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July 6, 1979

Mr. Boyce H. Grier, Director
U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region I
631 Park Avenue
King of Prussia, PA 19406

Subject: IE Bulletin No. 79-02
Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts
R. E. Ginna Nuclear Power Plant, Unit No. 1
Docket No. 50-244

Dear Mr. Grier:

Enclosed is a copy of our response to the subject IE Bulletin.

Very truly yours,

L. D. White, Jr.

L. D. White, Jr.

Enclosure

xc: U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, DC 20555

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Response to IE Bulletin No. 79-02
Pipe Support Base Plate Designs Using Concrete Expansion Anchor Bolts
R.E. Ginna Nuclear Power Plant, Unit No. 1
Docket No. 50-244

1. Base Plate Flexibility

a) In general, calculation of anchor bolt loads for pipe supports at Ginna Station has assumed rigid base plates. This includes both the shell type concrete expansion anchor bolts used in the original plant design and the wedge type which have generally been used for plant modifications.

b) In order to assess the significance of rigid versus flexible plate assumptions, a representative sample of typical pipe support base plates has been reanalyzed. The reanalysis was performed assuming both the base plate and bolts as elastic; and using separate procedures for moment and axial loadings. Figures 1 and 2 represent tension loading applied to the plate surface. Figures 3 and 4 represent moment loading applied to the plate. Equations were derived from statics and deflection compatibility which allow calculation of the prying force on the plate and subsequent determination of forces in the anchor bolts. These equations are shown on the figures. For cases involving simultaneous tension and moment loadings, anchor bolt forces for the individual cases are added to arrive at the total force.

c) The results of these analyses show increases in calculated bolt loads due to base plate flexibility between 0% and 24%. The magnitude of the increase depends on the size of the loading, amount of bolt preload, and type of load combination. In general, these increased calculated loads do not appear to have a significant effect on the design of anchor bolts.

d) It is not possible to reanalyze the base plates on all Seismic Category I pipe supports to verify anchor bolt loads prior to initiation of the testing and replacement program described below. In addition, other reviews are presently in progress on other IE Bulletins and the Systematic Evaluation Program which will probably result in changes to calculated pipe support loads. Therefore, we have developed a program for complete reanalysis of all Seismic Category I pipe supports on piping systems 2 inch nominal size and larger; including the concerns of this Bulletin relative to base plate flexibility and anchor bolt loadings. The schedule for completion of this work will be consistent with the dates established for the seismic review of piping systems under the Systematic Evaluation Program.

2. Factor of Safety

a) The original plant design used Cinch Anchor and Phillips Red Head self-drilling (shell type) concrete expansion anchors. The manufacturer's published factor of safety at that time for Cinch Anchors was 10.0; and for the Phillips Red Head anchors was 4.0. However, most of the Phillips Red Head anchors were purchased through the pipe support supplier, Bergen Paterson, who published a factor of safety of 10.0 for them also. Manufacturer's test results are available to verify the factor of safety for the Phillips Red Head anchors.

b) Plant modifications have used HiltiKwik-Bolt, Phillips Red Head, and Wej-It wedge type concrete expansion anchors. The manufacturers' published factor of safety for each of these anchors is 4.0. Test results are available from each of these manufacturers to verify this factor of safety.

c) Shear-tension interaction, minimum edge distance, and proper bolt spacing has been accounted for in the design of anchor bolts for plant modifications.

d) The sampling analyses described above have confirmed that the concrete expansion anchor bolts on the supports selected have the factors of safety published by the manufacturers at the time of installation. These factors of safety were met even for the increased loads due to base plate flexibility.

e) Verification of the factor of safety for all Seismic Category I support anchor bolts will be established through the reanalysis program described above. This verification will include the effects of plate flexibility and the currently accepted factors of safety.

3. Cyclic Loads

a) The capacity of concrete expansion anchor bolts to withstand cyclic loads (seismic as well as high cyclic operating loads) have been evaluated in FFTF tests (Reference: "Drilled-in Expansion Bolts Under Static and Alternating Load." Report No. BR-5853-C-4 prepared by Bechtel Power Corporation, San Francisco, California for the U.S. Atomic Energy Commission, Hanford Engineering Development Laboratory, Richland, Washington, January, 1973). The test results indicate that:

(1) The expansion anchors successfully withstood two million cycles of long term fatigue loading at a maximum intensity of 0.2 of the static ultimate capacity. When the maximum load intensity was steadily increased beyond the aforementioned value

and cycled for 2,000 times at each load step, the observed failure load was about the same as the static ultimate capacity.

(2) The dynamic load capacities of the expansion anchors under simulated seismic loading, were about the same as their corresponding static ultimate capacities.

b) Based on the above data, it is our conclusion that the design requirements for preloaded concrete expansion anchor bolts under cyclic loads are the same as for the static loads.

4. <u>QC Documentation</u>

a) Sufficient documentation does not exist to verify that anchor bolt design requirements have been met.

b) In order to provide assurance that load bearing pipe support base plate designs using concrete expansion anchor bolts will perform their design function, we have initiated a program of testing and replacement. We plan to test all wedge type anchor bolts in Seismic Category I piping systems 2 inch nominal size and larger to assure that minimum design requirements have been met. We plan to replace all shell type anchor bolts in Seismic Category I piping systems 2 inch nominal size and larger in order to upgrade them to current criteria.

c) The testing and replacement program will be performed in 2 phases. Phase 1 will include all load bearing anchor bolts in our Systematic Evaluation Program safe shutdown systems*. Phase 2 will include all other Seismic Category I piping systems 2 inch nominal size and larger. The testing and replacement of all anchor bolts in inaccessible supports included in Phase 1 will be completed prior to August 1, 1979. Testing and replacement of anchor bolts in all Phase 1 accessible supports will be completed prior to September 1, 1979. The testing and replacement of all anchor bolts in supports included in Phase 2 will be completed prior to the end of the Spring 1980 refueling outage.

*The seismic capability of these systems is being reviewed under the Systematic Evaluation Program. These systems have been selected based on reactor coolant system integrity and achieving a safe shutdown condition following a seismic event. In addition, systems necessary to mitigate the consequences of a design basis loss of coolant accident are included. These systems have been presented to the NRC seismic review team.

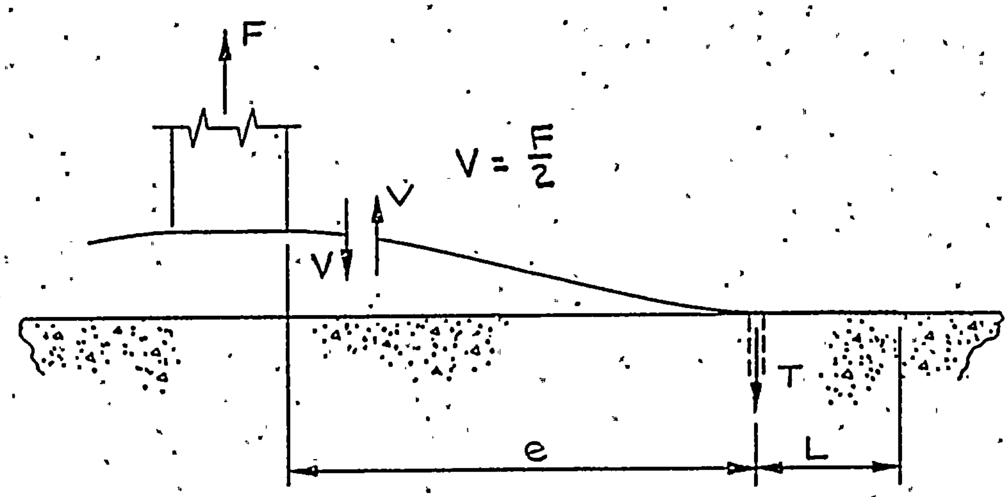
d) The testing program will provide assurance that the concrete expansion anchor bolt installations are in accordance with design requirements. Inspection parameters will include size and type of bolt, embedment depth, thread engagement, plate bolt hole size, bolt spacing, and edge distance to the side of a concrete member. Torque testing will be performed to assure that bolts are preloaded to a load equal to or greater than the bolt design load. The original calculated bolt loads will be increased in accordance with the percentages indicated above to account for base plate flexibility. Replacement anchor bolts will be inspected and tested following installation in accordance with these requirements.

5. <u>System Operability</u>

a) During the Spring 1979 refueling outage the anchor bolts in several Seismic Category I pipe supports were inspected. The results of these inspections were reported to you in LER 79-012/01T-0 dated June 20, 1979. It was our conclusion that the discrepancies found during these inspections were unique to the specific supports involved and appropriate corrective action was taken at that time.

b) Therefore, it is our determination that the capability of Seismic Category I pipe supports to perform their intended function in accordance with the original plant design has not changed. However, due to the development of new criteria for concrete expansion anchor bolts, the reviews being performed under the Systematic Evaluation Program, and to provide additional assurance of the capability of Seismic Category I pipe supports we have decided to perform the reanalyses and make the replacements described above. We do not believe that the operability of the Seismic Category I systems is affected in the meantime.

CONDITION 1

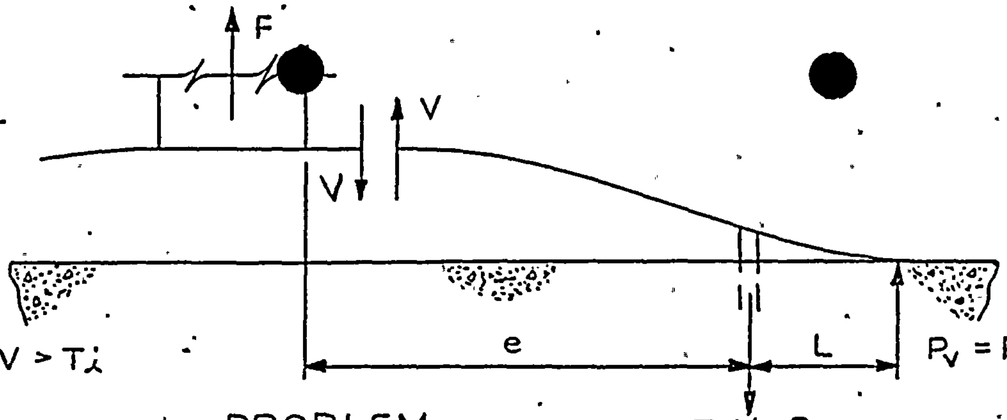


WHEN $(T_i - V)L = V\frac{e}{2}$, ANCHOR LOAD $T = T_i$ = PRELOAD IN THE ANCHOR.

T = TOTAL LOAD IN ANCHOR
T_i = PRELOAD IN ANCHOR

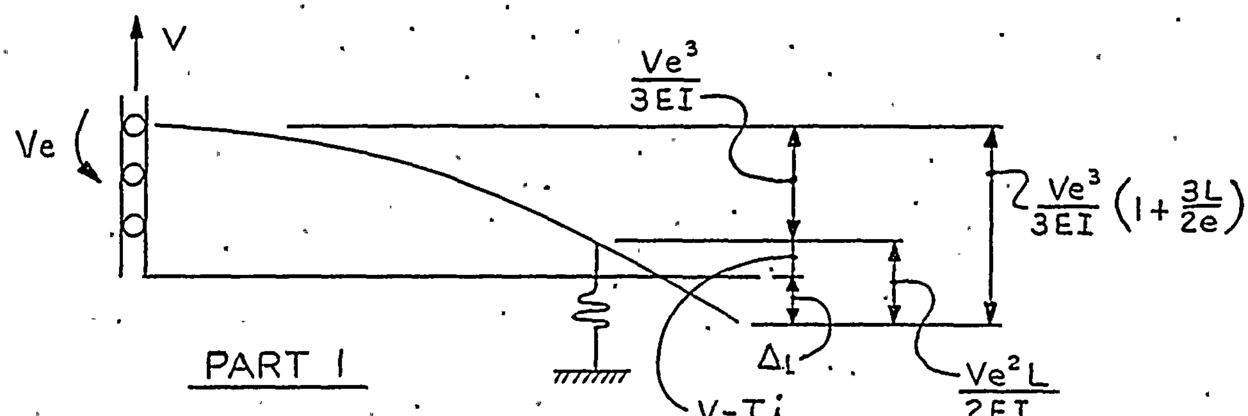
FIGURE 1

CONDITION 2



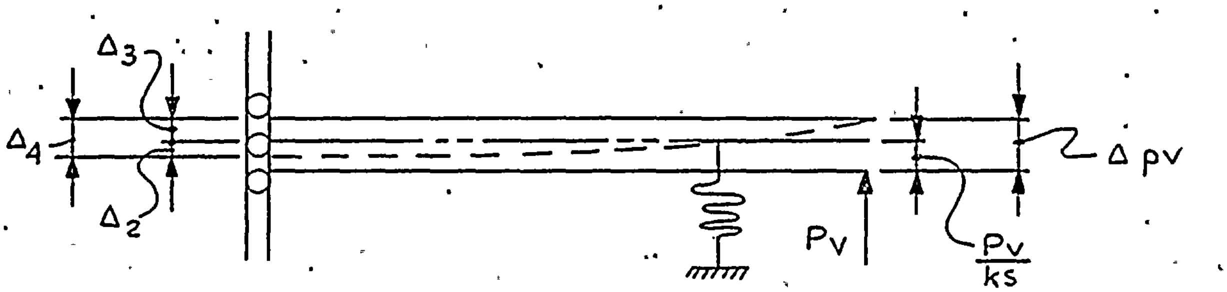
PROBLEM

THE PROBLEM IS SOLVED BY SUPERPOSITION, USING PARTS 1 AND 2 BELOW



PART 1

$$\Delta_1 = \frac{Ve^2L}{2EI} - \frac{V-Ti}{ks}$$



PART 2

$$\Delta_3 = \Delta_4 - \Delta_2 = \frac{P_V L^2 e}{EI} + \frac{P_V L^3}{3EI} + \frac{6}{5}\,\frac{P_V L}{AG}$$

$$\Delta pv = \Delta_3 + \frac{P_V}{ks} = \frac{P_V L^2 e}{EI} + \frac{P_V L^3}{3EI} + \frac{6}{5}.\frac{P_V L}{AG} + \frac{P_V}{ks}$$

(EQ.1) EQUATING $\Delta_1 = \Delta pv$; $P_V = \left[\frac{Ve^2L}{2EI} - (V-Ti)\frac{1}{ks}\right] \div \left[\frac{1}{Ks} + \frac{L^2e}{EI} + \frac{L^3}{3EI} + \frac{6}{5}\frac{L}{AG}\right]$

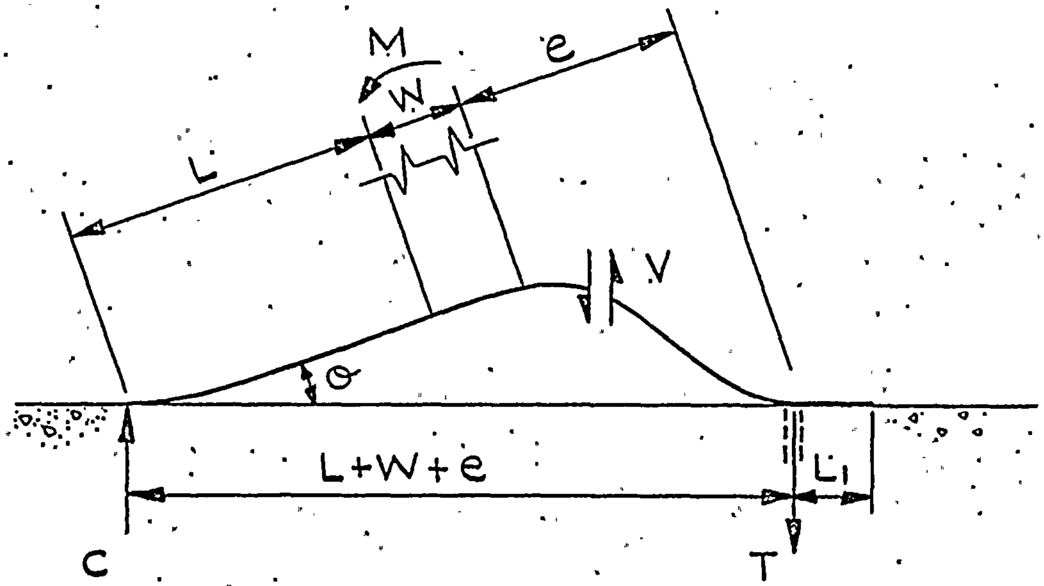
IF $\frac{Ve^2L}{2EI} < \frac{V-Ti}{Ks}$ NO PRYING EXISTS AND $T = V$

IF $\frac{Ve^2L}{2EI} > \frac{V-Ti}{ks}$ SOLUTION OF EQ-1 YEILDS THE PRYING FORCE. P_V.

TOTAL BOLT FORCE IS $V + P_V$

FIGURE 2

CONDITION 1: NO TENSION ANCHOR ROTATION OR DISPLACEMENT



T = TOTAL LOAD IN ANCHOR

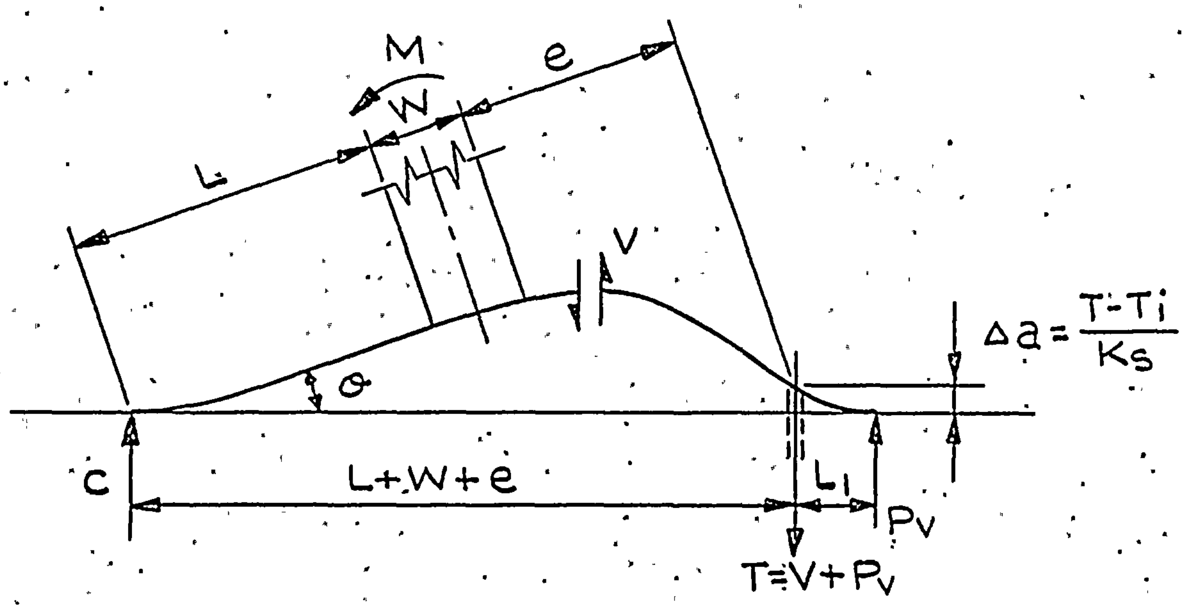
T_i = PRELOAD IN ANCHOR

FOR $M \leq \left(\frac{T_i L_1}{e/2 + L_1}\right)(L+W+e)$, $T = T_i$

PRYING FORCE = 0

FIGURE 3

CONDITION 2: TENSION ANCHOR ROTATION AND DISPLACEMENT



T=TOTAL LOAD IN ANCHOR
Ti=PRELOAD IN ANCHOR

$$T = V + P_V$$

$$\Delta a = \frac{T - T_i}{K_S}$$

$$\theta = \frac{VL^2}{2EI_p}$$

$$L = \frac{3}{\theta}\left\{\left[\Delta a - \frac{P_V L_1 e^2}{2EI} + \frac{Ve^3}{3EI}\right] - \theta W - \theta e\right\}$$

$$V = \frac{M + P_V L_1}{e + W + L}$$

$$P_V = \frac{\frac{Ve^2L_1}{2EI} - \frac{V - T_i}{K_S} - \theta L_1}{\frac{1}{K_S} + \frac{L_1^2 e}{EI} + \frac{L_1^3}{3EI} + \frac{6}{5}\frac{L_1}{AG}}$$

IF $\frac{V - T_i}{K_S} \geq \frac{Ve^2L_1}{2EI} - \theta L_1$, NO PRYING EXISTS AND $T = V = C$

IF $\frac{V - T_i}{K_S} < \frac{Ve^2L_1}{2EI} - \theta L_1$, SIMULTANEOUS SOLUTION OF THE SIX EQUATIONS GIVEN ABOVE WILL YIELD THE LOCATION OF THE COMPRESSIVE FORCE C AND THE MAGNITUDE OF THE PRYING FORCE P_V

FIGURE 4