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Affordable High-Rise Workforce Housing: Essential to the Future of Cities

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Steven Baldridge is the principal and founder of BASE, an award-winning structural engineering firm recognized for its work on buildings in areas of high seismic and hurricane risk worldwide. His experience includes over 50 high-rises in a diverse range of uses, from affordable workforce housing and luxury apartments to transit-oriented mixed-use projects. His interests go beyond structural engineering and he has worked closely with developers, architects and contractors to develop workforce housing projects, some of which have become home to several BASE employees.

Abstract

Often when new high-rise developments are announced in cities, focus is on the positive impacts such as job creation, increased local tax revenues and social pride in iconic structures. A potential side effect, however, is increased property values that can make housing less affordable for local workers in their hometowns. Cities have been wrestling with mitigating the sometimes-negative impacts of high-rise development in their communities including requirements for developers to build units or set aside funds for local workforce housing. Illustrating how one developer focused on the basics of affordable housing through optimization of building layout, repetitiveness in construction, and an efficient structural design to provide cost-effective workforce housing in his community, this can be translated to other cities. Community development, design, and construction professionals can work to provide affordable high-rise housing intended to help maintain a sustainable local workforce.

Keywords: Construction, Cost, Residential, Structure, Urban Habitat

Introduction

Cities around the United States are experiencing a boom in high-rise construction with a large percentage of those projects being residential towers. Often times when new high-rise developments are announced in cities, focus is on the positive impacts such as job creation, increased local tax revenues and social pride in iconic structures. These towers, however, rarely address local housing needs. Development is a risky business and therefore developers lean toward addressing market sectors that will sell quickly with an adequate return on investment. In some cities that market may be wealthy investors who might purchase units for investment or leisure second home purposes. A potential side effect, however, is that a robust market can increase property values to the point where housing is less affordable, or not affordable at all, for local workers in their own hometowns.

The challenge then becomes one of workforce sustainability. At some point if a worker cannot afford to live in their hometown they may have no choice but to move somewhere more affordable. How can a city function if its teachers, police officers, firefighters and other critical workers start leaving? How can new developments be constructed if the ironworkers, plumbers and electricians start leaving as well? In some markets, even professional workers such as architects, engineers and construction managers find it challenging to justify staying amid rising housing costs.

Cities in the United States with high housing costs have been wrestling with the challenge of facilitating the construction of building housing that is affordable for all of its citizens. Government regulations or incentives can only go so far to create cost-effective housing for its people. Communities and their development, design, and construction professionals can, however, work together to provide affordable high-rise housing intended to help maintain a sustainable local workforce. This paper illustrates how one developer focused on the basics of affordable housing, optimization of building layout, repetition in construction, and an efficient structural design to provide cost-effective workforce housing in his community and how this can be translated to other cities.

The Affordability Crisis

In the United States the monthly mortgage payment on a median home grew twice as fast as incomes over the past year. The monthly payment needed to support a home purchase with a 20 percent down payment grew 12 percent between 2017 and 2018, while incomes grew only six percent. Rising home prices, record debt levels and high medical costs, among other contributing factors, have converged in recent years to push homeownership further away for aspiring buyers. These factors have contributed to a stark reality: the homeownership rate for millennials—the largest generation in US history—is lower than that of their parents and grandparents at the same age.

It takes upwards of 25 years—and nearly double that in Los Angeles—to save for a 20 percent down payment for a new home in these 10 cities, which represent the least-affordable areas in the Unison Home Affordability Index. Notably, four of the 10 least affordable areas are in California (see Table 1).

San Francisco has the highest median home value by far, but it is actually more affordable than Los Angeles for a typical resident. That is because the median income is also higher. Prospective buyers in Los Angeles face not only high home values, but relatively low median incomes for a major city. In San Francisco, the median household income is US$102,300, and in San Jose, the median household income is not far behind at US$101,296. In urban Honolulu the median household income is US$71,326, but the median home value is nearly on par with San Jose (see Figure 1).

Personal Accounts of Affordable Housing Challenges

A young teacher in Hawaii with a salary in the bottom 25 percent of educators earns about US$3,330 monthly and it would take 70 percent of that monthly pay to afford the median rent in Hawaii, according to salary, rent and housing data provided to USA Today by Zillow (Richards 2019). That's before reducing any part of that salary to account for income taxes. Sound impossible? That's because most of the time, it

Market Name	2018 Unison Index (years to save)*	2013 Downpayment	2018 Downpayment	2013 Monthly Payment*	2018 Monthly Payment*	Home Value % Change 2013–2018	HH Income % Change 2013–2018
Los Angeles, CA	43	$78,258	$124,505	$1,802	$3,048	59%	23%
San Francisco, CA	40	$132,893	$206,346	$3,060	$5,052	55%	41%
Urban Honolulu, HI	40	$97,066	$143,513	$2,235	$3,514	48%	23%
Miami, FL	36	$37,828	$62,931	$871	$1,541	66%	29%
New York, NY	36	$90,435	$111,613	$2,083	$2,733	23%	26%
San Diego, CA	31	$76,015	$119,107	$1,750	$2,916	57%	26%
San Jose, CA	31	$105,084	$155,910	$2,420	$3,817	48%	28%
Boston, MA	30	$68,126	$97,350	$1,569	$2,384	43%	32%
Washington, DC	28	$78,229	$114,465	$1,801	$2,803	46%	31%
Seattle, WA	27	$71,491	$116,620	$1,646	$2,855	63%	42%

*Assumes a 20% down payment and a 4.54% mortgage interest rate for 2018, and a 3.98% rate for 2013, which are the average annual Freddie Mac 30-year fixed rates as reported by FRED.

Table 1. Table demonstrating how many years it would take to save for home ownership in the 10 least affordable US cities. © Unison. Source: 2019 Home Affordability Report

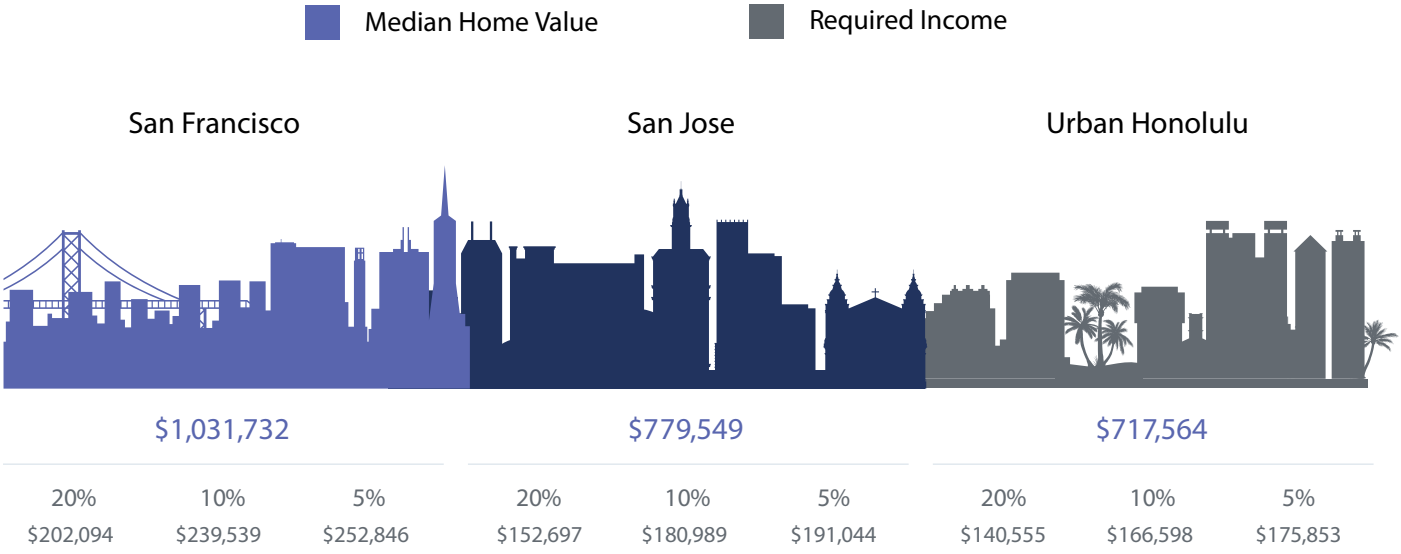

Figure 1. Graphic showing the required income for a home purchase in some of the most expensive US urban areas. © Unison. Source: 2019 Home Affordability Report

1133 Waimanu
282 Units
1996

1450 Young Street
246 Units
1998

1448 Young Street
200 Units
1999

215 North King Street
251 Units
2005

Country Club Village 6
269 Units
2009

Figure 2. Five affordable workforce high-rise Capital LLC developments in Honolulu.© Downtown Capital LLC

is. About 1,200 teachers in Hawaii resign every year, leaving the education department scrambling to fill positions in the statewide school district. The percentage of resigning teachers who noted "leaving Hawaii" as their primary reason climbed to 52 percent in the most recent state staffing report, up from 48 percent in previous years.

One unfailingly sunny afternoon in February, Corey Rosenlee, the Hawaii State Teachers Union president, was inching away from the office in typical island congestion. He was making three miles of progress in 20 minutes. He works in downtown Honolulu and was heading to his home on the cheaper, leeward coast of Oahu, Hawaii's most populous island.

"My daughter in middle school over the past two years has had four long-term substitute teachers," said Rosenlee, who lives in Ewa Beach (Richards 2019). "The vast majority of people want to pay our teachers better, but because everyone is struggling to make ends meet, funding becomes difficult."

Economists predict this "brain drain" to more affordable areas could become a trend for many cities.

"There are vast home price differences among metro markets. The condition of extremely high home prices may not be sustainable in light of many alternative metro markets that are much more affordable," National Association of Realtors' Chief Economist Lawrence Yun said in a statement. "Therefore, a shift in job search and residential relocations into more affordable regions of the country is likely in the future."

Yun continues to call on the construction industry to develop more affordable housing units, which he says will combat slower price gains and buyer pullback. "More supply is needed to provide better homeownership opportunities, taming home price growth and widening the inventory choices for consumers," he said.

Hawaii's population has declined for two consecutive years for the first time since statehood. The state population dropped by 3,712 from July 2017 to July 2018. During that time 12,430 residents left Hawaii for the US mainland. Locals are making the difficult decision to leave the islands despite Hawaii having one of the lowest jobless rates in the nation, tourism at record numbers and their strong roots and family here.

And if Hawaii officials don't do more to diversify the economy, reduce spending and bring more housing affordability, the population drain could become a long-term flood and threaten economic growth and the fabric of communities. These local communities are made of wonderful people, cultures and the Aloha Spirit. And that's what truly makes it so valuable to live in Hawaii.

Government Affordable Housing Programs

What can be done to help facilitate the construction of workforce housing? In the past many US cities would take on the task of constructing affordable housing, to varying outcomes. In general, the government has proven not to be the best at developing housing. Two recent public-private affordable projects in Honolulu had unit costs almost twice as high as what private developers could have delivered.

The government has also not been good at maintaining housing either. Examples include the Chicago Housing Authority which over the past 20 years has demolished over 18,000 units in multiple high-rise affordable housing developments due partially to neglect and lack of maintenance (Reed 2015). In Honolulu, the State of Hawaii's affordable housing portfolio was sold to a private developer who it felt could do a better job of both upgrading and maintaining the affordable units.

Privately-Developed Affordable Housing

A development group in Honolulu, Downtown Capital LLC's mission is to provide affordable housing to Oahu's working residents through vertical development in the urban core. Between 1996 and 2009 they successfully completed five

affordable workforce towers, bringing to market 1,248 units (see Figure 2).

Creating workforce housing is something of an uncharted territory for developers because there are few subsidies or tax credits they can take advantage of, such as those given to low income housing and projects. In order to bring moderate income workforce housing to market designs must be very efficiently executed. There are a number of design features to consider.

First, the lot must be large enough to construct a standalone residential tower with essentially the same floor plan from ground to roof and a standalone parking structure. Each structure is laid out for maximum efficiency of each use thereby eliminating the expenses inherent in transferring a residential layout onto a different parking layout. Additionally, in order for the towers to fit on the site, unit quantity must be achieved by going vertical. The denser and taller the project permitted on a site, the more units there are to reduce the land costs that must be worked into the unit price.

The residential tower must also be designed around the most efficient unit layouts. The shape of the building is entirely driven by interior efficiency rather than by exterior aesthetics. This doesn't mean that the building has to be unsightly, but the option to increase unit sizes to match a desired exterior look becomes less feasible.

Similarly, the parking structure must be laid out for maximum efficiency. Drive aisle, stall widths and mix of standard and compact stalls to meet code standards without much deviation. Structural systems should also be as efficient as possible. For residential towers, utilization of concrete tunnels form technology to reduce slab thickness down to six inches (150 millimeters) at minimum reinforcing ratios. For the parking structure, utilization of concrete garage beam forming system technology and post-tensioning to create efficient 58-foot (17-meter) spans to eliminate columns between parking stalls would increase the number of parking stalls.

The amount of glazing should be reduced on the exterior using stud-framed walls with punched windows. Unfortunately, glazing is an expensive component on a building. Amenities should be kept to a minimum as this helps keep both construction costs and future owner's maintenance fees down (see Figure 3).

Structural Systems—Tower Tunnel Form Construction

Tunnel form construction utilizes a steel formwork system for conventionally reinforced concrete buildings that combines a vertical wall form structure with one-half of the horizontal formwork for the structure's slab system. When combined with a similar form on the other side of the room it creates an inverted U-shaped enclosure. The combination of wall and slab forms allow for both to be poured on the same day, speeding up construction.

Each side of the form has diagonal braces that provide support for the slab formwork and concrete pour and triangulates this load down directly to supporting walls on lower floors. This creates another advantage: as the tower progresses, subsequent concrete floor pours do not load the floors below, often eliminating the need for reshoring. The shoring system is supported on wheels and once the concrete floor has set, the assembly can be dropped lightly and rolled out the side of the

Figure 3. 801 South Street Building B floor plan. © Downtown Capital LLC

Figure 4. Close-up of tunnel form. © Steven Baldridge

Figure 5. Affordable tunnel form tower under construction uses poured concrete walls, which are erected quickly and create a durable unit. © Steven Baldridge

building to be craned to the next level for the tower's next floor to be constructed.

From a structural system the final construction is both robust and efficient. Since the wall forms are placed between bedrooms and living rooms of a residential unit the spans are relatively short and can be easily accommodated with a thin six-inch (150-millimeter) concrete slab requiring only minimum reinforcement. Similarly, since the area of slab the walls carry is relatively small, can be limited to six inches (150 millimeters) concrete-reinforced with one layer of reinforcing vertical and horizontal, typically at minimum reinforcing requirements in the upper floors of a tower.

While it might seem counterintuitive that a building with closely spaced walls can be cost-effective, with this forming system the majority of a residential unit's interior walls are completed the same day as the concrete pour. In this scenario the cost of concrete room walls is not that different from the cost of a framed stud wall. They get constructed fast and create a very durable residential unit (see Figures 4 and 5).

Tunnel form technology was commonly used in Hawaii in the 1960s and 70s but lost favor due to the perceived rigidity of the system. Creative architects, engineers, and contractors, however, have found ways to work with the system to create useful and attractive buildings. Tunnel form may also have been perceived to have poor acoustics. With a minimum tunnel-formed wall or slab thickness of six inches (150 millimeters) a superior Sound Transmission Class (STC) rating of 55 is obtained and at that level most noises are inaudible and loud sounds can be faintly heard. Since this is also an integral cast-in-place concrete system there are no joints where sound might leak through. In regard to Impact Insulation Class (IIC), the transfer of sound through slabs created by impact above, such as footsteps, dropped pans, etc., there are new technologies available for flooring underlayment and padding that have significantly reduced these acoustical concerns.

Structural Systems: Parking Structures

One of the primary ways to bring down the cost of a parking structure is to start with a very efficient layout. The goal is to have a layout where the overall square footage in a parking structure is less than 300 square feet per car. In order to do that parking must be provided on the ramps and unused space at the parking tower's corners and any columns throughout the parking bays must be eliminated.

From a structural standpoint this can be achieved by utilizing post-tensioned concrete construction. A primary structural grid of about 25 feet (7.6 meters) by 58 feet (17.6 meters) can provide six parking stalls, three on each side of a sloped driving aisle, with no columns within the parking bays. The structural system consists of a six-inch (150-millimeter) post-tensioned concrete slab spanning between 16 inches (400 millimeters) by 31 inches (775 millimeters) deep post-tensioned beams. The effective average thickness of the overall concrete system is about 7.33 inches (183 millimeters), which is not bad for a 58-foot (18-meter) span. Both the slab and the beams are optimized such that their reinforcing requirements are also at, or close to, code minimum requirements.

Efficiency in the construction of this system is achieved by the concrete formwork as well. The beams are formed with a steel formwork platform that can support a panelized wood forming table for the slabs that can span between the steel beam forms. Both the steel beam forms and the panelized wood slab forming tables can be dropped and moved easily up the parking structure ramps for the next pour with a forklift,

reducing tower crane requirements that can add cost to a project (see Figures 6 and 7).

801 South Street Workforce Housing

801 South Street was a "workforce housing" project, which means at least 75 percent of units were sold to families earning between 100 percent and 140 percent of the Honolulu area median income. This is different from "reserved housing" where the State owns an equity component. There were no restrictions on resale and given the low maintenance fees, attractive location and well thought out clean-lined floor plans, prices have skyrocketed since

In 2012, Downtown Capital LLC acquired a large urban parcel that was formerly used by the Honolulu Advertiser as its newspaper publishing office and printing facility. At the time the buildings on the site were used as a soundstage for the CBS television show "Hawaii Five-0."

At approximately 340 by 480 feet (104 by 146 meters) the goal for the property was to try to figure out how to fit two projects on the site while maintaining the northwest corner for the historic renovation of the original 1929 phase of the Honolulu Advertiser building. This would require fitting in two efficient residential towers, two efficient parking structures, as well as parking and service access drives on what remained of the site. This goal was achieved by offsetting the towers to opposite corners of the site. The Building A tower at the southwest

Figure 6. Garage beam steel forms can be moved easily, cutting down on costly crane operations. © Steven Baldridge

Figure 7. Garage slab form panels can also be moved relatively easily up parking structure ramps. © Steven Baldridge

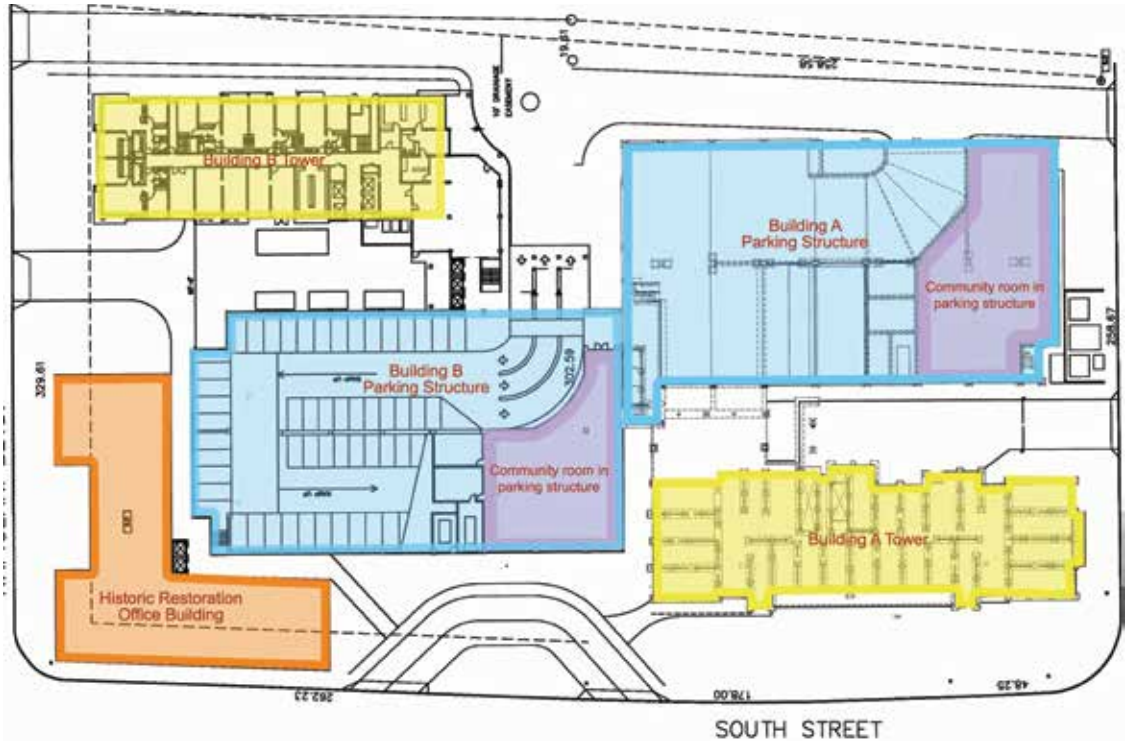

Figure 8. 801 South Street site plan demonstrates how two projects were slotted in on a single site by sliding the Building B parking structure and the Building A parking structure up against one another. © Downtown Capital LLC

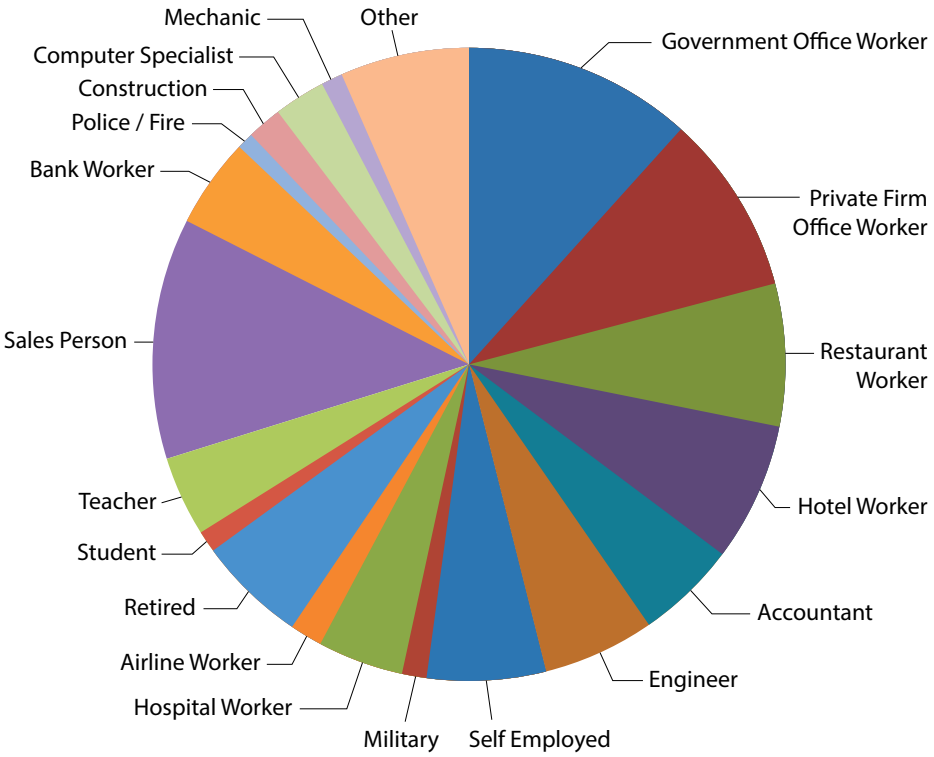

Figure 9. 801 South Street owner occupation composition. © Downtown Capital LLC

corner and the Building B tower at the northeast corner. The parking structures for each building were sent to opposite corners as well. With the historic Honolulu Advertiser building at the northwest corner, the Building B parking structure was slid up against the Building A parking structure on the site (see Figure 8).

801 South Street is made up of two towers: Building A (completed June 2015) and Building B (completion late 2017). The team included developer Downtown Capital LLC, contractor Hawaiian Dredging Construction Company, architect Kazu Yato & Associates, Inc., and structural engineer BASE.

Figure 10. Image of the completed 801 South Street, which sold out shortly after entering the market. © BASE

Building A

- 635 units on 46 floors—122 meters (400 feet) tall to the roof.
- Residential units include studios, one-bedroom and two-bedroom units.
- Maintenance fees are very low and help keep the overall costs down for the owners.
- 11-story parking structure with 915 parking stalls (30 are guest stalls).

Building B

- 410 units on 46 floors
- Residential units include studios, one-bedroom, two-bedroom and three-bedroom units.
- Maintenance fees are very low and help keep the overall costs down for the owners.
- 10-story parking garage with 794 parking stalls: 497 regular and 297 compact

Typical unit sizes

- Studios: 35.7 square meters (384 square feet)
- 1BR / 1BA: 46.5 square meters (500 square feet)
- 2BR / 1BA: 66.3 square meters (714 square feet)
- 2BR / 1.5BA: 72.1 square meters (776 square feet)
- 2BR / 2BA: 75.8 square meters (816 square feet)

Buyer demographics

The project met its goal of providing workforce housing:

- 100% of buyers were Honolulu residents
- 73% were first time homebuyers
- Average age of 42
- 24% under the age of 30
- 48% under the age of 40

Prior to buying (see Figure 9).

- 42% were living in multigenerational/multifamily homes
- 29% were renting
- 27% were owners
- 2% were purchasers returning home from other states

Both towers sold out within days of coming to market and have been a resounding success to the developer's goals to provide affordable housing for Honolulu's working residents. The project is also an example of an affordable housing strategy that can be replicated throughout the United States (see Figure 10).

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