CASE EXHIBIT 761

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

4/26/83

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of APPLICATION OF TEXAS UTILITIES GENERATING COMPANY, ET AL. FOR AN OPERATING LICENSE FOR COMANCHE PEAK STEAM ELECTRIC STATION UNITS #1 AND #2 (CPSES)	Docket Nos. 50-445 and 50-446

SURREBUTTAL TESTIMONY OF JACK DOYLE, WITNESS FOR INTERVENOR CASE

Q: Please state your name and address for the record.

A: My name is Jack Doyle. My address is P. O. Box 64, Turnpike Station, Shrewsbury, Massachusetts 01545.

Q: Are you the same Jack Doyle who testified as a witness for CASE in the September 1982 operating license hearings for Comanche Peak?

A: Yes, I am.

Q: In preparation of your testimony for the May 16-20, 1983, operating license hearings for Comanche Peak, was there an item of particular concern which you felt should be sent immediately to all parties?

A: Yes, there was.

Q: Please tell us what that item is and what your concerns are regarding it.

A: The problem with which I am concerned was discussed somewhat in CASE's 4/20/83 Brief Regarding Consideration of LOCA in Design Criteria for Pipe Supports (beginning on page 33, second paragraph, through page 34, second full paragraph). In addition, I will be discussing Applicants'

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Exhibit 142D regarding LOCA temperature effects on pipe supports.

Q: Why do you feel that this matter is so important that it should be gotten into the hands of the Board and all parties immediately?

A: The conclusions of the NRC Staff and the Applicants relative to self-relief of LOCA effects at the joints is based on this material, which the NRC Special Inspection Team reviewed during its investigation of the concerns of Mr. Walsh and me. The accuracy of this material must be assured. In the case of the equations and formulas in question, their accuracy is negated by an erroneous approach. There is no assurance that the supports will function during a LOCA or immediately thereafter.

A further question arises: If these equations are in error, what other equations that are used as proof of a position are also in error? These equations are prepared, checked, reviewed, and approved. They were further blessed by the NRC Special Inspection Team.

Q: Please tell us what your specific concerns are regarding this matter.

A: In the case of the moment restraint structural support, problem 45D (CASE Exhibit 761B), in determining the structural stiffness at joints 1, 4, and 5, the stiffness of only one anchor bolt was considered. In fact, there are multiple anchor bolts, and of more consequence, shear keys are welded to the base plate which results in k factors several hundred times those used by Gibbs and Hill, who apparently prepared the calculation.

These items, the anchor bolts and shear keys, are a parallel spring system. Effectively, these joints will act as rigid connections unless

there is a catastrophic failure of the concrete in the area of the shear keys, which will result in unpredictable consequences. For more details regarding this, see CASE Exhibit 761C.

Regarding the upper lateral restraint (CASE Exhibit 758, referred to on page 33, second paragraph, of CASE's 4/20/83 Brief on LOCA) this is approximately a 9 ton beam located a considerable distance above critical piping in the steam generator area. The analysis for this beam considering the flexibility of the walls is based on a simple three-springs series. Gibbs and Hill, in their approach, used an oblique approach that failed to consider, among other things, several critical factors.

(1) The beam reacts its loads to a vertical slab, not a beam. The method for determining the stiffness of the walls, therefore, should incorporate either the "Marsh method, 1904 cross-beam process," the "Okuna Abrams anologous grid method, 1952," or show that dimensionally the above procedures are not required for the aspect ratio in question. Further, the transformed section should have been used to determine the moment of inertia "ACI cracked beam procedure" instead of the monolithic method used.

(2) Since the wall deflection is angular to the lateral beam, a component to the deflection induces a side load into the beam across its minor axis, which was not considered.

(3) In the interaction equation in the analysis of the upper-lateral restraint, Gibbs and Hill used a compression allowable in excess of yield for A50 steel in a 280^{o}F environment.

As a result of these errors and other fundamental errors in the

equations themselves, I decided to approach the problem independently, using, however, the k factors of the walls, area of the beam, Young's modulus of the concrete, and coefficient of expansion and dimensions indicated in Gibbs and Hill's calculations. The results of approaching the problem from a springs-in-series position results in significant increase in the loads in the beam and on the wall. The hand calculations as shown in CASE Exhibit 761C on the lateral beam were subjected to a computer analysis substituting members of equivalent spring rates to those of the wall.

Q: And what were the results of those calculations?

A: The results of the hand calculations supported by the computer analysis indicate a gross error in the fundamental approach as used in the Gibbs and Hill calculations. (See CASE Exhibit 761A for the computer analysis.)

Q: Who performed the computer analysis?

A: It was performed by Mark Walsh at my request.

Q: Do you have anything further?

A: In reference to Applicants Exhibit 142D, three equations listed as Case 1, Case 2, and Case 3 were supplied to indicate the self-relieving characteristics of Hilti anchors, Richmond anchors, and Nelson studs. In all three cases, the procedures are in error. These are again a problem of several springs in series and additionally, in the case of Hilti Kwik-Bolts and Nelson studs, the joints are a parallel system of multiple springs. For the case of Hilti anchor bolts and Richmond anchors, see material contained in CASE Exhibit 761C. As for Case 3, Nelson

studs, the Gibbs and Hill calculations neglect a critical component in the effective spring system. These are embedded plates and therefore shear is transferred through the concrete and the Nelson studs in parallel. The effects of the concrete have not been considered by Gibbs and Hill and therefore their approach would be in gross error.

Q: What does all this mean?

A: The Applicants, Gibbs and Hill, and the NRC have predicated their arguments that thermal expansion during a LOCA or in fact during normal plant operating conditions is of no consequence in the design calculations, since the self-relieving characteristics of the joints preclude overstressing. This is based on five calculations which were supplied to CASE during discovery and in Applicants Exhibit 142D. These contain gross error <u>in fundamental engineering principles</u>.

The question arises: Where are the checks and balances system which assures the safety of a nuclear power plant if such gross errors can be introduced, checked, reviewed, approved, and blessed by the NRC? How far does this acceptance of gross error extend into other areas to which we are not privy, where we are told that something is acceptable because a document exists, but where the credibility of the document itself is now in doubt? What assurance do we have that the checks and balance system has not broken down, not only at Comanche Peak, but in the nuclear industry generally?

I have read the foregoing 5-page Surrebuttal Testimony of Jack Doyle, Witness for Intervenor Case (CASE Exhibit 761), which was prepared under my personal direction; the thoughts and words expressed therein are my own thoughts and words (with the exception of minor grammatical changes, either to correct spelling or to clarify what I meant, which did not change the intent of my thoughts). Where questions were posed, they were posed by CASE. This testimony is true and correct to the best of my knowledge and belief.

Jack J Doyle

Jack Doyle

Date: 4/26/83

STATE OF TEXAS

On this, the 26th day of April, 1983, personally appeared Jack Doyle, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes therein expressed.

Subscribed and sworn before me on the 26th day of April, 1983.

Loretta Rayner

Notary Public in and for the State of Texas

My Commission Expires: 2/28/85

CASE EXHIBIT 758

Item ~~56~~ 47 (Identified by NKC as Item 56)

Gibbs & Hill, Inc.

Calculation Cover Sheet

1E

G&H Job No. 2323 Client TUSI

Calculation Number SRB-111C SET 4"

Number of Sheets in Original Issue 1-14

Subject UNIT#1 R.B. S.G. UPPER LATERAL SUPPORT

☑ Nuclear Safety Related

☐ Non-Nuclear Safety Related—QA Program Applicable

☐ Non-Nuclear Safety Related

Revision	Sheets Deleted	Sheets Added	Sheets Revised	Job Engineer Signature	Job Engineer Date
Original					
5	SEE SHEET 1D				
6		29		JB 8-17-82 [signature] ELB	8-20-82
7		30-50		[signature] 9/7/82	9-7-82

F-167, 4-81

DESIGN REVIEW

RECORD FORM

Texas Utilities Services, Inc. — CLIENT
Comanche Peak S.E.S. — PROJECT
2323 — G&H Job No.

Title: S.G. UPPER LATERAL RESTRAINT ACCIDENT TEMP. INVEST.

[ ] Drawing [✓] Calculation [ ] Specification

SRB-IIIC SET 4 — DOCUMENT NO.
7 — REVISION NO.
DATE

COMMENTS ARE AS NOTED ON DOCUMENT SHEETS LISTED BELOW EXCEPT AS STATED HEREIN:

NONE

REQUIRED ACTION NONE

P.K. Banerjee — DESIGN REVIEW ENGINEER
9/7/82 — REVIEW DATE

REQUIRED ACTION SATISFACTORILY COMPLETED YES [ ] NO [ ]

COMMENTS

DESIGN REVIEW ENGINEER REVIEW DATE

DESIGN REVIEW PROCEDURE — STRUCTURAL CHECKLIST-CALCULATIONS

JOB NO. 2323 CALC. NO. SRB-IIC SET 4 REV. NO. 7

TITLE: S.G. UPPER LATERAL REST – ACCIDENT TEMP. INVEST.

ITEM	CONSIDERATION
1. USNRC "Current Events-Power Reactors" and "Operating Experience" records have been considered, where applicable (Ref. Job Engr.)	N/A
2. Scope covers all intended work, no interface gaps, no overlaps (Ref. Project Guide)	N/A
3. Assumptions are listed, clearly defined and reasonable	✓
4. Items to be re-verified later in design, identified	N/A
5. References, including other calculations and sources, are listed	✓
6. A description of the methods of analysis and design is included (Ref. FSAR)	✓
7. Formulae and equations are applicable and defined	✓
8. Mathematical check indicates satisfactory solution	✓ SPOT CHECK
9. Conforms to specification	✓
10. Loads and load combinations are correct (Ref. FSAR) (including Environmental Considerations)	✓
11. Deflections and displacements are suitable and reasonable (Interface with other disciplines)	✓
12. Compatible with equipment information (Loads, Dimensions)	N/A
13. Description of materials included (Ref. FSAR)	✓
14. Compatible with soils capability (Ref. FSAR and Soils Report)	N/A
15. Compatible with related drawings	✓
16. Conforms to FSAR	✓
17. Specific references to codes and standards are included and conforms thereto (Ref. FSAR and Project Guide)	✓
18. Conforms to Structural Design Criteria	✓
19. Interface with other disciplines has been accomplished	N/A
20. Properly indexed and filed	✓
21. Additional for Computerized Calculations:	
a. Proper Computer Program (Ref. FSAR) has been approved for use	N/A
b. Data Input, Assumptions and Model are listed, defined and are satisfactory	N/A
c. Interpretation of Output is included	N/A
d. Check results for reasonableness; preferably verified by simplified parallel check (Ref. FSAR)	N/A

NOTE: Design reviewer's signature confirms that design reviewer has considered each item on the checklist.

✓ Signifies design reviewer's completion of review

N/A Not Applicable

Design Reviewer's Signature PKBanerjee Date 9/7/82

Design Reviewer's Name P.K. BANERJEE

F-722, 8-81

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

Subject UPPER LATERAL RESTRAINT – ACCIDENT TEMP. INVESTIGATION

Calculation Number SRB-111C SET 4 Sheet No. 30

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SSC	8/31/82							
Checker			MLS	8/3'/82							

THIS STUDY HAS BEEN PERFORMED TO DETERMINE THE EFFECTS OF A LOCA TEMPERATURE RISE ON THE STRESS-STRAIN BEHAVIOR OF THE UPPER LATERAL RESTRAINT AND THE CONCRETE STRUCTURES TO WHICH IT IS CONNECTED.

THE RESULTS OF THIS ANALYSIS DEMONSTRATES THE SELF LIMITING ASPECTS OF THERMAL EFFECTS AND THE RESULTS ALSO JUSTIFY THE ORIGINAL DESIGN PHILOSOPHY IN THAT SUCH EFFECTS WOULD NOT HAVE AN IMPACT ON THE DESIGN OF THE STEEL MEMBERS NOR THE CONCRETE STRUCTURES TO WHICH IT IS CONNECTED, STRESSES AND STRAINS IN THE MEMBERS SATISFY FSAR ALLOWABLES.

LOADING COMBINATIONS - FSAR CLAUSE 3.8

REF. G&H CALCS AND DWGS.

(i) UPPER LATERAL RESTRAINT BOOK NO SRB-111C SET 4

(ii) S.G WALL " { SRB-120C SET 1 / SRB-120C SET 2 }

(iii) G&H DWGS 2323-S1-0539, 0540, 0541 AND 0542

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

Subject UPPER LATERAL RESTRAINT – ACCIDENT TEMP INVESTIGATION.

Calculation Number SRB-111C SET 4 Sheet No. 31

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSC	8/24/82						
Checker			MNS	8/31/82						

MAX UNRESTRAINED THERMAL GROWTH

$= l \alpha \Delta_T$

$= 13.6 \times 12 \times 6.632 \times 10^{-6} \times 220 = \underline{0.238 \text{ inches}}$

MAX COMPRESSIVE LOAD WITH ENDS REST.

$P = A \Delta_T \alpha E$

$= (357)(220)(6.632 \times 10^{-6})(27650)$ — 357 marked ** ; 27650 marked (*)

$= \underline{14402 \text{ KIPS}}$ ** REF (i)

DATA

L = LENGTH OF THE UPPER LATERAL REST. BEAM = 13.6'

α = COEFFICENT OF THERMAL EXPANSION AT 280° F

$\Delta_T = 280 - 60 = 220°$ F

E = MODULUS OF ELASTICITY AT 280° F (*)

* ACTUAL VALUE OF E_{280} = 27988 KSI. HOWEVER THIS WILL NOT MATERIALLY CHANGE THE RESULTS.

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

Subject UPPER LATERAL REST — ACCIDENT TEMP INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 32

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSe	8/24/82						
Checker			MNS	8/31/82						

BASED ON THE SUPPORT CONDITIONS AND SPANS, THE FOLLOWING TWO CASES ARE INVESTIGATED

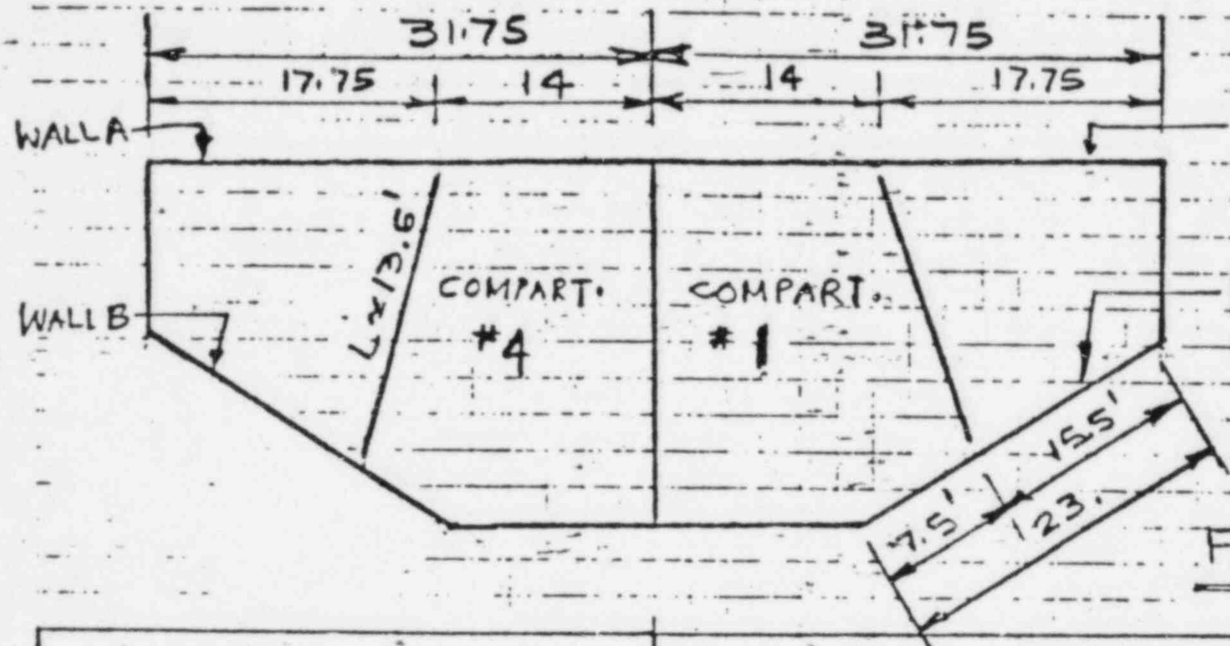


FIGURE 1

CASE I	CASE II
FOR COMPART. # 4	FOR COMPART # 1, 2 & 3
WALL A	WALL A
D ≃ 42	D = 42
d = EFFECTIVE = 38.75	d = 38.75
b = 96"	b = 96"
$I_g = \frac{1}{12} \times 96 \times 42^3 = 592704$ in⁴	$I_g = 592704$ in⁴
WALL B	WALL B
D = 45	D = 33
d = 41.75	d = 29.75
b = 110" (BASED ON PAD WIDTH + DEPTH OF WALL	b = 100" (BASED ON PAD WIDTH + DEPTH OF WALL
$I_g = \frac{1}{12} \times 110 \times 45^3 = 835313$ in⁴	$I_g = \frac{1}{12} \times 100 \times 33^3 = 299475$ in⁴

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

Subject UPPER LATERAL RESTRAINT - ACCIDENT TEMP. INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 33

Revision	Orig. Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSC	8/24/82						
Checker			MNS	8/31/82						

STIFFNESS OF WALLS A AND B

$$K_A = \frac{1}{\Delta_A} = \frac{1}{\dfrac{17.75^3 \times 14^3 \times 1728}{3 \times 3.6 \times 10^3 \times 592704 \times 31.75^3}} = 7726 \text{ k/inch}$$

(FOR case I AND II)

$$K_B = \frac{1}{\Delta_B} = \frac{1}{\dfrac{7.5^3 \times 15.5^3 \times 1728 \times 1728}{3 \times 3.6 \times 10^3 \times 835313 \times 23^3 \times 1728}} = 40433 \text{ k/inch}$$

(CASE I)

AND $= \dfrac{1}{\dfrac{7.5^3 \times 15.5^3 \times 1728 \times 1728}{3 \times 3.6 \times 10^3 \times 299475 \times 23^3 \times 1728}} = 14496$ k/in

(CASE II)

WHERE Δ_A AND Δ_B ARE THE DEFORMATIONS OF THE PERTINENT WALLS DUE TO UNIT LOAD,

$$\Delta_A \text{ AND } \Delta_B = \frac{a^3 b^3}{3EIl^3}$$

Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 [illegible]

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

Subject UPPER LATERAL REST - ACCIDENT TEMP. INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 34

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSe	8/27/82						
Checker			MNS	8/31/82						

GRAPHICAL SOLUTION

DURING LOCA TEMPERATURE, THE AXIAL THERMAL GROWTH OF THE UPPER LATERAL RESTRAINT STEEL BEAM WILL BE RESISTED BY THE STEAM GENERATOR WALLS AT THE TWO ENDS. THE BALANCED LOAD WILL BE REACHED WHEN THE GROWTH OF THE REST. BEAM IS EQUAL TO THE DEFORMATION OF THE WALLS AT THE ENDS. THIS BALANCING LOAD IS DETERMINED GRAPHICALLY IN FIGURE 2 (SHEET 35) AND ITS ANALYTICAL DERIVATION IS GIVEN IN FIGURE 3 (SHEET 37)

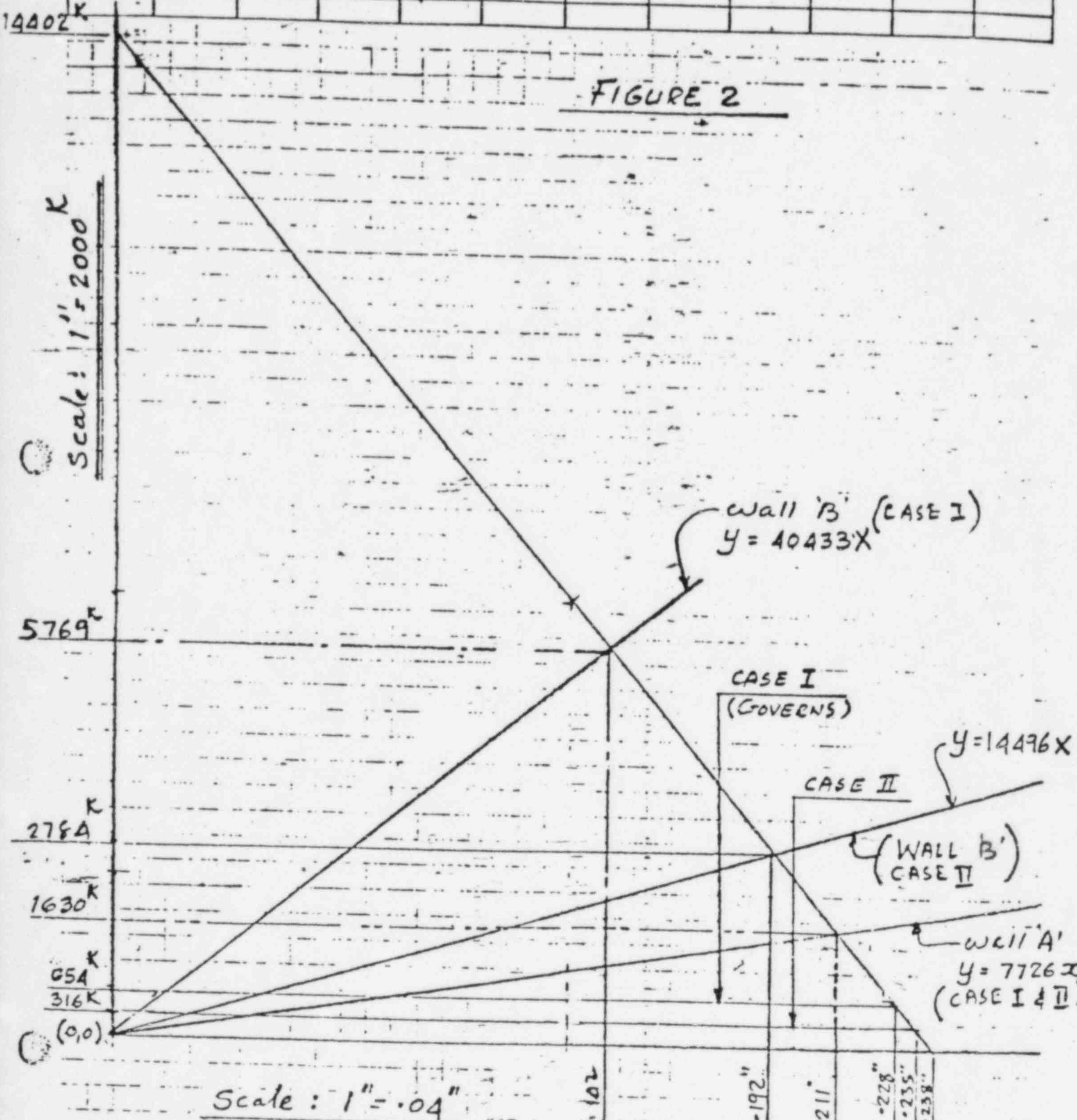
Checking Method #
1 Line-by-line checking
2 Alternative Calculation Results compared
3 ... Results compared
... and results of similar codes

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

Subject Upper lateral Support: Accident Temperature Investigation

Calculation Number SRB-111C Set 4 Sheet No. 35

Revision	Orig.	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method			1							
Preparer			MNS	8/31/82						
Checker			SSe	8/31/82						



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 TUSI

Subject UPPER LATERAL RESTRAINT – ACCIDENT TEMP. INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 36

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	8/24/82						
Checker			MNS	8/31/82						

VERIFICATION BY ANALYTICAL METHOD.

FROM THE FOLLOWING 3 EQUATIONS, THE DEFORMATIONS OF THE WALLS ARE DERIVED.

CASE I	CASE II
$\frac{x}{0.238} + \frac{Y}{14402} = 1$ (1)	$\frac{x}{0.238} + \frac{Y}{14402} = 1$ (1)
$Y = 40433x$ (2)	$Y = 14496x$ (2)
$Y = 7726x$ (3)	$Y = 7726x$ (3)
FROM EQ (1) AND (2)	FROM EQ (1) AND (2)
$\frac{x}{0.238} + \frac{40433x}{14402} = 1$	$\frac{x}{0.238} + \frac{14496x}{14402} = 1$
or $\Delta_1 = x = 0.142$ inch	or $\Delta_1 = x = 0.192$ inch
FROM EQ (1) AND (3)	
$\frac{x}{0.238} + \frac{7726x}{14402} = 1$	SAME AS CASE I
or $\Delta_2 = x = 0.211$ inch	$\Delta_2 = x = 0.211$ inch

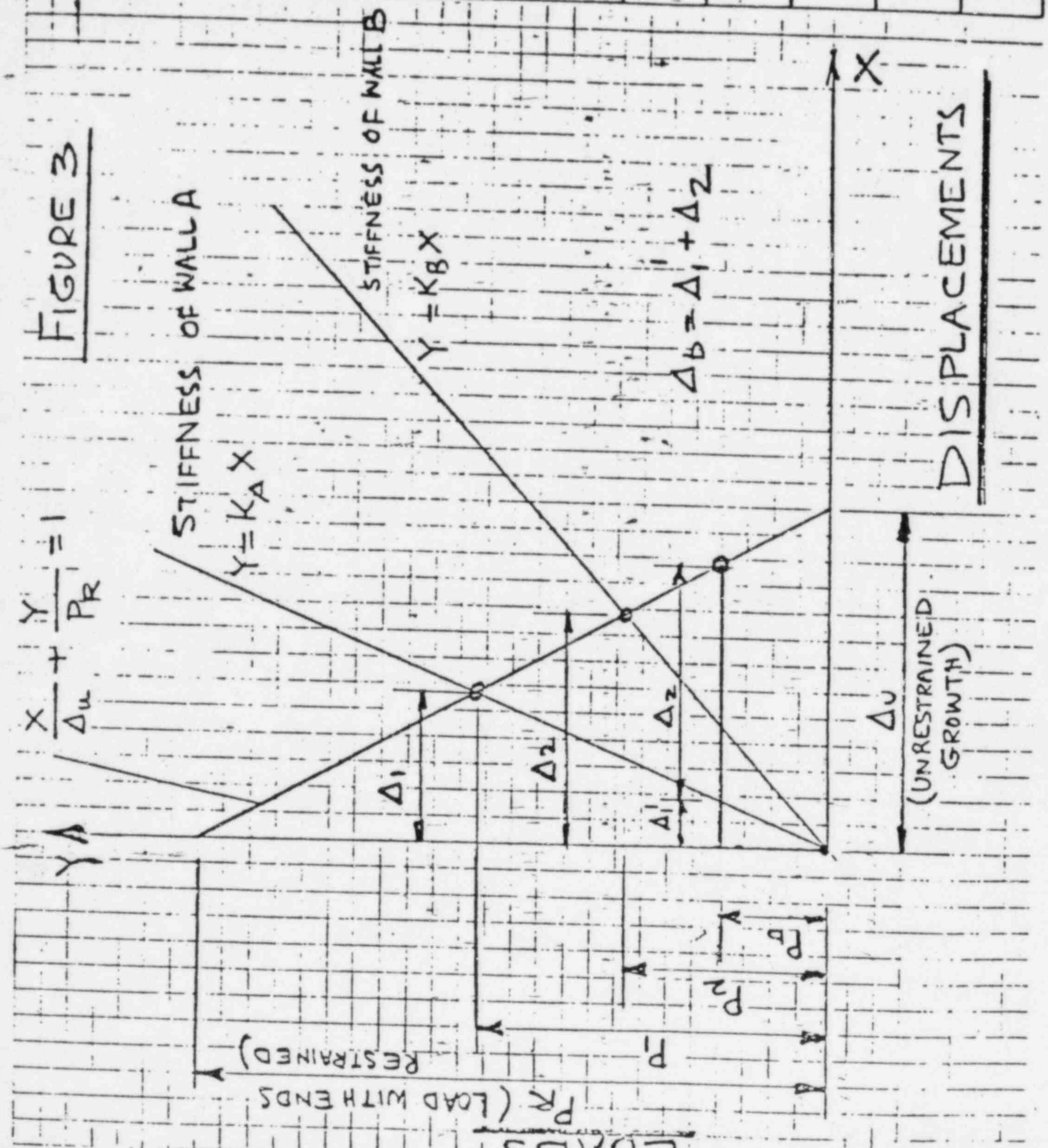
Checking Method #
1 Line by line checking
2 Alternative Calculation Results compared
3 Identical Calculation Results compared
4 Compare inputs and results of computer with corresponding inputs and results of similar codes

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

Subject UPPER LATERAL REST- ACCIDENT TEMP INVEST.

Calculation Number SRB-111.C SET 4 Sheet No. 37

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SSe	8/24/82							
Checker			MHS	8/31/82							



Checking Method # 1 Line by line checking 2 Alternative Calculation Results compared

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSC	8/24/82						
Checker			MNS	8/31/82						

FROM FIGURE 3

$$\Delta_1' = \frac{\Delta_1}{P_1} \times P_b$$

BUT $\Delta_1' + \Delta_2 = \Delta_b$ (4)

AGAIN FROM EQ (1)

$$\frac{\Delta_b}{.238} + \frac{P_b}{14402} = 1$$

or $\Delta_b = \left(1 - \frac{P_b}{14402}\right) \times 0.238$ (5)

FROM (4) AND (5)

$$\frac{\Delta_1}{P_1} P_b + \Delta_2 = \left(1 - \frac{P_b}{14402}\right) \times 0.238 \quad (6)$$

or $P_b\left(\frac{\Delta_1}{P_1} + \frac{.238}{14402}\right) = 0.238 - \Delta_2$

or $P_b = \dfrac{0.238 - \Delta_2}{\left(\dfrac{\Delta_1}{P_1} + \dfrac{.238}{14402}\right)}$ (7)

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

Subject UPPER LATERAL RESTRAINT — ACCIDENT TEMP. INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 39

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSe	8/19/82						
Checker			MWS	8/31/82						

FROM EQ (7)

FOR CASE I

$$P_b = \frac{0.238 - 0.211}{\left(\frac{1}{40433} + \frac{0.238}{14402}\right)} = 654 \text{ KIPS}$$

FOR CASE II

$$P_b = \frac{0.238 - 0.211}{\left(\frac{1}{14496} + \frac{0.238}{14402}\right)} = 316 \text{ KIPS}$$

THESE ARE THE LOADS SEEN BY THE UPPER LATERAL RESTRAINT ITSELF AS WELL AS THE S.G WALLS.

THE INVESTIGATION IN THE FOLLOWING SHEETS WILL BE DONE ONLY FOR HIGHER LOAD VIZ $P_b = 654$ KIPS (CASE I) UNLESS NOTED OTHERWISE.

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

Subject UPPER LATERAL REST – ACCIDENT TEMP. INVEST.

Calculation Number SRB-114C SET 4 Sheet No. 40

Revision	Orig'l Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SSC	8/13/82							
Checker			MNS	8/21/82							

CHECK OF UPPER LATERAL RESTRAINT BEAM

LOAD COMBINATION $1.6S = D + L + T_a + Y_j + Y_r + Y_m + F_{eqo}$

(PER FSAR 3.8)

AXIAL STRESS $f_a = \frac{P_b}{A} = \frac{654}{357} = 1.83$ ksi

REF (i)

BENDING STRESS $f_b = \frac{M}{Z} = \frac{16800 \times 12}{4945} = 40.76$ KSI

PLASTIC MODULUS

$l = (13.6 \times 12)$ inches

$A = 357 \text{ in}^2$

$I = 2 \times \frac{1}{12} \times 3 \times 42^3 + 30 \times 1.75 \times 2 (20.125)^2 = 79571 \text{ in}^4$

$r = \sqrt{\frac{I}{A}} = 11.26$ $\therefore$ $F_a = 29.17$ ksi FOR $F_y = 50$ ksi

$\therefore \frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{1.83}{1.6 \times 29.17} + \frac{40.76}{45} = 0.039 + 0.905$

$= 0.945 \leq 1$

THIS INDICATES THAT STRESSES ARE WITHIN YIELD.

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

Subject UPPER LATERAL REST — ACCIDENT TEMP INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 41

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSK	8/25/82						
Checker			MNS	8/31/82						

CHECK FOR WALL A (BENDING)

$$\text{MAX } M \,(M_u) = \frac{Wab^2}{l^2} = \frac{654 \times 17.75^2 \times 14}{31.75^2} = 2862\ 'K$$

$$F = \frac{bd^2}{12000} = \frac{96 \times (42 - 3.25)^2}{12000} = 12.01$$

$$\frac{M_u}{F} = \frac{2862}{12.01} = 238$$

$$A_s = \frac{0.46}{100} \times \frac{96 \times 38.75}{96} = 0.178 \text{ in}^2/\text{in}$$

AREA REQUIRED FOR OTHER LOADINGS = 0.26 in^2

SEE REF (ii)

TOTAL AREA REQD. = 0.178 + .26 = 0.438 in^2/in

AREA PROVIDED = 0.624 in^2/in

SEE REF (iii)

STRESSES ARE WELL BELOW YIELD

Checking Method # ; Line by line checking

F-166 7-82

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

Subject UPPER LATERAL REST – ACCIDENT TEMP INVESTIGATION.

Calculation Number SRB-111C SET 4 Sheet No. 42

Revision	Orig'l Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method			1							
Preparer			SSC	8/25/82						
Checker			MNS	8/31/82						

CHECK FOR WALL B (BENDING)

$$\text{MOMENT (MAX)} = \frac{Wab^2}{L^2}$$

$$M_u = \frac{654 \times 7.5 \times 15.5^2}{23^2} = 2228 \ 'K$$

$$F = \frac{bd^2}{12000} = \frac{110 \times (45-3.25)^2}{12000} = 18.83$$

$$\frac{M_u}{F} = 2228/18.83 = 118$$

$$A_s = \frac{0.22}{100} \times \frac{12 \times 41.75}{12} = 0.092 \ \square''/in$$

AREA REQUIRED FOR OTHER LOADINGS = 0.136 in²/inc
SEE REF (ii)

TOTAL AREA REQD = 0.136 + 0.092 = 0.228 in²/in

AREA PROVIDED = $\frac{(1.56+1.0)}{10}$ = 0.256 in²/in
REF (iii)

STRESSES ARE BELOW YIELD

Checking Method # 1 Line by line checking

F-166 7-82

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

Subject Upper lateral restraint : Accident Temperature Investigation

Calculation Number SRB-111C Set 4 Sheet No. 43

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MNS	8/26/82						
Checker			SSE	8/27/82						

CHECK FOR SHEAR:

The out of plane shear forces due to Pa, Feqo and Feqs was previously analyzed by computer (Stardyne). As that analysis does not allow us to determine precisely the available design margin, the following computations are performed to determine the shear forces due to Pa, Feqo and Feqs. These values are subsequently added to those for accidental temperature loading on the upper lateral restraint.

Load combination 3.8.3.3.2.2b

$U = 1.5\ Pa$ $\qquad Pa = 20.9\ psi$ (REF (ii))

$= 31.35\ psi$

load/linear inch (wall 'A') = $31.35 \times 96 = 3.0^k$

load/linear inch (wall 'B') = $31.35 \times 110 = 3.45^k$

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

Subject Upper lateral Support: Accident Temperature Investigation

Calculation Number SRB - 111C Set 4 Sheet No. 44

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			MNS	8/26/82						
Checker			Ssc	8/27/82						

Load combination 3.8.3.3.2.2C (Part)

U = 1.25 Pa + 1.25 Fego

From Fig. 139 - A (of FRB - GR)

Ax = Ay = 1.5g

Dead weight of wall 'A' = $\frac{96 \times 42 \times 150}{1728}$ = .35 k/inch

Dead weight of wall 'B' = $\frac{110 \times 45 \times 150}{1728}$ = .43 k/inch

Load/inch (Wall 'A') = $\frac{1.25 \times 20.9 \times 96}{1000}$ + 1.25 × .35 × 1.5

= 3.16 k

Load/inch (Wall 'B')

= $\frac{1.25 \times 20.9 \times 110}{1000}$ + 1.25 × .43 × 1.5

= 3.68 k

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 TUSI

Subject Upper Lateral Support: Accident Temperature Investigation

Calculation Number SRB-111C Set 4 Sheet No. 45

Revision	Orig. Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method			1							
Preparer			MNS	8/26/82						
Checker			SSe	8/27/82						

Load Combination 3.8.3.3.2.2d (Part)

$U = 1.0\ Pa + 1.0\ Feqs$

From Fig. 121-A (of FRB-6R)

$A_z = 2.0$

Load/inch (Wall 'A')

$= \frac{20.9 \times 96}{1000} + 2 \times .35$

$= \underline{2.71^K}$

Load/inch (Wall 'B')

$= \frac{20.9 \times 110}{1000} + 2 \times .43$

$= \underline{3.16^K}$

Summary

Load Combination	Wall 'A'	Wall 'B'
3.8.3.3.2.2b (Comb.#1)	3.0 K/inch	3.45 K/inch
3.8.3.3.2.2c (Comb#2)	3.16 K/inch	3.68 K/inch
3.8.3.3.2.2d (Comb#3)	2.71 K/inch	3.16 K/inch

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. 2323 Client TUSI

Subject Upper Lateral Support : Accident Temperature Investigation

Calculation Number SRB - 111C Set 4 Sheet No. 46

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			MNS	8/26/82						
Checker			SSC	8/27/82						

WALL 'A'

Combination # 1 : End reaction = $3 \times 31.75 \times 12/2 = 572^K$

Combination # 2 : End reaction = $3.16 \times 31.75 \times 12/2 = 603^K$ Governs

Combination # 3 : End reaction = $2.71 \times 31.75 \times 12/2 = 516^K$

WALL 'B'

Combination # 1 : End reaction = $3.45 \times 31.75 \times 12/2 = 657^K$

Combination # 2 : End reaction = $3.68 \times 31.75 \times 12/2 = 701^K$ (Governs)

Combination # 3 : End reaction = $3.16 \times 31.75 \times 12/2 = 602^K$

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, 4-81

Revision	Original Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SSC	8/26/82							
Checker			MNS	8/31/82							

SHEAR STRESS IN CONCRETE

CASE I

WALL A

SHEAR LOAD $V_u = 654 \times \frac{17.75}{31.75} \cos 22^0 + 603^k$

(DUE TO ACCIDENT TEMP SH 39) (DUE TO OTHER LOADS SH. 46)

$= 339 + 603 = 942$ KIPS

N_u = TENSION IN WALL

$= \left(\frac{22.75}{2} \times 1.5 \times 20.9 \times 96\right) = 34.23^{KIPS}$ (Pa)

$v_c = 2\left(1 + \frac{-0.002 \times 34230}{96 \times 42}\right) \times \sqrt{4000} = 124$ PSI

$A_u = \frac{(v_u - v_c)\,bS}{f_y} = \frac{(300-124) \times 20 \times 20}{60000} = 1.17 \text{ in}^2$

$\left\{ v_u = \frac{942}{0.85 \times 96 \times 38.5} = 0.30 \text{ KSI} \right\}$

PROVIDED 2-#7 @ 20" SHEAR TIES EACH WAY ($2 \times 0.6 = 1.2 \text{ in}^2$).

SHEAR TIE STRESSES ARE BELOW YIELD

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

Subject UPPER LATERAL REST— ACCIDENT TEMP INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 48

Revision	Original Issue	Date	Rev. 1	Date	Rev.	Date	Rev.	Date	Rev.	Date
Drawing Method			1							
Preparer				8/25/82						
Checker			MNS	8/31/82						

SHEAR STRESS (CONTD)

CASE I

WALL B

SHEAR LOAD (MAX) $= 654 \times \frac{15.5}{23} \cos 22^0 + 603^K$

(DUE TO ACCIDENT TEMP SH 39) (DUE TO OTHER LOADS SH 46)

$= 409 + 603 = 1012$ KIPS

$v_u = \frac{1012}{.85 \times 110 \times 41.75} = 0.259$ Ksi

$v_c = 0.124$ KSI CONSERVATIVELY ASSUMED

$A_v = \frac{(v_u - v_c) \times b s}{60.} = \frac{(.259 - .124) \times 10 \times 10}{60.} = 0.225$ in3

PROVIDED #7 @ 10" SHEAR TIES EW

$= 0.6 \text{ in}^2$

SHEAR TIE STRESSES ARE WELL BELOW YIELD.

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

Subject UPPER LATERAL REST – ACCIDENT TEMP INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 49

Revision	Orig'l Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	8/27/82						
Checker			MNS	8/31/82						

SHEAR STRESS (CONTD.)

CASE II

WALL A

SHEAR LOAD = $316 \times \frac{17.75}{31.75} \times \cos 22^\circ + 603$

(ACC. TEMP) SH 39 (OTHER LOADS) SH 46

= 164 + 603 = 767 KIPS

< 942 KIPS OK

SEE SHEET 47

WALL B

SHEAR LOAD = $316 \times \frac{15.5}{23} \times \cos 22^\circ + 701$

(ACCIDENT TEMP) SH 39 (OTHER LOADS) SH 46

= 197 + 701 = 898 KIP

$v_u = \frac{898}{0.85 \times 100 \times 29.75} = 0.355$ KSI

FROM SHEET

$A_u = \frac{(0.355 - 0.124) \times 10 \times 10}{60} = 0.385 \text{ in.}^2$

PROVIDED #7 @ 10" TIES (0.6 in²)

SHEAR TIE STRESSES ARE WELL BELOW YIELD

Checking Method # ...

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

Subject UPPER LATERAL REST — ACCIDENT TEMP INVEST.

Calculation Number SRB-111C SET 4 Sheet No. 50

Revision	Orig. Issue	Date	Rev. 7	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SSC	8/17/82							
Checker			MNS	8/31/82							

CONCLUSION: WITH THE LOCA TEMPERATURE ADDED TO THE OTHER LOADS, THE STRESSES IN THE UPPER LATERAL STEEL BEAM AND IN THE SUPPORTING CONCRETE WALLS ARE BELOW YIELD.

Checking Method #

F 166 7-82

4/26/83

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

'83 MAY -2 A10:50

In the Matter of

APPLICATION OF TEXAS UTILITIES GENERATING COMPANY, ET AL. FOR AN OPERATING LICENSE FOR COMANCHE PEAK STEAM ELECTRIC STATION UNITS #1 AND #2 (CPSES)

Docket Nos. 50-445 and 50-446

AFFIDAVIT OF MARK ANTHONY WALSH

My name is Mark Anthony Walsh. At the request of Jack Doyle, I ran the computer program which is attached as CASE Exhibit 761A to Mr. Doyle's 4/26/83 Surrebuttal Testimony.

Although the computer program which I used is not exactly like the STRUDL program used at Comanche Peak, it is a STRUDL program with sufficient similarities to assure that the results will be accurate.

This affidavit was prepared under my personal direction, and the thoughts and words expressed herein are my own thoughts and words (with the exception of minor grammatical changes, either to correct spelling or to clarify my meaning, which did not change the intent of my thoughts).

Mark Anthony Walsh
Mark Anthony Walsh

Date: 4/26/83

STATE OF TEXAS

On this, the 26th day of April, 1983, personally appeared Mark Anthony Walsh, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes herein expressed.

Subscribed and sworn before me on the 26th day of April, 1983.

Lott Rayner Jr.
Notary Public in and for the State of Texas

My Commission Expires: 2/28/85

4/25/83 - 15:10:40

CASE EXHIBIT 761A

```
*** SYSTEMS PROFESSIONAL STRESS - PROGRAM NO. 16.1 REV-201C.G1 ***

*********************************************************************

STRUCTURE - UPEER LAT RES (UPPERLAT.BM)
TYPE PLANE FRAME
NUMBER OF JOINTS 4  $ STATISTICS  $ TRACE
NUMBER OF MEMBERS 3
LIST MEMBER PROPERTIES IN INCHES
NUMBER OF LOADINGS 1
NUMBER OF SUPPORTS 2
UNITS KIPS INCH
TABULATE REACTIONS FORCES DISPLACEMENTS
JOINT COORDINATES
1 0 0 S $ 2 10 0 $ 3 172 0 $-4 182 0 S
UNITS KIPS INCHES
MEMB PROP PRIS AX 357 IZ 1. * BM.
2-
MEMB PROP PRIS AX 14.72 IZ 1. * WALL B
1
MEMB PROP PRIS AX 2.81 IZ 1. * WALL A
3
MEMBER INCIDENCES
1 1 2 $ 2 2 3 $ 3 3 4
UNITS KIPS INCHES
CONSTANTS E 27460. ALL
UNITS KIPS INCH
LOADING NO. 1
MEMBER TEMP CHANGES .000007
2 210
SOLVE
PROBLEM CORRECTLY SPECIFIED, EXECUTION TO PROCEED.
```

STRUCTURE - UPPER LAT RES (UPPERLAT.BM)

(UNITS IN INCHES AND KIPS)

MEMBER PROPERTIES

		AREAS			MOMENTS OF INERTIA			CONSTANT
MEMBER	LENGTH	X-AXIS	Y-AXIS	Z-AXIS	X-AXIS	Y-AXIS	Z-AXIS	E
1	10.00	1.5E 1	0.0E 0				1.0E 0	2.7E 4
2	162.00	3.6E 2	0.0E 0				1.0E 0	2.7E 4
3	10.00	2.8E 0	0.0E 0				1.0E 0	2.7E 4

STRUCTURE - UPPER LAT RES (UPPERLAT.BM)

==

(UNITS IN INCHES AND KIPS)

LOADING NO. 1

==

MEMBER FORCES

MEMBER	JOINT	AXIAL FORCE	SHEAR FORCE	MOMENT
1	1	1393.760	0.000	0.00
	2	-1393.760	0.000	0.00
2	2	1393.760	0.000	0.00
	3	-1393.760	0.000	0.00
3	3	1393.760	0.000	0.00
	4	-1393.760	0.000	0.00

APPLIED JOINT LOADS, FREE JOINTS

JOINT	FORCE X	FORCE Y	MOMENT Z
2	-0.002	0.000	0.00
3	0.001	0.000	0.00

REACTIONS,APPLIED LOADS SUPPORT JOINTS

JOINT	FORCE X	FORCE Y	MOMENT Z
1	1393.760	0.000	0.00
4	-1393.760	0.000	0.00
SUM	0.001	0.000	

FREE JOINT DISPLACEMENTS

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	ROTATION
2	-0.0345	0.0000	0.0000
3	0.1806	0.0000	0.0000

SYSTEM PROFESSIONAL STRESS 4/25/83

STRUCTURE - UPPER LAT RES (UPPERLAT.BM)

****

PLANE FRAME
3 MEMBERS
4 JOINTS
1 LOADINGS
27 LINES INPUT
55 RECORDS USED
0.8 MINUTES RUNTIME

Gibbs & Hill, Inc.

CASE EXHIBIT 761B

56 (47)

Calculation Cover Sheet

SHEET 1C

G&H Job No. 2323 Client TUSI

Calculation Number SRB-136C SET 6

Number of Sheets in Original Issue 75

Subject Moment Restraint Structural Support for CP1-CSSSMR-02 - Problem 45D

☑ 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						
Revision		FOR PREVIOUS REVISIONS SEE SH. 1B				
	4	—	132 to 163	6/30, 6/34, 6/35 78, 89	[signature]	3.17.82
	5	—	164 to 166	—	[signature]	5.18.82
	6	-	167 - 211	-	[signature]	9.14.82

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DESIGN REVIEW

RECORD FORM

Texas Utilities Services, Inc. — CLIENT
Comanche Peak S.E.S. — PROJECT
2323 — G&H Job No.

Title: RB 1 – MR SUPPT STRUCT (CP1-CSSSMR-02) ACCIDENT TEMP. INVESTIGATIONS

[ ] Drawing [✓] Calculation [ ] Specification

SRB-136C SET 6 — DOCUMENT NO.
6 — REVISION NO.
9/14/82 — DATE

RS

COMMENTS ARE AS NOTED ON DOCUMENT SHEETS LISTED BELOW EXCEPT AS STATED HEREIN:

REQUIRED ACTION — none —

P. J. Shimp[illegible]
DESIGN REVIEW ENGINEER

9/14/82
REVIEW DATE

REQUIRED ACTION SATISFACTORILY COMPLETED YES [ ] NO [ ]

COMMENTS

DESIGN REVIEW ENGINEER

REVIEW DATE

DESIGN REVIEW PROCEDURE

STRUCTURAL CHECKLIST-CALCULATIONS

JOB NO. 2323 CALC. NO. SRB-136c SET 6 REV. NO. 6

TITLE: AB1 : MR SUPPORT STRUCT (CP1-CSSSMR-02) ACCIDENT TEMP INVEST

ITEM	CONSIDERATION
1. USNRC "Current Events-Power Reactors" and "Operating Experience" records have been considered, where applicable (Ref. Job Engr.)	✓
2. Scope: covers all intended work, no interface gaps, no overlaps (Ref. Project Guide)	N/A
3. Assumptions are listed, clearly defined and reasonable	✓
4. Items to be re-verified later in design, identified	N/A
5. References, including other calculations and sources, are listed	✓
6. A description of the methods of analysis and design is included (Ref. FSAR)	✓
7. Formulae and equations are applicable and defined	✓
8. Mathematical check indicates satisfactory solution	✓
9. Conforms to specification	SPOT CHECK ✓
10. Loads and load combinations are correct (Ref. FSAR) (including Environmental Considerations)	✓
11. Deflections and displacements are suitable and reasonable (Interface with other disciplines)	✓
12. Compatible with equipment information (Loads, Dimensions)	✓
13. Description of materials included (Ref. FSAR)	N/A
14. Compatible with soils capability (Ref. FSAR and Soils Report)	✓
15. Compatible with related drawings	N/A
16. Conforms to FSAR	✓
17. Specific references to codes and standards are included and conforms thereto (Ref. FSAR and Project Guide)	✓
18. Conforms to Structural Design Criteria	✓
19. Interface with other disciplines has been accomplished	✓
20. Properly indexed and filed	N/A
21. Additional for Computerized Calculations:	✓
a. Proper Computer Program (Ref. FSAR) has been approved for use	✓
b. Data Input, Assumptions and Model are listed, defined and are satisfactory	✓
c. Interpretation of Output is included	✓
d. Check results for reasonableness; preferably verified by simplified parallel check (Ref. FSAR)	✓

NOTE: Design reviewer's signature confirms that design reviewer has considered each item on the checklist.

✓ Signifies design reviewer's completion of review

N/A Not Applicable

Design Reviewer's Signature P. I. Shroff Date 3/14/02

Design Reviewer's Name P. I. SHROFF

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

Subject MOMENT REST SUPT STRUCT- ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 167

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSe	9/7/82						
Checker			MNS	9/10/82						

THIS STUDY HAS BEEN PERFORMED TO DETERMINE THE EFFECTS OF A LOCA TEMPERATURE RISE ON THE STRESS-STRAIN BEHAVIOR OF A MOMENT LIMITING COMPONENT SUPPORT STRUCTURE AND AND ITS SUPPORTING EMBEDMENTS (G&H DWG 2323-S1-0538-07 / MR CPI-CSSSMR-02)

THE RESULTS OF THIS ANALYSIS DEMONSTRATE THE SELF LIMITING ASPECTS OF THERMAL EFFECTS AND THE RESULTS ALSO JUSTIFY THE ORIGINAL DESIGN PHILOSOPHY THAT SUCH EFFECTS WOULD NOT HAVE AN IMPACT ON THE DESIGN OF THE STEEL MEMBERS OR THE SUPPORTING EMBEDMENTS TO WHICH IT IS ATTACHED. STRESSES AND STRAINS IN THE MEMBERS SATISFY FSAR ALLOWABLES.

LOADING DATA

A_t = MAXIMUM ACCIDENT TEMP = $280^0 - 60^0 = 220^0$F

α = COEFFICIENT OF THERMAL EXPANSION

= 6.632×10^{-6}

E = MODULUS OF ELASTICITY OF STEEL AT 280^0F

= 27988 KSI

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 TUSI

Subject MR SUPT STRUCT - ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 168

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSe	9/7/82						
Checker			MNS	9/10/82						

DESIGN METHOD.

ANCHORAGES (RICHMOND INSERTS AND SUPER KWIK BOLTS) ARE ASSUMED TO SLIP DUE TO SHEAR AND/OR TENSION (DIRECT OR ROTATIONAL) LOADING. TENSION VRS. SLIP AND SHEAR VRS. SLIP CHARACTERISTICS OF THE 1½" DIA. RICHMOND INSERTS AND 1¼" DIA SUPER KWIK HILTI BOLTS ARE OBTAINED FROM THE RESPECTIVE MANUFACTURERS. THESE DATA ARE UTILIZED TO DETERMINE THE SHEAR STIFFNESS AND ROTATIONAL STIFFNESS OF THE PERTINENT SUPPORT POINTS. WITH THESE STIFFNESSES (SEE SH 170) THE STRUCTURE IS RE-ANALYSED WITH THE LOADING CONDITIONS INDICATED ON SHEET 169

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 TUSI

Subject MR SUPPORT STRUCT - ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 169

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #		X	1	X		X		X		X	
Preparer			SSC	9/10/82							
Checker			MdLS	9/10/82							

LOADING CONDITIONS

SEE COMPUTER OUTPUT SH 185 THRU 207

LOADING 1 ACCIDENT TEMP OF 280°F

LOADING 2 D+L + Feqs + ALL MR LOADINGS EXCEPT RUPTURE LOAD

LOADING 3 D+L + Feqs + ALL MR LOADING

LOADING 12 D+L + Feqs + ALL MR LOADING + Ta (LOCA TEMP)

TABULATION OF LOADS ON SUPPORT POINTS 1, 4 & 5 ARE MADE FOR LOADING 3 AND 12 IN SHEET 176

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.

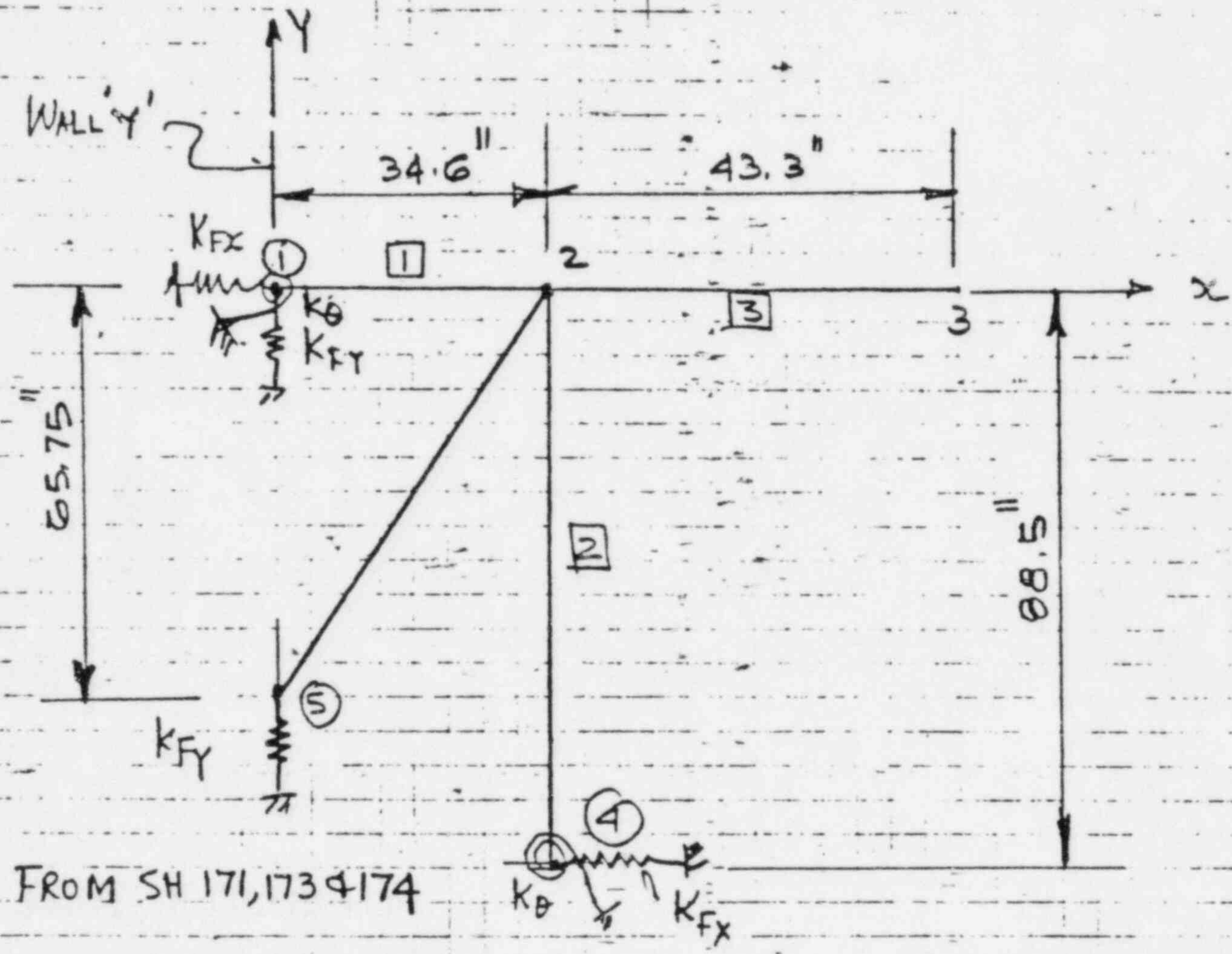
F-166, 7-82

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

Subject MR SUPPORT STRUCT - ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 170

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSa	9/7/82						
Checker			MNJ	9/10/82						



FROM SH 171, 173 & 174

JOINT 1

$K_{FX} = 4.32 \times 10^4$ K/inch

$K_\theta = 5.57 \times 10^5$ "K/rad

$K_{FY} = 162$ Kips/inch

JOINT 4

$K_{FX} = 83.0$ K/inch

$K_\theta = 5.79 \times 10^4$ "K/rad

JOINT 5

$K_{FY} = 162$ K/inch

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 TUSI

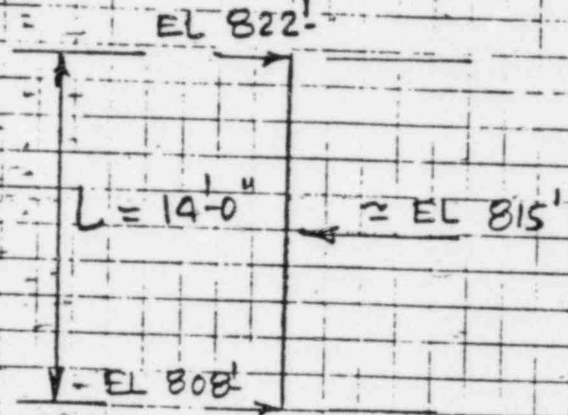
Subject MR SUPT STRUCT – ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 171

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	9/7/82						
Checker			MNS	9/10/82						

TO DETERMINE THE STIFFNESS OF COLUMN (WALL Y)

$$\delta_{COL} = \frac{PL^3}{48EI}$$



$$K_{COL} = \frac{1}{\dfrac{(14 \times 12)^3}{48 \times 3.6 \times 10^3 \times \frac{1}{12} \times 24 \times 84^3}}$$

$$= 4.32 \times 10^4 \text{ K}/''$$

$b_{COLUMN} = 24''$ } SEC G-H DWG 2323-SI-0519

$d_{COLUMN} = 84''$

$I = \frac{1}{12} \times 24 \times 84^3$

$E = 3.6$ KSI

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 TUSI

Subject MR SUPT STRUCT – ACCIDENT TEMP INVEST.

Calculation Number SRB-136 C SET 6 Sheet No. 172

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSe	9/10/82						
Checker			MNS	9/10/82						

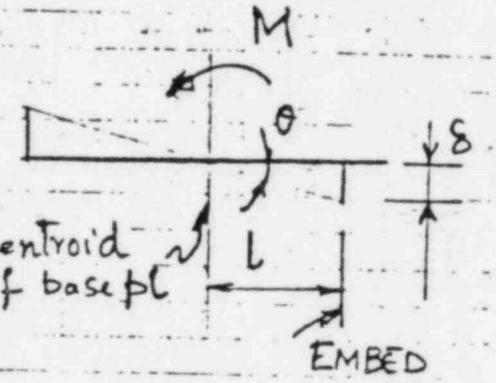
THE FOLLOWING CALCULATIONS SHOW THE METHOD USED TO COMPUTE K_θ (ROTATIONAL STIFFNESS) AND K_{FY} OR K_{FX} (SHEAR STIFFNESS) OF THE PERTINENT SUPPORT POINTS.

TO DETERMINE K_θ

$$K_\theta = \frac{M}{\theta}$$

$$\theta = \frac{\delta}{L} = \frac{P}{KL}$$ where P = LOAD ON EMBED DUE TO 'M'

$$\therefore K_\theta = \frac{MKL}{P}$$ K = TENSILE STIFF. OF EMBED.



δ = deformation or slip of embedment

L = distance of the embed from the centroid

K_{FX} or K_{FY}

DIRECTLY READ FROM SHEAR / SLIP DIAGRAM IN REFERENCES INDICATED IN SHEET 184

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

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSe	9/7/82						
Checker			MNS	9/10/82						

FOR POINT 1 SHEET 170
(ALL 1½"ϕ RICHMOND INSERTS)

TO EVALUATE K_θ

FROM SH 125 MOMENT = 206.74 "K

LOAD/RI = 4.53/2

FROM REF 1 SH 184

$K = \frac{45}{0.154} = 291\ K/"$; $\delta = \frac{4.53}{2 \times 291} = 0.007783$

$K_\theta = \frac{M}{\theta} = \frac{206.74 \times 21}{0.007783} = 5.58 \times 10^5$

FROM SH 162 MOMENT = 64.6 "K

LOAD/RI = 0.71 K (PRORATED PER SH 125)

FROM REF 1 (SH 184) $\delta = \frac{0.71}{291}$

$K_\theta = \frac{M}{\theta} = \frac{64.6 \times 291 \times 21}{0.71} = 5.56 \times 10^5$

Avg $K_\theta = 5.57 \times 10^5$ "K/radian

$K_{FY} = 55/0.34 = 162\ K/"$

FROM REF 1 SH 184

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

Subject MR SUPPORT STRUCT – ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 174

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date	
Checking Method #			1								
Preparer			SSC	9/7/82							
Checker			MNS	9/10/82							

FOR POINT 4 SHEET 170

ALL $1\frac{1}{4}$" SUPER KWIK HILTI BOLTS (SKHB)

EMBED ≈ $13\frac{1}{8}$"

FROM SHEET 138 M = 63.1 "K ; T/SKHB = 1.5 K

FROM REF 2 SH 184 $K = \frac{21}{0.125} = 168 K/"$

$$K_\theta = \frac{M}{\theta} = \frac{63.1 \times 168 \times 8.19}{1.5} = 5.79 \times 10^4 \text{ "K/RAD}$$

FROM REF 2 SH 184

$$K_x \approx \frac{50}{0.6} = 83 \text{ K/ INCH}$$

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, 7-8

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

Subject MR SUPPORT STRUCTURE – ACCIDENT TEMP INVEST.

Calculation Number SRB-13GC SET 6 Sheet No. 175

Revision	Original Issue	Date	Rev. 5	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #		X	1	X		X		X		X
Preparer			SSC	9/7/82						
Checker			MNS	9/10/82						

LOADING 2 (DL + SSE + MR THERMAL)
FROM SHEET 91 AND 92

$F_X = 7.814 + 5.203 = 13.02$ KIPS

$F_Y = 4.804 + 3.251 = 8.05$ KIPS

$M_X = 7.98$ "K

$M_Y = 12.40$ "K

$M_Z = 256.67$ "K

OUTPUT FROM STRUDL RUN FOR ALL THE LOADING COMBINATIONS ARE FROM SH 185 THRU 207

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 TUSI

Subject MR SUPT STRUCT — ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 176

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	9/8/82						
Checker			MNS	9/10/82						

THE FOLLOWING ARE THE TABULATION OF LOADS ON THE SUPPORT POINTS DUE TO LOADING 12 & 3 (SH. 201 & 202)

JOINT	LOADING	Fx	FY	FZ	MX	MY	MZ	COMMENT
1	12	1.9	-16.13	0.2	-2.	-8.3	-429.5	
	3	3.42	6.1	-1.92	-74.2	52.02	-575.9	
4	12	-5.	13.1	0.12	4.3	-	16.26	
	3	-4.2	-37.	1.9	51.3	-	-10.76	
5	12	-10.1	-5.	-	-	-	162.8	
	3	-12.0	-.3	-	1.74	-1.	262.	

LOADS ARE IN KIPS AND INCH-KIPS.

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 TUSI

Subject MR SUPT STRUCT - ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 177

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method			1							
Preparer			SSe	9/7/82						
Checker			MNS	9/10/82						

SUPPORT AT JOINT 1

CRITICAL LOADS (LOADING 3) SHEET 176 ARE TABULATED BELOW.

$F_x = 3.42$ KIPS

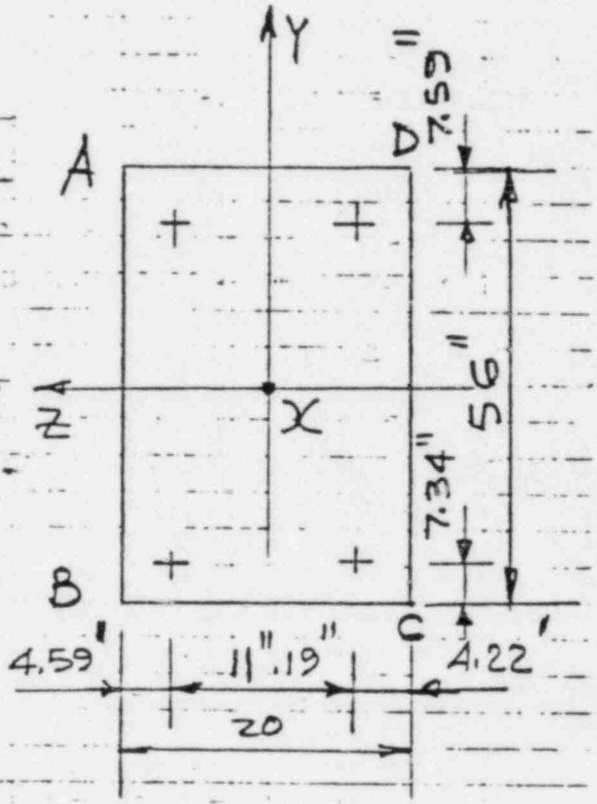
$F_y = 6.1$ KIPS

$F_z = -1.92$ KIPS

$M_x = -74.2$ "K

$M_y = 52.02$ "K

$M_z = -575.9$ "K



4 - BOLTS (1½" φ)

TENSILE AREA = 1.405 □"

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 problems

F-166, 7-82

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

Subject MOMENT REST SUPPORT STRUCT - ACCIDENT TEMP. INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 178

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	9/7/82						
Checker			MAS	9/10/82						

SUPPORT AT JOINT 1 (CONTD)

TENSION ON BOLTS

(1) DUE TO $F_x = \frac{3.42}{4} = 0.86\ K$

(2) DUE TO M_Z

FIND NA

$20\,n^2/2 = 8 \times 2 \times 1.405\,(48.66 - n)$ SOLVING $n = 9.4''$

$C = T = \frac{M}{2(d - n/3)} = \frac{575.9}{2\left(48.66 - \frac{9.4}{3}\right)} = 6.32^{K}$

(3) DUE TO M_Y

FIND NA

$56\,\frac{n^2}{2} = 8 \times 2 \times 1.405\,(15.78 - n) \Rightarrow n = 3.18$

$\text{TENSION / BOLT} = \frac{M}{2(d - n/3)} = \frac{52.02}{2\left(15.78 - \frac{3.18}{3}\right)} = 1.8\ k$

TOTAL TENSION / PER BOLT $\simeq 9.0^{K}$

(1) + (2) + (3)

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 TUSI

Subject MR SUPPT. STRUCT – ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 179

Revision	Original	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	9/7/82						
Checker			MNS	9/10/82						

SUPPORT AT JOINT 1 (CONTD)

(B) SHEAR ON BOLTS:

1) DUE TO $F_Y = 6.10/4 = 1.52$ KIPS

(2) DUE TO $F_Z = \frac{1.92}{4} = .5$ KIPS

(3) DUE TO $M_X = 74.2$ "k

C.G OF BOLT SYSTEM

FROM AB $= (4.59 + 15.78)/2 = 10.19$"

FROM AD $= (7.59 + 48.66)/2 = 28.125$"

$\Sigma dy^2 = 2(28.125 - 7.59)^2 + 2(48.66 - 28.125)^2 = 1686.7$

$\Sigma dz^2 = 2(10.19 - 4.59)^2 + 2(15.78 - 10.19)^2 = 125.$

$\Sigma dy^2 + dz^2 = 1811.7 \text{ in}^4$

SHEAR DUE TO M_X

HORIZ $\frac{74.2 \times 20.535}{1811.67} = 0.84$ KIPS

VERT $\frac{74.2 \times 5.59}{1811.67} = 0.23$ KIPS

TOTAL SHEAR / BOLT $= [(1.52 + .23)^2 + (0.5 + .84)^2] = 2.2^k$

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 TUSI

Subject MR SUPPORT STRUCT - ACCIDENT TEMP INVEST.

Calculation Number SRB-136C SET 6 Sheet No. 180

Revision	Original Issue	Date	Rev. 6	Date	Rev.	Date	Rev.	Date	Rev.	Date
Checking Method #			1							
Preparer			SSC	9/7/82						
Checker			MLS	9/14/82						

SUPPORT AT JOINT 1 (CONTD)

ALLOW RI CAPACITY

TENSION = 27 K
SHEAR ≃ 27 K } SH 128

CHECK FOR COMBINED TENSION & SHEAR

$$\left(\frac{9.00}{27.}\right)^{4/3} + \left(\frac{2.2}{27.}\right)^{4/3} = .23 + .04 < 1$$
$$= .27$$

O.K.

BASE PLATE

MOMENT @ FACE OF STIFF DUE TO THE BOLT IN TENSION

$= 9. \times (10 - 4.22) = 52$ "K

$$f_b = \frac{52}{1/6 \times 12 \times 1.5^2} = 11.56 \text{ ksi}$$

$< 0.9 \times 38.9 = 35.0$ ksi

REDUCED Fy DUE TO TEMP.

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

J E S 2   J O B   L O G

```
09.45.02 JOB  177  IEFUJV: THIS PROGRAM HAS BEEN VERIFIED AND IS ACCEPTABLE FOR USE IN ENGINEERING CALCULATIONS.
09.45.03 JOB  177  $HASP373 SSE$100  STARTED - INIT 35 - CLASS 7 - SYS 3033
09.45.03 JOB  177  IEF403I SSE$100 - STARTED - TIME=09.45.03
09.45.05 JOB  177  ***** 000085 RECORDS MOVED - END OF JOB
09.45.06 JOB  177  *PUNCH COMPLETED
09.45.06 JOB  177  ***** 000059 RECORDS MOVED - END OF JOB
09.45.41 JOB  177  IEF404I SSE$100 - ENDED - TIME=09.45.41
09.45.41 JOB  177  $HASP395 SSE$100  ENDED
```

------ JES2 JOB STATISTICS ------

09 SEP 82 JOB EXECUTION DATE

65 CARDS READ

1,018 SYSOUT PRINT RECORDS

0 SYSOUT PUNCH RECORDS

0.63 MINUTES EXECUTION TIME

JOB # 2323
SRB-136C SET 6
SHEET 186 REV 6

PREP. BY SSe	REV.
DATE 9/9/82	6
CHKD. BY MALS	
DATE 9/10/82	
CHECK METHOD 1	

```
 1      //SSE$100  JOB (G48,'11237','112323001','3201'),'SSE       11 FL. ',       JOB  177
        //  CLASS=7,MSGCLASS=A,TIME=(,10)
        ***JOBPARM  QUEUE=FETCH
        ***ROUTE PRINT RO
 2      //  EXEC   STRUDL
 3      XXSTRUDL      PROC   PROG=QQQICEXS,CORE=1024K,NOTE=0                 00000010
        ***     SET NOTE=1 IF ANNOUNCEMENTS ARE TO BE SUPPRESSED.
        ***      STRUDL VERSION V2M5 DELFT UNIVERSITY                          00000020
        ****************************************************************     00000030
        ***   THIS PROC EXECUTES PROGRAM STRUDL.                       *     00000040
        ***   REFER ANY QUESTIONS TO C.C.WU X8624.                     *     00000050
        ***             ********************                           *
        ***   PROGRAM HAS BEEN PARTIALLY VERIFIED.                     *
        ***   VERIFICATION HAS BEEN COMPLETED FOR THE STATIC           *
        ***   AND DYNAMIC ANALYSIS OF FRAME STRUCTURES.                *
        ***                              MTI    10/16/81               *
        ****************************************************************     00000060
 4      XXS1    EXEC PGM=IEFBR14
 5      XXDD1  DD  SYSOUT=A
        ***    LIST ANNOUNCEMENTS                                              00000070
 6      XX           EXEC PGM=ATSPRINT,COND=(NOTE,GT,S1)                      00000080
 7      XXOUT       DD    SYSOUT=A,DCB=(RECFM=FB,LRECL=80,BLKSIZE=400)        00000090
 8      XXIN        DD    DSN=ICES.NOTICES,DISP=OLD                           00000100
        ***   LIST STRUDL INPUT                                                00000110
 9      XXGO   EXEC   PGM=ATSPRINT,PARM=LISTPUNCH                              00000120
10      XXOUT    DD DSN=&&DATA,DISP=(NEW,PASS),UNIT=SYSDA,SPACE=(TRK,(1,1)),   00000130
        XX  DCB=(RECFM=FB,LRECL=80,BLKSIZE=6000)                               00000140
11      XXOUTPUNCH DD SYSOUT=A,DCB=*.OUT                                       00000150
12      XXIN DD DDNAME=SYSIN                                                   00000160
13      //GO.SYSIN  DD  *
14      XXST    EXEC   PGM=&PROG,REGION=&CORE                                  00000170
15      XXSTEPLIB         DD DSN=LIBR.ENGR10.LOADMOD,DISP=SHR                  00000180
16      XX                DD DSN=LIBR.ENGR11.LOADMOD,DISP=SHR                  00000190
17      XXFT07F001        DD SYSOUT=B                                          00000200
18      XXFT06F001        DD SYSOUT=A,DCB=(RECFM=UA,BLKSIZE=133)               00000210
19      XXFT06F002        DD SYSOUT=A,DCB=(RECFM=UA,BLKSIZE=133)               00000220
20      XXDD1             DD DSN=ICES.USERFILE,DISP=SHR                        00000230
21.     XXDD2             DD DSN=ICES.STRUDL.DATAPOOL,DISP=SHR                 00000240
22      XXDD3             DD DSN=LIBR.ADE201C.DATA,DISP=SHR                    00000250
23      XXDD4             DD DSN=&&TEMP,UNIT=SYSDA,DCB=(RECFM=F,BLKSIZE=800,   00000260
        XX        DSORG=DA),SPACE=(800,(400,50)),DISP=(,PASS)                  00000270
24      XXFT05F001 DD DSN=&&DATA,DISP=(OLD,DELETE)                             00000280
```

JOB # 2323
SRB-136C SET 6
SH 187 . REV 6.

PREP. BY She
DATE 9/9/82
CHKD. BY MNS
DATE 9/10/82
CHECK METHOD 1
REV. A 6

```
STMT NO. MESSAGE
-
     8      IEF653I SUBSTITUTION JCL - PGM=ATSPRINT,COND=(0,GT,S1)
    14      IEF653I SUBSTITUTION JCL - PGM=QQQICEX5,REGION=1024K
  IEF236I ALLOC. FOR SSE$100 S1
  IEF237I JES2 ALLOCATED TO 001
  IEF142I SSE$100 S1 - STEP WAS EXECUTED - COND CODE 0000
  IEF285I    JES2.JOB00177.SO0102                          SYSOUT
  IEF373I STEP /S1       / START 82252.0945
  IEF374I STEP /S1       / STOP  82252.0945 CPU    0MIN 00.01SEC SRB    0MIN 00.00SEC VIRT     4K SYS   184K
     ***************************************************************************************************
     * STEP  STEPNAME  PGM NAME    STEP       STEP     CPU TIME  PRIV  CORE  PAGES  PAGES  SYSIN        RETURN *
     *  NO                         INIT       TIME     MM:SS.TH  AREA  USED    IN    OUT   COUNT         CODE  *
     *   1    S1       IEFBR14    9:45:03    0:00:00   0:00.01 5040K   4K      0      0      0              0 *
     ***************************************************************************************************
     *      DEV   EXCPS    *     000      0      *     TOT      0     *                     *
     ***************************************************************************************************
  IEF236I ALLOC. FOR SSE$100
  IEF237I JES2 ALLOCATED TO OUT
  IEF237I 440  ALLOCATED TO IN
  IEF237I 451  ALLOCATED TO SYS00008
  **** 000085 RECORDS MOVED - END OF JOB
  IEF142I SSE$100 - STEP WAS EXECUTED - COND CODE 0000
  IEF285I    JES2.JOB00177.SO0103                          SYSOUT
  IEF285I    ICES.NOTICES                                  KEPT
  IEF285I    VOL SER NOS= D33310.
  IEF285I    SYSCTLG.VSYS000                               KEPT
  IEF285I    VOL SER NOS= SYS000.
  IEF373I STEP /         / START 82252.0945
  IEF374I STEP /         / STOP  82252.0945 CPU    0MIN 00.06SEC SRB    0MIN 00.00SEC VIRT    24K SYS   204K
     ***************************************************************************************************
     * STEP  STEPNAME  PGM NAME    STEP       STEP     CPU TIME  PRIV  CORE  PAGES  PAGES  SYSIN        RETURN *
     *  NO                         INIT       TIME     MM:SS.TH  AREA  USED    IN    OUT   COUNT         CODE  *
     *   2             ATSPRINT   9:45:03    0:00:01   0:00.06 5040K  24K      3      0      0              0 *
     ***************************************************************************************************
     *      DEV   EXCPS    *     000      0      *     040      4     *     451      0      *     TOT    4  *
     ***************************************************************************************************
  IEF236I ALLOC. FOR SSE$100 GO
  IEF237I 321  ALLOCATED TO OUT
  IEF237I JES2 ALLOCATED TO OUTPUNCH
  IEF237I JES2 ALLOCATED TO IN
  PUNCH COMPLETED
  **** 000059 RECORDS MOVED - END OF JOB
  IEF142I SSE$100 GO - STEP WAS EXECUTED - COND CODE 0000
  IEF285I    SYS82252.T094503.RA000.SSE$100.DATA           PASSED
  IEF285I    VOL SER NOS= WORK05.
  IEF285I    JES2.JOB00177.SO0104                          SYSOUT
  IEF285I    JES2.JOB00177.SI0101                          SYSIN
  IEF373I STEP /GO       / START 82252.0945
  IEF374I STEP /GO       / STOP  82252.0945 CPU    0MIN 00.06SEC SRB    0MIN 00.00SEC VIRT    72K SYS   208K
     ***************************************************************************************************
     * STEP  STEPNAME  PGM NAME    STEP       STEP     CPU TIME  PRIV  CORE  PAGES  PAGES  SYSIN        RETURN *
     *  NO                         INIT       TIME     MM:SS.TH  AREA  USED    IN    OUT   COUNT         CODE  *
     *   3    GO       ATSPRINT   9:45:05    0:00:00   0:00.06 5040K  72K      0      0     59              0 *
     ***************************************************************************************************
     *      DEV   EXCPS    *     921      1      *     000      0     *     000      0      *     TOT    1  *
     ***************************************************************************************************
  IEF236I ALLOC. FOR SS $100 ST
  IEF237I 453  ALLOCATED TO STEPLIB
  IEF237I 844  ALLOCATED TO
  IEF237I 323  ALLOCATED TO SYS00010
```

JOB# 2323
SRB-1366
SGT 6
SH188 REV 6

PREP. BY SSC	REV.
DATE 9/9/82	A
CHKD. BY MKB	
DATE 9/10/82	
CHECK METHOD 1	

```
IEF237I JES2 ALLOCATED TO FT07F001
IEF237I JES2 ALLOCATED TO FT06F001
IEF237I JES2 ALLOCATED TO FT06F002
IEF237I 440  ALLOCATED TO DD1
IEF237I 451  ALLOCATED TO SYS00012
IEF237I 854  ALLOCATED TO DD2
IEF237I 850  ALLOCATED TO DD3
IEF237I 228  ALLOCATED TO DD4
IEF237I 321  ALLOCATED TO FT05F001
IEF142I SSE$100 ST - STEP WAS EXECUTED - COND CODE 2184
IEF285I   LIBR.ENGR10.LOADMOD                              KEPT
IEF285I   VOL SER NOS= D33502.
IEF285I   LIBR.ENGR11.LOADMOD                              KEPT
IEF285I   VOL SER NOS= D33513.
IEF285I   SYSCTLG.VSYS001                                  KEPT
IEF285I   VOL SER NOS= SYS001.
IEF285I   JES2.JOB00177.S00105                             SYSOUT
IEF285I   JES2.JOB00177.S00106                             SYSOUT
IEF285I   JES2.JOB00177.S00107                             SYSOUT
IEF285I   ICES.USERFILE                                    KEPT
IEF285I   VOL SER NOS= D33510.
IEF285I   SYSCTLG.VSYS000                                  KEPT
IEF285I   VOL SER NOS= SYS000.
IEF285I   ICES.STRUDL.DATAPOOL                             KEPT
IEF285I   VOL SER NOS= D33507.
IEF285I   LIBR.ADE201C.DATA                                KEPT
IEF285I   VOL SER NOS= D33501.
IEF285I   SYS82252.T094503.RA000.SSE$100.TEMP              PASSED
IEF285I   VOL SER NOS= WORK03.
IEF285I   SYS82252.T094503.RA000.SSE$100.DATA              DELETED
IEF285I   VOL SER NOS= WORK05.
IEF373I STEP /ST     / START 82252.0945
IEF374I STEP /ST     / STOP  82252.0945 CPU    0MIN 01.34SEC SRB    0MIN 00.13SEC VIRT  1088K SYS   224K
   ************************************************************************************************
   *  STEP  STEPNAME  PGM NAME    STEP      STEP    CPU TIME  PRIV  CORE   PAGES  PAGES  SYSIN          RETURN  *
   *   NO                         INIT      TIME    MM:SS.TH  AREA  USED    IN     OUT   COUNT           CODE   *
   *   4    ST        QQQICEX5   9:45:06   0:00:34  0:01.34 5040K 1088K     0      0      0            , 29600  *
   ************************************************************************************************
   *  DEV   EXCPS  *   D33    46   *   844   10   *   323    0   *   000    0   *
   *  000     0    *   000     0   *   D40    2   *   451    0   *   854   10   *
   *  F50    88    *   228   423   *   321    2   *   TOT   581  *               *
   ************************************************************************************************
IEF237I 228  ALLOCATED TO SYS00001
IEF285I   SYS82252.T094540.RA000.SSE$100.R0000001          KEPT
IEF285I   VOL SER NOS= WORK03.
IEF285I   SYS82252.T094503.RA000.SSE$100.TEMP              DELETED
IEF285I   VOL SER NOS= WORK03.
IEF375I  JOB /SSE$100 / START 82252.0945
IEF376I  JOB /SSE$100 / STOP  82252.0945 CPU    0MIN 01.47SEC SRB    0MIN 00.13SEC
                          ****************************************************************
                          *  JOB NAME   JOB INIT   JOB TIME   CPU TIME   JOB READ   RDR TIME   TOTAL IO  *
                          *             HH:MM:SS   HH:MM:SS   MM:SS.TH   HH:MM:SS   MM:SS.TH             *
                          *  SSE$100    9:45:03    0:00:37    0:01.47    9:45:02    0:00.56       586    *
                          *                                                                              *
                          *   NO    CORE   PAGES   PAGES   TOTAL    JOB    PRTY                  PK      *
                          *  STEP   REQD    IN      OUT    SYSIN   CLASS                                 *
                          *   4    1088K     3       0      59       7      0                    0       *
                          *                                                                              *
                          *                          SEP 09, 1982                                        *
                          *                                                                              *
                          *                         GIBBS AND HILL                                       *
```

JOB # 2323

SRB-136C SET 6

SH 189 REV 6

PREP. BY SSe	REV.
DATE 9/9/82	A
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

JOB NO 2323
SRB-136C SET 6
SH 190 REV 6

PREP. BY SSe	REV.
DATE 9/2/82	A
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

```
STRUDL 'SUPPT' 'ACCIDENT TEMP INVESTIGATION'
$ SSE.STRUDL.FYY
$ G & H DWG # 2323-S1-0538-07
TYPE SPACE FRAME
UNITS INCH   KIPF FAH
JOINT COORDINATES
1    0.      0.       0.       S
2   34.6     0.       0.
3   77.9     0.       0.
4   34.6   -88.5      0.       S
5    0.    -65.75     0.       S
MEMBER  INCIDENCES
1    1    2
2    2    4
3    2    3
4    2    5
MEMBER PROPERTIES PRISMATIC
1 AX 74.0 IX 3862.0 IY 2487. IZ 2889. YD 16.0  ZD 16.0  YC 8.0  ZC 8.0
2 AX 38.8 IX   12.3 IY 1530. IZ  548. YD 14.66 ZD 14.73 YC 7.33 ZC 7.37
3 AX 74.0 IX 3862.0 IY 2487. IZ 2889. YD 16.0  ZD 16.0  YC 8.0  ZC 8.0
4 AX 22.5 IX   14.3 IY   54. IZ  267. YD  9.0  ZD  6.0  YC 4.5  ZC 3.0
JOINT  RELEASES
JOINT 1 RELEASES  KFX 4.32E4  KFY 162. KMZ 5.37E5
JOINT 4 RELEASES  KFX  83. KMZ 5.79E4
JOINT 5 RELEASES  KFY 162.
$ LOADING 1 IS ACCIDENT TEMP OF 280 DEG
$ LOADING 2 IS DL+SSE+MR THERMAL
$ LOADING 3 IS DL+SSE+MR THERMAL+PIPE RUPTURE
$ LOADING 12 IS DL+ SSE+MR THERMAL+ACCIDENT TEMP
LOADING  1
MEMBER TEMPERATURE LOADS
1 TO 4 FR LA 0.0 LB 1.0 AXIAL 220.0
LOADING  2
JOINT LOADS
3   FOR  X   13.02
3   FOR  Y    8.05
3   MOM  X    7.98
3   MOM  Y   12.40
3   MOM  Z -256.67
LOADING  3
JOINT LOADS
3   FOR  X   13.02
3   FOR  Y   31.06
3   MOM  X  189.11
3   MOM  Y   12.4
3   MOM  Z  354.67
LOADING COMBINATION 12  COMBINE  1  1.  2  1.
CONSTANTS
E 27988.  ALL
G 10765.  ALL
POISSON 0.3
CTE 6.632E-6
STIFFNESS ANALYSIS
OUTPUT DECIMAL 3
PRINT DATA
LIST  FORCES DISPLACEMENTS REACTIONS ALL
LIST MAX STRESS EACH LOADING MEMBER 1 TO 4 SECTION FR NS 3  0. .5 1.
FINISH
/*
//
```

INTEGRATED CIVIL ENGINEERING SYSTEM - V1 M3 NOV 1969
- ICES -
SEP 09, 1982 TIME=15.30.34

JOB NO 2323
SRB-136C SET 6
SH 191 REV 6

PREP. BY SSC	REV.
DATE 9/9/82	A
CHKD. BY MNS	6
DATE 9/10/82	
CHECK METHOD 1	

STRUDL 'MR SUPPT' 'ACCIDENT TEMP INVESTIGATION'

```
**********************************************************
*                                                        *
*              ICES STRUDL-II                            *
*       THE STRUCTURAL DESIGN LANGUAGE                   *
*              VERSION V2M5                              *
*                                                        *
*           ORIGINALLY RELEASED BY                       *
*   CIVIL ENGINEERING SYSTEMS LABORATORY,MIT             *
*                                                        *
*  UPDATED BY :                                          *
*    - DELFT UNIVERSITY OF TECHN.  JUNE 74 , SEPT 75     *
*                                  SEPT 76 , SEPT 77     *
*                                  SEPT 78               *
*    - COMBUSTION ENGINEERING      JUNE 74               *
*    - THE SERVICE BUREAU CO.      JUNE 74               *
*    - PACIFIC GAS & ELECTRIC      JUNE 74               *
*    - SOUTHERN SERVICES INC.      JUNE 74               *
*    - SHELL NETHERLANDS           JUNE 74 , SEPT 76     *
*    - MINISTRY OF WORKS N.Z.      JUNE 74               *
*    - PITTSBURGH DEMOINES STEEL   JUNE 74               *
*    - MIT LINCOLN LAB             JUNE 74               *
*                                                        *
*          15:32:46        9/09/82                       *
**********************************************************
```

JOB No 2323
SRB-136C SET 6
SH 192 REV 6

PREP. BY SSC DATE 9/9/82 CHKD. BY MNS DATE 9/10/82 CHECK METHOD 1	REV. A

```
$ SSE.STRUDL.EYY

$ G & H DWG # 2323-S1-0538-07

TYPE SPACE FRAME

UNITS INCH KIPF FAH

JOINT COORDINATES

1    0.      0.      0.      S

2   34.6     0.      0.

3   77.9     0.      0.

4   34.6   -88.5     0.      S

5    0.    -65.75    0.      S

MEMBER INCIDENCES

1    1    2

2    2    4

3    2    3

4    2    5

MEMBER PROPERTIES PRISMATIC
```

```
1 AX 74.0 IX 3862.0 IY 2487. IZ 2889. YD 16.0 ZD 16.0 YC 8.0 ZC 8.0
2 AX 38.8 IX 12.3 IY 1530. IZ 548. YD 14.66 ZD 14.73 YC 7.33 ZC 7.37
3 AX 74.0 IX 3862.0 IY 2487. IZ 2889. YD 16.0 ZD 16.0 YC 8.0 ZC 8.0
4 AX 22.5 IX 14.3 IY 54. IZ 267. YD 9.0 ZD 6.0 YC 4.5 ZC 3.0
JOINT RELEASES
JOINT 1 RELEASES KFX 4.32E4 KFY 162. KMZ 5.57E5
JOINT 4 RELEASES KFX 83. KMZ 5.79E4
JOINT 5 RELEASES KFY 162.
$ LOADING 1 IS ACCIDENT TEMP OF 280 DEG
$ LOADING 2 IS DL+SSE+MR THERMAL-PIPE RUPTURE
$ LOADING 3 IS DL+SSE+MR THERMAL+PIPE RUPTURE
$ LOADING 12 IS DL+ SSE+MR THERMAL+ACCIDENT TEMP
LOADING 1
MEMBER TEMPERATURE LOADS
1 TO 4 FR LA 0.0 LB 1.0 AXIAL 220.0
LOADING 2
JOINT LOADS
3 FOR X 13.02
3 FOR Y 8.05
3 MOM X 7.98
3 MOM Y 12.40
3 MOM Z 256.67
LOADING 3
JOINT LOADS
3 FOR X 13.02
3 FOR Y 31.06
3 MOM X 189.11
3 MOM Y 12.4
3 MOM Z 354.67
LOADING COMBINATION 12 COMBINE 1 1. 2 1.
CONSTANTS
```

JOB NO 2323
SRB-136C SET 6
SH 193 REV 6

PREP. BY SSC	REV: A
DATE 9/9/82	
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

E 27988. [illegible]L

G 10765. ALL

POISSON 0.3

CTF 6.632E-6

STIFFNESS ANALYSIS

OUTPUT DECIMAL 3

PRINT DATA

JOB NO 2323

SRB-136C SET 6

SH 194 REV 6

PREP. BY 3SC	REV.
DATE 9/9/82	A
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

```
****************************************
*  PROBLEM DATA FROM INTERNAL STORAGE  *
****************************************
```

JOB NO 2323
SRB-136C SET 6
SH 195 REV 6

PREP. BY SSC	REV.
DATE 9/9/82	A 6
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD	

JOB ID - MR SUPPT   JOB TITLE - ACCIDENT TEMP INVESTIGATION

ACTIVE UNITS	LENGTH	FORCE	ANGLE	TEMPERATURE	TIME
	INCH	KIP	RAD	FAH	SEC

********** STRUCTURAL DATA **********

ACTIVE STRUCTURE TYPE - SPACE FRAME

ACTIVE COORDINATE AXES X Y Z

JOINT COORDINATES / STATUS

JOINT	X	Y	Z	CONDITION	STATUS	
1	0.0	0.0	0.0	SUPPORT	ACTIVE	GLOBAL
2	34.600	0.0	0.0	FREE	ACTIVE	GLOBAL
3	77.900	0.0	0.0	FREE	ACTIVE	GLOBAL
4	34.600	-88.500	0.0	SUPPORT	ACTIVE	GLOBAL
5	0.0	-65.750	0.0	SUPPORT	ACTIVE	GLOBAL

JOINT RELEASES / ELASTIC SUPPORT RELEASES

JOINT	FORCE	MOMENT	THETA 1	THETA 2	THETA 3	KFX	KFY	KFZ	KMX	KMY	KMZ
1			0.0	0.0	0.0	43199.996	1624.000	0.0	0.0	0.0	556999.875
4			0.0	0.0	0.0	83.000	1040	0.0	0.0	0.0	57899.992
5			0.0	0.0	0.0	0.0	162.000	0.0	0.0	0.0	0.0

MEMBER INCIDENCES / LENGTH / RELEASES / STATUS / TYPE

MEMBER	START	END	LENGTH LOCAL COORD.	RELEASES START FORCE	START MOMENT	END FORCE	END MOMENT	STATUS	TYPE
1	1	2	34.600					ACTIVE	SPACE FRAME
2	2	4	88.500					ACTIVE	SPACE FRAME
3	2	3	43.300					ACTIVE	SPACE FRAME
4	2	5	74.298					ACTIVE	SPACE FRAME

MEMBER PROPERTIES

MEMBER/SEG	TYPE	SEG.L	COMP	AX/YD	AY/ZD	AZ/YC	IX/ZC	IY/EY	IZ/EZ	SY	SZ
1	PRISMATIC			0.740E 02	0.0	0.0	0.386E 04	0.249E 04	0.286E 04	0.0	0.0
				0.160E 02	0.160E 02	0.800E 01	0.800E 01	0.0	0.0		
2	PRISMATIC			0.388E 02	0.0	0.0	0.123E 02	0.153E 04	0.548E 03	0.0	0.0
				0.147E 02	0.147E 02	0.733E 01	0.737E 01	0.0	0.0		

3	PRISMATIC	0.740E 02 0.0	0.0	0.386E 04	0.249E 04	0.289E 04 0.0	0.0
4	PRISMATIC	0.160E 02 0.160E 02	0.800E 01	0.800E 01	0.0	0.0	
		0.225E 02 0.0	0.0	0.143E 02	0.540E 02	0.267E 03 0.0	0.0
		0.900E 01 0.600E 01	0.450E 01	0.300E 01	0.0	0.0	

JOB No 2323
SRB-136C SET6
SH 196 REV6

PREP. BY SSL	REV.
DATE 9/9/82	A
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD	

MEMBER CONSTANTS

CONSTANT	STANDARD VALUE	DOMAIN,	VALUE	MEMBER LIST
E	0.279880E 05	ALL		
G	0.107650E 05	ALL		
DENSITY	0.935724E-10	ALL		
CTE	0.663200E-05	ALL		
BETA	0.0	ALL		
POISSON	0.300000E 00	ALL		

********** LOADING DATA **********

LOADING - 1 STATUS - ACTIVE

MEMBER AND ELEMENT LOADS
MEMBER/ELEMENT

1	TEMPERATURE LOAD	LA	0.0	LB	1.000	AXIAL	220.000	BENDING	Y	0.0	Z	0.0
2	TEMPERATURE LOAD	LA	0.0	LB	1.000	AXIAL	220.000	BENDING	Y	0.0	Z	0.0
3	TEMPERATURE LOAD	LA	0.0	LB	1.000	AXIAL	220.000	BENDING	Y	0.0	Z	0.0
4	TEMPERATURE LOAD	LA	0.0	LB	1.000	AXIAL	220.000	BENDING	Y	0.0	Z	0.0

LOADING - 2 STATUS - ACTIVE

MEMBER AND ELEMENT LOADS
MEMBER/ELEMENT

JOINT LOADS

JOINT	STEP	FORCE X	Y	Z	MOMENT X	Y	Z
3		13.020	8.050	0.0	7.980	12.400	256.670

LOADING - 3 STATUS - ACTIVE

MEMBER AND ELEMENT LOADS
MEMBER/ELEMENT

JOINT LOADS

JOINT	STEP	FORCE X	Y	Z	MOMENT X	Y	Z

3	13.020	31.060	0.0	189.110	12.400	354.670	

LOADING - 12 STATUS - ACTIVE

COMBINATION GIVEN - 1 1.000 2 1.000

JOB NO 2323

SRB-136C SET 6

SH 197 REV 6

****
* END OF DATA FROM INTERNAL STORAGE *
****

PREP. BY SSe
DATE 9/9/82
CHKD. BY MVS
DATE 9/10/82
CHECK METHOD 1
REV. A

LIST FORCES DISPLACEMENTS REACTIONS ALL

JOB NO 2323
SRB-136C SET 6
SH 198 REV 6

PREP. BY SG	REV.
DATE 9/9/82	6
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

JOB NO 2323
SRB-136C SET 6
SH 199 REV 6

****
RESULTS OF LATEST ANALYSES
****

PROBLEM - MR SUPPT TITLE - ACCIDENT TEMP INVESTIGATION

ACTIVE UNITS -	LENGTH	FORCE	ANGLE	TEMPERATURE	TIME
	INCH	KIP	RAD	FAH	SEC

PREP. BY SSC	REV.
DATE 9/9/82	A
CHKD. BY MHS	
DATE 9/10/82	
CHECK METHOD 1	

ACTIVE STRUCTURE TYPE - SPACE FRAME

ACTIVE COORDINATE AXES X Y Z

LOADING - 1

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	FORCE SHEAR Y	FORCE SHEAR Z	MOMENT TORSIONAL	MOMENT BENDING Y	MOMENT BENDING Z
1	1	8.974	-18.317	0.0	0.0	0.0	-226.281
1	2	-8.974	18.317	0.0	0.0	0.0	-407.476
2	2	23.207	3.236	0.0	0.0	0.0	266.457
2	4	-23.207	-3.236	0.0	0.0	0.0	266.457
3	2	0.001	-0.000	0.0	0.0	0.0	19.908
3	3	-0.001	0.000	0.0	0.0	0.0	-0.007
4	2	-6.999	-2.801	0.0	0.0	0.0	-141.032
4	5	6.999	2.801	0.0	0.0	0.0	-67.110

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE X FORCE	FORCE Y FORCE	FORCE Z FORCE	MOMENT X MOMENT	MOMENT Y MOMENT	MOMENT Z MOMENT
1	GLOBAL	8.974	-18.317	0.0	0.0	0.0	-226.281
4	GLOBAL	-3.236	23.207	0.0	0.0	0.0	19.908
5	GLOBAL	-5.738	-4.889	0.0	0.0	0.0	67.110

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
1	GLOBAL	-0.000	0.113	0.0	0.0	0.0	0.000
4	GLOBAL	0.039	0.0	0.0	0.0	0.0	-0.000
5	GLOBAL	0.0	0.030	0.0	0.0	0.0	0.0

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	0.050	0.127	0.0	0.0	0.0	0.000
3	GLOBAL	0.113	0.143	0.0	0.0	0.0	0.000

JOB NO 2323
SRB-136C SET6
SH 200

-----LOADING - 2

PREP. BY	SSC	REV.
DATE	9/9/82	A
CHKD. BY	MNS	
DATE	9/10/82	
CHECK METHOD	1	

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	FORCE SHEAR Y	FORCE SHEAR Z	MOMENT TORSIONAL	MOMENT BENDING Y	MOMENT BENDING Z
1	1	-7.117	2.185	-0.118	-1.988	-8.323	-203.182
1	2	7.117	-2.185	0.118	1.988	12.411	278.774
2	2	-10.123	1.503	-0.116	-0.008	5.934	136.697
2	4	10.123	-1.503	0.116	0.008	4.333	-3.647
3	2	-13.020	-8.050	-0.000	-7.980	-12.400	-605.236
3	3	13.020	8.050	0.000	7.980	12.400	256.669
4	2	-2.147	-3.841	0.002	-0.011	-0.061	-189.761
4	5	2.147	3.841	-0.002	0.011	-0.099	-95.641

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE X FORCE	FORCE Y FORCE	FORCE Z FORCE	MOMENT X MOMENT	MOMENT Y MOMENT	MOMENT Z MOMENT
1	GLOBAL	-7.117	2.185	-0.118	-1.988	-8.323	-203.182
4	GLOBAL	-1.503	-10.123	0.116	4.333	-0.008	-3.647
5	GLOBAL	-4.399	-0.111	0.002	0.082	-0.056	95.641

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT		DISPLACEMENT X DISP.	Y DISP.	Z DISP.	ROTATION X ROT.	Y ROT.	Z ROT.
1	GLOBAL	0.000	-0.013	0.0	0.0	0.0	0.000
4	GLOBAL	0.018	0.0	0.0	0.0	0.0	0.000
5	GLOBAL	0.0	0.001	0.0	0.0	0.0	0.0

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT X DISP.	Y DISP.	Z DISP.	ROTATION X ROT.	Y ROT.	Z ROT.
2	GLOBAL	0.000	0.001	-0.000	0.000	0.000	0.000
3	GLOBAL	0.001	0.027	-0.000	0.000	0.000	0.001

JOB NO 2323
SRB-136C SET 6
SH 20F

PREP. BY SS
DATE 9/2/82
CHKD. BY MAS
DATE 9/10/82
CHECK METHOD 1
REV. A

LOADING - 3

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	SHEAR Y	SHEAR Z	MOMENT TORSIONAL	BENDING Y	BENDING Z
1	1	3.416	6.084	-1.920	-74.172	52.018	-575.887
1	2	-3.416	-6.084	1.920	74.172	14.415	786.401
2	2	-36.799	4.220	-1.835	0.014	111.045	-384.219
2	4	36.799	-4.220	1.835	-0.014	51.309	-10.759
3	2	-13.020	-31.060	-0.000	-189.110	-12.400	-1699.567
3	3	13.020	31.060	0.000	189.110	12.400	354.669
4	2	-5.994	-10.650	0.086	-0.042	-4.377	-528.947
4	5	5.994	10.650	-0.086	0.042	-1.977	-262.337

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE X FORCE	Y FORCE	Z FORCE	MOMENT X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	3.416	6.084	-1.920	-74.172	52.018	-575.887
4	GLOBAL	-4.220	-36.799	1.835	51.309	0.014	-10.759
5	GLOBAL	-12.216	-0.345	0.086	1.730	-0.958	262.337

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT /----------------DISPLACEMENT----------------//----------------ROTATION----------------/

JOINT		X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
1	GLOBAL	-0.000	-0.038	0.0	0.0	0.0	0.001
4	GLOBAL	0.051	0.0	0.0	0.0	0.0	0.000
5	GLOBAL	0.0	0.007	0.0	0.0	0.0	0.0

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT			ROTATION		
		X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
2	GLOBAL	-0.000	0.003	0.000	0.000	-0.000	0.001
3	GLOBAL	0.000	0.075	0.000	0.000	-0.000	0.002

JOB NO 2323
SRB 136C SET6
SH 202

PREP. BY	Ske	REV.
DATE	9/5/82	6
CHKD. BY	MNS	
DATE	9/10/82	
CHECK METHOD	1	

LOADING - 12

MEMBER FORCES

MEMBER	JOINT	FORCE			MOMENT		
		AXIAL	SHEAR Y	SHEAR Z	TORSIONAL	BENDING Y	BENDING Z
1	1	1.857	-16.132	-0.118	-1.988	-8.323	-429.463
1	2	-1.857	16.132	0.118	1.988	12.411	-128.702
2	2	13.083	4.739	-0.116	-0.008	5.934	403.154
2	4	-13.083	-4.739	0.116	0.008	4.333	16.261
3	2	-13.019	-8.050	-0.000	-7.980	-12.400	-605.242
3	3	13.019	8.050	0.000	7.980	12.400	256.663
4	2	-9.146	-6.643	0.002	-0.011	-0.061	-330.792
4	5	9.146	6.643	-0.002	0.011	-0.099	-162.750

RESULTANT JOINT LOADS - SUPPORTS

JOINT		FORCE			MOMENT		
		X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
1	GLOBAL	1.857	-16.132	-0.118	-1.988	-8.323	-429.463
4	GLOBAL	-4.739	13.083	0.116	4.333	-0.008	16.261
5	GLOBAL	-10.138	-5.000	0.002	0.082	-0.056	162.750

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT	DISPLACEMENT			ROTATION		
	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.

1	GLOBAL	-0.000	0.100	0.0	0.0	0.0	0.001
4	GLOBAL	0.057	0.0	0.0	0.0	0.0	-0.000
5	GLOBAL	0.0	0.031	0.0	0.0	0.0	0.0

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT		DISPLACEMENT X DISP.	DISPLACEMENT Y DISP.	DISPLACEMENT Z DISP.	ROTATION X ROT.	ROTATION Y ROT.	ROTATION Z ROT.
2	GLOBAL	0.050	0.178	-0.000	0.000	0.000	0.001
3	GLOBAL	0.114	0.170	-0.000	0.000	0.000	0.001

JOB NO: 2323
SRB 136C SET6
511 203

PREP. BY SSC
DATE 9/9/82
CHKD. BY MNS
DATE 9/10/82
CHECK METHOD 1
REV. A

LIST MAX STRESS EACH LOADING MEMBER 1 TO 4 SECTION FR NS 3 0. .5 1.

JOB NO 2323
SRB- 136.C SET 6
SH 204 REV 6

PREP. BY SSP	REV.
DATE 9/9/82	
CHKD. BY MNS	
DATE 9/10/82	
CHECK METHOD 1	

****
RESULTS OF LATEST ANALYSES
****

PROBLEM - MR SUPPT TITLE - ACCIDENT TEMP INVESTIGATION

ACTIVE UNITS	LENGTH	FORCE	ANGLE	TEMPERATURE	TIME
	INCH	KIP	RAD	FAH	SEC

JOB NO 2323
SRB 136C SET6
SPI 205 REV6

PREP. BY SS	REV.
DATE 9/9/82	
CHKD. BY MLP	6
DATE 9/16/82	
CHECK METHOD	

ACTIVE STRUCTURE TYPE - SPACE FRAME

ACTIVE COORDINATE AXES X Y Z

INTERNAL MEMBER RESULTS

MEMBER MAXIMUM STRESS FOR EACH LOADING

MEMBER 1

LOADING	MAX NORMAL	AT SECTION	MIN NORMAL	AT SECTION
1	1.007	1.000 FR	-1.250	1.000 FR
2	0.908	1.000	-0.716	1.000
3	2.178	1.000	-2.270	1.000
12	1.191	0.0	-1.241	0.0

MEMBER 2

LOADING	MAX NORMAL	AT SECTION	MIN NORMAL	AT SECTION
1	2.966	0.0 FR	-4.162	0.0 FR
2	2.118	0.0	-1.596	0.0
3	6.623	0.0	-4.726	0.0
12	5.084	0.0	-5.758	0.0

MEMBER 3

LOADING	MAX NORMAL	AT SECTION	MIN NORMAL	AT SECTION
	STRESS			
1	0.000	1.000 FR	-0.000	1.000 FR
2	1.892	0.0	-1.540	0.0
3	4.922	0.0	-4.570	0.0
12	1.892	0.0	-1.540	0.0

MEMBER 4

LOADING	MAX NORMAL	AT SECTION	MIN NORMAL	AT SECTION
	STRESS			
1	2.688	0.0 FR	-2.066	0.0 FR
2	3.297	0.0	-3.106	0.0
3	9.424	0.0	-8.892	0.0
12	5.985	0.0	-5.172	0.0

JOB NO 2323
SRB 136C SET 6
SH 206

PREP. BY SSC
DATE 9/9/82
CHKD. BY MJLSC
DATE 9/10/82
CHECK METHOD 1
REV. A

FINISH

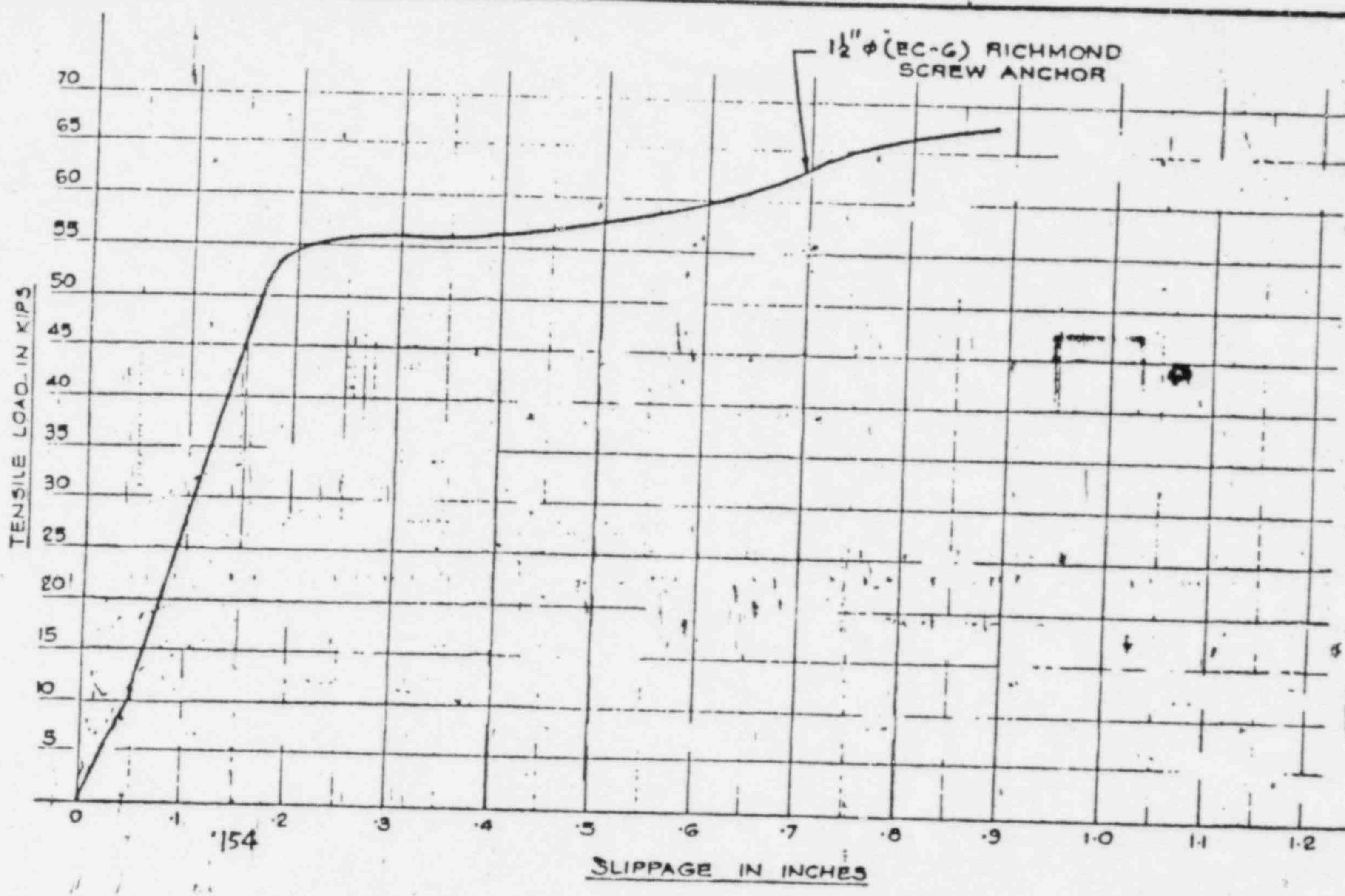
GOOD-BYE

JOB NO 2323

SRB-136C SET 6

SH 207 REV 6

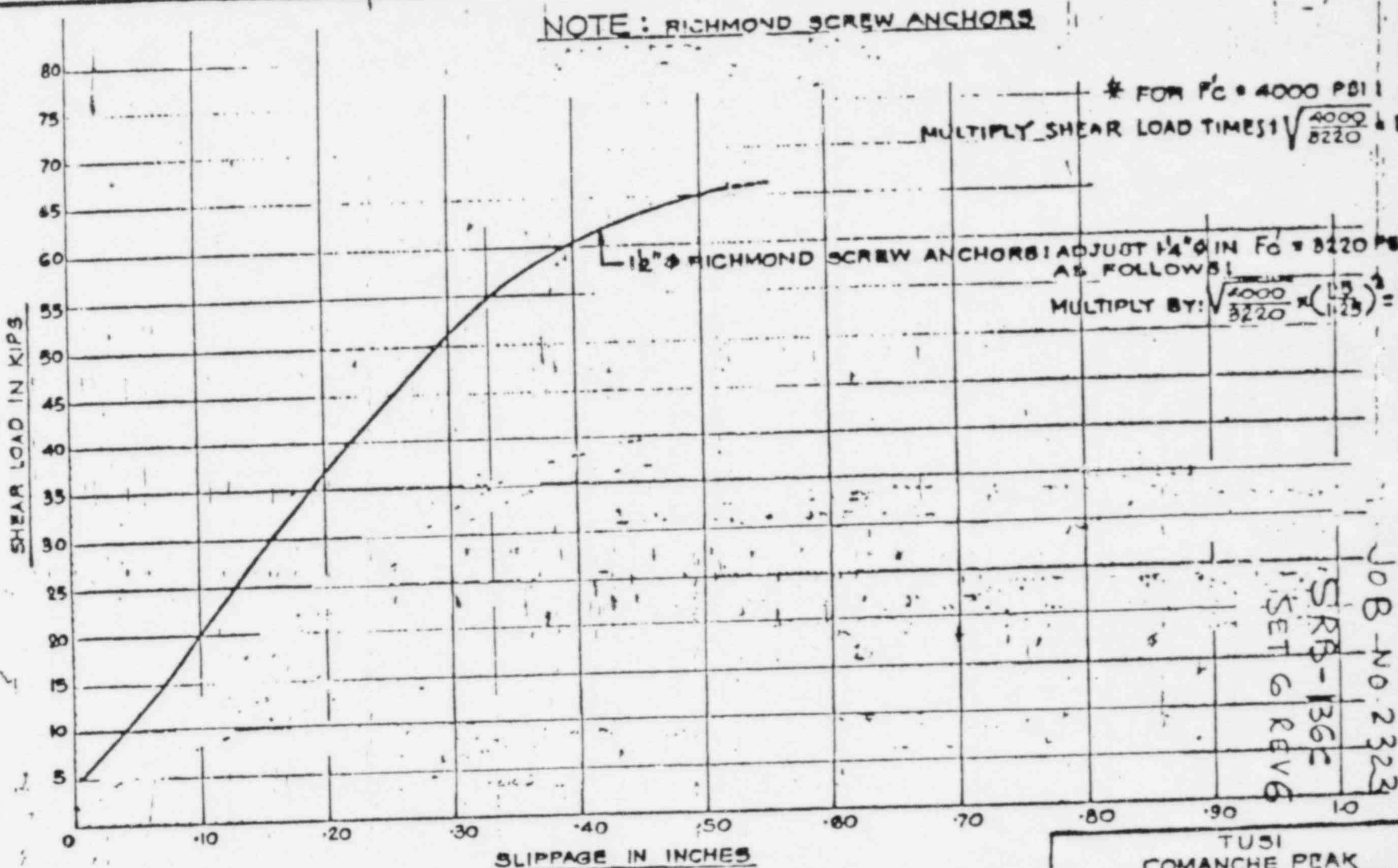
PREP. BY SEC	REV.
DATE 9/9/82	6
CHKD. BY MBS	
DATE 9/10/82	
CHECK METHOD	



SH 208
JOB NO 2323
SRB-136C SET 6
REV 6

TUSI COMANCHE PEAK	
TEST RESULTS FOR TENSION LOAD VERSUS SLIPPAGE FOR EMBEDMENTS.	
Gibbs & Hill, Inc.	SCALE - NTS
JOB NO. 2323	ATTACHMENT-R

MICRO FILM	ISSUE NO	DATE	DWN	CHKD											ISSUED FOR
					APPROVALS										



JOB NO. 2323
SRB-136C
SET 6 REV 6

TUSI
COMANCHE PEAK

TEST RESULTS FOR SHEAR L
VERSUS SLIPPAGE FOR RICHMO
SCREW ANCHOR TYPES

GIBBS & HILL, INC.

SCALE - N.T.S.

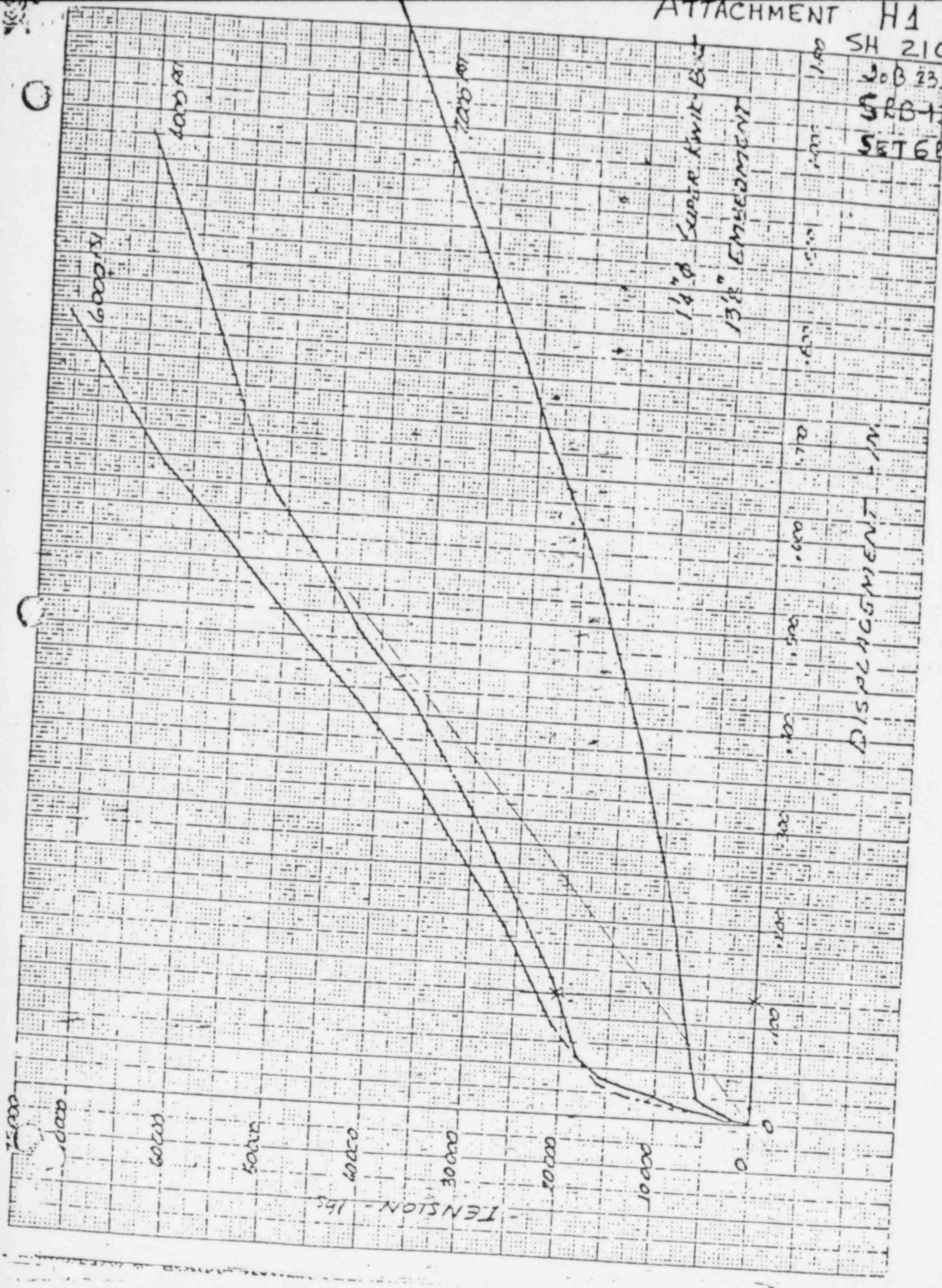
ATTACHMENT

JOB NO. 2323

ISSUED FOR

APPROVALS

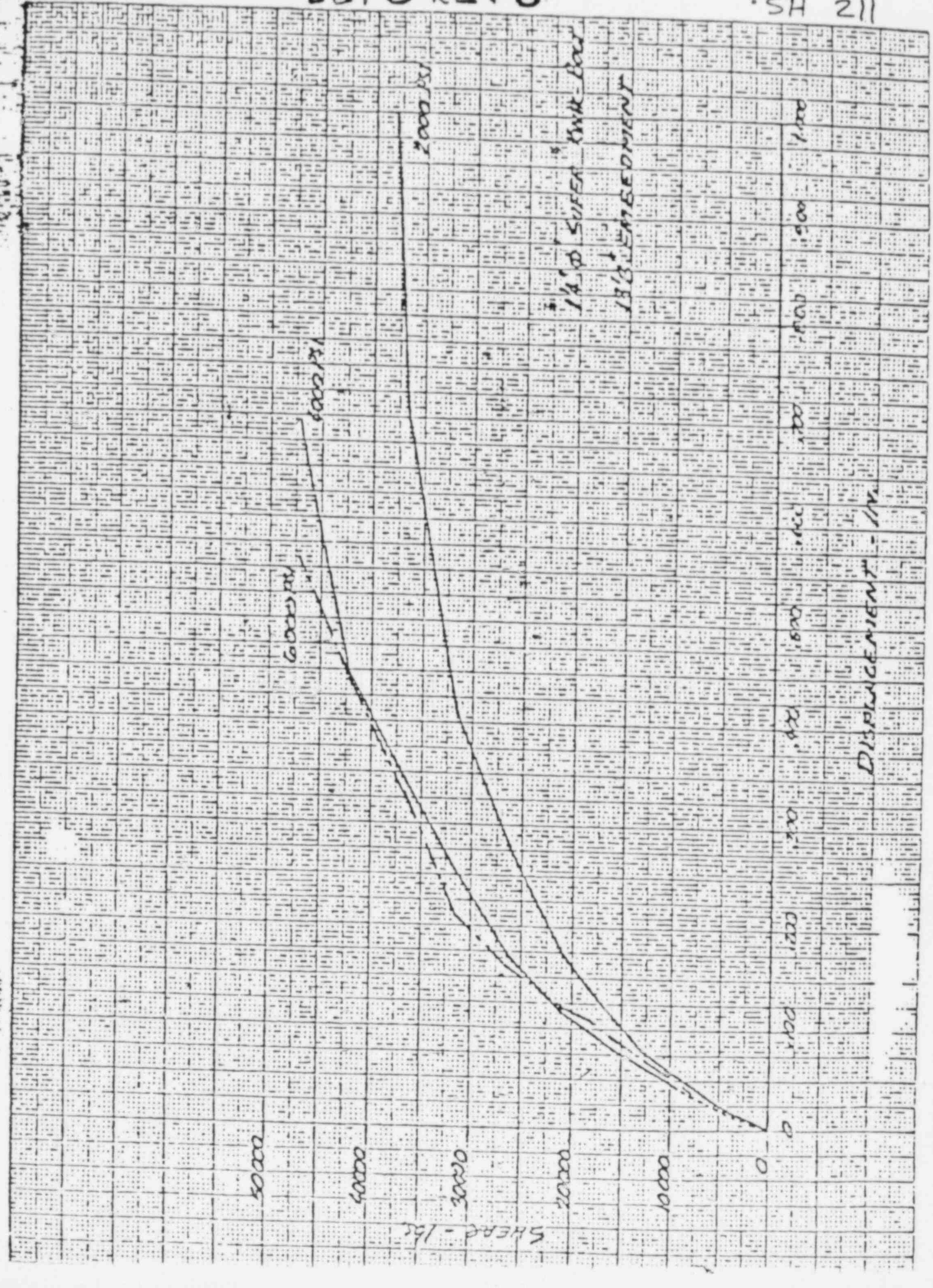
ATTACHMENT H1
SH 210
JOB 2323
SRB-136C
SET 6 CURVE



ATTACHMENT H2

SET 6 REV 6

SH 211



L. O. C. A.

EFFECTS OF FLEX. @ JTS ON CONSTRAINT.

— UPPER LATERAL RESTRAINT BEAM —

KNOWN ELEMENTS:

① ELONGATION = ETL

WHERE $\epsilon = 6.623E-6$ (PER GIBBS & HILL M.R & LATERAL UPPER RESTRAINT CALC'S).

② T (ASSUME 220° IS ACCURATE ALTHOUGH TEMP IS BASED ON PRESSURE CRITICAL ANALYSIS AND IN FACT SHOULD BE HIGHER UNDER TEMPERATURE CRITICAL ANALYSIS) = 280°-60° = ~~280°~~ 220°

③ L (PER GIBBS & HILL M.R. AND LAT. BM CALCS) = 162 INCHES.

④ ∴ ELONGATION = .238 (PER G&H LAT. BM. CALC)

⑤ THE CONSTRAINED DISPLACEMENT REMAINING IN A MEMBER THAT HAS RELEASE CAPABILITIES DUE TO VARIABLE END CONDITIONS, THAT IS TWO DIFFERENT SPRING FACTORS ONE AT EITHER END MAY BE FOUND AS FOLLOWS.

$$.238 - \left(P \, {}^{1}/_{k_1} + P \, {}^{1}/_{k_2}\right) = \Delta_R$$

WHERE $P_{1,2}$ IS A LOAD WHICH WILL BE THE SAME FOR EITHER SPRING AND AS THE AXIAL LOAD FOR THE BEAM.

FROM THIS THE FOLLOWING HOLDS:

IF $.238 \left(P_1 \, {}^1/k_1 + P_2 \, {}^1/k_2 \right) = \Delta_R$

AND IF $P_1 = P_2 = P_3$

THEN $.238 \left(P_1 \, {}^1/k_1 + P_2 \, {}^1/k_2 \right) = P_3 \, {}^1/k_3$

AND $P_1/k_1 + P_2/k_2 + P_3/k_3 = .238$

$\therefore P_1 = P_2 = P_3$

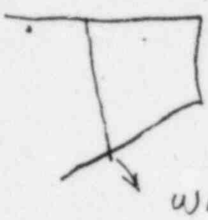
$$\frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} = \frac{.238}{P}$$

FINAL $.238 \left(1 / \left({}^1/k_1 + {}^1/k_2 + {}^1/k_3 \right) \right) = P$ ¢ $\therefore \left(\frac{\text{INITIAL LOAD}}{k_3} = .238 \right)$

OR AS I HAVE USED THE RATIO OF k FACTORS TIMES THE FULLY CONSTRAINED LOAD EQUALS THE FINAL LOAD IN THE BEAM AND AT THE REACTING POINTS.

NOTE: THIS PROCEEDURE HOLD TRUE ALSO FOR THE MATERIAL COVERED IN APPLICANTS EXIBIT 142 'D'

THE LATERAL BM



SINCE k IS AT AN ANGLE TO THE LOAD. A COMPONENT AFFECTS BM SIGNIF. LOAD IN BM ∴ IS HIGHER THAN CALCULATED.

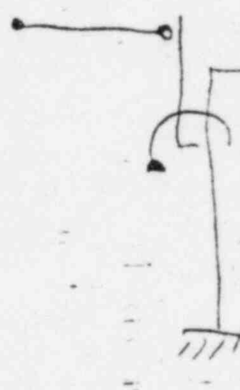
WALL ∠ IN THIS DIRECTION

∴ THERE IS A MINOR KICK ACROSS THE MINOR AXIS OF THE LAT. BM.

ALL IN ALL USING THERE FORCES & MOM. WITH REDUCED FY THE WALL AND THE BEAM FAIL

AS TO CC-1-107 008-E23R

IF THEY ADD THE EFFECTS OF TORSION ON THE 4WF AND THE 8" COL + THE MOMENT (PATHMON) OF THE COL - THE SUPPORT FAILS USING THE MOST SOPHISTICATED AND NON CONSERVATIVE MEANS WITH LOADS 75% OF THOSE USED IN THE ORIGINAL CALC.S



+ PLATFORM COL HAS ENOUGH MOM & TORSION + MINOR AXIS BENDING TO MAKE THIS SUPPORT STILL FAIL WITH ONLY 150# LOAD

& NO SEISMIC EFFECTS OF SUPPORT

UPPER LATERAL RESTRAINT

(1) GIBBS & HILL USED THE MONOLITHIC DIMS OF THE CONCRETE TO DETERMINE THE 'I' FOR THE CONCRETE SECTIONS. FOR EXAMPLE USING A.C.I PROVISIONS OF SECTION 909C THE MOMENT OF INERTIA FOR REINFORCED CONCRETE IS AS FOLLOWS FOR A BALANCED STEEL BEAM

WHERE k FOR f'_c 3750 EQUALS .3658
THE NUTRAL AXIS IS AT kd FROM THE TOP WITH ABOUT 2" OF COVER CONC. AND OBSERVING THE d SHOWN ON PG 32 OF GIBBS AND HILL $d \doteq 38.75$
USE $d = 38.75$ $\quad kd \therefore = .3658(38.75) = 14.175$

$I \therefore = (bd)$ FOR COMP. CON. AREA $(y^2) + A_s(y^2)$
$= 96(14.175)\left(\frac{14.175}{3}\right)^2 + .625$ (FROM PG 41 G&H) $(y)^2(n)$ $\quad n = 27.65/3.6 = 7.68$

$= 308\,208$ FOR A BALANCED REINFORCED CONC BM
BY THE MONOLITHIC METHOD $I = bd^3/12 = 96(42)^3/12 = 592,704$

WHICH IS WHY THE CODE REQUIRES THE CRACKED CONC. METHOD OF DETERMINING THE MOMENT OF INERTIA FOR HIGH STRESS & Δ CRITICAL AREAS. (REGARDLESS OF STEEL/CONC RATIO G&H ARE AT LEAST 15% TOO HIGH ON THE MOMENT OF INERTIA)
AS YOU SEE THE METHOD USED HAS A SIGNIFICANT IMPACT ON THE MOMENT OF INERTIA. BUT ACTUAL EFFECT ON K FACTOR NOT THAT SIGNIF.

ADDITIONAL FACTS

(2) GIBBS & HILL TREATS THE 280° L.O.C.A TEMP. AS IF IT WERE AN ESTABLISHED FACT.

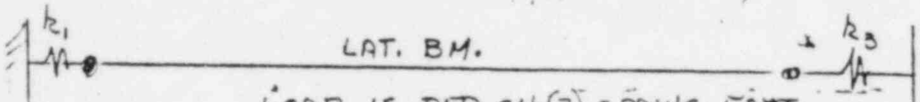
THE FACT IS THAT THE L.O.C.A. TEMP. PRESSURE PROFILES WERE DEVELOPED TO PRODUCE MAX. PRESSURE TO DESIGN CONTAINMENT. THE ACTUAL L.O.C.A. TEMP COULD BE SIGNIFICANTLY HIGHER THAN 280°. ∴ APPROCHING 1 (I.E. .945) FOR INTERACTION IS COURTING DISASTER.

(3) ON PAGE 40 GIBBS AND HILL FORGOT TO REDUCE THE Fy BECAUSE OF 300° TEMP.

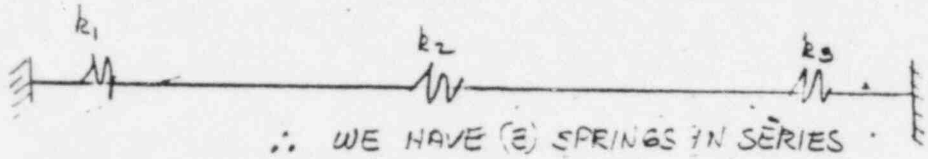
NO MATTER WHAT ELSE THE BEAM WILL EXPAND .238 OR RELIEF PLUS BM Δ = .238

WHEN THE SUM OF THE Δ FOR WALLS = .238 LOAD IN LAT BM = 0 Δ = 238
WHEN THE SUM OF THE Δ FOR WALLS = 0 LOAD IN BM = 14402 Δ = 0

THIS IS A STORED ENERGY PROB.



LOAD IS DEP. ON (3) SPRING FACT.



$\therefore$ WE HAVE (3) SPRINGS IN SERIES

THE RESULTANT SPRING FACTOR = $1/\Sigma\, 1/k_1 \ldots 1/k_n$ (BM k = 14402/.238)

$$k_R = 1 \Big/ \tfrac{1}{60513} + \tfrac{1}{40433} + \tfrac{1}{7726} = 5859$$

RELATIVE STIFF OF BM $\therefore$ IS 5859

LOAD IN BM AND ON WALLS IS NOW REDUCED TO
(5859/60513) 14402 = 1394

- CHECK -

Δ FOR WALL A = 1394 (1/7726) = .1805
Δ FOR WALL B = 1394 (1/40433) = .0345
TOTAL Δ = .215

THE UNRESTRAIND Δ = .238

$\therefore$ Δ STILL IN BEAM = .238 − .215 = .023

LOAD IN BM = (.023/.238) 14402 = 1392 (CHECKS WITHIN .14%)

CHECK GIBBS & HILL CALC.

MAX LOAD ON WALLS = 654^K CASE 1

Δ IN WALL A = 654 (1/7726) = .0846
Δ IN WALL B 654 (1/40433) = .0162

TOTAL Δ FROM WALLS (RELIEF) = .100
Δ IN BEAM = .138 AND LOAD = .138/.238 (14402) = 8351

SINCE 8351 $\neq$ 654 WE HAVE YOUR BASIC SCREW UP.

JT 1 $K_{FY} = 162 \times 4 + \left[E \sqrt{A} \quad \frac{1}{m(1-\nu^2)} \right]$

WHERE $E = 57000\sqrt{f'c}$ A = PLATE (3" X 20)
m = CONSTANT BASED ON ASPECT RATIO (20/3) ≃ 7
SAY 5 ∴ m = .82
ν FOR CONCRETE = .15
∴ $[E\sqrt{A} \ (1/.82(.9775))] = 1.2476\,(3{,}600{,}000\ \sqrt{60})$
= 40180 K/IN AND THE TOTAL SPRING RATE KFY
FOR JT 1 = 34790 + (162 X 4) = 35433 K/IN (Δ = 219 X AS STIFF)

JT 4 $K_{FX} = 168(4)$ 672 + [SP RATE FOR SHEAR LUG] (168 K/IN NOT 83 K/IN SEE SHT 174)

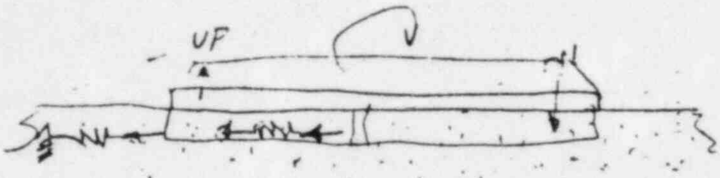
= 672 + $[3{,}600{,}000\ \sqrt{87}]\ 1/m\,(1-\nu^2)$
m = ((29/3) ≃ 10) ∴ m = .71 AND 1/.71 (.9775) = 1.4409

∴ SPRING RATE = 672 + $[3\,600\,000\sqrt{87}]$ 1.4409
= 49050 K/IN (Δ = 591 TIMES AS STIFF)

JT 5 ? NOT SHOWN (ADDED SINCE DEPOSITION REVEALED THAT A PROBLEM EXISTED SEE EX 6698 ITEM 9Q) BUT FROM THE SPRING RATE GIVEN IN GIBBS AND HILL CALC IT IS ABOUT THE SAME AS JT 1

THE STIFFNESS OF CONCRETE FOR FINITE AREA DISTRIBUTING A LOAD TO A SEMI INFINITE BODY IS By'S TIMOSHENKO THEORY OF ELASTIC STABILITY, 2ND EDITION 1951 EQUATION 212 AND IS THE PRINCIPLE BY WHICH FINITE (STARDYNE) ANALYSIS OF BASE PLATES IS POSSIBLE.

KQ THE PROCEEDURE USED BY GIBBS & HILL WOULD HAVE BEEN OK IF THIS WERE A FLAT AVG. BASE PLATE. HOWEVER THERE ARE SHEAR LUGS.



THE SPRING RATE FOR THE SHEAR LUGS WAS SHOWN ON THE PREVIOUS SHEET. HOWEVER THE POINT IS WITHOUT MERIT SINCE THE MORE CRITICAL SPRING FACTOR Ky WAS SHOWN TO BE IN ERROR BY A FACTOR OF OVER 250 TIMES

ADDRESSING APPENDIX 'D' OF APPLICANTS EXHIBIT 142

CASE '1' A TS 6X6X3/8 TUBE ATTACHED TO BASE PLATES WITH 4 HILTIES 3/4" DIA

① THE SPRING FACTOR FOR 3/4" DIA KWIK BOLTS MAY BE DETERMINED FROM THE MATERIAL SUPPLIED BY THE APPLICANT (THE LOAD SLIP CURVES) SPECIFIC. THE CURVE ON WHICH A 16^K LOAD PRODUCES ABOUT .09 DISPLACEMENT. - ALTHOUGH THESE FIGURES ARE USED THEY ARE NOT CONSERVATIVE, THE SPRING FACTORS USED IN FINITE ANALYSIS OF BASE PLATES ARE A BETTER BASIS BUT ARE NOT USED TO EXPIDITE THE MATER.

② k FOR A 3/4" BOLT ∴ EQUALS $16/.09 = 178$ K/IN

SINCE THERE ARE 4 BOLTS IN PARALELL THE k FACTOR PER JOINT EQUALS 712 KIPS PER INCH.

THE EFFECTIVE k FOR THE SYSTEM IN SERIES EQUALS $1/(1/712)2 + 1/k$ FOR BM WHERE $k_{BM} = AE/L = 7.95(27650)/72 = 3053$

③ EQUIV $k = 1/(1/712)2 + 1/3053 = 319$ K/IN

THE LOAD IN THE BM EQUALS

$319/3053\,(320) = 33.4^K$

LOAD PER BOLT (UNI DIRECTIONAL FORCE) = $33.4/4 = 8.35^K$

TENSION ON BOLT = 33.4(3" ecc)/S OF PAT. NORMAL PAT.

= 7.5cc ∴ $S = 3.5^2(4)/3.5 = 15$, $T = 100/15 = 6.7^K$

THIS DOES NOT INCLUDE

THE NORMAL OPER. LDS

OR MULTI DIRECTIONAL LOADING.

THE FORCE IN THE BM VARIES LITTLE WITH VARYING LENGTH OF BM.

— RICHHONDS —

CASE '2'

I DONT HAVE MY STEEL BOOK HANDY BUT ASSUME A TS 6X6X1/2 HAS AN AREA OF 10.5 SQ IN. 6'-0" LONG.

$P = 10.5(220)(6.632 \times 10^{-6})(27650) = 423^{K}$

$\Delta = 6(12)(6.632 \times 10^{-6})(220) = .1049''$

$k = 423/.1049 = 4032\ ^{K}/_{IN}$

1 1/2 IN RICHMONDS $k = 162\ ^{K}/_{IN}$ (G&H P 173 OF MR SUPPORT CALC)

$k_R = 1/\left(\frac{1}{4032} + \frac{1}{162} + \frac{1}{162}\right) = 79.4\ ^{K}/_{IN}$

$\therefore\ 423(79.4/4032) = 8.33\ ^{K}$ IN EH ₵ BOLTS

MOMENT IN BOLT = $(8.33^2 + 8.33^2)^{1/2}$ LOAD FROM THERMAL EXPANSION CAN COME FROM (2) DIRECTIONS @90° SIMULTANIOUS.

$\therefore M = 11.78(1''_{MIN}) = 11.78\ IN^{K}$

σ IN BOLT = 11.78/.33 = 35.7 KSI

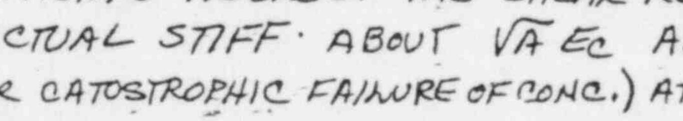
FROM L.O.C.A ONLY THIS IS (1/1.1) = 59% OF THE PLASTIC CAPACITY OF A-36 (I DONT KNOW THE COMPOSITION OF HILTIS)

THERE ARE NO TESTS FOR 1 1/2" RICHMONDS SO I DONT KNOW WHAT ALLOWABLES ARE APPROPRIATE BUT THEN NO ONE ELSE DOES. BUT I AM SURE WITH ALL THE COMBINED LOADS 35.7 KSI IS TOO MUCH MOMENT BY FAR.

CASE '3'

NELSON STUDS IN EMBEDED PLATES:

THE STIFFNESS FACTORS NEGLECT THE SHEAR RESISTANCE OF THE CONC. ACTUAL STIFF. ABOUT $\sqrt{A}\,E_c$ ASSUME 10" L_c $k \approx 11.5\ ^{K}/_{IN}$ (OR CATOSTROPHIC FAILURE OF CONC.) AT LEAST TO FAILURE.



UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

'83 MAY -2 A10:36

In the Matter of

APPLICATION OF TEXAS UTILITIES GENERATING COMPANY, ET AL. FOR AN OPERATING LICENSE FOR COMANCHE PEAK STEAM ELECTRIC STATION UNITS #1 AND #2 (CPSES)

Docket Nos. 50-445 and 50-446

CERTIFICATE OF SERVICE

By my signature below, I hereby certify that true and correct copies of CASE's Motion for Discovery Regarding "CAT Report"; CASE's Fourteenth Set of Interrogatories and Requests to Produce to Applicants; and CASE's Fourth Set of Interrogatories and Requests to Produce to NRC Staff.

have been sent to the names listed below this 28th day of April, 1983, by: Express Mail where indicated by * and First-Class Mail elsewhere.

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