

State of California Seismic Safety Commission



Seismic Safety in California's Schools **Findings and Recommendations on Seismic Safety Policies and Requirements For Public, Private and Charter Schools**



California Seismic Safety Commission

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Seismic Safety in California's Schools

EXECUTIVE SUMMARY

The Field Act was enacted on April 10, 1933, one month after the Long Beach Earthquake in which many schools were destroyed or suffered major damage. After the passage of the Field Act, Californians expect that their children are safe if an earthquake occurs while they are attending school. To a very great extent their expectations are being met. This report discusses areas in which the level of safety is questionable.

After the receipt of questions from members of the legislature and the public relating to the collapse of an Italian private school that killed 27 students in an October 2002 earthquake, the Seismic Safety Commission undertook a review of the standards for seismic safety in Californian schools. The timeliness of this effort was reinforced after the Commission toured the Paso Robles area and viewed the damage to a California public school resulting from the “moderate” December 22, 2003 San Simeon earthquake. The review, detailed in this report found that several issues impact the relative seismic safety of school children in California. These findings are:

- In any community, public schools constructed under the Field Act after 1978 are likely to be among the safest buildings in which to experience a major earthquake.
- Private schools are not required by law to meet the Field Act standards, and therefore are not likely to be as safe as public schools of similar age.
- Many private schools use older buildings and can pose a serious risk to the life-safety of their students. The full extent of the problem cannot be assessed because of lack of consistent regulation and enforcement. Also no survey has been done for private schools. In some jurisdictions, no special provisions for private school safety may be in force because of confusion about the applicable regulations. There is significant confusion and concern about seismic safety of private schools among the public.
- Older public schools (pre-1978) may not be as safe as modern buildings and could be improved.
- Non-structural components that are not anchored or braced, such as mechanical, electrical and architectural elements, in older schools can pose significant life-safety risks.
- No regulations cover the anchoring and bracing of the contents of buildings installed after construction is complete. These contents can pose significant risks of injury and possibly death to students even in recently constructed public school buildings.

The Commission recognizes the shortage of governmental funding and has focused its recommendations on little or no cost steps that can improve school safety now and provide information to policy makers that could be used to establish priorities for later funding. The Commission recommends that the State undertake several actions to reduce the risk faced by our children. These are:

- Modify the Private Schools Building Safety Act and Charter School Act to clarify seismic safety provisions. This could be done without cost to the taxpayers and need not wait until better economic times. Provide education and training to local jurisdictions to improve consistency and enforcement of the regulations.
- Establish a program to evaluate the seismic safety of existing public and private school buildings constructed prior to 1978 and 1986, respectively. About 7500 public school buildings were identified as potentially at risk by the Division of the State Architect (DSA) in a study mandated by AB 300 (Chapter 62, Statutes of 1999). Require this evaluation for all existing schools and whenever any building is converted to private school use. Explore options, such as interactive websites, for dissemination the resulting ratings to interested parties, including parents.
- Create seismic safety inventory for private and charter schools.
- Where possible, require retrofitting of older schools, both public and private, or if retrofitting is not feasible, provide disclosure of risks.
- Evaluate number of potentially hazardous architectural, electrical and mechanical elements in older schools that are not anchored or braced and develop and apply mitigation guidelines.
- Regulate and enforce securing of school contents.

INTRODUCTION

On October 2002, a magnitude 5.4 Earthquake struck San Giuliano Di Puglia in Italy and killed 27 children in a private school building that collapsed. On December 22, 2003, a magnitude 6.5 Earthquake struck San Simeon in the County of San Luis Obispo. The quake caused 2 deaths, 49 injuries and approximately 290 homes and 190 commercial structures were damaged. One building collapsed and 20 were severely damaged in Paso Robles. In general public school buildings performed very well except for one, the George H. Flamson Middle School that was a pre-Field Act school retrofitted in 1959 to the standards of that time. The building suffered minor to significant, although not life threatening, damage.



Private school building that collapsed when 5.4 magnitude earthquake struck San Giuliano Di Puglia in Italy in October 2002

The California Seismic Safety Commission has responded to inquiries from members of the Legislature, the public, and parents about the seismic safety requirements for schools in California. Concerns have been raised about the risks posed by older school buildings, the different seismic standards for public, private and charter schools, and the safety of buildings converted to school use. A common theme in these questions is that parents have a right and a desire to know if their children's schools are safe, regardless of whether they are public, private or chartered.

In response, the Commission established a committee to prepare a report on the standards for seismic safety in public, private and charter schools. The committee held four meetings and received testimony from the Division of State Architect and the building

officials from seven Californian communities. The goal was an in-depth look at the earthquake policies for schools to provide a way for parents to judge if there is a significant difference in risk to their children from the results of earthquakes and the various choices they may have for schools (public, private or charter) and for legislators and decision makers to determine if legislation is required to protect the safety of California's schoolchildren. The report considers the risks posed by new construction, existing buildings of differing ages, and the contents of the buildings for public, private and charter schools.

DISTRIBUTION OF K-12 SCHOOLS IN CALIFORNIA

Almost 9% of California's school children attend private schools and that percentage exceeds 15% in some counties. In addition, charter schools in California serve 2.2% of our students and some of these schools are not covered by public school regulations. The distribution of students in these three types of schools is shown below.

Type of K-12 Schools	Number of Schools	Enrollment
Public	9,100	6,299,015
Private >25 Enrollment	2,755	586,764
Private >5<26 Enrollment	996	12,841
Charter Schools	443	164,798

Data compiled by Specialized Programs Division, CDE, 2004 (www.cde.ca.gov). This table includes only private schools with enrollment of at least 6 or more students.

Students in private schools accounted for 8.7% of the total 2003-2004 enrollment of schools. Almost 64% of the students enrolled in private schools attended church-affiliated schools. Counties having more than 10% of their total students enrolled in private schools in 2003-2004 were: Alameda (11.8), Contra Costa (10.3), Los Angeles (10.5), Marin (19.7), Napa (13.4), Orange (10.1), San Francisco (29.1), San Mateo (15.4), Santa Clara (12.4), Santa Cruz (11.2).

CONSTRUCTION OF NEW SCHOOLS

The seismic safety standards for new private



Public school damaged in the 1933 Long Beach Earthquake

schools are not as stringent as those for new public schools. The construction of school buildings is covered by different regulations for public and private schools. Public school construction has been governed by the Field Act since 1933 and enforced by the State Division of the State Architect. There were no special regulations for construction of private schools before 1986. Since then, their construction is governed by the Private School Act and enforced by local jurisdiction building departments.

Public Schools and the Field Act. The Field Act was enacted on April 10, 1933, one month after the Long Beach Earthquake in which 70 schools were destroyed, 120 schools suffered major damage, and 300 schools received minor damage. Since (a) public schools are funded with public money, (b) schools house the children of the electorate, and (c) the State Constitution requires children to attend schools, the state is liable and thus responsible for protecting children and staff from injury in public schools grades K-12 and community colleges and protecting the public's investment in school buildings during and after earthquakes.

The Act requires:

- School building construction plans be prepared by qualified California licensed structural engineers and architects;
- Designs and plans be checked by the Division of the State Architect (DSA) for compliance before a contract for construction is awarded;
- Qualified inspectors, independent of the contractors and hired by the school districts, continuously inspect construction and verify full compliance with plans;
- The responsible architects and/or structural engineers inspect the construction periodically and prepare changes to plans (if needed) subject to approval by DSA;
- Architects, engineers, inspectors and contractors must file reports, under penalty of perjury, to verify compliance of the construction with the approved plans emphasizing the importance of testing and inspections to achieve seismically safe construction. Any person, who violates the provisions or makes any false statement in any verified report or affidavit required pursuant to the Act, is guilty of a felony.

Private Schools and the Private Schools Building Safety Act. Private schools are not subject to the Field Act and fall solely under the jurisdiction of the local building departments and their requirements. Private schools are covered under the Private Schools Building Act of 1986, with the legislative intent that children attending private schools be afforded life safety protection similar to that of children attending public schools.

The Act requires the following:

- School construction plans are prepared under the responsible charge of California-licensed architects, civil engineers or structural engineers;
- Designs and plans are checked by the enforcement agencies that have structural engineers, either on staff or under contract that are responsible for all design review conducted by enforcement agencies;
- During construction or alteration of a school structure special inspections by a qualified inspectors are required when need is determined by the enforcement agencies. Continuous inspection is not required;

- Jurisdictions that do not have an enforcement agency meeting the requirements of the Act shall obtain necessary qualified personnel to meet the requirements by contracting with other public agencies, private sector firms or individuals qualified to perform the necessary services;
- The architects, civil engineers or structural engineers exercise general responsibility over construction for compliance with the approved plans. If they are unable other architects, civil engineers or structural engineers shall be retained to exercise general responsible charge of construction. Any person who willfully violates the Act is guilty of a misdemeanor.

Charter Schools. Charter schools must comply with the Field Act requirements if their charter requires it. Moreover, to qualify for the 2002 and 2004 K-12 Bond (Prop. 47 and Prop. 55) funds allotted for new charter school construction they must comply with Field Act requirements. Which building regulations apply when the Field Act does not apply appears to be subject to debate and interpretation. Some charter schools have argued that they should be exempt from any plan review of the design or inspection of the construction by either the State Architect or the local building departments.

Finding 1. The Private School Act states that it is “the intent of the Legislature that children attending private schools be afforded life safety protection similar to that of children attending public schools.” (Education Code Section 17322) However, the differences in governing regulations have produced very different standards for seismic safety. Appendix A provides a summary of the differences in the requirements of the Field Act and Private School Act requirements. The most significant differences are:

- The Field Act provides more comprehensive field control of construction through continuous inspection.
- The Field Act provides more rigorous checking of the engineering designs and plans to ensure safety.
- Although the Private School Act called for equivalent seismic safety, it cites the California Building Code and not the portion of that code governing Field Act buildings as the standard resulting in many instances in lower standards (see Appendix A).
- Because the Private School Act is in the Education Code, apparently many local building departments are unaware of its existence and thus do not enforce it.

In summary, private schools are not required to be and therefore are not likely to be as safe as public schools of similar age.

The application of the Field Act has been estimated to add 3-4% to the cost of construction of a new school building (DSA, Field Act Cost Impact Study, 1992). However, the long-term costs are less because of the reduced damage levels to these buildings when large earthquakes do occur. One study of the 1971 San Fernando earthquake (Assessing Seismic Safety Policy, Daniel Barclay, Seismological Research Letters [SRL], Vol. 74, No. 1, Jan./Feb. 2003) showed that Field Act buildings within 25 miles of that earthquake’s epicenter suffered losses equal to 0.3% of the buildings’ value while other build- ings in the same area suffered losses

Public Schools – Pre-1978. Seismic building standards have been greatly strengthened after significant damage to buildings was observed in past earthquakes, especially the 1971 San Fernando earthquake. The building codes in place since 1978 are considered adequate in most cases. In the late 1960s (Section 15516, Appendix X, Education Code, 1968), regulations were put in place to have pre-Field Act (1933) buildings retrofitted, removed from school use or demolished. The Field Act also prohibits use of unreinforced masonry buildings as schools buildings.

Finding 2. Buildings built or retrofitted under the Field Act between 1933 and 1977 pose one of the most significant safety issues for public schools. AB 300 (Chapter 62, Statutes of 1999) required the Division of the State Architect (DSA) to conduct an inventory of pre-1978 non-wood frame public school buildings (K-12), i.e. those of concrete tilt-up, reinforced concrete or steel frame. Some of these suspect buildings have been retrofitted when other construction has triggered an upgrade of the safety standards. DSA determined that about 7500 buildings are potentially unsafe and required further evaluation. The potentially unsafe buildings amount to approximately 15% of the total number of public school buildings. DSA recommended that the standard for rehabilitation be to the performance objectives for new public school construction. However, no funds have been identified to enable school districts to undertake this rehabilitation or even to undertake the evaluation of their suspect buildings.

Finding 3. Further risks can be found in older structures from the mechanical, electrical, and architectural features in the school buildings. Since the 1980s the installation of these features has been regulated to ensure adequate anchoring of these heavy items. The features in older unmodified buildings can pose a significant safety risk.

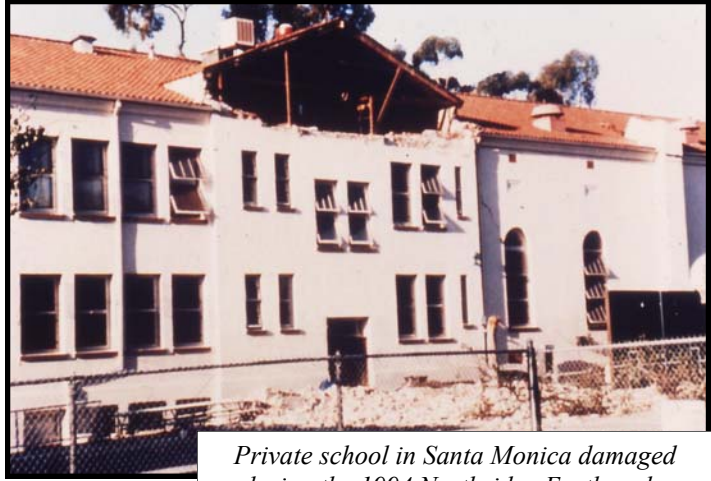
Private Schools. An unknown, but probably large number of private school buildings were constructed before the Private School Act of 1986 and some likely pose a significant life safety risk to their students. The regulations covering the original construction of these buildings and any retrofitting upon their conversion to school use vary widely between jurisdictions.



Collapse light fixtures in public school classroom during the 1983 Coalinga Earthquake

Finding 4. A current inventory of pre-1986 private school buildings does not exist. This makes it difficult to describe the regulations applicable to private schools in all situations. The major issues are:

- Unreinforced masonry buildings (URM) are widely recognized as the most dangerous type of construction in earthquakes. These buildings have not been built in California since 1935 and no public schools are in a URM. However, 40 private schools were in URM buildings in 1995. URM buildings that have been retrofitted to the requirements of Chapter 88 of the Unreinforced Masonry (URM) Code or 75% of the current code can be converted to private or charter school use.



Private school in Santa Monica damaged during the 1994 Northridge Earthquake

- The California Building Code requires that when a building is converted to a higher occupancy use, it must be retrofitted to modern safety standards for that level of use. However, this requires that the size of the school is large enough to trigger this requirement and that a building permit is requested.
- A school of long standing has no requirement to upgrade the seismic safety of its older buildings. The building has to come to the attention of the local building department after 1986 for any evaluation of the safety to be done. Moreover, because enforcement lies with local building jurisdictions rather than DSA, enforcement can be variable. Local building officials may be unaware of the Private School Act because it is in the Education Code and not the Building Code.

Charter Schools. The Charter Schools Act of 1992 created charter schools and there is no inventory of the buildings occupied by these schools. The Charter School Act left it unclear what seismic safety regulations apply to charter schools. To qualify for the 2002 and 2004 K-12 Bond (Prop. 47 and Prop. 55) funds allotted for new charter school construction they must comply with Field Act requirements.

Finding 5. Those charter schools that do not fall under the Field Act are left in a regulatory limbo. Some charter schools have argued that they are exempt both from the Field Act and from local building codes.

CONTENTS OF BUILDINGS

As building standards have improved, the risk to occupants posed by the contents of buildings including furniture and equipment have not seen similar improvements. Four of the direct deaths in the Northridge earthquake were caused by the movement of the contents of buildings, such as falling bookcases. The securing of most of the contents of school buildings is unregulated.

Finding 6. The movement of contents of buildings during earthquakes pose a significant risk to student safety in all types of schools, new and old, public and private. In general, these items are brought into the building after inspection is over. Guidelines, (Guide and Checklist for Nonstructural Earthquake Hazards in California Schools, January 2003) (SB 1122, Statutes of 1999) for securing these objects have been prepared by the Office of Emergency Services (OES) in a joint project with DSA, Seismic Safety Commission (CSSC) and Department of Education (CDE), but the use of them is completely voluntary. The application of these safety measures is often left to the PTA, resulting in higher safety levels for those schools with a more active PTA.

RECOMMENDATIONS

Clearly, California schools cannot guarantee the safety of schoolchildren even in some buildings constructed in accordance with the Field Act if an earthquake were to happen during school hours. Because children are in school less than 1/3 of the 24 hours of the day on less than one-half the days of the year, most earthquakes happen when they are not at school. Indeed, California has been lucky in that no damaging earthquake of the last 70 years has occurred during school hours. Nevertheless, it is only a matter of time until this will occur. The Loma Prieta Earthquake of 1989 and the Northridge Earthquake of 1994 released only a fraction of the energy released in the 1906 San Francisco Earthquake. If nothing is done to improve the safety of our schools, moderate and large earthquakes that occur while the buildings are occupied could injure or even kill children in school.

Ideally, all the deficient schools would be retrofitted and regulations developed to secure the non-structural items and building contents that pose a risk. In the real world, this will require substantial resources. The largest risks are posed by private schools, and will require actions by private groups and citizens to fund evaluations and retrofits. Given that this will probably prevent a complete elimination of the problem in the foreseeable future, the Seismic Safety Commission believes that parents need to be able to determine the safety risks of a school building so that they can make an informed decision about their children's educational options.

Recommendation 1. Establish a procedure to evaluate the seismic safety of existing public and private school buildings constructed prior to 1978 and 1986, respectively. About 7500 public school buildings were identified as potentially at risk by the Division of the State Architect (DSA) in a study mandated by AB 300 (Chapter 62, Statutes of 1999). This evaluation should be required for all existing schools and whenever a building is converted to private school use. Explore options, such as interactive websites, for dissemination the resulting ratings to interested parties, including parents. This seismic safety evaluation could be required to be given to prospective parents when they apply to a private school.

Of course, actually eliminating the risk is preferable. A minimum step is to assure that no future school buildings are created without adequate design and construction to resist damage from earthquakes. Existing building codes are adequate as long as they are enforced. This requires that the provisions covering private and charter schools be clearly delineated.

Recommendation 2. Modify the Private Schools Building Safety Act and Charter School Act to clarify seismic safety provisions. Charter schools should not be able to argue their way out of all building codes. Provide education and training to local jurisdictions to improve consistency and enforcement of the regulations.

The State has always expressed a great responsibility for the safety of public schools because students have no choice in being there. None-the-less the risk posed by older public schools needs to be addressed.

Recommendation 3. Explore options for funding the seismic upgrading of the public schools identified as hazardous under AB300.

Recommendation 4. Evaluate number of potentially hazardous architectural, electrical and mechanical elements in older schools that are not anchored or braced and develop and apply mitigation guidelines.

Recommendation 5. Regulate and enforce securing the anchoring and bracing of school contents installed, especially after construction is complete. Voluntary guidelines from the Division of State Architect and the Office of Emergency Services provide the information needed to accomplish this goal. Made mandatory, these regulations could be enforced by local fire departments as part of their annual fire inspection of public schools. This should not be left to local parent groups to complete. Doing so increases the disadvantages experienced by schools

without active parent participation.

* * *

APPENDIX A: Side by Side Comparison Field Act and the Uniform Building Code

General: *The Field Act gives the Division of the State Architect (DSA) authority to write regulations for design and construction of public schools from kindergarten through community colleges. The DSA writes amendments to the model code to create Title 24, California Code of Regulations (CCR) as they relate to public schools. The model building code has been the Uniform Building Code (UBC) ever since the Field Act went into effect. Below is a side-by-side comparison of the significant differences*

Title 24, CCR for Public Schools	Uniform Building Code
Administrative Requirements	
Design Professionals	
An architect or a structural engineer must be in general responsible charge of the design and construction	A civil engineer is also allowed to be in general responsible charge of the design and construction
Plan Approval Process	
Requirements for submitting the site data, geologic hazard reports, calculations, change orders are provided in detail. The process of reviewing, marking the plans, and verification of corrections are delineated	Detailed requirements are not provided.
Inspection	
Continuous inspection by an inspector approved by DSA is required	Periodic inspection at construction milestones (i.e. before concrete placement, before covering structural framing, gypsum board inspection)

between Title 24, CCR and the UBC. Since portions of the Field Act have direct impact on the development of the Title 24, CCR regulations those Field Act requirements will be shown in bold font.

Title 24	UBC
Verified Reports	
The inspector is required to provide a verified report under penalty of perjury attesting that the construction is in compliance with the approved plans and specifications based on personal knowledge provided by continuous inspection	No similar report is required
The architects, engineers, and contractors are required to provide a verified report under penalty of perjury attesting that the construction is in compliance with the approved plans and specifications based on periodic visits to the site and the reporting of others.	No similar report is required
Structural Requirements	
Bleachers	
Additional details and inspection requirements	No similar requirements
Dynamic Analysis	
A calculation is required to determine if an earthquake with a 10% probability of exceedance in 100 years would cause a collapse is required, in addition to the 10% in 50 years calculation of the design of a structural system.	The structural design to resist the forces for the 10% probability in 50 years earthquake is the same as Title 24, CCR. There is no similar 10% probability in 100 years collapse evaluation required.
Foundation Strength	
Additional requirements for foundation and superstructure-to-foundation connections	No similar requirements

Title 24	UBC
Elevators	
The design for stability of the elevator system is subject to additional requirements.	No similar requirements
Classroom Floor Loads	
50 pounds per square foot	40 pounds per square foot
Seismic Importance Factor for Occupancy over 300	
I = 1.15	I = 1.00
Wind Importance Factor for Occupancy over 300	
I = 1.15	I = 1.00
Precast Concrete Walls	
Additional reinforcing is required.	No similar requirements
Post-tensioned Precast Concrete	
Additional requirements for anchorages and couplers, lift slab construction, and flat slab construction are indicated.	No similar requirements
Expansion Anchors in Concrete	
Tension testing is required.	Testing not required
Bolts Embedded in Concrete	
Allowable loads are much smaller when the force on the bolt is directed towards the edge of the concrete. For example a 1-inch diameter bolt placed 6 inches from the edge would have an allowable value of 1,700 pounds.	A 1-inch bolt placed 6 inches from the edge would have an allowable value of 4,500 pounds.
Masonry Construction	
All cells filled solid with grout	Optional based on stresses
Wall reinforcing spacing 2 feet on center	Wall reinforcing spacing 4 feet on center
Masonry core testing required	Not required

Title 24	UBC
Wood Construction	
Glue-laminated beams special inspection required	Not required
Gypsum board not allowed to resist lateral forces	Gypsum board allowed to resist lateral forces
Not allowed: Project specific design required.	Use of standard sizes and spacing of wood members for design. “Conventional” wood framing design

This side-by-side comparison of the Title 24 (Field Act) with the Uniform Building Code doesn't address enforcement of the code provisions. The staffing of the over 500 jurisdictions that review designs and enforce the code provisions during construction varies considerably. Some jurisdictions rely almost entirely on the expertise of the designer and the contractor. Others such as the Los Angeles Building Department and the Division of the State Architect perform a rigorous review and have an active presence during the construction.

Necessarily the depth and breath of enforcement is inconsistent and can outweigh the difference in the code provisions as to the safety of the design and construction.

