Walking Tour of Seismic-resistant Design and the 1976 Earthquake Damage to Baroque Buildings in Antigua, Guatemala

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Introduction

La Antigua Guatemala was designated a UNESCO World Heritage Site in 1979 for its unique preservation of Spanish Colonial Baroque architecture planned in the 16th century along a grid of east-west streets (*calles*) and north-south avenues (*avenidas)*. A Central Plaza was constructed with the administrative buildings of City Hall and the Palace of the Captains General built on the north and south sides, and the Cathedral on the east. The colonial city served as the capital of New Spain, which encompassed Yucatán and Chiapas in Mexico, Guatemala, Belize, Honduras, El Salvador, Nicaragua, and Costa Rica.

Figure 1: Map of Antigua Guatemala.

The capital was built west of present-day Antigua at a location now known as *Ciudad Viejo*. This city was buried by a debris flow from the flank of Volcán de Aqua triggered by an earthquake and heavy rainfall. In 1543, the present location of Antigua was founded between the Guacalate and Pensativo rivers in the Panchoy Valley. The Baroque-era city is often referred to as *Santiago de Guatemala*, which is a shortened version of the official name: *Santiago de las Caballeros de Guatemala*. The Franciscans, Dominicans, Jesuits, and other

monastic orders were eager to establish a presence in Spanish America and built over 30 churches, monasteries, convents, and heritages.

Colonial Baroque architecture developed in Spanish territories in Central and South America evolved into a seismic-resistant style in response to frequent earthquakes. The *Antigueño* style (Markman, 1951; 1966) includes stubby and stout columns, low, broad arches, thick walls with buttress reinforcement, and short square bell towers and corner supports. Arches and domes were constructed of brick and plastered. Walls were constructed of uncoursed boulder rubble in mortar separated by courses of laid brick with lime mortar. The surfaces were plastered and adorned with stucco molding of high relief with intricately swirling floral and geometric designs, twisted and fluted columns, niches with statues, and fine plaster filigree on church façades.

Most of the ecclesiastical buildings you see today in Antigua were built in the mid-18th century, as the 16th and 17th-century structures, often constructed of wood, adobe, and thatch, were destroyed in earthquakes. The major earthquakes of 1717 and 1751 caused damage in Antigua (White, 1984; Feldman, 1993; Peraldo and Montero, 1999; White et al., 2004). But it was the two devastating earthquakes of July 29, 1773 (M 7.5) and December 13, 1773 (M 7.1) that laid Santiago de Guatemala in ruins and prompted Spain to move the capital to a new location, present-day Guatemala City.

Capuchinas

Completed in 1736, the *Iglesia y Convento de Capuchinas* was the fifth and final convent built in the city. The name of the convent is derived from the brown habits worn by the nuns. The convent is unique as the order was established for women who could not provide a dowry and served as an orphanage and infirmary for women. The nuns were not allowed to leave the convent.

Designed by Architect Diego de Porres, it preserves all the elements of seismic-resistant design, including enormous, wide short columns supporting low arches around the courtyard and exceedingly thick walls with low buttresses on the exterior (Fig. 2). A unique round structure (Tower of Retreat for the Novices), 24 m in diameter, contains 14 small rooms on the upper floor supported by a massive central column in a lower storage room. The Convent sustained some damage in the 1751/1773 earthquakes and was completely abandoned in 1774 when the capital was moved to present-day Guatemala City. In 1850, Capuchinas was sold to a family who dried coffee beans on the second floor. Today, the offices of the National Council for the Protection of Antigua Guatemala (CNPAG) are located in Capuchinas. The 1976 earthquake caused the collapse of a church vault and damage to the exterior walls of the church and convent (Fig. 3)

Figure 2: Left: Two asymmetrical towers frame the simple, unornamented façade of the Iglesia Capuchina. Note the uncommon use of stone veneer on the exterior (Markham, 1961). Vulcan de Fuego is seen erupting in the background. Right: Stout columns of the cloister courtyard.

Figure 3: Damage from the 1976 earthquake and repair to the Convento y Iglesia Capuchinas (Courtesy of CNPAG Sección de Registro y Catalogación).

Iglesia Carmen

Iglesia Carmen was initially built in 1638 but was severely damaged by earthquakes in the 17th and early 18th centuries and rebuilt twice. The elaborately decorated, ornate church seen today was constructed in 1728. Although the church sustained damage in the July 1773 earthquake, it was not until the December 1773 earthquake that the vaults, dome, and bell tower collapsed. Consolidation work began in the 1990s to help stabilize the church, and the reconstruction efforts are ongoing.

CNPAG conservation and reconstruction efforts on the Carmen Church follow traditional building methods, with the exception of the addition of Portland Cement in brickwork. The mortar is a mixture of soil (talpatate), black volcanic river sand, white pumaceous sand, and lime. Analyses of mortar and stucco indicate that a large component of pumice inclusions likely improved the strength and ultimately the longevity of the high-relief ornamentation (Trudell et al., 2025). Stress testing of the building components in situ using a Schmidt Hammer also suggest the composition of the mortar plays a role in the building cohesion.

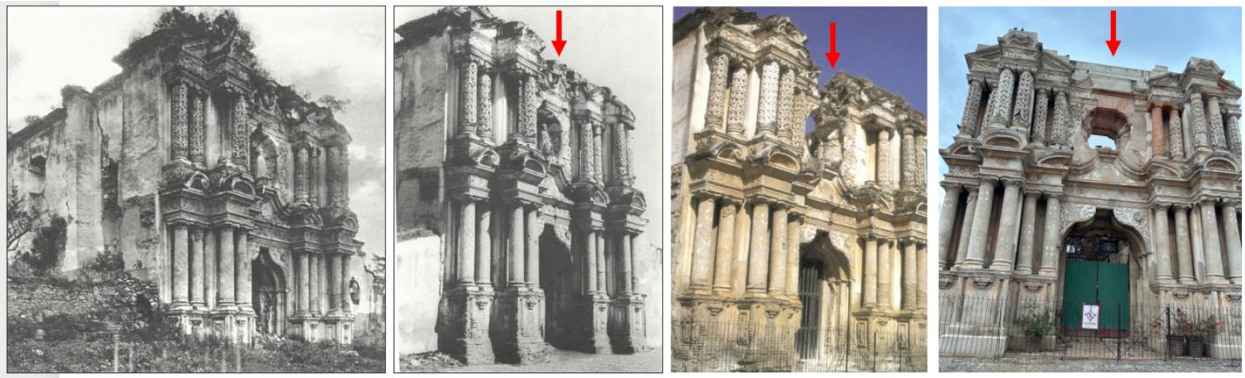

Figure 4: Façade of the Iglesia Carmen from left to right: 1876, pre-1976, post-1976, and 2024. Note the earthquake damage and toppling of both the statue of Our Lady of Carmen and one of the upper columns (Markman, 1966).

City Hall

The city of Antigua has administrative offices housed in City Hall (*Ayuntamiento),* a building inaugurated in 1743 (200 years after the founding of the capital). The 1773 earthquakes caused only slight damage to the structure. Like the rest of Santiago de Guatemala, the building was abandoned with the move to Guatemala City circa 1779. The mid-19th century saw a resurgence of building in Antigua with the new wealth brought by the local cultivation of coffee. In 1850, José María Palomo y Montúfar restored City Hall.

The design of City Hall clearly displays the unique style of earthquake-resistant architecture. The double arcade supports broad arches on wide, short stone columns. The exterior walls are 1.2 m (4 ft) thick and veneered with cut stone. The structure survived earthquakes in the 19th and 20th centuries. In 1976, the earthquake caused damage to part of the southeast arcade and roof domes (Fig. 5).

Figure 5: Stone columns and arches of City Hall showing damage to the southeast archway and roof domes from the 1976 earthquake (Photos courtesy of CNPAG Sección de Registro y Catalogación).

Palace of the Captains General

The *Palacio de los Capitanes Generales* served as the ceremonial meeting place for dignitaries and royal business. The buildings housed royal offices, including courts, treasury, notaries/scribes, barracks for the military, and other departments with supporting facilities.

The early wooden structures at the site were badly damaged in the 1717 and 1751 earthquakes. By 1764, the construction of the new palace with its massive stone columns and stone veneer was completed. The structure was only slightly damaged in the earthquakes of 1773. Most of the ornamentation and elaborate fixtures of the Palacio were removed and sent to the new capital in Guatemala City. An attempt to transport the columns failed as they were too heavy for mules to pull. The façade was rebuilt in 1890. The 1976 earthquake caused extensive damage to the east wall of the Palace (Fig. 6).

Figure 6: East wall of the Palace of the Captains General showing collapse and shearing of the exterior east wall (Photos courtesy of CNPAG Sección de Registro y Catalogación).

Catedral

Catedral y Palacio Episcopal lies along the east side of the Central Plaza. The modern church occupies only a small portion of the original great cathedral constructed in 1680, which now lies in ruins. The cathedral was designed and built under the direction of Architect Joseph de Porres over a raised stone platform that extended an entire city block. The cathedral was adorned with carvings, inlaid with mother-of-pearl, ivory, and silver. High-relief stucco in intricate patterns and niches with figurines covered the interior columns and arches. Although the 1717 earthquake only slightly damaged the church, the 1773 earthquake caused major collapse. The entrance to the church was restored in 1821 to function as the parish of San José.

The 1856 engraving of the Plaza, Palace of the Captains General, and Cathedral shows the bell tower to the north of the church façade (Fig. 7). The 1976 earthquake caused the collapse of the central façade of the church, which fell and damaged the stairway. Additional damage occurred inside the cathedral ruins.

Figure 7: Top: An illustration of the Central Plaza published in The Illustrated London News on August 3, 1856 (Bell, 2010, p. 18). Note the bell tower to the north of the façade of the cathedral. Bottom Row: Photographs showing the collapse of the central portion of the cathedral façade, damage to the steps below, and within the ruins. (Photos courtesy of CNPAG Sección de Registro y Catalogación).

Compañia Jesús

Iglesia y Convento de la Compañía de Jesús was established by the Jesuit fathers upon their arrival in Guatemala in 1607. An early thatched church was replaced by a new church in the 17th century. This structure was destroyed in the 1695 earthquake and replaced by a new church. The church withstood the 1717 earthquake but was severely damaged in the 1751 earthquake, as historical documents indicate the Jesuits received funds for repairs. By Spanish Royal decree in 1767, the Jesuits were expelled from Guatemala under armed guard. In 1865, a textile factory occupied the site, and in 1912, the Public Market (*Mercado*) relocated to the monastery from the plaza. The monument sustained significant damage in the 1976 earthquake, and the mercado was moved to its current location. Conservation by CPNAG and after 1990, by Cooperación Técnica Española, has led to the current renovation of the entire monastic complex extending across the entire city block.

Figure 8: Left: Illustration of Compañia Jesús from The Illustrated London News, March 12, 1859. (Bell, 2010, p. 79). Right: Photograph of the façade of the church of Compaña Jesús in 2025. The red arrows point to portions of the structure that collapsed and have been reconstructed.

Figure 9: Photographs showing the damage to the church and convent of Compañia Jesús after the 1976 earthquake (Photos courtesy of CNPAG Sección de Registro y Catalogación).

San Agustín

The *Iglesia y Convento de San Agustín* was conserved and reconstructed by CNPAG and opened as a museum in 2025. The Augustines arrived in Guatemala in 1610 and constructed the first church and convent in 1657. These buildings were damaged in the 1717 earthquake, repaired, and damaged again in the 1751 earthquake. With additional funds, the church was again rebuilt and inaugurated in 1761, only to be severely damaged in the 1773 earthquake.

Three building phases can be seen in the interior, where windows and arches are filled, and additional walls abut each other. The later phases have thicker mortar (>5 cm) within the brick arches, which may have weakened the structural integrity. The southwest exterior corner tower, which is wider at its base compared to the top, and the 2-m-thick southern wall support the load of the dome over the nave of the church. Additional buttresses and supporting towers were added to the southern wall. The northeast corner is supported by the bell tower, which contains its original dome, cupola, and portions of wooden floor joists and bell supports. The dome of the nave was intact until the 1917 Guatemala earthquake, when it collapsed. The 1976 earthquake caused the upper story of the choir to collapse.

Figure 10: Oblique view of the front (east) façade and south wall of the Church of San Agustín and bell tower showing antiseismic structural elements and earthquake damage. a) The white arrows point to exterior buttress walls at the base of the south wall of the church. The yellow box outlines the southeast structural corner tower. b) Statue of San Agustín holding a church located in the upper central niche of the church façade. Note the horizontal cracks marked with arrows that cross laterally through the niche and bifurcate into cracks on the north side, demonstrating clear earthquake damage.

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