Title: **What Could be the Correct Design Focus for the Supertall Buildings?**

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What Could be the Correct Design Focus for the Super Tall Buildings?

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Following the terrorist attacks on The World Trade Center on September 11th, 2001, many people questioned whether super tall buildings would ever be built again in the future. The answer seems to be a resounding "YES", especially in Asia and the Middle East. Naturally the next question is "can we design a tower better prepared to withstand a terrorist attack?" At the same time, we must ask "what is the correct design focus for future super tall buildings?" I discussed the first question "better prepared to withstand a terrorist attack" when I was here last time. Today I would like to talk about the next question "correct design focus/design approach for future tall buildings". Our quick answer to this question is "safety, safety, safety" because of the fear invoked by 9/11. However, we all know that this may be today's top priority but not necessarily tomorrows.

Throughout history, our buildings and cities have been destroyed by wars, fires and other natural disasters. We have improved our design and construction to prepare for those disasters. Terrorist attacks would be considered one of those. We should think about what then, are the most important **design goals** we should focus on. The ultimate design goals even after 9/11 may be "creating the best possible built-environment" for the residents and consumers that use the building. Therefore, our **design focus** should be based on how the building can contribute positively to the neighborhood, community and city that the building is located in. It can also be described as **"human centered design"**. This means that the design should focus **on people and for the people**. At the same time the design should be environmentally friendly and sustainable for people today and in the future. These design goals and design focus apply to all buildings as well as today's topic of super tall building.

Now let's think about why are we building super tall buildings, what are the major design issues and concerns? Most of you who are here know the issues but let's think about the idea of "human centered design focus".

Why Build the Super Tall Building

The main reason may be its **bold and powerful presence** in a city. It is a **symbol of pride** for the owners, communities and cities; it can also be a symbol of national pride. Other reasons may be land cost, convenience, market dominance, tourist attraction and if we stretch contribution to sustainable development.

Our office, Parker Durrant International (PDI), is fortunate enough to be involved in the design of Lotte World II Tower in Busan, Korea. This mixed-use complex of commercial, office, hotel and retail space will be housed in a 107-story, 510-meter tall building. The design approach and process of Lotte Tower,

including data gathering, research, analysis of the information, synthesizing, problem solving and creative activities is similar to other major complex buildings we have done. But there are some unique challenges due to the height and its mega-size, mixed-use functions.

Design Team

The more than 30 **design team members** of PDI need the assistance of more than 60 consultants/experts. These consultants/experts will provide design input at various stages of design with different levels of involvement. This means that the design team needs well organized, systematic coordination efforts throughout the entire design process.

Design Goal

Our design begins with a clear understanding of why we are building the tower, what are the **design goals** and **design criteria** and what is the most appropriate **design process** and **design approach** for the building.

Some of the major design **goals** and **objectives** for the team are as follow:

- Appropriate **image** – Image of the city, country and/or owner's company. For example, Lotte Tower has an image of **"Jang Seung"** a traditional Korean Totem. This tower shape symbolizes that the tower will protect Korea and Busan from the South Sea. The design team also shaped the tower with traditional Korean curve and with the Korean color **"Sac Dong"**.
- Aesthetically **pleasing** – The tower should be beautiful with the hi-tech image of Busan.
- Best design for **business success** – Lotte tower achieved the goal of100% ocean view rooms for all hotel rooms for better room rates.
- **Simple and clear** solution – complex mixed-use buildings require a simple design solution as well as easy wayfinding design internally.
- **Structurally sound**, economical and easy to construct – constructability issues will be thoroughly examined.
- Expression of **function** – Lotte tower has three major functions; commercial, office and hotel which were also expressed and defined by "Sac Dong" color.
- **Contributing** to the neighbors and to the citizens of the City of Busan for its symbolism, tourism and economy. Tower location is critical to achieve this goal.

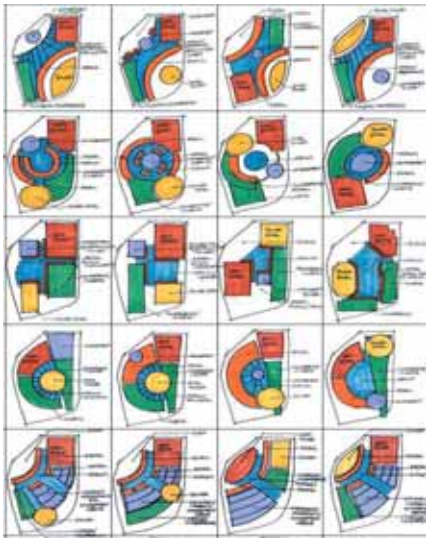
Mixed-Use Function

Super tall buildings generally contain many **mixed-use functions**, as a result they are often called **"city within a city"**. So when we are designing a tower, we are not only designing a **building** but also designing a **"vertical city"**.

Relationship with the City

The super tall building or "vertical city" has a very strong relationship with the city it is located within. Let's refer to the city

as the “mother city”. The analysis and research of the **“mother city’s”** population, character, landmark value, location, infrastructure and transportation system is as critical as for the new **“vertical city”** itself. This information is also crucial in finding a good location for the tower, which is very important to the success of the project. The city’s massive population increase caused by the super tall building and symbolic landmark value can increase tourism and commercial activities in the “mother city”. This can be considered a positive impact but the question is how can we design the tower to minimize the negative impacts to the “mother city”.



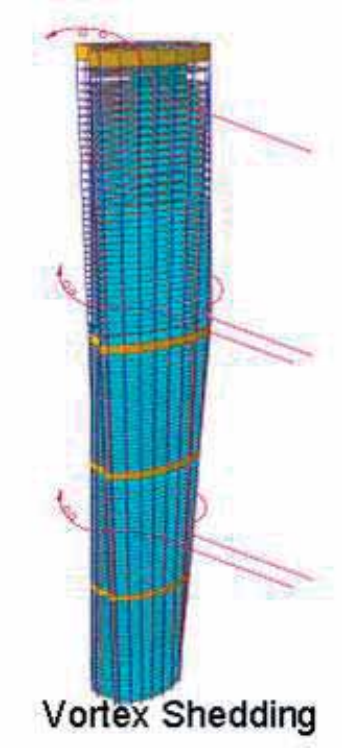
Mixed-use BLDG.
107 Story
510M
5,640.000 sf. Development
Office : 883,000 sf.
Hotel : 824 beds
Short term - 500 beds
Long term - 324 beds
Dept. Store : 546,000 sf.
Discount Store /Retail : 109,000 sf.
Cinema : 11 Screens
IMAX : 1 IMAX
Conf. Center :69,000 sf.
Parking : 2350 cars (980.000 sf.)
Observation / restaurant :105.500 sf.

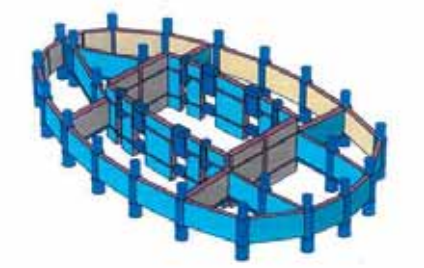
Master Plan / Site Plan
The **master plan** should be developed after a thorough site analysis and many option studies. Automobile, traffic and pedestrian impact, accessibility, minimal blockage of view and minimizing the building shadows to neighboring buildings are some of the design criteria to be considered. The proper site location for the Lotte tower and its triangle shape helped us to achieve the Lotte’s business goal of 100% ocean views for all hotel rooms. At the same time the major design issues and concerns were resolved.

Building Program
A good **program** based on a reliable economic feasibility study is critical for the success of the project. In the case of Lotte Tower, PDI obtained the expert knowledge of two economic consultants, ERA in the United States and KIRA in Korea. During the 2 year design process, the Lotte Tower program has been stable but the lower base building program changed a lot in order to respond to market changes. Due to the long duration of the design and construction phases, this type of program change is expected. It is important that the design team provide **built-in** space **flexibility** for future program/market changes throughout the life of the building, especially for the lower base building. Ten grid meter module has been used for flexibility of the lower building.

Program Allocation
The allocation of programmed space in the Tower has a conflict between functional requirements and structural requirements. Structurally the hotel and residential (due to short span requirement) should be lower than the commercial spaces, which is not functionally acceptable. These examples are too simple to make a decision but good space allocation for various other functions can be a tough one which can have a major impact in terms of initial construction costs as well as long term maintenance costs of the tower.

Design and Culture
The design team should be aware of and understand the importance of the cultures and political and social issues of the city and country where the tower will be located. The design team should also be aware of the codes, regulations, zoning





requirements and life safety issues of the various governments. Foreign A/E and consulting firms especially need to prepare themselves for working with local architects and engineers; their design approach and process can be drastically different from what they have been doing.

Technology and Building Materials

Learning about the possibilities and limitations of technology and building materials is critical to the success of the project. Designers working on tall buildings today will learn that the technology once used a few years ago is no longer valid. New technology and new building materials are being introduced at a fast pace; it is important to keep abreast of these changes and additions. The new demand by the ever changing nature of business and lifestyles also forced us to incorporate these technology changes. The demands for higher quality living and working conditions plus the desire for modern city life with better security, one-stop convenience and demand for more value for the money are all reasons for new technology in super tower.

Design Decision / Selection of System

The designer may make more than ten thousand design decisions during the design process for a large size building. This includes selection of the technology, building products and various systems. For the designer of the super tower these decisions are lot more complicated due to the height of the building as well as mixed-use functions. All the decision should be made based on good research, good analysis, thorough comparison of each option and value engineering techniques. Be sure to give first priority to a decision based on which decision will benefit the people who will use the building.

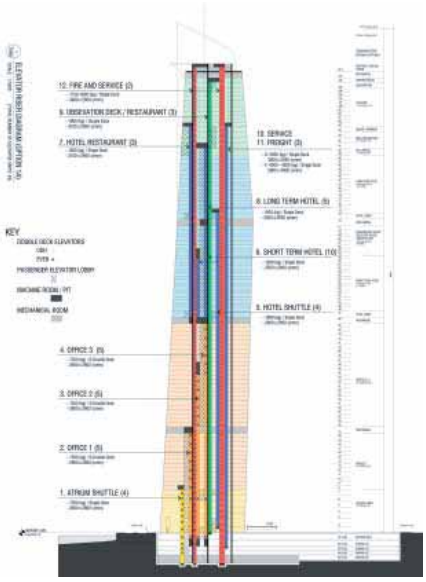
Structural System

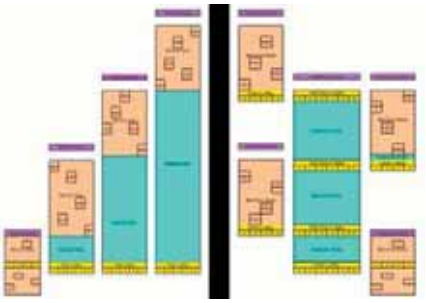
The good structural system for the tall building is the most important by the obvious reason. The Lotte World II structural system was selected based on construction cost, construction time and quality control issues during the construction. The other major selection criteria were life safety, tower height, functions (hotel/offices) of tower, core shape and size, and seismic and wind design requirement etc. The following are major selected structural systems for Lotte World II Tower:

- Core and floor framing system will be concrete.
- High strength concrete filled steel pipe columns of 2.25 meter diameter at the bottom and 0.7 meter at the top of tower.
- Column spacing is 4.8 meter on center
- Four full height concrete wall outriggers at mechanical floor levels.
- Tower shape was created based on the criteria of minimum vortex shedding effect.

Core Design

Core design is one of the most important and complicated problem solving design activities. Successful core design requires thorough coordination of many systems such as elevatoring, structural, mechanical/electrical, and communications systems





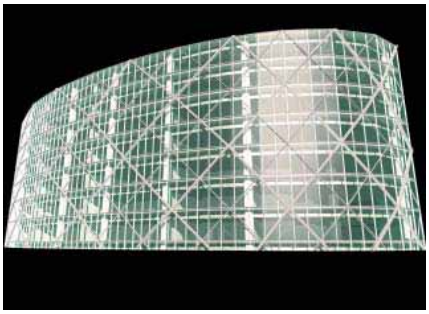
as well as fire and life safety systems. Emphasis shall be given to the convenience of the users. The RJA Group, life safety consultant for Lotte tower recommends some changes in core design as part of post 9/11 in order to improve safety for the occupants as well as for fire fighters during an emergency. They also recommend life safety redundancy such as additional areas of refuge, floor and building compartmentalization and protection of egress stairs, fire fighter's elevators and life safety system risers.

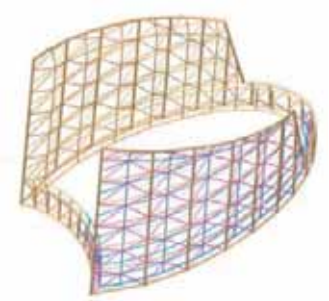
Elevatoring System

Elevators in tall buildings are the same as streets and highways in a city. Having an increased number of elevators for the tower would be nice for the occupants but the size of the core and the construction costs would be increased. A good balanced decision on the number of elevators and its system is critical for the users. The elevatoring systems should be selected based on following criteria:

1. Elevator performance
2. Passenger comfort
3. Building profit
4. Initial cost
5. Elevator space

Lotte tower will have a double deck system for the office with multi sky lobby system. The design of **elevator cab** has been improved to incorporate a hi-tech appearance with a computerized video information system and a security system; it even has a leaning seat. An elevator attendant will be hired for Lotte Tower to guide the customer from ground level to the hotel sky lobbies for their comfort.





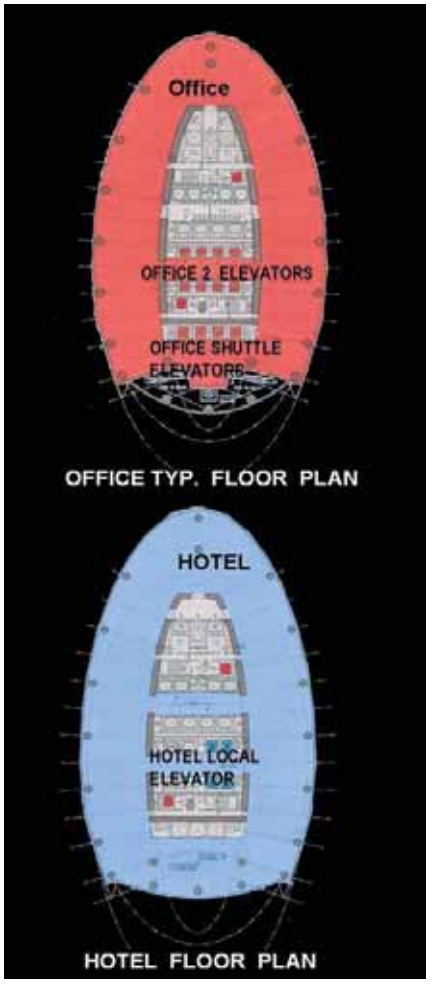
Curtainwall System

The curtainwall system for Lotte World II selected to use triangular facets due to the unique shape of tower. The curtainwall generated from radial grids and groupings of divisions formed by radial grid. Curtainwall design experts (CDC in Texas) are essential to the design team. They will ensure that the system will provide structural integrity, total resistance to water penetration, air infiltration, eliminate condensation, and provide proper weep hole system. We had to also find a device for fire prevention from one floor to another; inside as well as outside.

Low-E laminated insulating glass will be used for better energy saving. The design team is also looking into a **self cleaning glass system** which is new and it will substantially reduce maintenance costs.

Wind Tunnel Testing

The city of Busan, Korea is known for its strong wind. Wind tunnel testing is essential for structural systems, curtainwall system



design and for the determination of wind patterns at the pedestrian level. The following three types of wind tunnel testing were required:

- Force Balance Test – structural
- Pressure test - curtain wall
- Assessment of Wind Environmental Problems Test – pedestrian

PDI proposed to use a newly introduced computer based **numerical simulation testing** during the schematic phase instead of the wind tunnel test because we expect many design changes during the schematic design phase. However, we were informed that the Korean building review board will not approve the computer simulation test yet.

Damping System
The strong wind causes tower movement at the top, 1.0 meter maximum for Lotte World II tower. There are three major methods to stop the back and forth motion: “Tuned liquid mass damper system”, “Passive tuned mass damper system” and “Active mechanical damping system”. From these three options our design team selected the “Liquid damping system”. This system is a very effective damping system for the users and provides the option of using the liquid damping material as **water** during fire emergencies.

Other Systems
The highest level of intelligent building systems will be utilized for the tower in order to conserve energy and for the occupant’s conveniences. I expect that other speakers will cover this subject in detail; therefore I will limit my comments.

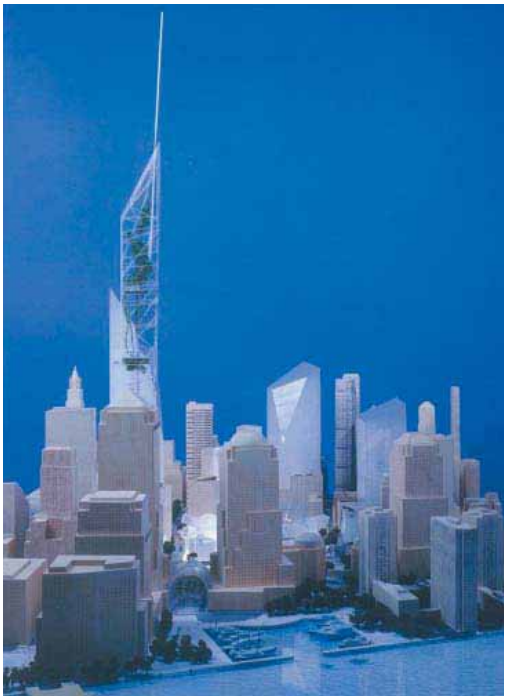
A good service and product **delivery system** and **recycling system** for trash is critical to the bottom line of management cost, which will lead to the success of the project. Lotte Tower has a central delivery and recycling center at B-2 level.

Design Coordination
Good coordination of design documents prepared by numerous design teams, consultants and experts will lead to better, smooth construction. This effort will also contribute to the saving of material by minimizing the changes. A good cost planning, design scheduling and implementation, constructability check, and good quality documents are also critical to the project success.

Conclusion
We have discussed very briefly for the major design issues and unique systems related to super tall buildings. Now we may have to conclude the discussion.

The super tall building is one of the highest achievements of human kind. It is the symbol of success and the pride of the people who own, use and have it's presence in their town, city and country.

The desire to build the tallest tower will be continued no matter what threat may exist. There may be many design processes and design approaches for the tower but the correct design focus should always be "human centered".



The tower has many unique design issues and concerns as well as many technology limitations due to its height and mixed use functions. I feel the correct design approach should be based on the idea that we are designing not only a building but a "vertical city" due to its size and its impact. This city should be very beautiful, safe, functional, and convenient to the residents, users and visitors. This "city" should also be a contributing member to the "mother city" as well as a symbolic pride to many people for a long time.

Thank you for the opportunity to speak to you today.

Design Architect : Parker Durrant International(PDI)

Korean Architect : Baum Architects

Structural Engineer : Magnusson & Klemencic Asso.

Mech. / Elec. Engineer : Cosentini / Durrant Engineering

Vertical Transportation Engineer : Otis / Latch Bate

Curtain Wall Consultant : Benson Global / CDC

Wind tunnel testing : The Boundary Layer Wind Tunnel Laboratory

Traffic Consultant : Do Hwa Engineering

Hotel Consultant : PDI HAWAII