# Chapter 4.2

# Delay the Generation of Demolition waste: Optimizing Building Lives of New Buildings

**4.2.1. Optimizing Design Lives**
**4.2.2. Design Flexibility**
**4.2.3. Design for Reuse and Recycle**
**4.2.4. Oversizing Structure**

This chapter investigates the possibilities to minimize waste generation by extending building life span through design measures and concepts such as: the optimization of design lives, design flexibility, design for reuse and recycle and oversizing structures.

- The optimization of building lives is one of the major factors of minimizing waste as it delays its generation; causing waste to stay away from the waste stream cycle.
- Flexibility is essential to allow longevity and to suit the needs of future occupants.
- Design for reuse and recycle allows easy repairs without total demolition, causing waste to also stay away from the waste stream cycle as it is reused and recycled.
- Oversizing structures allows for flexibility in loading and therefore optimizes building life.

According to a survey conducted by the Department of Civil and Structural Engineering of The Hong Kong Polytechnic University in 2001, the average life of buildings in Hong Kong is about 30 to 40 years, which is quite an optimistic view regarding the reality. In fact, some buildings are demolished after fewer than ten years of being built, and even shortly after the completion. The existing situation must change, and new designs must consider the optimization of building lives.
Therefore a global vision of the future is also necessary in the design.
“The architect must be a prophet, a prophet in the true sense of the word; if he can’t see at least ten years ahead then don’t call him an architect”.
Frank Lloyd Wright (Source, Green Architecture, James Wines, Taschen, 2000)

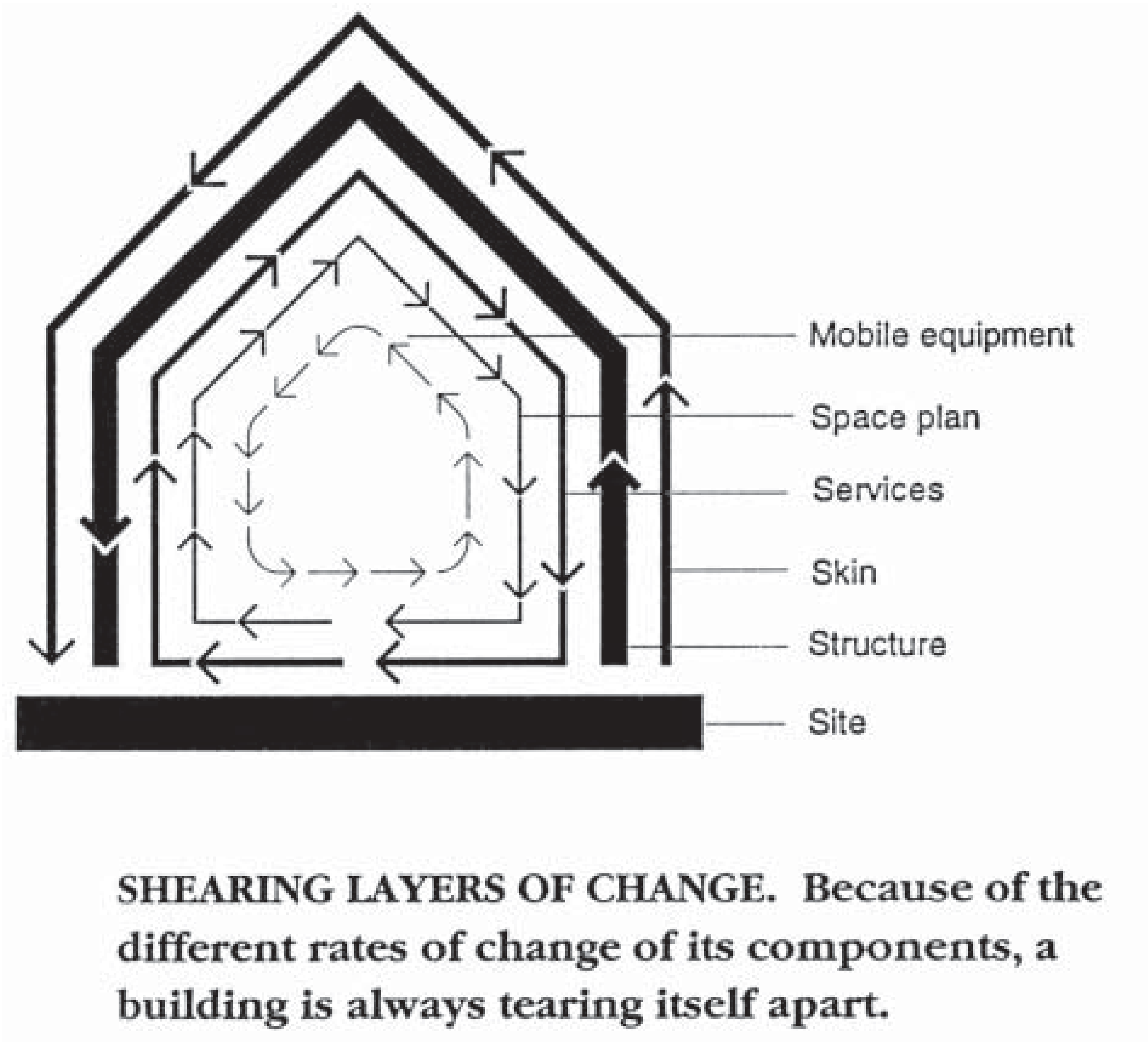



Figure 10: Shearing Layers of Change. (Source: How Building Learns: What Happens After Theyíre Built, Stewart Brand, 1994).

# 4.2.1. Optimizing design lives



Optimizing building lives through design concepts and measures is a major issue of minimizing waste as the generation of demolition waste is delayed for as long as possible.
The general attitude in Hong Kong is more concerned with short-term developments (and short-term profits) hence this attitude should change and evolve towards long-term developments, approaches and thoughts.

**Objectives**

- **Optimize the life span of new building structures to keep components out of the waste cycle for as long as possible.**

**Waste Type**

Types of waste generated in building demolition:

- Concrete.
- Reinforcement bars.
- Woods.
- Bricks.
- Soils and sands.

**Strategies**

- Consider better designs to allow flexibility for future occupant's needs (e.g. fitting out, capacity…) to avoid demolition of the building structure.
- Consider a design that can be adapted and last through the fashion waves.
- Consider flexible loading to insure change of use, and to match future occupants' needs.
- Optimizing building lives should consider both structural and architectural elements and services.
- Select durable structural elements, as they should last longer than services and still remain in good condition.
- Consider the principle of separated layers in the building (interior, space plan, services, structure, skin, and site) to allow easy replacement of layers (for reuse and recycle) without demolishing the whole building. If the different layers are incorporated in a single structure, short-term cycles will block long-term cycles and avoid longevity of the building. (Refer to "Design for reuse and recycle" in this chapter).
- Consider disassembly principles to allow replacement rather than demolition (Refer to "Design for reuse and recycle" in this chapter).
- Consider easy assembly and disassembly, therefore avoid screws, glue, mastic agents… preference given to welding and soldering methods.
- Consider the selection of materials including aspects such as durability, quality, easy and cheap maintenance… (Refer to chapter 5.2 "Material selection" for more detail).
- Consider Life Cycle Analysis (LCA), to view all the benefits of optimizing building life and the environmental impacts on buildings.

## Life Cycle Design

### Pre- Building

**Use materials that are...**

**- Made of renewable resources**

**- Harvested or extracted without ecological damage**

**- Recycled**

**- Recyclable**

**- Long-lasting and low maintenance**

**Minimize energy needed to distribute materials.**

### Building

**Schedule construction to minimize site impact.**

**Provide waste separation facilities.**

**Use nontoxic materials to protect construction workers as well as end users.**

**Specify regular maintenance with nontoxic cleaners.**

### Post-Building

**Adapt existing structures to new users and programs.**

**Reuse building components and materials.**

**Recycle building components and materials.**

**Reuse the land and existing infrastructure.**

Figure 11: Life Cycle Design, Sustainable Design and Pollution Prevention. (Source: Introduction to Sustainable Design).

*An environmentally responsible industry*
*"The construction industry is among the worst polluters. To improve the environmental performance of local construction and improve the quality of life for the community, we should widely promote the concept of sustainable construction with emphasis on life-cycle benefits rather than short-term efficiency. We urge major clients to take a lead in practicing the concept of life cycle costing, which refers to the systematic evaluation of all relevant costs associated with the acquisition and ownership of a built structure. The proposals recently put forward by the Task Force on Building Safety and Preventive Maintenance on defect liability warranty will help to promote more durable and maintainable buildings have our support."*
*Henry Tang, "Construction for Excellence", Report of the Construction Industry Review Committee, January 2001.*

## Benefits

**Cost**

- Designing long life buildings may be more expensive at the investment stage, because of the higher quality and durable materials… but the building will last longer. Therefore it is a long-term profit.

**Environment**

- Avoid rapid demolition rates of buildings, and keep the components out of the waste cycle for as long as possible. Less waste disposed of at landfills.
- The life span of landfills is extended.
- Transportation of waste disposal, pollution, energy used and noise are reduced.

**Others**

- Optimizing building lives can be a marketing advantage, in terms of durability and good quality products for long-term investment.
- It promotes long-term vision.

## References

**Books**

- Brand S., **How Buildings Learn: What Happens After They're Built,** New York, Viking, 1994.

**Journals**

- **TG 22** – Environmental Design Methods in Materials and Structural Engineering (RILEM), Integrated Life Cycle Design, Asko Sarja. (Refer to the web site http://www.cibworld.nl/pages/ib/0005/Pages/Publications/TG22.html)
- Pulakka S., **Life-Cycle Cost Design Methods and Tools**, Integrated Life-Cycle Design of Materials and Structures, ILCDES 2000, Proceedings of the RILEM/CIB/ISO, International Symposium, Helsinki, Finland, 22-24 May 2000.
- Vares S., Vanhatalo L., Holt E., **Computer Aided Environmental Assessment for Building Systems**, Integrated Life-Cycle Design of Materials and Structures, ILCDES 2000, Proceedings of the RILEM/CIB/ISO, International Symposium, Helsinki, Finland, 22-24 May 2000.
- "Best Before End…", Smart Architecture, http://www.smartarch.nl/o2columns/smartarch998.html

## Other references

**Inside**

- Refer to "Design flexibility", "Design for reuse and recycle" and "Oversizing structures", in this chapter.
- Refer to chapter 5.2 "Material selection to minimize waste".

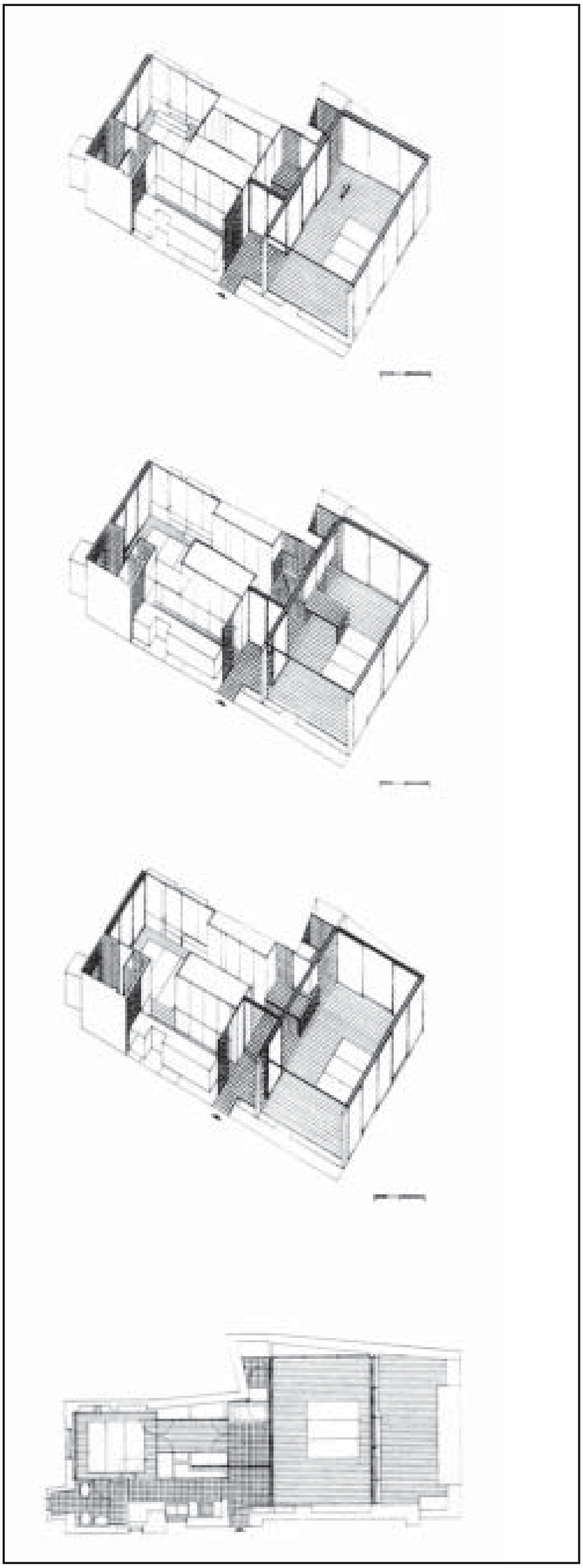
## Example

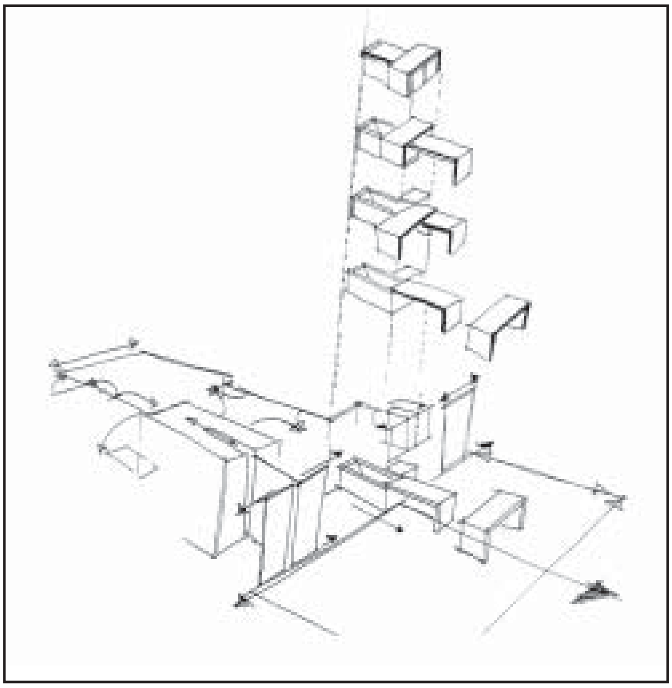
- ***Structural system for Porous-Type High-Density Dwelling Models.***

*http://www.takenaka.co.jp/takenaka_e/news_e/pr0101/m0101_05.htm*

*"By using this "Vertical and Horizontal Force Separation Support Structure System, the overall size and weight of materials can be reduced, and parts can be easily replaced, even the vertical support materials. This means it is relatively easy to change the exterior appearance and design, and residences with a long lifetime of over 200 years can be built."*

4.2





Monte Carlo apartment, 1997, Lazzarini Pickering.
Demonstrate the flexibilities in the layout of the appartment.
Left: Axonometric views showing the different types of layout of the appartment. Right: Scketch of the system.
(Source: Architectural Record)

# 4.2.2. Design flexibility



Flexibility is common in modern office buildings, which use open plan systems and removable partitions, but it is not so common in residential buildings. Flexibility should be considered in a safe way without generating waste. In Hong Kong, a lot of fitting waste is generated as people often change the layout of their apartments, and this should be avoided, or done in a waste minimization way.
It is a delicate subject as it may change the culture and way of living in residential buildings, which Hong Kong people may not be ready to as they usually require standards. It is a question of cultural change and market development. (e.g. The Integer project proposes changes and improvements on housing in Hong Kong).

**Objectives**

- **Allow flexibility for longevity to suit occupant needs for as long as possible.**
- **Allow refurbishment rather than replacement.**

**Waste Type**

Types of waste generated at demolition:

- Concrete.
- Reinforcement bars.
- Woods.
- Metals.
- Bricks.
- Soils and sands.

**Strategies**

**<u>Flexibility degree</u>**

- Allow for different degrees of flexibility to accommodate occupant choices and future needs, therefore:

Choices:

- Allow for flexibility to accommodate occupant choices, which includes minor changes such as internal or external colors and finishes, and medium changes such as partitions and layout.

Future needs:

- Allow for flexibility to accommodate occupant future needs, which includes also medium changes such as internal layout and major changes such as in structures, and allowing for flexible loading in the foundation (e.g. extension of a building or apartment…).

**<u>Flexibility for spatial changes:</u>**

- Spatial changes to accommodate different needs (capacity of people) and functions such as multi functional buildings. E.g. the polyvalent concert hall such as Bercy in Paris.
- For double use (daytime/night time, winter/summer) and efficient use of space. Example of the traditional houses in Vietnam. The houses are open spaces during daytime, and during night time, the spaces are partitioned with suspended fabric to create rooms.

**Flexibility and adaptation in time:**

To allow for flexibility, it is important to consider:

- Flexibility to provide choices in initial design, so that buyers and users can customize designs and physical arrangements to suit their particular requirements before the building is constructed.
- Adaptability to make easy alterations whilst the building is in use to satisfy user needs.
- Flexibility to enable periodical maintenance and renovation and upgrading of components, equipment and systems.

**Flexibility for reuse and recycle**

- Flexibility in the design can promote reuse and recycle of salvaged materials (see King County Case Study: Flexibility saves $6,500)
- Refer also to next chapter for details.

**IMPORTANT**
**Flexibility should allow changes without generating wastes. Therefore it should be considered either with longevity principle, and/or principles allowing reuse or recycle (e.g. the US company recycling carpets…).**

"This view has been strengthened by technological innovations that have taken place in the manufacturing process. These provide greater flexibility through the use of computer-controlled machines and make it feasible to produce every element as a unique item. Unfortunately, this also limits the replaceability, change of use and reuse of components – thus the flexibility and variability of architecture. The notion of uniqueness removes us even further from the concept of universal components and flexible building systems."
(Source: Open and Closed Systems – an Interview with Helmut Schulitz, Interviewed by Christian Schittich, Detail 4, 2001).

**Benefits**

**Cost**

- Flexibility for longevity avoids demolition and construction cost for new buildings.
- Flexibility allows for changes without demolition.

**Environment**

- Flexibility for longevity delays the demolition of the building and therefore delays the disposal of waste at landfills.
- The life span of landfills are extended.
- Transportation of waste disposal, pollution, energy used and noise are reduced.

**Others**

- Flexibility can be a marketing advantage in terms of adaptability for future needs (e.g. family needs change with children growing and moving out) and in terms of choices (e.g. selection of finishes materials and colors).

**References**

**Books**

- **Flexibility and Choice in Housing**, David Gann, Policy Press, University of Bristol, 1999.
- **Lifetime Homes: Built Today, Designed for Tomorrow**, Bright S., York: Joseph Rowntree Foundation, 1996.
- **Open Building for Housing,** Kendall S., Progressive architecture, November 1993.
- **Development Toward Open Building in Japan,** Kendall S., published by author, 1995.
- **Contemporary Change in the House Building Industry: Concentration and Standardization in Production**, Nicol C., Hooper A., Housing Studies, Focus Issue.

**Journals**

- Open Building Conference in Tokyo 2000.
- "Double Use", Smart Architecture, http://www.smartarch.nl/o2columns/smartarch900.html

**Web site**

- King County Solid Waste Division http://www.metrokc.gov



**Other references**

**Inside**

- Refer to "Optimizing design lives", "Designing for reuse and recycle", and "Oversizing", in this chapter.
- Refer to chapter 4.1 on "Rehabilitation of building" and "Extension".

**Outside**

- CIRIA, Adding Value to Construction Projects through Standardization and Pre-assembly, 1997.

Traveling membrane roof in Vienna City Hall (under Study), Silja Tillner.
It provides protection against sun and rain and allows the courtyard to be used for balls, concerts and other events.

Flexibility to accommodate different capacity and functions. Bercy Omnisports complex, Paris, France. It allows for different types of venues such as concerts, sports (hockey, boxing, moto-cross.. and even windsurfing and skiing), and training facilities.

**List of examples**

**Choice in finishes:**

- Example of Hong Kong Housing Authority projects allowing "purchasers choice" that provide options on type of wall and floor finishes, door finishes and sanitary wares, provision of bedroom partition, and choice of colour of kitchen/bathroom cabinets.

**Flexibility in the layout:**

- Office buildings that use the open plan system with removable partitioning systems.
- Monte Carlo apartment 1997, Lazzarini Pickering.
- Housing, Fukuoka Japan 1989-91, Steven Holl.
- Structural System for Porous-Type High-Density Dwelling Models.

http://www.takenaka.co.jp/takenaka_e/news_e/pr0101/m0101_05.htm
"This type of block is based on a design method called "Space Block", a method developed by Kazuhiro Kojima/ C+A and his Studio at Science University of Tokyo. This method works as putting together the "Basic Space Block", a combination of several cubic volumes, and create the whole with having voids in between.
The idea is to treat and design the interior space and exterior porous space simultaneously as equivalent entity. The basic cubes can be positioned freely, allowing for flexible changes to the interior design."

**Flexibility to accommodate change of function and adaptation in time:**

- Omni Quarter in Aoyama, Tokyo. (Refer to case study 14).
- Verbena Heights Residential Building, Tko Area 19B, Hong Kong, Anthony Ng Architects Ltd.

"Space designed to have increased flexibility for the ease of future adaptations (e.g., convertible housing units)."

**Flexibility and adaptation in time and sites:**

- Housing and Office Block in Kassel, Germany, Architect A. Reichel.

"The modular principle on which this urban villa is based was developed in response to the competition brief, which required a building type suitable for eight differently shaped sites. Designed to a regular column grid, the strict cubic form can be extended or modified to accommodate different uses and topographical situations. The prototype constructed here is 13.52 x 12.30 x 15.40 m high. The reinforced concrete skeleton frame and the solid areas of external walling are clad in glass-fibre-reinforced precast concrete elements. The various functions of the internal spaces are thus made legible externally. The plinth level and ground floor contain a 120 m2 maisonette, which can be used as an office or dwelling. The upper floors can be divided into 2- or-3-rooms units". (Source: Detail Magazine 4, 2001).

**Flexibility to accommodate different capacity and functions:**

- Traveling membrane roof in Vienna City Hall
- Bercy concert hall in Paris, France.

**Other examples**

- **"Flexibility Saves $6,500",** King County Solid Waste Division

http://dnr.metrokc.gov/greenworks/sus_build/Rafn.pdf
" Be flexible in the design – use what you have on hand.
When the design called for a door with a left-hand swing, Rafn substituted a salvaged hand door. A sliding divider wall separating two parts of a conference room was fabricated from salvaged hollow-core doors, and covered with homasote, a non-toxic interior paneling made from recycled newspapers. Electrical contractor Steve Marvich had 57 light fixtures which were salvaged from another demolition project and incorporated into the lighting design for this job."

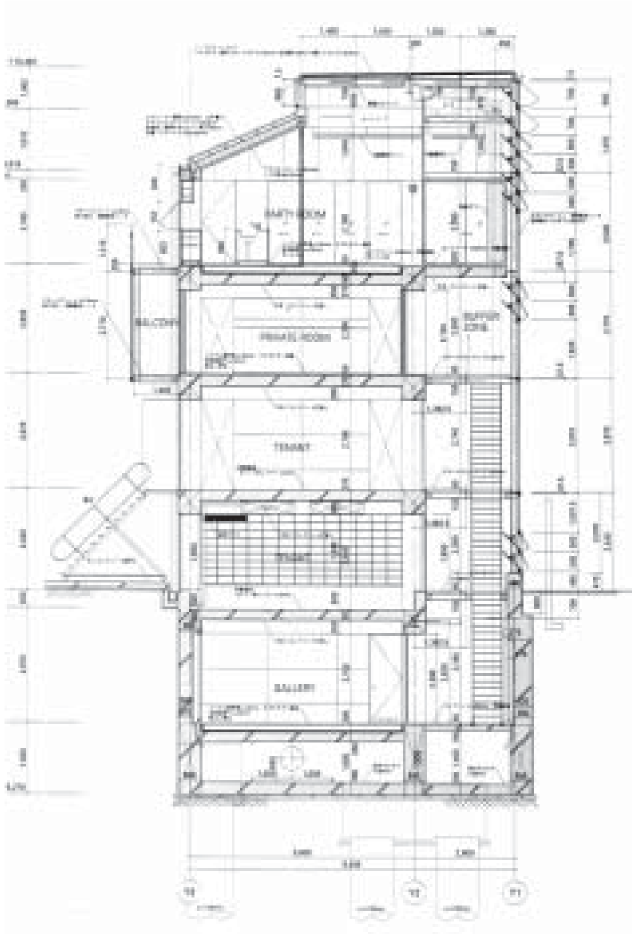
- **Matsushita Communication Industrial Co. Ltd, YRP Research Laboratory.**http://www.takenaka.co.jp/takenaka_e/majorworks_e/topics/1999/sp/03.html

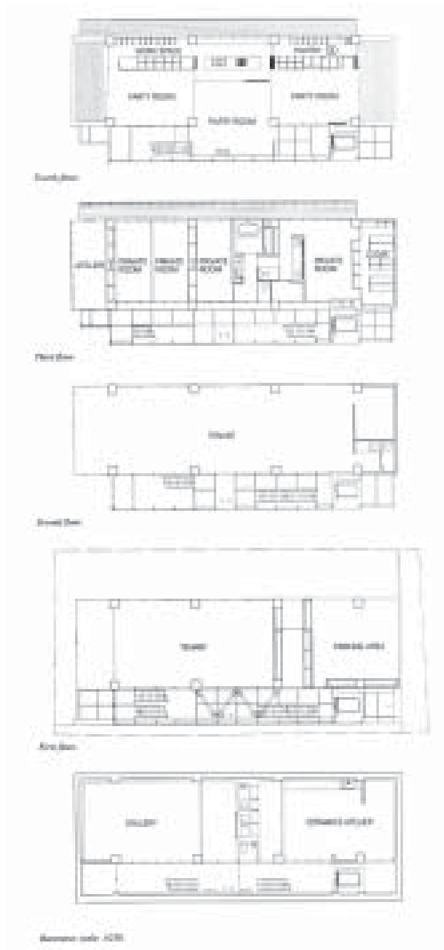
# Case Study 14 Omni Quarter in Aoyama, Tokyo, Japan



**Project:** Omni Quarter.
**Location:** Aoyama, Tokyo, Japan.
**Architects**: Ko Kitayama + Architecture Worrkshop.
**Year:** 2000

*"This building is a complex in Aoyama, Tokyo. The existing surroundings have always been divided up and a number of different functions are mixed together. Exactly the same condition exists in the building program, which consists of a residence, an atelier, shops, offices and so on. In order to respond to future changes, a reinforced concrete rigid frame structure was used, which allow various components to be installed. This building was created to be seen as a combination of various materials and readily available industrial products, rather to be seen as a single entity. In other words, by juxtaposing various components a condition was created in which parts can be changed non-hierarchically." (Source: The Japan Architect, 40 Winter 2001, Yearbook 2000).*

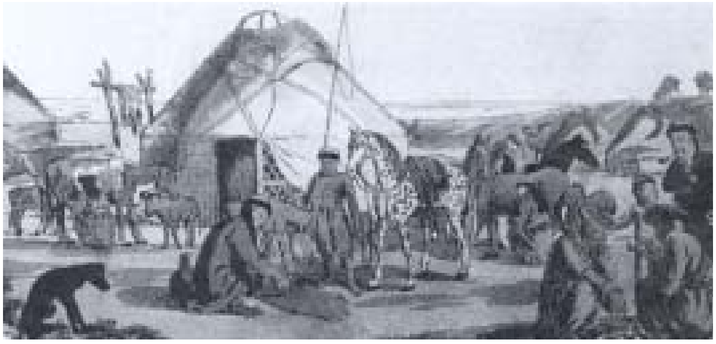




Left page: (top) General view from the West. (Middle) Entrance West corner. (Bottom)Left, Party room fourth floor, right, First floor.
Right page: (top) Entrance, section. (Bottom) Second floor and plans.
(Source: *The Japan Architect, 40 Winter 2001, Yearbook 2000*).

Left page: The steel structure of the Eiffel tower can be dismantled as it was designed as a temporary building for exhibition, Paris, France.
Right page: Mongolian yurt, 18th century (Source: Detail serie 6, 2000).

## 4.2.3. Design for reuse and recycle





Designing for reuse and recycle can minimize waste as waste stays away from the waste cycle. Designing for reuse is not new and is generally associated as temporary architecture for exhibitions and special events.
It requires special knowledge and special care in the design regarding assembly details and materials selection.
Maybe in the future architects will have to learn how to dismantle buildings and design them bearing in mind the consequences.

**Objectives**

- **Allow design for future reuse and recycle of materials, building components and/or structures.**

**Waste Type**

Types of waste generated at demolition stage:

- Concrete.
- Reinforcement bars.
- Woods.
- Metals
- Bricks.
- Soils and sands.

**Strategies**

**Site formation and filling**

- Consider the design to reuse as much as possible of the excavating spoil materials on site or on other sites for site formation and filling.
- Allow cut and fill balance on site.

**Assembly and material selection**

- Assembly and disassembly should be easy to accomplish. For example avoid using nails to allow for easier reuse or recycle of the materials. Example of traditional techniques in wood structure assembly.
- Also consider the separation of layers in the building (interiors, space plan, services, structure, skin, site) to avoid interference of long-term and short-term cycles of each layer that can lead to demolition.
- Consider disassembly possibilities within each layer to allow components to be easily replaced separately. Therefore components can be reused and recycled.
- See "Material selection" chapter 5.2 to consider the use of standardized monomaterial components.
- Consider materials that can be easily reused or recycled.
- For reusing materials or structures, consider the action of assembly, disassembly and reassembly.

Do not consider temporary architecture concepts but reusable concept, as temporary architecture might produce waste if components are not reused or recycled. Building materials and structures should stay out of the waste cycle for as long as possible.

Practical example:The use of pavement for access such as sidewalks and roads is a fine example of designing for reuse and recycle; It can be easily dismantled and reused or replaced when damaged. Also it allows maintenance and repairs without generating waste.

**Benefits**

**Cost**
- Design for reuse and recycle allows easy disassembly; therefore avoid demolition of the building.
- It extends building life span.
- Materials can be reused after the end of the building life span, or be sold for reuse and recycle.

**Environment**
- The building life is extended, and the generation of waste is delayed.
- The materials wastage (arising form maintenance and repair or demolition) can be reused and recycled and therefore will stay away from the waste cycle for the time being.
- The life span of landfills is extended.
- Transportation of waste disposal, pollution, energy used and noise are reduced.

**Others**
- The image of the building and the marketing advantage are advanced.

**References**

**Journals**
- "Architecture for Disassembly", Smart Architecture, http://www.smartarch.nl/o2columns/smartarch999.html

**Other references**

**Outside**
- Refer to mobile structures.

**Other examples**

Temporary architecture
- Exhibition architecture, Hanover 2000, Lisboa 98, La Cartuja Seville 93…
- Temporary structure Info box in Berlin, Schneider and Schumacher, 1995.
- The Bamboo Pavilion, Berlin in Hong Kong: Festival of Vision, Tamar Basin, Admiralty, architect Rocco Yim.

Dismantle with ease:
- The Kabuki-Cho Building, Tokyo, Richard Rogers Partnership.

"Buildings constructed from components and panels are more readily dismantled than monolithic ones, allowing for potential recycling".
- The traditional wood structures which have been reused and/or relocated.
- Steel structures can be easily dismantled and reused or recycled (see Interger Pavilion example).

# Case Study 15

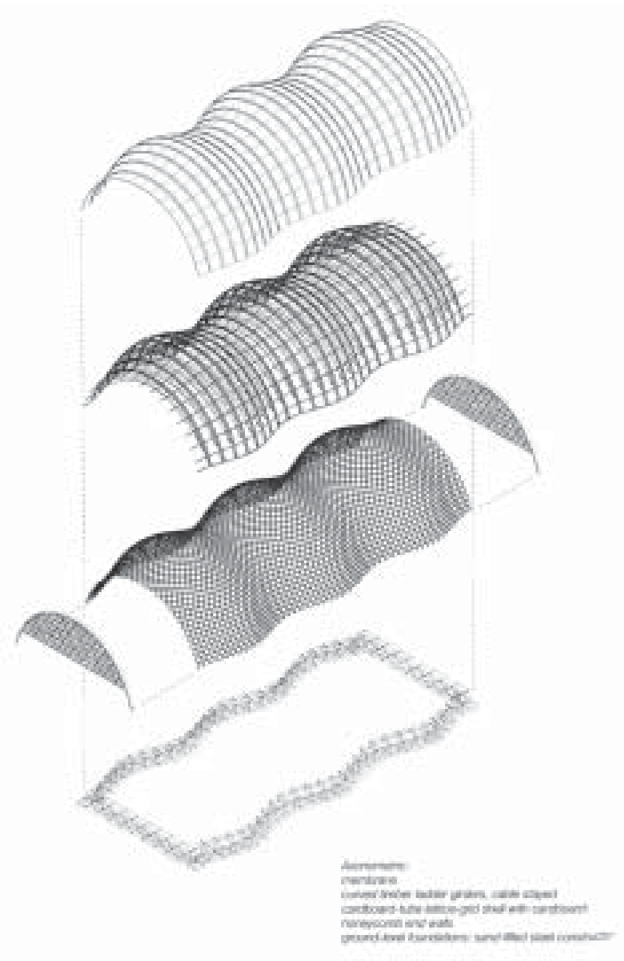
## *Japanese Pavilion Expo 2000, Hanover, Germany*



| | |
|---|---|
| **Project:** | Japanese Pavilion. |
| **Location:** | Hanover, Germany. |
| **Architects**: | Shigeru Ban, Architects, with Schurmann Spannel. |
| **Structural Engineers:** | Buro Happold, with Goeppner + Soulas. |
| **Structural; Consultants:** | Frei Otto. |
| **Year:** | 2000 |

This project, the Japanese Pavilion is made of recyclable materials such as cardboard tube structures, timber, steel, and paper roof membrane…
Therefore it will not generate waste at the end of its lifespan, as all the elements can be recycled.

*Extract from the Architectural Review September 2000: "At Hanover the structure is a lattice of comparatively thin (120mm diameter) cardboard tubes, lashed together with white rope at their nodes. The largest cardboard structure ever made, the pavilion is 72m long by 35m wide, with a maximum height of 15.5m. Fundamentally rectangular in plan, three domes are fused together to form a generous and lofty space… Tubes in shell are 20m long and weight 100 kilos each; they can be spigoted together, in some cases to achieve a total length of 68m. Stiffening is provided by thin ladder-like timber trusses, stayed with wires, arcing across the width of the plan. Loads are transmitted down to foundations made of mass sand enclosed above ground within scaffolding boards supported by steel frames. Sand is used because, unlike concrete, it is recyclable, and so of course are the steel, the timber and the tubes – the tubes made of recycled German paper, now destined to be recycled again (perhaps as cardboard files). Covering the roof is a specially developed waterproof and fireproof translucent paper (recyclable of course), which is reinforced by being bonded to an inner transparent PVC membrane. The ends of the dome are closed with the same material, carried on diagonal grids of cardboard stiffened with timber and connected by tubular steel nodes".*



Top: Pavilion view from the outside. Middle: Pavilion structure. Bottom, left, General view inside, right, details. (Source: Detail serie 6, 2000, Membrane structures).

# Case Study 16

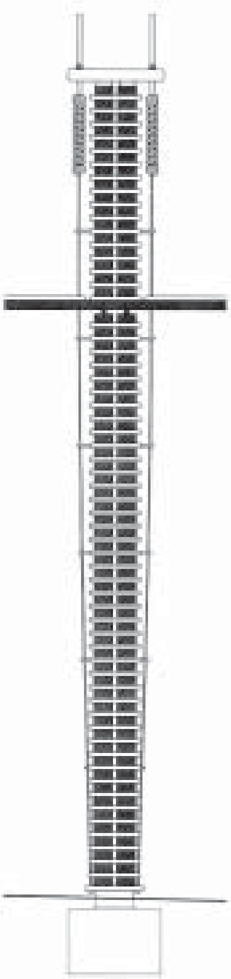
## *Swiss Pavilion Expo 2000, Hanover, Germany*

**Project:** Swiss Pavilion.
**Location:** Hanover, Germany.
**Architect:** Peter Zumthor.
**Project team:** Uta J. Graff, Rainer Weitschies, Krisi Leiman, Daniel Schmid, Miguel Kreisier.
**Engineer:** Conzett, Bronzini Gartmann, Chur.
**Year:** 2000



This project is a good example of using:

- Standard sized materials that does not require cutting and therefore does not generate cutting waste.
- The assembly for disassembly system to allow for materials to be reused in construction.
- Reuse is possible due to the absence of nails, screws or glue.



Top: Pavilion plan. Middle: Detailled plan tension point, stracked wall. Bottom, left, General view inside, right, carpenters at work. (Source: Swiss Sound Box, A Handbook for the Pavilion of the Swiss Confederation at Expo 2000 in Hanover)

*"It is a timber labyrinth. Bearing in mind the principles behind the Hanover exhibition, its wooden walls are held together without nails, screws or glue, so that at the end of Expo, they can be sold off (or reused). Long thick horizontal planks of ruddy pine are separated by pale square larch cross-members. Everything is held together by stainless-steel rods in tension quite highly stressed by springs to form in compression what Zumthor calls a "wood yard"… During the course of the exhibition, the height of the structure is expected to shrink by about 120 mm as the timber dries out and is compressed under the effect of the springs, which will gradually reduce their tension as the walls contract."*

*Extract from the Architectural Review, September 2000.*

*"**Basic structure**: Based on four stacks of parallel stacked walls grouped around an open square in a pin-wheel-like formation. By extending this basic arrangement into a regular fabric-like pattern, an ordering concept is obtained which is used to generate the floor plan of the Sound Box. The visitor experiences the Sound Box in spatial terms like a labyrinth, a series of walls running parallel and perpendicular to one another containing small internal voids.*
***Beams:** Planed timbers to strength class C24 in accordance the Eurocode EC 5 are the primary elements of the staked walls. Standard 100x200 mm rectangular section timbers of varying lengths are used, typically 4.48 m for standard beams and 2.9 m for edge beams.*
***Staked wall:** The primary element of the construction. In total there are 12 stacks with a total of 1050 linear meters of stacked wall. The staked walls are made up just under 37,000 planed beams (crossed section 200 x 100 mm) delivered in two main lengths of 4.48m (standard beam) and 2.90m (edge beam). Double rows of 57-6 layers of timber form approximately 9 meter high walls. But joints between the individual beams are staggered on alternating rows to ensure sufficient coupling between the timbers. In order to enable the unseasoned timber to dry out adequately, 168,000 stacking timbers have been inserted between the layers.*
*All in all, there are 144,000 linear meters of planed beams with a volume of 2,800 cubic meters. Douglas fir has been used for all walls running north-south, larch timber for walls running east-west. All beams will remain undamaged since they are held together by pressure and friction alone. There are no nails holes, screw holes, drill holes or other damage. This way the timber can be dismantled at the end of the expo 2000 and reused (as construction timber).*
***Staking timbers**: Lateral timbers measuring 45x45x544 mm are inserted between each layer of beams. As in a timber yard they keep the beams apart to ensure that air can circulate freely around the timbers so that they dry out evenly. At every tension point there are four stacking timbers per layer. In the lower layers they increase in number so that the weight of the stacked walls can be transferred to the supports of the tension points without deforming the lower beams".*
*Extract from "Swiss Sound Box".*

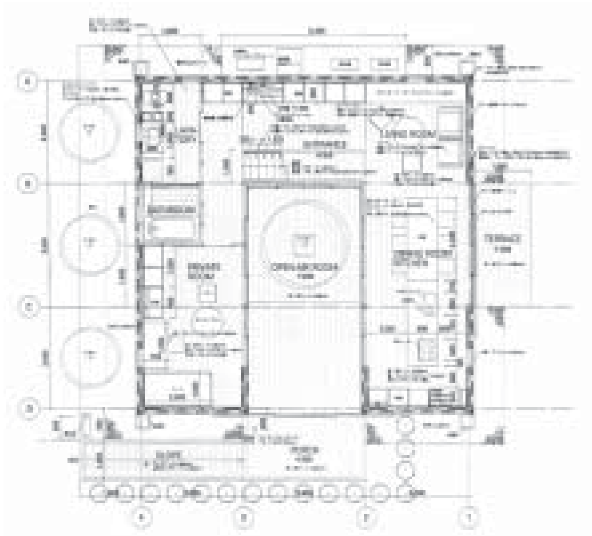
# Case Study 17

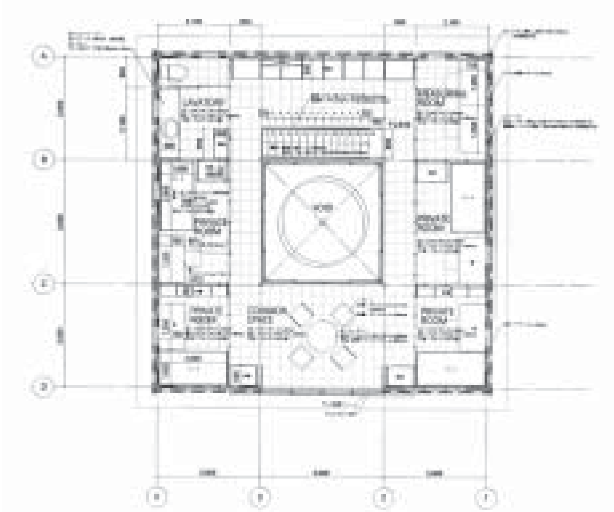
## *Aluminum Eco-Material House, Japan*



| | |
|---|---|
| **Project:** | Aluminum eco-material house. |
| **Location:** | Japan. |
| **Architects**: | Kazuhiko Namba + Kai Workshop |
| **Year:** | September 1999 |

*"An aluminum alloy is used in the structure of this experimental house. The important issues that were taken up here include making the most of the unique qualities of aluminum (such as the ease with which it can be processed and fabricated into parts, and its recyclability), energy conservation, and the development of images for housing for the near future. First, after studies into the best span for aluminum frame structure, the basic module was set at 4m. Using this module, various housing patterns were investigated. As a prototype for dense, central city areas, a courtyard plan was selected because it allowed complex experiments with detailing to be performed, and the demanding thermal characteristics of the large areas of external wall made it suitable for experiments. The building was completed in September 1999, after which further were carried out while it was actually occupied". (Source: Japan Architect Yearbook 2000).*





Top: First floor plan. Middle: Second floor plan and general view under construction. Bottom: General view from the southeast and view toward the living room and kitchen (Source: The Japan Architect, 40 winter 2001, Yearbook 2000).

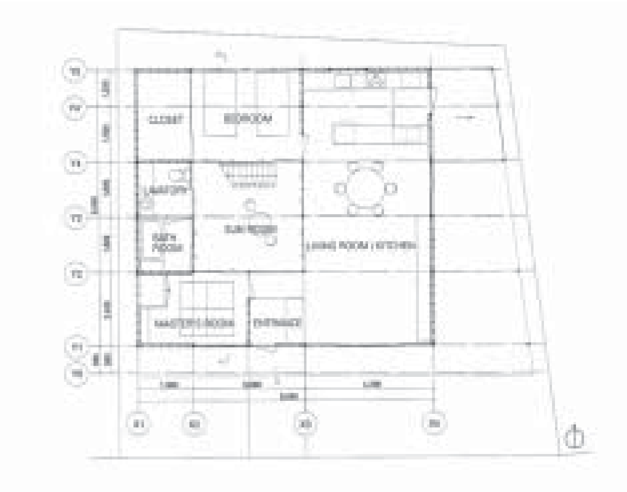
## Case Study 18

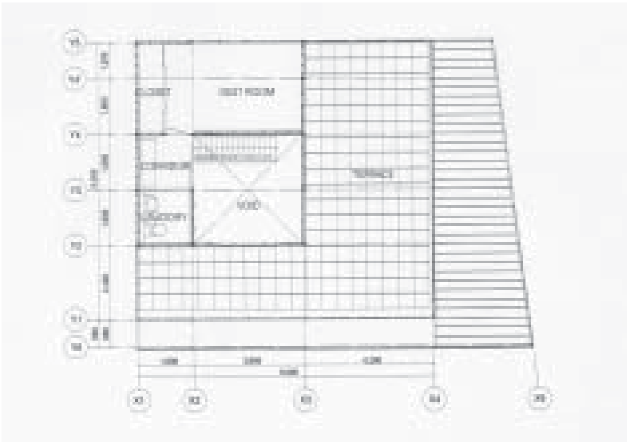
# Aluminum House, Sakurajosui, Japan

**Project:** Aluminum House.
**Location:** Japan.
**Architect:** Toyo Ito & Associates Architects.
**Year:** 2000

Top: Left, First floor plan, right, second floor plan. Middle: Left, Interior view under construction, right, general view from the southeast. Bottom, left, View toward the sunroom from the living room, right, View toward the living room from the kitchen. (Source: The Japan Architect, Yearbook 2000).






# 4.2.4. Oversizing structure



Oversizing is an important issue as it produces waste due to material usage being added. Flexibility for future fittings (change of usage) can be allowed.
For example, oversizing foundations will add material usage but will also allow changes in the structure such as vertical extension without the necessity of demolition of the building.
Oversizing structures generally provide an extra margin of safety.
According to a survey conducted by the Department of Civil and Structural Engineering of the Hong Kong Polytechnic University in 2001, the common reasons why oversizing can occur are: to provide an extra margin of safety in the design, building regulations, to simplify construction, to increase the speed of construction, to reduce the design period, to allow the use of prefabrication and for aesthetic reasons.

**Objectives**

- **Consider oversizing structures (including foundations) to allow for flexibility and longevity in buildings.**

**Waste Type**

Types of waste generated at demolition stage:

- Concrete.
- Reinforcement bars.
- Woods.
- Metals.
- Bricks.
- Soils and sands.

**Strategies**

These strategies cannot be used in all buildings and development projects, as each case is individual.

- Consider oversizing foundations to allow for flexible loadings in future building needs and requirements.
- Consider oversizing structures to allow the use of standardized components, which can result in efficient use of resources, cost and environmental benefits.
- Cost comparison between the oversized buildings and the normal ones (consideration of the building life cycle).

**Benefits**

**Cost**

- Oversizing may be more expensive as increased material usage is required, but it also provides flexible loading that will optimize the building life span.
- If all members are standardized, construction can be simplified and construction time reduced.

**Environment**

- The building life span is extended, and the generation of waste is delayed.
- The life span of landfills is extended.
- Transportation of disposal waste, pollution, energy used and noises are reduced.

**References**

**Books** CIRIA, *Waste Minimization and Recycling in Construction, Design Manual*, Special Publication SP 134, 1999.

**Other references**

**Inside**

- Refer to chapter 4.2.1 "Optimizing design lives".
- Refer to chapter 4.2.2 "Design flexibility".

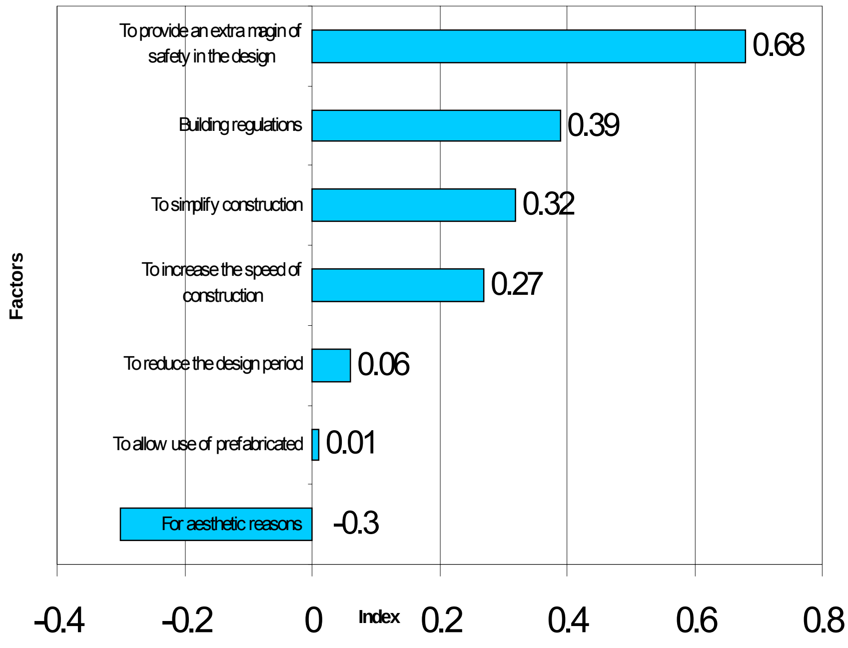



Figure 12: Common reasons why oversizing can occur in Hong Kong. (Source: Hong Kong Polytechnic Survey 2001)