

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

December 2004



California Seismic Safety Commission

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Seismic Safety in California's Schools

EXECUTIVE SUMMARY

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. The public concern was increased when a pre-Field Act California public school, seismically retrofitted in 1959, was damaged in the moderate December 22, 2003 San Simeon earthquake. A common theme in these questions is that parents have a right and a desire to know if their children's schools, whether public, private or chartered, are safe. A review of policies and standards was conducted and this report was developed to answer these questions.

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. Since the passage of the Field Act, Californians have expected that their children would be safe if an earthquake occurred while they were attending school. To a very great extent their expectations are being met. This report considers those situations where schools may fall short of our expectations. The goal of this investigation is to ensure that similar seismic safety be provided to all school children in California, whether they attend public, private or charter schools in new or old buildings.

The review detailed in this report found that several issues impact the relative seismic safety of school children in California. The principal 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;
- Private schools located in older buildings can pose a serious risk to the life-safety of their students. The full extent of the problem cannot be assessed because of the lack of information about historical regulation and enforcement during design and construction of private school buildings. No survey has been done for private schools. In some jurisdictions, no special provisions for private school safety may be in force because of the confusion about the applicable regulations;
- Certain older public school buildings may not be as safe as modern buildings and have the potential to be a life-safety risk to their occupants, because they were constructed to pre-1978 building code standards;
- Only some charter school buildings are subject to the Field Act provisions. What rules do apply when the Field Act does not is unclear to many school and building officials;
- Non-structural components that are not anchored or braced in older schools, public, private and charter, such as mechanical, electrical and architectural elements, 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, if not properly secured, can pose significant risks of injury and possibly death to students even in recently constructed public school buildings.

The Commission recognizes that only limited governmental funding is available 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:

- Complete the process of rating the seismic safety of existing public and private school buildings constructed prior to 1978 and 1986, respectively. About 7500 public school buildings were rated as potentially at risk by the Division of the State Architect (DSA) in a study mandated by AB 300 (Chapter 62, Statutes of 1999). Current ratings of seismic safety should be required for all existing schools and whenever a building is converted to public, private, or charter school use. Explore options, such as interactive websites, for disseminating the resulting ratings to interested parties, including parents. This seismic safety rating should be given to prospective parents when they apply to a public, private, or charter school;
- Modify the Private Schools Building Safety Act and Charter School Act to clarify seismic safety provisions. This could be done at minimal 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 current building codes and regulations. Provide training for private and charter schools to help them understand how to ensure seismic safety in their buildings, especially the benefits of building or retrofitting to the current Field Act standards;
- Explore options for funding the seismic upgrading of the public schools identified as hazardous under AB 300, and support private schools in their efforts to improve the seismic safety of their buildings. If retrofitting is not financially feasible, provide disclosure of risks;
- Include in the seismic safety ratings for all schools the potentially hazardous architectural, electrical and mechanical elements that are not anchored or braced and develop and apply mitigation guidelines;
- Regulate and enforce securing of school contents. Mandatory regulations could be enforced by local fire departments as part of their annual fire inspection of public schools.

INTRODUCTION

In response to damage to school buildings in recent earthquakes, the California Seismic Safety Commission established a Committee to determine and report to the Commission the standards for seismic safety that are currently applied to public, private and charter schools in the State of California. The committee held six 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-resistant building design and construction policies for schools, in order to provide legislators and decision makers enough information to determine if additional legislation is required to protect the safety of California's schoolchildren. The Committee also considered how to help parents judge if there is a significant difference in earthquake risk to their children among the various choices they may have for schools (public, private or charter). 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. The Committee received input from the Office of the Secretary for Education, Office of the State Superintendent of Public Instruction, California Association of Private School Organizations (CAPSO), California Catholic Conference (CCC), State Superintendents of Private Schools Advisory Committee (PSAC), California Charter Schools Association (CCSA), and Western Association of Schools and Colleges-Western Region Joint Accreditation of Public and Private Schools (WASC).



This school building collapsed when a 5.4-magnitude earthquake struck San Giuliano Di Puglia in Italy in October 2002.

DISTRIBUTION OF K-12 SCHOOLS IN CALIFORNIA

In the 2003-2004 school year, almost 9% of California's school children attended private schools and that percentage exceeded 15% in some counties. In addition, charter schools in California served 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	9,221	6,298,769
Private >25 Enrollment	2,755	586,764
Private >5<26 Enrollment	996	12,841
Charter Schools	443	164,798

Data compiled by DataQuest and the Specialized Programs Division, California Department of Education (CDE), 2004 (www.cde.ca.gov). This table includes only private schools with enrollment of at least six 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), and Santa Cruz (11.2).

CONSTRUCTION OF NEW SCHOOLS

The seismic safety standards for construction of new private schools are not as stringent as those for new public schools. Public school construction has been governed by the Field Act since 1933 and enforced by the Division of the State Architect. There were no special standards for construction of private schools before 1986. Since then, their construction has been governed by the Private School Act and enforced by local jurisdiction building departments. The two processes will be discussed separately.

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 for protecting the public's investment in school buildings during and after earthquakes.



Public school damaged in the 1933 Long Beach earthquake.

The Field 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 with the Field Act before a contract for construction can be 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 observe the construction periodically and prepare changes to plans (if needed) subject to approval by DSA;
- Architects, engineers, inspectors and contractors 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 verification 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 Private Schools Building Safety Act requires:

- School construction plans be prepared under the responsible charge of California-licensed architects, civil engineers or structural engineers;
- Designs and plans be checked by the enforcement agencies using structural engineers, either on staff or under contract, that are responsible for all design review;
- During construction or alteration of a school structure, special inspections by qualified inspectors 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 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 projects' 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 building officials during this study stated that 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 differences in governing regulations do produce different standards for seismic safety. Because private schools are not required to meet the same rigid requirements for design and inspection for construction control as public schools, they may be less safe than public schools of a similar age.

The Private Schools 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). Appendix A presents a summary of the differences in the requirements of the Field Act and Private Schools Act requirements. The most significant differences are:

- The Field Act requires more comprehensive field control of construction through continuous inspection;
- The Field Act requires more rigorous checking of the engineering designs and plans to ensure compliance with the Act;
- Although the Private Schools Act called for similar 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 Schools Act is in the Education Code, apparently many local building departments are unaware of its existence.

If the requirements of the Private Schools Building Safety Act are carefully followed, the resulting buildings should provide a level of safety about the same as other “non-school” buildings in the local community. Unfortunately, many local building departments do not have the resources to ensure full compliance with the Private Schools Building Safety Act. Because of the lack of continuous inspection, substandard construction is more likely in a non-Field Act building.

The application of the Field Act has been estimated to add 3-4% to the cost of construction of new school buildings (DSA, Field Act Cost Impact Study, 1992). However, the long-term costs are less, because in addition to protecting the lives and safety of the students, these buildings experience less damage when large earthquakes do occur. One study of the 1971 San Fernando earthquake 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 buildings in the same area suffered losses on average equal to 18% of their value (Assessing Seismic Safety Policy, Daniel Barclay, Seismological Research Letters [SRL], Vol. 74, No. 1, Jan./Feb. 2003).

OLDER STRUCTURES

Older buildings are less safe than new buildings for both public and private schools because they were designed and constructed to now out-dated codes. Moreover, the disparity in safety levels between public and private schools of similar age is even greater for older structures. The problems posed by older public and private school buildings are discussed separately below.

Public Schools – Pre-1978. 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. Seismic building standards in general were greatly strengthened after significant damage to buildings was observed, especially in the 1971 San Fernando earthquake. The Field Act regulations in place since 1978 are considered adequate for most public school buildings in most cases.

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. In 2003, the Division of State Architect determined that about 7,500 pre-1978 public school buildings are potentially a risk and require further evaluation. Those potentially at risk 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. The findings from the 2003 DSA study have not been generally forwarded to the individual school districts involved. DSA notified the districts that the information was available if the district wished to pursue the matter. Only 70 of more than 1,400 school districts have requested the information as of November 2004.

Finding 3. Further risks can be found in older structures from un-anchored and/or unbraced mechanical, electrical, and architectural features in the school buildings. Since the 1980s, the installation of these features has been regulated to ensure adequate anchoring or bracing 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. Some of those buildings likely pose a significant life safety risk to their students and teachers, especially those constructed of unreinforced masonry, concrete tilt-up, reinforced concrete or in some cases, steel frame. The regulations covering the original construction of these buildings, and any retrofitting upon their conversion to school use, vary widely between jurisdictions.

Because private schools are not subject to Field Act standards, and many private schools are housed in older buildings, older private schools are of the greatest concern for the life safety of students. Compilations of historical earthquake damage to private schools are not available, but there is no reason to think that private school buildings will behave differently than the general building stock. As cited earlier, a study in the 1971 earthquake showed that Field Act buildings performed substantially better than the general building stock.

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:



Damage to a private school in the 1994 Northridge earthquake.

- 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. Any URM building that has been retrofitted to the requirements of the Uniform Code for Building Conservation, Appendix Chapter 1 (i.e., 75% of the seismic loads required for design by the current code) can be converted to private or certain charter school use. In some cases URMs have been retrofitted to even lesser standards. Many engineers feel that the 75% seismic load criterion may provide protection against collapse but may not provide for life safety protection;
- 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 required retrofit may not have been triggered if the building was small or if the change of occupancy did not come to the attention of the local building authority;
- There are no requirements for private schools of long standing to upgrade the seismic safety of their older buildings. Generally these buildings do not come to the attention of the local building department. Moreover, because enforcement lies with local building jurisdictions rather than DSA, enforcement can be variable. There was testimony to the Committee that not all local building officials were aware of the Private Schools Act, because it is in the Education Code and not in the Building Code;

Charter Schools. There is no inventory of the buildings occupied by charter schools. The Charter School Act of 1992 left it unclear what seismic safety regulations would 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. Charter school buildings that do not fall under the Field Act are left in a regulatory limbo. Because of misunderstanding in interpretation of applicable building codes, local building officials have indicated that some charter schools moving into existing buildings have not been required to perform seismic upgrades of those buildings.

CONTENTS OF BUILDINGS

As building standards have improved, the risks to occupants posed by the contents of buildings, including furniture and equipment, have become more significant. Four of the deaths in the Northridge earthquake were directly caused by the movement of the contents of buildings, such as falling bookcases. The securing of most of the contents of school buildings is currently unregulated.

Finding 6. The movements 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 initial construction inspections are over. Guidelines (Guide and Checklist for Nonstructural Earthquake Hazards in California Schools, January 2003) (SB 1122, Statutes of 1999 mandated by Government Code Section 8587.7) for securing these contents 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 these guidelines is completely voluntary. The application of these safety measures is often left to the PTA, resulting in higher safety levels for those schools with more active PTAs.



Damage to non-structural components of a school in the Northridge earthquake.

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 the large damaging earthquakes of the last 70 years have all occurred outside of school hours. Nevertheless, it is only a matter of time until our luck will run out. If nothing is done to improve the safety of certain schools, occupants will die in future moderate and large earthquakes.

Ideally, all the deficient schools would be retrofitted and regulations developed to secure the non-structural items and building contents that pose a risk. However, this will require substantial financial resources. The largest risks are posed by private schools, and some charter schools that are housed in older buildings, especially those in unreinforced masonry buildings. Given that a complete elimination of the problem is

unlikely 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 informed decisions about their children's educational options.

Recommendation 1. Complete the process of rating 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 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 public, private, or charter school use. Explore options, such as interactive websites, for disseminating the resulting ratings to interested parties, including parents. This seismic safety evaluation should be given to prospective parents when they apply to a public, private, or charter 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 provide protection at about the same level as other non-school buildings in the community, as long as they are consistently enforced. This is not equivalent to the protection provided by the Field Act provisions, and the community must understand that there will be greater risk to children in these buildings and greater damage to the buildings themselves during earthquakes.

Recommendation 2. Modify the Private Schools Building Safety Act and Charter School Act to clarify seismic safety provisions. Provisions should be developed to ensure that charter schools must conform to the applicable local building codes when the Field Act does not apply.

Recommendation 3. Provide education and training to local jurisdictions to improve consistency and enforcement of the regulations. Provide training for private and charter schools to help them understand how to ensure seismic safety in their buildings.

The State has always expressed a great responsibility for the safety of public schools because students are required to attend school. The risk posed by older public schools needs to be addressed.

Recommendation 4. Explore options for funding the seismic upgrading of the public schools identified as hazardous under AB 300 and to support private schools in their efforts to improve the seismic safety of their buildings.

Recommendation 5. Evaluate the types of potentially hazardous architectural, electrical and mechanical elements in older schools that are not anchored or braced and develop mitigation guidelines. Require compliance with these improvements.

Recommendation 6. Regulate and enforce securing the anchoring and bracing of school contents installed, especially after construction is complete. Voluntary guidelines from DSA and OES 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 between Title 24, CCR and the UBC as applied to private schools.

Field Act Title 24, CCR for Public Schools	Uniform Building Code for Private Schools
Administrative Requirements	
Design Professionals	
An architect or a structural engineer must be in general responsible charge of the design and construction.	In addition to an architect and structural engineer, 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 special inspection at construction milestones (i.e. before concrete placement, before covering structural framing, gypsum board inspection).

Field Act Title 24, CCR for Public Schools	Uniform Building Code for Private Schools
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 above the UBC.	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.

Field Act Title 24, CCR for Public Schools	Uniform Building Code for Private Schools
Foundation Strength	
Additional requirements above the UBC for foundation and superstructure-to-foundation connections	
Elevators	
The design for stability of the elevator system is subject to additional requirements above the UBC.	
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 above the UBC.	
Post-tensioned Precast Concrete	
Additional requirements for anchorages and couplers, lift slab construction, and flat slab construction are indicated.	

Field Act Title 24, CCR for Public Schools	Uniform Building Code for Private Schools
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 shear value of 1,700 pounds.	A 1-inch bolt placed 6 inches from the edge would have an allowable shear 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.
Wood Construction	
Glue-laminated beams special inspection required.	Not required.
Gypsum sheathing board not allowed to resist lateral forces.	Gypsum sheathing board allowed to resist lateral forces.
"Conventional" wood framing design is not allowed: Project specific design required.	"Conventional" wood framing design allowed – Use of standard sizes and spacing of wood members for 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 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.