SMUD
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July 30, 1982

DIRECTOR OF NUCLEAR REACTOR REGULATION
ATTENTION JOHN F STOLZ CHIEF
OPERATING REACTORS BRANCH 4
U S NUCLEAR REGULATORY COMMISSION
WASHINGTON DC 20555

DOCKET 50-312
RANCHO SECO NUCLEAR GENERATING STATION
UNIT NO 1
MASONRY WALL DESIGN - IE BULLETIN 80-11

In a conference call on July 22, 1982, Mssrs. M. Padovan and N. Chokski of the NRC and Mr. Bucon of the Franklin Research Institute requested additional information to a submittal made by the Sacramento Municipal Utility District on June 8, 1982. Specifically, they requested justification by the District for using the Component Factor Method for the combination of three directional forces in our masonry wall analysis when the Standard Review Plan Section 3.7.2 requires that the SRSS method be used for combination of the three directional forces in this type of analysis. They also requested a sample calculation which showed the application of the Component Factor Method in Rancho Seco Unit No. One's masonry wall analysis.

Attachment 1 shows mathematically that the Component Factor Method is more conservative than the SRSS method and describes the application and the validity of the Component Factor Method. Attachment 2 is a sample calculation utilizing the Component Factor Method in the Rancho Seco Unit 1 masonry wall analysis.

If we can provide any additional information, please advise.

Wm. C. Walbridge

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General Manager

Attachments

A001

TOTAL STRUCTURAL RESPONSE FROM SEPARATE LATERAL AND VERTICAL ANALYSES

The total structural response is predicted by combining the applicable maximum codirectional responses, say, R_x, R_y and R_z, calculated from the two lateral and the vertical analyses. The combination usually is done according to the criterion of "the square root of the sum of the squares" as follows:

$$R_{total} = \sqrt{R_x^2 + R_y^2 + R_z^2} \tag{4-7}$$

However, the SRSS method has an inherent difficulty for certain engineering applications such as in basemat design where separation of the base from the soil is possible. Under these circumstances, the combination is done according to "the component factor method" as follows:

$$R_{total} = R_i + 0.4\,R_j + 0.4\,R_k \tag{4-7a}$$

where R_i, R_j, and R_k are the set of three codirectional response maxima due to the individual excitation in three directions. Under the condition that $R_i \geq R_j \geq R_k \geq 0$, the probable error involved in using Equation (4-7a) with respect to the SRSS method in Equation (4-7) is less than 1%. Appendix J provides the justification of this criterion.

In the actual application of Equation (4-7a), the condition that $R_i \geq R_j \geq R_k \geq 0$ cannot always be satisfied. Under these conditions, in order to ensure conservatism, all possible permutations of R_i, R_j, and R_k and both the positive and negative signs of each response should be considered. For all possible combinations, the application of Equation (4-7a) results in 24 possible combinations in principle. However, in specific applications, the number of combinations can usually be reduced to a smaller number through judicious choices of governing combinations.

VALIDITY OF THE COMPONENT FACTOR METHOD

This appendix presents a demonstration of the adequacy of the component factor method expressed by Eq. (4-7a). First, consider a combined response, R' defined as follows:

$$R' = R_i + 0.414R_j + 0.318R_k \qquad (J\text{-}1)$$

in which

$$R_i \geq R_j \geq R_k \geq 0 \qquad (J\text{-}2)$$

Let

$$R_j = \bar{R}_j + R_k \quad (\bar{R}_j = 0 \text{ if } R_j = R_k)$$

$$R_i = \bar{R}_i + R_j = \bar{R}_i + \bar{R}_j + R_k \quad (\bar{R}_i = 0 \text{ if } R_i = R_j) \qquad (J\text{-}3)$$

According to Eq. (4-7), the SRSS method gives:

$$R = \{(\bar{R}_i + \bar{R}_j + R_k)^2 + (\bar{R}_j + R_k)^2 + R_k^2\}^{1/2}$$

$$= \{3R_k^2 + 2\bar{R}_j^2 + \bar{R}_i^2 + 2\bar{R}_i(\bar{R}_j + R_k) + 4\bar{R}_jR_k\}^{1/2} \qquad (J\text{-}4)$$

According to Eq. (J-1),

$$R' = (\bar{R}_i + \bar{R}_j + R_k) + 0.414(\bar{R}_j + R_k) + 0.318R_k$$

$$R' = 1.732R_k + 1.414\bar{R}_j + \bar{R}_i = \{[1.732R_k + 1.414\bar{R}_j + \bar{R}_i]^2\}^{1/2}$$

$$R' = \{3R_k^2 + 2\bar{R}_j^2 + \bar{R}_i^2 + 2\bar{R}_i(1.414\bar{R}_j + 1.732R_k) + 4.9\bar{R}_jR_k\}^{1/2} \quad (J-5)$$

Comparing Eqs. (J-4) and (J-5), it is obvious that the combined response calculated according to Eq. (J-1) is always more conservative than the combined response by the SRSS method. In the special case that $R_i = R_j = R_k$, they become identical to each other, i.e., $R = R' = \sqrt{3}R_k$.

For convenience of engineering applications, Eq. (J-1) can be simplified by replacing the factors 0.414 and 0.318 by a common factor of 0.4. This reduces Eq. (J-1) to Eq. (4-7a). By inspection, the maximum probable error of Eq. (4-7a) with respect to the SRSS method is less than 1%. This maximum error occurs when $R_k = 0$ and $R_i = R_j$. In this special case, the SRSS method gives $R = 1.41R_i$ and Eq. (4-7a) gives $R = 1.4R_i$.

ATTACHMENT (2)

CALCULATION SHEET

CALC. NO C515-1

SIGNATURE Greenwalt DATE 12/11/78 CHECKED [illegible] DATE 1/23/79

PROJECT SMUD JOB NO 12334-515

SUBJECT TRANSFORMER ENCLOSURE SHEET 6 OF 52 SHEETS

DESIGN CRITERIA (CONT)

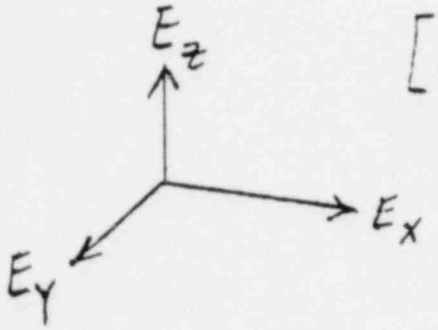
SHEAR WALL DESIGN FOR CAT I MASONRY WALLS

19.

D.C.

THE MODIFIED SRSS METHOD WILL BE USED WHEREBY THE 3-COMPONENT EARTHQUAKE WILL BE DONE IN 3 LOAD COMBINATIONS.

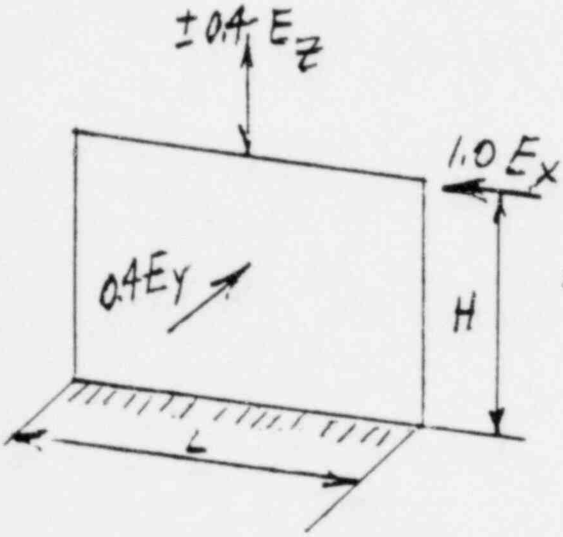
CE = EARTHQUAKE FORCE

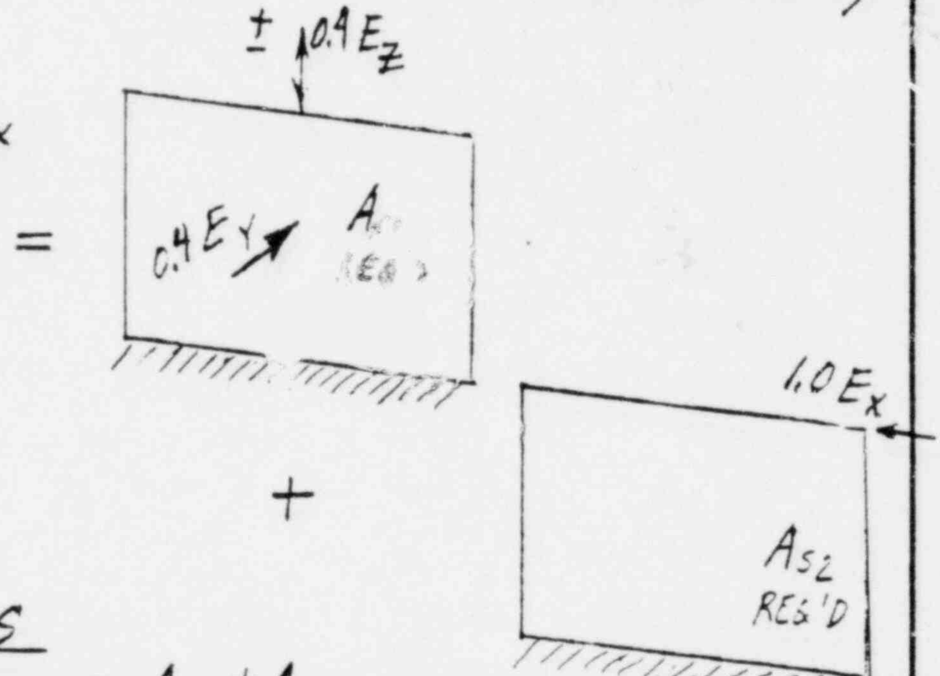


$$[A \; B \; C] = [E_X \; E_Y \; E_Z] \begin{bmatrix} 1.0 & 0.4 & 0.4 \\ 0.4 & 1.0 & 0.4 \\ 0.4 & 0.4 & 1.0 \end{bmatrix}$$

LOAD COMBINATIONS

(NOTE 1.0 AND 0.4 ARE CONSTANTS)





SHEAR WALL SHOWN W/ COMBO A FORCES

$\therefore A_{s\,TOTAL} = A_{s1} + A_{s2}$

CALCULATION SHEET

CALC. NO C515-1

SIGNATURE Greenawalt DATE 10/13/78 CHECKED [initials] DATE 1/23/79

PROJECT SMUD JOB NO 12334-515

SUBJECT TRANSFORMER ENCLOSURE SHEET 29 OF 52 SHEETS

WALLS (CONT)

SOUTH WALL

USE SAME PERIOD AS FOR NORTH WALL.

USE EQ.(4), COMBO A SINCE GOVERNS FOR BENDING ($S = D + L_o + E'$)

$\therefore E'_X$ ACCEL. $= .60g$, $E'_X = .60(140) = 84$ PSF

E'_Y " $= .32g$, $E'_Y = .32(140) = 45$ PSF

E'_Z " $= .20g$, $E'_Z = .20(28)(1.8) = 10$ LB/FT

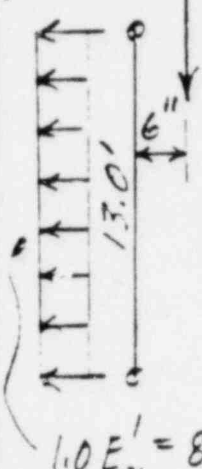
$D \pm 0.4E'_Z = 50 \pm 0.4(10)$ ← 4

$= 54$ LB

46 LB

$D = 28(1.8) = 50$ LB/FT GRATING

↑ TRIB. LENGTH



$1.0E'_X = 84$ LB/FT

TOTAL P LOAD AT MID HT. OF WALL

WALL $= 6.25(140) = 875$ lb ✓

BOND BM. $= 1.75(145) = 254$ ✓

1129 lb

USE $[1 + .2(.4)]$ FACTOR $= 1219$ lb ✓

MOD. SRSS FACTOR ADD 54 ✓

ACCEL. FACTOR

$P_{TOT} = 1273$ LB

$M = \frac{54}{2}(6) + \frac{1}{8}(84)(13)^2 12$

$= 21456$ in lb

NEED TWO CURTAINS OF STEEL:

$d = 8.62''$ (3' EDGE DISTANCE)

$K = \frac{21456}{12(8.62)^2} = 24.1$, OK, $K_B = 33.2$!

TRY #4 @ 16, EACH FACE.

$p = \frac{.20}{16(8.62)} = .0015$, $np = .060$

BOTH CURTAINS COUNTED

$f_b = 24.1(7.60) = 183$ psi, OK

$= (.341, .006)$

$p_H = .0022$ OK

$\therefore$ #4 @ 16, OK

$f_a = \frac{1264}{12(11.62)} = 9.1$ psi

$F_a = 145$ psi ← (13' HT.)

$F_b = 250$ psi

f_b MAX $= \left(1 - \frac{9.1}{145}\right) 250 = 234$ psi

HOR. STEEL:

$A_s = .0007(11.62)(12)$

$= 0.10$ IN²/FT MIN.

USE 2-#4 @ 2-8 (EVERY 4TH COURSE) $p_H = .0011$, OK