LIFTING DEVICE

DEVICE NAME: MONORAIL CRANE IN M TEST

ENGINEERING NOTE NUMBER: 59

DRAWING NUMBER:

APPLICABLE STANDARD: ANSI, ASME B30.2-1990, OSHA

RATED LOAD: 1000 #

TEST LOAD:

TEST LOAD PERCENT:

LAST LOAD TEST DATE:

COLOR:

STRESS CALCULATIONS:

Done by: [illegible]

Date: 11-28-92

Reviewed by: [illegible]

Date: 11/11/92

REMARKS:

IDENTIFICATION:

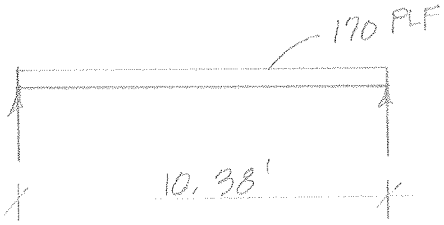
Engineering Note Number & Rated Load Must be Clearly Marked On a Conspicuous Surface.

CHECK LOAD RATING FOR 2 TROLLEY CRANES
FERMI ASSET # 0000000670 & # 0000000667
IN MESON TENT AREA IN MESON DETECTOR BUILDING

FROM DRAWING 2802.160-SE-177080:
DESIGN LIVE LOAD = 10 PSF
DESIGN DEAD LOAD = 3 PSF (FRAME ONLY)
13 PSF

BEAM SIZE = W 8 x 15
LARGER SPAN = 10.38 FT SMALLER SPAN = 9.88 FT
$A = 4.44\ IN^2$ $I_x = 48.0\ IN^4$
$S_x = 11.8\ IN^3$ $r = .876$ $r_T = 1.03$

UNIFORM LOAD $= \frac{1}{2}(20.83 + 5.37)(13.0)$
$= 170\ \#/FT$



$R_R = R_L = 170(10.38)/2$
$= 882.3\#$

$M = wl^2/8 = 170(10.38)^2/8$
$= 2290\ \#FT$

$\Delta = \frac{5wl^4}{384EI}$
$= \frac{5(.170)(10.38)^4(1728)}{384(29{,}000)(48)}$
$= 0.0003''$

$f_v = 882.3/(8.11)(.245) = 444\ PSI$

$f_b = 2290(12)/11.8 = 2329\ PSI$

F_b ALLOW.:

$l/r_T = 10.38(12)/1.03$
$= 121 > 119$ (AISC F1.3 P 5-47)

$\therefore F_b = \frac{170 \times 10^3 C_b}{(l/r_T)^2}$
$= \frac{170 \times 10^3 (1)}{(121)^2} = \underline{11.6\ KSI} > 2.3\ KSI$ ok

F_V ALLOW.: $h/t_w = 8.11/0.245 = 33.1$

$380/\sqrt{36} = 63.3 > 33.1 \therefore F_V = 0.4(36) = \underline{14.4\ KSI}$
$> .444\ KSI$ OK

FIND MAXIMUM POINT LOAD @ CENTER ALONG WITH UNIFORM LOAD:

ALLOW BENDING = 11.6 − 2.3
= 9.3 KSI

ALLOWABLE POINT LOAD MOMENT = 9.3(11.8)
= 109 K-IN
= 9.08 K-FT

FOR POINT LOAD:

$M = Pl/4$

$9.08 = P(10.38)/4$

$3.5^K = P$

$\underline{3{,}500^\#} = P_{MAX}$

CHECK BEAM SHEAR FOR 3500# LOAD @ END:

$3500/(8.11)(0.245) = 1762$ PSI

FROM UNIFORM LOAD 444 PSI
2206 PSI TOTAL SHEAR

= 2.2 KSI < 14.4 KSI ok

CHECK TOTAL DEFLECTION FOR 3500# LOAD + UNIF. LOAD:

$\Delta = Pl^3/48EI$

$= 3{,}500(10.38)^3(1728)/48(29000)(48)$

$= 0.10''$

ALLOW. DEFLECT. $= l/360 = 10.38(12)/360$
$= 0.35'' > (0.0003 + 0.10)$

ok

CHECK BEAM CONNECTION:

TOTAL END REACTION = 3500 + 882.3
= 4382#

BOLTS = 3/4" ϕ A325 F_V = 7.51 K/BOLT (AISC TABLE 1-D P4-5)

2(7.51)(1000) = 15,020# > 4382# ok

CHECK BEAM SUPPORTING CRANE BEAMS:

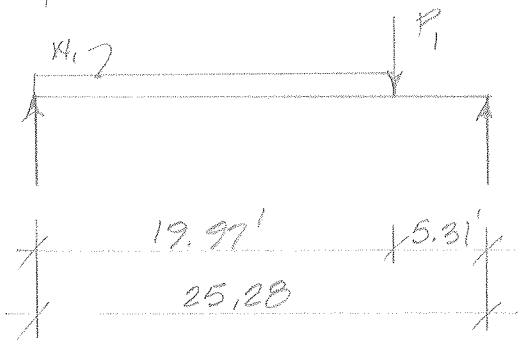
BEAM SIZE = W 14 x 26

$A = 7.69 \quad D = 13.91 \quad t_w = 0.255$

$I_x = 245 \quad S_x = 35.3 \quad r_T = 1.28$

SPAN = 14.06 + 10.82 + .40
= 25.28'

LOADING WITHOUT CRANES:

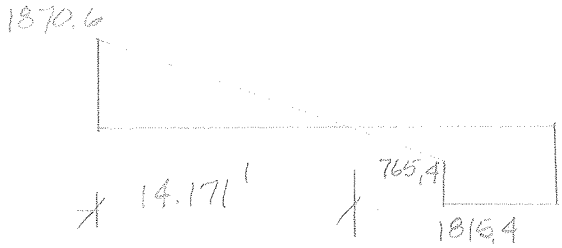


$w_1 = \left(\frac{10.38+9.88}{2}\right)(13.0)$
$= 132$ #/FT

$P_1 = \left(5.31/2 + 5.31\right)(13.0) \times \left(\frac{10.38+9.88}{2}\right)$
$= 1050$ #

$R_L = \left(19.97(132)(19.97/2) + 19.97(1050)\right) / 25.28$
$= 1870.6$ #

$R_R = \left(19.97(132)(19.97/2 + 5.31) + 5.31(1050)\right) / 25.28$
$= 1815.4$ #



$M_{MAX} = \frac{1870.6(14.171)}{2}$
$= 13\,254$ # FT

$f_b = 13\,254(12)/35.3 = 4506$ psi

$\ell/r_T = 19.97(12)/1.28$
$= 187.2$

$\therefore F_b = \frac{170 \times 10^3 C_b}{(\ell/r_T)^2} = \frac{170 \times 10^3 (1.0)}{(187.2)^2}$
$= 4.85$ KSI $= 4850$ PSI

OR

$F_b = \frac{12 \times 10^3 C_b}{\ell d / A_f} = \frac{12 \times 10^3 (1.0)}{19.97(12)(6.59)}$
$= 7.62$ KSI $= 7620$ PSI

USE LARGER VALUE

FIND MAXIMUM ADDITIONAL MOMENT DUE TO CRANE:

$7620 - 4506 = 3114$ psi

MAX. ADD'L MOMENT $= 3114(35.3)/12$
$= 9160$ #Ft

$9160 = Pab/\ell$
$= P(5.31)(19.97)/25.28$
$2190\# = P$

∴ MAXIMUM ADDITIONAL LOAD ON W14x26 CONTROLS.

MAXIMUM RATING FOR CRANE $= 2190/2(1.25)$
$= 876\# \approx 1/2$ TON

ADDITIONAL DEFLECTION W/ 2 CRANES LOADED:

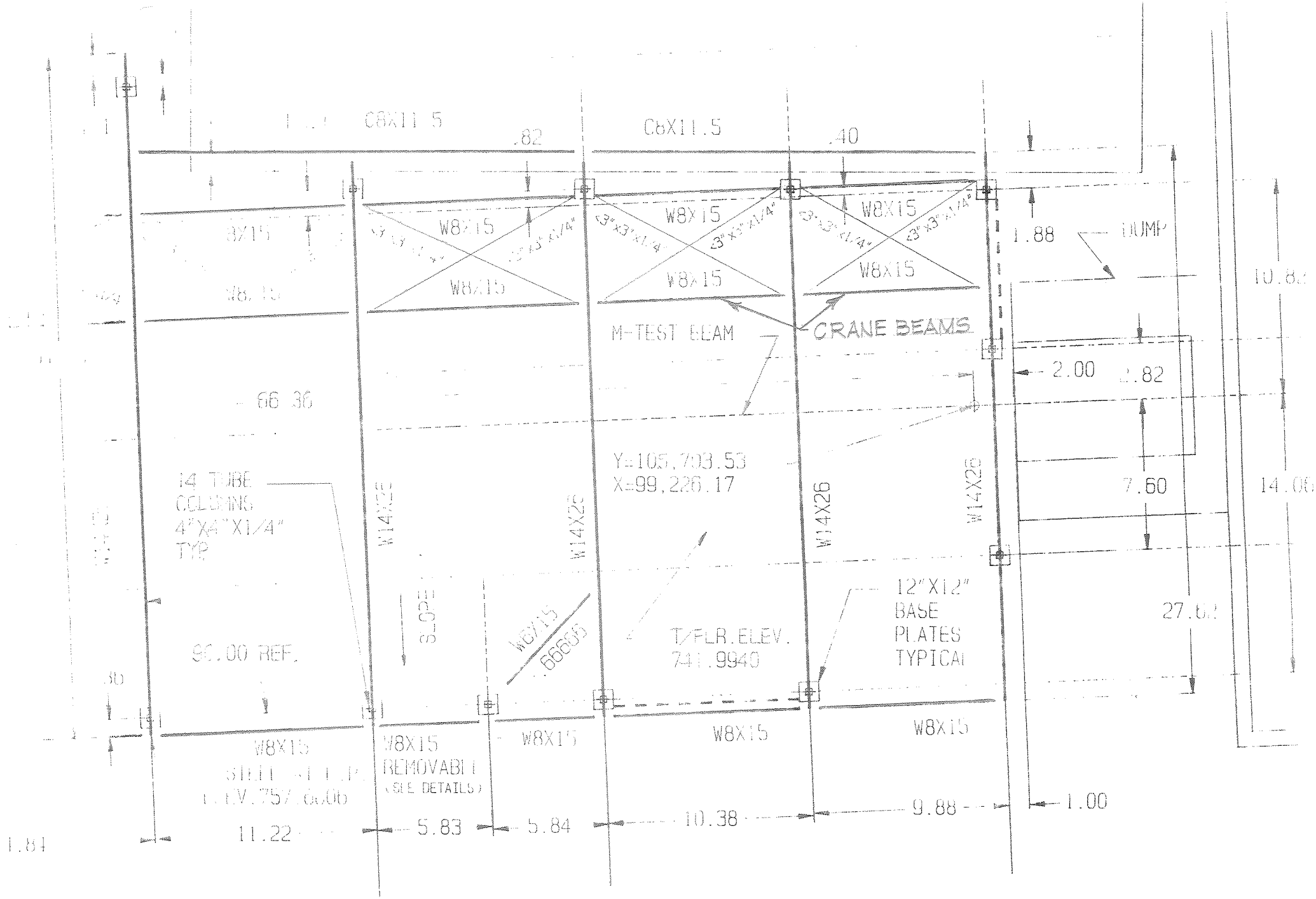
$$\Delta = \frac{Pab(a+2b)\sqrt{3a(a+2b)}}{27EI\ell}$$

$$(1778)\frac{2000(19.97)(5.31)(19.97+2(5.31))\sqrt{3(19.97)(19.97+2(5.31))}}{27(29000)(245)(25.28)}$$

$= 0.10''$

$\ell/360 = 25.28(12)/360$
$= 0.843'' > 0.10''$ ok

MAXIMUM CRANE RATING = 1/2 TON



M TEST PARTIAL PLAN

(FROM DWG. NO. 2802.160-SE-177080)

When

$$\sqrt{\frac{102 \times 10^3 C_b}{F_y}} \le \frac{l}{r_T} \le \sqrt{\frac{510 \times 10^3 C_b}{F_y}}:$$

$$F_b = \left[\frac{2}{3} - \frac{F_y\,(l/r_T)^2}{1530 \times 10^3 C_b}\right] F_y \le 0.60\,F_y \qquad \text{(F1-6)}$$

When

$$\frac{l}{r_T} \ge \sqrt{\frac{510 \times 10^3 C_b}{F_y}}:$$

$$F_b = \frac{170 \times 10^3 C_b}{(l/r_T)^2} \le 0.60\,F_y \qquad \text{(F1-7)}$$

For any value of l/r_T:

$$F_b = \frac{12 \times 10^3 C_b}{ld/A_f} \le 0.60\,F_y \qquad \text{(F1-8)}$$

where

l = distance between cross sections braced against twist or lateral displacement of the compression flange, in. For cantilevers braced against twist only at the support, l may conservatively be taken as the actual length.

r_T = radius of gyration of a section comprising the compression flange plus ⅓ of the compression web area, taken about an axis in the plane of the web, in.

A_f = area of the compression flange, in.^{2}

C_b = $1.75 + 1.05\,(M_1/M_2) + 0.3\,(M_1/M_2)^2$, but not more than 2.3,* where M_1 is the smaller and M_2 the larger bending moment at the ends of the unbraced length, taken about the strong axis of the member, and where M_1/M_2, the ratio of end moments, is positive when M_1 and M_2 have the same sign (reverse curvature bending) and negative when they are of opposite signs (single curvature bending). When the bending moment at any point within an unbraced length is larger than that at both ends of this length, the value of C_b shall be taken as unity. When computing F_{bx} to be used in Equation (H1-1), C_b may be computed by the equation given above for frames subject to joint translation, and it shall be taken as unity for frames braced against joint translation. C_b may conservatively be taken as unity for cantilever beams.**

*It is conservative to take C_b as unity. For values smaller than 2.3, see Table 6 in the Numerical Values Section.

**For the use of larger C_b values, see Galambos (1988).

except that it need not be less than 1,200 (b/F_y), where M_1 is the smaller and M_2 the larger bending moment at the ends of the unbraced length, taken about the strong axis of the member, and where M_1/M_2, the ratio of end moments, is positive when M_1 and M_2 have the same sign (reverse curvature bending) and negative when they are of opposite signs (single curvature bending).

2. Members With Noncompact Sections

For box-type and tubular flexural members that meet the noncompact section requirements of Sect. B5, the allowable stress is

$$F_b = 0.60\ F_y \tag{F3-3}$$

Lateral bracing is not required for a box section whose depth is less than 6 times its width. Lateral-support requirements for box sections of larger depth-to-width ratios must be determined by special analysis.

F4. ALLOWABLE SHEAR STRESS

For $h/t_w \leq 380/\sqrt{F_y}$, on the overall depth times the web thickness, the allowable shear stress is

$$F_v = 0.40\ F_y \tag{F4-1}$$

For $h/t_w > 380/\sqrt{F_y}$, the allowable shear stress is on the clear distance between flanges times the web thickness is

$$F_v = \frac{F_y}{2.89}(C_v) \leq 0.40F_y \tag{F4-2}$$

where

$$C_v = \frac{45{,}000k_v}{F_y(h/t_w)^2} \text{ when } C_v \text{ is less than } 0.8$$

$$= \frac{190}{h/t_w}\sqrt{\frac{k_v}{F_y}} \text{ when } C_v \text{ is more than } 0.8$$

$$k_v = 4.00 + \frac{5.34}{(a/h)^2} \text{ when } a/h \text{ is less than } 1.0$$

$$= 5.34 + \frac{4.00}{(a/h)^2} \text{ when } a/h \text{ is more than } 1.0$$

t_w = thickness of web, in.
a = clear distance between transverse stiffeners, in.
h = clear distance between flanges at the section under investigation, in.

For shear rupture on coped beam end connections see Sect. J4.

Maximum h/t_w limits are given in Chapter G.

An alternative design method for plate girders utilizing tension field action is given in Chapter G.

Fermilab

November 9, 1992

To: Bob Woods

From: Bob Wands BW

Subject: Mtest Crane Beam Load Ratings

I have reviewed your calculations of the load ratings of the crane beams in the Meson Detector Building and found them to be accurate and complete. The load rating of 1/2 ton/crane is appropriate.