Fermilab

Particle Physics Division

Mechanical Department Engineering Note

Number: MD-ENG-231 Date: 03/12/2010

Project:----------NOvA

Proj Intern Ref:

Title:----------MUON CATCHER FRAME

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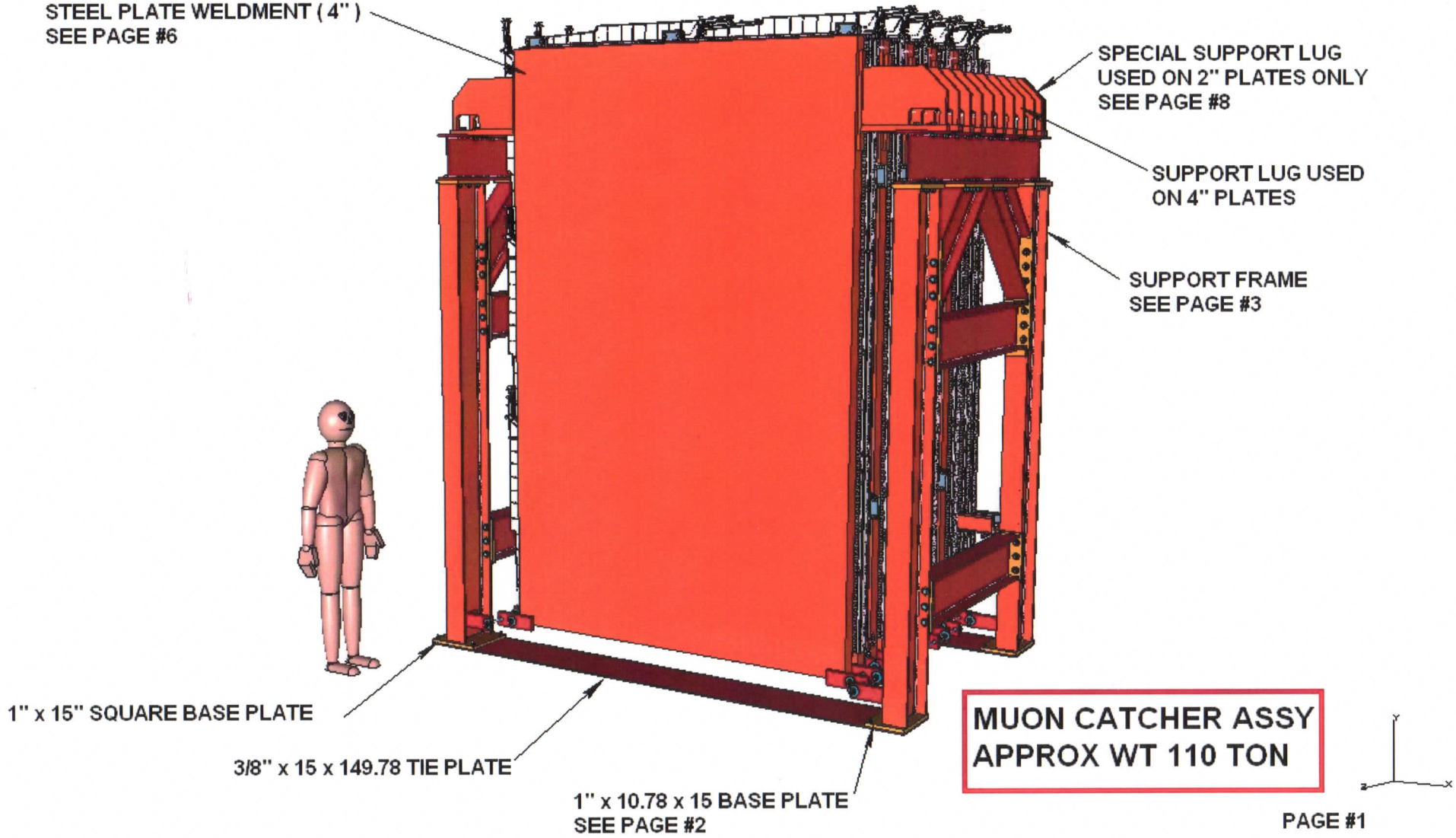
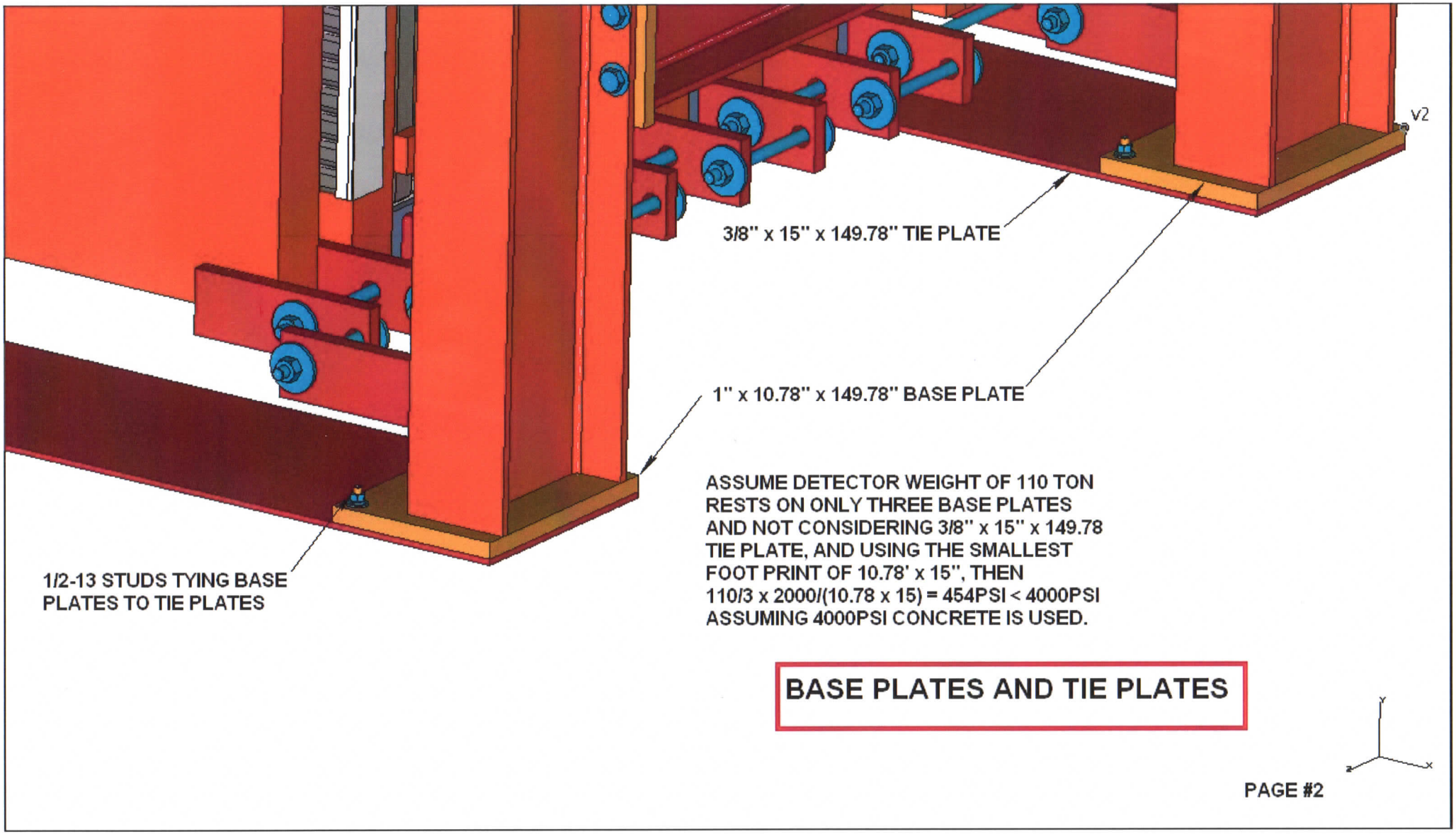
Key Words:---------BASE PLATES,SUPPORT FRAME,SUPPORT LUGS, CLIPS

Abstract/Summary:THE DETECTOR IS COMPOSED OF THE FOLOWING:

(1) FIVE HORIZ PLANES MOUNTED ON 4" THICK PLATES
(2) FOUR VERT. PLANES MOUNTED ON 4" THICK PLATES
(3) ONE 4-PLANE BLOCK MOUNTED ON 2" THICK PLATE
(4) A 2" NAKED PLATE IS MOUNTED JUST UPSTEAM OF ITEM #3
(5) EACH PLATE IS MOUNTED BY MEANS OF SUPPORT LUGS TO A FRAME WHICH IS BOLTED T0 4000 PSI CONCTRETE FLOOR
(6) THE DETECTOR WEIGHT IS APPROXIMATELY 110 TON

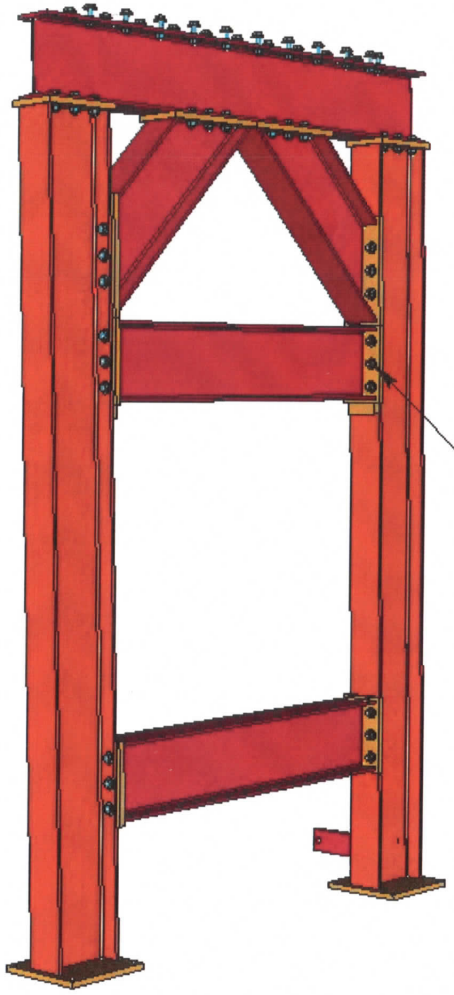
Applicable Codes:--AISC " MANUAL OF STEEL CONSTRUCTION "


STEEL PLATE WELDMENT (4")
SEE PAGE #6
SPECIAL SUPPORT LUG
USED ON 2" PLATES ONLY
SEE PAGE #8
SUPPORT LUG USED
ON 4" PLATES
SUPPORT FRAME
SEE PAGE #3
1" x 15" SQUARE BASE PLATE
3/8" x 15 x 149.78 TIE PLATE
1" x 10.78 x 15 BASE PLATE
SEE PAGE #2
MUON CATCHER ASSY
APPROX WT 110 TON



ASSUME DETECTOR WEIGHT OF 110 TON RESTS ON ONLY THREE BASE PLATES AND NOT CONSIDERING 3/8" x 15" x 149.78 TIE PLATE, AND USING THE SMALLEST FOOT PRINT OF 10.78' x 15", THEN 110/3 x 2000/(10.78 x 15) = 454PSI < 4000PSI ASSUMING 4000PSI CONCRETE IS USED.

BASE PLATES AND TIE PLATES



SEE PAGES 4 & 5 FOR
ONE-DIMENSIONAL
FRAME FEA

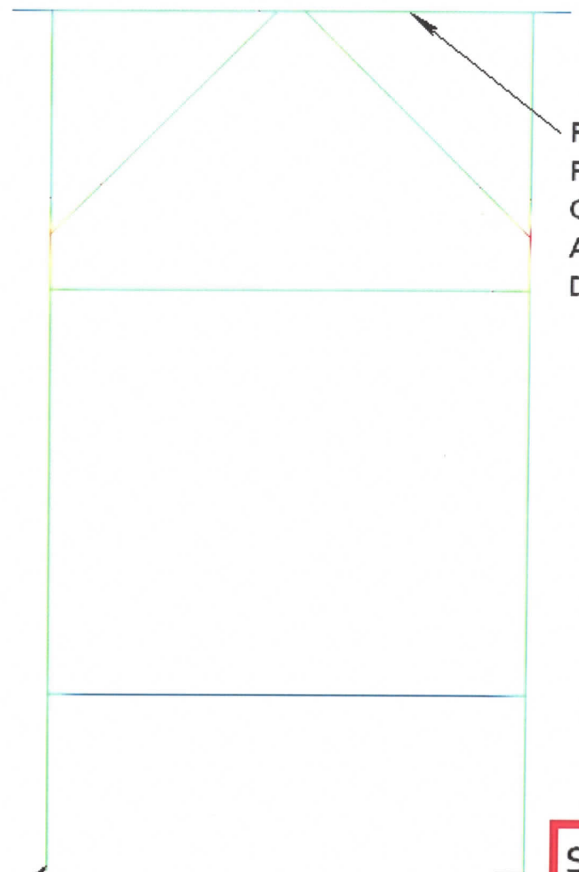
ALL FASTENERS 3/4-10 GRADE 8 BOLTS

SUPPORT EAST FRAME

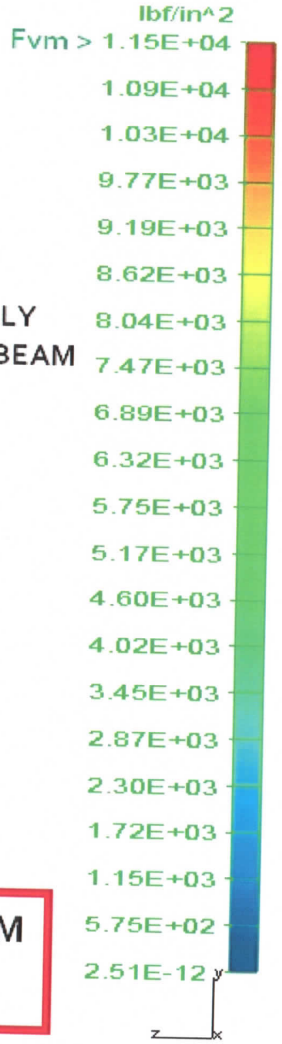
I-DEAS 12 NX Series m2: I-DEAS Visualizer

MUON_CATCHER_SUPT_FRAME_FEM
55_TON_LOAD
STRESS Von Mises Averaged Top shell
Beam stress: Von Mises , maximum point
Min: 2.51E-12 lbf/in^2 Max: 1.15E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 0.00E+00 in

MATERIAL: ASTM A36 STEEL
Fvm = 0.6 X 36,000 = 21,600 PSI (ALLOWED)



FOUR LOADS OF 10522#
FIVE LOADS OF 10,468#
ONE LOAD OF 12806#
ALL LOADS ACT VERTICALLY
DOWNWARD ON W12X35 BEAM



HILTI FASTEN TO 4000 PSI
CONCRETE FLOOR

SUPPORT FRAME FEM
STRESSES

I-DEAS 12 NX Series m2: I-DEAS Visualizer

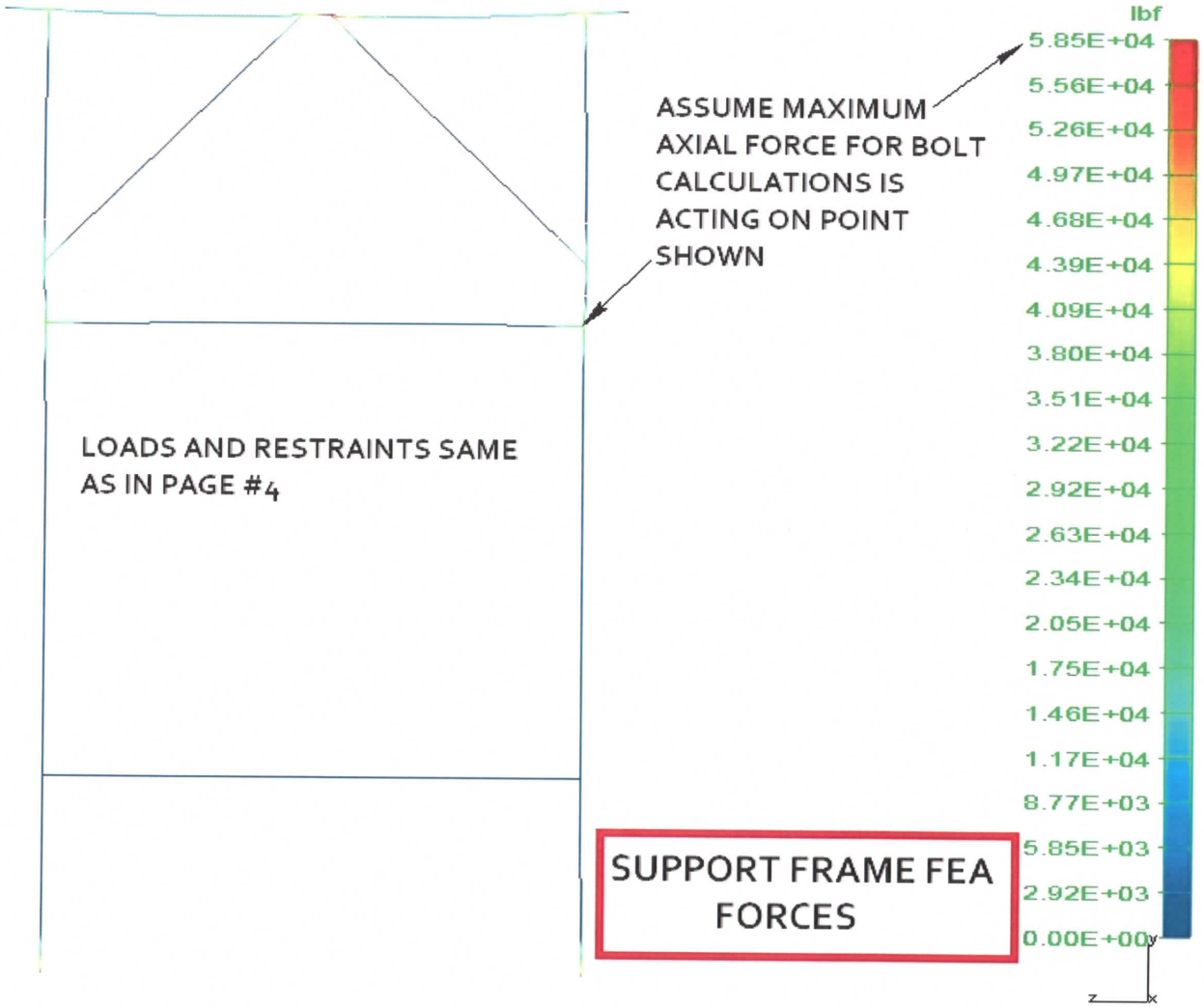
MUON_CATCHER_SUPT_FRAME_FEM
55_TON_LOAD
ELEMENT FORCE Magnitude Averaged Top shell
Min: 0.00E+00 lbf Max: 5.85E+04 lbf
B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 4.04E-02 in

BOLTS USED : 3/4-10 GRADE 8 (A = .3344 IN^2)
PROOF LOAD TEST = 12,000 PSI
MAXIMUM CLAMP LOAD ALLOWED
= 75%X120,000 X .3344 = 30,096 #

58500#/6BOLTS = F = 9750# CLAMP FORCE REQUIRED

TORQUED = KFD = .25 X 9750 X .75 = 1828 IN-LB
= 152 FT-LB

WHERE K = .25 = COEFFICIENT OF FRICTION
F = 9750 = DESIGN LOAD
D = .75 = BOLT DIAMETER



SUPPORT FRAME FEA FORCES

USE 1/2" FILLET WELDS, 3" LONG, 3 PER SIDE

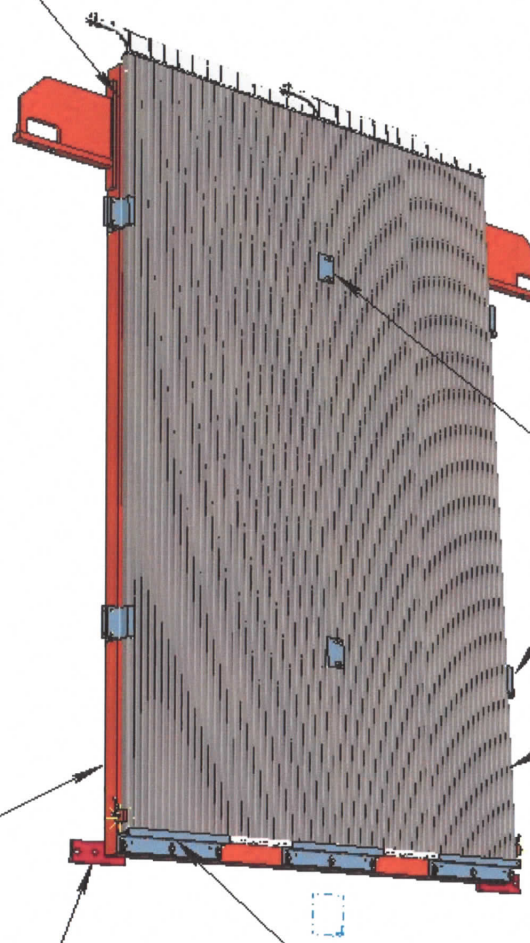
MATERIAL : ASTM A36, Fvm = 0.6 X 36,000
= 21,600 PSI ALLOWED

USING WELD ELECTRODES E60XX
Fv = 0.3X62,000 = 18,600 PSI ALLOWED
Fw = SIN45 X 0.5 X Fv
=6,576 #/IN ALLOWED

WELDS IN SHEAR
fw = 21,044/2X2X3X3 = 585 #/IN < Fw

MINIMUM WELD SIZE REQUIRED :
w = fw/Fw = 585/6576 = .089"

1/2" WELD WAS USED TO CONFORM WITH HEAT DISTRIBUTION PRINCIPLE OF THICKER PLATE (4")



WEIGHT

PVC----------514#
OIL----------1030
STEEL PLATE 4"----------19500
TOTAL-----21,044#

SUPT LUG

(2)INNER CLIPS

(4) OUTER CLIPS

VERTICAL PLANE

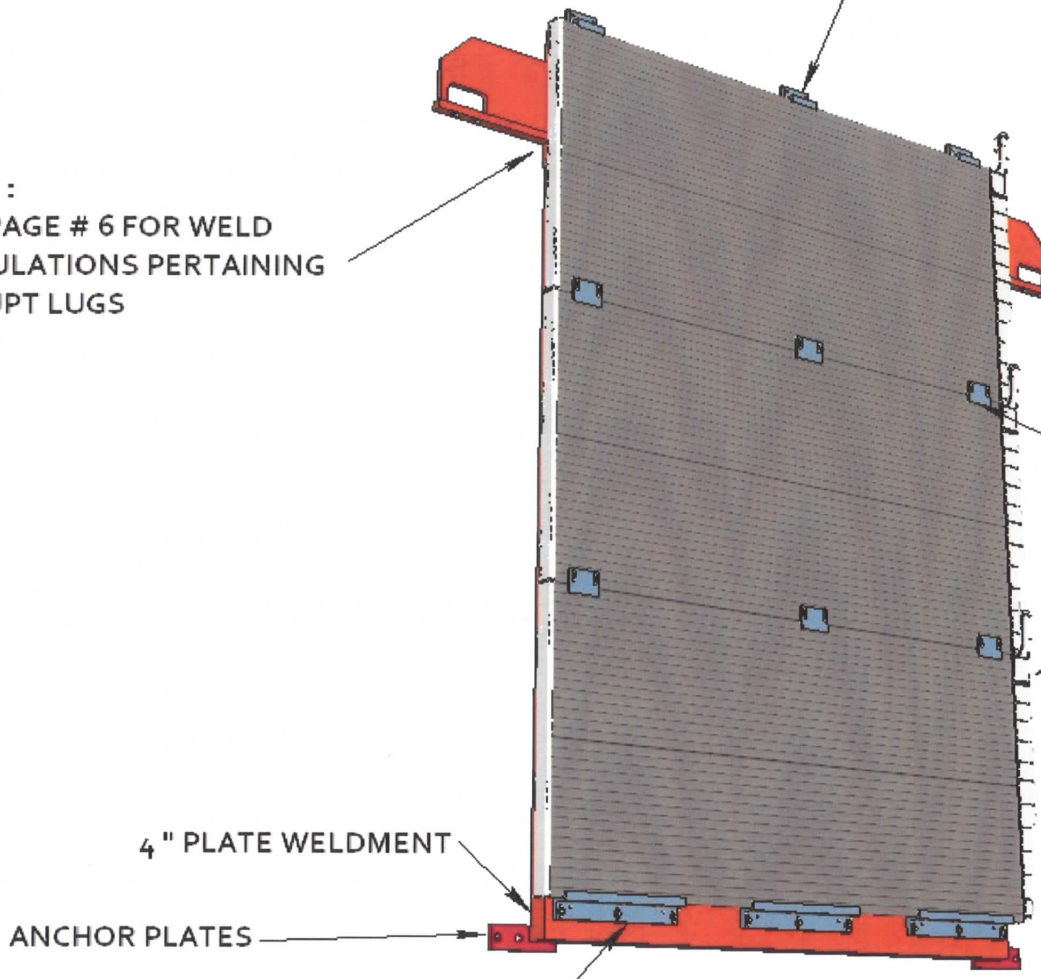
4"PLATE WELDMENT
SEE PAGE #9

ANCHOR PLATES

(3) BOTTOM CLIPS
SEE PAGE #10

VERTICAL PLANE ASSY

PAGE #6



WEIGHT

PVC----------393#
OIL----------1,044
STEEL PLATE (4")-----19,500
TOTAL--21,044#

HORIZONTAL PLANE ASSY

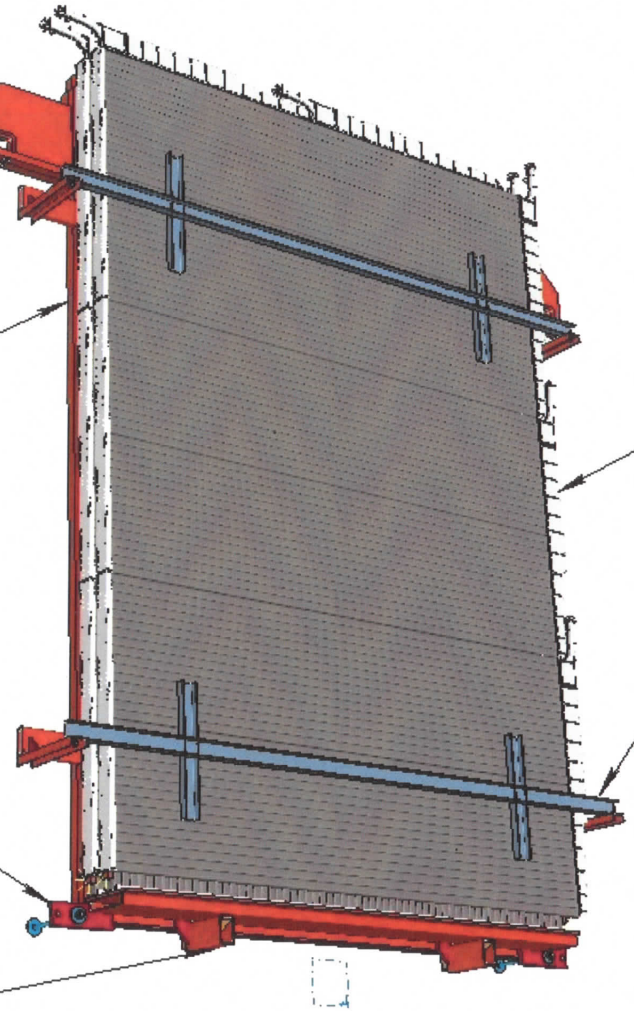
PAGE #7

SPECIAL SUPPORT LUG
SEE PAGE #6 FOR
WELD CALCULATIONS
PERTAINING TO LUGS

2" PLATE WELDMENT
SEE PAGE #9 FOR FEA

ANCHOR PLATE

PALLET
SEE PAGE #12 FOR FEA



WEIGHT

PVC	1,814#
OIL	4,148
STEEL PLATE (2")	9,825
TOTAL	15,787#

4-PLANE BLOCK

ALUM BLOCK STABILIZERS

BLOCK ASSEMBLY

I-DEAS 12 NX Series m2: I-DEAS Visualizer

BLOCK_PLATE_WELDMENT_FEM
12K_LOAD_PLUS_GRAVITY
STRESS Von Mises Averaged Top shell
Min: 2.97E+00 lbf/in^2 Max: 9.64E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 2.25E-02 in

MATERIAL : ASTM A36

Fvm = 0.6 X 36,000 = 21,600 PSI ALLOWED

WELD ELECTRODES E60XX

Fv = 0.3 X 62,000 = 18,600 PSI

Fw = sin45 X 0.5 X Fv = 6576 #/IN ALLOWED

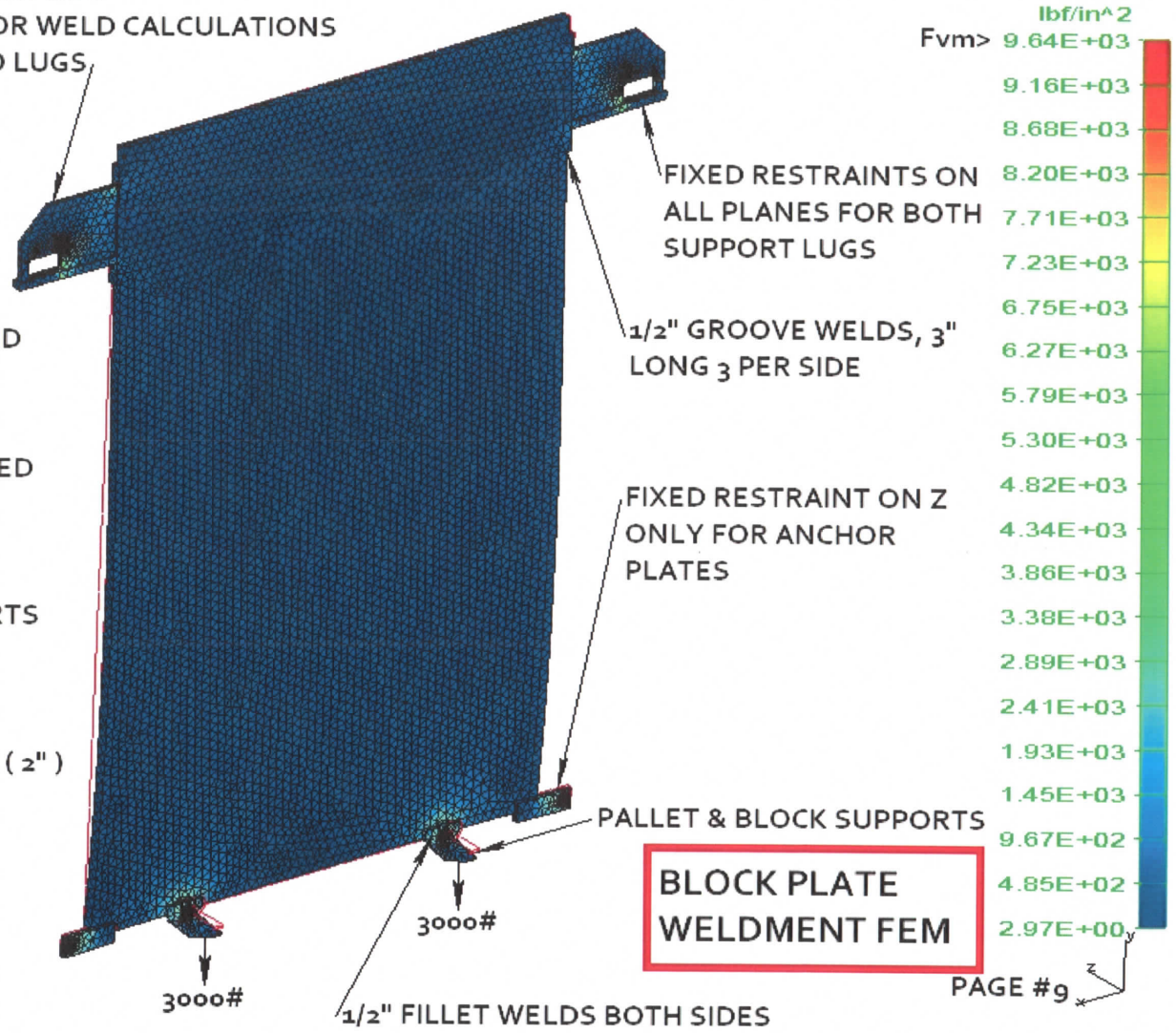
WELDS IN SHEAR AT BLOCK & PALLET SUPPORTS

fw = 3000/2/2 = 750#/IN < Fw

WELD SIZE REQUIRED AT BLOCK & PALLET SUPPORTS

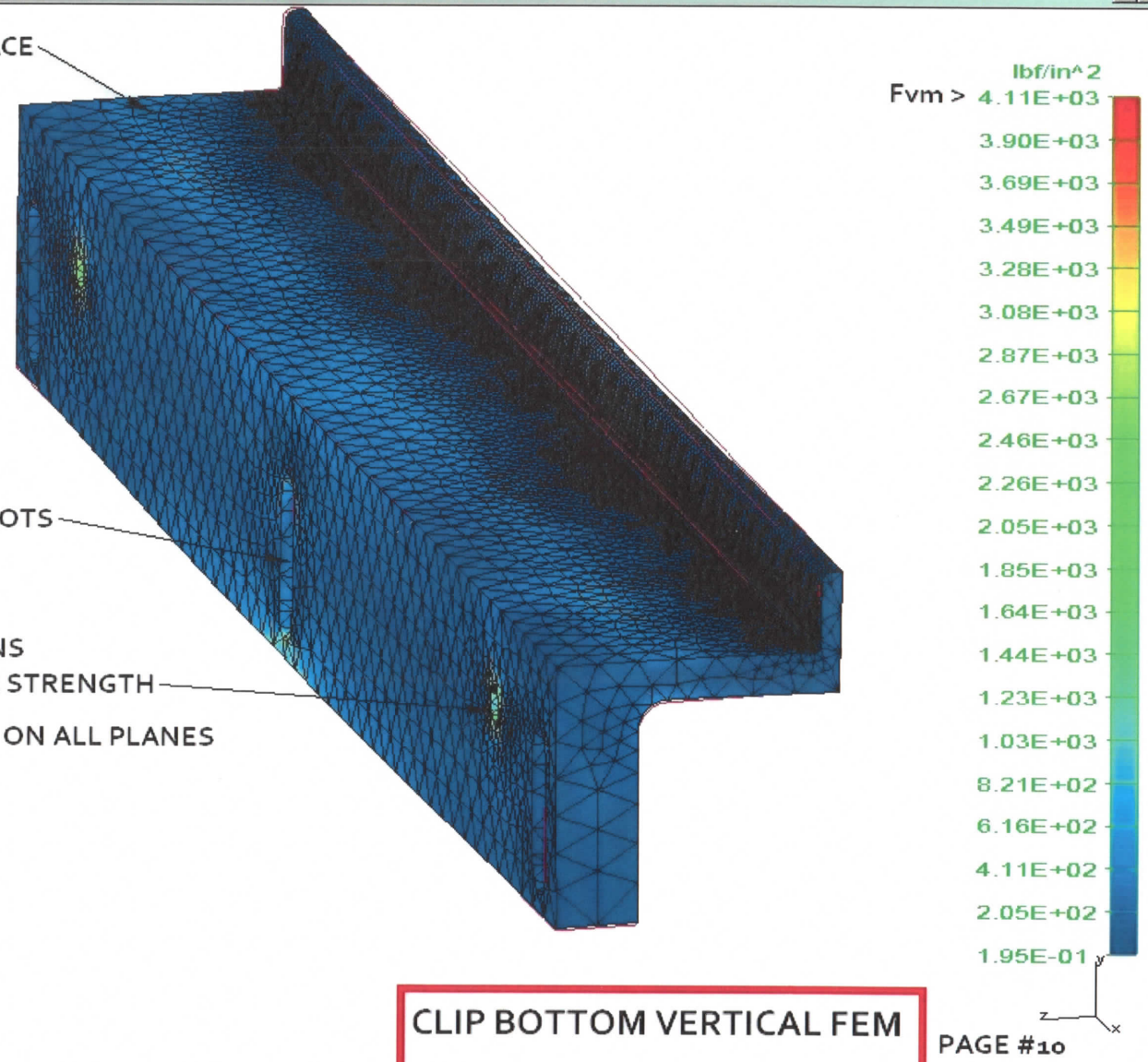
w = fw/Fw = 750/6576 = .144"

1/2" WELD WAS USED TO CONFORMED WITH HEAT DISTRIBUTION PRINCIPLE OF THICKER PLATE (2")



BLOCK PLATE WELDMENT FEM

I-DEAS 12 NX Series m2: I-DEAS Visualizer

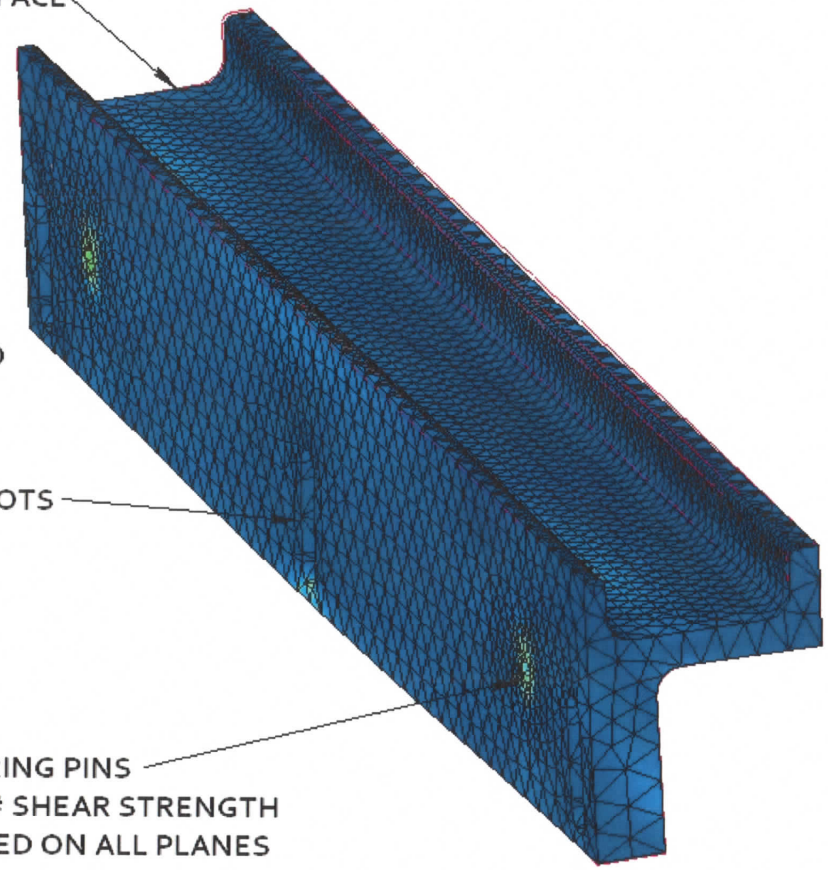


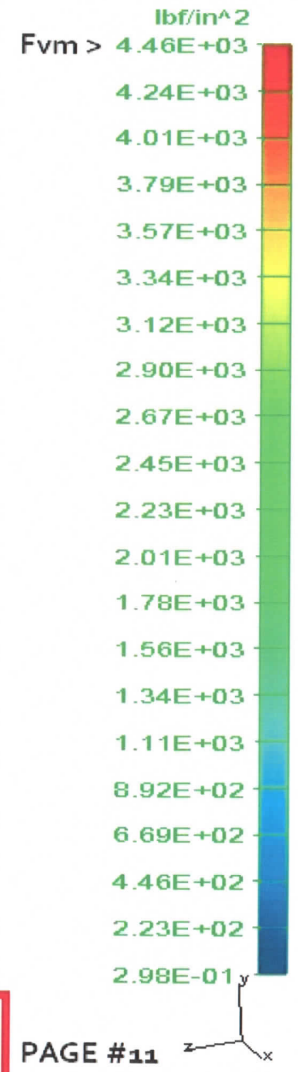
CLIP BOTTOM VERTICAL FEM

I-DEAS 12 NX Series m2: I-DEAS Visualizer

CLIP_BOTT_HORIZ_FEM
750LB_LOAD
STRESS Von Mises Averaged Top shell
Min: 2.98E-01 lbf/in^2 Max: 4.46E+03 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 2.31E-03 in

MATERIAL : ALUMINUM 6061-T6
Fvm = 0.6 X 35,000 = 21,000 PSI ALLOWED



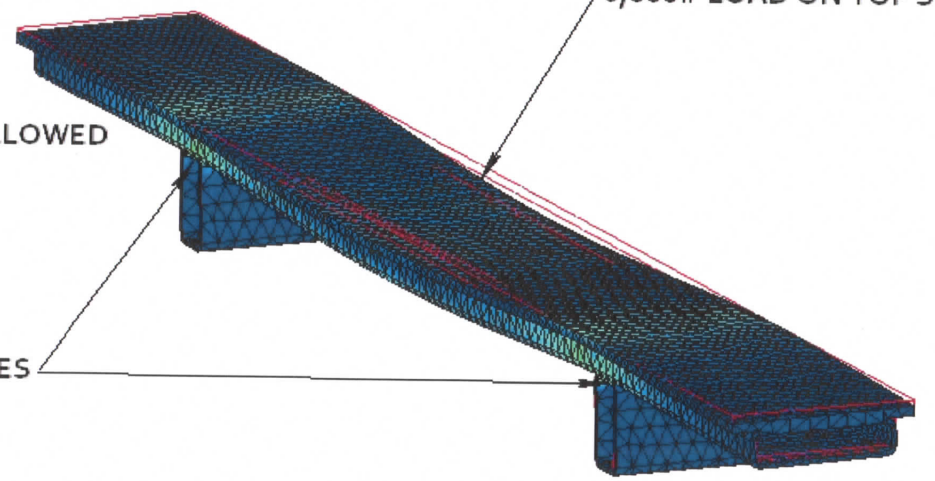


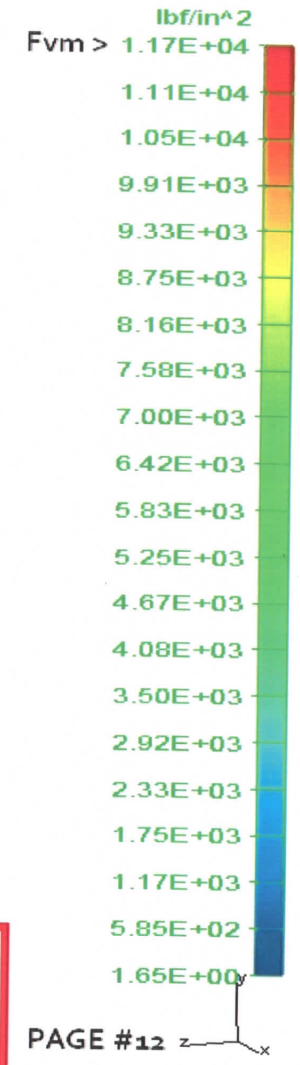
CLIP BOTTOM HORIZONTAL

I-DEAS 12 NX Series m2: I-DEAS Visualizer

MUON_CATCHER_BLOCK_PALLET_FEM
6000LB_LOAD_2-RESTRAINTS
STRESS Von Mises Averaged Top shell
Min: 1.65E+00 lbf/in^2 Max: 1.17E+04 lbf/in^2
B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 1.78E-02 in

MATERIAL : ASTM A36 STEEL
Fvm = 0.6 X 36,000 = 21,600 PSI ALLOWED

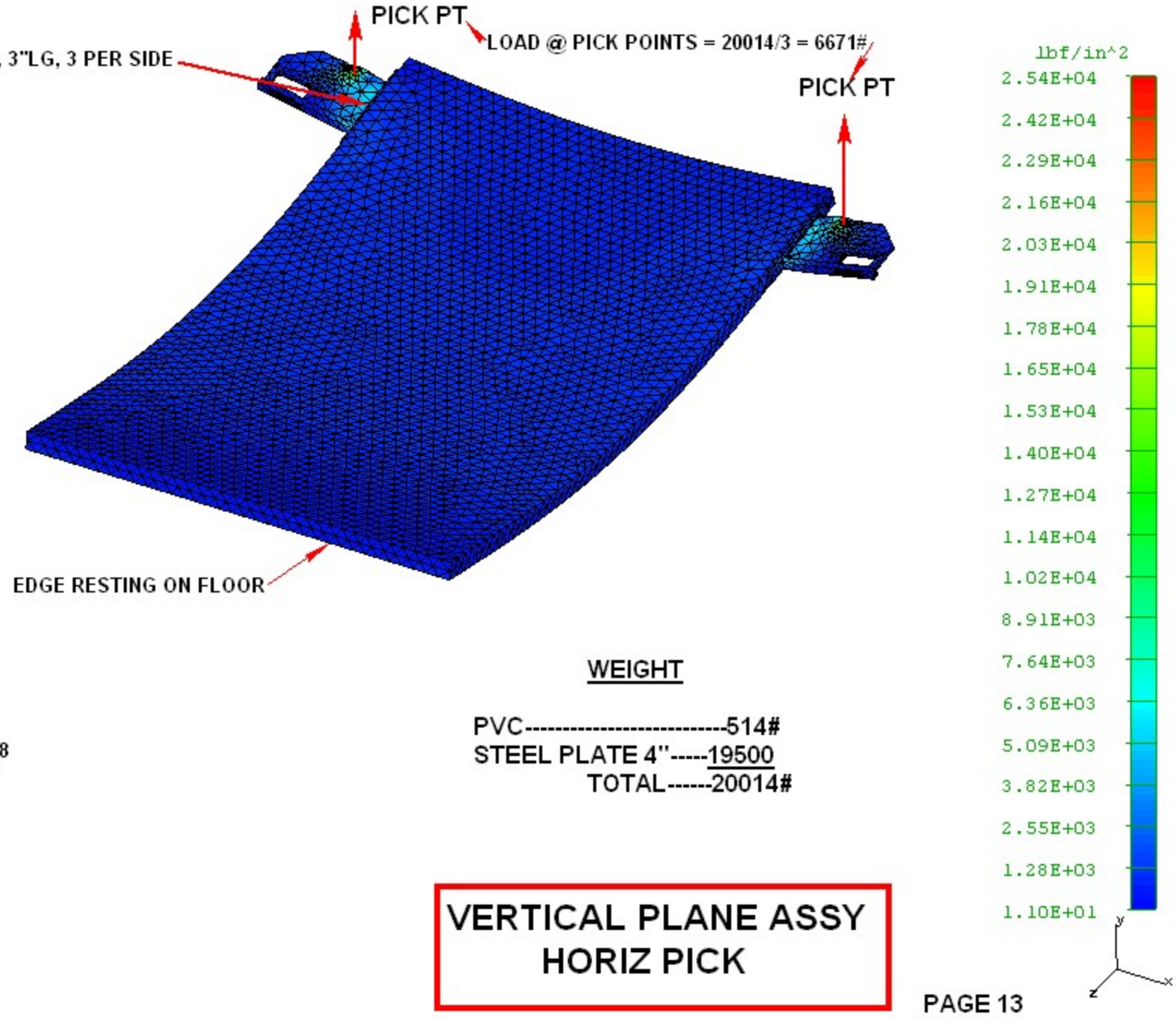




MUON CATCHER BLOCK PALLET
ATTACHED TO 2" STEEL PLATE AND
BLOCK IS FILLED WITH OIL

I-DEAS 12 NX Series m4: I-DEAS Visualizer

I-DEAS Visualizer
MUON_CATCHER_VERT_SUPT_WLDNT_FEM
GRAVITY_PLUS_PVC_HORIZ_PICK
STRESS Von Mises Averaged Top shell
Min: 1.47E+01 lbf/in^2 Max: 2.54E+04 lbf/in^2
DISPLACEMENT XYZ Magnitude
Min: 0.00E+00 in Max: 5.52E-02 in



USE WELD ELECTODES E60XX

Fv = 0.3 x 62,000 = 18,600 PSI ALLOWED

Fw = SIN45x0.5xFv = 6,576 3/IN ALLOWED

WELD IN SHEAR

fw = 20014/2x2x3X3 = 556 #/IN < Fw

WELD IN BENDING

fw = M/Sw = 3336 #/IN < Fw

WHERE SECTION MODULUS OF WELD = (3x3)2 = 18
MOMENT = 9" X 6671 = 60039 IN-LBS
9" IS DISTANCE OF PICK HOLE TO
TO BASE OF BRACKET

WEIGHT

PVC----------514#
STEEL PLATE 4"-----19500
TOTAL------20014#

VERTICAL PLANE ASSY
HORIZ PICK