Summary of Platform and Hilman Rollers Deformation Studies

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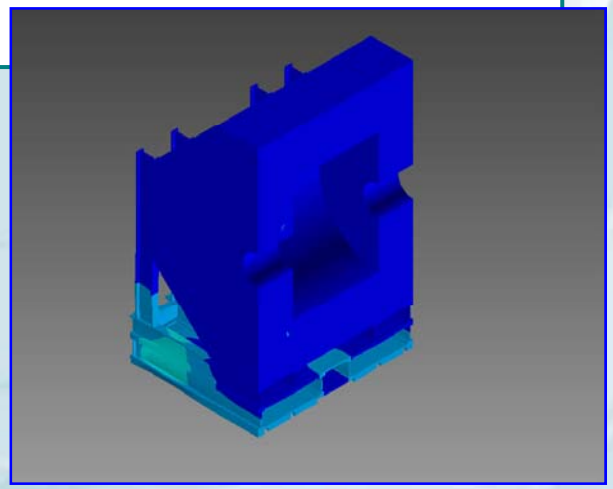
Disclaimer:

The designs and models for the detector, supports, and mobile platform used for the ANSYS simulations are crude at best and simplified to speed computation. The actual designs and subsequent performance may differ vastly. Scales are exaggerated on ANSYS contour plots for visual effect.

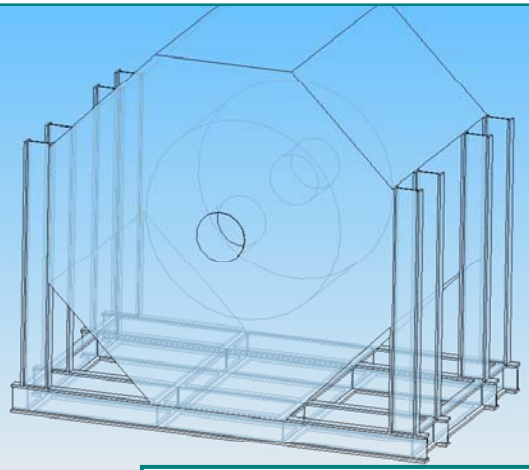


Air Casters and Platform Deformation….

Investigated displacements due to asymmetric forces.

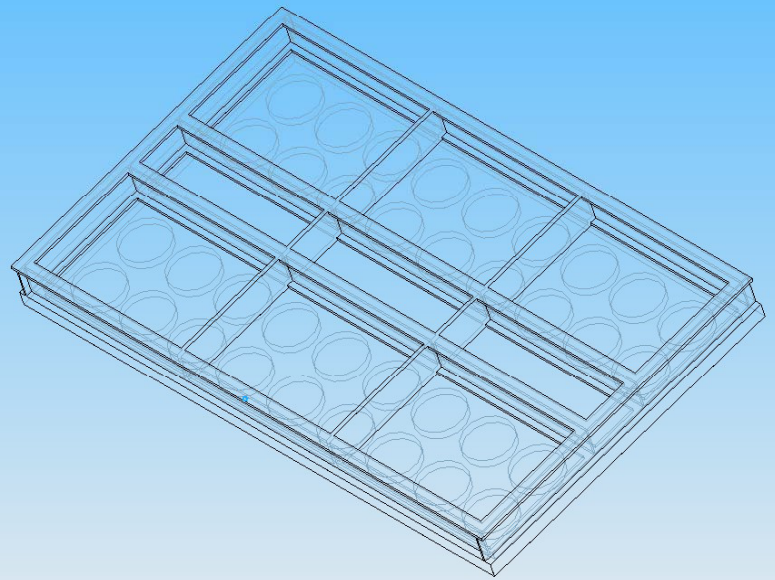
Created simple SolidEdge model of steel platform and generic detector for ANSYS studies. Platform, detector yoke and support structure made of welded A36 steel. Platform uses W40x655 size I beams, bar, and plate stock. Assembly rests on steel capped concrete floor.

Yoke and Support Structure



W Size I-Beam
Flange 90mm thick
Web 50mm thick
429mm wide and
1108mm high

Platform with 36 60” air casters



Platform deck, air caster support plate, and web plates are 12.5 cm thick steel plate.

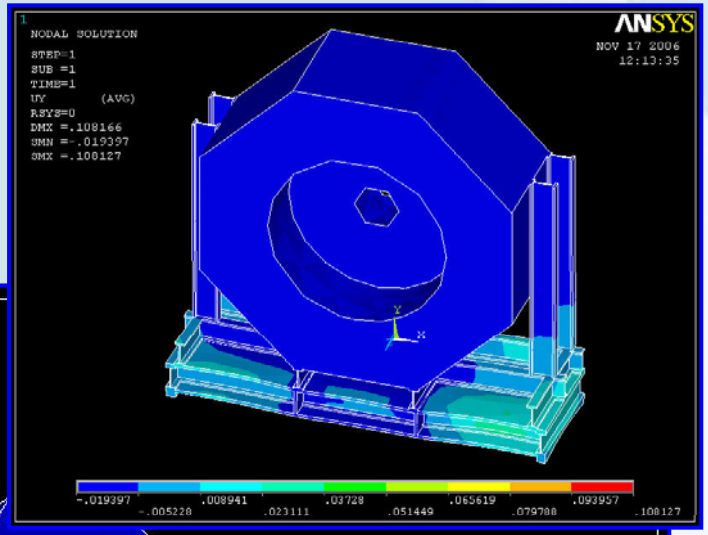
Limitation: No information on detector yoke structure, modeled as solid entity which makes the total assembly quite stiff.

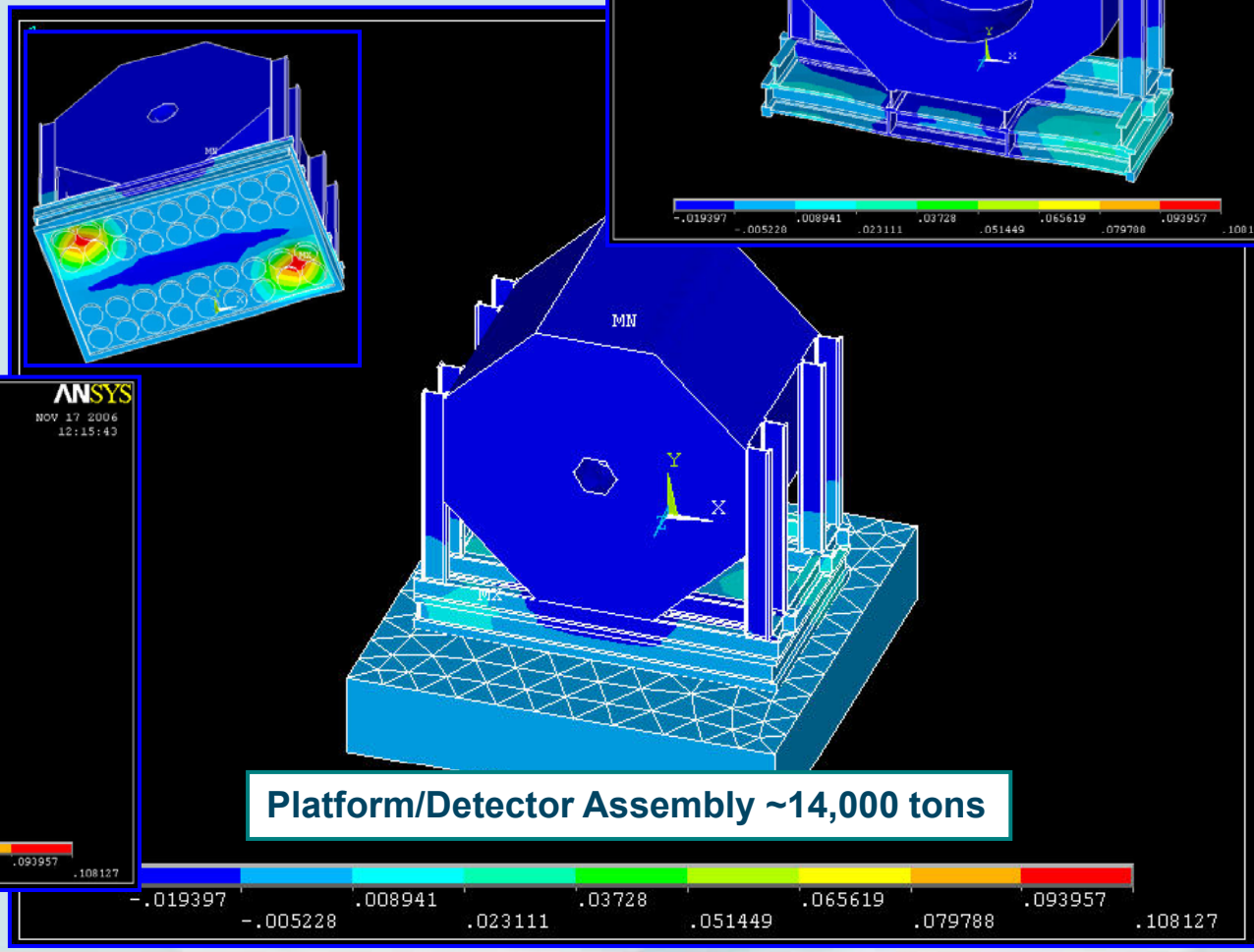
Platform/Detector Assembly ~14,000 tons
Platform ~1000tons

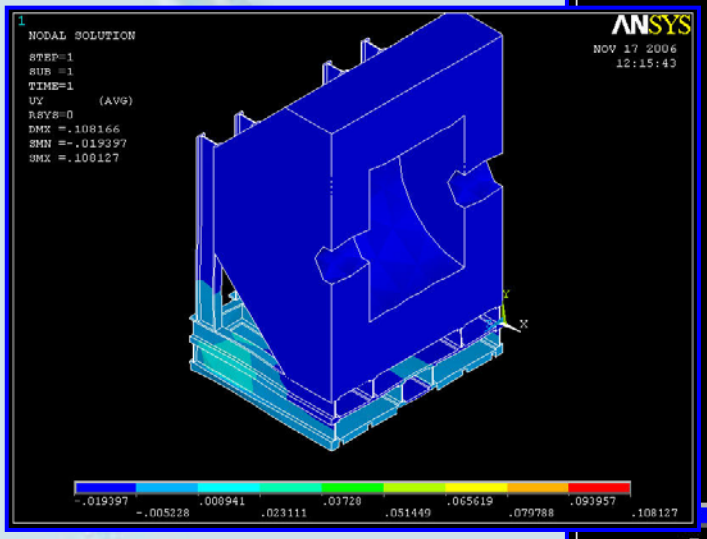
ANSYS Results…

Detector subject to gravity with opposing corner air casters activated.

Maximum Y Displacements:
Platform ~2mm
Detector Barrel ~.5mm







Platform/Detector Assembly ~14,000 tons

Conclusions and Concerns…

Solid detector yoke adds significant stiffness to the assembly and is unrealistic. To evaluate the effectiveness of a platform:

- **Need better information about detector structure to accurately model assembly and make predictions.**
- **Need to optimize structural design for lightness, stiffness and functionality.**

The real platform could be significantly heavy (1000s tons) resulting in the need for more air casters and a larger IR footprint for the platform.

- **Platform will need more reinforcement at air caster locations.**
- **Platform will be more complicated as access structure to air casters for maintenance will add weight and may reduce platform rigidity.**

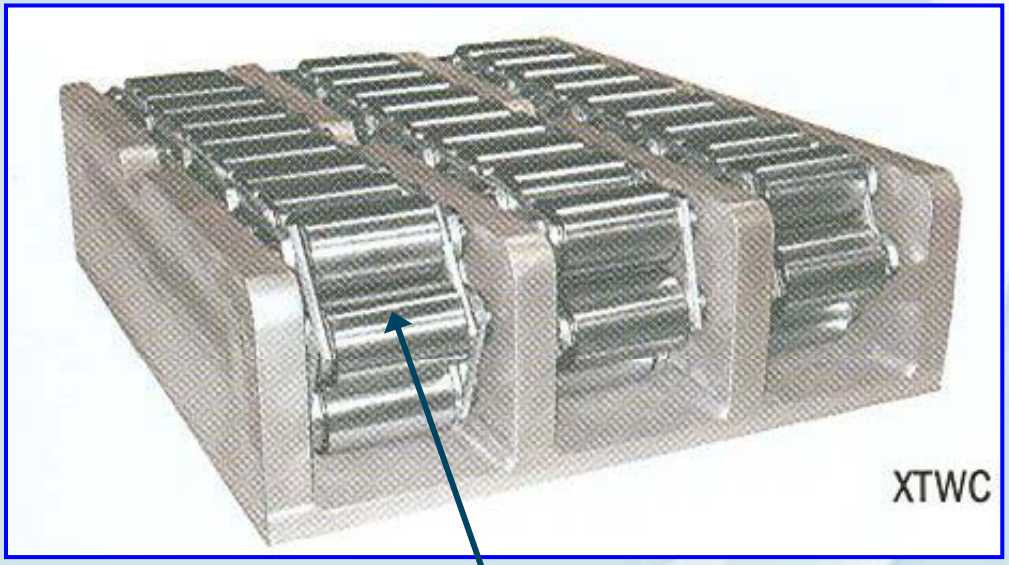
Could find no example of air casters moving loads >10,000 tons.

What About Using Hilman Rollers Under Platform?

Hilman Rollers for 14000 ton Load

While not standard items, Hilman has recently manufactured 3 5000 ton capacity rollers for offshore oil drilling application.

- Use 4 5000 ton roller modules.
- Capacity of 5000 ton recommended in case load CG not in geometric center (tripod condition).
- Each module weighs ~16.5 tons.
- Contact roll diameter ~6”.
- Contact roll width 6”.
- Module dimensions ~1.5 x 3 x .5m.



5000 ton module will have
51 contact rolls in 3 rows of 17

Total number of rolls (51x2)+2=104

Vertical Compression of Single 6” Hilman Roller

Analytic Formula

(from: Roark’s Formulas for Stress & Strain, 4th Ed., p.320 #4)

Cylinder between flat plates, p=P/L:

$$\Delta D = 4p(1-\nu^2/\pi E)(1/3+\ln(2D/b))$$

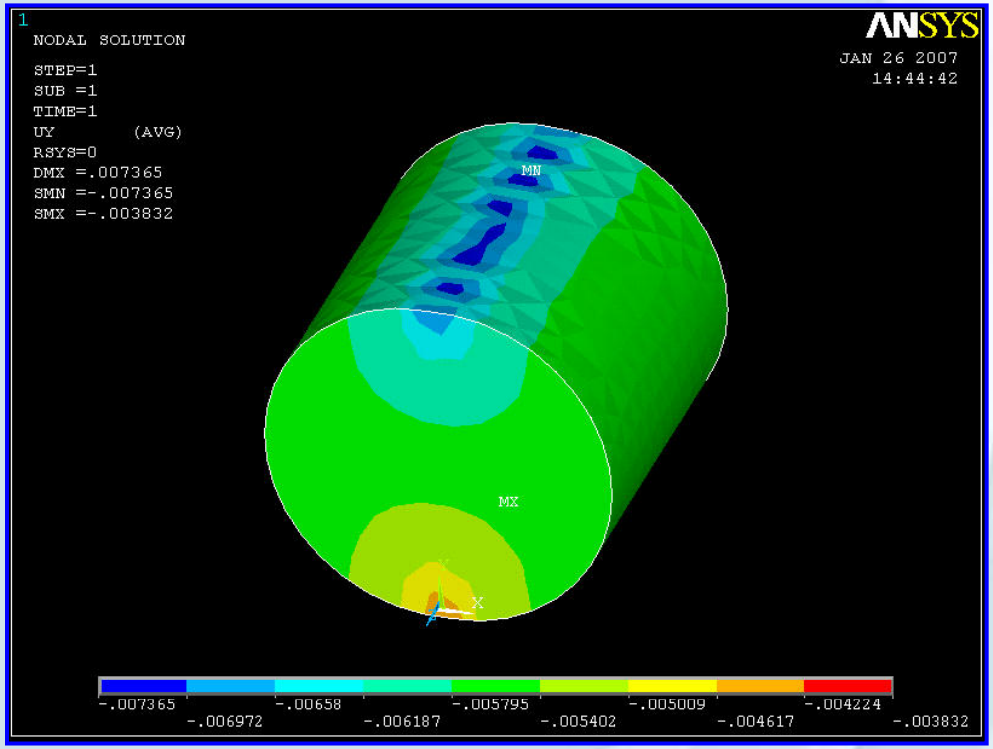
$$\text{where: } b = 1.6\sqrt{pD[(1-\nu_1^2/E_1)+(1-\nu_2^2/E_2)]}$$

$$E = E_1 = E_2 = 30e6 \text{ psi}$$

$$\nu = \nu_1 = \nu_2 = .29$$

For 6” diameter roller with P=151,000lbs.

ΔD = .00459”



ANSYS Simulation

Y displacement = .003832 - .007365”
and ΔD= .003533” or .09mm

Maximum Compressive Stress…

Can the floor be bare concrete?

Analytic Formula

(from: Roark's Formulas for Stress & Strain, 4th Ed., p.320 #4)

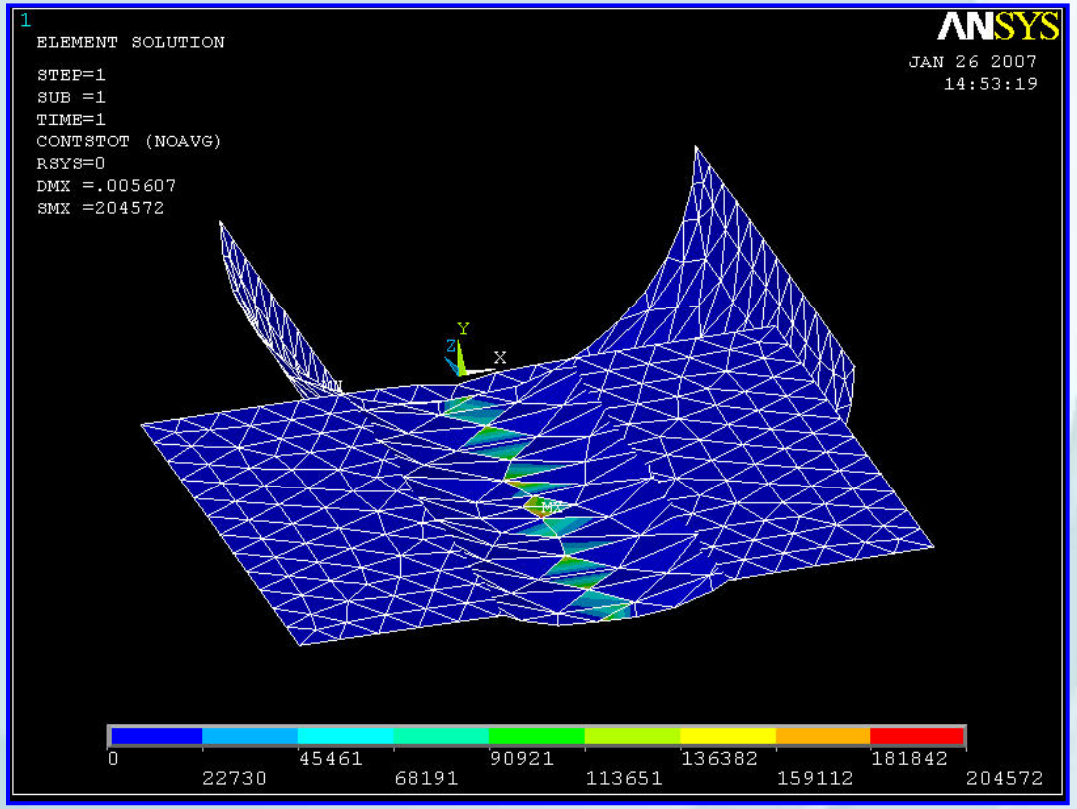
$$\text{Max } s_c = 0.798\sqrt{p/D[(1-\nu_1^2/E_1)+(1-\nu_2^2/E_2)]}$$

Max s_c = 209,153 psi

Contact Stress from Hilman Rollers Engineer

= 207,100 psi

Contact stress too great for bare concrete!



ANSYS Simulation

Max Contact Stress = 204,572 psi

Conclusions and Concerns…

Hilman Rollers have small deflections (~.1mm) when loaded.

- This results in small y displacements as the detector is rolled along the IR floor.

Hilman Rollers would have more compact footprint and could eliminate need for a platform if detector is made sufficiently stiff.

- Large number of air casters would be difficult to locate at detector corner legs and require more footprint outside the detector space.

Contact forces are high at rolls.

- IR floor will need to be capped with steel plate to prevent damage to concrete.
- Some localized permanent deformation of IR floor steel plate may occur. ANSYS studies needed to understand cyclical loading effects.

Hilman Rollers have demonstrated the ability to successfully and repeatedly move loads of this large magnitude.