Modelling (DEM) technology
- Used for virtual testing of equipment design
A World of Bulk Materials
The Challenge of Bulk Materials

Material type and behavior results in forces on equipment

Material force cause stresses and strains in the system, influencing structural integrity and performance
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Material type and behavior results in forces on equipment.

Material force cause stresses and strains in the system, influencing structural integrity and performance.

Durability
Optimization
Performance
Efficiency
Reliability
Innovation
The Challenge of Bulk Materials

- Large Lumps - Limestone
- Dry Fine - Sand
- Stick, Cohesive - Mined ores, Clay
Designing for Bulk Materials

How to get accurate loads for complex materials and different operating conditions?

Hand Calculation, Experience

- Equipment Loads:
  - Estimate material loads
  - Low-fidelity, especially over time dependent events

Incorporate Test Data

- Equipment Loads:
  - Loads from experiments
  - Constant or variable loads
  - Requires suitable physical test

How to get accurate loads for complex materials and different operating conditions?
EDEM: Realistic Bulk Materials Simulation

Large Lumps, Rough

Fine grade, Loose

Sticky, Cohesive, Resistant
Introducing
EDEM-Abaqus Coupling
EDEM-Abaqus Coupling

- Enables realistic EDEM material forces acting on equipment to be used in Abaqus FE analysis
- Replaces need for rough estimates of material loads
- Streamlined workflow - automatically call Abaqus from inside EDEM
- Perform realistic design analysis early in the design cycle
EDEM-Abaqus Coupling: CAE Based Design Approach

**Equipment Loads:**
- Estimate material loads
- Low-fidelity, especially over time dependent events

**Equipment Loads:**
- Loads from experiments
- Constant or variable loads
- Requires suitable physical test

**Equipment Loads:**
- Realistic material loads without physical testing
- Design for a range of materials
- Broad ‘what-if’ analysis
Workflow:
EDEM-Abaqus Coupling
Workflow

1. Set-up and run EDEM simulation

Import your CAD equipment

Define bulk material

www.edemsimulation.com/gemm
Workflow

2. Set-up the Abaqus simulation

- Mesh the parts
- Define the co-simulation interface
- Set-up the boundary conditions
Workflow

3. Choose EDEM data to transfer into Abaqus
Workflow

4. Solve!

Contact forces mapped onto Abaqus mesh

U, Magnitude

S, Mises
Examples:
- Excavator
- Mini-Dozer
Excavator

Analysis of an under Realistic
Mini-Dozer: Dry Soil

Time: 0.0501738 s
Mini-Dozer: Dry Soil

1) Max load on excavator blade at ~ 0.3s (Static Mode)

2) Average load on excavator blade between 0.2s to 0.8s (Average Mode)
Mini-Dozer: Dry Soil

Static at 0.3s

Averaged at 0.2s to 0.8s

Stress, Mises

Deformation

S, Mises (Avg: 75%)

U, U1

EDM®
Mini-Dozer: Cohesive Soil
Mini-Dozer: Cohesive Soil

Higher peak force

Dozer Blade Total Force

Longer period of time where dozer blade is experiencing higher loads

Dry soil

Cohesive soil
Mini-Dozer: Dry vs Cohesive Soil

Dry Soil

Cohesive Soil

Stress, Mises

Deformation
Applications

Construction & Agricultural
Wheel loaders & excavators, backhoes, tracked vehicles, tillage, grain harvesters and combines, augers

Mining
Long-wall shearers, drag line excavators, transfer chutes, crushers, mills, screens

Process & Food
Mixers, tablet coating, powder handling and processing, conveying, filling devices, driers
Summary

EDEM Abaqus coupling provides new insights into equipment design

- Replace simplified material assumptions in FE analysis
- Use realistic material behaviors and loads as standard
- Insight into equipment performance early in design cycle
- Improve design accuracy and reduce prototyping
Thank you for listening!

To learn more come see us at booth 22!

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