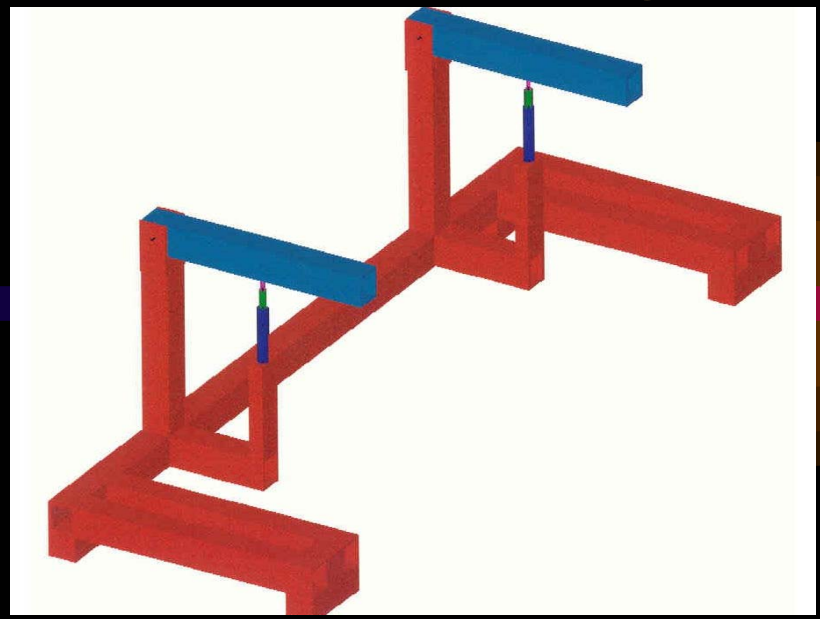
3Q120-M Quadrupole Magnet Transport

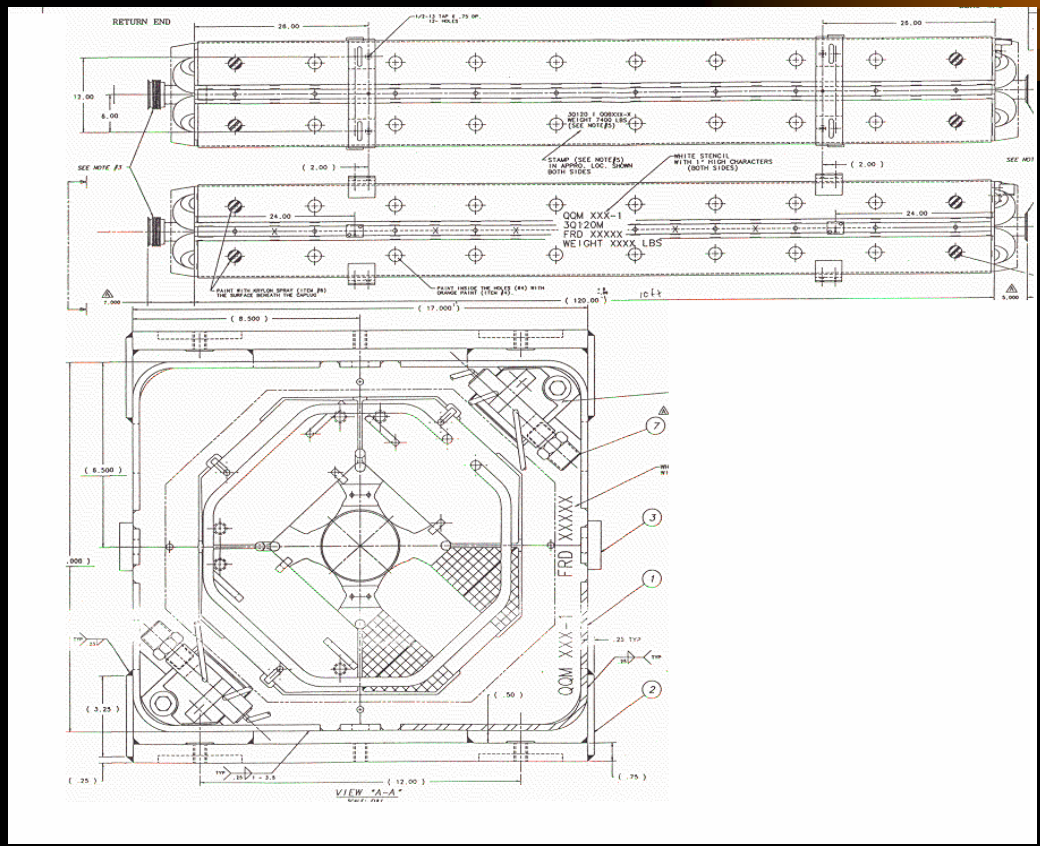


By: Joseph Martinez

University of Michigan

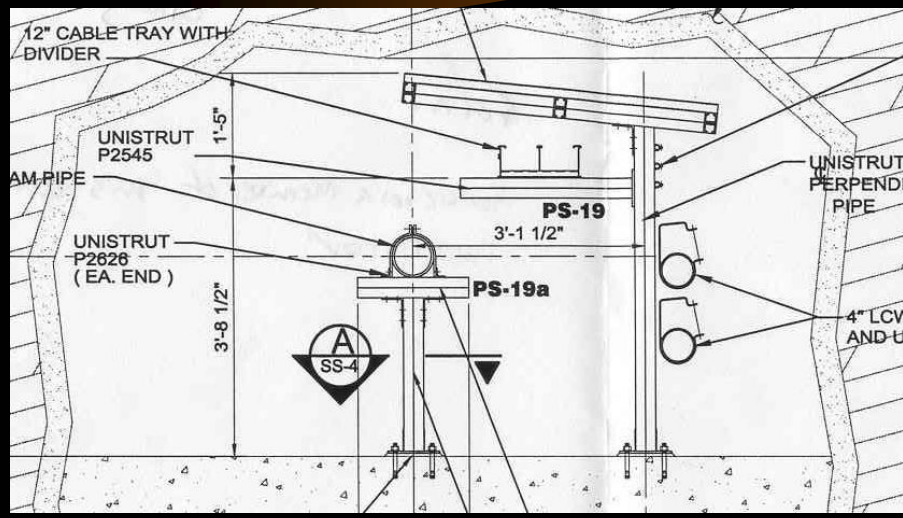
Supervisor: Dave Pushka, NuMI Project

3Q120M Quadrupole Magnets



Beam Tunnel

Elevation view of the Carrier Tunnel



Cross Section view of the Carrier Tunnel

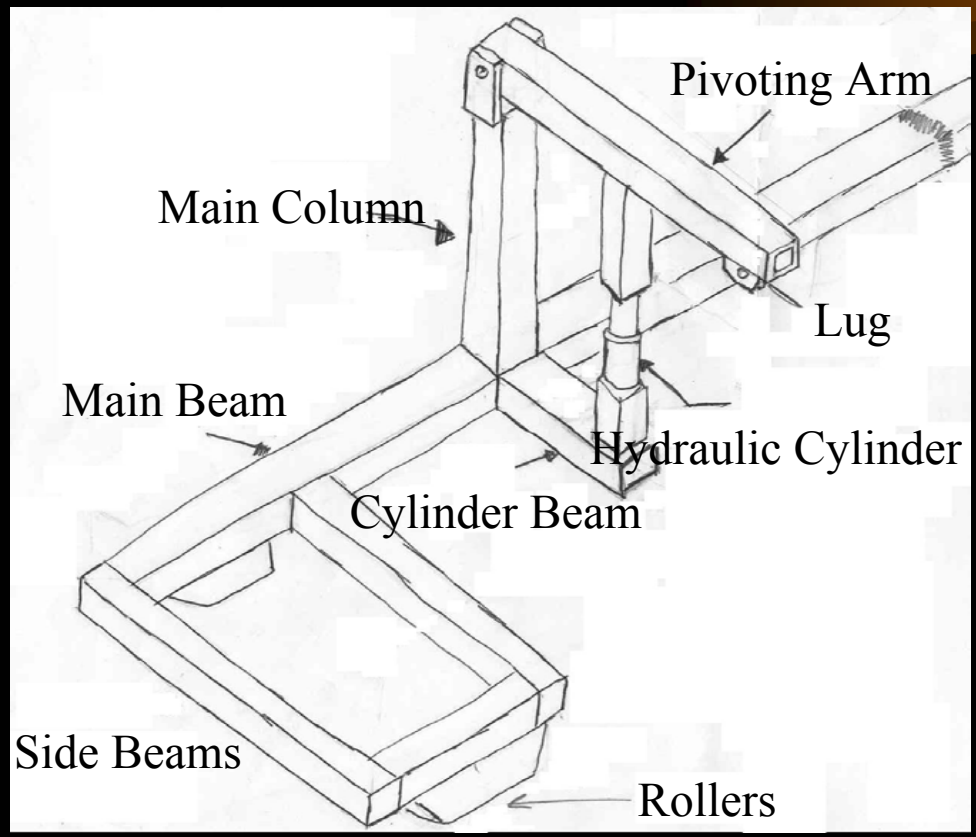
Tunnel Constraints

- Minimum Height: 6’0”
- Width: 40”
- 9 Degree Slope
- Height of Center of Magnet: 31.5”

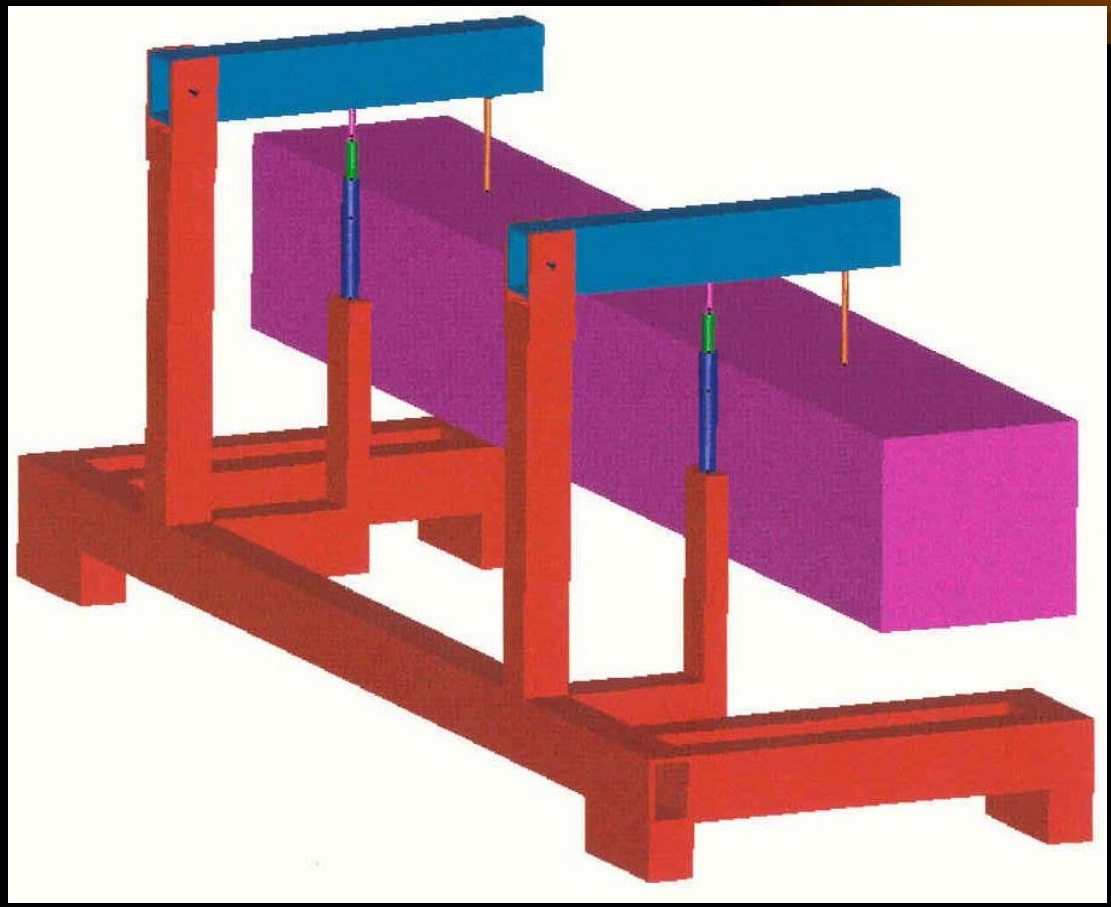
Initial Concepts

Push Cylinders	Pull cylinders	Modified Engine Lift
•Short •Few moving parts •Can't attach to magnet	•Few moving parts •Simple to use •Too tall for tunnel	•Biggest range of motion •Simple to use •Meets constraints of tunnel
X	X	✓

Sketch of Design

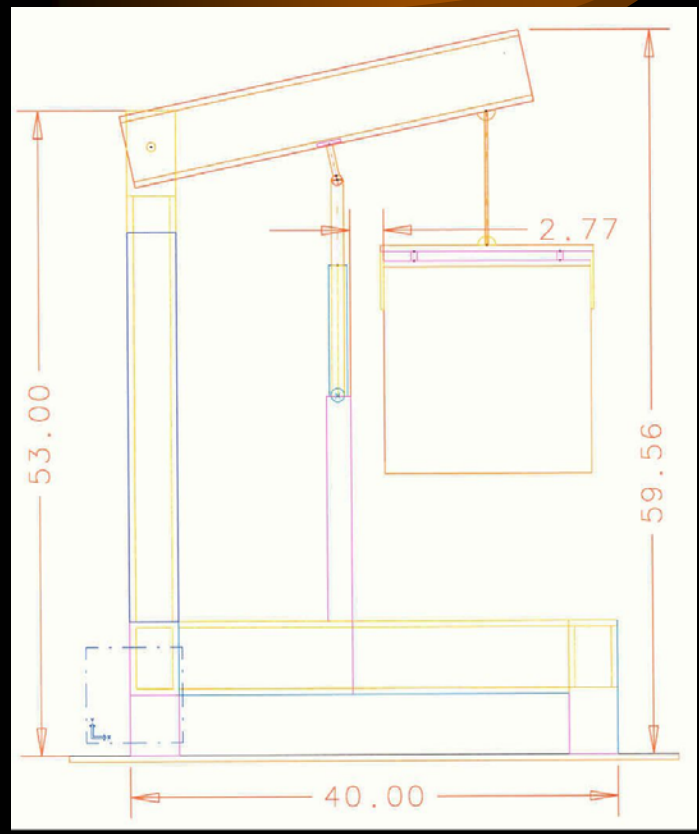


Lift with Magnet



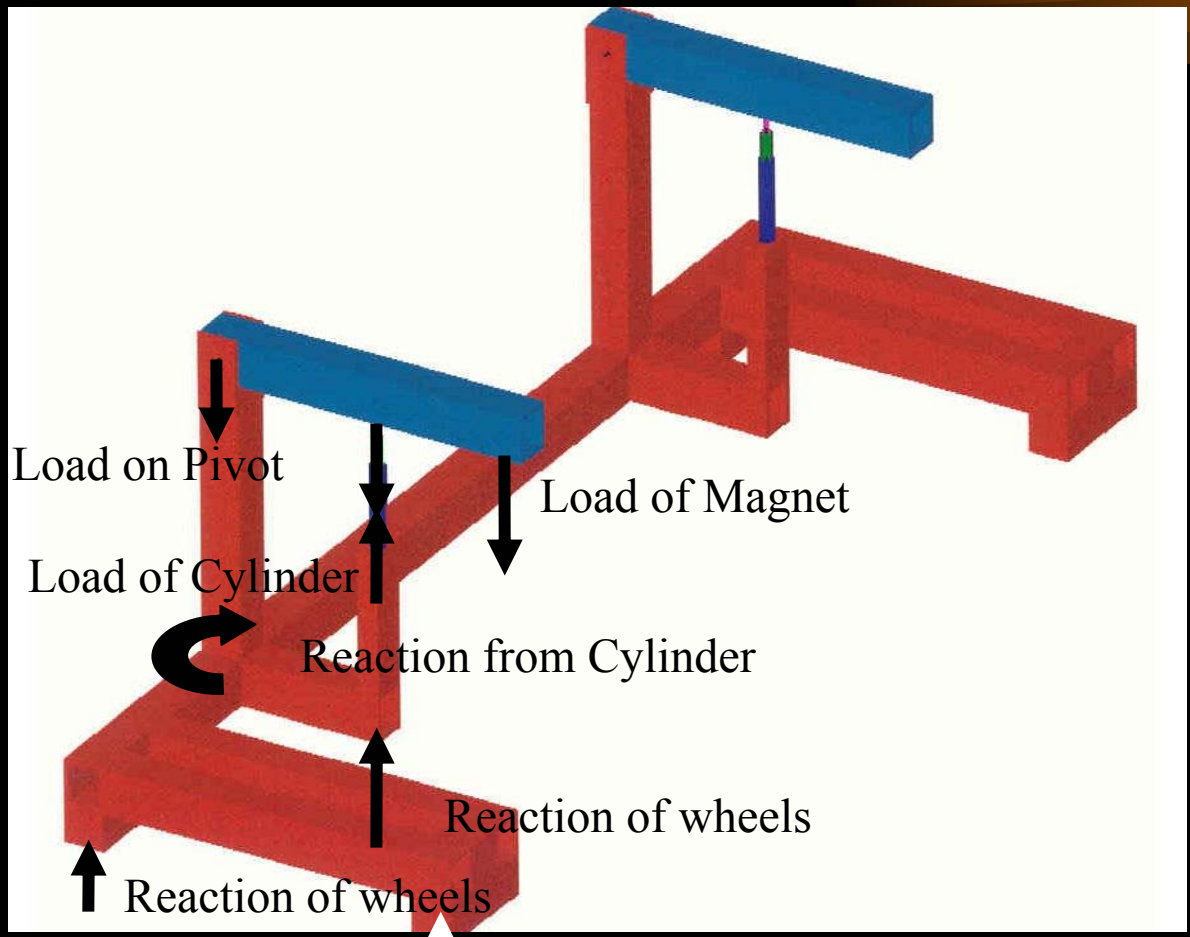
Operation of Device

- Slide over the magnet from the side
- Attach to magnet
- Lower to carrying height
- Pull up incline
- Push around the stands
- Lower the magnet onto the stands



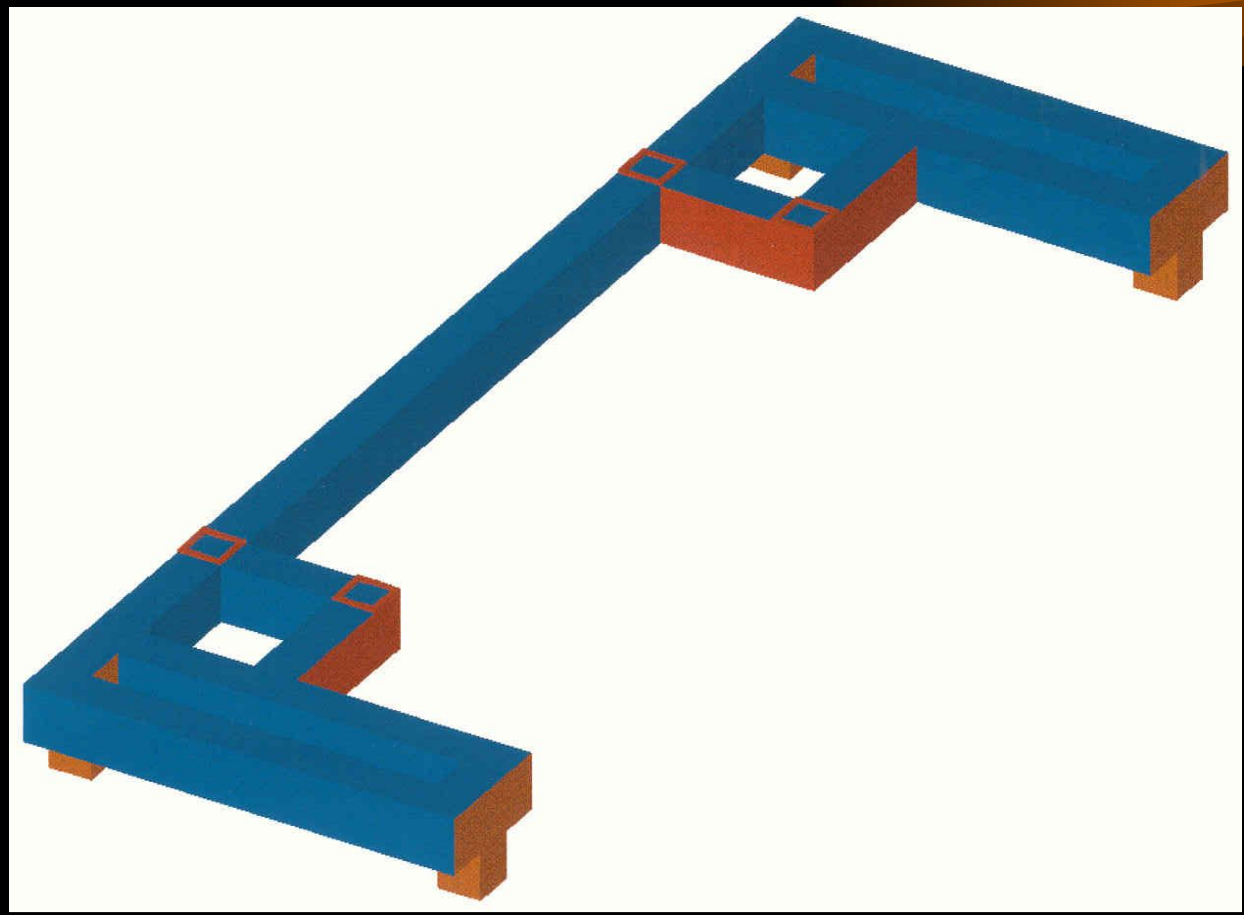
Magnet Fully Raised

Free Body Diagram with Magnet Loaded

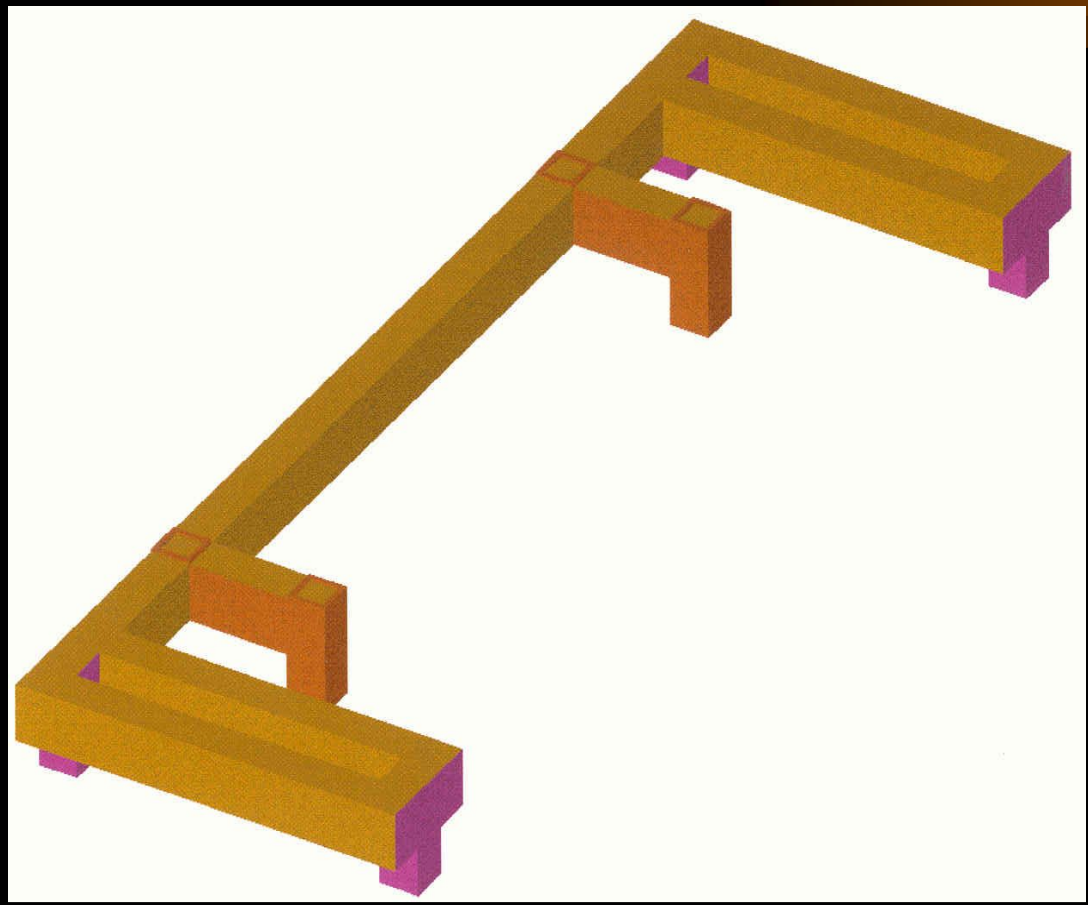


Moment from Cylinder

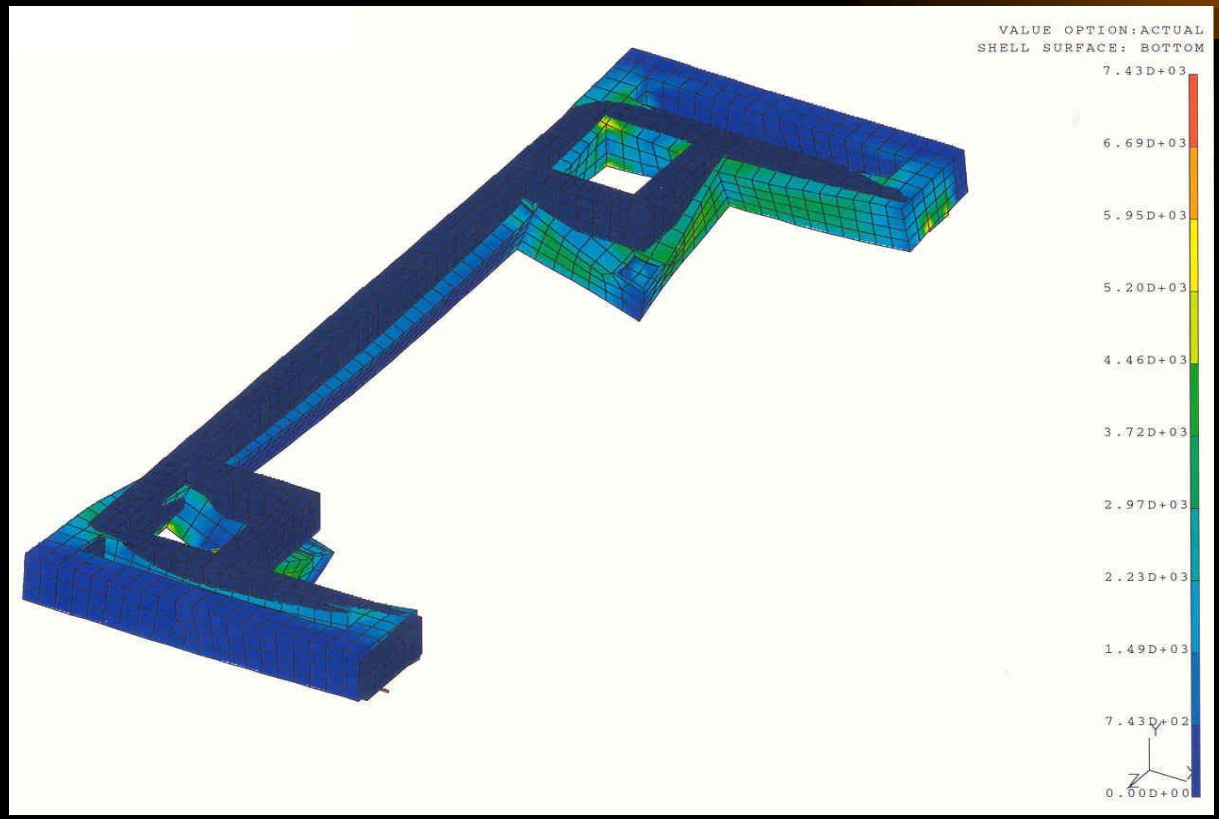
4 Wheel Design



6 Wheel Design



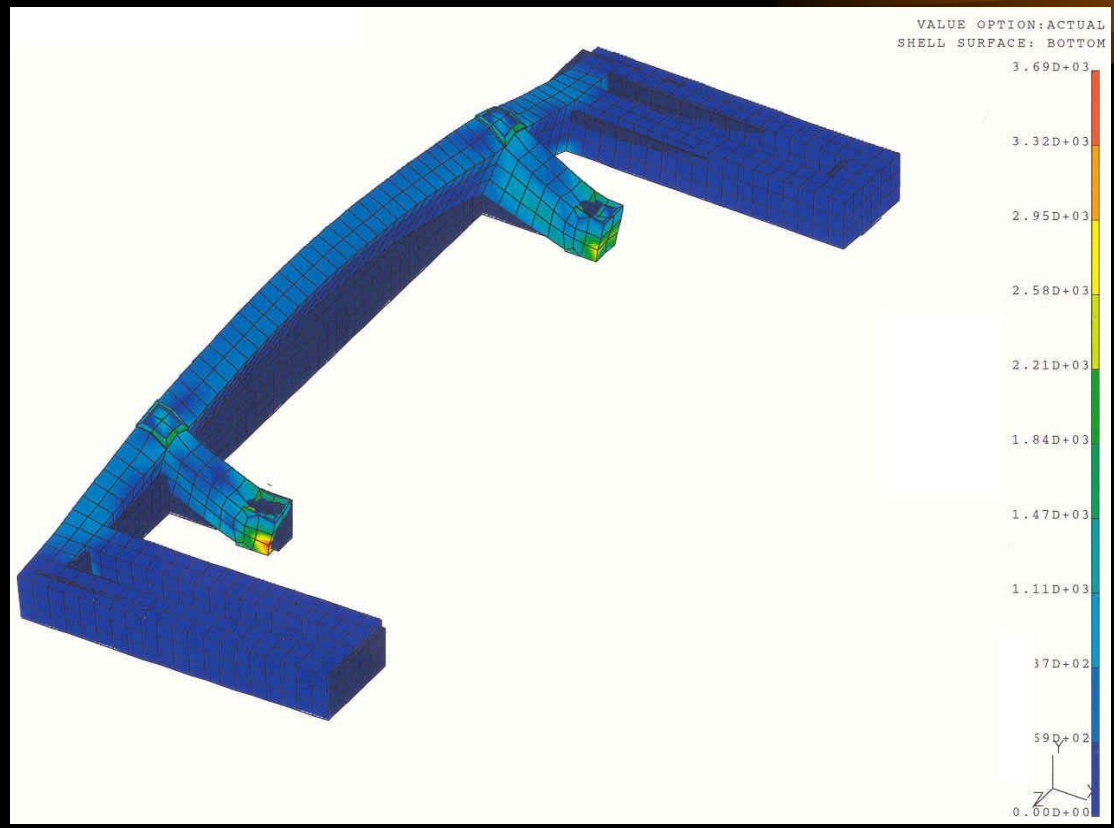
Base Stress Analysis
(4-Wheel Design)



Max Stress: 7430 p.s.i.

Max Deflection: .0359”

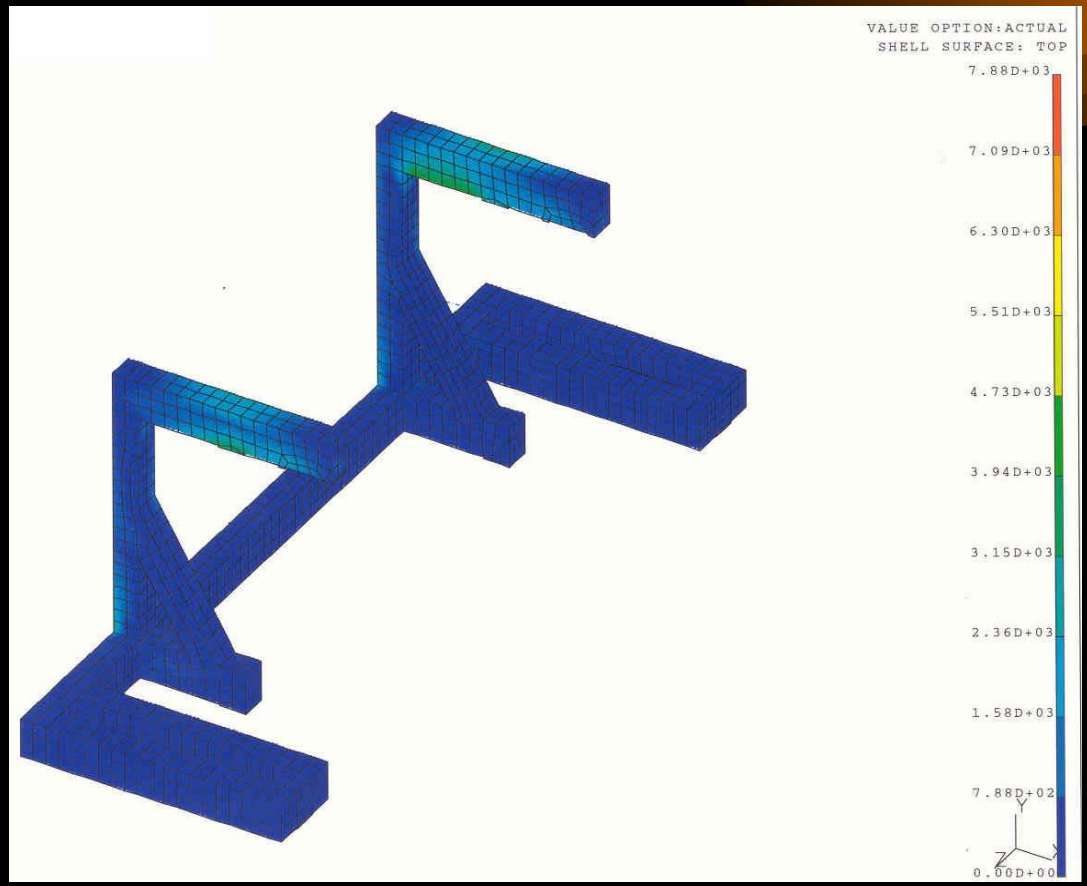
Base Stress Analysis
(6-Wheel Design)



Max Stress: 3690 p.s.i.

Max Deflection: .006”

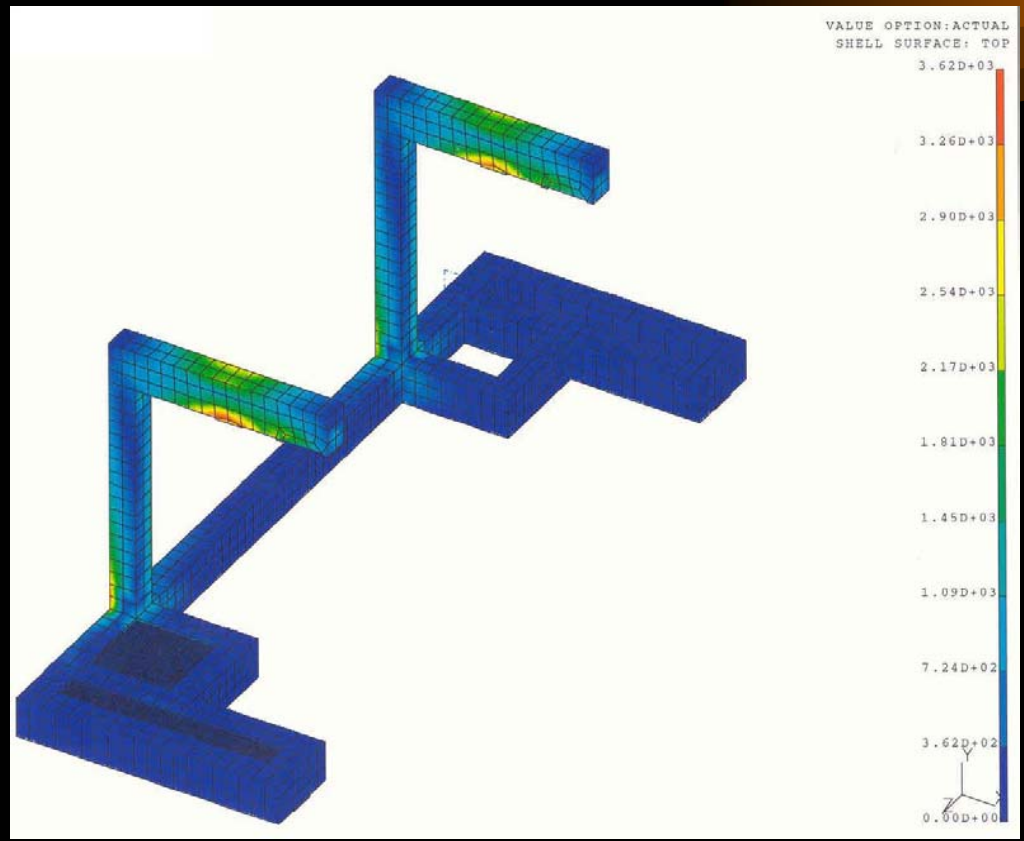
Top Stress Analysis
(With Supports)



Max Stress:7880 p.s.i.

Max Deflection: .0471”

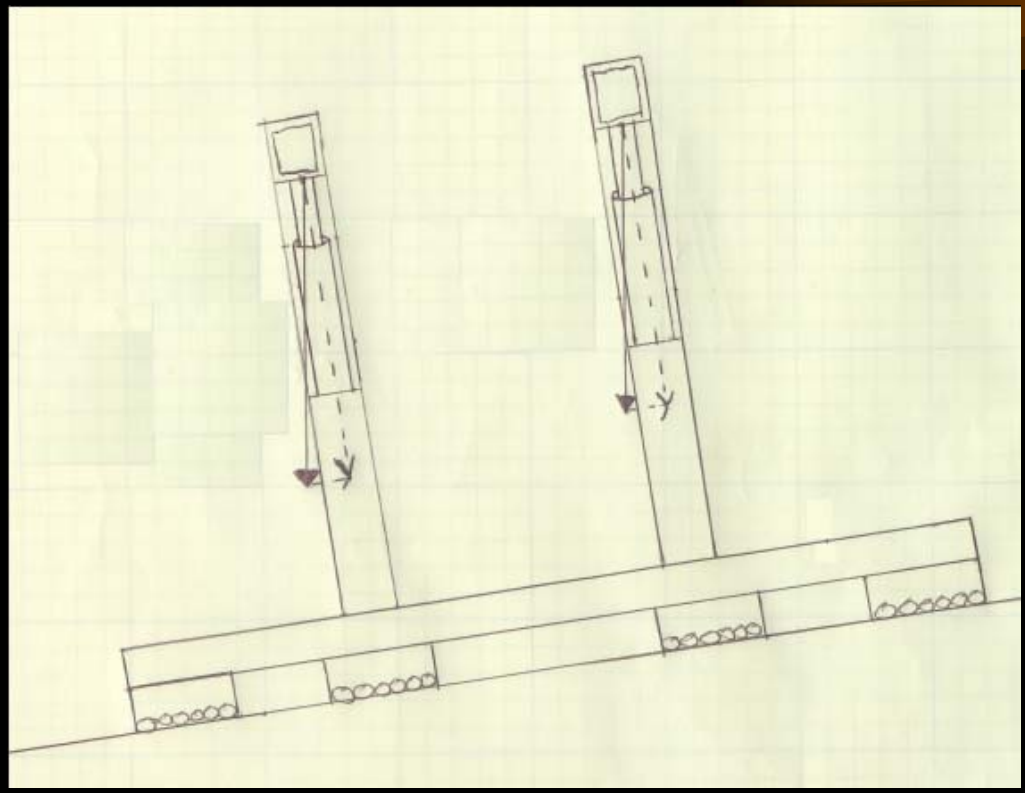
Top Stress Analysis
(Without Supports)



Max Stress: 3620 p.s.i.

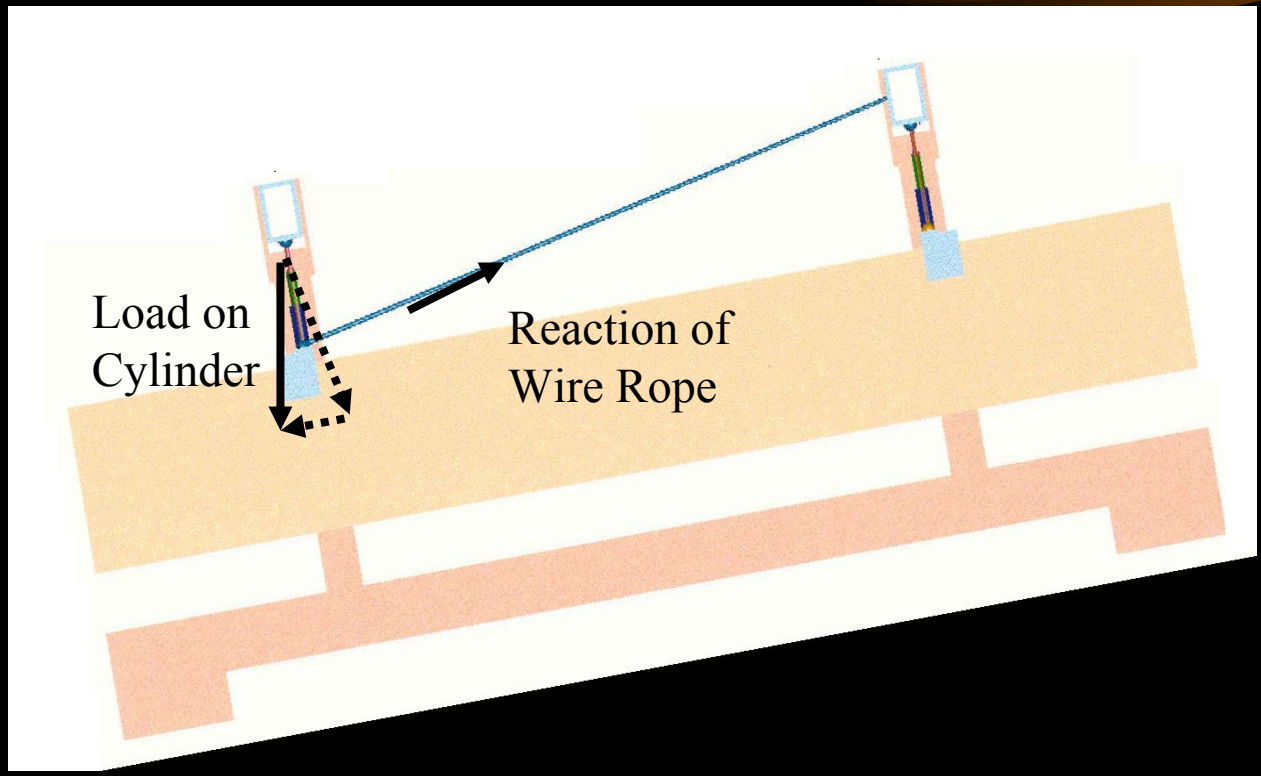
Max Deflection: .0497”

Inclined Load on Cylinders



Hydraulic cylinders are very weak against shearing loads.

Solution

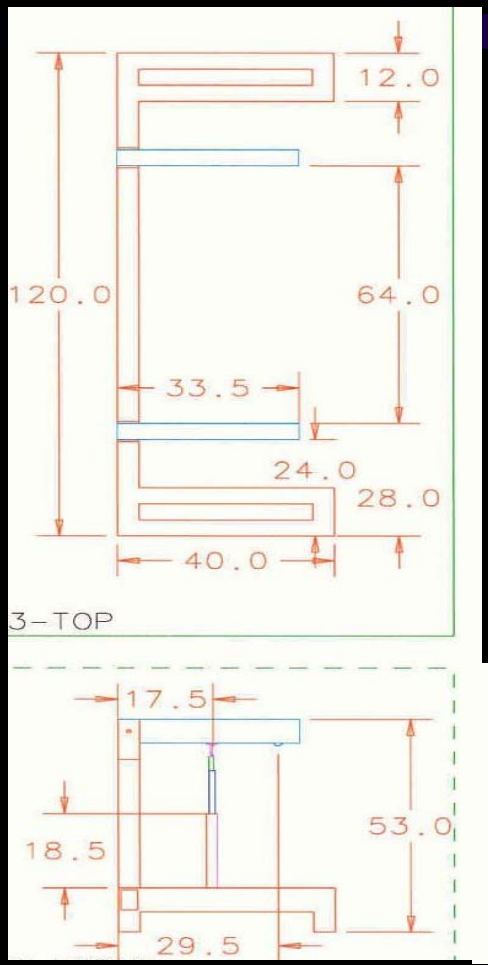


Wire Rope attached from the pivoting beam to bottom lifting lug.

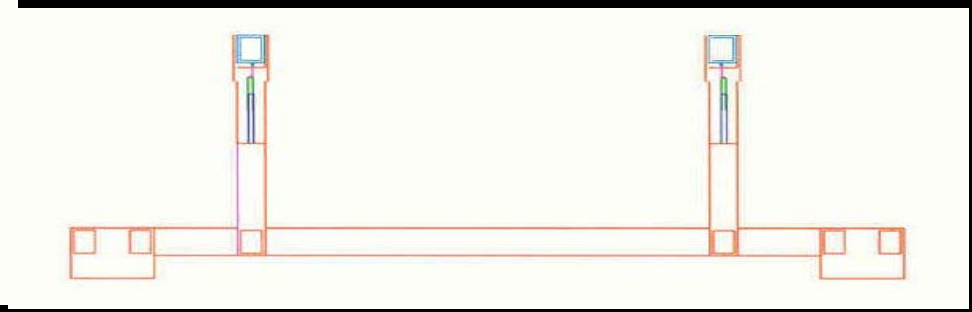
Materials

- 2 - 5-ton capacity Hillman rollers and 4 - 3.75-ton capacity Hilman Rollers
- Beam Dimensions: 6” x 4” x ½” A500 Structural Steel Tube
- Column Dimensions: 4” x 4” x ½” A500 Structural Steel Tube
- 2 - 5-ton capacity Hydraulic Cylinders
- Length of Frame: 120”
- Height of Frame (pivoting arm parallel to ground): 53”
- Width of Frame: 40”

Conclusion



- Materials have been carefully selected.
- Stress analyses have been completed.
- Constraints have been met.
- Adequate safety factors have been taken into consideration

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