CYGNA
ENERGY SERVICES
101 California Street, Suite 1000, San Francisco, CA 94111-5894 415 397-5600

June 30, 1984
84042.023

50-445

Mrs. Juanita Ellis
President, CASE
1426 S. Polk
Dallas, Texas 75224

Subject: Responses to Cygna Design Control, Pipe Support, and Pipe Stress Questions
Comanche Peak Steam Electric Station
Independent Assessment Program - Phase 3
Texas Utilities Generating Company
Job No. 84042

Dear Mrs. Ellis:

Enclosed please find copies of additional responses to Cygna design control, pipe support and pipe stress questions.

Feel free to call me if you have any questions or wish to discuss the enclosed documents.

Very truly yours,

N.H. Williams

N.H. Williams
Project Manager

Attachments

cc: Mr. S. Treby, NRC, w/attachments
Mr. S. Burwell, NRC, w/attachments
Mr. D. Wade, TUGCO, w/o attachments
Mr. G. Grace, TUGCO, w/o attachments
Mr. D. Pigott, Orrick, Herrington & Sutcliffe, w/o attachments

2222

Use attached dist. per S. Burwell

CYGNA
ENERGY SERVICES

Mrs. Juanita Ellis
July 2, 1984
Page 2

ATTACHMENTS

1. A. Vega (TUGCO) memorandum to D. Smedley (Cygna), "Transmitting IR's," June 7, 1984, TUQ-219.

2. A. Vega (TUGCO) letter to N. Wiliams (Cygna), "Comanche Peak Steam Electric Station, Cygna Review Questions (Inspection Report)," June 12, 1984.

3. R.E. Ballard (G&H) letter to J.B. George (TUGCO), GTN-69118, "Texas Utilities Generating Company, Comanche Peak Steam Electric Station, G&H Project No. 2323, Phase 3 Cygna Pipe Support Questions, WOS-046/DOW-3464," June 14, 1984.

4. G. Grace (TUGCO/EBASCO) memorandum to N. Williams/J. Minichiello (Cygna), "Attachment C to June 8th letter to N. Williams (Cygna) from L. Popplewell (TUGCO)," June 18, 1984.

5. A. Vega (TUGCO) letter to N. Williams (Cygna) "Comanche Peak Steam Electric Station, Cygna Review Questions (Inspection Report)," June 18, 1984.

6. R. E. Ballard (G&H) letter to J. B. George (TUGCO), GTN-69135, "Texas Utilities Generating Company, Comanche Peak Steam Electric Station, G&H Project No. 2323, Phase 3 Cygna Support Questions, WOS-046/DOW-3464," June 21, 1984

7. R.E. Ballard (G&H) letter to J.B. George (TUGCO), GTN-69162, "Texas Utilities Generating Company, Comanche Peak Steam Electric Station, G&H Project No. 2323, Proposed Mass Participation Fraction Sensitivity Study," June 26, 1984.

NOTED JUN 2 8 1984 N.WILLIAMS

TEXAS UTILITIES GENERATING COMPANY

OFFICE MEMORANDUM

To: Nancy Williams/John Miniciello — Glen Rose, Texas June 18, 1984

Subject: ATTACHMENT C TO JUNE 8TH LETTER TO N. WILLIAMS (CYGNA) FROM L. POPPLEWELL (TUGCO)

The calculation for hanger CC-1-028-007-S33R was revised to properly account for the elongation of the U-bolt due to thermal expansion. Attached is the revised calculation.

CYGNA
JOB NO.: 84042
DATE LOGGED: 6/29/84
LOG NO.: 402
FILE:
CROSS:

George E. Grace

GEG:pew
cc: J. C. Finneran
D. M. Rencher
D. H. Wade

Distribution
84042 PF
J. Miniciello
N. Williams

FORM DHE-5

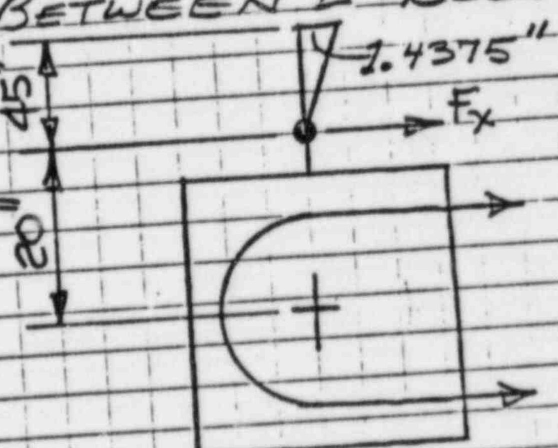
TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-19-84
Calc By GMC
Chk'd/Apprd. By NHB 6-21-84
Subject CC-1-028-007-S33R

Filing Code
Sheet No. 1 of 9
G & H Job. No.
Ref. Dwg./Spec. No.

OBJECTIVE: THE CALCULATIONS DATED 3/23/84,
BY "A.T.", TO DESIGN U-BOLTS ADDED
TO ENHANCE LATERAL STABILITY,
HAD AN ERROR IN THE CALCULA-
TIONS. ON PAGE 4 OF 6 OF THE
REF'D CALCULATIONS, THE
ASSUMED LENGTH OF THE U-BOLT
IS NOT CORRECT. THE ERROR IS
UNCONSERVATIVE, BUT BECAUSE
OF OTHER CONSERVATIVE ASSUMPTION.
MADE ELSEWHERE IN THE CALC'S
THE DESIGN IS STILL MORE
THAN SUFFICIENT. THE FOLLOWING
CALCULATIONS WILL DEMONSTRATE
THAT.

REQUIRED FRICTION BETWEEN U-BOLT AND PIPE



SWAY STRUT C-C = 45"
$F_y = 6018^{\#}$ @ EMER.

$\therefore F_x = \tan\theta \; F_y$
$= \frac{1.4375''}{45''}(6018^{\#})$
$= 192^{\#}$

θ IS 1.82°, FOR CONSERVATISM CONSIDER THE MAX STRUT BRACKET 5° SWING OF A STRUT BRACKET 5°

$\therefore F_x = \tan 5° \; F_y = 526^{\#}$

TORSION @ ℄ OF PIPE $= 526^{\#}(20'') = 10{,}520$ IN#

SINCE THERE ARE 2 U-BOLTS $\frac{10520\text{ IN}^{\#}}{2} = 5260$ IN# EACH

FORM DHE-5

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Agent For
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TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-19-84
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Chk'd/Apprd. By [initials] 6-21-84
Subject CC-1-028-007-S33R

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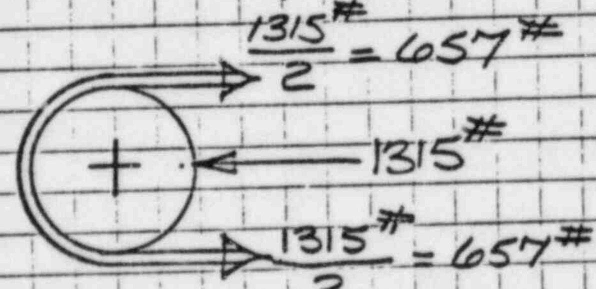
G & H Job. No.
Ref. Dwg./Spec. No.

FRICTION REQ'D TO RESIST 5260 IN# TORSION

5260 IN# / PIPE RAD. = 5260 IN# / 12 IN* = 438# TOTAL FRICTIONAL RESISTANCE

* CONSERVATIVE, SHOULD BE 2R RW 6-27-84

FRICTION = 1/3 BEARING ∴ 438#(3) = 1315# BEAR'G REQ'D



USE 2:1 FACTOR OF SAFETY

657#(2) = 1315# TENSION REQ'D IN EMER. COND.

TENSION IN U-BOLT BECAUSE OF:

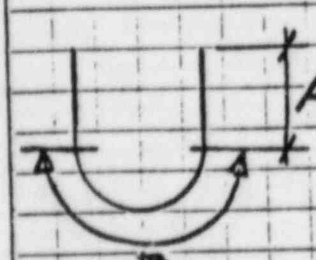
a) TEMPERATURE
b) RADIAL EXPANSION OF PIPE DUE TO PRESSURE
c) TORQUE ON U-BOLT.

a) TEMPERATURE "T" AMBIENT = 75°

"T" PIPE = 150°

∴ δT = 150° − 75° = 75°

PIPE Δ = α (δT) L = (5.91)(10^-6)(75°)(π DIA) = .0334202



FROM (RAD + T.S. + R) TO (RAD' + T.S. + R)
(12" + 4" + 1") TO DIA + .03342/π / 2 + 4" + 1"

∴ Δ IN ONE SIDE OF U-BOLT } .03342026/π / 2 = .005319"

a) CONTINUED

PORTION B OF U-BOLT

NOTE THAT MSS SP-58, 4.5 STATES THAT PORTIONS OF SUPPORTS IN CONTACT WITH PIPE WILL EXPERIENCE SAME TEMP. AS PIPE. ∴, SINCE BOTH ARE CARBON STEEL, NO ADD'L PRETENSIONING WILL RESULT IN PORTION B.

PORTION A, U-BOLT, WILL ELONGATE SOME DUE TO TEMPERATURE. MSS SP-58 STATES THAT THE TEMP. IN THIS AREA IS 1/3 OF PIPE OR AMBIENT WHICH EVER IS GREATER.

$(1/3)(150°) = 50°$ $\quad T_{AMB.} = 75°$

∴ CONSIDER NO CHANGE

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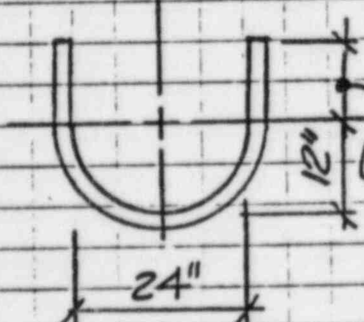
Ref. Dwg./Spec. No. ______

b) Δ IN U-BOLT DUE TO RADIAL EXPANSION OF PIPE FROM INTERNAL PRESSURE.

$$\Delta R = \frac{q R^2}{E t}$$ ROARK, TABLE 29

$= (150\text{ psi})(12^2) / (27.85)(10^6)(.375")$

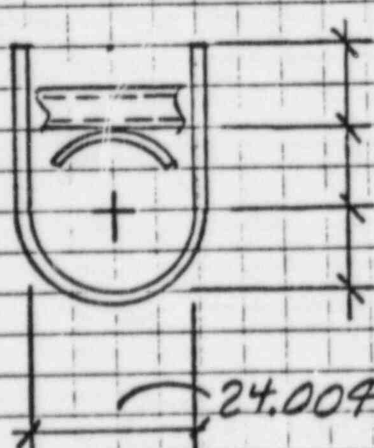
$= .0020682$ @ 150° F



PREVIOUS LENGTH OF U-BOLT

(12" + 4" + 1")

$2(12+4+1) + \frac{\pi\, 24}{2} = 71.69911185"$



LENGTH CONSIDERING EXPANSION OF PIPE DUE TO PRESSURE

$(12.0020682 + 5)(2) + \frac{\pi\ 24.0041364}{2} = 71.709746$

Δ = NEW LENG − PREV. LENG = .01063"

C.) TORQUE ON U-BOLT IS 700 IN#

SOLVE FOR LOAD "P"

$$T = P\left[R_m\left(\frac{\tan\alpha + f/\cos\theta_n}{1 - f\tan\alpha/\cos\theta_n}\right) + f_c R_c\right]$$

SCHAUMS OUTLINE SERIES, MACHINE DESIGN

WHERE:

R_m = MEAN RADIUS $(1+.847)(\frac{1}{2})(\frac{1}{2}) = .46175$

f = 0.12 THRD FRICTION

f_c = 0.25 NUT FRICTION

R_c = COLLAR RADIUS .625"

$\tan\alpha = \frac{LEAD}{2\pi R_m} = \frac{1/8}{2\pi(.46175)} = .043084$

$\cos\theta$ WHERE $\theta = 30°$ IS (.866)

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TEXAS POWER & LIGHT COMPANY

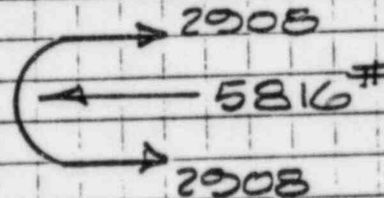
Date: 6-19-84
Calc By: GMC
Chk'd/Apprd. By:
Subject: CC-1-028-007-S33R

Filing Code:
Sheet No. 6 of 9
G & H Job. No.
Ref. Dwg./Spec. No.

C) CONTINUED

$$700\,\text{IN}^{\#} = P\left[.46175\left(\frac{.043034 + \frac{.12}{.866}}{1-(.12)(.04384)/.866}\right) + .25(.625)\right]$$

$P = 2908^{\#}$



ASSUME THERE IS NO ADD'L PRETENSION IN THE U-BOLT DUE TO TEMPERATURE OR PRESSURE IN A EMERGENCY CONDITION.

$2908^{\#}/657^{\#} = 4.4$ FACTOR OF SAFETY

U-BOLT STRESS

THE STRESS IN THE U-BOLT COMES FROM THREE CONDITIONS:

1. THERMAL 2. RADIAL PRESSURE 3. TORQUE	P = 2908	Δ = .005319 Δ = .01063 Δ = NA

FORM DHE-5

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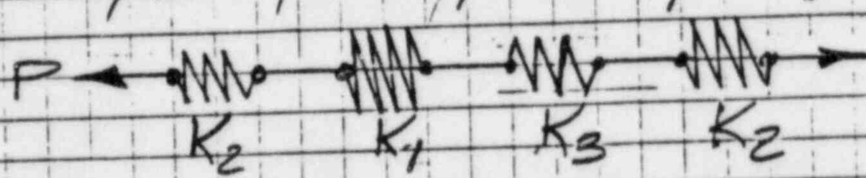
Sheet No. 7 of 9
G & H Job. No
Ref. Dwg./Spec. No.

/PLATE/U-BOLT/ PIPE /PLATE/

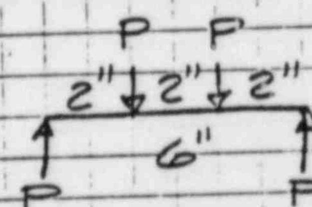


K_1 U-BOLT K_1

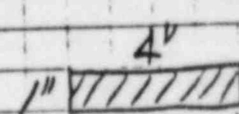
$\Delta = \frac{PL}{AE}$ $K_1 = \frac{P}{\Delta}$ ∴ $K = \frac{PAE}{PL} = \frac{AE}{L} = \frac{.785(27.7)10^6}{71.699}$

$K_1 = (3.032)\,10^5$

K_2 PLATE K_2 $\Delta = \frac{Pa}{24EI}(3l^2 - 4a^2)$



$K_2 = \frac{P}{\Delta} = \frac{P\,24EI}{Pa(3l^2 - 4a^2)} = \frac{24EI}{a(3l^2 - 4a^2)}$



$I = \frac{bd^3}{12}$

$= \frac{24(27.7)(10^6)(.333)}{2[3(6^2) - 4(2^2)]}$

$K_2 = 1.2MEG$

FORM DHE-5

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COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-20-84
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Subject CC-1-028-007-S33R

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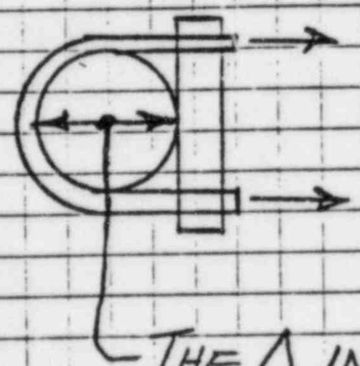
Sheet No. 8 Of 9
G & H Job. No.
Ref. Dwg./Spec. No.

K_3 CONSIDER THE DEFLECTION OF PIPE K_3



$$K_3 = \frac{P}{\Delta}$$

THE Δ IN THE PIPE DIAMETER WILL PRODUCE A 2Δ CHANGE IN U-BOLT LENGTH, IE NUT TO NUT LENGTH

Δ DUE TO PIPE

ROARK TABLE 31, PP 495

$$\Delta = 6.5 \frac{P}{Et}\left(\frac{R}{t}\right)^{3/2}\left(\frac{L}{R}\right)^{-3/4}$$

$P = 1000^{\#}$
$R = 12''$
$t = .375$
$L = 72''$
$E = 27.7\ (10^6)$

$$\Delta = 6.5\left(\frac{1000}{27.7(10^6).375}\right)\left(\frac{12}{.375}\right)^{3/2}\left(\frac{72''}{12''}\right)^{-3/4} = .02954703$$

$K_{PIPE} = 1000/\Delta$ HOWEVER WE ARE NOT INTERESTED HERE IN THE STIFFNESS OF THE PIPE ITSELF BUT RATHER HOW IT CONTRIBUTES TO THE Δ IN THE U-BOLT. A .02954703" CHANGE IN PIPE DIA WILL BE (2)Δ CHANGE IN U-BOLT ∴

$K = 1000/2\Delta = .169\ E5$

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-21-84
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Subject CC-1-028-007-S33R

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Sheet No. 9 Of 9
G & H Job. No.
Ref. Dwg./Spec. No.

$$K_E = \frac{1}{1/K_3 + 1/K_2 + 1/K_1 + 1/K_2}$$

$$= \frac{1}{1/.169E5 + 1/12.04E5 + 1/3.032E5 + 1/12.04E5}$$

↑ PIPE ↑ PLATE ↑ U-BOLT ↑ PLATE

$= .1559\,E5$

$K = P/\Delta$ $\Delta = (2)(.005319) + (0.01063) = .021268$

↑ TEMP ↑ PRESSURE

$\therefore P = \Delta K = .021268\,(.1559\,E5) = 331$

$331^{\#} + 2908^{\#} = 3239^{\#}$

↑ TORQUE

$3239^{\#} / .551\,IN^2 = 5879$ PSI @ ROOT AREA

$5879 < (.6)(32.8\,KSI)$ OR $5879/19680 = 30\%$

W/ LCD 5879 PSI / 9000 PSI (65%)

TEXAS UTILITIES GENERATING COMPANY
P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

June 18, 1984

Distribution
S. Bibo
D. Smedley
N. Williams
84042 PF

CYGNA	
JOB NO.:	84042
DATE LOGGED:	6/26/84
LOG NO.:	#38
FILE:	2.1.1 Inc. QR
CROSS REF. FILE	2.1 Inc. QR Log

CYGNA Energy Services
101 California Street
Suite 1000
San Francisco, CA 94111

Attention: Ms. Nancy Williams, Project Manager

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
CYGNA REVIEW QUESTIONS
(Inspection Reports)

Reference: June 7, 1984 Letter to J. B. George (TUGCO) from N. Williams (CYGNA)

Dear Ms. Williams:

Transmitted herewith are TUGCO's supplemental responses to the above referenced letter concerning Items Nos. 1 & 2.

If there are any additional questions, please contact the undersigned at Ext. 321 or B. C. Scott at Ext. 859.

Very truly yours,

TEXAS UTILITIES GENERATING COMPANY
QUALITY ASSURANCE DEPARTMENT

A. Vega

A. Vega
TUGCO Site QA Manager

AV/BCS/bll
Attachments
cc: D. N. Chapman
D. H. Wade

Supplemental Response Item #1

An unsatisfactory inspection report will remain open until the condition is verified to be satisfactory. In addition to the inspection report, accountability of IR is maintained through an IR log which reflects the open/closed status. Also, the unsatisfactory condition is identified in the Master System Data Base Punchlist as an open work item.

The worst case condition would be losing an inspection report. However, as explained above the unsatisfactory report would continue to be identified and statused as an open item.

The unsatisfactory condition has to be verified acceptable after rework by craft. Any work performed during the time the IR was lost and later identified as an open item would have to be redone. This worst case condition is not a safety concern in that inadvertent use is precluded, but rather an economic consideration.

Procedural controls historically and current are CP-QP-18.0, titled "Inspection Report".

Supplemental Repsonse Item #2

In some cases Engineering will issue a DCA/CMC accepting an unsatisfactory condition when a rework disposition is not practicable. In such cases the DCA/CMC number will be referenced on the inspection report reflecting acceptance of the as-built condition.

REBallard/SMMarano/077, TDHawkins/HMLapinig, HWMentel/SLim (17), MAVivirito (19), JLEichler/CMJan (16), OUTGOING, ELBezkor

84042
Rec'D 6/22

Received: 21 June 84

June 21, 1984

Distribution:
N. Williams
C. Wong

GTN- 69135

CYGNA	84042 TF
JOB NO:	84042
DATE LOGGED:	6/26/84
LOG NO.:	#39
FILE:	2.1.1 Inc. CR.
CROSS REF. FILE	21 Inc. CR. Log

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George,
Vice President/Project Gen. Mgr.

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
G&H PROJECT NO. 2323
PHASE 3 CYGNA PIPE SUPPORT QUESTIONS
WOS-046/DOW-3464

Our response to your telecon request of June 12, 1984 is as follows:

Question 1: Is there a calculation developing the allowable ultimate pullout load/bolt for 9 or 12 bolt groups with 20 inch spacing? If so, please provide it to justify the 50% reduction noted in GTN-41315.

2: Is there a calculation for the same group based on 10 inch spacing? Please provide.

Answers to 1 and 2 : G&H Calculation Book SRB-123C, Set 1 provides the general guidelines as well as some specific sample examples for the evaluation of the embedment capacity of anchor bolts and Richmond inserts. The specific cases referenced in Question 1 and 2 are not included in the sample examples.

TRANSMITTED BY TELECOPIER
6/21/84, 2 pm

Dravo

However, reference is made to GTT-10394 where the subject cases in Item 5 of GTN-41315 are modified. The modified note limits the number of bolts in a group within which the 50% of the maximum ultimate tensile capacity may be used. Pertinent calculations are in G&H Book No. SRB-123C, Set. 5, Rev. 0.

GTT-10395 requests the site to reconfirm that for support design by other than G&H, the limiting bolt group stipulations are adhered to.

Please note that for G&H support designs using anchor bolts in groups, actual pullout capacity is calculated rather than using the 50% criteria.

Question 3: What thickness wall is needed in this calculation to develop the calculated load in the concrete?

Answer to 3 : The calculation referenced above (SRB-123C, Set 5, Rev. 0) indicate the necessary concrete thicknesses to develop the calculated loads.

Question 4: What justification or calculation does G&H have for the Richmond insert loads presented in GTN-61623?

Answer to 4 : Please refer to GTN-69118 for the response.

Very truly yours,

GIBBS & HILL, Inc.

Robert E. Ballard, Jr.
Project Manager

ELB

REBa/ELB:gw
1 Letter

cc: ARMS (B&R Site) OL
G. Grace/J. Minichiello (TUSI Site) 1L
P.M. Milam/F. Bleck (TUSI/NY) 1L

TUSI SITE

ST-5292/SSe-793

TELECOPY

JUNE 21, 1984

GTT - 10395

ATTENTION: J.B. GEORGE/M.R. MC BAY/C.R. HOOTON

JOB: 2323

SUBJECT: CRITERIA FOR EMBEDDED ANCHOR BOLT ALLOWABLE LOADS
WOS-464/DOW-3465

REF: 1. GTT- 10394
2. GTN-41315

IT IS OUR UNDERSTANDING THAT FOR SUPPORTS DESIGNED BY OTHER THAN G&H, NO GROUP OF BOLTS USED EXCEEDS THE GUIDELINES INDICATED IN ABOVE REF. 1, EXCEPT ONE NPSI PIPE SUPPORT DESIGN (MK NO. MS-1-002-007-C72K). THIS PIPE SUPPORT IS DESIGNED PER GUIDELINES GIVEN IN GTN-64940 AND NOT GOVERNED BY REF. 2. PLEASE RECONFIRM.

R.E. BALLARD/E.L. BEZKOR/A.M. KENKRE/S. SENGUPTA

Confirmation: Gerry Winfrey, 11th Floor

TRANSMITTED BY TELECOPIER
6/21/84 11 am

REBa/375, ELB/AMK/SS
outgoing. TDH/HMLa
P.M. Milam/Rill)elson/
F. Blech

TUSI SITE ST-5289/SSe-792

TELECOPY

JUNE 21, 1984

GTT- 10394

ATTENTION: J.B. GEORGE/M.R. MC BAY/C.R. HOOTON

JOB: 2323

SUBJECT: CRITERIA FOR EMBEDDED ANCHOR BOLT
ALLOWABLE LOADS
WOS-464/DOW-3465

REFERENCE: GTN-41315

THE ABOVE REFERENCE PROVIDES THE CAPACITY OF ANCHOR BOLTS WHEN LOADED IN TENSION AND/OR SHEAR. HOWEVER, ITEM 5 OF THE REFERENCE SHOULD BE MODIFIED AND READ AS FOLLOWS:

5. PULLOUT CAPACITY AS GOVERNED BY CONCRETE, USE 50 PERCENT OF THE MAXIMUM ULTIMATE TENSILE CAPACITY WHERE 4 OR MORE BOLTS IN A GROUP ARE USED, BUT NOT TO EXCEED FOR;
   a. 1 1/2 DIA. BOLTS - 9 IN A GROUP
   b. 2 DIA. BOLTS - 6 IN A GROUP

FOR A GROUP OF BOLTS EXCEEDING THIS LIMIT, ACTUAL EVALUATION OF CAPACITY SHOULD BE MADE.

R.E. BALLARD/E.L. BEZKOR/S. SENGUPTA

TRANSMITTED BY TELECOPY
6/21/84 11 am

Confirmation: Gerry Winfrey, 11th Floor

REB/375 ELB/S.S.
outgoing, TDH/Hilla
Ann McLean/B. Nelson/F.Bl.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULLOUT CAPACITY OF A.Bs IN GROUPS

Calculation Number SRB - 123C SET 5 Sheet No. 2

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	SSL	6.20.84								
Checker	C.P.	6.20.84								

PURPOSE OF CALCULATION:

TO DETERMINE THE PULLOUT CAPACITY OF ANCHOR BOLTS IN A GROUP AS GOVERNED BY CONCRETE AND TO ESTABLISH THE LIMIT OF GROUP ACTION UPTO WHICH 50 % OF THE MAXIMUM ULTIMATE TENSILE CAPACITY MAY BE USED (SEE REFERENCE 1 AND 3 BELOW.)

PER REF 1, 3 CASES ARE CONSIDERED.

(i) 1½" Φ BOLT 5x5 ANCHOR PLATE
(ii) 1½" Φ BOLT 6x6 " "
(iii) 2" Φ BOLT 7x7 " "

} BOLT MATL ASTM A-320

RELEVANT DETAILS CHOSEN ARE FROM

(a) G&H DWG S1-0566 R/4 1½" Φ BOLT
(b) G&H DWG S1-0567 R/4 MK-2 & MK-4

RELEVANT REFERENCES

1. GTN-41315
2. CALC NO SRB-123C SET 1
3. CYGNA QUESTIONS (#1 & #2) (SH 16 AND 17)
4. ACI 349-76

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

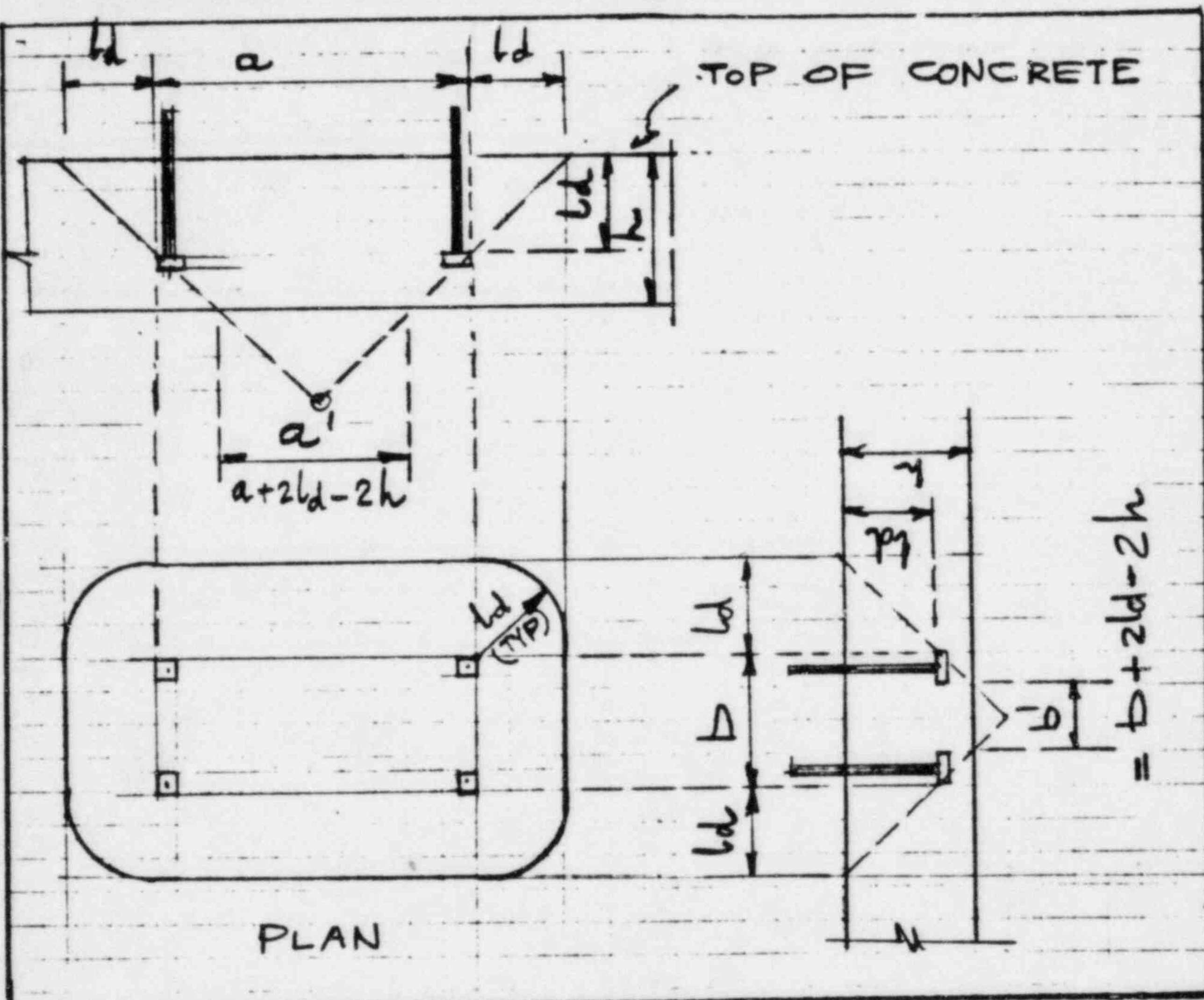
F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULLOUT CAPACITY OF A.BS IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 3

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	SSe	6.18.84								
Checker	C.P.	6.18.84								



n = NO OF BOLTS IN A GROUP ; A = AREA OF ANCHOR PL

A_c = CONC. PULLOUT AREA (REF SRB-123C SET 1 REV 0) & ACI 349-76

$$= \pi l_d^2 + a \times b + 2l_d(a+b) - a' \times b' - nA$$

P_{uc} = CONC. PULLOUT CAPACITY / BOLT

$$= 4\phi\sqrt{f_c'}A/n = 0.164438\,A/n \text{ KIPS}$$

$[f_c' = 4000 \text{ PSI} ; \phi = 0.65]$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

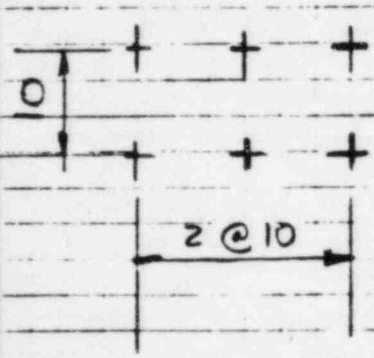
Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.^S IN GROUPS

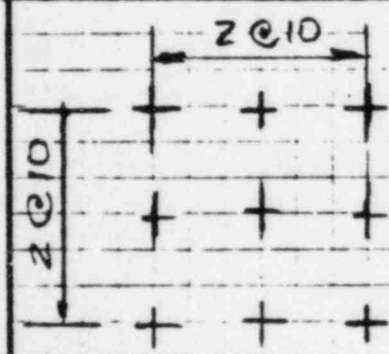
Calculation Number SRB-123C SET 5 Sheet No. 4

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1	X		X		X		X		X
Preparer	SS	6.18.84								
Checker	C.P.	6.18.84								

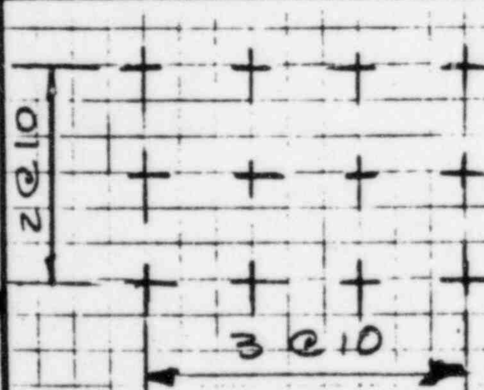
TYPE 1a 4 BOLTS @ 10 EW WITH 5x5 PL
1b " " " 6x6 "
1C " " " " " 7x7 "



TYPE 2a 6 BOLTS @ 10 EW WITH 5x5 PL
2b 6 " " EW " 6x6 "
2C 6 " " EW " 7x7 "



TYPE 3a 9 BOLTS @ 10 EW WITH 5x5 PL
3b 6x6 PL
3C 7x7 PL



TYPE 4a 12 BOLTS @ 10 EW WITH 5x5 PL
4b " " " " " " 6x6 PL
4C " " " " " " 7x7 "

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

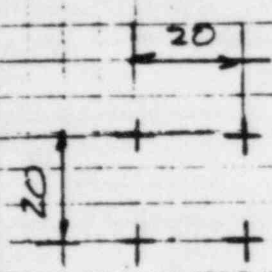
F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

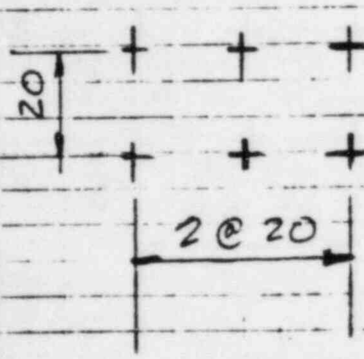
Subject CONC. PULL-OUT CAPACITY OF A.B.s IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 5

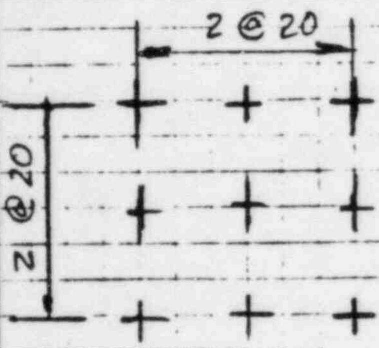
Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	SSL	6.18.84									
Checker	DP	6.18.84									



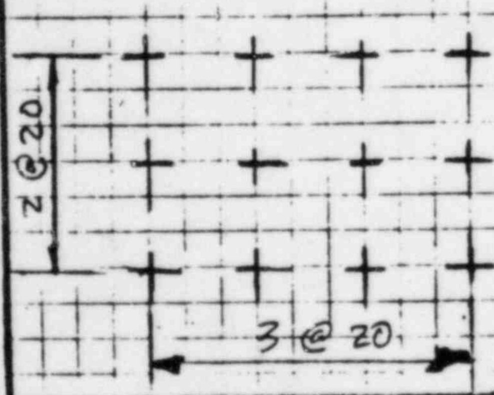
TYPE 11a 4 BOLTS @ 20 EW WITH 5x5 PL
11b " " " 6x6 "
11c " " " " " 7x7 "



TYPE 12a 6 BOLTS @ 20 EW WITH 5x5 PL
12b 6 " " EW " 6x6 "
12c 6 " " EW " 7x7 "



TYPE 13a 9 BOLTS @ 20 EW WITH 5x5 PL
13b " " 6x6
13c " " 7x7 PL



TYPE 14a 12 BOLTS @ 20 EW WITH 5x5 PL
14b " " " 20 " " 6x6 PL
14c " " " 20 " " 7x7 "

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

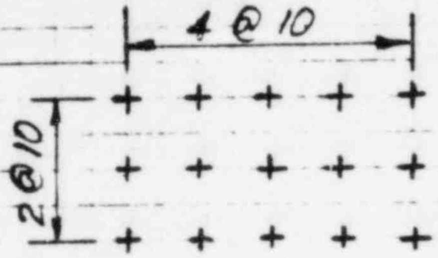
F-166, 7-82

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

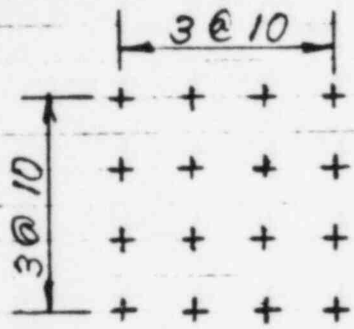
Subject CONC. PULL-OUT CAPACITY OF A.B.^{s} IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 6

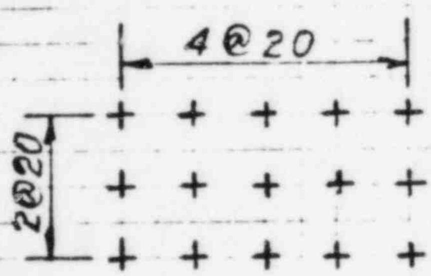
Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	C.P	6.19.84								
Checker	SSe	6.20.84								



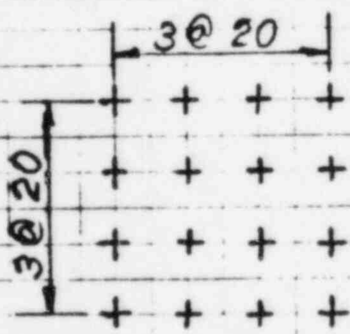
TYPE 5a 15 BOLTS @10 WITH 5x5 PL
5b 15 " " " 6x6 PL
5C 15 " " " 7x7 PL



TYPE 6a 16 BOLTS @10 EW WITH 5x5 PL
6b 16 " " " " 6x6 PL
6C 16 " " " " 7x7 PL



TYPE 15a 15 BOLTS @ 20 WITH 5x5 PL
15b 15 " " " 6x6 PL
15C 15 " " " 7x7 PL



TYPE 16a 16 BOLTS @ 20 EW WITH 5x5 PL
16b 16 " " " " 6x6 PL
16C 16 " " " " 7x7 PL

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.^{S} IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 7

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	MLK	6-18-84								
Checker	CP.	6.19.84								

1 1/2" ϕ BOLT GROUP

TYPE	PL SIZE	SPACING (in)	DEPTH OF SLAB (h)	DEPTH OF EMBED (l_d)	a	b	$a+2l_d-2h = a'$	$b+2l_d-2h = b'$	$A_c = \pi l_d^2 + a.b + 2l_d(a+b) - a'.b' - nA$	$P_u = 0.16\sqrt{3800}\,A_c/n$
1a	5x5	10x10	33	16	15	15	0	0	1889	77.6
2a	5x5	10x10	33	16	25	15	0	0	2309	63.3
3a	5x5	10x10	33	16	25	25	0.	0.	2804.	51.
4a	5x5	10x10	33	16	35	25	1.	0	3299.	45.2
5a	5x5	10x10	33	16	45	25	11.	0	3794	41.6
6a	5x5	10x10	33	16	35	35	1.	1.	3868	39.7
1a	5x5	10x10	24	16	15	15	0	0	1889	77.6
2a	↓	↓	↓	16	25	15	9	0.	2309	63.3
3a	↓	↓	↓	16	25	25	9	9	2723	49.7
4a	5x5	10x10	24	16	35	25	19	9	3128	42.8
5a	↓	↓	↓	16	45	25	29	9	3533	38.7
6a	5x5	10x10	24	16	35	35	19	19	3508	36.0

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.s IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 8

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	C.P.	6.18.84								
Checker	MLK	8-20-84								

1½" ⌀ BOLT GROUP

TYPE	PLATE SIZE	SPACING (IN)	DEPTH OF SLAB (L)	DEPTH OF EMBED (d)	a	b	a' = a+2d-20"	b' = b+2d-2L	$A_c = \pi d^2 + a.b + 2d(a+b) - a'.b' - nA$	$P_u = \phi\, 0.16\sqrt{3000}\, A_c/1000$ KIPS
11a	5x5	20x20	24	16	25	25	9	9	2848	117
12a	←	←	←	←	25	45	9	29	3758	103
13a					45	45	29	29	4643	84.8
14a					45	65	29	49	5528	75.7
15a	→	→	→	→	45	85	29	69	6413	70.3
16a	5x5	20x20	24	16	65	65	49	49	6388	65.6

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar cortes

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #										
Preparer	MLK	6-19-84								
Checker	C.P.	6.19.84								

1½" Φ BOLT GROUP

TYPE	PL SIZE	SPACING (IN)	DEPTH OF SLAB (h)	DEPTH OF EMBED (ld)	a	b	a+2ld-2h = a'	b+2ld-2h = b'	$A_c = \pi l_d^2 + a.b + 2l_d(a+b) - a'.b' - nA$ SQ IN	$P_{uo} = 0.16438 A_c / n$
1b	6x6	10x10	33	22	16	16	0	0	3041	125.0
2b	6x6	10x10	33	22	26	16	4	0	3569	97.8
3b	6x6	10x10	33	22	26	26	4	4	4145	75.7
4b	6x6	10x10	33	22	36	26	14	4	4697	64.3
5b	6x6	10x10	33	22	46	26	24	4	5249	57.5
6b	6x6	10x10	33	22	36	36	14	14	5213	53.6

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.s IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 10

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	CP	6.18.84								
Checker	MLK	6.20.84								

1½" Φ BOLT GROUP

TYPE	Φ SIZE	SPACING (IN)	DEPTH OF SLAB (h)	DEPTH OF EMBED (ld)	a	b	a+2ld-2h = a'	b+2ld-2h = b'	$A_c = \pi l_d^2 + a \cdot b + 2l_d(a+b) - a' \cdot b' - nA$	$P_{ua} = 0.16438 A_c/n$
11a	5×5	20×20	33	16	25	25	0	0	2929	120
12a	↕	↕	↕	↕	25	45	0	11	4019	110
13a	↕	↕	↕	↕	45	45	11	11	5363	98
14a	↕	↕	↕	↕	45	65	11	31	6608	90.5
15a	↕	↕	↕	↕	45	85	11	51	7853	86
16a	5×5	20×20	33	16	65	65	31	31	7828	80

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.'S IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 11

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Preparer	C.P.	6.1984								
Checker	MLK	6.20.84								

1½" Φ BOLT GROUP

TYPE	PL SIZE	SPACING (IN)	DEPTH OF SLAB (h)	DEPTH OF EMBED (ld)	a	b	a+2ld-2h = a'	b+2ld-2h = b'	Ac = π ld² + a.b + 2ld(a+b) − a'.b' − nA	Pua = 0.16438 Ac/n
11b	6x6	20x20	33	22	26	26	4	4	4325	178
12b	↑	↑	↑	↑	26	46	4	24	5573	153
13b					46	46	24	24	6785	124
14b					46	66	24	44	7997	109.5
15b	↓	↓	↓	↓	46	86	24	64	9209	101
16b	6x6	20x20	33	22	66	66	44	44	9173	94

Checking Method #

1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.S IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 12

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #										
Preparer	MLK	6-18-84								
Checker	C.P	6.19.84								

2"Φ A.BOLT GROUP

TYPE	PL SIZE	SPACING (IN)	DEPTH OF SLAB (h)	DEPTH OF EMBED (ld)	a	b	a+2ld-2h = a'	b+2ld-2h = b'	$A_c = \pi l_d^2 + a.b + 2l_d(a+b) - a'.b' - nA$	$P_{ua} = 0.16438 A_c/n$
1C	7x7	10x10	33	23	17	17	0	0	3326	136.4
2C	↓	↓	↓	↓	27	17	7	0	3851	105.5
3C	↓	↓	↓	↓	27	27	7.	7.	4385	80.1
4C	7x7	10x10	33	23	37	27	17.	7.	4898	67.10
5C	↓	↓	↓	↓	47	27	27	7	5410	59.3
6C	7x7	10x10	33	23	37	37	17	17	5362	55.10

Checking Method #

1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULL-OUT CAPACITY OF A.B.s IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 13

Revision	1	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Preparer	C.P.	6.19.84								
Checking Method #										
Checker	MLK	6.20.84								

2" Φ A.B GROUP

TYPE	PL SIZE	SPACING (IN)	DEPTH OF SLAB (h)	DEPTH OF EMBED (ld)	a	b	a+2ld-2h = a'	b+2ld-2h = b'	$A_c = \pi l_d^2 + a.b + 2l_d(a+b) - a'.b' - nA$	$P_{ua} = 0.16438 A_c/n$ KIPS
11C	7×7	20×20	33	23	27	27	7	7	4630	190
12C	↓	↓	↓	↓	27	47	7	27	5852	160
13C	↓	↓	↓	↓	47	47	27	27	7025	128
14C	↓	↓	↓	↓	47	67	27	47	8198	112
15C	↓	↓	↓	↓	47	87	27	67	9371	103
16C	77	20×20	33	23	67	67	47	47	9322	96

Checking Method #

1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULLOUT CAPACITY OF A.BS IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 14

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	SSe	6/20/84								
Checker	MLK	6·20·84								

SUMMARY OF RESULTS
DEPTH OF WALL / SLAB = 33"

DIA	PL SIZE	20 x 20 PATTERN						10 x 10 PATTERN					
		4	6	9	12	15	16	4	6	9	12	15	16
1 1/2	5x5	120	110	98	90.5	86	80	77.6	63.3	51	45.2	41.6	39.7
1 1/2	6x6	178	153	124.	109.5	101.	94.	125	97.8	75.7	64.3	57.5	53.6
2"	7x7	190	160	128	112	103	96	136.4	105.5	80.1	67.1	59.3	55.1

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes.

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject CONC. PULLOUT CAPACITY OF ABS IN GROUPS

Calculation Number SRB-123C SET 5 Sheet No. 15

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1	X		X		X		X		X
Preparer	SC	6/20/84	.							
Checker	MLK	6-20-84								

SUMMARY OF RESULTS
DEPTH OF SLAB/WALL = 24"

DIA	PL SIZE	20×20 PATTERN						10×10 PATTERN					
		4	6	9	12	15	16	4	6	9	12	15	16
1 1/2	5×5	117	103	84.8	75.7	70.3	65.6	77.6	63.3	49.7	42.8	38.7	36.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes.

F-166, 7-82

PRELIMINARY

~~PRELIMINARY~~

Communications Report SSe

Company: ☒ Telecon ☐ Conference Report

Project: CPSES IAP PHASE 3 — Job No. 84042

Date: 6/12/84

Subject: PIPE SUPPORT QUESTIONS — Time: 2:00

Place: SITE

Participants:

~~ED BEEKOR~~ of GIBBS + HILL

J. MINICHIELLO of CYGNA

of

Item	Comments	Req'd Action By
	In reviewing ~~the~~ TUGCO response to item 23 (5/24/84 telecon), Cygna needed to verify how the allowable loads ~~are~~ ~~were~~ were developed. Cygna, therefore, asked Gibbs and Hill the following: 1) Is there a calculation developing the allowable ultimate pullout load/bolt for 9 or 12 bolt groups with 20 inch spacing. If so, please provide it ~~and to~~ ~~that~~ to justify the 50% reduction noted in GTN 41315	

SSe

TDH advance EDB JM.

RECEIVED BY TELECOPIER ... FLOOR

6/12 DATE 3:30 PM TIME

INITIATED

Date: 6-18-84 Calc. by: SSe

Chk'd & Appr. by: MLK/6-2?

Subject: CONC. PULL-OUT CAPACITY OF A.B. IN GROUPS

Filing Code: SRB-123C SET 5 Rev: 0

Sheet No. 16

G&H Job No. 2323

Signed: Page of 2

Distribution:

CYGNA

Communications Report

Company:	☐ Telecon
	☐ Conference Report
Project:	Job No.
	Date:
Subject:	Time:
	Place:
Participants:	of
	of
	of

Item	Comments	Req'd Action By
	2) Is there a calculation for the same group based on a 10" spacing. Please provide. 3) What thickness wall is needed in these calculations to develop the calculated load in the concrete. 4). What justification or calculation does Gibbs and Hill have for the Richmond Insert ~~load~~ loads presented in GTN 6/677. Cygna requested response no later than 6/18 to meet the phase 3 schedule.	—

INITIATED
Date: 6-18-84 Calc. by: SSe
Chk'd & Appr. by: MLK/6-20-84
Subject: CONC. PULL-OUT CAPACITY OF A.B.'s IN GROUPS
Filing Code: SRB-123 SETS Rev: 0
Sheet No. 17
G&H Job No. 2323

Signed: Page 2 of 2

Distribution:

Gibbs & Hill, Inc.	Job No. 2323	Client TUGCO
Subject CONC. PULLOUT CAPACITY OF A.BS IN GROUPS		
Calculation Number SRB-123C SET 5	Sheet No. 18	

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1									
Preparer	SSC	6/20/84								
Checker	MLK	6·20·84								

CONCLUSION: PULLOUT CAPACITY AS GOVERNED BY CONCRETE, USE 50 % OF THE MAXIMUM ULTIMATE TENSILE CAPACITY (REF 1 ITEM 2) WHERE 4 OR MORE BOLTS IN A GROUP ARE USED BUT NOT TO EXCEED FOR

(a) $1\frac{1}{2}$" ϕ BOLTS — 9 IN A GROUP

(b) 2" ϕ BOLTS — 6 IN A GROUP.

SRB-123C

Date: AUG. 1978
Calc By: P. K. BANERJI
Chk'd/Apprd. By: S. Sengupta

Gibbs & Hill, Inc.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

1/1

Filing Code: ....
Sheet No. 1 of ......
G & H Job No.: 2323

Subject: TUSI : PIPE WHIP RESTRAINT
Ref. Dwg./Spec. No. ....

CONNECTION DESIGN

"Nuclear Safety Related"

(1) ANCHOR BOLTS:

ASTM A 320 BOLTS

$f_{ut} = 125$ ksi $\quad f_y = 105$ ksi

$f_t = 47$ ksi for Elastic Design

(A) AREA: Use tensile area of bolt

A_t = Tensile Area of $1\frac{1}{2}"\phi$ bolt $= 1.49\ in^2$

$2"\phi$ bolt $= 2.77\ in^2$

$2\frac{1}{2}"\phi$ bolt $= 4.44\ in^2$

(B) TENSILE CAPACITY:

Connection capacity in tension is governed by one of the following types of failures:

(i) Tensile Capacity of Bolt
(ii) Pull-out Strength of Concrete
(iii) Anchorage Capacity based on bearing stress of Anchor Plate.

Use the lowest value for design purpose.

(i) TENSILE CAPACITY OF BOLT: (F_t)

Assume $2"\phi$ A320 Bolt : $A_t = 2.77\ in^2$

Allowable stress: either $0.9 f_y = 0.9 \times 105 = 94.5$ ksi

or $1.6 f_t = 1.6 \times 47 = 75.2$ ksi (GOVERNS)

∴ Tensile Capacity $= A_t \times (1.6 f_t) = 2.77 \times 75.2 = 208^K$

(ii) PULL-OUT STRENGTH OF CONCRETE:

For details, See sheets 2 thru 5

(iii) ANCHORAGE CAPACITY: Limiting bearing Stress on Concrete = 4 ksi

Diam of Hole in Anchor plate for $2"\phi$ Anch. Bolt = $2\frac{1}{4}"$

Assume $2" \times 8" \times 8"$ Anchor Pl.

∴ Net Area of Anch. Pl. $= (8 \times 8 - \pi/4 \times 2.25^2) = 60\ in^2$

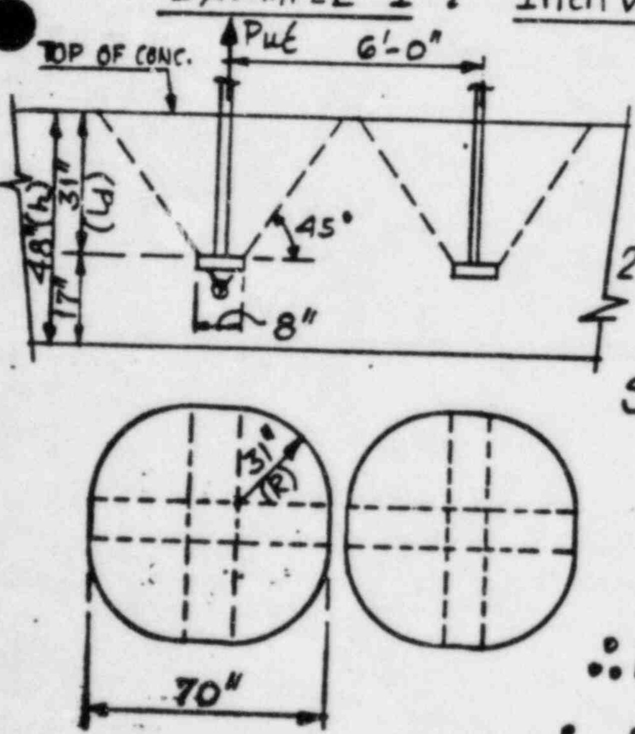
∴ Anchorage Capacity = Net Area × Bearing Stress $= 60 \times 4 = 240^K$

To prevent failure due to lateral bursting forces (tensile loading) at an anchor head, side cover (Edge) distance shall not be less than the following:

- $1\frac{1}{2}''\phi$ bolt = 9"
- $2''\phi$ bolt = 12"
- $2\frac{1}{2}''\phi$ bolt = 15"

(ii) CAPACITY AS GOVERNED BY CONCRETE :

EXAMPLE 1 : Individual Stress Cone :



(Unlimited Thickness. Apex of shear cone inside slab depth)

4'-0" thick slab ($f_c' = 4000$ psi)

2"ϕ A320 Bolts spaced at 6'-0" c/c both ways.

Depth of Embedment = 31"

Size of Anchor Pl. = 2"×8"×8" (A588, Fy=50)

Effective stress Area Ae

= (Projected Area of Stress Cone) - (Area of Anch. Pl.)

$\therefore A_e = [\pi \times (31)^2 + 4\times31\times8 + 8\times8] - 8\times8$

$\therefore A_e = 4075 - 64 = 4{,}011 \text{ in}^2$

$\therefore$ Pull-out Load = Tensile Stress × Eff. Area

$= (4\phi\sqrt{f_c'}) \times A_e$

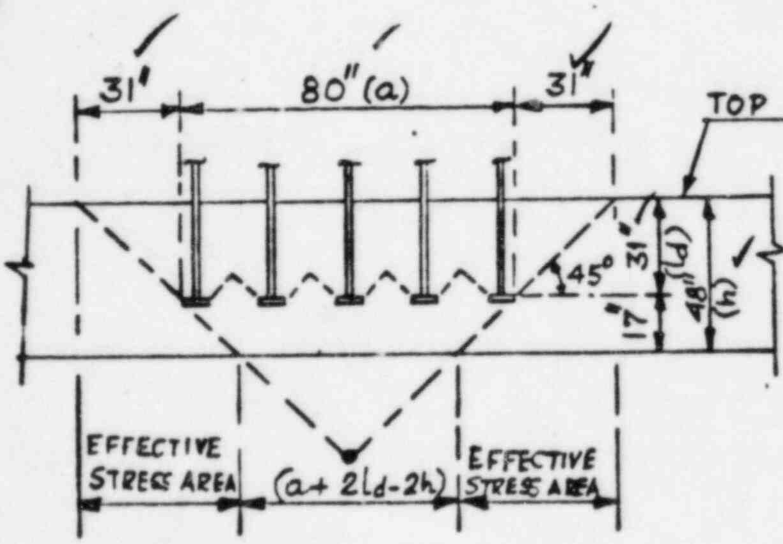
$\phi = 0.65$

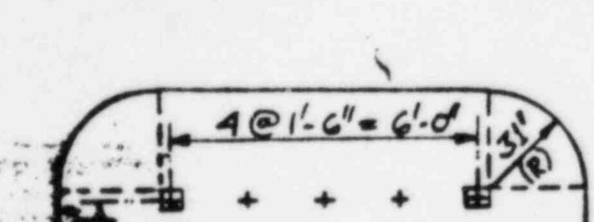
$\therefore$ Pull-out Load $= (4\times0.65\times\sqrt{4000})\times 4011 = 659^k$

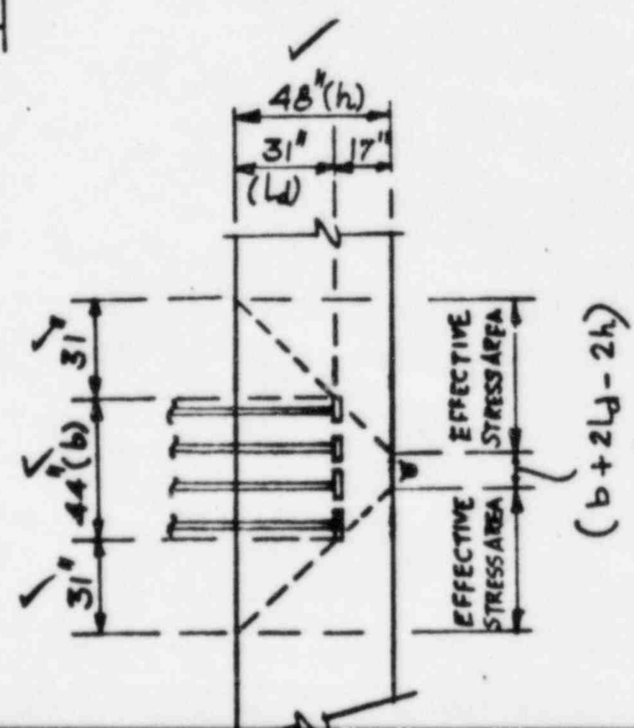
NOTE:
BOLT CAP. = 208^K
PULL-OUT CAP. = 659^K
ANCHORAGE CAP. = 240^K

∴ Tensile Cap. of Bolt controls.

EXAMPLE 2: Overlapping Stress Cones.
(Limited Thickness.
Apex of Group shear cone OUTSIDE slab depth)
2"φ Bolts @ 1'-6" & 1'-0" c/c
other data same as Example 1







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Eff. Stress Area Ae = (Projected Area of Stress Cone) - (Area reduction for Limited depth) - (Total bearing area for Anchor PL)

$$\therefore A_e = \left[\pi \times (31)^2 + 2\times 80\times 31 + 2\times 44\times 31 + 80\times 44\right] - \left[(80+2\times 31-2\times 48)\times(44+2\times 31-2\times 48)\right] - \left[20\times 8\times 8\right]$$

$$\therefore A_e = 14227 - 460 - 1280 = 12{,}487 \text{ in}^2$$

$$\therefore \text{Pull-out Load (Group Load)} = 4\phi\sqrt{f_c'} \times A_e$$

$$= 4\times 0.65\sqrt{4000}\times 12487 = \underline{2{,}053^K}$$

$$\therefore \text{Load per bolt} = \frac{2053}{20} = \underline{102^K}$$

NOTE:

BOLT CAP. = 208^K

PULL-OUT CAP. = 102^K

ANCHORAGE CAP. = 240^K

∴ Pull-out capacity controls.

SRB-123C

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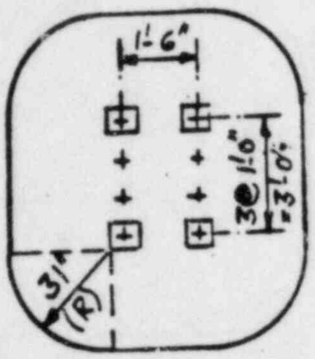
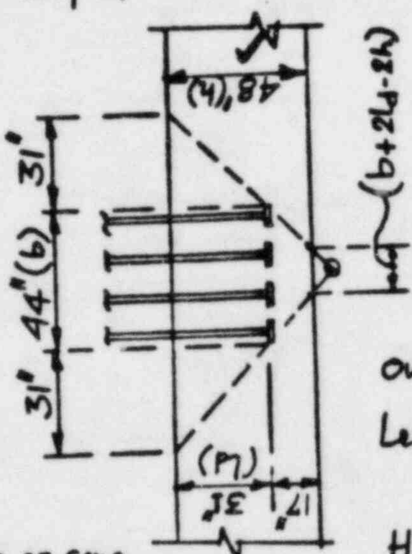
Chk'd/Apprd. By S. Sengupta

Subject I.D.S.T.: PIPE WHIP RESTRAINT — Ref. Dwg./Spec. No. ....

EXAMPLE 3 :- overlapping Stress Cones - (Limited Thickness. Apex of Group Shear Cone INSIDE Slab depth in one direction and OUTSIDE Slab depth in other direction.)

2" φ Bolts @ 1'-6" & 1'-0" c/c. Other data same as Example 1



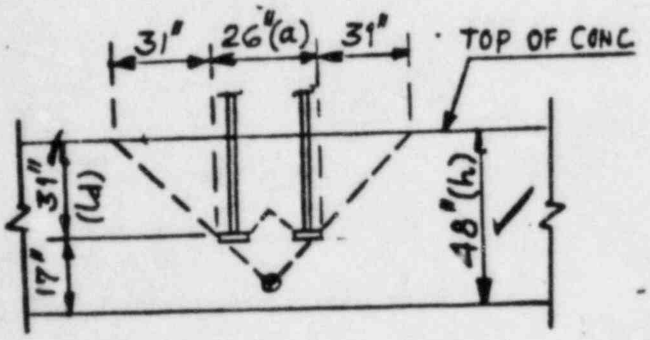


Apex of shear cone falls outside in one direction only. Length (b+2ld-2h) is small.

$b + 2l_d - 2h = 44 + 2\times31 - 2\times48 = 10"$

Hence this is neglected in this case.

∴ As a conservative measure, it will be assumed that apex of stress cones falls INSIDE in both directions.



Eff. stress area computation similar to Example 2.

$$A_e = \left[\pi\times(31)^2 + 2\times26\times31 + 2\times44\times31 + 26\times44\right] - (8\times8\times8)$$

$$\therefore A_e = 8503 - 512 = 7991 \text{ in}^2$$

Pull-out Load (for Group) $P'_{uc} = 4\times0.65\sqrt{4000}\times7991 = 1314^K$

$$\therefore \text{Load/bolt} = \frac{1314}{8} = 164^K$$

NOTE: BOLT CAP. = 208^K; PULL-OUT CAP. = 164^K ∴ Pull-out capacity controls.

C) SHEAR CAPACITY: (FOR ANCHOR BOLTS)

Connection capacity in shear as governed by concrete (V'_{uc}) will be computed using shear friction concept: $V'_{uc} = \phi f_y \mu A_{vf}$ ✓

$\phi = 0.85$ ✓
$f_y = 105$ ksi ✓
$\mu = 0.55$ ✓
A_{vf} = Tensile Area of Anchor Bolt

DIAM. (IN)	TENSILE AREA A_{vf}	V'_{uc} (KIPS)
1½	1.49	73 ✓
2	2.77	136 ✓
2½	4.45	218 ✓

For full development of shear strength of Anchor Bolts to control design, side cover (edge) distance toward a free edge shall not be less than the following:

1½"φ bolt = 24" ✓
2" φ bolt = 32" ✓
2½"φ bolt = 40' ✓

If side cover (edge) distance is less than as specified above, ultimate concrete shear strength (V'_{uc}) have to be reduced.

To prevent side blow out cone failures and loss of anchorage, minimum side cover (edge) distance toward a free edge shall not be less than the following:

1½"φ bolt = 8" ✓
2" φ bolt = 10½" ✓
2½"φ bolt = 13" ✓

(D) COMBINED TENSION & SHEAR:

(i) ANCHOR BOLT AREA: Compute Anchor Bolt area required for tension & shear separately and then add for Combined effect.

EXAMPLE: Allow. stress for anchor bolt = $0.9 F_Y = 0.9 \times 105 = 94.5$ Ksi

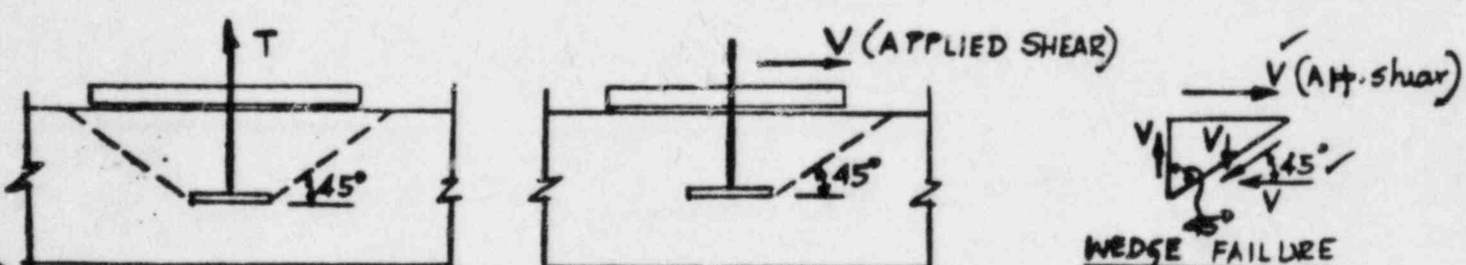
OR $1.6 f_t = 1.6 \times 47 = 75.2$ Ksi (GOVERNS)

Area reqd for Tension $= A_t = \dfrac{T}{1.6 f_t}$

Area reqd for Shear $= A_v = \dfrac{V}{\phi f_y \mu}$

$\therefore \Sigma A_{reqd.} = (A_t + A_v) \leq$ Area of Anch. Bolt

(ii) MINIMUM CAPACITY: Effect due to Axial Tension and/or Tension due to moment and Shear in a bolt or a group of bolts shall be added. This should not exceed the minimum capacity as governed by bolt or concrete pull-out or anchorage capacity (See sh. 1)



WEDGE FAILURE DUE TO SHEAR

Tension in bolt due to shear = Applied Shear V

$\therefore T + V \leq$ MINIMUM CAPACITY AS GOVERNED BY BOLT OR CONC. PULL-OUT OR PL. BEARING. (See Sheet 1)

NOTE ON DETERMINATION OF PULL-OUT CAPACITY:
(DUE TO COMBINED TENSION & SHEAR)

For computing Pull-out Load of concrete, due care must be exercised in evaluating effective stress area A_e as shown on Pages 2 to 5.

When a base section is subjected to moment & shear, determine the tension due to moment ONLY FOR THOSE BOLTS IN THE GROUP which are assumed to be effective. The tension due to shear is assumed to be resisted equally by all bolts in the ENTIRE group.

If the magnitude of tension per bolt due to moment is large compared to tension due to shear, effective stress area A_e will be computed only for those bolts in the group subjected to both tension & shear and NOT for the entire group of bolts.

However, if the tension per bolt due to shear is high compared to tension per bolt due to moment then the ENTIRE group of bolts to be used in computing effective stress area A_e for pull-out.

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(2) 1"ϕ & 1½"ϕ CONCRETE INSERTS: (RICHMOND SCREW ANCHOR)

1"ϕ Insert : Type EC2 & EC2W

1½"ϕ Insert : Type EC6 & EC6W

Richmond Inserts will be used with A325 bolts. unless noted otherwise.

(A) AREA: Use Tensile Area of Bolt: 1½"ϕ Bolt with 6 threads/inch: $A_t = 1.405 \text{ in}^2$; 1"ϕ Bolt with 8 threads/inch: $A_t = 0.606 \text{ in}^2$

NOTE: 1½"ϕ Bolts with 8 threads/inch ($A_t = 1.49 \text{ in}^2$) will NOT be used as standard. If this is required for design, proper reference must be made in the drawing such as 1½"ϕ Bolts with 8 threads/inch.

(B) TENSILE CAPACITY:

Capacity in tension (P_{uc}') is governed by one of the following three types of failures:

(i) Tensile capacity of Insert
(ii) Tensile capacity of A325 bolt
(iii) Pull-out strength of Concrete

Use the lowest value for design purpose.

(i) Tensile Capacity of Inserts:

From Laboratory Test data and results as supplied by Richmond Screw Anch Co. (Bulletin # 6, dated 1972):

Tensile Capacity of 1"ϕ Type EC-2 Inserts = 24.6^K

Allowable Tensile Capacity = $0.9 \times 24.6 = 22^K$

Tensile Cap. of 1½"ϕ Type EC-6 Insert = 64.5^K

Allowable Tensile Capacity = $0.9 \times 64.5 = 58^K$

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NOTE : $F_{insert} = 58^K$

$F_{bolt} = 90^K$

∴ Pull-out Cap. $= 50^K$

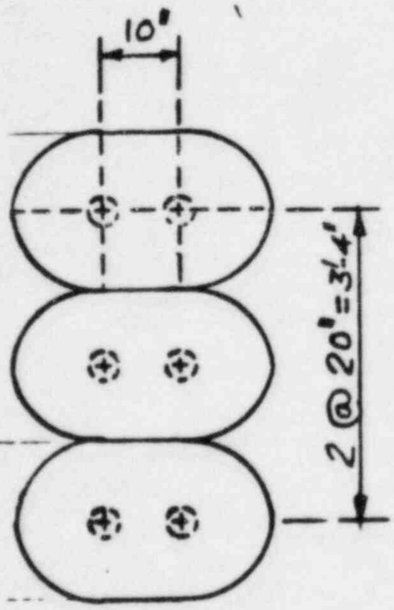
∴ Pull-out of Conc. Controls.

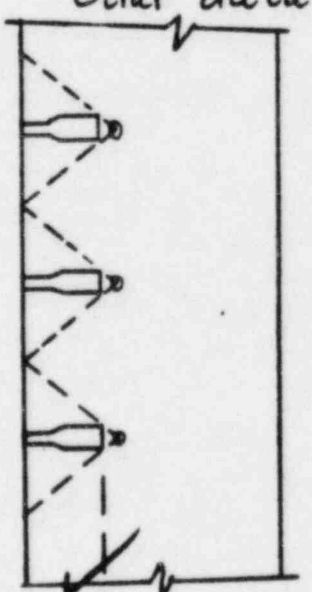
Minimum spacing for development of full shear cones = $22\frac{1}{4}''$
(Overlapping of cones @ 20" c/c is very little. It is neglected.)

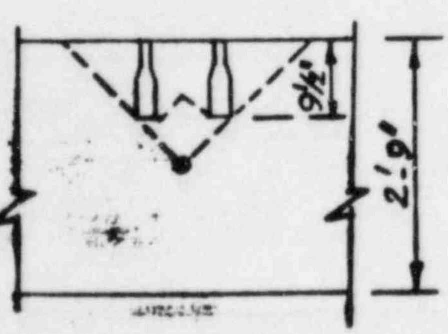
EXAMPLE 2: overlapping stress cones in one direction only.
(Apex of shear cone inside slab depth)

$1\frac{1}{2}''\phi$ Inserts @ 10" & 20" c/c

Other data same as Example 1.







Configuration of stress cones as shown.

Effective Stress Area

$A_e = \left[\pi \times (10)^2 + 20 \times 10\right] - \frac{\pi}{4} \times (3.25)^2 \times 2$

$A_e = 514 - 16 = 498 \text{ in}^2$

Pull-out Load $= 4\phi\sqrt{f_c'} \times A_e$

$= 4 \times 0.65 \times \sqrt{4000} \times 498$

$= 82^K$

∴ Load per Insert $= \frac{82}{2} = 41^K$

∴ Pull-out of Concrete Controls.

SRB-123C

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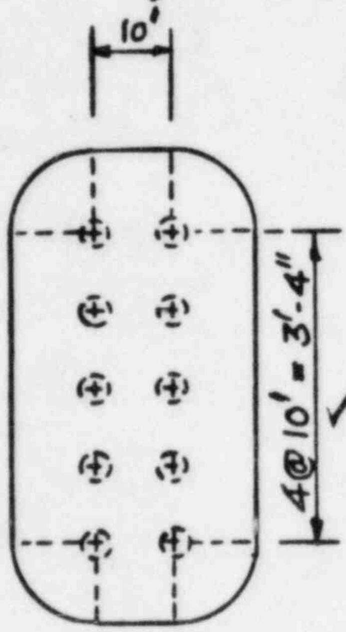
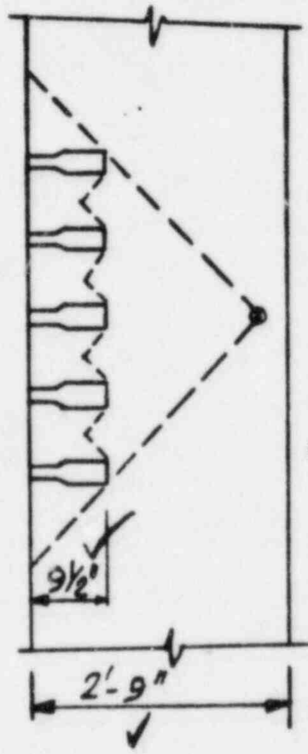
EXAMPLE 3: Overlapping of stress cones in both directions. (Apex of shear cone inside slab depth)

$1\frac{1}{2}''\phi$ Inserts @ 10" c/c bothways

Other data same as Example 1.





Effective Stress Area

$$A_e = \left[\pi \times (10)^2 + 2\times10\times10 + 2\times40\times10 + 40\times10\right] - 10\times\frac{\pi}{4}\times(3.25)^2$$

$$A_e = 1714 - 83 = 1631 \text{ in}^2$$

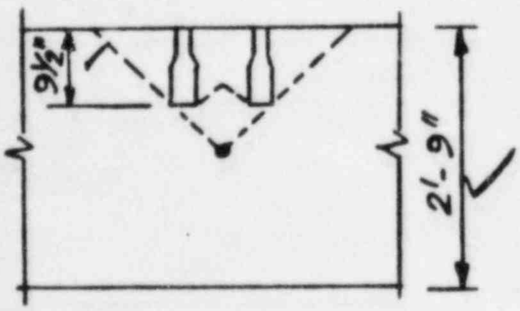
∴ Pull-out Capacity

$$= 4\times0.65\times\sqrt{4000}\times1631$$

$$= 268^K$$

∴ Load per Insert $= \frac{268}{10} = \underline{27^K}$

∴ Pull-out of Concrete controls.



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1/13
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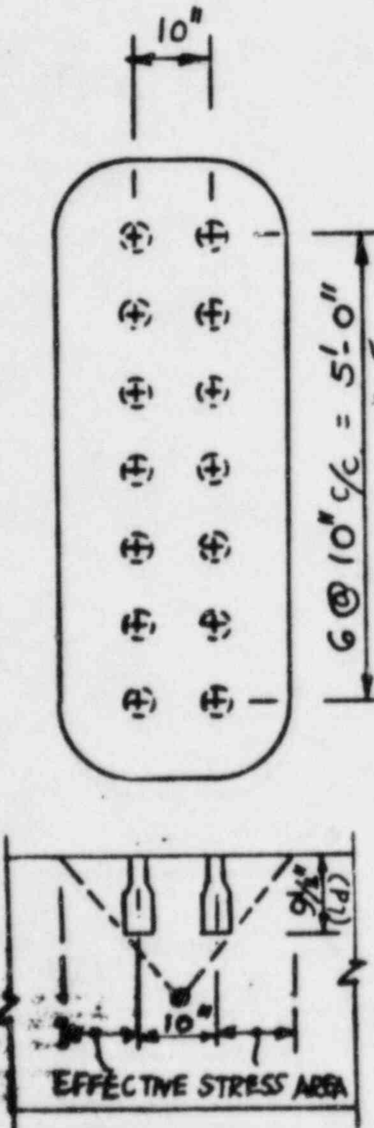
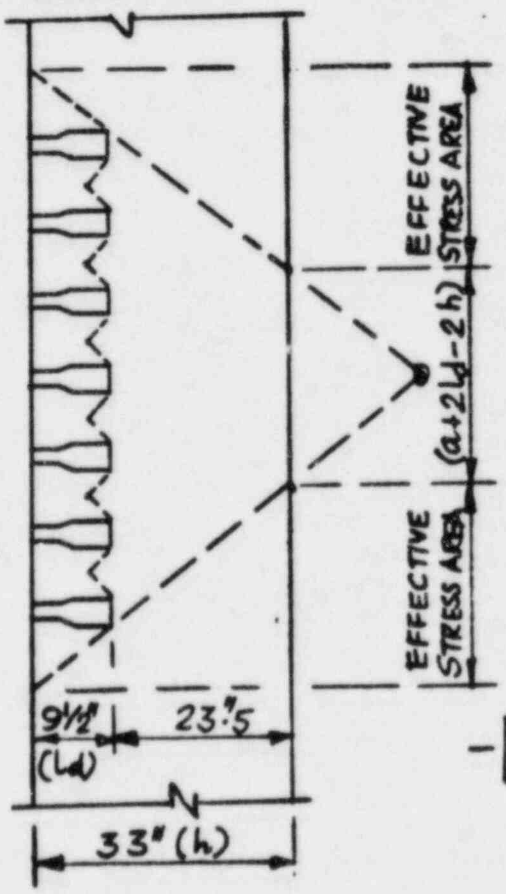
Sheet No. 13 of
G & H Job No. 2323
Subject TUSI: PIPE WHIP RESTRAINT
Ref. Dwg./Spec. No.

EXAMPLE 4: overlapping of Stress Cones in both directions (Limited Thickness. Apex of shear cone inside slab depth in one direction & outside slab depth in other direction)

1½"φ Inserts @ 10' c/c bothways.

Other data same as Example 1.





NOTE: As a conservative measure, it will be assumed that apex of stress cones falls INSIDE in both directions. Assumptions for eff. stress area computation similar to Example 3 of Anchor Bolt.

$A_e = [\pi \times (10)^2 + 2 \times 10 \times 10 + 2 \times 60 \times 10 + 60 \times 10] - [14 \times \pi/4 \times (3.25)^2]$ (REV. 3: ~~1.5~~ → 3.25)

$\therefore A_e = 2314 - 116 = 2198 \text{ in}^2$

$\therefore P'_{uc} = 4 \times 0.65 \times \sqrt{4000} \times 2198 = 361^K$

$\therefore$ Load per Insert $= \frac{361}{14} = 25^K$

$\therefore$ Pull-out of concrete controls.

PREP. BY Vapiwala	REV.
DATE 4-11-83	
CHKD. BY P.K. Banerjee	3
DATE 4/6/83	
CHECK METHOD 1	

(C) SHEAR CAPACITY:

Connection capacity in shear (V_{uc}') is governed by one of the following:

(i) Shear capacity of Insert
(ii) shear Capacity of A 325 Bolt.
(iii) Shear capacity of Concrete

] Use the Lowest value for design purpose.

NOTE: To increase shear capacity, A 490 bolts may be used in place of A 325 bolts

(i) Shear Capacity of Inserts:

From Laboratory Test data and results as supplied by Richmond Screw Anchor Co. (Bulletin # 6 dated 1975)

Shear strength of $1\frac{1}{2}"\phi$ Type EC-6 Insert (Safety factor 3:1) $= 3 \times 18 \times 0.9 = \underline{48.6^K}$

Shear strength of $1"\phi$ Type EC-2 Insert $= 3 \times 8 \times 0.9 = \underline{21.6^K}$

(ii) Shear Capacity of A-325 bolts: Design as per F.S.A.R. & A.I.S.
Use Tensile area of Bolt (Threads NOT excluded from shear plane)
Yield stress for $1\frac{1}{2}"\phi$ bolt = 81 KSI, Yield stress for $1"\phi$ bolt = 92 KSI

Allowable shear stress $= 0.5 F_Y = 0.5 \times 81 = 41$ KSI
OR $15 \times 1.6 = 24$ KSI (GOVERNS)

Shear Capacity of $1\frac{1}{2}"\phi$ bolt $= 1.405 \times 24 = \underline{33.7^K}$

(iii) SHEAR CAPACITY AS GOVERNED BY CONCRETE :

- Ultimate concrete shear strength will be assumed to be equal to Ultimate Concrete Pull-out strength P'_{uc} provided side cover (edge) distance toward a free edge is at least 1'-10" for 1½"φ Insert and 1'-4" for 1"φ Insert.

If side cover (edge) distance is less than as specified above, ultimate Concrete Shear strength have to be reduced.

(D) COMBINED TENSION & SHEAR :

$$\left[\frac{P_u}{P'_{uc}}\right]^{4/3} + \left[\frac{V_u}{V'_{uc}}\right]^{4/3} \leq 1$$ ✓

P_u = Actual Tensile force on Insert connection

V_u = Actual Shear applied to connection

P'_{uc} = Minimum Tensile capacity as governed by Insert or structural bolt or pull-out of Concrete (See sheet 9)

V'_{uc} = Minimum Shear capacity as governed by Insert or Struct bolt or Concrete. (See sh. 14)

EXAMPLE ON COMBINED TENSION & SHEAR:

$P_u = 15^K$ (assumed)

$V_u = 10^K$ (assumed)

Assume further that this load is being applied on an insert group as shown in Page 12

$\therefore P'_{uc} = V'_{uc} = 27^K$

$$\left[\frac{P_u}{P'_{uc}}\right]^{4/3} + \left[\frac{V_u}{V'_{uc}}\right]^{4/3} < 1.0$$

$$\therefore \left(\frac{15}{27}\right)^{4/3} + \left(\frac{10}{27}\right)^{4/3} = 0.46 + 0.27 = \underline{0.73} < 1.0$$

CHECK BOLT FOR COMBINED TENSION & SHEAR:

A 325 bolt
SEE PAGE 10 & PAGE 14

Allowable Tensile stress = 64 ksi

Allowable Shear stress = 24 ksi (Threads not excluded)

$1\frac{1}{2}''\phi$ A 325 bolt, Tensile Area = 1.405 in^2

$\therefore P_{us} = 1.405 \times 64 = 90^K$

$V_{us} = 1.405 \times 24 = 33.7^K$

$$\therefore \left[\frac{P_u}{P_{us}}\right]^2 + \left[\frac{V_u}{V_{us}}\right]^2 \leq 1.0$$

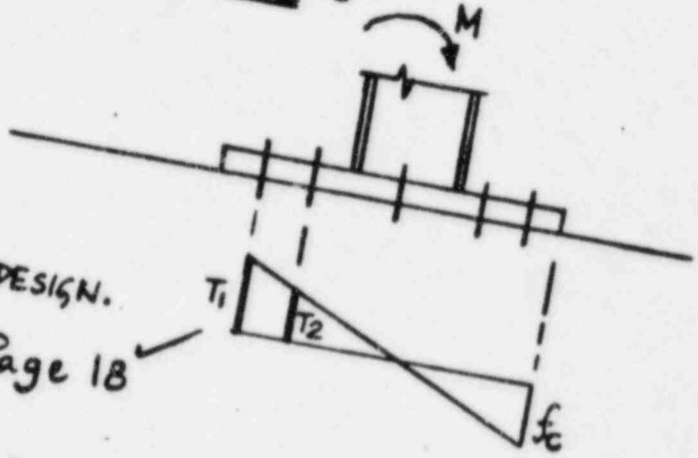
$$\therefore \left(\frac{15}{90}\right)^2 + \left(\frac{10}{33.7}\right)^2 = 0.03 + 0.09 = 0.12 < 1.0$$

O.K.

(3) **COMPUTATION OF APPLIED TENSILE LOAD ON INSERTS & ANCHOR BOLTS:**

(i) APPLIED MOMENT ONLY:

Compute tensile load on Bolts T_1 & T_2 and concrete compressive stress by ELASTIC DESIGN. For details, See example on Page 18



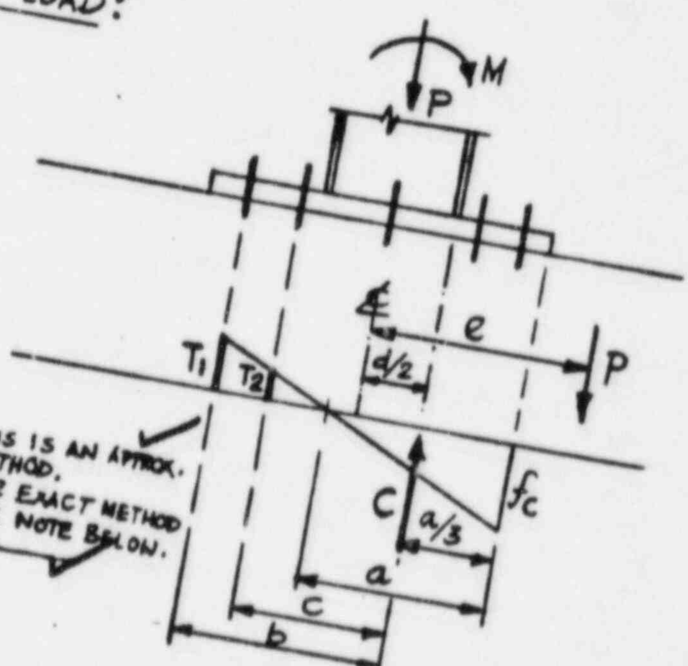
(ii) APPLIED MOMENT & COMPRESSIVE LOAD:

Compute tensile load on Bolts T_1 & T_2 and Concrete compressive stress by ELASTIC DESIGN. Design similar to example on Page 18 with the following exceptions:

(a) Concrete compressive stress resultant lies directly below compression flange. THIS IS AN APPROX. METHOD. FOR EXACT METHOD SEE NOTE BELOW.

$$C = P + (T_1 + T_2)$$

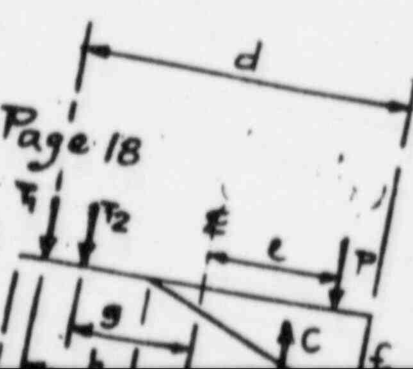
$$P(e - d/2) = T_1 \times b + T_2 \times c$$



...n design similar to example on Page 18

...xact Method for App. Mom. & Compr. Load: Eccentricity greater than D/6

$+ (T_1 + T_2)$
$b = c$
$T_2 \times g) + C(D/2 - n/3) = P \times e$
$T_1 = A_{s_1} \times f_{s_1}$
$T_2 = A_{s_2} \times f_{s_2}$
...n diag: $f_{s_1} = \frac{8 f_c}{n}(d-n)$ THIS WILL FINALLY REDUCE TO A CUBICAL EQUATION OF ...



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G & H Job No. 2323
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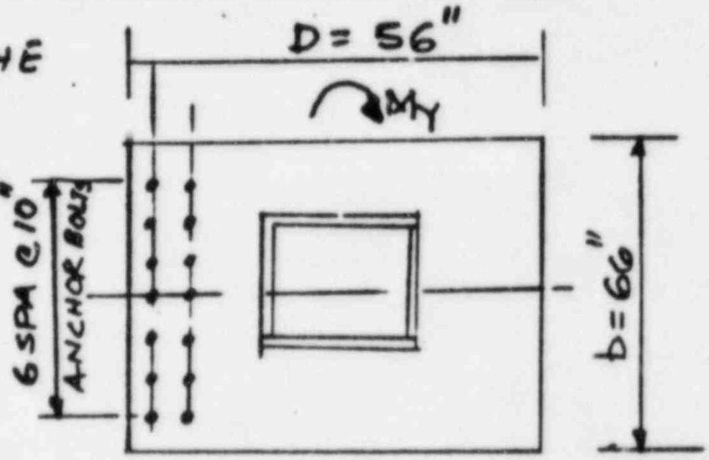
Ref. Dwg./Spec. No. ...

CONNECTION DESIGN WITH ANCHOR BOLTS.

TO FIND FORCES IN BOLTS DUE TO MOMENT.



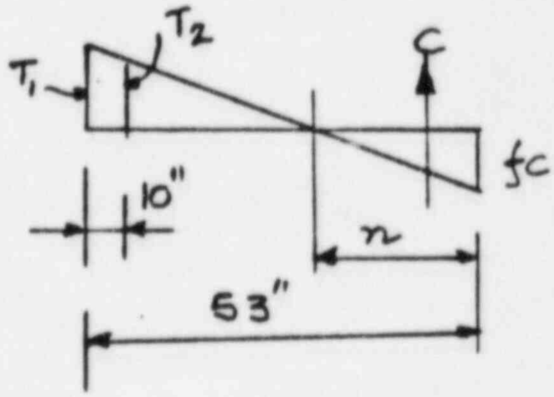
EQUATING MOMENTS OF THE AREAS TO FIND N.A.

$$66\frac{n^2}{2} = 8 \times 7 \times 2.77 \times [(53-n)+(48-n)]$$

(8 = MODULAR RATIO; 2.77 = AREA OF A.B.)

SOLVING $n = 17.1''$ ✓

TO FIND THE CENTROID OF FORCES T_1 & T_2.



$$T_1 \propto \frac{d-n}{n} f_c = \frac{53-17.1}{17.1} f_c$$ ✓

$$= 2.1\, f_c$$ ✓

$$T_2 \propto \frac{d-n-10}{n} f_c = \frac{43-17.1}{17.1} f_c$$ ✓

$$= 1.52\, f_c$$ ✓

$$\bar{x} \text{ FROM } T_1 = \frac{1.52 f_c \times 10}{2.1 f_c + 1.52 f_c} = 4.2''$$

TAKING MOMENT ABOUT THE CENTROID OF T_1 & T_2

$$C\left[53 - \frac{17.1}{3} - 4.2\right] = 3000 \times 12$$

(3000 = M_Y ASSUMED.)

$$C = \frac{3000 \times 12}{43.1} = 835.26\ \text{K.}$$

$$C = \frac{1}{2} f_c\, b\, n \qquad f_c = \frac{835.26 \times 2}{66 \times 17.1} = 1.48\ \text{KSI}$$

$< 0.45 f_c$

O.K.

MAVivirito, JLEichler/CMJan, ELBezkor/AMKenkre, HWMentel, PTHuang, SMMarano/077, REBallard, TDHawkins/HMLapinig, OUTGOING

Telecopy to (1) Nancy Williams CYGNA
(2) George Grace @ CPSES

Rev. 6/27 NW

Domestic: 127636/968694
International: 428813/234475
A Dravo Company

Distribution
N. Williams
L Weingart
J. Minichiello
84042 File
M. Shulman
G. Bjorkman

June 26, 1984

GTN- 69162

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George
Vice President/Project Gen. Mgr.

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
G&H PROJECT NO. 2323
PROPOSED MASS PARTICIPATION
FRACTION SENSITIVITY STUDY

By copy of this letter to Nancy Williams of CYGNA, attached is Gibbs & Hill's proposed plan of action regarding the Mass Participation Fraction Sensitivity Study. This plan is additional work by way of follow-up on the initial response on seismic analysis of piping presented in GTN-69098 dated June 11, 1984.

Should you have any questions or comments regarding the proposed plan contact Henry W. Mentel.

Very truly yours,

GIBBS & HILL, Inc.

S M Marano

Robert E. Ballard, Jr.
Project Manager

HWM

REBa-HWMe:lc
1 Letter + 1 Attachment
CC: ARMS (B&R Site) OL + 1A
N. Williams (CYGNA, Calif.) 1L 1A
G. Bjorkman (CYGNA, Boston) 1L 1A
G. Grace (CPPE Site) 1L 1A
D. Wade (CPPE Site) 1L 1A

Dravo

CYGNA	703
JOB NO.:	84042
DATE LOGGED:	6/28/84
LOG NO.:	#92
FILE:	2.1.1 Inc. Cor
CROSS REF. FILE	2.1 Inc. Cor Log

SEISMIC ANALYSIS OF PIPING
EFFECT OF HIGHER ORDER MODES/MASS PARTICIPATION

PROPOSED MASS PARTICIPATION FRACTION SENSITIVITY STUDY

Gibbs & Hill presented its initial position regarding the effect of higher order seismic modes in a response to CYGNA Energy Services transmitted via GTN-69098 dated June 11, 1984. Based upon that response and following several discussions with CYGNA, Gibbs & Hill proposes the following plan of action:

1. An expanded explanation will be provided of the preliminary results of the mass participation survey conducted by Gibbs & Hill. In Gibbs & Hill's present response a simplified table of results indicating an average of 46.5 percent mass participation is presented. The basis for this and the means by which this number was arrived at will be expounded upon.

2. A selected number of stress problems will be re-analyzed. This re-analysis would be performed on a later version of ADLPIPE which accounts for the non-participating masses of the higher order modes. (Our present analysis is based upon versions 1C and 2C of ADLPIPE obtained from DIS/ADLPIPE, Inc., which has the program imposed limitation of not considering in the modal combination those modes exhibiting a deflection of less than .001 inch.) The selection and re-analysis would be done according to the following steps:

   a. The selection being based upon

      Problems presently exhibiting low mass participation fractions in all directions (x, y & z) as well as problems with isolated low fractions i.e., 'y' only.

      The selection being from various pipe sizes and piping systems.

      The selection covering a variety of buildings and elevations.

The selected problems being a mix of those which do and do not contain a seismic anchor movement load case.

b. The selected problem input data would remain as is except for necessary modifications to make them adaptable to the later version of ADLPIPE utilized.

c. The results of the re-analysis of the selected problems will be compared with the original as-built analysis.

To be compared would be:

Resulting Code equation stress levels

Support loads on the basis of individual load contributions as well as loading conditions i.e., normal, upset, emergency and faulted.

Participating modes and higher order modal deflections.

Equipment loads, where applicable.

3. Upon completion of the re-analysis a preliminary report will be made to CYGNA Energy Services. It will be at that time that Gibbs & Hill will be in a better position to ascertain whether additional work is required.

TUQ-2169

TEXAS UTILITIES GENERATING COMPANY

OFFICE MEMORANDUM

To: Dave Smedley — Glen Rose, Texas, June 7, 1984

Subject: Transmitting IR's

Attached are the copies of the Inspection Reports that you requested copies of:

BP-00258
BP-00341
ME-25096 ✓

On Inspection Report ME-25096, the original was not in the package at the time of your review, it was a copy of the IR.

The copy is still in the package along with the original which was closed on May 15, 1984.

We are also transmitting copies of the Master IR Log which shows the two BP reports to still be Unsat and open.

A. Vega
A. Vega
TUGCo Site QA Manager

AV/dl
cc: D.N. Chapman
D. Wade

Distribution
84042 PF
N. Williams
S.B.bO

CYGNA
JOB NO.: 84042
DATE LOGGED: 6/26/84
LOG NO.: #34
FILE: 2.1.1 Insc. IR
CROSS REF. FILE: 2.1 Insc. IR Log
11.1.1 Sect. [illegible] (# 166)

12-18-82

INSPECTION REPORT LOG

INSPECTION REPORT NUMBER	HANGER #	SYSTEM	BLDG. #	ROOM #	REPORT DATE	SAT	UNSAT	CLOSED DATE
~~BP00268~~ 338	HGH-X-AB-053-006-3	GH	AUX	243	12-1-82	✓		
↓	HGH-X-AB-053-007-3	GH	AUX	243	12-17-82	✓		
↓	HGH-1-AB-011-004-3	GH	AUX	243	12-17-82	✓		
↓	HGH-1-AB-011-001-3	GH	AUX	243	12-17-82	✓		
↓	HGH-X-AB-054-001-3	GH	AUX	243	12-17-82	✓		
BP00339	C1MSS19-1+2	NA	SG#1	?	12-9-82	✓	✓	2-20-83
BP00340	C1MS-S13-7+10	NA	SG#1	?	12-8-82	✓	✓	2-29-83
BP00341	C14K 30728	NA	SG#1	?	12-1-82	Transmitted SG PFG on 1-20-83 ✓	✓	1-20-83
BP00342	C13G17540-1	NA	SG#1	?	12-1-82	Transmitted SG PFG ✓	✓	↓
BP00343	C12G 18890-20	NA	RB1	?	12-13-82	✓	✓	6-14-83
BP00344	C12G 18890-33	NA	RB1	?	12-13-82	✓	✓	6-14-83
BP00345	CC2G 19428-1	NA	CNTL BLDG	?	12-2-82	✓	✓	2-18-83
BP00346	CC2G 19425-9	NA	CNTL BLDG	?	12-2-82	✓	✓	2-18-83
BP00347	C13G 19776-1	NA	CNTL BLDG	?	11-24-82	✓	✓	1-27-83
BP00348	C14K 30729-14	NA	SG#1	?	12-15-82	✓	✓	1-20-83
BP00349	C14K 30729-13	NA	SG#1	?	12-15-82	✓	✓	↓
BP00350	HGH-1-SB-005-003-5	GH	AUX	225	12-15-82	✓	✓	10-11-83
BP00351	HGH-1-SB-005-002-5	GH	AUX	225	12-15-82	✓	✓	12-17-83
BP00352	HGH-1-SB-005-001-5	GH	AUX	225	12-15-82	✓	✓	2-16-83
BP00353	HGH-1-AB-052-001-3	GH	AUX	225	12-15-82	✓	✓	1-20-83
BP00354	HGH-X-AB-017B-017-3	GH	AUX	225	12-15-82	✓	✓	1-27-83

INSPECTION REPORT LOG

INSPECTION REPORT NUMBER	HANGER #	SYSTEM	BLDG. #	ROOM#	REPORT DATE	SAT	UNSAT	CLOSED DATE
BP00247	HCS-2-AB-010-001-3	CS	AUX	215	12-13-82	✓	✓	1-8-83
BP00248	HCS1-AB-013-002-3	CS	AUX	215	12-13-82	✓	✓	5-4-83
BP00249	HCS1-AB-029-002-3	CS	AUX	215	12-13-82	✓	✓	2-24-83
BP00250	CS1-AB-029-001-3	CS	AUX	215	12-13-82	✓	✓	2-18-83
BP00251	CS2-032-001-AS3R	CS	AUX	215	12-13-82	✓	✓	12/30/82
BP00252	CS2-027-700-AS3R	CS	AUX	215	12-13-82	✓	✓	1-8-83
BP00253	HBRX-AB-013-001-5	BR	AUX	215	12-13-82		✓	
BP00254	CS1-273-001-AS3R	CS	AUX	215	12-13-82	✓	✓	12/30/82
BP00255	HCS1-AB-030-001-3	CS	AUX	215	12-13-82	✓	✓	1-8-83
BP00256	CS1-259-700-AS3R	CS	AUX	215	12-14-82	✓	✓	12/30/82
BP00257	HCS1-AB-032-001-3	CS	AUX	215	12-14-82	✓	✓	1-8-83
BP00258	CS1-302-700-AS3R	CS	AUX	215	12-14-82		✓	
BP00259	SB1-066-002-AS5R	SB	AUX	215	12-14-82	✓	✓	12/30/82
BP00260	SB1-002-001-AS5R	SB	AUX	215	12-14-82	✓	✓	12/30/82
BP00261	SB1-066-001-AS5R	SB	AUX	215	12-14-82	✓	✓	12/30/82
BP00262	SB1-045-001-AS5R	SB	AUX	215	12-14-82	✓	✓	12/30/82
BP00263	SB2-062-001-AS5R	SB	AUX	215	12-13-82	✓		
↓	SB2-066-002-AS5R	SB	AUX	215	12-13-82	✓		
↓	SB2-044-001-AS5R	SB	AUX	215	12-13-82	✓		
↓	SB2-036-005-AS5R	SB	AUX	215	12-13-82	✓		
↓	SB2-035-004-AS5R	SB	AUX	215	12-13-82	✓		

COMANCHE PEAK STEAM ELECTRIC STATION

INSPECTION REPORT

SHEET 1 OF 1
NO. [illegible]

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM / STRUCTURE DESIGNATION
Pipe Support	CS1 302 700-A53R	CS [illegible] 832

SPEC.NO.	REV.	REF. Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
2323-SS-9	5	QI-QP-11.0-15 Rev. 0	N/A

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☑ FINAL INSPECTION ☐ PRETEST INSPECTION

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☑ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

[signature] 12-14-82
QC INSPECTOR DATE

ITEM NO.	INSPECTION ATTRIBUTES	SAT	UNSAT.	DATE	QC SIGNATURE
1.	Gap does not exceed ½" at any point between baseplate and concrete surface. Para. 3.1.	✓			
2.	Gap does not exceed 1/16" for 80% or more of baseplate bearing surface Para. 3.1.		✓		
3.	For floor mounted equipment gap does not exceed 1/16" between cured cement grout and equipment base (without engineering approval). Para. 3.2.	N/A			
4.	Shims installed. Para. 3.1	✓			
	North Wall Mount EL 848'6" 3'3" East of JA 7'3" North of 4-A	✓			

REMARKS (DWGS, SPECS, ETC.)

* Located in Rm #215 Access from EL. 852'

RELATED NCR NO.	I.R. CLOSED	DATE	SIGNATURE QC INSPECTOR
N/A	☐		

COMANCHE PEAK STEAM ELECTRIC STATION

INSPECTION REPORT

SHEET 1 OF 1

NO. BP 00341

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM/STRUCTURE DESIGNATION
BASE PLATE	C14K30728-1	810' SG-1

SPEC. NO.	REV.	REF. Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
2323-SS-9	2	QI-QP-11.0-15 Rev. 0	N/A

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☑ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRETEST INSPECTION

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☑ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

[signature] QC INSPECTOR 12/1/8- DATE

ITEM NO.	INSPECTION ATTRIBUTES	SAT	UNSAT	DATE	QC SIGNATURE
1.	Gap does not exceed ½" at any point between baseplate and concrete surface. Para. 3.1.	✓			
2.	Gap does not exceed 1/16" for 80% or more of baseplate bearing surface Para. 3.1.		✓		
3.	For floor mounted equipment gap does not exceed 1/16" between cured cement grout and equipment base (without engineering approval). Para. 3.2.	N/A			
4.	Shims installed. Para. 3.1	✓			
#	LOCATION OF SUPPORT #1 EL' 816' 3' SO. of 4-S 15'-6" W. of F/S LOCATED ON WALL				

ARMS INDEXED

DATE:

PERM PLT. RECORD
FILE LOC. 17.1.99.21
RTN. L
SUBFILE LOC.
CONDUIT NO.

REMARKS (DWGS, SPECS, ETC.) N/A

RELATED NCR NO.	I.R. CLOSED	DATE	SIGNATURE
N/A	☐ NA		QC INSPECTOR

FOR INFORMATION ONLY

TEXAS UTILITIES GENERATING COMPANY
P. O. BOX 1002 · GLEN ROSE, TEXAS 76043

June 12, 1984

Distribution
S. Bibo
D. Smedley
N. Williams
84042 PF

CYGNA Energy Services
101 California Street
Suite 1000
San Francisco, CA 94111

Attention: Ms. Nancy Williams, Project Manager

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION
CYGNA REVIEW QUESTIONS
(Inspection Reports)

Reference: June 7, 1984 Letter to J. B. George (TUGCO)
from N. Williams (CYGNA)

CYGNA	
JOB NO.:	84042
DATE LOGGED:	6/26/84
LOG NO.:	#35
FILE:	2.1.1 Inc. OR
CROSS REF. FILE	2.1 Inc. OR Log

Dear Ms. Williams:

Enclosed are TUGCO's responses to the above referenced letter.

If there are any further questions, please contact the undersigned at Ext. 321 or B. C. Scott at Ext. 859.

Very truly yours,

TEXAS UTILITIES GENERATING COMPANY
QUALITY ASSURANCE DEPARTMENT

A. Vega

A. Vega
TUGCO Site QA Manager

AV/BCS/bll
Attachments
cc: D. N. Chapman
D. H. Wade

Item #1

No methods were identified to address the segregation of deficient items documented on Inspection Reports (IR's) to preclude inadvertent use of or further work to the items. The concern is that a deficiency could be made irretrievable or the condition could be made worse without some type of restraint. What procedural guidelines existed historically and exist currently to address this area?

Response

The Inspection Report is used to document field inspections. The inspection is identified as either being satisfactory or unsatisfactory. Inspection reports which reflect unsatisfactory inspection results remain open until such time they become satisfactory.

Please refer to ANSI N45.2, Section 9 "Identification and Control of Materials, Parts and Components" which states in part "...where physical identification is either impractical or insufficient, physical separation, procedural control or other appropriate means shall be employed. Identification may be either on the item or on records traceable to the item, as appropriate." In all cases unsatisfactory inspection reports are traceable to the item and are verified acceptable prior to closing the inspection report.

Item #2

Inspection Reports which identify unsatisfactory conditions do not appear to identify corrective actions which were taken to correct the unsatisfactory condition. What documentation exists delineating corrective action steps taken to eliminate the deficiencies?

Response

Inspection Reports (IR's) document either satisfactory/unsatisfactory conditions as implemented through comprehensive inspection instructions. Unsatisfactory conditions which can be corrected by rework, and then found acceptable, are documented as satisfactory on the IR. Unsatisfactory conditions which require a repair or use-as-is disposition are documented on a NCR which requires Engineering review for corrective action.

Item #3

A review of CP-QP-16.0, "Nonconformances" and CP-QP-18.0, "Inspection Reports" does not appear to address specific guidelines for determining when an Inspector should issue an unsatisfactory Inspection Report or a Nonconformance Report. What procedural guidelines were available historically and are available now to quality control inspectors which delineate when an unsatisfactory IR is generating instead of a Nonconformance Report.

Response

Please refer to Procedure CP-QP-16.0 (copy attached) "Nonconformances", paragraph 2.1 under NOTE: "When nonconformances are detected by inspection and testing, they shall be reported in accordance with quality procedures/instructions describing the inspection or testing functions (IR's). Where specific guidelines are not given in quality procedure/instructions, the provisions of this procedure shall govern (NCR's)." In other words, each inspection instruction establishes specific inspection attributes to be inspected. When an attribute is found unsatisfactory an unsatisfactory IR is written. In cases where unsatisfactory conditions are found that are not within the scope of an inspection procedure/instruction an NCR is written. For example, please see attached Inspection Instruction QI-QP-11.3-26.

NONCONFORMANCES	PREPARED BY: George Weller 3-16-84 DATE APPROVED BY: MKrusher 3/22/84 DATE

1.0 REFERENCES

1-A CP-QP-15.0, "Tagging System"

2.0 GENERAL

FOR INFORMATION ONLY

2.1 PURPOSE AND SCOPE

The purpose of this procedure is to establish a method of documenting the identification, resolution, and closeout of nonconformances as defined in Paragraph 2.2. It is the responsibility of all site employees to report items of nonconformance to their supervisor or to the TUGCO Site QA Supervisor. The requirements contained herein are applicable to nonconformances identified for materials, services or items associated with safety-related structures, systems and components not under the jurisdiction of the ASME Code, Section III, Division 1.

NOTE: When nonconformances are detected by inspection and testing, they shall be reported in accordance with quality procedures/instructions describing the inspection or testing functions. Where specific guidelines are not given in quality procedure/instructions, the provisions of this procedure shall govern.

In Oct. 1983, a Building/Matrix Management Organization was established for the completion of Unit 1 and Common. Section 3.1 and 3.3 of this procedure describe the processing of nonconformances under this system. Section 3.1 and 3.2 describe the processing of nonconformances for Unit 2 and areas not under the Matrix organization.

2.2 DEFINITION

2.2.1 Nonconformance

A deficiency in characteristic, documentation, or procedure which renders the quality of an item unacceptable or indeterminate.

3.0 PROCEDURE

3.1 NONCONFORMANCE IDENTIFICATION

3.1.1 Field Identification

When a nonconforming condition as defined in Paragraph 2.2.1 is identified, the individual shall immediately apply a Hold Tag, when practical, (Reference 1-A) and note his name and telephone extension on the tag. He shall return and note on the Hold Tag the appropriate NCR number when obtained from the TUGCO NCR Coordinator.

NOTE: For electrical activities, the inspector may use his judgement to apply a Hold Tag to a nonconforming internal component. For example, the inspector may apply a Hold Tag to a broken/damaged terminal strip and note on the Hold Tag wording such as "Applied to Terminal Strip Only." On the NCR the statement would be "Applied to Terminal Strip Only - other unrelated activities may proceed."

3.1.2 Reporting

Nonconforming conditions shall be reported on the NCR form (Attachment 2). Supporting documentation, e.g., Inspection Reports, NDE reports, drawings shall also be attached to the NCR where appropriate. The location of the nonconforming condition (structure, room number, elevation and area code) and the system/subsystem number shall be recorded on the NCR form.

NOTE: The system/subsystem number is not required for discrepancies relating to conduit, cable trays, protective coatings, cable tray hangers or anchor bolt locations provided that the structure is identified.

3.1.3 Numbering the NCR

Before sending the NCR to the Quality Control Supervisor, or his designee, the individual reporting the nonconformance shall obtain a number from the TUGCO NCR Coordinator. This number shall be noted on the NCR and on the Hold Tag per Reference 1-A that is applied to the nonconforming item/equipment.

The TUGCO NCR Coordinator shall assign numbers as follows:

e.g. NCR M - 80 - 00214

sequential NCR number for that year

year

Discipline (Mechanical, Electrical Instumentation, Civil)

For NCR's on items/components turned over to TUGCO, the TUGCO NCR Coordinator shall add the letter "S" after the NCR number and forward a copy to TUGCO Startup for information.

The TUGCO NCR Coordinator enters the NCR number and brief description of the nonconforming condition in the Master NCR Log (Attachment 3).

NOTE: The TUGCO NCR Coordinator shall periodically review the Master NCR Log (at least annually) to ensure accuracy.

3.2 PROCESSING NONCONFORMANCE REPORTS FOR UNIT 2 AND AREAS NOT UNDER THE MATRIX ORGANIZATION

3.2.1 Draft NCR

The inspector will sign and forward the draft NCR to the Discipline QC Supervisor or designee. When individuals assigned to departments other than QA/QC are reporting a nonconformting condition, they shall forward the draft Nonconformance Report to the TUGCO NCR Coordinator for processing in accordance with this procedure.

3.2.2 Pre-Issuance Review and Preparation

The reported nonconformance shall be evaluated by the Discipline Quality Control Supervisor or his designee for clarity, accuracy, validity, specificity and legibility.

3.2.2.1 NCR's may be voided at any time if it is determined that nonconforming conditions do not exist, the nonconformance was previously reported on another NCR or other similar conditions exist. In the event that an NCR is determined to be invalid, "Void" shall be entered in bold letters in the disposition block with the reason and justification for voiding the NCR. Any pertinent supporting documentation shall be attached to the NCR and referenced in the reason/justification statements. Voiding of NCR's shall be approved by the QA/QC Supervisor or his designee by placing his signature and the date under the reason/justification statement. The original voided NCR will be forwarded to the TUGCO NCR Coordinator.

3.2.2.2 If the NCR is determined to be valid, the Discipline QC Supervisor signs and forwards the draft NCR to the TUGCO NCR Coordinator.

3.2.3 NCR Issue

The TUGCO NCR Coordinator enters the date issued in the NCR Log, maintains the original and forwards a copy of the NCR to an "Action Addressee".

(The "Action Adressee" normally is the responsible Engineering Supervisor who evaluates and dispostitions the reported nonconformances.)

3.2.4 Disposition

3.2.4.1 Final Disposition (Rework, Repair, Scrap, Use-as-is)

The "Action Addressee" shall evaluate each reported nonconforming condition and determine an appropriate disposition to correct and/or resolve the nonconformance. The disposition shall be clearly and concisely recorded in the "Disposition" space on each NCR according to the following:

a. The respective disposition block(s) shall be checked (i.e., Rework, Repair, Use-As-Is and/or Scrap).

b. Rework Dispositions shall specify the rework actions required to correct the nonconforming conditions and bring the affected items into compliance with the specified requirements.

c. Repair Dispositions shall specify the repair actions required to bring the nonconforming characteristic(s) to a condition such that the capability of the affected item to function reliably and safely is unimpaired, even though the item still may not conform to specified requirements. Repair dispositions shall also include appropriate Engineering technical justification for acceptance of the item with characteristics that do not comply with specified design requirements.

d. Use-As-Is Dispositions shall include sufficient Engineering technical justification to establish that the nonconforming characteristic will result in no adverse conditions and that the affected item will continue to meet all Engineering functional requirements, including performance, maintainability, fit and safety.

e. Scrap Dispositions shall be made when it is determined that an item is unsuitable for its intended purpose and cannot be feasibly or economically reworked or repaired.

3.2.4.2 Temporary Waiver

For those nonconforming items which Construction/Engineering desires to continue to process on a "risk removal" basis, authorization shall be requested in the NCR disposition. In order to receive this authorization to continue the process, the following conditions must be satisfied:

a. The NCR disposition shall include sufficient information and direction for accomplishing the work. Detail shall be provided to permit adequate evaluation of potential impact to affected parties (i.e., construction, engineering, QA/QC, records, start-up and operations);

b. Engineer Review/Approval shall be by the Engineering Group Supervisor or above;

c. Quality Assurance Review/Approval shall be by the Discipline QA/QC Supervisors or above.

After approval of the disposition a Blue Temporary Waiver Tag, per Reference 1-A, shall be affixed to the item. The NCR number shall be noted on the Temporary Waiver Tag.

3.2.5 <u>Engineering Review/Approval</u>

Engineering review/approval of NCR disposition shall be authorized by the Site Engineering Manager or his designee. For weld related nonconformances in which "rework" <u>only</u> is specified, the Site Welding Engineer is authorized to approve the disposition. For Construction procedural violation NCR's in which hardware is not affected, the Construction Manager or his designee is authorized to sign the Engineering Review/Approval block.

3.2.6 Quality Assurance Review

The NCR disposition shall be reviewed by the Discipline Quality Engineer for adequacy and conformance to applicable specifications, code requirements and current drawing/ design change.

If the review is satisfactory the TUGCO NCR Coordinator will have the disposition entered on the original, obtain the required signatures, and enter the date on the NCR log. If the disposition is not satisfactory, the Quality Engineer shall resolve all comments with the Engineer who dispositioned the NCR.

Based on his review, the QE may recommend voiding in accordance with Section 3.2.2.1.

Upon Quality Engineering approval of the disposition, and prior to beginning any rework/repair, QC shall remove the red hold tag and blue waiver tag (if applicable).

3.2.7 Revision of Nonconformance Reports

When changes are required to the nonconforming condition or disposition, the NCR shall be revised. This revision shall be denoted on the NCR number and the reason(s) for revision included in the comments section. The necessary approvals shall be obtained in accordance with this procedure for the portion affected by revision.

3.2.8 Implementation of the Disposition

NCR's dispositioned "Rework", "Repair" or "Scrap" shall be sent by the TUGCO NCR Coordinator to the appropriate department responsible for scheduling/coordinating work activities for implementation of the disposition.

NCR disposition "Use As Is" shall be sent to the Non-ASME discipline Level III QE for approval as designated by the QA/QC Supervisor.

For NCR's dispositioned as "Rework", "Repair", or "Scrap" and identified with an "S" after the NCR number, an information copy will also be sent to TUGCO Startup.

3.2.9 Verification/Closure

The Discipline QC Supervisor shall ensure that the NCR disposition work items are verified and/or witnessed by QC. QC shall document their inspections (via, inspection reports, checklists, travelers, etc. as required). These documents shall be either attached to or referenced on the NCR as appropriate.

The QA/QC Supervisors, or their designee, shall close the NCR by signing the "Verification" block of the original.

The closed NCR will then be transmitted by the NCR Coordinator to the Permanent Plant Records Vault and the date entered in the NCR log.

3.3 PROCESSING NONCONFORMANCE REPORTS FOR UNIT 1 AND COMMON (SEE ATTACHMENT 1 FOR NCR FLOW)

3.3.1 Draft NCR

Following completion of activities specified in Section 3.1, the inspector will sign and forward the draft NCR to the Building QC Supervisor or designee. When individuals assigned to departments other than QA/QC are reporting a nonconforming condition, they shall forward the draft Nonconformance Report to the Building NCR Coordinator for processing in accordance with this procedure.

3.3.2 Pre-Issuance Review and Preparation

The reported nonconformance shall be evaluated by the Building Quality Control Supervisor or his designee for clarity, accuracy, validity, specificity and legibility.

3.3.2.1 NCR's may be voided by the Building QC Supervisor if it is determined that nonconforming conditions do not exist, the nonconformance was previously reported on another NCR or other similar conditions exits. In the event that an NCR is determined to be invalid, "Void" shall be entered in bold letters in the disposition block with the reason and justification for voiding the NCR. Any pertinent supporting documentation shall be attached to the NCR and referenced in the reason/justification statements. The original voided NCR with supporting doucmentation shall be filed in the PPRV and a copy forwarded to the TUGCO NCR Coordinator.

3.3.2.2 If the NCR is determined to be valid, the Building QC Supervisor signs and forwards the draft NCR to the Building NCR Coordinator. The Building NCR Coordinator sends a duplicate copy to the TUGCO NCR Coordinator for reduntant filing.

3.3.3 <u>NCR Issue</u>

The Building NCR Coordinator enters the date issued in the Building NCR Log and forwards the original NCR to an "Action Addressee". (The Building NCR Log will be similar to the Master Log maintained by the TUGCO NCR Coordinator.)

(The "Action Adressee" normally is the responsible Construction/Engineering Building Supervisor who evaluates and dispositions the reported nonconformances.)

3.3.4 <u>Disposition</u>

3.3.4.1 Final Disposition (Rework, Repair, Scrap, Use-as-is)

The "Action Addressee" shall evaluate each reported nonconforming condition and determine an appropriate disposition to correct and/or resolve the nonconformance. The disposition shall be clearly and concisely recorded in the "Disposition" space on each NCR according to the following:

a. The respective disposition block(s) shall be checked (i.e., Rework, Repair, Use-As-Is and/or Scrap).

b. Rework Dispositions shall specify the rework actions required to correct the nonconforming conditions and bring the affected items into compliance with the specified requirements.

c. Repair Dispositions shall specify the repair actions required to bring the nonconforming characteristic(s) to a condition such that the capability of the affected item to function reliably and safely is unimpaired, even though the item still may not conform to specified requirements. Repair dispositions shall also include appropriate Engineering technical justification for acceptance of the item with characteristics that do not comply with specified design requirements.

d. Use-As-Is Dispositions shall include sufficient Engineering technical justification to establish that the nonconforming characteristic will result in no adverse conditions and that the affected item will continue to meet all Engineering functional requirements, including performance, maintainability, fit and safety.

e. Scrap Dispositions shall be made when it is determined that an item is unsuitable for its intended purpose and cannot be feasibly or economically reworked or repaired.

3.3.4.2 Temporary Waiver

For those nonconforming items which Construction/Engineering desires to continue to process on a "risk removal" basis, authorization shall be requested in the NCR disposition. In order to receive this authorization to continue the process, the following conditions must be satisfied:

a. The NCR disposition shall include sufficient information and direction for accomplishing the work. Detail shall be provided to permit adequate evaluation of potential impact to affected parties (i.e., construction, engineering, QA/QC, records, start-up and operations);

b. Engineer Review/Approval shall be by the Building Group Supervisor or above;

c. Quality Assurance Review/Approval shall be by the Building QA/QC Supervisors or above.

After approval of the disposition a Blue Temporary Waiver Tag, per Reference 1-A, shall be affixed to the item. The NCR number shall be noted on the Temporary Waiver Tag.

3.3.5 <u>Quality Assurance Review</u>

The NCR disposition shall be reviewed by Quality Assurance for adequacy and conformance to applicable specifications, code requirements and current drawing/design change. Disposition for scrap, rework, and standard repairs are approved by the Building QC Supervisor. Dispositions for use-as-is and non-standard repairs shall be approved by the Non-ASME discipline Level III QE as designated by the QA/QC Supervisor.

If review is satisfactory the Building NCR Coordinator shall enter the date on the NCR log. If the disposition is not satisfactory, the Building QC Supervisor or Non-ASME discipline Level III QE as designated by the QA/QC Supervisor, as appropriate, shall resolve all comments with the Engineer who dispositioned the NCR. The Building NCR Coordinator sends a duplicate dispositioned copy to the TUGCO NCR Coordinator.

Upon Quality Assurance approval of the disposition, and prior to beginning any rework/repair, QC shall remove the red hold tag and blue waiver tag (if applicable).

3.3.6 Revision of Nonconformance Reports

When changes are required to the nonconforming condition or disposition, the NCR shall be revised. This revision shall be denoted on the NCR number and the reason(s) for revision included in the comments section. The necessary approvals shall be obtained in accordance with this procedure for the portion affected by revision.

3.3.7 Implementation of the Disposition

NCR's dispositioned "Rework", "Repair" or "Scrap" shall be sent by the Building NCR Coordinator to the appropriate building department responsible for scheduling/coordinating work activities for implementation of the disposition.

For NCR's dispositioned as "Rework", "Repair", or "Scrap" and identified with an "S" after the NCR number, an information copy will also be sent to TUGCO Startup.

3.3.8 Verification/Closure

The QC Building Supervisor shall ensure that the NCR disposition work items are verified and/or witnessed by QC. QC shall document their inspections (via, inspection reports, checklists, travelers, etc. as required). These documents shall be either attached to or referenced on the NCR as appropriate.

The QE or QC Supervisors, as appropriate, or their designees, shall close the NCR by signing the "Verification" block of the original.

Copies of closed NCR's will be distributed by the cognizant Building NCR Coordinator as follows:

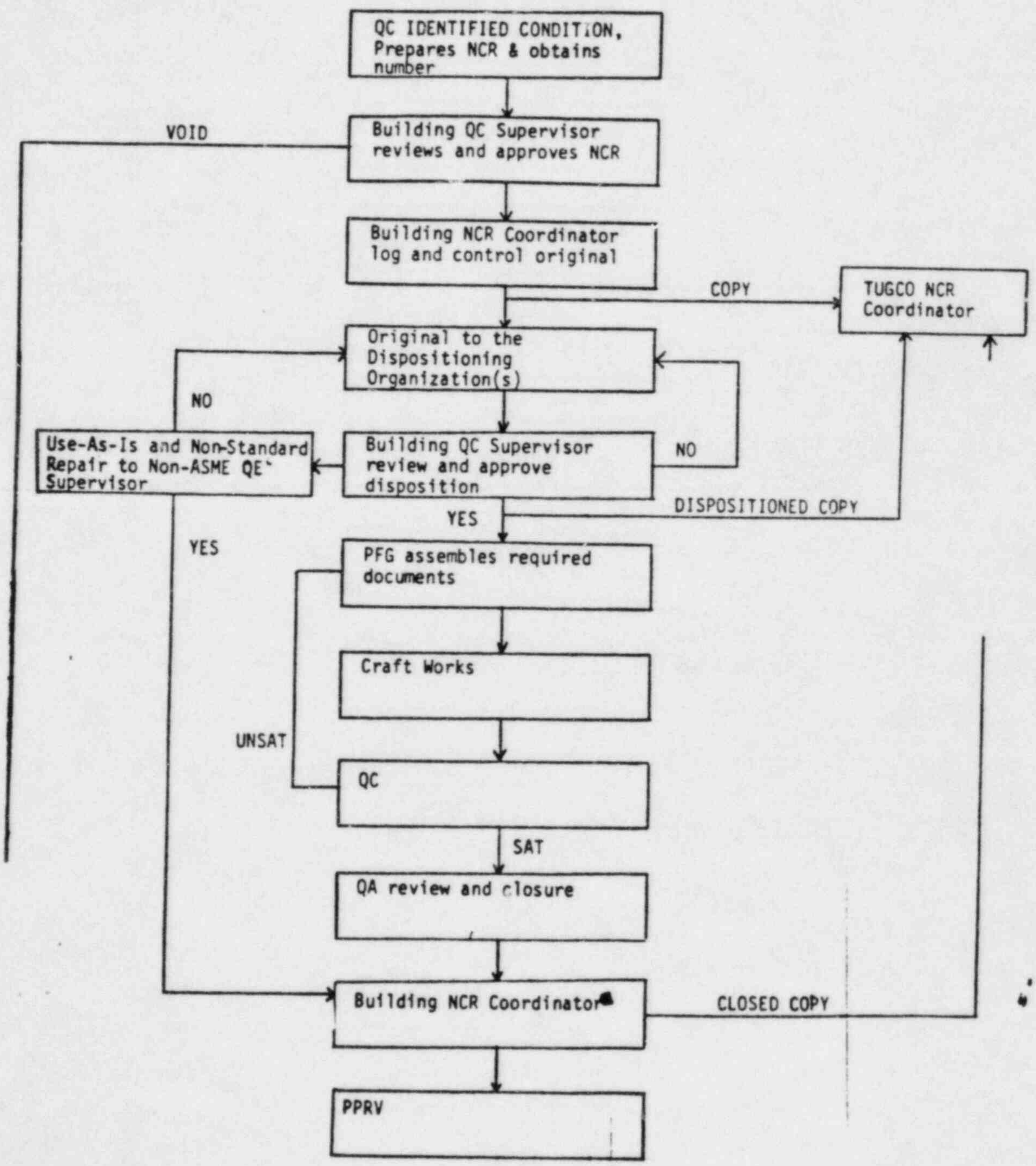
a. The original will be sent to the appropriate building Paper Flow Group who will transmit to the Permanent Plant Records Vault (PPRV).

b. A copy of the closed NCR will be sent to the TUGCO NCR Coordinator for Master Log updating and duplicate filing.

ATTACHMENT 1

UNIT 1 AND COMMON

NCR FLOW CHART



ATTACHMENT 2

TEXAS UTILITIES GENERATING CO

COMANCHE PEAK STEAM ELECTRIC STATION
NONCONFORMANCE REPORT (NCR)

NCR No

REPORTING PERSONNEL

NONCONFORMING CONDITION

REFERENCE DOCUMENT ______ REV ______ PARA ______

REPORTED BY: | DATE: / /

QE

QE REVIEW/APPROVAL: | DATE: / /

ACTION ADDRESSEE | DEPARTMENT

ACTION ADDRESSEE

DISPOSITION:
REWORK ______ REPAIR ______ USE AS IS ______ SCRAP ______

ENG. REVIEW/APPROVAL | DATE: / /

QE

QE REVIEW APPROVAL: | DATE: | ANII REVIEW APPROVAL | DATE: / /

DISPOSITION VERIFICATION & CLOSURE | DATE: | ANII REVIEW APPROVAL | DATE: / /

COMMENTS:

ATTACHMENT 3

TUGCO NCR LOG

NCR NO.	REV NO.	NONCONFORMING CONDITION	REPORT & DATE	RM. NO.	ISSUED DATE	ACTION ADDRESSEE	ENG. DISP. SIGNATURE	QE	QE REVIEW SIGNATURE	QE	QE REVIEW QA SIGN.	CLOSURE

ELECTRICAL CABLE INSTALLATION INSPECTIONS

PREPARED BY: Wesley Watson 6/7/84 DATE

APPROVED BY: W E Darofl 6-7-84 DATE

APPROVED BY: L M Biefeldt 6-7-84 DATE

1.0 REFERENCES

1-A CP-QP-11.3, "Electrical Inspection Activities"

1-B CP-QP-18.0, "Inspection Report"

1-C CP-QP-16.0, "Nonconformances "

FOR INFORMATION ONLY

2.0 GENERAL

2.1 PURPOSE AND SCOPE

This Quality Instruction supplements Reference 1-A and is established to assure the adequacy of Class 1E electrical cable installations at Comanche Peak Steam Electric Station.

3.0 INSTRUCTION

3.1 INSPECTION FREQUENCY AND SCOPE

The frequency of inspection efforts, as a minimum, shall be established within this instruction or its daughter documents. The QC Supervisor or his designee may direct inspection to a greater frequency should circumstances warrant this action.

The complexity of particular cable installations may vary; the following are the required minimum inspection frequencies:

a. Class 1E raceways will be verified to be free from cable pulling hazards; It is acceptable to pull cable in cable tray which has Thermo-Lag applied without removal of Thermo-Lag. Quality Control verification of tray section has been established prior to installation of Thermo-Lag.

b. Class 1E cables not requiring tension monitoring--This Instruction authorizes a monitoring of all Class 1E cable pulling operations.

c. Class 1E cables requiring tension monitoring device--QC shall witness that the maximum allowable tension is not exceeded. In addition, QC shall provide a continous monitoring of the cable pulling operations.

d. Class 1E cable installation will be verified to be free from damage, properly identified, maintained spacing if required and tied down.

e. Prior to any NIS triaxal cable installation, the Electrical QC Inspector shall verify that the cable has been in Class "A" storage for a minimum of 48 hours and the cable reel test is complete.

3.2 DOCUMENTATION

Inspection results shall be documented on the Inspection Report (Figure 1, 2, 3, 4 or 5) in accordance with Reference 1-B.

If a cable is partially pulled, the Inspector shall accurately describe in the space provided (Item #7) of the Inspection Report, the raceway(s) through which the cable had been pulled. If no deficiencies are noted, except incomplete processing of the cable, no entries will be made in the "Sat-Unsat" attribute blocks, items 1 through 6, of the IR. Item #7 shall be checked "Unsat", signed and dated by the inspector in the spaces provided. To prevent further processing of the incompleted cable, the QC Inspector shall apply a "hold" tag to both ends of the incompleted cable. A brief explanation should be noted in the "Remarks" section of the IR showing why the cable was partially pulled.

The QC Inspector completing the cable pull shall check all attributes on the IR (Sat - Unsat - NA) and process the IR in accordance with Reference 1-B.

If cable is reworked (cable physically moved in raceway) it shall be documented on the appropriate Inspection Report. The portion of the route pulled back shall be described in the remarks section. If cable was completely repulled through the entire raceway, "complete re-pull" shall be noted in remarks.

Handling of revisions to cable cards when the new card set is received with changes which do not affect the actual installation, such as a new card showing a change in system number, will have the information from the old card transferred to the new card and the revision number of the old cards noted on the new card by craft. This information is to be reviewed for accuracy by QC and this review documented on Figure 4 for filing in vault. The new set of cards are now handled as completed, the old card may be destroyed.

3.3 DISCREPANCIES

Discrepancies found during inspection shall be documented on the IR (Figures 1, 2, 3, 4 or 5) and/or a NCR per References I-B and I-C respectively, as directed by the QA/QC Supervisor.

FIGURE 1

COMANCHE PEAK STEAM ELECTRIC STATION
INSPECTION REPORT

SHEET NO. 1 OF 2

ITEM DESCRIPTION: ELECTRICAL CABLE INSTALLATION	IDENTIFICATION NO.: CABLE #	SYSTEM / STRUCTURE DESIGNATION: RM#
SPEC. NO. / REV.	REF Q.C. DOC. & REV & CHANGE NO.: QI-QP-11.3-26, Rev.	MEASURE OR TEST EQUIP. CERT. NO.: DEVICE #: ______ CALIBRATION DATE: ______

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRETEST INSPECTION

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☐ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

QC INSPECTOR ______ DATE ______

ITEM NO.	INSPECTION ATTRIBUTES	SAT	UNSAT	DATE	QC SIGNATURE
1.	Verify Cable Pull Card (Refer to QI-QP-11.3-26.2)				
	A. Multiple pull required				
	B. Calculation sheet required				
2.	Monitor Cable Acceptability(Refer to QI-QP-11.3-26)				
	A. Verify Cable Color and Type				
	B. Cable Free of Defects				
	C. Verify NIS Cable Reel Test is Complete				
	D. Verify Triaxial Cable installed Inside Containment				
	is Tefzel Insulated				
	E. Verify Triaxial Cable Installed Outside Containment				
	is XLPE Insulated				
3.	Verify Conduit Raceway Swabbed (Refer to QI-QP-11.3-26.4)				
4.	Monitor Cable Pulling "Set-Up" (Refer to QI-QP-11.3-26.5)				
	A. Monitor immediate cable pulling is free of				
	pulling hazard				
	B. Verify tension device properly calibrated and				
	properly attached (if required)				
5.	Verify Cable Pulling Operations (Refer to QI-QP-11.3-26.6)				
	A. Verify cable lubricant is Engineering approved				
	(if required)				
	B. Witness Tension Device (if required)				
	1) Actual tension witnessed:				
	2) Maximum tension allowed:				
	C. Verify cable pulling operation (routing)				
	D. Ensure that cable pull boxes are actually utilized				
	E. Verify cable did not sustain damage as a result				
	of the process				

FIGURE 1 cont.

COMANCHE PEAK STEAM ELECTRIC STATION

INSPECTION REPORT

(SUPPLEMENTAL)

Sheet 2 of 2

FOR FULL HEADINGS, SEE SHEET 1 NO.

ITEM NO.	INSPECTION ATTRIBUTES	SAT.	UNSAT.	DATE	Q.C. SIGNATURE
	F. Verify cable slack is acceptable where required.				
	G. Verify proper cable spacing for power cables.				
	H. Verify cable tie down is acceptable.				
	I. Verify cable identification is acceptable.				
	J. Verify cable is routed per cable pull card.				
6.	Verify compliance with seperation requirements. (Refer to QI-QP-11.3-26.7)				
7.	Partial Pulls Refer to QI-QP-11.3-26 Cable # was partially pulled. Beginning Raceway through. Raceway All attributes listed above. (1 through 6) are satisfactory, unless marked otherwise.				
	QC INSPECTOR:				
	Date:				

REMARKS: (DWGS, SPECS, ETC.)

Reel no.__________

RELATED NCR NO.	I.R. CLOSED ☐	DATE	SIGNATURE QC INSPECTOR

Form No. 1

FIGURE 2

COMANCHE PEAK STEAM ELECTRIC STATION

INSPECTION REPORT

SHEET 1 OF 1

NO. EC-

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM/STRUCTURE DESIGNATION
ELECTRICAL CABLE INSPECTION	CABLE #	

SPEC.NO.	REV.	REF. Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
		QI-QP-11.3-26, Rev.	N/A

☐ IN PROCESS INSPECTION ☒ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRETEST INSPECTION

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☐ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

QC INSPECTOR ______ DATE ______

ITEM NO.	INSPECTION ATTRIBUTES	SAT	UNSAT	DATE	QC SIGNATURE
(V) 1.	Verify raceway acceptable for cable pull				
	(Refer to QI-QP-11.3-26.1)				
	A. Verify no pulling hazards				
	B. Verify raceway identification				
	C. Evaluation of QA Hold Tags applied.				
(V) 2.	Verify Cable Pull Card				
	Revision Code ____________ in agreement with				
	E1/E2-1700, Section 98.				
	(Refer to QI-QP-11.3-26.2)				
(V) 3.	Verify unscheduled pull boxes				
	(Refer to QI-QP-11.3-26.6)				
(V) 4.	Verify compliance with separation requirements				
	(Refer QI-QP-11.3-26.7)				

REMARKS (DWGS, SPECS, ETC.)

RELATED NCR NO.	I.R. CLOSED ☐	DATE	SIGNATURE ______ QC INSPECTOR

Figure 3

COMANCHE PEAK STEAM ELECTRIC STATION

INSPECTION REPORT

SHEET ___ OF ___
NO.

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM / STRUCTURE DESIGNATION
ELECTRICAL CABLE REMOVAL 2	CABLE # 3	RM# 4

SPEC.NO.	REV.	REF Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
ES-100 5	6	QI-QP-11.3-26, Rev. 7	8

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRE TEST INSPECTION 9

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☐ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

____
QC INSPECTOR DATE 10

ITEM NO. 11	INSPECTION ATTRIBUTES 12	SAT	UNSAT	DATE	QC SIGNATURE 13
1.	VERIFY CABLE REMOVAL OPERATIONS				
	(REFER TO 11.3-26.6)				
	A. ENSURE CABLE PULL BOXES ARE UTILIZED				
	B. VERIFY CABLE DID NOT SUSTAIN DAMAGE AS A RESULT OF THE				
	PROCESS				
	C. VERIFY PROPER CABLE IDENTIFICATION				
	D. VERIFY NO RACEWAY HAZARDS				
	E. VERIFY MAXIMUM CABLE TENSION PARAMETERS WERE				
	NOT EXCEEDED				
	F. VERIFY CABLE ENDS ARE SEALED				

REMARKS (DWGS, SPECS, ETC.)

IRN #________________

14

RELATED NCR NO. 15	I.R. CLOSED ☐	DATE	SIGNATURE ________ QC INSPECTOR 16

REVIEWED BY:____________________LEVEL DATE:____________________

FIGURE 4

COMANCHE PEAK STEAM ELECTRIC STATION
INSPECTION REPORT

SHEET ____ OF ____
NO.

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM / STRUCTURE DESIGNATION
ELECTRICAL CABLE INSTALLATION 2	CABLE # 3	RM# 4

SPEC.NO.	REV.	REF Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
5	6	QI-QP-11.3-26 R. 7	8

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRETEST INSPECTION 9

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☐ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

QC INSPECTOR ____ DATE ____ 10

ITEM NO. 11	INSPECTION ATTRIBUTES 12	SAT	UNSAT	DATE	QC SIGNATURE 13
1.	Cable Card Revision				
	All Info on Previous Card Transcribed				
	(No Installation Change Required)				
	Revision Number of Old Card Noted:				
	Revision Number of New Card:				

REMARKS (DWGS, SPECS, ETC.)

14

RELATED NCR NO. 15	I.R. CLOSED ☐	DATE	SIGNATURE ____ QC INSPECTOR 16

REVIEWED BY: ____________ LEVEL DATE: ____________

FIGURE 5

COMANCHE PEAK STEAM ELECTRIC STATION
INSPECTION REPORT

SHEET ___ OF ___
NO. EC

ITEM DESCRIPTION	IDENTIFICATION NO.	SYSTEM/STRUCTURE DESIGNATION
Electrical Cable Install	Cable #	RM#

SPEC.NO.	REV.	REF Q.C. DOC. & REV. & CHANGE NO.	MEASURE OR TEST EQUIP. IDENT. NO.
ES-100		QI-QP-11.3-26 R.	N/A

☐ IN PROCESS INSPECTION ☐ PRE INSTALLATION VERIFICATION ☐ INSTALLATION INSPECTION ☐ FINAL INSPECTION ☐ PRETEST INSPECTION

INSP. RESULTS

☐ INSPECTION COMPLETED, ALL APPLICABLE ITEMS SATISFACTORY

☐ INSPECTION COMPLETED, UNSATISFACTORY ITEMS LISTED BELOW

_______________ QC INSPECTOR _______ DATE

ITEM NO.	INSPECTION ATTRIBUTES	SAT	UNSAT	DATE	QC SIGNATURE
(V)	1. Verify Cable Identification Change				
	a. Cable changed from: __________ TO: __________				
	b. Revcode: DCA:				
(V)	2. Verify color code				
(V)	3. Verify cable type				

REMARKS (DWGS, SPECS, ETC.)

RELATED NCR NO.	I.R. CLOSED ☐	DATE	SIGNATURE ________ QC INSPECTOR

REVIEWED BY:____________________LEVEL DATE:______________

Gibbs & Hill, Inc.

11 Penn Plaza
New York, New York 10001
212 760- 4438
Telex:
Domestic: 127636/968694
International: 428813/234475

A Dravo Company

TCS - 84042
LOG IN + GIVE COPY TO CHUN
COPY 4 LOG

June 14, 1984

CYGNA	
JOB NO :	84042
DATE LOGGED:	6/26/84
LOG NO.:	#37
FILE:	2.1.1 Inc. cr
CROSS REF. FILE	2.1 Inc. cr. log

Distribution:
N. Williams
C. Wong
84042 PF

GTN- 69118

Texas Utilities Generating Company
Post Office Box 1002
Glen Rose, Texas 76043

Attention: Mr. J. B. George,
Vice President/Project Gen. Mgr.

Gentlemen:

TEXAS UTILITIES GENERATING COMPANY
COMANCHE PEAK STEAM ELECTRIC STATION
G&H PROJECT NO. 2323
PHASE 3 CYGNA PIPE SUPPORT QUESTIONS
WOS-046/DOW-3464

In accordance with your telecon request of June 12, 1984, we are sending the attached in response to Item 4 of the telecon.

Very truly yours,

GIBBS & HILL, Inc.

Robert E. Ballard, Jr.
Project Manager

REBa/ELB/PTH:gw
1 Letter

cc: ARMS (B&R Site) OL
S. Grace/J. Minichello (TUSI Site) 1L, 1A
P.M. Milam/F. Bleck (TUSI/NY) 1L

Dravo

March ~~14~~ 26, 1984

Revision 1 April 27, 1984

Item 8(i)

BASIS FOR ESTABLISHING ALLOWABLE LOADS ON RICHMOND INSERTS

Recommended allowable tension loads by the Richmond Screw Anchor Co. are based on tension tests conducted at the Polytechnic Institute of Brooklyn in 1957. Two tension tests each were performed on 1" Ø and 1½" Ø inserts in concrete test blocks with moderate reinforcement with the following results:

	1" Ø	1½" Ø
Avg. Conc. Strength	2850 psi	2950 psi
Avg. Ultimate Load	25050#	65000#*
Failure Mode	Conc. pullout	Bolt threads

*Ultimate strength of 1½" Ø insert mechanism or of concrete failure cone not determined.

Richmond's recommended allowable tension loads are based on their average ultimate test loads and a factor of safety which has varied over the years, i.e.,

Richmond Bulletin	Recommended Allowable Tension Load (Factor of Safety) 1"Ø	1½"Ø
#6, 1961	11.0^k(2.3)	25^k(2.6)
#6, 1971	10.0^k(2.5)	25^k(2.6)
#6, 1975	8.27^k(3.0)	21.67^k(3.0)

Design Approach - It was recognized that the CPSES 4000 psi design concrete strength, being significantly greater than the nominal 3000 psi concrete used in the Richmond tests, would result in higher ultimate capacities for the inserts than the Richmond test values. It was also evident very early in construction that the concrete strengths actually being achieved were between 4500 and 5000 psi, which would further increase the ultimate capacity of the inserts. In addition, the heavier surface reinforcement used in

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MAVivirito, JLEichler (2) RIotti (Ebasco), JFinneran (TUSI), ELBezkor, PTHuang, CMJan, REBallard, SMMarano/TDHawkins/077 the actual construction at CPSES as compared to that used in the test blocks for the Richmond tests would tend to result in yet higher concrete pullout cone tensile strengths. The design approach used was to calculate the ultimate insert capacity based on 4000 psi using the ultimate concrete tension value $4\phi\sqrt{f'c}$ over the projected area of the postulated cone pullout, where $\phi = 0.65$ as recommended in ACI 349, Appendix B and, checking for an equivalency to the actual test results. Because of the conservatism inherent in discounting the high concrete strength test values being achieved and the effects of heavier surface rebar described above, a factor of 2 was applied to these values to establish allowable loads. On this basis there is good agreement between the Richmond test values and the calculated ultimate load:

A. Allowable Tensile, $\phi = 0.65$ f'c = 4000, Safety Factor = 2

Size	Richmond Test Load	Calculated Ultimate Load	Allowable Load
1"Ø	25.05^k	23.1^k	11.5^k
1½"Ø	65^k	62.6^k	31.3^k for A325/A490 28.1^k for A307/A36

However, the tabulated values in A above, do not consider that the Richmond test results would indicate an actual $\phi = 0.84$ and that f'c at CPSES was significantly higher. A more accurate safety factor considering these higher values is shown in B:

B. Estimated Ultimate Tensile Loads & Safety Factors

Size	Ø	Allowable Load	Est. Ult. Loads & (Safety Factors) 4000 psi	4500 psi	5000 psi
1"Ø	.84	11.5^k	29.8^k(2.6)	31.6^k(2.7)	33.4^k(2.9
1½"Ø	.84*	31.3^k (w/A325,A490 Bolt)	80.9^k(2.6)	85.8^k(2.7)	90.4^k(2.9
	.84*	28.1^k (w/A307,A36 Bolt)	80.9^k(2.9)	85.8^k(3.0)	90.4^k(3.

*Used 1"Ø value as calculated Ø of 0.79 for 1½"Ø based on bolt thread failure not concrete pullout.

Thus the actual minimum safety factors range from 2.6 to 2.9 for 4000 psi concrete to 2.9 to 3.2 for 5000 psi concrete. An evaluation of the concrete strength tests indicates that the actual minimum design strength of the concrete produced at CPSES is about ~~5500~~ 4500 psi.

The estimated loads in B, are based on concrete considerations only. Actual ultimate capacities of 1"Ø and 1½"Ø inserts have not been determined by the manufacturer. However, the following results, obtained from tests conducted for other purposes provide some insight into the capacity of the inserts.

1. Two tensile tests on 1½"Ø inserts were run for Richmond on 11/18/76 to establish the capacity of threaded rods. These tests were run only to predetermined levels of 70 and 72 kips respectively, not to failure. These values are both above the 65 kip Richmond test load for the 1½"Ø insert.
2. Shear tests were conducted on 1½" inserts in March, 1983 at CPSES and were run to between 88.1 kips and 95.4 kips without failure of concrete or insert.
3. Tests run on 1½"Ø inserts on 8/23/79 at PCA for Richmond indicated that one insert failed by simultaneous pullout and insert failure at 91.4 kips.

A similar approach was taken to establish allowable shear values for the 1"Ø and 1½"Ø Richmond inserts. Shear tests conducted by Richmond in 1965 on 1"Ø inserts an average load at failure of 27 kips. Failure mode was by shearing of the bolts. Allowable shear values were established based on AISC bolt values for the materials used, but were not permitted to exceed the allowable tension loads in A, above. As shear tests did not involve concrete failure, the concrete shear capacity of the insert could only be estimated using f'c = 4000 psi and assuming Ø = 0.84 as for tensile loads discussed above. Finally, shear tests conducted in 1983 on 1½" Ø inserts indicated that ultimate capacities were governed by bolt material, and varied between 88.1 and 95.4 kips. Ultimate capacity of the insert and of concrete in shear were not reached.

C. Allowable and Ultimate Shear Capacities and (Safety Factors

Size	Material	Allowable Loads		Est. Ult. Conc. Shear Strength 4000 psi/Ø=0.84	Test Ult. Load
		Richmond	CPSES		
1"Ø	A-307	8.0^k	7.85^k	29.7^k (3.8)	--
1"Ø	A-325	—	11.5^k	29.7^k (2.6)	—
1½"Ø	A-307	18.0^k	17.67^k	80.5^k (4.6)	88.1-95.4 (5 5
1½"Ø	A-325	—	26.51^k	80.5^k (3.0)	88.1-95.4 (3 3

To put the factors of safety utilized for the Richmond anchors at CPSES in perspective, it is useful to look at the factors of safety required by the FSAR (and NRC Standard Review Plan) for steel and concrete structures. (See FSAR paragraphs 3.8.3.3.2, 3.8.3.3.3, 3.8.3.5.2 and 3.8.3.5.4). These safety factors can be as low as 1.56 for concrete and 2.0 for steel under normal and upset load conditions when compared to the ultimate strength of the materials.

To further evaluate the significance of the factors of safety for the CPSES Richmond inserts, their reliability should be considered. The manufacturing process for the inserts furnished for CPSES use is controlled by QA/QC procedures to assure that the anchor material and fabrication conforms to or exceeds requirements necessary to assure material capability to meet capacity requirements. Construction procedures and tolerance requirements are controlled by site QA/QC regulations. Failures to meet these procedures and requirements are visually identified upon removal of concrete forms. When out-of-tolerance placement or improperly consolidated concrete around the insert is observed, corrective action or abandonment of the insert is required.

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Gibbs & Hill, Inc.

Calculation Cover Sheet

SH. 1

G&H Job No. 2323 Client TUGCo

Calculation Number SCS - 228 C SET # 1

Number of Sheets in Original Issue 1 To 10

Subject RICHMOND INSERT CAPACITIES

- [x] Nuclear Safety Related
- [ ] Non-Nuclear Safety Related—QA Program Applicable
- [ ] Non-Nuclear Safety Related

	Sheets Deleted	Sheets Added	Sheets Revised	Job Engineer Signature	Job Engineer Date
Original	X	X	X	S/ Boyle	3-13-84
Revision					

F-167, 4-81

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Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

Subject Richmond Insert Capacities

Calculation Number SCS-228C SET #1 Sheet No. 2

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	PJH	3/8/84									
Checker	JB	3-9-84									

Purpose: The purpose of this calculation is to establish the design basis, the design approach and to evaluate the conc. ultimate & allowable loads for the 1"φ & 1½"φ Richmond Inserts.

References:

(1) Code Requirements for Nuclear Safety Related Concrete Structures – ACI-349-80 Appendix B

(2) Richmond Bulletin #6, 1961, 1971 & 1975 printing

(3) Test Report by Polytechnic Institute of Brooklyn on 1"φ & 1½"φ Richmond Insert dated 10/11/57 & 12/20/57

(4) Letter from Mr. Harry B. Lancelot of Richmond Screw Anchor Co. Inc to Mr Dilip Patankar of G&H at Comanche Peak dated 1/30/84

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

2

Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

Subject Richmond Insert Capacities

Calculation Number SCS-228C SET #1 Sheet No. 3

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #	1	X		X		X		X		X
Preparer	RJH	3/8/84								
Checker	JB	3-9-84								

The following is a summary of reference (3) test report for 1" φ Richmond Insert

Ave. Conc. Strength: 2850 psi

Ave. Ultimate (test) load: $\frac{1}{2}(24600 + 25500) = 25050$ #

Failure Mode: Concrete pullout

For 1½" φ Richmond Insert

Ave. Conc. Strength: 2950 psi

Ave Ult. (test) load: $\frac{1}{2}(65500 + 64500) = 65000$ #

Failure Mode: Bolt threads (reference 4)
Note = Ultimate strength of Insert Mechanism or of Concrete failure cone not determined

Design Basis, Design Approach and the Capacity Values

- The Richmond Allowables for the CPSES project is established based on 4000 psi concrete strength which is the design concrete strength used for the entire project.
- The ultimate Concrete pullout capacity is based on reference (1) recommendation
- The Allowable concrete pullout capacity is based on the Ultimate capacity divide by 2 recognizing the following inherent conservatisms (1) Actual test loads (on weaker conc.) are higher than the design pullout strength (on stronger conc.) (2) The actual concrete strength is higher than the design conc strength of 4000 psi (3) Heavier surface rebars used in the plant construction than that of the test specimen.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

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Gibbs & Hill, Inc. Job No. 2322 Client TUGCo

Subject Richmond Insert Capacities

Calculation Number SCS-228C SET # 1 Sheet No. 4

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	BJH	3/8/84									
Checker	JB	3-9-84									

Establishment of Allowable loads used in design*

Based on reference (1), the design pullout strength of concrete in tension is

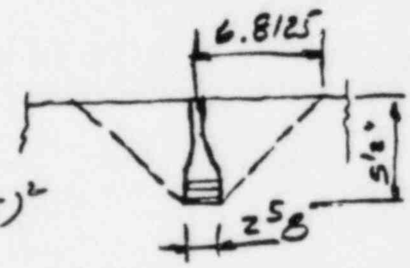
$P_d = 4\phi\sqrt{f_c'}\,A_c$

where $\phi = 0.65$

f_c' = Specified compressive strength of concrete = 4000 psi

A_c = Effective stress area which is defined by the projected area of stress cone radiating toward the attachment from the bearing edge of the anchor

For 1" ϕ Richmond Insert



$A_e = \pi(6.8125)^2 - \frac{\pi}{4}(2.625)^2$
$= 140.4\ in^2$

$P_d = 4\phi\sqrt{f_c'}\,A_c$
$= 4 \times 0.65\sqrt{4000} \times 140.4$
$= 23087$ #

The allowable load is
$P_A = \frac{1}{2}P_d = 11544$ #   Use $P_A = 11500$ #

* Resurrect from previous calc. on book SCS-17C set 1 sheets 8, 13 & 30 all Rev. 0

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

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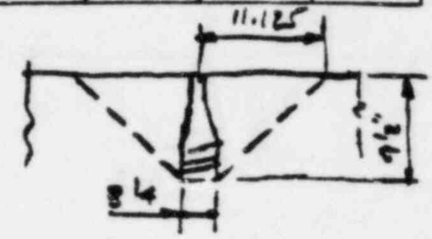
Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

Subject Richmond Insert Capacities

Calculation Number SCS - 228C SET #1 Sheet No. 5

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	BJH	3/8/84									
Checker	JB	3-9-84									

For $1\frac{1}{2}''\phi$ Richmond Insert



$$A_e = \pi(11.125)^2 - \frac{\pi}{4}(3.25)^2$$

$$= 380.53\ in^2$$

$$P_d = 4\phi\sqrt{f_c'}\ A_e$$

$$= 4 \times 0.65\sqrt{4000} \times 380.53\ in^2$$

$$= 62574\ \#$$

The allowable load is

$$P_A = \frac{1}{2}P_d = 31287\ \# \quad \text{use } 31300\ \#$$

Establishment of Ultimate Loads & Safety Factors

The above design allowables are calculated based on ACI 349 Appendix B formula using their recommended ϕ value (0.65). However, by comparing with the test result values (reference 3), it is obvious that the ϕ value used in the calculation is too conservative since the calculated concrete pullout strength for a 4000 psi concrete is less than that of a 2850 psi concrete. Therefore, a more realistic ϕ is derived based on the actual test result and this calculated ϕ value is used to establish the theoretical estimate ultimate loads.

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

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Gibbs & Hill, Inc. Job No. 2323 Client TUGCo

Subject Richmond Insert Capacities

Calculation Number SCS - 228C SET # 1 Sheet No. 6

Revision	Original Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	BJH	3/8/84									
Checker	JB	3-9-84									

for 1" ϕ insert

$$P_T = 4\phi\sqrt{f_c'}\,A_e$$

where P_T = test or actual pullout strength

= 25050 #

f_c' = test or actual concrete compressive strength

= 2850 psi

A_e = projected area of the postulated cone pullout

= 140.4 in²

$$\phi = \frac{P_T}{4\sqrt{f_c'}\,A_e} = \frac{25050}{4\sqrt{2850}\times 140.4}$$

= 0.836 use $\phi = 0.84$

for $1\frac{1}{2}$" ϕ insert

P_T = 65000 #

f_c' = 2950 psi

A_e = 380.53 in²

$$\phi = \frac{65000}{4\sqrt{2950}\times 380.53} = 0.786$$

However, the failure mode for this size insert is bolt thread failure not concrete pullout. The pullout capacity would be higher than 65000 #. Thus use $\phi = 0.84$ for this size insert also

Checking Method #
1. Line-by-line checking
2. Alternative Calculation Results compared
3. Identical Calculation Results compared
4. Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

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6

Gibbs & Hill, Inc. Job No. 2323 Client TUGCO

Subject Richmond Insert Capacities

Calculation Number SCS-228C SET #1 Sheet No. 7

Revision	Orig. Issue	Date	Rev.	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #	1	X		X		X		X		X	
Preparer	BJH	3/6/84									
Checker	JB	3-9-84									

The estimate Conc. Ultimate load can be calculated by using the following formula

$$P_E = 4\phi\sqrt{f_c'}\,A_e$$

$$= 4 \times 0.84\sqrt{f_c'}\,A_e$$

The following table lists the concrete ultimate load and the corresponding factors of safety (for the varying f_c') for the 1"φ & 1½"φ inserts

Insert Size	Ae	Design Allowable	PE = Est. Ult. loads & (Safety factors) 4000 psi	4500 psi	5000 psi
1"φ	140.4 in²	11.5 K	29.8 K (2.6)	31.6 K (2.8)	33.4 K (2.9)
1½"φ	380.53 in²	31.3 K (A325, A490)	80.9 K (2.6)	85.8 K (2.7)	90.4 K (2.9)
		** 28.1 K (A307, A36)	80.9 K (2.9)	85.8 K (3.1)	90.4 K (3.2)

** Design allowable for 1½"φ insert with A307 or A36 bolt is 28.1 K see G+H spec. 2323-SS-30 rev. 1

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

F-166, 7-82

FOR REFERENCE ONLY
REF # 3

POLYTECHNIC INSTITUTE OF BROOKLYN

BY L.P. DATE 10/17/57 DEPARTMENT

TEST DATE 10/11/57 SUBJECT Test Report

for

Richmond Screw Anchor Co., Inc.

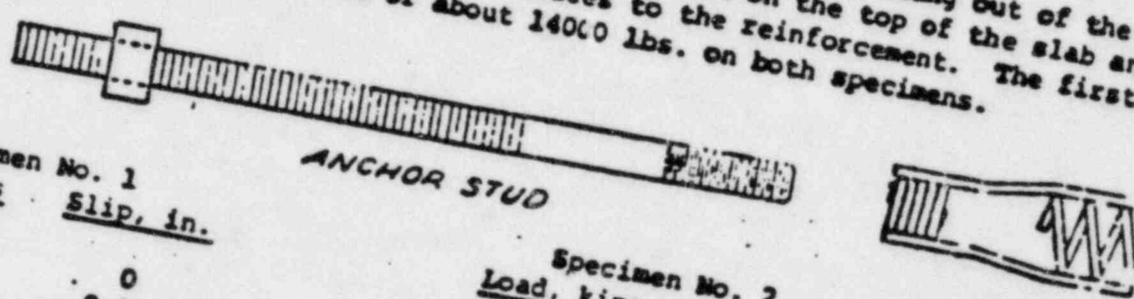
SHEET NO. 5

JOB NO.

Product: 1" diameter Richmond E.C. Type Insert with machine thread coil pul[led] from 18" x 18" x 6" concrete slab by means of 1" x 36" Anchor Stud with nuts. The insert was made of .442E wire, and its setback in t[he] concrete was 1/8". The concrete slab was reinforced with a .442 wi[re] mat, 6" x 6" center opening, located at mid-depth of the slab. The strength of the concrete was 2850 p.s.i., and the slip dial indicato[r] was zeroed in at a load of 2000 lbs.

Failure occurred in both specimens by the insert pulling out of the co[ncrete] slab. Six cracks emanated from the insert on the top of the slab and extended down on four side surfaces to the reinforcement. The first c[rack] appeared with a load of about 14000 lbs. on both specimens.

Detail:



Specimen No. 1

Load, kips	Slip, in.
2	
4	0
6	0.021
8	0.036
10	0.048
12	0.066
14	0.080
16	0.092
18	0.141
20	0.162
22	0.182
24	0.205
	0.245

Ultimate Load = 25500 lbs.

Specimen No. 2

Load, kips	Slip, in.
2	
4	0
6	0.008
8	0.015
10	0.023
12	0.044
14	0.058
16	0.072
18	0.089
20	0.107
22	0.127
24	0.149
	0.180

Ultimate Load = 24600 lbs.

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Signed: Louis J. Pignataro

Louis J. Pignataro
Asst. Professor of Civil Engineering

FOR REFERENCE ONLY
REF # 3

DEPARTMENT

BY L.P. DATE 12/23/57 SUBJECT Test Report SHEET NO. 4 OF 4

TEST DATE 12/20/57 for JOB NO.

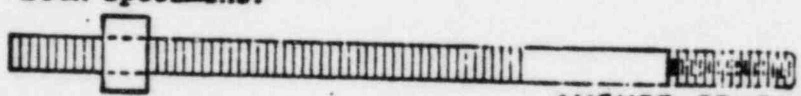
Richmond Screw Anchor Co., Inc.

PREP. BY 3/6/81
CHCK'D. BY JB 3-9-81

Product: 1 1/2" x 9 1/2" Richmond E.C. Type Insert (six struts) with machine thread coil pulled from 18" x 18" x 12" concrete block by means of 1 1/2" x 36" Anchor Stud Bolt with nuts. The setback of the insert in the concrete was 1/8". The concrete block was heavily reinforced with a cage 14" square and 12" high. The cage was made of .442 wire spaced 5" o.c. in the horizontal direction and 6" o.c. in the vertical direction. The strength of the concrete was 2950 p.s.i., and the slip dial indicator was zeroed in at a load of 2000 lbs.

Failure occurred in both specimens due to a shear failure of the machine threads on the anchor stud and in the insert. There was no evidence whatsoever of the insert pulling out of the concrete block. Prior to failure, four fine cracks emanated from the insert on the top of the block on both specimens. The first crack appeared with a load of about 48000 lbs. on both specimens.

Detail:



INSERT

Specimen No. 1 Load, kips	Specimen No. 1 Slip, in.	Specimen No. 2 Load, kips	Specimen No. 2 Slip, in.
2	0	2	0
4	0.011	4	0.017
6	0.022	6	0.035
8	0.031	8	0.048
10	0.039	10	0.058
12	0.047	12	0.068
14	0.054	14	0.077
16	0.061	16	0.086
18	0.067	18	0.095
20	0.072	20	0.103
22	0.080	22	0.111
24	0.085	24	0.119
26	0.091	26	0.126
28	0.096	28	0.135
30	0.101	30	0.143
32	0.106	32	0.152
34	0.111	34	0.159
36	0.117	36	0.170
38	0.121	38	0.178
40	0.127	40	0.188
42	0.132	42	0.197
44	0.138	44	0.206
46	0.147	46	0.217
48	0.169	48	0.437
50	0.537	50	0.520
52	0.608	52	0.659
54	0.675	54	0.690
56	0.748	56	0.739
58	0.830	58	0.929
60	0.923		

Ultimate Load = 65500 lbs. Ultimate Load = 64500 lbs.

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Signed: Louis J. Pignataro

Louis J. Pignataro
Asst. Professor of Civil Engineering

POLYTECHNIC INSTITUTE OF BROOKLYN

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DEPARTMENT

BY L.P. DATE ________ SUBJECT Test Report SHEET NO. 5 OF ____

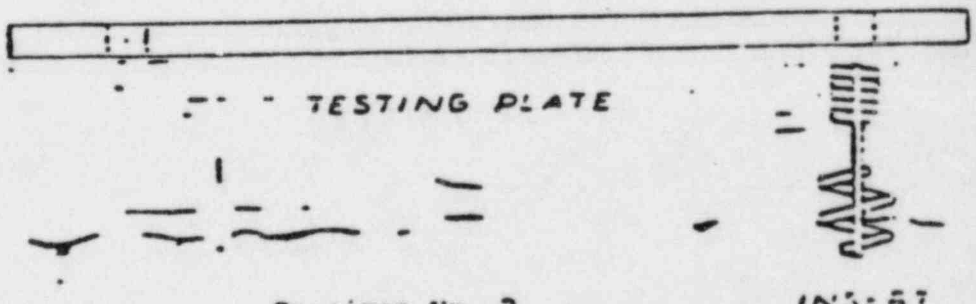
TEST DATE 01/11/65 for JOB NO. ________

Richmond Screw Anchor Co., Inc.

Product: Richmond 1" diameter E.C.-2 Structural Concrete Insert sheared from 18" x 18" x 12" concrete block by means of a testing plate: 45" long, 3 1/2" wide, 1 1/4" thick. The block was clamped on top of the testing machine with two 4" x 4" x 3/4" bracing angles. The insert was placed at the center of the 18" x 18" face and installed flush with the surface of the concrete. The concrete block was reinforced with a .440 wire mat, 6" x 6" center opening, located at mid-depth of the block. The strength of the concrete was 3220 psi, and the slip dial indicator was zeroed in at a load of 2000 lbs. The testing bolt was snugly tightened using a 12" monkey wrench. The shear load was applied perpendicular to the plane of the struts.

Failure occurred in both specimens due to a shear failure of the testing bolt at the face of the block. The concrete spalled in a 3" radius, semi-circular patch below the insert, and there was no further cracking of concrete.

Detail:



Specimen No. 1

Load, kips	Slip, in.
2	0
4	0.027
6	0.050
8	0.070
10	0.082
12	0.097
14	0.110
16	0.123
18	0.140
20	0.161
22	0.214
24	0.315
26	0.445

Ultimate Load = 26,800 lbs.

Specimen No. 2

Load, kips	Slip, in.
2	0
4	0.022
6	0.043
8	0.063
10	0.081
12	0.100
14	0.120
16	0.140
18	0.162
20	0.192
22	0.265
24	0.400
26	0.515

Ultimate Load = 27,200 lbs.

1"ϕ

ave: 27,000

Louis O. Pionataro

FACTOR OF SAFETY OF RICHMOND INSERT FOR CPSES BASED ON THE 1983 & 1984 FIELD TEST DATA

Background

The maximum working allowables for the 1"Ø and 1 1/2"Ø Richmond inserts recommended by the Richmond Screw Insert Anchor Co. in their Bulletin No. 6 are based on limited tension and shear tests conducted at the Polytechnic Institute of Brooklyn in 1957 and 1965. These test inserts were embedded in concrete with a nominal ultimate compressive strength of 3000 psi with minimal reinforcement.

The inserts at CPSES are embedded in concrete with a minimum ultimate compressive strength of 4000 psi (actual compressive strength is about 4500 psi) and more heavily reinforced. For this reason, G&H established the allowable values as shown in Specification SS-30 Appendix 3 which are moderately higher than those recommended by the Richmond Screw Anchor Co. Consequently, the G&H allowables result in a factor of safety of less than 3 when compared with the Richmond test loads. The basis and the methodology used in establishing the G&H allowables are explained in the response to ASLB question Item 8(i).

FIELD TEST PROGRAM

To put the factors of safety utilized for the Richmond anchors at CPSES in prospective and to establish the actual factors of safety, a series of controlled tests were performed utilizing the same concrete mix and representative reinforcing steel as used for the plant construction. The test was in accordance with ASTM E-488 "Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements."

Five tests each on shear tension and combined shear and tension were performed in April 1984 on the 1"Ø and 1 1/2"Ø inserts. Also, nine 1 1/2"Ø inserts were tested in shear in March 1983.

FACTORS OF SAFETY OF INSERTS

(a) Service Load Conditions(Normal & Upset Conditions):

Maximum allowable working loads specified in G&H Specification SS-30 are used and compared with the test failure loads to establish the factors of safety. These are the factors of safety against insert failures (failure of insert, insert shear cone or both). The factors of safety of the anchor bolts used with the insert are not part of the test program as the anchor bolt working allowables used in SS-30 are based on AISC specification allowable values.

The factors of safety for the service load conditions are above 3 for tension shear and the combined tension and shear test loads on the 1"Ø and 1 1/2"Ø inserts. Table A lists the factors of safety for each group of inserts. The factors of safety for the combined loads are based on insert interaction formula given in SS-30 Appendix 3, Page 2 of 10.

$$\left(\frac{T}{T'}\right)^{4/3} + \left(\frac{S}{S'}\right)^{4/3} \leq 1$$

Since the minimum factor of safety, in all cases, is above 3 which exceeds the Richmond's factor of safety recommendation of 3, the working allowables in SS-30 for Richmond inserts are well justified and are conservative.

(b) Factored Load Conditions (Emergency and Faulted Conditions): Allowable loads under factored load conditions are higher than those of the service load conditions. Based on FSAR, for steel design, the factored load allowables are equal to 1.6 times the normal (service) allowable loads. By applying the same ratio on the inserts, 3 ÷ 1.6 the minimum factor of safety is reduced to 1.87 for the factored load conditions.

ACI-349 "Code Requirements for Nuclear Safety Related Concrete Structures", Appendix B - Steel Embedments Section B.8.1 and B.8.2 stated that "Design allowable shall be based on actual test data of tests performed on inserts embedded in concrete....., A Ø factor of 0.5 shall be applied to the average test failure loads in determining strength requirements." This implied that a factor of safety of 2 for insert for factored loads.

Similarly, ASME code allows increased allowable for the factored loads. However, no specific values are given for the inserts.

Based on the above understanding, the recommended factor of safety for Richmond inserts under factored load conditions should be in the range of 1.8 to 2.0 and 1.8 as a minimum.

In 1982, G&H issued allowable loads for the Emergency and Faulted conditions for the 1"0 and 1 1/2"Ø Richmond inserts. These allowable loads are shown on DCA-15338. The factors of safety for these allowables against the test failure loads range from a low of 1.8 to a high of 4.6 which meet or exceed the recommended minimum factor of safety requirement for inserts under factored loads. Thus, the above DCA factored load values are justified and are valid for use. Table B lists in detail the factors of safety results.

TABLE A F.S. OF R.I. UNDER

SERVICE LOAD CONDITIONS

Maximum allowable working loads specified in Specification SS-30 are used and compared with the test failure loads to establish the factors of safety.

GROUP A: BASED ON THE 1984 TEST

Size	Bolt Type	Load	SS-30 Allowables	Test Failure Load	*Failure Mode	F.S.
	A307/A36	Tension	11.5^K	41.28^K	C&I	3.6
		Shear	7.85^K	40.28^K	B,I&C	5.1
1"Ø		Combined	11.5^K & 7.85^K	28.36^K	B	5.2
	A325/A490	Tension	11.5^K	41.28^K	C&I	3.6
		Shear	11.5^K	40.28^K	B,I&C	3.5
		Combined	11.5^K & 11.5^K	28.36^K	B	4.2
	A307/A36	Tension	28.11^K	101.96^K	B,I&C	3.6
1½"Ø		Shear	17.67^K	94.34^K	B	5.3
		Combined	28.11^K & 17.67^K	63.47^K	B&I	5.0
	A325/A490	Tenson	31.3^K	101.96^K	B,I&C	3.3
		Shear	26.51^K	94.34^K	B	3.6
		Combined	31.3^K & 26.51^K	63.47^K	B&I	3.7

TABLE A

GRCUP B: BASED ON THE 1983 TEST

Size	Bolt Type	Load	SS-30 Allowables	Test Failure Load	Failure Mode	F.S.
1½"Ø	A307/A36	Shear	17.67^K	61.83^K	**	3.5
	A325/A490	Shear	26.51^K	92.42^K	**	3.5

* Failure Mode: B = Bolt; I = Insert; C = Concrete Cone

** Tests were halted before failure.

TABLE B F.S. OF R.I. UNDER

EMERGENCY (E) & FAULTED (F) CONDITIONS

Allowable loads as shown on DCA-15338 are used and compared with the test failure loads to establish the factors of safety.

GROUP A - BASED ON THE 1984 TEST

Size	Bolt Type	Load	Condition	DCA Allowables	Test Failure Load	*Failure Mode	F.S
	A307/A36	Tension	E&F	19.4K	41.28K	G&I	2.1
		Shear	E	8.78K	40.28K	B,I&C	4.6
		Shear	F	9.7K	40.28K	B,I&C	4.2
1"Ø		Combined	F	19.4K & 9.7K	28.36K	B	3.8
	A325/A490	Tension	E&F	22K	41.28K	C&I	1.9
		Shear	E	18.17K	40.28K	B,I&C	2.2
		Shear	F	18.85K	40.28K	B,I&C	2.1
		Combined	F	22K & 18.85K	28.36K	B	2.4
	A307/A36	Tension	E&F	45.12K	101.96K	B,I&C	2.3
		Shear	E	20.56K	94.34K	B	4.6
1½"Ø		Shear	F	22.56K	94.34K	B	4.2
		Combined	F	45.12K & 22.56K	63.47K	B&I	3.6
	A325/A490	Tension	E&F	58K	101.96K	B,I&C	1.8
		Shear	E	37.23K	94.34K	B	2.5
		Shear	F	42.4K	94.34K	B	2.2
		Combined	F	58K & 42.4K	63.47K	B&I	2.2

TABLE B

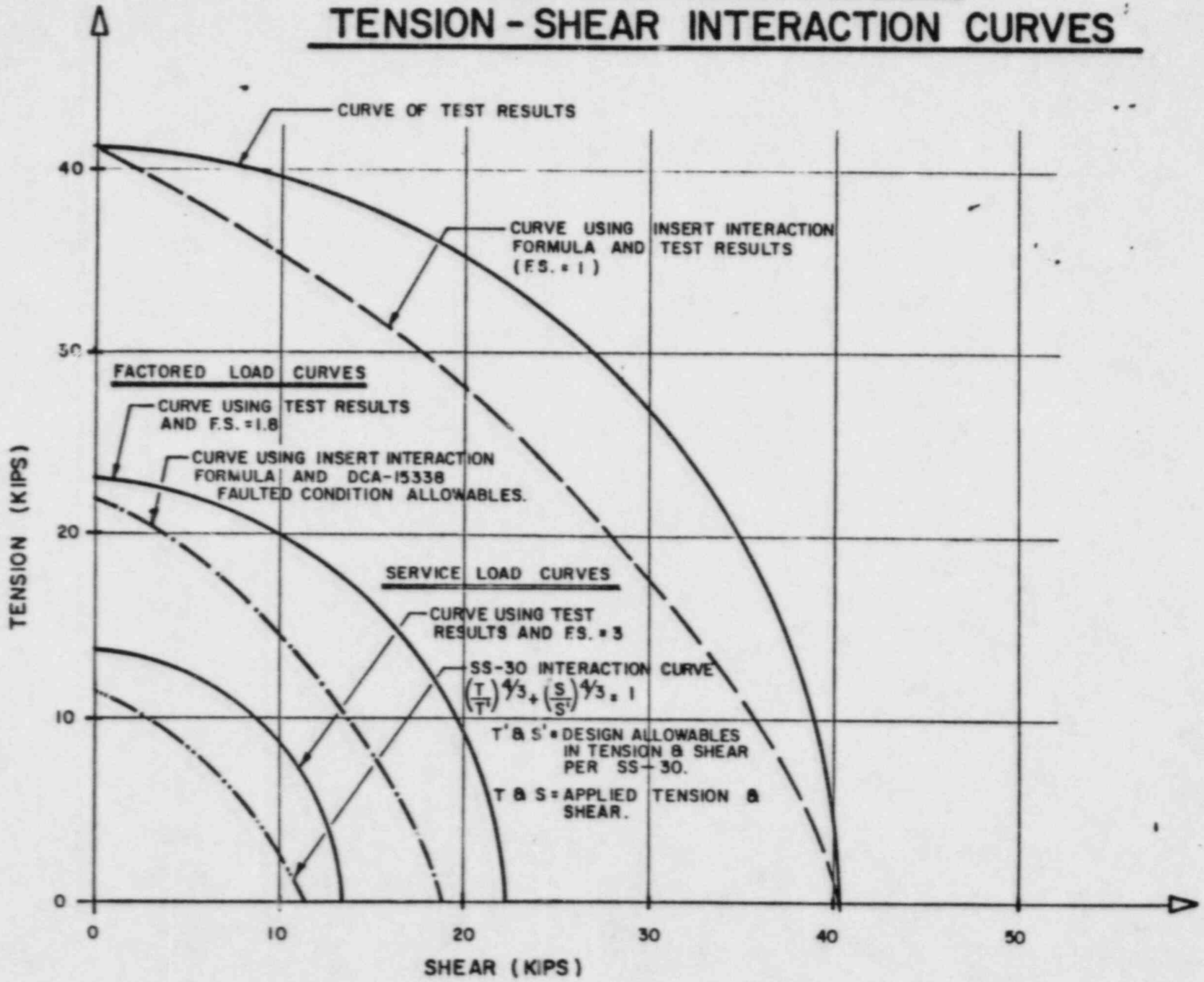
GROUP B - BASED ON THE 1983 TEST

Size	Bolt Type	Load	Condition	DCA Allowables	Test Mode	Failure Mode	F.S.
	A307/A36	Shear	E	20.56^K	61.83^K	**	3.0
1½"Ø		Shear	F	22.56^K	61.83^K	**	2.8
	A325/A490	Shear	E	37.23^K	92.42^K	**	2.5
		Shear	F	42.4^K	92.42^K	**	2.2

*Failure Mode: B = Bolt; I = Insert; C = Concrete Cone

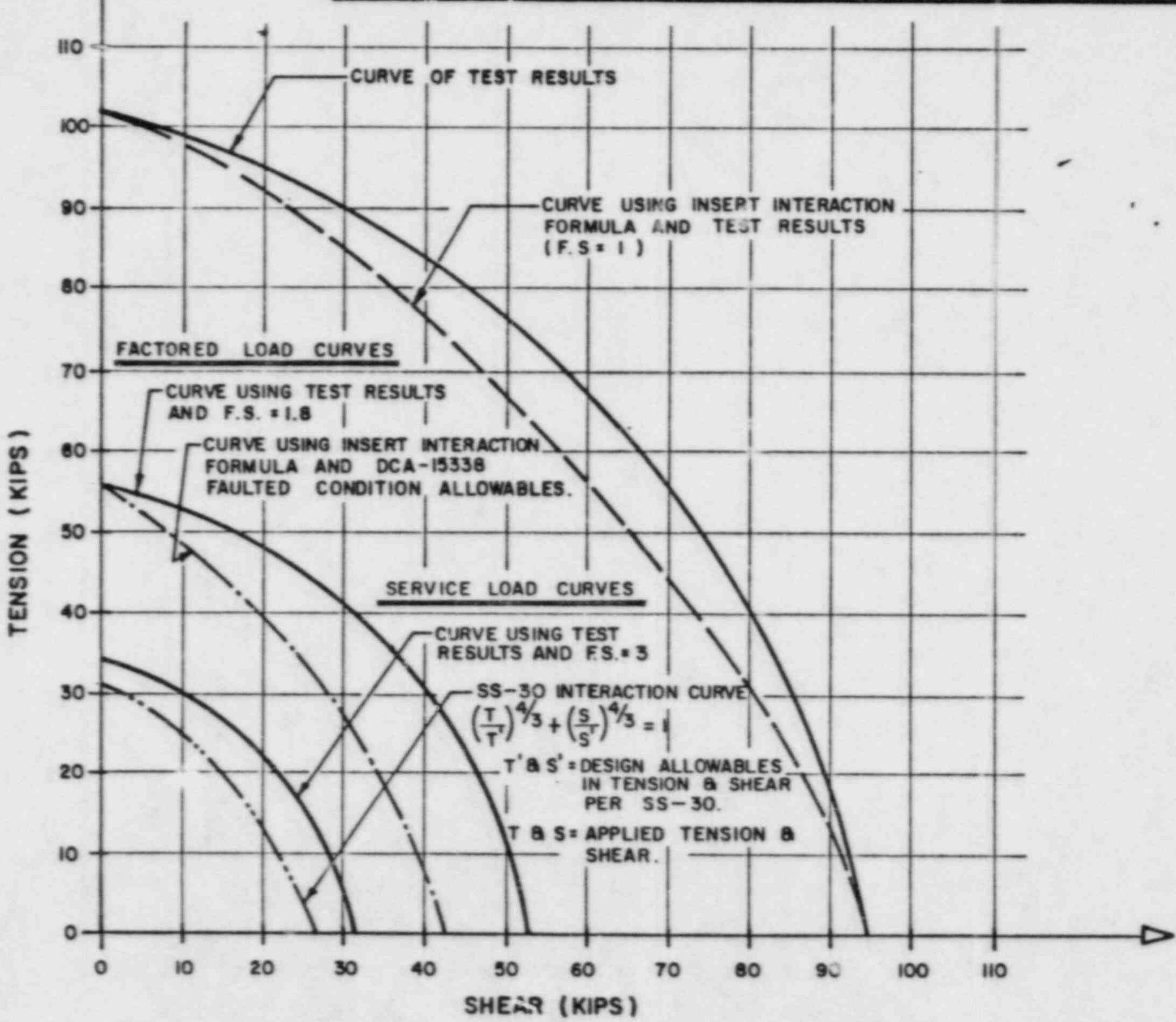
**Tests were halted before failure.

1"ø RICHMOND INSERT
TENSION - SHEAR INTERACTION CURVES



1½"ø RICHMOND INSERT

TENSION - SHEAR INTERACTION CURVES



ALLOWABLE LOADS OF 1½"ø RICHMOND INSERTS (EC6W) AND BOLTS TO BE USED IN INTERACTION FORMULAS FOR WALLS, SLABS & COLUMNS

I: INSERT CAPACITY B: BOLT CAPACITY T: TENSION S: SHEAR

CONCRETE THICKNESS		INSERT SPACING ON 20"C/C BOTH WAYS				INSERT SPACING ON 22"C/C OR MORE BOTH WAYS (FULL CAPACITY)			
		A-307 BOLTS OR A-36 THD. RODS USED WITH INSERT		A-325 OR BETTER BOLTS USED WITH INSERT		A-307 BOLTS OR A-36 THD. RODS USED WITH INSERT		A-325 OR BETTER BOLTS USED WITH INSERT	
		T	S	T	S	T	S	T	S
12" OR THICKER	I	25	25	25	25	[redacted]	[redacted]	31.3	[redacted]
	B	28.11	17.67	56.21	26.51	28.11	17.67	[redacted]	26.51

TABLE I (Contd.)

(APPENDIX 3
PAGE 7 OF 10)

ALLOWABLE LOADS OF 1"ø RICHMOND INSERTS (EC2W) AND BOLTS TO BE USED IN INTERACTION FORMULAS FOR WALLS, SLABS & COLUMNS

I: INSERT CAPACITY B: BOLT CAPACITY T: TENSION S: SHEAR

CONCRETE THICKNESS		INSERT SPACING ON 10"C/C BOTH WAYS				INSERT SPACING ON 12"C/C BOTH WAYS				INSERT SPACING ON 14"C/C OR MORE BOTH WAYS (FULL CAPACITY)			
		A-307 BOLTS OR A-36 THD. RODS USED W/INSERT		A-325 OR BETTER BOLTS USED W/INSERT		A-307 BOLTS OR A-36 THD. RODS USED W/INSERT		A-325 OR BETTER BOLTS USED W/INSERT		A-307 BOLTS OR A-36 THD. RODS USED W/INSERT		A-325 OR BETTER BOLTS USED W/INSERT	
		T	S	T	S	T	S	T	S	T	S	T	S
10" OR THICKER	I	6	6	6	6	8.85	8.85	8.85	8.85	11.5	[redacted]	11.5	11.5
	B	12.11	7.85	24.23	11.78	12.11	7.85	24.23	11.78	[redacted]	7.85	[redacted]	[redacted]

TABLE I (Contd.)

ALLOWABLE LOADS ON 1"ϕ INSERTS

I = INSERT CAPACITY
B = BOLT CAPACITY
T = TENSION
S = SHEAR
E = EMERGENCY
F = FAULTED

CONCRETE THICKNESS			INSERT SPACING ON 10" C/C BOTHWAYS				INSERT SPACING ON 14" OR MORE BOTHWAYS			
			A307 BOLTS OR A36 THRD. RODS USED W/INSERT		A325 OR BETTER BOLTS USED W/INSERT		A307 BOLTS OR A36 THRD. RODS USED W/INSERT		A325 OR BETTER BOLTS USED W/INSERT	
			T	S	T	S	T	S	T	S
10" OR THICKER	I	E	12	12	12	12	[redacted]	[redacted]	22	[redacted]
		F	12	12	12	12	[redacted]	[redacted]	22	[redacted]
	B	E	19.4	8.78	48.36	18.17	19.4	8.78	[redacted]	18.17
		F	19.4	9.7	50.18	18.85	19.4	9.7	[redacted]	18.85

ALLOWABLE LOADS ON $1\frac{1}{2}$"ϕ INSERTS

CONCRETE THICKNESS			INSERT SPACING ON 20" C/C BOTHWAYS				INSERT SPACING ON 22" OR MORE BOTHWAYS			
			A307 BOLTS OR A36 THRD. RODS USED W/INSERT		A325 OR BETTER BOLTS USED W/INSERT		A307 BOLTS OR A36 THRD. RODS USED W/INSERT		A325 OR BETTER BOLTS USED W/INSERT	
			T	S △1	T	S	T	S	T	S
12" OR THICKER	I	E	50	48.6	50	48.6	[redacted]	[redacted]	58	[redacted]
		F	50	48.6	50	48.6	[redacted]	[redacted]	58	[redacted]
	B	E	45.12	20.56	98.45	37.23	45.12	20.56	[redacted]	37.23
		F	45.12	22.56	102.8	42.4	45.12	22.56	[redacted]	42.4

INTERACTION :

FOR BOLTS :

$$\left\{\frac{T}{T_A}\right\}^2 + \left\{\frac{S}{S_A}\right\}^2 \leq 1$$

FOR INSERTS :

$$\left\{\frac{T}{T_A}\right\}^{4/3} + \left\{\frac{S}{S_A}\right\}^{4/3} \leq 1$$

WHERE

T = ACTUAL TENSION ON BOLT/INSERT
T_A = ALLOWABLE TENSION ON BOLT/INSERT
S = ACTUAL SHEAR ON BOLT/INSERT
S_A = ALLOWABLE SHEAR ON BOLT/INSERT

10-6-82

REV. 1	
ATTACH. TO GTN-	

DCA - 15338

ATTACHMENT A

TEST REPORT

SHEAR TESTS

ON

RICHMOND 1 1/2-INCH TYPE EC-6W INSERTS

MARCH 30, 1983

Prepared by

J.C. Gilbreth, P.E.

J.C. Gilbreth
Civil Engineer

Approved by

R.M. Kissinger, P.E.

R.M. Kissinger
Project Civil Engineer

TABLE OF CONTENTS

TEST REPORT

SHEAR TESTS

ON

RICHMOND 1 1/2-INCH TYPE EC-6W INSERTS

1.0 REFERENCES

1-A CP-EP-13.0 Test Control

1-B CP-EI-13.0-8 1 1/2" Richmond Insert Shear Tests

2.0 GENERAL

2.1 PURPOSE AND SCOPE

These tests were performed to determine the characteristics of Richmond 1 1/2-Inch Type EC-6W Inserts when installed in concrete representative of that used in the power block structures at CPSES and subjected to shear-type loading. The strength, deflections, and type of deformations produced by this loading were the qualities to be determined. This series of tests employed only 1 1/2"-Inch Type EC-6W Inserts subjected to shear loads.

2.2 RESPONSIBILITY

The tests were performed under the direction of the CP Project Civil Engineer. Witnesses to the tests were: A Nuclear Regulatory Commission (NRC) Representative from the Arlington, Texas Regional Office, the NRC Inspector stationed at CPSES, a TUSI site Quality Assurance representative, and other site engineering personnel.

2.3 TEST APPARATUS

The arrangement and details of the test apparatus are shown on Drawing No. FSC-00464, Sheet 1, included in Appendix 1 to this report. The insert specimens tested were taken at random from the Constructor's stock on site and were; therefore, representative of those installed in the plant structures. They were placed in a thick concrete slab cast specifically for these tests and which was composed of materials and reinforcement similar to those elements of the plant buildings. This is "4000-pound concrete" (28-day strength). The laboratory test report on the concrete of which this slab is composed is included here in Appendix 1.

An apparatus for applying shear loads to the specimens was designed and built on site. This facility employed a 60-ton capacity manually operated hydraulic ram whose thrust against a crosshead was transmitted by tension rods to a 1 1/2-inch thick shear plate bolted to the insert specimen. Base reaction of the ram was transmitted through a structural steel grillage to the outer face of the concrete slab. Ram thrust was determined by multiplying the fluid pressure (PSI), as indicated by a gauge on the pump, by a number equal to the ram piston area in square inches. Deflections were measured by a dial indicator mounted on a remotely anchored bracket and with its spring-loaded probe in contact with the specimen bolt head or bottom nut where threaded rods were used. These instruments bore valid stickers showing them to be currently in calibration.

3.0 PROCEDURE

In performance of the tests, inserts were cleaned of concrete mortar and other trash that would affect bolt thread engagement. The shear plate was attached to the specimen insert by a suitable length bolt or threaded rod of type shown on the test data sheets, Appendix 2. A new and different bolt was used for each insert. These fasteners were tighteded "snug tight". On three specimens the shear plate was attached in direct contact with the top of the insert. On six other specimens a 1-inch thick plate was inserted between the shear plate and the insert, representing the "washer" used frequently at this location in pipe hanger installation. Shear loads were applied by the ram by operation of the manual pump. As the load increased from zero (o), indications of fluid pressure (later converted to load) and bolt head deflection were read at regular intervals . These intervals were at 400 PSI on the pressure gauge, corresponding to 5300 pounds thrust. Load application on each specimen was halted before failure occured and when the load had reached a size considered to be sufficient in comparison with the design load values. At this point in each test, the NRC Representative indicated his concurrence with this consideration. After this, the load was removed, the apparatus detached, and observation was made of the condition of the specimen.

4.0 RESULTS

As can be seen on the test data sheets, the maximum load applied to specimens on which ASTM A490 bolts were used ranged from 88,110 lb. to 95,400 lb.. The bolts could be seen, after removal from the insert, to be slightly bent. By measuring the distance of the bolt tip from a line perpendicular to the bolt head these deflections were approximately as follows:

Fastener Type	Specimen No.	Bolt Length	Deflection of Tip
A-490	1	4 1/2-in.	0.0 in.
A-490	2	5 1/2 in.	0.05 in.
A-490	3	5 1/2 in.	0.10 in.
A-490	4	4 1/2 in.	0.05 in.
A-490	5	5 1/2 in.	0.10 in.
A-490	6	4 1/2 in.	0.0 in.

Other than these deformations, no bolt showed signs of incipient failure.

Loading of the three specimens employing a double-nutted SA-36 threaded rod for attaching the shear plate and including the 1-inch washer plate produced a reverse curve in the threaded rod. The offset between the approximately parallel ends of each rod was approximately as follows:

Specimen No.	Offset
7	0.4 in.
8	.4 in.
9	.4 in.

The fact that the end portions of rods were not truly parallel accounts for the difference in deflection measured at the bottom nut on the rods. Although these deflections were experienced, there was no sign of imminent failure of either the threaded rod, the insert, or the concrete.

There was small spalling of concrete around the top of some inserts. This allowed the top of insert to deflect laterally and in the case of Specimen No. 1 to deform to a small extent. However, in no part of any test specimen did breakage or complete failure appear to be imminent. In each case at the time operation of the hydraulic pump was halted, the applied load was increasing, showing that neither the insert nor fastener had reached its maximum load carrying capability.

The factor of safety for each specimen based on these maximum applied loads is shown in the following table.

FACTORS OF SAFETY

BASED ON

MAXIMUM APPLIED LOAD

Fastener	Specimen Number	Maximum Applied Shear Load (Kips)	Factor of Safety F.S. = Max. Applied Load / Design Allowable Ld.
A-490 Bolt w/ 1" Shim PL	1	88.1 *	88.1/26.51 = 3.32
	3	90.1	90.1/26.51 = 3.40
	5	95.4	95.4/26.51 = 3.60
A-490 Bolt w/o 1" Shim PL	2	95.4	95.4/26.51 = 3.60
	4	95.4	95.4/26.51 = 3.60
	6	90.1	90.1/26.51 = 3.40
SA-36 Threaded Rod w/ 1" Shim PL	7	58.3	58.3/17.67 = 3.30
	8	63.6	63.6/17.67 = 3.60
	9	63.6	63.6/17.67 = 3.60

* Load halted due to dial indicator for deflection having reached its limit of travel.

5.0 CONCLUSION

These test results show that the performance capabilities of the Richmond Insert in shear exceed the design allowable by a ratio of more than 3 to 1. Thus, a minimum factor of safety of 3 is indicated. The test results for the specimens with the 1" thick washer are comparable to the test results for the specimens without the washer. This indicates that the presence of the washer had little effect on the performance of the bolt or the Richmond Insert. If additional bending stresses are introduced into the bolt as a result of the presence of the 1" thick washer, the test results show that it is not significant enough to distinguish the difference.

Based on this test, the design allowables for shear loading are acceptable for use without further investigation or additional calculations.

APPENDIX 1

NOTE: 017-9840-001 (Test Block)

APP. - 1

COMANCHE PEAK STEAM ELECTRIC STATION

REPORT ON COMPRESSIVE TESTS OF CONCRETE

PROCEDURE CP-CP11.1-41

DATE 2-11-83
POUR NO. Site G-7?
CYL. SET NO. 2315

MIX — COMPLETE DATA AS APPLICABLE FROM BATCH TICKET

(a) MOIST ADDR.	F.A.	H_2O F.A.	C.A.	H_2O C.A.	TOTAL WATER/BATCH	TYPE OF CURING
	6120 LBS.	120 LBS	8460 LBS.	0 LBS	1183 LBS	M?W

CEMENT / CU. YD.	H_2O ADDED	H_2O/CEMENT RATIO	AIR CU.YD.	TOTAL AIR	SPECIFIED DESIGN STRENGTH
3157 LBS	4 GAL.	.376	11.6 1/2 OZ.	58 1/2 OZ.	4000 PSI 28 DAYS

MATERIALS

BRAND OF CEMENT	TYPE OF CEMENT	BRAND OF AIR ENTRAINING ADMIXTURE	BRAND OF WATER REDUCING ADMIXTURE	MAX SIZE C.A.
C-H	II	MB VR	II	3/4

SOURCE C.A.	SP. GR. C.A.	SOURCE F.A.	SP. GR. F.A.	FINENESS MODULES F.A.
TXI Cleburne	2.63	TXI Cleburne	2.63	2.51

SAMPLING

TYPE OF MIXING	BATCH LOAD	TICKET NO.	SAMPLE TAKEN AT:
Plant I	5 C.Y.	62256	☐ CENTRAL MIXER ☐ FORMS ☑ POINT OF DISCHARGE

METHOD OF PLACING	DATE SAMPLED	HOUR	WEATHER	AIR TEMP.	CONC. TEMP.	SLUMP
☐ BUGGIES ☐ BELT ☐ CHUTE ☑ PUMP ☐ BUCKET	2-11-83	1957 PM	Clear	50 °F	64 °F	3 3/4 IN

TIME OF MIXING AT CENTRAL PLANT	UNIT WT. CU. FT.	MIX I.D.	SPECIMEN TAKEN BY	SPECIMEN CAST BY	AIR
70 Revs	144.56 LBS	132	Osborne	RG-IAS	5.2%

TESTS

	CYLINDER ID.	AGE	MEASURED DIA. IN.	AVG. DIA. IN.	DATE CAPPED	CAPPED BY	TIME TESTED	DATE TESTED	MAX LOAD LB.	COMPRESSIVE STRENGTH	CAP CHECKED BY	CYLINDER TESTED BY	TYPE OF BREAK
LAB CURED	2315-A	7	6.010 / 6.002	6.006	2-13-83	[illegible]	0728	2-18-83	94500	3340	[illegible]	[illegible]	[illegible]
LAB CURED	2315-B	7	5.991 / 6.022	6.007	2-13-83	[illegible]	0730	2-18-83	95500	3370	[illegible]	[illegible]	[illegible]
LAB CURED	2315-C	28	6.014 / 6.004	6.009	3-9-83	[illegible]	0706	3-11-83	159,000	5610	R.G.	R.G.	REG.
LAB CURED	2315-D	28	[illegible]	6.012	3-9-83	[illegible]	0702	3-11-83	158,000	5570	R.G.	R.G.	REG.
FIELD CURED	2315-E	28	[illegible]	6.009	3-9-83	[illegible]	0658	3-11-83	132,000	4650	R.G.	R.G.	REG.
FIELD CURED	2315-F	28	6.003 / 6.003	6.003	3-9-83	[illegible]	0655	3-11-83	129,500	4570	R.G.	R.G.	REG.
FIELD CURED	NA												
FIELD CURED	NA												

DATE & TIME STRIPPED: 2-12-83 1230 PM

REMARKS:

CURING CONTROL TEST RESULTS
FOR 28 DAY BREAK

LABORATORY CURED CYLINDER(S)

STRENGTH (P.S.I.) 5610 (c)

5570 (d)

1. (E)+(F) ÷ (C)+(D) = 0.82 *

FIELD CURED CYLINDERS

STRENGTH (P.S.I.) 4650 (E)

4570 (F)

2. (E)+(F) ÷ 2 = 4610 *

*NOTE: (1) ABOVE MUST BE EQUAL TO OR GREATER THAN 0.85; OR (2) ABOVE NEED NOT EXCEED THE DESIGN STRENGTH BY MORE THAN 500 PSI EVEN THOUGH THE 0.85 CRITERION IS NOT MET.

MEASURING CALIPERS NO. AITE-1392
COMPRESSION MACHINE NO. AITE-2031
CAPPING MOLD NO. L101-L102

7 DAY PREPARED BY [illegible] CHECKED BY IAS
28 DAY PREPARED BY R.G. CHECKED BY IAS

PROBLEMS AND/OR COMMENTS (IF APPLICABLE)

FOR INFORMATION ONLY!

[signature]
TUGCO LAB SUPV/QA

NOTE: 017-9840-001 (Test Block)

APP. 1

COMANCHE PEAK STEAM ELECTRIC STATION

REPORT ON COMPRESSIVE TESTS OF CONCRETE

PROCEDURE QI-QP-11.1-4?

DATE 2-11-83
POUR NO. Test Block
CYL. SET NO. 2315

MIX							
COMPLETE DATA AS APPLICABLE FROM BATCH TICKET	(a) MOIST AGGR.	F.A. 6120 LBS	H_2O F.A. 120 LBS	C.A. 8460 LBS	H_2O C.A. 0 LBS	TOTAL WATER/BATCH 1188 LBS	TYPE OF CURING M&W
	CEMENT / CU YD. 357 LBS	H_2O ADDED 4 GAL.	H_2O/CEMENT RATIO .376	AIR CU. YD. 11.6 1/2 OZ.	TOTAL AIR 58 1/2 OZ.	SPECIFIED DESIGN STRENGTH 4000 PSI 28 DAYS	

MATERIALS				
BRAND OF CEMENT: C-A	TYPE OF CEMENT: I	BRAND OF AIR ENTRAINING ADMIXTURE: MBVR	BRAND OF WATER REDUCING ADMIXTURE: N/A	MAX SIZE C.A. 3/4
SOURCE C.A. Tx Cleburne	SP. GR. C.A. 2.63	SOURCE F.A. Tx Cleburne	SP. GR. F.A. 2.63	FINENESS MODULUS F.A. 2.51

SAMPLING						
TYPE OF MIXING: Plant 1	BATCH LOAD: 5 C.Y.	TICKET NO. 62256	SAMPLE TAKEN AT: ☐ CENTRAL MIXER ☐ FORMS ☒ POINT OF DISCHARGE			
METHOD OF PLACING: ☑ PUMP ☐ BUCKET ☐ BUGGIES ☐ BELT ☐ CHUTE		DATE SAMPLED 2-11-83	HOUR 1957 PM	WEATHER Clear	AIR TEMP. 50 °F	CONC. TEMP. 64 °F / SLUMP 3 3/4 IN.
TIME OF MIXING AT CENTRAL PLANT: 70 Revs	UNIT WT. CU. FT. 144.56 LBS.	MIX I.D. 132	SPECIMEN TAKEN BY Osborne	SPECIMEN CAST BY RG-IAS	AIR 5.2 %	

TESTS

	CYLINDER I.D.	AGE	MEASURED DIA. IN.	AVG. DIA. IN.	DATE CAPPED	CAPPED BY	TIME TESTED	DATE TESTED	MAX. LOAD LB.	COMPRESSIVE STRENGTH	CAP CHECKED BY	CYLINDER TESTED BY	TYPE OF BREAK
LAB CURED	NA												1
LAB CURED	NA												2
LAB CURED	NA												2
LAB CURED	NA												3
FIELD CURED	2315	3	6.008 / 6.013	6.011	2-14-83	IAS	6:59 PM	2-14-83	55500	1960	IAS	IAS	Reg
FIELD CURED	2315	4	6.012 / 6.004	6.008	2-15-83	[initials]	6:59 PM	2-15-83	64,500	2280	[initials]	[initials]	Reg
FIELD CURED	2315	5	6.009 / 5.995	6.002	2-16-83	[initials]	6:59 PM	2-16-83	67,000	2370	R.G.	R.G.	Reg
FIELD CURED	NA												1

DATE & TIME STRIPPED: 2-12-83 1230 PM

REMARKS:

CURING CONTROL TEST RESULTS
FOR 28 DAY BREAK

LABORATORY CURED CYLINDER(S)
STRENGTH (P.S.I.) NA (c)
(d)
1. (d) ÷ (c) = (c)(d) = *

FIELD CURED CYLINDER(S)
STRENGTH (P.S.I.) NA (a)
(b)
2. (a) ÷ (b) ÷ 2 = *

*NOTE: (1) ABOVE MUST BE EQUAL TO OR GREATER THAN 0.85; OR (2) ABOVE NEED NOT EXCEED THE DESIGN STRENGTH BY MORE THAN 500 PSI EVEN THOUGH THE 0.85 CRITERION IS NOT MET.

MICROMETER OR CALIPERS NO. MTE-1392
COMPRESSION MACHINE NO. MTE-3031
CAPPING MOLD NO. L-111-6102

3 DAY PREPARED BY IAS CHECKED BY [initials]
4 DAY PREPARED BY [initials] CHECKED BY IAS
5 Day Prepared By [initials] Checked By IAS

ORIGINAL CYLINDERS COMPLETED (IF APPLICABLE)

FOR Information Only!

[signature]
TUGCO LAB SUPERVISOR

APPENDIX 2

TEST DATA SHEETS

APPENDIX

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 1 DATE 22 March 83

BOLT SPEC: A-490 W/SHIM PL. ✓ W/O SHIM PL. ____

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
~~0.10~~	~~400~~		
~~.40~~	~~800~~		
~~.80~~	~~1200~~		
0.023	400	5,300	
0.041	800	10,600	
.055	1200	15,900	
.083	1600	21,200	
.105	2000	26,500	
.138	2400	31,800	
.168	2800	37,100	
.200	3200	42,400	
.230	3600	47,700	
.270	4000	53,000	
.306	4400	58300	Started Yield – Jack load floated due probably to pump leakage.
.360	4800	63,600	
.452	5200	68,900	
.530	5600	74,200	
.613	6000	79,500	
.377	6400	84,800	
1.000	6600	88,110	Insert [illegible] over – relief [illegible] on tension side

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

[signature] 22 March 83
DATE

[signature] 3-22-83
QA REPRESENTATIVE DATE

APPENDIX

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 2 DATE 22 March '83

BOLT SPEC: A - 490 W/SHIM PL. ____ W/O SHIM PL. ✓

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.010	400	5,300	
.028	800	10,600	
.062	1200	15,900	
.094	1600	21,200	
.130	2000	26,500	
.172	2400	31,800	
.212	2800	37,100	
.254	3200	42,400	
.285	3600	47,700	
.306	4000	53,000	
.326	4400	58,300	
.348	4800	63,600	
.371	5200	68,900	
.400	5600	74,200	
.434	6000	79,500	
.472	6400	84,800	
.513	6800	90,100	
.560	7200	95,400	Concrete failure - cone type spall
			in bottom - prying action.
			Spall - approx. 7" diam.

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

Joe Halleth 3-22-83 Victor McDermott 3-22-83

DATE QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 3 DATE 22 March 83

BOLT SPEC: A-490 W/SHIM PL. ✓ W/O SHIM PL.

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.018	400	5,300	
0.053	800	10,600	
0.086	1200	15,900	
0.130	1600	21,200	
.145	2000	26,500	
.175	2400	31,800	
.207	2800	37,100	
.248	3200	42,400	
.304	3600	47,700	
.365	4000	53,000	
.417	4400	58,300	
.463	4800	63,600	
.508	5200	68,900	
.559	5600	74,200	Concrete started spall
.612	6000	79,500	
.668	6400	84,800	
.725	6800	90,100	
			Concrete spalled around upper
			part of insert permitting lateral
			deflection of insert.

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June 83

DIAL GAUGE: M&TE NUMBER 2044 DUE DATE: 20 June 83

PERFORMED BY: WITNESSED BY:

[signature] 3-22-83 [signature] 3-22-83
DATE QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 4 DATE 22 Mar '83

BOLT SPEC: A-490 W/SHIM PL.____ W/O SHIM PL. ✓

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.004	400	5,300	
.019	800	10,600	
.043	1200	15,900	
.070	1600	21,200	
.100	2000	26,500	
.132	2400	31,800	
.165	2800	37,100	
.198	3200	42,400	
.249	3600	47,700	
.308	4000	53,000	
.380	4400	58,300	
.448	4800	63,600	
.511	5200	68,900	
.536	5600	74,200	Concrete spalled at edge of
.571	6000	79,500	slab at jack end of rod.
.604	6400	84,800	
.646	6800	90,100	
.688	7200	95,400	
			Concrete spalled @ insert allowing
			lateral deflection of specimen at top

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June 83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June 83

PERFORMED BY: WITNESSED BY:

[signature] 3-22-83
DATE

[signature] 3-22-83
QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 5 DATE 22 March '83

BOLT SPEC: A-490 W/SHIM PL. ✓ W/O SHIM PL. [illegible]

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.013	400	5,300	
.052	800	10,600	
.091	1200	15,900	
.132	1600	21,200	
.180	2000	26,500	
.220	2400	31,800	
.265	2800	37,100	
.303	3200	42,400	
.336	3600	47,700	
.365	4000	53,000	
.391	4400	58,300	
.415	4800	63,600	
.446	5200	68,900	
.479	5600	74,200	Concrete spalled slightly at
.509	6000	79,500	edge of slot under jack support
.538	6400	84,800	
.570	6800	90,100	
.616	7200	95,400	failed by local spalling of concrete
			at insert permitting lateral move-
			ment of insert.

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

J. C. [illegible] 3-22-'83 [illegible] 3-22-83

DATE QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 6   DATE 22 March '83

BOLT SPEC: A-490   W/SHIM PL. ____   W/O SHIM PL. ✓

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.034	400	5,300	
.067	800	10,600	
.099	1200	15,900	
.134	1600	21,200	
.173	2000	26,500	
.225	2400	31,800	
.284	2800	37,100	
.352	3200	42,400	
.407	3600	47,700	
.442	4000	53,000	
.490	4400	58,300	
.624	4800	63,600	
.672	5200	68,900	Concrete spalling at upper edge of
.725	5600	74,200	slab at jack end of rod
.765	6000	79,500	
.809	6400	84,800	
.855	6800	90,100	
			Concrete crushed locally
			around insert - allowing
			lateral deflection of upper
			part of insert

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821   DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094   DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

[illegible] 3-22-83   [illegible] 3-22-83

DATE   QA REPRESENTATIVE DATE

APPENDIX

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 7 DATE 22 March 83

BOLT SPEC: SA 36 Rod W/SHIM PL. ✓ W/O SHIM PL. [illegible]

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.081	400	5,300	
.272	800	10,600	
.400	1200	15,900	
.483	1600	21,200	
.516	2000	26,500	
.568	2400	31,800	
.665	2800	37,100	
.732	3200	42,400	
.811	3600	47,700	
.883	4000	53,000	
. -	4400	58,300	Dial gauge bottomed out
			all discernable deflections
			were deformation of [illegible]

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

J. C. Gilbreth
3-22-83
DATE

Victor M[illegible] 3-22-83
QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-8

SPECIMEN NUMBER: 8 DATE 22 March '83

BOLT SPEC: SA 36 Rod W/SHIM PL. ✓ W/O SHIM PL. ____

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
0.029	400	5,300	
.190	800	10,600	
.345	1200	15,900	
.408	1600	21,200	
.457	2000	26,500	
.526	2400	31,800	
.618	2800	37,100	
.698	3200	42,400	
.745	3600	47,700	
.815	4000	53,000	
.890	4400	58,300	Slight spalling of concrete
.992	4800	63,600	but practically
			all deformations were in the
			bolt, it being deformed
			thus: 

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: J. C. Gilkroth

3-22-83
DATE

WITNESSED BY: [illegible] 3-22-83
QA REPRESENTATIVE DATE

RICHMOND 1-1/2-INCH TYPE EC-6W INSERTS
SHEAR TESTS
REFERENCE: CP-EI-13.0-B

SPECIMEN NUMBER: 9 DATE 22 March 83

BOLT SPEC: SA-36 Rod W/SHIM PL. ✓ W/O SHIM PL. ____

DEFLECTION (IN.)	GAUGE PRESSURE (P.S.I.)	JACK* THRUST (LBS).	NOTES - FAILURE MODE
.027	400	5,300	
.071	800	10,600	
.120	1200	15,900	
.179	1600	21,200	
.225	2000	26,500	
.266	2400	31,800	
.340	2800	37,100	
.440	3200	42,400	
.526	3600	47,700	
.609	4000	53,000	
.698	4400	58,300	
.821	4800	63,600	
			all deflection was result of deformation of bolt. no sign of failure of bolt, only deformation.

*JACK THRUST EQUAL SHEAR LOAD ON INSERT.

JACK THRUST (LBS) = GAUGE PRESSURE (P.S.I.) TIMES 13.25

JACK: EQUIPMENT NUMBER RCH 606

PRESSURE GAUGE: M&TE NUMBER 1821 DUE DATE: 9 June '83

DIAL GAUGE: M&TE NUMBER 2094 DUE DATE: 20 June '83

PERFORMED BY: WITNESSED BY:

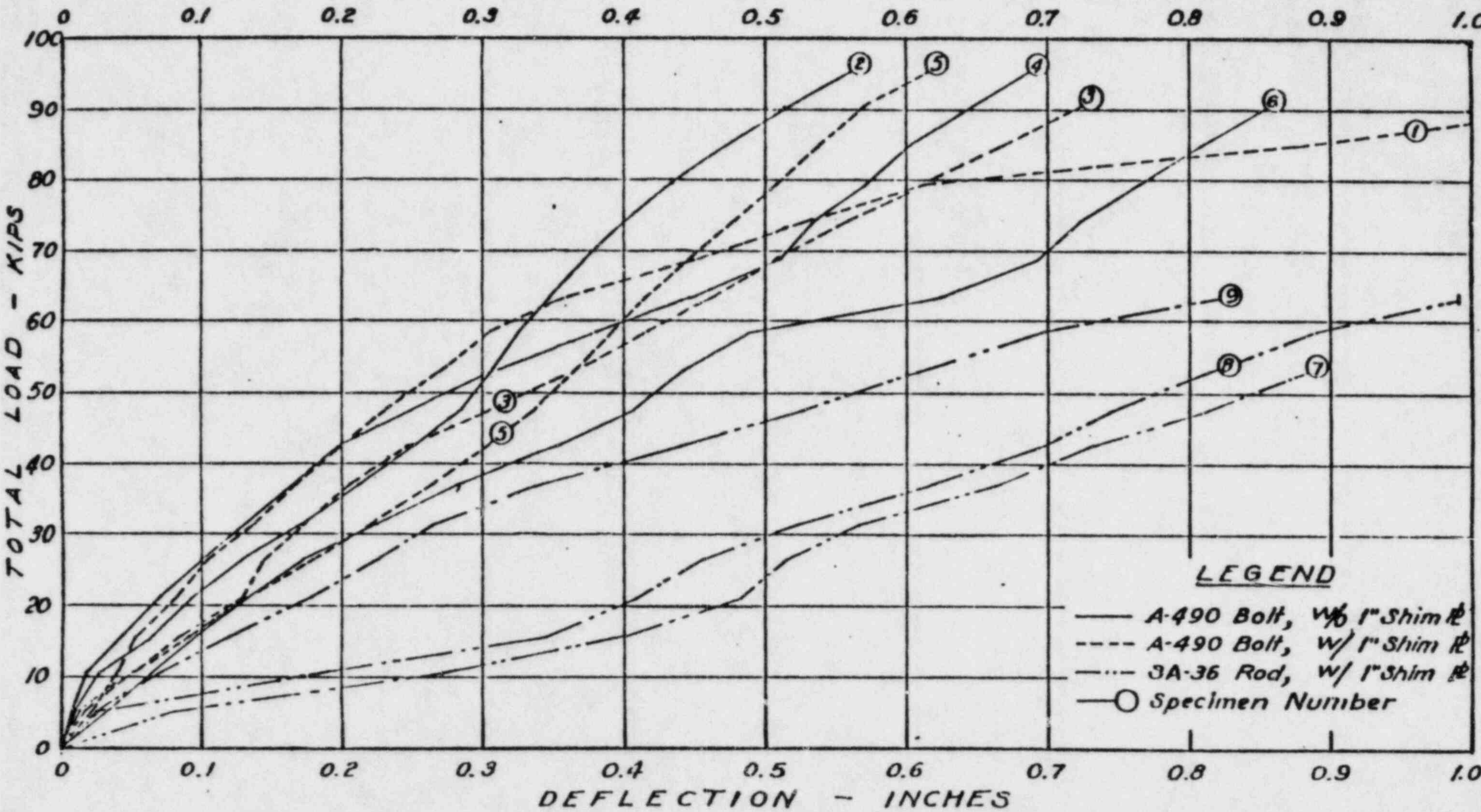
C. O. Gilbert

3-22-83 Victor T. E... 3-22-83

DATE QA REPRESENTATIVE DATE

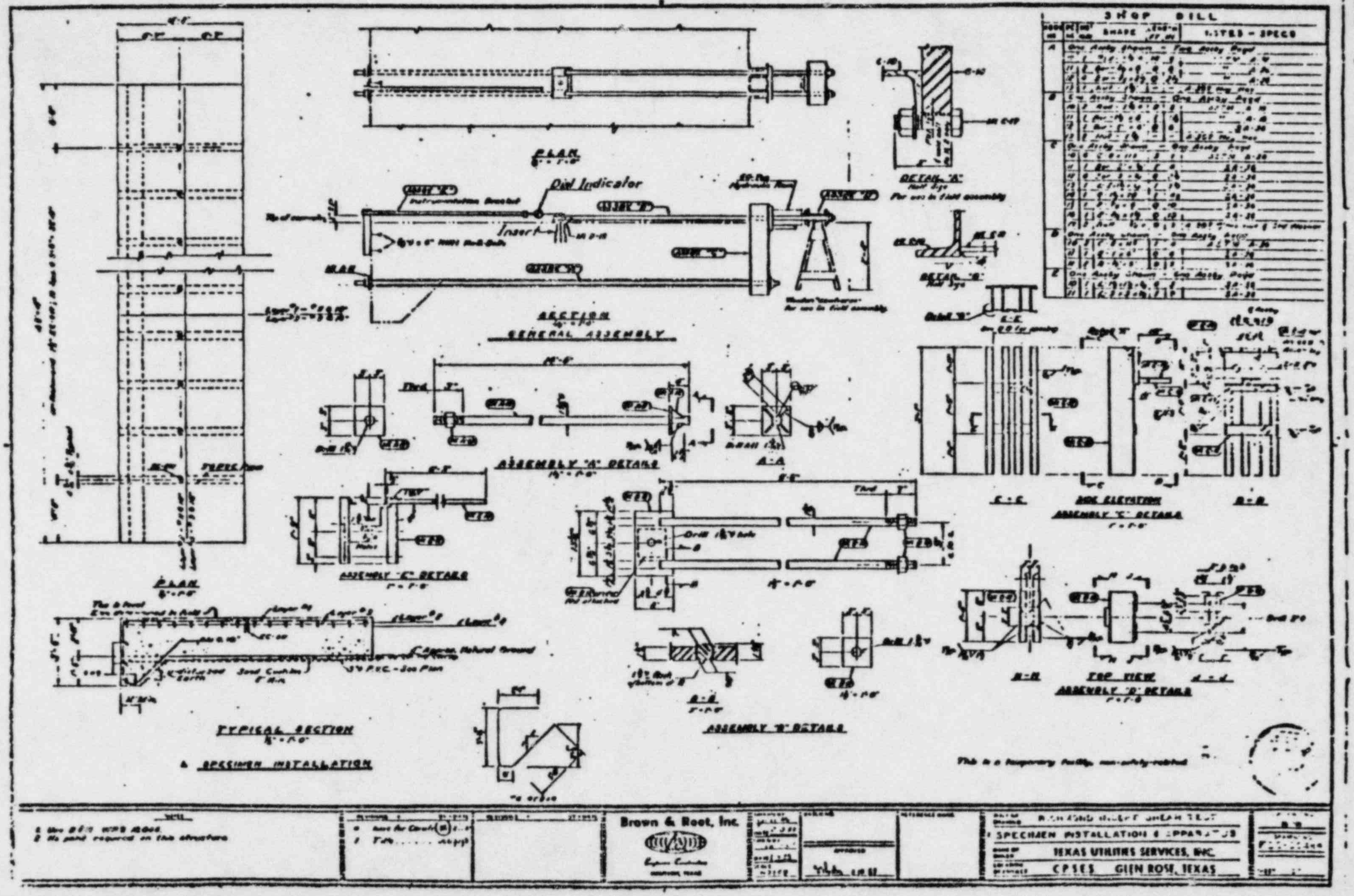
APPENDIX 3

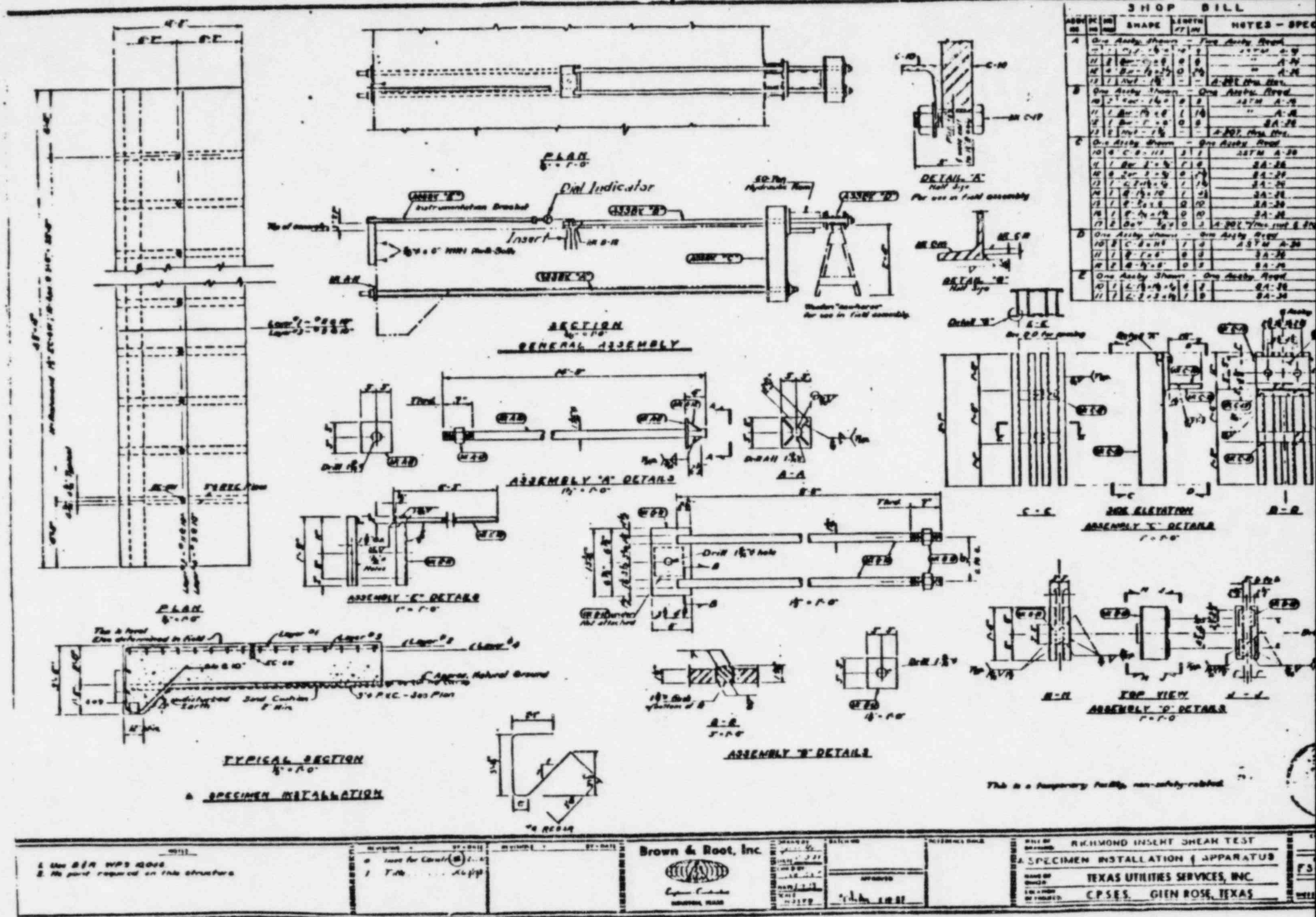
LOAD-DEFLECTION CURVES



LOAD - DEFLECTION CURVES

APPENDIX


SHOP BILL
SHAPE
NOTES - SPECS
PLAN
Dial Indicator
Insert
SECTION
GENERAL ASSEMBLY
DETAIL "A"
For use in field assembly
DETAIL "B"
ASSEMBLY "A" DETAILS
A-A
ASSEMBLY "C" DETAILS
SIDE ELEVATION
C-C
B-B
ASSEMBLY "B" DETAILS
TOP VIEW
ASSEMBLY "D" DETAILS
TYPICAL SECTION
& SPECIMEN INSTALLATION
This is a temporary facility, non-safety-related
Brown & Root, Inc.
SPECIMEN INSTALLATION & APPARATUS
TEXAS UTILITIES SERVICES, INC.
CPSES GLEN ROSE, TEXAS


SHOP BILL
PLAN
Dial Indicator
Insert
SECTION
GENERAL ASSEMBLY
DETAIL "A"
DETAIL "B"
ASSEMBLY "A" DETAILS
A-A
ASSEMBLY "C" DETAILS
SIDE ELEVATION
ASSEMBLY "C" DETAILS
C-C
B-B
TOP VIEW
ASSEMBLY "D" DETAILS
ASSEMBLY "B" DETAILS
TYPICAL SECTION
SPECIMEN INSTALLATION
This is a temporary facility, non-safety-related.
Brown & Root, Inc.
RICHMOND INSERT SHEAR TEST
SPECIMEN INSTALLATION & APPARATUS
TEXAS UTILITIES SERVICES, INC.
CPSES GLEN ROSE, TEXAS

ATTACHMENT B

TEST REPORT

SHEAR AND TENSION LOADING

OF

RICHMOND INSERTS

1 1/2-INCH TYPE EC-6W

1-INCH TYPE EC-2W

APRIL 19, 1984

Prepared by

S.G. McBee
Civil Engineer

Approved by

R.M. Kissinger, P.E.
Project Civil Engineer

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TEST REPORT

SHEAR AND TENSION LOADING
OF
RICHMOND INSERTS
1 1/2-INCH TYPE EC-6W
AND
1-INCH TYPE EC-2W

1.0 REFERENCES

A CP-EP-13.0 Test Control

B CP-EI-13.0-13 1 1/2" and 1" Richmond Insert Shear and Tension Tests

2.0 GENERAL

2.1 DEFINITIONS

Ulimate Load - The load applied to the specimen which caused a physical rupture of the specimen.

Failure Load - The load applied to the specimen beyond which, deflections increased considerably without substantial increase in the applied load.

2.2 PURPOSE AND SCOPE

These tests were performed to determine the characteristics of 1 1/2-Inch Type EC-6W and 1-Inch Type EC-2W Richmond Inserts when installed in concrete representative of that used in the power block structures at CPSES. The test specimens were subjected to shear, tension, and combined shear and tension loadings. The strength, deflections, and type of deformations produced by these loadings were the qualities to be determined.

2.3 RESPONSIBILITY

The tests were performed under the direction of the CP Project Civil Engineer. Witnesses to the tests were: A TUGCO site Quality Assurance representative and other site engineering personnel.

2.4 TEST APPARATUS

2.4.1 CONCRETE SLAB & EMBEDMENTS

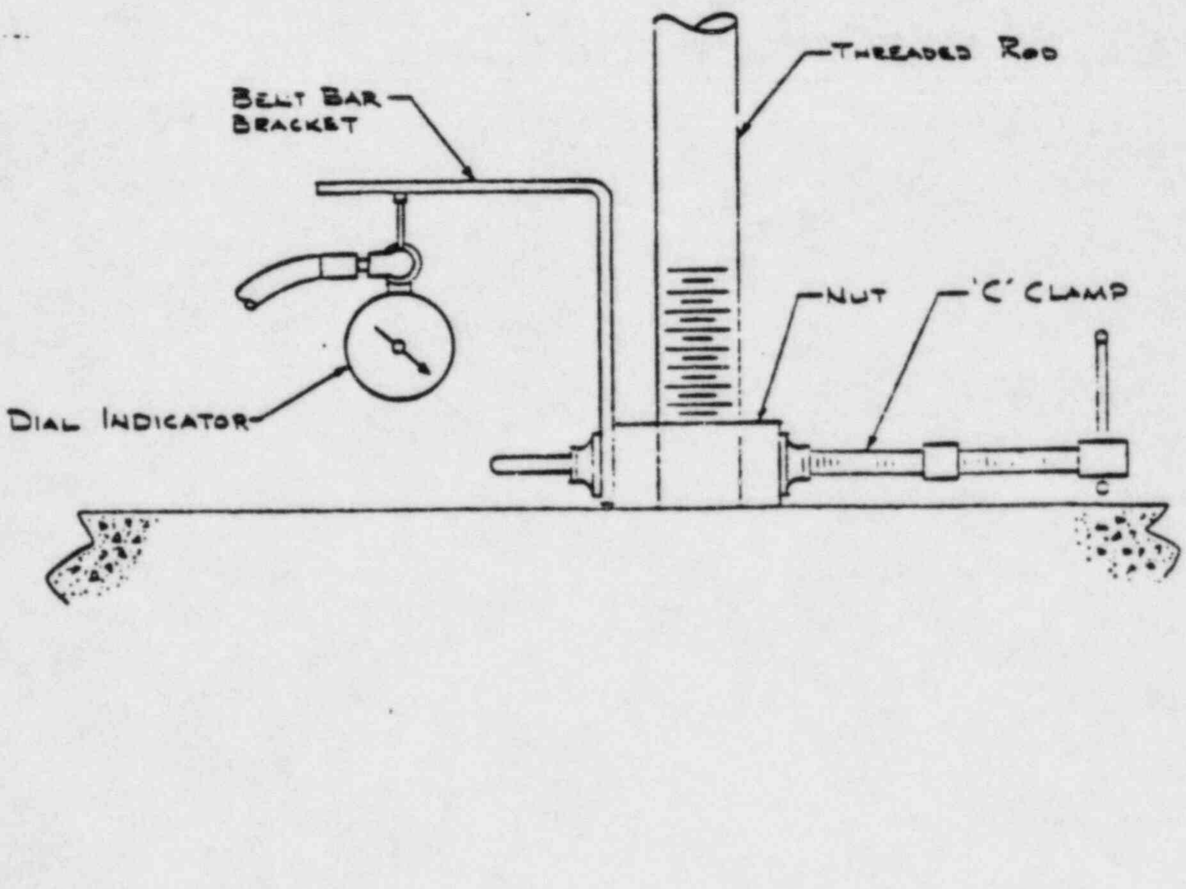
The arrangement and details of the test apparatus are shown on Drawing No. FSC-00464, Sheet 1, 2 and 3, which are included in Appendix 1 to this report. (Note that only MK C-14, C-15, C-16 and Assembly 'D' on Sheet 1 were used in this test.) The insert specimens tested were taken at random from the Constructor's stock on site and therefore, were representative of those installed in the plant structures. They were placed in a concrete slab cast specifically for these tests and which was composed of materials and reinforcement similar to those elements of the plant buildings. The concrete used was based on having a minimum design strength of 4000 pounds per square inch at 28 days. The laboratory test report on the concrete of which this slab is composed is included here in Appendix X. 2.

2.4.2 SHEAR TEST APPARATUS

An apparatus for applying shear loads to the specimens was designed and built on site. This facility employed a 60-ton capacity, manually operated hydraulic ram whose thrust against a cross head was transmitted by tension rods to a 1 1/2-inch thick shear plate bolted to the insert specimen. The base reaction of the jack was transmitted through a structural steel "bridge" to the outer face of the concrete test slab. This arrangement, as shown in Appendix 1, provided a horizontal shear load on the vertically positioned insert without producing secondary or reactive concrete stresses in the vicinity of the specimen. Ram thrust was determined by multiplying the fluid pressure (PSI), as indicated by a calibrated gauge on the pump, by a number equal to the ram piston area in square inches. Deflections were measured by a calibrated dial indicator mounted on a remotely anchored bracket and with its spring loaded probe in contact with a lug welded to the shear plate directly behind the bolt head or threaded rod.

2.4.3 TENSION TEST APPARATUS

An apparatus for applying tension loads to the specimens was also designed and built on site. This facility employed a 60-ton capacity, manually operated hydraulic ram which serves as an end loading on a built-up steel beam. The other end of the beam was bearing against a well-supported round bar which served as a fulcrum and provided the other end reaction of the beam when the jack was operated to load the specimen. A threaded rod protruded through the beam at mid-span, through a nut and bearing plate on the beam with the opposite and threaded into the Richmond Insert. This arrangement caused the load on the rod to be equal to twice the force applied to the jack. Location of the base plates for the reactions of the beam provided clearance from the insert of at least 4 times the overall insert height; i.e., at least 39 1/2 inches for the 1 1/2 inch inserts and 23 inches for the 1 inch inserts. Ram thrust was determined by miltiplying the fluid pressure (PSI), as indicated by a calibrated gauge on the pump, by a number equal to the ram piston area in square inches. Deflections were measured by a calibrated dial indicator mounted on a remotely anchored bracket and with its spring loaded probe in contact with a bracket which was securely clamped to the nut on the threaded rod, as shown in the sketch below.



2.4.4 COMBINED SHEAR AND TENSION TEST

The apparatus for the combined shear and tension test utilized the same equipment as that used on the individual shear and tension tests. For the shear portion, the equipment was set up identically to the individual shear test. For the tension portion, the equipment was arranged in a slightly different fashion. The hydraulic ram was not placed under the end of the beam, but instead, on the center of the beam on top. The ram thrust was applied directly to the threaded rod, which passed through the center of the ram, by means of a plate which was placed on top of the ram. The base reaction was resisted by the tension beam, loading which was supported by two wide flange stands at sufficient distance from the insert so as not to induce secondary or reactive concrete stresses in the vicinity of the specimen. This arrangement caused the load on the rod to be equal to the ram thrust. Both rams (one applying tension and one applying shear) were operated by a single hand pump with a calibrated pressure gauge. In this fashion, the shear and tension loads applied to the test specimen would be equal at all times.

3.0 TEST PROCEDURE

In performance of all of the tests, inserts were cleaned of concrete mortar and other trash that would affect bolt thread engagement. A new bolt (A-490) or threaded rod (SA-193 Grade B7) was used for each insert. The fasteners were all tightened "snug tight". The application of all loads was applied by the ram by operation of the manual hydraulic pump. As the load increased from zero (0), indications of fluid pressure (later converted to load) and simultaneous bolt head deflection were read at regular intervals. These intervals were at 400 PSI on the pressure gauge, corresponding to 5300 pounds thrust with the exception of the direct tension tests. On the direct tension test, these intervals were at 200 PSI on the pressure gauge, which also corresponded to 5300 pounds thrust on the specimen due to the configuration used. The load as indicated by these gauge pressures was maintained as constant as possible for a period of two (2) minutes. At the end of this time period, the deflection was again observed and noted. Load application on each specimen was carried out until ultimate failure of the specimen occured (except specimen no. 1, which was tested in shear). At this point, observations were made of the condition of the specimens and the failure mode.

4.0 RESULTS

4.1 1 1/2-INCH RICHMOND INSERTS

4.1.1 SHEAR TESTS

As can be seen on the test data sheets, the ultimate load applied to the specimens ranged from 90,100 lbs, to 106,000 lbs.. The failure loads ranged from 84,800 lbs. to 106,000 lbs.. All bolts sheared abruptly (except specimen #1; test was halted prior to ultimate failure), with minor spalling of the concrete on the compression side of the Richmond Insert. All five (5) specimens were utilizing A-490 bolts.

SPECIMEN NO.	ULTIMATE LOAD (lbs)	FAILURE LOAD (lbs)
1	90,100	84,800
2	95,400	90,100
3	95,400	90,100
4	106,000	100,700
5	106,000	106,000
Average	98,580	94,340

Using the allowable insert laods given in specification 2323-SS-30 for 1 1/2-inch Richmond Inserts, the factor of safety is determined.

Allowable Shear = 27.0^k

$$\text{Factor of Safety (F.S.)} = \frac{\text{Average Failure Ld.}}{\text{Design Allowable Ld.}}$$

SPECIMEN NO.'s	AVERAGE FAILURE LOAD (k)	FACTOR OF SAFETY
1 thru 5	94.34	$\frac{94.34}{27.0} = 3.49$

4.1.2 TENSION TESTS

The ultimate load applied to the tension test specimens ranged from 87,650 lbs. to 114,150 lbs.. The failure loads ranged from 87,650 lbs. to 108,850 lbs.. The failure mode for specimens 11 and 12 was by striping the threads between the threaded rod and the Richmond Insert. Specimen 13 failed in the Richmond Insert by a failure of the welds between the axial strut rods to the upper threaded coil. Specimens 14 and 15 failed by concrete shear cone failures. All specimens were utilizing SA-193 Grade B7 threaded material.

SPECIMEN NO.		ULTIMATE LOAD	FAILURE LOAD
11		106,200	103,550
12		114,150	108,850
13		114,150	108,850
14		87,650	87,650
15		100,900	100,900
	Average	104,610	101,960

Allowable Tension = 31.3k

$$\text{Factor of Safety (F.S.)} = \frac{\text{Average Failure Ld.}}{\text{Design Allowable Ld.}}$$

SPECIMEN NO.'s	AVERAGE FAILURE LOAD (k)	FACTOR OF SAFETY
11 thru 15	101.96	101.96/31.3 = 3.26

4.1.3 COMBINED SHEAR AND TENSION TESTS

The shear and tension loads applied to the specimens under this loading condition are equal and the ultimate loads ranged from 60,950 lbs. to 68,900 lbs.. The failure loads ranged from 58,300 lbs. to 67,575 lbs.. Specimens 6 through 9 failed by an abrupt shearing of the threaded rod. There was some deformation of the rod in bending at the shear zone (ranging for 20° to 45° bend). Upper insert washer moved from 1/2 inch to 3/4 inch with some concrete spalling on the compression side of the insert. Specimen 10 failed by striping the threads between the threaded rod and the insert. This failure lifted the upper insert washer from the struts, but the insert remained in place.

SPECIMEN NO.	ULTIMATE LOAD (lbs)	FAILURE LOAD (lbs)
6	68,900	67,575
7	67,575	67,575
8	60,950	58,300
9	61,613	61,613
10	64,925	62,275
Average	64,793	63,468

Allowable Tension = 31.3k

Allowable Shear = 27.0k

Factor of Safety (F.S.)

$$\left(\frac{\text{Average Failure Tension}}{\text{Design Allowable Tension x F.S.}}\right)^{4/3} + \left(\frac{\text{Average Failure Shear}}{\text{Design Allowable Shear x F.S.}}\right)^{4/3} = 1.$$

SPECIMEN NO's.	TENSION AND SHEAR AVERAGE FAILURE LOAD (k)	FACTOR OF SAFETY
6 thru 10	63.47	$\left(\frac{63.47}{31.3 \times F.S.}\right)^{4/3} + \left(\frac{63.47}{27.0 \times F.S.}\right)^{4}$ =1.0 F.S. = 3.68

4.2 1-INCH RICHMOND INSERTS

4.2.1 SHEAR TESTS

From the test data sheets, the ultimate load applied to the specimens ranged from 39,750 lbs. to 50,350 lbs.. The failure loads ranged from 37,100 lbs. to 42,400 lbs.. Specimens 16 thru 19 failed by shear failure of the A-490 bolt. The top portion of the inserts deflected from 1/8 inch to 7/8 inch with some spalling on the compression side of the insert. Specimen 16 showed some rotation of the top of the insert. Specimen 17 and 18 showed no apparent sign of rotation. Specimen 19 failed by breaking the weld between the upper coil and the struts. The bolt then failed in bending after rotating with the upper portion of the coil. Specimen 20 failed by crushing the concrete on the compression side of the insert. The insert then rotated intact and the bolt ultimately failed in bending.

SPECIMEN NO.	ULTIMATE LOAD (lbs)	FAILURE LOAD (lbs)
16	46,375	42,400
17	43,050	37,100
18	50,350	42,400
19	46,375	42,400
20	39,750	37,100
Average	45,182	40,280

Allowable Shear = 11.5^k

$$\text{Factor of Safety (F.S.)} = \frac{\text{Average Failure Ld.}}{\text{Design Allowable Ld.}}$$

SPECIMEN NO's.	Average Failure Load (k)	Factor of Safety
16 thru 20	40.28	40.28/11.5 = 3.50

4.2.2 TENSION TESTS

The ultimate load applied to the specimens ranged from 41,270 lbs. to 43,920 lbs.. The failure foads ranged from 39,950 lbs. to 43,920 lbs.. Specimens 26, 28 and 29 failed by concrete shear cone failure. Specimens 27 and 30 failed by Richmond Insert failure. The inserts failed by a failure of the welds between the struts and the lower coil. There was some surface spalling associated with these failures.

SPECIMEN NO.	ULTIMATE LOAD (lbs)	FAILURE LOAD (lbs)
26	42,600	42,600
27	43,920	43,920
28	42,600	39,950
29	42,600	39,950
30	41,270	39,950
Average	42,598	41,276

Allowable Tension = 11.5^k

Factor of Safety (F.S.) = $\frac{\text{Average Failure Ld.}}{\text{Design Allowable Ld.}}$

SPECIMEN NO's.	AVERAGE FAILURE LOAD (k)	FACTOR OF SAFETY
26 thru 30	41.276	41.276/11.5 = 3.59

4.2.3 COMBINED SHEAR AND TENSION TESTS

The shear and tension loads applied to the specimens under this loading condition are equal and the ultimate loads ranged from 27,825 lbs. to 30,475 lbs.. The failure loads ranged from 27,825 to 29,150 lbs.. Specimens 21 thru 25 failed abruptly due to shear failure of the threaded rod. All inserts remained intact with only surface spalling of the concrete.

SPECIMEN NO.	ULTIMATE LOAD (lbs)	FAILURE LOAD (lbs)
21	27,825	27,825
22	29,150	29,150
23	30,475	29,150
24	29,150	27,825
25	28,487	27,825
Average	29,017	28,355

Allowable Tension = 11.5^k

Allowable Shear = 11.5^k

Factor of Safety (F.S.)

$$\left(\frac{\text{Average Failure Tension}}{\text{Design Allowable Tension x F.S.}}\right)^{4/3} + \left(\frac{\text{Average Failure Shear}}{\text{Design Allowable Shear x F.S.}}\right)^{4/3} = 1.0$$

SPECIMEN NO's	TENSION AND SHEAR AVERAGE FAILURE LOAD (k)	FACTOR OF SAFETY
21 thru 25	28,355	$\left(\frac{28.36}{11.5 \times F.S.}\right)^{4/3} + \left(\frac{28.36}{11.5 \times F.S.}\right)^{4/3} = 1.0$

F.S. = 4.15

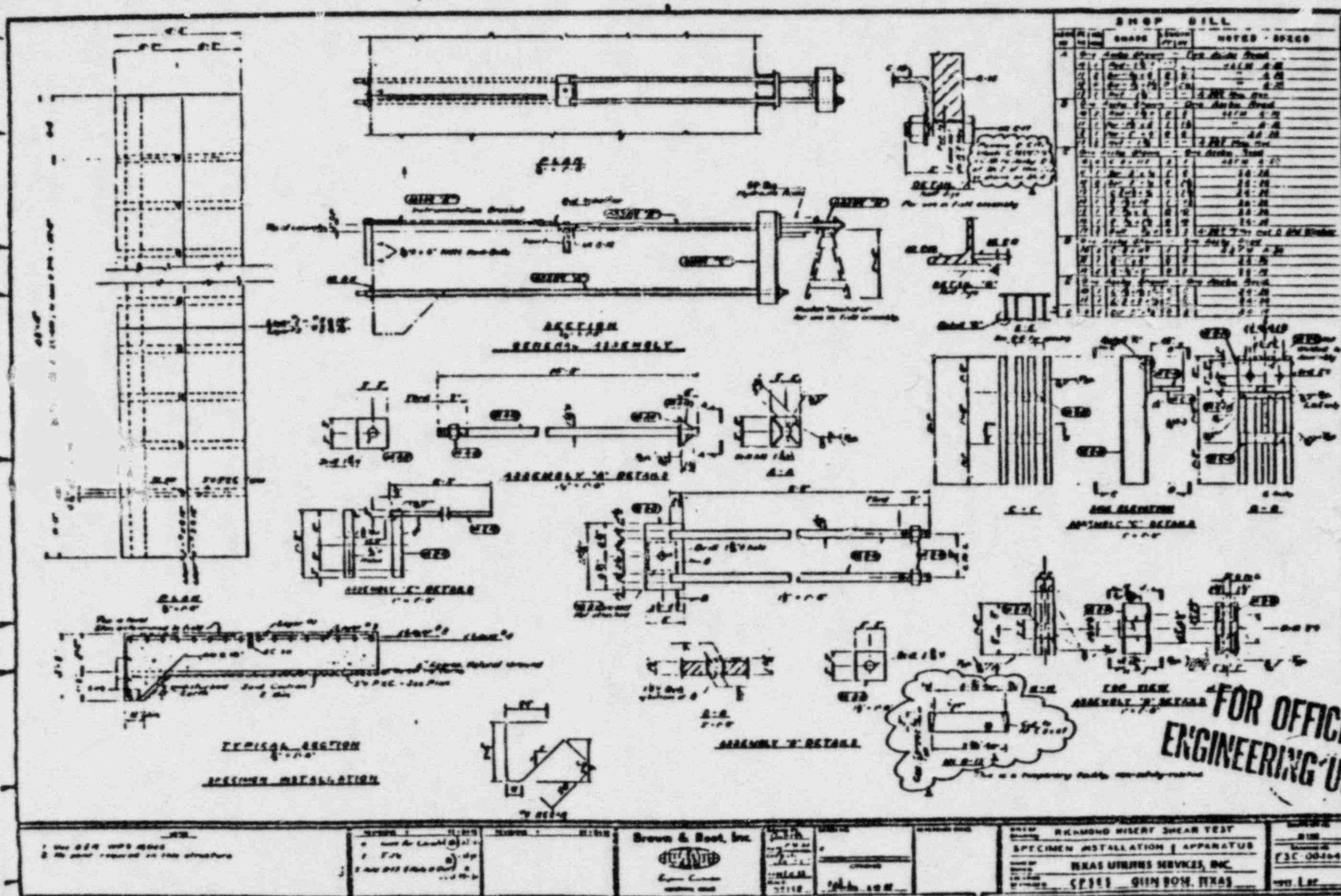
5.0 CONCLUSIONS

These test results show that the performance capabilities of the 1 1/2-inch type EC-6W and the 1-inch type EC-2W Richmond Inserts in shear, tension and combined shear and tension exceed the design allowable by a ratio of more than 3 to 1. These conclusions are valid for the design allowables shown in Specification 2323-SS-30, based on a spacing of the Richmond Inserts such that a full shear cone can develop.

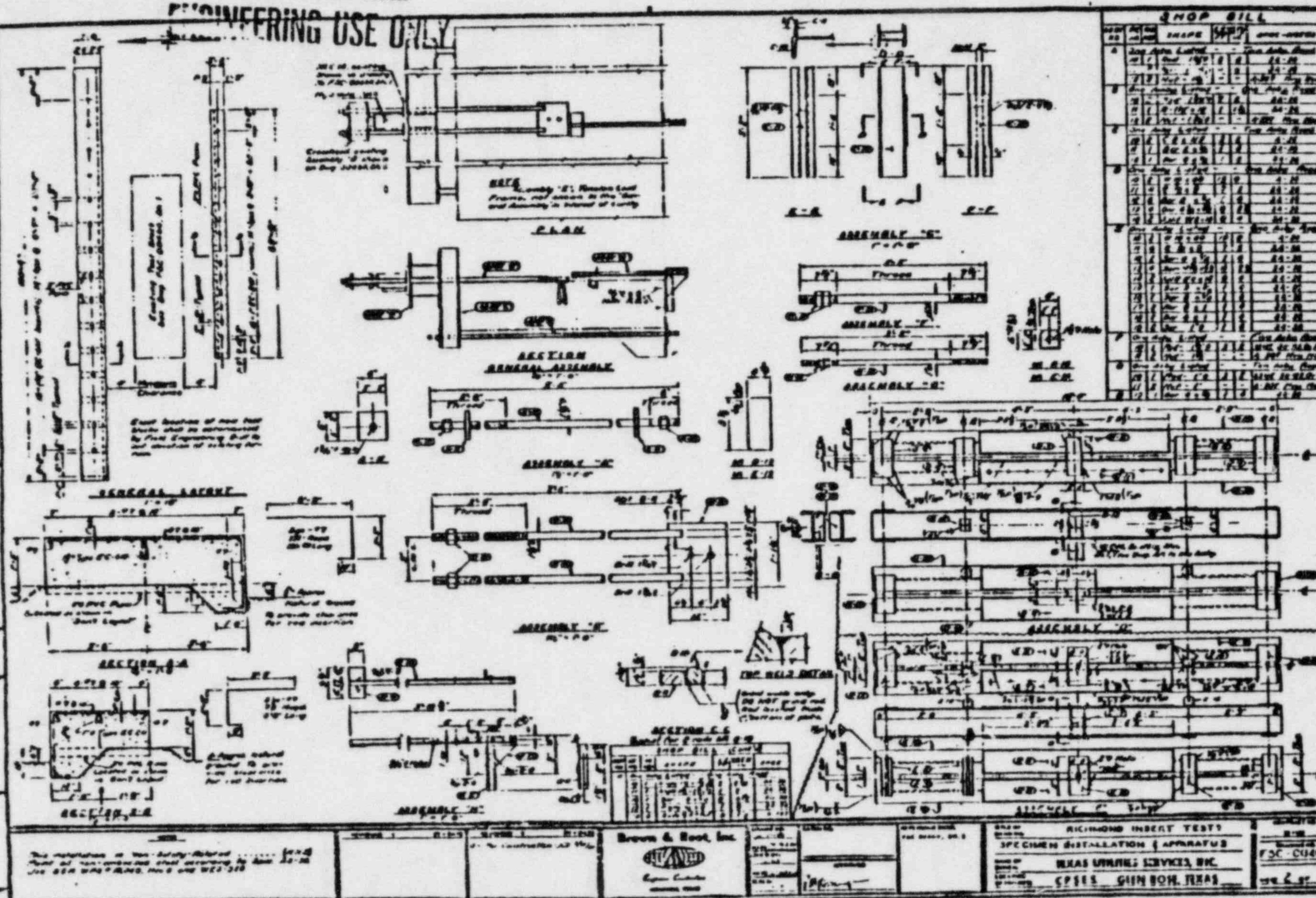
Based on this test, the design allowables for shear, tension and combined shear and tension are acceptable for use without further investigation or additional calculations. Richmond's recommendation of a minimum safety factor of 3 has been complied with.

APPENDIX 1

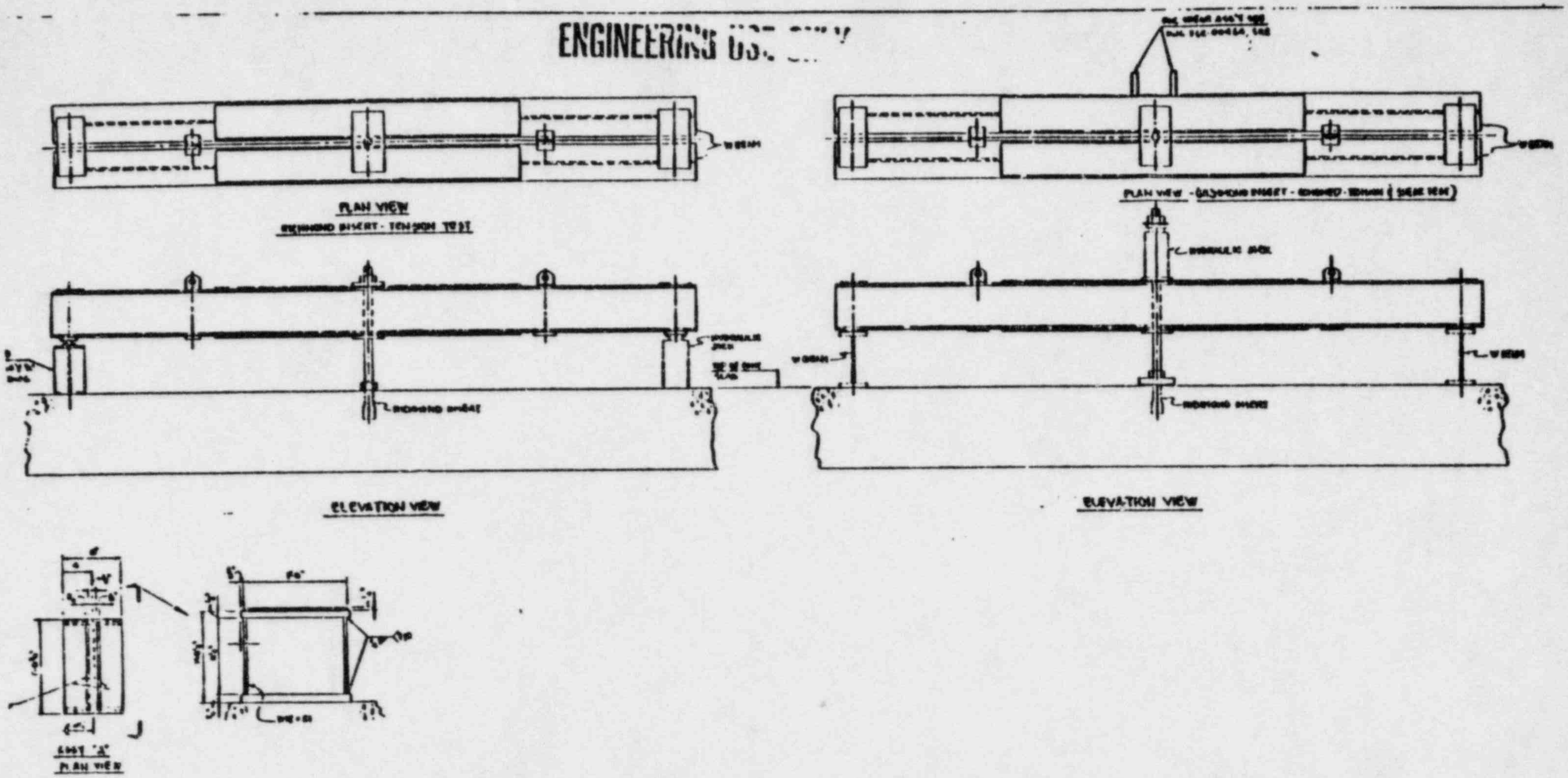
DRAWING NO. FSC-00464 SHT. 1, 2 & 3


SHOP BILL
PLAN
SECTION
GENERAL ASSEMBLY
TYPICAL SECTION
SPECIMEN INSTALLATION
FOR OFFICE AND ENGINEERING USE ONLY
Brown & Root, Inc.
RICHMOND INSERT SHEAR TEST
SPECIMEN INSTALLATION & APPARATUS
TEXAS UTILITIES SERVICES, INC.
CPSES GLEN ROSE, TEXAS
FSC-00464

FOR OFFICE AND ENGINEERING USE ONLY



ENGINEERING USE ONLY



THIS INSTALLATIONS ARE NON SAFETY RELATED - (NNS)

Brown & Root, Inc.

RICHMOND INSERT TESTS

TENSION AND TENSION & SHEAR COMBINED

TEXAS UTILITIES SERVICES, INC.

CPSES GLEN ROSE, TEXAS

FSC-00464

APPENDIX 2

CONCRETE COMPRESSIVE TEST REPORT

COMANCHE PEAK SES

DATE 2-29-84

POUR NO 017-9834-001

CYL. SET NO 2473

(Test Block)

PORT ON COMPRESSIVE TESTS OF CONCRETE

OCEDURE QI-QP-11.1-41

MIX							
COMPLETE DATA AS APPLICABLE FROM BATCH TICKET	(a) MOIST AGGR	F A 9608 LBS	H_2O F A 289 LBS	C A 13560 LBS	H_2O C A 0 LBS	TOTAL WATER/BATCH 1966 LBS	TYPE OF CURING M+W
	CEMENT / CU YD 5061 LBS	H_2O ADDED 0 GAL	H_2O/CEMENT RATIO 0.388	AIR CU YD 11.625 oz	TOTAL AIR 93 1/2 oz	SPECIFIED DESIGN STRENGTH 4000 PSI 28 DAYS	

MATERIALS				
BRAND OF CEMENT G-H	TYPE OF CEMENT II	BRAND OF AIR ENTRAINING ADMIXTURE MBVR	BRAND OF WATER REDUCING ADMIXTURE NA	MAX SIZE C.A. 3/4
SOURCE C.A. TXI-TIN TOP	SP GR C.A. 2.65	SOURCE F.A. TXI-TIN TOP	SP GR F.A 2.63	FINENESS MODULES F.A 2.71

SAMPLING						
TYPE OF MIXING PLANT I	BATCH LOAD 8 C.Y.	TICKET NO. 62989	SAMPLE TAKEN AT: ☐ CENTRAL MIXER ☐ FORMS ☑ POINT OF DISCHARGE			
METHOD OF PLACING ☐ PUMP ☐ BUCKET ☐ BUGGIES ☐ BELT ☑ CHUTE	DATE SAMPLED 2-29-84	HOUR 1030 AM	WEATHER Clear	AIR TEMP. 46 °F	CONC. TEMP. 60 °F	SLUMP 3 3/4 IN.
TIME OF MIXING AT CENTRAL PLANT 70 REV MIN	UNIT WT. CU. FT. 144.36 LBS	MIX I.D. 132	SPECIMEN TAKEN BY Birchfield	SPECIMEN CAST BY RG-DO-IAS	AIR 5.0%	

	CYLINDER I.D.	AGE	MEASURED DIA IN	AVG. DIA. IN.	DATE CAPPED	CAPPED BY	TIME TESTED	DATE TESTED	MAX. LOAD LB.	COMPRESSIVE STRENGTH	CAP CHECKED BY	CYLINDER TESTED BY	TYPE OF BREAK
LAB CURED	2473A	7	5.980 / 6.000	5.990	3-6-84	DW	0710	3-7-84	116000	4120	UT	UT	Reg
	2473B	7	6.001 / 6.000	6.001	3-6-84	DW	0704	3-7-84	119000	4210	UT	UT	Reg
	2473C	28	5.998 / 6.002	6.000	3-23-84	DW	0702	3-28-84	153500	5430	UT	UT	Reg
	2473D	28	6.000 / 6.016	6.008	3-23-84	DW	0648	3-28-84	155500	5490	UT	UT	Reg
FIELD CURED	2473E	28	6.001 / 6.002	6.002	3-23-84	DW	0650	3-28-84	139500	4930	UT	UT	Reg
	2473F	28	6.016 / 5.991	6.004	3-23-84	DW	0656	3-28-84	141000	4980	UT	UT	Reg
	NA												
	NA												

DATE & TIME STRIPPED 3-1-84 915 AM

REMARKS

CURING CONTROL TEST RESULTS
FOR 28 DAY BREAK

LABARATORY CURED CYLINDER(S)

STRENGTH (P.S.I.) 5430 (C)

5490 (D)

1. (E)+(F) ÷ (C)+(D) = 0.91 *

FIELD CURED CYLINDER(S)

STRENGTH (P.S.I.) 4930 (E)

4980 (F)

2. (E)+(F) ÷ 2 = 4955 *

*NOTE: (1) ABOVE MUST BE EQUAL TO OR GREATER THAN 0.85; OR (2) ABOVE NEED NOT EXCEED THE DESIGN STRENGTH BY MORE THAN 500 PSI EVEN THOUGH THE 0.85 CRITERION IS NOT MET

MICROMETER OR CALIPERS NO MITC 1292

COMPRESSION MACHINE NO MITC 1307

CAPPING MOLD NO MITC 2110?

7 DAY PREPARED BY UT CHECKED BY IAS

28 DAY PREPARED BY UT CHECKED BY IAS

IGN ENGINEERS COMMENTS (IF APPLICABLE)

TUGCO [illegible] SUPERVISOR

APPENDIX 2

TEST DATA SHEETS

COMANCHE PEAK SES

SHEAR TESTS

RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~4~~ 13, cd

Specimen Number: 1 Bolt Spec: A-490 Date: 3 Apr '84

(First insert @ west end of conc. slab)

DEFLECTION (IN.) INITIAL	AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
0.003	0.003	400	5300	
.032	.035	800	10600	
.060	.060	1200	15900	
.076	.079	1600	21200	
.095	.098	2000	26500	
.111	.116	2400	31800	
.128	.132	2800	37100	
.144	.150	3200	42400	
.160	.167	3600	47700	
.178	.185	4000	53000	
.196	.206	4400	58300	
.220	.233	4800	63600	
.250	.264	5200	68900	
.277	.297	5600	74200	
.304	.348	6000	79500	Bolt deformed.
.380	.429	6400	84800	Crushing of concrete was
.510	1.125	6800	90100	principal failure. No increase
				in load with increased deflec-
				tion. Did not load to destructio
		Burned off bolthead for removal. Insert stayed fast		
		in concrete		

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr 84
Dial Gauge:......M & TE Number 2949 Due Date: 29 June '84

Performed By: J. C. Gilbreth 3 April 84
Name Date

Witnessed By: [signature] 4-3-84
QA Representative Date

COMANCHE PEAK SES

SHEAR TESTS

RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~?~~ 18 pcb

Specimen Number: 2 (2nd from west end)   Bolt Spec: A-490   Date: 4 april 84

DEFLECTION (IN.)		GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
INITIAL	AFTER 2-MIN.			
0.002	0.002	400	5,300	
.021	.022	800	10,600	
.034	.036	1200	15,900	
.049	.051	1600	21,200	
.063	.066	2000	26,500	
.080	.083	2400	31,800	
.096	.102	2800	37 100	
.115	.121	3200	42 400	
.133	.142	3600	47 700	
.157	.166	4000	53 000	
.180	.192	4400	58 300	
.208	.217	4800	63 600	
.237	.247	5200	68,900	
.263	.276	5600	74,200	
.293	.314	6000	79,500	
.338	.370	6400	89,800	
.480	.555	6800	90 100	
.770	1.110	7200	95,400	Bolt sheared abruptly. Concrete
				spalled on compression side of ins.
	approx 1½" deep, running out			to zero @ 7" away. Spall approx
	6" wide near insert.			

* Jack Thrust equal Shear Load on Insert.

Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25

Jack:.......Equipment Number RCH 606

Pressure Gauge: M & TE Number ~~2949~~ 2355 Due Date: 16 Apr 84

Dial Gauge:......M & TE Number 2949 Due Date: 29 Jun 84

Insert tear deflected ⅞"

Performed By: J. C. Gilbreath   4 april 84

Name   Date

Witnessed By: [signature]   4-4-84

QA Representative   Date

COMANCHE PEAK SES

SHEAR TESTS

RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~X~~ 13 ~~[illegible]~~

Specimen Number: 3 Bolt Spec: A-490 Date: 4 April 84

(3rd from West End)

DEFLECTION (IN.) INITIAL	DEFLECTION (IN.) AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
0.001	.001	400	5300	
.002	.002	800	10600	
.003	.003	1200	15900	
.006	.007	1600	21200	
.012	.018	2000	26500	
.032	.036	2400	31800	
.049	.052	2800	37100	
.067	.069	3200	42400	
.078	.083	3600	47700	
.096	.107	4000	53000	
.126	.131	4400	58300	
.144	.154	4800	63600	
.174	.182	5200	68900	
.206	.218	5600	74200	
.242	.259	6000	79500	
.283	.315	6400	84800	
.365	.399	6800	90100	
.540	(1.2)	7200	95400	Bolt sheared abruptly. Concre
		Spalled 1" deep @ insert, tapering to zero depth		
		@ 5" out (on compression side of insert). Insert		
		deformed where visible (Ins. A). Insert seemingly intact where still		
				in. concrete

* Jack Thrust equal Shear Load on Insert.

Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25

Jack:.......Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr 84

Dial Gauge:......M & TE Number 2949 Due Date: 29 Jun 84

Insert top deflected abt 5/8

Performed By: J. C. Gilbreth 4 April 84

Name Date

Witnessed By: Anthony Pietrzak 4-4-84

QA Representative Date

COMANCHE PEAK SES

SHEAR TESTS

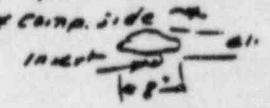
RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~X~~ 13 gen

Specimen Number: 4 Bolt Spec: A-490 Date: 4 April '84

(4th from West End)

DEFLECTION (IN.) INITIAL	DEFLECTION (IN.) AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
.0005	.0005	400	5,300	
.003	.003	800	10,600	
.012	.013	1200	15,900	
.024	.026	1600	21,200	
.035	.038	2000	26,500	
.047	.048	2400	31,800	
.058	.059	2800	37,100	
.067	.070	3200	42,400	
.078	.081	3600	47,700	
.089	.094	4000	53,000	
~~.102~~	~~.1~~	~~4400~~		accidental opening of valve - Load returned
.107	.109	4400	58,300	
.116	.120	4800	63,600	
.128	.133	5200	68,900	
.142	.146	5600	74,200	
.156	.164	6000	79,500	
.173	.181	6400	84,800	
.292	.303	6800	90,100	
.315	.333	7200	95,400	
.360	.389	7600	100,700	
.550		8000	106,000	Bolt sheared abruptly. Concrete spall 1" deep @ insert to 0" @ 4" out. spall 8" wide



* Jack Thrust equal Shear Load on Insert.

Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25

Jack:.......Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr 84

Dial Gauge:......M & TE Number 2949 Due Date: 24 Jun 84

Insert deflected about ¼"

Performed By: Witnessed By:

J. C. Gilbert 4 april 84 — Name / Date

Andrew Rutz 4-4-84 — QA Representative / Date

COMANCHE PEAK SES
SHEAR TESTS

RICHMOND 1/2-INCH, TYPE ___ INSERT

Reference: CP-EI-13.0-~~3~~ 13 gc4

Specimen Number: 5 (5th from West End) Bolt Spec: A-490 Date: 4 April '84

DEFLECTION (IN.)		GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
INITIAL	AFTER 2-MIN.			
0.002	0.002	400	5 300	
.004	.005	800	10 600	
.013	.015	1200	15 900	
.035	.037	1600	21 200	
.057	.063	2000	26 500	
.090	.096	2400	31 800	
.117	.124	2800	37 100	
.150	.157	3200	42 400	
.176	.183	3600	47 700	
.200	.209	4000	53 000	
.223	.236	4400	58 300	
.248	.261	4800	63 600	
.276	.295	5200	68,900	
.307	.322	5600	74,200	
.338	.356	6000	79,500	
.370	.389	6400	84,800	
.408	.428	6800	90,100	
.447	.479	7200	95,400	
.506	.556	7600	100 700	
.585	.	8000	106000 Bolt sheared abruptly. Concrete spall	
	1.1" @ Break	1" deep @ insert to 0" @ 4" out, 6" wide		

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25

[illegible]:  Insert top deflec 3/8".

Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84
Dial Gauge:......M & TE Number 2944 Due Date: 29 Jun '84

Performed By: L.C. Gilbreth 4 Apr 84
Name Date

Witnessed By: [signature] 4-4-84
QA Representative Date

COMANCHE PEAK SES

COMBINED SHEAR & TENSION TESTS

Richmond 1½-Inch, Type SC-SW Insert

Reference: CP-EI-13.0-13 [illegible]

Specimen Number: 6 (6th from west)   Inserted Load Rod: A-193   Date: 10 April '84

Common	SHEAR			TENSION						Notes - Failure Mode
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	
400	5300	0.007	0.007		5300			0.0015	0.0015	
800	10 600	.023	.024		10 600			.005	.005	
1200	15 900	.041	.042		15 900			.0095	.0105	
1600	21 200	.062	.064		21 200			.018	.019	
2000	26 500	.088	.095		26 500			.031	.034	
2400	31,800	.146	.153		31,800			.046	.048	
2800	37,100	.192	.199	N/A	37,100	N/A	N/A	.054	.056	
3200	42400	.236	.246		42,400			.062	.0635	
3600	47,700	.290	.304		47,700			.0715	.074	
4000	53,000	.339	.382		53,000			.083	.087	
4250	56,313	.420			56,313					
4300	56,975	.460			56,975					
4400	58300	.475	.559		58,300			.115	.139	
4500	59625		.58		59,625					
4600	60,950	.630			60,950					

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A Lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam~~
*** Insert Load = ~~Net~~ Jack Thrust ~~÷ 2~~ BOW

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Jun '84
Dial Gauge-M&TE No: 2849 Due Date: 29 Jun '84

Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun '84

Performed By: J. C. Hilbert 4-10-84
Name Date

Witnessed by: [signature] 4-13-84
QA Representative Date

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1½-Inch, Type EC-6W Insert
Reference: CP-EI-13.04 13 pct

Specimen Number: 6 (p. 2 of 2) Inserted Load Rod: A-193 Date: 10 April '84

SHEAR				TENSION						Notes - Failure Mode
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	
4800	63600	.750	.808		63 600			.164	.167	
5000	66 250	.820			66 250					
5100	67 575	.910			67 575					
5200	68 900	1.010			68 900	N/A	N/A	.186		
5100	67575			N/A	67 575					Abrupt shearing of Rod. Rod deformed
										in bending @ shear plane, carrying insert
										washer some ½" horizontally.

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2~~. pcw

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr '84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun '84
Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun '84

Performed By: J. C. Gilbert 4-10-84
Name Date

Witnessed By: [signature] 4-10-84
QA Representative Date

/

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1½-Inch, Type EC-CW Insert
Reference: CP-EI-13.0-4-13 QCH

Specimen Number: 7 (7th from west end)   Inserted Load Rod: A-193   Date: 11 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5 300	0.000	0.000	N/A	5 300	N/A	N/A	0.000	0.000	
800	10 600	.009	.000		10 600			.003	.003	
1200	15 900	.023	.026		15 900			.012	.012	
1600	21 200	.041	.043		21 200			.028	.023	
2000	26 500	.070	.0765		26 500			.039	.043	
2400	31 800	.125	.133		31 800			.063	.065	
2800	37 100	.179	.182		37 100			.084	.086	
3200	42 400	.233	.236		42 400			.102	.1043	
3600	47 700	.277	.293		47 700			.117	.121	
4000	53 000	.345	.371		53 000			.132	.144	
4400	58 300	.458	.499		58 300			.165	.179	
4600	60 950	.58			60 950			.195		Vert. deflection sensor reversed direction due
4700	62 275	.770			62 275			.210		to fouling of bracket with bending rod.
4800	63 600	.802	.846		63 600			.206	.198	*Rod failed in shear. Top of insert
4950	65 588	.870			65 588					deflected horizontally some 5/8". Rod dis-
5000	66 250	.900			66 250					toried to some 30° from vert @ shear zone.
5050	66 913	1.15			66 913					Concrete spalled slightly around insert
5100	67 575	1.200 1.38			67 575					break! Insert intact.

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A Lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = Net Jack Thrust ~~x 2.~~ QCH

Shear Apparatus: Jack---Equipment No: RCH 600
Pressure Gauge-M&TE No: 2355 Due Date: 16 Jun '84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun 84
Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date: ______
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun 84

Performed By: J. C. Gilbreth, 4-11-84 (Name, Date)

Witnessed By: Andrew Rietland 4-11-84 (QA Representative, Date)

/

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1½-Inch, Type EC-6W Insert
Reference: CP-EI-13.0-13 901

Specimen Number: 8 (8th from west end) Inserted Load Rod: A-193 Date: 11 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5300	0.000	0.000		5300			0.000	0.000	
800	10 600	.021	.021		10 600			.001	.001	
1200	15900	.046	.047		15 900			.0035	.0045	
1600	21200	.066	.068		21 200			.008	.009	
2000	26 500	.092	.094		26 500			.018	.0295	
2400	31 800	.130	.136		31 800			.026	.0475	
2800	37 100	.177	.184		37 100			.060	.073	
3200	42 400	.229	.237		42 400			.085	.088	
3600	47 700	.296	.312		47 700			.113	.159	
4000	53 000	.508	.357		53 000			.203	.227	
4400	58200	.750		N/A	58 300	N/A	N/A	2.23		
4400	58300	.90			58 300			.50		
4500	59625				59 625					Dial indicators removed to prevent damage
4600	60950				60 950					@ time of failure.
4550	60288				60288					Break! Shear failure of rod. Rod bent
										about ∢ 30° @ shear zone. Washer at
										insert moved horizontally ½". 2 struts
										broke @ weld from washer. Concrete spalled
										1" deep to zero @ 5" out on comp side of insert.

1-* Jack Thrust = Shear load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A Lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = Net Jack Thrust ~~÷ 2.~~ JCG

Shear Apparatus: Jack---Equipment No: RCN 606
Pressure Gauge-M&TE No: 2355 Due Date: 14 Jun '84
Dial Gauge-M&TE No: 2949 Due Date: 8 Jun '84
Tension Apparatus: Jack-Equipment No: RCN 603T
Pressure Gauge-M&TE No: Same Due Date: ______
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun 84

Performed By: J.C. Gilbreth 4-11-84
Name Date

Witnessed By: Albert Pickard 4-11-84
QA Representative Date

86 136
65 579

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 1/2-Inch, Type EC-6W Insert
Reference: CP-EI-13.0-4 13 poem

Specimen Number: 9 (9th from west end)   Inserted Load Rod: A-193   Date: 11 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5300	0.000	0.000		5,300			0.000	0.000	
800	10 600	.002	.002		10,600			.000	.000	
1200	15 900	.020	.022		15,900			.002	.003	
1600	21 200	.042	.047		21,200			.0085	.008	
2000	26 500	.073	.080		26,500			.016	.018	
2400	31 800	.135	.143		31,800			.037	.044	
2800	37 100	.200	.211		37,100			.066	.067	
3200	42 400	.257	.253		42,400			.092	.090	
3600	47 700	.311	.330		47,700			.122	.131	
4000	53 000	.392	.516		53,000			.165	.176	
4400	58 300	.590	.636		58,300			.215	.236	
4600	60950	.720		N/A	60,950	N/A	N/A	.30		Dial gages removed to prevent damage.
4650	61613	.77			61,613					
3500	46 375				46,375					Break! Shear failure of rod. Rod shear
										zone rotated about 45°. Struts on
										comp. & tension sides of insert broke
										loose from washer @ welds. Washer
										moved 3/4" horizontally. Insert below
										washer appeared to be 'intact' but threaded
										coil slightly distorted. Conc. spalled 1 1/2" x 6 1/2" on comp. side

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A
** ~~Net Jack Thrust = Total Thrust Minus ½ Wt. of Beam.~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2.~~ JCG

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr '84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun 84

Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun 84

Performed By: J.C. Gilbreth 4-11-84
Name Date

Witnessed By: [signature] 4-11-84
QA Representative Date

/

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS

Richmond 1½-Inch, Type EC-GW Insert
Reference: CP-EI-13.0-~~9~~ 13 pcw

Specimen Number: 10 (10th from west end) Inserted Load Rod: A-193 Date: 11 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5 300	0.000	0.005		5 300			0.000	0.000	
800	10 600	.008	.009		10 600			.000	.000	
1200	15 900	.025	.026		15 900			.001	.001	
1600	21 200	.046	.048		21 200			.018	.003	
2000	26 500	.065	.067		26 500			.072	.077	
2400	31 800	.082	.085		31 800			.096	.097	
2800	37 100	.100	.103		37 100			.120	.118	
3200	42 400	.121	.125		42 400			.140	.140	
3600	47 700	.148	.158		47 700			.120		Reset Tension dial due to its fouling beam
4000	53 000	.185	.194		53 000			.127	.157	
4400	58 300	.226	.242		58 300			.134	.138	
4600	60950	.270		N/A	60 950	N/A	N/A			
4700	62 275	.310			62 375					
4800	63 600	.335			63 600			.165		
4800	63 600	.550			63 600					
4800	63 600	.600	.625		63 600			.230	.245	Threads stripped. Lifted insert washer
4900	64 925				64 925					loose from struts. Insert remained in place.
↑										

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A Lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2~~. JCM

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr '84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun '84

Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Jarma Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun 84

Performed By: J.C. Gilbert (Name) 4-11-84 (Date)

Witnessed By: [signature] (QA Representative) 4-11-84 (Date)

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-#13, rev

Specimen Number: 11   Load Rod Spec: A-193   Date: 5 Apr 84
(11th from west, 5th from east

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	0.000	0.000	
600	7950	6725	13450	.000	.000	
800	10 600	9 375	18 750	.001	.001	
1000	13 250	12 025	24 050	.003	.0035	
1200	15 900	14 675	29 350	.005	.006	
1400	18 550	17 325	34 650	.009	.011	
1600	21 200	19 975	39 950	.013	.015	
1800	23 850	22 625	45 250	.0155	.017	
2000	26 500	25 275	50 550	.0195	.020	
2200	29 150	27 925	55 850	.022	.023	
2400	31 800	30 575	61 150	.027	.028	
2600	34 450	33 225	66 450	.032	.035	
2800	37 100	35 875	71 750	.073	.078	
3000	39 750	38 525	77 050	.096	.099	
3200	42 400	41 175	82 350	.103, ~~.100~~	.1055	
3400	45 050	43 825	87 650	.109	.111	
3600	47 700	46 475	92 950	.123	.123	
3800	50,350	49 125	98 250	.138	.148	
4000	53,000	51 775	103 550	.190	.214	
4100	~~[illegible]~~ 54 325	53,100	106,200			Abrupt failure of threads (Insert and rod). Thread engagement was "full". Threads on both rod & insert were stripped. Concrete spalled to about 1½" depth, 18"x15" cone, concrete only. Rebar not exposed.

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 — {By dynamometer No. M&TE # 1432 due Apr. 17, '84}
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (½ wt. of bm. = 1225#)
** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355   Due Date: 16 Apr 84

Dial Gauge: M & TE Number 2949   Due Date: 29 Jun '84

Performed By: J. C. Gilbert(?) 5 Apr '84
Name   Date

Witnessed By: Andrew Pietrzyk(?) 4-5-84
QA Representative   Date

COMANCHE PE[illegible] [illegible]SES
TENSION TESTS

RICHMOND 1/2-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~8~~ 13,0 ch

Specimen Number: 12 (12 from West, 4th from East) Load Rod Spec: A-193 Date: 5 April '84

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	0.000	.000	
600	7950	6725	13450	.000	.000	
800	10600	9375	18750	.0015	.002	
1000	13250	12025	24050	.0035	.0055	
1200	15900	14675	29350	.007	.008	
1400	18550	17325	34650	.009	.010	
1600	21200	19975	39950	.0115	.012	
1800	23850	22625	45250	.014	.0145	
2000	26500	25275	50550	.017	.0175	
2200	29150	27925	55850	.0195	.020	
2400	31800	30575	61150	.022	.0225	
2600	34450	33225	66450	.0245	.0265	
2800	37100	35875	71750	.028	.0295	
3000	39750	38525	77050	.032	.034	
3200	42400	41175	82350	.036	.037	
3400	45050	43825	87650	.040	.043	
3600	47700	46475	92950	.048	.051	
3800	50350	49125	98250	.057	.0625	
4000	53000	51775	103550	.070	.075	
4200	55650	54425	108850	.084	.092	
4400	58300	57075	114150	.120		Failure by stripping

threads, Rod to insert. Thread engagement was "full" stripped length was 3". Concrete surface spalled in 18" dia. area. Spalling apparently result of impact when threads stripped. This failure was abrupt. Max depth of surface spall was 1". Did not expose rebar.

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 Wt. = 1225#)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2949 Due Date: 29 Jun '84

Performed By: J. C. Gilbreth 5 Apr 84
Name Date

Witnessed By: Andrew Pietrzyk 4-5-84
QA Representative Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1/2-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0 #13 yes

Specimen Number: 13 Load Rod Spec: A-193 Date: 5 Apr '84
(13th from West, 3rd from East)

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	0.000	0.000	
600	7950	6725	13 450	0.000	0.000	
800	10 600	9375	18 750	0.000	0.000	
1000	13 250	12 025	24 050	0.001	0.001	
1200	15 900	14 675	29 350	.001	.001	
1400	18 550	17 325	34 650	.0015	.0015	
1600	21 200	19 975	39 950	.003	.004	
1800	23 850	22 625	43 250	.0045	.0045	
2000	26 500	25 275	50 550	.0055	.007	
2200	29 150	27 925	55 850	.0075	.008	
2400	31 800	30 575	61 150	.009	.010	
2600	34 450	33 225	66 450	.011	.012	
2800	37 100	35 875	71 750	.0135	.015	
3000	39 750	38 525	77 050	.0175	.0185	
3200	42 400	41 175	82 350	.021	.023	
3400	45 050	43 825	87 650	.0255	.0285	
3600	47 700	46 475	92 950	.033	.0385	
3800	50 350	49 125	48 250	.045	.051	
4000	53 000	51 775	103 550	.059	.063	
4200	55 650	54 425	108 850	.074	.080	
4400	58,300	57,075	114,150	—	—	Concrete failed

On surface in area some 18" x 18"! structural failure that allowed this was failure of the weld connecting the axial strut rods to the threaded coil. This permitted surface spalling of the concrete. However there was no discernable sign of a cone failure in the concrete. Concrete visible @ rebar depth looked intact and there was no sound like a void when tapped with a metal object.

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 wt. = 1225#)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2949 Due Date: 29 Jun '84

Performed By: J. C. Gilbreth 5 Apr 84
Name Date

Witnessed By: Andrew Pietrzyk 4.5.84
QA Representative Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1½-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-~~4~~ 13 gcH

Specimen Number: 14 Load Rod Spec: A-193 Date: 5 Apr 84
(14th from West End, 2nd from East)

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2 850	0.000	0.000	
400	5300	4075	8 150	0.001	0.001	
600	7950	6725	13 450	.0015	.0015	
800	10 600	9375	18 750	.002	.002	
1000	13 250	12 025	24 050	.004	.004	
1200	15 900	14 675	29 350	.004	.0065	
1400	18 550	17 325	34 650	.008	.0085	
1600	21 200	19 975	39 950	.0095	.0095	
1800	23 850	22 625	45 250	.010	.010	
2000	26 500	25 275	50 550	.010	.010	
2200	29 150	27 925	55 850	.010	.010	
2400	31 800	30 575	61 150	.012	.012	
2600	34 450	33 225	66 450	.0135	.014	
2800	37 100	35 875	71 750	.016	.0165	
3000	39 750	38 525	77 050	.018	.019	
3200	42 400	41 175	82 350	.020	.024	
3400	45 050	43 825	87 650	.028	.035	Concrete failed
~~3600~~						

Concrete failed shear cone type failure. Depth of cone equal full depth of insert. Top of cone limited in size by rebars (@10" E.W. After initial failure rebars lifted cover concrete, fracturing an area about 3'x5', the long dimen. corresponding to the direction of upper layer of rebar.

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (½ wt = 1225#)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2944 Due Date: 29 Jun '84

Performed By: J. C. Gilbert 5 April 84
Name Date

Witnessed By: [signature] 4-5-84
QA Representative Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1/2-INCH, TYPE EC-6W INSERT

Reference: CP-EI-13.0-7/13 Rev 4

Specimen Number: 15 Load Rod Spec: A-193 Date: 4 April '84
(15th from West end - 1st on East End)

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	0.000	0.000	
600	7950	6725	13450	0.001	0.001	
800	10600	9375	18750	0.003	0.003	
1000	13250	12025	24050	0.004	0.006	
1200	15900	14675	29350	.008	.008	
1400	18550	17325	34650	.009	.010	
1600	21200	19975	39950	.010	.012	
1800	23850	22625	45250	.013	.015	
2000	26500	25275	50550	.017	.0175	
2200	29150	27925	55850	.021	.024	
2400	31800	30575	61150	.026	.027	
2600	34450	33225	66450	.028	.031	
2800	37100	35875	71750	.034	.036	
3000	39750	38525	77050	.038	.040	
3200	42400	41175	82350	.041	.042	
3400	45050	43825	87650	.049	.053	
3600	47700	46475	92950	.058	.065	
3800	50350	49125	98250	.069	.081	
3900	51,675	50,450	100,900	.70		Concrete failed,

shear cone type, limited in area by rebar pattern. Concrete above remained spalled in oval 3' x 4'. Cone below concrete... Cone about 10" dia at top. depth = insert dimension top of conc. to offset in vertical rods of insert. (Abt. 6")

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 (By dynamometer M&TE 1432 due Apr 17, '84)
Total Weight of Load Beam = 2450 lb. (÷2 = 1225)
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam.
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr 84

Dial Gauge: M & TE Number 2949 Due Date: 29 Jun 84

Performed By: J. C. Gilbreth 4 Apr. 84 (Name, Date)

Witnessed By: Adrian Pietzyk 4-4-84 (QA Representative, Date)

COMANCHE PEAK SES
SHEAR TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~X~~ 13 per

Specimen Number: 16 (1st on West end) Bolt Spec: A-~~193~~ 490 Date: 6 April '84

DEFLECTION (IN.) INITIAL	DEFLECTION (IN.) AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
0.000	0.000	400	5,300	
.001	.001	800	10,600	
.0195	.021	1200	15,900	
.042	.044	1600	21,200	
.062	.0655	2000 ~~2000~~	26,500	
.085	.091	2400	31,800	
.0112	.123	2800	37,100	
.152	.170	3200	42,400	
.22		3,500 ~~3600~~	46,375	Failure of bolt in shear.
		~~4000~~		
		Insert top deflected 1/8" by crushing of upper portion of concrete. Within this yield pattern the top of insert rotated a few degrees.		

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84
Dial Gauge:......M & TE Number 2749 Due Date: 29 Jun 84

Performed By:

J. C. Gilfidk, 6 April '84
Name Date

Witnessed By:

[signature] 4-6-84
QA Representative Date

COMANCHE PEAK SES
SHEAR TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~X~~ 13 gcB

Specimen Number: 17 (2nd fr West End)

~~Bolt~~ * Bolt Spec: A-490 ~~A 193~~ gcB Date: 6 Apr '84

DEFLECTION (IN.)		Jack ~~GAUGE PRESSURE~~ Thrust (Lbs) ~~(P.S.I.)~~	Gauge ~~JACK THRUST~~ * Pressure (PSI) ~~(Lbs.)~~	NOTES-FAILURE MODE
INITIAL	AFTER 2-MIN.			
0.000	0.000	5300	400	
.020	.020	10,600	800	
.037	.039	15,900	1200	
.060	.0645	21200	1600	
.087	.093	26500	2000	
.127	.129	31800	2400	
.166	.186	37100	2800	
.313	.332	42400	3200	
		43060	3250	Failure by bolt shear
		Insert deflected horizontally 3/8", being permitted by crushing failure of concrete. No apparent rotation of ~~=~~ top of insert.		

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84
Dial Gauge:......M & TE Number 2949 Due Date: 29 Jun '84

Performed By:
J C Gilkrist 6 Apr '84
Name Date

Witnessed By:
[signature] 4-6-84
QA Representative Date

COMANCHE PEAK SES
SHEAR TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-13

Specimen Number: 18 (3rd from West end) Bolt Spec: A-490 Date: 6 Apr '84

DEFLECTION (IN.) INITIAL	DEFLECTION (IN.) AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
0.000	0.000	400	5300	
.003	.004	800	10 600	
.023	.0245	1200	15 900	
.042	.045	1600	21 200	
.060	.063	2000	26 500	
.080	.085	2400	31 800	
.104	.109	2800	37100	
.136	.148	3200	42 400	
.200	.332	3600	47 700	
.400		3800	50 350	Failure by bolt shear.
				Insert top deflected about 1/8", no
				apparent rotation of insert.
				Top of concrete crushed (spalled)
				about 2" in front of insert.
				The insert washer sheared off
				from the struts, thus the 1/8
				deflection was after this shear
				failure. Coils & struts did
				not move.

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr 84
Dial Gauge:......M & TE Number 2949 Due Date: 29 Jun '84

Performed By: J. C. Gilbert 6 Apr '84
Name Date

Witnessed By: [signature] 4-6-84
QA Representative Date

COMANCHE PEAK SES
SHEAR TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-13

Specimen Number: 19 (4th from west end) Bolt Spec: A-490 Date: 9 Apr '84

DEFLECTION (IN.) INITIAL	AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
0.004	0.0035	400	5300	
.036	.036	800	10600	
.050	.0505	1200	15900	
.080	.081	1600	21200	
.098	.099	2000	26500	
.122	.127	2400	31800	
.147	.155	2800	37100	
.190	.2225	3200	42400	
		~~3600~~		
.270		3500	46375	Insert failed by breaking weld between upper coil and struts. Bolt failed after rotating with the engaged upper coil thru several degrees. The bolt failed in bending with a lesser load than the 46375 lb.

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84
Dial Gauge:......M & TE Number 2949 Due Date: 29 Jun '84

Performed By: J. C. Gilbert 9 Apr '84
Name Date

Witnessed By: Andrew Rietzke 4-9-84
QA Representative Date

COMANCHE PEAK SES
SHEAR TESTS
EC-2W
RICHMOND 1 -INCH, TYPE ___ INSERT

Reference: CP-EI-13.0-~~5~~ 13gch

Specimen Number: 20 (5th from West End)   Bolt Spec: A-490   Date: 9 Apr 84

DEFLECTION (IN.) INITIAL	DEFLECTION (IN.) AFTER 2-MIN.	GAUGE PRESSURE (P.S.I.)	JACK * THRUST (Lbs.)	NOTES-FAILURE MODE
~~0.002~~	~~0.007~~	~~400~~		Slack not out of apparatus.
		~~800~~		
~~0.004~~	~~0.004~~	~~400~~		
~~.008~~	.008	~~600~~		
		~~1200~~		
0.003	0.003	400	5300	
.025	.032	800	10600	
.046	.046	1200	15900	
.063	.064	1600	21200	
.085	.087	2000	26500	
.115	.122	2400	31800	
.154	.173	2800	37100	
.270		~~3200~~ 3000	39750	Concrete crushed. insert remained intact but upper portion rotated thru a few degrees. Deflection of upper part of insert (washer) 3/8". Bolt broke in bending at lower load than the max 39750. Rotation caused cone spall to lift on tension side 1½ deep tapering to zero 10" back. Spall total 12" dia (I)

* Jack Thrust equal Shear Load on Insert.
Jack Thrust (Lbs.) = Gauge Pressure (PSI) x 13.25
Jack:.......Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355   Due Date: 16 Apr '84
Dial Gauge:......M & TE Number 2949   Due Date: 29 Jun '84

Performed By:
J.C. Gilbreth   9 Apr '84
Name   Date

Witnessed By:
[signature]   4-9-84
QA Representative   Date

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 -Inch, Type EC-2W Insert
Reference: CP-EI-13.0-413,01

Specimen Number: 21 (6th from West End) Inserted Load Rod: A-193 Date: 9 Apr 84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5300	0.000	0.000		5,300			0.000	0.000	
800	10600	.001	.001		10,600			.000	.000	
1200	15900	.065	.061		15,900			.022	.0225	
1600	21200	.173	.183		21,200			.049	.0525	
2000	26500	.330	.378		26,100			.111	.134	
~~2000~~ 2100 3/4	27,825	.400			27,825			.15		Sound of a weld breaking. ~~Bolt~~ Rod sheared
				N/A		N/A	N/A			@ 2100 = 27,825#. Insert washer deflected laterally 3/8". Some bending of rod
										but fractured surface indicated a
										shear break. Top of insert rotated
										thru
										Concrete spalled all around @ about
										12" dia. 1 1/2" deep @ insert, zero depth @ edge

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2~~

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr 84
Dial Gauge-M&TE No: 2149 Due Date: 29 Jun 84
Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: ~~2450~~ 2149 Due Date: 18 Jun 84

Performed By: J. C. Mitchell (Name) 9 April 84 (Date)

Witnessed By: Adam Rutzel (QA Representative) 4-9-84 (Date)

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 -Inch, Type EC-2W Insert
Reference: CP-EI-13.0-4/13,0-8

Specimen Number: 22 (7th from West) Inserted Load Rod: A-193 Date: 9 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	~~5300~~	0.006	0.004		5300			0.001	0.001	
800	10,600	.037	.038		10600			.013	.014	
1200	15,900	.105	.109		15900			.0255	.026	
1600	21,200	.196	.205		21200			.055	.058	
2000	26,500	.342	.428		26500			.115	.145	
2200	29150	.52			29150			.16		
1800	23850			N/A	23850	N/A	N/A			~~Water broke~~ Sharp noise, cause unknown
1500	19875				19875					Rod sheared. Rod had rotated @ shear
										line thru approx. 20° when broke.
										Concrete spalled approx 15" diameter,
										being 18" on tension side & 3" on comp. (toward
										shear jack) side. 2" deep @ insert
										Insert remained intact.

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A Lb.
~~** Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2.~~ JCH

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2935 Due Date: 16 Jun 84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun 84

Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun '84

Performed By: J. C. Hilbath [signature] (Name) 9 Apr '84 (Date)

Witnessed By: [signature] (QA Representative) 4-9-84 (Date)

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 -Inch, Type EC-6W Insert
Reference: CP-EI-13.0-9 pau

Specimen Number: 23 (9th from west end) Inserted Load Rod: A-193 Date: ~~8~~ 10 Apr. 84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5300	0.002	0.002		5 300			0.0005	0.0005	
800	10 600	.035	.0375		10 600			.009	.010	
1200	15 900	.122	.134		15 900			.038	.041	
1600	21 200	.290	.269		21 200			.075	.084	
2000	26 500	.350	.410		26 500			.140	.158	
2200	29 150	.430			29 150			.20		Deflection increased rapidly.
2300	30 475	.620		N/A	30 475	N/A	N/A			Abrupt failure by shear of rod. Insert
										washer moved horizontally 1/8". No breakage
										of insert. Rod rotated some 30° above
										threads of insert. This permitted by
										crushing of concrete and probably defor-
										mation of threaded coil. Rod failure
										was by shear after considerably defor-
										mation

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A lb.
~~** Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = ~~Net~~ Jack Thrust ~~÷ 2~~ JCP

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2755 Due Date: 16 Apr 84
Dial Gauge-M&TE No: 2749 Due Date: 29 Jun 84
Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun 84

Performed By: J. C. [signature] 10 Apr '84
Name Date

Witnessed By: Andrew [signature] 4-10-84
QA Representative Date

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 -Inch, Type EC-2W Insert
Reference: CP-EI-13.0-5904

Specimen Number: 24 (9th from west end) Inserted Load Rod: A-193 Date: 10 April '84

Common	SHEAR			TENSION						
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Notes - Failure Mode
400	5,300	0.001	0.001		5,300			0.002	0.002	
800	10,600	.008	.008		10 600			.0065	.0065	
1200	15 900	.060	.070		15 900			.027	.030	
1600	21 200	.153	.171		21 200			.062	.069	
2000	26 500	.325	.390		26 500			.135	.159	
2100	27 825	.400			27 825			.17		Rapid yielding began.
2100	27 825	.500		N/A	27 825	N/A	N/A	.20		
2200	29 150	.540			29 150			.227		
2200	29 150	.700			29 150			.227		
2000	26500				26 500					Break. Abrupt shear failure of rod. Some 1/8" horizontal deflection of top of insert permitted by ~~rotation~~ crushing of concrete and ~~deformation~~ deflection of upper coil of insert. Concrete spalled 2" deep on tension. Visible 2" of insert seen to have tilted 5°(±). Insert intact

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
Total Wt. of Tension Load Beam = N/A lb.
** ~~Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam~~
*** Insert Load = ~~Net~~ Jack Thrust ~~x 2~~ 2/08

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr '84
Dial Gauge-M&TE No: 2949 Due Date: 29 Jun '84
Tension Apparatus: Jack-Equipment No: RCH 603T
Pressure Gauge-M&TE No: Same Due Date:
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun '84

Performed By: J. C. Gilbert 10 April '84
Name Date

Witnessed By: [signature] 4-10-84
QA Representative Date

COMANCHE PEAK SES
COMBINED SHEAR & TENSION TESTS
Richmond 1 -Inch, Type EC-2W Insert
Reference: CP-EI-13.0-9 pcw

Specimen Number: 25 (10th from West End) **Inserted Load Rod:** A-193 **Date:** 10 April '84

Common	SHEAR			TENSION						Notes - Failure Mode
Gauge Press. (PSI)	1-* Jack Thrust (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	Gauge Press. (PSI)	2-* Jack Thrust (Lb.)	** Net Jack Thrust (Lb.)	*** Insert Load (Lb.)	Deflection (Inch) Init.	Deflection (Inch) After 2-Min.	
400	5 300	0.0015	0.0015		5 300			0.000	0.000	
800	10 600	0.026	.028		10 600			.0025	.009	
1200	15 900	.115	.122		15 900			(-).005		
1600	21 200	.217	.229		21 200			.006	.010	
2000	26 500	.260	.304		26 500			.047	.063	
2100	27 825	.320			27 825			.070		
2150	28,487	.400		N/A	28,487	N/A	N/A	.080		Abrupt break. Insert deflected 1/32" (-). Rod failed in shear.

1-* Jack Thrust = Shear Load on Insert.
1-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Shear Load.
2-* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25 for Tension Load.
~~Total Wt. of Tension Load Beam =~~ N/A lb.
~~** Net Jack Thrust = Total Thrust Minus 1/2 Wt. of Beam.~~
*** Insert Load = Net Jack Thrust ~~÷ 2~~. JCG

Shear Apparatus: Jack---Equipment No: RCH 606
Pressure Gauge-M&TE No: 2355 Due Date: 16 Apr '84
Dial Gauge-M&TE No: 2449 Due Date: 29 Jun '84
Tension Apparatus: Jack-Equipment No: RCH 605T
Pressure Gauge-M&TE No: Same Due Date: ______
Dial Gauge-M&TE No: 2094 Due Date: 18 Jun '84

Performed By: J C Gilbreth (Name) 10 april 84 (Date)

Witnessed By: [signature] (QA Representative) 4-10-84 (Date)

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-5 13gcu

Specimen Number: 26 Load Rod Spec: A-193 Date: 6 Apr '84
11th ~~12th~~, from west end, 5th from east

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	.003	.003	
600	7950	6725	13450	.007	.0075	
800	10600	9375	18750	.012	.0125	
1000	13250	12025	24050	.0175	.019	
1200	15900	14675	29350	.037	.038	
1400	18550	17325	34650	.070	.070	
1600	21200	19975	39950	.098	.105	
1700	22525	21300	42600	.134		Failure.

Insert remained intact. Shear cone type failure of concrete. Insert was located near center between E-W & N-S rebars. Cone was restricted somewhat by 4-bars 2-each way. Some lifting force on bars caused concrete to spall 3-ft. ea. side of insert. Shear cone depth = full height of insert less 3/4" @ bottom.

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 wt. = 1225 lb)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2949 Due Date: 29 Jun '84

Performed By: [signature] 6 Apr '84
Name Date

Witnessed By: [signature] 4-6-84
QA Representative Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~8~~ 13 gen

Specimen Number: 27   Load Rod Spec: A-193   Date: 6 Apr '84

12th ~~[illegible]~~ from West End, 4th from east)

GAUGE PRESS. P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	.000	.000	
600	7950	6725	13450	.000	.000	
800	10600	9375	18750	.0005	.0005	
1000	13250	12025	24050	.0065	.0075	
1200	15900	14675	29350	.0165	.0175	
1400	18550	17325	34650	.050	.056	
1600	21200	19975	39950	.080 ~~.060~~	.098	
~~1800~~ 1750				.146		Failure
~~2000~~	23,188	21,960	43,920			
			Failure occurered by failure of the insert. Weld between lower coil and vertical struts broke. Threaded, upper, coil came out and carried the two struts wit. Concrete spalled an oval area about 1.5' x 2.25' max depth 2" @ insert. Exposed one reber located 3" o.c. from insert. Rebar not disturbed. Only concrete cover removed.			

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 Wt. = 1225)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355   Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2949   Due Date: 29 Jun '84

Performed By: J. C. Gilbreth 6 Apr '84
Name   Date

Witnessed By: [signature] 4-6-84
QA Representative   Date

COMANCHE PEAK [illegible]
TENSION TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~?~~ 13 gcy

Specimen Number: 28 (3rd from east end)   Load Rod Spec: A-193   Date: 10 April '84

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	.000	.000	
600	7950	6725	13450	,000	.000	
800	10600	9375	18750	.002	.002	
1000	13250	12,025	24,050	.004	.005	
1200	15,900	14,675	29,350	.009	.010	
1400	18550	17325	34650	.015	.029	
~~1600~~ 1550	20538	19313	38626	.055	—	
1600	21,200	19,975	39950	.067	.082	
1700 ~~2000~~	22,525	21,300	42,600	.15		Concrete shear
~~2200~~ ~~2400~~ ~~2600~~				cone failure. Insert and rod		
				remained intact. Cone height		
				equal insert height. Size of cone		
				top limited by rebar ~~[illegible]~~ mat.		
				Rebars lifted with cone and lifted		
				area 4.5 x 3.5'. Rebars @ 9" o.c. E.W.		

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 wt. = 1225 Lb)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355   Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2049   Due Date: 18 Jun '84

Performed By: Witnessed By:

[signature] 4-10-84   [signature] 4-10-84
Name   Date   QA Representative   Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~9~~ 17 *pek*

Specimen Number: 29 (2nd from East, 14th fr. west)   Load Rod Spec: A-193   Date: 6 April '84

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	.005	.005	
600	7950	6725	13450	.009	.009	
800	10 600	9 375	18 750	.0145	.015	
1000	13 250	12 025	24 050	.021	.022	
1200	15900	14 675	29 350	.033	.037	
1400	18 550	17 325	34 650	.101	.104	
1600	21 200	19 975	39 950	.135	.1455	
~~1800~~ ~~2000~~						
1700	22,525	21,300	42,600	concrete failed by the load on insert lifting the rebar mat. An area some 3.5' x 6.0' failed in this manner then insert pulled out taking a small cone with it. Top rebar was placed in contact with insert, thus contributing to the cause of this large area concrete failure.		

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 wt. = 1225)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606

Pressure Gauge: M & TE Number 2355   Due Date: 16 Apr '84

Dial Gauge: M & TE Number 2949   Due Date: 29 [illegible] 84

Performed By: J.C. Gilbert [signature]   6 April 84
Name   Date

Witnessed By: Andrew Pietrzak [signature]   4-5-84
QA Representative   Date

COMANCHE PEAK SES
TENSION TESTS

RICHMOND 1 -INCH, TYPE EC-2W INSERT

Reference: CP-EI-13.0-~~F~~ 9CH

Specimen Number: 30 (1st on east end) Load Rod Spec: A-193 Date: 5 April '84

GAUGE PRESS. (P.S.I.)	* JACK THRUST (Lb.)	** NET JACK THRUST (Lb.)	*** INSERT LOAD (Lb.)	DEFLECTION (IN.) INIT.	DEFLECTION (IN.) AFTER 2-MIN.	NOTES-FAILURE MODE
~~200~~ ~~400~~ ~~600~~				~~0.000~~ ~~.008~~ ~~.0035~~	~~0.000~~ ~~.002~~	—
200	2650	1425	2850	0.000	0.000	
400	5300	4075	8150	0.000	.000	
600	7950	6725	13450	.001	.001	
800	10600	9375	18750	.005	.006	
1000	13250	12025	24050	.019	.021	
1200	15900	14675	29350	.047	.049	
1400	18550	17325	34650	0.106	.109	
1600	21200	19975	39950	.153	.174	
~~1800~~ ~~2000~~						
1650	21860	20635	41270	.250		Load Peaked Ou[t]

Insert failed by breaking weld between lower coil and vertical struts. Upper (threaded coil) came out w/rod, also struts came out. Top concrete spalled, abt 18" dia surface spall only. Rebar ~~[illegible]~~ (6") exposed by removal of cover. Bar not deformed. Concrete

* Jack Thrust (Lb.) = Gauge Pressure (PSI) x 13.25
Total Weight of Load Beam = 2450
** Net Jack Thrust = Total Thrust Minus 1/2 Weight of Beam. (1/2 wt. = 1225)
*** Insert Load = Net Jack Thrust x 2.
Jack:..........Equipment Number RCH 606
Pressure Gauge: M & TE Number 2355 Due Date: 16 Apr '84
Dial Gauge: M & TE Number 2949 Due Date: 29 Jun '84

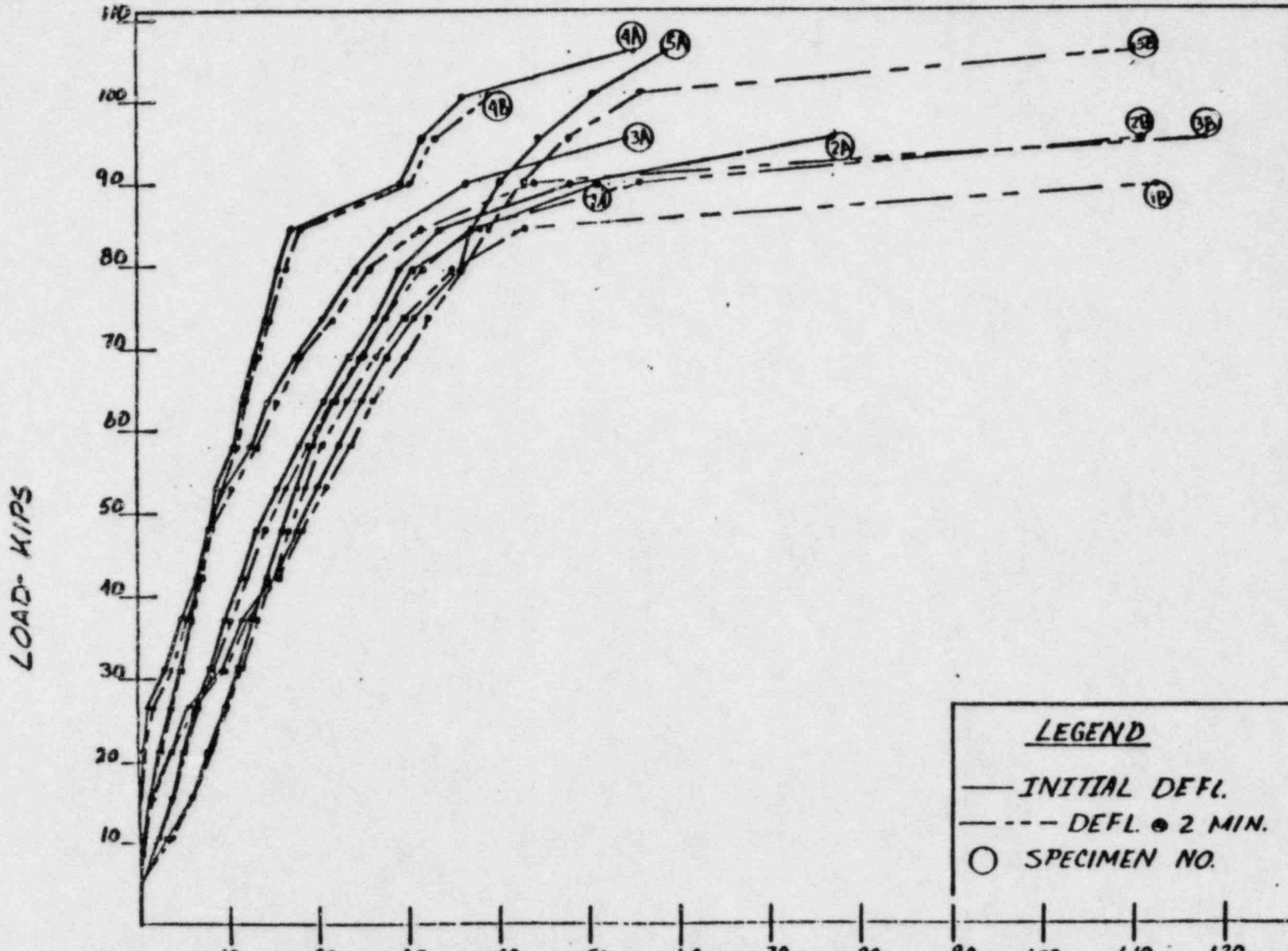
Performed By: O C Gilbrath 5 Apr 84
Name Date

Witnessed By: Andrew Pietrzak 4-5-84
QA Representative Date

APPENDIX 3

LOAD-DEFLECTION CURVES

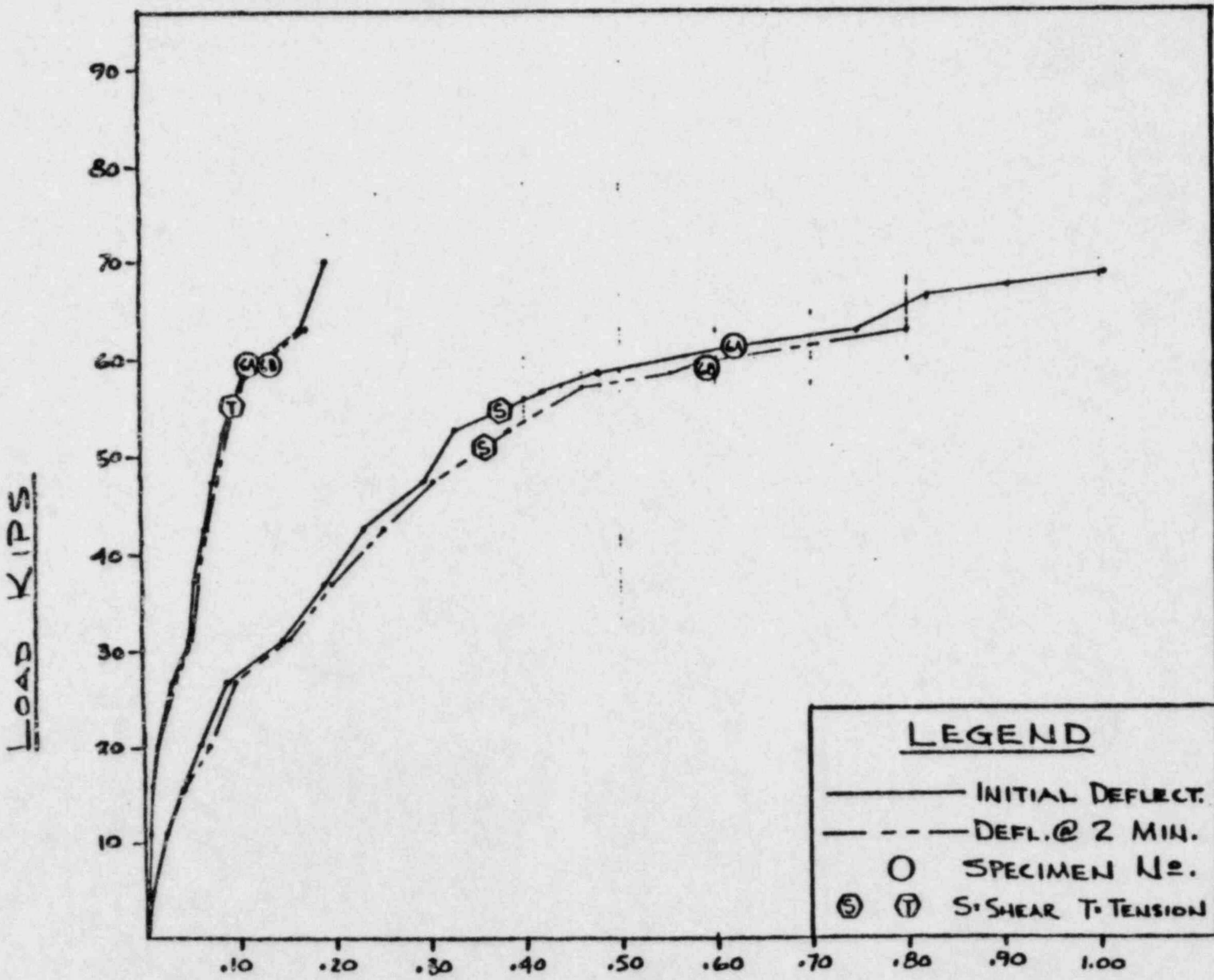
LOAD-DEFLECTION CURVES
1½-INCH TYPE EC-6W, SHEAR TEST

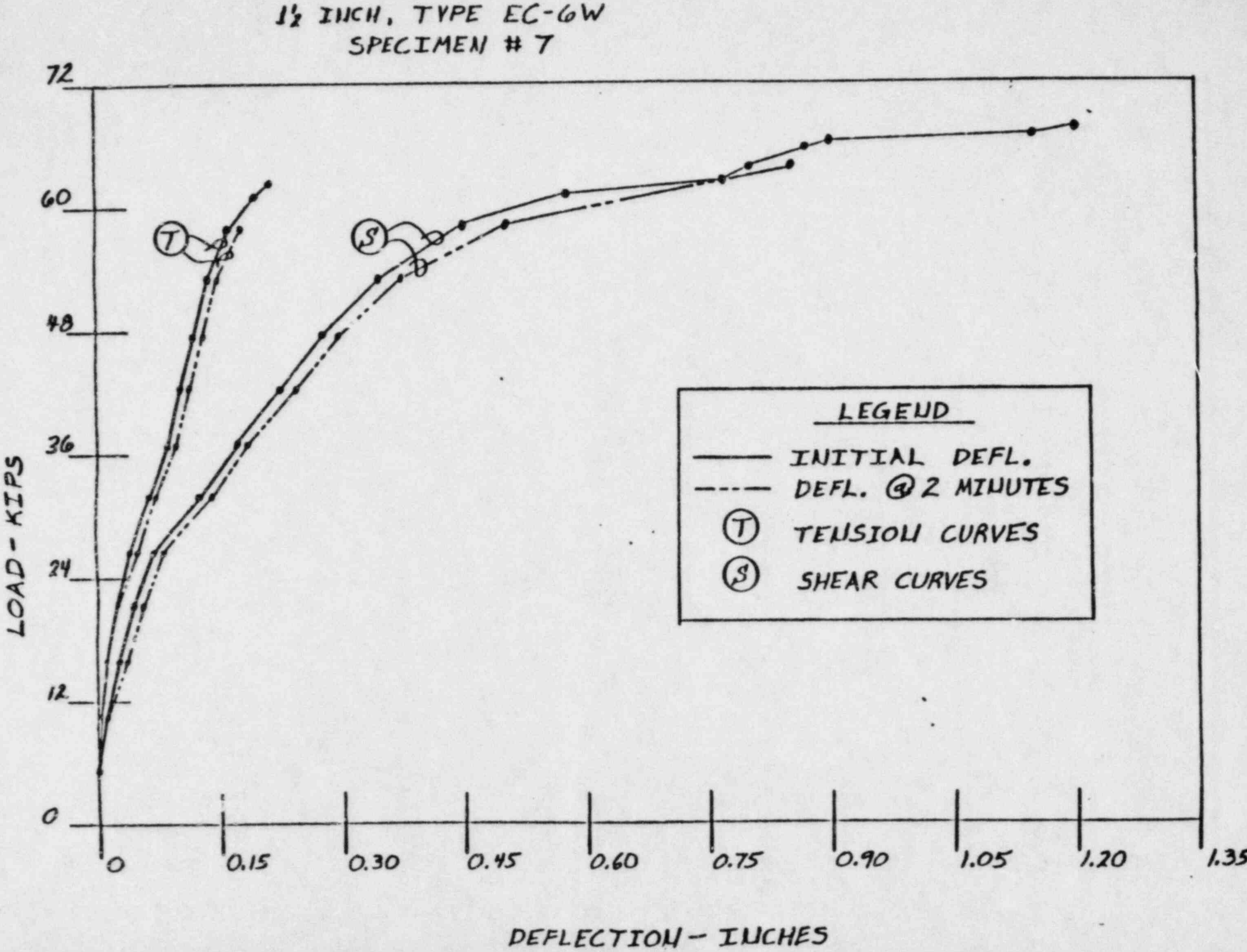


COMBINED SHEAR & TENSION TEST CHART

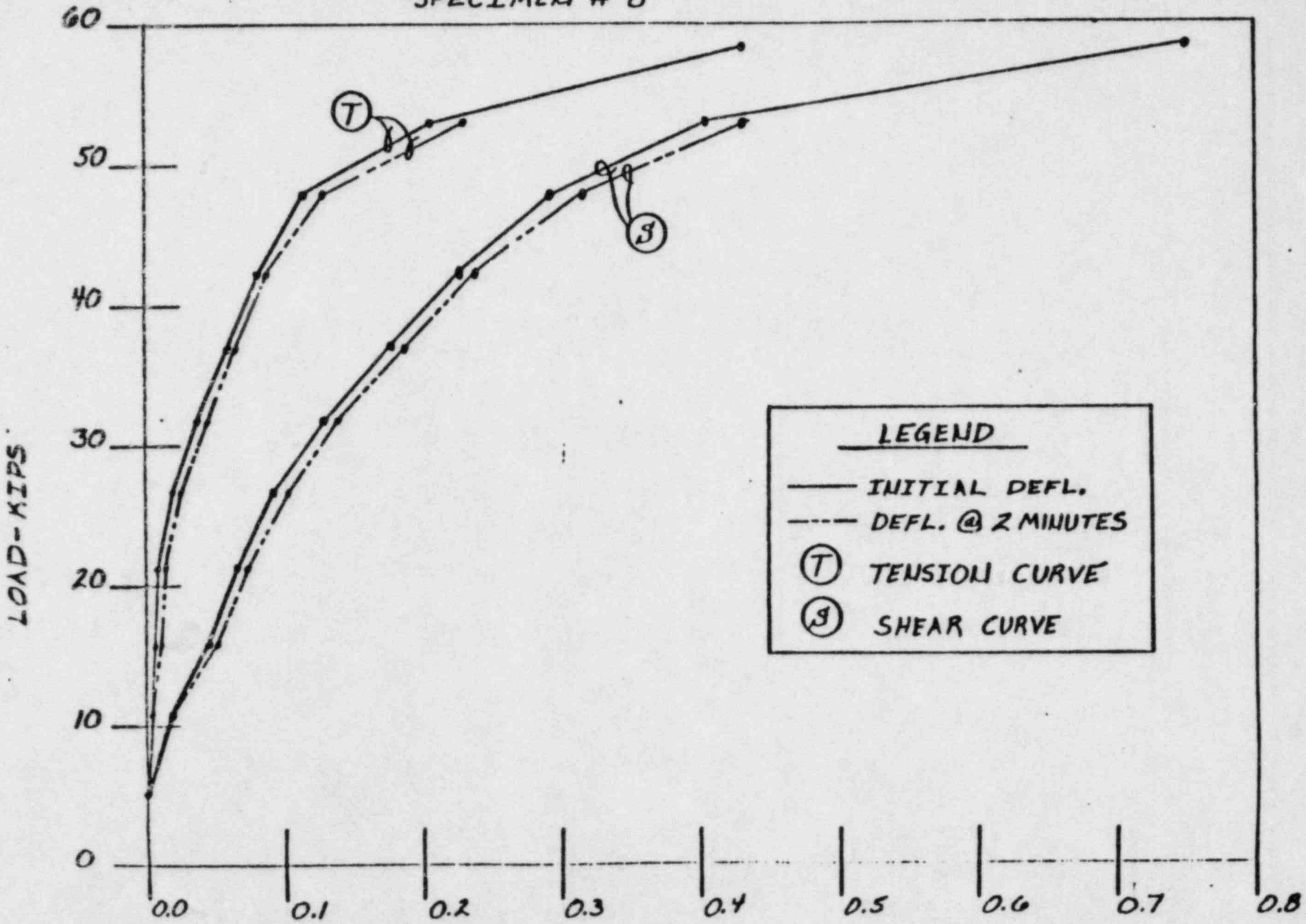
RICHMOND 1½ INCH, TYPE EC-6W INSERT

SPECIMAN No. 6

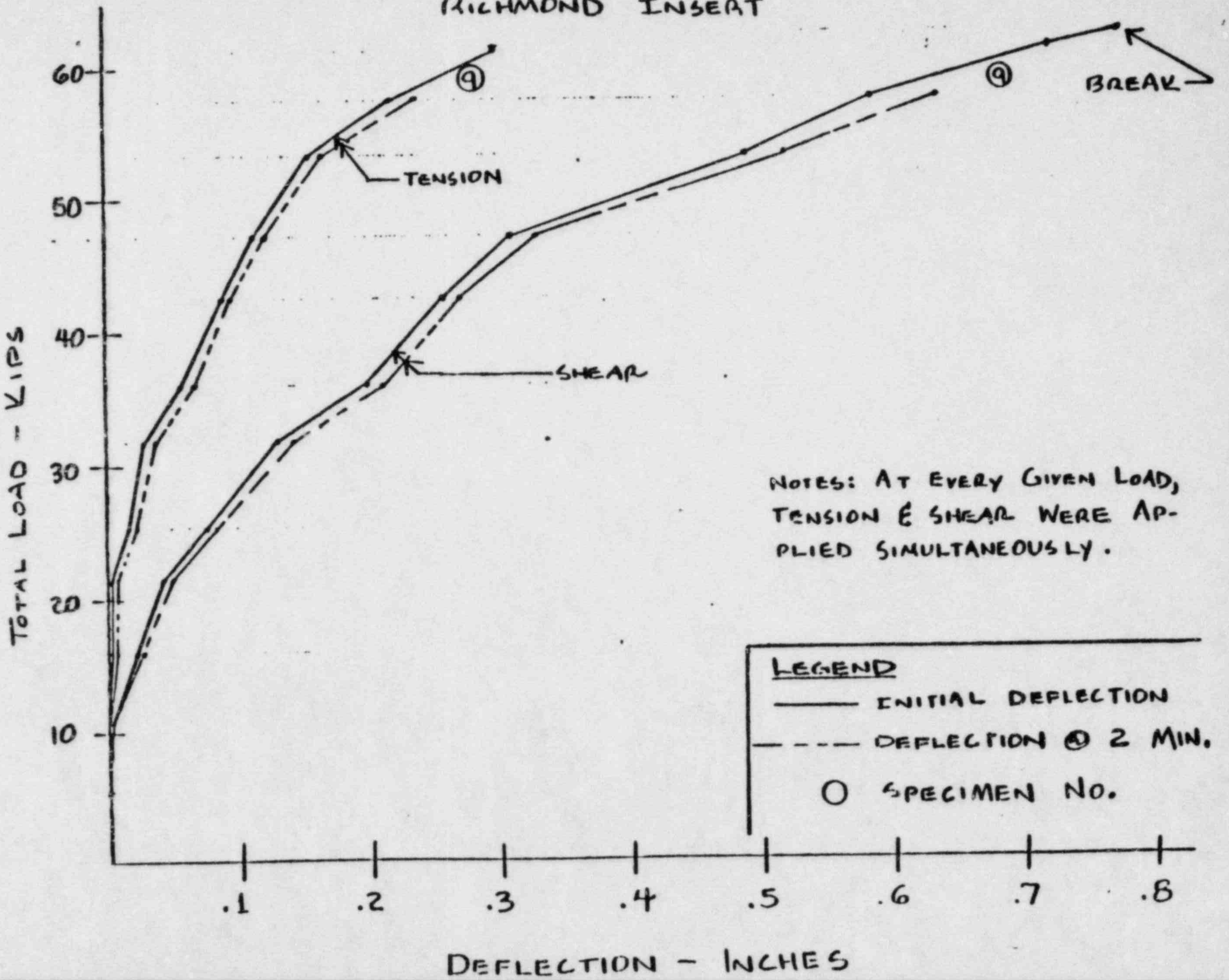



1½ INCH, TYPE EC-6W
SPECIMEN # 7
LOAD - KIPS
72
60
48
36
24
12
0
DEFLECTION - INCHES
0
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.35
T
S
LEGEND
INITIAL DEFL.
DEFL. @ 2 MINUTES
T TENSION CURVES
S SHEAR CURVES

COMBINED SHEAR & TENSION TEST CURVES
1½ INCH, TYPE EC-6W
SPECIMEN # 8

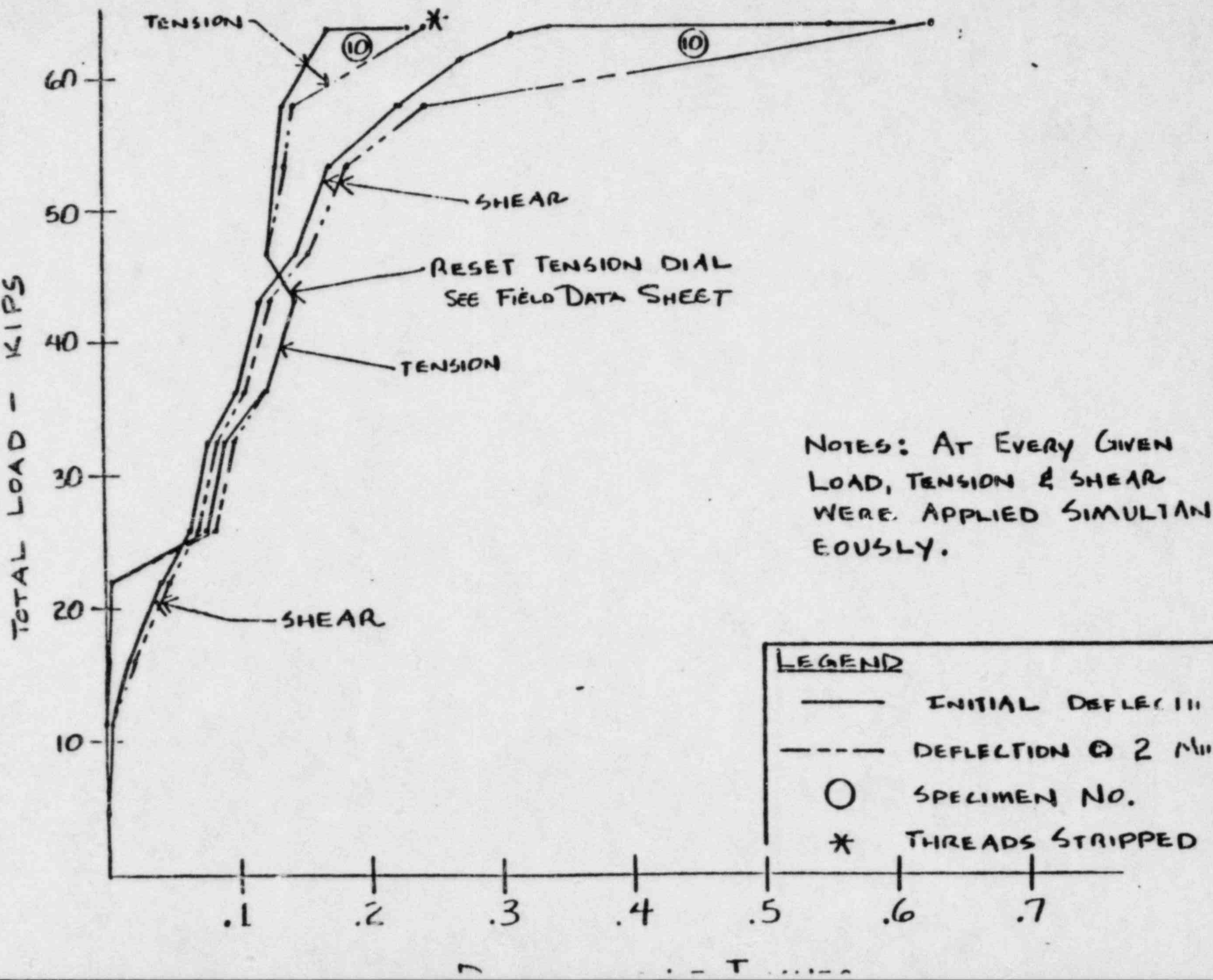


LOAD DEFLECTION CURVES FOR $1\frac{1}{2}$" TYPE EC-6W
RICHMOND INSERT

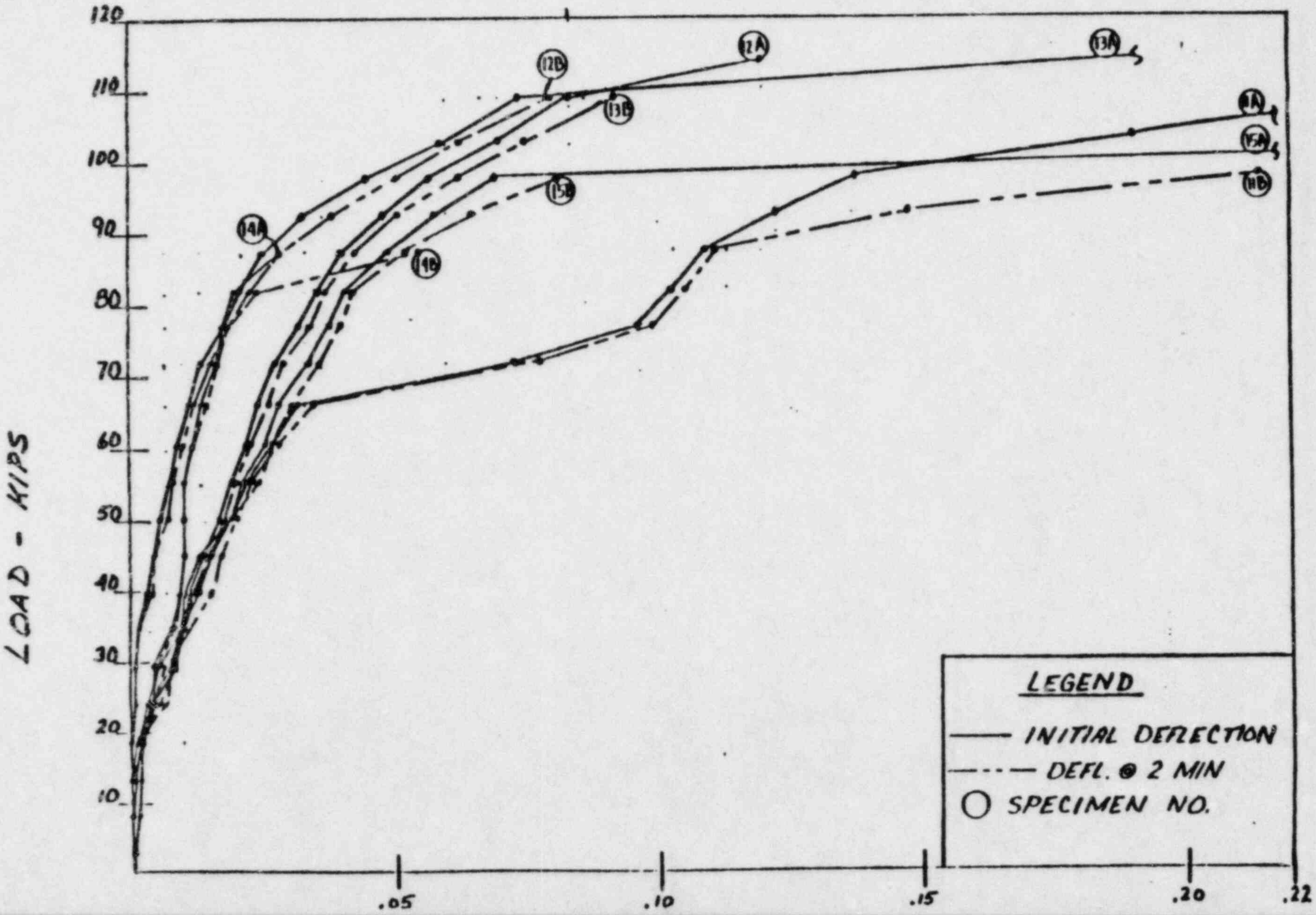


NOTES: AT EVERY GIVEN LOAD, TENSION & SHEAR WERE APPLIED SIMULTANEOUSLY.

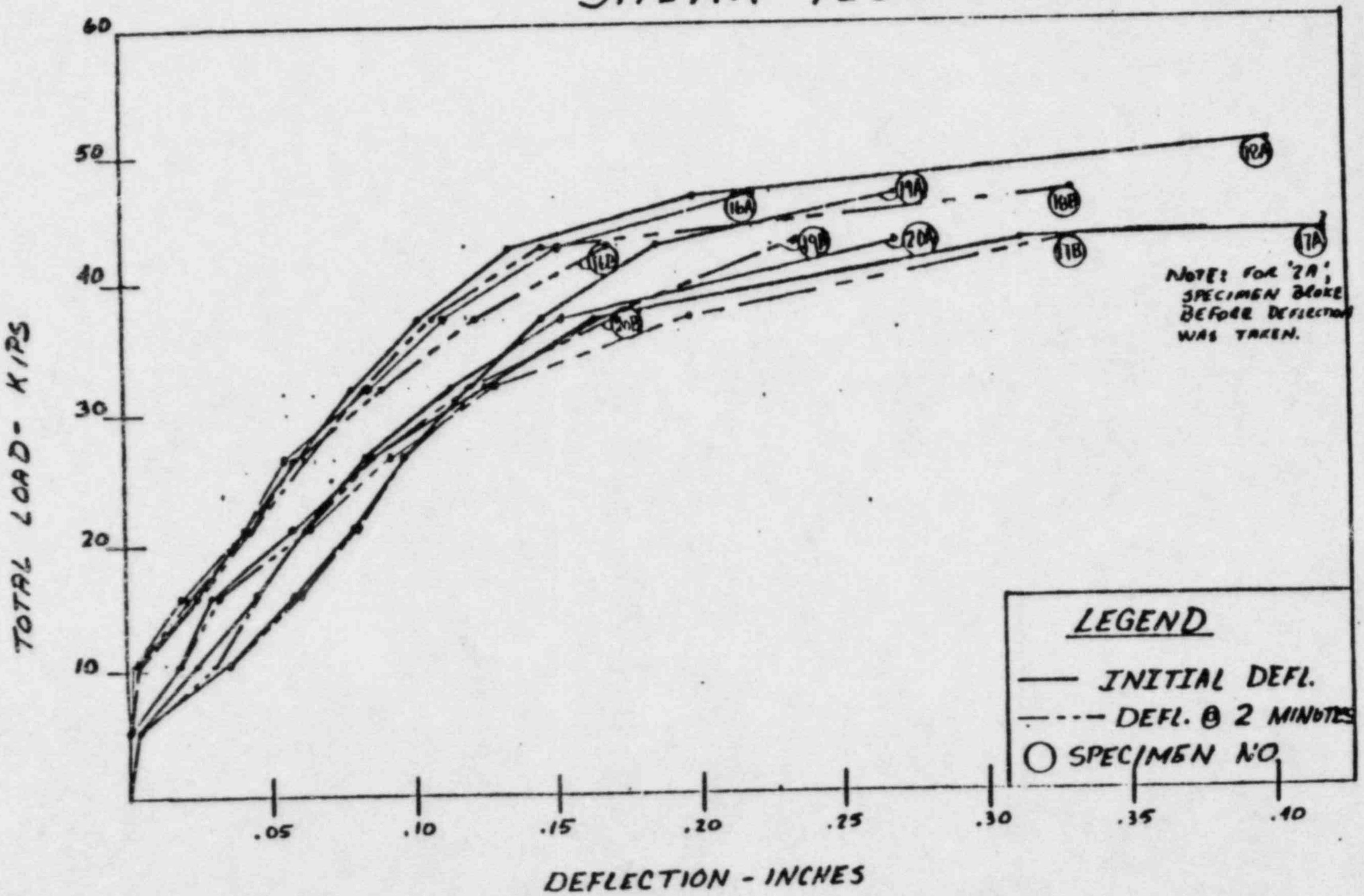
LOAD DEFLECTION CURVES FOR 1¼ Ø TYPE EC-6W
RICHMOND INSERT



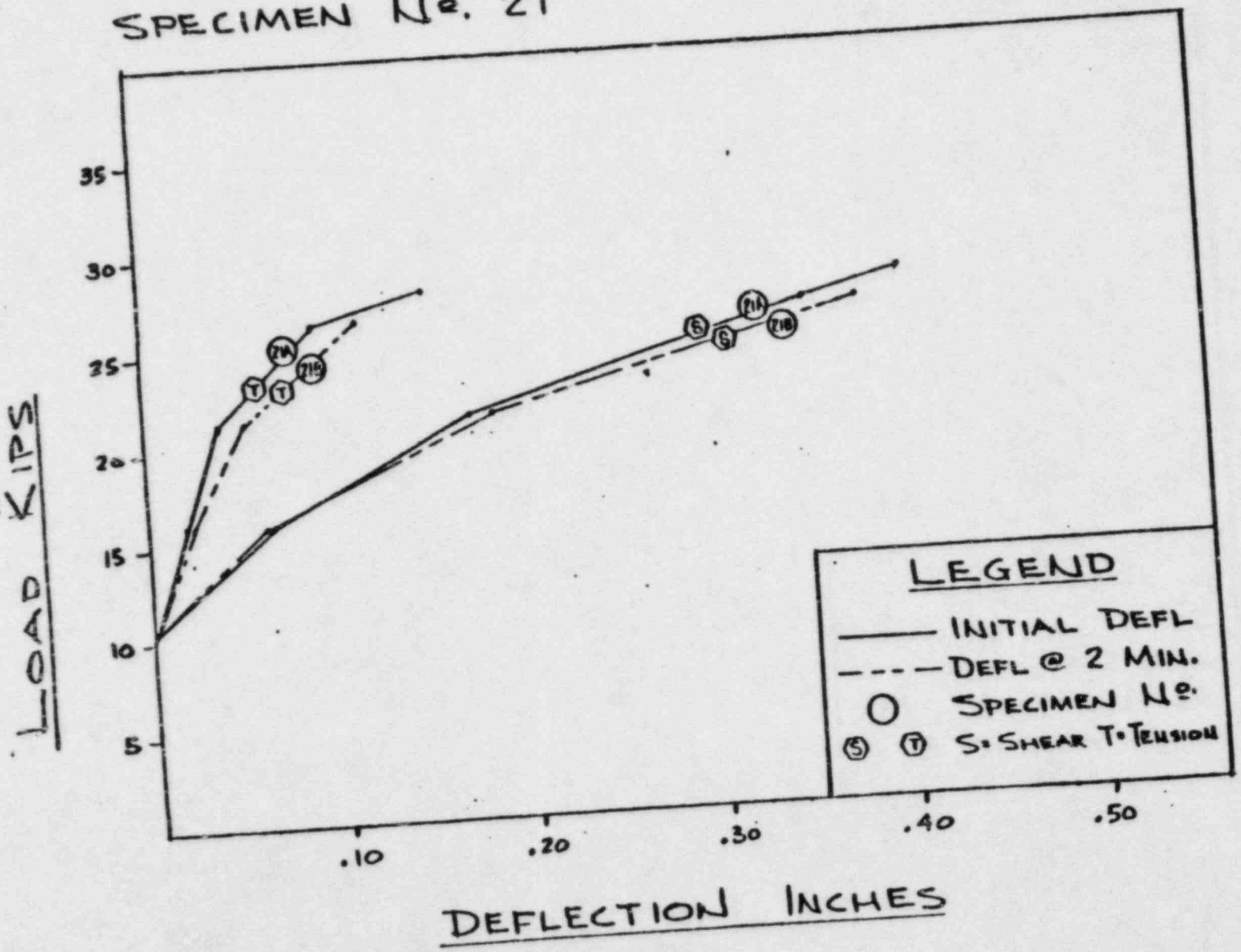
LOAD-DEFLECTION CURVES
1½-INCH TYPE EC-6W, TENSION TEST



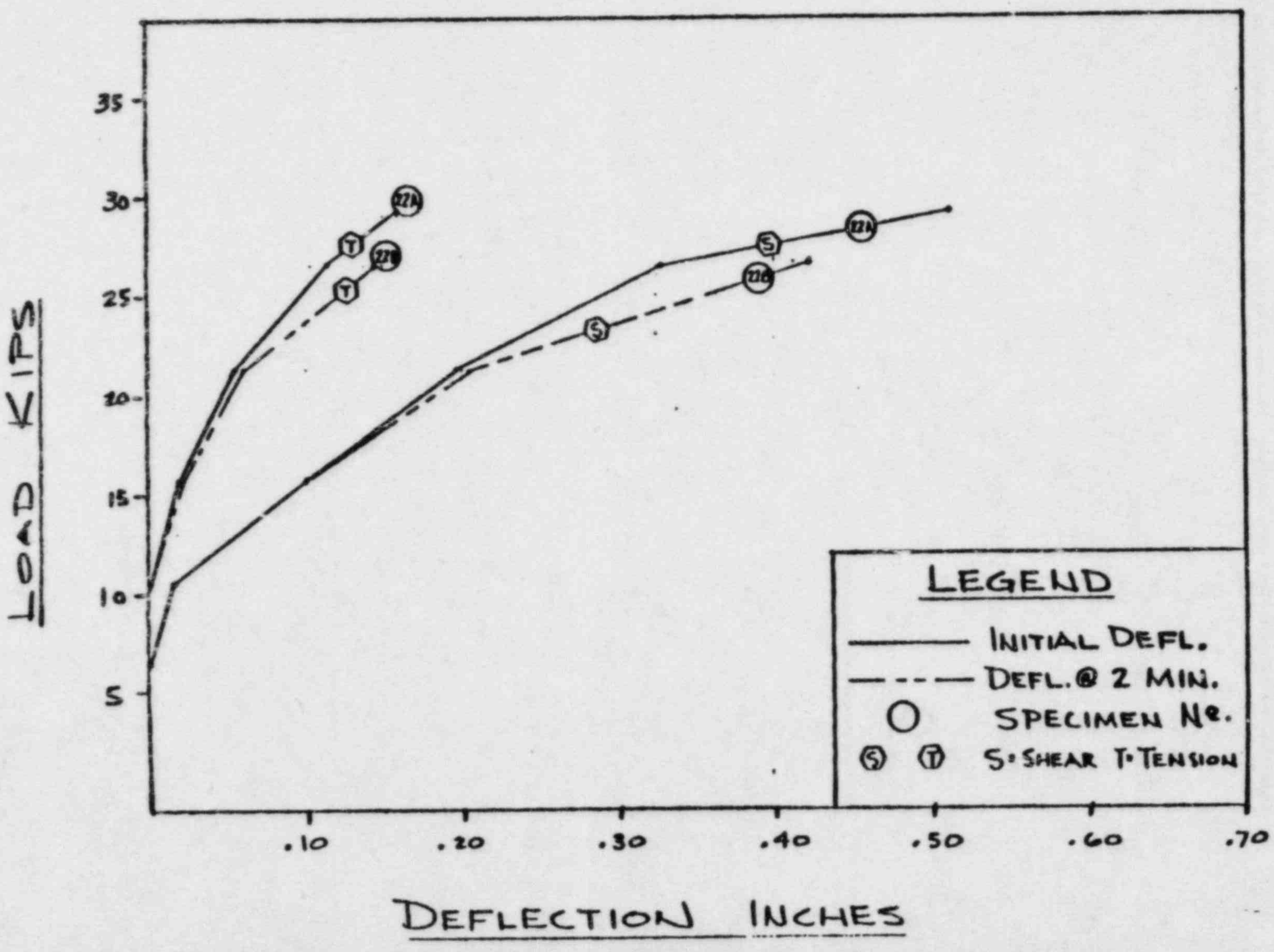
LOAD-DEFLECTION CURVES
1-INCH TYPE EC-2W
SHEAR TEST



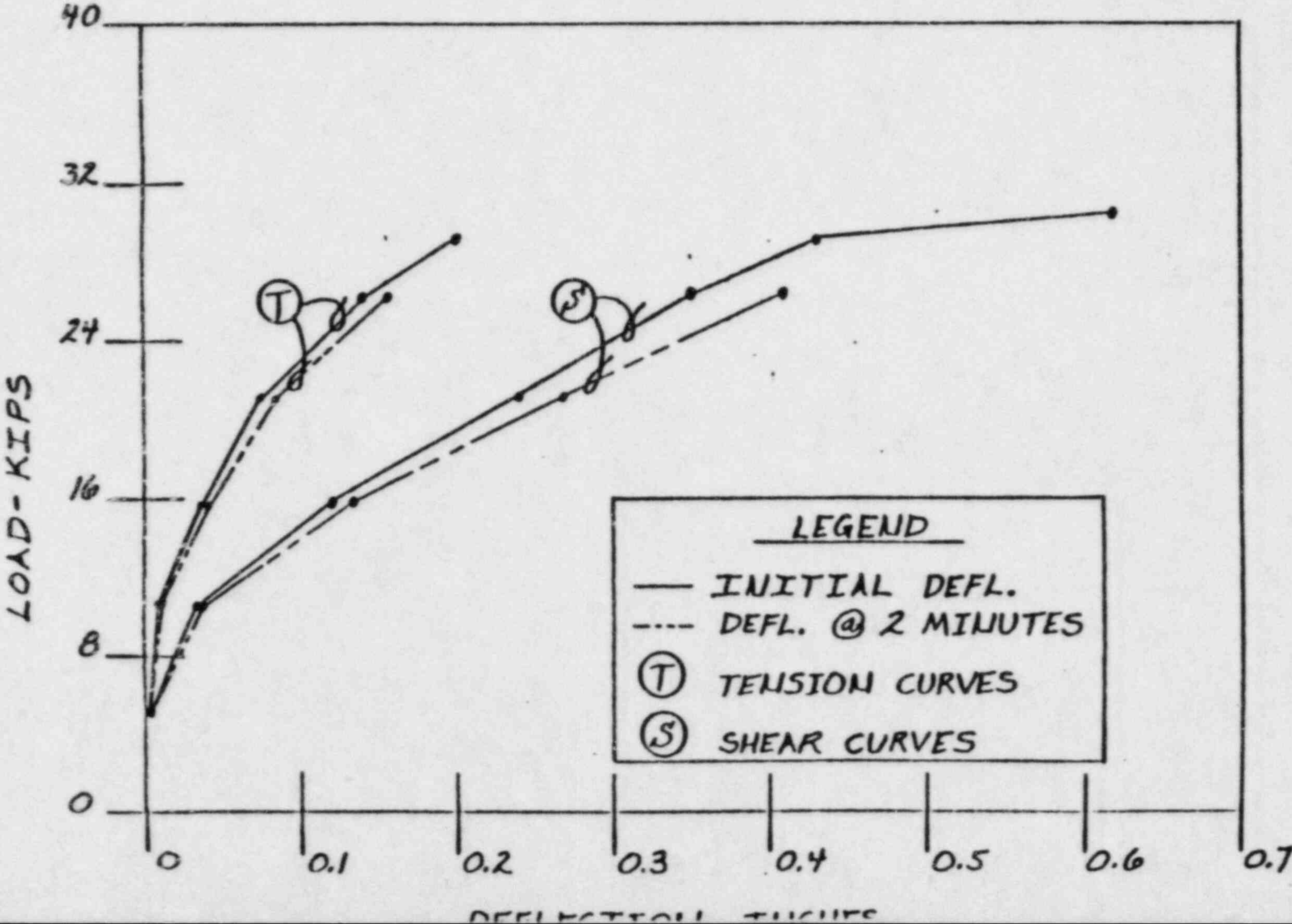
COMBINED SHEAR & TENSION CHART
RICHMOND 1 INCH, TYPE EC-2W INSERT
SPECIMEN No. 21



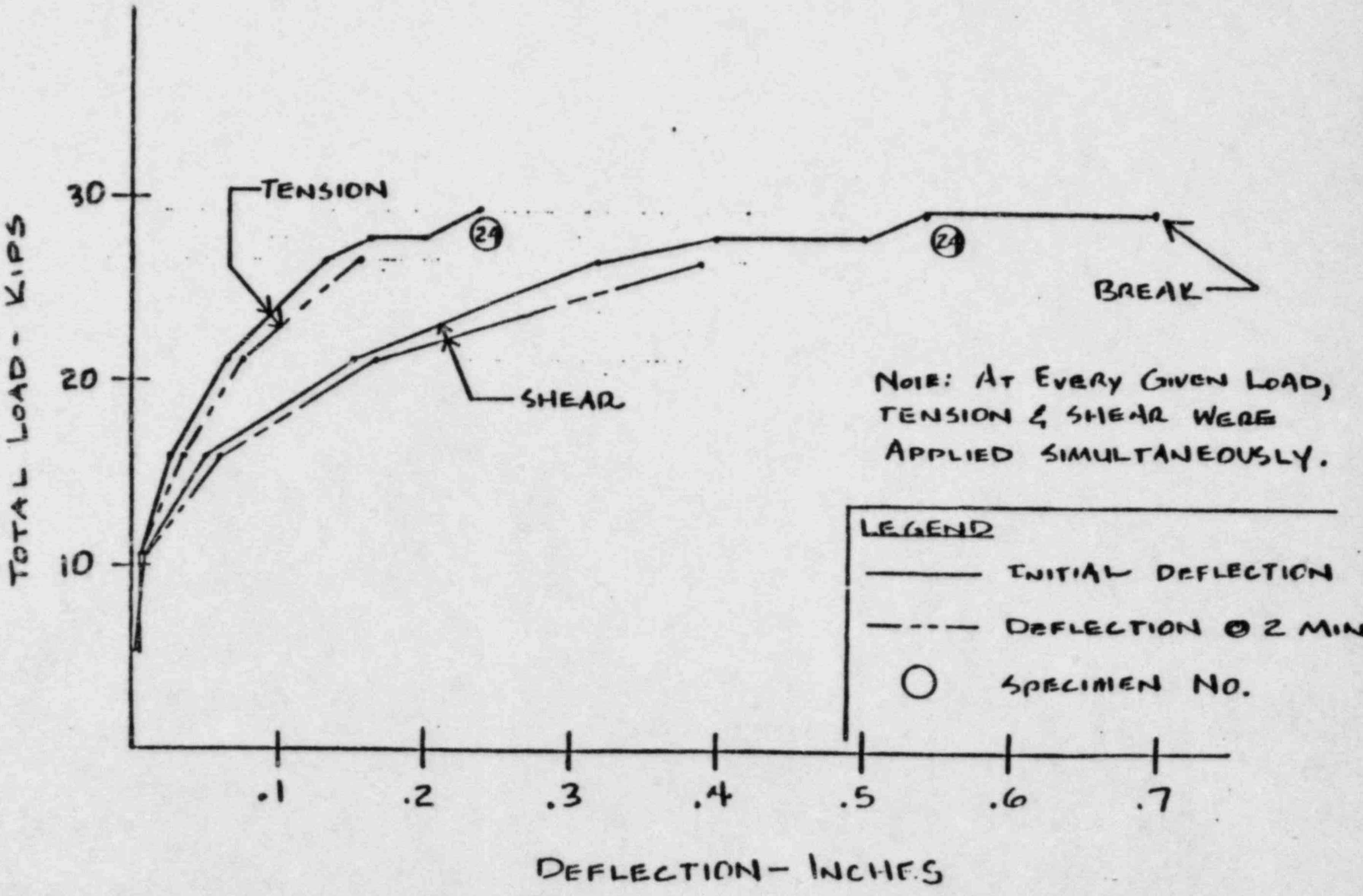
COMBINED SHEAR & TENSION CHART
RICHMOND 1 INCH, TYPE EC-2W INSERT
SPECIMAN No. 22



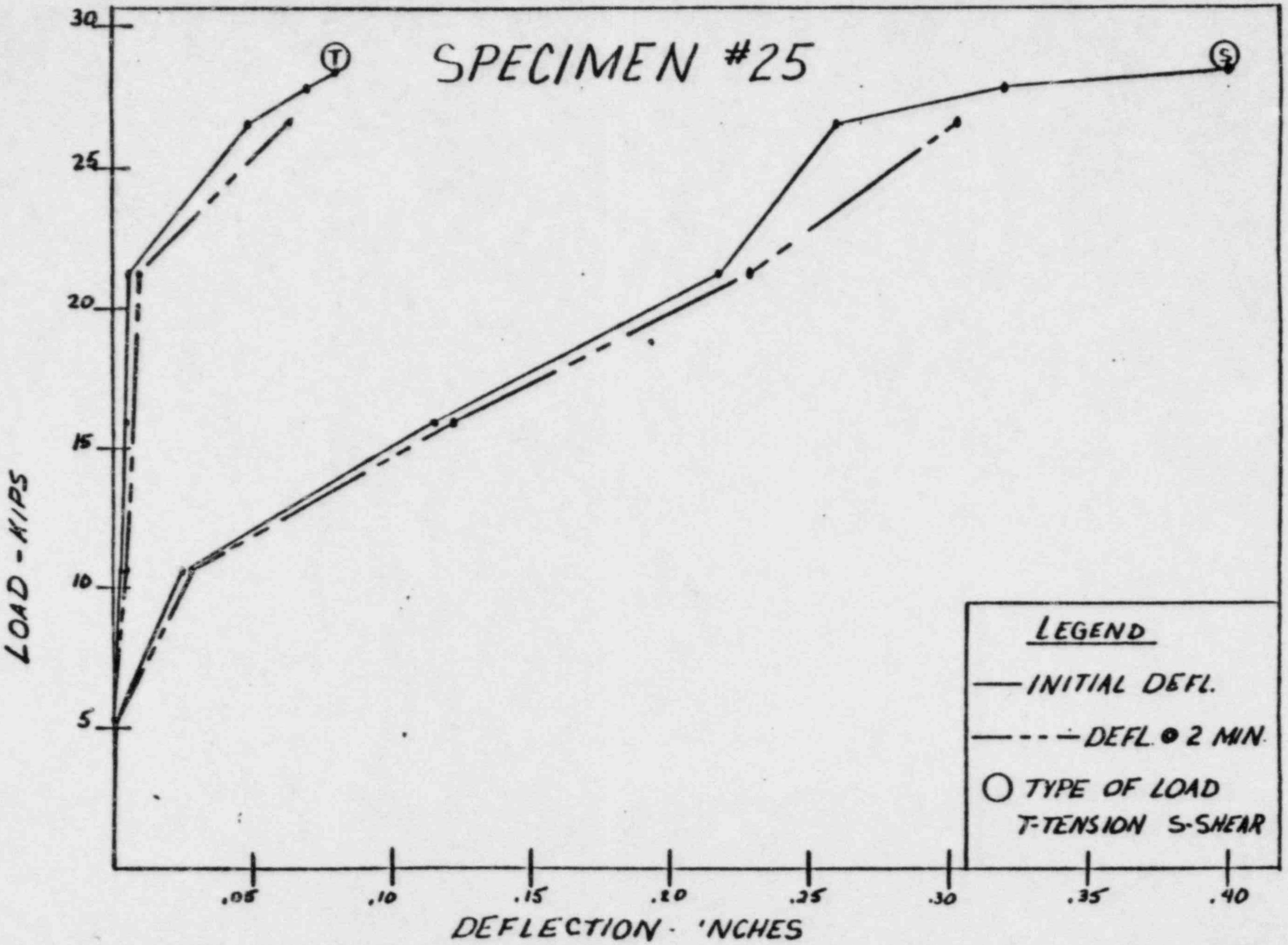
COMBINED SHEAR & TENSION TEST CURVES
1 INCH, TYPE EC-2W
SPECIMEN #23



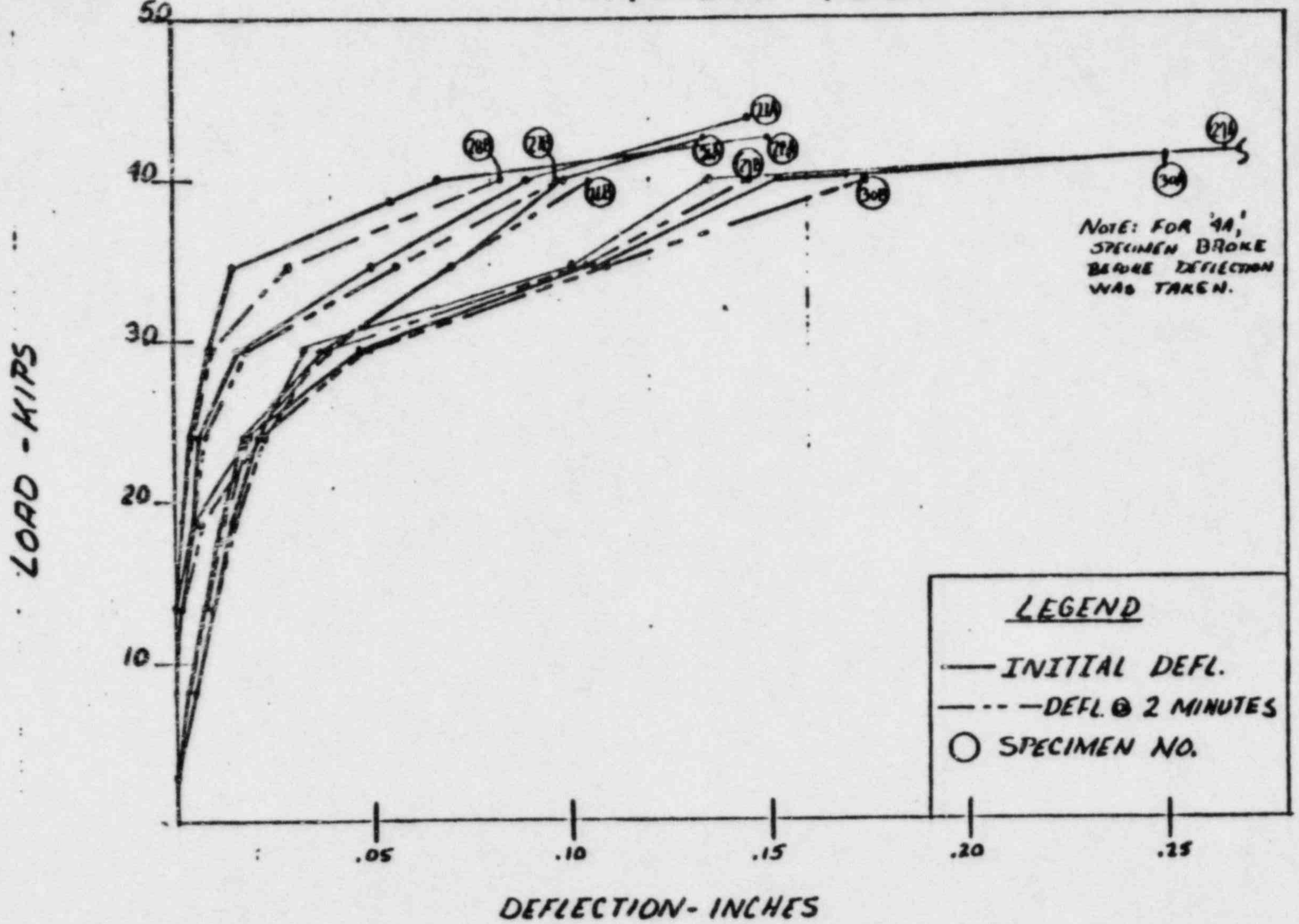
Load Deflection Curves for 1"ø Type EC-2W Richmond Insert



LOAD- DEFLECTION CURVE
1- INCH TYPE EC-2W
COMBINED SHEAR AND TENSION



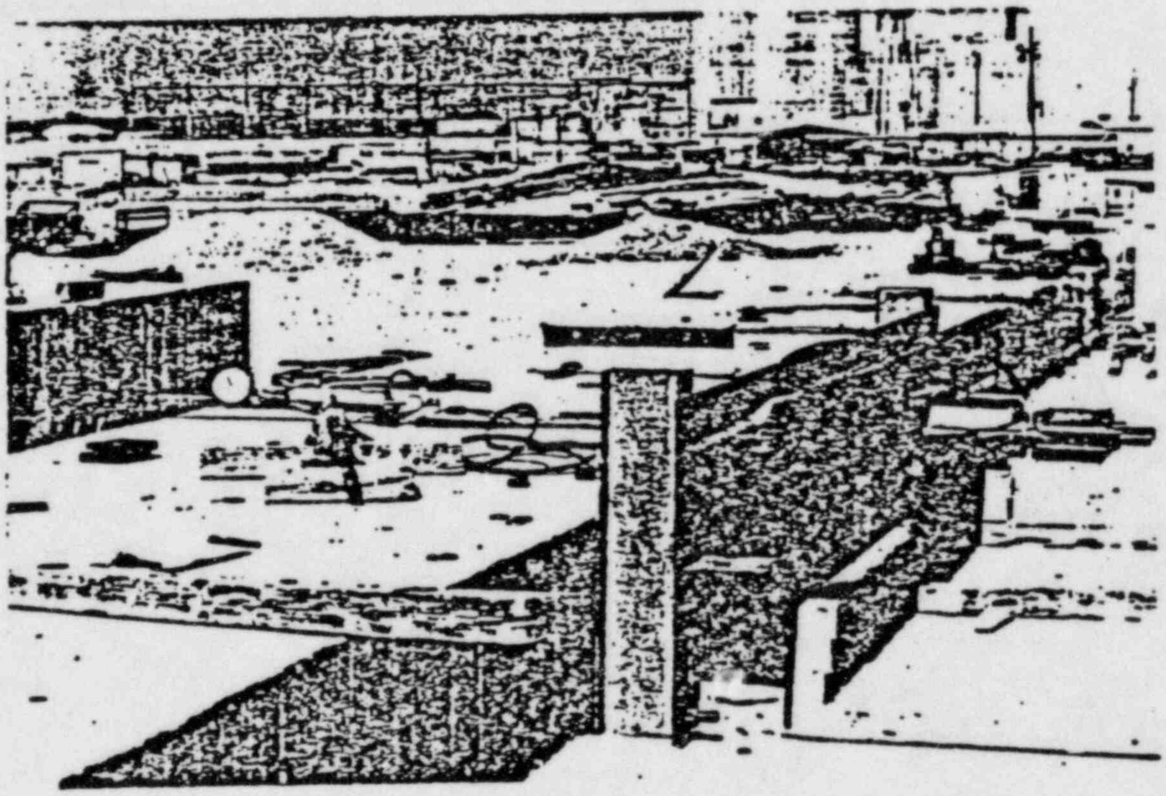
LOAD-DEFLECTION CURVES
1-INCH TYPE EC-2W TENSION TEST



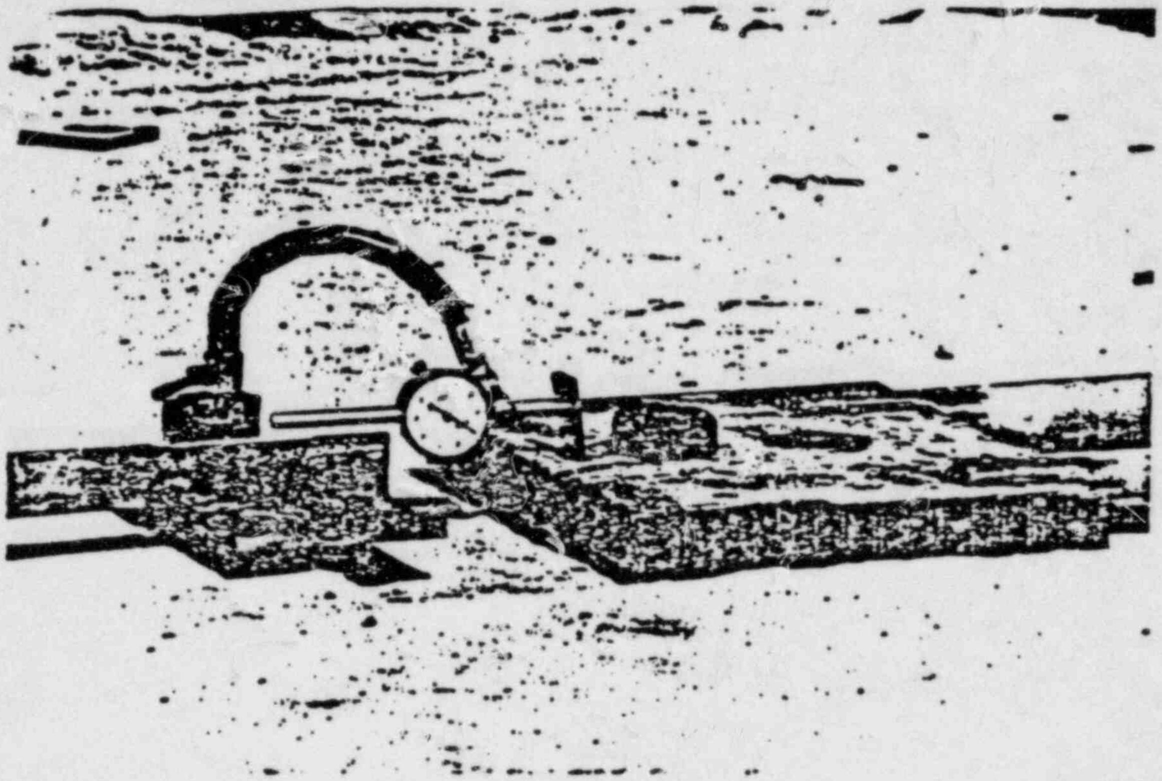
APPENDIX 4

PICTURES OF ACTUAL TEST APPARATUS

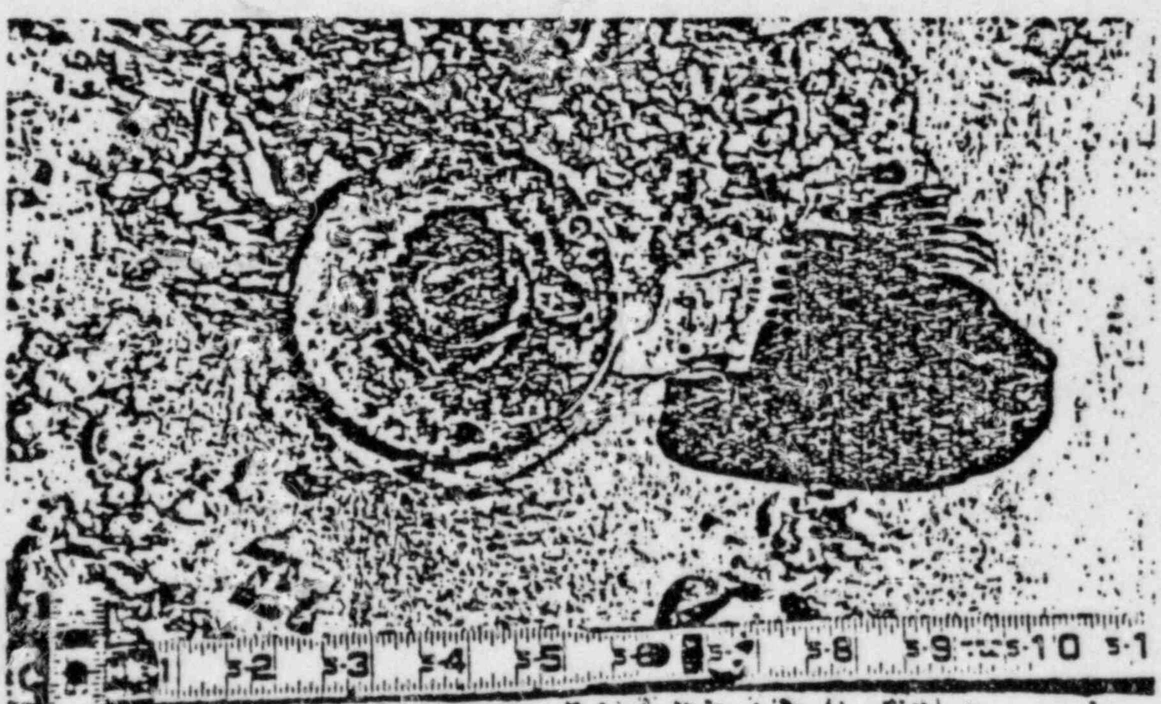
SHEAR TEST



TEST APPARATUS

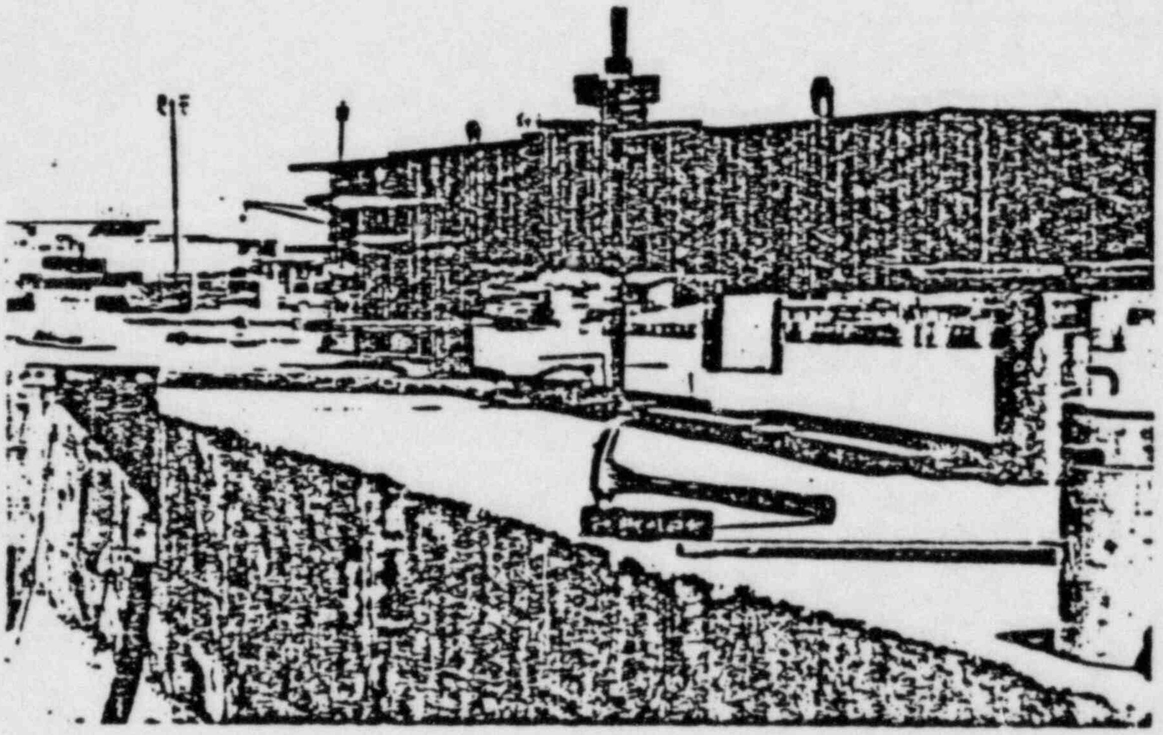


DIAL INDICATOR ARRANGEMENT

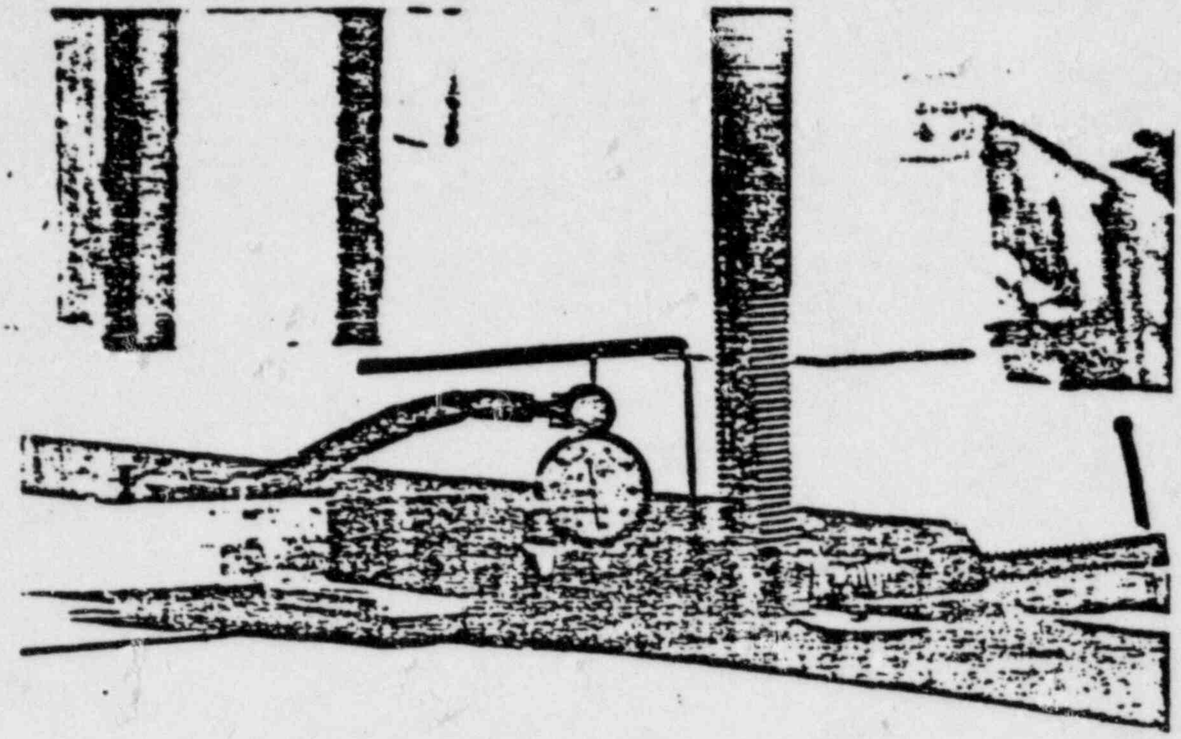


TYPICAL SHEAR FAILURE

TENSION TEST



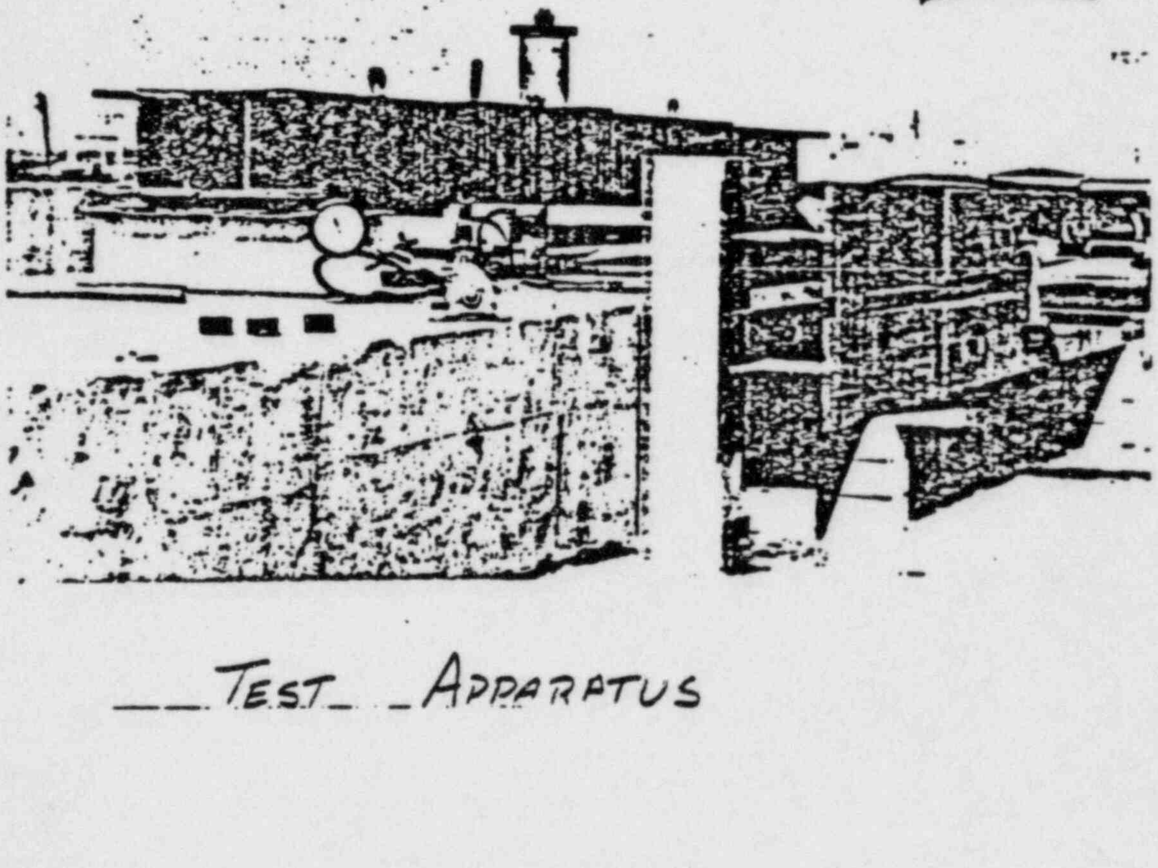
TEST APPARATUS



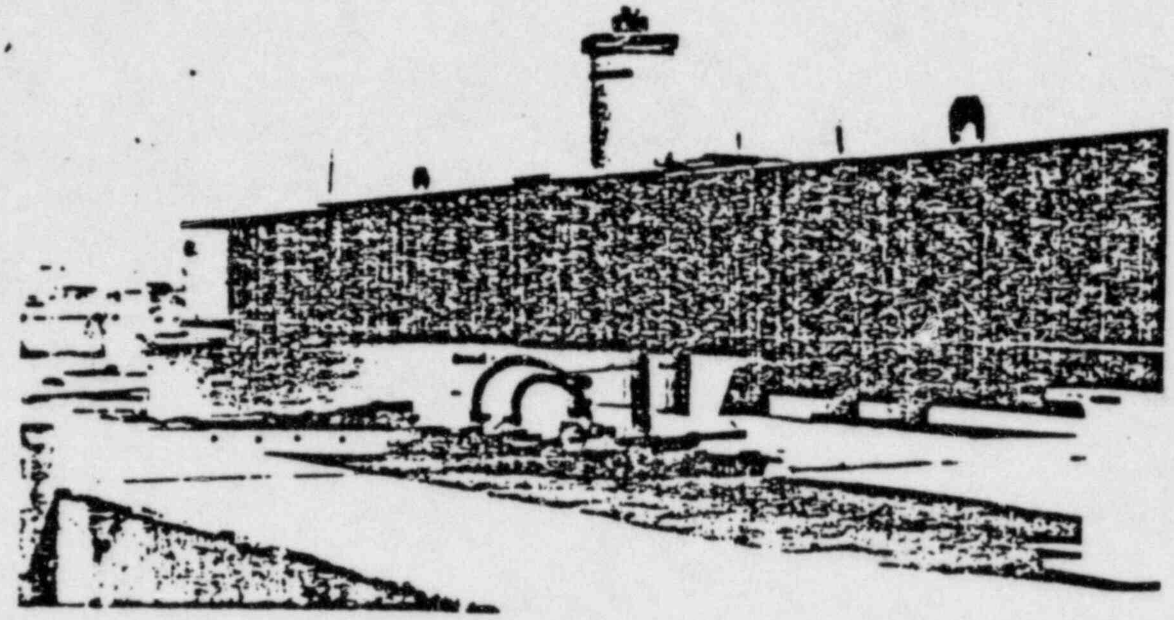
DIAL INDICATOR ARRANGEMENT

CONCRETE SHEAR CONE FAILURE

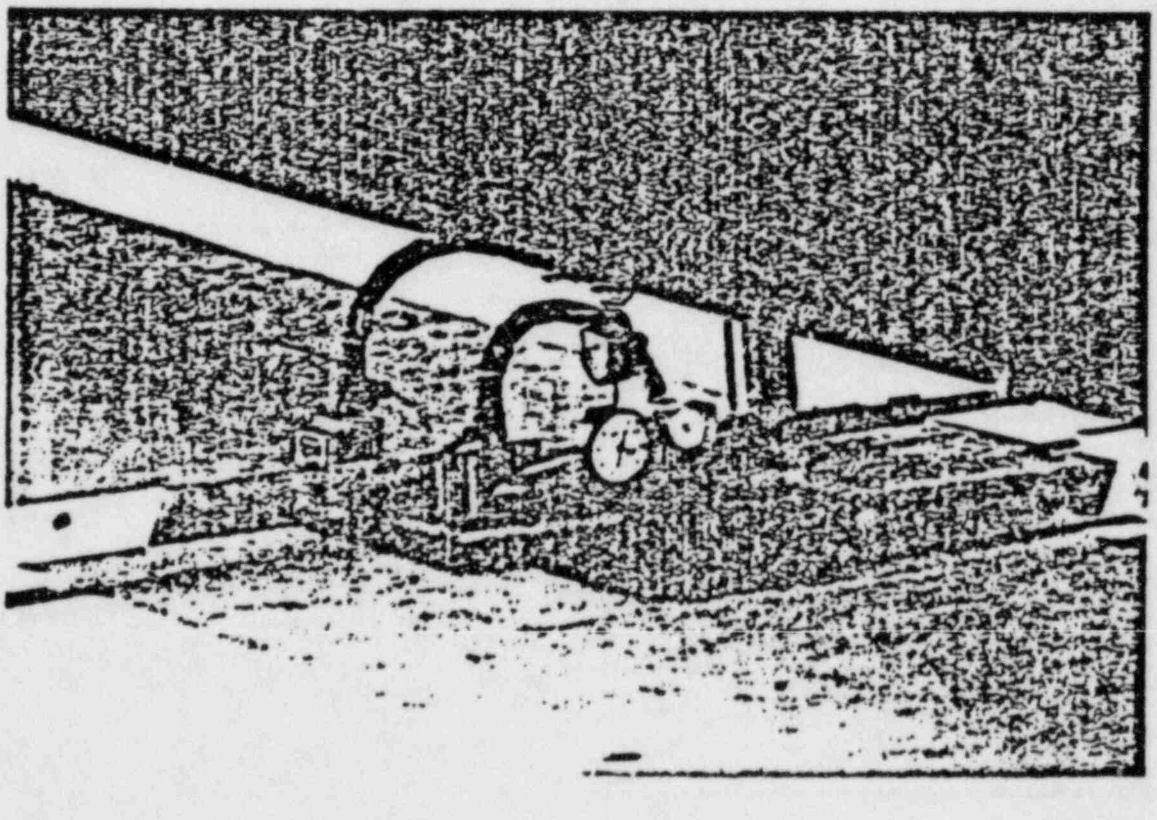
COMBINED SHEAR AND TENSION TEST



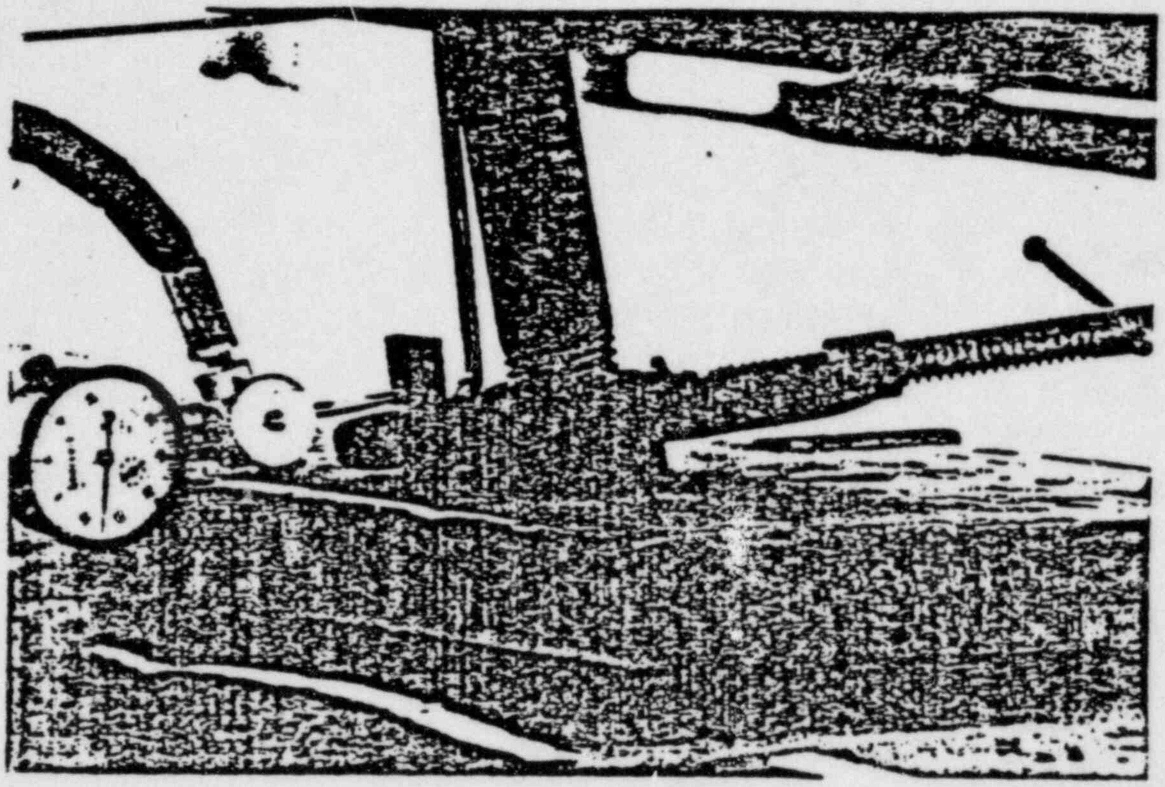
TEST APPARATUS



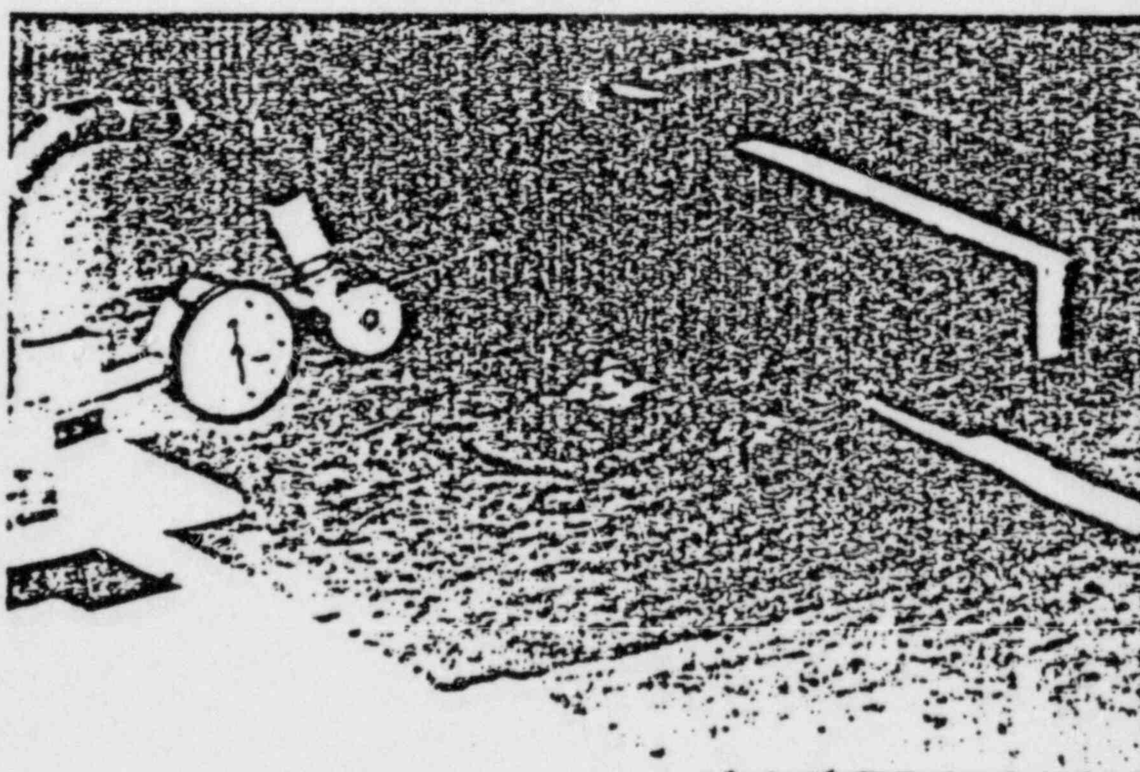
_ TEST APPARATUS



DIAL INDICATOR ARRANGEMENT



1½-INCH SPECIMEN JUST PRIOR TO FAILURE



1½-INCH SPECIMEN AT FAILURE

1½-INCH FAILED SPECIMEN

TYPICAL FAILURE