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SEISMIC REVIEW OF VAULT FOR MFTF UPGRADE PROJECT

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MASTER

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Livermore
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September 29, 1983

To: Livermore Lawrence National Laboratory
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Attention: James N. Doggett, Project Manager

Reference: P.O. No. 3041805, Bechtel Job No. 16187

Subject: Seismic Review of Vault for
MFTF Upgrade Project

Gentlemen:

This letter report was prepared in accordance with the scope of work for the preconceptual seismic evaluation of the (α +T) Tandem Mirror Fusion Machine concrete vault. The scope of work was developed with the assistance of the Bechtel site representative Dr. Sunil Ghose. The report contains comments and preconceptual recommendations on wall upgrading for a 150-ton crane installation, concrete vault seismic capability for (α +T) conditions, and recommendations for future work.

1. Vault Upgrade for a 150-Ton Crane

A general view of the crane and vault is shown in Sketches 1 & 2. Crane parameters such as weight and height were selected using the "Whiting Crane Handbook" and were determined using extrapolation of the values presented in the above reference, shown in Sketch 3.

Predicted parameters of the crane concept are: estimated weight of the crane is 170 kips; span is 64'-4"; trolley height is about 6'; height from top of trolley to the bottom of crane girder is approximately 14 feet; hook can be raised to approximately 11' from the top of the crane.

As can be seen from Sketch 1, two possible types of crane girder supports were considered. They were either brackets attached to the upper wall faces or columns from the vault floor.

The bracket supports consist of anchor plates and stiffened web ledges (Sketches 4 and 5) attached to the walls by 1 1/4" ϕ HVA type anchor bolts manufactured by Hilti Inc.. Anchor bolt embedment into the concrete is about 15". Brackets are spaced at 18'-0" on centers. Additional smaller upper anchor plates are provided for the lateral restraint of the top chord of the crane rail girder (Sketch 6).

EMB

The column type of support consists of W14x90 columns with a cover plate. They are spaced at 18' -0" on centers and supported by new foundations. Columns are laterally restrained each vertical 10 feet by anchors to the wall (Sketch 7).

The crane girder concept consists of a W36x230 beam with added top flange cover plate and angles (Sketch 8). Equivalent plate girder sections may be used instead of the W36x230. Nominal span of the crane girder over its supports is 18' -0".

2. Seismic Capability for (α + T) Specification

Simplified dynamic analysis was used to compute the preliminary dynamic forces required to design the vault wall for the (α + T) condition. A schematic view of the concrete vault is shown in Sketch 9. The entire building was modeled as a single degree of freedom system. The final forces were computed using the following procedure:

1. Compute the weight of the walls, roof and crane for a one foot strip. For OBE analysis the weight of the crane and its maximum load (live load) were distributed over 28 feet length of the wall - twice the distance spanned by the end trucks. For DBE analysis, live load was not included.
2. Compute the longitudinal, transverse and vertical stiffness of the wall based on a 7 ft. thick wall.
3. Compute the natural frequencies of this simplified system.
4. Select the spectral accelerations from spectral curves provided in Foster Engineering Inc's report for the maximum accelerations and dampings shown in Table 1. The values of spectral accelerations for the computed frequencies of the structure used for force calculations were 1.1g and 1.9g for OBE and DBE forces respectively. These values are higher than the ground input values 0.4g and 0.8g due to structural amplification.
5. Compute maximum forces and moments resulting in the wall, per lineal foot, which are listed in Tables 2 and 3. Computed forces were increased by a factor of 1.5 to account for the contribution of higher modes.

Although the results obtained from this simplified approach are approximate, the results compared reasonably well with values reported by Foster Engineering. However, for the final design we recommend that 3-D finite element dynamic analysis be performed to compute the required forces. In the simplified approach used, coupling effects and additional forces due to torsion were neglected.

The calculations of the strength of the walls showed that they would not be adequate to resist the bending moments due to the ($\alpha_c + T$) earthquake forces and therefore an upgrading of those walls would be required. Somewhat less reinforcement would be added to the monolithic walls compared to the block walls.

One of the upgrade possibilities is to provide a rigid connection between roof and wall. This would reduce bending moments at the base of the wall for lateral loads. Another possibility is to provide outside reinforcement of the wall using steel plates attached to the surfaces by drilled anchors (Sketch 10), although this will be visually unattractive. Still another possibility is to install additional vertical prestress tendons as shown in Sketch 11.

Order-of-magnitude preconceptual estimates of materials for upgrading the vault are as follows:

Crane Support Systems

Bracket-type supports: Steel-150 tons. The amount of drilling into concrete is about 20,000 inches

Column-type supports: Steel-225 tons; concrete - 200 cu. yd, reinforcing steel - 25 tons. It should be noted that the length of drilled anchor bolts for column-type supports is expected to be less than for bracket-type supports. (approximately 7,000 inches)

Seismic Upgrading of Walls: For the steel plate concept only, steel - 1500 tons. It is expected that this quantity may be reduced as a result of more detailed analysis and design.

3. Recommendations For Future Work

The work reported herein was necessarily of a preconceptual nature using quite approximate methods to scope the structural influence of the ($\alpha_c + T$) seismic specification.

Below are some suggestions for future work:

- a) Perform a preliminary design for each of two methods of upgrading the walls to meet requirements of ($\alpha_c + T$) seismic events. Investigate the quantities of materials and cost aspects of upgrading.
- b) Investigate the performance and reliability of HVA 1 1/4" ϕ anchor bolts (which use epoxy grout) for heavily-loaded crane girder bracket supports.

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- c) Perform a preliminary design of support members for the 150-ton crane.
- d) Perform a computer seismic analysis of the vault considering new crane loads.
- e) Investigate geometry parameters of the crane concept and propose criteria for the crane design.
- f) Investigate crane/load clearance requirements and influences on the vault layout.

Submittal of this letter report completes all technical work under the above purchase order.

H. A. Franklin
Project Manager
Bechtel Job No. 16187
Research and Engineering

HAF:dmc

cc: H. A. Pitkin

Case	Damping	ZPGA(H)	ZPGA(V)
OBE	4%	0.4g	0.27g
DBE	7%	0.8g	0.53g

Table 1 Maximum Design Accelerations and Damping Values

Case	F _x (k/ft)	F _y (k/ft)	F _z (k/ft)
OBE	50	97	27
DBE	81	137	48

Table 2 Shear Forces Per Linear Foot of Wall

Case	M _x (k·ft/ft)	M _y (k·ft/ft)
OBE	5150	2650
DBE	7260	4300

Table 3 Bending Moments Per Linear Foot of Wall at Elevation 0.0

EL. 54' - 6"

**2 TYPES OF CRANE GIRDER SUPPORTS:
BRACKETS & COLUMNS**

SKETCH 1 OF 11

VAULT PLAN

SKETCH 2 OF 11

THIS CHART IS BASED ON DATA PRESENTED IN
WHITING CRANE HANDBOOK

PREDICTED WEIGHT OF CRANE (Kips)

SKETCH 3 OF 11

ANCHOR PLATE & BRACKET

SKETCH 8 OF 11

SKETCH 6 OF 11

SECTION A - A (SEE SKETCH 2)
BRACKET TYPE SUPPORTS

DETAILS OF COLUMN SUPPORTS

SKETCH 7 OF 11

TYPICAL CRANE GIRDER CONCEPT

SCHEMATIC DRAWING OF CONCRETE VAULT

SIMPLIFIED MODEL

SKETCH 10 OF 11

VAULT UPGRADING
PRECONCEPTUAL SCHEME

PLAN

VAULT UPGRADING
PRECONCEPTUAL SCHEME

SKETCH 11 OF 11