CITY OF CUPERTINO

City Hall
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DEPARTMENT OF PUBLIC WORKS

MEMORANDUM

TO: Ralph Qualls, Director of Public Works

FROM: Terry W. Greene, City Architect December 9, 2005

SUBJECT: City Hall: Essential Facility Classification

Issue

City Hall does not now fully meet, nor was it properly modified in 1986 to fully meet the structural requirements to enable it to be classified as an Essential Facility and thereby house an Emergency Operations Center.

Background

Cupertino City Hall was designed in 1965 by San Jose architect Wilfred Blessing and San Jose structural engineer Kirk McFarland, using the 1964 Uniform Building Code. A Building Permit was issued on December 2, 1965 and construction by Pursely Construction Company of Sunnyvale, was completed on November 19, 1966, at a cost of $433,598.49. Notice of Completion was filed with the Santa Clara County Recorder's Office on December 2, 1966.

According to documents on file, the building, in December of 1965, had 24,233 square feet, was a Type 5, B-2 (1 hour) building, located in Fire Zone No. 2, and insured for $446,260. The building had offices and a Council Chamber on the main floor and an open basement, which housed mechanical and electrical equipment.

It appears that no significant work was done to the building until 1986 when the architectural firm of Holland East and Duvivier (HED) of Redwood City, and the structural engineering firm of CYGNA of San Jose was hired to develop office space in the basement and upgrade the building to Essential Facility status in accordance with the UBC.

According to the details of the attached two letters from structural engineer, Bill Knox, of Ahearn, Knox & Hyde, and subsequent conversations I've had with him, the Uniform Building Code of 1976 prescribed the structural criteria for the design of an Essential Facility. The criteria were derived from failures in the 1971 San Fernando earthquake and significantly altered two important aspects of building design; Importance Factor and concrete shear wall ductility.

The Importance Factor was created in 1976 for the design of Essential Facilities, defined as Fire and Police stations, Hospitals, and Municipal Government Disaster Operation and Communication Centers. The application of an Importance Factor of 1.5, established in 1976, resulted in a 50% increase in earthquake design loads.

Shear wall ductility was also increased in 1976, with the application of more reinforcing steel, allowing for a more gradual failure of a shear wall rather than an abrupt failure.

In 1985, when the City of Cupertino entered into an agreement with HED to build out the City Hall basement and add on to the existing Library, the City explicitly requested that City Hall be upgraded to an Essential Facility for the purposes of creating an Emergency Operations Center. The 1985 Uniform Building Code, used for the upgrades, had reduced the Importance Factor to 1.25 but retained the shear wall ductility requirements of 1976.

HED, with structural sub consultant CYGNA, designed the structural changes to the terrace and basement offices using the more conservative, and allowable, Importance Factor of 1.5 and the appropriate shear wall ductility in accordance with the 1985 Uniform Building Code.

According to Bill Knox's review of the 1986 structural calculations, the CYGNA structural engineers did a thorough analysis of the upper level but mistakenly assumed the existing shear walls were sufficiently strong enough and contained proper reinforcing. Ironically, Bill Knox was the original structural engineer of City Hall as an employee of Kirk McFarland and is quite familiar with the original design.

Unfortunately CYGNA did not catch their mistake and as a result did not modify or upgrade any of the main floor structural walls, columns or beams to meet the 1985 UBC shear wall ductility requirements. According to Bill Knox, the existing shear walls, structural columns, beams, and roof members at the main level, are currently overloaded and do not meet the code requirements of 1976 or those of 1985.

A significant contributor to the overloading comes from the tile roof, a last minute change to the original design insisted on by the public and agreed to by the City Council on January 5, 1965. Removal of the roof tile would not, however, eliminate the need for additional ductile shear walls at each corner of the building and possible other structural modifications.

Bill Knox has expressed concern to me that in an earthquake, in which the EOC would be an important City function and through which it would be expected to be operational, the upper level might partially or completely collapse and possibly prevent access to the terrace level, even if the internal terrace level offices are undamaged.

Conclusion

City Hall does not qualify as an Essential Facility, according to the criteria established in the 1976, 1985, or 2001 Uniform Building Code or the California Building Code. Since it cannot be classified as an Essential Facility, it cannot technically house an Emergency Operations Center.

Sugimura and Associates is currently underway with the Construction Document phase for City Hall, Phase 2, Lobby remodel and EOC expansion. I have instructed them to include the necessary structural upgrades for the shear walls and other structural members without making any changes to the roof.

Without roof changes, approximately 110 additional linear feet of full height shear wall will be required, applied equally at the four corners.

Gene Sugimura is also available to investigate alternatives to reduce the roof loading which would in turn reduce the number of changes that need to be made to the columns and shear walls below the roof. Bill Knox has suggested that the removal of the roof tile might reduce the length of new shear wall by 10 to 15%.

Recommendation

Determine if the EOC must remain in City Hall. Alternative locations might include the Service Yard, or the Quinlan Center, if they meet Essential Facility requirements. Another alternative might be to use the Fire Station on Stevens Creek Blvd, which is an Essential Facility. Finally, a challenging but inexpensive alternative might be to purchase and use a large tent structure.

If the EOC must remain in City Hall, it is recommended that one of the following alternatives be taken:

Alternative 1

Stop the Emergency Generator project and shift the remaining funds to design and construct the necessary shear walls.

Alternative 2

Identify an additional $200,000 and expand the scope of work for the Emergency Generator project to include new shear walls.

Alternative 3

Identify approximately $350,000 additional funds and expand the scope of work of the Emergency Generator project to include new shear walls and a new roof profile and new, lighter material.

Alternative 4

Identify approximately $350,000 of additional funds for the shear walls and new light weight roof material, and identify the additional funding for the Lobby and EOC upgrades and incorporate those funds into the Emergency Generator project for construction in April of 2006.

akh AHEARN, KNOX & HYDE, INC.
Structural Engineers

Dennis B. Ahearn, S.E.
William S. Knox, S.E.
Tim D. Hyde, S.E.

December 7, 2005

Sugimura & Associates Architects
2155 S. Bascom Avenue, Suite 200
Campbell, CA 95008

Att: Gene Sugimura
Ref: Cupertino City Civic Center Remodel

Dear Gene;

Terry Greene provided me with a copy of the structural calculations that CYGNA compiled for the modifications to the building in 1986. These calculations show that CYGNA did investigate the upper level of the building for seismic loading using an importance factor as required by the 1985 Uniform Building Code.

My review of CYGNA's calculations indicated that their seismic loading agrees very closely with mine. The problem appears to be with an assumption that CYGNA made, as well as a significant omission. They assumed that the walls contain shear reinforcing but the original drawings do not specify this. For the wall reinforcing to be considered as shear reinforcing a full 180-degree hook is required at each end of each reinforcing bar in the wall. This hook is not shown on the original 1965 drawings. Typically this reinforcing is not hooked unless specifically called for. By both our calculations shear reinforcing is required and the concrete shear walls are overstressed without it.

It appears that CYGNA did not check for boundary member requirements. A boundary member is in essence a column or pilaster built into the ends of highly loaded shear walls. There is a Building Code requirement for the minimum size and reinforcing of these boundary members. The existing walls do not have the required boundary members.

At the time this building was originally designed the 1964 Uniform Building Code was in effect. This Code had no requirements for hooked shear reinforcement or boundary members. Increasing the length of the upper level concrete shear walls, as previously discussed, can reduce the stresses in the walls to the extent that neither shear reinforcing nor boundary members are required.

A possible solution to this problem that has been discussed is to remove the tile roofing and replace it with a metal standing seam roof to reduce the building's seismic mass. While this would help, it would not rectify the situation, as it would reduce the seismic loads to the shear walls by only 14%, not enough to eliminate the overstress condition.

The concrete shear walls supporting the roof structure are overstressed and we recommend that the shear walls be strengthened by increasing their length as previously discussed with you..

If you have any questions please give me a call.

Sincerely,

William S. Knox
Structural Engineer

cc Terry Greene

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AHEARN, KNOX & HYDE, Inc. **Structural Engineers**
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LETTER of TRANSMITTAL

PROJECT: Cupertino City Hall Investigation

RECIPIENTS: **AKH Job No.** _____

(1) Terry Green
Attn: _____
Fax: _____

(2) _____
Attn: _____
Fax: _____

(3) _____
Attn: _____
Fax: _____

(4) _____
Attn: _____
Fax: _____

Date	Quantity	Description
		CYGNA Structural Calculations

Comments:
Terry,
I have made a copy of the appropriate pages. My initial review indicated that CYGNA's loading agrees very closely with mine. The problem appears to be an assumption that they made as well as an omission. They assumed that the walls contain shear reinforcing but the original drawings do not specify this. For the wall reinforcing to be considered as shear reinforcing requires a full 180 degree hook at each end and this is not shown on the drawings. By both our calculations shear reinforcing is required.
It appears that CYGNA did not check for boundary member requirements. A boundary member is in essence a column built into the ends of highly loaded walls with a specified minimum size and reinforcing. The existing walls do not have the required boundary members.
I will do a more complete check and get back to you early next week. Thanks

These Items transmitted via:

_____ Mail _____ Overnight __X__ Hand Delivered _____ Messenger
_____ Picked Up _____ Separate Cover _____ Fax _____ page(s), Including this page

Sent By: Bill Knox **Date:** 11/22/2005

akh AHEARN, KNOX & HYDE, INC.
Structural Engineers

Dennis B. Ahearn, S.E.
William S. Knox, S.E.
Tim D. Hyde, S.E.

November 10, 2005

Post-it® Fax Note 7671	Date 11/10/05	# of pages ▶ 3
To TERRY GREENE	From GENE SUGIMURA	
Co./Dept.	Co.	
Phone #	Phone #	
Fax # 408-~~777~~-3333	Fax #	

Sugimura & Associates Architects
2155 S. Bascom Avenue, Suite 200
Campbell, CA 95008

Att: Gene Sugimura
Ref: Cupertino City Civic Center Remodel

Dear Gene;

We have completed our analysis of the existing building with reference to the current code, the 2001 California Building Code. Since we were informed at our last meeting that the facility is considered to be an Essential Facility due to the Emergency Operations Center within, we have modified our analysis to include this requirement. This requirement increases the seismic forces that the structure is required to resist by 25%.

At the time this building was originally designed the 1964 Uniform Building Code was in effect. This Code had no provisions for Essential Facilities. The 1976 Uniform Building Code introduced an Importance Factor to be used in the design of Essential Facilities to resist earthquake loads. This was done due to the damage caused by the 1971 San Fernando earthquake to structures that are considered essential in the aftermath of disasters. Many of these buildings were not able to operate. An Essential Facility is defined by the Code as 1) Hospitals, 2) Fire and Police Stations and 3) Municipal Government Disaster Operation and Communication Centers. The initial Importance Factor in the 1976 Code was 1.5, resulting in a 50% increase in the earthquake loads on an Essential Facility compared to the earthquake loads on a non-essential building. The Importance Factor was reduced to 1.25 in the 1985 Uniform Building Code. This requirement has been carried on through the current Code.

Another change made in the 1976 Uniform Building Code was to increase the requirements regarding concrete shear walls. During the San Fernando earthquake non-ductile concrete construction received considerable damage. Non-ductile concrete is that which may experience compression or shear failure, which can result in a sudden and catastrophic failure. Ductile concrete is that in which the reinforcing steel yields prior to concrete failure. This results in a failure that is much slower in occurring and with less devastating results. Highly loaded shear walls are required to meet ductility requirements of the building codes since 1976.

Our analysis shows that the existing structure generally has the strength to resist the required loads. The exception to this is the second level exterior concrete shear walls. These shear walls are considerably overstressed and do not meet the ductility requirements of the current Code. These shear walls would not be allowed to be constructed today. A significant amount of new concrete walls need to be added to the existing structure to bring the building into conformance with the current Code. Enclosed is a preliminary drawing indicating recommended locations of wall additions.

The California Building Code recognizes two reasons that would require an existing building to be upgraded to the current Code, 1) Change to a more restrictive use or occupancy (CBC Section 3405) and 2) Change to the building which causes the existing building to become overloaded

(CBC Section 3403.2). We do not know when the Emergency Operations Center was installed in this building. If it was prior to the City adopting the 1976 Building Code then there is no Code requirement for the building to be brought into conformance with the current Code. If it was installed after the 1976 Building Code then the structure should have brought into conformance with the Code in force at that time. Either way, we strongly recommend that the shear wall strengthening take place as soon as possible. The current walls are overstressed for the loads required by the current Code and, most importantly, do not meet the ductility requirements for any building code since 1976.

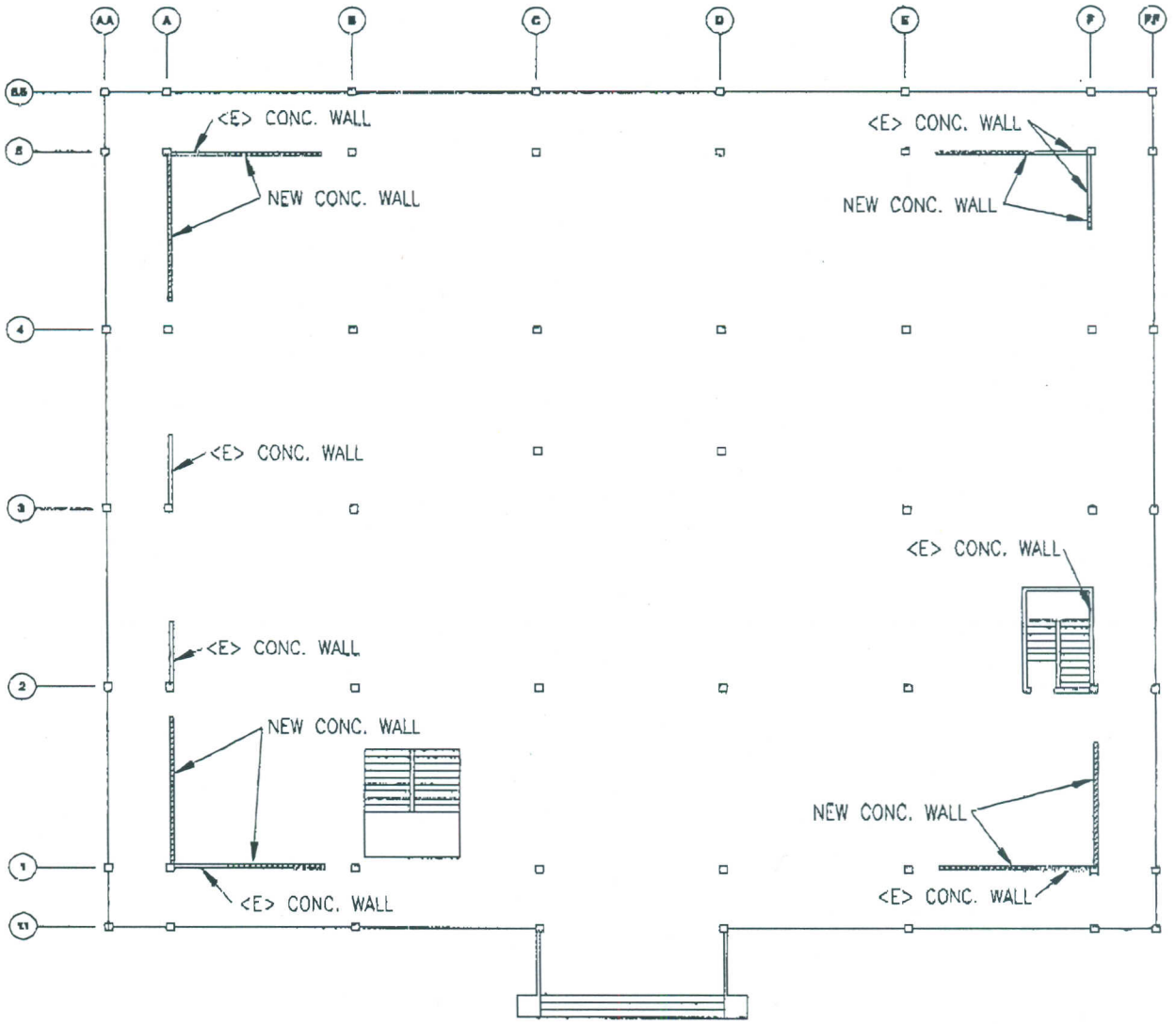
Our analysis also indicates that the plywood roof diaphragm is overstressed by approximately 15% due to the above 25% increase in loading. This overstress could be rectified by removing the existing roofing and re-nailing the plywood sheathing around the perimeter of the building. In our opinion, the cost-to-benefit to do this would be excessive. The City should make the decision whether to upgrade the roof diaphragm and we would be available to meet and explain the situation.

A rough cost estimate for the work of adding approximately 110 feet of new concrete shear wall, per the enclosed plan, is $130,000. This represents approximately $1,180.00 per foot of wall. This includes demolition of the existing stud walls, new concrete walls, furring the interior with gypsum board, painting, minor ceiling, floor and electrical work.

If you have any questions please give me a call.

Sincerely,

William S. Knox
Structural Engineer



FLOOR PLAN – MAIN LEVEL