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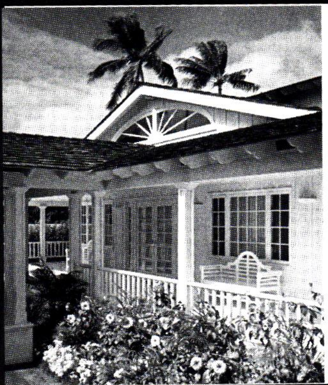

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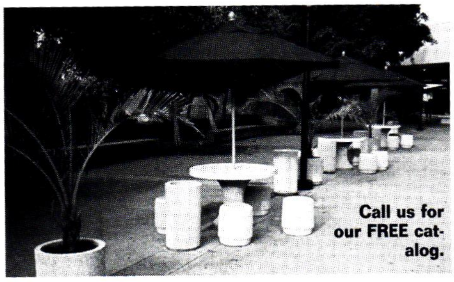

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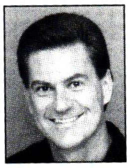

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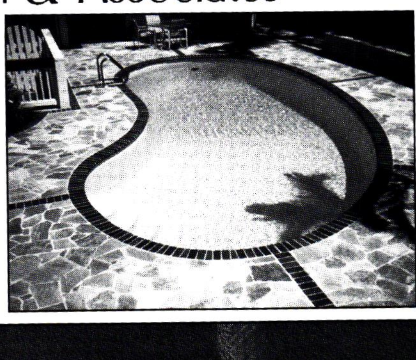

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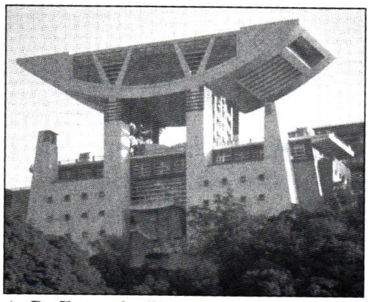

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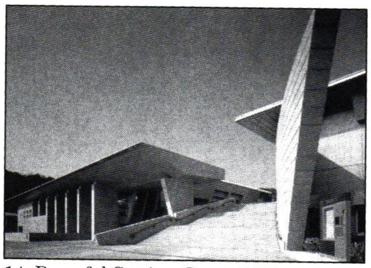

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IN THIS ISSUE ...

This issue marks an exciting first for *Hawaii Pacific Architecture*. Although this magazine remains committed to featuring the work of Hawaii architects, it was time for a new perspective – to show local architects some of the innovative work of architects in Asia. *Hawaii Pacific Architecture* thanks Jack Sidener, Ken Yeang, Ivor Richards and Junzo Munemoto for their outstanding contributions to an issue that is sure to be greatly enjoyed by the readers.

COVER: The evening light creates a dazzling effect in this view of the Hong Kong Convention and Exhibition Centre from Hong Kong Harbor.

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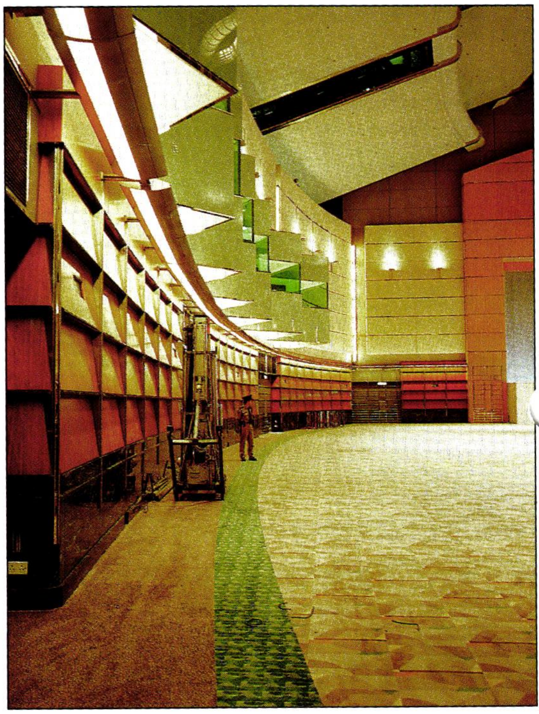
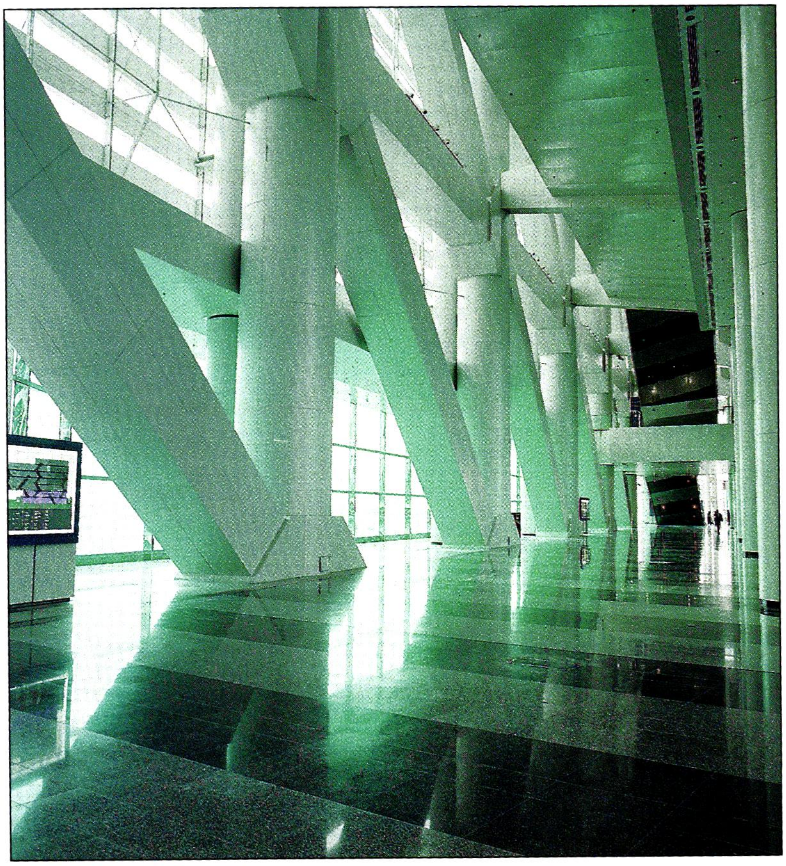
Hong Kong's sinuous new architecture

Re-Enter the Dragon

by Jack Sidener, FAIA

No one knows if the recent return of Hong Kong to China will presage a more conservative design movement, but for the next few years the city will still be building the legacy of design produced in the 1990s. These notable designs seem poised for flight, with an exterior character dominated by sinuous curves and thin membranes held aloft by slender bones and taut tendons.





The interior of the Hong Kong Convention and Exhibition Centre (above and above right) reflects its open, spacious design.

Partly this is the result of a massive infusion of new transportation infrastructure – airport, railways, bridges and highways with their soaring cloverleaves. Partly it is the worldwide trend toward a high-tech architecture of glass and tensioned steel. Partly it is the result of a core of sophisticated clients, particularly government or quasi-government clients, willing to spend money on good design. This sophistication in taste is one of the best legacies left by the disappearing British Empire.

Colonial Roots: The Architecture of Repose

The original tenuous foothold of the British colonists at the edge of the Pearl River Delta which is Hong Kong was built as a typical outpost of power – stone and brick *godowns* (warehouses) on the waterfront, brick and plaster manses on the hills behind.

These buildings expressed solidity and power and created a dramatic port city with a mountainous backdrop. The mountain is really a sinuous ridge, symbolizing the dragon beneath it in local mythology.

Unknowingly, the early colonists reinforced the good *feng shui* of the place. For most of its history Hong Kong felt solid, rooted to the ground by the weight and lines of its structures, comfortably sited with their backs to the hills.

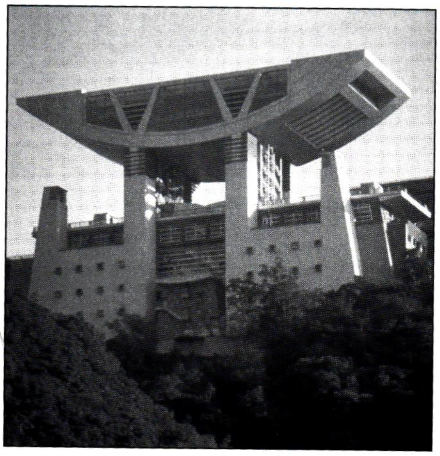
Boom Times: Angular Architecture

After the great migrations of the '60s and '70s which populated Hong Kong with an energetic new amalgam of entrepreneurs, Hong Kong became more dynamic and so did its architecture. Tycoons who became rich from great fluctuations in property values and by manufacturing what a wealthy world wanted brought in flamboyant architects from elsewhere. The city of repose became a city of leaning, thrusting and zigzagging buildings.

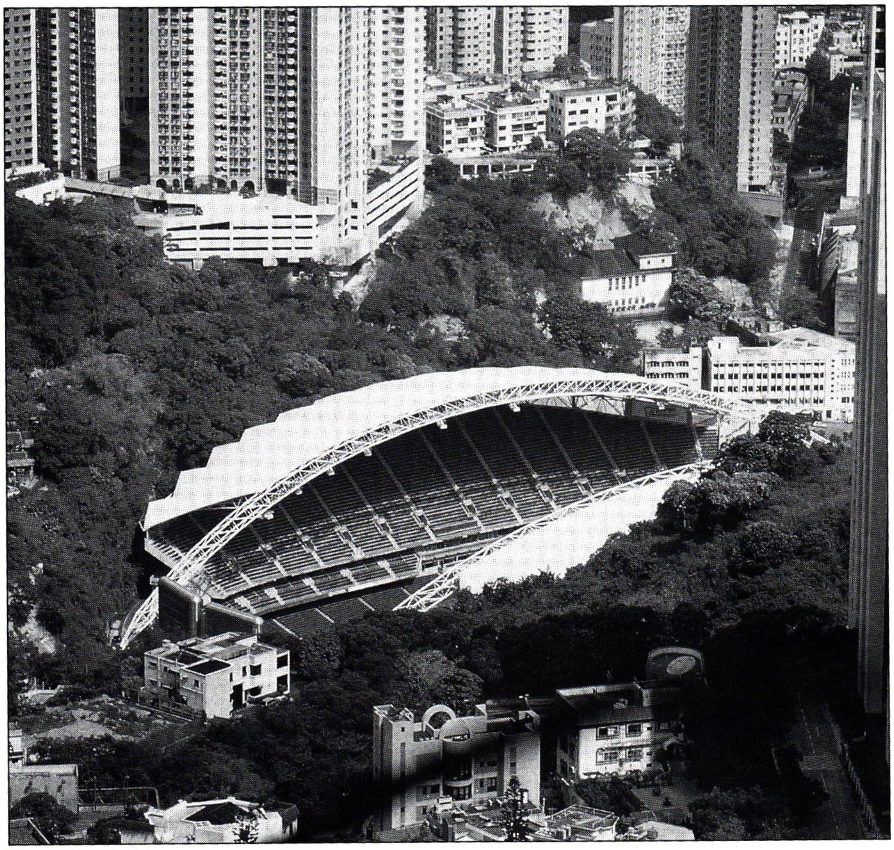
Paul Rudolph produced designs from concept sketches unrealized in the 1950s in the United States. Tao Ho brought the angular power of Louis I. Kahn's Yale projects, and Norman Foster and I.M. Pei created strong images for the two major banks. The angles were directly contradictory to the sense of repose and respect for *feng shui* of the earlier cityscape; however, this was still institutional architecture and curiously still somewhat static.

Zaha Hadid startled Hong Kong, and much of the architectural world, with the ultimate zigzags in her proposal for a restaurant which burst from Hong Kong's peak like fiery breath from the sleeping dragon, but the design was never realized. Terry Farrell and Partners have recently completed the successor, a work of architecture which creatively bridges the past and the dynamic present with its thrusting cantilevered building rising from a neo-Tibetan base.

This structure forms the upper terminus of the cable tramway which climbs from Central (downtown) straight up the Peak, and houses restaurants, curio shops and a wax museum,



The Peak Tower, designed by Terry Farrell and Partners, connects past and present architectural styles.



Sun floods the Hong Kong Stadium through its retracting roof.

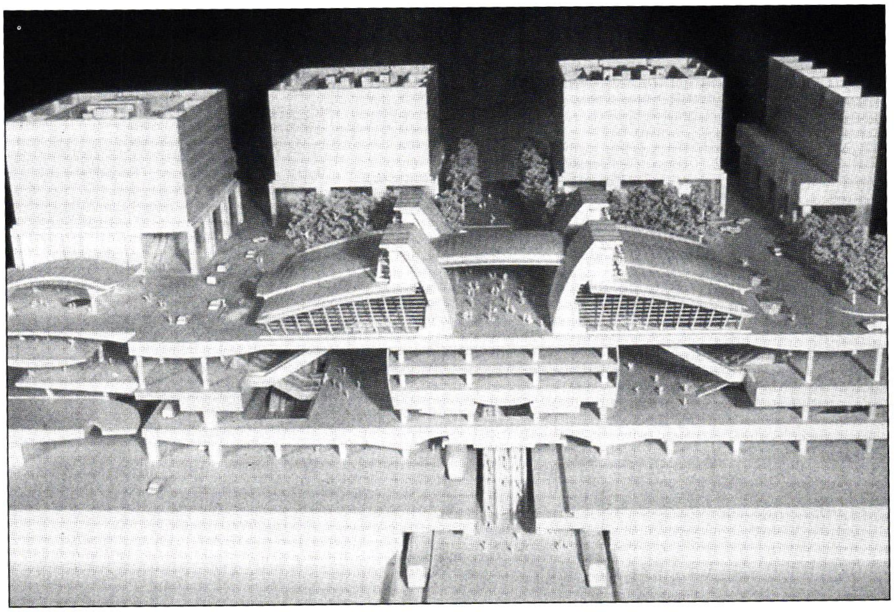
much to the chagrin of the architects.

The Dynamic '90s: Movement and Arrival

Terry Farrell, who studied with the famed architect Louis I. Kahn, seems to have taken one of Kahn's teachings to heart. Kahn said that the architecture of transportation facilities should "celebrate" movement and arrival through iconography as well as structure.

The architecture of gathering places, such as Hong Kong's new Convention and Exhibition Centre, also celebrates the movement and color of people arriving and meeting. The Convention Centre's grand concourse and vertical circulation spaces are on the outside of the building, putting people veritably on stage. This building, by Wong and Ouyang with Skidmore, Owings and Merrill, thrusts into the center of Hong Kong's harbor, and is the current star on the waterfront stage as seen from the promenade along Kowloon's southern edge.

The light and sensuous roofs of the Convention Centre have caught the public's fancy. Together with the retracting roof of Hong Kong Stadium, Farrell's Peak building, and the new Tsing Ma suspension bridge, the center is featured on the first set of commemorative stamps issued without royal imagery to celebrate the political exchange to China.



A model of the Airport Railway Kowloon Station highlights its dynamic roof design details.

In Process: Even Freer Curves

Housing estates in Hong Kong, rigidly formulated and very high-rise, high-density blocks with parking podium bases, offer architects a challenge – how to produce humanized architecture within cereal box types of developments. Such calculated schemes are planned atop most of the new stations along two new major heavy rail lines – the Airport Railway between Hong Kong's Central and the new Chek Lap Kok Airport, and the Kowloon Canton Railway Corporation's (KCRC) new West Rail line from Kowloon to Shenzhen.

Leigh and Orange and Terry Farrell and Partners are two of the principal firms carving away at the cereal boxes, particularly to introduce natural light deep into the stations and create visible evidence of the otherwise buried stations so they'll serve as local landmarks. Farrell's dynamic roof lantern for the Airport Railway's Kowloon station is well into construction. It is very handsome, but probably will be overwhelmed by the surrounding massive property development. At

Hong Kong gave architect Paul Rudolph the freedom to design innovative buildings such as the Lippo Centre.

KCRC's West Kowloon Station, early studies forecast a more publicly visible solution, making the station identifiable as a railway station.

These architects, along with the designers of Urbis, a landscape and planning firm, are producing an interesting set of dynamic concepts for the new West Rail as it snakes across the New Territories (as the northern part of the old colonial territory is called).

Joining China

While there is some evidence of design freedom in places such as Shanghai, where Western (including Taiwanese) architects are gaining commissions for office and commercial buildings, most architectural design in mainland China is subjected to the sometimes deadening conservative forces of centralized control. The question for Hong Kong in the next few years is, will this be the last flexing of the wings of artistic freedom? Are architects, like Icarus, defying gravity, burning up by being too near the sun?

The exuberant architecture currently happening in Hong Kong may well continue, judging from the work of the younger firms and student work at the universities. The next generation of architects is very worldly and talented, and able to compete with firms from elsewhere that have set up offices in Hong Kong. The next round of projects related to infrastructure, such as a joint rail station at the border between Hong Kong and Shenzhen, offers opportunities for a new Hong Kong China architecture.

Jack Sidener, Ph.D., FAIA, is a professor of architecture at the Chinese University of Hong Kong. For the past several years he has been chief architect and urban designer for Pacific Bechtel Corporation, designing rail projects, new communities and leisure facilities throughout Pacific Asia. He spent several years in Hawaii with Lanai Company and Oceanic Properties, and was an associate professor of architecture at the University of Hawaii, Manoa.

Architecture that responds to a tropical climate

The Ecological Design of Ken Yeang

by Ivor Richards

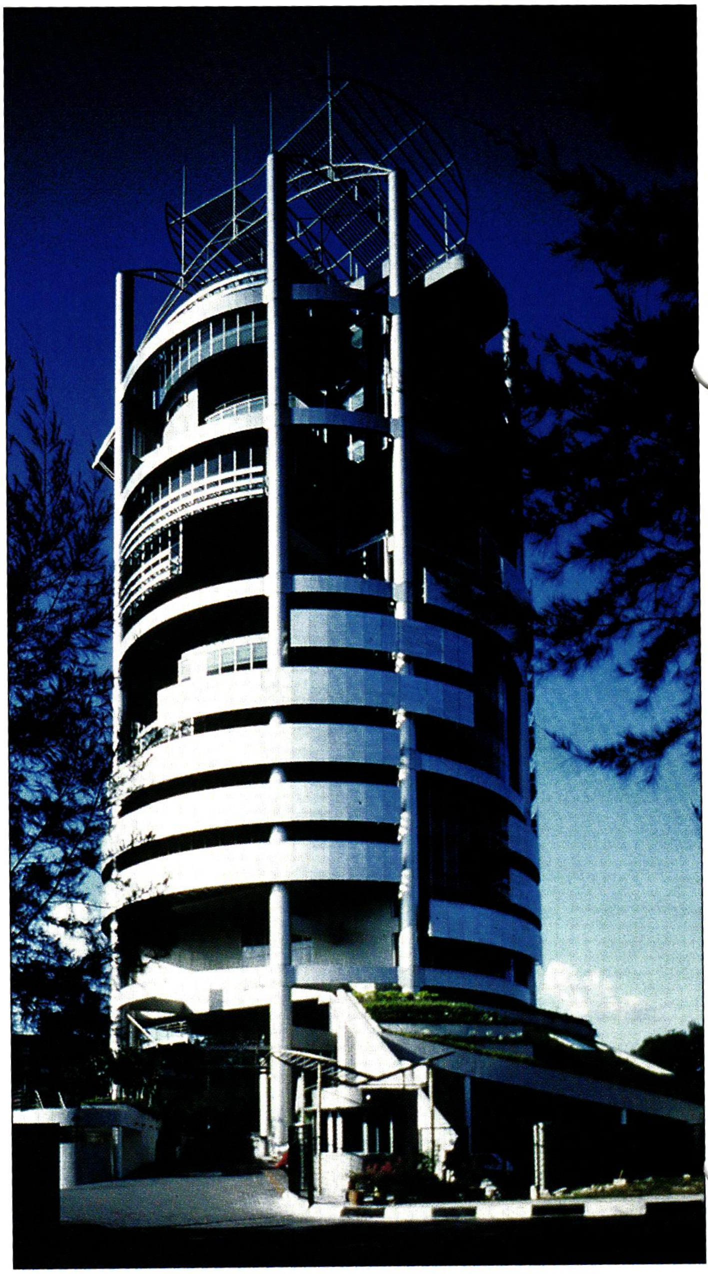
Dr. Ken Yeang, of the firm T. R. Hamzah and Yeang in Kuala Lumpur, is an architect whose presence is increasingly evident in a vast range of buildings recently constructed in major cities of the Pacific Rim. These include a special form of skyscraper architecture based upon *bioclimatic principles*.

These principles of environmental design are constantly supported by Yeang's research, design and development. The principles of orientation, shading, shielding, solar control, natural ventilation and cooling all derive from his Ph.D. thesis, which is summarized in *Designing with Nature - The Ecological Basis for Architectural Design* (McGraw/Hill, New York 1995).

Three examples constructed in Kuala Lumpur during the last five years demonstrate the developmental trajectory of Yeang's bioclimatic skyscrapers. They include the Menara Mesiniaga, Menara Budaya and Central Plaza. All are designed in response to program and land value and precise climatic principles.

World-Renowned Design

Menara Mesiniaga is a cylindrical landmark building that, having received an Aga Khan award, has become the icon of



Menara Mesiniaga combines bioclimatic principles with innovative, award-winning design. It has become the prototype of Yeang's bioclimatic design method.

Design Considerations	Design Mode		
	Others	Bioclimatic	Ecological
Builtform Configuration	Other Influences	Climate Influenced	Environment Influenced
Building Orientation	Relatively Unimportant	Crucial	Crucial
Facade & Windows	Other Influences	Climate Responsive	Envronment Responsive
Energy Source	Generated	Generated / Ambient	Generated / Ambient / Local
Energy Loss	Relatively Unimportant	Crucial	Crucial / Reused
Environmental Control	Electro-Mech	Electro-Mech / Manual	Electro-Mech / Manual
	Artificial	Artificial / Natural	Artificial / Natural
Comfort Level	Consistent	Variable / Consistent	Variable / Consistent
Low-Energy Response	Electro-Mech	Passive / Electro-Mech	Passive / Electro-Mech
Energy Consumption	Generally High Energy	Low Energy	Low Energy
Materials Source	Relatively Unimportant	Relatively Unimportant	Low Environmental Impact
Materials Output	Relatively Unimportant	Relatively Unimportant	Reuse/ Recycle / Reintegrate
Site Ecology	Relatively Unimportant	Important	Crucial
Landscaping	Aesthetically Important	Climatically Important	Ecologically Crucial

Yeang outlines his bioclimatic and ecological design principles in this chart.

Yeang's skyscraper architecture prototypes. While this project is a relatively low tower of 15 stories, the same principles could apply to a 50-story version (such as Yeang's Nara Tower for Japan recently demonstrated). In Yeang's own words, Menara Mesiniaga incorporates the central principles of his bioclimatic design method, including:

". . .spiralling vertical landscaping, climbing the face of the building; ramped turfing and planting up the lower floors of the building; recessed and shaded windows on east and west sides; curtain-wall glazing to north and south sides; single core services-core on hot side; naturally ventilated and sunlit toilets, stairways and lift-lobbies; skycourts - spiralling balconies on the external wall with full-height sliding doors for natural ventilation (if required) to the interior offices and as transitional spaces for building users; sunshaded roof over last floor."

The ramped landscape plinth incorporates a spacious entrance foyer and the associated radial arrangement of computer suites with naturally-lit, concentric circulation. Beneath the base are sunken, protected parking spaces.

The open, sun-shaded roof is defined by the "flycatcher" umbrella – a local landmark – which can also receive future installations of solar cells to provide background sources of energy. The umbrella also signals the presence of the roof-top swimming pool and a gymnasium available to the office building's staff.

Yeang has encouraged further social innovations, which include the grouping of enclosed and serviced executive and conference spaces at the center of the circular plan. This leaves the peripheral spatial ambulatory free for open-office installations with natural light and views and free access to the skycourts. Thus, all considerations of the design are directed either toward low-energy objectives or to improvements of the social environment for the office community.

Passive low-energy features, such as external solar-shading louvers which reduce heat gain into the internal spaces, are typical of Yeang's applied research and development. He has developed guidelines for the universal application of these devices in any climatic context. Similarly, the clear glazing of north and south facades, a direct response to the tropical overhead sun path, provides both good views and further opportunities for natural ventilation.

Climate Affects Design

The ultimate purpose of Yeang's innovative architectural practice is at once both extremely simple and yet deeply important. His work is directed at energy reduction and the overall performance of buildings within the context of a tropical climate. The aim is a sustainable standard of well-being and comfort. Subsequently, his principles are intended to apply to all global climatic conditions, including the significant impact of high-rise and other forms of development on the ecosystems of late 20th Century cities.

Yeang's work is directed at energy reduction and the overall performance of buildings within the context of a tropical climate.

The capsule shape of Menara Budaya provides optimum floor area and efficient wall area.

While Menara Mesiniaga is situated in a business park environment on the periphery of the city, both Menara Budaya (now re-aligned as Menara TA1) at 40 stories and Central Plaza at 27 stories are significant tower forms located in the intense density of Kuala Lumpur's Golden Triangle.

All three projects are classified by Yeang as Series Two Skyscrapers. In this series, Menara Mesiniaga is the bench-mark project as it incorporates the key design features of the evolving bioclimatic skyscraper. In turn, Menara Budaya and Central Plaza both incorporate the design principles of the bench-mark project and develop these to suit their context and evolving technologies.

Innovation on Budget

Menara Mesiniaga (1992) was built and customized for IBM's

Malaysian agency's exclusive occupation, whereas Budaya (1996) and Central Plaza (1996) are for multi-occupancy use and constructed on restricted urban sites with both high land costs and rigorous construction budgets. However, what Yeang has demonstrated is that despite the constraints, he is able to deliver an innovative product in a fiercely competitive and commercially-driven marketplace.

Budaya and Central Plaza both incorporate a seven-floor plinth of parking levels together with naturally-ventilated and shaded entrance plazas, with some retail facilities such as restaurants and banking halls at grade. Again, the roof levels are treated as a fifth elevation and are inhabited.

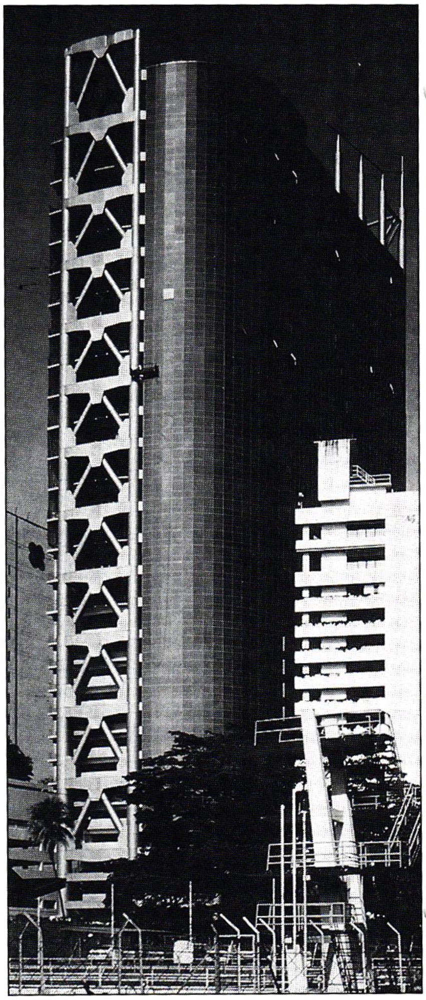
"The global economy today is clearly increasingly aware of energy as a scarce resource; the need to conserve energy and design for a sustainable future is becoming imperative for all designers."

Budaya has a partially covered roof space which is formed by the use of fabric structures which are also used as an entrance canopy to the porte cochere. Central Plaza incorporates extensive vertical landscaping which culminates in roof-level terraces and a recreational space with a swimming pool. Both projects exhibit thin plan-forms due to their site configuration and to respond to orientation and sun path.

Menara Budaya is configured with the battery of service cores to one side as a solar shield. This design has produced a remarkable effect on the building's form and visual narrative, which reveals two distinctly opposite faces of the plan form with curved ends that reduce insulation, and carefully tuned shading devices incorporating both egg-crate and louver formats.

All of these factors spring initially from the fact that the Budaya site lies diagonally across the north-south axis, and the resultant slimline plan introduces options for natural ventilation together with recessed balconies and opportunities for vertical landscaping.

Central Plaza confronts different challenges in relation to both orientation and urban design. The elongated site in this case lies east-west and again, logically exhibits a linear servicing zone. However, the west facade faces an interesting main street and urban setting which requires it to be viewed from within. Consequently, the sun shading to the western street facade is compensated and integrated by expressing the structure and recess-



Central Plaza has a "cigarette pack" slim form and offers offices panoramic views.

ing the facade glazing.

Once again, both Budaya and Central Plaza incorporate, in varying quantities, fully-glazed northern facades which afford panoramic views, in some locations to the distant hills beyond Kuala Lumpur.

What can be summarized is a developing tradition in architecture incorporating Yeang's principles of bioclimatic design and vertical urbanism. In addition, there is constant experiment with materials, components, devices and color as applied to the whole building form. From the gray aluminum of Mesiniaga to the startling white of Budaya and the sophisticated pink of Central Plaza, there is an underlying program of research in the range of materials and detailing including, more recently, marble and laminated float glass and the increasing use of fabric

(Continued on page 13)

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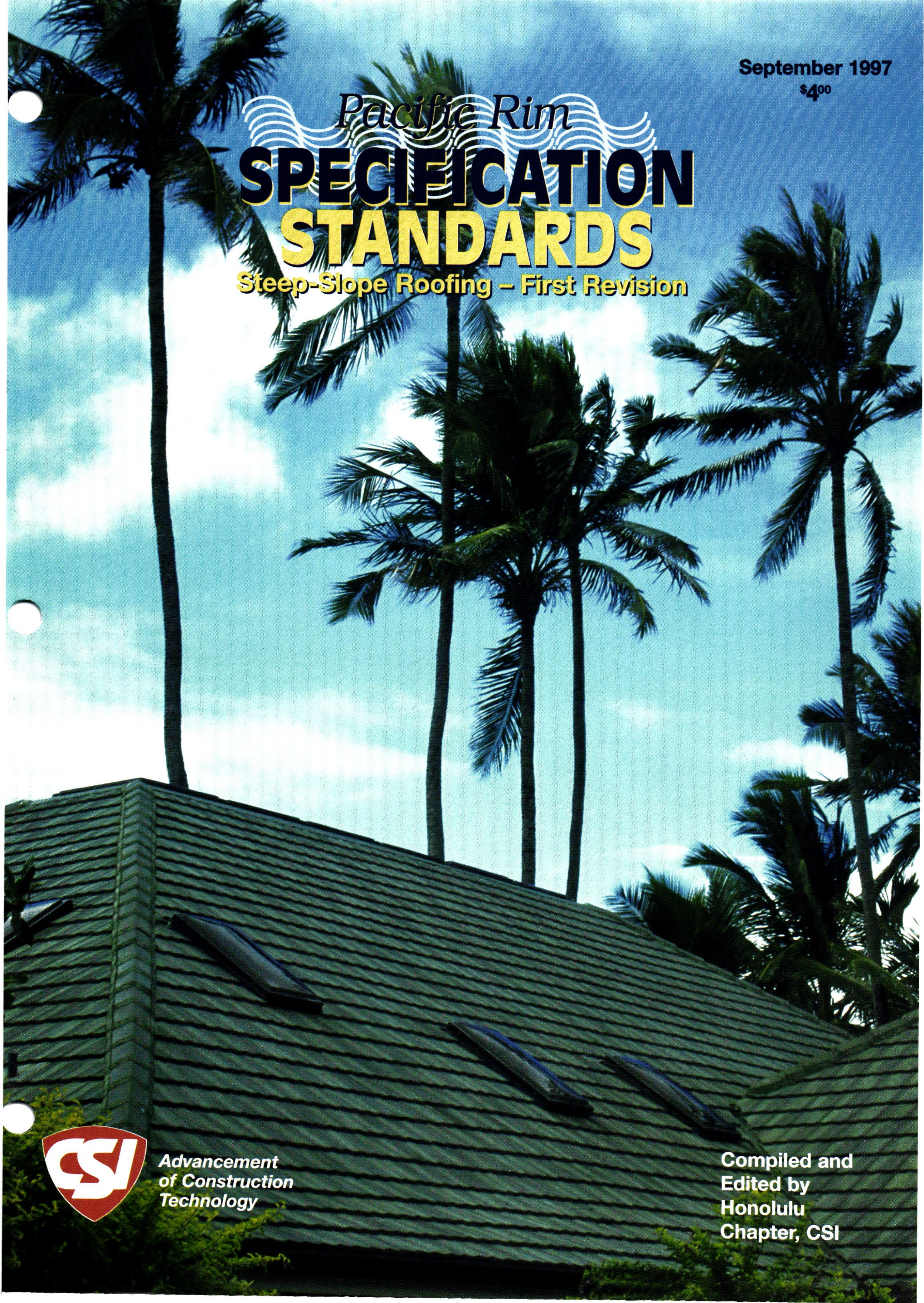

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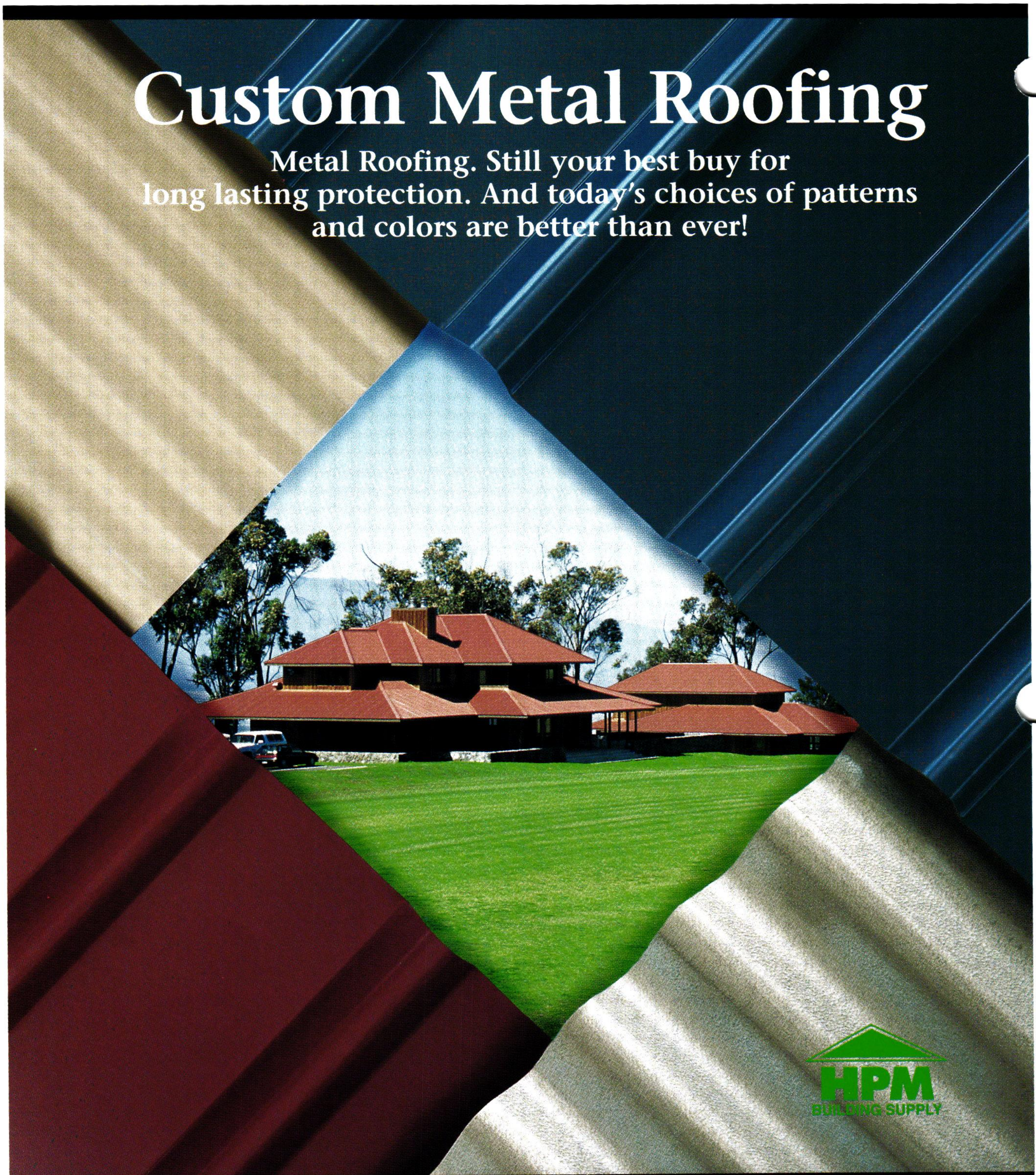

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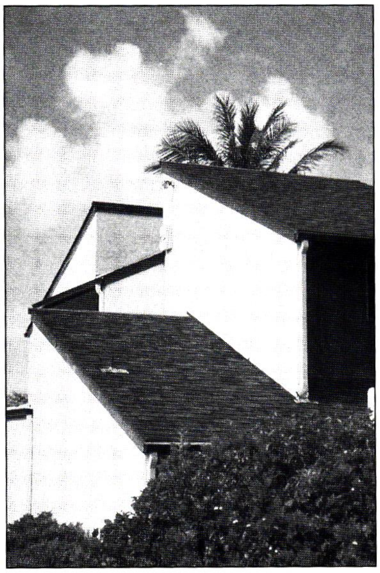


STEEP-SLOPE OVERVIEW

In days past, steep roofs were largely constructed of thatch. Today, visitors to our islands see many traditionally popular roofing materials, such as asphalt shingles, roll roofing, wood shakes and shingles, clay tile, concrete tile, slate, and metal tiles and panels. New technology in recent years has led to the appearance of many new products on the market utilizing plastics, foam, coatings and other non-traditional roofing materials.

Through long experience, those involved in roof design and installation in Hawaii and the Pacific Rim have learned to adopt a cautious approach when recommending or specifying roofing products. On average the roof represents only about five percent of a new building's total cost, yet the vast majority of construction litigation results from roofing-related problems. Hawaii's unique and varied environment presents many challenges not typically encountered by our mainland counterparts.

While we don't contend with freeze-thaw, snow loads or ice dams, we do have our own unique problems which must be weighed carefully when considering roofing materials and accessories. These include:

- Corrosion
- Wind
- Ultraviolet radiation
- Thermal shock
- Vegetation / fungus / algae / mildew
- Insect / animal damage

Corrosion

The best rule of thumb for roofing in the Pacific is to assume anything that can corrode will. With our humid, salt-laden air and frequent precipitation, the Pacific Rim constitutes an extremely harsh environment for metals.

Corrosion can result from many environmental mechanisms. The various manifestations of corrosion may be categorized in different ways, including general (oxygen type) corrosion, galvanic (hydrogen type) corrosion, chemical corrosion, localized corrosion (pitting), and biochemical corrosion.

Biochemical corrosion can occur as a result of organic acids produced by microorganisms, which can live on coats of paint and on plastic coatings. Islands with volcanic activity are subject to "VOG", a corrosive mixture of volcanic smoke and gas that produces a fog-like haze. Depending upon the direction of prevailing winds, VOG may travel to neighboring islands several hundred miles away.

Frequently, the different types of corrosion do not develop separately but are interdependent in a complex way. Therefore, the terms "corrosion resistance" and "corrosion prevention" are relative and must be considered together with the requirements.

Simply specifying hot dipped galvanizing or stainless steel may not be the answer. Stainless steel nails and staples are typically smooth shanked and may not meet the pull-out resistance required.

The impact of nailing, by hand or gun, chips the protective layer of galvanizing, providing an exposed point of entry for corrosion. Similarly, the process of hot dip galvanizing often clogs fastener holes, which must be nailed through or knocked out during installation, thereby damaging the integrity of the protective coating.

Steel roofing will corrode (rust) more quickly than non-ferrous materials, such as copper and aluminum, and should be galvanized or aluminum-coated (commonly referred to as "galvalume"). All exposed steel roofing metals and flashings should be finished with high-performance paints, such as a fluoropolymer or polyvinylidene fluoride (PVF2). Accessories should be protected with a minimum of 1.5 ounces of zinc/SF on both sides.

Wind

Our unique topography – long spans of ocean broken abruptly by mountainous islands and tall buildings – can produce unusual weather patterns, creating additional uplift and scour forces.

Four major hurricanes have hit Hawaii since 1957, resulting in lost lives and hundreds of millions of dollars in damages. Dozens of gales and tropical storms are routinely recorded each year and wind gusts exceeding 60 mph are a normal occurrence throughout the Pacific.

Under the 1994 Uniform Building Code (UBC), currently in effect for Hawaii, roofing materials must be designed to withstand a minimum 80 mph wind uplift. Although building codes are intended to provide only minimum requirements, many manufacturers cover even less, limiting warranty coverage to gale force winds (39 – 55 mph). Some manufacturers will void their warranty if the project is located within 10 miles of the ocean, without special approval from their technical service departments. Other manufacturers exclude warranty coverage for roofs in "wet areas."

Finding information about special installation requirements and warranty limitations may not always be straightforward. References are often vague or obscure. The product warranty may refer to the installation instructions, which may in turn refer to technical bulletins that are not normally available except by written request.

A knowledgeable product representative may be helpful in providing information, but be aware that most product representatives are not authorized by the manufacturer to provide technical opinions.

Some suggestions to provide quality assurance are: 1) Research the product requirements. 2) Provide the project description, location and warranty requirements to the product manufacturer, requesting written installation instructions. 3) Require the contractor to submit the roofing system manufacturer's review of Contract Documents and acceptance of applicator and warranty conditions.

Ultraviolet Radiation

With Hawaii's location near the equator, ultraviolet radiation is very intense. Honolulu, for example, has an average of 90 clear days and 174 partly cloudy days each year.

Ultraviolet degradation decomposes every organic material, such as bitumen, elastomers, thermoplastics, felts and more. Roofing materials must be protected from direct sunlight by the incorporation of UV absorbers or by protecting the surface using some form of durable covering material.

To be effective, protective granules and coatings must be completely opaque to ultraviolet light. If the short actinic rays of the sun (ultraviolet light) are allowed to pass through, UV degradation will occur as much as if the product were directly exposed to the weather.

Color selection is another consideration. Deep blue, red and green fade quickly in intense sunlight. Other colors will fade, but less noticeably.

Thermal Shock

Air temperature and solar radiation impose a heat load on the roof. Under intense solar radiation, a dark-colored roof can reach temperatures of 170 degrees F.

In tropical climates, precipitation is often characterized by light, cool rains of short duration, which may occur up to four or five times each day, despite sunny skies. When these showers contact the roof surface, they immediately drop the surface temperature to around 80 degrees F. Then, in 10 or 20 minutes, when the shower has passed, the surface temperature again climbs rapidly to 170 degrees F.

Rapid temperature changes can put tremendous stress on roofing materials and their connections. Never rely on mastics or sealants alone to maintain waterproof integrity. Attach metals securely using the correct number and placement of fasteners. A light heat-reflective foil or organic coating can reduce surface temperatures by 50 degrees F or more.

Vegetation, Fungus, Algae and Mildew

A common problem in the Pacific is falling coconuts. Although slate, tile and thatched roofs are more susceptible to impact damage, no roof is immune. During Hurricane Iniki, the damage from windblown coconuts was so severe, they were nicknamed Iniki cannon balls.

Banyan trees and other tropical plants are another problem. Since their shallow root structures require very little water, they grow in any space that has accumulated dirt and a little moisture. Plant roots can penetrate felts and flashings, providing a path along which water can travel. When the plant dies, it leaves a large opening through which water and insects can enter.

Clogged gutters are ideal for growing vegetation. Make sure gutters have adequate slope to ensure proper drainage and are regularly maintained.

In wet areas, wood shakes and shingles have a limited service life due to moss and mildew growth, while in dry areas, the wood oils bake out. Regular cleaning and treatment with boiled linseed oil coatings or proprietary treatments help prolong the life expectancy of wood shingles and shakes.

Glazed roof tiles are recommended because their smooth surfaces discourage mildew and fungus deposits from forming. Since concrete tiles are not fired and thus cannot be "glazed," concrete tiles are topped with colored slurry and acrylic spray. This high gloss finish may degrade and lose its sheen over time.

Algae staining is primarily an aesthetic problem on asphalt shingles. Although algae growth does not structurally damage the roof, it looks unsightly and the dark stains absorb more ultraviolet light than light-colored shingles. This can increase the heat build-up in the attic, resulting in higher air conditioning cost if the attic space is not well ventilated. Algae can feed on inorganic materials such as calcium carbonate, a filler used in the manufacture of asphalt shingles. Ceramic coated, algae-inhibiting granules are available, but not used on all shingle products.

Termites, Insects and Animals

Just because wood is off the ground doesn't mean it isn't susceptible to termite damage. Termites have been known to nest in roofs on top of skyscrapers.

Wood purlins, battens and plywood roof sheathing must be treated with preservative to prevent termite damage. Wood shingles and shakes should also be termite treated with preservative. Oil-borne preservatives are usually recommended for wood exposed to the elements, while waterborne preservatives are recommended for concealed wood.

Rats, bees, wasps and other insects and birds will seek out openings in roofs and create nests; therefore, eave closure strips or "bird blocking" is recommended for use on the open ends of roofing tiles.

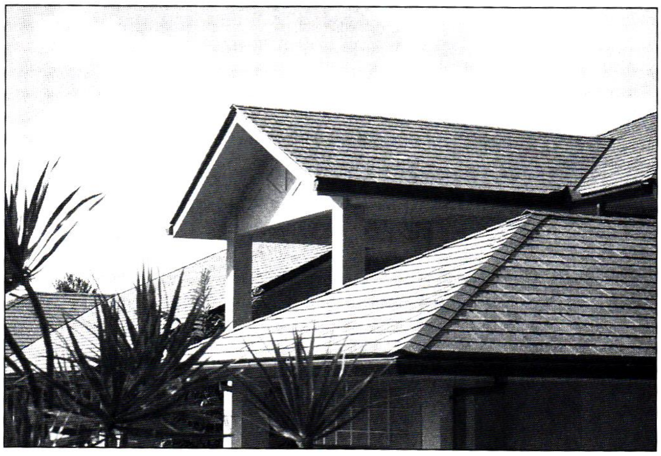
Miscellaneous

Other important factors which should be considered are:

- The remoteness of location
- Local stock of materials
- A local manufacturer's representative, who is knowledgeable and conscientious
- The availability of qualified, experienced installers
- A history of successful experience at that location or similar environment

Roofing products, for the most part, must be brought to our islands via ship. This can contribute to long lead times and added expense for additional parts or materials overlooked in the original order or damaged during transit. The importance of local stock cannot be overemphasized.

STEEP-SLOPE ROOFING MATERIALS



Thatched Roofing

A discussion of steep-slope roofing in the Pacific Rim would not be complete without a mention of thatched roofs. Thatching is the oldest type of roofing, using primarily reeds, straw, flax, heather or palm leaves as the main element.

Like most steep-slope roofing materials, thatch is applied in courses starting at the eave and layered upward, similar to shingles. For proper drainage of the roof, the minimum recommended slope is 44 degrees. A nominal thickness of 14 inches or more will provide an insulation rating R value of 30, providing warm interiors in cool weather and cool interiors in warm weather. Although installation methods have changed little since the system was first used, there are now licensed thatching authorities certified in the craft.

Although accepted by most building codes when properly treated for fire resistance, thatch is not always accepted by the public because of the fear of fire, thereby limiting its use. (See testing guidelines in UBC Standard 15-2 and UL fire-resistance test for roof-covering materials, UL 790.) The primary uses today are historical renovations and custom decorating of resorts and restaurants.

Corrugated Metal Roofing

Because of cost and availability after World War II, corrugated metal became a popular steep-slope roofing material on many Hawaiian Islands and in the Pacific Rim. At the end of the war, the military left large quantities of this material in the Islands and residents used it for building materials. Because it withstands heavy rains and winds, it is still used.

Since more modern metal roofing systems in large part have replaced this material, its primary use today is not for roofing. For more information about this material, consult your local supplier for proper procedures.

Slate Roofing

Slate offers a roof that is permanent and fireproof, has a dark non-fading color and a variety of patterns, and needs relatively no maintenance. Slate is expensive, especially considering the cost of freight and the amount of breakage normally experienced, and requires a strong roof structure to carry its weight.

The National Slate Association (NSA) issued the standards for slate roofing in 1925. The association no longer exists but the standards are still as valid as when they were written. The association also published *Laying Slate*, which describes in detail the proper installation of slate roofs.

Slate is appropriate for roof slopes of 4:12 and steeper over a nailable deck. A membrane underlayment is required, usually a minimum of one ply of Type II roofing felt. Considering the high winds and heavy rains often encountered in the Pacific Rim, a self-adhering, polymer-modified bitumen membrane, ASTM D1970, should be considered.

Valleys are formed by two methods. The open valley leaves a channel of the metal flashing exposed. The closed valley covers the metal flashing, often in a "round" or "canoe" profile. The open valley is the most trouble-free.

Flashings should be selected as carefully as other roofing materials. The first consideration is durability. It would be poor economy to use an inferior flashing with a roof as permanent as slate. Flashings appropriate to coastal environments are copper, lead and zinc.

Roof Tile

Standards

Roof tile is defined as units, typically clay or concrete, which comply with UBC Standard No.15-5, 1994 edition. The code requires testing for water absorption and transverse breaking strength. Barrel-shaped or "S" tiles having a minimum rise-to-width ratio of 1:4 must have an average breaking strength of not less than 400 pounds with no single load less than 350 pounds. All other non-barrel-shaped tiles must have an average breaking strength of not less than 300 pounds for five consecutive samples or 250 pounds for any individual sample. For water absorption, not more than 15 percent of the tile's dry weight is permitted.

Clay Tile

Terra cotta roof tiles have protected homes for thousands of years. Clay roof tile is selected for its beauty, long life, durability, weatherability and range of colors and blends.

Terra cotta is a natural clay material mined from deposits in the earth and processed into roofing tiles. The bulk clay material has small amounts of water added to allow for shaping by extrusion or pressing into various shapes. The tiles are dried in drying bays and fired in ovens to remove all moisture. After slow cooling, they are sorted and defective products are removed. The tiles come out a natural earth tone or body color. For a colorful glossy finish, a second firing with a glaze is required.

Concrete Tile

Extruded roof tiles are interlocking elements with various dimensions and configurations. Accessory tile units are used for ridge, hip and gable areas. Concrete tiles are composed of Portland cement, sand and water mixed in varying proportions. These materials are mixed and extruded on individual molds under high pressure to form the tile. Tiles are stored in conditions to reach a required strength prior to shipment. Concrete tile can be classified into two types:

- Roll Tile:
  1. Pan and cover shape (barrel/mission)
  2. S-shape (Spanish S) tiles
- Flat Tile:
  1. Flat shake or slate-shaped till with interlocking waterlocks
  2. Flat ribbed-shaped tile with interlocking waterlocks
  3. Tile with a small roll centered in the tile with interlocking waterlocks

The exposed surface is generally finished with a cementitious material colored with processed oxides (slurry coat). Alternately, process oxides are mixed integrally with the tile mix to produce a through-colored product. The use of each particular coloring type is dictated by several different requirements. The first of these relates to cosmetic and aesthetic appeal. The slurry-coat product offers a wider variety of vibrant color hues, while the through-colored product is more subdued in appearance and has a limited color range.

Application requirements for both product types relate primarily to atmospheric and climatic conditions as well as aesthetic and architectural intent. Experience has shown that the surface-coated product is more resistant to growth and discoloration caused by moss and lichen in tropical, high-rainfall areas. However, the through-colored product is more resistant to color fading due to ultraviolet oxidation.

In addition, if structural support is a concern, lightweight concrete tiles are available. These tiles are produced with lightweight aggregates. The dry weights of installed tiles with the minimum required headlap of three inches range from 5.8 pounds to 10.3 pounds per square foot. Lightweight tiles are available in various profiles and have the color option of slurry coat or color-through.

Concrete tiles are used on pitched roofs where appearance, durability, low maintenance and a Class A fireproof rating are desired. The minimum allowable pitch is 3:12. Roof slopes below this minimum require approval of local building officials, with the tile being used strictly as ornamental material installed over a built-up roof.

Most concrete tiles carry a 50-year limited warranty and have been installed in Pacific Rim projects for over 70 years. The product has demonstrated an ability to withstand and perform through the harsh climatic conditions prevalent in the Pacific.

Metal Tiles and Shingles

More than 30 years of research and development have gone into the metal roofing tiles and shingles available today. They come in panels, typically 1-foot by 4-foot, and are deeply formed to resemble wood shakes or clay tiles. The forming stiffens the panels and makes them walkable.

Common advantages include light weight (which reduces framing costs), Class A fire resistance, longevity, high wind resistance, ability to remain weathertight after years of heavy service and insulating properties due to dead air space.

Steel Tiles and Shingles

Usually formed from 26-gauge galvanized steel, these are the most walkable and damage-resistant of the metal tiles and shingles. They are available in two finishes – stone chips, which provide a rugged appearance, and smooth acrylic or other special coating, which is shinier and stays clean in wet locales. The stone chip finish offers good fire protection. The weight is 140 pounds per square.

Steel tiles and shingles are attached with fasteners driven horizontally into wood or steel battens over solid or spaced sheathing. This allows the system to withstand strong winds. Some warranties state resistance to 120 mph winds.

The longevity of stone-coated steel tiles in Hawaii is well known. Many roofs installed in the 1960s are still in place. Earlier products lost some of their stone chips, but now the chips are firmly held in place with modern epoxy and acrylic resins.

Standing Seam Metal Roofing

From the Bronze Age to the present, metal clad roofing systems have protected buildings from the severest weather conditions. Hawaii experiences 25 of the world's 27 climatic conditions, such as wind, humidity, torrential rain, high UV exposure and salt air. These will challenge any roof system.

New technologies have allowed a greater use of metal-clad roofing, including:

1. Introduction of machine-formable aluminum and steel versus the high cost of handcrafted gold and copper.
2. Development of protective coatings, improving performance over galvanized steel.
3. Development of totally reliable sealant technology to waterproof a variety of slopes and flashing details.
4. Provision of wind anchorage while accommodating thermal movement with clips designed to divorce the metal panel from the substrate.

Roll-formed trapezoidal and vertical rib panels with close tolerances are now taken for granted. Zinc-aluminum alloy coatings, used in coil production, are highly resistant to salt air, moisture and UV. Because zinc-aluminum is inorganic, UV breakdown doesn't occur. The galvanic action is ongoing, which helps reseal any breaks in the finish when the waterborne coating is washed into cuts, breaks or bends in the envelope, thereby inhibiting rust. With specialized coating formulas, the variety of surface or finish colors is unlimited. Most importantly, these finishes offer superior resistance to UV, surpassing standard paints' finishes.

Architectural (water-shedding, deck-supported) metal systems are steeply sloped and visible. In these cases, seams need not resist hydrostatic pressure. These panel systems are no longer through-fastened like older, corrugated-metal roofing panels, but use hidden clips to hold the panels to the deck or substrate.

For lower slopes, structural standing seam roofing is needed. Closures incorporate high-tech sealants, usually injected in the seam by the panel manufacturer. Floating clips anchor the panels against wind uplift, meeting UL test requirements, and permit nearly unlimited thermal expansion and contraction. With properly installed flashings, these systems resist hydrostatic pressures such as flooding or clogged drains.

Asphalt Shingles

Asphalt shingles have a 130-year history and are one of the most frequently specified roofing materials for residential and light commercial use.

Shingles are made of asphalt-impregnated and coated mat, usually fiberglass, which is surfaced with mineral granules. The sheet is then cut to particular patterns and bundled. The weight and length of warranty often categorize shingles. A 40-year dimensional, for example, is an asphalt shingle with a 40-year warranty, weighing as much as 365 pounds per square (10-foot by 10-foot area). The weight is a direct measure of quality and should be considered when specifying.

Fiberglass mats began dominating the industry in the mid-1960s. Early glass mats may have given asphalt-coated materials a thinner appearance and lighter weight, but the advent of fiberglass-based products boosted asphalt roofing products' performance in thermal stability, durability and fire resistance. Most asphalt shingles therefore achieve UL class A Ore rating. On steep slopes, fire rushes up the incline, devouring asphaltic materials with lesser felts and improper ceramic granule coatings.

New thicker profiles add a bold dimension to the shingles' appearance, creating the look of a wood-shake shingle. Another popular manufacturing technique to deepen a laminated shingle's appearance is shadow banding. The manufacturer applies a darkened band of granules to the shingle tab, giving the illusion of a shadow cast from a much thicker product than the actual shingle.

Wind uplift is an obvious concern. The 25-year or heavier shingle products are recommended to better withstand Hawaii's gale-force winds and intense UV light. Self-sealing asphalt-strip shingles are recommended for areas where wind velocities exceed 60 mph. Another alternative is double sealing shingles. Also, free-tab shingles (without factory-applied adhesives) can be cemented at each tab during installation or the number of nails on self-sealing products can be increased or both, improving wind uplift performance.

Modified Bitumen Shingles

A recent innovation is the use of "modified asphalt," rather than conventional oxidized asphalt, in the production of shingles. These modified shingles have improved weathering characteristics and greatly improved wind resistance, with some manufacturers offering warranties for winds up to 110 mph.

Roll Roofing

Although specified less frequently than in the past, roll roofing still has its place in Hawaii. Roof slope, coverage, wind conditions, budget and aesthetics are a few considerations when choosing the appropriate products.

Roll roofing is asphalt-impregnated, 90 pounds per square and packaged in rolls approximately 36 inches wide by 38 feet long. It is typically granule surfaced, which provides UV resistance and some color selection.

Roll roofing materials are applied in single-lapped layers, making it cost-effective. Properly chosen and applied, roll roofing can provide lengthy service requiring little or no maintenance and is easily repaired or recovered. As such, this method of roofing is most often found on garages, sheds and similar structures.

Fiber-Cement Roofing

Fiber-cement is the general name given to products produced with Portland cement, organic or inorganic fibers and, in some cases, lightweight aggregate.

Today, fiber-reinforced cement products are used in the construction industry as cladding and roofing materials.

They are easy to work with and can be made to match the general appearance of wood shakes and shingles, concrete and clay tiles, and slate. Relative cost, appearance, weight and attractive warranties are key factors in the rising popularity of fiber-cement products.

Fiber-cement products must comply with basic performance criteria to be approved for use by ICBO. These include wind uplift and fire rating, accelerated weathering, permeability, freeze/thaw and temperature cycling. NRCA recommends a minimum roof slope of 4 inches per foot; however, some manufacturers will allow application on lower slopes, if special precautions and underlayment configurations are followed. Applications over spaced or solid sheathing are allowed for most products.

Product warranties and guarantees should be carefully studied and completely understood before the product is specified or purchased. Some warranties state the product should not be used above a height of 40 feet for basic wind speeds over 80 mph within Exposure B, as defined by the UBC, while others exclude warranty coverage if the product is installed in a "wet" area.

In the recently updated fourth edition of the *NRCA Roofing and Waterproofing Manual*, concern is expressed regarding potential problems associated with some fiber-cement products exposed to severe wet-dry cycling. Although test data from the manufacturer may be helpful, there is no substitute for a history of successful performance of the product at that location.

In general, fiber-cement products are less impact resistant than wood shake. Special attention should be given to deck preparation and nailing instructions. Decks must be level, without ridges or obstructions. Fasteners must be carefully installed to prevent over or under driving.

Another issue is color. Some fiber-cement products are surface-coated to achieve specific colors, while others are mixed with inorganic pigments to provide color throughout the product. Although many fiber-cement products are marketed with long-term warranties (30 to 50+ years), the product's color and/or surface coating is typically not covered at all.

Foil-Laminate Shingles

Metal foil-laminate shingle products may be based on shingles manufactured with polymer modified asphalt or air-blown roofing asphalt (not modified with polymer). The metal foil is then laminated to the bituminous shingle base and may be copper, aluminum,or a resin-color coated metal foil.

Metal foil-laminate shingles are available as straight-butt three-tab shingles, fish scale, and round-shaped butts.

Like any shingle, metal foil-laminates are subject to wind uplift. In high wind regions, additional nailing should be required through the field, with double the normal number of fasteners at eaves and rakes.

Care should be taken to direct the runoff from some foil-laminate shingles (e.g., copper laminate) away from adjacent areas where staining is not desired.

Fluid-Applied Roofing Systems

Fluid-applied roofing is applied as systems, not just coatings. A system usually has more than one layer and is reinforced with either polyester fabric or fiberglass matting. For steep-slope roofing, the most widely used types are acrylic, urethane, or emulsion and alumination. Fluid-applied systems have been around for a long time but with the advancement of technology, new products are always being introduced.

In the Pacific Rim, one of the primary uses of fluid-applied systems is as a coating for older metal roofing systems that have started to deteriorate. Other applications are being found all the time, and with advancements in the industry this could become a primary material in steep-slope roofing.

Like other forms of roofing, the primary ingredients in fluid-applied roofing will affect how the system performs and must be checked carefully for aging, brittleness and the ability to withstand ultraviolet (UV) rays. The reinforcement is an important consideration. Because a roof will move under various conditions (i.e., expansion and contraction, wind, building settlement), the polyester fabric may work better than the fiberglass matting due to its elongation properties and ability to stretch in any direction. In areas where there is little movement, the fiberglass matting may be a better choice due to its high-tensile strength.

Fluid-applied roofing has other benefits. It forms a seamless membrane and has excellent adhesion characteristics, depending on the product. This is important when it comes to wind uplift. With a seamless membrane, the wind has nothing to "grab" and the adhesion of the systems far surpasses the wind-uplift requirements.

STEEP-SLOPE ACCESSORIES

Roofing Felts and Fabrics

Asphalt-saturated organic felt is the most popular felt for steep-slope roofing. Unlike glass-fiber felts, organic felts absorb asphaltic saturants to double their weight. This produces a "closed" sheet – without pores or perforations – that resists moisture penetration.

Felts used in steep-slope roofing fall into two categories: underlayment and interlayment. The 1991 UBC defines these as:

- Underlayment is one or more layers of felt, sheathing paper, non-bituminous saturated felt, or other approved material over which a roofing system is applied.
- Interlayment is a layer of felt or non-bituminous saturated felt, not less than 18 inches wide, shingled between each course of roof covering.

Asphalt-saturated organic roofing felts are typically available in two standard types:

Type I felt, commonly referred to as Number 15 felt, is available in three and four-square rolls (rolls that will cover three or four squares). Each roll is 36 inches (91.4 centimeters) wide and contains 108 or 144 lineal feet, respectively. Unperforated Number 15 felt is used as underlayment with shingles and other rigid roofing materials. Perforated Number 15 felt is used for asphaltic adhesion in built-up waterproofing and dampproofing systems and as a dampproofing membrane.

Type II felt, commonly referred to as Number 30 felt (unperforated), is available in two-square rolls. Rolls are 36 inches (91.4 centimeters) wide and contain 72 lineal feet (21.9 meters) or 216 square feet (20.1 square meters). Number 30 felt is used as a base sheet in built-up roofing systems and as an underlayment for tile and asphalt and asbestos shingles. An 18-inch half-roll of this product, called Shake Liner, is used for interlayment for shakes and other shake-like products.

Standards

ASTM's goal is to establish standards that ensure a minimum level of product quality. Two primary standards govern the quality and performance of asphalt-saturated organic roofing felts:

- ASTM D226: Originally published in 1925, this standard covers asphalt-saturated felt, primarily for built-up roofing and waterproofing.
- ASTM D4869: Published in 1988, this relatively recent standard governs the requirements for shingle underlayment.

All Felts Are Not Created Equal

Until the 1970s, felts were classified as either 15-pound or 30-pound, depending on the weight of the felt per roofing square (100 square feet). At that time the Bureau of Weights and Measures directed that a product must weigh 15 pounds at least 95 percent of the time to be called 15-pound felt. Rather than modify its production criteria, the roofing industry decided to change the product designation to No. 5 and No. 30 asphalt felts.

Originally, ASTM D226 required dry felt to weigh a minimum of 5.2 pounds per square for Type I felt and 10 pounds for Type II. The asphalt saturant had to weigh 6.2 pounds per square for Type I and 15 pounds for Type II, or a minimum saturation of 140 percent of the dry felt weight. Under D226, the finished product should weigh 12.42 pounds per square for Type I and 28.08 pounds for Type II, 95 percent of the time.

In recent years, however, the industry has increased its use of wastepaper in the manufacture of dry felt. Wastepaper is more difficult to saturate than rags and other ingredients. Under industry pressure, ASTM allowed the percent saturation to drop from 140 percent to 120 percent of the dry felt weight.

Then in 1988, again at the industry's urging, ASTM issued standard D4869 to specifically set standards for shingle underlayment. Under D4869 there are no longer references to No. 15 or No. 30. Instead, the new designations are Type I Shingle Underlayment and Type II Heavy Duty Shingle Underlayment.

Although D4869 does include some performance requirements, such as water resistance, it lowers the saturant requirement even further to 100 percent. With less saturant, these felts are more susceptible to wrinkling and other moisture-related problems.

So, what does a 15-pound felt weigh? In 1925, it weighed 15 pounds at least half of the time. If you specify ASTM D226, it should weigh a minimum of 12.42 pounds. Under D4869, however, it may weigh only 8.64 pounds. Felts that are non-rated by ASTM can weigh as little as 7.56 pounds or less, the average of some recently weighed products.

Sheetmetal Flashing

The importance of properly installing sheetmetal flashing on any type of roof cannot be overstated. While modern building materials may be waterproof, they do not remain permanently resistant to moisture. Because buildings shift and certain materials shrink, leaks are inevitable.

Unwanted moisture can enter the building's interior from any point on the roof where a seam, joint or connection is unprotected by flashing, damaging the interior, disintegrating mortar and masonry, and rusting steel spandrels, lintels and more. Counter flashing (or wall flashing), valley flashing and gravel stops (or other edge metals) are frequently installed for protection.

Counter flashing is used where the roof joins a wall, and turns water from the wall onto the roof. Counter flashing is used with composition base flashing and must keep water from entering the building and allow for building movement. It is strongly recommended that base flashing be applied over a cant strip and extended up the wall a minimum of 10 inches above the roof line, and that a minimum of four inches is covered by the counter flashing.

Valley flashing is used to protect the valley on shingle, slate and tile roofs. The open portion of the valley should be a minimum of five inches. The edges of the valley should be formed with a hook edge, cleated on 2-foot intervals and lapped 8 inches in the direction of the flow, while the top of each section fastened with nails of material compatible with the flashing. Copper (minimum of 16 oz.) or stainless steel (minimum of 26 gage) is recommended material for valley flashing, but painted galvanized (minimum of 24 gage) can be used when the expected life of the roof is less than 15 years.

Gravel stops (and other edge metals) are used on the perimeter, rakes and eaves of the roof, directing water in a certain direction or away from the wall. An edge metal should be a minimum of 4 inches by 4 inches, with a minimum of 4-inch laps, although 6 inches would be ideal.

When installing flashing, caulking should be used under the flashing before attaching it to the roof. A bead should also be applied along the seam after placing the flashing, to prevent water from leaking under the flashing.

Gutters & Downspouts

Once the roof type has been determined, careful attention must be paid to the roof drainage system. When selecting system, make sure to consider the area to be drained, the size of gutters, downspouts and outlets, the slope of the roof, the type of building, and appearance. Whatever system is chosen, all fabrication and installation work should be done in accordance to SMACNA standards and specifications.

When calculating the roof area to decide the size of gutter and downspouts, remember that rain does not always fall vertically, but rather at an angle. To determine the design area of a pitched roof, follow the chart in the SMACNA sheet-metal manual.

The gutter system's appearance also should be considered. In steep slope applications, the two choices are custom rectangular gutter designs and roll-formed seamless gutters.

The custom rectangular gutter is hand-fabricated and installed in 8 to 10-foot sections. The minimum ratio of the depth to width should be three to four. Gutters should be properly supported with hangers and support brackets with enough strength to remain intact when full of water. When selecting the gutter material, consider cost, similarity of metals between gutter, flashing, roofing and appearance. The most common materials for custom rectangular gutters are copper, galvanized and vinyl or PVC.

Roll-formed seamless gutters are fabricated on the jobsite in custom lengths, and have a smooth appearance. Seamless gutters are available in 5, 6, 7, and 8-inch widths measured by the girth or by top opening. Although gutter can be fabricated to extremely long lengths, expansion joints with 2-inch laps should be placed every 50 feet. All gutter joints – at corners, elbows, outlet connections and expansion joints – need to be caulked and riveted for aluminum gutters and soldered for copper gutters.

Roofing Ventilation

Roof vents are used to reduce the temperature in the attic (or crawl space) between the roof and the ceiling. An unvented attic space becomes considerably hotter (by up to 30 degrees) than the living area on a sunny afternoon. This energy then radiates through the ceiling into the living area. With proper venting the living space will be cooler, and cooling bills will be lower. Roofing materials are also likely to last longer over vented attics.

The shape, size and location of vent openings affects the airflow. Since increasing the air exchange rate is the principal function of attic vents, vent performance hinges on aerodynamics and resistance to airflow. Net free-area calculations give a rough indication of a product's performance in these areas and offer a simple basis of comparison. Capacity, location and distribution of vents over the roof area are important factors; roof pitch and attic size will also affect overall system performance.

Active vent systems are also available, and provide the additional venting necessary in our semitropical environment. Electric exhaust fans are an option, either photovoltaic-powered or connected to the building's power supply. Variable-speed photovoltaic units offer the advantage of working harder during the hottest part of the day. As with passive ridge vent systems, adequate soffit vents are necessary to provide make-up air.

STANDARDS & COMMON PRACTICES

Fire and Wind Performance Ratings

Two of the most important performance criteria for roofing products – aside from keeping out weather, moisture, heat and cold – are fire and wind resistance. Under the UBC, roofing products are required to have a fire and wind-resistance rating.

Fire Resistance

Underwriters Laboratories Inc. (UL) has been testing and classifying roofing products for fire performance for over 80 years. The results of these tests are used to demonstrate compliance with building codes. Only one standard test method is applicable to steep-slope roofing products: UL 790.

While UL initially developed the test protocol, any ICBO-approved laboratory might perform the test using the established test procedures. The UL 790 standard has been widely accepted in the industry and has been adopted by agencies such as ASTM, UBC and NFPA.

Standardized tests measure distinct characteristics, under uniform conditions. Materials and construction methods required for appropriate performance may not be the same for all products. Therefore, it is important to know what rating is required and to be sure that the proper materials are installed correctly. Even small changes can lead to large differences in performance.

Roof-covering materials and systems that comply with UL requirements are identified in UL's *Building Materials Directory* or *Fire Resistance Directory*. Products that conform to these requirements are entitled to bear the UL mark on each piece or package.

UL 790

Roof coverings protect buildings from fire exposure. This might include flying, burning embers from a distant fire or flames from adjacent structures. The ability of a roof-covering material to resist spreading fire or fire penetration is investigated by UL Standard 790, "Tests of Fire Resistance of Roof Covering Materials." UL 790 evaluates roofing-component assemblies for resistance to fires originating on a building's exterior. These tested assemblies are classified as Class A, B or C based on their ability to resist fires of varying degrees of severity. Reference to such assemblies is found in UL's *Building Materials Directory* under the headings, "Built-Up Roof Covering Materials" and "Prepared Roof Covering Materials."

Under "Prepared Roof Covering Materials," the listing for each manufacturer indicates the type(s) of products covered. It also specifies restrictions, such as minimum thickness of plywood or special underlayment systems.

Wind Performance

The wind performance of steep-slope roof-covering materials has become controversial. The International Conference of Building Officials (ICBO), which publishes the UBC, endorses the ANSI 7-88 test for establishing wind performance characteristics. However, this standard is inappropriate for segmented roofing products, which make up the majority of steep-slope roof coverings.

Since hurricanes Andrew and Iniki, consumer groups and insurance companies have pushed the industry to develop new test methods that better evaluate the performance of roof-covering materials in high-wind conditions. The leader in this area is the Building Department of Dade County, Florida, which has developed testing protocols for steep-slope roofing products. The Dade County Protocols, specifically 102 and 103, apply to steep-slope roofing products and are gaining acceptance within the industry, although they are not yet adopted by the ICBO.

Reroofing Guidelines

If a roof is beyond repair or maintenance, reroofing is required. It is imperative that a qualified individual evaluate the roof's condition and include all necessary criteria in the specification to replace the roof system.

When Removing an Existing Roof:

1. Determine number of roofs, retrofitted roofs or existing layers by sampling representative areas of the roof system(s).
2. If two or more roofs already exist, remove roofing to the deck because:
   A. Weight may affect structural integrity.
   B. Recurring problems hidden by existing roofs may cause additional problems.
   C. Building code requirements necessitate it.
3. Check existing roofing system materials for degradation, embrittlement and moisture contamination. Remove materials that fall apart or crack when disturbed.
4. Check the asphalt-shingle roof system(s) attachment. If the existing roof system's attachment is questionable, mechanically fasten the new felt and/or shingles through the existing system to the structural deck, using appropriate length fasteners, provided there are no more than two roof systems.
5. Check existing details (penetrations, curbs, window and

doorsills, etc.) and the dimensions between the roofing system height or thickness. Compare with industry standards or manufacturers' recommended details.

6. Check for moisture, wood rot, corrosion, decay or dry rot of substrate or deck materials. Repair or replace where required.
7. Determine roofing budget and system longevity.
   - A. Available funds or financing are sometimes the only criteria, but remember, you get what you pay for.
   - B. For a durable and/or warranted roof system, and to minimize the risk of damages, use better materials with additional layers for added redundancy and reliability; use additional fastening or other measures to increase wind resistance and have a good maintenance program.
   - C. Check life expectancy required by owner and specify a conforming system and warranty. The amortization of initial cost may result in annual cost savings.
   - D. Some products provide more protection than the criteria outlined in building codes.
   - E. The lowest bid from a contractor may dictate the budget, but beware of proposals that include insufficient criteria to do the job correctly or to meet owner, insurer, and code manufacturer requirements.
8. Roofing system warranties are documents designed to outline the limits of liability accepted by the manufacturer. Sometimes vague and confusing, they usually provide for leak repair or material replacement but do not pay for damages to the building or contents. A surety backs some warranties or the manufacturer maintains a warranty repair fund. Various types of warranties, some free and some at additional cost, are:
   - A. Material only: Warrants fitness of merchantability and the absence of defects. Provides for replacement of material or reimbursement of material's original cost but not the labor to replace it.
   - B. Pro-rated material: The same as A, but worth less as time progresses.
   - C. Material and labor: Warrants material performance (not contractor workmanship) and the labor to replace the material. It's usually subject to a dollar amount limitation known as "penal sum."
9. Performance requirements or standards: May be included in the specifications to limit the inclusion of roofing products or systems with unacceptable characteristics, warranties, potentially unreliable contractors, etc. Be aware of "or equals" that may not meet all of your design or performance criteria. Standards a manufacturer or contractor are required to meet or exceed are:
   - A. ARMA Standards
   - B. UBC
   - C. Metro-Dade
   - D. Underwriters Laboratory testing
   - E. A minimum number, such as 10 satisfactorily-completed projects in the area installed for at least five years, may help determine the reliability of a contractor or manufacturer, with the exception of new modified asphalt shingles.
   - F. Require the contractor to provide a performance bond.
10. Building height, location and accessibility may dictate wind resistance requirements.
11. Consider roofing and asbestos-containing materials (ACM) removal.
    - A. High cost of asbestos removal may warrant emphasis on encapsulation or deviation from a normal reroof procedure.
    - B. Roof tear-off presents additional risk and exposure to water damage.
12. Take necessary action to overcome original construction deficiencies or defects and ensure conformance to manufacturer and/or industry standards. Compromise a deficiency only if there are no options and make sure everyone is aware of the condition.
13. Check flashings and counterflashings:
    - A. Ensure membrane terminations are sealed immediately after installation. Ensure sufficient covering of system terminations.
    - B. Ensure fabrication and installation follows SMACNA requirements.
    - C. Ensure appropriate type and number of fasteners.

Inspection Guidelines

Inspecting roofing materials, components and accessories as they are installed is important, since it is always less expensive to do the job right the first time than to do it over. Knowing critical times to be present and how to coordinate inspection is crucial to cost effectiveness and quality performance.

General guidelines for inspecting steep-slope roofing installations are:

1. Check the condition of the deck before beginning operations.
   - A. Make sure the deck is level and free of downs or slumps.
   - B. Make sure that all structural members are properly supported and attached. For reroofing projects, make sure old nails, felts and flashing materials have been removed.
   - C. Inspect the roof deck for damaged members or other structural defects. Rot and insect damage should be identified and repaired.
   - D. Make sure all penetrations through the roof are complete or their positions marked.
   - E. Measure to verify the correct spacing of battens and counter-battens.
2. Check the materials delivered against those listed in the specification. Tremendous variations exist among the quality of products available.
3. Measure the distance between the eave and ridge to determine the number and spacing of courses.
4. Check the installation of under and interlayments.
   - A. Make sure the correct number of plies is used.
   - B. Check overlaps at felt ends and sides.
   - C. Felt lines should be straight and parallel to the eave.
   - D. Measure the lines of the felt lines to verify their placement. Felt lines are sometimes misplaced during manufacture, resulting in spacing problems when laying the roofing material.
   - E. Make sure fasteners are properly placed.
5. Check the installation of metals and flashings.
   - A. Check step flashings and counter flashings to verify their spacing and attachment.
   - B. Make sure valleys are treated with correct underlayment and are secured.
   - C. Check to see that roof penetrations are properly sealed before installing flashings and jacks.
   - D. Make sure differing metals are properly separated to prevent galvanic corrosion.
6. Check the placement of the starter course.
   - A. Determine how architectural features and tie-ins should be handled.
   - B. Make sure starter pieces are correctly placed with side and overhang spacing.
   - C. Overhang spacing should be uniform. Proper placement of the starter and first course often determines the roof's appearance.
   - D. Check for the correct number and placement of fasteners. Make sure fasteners are not under- or over-driven.
7. Verify that patterns are followed and course lines remain straight. Snap a chalk line at least every four to five courses to verify spacing.
8. Check the attachment of hip and ridge pieces.
   - A. Make sure fasteners are long enough to penetrate securely into the deck and the number and placement of each fastener is correct.
   - B. Check that the correct numbers of felt plies are used to protect the ridge.
9. Check the roof's overall appearance.
   - A. Make sure courses and lines are correct.
   - B. Check that the roof has been cleaned of all construction debris, dust and dirt. Cementitious dust can stick to the surface of roofing material when exposed to moisture. Construction debris and nails can be washed into the ground or into gutters, where they clog downspouts.
10. Check surrounding grounds and landscaping to ensure all construction debris has been removed.
11. Before final payment to the contractor, make sure lien releases are completed for all suppliers and subcontractors.
12. If not previously delivered, make sure all warranties are received and executed.

SUGGESTED STANDARD SPECIFICATION SECTIONS

The following are suggested specification sections developed by many of the certified construction specifiers in the Pacific Rim. These specifications follow the *CSI 1995 MasterFormat* and *SectionFormat* developed by CSI. The *PageFormat* has been compressed to save space. They are set up to be edited for content and insertion of other special information. Special notes to the specifiers are indicated where special care or information is required. Follow these notes closely. A basic knowledge of the subject matter is required before attempting to specify any products. It is recommended that all specifications be done under the guidence of a Certified Construction Specifier (CCS) or with the help of a Certified Construction Product Representative (CCPR). These people have specialized education in the preparation of specifications and have been tested for this knowledge.

SECTION 07310
ASPHALT SHINGLES

PART 1 GENERAL

Specifier Notes. *This section includes installation of organic mat base or glass fiber felt base asphalt composition shingles, mineral granule surfaced, over sloped nailable roof deck surface, with flashings, and underlayment. This section can be edited to include vertical or near vertical (Mansard) shingle applications. This section does not include requirements for deck treatment for reroofing work with either the old roofing remaining in place or a complete removal.*

1.1 SECTION INCLUDES

A. Granular surfaced asphalt shingle roofing, underlayment, eave, valley, and ridge protection, metal flashings.

1.2 SUBMITTALS

Specifier Note: *Do not request submittals if drawings sufficiently describe the products of this section or if proprietary specifying techniques are used.*

A. Product Data: Provide data indicating material characteristics, and limitations.

1.3 DELIVER AND STORAGE

A. Deliver materials in manufacturer's unopened bundles or containers with the manufacturer's brand and name clearly identified.
B. Shingle bundle wrapping shall bear the label of Underwriters Laboratories, Inc.
C. Store shingles in accordance with manufacturer's printed instructions. Store roll goods on end in an upright position.
D. Keep materials dry, covered completely and protected from the weather.

1.4 QUALITY ASSURANCE

Specifier Note: *Utilize this article if referencing the NRCA Manual. The NRCA Manual does not address special proprietary shingle shapes or configurations.*

A. Perform work in accordance with NRCA Steep Roofing Manual.

PART 2 PRODUCTS

2.1 ASPHALT SHINGLES

Specifier Note: *Refer to Honolulu Chapter CSI Building Products Directory for assistance in selecting manufacturers. Verify code requirements for use of Class A or Class C shingles.*

A. Manufacturers:
1. [______________________________] Product [________].
2. [______________________________] Product [________].
3. [______________________________] Product [________].
4. Substitutions: In accordance with Section 01600.

Specifier Note: *Select one of the following two paragraphs. The weights noted are net shingle weight, not installed coverage weight. If proprietary specifying, the weight statement may be redundant and unnecessary.*
If the option to select the ASTM D225 standard is used, delete reference to the shingle weight as the standard identifies the required weight. Note that the Type II shingle is a tapered thickness shingle; the referenced weight is the average weight.

B. Asphalt Shingles: [ASTM D225, Type [I uniform non-uniform thickness] [II thick butt, square tab, strip] [III uniform or non uniform thickness]; [UL Rating of C and Wind Resistance Label,] organic felt base, mineral granule surfaced type; [95] [90] [___] lb/100 sq ft ([4.6] [4.3] [___] kg/sq m) weight; [standard] [interlocking] [self sealing] [_______] type; [square] [hexagonal] tab; [_______] color [as selected].

****** [OR] ******

Specifier Note: *In the following paragraph, if the option to select ASTM D3018 or ASTM D3462 standard is used in lieu of proprietary specifying, the shingle weight may need to be identified.*

C. Asphalt Shingles: [ASTM D3018, Class A with Type [I - Self Sealing] [II - Non-self Sealing] [ASTM D3462]; [UL Rating of A and Wind Resistance Label,] [organic felt or glass fiber] [glass fiber] mat base, mineral granule surface type; [95] [90] [____] lb/100 sq ft ([4.6] [4.3] [____] kg/sq m) weight; [standard] [self sealing] type; [square] [laminated overlay] [staggered edge butt] [________] type; [________] color [as selected].

2.2 SHEET MATERIALS

Specifier Note: *A wide variety of weights are available; consult local available products.*

A. Roll Roofing: Asphalt saturated roll roofing; [40] [55] [____] lb/square ([1 943] [2 666] [____] kg/sq m) surfaced on weather side with mineral granules of [________] color [same as shingles] [as selected]; [________] manufactured by [________].
B. Underlayment: [Cellulose fiber building paper, water repellent breather type] [No. 15 unperforated asphalt saturated felts] [4] [____] mil ([0.025] [____] mm) thick translucent polyethylene film; [low] [standard] permeance type].

2.3 ACCESSORIES

A. [Nails:] [Staples:] Standard wire shingle, [hot dipped zinc coated steel] [stainless steel] [deformed shanks] [________] type, of sufficient length to penetrate roof sheathing.
B. Plastic Cement: Asphalt type with mineral fiber components, [________] manufactured by [________].
C. Lap Cement: Fibrated cutback asphalt type, [________] manufactured by [________].

2.4 FLASHING MATERIALS

Specifier Note: *A 1.25 oz/sq ft (380 g/sq m) coating should be a minimum galvanizing coating for exterior applications.*

A. Sheet Flashings: As specified in Section 07620 - Sheet Metal Flashing and Trim.

****** [OR] ******

B. Sheet Flashings: ASTM A361; [24] [26] [____] gage ([0.60] [0.50] [____] mm) thick steel with minimum [1.25] [____] oz/sq ft ([380] [____] gm/sq m) galvanized coating [; prepainted with [________] color [as selected].

****** [OR] ******

C. Sheet Flashings: ASTM B209; [0.03] [____] inch ([0.76] [____] mm) thick [stucco embossed] aluminum.
D. Bituminous Paint: Acid and alkali resistant type; black color.

2.5 FLASHING FABRICATION

Specifier Note: *Delete this article if specifying flashings in Section 07620.*

A. Form flashings [to profiles indicated on Drawings, and] to protect roofing materials from physical damage and shed water.
B. Form sections square and accurate to profile, in maximum possible lengths, free from distortion or defects detrimental to appearance or performance.
C. Hem exposed edges of flashings minimum [1/4] [____] inch ([6] [____] mm) on underside.
D. Apply bituminous paint on concealed surfaces of flashings.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that plumbing stacks and roof penetrations are flashed to deck surface.
B. Verify deck surfaces are dry, free of ridges, warps, or voids. Broom clean surfaces.

3.2 INSTALLATION - PROTECTIVE UNDERLAYMENT

A. Place one ply of underlayment with ends and edges weather lapped and nailed. Stagger end laps of each consecutive layer.
B. Install perpendicular to slope of roof.
C. Weather lap and seal watertight with plastic cement, items projecting through or mounted on roof.

3.3 INSTALLATION - VALLEY PROTECTION

Specifier Note: *Select the first Paragraph A for roll roofing or the second Paragraph A for sheet metal. Edit the statements to suit the material specified.*

A. Place one ply of roll roofing centered over valleys. [Place with mineral surfaced side down.] Weather lap joints and nail in place.

****** [OR] ******

B. Place one layer of sheet metal flashings, minimum [24] [____] inches ([600] [____] mm) wide, centered over open valleys and crimped to guide water. Weather lap joints and nail in place.

Specifier Note: *Select the first Paragraph B following for an exposed valley, the second Paragraph B for a closed cut valley, the third Paragraph B for woven valley protection.*

C. Apply a band of lap cement along each edge of first [ply] [layer] and embed ply of roll roofing centered. [Place with mineral surface side up.] Press into cement to encourage bond and nail in place.

****** [OR] ******

D. Extend shingles on one slope across valley and fasten. Trim shingles from other slope to achieve closed cut valley, concealing the valley protection.

****** [OR] ******

E. Extend shingles on both slopes across valley in a weave pattern and fasten. Extend shingles beyond valley center line to achieve woven valley, concealing the valley protection.

3.4 INSTALLATION - METAL FLASHING

A. Weather lap joints and seal weather tight with plastic cement. Secure in place with concealed fastenings.

B. Flash and seal work projecting through or mounted on roofing with plastic cement, weather tight.

3.5 INSTALLATION - ASPHALT SHINGLES

A. Install shingles in accordance with manufacturer's instructions.

B. [Provide [double] [triple] course of shingles at eaves.]

C. Place shingles in [straight] [________] coursing pattern with required weather exposure to produce [double] [triple] thickness over full roof area.

D. Project first course of shingles [3/4] [____] inch ([19] [____] mm) beyond eave boards.

E. Extend shingles [1/2] [____] inch ([13] [____] mm) beyond face of gable edge fascia boards.

F. Cap [hips] [and] [ridges] with individual shingles, maintaining weather exposure. Place to avoid exposed nails.

Specifier Note: *Use the following paragraph for roof slopes less than 4 in 12.*

G. After installation, place [one daub] [[____] daubs] of plastic cement, under each individual shingle exposed to weather, to prevent lifting.

H. Complete installation to provide weather tight service.

END OF SECTION

SECTION 07320
ROOFING TILES

PART 1 GENERAL

Specifier Note: *This section includes installation of formed clay, concrete, or metal roofing tiles over sloped plywood or wood roof deck surface, with or without horizontal wood battens, with moisture shedding underlayment, and flashings.*

1.1 SUMMARY

A. [Clay] [Concrete] [Metal] roofing tiles; underlayment, valley, rake, and ridge protection; nailers, metal flashings.

1.2 SUBMITTALS

Specifier Note: *Do not request submittals if drawings sufficiently describe the products of this section or if proprietary specifying techniques are used.*

A. Shop Drawings: Indicate specially configured metal flashings and joint locations.

B. Product Data: Provide tile properties, configurations, special shapes, and securement methods.

C. Samples: Submit [two] [_______] tile units, [____x____] inch ([____x____] mm) in size illustrating [color] [color range], surface finish and texture, exposure, tile configuration.

D. Details of fabricated custom shapes.

1.3 QUALITY ASSURANCE

Specifier Note: *The SMACNA Manual referenced in the following paragraph only addresses metal flashing work; not metal tile work.*

A. Perform Work in accordance with NRCA - Steep Roofing Manual and SMACNA Architectural Sheet Metal Manual.

B. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum [three] [_______] years [documented] experience.

1.4 WARRANTY

Specifier Note: *Improper specifying of warranty and correction period extensions may limit the statutory rights of the owner and the ability to enforce claims under the contractor's contractual warranty. The following paragraph extends the correction period beyond one year. An extended correction period adds to the construction cost and may not be enforceable.*

A. Provide a [five] [____] year warranty to include coverage for discoloring, fading, deterioration of pre-coated metal tiles; cover damage to building resulting from failure to resist penetration of water.

PART 2 PRODUCTS

2.1 ROOF TILE

Specifier Note: *Refer to Honolulu Chapter CSI Building Products Directory for assistance in selecting manufacturers.*
Make material requirements agree with requirements specified in the references indicated.

A. Manufacturers:

1. [________________________________] Model [________].
2. [________________________________] Model [________].
3. [________________________________] Model [________].
4. Substitutions: In accordance with Section 01600.

B. Clay Tile: [________] style; [__ x __] inch ([__ x __] mm) nominal size; form holes before firing; [one piece semi-circular] [two piece "S"] [________] profile; special shapes to suit valley, ridge, rake, eave, and other conditions; [[gloss] [semi-gloss] [matte] glazed] [unglazed] exterior surface finish, [________] color [as selected].

****** [OR] ******

C. Concrete Tile: [________] style; [__ x __] inch ([__ x __] mm) nominal size; holes provided for attachment; [one piece semi-circular] [two piece "S"] [________] profile; special shapes to suit valley, ridge, eave, and other conditions; [natural] [________] color [as selected].

****** [OR] ******

D. Metal Tile: [________] style, formed galvanized steel conforming to [ASTM A361;] [____] gage ([____] mm) thick steel with galvanized coating; [__ x __] inch ([__ x __] mm) nominal size; [one piece semi-circular] [two piece "S"] [________] profile; special shapes for valley, ridge, eave, and other conditions; pre-painted with [________] to [________] color [as selected].

****** [OR] ******

E. Metal Tile: [________] style, formed [stucco embossed] [________] aluminum conforming to ASTM B209; [0.03] [____] inch ([0.76] [____] mm) thick; [__ x __] inch ([__ x __] mm) nominal size; [one piece semi-circular] [two piece "S"] [________] profile; special shapes for valley, ridge, eave, and other conditions; pre-painted with [________] to [________] color [as selected].

Specifier Note: *Only use the following paragraph with clay or concrete tile.*

F. Mortar: Portland cement, sand and water to [____] psi ([____] MPa) strength, [____] color [to match tile.] [as selected.]

G. Tile Nails: [ASTM A555] Standard round wire stainless steel type, of sufficient length to penetrate through roof sheathing. [As recommended by NRCA.]

H. Wire Ties: [ASTM A580] Stainless steel, Type 302 or 304, minimum 0.029 inch diameter.

****** [OR] ******

I. Wire Ties: [ASTM B99] Copper, minimum 0.05 inch diameter.

J. Roll Roofing: [ASTM D249;] asphalt saturated roll roofing; [____] lb/square ([____] kg/sq m) surfaced on weather side with mineral granules of [________] color; [________] manufactured by [____________].

K. Underlayment: [Cellulose fiber building paper, water repellent breather type.] [[ASTM D226,] No. [15] [30] un-perforated asphalt saturated felts.]

L. Plastic Cement: [ASTM D2822;] asphalt type with mineral fiber components.

M. Lap Cement: Fibrated cutback asphalt type.

N. Deck Tape: [Aluminum coated cloth duct tape with adhesive backing.] [________.]

O. Wood Battens: Softwood lumber [________] species, as specified in Section [06114] [________]; [pressure preservative treated.]

2.2 FLASHING MATERIALS

A. Sheet Flashings: As specified in Section 07620 - Sheet Metal Flashing and Trim.

****** [OR] ******

B. Sheet Flashings: [ASTM A361;] [24] [26] [____] gage ([0.60] [0.50] [____] mm) thick steel with [galvanized coating.], [shop pre-coated] with [silicone polyester] [________] coating of [________] color [to match [________]].

****** [OR] ******

C. Sheet Flashings: ASTM B209; [0.03] [____] inch ([0.76] [____] mm) thick [stucco embossed] aluminum, shop pre-coated with [silicone polyester] [________] coating of [________] color [to match [________]].

D. Bituminous Paint: Acid and alkali resistant type; black color.

E. Flashing Nails: Standard round wire roofing type, [hot dipped zinc coated steel] [________].

2.3 FLASHING FABRICATION

Specifier Note: *Delete this article if specifying flashings in Section 07620.*

A. Form flashings [to profiles indicated on Drawings, and] to protect materials from physical damage and shed water.

B. Hem exposed edges of flashings on underside.

C. Apply bituminous paint on concealed surfaces of flashings.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify roof openings are correctly framed prior to installing work of this section.

B. Do not start installation until other trades requiring traffic on roof have completed their work.

C. Verify vent pipes and other projections through roofs and related flashing materials are in place prior to starting installation.

D. Verify deck surfaces are dry, free of ridges, warps, or voids.

E. Seal roof deck joints wider than [1/16] [____] inch ([1.5] [____] mm) with deck tape.

3.2 INSTALLATION - GENERAL

A. Install roof system in accordance with [NRCA requirements] [manufacturer's instructions] and [Section 07620] [SMACNA Architectural Sheet Metal Manual requirements].

3.3 INSTALLATION - UNDERLAYMENT

A. Place [one ply] [two plies] of underlayment over full roof area, with ends and edges weather lapped. Stagger end laps of each consecutive layer; nail in place.

B. Install underlayment [perpendicular] [parallel] to slope of roof; weather lap and seal watertight with plastic cement, items projecting through or mounted on roof.

C. Extend underlayment up six inches at abutting vertical surfaces.

3.4 INSTALLATION - VALLEY PROTECTION

A. Place one ply of [smooth] [granule] surfaced roll roofing, minimum [18] [____] inches ([450] [____] mm) wide, centered over valleys. Weather lap joints; nail in place.

Specifier Note: *Select the first paragraph below for sheet metal exposed or the subsequent paragraph for mineral surfaced roll roofing exposed.*

B. Place one layer of sheet metal flashing, minimum [24] [____] inches ([600] [____] mm) wide, centered over open valleys and crimped to guide water. Weather lap joints, nail in place.

****** [OR] ******

B. Apply a band of lap cement along each edge of first [ply] [layer] and embed ply of roll roofing, centered; [place with mineral surface side up.] Press into cement to encourage bond and nail in place.

3.6 INSTALLATION - METAL FLASHING

A. Weather lap joints and seal weather tight with plastic cement. Secure in place with nails.

B. Flash and seal work projecting through or mounted on roofing with plastic cement, weather tight.

3.7 TILE INSTALLATION

A. Install in accordance with [manufacturer's instructions.] [NRCA Steep Roofing Manual.]

B. Place wood battens of size and configuration to suit tile system. Place battens parallel to roof edge; notch to allow natural air ventilation.

C. Place tile square with building lines and parallel with roof slope. Place filler and closure pieces as required.

D. Secure tile by at least two nails, where practicable. Use copper or stainless steel wire fastening where nails are not used through tile. Cover nails and wire fastenings in finished work.

E. Place mortar with tile units, cut flush and tool exposed joints with tile unit.

F. Project tile [1/2] [____] inch ([12] [____] mm) beyond face of facia boards.

G. Complete installation to provide weather tight service.

3.8 CLEANING AND REPAIR

A. Upon completion remove any cement or mortar splatters from tile and adjacent surfaces.

B. Replace broken, cracked, or stained tile.

END OF SECTION

Roma Four-Seasons Blue, Kihei, Maui

AMP

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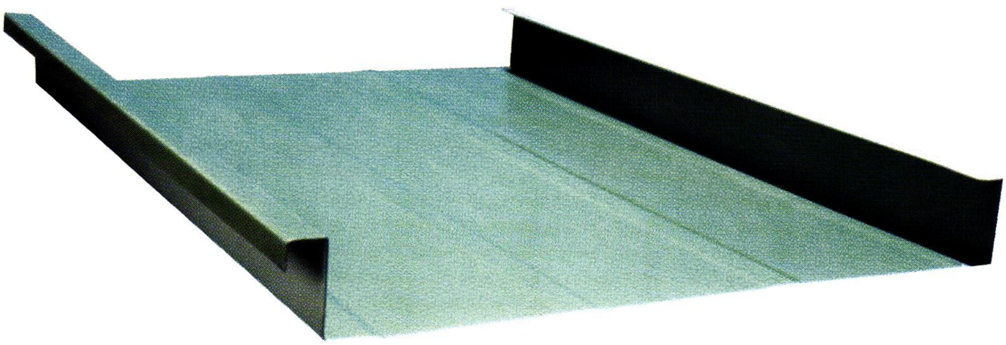
Ultra Seam Metal Roofing System installed by Ridgetop Hawaii, Inc.

Ultra Seam Concealed Fastener Metal Roofing Systems



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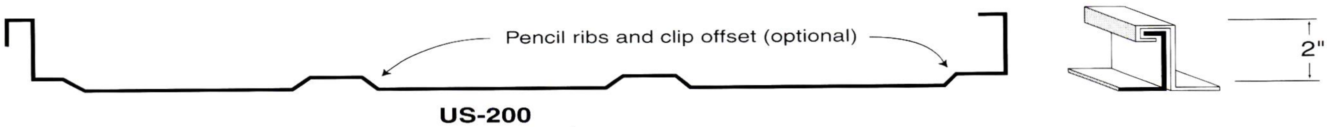


structures.

In the introduction to Yeang's latest book, *The Skyscraper Bioclimatically Considered,* (Academy 1996), he makes two significant statements:

"The global economy today is clearly increasingly aware of energy as a scarce resource; the need to conserve energy and design for a sustainable future is becoming imperative for all designers."

He continues, if *"the designer accepts the objectives of the bioclimatic approach – that is, to seek by design a low energy, passive building and better occupant comfort – as being vital issues ... we might contend that rather than complicating skyscraper design the bioclimatic approach will, in effect, simplify it."*

These statements summarize Ken Yeang's central mission, which given time will result in a truly ecological architecture. The significance of this cycle of exemplary work has important consequences for architecture, cities and the wider global environment. It is a mission which Dr. Buckminster Fuller would have respected, and it is increasingly vital that the principles of Yeang's architecture are properly understood by the global community of architects, designers and all those responsible for the procurement, maintenance and renewal of our built environment.

Ivor Richards is a professor of architecture at the University of Newcastle, United Kingdom, and has collaborated with Dr. Ken Yeang on several publications of Yeang's work.

Letter to the Editor

Dear Editor:

As Director, I have the opportunity to review and read through many journals of architecture that are sent to me from the United States and foreign countries.

I just received the July 1997 issue of *Hawaii Pacific Architecture* and it is one of the best editions yet produced by the Hawaii State Council. And, it is definitely one of the better journals produced by AIA components in the country. This is my opinion.

The graphical clarity and format is much improved, the content timely and informative. In fact, the inclusion of the *Pacific Rim Specifications Standards* is so very useful, that I am forwarding this information to the contractor on a Kapolei project I am working on.

I am pleased to see that *Hawaii Pacific Architecture* has matured to a thought provoking, scholarly journal on the practice of Architecture in our region. Please convey my sincere appreciation to the HPA Editorial Board for their vision and commitment toward making this journal one of the finest in the nation.

Sincerely,
Theodore E. Garduque, AIA
Director, Northwest and
Pacific Region

Cultural center connects to the scenery and needs of a small island microcosm

Peaceful Setting, Powerful Design

by Junzo Munemoto

Design possibilities are infinite in the field of contemporary architecture. Therefore, the design that results from assembling the various possibilities depends on the act of choosing and the way of thinking in a given environment.

Microcosmic Geography

Iki island, situated between Japan and the Korean Peninsula, has been preserved from industrial destruction and has remained enriched by its natural landscape. Most of the roads are curved and, not being able to see far ahead, one remains immersed in this landscape. Iki has no high mountains, few wide plains, and is made up of numerous bays and inlets. The actual project site is complicated, having terraced paddy fields in a range in level of about 15 meters. At the end of the site exists a spring known as Tokiwa Spring, which is still full of fresh water. It is difficult to imagine that this is the same spring described in *Iki Meishoezu*, a woodprint book of famous places in Iki compiled in 1861. That scenery was destroyed by the construction of a road. The geographical microcosm which existed in the prints of Tokiwa Spring in *Iki Meishoezu* is the image from which we planned this project.

Concrete was deemed the best construction material for design and budget purposes.

As there were no adequate roads approaching the site, we began with a new road plan for the town. The approach road helped develop the city by connecting the cultural center with the harbor supporting the residents' lives.

The road system and car-parking facilities on Iki are far behind. Considering this, we made use of changes in level for setting a 300-car parking area at a lower level and for creating an open space on an artificially raised level.

An Image of Scenery

Two design themes in the planning of this facility were to be followed. The first was to recognize the characteristics of the site and to connect this image with a water park named Tokiwa Spring Park situated to the rear of the hall. The second theme was how the cultural hall is involved in the scenery of the microcosm.

Intuition told us to read the structure of the scenery. To give impact to that derived form, the space should acquire a strong horizontal

Geometric forms add design interest to wall facades.

in the foreground. This arc gives a seal of the land's order to the scenery of the town. The top edge of this arc is meant to be a sharp bow of a ship. Through this arc, the open truss bridge is combined with the slope of Tokiwa Spring. The architectural vocabulary derives from the original land imaged as scenery and responds to the microgeography of Iki, producing a new microgeography as the scenery of the town.

Concrete Architecture

In an early stage, we decided to use concrete for creating this new microgeography. Given a limited budget, concrete was the best material to express simply the original image of the microgeography and to preserve the strength of the architectural concept. Apart from its external characteristics of smoothness and the feel-

axis, with contrasts of deep shade and light. The space should have the directness of the original image and sculpturesque quality characteristic of Greek classical architecture.

Our solution for combining the hall function and Tokiwa Spring was to separate the hall into two parts, a large hall and a small hall, creating a courtyard in between and connecting to the park on several different levels. This provides an interaction of spaces and creates a gentle play of levels on the site.

The features of the large eaves and vault roof emphasize the horizontal line. The assemblage of elements lying one on top of another is derived from the original image of the sea, while the large stairs facing toward Tokiwa Spring derive from the table-like land which originally existed. At the center of these elements and through the courtyard which diagonally cuts across the inclined slope to Tokiwa Spring, a large arc broadly divides the land. It sharply emerges from the stairs, echoing the lay of the flat land

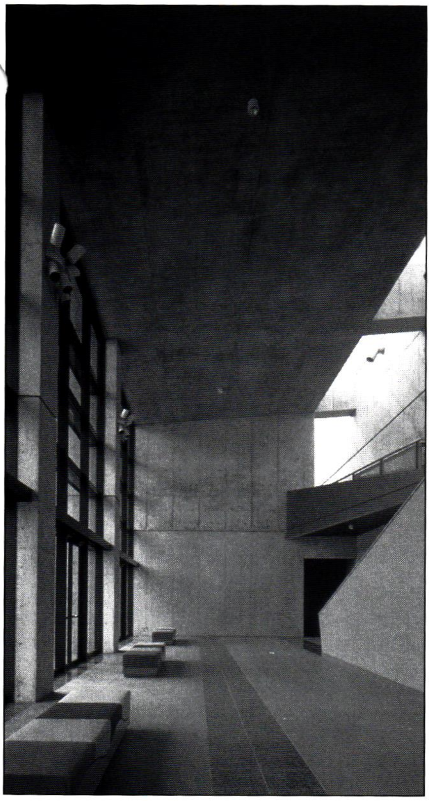
The stairs facing Tokiwa Spring echo the original geography of the area.

The "hyper-performance" hall was designed to accommodate concerts, conventions, meetings or lectures.

ing of texture, the material gives a subtle balance of heaviness and strain consistent with the original image. The strong intention of the architecture is exposed through the medium of light and shadow. The presence of glass and sash risks losing this strong spatial expression. Hence, in sticking to concrete as a means of expressionism, we were forced to seek other means in preventing dirt from rain drops and resisting strong winds in the case of typhoons. This led to the use of titanium sheeting and rust-preventive reinforcing rods.

A Gathering Place

Recently, progress in the specialization of hall design has been greatly advanced in Japan. However, for utilizing



High ceilings and clean lines add to the feeling of spaciousness.

such specialized halls to their full potential, a significant population base is required as well as a network of cooperation in order to manage the halls effectively. It is obvious these conditions could not be fulfilled on a small island with only 35,000 residents. Furthermore, there would be little use in providing a hall for one specific purpose.

After consultations with various groups of users, it appeared people thought a hall appropriate for conventions, meetings or lectures would be most useful. However, a concert hall was also desired. Considering diversified purposes and a limited budget, there was no alternative but to construct a multi-purpose hall for the area. Having isolated the basic purposes, we tried to remain faithful to the demands of specifically intended uses. We defined the basic purpose of the hall as a wide area space equipped with a service space, and then considered how the audience would listen to music or watch theater comfortably. Through extreme care, the hall acoustic performance achieved the level of famous concert halls.

As for the stage space and stage-related facilities, these specific demands could not be disregarded in the pursuit of a generic multi-purpose hall, as this would result in a compromised performance. We decided that the hall should not have to fulfill all possible demands but that it should limit its intended use, and we should follow that intention faithfully. The Iki Cultural Hall was constructed along these lines of thinking. We call the hall a "hyper-performance" hall, not multi-purpose. We believe this hall will be influential in the tide of constructing specialized halls and will be the hub of local cultural exchange.

Dr. Junzo Munemoto is a professor in the Graduate School of Engineering at the Department of Architecture and Architectural Systems, Kyoto University, Japan. He and RAUM Associates were architects of the Iki Cultural Center, completed in February 1996.

The University of Hawaii builds its Asia-Pacific focus

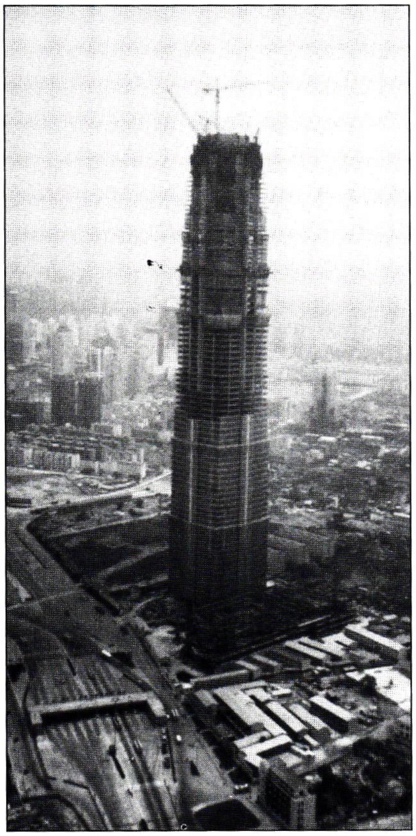
The Future is Asia

by Jamie Kemp

During a recent whirlwind visit to Taipei, Hong Kong, Bangkok, Shanghai, Beijing, and Sian in north-central China, Dean Ray Yeh of the University of Hawaii School of Architecture toured numerous projects and met with designers, clients and building officials. He also visited four national universities and met with the faculty and students in architecture. He returned to UH with a renewed commitment to further strengthen the Asian focus in the School of Architecture's academic program.

"It is important for an architect today to be able to work globally. The world is becoming much smaller and the marketplace is more reachable," Yeh said.

The UH School of Architecture already has one of the strongest off-campus programs of all architectural schools in the United States. Currently, about 14 students each year participate in overseas programs on study fellowships. However, it is Yeh's goal to increase that participation to 100 percent of the 30-plus students who graduate from the School of Architecture each year.



Ray Yeh toured buildings such as this project by Skidmore, Owings & Merrill in Pudong, Shanghai, which will be the world's tallest building when completed.

"I would like to eventually make it a school requirement that all students spend at least one semester overseas," he said.

According to Yeh, Asia offers tremendous opportunities for Hawaii architects. First, Asian countries are growing at remarkable rates. The 1.2 billion people in China alone provide a huge population base for infrastructure and building projects. This means jobs – jobs that are in short supply in Hawaii's currently flat economy. Even countries that have been accused of overbuilding, such as Singapore and Malaysia, are still growing at rates of 5 to 6 percent a year.

Second, projects in Asia are often great opportunities to support creative design ideas, which helps the designers to receive professional recognition.

Finally, Hawaii's ethnically diverse population and sensitivity to Asian culture create an environment that allows for effective cross-cultural communication. "We learn how to see things in a different way," said Yeh.

Numerous Hawaii architectural firms are already doing a significant portion of their business throughout Asia and many mainland firms consider the Asia-Pacific region their main focus. With the support of the dean and faculty, the UH School of Architecture is poised to make an important contribution to the architectural development of this world region.

Lessons learned in professional practice

"Street-Smart" Installations

by Andrew C. Yanoviak, AIA, APA, CSI

As essential building materials, flooring and wall covering are both included within Section 9 of the Contract Specifications. This data is established in AIA and CSI Specification Formats and the Architectural Graphic Standards. The contractor and subcontractors are given specific instructions by the architect and interior designer which incorporate installation system specifications from the product manufacturer as well as lessons learned in professional practice.

Fundamental to a successful installation is the preparation of the substrate. The final acceptance of the substrate is the responsibility of the specialty subcontractor, who may reject substandard workmanship produced by the general contractor or another subcontractor. If the specialty subcontractor or manufacturer's representative accepts the "as-is" substrate and subsequently blames the "substandard" substrate for an unacceptable installation rejected by the architect and/or owner, the recourse may involve extensive repairs with substantial project costs, delays and protracted disputes.

An alternative approach is for the specifications or project manual to require that the contractor prepare a model unit area or panel for inspection, acceptance and approval before proceeding further with the installation. Architects who are "street-smart" will ascertain that the Contract Specifications require that the contractor not only submit swatches of fabric or tile samples for approval, but also actual installation samples of the flooring or wall-covering material applied to a portion of the substrate for stringent quality-control purposes.

Even if the Contract Specifications do not require the contractor to protect his installation from damages by other trades during construction, many street-smart subcontractors will exercise this precautionary measure. Flooring materials can be protected with a plywood overfloor. Wall-covering materials can be protected with plastic until completion.

The Contract Specifications also generally require that the contractor supply the owner with extra materials after project completion for post-occupancy repair of damaged areas.

Continued on page 22

Award of Merit

Office, Commercial and Institutional

Okita Kunimitsu & Associates, Inc.

Japanese Cultural Center of Hawaii

The mission of this project was to create a cultural center to preserve and promote Japanese heritage in Hawaii. Okita Kunimitsu & Associates, Inc. achieved this challenge by designing a center with a blend of concepts of Zen, "the quiet way," and *shibui*, the Japanese aesthetic of understated elegance. To attain this combination, simple structures were made of concrete, utilizing heavy proportion and clean details to give the composition a sense of calmness, stability and strength. The design intent was further perpetuated in the decorative details and concealed lighting used along the major facades of the structure.

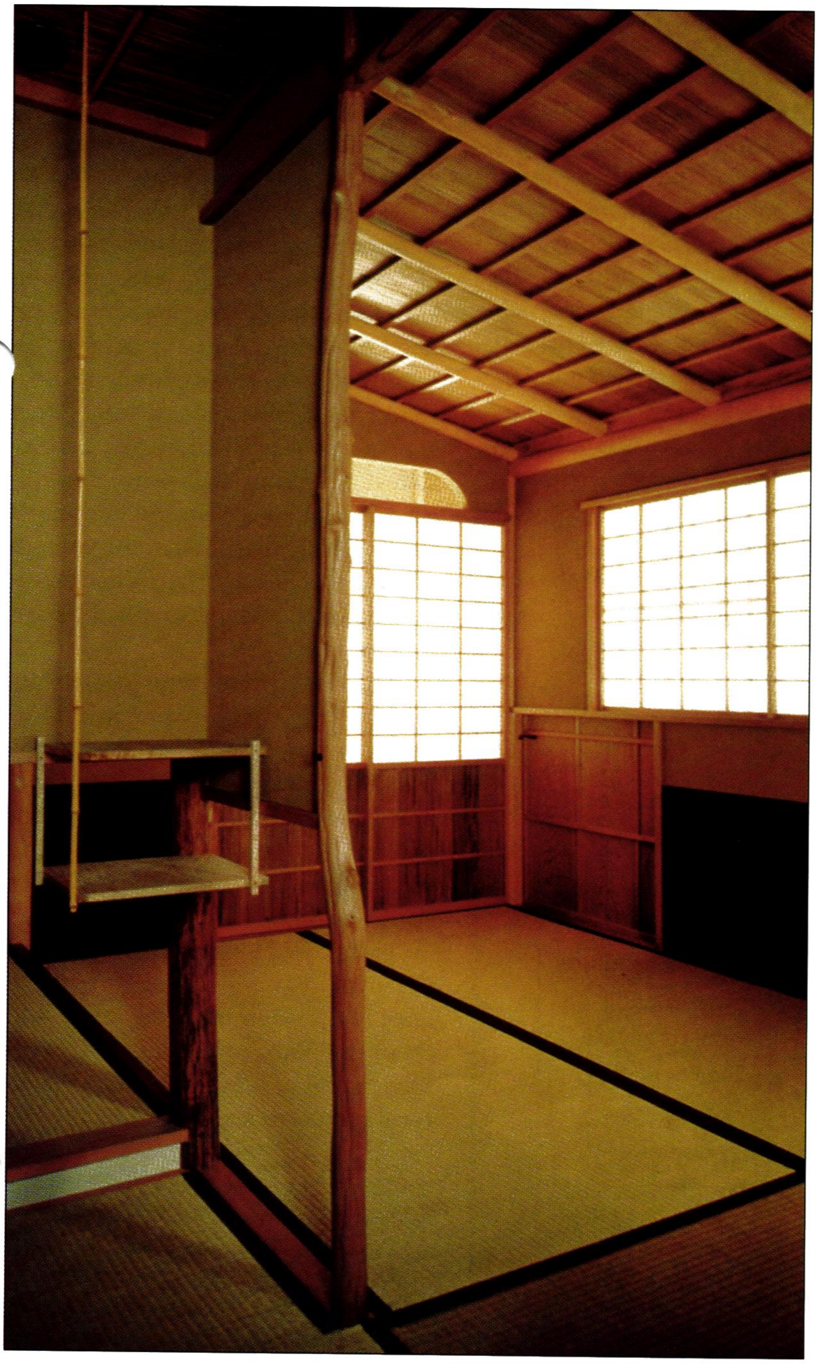
Japanese ornamentation and Hawaiian motifs were employed in the outdoor areas. A *seikoan*, or teahouse, and adjacent Japanese garden were created to emphasize the concept of building from the past to the future. Inside, a gallery containing historic memoribilia, a resource center, a *dojo* (martial arts practice room) and a banquet hall were built with the comfort of guests and the preservation of artifacts in mind. A 50-foot concrete bridge was completed to connect the separate facilities of the center.

The decorative aspects used in Phase II give the center the effect of a lantern (top), while clean details accent the ground floor arcade (above).

Jury's Comments:

"The interior and courtyard movements in this center were really inviting. Once beyond the exterior wall, almost all of the space here feels comfortable and genuine. A building designed to be used often and in a variety of ways — and all of them seem to work."

Simple, concrete construction was used in building Phase I and II elevations.



Credits

Owner/client:
Japanese Cultural Center

Architect:
Okita Kunimitsu & Associates, Inc.

Contractor:
Phase I: Robert Kaya Builders, Inc.
Phase II: Albert C. Kobayashi, Inc.

Consultants:
Civil: Wilson Okamoto & Associates, Inc.
Structural: SSFM Engineers, Inc.
Mechanical: Okahara & Associates, Inc.
Electrical: Ho & Okita, Inc.
Landscape: Miyabara Associates

The teahouse was assembled using traditional Japanese construction style and materials.

Sanders Offers Prefinished Bamboo

Sanders Trading Co., Honolulu, now offers Plyboo prefinished bamboo flooring in two colors, natural and amber, plus stair nosing, thresholds and reducer strips. Tambour panels for use as wall coverings, bamboo plywoods and a bamboo veneer are also available. For more information, call Sanders Trading Co. at 596-2303.

Plyboo bamboo flooring adds to the attractive tropical design of Hoku's restaurant at the Kahala Mandarin Oriental Hotel.

"Street-Smart" Installations

Continued from page 19

Many of these damages can be attributed to substandard daily custodial care, maintenance of mechanical or electrical systems, delivery services and furniture movers. These repeated building-usage abuses must be taken into consideration by design professionals.

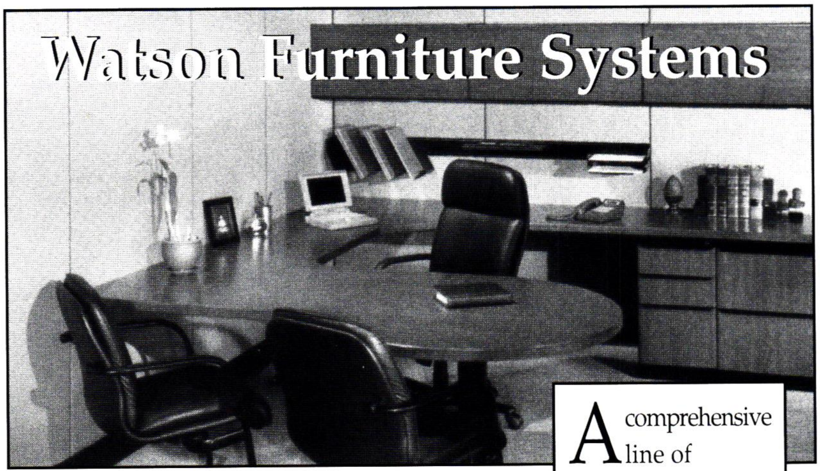
Other essential design considerations include environmental protection for users, especially indoor air quality, sick-building syndrome and chemical-sensitivity concerns attributed to outgassing of installation products including adhesives and substrate preparation materials. These are of special concern in hermetically-sealed occupied spaces with inoperable windows, inadequate mechanical ventilation systems or deficient design standards. Consequently, the Contract Specifications will call for bake-outs whereby the chemical outgassing process is accelerated prior to occupancy. Many operative regulatory controls and design guidelines also need to be utilized in a successful project with due concern for the health and safety of occupants.

There are some aspects of the installation of flooring or wall-covering materials over which subcontractors have little control. One example is damage from water infiltration which can cause the accumulation of mold, mildew, fungi and bacteria within or behind the wall covering which enter air conditioning systems and are too small to be filtered. Another example is the application of maintenance substances such as cleansers, insect repellents, strippers and waxes to flooring which are subsequently the cause of "slip and fall" accidents. In this area, the ADA design guidelines for "coefficient of friction" now exceed the ASTM design standards.

Certain geometric patterns and color combinations in the installation of flooring materials, especially on stairs and landings, can cause "trip and fall" accidents due to perceptual-cognition problems. Lighting is also a concern, because it can completely change the color, endurance, perception and quality of flooring or wall-covering materials. In the lifetime of the building these decisions are too often controlled by the owner or occupants rather than qualified design professionals.

With the current trend toward "design-build," the contractor and/or owner assume a major portion of the associated project liability responsibility. This is also the case when contractors, material suppliers and manufacturers are involved in "Substitution Requests" (often motivated by profit) to the Contract Specifications. Many years of qualified experience by design professionals and their firms are unfortunately too often ignored by relatively hasty, short-term cost-savers.

Andrew C. Yanoviak, AIA, APA, CSI is a voting member on several American Society for Testing Materials committees. Many of his manuscripts have been presented at ASTM symposiums and published in ASTM publications.



"Allied Builders rewrote our view of Hawaii contracting..."

So observes architect Kevin Coleman of California based Net Development in recalling plans' execution for Honolulu's new Renal Treatment Centers facility.

This fast-track project involved front-end unknowns, a series of medical moves — and human lives depending upon Allied Builders' speed, sensitivity, pro-active thinking and ability to work in concert with continuing renal care.

Recalls owner's representative Alvin Cecil: "Allied Builders' coordination with hospital staff was hand-and-glove superb. They brought order out of chaos for us, and they accomplished all the change orders we requested and still got the job done on time."

Adds Coleman: "Work with Allied Builders again? In a heartbeat..."
And heartbeats were what this job was all about.

ALLIED BUILDERS SYSTEM
Teamwork. Our motto. Our method.
1717 Akahi Street, Honolulu, Hawaii 96819, Telephone (808) 847-3763
Contractor License BC-5068