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Tall Structural Sustainability in an Island Context: The Hawaii Experience

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Biography

Steven M. Baldrige, P.E., S.E, President of Baldrige & Associates Structural Engineering headquartered in Honolulu, Hawaii, has had over 25 years of experience as a structural engineer working on more than 60 major projects, including over 20 high-rise buildings. His primary responsibilities include conceptual structural design, project management and design review with a focus on system optimization. He strives to design buildings that are cost effective to construct while maintaining their necessary strength and safety qualities. A benefit and goal is the reduction in the use of construction materials, one of the governing principles of Sustainable Design. This can be achieved by collaborating with the owner, the architect and the contractor to bring best value to a project. The Trump International Hotel and Tower and the 48-story Moana Vista, projects under construction in Hawaii serve as examples of highly efficient structural designs.

Steven Baldrige holds degrees from the University of Wisconsin and University of Texas and is licensed in Hawaii, California, Guam, Illinois and Texas. His practice includes both International and U.S. based projects.

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Abstract

We are in a period of global growth and along with it increased consumption and strain on the resources of the world. The impacts of this growth are far-reaching, as emerging countries are now competing for the same materials and resources that the developed world has taken for granted. Tall buildings present an opportunity to provide needed commercial space and housing in an efficient manner that can help minimize the use of materials and energy.

Even though designers and builders have become more global in their practice, attention must be paid to both the local opportunities and challenges of their projects. While not readily apparent, there are often times where these unique local practices and lessons learned can provide benefits in other geographical areas.

This paper examines high-rise projects in an island context from the most remote large city in the world – Honolulu, Hawaii. From a social standpoint there is some local opposition to building taller. For projects that are approved, the challenges of construction include availability of both labor and materials along with the logistics of shipping. Unexpected consequences of floor area and height restrictions have resulted in building designs that are optimized both from a functional use and structural systems approach resulting in reduced material requirements and thus sustainability.

Keywords: sustainable design, structural system optimization, residential, slab design, shear wall

Introduction

Tall building design and construction must always take into account the unique aspects of the project location. In conceiving the project, consideration must be given to local political and social culture. The construction planning must take into account the capabilities of the local workforce along with preferred methods. Final performance is dependent on the timely supply and delivery of materials. All of these issues are amplified in an island environment.

The introduction of sustainable design into the mix presents additional challenges. In some localities labor is so expensive that increasing material usage can result in more economical construction costs. This condition can be contrary to sustainable practices. In some localities technologies and installers for sustainable systems may not be available.

While we enjoy a robust global economy filled with new and exciting construction projects, we must constantly remind ourselves that there is a definite need to be innovative rather than consumptive.

Tall can be sustainable

In many communities there is an aversion to tall buildings. Cities with great heritage wrestle with balancing their historic nature with progress that must occur. In Honolulu the opposition is typically over concern of becoming too urban, losing the island feel.



Figure 1. Honolulu city skyline (Sheehan, 2007).

While many in Hawaii do not want Honolulu to become a Hong Kong or a Miami, we are, in reality, already a city with one of the highest number of skyscrapers per population in the world.

Most Skyscrapers per Population				
#	City	Population	Skyscrapers	Ratio
1.	Benidorm	67,627	378	178
2.	Balneário Camboriú	94,222	222	424
3.	North Sydney	56,547	109	518
4.	Miami Beach	86,916	136	639
5.	Macao	453,733	583	778
6.	Honolulu	377,379	427	883

Figure 2. Skyscraper density as measured by the number of skyscrapers per population (Emporis, 2007).

In Honolulu building heights have been limited in most areas from 350 to 400 feet. These restrictions date back to the 50s when politics of the time were focused on preserving ocean and mountain views. Francis Haines, of Architects Hawaii, Ltd., said that the height limit was put into place because it was one-half the height of Diamond Head, the picturesque backdrop to many of the postcard views of Waikiki.

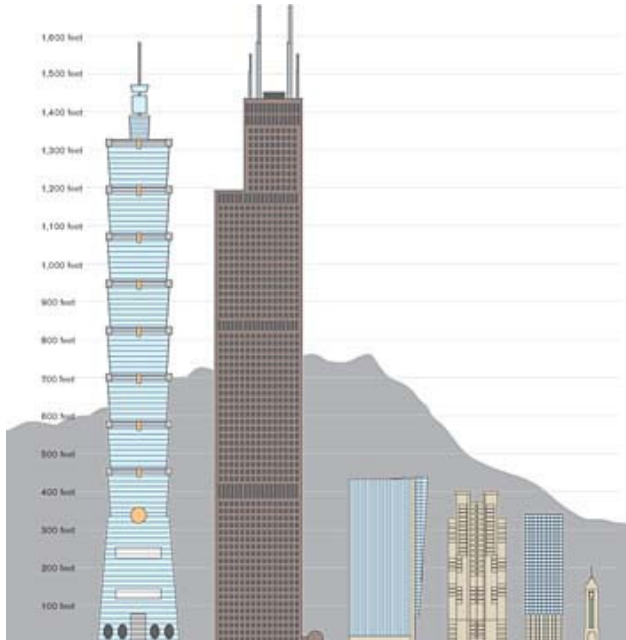


Figure 3. Reaching for higher limits, overlay of worlds tallest buildings, landmark Diamond Head and some of Honolulu's high rise buildings (Honolulu Star-Bulletin, 1 April 2007).

Several decades have passed, and as with all communities, growth and change have continued. These restrictions have actually resulted in a monotonous densification of the urban landscape. Where tall graceful buildings could have opened up the skyline to view planes to the ocean and mountains the opposite has occurred, saddling the community with long continuous "walls" of buildings blocking out the natural beauty.



Figure 4. Height restrictions have created bulky wide buildings that blend into each other, blocking viewplanes (Sheehan, 2007).

The benefits of building tall are being realized again in the rebirth and rebuilding of commercial and residential tall projects in the central business districts of many U.S. cities. The urban sprawl of the 60s has done more to destroy beautiful woodlands and farms than any other type of development. The highways and public transport along with continued consumption of energy to transport citizens back and forth are a continuing drain on the world. While not all of the citizenry will want to live in the urban core, there certainly should not be opposition to those who do. In the end they will conserve both open space and energy for all of us.

In Hawaii as with many cities, the realization that there are benefits to going taller is taking hold. In January 2007 the Honolulu City Council unanimously approved a resolution that would allow for buildings to be built taller. The resolution, authored by Zoning Chairman Charles Djou, highlights the benefits of tall buildings from both a nature preservation and sustainability standpoint. "What motivates me, is I think one of the reasons a lot of people choose to live in Hawaii is its beautiful, natural environment," he said. "We have a choice: either we continue to pave over paradise, and build out, or look at going up. I think the policy decision of city government for too long has been to go out" (Wu, 1 April 2007). According to the resolution, more urban density will discourage urban sprawl while encouraging the use of public transportation.

Similar issues have been discussed in cities such as San Francisco and Vancouver. In San Francisco, SPUR (San Francisco Planning Urban Research Association), has recognized height restrictions as one of the impediments to affordable housing. For transit-based development, city officials are looking at substantial increases in height, potentially exceeding the height of the Transamerica Pyramid. Vancouver is looking at stressing building design rather than prescriptive height limits, in effect trading exceptional height for exceptional design. What's sought is a skyline that reflects the sweep of the mountains but stays below the peaks and doesn't dwarf the surrounding bays. "The correct goal should be a Zen skyline," says Michael Gordon, senior planner for central Vancouver, the "balance of land and water and skyline all together" (Metropolis, 12/2003).

Unexpected Benefit of Height Restrictions

Most building developers in Honolulu have found that the only way to make projects economically viable has been to maximize both the allowable density and height on their property. One unexpected benefit of the height restrictions that have been imposed over the years has been the need to create efficient building systems required to construct the maximum number of floors within the height envelope.

There are numerous buildings in Honolulu with floor to floor heights less than 8'-6". Honolulu-based Architect Jo Paul Rognstad developed the design for an extremely efficient high-rise tower that became a prototype of sorts. His work includes approximately

eighty condominium projects with 11,000 units. The tower work in Honolulu has included:

#	Building [newest to oldest]	Floors	Year
1.	Executive Center	41	1984
2.	The Aqua Waikiki Marina Towers	39	1984
3.	Century Square	37	1982
4.	Hawaiian Monarch Hotel	43	1979
5.	Century Center	41	1978
6.	Fairway Villa	28	1974

Figure 5. Projects designed by Jo Paul Rognstad (Emporis, 2007).

The tower configurations were typically square to slightly rectangular in plan with a relatively small floor plate less than 4,000 square feet per floor. The core of the building included two elevators and a single intertwining exit stair that provided means of egress from each floor. While typically used as residential structures, many of these buildings were mixed-use, providing small office condominium space.



Figure 6. Century Square Office Condominium, downtown Honolulu (Baldrige, 2007).

The structural systems for these projects included thin post-tensioned slabs with many of the projects utilizing a slab thickness of only 5 inches. With a 5-inch slab it was possible to squeeze 47 occupiable floors within a mandated 400-foot height limit. In Honolulu there are at least ten buildings of this general design. Rumor has it that this design was transplanted to other locations including Libya.



Figure 7. Century Park Plaza, Pearl City, Oahu (Sheehan, 2007).

Sustainable Structural Design

With the appropriate trend toward sustainable design, each building team member is expected to contribute a design philosophy from which can be utilized to help achieve sustainable design or LEED rating goals. While architects, mechanical and electrical engineers have many tools to work with, structural engineers have often limited their recommendations to maximizing recycled content of steel or using flyash or slag to reduce the cement content of concrete. Sustainable design is also about the efficient use of materials as noted in the following excerpt from the Minnesota Sustainable Design Guide (1999-2001):

Building design and construction use significant quantities of natural resources and materials. The building industry consumes 3 billion tons of raw materials annually – 40 percent of the total material flow in the global economy. The manufacturing process of new materials is water and energy intensive, which contributes to environmental degradation and pollution. Harvesting, extraction, mining, and processing new materials pollute the air and rivers, threatening ecosystems and wildlife habitat.

Materials Goals

In view of these environmental concerns, sustainable design embodies the following goals:

- Minimize consumption and depletion of material resources.
- Minimize the life-cycle impact of materials on the environment.

From a structural engineering standpoint, the most significant contribution to sustainable design can be made by optimizing the structural systems to reduce material requirements on a project. One current project under construction, the Moana Vista, is an example of structural and functional efficiency. The unique design challenges of Honolulu, which include height restrictions, high labor costs and the cost and supply implications of shipping construction materials to the most remote city in the world, require structural design to be efficient.

The efficiency of the overall project was dependent on several factors including;

- Column and Shear Wall Layout
- Slab Systems – Utilizing post-tensioning
- Advanced Analysis Methods
- Specialty Construction Products
- High Strength Materials
- Appropriate Design Philosophy



Figure 8. Moana Vista (Architects Hawaii, Ltd, 2007).

The Moana Vista project utilizes a combination of thin concrete shear walls with an architecturally expressed exterior x-brace to efficiently resist lateral seismic and hurricane forces.

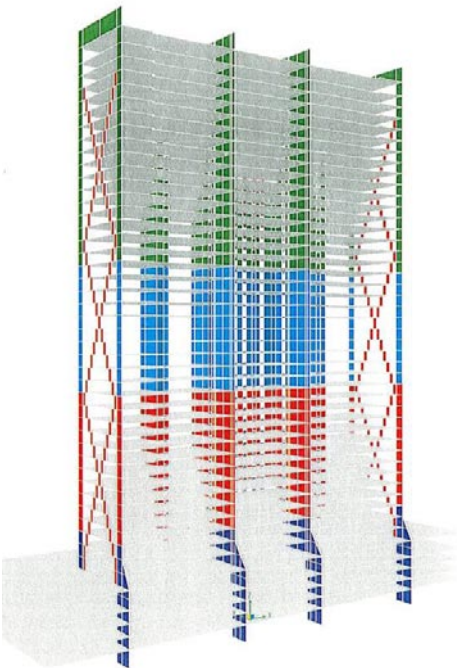


Figure 9. Moana Vista structural lateral analysis model (Baldridge & Associates Structural Engineering, Inc., 2007).

As previously noted, the majority of high rise buildings in Honolulu must utilize the thinnest floors possible in order to optimize the number of units within a building. For the Moana Vista project there are 53 distinct levels within its 400-foot height restriction.

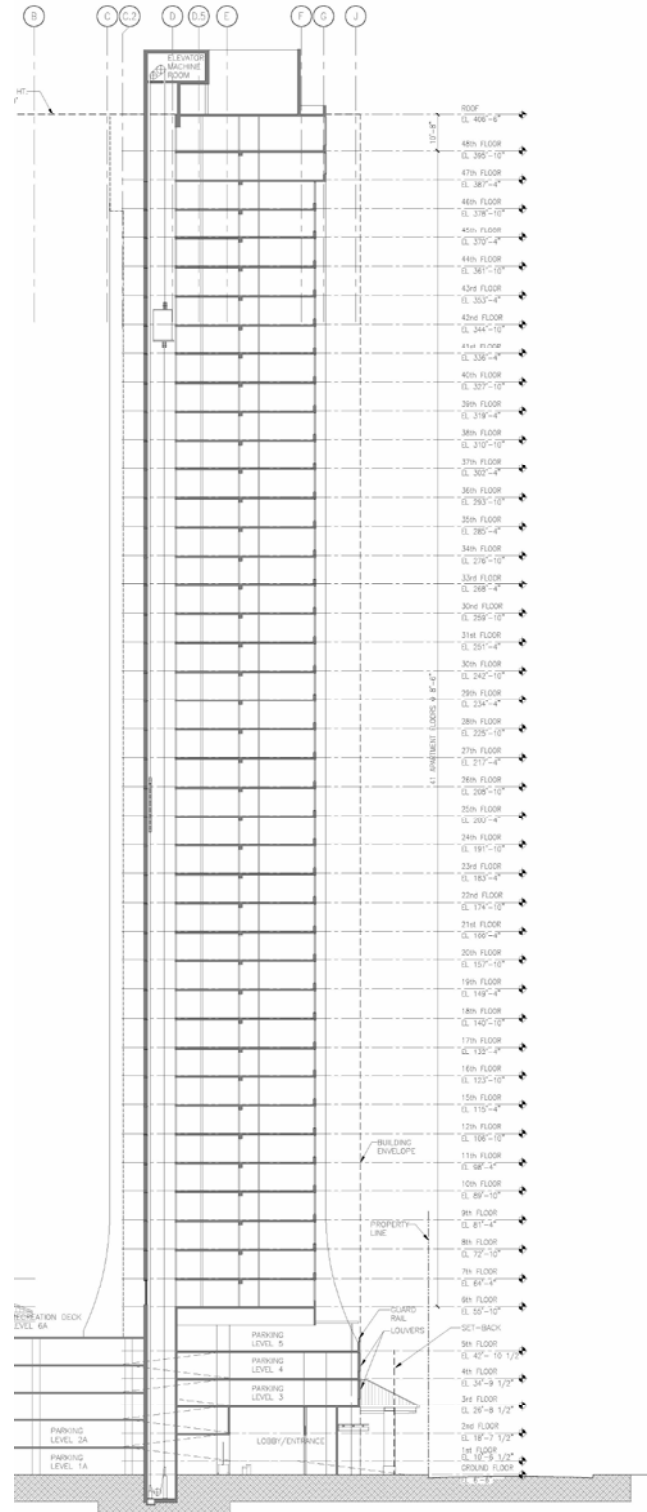


Figure 10. Architectural section through the Moana Vista tower indicating its 53 distinct levels (Architects Hawaii, Ltd., 2007).

Starting the design with a thin slab is the beginning of the optimization process. There are many other advantages to thinner post-tensioned slab buildings. For residential construction the bottom of slab serves as finished ceilings throughout most of the unit. This requires some grinding and patching to remove formwork imperfections and finishing with a variety of textured coatings. Mechanical and fire sprinkler services are provided in limited areas of dropped ceilings in bathroom and kitchen areas. Using the bottom of slab as the finished material eliminates the need for interstitial space, thus reducing the overall height of the building.

In high-rise buildings, consideration for the overall weight of the building must be kept in mind during the design process. In general, because of the structural demands required to support multiple floors, minimizing the weight of the structure can result in several efficiencies. In addition to reduced foundation requirements, a lighter building will have lower seismic design forces. Care should be taken in the lateral system layout to mobilize as much of this “lighter” weight to help counterbalance wind load overturning forces that increase with building height.

By collaborating with the architect and contractor, the layout of the structure can be set with efficiency in mind. Minor changes to column and wall layouts can reduce the structural requirements. In a large scale project, material requirements can often be reduced by 10 to 20%.

Column Layout

The thickness of the structural system is directly impacted by the span and location of columns. Because column location is initially dictated by important architectural requirements related to space planning and function, their location can be an afterthought, not given much importance in the initial design process. It is important therefore to provide early discussion and collaboration, with the goal to make adjustments to final column locations that can achieve the desired functional layout while providing a more efficient structural system.

Current design trends often requires irregularly shaped floor plates to enhance the architectural interest of the building, accommodate greater view planes, or simply fit the building on to a geometrically challenged building site, making it difficult to obtain consistent column spacing and spans for the slab system. This can result in a slab being thicker than required for much of the floor plate, resulting in overall project inefficiencies.

For the Moana Vista project, the residential tower is situated over parking levels squeezed onto a very tight site. In order to avoid costly and materially consuming transfer girders, the column layout had to take into consideration not only the residential floor requirements, but parking stall and drive aisle requirements as well.

In order to provide an efficient system, meetings were held with the architect to massage the column layout to help minimize the few longer spans that impact the entire system. Where column locations could not be

adjusted these discussions were extended to the design/assist contractor. With the availability of new forming systems, it was determined that the slab thickness could be changed across a floor plate with little difficulty. The resulting reduction in the number of columns and their foundations justified having two different slab thicknesses in the floor system.

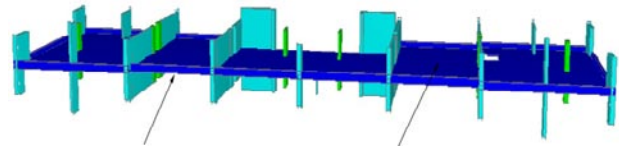


Figure 11. Moana Vista column and wall layout (Baldrige & Associates Structural Engineering, Inc., 2007).

At the perimeter of the building, longer spans were accommodated by an upturned beam. This decision again was based on the collaborative efforts of the team. From a structural standpoint, this beam allowed a span 50% greater than the thin 6” floor system could accommodate. Architecturally, a low upturn did not obstruct views out of the residential units and created a rhythm to the exterior look.

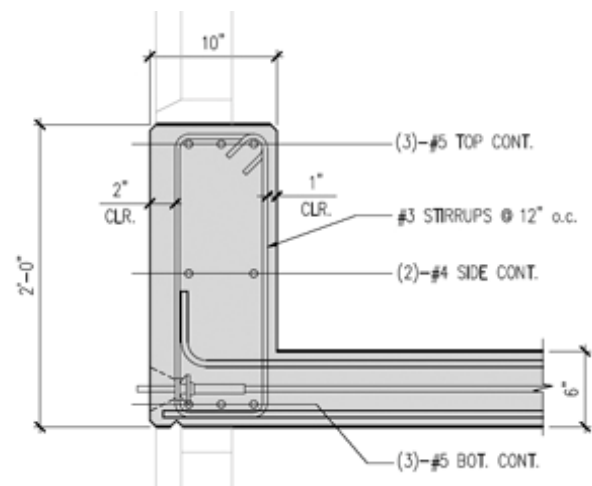


Figure 12. Moana Vista perimeter post tensioned upturned beam (Baldrige & Associates Structural Engineering, Inc., 2007).

Because the beam was upturned, the difficulty of formwork was reduced. This system also resulted in cost savings for the building’s exterior cladding as the concrete was less expensive than the glazing system. From an energy consumption standpoint, the potential heat gain through the building’s glazing was reduced as well.

Slab Systems

Two typical slab systems in high-rise residential buildings include conventionally reinforced and post-tensioned concrete slabs. From an optimization standpoint, post-tensioned concrete slabs represent the more desirable system. Maximum efficiency is achieved by combining conventional concrete slab construction

with high-strength steel cables that are draped within the slab to match the moment profile and create a compression force throughout the slab. Post-tensioned concrete slabs typically require 25% less thickness than a conventionally reinforced slab to carry the same loads.

The use of post-tensioning in a slab system represents not only a reduction in material requirements but a reduction in the overall weight that must be carried by the structure. The reduced weight of the floor systems has a ripple effect throughout the structure. For the supporting columns and foundations, reduced weight decreases the material requirements in these elements. The seismic design requirements of a structure are based on the overall weight or mass of the structure as well. Reducing the weight of the structure can result in lower material requirements for the lateral load resisting systems and the foundations carrying them.

In a 2006 presentation to the Post Tensioning Institute, C. Nicholas Watry compared a post-tensioned 10-story building design to a comparable reinforced concrete alternate in terms of LEED and sustainability. He concluded that seven additional LEED points were available for “Innovations in Design”:

- Reduction of concrete material (16% less concrete)
 - Reduction of reinforcing materials (20% less steel)
 - A less costly structural frame (13% less expensive)
 - Reduced building weight
 - Lower building height, less shadow
 - Faster Construction
 - Building Footprint could be smaller
- (Engineering News Record 17 September 2007)

Analysis Methods

A variety of methods may be used to design a slab system. The different design methods vary in level of effort and sophistication, allowing a designer to choose appropriately for their project. For conventionally reinforced systems, the simplified Direct Design Method is applicable. The next level of sophistication is the Equivalent Frame Method. For irregular and complex floor layouts the Finite Element Method provides a more accurate design.

While each method provides a code-compliant design, the results can vary. Simpler design methods require approximations, and hence, the results tend to be more conservative. Conservative results can lead the designer to specify a thicker slab and/or more reinforcement than is actually required for adequate performance of the slab system.

The Post-Tensioning Institute acknowledges the increased accuracy of a three-dimensional Finite Element Method: “The equivalent frame method (EFM) is essentially a design tool which is intended to yield a swift and safe design. It does not provide an in-depth insight into the actual behavior of a complex floor system. Where the actual response of a floor system under loading is sought, the finite element method (FEM) is a better tool” (Aalami and Bommer, 1999). Figure 13 illustrates FEM model and Figure 14 the deflection plots.

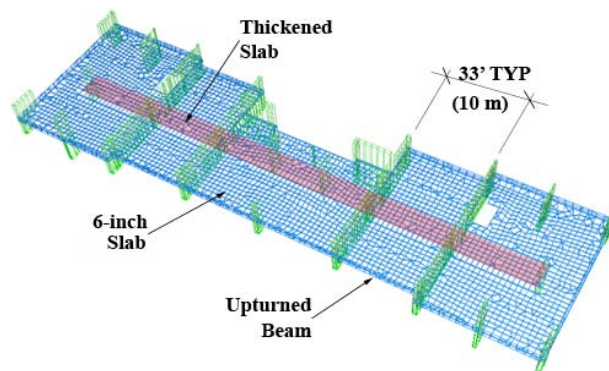


Figure 13. Moana Vista post-tensioned slab finite element analysis model (Baldridge & Associates Structural Engineering, Inc., 2007).

During the past decade, several structural analysis software developers have expanded FEM products to design post-tensioned concrete slab systems as well. While some engineers may consider this “pushing the envelope,” the use of the FEM approach ultimately provides a better understanding of slab performance and therefore can provide a better design. The added benefit is that reinforcing steel that is added as a result of more approximate approaches can be reduced or placed where it is more effective.

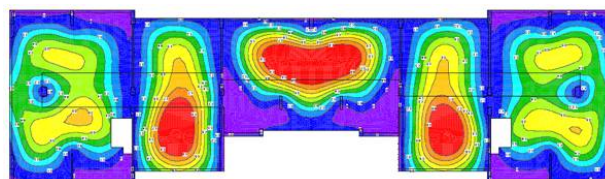


Figure 14. Moana Vista floor slab 3-D finite element analysis of deflections. (Baldridge & Associates Structural Engineering, Inc., 2007).

Specialty Products

A simple but effective newer product is shear stud reinforcement placed in a zone around columns to provide resistance to punching shear. Prior to the advent of shear stud reinforcement, thickness of a flat plate slab system was often governed by punching shear resistance of the concrete. Slabs were often thickened throughout to address a localized overstress.

A relatively small amount of shear stud reinforcing strengthens the slabs punching shear resistance. This eliminates the need for drop panels and can reduce the slab thickness requirement. An additional benefit of shear stud reinforcement is that it increases the slabs' capacity to resist stresses caused by lateral displacement of the overall building system under heavy seismic loading. The end result is a slightly thinner but stronger slab system.

Materials

Column material quantities can be minimized through the use of higher-strength materials. In general, it is desirable to maintain column sizes that are relatively small and uniform throughout the entire building height, reducing both material requirements and allowing reuse

of formwork. Additionally smaller columns benefit the developer and end user as smaller columns take up less leaseable or sellable space in a building.

Optimum column sizing is achieved by varying concrete and/or reinforcing steel strengths to most efficiently match the column load as it supports more floors. High strength concrete with compressive strengths up to 8,000 psi is readily available in most locations. In some markets, commercially available concrete mixes above 10,000 psi can be obtained. Strength of column vertical reinforcement can also be increased from $f_y=60$ ksi to $f_y=75$ ksi to provide additional capacity at lower floors. For both high-strength concrete and reinforcing steel, additional capacity is provided without a comparable increase in material quantity requirements.

Shear Walls

Shear wall configuration and layout in a high rise building has a significant impact on the efficiency of the overall system. Good locations for these are stair and elevator cores where the walls can perform “double-duty,” providing lateral strength along with required fire separation. In a high-rise building these walls are, in essence, flexural members cantilevering from the ground. Therefore consideration should also be given to configuring walls to act in as long of lengths as possible with returns or “flanges” that will considerably increase overall strength and stiffness of the system.

In taller buildings, a number of strategies can provide this efficiency, reducing wall thickness and reinforcing requirements. Some of these include:

1. **Coupled Shear Walls** - By linking two or more shear walls together with a series of beams, the total stiffness and strength of the system will exceed the sum of these walls acting independently.
2. **Outrigger Systems** – Full floor links can distribute overturning forces further out in a building, thereby increasing the “moment arm” of the system.
3. **Punched Shear Wall** – In residential buildings, exterior walls can be constructed of concrete with openings for windows. Depending on the depth of concrete below and between the windows, frame or tube action can be developed.
4. **Shear Wall-Frame Interaction** – Where it is possible or desirable to have beams within a building, frame action of the beam-column system can reduce some of the demands on the building’s shear walls.

Even with an efficient shear wall configuration, the effectiveness of the overall lateral load resisting system is diminished if walls are not located appropriately within the floor plate. Efficiency is increased the closer the shear wall system center of rigidity is to the building’s center of mass for seismic force and the center of wind exposure for wind forces. In most regular-shaped buildings, the center of mass and center of wind exposure should be close to each other.

On the Moana Vista project, thin 8-inch thick shear walls used as unit partitions were linked together across

the building’s center corridor creating a system utilizing the entire width of the system. Additional strength and torsional stiffness were provided by exterior concrete x-bracing. This system provided both an architecturally interesting and structurally efficient system.

Design Philosophy

The Building Code in the United States has evolved through an elaborate consensus process, and defines an appropriate and consistent level of safety. Some engineers, however, believe designing to code minimum requirements is “pushing the envelope” and often add arbitrary safety factors. While there are times when serviceability requirements may override code minimums, providing additional safety factors can be wasteful and may create other problems. Some justifications for adding to code requirements have included the following:

1. Concern about poor construction that is better addressed through quality control rather than the addition of excessive material quantities.
2. Engineers from seismic-prone regions may be inclined to use the same seismic detailing requirements for buildings in lower seismic risk areas that may never experience higher loading conditions.
3. Some design teams may justify increasing slab thickness and reinforcing in condominium projects in the U.S. as a safety net against future litigation. Increasing material use does not necessarily prevent litigation or enhance performance.

These design philosophies are contrary to sustainable design principles by using more material than what is actually required.

Moana Vista summary

The efficiency of a building’s structural design can be quantified by comparing buildings of similar height and use, as indicated in Table 1 below. For example, when compared to the Hokua project, the Moana Vista design required 1.6 million less pounds of reinforcing steel. Evidence of the efficiency of the final design of Moana Vista is reflected in the low reinforcement ratios in this table.

Table 1. Summary of reinforcing steel quantities for high-rise projects in Honolulu (Baldridge & Associates Structural Engineering, Inc., 2007).

Project	Square Feet (SF)	Rebar	# SF	Post-Tension	# SF
Hokua	850,000	7,150,000	8.4	545,000	.65
Ko’olani	1,100,000	7,600,000	7.0	703,000	.65
Moana Pacific	1,540,000	12,000,000	7.0	1,200,000	.77
Capitol Place	800,000	7,000,000	8.8	665,000	.87
909 Kapiolani	396,000	2,900,000	7.3	263,700	.67
Watermark	435,000	4,000,000	9.2	263,000	.60
Moana Vista	863,500	5,486,000	6.3	515,000	.60

Hawaii's Sustainable Future

As with other communities, sustainable design is being embraced and gaining momentum. The following projects are two examples of Hawaii's sustainable future.

Frear Hall - Sustainable dormitory

When the University of Hawaii started planning on their first new dormitory in 30 years, it was decided to incorporate sustainable principles. The major item investigated was to create a building that would be naturally ventilated to reduce the energy requirements required for air-conditioning.



Figure 15. Photomontage of the planned new Frear Hall at the University of Hawaii at Manoa (Wacker Ingenieure, 2006).

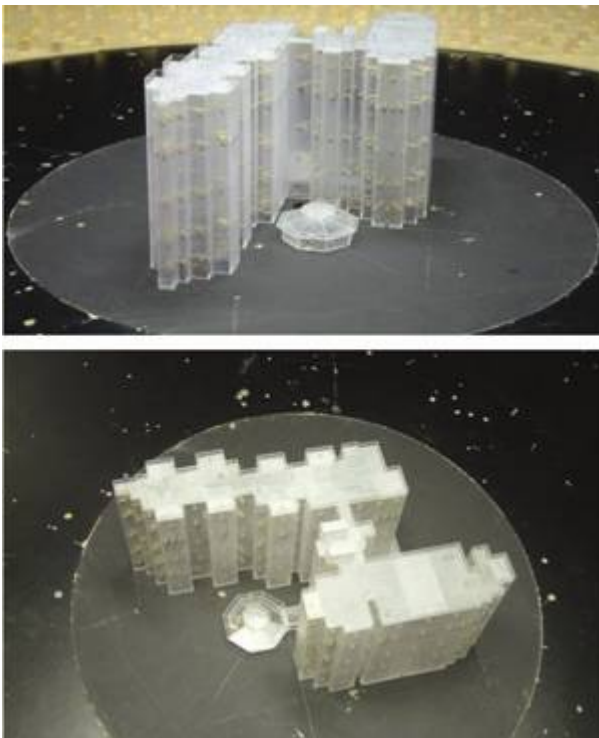


Figure 16. Alone-standing planned building complex in the wind-tunnel (Wacker Ingenieure, 2006).

Providing natural ventilation in a high-rise building requires appropriate studies and planning. The project architect, CDS International, worked with German wind consultant Wacker Ingenieure to investigate the feasibility

of natural ventilation. This work included creating models of the building to be placed in a wind-tunnel.

These studies included investigating the impact of having different sets of windows open in the building. The idea was to determine which combination of open windows would provide the best natural ventilation.

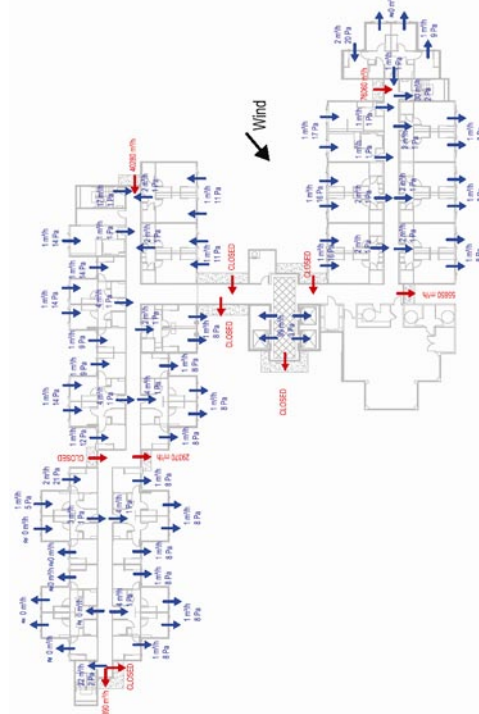


Figure 17. Airflow through the building (Wacker Ingenieure, 2006).

Future Projects – One Piazza Tower

As with other communities, sustainable design is being discussed and in some cases implemented. One developer in Honolulu, Joe Nicolai, has made sustainable design a goal on all of his projects. Photovoltaic systems were incorporated into his Harley Davidson dealership constructed on the island of Maui in 2001.

The dealership is now a step closer to its goal of being the nation's first energy self-sufficient dealership, says Joe Nicolai, president of Wholesale Motors, Inc., parent company for JN Automotive. "Our goal is to establish a model for sustainable business practices in our industry," Nicolai says. "We've shown on these projects that, with careful design, it is possible to protect the environment while lowering your net energy operating costs" (DiPietro, 17 September 2001).

Joe Nicolai's next project constructed in Honolulu in 2004 took his sustainable design principles to the next level. This larger Harley Davidson dealership incorporated additional sustainable design principles. The configuration and design of the building intended to maximize an open sales area and intended to catch the eye of passersby, while incorporating natural ventilation principles. The ground floor utilized large aircraft hangar doors outfitted with showroom glass that could be opened during the day for natural ventilation. The area also used

a large solar-powered ceiling fan to aid in creating a cooling effect in the space. With Hawaii's temperate climate customers could be comfortable most of the year without the use of air-conditioning.



Figure 18. One Piazza Tower (Nicolai, 2005).

Joe Nicolai's future plans include a sustainable high-rise. One Piazza Tower (Figure 10) includes a five-level themed retail podium that combines luxury automobile dealerships with themed restaurants. The attached residential tower extends another 24 levels above the podium. The project is planned to incorporate vertical wind turbines integrated into the architecture along with electric and hot water solar collectors. Condensate water from what air conditioning is used will be recycled for a variety of uses. This project, as conceived, marks a new standard for sustainable high-rises, not only for Hawaii, but on a global stage.

Conclusion

Sustainable design can be achieved through several approaches; while some may add cost to a project, others can reduce the overall project cost. The most effective contribution a structural engineer can make as part of the design team's sustainable design effort is to use "Innovations in Design" and use as little material as possible to provide a safe, durable structure. This takes collaborating with the architect in the early layout stages, providing input needed to help create an efficient structural layout within functional and aesthetic requirements. Successful completion of this effort requires the utilization of appropriate analysis tools to minimize material waste from the project.

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