THE SUANKULARB COLLEGE, BANGKOK, THAILAND – A CASE STUDY OF THE RESTORATION OF A LATE 19TH CENTURY THAI SCHOOL BUILDING

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ABSTRACT

The Suankularb Building has been used as a school building for Suankularb College founded by King Rama the Fifth in 1884. The 200 metre-long building, which reflects the early influence of European Architecture in Thailand, was built in 1910. The importance of the building is that it had been used as the first public high school in Thailand, and that it is the longest building without a construction joint built in the late nineteenth century. The school building had suffered from major structural problems due to settlement of the central segment of the building. The building was declared a historically significant building in 1987 by the Thai government. This paper documents the history and construction of the original building, outlines the damage to the building from ground settlement, and presents the repair techniques adopted including the use of micro-piles to stabilize the settlement of the central portion of the building. The preservation of this building presented a significant challenge in the reconstruction process, as the settling footings needed to be stabilized and the heavily damaged masonry needed to be supported and then repaired.

KEYWORDS: masonry walls, renovation, settlement, historic preservation

INTRODUCTION

The Suankularb Building (Figure 1) has been used as a school building since the early 1990's for Suankularb College founded by King Rama the Fifth in 1884. The building, which reflects the influence of European Architecture, was built in 1910, and is located in a historic district. The school building consisted of classrooms for grades 1 through 5 with a library covering half of the second floor. Rooms on the first and second floor were used as classrooms and rooms for student clubs. The architectural and historical significance of the building is its use as the first public high school in Thailand, which represents the modernization of Thai education. In addition, it is the longest masonry building without construction joints in Thailand built in the late nineteenth century.

The building is constructed of brick masonry walls and columns supporting arches on a concrete foundation over soft soil. The original roof was a timber structure with concrete tiles. The building has been renovated many times since the 1930's. The important renovations are:

1931: Construction of an addition to the north for classrooms, extending the length
1945: Repair of damage caused by bombing during World War II
1974: Replacement of the wood flooring on the first floor with terrazzo floor
1979: Repair of the first floor, and replacement of the brick masonry foundation with concrete

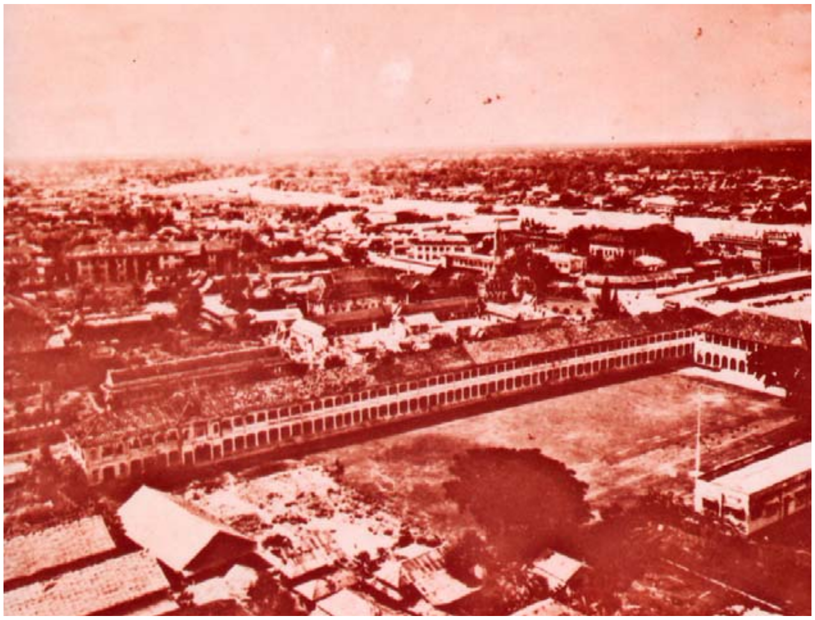

Figure 1 - Sankularb Building Circa 1900

The building was designated by the Department of Fine Art as a National Historic Building in 1987. The Department of Fine Art is a government agency responsible for restoration and renovation of historic buildings in the entire country. Due to the condition of the building, the library was moved to a new building and the classrooms were vacated in the mid 1990's. Suankularb College wanted to renovate the building to house an education museum. In addition to accommodating the education museum, the Suankularb College required space for a hall of fame to promote the famous alumni and for reception halls for the school's famous guests. Other space was required for demonstrating the activities of the Ministry of Education. Investigation of the existing structure revealed major strength and serviceability problems. The middle part of the building had settled during the last decade and caused 25 mm (1 in.) cracks in the walls and columns. This damage would require extensive and difficult repair. The cracks were found in many rooms running the length of the ceiling to the floor. The architects and engineers from the Department of Fine Art recommended that the school be renovated by strengthening the structure of the entire building, in particular the foundations, floors, and walls, and replacing deteriorated materials that were more than 90 years old.

IMPACT OF HISTORIC REGULATIONS

The registration of the building as a National Historic Building required that any changes of the historic properties, both exterior and interior, be approved by the Historic Preservation Board of the Department of Fine Art. Although the College is a government organization, there were no exceptions to the regulations for the project. However, the architects were experienced with preservation projects and restrictions due to working closely with the Department of Fine Art. And as a result, no major change was made to the building features.

DESIGN AND RENOVATION

Because the building was designated as a historic building by the Fine Art Department, all modifications had to be approved by the Historic Preservation Board and the President of the Fine Art Department [2]. The historic regulations do not allow the building modifications to change the original appearance. This includes the modification of exterior and interior. The Historic Preservation Board, which consisted of specialists from the Fine Art Department, was responsible for approving and providing suggestion for all historic preservation projects. Permits for construction on the school were issued by the Department after all drawings and specifications were evaluated. No significant changes were made to the floor plans, since the college and the Department wanted to keep the original building architecture according to the historic regulations. The responsibility of the architects was to identify the original appearance and restore the building to this condition, as well as restore the interior of the building. Because the building had been used for decades with few major interventions, it needed to be repaired for the safety of users and the air-conditioning and mechanical systems had to be upgraded. Figures 2 and 3 show the building before and after renovation. The roof before renovation was cement tiles and the building exterior had deteriorated. After renovation, the roof was replaced by new light-weight cement tiles and the building exterior was replastered and repainted.

Figure 2 - Suankularb Building before Renovation

Figure 3 - Suankularb Building after Renovation

The design team from the Department of Fine Art relied on a condition survey and building measurement survey to select the appropriate solutions for the problems of the building [2]. Since the design team needed to stabilize the entire building structure and protect the building from further settlement due to the deteriorated original foundation, they decided to reinforce the entire structure and build a new foundation to support the building. Figure 4 illustrates the building settlement and restoration levels. Because the soft soil could not support the building, micro-piles were used to support the new foundation and reinforced beams adjacent to the footing wall were used to stabilize the entire building structure. These micro-piles transferred the load of the building to a deeper soil layer strong enough to support the building weight. Concrete columns placed in the middle of the walls were used to stabilize the deteriorated masonry walls. The masonry columns in the arched corridor were repaired by repointing and replacing the existing plaster with new plaster. These columns were not reinforced. However, the columns that were severely deteriorated were repaired using reinforced concrete (Figure 5).

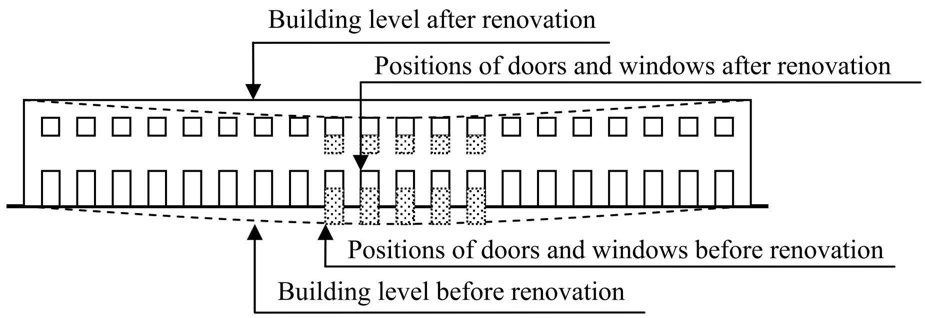

Figure 4 – Building Settlement

The building's structure was the primary concern for the design team from the Department of Fine Art. Because of the extensive settling of the building, the options for restoring the floor elevations to the original level were limited. The architects assumed that the renovation which replaced the old burnt clay roofing tiles with heavier cement tiles was the primary cause of settlement. Soft soil under mid-length of the building could not support the increased weight of the heavy cement tiles. The cracks in the walls and columns were likely caused by the heavy traffic condition in front of the building and the soil layers under the building. These problems were a challenge for the designers.

The existing roof was found to need repair and replacement (Figure 6). The design team proposed to replace the existing cement tiles with light-weight cement tiles. The new roof tiles were selected to replicate the original roof appearance, although the tile was smaller and lighter. The exterior and interior walls were repainted as the original scheme indicated in the archives of the Department of Fine Art [2]. To address the settlement of the building, the height of the wall was increased instead of lifting the entire 200 metre-long structure (Figure 4).

In addition to the damage to the walls and additional weight from the previous roof renovation, moisture from underground water (rising damp) contributed to deterioration of the existing walls and columns. The deteriorated columns of the arched corridor (Figure 7) were repaired by replacing the damaged plaster which had been affected by moisture from rain. The walls had distinguishable stain due to moisture 1.50 to 1.80 metres above ground level. The damage from underground water greatly affected the wall finish. To protect against this moisture absorbed through the concrete foundation grade beams, the design team decided to cut the existing foundation horizontally into two parts and support the building structure with a new foundation straddling the lower portion of the old beam. This technique would not only protect the building from the moisture, but also from future settlement.

Figure 5 - Reinforced Column

Figure 6 - Roof under Construction

Selection and installation of the mechanical system was a major concern due to the shape of the building. The 200 metre-long building required a large number of ducts and high capacity equipment. This equipment was externally located in the new mechanical area adjacent to the north side of the existing building. Parts of the building structure were modified to accommodate the electrical and air-conditioning system. For example, the space above the ceiling had to be modified to install ducts for the electrical wire and air-conditioning equipment. As a consequence, the structure of the ceiling was also strengthened to support these services.

Figure 7 -Existing Arches and Moldings

ANALYSIS OF CONTRACT TYPE AND PROCUREMENT

The historic preservation regulations also required that any redevelopment or restoration of government designated historic buildings be performed by the architects from the Fine Art Department [4]. The college administrators retained the architects from the Department without a selection process. The officials from the Department of Fine Art provided the design service and specifications for the contractors. The architects prepared the construction documents and then provided advice for the College Board of Direction and contractors. There was no mandated building code. After the completion of the project, the College Board of direction also acted as official inspectors. Table 1 shows the major project participants.

Table 1 - Project Participants

Owner	Suankularb College/ Ministry of Education
Chief Engineer	Mr.Arak Sanghitakul, Department of Fine Art
Architect	Mr.Suphachai Nakthong, Department of Fine Art Mr.Somchart Chungsiriarak, Department of Fine Art
General Contractor	Phromprakasit Construction Co.
Function	Education Museum
Construction Cost	$3.5 million USD
Completion Date	1999

Because the building is also a public school, a bid process was required to select the contractor. However, because the building was a unique project, the government allowed the school board to award the contract under special requirements. The bid committee consisted of officials from the General Education Department, Department of Fine Art, and the College Board of Direction. The contractors who intended to submit bids had to prequalify with the Department of Fine Art based on past performance, size of past projects, and experience in historic preservation projects.

PLANNING AND CONSTRUCTION

As indicated in the condition survey, the entire building structure was vulnerable to collapse and in bad shape due to many cracks in the walls and columns (Figure 7). The contractor had to temporarily stabilize the entire building structure for the safety of the workers by using scaffolding and steel cables. The reinforcement of the walls with new concrete columns was used to permanently stabilize the entire building [5]. This prevented the walls from collapse while the reinforcement of foundation was being performed. After the existing floor was removed to repair and replace the deteriorated materials, the floor was reinstalled at the higher level as indicated by the architects. This increased the floors on the first and second floors 45 cm (18 in.) higher. Because of the increase to the floor levels, all windows and doors on both floors had to be removed and the lower levels of arches and thresholds on both floors also had to be increased. In order to elevate the windows and doors, the contractor added a few courses of bricks to the existing walls. This increased the height of windows and door sills approximately 30-40 cm (Figure 4).

Figure 8 - Original Structure of Second Floor

The construction began with demolition of the interior. Many pieces of timber on the second floor were removed and salvaged to reduce the amount of new timber needed because timber 7.50 by 10.50 cm (roughly 3 by 4 in.) was hard to find locally. Figure 8 illustrates the original structure supporting the second floor and new reinforced concrete columns in the masonry walls. The terrazzo floor on the first level was removed and replaced with wood flooring which was the original material. When the first and second floors were removed, the foundation was exposed. The soil was excavated in order to drive reinforced concrete micro-piles around the building perimeter. The contractor placed about 400 25-metre micro-piles to support the building structure. These piles were put every 1.20 metres along both sides of the existing foundation of unreinforced concrete grade beams. New reinforced concrete ground beams were cast on top of the micro-piles to stabilize the existing foundation. Figure 9 shows placement of the micro-piles, indicated by the vertical reinforcement. In Figure 9, the new concrete ground beams cannot be seen due to the formwork at the lower left of the figure. When the new concrete ground beams reached sufficient strength, the existing foundation was cut by drilling cores to allow the workers to insert steel girders into the gaps in the foundation. The cut holes, steel beams, and cores are shown to the left in Figure 9. This effectively separated the existing foundation, transferring the building loads to the steel girders supported by the new concrete ground beams on the micro-piles. Reinforced concrete beams were cast above the steel girders on both sides of the existing footing as shown to the right in Figure 9.

Figure 9 - Micro-piles, New Ground Beams, and Coring of Existing Grade Beam

Figure 10 shows the sequence of foundation stabilization.

A. The soil was dug to expose the existing foundation (1).
   Micro-piles were driven into the ground (2) and the existing foundation was cut (3).
B. New ground concrete beams were cast on the top of the micro-piles to support the steel beams (4), and the steel beams were cast on the new concrete beams (5).
C. Other concrete beams were cast on steel beams to stabilize the upper part of the existing foundation (6).
   The lower part of the existing foundation was free to settle (7).

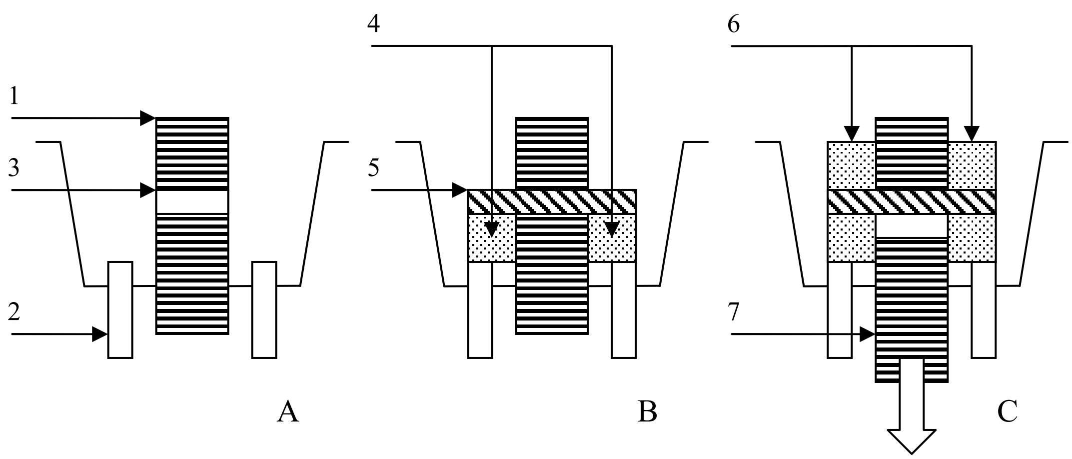

Figure 10 - Sequence of Foundation Stabilization

While the stabilization of the foundation was performed, the plaster was removed from the brick wall surfaces. Every half bay of wall was reinforced by a new concrete column, as shown in Figures 8 and 9. To construct the concrete columns, workers had to remove half the wall thickness and anchor rebar before placing concrete. After completion, the other half of the wall was removed and constructed in the same manner. The purpose of reinforcing half a wall at a time was that the walls would not be stable if cut through entirely. The thickness of a wall was 60 cm (24 in.), so the worker had to remove 30 cm of the walls at a time. The arch soffits of the corridor were raised approximately 45 cm (18 in.) throughout the entire building by removing the masonry and rebuilding to the new height. The plaster moldings were removed after the adjustment of floor levels.

While the walls were being reinforced, the roof was removed. Most rafters were usable; however, many had rot at the end due to moisture damage. The contractor attempted to keep as many rafters as possible because the same size rafters were not readily available in the local market [5]. The rotten parts were cut and patched by nailing pieces from other rafters. This was strong enough to support the new roof tiles and helped reduce project costs of new materials [5]. When the roof structure was removed, steel cables were used to provide lateral support for the walls. The top part of every wall was tied with the strong points on the ground by steel cable to keep the walls in position. After the entire building structure was permanently stabilized, all temporary steel cables were removed. To protect the roof timber from damage by termites, the contractor chose to dip the timber into a specially constructed trough containing a chemical treatment (Figure 11) rather than painting the timber which was considered to be too time consuming.

Figure 11 – Trough Used for Termite Protection

The timber was installed on the first floor and second floor sequentially as the foundation was completed. Hard timber floor beams were supported on the new concrete beams at the foundation, which supported the wood floor finished as the original appearance. The supply of timber for the floor beams was a problem because the large size was not available in the local market. The standard size available in the market was smaller than the existing timber used for the building floor beams, and had not been available for decades. The contractor had to specially order sawn timber to the required size. By salvaging good timber, the amount of new lumber was reduced by 20 percent.

With the flooring in place, the doors and windows were installed. Most door and window frames were replicated because the timber had rotted. The contractor found it difficult to find replacement frames in the market because the sizes were not standard.

The walls were repaired in conjunction with the door and window replacement. All plasterwork and molding were installed by skilled craftsmen, delaying the project due to a shortage of these craftsmen. Once the plasterwork and molding installation was completed, the building was left for more than six months to completely dry the approximately 60 cm (24 in) thick walls prior to painting.

To house the new mechanical and electrical equipment, an additional area was built adjacent to the building for air handling units, water pump, and generator. This isolated the masonry structure from any vibration.

CONCLUSION

The Thai government has a policy that public agencies have to use government designers whenever possible. In addition, the historic preservation regulations require that only architects from the Department of Fine Art can perform design services for historic government buildings. The architects and engineers from the Department of Fine Art were assigned to this prominent historic building restoration. The contractor had extensive experience in historic preservation projects as well as in public works projects.

The building and historic preservation regulations limited alterations. The architects and engineers were very concerned about structurally reinforcing the building because any changes had to comply with historic regulations. Only minor changes were made during construction to stabilize the entire building structure. The technique used to stabilize the structure did not interfere with the architectural significance as required by the Department of Fine Art. All components of the building were preserved to the original design; however; some elements were rebuilt that were too deteriorated to be repaired. The use of micro-piles, steel girders, reinforced concrete grade beams, and reinforced concrete columns did not disturb the historic character of the building features. The transfer of the building load to the new foundation did not result in measurable settlement and the few minor cracks in parts of the wall plaster were determined to be acceptable.

The age of the building and the preservation requirements presented unusual challenges. Because of 60 cm-thick walls, the building had to dry for six months before repainting. The special equipment for stabilizing the foundation was also a major cost concern. The contractor had to work within the area of the existing historic structure which was very limited. While the contractor was driving the micro-piles, only small equipment could be used in this tight area. The height of the door frame was an obstacle for moving the drilling equipment, different from conventional projects in which larger working spaces are often available.

This project represents a unique preservation method rarely used in Thailand. The building was a brick masonry structure with stabilization and deterioration problems. The limited working space due to the building features caused the design team and contractor to find creative solutions for the problems. Small equipment was used to stabilize the entire build structure and a relatively simple technique was used to level the floors and increase the building height. Instead of elevating the entire building structure, the design team chose to increase the height of walls and arches by adding more layers of bricks. This method was more cost effective than elevating the entire building by lifting the foundation.

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