Platform Moved on Hillman Rollers, Deformations

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Scope of Talk

The platform design concept is intended to stimulate discussion and identify issues related to push pull operation using a platform.

It may be possible to move the detectors without a platform, but this must be addressed by each detector group.

Why use a platform?

Convenient interface:

Engineering boundary for machine group vs. detector group.

Differential settlement of IR vs. beamline tunnels and local elastic deformations of IR floor. Simplifies shimming as only need to shim platform and not individual components.

Requirements on detector rigidity not as stringent.

Why use Hilman Rollers?

Hilman rollers have been manufactured to 5000t capacity.

Used to move 10kT+ loads in petroleum industry. Air pads have been demonstrated for ~2kT loads, but haven't seen any examples of 10kT.

Only linear motion needed for push pull.

More durable than air pads (gasket failure).

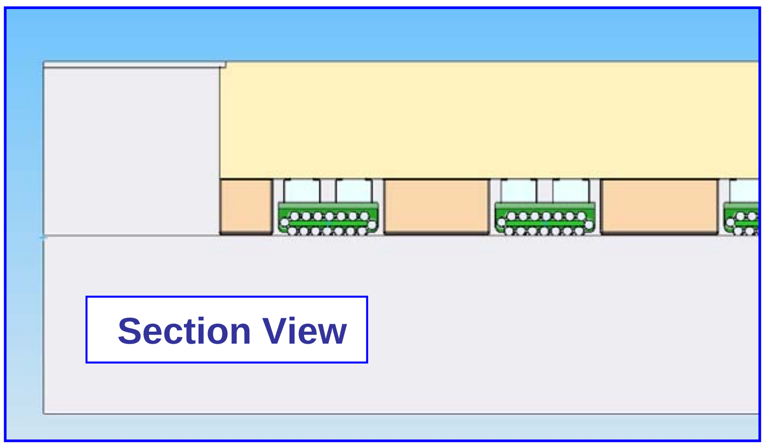
Slope of track not as important with rollers.

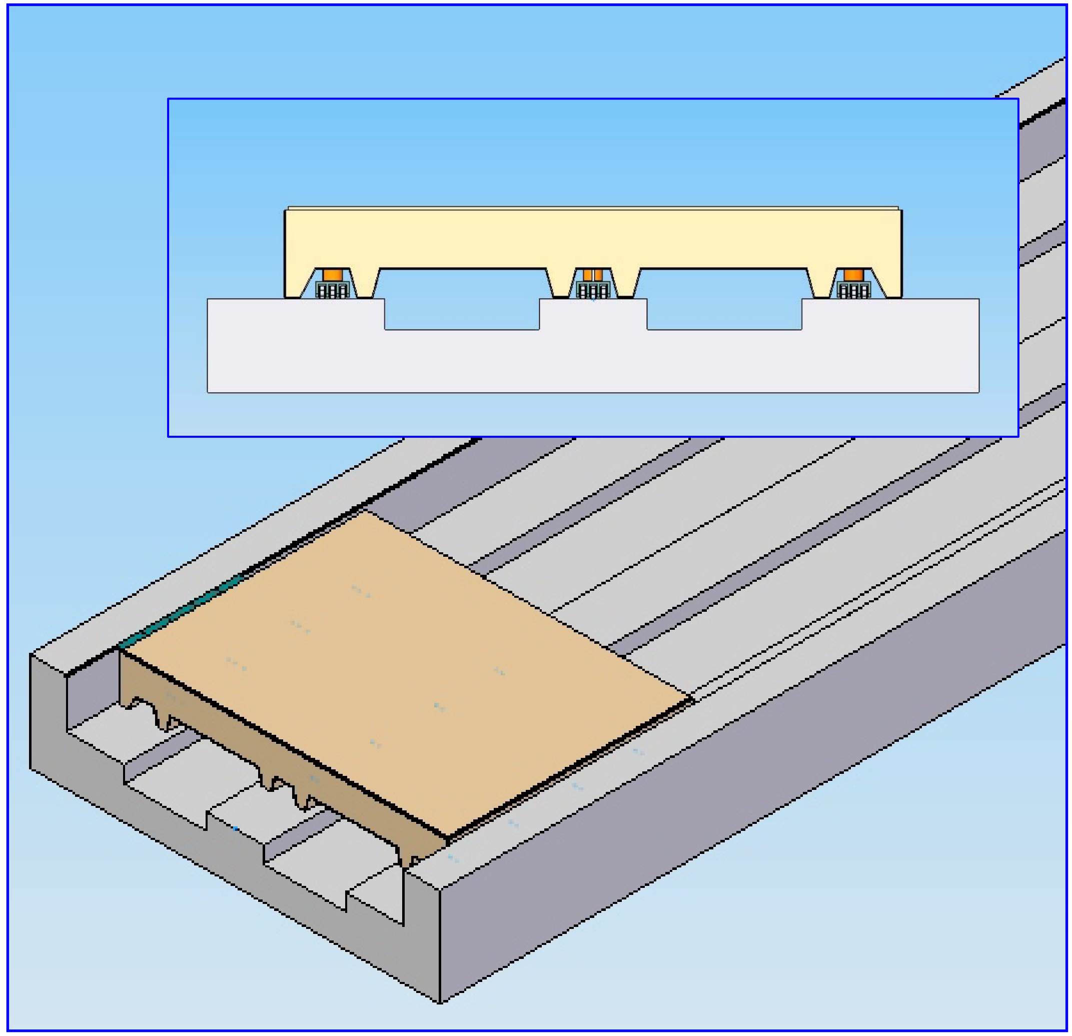
Sliding Platform Design Concept

Concept developed in discussions with A. Herve and A. Seryi.

Platform details:

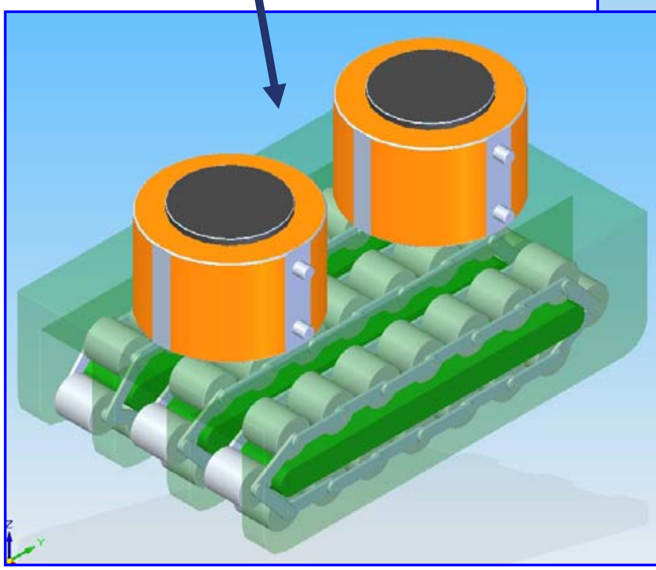
- 20x15x2m
- 5m wide trenches for cable chain and roller access.
- Steel reinforced concrete or steel plate construction.

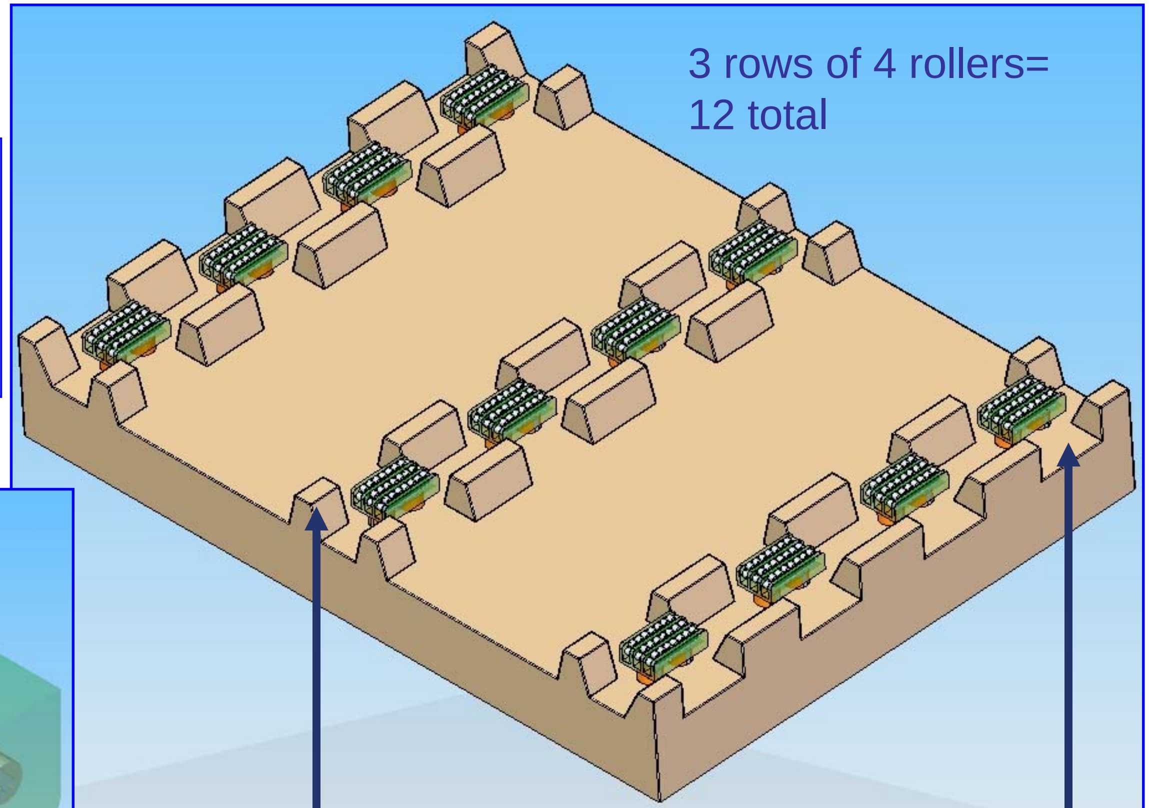




Platform/Roller Arrangement

Uses 1.5kT roller module with 1kT hydraulic jacks. Design must be optimized to distribute load evenly over roller module.



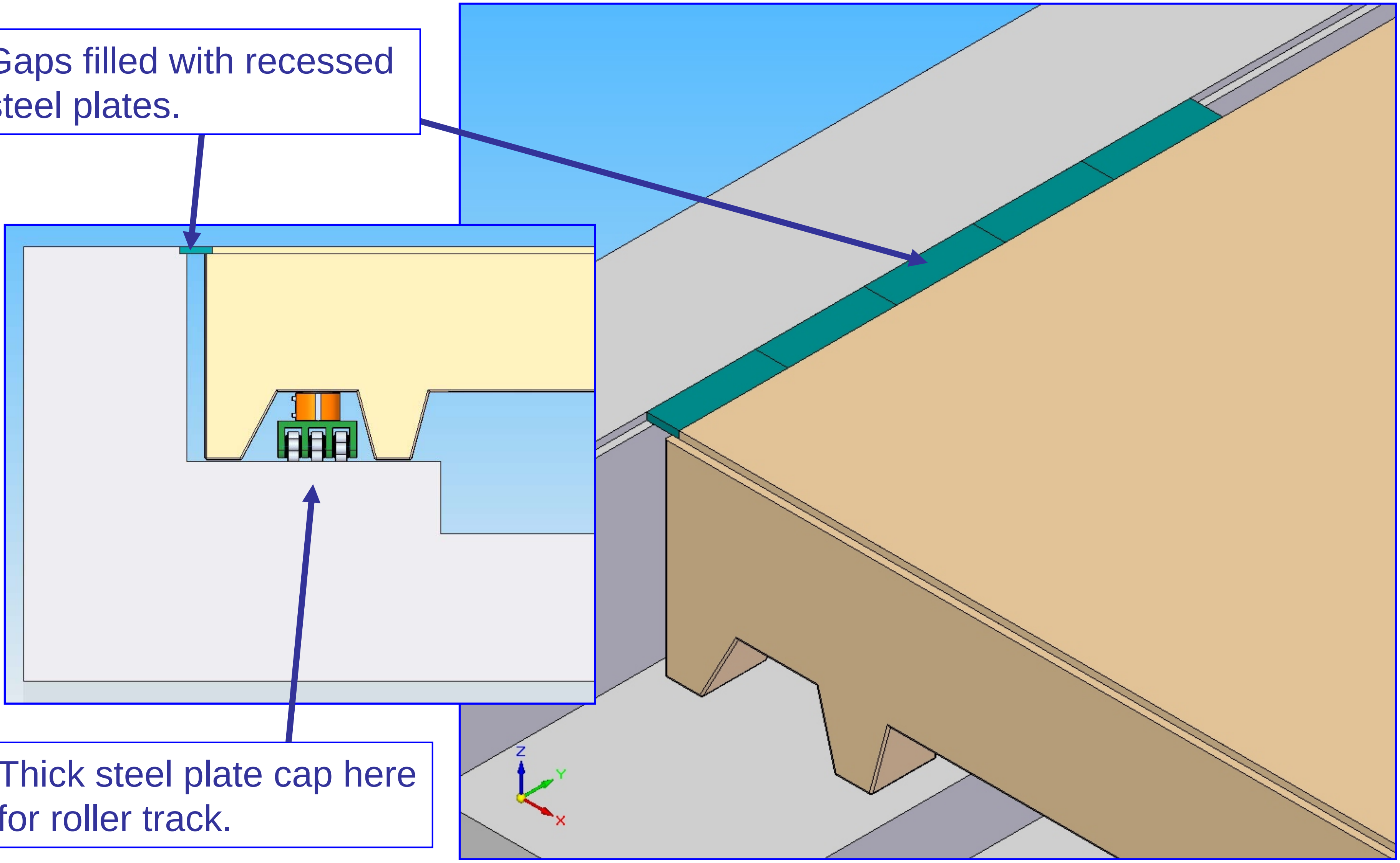


Feet support platform when stationary.

Space for access to rollers/jacks.

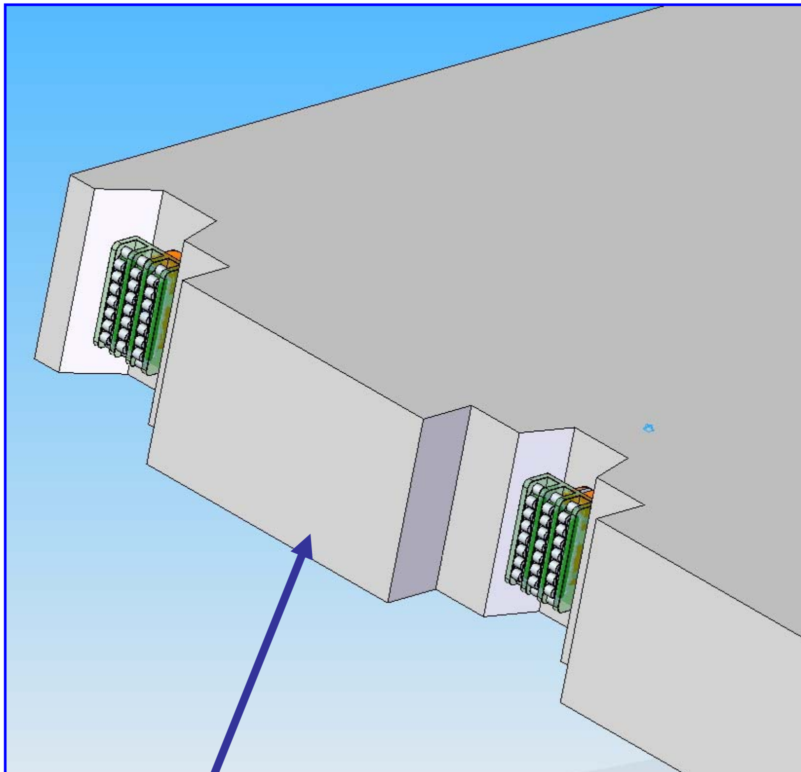
Bridging the Gaps

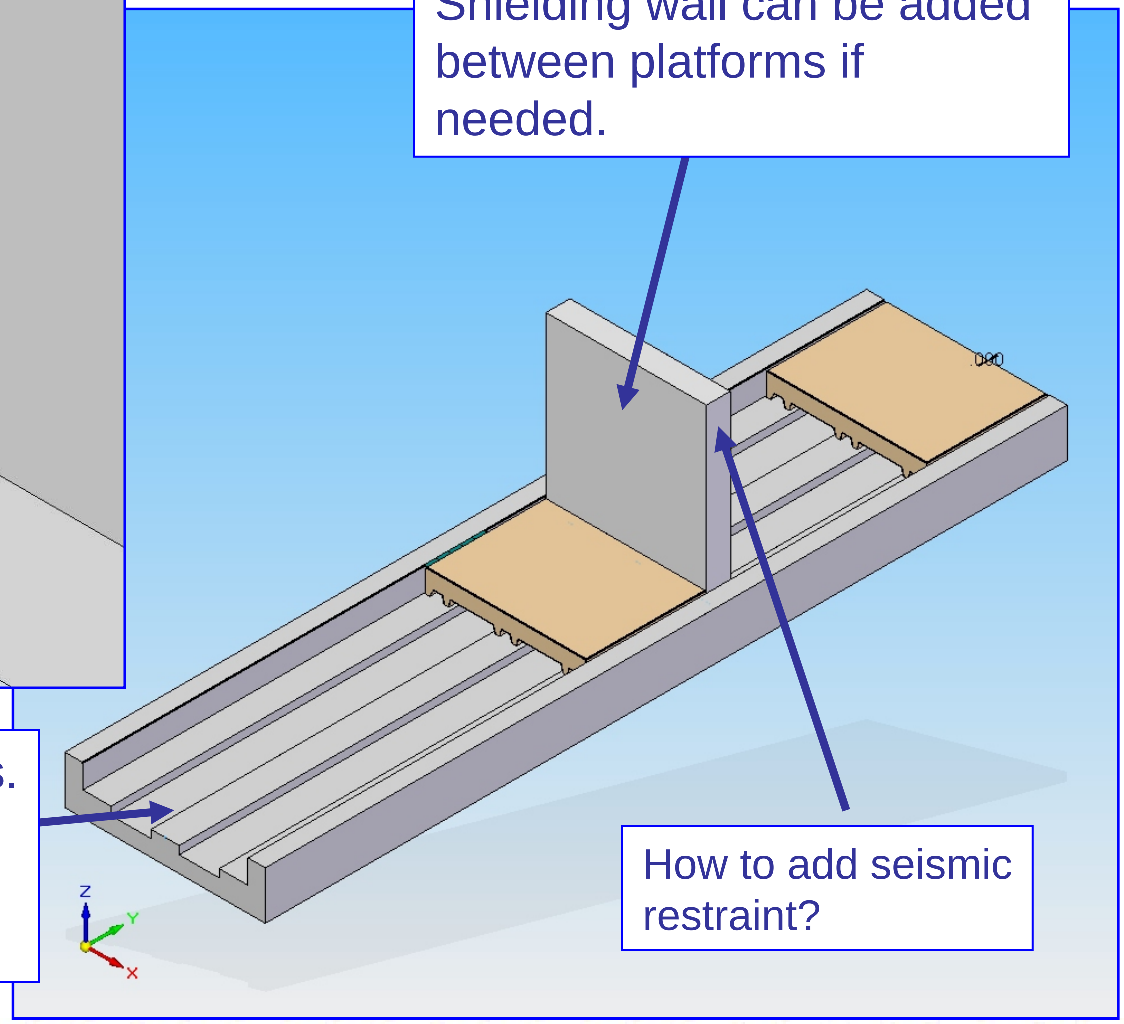
Gaps filled with recessed steel plates.



Thick steel plate cap here for roller track.

3m Shielding Wall on Rollers



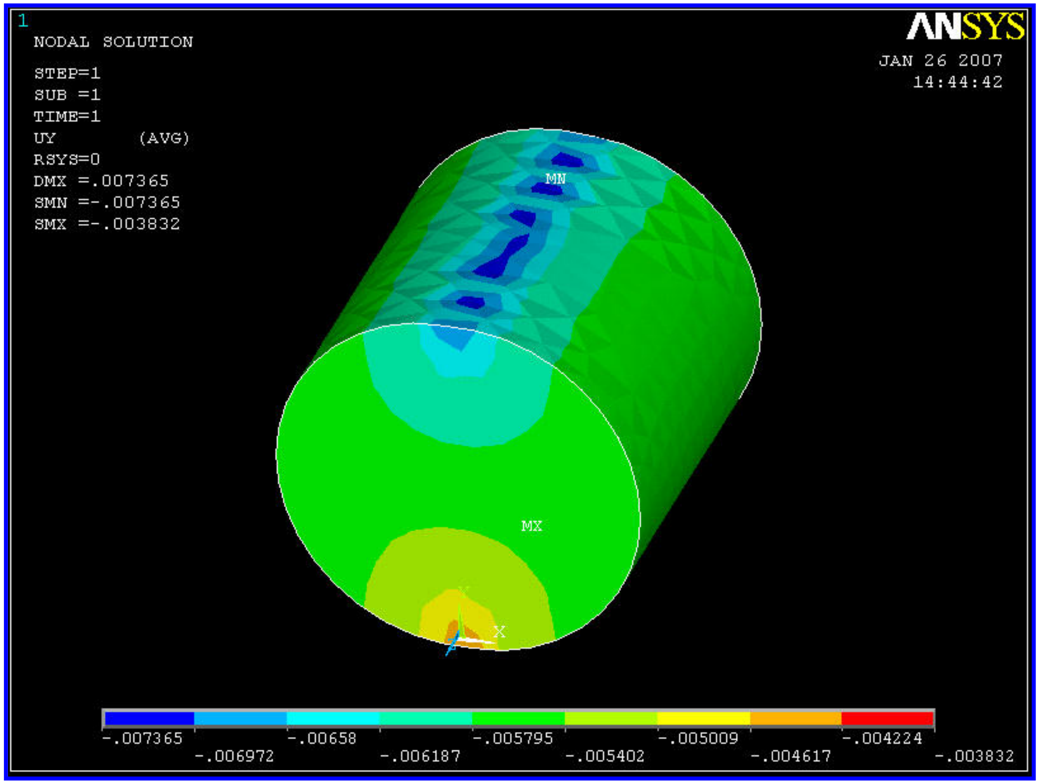


Shielding wall can be added between platforms if needed.

Protrusions shield cable trenches.

May not be needed if radiation requirements allow.

How to add seismic restraint?



Analytic Formula

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

Cylinder between flat plates, p=P/L:

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

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

$E = E_1 = E_2 = 30e6$ psi

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

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

$\Delta D = .00459$”

ANSYS Simulation

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

Maximum Compressive Stress…
Can the floor be bare concrete?

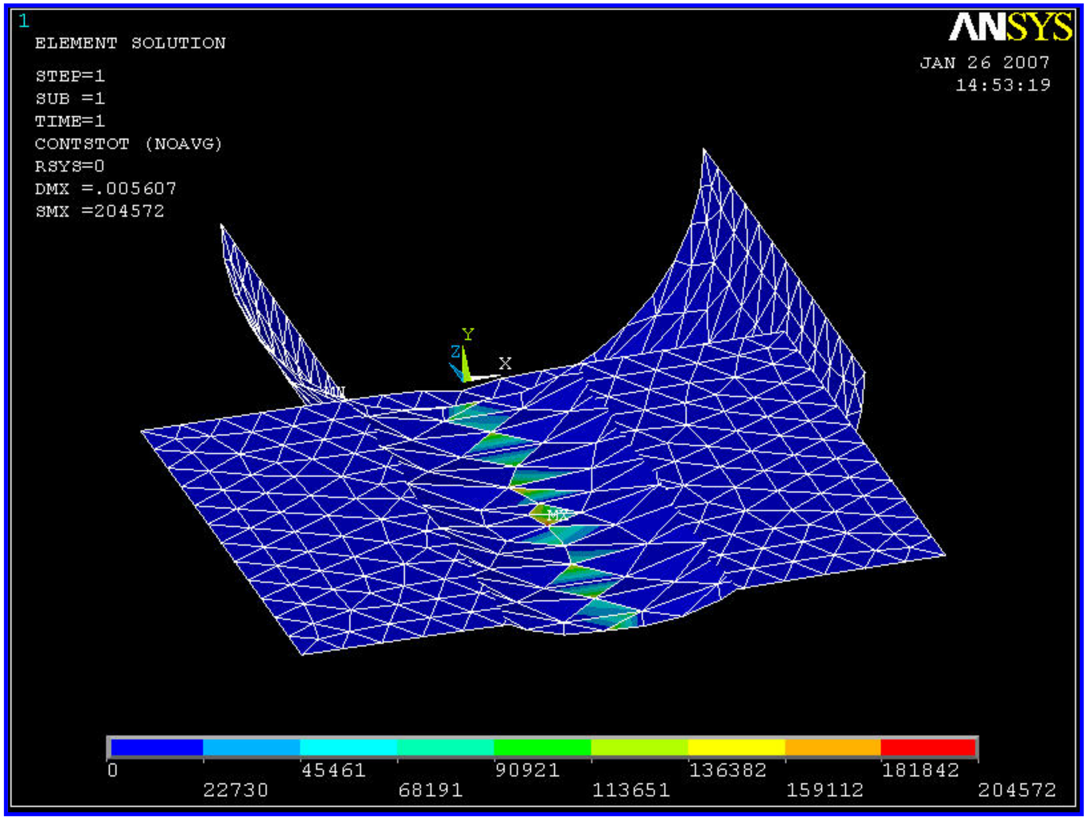
Analytic Formula
(from: Roark's Formulas for Stress & Strain, 4th Ed., p.320 #4)

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

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

Modeling Concrete

(From: Design of Reinforced Concrete ACI 318-05 Code Edition, McCormac and Nelson, 7th Ed.)

Problem:
Elastic modulus of concrete difficult to determine.

Ultimate strength @ strain of .002

Rupture @ .003-.004

Nearly linear @ loads ~1/3-1/2 f'_c

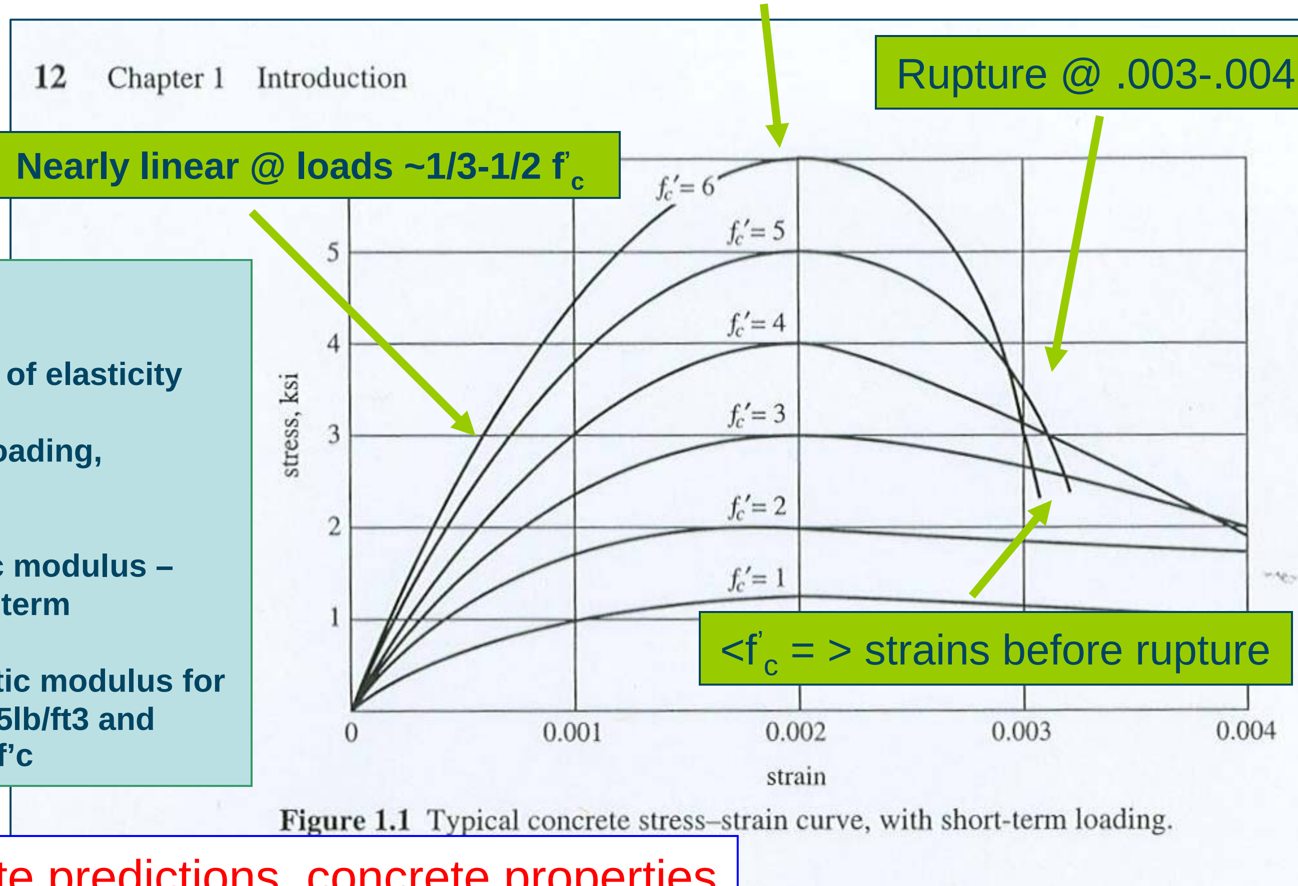


Figure 1.1 Typical concrete stress–strain curve, with short-term loading.

$<f'_c$ = > strains before rupture

Static Modulus of Elasticity

- **No straightforward modulus of elasticity**
- **Depends on strength, age, loading, aggregate, etc.**
- **Various definitions of elastic modulus – initial, tangent, secant, long-term**
- **Formula for calculating elastic modulus for concretes weighing 90 to 155lb/ft3 and f'c<6000psi : $Ec = wc1.533\sqrt{f'c}$**

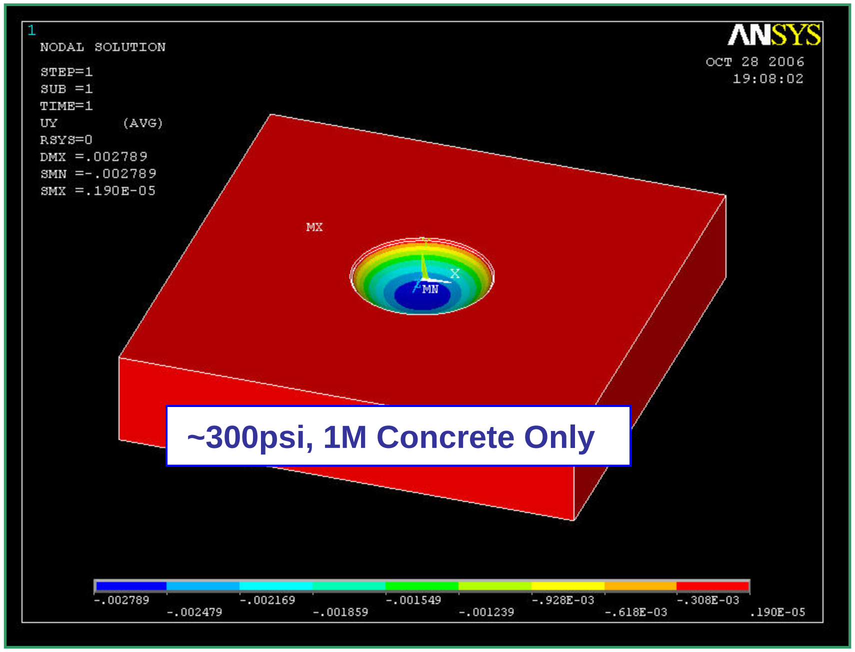
In order to make accurate predictions, concrete properties will have to be studied.

Elastic Deformations of IR Floor

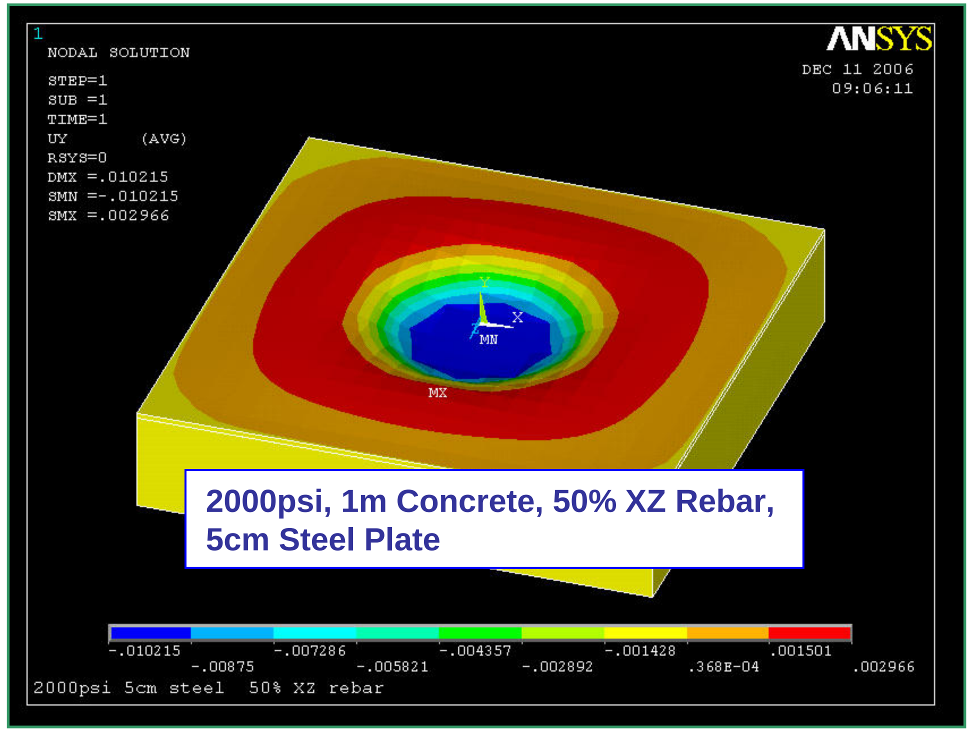
Analytical Model Predicts
(Formulas for Stress and Strain, Roark, 4th Ed. p.323 eq.13)

Deformations modeled for air pad studies but gives idea of range of deformations.

Y max = .003823”/.097mm



Y max = .010215”/.26mm



ANSYS Predicts

Y max = .002789”/.0708mm

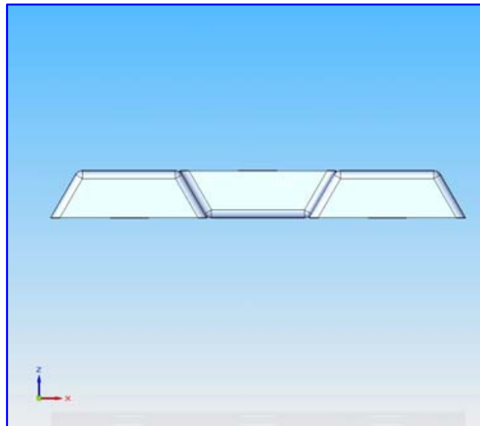
Passive Alignment – V Blocks

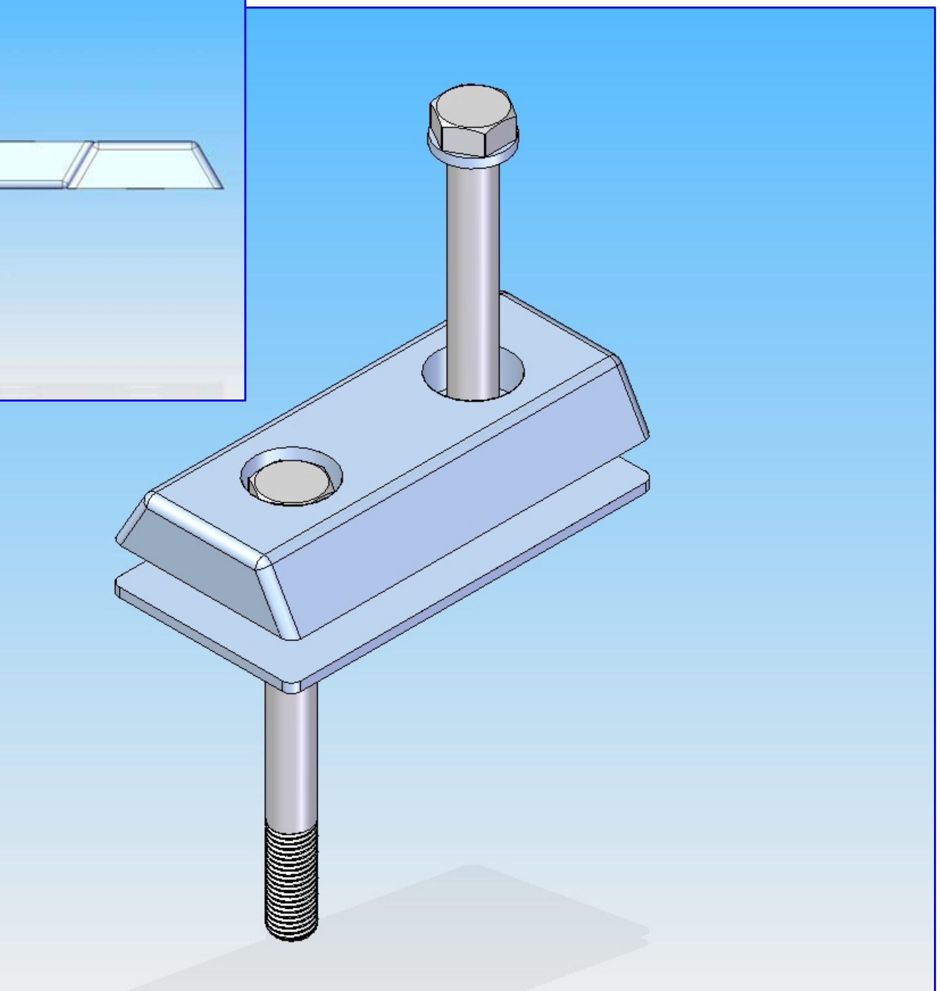
The two platforms will likely need different shimming. So V blocks on IR floor should be fixed and each platform will have adjustable blocks.

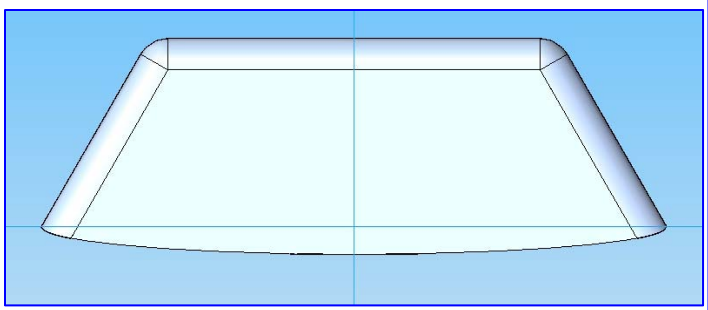
By machining a curved mating surface on V block base and corresponding shim we can provide small angular adjustment to V blocks.

Then we don't have to make platform precisely flat.

Alignment in X,Y,Z and Y angle







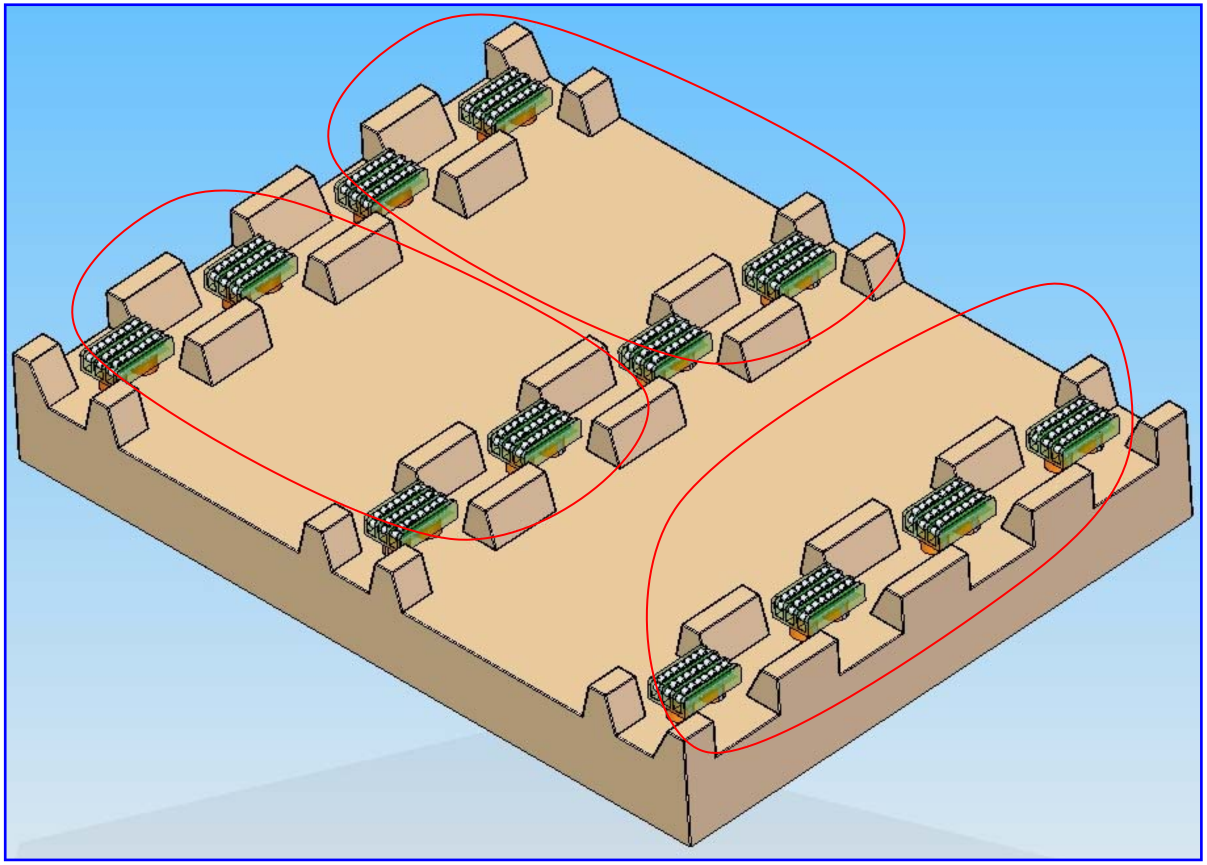
What about X, Z angle alignment?

Operate hydraulic jacks in desired configuration.

Platform will have to be rigid enough to withstand local jacking.

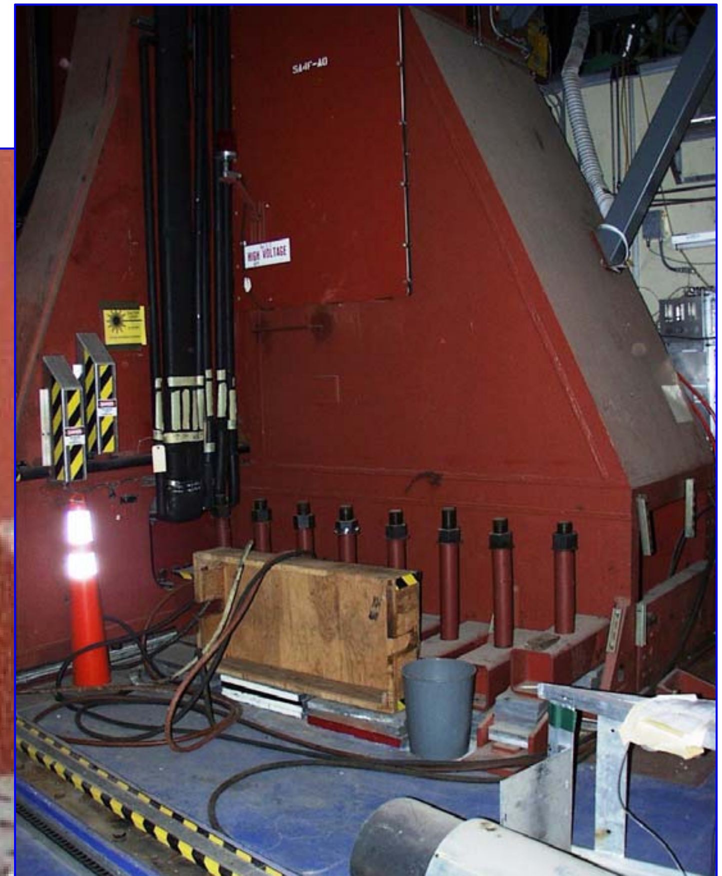
Shims may be needed at jack locations if jack range is not sufficient.

Consider having permanently installed alignment system.



Seismic Restraint?

Is this type of restraint required at other sites?
Will this disturb alignment?



Platform to IR?
Detector to platform?

Need to Investigate….

1) How to return platform to beam line position with mm accuracy?

   System of alignment V-blocks on platform feet and IR runway. Platform rolled onto beam line roughly aligned. When platform is lowered, grooves mate to align platform to better tolerance than achievable with rollers. What about active alignment?

2) How to propel platform? Screw drive, hydraulic ram, cable and reel?

   Hydraulic ram seems best for large movements. A long screw drive could be difficult to engineer.

3) How to cover trench? “Accordion” style folding panels? What sort of load could these withstand? Safety issues?
   If floor panels with trusses are to be used what are the operational issues during a swap?

4) While it seems technically possible, can it be done in a few days time?

5) Would like to hear concerns from detector groups to identify other issues to study.