



**OECD PROGRAMME ON EDUCATIONAL BUILDING (PEB)  
AND GEOHAZARDS INTERNATIONAL (GHI)**



**AD HOC EXPERTS' GROUP MEETING  
ON EARTHQUAKE SAFETY IN SCHOOLS**

**OECD, PARIS, 9 TO 11 FEBRUARY 2004**

**PREFACE**

Schools play a vital role in every community. They are the places where students learn and teachers teach, and they are used for social gatherings, theatre and sports. Schools are a measure of community well being.

School buildings also play an important role in responding to and recovering from natural disasters. When a hurricane or flood is expected, schools can serve as emergency shelters and, as such, can be used to house, feed and care for the local population. After an earthquake, schools provide shelter for people whose homes were destroyed or damaged.

Earthquake-threatened communities need earthquake-resistant schools. When schools are closed because of earthquake damage, education is hampered, community life disrupted, and emergency shelters unavailable. Where school attendance is compulsory, communities have a moral obligation to provide a safe study and work environment. But most importantly, earthquake-threatened communities need earthquake-resistant schools to protect their children and teachers.

The recent earthquakes in Morocco, Iran, Algeria, Turkey and Italy all demonstrate that earthquake-threatened communities do not yet have earthquake-resistant schools. In some of these earthquakes, schools that collapsed and killed students were modern and located near older buildings that did not collapse. In one case, a poorly constructed new addition appears to be the cause of collapse; in other cases, unexpectedly strong ground shaking appears to be the problem; and in most cases, it appears that the building code was not enforced. Most of these earthquakes did not occur when school was in session; otherwise, the death toll could have been far heavier.

Unless something changes, this situation will worsen. Many countries experiencing the greatest increase in population (and, hence, having the greatest increased need for schools) are also the poorest. Under these circumstances, there is the temptation to build new schools and enlarge existing schools using inferior designs, materials and construction techniques. All countries – rich and poor – face the problem of how to make the large number of their *existing* schools earthquake-resistant. The infrequency of great earthquakes in any one location makes it easy for the public and public officials to forget about the importance of designing, constructing and maintaining earthquake-resistant schools – until it is too late.

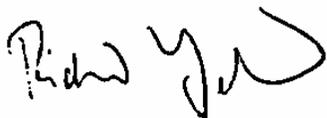
In response to this need, GeoHazards International and the OECD's Programme for Educational Building convened a meeting of internationally renowned experts on school earthquake safety to review

this problem and identify possible solutions. The meeting was held at the OECD in Paris from February 9-11, 2004. The participants were asked to prepare a report that would provide the following:

- A statement of the obstacles to achieving seismic safety of schools and educational systems,
- A discussion of methodologies and criteria for assessing the seismic safety of schools and educational systems, and for monitoring progress toward achieving seismic safety,
- Suggestions for strategies to promote greater seismic safety internationally, and
- Recommendations for OECD actions to assure seismic safety of schools in its member countries.

This publication contains the report of this Ad Hoc Experts Group. It provides a clear and urgent message to the OECD and the governments of its member countries that the problem of schools collapsing during earthquakes and killing students and teachers can and must be addressed before more, greater disasters occur.

We urge you to read this report and help us implement its recommendations.



Richard Yelland  
Head  
OECD Programme on Educational Building (PEB)



Brian Tucker  
President  
GeoHazards International (GHI)

## RECOMMENDATION OF THE EXPERTS' GROUP

The *ad hoc* Experts' Group on Earthquake Safety in Schools unanimously recommends to the Organisation for Economic Co-operation and Development that it undertake urgent action to establish mandatory national programmes for the seismic safety of schools and education systems.

### **Rationale for the recommendation**

All too frequently, strong earthquakes strike OECD member countries, causing collapse of school buildings and the death of innocent children. Although earthquakes are natural and unavoidable events, school buildings need not collapse during earthquakes. The knowledge presently exists to significantly lower the seismic risk of schools and to help prevent further injury and death of school occupants during earthquakes.

Experts from 14 countries and five continents representing international organisations, government, academia, business and non-government organisations (NGOs) deliberated for two and one-half days regarding possible measures to assure the seismic safety of schools and education systems. During these deliberations, scientific, technical, economic, social, political and public policy issues related to earthquake safety of schools were examined. The recommendations contained in this document represent the strong and unanimous view of the *ad hoc* Experts' Group.

The *ad hoc* Experts' Group finds it unconscionable that schools built world-wide routinely collapse in earthquakes due to avoidable errors in design and construction, causing predictable, unacceptable and tragic loss of life. In the last few decades alone, thousands of school children have died because existing knowledge was not applied to make their schools safe from earthquakes. It is only by chance that there has not been much greater loss of life since many earthquakes have occurred outside of school hours. Unless action is taken immediately to address this problem, much greater loss of life of school children and teachers will occur. Currently available technology can resolve this problem at reasonable cost and in a reasonable time frame.

The motivation for school seismic safety is much broader than the universal human instinct to protect and love children. The education of children is essential to maintaining free societies, the social and economic progress of nations, and the welfare of individuals and their families. As a result, most nations make education compulsory. However, a state requirement for compulsory education, while allowing the continued use of seismically unsafe buildings, is an inconsistent and unjustifiable practice. The school seismic safety initiative recommended herein is based on the premise that the very future of society is dependent upon the safety of the children of the world.

The *ad hoc* Experts' Group believes that any meaningful effort to improve the seismic safety of schools and education systems must involve national programmes that are mandatory. The *ad hoc* Experts' Group further believes that an appropriate means through which this goal could be accomplished is the "Decision" form of action employed by the OECD to address other important international issues. The *ad hoc* Experts' Group defers however to the OECD to use its discretion to determine the best means of establishing effective mandatory national programmes for school seismic safety.

## **Role of the OECD in achieving school seismic safety**

Earthquake safety of schools can only be achieved through long-term efforts sustained by participating nations, and understood and supported by all stakeholders. The OECD is ideally suited to play a leadership role in such efforts. The *ad hoc* Experts' Group strongly recommends that the OECD take steps to encourage the establishment of mandatory programmes of school seismic safety among its member countries, and also in OECD partner countries.

The OECD should consider establishing a responsible organisational entity to co-ordinate and manage this effort. This entity would fit well within the OECD Programme on Educational Building (PEB). It should have an Advisory Committee consisting of earthquake safety experts, code enforcement officials, and school facility managers from participating countries, and national advisory committees.

The OECD should work with member countries and partner countries to help them develop and sustain effective school earthquake safety programmes. The OECD organisational entity should be charged with establishing a procedure for accreditation of national school seismic safety programmes and a means for assessing and validating the status, progress and effectiveness of these programmes. Participating countries should regularly submit updated school seismic safety implementation plans and progress reports for review and acceptance by the OECD organisational entity. This entity should periodically evaluate national programmes by conducting reviews of reports and inspection of practices within the nations. OECD should publicise the results of its evaluations and possibly issue certificates of compliance, publicly recognising those nations that meet or exceed the expectations established for acceptable national programmes. The OECD organisational entity should develop recommendations for how to reward exemplary programmes, and improve programmes that are less than exemplary.

Participating countries will have common needs for school risk management tools and programme materials to increase the effectiveness of their school seismic risk reduction programmes. The OECD entity should provide information, facilitate international information sharing, develop and disseminate informational materials and tools, and advise participating countries on effective strategies to develop support for programmes. It may develop some tools and materials using its own resources, but should also disseminate best practices selected from participating national programmes. Examples of the products needed are vulnerability assessment tools, priority-setting tools, cost evaluation tools, school curricula, and preparedness and awareness information. Some of these tools may be developed by nations whose programmes for school seismic safety are more advanced, by experts drawn from groups of nations, or by the OECD organisational entity directly using its own staff and/or contractors.

The OECD should also seek to find ways to enhance the support provided to non-member countries to facilitate the achievement of the targets and goals set forth in this report globally, in line with the objectives of other relevant international organisations.

## **Guiding principles for mandatory national school seismic safety programmes**

The following guiding principles should serve as the basis for establishing national programmes for seismic safety in schools:

1. National programmes should recognise the safety of children in schools as a basic human right and formally establish this as a national policy.
2. National programmes should establish clear and measurable objectives for school seismic safety that can be implemented and supported by the affected residents of communities and agencies at the local government level, and should provide adequate resources and realistic timelines to achieve these objectives.

3. National programmes should address all schools regardless of ownership, as preservation of the educational system is vital to the continuity of society, and the functioning of schools as emergency shelters and cultural centres provides an important point of community convergence.
4. National programmes should be mandatory, but should provide flexibility for alternative means of achieving equivalent results depending on the level of seismic hazard, knowledge, technology and resources, and commensurate with indigenous capacity, need and level of sophistication.
5. National programmes should define the level of the earthquake hazard for the country in order to facilitate the development and application of construction codes and standards. At a minimum, natural hazard zones should be established and, where possible, seismic hazard maps should be based on probabilistic analysis.
6. National programmes should set forth expectations or objectives that define the desired ability of school buildings to resist earthquakes. All school buildings should be designed and constructed, or retrofitted, to prevent collapse, partial collapse or other failure that would endanger human life when subjected to specified levels of ground shaking and/or collateral seismic hazards such as surface fault rupture, landslide or inundation from tsunami waves or dam failure. However, some countries may desire that school buildings have additional seismic resistance to the extent that damage is limited and the buildings can be occupied immediately after earthquakes and used for shelter or emergency operations.
7. National programmes should be established on an urgent basis to assure earthquake safety of new and existing schools. Initial priority should be given to making new schools safe. Efforts to identify vulnerable existing schools, establish standards for retrofitting or replacement of dangerous buildings, and develop a list of priority actions can be accomplished over a reasonably short period of time. Longer-term actions will likely be needed to correct seismic weaknesses of existing school buildings.
8. National programmes should be established as long-term undertakings with a strong commitment to sustained effort rather than one-time action.
9. National programmes should employ advisory committees as needed to assure that policy and technical decisions are consistent, and to provide long-term independent support and evaluation for the seismic safety effort.
10. National programmes should adopt a multi-hazard approach to school safety, with earthquake mitigation strategies that complement disaster countermeasures for other hazards.

### **Major elements of effective national school seismic safety programmes**

An effective national school seismic safety programme will include the major elements described below:

#### ***Community awareness and participation element***

Paramount to the success of a programme to improve the seismic safety of schools is the understanding and involvement of the community. All members of the community should understand the seismic hazard of the region, the vulnerability of existing school buildings, the consequences of not properly constructing new school buildings or improving the resistance of existing buildings, and the feasibility of improving seismic safety. In particular, those members of the community who are involved in the construction of school buildings need to understand why they are required to follow prescribed

practices, and the consequences of their failing to do so. An effective community awareness effort will include:

- Programmes to raise public awareness and knowledge of the risk from earthquakes and other natural hazards;
- Educational programmes to transfer and disseminate technical knowledge and explanation of risk in terms understandable to community stakeholders;
- Activities to empower the community to be part of, and contribute to, the reduction of seismic risk of schools;
- Use of school curricula to promote a culture of prevention in the future generations of community members.

### ***Seismic safety policy element***

A national policy should be established by law with well defined and measurable objectives. Priorities and strategies for satisfying the objectives should be established by the appropriate authorities. The policy must be clear and should have adequate governmental authority to enforce its scope and objectives and carry out the plan over a specified number of years. The policy should:

- Recognise the safety of school children as a basic human right;
- Recognise the need for the safety of school buildings;
- Establish minimum standards for protection of human life;
- Adopt sustainable standards to guide design for new and existing school infrastructure based on prescribed performance objectives, knowledge of the ground shaking severity in different regions, quantification of site specific hazards, and the ability of the community to educate, train and license its members to effectively achieve established objectives;
- Establish programmes for seismic risk reduction of school buildings and their components;
- Provide adequate funding and human resources for the protracted duration of the programme;
- Be supported by committed and competent leaders with sufficient legal and moral authority to ensure the effectiveness, sustainability, and continuity of the programmes that derived from the policy.

### ***Accountability element***

There should be a legal basis for action with clear lines of accountability of the different members of society who are given responsibility for the implementation of earthquake safety programmes. To achieve the objectives of these programmes there should be:

- A clear definition of the roles and responsibilities of the various individuals, agencies and organisations involved in school seismic safety;
- A process for making planning, design, regulation, and enforcement decisions transparent;

- Qualification requirements for professionals engaged in the design of school facilities;
- A responsible enforcement agency, independent of the organisations responsible for designing, construction and financing school facilities, charged with overseeing and approving proper design, construction and maintenance of school facilities including:
  - Conducting assessments of existing school facilities;
  - Reviewing and approving construction documents prepared for new structures and the retrofit of existing structures;
  - Inspecting and approving construction;
  - Qualifying personnel for design, plan review and inspection, materials testing and support functions;
- A clearly identified jurisdiction in terms of the area and the type of school systems and buildings affected.

***Risk reduction element for new facilities***

Verified procedures currently exist to ensure good seismic performance of school buildings and their contents, and the implementation of such procedures is feasible. The following components are needed in a risk reduction element for ***new*** facilities:

- Determination of seismic hazard in the region and development of seismic hazard maps;
- Development of performance criteria and codes suitable to the culture and economic conditions of the region with recognition of the fundamental societal importance of schools and the shelter function of school structures in post-disaster emergencies;
- Development of simple regulations, or best construction practices, for regions where such an approach may have an immediate impact on seismic safety (*e.g.* simple, low-cost education facilities in rural regions of developing countries);
- Training and education of professionals, technicians and the construction workforce;
- Target dates for implementation of construction standards recognising the different levels of current practice in different countries;
- Effective building codes and regulations, and rigorous enforcement of these regulations;

***Risk reduction element for existing facilities***

To reduce the seismic risk of existing school buildings, it is important to understand why this risk exists and what actions can be taken by the community to eventually reduce the risk. Community values, economic conditions, financing possibilities and the type of building materials available in the region should be considered when developing and implementing a risk reduction plan.

Key ingredients for an effective risk reduction element for existing facilities include:

- Determination of the seismic hazard and preparation of hazard maps;
- Assessment of risk to existing schools and their contents;
- Evaluation of the consequences of not taking corrective action;
- Development and implementation of technical guidelines to improve performance of existing facilities during earthquakes (*e.g.* methods and procedures to estimate forces and displacements of the structure and predict damage, acceptable margins of safety or confidence, proper use of building materials and monitoring of the construction processes);
- Formulation of an action programme based on availability of funding, human resources and their qualifications, existing infrastructure and the operational structure of the community;
- Prioritisation and risk reduction plan implementation, considering financial and human resources and the role of school buildings in post-disaster emergency management;
- Monitoring of effectiveness of plan implementation.

Given the magnitude of the retrofitting task in many countries, responsible officials should establish time schedules and priorities to retrofit at least those facilities deemed to be at the highest risk. While several decades may be needed to complete implementation of a school seismic retrofit programme, work on the facilities at greatest risk can be undertaken on a priority basis over a much shorter period.

### ***Building codes and code enforcement element***

The primary objective of school building codes and regulations should be to protect the life of occupants of a school building. Other objectives could include minimising damage to allow rapid occupancy of buildings after earthquakes. Building codes should govern the design of new and retrofitted school buildings. Design earthquake ground motions may be based on a probabilistic approach, a deterministic approach, or on a map of seismic zones. Individual nations should determine the most appropriate design criteria, based on a review of their country's seismic hazard and other pertinent factors.

An effective school building code and enforcement element should:

- Establish clear building performance objectives based on:
  - Ground motion characteristics and geology of the region,
  - Collapse prevention and structural damage control criteria,
  - Secondary effects such as tsunamis, landslides, surface rupture, etc., and
  - Socio-economic impacts to the community.
- Establish a process for periodic review and revision of codes and guidelines by knowledgeable individuals to reflect current understanding of good earthquake engineering practice.
- Establish enforcement procedures for school building code and construction regulations, that take into account community needs, but provide clear provision for:

- Checking of design plans for school buildings by qualified reviewers, and
- Review and certification of constructed school facilities.
- Establish a regulatory body with a responsible official who is independent of those who finance, design and construct the buildings to assure that enforcement activities are not compromised by overt or subtle pressures due to project specific cost, deadlines or other financial considerations.

The mere existence of a building code in a community can give the false impression that buildings are being constructed safely and that their seismic performance will be satisfactory. While extremely important, the writing and adoption of building codes and regulations can be an incomplete strategy if they are not enforced at every step of the design and construction process. Steps should be taken to ensure that proper implementation and enforcement of code regulations is done in a consistent manner and has equal priority to code development.

### ***Training and qualification element***

Building safety relies on regulations and laws that require proper training and qualification of professionals, builders, and technicians involved in the different aspects of the design and construction process. Building safety training programmes should be carried out within the context of each individual country. Training programmes must accommodate governmental structure and division of responsibilities, perception of risk to the institution and its stakeholders, community values and economic conditions. Training and licensing should be required for design professionals, code enforcement officials, plan checkers, inspectors and contractors.

- ***Engineers and architects*** should be properly trained on current practices of seismic design and should pass rigorous tests to obtain a license to design and prepare school construction documents.
- ***Qualifications of contractors*** should be considered in awarding of construction projects. For instance, contractors could be tested and licensed to assure minimum levels of competence. This would require the establishment of training programmes on best constructions practices for contractors and trades.
- ***Building officials, plan-check professionals and inspectors*** should be certified through a process of adequate training and experience.

### ***Preparedness and planning element***

Effective national programmes should require each school organisation and every individual school to take measures to reduce risks and to prepare employees and students to react in safe ways during emergencies. These school safety elements should include the following:

- ***Education:*** Develop and teach curricula for primary and secondary school students on earthquakes, societal issues relating to earthquakes and preparedness actions. Use the school curricula to promote a culture of prevention in future generations of the community.
- ***Risk reduction measures:*** Undertake measures to improve the safety of the physical environment by bracing and anchoring furnishings, bookcases, and equipment and building components such as lights, heaters and water heaters.

- **Emergency plan:** Prepare and maintain plans that identify the actions, decisions and responsibilities needed before, during and following an earthquake, organisation and responsibilities to carry out these plans, determine to shelter or release students, use school facilities as community shelters, and the equipment and supplies needed to carry out these decisions.
- **Safety assessments:** Establish standards, line of responsibility, and procedures to assess the safety of buildings following earthquakes and decide on evacuation, repair and re-occupancy procedures.
- **Training:** Provide training and materials for employees and students on earthquake hazards and actions to take to improve personal safety.
- **Drills:** Hold periodic drills simulating realistic conditions of earthquake events to reinforce training and to test the adequacy of plans and safety assessments.

## **Conclusion**

The members of the *ad hoc* Experts' Group believe that the recommendations presented herein are feasible for implementation by all seismically prone countries, OECD members and non-members alike, and, if implemented will lead to significant improvement in the safety of their school children and a brighter future for the societies they represent.