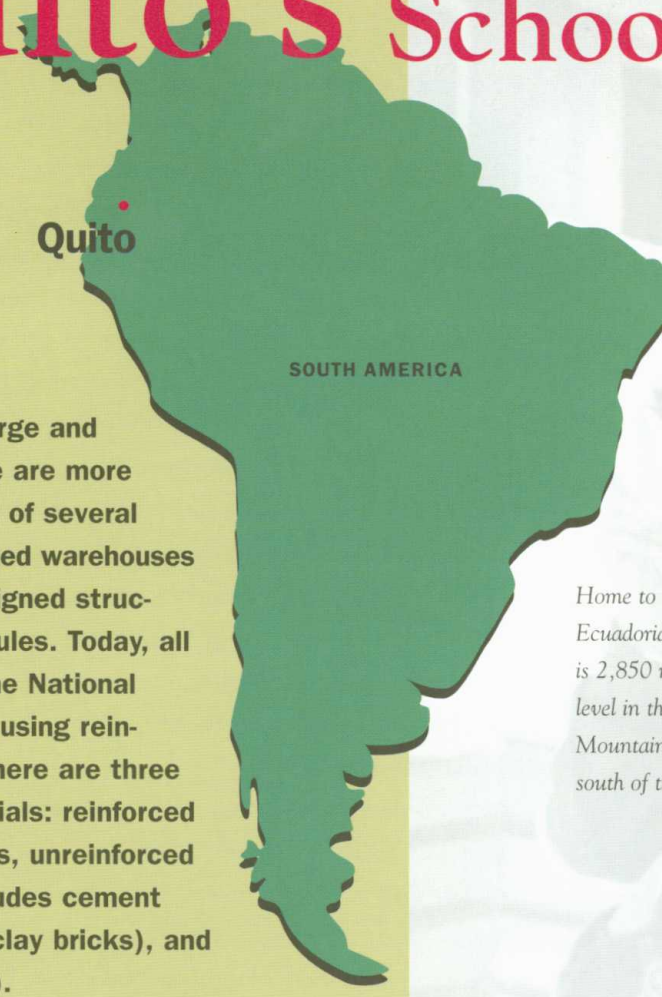
Evaluating Quito's Schools



Quito's public schools comprise a large and diverse collection of buildings. There are more than 700 schools, and many consist of several separate buildings. Some are converted warehouses or homes. Some are individually designed structures, and others are groups of modules. Today, all public schools are constructed by the National Directorate for School Construction, using reinforced concrete or steel modules. There are three prevalent school construction materials: reinforced concrete, steel, and, in older schools, unreinforced masonry. Unreinforced masonry includes cement block, adobe (handmade, sun-dried clay bricks), and ladrillo (handmade, fired clay bricks).

Home to 1.2 million Ecuadorians, Quito is 2,850 m above sea level in the Andes Mountains, and 22 km south of the equator.

"SOFT" FIRST STORY

Because of the number and diversity of school buildings, it was not practical to evaluate the vulnerability of them all. Instead, this project focused on a sample of schools that are in high use (a large number of students using the building per day per building area), highly vulnerable to earthquakes, and representative of the three prevalent construction materials. Schools that are both in high use and highly vulnerable are referred to as "high-risk" schools.

The process of choosing this sample and evaluating the vulnerability of its schools consisted of selecting Quito's high-use schools, classifying them by construction material, and determining the most vulnerable within each group. Data provided by the City of Quito were used to select 340 high-use school buildings. Inspectors visited each, recording information including construction material and superficial condition of the structure. The buildings were then grouped according to construction material. Three steps were taken to determine the vulnerability of buildings in each group. First, project engineers selected a total of 60 buildings that appeared the most vulnerable. Next, each of these buildings was given a vulnerability ranking using the Applied Technology Council's "rapid visual screening" method, adapted by project engineers to local seismicity and local construction materials. Finally, detailed structural analyses were performed for those buildings, a total of 20, with the highest vulnerability rankings within each group. The analyses included an investigation of the structural system (including that of the foundation) to evaluate the location, size, and connection details of all structural elements. Structural deterioration was also documented. Dynamic analyses were completed for each building, considering various levels of earthquake ground shaking. Soils engineers determined, based on a preliminary evaluation, that none of the buildings was situated on unstable soils.

As a result of this process, project engineers identified 15 individual high-risk school buildings. They also concluded that the two types of school modules constructed by the National Directorate for School Construction were at risk. The 15 individual school buildings and the thousands of modular schools located throughout Ecuador are the focus of the next section.

"SHORT" COLUMNS

Two common structural deficiencies are "soft" stories (such as stories without infill walls) and "short" columns (columns effectively shortened by partial infill walls). Shown are examples of each in Quito schools, and an earthquake-damaged building that had a "soft" first story.