EFFORTS TO CORRECT EXISTING EARTHQUAKE HAZARDOUS BUILDINGS IN THE STATE OF CALIFORNIA

by

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SYNOPSIS

California earthquakes as low as 4.7 Richter magnitude earthquakes have damaged existing unreinforced masonry buildings.[1] Larger magnitude earthquakes, such as the June 26, 1925, Santa Barbara Earthquake and the Long Beach March 10, 1933, Earthquake, both of which were 6.3 Richter magnitude earthquakes, collapsed or heavily damaged existing unreinforced masonry buildings. The 1933 Long Beach Earthquake prompted both the State of California and local jurisdictions to prepare and adopt earthquake resistant design requirements for the design and construction of new buildings; however, little or nothing was done to correct existing earthquake hazardous buildings until the 1950's and 1960's when legislation was proposed and passed requiring the correction of existing earthquake hazardous buildings.

INTRODUCTION

The March 10, 1933, Long Beach Earthquake damaged 86% of the Type III unreinforced masonry buildings built prior to March 10, 1933.[2] The severe damage and destruction of public school buildings resulted in the State of California occupying the field of structural design requirements for new public school buildings when the Governor of California approved the Field Act on April 10, 1933.[3] The legislative intent of the Field Act is included in Section 9 of the Act, which reads in part as follows:

> "Sec. 9. . . . . .
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> ". . . . . The series of earthquakes occurring in the southern portion of the State has caused great loss of life and damage to property. The public school buildings, constructed at public expense, were among the most seriously damaged buildings. Much of this loss and damage could have been avoided if the buildings and other structures had been properly constructed. The school buildings which will be erected, constructed and reconstructed to replace the buildings damaged or destroyed by the earthquakes should be so constructed as to resist, in so far as is possible, future earthquakes. These buildings will be erected, constructed and reconstructed at once and accordingly it is necessary that this act go into immediate effect in order that the lives and property of the people will be protected."

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Section 5 of the Field Act granted full power and authority to the Division of Architecture to draft earthquake resistant design requirements for school buildings. Section 5 of the Field Act reads in part as follows:

> "Sec. 5. The Division of Architecture is hereby granted full power and authority from time to time to make all such rules and regulations as to it may seem necessary, proper or suitable effectually to carry out the provisions of this act."

The Field Act did not deal directly with the problem of existing hazardous school buildings. Section 8 of the Field Act provided for the inspection of existing school buildings only. Section 8 of the Field Act reads in part as follows:

> "Sec. 8. Upon request of the board of trustees of any school district or at least ten per cent of the parents having pupils enrolled in said school district as certified to by the county superintendent of schools, the Division of Architecture shall make an examination and report on the structural condition of any public school building. . . . . ."

The Garrison Act in 1939 added a provision to the Field Act providing that where pre-1933 schools were inspected and found to be noncomplying, that such school buildings should be brought into compliance with the Field Act or vacated. On May 7, 1964, Stanley Mosk, then State Attorney General, warned school board members of their personal liability for loss of life in the event that any pre-Field Act building collapsed in an earthquake.

In 1967 the Education Code of the State of California was amended to provide that all public school buildings be brought up to Field Act standards or be vacated by 1975. This legislation also included a requirement that the State Department of Education make a survey of existing school buildings every two years and show the number of existing school buildings which do not comply with the Field Act. A 1970 survey showed 1810 public school buildings which did not comply with the Field Act. A 1972 survey showed 909 School Districts with complying public school buildings and 226 School Districts with noncomplying school buildings. The number of noncomplying school buildings in 1972 shows a total of 1593 school buildings which do not comply with the Field Act. The State of California has set a deadline of 1975 to bring all public school buildings up to minimum earthquake resistant requirements. Such is certainly a worthy goal; however, very little progress has been made to require the correction of other existing earthquake hazardous buildings. Page 28 of the report entitled, "Earthquake Safety in the City of Long Beach Based on the Concept of Balanced Risk"[4] deals with the problem of existing earthquake hazardous buildings. Page 28 of this report reads in part as follows:

> ". . . The problem of many existing structures which will become life hazards, in the event of even

a moderate earthquake, has not been well understood by the average layman. It might be assumed by some uninformed persons that since we have had earthquake provisions in our codes since about 1933, overall damage and loss of life should be small in future earthquakes. This is not so.

". . . . . It has been estimated that as many as 200,000 potentially hazardous buildings exist in seismic zone 3*, see Uniform Building Code, 1967 edition, including many school buildings.

"There are 40,000 such buildings in the city of Los Angeles and about 100,000 in the metropolitan area. If we assume an average occupancy of five persons per building, which is probably low, there is a potential life hazard to 5000 persons in Long Beach and one-half million in Los Angeles metropolitan area.

". . . . . ."

Some existing earthquake hazardous buildings have been repaired in an earthquake resistant manner under the provisions of Section 502 of the 1970 Edition of the Uniform Building Code which reads in part as follows:

"Sec. 502. No change shall be made in the character of occupancies or use of any building which would place the building in a different division of the same group of occupancy or in a different group of occupancies, unless such building is made to comply with the requirements of this Code for such division or group of occupancy.

" . . . . . ."

Section 502 of the Uniform Building Code has included this requirement since the early 1930's. Although Building Officials have had the authority to require, under change of occupancies, that buildings be altered structurally to comply with earthquake resistant requirements, very few Building Officials in the State of California have exercised such requirements.

In the early 1950's the City of Los Angeles adopted amendments to its Building Regulations which required the correction of hazardous parapets and appendages. Other jurisdictions in the Los Angeles area, including the City of Long Beach, adopted comparable provisions. These so-called parapet regulations did not require reasonable earthquake resistance for the overall building but only provided for the removal or the strengthening of parapets and appendages. Several jurisdictions in the Southern California area have enforced parapet and appendages provisions by requiring the removal or strengthening of dangerous parapet walls and appendages. These provisions will help somewhat to reduce the life hazard to persons outside the buildings in a moderate shock period;

however, a serious hazard still exists due to the collapse of the entire building in moderate or severe earthquakes.

In 1959 the Long Beach Building Department was successful in proposing for adoption amendments to the Long Beach Building Regulations which gave the Building Department the authority to require that existing hazardous buildings be repaired in an earthquake resistant manner.

Paragraph (a) of Section 8100.206 of the Long Beach Building Regulations reads as follows:

> "(a) General— Whenever the building official shall determine by inspection that an existing building is substandard, or constitutes a nuisance, he shall institute proceedings to cause the repair or rehabilitation of such building or, if such repairs or rehabilitation are impracticable or impossible, to cause the building to be vacated and demolished as hereinafter provided."

Section 8100.206 of the Long Beach Building Regulations, plus Paragraph (i) of the definition of "Nuisance" which appears as one of the definitions under Section 8100.401 of the Long Beach Building Regulations gave the Building Department the necessary authority to condemn and require repair of such existing earthquake hazardous buildings or their demolition. Paragraph (i) of the definition of "Nuisance" reads in part as follows:

> "(i) Maintenance or occupancy of any building or other structure, or portion thereof, which is so constructed, situated or maintained as to be dangerous to persons therein, or in the vicinity thereof, in case of fire, collapse, earthquake, flood, or other cause; . . . . . ."

Using the above sections of the Long Beach Building Regulations, the Long Beach Building Department condemned 116 Type III unreinforced masonry buildings (Type III unreinforced masonry buildings are buildings with unreinforced masonry exterior walls, wood floors and wood roofs). Such condemnations resulted in demolition of 33 such buildings and the repair of some 21 others.

While the Building Regulations of the City of Long Beach provided the Building Department with the authority to condemn earthquake hazardous buildings, it did not set up minimum repair requirements for such buildings. In reviewing accepted repair methods for unreinforced masonry buildings, the Long Beach Building Department came to the conclusion that minimum repairs for such buildings should be the same as required for public school buildings. The repair of existing masonry walls as permitted for public school buildings in California is provided for in Section 414 of Title 21 of the California Administrative Code. Section 414 of Title 21 of the California Administrative Code reads as follows:

"414. Use of Existing Masonry. (a) General. The architect or engineer proposing to use existing brickwork or existing concrete for structural purposes, shall submit a written statement that he has investigated the structure thoroughly, and he has satisfied himself as to the structural adequacy of the existing construction, and that as a result of his investigation he recommends definite safe working stresses. The statement should be accompanied by a report giving details of the examination, results of tests, etc. The use of existing brickwork or existing concrete work (See Section 701) for structural purposes shall be subject to the approval of the Division of Architecture. Uninspected brickwork laid up in lime or lime-cement mortar or brickwork from which cores test less than 900 pounds per square inch shall not be accepted for structural purposes.

"(b) Method of Repair. Gunite or concrete may be used to supplement existing masonry which does not comply with the requirements of Article 4. Such masonry shall be relieved of stress by the gunite or concrete, except that it may be assumed to carry its own weight.

"(c) Gunite or Concrete Method of Reinforcement. (1) Ribs or minor columns of gunite or concrete may be incorporated into the type of masonry described in Section 414(a). If they are spaced more than five feet apart in the clear, there shall be a gunite or concrete membrane between the ribs. The thickness of this membrane shall not be less than one twenty-fourth of the clear distance between the ribs or minor columns and in any case not less than that required by Article 7.

(2) If ribs or minor columns are not more than five feet apart, and extend to the far tier of masonry, no membrane will be required.

(3) There shall be a rib or minor column within at least two feet of each vertical edge of each opening in the wall where there is a membrane, but where there is no membrane there shall be a rib or minor column at each vertical edge of each opening.

(4) If gunite or concrete is placed against only one side of a unit masonry wall, the gunite or concrete shall be in contact with the far tier of the unit masonry at not less than one point in any rectangle four feet wide and three feet high. The area of such contact shall be not less than 64 square inches, except that if there are continuous ribs or minor columns not more than five feet apart which extend through to the far tier,

intermediate contact points may be omitted.

(5) Where composite walls are in contact with reinforced concrete or gunite columns, beams, or walls, the concrete or gunite portion of the composite wall shall either be constructed integrally with such abutting columns, beams, or walls, or keyways shall be provided to resist adequately the design forces.

(6) Surfaces against which gunite is to be deposited shall be prepared as specified in Section 737.

Surfaces against which concrete is to be placed shall be prepared as prescribed for gunite, and in addition joints at the header courses in brickwork shall be raked back one-half inch. The height of each pour and of each lift of forms shall not exceed nine times the thickness of the membrane.

(7) Ribs supported laterally by gunite membranes shall be reinforced with not less than two five-eighth bars. Other ribs shall be reinforced with a minimum of four five-eighth bars. Ribs shall have one-fourth inch ties at six inches on centers and shall have one dowel, top and bottom, into the existing construction.

The membrane shall be reinforced with not less than three-eighth inch bars 18 inches on center each way. The membrane steel need not be doweled."

In addition to the above-mentioned repair of unreinforced masonry walls, the Long Beach Building Department also required that floor and roof diaphrams of such buildings be altered as necessary to adequately support the repaired masonry walls.

The Long Beach Building Department's condemnation of Type III unreinforced masonry buildings built prior to earthquake regulations resulted in the formation of the United Property Owners Association of Long Beach. The formation of this organization took place in the early part of 1969. This organization requested a hearing before the City Council on April 22, 1969, in regard to re-evaluation of condemnation proceedings and requested a financial assistance program. The United Property Owners Association recommended that the City Council of Long Beach adopt the following program:

"1. A-City Council directs the Building and Safety Department to completely investigate and survey all buildings within the City of Long Beach that might be in violation of the 1959 Ordinance under

which the Building Department is currently condemning owner's property.

B-City Council instructs the Building and Safety Department to cease issuing notices of condemnation, as well as cease action on present owners' property under condemnation, until the survey of all properties is completed.

"2. With all of the above information obtained, a dollar estimate be made by the City Manager's office to make these improvements and corrections to comply with present City ordinances.

"3. City Council then, with a dollar estimate, sets up a finance committee for the City with the purpose of obtaining financing for the people.

"4. With a plan for financing secured, the Building and Safety Department then informs every property owner that might be affected, not with a threatening letter of condemnation, but with a letter with a positive approach that the Building and Safety Department wishes to discuss possible improvements and corrections that are necessary and that financing, as well as maximum compensation, is available at the owners option."

After a lengthly discussion of this matter, which included a request for a moratorium period, the City Council adopted a motion to refer the matter to the City Council's Ordinance Committee for analysis and report. Under date of January 5, 1970, City Manager John R. Mansell sent a communication to the Ordinance Committee of the Long Beach City Council which read in part as follows:

"Since your November meeting, we have continued to review this matter and have come to the conclusion it would be advantageous to have this subject thoroughly reviewed by a qualified consultant with the thought of providing your Committee with the best available outside professional counsel. To this end, we have met with Dr. J. H. Wiggins, President J. H. Wiggins Company, Engineering Consultants in Earthquake Risk and Hazard Evaluation. Dr. Wiggins' Company has provided consulting services in the area of risk and hazard evaluation to Federal, State, and local governments, as well as insurance, mineral and manufacturing industries."

On January 28, 1970, the City of Long Beach contracted with the J. H. Wiggins Company to perform a study evaluating the earthquake hazards in the City of Long Beach. The J. H. Wiggins Company fulfilled the terms of its contract by submitting to the City a report entitled, "Earthquake Safety in the City of Long Beach Based on the Concept of

Balanced Risk" by John H. Wiggins, Jr. and Donald F. Moran. In his report Dr. Wiggins recommended that Section 2314 of the 1970 Edition of the Uniform Building Code be adopted in its entirety with the exception of the following:

1. Lateral forces should vary with importance factors for buildings.

2. Lateral force factors should vary with foundation and site dynamics characteristics.

3. A damping factor of 5% should be used with the possibility of the engineer using a higher damping factor if he can substantiate such a conclusion.

Other recommendations included in Dr. Wiggins' report are as follows:

1. Structures over ten stories in height shall be designed using site dynamics and structural dynamics investigation techniques approved by the Building Official.

2. A specific grading system for evaluating the earthquake hazard is recommended.

3. Specific procedures for inspecting and condemning buildings are delineated.

4. General strengthening procedures are suggested.

5. Calls for the development of a specific post-earthquake plan of action.

6. Suggests that simplified earthquake instrumentation be placed on structures to record future earthquakes.

7. A map of site dynamics of the City should be prepared.

8. An investigation which improves the earthquake insurance and loan situation should be implemented.

9. The harbor soil should be investigated for the quicksand effect during earthquake in light of the investment that is already there and the future investment planned.

10. An approved code dealing with the anchorage of articles such as light fixtures and internal contents be developed.

In June of 1970 a Downtown Property Owners Association hired Attorney Phillip Fife to draft a proposed earthquake safety ordinance for the City

of Long Beach. Such proposed ordinance dealt specifically with the problem of earthquake hazard regulations for the rehabilitation of existing structures within the City of Long Beach. This proposed ordinance was submitted to the Long Beach City Manager's office in December of 1970 and was subsequently reviewed and revised by a committee representing the Long Beach City Attorney's office, the Long Beach City Manager's office, Dr. J. H. Wiggins, Jr., the Long Beach Building Department and Attorney Phillip Fife.

Under date of June 29, 1971, the Long Beach Building Regulations were amended to adopt Ordinance No. C-4950 which appears as Subdivision 80 of the Long Beach Building Regulations entitled, "Earthquake Hazard Regulations for Rehabilitation of Existing Structures Within the City." The main features of such ordinance involve a priority of grading which involves Type III unreinforced masonry buildings as a first order of priority followed by unreinforced masonry veneer walls, reinforced Type III buildings with inadequate lateral capacity and Type I buildings with unreinforced masonry filler walls and poor quality mortar. Another feature of the ordinance is recognition of the fact that existing buildings have some lateral capacity. The ordinance arbitrarily assumes that all existing buildings have a lateral capacity sufficient to resist one-half of the wind forces of the 1970 Uniform Building Code on exposed portions of exterior walls of such buildings. The ordinance also allows the owner to repair existing hazardous buildings for limited periods of life ranging two years to eighty years.

The legal authority to condemn earthquake hazardous buildings was strengthened by a Supreme Court decision of the State of California in the case of City of Bakersfield vs. Milton Miller, L.A. 28224. The Supreme Court said on Page 11 of its opinion the following:

> "The fact that a building was constructed in accordance with all existing statutes does not immunize it from subsequent abatement as a public nuisance. (Queenside Hills Co. v. Saxl (1946) 328 U.S. 80, 83; Knapp v. City of Newport Beach (1960) 186 Cal.App.2d 669,681.) In this action the city does not seek to impose punitive sanctions for the methods of construction used in 1929, but to eliminate a presently existing danger to the public. It would be an unreasonable limitation on the powers of the city to require that this danger be tolerated ad infinitum merely because the hotel did not violate the statutes in effect when it was constructed 36 years ago."

The Long Beach Building Department is processing existing earthquake hazardous buildings under the above-mentioned Subdivision 80 of the Long Beach Municipal Code. It is hoped that this ordinance and its enforcement will resolve the problem of existing earthquake hazardous buildings in the City of Long Beach in a reasonable manner.

This paper attempts to outline two methods of correcting existing earthquake hazardous buildings, namely, the State of California's

program to correct existing earthquake school buildings by the year 1975 and the City of Long Beach, California's efforts to correct existing earthquake hazardous buildings other than public schools. The State of California's efforts to correct existing earthquake hazardous school buildings is the best method. It requires that all public school buildings be brought up to existing earthquake resistant standards of the State of California or be vacated by the year 1975. The City of Long Beach's efforts to correct other earthquake hazardous buildings does not bring under question all existing buildings but only specific types of construction, as mentioned in this paper. Limited life repairs of buildings as permitted by Subdivision 80 of the Long Beach Building Regulations permits owners of structures to repair buildings for earthquake forces which are much less than the earthquake forces required of public school buildings.

Building regulations in the United States at this time include earthquake resistance requirements which are intended only to protect life and limb. Certainly the time has come to go beyond the protection of life and limb and to protect property so that future buildings will be able to survive all the loading conditions they may be subjected to during their lives and still be useful buildings after all such loading conditions. If this is to be done, it will be necessary to (1) design for the vertical accelerations as generated by high magnitude earthquakes and (2) increase lateral force requirements to compare with the accelerations that buildings are subjected to during high magnitude earthquakes. If realistic seismic forces are used in the design of earthquake resistant structures and if the combined stresses of all loading conditions are kept below the yield stresses of the materials used, then future structures may be able to ride all the earthquakes that they will be subjected to during their lives and be useful buildings after such loading conditions.

The engineering profession and building officials of the United States have been and are permitting new buildings to be designed in an unconservative manner. An attempt is made in other man-design and built structures, such as aircraft, to keep stresses induced by all loading conditions within the elastic range of the materials used. In the next revision of building codes all loading conditions which buildings will be subjected to should be recognized and stresses induced by all such loading conditions kept within the elastic range of the materials used. This would not only give reasonable protection to life and limb but would also result in buildings which would be usable after being subjected to high magnitude earthquakes and high velocity winds along with other loading conditions.

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[1]See Elementary Seismology by Charles F. Richter, Seismologist, Page 40

[2]Survey of Earthquake Damage at Long Beach, California by C. D. Wailes,Jr. Chief Building Inspector, Long Beach, and A. C. Hornor, Consulting Engineer, San Francisco

[3]Field Act, Chapter 59 of 1933 Statutes of California

[4]Earthquake Safety in the City of Long Beach Based on the Concept of Balanced Risk by John H. Wiggins, Jr. and Donald F. Moran