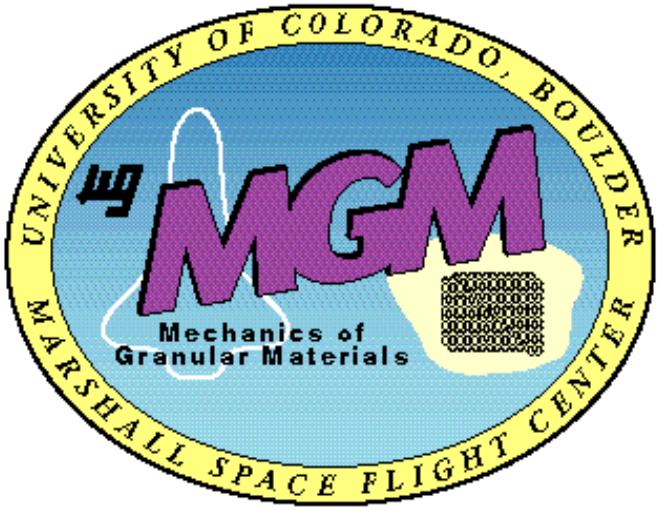
MGM-III

STS-107 IWG Presentation



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Presented by	Susan Batiste, LASP

Scientific Objectives 1

- Determine the constitutive behavior of cohesionless granular material at very low confining pressures
- Assess the influence of the 1-g gravitational field on granular material behavior by comparing ground-based and microgravity tests
- Study the influence of particle interlocking and other fabric properties on the shape of the Mohr-Coulomb strength criterion near the effective stress space origin
- Study whether strain-softening and associated instability phenomena, including localization of deformation in shear bands, occur before or after peak resistance to deformation occurs, either because the material has reached a peak strength or a bifurcation point

Scientific Objectives 2

- Determine whether cohesionless granular materials under very low effective confining pressures tend to dilate or contract
- Study whether the critical void ratio of cohesionless granular materials tends to approach the maximum void ratio at which the material can deform indefinitely without changes in its internal stress state and volumetric strain

Applications

Improve and enhance science and technology in a variety of disciplines:

- Soil mechanics and geotechnical engineering
- Earthquake engineering
- Coastal and off-shore engineering
- Mining engineering
- Powder technology
- Terrestrial and planetary geology
- Erosion processes

Aid in granular material modeling techniques

More accurate model

--> design with more confidence and less “over design”

--> build safer structures with reduced project costs

Applications

The results of the MGM experiment may lead to answers concerning consequences of earthquakes, the most important being the damage of soils and foundations of many structures, caused when liquefaction, the process where a sand loses strength and behaves like a viscous fluid, occurs.

- Examples of damage due to liquefaction
  - building tilting and settlement
  - bridge failure (due to foundation failure)
  - dam failure
  - buried structures rise to surface
- Liquefaction seen in several earthquakes

  Loma Prieta - 1989 San Fernando - 1971

  Niigata - 1964 Alaska - 1964

Background

- 2 previous missions in SPACEHAB
  - STS-79/Mir 4 September, 1996
    - 3 experiments
  - STS-89/Mir 8 January 1998
    - 6 experiments
- Ground studies
  - Granular material is well characterized in 1-g
  - MGM performs same tests in 1-g as 0-g
  - Also tests at higher pressures in 1-g

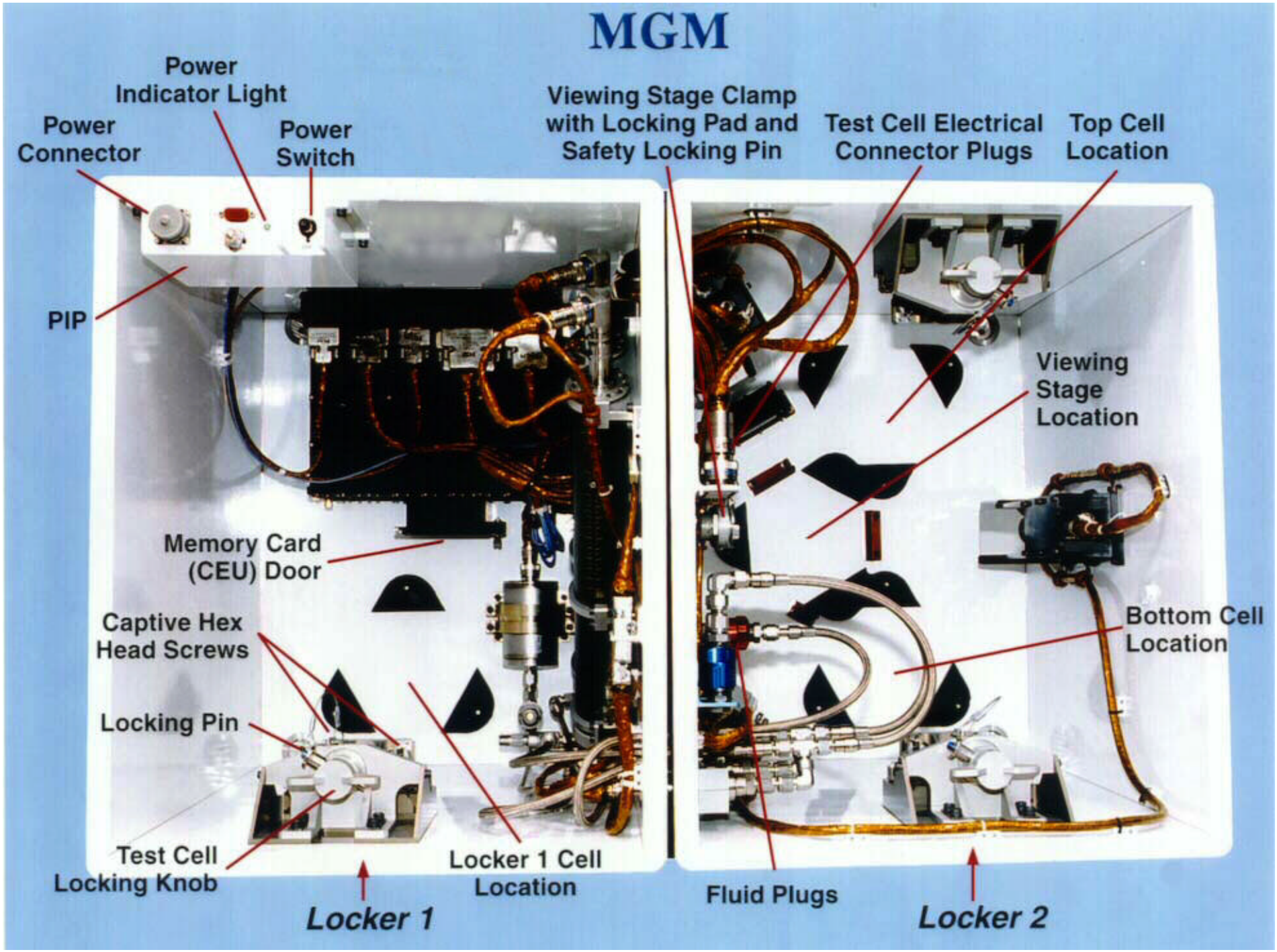
Results

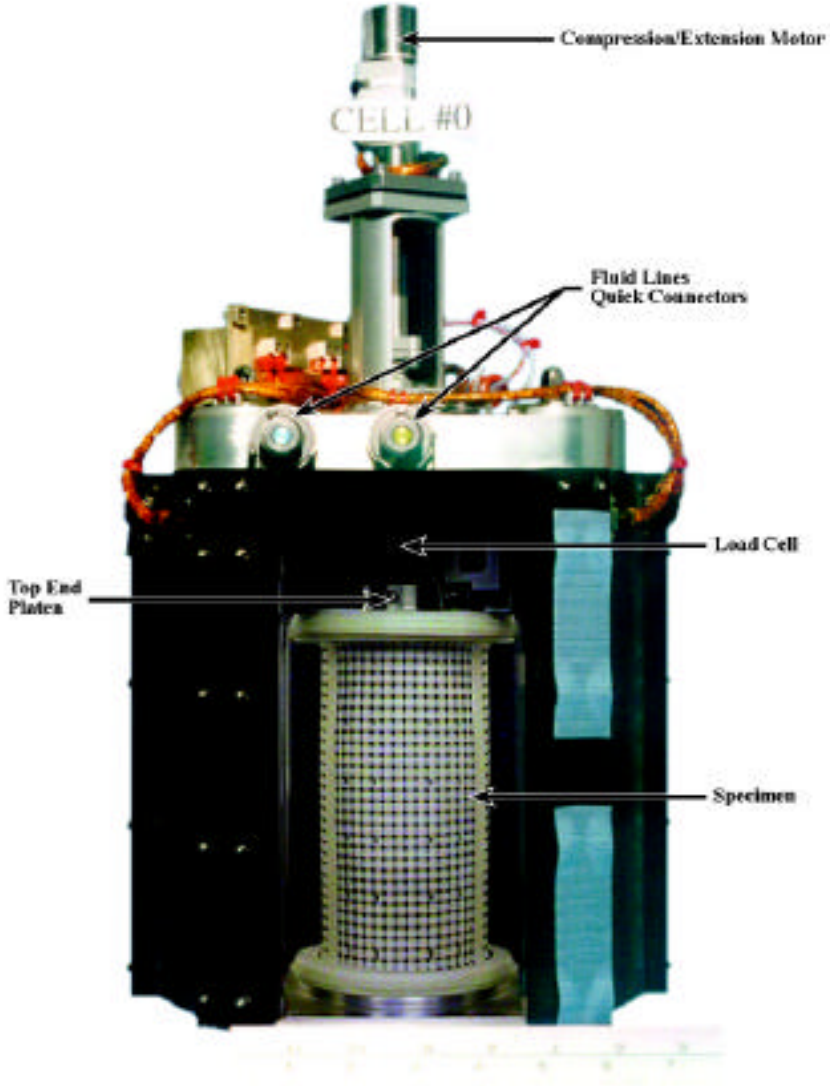
- Strength criterion near effective stress origin mapped
  - High dependency on stress level
  - Geometrical effects play a large role
- Bifurcation/shear banding occurs well after peak stress ratio
- High strength and dilatancy at extremely low stress
- Numerous shear bands forming
  - Critical void ratio has not been achieved
  - Critical void ratio appears to be extremely low

Hardware Overview

- Twin Double Locker Assembly (TDLA)
  - Two double-size lockers mounted side by side
  - Contains equipment for testing specimen
    - Fluid control system
    - CEU (Embedded software)
    - Test mount
- Test Cell (3x3)
  - Sand sample
  - Sample container
  - Test equipment (motor, transducers, lighting)
- External
  - PGSC (User Interface Software)
  - Camcorder (record video from TDLA CCD cameras)

MGM


Power Indicator Light
Power Connector
Power Switch
Viewing Stage Clamp with Locking Pad and Safety Locking Pin
Test Cell Electrical Connector Plugs
Top Cell Location
PIP
Viewing Stage Location
Memory Card (CEU) Door
Captive Hex Head Screws
Bottom Cell Location
Locking Pin
Test Cell Locking Knob
Locker 1 Cell Location
Fluid Plugs
Locker 1
Locker 2


Compression/Extension Motor
CELL #0
Fluid Lines
Quick Connectors
Load Cell
Top End
Platen
Specimen

Functional Objectives - DRAFT

Step		Set-up	Test	Teardown
Performances		3	9	3
Duration (Mins)	Min	45	150	45
	Max	60	150	60
	Preferred	60	150	60
Crewpersons	Number	1	1 (a)	1
	Preferred	1	1 (a)	1
Inhibits		n/a	Primary Thrusters	n/a
DC power (W)		n/a	40	n/a
Data	Realtime	n/a	TV (c), D, C	n/a
	Recorded	n/a	TV (c)	n/a
Special Equipment		PGSC Camcorder	PGSC Camcorder	n/a

Notes:

a The 9 MGM runs must be performed while on-orbit. Sequential runs are not required. Each run lasts approximately 2.5 hours, with the setup and teardown lasting about 2 hours every 3rd run.

b MGM operations require a 5 min. status check by the crew every 15 minuts for the full duration of this step.

c MGM operations require use of a PGSC and a camcorder. The camcorder is used to record the video output signal from te MGM experiment internal CCD cameras. Downlink TV is required.

d The SPACEHAB module cabin pressure reading shall be 14.7 ± 0.2 psia during MGM operations.

Not Applicable: Step Delay, Targets, Attitude, AC power, NRT data

Flight Operations Summary

- Perform 9 experiments
  - 3 specimens x 3 tests each
  - Test cells re-used/reformed for 2nd and 3rd tests
- Each experiment performed separately
  - Power off between experiments
- 3-part experiment
  - Set-up (astronaut intensive)
  - Test (automated)
  - Shut-down (astronaut intensive)
- Data recorded
  - Digital on memory cards inserted in CEU
  - Video using camcorder

Schedules

✓	Flight Design Review	1/27/00
	Phase III Safety Review	8/7/00
	TDLA Acceptance Review	8/14/00
	Flight Readiness Review	12/14/00
	Test Cell Acceptance Review	12/22/00