Stilt Structure for Remote Observatories in Antarctica

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Introduction

Recently the Magnetosphere-Ionosphere Research Laboratory (MIRL) has been working on sending a remote observatory to Western Antarctic Ice Shelf (WAIS) Divide, Antarctica. As a part of this there was a need to develop a Stilt structure that could support the observatory and deal with the extreme weather conditions of Antarctica.

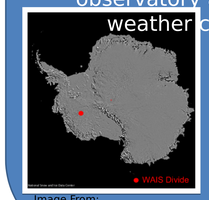


Image From: http://nsidc.org/data/nsidc-0375.html

Assumptions

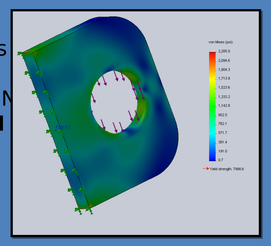
- Material: Aluminum 6061 Alloy (minimum yield strength of all 6061 Alloys)
- Factor of Safety =2
- Box Weight= 2000lbs

Image From: http://www.waisdivide.unh.edu/Gallery/ImageDetail.shtml?IMAGE_ID=43

Clevis

Calculations of Stress:
Total weight= 2295.56lbs
=1041.2485 kg
1041.25*9.8= 10204.25 N
10204.25/4= **2557.06 N**

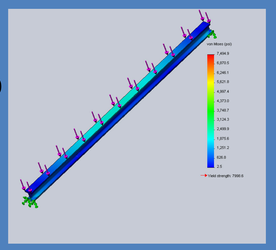
Total deformation:
= **.00136 cm**



I-Beam

Calculations of Stress:
Box weight= 2000lbs
= 907.184 kg
907.184*9.8= 8890.40 N
8890.40/3=
2963.4677 N

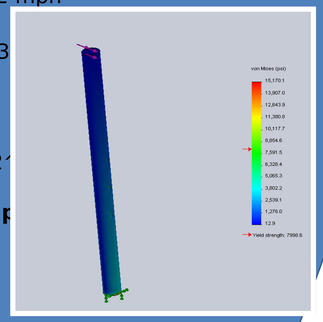
Total deformation:
= **.1357 cm**

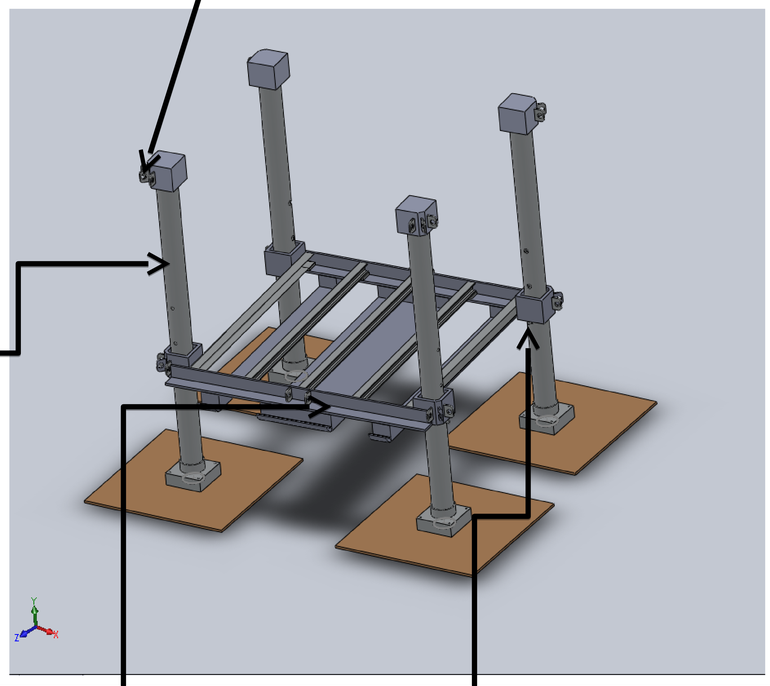


Stilt Leg

Calculations of Stress:
Maximum wind speed= 92 mph
Drag Force= $\frac{1}{2}\rho_{air}C_dA_pV^2$
P_{air} @ -40°F=1.506 kg/m^3
C_d =2
A_p =2.323 m^2
V= 41.2 m/sec
=½(1.506)(2)(2.323)(41.2
=5925.13 N
5925.13/2= **2962.565 N p**

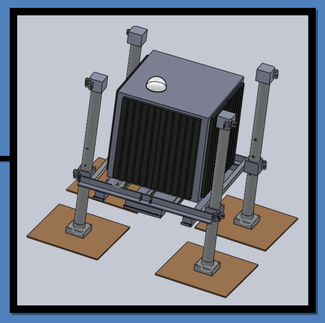
Total deformation
= 1.23 cm





Stilt Design

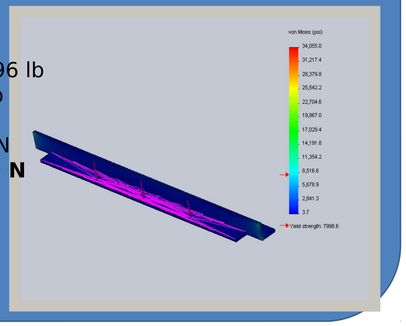
- Extreme conditions
- Ease of assembly and transportation
- Long term use
- Cost of materials and production



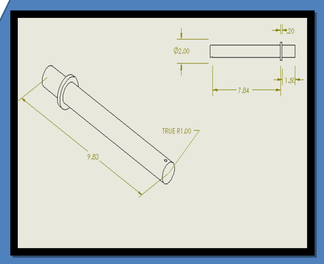
T-Bar

Calculations of Stress:
Box + 3 I-Beams
2000 +20.98*3= 2062.96 lb
2062.96/2= 1031.479 lb
= 467.87 kg
467.87*9.8= 4585.136 N
4585.136/3= **1528.379 N**

Total deformation:
= **.149 cm**



Pin



Shear Stress:
T= shear stress
F= Force due to box + palette
FS= Factor of Safety
A= Cross sectional area of pin
R= Radius of Pin

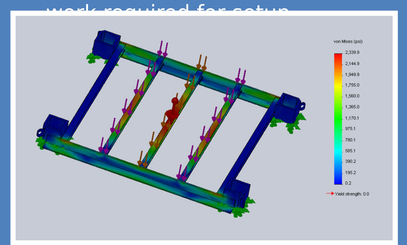
Calculations:
Box + Palette=2295.56lbs
F=2295.56/4= **573.89lbs per leg**
T=F/A
$FS=T_{ultimate}/T_{design}$
FS=2
$T_{ultimate}$= 12000 psi
T_{design} = 12000/2= 6000 psi
$6000=F/(\pi R^2)$
R^2=573.89/6000π
R= .1745
Minimum Diameter= .3489 inches
Diameter= 1 inch
T_{design} = 182.67 psi
12000/182.67= 65
FS= 65

Bearing Stress:
$\sigma_B=P/dt$
P=Load on Pin
d= diameter of pin
t= thickness of leg

Calculations:
σ_B= (573.89)/(1*.65)
= **882.907 psi**
Bearing Yield Strength= 14900psi
14900/882.907= 16.87
FS=**16.87**

Summary

This design is being used in a proposal for an observatory to be put in WAIS divide. These stilts were a crucial part of the proposal due to the appeal of the minimal work required for setup.



Total deformation: