SPREADER BAR

I.D. Nº 40 COLOR OF BAR : BROWN PRIMER

LOAD CAPACITY PAINTED ON BAR 36 TONS.

DATE CAP. & I.D. Nº PAINTED ON BAR Nov. 18, 1991

DATE OF LAST LOAD TEST. Nov 16, 1991

TEST LOAD WEIGHT 45 TONS

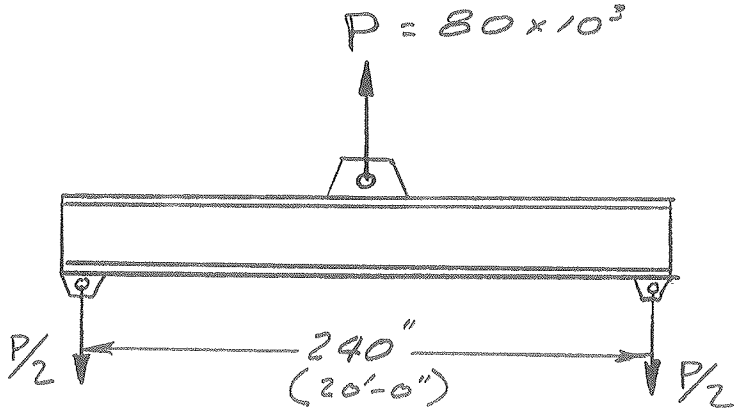
TEST LOAD % 125%

STRESS CALCULATIONS :
DONE BY E.M. VILLEGAS

DATE Nov. 8, 1991

REMARKS :
TEST LOAD WAS SUSPENDED FOR A FIVE MINUTE PERIOD AND WAS WITNESS BY J. KILMER, H. STREDDE & E.M. VILLEGAS. ALTHOUGH THE RATED LOAD IS 36 TON, THE SPREADER BAR WAS DESIGNED FOR 40 TON.

SPREADER BAR Nº 40 PAINT COLOR BROWN PRIMER PAINT



BEAM SIZE W18 x 119#

d = 12.92
L = 240"
d/A_f = .589
S_x = 628.5
t_w = 1.310

$A_w = d \cdot t_w$ = 26.161

$M = \frac{PL}{4} = 4.8 \times 10^6$ IN-LB

$V = \frac{P}{2} = 40 \times 10^3$ #

BENDING STRESS:

$F_{b\ ALLOW}$ = 12,000 psi

OR $F_{b\ ALLOW} = \frac{12 \times 10^6}{L \cdot d/A_f} = \frac{12 \times 10^6}{240 \times .589} = 85 \times 10^3$ } USE THE LEAST

$\therefore f_{b\ MAX} = \frac{M}{S_x} = 7.64 \times 10^3$ psi $< 12 \times 10^3$ psi

SHEAR STRESS:

$F_{V\ ALLOW} = \frac{.4\ F_y}{3} = 4800$ psi

$\therefore f_{V\ MAX} = \frac{V}{A_w} = 1.53 \times 10^3$ psi $< F_{V\ ALLOW}$

SUMMARY: $\therefore$ P = 40 TONS

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ENGINEERING NOTE

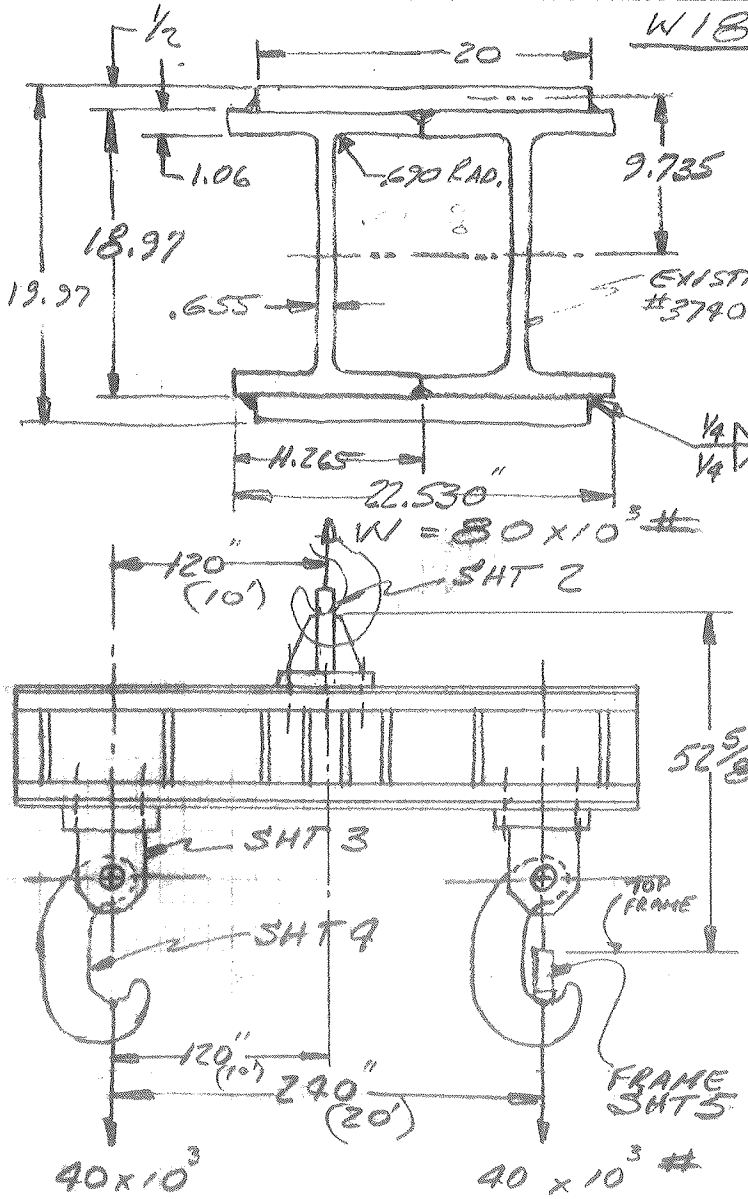
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			1

SUBJECT: SPREADBAR FOR DØ EMC FRAME
RD/MECH DEPT DEPT.

NAME: E.M. Villegas

DATE: 11-3-91

REVISION DATE:



W18 x 119# A36 STEEL

$I = 2I_{WF} + 2(I_o + Ad^2)$

where $I_{WF} = 2190\ in^4$

$I_o = \frac{20 \times .5^3}{12} = .208\ in^4$

$A = 20 \times .5 = 10\ in^2$

$d = 9.735\ in$

$\therefore$

$I = 6276\ in^4$

$F_b = F_v = .33 \times 36 \times 10^3$
$= 12 \times 10^3\ psi$ ALLOWED

$F_w = \sin 45° \times .33 \times 60 \times 10^3$
$= 14.1 \times 10^3\ \#/in$ ALLOWED FOR E70XX

$M = 40 \times 10^3 \times 120 = 4.8 \times 10^6\ psi$

$V = \frac{80 \times 10^3}{2} = 40 \times 10^3\ \#$

$f_b = \frac{4.8 \times 10^6 \times 9.985}{6276} = 7.64 \times 10^3 < F_b$

$f_v = \frac{40 \times 10^3}{2(.655 \times 19.97)} = 1.53 \times 10^3$ ACROSS WEB $< F_v$

$f_H = \frac{Vad}{I_n} = 310\ \#/in$ where $a = .5 \times 20 = 10\ in^2$
$n = 2$ (No OF WELD)

$w = \frac{f_H}{F_w} = .022$" LEG SIZE CONT. WELD

% WELD $= \frac{.022}{.210} = .09$ say 10

USING 2" LONG WELD

TO ℄ $= \frac{2}{.09} = 22.7$ say 23 → ¼ V 2-23 (70XX

534393

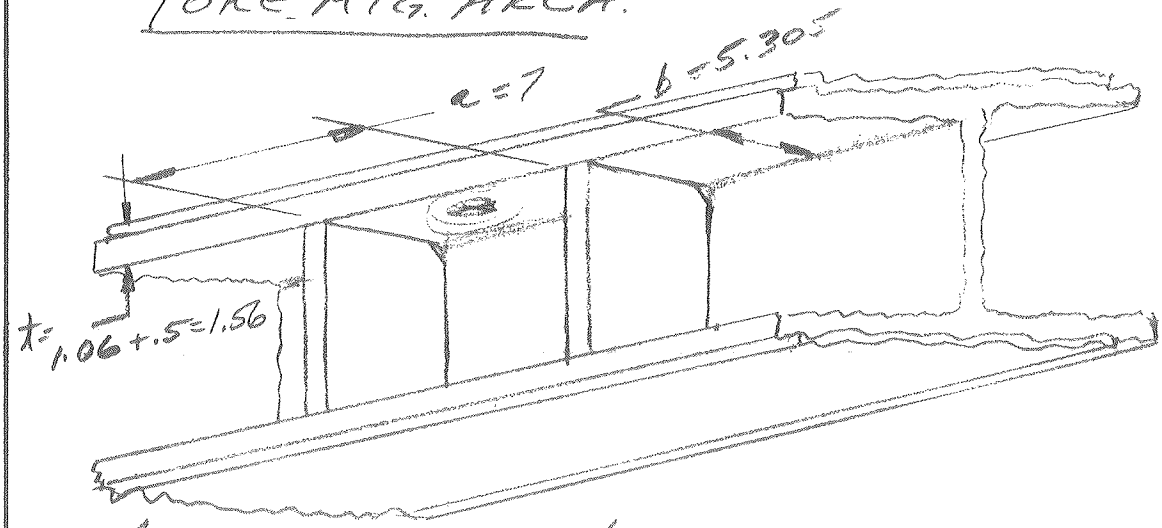
FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			1A

SUBJECT: SPREADBAR FOR DØ EMC FRAME
RD/MECH DEPT

NAME: Eric Volk
DATE: 11-8-91
REVISION DATE:

YOKE MTG. AREA.



ASSUME UNIFORM LOAD OVER WIDTH INSIDE OF GUSSETED AREA. THEN BY ROARK'S (4TH EDITION) CASE 45, Pg 227.

$$f_b = \frac{\beta w b^2}{t^2} \quad \text{where} \quad \frac{a}{b} = 1.32$$

$$\beta = .719$$

$$\alpha = .1234$$

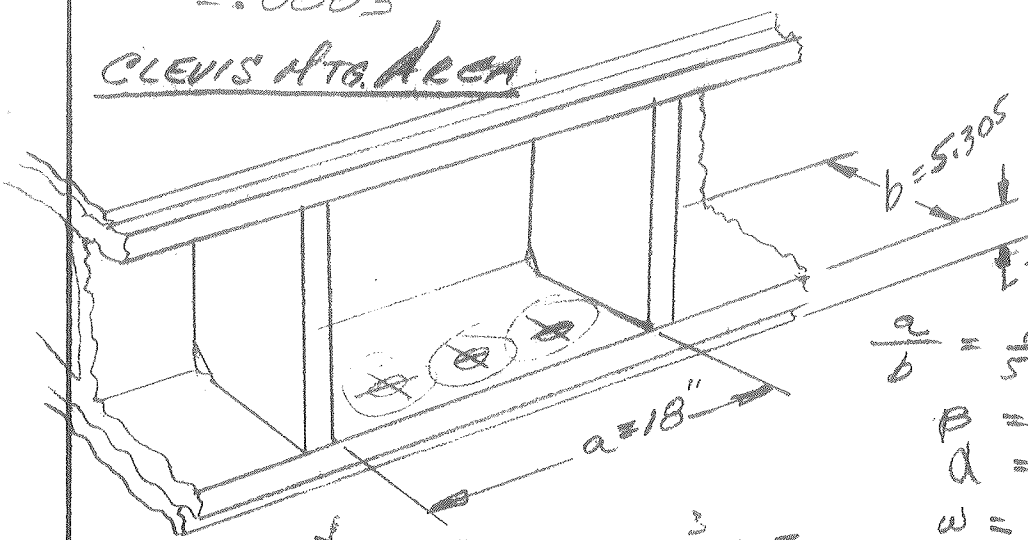
$$w = \frac{80 \times 10^3}{6 \times 5.305 \times 7} = 359 \text{ psi}$$

$$= 2.12 \times 10^3 < F_b$$

$$y = \frac{\alpha w b^4}{E t^3}$$

$$= .0003''$$

CLEVIS MTG. AREA



$$\frac{a}{b} = \frac{18}{5.305} = 3.4$$

$$\beta = 2.6$$

$$\alpha = 1.03$$

$$w = \frac{20 \times 10^3}{2 \times 5.305 \times 18} = 209 \text{ psi}$$

$$f_b = 6.28 \times 10^3 < F_b$$

$$y = .002''$$

534393

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			1B

SUBJECT: SPREADBAR FOR DØ END FRAME RD/MECH DEPT

NAME: E.M. Gallagher

DATE: 1-8-91 REVISION DATE:

BOLTS REQ'D. 1"-8 UNC x 5 1/2 L.G. (2 1/2" THREADED LG.)
ASTM A325
OR
SAE J429 GRADE 5.2

TENSION ONLY $F_t = .33 \times 92 \times 10^3 \times 1$

$= 30.6 \times 10^3$ psi ALLOWED

$f_t = \frac{80 \times 10^3}{6 \times 1}$

$= 13.3 \times 10^3$ psi DESIGN

BEARING TYPE CONNECTION WITH THREADS NOT INCLUDED IN SHEAR PLANE

$F_v = .22 \times 92 \times 10^3$

$= 20.24 \times 10^3$ psi ALLOWED

$f_v = \frac{Pa^2}{2gSnA_g} + \frac{P}{nA_g}$ where $P = 80 \times 10^3$ #

$= 19.04 \times 10^3$ psi DESIGN

$a = 1.67$ FT/SEC (10'/MIN)

$g = 32.6$ FT/SEC^2

$n = 6$ (NO OF BOLTS)

$A_g = 1$ IN^2

$S = .001$ (ASSUMED DISTANCE OBJECT IS MOVED AFTER IMPACT)

BOLT TIGHTENING REQMT.
1/2 TURN ($180^\circ +30^\circ_0$)
FROM SNUG FIT.

534393

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ENGINEERING NOTE

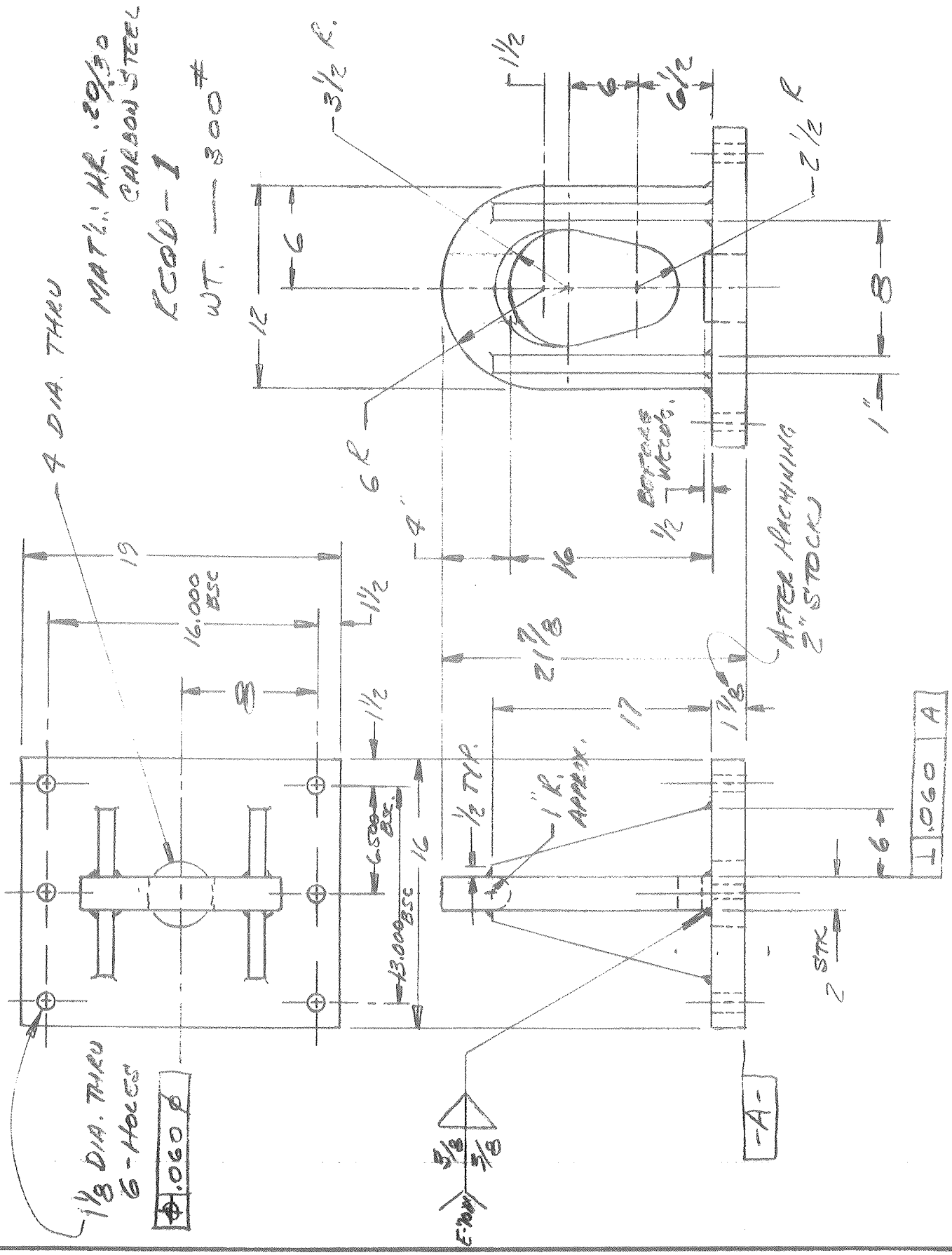
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			2

SUBJECT: SPREADER BAR YOKE, 40 T CAP. LIFTING DEVICES RD / MECH DEPT.

NAME: E.W. Dettyna

DATE: 11/1/91

REVISION DATE:



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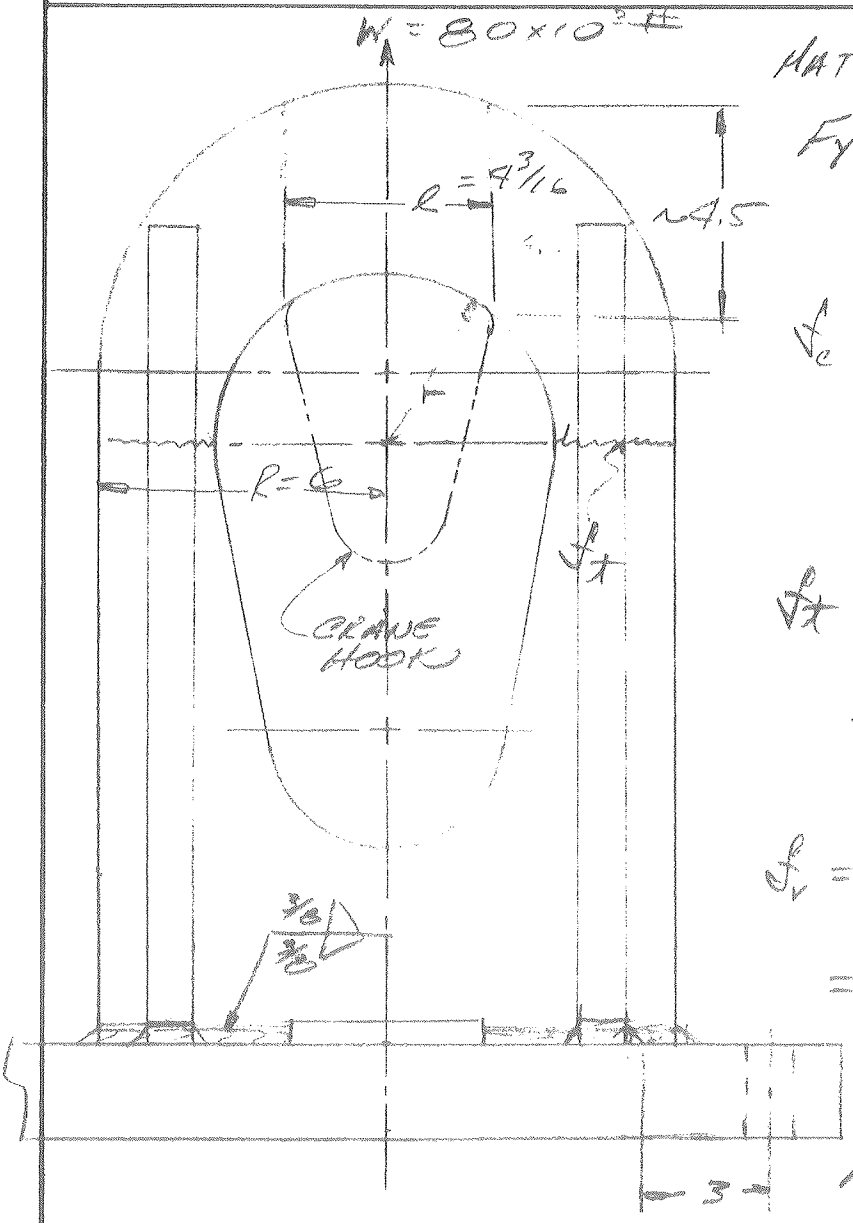
ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			2A

SUBJECT: SPREADBAR YOKE, 90 TON CAP

NAME: E. Wildman

DATE: 11-8-91 | REVISION DATE:



MAT'L. H.L. 20/30 GRADE STEEL

$F_y = .33 \times 90 \times 10^3$

$= 13.2 \times 10^3$ psi Allowed

$f_c = \frac{W}{\ell t}$ — $t = 2''$

$= 9.6 \times 10^3 < F_y$

$f_x = \frac{W}{2t(R-r)}$

$= 8 \times 10^3 < F_y$

$f_v = \frac{80 \times 10^3}{2 \times 2 \times 4.5}$

$= 4.4 \times 10^3 < F_y$

$M = 3 \times 40 \times 10^3$

$= 1.2 \times 10^5$

$f_b = \frac{1.2 \times 10^5 \times 1.875}{2\left(\frac{16 \times 1.875^3}{12}\right)}$

$= 12.8 \times 10 < F_y$

WELD SIZE

$F_w = 2 \sin 45^\circ \times .33 \times 60 \times 10^3$

$= 14.1 \times 10^3$ #/in Allowed

$f_w = w F_w = .375 \times 14.1 \times 10^3$

$= 5.3 \times 10^3$ #/in design

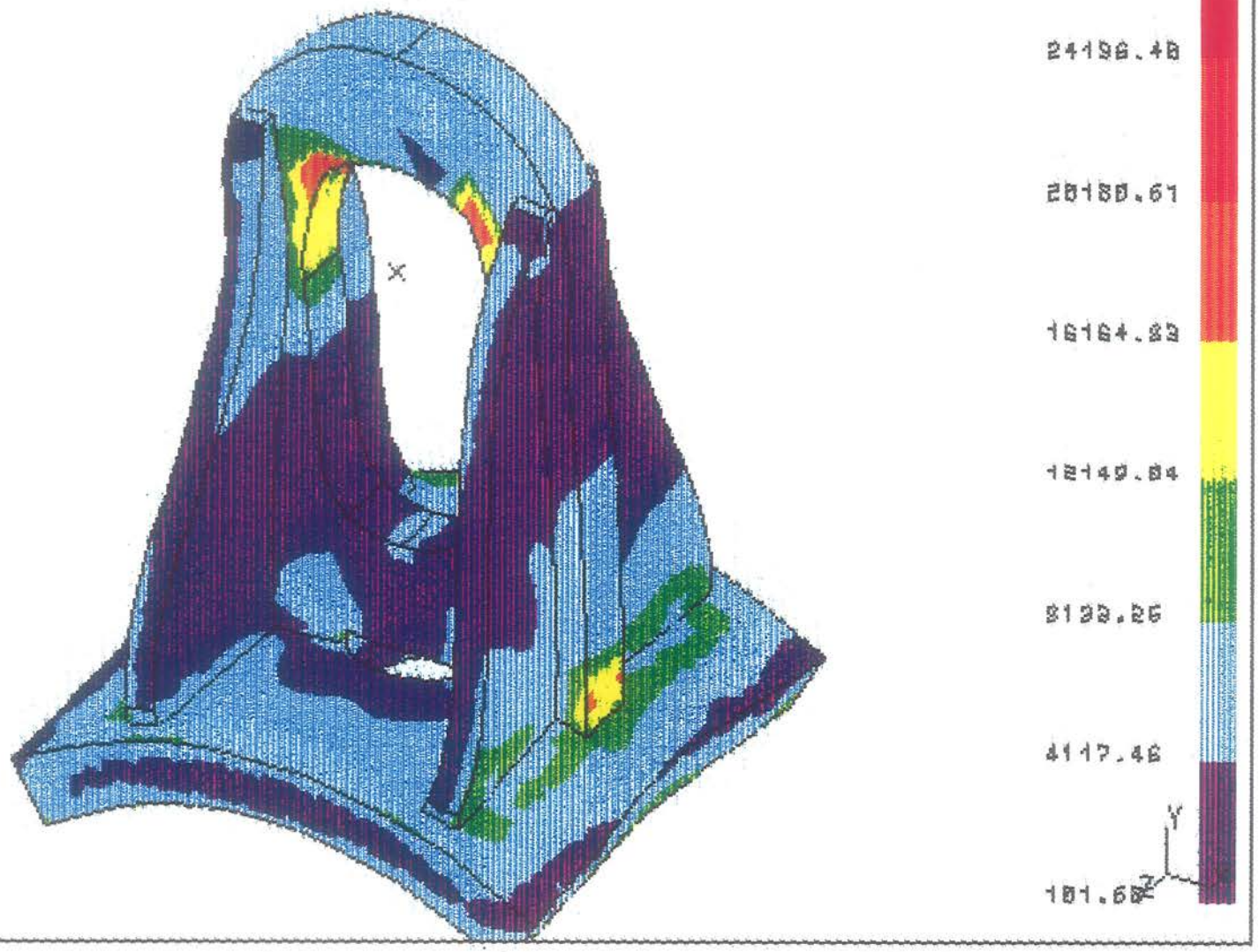
SINCE TOTAL LENGTH OF WELD IS 18", THEN ALLOWED LOAD ON WELD JOINT IS $18 \times 5.3 \times 10 = 95.4 \times 10^3$ # > 80×10^3 #

534393

PAGE 2B

SPRDRBAR

LOAD SET: 1 - 40T
FRAME OF REF: GLOBAL
STRESS - VON MISES MIN: 101.62 MAX: 22212.19



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ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
		1	3

SUBJECT: HOOK CLEVIS, 20T CAP. LIFTING DEVICES RD/MECH DEPT.

NAME: E.W. Voss

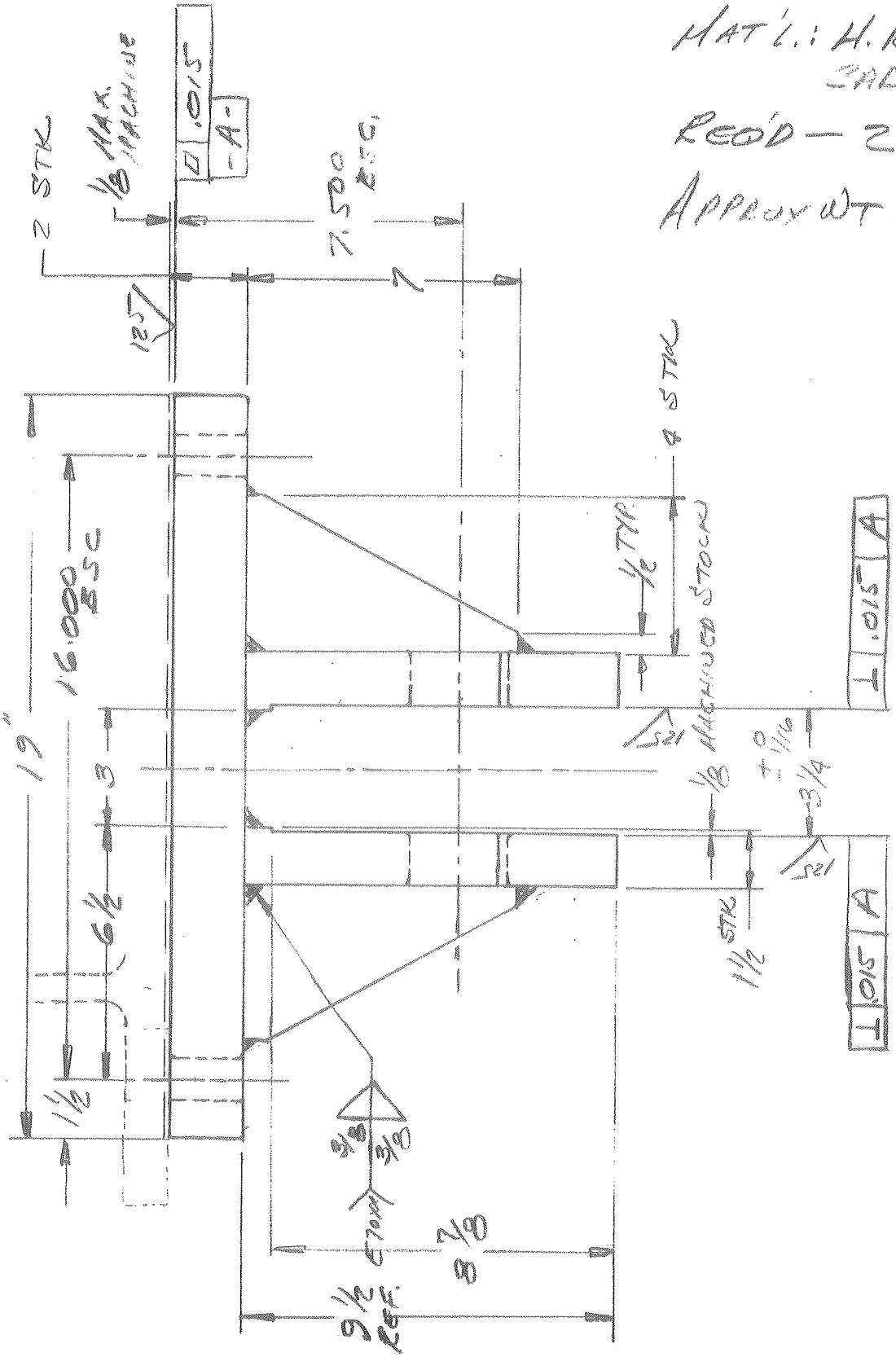
DATE: 10/30/91

REVISION DATE:

MAT'L.: H.R. 1020/1030 ALLOW STEEL

REQ'D — 2

APPROX WT. = 238 #



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ENGINEERING NOTE

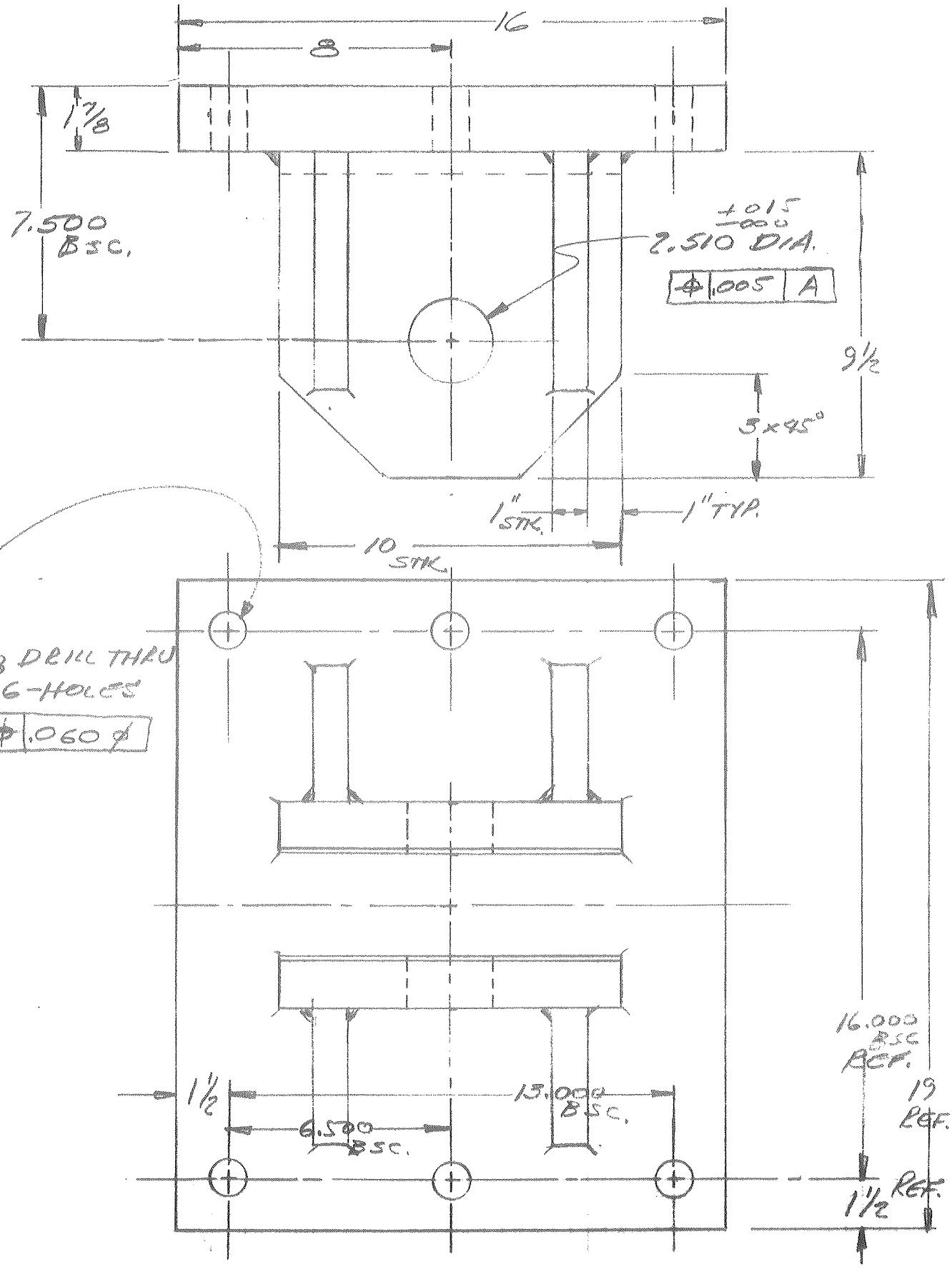
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
		2	3A

SUBJECT: HOOK, CLEVIS, 20T CAPACITY LIFTING DEVICES RD/MECH DEPT

NAME: E M Gilbert

DATE: 10/30/91

REVISION DATE:



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ENGINEERING NOTE

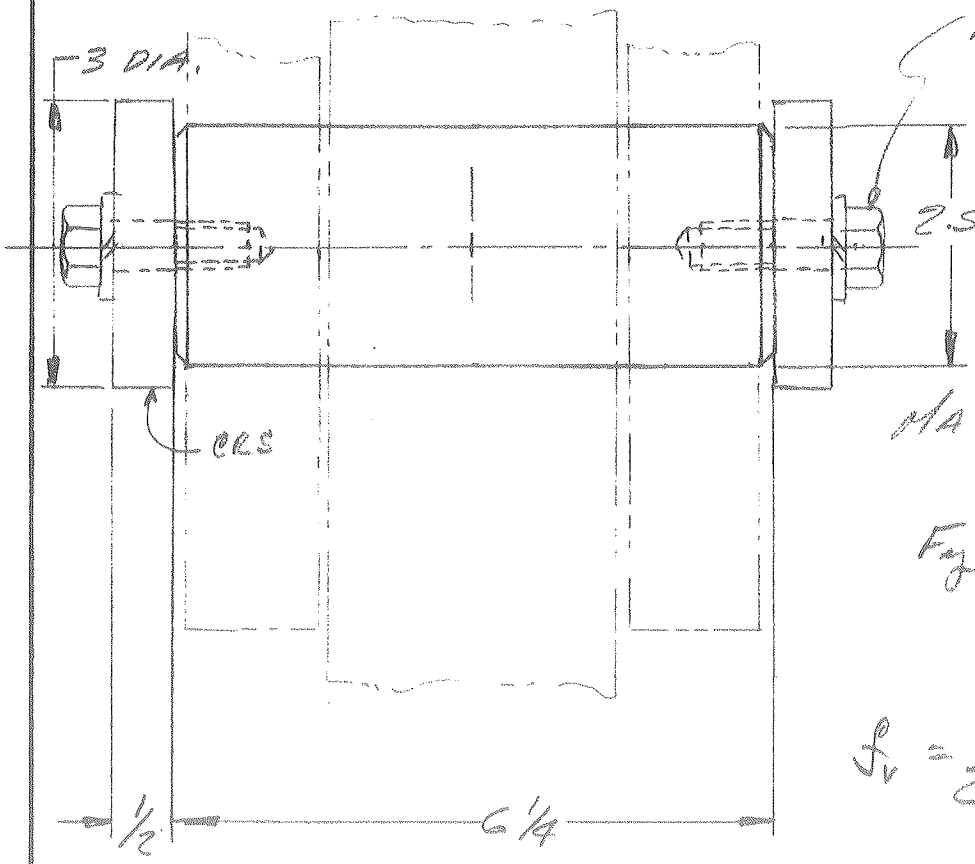
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			35

SUBJECT: Hook Beams Pin

NAME: E.W. Villegas

DATE: 11-8-91

REVISION DATE:



MAT'L. STNLS STL.
TYPE 304

$F_y = .33 \times 30 \times 10^3$

$= 9.9 \times 10^3$ psi

Allowed

$f_v = \frac{40 \times 10^3}{2\left(\frac{\pi 2.5^2}{4}\right)}$

$= 4.05 \times 10^3 < F_y$

534393

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ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			4

SUBJECT: HOOK, 20T CAPACITY LIFTING DEVICES RD/MECH DEPT

NAME: E. Wilson

DATE: 10-29-91

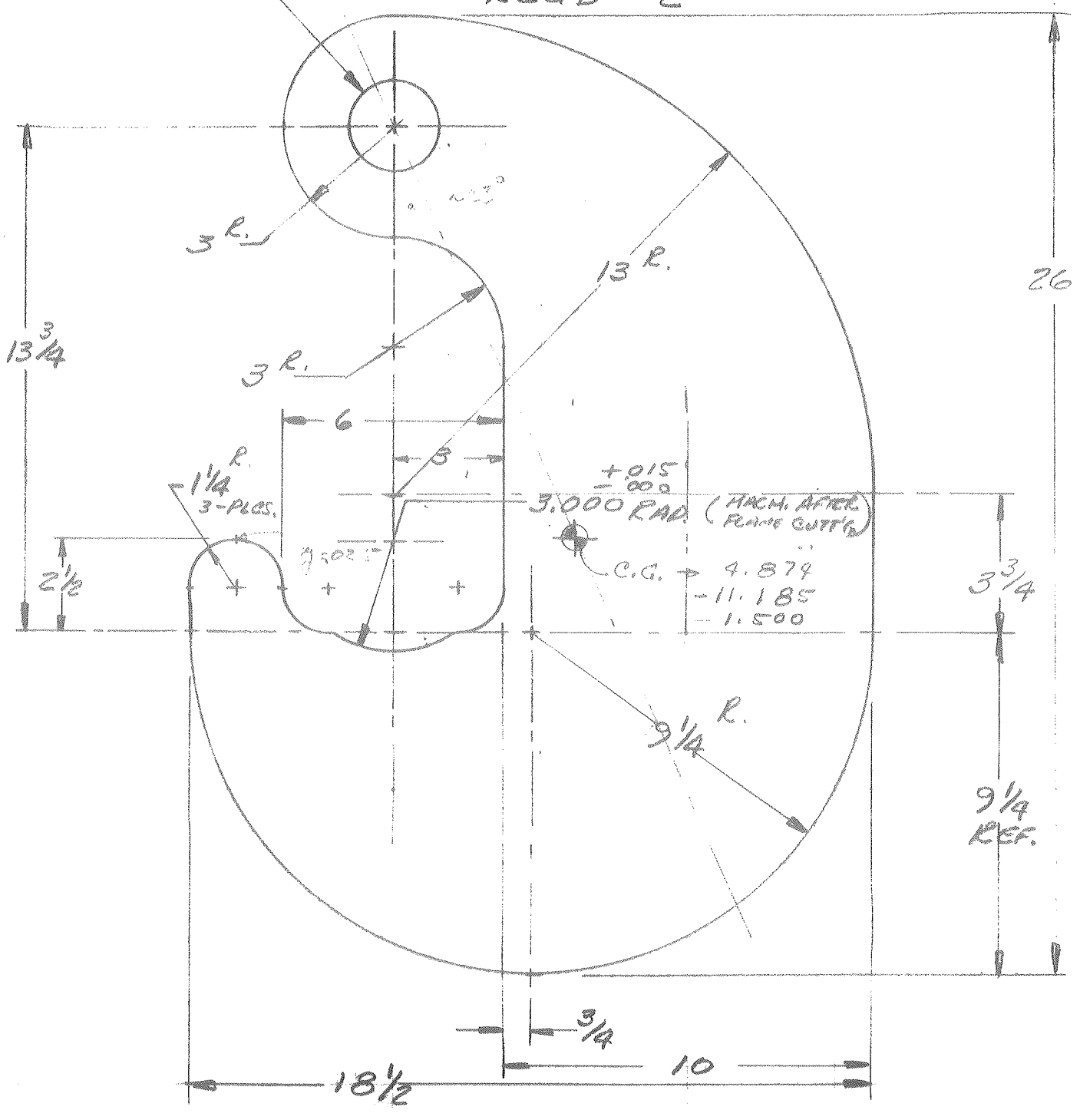
REVISION DATE: 11-5-91

MAT'L: H.R. .20/.30 CARBON STEEL

WT. — 249 #

SCALE — 1/4" = 1"

REQ'D — 2



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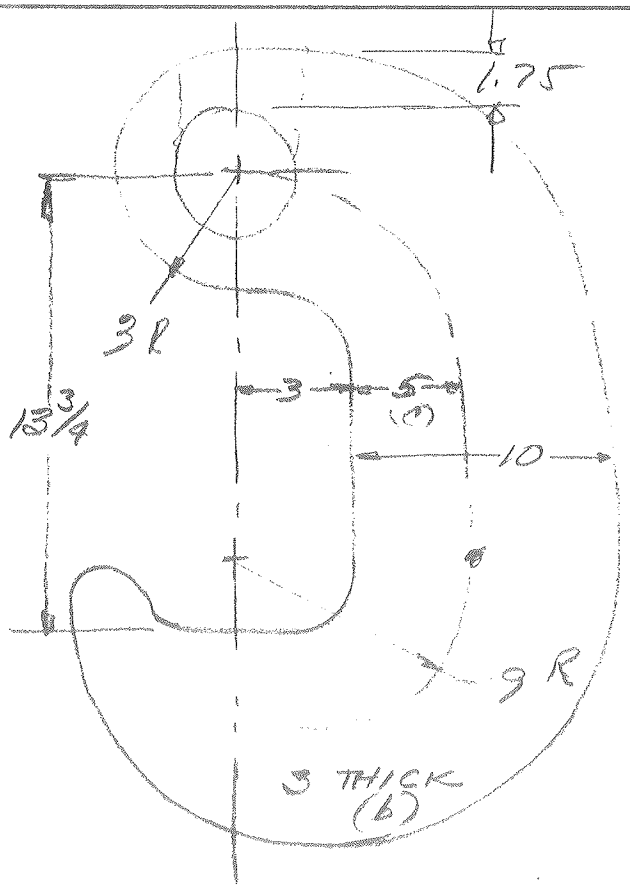
ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE
			4A

SUBJECT: HOOK, 20 TON CAP

NAME:

DATE: 10-29-91 | REVISION DATE:



$F_v - F_b = .33 \times 80 \times 10^3$

$= 13.2 \times 10^3$ psi Allowed

$f_b = K_i \left(\frac{Mc}{I}\right)$

$K_i = 1 + \frac{I}{2bc^2}\left(\frac{1}{R-c} + \frac{1}{R}\right)$

$= 1.79$

$M = 8 \times 40 \times 10^3$

$= 3.2 \times 10^5$

$I = \frac{8 \times 10^3}{12}$

$= 250$

$\therefore f_b = 11.5 \times 10^3$ Desired

$f_v = \frac{40 \times 10^3}{1.75 \times 3 \times 2}$

$= 3.8 \times 10^3$ Desired

534393

SDRC I-DEAS UI: FE_Modeling_&_Analysis 12-NOV-91 13:23:05

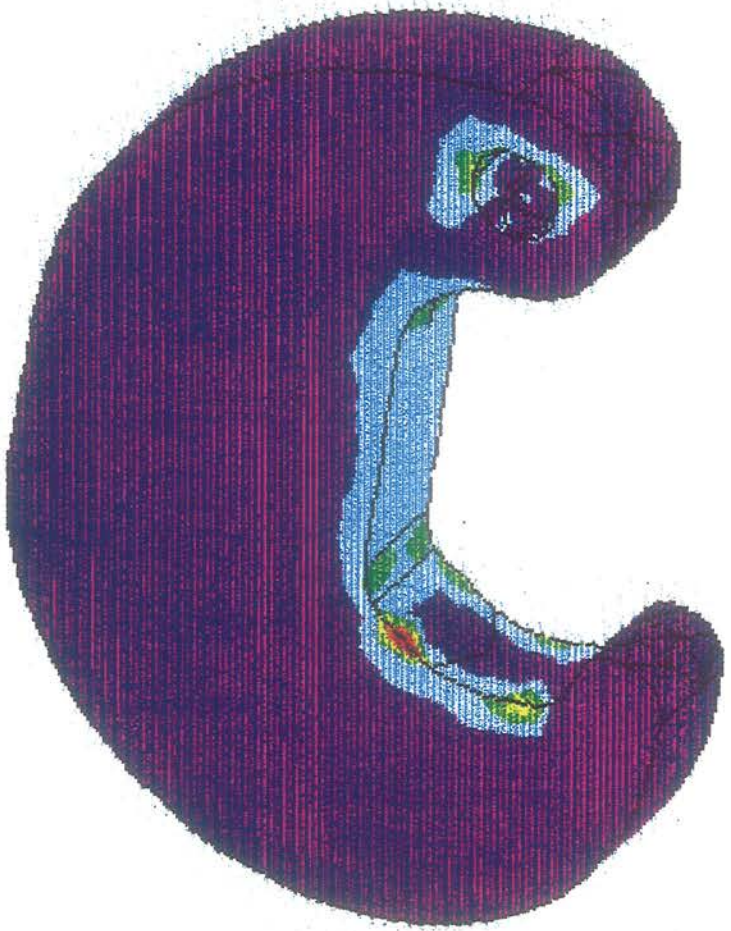
Database: SPRDREAR
View : No stored View
Task: Post Processing
Model: 1-MODKFE

Units : IN
Display : No stored Option
Model Bin: 1-MAIN
Associated Workset: 3-WORKING SET3

PAGE 48

SPRDRBAR

LOAD SET: 1 - LOAD
FRAME OF REF: GLOBAL
STRESS - VON MISES MIN: 11.86 MAX: 51952.71



51958.71
44537.62
37116.53
29695.43
22274.34
14853.24
7432.15
11.86

Y
Z

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ENGINEERING NOTE

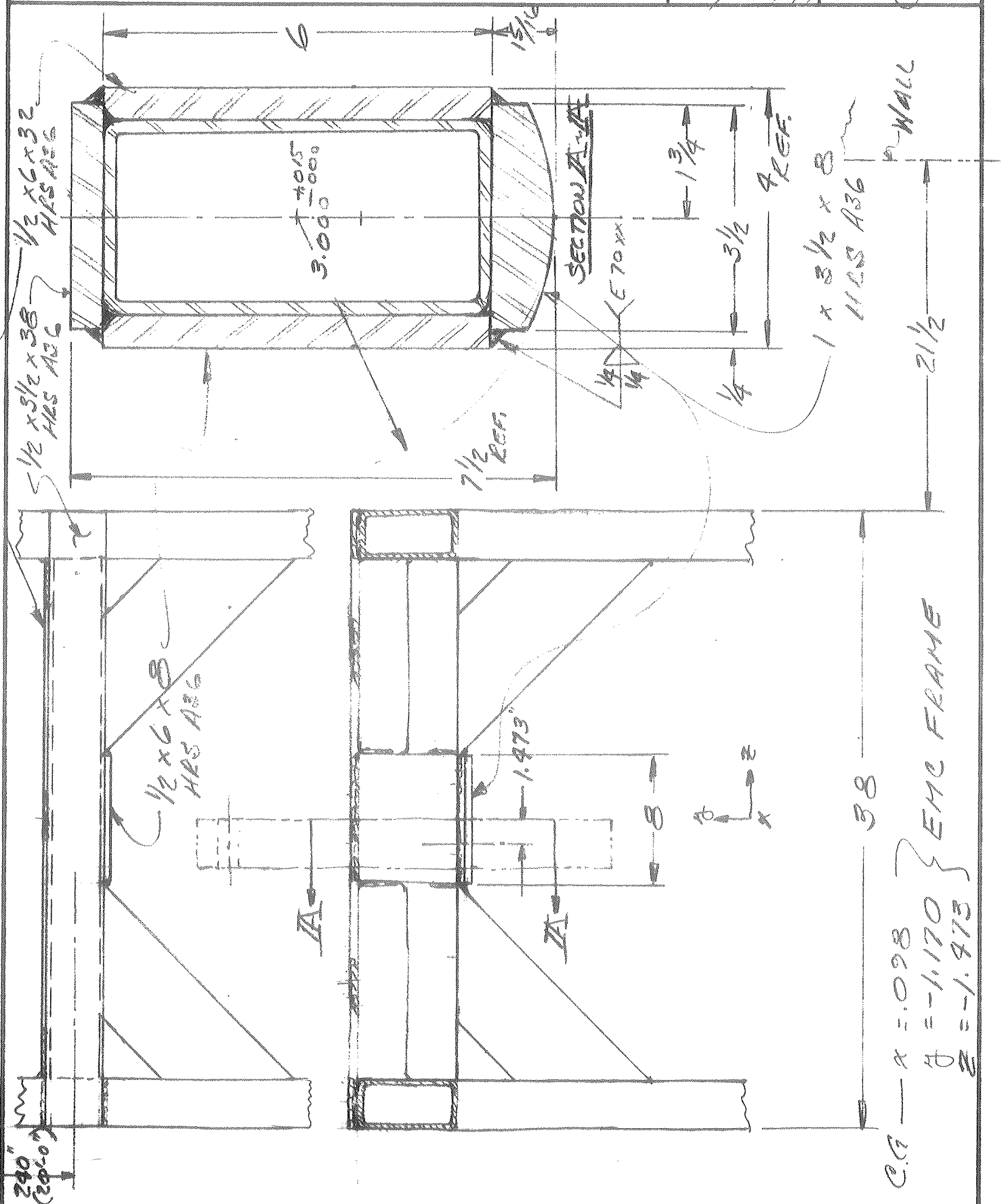
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
		1	5

SUBJECT: EMC FRAME REINFORCEMENT MODIFICATION

NAME: E. M. Urbaitis

DATE: 10/28/91

REVISION DATE:



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ENGINEERING NOTE

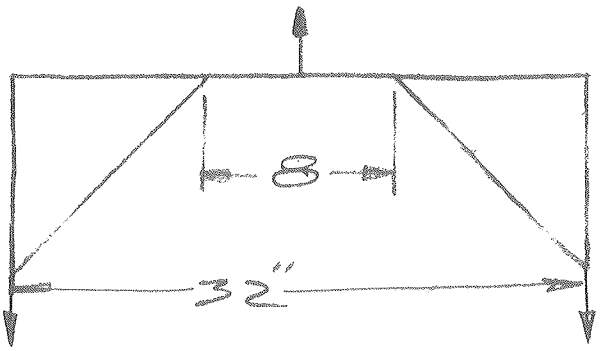
SECTION	PROJECT	SERIAL - CATEGORY	PAGE
		2	5A

SUBJECT: EMC FRAME REINFORCEMENT MOD.

NAME: E.W. Ashley

DATE: 10/28/91 REVISION DATE:

40×10^3 #



$$F_b = \frac{M\,c}{I}$$

$$I_{x\,(req'd)} = \frac{80 \times 10^3 \times 3.5}{12 \times 10^3}$$

$$= 23.3 \text{ in}^4 \text{ req'd.}$$

$$M = 4 \times 20 \times 10^3$$

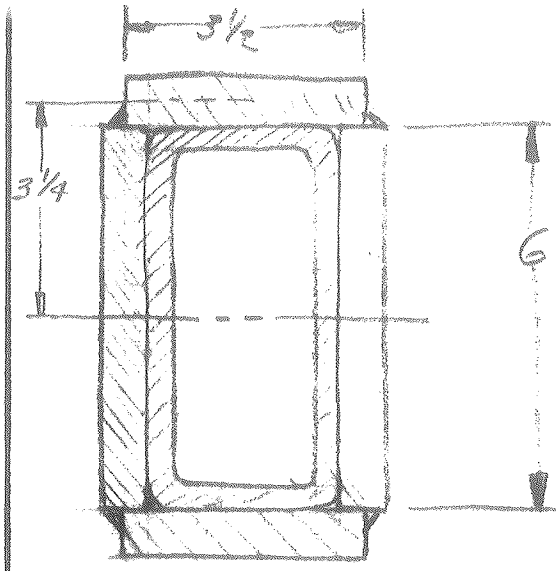
$$= 80 \times 10^3 \text{ in-lb}$$

$$F_v = F_b = .33 \times 36 \times 10^3$$

$$= 12 \times 10^3 \text{ psi}$$

$A = 3.14$
$I_x = 19.3$ } TUBE

$A_{TOTAL} = 10.14$



$$I = \Sigma(I_o + Ad^2)$$

$$= 19.3 + \frac{.5 \times 6^3}{12} + 2\left(\frac{3.5 \times .5^3}{12} + 3.5 \times .5 \times 3.25^2\right)$$

$$= 60 \text{ in}$$

$$f_b = 4.7 \times 10^3 < F_b$$

$$f_v = \frac{20 \times 10^3}{10.14} = 1.97 \times 10^3 < F_v$$

$$f_v = \frac{VQ}{Ib} \quad \text{where } Q_w = 3.5 \times 6.5 \times \frac{6.5}{8} = 36.8$$

$$= 2.2 \times 10^3$$

$$w = \frac{f_v}{F_v} = \frac{2.2}{12} = .181'' \text{ avg } 1/4''$$

FERMILAB

MECHANICAL DEPARTMENT - MS#221
WILSON HALL 13TH FLOOR - EXT: 3099

SPRDRBAR ID#40

NOVEMBER 14, 1991

TO: ***KURT KREMPETZ***
FROM: ***ROBERT J. WOODS***
SUBJECT: **SAFETY CHECK OF D0 EC IH MODULE LIFTING FIXTURE**

I HAVE COMPLETED MY REVIEW OF D0 LIFTING FIXTURE DESIGNED BY ERNIE VILLEGAS. THE PURPOSE OF THIS REVIEW WAS TO INSURE THAT THIS FIXTURE WAS DESIGNED AND BUILT TO CONFORM T0 FERMILAB'S BELOW-THE-HOOK LIFTING DEVICE STANDARD.

THIS FIXTURE IS TO BE USED WITH THE D0 CRANE TO LIFT AND POSITION A MODULE LOAD OF FORTY (40) TONS. THE MAIN SPREADER BEAM IS FABRICATED FROM TWO STANDARD W18X119 STEEL BEAMS POSITIONED SIDE BY SIDE, WITH THE TOP AND BOTTOM FLANGES WELDED TOGETHER. A ONE HALF INCH THICK BY TWENTY INCH WIDE COVER PLATE IS WELDED TO BOTH THE TOP AND BOTTOM FLANGES. THIS STRUCTURE IS ATTACHED TO THE CRANE BY A "SPREADER BAR YOLK", WHICH IS BOLTED TO THE SPREADER BAR'S TOP FLANGE. THE MODULES ARE ENGAGED BY FERMILAB DESIGNED HOOKS WHICH ARE CONNECTED TO THE SPREADER BEAM BY FERMILAB DESIGNED CLEVIS PINS AND BRACKETS. THESE BRACKETS ARE BOLTED TO THE BOTTOM OF THE SPREADER BEAM.

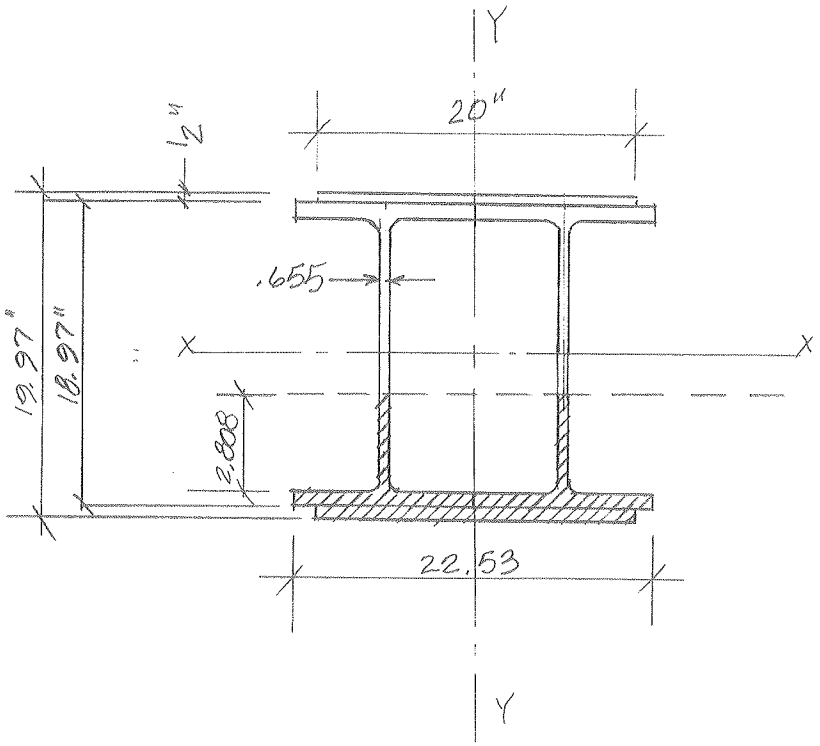
I HAVE CHECKED ERNIE'S CALCULATIONS WHICH PROVE THAT ALL STRESSES ARE WELL BELOW THE ALLOWABLE OF ONE THIRD YIELD AS REQUIRED BY ANSI/ASME B30.20. I ALSO CHECKED THIS STRUCTURE FOR COMPLIANCE TO THE AISC STEEL CODE. MY CALCULATIONS INDICATE THAT THE ALLOWABLE STRESSES AS COMPUTED BY AISC REQUIREMENTS ARE GREATER THAN THOSE PERMITTED BY THE ANSI/ASME STANDARD, THUS THIS DEVICE ALSO CONFORMS TO AISC STANDARDS. I DID FIND THAT THE CALCULATIONS CALLED FOR THE WELD BETWEEN THE FLANGE COVER PLATES AND THE BEAM FLANGES TO BE ONE QUARTER INCH FILLET WELDS. THIS WOULD NOT MEET THE AISC REQUIREMENTS DUE TO THE THICKNESS OF THE BEAM FLANGES; HOWEVER, BY VISUAL INSPECTION OF THIS WELD IN THE SHOP I FOUND THE WELD TO BE A MINIMUM OF FIVE SIXTEENTHS, WHICH DOES MEET CODE REQUIREMENTS.

THIS DEVICE WAS FABRICATED FROM STEEL WHICH HAS NO MILL CERTIFICATION AVAILABLE. SINCE THE STRESSES ARE WELL BELOW THE MAXIMUM ALLOWABLE STRESS AND A LOAD TEST IS SCHEDULED, THIS SHOULD NOT BE A PROBLEM. IF DEFLECTIONS ARE CAREFULLY MONITORED AND RECORDED DURING THE LOAD TEST, A CALCULATION CAN BE MADE TO VERIFY THE STEEL STRENGTH.

I WOULD LIKE TO SEE SOME CALCULATIONS ON HOW A HORIZONTAL LOAD OF APPROXIMATELY TEN PER CENT OF THE VERTICAL WOULD EFFECT THE BOLTED CONNECTIONS. THIS HORIZONTAL FORCE COULD BE CAUSED BY IMPROPER CRANE HANDLING OR AN ACCIDENT WHERE THE LOAD IS DRIVEN INTO A FIXED OBJECT.

CC J. KILMER
H. STREDDE
E. VILLEGAS

A) COMPUTE r_T FOR BUILTUP SECTION



r_T = RAD. OF GYRATION OF COMPRESSION FLANGE + ⅓ COMPRESSION WEB ABOUT Y-Y

$A_F = 22.53(1.06) + (20)(0.5)$
$= 33.882$

$A_{⅓W} = 2(2.808)(.655)$
$= 3.679$

$A_{TOTAL} = 33.882 + 3.679$
$= 37.561 \text{ IN}^2$

$I_{F_1} = \frac{1.06(22.53)^3}{12} = 1010.2 \text{ IN}^4$

$I_{F_2} = \frac{0.5(20)^3}{12} = 333.3 \text{ IN}^4$

$I_W = \frac{2.808((11.92)^3 - (10.61)^3)}{12}$
$= 116.8$

$I_{TOTAL} = 1010.2 + 333.3 + 116.8$
$= 1460.3 \text{ IN}^4$

$r_T = \sqrt{I/A} = \sqrt{1460.3/37.561}$

$= \underline{6.24 \text{ IN}}$

B) FIND F_B ALLOW.

$\ell/r_T = 240/6.24 = 38.46 < 53$

$\therefore F_b = \frac{12 \times 10^3 C_b}{\ell d/AF} = \frac{12 \times 10^3 (1)}{240(19.97)/33.882} = 84.8 \text{ KSI} > .6F_y$

$\therefore F_b = .6(36) = \underline{21.6 \text{ KSI}}$

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL - CATEGORY	PAGE

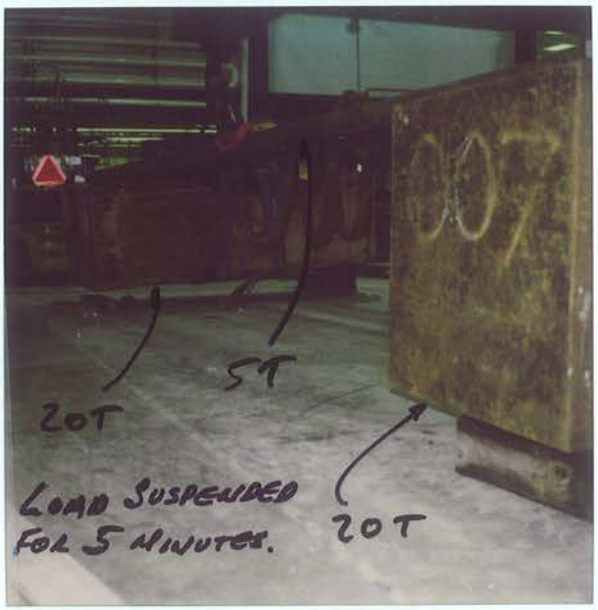
SUBJECT

NAME

DATE

REVISION DATE

SPREADER BAR HE-285274
45 TON LOAD TEST.
NOV 16, 1991



45 TON SPREADER BAR (HE-285274)
LOAD TEST.
NOV 16, 1991

SPREADER BAR HE-285274
45 TON LOAD TEST
NOV 16, 1991

SPREADER BAR HE-285274
45 TON LOAD TEST
NOV 16, 1991

534393