FORCES IN GRAIN BINS

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It takes more than 325 pounds of force to extract a 165-pound person from grain in a corn bin.

Photo credit: Charles V. Schwab, Iowa State University
2  a Idealized system. b Mutual forces exchanged between two adjacent grains, between the grain and the silo wall, and between the grain and the silo base
Variables to consider

- Type and variety of grain, moisture content, condition
- Bin wall types: corrugated, smooth, concrete
- Bottom and discharge design
- Plug flow, funnel flow....
- Bin Height to diameter ratio
- Loading, unloading forces
- Packing factors
- Vibration from outside sources (train, truck, seismic)
- Location within the bin
- Dynamic vs static loads
- Rankine and Janssen equations for force estimations
Why do we care?

- Bin failures and design improvements
- Power to handle and work with grain
- Prediction of damage to kernels during handling
- Entrapments and rescue
- Anchor point and other design criteria load ratings
- Equipment design
Where to start?? Applications.....
First project: Coffer Dam testing

• Question: How hard is it to insert coffer dams in grain?
Vertical dynamic force (resistance) analysis

Summary of results

- Directly proportional to the service area in contact with the grain (dynamic loads)
- 300 lbs to 700 lbs of steady force in dry corn to a depth of 3 ft.
- Force required increased linearly for 2 ft….then exponentially for the 3rd ft.
- Straight wood board coffer dams were least
- Large steel coffer dams with “fixtures” were the greatest
Latest project: forces on a buried person

• Using pressure mapping, gather information about forces experienced by entrapment victims.
• Gather understanding of the physiological response of the human body based on the pressure mapping data.
• Suggest new treatment guidelines and offer training materials for physicians and first responders.

"Somebody call 911," yelled Aaron Fink as he held onto the edge of a grain trailer inside the Farmers Alliance elevator in Mitchell. "We've got somebody in the grain!"
Rescue protocol questions

- What are the pin point force interactions with the skin and muscles?
- Is immediate release of pressure optimal for recovery?
- What physiological changes are happening due to this unique kind of pressure on the body?
- What residual changes can we expect due to this kind of pressure?
- How does that compare to other force trauma and the treatments/protocols for rescues?
Equipment for testing

- Tekscan CONFORMat pressure mapping systems
- Test grain: Canola, wheat, soybeans, and corn.
- Test initially in smaller bin with no surface interaction and no dynamic loading
- Collaborate with Dr. Paul Rock of OSU’s medical center in Tulsa, OK.

Next steps:
- dynamic loading (pulling)
- pressures from rescuers working around victims
Meet “Jimmy Hoffa”!!!
Tekscan

- In-Shoe Plantar Pressure Analysis
- Barefoot Pressure Analysis
- Seating & Positioning Pressure Analysis
- Human Joint Analysis
- Animal Gait Analysis
- MobileMat BESS
What does the “map” mean?

• The graph is actually a time-lapsed video
• With calibration, we can tell the amount of pressure (force over area) on each body part over time
• This pressure can be correlated to force research done by g-force, sub-oceanic pressure and deep tissue impact injury specialists

Goals:
• Safer and more effective rescues and rescue equipment
• Better designs for storage
• Understanding of load changes and modeling of storage environment BEFORE the accident happens!