THE MID-CENTURY MODERN ARCHITECTURE OF ENGINEER KENNETH SATO; AND THE UTILIZATION OF THIN-SHELL CONCRETE

Historic Context Study

Final Report

June 17, 2021

FUNG ASSOCIATES INC.

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INTRODUCTION

This historical context study was undertaken in compliance with the Memorandum of Agreement (MOA) between the City and County of Honolulu (CCH); Halewaiolu Senior Development, LLC (HSD); and the Hawaii State Historic Preservation Officer (SHPO) for the Halewaiolu Affordable Housing for Seniors Project. The Halewaiolu Senior Residences development will replace the John R. Gilliland Building designed by engineer Kenneth Sato in 1958. The John R. Gilliland Building was deemed eligible for listing in the Hawaii and National Register of Historic Places under Criterion C, as a unique example of mid-twentieth century modern architecture.[1] Therefore, as mitigation for the demolition of the John R. Gilliland building a historical context study will be completed, per HAR §13-275-8(a)(1)(B). The Stipulation set forth in section IV.A of the MOA states:

"*The historical context study shall include the history of the engineer and the engineering of the building, its materials and construction methods, and its relationship with the area. The context study shall follow the guidelines provided at https://www.nps.gov/articles/sec-standards-arch-and-eng-doco-standards.htm by the National Park Service."*

Prior to the start of any work, qualified personnel were chosen as Section IV.B of the MOA stipulates: *"…measurements, photographs, and documentation activities are performed or directly supervised by a person or persons who meet the minimum qualifications as specified in the Secretary of the Interior's Professional Qualifications Standards ("Qualification Standards") for an Architectural Historian or Historic Architect, as further defined in 36 CFR Part 61."* Mrs. Alison Chiu, Dr. Don Hibbard, and Ms. Bethany Zedalis who meet the Secretary of Interior's Standards as architectural historians, and Ms. Kelsey Liu, conducted the research and prepared the historical context study.

This historical context study followed a methodology which included performing background research, and gathering information including referencing the 2016 reconnaissance level survey (RLS) on the John R. Gilliland Building and the Hawaii Modernism Context Study (Fung Associates, 2011). Additional research was undertaken including investigating land

1 "John R. Gilliland Building." *Reconnaissance Level Survey.* Honolulu, Hawaii, Fung Associates Inc. 2016.

development maps, and newspapers articles. Subsequently, this report was prepared, reviewed and finalized.

The focus of this report is engineer Kenneth Sato, and his body of architectural engineering work in Hawaii given that he designed and constructed the John R. Gilliland Building. Sato was an early proponent of thin-shell concrete technology, and the John R. Gilliland Building was among the earlier examples of this work. This report explores the design of the John R. Gilliland Building, as well as the building's history, and its namesake. An examination of concrete, and the technological advancement in thin-shell concrete, are also expounded upon as these advancements led to a significant character defining feature on the John R. Gilliland Building in addition to other buildings and structures in the state of Hawaii. Additionally, local examples of thin-shell concrete were gathered and are presented in this report which illustrate Sato's role utilizing the form and as a pioneer of modern design in Hawaii.

While we greatly respect and honor the Hawaiian language as *ka olelo makuahine o* Hawaii (the mother tongue of Hawaii) and recognize it is one of two official languages in the State of Hawaii, we acknowledge that the global use and readability of diacritical markers (the *kahako* and *okina macron* and glottal stop, respectively) in electronic formatting may cause words to display incorrectly when presented in different documentation and databases. Accordingly, diacritical markers have been omitted from Hawaiian words and place names in this report, and we apologize for its non-inclusion in this draft. Mahalo for your understanding.

THE JOHN R.GILLILAND BUILDING

Figure 1: *John R. Gilliland Building Location*
Source: Google Earth (2018)

The John R. Gilliland Building was designed and built in 1958 by engineer Kenneth Sato. It is located at 1331 River Street, Honolulu, Hawaii on the island of Oahu. The building is located adjacent to the Chinatown Historic District in a dense urban setting; and fronts River Street, and is bounded by North Vineyard Boulevard, North Kukui Street, and Mauanakea Street (Figure 1).

This two-story modern style building's façade is distinguished by a folded plate canopy with a drip edge between the first and second story that extends the length of the façade and has a folded plate roof with a drip edge. The façade is further enriched by the roof which is a series of front-facing segmental-arched barrel vaults with overhanging eaves on both the front and rear elevations of the structure. The reinforced concrete building is eight bays wide, with all the bays being of similar width except the northeast-most bay, which is narrower. The barrel vaults define the bays with one covering each bay. On the second story, each bay features a picture window, flanked on either side by a pair of jalousie windows.

The rear (northeast) elevation on the ground level has a single door entry in each bay at its south side. The design of the rear of the second story mimics the main façade's second story. At either end of the building, a double concrete stair leads to the second floor, and a flat roof extends from the sides of the end barrel vaults to protect the stairs from the elements.

The John R. Gilliland Building retains its integrity of design, workmanship, material, setting, feeling, location and association. The building was evaluated for its significance for the State and National Register of Historic Places. The John R. Gilliland Building is eligible under Criterion C as it is architecturally significant as a unique example of a small retail/ office building constructed in Hawaii in the mid-century modern style of the 1950s. It is also a very good example of the architectural work of engineer Kenneth Sato. The building's

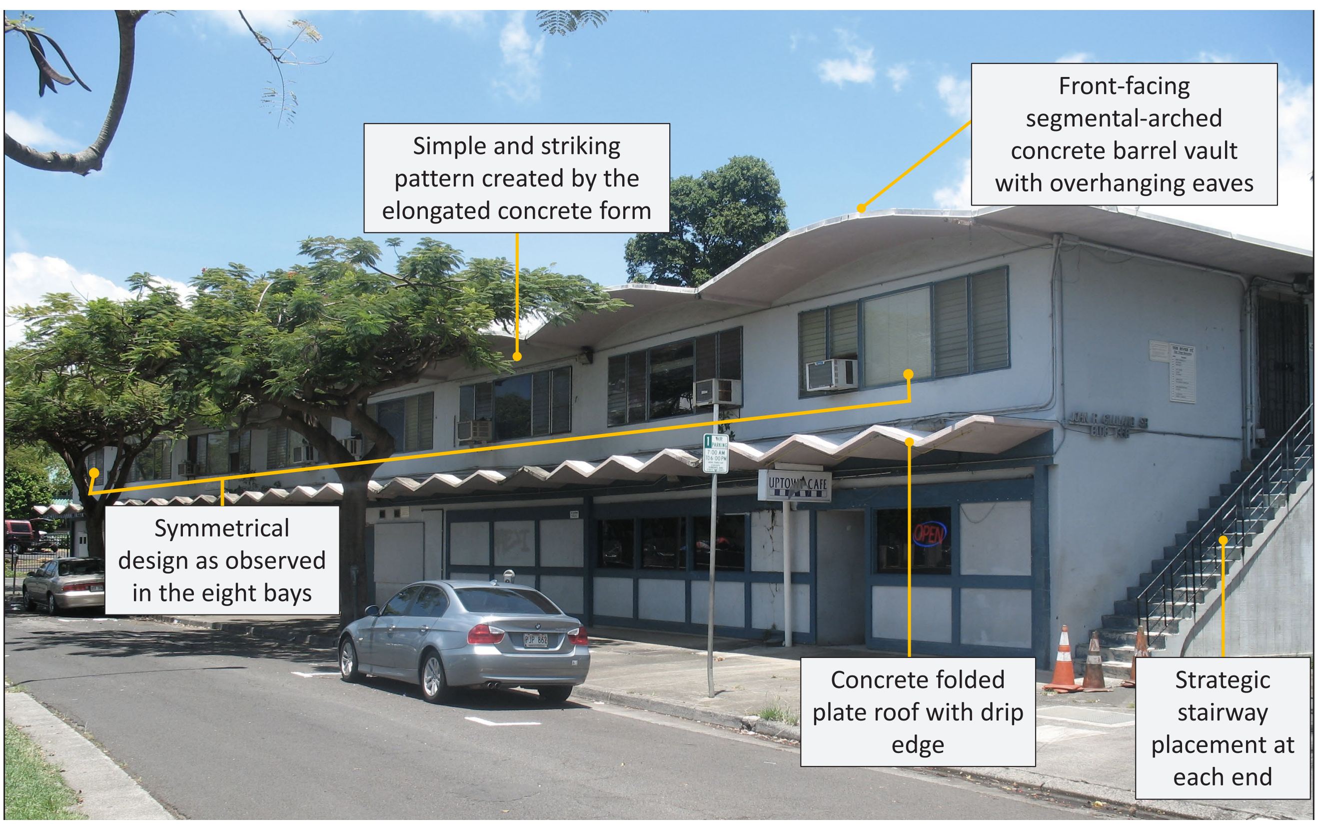


Figure 2: *John R. Gilliland Building Character Defining Features*
Source: Reconnaissance Level Survey, Fung Associates Inc. 2016

character is distinguished by: the front-facing, segmental-arched, concrete barrel vaults with overhanging eaves, the concrete folded plate roof with a drip edge, the simple and striking pattern created by the elongated concrete form, symmetrical design as observed in the eight bays, fenestration, stairway placement, its setting and orientation to Nuuanu Stream.

As such, the building stands as an excellent example of the dramatic and eye-catching mid-century modern movement in Hawaii. The building's folded plate canopy, combined with its concrete barrel-vaulted roof, make it a distinctive architectural statement celebrating the plastic qualities of concrete and the variety of forms it could assume. It is typical of its period in its design, materials, workmanship, and construction methods (Figure 2).

Vineyard Boulevard Corridor Development

Vineyard Boulevard is one of the oldest streets in Honolulu. It was originally named Vineyard Street as it terminated at the vineyard of Don Francisco de Paula Marin.[2] In the early 1900s, Vineyard Street was not the major thoroughfare it is today, but rather a street with many large and small dwellings. One of the earliest mentions of Vineyard Street appears in a newspaper article from 1884 with a resident reporting a home break-in. In 1888, the Committee on Public Land and Internal Improvements presented petitions to the Legislative Assembly; one petition requested the extension of Vineyard Street to Nuuanu Stream in an effort to improve the neighborhood.[3] Improvements to Vineyard street included new sidewalks in 1893, and the Nuuanu Avenue end was widened by approximately 15 feet which was said to, "greatly improve the appearance and convenience of the thoroughfare."[4]

2 "Hawaiian Dictionaries." Accessed February 1, 2021. https://archive.is/20120716141111/http://wehewehe.org/cgibin/hdict?a=q&j=pp&l=en&q=vineyard.

3 "St. Louis Student Named the First Gilliland Scholar," *Honolulu Star-Bulletin*, June 12,1990, p.2.

4 "Local and General News," *Evening Bulletin,* October 18, 1893, p.3 & "Widening Vineyard Street," *The Honolulu Advertiser,* October 24, 1893, p.3.

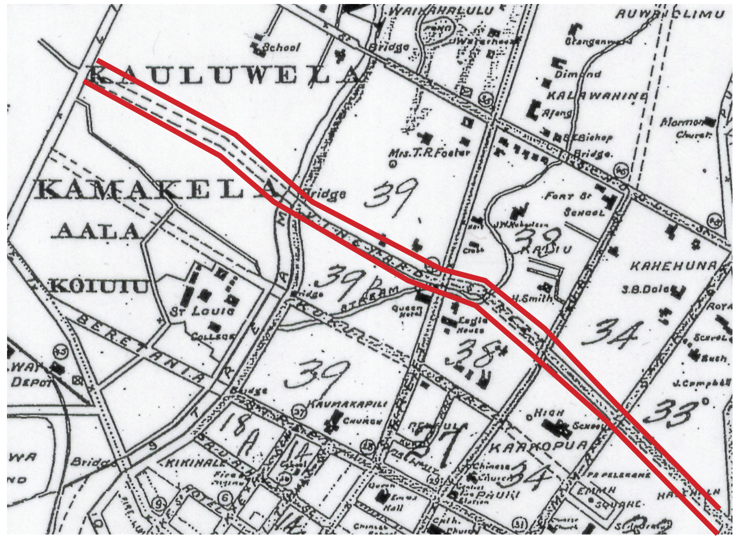


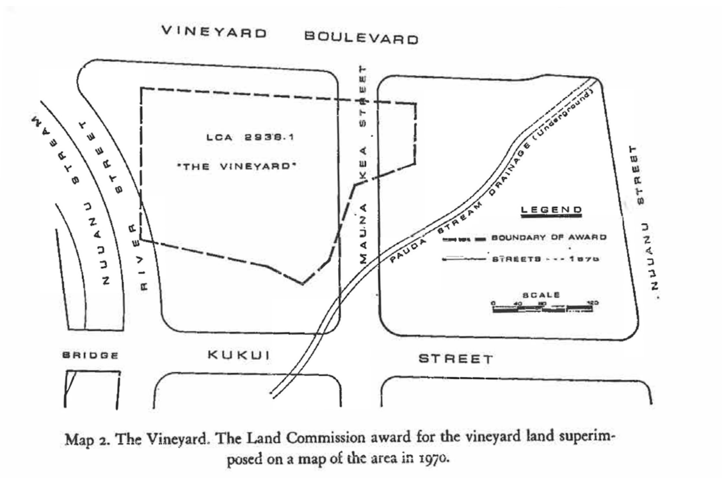
Figure 3: *Honolulu 1897, Monsarrat Map*
Source: Monsarrat, M.D. Map of Honolulu. 1897. http://hdl.handle.net/10524/59520

The Territory of Hawaii negotiated with property owners to obtain deeds to improve and expand roadways. In 1897, the Interior Minister along with J.R. Gilliland and his wife, "exchanged deeds for portions of land near Vineyard Street on account of projected street improvements."[5] The landscape of Nuuanu and Vineyard Street continued to change over time as the area became more urbanized and Vineyard Street continued to be improved and expanded in the east and west directions (Figure 3). The 1950s brought about a significant change to the area as Vineyard was expanded to become Vineyard Boulevard, a six-lane road constructed to be a feeder to the Lunalilo Freeway. In conjunction with the roadway improvements, the City and County of Honolulu redeveloped large portions of the lands surrounding the new boulevard. The Gilliland family retained a portion of their land even after the urbanization of Honolulu, and the Vineyard Boulevard development. The construction of the John R. Gilliland building may be viewed as contributing to the overall effort to renew the Vineyard area.

History of the Building

The Gilliland family members are direct descendants of Don Francisco de Paula Marin. The land upon which the John R. Gilliland Building sits has been in the Gilliland family since the early 1800s. The land was originally garden plots for the cultivation of *loi kalo*, or taro. In the early 1800's the land was gifted by the king to Marin, often referred to locally

5 "Local and General News," *Evening Bulletin*, February 18, 1897, p.5.



Map 2. The Vineyard. The Land Commission award for the vineyard land superimposed on a map of the area in 1970.

Figure 4: *Land Commission 2938.1 Overlayed on a 1970s Map*
Source: Gast, Ross, Don Francisco de Paula Marin. p.54

as Marin or Manini. He was born in Jerez, Spain on November 28, 1774, and arrived in Hawaii in 1793 or 1794, purportedly a deserter of the Spanish Navy.[6] He was an advisor to King Kamehameha I, and served as an: interpreter, business counselor, accountant, physician, and "provided the king and the king's retinue with their daily supply of spirits."[7] Marin called his land "New Vineyard," and in 1815 produced his first 38 gallons of wine.[8]

Marin's vineyard was located in an area called Kalawahine, located at the junction of Nuuanu and Pauoa streams, presently near Kukui and River Streets.[9] After Marin's death in 1837 his land was divided between several of his children and grandchildren (Figure 4). As a result of The Great Mahele of 1848, the Land Commission award (LCA 2938.1) for the 2.311 acres known as "The Vineyard" were confirmed to be owned by the heirs of Marin's daughter, Lahilahi. Maria Lahilahi was Marin's fourth child with wife Haiamaui, who according to oral tradition was of high rank from Waipio Valley and close to Kamehameha I.[10]

After the overthrow of the Hawaiian Kingdom in 1893, and the Annexation by the United States in 1898, the landscape of the island was forever changed. The Gilliland family continued to retain the land upon which Marin's vineyard was located. A 1906 Dakin fire insurance map shows four wood-framed buildings containing stores, dwellings and

6 Ross H. Gast, Don Francisco De Paula Marin: A Biography; The Letters and Journal of Francisco De Paula Marin. (Honolulu: University Press of Hawaii, 1973.) p.3-4.
7 Ibid, 13.
8 Ibid.
9 Ibid, 50.
10 Ibid, 137.

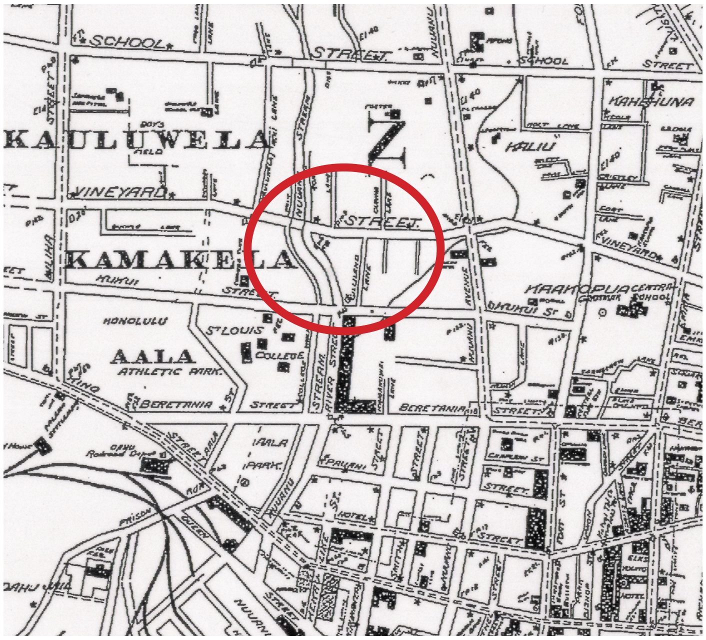


Figure 5: *1912 Dove Map Illustrating Gilliland Land*
Source: Dove, Charles V.E. Map of Honolulu, 1912.

tenements with two kitchens located on the River Street site, and a 1912 Dove map illustrates that Gilliland Lane was created directly behind the current building parcel (Figure 5). By 1927, there were three wood-framed buildings on the lot comprised of shops fronting River Street, and the tenement building remained on the rear east section of the parcel behind the stores. The shops were numbered from 1329-1357 River Street, and 1333 River Street was a Plumbing and Tin Shop.

By 1950 the parcel was transformed and enlarged slightly. The three buildings remained retail stores that fronted River Street, but now there were fewer tenants in each building and the buildings were upgraded with concrete floors (Figure 6). Two additional dwellings were added on the northeast portion of the parcel, and the tenements remained, but due to the new configuration were centered in the parcel. The biggest change is the addition of a metal building used for the storage of vehicles positioned on the southeast of the lot.

Figure 6: *Sanborn Fire Insurance Map, 1950*
Source: Sanborn Fire Insurance Map from Honolulu, Oahu County, Hawaii. Sanborn Map Company, Vol. 2, 1950

Figure 7: *Honolulu Iron Works Employees, (circa 1888) (PP-8-12-010-00001)*
Source: *imagesofoldhawaii.com/honolulu-iron-works/*

Figure 8: *Honolulu Iron Works, (Date Unknown) (PP-8-12-004-00001)*
Source: *imagesofoldhawaii.com/honolulu-iron-works/*

The Gilliland Family

John Richard Gilliland was the great grandson of Don Francisco de Paula Marin. John's grandmother, Maria Lahilahi (1811-1844) became the common law wife of John C. Jones Jr., and they had three children: Rosalie, Francis, and John III. Rosalie Coffin Jones (c.1828- 1879) married Richard Gilliland (c.1822-c.1870s) in January of 1854. Gilliland was a foreman, and then chief engineer of the Mechanics Fire Company No.2.[11] Richard and Rosalie Gilliland had three children: John R. (c.1856), Angela (1859) and Richard L. (1866). The Gilliland family lived on the vineyard property belonging to the late Marin. An 1857 article describes that the Gilliland's resided on the lower garden on Marin's property which was comprised of 14-acres beginning at the head of Pauoa Valley extending two-and-a-half miles to town.[12] The author describes a former beautiful garden now overgrown with weeds, grass, and shrubbery.

John Richard Gilliland married Constance Perreira De Nobrega, originally of Funchal, Madeira, Portugal. John was a machinist at Honolulu Iron Works where he worked for 35 years (Figure 7 & 8).[13] He and his wife had three children: Rosana Annie (1895), James

11 "Manini's Garden in Pauoa Valley," *The Pacific Commercial Advertiser,* December 10, 1857, p. 2.
12 Ibid.
13 "Gilliland Dead," *Evening Bulletin*, March 29, 1909, p.4.

Francis (1899), and John Richard (1897). The family resided at 137 Vineyard Street, near Nuuanu Avenue. John died of a stroke in 1909 while standing over his lathe at the Iron Works. Constance continued to reside at the home on Vineyard Street with her son James.[14]

By all appearances, John Gilliland's son, James F. Gilliland, a prominent lawyer in Honolulu, and daughter, Annie Franco (born Gilliland), commissioned the construction of the John R. Gilliland Building in the 1950s (Figure 9). The building was originally referred to as the Gilliland Franco Building and built with fourteen (14) offices and seven (7) retail stores. In 1975 when Annie Franco (Gilliland) died, she bequeathed her half of interest in the River Street property to St. Louis School to which her brothers attended. St. Louis School was located near the Gilliland property until it moved to Kaimuki in 1928 at the request of parents and alumni who felt greater space was needed. The gift to the school was for scholarships in memory of her parents, John and Constance. James F. Gilliland owned the other half of the property which was transferred to his wife Agnes upon his death in 1961.[15] Upon the sale of the commercial property on River Street in 1989, 1.5 million dollars went to the St. Louis school for the Gilliland Scholar Endowment.[16]

Figure 9: *James F. Gilliland (1942) Source: The Honolulu Advertiser, Honolulu, Hawaii, Sep. 30, 1942*

It can be assumed the children of John Gilliland relied on Sato's creativity, and engineering knowledge to create an eye-catching, edgy and modern design for their commercial building. Sato's original drawings of the John R. Gilliland Building were not unearthed during research; however, the building appears to be one of Sato's early endeavors in thin-shell construction utilizing two novel techniques, a barrel vault and folded plate, in thin-shell concrete on one structure.

14 "Local Attorney Seeks Senate Seat," *The Honolulu Advertiser*, September 30, 1942, p.26.
15 Ibid
16 "St. Louis Student Named the First Gilliland Scholar," *Honolulu Star-Bulletin*, June 12, 1990, p.2.

THIN-SHELL CONCRETE

Thin-Shell Concrete

Thin-shell concrete roofs can be identified by their continuous eye-catching exteriors, and grand uninterrupted interior spaces. Thin-shells, as defined by the American Concrete Institute are, "three-dimensional spatial structures made up of one or more curved slabs or folded plates whose thicknesses are small compared to their other dimensions.[17] The use of cement dates back to the Greek and Roman Periods where it was used to create fluid shapes without having to use traditional methods of stone carving.[18] The Romans used concrete to build aqueducts, foundations, and columns.[19] The dome was one of the earliest shapes be traced back to ancient times where it appeared on huts and mounds used for shelter. The Romans were the first to create intersecting vaults which eventually evolved into the dome. Originally created out of dirt and rocks, the dome evolved to become more sophisticated utilizing a series of groin arches and ribs to distribute the load to the perimeter of the form.[20] The most notable structures being the Pantheon (27 B.C.) in Rome, Italy, and Hagia Sophia (360 A.D.) in Istanbul, Turkey. The concrete was laid, opposed to poured, and since the aggregate was far larger than modern aggregate, a thick layer of concrete was formed that could support the load of the dome.[21] The dome continued to develop through the use of materials, and structural technology, from monumental masonry to light weight concrete, and now geodesic domes out of glass and steel.

Over time concrete material mixtures changed due to exterior influences, and the use of concrete began to be re-popularized at the onset of the 20th century due to the introduction of reinforced concrete. The world wars caused a material shortage of steel and timber; therefore, concrete was utilized as a cheaper, and more readily available building

17 "Building Code Requirements for Concrete Thin Shells (ACI 318.2-14)," American Concrete Institute, (September 2014): 5. https://www.concrete.org/portals/0/files/pdf/318_2_14.pdf.

18 Gabriel Tang, "An Overview of Historical and Contemporary Concrete Shells, their Construction and Factors in their General Disappearance," International Journal of Space Structures, 30, p.2.

19 Ibid

20 "Dome Architecture," Accessed February 3, 2021, https://www.britannica.com/technology/dome-architecture.

21 Maria J. Mosquera, "What is Concrete Shell Architecture?" 2018, https://www.innovaconcrete.eu/what-is-concrete-shell-architecture/.

material.[22] It is believed there were two distinct periods of development for concrete shell roofs: the initial period of development was the 1920s to 1939, influenced by World War I that created new building functions, and the Bauhaus movement that viewed concrete construction as a combination of necessity and thought.[23] The second period from the 1950s to 1970s was considered the golden age for concrete development, where aesthetics and a "wow" factor were considered imperative.[24]

The 1920s to 1939

The first period of development can be identified in the architecture of the Zeiss-Planetarium (1922) constructed by the German firm of Dyckerhoff and Widmann. The dome of the planetarium was constructed using the patented Zeiss-Dywidag (Z-D) system.[25] The dome was based off the traditional dome form using concrete to create a thin-shell that spanned 16 meters with a thickness of three centimeters.[26] Thin-shell concrete domes were predominantly used in Europe, but during the early 1930s were introduced to America by Anton Tedesko, a German engineer. Tedesko worked in the Dyckerhoff and Widmann office, and was hired to utilize the Z-D system to be featured on a structure at "A Century of Progress International Exposition," also known as the 1933 World's Fair in Chicago. Tedesko created a repetitious barrel vault roof on a portion of the Brookhill Dairy Exhibit.[27] He continued to design utilitarian structures such as aircraft hangers and arenas using the Z-D system throughout the east coast.[28]

22 Tang, p.2.
23 Tang, 3
24 Ibid.
25 Tang, p.3.
26 Ibid
27 Nanette South Clark, "A History of Thin-Shells and Monolithic Domes," Accessed February 3, 2021, https://www.monolithic.org/blogs/engineering/the-history-of-thin-shells-and-monolithic-domes.
28 Thomas E. Boothby, M. Kevin Parfitt and Mark Ketchum, "Milo S. Ketchum and Thin-Shell Concrete Structures in Colorado," APT Bulletin: The Journal of Preservation Technology, 2012, Vol. 43, No. 1 (2012), p 40-41.

The 1950s to 1970s

The second period of concrete development was known as the golden age of thin-shell engineering, and was reflected in the fact that thin-shell concrete construction had gained such notoriety it began to be utilized in various commonplace buildings types,

Figure 10: *Hipodromo de la Zarzuela, (1941)*
Source: Andres Patino, "Architecture Classic: The Zarzuela Hippodrome/Carlos Arniches Martin Dominguez and Eduardo Torroja." 2020

Figure 11: *Los Manantiales, (1958)*
Source: Michelle Miller, "AD Classics: Los Manantiales/ Felix Candela." 2018

from factories to theaters, to houses, churches, and commercial storefronts.[29] A variety of different thin-shell concrete forms began to be created which derived from the traditional dome and vault. Eduardo Torroja, a Spanish engineer, combined modernist ideas with artistic form to create innovative and experimental structures.[30] Most notably, Torroja's Hipdromo de la Zarzuela (1941) on the outskirts of Madrid, Spain, is a grandstand for a race track with an undulating shell canopy roof that is a bold and eye-catching use of thin-shell concrete (Figure 10). Another notable designer was Felix Candela, a self-taught Spanish-Mexican architect exiled from Spain to Mexico after the civil war ended in 1939. Candela helped redefine the typical hyperbolic paraboloid shape with his restaurant Los Manantiales in 1958. The roof is, "comprised of four intersecting hypars, (and) a strikingly

29 Tang, p.3.
30 Maria Josefa Cassinello Plaza, "Eduardo Torroja Miret," Accessed February 3, 2021 http://www.fundacioneduardotorroja.org /index.php/en/eduardo-torroja/ biografia .html ? showall =1&limitstart.

thin roof surface creates a dramatic dining space (Figure 11)."[31] Candela's innovative hyperbolic paraboloid roof inspired the next generation of contemporary engineers, and architects like, Zaha Hadid and Santiago Calatrava.

Pier Luigi Nervi was an innovative Italian structural engineer credited with the ferro-cement process. Nervi used steel mesh as a core layer and brushed cement on top, creating a thin elastic flexible surface which could be implemented on a variety of shapes.[32] The Palazzetto delo Sport (1957) in Rome, Italy, is a low-rise dome which sits upon a collection of windows giving rise to a floating concrete roof with a light and airy feel. (Figure 12) The prefabricated roof dome was constructed with ribbed concrete and braced by concrete flying buttresses.[33] Without Nervi's expertise, the roof of the Palazzetto delo Sport could have potentially been heavy and imposing. Other significant contributors to the concrete shell typology included: Franz Dischinger, Ulrich Muther, Eladio Dieste, Heinz Isler, and Robert Maillart.

Figure 12: *Palazzetto delo Sport, (1957)*
Source: Daniel Da Rocha, "Pier Luigi Nervi and His Buildings in Rome."

Thin-Shell Concrete Roof Typologies

As a result of modeling and experimenting, different types of thin-shell concrete roofs were invented. The earliest type was based on traditional forms such as domes, and barrel vaults. As technology and learning advanced, architects and engineers began to

31 Michelle Miller, "Los Manantiales / Felix Candela," Accessed February 2, 2021, https://www.archdaily.com/496202/ad-classics-los-manantiales-felix candela?admedium=gallery.
32 Clark, "A History of Thin-Shells and Monolithic Domes."
33 "Palazetto delo Sport," Accessed February 2, 2021, http://architectuul.com/architecture/palazzetto-delo-sport.

Table 1. Shell Types

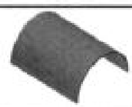
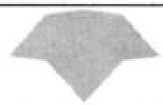
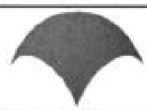
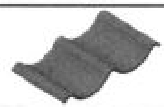
Image	Shell type	Example	Architect/Engineer	Date
	Dome	Jena Planetarium	Walther Bauersfeld and Franz Dischinger, engineers	1922
	Barrel vault	Denver Coliseum	Roland Linder, architect; Anton Tedesko, engineer	1952
	Hyperbolic paraboloid (hypar)	The Paraboloid May D & F Entrance	I. M. Pei, architect; Anton Tedesko, engineer	1958
	Translation shell	Fan Fair Discount City	Milo Ketchum, engineer	c. 1960
	Undulating shell	Wonder Bread	Milo Ketchum, engineer	1962
	Folded plate	Moore Equipment Company	Milo Ketchum, engineer	c. 1960

Figure 13: *Shell Types*
Source: Thomas E. Boothby, M. Kevin Parfitt and Mark Ketchum," Milo S. Ketchum and Thin-Shell Concrete Structures in Colorado," 2012

experiment with different shapes and forms (Figure 13). Shapes such as the hyperbolic paraboloid which originated in thin-shell concrete in 1958, and the translation shell in the late 1950s, began to be applied on the roofs of modern buildings. The experimentation with concrete persisted, and in 1962 the undulating shell, a roof that appears to be wavelike, and a folded plate iteration, began to be utilized. These novel roof forms were a defining feature on many modern buildings throughout Europe, the United States and Hawaii.

The barrel vault originated from the arch form, which transfers loads to the side away from the top. The barrel vault is composed of consecutive arches which create a semi-circle atop the abutments, or jambs, that it sits upon. The barrel vault traces its roots to the time of the Egyptians and continues to be a feature in modern architecture.[34]

34 "Vault Architecture," Accessed February 3, 2021, https://www.britannica.com/technology/vault-architecture.

The hyperbolic paraboloid is a double curved surface that resembles a saddle. Originally designed in Europe, the two arches act in opposite tension and compression allowing for long spans without intermediate support. This shape was also formed with other materials such as bamboo, wood, steel, and glass.[35] The translation shell is a square dome with similar qualities to a dome, where the ends come to a point instead of a circle. The design creates equal vertical slices resulting in an effortless application compared to the creation of form work required to construct a dome.[36] The undulating shell is a combination of a traditional arch, dome, and the hyperbolic paraboloid resulting in a wavelike structure. The utilization of concrete, and steel helps to create the curved forms allowing for an exterior system to be applied.

35 Manasi Khankhoje,"What are Hyperbolic Paraboloid Shells?" Accessed February 3, 2021, https://www.re-thinkingthefuture.com/materials-/a2294-what-are-hyperbolic-paraboloid-shells/.

36 Rahul Patil, "Shell Structure," Accessed February 3, 2021, https://constructionor.com/shell-structure/.

THE FOLDED PLATE ROOF TYPOLOGY

The Folded Plate Thin-Shell Concrete Roof

Folded plate roofs, like the canopy on the John R. Gilliland building, evolved from the concrete shell roof. The initial theory of folded plate structures was created by G. Ehlers & H. Craemer in Germany in 1930.[37] In 1947, G. Winters & M. Pei were the first to contribute a streamlined theory on folded plate technology in American literature.[38] In the United States, folded plate roofs were originally constructed for utilitarian or industrial buildings, a warehouse roof in San Francisco and other ancillary structures in California.[39]

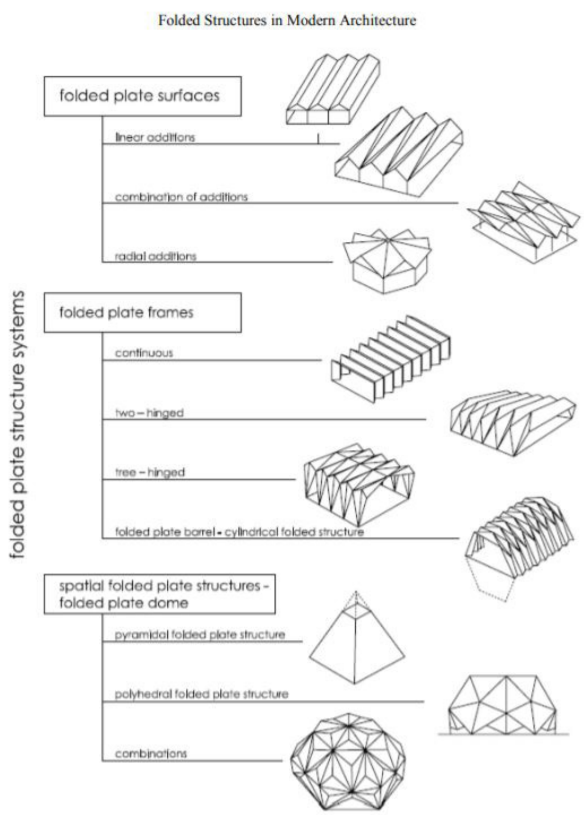


Figure 14: *Folded Plate Structural Systems*
Source: Nenad Šekularac, Etal. "Folded Structures in Modern Architecture," 2011

The folded plate technology was an attempt to simplify design, analysis, and form work while retaining many of the advantageous characteristics of shells.[40] A folded plate structure is formed when several flat plates are joined at the edges, and are supported by end diaphragms.[41] The inclined components of the folded plates are stiffened at the edges which carry the load. The slope angle of the folded plate is typically less than 45 degrees.[42]

37 Frederick Mitchell Graham, "The Behavior of A Folded Plate Roof System," Retrospective Theses and Dissertations. 2898. https://lib.dr.iastate.edu/rtd/2898, p.8.
38 Ibid.
39 S. Aroni B.C.E., A.M.I.E.Aust. (1964) "Folded Plate Roofs," Architectural Science Review, 7:4, 146 150, DOI:10.1080/00038628.1964.9697086, p.146.
40 Daryl Armentrout, "Light Gauge Steel Folded Plates," (Thesis, Virginia Polytechnic Institute, 1968), p.5.
41 Graham, p.8.
42 Armentrout, p.7.

Folded structures can be made of different materials such as: metal plates, wood, glass, plastic, and reinforced concrete which is the most common material used to make folded structures.[43] The common “V” shape makes casting concrete on site effortless, in addition, precast panels can be connected on site.[44] The form work created for cast-in-place is relatively simple compared to other forms, and can be reused to create the repetitive structural pattern.

Figure 15: *The United States Air Force Academy Cadet Chapel, (1962)*
Source: Dan Boyce, “The Air Force Academy Chapel Just Closed For A 4-Year, $158 Million Renovation,” 2019

Folded plate structures or buildings can be designed and constructed in a variety of forms, and have been referred to as origami construction as the surfaces can be linear, radial or a combination (Figure 14). [45] The frames of the folded plate structures are considered rigid and can be: contiguous, two-hinged, three-hinged or cylindrical.[46] Structures designed utilizing folded plates use the wall, and the plates to create pyramidal structures, polyhedral structures, or combination spaces. The United States Air Force Academy Cadet Chapel in Colorado designed in 1962 by Walter Netsch from Skidmore, Owings & Merrill (SOM) is an outstanding example which uses folded plates as a structure and frame (Figure 15).

43 Rohan Narvekar, “Folded Plates,” Accessed February 3, 2021, https://www.slideshare.net /RohanNarvekar2/folded-plates, p.4.
44 Nenad Šekularac, Et al., p.4-5.
45 Ibid.
46 Narekar, p. 5-11.

THIN-SHELL CONCRETE IN THE STATE OF HAWAII

Thin-Shell in Hawaii

Thin-shell concrete is believed to be first employed in Hawaii in the 1950s. Local architects predominantly utilized two types of thin-shell concrete: the barrel vault and the folded plate, with some variations on both forms. Early adopters of thin-shell concrete were architects Ernest Hara, Wimberly and Cook, and engineer Kenneth Sato. These architects seemed to be fascinated by thin-shell concrete as it appears in a number of their buildings and structures throughout the 1950s-1960s. Appendix A details the remaining thin-shell concrete buildings, structures, or features in Hawaii. It was compiled from memory and quasi-systematic driving the streets of Oahu in search of the specific forms. The results are meant to be inclusive but not an exhaustive list; however, where additional buildings are found, they should be added by future researchers.

Figure 16: *1165 Bethel Street, (1950)*
Source: Google (2021)

One of the earliest known thin-shell examples in Hawaii is the building at 1165 Bethel Street designed by architect Ernie Hara in 1950. It is a three-story, relatively unassuming building constructed of concrete, divided into 10-bays with symmetrical fenestration, and a tri-partite folded plate canopy positioned over the left side of the building (Figure 16). Hara seemed to have a beloved preference for thin-shell concrete, as in 1965 he designed the Aiea Shopping center, Aiea Bowl, and across the street, the Aiea Commercial Center. The overhanging roof on the buildings is a shallow folded plate with exposed concrete rafters. Hara’s roof design appears to be an amalgamation of modern design with his use of the folded plate, and a regional interpretation as demonstrated with the exposed rafters. Subsequently, Hara designed Boulevard Apartments, presently known as Holiday Surf, in 1966 which feature an almost identical folded plate canopy as designed on the Aiea Shopping Center, and is positioned over the apartment buildings entrance. In 1967, Hara continued to embrace thin-shell construction while exchanging the folded plate design for a barrel vault on Leeward Bowl. Hara's eye-catching concave barrel vault roof and canopy are a unique character defining feature (Figure 17).

Figure 17: *Leeward Bowl, (1967)*
Source: Fung Associates, Inc. (2018)

Like Hara, architects Wimberly and Cook had an affinity for thin-shell concrete, and designed Kelly's Bowl (1955) with a repetitious barrel vault roof. They also designed a structure at Hawaii Memorial Park Cemetery (1958) which features a folded plate roof, and the Windward City Shopping Center in (1958) in Kailua, Oahu which originally featured an undulating shell roof in addition to a domed shell on the Foodland grocery store. All that remains of the thin-shell concrete at the shopping center is the dome shell on Foodland, and an undulating shell roof on an ancillary building. In the 1960s, Wimberly and Cook designed the Kailua Baptist Church, which is no longer extant, and the preschool building which features a concrete folded plate roof. Additionally, the duo designed Pali Lanes which features a dramatic semi-circular shallow domed roof with concrete buttresses that covers the bowling alley building. Pali Lanes is listed on the Hawaii Register of Historic Places.

Figure 18: *First Southern Baptist Church of Pearl Harbor, (1960)*
Source: http://www.docomomo-hi.org/

There are a few notable structures which feature thin-shell concrete roofs that are worth mentioning for their striking, unique design. The First Southern Baptist Church of Pearl Harbor was designed in 1960 by Ralph Meldrim Buffington. It has a fantastic combination folded plate roof inspired by the Koolau Mountain Range on Oahu (Figure 18). The Mystical Rose Oratory (1966) is located on the campus of Chaminade University, and was designed by Brother James Roberts with Guy Rothwell. The building is circular in shape with glass walls, and a triple-layer rose-shaped thin-shell concrete shallow undulating barrel roof that is completely open.[47] It is an excellent, innovative, and unique example of thin-shell concrete (Figure 19). Finally, facility 1514 on the U.S. Naval Base, Pearl Harbor, is a concrete building which houses the Aloha Jewish Chapel, Naval Health Clinic, and the Navy-Marine Corps Relief Society, that was designed in 1975 by Ossipoff, Synder, Rowland, and Goetz. The building features a series of semi-circular barrel vaults which extend from the ground level, and form a portion of the building's roof. The Naval Station Pearl Harbor Library/Navy Relief/Chapel has been nominated to the National Register of Historic Places.

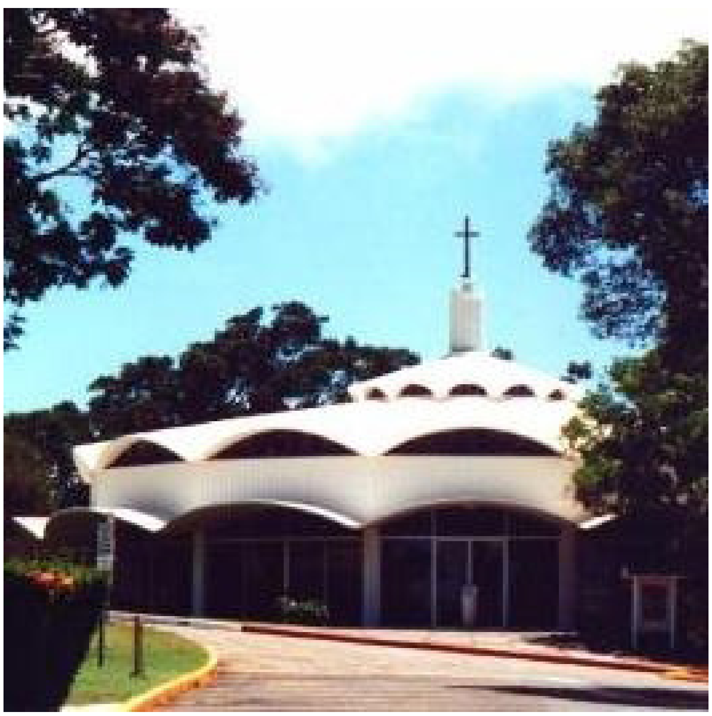


Figure 19: *Mystical Rose Oratory, (1966)*
Source: https://sites.google.com/site/mysticalroseoratory/

While thin-shell roofs seem to have a poor reputation due to performance issues and exorbitant maintenance costs, the form lends itself well to Hawaii's mild climate, as

47 Don Hibbard, "Mystical Rose Oratory," Accessed February 5, 2021, https://sah-archipedia.org/buildings/HI-01-OA158.2.

insulation is not required, and offers design flexibility without an outrageous price tag. Local architects, and engineers, embraced the thin-shell trend while adapting the form regionally to produce several fantastic interpretations.

KENNETH SATO

Kenneth Sato

Kenneth Sato was born in 1908 in Kahuku on Oahu. He attended McKinley High School and was a sergeant in the school's R.O.T.C (Reserve Officers' Training Corps) program.[48] He was also a member of the rifle team and won multiple awards for high scores in marksmanship, and was awarded a letter for his participation on the rifle team.[49] Sato graduated on the honor roll from McKinley High School in 1926.[50]

Succeeding high school, Kenneth Sato attended the University of Hawaii. While attending the university he continued to participate in R.O.T.C. as a member of the UH rifle team. During the summer of 1928 he attended the annual summer training camp for members of the R.O.T.C. at Schofield Barracks and, "won the distinction of being high man for the R.O.T.C. camp in record firing with the rifle on the Schofield Range."[51] In addition, Sato was a member of the Christian Young People, and the Harris Memorial Church. He also played the violin as a member of the Japanese Orchestra of Honolulu (Figure 20).

Figure 20 : *Japanese Orchestra of Honolulu, (1929)*
Source: The Honolulu Advertiser, April 11, 1929, p.2

48 "Name 8 Captain and other McKinley R.O.T.C Officers," *Honolulu Star-Bulletin*, December 23, 1924, p.3.
49 "Give Letters and Medals to McKinley High Stars," *Honolulu Star-Bulletin*, June 10, 1926. p. 12.
50 "Territory's Largest Class Receives Diplomas from McKinley High School," *Honolulu Star-Bulletin*, June 9, 1926, p.5.
51 "Sato is Winner in Rifle Shoot," *Honolulu Star-Bulletin*, July 13, 1928, p.13.

Kenneth Sato studied civil engineering and received a Bachelor of Science degree upon his graduation from the University of Hawaii in 1930 (Figure 21). In June of 1937 he married Ms. Myrtle Yoshiko Kanmitsu. They had their first child, a son, born on June 12, 1940, and later a daughter was born. Throughout his childhood, and continuing through his adult life, Sato was strongly committed to his church as he led and sang in the Harris Memorial Church choir, and served on the board.

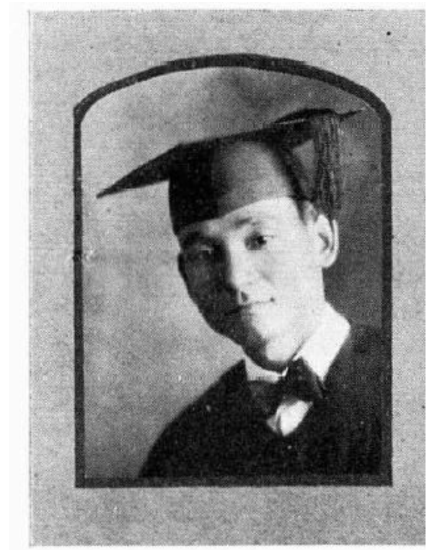


Figure 21: *Kenneth Kenkichi Sato*
Source: Ka Palapala 1930

Kewalo Steel Company

Following college, Sato began practicing and receiving commissions in the field of engineering, architecture, and started a contracting company, Kewalo Steel Company. The Kewalo Steel Company was launched sometime prior to 1941. [52] The company specialized in steel manufacturing, were an authorized builder of all-steel trucks bodies, and a construction contractor. Kewalo Steel & Construction Company was incorporated with Myrtle Y. Sato as president, and Lawrence K. Moriguchi as vice president.[53] In a 1957 article published by the *Honolulu-Star Advertiser,* Sato was interviewed for a series of personality sketches on men in Hawaiian Industry. Sato explained that Kewalo Steel Company was, "owned by his wife (Myrtle) in deference to his colleagues who feel that an engineer shouldn't be in the contracting business."[54] In many instances, Sato was the engineer/architect for a project in addition to the building contractor through Kewalo Steel Company.

The Kewalo Steel Company was contracted to construct a great deal of buildings and structures in the state of Hawaii for a variety of projects. In the 1950s, Kewalo Steel

52 Initial articles of incorporation were not located for Kewalo Steel Company. The first mention of Kewalo Steel Company is in December 1941. "Blackout Relaxed for Necessary Defense Activity," *Honolulu Star-Bulletin*, December 12, 1941, p. 12.
53 "Kewalo Steel Adds Construction." *The Honolulu Advertiser*, February 1, 1958, p. 6.
54 Ed Greaney, "Engineer's Dream Ideas Pay Off," *The Honolulu Advertiser*, August 11, 1957, p. 22.

Company was the general contractor for classroom buildings at: Palolo School (1950), Fern School (1950), Kailua School (1950), and a four-classroom addition at Waiahole School (1957) on windward Oahu. Kewalo Steel was also the contractor for two apartment buildings at 1850 and 1746 Ala Moana (1948), and 1650 Lusitana Street.

The Kewalo Steel Company specialized in school and apartment construction, but at times were contracted for atypical projects. In 1949, Kewalo Steel Company was awarded a contract to construct ambulance sheds at an emergency hospital, and in 1952 they were awarded $218,474 for work on the new family quarters at Naval Air Station Barber's Point.[55] Subsequently, in 1953 the Kewalo Steel Company was contracted to furnish the reinforcing steel, weld metal, and other reinforcing materials for the new Beach Coffee Shop, Winifred Dick's Resort Shop and the conversion of an apartment building into a hotel, at the Halekulani Hotel.[56] Sato also "furnished valuable technical advice" to the general contractor, Y. Okita, in building the seawall at the hotel.[57] Research unearthed multiple instances of, "Owners Notice of Completion of Contract," for residential homes on the island of Oahu that pronounce Kenneth Sato or Kewalo Steel Company completed construction. Unfortunately, no photos or sketches accompany the legal notices; however, the amount of notices suggest that Kenneth Sato was very active in residential design and the building industry.

Sato's portfolio of projects is diverse, however, he largely designed or constructed, churches, apartment buildings, and school buildings. In a 1957 Honolulu Advertiser article, Sato mentioned that, "designing churches has been something of a specialty for him. He has done about 15 in all."[58] Sato worked for himself at times, in addition to partnering with local architects and engineers in a firm. Much like other architects and engineers of the time, Sato designed in a modern aesthetic utilizing concrete, clean lines, a lack of ornament, and experimented with thin-shell concrete. A list of his projects is included

55 "Navy Awards Contracts," *Honolulu Star-Bulletin*, September 17, 1952, p. 10.
56 "All Halekulani-Dick Contractors Have Given Long, Efficient Service," *Honolulu Star-Bulletin*, August 22, 1953, p. 4.
57 Ibid.
58 Greaney, p.22.

(Appendix B) which illustrate the breadth of his work. The list is not comprehensive, but compiled based on projects easily identified through newspaper research.

Churches

Kenneth Sato designed a variety of churches throughout his career. Church design was most likely very appealing to him due to his dedication to his faith. Also, his active roles in his church may have placed him in contact with members of other churches building committees. In the 1940s Sato had two commissions for religious buildings in which he was the general contractor. The first was South King Methodist Church (1945), and then he designed a convent for St. Joseph's (1948) in Waipahu, Oahu. The convent was two-story, L-shaped, cream in color trimmed in blue with an airy courtyard, and rooms for 16 nuns (Figure 22).[59]

In the 1950s Sato continued to receive commissions to construct religious buildings. He designed three churches: Waiola Church (1953) in Lahaina, Maui, Door of Faith Church (1953) in Honolulu, Oahu, and Hanapepe Congregational Church (1956) in Hanapepe,


WAIPAHU'S NEW CONVENT for the sisters of St. Joseph's will be dedicated in ceremonies Sunday afternoon. The $65,000 structure has facilities and living quarters for 16 nuns. The St. Joseph's church is sponsoring a three day carnival, beginning today, to raise funds to pay for the new convent.—Photo by J. Tong.

Figure 22: *St. Josephs Convent, (1948)*
Source: Honolulu Star-Bulletin, June 19, 1948, p.7

59 "Dedication Ceremonies for New Waipahu Convent Set for Sunday," *Honolulu Star-Bulletin*, June 19, 1948, p.7.

Kauai. The Waiola Church was rebuilt on the same site of a previous church, old Wainee Church, which was established in 1823.[60] The church plans were sketched out by the church's pastor and Sato drew the plans for a new, modern structure. The church is symmetrically designed with its main façade featuring a unique roof shape that appears to be a combination front gable, and bonnet roof, with sides that slope down at an angle. It is constructed of concrete with symmetrical fenestration, a covered walkway, and double-gabled entryways on the rear of the left (north) and right (south) elevations (Figure 23).

Figure 23 : *Waiola Congregational Church, (1953)*
Source: https://sah-archipedia.org/buildings/HI-01-MA23

Sato's Door of Faith Church (1953) on Young Street in Honolulu, was designed in a similar aesthetic as Waiola Church. The main (north) façade features a combination front gable roof with sides that slope down to meet a vertical end wall. Although the design of the Door of Faith church is comparable to Waiola Church in massing and symmetry, it is more austere and unassuming than Waiola Church. It was constructed utilizing concrete, and the main façade shows "slight streamline motifs."[61]

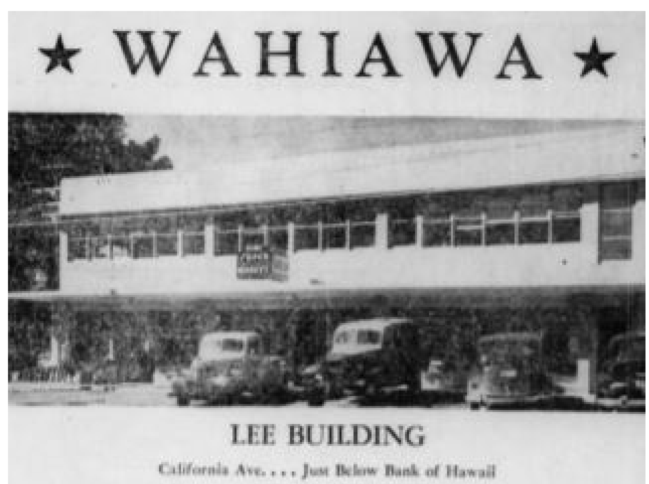


Figure 24: *Lee Building, (1947)*
Source: *Honolulu Star-Bulletin, December 26, 1947*

60 Charles C. Young, "New Waiola Church Traces History to Old Hawaii." *Honolulu Star-Bulletin*, May 16,1953, p.9.
61 "Door of Faith Church,"1161 Young Street, Honolulu," Accessed January 5, 2021, https://docomomo-hi.org/items/show/923.

Commercial Buildings

Kenneth Sato designed various commercial buildings from the late 1930s through the late 1950s such as: shopping centers, low-rise office buildings, and multi-functional buildings for office, retail and business. The Lee Building located in Wahiawa, Oahu was built in the modern style by Sato in 1947 (Figure 24). The building is two-stories, horizontally massed, with a symmetrical fenestration pattern, a concrete awning separating the upper and lower level, and a flat overhanging roof. A new shopping center, Aloha Shopping Center, opened in 1948 in Waipahu and was designed by Sato. The shopping center was designed in the modern aesthetic and featured multiple retail shops and a service station meant to help "beautify Waipahu (Figure 25)."[62]

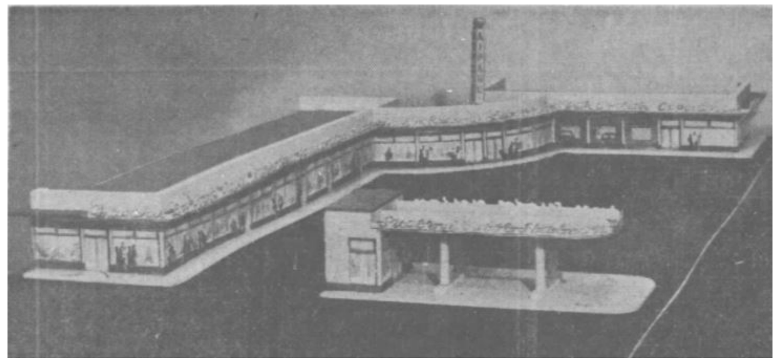


Figure 25: *Aloha Shopping Center Rendering, (1948)*
Source: The Honolulu Advertiser, January 18, 1948

The 1950s ushered in an active era for Sato as he drew plans, and constructed over five commercial buildings. In 1951 Sato paired with architects Wimberley and Cook to build the new sales headquarters for The Hawaii Builders Supply Co. Ltd.[63] The cost of the new building was $100,000, and included a retail space in addition to a warehouse area to serve wholesale customers. In 1958, Sato planned and designed a $1.2 Million dollar building on Emma Street.[64] The building was the York International Building, an 11-story commercial office building adjacent to St. Andrew's Cathedral owned by U. Char ltd.65 The building was never constructed as U. Char Ltd. was dissolved in 1960, and in 1964 the Queen Emma Building (1270 Queen Emma Street) was built in its place.

62 "Aloha Shopping Center for Waipahu," *The Honolulu Advertiser*, January 18, 1948, p. 10.
63 "Several Honolulu Building Projects Sanctioned," *Honolulu Star-Bulletin*, April 24, 1951, p. 20.
64 "$1.2 Million Building Planned on Emma St." *The Honolulu Advertiser*, October 3, 1959, p. 3.
65 Ibid.

Figure 26: *Waimalu Shopping Center, (1960)*
Source: The Honolulu Advertiser, March 15, 1960

Figure 27: *Waimalu Shopping Center, (2021)*
Source: https://www.loopnet.com/Listing/98-020-98-048-Kamehameha-Hwy-Aiea-HI/15910740/

Toward the end of Kenneth Sato's career, he designed and built the Waimalu Shopping Center in Waimalu, Oahu. The shopping center was built in two increments: increment no. 1 (1959) was a commercial building and two-story apartments; increment no. 2 (1962) was the expansion of increment no. 1 in the southeast direction.[66] The two increments are each 12-bays wide, with rectangular massing, and concrete barrel vault roofs. Sato mimicked the barrel vault roof on the ground level canopy utilizing corrugated metal and corrugated fiberglass to allow light penetration. The Waimalu Shopping Center is listed in the Hawaii Register of Historic Places (2017) (Figure 26 &27).

Apartment Buildings

Throughout his career Kenneth Sato designed many apartment buildings in a modern aesthetic. In 1948, Sato designed, and was the general contractor, for two apartment buildings: 1850 Ala Moana, and 1746 Ala Moana. Two building permits for two eight-

66 Stanley Solamillo, "Waimalu Shopping Center," National Register of Historic Places Nomination Form, (Washington, DC: U.S. Department of the Interior, National Park Service, 2017) p. 5.

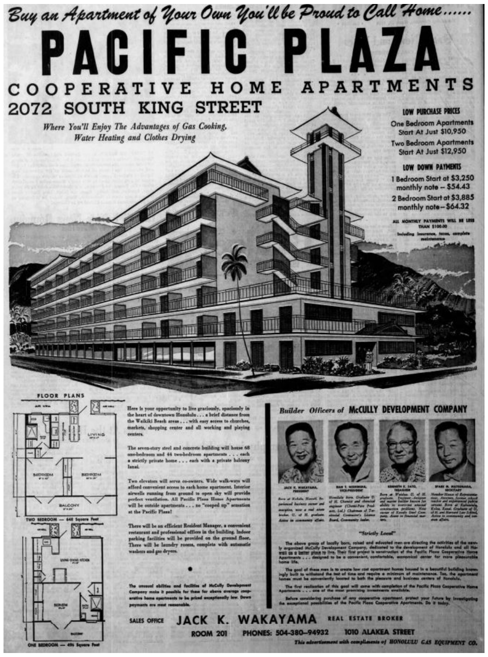


Figure 28: *Pacific Plaza, (1958)*
Source: The Honolulu Advertiser, March 30, 1958

unit apartment buildings were issued on June 4, 1948 to owner Wataru Watanabe and were expected to be completed in six months.[67] In the 1950s Sato designed Kew Chung Apartments (1956) an 18-unit apartment building, 1650 Lusitana Street (1957) a two-story 10-unit apartment building, Kanakapolei Street (1957) 33 studio apartments, 451 Launiu Street (1958), and a 21-unit apartment building owned by Kenneth Sato and Henry Felix.

In 1958 Sato designed the Pacific Plaza Building, a seven-story 112-unit cooperative apartment building with office space. A 1958 newspaper advertisement contains renderings and illustrates a modern seven-story concrete building with individual lanai (Figure 28).[68] Additionally, the advertisement described the formation of the McCully Company. The McCully company was incorporated, and comprised of four men, including Sato, which was formed for the development of the Pacific Plaza apartments.[69] It is unclear whether the apartment was actualized. A building permit was issued; however, the apartment building does not appear on a current map.

Figure 29: *Waikiki Shore, (1961)*
Source: Honolulu Star-Bulletin, October 20, 1961

67 “Building Permits For 2 Apartments Issued by City,” *Honolulu Star-Bulletin*, June 4, 1948, p.5.
68 “Pacific Plaza,” *The Honolulu Advertiser*, March 30, 1958, p. 60.
69 Ibid.

In 1959, plans for a $2.5 million-dollar cooperative apartment building on Waikiki beach were announced.[70] The Waikiki Shore was designed by Kenneth Sato and is located between the Reef hotel and Fort DeRussy on YWCA property (Figure 29). The building opened in March of 1962 and is a 14-story structure with 143 apartment units, and the two bottom floors were the YWCA beach club.[71] Waikiki Shore was designed in the modern aesthetic and built of steel and concrete to be "essentially fire-proof and practically sound-proof."[72] The building features horizontal massing; each apartment has an individual lanai, and the roof is folded plate similar to the canopy Sato used on the John R. Gilliland Building.

Schools

Kenneth Sato designed classroom buildings, but was the general contractor for multiple schools on the island of Oahu in the 1940s and 1950s. In the 1940s, Sato designed classroom buildings for the Hawaiian Mission Academy (1943), and St. Joseph's Catholic School (1947). The two classroom buildings at the Hawaiian Mission Academy were made out of hollow tile, concrete, and plaster was used for the interior and exterior.[73] As St. Josephs, Sato designed a new classroom building with funds raised by the St. Joseph's Church.[74] A dedication carnival was held on December 14, 1947 celebrating the completion of the new, modern classroom. The two-story building featured a projected double stairway flanking an arched entry, a covered walkway on the ground level, and a flat roof with symmetrical fenestration.

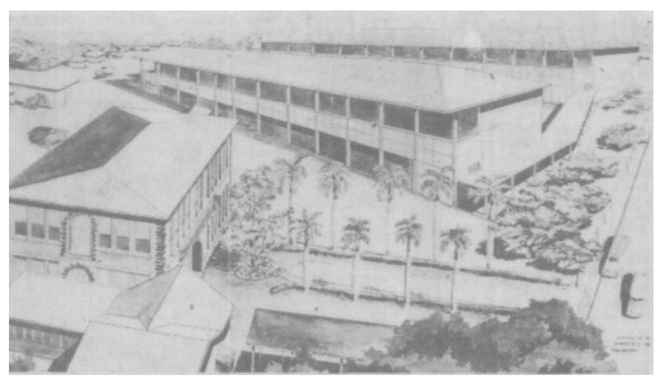


Figure 30: *Kaiulani School Rendering, (1956)*
Source: The Honolulu Advertiser, March 25, 1956

70 "Co-op Will be Built on YWCA Beach Site," *The Honolulu Advertiser*, March 9, 1959, p. 13.
71 Ibid.
72 Ibid.
73 "New Building Completed by Mission Academy," *Honolulu Star-Bulletin*, October 23, 1943, p. 2.
74 "St Joseph's Church Carnival," *Honolulu Star-Bulletin*, December 6, 1946, p.17.

In 1955, Sato partnered with Dean Keller of A.R. Keller, his former professor at the University of Hawaii, to construct twin buildings with 20 classrooms each at Kaiulani School (Figure 30).[75] Kaiulani School originally opened in 1889 with one classroom building named after Princess Kaiulani.[76] The newly designed classroom buildings featured a symmetrical design with a large overhanging roof which created a covered walkway supported by columns on both levels. A covered walkway connected the two buildings and they were said to be constructed of cream-colored cement blocks, and red clay brick to blend nicely with the existing buildings.[77]

Public Works Projects

Kenneth Sato worked on two civic projects: Wahiawa Post Office (1954) in Wahiawa, Oahu and Waiakamoi Water Storage (1961) in Wailuku, Maui. In 1954, Post Office Inspector E.L. Jacobson announced the contract to construct the Wahiawa Post Office was awarded to Dr. George Ohara.[78] Ohara commissioned Sato as engineer and architect to design and build a 3,200 square foot open "lanai-type" building.[79] The building was imagined to be two-story and made of hollow tile; the second-level offered offices, one of which would be occupied by Dr. Ohara.[80]

Kenneth Sato was a partner in an engineering consulting firm with William C. Vannatta. Vannatta worked as a public servant in the Territorial Highway Department, Public Works and City Hall in 1953 as chief engineer.[81] In March of 1957, Vannatta and Sato were awarded the contract to draw plans for one-million dollars of improvements to the Waiakamoi water storage project for the Kula pipeline in Wailuku, Maui. The project was

75 "2 Kaiulani Classroom Buildings Open." *The Honolulu Advertiser*, December 17, 1955, p. 11.
76 Ibid.
77 Ibid.
78 "Dr. George R. Ohara." *The Honolulu Advertiser*, January 11, 1955, p. 14.
79 Ibid.
80 Ibid.
81 Brady Spence, "Vannatta Richer; Mum on Happiness," *The Honolulu Advertiser*, January 16, 1958, p. 6.

reported to be constantly delayed, and Sato attributed the delays to Maui County for not only constructing inferior tanks, but placing them inside of Waiakamoi rain-forest instead of a drier location in order to save money.[82]

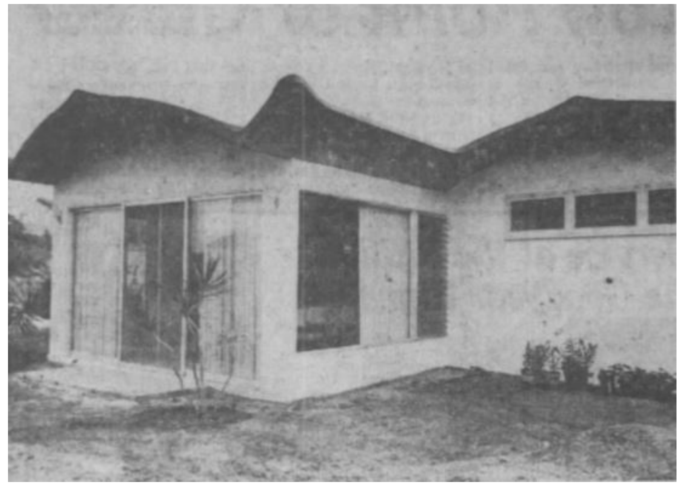


Figure 31: *Yokoyama Residence, (1962)*
Source: Honolulu Star-Bulletin, June 7, 1962

Other Work

One of Sato's early designs was a home in Wahiawa, Oahu for Ms. Christine Loppin (1935), and a grocery store on 10th Avenue owned by S.F. Lau.[83] Sato's plans for the grocery store incorporated modern lines, cross-ventilation, and allowed for the penetration of light throughout the building.[84]

In the summer of 1937, Café Venice celebrated the grand re-opening of their Chinatown restaurant designed by Sato. The café boasted of an "ultra-modern" attractive renovation with a dance floor, orchestra platform, and indirect lighting.[85] In 1937, Kenneth Sato was the architect for the three new industrial buildings at Kahuku Plantation, which began farming sugarcane in 1892: a 10,800 square foot boiler room, a 5,900 square foot clarification building, and a 2,400 square foot power house.[86]

In 1962 Sato designed two projects utilizing thin-shell concrete. Mr. and Mrs. Kazumi Yokoyama hired Sato to design their home at 1347-A North Vineyard.[87] The home was constructed completely out of concrete resulting in a fire, and termite proof home.[88] The roof of the home appears to be an undulating folded plate roof. Sato utilized reinforced

82 "Delays in Maui Water Storage Project Explored," *Honolulu Star-Bulletin*, June 11, 1961, p.19.
83 "Wahiawa Homes Now Being Built," *The Honolulu Advertiser*, November 24, 1935 p.16.
84 Ibid.
85 "New, Modern Café Venice Opens Today," *The Honolulu Advertiser*, June 17, 1937, p.7
86 "New Buildings at Kahuku Planned," *Honolulu Star-Bulletin*, July 13, 1937, p. 3.
87 "18,000 Concrete Home May Be First in Islands," *Honolulu Star-Bulletin*, June 7, 1937, p.3.
88 Ibid.

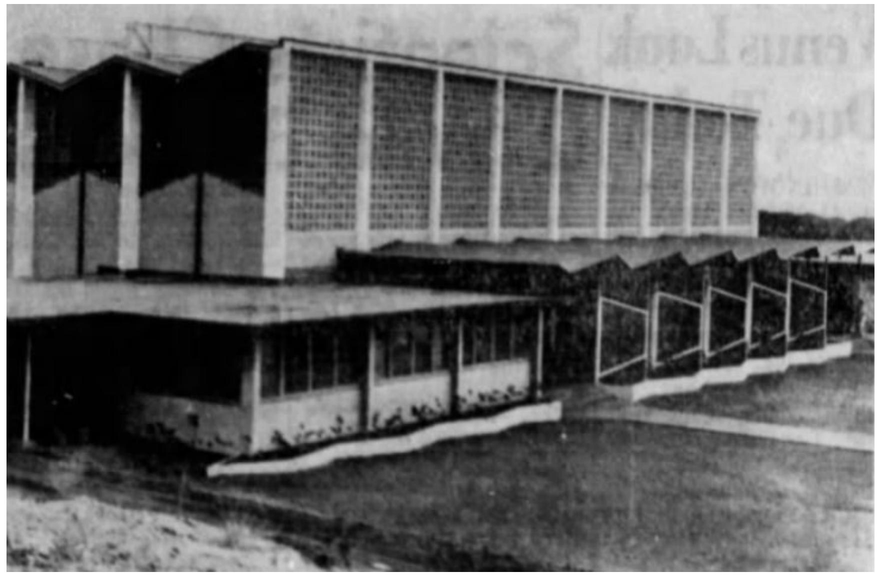


Figure 32: *Maui War Memorial Center, (1962)*
Source: The Honolulu Advertiser, December 14, 1962

concrete that was poured in place on a paper and wire mesh form and measured two-inches in thickness (Figure 31).[89] Kenneth Sato and Noboru Kobayashi, were the architects of the Maui War Memorial Center Gymnasium. It was a $700,000 project that originated from a group of Maui citizens, and financed by the state.[90] The building was located on 32-acres adjacent to Baldwin High School and imagined to be the primary athletic facility.[91] The building is square in massing, constructed of concrete, and appears to be three stories. Originally the main façade (south) featured a folded plate canopy sheltering the ground level, and nine bays of decorative metal screens on the upper levels (Figure 32). Additionally, the east and west elevations had a folded plate roof. Recent images show a flat roof with exposed concrete rafters indicating a renovation must have occurred which removed the folded plates.

89 Ibid.
90 "Sunday Rites Open New Maui Center," *The Honolulu Advertiser*, December 14, 1962, p.4.
91 Ibid.

CONCLUSION

Hawaii's local architects and engineers succeeded in applying the European thin-shell concrete techniques to buildings in the state of Hawaii such as: hotels, churches, shopping centers, office buildings, and comfort stations. The diverse application conveys its versatility as a dynamic, and seemingly effortless, cost effective technique. The characteristics of thin-shell concrete proved ideal for the local tropical environment as insulation is at times unnecessary, and concrete is a preferred building material as it is insect and rot resistant. Thin-shell concrete seamlessly harmonized and enhanced the characteristic of the modern movement in Hawaii which emphasized clean lines, symmetry, the use of concrete, a rejection of ornamentation, and at times a regionalist building style.

The modern movement in Hawaii began slowly as building's reflecting a "clear influence of modernist ideals" began to be constructed in the late 1940s and early 1950s.[92] The increased cost of importing steel for curtain wall construction resulted in the utilization of concrete as a primary building material, and compelled architects and engineers to creatively design with concrete and concrete block. In addition, new construction was not often high-end, but designed to meet the needs of the local population. A proliferation of two-story walk-up apartments, and homes were constructed during the time period in the modern style.

Sato's building designs contributed to the modern movement in Hawaii. He adhered to the characteristics of the modern movement by creating structures of concrete that were often symmetrical, lacked ornamentation and utilized the emerging technology of thin-shell concrete to enhance his designs as illustrated on the John R. Gilliland Building, Waimalu Shopping Center, and Waikiki Shore. A self-proclaimed dreamer, Sato believed in pushing the envelope, and recognized that clients perceived him as "half-crazy" when he suggested innovative construction techniques.[93] Sato was one of the first designers to utilize thin-shell concrete and

92 Fung Associates, Inc. et al., Hawaii Modernism Context Study, (Honolulu, Hawaii,2011), p. 3-18.
93 Greaney, p.22.

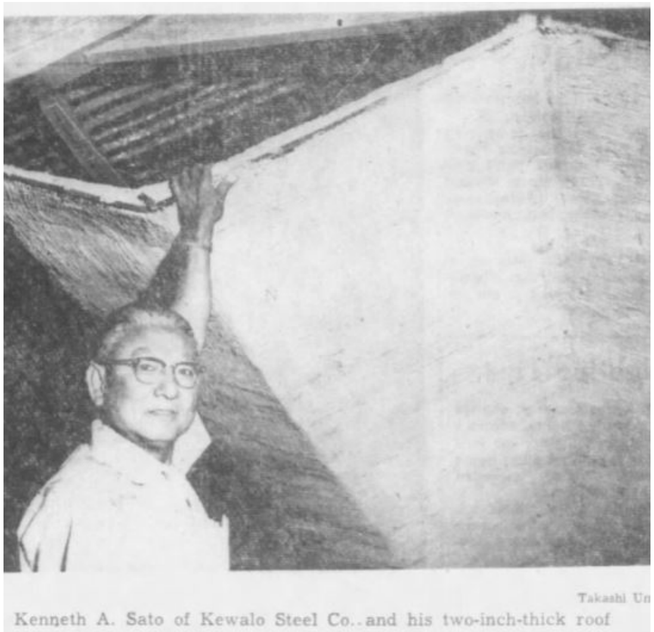


Figure 33: *Kenneth Sato with Folded Plate Roof, (1957)*
Source: The Honolulu Advertiser, August 11, 1957

demonstrably felt confident experimenting with the technique (Figure 33).

Sato's early ventures into thin-shell construction was on 1037 Kilani Avenue, an apartment building in Wahiawa, Oahu and the John R. Gilliland Building. It is unclear as to the clients wishes for the design of the John R. Gilliland Building, but one can surmise the Gilliland children allowed Sato to produce a charming modern building memorializing their family's history in the region. He seamlessly blended the barrel vault roof, and folded plate canopy on the John R. Gilliland Building which by all appearances had not been seen before on the islands. Buildings of the modern style, in which Sato contributed, featuring thin-shell concrete roofs are being replaced or augmented such as on the removal of the folded plate roof and canopy on the Maui War Memorial Center, and recently the folded plate canopy on the Kauai Sales Company Ltd. building was sheared in half. As many modern buildings with thin-shell concrete continue to be eradicated we will lose an integral piece of the modern movement in Hawaii.

There were no references detailing Sato's retirement, however, mention of him in newspapers ceases in the mid-1960s which can be assumed was when he retired. Kenneth Sato died in 2006 at the age of 98 and survived by his two children and eight grand-children.

Similar to the seasonal changes of fashion, architectural styles often become passé, resulting in their disappearance. Thin-shell concrete roofs began to disappear around the 1970s which was ultimately due to architectural tastes, trends, societal values, economic concerns, and political outlooks of the time. A contributing factor was the passing of the great masters. Many of the people who were experimenting with the curved forms passed away or retired, and never transferred their knowledge or expertise to colleagues in their firm.

Another factor leading to the demise of the thin-shell roof was the complex analysis used for creating the concrete structures which was often carried out by hand using the fourth order partial differential equation.[94] This was not only a tedious process, but calculations were difficult to interpret and apply.[95] Additionally, the building physics and tolerances for creating the form work required specialized skill, and unlike other construction, left little room for flexibility. The thin-shells themselves were extremely fragile and unexpected loads could cause buckling and failure.[96]

The cost of labor to construct the thin-shell concrete increased due to the specialized nature of each concrete pour. Labor was economical at the beginning of the 1920s; however, after the war, and during the great depression, complex form work became more of a craft resulting in increased costs.

In addition, thin-shell roofs were initially utilized on hangers and warehouses in warmer climates. With the growth in popularity, thin-shells began to be built around the world, and colder climates required additional construction considerations. The thin-shell forms required insulation which eliminated the slender profile; therefore, many of the roof forms were no longer truly thin-shell concrete.[97] Lastly, the impractical morphology of shells made for awkward junctions between roofs and walls creating dysfunctional, and impractical interior spaces.[98]

Eventually, architects and engineers came up with innovative, and different construction techniques pushing the boundary of form work. The lack of material opacity of concrete

94 Tang, p.5.
95 Ibid.
96 Ibid.
97 Tang, 6.
98 Ibid.

could not compete with the optical opacity of glass. During the 1980s, the infiltration of light and the optimization of a view, became the focal point for the construction of buildings. Although there were ways to create openings in thin-shell concrete roofs, the complexity of thin-shell concrete did not offer a substantial tradeoff for what little light infiltrated the openings.[99] Competing material like light weight steel, membrane roof structures, and cables and nets began to be utilized as new structural material. With these new materials, function followed form, and building materials with superior structural capability than concrete became popularized in building applications.[100]

99 Ibid, 5.
100 Ibid.

BIBLIOGRAPHY

Articles

Armentrout, Daryl. “Light Gage Steel Folded Plates*.”* Blacksburg, Virginia:Virginia Polytechnic Institute, 1968. Accessed February 2, 2021. http://hdl.handle.net/10919/52224.

Boothby, Thomas E., M. Kevin Parfitt, and Charlene K. Roise. “Case Studies in Diagnosis and Repair of Historic Thin-Shell Concrete Structures.” *APT Bulletin: The Journal of Preservation Technology* 36, no. 2/3 (2005): 3-11. Accessed February 2, 2021. http://www.jstor.org/stable/40004699.

Boyce, Dan. *“*The Air Force Academy Chapel Just Closed For a 4-Year, $158 Million Renovation.” Accessed February 2, 2021. https://www.cpr.org/2019/09/04/the-air-force-academy-chapel-just-closed-for-a-4-year-158-million-renovation/.

Clark, Nanette South. *The History of Thin-Shells and Monolithic Domes*. Accessed February 2, 2021.https://www.monolithic.org/blogs/engineering/the-history-of-thin-shells-and-monolithic-domes.

García, Rafael. “Concrete folded plates in The Netherlands.” *Second International Congress on Construction History*. Cambridge MA, 2018. Accessed February 2, 2021. https://www.researchgate.net/publication/322636638_Concrete_folded_plates_in_The_Netherlands.

Miller, Michelle. “Los Manantiales / Felix Candela.” Accessed February 2, 2021.https://www.archdaily.com/496202/ad-classics-los-manantiales-felix candela? ad_medium= gallery.

Mosquera, Maria J. “What Is Concrete Shell Architecture*?”* Accessed February 4, 2021. https://www.innovaconcrete.eu/what-is-concrete-shell-architecture/.

Patino, Andres. “Architecture Classic: The Zarzuela Hippodrome/Carlos Arniches Martin Dominguez and Eduardo Torroja.” Accessed February 2, 2021.https://www.archdaily.com/942985/architecture-classic-the-zarzuela-hippodrome-carlos-arniches-martin-dominguez-and-eduardo-torroja.

Plaza, Maria Josefa. *Eduardo Torroja Miret*. Fundacion Eduardo Torroja. 2011. Accessed February 2, 2021.http://www.fundacioneduardotorroja.org/index.php/en/eduardo-torroja/biografia.

Šekularac, Nenad & Ivanovic-Sekularac, Jelena & Tovarovic, J. “Folded Structures in Modern Architecture.” Facta Universitatis, Architectura and Civil Engineering. 2012. Accessed February 2, 2021. https://www.researchgate.net/publication/281395871_Folded_ structures_in_modern_architecture.

Tang, Gabriel. “An Overview of Historical and Contemporary Concrete Shells, their Construction and Factors in their General Disappearance.” International Journal of Space Structures. 2015. Accessed February 2, 2021. https://journals.sagepub.com/doi/10.1260/0266-3511.30.1.1.

Books

Gast, Ross H. *Don Francisco De Paula Marin: A Biography; The Letters and Journal of Francisco De Paula Marin*. Honolulu: University Press of Hawaii, 1973.

Maps

Dove, Charles V.E. Map of Honolulu. Scale approximately 1:12,000. Chicago: Rand Mc Nally & Co., 1912.

Monsarrat, M.D. Map of Honolulu. 1897. http://hdl.handle.net/10524/59520.

Sanborn Fire Insurance Map from Honolulu, Oahu County, Hawaii. Sanborn Map Company, Vol. 2, - 1950; Reprinted 1951. Map. https://www.loc.gov/item/sanborn01537_010/.

Newspaper

"$1.2 Million Building Planned on Emma St." *The Honolulu Advertiser*. October 3, 1959.

"18,000 Concrete Home May Be First in Islands." *Honolulu Star-Bulletin*. June 7, 1937, p.3.

"2 Kaiulani Classroom Buildings Open." *The Honolulu Advertiser*. December 17, 1955.

"All Halekulani-Dick Contractors Have Given Long, Efficient Service." *Honolulu Star-Bulletin*. August 22, 1953.

"Aloha Shopping Center for Waipahu." *The Honolulu Advertiser.* January 18, 1948.

"Bigger Kaiulani School." *The Honolulu Advertiser*. March 25, 1956.

"Blackout Relaxed for Necessary Defense Activity." *Honolulu Star-Bulletin*. December 12, 1941.

"Building Permits For 2 Apartments Issued by City." *Honolulu Star-Bulletin*. June 4, 1948.

"Co-op Will be Built on YWCA Beach Site." *The Honolulu Advertiser*. March 9, 1959.

"Dedication Ceremonies for New Waipahu Convent Set for Sunday." *Honolulu Star-Bulletin*. June 19, 1948.

"Delays in Maui Water Storage Project Explored." *Honolulu Star-Bulletin*. June 11, 1961.

"Dr. George R. Ohara." *The Honolulu Advertiser*. January 11, 1955.

"Gilliland Dead." *Evening Bulletin*. March 29, 1909.

"Give Letters and Medals to McKinley High Stars." *Honolulu Star-Bulletin*. June 10, 1926.

Greaney, Ed. "Engineer's Dream Ideas Pay Off." *The Honolulu Advertiser*. August 11, 1957.

"High School Captures Civic Club Trophy." Honolul*u Star-Bulletin*. May 16, 1925.

"Kenneth Sato Return from Rifle Matches." *The Honolulu Advertiser*. October 13, 1928.

"Kewalo Steel Adds Construction." *The Honolulu Advertiser*. February 1, 1958.

"Local and General News." *Evening Bulletin*. February 18, 1897

"Local and General News." *Evening Bulletin*. October 18, 1893.

"Local Attorney Seeks Senate Seat." *The Honolulu Advertiser*. September 30, 1942

"Manini's Garden in Pauoa Valley." *The Pacific Commercial Advertiser*. December 10, 1857.

"More than 225 graduates from McKinley High." *Honolulu Star-Bulletin*. June 10, 1925.

"Name 8 Captain and other McKinley R.O.T.C Officers." *Honolulu Star-Bulletin*. December 23, 1924.

"Navy Awards Contracts." *Honolulu Star-Bulletin*. September 17, 1952.

"New Buildings at Kahuku Planned." *Honolulu Star-Bulletin*. July 13, 1937.

"New Building Completed By Mission Academy." *Honolulu Star-Bulletin*. October 23, 1943.

"New, Modern Café Venice Opens Today." *The Honolulu Advertiser*. June 17, 1937.

"Orchestra of Japanese Youth to Give Concert." *The Honolulu Advertiser*. April 11, 1929.

"Pacific Plaza." *The Honolulu Advertiser*. March 30, 1958.

"Sato is Winner in Rifle Shoot." *Honolulu Star-Bulletin*. July 13, 1928.

"School Annex Permit Given." *The Honolulu Advertiser*. August 25, 1956.

"Several Honolulu Building Projects Sanctioned." *Honolulu Star-Bulletin.* April 24, 1951.

"Shed Bid Recommended." *The Honolulu Advertiser*. August 27, 1949.

Spence, Brady. "Vannatta Richer; Mum on Happiness." *The Honolulu Advertiser*. January 16, 1958.

"St. Joseph's Church Carnival." *Honolulu Star-Bulletin*. December 6, 1946.

"St. Louis Student Named the First Gilliland Scholar." *Honolulu Star-Bulletin*. June 12, 1990.

"Sunday Rites Open New Maui Center." *The Honolulu Advertiser*. December 14, 1962.

"Territory's Largest Class Receives Diplomas from McKinley High School." *Honolulu Star-Bulletin*. June 9, 1926.

"The Legislative Assembly." *The Honolulu Advertiser*. July 18, 1888.

"Today in the Churches." *The Honolulu Advertiser.* March 17, 1929.

"Wahiawa Homes Now Being Built." *The Honolulu Advertiser*. November 24, 1935.

"Wahiawa To Get New P.O." *The Honolulu Advertiser*. December 5, 1954.

"Waikiki Shore." *Honolulu Star-Bulletin*. October 20, 1961.

"Waiphau's New Convent." *Honolulu Star-Bulletin*. June 19, 1948.

"Widening Vineyard Street." *The Honolulu Advertiser*. October 24, 1893.

Young, Charles C. "New Waiola Church Traces History to Old Hawaii." *Honolulu Star-Bulletin*. May 16, 1953.

Other

Aroni, S. B.C.E., A.M.I.E.Aust. "Folded Plate Roofs, Architectural Science Review." 7:4, 146-150. 1964. DOI: 10.1080/00038628.1964.9697086.

"Building Code Requirements for Concrete Thin Shells (ACI 318.2-14)." *American Concrete Institute*, (September 2014): 5. https://www.concrete.org/portals/0/files/pdf/318_2_14.pdf.

Fung Associates Inc., et al. *Hawaii Modernism Context Study*. Honolulu, Hawaii. 2011.

Graham, Frederick Mitchell. *The Behavior of a Folded Plate Roof System*. Retrospective Theses and Dissertations, 1966. https://lib.dr.iastate.edu/rtd/2898.

"John R. Gilliland Building." *Reconnaissance Level Survey.* Honolulu, Hawaii, *Fung Associates Inc. 2016.*

Ketchum, Mark, Bothby, Thomas, & Parfitt, Kevin M. *Milo S. Ketchum and Thin-Shell Concrete Structures* *in Colorado*. APT Bulletin: The Journal of Preservation Technology, 2012. https://www.jstor.org/stable/41548693.

Narvekar, Rohan. Folded Plates: Theory of Structures. Mumbai, 2017. https://www.slideshare.net/RohanNarvekar2/folded-plates.

Solamillo, Stanley. "Waimalu Shopping Center," National Register of Historic Places Nomination Form. Washington, DC: U.S. Department of the Interior, National Park Service, 2017.

University of Hawaii. Ka Palapala, 1930. Published by the Associated Students of University of Hawaii, Honolulu, Hawaii.

Website

"Aloha Jewish Chapel." Accessed February 4, 2021. https://jbchapel.info/jewish.

Da Rocha, Daniel. "Pier Luigi Nervie and His Buildings in Rome." Accessed February 3, 2021. https://theforeignarchitect.com/blog/pier-luigi-nervi-in-rome/.

"Dome Architecture" Accessed February 2, 2021. https://www.britannica.com/technology/dome-architecture.

"Door of Faith Church- 1161 Young Street, Honolulu." Accessed January 5, 2021. https://docomomo-hi.org/items/show/923.

"Hawaiian Dictionaries." Accessed February 1, 2021. http://wehewehe.org/cgibin/hdict?a=q&j=pp&l=en&q= vineyardimagesofoldhawaii.com/honolulu-iron-works/.

Hibbard, Don. "Mystical Rose Oratory." Accessed February 5, 2021. https://sah- archipedia.org/buildings/HI-01-OA158.2.

"Imperial Hawaii Resort." Accessed February 4, 2021. https://www.agoda.com/imperial-hawaii-resort-at-waikiki/hotel/honolulu-hi-us.html?cid=1844104.

Khankhoje, Manasi. "What are Hyperbolic Paraboloid Shells?" Accessed February 4, 2021. https://www.re-thinkingthefuture.com/materials-construction/a2294-what-are-hyperbolic-paraboloid-shells/.

"Palazzetto delo Sport." February 2, 2021. http://architectuul.com/architecture/palazzetto-delo-sport.

Patil, Rahul. "Shell Structure." Accessed February 2, 2012. https://constructionor.com/shell-structure/.

"Robert Maillart." Accessed February 2, 2021. https://structurae.net/en/persons/robert-maillart.

"Vault". Accessed February 2, 2021. https://www.britannica.com/technology/vault-architecture.

"Waimalu Shopping Center." Accessed February 4, 2021. https://www.loopnet.com/Listing/98-020-98-048-Kamehameha-Hwy-Aiea-HI/15910740/.

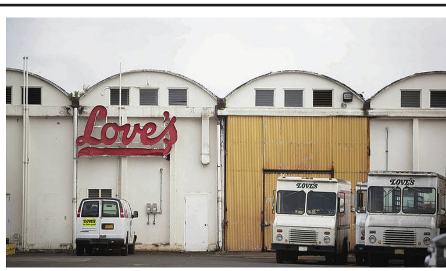
"Waiola Congregational Church." Accessed February 4, 2021. https://sah-archipedia.org/buildings/HI-01-MA23.

APPENDIX A

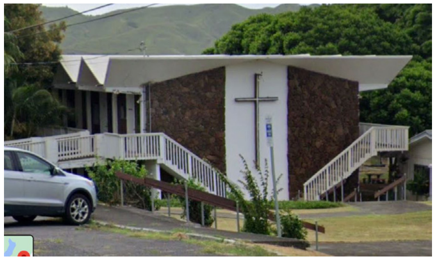
Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	1165 Bethel Street	1950	Ernest Hara	Folded plate canopy
	Tennent Art gallery Foundation	1954	Vladimir Ossipoff	Semi-circular barrel vault roof
	Kelly's Bowl	1955	Wimberly and Cook	Semi-circular barrel vault roof
	Diamond Head Memorial Park Columbariums	Circa 1955	John G. Minton of San Francisco	Semi-circular barrel vault roof
	St. Theresa Catholic School	1956	Ray S. Akagi	Semi-circular barrel vault covered walkway

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	1044 Kilani Avenue	1957	Kewalo Steel Co.	Segmental-arched barrel vault roof
	John R. Gilliland Building	1958	Kenneth Sato	Folded plate roof canopy with a drip edge on lower level and a segmental-arched barrel vault roof
	Hawaii Memorial Park Cemetery	1958	Wimberly and Cook	Folded plate roof
	Windward City Shopping Center-Foodland	1958	Wimberly and Cook	Shell roof
	Love's Bakery (Formerly Honolulu Construction and Draying)	1960	Unknown	Semi-circular barrel vault roof

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Kailua Baptist Church Preschool	1960	Wimberly, Whisenand, Allison & Tong	Folded plate roof
	King Center	1960	Takashi Anbe	Concave canopy with upturned edges
	First Southern Baptist Church of Pearl Harbor	1960	Ralph Meldrim Buffington	Folded plate roof
	Waimalu Shopping Center	1960-1963	Kenneth Sato	Semi-circular barrel vault roof
	32 N. School Street	1961	Unknown	Thin-shell angled canopy

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Chinese Consulate	1961	Wong and Wong	Concave semi-circular roof with upturned edges
	Aina Haina Community Park Comfort Station	1961	James B. Fagothey	Folded plate roof
	Aiea High School	1961	Tsutomu Izumi and Ted Vierra	Semi-circular barrel vault roof
	Pali Lanes Kailua	1961	Wimberly and Cook	Shallow dome/arch roof
	Kauai Sales Company Ltd. (Lihue, Kauai)	1962	Unknown	Folded plate canopy

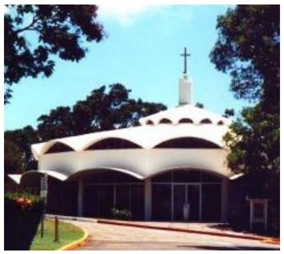
Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Waikiki Shore	1962	Kenneth Sato	Folded plate roof canopy
	West Oahu Christian Church	1962	Edwin Bauer	Semi-circular barrel vault roof
	Foster Tower	1964	Thomas Bourne and Associate	Undulating concave semi-circular barrel vault canopy
	Neil Blaisdell Center Arena	1964	Merril, Simms & Roehrig and Adrian Wilson & Assoc. designed the Arena	Undulating domed roof
	Safeway- Pali	1964	Wayne F. Owens	Shallow dome/arch roof

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Waialae Beach Park Pavilion	1965	Shoso Kagawa	Folded plate roof
	Aiea Bowl	1965	Ernest Hara	Shallow folded plate roof
	Aiea Shopping Center	1965	Ernest Hara	Shallow folded plate roof
	Aiea Commercial Center- Building 2	1965	Ernest Hara	Shallow folded plate roof
	Punahou Circle Apartments	1965	Park Associates	Folded plate entry canopy

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Holiday Surf (Formerly Boulevard Apartments)	1966	Ernest Hara	Folded plate entry canopy
	Mystical Rose Oratory Chaminade University	1966	Brother James Roberts and Guy Rothwell	Bi-fold roof with semi-circular barrel vault
	Imperial Hawaii Resort Waikiki	1967	Fred Kaiser	Folded plate canopy at ground level
	Leeward Bowl	1967	Ernest Hara	Concave barrel vault roof
	Pearl Harbor Kai Elementary School, Building A	1967	Katsuyoshi & Fuchino	Folded plate roof

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Kaimuki Jade (Formerly Jade Aparments)	1966	Park Associates Inc.	Folded plate canopy on ground level
	Building 1790- United States Coast Guard Barbers Point	1968	Unknown	Folded plate canopy on ground entry and second level vestibule
	Francis Wong Stadium (Hilo, HI)	1969-1970 confirm dates	Richard S. Matsunaga	Semi-circular barrel vault canopy
	Pauoa Elementary School	Circa 1960's	Unknown	Applied folded plate awning at ground level
	Naval Station Pearl Harbor Library/Navy Relief/Chapel	1975	Ossipoff, Snyder, Rowland and Goetz	Semi-circular arched barrel vaults

Thin-Shell Roofs in the State of Hawaii

	Name	Date	Architect/Engineer	Concrete Feature
	Soto Mission of Aiea	1975	Ossipoff, Snyder, Rowland and Goetz	Semi-circular barrel vault roof
	Palolo Valley District Park	Unknown	Unknown	Partial folded plate roof

APPENDIX B

Table of Projects by Kenneth Sato							
	Property Name	**Date**	**Building Type**	**Location**	**Architect/ Engineer**	**General Contractor**	**Notes:**
1	Loppin Residence	1935	Residence	Wahiawa, Oahu	X		
2	S.F. Lau Grocery	1935	Commercial	Honolulu, Oahu	X		
3	City Transfer Company Warehouse	1936	Warehouse	Honolulu, Oahu	X		In collaboration with John Hansen, a wing was added to the warehouse
4	Cafe Venice	1937	Commerical	Honolulu, Oahu	X		
5	Kahuku Plantation	1937	Commerical	Kahuku, Oahu	X		Boiler Room, Clarification Building, Power House
6	Hawaiian Mission Academy	1943	Education	Honolulu, Oahu	X		Two classroom buildings
7	South King Methodist Church	1945	Religious	Honolulu, Oahu		X	
8	St. Joseph's School	1947	Religious	Waipahu, Oahu	X		One classroom building
9	Lee Building	1947	Commercial	Wahaiwa, Oahu			
10	1850 Ala Moana	1948	Residential	Honolulu, Oahu	X	X	Apartment Building
11	1746 Ala Moana	1948	Residential	Honolulu, Oahu	X	X	Apartment Building
12	St. Joseph's Convent	1948	Religious	Waipahu, Oahu	X		
13	Aloha Shopping Center	1948	Commercial	Waipahu, Oahu	X		
14	Chubby's Liquors	1950	Liquor Store	Pearl City, Oahu	X		
15	Palolo School	1950	Education	Honolulu, Oahu		X	A classroom building
16	Fern School	1950	Education	Honolulu, Oahu		X	Six-unit classroom building
17	Kailua School	1950	Education	Kailua, Oahu		X	Three Kindergarden buildings
18	Hawaii Builders Supply Co. Ltd.	1951	Commercial	Honolulu, Oahu	Wimberley and Cook		Office building
19	Waiola Church	1953	Religious	Lahaina, Maui	X		
20	Door of Faith Church	1953	Religious	Honolulu, Oahu	X		
21	Miyamato Buildings	1953	Commercial	Honolulu, Oahu			
22	Wahiawa Post Office	1954	Civic	Wahiawa, Oahu	X		
23	Kaiulani School	1955	Education	Honolulu, Oahu	X		Built in collaboration with Dean Keller-- two buildings with 20 classrooms
24	Kew Chung Apartments	1956	Residential	Honolulu, Oahu	X		18-unit apartment building
25	Hanapepe Congregational Church	1956	Religious	Hanapepe, Kauai	X		
26	1037 Kilani Avenue	1957	Residential	Wahiawa, Oahu		X	12-unit apartment building
27	Sunset Funeral Home	1957	Religious	Pearl City, Oahu	X		
28	1650 Lusitana St.	1957	Residential	Honolulu, Oahu	X	X	Two- story 10-unit apartment building

Table of Projects by Kenneth Sato							
	Property Name	**Date**	**Building Type**	**Location**	**Architect/ Engineer**	**General Contractor**	**Notes:**
29	Unknown	1957	Residential	Honolulu, Oahu	X	X	500-unit, 3-story, Low Cost Cooperative Apartments
30	Kanakapolei Street	1957	Residential	Honolulu, Oahu	X		33 Studio apartments
31	Pacific Plaza Building	1958	Residential/Commerical	Honolulu, Oahu	X	X	Seven-story, 112-unit apartment building with office space
32	451 Launiu Street	1958	Residential	Honolulu, Oahu	X		Twenty-one-unit apartment building. Owned by Kenneth Sato and Henry Felix
33	John R. Gilliland Building	1958	Commerical	Honolulu, Oahu	X		
34	York International Building	1959	Commerical	Honolulu, Oahu	X		Ten-story apartment buidling with space for offices and retail. Plans only
35	Waikiki Shore	1959	Residential	Honolulu, Oahu	X		Fourteen-story 143-unit cooperative apartments
36	Waimalu Center	1959 & 1962	Commerical	Waimalu, Oahu	X		
37	Waiakamoi Water Storage	1961	Civic	Wailuku, Maui	X		Vannatta and Sato
38	Yokoyama Residence	1962	Residential	Honolulu, Oahu	X	X	
39	War Memorial Center	1962	Commerical	Wailuku, Maui	X		Noboru Kobyashi and Kenneth Sato architects
40	Long Lane Apartments	1962	Residential/Commerical			X	Two-story apartment building
41	Kaimuki House	Unknown	Residential	Honolulu, Oahu	X		

* This is not a comprehensive list of all of Kenneth Sato's works, but rather his projects that were easily identifiable through research

APPENDIX C

HAWAII STATE HISTORIC PRESERVATION DIVISION
HISTORIC RESOURCE INVENTORY FORM – Reconnaissance Level

FOR SHPD USE ONLY: **Site #** Click here to enter text. **TMK #** Click here to enter text.

I. GENERAL INFORMATION

Common / Present Name: John R. Gilliland Building

Historic Name: Same

Property Owner: City and County of Honolulu

Address: 1331 River Street / Units 1331, 1341, 1343, 1347, 201 through 216

City/ Town/ Location: Honolulu

County: Honolulu

TMK [(X)-X-X-XXX:XXX)]: (1)-7-0-060: 120: 000 through 020

Subdivision/Neighborhood: Chinatown

Latitude: 157°51'35"W

Longitude: 21°18'56"N

Parcel Number:

Historic District: N/A

Original Use: Commercial

Current Use: Commercial

Architect/ Builder (if known): Kenneth Sato

Date of Construction (if known): 1958

II. Photograph of Resource

Prepared By: Don Hibbard and Alison Chiu **Consulting Firm:** Fung Associates, Inc.
Address: 1833 Kalakaua Avenue, Suite 1008, Honolulu, HI 96815
Telephone Number: (808) 941-3000 **Email:** Alison@funghawaii.com **Date:** 09/09/2016

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III. CONDITION ASSESSMENT

Category (select all that apply):

☐Building(s)

☐Residential ☒**Commercial** ☐Educational ☐Public/Civic ☐Religious

☐Structure(s)

☐Object(s)

☐Site(s)/Landscape(s)

☐Archaeology or potential for archaeology (Please provide a description of the potential for archaeology within VI. Description of Resource Features below.)

Condition:

☐Excellent

☐Good

☒**Fair**

Eligibility (select all that apply):

☐National Register of Historic Places

☐State Register of Historic Places

☐Not Eligible

☒**Eligible**

☐Listed

☐Contributing to Historic District:

Name of District: Click here to enter text.

☐Unknown

Criteria of Significance (select all that apply)

☐A: Associated with Events

☐B: Associated with Significant Person(s)

☒**C: Distinctive characteristics of a type, period or method of construction; work of a master; possess high artistic values (Architecture, Engineering, Design)**

☐D: Have yielded or may be likely to yield information important to history or prehistory.

IV. MAP

HAWAII STATE HISTORIC PRESERVATION DIVISION
HISTORIC RESOURCE INVENTORY FORM –Reconnaissance Level

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V. DESCRIPTION

Materials (please check those materials that are visible):

Height

☒**Stories: 2** ☐N/A
☐Below Ground ☐Other:

Exterior Walls (siding):

☐Aluminum Siding ☐Metal ☐Plywood
☐Asbestos ☐Shingles-Asphalt ☐OSB
☐Brick ☐Shingles-Wood ☐Fiberboard
☐Ceramic ☐Stone ☐Fiber Cement
☒**Concrete** ☐Stucco ☐Vinyl Siding
☐Horizontal Wood Siding ☐Vertical Wood Siding ☐Other:
☐Log ☐Engineered Siding

Roof

☐Asphalt, shingle ☐Slate ☐Wood Shingle
☐Asphalt, roll ☒**Built Up** ☐None
☐Metal ☐Ceramic Tile
☐Other:

Foundation

☐Brick ☒**Concrete Slab** ☐Stone
☐Concrete Block ☐Poured Concrete ☐Raised/Pile
☐Other:

Structural Support

☐Baled Hay ☐Frame-wood ☐Puddled Clay
☐Concrete Block ☐Frame-metal/steel ☐Rammed Earth
☐Concrete Framed ☐Brick-load bearing ☐Sod
☒**Concrete Poured** ☐Stone-load bearing
☐Other:

Windows

☐Double Hung Sash ☒**Jalousie** ☐Stained Glass
☐Single Hung Sash ☐Glass Block ☐Replacement
☐Casement ☐None/Unknown ☐Aluminum
☒**Fixed** ☐Ribbon ☐Vinyl
☐Other:

Lanai(s)

☐Arcade ☐Recessed ☐Wrap-around
☐Balcony ☐Stoop ☐Verandah
☐Porte-Cochere ☐Portico ☒**None**
☐Other:

Chimney

☐Brick ☐Stuccoed Masonry ☐Stove Pipe
☐Concrete ☐Stone ☐Siding
☒**None** ☐Other:

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VI. Narrative Description

Include within the description of resource features any changes to the resource that have been made over time.

A. Describe exterior features:

This two-story modern style building is distinguished by a canopy between the first and second stories that runs the length of the façade and has a folded plate roof with a drip edge. The façade is further enriched by the roof, which is a series of front-facing, segmental-arched, barrel vaults with overhanging eaves on both the front and rear elevations of the structure. The reinforced concrete building is eight bays wide, with all the bays being of similar width except the northeast-most bay, which is narrower. The barrel vaults define the bays with one covering each bay. On the second story each bay features a picture window, flanked on either side by a pair of jalousie windows. A window air-conditioning unit is set in the lower half of one jalousie window in each bay. At ground level, each bay contained a store front, but the three southeast bays have been modified to address the consolidation of the interior spaces to develop a larger restaurant area. The original store fronts have a hinged door to the north with an adjoining display window to the south. The windows have been modified over time. The kick plate below the windows is simply the flat wall, which is composed of concrete masonry units (CMU) blocks. The narrower, north bay has a set of three jalousie windows on the second story and on the first a tri-fold door, opening the store space to the sidewalk. The three south bays each have six panels. The six north-most panels are solid, while in the middle bay each panel contains a fixed, plate glass window in its upper portion. The south-most bay has a north of center, recessed doorway with a fixed plate glass window to the entry's south. A box neon sign is suspended from the canopy above the entry and reads, "Uptown Café." A second box neon sign is similarly suspended from the canopy in the third bay from the north and this one reads, "Hanagasa Inn."

The rear, southeast side of the building on the ground level has a single door entry in each bay at its south side. The second story is handled the same as the façade's second story. A 3'-6" concrete sidewalk runs the length of the rear elevation and is defined by a 3" curb on its parking lot edge. The parking lot is elevated above the sidewalk and is flush with the top of the curb. Air conditioning/ventilation duct work, conduits, and electrical equipment protrude from the face of the rear elevation.

At either end of the building a double stair, each stair having eighteen steps, leads up to the second floor. The steps are concrete, and a flat roof extends 3'-9" from the sides of the end barrel vaults to protect the stairs from the elements. The space under the stairways has been enclosed with T-111 in recent years, to provide storage areas. The storage spaces are accessed by a centered, hinged, T-111 door. The stairways retain their wrought iron railings with their stylized post and rail pattern. A hinged, metal, security screen door is at the head of the stair.

B. Describe distinguishing interior features:

The screen doors at the head of the stairs provide access to a double-loaded, central hallway. The hall is approximately 4'-0" wide and curves to follow the line of the street. The ceiling in the hallway follows the vaulting of the roof and is approximately 20'-6" high at its apex. The concrete floor has been covered by modern tiles. There are eight doors on each side of the hall, which lead into office spaces. Nine of the doors are original and feature four horizontal-paned windows. At the bottom of some of the doors is a gravity flap letter plate. None of the original doors retain their original knobs. Each office has a picture window flanked on either side by a pair of jalousie windows, except the narrower, northern-most offices which only have a set of three jalousie windows. In a corner of each office is a half bath, which is entered via a single panel door. None of these doors have their original knobs. The offices have 9'-4" high dropped ceilings and originally had connecting doors in the plastered partition walls to allow access to the other office spaces. A number of these openings have been sealed up, but some original single panel doors still remain, again minus their original knobs.

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On the ground floor only two spaces are occupied: the Uptown Café and Hanagasa Inn. The former occupies the three southern-most bays of the building. It has an L-shaped dining area with a bar niche at the north end of the dining room. It was remodeled around 2000. The Hanagasa Inn occupies the second and third bays from the north. It was remodeled in the 1990s. Chikara Mochi occupied the space south of Hanagasa Inn. It still retains obscure, wire fire glass jalousie windows in its front and rear walls, a material which is rarely found today.

C. Describe the landscape and setting (include adjacent sites/resources):

This commercial building sits on a flat, 26,925 square foot lot, and fronts on River Street with vacant lots to either side. Three Royal Poincianna trees (*Delonix regia*) line the sidewalk in front of the building. A blacktop-paved parking lot occupies the rear of the property behind the building. The rear parking lot was improved and enclosed in 1966 by a CMU retaining wall.

VII. Statement of Significance

The Gilliland Building was constructed in 1958, following designs prepared by Kenneth Sato. It is architecturally significant as a very good example of a small retail/office building constructed in Hawaii in a modern style in the 1950s. It is typical of its period in its design, materials, workmanship, and construction methods. It is also important as a very good example of the architectural work of Kenneth Sato.

The façade of the building is distinguished by its folded plate canopy and segmental arched barrel vaulted roof. Folded plate technology originated in Germany in 1925 when it was utilized to cover a coal bunker. The idea spread to Russia and its earliest known use in the United States was in a 44’-0” x 77’-0” San Francisco warehouse in 1935. Other warehouses in California utilized this new type of roof, but as late as 1949, it was still not well known in the United States. An assembly of flat plates, or slabs, inclined in different directions and joined along their longitudinal edges, the folded plate structural system is capable of carrying loads without the need for additional supporting beams along mutual edges. Typically made of cast *in situ* or precast reinforced concrete, these roofs require less material, are cheaper to construct, are simpler to manufacture than other shells and are economical over long spans that need to be free of internal columns. Following World War II the distinctive, eye catching appeal of the form slipped nicely into the mid-century modern architectural vocabulary, celebrating the new age, the wonders of technology and its accompanying affluence. The only other use of a folded plate canopy utilized on a commercial building in Honolulu’s downtown area is at 1165 Bethel Street.

The segmental ached, barrel-vaulted, concrete roof also enunciated the advances in concrete technology as applied to the building trade. The designer of the building, Kenneth Sato, also utilized this form at the Waimalu Shopping Center in both the roof and first-story canopy.

As such the building stands as an excellent example of the dramatic and eye-catching mid-century modern movement in Hawaii. The building’s folded plate canopy, combined with its concrete barrel vaulted roof, make it a distinctive architectural statement, celebrating the plastic qualities of concrete and the variety of forms it could assume. There are no other comparable buildings in the city.

Kenneth Sato (1908-2006) was born in Kahuku, on Oahu, graduated from McKinley High School, and received a degree in civil engineering from the University of Hawaii in 1930. He owned the Kewalo Steel Company, and designed a number of churches, apartments, and low rise commercial buildings, and worked on a number of public schools and bridges for the Territory of Hawaii. Other works include the Waiola Congregational Church in Lahaina, the Miyamoto Buildings at 1331 Nuuanu Avenue, and the Door of Faith Church on Young Street in Honolulu.

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VIII. Survey Analysis

Please provide your observations about the survey; including constraints and opportunities for future research and/or survey in connection to this site.

The survey was straight-forward and encountered no problems. Two of the ground floor commercial spaces were boarded up and could not be accessed. It would be of value to learn more about the designer of the building, Kenneth Sato, and at some point an inventory should be compiled on folded plate roofs in Honolulu.

IX. References

City and County of Honolulu Real Property Tax records.

Polk's City Directories for Honolulu, 1957-1965.

Building Permit 142902.

"Kenneth Kenkichi Sato," obituary. *Honolulu Advertiser*, June 28, 2006: p. B-2.

Hibbard, Don. *Buildings of Hawaii.* Charlottesville, Virginia: University of Virginia Press, 2011.

Wang, Y. P. (1965). *Analysis of Continuous Folded Plate Roofs (Master Thesis), Missouri University of Science and Technology*. Accessed on September 16, 2016 at http://scholarsmine.mst.edu/cgi/viewcontent.cgi?article=7693&context=masters_theses.

Wilby, C. B. *Concrete Folded Plate Roofs*. Burlington, Massachusetts: Elsevier Butterworth-Heinemann, 1998.

Internet Archive. "Concrete Shell and Barrel Roofs." Accessed on September 16, 2016 at https://archive.org/stream/ConcreteShellAndBarrelRoofs/ConcreteShellAndBarrelRoofsCca113193_djvu.txt.

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X. Continuation Sheet

Please use this sheet those that follow to attach additional information about the site; including, but not limited to additional floor plans, drawings, photographs, maps, etc.

Figure 1: View of River Street façade, showing typical store front spaces with folded plate concrete awning at first floor and second floor offices with thin shell concrete barrel arched roof. View facing southeast.

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Figure 2: "John R. Gilliland Sr. Building, 1958" nameplate and stair railing detail. View facing northeast.

Figure 3: Open entry door detail at south end of second floor hallway. View facing southwest.

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Figure 4: Overall at second floor hallway, showing original 4-pane office door and barrel arched roof.

View facing southeast.

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Figure 5: Typical second floor office space with barrel arched roof. View facing east.

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Figure 6: First floor former Chikara Mochi commercial space. View facing southeast.

Figure 7: First floor New Hanagasa Inn. View facing northeast.

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Figure 8: First floor Uptown Café bar. View facing northeast.