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SKYSCRAPER Driven From Inside Out Towards Nature

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An essential element of skyscraper architecture lies in its adaptability to an existing environment. For its massiveness in height and size, a skyscraper, while becoming a new landmark, brings inevitable influences – both positive and negative – to its surroundings. It is in that notion that Haeundae Resort Project (HRP) seeks for inspiration in nature as a key design principle, believing it is what will effectively bridge a high-rise and society together.

As the second busiest metropolis of South Korea, Busan has a history that is more than 1000 years long, which includes 140 years as a port city. One month after the outbreak of the Korean War in 1950, Busan was the only city left that had not been captured during the North Korean attack; during this time, the city became a refugee camp site, and broke records for sudden overgrowth in population. Later, the South Korean and UN forces were able to rearrange the troops for retaliation.

Since 2000, Busan has been transforming into an international city through swift growth in urban structure. The city has begun to play an important role as a resort city, and hosts numerous local and global cultural events each year that include worldwide conventions and film festivals. In contrast to the rapid, unanticipated population growth during the Korean War, the current population is growing within a carefully developed urban environment, creating a desirable lifestyle.

Haeundae Resort Project

Haeundae Beach is best known for its beautiful beach, but has also been developed with several supertall buildings since the early 1990s. The high-rise residential tower is a necessary response to the city's growing population. As a component that houses mixed-use facilities, the podium provides many conveniences found in a dense urban area.

HRP is a mixed-use complex consisting of residential, hotel, retail, and entertainment components. Its development began in 2008 by Triple Square (AMC). The program is distributed across three towers with a shared podium at their base. To the north, there are two 85-story residential towers, both 332 meters tall. To the east and closest to the beach, the 101-story Landmark Tower stands at 414 meters tall, and includes luxury hotel rooms, condominium units, topped by an observation deck.

The project has been developed with one overarching goal: how the supertall building will regenerate and harmonize with existing surroundings. Moreover, how the project will enhance the City of Busan socially, culturally, regionally, and environmentally has been examined carefully. Hence, its primary design guideline focuses on integrating natural assets into the proposed high-rises.

Such an approach begins from the inside out, evolving from a unit plan that considers the natural lines and boundaries of the nearby sea and mountains, to a building mass, and then finally to a master plan. This method of developing a unique configuration of an interior space affects the form of the exterior, which requires a delicate and morphological identity as a new skyscraper. Haeundae has optimal environmental conditions, with several extraordinary natural elements. Architecture in Haeundae searches for design inspiration from its rich natural setting, in its aspiration to make the area a more wholesome place.

Left: Map showing phases of the Korean War. Source: Vox.com

Opposite Left: View of the Haeundae beach view, showing the future site of the building. Source: Samoo Architects & Engineers

Opposite Right: Aerial diagram showing the view boundaries of the Haeundae Resort. Source: Samoo Architects & Engineers

The beach forms a gentle U-shape, with Dongbaek Island visible in the distance. People looking out to the sea enjoy a peaceful, calming landscape. "Dongbaek" is a Korean term for camellia flowers. Blooming in the beginning of spring, the camellias alert people to the end of a long winter, and serve as a unifying symbol for the community. A neighboring bridge to Gwangan that was erected in 2003 is a great addition to the touristic area because of its structural beauty that attracts more visitors to Haeundae Beach, as well as serving its basic function as a connector.

When overlooking the Pacific Ocean, besides Dongbaek Island and Gwangan Bridge, viewers can also see Tsushima Island. Haeundae is a place of beautiful scenery, holding the promise of a great resort destination, where Busan city officials are trying to re-invigorate the tourism, encouraging the city towards being a new future international travel destination.

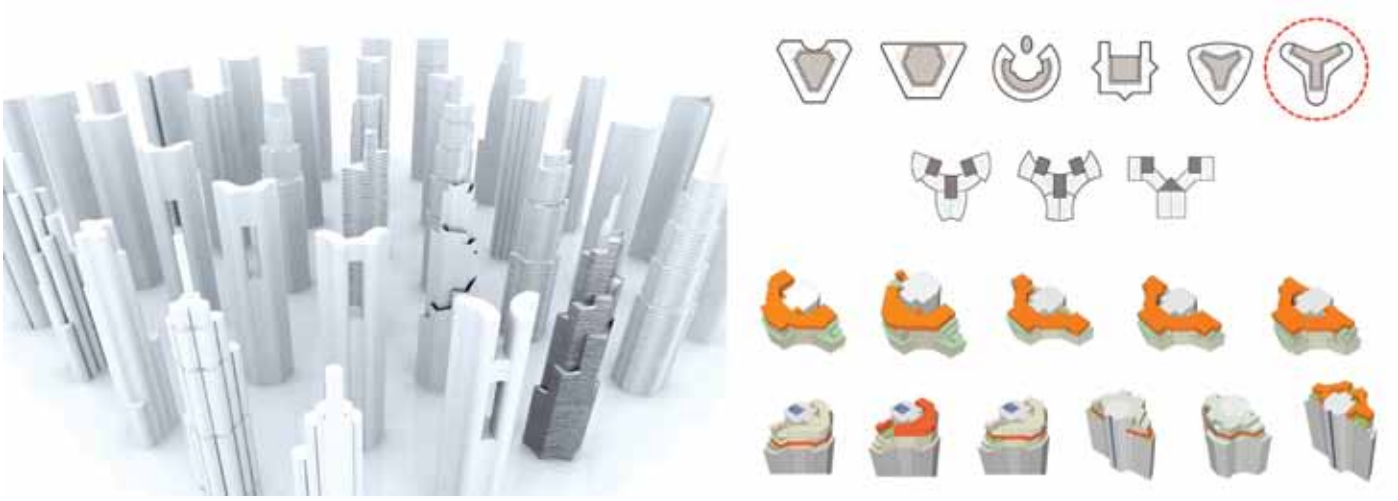
SKYSCRAPER Driven From Inside Out

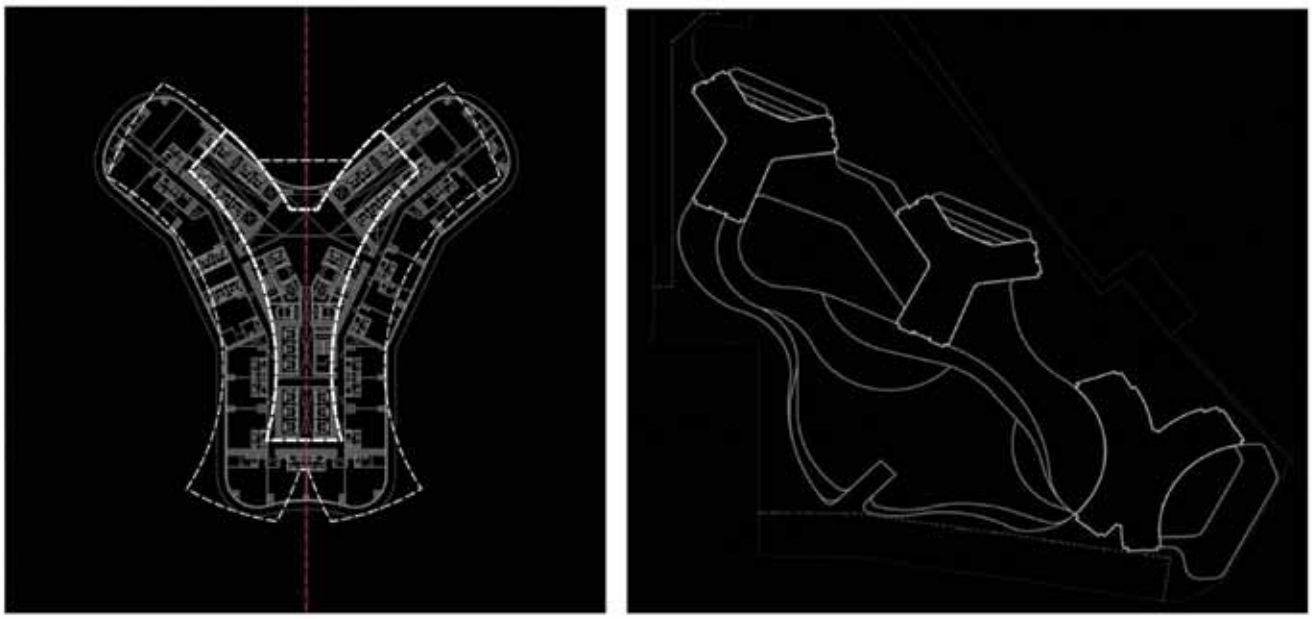
Relishing the attractive natural and artificial beauty of Haeundae, how would one develop an ideal form of architecture? While the ideal option lies in maintaining nature as is, it is inevitable to take a method of vertical expansion as compact as possible - into account to accommodate the fast growing city. Busan, with its contextual advantages from nature and infrastructure, seeks for a kind of skyscraper that would call attention to nature while functioning as an anchoring landmark.

In HRP, considering the residential density, providing every unit with an unobstructed view is a challenging task. The distance between the three towers is determined by gross floor area (GFA). In order to offer every unit a private terrace, the tower mass becomes a tapered Y-shape. Such a shape has the advantage of having a longer perimeter to retain more visual openness. The tower placement has undergone various forms of simulation analysis and confirmation to achieve the wider perspective with optimal efficiency. The 101-story landmark tower follows the two residential tower shapes to create similarity in forms. After resolving the basic placement, the next step was to decide orientation angles for each tower.

In the HRP Design Competition in 2007, Samoo was selected as lead architect and – in addition to collaborating with Kohn Pedersen Fox Associates and Skidmore, Owings & Merrill LLP as a team developing and preparing design packages for multiple proposals through from 2010 to 2012 – has continued to work independently on delivering the design development package for three following years.

The floor plan is developed to ensure that every unit gets an open view while remaining a comfortable distance from each other, without losing the exclusive quality of a luxury resort apartment. Accentuating the spatial quality of the Master Zone that includes a master bathroom with an ocean view, distancing between rooms within units for privacy, and efficient kitchen layouts were all considered as formative factors. To achieve the maximum number of rooms with southern-facing ocean views, the core is shifted from the center to the north, though the center is typically thought of as the most efficient. Fin walls between units support the Y-directional loads.





Determining the best orientation of the tower involved various simulations to provide sufficient openness. To accomplish this, simulations were done for every single unit, despite some of them sharing the same layout. These were then presented to the public to communicate a better sense of the spatial experience. The view varies from each floor level of the same tower, and from each direction in the tower, as well as the distance between towers. Preferences of future inhabitants were thoroughly analyzed and were reflected in later designs. Unit conditions are then sorted by field of vision in the following categories, in hierarchical order: "ocean + bridge + island," "ocean + urban," "ocean" and "mountain."

The first three conditions have the best views, and are thus are dedicated to residential functions. A notion that the graded quality of a view could be converted into price for housing and/or hotel is not without precedent, but HRP's architectural configuration featuring a detailed classification of views is a new approach in a high-rise tower.

Since the introduction of 20–30 story apartments in Korea in the 1980s, large-scale residential architecture has been developed almost solely around efficiency in unit plan, circulation, and function. Regretfully, this has resulted in a culture where large-scale housing developments without such elements are seen as unprofitable, and so are not typically built.

Parameters for height have been set through view simulations to avoid possible visual disturbances. For instance, the podium program is set above the 7th floor, which is the height that surrounding buildings are limited to. The design intention focuses on how the space would be perceived looking outwards, rather than how it would be seen from outside, leading its users to appreciate the value of the landscape by inhabiting it.

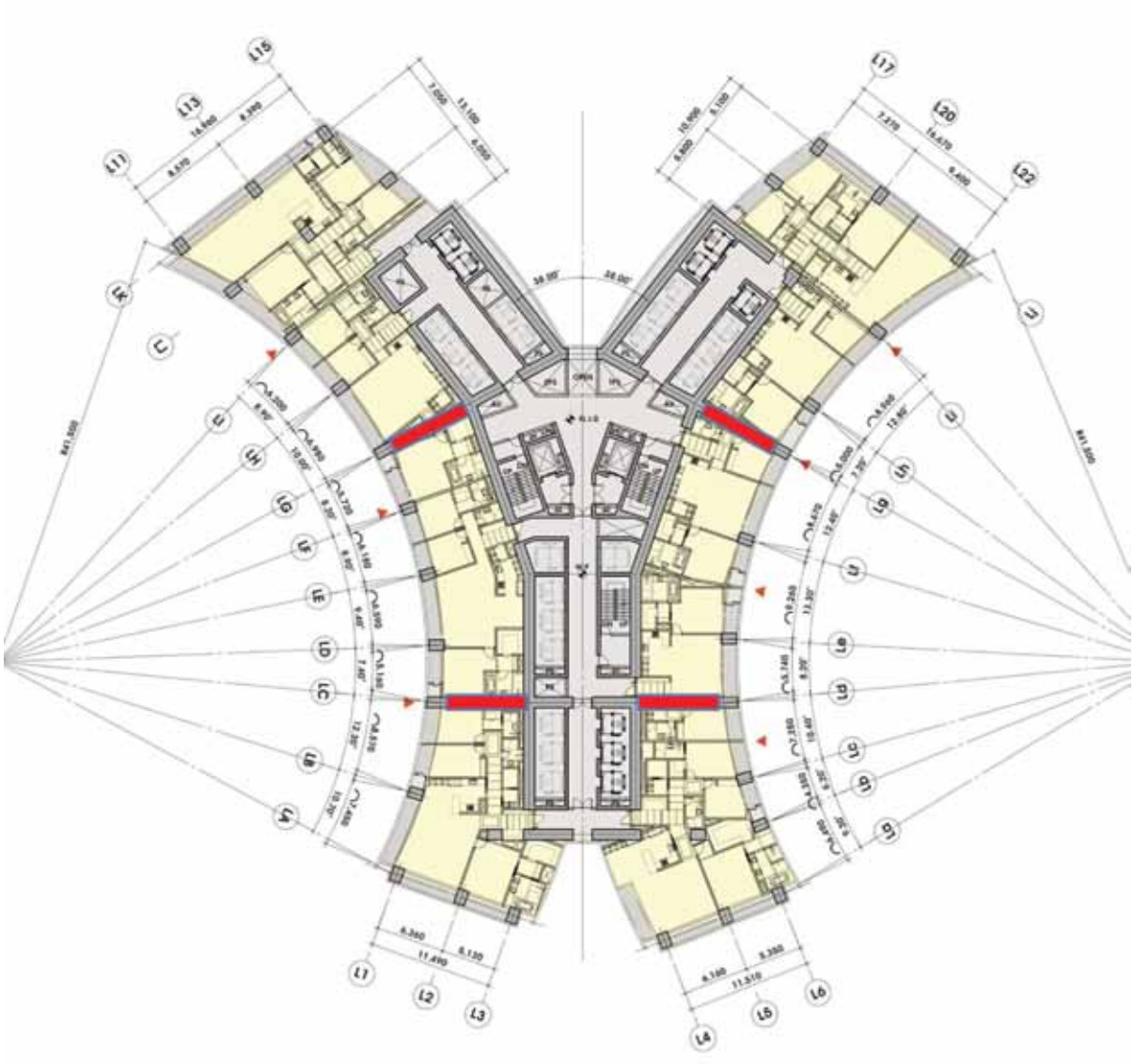
Through these arrangements, unfortunately, the thickness of the north core wall reaches 3.5 meters. These structural solutions aren't made based on objective parameters, but as an immediate response to the design needs and conditions. By comparing various structural alternatives, the structural

Opposite Top: Tower and plan options in the concept phase. Source: Samoo Architects & Engineers

Opposite Bottom: Plan showing the orientation of the towers with respect to each other. Source: Samoo Architects & Engineers

Bottom: To achieve the maximum southern-facing ocean view, the core wall has shifted to the north from the center. The structural team suggested fin wall between units to support Y–direction lateral forces. Source: Samoo Architects & Engineers

"The project has been developed with one overarching goal: how the supertall building will regenerate and harmonize with existing surroundings… Such an approach begins from the inside out, evolving from a unit plan that considers the natural lines and boundaries of the nearby sea and mountains, to a building mass, and then finally to a master plan."



Bottom: The four categories, ocean + bridge/ island view, ocean + urban view, ocean view, mountain view. Source: Samoo Architects & Engineers

Opposite Top: View simulation for each residential unit. Source: Samoo Architects & Engineers

Opposite Bottom: On the process of mass variation, non-symmetrical methodology was used to reduce for each wing over outrigger floor. Floor plan shape is reduced from 50th and 78th floor level. Source: Samoo Architects & Engineers

engineers determined the most efficient system for the project.

The combination of units on a typical floor has since changed, but equally intentional architectural and structural evaluations and analysis are still in progress. Tight requirements set by the client – to give every unit an open view, and to create a gross leasable area that is 70% of gross floor area, and six separate unit types – didn't allow much morphological freedom in the tower design.

Tower's Column Spacing & Massing Principle – Regular vs. Irregular

In residential building types, columns are undesirable. Concrete is the preferred material for residential buildings, due to its high resistance to noise and vibration. However, when compared with steel, it allows for smaller span lengths.

In many high-rises, although various programs are stacked together physically, they stay independent from one another functionally. The lack of elevated connection between programs on different levels makes it difficult to find a column spacing with the least spatial interruption. Exposed columns in a residential unit are even more problematic; thus, establishing a column grid that satisfies the residential, commercial, and hotel floors called for very careful planning. In order to accomplish optimal living conditions for the housing units, the project team confronted several technical issues, such as column spacing for best views, building operable windows and outdoor balconies within high windy conditions.

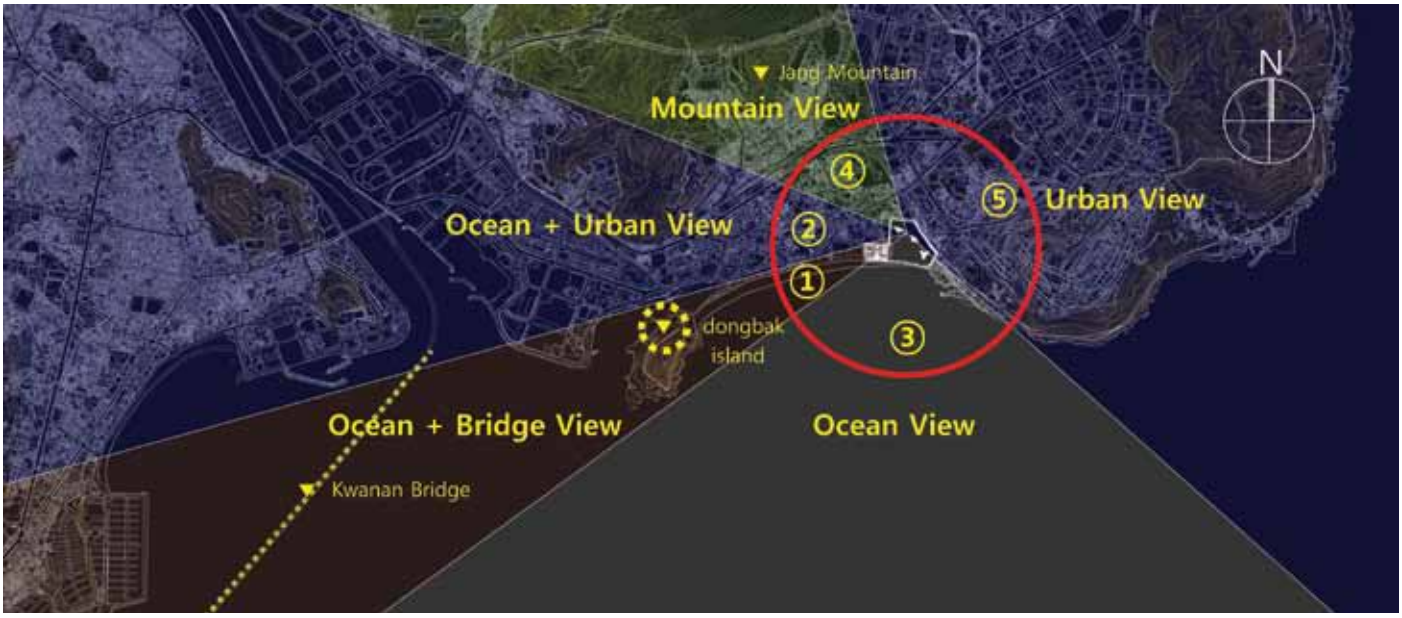
To solve one of these issues, columns are located irregularly to avoid being exposed in living or dining rooms. These irregular columns have various profiles for different programs, and are sometimes substituted with appropriate fin walls; these are then further supported by edge beams added to the end of floor slabs, which are used to transfer loads properly and equally. Outrigger floors between independent programs have been introduced as another structural solution.

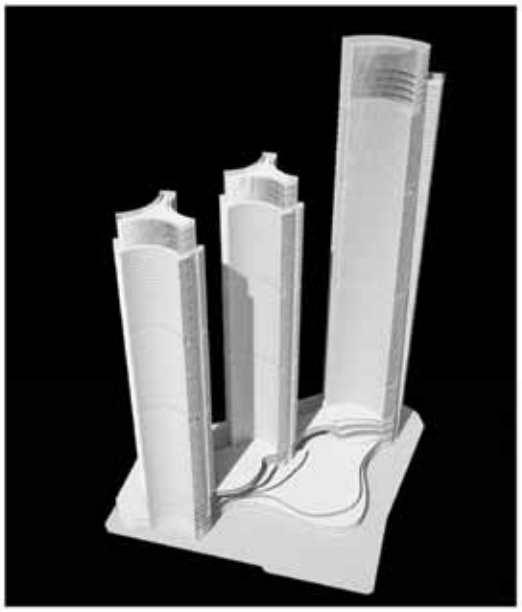
Another structural irregularity is in transforming its vertical volume. The 101-story landmark tower is composed of four outrigger floors. For better efficiency in resisting the lateral force and wind pressure, and further optimization of spatial use, the floor area on the 50th and 78th levels has have been reduced. To allow more panoramic views to the south volume, the north volume has been diminished as well. During the study of massing, non-symmetrical methodology has been continuously used to deduct floor areas from each wing to highlight the outrigger floors.

Adaptation to Allow for Natural Air-flow in Residential Units

Other than through floor plans that brings the landscape inside and variance in elevation that maximizes openness and closure on required levels, what other ways could architecture communicate through nature? Despite the major structural implications of typhoons on the building, and the necessary strength and rigidity they have to provide to account for those conditions, it was still very important for the design process to consider the sensory experience of the building's inhabitants and neighbors.

RWDI, BMT, and Chonbuk University have been brought on to the project to identify a way to optimize a design for this harsh wind





environment along with structural engineers and curtain wall consultants. The range of research covered tower shape, orientation, and material selection and thickness.

Wind tunnel simulations were used to determine the ideal shape of the building and its orientation for the site. Cladding pressure (net design and differential design cladding pressure) and wind environment studies are executed to further optimize the cladding design. The average maximum (positive) and minimum (negative) pressure on the cladding for each tower are tested between 4 to 6 Kpa. However, from a rationalized block diagram, pressure levels at the most affected point is measured from -8 to -9 Kpa. To keep balance between design intent and cost, the material division of horizontal and vertical was tested which would affect the façade design.

To maintain living conditions ideal from the stack effect, the location of the core and the entrances are arranged accordingly. Additional doors are added in the hall at each floor to control air flow from elevator shafts. Additionally, operable windows in residential units boost natural ventilation. Mock-ups were made and tested prior to the construction phase.

Evolution Tower of Moscow (2014) has a restaurant at the observation level. Its windows, which are operated by remote sensors, open up to delight visitors on the 61st floor. This has greatly inspired the architectural team to create such an experience taking advantage of the natural beauty of HRP's surroundings. Some challenges of these operable openings included issues of drafts, air-tightness, air-pollution, noise, and safety.

Balconies on Tall Buildings for Communion with Nature

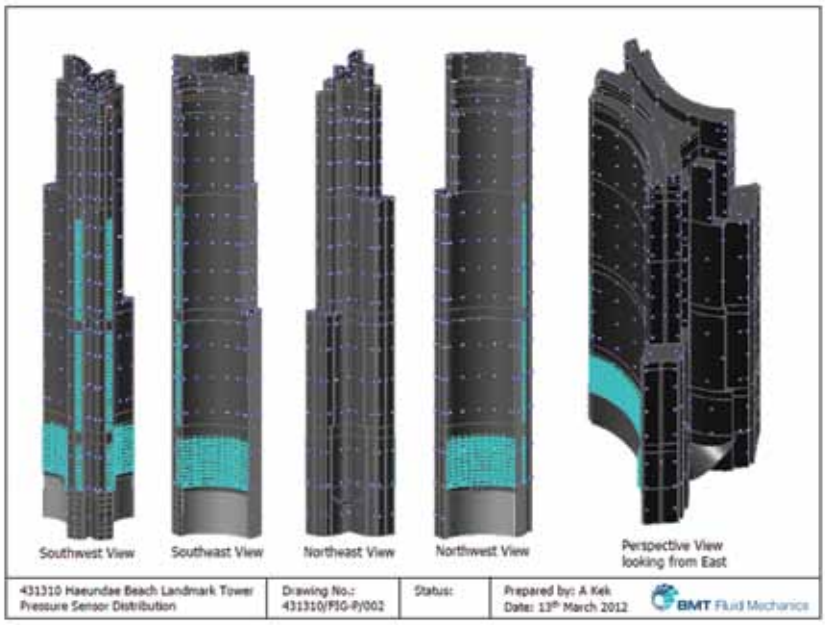
While operable windows are planned as a passive ventilation system, a balcony for each unit is proposed as an active one. These balconies provide high-rise tenants with access to fresh air. Similar to operable windows, these balconies are followed by concerns of maintenance as mentioned above - which is why related consultants have been against them, regardless of the possible cost savings from natural air-conditioning.

To cope with the stack effect, the entrances and elevators are situated in such a way as to block rapid air movement, and doors on other levels are remotely controlled to secure airlock. These systems all add to bigger construction costs and a heightened need for safety; however, they are still pursued to provide sufficient exposure to nature on higher levels, as such desire is considered primary to the residents' wellbeing.

Cascaded Shaping of Podium for Natural Landscaping

The lower-level podium design has to be treated differently from the tower design. In contrast to how the tower needs to be quiet and private for residents, the podium needs to be vibrant and public, as it is open to both residents and visitors. The podium includes a water park, hotels, retail areas, restaurants, and other amenities. Such a contrast in tone led to a decision for a clear spatial separation between the two.

Creating a large-scale podium implicitly causes visual interruptions for its neighbors. Local civic organizations resisted the construction of the high-rise building. One of the main reasons was the potential visual disruption of the surroundings.



Left: The cladding maximum (positive) pressure and minimum (negative) pressure in elevation for each tower is general 4-6 KPa. But worst point from graphical presentations of rationalized block diagram is closed to -8~-9 Kpa.
Source: Samoo Architects & Engineers

Bottom: Each program has separate points of access. The podium mass is stacked in a cascade to allow the independent entrances and lobbies to be closer to the landscape. These setback spaces allow circulation in and out freely.
Source: Samoo Architects & Engineers

Opposite: The cascading terrace provides a connection from Haeundae beach. Source: Samoo Architects & Engineers

The upper middle section of the podium volume is removed to allow a big open space facing the mountain, accessible from the tower while in dialogue with the context visually and physically. The visually open circulation paths on the north and south façades on lower levels allow panoramic views of the beach to the mountains.

The pedestrian retail entry at the south of the Haeundae Beach has been developed as a gateway to the retail and entertainment program within the podium complex, as well as a destination in and of itself. Designed as a gathering point for the public along Haeundae Beach, the interior and exterior space has been designed as a space to gather and socialize.

A water park is located at the top level of the podium, which opens up to the ocean. Much like in the infinity pool of the Marina Bay Sands Hotel of Singapore, the HRP podium is designed to be a place memorable for its unexpected openness, set in the middle of a bustling metropolis. Through such openness to nature and the city, the skyscraper approaches to people as more friendly and welcoming. Once people experience the ocean view from the water park, they will surely have a strong desire to return.

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Visitors exploring the shopping mall and complex may want to take a break to enjoy the outdoors. A cascading terrace provides a connection from the beach to the above podium levels, and offer seating with great views where visitors can rest.

The designers of the HRP Resort were inspired by houses in Santorini, Greece, which are laid out naturally on the undulating contours of the hills, rather than in an orderly arrangement, making each house unique and personal.

Getting away from the rigidness of a mega-structure, and incorporating the natural flow seems extremely relevant considering Korea's mountainous topography. HRP aims to become an urban paradise within a busy commercial district.

Beyond New Technologies for Skyscrapers

Each high-rise project requires that appropriate design technology is selected, based on budget, trend, and programmatic relationships. Fortunately with current advancements in technology, limitation for design and construction is becoming infinite and calls for newer ideas and challenges.

Many of the earlier mentioned strategies are rather radical to the related consultants and thus seem structurally risky and problematic from conservative perspectives. HRP has been developed over the past seven years, and its underground civil engineering work began in 2014. During this time, several circumstantial changes were made - including government reinforcement in tall building code (requiring extra permit processes); and program revisions requested by the client.

As an aftermath of 9/11, the preventive measures in Korea against terrorism, fire hazard, and other natural disasters have intensified. Social demands for architectural solutions require newer systems, materials, and methodologies. In delivering such an architectural response, a representation

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of tall buildings needs also be more sympathetic. A skyscraper is an ideal architectural solution for a compact city that resolves extreme population density issues, while its construction—aided by advancing technology—is cheaper, faster, and more efficient. It is a solution that needs to be continuously developed and challenged.

A skyscraper should not be an grandiose building that overpowers its community and environment. Moreover, as it will significantly influence the urban and regional environment, the designer and client should focus not on their profits, but should instead sufficiently consideration of how to contribute to the regional development and environment. HRP is developed with a conscious effort to harmonize with nature and bring its beauty and experience into the city.

Final Thoughts

The HRP design team was able to resolve all of the unique challenges of this project: providing open views to the ocean, an efficient structural system, and a vital dialogue with nature. In addition, the building design has been developed by unique and strong requests by the clients. For this, it has been confronted by several technical issues as described above. In spite of all difficulties the design team has been achieved the most efficient solutions for the project. From the beginning, the design team has been developed with one strong goal, which is how the supertall building will harmonize with its surroundings and blend well with nature. Moreover, it has been carefully examined in many aspects above all how the project will enhance the City of Busan.

HRP will indeed be one of tallest buildings in Busan by 2019, when the building is projected to be completed; moreover, it will truly be an icon of the city.