開発途上国の建築生産における現代建築の適応に関する研究

3-7-4 Fire Safety Systems

At the turn of the century until 1925, sprinkler systems were made of bamboo or pipes with holes. These were connected to a water tank. In 1925, the fire code of the USA (NAPA) and the UK (FOC) were adopted. During this period, sprinkler systems were made available. In the 1930s, foam water was used as a fire retardant.

After the war, sprinkler systems in the Philippines were first introduced in oil refineries which required fire protection systems. Floor control valves were implemented at a commercial scale in the Philippines. Fire protection systems were required for the US Bases (Clark and Subic) particularly, in airport hangars. In 1948, the P&G PMC Building used river water to stop fires. The practice was followed by others. Also in 1948, dry chemicals, wet chemicals, and CO_2 fire extinguishers became available for commercial kitchens.

In 1950's to comply with insurance requirements, the following companies had fire protection systems implemented: Goodyear Tires, Firestone, Ford Philippines, Abbott, Squibb, Pfeizer, Philippine Packing Corporation, Victoria Milling Corporation I. Various firms which specialized in fire protection were: WA Chittick, AG&P, EEI, Caravo, Inc. Gasoline and diesel engine driven pumps were used.

After the 1966 fire of Manila, portable fire extinguishers became unpopular. In 1968, the Aquamatic On & Off System was developed for Reynold's Company. In 1975, the Philippine Fire Code (PD 1186) mandated the use of automatic sprinkler systems (ASS). From 1975-1977, projects built employing automatic sprinkler systems (ASS) were the Philippine Plaza Hotel in Manila, PICC, Manila Sheraton Hotel, and the Manila Ramada Hotel.

3-7-5 Vertical Transport

In 1950's the first elevators used during this period were controlled manually. High speed elevators came into use during this period. An example of such a building was the Hilton Hotel that was constructed in 1965.

In 1960's professional practice in elevator design gained significance during this period.

After 1980's architects begin considering occupancy and building character in elevator design. The Philippine National Building Code mandates specifies elevators as requirements. In the mid-1980s, consultants begin considering crowd behavior in elevator design.

In the early 1990s, tower structures required the splitting of elevators, that is, a group of elevators servicing specified number of floors. Fire-rated elevators of up to 1,5 hours come into use. Microcomputer systems for electrical systems come into use. AC Variable Voltage Drives also come into use. AC Variable Voltage / Variable Frequency Drives likewise come into use. Milestone buildings during this period are the Rockwell-Lopez Center (60 storeys high) and the Ayala Triangle (35-40 storeys high).

3-7-6 Electrical Systems

During 1890's, there was no high demand for electricity because there was little need for artificial lighting and airconditioning. Only moviehouses were provided with airconditioning. The situation remained the same until around 1919.

From the 1930s to the 1940s, offices used electric fans. Airconditioning was still uncommon. Prior to 1948, there were at least 238 registered electrical engineers. Airconditioning became a standard feature in buildings during this period.

Professional practice began to flourish during the early 1960s. In 1967, bus ducts were employed to save on rentable space. Few power failures in the late 1960s made the provision of generators unnecessary.

In 1970's the frequent power failures during the martial law period called for the provision of emergency systems. These were installed is critical areas such as corridors, stairways, toilets, pumps, and a portion of lighting fixtures and convenience outlets.

In the early 1980s, a growing consciousness for the necessity of generators (GENSETS) brought about major changes in building design. This was partly due to the power crisis that rocked the administration of President Corazon Aquino.

Additional power plants were built during the administration of President Fidel Ramos such as the ones in Batangas and Pangasinan. Chillers for airconditioning required less power. LOGIC-CONTROL LED SYSTEMS come into use in buildings. AUTOMATIC SYNCHRONIZERS come into use especially for industrial purposes. The same system is provided for hospitals. As part of the move to fully automate building efficiency, METERING, MONITORING, AND PROTECTIVE systems (to protect against overloads) come into use. K-RATED TRANSFORMERS come into use to protect data in computers from harmonics.

Table 3-1 Practice of structural engineering

PERIOD	TIMBER	REINFORCED CONCRETE	STRUCTURAL STEEL
1880-1900	• Most buildings were 1-2 storey wooden structures. Structural engineering was unknown as a discipline. Civil engineers did architectural and structural analyses on their own. [14]	• Most buildings were 1-2 storey wooden structures. Structural engineering was unknown as a discipline. Civil engineers did architectural and structural analyses on their own. [14]	• Most buildings were 1-2 storey wooden structures. Structural engineering was unknown as a discipline. Civil engineers did architectural and structural analyses on their own. [14]
1901-1919			
1920-1940	• Timber piles were used reaching only 30 feet [1] • The Crystal Arcade was designed by Jose Cortez (who was educated in the US) in 1930. This was a landmark building with glass floors and skylights. [14] • Friction piles were used in the 1940s. [2]		
1941-1945			
1946-1949		• This period witnessed the shift from the use of wood as a structural material to concrete. [14] • Before the advent of research in reinforced concrete technology, the maximum strength of concrete was 2,000 PSI. [4]	
1950-1959		• Development of reinforced concrete as a building material. [14] • Raul Ura developed the post-tensioning technology in the early part of 1950 and mass produced concrete joists. [14] • Shell construction using reinforced concrete as a material was introduced in 1956 with the construction of the UP Chapel by Locsin. The strength of concrete was approximately 3,000 PSA. [4] • In the late 1950s, the standard strength of concrete ranged from 1,800-2,000 PSI.	• During this period, steel members were already available. These were assembled by the Chinese makers of wrought iron grilles. [14] • Steel construction was widely used during this period just prior to the advent of post-tensioning. [4]
1960-1969		• PHILSTRESS, CONSTRESS, and PERMASTRESS (manufacturers of pre-stressed reinforced concrete components) produced plant-assembled pre-stressed piles with strengths ranging from 3,000-4,000 PSI and reaching lengths of up to 40 feet in 1962. [2] • In the mid-1960s, pre-stressed piles with good bending qualities were built with lengths reaching 90-120 feet. [2]	

		• The maximum capacity for piles was 50 tons. [4]	
1970-1979		• The PNB Building in Escolta was the first building to use piles with 100 tons capacity. [4] • In the early 1970s, the standard strength of concrete was 3,000 PSI. [14]	

1980-1989		• In the early 1980s, the strength of reinforced concrete ranged from 2,500-3,000 PSI. The PSI Telecom Plaza built in 1983 is an example. • During this period, the standard strength of concrete ranged from 3,000-4,000 PSI. [2] • High strength concrete, around 6,000 PSI was developed in the late 1980s. The Pacific Plaza Condominium is an example. [2]	• High tensile steel reinforcing bars were developed with high strength concrete. [4]
1990-1999		• Caisson piles (cast-in-place technology for piling systems) were introduced. This new technology permitted the construction of buildings using piles of infinite depths. [2] • The maximum capacity of piles reached 3,000 tons. [4] • Fly-ash was used to disperse water in reinforced concrete to arrive at a stronger concrete. The method is used by DMCI. [4] • Maximum strength of reinforced concrete reached 8,000 PSI. The Robinson's Galleria Corporation Towers is an example. [4] • Presently, structural engineers and contractors are experimenting with concrete with strengths reaching 10,000 PSI. [2] • The PCI building in Ortigas Avenue is an example. [4] • The use of computers in structural design has greatly aided the engineer in making more efficient designs. [2]	• Steel construction was re-introduced in the early 1990s. The economic crisis (which caused the country's currency to weaken against the dollar) and the relative inexperience of most construction workers with steel caused the use of steel to be short-lived. [2] • Some buildings built in the late 1990s use a combination of structural steel and reinforced concrete. [2]

NOTES			• Landmark buildings of the 1990s are: The Jaku Tower, Philamlife Tower, Petron Mega Plaza.

Table 3-2 Use of building materials (1)

PERIOD	EXTERIOR FINISHES	INTERIOR FINISHES
1880-1900	• Adobe and wood are prevalent materials used for offices. • At the turn of the century until just before the war, Philippine hardwoods were extensively used for exterior finishing such as Ipil and Narra (1st class wood), Lauaan, Apitong and Tanguile. [14]	• At the turn of the century until just before the war, wood panels, painted or wall-papered surfaces were widely used. [8]
1901-1919	•	• At the turn of the century until just before the war, wood panels, painted or wall-papered surfaces were widely used. [8]
1920-1940		
1941-1945		
1946-1949		
1950-1959	• Shell piqueta finish for exterior walls became popular. The technique became popular in the early 1970s and lasted until the late 1970s. [8]	
1960-1969	• Shell piqueta finish for exterior walls became popular. The technique became popular in the early 1970s and lasted until the late 1970s. [8]	

PERIOD	EXTERIOR FINISHES	INTERIOR FINISHES
1970-1979	• Shell piqueta finish for exterior walls became popular. The technique became popular in the early 1970s and lasted until the late 1970s. Examples of buildings using this finish are the Ayala Museum and the Makati Stock Exchange Building which was built in 1971. [8] • Brick veneer finish also became popular during this period. [8]	• The use of chip boards and particle boards come into use during this period. [13]
1980-1989	• Pre-cast ballustrade system become popular during this period. [8] • In the late 1980s, Glass Fiber Reinforced Concrete (GFRC) is tried in the Philippines. An example is the Robinsons Galleria Building. [8]	• Synthetic Fiber Carpets are introduced. [8]
1990-1999	• The use of granite as exterior finishing becomes popular in 1993 and 1994. Two attachment processes are employed: wet and dry. The Philippine Stock Exchange (PSE) Tower 1 uses imported granite and employs the dry process. The use of Benguet granite on the other hand uses the wet process. [8] • Paint (in pastel tones) is widely used during this period. [8] • Granite like paint are also popular. [8] • Duavit, Pleko ? (1996-1997) • Metal Cladding (by Reynolds and Aheco Bond) appear in quite a number of buildings such as the JMT Tower. [8] • Mosaic exterior finish is also used such as in the BIR Building built in 1996. [8]	• For interior finishing wood walls, bamboo panelling, and synthetic stones come into use. [8] • As substitutes for traditional wood finishing, PVC trimmings, gypsum boards, waterproof gypsum, and pre-cast gypsum mouldings become popular during this period. [8] • Gypsum boards become particularly popular in 1997-1998. [8]
NOTES		

PERIOD	WINDOW SYSTEMS	ROOFING MATERIALS	FLOORING MATERIALS
1880-1900	• Use of punched windows (steel mullions) with glass in fixed, awning, and steel casement windows. For office buildings, the use of this type of window was popular until the late 1950s. [1] • Presently, this type of window is still used in small buildings where budget is a major consideration. [YAP]	• Clay tiles is the common roofing material during this period. • Thatch roofing is also common. [YAP]	
1901-1919	• Punched windows in use.	• In the early 1900s, Galvanized Iron as a roofing material was introduced. The first to appear had the brand name "Apollo Ga. 24" and was sold in lengths of 8 feet and 12 feet. • Presently, galvanized iron sheets are still popular among residential uses and small office buildings. [YAP]	
1920-1940	• During this period, glass blocks come into use.	• Terracotta tiles for roof decks come into use. An example is the UP College of Liberal Arts Building. [8]	• Terracotta floor tiles come into use during this period. [8] • Another popular flooring material are mosaic floors. An example is the UP College of Engineering. [8]
1941-1945			
1946-1949			

PERIOD	WINDOW SYSTEMS	ROOFING MATERIALS	FLOORING MATERIALS
1950-1959			• Polished concrete became a popular floor material for low-cost housing. [8] • Mosaic floors became widely used in office lobbies. [8]
1960-1969	• Aluminum sliding windows come into use. [1]	• Asbestos cement tiles become popular particularly from the 1960s to the 1970s. [8]	
1970-1979	• The period from 1970 to the early 1990s witnessed the recurrence of glass blocks. [8] • Glass tinting comes into fashion during this period.	• The use of long span galvanized iron roofs become popular during this period. Popular brands are Philsteel and Metal Forming Corporation. [14]	• Popular flooring materials during this period are: vinyl tiles, Bulacan marble, carpets, and crazy-cut marble. [8]
1980-1989	• The Stick System of glass cladding (using aluminum frames) come into use. An example is the Rufino Tower. [1]	• Tegula concrete tiles become popular. [8] • The Eternit roofing system likewise become popular. [8]	

Table 3-3 Use of building materials (2)

PERIOD	WINDOW SYSTEMS	ROOFING MATERIALS	FLOORING MATERIALS
1990-1999	• Analok Finish and powder coated aluminum frames becom popular (1999-). [8] • Mullionless aluminum case windows also make their first appearance. [8] • Another popular material is the use of frameless glass. [8] • Polycarbonate window systems are popularized. [8] • Panelized system of glass cladding; combinations of punched, stick, and panelized systems become widely used. The use however depends tremendously on the requirement of the cliend and the budget. An example is the Citibank Tower I. [1]	• Coconut coir come into use as building materials. [8] • As part of government's programs to develop alternative building materials for low cost housing, non-traditional materials such as coconuts have been experimented upon to determine their potential as alternative building materials. [YAP] • Curved roofs come into use. [8]	• Raised floors for concealing wiring systems are introduced. The cost however is exorbitant (5,000/sq,m.) and are therefore not widely used. [1] • The use of raised flooring are probably a result of the advent of computers where units are interconnected using a LAN system. [YAP] • Laminated floors make their first appearance. [8] • Glazed granite tiles also become popular. An example is the SM Megamall. [8] • Vitrified tile systems also come into use. [8]
NOTES		Undated: Use of rice hull husks, concrete tiles, and a 2-roof system (tiles and GI shts. • Rice hull husks were experimented upon in the 1980s wherein the ash from burned rice hull was combined with cement in the hope of lowering the cost of the concrete or mortar mix. The admixture was used in making concrete hollow blocks. [YAP] • Concrete tiles probably made their appearance immediately before or after the war. [YAP] • 2-roof systems became popular in the advent of using clay tiles as a roofing material in the late 1970s until the early 1980s when the search for "what Philippine architecture is" came into fashion. [YAP]	

Table 3-4 Practice of Tropical design

PERIOD	
1880-1900	• Houses were built with wide eaves popularly called "medya-agua" to protect the house against harsh weather conditions. [7]
1901-1919	
1920-1940	
1941-1945	
1946-1949	• During the period, it could be observed that the work of architects exhibited a general concern for the effects of climate on architecture. Among the common features during this period were: large window openings, sun-shading devices, and ventilation in terms of open spaces. [6]
1950-1959	• The use of vertical and horizontal sun shading devices became popular during the 1950s and 1960s. The works of Pablo Antonio, Cesar Concio, and Felipe Mendoza attests to this. [7]
1960-1969	• Wide overhangs (made of concrete roof extrusions) became widely used. This began in the 1960s and lasted until the 1980s. [7] • Considerations for the climate (as expressed in tropical design) could be seen in the works of Bobby Mañosa (San Miguel Head Quarters Building and other resorts); Toti Villalon (DAP Building); Nestor David; UP Faculty. [7]
1970-1979	
1980-1989	• An example of a building that took tropical design into consideration is the Ateneo Building Science Complex by Bobby Mañosa. [6]
1990-1999	• The advent of tower structures and the popularity of glass curtain walls set back advocacies for tropical design considerations during this period. [7] • There are however a growing number of architects who incorporate tropical design features in their works. [7] • An example of such a project is the Rockwell Center by Bobby Mañosa. [6]

Table 3-5 Practice of Building technology (1)

PERIOD	AIRCONDITIONING SYSTEMS	LIGHTING SOLUTIONS
1880-1900		• Lighting solutions for residential buildings consisted of large window openings, use of transoms, ventanillas, and screens. This practice lasted until 1919.
1901-1919		
1920-1940	• Before the war, only the opera house was provided with airconditioning. • "Canetex", a form of fiber insulation came into use.	• The American influence on the use of non-renewable sources of energy resulted in smaller windows as well as enclosed spaces.
1941-1945		
1946-1949		• Lack of resources after the war resulted in simpler structures with fewer openings. The increased dependence on electric lighting sources was observed.
1950-1959	• The direct expansion system came to be used for offices and theatres. • Prior to 1956, there were no practicing airconditioning consultants. Suppliers would design systems for buildings. • In the late 1950s, centralized airconditioning systems became fashionable in Forbes Park residences. An example is the Stonewall residence.	
1960-1969	• Fiberglass insulation became favored over styrofoam insulation. • In the early 1960s, the Araneta Center was built. This became the country's first airconditioned stadium. The Campos residence was also built during this period (1960). • The use of chilled water systems were employed for taller buildings. An example is the Philam Life Building which was built circa 1960-62. • Airconditioning consultants from the US bases in Clark and Subic arrived during this period. There were likewise a few independent consultants such as Val de la Fuente, Mr. Campos, and Mr. Juinio from UP. • These consultants provided their services in the design of buildings such as the San Miguel Head Quarters Bldg., Makati Stock Exchange, Meralco Building (1968), CCP (1969).	• Increased dependence on electricity for airconditioning and lighting systems resulted in smaller windows or none at all, enclosed spaces, and plain walls.
1970-1979	• The chilled water system became widely used for large buildings such as the PICC (built in 1975) and other hotels. • Buildings such as the PICC (Philippine International Convention Center), CCP (Cultural Center of the Philippines), and 1st Citibank Building heightened standards for the quality of airconditioning systems. • Many airconditioning consultants emerged with the advent of hotel design in the early 1970s. • The zoning system for airconditioning design came into use.	• The worldwide oil crisis from 1974-1975 made designers revitalize the study of daylighting solutions. • Landmark buildings during this period were the Philam Life Building and the San Miguel Head Quarters Building.

	• Variable air and volume supply came into use. • Individual fan coil units became popular in hotels. • Airconditioning of office building further made the profession attractive.	

1980-1989	• Polyfoam, Ewafoam (?), and other foam-based products became popular as insulators. • This period witnessed a growing concern for the "sick building syndrome" popularized in the US. • Building management came into use. An example is the Bank of Philippine Island (BPI) Building that was built in 1983. Sound traps also became popular during this period.	
1990-1999	• Polyurethane insulation came into use during this period. • In 1991, the growing concern for the sick building syndrome made airconditioning specialists increase the tonnage requirements from 7-10 cfm to 20 cfm. An example is the Citibank Tower 2. • Special requirements for tower structures are: 1) one main compressor at the basement level, 2) an AHU unit for every floor, 3) a cooling tower at the roof deck, and 4) a machine room at intermediate floors to counteract friction loss.	
NOTES		

Table 3-6 Practice of Building technology (2)

PERIOD	WATER SUPPLY AND SANITARY SERVICES	FIRE SAFETY SYSTEMS
1880-1900	• In 1880, the Carriedo Water System was inaugurated. The system was supplemented by water from esteros and cascos. • The outhouse ("kubeta" or toilet) was used. The method was unsanitary however because wastes from the cistern leached nto the ground.	
1901-1919	• In 1908, the Montalban River was tapped as an additional water source by the Americans.	• At the turn of the century until 1925, sprinkler systems were made of bamboo or pipes with holes. These were connected to a water tank.
1920-1940	• In the early 1920s, the Ipo Dam-Novaliches-Manila Water System was developed and tapped water from the Angat River. The La Mesa impounding dam was opened. The Alat River served as a supplementary dam. • The Manila Water System served opulent areas. Middle and lower income citizens bought water from cascos (for 6 months). Bathing and washing was done in the river.	• In 1925, the fire code of the USA (NAPA) and the UK (FOC) were adopted. During this period, sprinkler systems were made available. • In the 1930s, foam water was used as a fire retardant.
1941-1945		
1946-1949	• Waste disposal methods were observed as follows: 3. Wrap and throw system done by lower income families. 4. Antipolo system (container under toilet) was popular in rural areas and suburbs. 5. Pail system was done in Binondo, Sampaloc, and Tondo.	• After the war, sprinkler systems in the Philippines were first introduced in oil refineries which required fire protection systems. • Floor control valves were implemented at a commercial scale in the Philippines. • Fire protection systems were required for the US Bases (Clark and Subic) particularly, in airport hangars. • In 1948, the P&G PMC Building used river water to stop fires. The practice was followed by others. • Also in 1948, dry chemicals, wet chemicals, and CO_2 fire extinguishers became available for commercial kitchens.
1950-1959	• In 1955, under the administration of President Ramon Magsaysay, the National Sanitary Engineering Law and Master Plumbing Law was created to regulate the practice. • In the late 1950s, Ayala Corporation introduced sanitary sewage systems in their developments. A sewerage treatment plant was built in Dasmariñas Village in Makati. • Though expensive, a recirculating drinking water system was first used in the high-end projects of Locsin and other architects particularly in hotels. • The use of airconditioning and fire protection systems increased water loads. • Tank type water closets came into fashion.	• To comply with insurance requirements, the following companies had fire protection systems implemented: Goodyear Tires, Firestone, Ford Philippines, Abbott, Squibb, Pfeizer, Philippine Packing Corporation, Victoria Milling Corporation I. • Various firms which specialized in fire protection were: WA Chittick, AG&P, EEI, Caravo, Inc. • Gasoline and diesel engine driven pumps were used.
1960-1969	• In the early 1960s, a law was passed requiring all subdivisions who applied for water supply connections with MWSS were required to set up their own sewage systems and sewage treatment plants. • In the mid-1960s, probably to save on	• After the 1966 fire of Manila, portable fire extinguishers became unpopular. • In 1968, the Aquamatic On & Off System was developed for Reynold's Company.

	construction costs, the storm drain was joined to the waste water pipes which brought about the pollution of rivers.	
1970-1979		• In 1975, the Philippine Fire Code (PD 1186) mandated the use of automatic sprinkler systems (ASS). • From 1975-1977, projects built employing automatic sprinkler systems (ASS) were the Philippine Plaza Hotel in Manila, PICC, Manila Sheraton Hotel, and the Manila Ramada Hotel.

1980-1989	• The Flushometric type of water closet came into use.	
1990-1999		
NOTES		

Table 3-7 The practice of Building technology (3)

PERIOD	VERTICAL TRANSPORT (ELEVATORS AND ESCALATORS)	ELECTRICAL SYSTEMS
1880-1900		• During this period, there was no high demand for electricity because there was little need for artificial lighting and airconditioning. Only moviehouses were provided with airconditioning. • The situation remained the same until around 1919.
1901-1919		
1920-1940		• From the 1930s to the 1940s, offices used electric fans. Airconditioning was still uncommon.
1941-1945		
1946-1949		• Prior to 1948, there were at least 238 registered electrical engineers.
1950-1959	• The first elevators used during this period were controlled manually.	
1960-1969	• High speed elevators came into use during this period. An example of such a building was the Hilton Hotel that was constructed in 1965. • Professional practice in elevator design gained significance during this period.	• Airconditioning became a standard feature in buildings during this period. • Professional practice began to flourish during the early 1960s. • In 1967, bus ducts were employed to save on rentable space. • Few power failures in the late 1960s made the provision of generators unnecessary.
1970-1979		• The frequent power failures during the martial law period called for the provision of emergency systems. These were installed is critical areas such as corridors, stairways, toilets, pumps, and a portion of lighting fixtures and convenience outlets.d
1980-1989	• Architects begin considering occupancy and building character in elevator design. • The Philippine National Building Code mandates specifies elevators as requirements. • In the mid-1980s, consultants begin considering crowd behavior in elevator design.	• In the early 1980s, a growing consciousness for the necessity of generators (GENSETS) brought about major changes in building design. • This was partly due to the power crisis that rocked the administration of President Corazon Aquino.
1990-1999	• In the early 1990s, tower structures required the splitting of elevators, that is, a group of elevators servicing specified number of floors. • Fire-rated elevators of up to 1,5 hours come into use. • Microcomputer systems for electrical systems come into use. • AC Variable Voltage Drives also come into use. • AC Variable Voltage / Variable Frequency Drives likewise come into use. • Milestone buildings during this period are the Rockwell-Lopez Center (60 storeys high) and the Ayala Triangle (35-40 storeys high).	• Additional power plants were built during the administration of President Fidel Ramos such as the ones in Batangas and Pangasinan. • Chillers for airconditioning required less power. • LOGIC-CONTROL LED SYSTEMS come into use in buildings. • AUTOMATIC SYNCHRONIZERS come into use especially for industrial purposes. The same system is provided for hospitals. • As part of the move to fully automate building efficiency, METERING, MONITORING, AND PROTECTIVE systems (to protect against overloads) come into use. • K-RATED TRANSFORMERS come into use to protect data in computers from harmonics.
NOTES		