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       50-401 Shearon Harris Nuclear Power Plant, Unit 2, Carolina      05000401  
 AUTH. NAME                      AUTHOR AFFILIATION  
 MCDUFFIE, M.A.                  Carolina Power & Light Co.  
 RECIP. NAME                      RECIPIENT AFFILIATION  
 DENTON, H.R.                      Office of Nuclear Reactor Regulation, Director

SUBJECT: Forwards response to draft SER Open Item 335 from Structural Engineering Branch. Response supersedes 831027 response, Factor of safety against overturning clarified, Supporting documentation from Ebasco encl.

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REPORT ON THE PROGRESS OF THE PROJECT

The following report details the work completed during the period from June 1, 1964, to August 31, 1964. It includes a summary of the objectives, a description of the methods used, the results obtained, and a discussion of the findings.

The primary objective of this project was to determine the effect of various factors on the rate of reaction between X and Y. This was achieved by conducting a series of experiments under different conditions.

The methods employed included the use of a spectrophotometer to measure the absorbance of the reaction products over time. The reaction was initiated by the addition of X to a solution of Y, and the absorbance was recorded at regular intervals.

The results of the experiments show that the rate of reaction is directly proportional to the concentration of X. This relationship is described by the equation: Rate = k[X], where k is a constant. The value of k was determined to be 0.025 min<sup>-1</sup> M<sup>-1</sup>.

The discussion of the findings indicates that the reaction is first-order with respect to X. This is consistent with the proposed mechanism, which involves a single-step reaction between X and Y.

Run	[X] (M)	[Y] (M)	Rate (M min <sup>-1</sup> )	Calculated Rate (M min <sup>-1</sup> )
1	0.010	0.010	0.00025	0.00025
2	0.020	0.010	0.00050	0.00050
3	0.030	0.010	0.00075	0.00075
4	0.040	0.010	0.00100	0.00100
5	0.050	0.010	0.00125	0.00125
6	0.010	0.020	0.00025	0.00025
7	0.010	0.030	0.00025	0.00025
8	0.010	0.040	0.00025	0.00025
9	0.010	0.050	0.00025	0.00025
10	0.010	0.010	0.00025	0.00025
11	0.010	0.020	0.00025	0.00025
12	0.010	0.030	0.00025	0.00025
13	0.010	0.040	0.00025	0.00025
14	0.010	0.050	0.00025	0.00025
15	0.020	0.020	0.00050	0.00050
16	0.030	0.030	0.00075	0.00075
17	0.040	0.040	0.00100	0.00100
18	0.050	0.050	0.00125	0.00125



SERIAL: LAP-83-524

Carolina Power & Light Company

NOV 08 1983

Mr. Harold R. Denton, Director  
Office of Nuclear Reactor Regulation  
United States Nuclear Regulatory Commission  
Washington, DC 20555

SHEARON HARRIS NUCLEAR POWER PLANT  
UNIT NOS. 1 AND 2  
DOCKET NOS. 50-400 AND 50-401  
DRAFT SAFETY EVALUATION REPORT RESPONSES  
STRUCTURAL ENGINEERING BRANCH

Dear Mr. Denton:

In response to the Draft Safety Evaluation Report (DSER) Open Item No. 335 from the Structural Engineering Branch, Carolina Power & Light Company hereby submits additional information as requested by the reviewer. The attached response supersedes our previous response dated October 27, 1983.

We will be providing responses to other requests for additional information shortly.

Yours very truly,

M. A. McDuffie  
Senior Vice President  
Nuclear Generation

JHE/mf (8448COM)  
Attachment

- |                                 |                            |
|---------------------------------|----------------------------|
| cc: Mr. B. C. Buckley (NRC)     | Mr. Wells Eddleman         |
| Mr. S. B. Kim (NRC-SEB)         | Dr. Phyllis Lotchin        |
| Mr. G. F. Maxwell (NRC-SHNPP)   | Mr. John D. Runkle         |
| Mr. J. P. O'Reilly (NRC-RII)    | Dr. Richard D. Wilson      |
| Mr. Travis Payne (KUDZU)        | Mr. G. O. Bright (ASLB)    |
| Mr. Daniel F. Read (CHANGE/ELP) | Dr. J. H. Carpenter (ASLB) |
| Mr. R. P. Gruber (NCUC)         | Mr. J. L. Kelley (ASLB)    |
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Shearon Harris Nuclear Power Plant  
Open Item 335  
Second Supplementary Response

Provide additional clarification on factor of safety against overturning and document the overturning calculations.

Response:

The factor of safety against overturning was computed by dividing the resisting moments by the overturning moments, as stated in FSAR Section 3.8.5.5.

The overturning moment for Shearon Harris was calculated by the square root of the sum of the squares of the horizontal acceleration only in both the E-W and N-S directions. The vertical seismic overturning moment was added directly, as 0.4 times the actual moment.

$$M = \sqrt{M^2_{EW} + M^2_{NS}} + 0.4M_v \quad (1)$$

A study was also conducted for Shearon Harris to compute the overturning moment by the SRSS method by taking the square root of the sum of the square of the overturning moments due to the horizontal acceleration in both the E-W and N-S directions, plus the overturning moments due to the vertical seismic uplift forces.

$$M = \sqrt{M^2_{EW} \text{ or } M^2_{NS} + M^2_v} \quad (2)$$

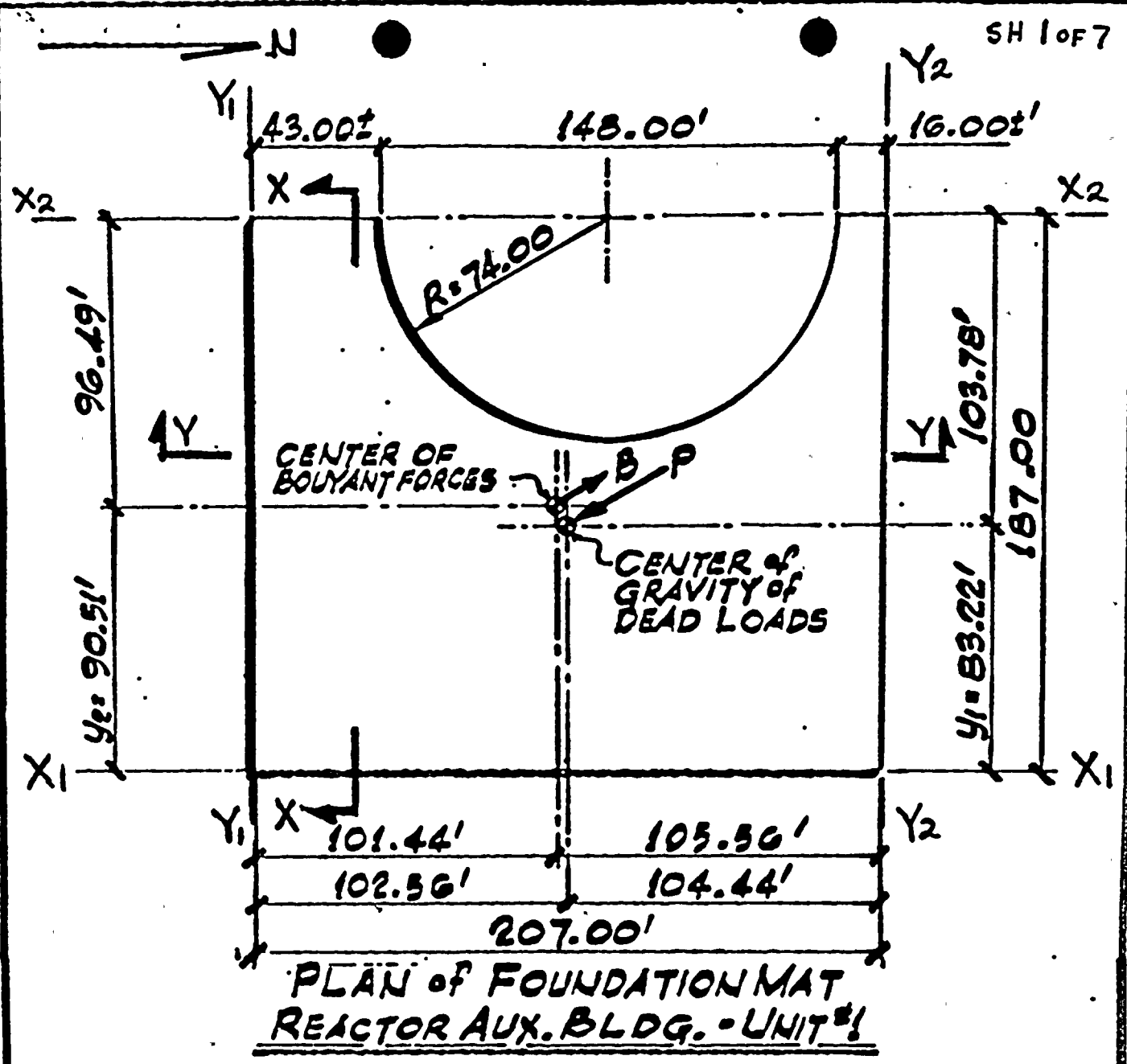
The resisting moment is the vertical load of the building and mat (reduced by buoyancy) multiplied by the distance to the edge of the building.

The factor of safety against overturning computed by both the methods described above resulted in higher factor of safety than the minimum required by the FSAR.

The factor of safety for the RAB Unit #1 calculated in accordance with Method 1 above is 1.25 and for Method 2 is 1.33. Both are higher than the acceptable limit of 1.10.



4 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100



**SIMULTANEOUS EFFECT OF EARTHQUAKE  
(OVERTURNING ABOUT EDGE "X<sub>1</sub>-X<sub>1</sub>")**

**OVERTURNING MOMENTS:**

$$SRSS M_o = \sqrt{M_e - W^2 + M_{VERT}^2}$$

**RESISTING MOMENTS:**

$$M_R = P \cdot y_1 - B \cdot y_2$$

**FACTOR OF SAFETY AGAINST OVERTURNING:**

$$FS = M_e \div M_o$$

SM

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BY D. PATEL DATE 11-2-83

SHEET 2 OF 7

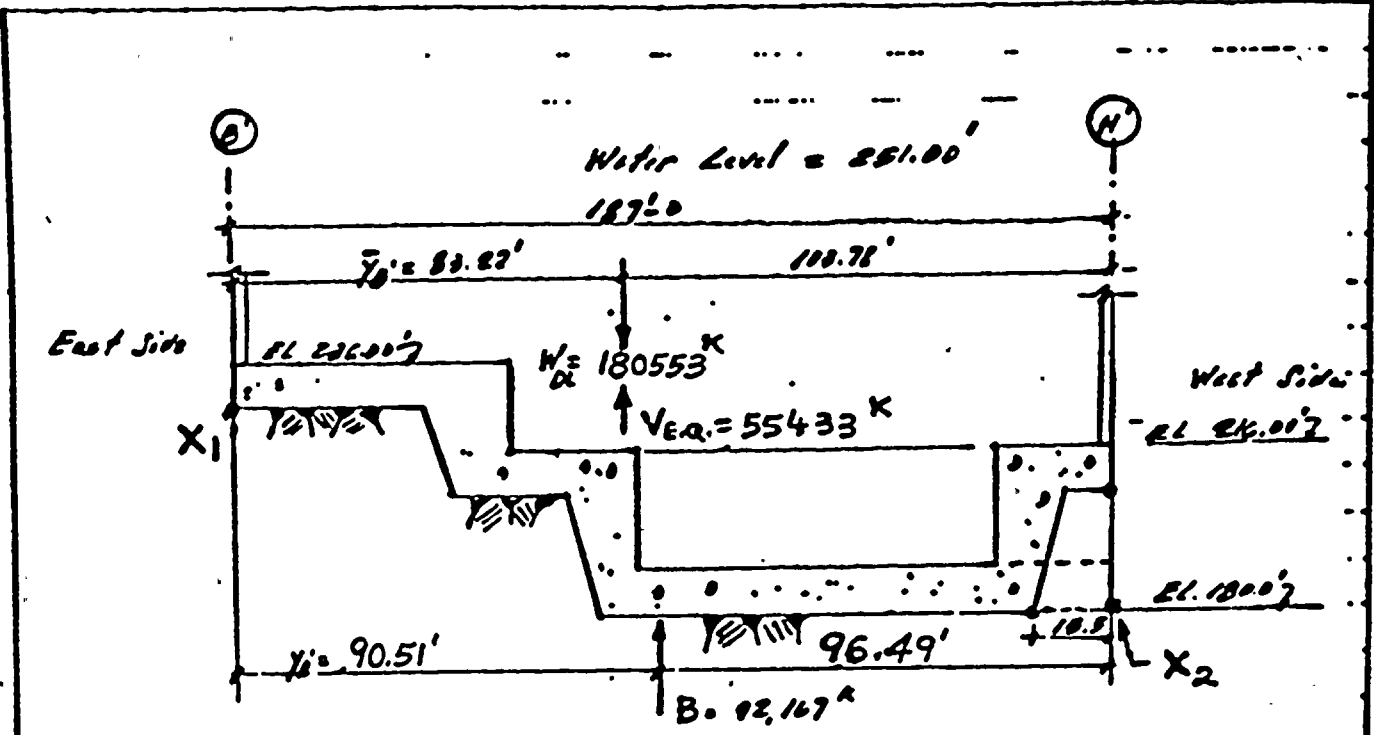
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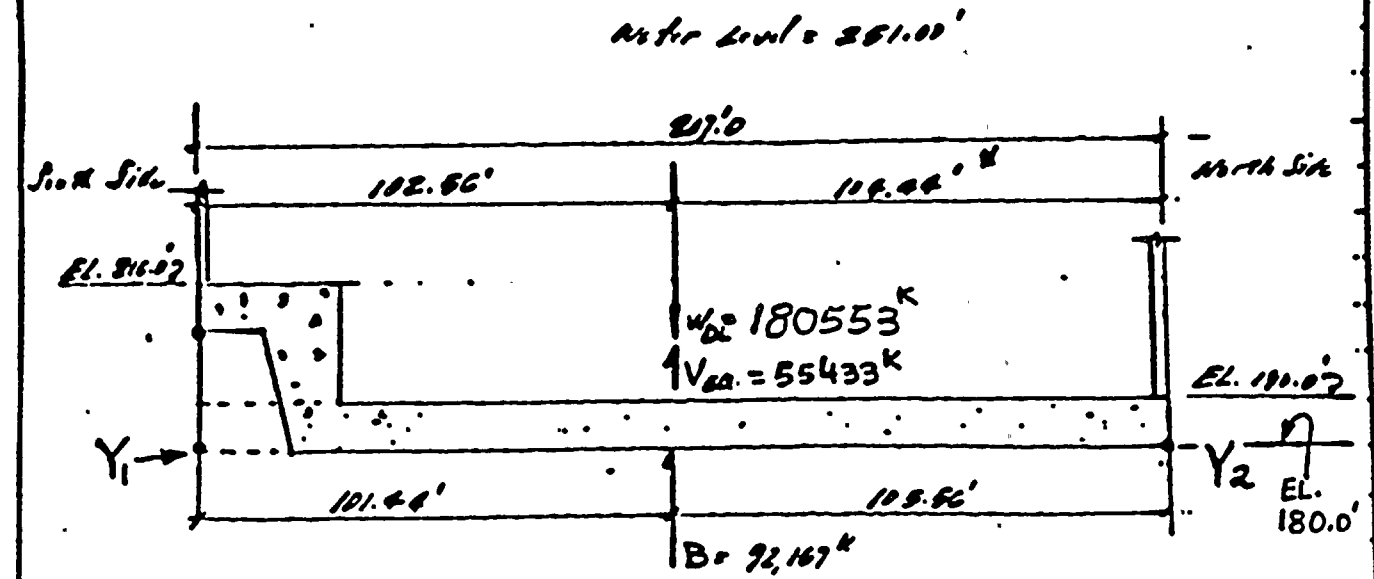
CLIENT CAROLINA POWER & LIGHT COMPANY  
SHEARON HARRIS NUCLEAR POWER PLANT

PROJECT 1984 86 900,000 KW UNITS 1, 2

SUBJECT RAB UNIT #1 - STABILITY AGAINST OVERTURNING



SECTION X-X



SECTION Y-Y



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SHEET 3 OF 7

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CLIENT CAROLINA POWER & LIGHT COMPANY

SHELDON HARRIS NUCLEAR POWER PLANT

PROJECT 1984 86 900,000 KW UNITS 1, 2

SUBJECT RAB - UNIT #1 - STABILITY AGAINST OVERTURNING

1. OVERTURNING ABOUT WEST FACE OF BLDG. WITH VERTICAL EARTHQUAKE (UPWARD) AND E-W EARTHQUAKE (EAST TO WEST) (ABOUT LINE 'X2')

OVERTURNING MOMENT:

OVERTURNING MOMENT DUE TO E-W EARTHQUAKE: ...

$$M_{EWEQ} = 2,762,046 \text{ k}' \quad (\text{AT EL. } 180.00', \text{ ABOUT LINE } X_2)$$

VERTICAL EARTHQUAKE FORCE:  $X_2$  - SEE SECT. X-X, SH2)

$$V_{VEQ} = 55,433 \text{ k}$$

OVERTURNING MOMENT DUE TO VERT. EARTHQUAKE:

$$M_{VVEQ} = 55,433 \times 103.78 = 5,752,837 \text{ k}'$$

TOTAL OVERTURNING MOMENT: (USING SRSS)

$$M_O = \sqrt{(5,752,837)^2 + (2,762,046)^2} = 6,381,538 \text{ k}'$$

RESISTING MOMENT:

RESISTING MOMENT DUE TO DEAD LOAD OF BLDG:

$$W_{DL} = 180,553 \text{ k}$$

$$M_{DL} = 180,553 \times 103.78 = 18,737,790 \text{ k}'$$

REDUCTION IN RESISTING MOMENT DUE TO BUOYANCY:

(GROUND WATER TABLE AT EL. 251.00')

$$B = 92,167 \text{ k}$$

$$M_B = 92,167 \times 96.49 = 8,893,194 \text{ k}'$$

NET RESISTING MOMENT:

$$M_R = 18,737,790 - 8,893,194 = 9,844,596 \text{ k}'$$

FACTOR OF SAFETY AGAINST OVERTURNING:

$$F.S. = \frac{9,844,596}{6,381,538} = \underline{\underline{1.54}} > 1.10$$

OK

REF: RAB DYNAMIC ANALYSIS BOOK #118  
RAB STABILITY ANALYSIS BOOK #124 VOL 2.

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BY A. BAIG DATE 11-2-83

SHEET 4 OF 7

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CLIENT CAROLINA POWER & LIGHT COMPANY

SHEARON HARRIS NUCLEAR POWER PLANT

PROJECT 1984 86 900,000 KW UNITS 1, 2

SUBJECT RAB UNIT #1 - STABILITY AGAINST OVERTURNING

2. OVERTURNING ABOUT EAST FACE OF BLDG. WITH VERTICAL EARTHQUAKE (UPWARD) AND E-W EARTHQUAKE (WEST TO EAST) (ABOUT LINE 'X<sub>1</sub>)

OVERTURNING MOMENT:

OVERTURNING MOMENT DUE TO E-W EARTHQUAKE: (FROM SH 5)

$$M_{EWEQ} = 1,971,856 \text{ K}' \quad (\text{AT EL. } 226.00', \text{ ABOUT LINE } X_1)$$

VERTICAL EARTHQUAKE FORCE: SEE SECT. 'X-X', SH 2)

$$V_{EQ} = 55,433 \text{ K}$$

OVERTURNING MOMENT DUE TO VERTICAL EARTHQUAKE:

$$M_{VEQ} = 55,433 \times 83.22 = 4,613,134 \text{ K}'$$

TOTAL OVERTURNING MOMENT:

$$M_O = \sqrt{(4,613,134)^2 + (1,971,856)^2} = 5,016,894 \text{ K}'$$

RESISTING MOMENT:

RESISTING MOMENT DUE TO DEAD LOAD OF BLDG:

$$W_{DL} = 180,553 \text{ K}$$

$$M_{DL} = 180,553 \times 83.22 = 15,025,621 \text{ K}'$$

REDUCTION IN RESISTING MOMENT DUE TO BUOYANCY:

(GROUND WATER TABLE AT EL. 251.00')

$$B = 92,167 \text{ K}$$

$$M_B = 92,167 \times 90.51 = 8,342,035 \text{ K}'$$

NET RESISTING MOMENT:

$$M_R = 15,025,621 - 8,342,035 = 6,683,586 \text{ K}'$$

FACTOR OF SAFETY AGAINST OVERTURNING:

$$F.S. = \frac{6,683,586}{5,016,894} = \underline{\underline{1.33}} > 1.10$$

OK

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BY D. PATIL DATE 11-2-83

SHEET 5 OF 7

CHKD. BY A. BAIG DATE 11-2-83

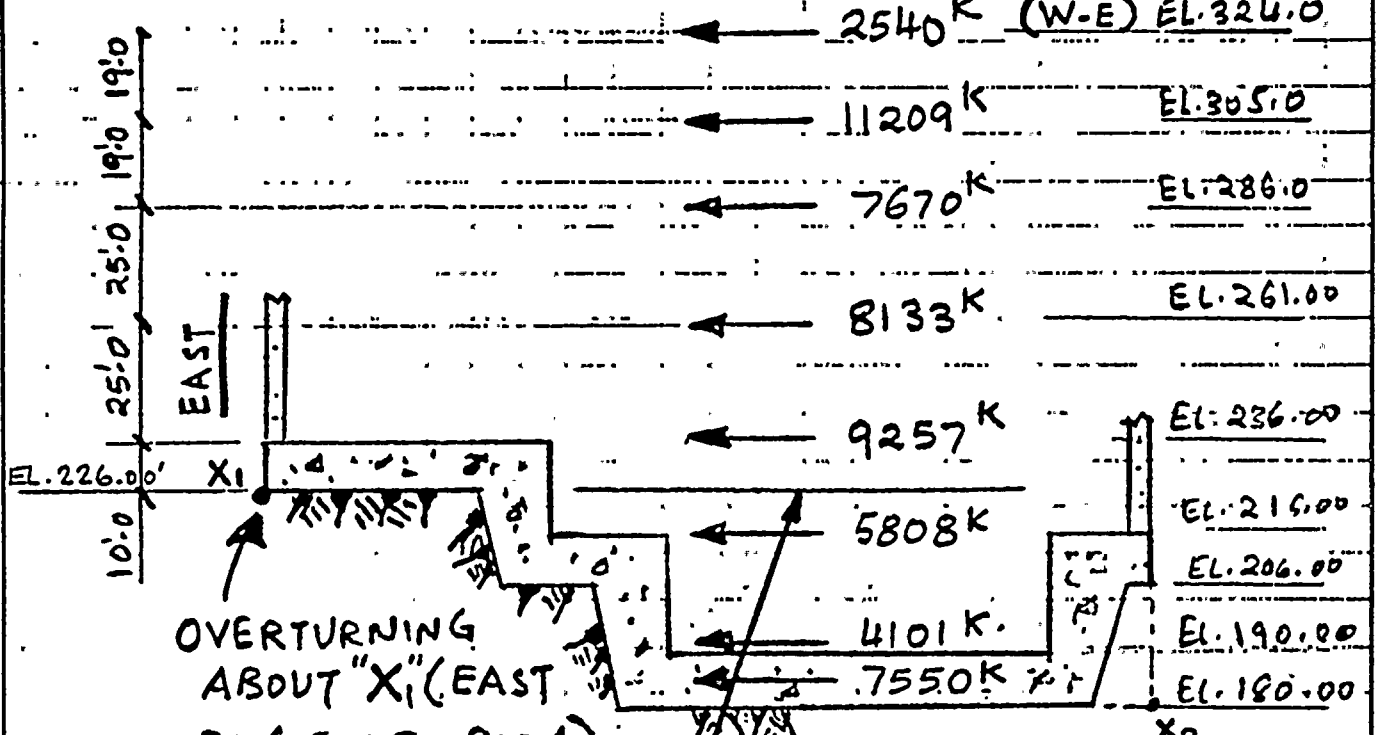
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CLIENT CAROLINA POWER & LIGHT COMPANY  
SHEARON HARRIS NUCLEAR POWER PLANT

PROJECT 1984 88 900,000 KW UNITS 1, 2

SUBJECT RAB UNIT #1 - STABILITY AGAINST OVERTURNING

REF: DYNAMIC ANALYSIS. BOOK A.118 P.37  
 FOR HORIZ. FORCES DUE TO EARTHQUAKE



OVERTURNING ABOUT "X<sub>1</sub>" (EAST EDGE OF BLDG)  
OVERTURNING MOMENT AT 'X<sub>1</sub>' (EL.226.00)

HORIZONTAL FORCES BELOW EL.226.00 ARE CONSERVATIVELY NOT CONSIDERED FOR OVERTURNING ABOUT X<sub>1</sub>.

$$\begin{aligned}
 M_{EWER} &= 2540 \times 98 + 11209 \times 79 + 7670 \times 60 \\
 &\quad + 8133 \times 35 + 9257 \times 10 \\
 &= 248,920 + 885,511 + 460,200 \\
 &\quad + 284,655 + 92,570
 \end{aligned}$$

$M_{EWER} = \underline{\underline{1,971,856 \text{ KF}}}$

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BY A. BAIG DATE 11-2-83

SHEET 6 OF

CHKD. BY D. PAER DATE 11-2-83 CAROLINA POWER & LIGHT COMPANY OFS NO. 6418

CLIENT SHEPSON HARRIS NUCLEAR POWER PLANT

PROJECT 1984 86 900,000 KW UNITS 1, 2

SUBJECT RAB - UNIT #1 - STABILITY AGAINST OVERTURNING

2. OVERTURNING ABOUT NORTH FACE OF BLDG. WITH VERTICAL EARTHQUAKE (UPWARD) AND N-S EARTHQUAKE (SOUTH TO NORTH) (ABOUT LINE 'Y<sub>2</sub>')

OVERTURNING MOMENT:

OVERTURNING MOMENT DUE TO N-S EARTHQUAKE:

$$M_{NSEQ} = 3,106,305 \text{ K}' \text{ (AT EL. 180.00' ABOUT LINE 'Y}_2\text{')}$$

VERTICAL EARTHQUAKE FORCE:  $Y_2$  - SEE SECT Y-Y, SH2)

$$V_{EQ} = 55,433 \text{ K}$$

OVERTURNING MOMENT DUE TO VERT. EARTHQUAKE:

$$M_{VER} = 55,433 \times 104.44 = 5,789,423 \text{ K}'$$

TOTAL OVERTURNING MOMENT: (USING SRSS)

$$M_0 = \sqrt{(5,789,423)^2 + (3,106,305)^2} = 6,570,126 \text{ K}'$$

RESISTING MOMENT:

RESISTING MOMENT DUE TO DEAD LOAD OF BLDG:

$$W_{DL} = 180,553 \text{ K}$$

$$M_{DL} = 180,553 \times 104.44 = 18,856,955 \text{ K}'$$

REDUCTION IN RESISTING MOMENT DUE TO BUOYANCY:

(GROUND WATER TABLE AT EL. 251.00')

$$B = 92,167 \text{ K}$$

$$M_B = 92,167 \times 105.56 = 9,729,149 \text{ K}'$$

NET RESISTING MOMENT:

$$M_R = 18,856,955 - 9,729,149 = 9,127,806 \text{ K}'$$

FACTOR OF SAFETY AGAINST OVERTURNING:

$$F.S. = \frac{9,127,806}{6,570,126} = \underline{\underline{1.39}} > 1.10$$

OK

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BY A BAIG DATE 11-2-83

SHEET 7 OF 7

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CLIENT CAROLINA POWER & LIGHT COMPANY

PROJECT 1994 SR 900,000 KW UNITS 1, 2

SUBJECT RAB UNIT #1 - STABILITY AGAINST OVERTURNING

3. OVERTURNING ABOUT SOUTH FACE OF BLDG WITH VERTICAL EARTHQUAKE (UPWARD) AND N-S EARTHQUAKE (NORTH TO SOUTH) (ABOUT LINE 'Y1')

OVERTURNING MOMENT:

OVERTURNING MOMENT DUE TO N-S EARTHQUAKE:

$$M_{NSEQ} = 3,106,305 \text{ k}' \quad (\text{AT EL. } 180.00', \text{ ABOUT LINE 'Y1'})$$

VERTICAL EARTHQUAKE FORCE:  $Y_1$  - SEE SECT Y-Y, SH 2)

$$V_{EQ} = 55,433 \text{ k}$$

OVERTURNING MOMENT DUE TO VERTICAL EARTHQUAKE:

$$M_{VER} = 55,433 \times 102.56 = 5,685,208 \text{ k}'$$

TOTAL OVERTURNING MOMENT: (USING SRSS)

$$M_0 = \sqrt{(5,685,208)^2 + (3,106,305)^2} = 6,478,482 \text{ k}'$$

RESISTING MOMENT:

RESISTING MOMENT DUE TO DEAD LOAD OF BLDG:

$$W_{DL} = 180,553 \text{ k}$$

$$M_{DL} = 180,553 \times 102.56 = 18,517,516 \text{ k}'$$

REDUCTION IN RESISTING MOMENT DUE TO BUOYANCY:

(GROUND WATER TABLE AT EL. 251.00')

$$B = 92,167 \text{ k}$$

$$M_B = 92,167 \times 101.44 = 9,349,420 \text{ k}'$$

NET RESISTING MOMENT:

$$M_R = 18,517,516 - 9,349,420 = 9,168,096 \text{ k}'$$

FACTOR OF SAFETY AGAINST OVERTURNING:

$$F.S. = \frac{9,168,096}{6,478,482} = 1.42 > 1.10$$

OK.

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