# Fermilab

## Particle Physics Division
## Mechanical Department Engineering Note

Number: MD-ENG-04-041 Date: 4/9/04

Project Internal Reference: WBS 114

Project: NUMI

Title: GANTRY HEADER BEAM

Author(s): 2DM ASSOCIATES INC.

Reviewer(s): Ernest M. Villegas

Key Words:

Abstract Summary: BRIDGE BEAM DESIGNED & BUILT BY TAFT CONTRACTING CO. TO BE USED BY THEM IN THE CONSTRUCTION OF THE HADRON ABSORBER.

Applicable Codes:

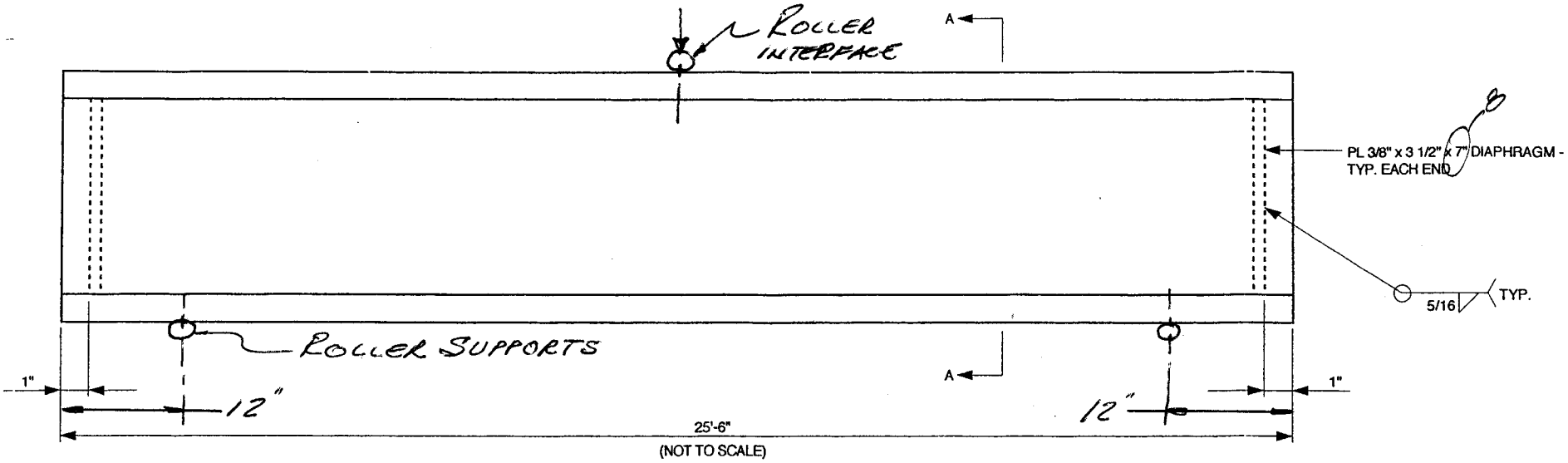
NOTE:

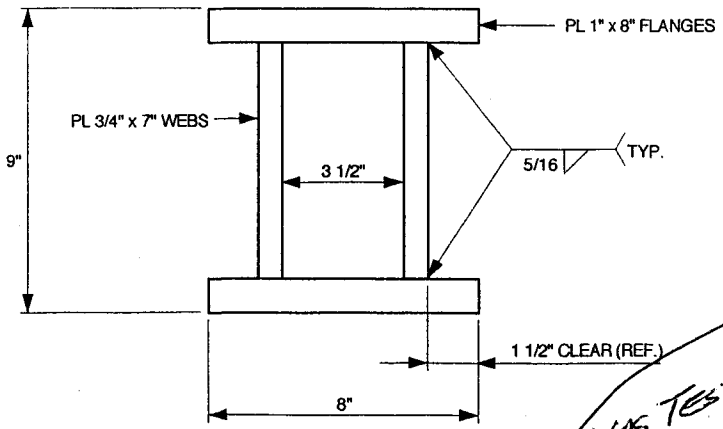
LOAD TESTED 5/07/04

TEST LOAD = 28000#

MEASURED DEFLECTION @ LOAD = 1 9/16

TEST WITNESS BY: DAVE ERICKSON
OTTO ALVAREZ
MIKE MASCIONE
TOM OLSZANOWSKI
ERNIE VILLEGAS




WAS TESTED A 23'-6"

## SECTION A-A

NOTES:

1. ALL STEEL SHALL BE ASTM A572 GRADE 50.
2. WELDING SHALL BE IN ACCORDANCE WITH AWS D1.1-2002 USING E70XX ELECTRODES.
3. FABRICATION SHALL BE IN ACCORDANCE WITH THE AISC *SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS* AND THE AISC *CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES.*
4. IF FLANGE OR WEB PLATES MUST BE SPLICED, THE SPLICES SHALL BE FULL PENETRATION GROOVE WELDS. IF BOTH FLANGE AND WEB PLATE SPLICES ARE REQUIRED, THE WEB SPLICES SHALL BE AT LEAST 12" FROM THE FLANGE SPLICES.
5. THIS HEADER BEAM HAS BEEN DESIGNED TO SUPPORT A LOAD OF 20,000 POUNDS (9,075 KG) APPLIED IN THE MIDDLE OF A SPAN OF 23'-7" (7.19 METERS). OTHER LOAD AND SPAN COMBINATIONS MUST BE CHECKED BY THE USER.
6. DESIGN IS BASED ON THE REQUIREMENTS OF THE SC&RA *RECOMMENDED PRACTICES FOR HYDRAULIC JACKING SYSTEMS.*
7. DEAD WEIGHT OF HEADER BEAM = 2,310 POUNDS (1,050 KG).

DAVID DUERR
062-048496
REGISTERED PROFESSIONAL ENGINEER
STATE OF ILLINOIS

12/16/03

| | |
|---|---|
| TAFT CONTRACTING COMPANY, INC. | |
| 25'-6" GANTRY HEADER BEAM | |
| 2DM ASSOCIATES, INC. | |
| DWG. 2355-201 | REV. 0 - ISSUED 12-11-03 |

Loads and Dimensions...

10% ??

| | | | |
|---|---|---|---|
| Weight of Load | 20,000 | pounds | → LOAD TESTED AT 1.25 × 20 × 10³ = 25K # |
| Vertical Impact Factor | 5.00% | | → 1250# |
| Lateral Load Factor | 10.00% | | → 2000# |
| Left Support to Left Lift Link | 11.79 | feet | → 11.75' TEST DIM. |
| Lift Link Spacing (= 0 for one load) | 0.00 | feet | |
| Lift Link Thickness | 1.000 | inch | |
| Beam Span | 23.58 | feet | 23.50' TEST SPAN |
| Overall Beam Length | 25.50 | feet | |

| | | | |
|---|---|---|---|
| Weight | 90.59 | plf | 3D MODEL YIELD 90.3#/FT = 2302# |
| Depth | 9.000 | inches | |
| Web Thickness | 0.750 | inch | |
| Web Spacing, center-to-center | 4.250 | inches | |
| Flange Width | 8.000 | inches | |
| Flange Thickness | 1.000 | inch | |
| Flange Hole Width | 0.000 | inch | |
| Fy | 50 | ksi (ASTM A572 Grade 50) | |
| E | 29,000 | ksi | |

| | | | |
|---|---|---|---|
| Weld Size | 5/16 | inch | BASED ON THICKNESS |
| Length of Weld per Foot | 12.000 | inches | CONTINUOUS |
| Filler Metal Strength | 70 | ksi | E70XX |

Analysis Results...

| | | | | | |
|---|---|---|---|---|---|
| Ix | 300.21 | in.^4 | Sx | 66.71 | in.^3 |
| Iy | 133.24 | in.^4 | Sy | 33.31 | in.^3 |
| A | 26.5 IN² | | | | |

3D MODEL VERIFIED

Check element slenderness ratios:

| | | Ratio | | Limit | |
|---|---|---|---|---|---|
| Flange Stiffened b/t | 5/1 | = 5.00 | < | 26.87 | O.K. = 190 ÷ √50 |
| Flange Unstiffened b/t | 1.5/1 | = 1.50 | | 9.19 | O.K. = 65 ÷ √50 |
| Web d/t | 9/.75 | = 12.00 | | 90.51 | O.K. = 640 ÷ √50 |
| Web h/t | 7/.75 | = 9.33 | | 138.76 | O.K. = 760 ÷ √30 |
| Web b/t | | 9.33 | | 26.87 | O.K. = 190 ÷ √50 |

$I_x = 300.21$
$I_y = 133.24$
} 3D SECTION

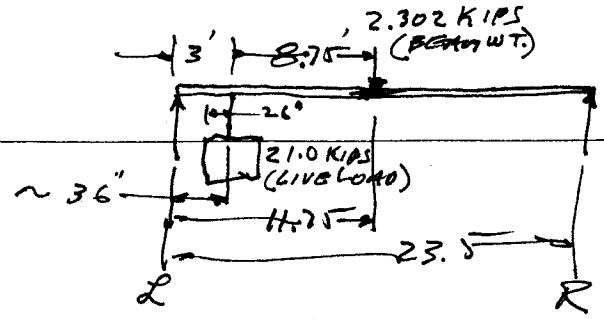
Analysis Results (con't.)...

| | | |
|---|---|---|
| Vertical Load | 21.00 kips per lift link | = 20 × 1.05 |
| Lateral Load | 2.00 kips per lift link | = 20 × 10% |
| Shear at Left Support | 11.57 kips | — $\frac{21+2.3}{2}$ = 11.65 |
| Shear at Right Support | 11.57 kips | — 11.65 |
| fv | 0.86 ksi | — .38 KSI |
| Fv | 20.00 ksi | |
| **Shear S.R.** | **0.04 ≤ 1.00 O.K.** | — .044 ≤ 1.00 OK |
| Maximum Mx | 1,561.32 kip-inches | — 1561.64 = $\frac{21 \times 23.5 \times 12}{4} + \frac{2.302 \times 23.5 \times 12}{8}$ |
| fbx | 23.40 ksi | — 23.41 |
| Fbx | 30.00 ksi | |
| Maximum My | 141.50 kip-inches | — 141.00 = $\frac{2 \times 23.5 \times 12}{4}$ |
| fby | 4.25 ksi | — 4.23 |
| Fby | 30.00 ksi | |
| **Bending S.R.** | **0.92 ≤ 1.00 O.K.** | — .92 = $\frac{23.41 + 4.23}{30}$ |
| Mid-Span Deflection | 1.085 inches | — 1.204 = $\frac{21 \times 10^3 (23.5 \times 12)^3}{48 \times 29 \times 10^6 \times 300.2} + \frac{5 \times 2.302 (23.5 \times 12)^3}{384 \times 29 \times 10^6 \times 300.21}$ |
| = | L / 261 | |
| Weld v | 7.40 kips per foot per weld | — 6.52 = $\frac{11.65 \times 8 \times 3.5 \times 12}{300.21 \times 2}$ |
| Weld V | 55.68 kips per foot per weld | — 57.28 = sin 45° × .312 × 21.6 × 12 |
| **Weld S.R.** | **0.13 ≤ 1.00 O.K.** | — .11 ≤ 1.00 OK |
| Lift Link Load | 21.00 kips | |
| Local Web Bearing Stress fp | 3.70 ksi | = $\frac{21}{.75(1+5 \times 1.312)}$ [ASSUMES ONLY ONE WEB] |
| Fp | 33.00 ksi | |
| Section K1.3 S.R. | 0.11 ≤ 1.00 O.K. | |
| Web Crippling Strength | 377.13 kips | — $67.5 \times .75^2 \left[1+3\left(\frac{1}{9}\right)\left(\frac{.75}{1}\right)^{1.5}\right] \sqrt{50 \times 1 \div .75}$ [ASSUMES ONLY ONE WEB] |
| Section K1.4 S.R. | 0.06 ≤ 1.00 O.K. | $\frac{21}{377.13}$ = .0556 |

Reactions to Jacks...

| | | |
|---|---|---|
| Total Weight of Header Beam | 2,310 pounds | — 2302 (3D MODEL) |
| Left Gantry Reaction | 11,155 pounds | — 11.60 KIPS } when load is @ CTR. |
| Right Gantry Reaction | 11,155 pounds | — 11.60 KIPS } |

LEFT GANTRY REACTION — 19.47 KIPS } when load is PICKED NEAREST LEFT SUPT.
RIGHT GANTRY REACTION — 3.83 KIPS }



Weight Take-Off

| Item | Quantity | Wt. each | Weight, lbs. |
|---|---|---|---|
| Flange Plates | 2 | 694 | 1,388 |
| Web Plates | 2 | 456 | 911 |
| End Diaphragms | 2 | 3 | 5 |
| | | Computed Weight | 2,305 |
| | | Design Weight to be Used | 2,310 |

# FEA RESULTS



I-DEAS 9 m3: Simulation 09-Apr-04 16:22:30
/cadwhs/server04/ms_villegas/TAFT.mf1
TAFT

Group ID : None
Result Set : 2 - B.C. 1,STRESS_2,LOAD SET 1
Report Type : Contour Units : IN
Result Type : STRESS
Frame of Reference: Part Data Component: Von Mises

| | Max Prin | Mid Prin | Min Prin | Max Shear (ALLOWED 20 KSI) | Von Mises (ALLOWED 30 KSI) |
|---|---|---|---|---|---|
| Actual Maximum | 9<br>2.764E+04 | 586<br>1.148E+03 | 510<br>3.236E+02 | 27<br>1.391E+04 | 9<br>2.763E+04 |
| Actual Minimum | 4155<br>-8.824E+02 | 4145<br>-2.764E+03 | 27<br>-2.863E+04 | 1225<br>9.429E+02 | 1225<br>1.692E+03 |
| Actual Average | 8.230E+03 | -2.506E+02 | -8.243E+03 | 8.236E+03 | 1.625E+04 |

21 KIPS DOWNWARD LOAD + 2 KIPS LATERAL LOAD.
BOTH ACTING @ CTR OF SPAN.

CTL
Construction Technology Laboratories, Inc.

5400 Old Orchard Road
Skokie, Illinois 60077
847.965.7500
Fax 847.965.8997
www.CTLGroup.com

March 4, 2004

**TELEFAX: (414) 353-1903**

Mr. Kent A Johnson
Quality Assurance Manager
Monarch Corporation
7050 North 76th Street
Milwaukee, WI 53223

COPY

Dear Mr. Johnson:

As authorized by Monarch Corporation's Purchase Order 167-01-1-JG, Construction Technology Laboratories, Inc. has completed proof load testing of a gantry header beam, drawing number 2355-201, rev. 0, dated 12-11-03.

The beam was proof load tested to 25,000 lb in our Baldwin, one million lb capacity test machine, Serial No. 493160, which was calibrated on May 29, 2003. The test was performed in the 50,000 lb range.

The beam was simply supported at a span of 23 ft, 6 in. on roller supports, and the load was applied at mid span also via a roller interface. A digital readout micrometer was placed at beam mid span to measure deflection. Photographs of the set-up are shown in Figs. 1 and 2.

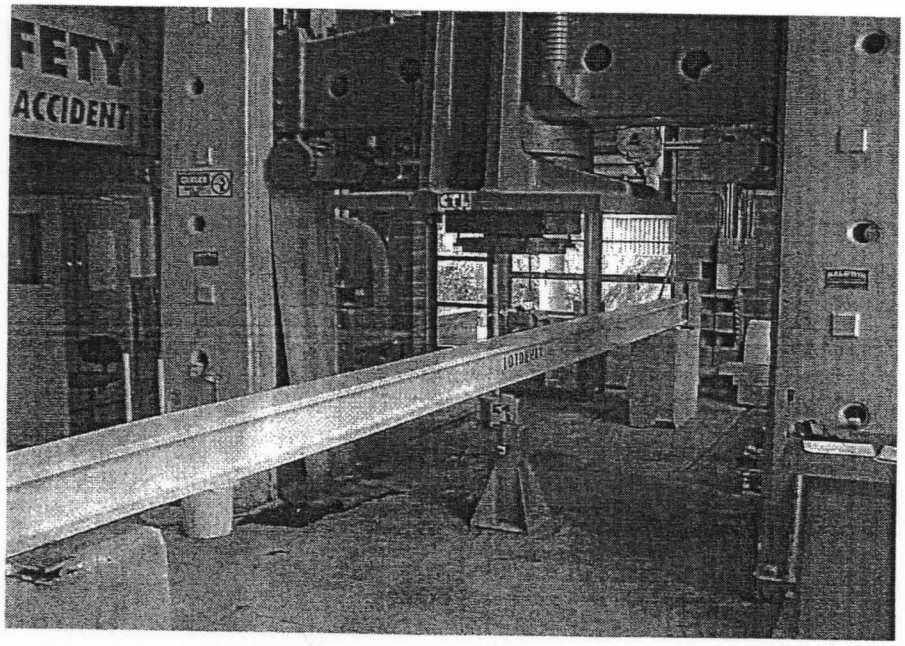



Figure 1 – Test Set-Up

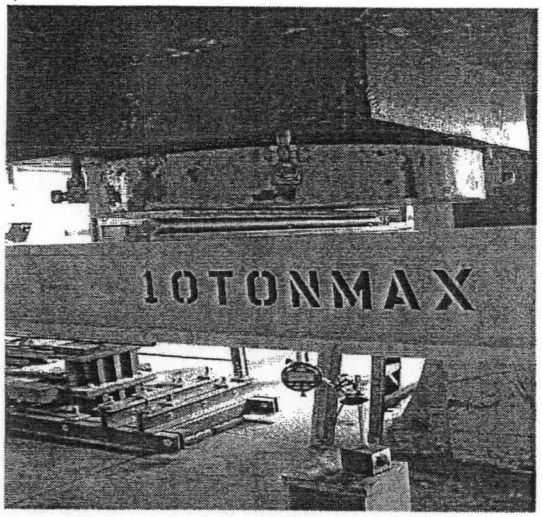



Figure 2 – Displacement Transducer

The load was applied in 5,000 lb increments and corresponding defection readings taken. At 25,000 lb, the mid-span deflection was 1.235 in. The load was held at 25,000 lb for one minute and then unloaded in 5,000 lb increments. When the load was released, the residual deflection was zero.

We appreciate the opportunity to serve Monarch Corporation. If you have any questions, please contact me.

Sincerely,

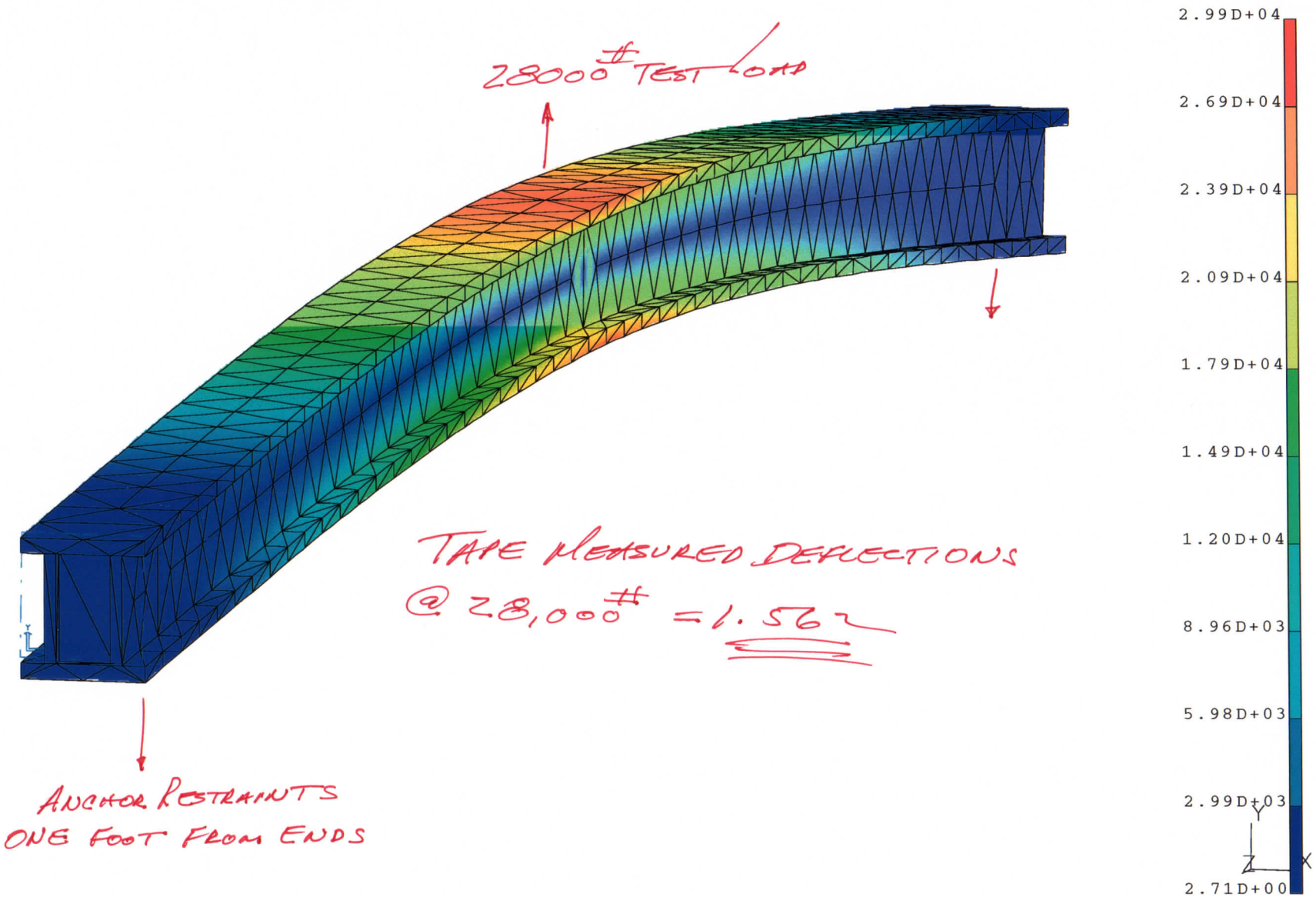
Jeffrey P. Gilmore
Group Manager
Structural and Transportation Laboratory

250695

/cadwhs/server04/ms_villegas/TAFT_HEADER_BEAM.mf1

RESULTS: 2- B.C. 1,STRESS_2,LOAD SET 1
STRESS - VON MISES MIN: 2.71E+00 MAX: 2.99E+04
DEFORMATION: 1- B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT - MAG MIN: 0.00E+00 MAX: 1.45E+00
FRAME OF REF: PART

VALUE OPTION:ACTUAL




Plotted by villegas on 07-May-04 , File: generic.pff