Understanding Existing School Infrastructure – a New Zealand Experience

Overview

Country: New Zealand

Stakeholders: Government of New Zealand's (GoNZ) Ministry of Education (MoE), local government, engineers, local communities, public and private schools

Hazards: Earthquakes

The Building Act is the National Building Code (2004 No 72) which has been revised and updated several times, including most recently in 2016. The Building Act regulates all building design and construction in New Zealand.

Summary: Earthquakes occur frequently in New Zealand and pose a risk to school infrastructure. The Building Act has been strengthened over time to respond to these risks and reflect best practice globally.

All school buildings are required to meet the performance levels set out in the current 2004 Building Act, however schools built to previous outdated codes often do not comply. While upgrading efforts have been made, a survey of the Ministry of Education's 23,500 school buildings was undertaken between 1998 and 2001 to address the likelihood that not all infrastructure was compliant with current requirements. This provided a 'baseline' of information to identify, assess, and prioritize action on school buildings and a number of safer schools programs, some of which are ongoing today.

CONTEXT

Evidence of large historic impact of earthquakes in New Zealand

New Zealand is an industrialized and democratic nation of 4.4 million people. It is located at the collision zone of the Australia and Pacific tectonic plates in the 'Pacific Basin Ring of Fire' and experiences 15,000 earthquakes each year, 150 of which have an intensity that can be felt. Due to the relatively small and dispersed population, the level of exposure is low, but the impact can still be devastating such as the earthquakes in Hawkes Bay which killed 256 people in 1931, and in Christchurch in 2011 which killed 185 people. The Ministry of Education (MoE) is responsible for procuring the design and construction of new state school buildings, as well as maintaining and managing the existing asset portfolio of state school buildings constructed predominantly over the past 100 years.

This case study is based on research on safer schools investment programs in New Zealand, undertaken by Arup in 2016.

OBJECTIVES

The role of structural information in guiding action on safer schools

The MoE manages one of the largest property portfolios in New Zealand, currently with more than 30,000 buildings in about 2,500 state schools with a replacement value exceeding NZ$23 billion. The structural typologies of school buildings have changed over time. Unreinforced masonry was commonplace before 1930 but is inherently vulnerable to earthquake loading and has since been replaced with mostly low rise timber frame school buildings. As building codes were refined and construction typologies evolved, older buildings using unreinforced masonry were replaced or retrofitted up to the mid-1990s. Even though construction practices and materials are typically of a high quality, and older school buildings have often been replaced or upgraded, there remained uncertainty of the overall safety of school buildings over the whole country. There was also the need to assess the condition of the school buildings related to maintenance.

The absence of any conclusive data set on existing school infrastructure led to the MoE undertaking a systematic and comprehensive survey between 1998 and 2001. The survey was intended to provide a comprehensive understanding of the MoE school assets in order to inform investment decisions to improve the safety and quality of school infrastructure across the country.

90% of schools in New Zealand are timber frame low rise construction typology which can perform well in an earthquake due to the lightweight and flexible nature of the structure.

METHODOLOGY

Collecting and using structural information

The MoE survey in 1998 included a structural assessment of 23,500 school buildings across the country's 2,400 schools and was carried out by qualified structural engineers. The survey was intended to establish baseline information to inform upgrading of existing facilities to make school buildings safer. It provided comprehensive structural information in order to minimize risk to life, serious injury, damage to school infrastructure and inform investment opportunities. The survey information collected relating to building vulnerability included structural typology, design quality, the quality of construction and materials, the appropriateness of any modifications, and the quality of maintenance. For typical low-rise structures with light-weight frames, a walk-through survey was conducted using common sense engineering principles based on the 2004 Building Act which regulates all building design and construction in New Zealand. For pre-1976 blocks with two or more stories, which were more vulnerable and contained higher numbers of children, a more detailed evaluation method was applied to identify structural defects.

The survey information was collated into a database and used to identify 'at-risk' school infrastructure based on the building vulnerabilities and exposure to natural hazards, and to prioritize an approach to remedial works. Approximately 90% of the state school building stock is now timber-framed low-rise construction, but the majority of buildings were constructed prior to the application of modern codes. The survey found that only four school buildings had unacceptable structural defects and required immediate remedial action. A further 11% of school buildings had defect requiring less onerous interventions. Following the survey, a retrofitting program commenced in 2001, and prioritising 2,300 buildings for a budget of USD$21.5 million.

This was then developed into the countrywide 'Earthquake Resilience Program' which started in 2004. The database was used to prioritize additional investments to upgrade school buildings to comply with the 2004 Building Act.

Source: M. Taylor

Lightweight timber clad low rise school buildings can often suffer little or no damage during significant earthquake events

CHALLENGES & OPPORTUNITIES

A systematic approach to assessing thousands of buildings

The MoE's property portfolio of school buildings is spread over both urban and rural populations. Collecting and collating structural information from all parts of the country was therefore a relatively large undertaking. A practical approach was taken to reduce the costs and match the level of survey detail required with the requisite skilled engineers and personnel. For example, there was no need to conduct a detailed inspection of all structures given that many buildings used similar designs. A simple walk-through method was used to identify potentially dangerous buildings which required more detailed evaluations from the majority that were structurally sound.

OUTCOMES

Informed programming for safer schools

Following the initial program which identified the four schools most at risk, and enhanced a further 2,300 priority buildings, following the Earthquake Resilience Program was established to include investment in all schools in New Zealand which included approximately 30,000 buildings. This ongoing program continually updates information on school buildings in the database to provide live reprioritization of the building stock. This includes 'high priority' buildings which require immediate strengthening within a period of five years or even shorter time periods if they are particularly vulnerable. The data is also used to establish 'medium priority' buildings that were given a 10 year deadline for retrofitting and 'low priority' buildings given a deadline in excess of 10 years. For 'medium priority' buildings, retrofitting efforts wereare coordinated to coincide with scheduled building improvements within the 10 year timeframe to optimize resources and minimize disruption to education.

Learning

- A risk-based approach - whereby higher risk buildings are prioritized for remedial action, is particularly appropriate, in areas of high seismicity.
- The quality and detail of the structural information is important and forms a baseline to inform the development of long-term and systematic strategies for the planning, management and protection of education infrastructure, including the retrofit and reconstruction of selected schools.
- The need to continuously update the data which allows for optimization of resources, reprioritization of investments, and minimizes disruption to education.

Find out more

Read: Making Schools Safer, OECD, 2004, www.goo.gl/7dBBkS

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